CAT.No.U029-4

SHINDENGEN

SILICON SURGE PROTECTOR

SHINDENGEN
ELECTRIC MFG. CO., LTD.

SILICON SURGE PROTECTOR

■The products shown in this catalog are intended for use in standard applications requiring normal, commercial levels of reliability. If these products are to be used in equipment or devices requiring special or specific levels of quality and reliability in which failure or malfunction of a product may directly affect human life or health, contact the local SHINDENGEN office to confirm that the intended use of the product is appropriate.

The quality levels of our products are defined below :

Standard Applications
Computers, office automation, communication terminals, test and measurement instrumentation, AV equipment, video games and related amusement equipment, home appliances, machine tools, industrial robots, personal equipment, etc.

Special Applications
Transportation (automotive, marine, etc.) trunk-line communication, traffic signal equipment, commercial fire prevention/anti-theft equipment, various safety devices, medical equipment, etc.

Specific Applications
Nuclear power controls, aerospace and aeronautical equipment, submarine relay equipment, devices and systems for preserving life, etc.

■Although efforts are constantly made to improve quality and reliability, please select a product after careful examination so that personal injury, accidents and social damage can be prevented as a result of deploying measures such as a redundant design, designs that prevent the spreading of fire, designs that prevent malfunctions and so forth while taking safety into consideration as necessary.

One of the most important issues regarding the construction of a high-level information system is to protect the electronic equipment and systems against various disasters.

SHINDENGEN is proud to introduce our line of high-performance Silicon Surge Protectors, which are suited to a wide variety of digital applications. These products are based on semiconductor device technology developed over many years in the industry. SHINDENGEN offers three series of surge protectors for specific applications where they are used to protect a variety of system loads against abnormal voltages such as transient surges induced by lightning strikes. Designed for use in a broad range of products, these surge protectors are available in a number mounting styles from a wide variety of packages.

CONTENTS

1. Outline

There are two types of devices that are used to protect electronic equipment against transient surge voltage. One, is the diode-type surge protective device that operates by voltage clamping using the forward voltage drop or using the reverse avalanche breakdown of the silicon PN junction. The other is a thyristor-type surge suppressor (TSS), that operates by diverting current and is comprised of a silicon PNPN junction.

Diode-type surge protective device operating by voltage clamping is divided into silicon varistor type and avalanche (Zener) type.

TSS, which has attracted considerable attention in recent years as a new type of device for protection against surge voltage, consists of a bi-directional type that operates bi-directions with two terminals, and reverse conducting type.

In the past, protection against overvoltage and other forms of abnormal voltages was mainly provided by gas discharge tube (GDT) and metal oxide varistor (MOV).

However, since various types of communication devices and electronic equipment systems that support the high-level information intensive society of today contain numerous ICs and LSIs, they are fragile against surge voltages and abnormal voltages induced by lightning strikes and noise. Thus, there is a need for surge protective device that feature reliable protective operation and high reliability.

The following describes the technical characteristics of silicon surge protector.

(1) Rapid response to abnormal voltage(see Fig.1).

In comparison with conventional protective devices (MOV, GDT), silicon surge protective devices exhibit adequate suppressing effects against surge voltage, promoting simplification of protective circuits as well as reduced circuit size (see Fig.2).

(2) Because silicon surge protective devices being based on the operating principle of the solidstate silicon, there is no degradation and the devices are essentially maintenance-free.

The resulting free from maintenance work during use of conventional devices (MOV, GDT) results in significant economic benefits.

(3) The operating mechanism at the PN junction offers the advantages of precision design of bi-directional, unidirectional and switching operations, making it possible to offer a wide selection of devices according to the desired circuit voltage.

SHINDENGEN offers a complete lineup of surge protector over the range of 2V to 500V.

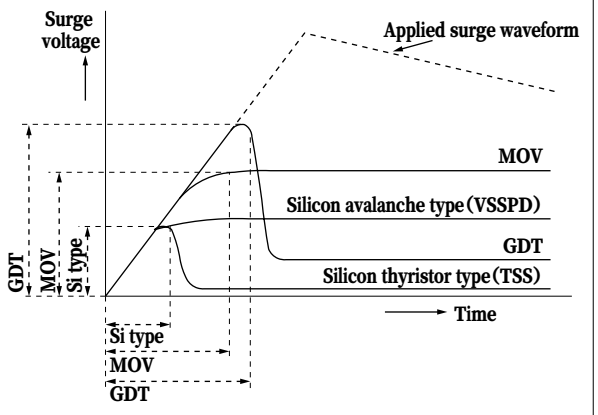


Fig.1 Response waveforms of various types of surge protective device

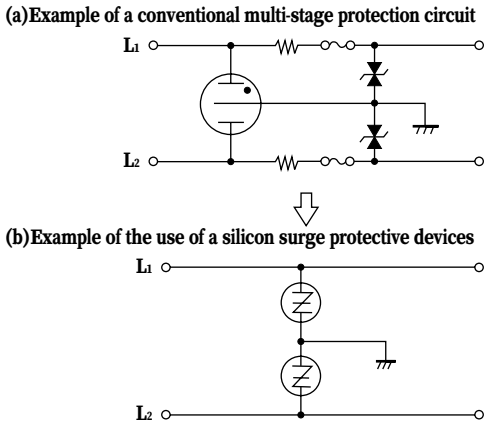


Fig.2 Examples of protection circuits

2. Surge Types and Characteristics

Typical examples of noise and surges that affect electronic equipment are shown in Table 1 and Fig.3.

There are various patterns in which noise and surges occur, including transient surge induced by lightning strikes, the transient/burst surge generated by electronic equipment itself, and the electromagnetic wave noise that is induced artificially such as during a nuclear explosion. It is necessary to understand their properties and study the paths by which they enter electronic equipment, in order to select the most effective type of device for protection.

In today's sophisticated equipment, it is necessary not only to prevent shortening insulation resistance within the equipment caused by high-energy surges, but also to prevent shortening and misoperations caused by surge that, although may be of a low energy level, has extremely rapid rise-time and contains high frequency surge, a typical example of which is electrostatic surge.

Conventional MOV and GDT used for protection against surge voltages have the following dis-advantages.

1.Wide tolerance in operating voltage

2.Slow response speed

3.High capacitance resulting in the risk of deterioration of transmission quality

4.Inferior impulse durability ; degradation caused by repetition surge

In the past, the high-speed response characteristics of silicon were observed, as a result, silicon surge protectors have come to be used in various fields as ideal devices for protection against surge voltages.

SHINDENGEN provides a complete family of silicon surge protective devices that satisfy the needs of today's electronic equipment.

Type of Surge	Infiltration Path of Surge	Feature of Surge
Direct Lightning	High-voltage power-lines	Unpredictable, Unpreventable
Induced Surge	AC power lines, Telephone-lines, Communication lines	Slow rise, High energy
Electrostatic Discharge	DC power lines, Signal lines	Rapid rise, High-peak-voltage
Impulse Surge	DC power lines, Signal lines	Rapid rise, Relatively high energy
Electrical Fast Transient Burst	AC／DC power lines, Inductive-load, Relay contacts	Rapid rise
Load Dump	Automobile engines, Control unit	Rapid rise, High energy

Table 1 Surge types and feature

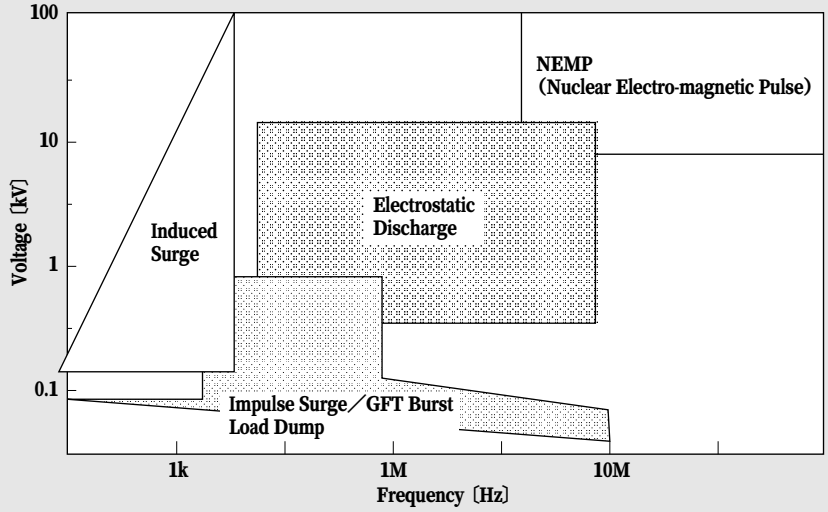


Fig.3 Surge voltage vs frequency

3. Applications

(1) Protection of integrated data system and communication systems from any type of surge(central office exchangers, PBX, DSU, OCU, digital telephones, facsimiles, modems, multi-media equipment, radio-controlled equipment, etc)
(2) Protection of CATV and data transmission equipment from any type of surge
(3) Protection of communication lines from AC power cross
(4) Protection of various ICs, LSIs and other semiconductor integrated circuits

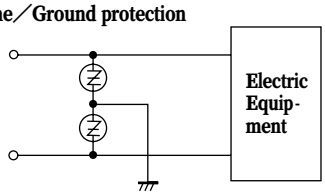
4. Features

(1) The use of current diverting type makes these devices perfect for protection of data and communication lines.
(2) Fast response and reliable clamping operation.
(3) Wide range of product variations enables these devices to be selected for each application.
Maximum surge on-state current class：30, 40, 100, 150 and 400 A (10／1000 μs)
Breakover voltage range：2V to 500V
(4) Reliable operation eliminates the need for multi-stage protection and operation coordinated components.
(5) Compact size and high reliability (SMD are available).
(6) Bi-directional/Uni-directional characteristics and low Capacitance.

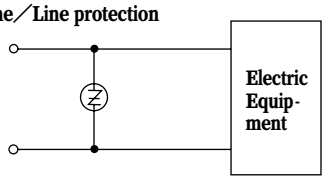
5. Examples of Basic Protection Circuits

（1）TSS

①Line／Ground protection

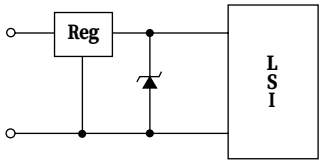


②Line／Line protection



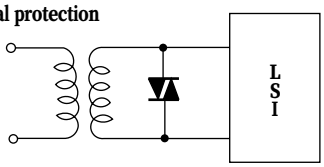
（2）Trankiller

① LSI protection

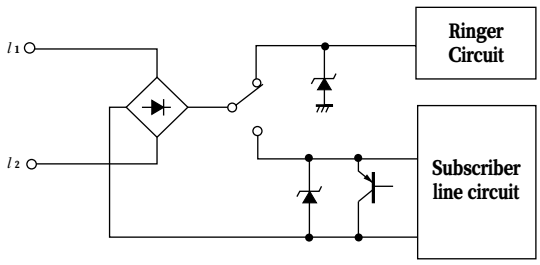


（3）Varistor

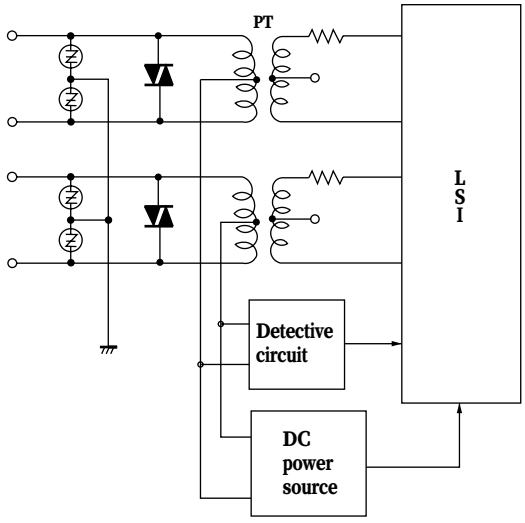
①Signal protection



（4）Telephone circuit (Analog IC telephone)



（5）ISDN equipment



6. Arrangement of Selecting Thyristor Surge Suppressor(TSS)

The optimum device can be selected by using the method described below. The following explanation is described with the schematic diagram shown in Fig.4 and with the OFF operation characteristics diagram shown in Fig.5.

Step 1 **Determine off-state voltage, V_{DRM}.**

Determine off-State voltage from the maximum power supply voltage, V_B, applied to the devices shown in Fig.4. Off-state voltage V_{DRM} Should be selected to guarantee the non-operating under normal conditions.

Step 2 **Determine clamping voltage, V_{CL}.**

Clamping voltage is determined the maximum withstand voltage of the circuit to be protected.(withstand voltage of the IC or LSI)

Step 3 **Determine surge on-state current, I_{TSM}.**

Determine the surge on-state current of the device from the surge current waveform predicted in advance.

Step 4 **Determine holding current, I_H.**

Calculate value of short circuit current i_L from the power supply voltage and circuit impedance R_L shown in Fig.4, and guarantee self-reset-operation of the TSS in the form of $i_L < I_H$, however, since holding current I_H varies according to temperature, please refer to the temperature characteristics diagram of holding current I_H, while taking into consideration the ambient temperature at which the device is to be used.

{in the case of $i_L > I_H$ in Fig.5, the load line will move when surge current decreases so that the operating point moves from point (b) to point (c) self-reset to point (a) will not be performed and the device will remain in the on state.}

Step 5 **Confirm junction capacitance Cj.**

If the signal frequency is high, Signal degradation may occur.Please check the junction capacitance Cj of the device.

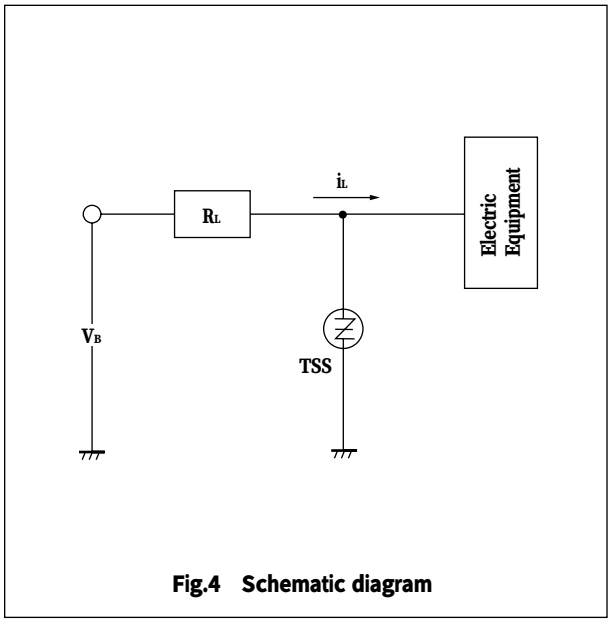


Fig.4 Schematic diagram

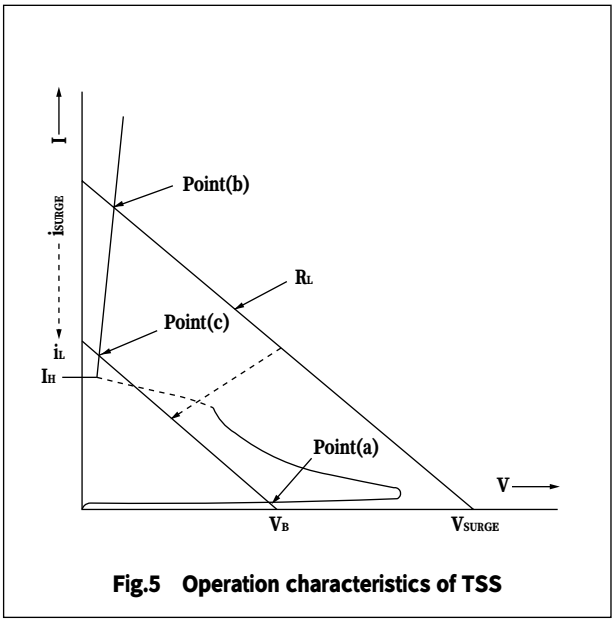


Fig.5 Operation characteristics of TSS

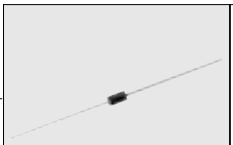
Silicon Surge Protector

Silicon Surge Protectors

Thyristor Surge Suppressor (TSS)

- High surge on-state current capability and fast-response time
- Reliable clamping operation and bi-directional characteristics
- SMD packages available
- Compact size and high reliability

- Three-terminal, fully molded insulated type
- Two-circuit configuration for improved mounting efficiency
- High surge on-state current capability and fast-response time
- Reliable clamping operation and bi-directional characteristics



- Axial lead type
- Compact size and large surge on-state current capability
- Maintenance-free
- Reliable clamping operation and bi-directional characteristics

Trankiller (Avalanche Breakdown Diode)

- Voltage clamping characteristics offering both excellent low-clamping voltage and fast response
- SMD types
- Compact size and high reliability

- Axial lead, voltage clamping type
- Compact outline-size and high reliability

- Surge protective devices for various types of electronic equipment used in automobile electronics
- Compatible with JASO-A standards
- Perfect for protection against load dump
- Surge on-state current capability of 7kW (10／1000μs)

Silicon Varistor

- Optimum for protecting signal lines
- Low capacitance
- Clamping voltage of 15V using high-density pile-up-technology
- Bi-directional, SMD type

- Optimum for anti-noise measures in telephone networks
- Low-clamping voltage and high reliability
- Axial lead type
- Low capacitance

1.Fast-response speed for stable protective characteristics.
2.Three types of surge protective devices are available to match the specific application:
TSS-KL, KP, KA, KT and KU series
Trankillers-ST series
Silicon varistors-VR series
3.Various packages are available to accommodate a wide range of mounting types, including SMD.
4.Please confirm minimum order and delivery about ☆ New product.
5.Please confirm sample schedule.

1. Common Terms

Tstg	Storage Temperature
Tj	Junction Temperature
V_{BR}	Breakdown Voltage
V_{RM}	Maximum Reverse Voltage
I_R	Reverse Current
V_{CL}	Clamping Voltage
Cj	Junction Capacitance
f	Frequency

2. Thyristor Surge Suppressor (TSS)

V_{DRM}	Maximum Off-State Voltage
I_{TSM}	Surge On-State Current
V_{BO}	Breakover Voltage
I_{DRM}	Off-State Current
I_H	Holding Current
V_T	On-State Voltage
I_T	On-State Current
V_D	Off-State Applied Voltage

3. Trankiller

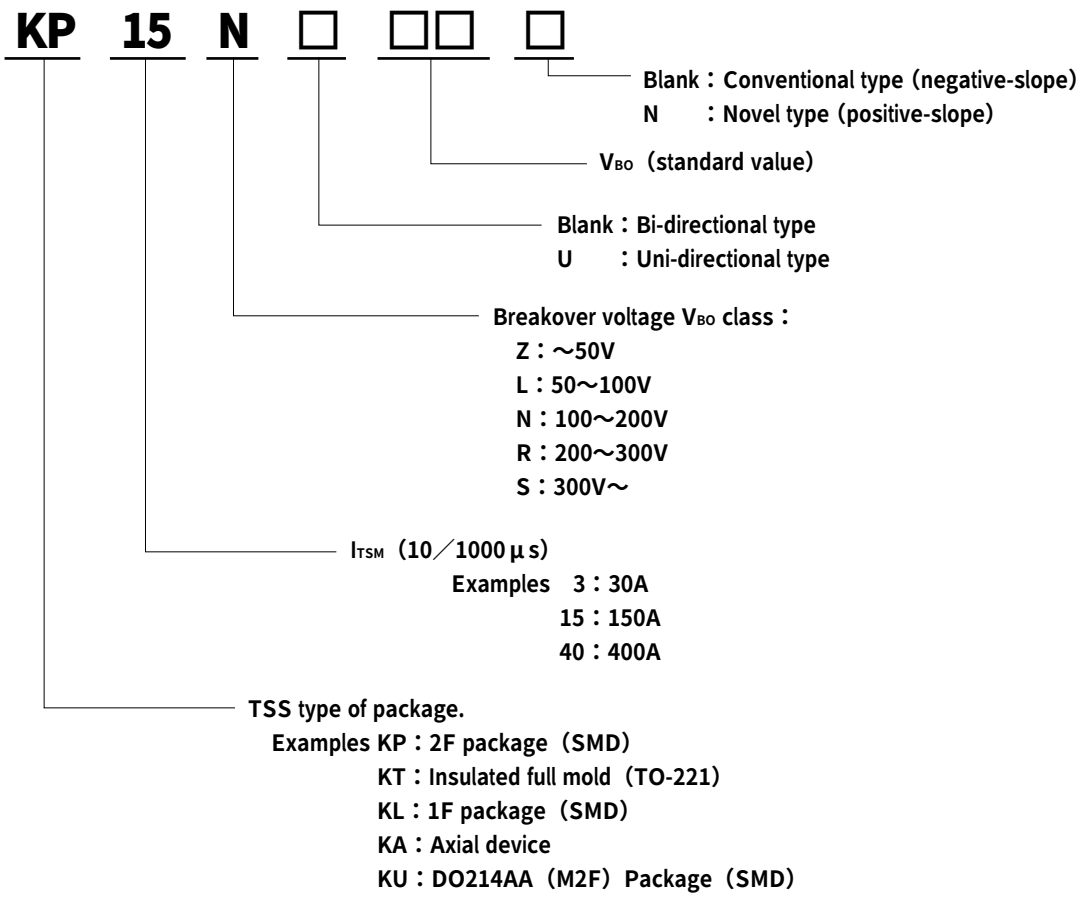
I_{RSM}	Peak Surge Reverse Current
I_{PP}	Peak Pulse Current
t_P	Pulse Width
V_R	Reverse Applied Voltage

4. Varistor

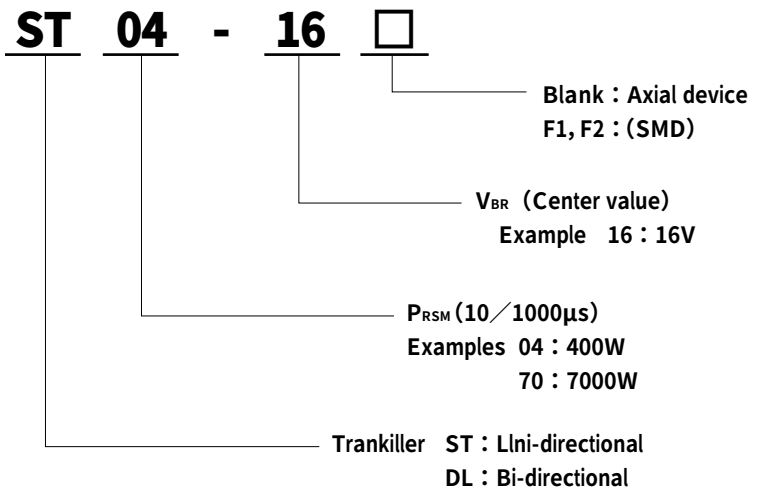
I_O	Average Rectified Forward Current
I_{FSM}	Peak Surge Forward Current
V_F	Forward Voltage
P	Power Dissipation
θja	Thermal Resistance Junction to Ambient
Ta	Ambient Temperature

Naming Rule for Type Numbers

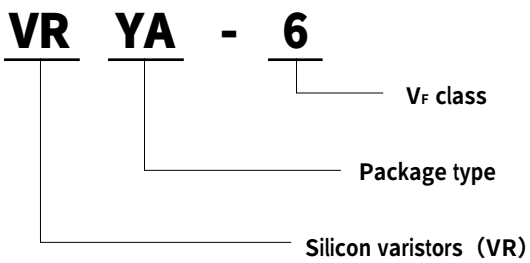
1.Thyristor Surge Suppressor(TSS)



2.Trankiller



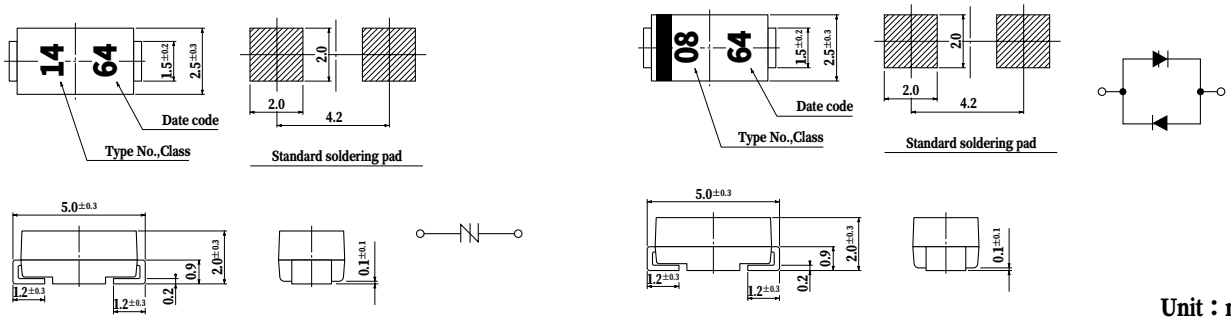
3.Silicon Varistor



■KL Series

Package : 1F

Reverse conductive type (KL3LU08)



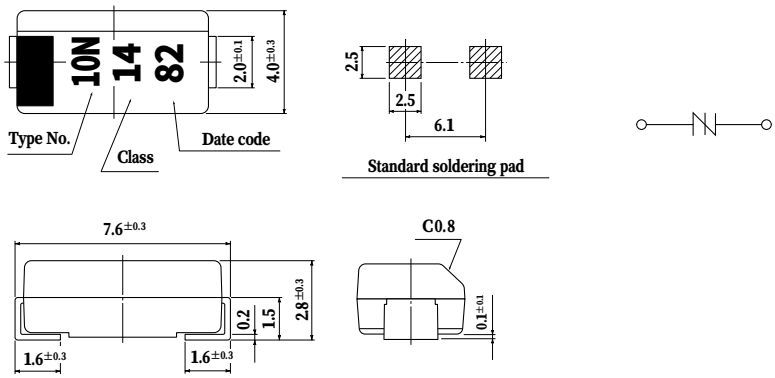
Unit : mm

Ratings, Conditions \ Type No.				KL3Z		KL3L☆	KL3N	KL3R	
				07	18	07	14	20☆	25★
V_{DRM}	〔V〕			5	15	58	120	175	190
V_{BO}	〔V〕	Pulse measurement(Peak hold)		(5.5)*1	(15.5)*1	65	130	180	220
I_{TSM}	〔A〕	10/1000 μs	Non-repetitive	30					
		8/20 μs		150		100			
I_H	〔mA〕	Pulse measurement		50		100			
Cj	〔pF〕	f=1kHz OSC=1Vrms V_D=50V		100*2		90	50	30	
Marking				Z1 57	Z2 62	07 64	14 65	20 62	25 62
page				26		28	30	32	—

*1 V_{BR} *2 OSC=20mVrms V_D=0V ★ : Under development ☆ : New product

■KP Series

Package : 2F



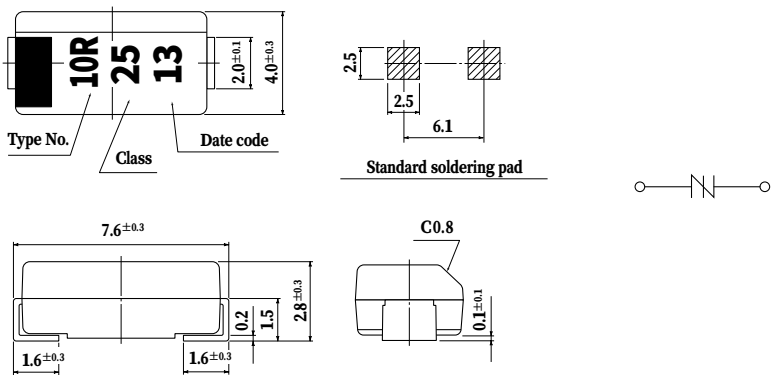
Unit : mm

Ratings, Conditions \ Type No.				KP4L		KP4N		KP10L			KP10N	
				07	08★	12	14★	06	07	08	12☆	14
V_{DRM}	〔V〕			58	63	100	120	48	58	63	100	120
V_{BO}	〔V〕	Pulse measurement(Peak hold)		65	70	110	130	55	65	70	110	130
I_{TSM}	〔A〕	10/1000 μs	Non-repetitive	40				100				
		8/20 μs		150				250				
I_H	〔mA〕	Pulse measurement		100								
Cj	〔pF〕	f=1kHz OSC=1Vrms V_D=50V		90		50		180			140	
Marking				4L 7 19	4L 8 19	4N 12 18	4N 14 18	10L 6 19	10L 7 19	10L 8 19	10N 12 19	10N 14 19
page				34	—	36	—	38			40	

★ : Under development ☆ : New product

Quick Reference(Series Ratings Table)

Package : 2F



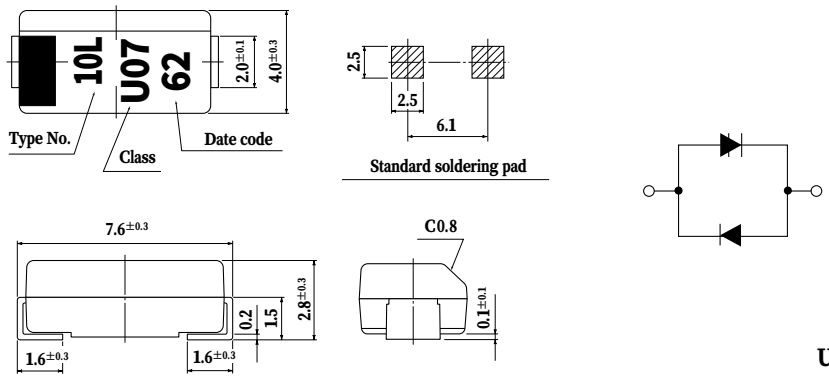
Unit : mm

Ratings, Conditions \ Type No.				KP10R	KP15L		KP15N		KP15R
				25	07★	08☆	12★	14	25
V_{DRM}	〔V〕			190	58	63	100	120	190
V_{BO}	〔V〕	Pulse measurement(Peak hold)		220	65	70	110	130	220
I_{TSM}	〔A〕	10/1000 μs	Non-repetitive	100	150				
		8/20 μs		250	300				
I_H	〔mA〕	Pulse measurement		100					
Cj	〔pF〕	f=1kHz OSC=1Vrms V_D=50V		90	320		200		150
Marking				10R 25 19	15L 7 19	15L 8 19	15N 12 15	15N 14 15	15R 25 19
page				42	—	44	—	46	48

★ : Under development ☆ : New product

Package : 2F

Reverse conductive type



Unit : mm

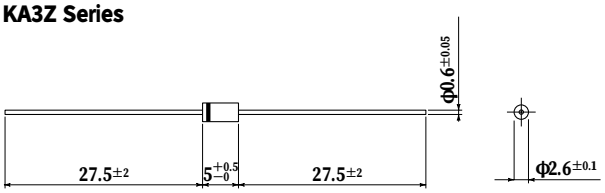
Ratings, Conditions \ Type No.				KP8LU	KP10LU
				07	07
V_{DRM}	〔V〕			58	
V_{BO}	〔V〕	I_{BR}=1mA		65	62
I_{TSM}	〔A〕	10/1000 μs	Non-repetitive	80	100
		8/20 μs		200	250
I_H	〔mA〕	Pulse measurement		100	
Cj	〔pF〕	f=1kHz OSC=20Vrms V_D=50V		100	180
Marking				8L U07 63	10L U07 63
page				50	52

■KA Series

Package : AX06

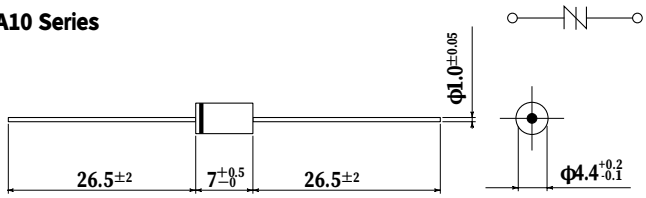
Axial type

KA3Z Series



Package : AX10

KA10 Series



Unit : mm

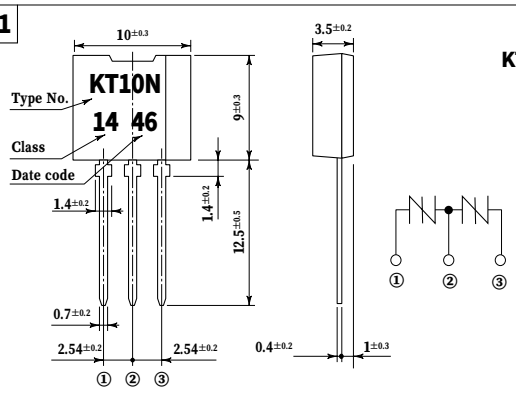
Ratings, Conditions \ Type No.				KA3Z		KA10R
				07	18	25
V_{DRM}	〔V〕			5	15	190
V_{BO}	〔V〕	Pulse measurement(Peak hold)		5.5*2	15.5*2	220
I_{TSM}	〔A〕	10/1000 μs	Non-repetitive	30		100
		8/20 μs		150		250
I_H	〔mA〕	Pulse measurement		50		100
Cj	〔pF〕	f=1kHz OSC=1Vrms V_D=50V		100*1		90
Marking				KZ 61	KZ 67	10R5 09
page				54		56

*1 : OSC=20mVrms V_D=0V *2 : V_{BR}

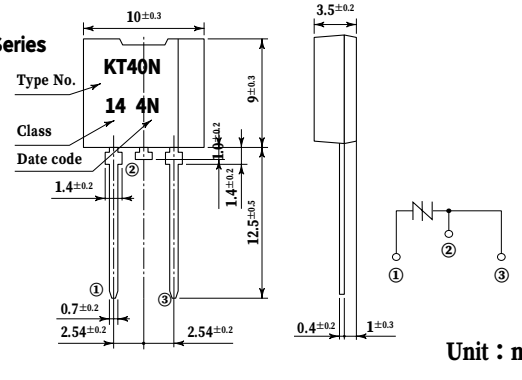
■KT Series

Package : TO-221

KT10、15 Series



KT40 Series



Unit : mm

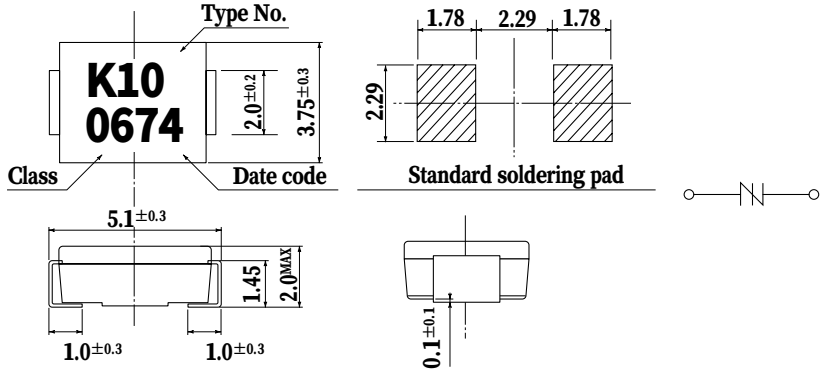
Ratings, Conditions \ Type No.				KT10L		KT10N		KT10R☆	KT15N	KT15R	KT40N	KT40R★
				07	08	12★	14	25	14	25	14	23
V_{DRM}	〔V〕			58	63	100	120	190	120	190	120	170
V_{BO}	〔V〕	Pulse measurement(Peak hold)		65	70	110	130	220	130	220	130	220
I_{TSM}	〔A〕	10/1000 μs	Non-repetitive	100					150		400	
		8/20 μs		250					300		1000*	
I_H	〔mA〕	Pulse measurement		100							200	
Cj	〔pF〕	f=1kHz OSC=1Vrms V_D=50V		180		140		90	200	90	300	200
Tarminal No.				1−2、3−2							1−3	
Marking				KT10L 08 65		KT10N 14 65		KT10R 25 65	KT15N 14 65	KT15R 25 65	KT40N 14 65	KT40R 23 65
page				58		—	60	62	64	66	68	—

* : 15/100 μs ★ : Under development ☆ : New product

■KU Series (UL497B Lisited File No. E183905)

Package : M2F

KU10L06



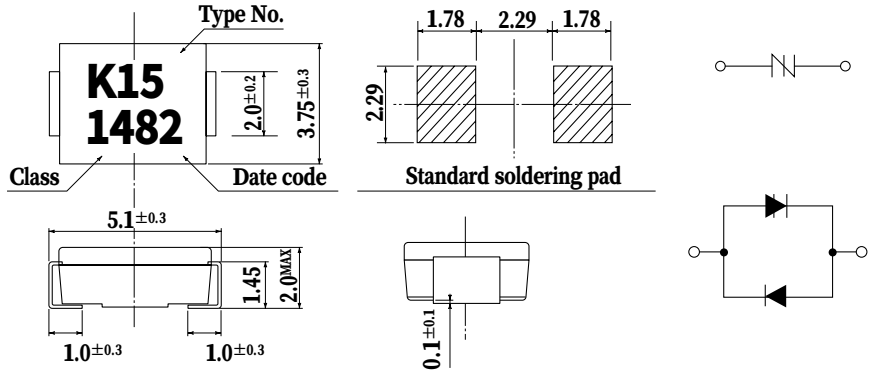
Unit : mm

Ratings, Conditions \ Type No.			KU5L★		KU5N		KU5R	KU10L		
			07	08	12☆	14★	29N☆	06★	07★	08
V_{DRM}	〔V〕		58	63	100	120	250	48	58	63
V_{BO}	〔V〕	Pulse measurement(Peak hold)	65	70	110	130	275	55	65	70
I_{TSM}	〔A〕	10/1000 μs	50				50	100		
		8/20 μs	150				150	250		
I_H	〔mA〕	Pulse measurement	100				100	100		
Cj	〔pF〕	f=1MHz OSC=1Vrms V_D=50V	90		50		50	180		
Marking			K05 0782	K05 0882	K05 1282	K05 1482	K05N 2991	K10 0682	K10 0782	K10 0882
page			—		70	—	72	—		74

★ : Under development ☆ : New product

Package : M2F

KU15N14



Unit : mm

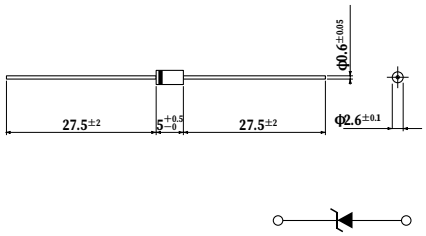
Ratings, Conditions \ Type No.			KU10N☆		KU10R		KU10N☆		KU15N☆	KU10LU☆
			14	16	25N★	29N	35N	40N	14	07
V_{DRM}	〔V〕		120	140	190	250	275	300	120	58
V_{BO}	〔V〕	Pulse measurement(Peak hold)	125	145	220	275	310	350	130	62*2
I_{TSM}	〔A〕	10/1000 μs	100		100		100		150	100
		8/20 μs	250		250		250		300	250
I_H	〔mA〕	Pulse measurement	100		100		100		100	100
Cj	〔pF〕	f=1kHz OSC=1Vrms V_D=50V	140	150	90		90	60	200	200*1
Marking			K10 1416		K10N 2582	K10N 2982	K10N 4082		K15 1482	K10 0782
page			76		—	78	80		82	84

*1 : OSC=20mVrms *2 : V_{BR} ★ : Under development ☆ : New product

■Trankiller

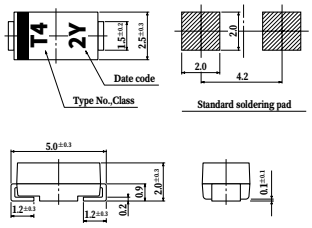
Package : AX06

Axial type ST04-16、-27



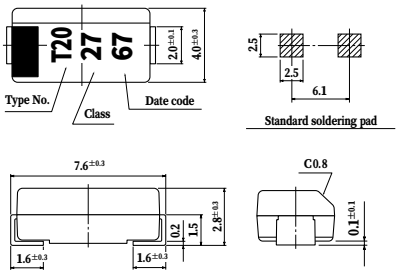
Package : 1F

SMD ST04-16F1、-27F1
ST03-58F1



Package : 2F

ST20-27F2



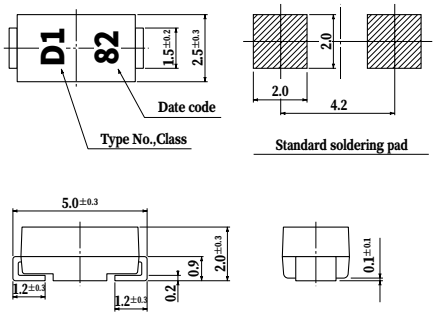
Unit：mm

Ratings, Conditions / Type No.			ST04-16	ST04-27	ST04-16F1	ST04-27F1	ST03-58F1	ST20-27F2★
Tstg 〔℃〕			−40～150		−55～175		−55～150	−40～150
IRSM 〔A〕	10/1000 μs	Non-repetitive	15	10	15	10	4	50
VRM 〔V〕			13.6	23	13.6	23	45	23
VBR 〔V〕	IR=1mA		14.4～17.6	24.3～29.7	14.4～17.6	24.3～29.7	52～64	24.3～29.7
VCL 〔V〕	IP=IRSM (10/1000 μs)		23	37	23	37	80	40
IR 〔μA〕	VR=VRM		5.0					
Marking			ST16	ST27	T4 1D	T4 2D	T5 75	T20 27 48
page			86	88	90	92	94	—

★：Under development

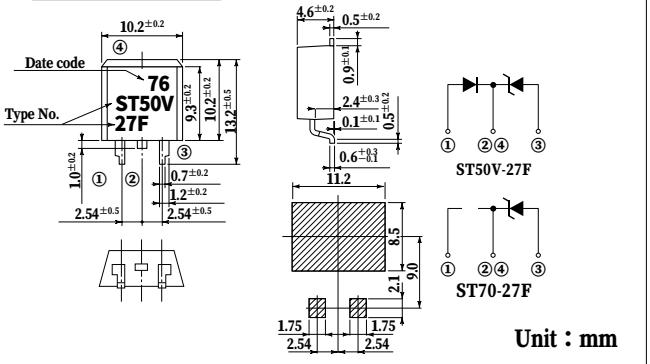
Package : 1F

Bi-directional DL04-18F1、28F1



Package : STO-220

For Automotive ST50V-27F、ST70-27F



Unit：mm

Ratings, Conditions / Type No.			DL04-18F1	DL04-28F1★	ST50V-27F	ST70-27F
Tstg 〔℃〕			−55～150		−40～150	
IRSM 〔A〕	10/1000 μs	Non-repetitive	15	10	130	180
VRM 〔V〕			13	23		
VBR 〔V〕	IR=1mA		16.8～19.1	25～32	24.3～29.7	
VCL 〔V〕	IP=IRSM (10/1000 μs)		26	40	38	40
IR 〔μA〕	VR=VRM		5.0			
Marking			D1 82	D2 82	63 ST50V 27F	67 ST70 27F
page			96	—	98	100

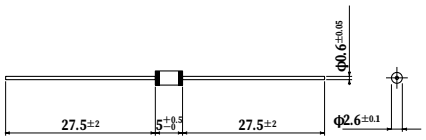
★：Under development

Quick Reference(Series Ratings Table)

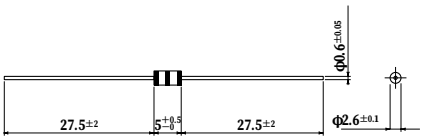
■Silicon Varistor

Package : AX06

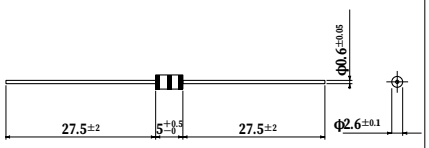
VR-60B(A)



VR-61B(A)



VR-51B(A)

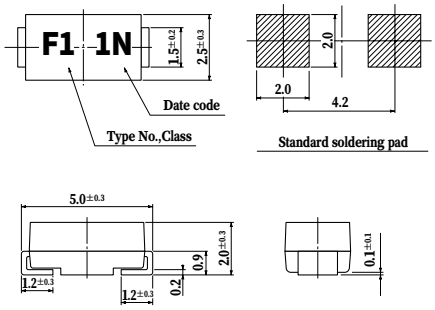


Unit : mm

Ratings, Conditions / Type No.		VR-60B (A)	VR-61B (A)	VR-51B (A)
Tstg 〔℃〕		−30～125		
Io 〔Arms〕	Ta=40℃ Sine wave,R-load	0.5	0.15	0.15
IFSM 〔A〕	50Hz, Sine wave, Non-repetitive	16	7.5	7.5
VF 〔V〕	IF=1mA	—	2.05～2.55	1.55～2.05
	IF=10mA	—	2.50～3.00	1.85～2.35
	IF=70mA	—	2.85～3.35	2.15～2.65
	IF=1A	MAX1.5	—	—
Marking				
page		102	104	106

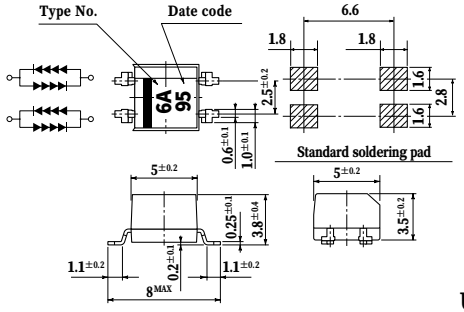
Package : 1F

VR-61F1

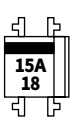


Package : 1Y

VRYA

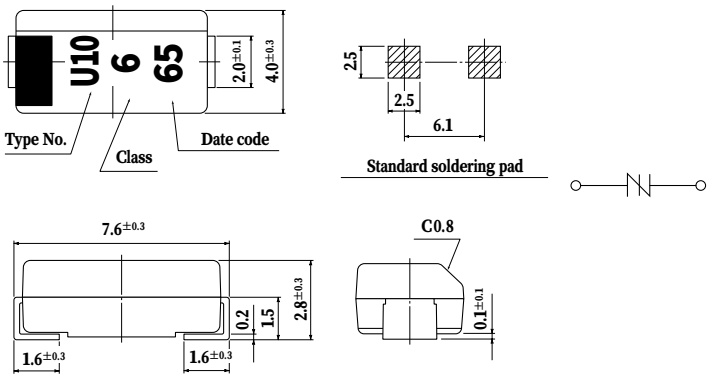


Unit : mm

Ratings, Conditions / Type No.			VR-61F1	VRYA6	VRYA15
Tstg 〔℃〕			−55～150	−30～125	
Io 〔Arms〕	Ta=40℃ Sine wave、R-load	On alumina substrate	0.37 (Ta=25℃)	0.31 (1 element operation)	0.14 (1 element operation)
		On glass-epoxy substrate	0.28 (Ta=25℃)	0.20 (1 element operation)	0.09 (1 element operation)
IFSM 〔A〕	10/200 μs		60	65 (2 elements operation)	50 (2 elements operation)
	10/1000 μs		30	30 (2 elements operation)	24 (2 elements operation)
VF 〔V〕	IF=1mA	1 Circuit	2.05～2.55		5.13～6.37
	IF=10mA		2.50～3.00		6.25～7.50
	IF=70mA		2.85～3.35		7.13～8.37
Marking					
page			108	110	112

■UKP Series (UL497B Listed File No. E183905)

Package : 2F



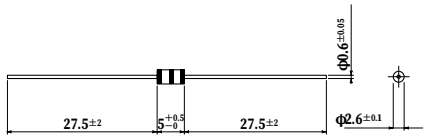
Unit : mm

Ratings, Conditions / Type No.			UKP10L06	UKP10R25	UK15N14
V_{DRM}	〔V〕		48	190	120
V_{BO}	〔V〕	Pulse measurement(Peak hold)	55	220	130
I_{TSM}	〔A〕	10/1000 μs	100		150
		8/20 μs	250		300
I_H	〔mA〕	Pulse measurement	100		100
Cj	〔pF〕	f=1kHz OSC=1Vrms V_D=50V	180	90	200
Marking			U10 6 65	U10 25 65	U15 14 65
page			—	—	—

■UVR Series (UL497B Listed File No. E183905)

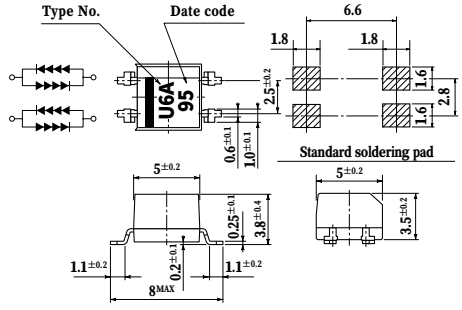
Package : AX06

UVR-61BF



Package : 1Y

UVRYA6

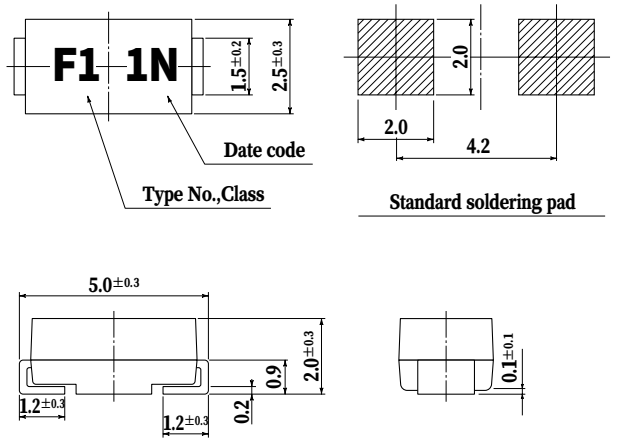


Unit : mm

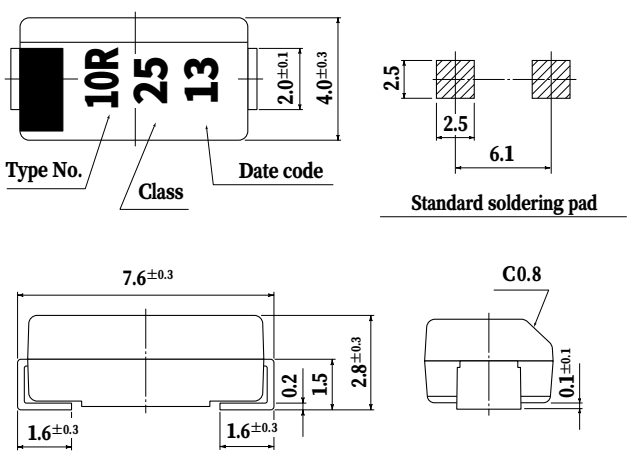
Ratings, Conditions / Type No.				UVR-61BF	UVRYA6
Tstg	〔℃〕			−30～125	
I_O	〔Arms〕	Ta=40℃ Sine wave,R-load		0.15	0.31(1 element operation)
I_{FSM}	〔A〕	50Hz, Sine wave, Non-repetitive		7.5	—
		10/1000 μs		—	30(2 elements operation)
V_F	〔V〕	I_F=1mA	1 Circuit	2.05～2.55	
		I_F=10mA		2.50～3.00	
		I_F=70mA		2.85～3.35	
Marking					U6A 95
page				—	—

Outline Dimensions, Standard Soldering Pad

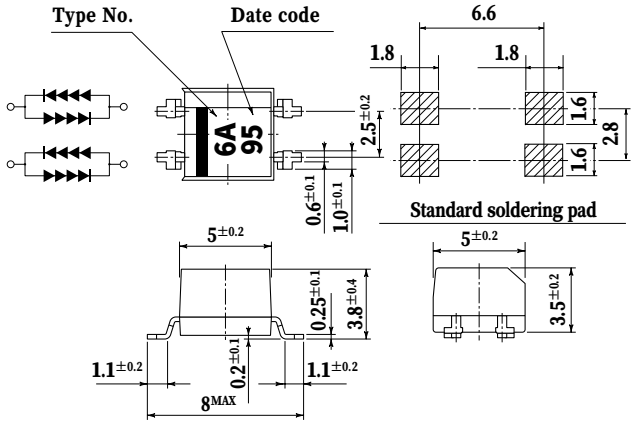
■1F Package



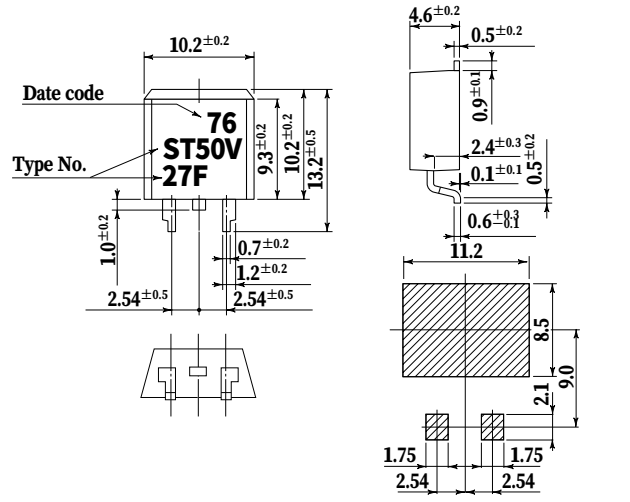
■2F Package



■1Y Package

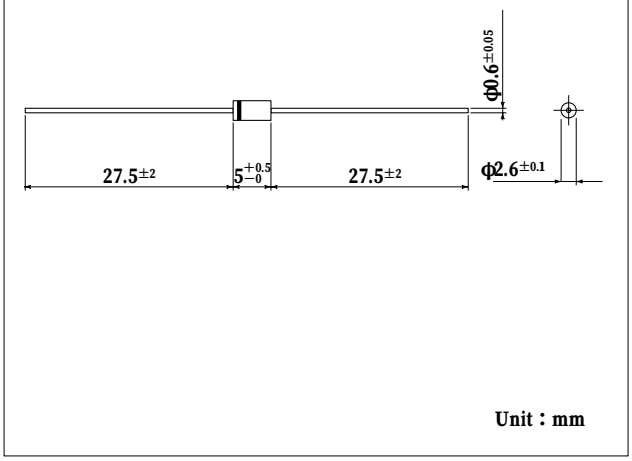


■STO-220 Package



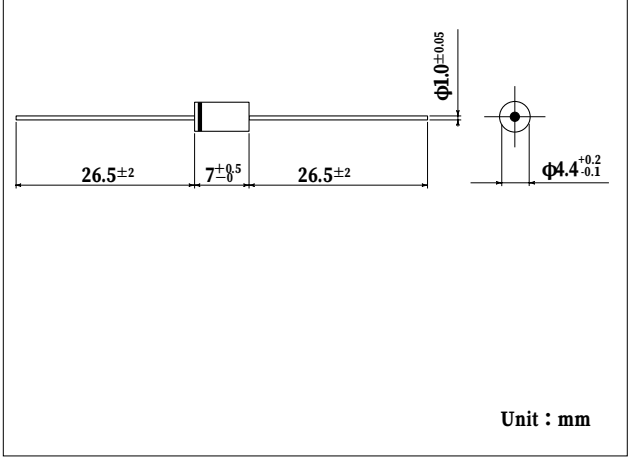
One example of soldering pad dimensions is shown here. Refer to these dimensions when designing your printed circuit board.

