

### 1. Features

- Wide Input voltage range : 4.0V to 14.0V
- User Adjustable Output voltage : 0.8 to 5.3V
- Small footprint Buck converter for up to 1.5A output current application
- Low EMI noise by using an inductor-embedded ferrite substrate
- High efficiency using synchronous rectifier technology at 2MHz operation
- Superior transient response using quasi-fixed-frequency COT technology
- Seamless Power-Save Mode Transition
- Power-Good function ,Over current protection, Over temperature protection
- Quiescent Current of 150  $\mu$ A (typ.)



### 2. Description

The LXDC55F series is an easy-to-use synchronous step-down DC-DC converter optimized for applications with high power density. The device utilizes an inductor-embedded ferrite substrate, and the substrate eliminates radiated EMI noise and conduction noise efficiently.

With its wide operating input voltage range of 4 V to 14 V, the devices are ideally suited for systems powered from either a Li-Ion or other batteries, as well as from 12-V intermediate power rails. It supports up to 1.5 A of continuous output current at output voltages between 0.8 V and 5.3 V

The LXDC55F series utilizes a constant on time feedback technology and has superior load transient response. It has a unique circuit that roughly keeps the switching frequency constant, which makes it easy to filter the switching noise.

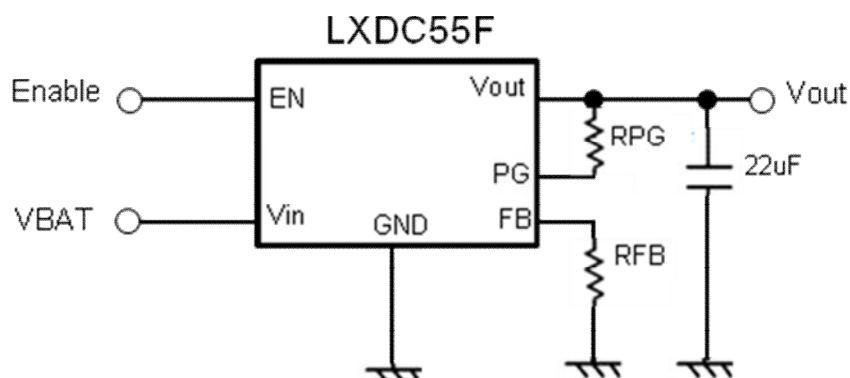
The output voltage of LXDC55F series can be adjusted from 0.8 V to 5.3 V by using a resistor (RFB) between FB pin and GND pin. In terms of resistor value is calculated by  $R_{FB} = 7.28 / (V_{out} - 0.8V) - 1.6$  [kohm]

The LXDC55F series has Power Good Output function. It's to indicate whether the output voltage has reached its appropriate level or not.

The device has an internal soft-start function to control the output voltage slope during start-up.

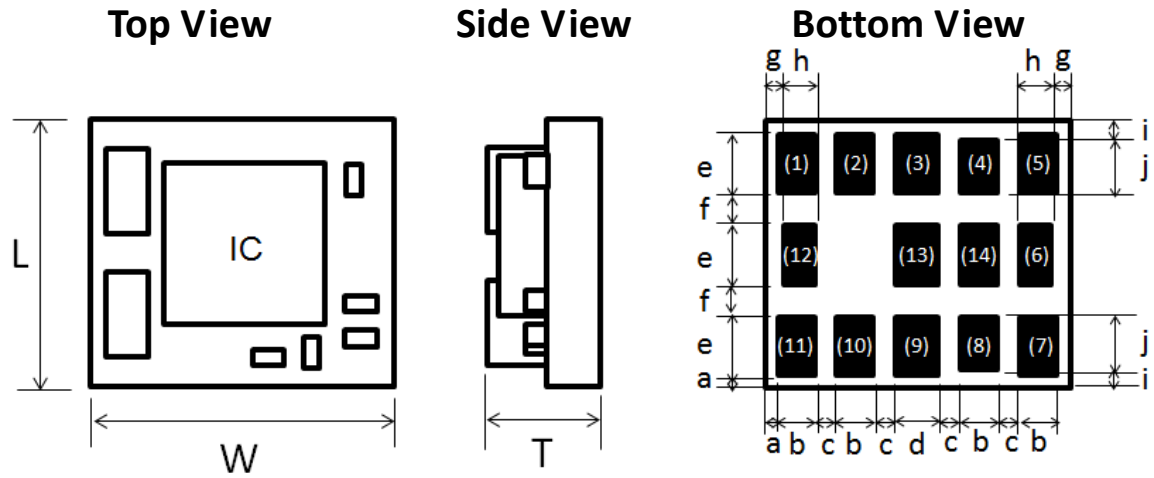
In power-save mode, the devices show quiescent current of about 150  $\mu$ A from VIN. Power-save mode, it enters automatically and seamlessly if load is small, maintains high efficiency over the entire load range.

### 3. Typical Application Circuit



### 4. Mechanical details

#### 4-1 Outline



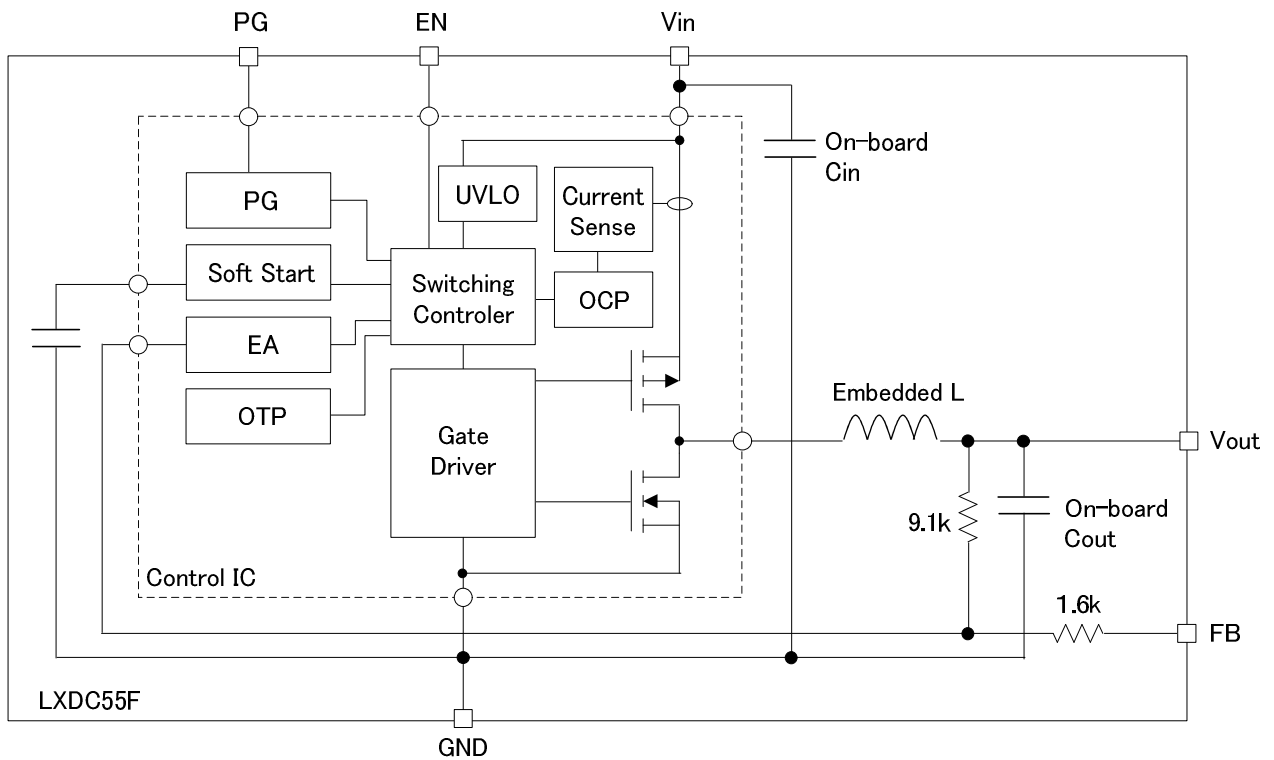
Unit:(mm)

