REFERENCE DATA

Production Standard Note

TK111xxMI

Table of Contents

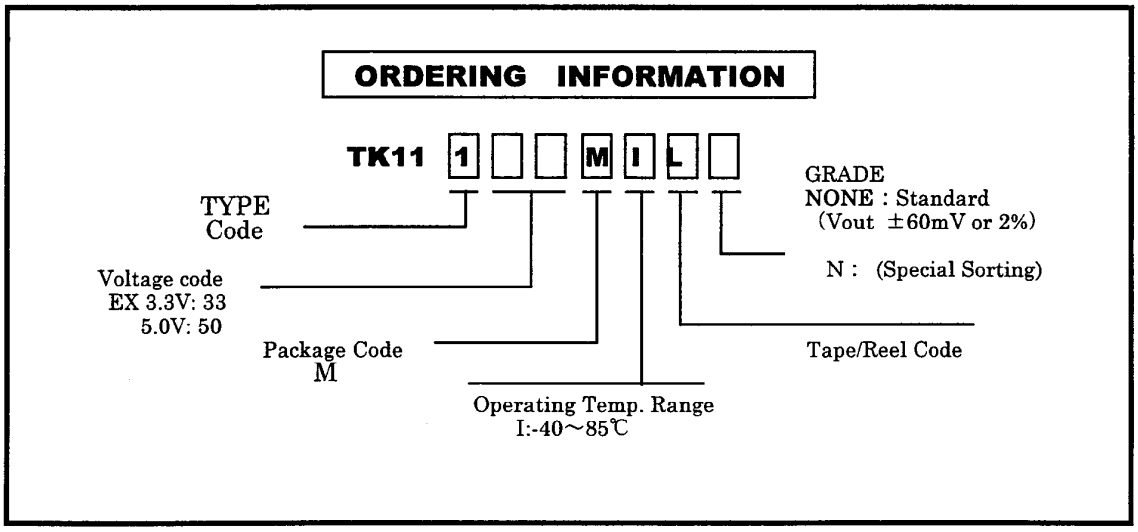
	Signature	Date
Drawn by	A. Isiyu	5 NOV 1998
Checked by	Ringo Hosoo	5 NOV '98
Approved by	M. Tanaka	12 Nov. 1998

TOKO inc.	TOKO Parts No TK111XXM	Drawing No DB4-K011	1/16	Rev

1 Structure/Feature

The TK111XXM 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 μVrms.

An internal PNP pass transistor is used to achieve a low dropout voltage of 85mV (typ.) at 30mA loading current. The TK111xxM has a very low quiescent current of 140 μA 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℃. The loading current is internally monitored and the device will be shutdown by a short circuit or excessive current condition at the output.



2. Electrical Characteristics Specification for Wide Temperature Range Operating Device (I rank)

Absolute Maximum Ratings

Parameters	Symbol	Values
Supply Voltage	Vcc Max	—0.3～15V
Np terminal Voltage	VnpMax	−0.3～5 V
Control terminal Voltage	VcontMax	−0.3～12V
Reverse Bias	VR Max	—3～10 V
Storage Temperature Range	Tstg	55～150℃
Operating Temperature Range	Top	—40～85℃ Ta
Operating Voltage Range	Vop	2.0～12 V
Over Heat Protection		150℃ Tj
Power Dissipation	Pd Max	Internal Limited

Test conditions Vtest=$Vout_{Typ}$+1v Ta=-40～85℃,unless otherwise specified.