■AX06 Package



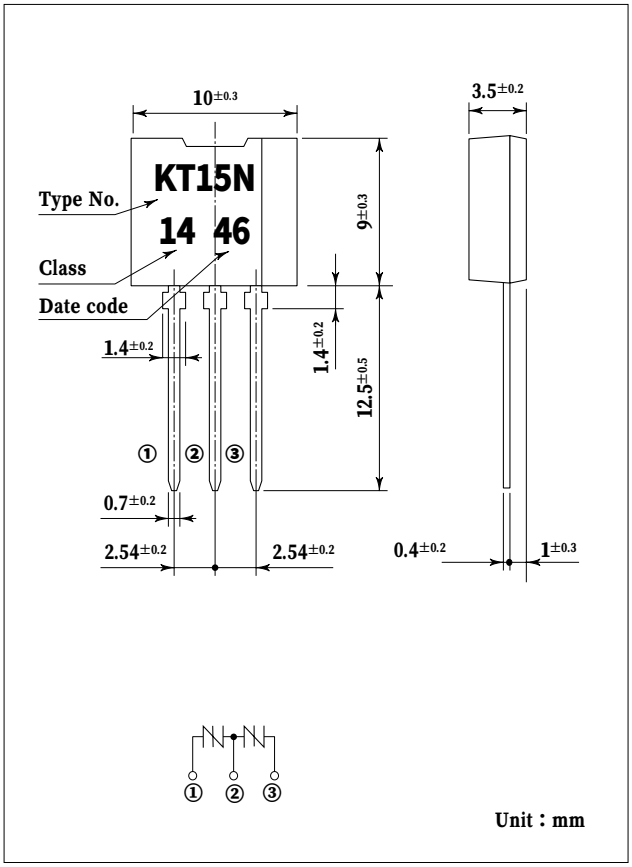
Unit：mm

■AX10 Package



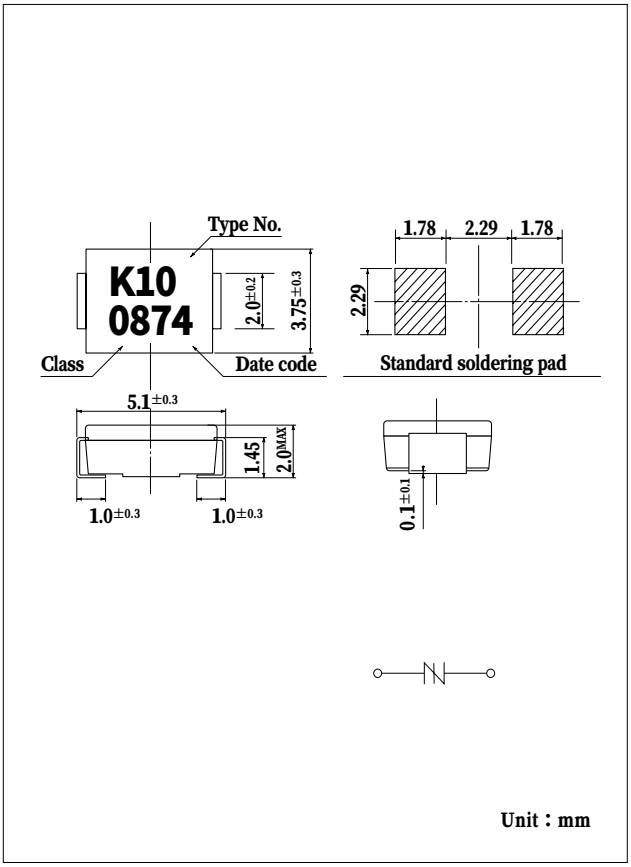
Unit：mm

■TO-221 Package



Unit：mm

■M2F(DO-214AA) Package



Unit：mm

Technical Information for Thyristor Surge Suppressor

1. Summary

It has been over 30 years since SHINDENGEN developed and released its silicon bi-directional, two-terminal thyristor, referred to as "SIDAC"(Silicon Diode for Alternating Current). During that time, these thyristors have been used by numerous customers and have built up an impressive record of achievement.

TSS is developed to offer excellent surge protection features by taking full advantage of the basic structure of the SIDAC and combining that with our development and technical capabilities.

TSS integrate the outstanding technical capabilities of SHINDENGEN to realize a completely new and ideal type of surge protector that has satisfied customers for their protection of advanced data communication equipment and terminals from voltage surges induced by lightning strikes.

2. Basic Structure and Operating Principle

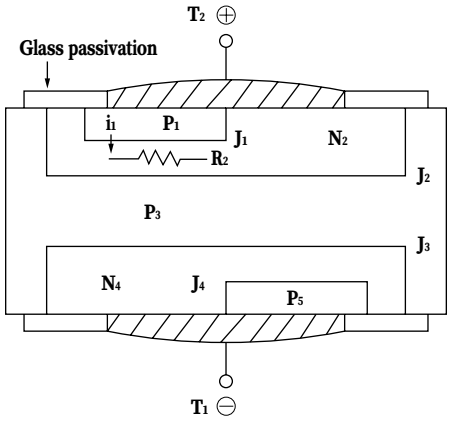


Fig.6 Structure

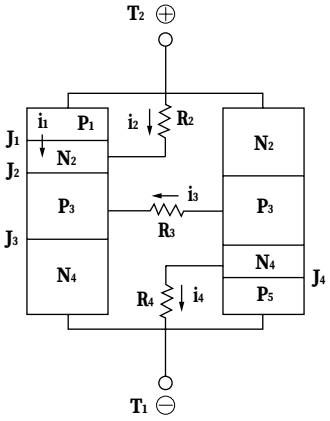


Fig.7 Electrical equivalent circuit

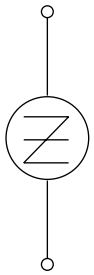


Fig.8 Symbol

The structure of TSS consists of a planar, five-layer structure as shown in Fig.6.It employs glass passivation that is the result of our original research and development activities.

Fig.7 shows the electrical equivalent circuit of the TSS. TSS can be considered to be a complex device in which two SCR are connected in parallel while facirg in opposite directions.

As described below, operation in the case of applying a plus (+) voltage to T_2 and a minus (—) voltage to T_1 in the structural drawing of Fig.6, can be perceived in terms of each of the stages of the V-I characteristics curve of Fig.9.

1.Stage (I)

Junction J_2 is in the reverse bias state, and recoupling current the same as an ordinary PN junction diode (reverse leakage current)flows putting the TSS into the off state.

2.Stage (II)

As the applied voltage V increases up to the breakdown voltage V_B of junction J_2, junction J_2 begins avalanche breakdown.

3. Stage (III)

When the voltage drop of $i_2 \times R_2$ exceeds breakover voltage V_{BO} and reaches the diffusion potential V_{Bi} of junction J_1 due to current I_2 flowing directly beneath layer P_1, carrier injection begins from layer P_1 to layer N_2 resulting in the flow of current i_1.

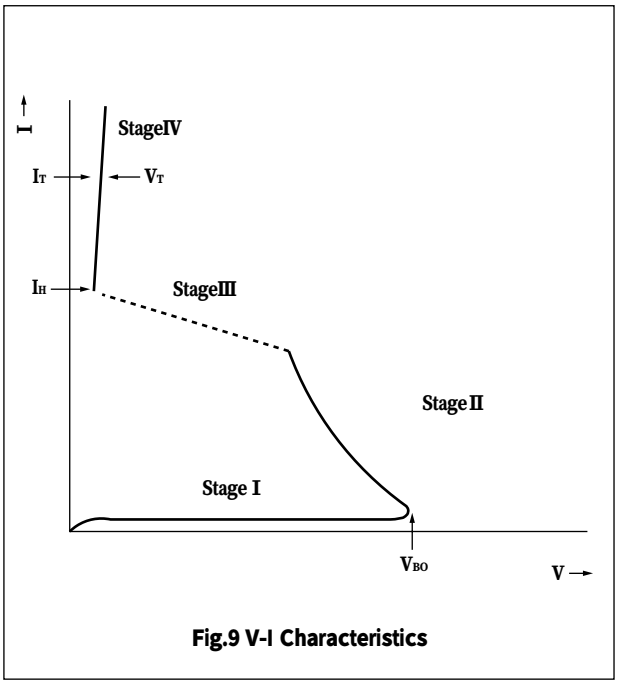


Fig.9 V-I Characteristics

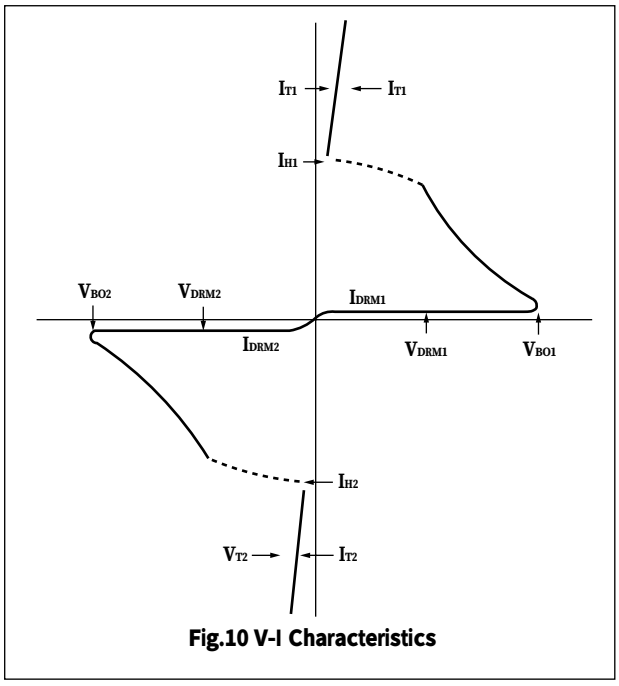


Fig.10 V-I Characteristics

As a result, the TSS switches to the on state when the sum of the two current amplification factors α_1 of the N_2 P_3 N_4 transistor and α_2 of the P_1 N_2 P_3 transistor, which both exhibit current dependency, is $\alpha_1 + \alpha_2 = 1$.

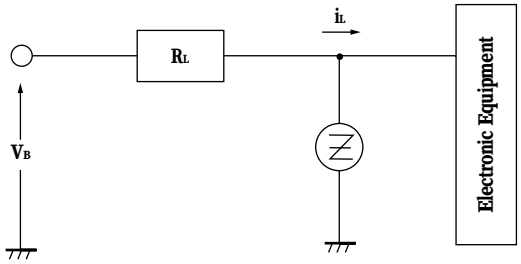
4.Stage(IV)

An on-state voltage V_T is similar to forward voltage drop of the ordinary PN junction diode.

Since the case in which the direction of the applied voltage is the opposite (T_2→minus (−), T_1→plus (+)) is valid in completely the same manner, V-I characteristics that are symmetrical in both directions are exhibited as shown in Fig.10.

3.Basic Operation and V-I Characteristics

①Normal State



The operating point is point (a) of the off region on the V-I characteristics in Fig.11.

Load current i_L is supplied to the electronic equipment.

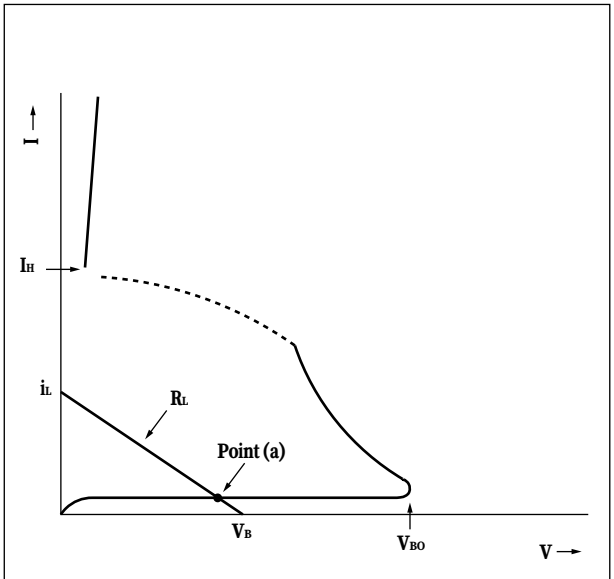
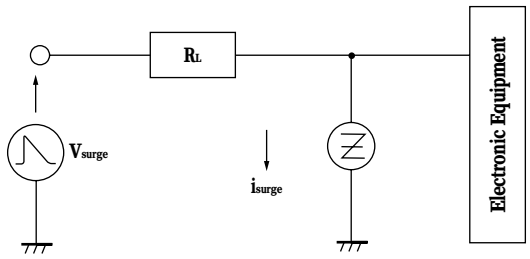


Fig.11 V-I Characteristics during normal operation

②Operation during Surge Voltage Induced



At the moment a surge voltage that exceeds the breakover voltage V_{BO} is applied to both terminals of the TSS, the TSS switches on to the on state, and the operation point moves to point b of the V-I characteristics.
As a result, only a voltage equivalent to the on-state voltage V_T of the TSS is applied to the electronic equipment.

As isurge gradually decreases so that it falls below holding current I_H, the TSS is automatically reset so that the normal load current i_L is supplied to the electronic equipment.

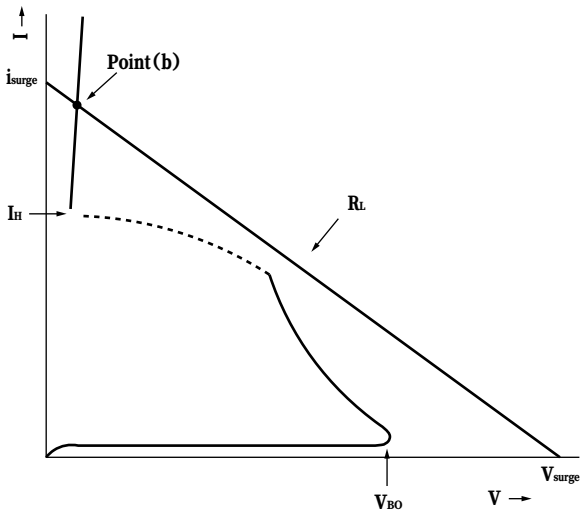
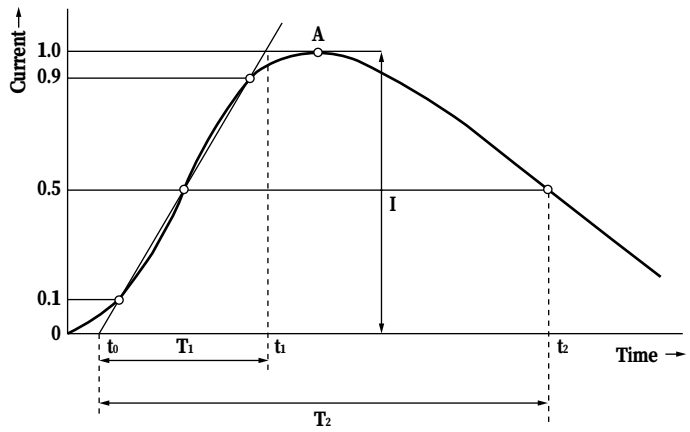


Fig.12 V-I Characteristics during surge voltage induced

4.Impulse Waveform

The waveform of lightning surge current can be described as shown in Fig.13
Our TSS are tested based on the following waveform.



T1 : Duration of wave front
T2 : Duration of wave tail
I : Crest value
A : Peak point

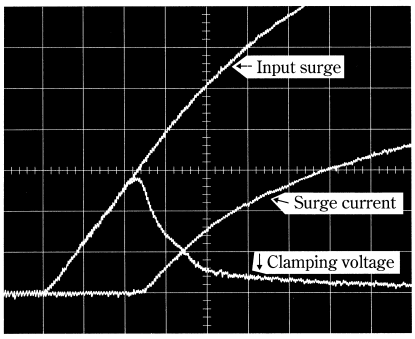
Fig.13 Impulse waveform

※The waveform is represented in terms of the duration of the wave front and the duration of the wave tail(T_1/T_2)μs
Example : For an indication of 10／1000μs, the duration of the wave front (T_1) is 10μs
and the duration of the wave tail (T_2) is 1000μs

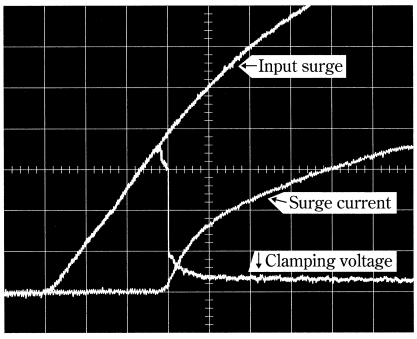
5.Comparison of Surge Response

A comparison of the clamping waveforms of our TSS, a Gas discharge tube (GDT) and a metal oxide varistor (MOV) is shown in photographs 1 through 3 at an I_P value of 100A (10/1000μs).

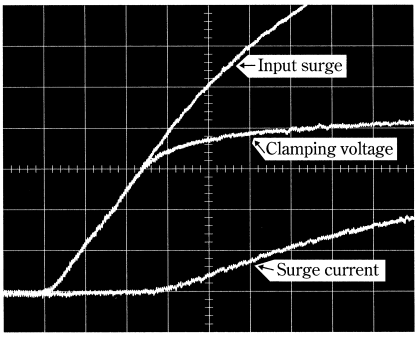
Test conditions I_P : 100A (10/1000μs)
V_P : 1000V
V : 100V/div I: 20A/div t: 0.5μs/div



Photograph 1 Shindengen TSS (V_{BO} : 252V)



Photograph 2 GDT (DC discharge voltage : 230V)

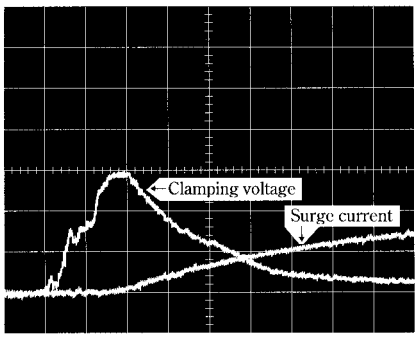


Photograph 3 MOV (Vz : 264V at 1 mA)

Photographs 4 through 6 indicate a comparison of clamping waveforms V_{CL} at dv/dt=1000V/μs.

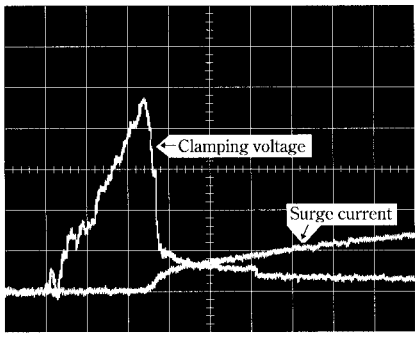
Test conditions I_P : 50A dv/dt : 1000V/μs
V_P : 1500V V : 100V/div I : 20A/div t : 200ns/div

V_{CL} : 295V



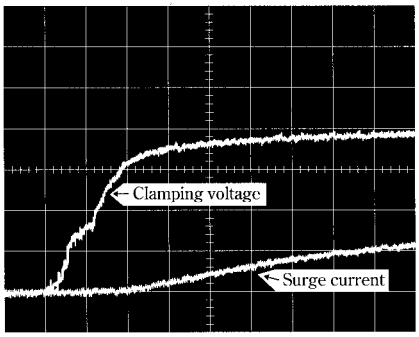
Photograph 4 Shindengen TSS (V_{BO} : 252V)

V_{CL} : 470V



Photograph 5 GDT (DC discharge voltage : 230V)

V_{CL} : 380V



Photograph 6 MOV (Vz : 264V at 1 mA)

In the case of a surge protective device such as, gas tube arrestors and metal oxide varistors (MOV), the clamping voltage at the time of surge operation is extremely high relative to nominal values (DC discharge voltage and breakdown voltage V_Z). The dv/dt-V_{CL} characteristics and V_{CL}-T characteristics (clamping voltage-time characteristics) are shown in Figs.14 and 15, respectively.

In consideration of these characteristics, it is necessary to employ a protective circuit design that anticipates the withstand voltage of the electronic equipment and the dv/dt value of the incoming surge when using a gas tube arrestor or metal oxide varistor.As can also be understood from the V_{CL}-T characteristics, particularly in gas tube arrestors, the operating voltage (discharge voltage) tends to become higher relative to a sharp dv/dt waveform due to discharge delay phenomena.This phenomena presents a difficult problem when designing protective circuits in the case of actual surge protection.

In recent years, due to the low withstand voltages of ICs, LSIs and other semiconductors and electronic equipment, protective circuits are required to respond rapidly to sudden voltage surges.TSS is able to operate at a constant clamping voltage for even sharp surge waveforms.It facilitates the use of individual devices, and no special protection.Moreover, they are not subject to degradation over time even when surge voltage is applied repeatedly, and offer greater stability than gas tube arrestors and metal oxide varistors, making them much easier to use.

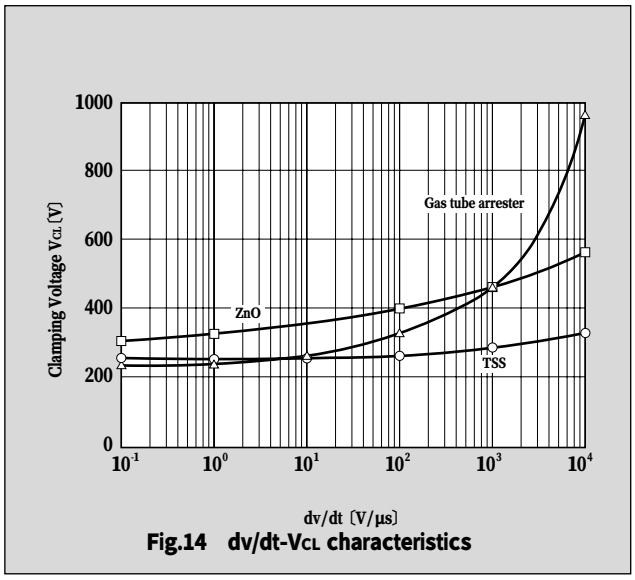


Fig.14 dv/dt-V_{CL} characteristics

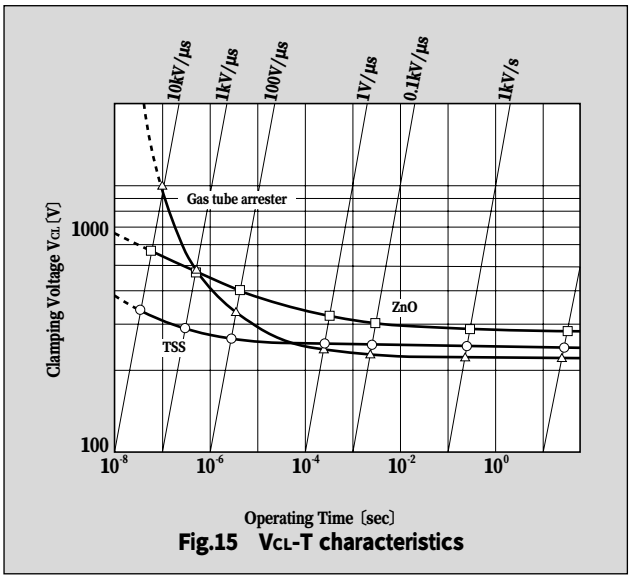


Fig.15 V_{CL}-T characteristics

6.New Producut and Technology Trend

Over the passed years, TSS is developed mainly as bi-directional type.

Recently, Novel type, Low voltage type and Reverse conductive type TSS were developed based on the technical research closely related to market requirements.V-I characteristics of Conventional type TSS is shown by figure 16-1. Since Conventional type TSS has negative resistance region, it works as " quickly-breaking-over " when surge exceeds breakover voltage.

While V-I characteristics of Novel type TSS is shown by figure 16-2, which has more stable characteristics in high frequency application.

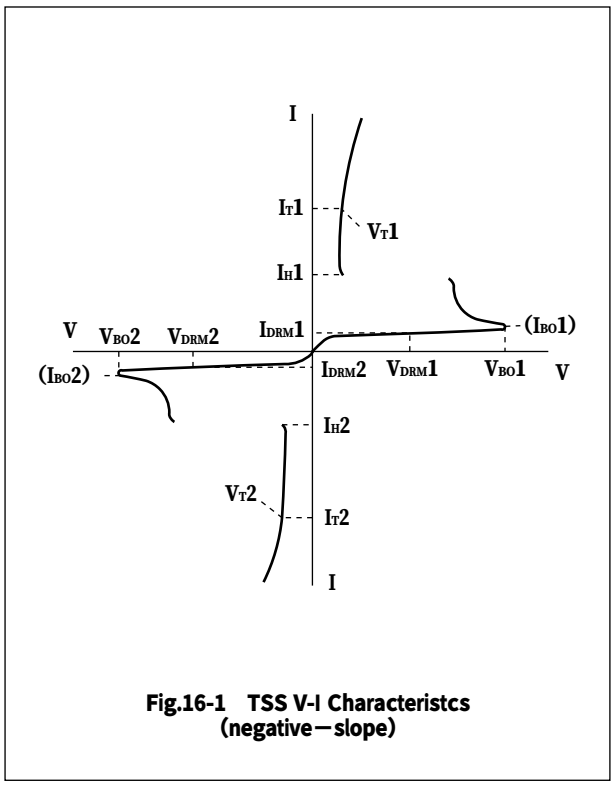


Fig.16-1 TSS V-I Characteristcs (negative−slope)

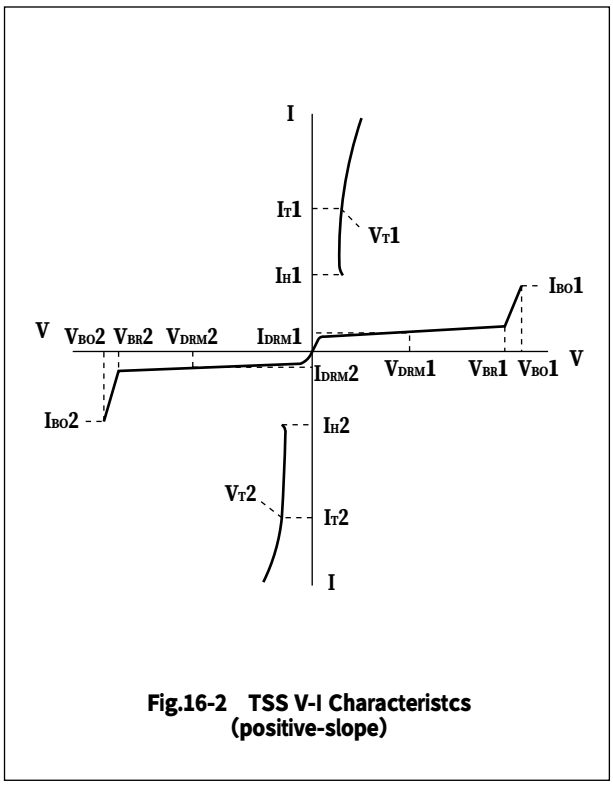


Fig.16-2 TSS V-I Characteristcs (positive-slope)

The V-I characteristic of low-voltage type TSS device is shown in figure 16-3. Built with a conventional structure , the low-voltage designs exhibit high capacitance, a serious drawback. To solve this problem, SHINDENGEN has developed a special structure which is incorporated in current production. (under requirement of its patent.)

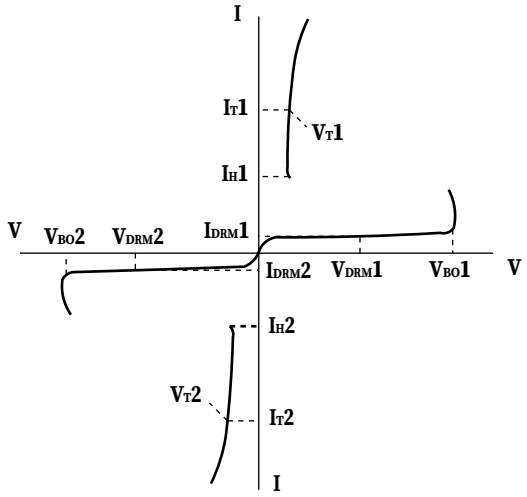


Fig.16-3 TSS V-I Characteristics (Bi-Directional/Low voltage type)

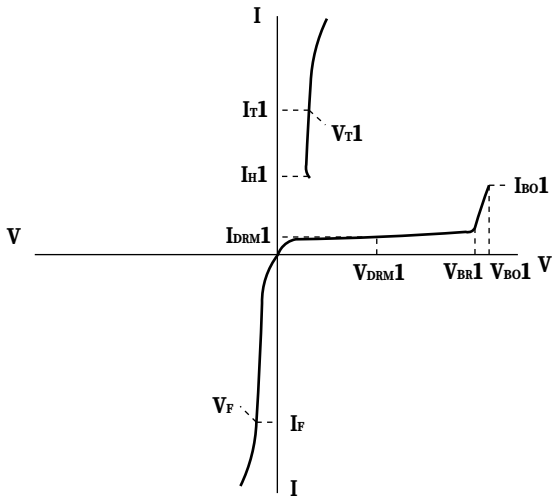


Fig.16-4 TSS V-I Characteristics (Uni-Directional/Reverse conductive type)

The V-I characteristic of the reverse-conduction type TSS is shown in Figure 16-4. Because most telecommunication applications use a negative voltage line. In this case, a TSS with reverse-conduction characteristics is suitable.

The schematic symbol for a reverse-conduction TSS, as differentiated from a bidirectional-type, is shown in Figure17.

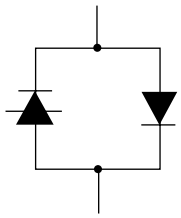


Fig.17 Circuit symbol

■Trankiller

Trankiller (Transient Surge Killers: registered trademark of SHINDENGEN) is a type of voltage clamp silicon surge protective device that applies the reverse avalanche breakdown phenomenon of a silicon PN junction.

These devices are also referred to as Power Zeners, since they allow a large surge current (avalanche current) to flow in the reverse direction compared to Zener diodes, which are ordinary constant voltage devices.

Fig.18 shows the voltage-current (V-I) characteristics of Trankillers.

Since these devices exhibit remarkable non-linear characteristics, between when off (saturation stage) and when on (breakdown stage), the response characteristics to surges are quick, enabling them to obtain a stable clamping voltage.

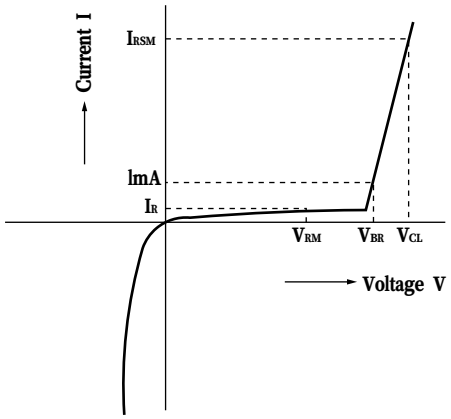


Fig.18 Voltage-Current characteristics

(Features)

1. The fast response speed enables the obtaining of a stable clamping voltage.
2. The allowable power is much larger than ordinary constant voltage devices (avalanche diodes).
3. There is no degradation over time relative to repeated surges and they are maintenance-free.
4. Leakage current during the steady state is extremely low.
5. Two types are available, consisting of a compact surface-mounted type and an axial lead type.

(selection Criteria for Tankiller)

Selection Method	Main Conditions
Determination of maximum reverse voltage V_{RM}	●Circuit voltage (peak value of voltage applied in the normal state)
Input surge current	●Peak surge voltage ●Surge impedance
Determination of clamping voltage $V_{CL1} < V_{CL}$	●Withstand voltage of circuit to be protected
Other special conditions etc.	●Capacitance

(Estimation of surge current)

The surge current Is that flows to the trankiller in the equivalent circuit shown in Fig.19 is determined according to the following formula :

$$Is = \frac{Vs}{\dot{Z}o} \qquad I_{RSM} > Is$$

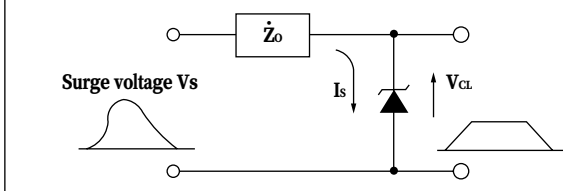


Fig.19 Equivalent circuit in surge operation

Is : Suge current (A)
I_{RSM} : Max.surge current (A)
Vs : Surge voltage (V)
V_{CL} : Clamping voltage (V) (limiting voltage)
Żo : Equivalent surge impedance

For reference, in the case of trankillers, clamping voltage (V_{CL}) characteristics are indicated in the form of the V-I characteristics. According to the current value (I_{RSM}) that flows in protection circuit, clamping voltage applied on electronic equipment has to be lower than withstand voltage of electronic equipment.

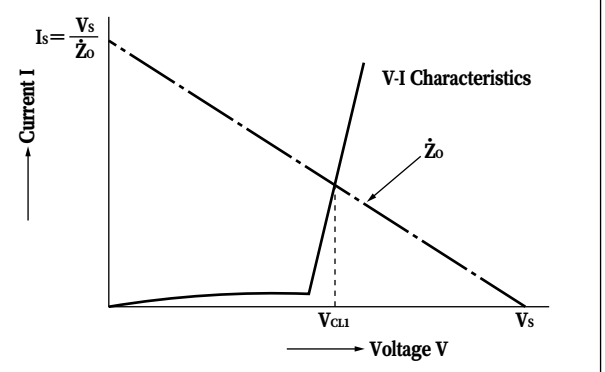


Fig.20 Suge impedance characteristics

■Silicon Varistors

Silicon varistors are a voltage-clamp type of surge protective device that utilizes the forward voltage drop of a PN junction. These devices demonstrate the bi-directional characteristics resulting when PN diodes are connected in parallel in reverse.

SHINDENGEN has succeeded in composing these bi-directional characteristics in a single chip using isolation diffusion technology.

In addition, the use of glass passivation produced results in outstanding reliability.

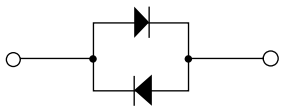


Fig.21 Silicon Varistor internal equivalent circuit

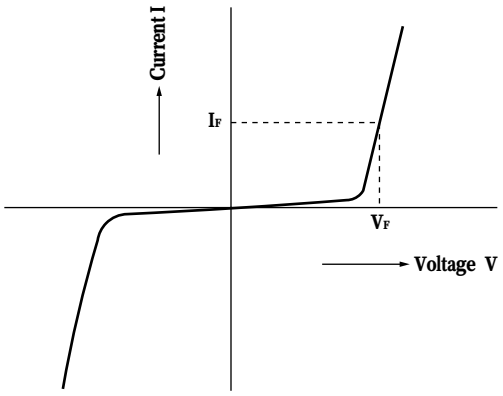


Fig.22 Voltage-Current characteristics

(Features)

1. Perfect as a device for signal protection.
2. Compact size and highly reliable.
3. Various voltage variations through the use of high-density technology.
4. Both surface-mounted and axial types are available.
5. Low capacitance.

■Standard Measurement of Surge ON−state Current

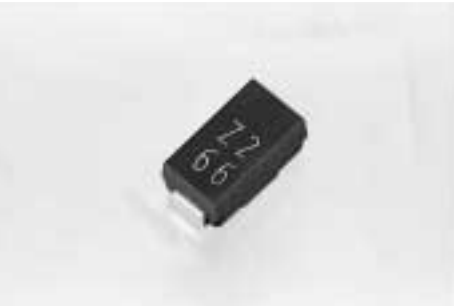
Historically, SHINDENGEN has used three standardized waveforms to define Surge On-state Current (8/20μs, 10/200μs and 10/1000μs). Recently, though, the rapid expansion of communication applications has brought into use many new evaluation waveforms that more closely approximate actual usage. In response.SHINDENGEN has expanded its list of measured standards to those listed in Table 2.

SHINDENGEN application engineers are available to assist in selecting specific devices that are expected to operate outside the range defined by these standards.

Waveform	Peak Surge Current	Proper International Standard		
2/10μs	1kA	FCC Par. 68	Belcore 1089	———
8/20μs	1kA	IEC1000-4-5	VDE 0878	ANSI C62.41
15/100μs	200A	———	———	———
10/160μs	200A	FCC Par. 68	———	———
10/200μs	200A	———	———	———
10/560μs	100A	FCC Par. 68	———	———
10/1000μs	100A	Belcore 00974	ITU-T K.28	REA PE-60

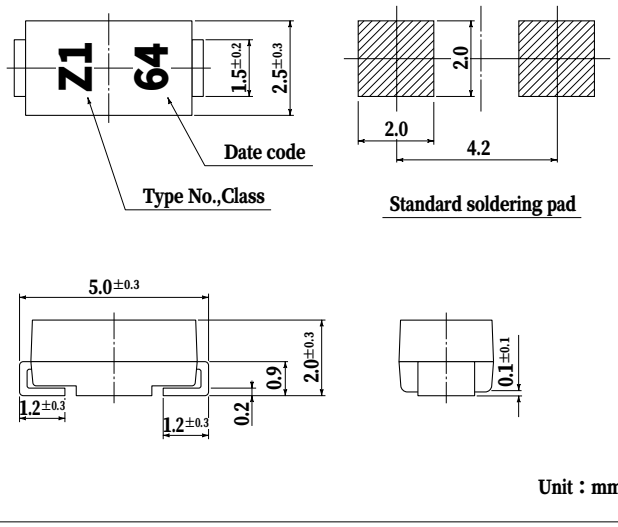
Table2 Standard surge waveform in SHINDENGEN

KL3Z07, 18



■OUTLINE DIMENSIONS

Package : 1F



■RATINGS

Absolute Maximum Ratings

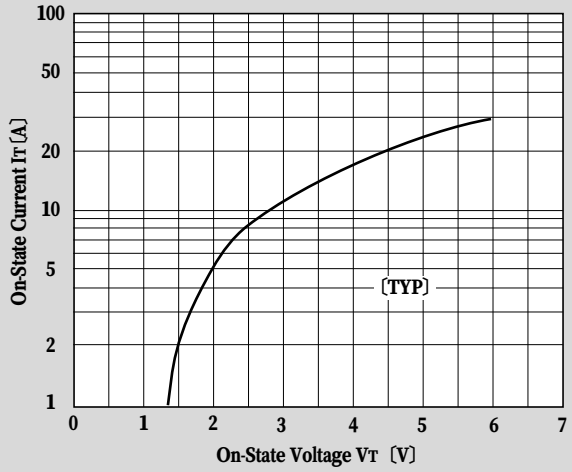
Item	Symbol	Conditions \ Type No.		KL3Z07	KL3Z18	Unit
Storage Temperature	Tstg			−40～125		℃
Junction Temperature	Tj			125		℃
Maximum Off-State Voltage	V_{DRM}			5	15	V
Surge On-State Current	I_{TSM}	10/1000 μs	Non-repetitive	30		A
		8/20 μs		150		

Electrical Characteristics T_j=25℃

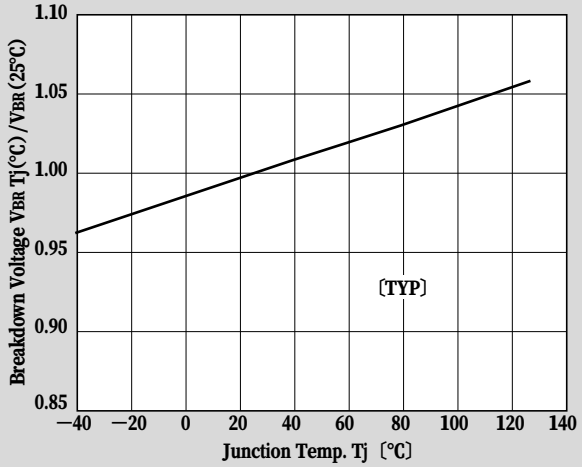
Breakdown Voltage	V_{BR}	I_{BR}=1mA	MIN 5.5	MIN 15.5	V
Off-State Current	I_{DRM}	V_D=V_{DRM}	MAX 10		μA
Holding Current	I_H	Pulse measurement	MIN 50		mA
On-State Voltage	V_T	I_T=2A	TYP 1.5		V
Junction Capacitance	Cj	f=1kHz OSC=20mVrms V_D=0V	MAX 100		pF

■CHARACTERISTIC DIAGRAMS

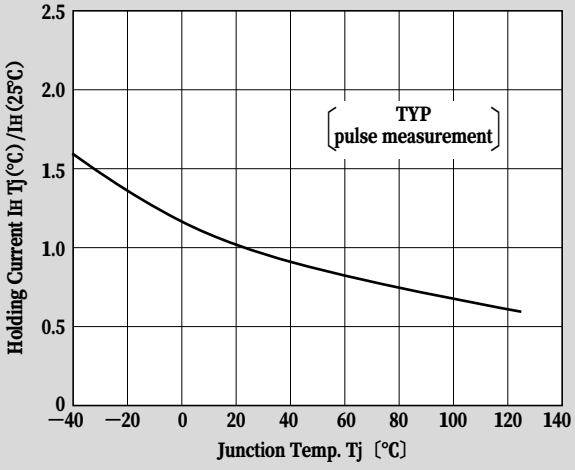
On-State Voltage—On-State Current



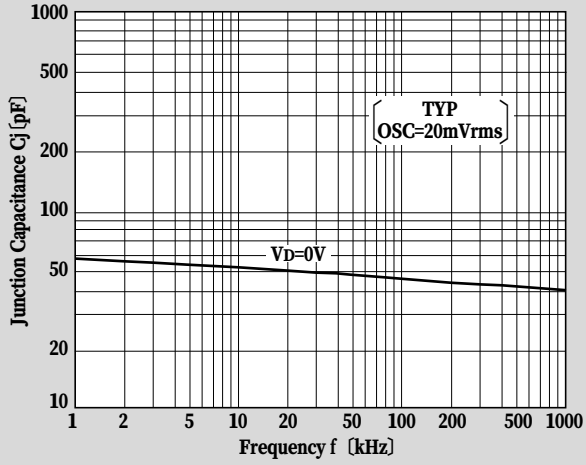
Breakdown Voltage



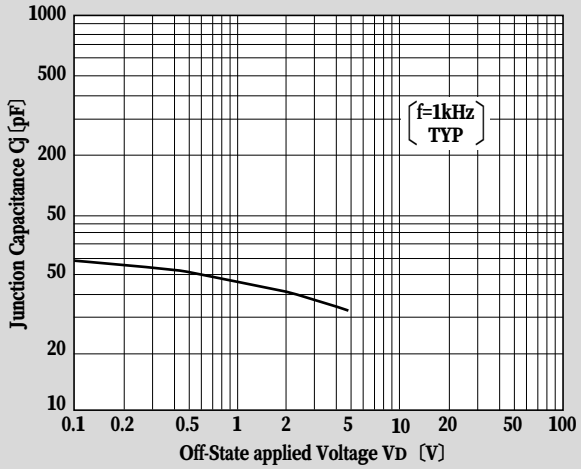
Holding Current



Junction Capacitance f-Cj



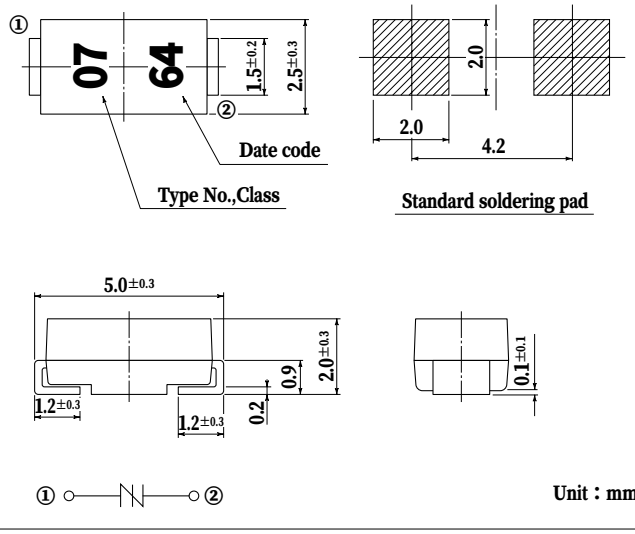
Junction Capacitance VD-Cj



KL3L07

■OUTLINE DIMENSIONS

Package : 1F



■RATINGS

Absolute Maximum Ratings

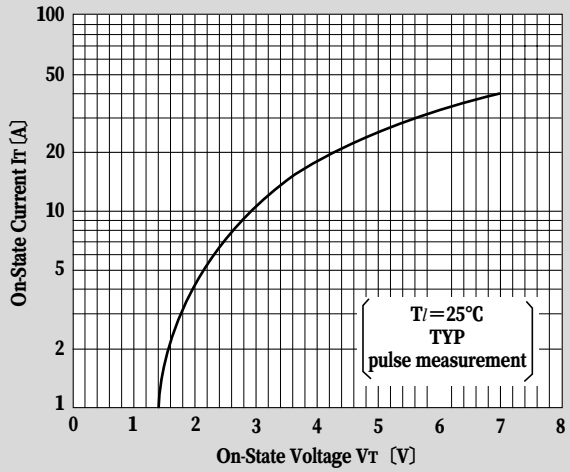
Item	Symbol	Conditions / Type No.		KL3L07	Unit
Storage Temperature	Tstg			−40～125	℃
Junction Temperature	Tj			125	℃
Maximum Off-State Voltage	V_{DRM}			58	V
Surge On-State Current	I_{TSM}	10/1000 μs	Non-repetitive	30	A
		8/20 μs		100	

Electrical Characteristics T_j=25℃

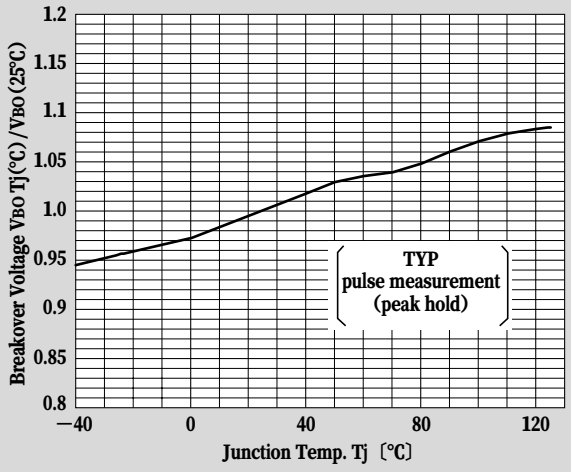
Breakover Voltage	V_{BO}	Pulse measurement (Peak hold)	MIN 65	V
Off-State Current	I_{DRM}	$V_D=V_{DRM}$	MAX 10	μA
Holding Current	I_H	Pulse measurement	MIN 100	mA
On-State Voltage	V_T	I_T=2A	TYP 1.5	V
Junction Capacitance	Cj	f=1kHz OSC=1Vrms V_D=50V	MAX 90	pF
Clamping Voltage	V_{CL}	dv/dt=100V/μs	MAX 80	V

■CHARACTERISTIC DIAGRAMS

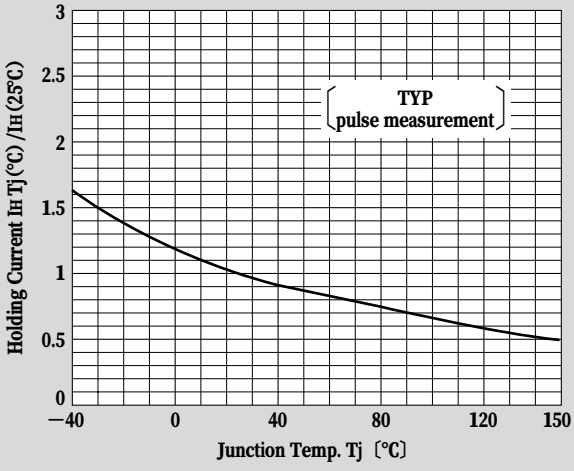
On-State Voltage—On-State Current



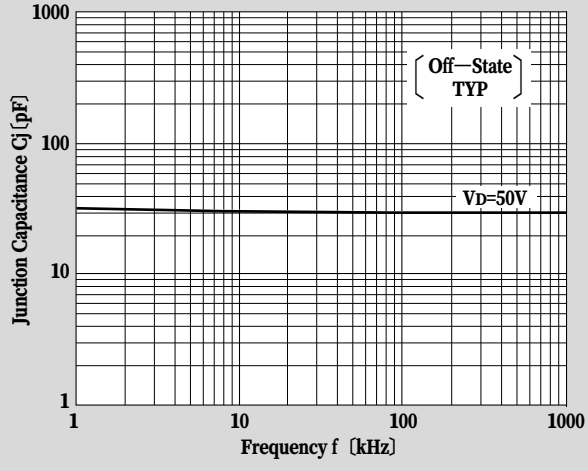
Breakover Voltage



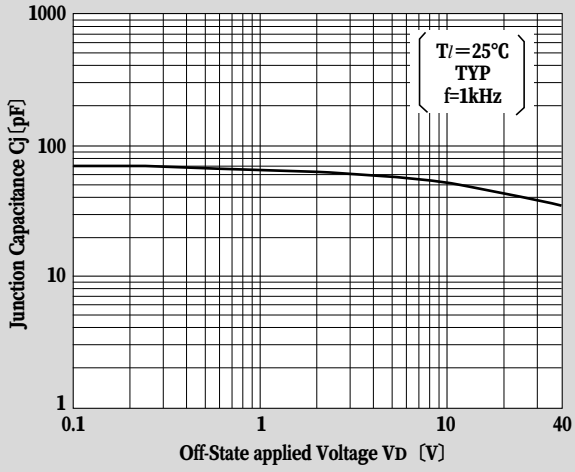
Holding Current



Junction Capacitance f-Cj



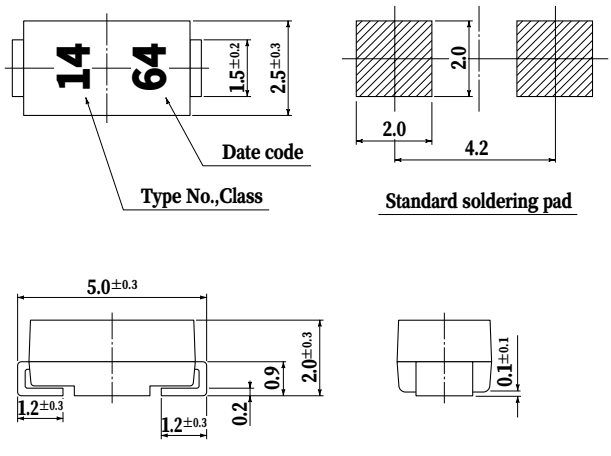
Junction Capacitance VD-Cj



KL3N14

■OUTLINE DIMENSIONS

Package : 1F



Unit : mm

■RATINGS

Absolute Maximum Ratings

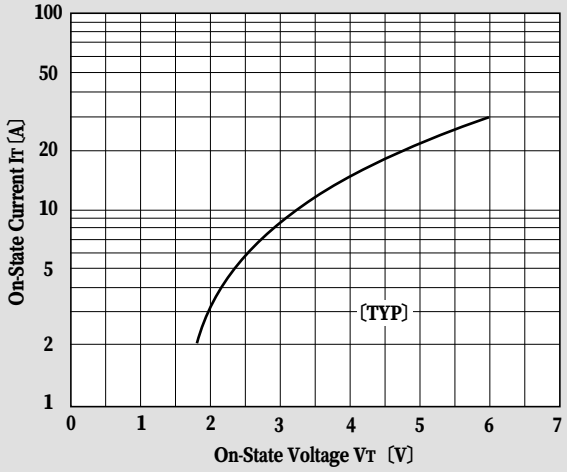
Item	Symbol	Conditions / Type No.		KL3N14	Unit
Storage Temperature	Tstg			−40～125	℃
Junction Temperature	Tj			125	℃
Maximum Off-State Voltage	V_{DRM}			120	V
Surge On-State Current	I_{TSM}	10/1000 μs	Non-repetitive	30	A
		8/20 μs		100	

Electrical Characteristics T_j=25℃

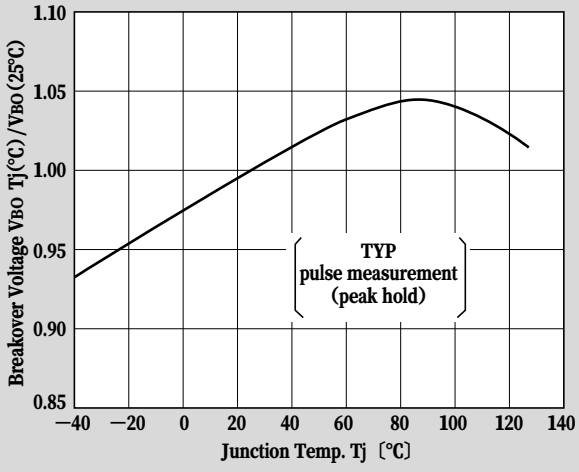
Breakover Voltage	V_{BO}	Pulse measurement (Peak hold)	MIN	130	V
Off-State Current	I_{DRM}	$V_D=V_{DRM}$	MAX	10	μA
Holding Current	I_H	Pulse measurement	MIN	100	mA
On-State Voltage	V_T	I_T=2A	TYP	1.8	V
Junction Capacitance	Cj	f=1kHz OSC=1Vrms V_D=50V	MAX	50	pF
Clamping Voltage	V_{CL}	dv/dt=100V/μs	MAX	195	V