Mark	Dimension	Mark	Dimension
L	5.0 +/- 0.2	e	1.1
W	5.7 +/- 0.2	f	0.6
T	2.1 MAX	g	0.35
a	0.25	h	0.6
b	0.7	i	0.35
c	0.4	j	1.0
d	0.8		

#### 4-2. Pin Function

Pin No.	Symbol	I/O	Description
1	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 0.9V enables the device with soft start. This pin should not be left floating. EN=H: Device ON, EN=L: Device OFF
2	NC	-	No connection
3,4,5	Vin	Input	Vin pin supplies current to the LXDC55F internal regulator.
6,12,13,14	GND	-	Ground pin
7,8,9	Vout	Output	Regulated voltage output pin. Apply output load between this pin and GND.
10	PG	Output	Power good voltage output pin (Open drain). This is to indicate whether the output voltage has reached its appropriate level or not.
11	FB	Input	External resistor connection pin for output voltage setting

### 4-3. Functional Block Diagram



### 5. Ordering Information

Part number	Device Specific Feature	MOQ
LXDC55FAAA-203	Standard Type	T/R, 1,000pcs/R
LXDC55FAAAA203	Standard Type	T/R, 300pcs/R

### 6. Electrical Specification

#### 6-1 Absolute maximum ratings

Parameter	symbol	rating	Unit
Input voltage	$V_{in}$	16	V
Enable voltage	EN	$V_{in}$	V
FB pin voltage	FB	6	V
PG pin voltage	PG	6	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)**

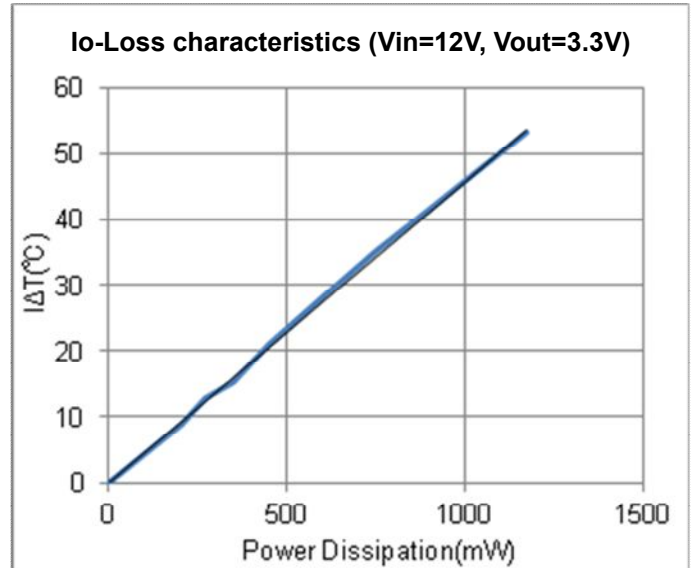
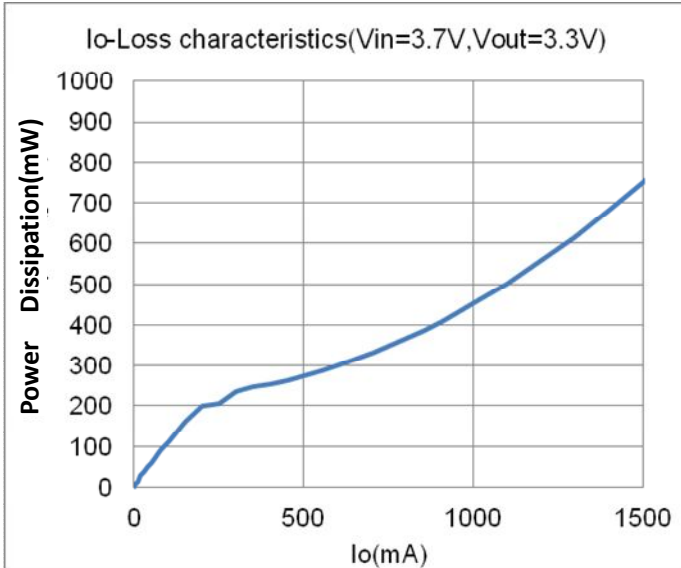
Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Input voltage	Vin		4		14	V
Output voltage range	Vout	Vin-Vout>1V	0.8		5.3	V
UVLO	UVLO	Vin Falling	2.6	2.7	2.8	V
		Hysteresis		200		mV
Standby current	IinOFF	Vin=12V,,EN=0.3V		3	7	uA
Quiescent current	Iin0	Vin=12V, RFB=1312Ω (Vout=3.3V) Iout=0A		150	200	uA
Output voltage accuracy	Vacc	PWM mode	-3.0		+3.0	%
Load current range	Iout		0		1500	mA
Over current protection	OCP	Auto-recovery	1500		3500	mA
Ripple voltage	Vrpl	Vin=12.0V, RFB=1.31kohm, (Vout=3.3V) Iout=1A, BW=100MHz		20		mV
Efficiency	EFF	Vin=12.0V, RFB=1.31kohm, (Vout=3.3V) Iout=1000mA		87		%
EN control voltage	VENH	ON ; Enable	0.9		Vin	V
	VENL	OFF ; Disable	0		0.3	V
Switching frequency	fosc	Vin=12V, RFB=1312Ω (Vout=3.3V) Iout=1000mA		2		MHz
Power good threshold	PGTHH	Output voltage rising		95		%
	PGTHL	Output voltage falling		90		%
Rise time	TSU	Vin=12V, Iout=0A		0,8		msec
Power good sink current	IPG				2	mA

