

REFERENCE DATA

Production Standard Note

TK111 x xSC

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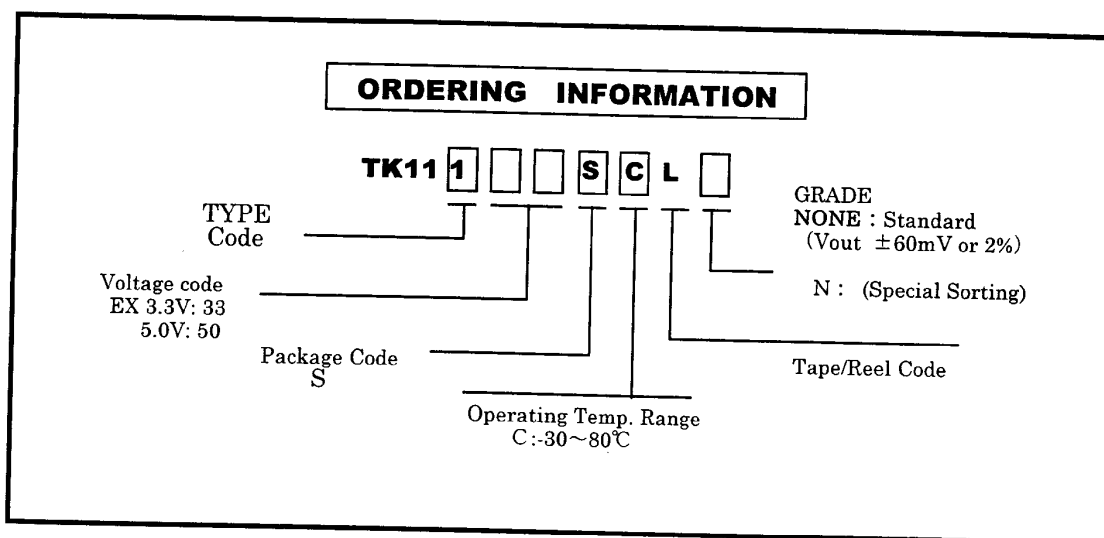
TOKO inc.

TOKO Parts No
TK111XXS

Structure/Feature

The TK111XXS is the low dropout linear regulators with a built in electronic switch. The internal switch can be controlled by logical levels. The device is in the ON state when the control pin is pulled to a logical high level. An external capacitor can be connected to the noise bypass pin to lower the output noise level to 30~60 μ Vrms.

An internal PNP pass transistor is used to achieve a low dropout voltage of 85mV(typ.) at 30mA loading current. The TK111xxS has a very low quiescent current of 140 μ A at no load and 1mA with a 30mA load. The standby current is typically 100pA. The internal thermal shutdown circuitry limits the junction temperature to below 150°C. The loading current is internally monitored and the device will be shutdown by a short circuit or excessive current condition at the output.



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2. Electrical Characteristics Specification for Standard Device(C rank)

Absolute Maximum Ratings

Parameters	Symbol	Values
Supply Voltage	V _{cc} Max	-0.3~16V
Np terminal Voltage	V _{np} Max	-0.3~5 V
Control terminal Voltage	V _{cont} Max	-0.3~12V
Reverse Bias	V _R Max	-3~10 V
Storage Temperature Range	T _{stg}	55~150°C
Operating Temperature Range	T _{op}	-30~80°C Ta
Operating Voltage Range	V _{op}	1.8~12 V
Power Dissipation	P _d Max	Internal Limited
Over Heat Protection		150°C T _j

ELECTRICAL CHARACTERISTICS

Standard Device Test conditions V_{test}=V_{out}Typ+1v Ta =25°C, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	Min	Typ	Max	UNITS
I _q	Quiescent Current	I _o =0mA Except I _{CONT}		140	200	μA
I _{STBY}	Standby Current	V _{IN} =6V, V _{cont} ≤0.15 V _{out} off			0.1	μA
V _{out}	Output Voltage	I _o =10mA See table 1				
Line Reg	Line Regulation	Δ _{vin} : 5V		0.8	18	mV
Load Reg 1	Load Regulation	I _o =1mA→60mA(note1)		8	30	mV
Load Reg 2	Load Regulation	I _o =1mA→100mA(note1)		14	55	mV
V _{drop}	Dropout Voltage	I _o =60mA		120	200	mV
I _{out}	Continuous Output Current				100	mA
I _o (PULSE)	Pulse Output Current	I _o when V _o drops 0.3V From V _o (Typ) (Note 1) 5mS Duty 12.5%			130	mA
Control Terminal Specification						
I _{cont}	Control Current	V _o =on V _{CONT} =1.8V		1.2	4	μA
V _{cont 1}	Control Voltage 1	Output on	1.5			V
V _{cont 2}	Control Voltage 2	Output off			0.35	V
V _{np}	Noise bypass terminal voltage			1.25		V
ΔV _o /Ta	Output Voltage Temperature Coefficient	I _o =10mA		25		PPM/°C

Note 1: Refer to Definition of Terms

Note 2: Parameters with min. or max. values are 100 % tested at Ta=25°C.