■CHARACTERISTIC DIAGRAMS

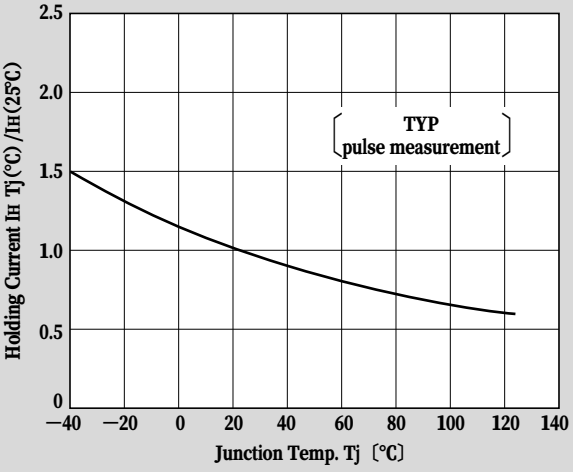
On-State Voltage—On-State Current



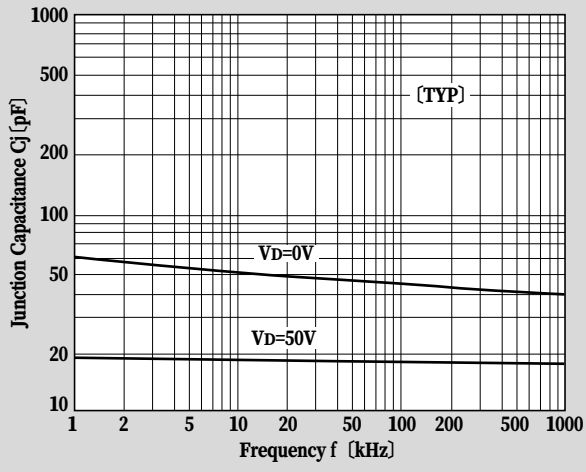
Breakover Voltage



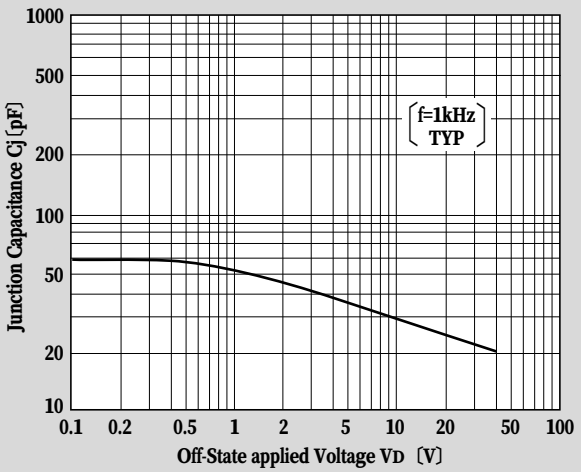
Holding Current



Junction Capacitance f-Cj



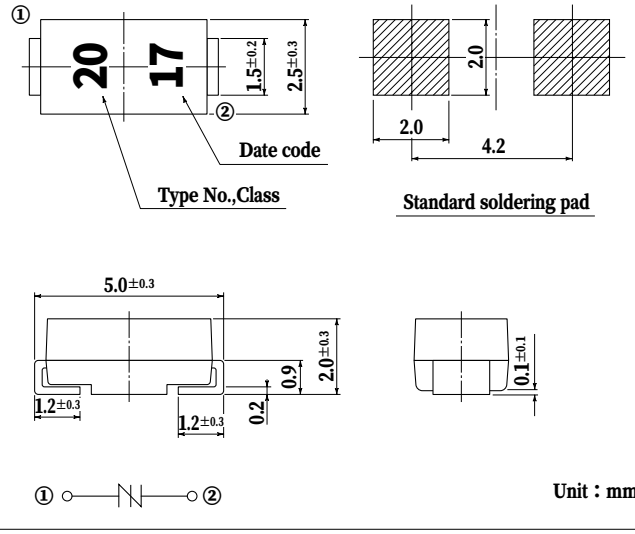
Junction Capacitance VD-Cj



KL3R20

■OUTLINE DIMENSIONS

Package : 1F



■RATINGS

Absolute Maximum Ratings

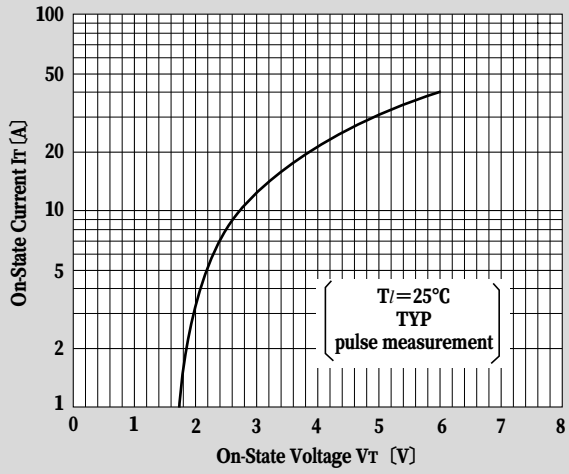
Item	Symbol	Conditions / Type No.		KL3R20	Unit
Storage Temperature	Tstg			−40～125	℃
Junction Temperature	Tj			125	℃
Maximum Off-State Voltage	V_{DRM}			175	V
Surge On-State Current	I_{TSM}	10/1000 μs	Non-repetitive	30	A
		8/20 μs		100	

Electrical Characteristics T_j=25℃

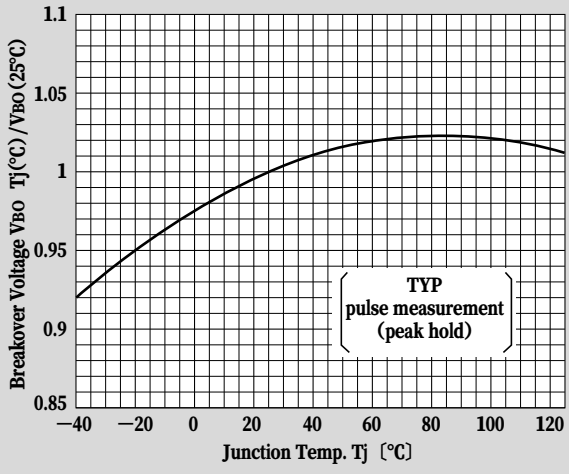
Breakover Voltage	V_{BO}	Pulse measurement (Peak hold)	MIN 180	V
Off-State Current	I_{DRM}	$V_D=V_{DRM}$	MAX 10	μA
Holding Current	I_H	Pulse measurement	MIN 100	mA
On-State Voltage	V_T	I_T=2A	TYP 1.8	V
Junction Capacitance	Cj	f=1kHz OSC=1Vrms V_D=50V	MAX 30	pF
Clamping Voltage	V_{CL}	dv/dt=100V/μs	MAX 250	V

■CHARACTERISTIC DIAGRAMS

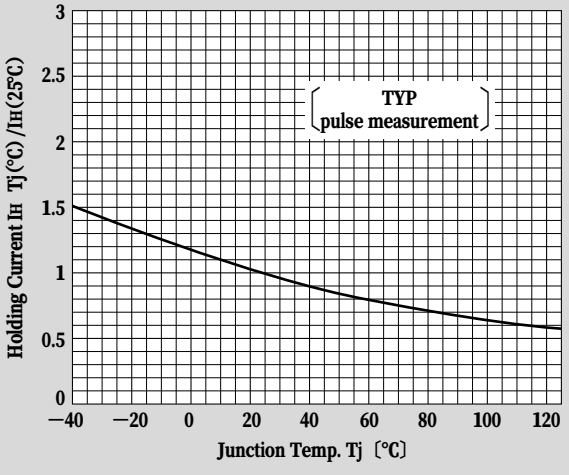
On-State Voltage—On-State Current



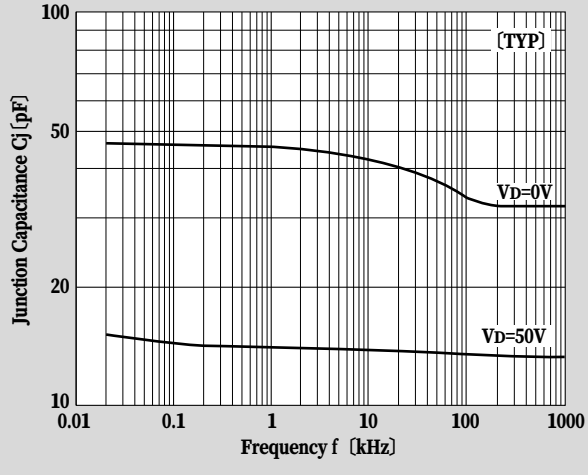
Breakover Voltage



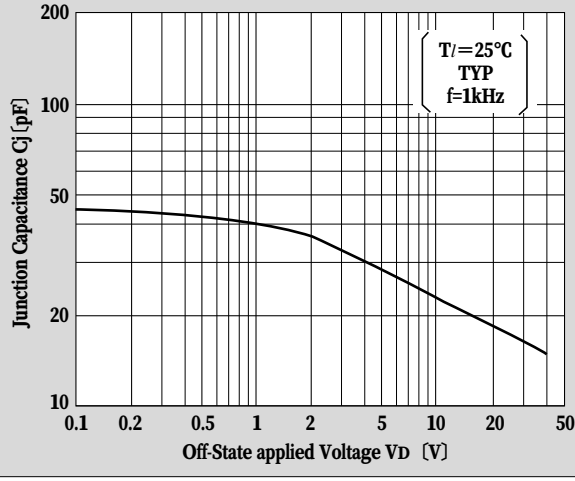
Holding Current



Junction Capacitance f-Cj



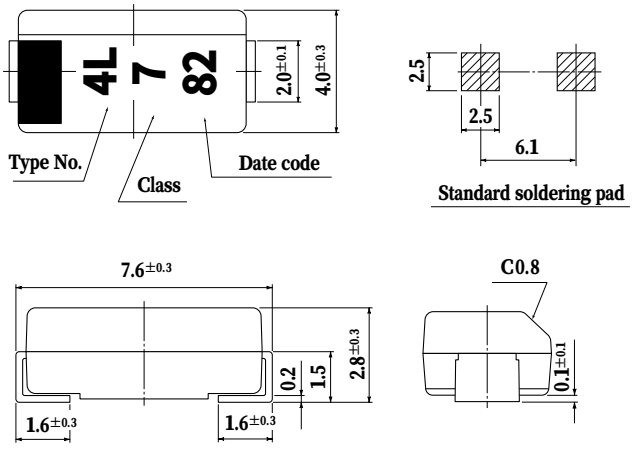
Junction Capacitance VD-Cj



KP4L07

■OUTLINE DIMENSIONS

Package : 2F



Unit : mm

■RATINGS

Absolute Maximum Ratings

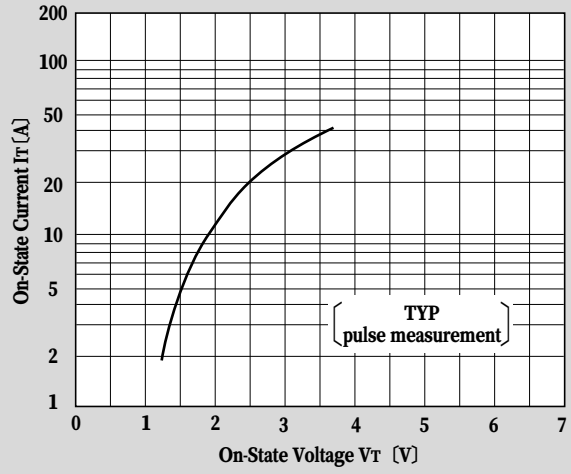
Item	Symbol	Conditions \ Type No.		KP4L07	Unit
Storage Temperature	Tstg			−40～125	℃
Junction Temperature	Tj			125	℃
Maximum Off-State Voltage	V_{DRM}			58	V
Surge On-State Current	I_{TSM}	10/1000 μs	Non-repetitive	40	A
		10/200 μs		60	
		8/20 μs		150	

Electrical Characteristics T_j=25℃

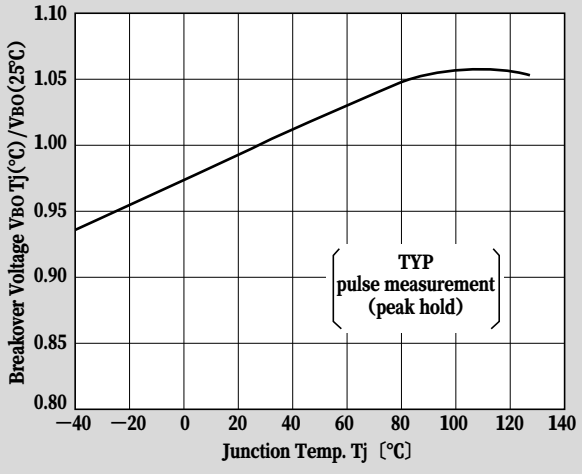
Breakover Voltage	V_{BO}	Pulse measurement (Peak hold)	MIN 65	V
Off-State Current	I_{DRM}	$V_D=V_{DRM}$	MAX 10	μA
Holding Current	I_H	Pulse measurement	MIN 100	mA
On-State Voltage	V_T	I_T=2A	TYP 1.25	V
Junction Capacitance	Cj	f=1kHz OSC=1Vrms V_D=50V	MAX 90	pF
Clamping Voltage	V_{CL}	dv/dt=100V/ μs	MAX 80	V

■CHARACTERISTIC DIAGRAMS

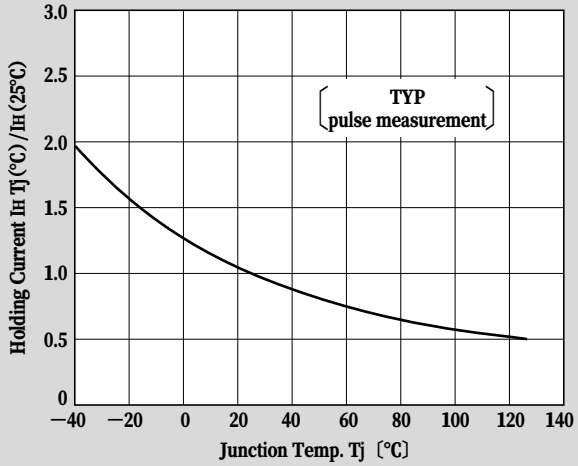
On-State Voltage—On-State Current



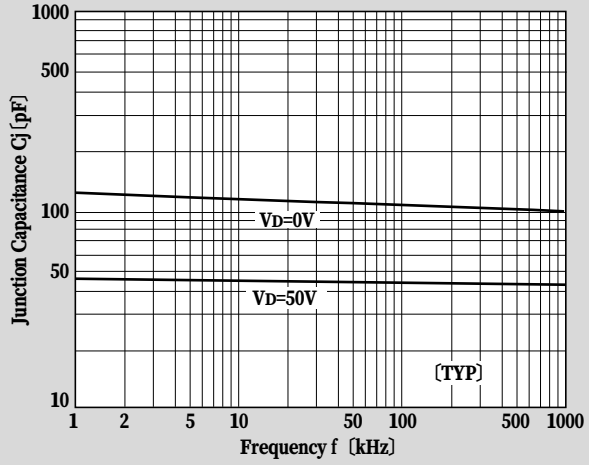
Breakover Voltage



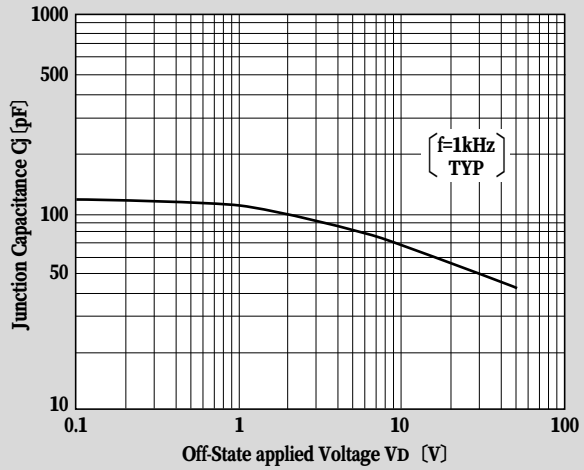
Holding Current



Junction Capacitance f-Cj



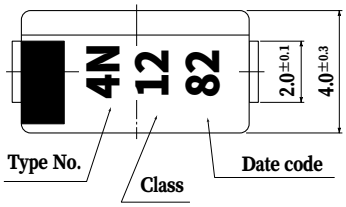
Junction Capacitance VD-Cj

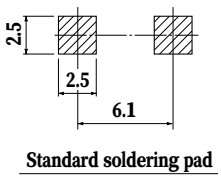


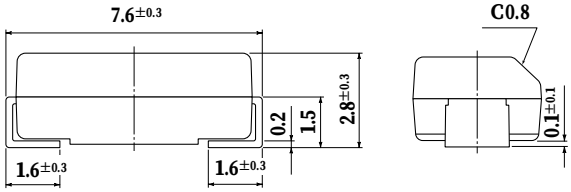
KP4N12

■OUTLINE DIMENSIONS

Package : 2F







Unit : mm

■RATINGS

Absolute Maximum Ratings

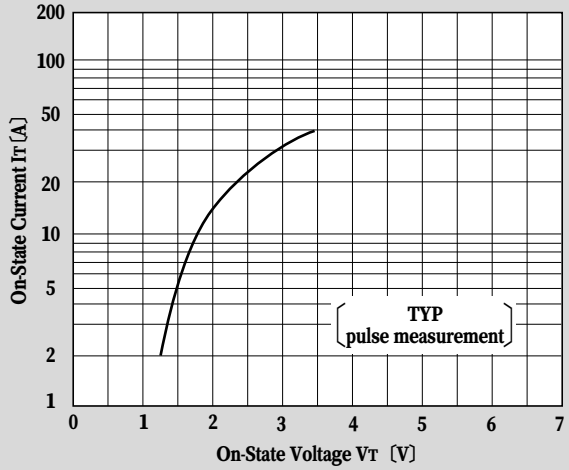
Item	Symbol	Conditions / Type No.		KP4N12	Unit
Storage Temperature	Tstg			−40～125	℃
Junction Temperature	Tj			125	℃
Maximum Off-State Voltage	V_{DRM}			100	V
Surge On-State Current	I_{TSM}	10/1000 μs	Non-repetitive	40	A
		10/200 μs		60	
		8/20 μs		150	

Electrical Characteristics T_j=25℃

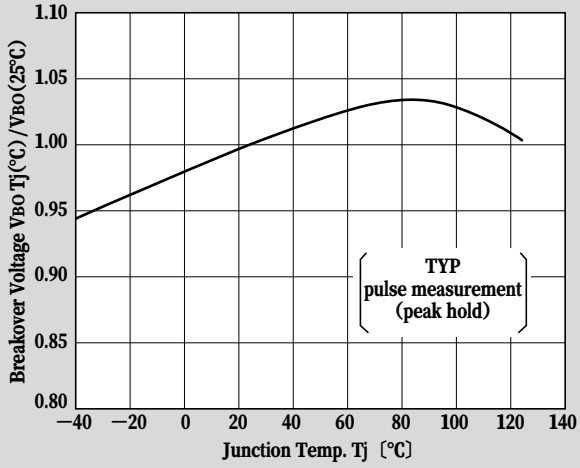
Breakover Voltage	V_{BO}	Pulse measurement (Peak hold)	MIN 110	V
Off-State Current	I_{DRM}	$V_D=V_{DRM}$	MAX 10	μA
Holding Current	I_H	Pulse measurement	MIN 100	mA
On-State Voltage	V_T	I_T=2A	TYP 1.25	V
Junction Capacitance	Cj	f=1kHz OSC=1Vrms V_D=50V	MAX 50	pF
Clamping Voltage	V_{CL}	dv/dt=100V/μs	MAX 135	V

■CHARACTERISTIC DIAGRAMS

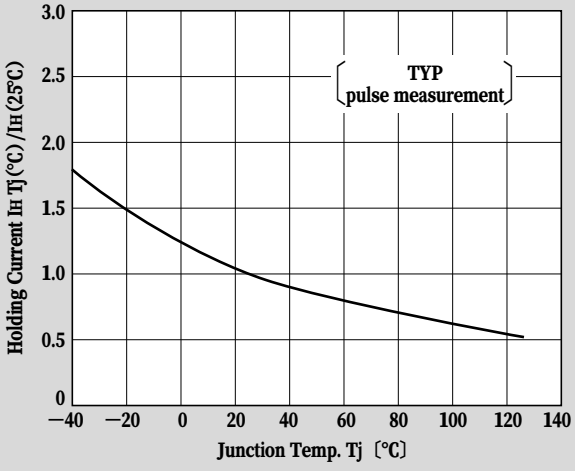
On-State Voltage—On-State Current



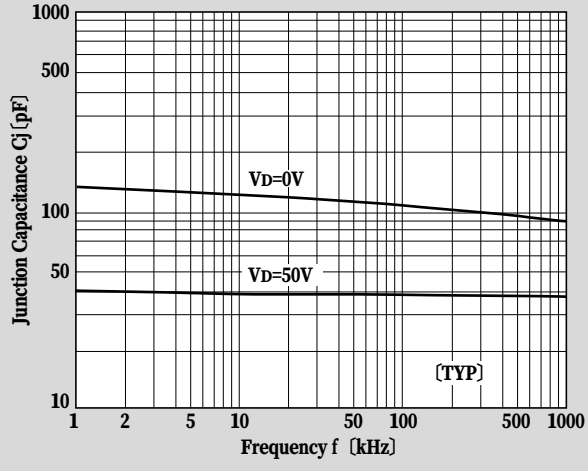
Breakover Voltage



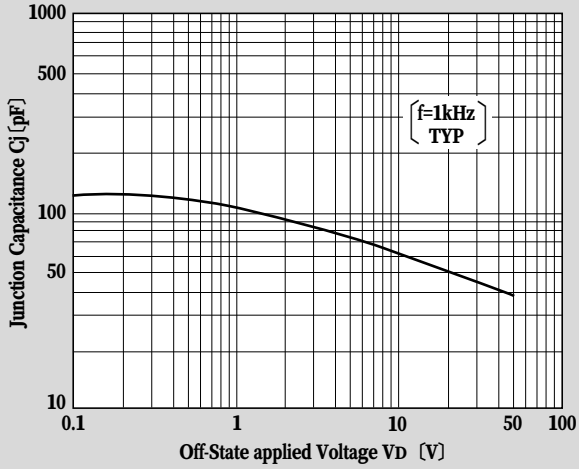
Holding Current



Junction Capacitance f-Cj

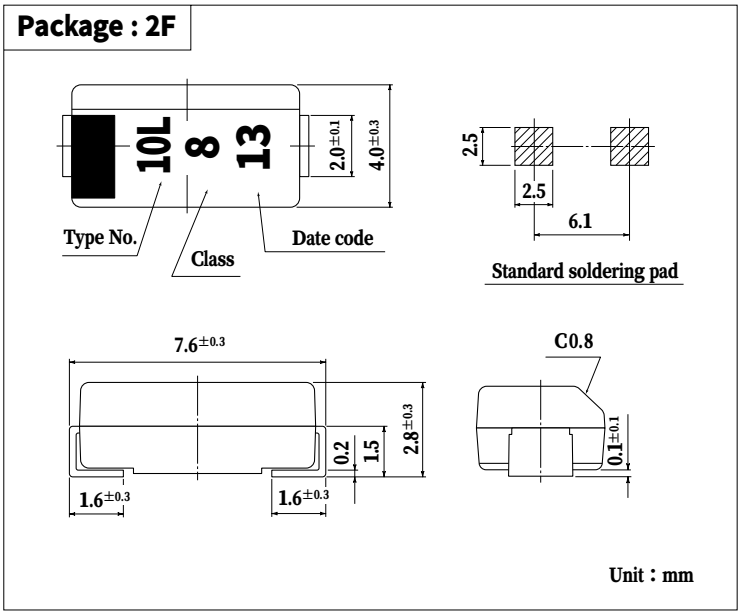


Junction Capacitance VD-Cj



KP10L06, 07, 08

■OUTLINE DIMENSIONS



■RATINGS

Absolute Maximum Ratings

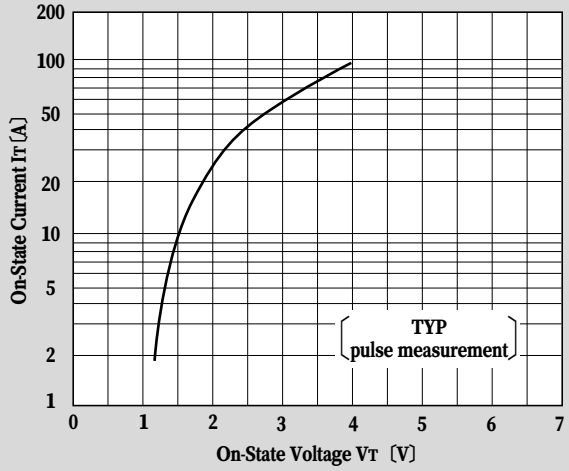
Item	Symbol	Conditions / Type No.		KP10L06	KP10L07	KP10L08	Unit
Storage Temperature	Tstg			−40～125			℃
Junction Temperature	Tj			125			℃
Maximum Off-State Voltage	V_{DRM}			48	58	63	V
Surge On-State Current	I_{TSM}	10/1000 μs	Non-repetitive	100			A
		10/200 μs		150			
		8/20 μs		250			

Electrical Characteristics T_j=25℃

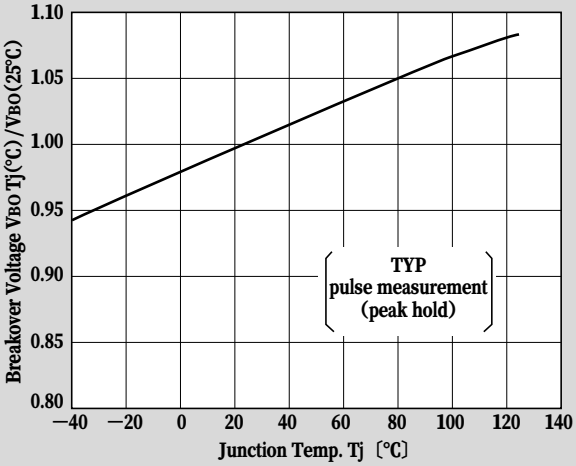
Breakover Voltage	V_{BO}	Pulse measurement (Peak hold)	MIN 55	MIN 65	MIN 75	V
Off-State Current	I_{DRM}	$V_D=V_{DRM}$	MAX 10			μA
Holding Current	I_H	Pulse measurement	MIN 100			mA
On-State Voltage	V_T	I_T=2A	TYP 1.15			V
Junction Capacitance	Cj	f=1kHz OSC=1Vrms V_D=50V	MAX 180			pF
Clamping Voltage	V_{CL}	dv/dt=100V/μs	MAX 70	MAX 80	MAX 100	V

■CHARACTERISTIC DIAGRAMS

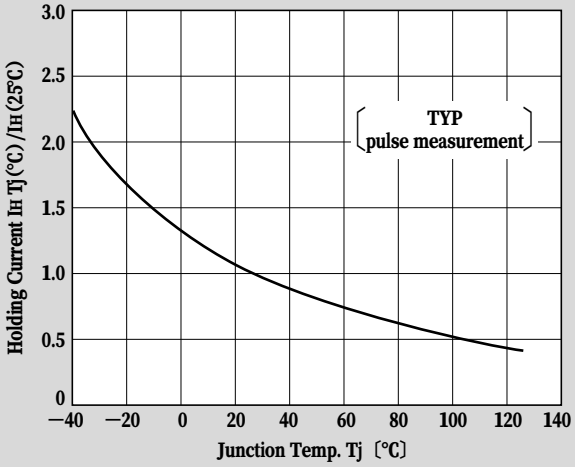
On-State Voltage—On-State Current



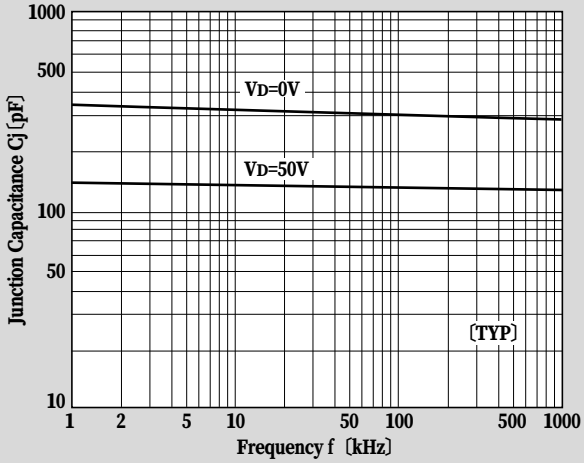
Breakover Voltage



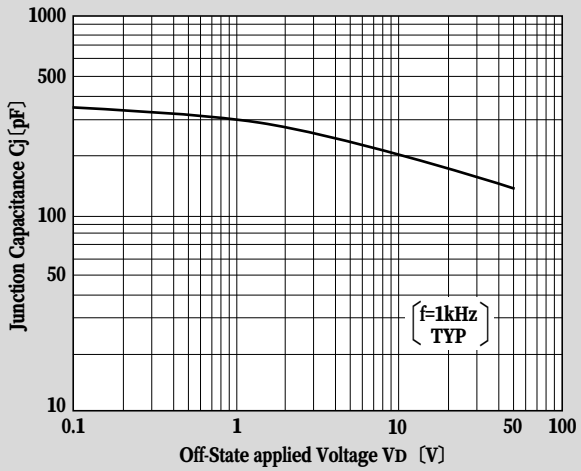
Holding Current



Junction Capacitance f-Cj



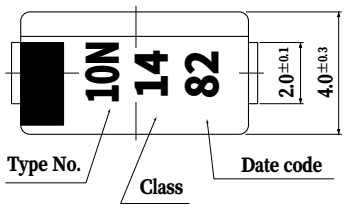
Junction Capacitance VD-Cj

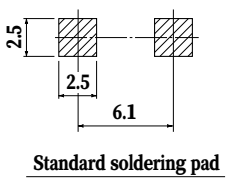


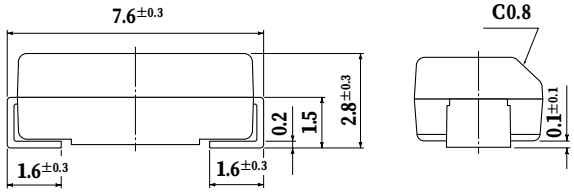
KP10N12, 14

■OUTLINE DIMENSIONS

Package : 2F







Unit : mm

■RATINGS

Absolute Maximum Ratings

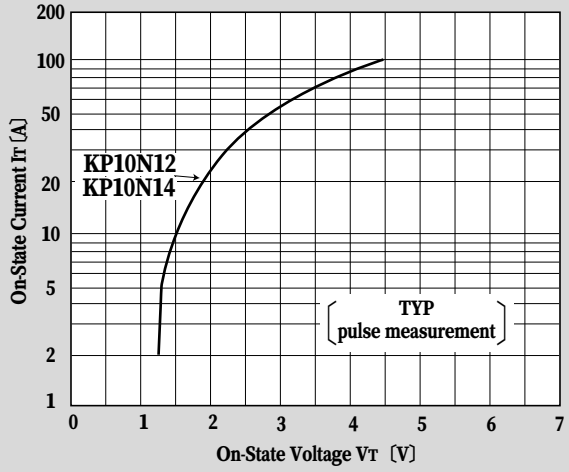
Item	Symbol	Conditions / Type No.		KP10N12	KP10N14	Unit
Storage Temperature	Tstg			−40～125		℃
Junction Temperature	Tj			125		℃
Maximum Off-State Voltage	V_{DRM}			100	120	V
Surge On-State Current	I_{TSM}	10/1000 μs	Non-repetitive	100		A
		10/200 μs		150		
		8/20 μs		250		

Electrical Characteristics T_j=25℃

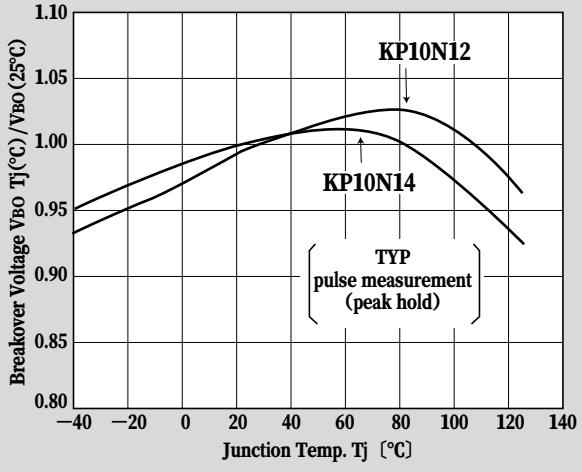
					Unit
Breakover Voltage	V_{BO}	Pulse measurement (Peak hold)	MIN 110	MIN 130	V
Off-State Current	I_{DRM}	$V_D=V_{DRM}$	MAX 10		μA
Holding Current	I_H	Pulse measurement	MIN 100		mA
On-State Voltage	V_T	I_T=2A	TYP 1.15		V
Junction Capacitance	Cj	f=1kHz OSC=1Vrms V_D=50V	MAX 140		pF
Clamping Voltage	V_{CL}	dv/dt=100V/μs	MAX 135	MAX 195	V

■CHARACTERISTIC DIAGRAMS

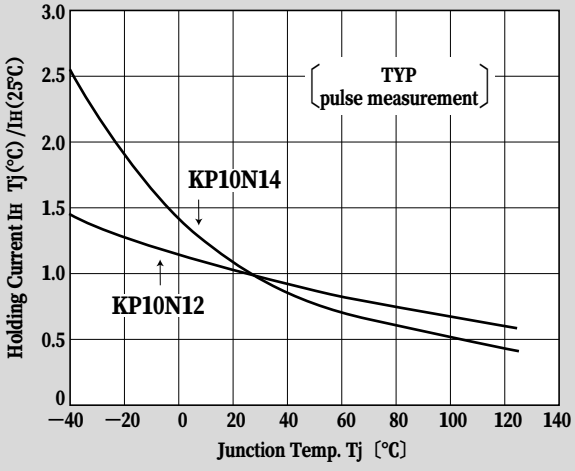
On-State Voltage—On-State Current



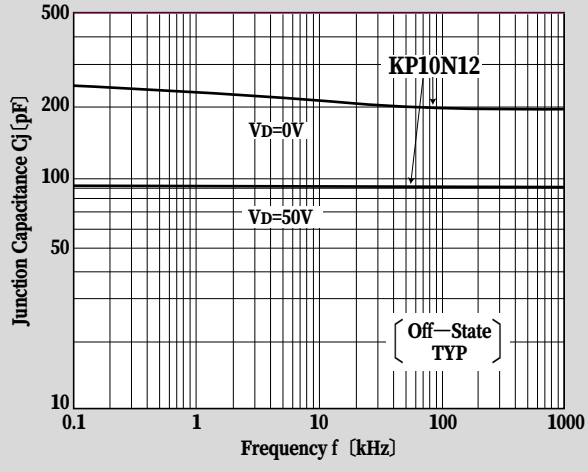
Breakover Voltage



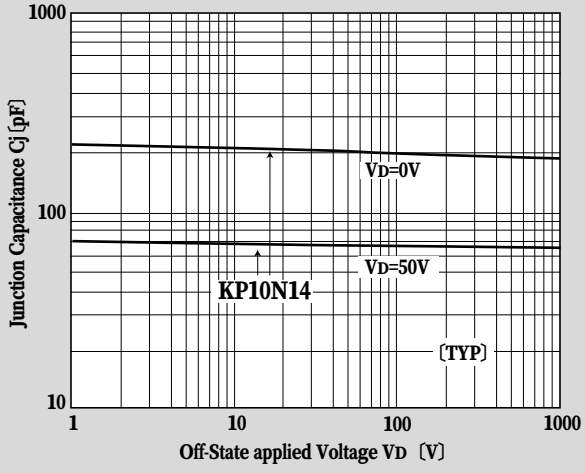
Holding Current



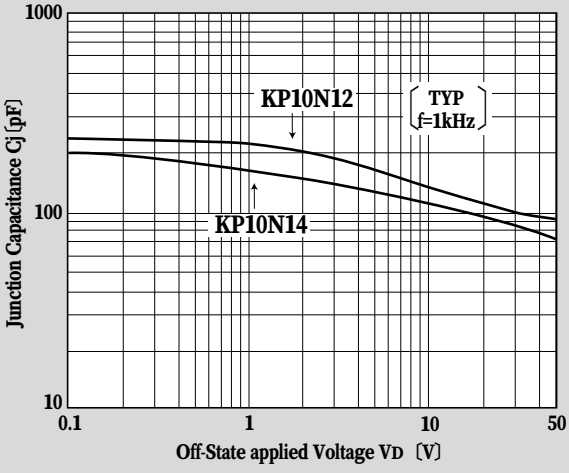
Junction Capacitance f-Cj (KP10N12)



Junction Capacitance VD-Cj (KP10N14)

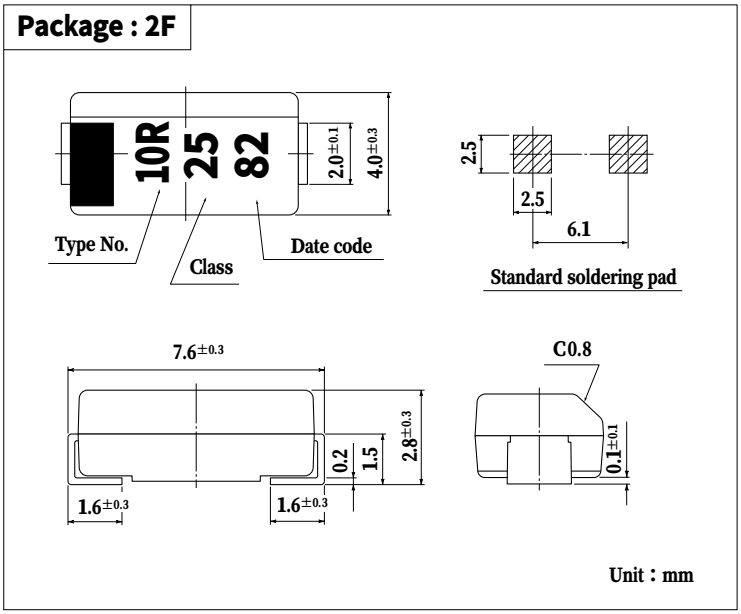


Junction Capacitance VD-Cj



KP10R25

■OUTLINE DIMENSIONS



■RATINGS

Absolute Maximum Ratings

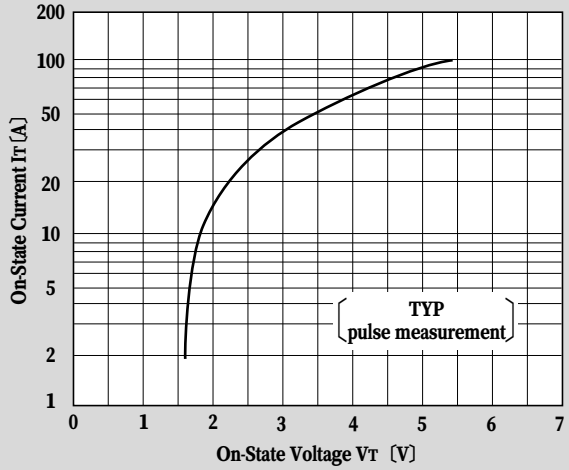
Item	Symbol	Conditions \ Type No.		KP10R25	Unit
Storage Temperature	Tstg			−40～125	℃
Junction Temperature	Tj			125	℃
Maximum Off-State Voltage	V_{DRM}			190	V
Surge On-State Current	I_{TSM}	10/1000 μs	Non-repetitive	100	A
		10/200 μs		150	
		8/20 μs		250	

Electrical Characteristics T_j=25℃

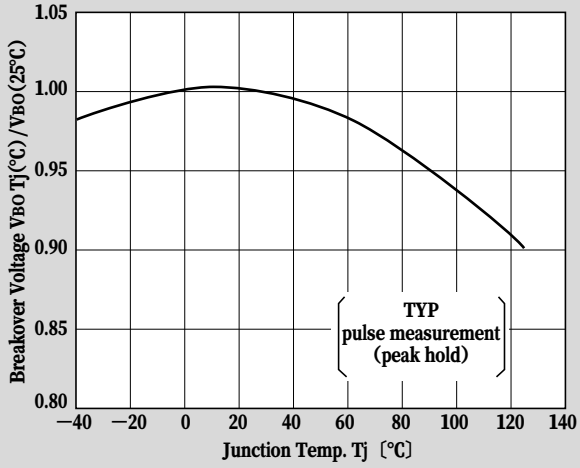
Breakover Voltage	V_{BO}	Pulse measurement (Peak hold)	MIN 220	V
Off-State Current	I_{DRM}	$V_D=V_{DRM}$	MAX 10	μA
Holding Current	I_H	Pulse measurement	MIN 100	mA
On-State Voltage	V_T	I_T=2A	TYP 1.60	V
Junction Capacitance	Cj	f=1kHz OSC=1Vrms V_D=50V	MAX 90	pF
Clamping Voltage	V_{CL}	dv/dt=100V/μs	MAX 290	V

■CHARACTERISTIC DIAGRAMS

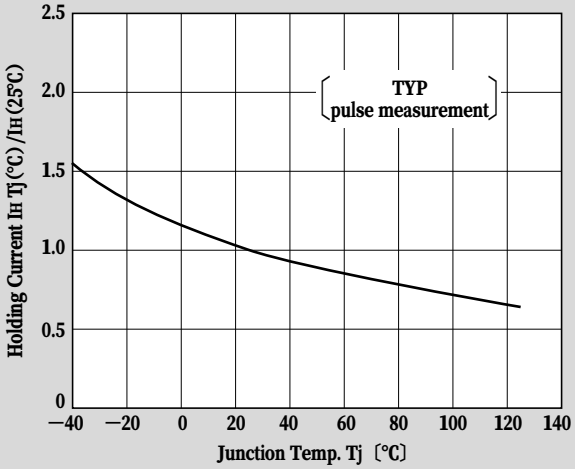
On-State Voltage—On-State Current



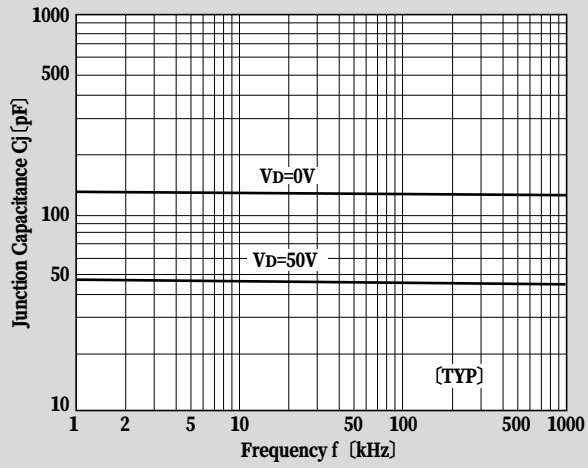
Breakover Voltage



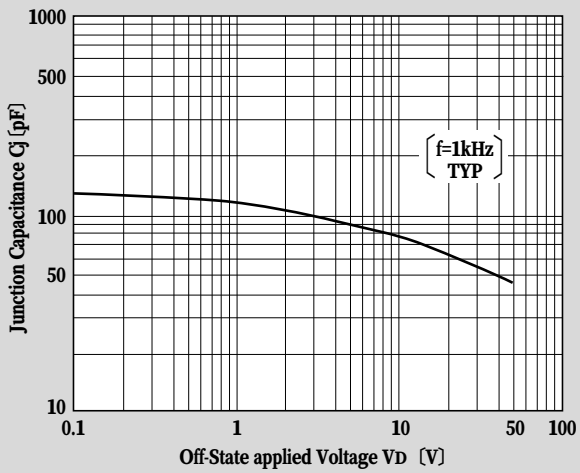
Holding Current



Junction Capacitance f-Cj



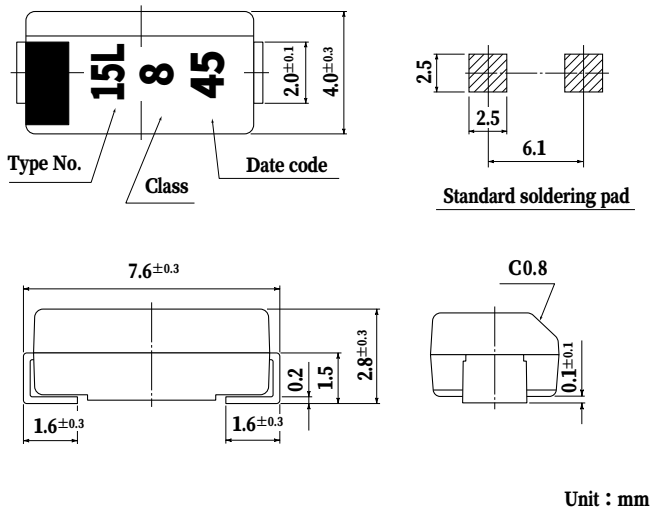
Junction Capacitance VD-Cj



KP15L08

■OUTLINE DIMENSIONS

Package : 2F



■RATINGS

Absolute Maximum Ratings

Item	Symbol	Conditions / Type No.		KP15L08☆	Unit
Storage Temperature	Tstg			−40～125	℃
Junction Temperature	Tj			125	℃
Maximum Off-State Voltage	V_{DRM}			63	V
Surge On-State Current	I_{TSM}	10/1000 μs	Non-repetitive	150	A
		10/200 μs		200	
		8/20 μs		300	

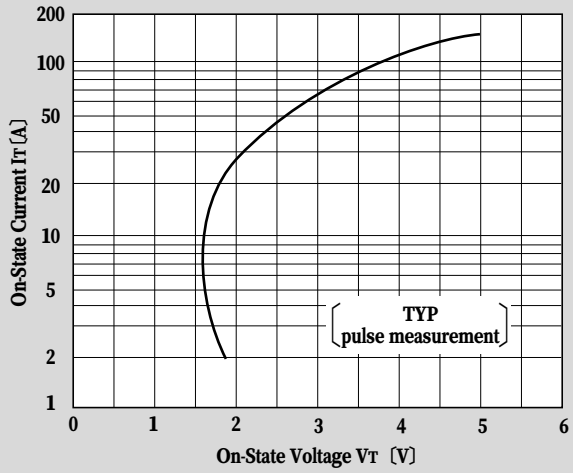
Electrical Characteristics T_j=25℃

Breakover Voltage	V_{BO}	Pulse measurement (Peak hold)	MIN 70	V
Off-State Current	I_{DRM}	$V_D=V_{DRM}$	MAX 10	μA
Holding Current	I_H	Pulse measurement	MIN 100	mA
On-State Voltage	V_T	I_T=2A	TYP 1.85	V
Junction Capacitance	Cj	f=1kHz OSC=1Vrms V_D=50V	MAX 180	pF
Clamping Voltage	V_{CL}	dv/dt=100V/μs	MAX 100	V

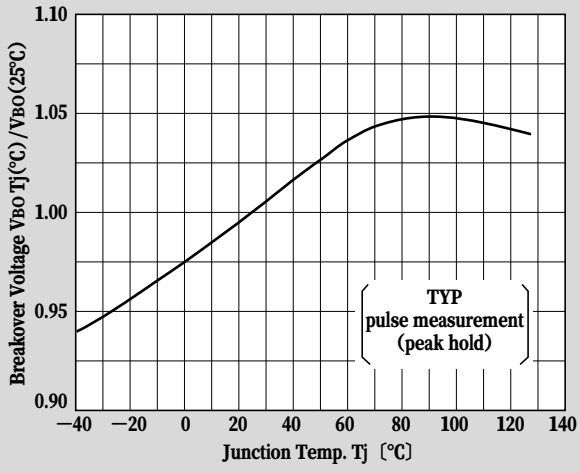
☆ : New product

■CHARACTERISTIC DIAGRAMS

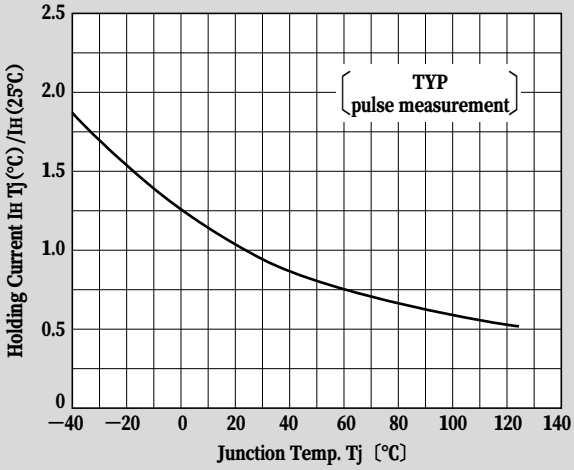
On-State Voltage—On-State Current



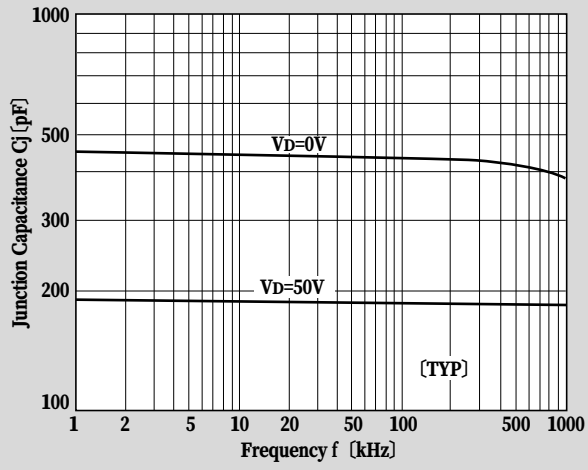
Breakover Voltage



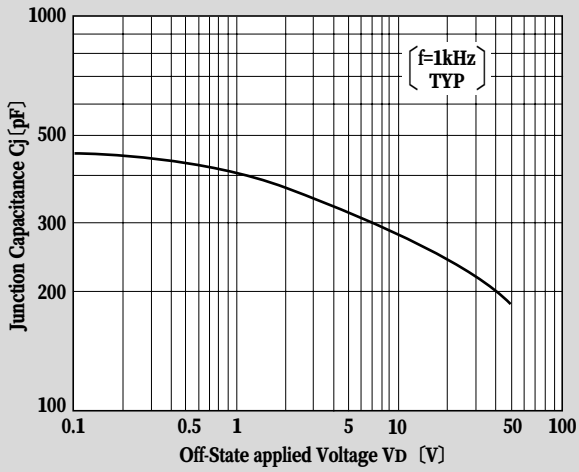
Holding Current



Junction Capacitance f-Cj



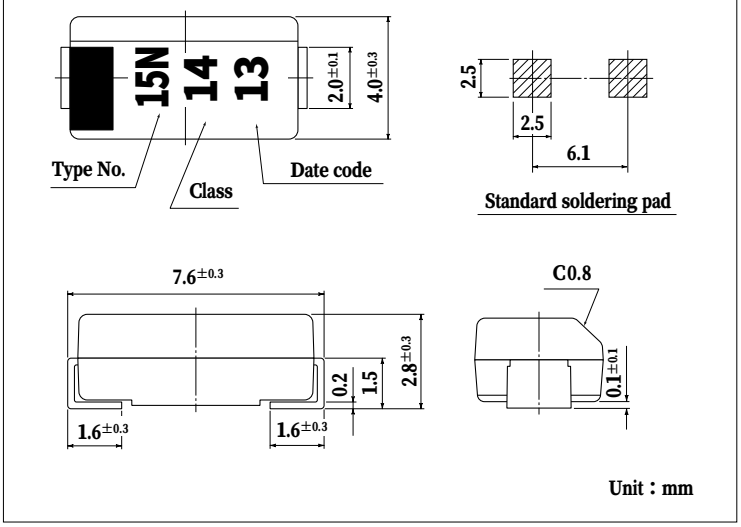
Junction Capacitance VD-Cj



KP15N14

■OUTLINE DIMENSIONS

Package : 2F



■RATINGS

Absolute Maximum Ratings

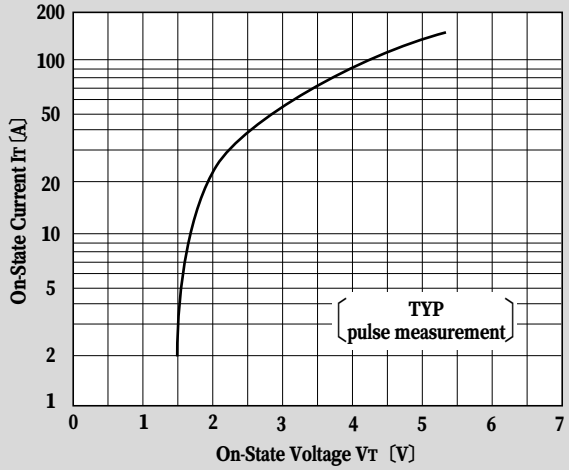
Item	Symbol	Conditions \ Type No.		KP15N14	Unit
Storage Temperature	Tstg			−40～125	℃
Junction Temperature	Tj			125	℃
Maximum Off-State Voltage	V_{DRM}			120	V
Surge On-State Current	I_{TSM}	10/1000 μs	Non-repetitive	150	A
		10/200 μs		200	
		8/20 μs		300	

Electrical Characteristics T_j=25℃

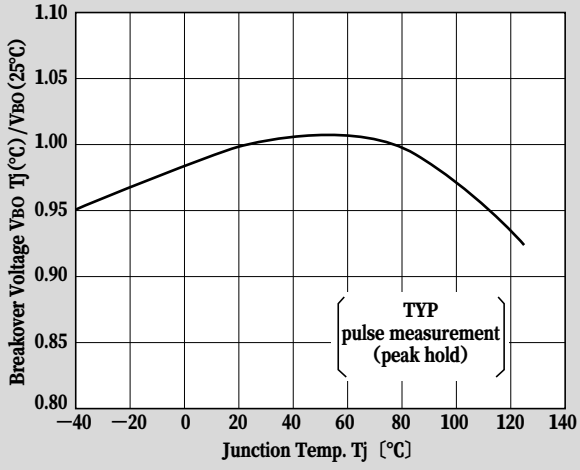
Breakover Voltage	V_{BO}	Pulse measurement (Peak hold)	MIN 130	V
Off-State Current	I_{DRM}	$V_D=V_{DRM}$	MAX 10	μA
Holding Current	I_H	Pulse measurement	MIN 100	mA
On-State Voltage	V_T	I_T=2A	TYP 1.45	V
Junction Capacitance	Cj	f=1kHz OSC=1Vrms V_D=50V	MAX 200	pF
Clamping Voltage	V_{CL}	dv/dt=100V/μs	MAX 195	V

