REFERENCE

SPEC. No. ED-03084
ISSUE June 2, 2003

SHARP

OPTO-ELECTRONIC DEVICES DIVISION
ELECTRONIC COMPONENTS GROUP
SHARP CORPORATION

SPECIFICATION

DEVICE SPECIFICATION FOR

VOLTAGE REGULATOR

MODEL No.

PQ1CX12H2ZP

Specified for

Enclosed please find copies of the Specifications which consists of 18 pages including cover.
After confirmation of the contents, please be sure to send back ☐ copies of the Specifications with approving signature on each.

CUSTOMER'S APPROVAL

DATE

BY

PRESENTED

DATE Jan. 5. 2003

BY K. Hachimura

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SHARP CORPORATION

REFERENCE

ED-03084 PQ1CX12H2ZP
June 2, 2003

Product name : VOLTAGE REGULATOR

Model No. : PQ1CX12H2ZP

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2. When using this product, please observe the absolute maximum ratings and the instructions for use outlined in these specification sheets, as well as the precautions mentioned below. Sharp assumes no responsibility for any damage resulting from use of the product which does not comply with the absolute maximum ratings and the instructions included in these specification sheets, and the precautions mentioned below.

(Precautions)

(1) This product is designed for use in the following application areas ;

(· OA equipment · Audio visual equipment · Home appliances
· Telecommunication equipment (Terminal) · Measuring equipment
· Tooling machines · Computers)

If the use of the product in the above application areas is for equipment listed in paragraphs (2) or (3), please be sure to observe the precautions given in those respective paragraphs.

(2) Appropriate measures, such as fail-safe design and redundant design considering the safety design of the overall system and equipment, should be taken to ensure reliability and safety when this product is used for equipment which demands high reliability and safety in function and precision, such as ;

(· Transportation control and safety equipment (aircraft, train, automobile etc.)
· Traffic signals · Gas leakage sensor breakers · Rescue and security equipment
· Other safety equipment etc.)

(3) Please do not use this product for equipment which require extremely high reliability and safety in function and precision, such as ;

(· Space equipment · Telecommunication equipment (for trunk lines)
· Nuclear power control equipment · Medical equipment etc.)

(4) Please contact and consult with a Sharp sales representative if there are any questions regarding interpretation of the above three paragraphs.

3. Please contact and consult with a Sharp sales representative for any questions about this product.

1. Application

This specification applies to the outline and characteristics of chopper type regulator, Model No. PQ1CX12H2ZP.

Usage

The PQ1CX12H2ZP is a step-down variable output type PWM method chopper type regulator built-in ON/OFF control function of output voltage, over current protection function, over heat protection function, low consumption current at OFF-state (stand-by) and soft start circuit, and is suitable for large dropout voltage application between input and output.

Block diagram : Refer to the attached sheet, page 3.

2. Outline : Refer to the attached sheet, page 4.

3. Ratings and characteristics : Refer to the attached sheet, page 5, 6.

3.1 Absolute maximum ratings

3.2 Electrical characteristics

3.3 Electrical characteristics measuring circuit

3.4 Pd-Ta rating (Typical value)

4. Reliability

Refer to the attached sheet, Page 7.

5. Outgoing inspection

Refer to the attached sheet, Page 8.

6. Supplement

6.1 Example of application : Refer to the attached sheet, Page 8.

6.2 Packaging : Refer to the attached sheet, Page 8 to 11.

6.3 This product is not designed as electromagnetic and ionized-particle radiation resistant.

6.4 ODS materials

This product shall not contain the following materials.

Also, the following materials shall not be used in the production process for this product.

Materials for ODS : CFC_S, Halon, Carbon tetrachloride, 1.1.1-Trichloroethane (Methyl chloroform)

6.5 Brominated flame retardants

Specific brominated flame retardants such as the $PBBO_S$ and PBB_S are not used in this device at all.