Ripple rejection

when [V_{nois}=200mV_{RMS}, V_{in}=V_{out}Typ+2v, I_o=10mA]

[CL=4.7μF, C_n=0.01μF, 1KHZ 64dB Typ]

[CL=4.7μF, C_n=0.1μF, 1KHZ 70dB Typ]

Noise level is about 30μV to 60μV rms.

Connecting a capacitor to a noise pass terminal can reduce output noise voltage. Ripple rejection and noise voltage are affected by the value and characteristics of the capacitor used.

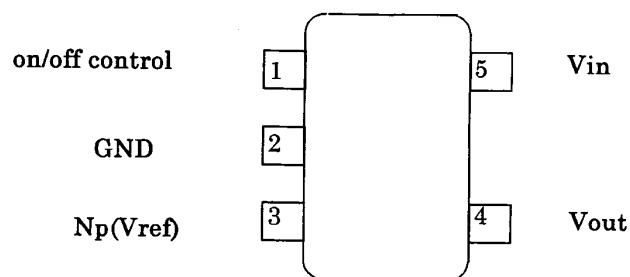
REFERENCE DATA

TK111XXS

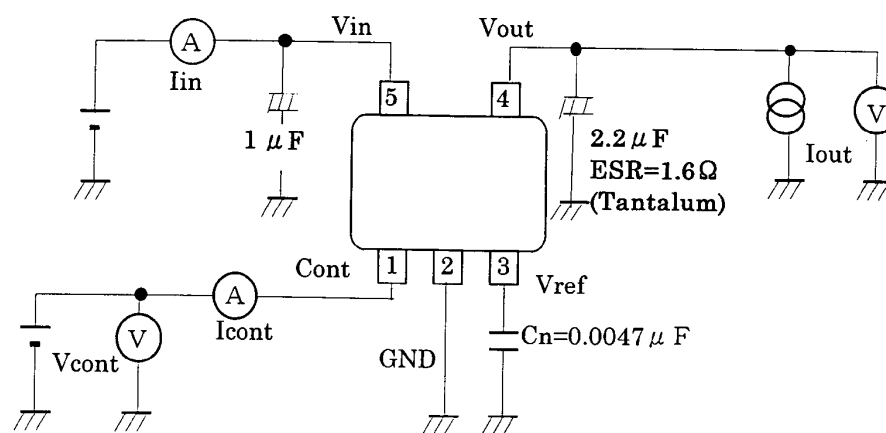
Table 1
C rank (Standard Device) Output Voltage List

Ta=25°C Iout=10mA									
Output Voltage	Voltage Code	Vout Min	Vout Max	Test Voltage	Output Voltage	Voltage Code	Vout Min	Vout Max	Test Voltage
2.0V	20	1.94V	2.060V	3.0 V	3.6V	36	3.528	3.672	4.6
2.1	21	2.040	2.160	3.1	3.7	37	3.626	3.774	4.7
2.2	22	2.140	2.260	3.2	3.8	38	3.724	3.876	4.8
2.3	23	2.240	2.360	3.3	3.9	39	3.822	3.978	4.9
2.4	24	2.340	2.460	3.4	4.0	40	3.920	4.080	5.0
2.5	25	2.440	2.560	3.5	4.1	41	4.018	4.182	5.1
2.6	26	2.540	2.660	3.6	4.2	42	4.116	4.284	5.2
2.7	27	2.640	2.760	3.7	4.3	43	4.214	4.386	5.3
2.8	28	2.740	2.860	3.8	4.4	44	4.312	4.488	5.4
2.9	29	2.840	2.960	3.9	4.5	45	4.410	4.590	5.5
3.0	30	2.940	3.060	4.0	4.6	46	4.508	4.692	5.6
3.1	31	3.038	3.162	4.1	4.7	47	4.606	4.794	5.7
3.2	32	3.136	3.264	4.2	4.8	48	4.704	4.896	5.8
3.3	33	3.234	3.366	4.3	4.9	49	4.802	4.998	5.9
3.4	34	3.232	3.468	4.4	5.0	50	4.900	5.100	6.0
3.5	35	3.430	3.570	4.5					