■CHARACTERISTIC DIAGRAMS

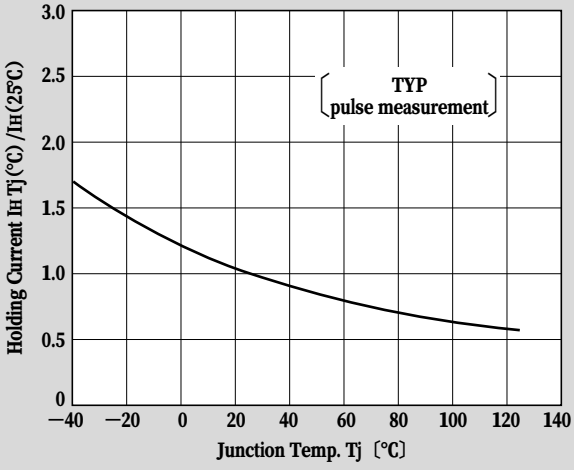
On-State Voltage—On-State Current



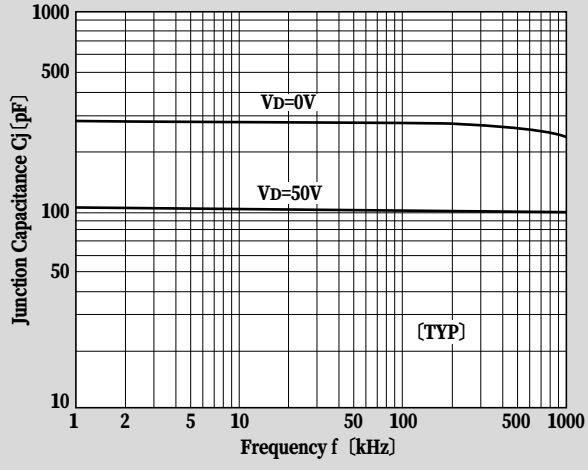
Breakover Voltage



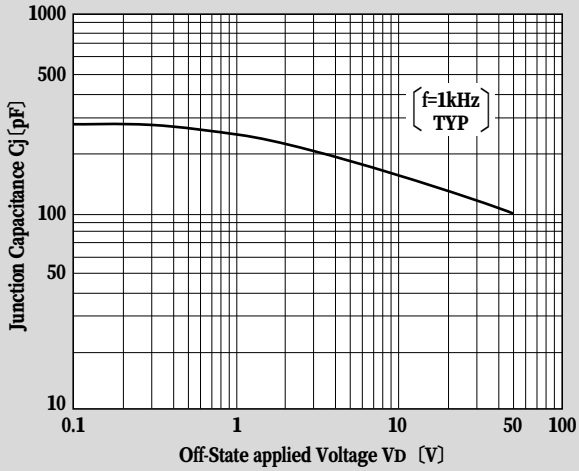
Holding Current



Junction Capacitance f-Cj

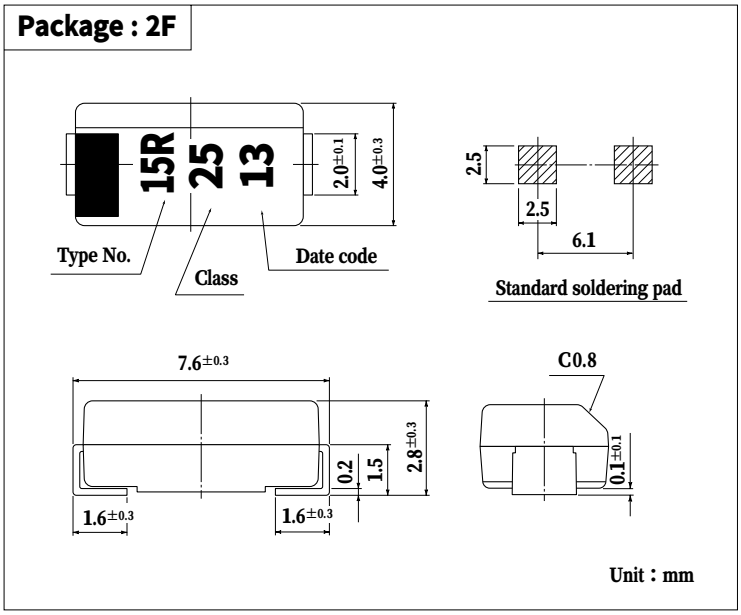


Junction Capacitance VD-Cj



KP15R25

■OUTLINE DIMENSIONS



■RATINGS

Absolute Maximum Ratings

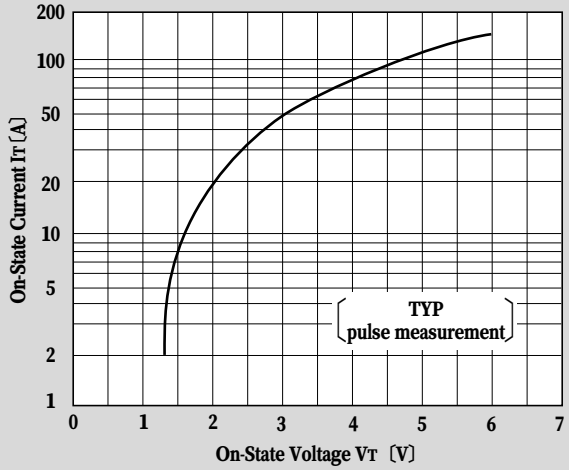
Item	Symbol	Conditions \ Type No.		KP15R25	Unit
Storage Temperature	Tstg			−40～125	℃
Junction Temperature	Tj			125	℃
Maximum Off-State Voltage	V_{DRM}			190	V
Surge On-State Current	I_{TSM}	10/1000 μs	Non-repetitive	150	A
		10/200 μs		200	
		8/20 μs		300	

Electrical Characteristics T_j=25℃

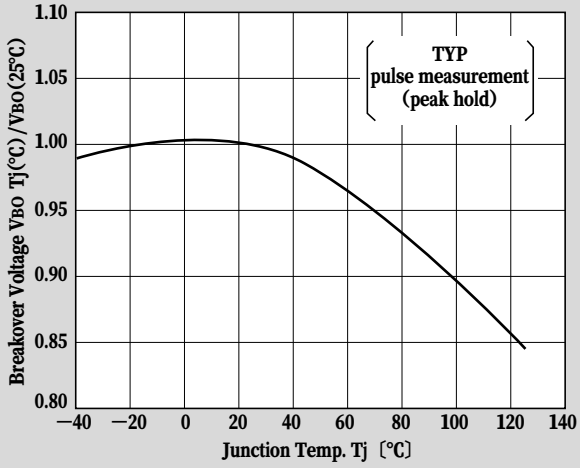
Breakover Voltage	V_{BO}	Pulse measurement (Peak hold)	MIN 220	V
Off-State Current	I_{DRM}	$V_D=V_{DRM}$	MAX 10	μA
Holding Current	I_H	Pulse measurement	MIN 100	mA
On-State Voltage	V_T	I_T=2A	TYP 1.35	V
Junction Capacitance	Cj	f=1kHz OSC=1Vrms V_D=50V	MAX 150	pF
Clamping Voltage	V_{CL}	dv/dt=100V/μs	MAX 290	V

■CHARACTERISTIC DIAGRAMS

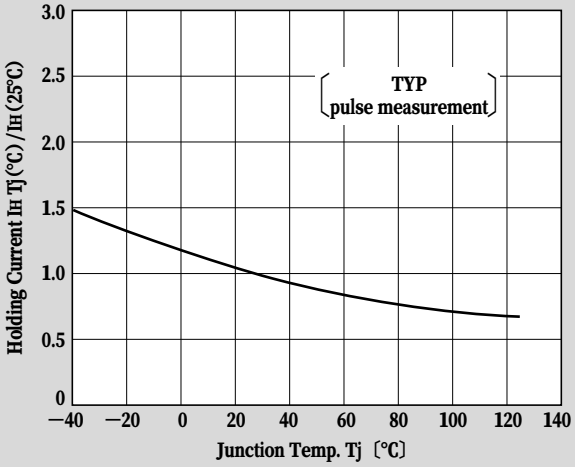
On-State Voltage—On-State Current



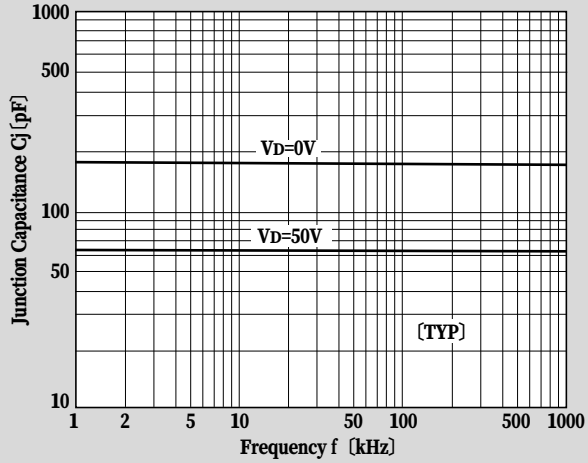
Breakover Voltage



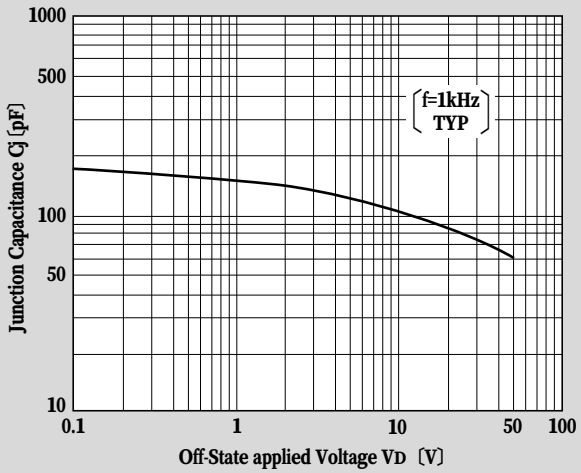
Holding Current



Junction Capacitance f-Cj



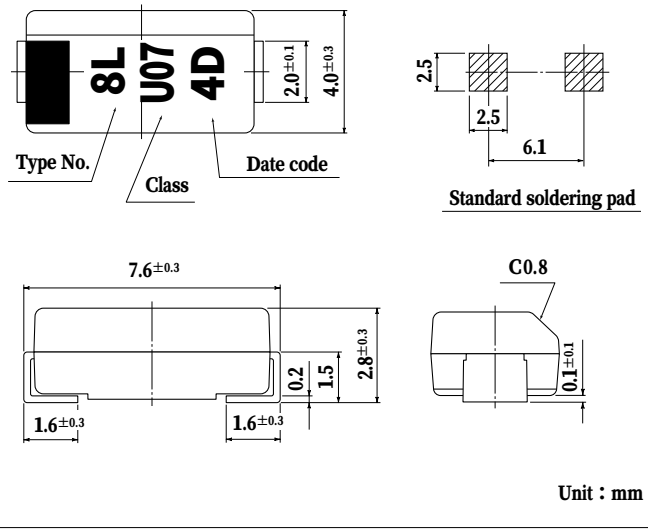
Junction Capacitance VD-Cj



KP8LU07

■OUTLINE DIMENSIONS

Package : 2F



Unit : mm

■RATINGS

Absolute Maximum Ratings

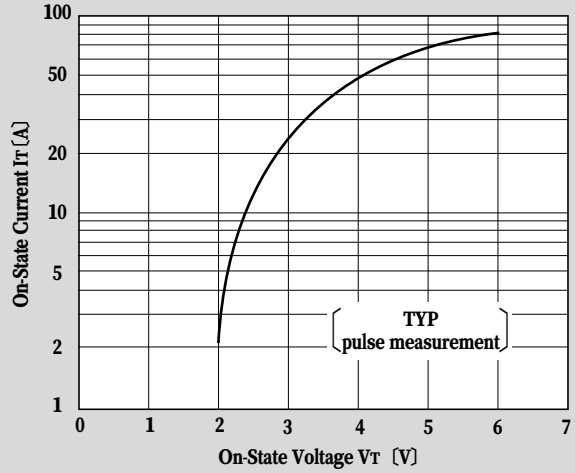
Item	Symbol	Conditions / Type No.		KP8LU07	Unit
Storage Temperature	Tstg			−40～125	℃
Junction Temperature	Tj			125	℃
Maximum Off-State Voltage	V_{DRM}			58	V
Surge On-State Current	I_{TSM}	10/1000 μs	Non-repetitive	80	A
		8/20 μs		200	
Surge On-State Current	I_{FSM}	10/1000 μs		80	

Electrical Characteristics T_j=25℃

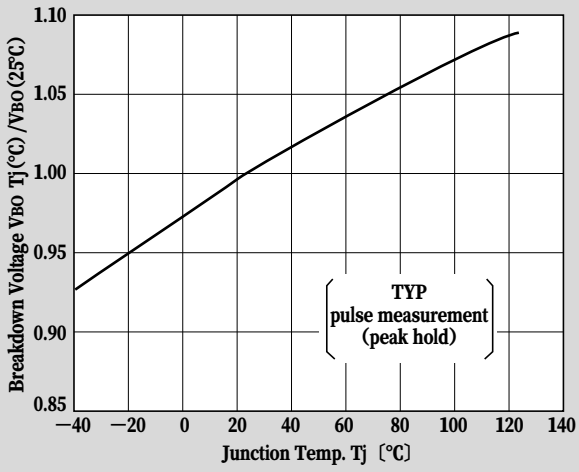
Breakdown Voltage	V_{BR}	I_{BR}=1mA	MIN 65	V
Off-State Current	I_{DRM}	V_D=V_{DRM}	MAX 10	μA
Holding Current	I_H	Pulse measurement	MIN 100	mA
On-State Voltage	V_T	I_T=2A	TYP 2.0	V
Forward Voltage	V_F	I_F=2A	TYP 1.25	V
Junction Capacitance	Cj	f=1kHz OSC=20mVrms V_D=50V	MAX 100	pF
Clamping Voltage	V_{CL}	dv/dt=100V/μs	MAX 80	V

■CHARACTERISTIC DIAGRAMS

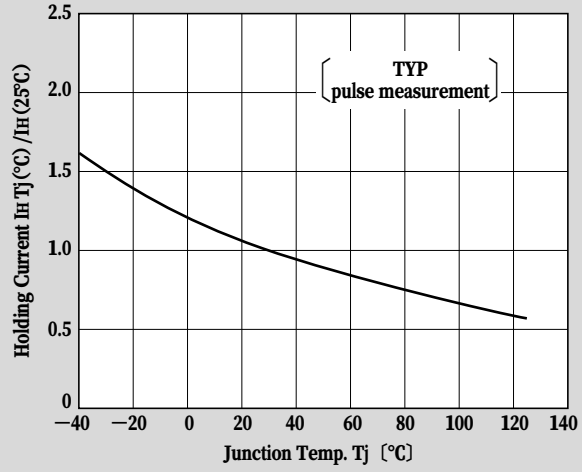
On-State Voltage—On-State Current



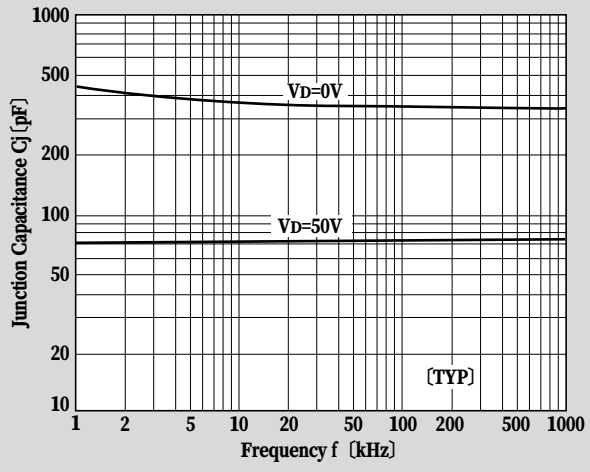
Breakdown Voltage



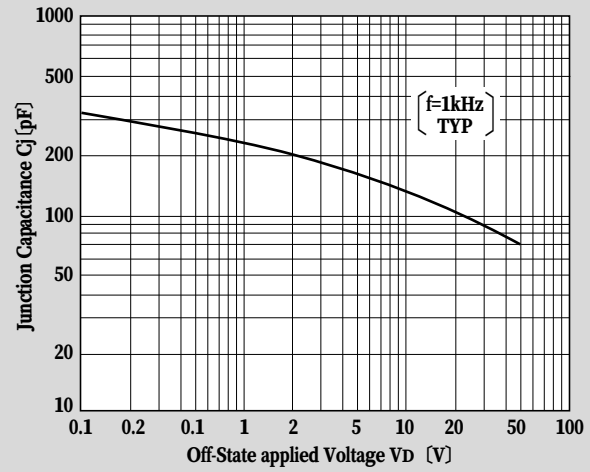
Holding Current



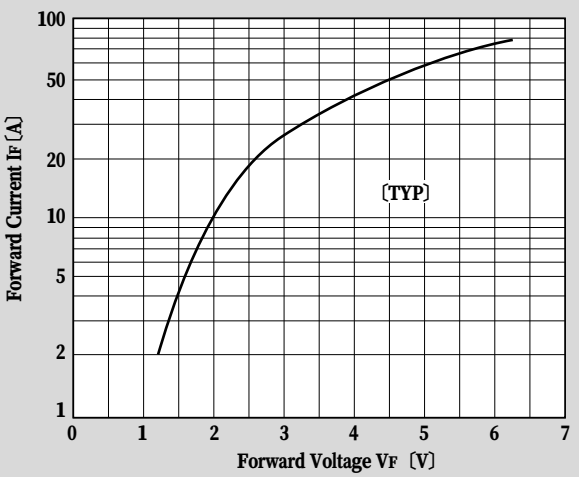
Junction Capacitance f-Cj



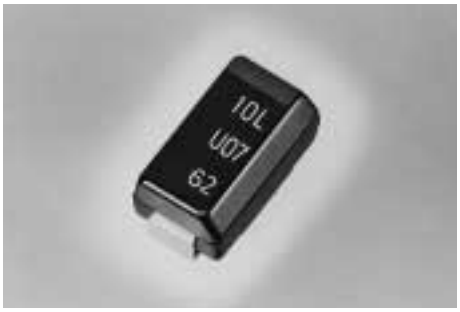
Junction Capacitance VD-Cj



Forward Voltage—Forward Current

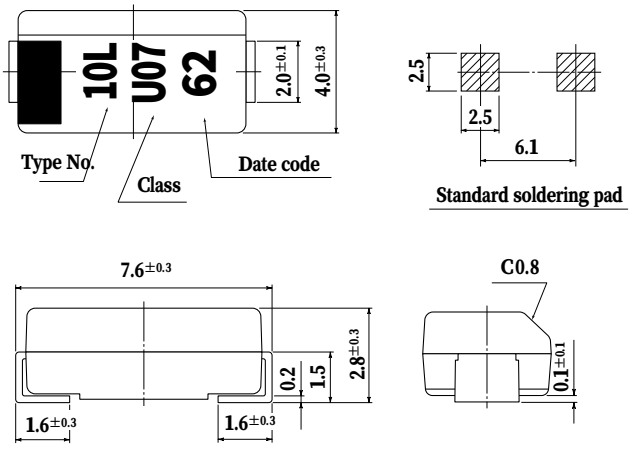


KP10LU07



■OUTLINE DIMENSIONS

Package : 2F



Unit : mm

■RATINGS

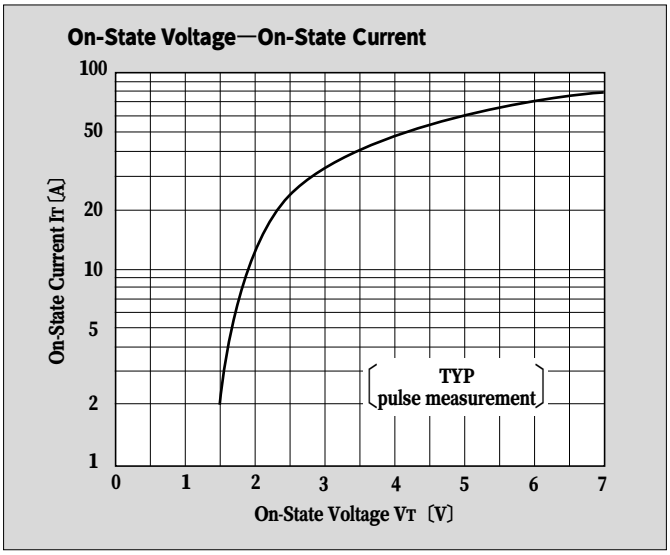
Absolute Maximum Ratings

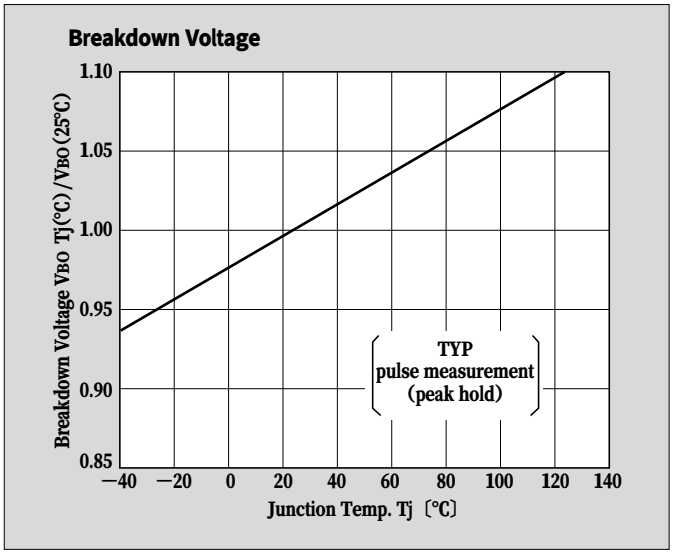
Item	Symbol	Conditions / Type No.		KP10LU07	Unit
Storage Temperature	Tstg			−40～125	℃
Junction Temperature	Tj			125	℃
Maximum Off-State Voltage	V_{DRM}			58	V
Surge On-State Current	I_{TSM}	10/1000 μs	Non-repetitive	100	A
		8/20 μs		250	
Surge On-State Current	I_{FSM}	10/1000 μs		100	

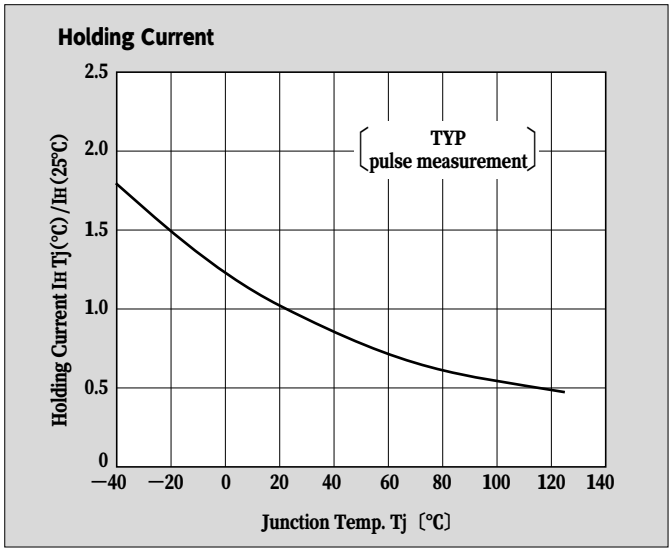
Electrical Characteristics T_j=25℃

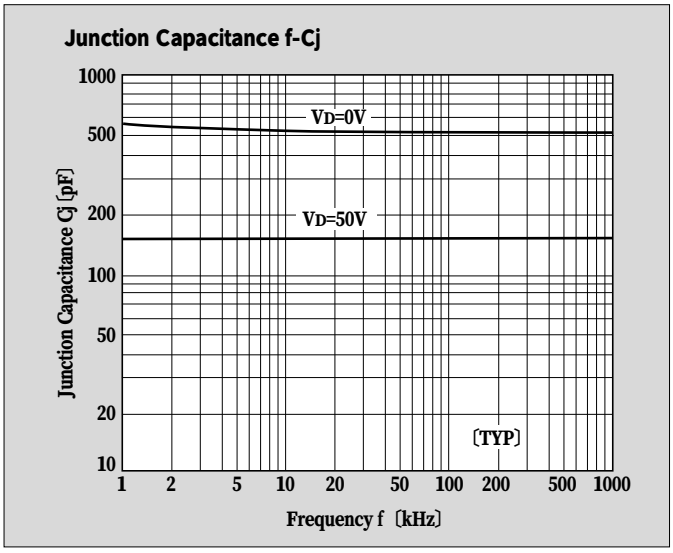
Breakdown Voltage	V_{BR}	I_{BR}=1mA	MIN 62	V
Off-State Current	I_{DRM}	V_D=V_{DRM}	MAX 10	μA
Holding Current	I_H	Pulse measurement	MIN 100	mA
On-State Voltage	V_T	I_T=2A	TYP 2.0	V
Forward Voltage	V_F	I_F=2A	TYP 1.25	V
Junction Capacitance	Cj	f=1kHz OSC=20mVrms V_D=50V	MAX 200	pF
Clamping Voltage	V_{CL}	dv/dt=100V/ μs	MAX 80	V

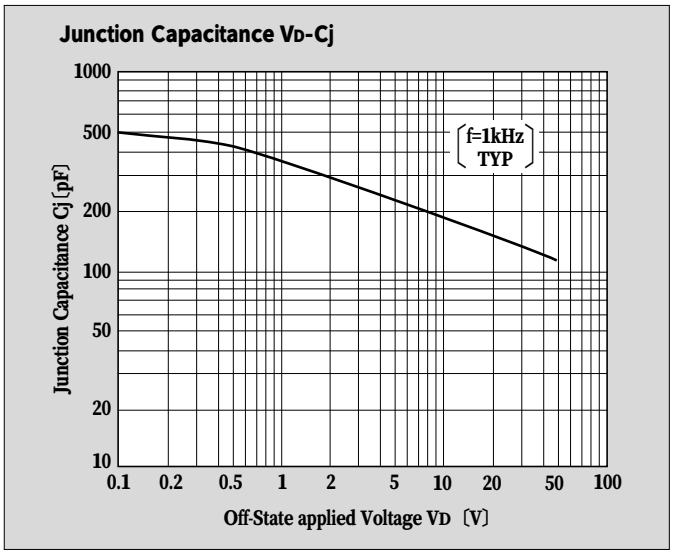
■CHARACTERISTIC DIAGRAMS

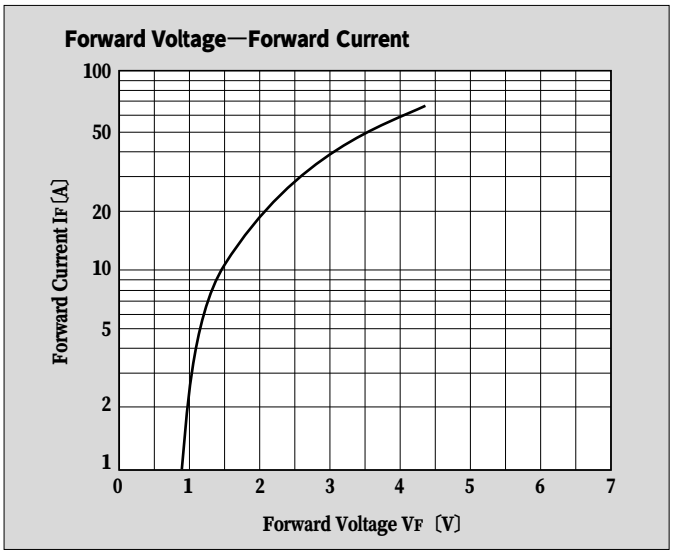




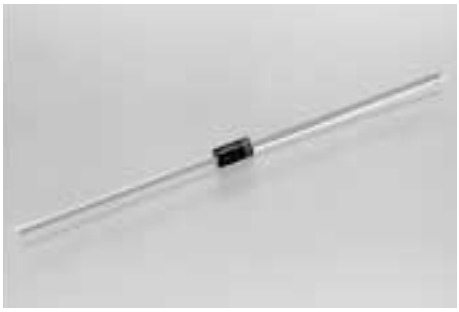






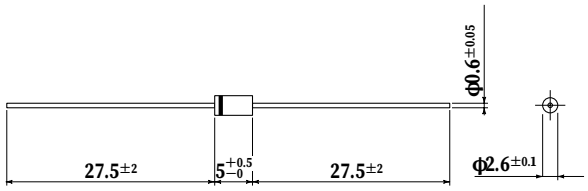


KA3Z07, 18

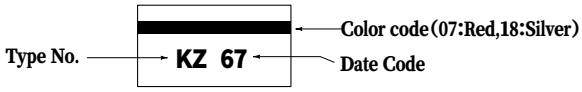


■OUTLINE DIMENSIONS

Package : AX06



●Marking



Unit : mm

■RATINGS

Absolute Maximum Ratings

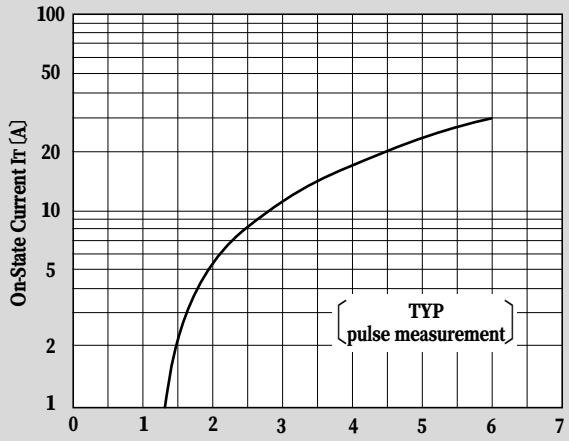
Item	Symbol	Conditions / Type No.		KA3Z07	KA3Z18	Unit
Storage Temperature	Tstg			−40～125		℃
Junction Temperature	Tj			125		℃
Maximum Off-State Voltage	V_{DRM}			5	15	V
Surge On-State Current	I_{TSM}	10/1000 μs	Non-repetitive	30		A
		8/20 μs		150		

Electrical Characteristics T_j=25℃

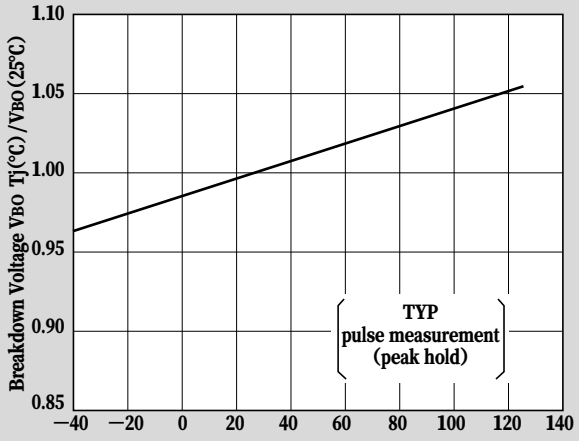
Breakdown Voltage	V_{BR}	I_{BR}=1mA	MIN 5.5	MIN 15.5	V
Off-State Current	I_{DRM}	V_D=V_{DRM}	MAX 10		μA
Holding Current	I_H	Pulse measurement	MIN 50		mA
On-State Voltage	V_T	I_T=2A	TYP 1.5		V
Junction Capacitance	Cj	f=1kHz OSC=20mVrms V_D=0V	MAX 100		pF

■CHARACTERISTIC DIAGRAMS

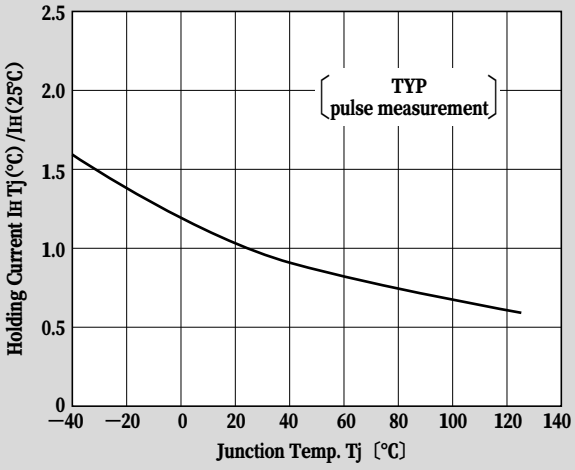
On-State Voltage—On-State Current



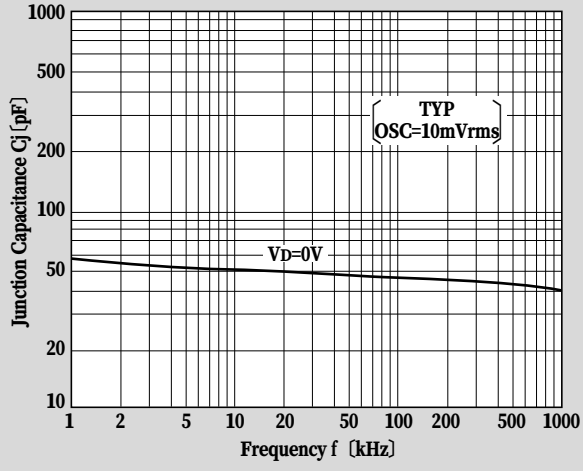
Breakdown Voltage



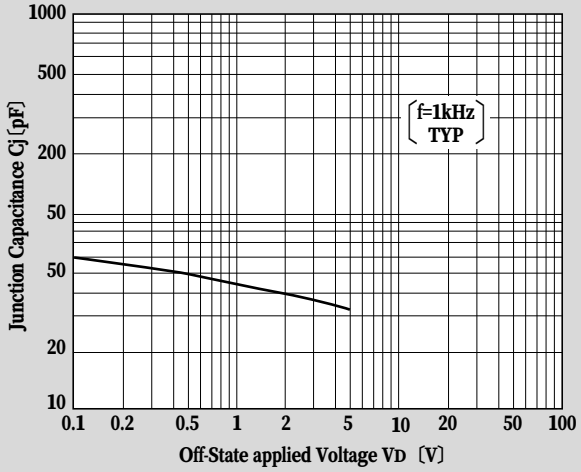
Holding Current



Junction Capacitance f-Cj



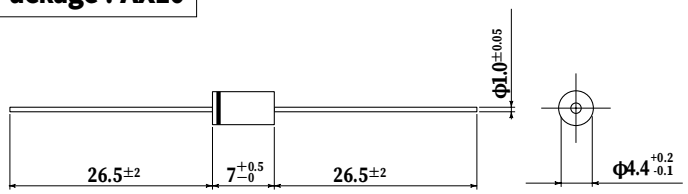
Junction Capacitance VD-Cj



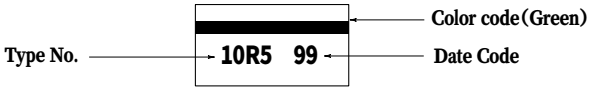
KA10R25

■OUTLINE DIMENSIONS

Package : AX10



●Marking



Unit : mm

■RATINGS

Absolute Maximum Ratings

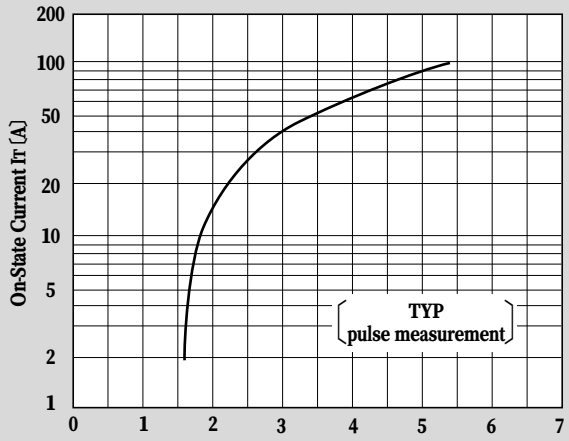
Item	Symbol	Conditions / Type No.		KA10R25	Unit
Storage Temperature	Tstg			−40～125	℃
Junction Temperature	Tj			125	℃
Maximum Off-State Voltage	V_{DRM}			190	V
Surge On-State Current	I_{TSM}	10/1000 μs	Non-repetitive	100	A
		8/20 μs		250	

Electrical Characteristics T_j=25℃

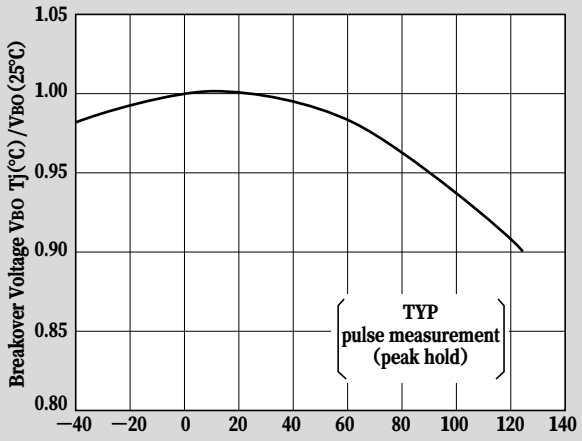
Breakover Voltage	V_{BO}	Pulse measurement (Peak hold)	MIN 220	V
Off-State Current	I_{DRM}	$V_D=V_{DRM}$	MAX 10	μA
Holding Current	I_H	Pulse measurement	MIN 100	mA
On-State Voltage	V_T	I_T=2A	TYP 1.60	V
Junction Capacitance	Cj	f=1kHz OSC=1Vrms V_D=50V	MAX 90	pF
Clamping Voltage	V_{CL}	dv/dt=100V/μs	MAX 290	V

■CHARACTERISTIC DIAGRAMS

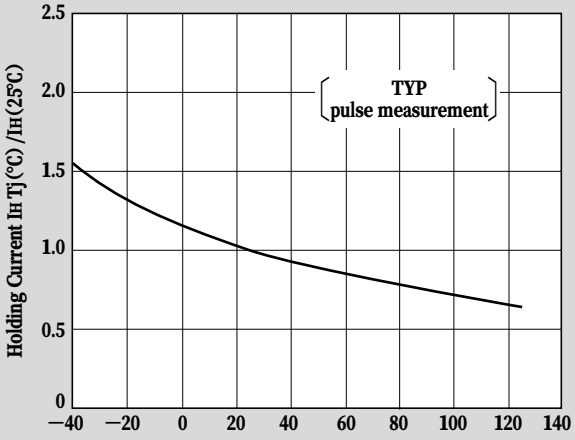
On-State Voltage—On-State Current



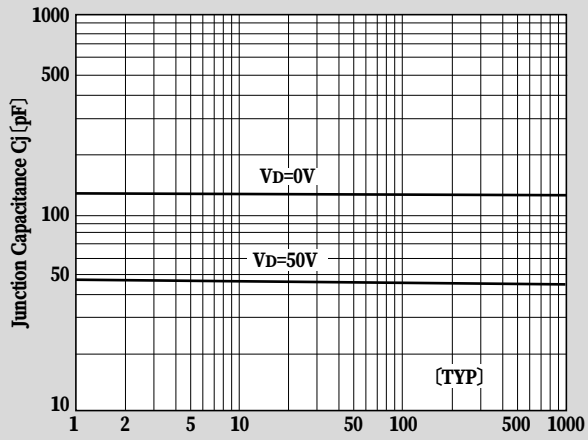
Breakover Voltage



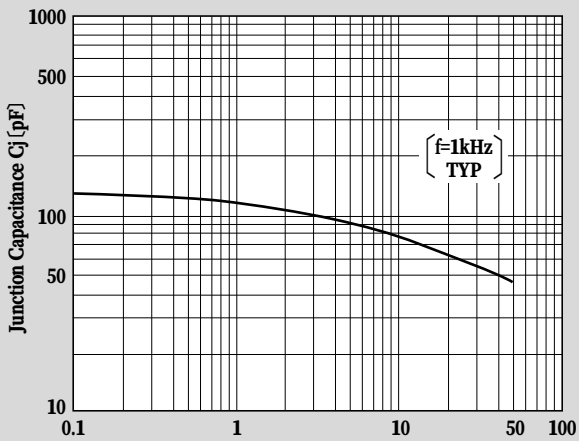
Holding Current



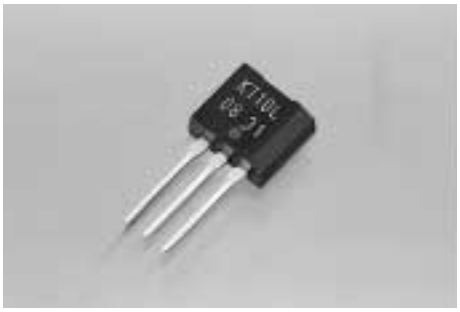
Junction Capacitance f-Cj



Junction Capacitance VD-Cj

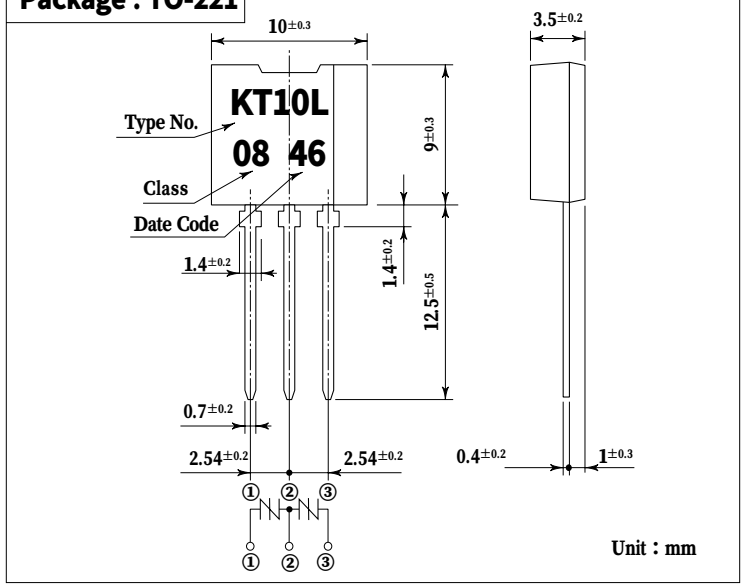


KT10L07, 08



■OUTLINE DIMENSIONS

Package : TO-221



■RATINGS

Absolute Maximum Ratings

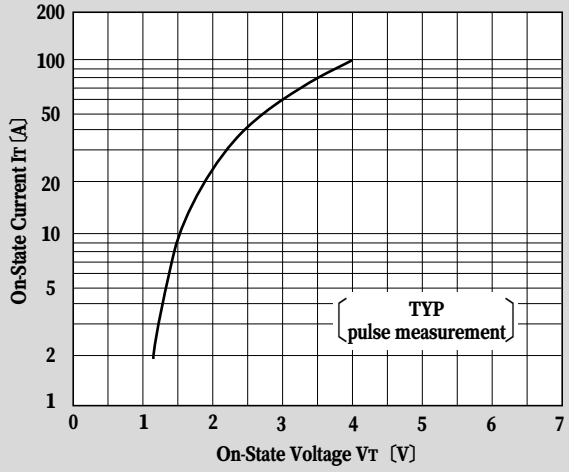
Item	Symbol	Conditions / Type No.		KT10L07	KT10L08	Unit
Storage Temperature	Tstg			−40～125		℃
Junction Temperature	Tj			125		℃
Maximum Off-State Voltage	V_{DRM}			58	63	V
Surge On-State Current	I_{TSM}	10/1000 μs	Non-repetitive	100		A
		10/200 μs		150		
		8/20 μs		250		

Electrical Characteristics T_j=25℃ Terminal No.①—②、③—②

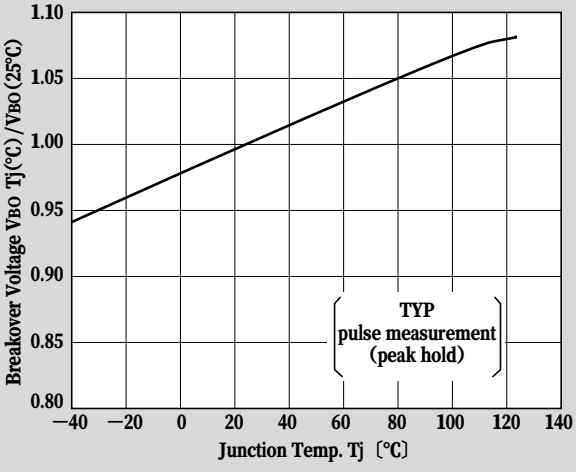
Breakover Voltage	V_{BO}	Pulse measurement (Peak hold)	MIN 65	MIN 70	V
Off-State Current	I_{DRM}	V_D=V_{DRM}	MAX 10		μA
Holding Current	I_H	Pulse measurement	MIN 100		mA
On-State Voltage	V_T	I_T=2A	TYP 1.15		V
Junction Capacitance	Cj	f=1kHz OSC=1Vrms V_D=50V	MAX 180		pF
Clamping Voltage	V_{CL}	dv/dt=100V/μs	MAX 80	MAX 100	V

■CHARACTERISTIC DIAGRAMS

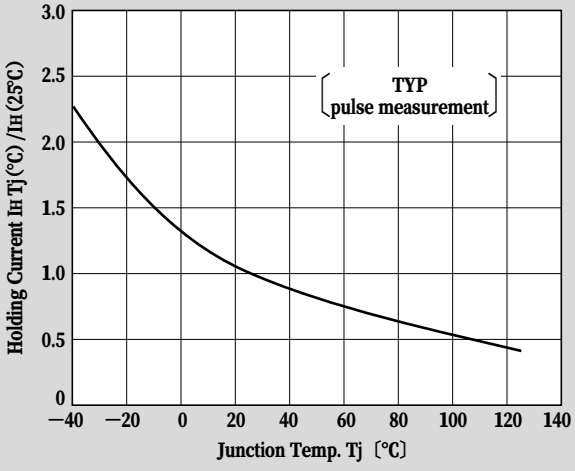
On-State Voltage—On-State Current



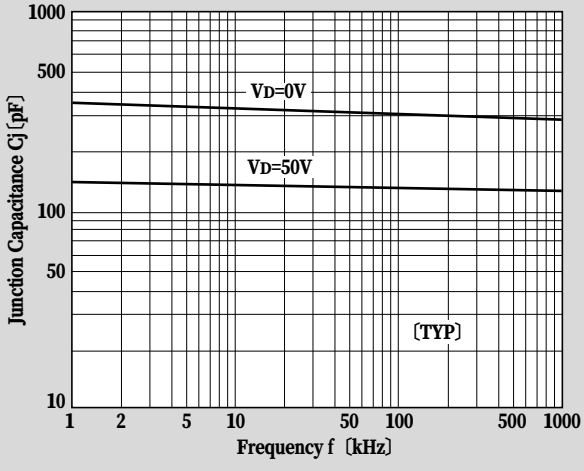
Breakover Voltage



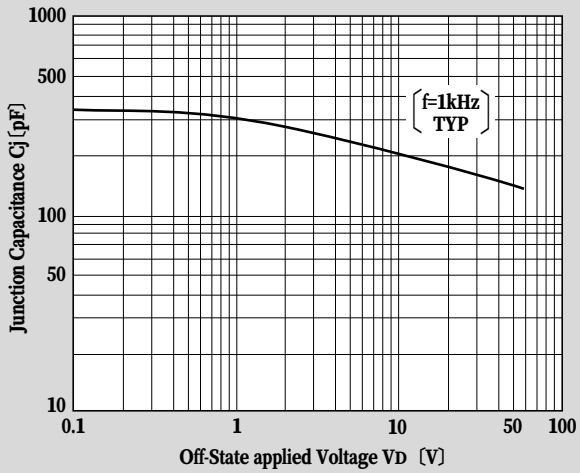
Holding Current



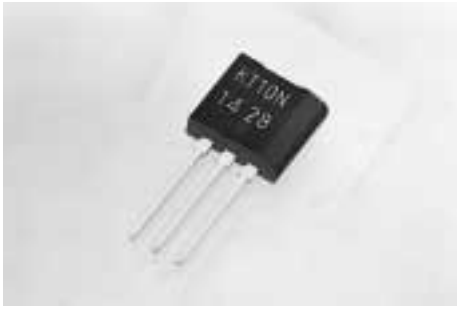
Junction Capacitance f-Cj



Junction Capacitance VD-Cj

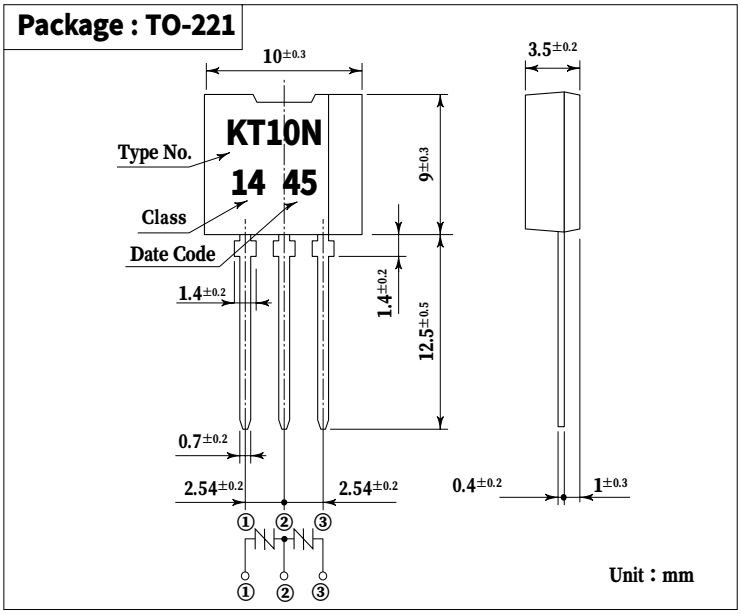


KT10N14



■OUTLINE DIMENSIONS

Package : TO-221



■RATINGS

Absolute Maximum Ratings

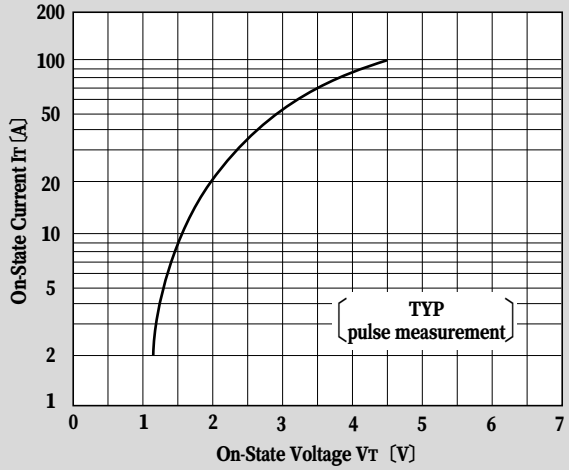
Item	Symbol	Conditions / Type No.		KT10N14	Unit
Storage Temperature	Tstg			−40～125	℃
Junction Temperature	Tj			125	℃
Maximum Off-State Voltage	V_{DRM}			120	V
Surge On-State Current	I_{TSM}	10/1000 μs	Non-repetitive	100	A
		10/200 μs		150	
		8/20 μs		250	

Electrical Characteristics T_j=25℃ Terminal No.①—②、③—②

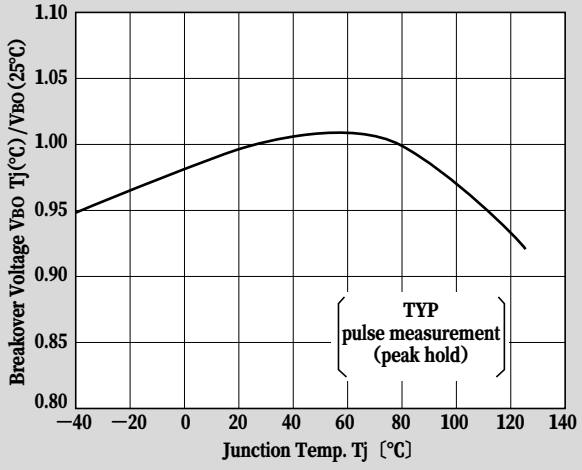
Breakover Voltage	V_{BO}	Pulse measurement (Peak hold)	MIN 130	V
Off-State Current	I_{DRM}	$V_D=V_{DRM}$	MAX 10	μA
Holding Current	I_H	Pulse measurement	MIN 100	mA
On-State Voltage	V_T	I_T=2A	TYP 1.15	V
Junction Capacitance	Cj	f=1kHz OSC=1Vrms V_D=50V	MAX 140	pF
Clamping Voltage	V_{CL}	dv/dt=100V/μs	MAX 195	V

■CHARACTERISTIC DIAGRAMS

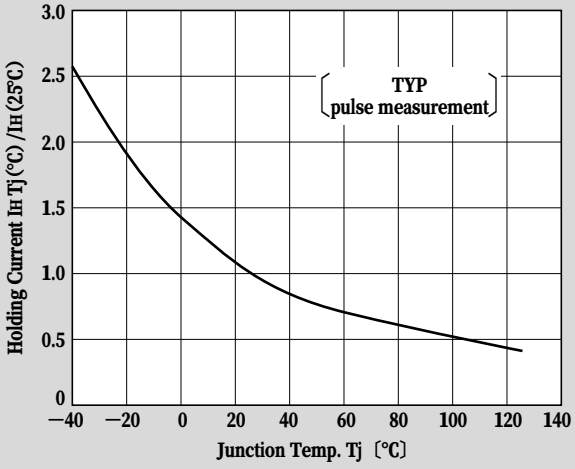
On-State Voltage—On-State Current



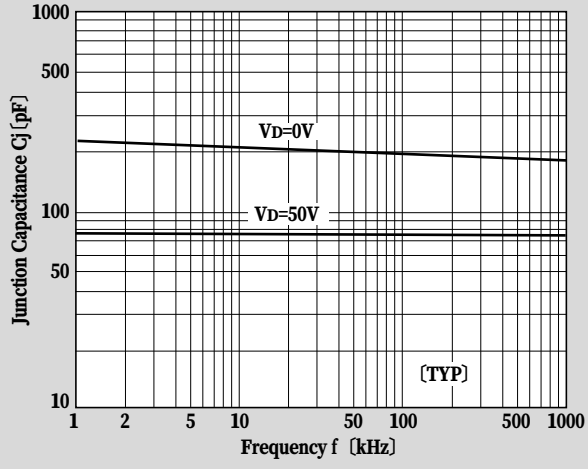
Breakover Voltage



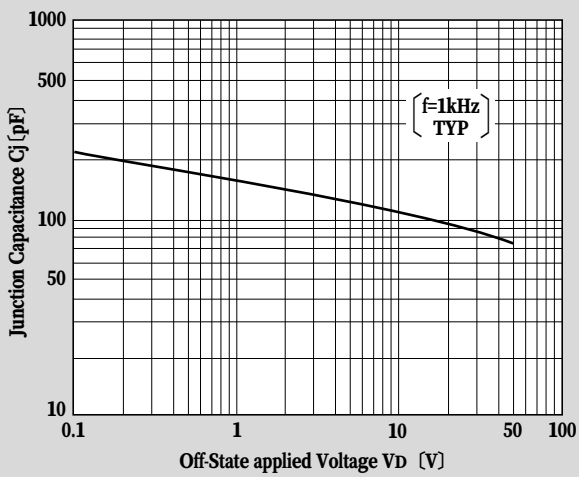
Holding Current



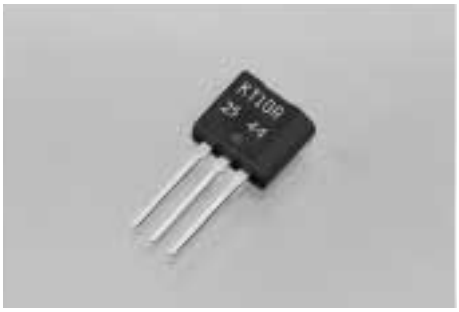
Junction Capacitance f-Cj



Junction Capacitance VD-Cj

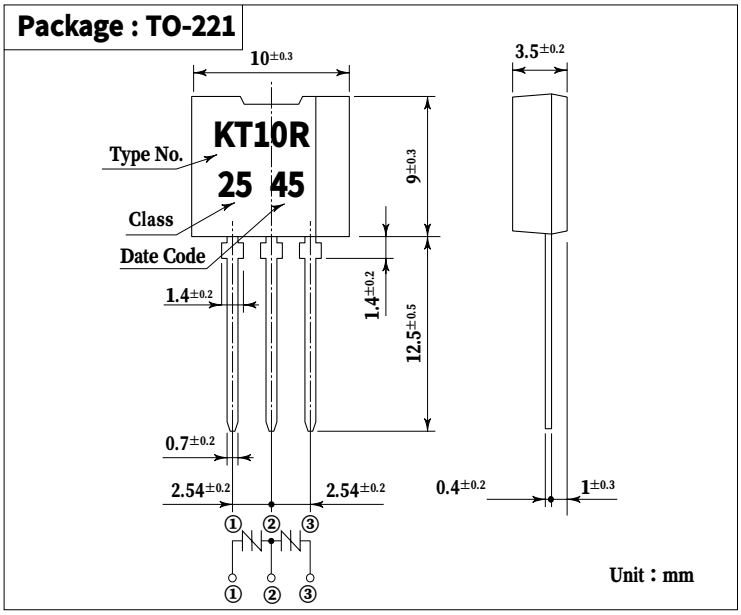


KT10R25



■OUTLINE DIMENSIONS

Package : TO-221



■RATINGS

Absolute Maximum Ratings

Item	Symbol	Conditions / Type No.		KT10R25☆	Unit
Storage Temperature	Tstg			−40～125	℃
Junction Temperature	Tj			125	℃
Maximum Off-State Voltage	V_{DRM}			190	V
Surge On-State Current	I_{TSM}	10/1000 μs	Non-repetitive	100	A
		10/200 μs		150	
		8/20 μs		250	