7. Notes : Refer to the attached sheet, Page 11 to 17.

7.1 External connection

7.2 Thermal protection design

7.3 Adjustment of output voltage

7.4 V_B terminal

7.5 ON/OFF control terminal in the following circuit

7.6 Overcurrent protection

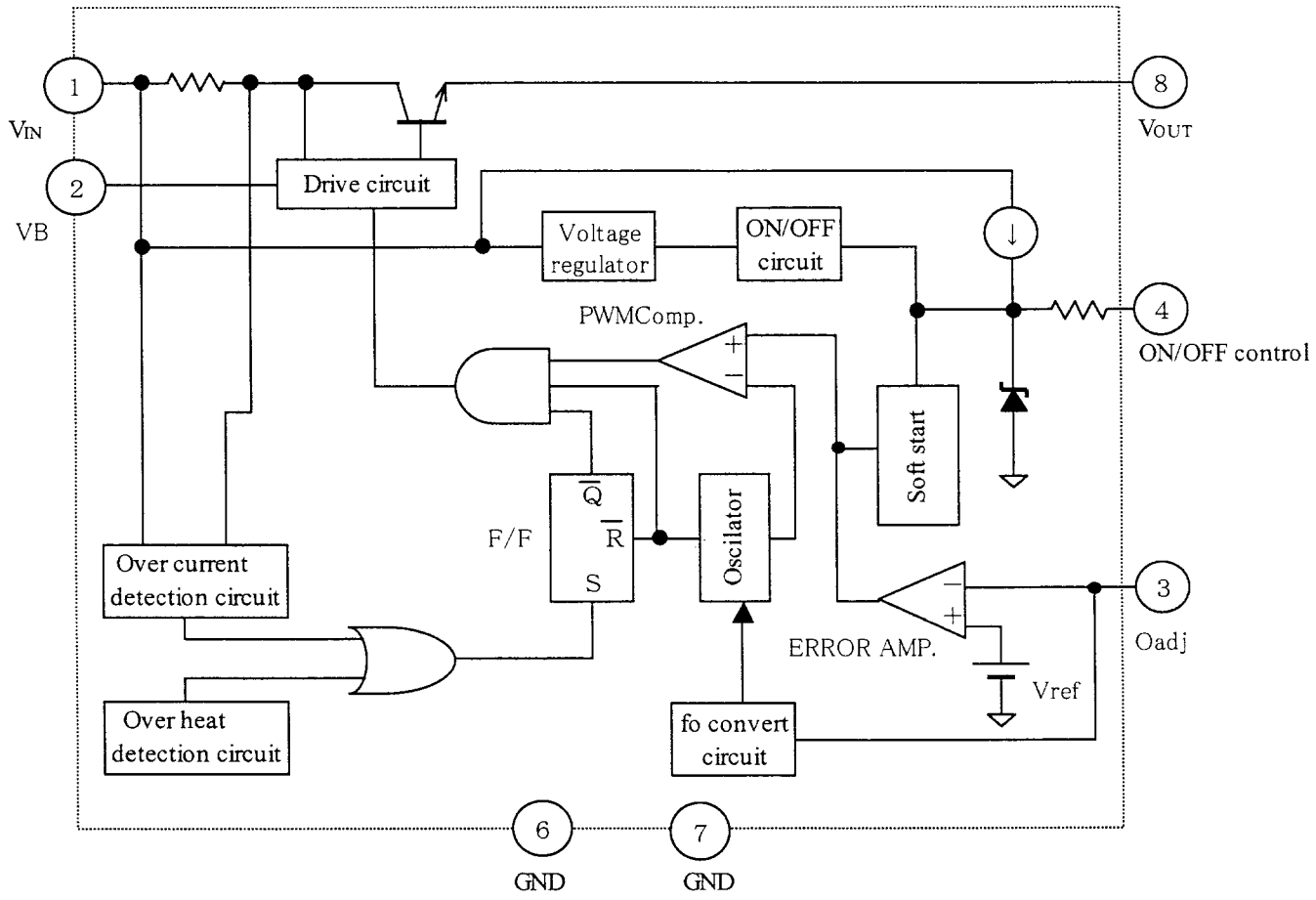
7.7 Input voltage to Oadj terminal

7.8 Soldering

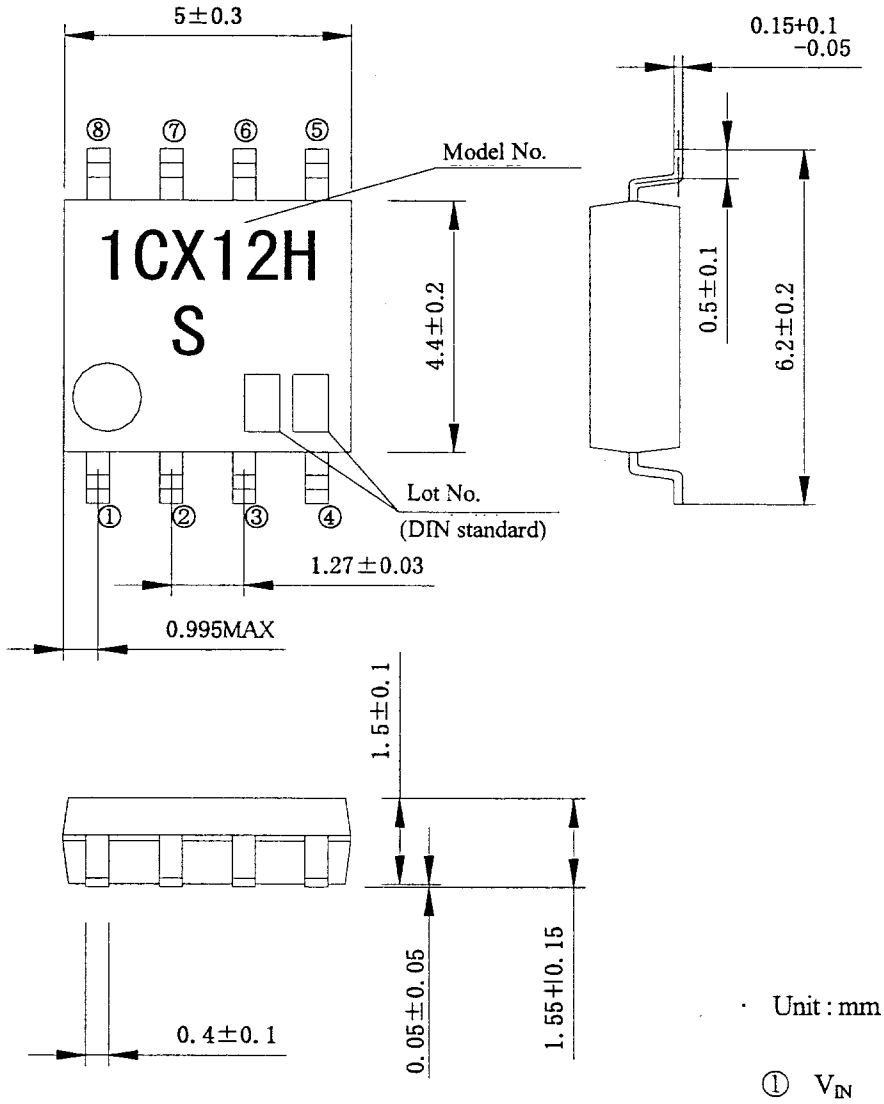
7.9 Static electricity

7.10 For cleaning

1. PQ1CX12H2ZP Block diagram



2. Outline



Unit : mm

① V_{IN}
② V_B
③ Oadj
④ ON/OFF control
⑤ N.C.
⑥ GND
⑦ GND
⑧ V_{OUT}

Lead finish : Solder plating
Lead material : Cu
Product mass : 0.08g

3. Ratings and characteristics

3.1 Absolute maximum ratings

Ta=25°C

Parameter	Symbol	Rating	Unit	Conditions
Input voltage (*1)	V_{IN}	33	V	
VB voltage	V_B	33	V	
Voltage between V_B and V_{IN} (*2)	V_{B-I}	15	V	
Malfunction input voltage	Vadj	7	V	
Input-output voltage	V_{I-O}	34	V	
Output-GND voltage (*3)	V_{OUT}	-1	V	
ON/OFF control voltage (*4)	Vc	-0.3 to 20	V	
Switching current	I_{SW}	2.5	A	
Power dissipation (*5)	Pd	0.9	W	Refer to Fig. 1
Junction temperature	Tj	150	°C	
Operating temperature	Topr	-30 to +85	°C	
Storage temperature	Tstg	-40 to +150	°C	
Soldering temperature	Tsol	260	°C	For 10s

(*1) Voltage between V_{IN} terminal and GND terminal.

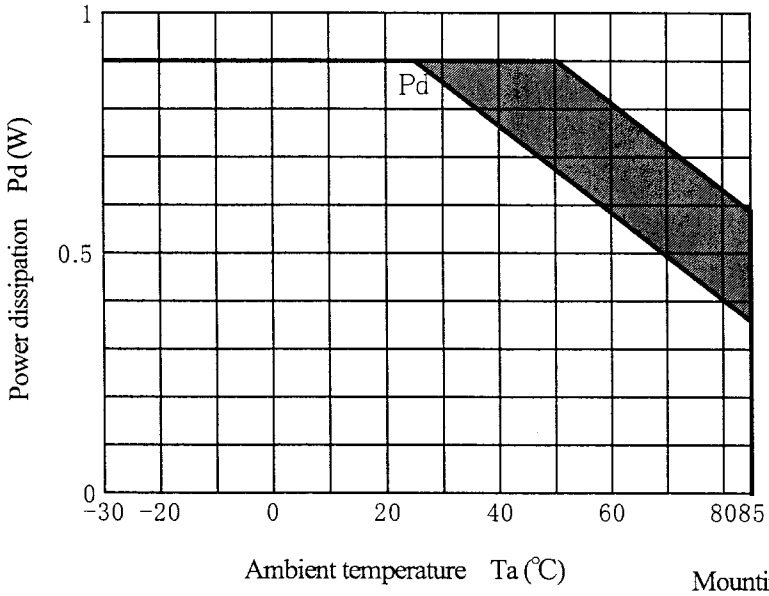
(*2) Voltage between V_B terminal and V_{IN} terminal.