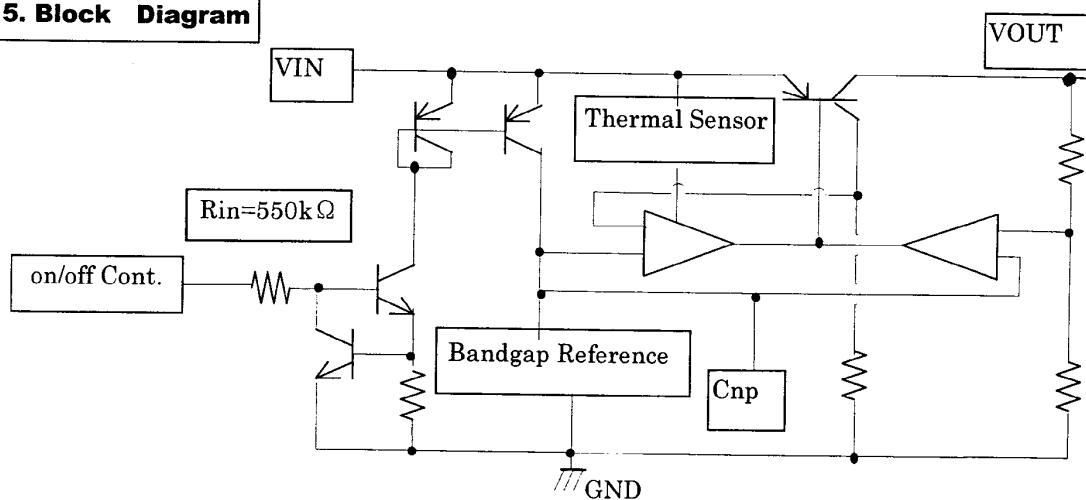
3. Pin Layout



4. Test Circuit



5. Block Diagram



6. Definition and Explanation of Technical terms

- **Output Voltage (V_o)**

The output voltage is specified with $V_{IN}=V_o(TYP)+1V$ and $I_o=10mA$

- **Dropout Voltage (V_{drop})**

The dropout voltage is the difference between the input voltage and the output voltage at which point the regulator starts to Subside the regulation. Below this value, the output voltage will decline as the input voltage is reduced. It is dependent upon the loading current and the temperature.

- **Output Current ($I_{out Max}$)**

The rated output current is specified under the condition where the output voltage drops 0.3V below the value specified with $I_o=10mA$. The input voltage is set to V_o+1V , and the current is pulsed to minimize temperature effect.

- **Continuous Output Current (I_o)**

Normal operating output current. This is limited by package power dissipation.

- **Pulse Output Current ($I_o(PULSE)$)**

Max pulse width 5 or 7ms Duty 12.5%:pulse load only.



- **Line Regulation (Line Reg)**

Line regulation is the ability of the regulator to maintain a constant output voltage as the input voltage changes. The line regulation is specified as the input voltage is changed from $V_{IN}=V_o+1V$ to $V_{IN}=V_o+6V$.

- **Load Regulation (Load Reg)**

Load regulation is the ability of the regulator to maintain a constant output voltage as the loading current changes. It is a pulse measurement to minimize the temperature effects with the input voltage set to $V_{IN}=V_o+1V$.

The load regulation is specified under two output current step conditions of 1mA to 60mA and 1mA to 100mA.

- **Quiescent Current (I_Q)**

The quiescent current is the current which flows through the ground terminal under no load conditions ($I_o=0mA$).

- **Ripple Rejection Ratio (RR)**

Ripple rejection is the ability of the regulator to attenuate the ripple content of the input voltage at the output. It is specified with 200mV rms, 1kHz superimposed on the input voltage, where $V_{IN}=V_o+2V$. The output decoupling capacitor is set to $4.7\mu F$, the noise bypass capacitor is set to $0.01\mu F$, and the loading current is set to 10mA. Ripple rejection is the ratio of the ripple content of the output V_s the input and is expressed in dB.

- **Standby Current**

Standby current is the current, which flows into the regulator when the output is turned off by the control function. It is measured with $V_{in}=8V$, $V_{cont}\leq 0.2V$.

7. SENSOR CIRCUIT

- **Over Current Sensor**

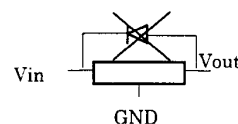
The over current sensor protects the device in the event that the output is shorted to ground.