ELECTRICAL CHARACTERISTICS

SYMBOL	PARAMETER	TEST CONDITIONS	Min	Typ	Max	UNITS
I q	Quiescent Current	Io=0mA Except ICONT		140	200	μA
I STBY	Standby Current	V_{IN}=6V,Vcont≦0.15 Vout off			0.2	μA
Vout	Output Voltage	Io=10mA See table 1				
Line Reg	Line Regulation	Δvin : 5V		0.8	18	mV
Load Reg 1	Load Regulation	Io=1mA→60mA(note1)		8	30	mV
Load Reg 2	Load Regulation	Io=1mA→100mA(note1)		14	55	mV
Vdrop	Dropout Voltage	Io=60mA		120	200	mV
Iout	Continuous Output Current				100	mA
Io (PULSE)	Pulse Output Current	Iout when Vout drops 0.3V From Vout(Typ) (Note 1) 5mS Duty 12.5%			130	mA
	Control Terminal Specification					
Icont	Control Current	Vout=on V_{CONT}=1.8V		1.2	6	μA
Vcont 1	Control Voltage 1	Output on	1.5			V
Vcont 2	Control Voltage 2	Output off			0.35	V
Vnp	Noise bypass terminal voltage		-	1.25	-	V
ΔVo/Ta	Output Voltage Temperature Coefficient	Io=10mA	-	25	-	PPM/℃

Note 1: Refer to Definition of Terms

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

Ripple rejection

when [V_{nois}=200mV_{RMS},Vin=$Vout_{Typ}$+2v,Io=10mA]

[CL=4.7μF, Cn=0.01μF, 1KHZ 64dB Typ]

[CL=4.7μF, Cn=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.

Table 1

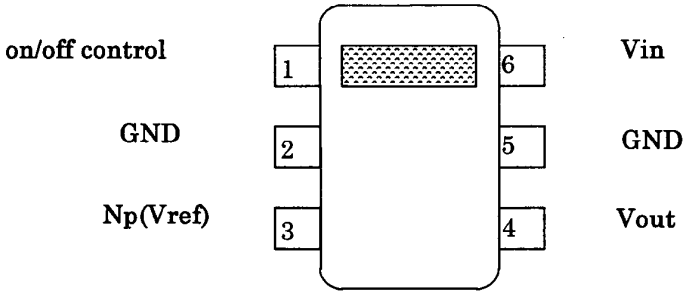
I rank (Wide Range Temperature Operating Device) Output Voltage List

Boldface type applies over the full operating temperature range. (-40℃～85℃)