(\*1) External capacitors (Cout: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**

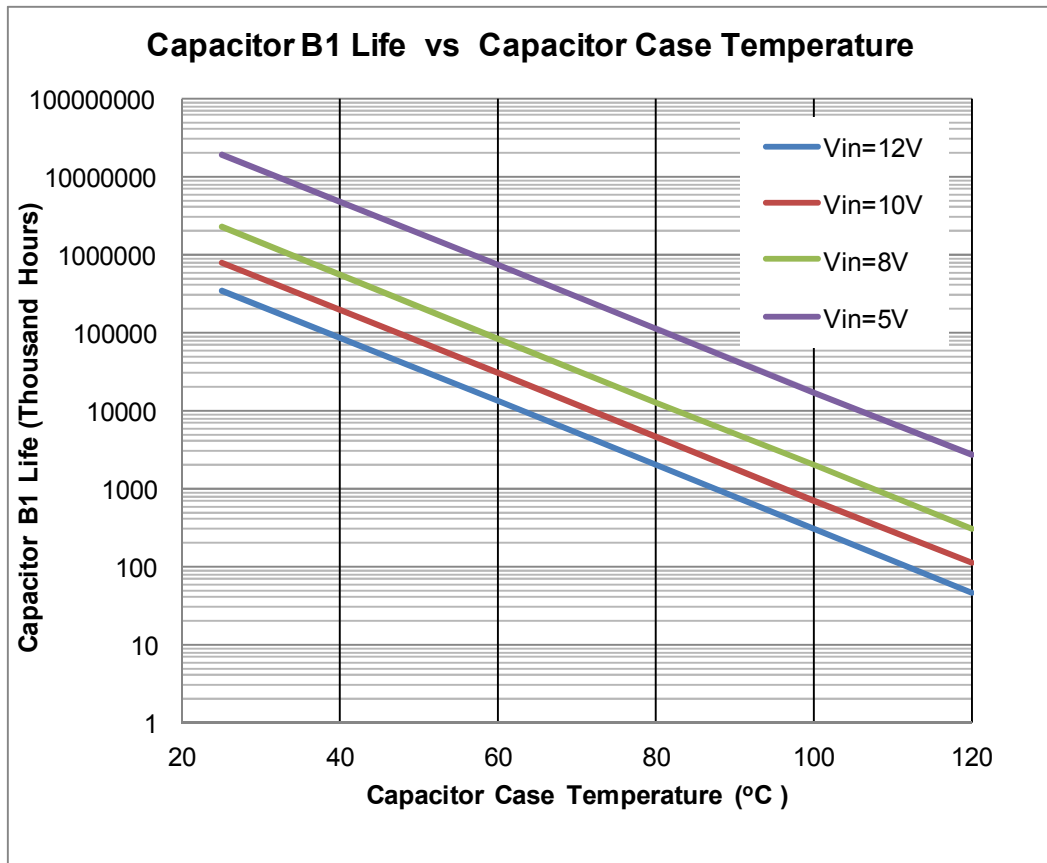
The following figure shows the power dissipation and temperature rise characteristics example. These data are measured on Murata's evaluation board of this device at no air-flow condition.



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 lifetime are also depending 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 a 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

### Adjustable output voltage

The output voltage of LXDC55F series can be adjusted from 0.8 V to 5.3 V by using a resistor (RFB) between FB pin and GND pin. In terms of resistor value is calculated by  $RFB = 7.28/(V_{out}-0.8V) - 1.6$  [kohm].

### Pulse-Width Modulation (PWM) Operation

The LXDC55F series operates with pulse-width modulation in continuous-conduction mode (CCM). The device operates in PWM mode as long the output current is higher than half the inductor ripple current. To maintain high efficiency at light loads, the device enters power-save mode at the boundary to discontinuous conduction mode (DCM). This happens if the output current becomes smaller than half the inductor ripple current.

### Power-Save Mode Operation

The LXDC55F series enters its built-in power-save mode seamlessly if the load current decreases. This secures a high efficiency in light-load operation. The device remains in power-save mode as long as the inductor current is discontinuous. In power-save mode, the switching frequency decreases linearly with the load current, maintaining high efficiency. The transition into and out of power-save mode happens within the entire regulation scheme and is seamless in both directions.

### UVLO (Under Voltage Lock Out)

The input voltage ( $V_{in}$ ) must reach or exceed the UVLO voltage (2.7V<sub>typ</sub>) before the device begins the start up sequence even when the EN pin is kept high. The UVLO function protects against unstable operation at low  $V_{in}$  levels

### Enable

The device starts operation when EN is set high and starts up with soft start. For proper operation, the EN pin must be terminated to logic high and must not left floating. Pulling the EN pin to logic low forces the device shutdown.

### Power Good (PG)

The LXDC55F series has a built-in power-good (PG) function to indicate whether the output voltage has reached its appropriate level or not. It can sink 2mA current and maintain its specified logic-low level.

### 100% Duty Cycle Operation

The duty cycle of the buck converter is given by  $D = V_{out}/V_{in}$  and increases as the input voltage comes close to the output voltage. In this case, the device starts 100% duty-cycle operation, turning on the high-side switch 100% of the time. The high-side switch stays turned on as long as the output voltage is below the internal set point. This allows the conversion of small input-to-output voltage differences, e.g., for longest operation time of battery-powered applications. In 100% duty-cycle mode, the low-side FET is switched off.