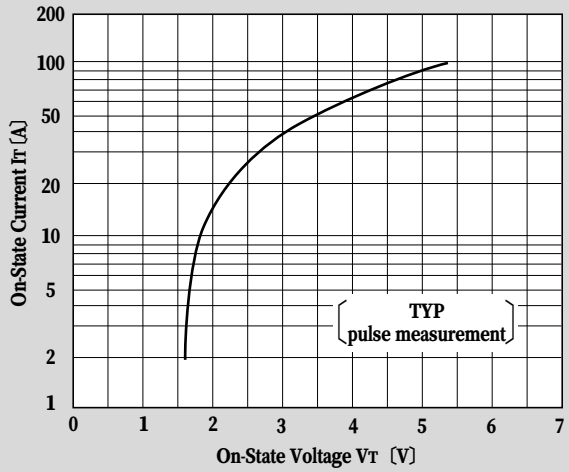
Electrical Characteristics T_j=25℃ Terminal No.①—②、③—②

Breakover Voltage	V_{BO}	Pulse measurement (Peak hold)	MIN 220	V
Off-State Current	I_{DRM}	$V_D=V_{DRM}$	MAX 10	μA
Holding Current	I_H	Pulse measurement	MIN 100	mA
On-State Voltage	V_T	I_T=2A	TYP 1.60	V
Junction Capacitance	Cj	f=1kHz OSC=1Vrms V_D=50V	MAX 90	pF
Clamping Voltage	V_{CL}	dv/dt=100V/ μs	MAX 290	V

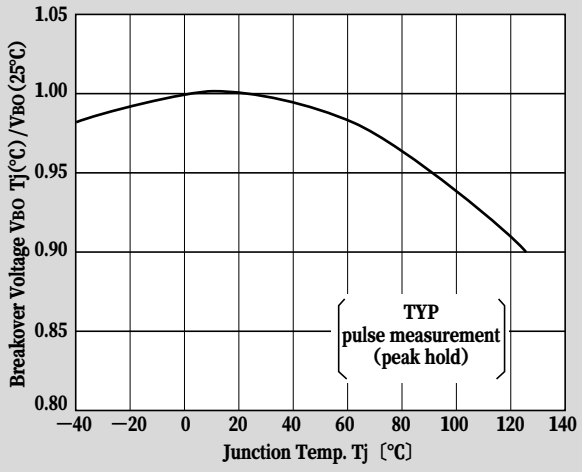
☆ : New Producut

■CHARACTERISTIC DIAGRAMS

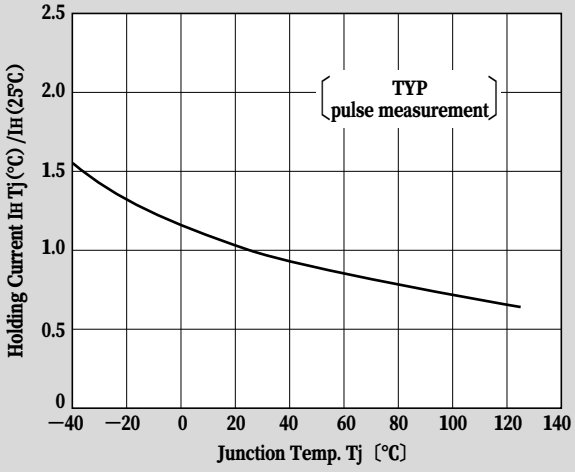
On-State Voltage—On-State Current



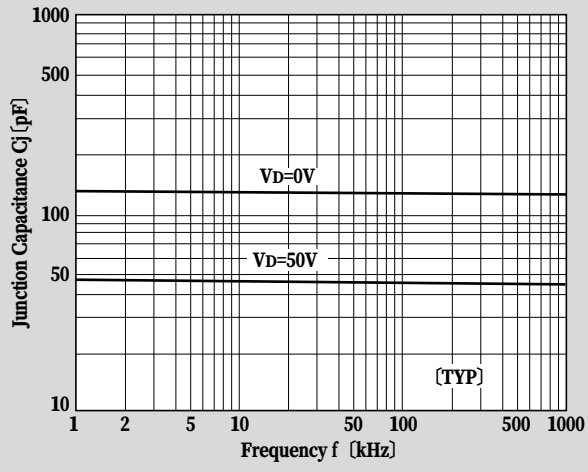
Breakover Voltage



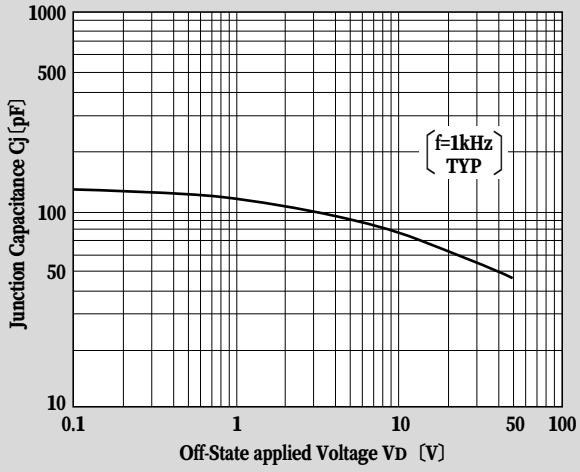
Holding Current



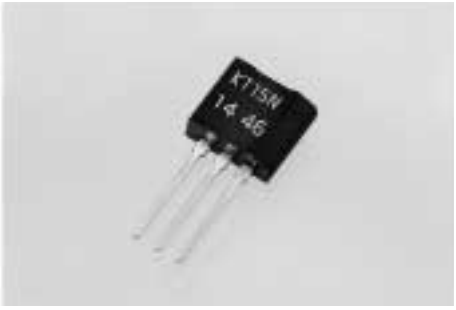
Junction Capacitance f-Cj



Junction Capacitance VD-Cj

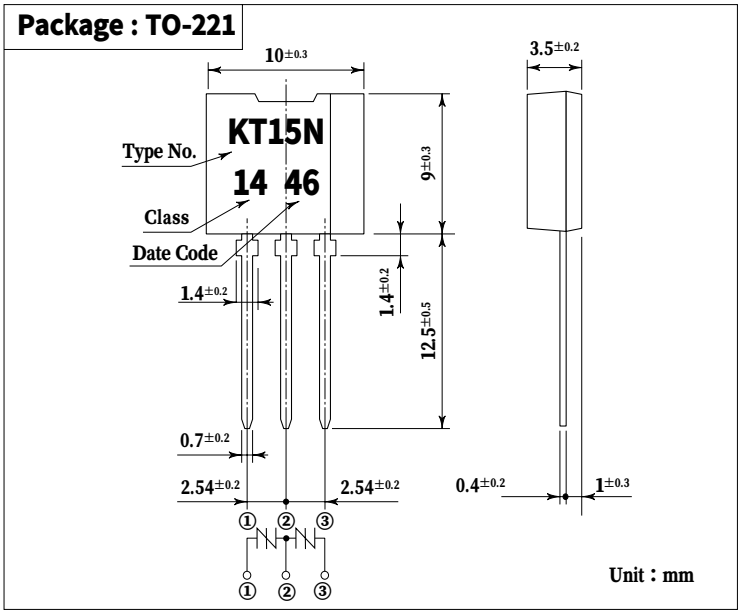


KT15N14



■OUTLINE DIMENSIONS

Package : TO-221



■RATINGS

Absolute Maximum Ratings

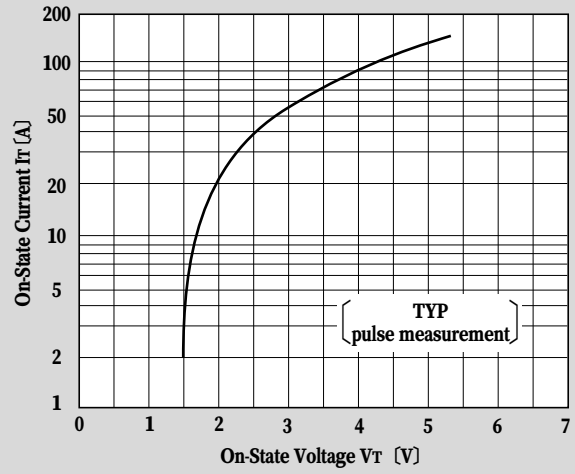
Item	Symbol	Conditions / Type No.		KT15N14	Unit
Storage Temperature	Tstg			−40～125	℃
Junction Temperature	Tj			125	℃
Maximum Off-State Voltage	V_{DRM}			120	V
Surge On-State Current	I_{TSM}	10/1000 μs	Non-repetitive	150	A
		10/200 μs		200	
		8/20 μs		300	

Electrical Characteristics T_j=25℃ Terminal No.①—②、③—②

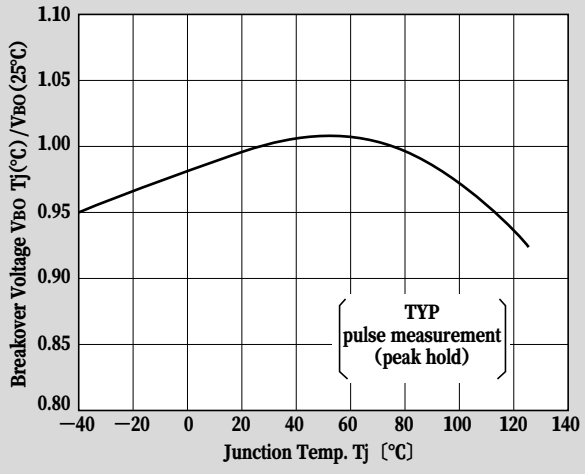
Breakover Voltage	V_{BO}	Pulse measurement (Peak hold)	MIN 130	V
Off-State Current	I_{DRM}	$V_D=V_{DRM}$	MAX 10	μA
Holding Current	I_H	Pulse measurement	MIN 100	mA
On-State Voltage	V_T	I_T=2A	TYP 1.45	V
Junction Capacitance	Cj	f=1kHz OSC=1Vrms V_D=50V	MAX 200	pF
Clamping Voltage	V_{CL}	dv/dt=100V/μs	MAX 195	V

■CHARACTERISTIC DIAGRAMS

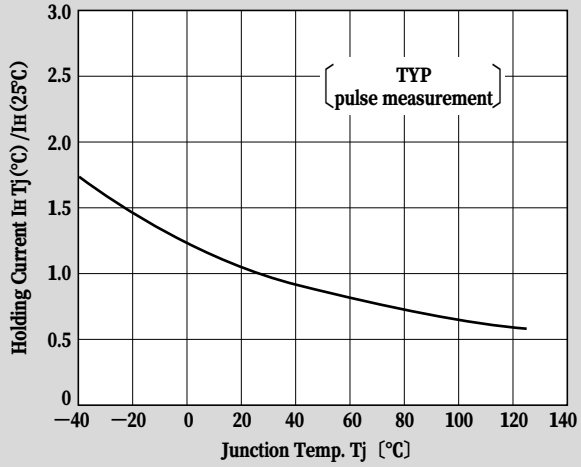
On-State Voltage—On-State Current



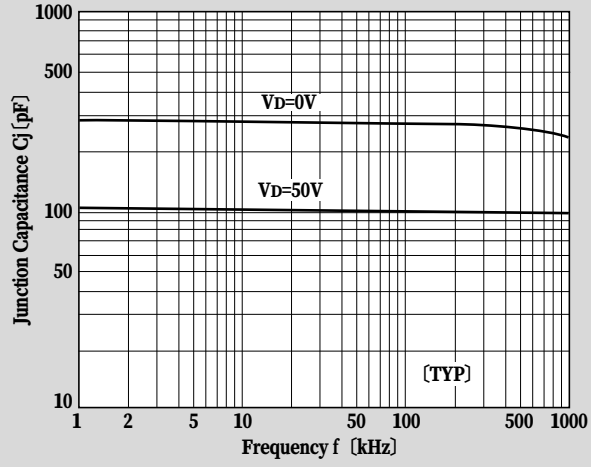
Breakover Voltage



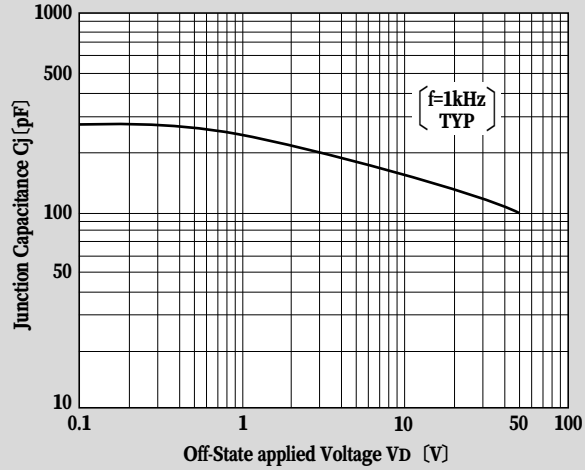
Holding Current



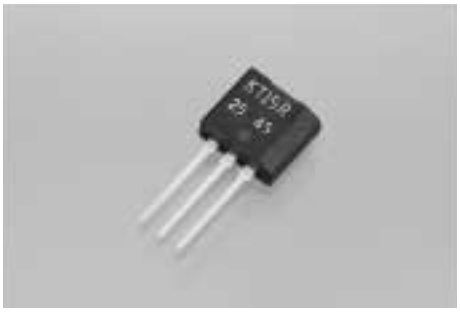
Junction Capacitance f-Cj



Junction Capacitance VD-Cj

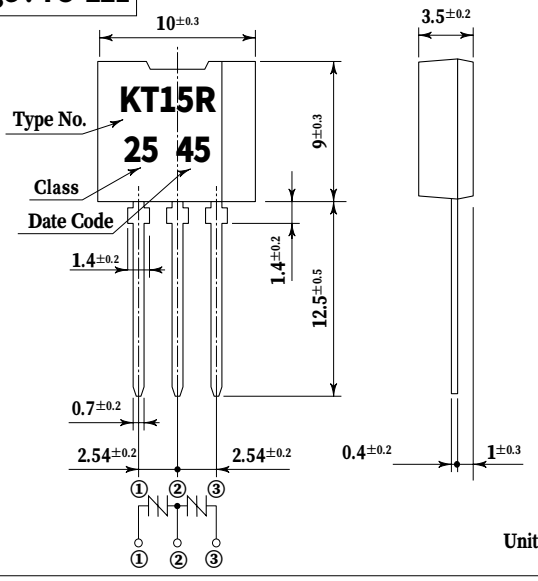


KT15R25



■OUTLINE DIMENSIONS

Package : TO-221



■RATINGS

Absolute Maximum Ratings

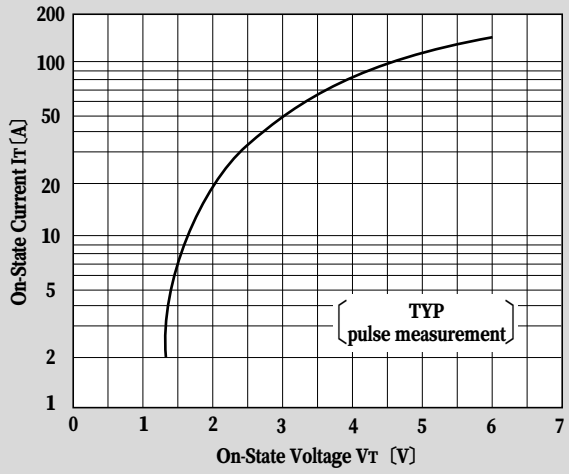
Item	Symbol	Conditions / Type No.		KT15R25	Unit
Storage Temperature	Tstg			−40～125	℃
Junction Temperature	Tj			125	℃
Maximum Off-State Voltage	V_{DRM}			190	V
Surge On-State Current	I_{TSM}	10/1000 μs	Non-repetitive	150	A
		10/200 μs		200	
		8/20 μs		300	

Electrical Characteristics T_j=25℃ Terminal No.①—②、③—②

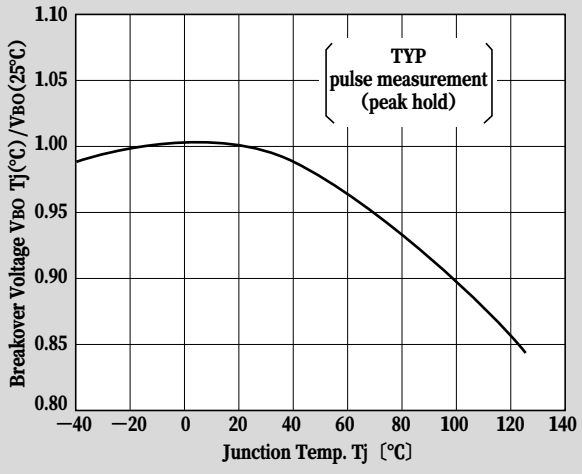
Breakover Voltage	V_{BO}	Pulse measurement (Peak hold)	MIN 220	V
Off-State Current	I_{DRM}	$V_D=V_{DRM}$	MAX 10	μA
Holding Current	I_H	Pulse measurement	MIN 100	mA
On-State Voltage	V_T	I_T=2A	TYP 1.35	V
Junction Capacitance	Cj	f=1kHz OSC=1Vrms V_D=50V	MAX 150	pF
Clamping Voltage	V_{CL}	dv/dt=100V/ μs	MAX 290	V

■CHARACTERISTIC DIAGRAMS

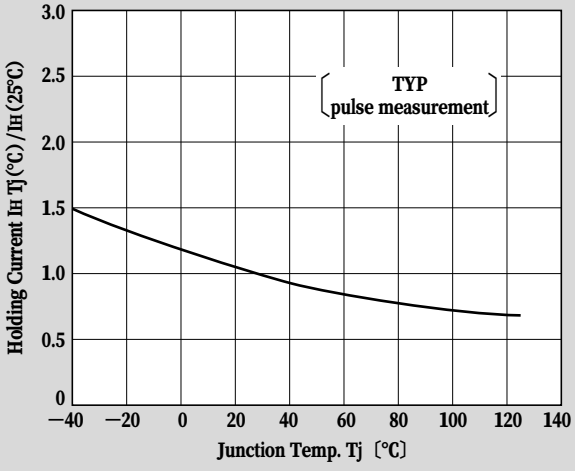
On-State Voltage—On-State Current



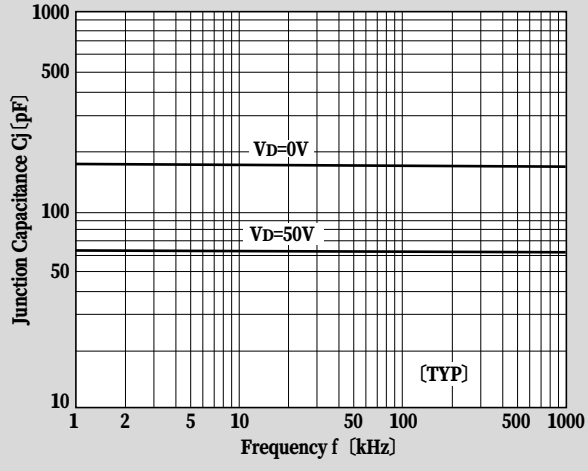
Breakover Voltage



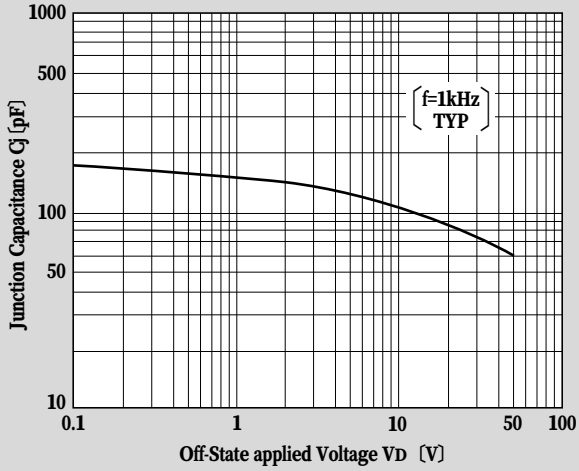
Holding Current



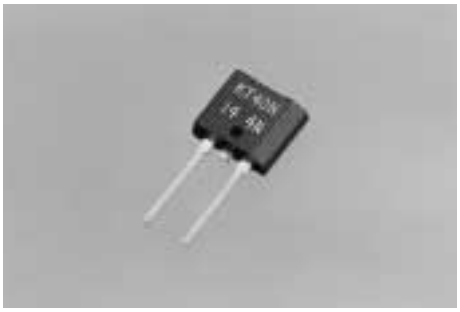
Junction Capacitance f-Cj



Junction Capacitance VD-Cj

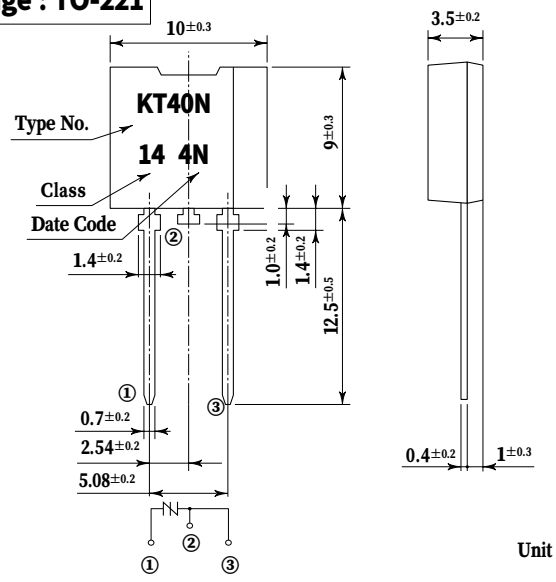


KT40N14



■OUTLINE DIMENSIONS

Package : TO-221



■RATINGS

Absolute Maximum Ratings

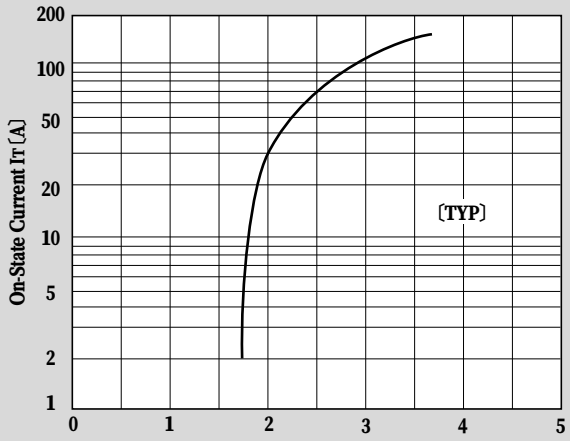
Item	Symbol	Conditions \ Type No.		KT40N14	Unit
Storage Temperature	Tstg			−40～125	℃
Junction Temperature	Tj			125	℃
Maximum Off-State Voltage	V_{DRM}			120	V
Surge On-State Current	I_{TSM}	10/1000 μs	Non-repetitive	400	A
		15/100 μs		1000	

Electrical Characteristics T_j=25℃ Terminal No.①—③

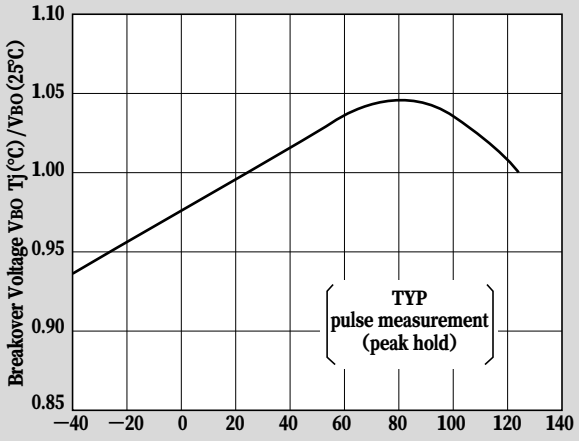
Breakover Voltage	V_{BO}	Pulse measurement (Peak hold)	MIN 130	V
Off-State Current	I_{DRM}	$V_D=V_{DRM}$	MAX 10	μA
Holding Current	I_H	Pulse measurement	MIN 200	mA
On-State Voltage	V_T	I_T=2A	TYP 1.8	V
Junction Capacitance	Cj	f=1kHz OSC=1Vrms V_D=50V	MAX 300	pF
Clamping Voltage	V_{CL}	dv/dt=100V/ μs	MAX 195	V

■CHARACTERISTIC DIAGRAMS

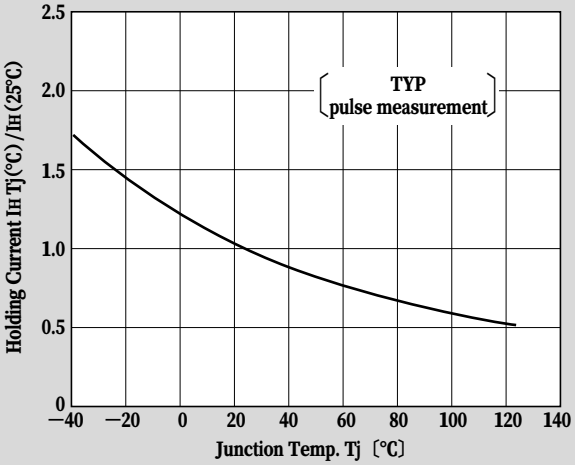
On-State Voltage—On-State Current



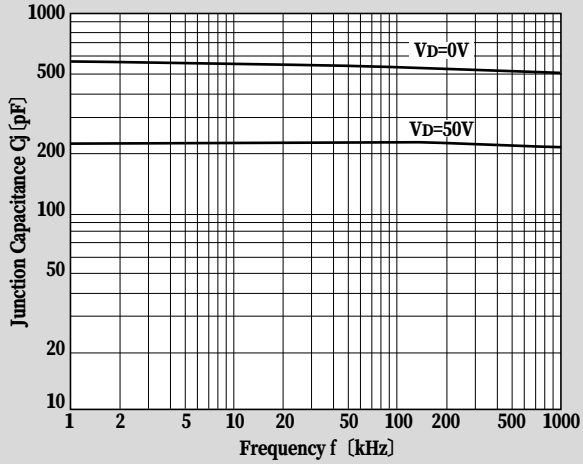
Breakover Voltage



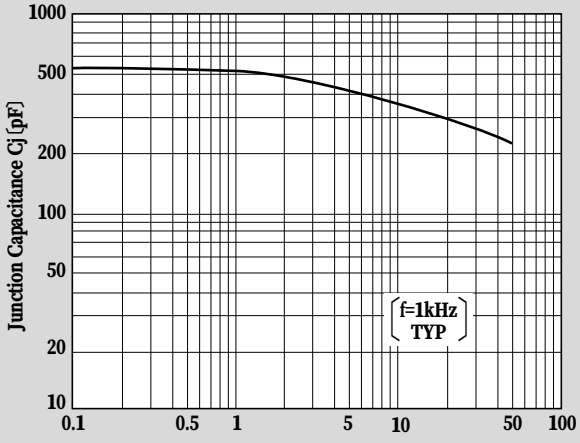
Holding Current



Junction Capacitance f-Cj



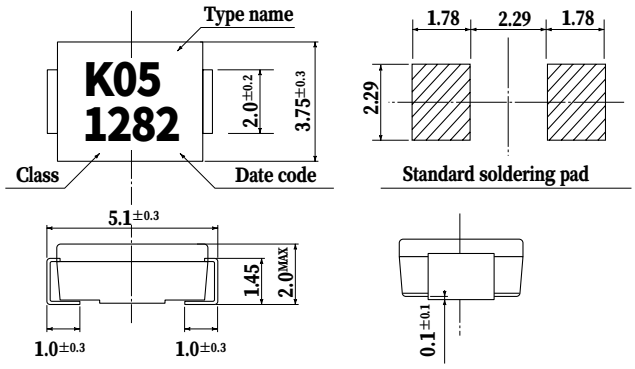
Junction Capacitance VD-Cj



KU5N12

■OUTLINE DIMENSIONS

Package : M2F



Unit : mm

■RATINGS

Absolute Maximum Ratings

Item	Symbol	Conditions \ Type No.	KU5N12☆	Unit
Storage Temperature	Tstg		−40～125	℃
Junction Temperature	Tj		125	℃
Operating Temperature	Top		−40～70	℃
Maximum Off-State Voltage	V_{DRM}		100	V
Surge On-State Current	I_{TSM}	Pulse-waveform ,10/1000 μs	50	A

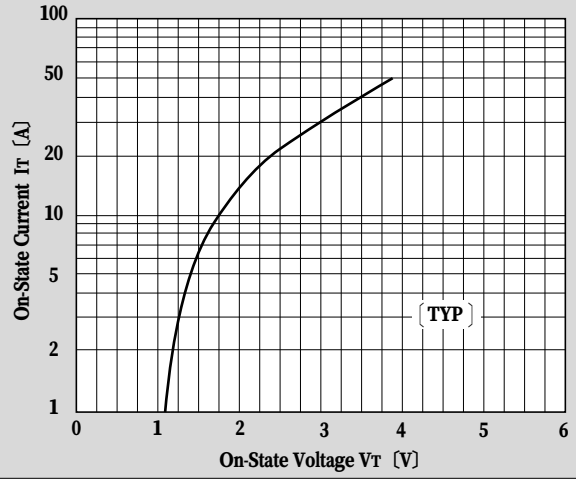
Electrical Characteristics Tc=25℃

Breakover Voltage	V_{BO}	dv/dt=8V/ms (Peak hold)	MIN 110	V
Off-State Current	I_{DRM}	$V_D=V_{DRM}$	MAX 5.0	μA
Holding Current	I_H	Pulse measurement	MIN 150	mA
On-State Voltage	V_T	I_T=2A	TYP 1.25	V
Capacitance	Cj	f=1MHz OSC=1Vrms V_D=50V	MAX 50	pF
Clamping Voltage	V_{CL}	dv/dt=100V/μs	MAX 135	V

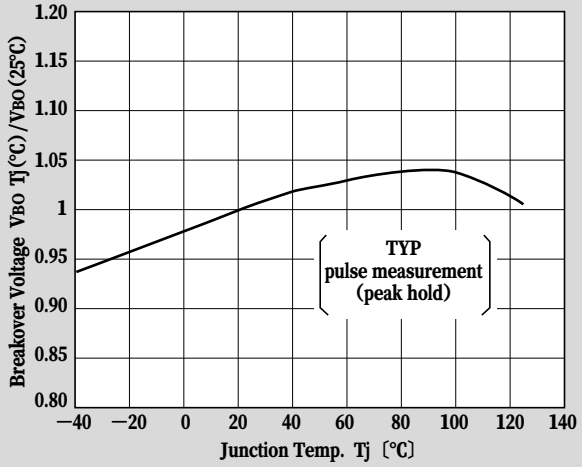
☆ : New product

■CHARACTERISTIC DIAGRAMS

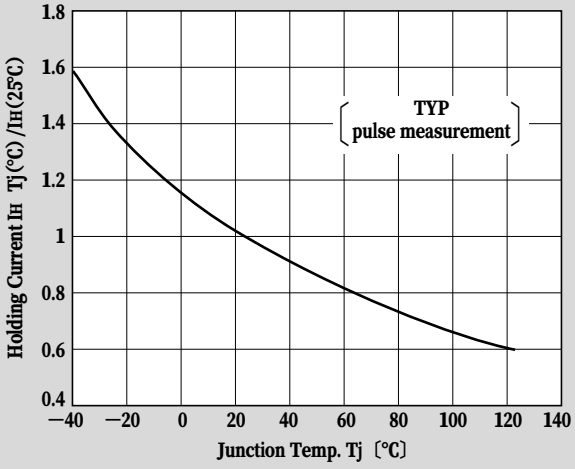
On-State Voltage — On-State Current



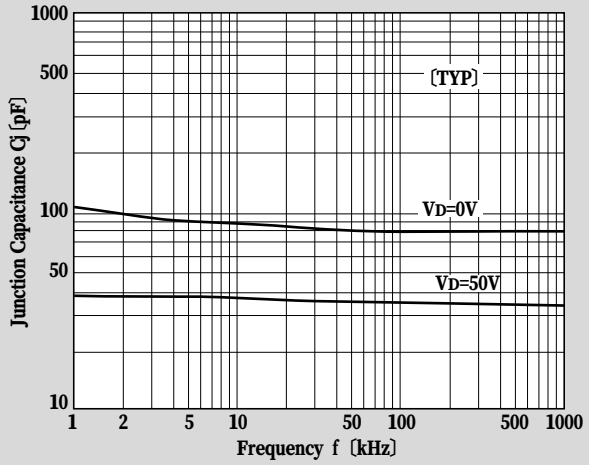
Breakover Voltage



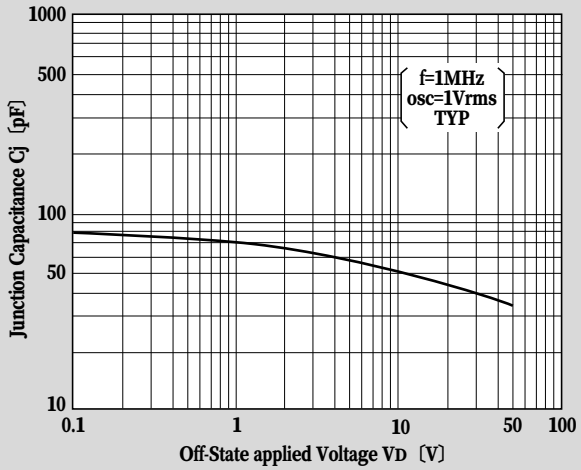
Holding Current



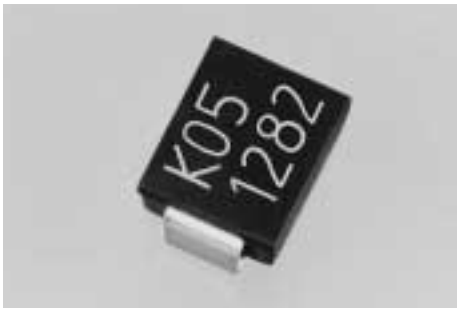
Junction Capacitance f-Cj



Junction Capacitance VD-Cj

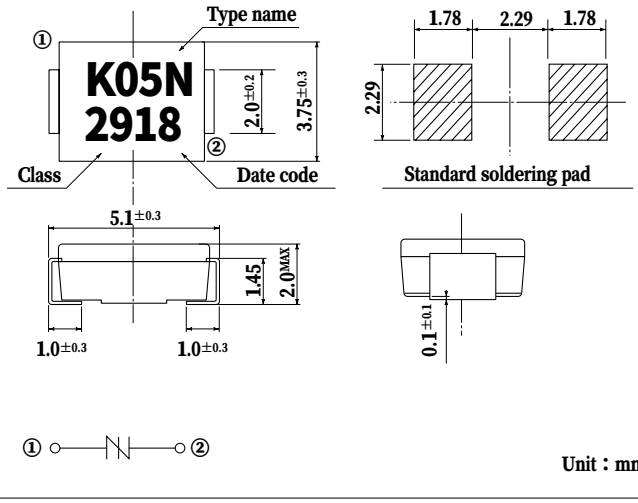


KU5R29N



■OUTLINE DIMENSIONS

Package : M2F



■RATINGS

Absolute Maximum Ratings

Item	Symbol	Conditions \ Type No.	KU5R29N☆	Unit
Storage Temperature	Tstg		−40～125	℃
Junction Temperature	Tj		125	℃
Operating Temperature	Top		−40～70	℃
Maximum Off-State Voltage	V_{DRM}		250	V
Surge On-State Current	I_{TSM}	Pulse-waveform ,10/1000 μs	50	A

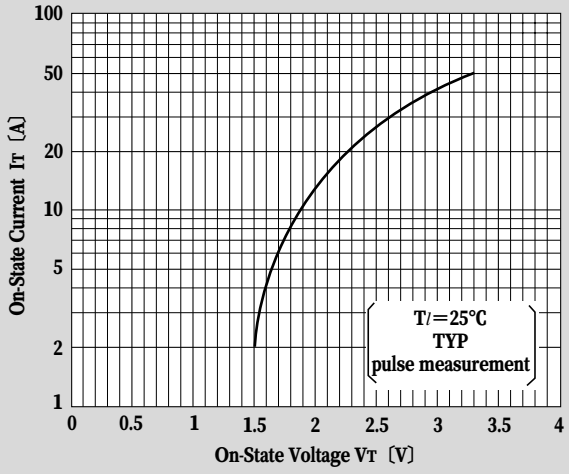
Electrical Characteristics T_j=25℃

Breakover Voltage	V_{BO}	dv/dt=8V/ms (Peak hold)	MIN 275	V
Off-State Current	I_{DRM}	$V_D=V_{DRM}$	MAX 5.0	μA
Holding Current	I_H	Pulse measurement	MIN 150	mA
On-State Voltage	V_T	I_T=2A	MAX 3	V
Capacitance	Cj	f=1MHz OSC=1Vrms V_D=50V	MAX 70	pF
Clamping Voltage	V_{CL}	dv/dt=100V/μs	MAX 400	V

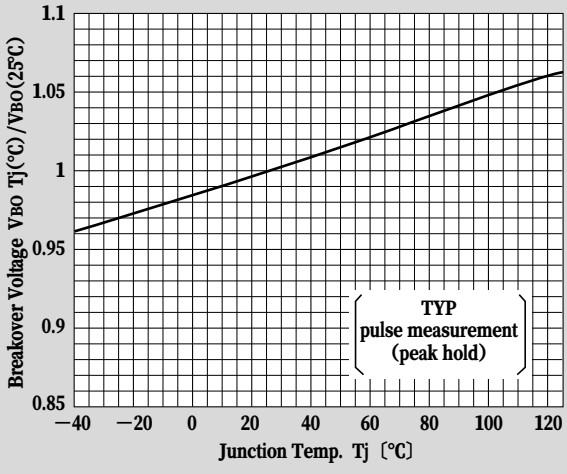
☆ : New product

■CHARACTERISTIC DIAGRAMS

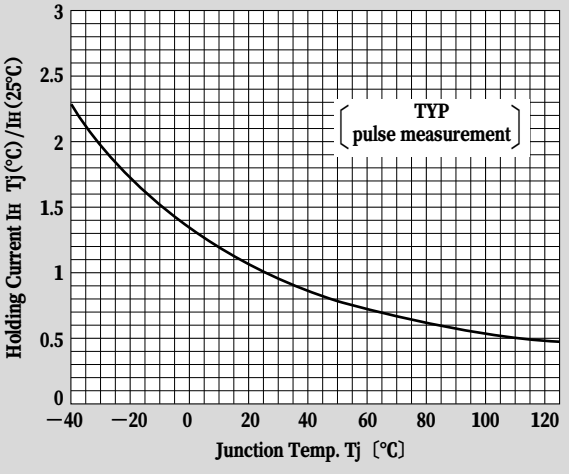
On-State Voltage — On-State Current



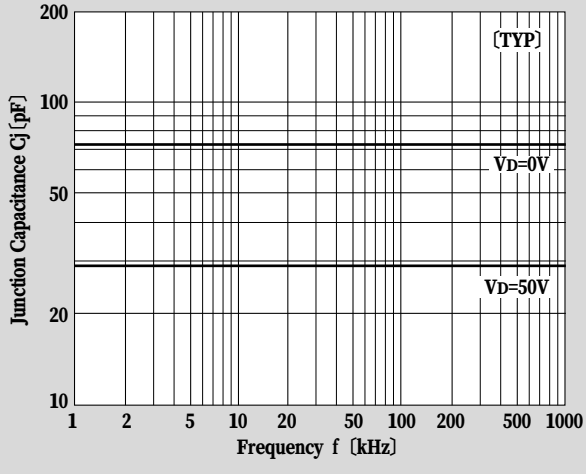
Breakover Voltage



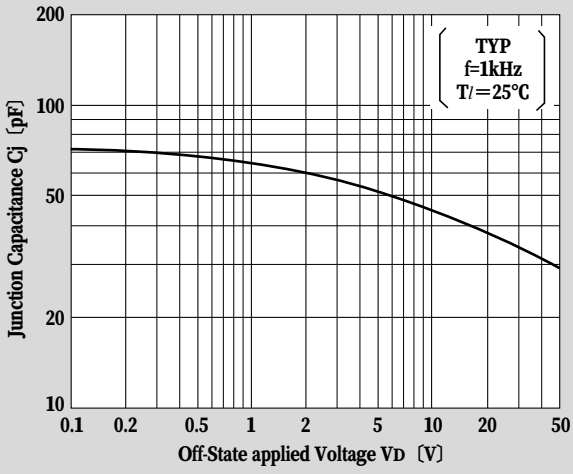
Holding Current



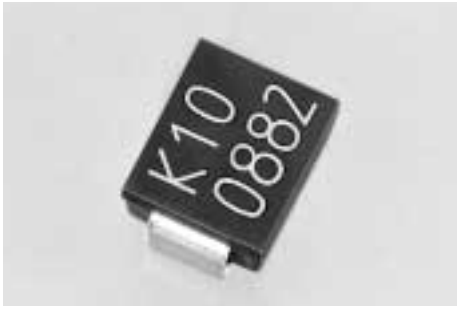
Junction Capacitance f-Cj



Junction Capacitance VD-Cj

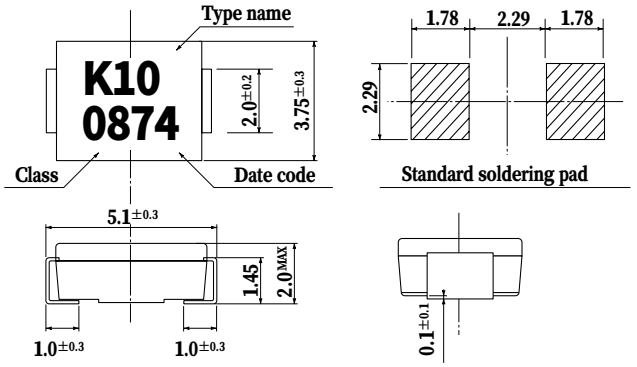


KU10L08



■OUTLINE DIMENSIONS

Package : M2F



Unit : mm

■RATINGS

Absolute Maximum Ratings

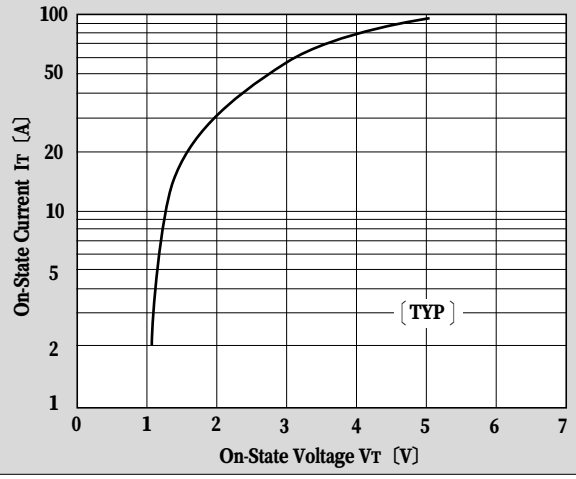
Item	Symbol	Conditions \ Type No.	KU10L08	Unit
Storage Temperature	Tstg		−40～125	℃
Junction Temperature	Tj		125	℃
Operating Temperature	Top		−40～70	℃
Maximum Off-State Voltage	V_{DRM}		63	V
Surge On-State Current	I_{TSM}	Pulse-waveform ,10/1000 μs	100	A

Electrical Characteristics Tc=25℃

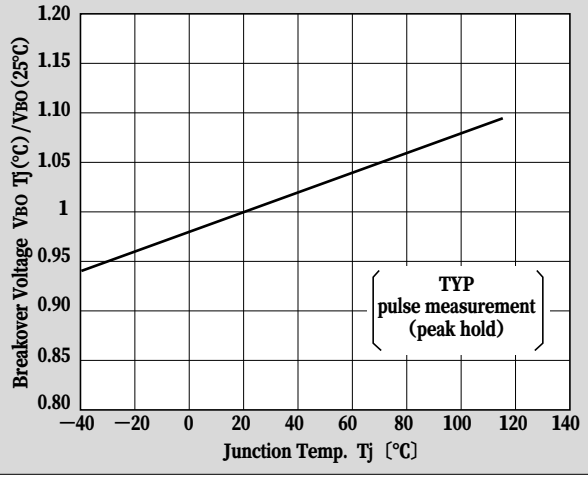
Breakover Voltage	V_{BO}	dv/dt=8V/ms (Peak hold)	MIN 70	V
Off-State Current	I_{DRM}	$V_D=V_{DRM}$	MAX 5.0	μA
Holding Current	I_H	Pulse measurement	MIN 150	mA
On-State Voltage	V_T	I_T=2A	TYP 1.15	V
Capacitance	Cj	f=1MHz OSC=1Vrms V_D=50V	MAX 180	pF
Clamping Voltage	V_{CL}	dv/dt=100V/μs	MAX 100	V

■CHARACTERISTIC DIAGRAMS

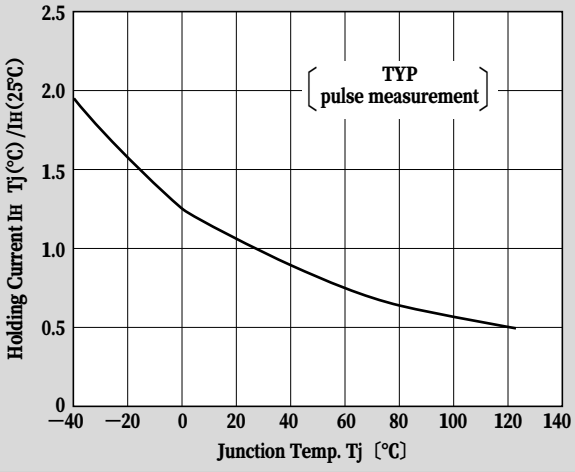
On-State Voltage — On-State Current



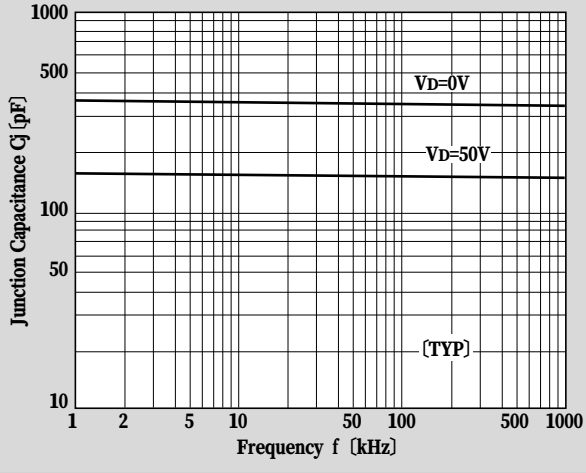
Breakover Voltage



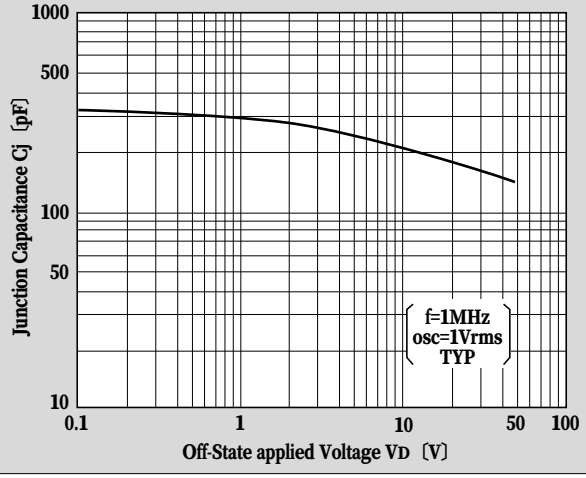
Holding Current



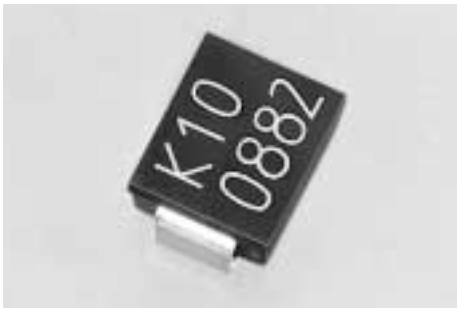
Junction Capacitance f-Cj



Junction Capacitance VD-Cj

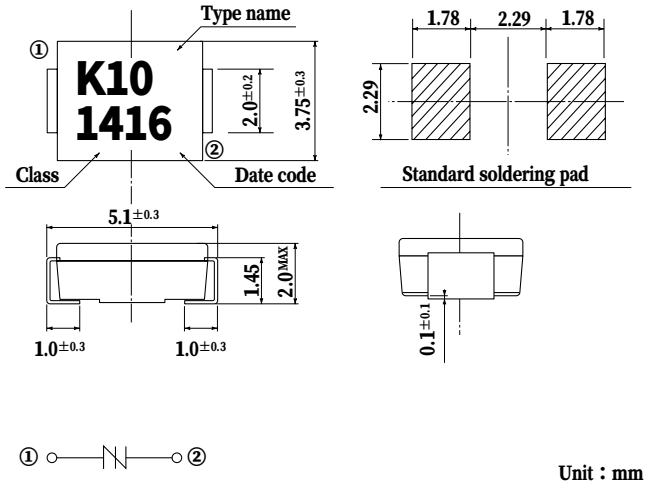


KU10N14,16



■OUTLINE DIMENSIONS

Package : M2F



■RATINGS

Absolute Maximum Ratings

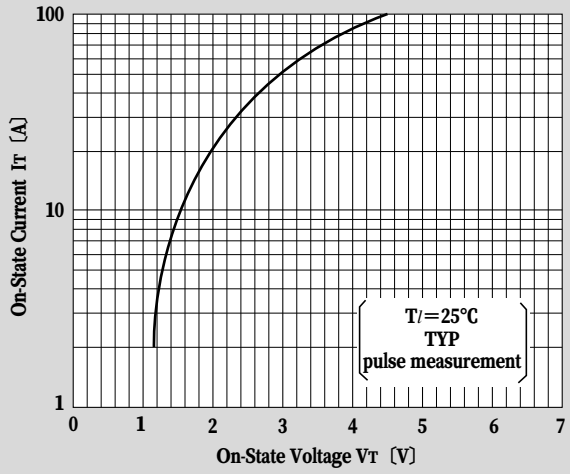
Item	Symbol	Conditions \ Type No.	KU10N14	KU10N16	Unit
Storage Temperature	Tstg		−40～125		℃
Junction Temperature	Tj		125		℃
Operating Temperature	Top		−40～70		℃
Maximum Off-State Voltage	V_{DRM}		120	140	V
Surge On-State Current	I_{TSM}	Pulse-waveform ,10/1000 μs	100		A

Electrical Characteristics Tc=25℃

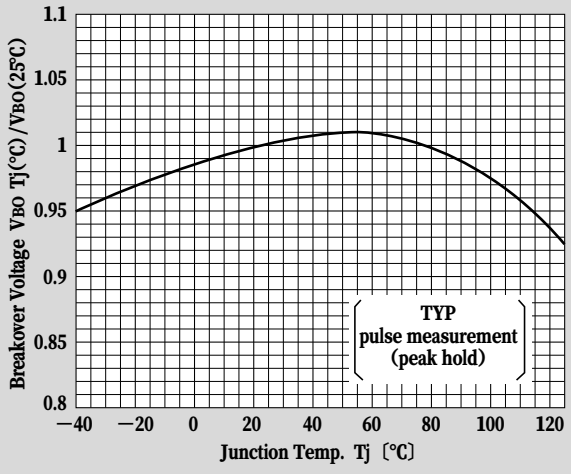
Breakover Voltage	V_{BO}	Pulse measurement（Peak hold）	MIN 125	MIN 145	V
Off-State Current	I_{DRM}	$V_D=V_{DRM}$	MAX 5.0		μA
Holding Current	I_H	Pulse measurement	MIN 100		mA
On-State Voltage	V_T	I_T=2A	MAX 3.0		V
Capacitance	Cj	f=1kHz V_D=50V	MAX 140	MAX 150	pF
Clamping Voltage	V_{CL}	dv/dt=100V/μs	MAX 195	MAX 200	V

■CHARACTERISTIC DIAGRAMS

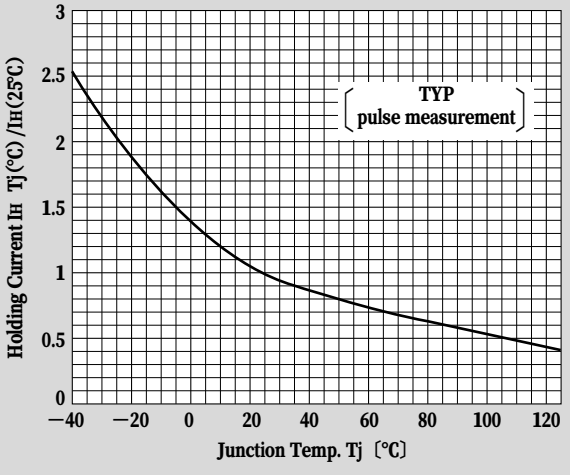
On-State Voltage — On-State Current



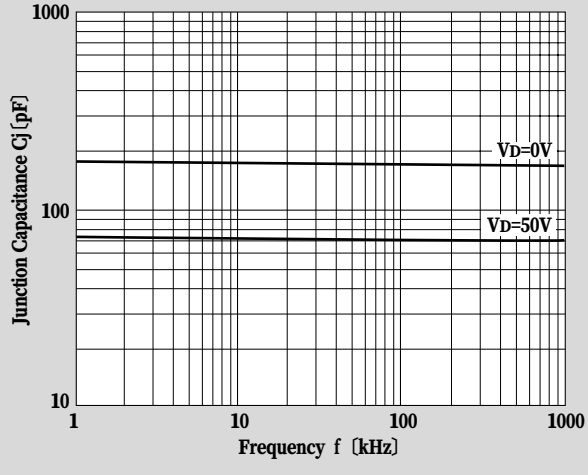
Breakover Voltage



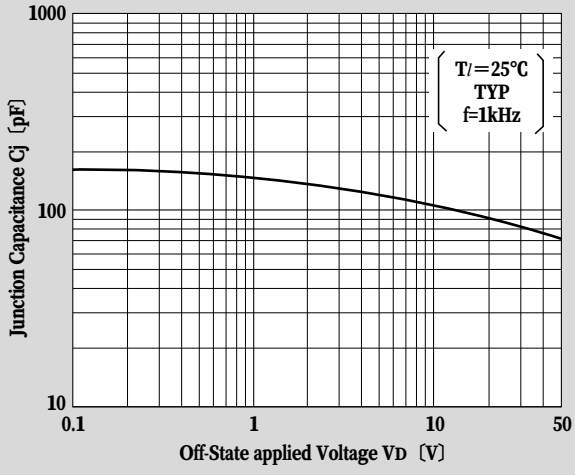
Holding Current



Junction Capacitance f-Cj



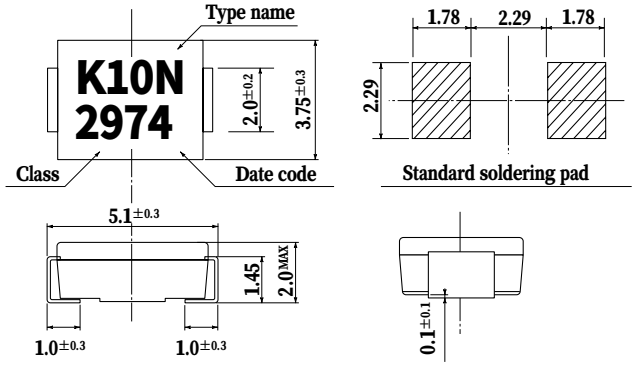
Junction Capacitance VD-Cj



KU10R29N

■OUTLINE DIMENSIONS

Package : M2F



Unit : mm

■RATINGS

Absolute Maximum Ratings

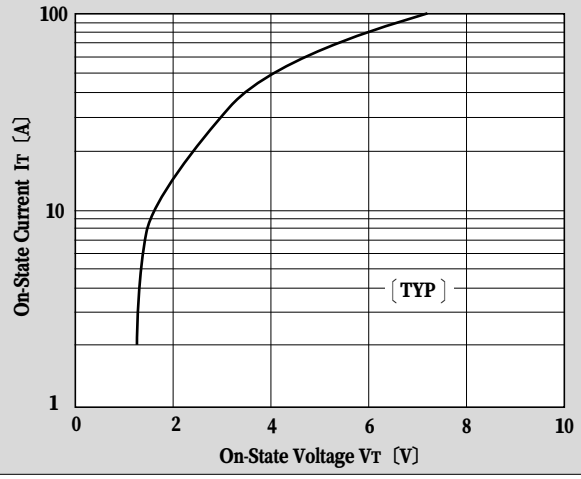
Item	Symbol	Conditions \ Type No.	KU10R29N	Unit
Storage Temperature	Tstg		−40～125	℃
Junction Temperature	Tj		125	℃
Operating Temperature	Top		−40～70	℃
Maximum Off-State Voltage	V_{DRM}		250	V
Surge On-State Current	I_{TSM}	Pulse-waveform ,10/1000 μs	100	A