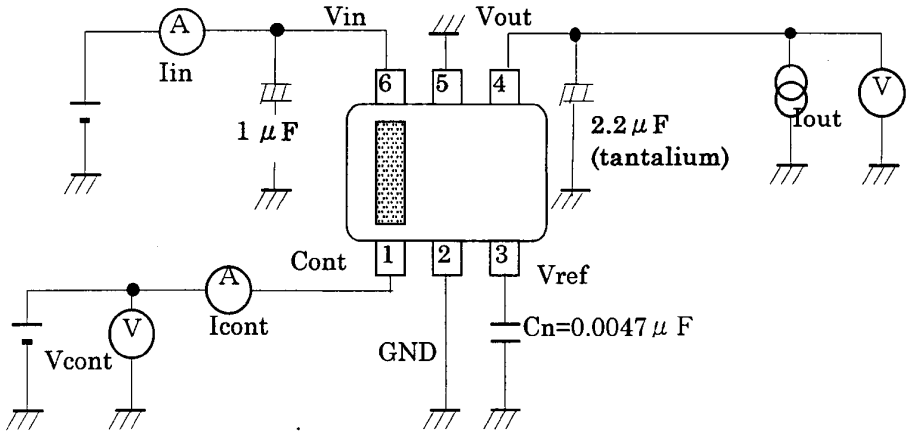
Ta=25℃ IOUT=10mA

Output Voltage	Voltage Code	Vout Min	Vout Max	Test Voltage	Output Voltage	Voltage Code	Vout Min	Vout Max	Test Voltage
2.4V	24	2.340V **2.305**	2.460V **2.495**	3.4V	4.0	40	3.920V **3.880**	4.080V **4.120**	5.0V
2.5	25	2.440 **2.405**	2.560 **2.595**	3.5	4.1	41	4.018 **3.977**	4.182 **4.223**	5.1
2.6	26	2.540 **2.505**	2.660 **2.695**	3.6	4.2	42	4.116 **4.074**	4.284 **4326**	5.2
2.7	27	2.640 **2.605**	2.760 **2.795**	3.7	4.3	43	4.214 **4.171**	4.366 **4.429**	5.3
2.8	28	2.740 **2.705**	2.860 **2.895**	3.8	4.4	44	4.312 **4.268**	4.488 **4.532**	5.4
2.9	29	2.840 **2.805**	2.960 **2.995**	3.9	4.5	45	4.410 **4.365**	4.590 **4.635**	5.5
3.0	30	2.940 **2.905**	3.060 **3.095**	4.0	4.6	46	4.598 **4.462**	4.692 **4.738**	5.6
3.1	31	3.038 **3.007**	3.162 **3.193**	4.1	4.7	47	4.696 **4.559**	4.794 **4.841**	5.7
3.2	32	3.136 **3.104**	3.264 **3.296**	4.2	4.8	48	4.794 **4.656**	4.896 **4.944**	5.8
3.3	33	3.234 **3.201**	3.366 **3400**	4.3	4.9	49	4.892 **4.753**	4.998 **5.047**	5.9
3.4	34	3.332 **3.298**	3.468 **3.502**	4.4	5.0	50	4.900 **4.850**	5.100 **5.150**	6.0
3.5	35	3.430 **3.395**	3.570 **3.605**	4.5					
3.6 V	36	3.528 **3.492**	3.672 **3.708**	4.6					
3.7	37	3.626 **3.589**	3.774 **3.811**	4.7					
3.8	38	3.724 **3.686**	3.876 **3.914**	4.8					
3.9	39	3.822 **3.783**	3.988 **4.017**	4.9					