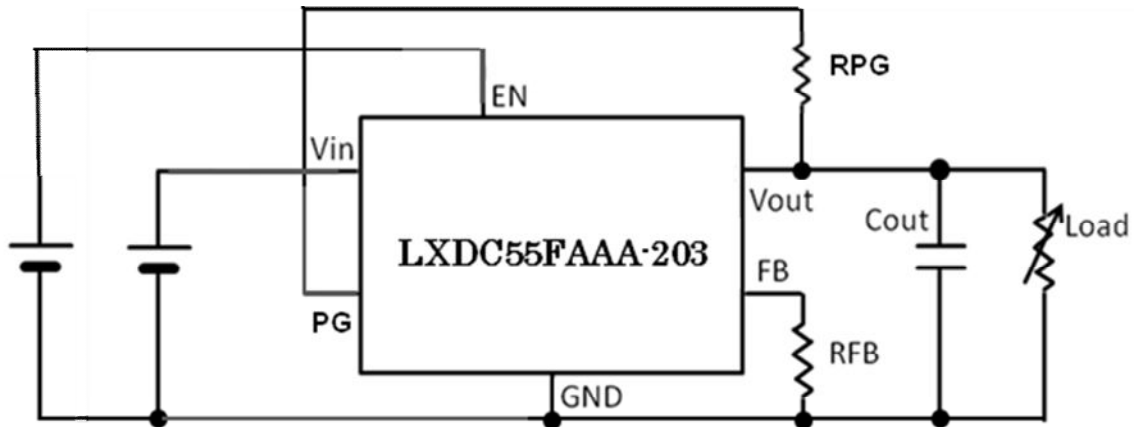
### Over Current Protection

The device integrates a current limit function to protect internal components against heavy load or short circuits. If the OCP event is removed, the output voltage recovers to the nominal value automatically.

### Thermal Shutdown

As soon as the internal IC's junction temperature exceeds 160°C (typ), the device goes into thermal shutdown. The device continues its operation when the Internal IC's junction temperature again falls below 140°C (typ).

## 8. Test Circuit



COUT: GRM21BB30J226 (22uF/6.3V MLCC)

## 9. Output Voltage adjustment

Output voltage can be adjusted by using a resistor (RFB) between FB pin and GND pin.

$$RFB = 7.28 / (V_{out} - 0.8V) - 1.6 \text{ [kohm]}$$

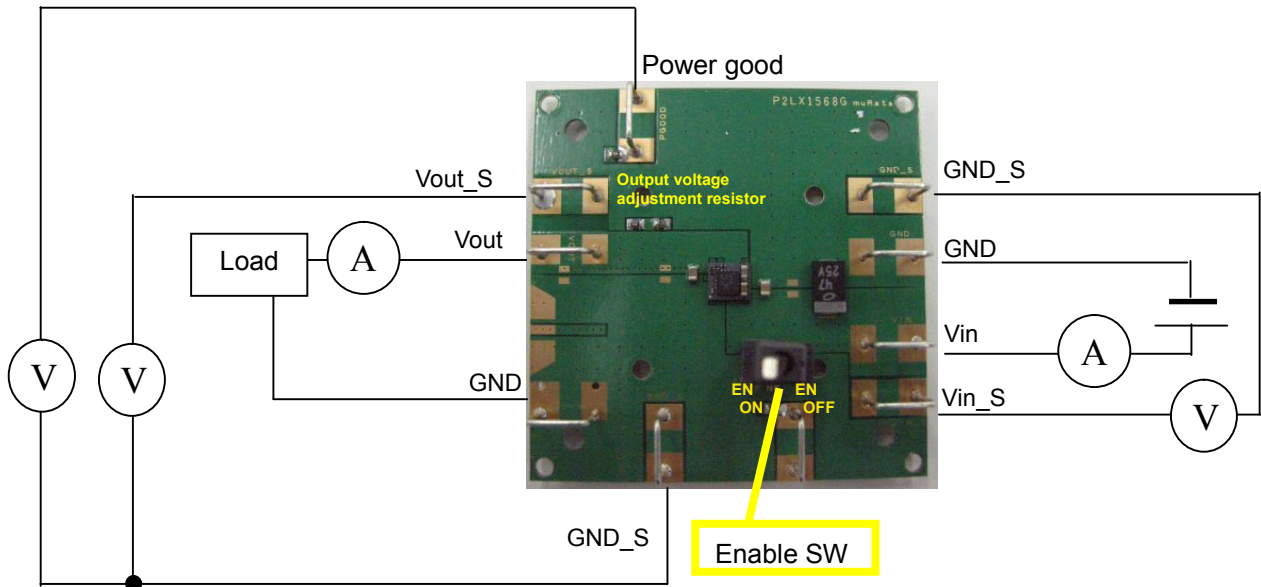
### RFB Example

Vout(V)	RFB(kohm)	Vout(V)	RFB(kohm)
0.8	OPEN	3.0	1.709
1.2	16.60	3.3	1.312
1.5	8.800	3.6	1.000
1.8	5.680	3.9	0.7484
2.5	2.682	5.0	0.1333

## 10. Measurement Data

### Micro DC-DC Converter evaluation board (P2LX1568F)

#### Measurement setup



**\* Evaluation board initial output Voltage setting : 3.3V ( resistor : 1.3k $\Omega$  + 12 $\Omega$  )**

The enable switch has three positions.

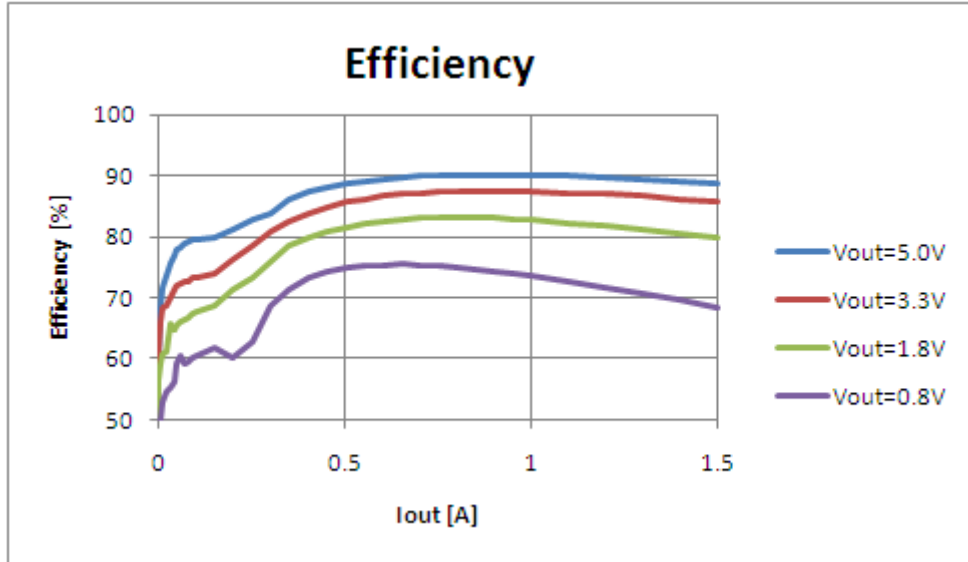
1. When it is toggled to “ON” side, the device starts operation.
2. When it is toggled to “OFF” side, the device stop operation and keep shut down status.
3. When it is set to middle of “ON” and “OFF”, the EN pin becomes floated and can be applied an external voltage through the EN terminal pin on the 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)