(*3) Voltage between V_{OUT} terminal and GND terminal

(*4) Voltage between ON/OFF control and GND terminal

(*5) Pd: At the time of the following PCB mounting

Fig. 1 Pd - Ta rating



Mounting PCB
Material: Glass-cloth epoxy resin
Size: 40mm×70mm×1mm
GND pattern copper foil area: 7mm×7mm, 35μm

Pd: At the time of PCB mounting

(Note) There is case that over heat protection function operates at oblique line portion.

3.2 Electrical characteristics

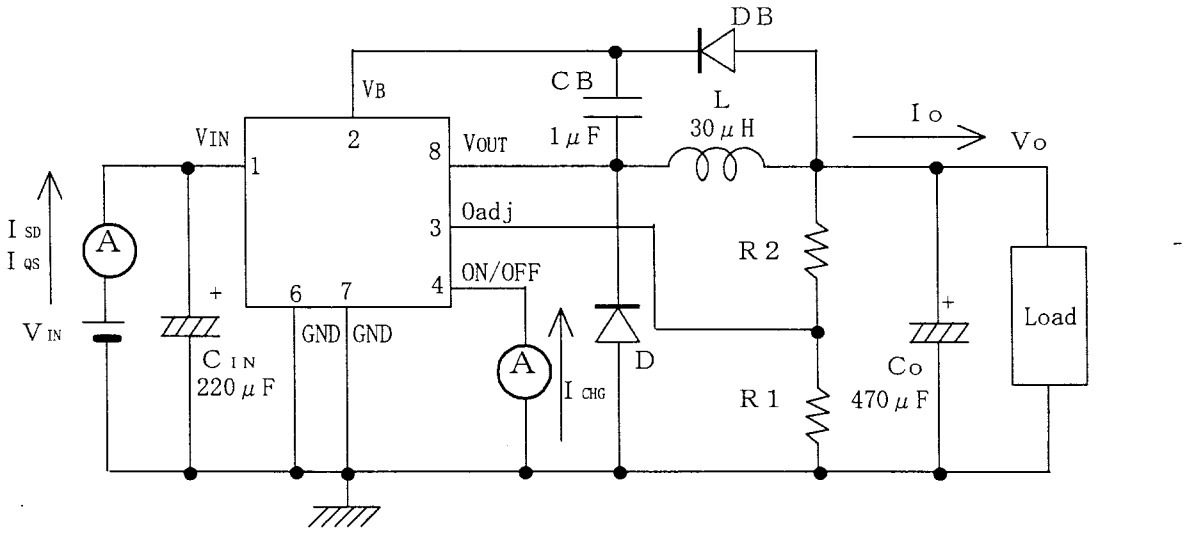
Unless otherwise specified condition shall be V_{IN}=5V, Io=0.5A, Vo=3.3V, ON/OFF terminal : Open Ta=25℃

Parameter	Symbol	MIN.	TYP.	MAX.	Unit	Conditions
Input-output voltage ratio (*6)	D_{I-O}	15	-	-	%	
Output saturation voltage	V_{SAT}	-	0.3	0.4	V	Isw=2.0A
Reference voltage	V_{REF}	1.235	1.26	1.285	V	
Load regulation	|RegL|	-	0.2	1.5	%	Io=0.5 to 2.0A
Line regulation	|RegI|	-	1.3	2.5	%	V_{IN}=5 to 20V
Efficiency	η	-	88	-	%	Io=2.0A
Oscillator frequency	fo	135	150	165	kHz	
Overcurrent detector level	I_L	2.55	3.2	4.2	A	
Maximum. duty	D_{MAX}	83	90	-	%	3 pin =1.1V
Charging current	I_{CHG}	-	-10	-	μA	3, 8 pin : Open, 4 pin
Input threshold voltage	V_{THL}	-	1.3	-	V	Duty=0%, 3 pin=0V, 4 pin
	V_{THH}	-	2.3	-	V	Duty=D_{MAX}, 3 pin : Open, 4 pin
On threshold voltage	V_{THON}	0.7	0.8	0.9	V	3 pin=0V, 4 pin
Stand-by current	I_{SD}	-	110	400	μA	V_{IN}=33V, 4 pin=0V
Output off-state consumption current	I_{QS}	-	5	10	mA	V_{IN}=33V, 4 pin=0.9V
Minimum input voltage	$V_{IN(MIN)}$	-	-	4.5	V	
Minimum boot voltage	V_{BMIN}	-	2	3	V	

(*6) Vo/V_{IN}

3.3 Electrical characteristics measuring circuit

Fig. 2 Standard measuring circuit



L : HK-08S080-3000 (TOHO ZINC CO., LTD.)

D, DB : ERC80-004 (FUJI ELECTRONIC COMPONENTS, LTD)

4. Reliability

The reliability of products shall satisfy items listed below.

Confidence level : 90%
LTPD : 10 or 20

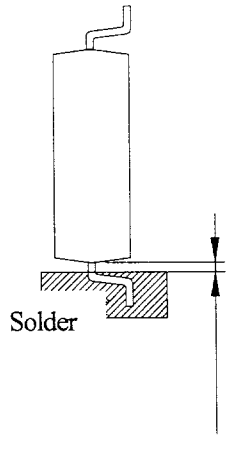
Test Items	Test Conditions	Failure Judgement Criteria	Samples (n) / Defective(C)
Temperature cycling	1 cycle -40℃ to +150℃ (30min) (30min) 20 cycles test	$V_{REF}<L\times0.8$, $V_{REF}>U\times1.2$, $fo<L\times0.8$, $fo>U\times1.2$, $\lvert RegL\rvert>U\times1.2$, $\lvert RegI\rvert>U\times1.2$, $V_{SAT}>U\times1.2$	n=22, C=0
Humidity (Steady State)	+60℃, 90%RH, 1000h		n=22, C=0
Damp Heat cyclic	1 cycle : -20℃(2h) to +70℃(2h) Transfer time between high and low temp. is 1h. 40 cycles test, 90%RH		n=22, C=0
High temp. storage	+150℃, 1000h		n=22, C=0
Low temp. storage	-40℃, 1000h		n=22, C=0
Operation life	Ta=25℃, Tj=125℃, 1000h		n=22, C=0
Mechanical shock	15km/s^2, 0.5ms 3 times/ ±X, ±Y, ±Z		n=11, C=0
Vibration (Variable frequency)	200m/s^2 100 to 2000 to 100Hz/4 min 4 times/ X, Y, Z direction	U: Upper specification limit L: Lower specification limit	n=11, C=0
Soldering heat	260℃, 10s *1		n=11, C=0
Electrostatic discharge	±250V, 200pF, 0Ω Between GND and each terminal/ 3 times		n=11, C=0
Robustness of Termination (Tensile test)	Weight: 2.5N 10s/ each terminal *2	Failure if it has breakdown and loosened pin *3	n=11, C=0
Solderability	230±5℃, 5±0.5s Use rogin flux *1	Failure if A portion area is not soldered 95% or more. *4	n=11, C=0