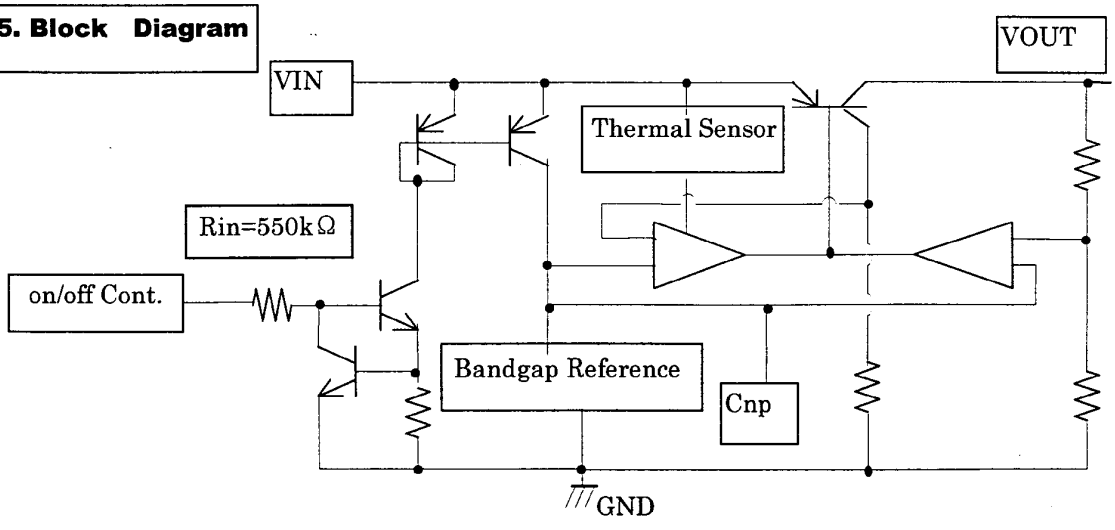
3. Pin Layout



4. Test Circuit



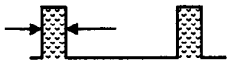
5. Block Diagram



DB4-K011

6. DEFINITION AND EXPLANATION OF TECHNICAL TERMS

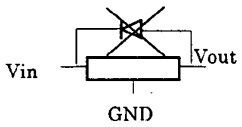
- **Output Voltage (Vo)**
  The output voltage is specified with $V_{IN}=V_{O\,(TYP)}+1V$ and Io=10mA
- **Dropout Voltage (Vdrop)**
  The dropout voltage is the difference between the input voltage and the output voltage at which point the regulator starts to Subside the regulation. Below this value, 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 Io=10mA. The input voltage is set to Vo+1V, and the current is pulsed to minimize temperature effect.
- **Continuous Output Current (Io)**
  Normal operating output current. This is limited by package power dissipation.
- **Pulse Output Current (Io (PULSE))**
  Max pulse width。 5 or 7ms Duty 12.5%:pulse load only



- **Line RegulatioOn (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}= Vo +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}= Vo +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 (Io=0mA).
- **Ripple Rejection Ratio (R R)**
  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}= Vo +2V. The output decoupling capacitor is set to 4.7μF, the noise bypass capacitor is set to 0.01μF , and the loading current is set to 10mA . Ripple rejection is the ratio of the ripple content of the output Vs 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 Vin= 8V, Vcont≦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 (Tj=150℃). 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 sustaind 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.



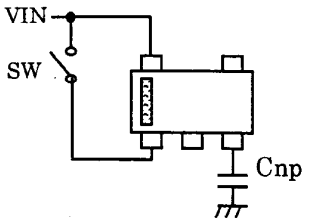
Toko regulators don't need an inherent diode connected between the input and output (see up).

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)

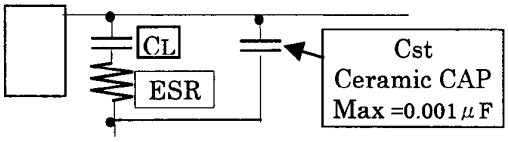
The on/off response depends on the value of the output capacitor and the noise bypass capacitor. The on/off response increases, with the value of smaller capacitor.

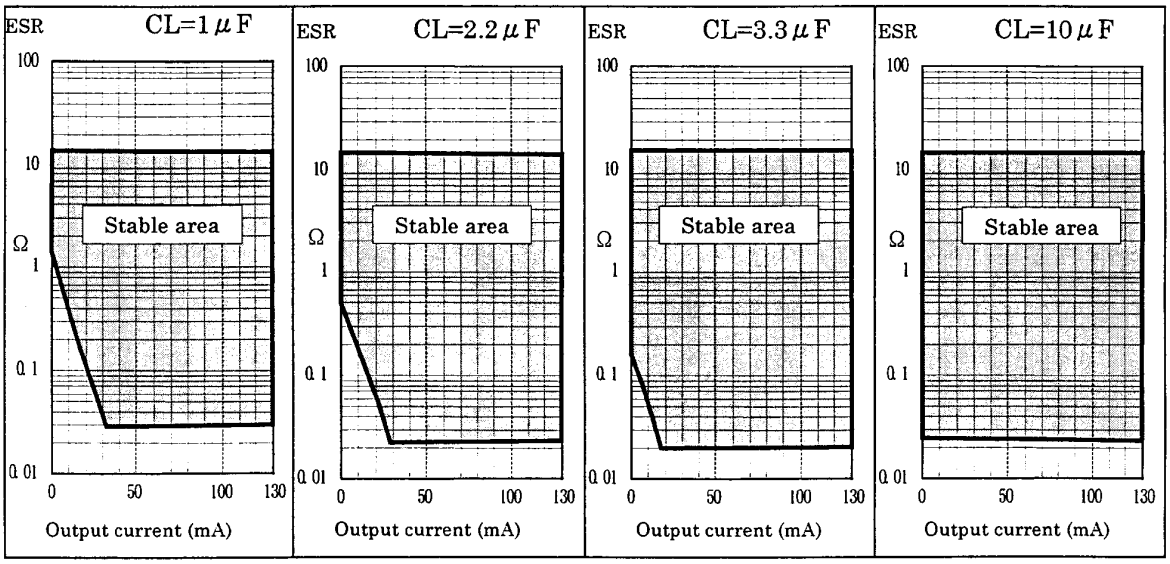
10. Input and Output Capacitor

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 μF.