- **Thermal Sensor**

The thermal sensor protects the device in the event that the junction temperature exceeds the safe value ($T_j=150^\circ C$). This temperature rise can be caused by large input to output voltage drops, or excessive output current. The regulator will shut off when the temperature exceeds the safe value. As the junction temperature decreases, the regulator will begin to operate again. Under sustained fault conditions, the regulator output will oscillate as the device turns off then resets. Damage may occur to the device under extreme fault condition.

- **Reverse Voltage Protection**

Reverse voltage protection prevents a damage due to the output voltage being higher than the input voltage. This fault condition can occur when the output capacitor remains charged and the input is reduced to zero, or when an external voltage being higher than input voltage is applied to the output side.



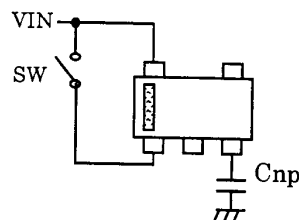
Toko regulators don't need an inherent diode connected between the input and output (see up).

DEFINITION AND EXPLANATION OF TECHNICAL TERMS (CONT.)

8.ON/OFF Control Function

TK111XX is the device of High on. Pull down resistor is not built in.

If the control function is not used, must be connected the control terminal to Vin.



9.ON/OFF Response with Control (Speed)

The on/off response depends on the value of the output capacitor and the noise bypass capacitor. The on/off response increases, with the value of smaller capacitor.

10. Input and Output Capacitor

Toko regulator requires an output capacitor to maintain regulator loop stability.

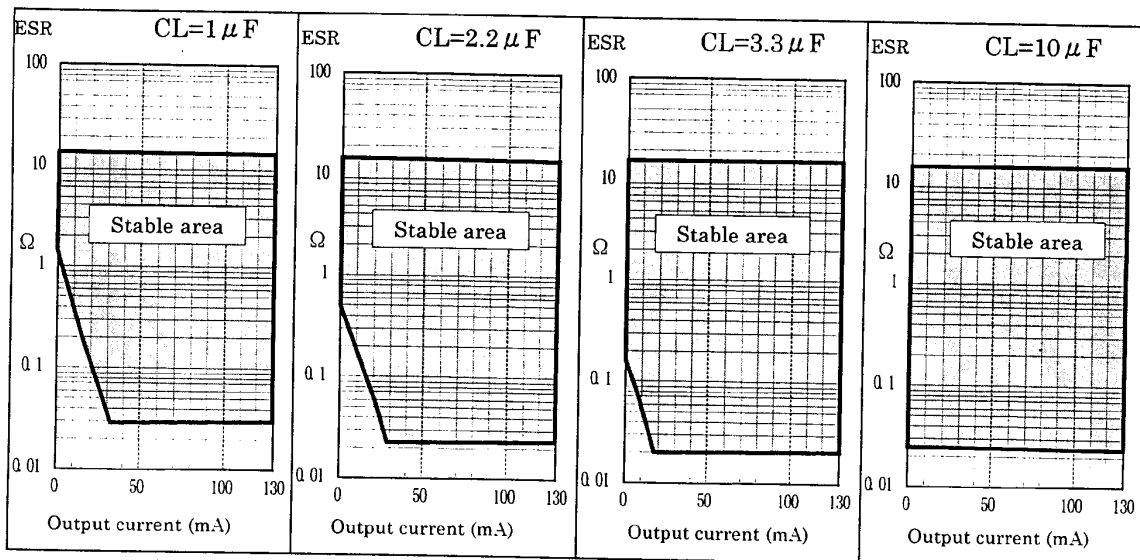
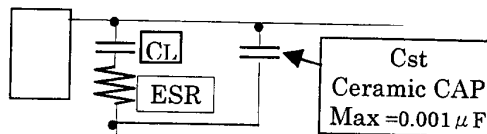
In case of no capacitor, the regulator will cause parasitic oscillation with out capacitor (CL).

The performance of output capacitor (CL) is particularly important.

The characteristic (capacitance and ESR value) of CL must be within the stable area as shown in graphic below under operating temperature. Series connection of resistor and CL is also a solution to assist ESR value to be in the stable area.

For your reference see the graphs below showing stable region based on capacitance performance.

Please do not add any other capacitor (Cst) parallel with CL. IC will be unstable if ESR value exceeds the temperature recommended in the stable area.
Maximum recommended value for Cst is $0.001 \mu F$.



11.Reduction of Output Noise

Although the architecture of the Toko regulators is designed to minimize semiconductor noise, further reduction can be achieved with the selection of external components. The obvious solution is to increase the size of the output capacitor. The solution will be more effective by adding a capacitor to the noise bypass terminal.