*1 Soldering area is shown below.
*2 Terminal tensile direction is shown below.
*3 Terminal bending direction is shown below.
*4 Except for the bending of terminal.

Terminal tensile direction

Weight : 2.5N

Soldering area



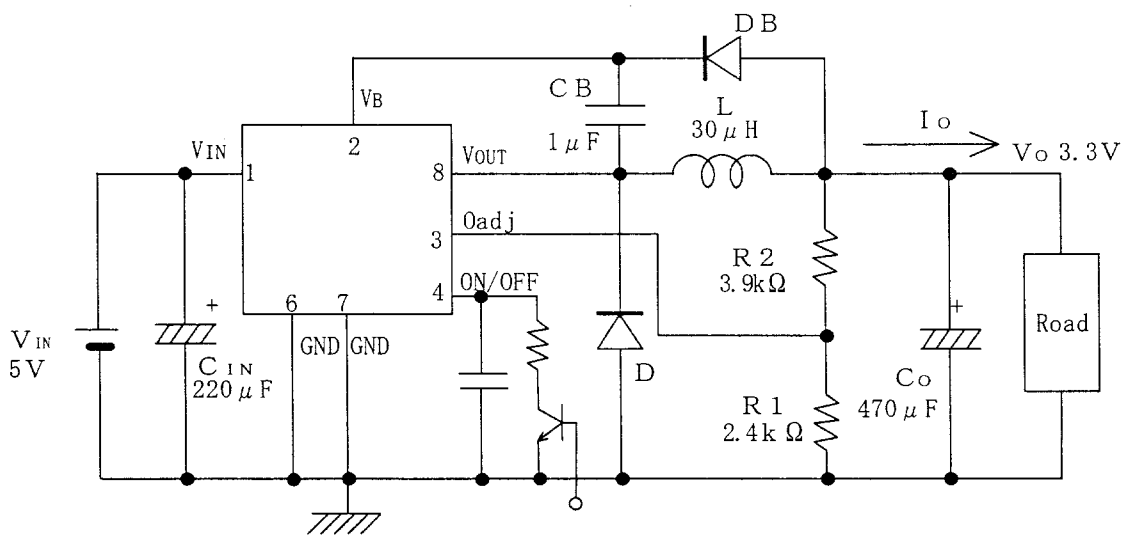
5. Outgoing inspection

TABLE II-A single sampling plans for normal inspection based on ISO 2859 is applied.
The AQL according to the inspection items are shown below.

Defect	Inspection items	AQL (%)	Judgement criteria
Major defect	Electrical characteristics	1.0	It is based on the contents in the specification.
	Marking		To be recognized.
Minor defect	Dimensions	2.5	It is based on the contents in the specification.
	Appearance		There should not have resin break off and lead bending.

6. Supplement

6.1 Example of application



Step down type circuit diagram

6.2 Taping and reel packaging

6.2.1 Packing conditions

(1) Tape structure and Dimensions (Refer to Fig. A)

The tape is made of the carrier tape (material : PS+Carbon) and the cover tape (material : PET and PS), which are combined together by heating. Each dimension is shown at Fig. A.

(2) Reel structure and Dimensions (Refer to Fig. B)

Each dimension of the reel (material : PS) is shown at Fig. B.

(3) Direction of product insertion (Refer to Fig. C)

Product direction in carrier tape are shown at Fig. C.

(4) Joint of tape

The cover tape and carrier tape in one reel shall be jointless.

(5) The way to repair taped failure devices

The way to repair taped failure devices cut a bottom of carrier tape with a cutter, and after replacing to good devices, the cut portion shall be sealed with adhesive tape.

6.2.2 Tape characteristics

(1) Adhesiveness of cover tape

The peel-back force between carrier tape and cover tape shall be 0.1N to 1N for the angle from 160° to 180° .
(Tape speed : 5mm/s)

(2) Bending strength for sealed tape

Sealed tape : Bended tape radius shall be more than 30mm.
If bended tape radius is less than 30mm, there is case that cover tape come off carrier tape.

6.2.3 Rolling method and quantity

(1) Rolling method

Wind the tape back on the reel so that the cover tape will be outside the tape. Attach more than 10 pitch of empty cavities to the trailer and attach more than 20 pitch of empty cavities to the leader of the tape and fix the both ends with adhesive tape.

(2) Quantity

One reel shall contain 1000pcs.

6.2.4 Indication

(1) Reel

The reel shall be pasted label with following information.

* Model No. * Number of pieces contained * Production date

(2) Package case

The outer packaging case shall be marked with following information.

* Model No. * Number of pieces contained * Inspection date

6.2.5 Storage condition

Taped products shall be stored at the temperature lower than 5 to 30℃ and the humidities lower than 70%RH.
If taped products aren't used longer than for 10days, Please rewind the tape pulled out and storage.