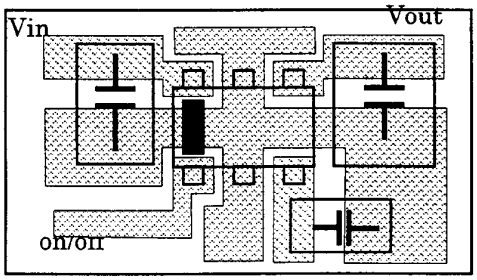
11 • REDUCTION OF OUTPUT NOISE

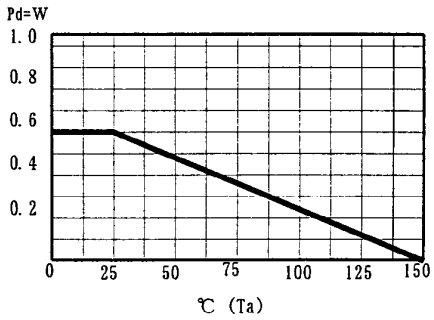
Although the architecture of the Toko regulators is designed to minimize semiconductor noise, further reduction can be achieved by the selection of external components. The obvious solution is to increase the size of the output capacitor. A more effective solution would be to add a capacitor to the noise bypass terminal .The value of this capacitor should be 0.0047 μF 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-23L is 600mW double-sided boards, and different Copper patters can change these values.

13. Layout Example



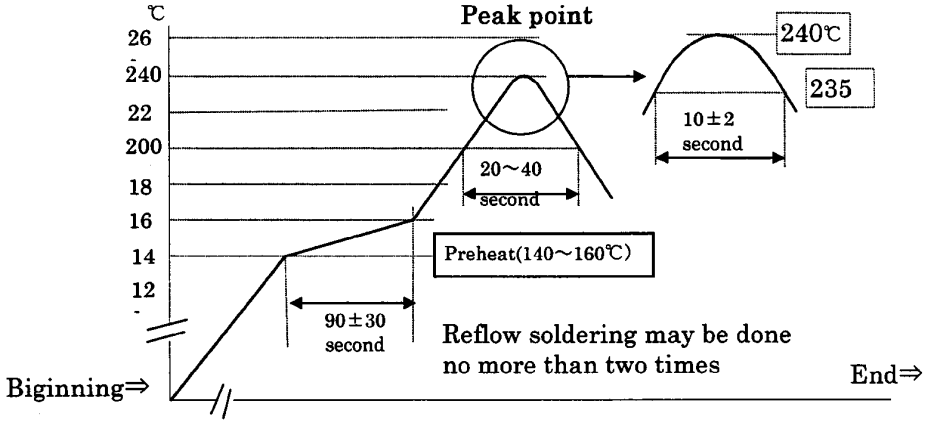


Approximate power dissipation Pd≠600mW at 25℃ / derating value 4.8mW/℃ / θja=208℃/W

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℃ 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℃.

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℃ 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.

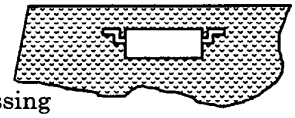
1 · Soldering irons, tools, test instruments, and fixture should be connected to a ground point on the workstation.
2 · The IC should not be inserted or removed when power is applied to the circuit.
3 · Care should be taken when handing the IC to physical damage.
4 · Avoid exposure to chemicals which 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.

