

1. Features

- Small footprint boost converter for up to 700mA output current application
- Low EMI noise by using an inductor-embedded ferrite substrate
- Input voltage range : 2.7 to 5.5V
- Output voltage : 5V-6V (Adjustable to one fixed voltage at factory setting: 5.0 to 6.0V)
- Switching frequency : 3.3MHz
- Automatic PWM/PFM mode switching for high efficiency



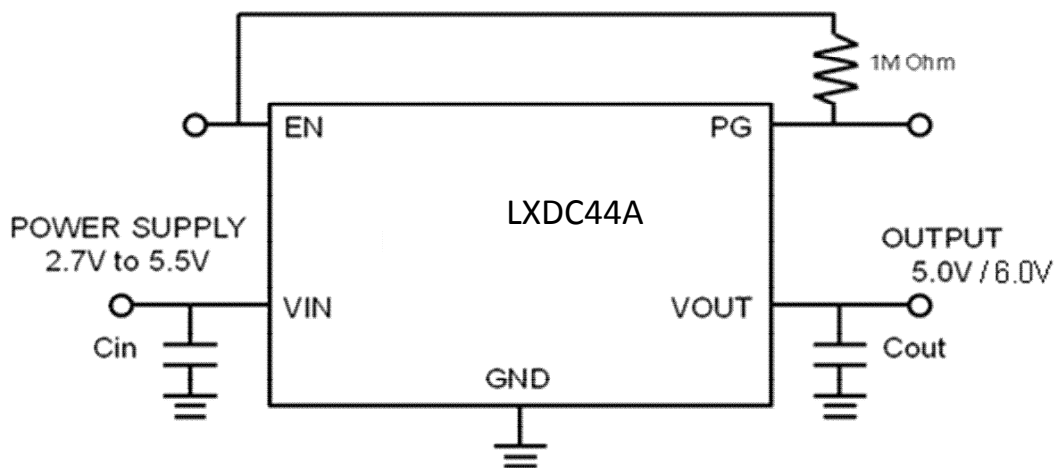
2. Description

The LXDC44A series is a small boost converter for products powered by either a three-cell alkaline, NiCd or NiMH battery, or an one-cell Li-Ion or Li-polymer battery. The wide input voltage range is ideal to power portable applications like mobile phones or for computer peripherals. The device utilizes an inductor-embedded ferrite substrate that reduces radiated EMI noise and conduction noise.

At light load currents the converter will automatically enter PFM (Pulse Frequency Modulation) mode and keep good conversion efficiency. When load current increases, it operates in PWM (Pulse Width Modulation) mode.

The converter utilizes a quasi-constant on-time valley current mode control, which offers fast load transient response.

3. Typical Application Circuit

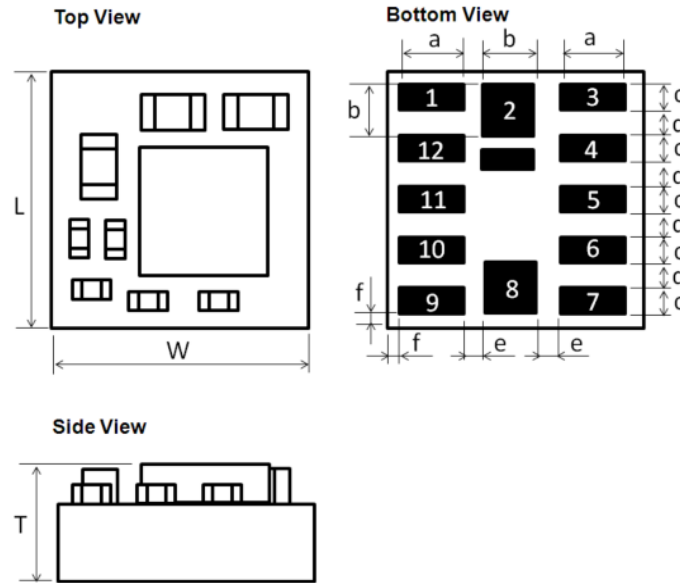


Cin : 10uF / 6.3V (GRM188B30J106M)

Cout : 22uF / 6.3V (GRM21BB30J226M)

4. Mechanical details

4-1 Outline



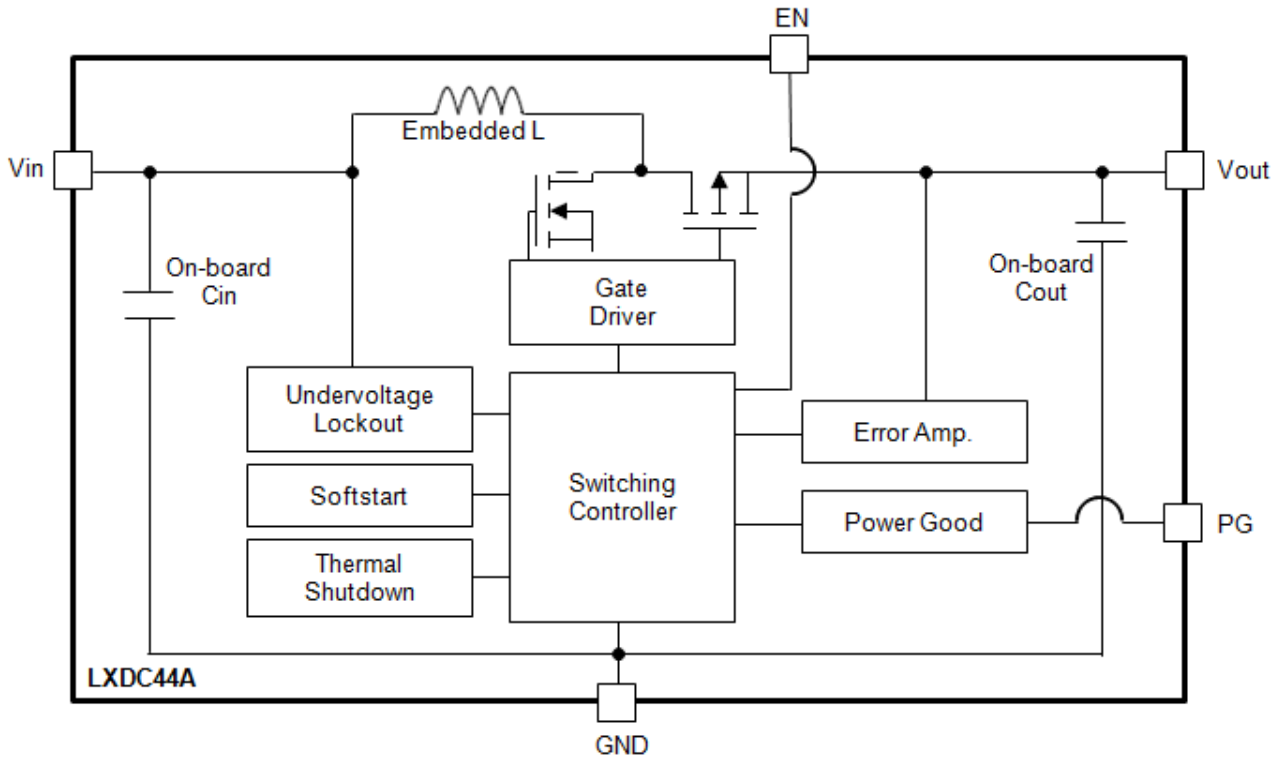
Unit:mm

| Mark | Dimension | Mark | Dimension |
|------|---------------|------|---------------|
| L | 4.0 ± 0.2 | c | 0.4 ± 0.1 |
| W | 4.0 ± 0.2 | d | 0.4 ± 0.1 |
| T | 2.0 (Max) | e | 0.4 ± 0.1 |
| a | 1.0 ± 0.1 | f | 0.2 ± 0.2 |
| b | 0.8 ± 0.1 | | |