Fig. A Tape structure and Dimensions

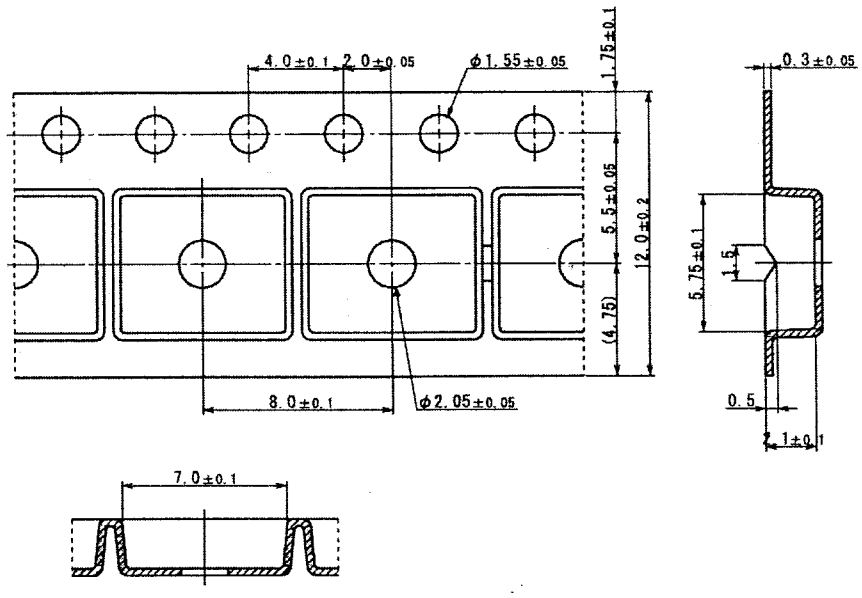
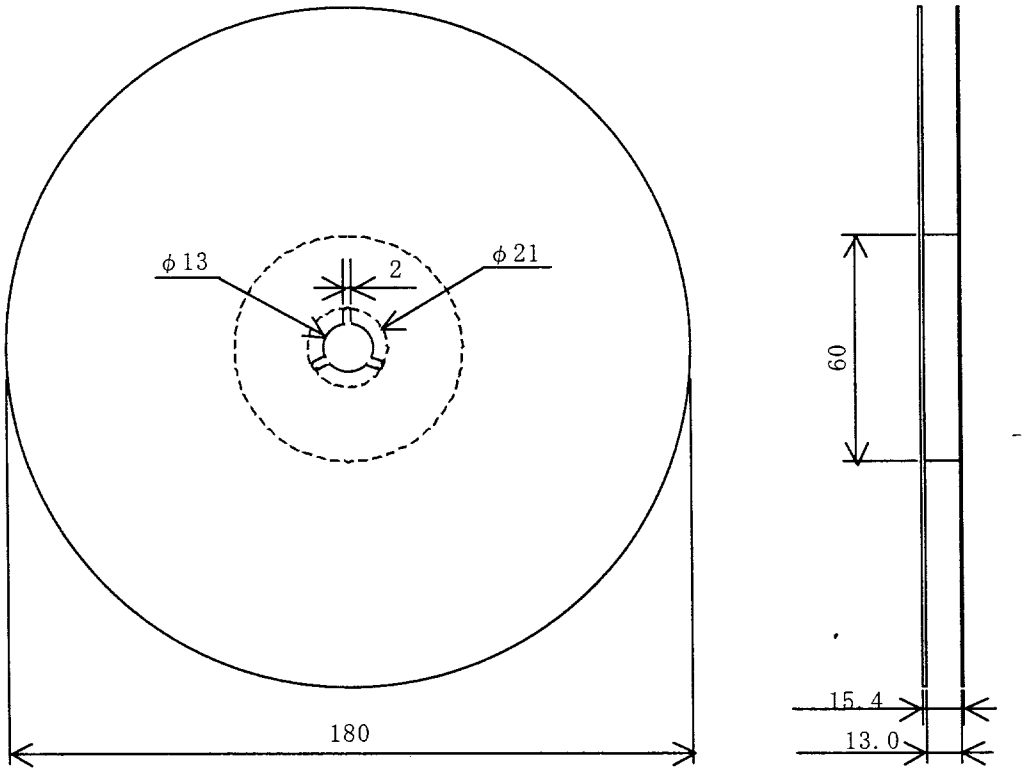
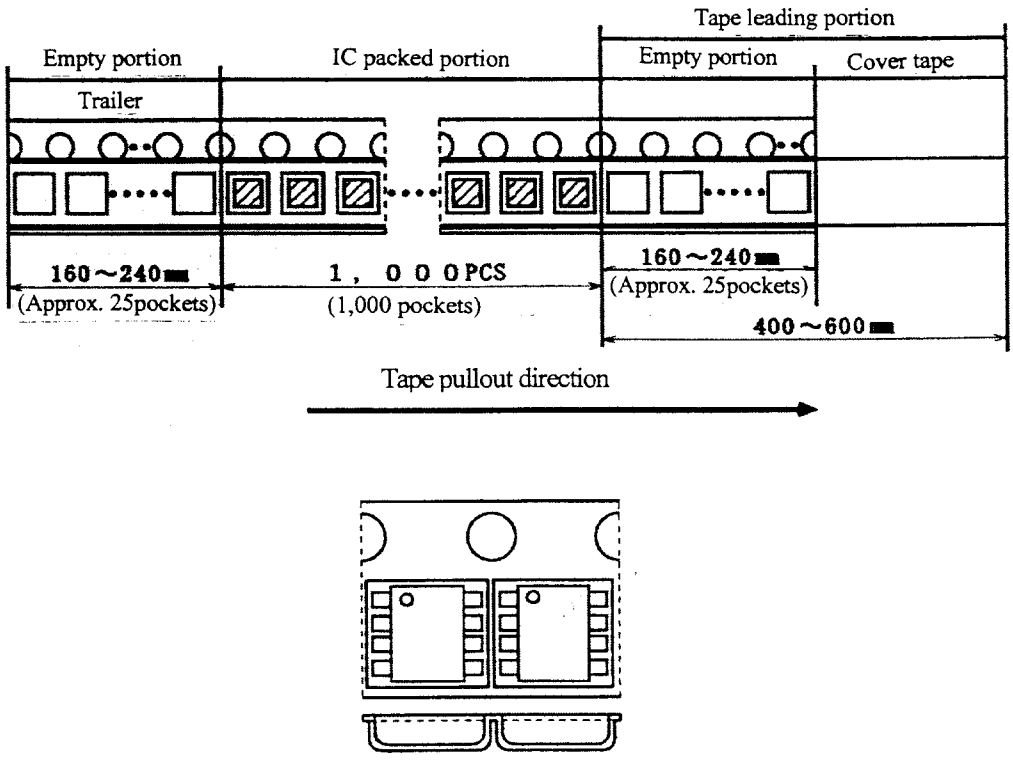