Electrical Characteristics Tc=25℃

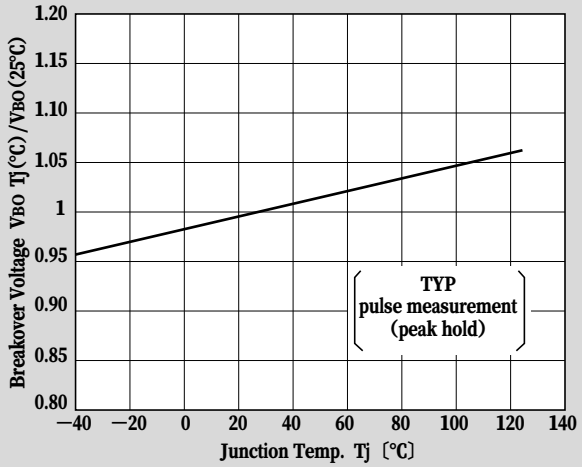
Breakover Voltage	V_{BO}	dv/dt=8V/ms (Peak hold)	MIN 275	V
Off-State Current	I_{DRM}	$V_D=V_{DRM}$	MAX 5.0	μA
Holding Current	I_H	Pulse measurement	MIN 150	mA
On-State Voltage	V_T	I_T=2A	TYP 1.60	V
Capacitance	Cj	f=1MHz OSC=1Vrms V_D=50V	MAX 90	pF
Clamping Voltage	V_{CL}	dv/dt=100V/μs	MAX 400	V

■CHARACTERISTIC DIAGRAMS

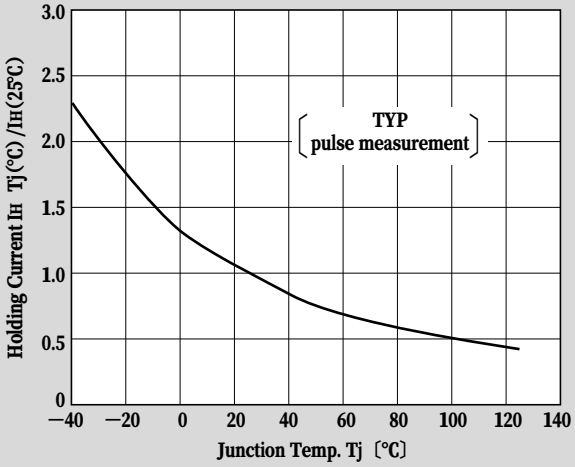
On-State Voltage — On-State Current



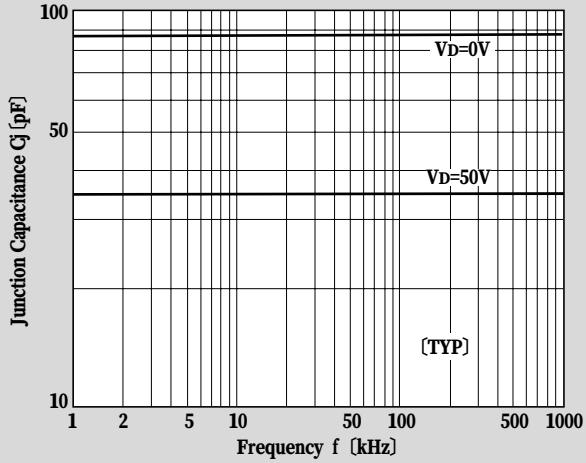
Breakover Voltage



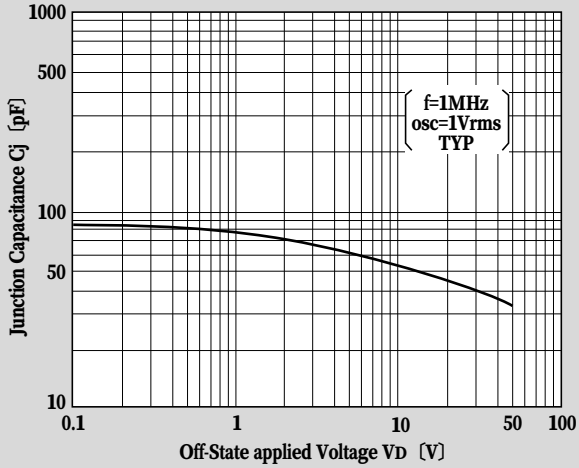
Holding Current



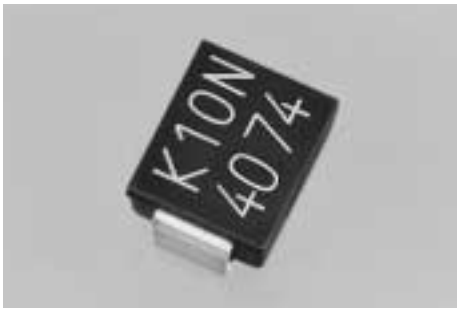
Junction Capacitance f-Cj



Junction Capacitance VD-Cj

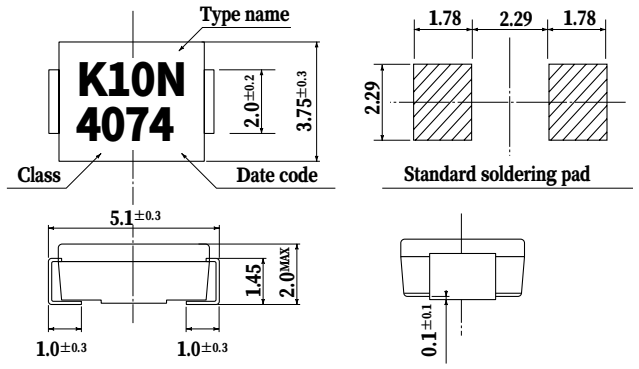


KU10S35N, 40N



■OUTLINE DIMENSIONS

Package : M2F



Unit : mm

■RATINGS

Absolute Maximum Ratings

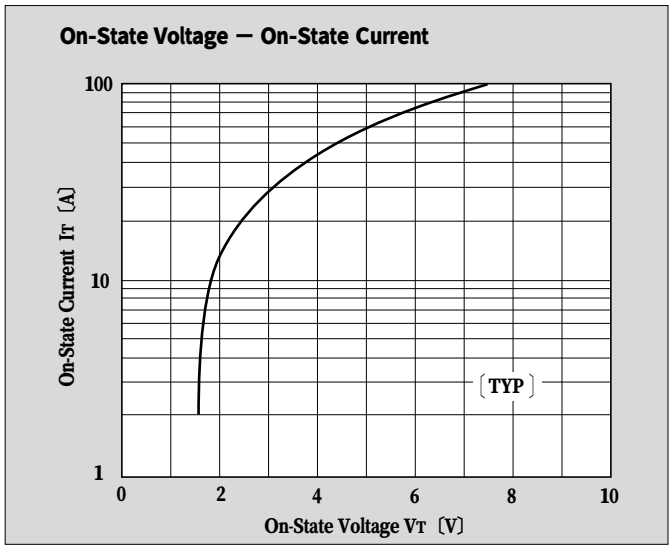
Item	Symbol	Conditions \ Type No.	KU10S35N☆	KU10S40N☆	Unit
Storage Temperature	Tstg		−40～125		℃
Junction Temperature	Tj		125		℃
Operating Temperature	Top		−20～85		℃
Maximum Off-State Voltage	V_{DRM}		275	300	V
Surge On-State Current	I_{TSM}	Pulse-waveform ,10/1000 μs	100		A

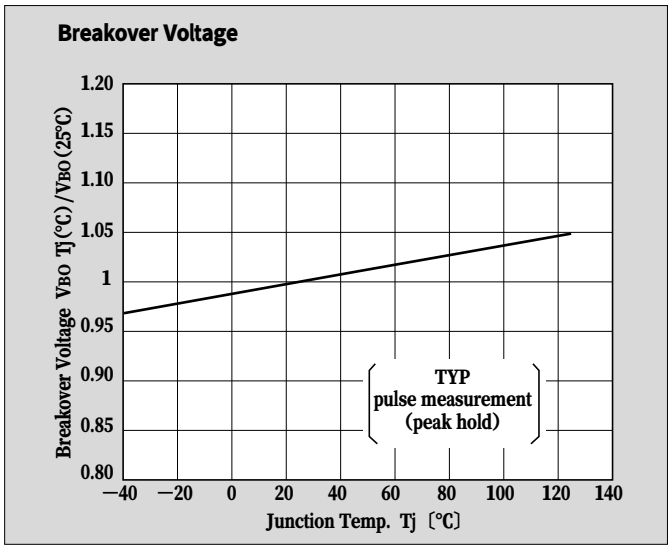
Electrical Characteristics Tc=25℃

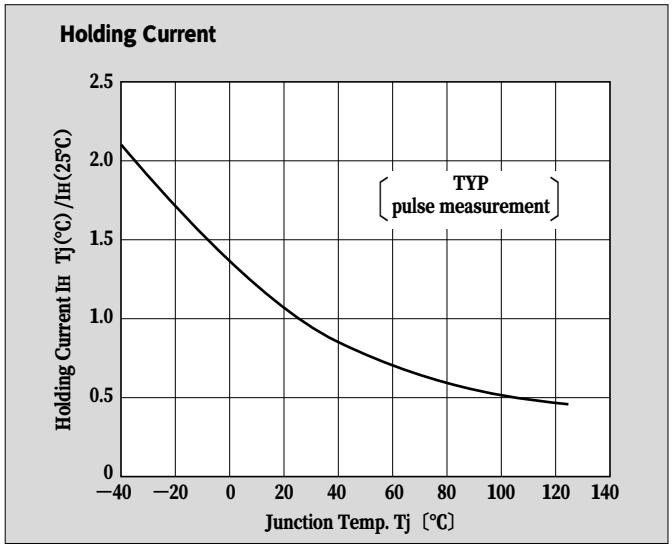
Breakover Voltage	V_{BO}	Pulse measurement（Peak hold）	MIN 310	MIN 350	V
Off-State Current	I_{DRM}	$V_D=V_{DRM}$	MAX 5.0		μA
Holding Current	I_H	Pulse measurement	MIN 150		mA
On-State Voltage	V_T	I_T=2A	MAX 1.7		V
Capacitance	Cj	f=1MHz V_D=50V	MAX 90	MAX 60	pF
Clamping Voltage	V_{CL}	dv/dt=100V/μs	MAX 450	MAX 500	V

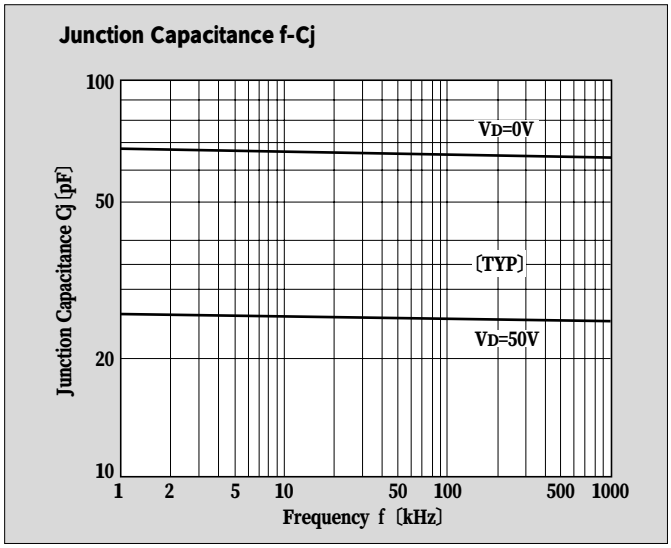
☆ : New product

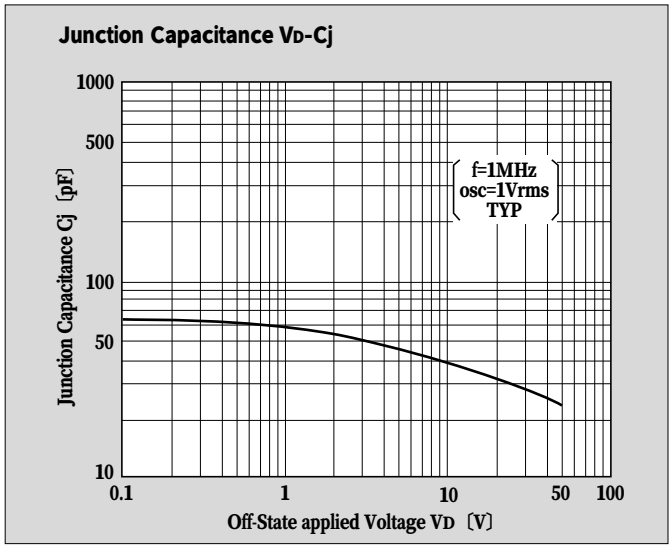
■CHARACTERISTIC DIAGRAMS







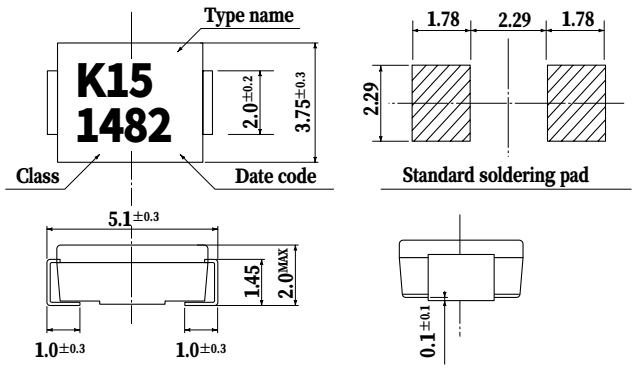




KU15N14

■OUTLINE DIMENSIONS

Package : M2F



Unit : mm

■RATINGS

Absolute Maximum Ratings

Item	Symbol	Conditions \ Type No.	KU15N14☆	Unit
Storage Temperature	Tstg		−40～125	℃
Junction Temperature	Tj		125	℃
Operating Temperature	Top		−40～70	℃
Maximum Off-State Voltage	V_{DRM}		120	V
Surge On-State Current	I_{TSM}	Pulse-waveform ,10/1000 μs	150	A

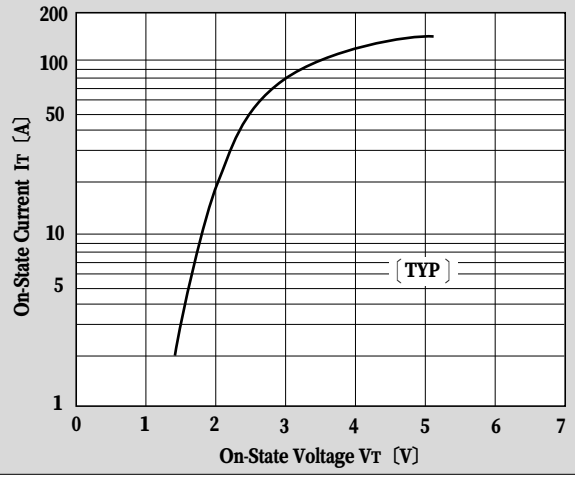
Electrical Characteristics Tc=25℃

Breakover Voltage	V_{BO}	dv/dt=8V/ms (Peak hold)	MIN 125	V
Off-State Current	I_{DRM}	$V_D=V_{DRM}$	MAX 5.0	μA
Holding Current	I_H	Pulse measurement	MIN 100	mA
On-State Voltage	V_T	I_T=2A	TYP 1.45	V
Capacitance	Cj	f=1MHz OSC=1Vrms V_D=50V	MAX 200	pF
Clamping Voltage	V_{CL}	dv/dt=100V/μs	MAX 195	V

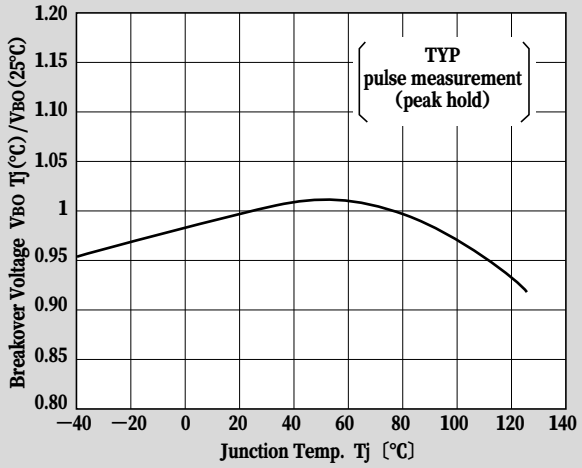
☆ : New product

■CHARACTERISTIC DIAGRAMS

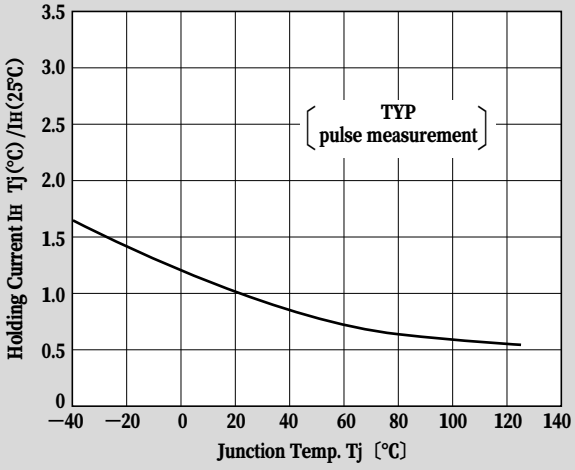
On-State Voltage — On-State Current



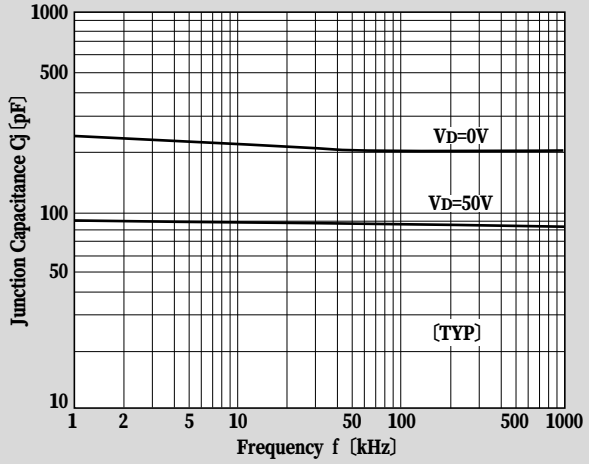
Breakover Voltage



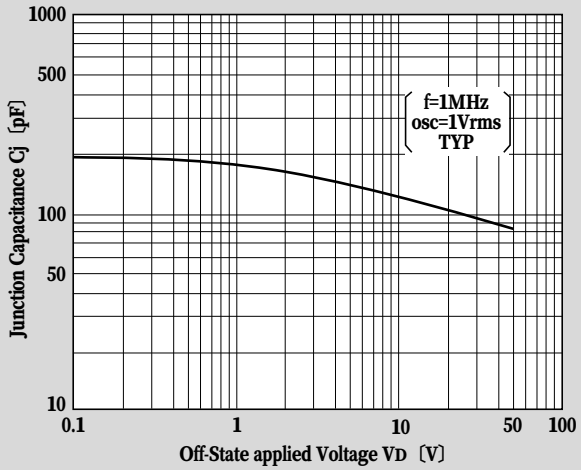
Holding Current



Junction Capacitance f-Cj



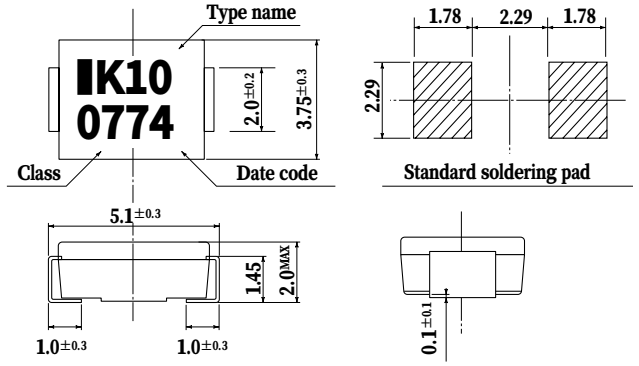
Junction Capacitance VD-Cj



KU10LU07

■OUTLINE DIMENSIONS

Package : M2F



Unit : mm

■RATINGS

Absolute Maximum Ratings

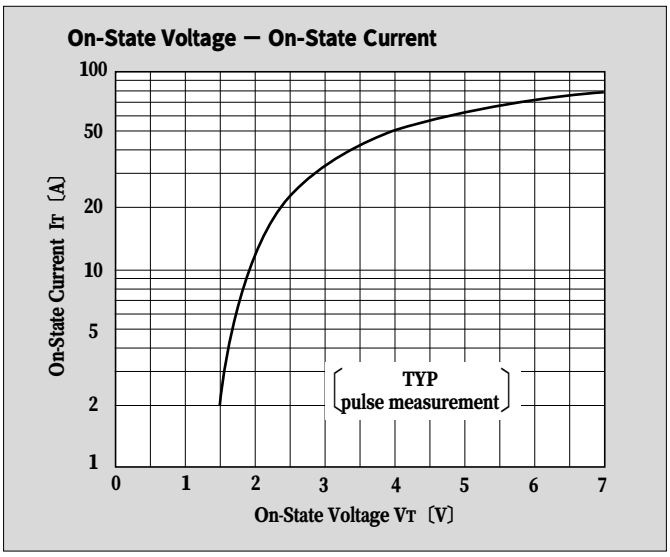
Item	Symbol	Conditions \ Type No.	KU10LU07☆	Unit
Storage Temperature	Tstg		−40～125	℃
Junction Temperature	Tj		125	℃
Operating Temperature	Top		−40～70	℃
Maximum Off-State Voltage	V_{DRM}		58	V
Surge On-State Current	I_{TSM}	Pulse-waveform ,10/1000 μs	100	A

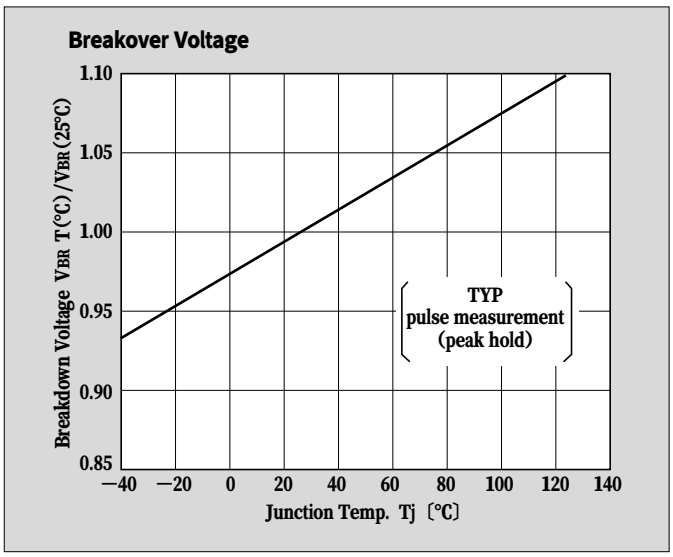
Electrical Characteristics Tc=25℃

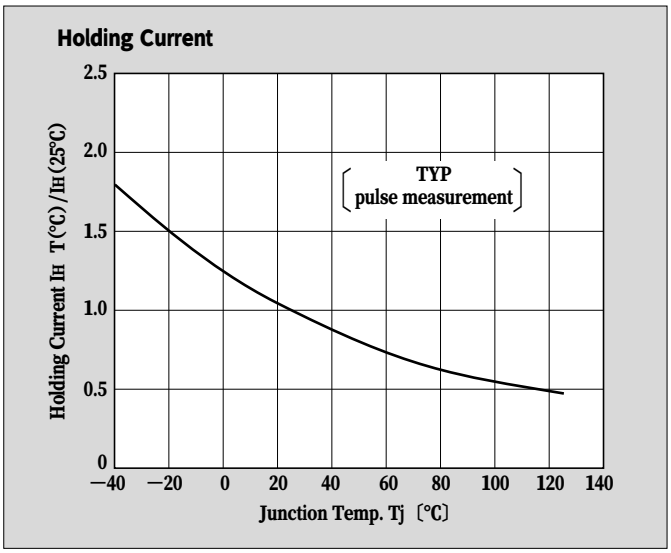
Breakover Voltage	V_{BR}	I_{BR}=1mA	MIN 65	V
Off-State Current	I_{DRM}	V_D=V_{DRM}	MAX 5.0	μA
Holding Current	I_H	Pulse measurement	MIN 150	mA
On-State Voltage	V_T	I_T=2A	TYP 1.15	V
Capacitance	Cj	f=1MHz OSC=20mVrms V_D=50V	MAX 200	pF
Clamping Voltage	V_{CL}	dv/dt=100V/μs	MAX 80	V

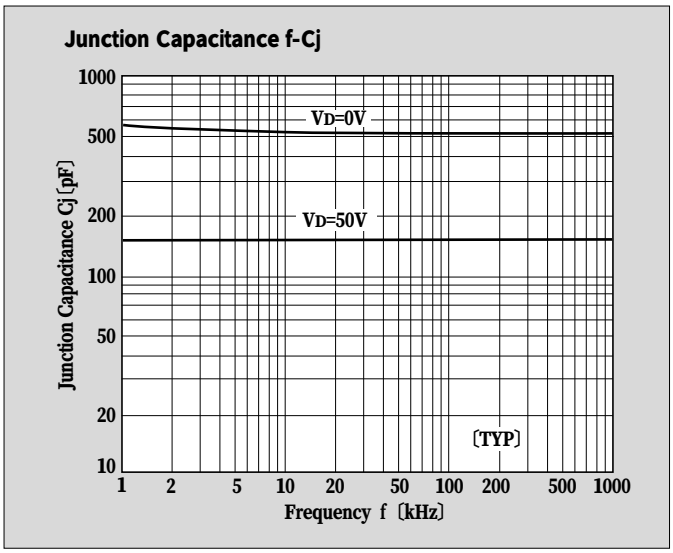
☆ : New product

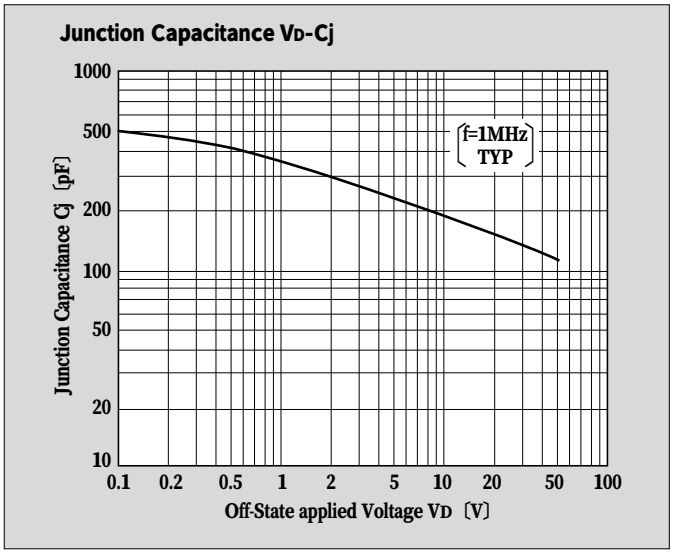
■CHARACTERISTIC DIAGRAMS

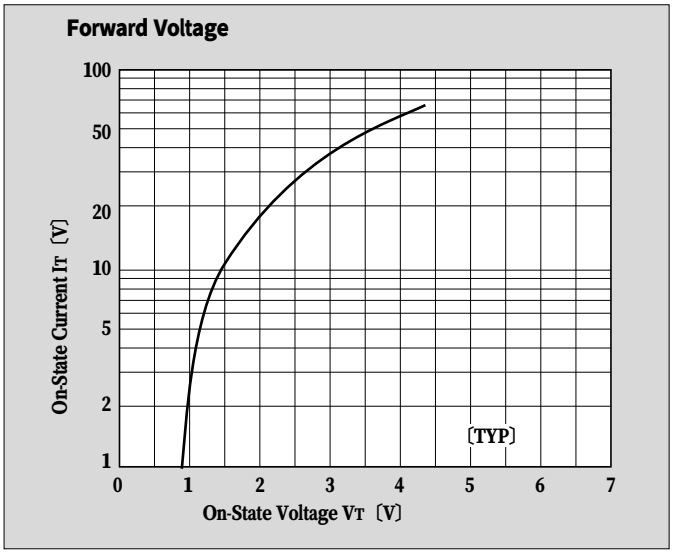












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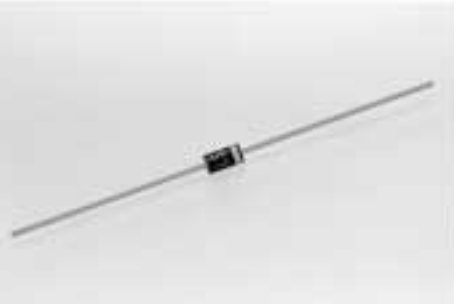
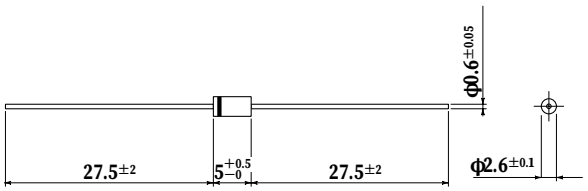


■OUTLINE DIMENSIONS

Package : AX06



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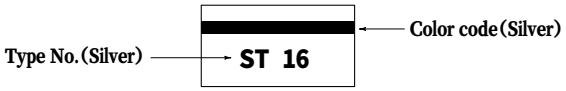


Unit : mm

■RATINGS

Absolute Maximum Ratings

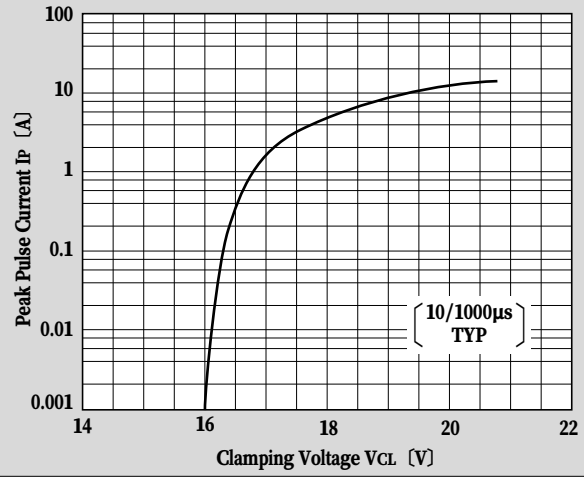
Item	Symbol	Conditions		Ratings	Unit
Storage Temperature	Tstg			−40～150	℃
Junction Temperature	Tj			150	℃
Peak Surge Reverse Current	I_{RSM}	10/1000 μs	Non-repetitive	15	A
		10/200 μs		28	
Maximum Reverse Voltage	V_{RM}			13.6	V

Electrical Characteristics T_l=25℃

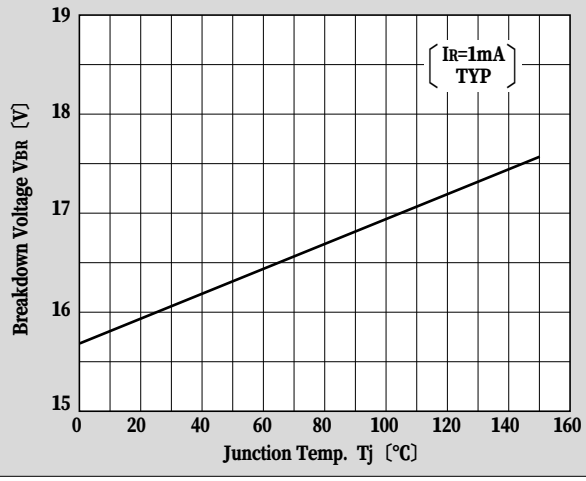
Breakdown Voltage	V_{BR}	I_R=1mA	14.4～17.6	V
Clamping Voltage	V_{CL}	I_{PP}=15A	MAX 23	V
Reverse Current	I_R	V_R=13.6V	MAX 5	μA

■CHARACTERISTIC DIAGRAMS

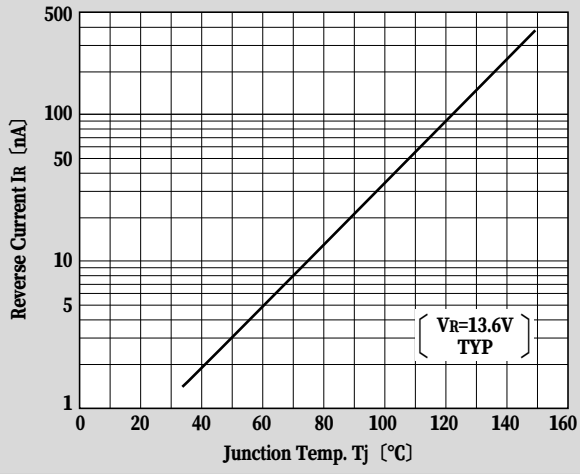
Clamping Voltage



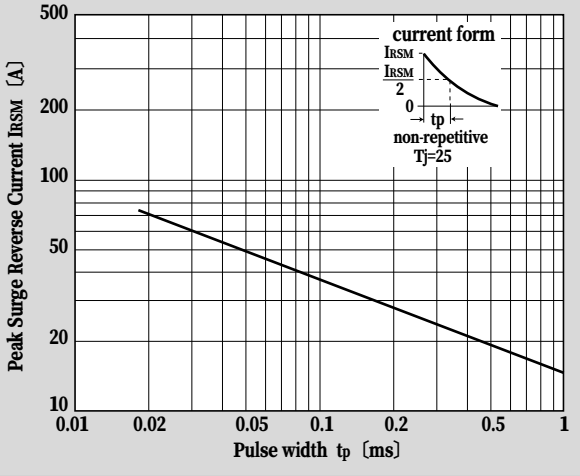
Breakdown Voltage



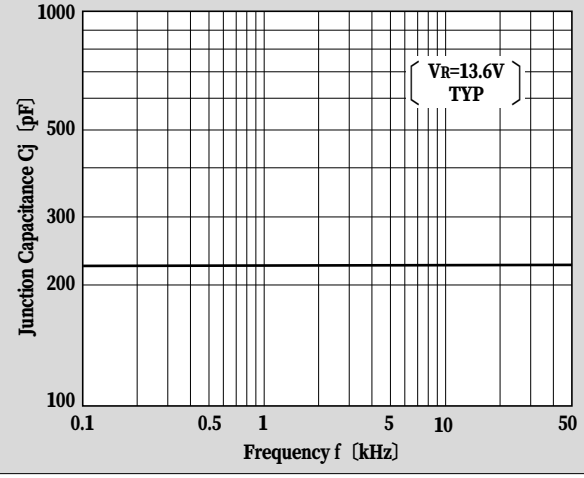
Reverse Current



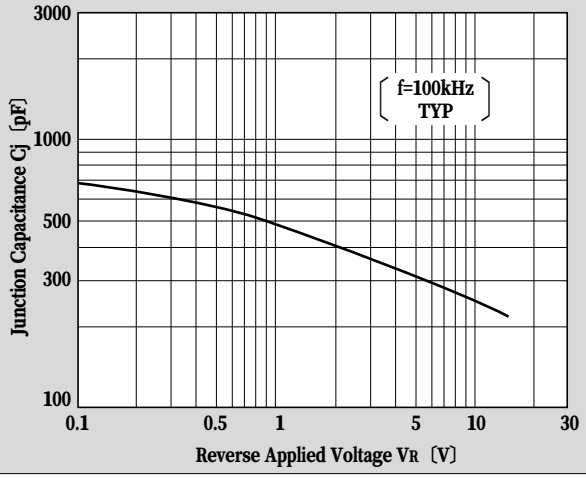
Peak Surge Reverse Current



Junction Capacitance f-Cj



Junction Capacitance VR-Cj



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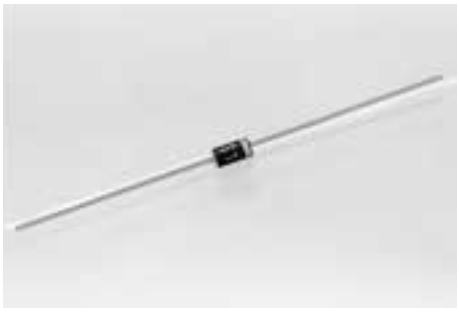
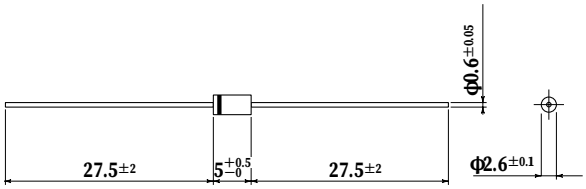


■OUTLINE DIMENSIONS

Package : AX06



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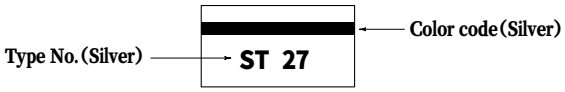


Unit : mm

■RATINGS

Absolute Maximum Ratings

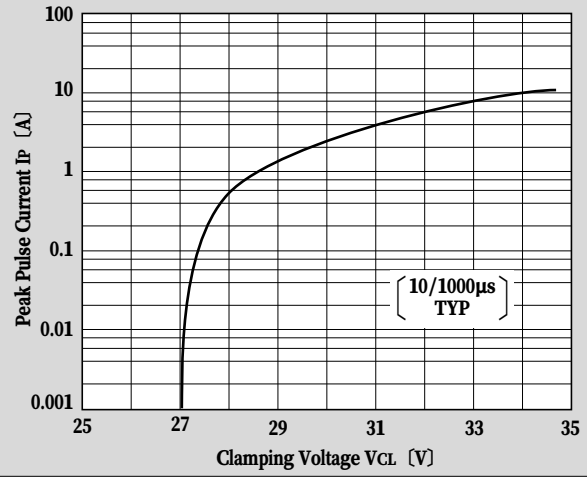
Item	Symbol	Conditions		Ratings	Unit
Storage Temperature	Tstg			−40～150	℃
Junction Temperature	Tj			150	℃
Peak Surge Reverse Current	I_{RSM}	10/1000 μs	Non-repetitive	10	A
		10/200 μs		19	
Maximum Reverse Voltage	V_{RM}			23	V

Electrical Characteristics T_j=25℃

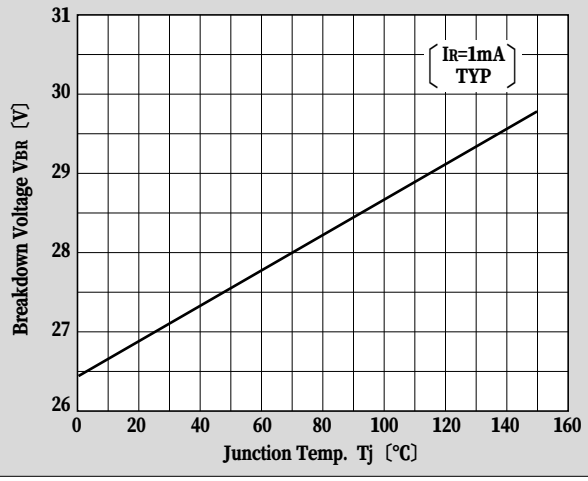
Breakdown Voltage	V_{BR}	I_R=1mA	24.3～29.7	V
Clamping Voltage	V_{CL}	I_{PP}=10A	MAX 37	V
Reverse Current	I_R	V_R=23V	MAX 5	μA

■CHARACTERISTIC DIAGRAMS

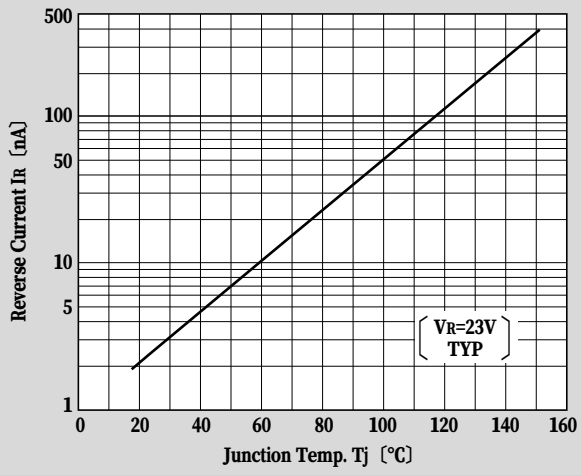
Clamping Voltage



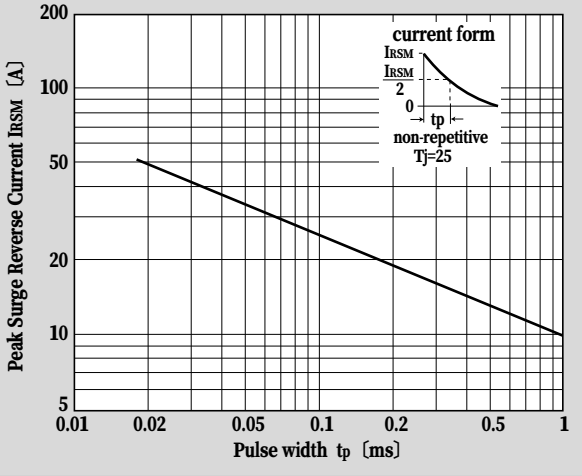
Breakdown Voltage



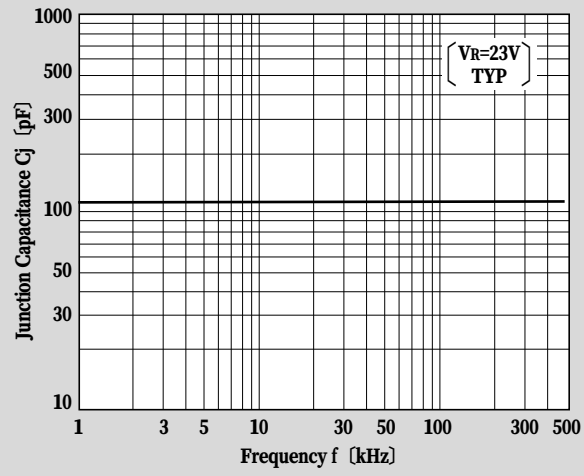
Reverse Current



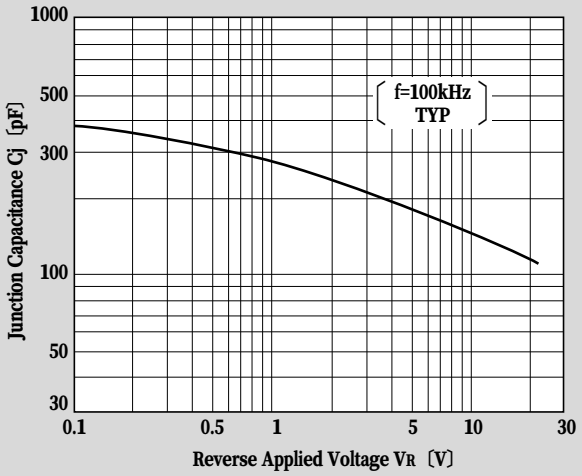
Peak Surge Reverse Current



Junction Capacitance f-Cj



Junction Capacitance VR-Cj



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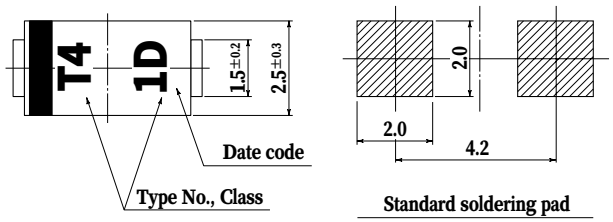
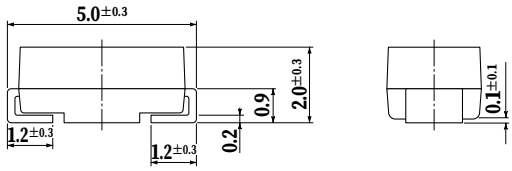
■OUTLINE DIMENSIONS

Package : 1F





Unit : mm

■RATINGS

Absolute Maximum Ratings

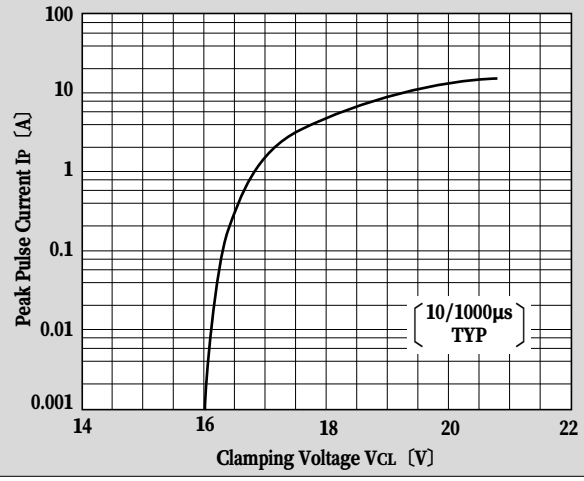
Item	Symbol	Conditions		Ratings	Unit
Storage Temperature	Tstg			−55～175	℃
Junction Temperature	Tj			150	℃
Peak Surge Reverse Current	I_{RSM}	10/1000 μs	Non-repetitive	15	A
		10/200 μs		28	
Maximum Reverse Voltage	V_{RM}			13.6	V

Electrical Characteristics T_j=25℃

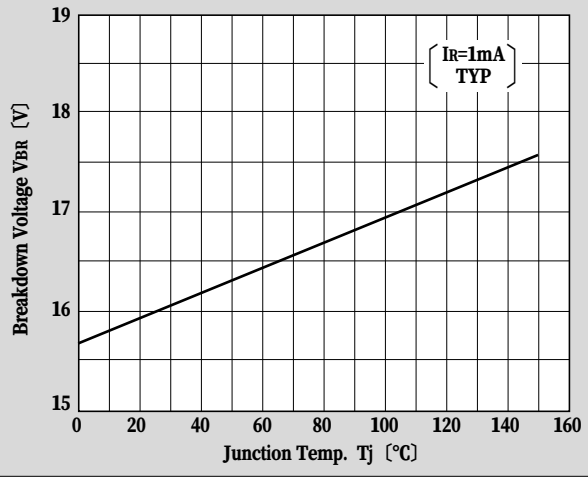
Breakdown Voltage	V_{BR}	I_R=1mA	14.4～17.6	V
Clamping Voltage	V_{CL}	I_{PP}=15A	MAX 23	V
Reverse Current	I_R	V_R=13.6V	MAX 5	μA

■CHARACTERISTIC DIAGRAMS

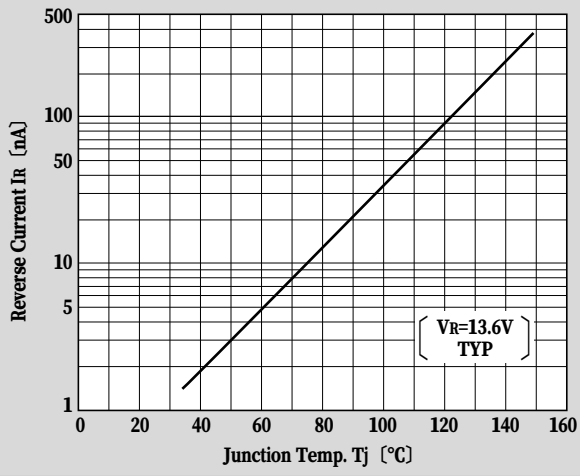
Clamping Voltage



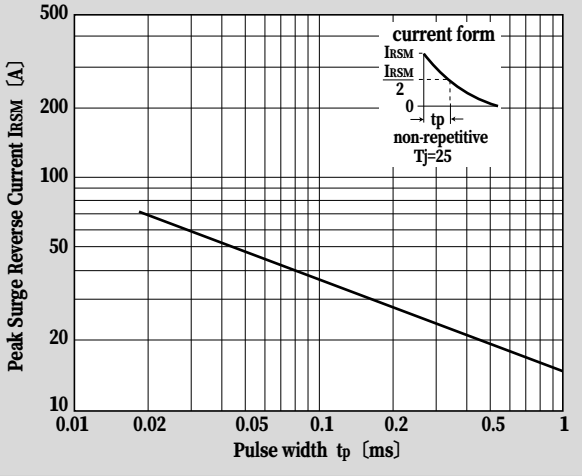
Breakdown Voltage



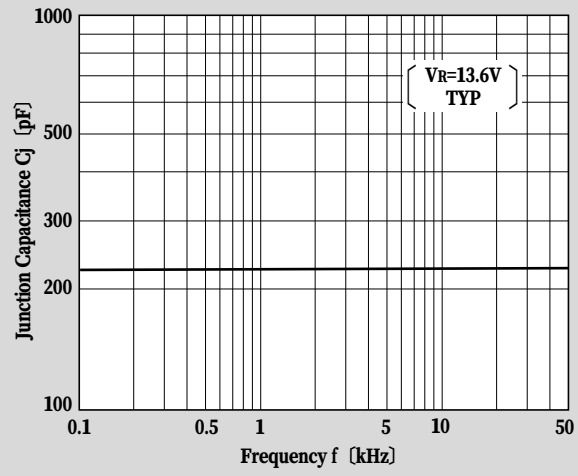
Reverse Current



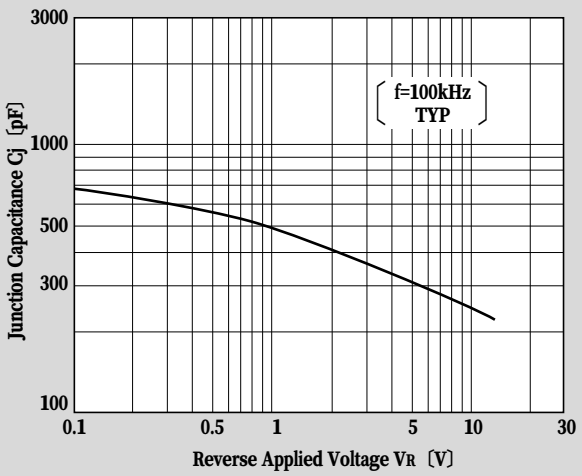
Peak Surge Reverse Current



Junction Capacitance f-Cj



Junction Capacitance VR-Cj



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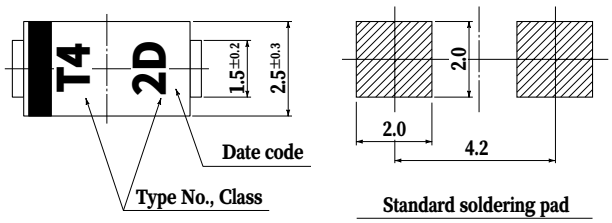
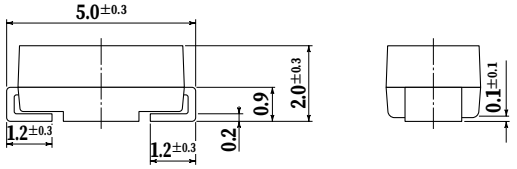
■OUTLINE DIMENSIONS

Package : 1F





Unit : mm

■RATINGS

Absolute Maximum Ratings

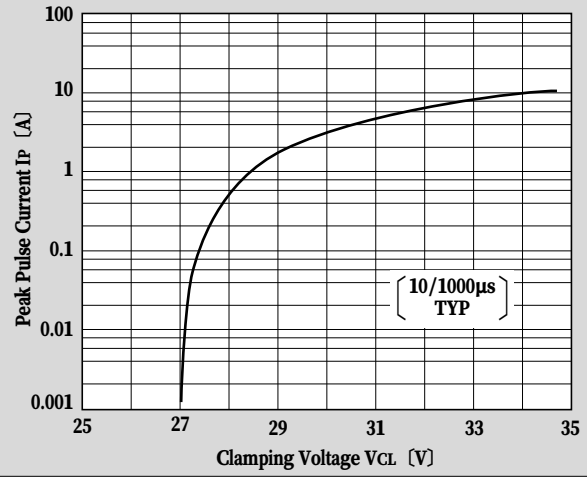
Item	Symbol	Conditions		Ratings	Unit
Storage Temperature	Tstg			−55～175	℃
Junction Temperature	Tj			150	℃
Peak Surge Reverse Current	I_{RSM}	10/1000 μs	Non-repetitive	10	A
		10/200 μs		19	
Maximum Reverse Voltage	V_{RM}			23	V