4-2. Pin Function

| Pin number | Symbol | I/O | Function |
|------------|--------|--------|---|
| 2,3,8 | GND | - | Ground pin |
| 4,5,6 | Vout | Output | Regulated voltage output pin. Apply output load between this pin and GND. |
| 7 | NC | - | No connection |
| 9 | PG | Output | Power good voltage output pin (Open drain). This is to indicate whether the output voltage has reached its appropriate level or not. |
| 10 | EN | Input | This is the ON/OFF control pin of the device. The device is in shutdown when the voltage to this pin is below 0.3V. Pulling this pin above 1.4V enables the device with soft start. This pin should not be left floating. EN=H: Device ON, EN=L: Device OFF |
| 1,11,12 | Vin | Input | Vin pin supplies current to the LXDC44A internal regulator. |

4-3. Functional Block Diagram



5. Ordering Information

| Part number | Output Voltage | Device Specific Feature | MOQ |
|----------------|----------------|-------------------------|---------------|
| LXDC44AAAC-169 | 5.0V | Standard Type | T/R,1000pcs/R |
| LXDC44AAAC-212 | 6.0V | Standard Type | T/R,1000pcs/R |

6. Electrical Specification

6-1. Absolute maximum ratings

| Parameter | Symbol | Rating | Unit |
|-------------------------------|-----------|-------------|------|
| Maximum input Voltage | V_{in} | 6.0 | V |
| Operating ambient temperature | T_a | -40 to +85 | °C |
| Operating IC temperature | T_{ic} | -40 to +125 | °C |
| Storage temperature | T_{STO} | -40 to +85 | °C |

6-2. Electrical characteristics (Ta=25°C)

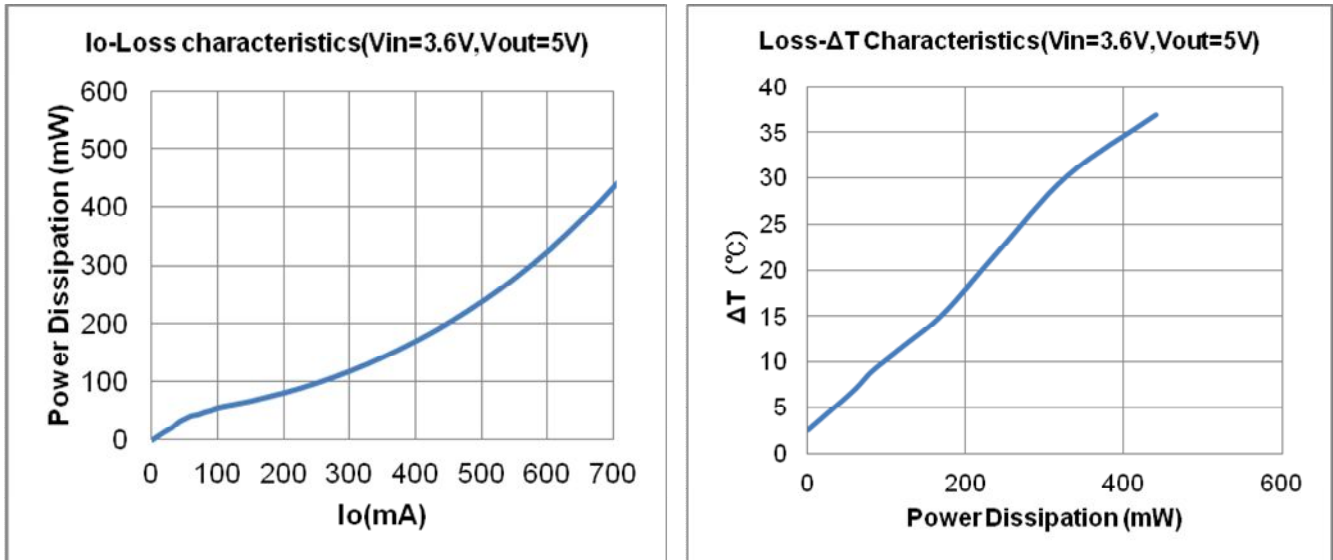
| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|-----------------------------|--------------|--|------|------|----------|------|
| Input Voltage Range | V_{in} | | 2.7 | | 5.5 | V |
| UVLO Threshold Voltage | V_{uvlo} | | | 2.0 | 2.2 | V |
| Input leakage current | I_{in-off} | $V_{in}=3.6V$ | | | 3.5 | uA |
| Output Voltage | V_{out} | LXDC44AAAC-169 | 4.85 | 5.0 | 5.15 | V |
| | | LXDC44AAAC-212 | 5.82 | 6.0 | 6.18 | |
| Output Current Range | I_{out} | LXDC44AAAC-169 $3.3V \leq V_{in} \leq 4.5V$ | 0 | | 700 | mA |
| | | LXDC44AAAC-212 $3.3V \leq V_{in} \leq 5.5V$ | 0 | | 550 | |
| Vout Ripple | V_{rpl} | $V_{in}=3.6V, I_{out}=300mA$ BW=100MHz | | 10 | | mV |
| Efficiency | EFF | $V_{in}=3.6V, I_{out}=300mA$ | | 90 | | % |
| EN,MODE input H Level | VH | | 1.4 | | V_{in} | V |
| EN,MODE input L Level | VL | | 0 | | 0.3 | V |
| Start-up Time | T_{on} | | | 0.35 | | msec |
| Switching Frequency | FOSC | | | 3.3 | | MHz |
| Over Current Protection | OCP | LXDC44AAAC-169 Auto recovery | 700 | 900 | 1800 | mA |
| | | LXDC44AAAC-212 Auto recovery | 550 | 750 | 1800 | |
| Over Temperature Protection | OTP | Auto recovery | | 140 | | °C |

(*1) External capacitors (C_{in} :10uF, C_{out} :22uF) shall be placed near the module in order to proper operation.

(*2)The above characteristics are tested using the application circuit on section 8

6-3 Thermal and Current De-rating Information

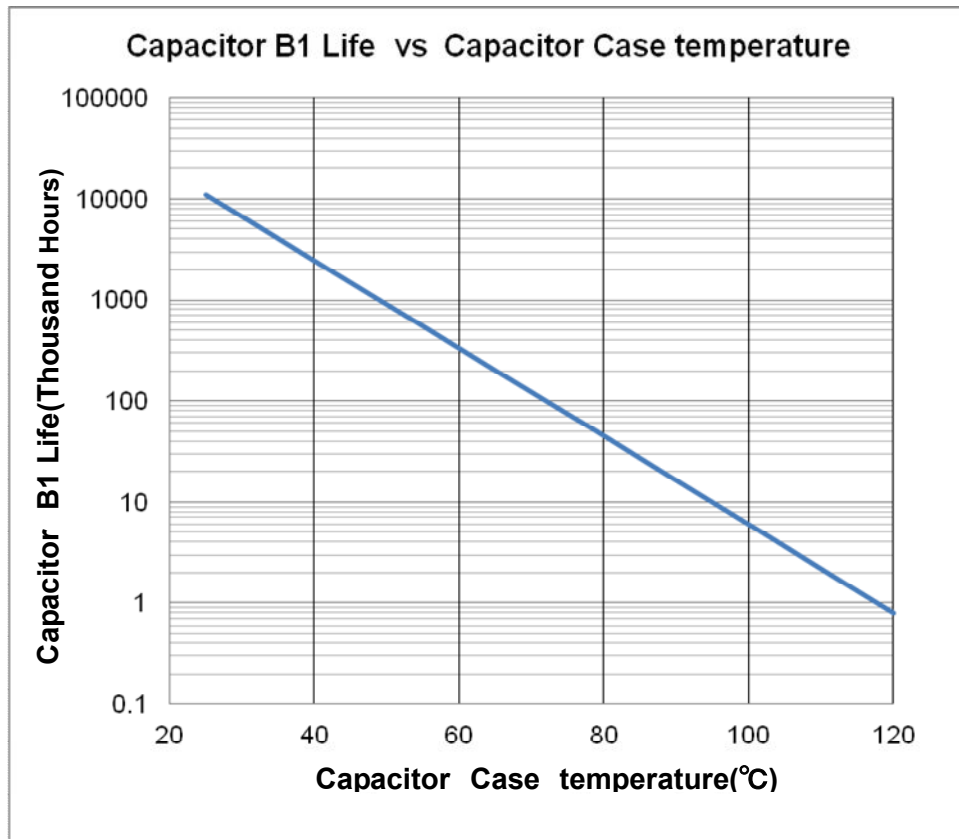
The following figures show the power dissipation and temperature rise characteristics. These data are measured on Murata's evaluation board of this device at no air-flow condition.