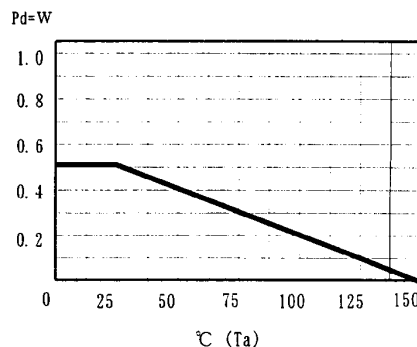
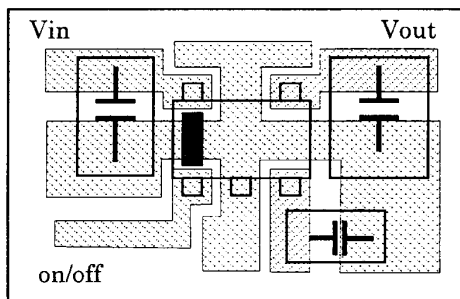
The value of this capacitor should be $0.0047\mu\text{F}$ or higher (higher values provide greater noise reduction and ripple reduction). Although stable operation is possible without the noise bypass capacitor, this terminal has high impedance and care should be taken to avoid a large circuit area on the printed circuit board when the capacitor is not used. Please note that several parameters are affected by the value of the capacitors and bench testing is recommended when deviating standard values.

12.Power Dissipation

Small surface mount packages have relatively low thermal radiation characteristics.

Proper mounting can reduce the temperature of the regulator and increase the power dissipation capability of the device. This will prevent premature shutdown due to the internal protection sensor. When using single sided glass epoxy printed circuit boards with the patterns shown below, the power dissipation for the SOT-23 is 500mW double-sided boards, and different Copper patterns can change these values.

13. Layout Example

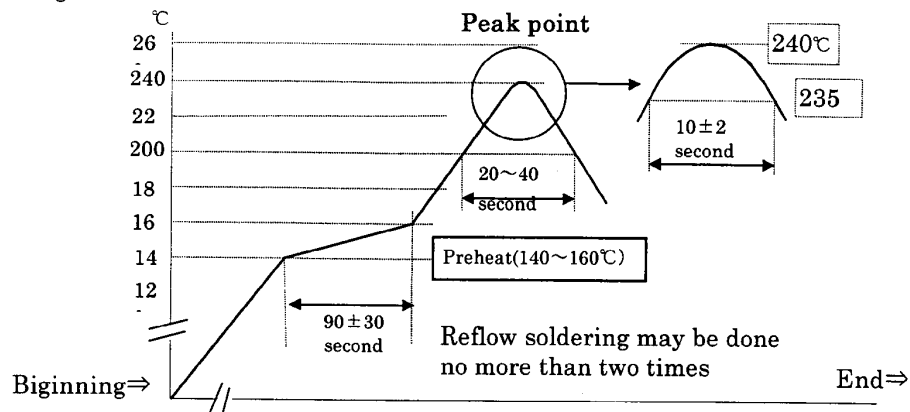


Approximate power dissipation $P_d \approx 500\text{mW}$ at 25°C / derating value: $4.0\text{mW}/^\circ\text{C}$ / $\theta_{ja} = 250^\circ\text{C}/\text{W}$

14. Soldering Conditions

Reflow soldering is recommended for mounting these parts to printed circuit boards in order to reduce thermal stress. The chart below shows the recommended oven profile and well times. Since oven types and materials can alter this profile, it is recommended to self-check the process to ensure that defects do not occur.

(1) Reflow soldering



(2) Soldering Iron

If manual soldering is required, then the temperature of the soldering iron tip should be less than 320°C and the operation should not exceed three second. The part should only be soldered once. It is recommended that you check your process to ensure that defects do not occur.

15.Storage Conditions

Storage period should be within one year. Please keep the dry packs where load does not come on and temperature is at 5-30°C.

Please handle the packs carefully not to break. The packs should be opened just before using the device inside. Please solder the devices within 10 days at less than 30°C and 40-75% after you opened the packs.

The device may be damaged due to electrostatic discharge with careless handling. As for taped devices, cover tape peel off strength might be changed when the taped ones are stored for six-month and more. If so, please check the peering off before your use.

16.Cautions for Usage with Handling Instructions

(a) This IC contains a protection circuit against electrostatic damage. However, you should follow the following precautions to avoid electrostatic or physical damage.

1. Soldering irons, tools, test instruments, and fixture should be connected to a ground point on the workstation.
2. The IC should not be inserted or removed when power is applied to the circuit.
3. Care should be taken when handing the IC to physical damage.
4. Avoid exposure to chemicals which may cause physical damage to the IC body or leads.
5. Care should be taken when mounting the IC in order to achieve optical electrical, material, and thermal performance.