17 • Quality Level

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

No	Test Item	Test Condition	Test Time	Criterion
1	High Temperature Biased	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 (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	260℃ for 5 Sec, using Rosin Flux  Preprocessing Dampened (85℃,85%RH,16H)	1 time	n=20, c=0
10	Solder-ability Test	Preprocessing Dampened (85℃,85%RH,16H) Covered with Fresh solder more than 95%		n=15 leads c=0 lead
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 reed	1 time	n=15 leads c=0 lead

n: number of DUT c: acceptable number of failure

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.

REFERENCE DATA

18. Fault Determination Standard

Parameter	Symbol	MIN	MAX
Supply Current 1	I cc1		1.5×U
Supply Current 2	I cc2		10×U
Output Voltage	VOUT	0.96×L	1.04×U
Line Regulation	LinReg		1.5×U
Line Regulation 1	LoaReg 1		1.5×U
Load Regulation 2	LoaReg 2		1.5×U
Dropout Voltage	Vdrop		1.5×U
on/off Control Current	Icont		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**

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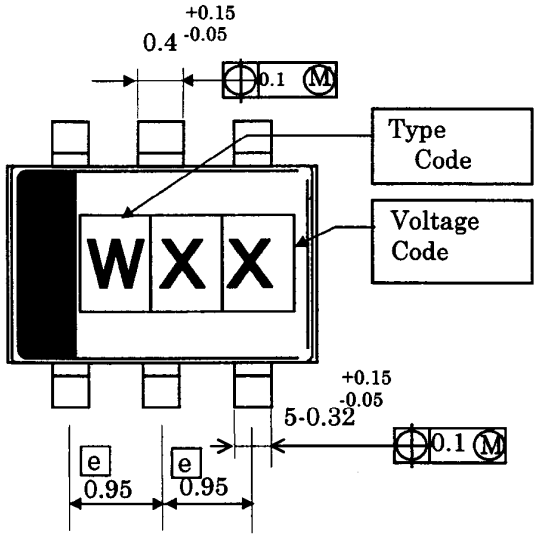
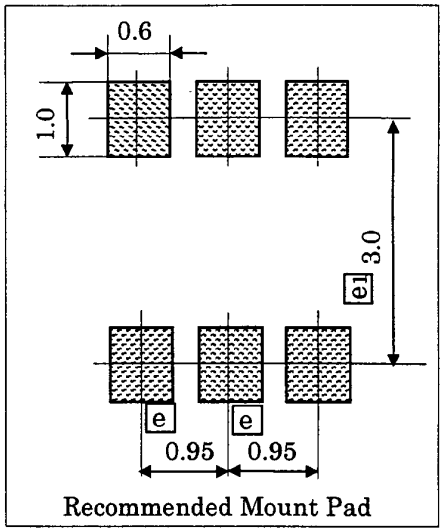
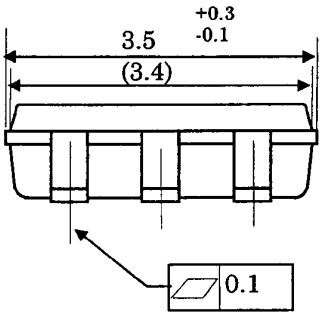
Life Support Policy

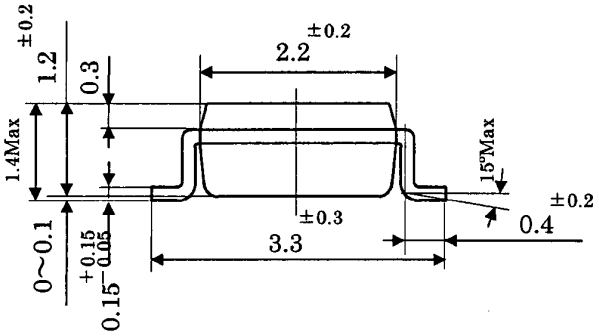
Toko's products are not authorized for use as critical components in life support devices or systems without the express written approval of the president of Toko, Inc. As used herein, life support devices or systems are devices or systems which (1) are intended for surgical implant into the body, or (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