Fig. B Reel structure and Dimensions



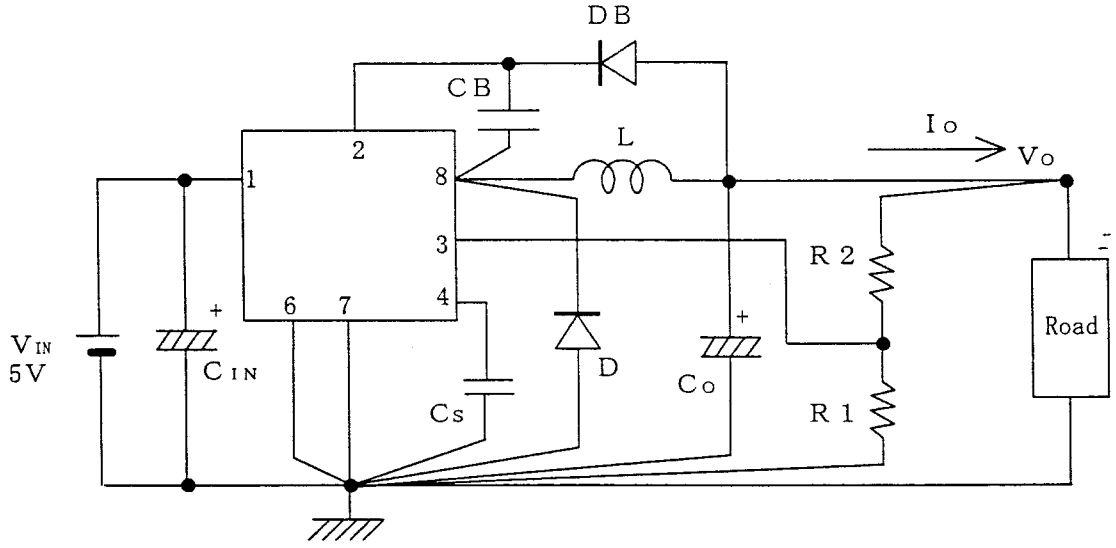
Unit : mm

Fig. C Direction of product insertion



7. Notes

7.1 External connection



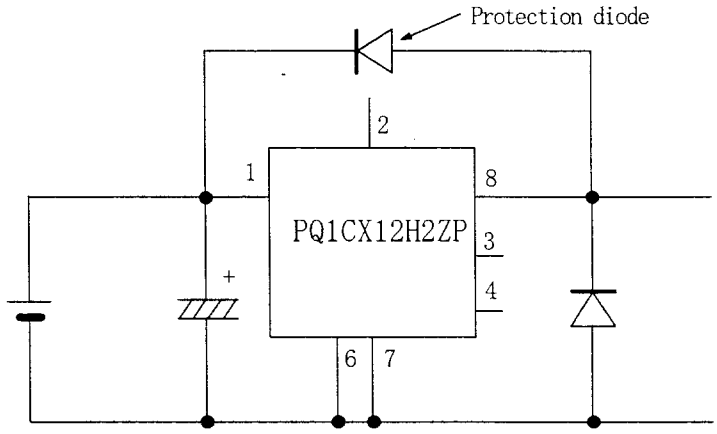
(1) Please pay attention for wire layout since noise problem may occur depending on layout pattern due to its inductance. Sharp recommends the layout to have heavy & short line between diode through which high current goes, Input-output capacitor and switching transistor. Also, single point grounding for the above 3 portion is recommended.

(2) First switching speed and low forward voltage type schottky barrier diode should be recommended for the catch-diode because it affects the efficiency.
Please use the catch-diode current rating must be at least 1.2 times greater than maximum load current.

(3) The output ripple voltage is highly influenced by ESR (Equivalent Series Resistor), and can be minimized by selected Low ESR capacitor.

(4) An inductor should not be operated beyond its maximum rated current because it may saturate.

(5) When voltage that is higher than V_{IN} ①, is applied to V_{OUT} ②, there is the case that the device is broken. Especially, in case V_{IN} ① is shorted to GND in normal condition, there is the case that the device is broken since the charged electric charge in output capacitor (Co) flows into input side.
In such case a schottky barrier diode or a silicon diode shall be recommended to connect as the following circuit.



7.2 Thermal protection design

Internal power dissipation (P) of device is obtained by the following approximately.

$P=I_{SW}$ (Average) $\times V_{SAT} \times D' + V_{IN}$ (V_{IN} to GND terminal) $\times IQ'$ (consumption current) $+V_{B\text{-}OUT} \times I_B \times D' + Psw$

$$D'(\text{Duty}) = \frac{T_{ON}}{T\ (\text{Period})} = \frac{Vo+V_F}{V_{IN}-V_{SAT}+V_F}$$

I_{SW} (Average) = Io (Output current)

$$Psw = \frac{0.05\times10^{-6}}{6}\left\{ Io - \frac{(V_{IN}-V_{SAT}-Vo)}{2\times L\times fo}\times D' \right\} \times (2V_{SAT}+V_{IN}+V_F)\times fo$$

$$+\frac{0.05\times10^{-6}}{6}\left\{ Io + \frac{(V_{IN}-V_{SAT}-Vo)}{2\times L\times fo}\times D' \right\} \times (2V_{SAT}+V_{IN}+V_F)\times fo$$

V_F : Forward voltage of the diode

I_B : Current loaded on V_B terminal (At the time of Isw=2.5A, approx. 35mA)

$V_{B\text{-}OUT}$: Voltage between V_B terminal and V_{OUT} terminal.

If the maximum operating temperature and Pd when the element is operating are determined, use such a heat sink as allows the element to operate within the safety operation area specified by the derating curve in 3.4.
Insufficient radiation gives an unfavorable influence to the normal operation and reliability of the device.
In the case of no passage within the safety operational territory illustrated by the derating curve, the overheat protection circuit operates to shout down output, please avoid keeping such condition for a long time.

7.3 Adjustment of output voltage

Output voltage can be adjustable by loading external resistor R1 and R2 in to pin No. 3, No. 4 terminal.
Adjustable range as follows ;

$V_O=V_{REF}$ to 24V (※1)

$$\text{Output voltage} \quad |V_O| = V_{REF} \times (1+R2/R1) \qquad (V)$$

※1 The maximum output voltage is limited by input voltage $(V_{IN}-V_{SAT})\times D_{MAX}$ value and V_B terminal voltage (MAX. 33V).

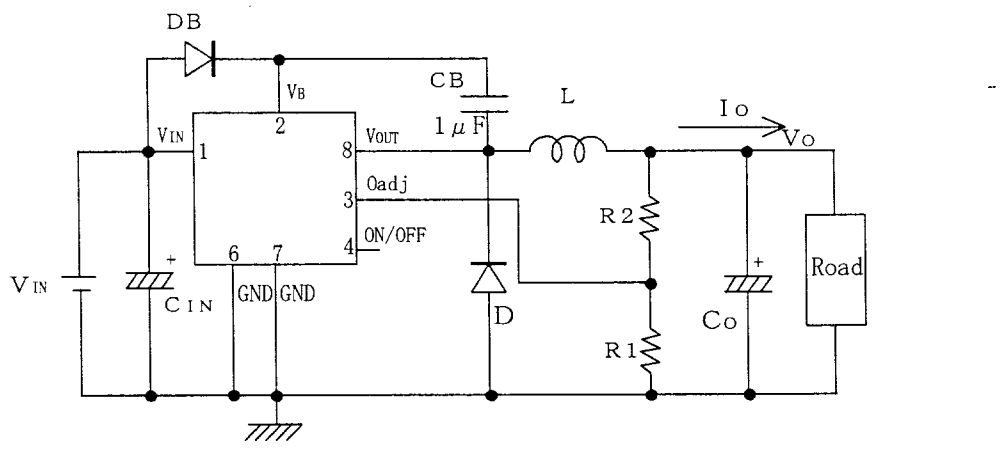
7.4 V_B Terminal

In case of booting V_B terminal from output voltage, input voltage plus output voltage will be applied to V_B terminal.
And in case of booting V_B terminal from input voltage, double input voltage will be applied to V_B terminal.
So please be carefully not to exceed the absolute maximum rating 33V of V_B terminal.
In order to keep good efficiency, the voltage between V_B terminal and V_{OUT} terminal should be applied minimum boot voltage 3V or more. If the voltage is less than 3V, V_{SAT} will increase and the efficiency will be decreased.
In case that the output voltage is less than minimum boot voltage 3V, we recommend to boot from input voltage as shown the circuit example below.