The output current of the device may need to be de-rated if it is operated in a high ambient temperature or in a continuous power delivering application. The amount of current de-rating is highly dependent on the environmental thermal conditions, i.e. PCB design, nearby components or effective air flows. Care should especially be taken in applications where the device temperature exceeds 85°C.

The IC temperature of the device must be kept lower than the maximum rating of 125 °C. It is generally recommended to take an appropriate de-rating to IC temperature for a reliable operation. A general de-rating for the temperature of semiconductor is 80%.

MLCC capacitor's reliability and the lifetime is also dependant on temperature and applied voltage stress. Higher temperature and/or higher voltage cause shorter lifetime of MLCC, and the degradation can be described by the Arrhenius model. The most critical parameter of the degradation is IR (Insulation Resistance). The below figure shows MLCC's B1 life based on a failure rate reaching 1%. It should be noted that wear-out mechanisms in MLCC capacitor is not reversible but cumulative over time.



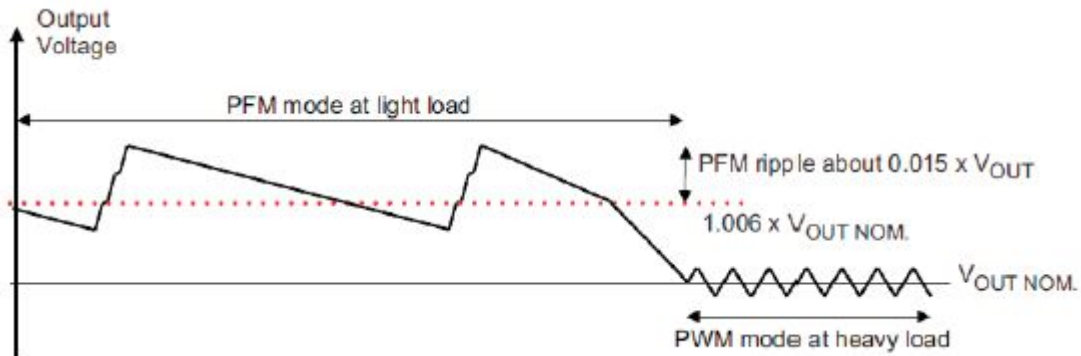
The following steps should be taken before the design fix of user's set for reliable operation.

1. The ambient temperature of the device should be kept below 85 °C
2. The IC temperature should be measured on the worst condition of each application. The temperature must be kept below 125 °C. An appropriate de-rating of temperature and/or output current should be taken.
3. The MLCC temperature should be measured on the worst condition of each application. Considering the above figure, it should be checked if the expected B1 life of MLCC is acceptable or not.

7. Detailed Description

PFM MODE

The device integrates a PFM mode to improve efficiency at light load. In PFM mode the converter only operates when the output voltage trips below a set threshold voltage. It ramps up the output voltage with several pulses. During the PFM operation when the output voltage is above the set threshold the converter turns off some of the inner circuits to save energy. The converter goes into PWM mode in case the output current can no longer be supported in PFM mode.



UVLO (Under Voltage Lock Out)

The under voltage lockout circuit prevents the device from malfunctioning at low input voltages and the battery from excessive discharge. It disables the output stage of the converter once the falling V_{IN} trips the under-voltage lockout threshold V_{UVLO} which is typically 2.0V. The device starts operation once the rising V_{IN} trips V_{UVLO} threshold plus its hysteresis of 100 mV at typ. 2.1V.

Soft Start

The device has an internal soft start circuit that controls the ramp-up of the current during start-up and prevents the converter from inrush current that exceeds the set current limit. For typical 100 μ s the current is ramped to the set current limit. After reaching the current limit threshold it stays there until $V_{in} = V_{out}$ then the converter starts switching and boosting up the voltage to its nominal output voltage. During the complete start-up the input current does not exceed the current limit.

POWER GOOD

The device has a built in power good function to indicate whether the output voltage operates within appropriate levels. The power good output (PG) is set high after the output voltage reaches 95% of its nominal value and stays there until the output voltage falls below 90 % of the nominal value. The power good is operable as long as the converter is enabled and V_{in} is present. If the converter is disabled by pulling the EN pin low the PG open drain output is high resistive. That means it follows the voltage it is connected to via the pull-up resistor.

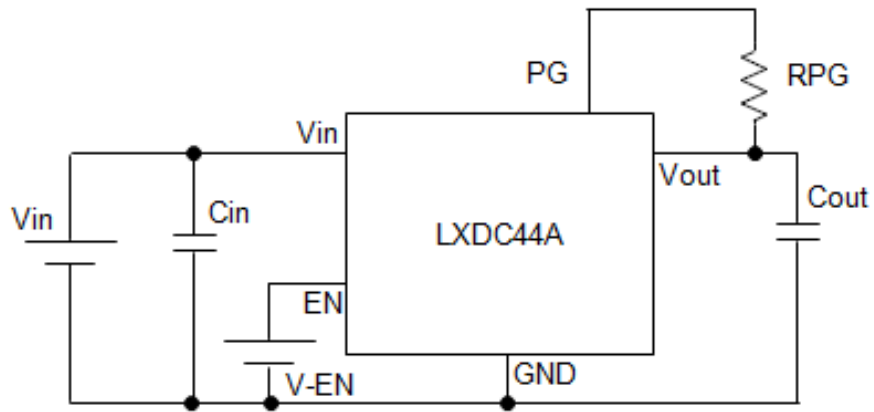
Over Current Protection

LXDC44A series integrates a current limit function to avoid inrush current and to protect internal components against heavy load including short circuit event. When over current event is removed, the device returns to the normal operation automatically.

Over Temperature Shutdown

As soon as the internal IC's junction temperature exceeds 140°C (typ), the device goes into thermal shutdown. The device returns to its normal operation when the Internal IC's junction temperature again falls below 120°C(yp).

8. Test Circuit

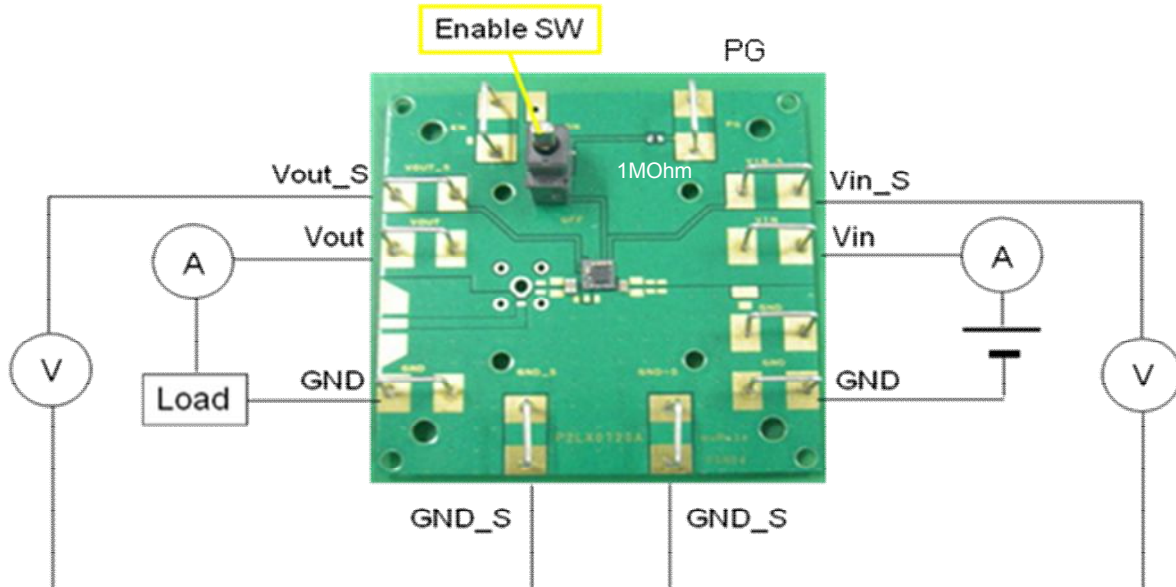


C_{in} : 10 μ F/6.3V (GRM188B30J106M)