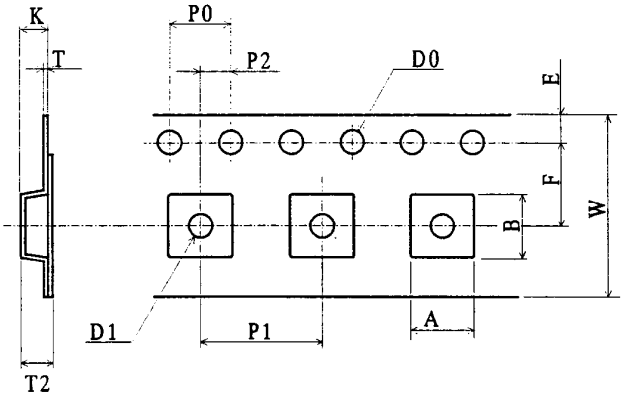
Molded Resin	: Epoxy Resin
Lead Frame	: Copper Alloy
Terminal Treatment	: Solder Plating(5~15 μm)
Marking Method	: Ink or Laser
Weight	: 0.023g
Country of Origin	: Japan

V OUT	V CODE	V OUT	V CODE	V OUT	V CODE	V OUT	V CODE
		3.0v	30	4.0v	40	5.0v	50
		3.1	31	4.1	41		
		3.2	32	4.2	42		
		3.3	33	4.3	43		
2.4v	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. Packaging Specifications

Dimensions and composition of taping

1. Dimensions of carrier tape



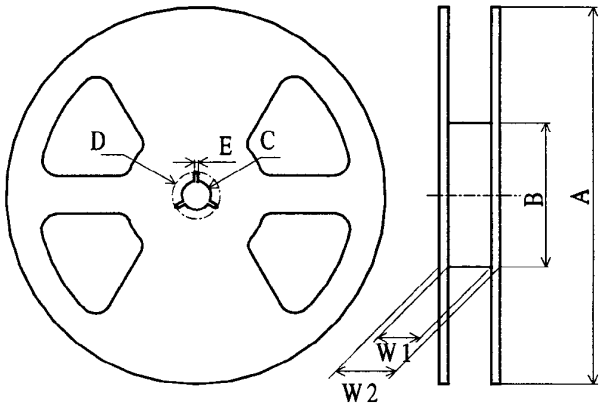
Unit : mm

Symbol	Dimension
A	※ (3.50)
B	※ (3.65)
W	12.0 ±0.3
F	5.5 ±0.05
E	1.75 ±0.1
P 1	8.0 ±0.1
P 2	2.0 ±0.05
P 0	4.0 ±0.1
D 0	φ1.5 $^{+0.1}_{0}$
D 1	φ1.5 $^{+0.1}_{0}$
T	0.3 ±0.05
T 2	Max 2.0
K	1.7 ±0.1

※ The dimensions of A and B are reference values the following information's for the component.
Component clearance : 0.5mm Max./ 0.05mm Min.
Component rotation : 20° Max.

(Conductivity)

2. Dimensions of reel

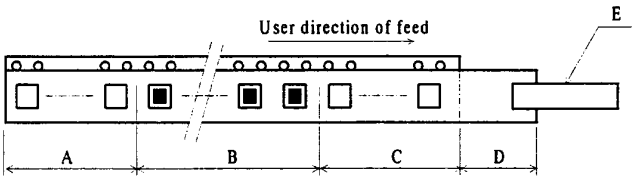


Unit : mm

Symbol	Dimension
A	φ330 ±2.0
B	φ100 ±1.0
C	φ13 ±0.2
D	φ21 ±0.8
E	2.0 ±0.5
W 1	13.5 ±1.0
W 2	17.5 ±1.0