Electrical Characteristics T_j=25℃

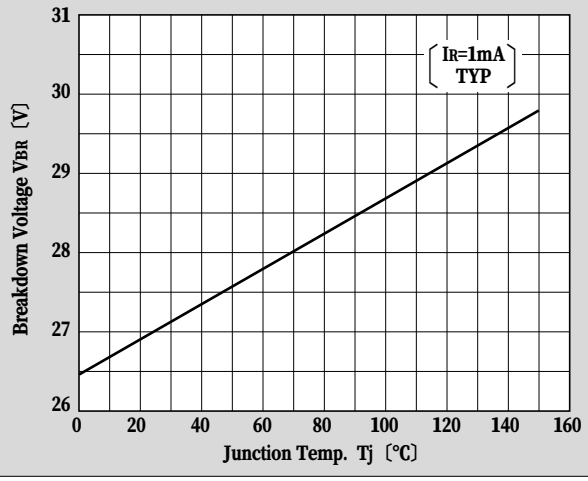
Breakdown Voltage	V_{BR}	I_R=1mA	24.3～29.7	V
Clamping Voltage	V_{CL}	I_{PP}=10A	MAX 37	V
Reverse Current	I_R	V_R=23V	MAX 5	μA

■CHARACTERISTIC DIAGRAMS

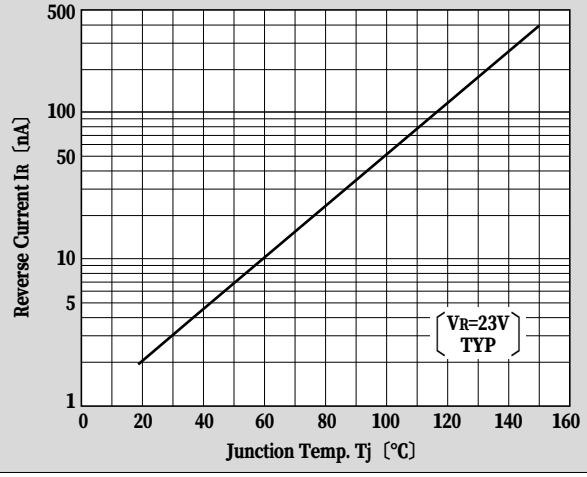
Clamping Voltage



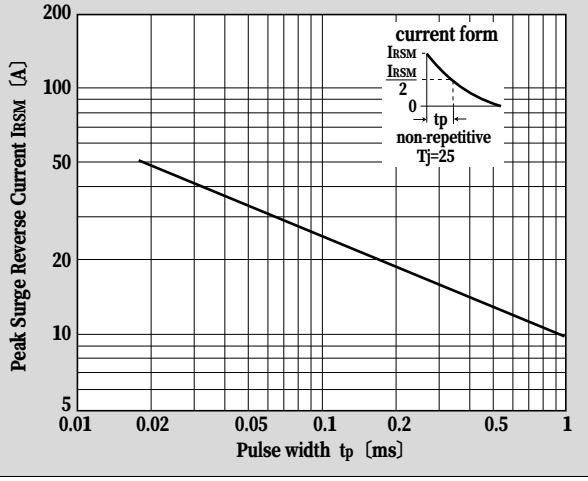
Breakdown Voltage



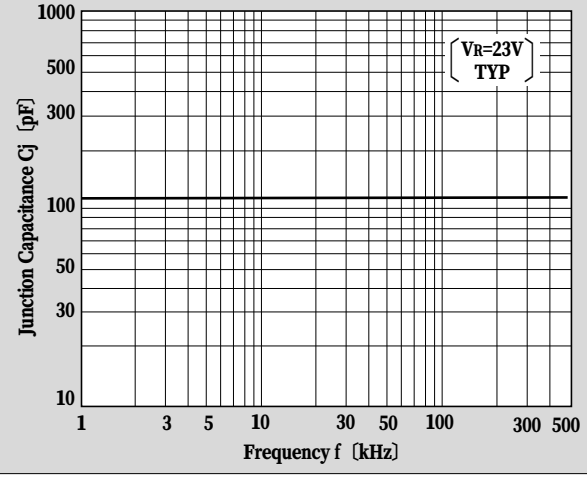
Reverse Current



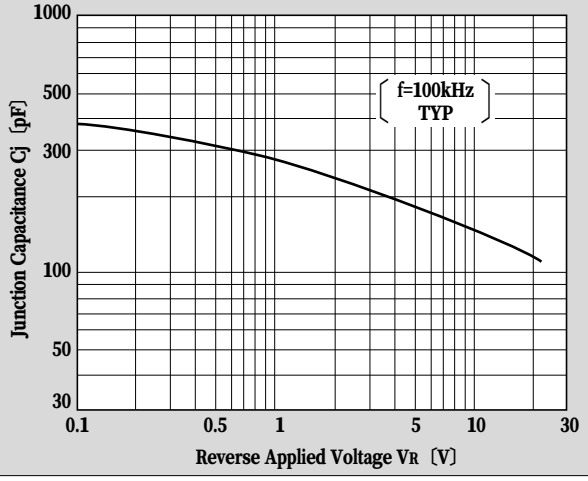
Peak Surge Reverse Current



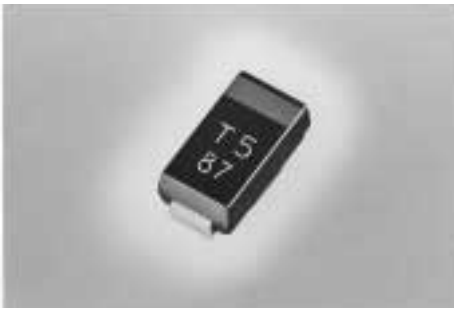
Junction Capacitance f-Cj



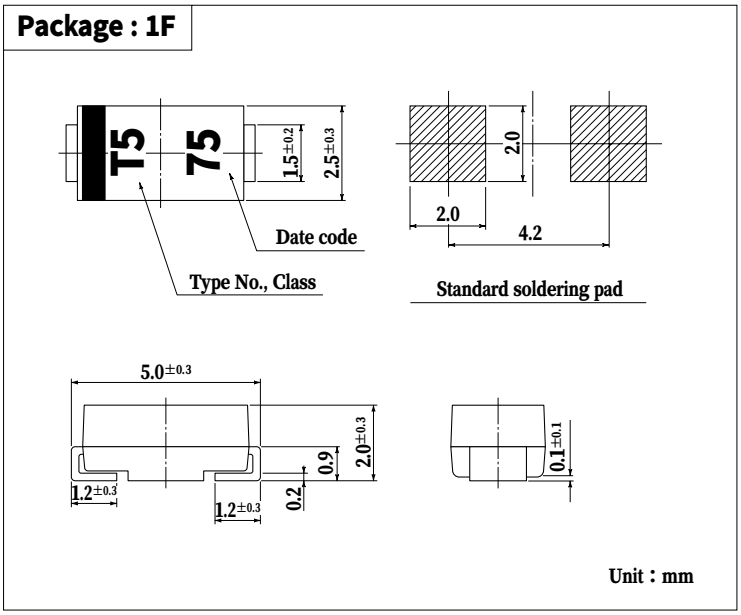
Junction Capacitance VR-Cj



ST03-58F1



■OUTLINE DIMENSIONS



■RATINGS

Absolute Maximum Ratings

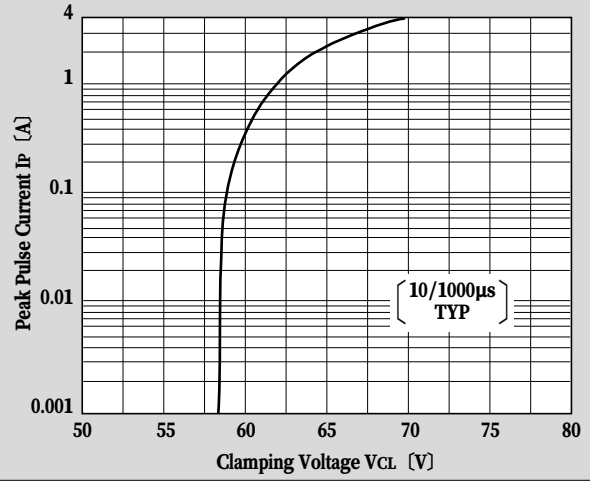
Item	Symbol	Conditions		Ratings	Unit
Storage Temperature	Tstg			−55～150	℃
Junction Temperature	Tj			150	℃
Peak Surge Reverse Power	P_{RSM}	10/1000 μs	Non-repetitive	300	W
Peak Surge Reverse Current	I_{RSM}			4	A
Maximum Reverse Voltage	V_{RM}			45	V

Electrical Characteristics T_j=25℃

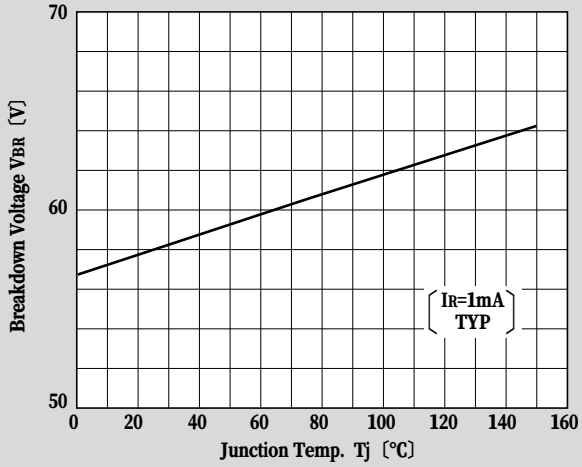
Breakdown Voltage	V_{BR}	I_R=1mA	52～64	V
Clamping Voltage	V_{CL}	I_{PP}=4A	MAX 80	V
Reverse Current	I_R	V_R=45V	MAX 5	μA

■CHARACTERISTIC DIAGRAMS

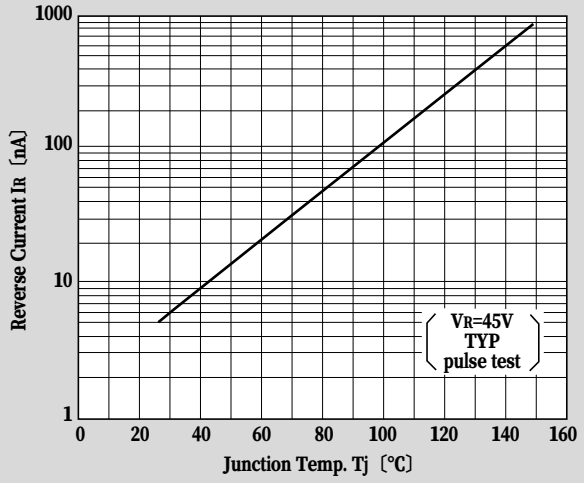
Clamping Voltage



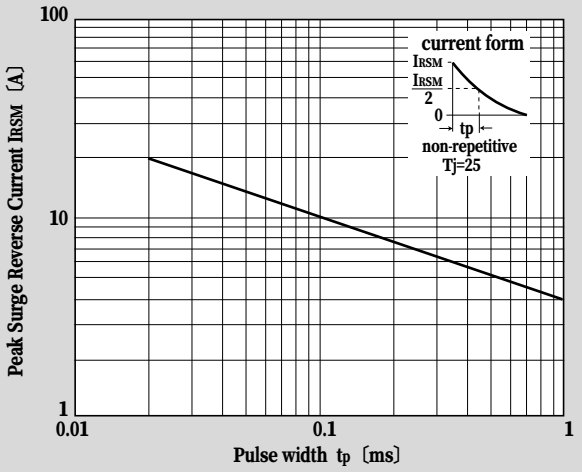
Breakdown Voltage



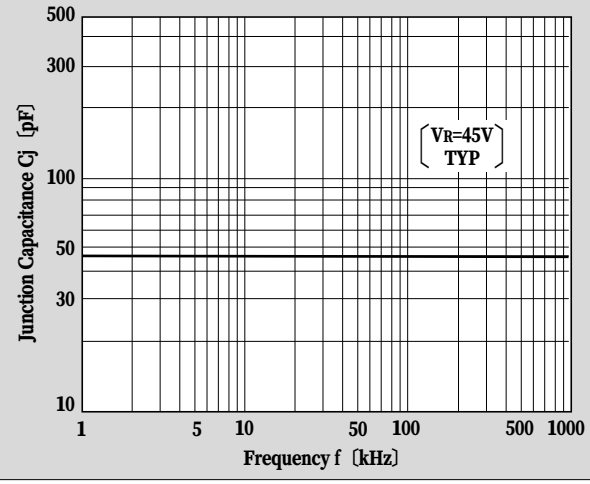
Reverse Current



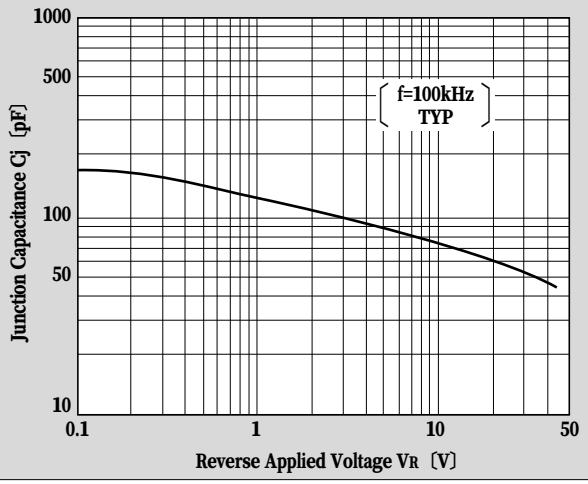
Peak Surge Reverse Current



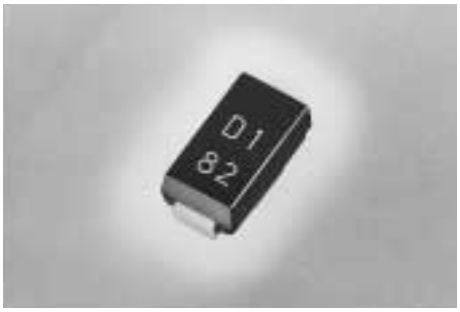
Junction Capacitance f-Cj



Junction Capacitance VR-Cj

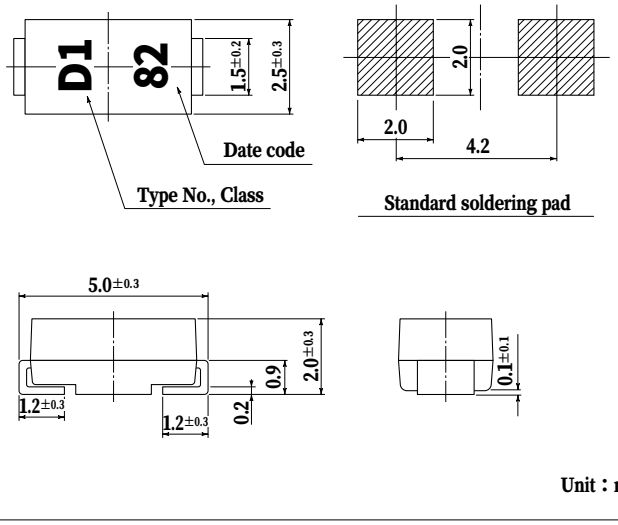


DL04-18F1



■OUTLINE DIMENSIONS

Package : 1F



Unit : mm

■RATINGS

Absolute Maximum Ratings

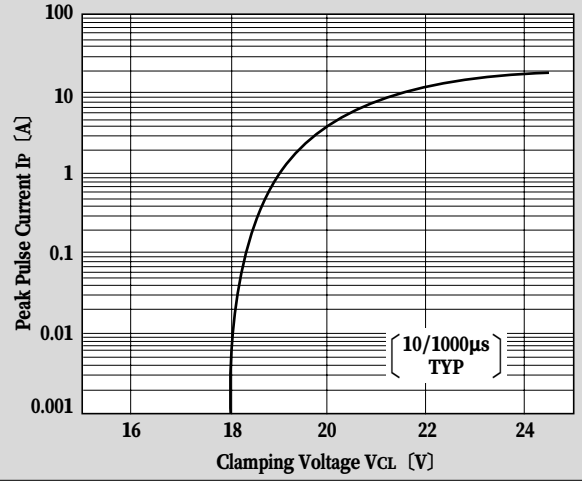
Item	Symbol	Conditions		Ratings	Unit
Storage Temperature	Tstg			−55～150	℃
Junction Temperature	Tj			150	℃
Peak Surge Reverse Power	P_{RSM}	10/1000 μs	Non-repetitive	400	W
Maximum Reverse Voltage	V_{RM}			13	V

Electrical Characteristics T_j=25℃

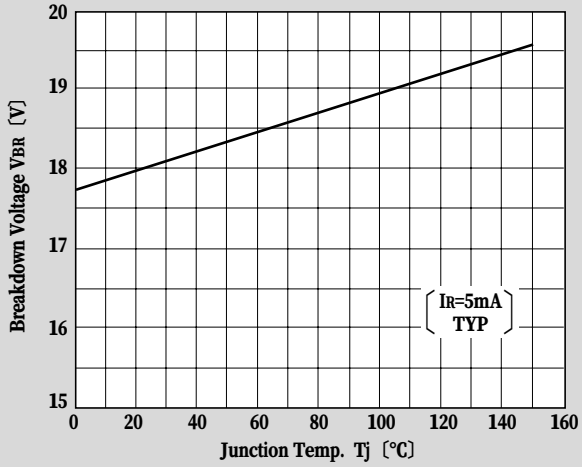
Breakdown Voltage	V_{BR}	I_R=5mA	16.8～19.1	V
Clamping Voltage	V_{CL}	I_{PP}=15A	MAX 26	V
Reverse Current	I_R	V_R=13V	MAX 5	μA

■CHARACTERISTIC DIAGRAMS

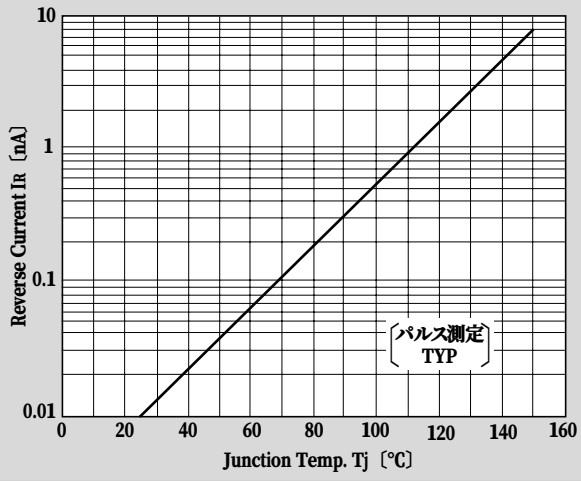
Clamping Voltage



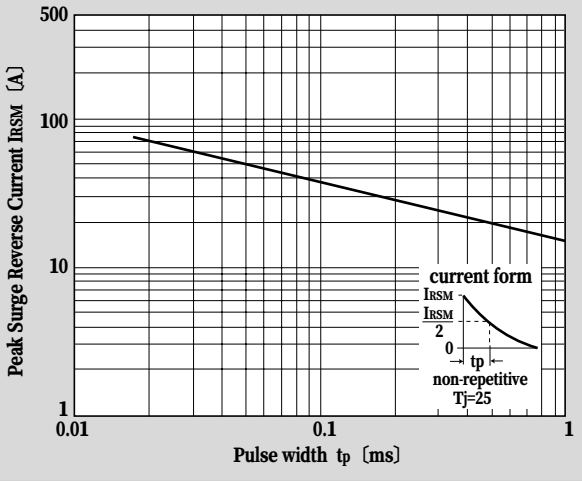
Breakdown Voltage



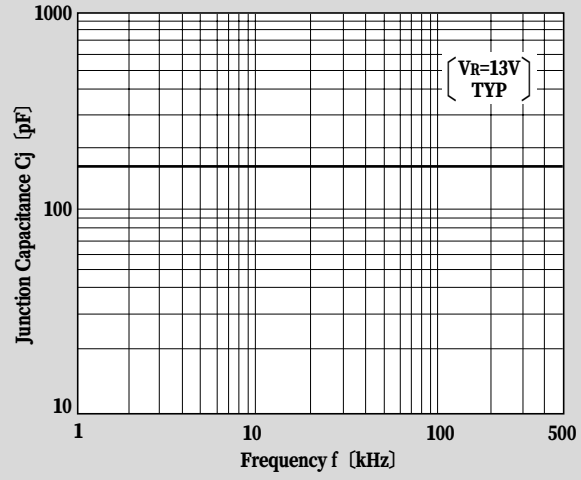
Reverse Current



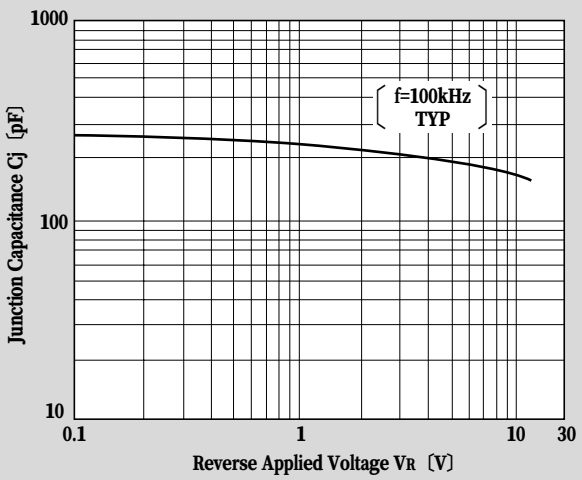
Peak Surge Reverse Current



Junction Capacitance f-Cj



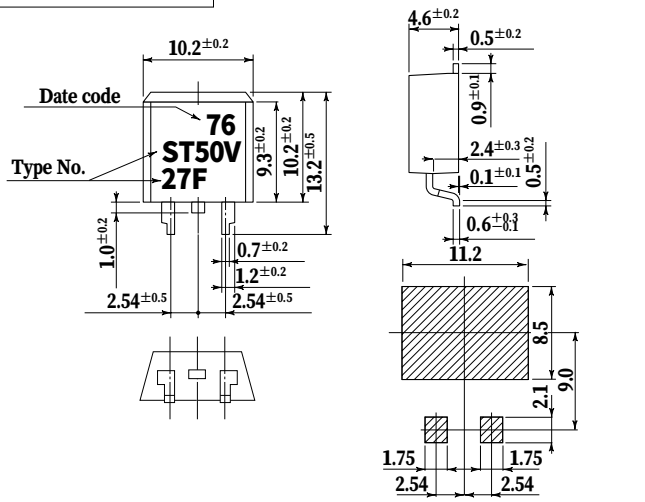
Junction Capacitance VR-Cj



ST50V-27F

■OUTLINE DIMENSIONS

Package : STO-220



■RATINGS

Absolute Maximum Ratings

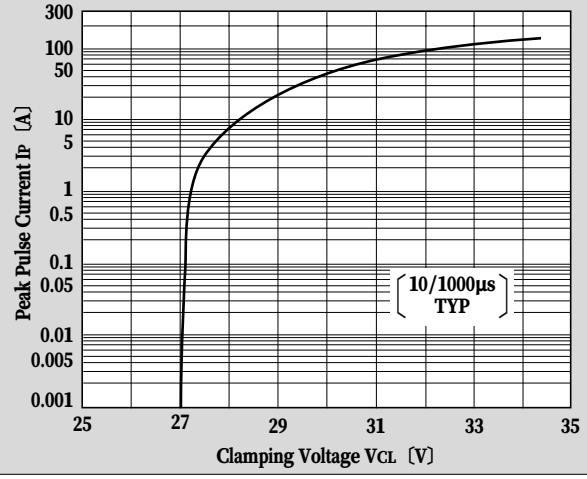
Item	Symbol	Conditions		Ratings		Unit
				Trankiller	Diode	
Storage Temperature	Tstg			−40～150		℃
Junction Temperature	Tj			150		℃
Peak Surge Reverse Power	P_{RSM}	10/1000 μs	Non-repetitive	5000	—	W
Peak Surge Reverse Current	I_{RSM}	10/1000 μs	Non-repetitive	130	—	A
Maximum Reverse Voltage	V_{RM}			23	400	V

Electrical Characteristics T_j=25℃

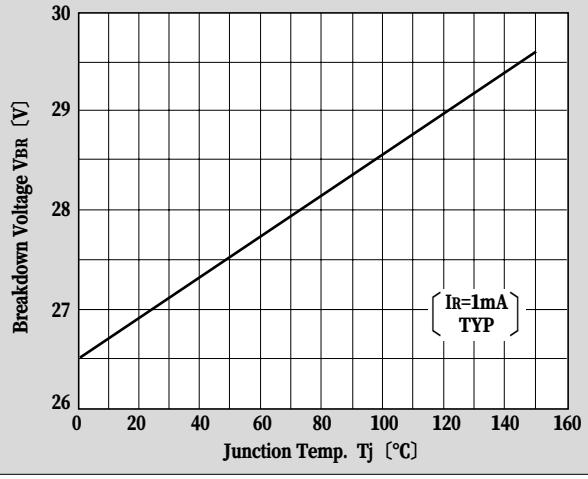
Breakdown Voltage	V_{BR}	I_R=1mA	24.3～29.7	—	V
Clamping Voltage	V_{CL}	I_{PP}=130A	MAX 40	—	V
Reverse Current	I_R	V_R=23V	MAX 5		μA
Forward Voltage	V_F	I_F=1.1A	—	MAX 1.2	V

■CHARACTERISTIC DIAGRAMS

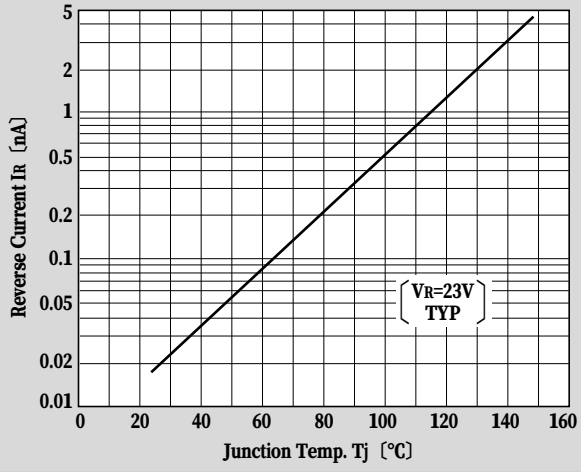
Clamping Voltage



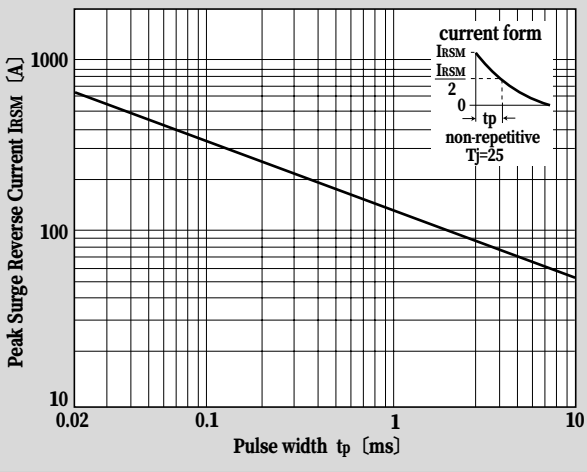
Breakdown Voltage



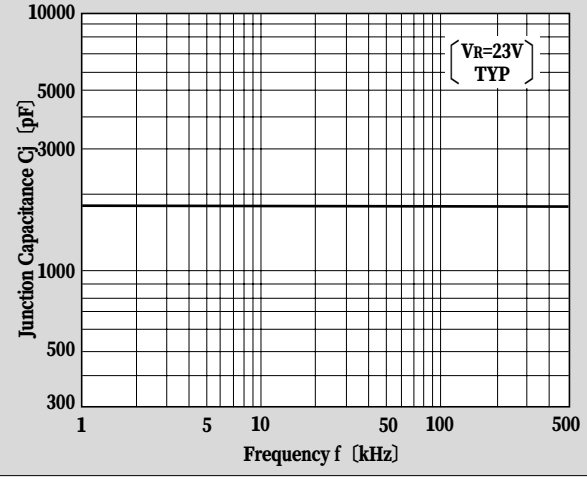
Reverse Current



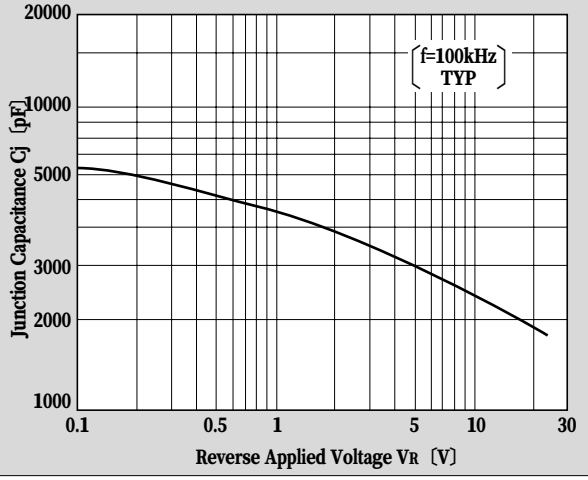
Peak Surge Reverse Current



Junction Capacitance f-Cj



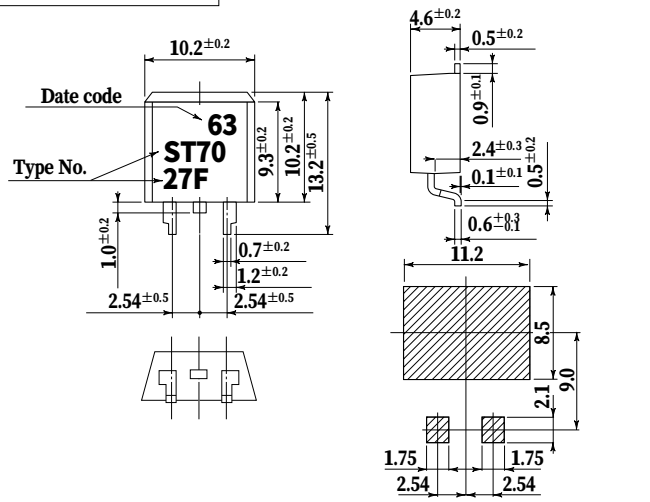
Junction Capacitance VR-Cj



ST70-27F

■OUTLINE DIMENSIONS

Package : STO-220



■RATINGS

Absolute Maximum Ratings

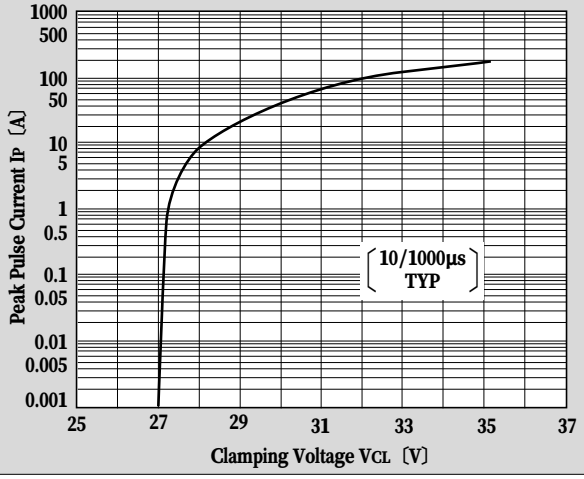
Item	Symbol	Conditions \ Type No.	ST70-27F	Unit
Storage Temperature	Tstg		−40～150	℃
Junction Temperature	Tj		150	℃
Peak Surge Reverse Power	P_{RSM}	Non-repetitive 10/1000 μs	7000	W
Peak Surge Reverse Current	I_{RSM}		180	A
Maximum Reverse Voltage	V_{RM}		23	V

Electrical Characteristics T_j=25℃

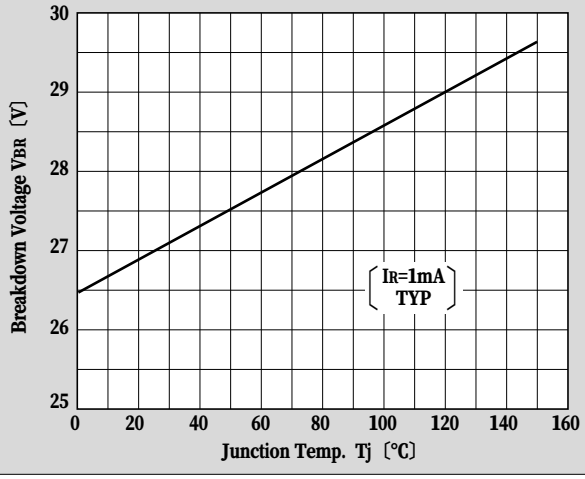
Breakdown Voltage	V_{BR}	I_R=1mA	24.3～29.7	V
Clamping Voltage	V_{CL}	I_{PP}=180A	MAX 40	V
Off-State Current	I_R	V_R=V_{RM}	MAX 5	μA

■CHARACTERISTIC DIAGRAMS

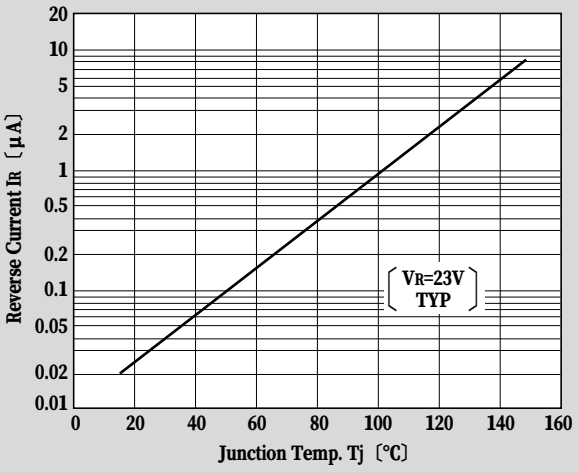
Clamping Voltage



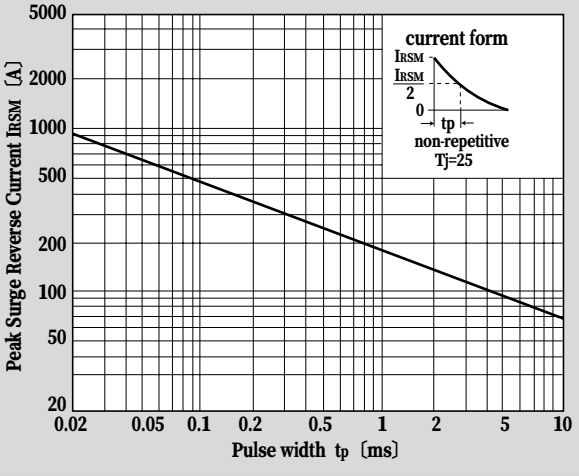
Breakdown Voltage



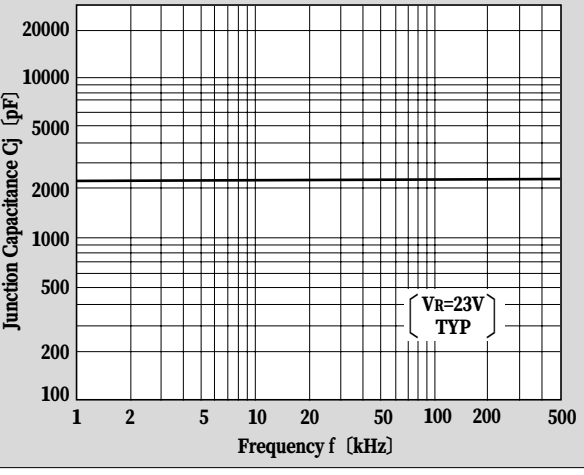
Reverse Current



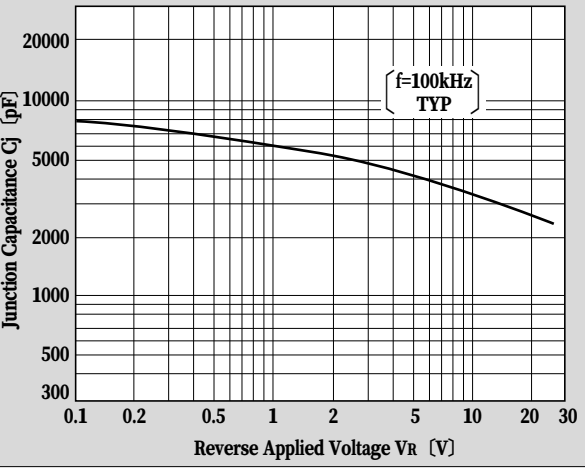
Peak Surge Reverse Current



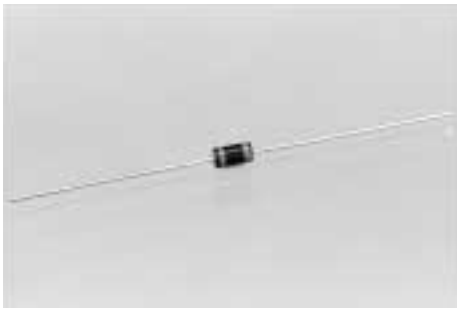
Junction Capacitance f-Cj



Junction Capacitance VR-Cj

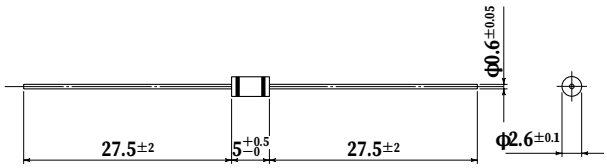


VR-60B(A)



■OUTLINE DIMENSIONS

Package : AX06



●Marking

Unit : mm

■RATINGS

Absolute Maximum Ratings

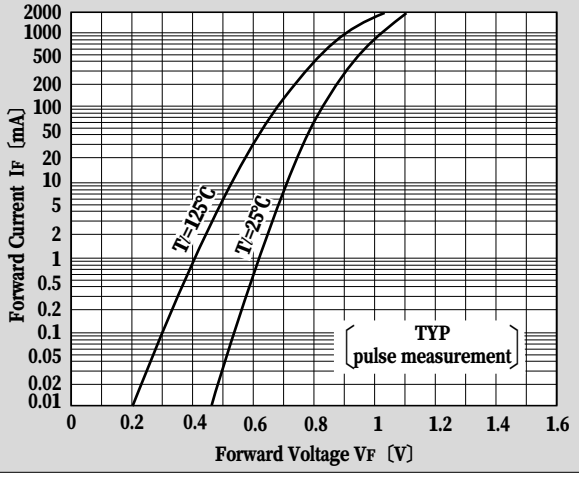
Item	Symbol	Conditions	Ratings	Unit
Storage Temperature	Tstg		−30～125	℃
Junction Temperature	Tj		125	℃
Average Rectified Forward Current	Io	Ta=40℃ Sine wave R-load Commercial frequency On glass-epoxy substrate	0.5	Arms
Peak Surge Reverse Current	I_{FSM}	50Hz Sine wave 1 cycle Non-repetitive T/=25℃	16	Arms

Electrical Characteristics T/=25℃

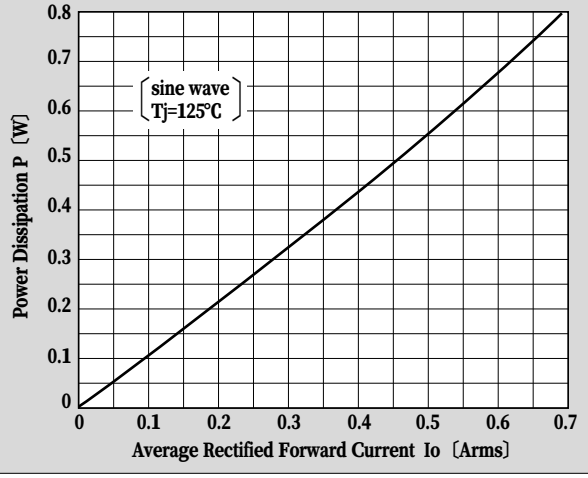
Forward Voltage	V_F	I_F=1.0A	^{MAX}1.5	V
Current	I	V=0.2V	^{MAX}20	μA
Thermal Resistance	θja	Junction to ambient	^{MAX}156	℃／W

■CHARACTERISTIC DIAGRAMS

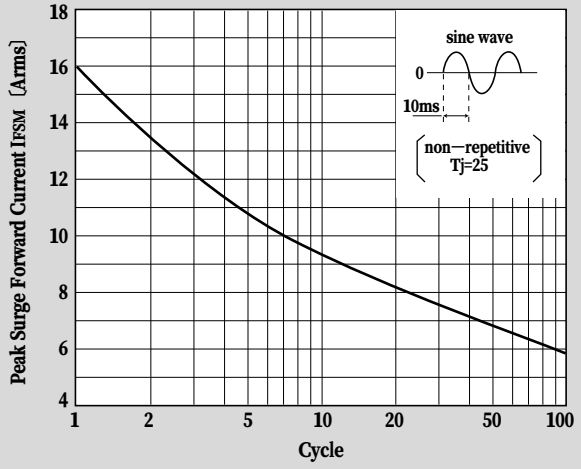
Forward Voltage



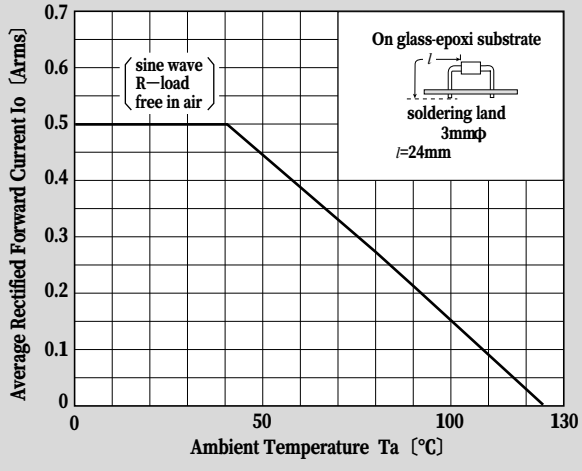
Power Dissipation



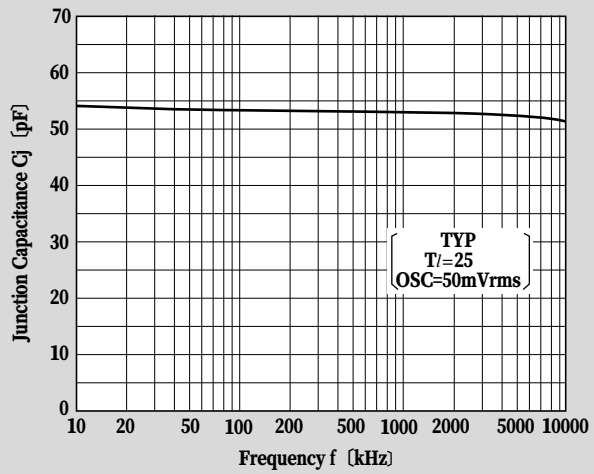
Peak Surge Forward Current



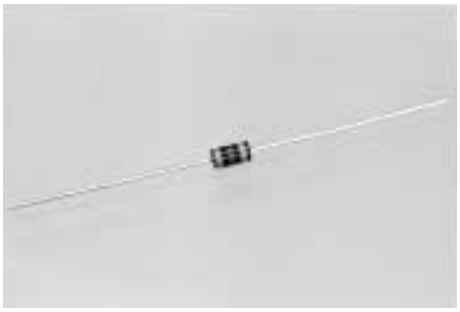
Derating Curve Ta-lo



Jubction Capacitance f-Cj

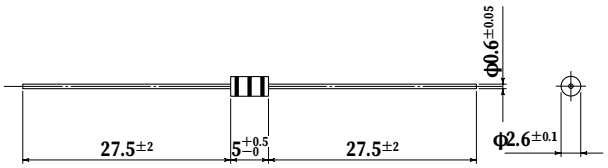


VR-61B(A)

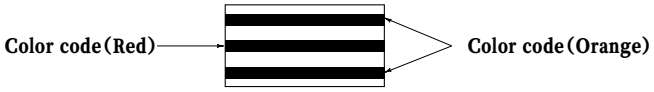


■OUTLINE DIMENSIONS

Package : AX06



●Marking



Unit : mm

■RATINGS

Absolute Maximum Ratings

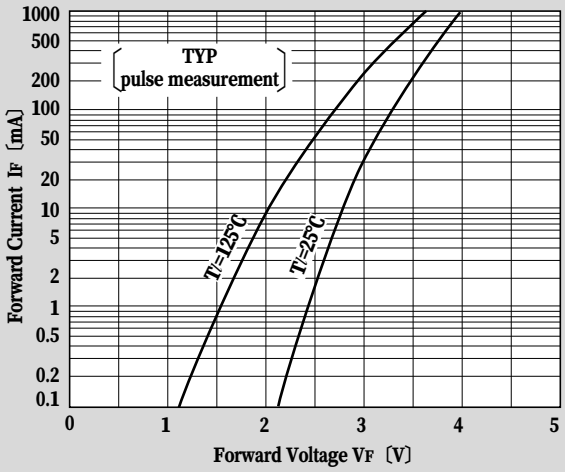
Item	Symbol	Conditions	Ratings	Unit
Storage Temperature	Tstg		−30～125	℃
Junction Temperature	Tj		125	℃
Average Rectified Forward Current	Io	Ta=40℃ Sine wave R-load Commercial frequency On glass-epoxy substrate	0.15	Arms
Peak Surge Forward Current	I_{FSM}	50Hz Sine wave 1 cycle Non-repetitive T/=25℃	7.5	Arms

Electrical Characteristics T/=25℃

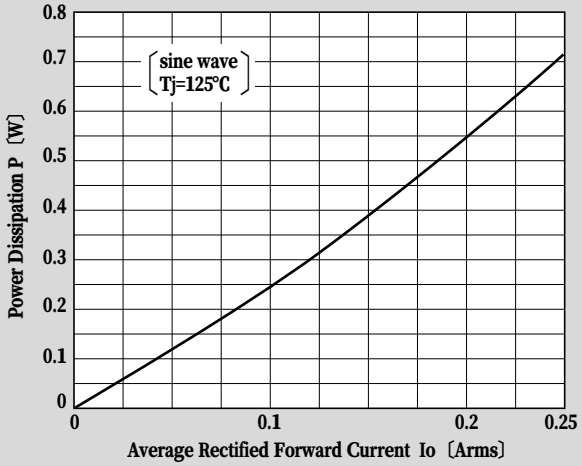
Forward Voltage	V_F	I_F=1mA	2.05～2.55	V
		I_F=10mA	2.50～3.00	
		I_F=70mA	2.85～3.35	
Thermal Resistance	θja	Junction to ambient	MAX 215	℃/W

■CHARACTERISTIC DIAGRAMS

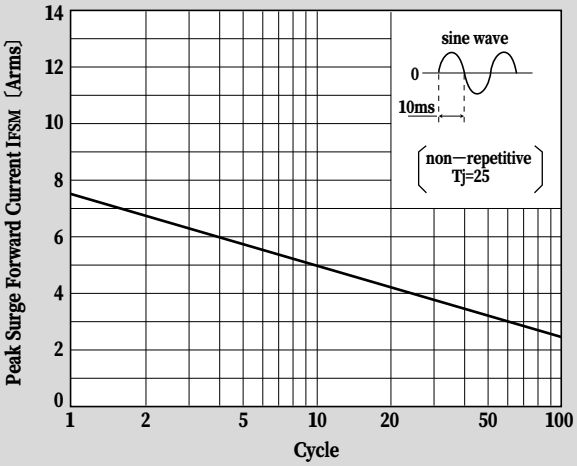
Forward Voltage



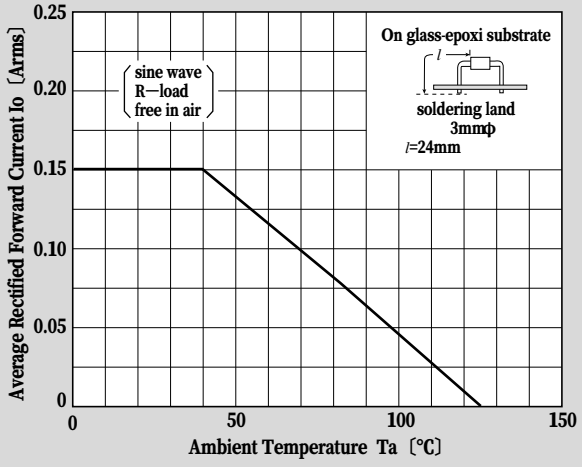
Power Dissipation



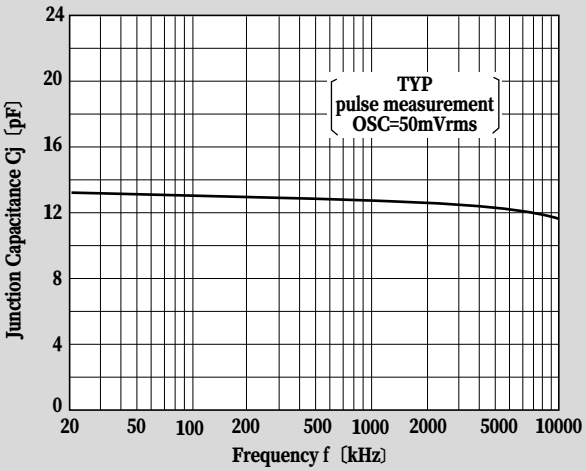
Peak Surge Forward Current



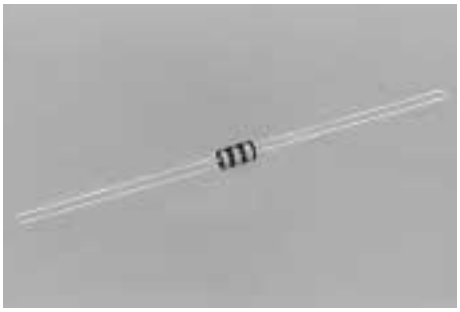
Derating Curve Ta-lo



Jubction Capacitance f-cj

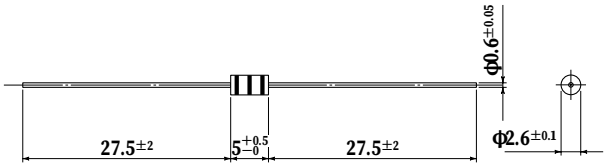


VR-51B(A)



■OUTLINE DIMENSIONS

Package : AX06



●Marking

Color code (Silver)

Unit : mm

■RATINGS

Absolute Maximum Ratings

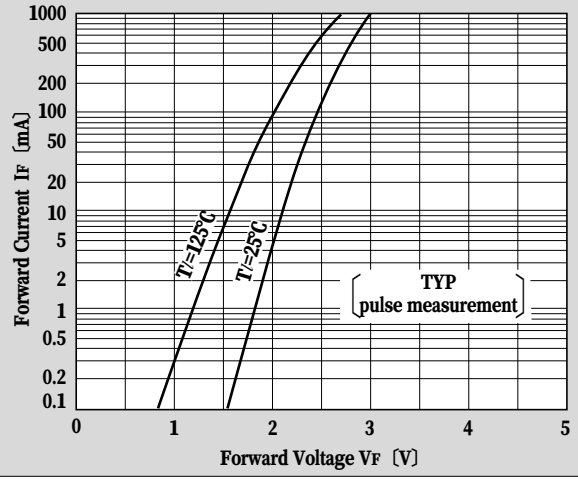
Item	Symbol	Conditions	Ratings	Unit
Storage Temperature	Tstg		−30～125	℃
Junction Temperature	Tj		125	℃
Average Rectified Forward Current	Io	Ta=40℃ Sine wave R-load Commercial frequency On glass-epoxy substrate	0.15	Arms
Peak Surge Reverse Current	I_{FSM}	50Hz Sine wave 1 cycle Non-repetitive Tj=25℃	7.5	Arms

Electrical Characteristics Tj=25℃

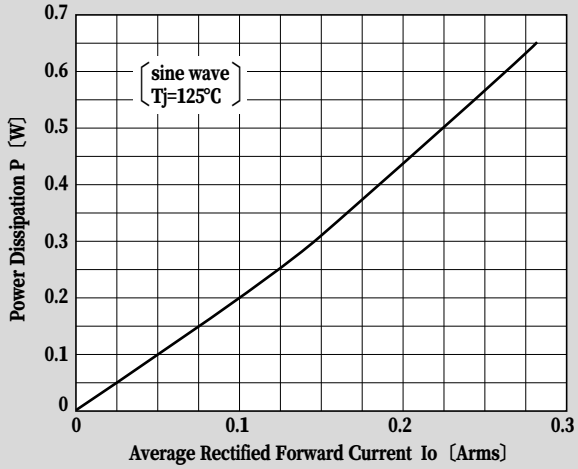
Forward Voltage	V_F	I_F=1mA	1.55～2.05	V
		I_F=10mA	1.85～2.35	
		I_F=70mA	2.15～2.65	
Thermal Resistance	θja	Junction to ambient	MAX 270	℃/W

■CHARACTERISTIC DIAGRAMS

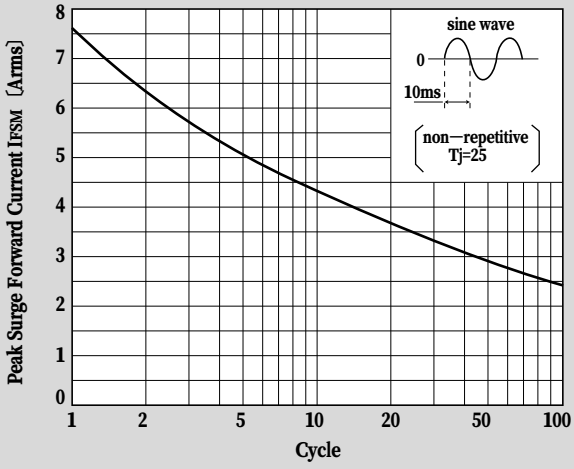
Forward Voltage



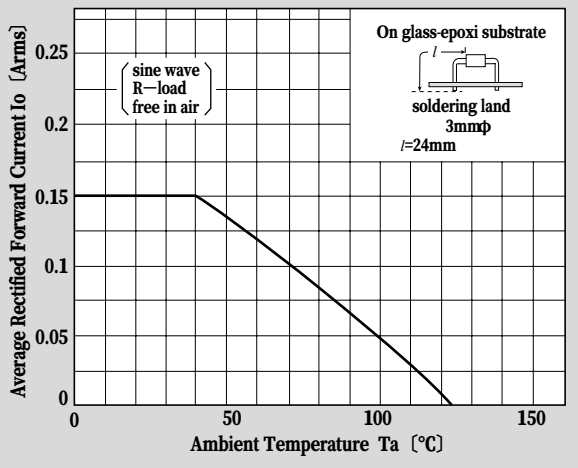
Power Dissipation



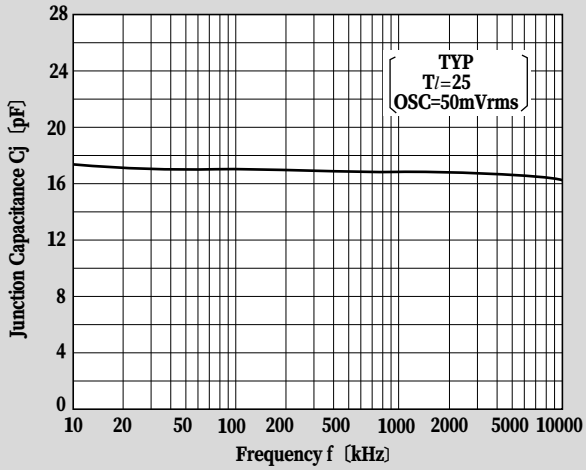
Peak Surge Forward Current



Derating Curve Ta-lo



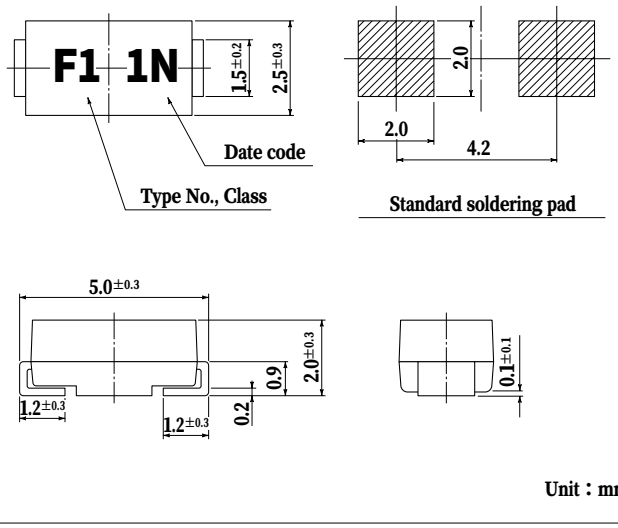
Jubction Capacitance f-cj



VR-61F1

■OUTLINE DIMENSIONS

Package : 1F



■RATINGS

Absolute Maximum Ratings

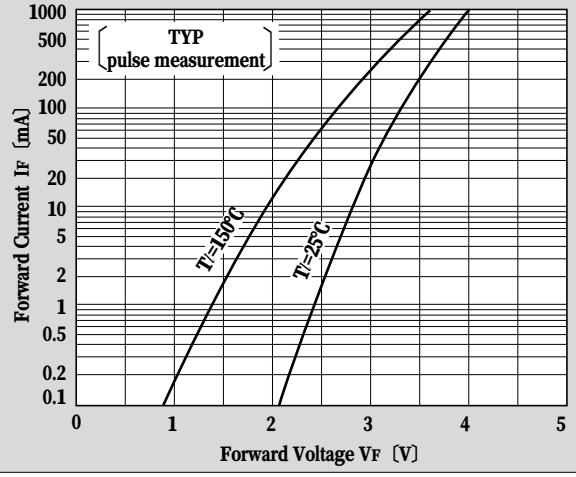
Item	Symbol	Conditions		Ratings	Unit
Storage Temperature	Tstg			−55～150	℃
Junction Temperature	Tj			150	℃
Average Rectified Forward Current	Io	Ta=25℃ Sine wave R-load Commercial frequency	On alumina substrate	0.37	Arms
			On glass-epoxy substrate	0.28	
Peak Surge Forward Current	IFSM	50Hz Sine wave	Non-repetitive	7.5	Arms
		10/200 μs		60	A
		10/1000 μs		30	