・Maximum rating of Input voltage(V_{IN})

(1) In case of boot voltage from input voltage

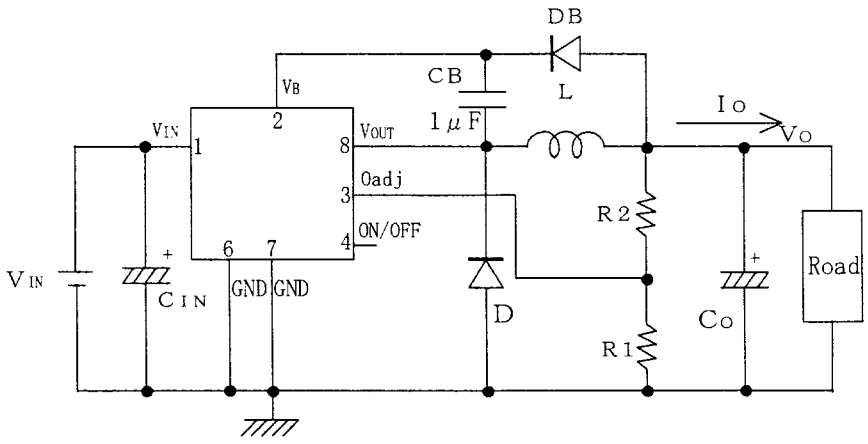
Maximum value of input voltage(V_{IN}) will be limited up to 16.5V from $V_B=2\times V_{IN}\leqq 33V$(Voltage from separate power supply).



Circuit example of booting from input voltage

(2) In case of boot voltage from input voltage

Maximum value of input voltage (V_{IN}) will be limited up to (33-Vo)V or less from $V_B=V_{IN}+Vo \leqq 33V$.

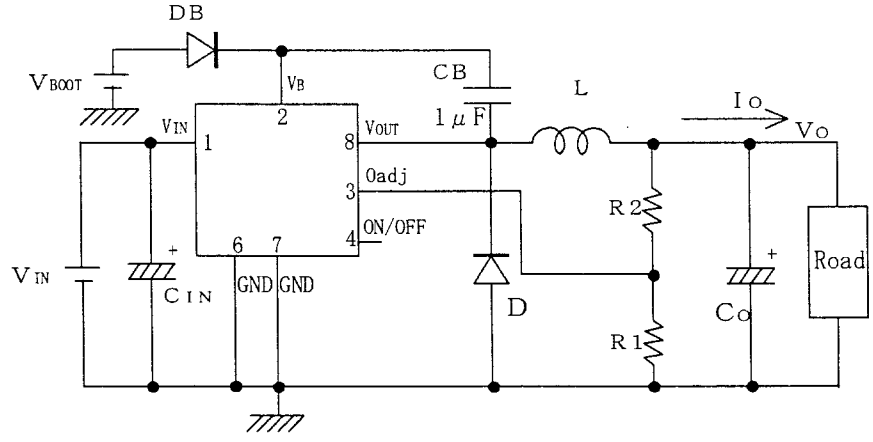


Circuit example of booting from output voltage

(3) In case of boot voltage from separate power supply

Maximum value of input voltage(V_{IN}) will be limited up to (33-Vboot)V or less from $V_B=V_{IN}+V_{BOOT}$ (Voltage from separate power supply)$\leqq$33V.

However, V_{BOOT} (Voltage from separate power supply) is necessary by more than 3V.



Circuit example of booting from separate power supply

7.5 ON/OFF control terminal in the following circuit

〈ON/OFF control〉

When transistor Tr becomes ON and ON/OFF control terminal (Pin No.4) becomes low (V_{THON} or less), output voltage can be turned OFF and become stand-by mode.

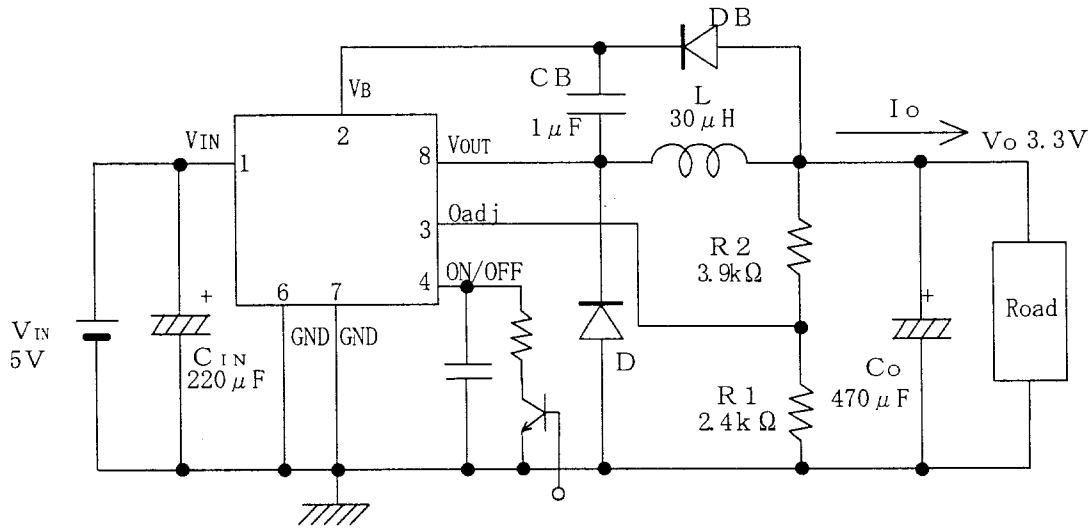
Stand-by mode current dissipation becomes Max. 400 μA.