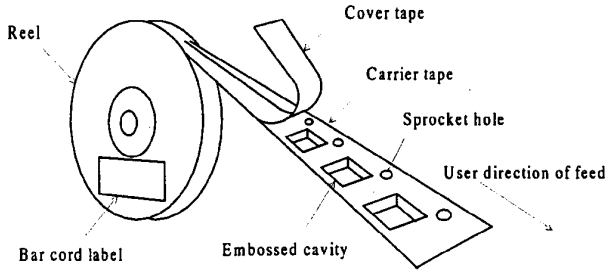
Type name : EIAJ-RRM12DC
Material : Polystyrene
(Conductivity)

3. Tape leader and trailer



Symbol	Application	Standard
A	Trailer (Carrier tape with no components)	Over160 mm
B	Components	
C	Leader (Carrier tape with no components)	Over160 mm
D	Leader (Cover tape)	Over240 mm
E	Binder tape	

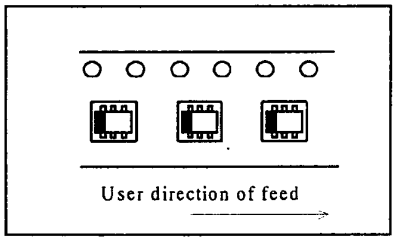
4. Composition of taping



The embossed taping are inserted a component into the carrier tape and pasted the cover tape on the upper side. The reel flange has a gauge for remaining components roughly.

5. Mechanical polarization

[L type]



6. Performance of taping

6.1. Break force of the carrier tape

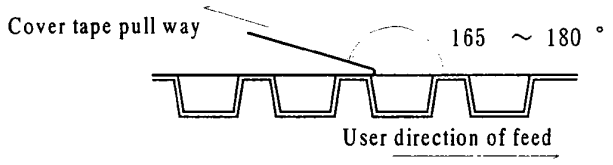
The break force of the carrier tape in the direction of feed is 10N min.

6.2. Break force of the cover tape

The break force of the cover tape is 10N min.

6.3. Peel strength of the cover tape

The peel strength of the cover tape is 0.1N~0.7N. The peel strength is measured at 165 to 180 degrees with respect to the carrier tape at speed 300 mm/min.



REFERENCE DATA

6.4. 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.

6.5. Splicing of tape

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

7. Packing for shipping

7.1. Packing quantity

The quantity in one reel is **4 0 0 0 pcs .**

The quantity in one inner box is **2 reel (8 0 0 0 pcs) max.**

7.2. Marking (Bar code label)

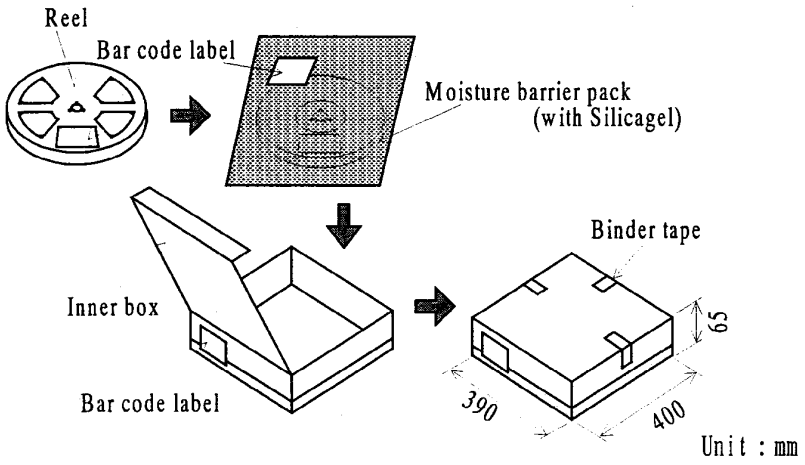
The following items are marked on the surface of the reel, the moisture barrier pack and the inner box.

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

7.3. Composition of packing



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.