C_{out} : 22 μ F/6.3V (GRM21BB30J226M)

9. Micro DC-DC Converter evaluation board (P2LX0720A)

Measurement setup



The enable switch has three states (ON, OFF and Open).

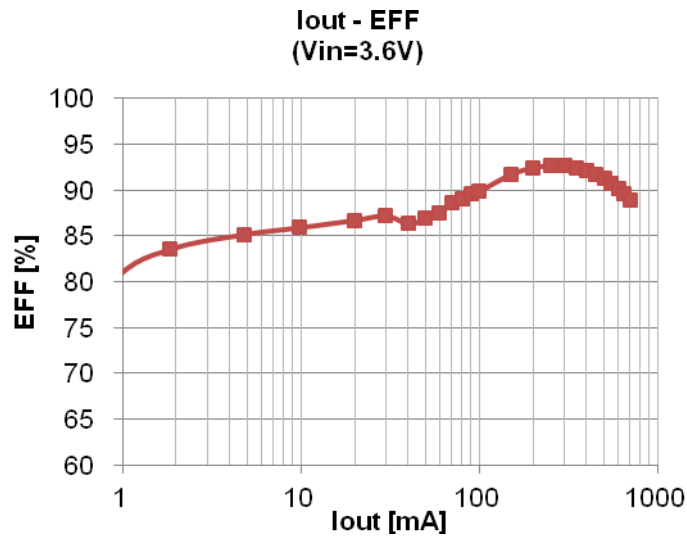
1. When it is shorted to "ON" side, the device starts operation.
2. When it is shorted to "OFF" side, the device stop operation and keep shut down status.
3. When it is set to open, the EN pin becomes floated and can be applied an external voltage through the EN terminal pin on the EVB. If you don't apply external voltage to EN pin, the enable switch should NOT to be set to the middle position.

※The 47uF capacitor is for the evaluation kit only, and has been added to compensate for the long test cables.

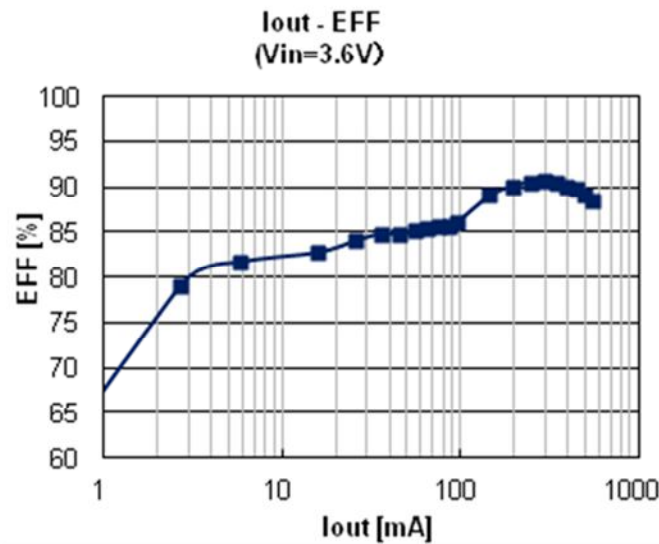
Typical Measurement Data (reference purpose only) (Ta=25°C)

Conversion Efficiency

P/N : LXDC44AAAC-169

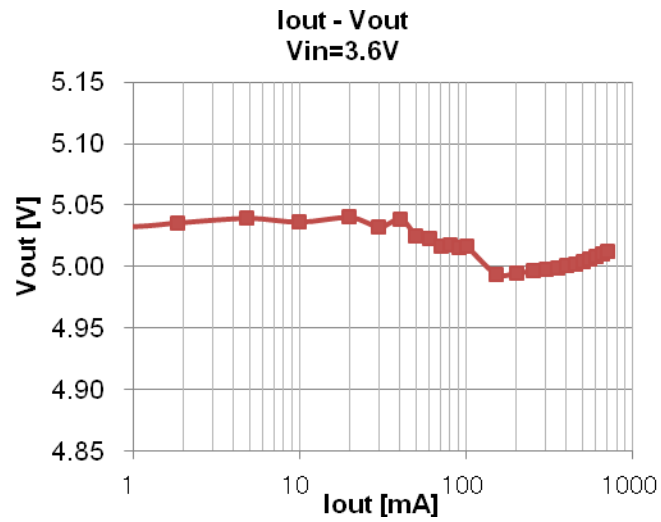


P/N : LXDC44AAAC-212

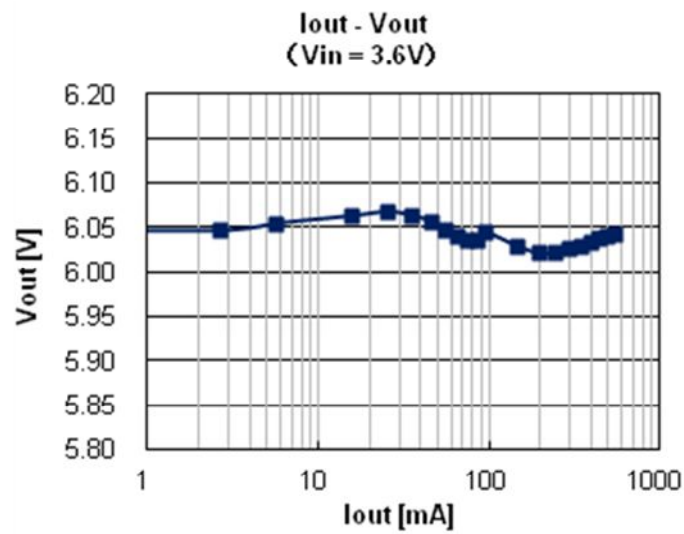


Load Regulation

P/N : LXDC44AAAC-169



P/N : LXDC44AAAC-212

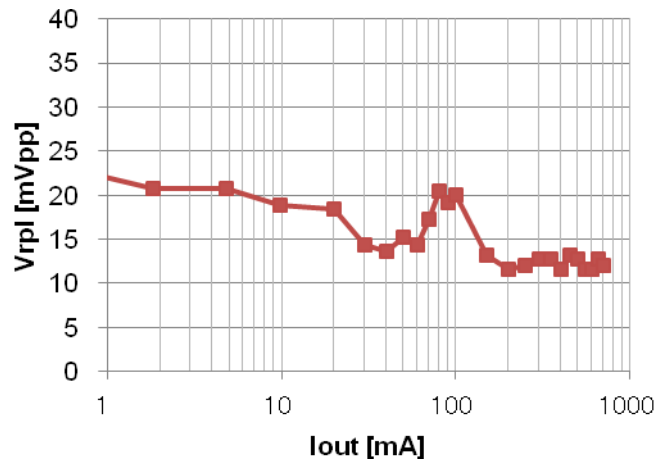


Typical Measurement Data (reference purpose only) (Ta=25°C)