(b) Environmental Issues

1. This part is not certified for use in nuclear radiation environments.
2. This part is molded from resin conforming to UL94V-0 (Inflammability) requirements.
3. Ozone depleting substances are not used in the manufacture of this part.
4. Materials used in the manufacture of this part do not contain brominated PBBOs or PDDs.

REFERENCE DATA

TK111XXS

17. Quality Level

1. Average Fault Rate : 1 0FIT
2. Reliability Test The following tests are performed for new product development, Design changes and processes change (manufacturing equipment, processes, materials, Etc.).

No	Test Item	Test Condition	Test Time	LTPD
1	High Temperature Operating	Ta=80℃、Vin=Vop, Max Tj≤150℃	1000 h	n=32, c=0
2	High Temperature High Humidity Biased	Ta=85℃、RH=85%、VopMax Iout=0mA	1000 h	n=32, c=0
3	High Temperature Storage	Ta=150℃	1000 h	n=22, c=0
4	Low Temperature Storage	Ta=-55℃	1000 h	n=22, c=0
5	High Temperature High Humidity Storage	Ta=65℃ RH=90%	1000 h	n=32, c=0
6	Pressure Cooker Storage Test (Autoclave)	Ta=120℃、RH=85%、	96 h	n=22, c=0
7	Thermal Shock Test	Ta=-55℃⇔(within 10 Sec.)⇔150℃ 5 min. each	100 cycle	n=32, c=0
8	Electrostatic Discharge Sensitivity Classification	MIL-STD-883C Method 3015.7 Class 2	3 times	n=20, c=0
9	Resistance to Soldering Heat	Refer 14.(1) :Reflow oven profile Condition Pre disposal (85℃,85%RH,16H)	Reflow 2 times	n=22, c=0
10	Solderability Test	Solder Temp. 230℃ for 3 Sec with Rosin Flux: same soldering conditions as item 9 Pre disposal (85℃,85%RH,16H)		n=15 reeds c=0 reed
11	Anti Solvent Test	Immerse Isopropyl alcohol	1 Min	n=15, c=0
12	Lead Integrity Test	Pull 250g 30 Sec to the axis of the lead	1 time	n=15 reeds c=0 reed

Note : Surface mounted devices are exposed twice to heat stress from a reflow furnace set to the standard temperature profile (See 14: Soldering Condition) prior to test 2, 5, and 6.

18. Fault Determination Standard

Parameter	Symbol	MIN	MAX
Quiescent current	I _q		1.5×U
Standby Current	I _{stnby}		10×U
Output Voltage	V _{out}	0.96×L	1.04×U
Line Regulation	LinReg		1.5×U
Load Regulation 1	LoaReg 1		1.5×U
Load Regulation 2	LoaReg 2		1.5×U
Dropout Voltage	V _{drop}		1.5×U
on/off Control Current	I _{cont}		1.5×U
Functions	not satisfy the specified functions		

L : Lower initial standard U : Upper initial standard (Same test condition)

19. Handling Quality Claims

1. If a lot is rejected by the customer, Toko will review the non-conformance and customer data. When both parties agree that there is a non-conformance or defect and the responsibility is Toko's the customer should send the reject lot to Toko.
Toko will send a replacement as soon as possible upon receipt. If the non-conformance or defect is found that is not wholly the responsibility of Toko, both parties will settle the non-conformance or defect through reasonable discussion.
2. Toko shall analyze the defective IC(s) which have been identified and returned by the customer. In general, the customer will perform an analysis on ICs mounted on his printed circuit board and send the data to Toko for analysis. If the analysis indicates that the responsibility is Toko's, Toko will make a corrective action plan and carry out this as soon as possible.
3. If the non-conformance involves a parameter within measurement system inaccuracy, the customer and Toko should settle the non-conformance through reasonable discussion.
Returns of ICs damaged by careless handling may not be accepted by Toko.

If a problem occurs which is not covered by this specification, you should contact Toko for resolution of this problem.

This document is a standard specification. When there is a special demand, a supplementary document is provided and is appended to this one. The description and value in the appended document has priority over the counter-description and value in this document when an overlapped description and value is different between the both documents.