Electrical Characteristics T/=25℃

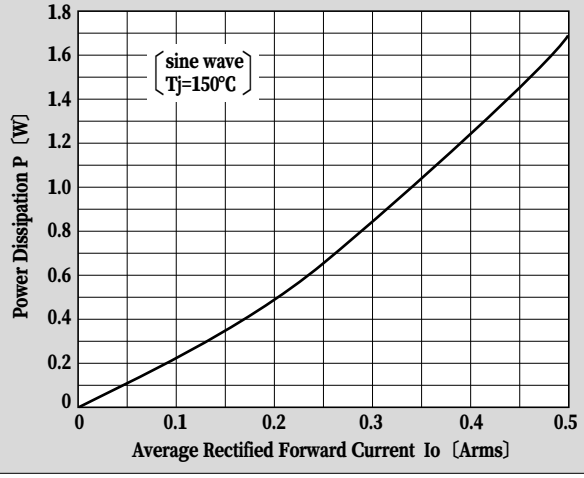
Forward Voltage	VF	IF=1mA		2.05～2.55	V
		IF=10mA		2.50～3.00	
		IF=70mA		2.85～3.35	
Junction Capacitance	Cj	f=100kHz VD=1V OSC=50mVrms		TYP 15	pF
Thermal Resistance	θja	Junction to ambient	On alumina substrate	MAX 108	℃/W
			On glass-epoxy substrate	MAX 157	

■CHARACTERISTIC DIAGRAMS

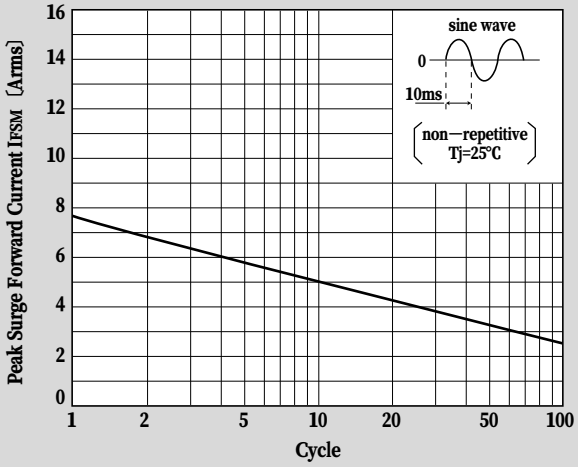
Forward Voltage



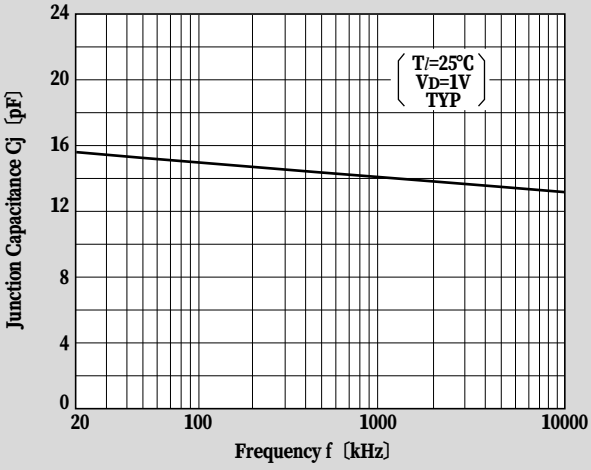
Power Dissipation



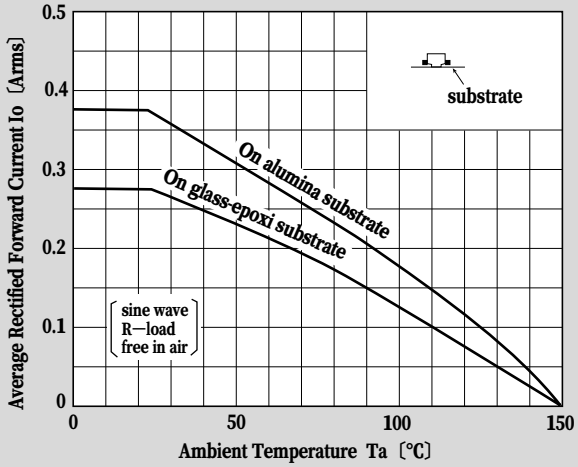
Peak Surge Forward Current



Junction Capacitance f-cj



Derating Curve Ta-Io

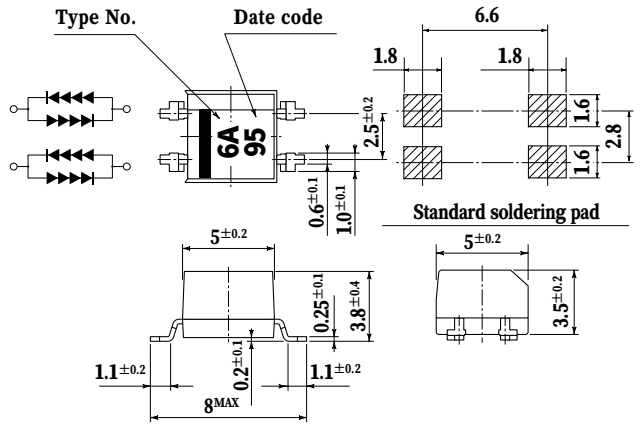


	On giass-epoxi substrate	On alumina substrate
soldering land	2mm□	2mm□
conductor layer	35μm	20μm
substrate thickness	——	0.64mm

VRYA6

■OUTLINE DIMENSIONS

Package : 1Y



■RATINGS

Absolute Maximum Ratings

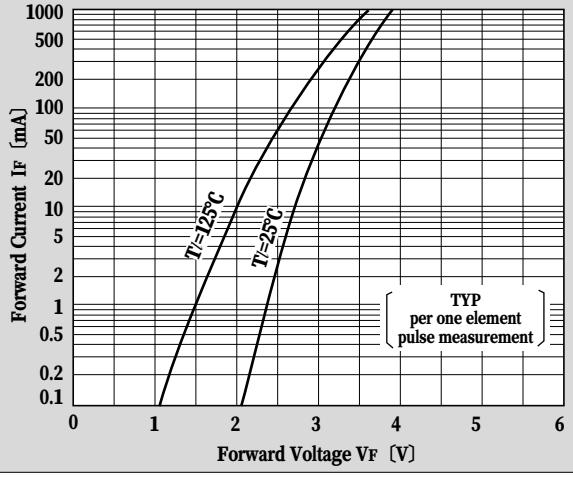
Item	Symbol	Conditions			Ratings	Unit
Storage Temperature	Tstg				−30～125	℃
Junction Temperature	Tj				125	℃
Average Rectified Forward Current	Io	Ta=40℃ Sine wave R-load Commercial frequency	On alumina substrate	1 element operation	310	mArms
				2 elements operation	200	
			On glass-epoxy substrate	1 element operation	200	
				2 elements operation	130	
Peak Surge Forward Current	I_{FSM}	50Hz Sine wave	Non-repetitive	2 elements series operation	8	Arms
		10/200 μs			65	A
		10/1000 μs			30	

Electrical Characteristics T_j=25℃

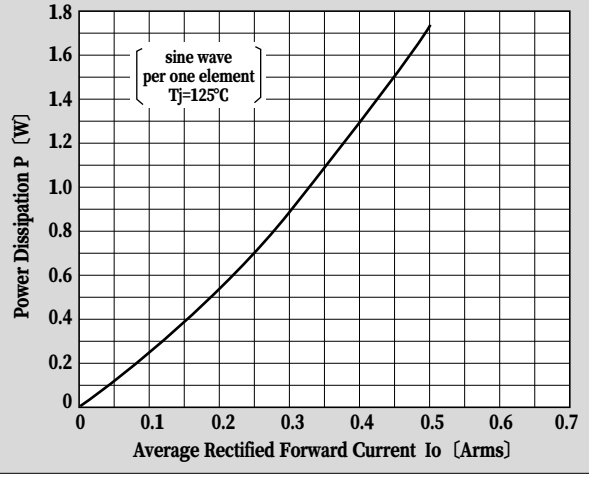
Forward Voltage	V_F	I_F=1mA	1 element	2.05～2.55	V
			2 elements series	4.10～5.10	
		I_F=10mA	1 element	2.50～3.00	
			2 elements series	5.00～6.00	
		I_F=70mA	1 element	2.85～3.35	
			2 elements series	5.70～6.60	
Junction Capacitance	Cj	f=100kHz V_D=0V OSC=50mVrms		TYP 13	pF
Thermal Resistance	θja	Junction to ambient	On alumina substrate	1 element operation	MAX 90	℃/W
				2 elements operation	MAX 150	
			On glass-epoxy substrate	1 element operation	MAX 150	
				2 elements operation	MAX 250	

■CHARACTERISTIC DIAGRAMS

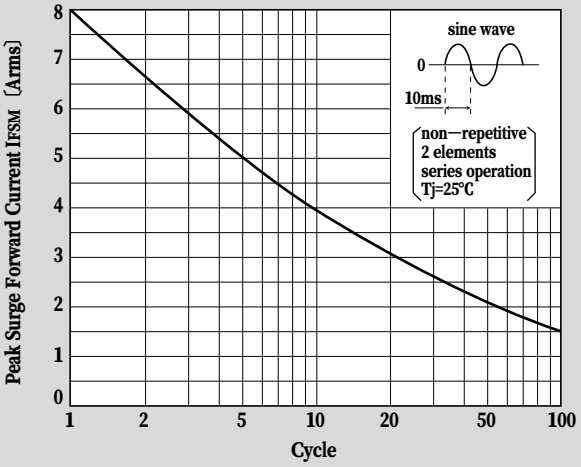
Forward Voltage



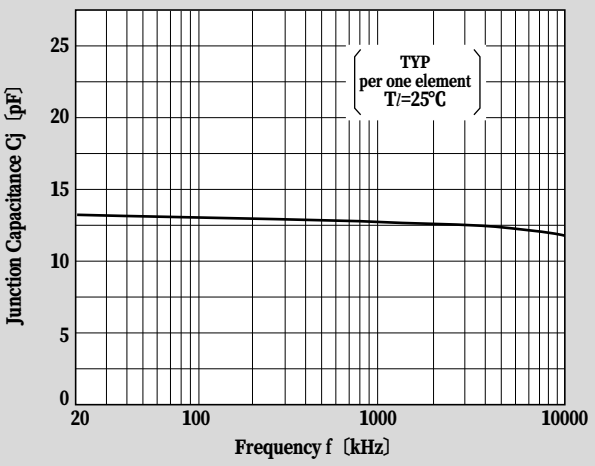
Power Dissipation



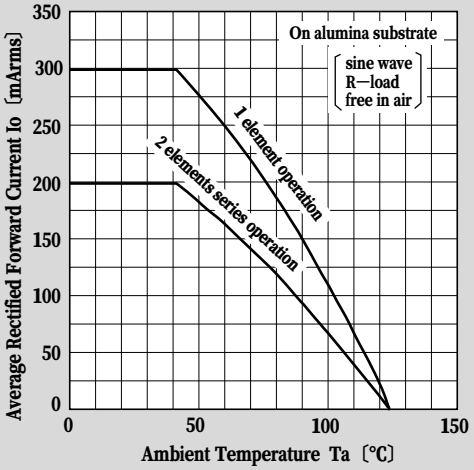
Peak Surge Forward Current



Junction Capacitance f-cj

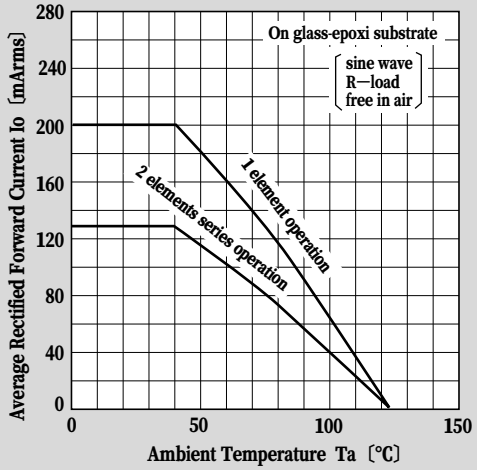


Derating Curve Ta-Io

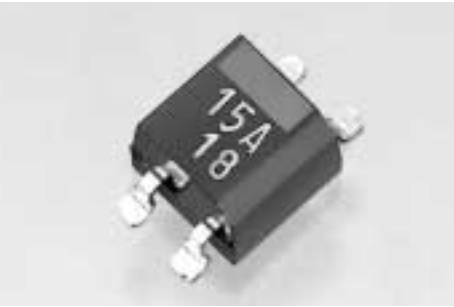


	On alumina substrate	On glass-epoxi substrate
substrate size	25×25mm	
soldering land	1mm□	
conductor layer	20μm	35μm
substrate thickness	0.64mm	1.5mm

Derating Curve Ta-Io

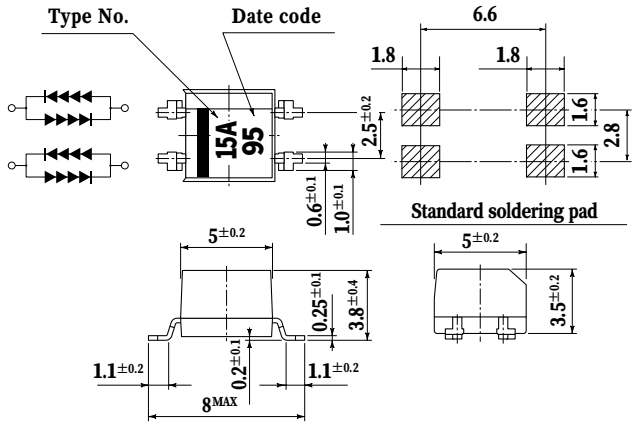


VRYA15



■OUTLINE DIMENSIONS

Package : 1Y



■RATINGS

Absolute Maximum Ratings

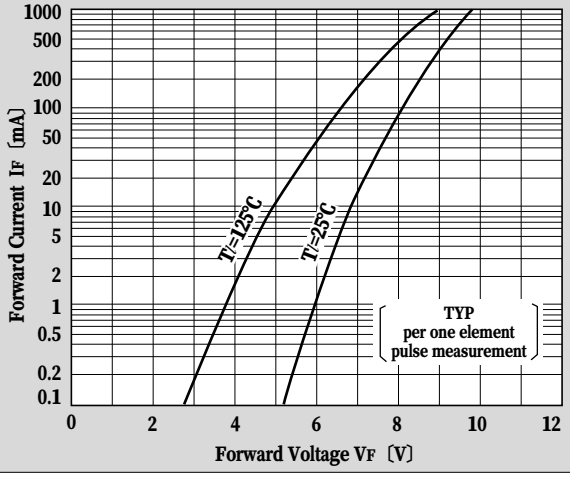
Item	Symbol	Conditions			Ratings	Unit
Storage Temperature	Tstg				−30～125	℃
Junction Temperature	Tj				125	℃
Average Rectified Forward Current	Io	Ta=40℃ Sine wave R-load Commercial frequency	On alumina substrate	1 element operation	140	mArms
				2 elements operation	90	
			On glass-epoxy substrate	1 element operation	90	
				2 elements operation	50	
Peak Surge Forward Current	I_{FSM}	50Hz Sine wave	Non-repetitive	2 elements series operation	6.5	Arms
		10/200 μs			50	A
		10/1000 μs			24	

Electrical Characteristics T/=25℃

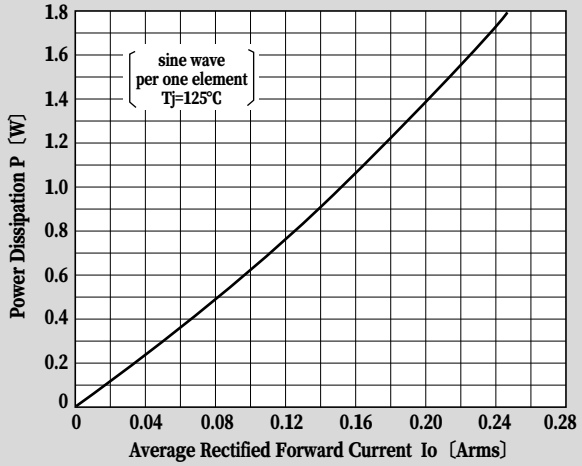
Forward Voltage	V_F	I_F=1mA	1 element	5.13～6.37	V
			2 elements series	10.25～12.75	
		I_F=10mA	1 element	6.25～7.50	
			2 elements series	12.50～15.00	
		I_F=70mA	1 element	7.13～8.37	
			2 elements series	14.25～16.75	
Junction Capacitance	Cj	f=100kHz V_D=0V OSC=50mVrms		TYP 5	pF
Thermal Resistance	θja	Junction to ambient	On alumina substrate	1 element operation	MAX 90	℃/W
				2 elements operation	MAX 150	
			On glass-epoxy substrate	1 element operation	MAX 150	
				2 elements operation	MAX 250	

■CHARACTERISTIC DIAGRAMS

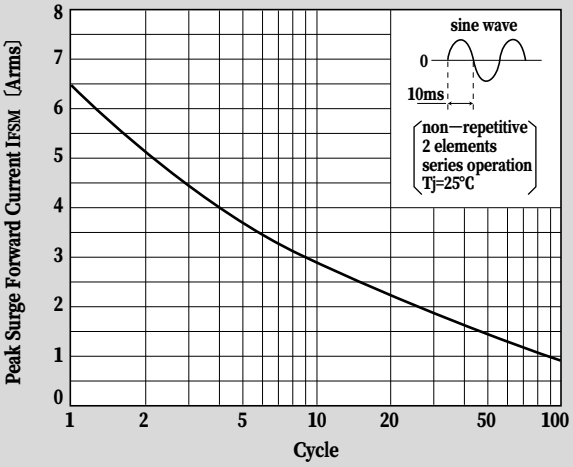
Forward Voltage



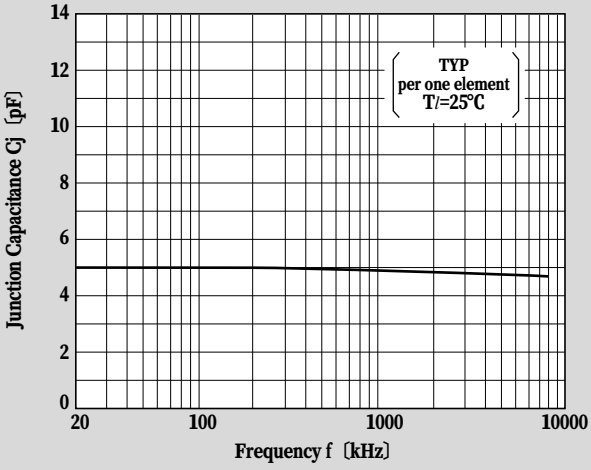
Power Dissipation



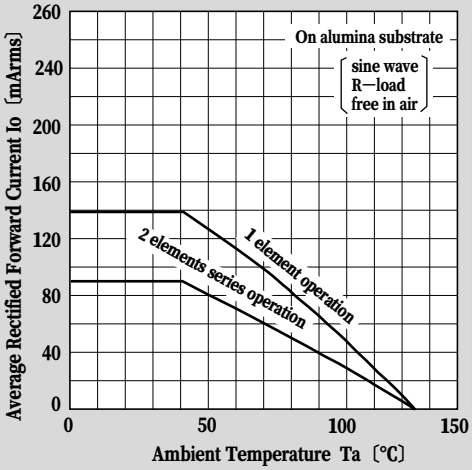
Peak Surge Forward Current



Junction Capacitance f-cj

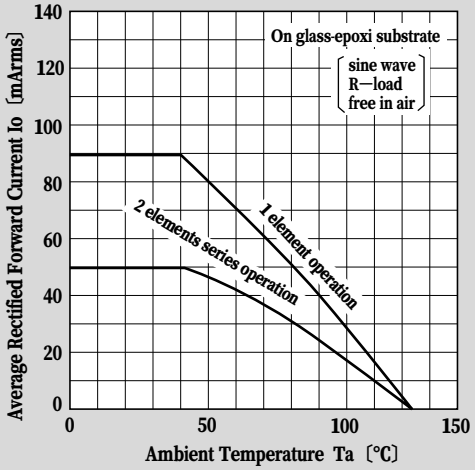


Derating Curve Ta-Io



	On alumina substrate	On glass-epoxi substrate
substrate size	25×25mm	
soldering land	1mm□	
conductor layer	20μm	35μm
substrate thickness	0.64mm	1.5mm

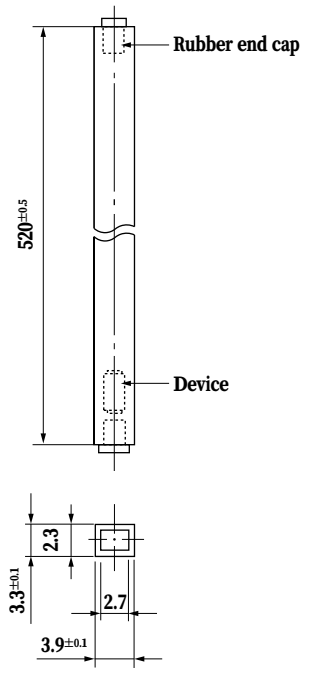
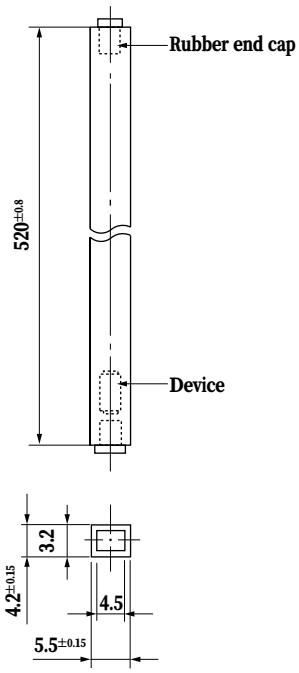
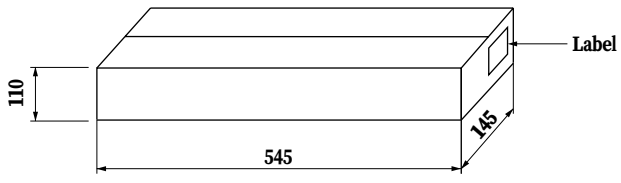
Derating Curve Ta-Io



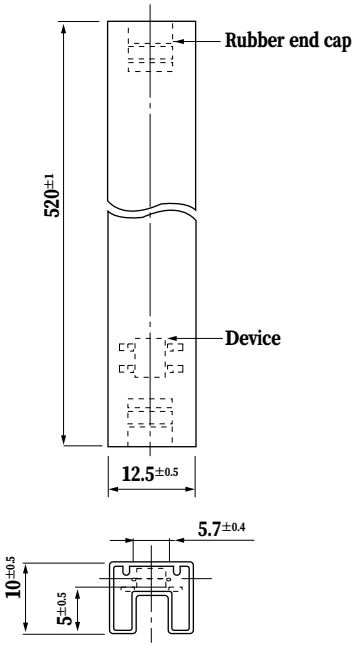
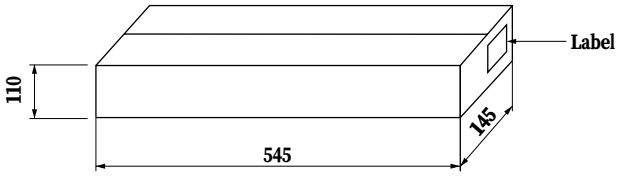
Basic Ordering Quantities and Packing Standards

Classification	Type No.	Code No.	Basic Ordering Quantities			Packing Quantities		Packing Box Dimensions〔mm〕		
			Quantity	Stick	Taping	Quantity／Box	Weight〔kg〕	L	W	D
TSS										
Surface-mounted package (Type 2F)	KP□−□	4103	60	○		18,000	5.2	545	145	110
		4063	750		○	15,000	4.2	340	195	205
		4073	3,000		○	36,000	9.2	395	245	395
Three-terminal insulated package	KT□−□	4000	50	○		1,000	—	265	205	210
		4100	50	○		3,000	—	545	145	100
KA series (axial)	KA□−□	4000	200			5,000	—	340	190	115
Surface-mounted package (Type 1F)	KL□−□	4103	100	○		15,000	2.3	545	145	110
		4063	1,500		○	60,000	7.0	395	350	235
		4073	7,500		○	90,000	10.8	395	245	395
Surface-mounted package (Type M2F)	KU□−□	4063	1,000		○	20,000	—	340	195	205
		4073	4,000		○	48,000	—	395	245	395
Trankillers										
Surface-mounted package (Type 1F)	ST□−□F1	4103	100	○		15,000	2.3	545	145	110
		4063	1,500		○	60,000	7.0	395	350	235
		4073	7,500		○	90,000	10.8	395	245	395
Single device (axial)	ST□−□	4060	4,000		○	4,000	1.5	255	78	95
		4070	3,000		○	3,000	0.6	255	51	95
		4081	5,000		○	5,000	1.5	330	40	275
STO-220	ST□□−□□F	4102	50	○		4,500	9.5	535	145	110
		4062	250		○	3,000	6.3	385	205	245
		4072	1,000		○	3,000	6.0	362	362	160
Silicon Varistors										
Surface-mounted package (Type 1F)	VR−61F	4103	100	○		15,000	2.3	545	145	110
		4063	1,500		○	60,000	7.0	395	350	235
		4073	7,500		○	90,000	10.8	395	245	395
Surface-mounted package (Type 1Y)	VRYA□	4101	100	○		10,000	—	545	145	110
		4102	100	○		10,000	—	545	145	110
		4062	1,000		○	10,000	—	335	245	370
		4072	2,000		○	20,000	—	395	245	385
Single device (axial)	VR−□B(A)	4060	4,000		○	4,000	1.5	255	78	95
		4070	3,000		○	3,000	0.6	255	51	95
		4081	5,000		○	5,000	1.5	330	40	275

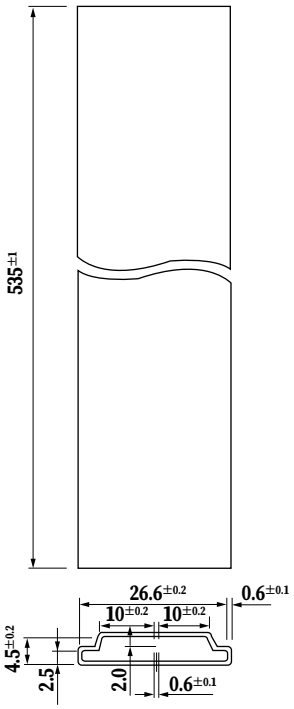
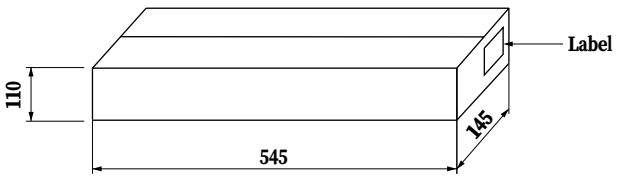
■ 1F，2F Type Device (Stick)

Type No.		VR-61F1 ST04-16F1, 27F1 KL3Z,KL3L, KL3N KL3R, KL3LU	KP4L, 4N, 10L, 10N, 10R 15L, 15N, 15R 8LU, 10LU
Package No.		Type 1F	Type 2F
Order Code		4103	4103
Stick	Dimensions	 Material：PIastic	 Material：PIastic
	Quantity	Standard capacity：100pcs／stick	Standard capacity：60pcs／stick
Standard Package	Dimensions	 Material：Corrugated cardboard	
	Quantity	Standard capacity：15,000pcs／carton (150sticks／carton)	Standard capacity：18,000pcs／carton (300sticks／carton)

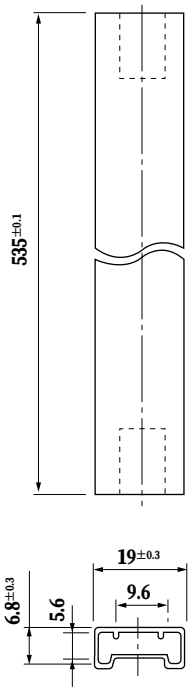
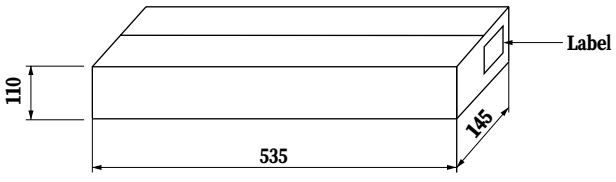
■ 1Y Type Device (Stick)

Type No.		VRYA6, 15
Package No.		Type 1Y
Order Code		4101, 4102
Stick	Dimensions	 Material：PIastic
	Quantity	Standard capacity：100pcs／stick
Standard Package	Dimensions	 Material：Corrugated cardboard
	Quantity	Standard capacity：10,000pcs／carton (100sticks／carton)

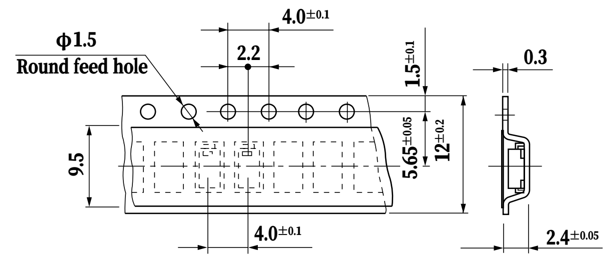
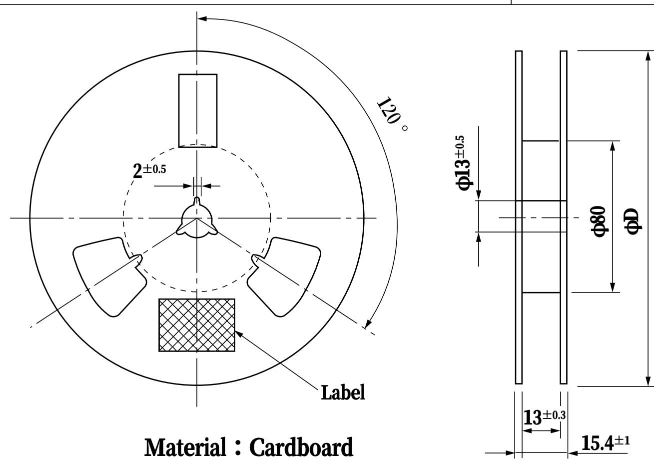
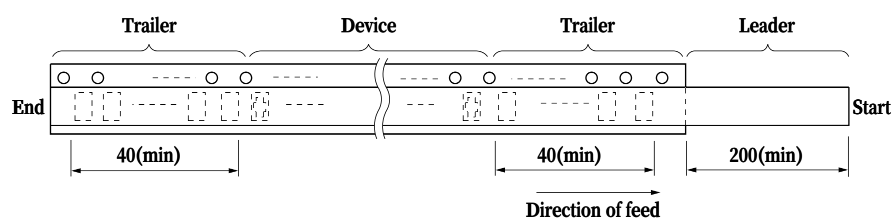
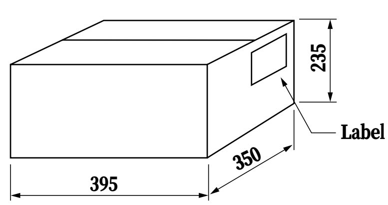
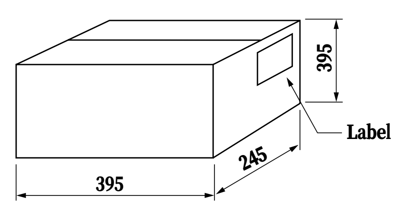
■ TO-221 Type Device (Stick)

Type No.		KT10L, 10N, 10R KT15N, 15R KT40N, 40R
Package No.		Type TO-221
Order Code		4100
Stick	Dimensions	 Material：Hard transparent PVC
	Quantity	Standard capacity：50pcs／stick
Standard Package	Dimensions	 Material：Corrugated cardboard
	Quantity	Standard capacity：3,000pcs／carton (60sticks／carton)

■ STO-220 Type Device (Stick)

Type No.		ST50V-27F ST70-27F
Package No.		Type STO-220
Order Code		4102
Stick	Dimensions	 Material：Hard transparent PVC
	Quantity	Standard capacity：50pcs／stick
Standard Package	Dimensions	 Material：Corrugated cardboard
	Quantity	Standard capacity：4,500pcs／carton (90sticks／carton)

■CaseNo.1F Device (Reel) Reel sizeφ180 (JEITA R15) ／Reel sizeφ330 (JEITA R25)

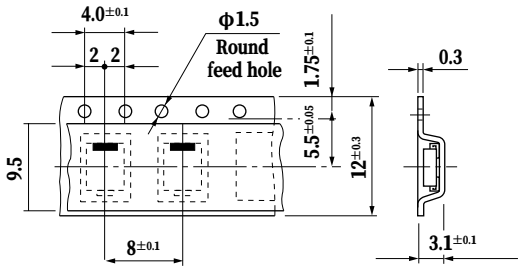
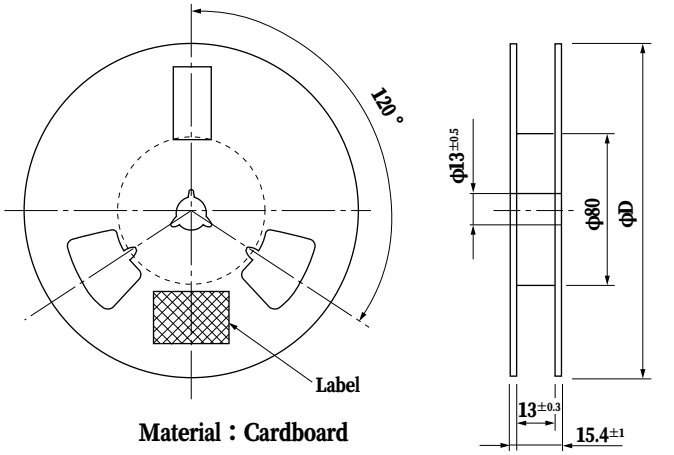
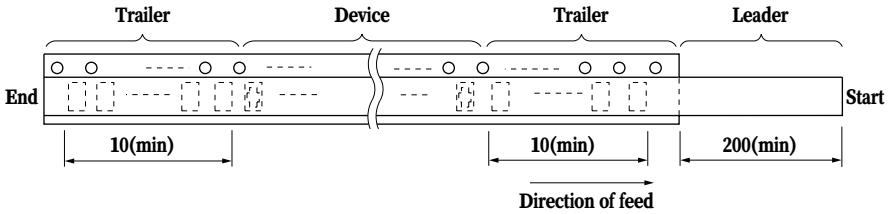
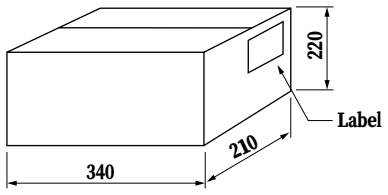
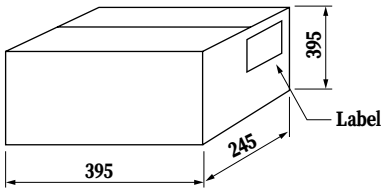
		4063	4073
Type No.		VR-61F1 ST04-16F1,27F1 KL3Z,KL3L,KL3N KL3R,KL3LU	
Package No.		Type 1F	
Order Code		4063	4073
Taping (12mm wide)	**Dimensions**	 Material：Plastic	
	Quantity	Standard capacity：1,500pcs／reel	Standard capacity：7,500pcs／reel
Reel	**Dimensions**	 Material：Cardboard	
	Leader and Trailer		
Standard Package	**Dimensions**	 Material：Corrugated cardboard	 Material：Corrugated cardboard
	Quantity	Standard capacity：60,000pcs／carton (40 reels／carton)	Standard capacity：90,000pcs／carton (12 reels／carton)

Order code / Dimensions	4063	4073
φD	$180^{\pm 2}$	$330^{\pm 2}$

Taping and reel dimensions comply with JEITA, RC−1009A

Standard Package

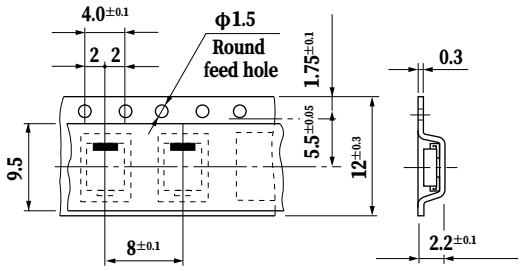
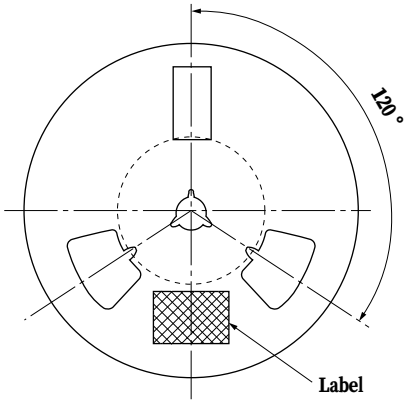
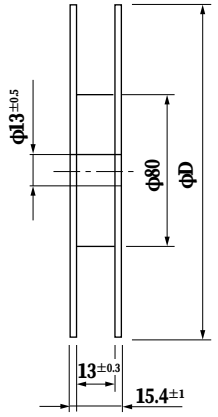
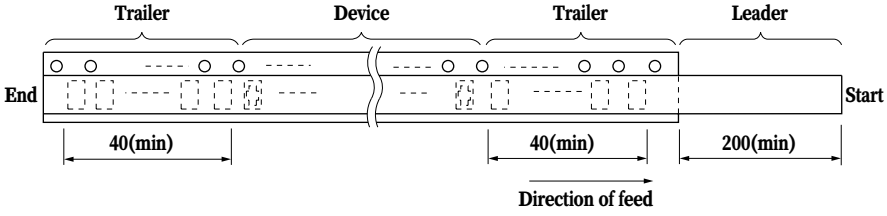
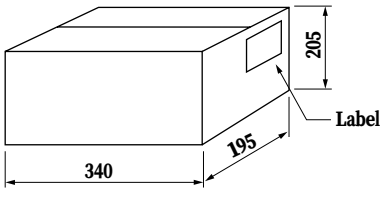
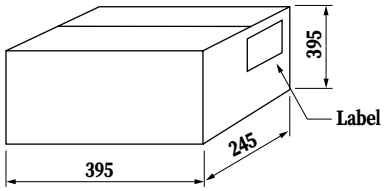
■CaseNo.2F Device (Reel)　　Reel sizeϕ180 (JEITA R15) ／Reel sizeϕ330 (JEITA R25)

Type No.		KP4L, 4N, 10L, 10N, 10R, 15L, 15N, 15R, 8LU, 10LU　UKP-10, UK-15	
Package No.		Type 2F	
Order Code		4063	4073
Taping (12mm wide)	Dimensions	 Material：Plastic	
	Quantity	Standard capacity：750pcs／reel	Standard capacity：3,000pcs／reel
Reel	Dimensions	 Material：Cardboard Order code / Dimensions: φD 180±2 / 330±2	
	Leader and Trailer		
Standard Package	Dimensions	 Material：Corrugated cardboard	 Material：Corrugated cardboard
	Quantity	Standard capacity：15,000pcs／carton (20 reels／carton)	Standard capacity：36,000pcs／carton (12 reels／carton)

Taping and reel dimensions comply with JEITA, RC−1009B

■CaseNo.M2F Device (Reel)

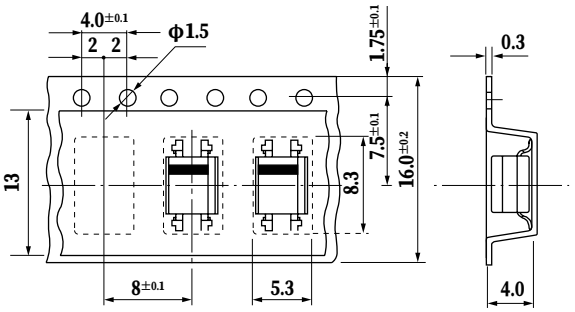
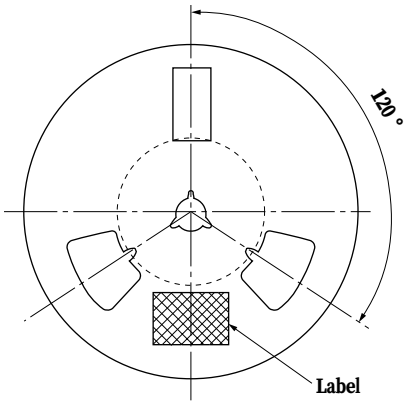
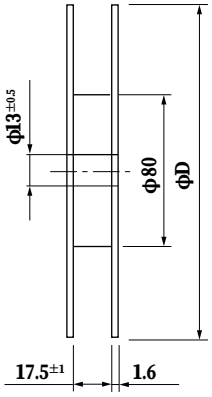
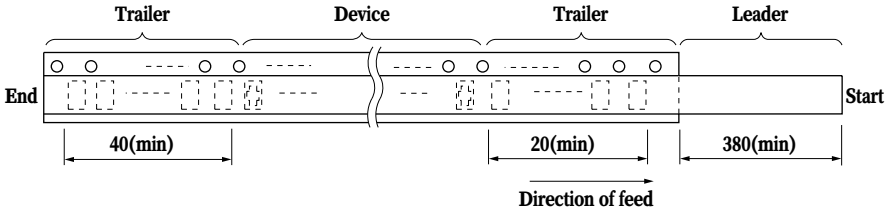
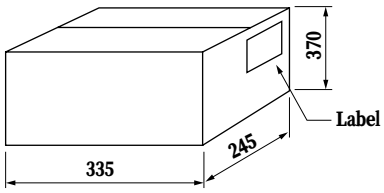
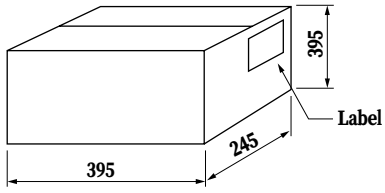
Reel sizeϕ180 (JEITA R15) / Reel sizeϕ330 (JEITA R25)

Type No.		KU5L, 5N, 5R KU10L, 10N, 10R, 10S, 10LU KU15N, 15R	
Package No.		Type M2F (DO214−AA)	
Order Code		4063	4073
Taping (12mm wide)	Dimensions	 Material : Plastic	
	Quantity	Standard capacity : 1,000pcs / reel	Standard capacity : 4,000pcs / reel
Reel	Dimensions	 Material : Cardboard  Order code / Dimensions: 4063 / 4073; φD: 180±2 / 330±2	
	Leader and Trailer		
Standard Package	Dimensions	 Material : Corrugated cardboard	 Material : Corrugated cardboard
	Quantity	Standard capacity : 20,000pcs / carton (20 reels / carton)	Standard capacity : 48,000pcs / carton (12 reels / carton)

Taping and reel dimensions comply with JEITA, RC−1009B

Standard Package

■**CaseNo.1Y Device** (Reel)　　**Reel sizeϕ250 (JEITA R25) ／Reel sizeϕ330 (JEITA R33)**

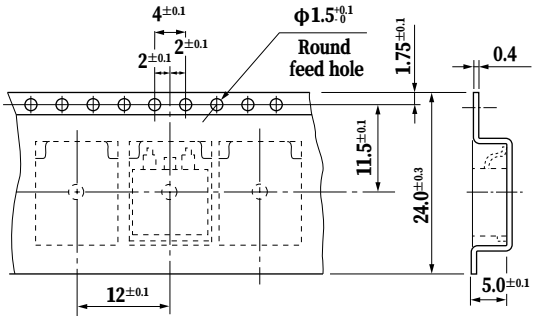
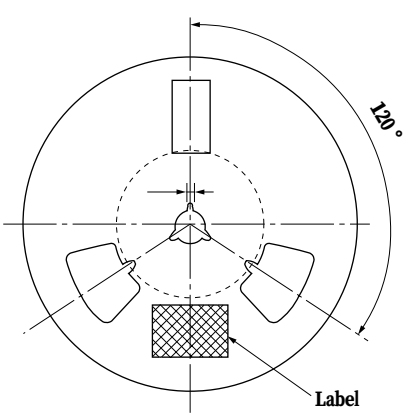
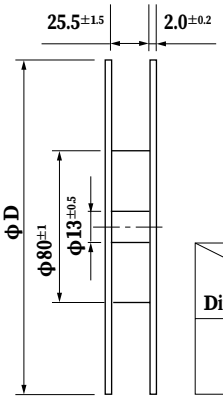
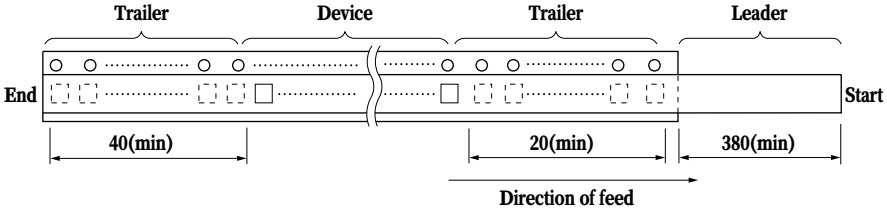
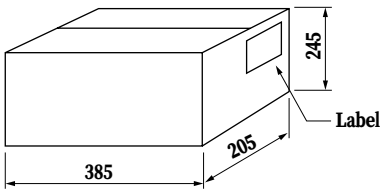
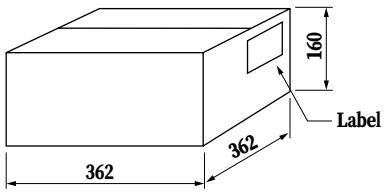
Type No.		**VRYA6, 15 UVRYA6**	
Package No.		**Type 1Y**	
Order Code		**4062**	**4072**
Taping (16mm wide)	**Dimensions**	 **Material：Plastic**	
	Quantity	**Standard capacity：1,000pcs／reel**	**Standard capacity：2,000pcs／reel**
Reel	**Dimensions**	 **Material：Cardboard** 	
	Leader and Trailer		
Standard Package	**Dimensions**	 **Material：Corrugated cardboard**	 **Material：Corrugated cardboard**
	Quantity	**Standard capacity：10,000pcs／carton (10 reels／carton)**	**Standard capacity：20,000pcs／carton (10 reels／carton)**

Dimensions \ Order code	4062	4072
φD	250±2	330±2

Taping and reel dimensions comply with JEITA, RC−1009B

Standard Package

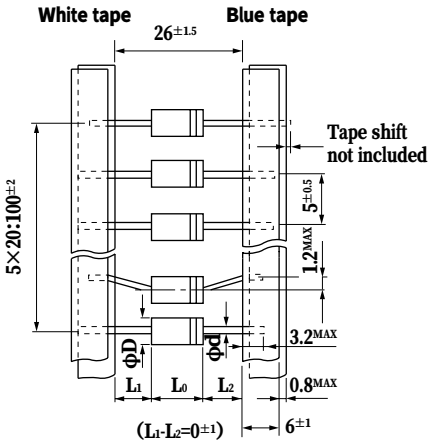
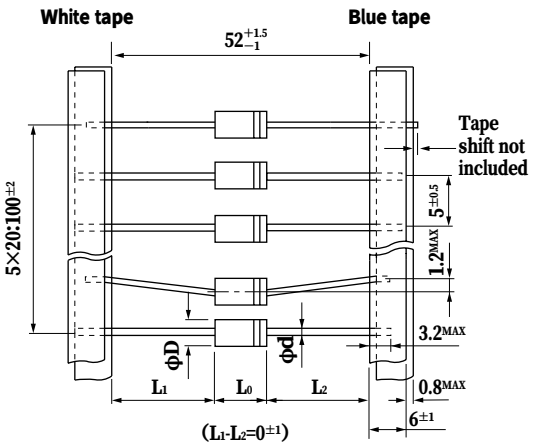
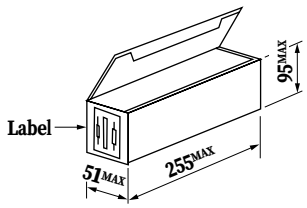
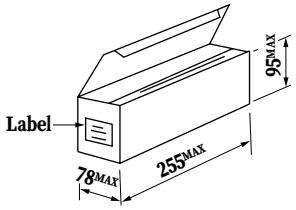
■**CaseNo.STO-220 Device** (Reel)　　**Reel size**φ**180 (JEITA R24) ／Reel size**φ**330 (JEITA R24)**

Type No.		**ST50V-27F ST70-27F**	
Package No.		**Type STO-220**	
Order Code		**4062**	**4072**
Taping (16mm wide)	**Dimensions**	 **Material：Plastic**	
	Quantity	**Standard capacity：250pcs／reel**	**Standard capacity：1,000pcs／reel**
Reel	**Dimensions**	 **Material：Cardboard** 	
	Leader and Trailer		
Standard Package	**Dimensions**	 **Material：Corrugated cardboard**	 **Material：Corrugated cardboard**
	Quantity	**Standard capacity：3,000pcs／carton (12 reels／carton)**	**Standard capacity：3,000pcs／carton (3 reels／carton)**

	Order code	
Dimensions	**4062**	**4072**
φD	**180±2**	**330±2**

Taping and reel dimensions comply with JEITA, C−0806

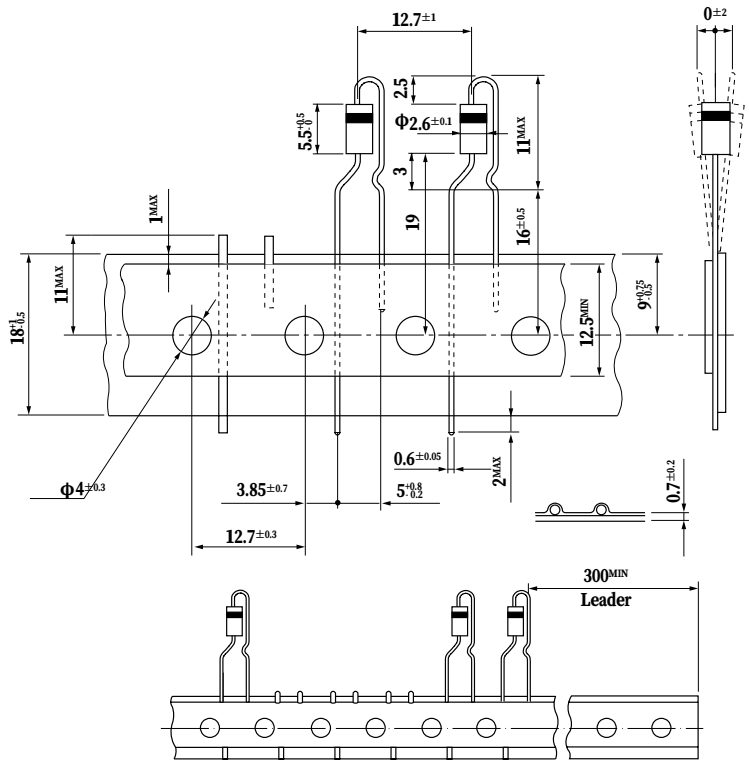
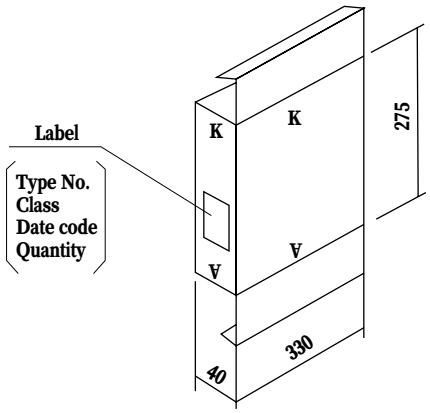
■Axial Taping

Type No.	VR-60B(A) ,UVR-61BF VR-61B(A) VR-51B(A) ST04-16, 27	
Package No.	AX06	
Tape Width	26mm	52mm
Order Code	4070	4060
Dimensions		
Standard Package		
Quantity	Standard capacity：3,000 pcs／carton	Standard capacity：4,000 pcs／carton

Dimensions	L_0	$5^{+0.5}_{-0}$
	ΦD	$2.6^{\pm0.1}$
	Φd	$0.6^{\pm0.05}$

Dimensions	L_0	$5^{+0.5}_{-0}$
	ΦD	$2.6^{\pm0.1}$
	Φd	$0.6^{\pm0.05}$

■Radial Taping

Type No.	VR-60B(A), UVR-61BF VR-61B(A) VR-51B(A) ST04-16,27
Package No.	AX06
	Panasert-compatible
Order Code	4081
Dimensions	 ※There are to be no more than 3 consecutive missing devices as shown in the diagram above. ※There is at least 300 mm of leader at the start and the end of the reel.
Standard Package	
Quantity	Standard capacity：5,000 pcs／carton

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