Output Ripple-Noise

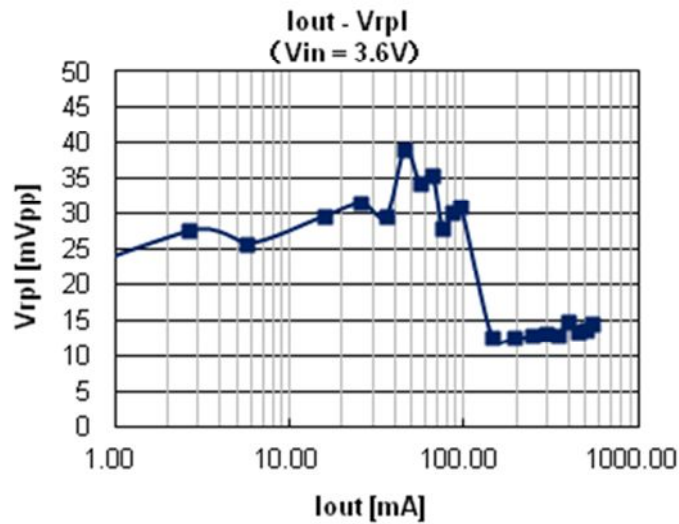
P/N : LXDC44AAAC-169

Vin=3.6V, Vout=5.0V, BW : 150MHz



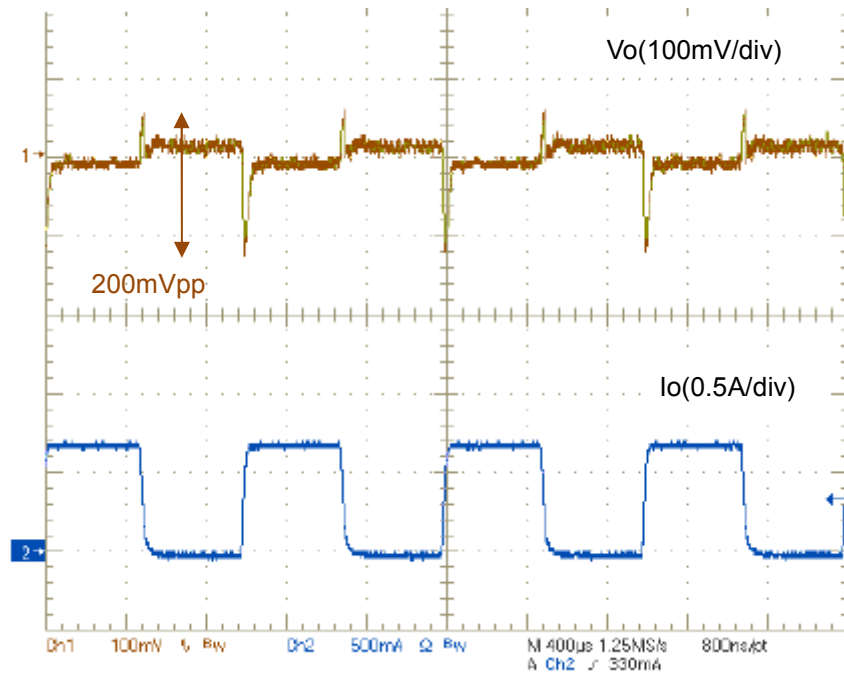
P/N : LXDC44AAAC-212

Vin=3.6V, Vout=6.0V, BW : 150MHz

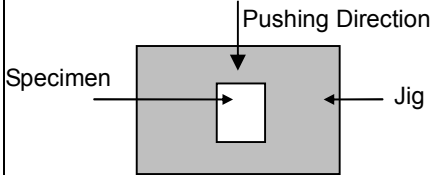


Load Transient Response

P/N : LXDC44AAAC-169

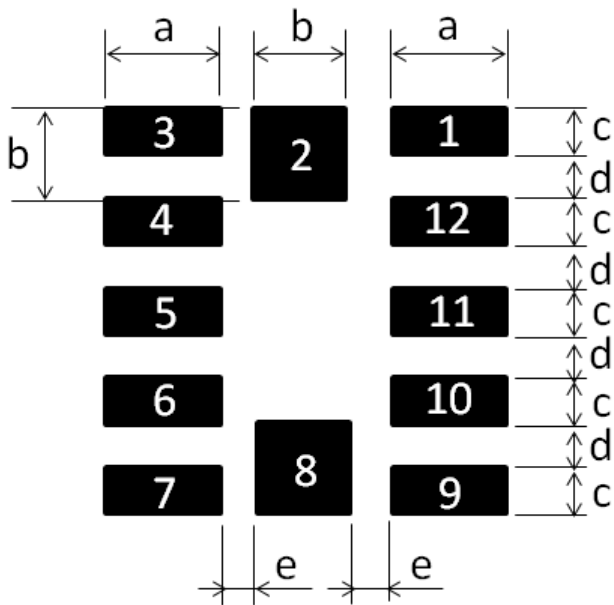


10. Reliability Tests

| No. | Items | Specifications | Test Methods | QTY | Result (NG) | |
|-----|---------------------------------------|--|--|--|-------------|----------|
| 1 | Vibration Resistance | Appearance : No severe damages | Solder specimens on the testing jig (glass fluorine boards) shown in appended Fig.1 by a Pb free solder. The soldering shall be done either by iron or reflow and be conducted with care so that the soldering is uniform and free of defect such as by heat shock. Frequency : 10~2000 Hz Acceleration : 196 m/s ² Direction : X,Y,Z 3 axis Period : 2 h on each direction Total 6 h. | 18 | G (0) | |
| 2 | Deflection | | Solder specimens on the testing jig (glass epoxy boards) shown in appended Fig.2 by a Pb free solder. The soldering shall be done either by iron or reflow and be conducted with care so that the soldering is uniform and free of defect such as by heat shock. Deflection : 1.6mm | 18 | G (0) | |
| 3 | Soldering strength (Push Strength) | 9.8 N Minimum | Solder specimens onto test jig shown below. Apply pushing force at 0.5mm/s until electrode pads are peeled off or ceramics are broken. Pushing force is applied to longitudinal direction.  | 18 | G (0) | |
| 4 | Solderability of Termination | 75% of the terminations is to be soldered evenly and continuously. | Immerse specimens first an ethanol solution of rosin, then in a Pb free solder solution for 3±0.5 sec. at 245±5 °C. Preheat : 150 °C, 60 sec. Solder Paste : Sn-3.0Ag-0.5Cu Flux : Solution of ethanol and rosin (25 % rosin in weight proportion) | 18 | G (0) | |
| 5 | Resistance to Soldering Heat (Reflow) | Appearance Electrical specifications | No severe damages Satisfy specifications listed in paragraph 6-2. | Preheat Temperature : 150-180 °C Preheat Period : 90+/-30 sec. High Temperature : 220 °C High Temp. Period : 20sec. Peak Temperature : 260+5/-0 °C Specimens are soldered twice with the above condition, and then kept in room condition for 24 h before measurements. | 18 | G (0) |