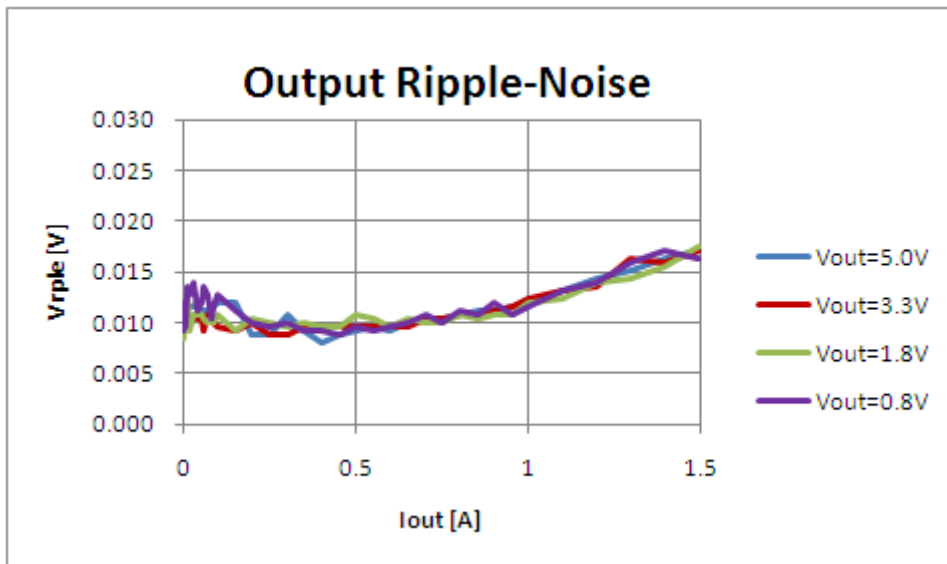
### Efficiency

Vin=12.0V,



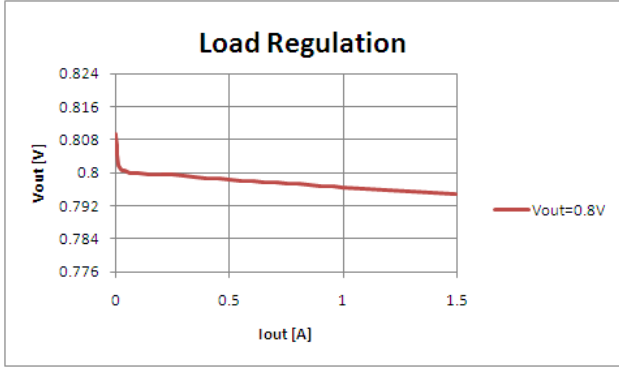
### Output Ripple-Noise

Vin=12.0V, BW : 100MHz

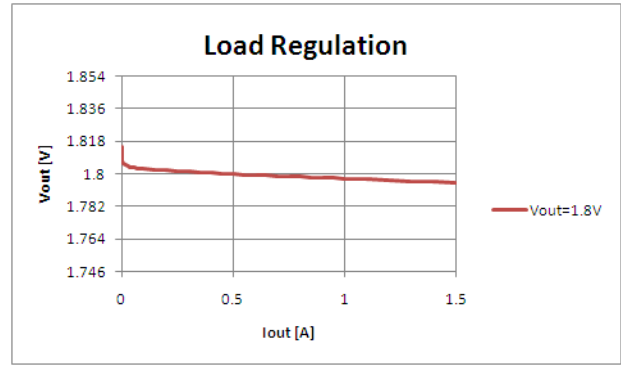


### Load Regulation

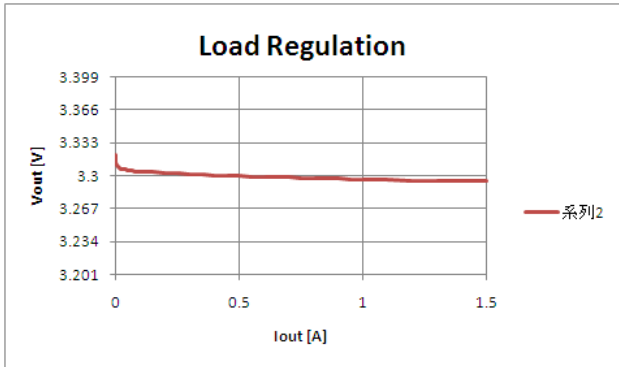
Vin=12.0V, Vout=0.8V



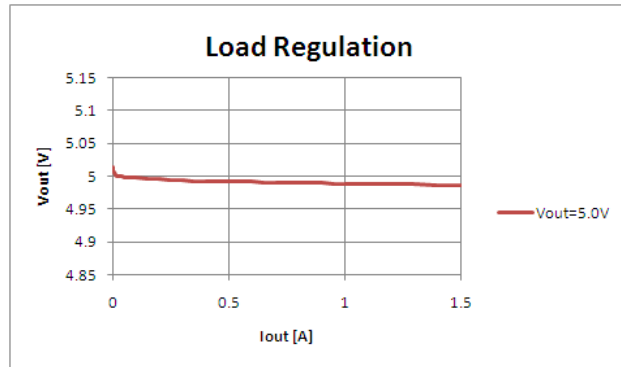
Vin=12.0V, Vout=1.8V



Vin=12.0V, Vout=3.3V

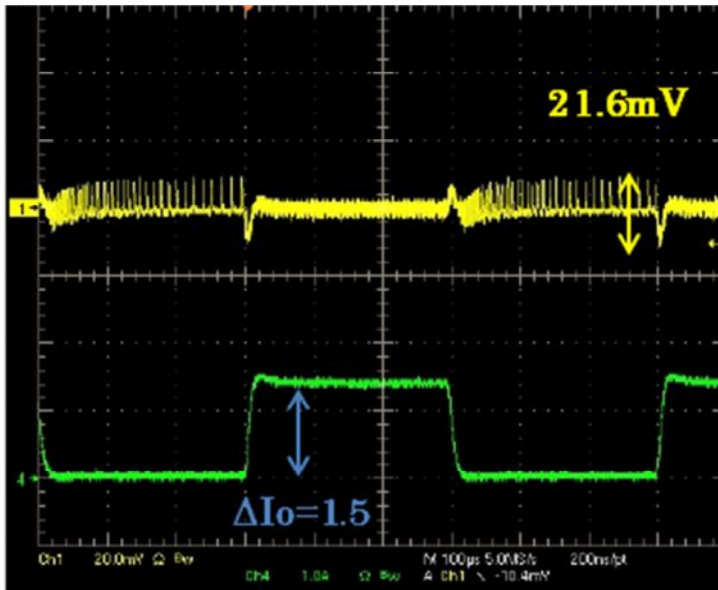


Vin=12.0V, Vout=5.0V

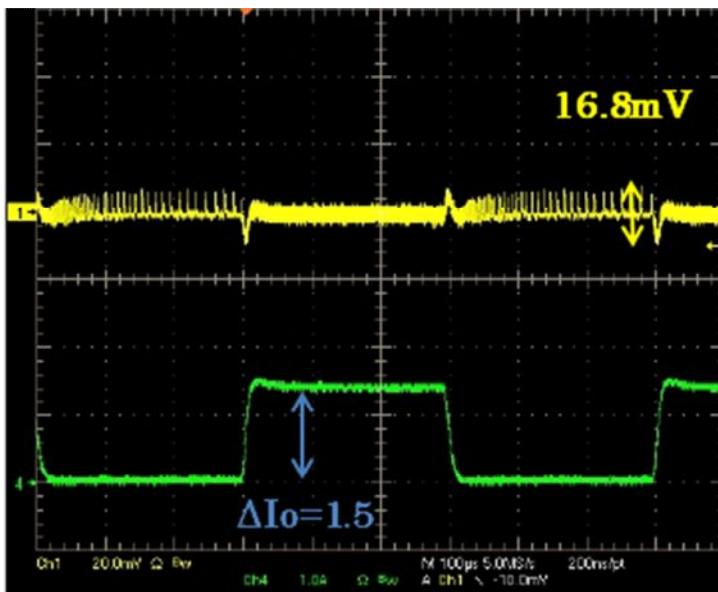


## Load Transient Response

• Vin=12V, Vout=5V

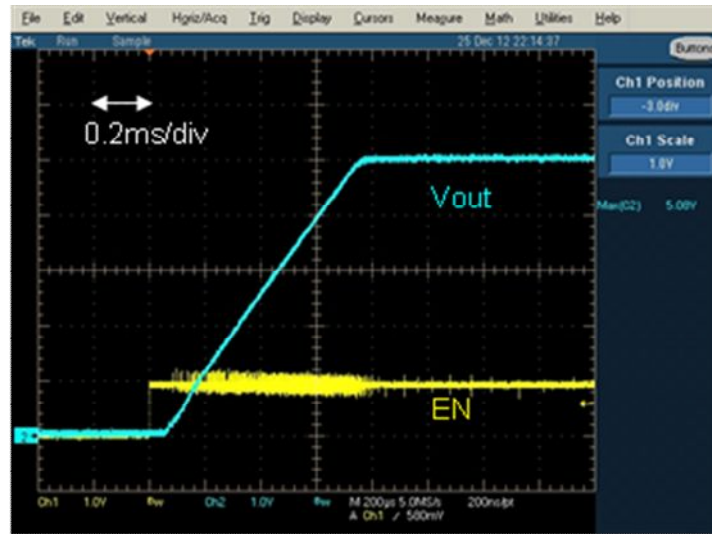


• Vin=12V, Vout=3.3V