20. Disclaimer

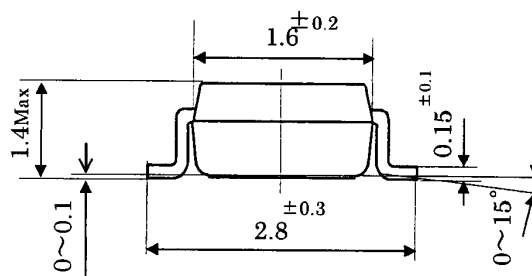
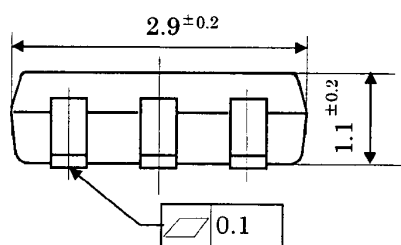
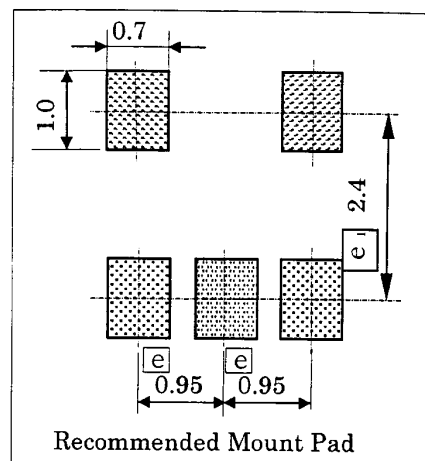
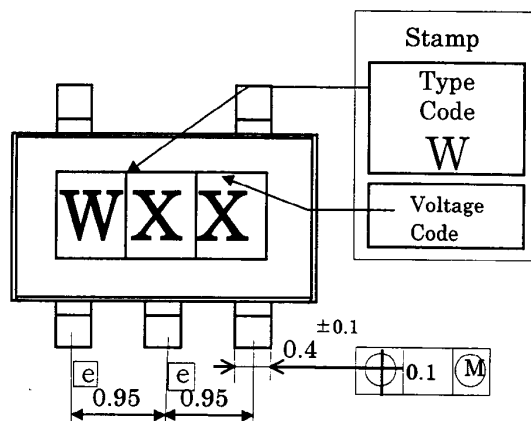
Information furnished herein is believed to be accurate and reliable. However, no responsibility is assumed for its use. Toko, Inc. makes no representation that the interconnection of its circuit, as described herein, will not infringe on existing patent rights.

Toko reserves the right, at any time without notice, to change said circuitry and specifications. Applications described herein are for illustrative purposes only. Toko makes no representation or warranty that such application will be suitable for the specific use without further testing and modification. Moreover this specification does not signify that Toko agrees implicitly or explicitly to license any patent rights or other intellectual property rights which it holds.

Life Support Policy

Toko's products are not authorized for use as critical components in life support devices or systems without the express written approval of the president of Toko, Inc. As used herein, life support devices or systems are devices or systems which (1) are intended for surgical implant into the body, or (2) support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in a significant injury to the user. A critical component is any component in a life support device or system whose failure can be reasonably expected to cause the failure of the life support device or system or to affect its safety or effectiveness.

21 . Package Outline Dimensions/Marking



Unit : mm

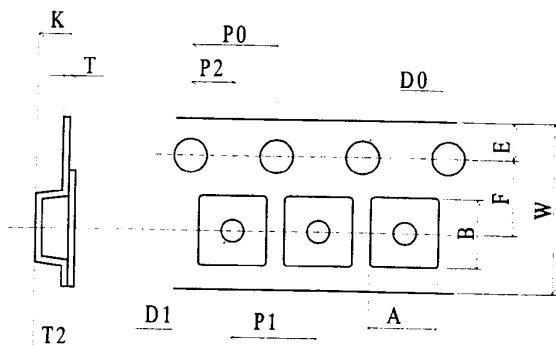
General tolerance : ± 0.2

Molded Resin : Epoxy Resin
 Lead Frame : Copper Alloy
 Terminal Treatment : Solder Plating(5~15 μ m)
 Marking Method : Ink or Laser
 Country of Origin : Japan : Korea
 Weight : 0.014g

V OUT	V CODE	V OUT	V CODE	V OUT	V CODE	V OUT	V CODE
2.0v	20	3.0V	30	4.0V	40	5.0V	50
2.1	21	3.1	31	4.1	41		
2.2	22	3.2	32	4.2	42		
2.3	23	3.3	33	4.3	43		
2.4	24	3.4	34	4.4	44		
2.5	25	3.5	35	4.5	45		
2.6	26	3.6	36	4.6	46		
2.7	27	3.7	37	4.7	47		
2.8	28	3.8	38	4.8	48		
2.9	29	3.9	39	4.9	49		

22. Dimensions and composition of taping

1. Dimensions of carrier tape



※ The dimensions of A and B are reference values the following information for the component.