| No. | Items | Specifications | Test Methods | QTY | Result (NG) | | | | | | | | | |
|------|---------------------------|---|--|---|-------------|-----------|---|---------------------------|------|---|---------------------------|------|----|----------|
| 6 | High Temp. Exposure | Appearance Electrical specifications | Temperature: 85±2 °C Period: 1000+48/-0 h Room Condition: 2~24h | 18 | G (0) | | | | | | | | | |
| 7 | Temperature Cycle | | Condition: 100 cycles in the following table <table border="1" data-bbox="826 521 1209 779"> <thead> <tr> <th>Step</th> <th>Temp(°C)</th> <th>Time(min)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Min. Operating Temp.+0/-3</td> <td>30±3</td> </tr> <tr> <td>2</td> <td>Max. Operating Temp.+3/-0</td> <td>30±3</td> </tr> </tbody> </table> | Step | Temp(°C) | Time(min) | 1 | Min. Operating Temp.+0/-3 | 30±3 | 2 | Max. Operating Temp.+3/-0 | 30±3 | 18 | G (0) |
| Step | Temp(°C) | | Time(min) | | | | | | | | | | | |
| 1 | Min. Operating Temp.+0/-3 | | 30±3 | | | | | | | | | | | |
| 2 | Max. Operating Temp.+3/-0 | | 30±3 | | | | | | | | | | | |
| 8 | Humidity (Steady State) | | Satisfy specifications listed in paragraph 6-2. | Temperature: 85±2 °C Humidity: 80~90%RH Period: 1000+48/-0 h Room Condition: 2~24h | 18 | G (0) | | | | | | | | |
| 9 | Low Temp. Exposure | | Temperature: -40±2 °C Period: 1000+48/-0 h Room Condition: 2~24h | 18 | G (0) | | | | | | | | | |
| 10 | ESD(Machine Model) | | C: 200pF, R: 0Ω TEST Voltage : +/-100V Number of electric discharges: 1 | 5 | G (0) | | | | | | | | | |
| 11 | ESD(Human Body Model) | | C: 100pF, R: 1500Ω TEST Voltage : +/-1000V Number of electric discharges: 1 | 5 | G (0) | | | | | | | | | |

Fig.1
Land Pattern

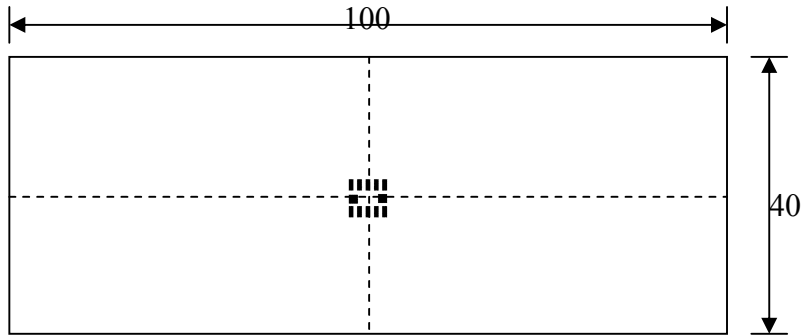


Unit:mm

| Symbol | Dimension |
|--------|-----------|
| a | 1.0 |
| b | 0.8 |
| c | 0.4 |
| d | 0.4 |
| e | 0.4 |

•Reference purpose only.

Fig.2
Testing board

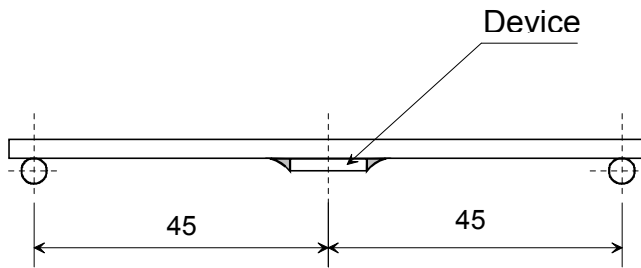


Unit: mm

■ : Land pattern is same as figure 1
Glass-fluorine board $t=1.6\text{mm}$
Copper thickness over $35\ \mu\text{m}$