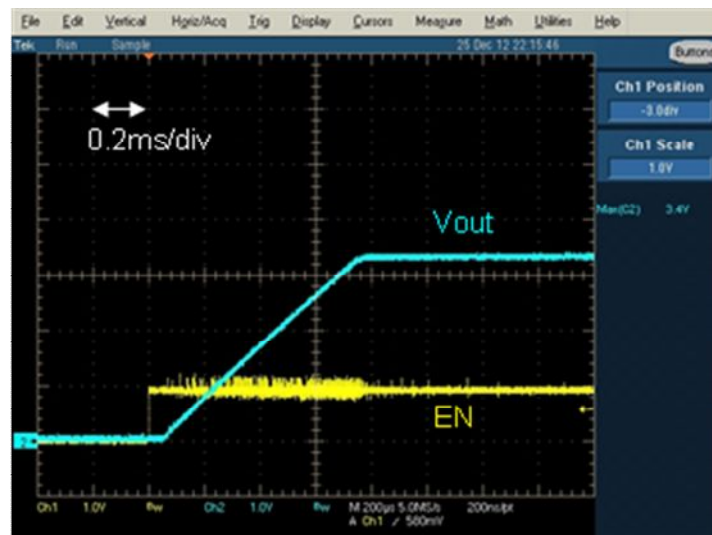


## Start Up Waveform

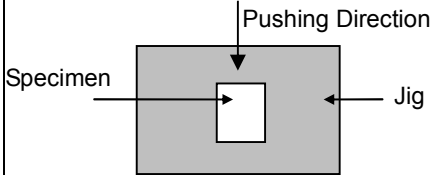
- Vin=12V, Vout=5V



- Vin=12V, Vout=3.3V

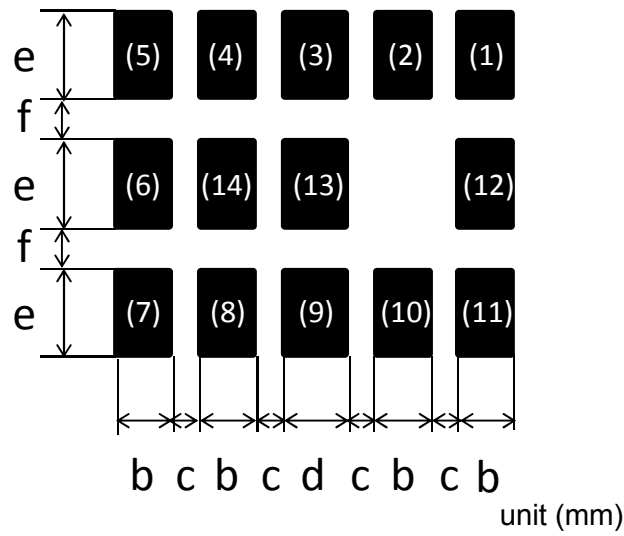


### 11. Reliability Tests

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 <sup>2</sup> 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"> <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)		No severe damages 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

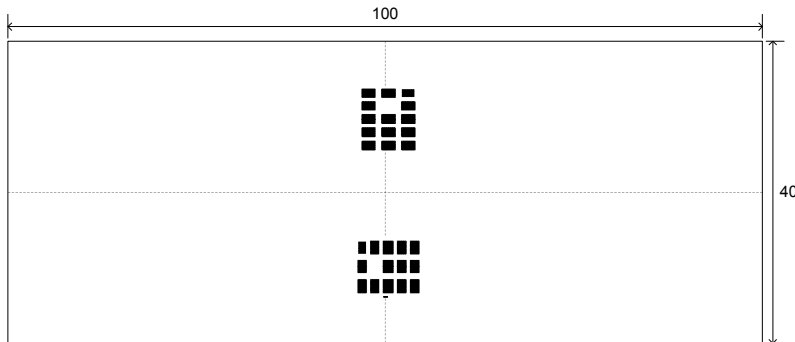


Mark	Dimension
b	0.7
c	0.4
d	0.8
e	1.1
f	0.6

•Reference purpose only.