Component clearance : 0.5mm Max./ 0.05mm Min

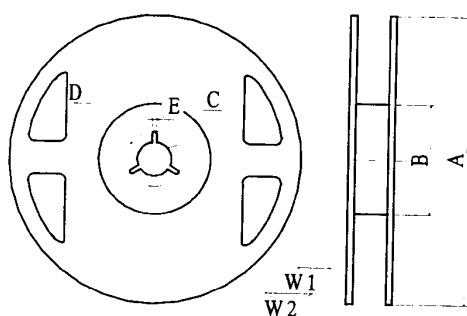
Component rotation : 2 0° Max.

Material : Polystyrene (Conductivity)

Unit : mm

Symbol	Dimension
A	※ (3.3)
B	※ (3.2)
W	8.0 ±0.3
F	3.5 ±0.05
E	1.75 ±0.1
P 1	4.0 ±0.1
P 2	2.0 ±0.05
P 0	4.0 ±0.1
D 0	φ1.5 +0.1 0
D 1	φ1.05 +0.1 0
T	0.25 ±0.05
T 2	MAX 1.8
K	1.45 ±0.1

2. Dimensions of reel

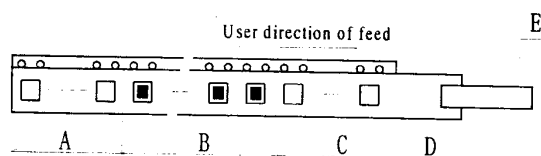


Type name : EIAJ-RRM08BC
Material : Polystyrene (Conductivity)

Unit : mm

Symbol	Dimension
A	φ180 0 -0.3
B	φ60 +0.1 0
C	φ13 ±0.2
D	φ21 ±0.8
E	2.0 ±0.5
W 1	9.0 ±0.3
W 2	11.4 ±1.0

3. Tape leader and trailer



Symbol	Application	Standard
A	Trailer (No components)	Over160mm
B	Components	
C	Leader (No components)	Over160mm
D	Leader (Cover tape)	Over240mm
E	Binder tape	

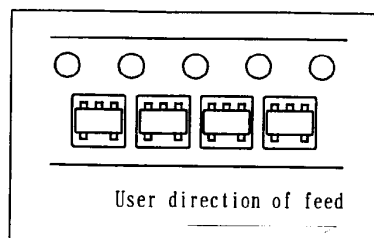
4. Number of absent components

The number of absent components is within 0.1% of the total number (indicated number) of components or 1 piece, whichever is the larger. There is no absence exceeding consecutive 2 pieces of components.

5. Splicing of tape

There is no splicing of both the carrier tape and the cover tape.

6. Mechanical polarization [L type]



7. Packing quantity

The quantity in one reel is 3000 pcs .

The quantity in one inner box is 3 reel (9000 pcs) max.

8. Marking (Bar code label)

The following item is marked on the surface of the reel, the moisture barrier pack and the inner box.
The bar code label is conformed to EIAJ C-3 label (bar code 39).

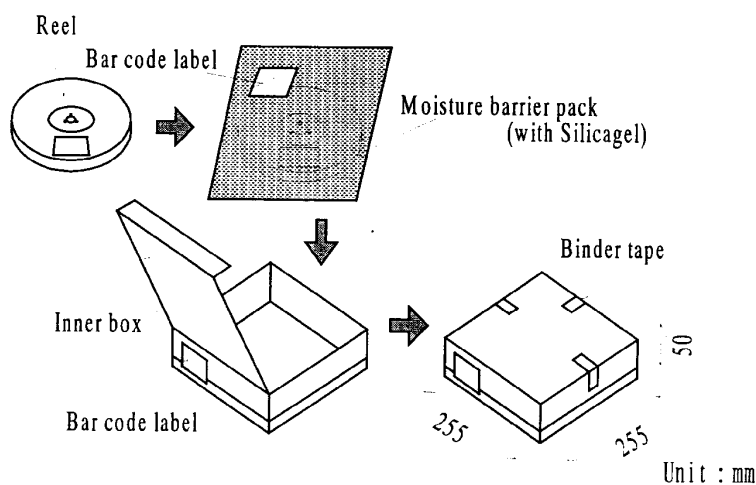
[Characters and Bar code data]

Customer's parts No., Quantity, and Serial No.

[Characters data]

Manufacturer's parts No., Country of origin, Mechanical polarization, Manufacturer's name

9. Composition of packing



10. Cautions

- (1) Please handle the inner box with care. Please pay attention sufficiently because of becoming the transformation of lead and the defective if the inner box is shocked strongly and fallen.
- (2) Please keep the inner box dry because it is made of corrugated cardboard.