〈Soft startup.〉

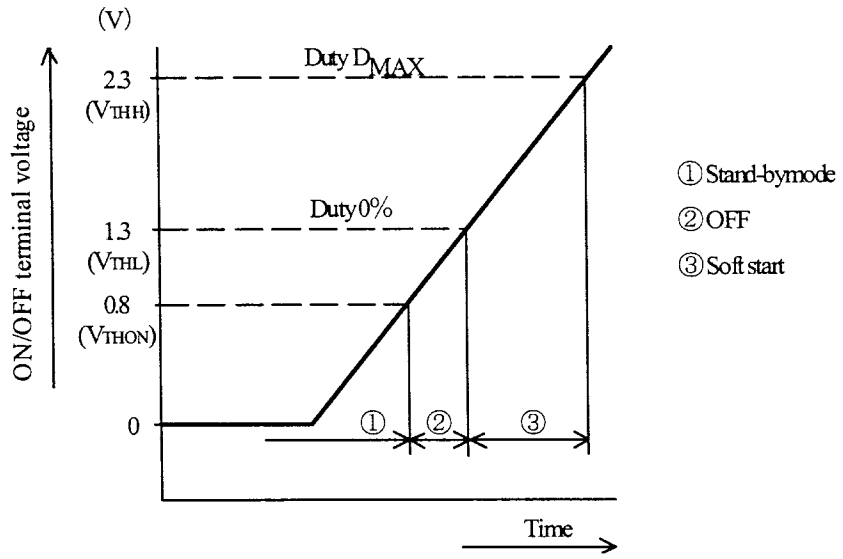
When capacitor Cs is loaded, output pulse gradually expanded and output voltage will start softly.

〈ON/OFF control with soft startup.〉

External resistor Rs should be leaded to avoid discharge current of Cs, and not to break the transistor Tr.



Step down type circuit diagram



7.6 Overcurrent protection

① In case that voltage difference between input voltage and output voltage is large, there is a case that peak current of overcurrent protection becomes large.
If there is concern about the peak current, please use this device after confirming fully at the actual usage conditions.

② Depend on the value of coil inductance, there is cases that output voltage does not work well due to overcurrent protection function when starting. In the case mentioned above, please use this device after confirmation that output voltage works well at the actual usage conditions by increasing the value of inductance.

7.7 Input voltage to Oadj terminal

In case that ripple voltage of output is big, ripple voltage to Oadj voltage becomes big also and frequency of the chopper regulator may change. Especially under low temperature, impedance of an output capacitor increases and it makes the ripple voltage of output increase.
Therefore, please evaluate the device thoroughly on this point and make sure that it works under actual usage conditions.

7.8 Soldering

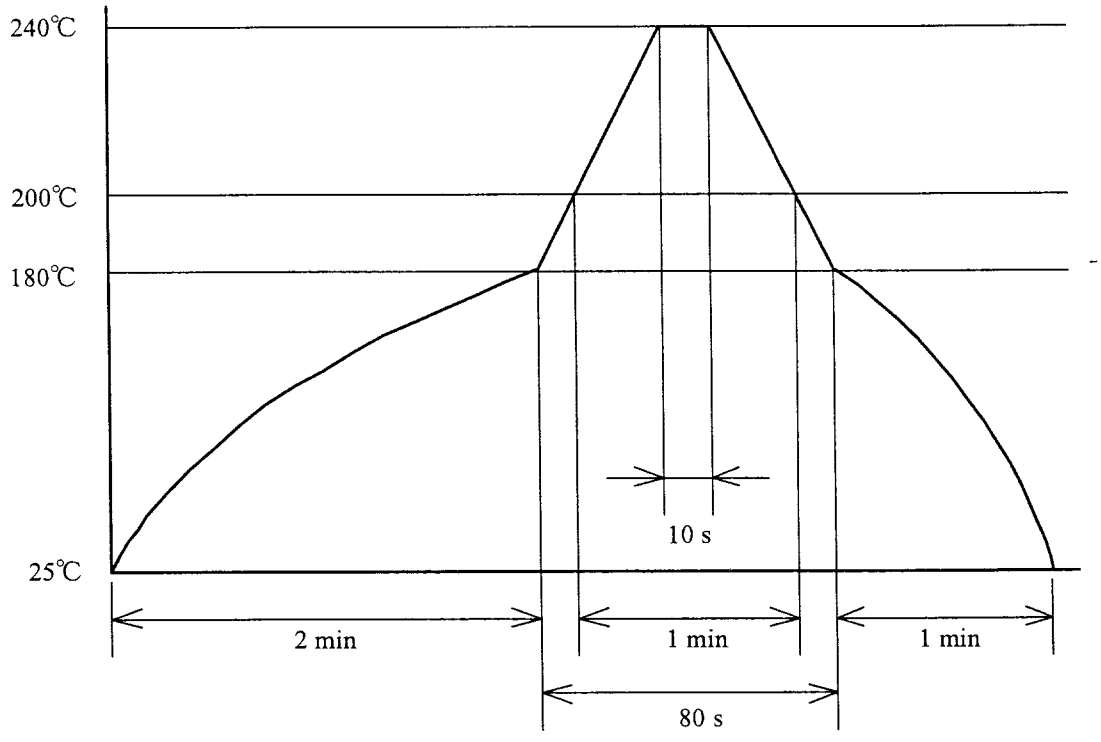
(1) Reflow soldering

It is recommended that within only twice soldering may be done at the temperature and the time within the temperature profile as shown in the figure below. (The temperature shown in the figure is fin portion temperature of the device.)
Please obey the note items below concerning solder reflow.

(a) Please avoid mounting to ceramic PCB.

(b) An infrared lamp used to heat up for soldering may cause a localized temperature rise in the resin.
The temperature of resin portion should be with in the temperature profile below.

(c) The temperature sloping when soldering-reflow is 4℃/s or less.



Even though within the conditions shown in the temperature profile above, if there is any external force on lead terminnals, there is possibility that internal gold wire break may occur. Please use this device after confirming by the actual usage conditions.

7.9 Static electricity

Good caution must be exercised against static electricity since this device consists of a bipolar IC.

Following are some examples of preventive measures against excessive voltages such as caused by static electricity.

(a) Human body must be grounded to discharge the static electricity from the body or cloth.

(b) Anything that is in contact with the device such as workbench, inserter, or measuring instrument must be grounded.

(c) Use a solder dip basin with a minimum leak current (isolation resistance 10MΩ or more) from the commercial power supply. Also the solder dip basin must be grounded.

7.10 For cleaning

(1) Solvent cleaning : Solvent temperature 45℃ or less, Immersion for 3 min or less

(2) Ultrasonic cleaning : The effect to device by ultrasonic cleaning differs by cleaning bath size, ultrasonic power output, cleaning time, PCB size or device mounting condition etc.
Please test it in actual using condition and confirm that doesn't occur any defect before starting the ultrasonic cleaning.

(3) Applicable solvent : Ethyl alcohol, Methyl alcohol, Isopropyl alcohol
When the other solvent is used, there are cases that the packaging resin is eroded.
Please use the other solvent after thorough confirmation is performed in actual using condition.