Fig.2  
Testing board

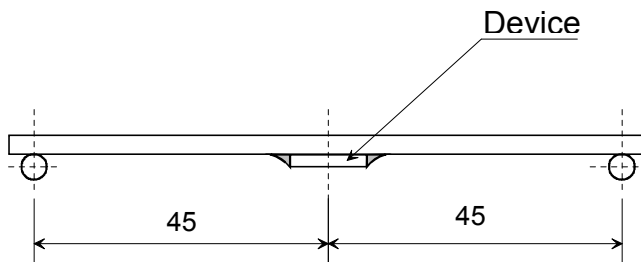
Unit: mm



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

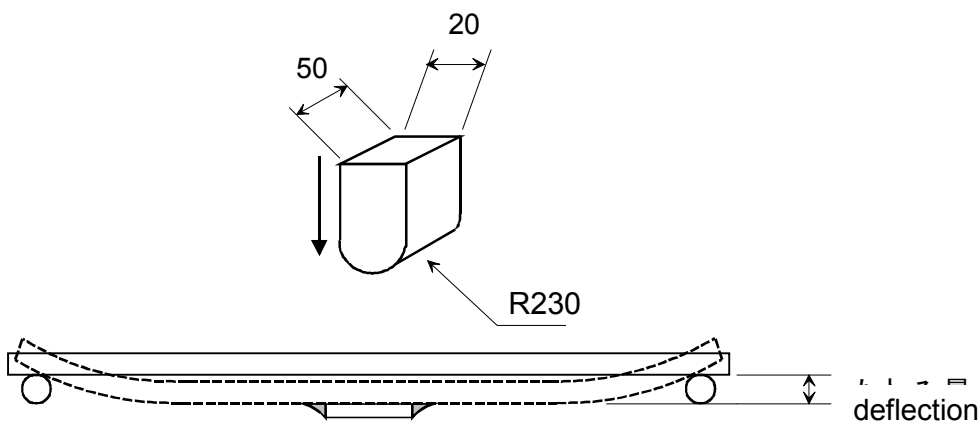
Mounted situation

Unit: mm



Test method

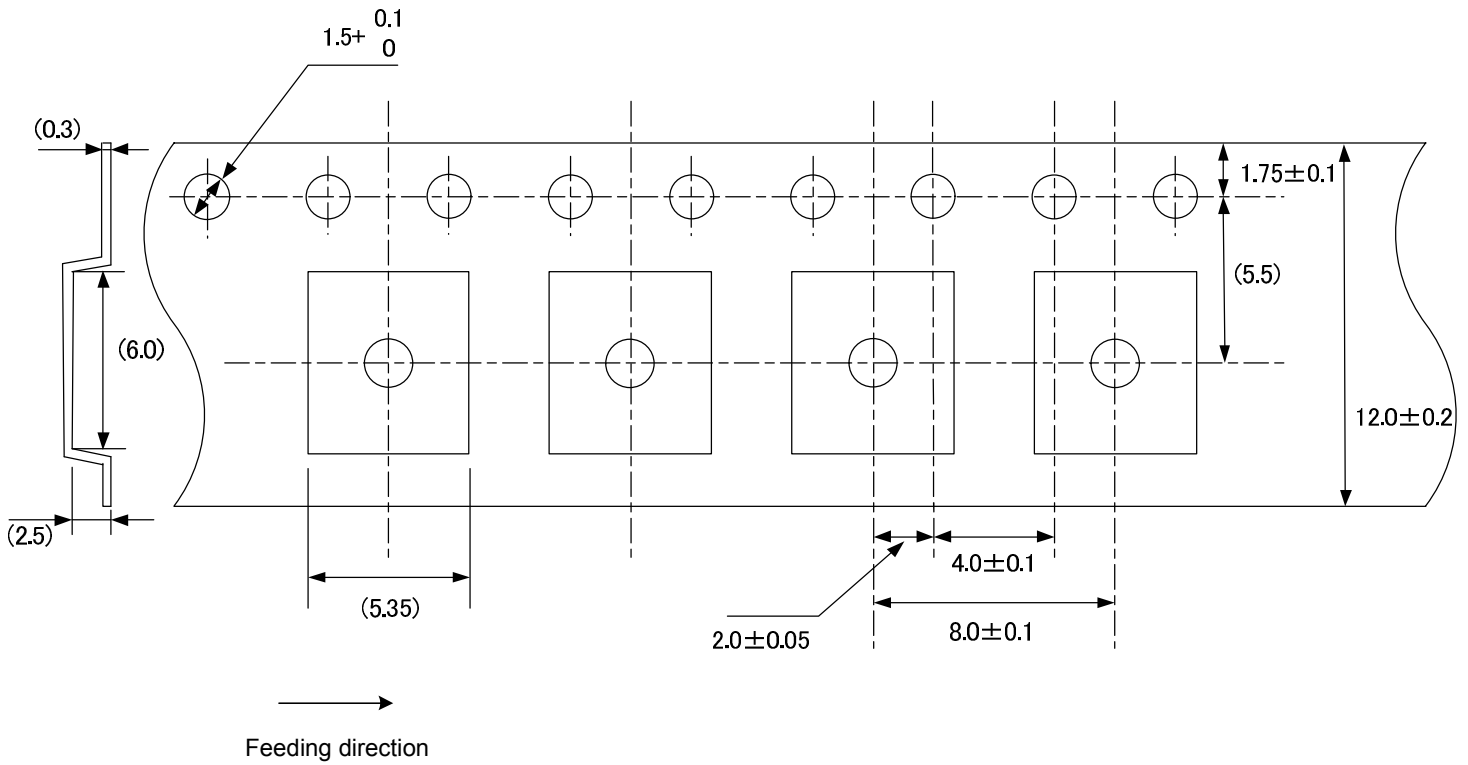
Unit: mm