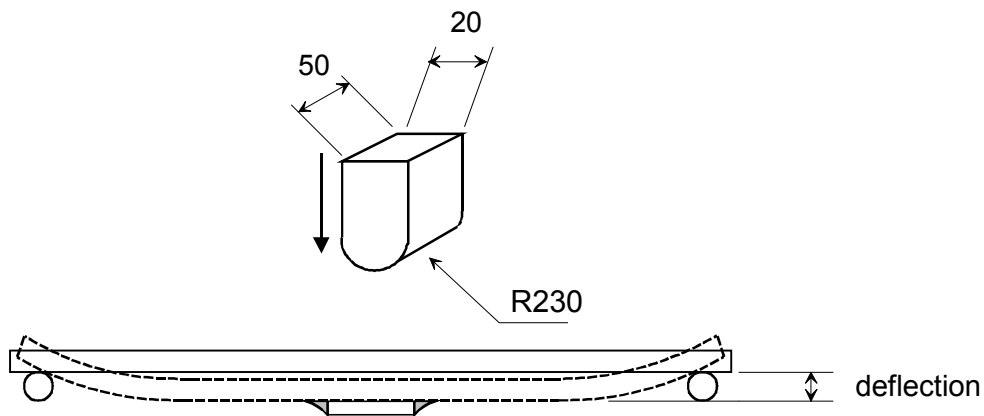
Mounted situation

Unit: mm



Test method

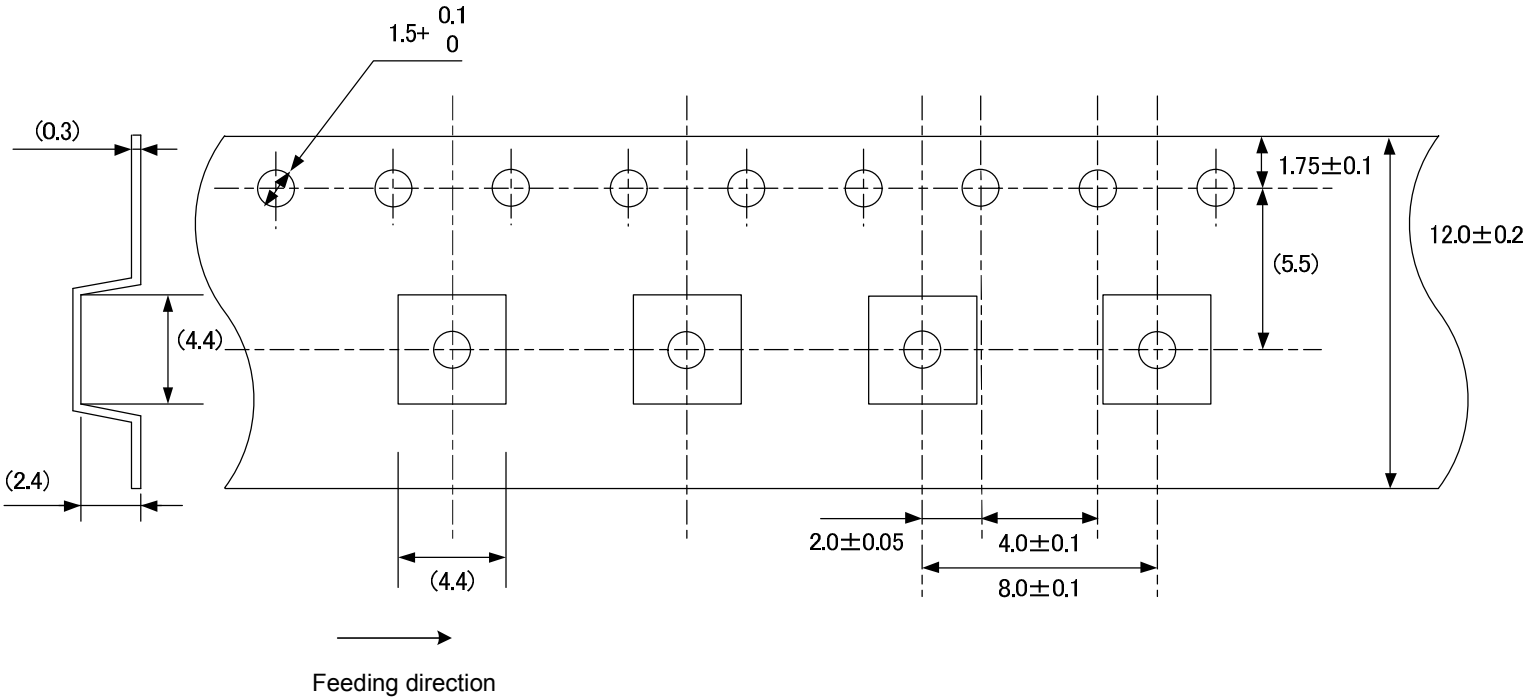
Unit: mm



11. Tape and Reel Packing

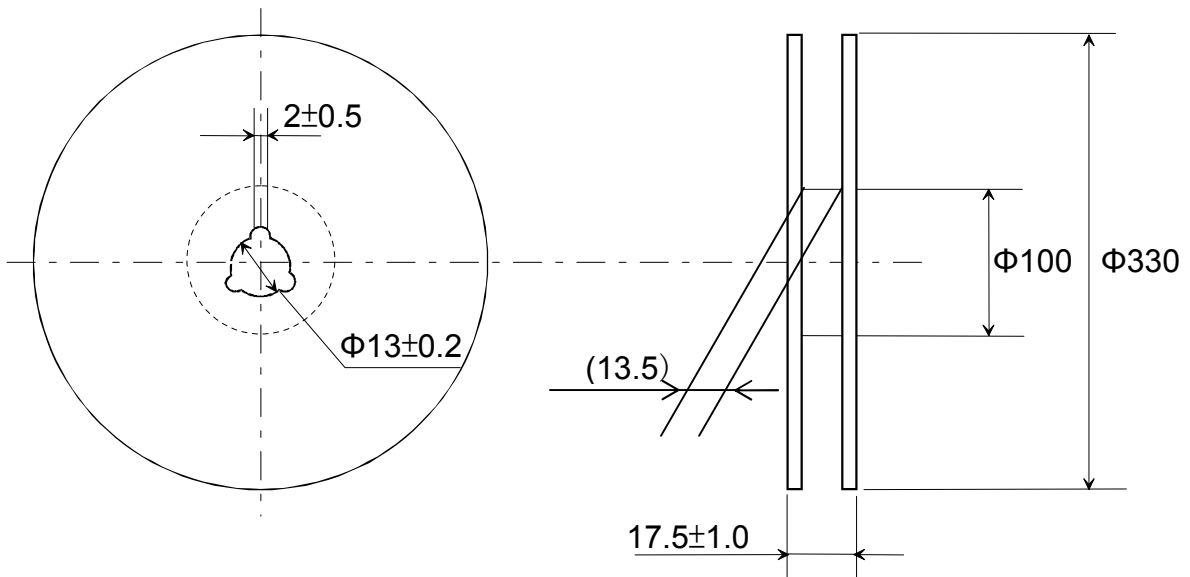
1) Dimensions of Tape (Paper tape)

(Unit : mm)



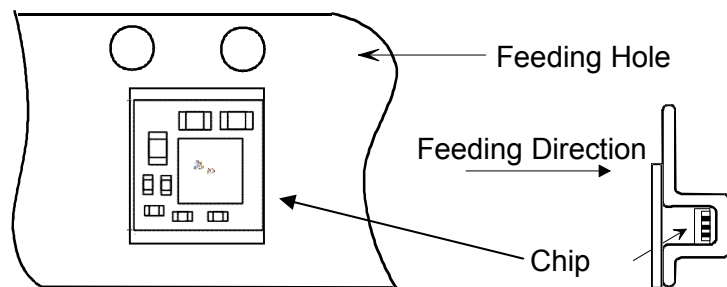
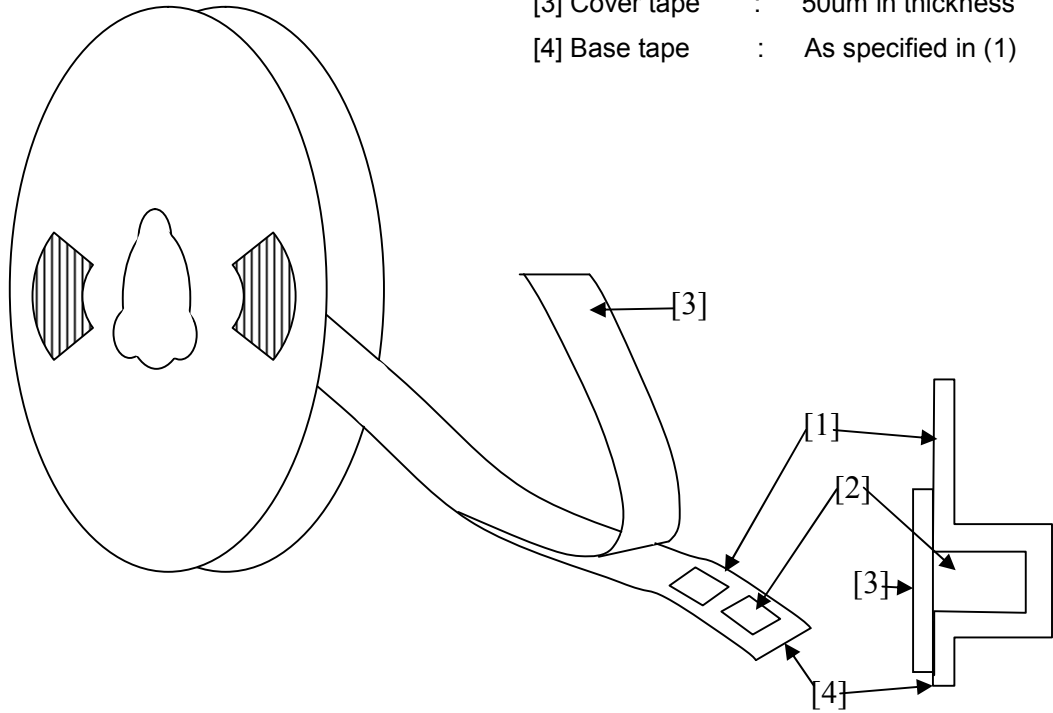
2) Dimensions of Reel

(Unit : mm)

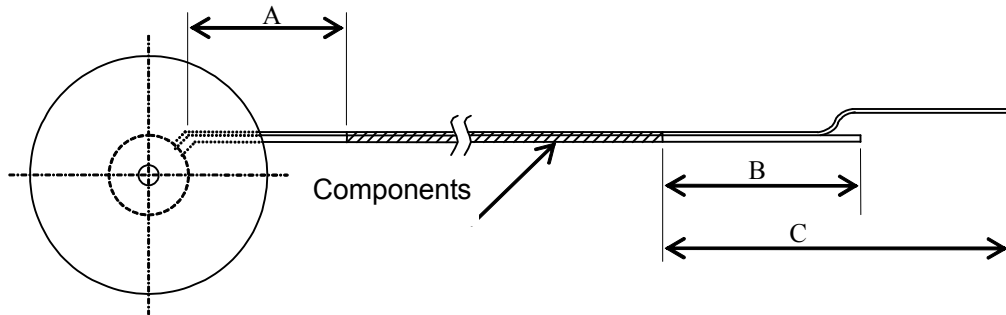


3) Taping Diagrams

- [1] Feeding Hole : As specified in (1)
- [2] Hole for chip : As specified in (1)
- [3] Cover tape : 50um in thickness
- [4] Base tape : As specified in (1)



4) Leader and Tail tape



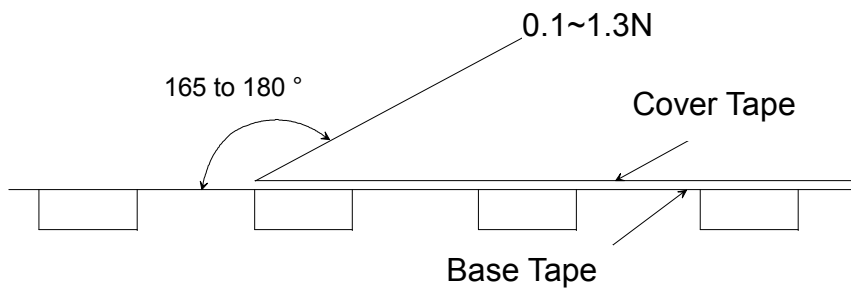
| Symbol | Items | Ratings(mm) |
|--------|--------------------------|-------------|
| A | No components at trailer | min 160 |
| B | No components at leader | min 100 |
| C | Whole leader | min 400 |

5) The tape for chips are wound clockwise and the feeding holes are to the right side as the tape is pulled toward the user.

6) Packaging unit: 1,000 pcs./ reel

7) Material : Base Tape ... Plastic
 Reel ... Plastic
 Antistatic coating for both base tape and reel

8) Peeling of force



NOTICE

1. Storage Conditions:

- The product shall be stored without opening the packing under the ambient temperature from 5 to 35 deg.C and humidity from 20 to 70%RH.
(Packing materials, in particular, may be deformed at the temperature over 40 deg.C.)
- The product left more than 6 months after reception, it needs to be confirmed the solderability before used.
- The product shall be stored in non corrosive gas (Cl₂, NH₃, SO₂, No_x, etc.).
- Any excess mechanical shock including, but not limited to, sticking the packing materials by sharp object and dropping the product, shall not be applied in order not to damage the packing materials.
- After the packing opened, the product shall be stored at ≤ 30 deg.C / ≤ 60 %RH and the product shall be used within 168 hours.

When the color of the indicator in the packing changed, the product shall be baked before soldering.

This product is applicable to MSL3 (Based on IPC/JEDEC J-STD-020)

2. Handling Conditions:

Be careful in handling or transporting the product. Excessive stress or mechanical shock may damage the product because of the nature of ceramics structure.
Do not touch the product, especially the terminals, with bare hands. Doing so may result in poor solderability.

3. Standard PCB Design (Land Pattern and Dimensions):

All the ground terminals should be connected to ground patterns. Furthermore, the ground pattern should be provided between IN and OUT terminals. Please refer to the specifications for the standard land dimensions.

The recommended land pattern and dimensions are shown for a reference purpose only.
Electrical, mechanical and thermal characteristics of the product shall depend on the pattern design and material / thickness of the PCB. Therefore, be sure to check the product performance in the actual set.
When using underfill materials, be sure to check the mechanical characteristics in the actual set.

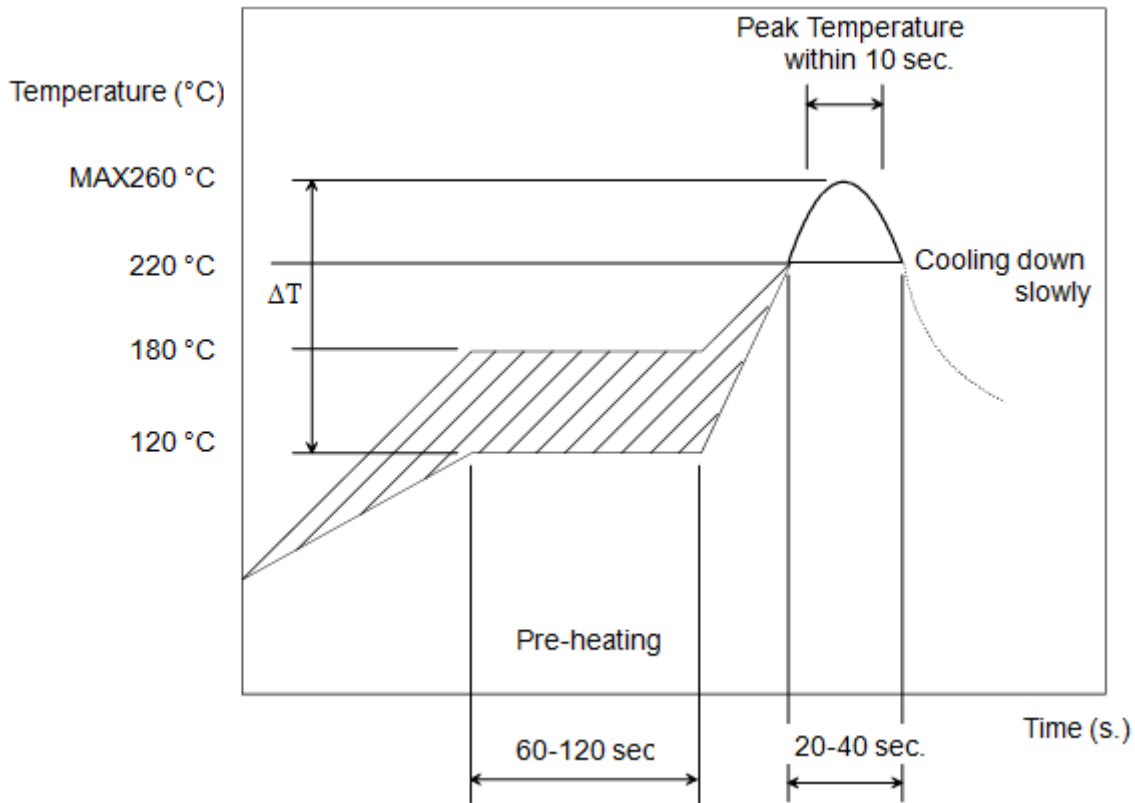
4. Soldering Conditions:

Soldering is allowed up through 2 times.

Carefully perform preheating : ΔT less than 130 °C.

When products are immersed in solvent after mounting, pay special attention to maintain the temperature difference within 100 °C. Soldering must be carried out by the above mentioned conditions to prevent products from damage. Contact Murata before use if concerning other soldering conditions.

Reflow soldering standard conditions (example)



Use rosin type flux or weakly active flux with a chlorine content of 0.2 wt % or less.

5. Cleaning Conditions:

The product is not designed to be cleaned after soldering.

6. Operational Environment Conditions:

Products are designed to work for electronic products under normal environmental conditions (ambient temperature, humidity and pressure). Therefore, products have no problems to be used under the similar conditions to the above-mentioned. However, if products are used under the following circumstances, it may damage products and leakage of electricity and abnormal temperature may occur.

- In an atmosphere containing corrosive gas (Cl₂, NH₃, SO_x, NO_x etc.).
- In an atmosphere containing combustible and volatile gases.
- In a dusty environment.
- Direct sunlight
- Water splashing place.
- Humid place where water condenses.
- In a freezing environment.

If there are possibilities for products to be used under the preceding clause, consult with Murata before actual use.

If static electricity is added to this product, degradation and destruction may be produced.

Please use it after consideration enough so that neither static electricity nor excess voltage is added at the time of an assembly and measurement.

If product malfunctions may result in serious damage, including that to human life, sufficient fail-safe measures must be taken, including the following:

- (1) Installation of protection circuits or other protective device to improve system safety
- (2) Installation of redundant circuits in the case of single-circuit failure

7. Input Power Capacity:

Products shall be used in the input power capacity as specified in this specifications.

Inform Murata beforehand, in case that the components are used beyond such input power capacity range.

8. Limitation of Applications:

The products are designed and produced for application in ordinary electronic equipment (AV equipment, OA equipment, telecommunication, etc). If the products are to be used in devices requiring extremely high reliability following the application listed below, you should consult with the Murata staff in advance.

- Aircraft equipment.
- Aerospace equipment
- Undersea equipment.
- Power plant control equipment.
- Medical equipment.
- Transportation equipment (vehicles, trains, ships, etc.).
- Automobile equipment which includes the genuine brand of car manufacture, car factory-installed option and dealer-installed option.
- Traffic signal equipment.
- Disaster prevention / crime prevention equipment.
- Data-processing equipment.
- Application which malfunction or operational error may endanger human life and property of assets.
- Application which related to occurrence the serious damage
- Application of similar complexity and/ or reliability requirements to the applications listed in the above.



Note:

Please make sure that your product has been evaluated and confirmed against your specifications when our product is mounted to your product.

Product specifications are subject to change or our products in it may be discontinued without advance notice.

This catalog is for reference only and not an official product specification document, therefore, please review and approve our official product specification before ordering this product.