## 12. Tape and Reel Packing

### 1) Dimensions of Tape (Plastic tape)

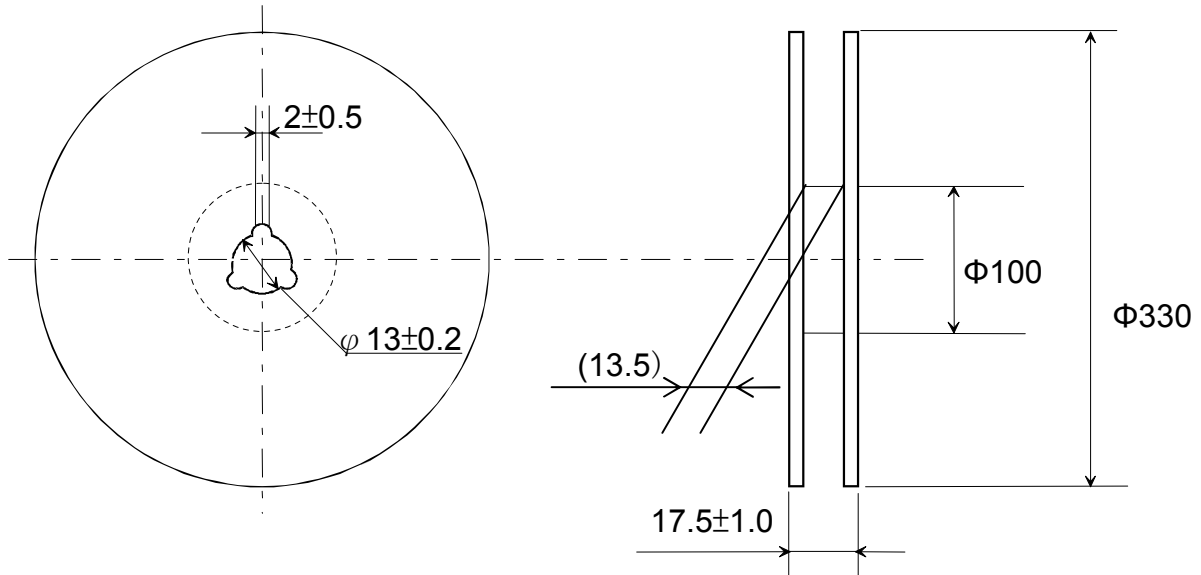
(Unit : mm)



2) Dimensions of Reel

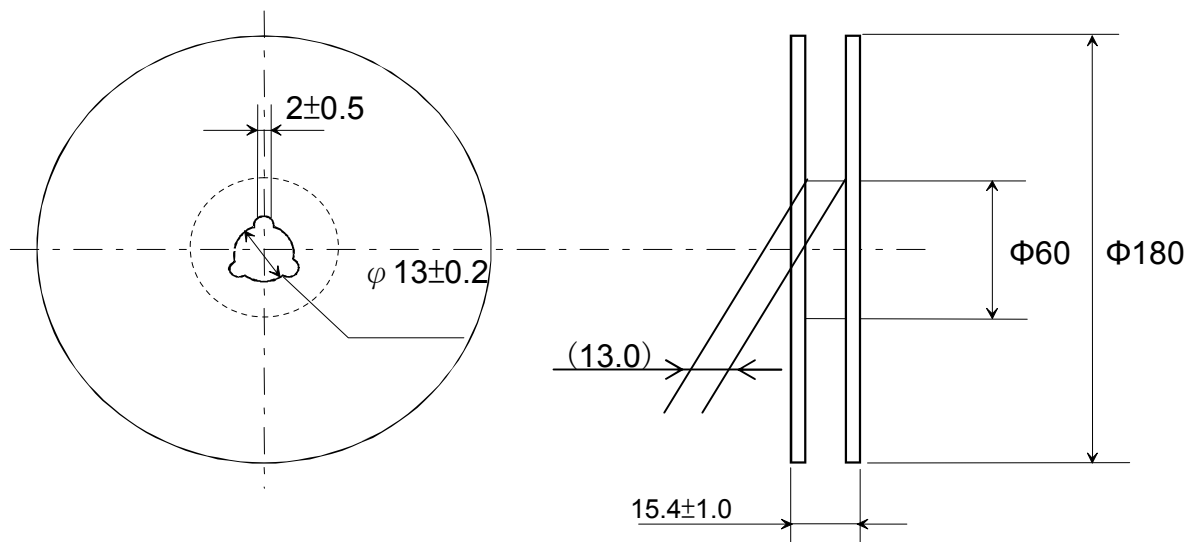
2-1. LXDC55FAAA-203 : 1,000pcs/reel

(Unit : mm)



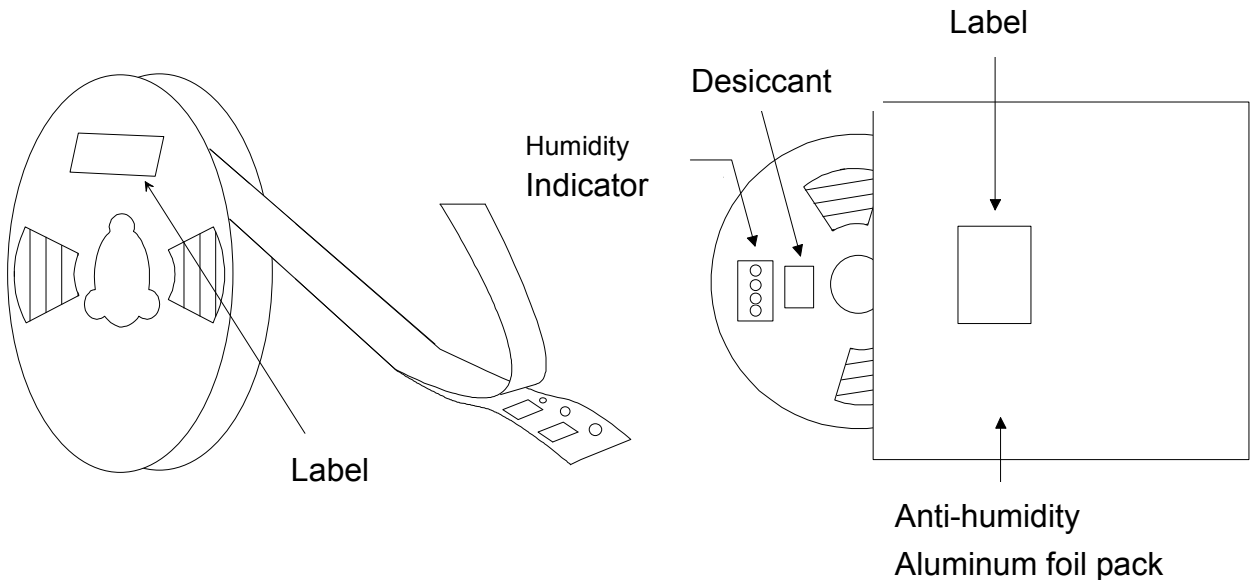
2-2. LXDC55FAAAA203 : 300pcs/reel

Unit: mm

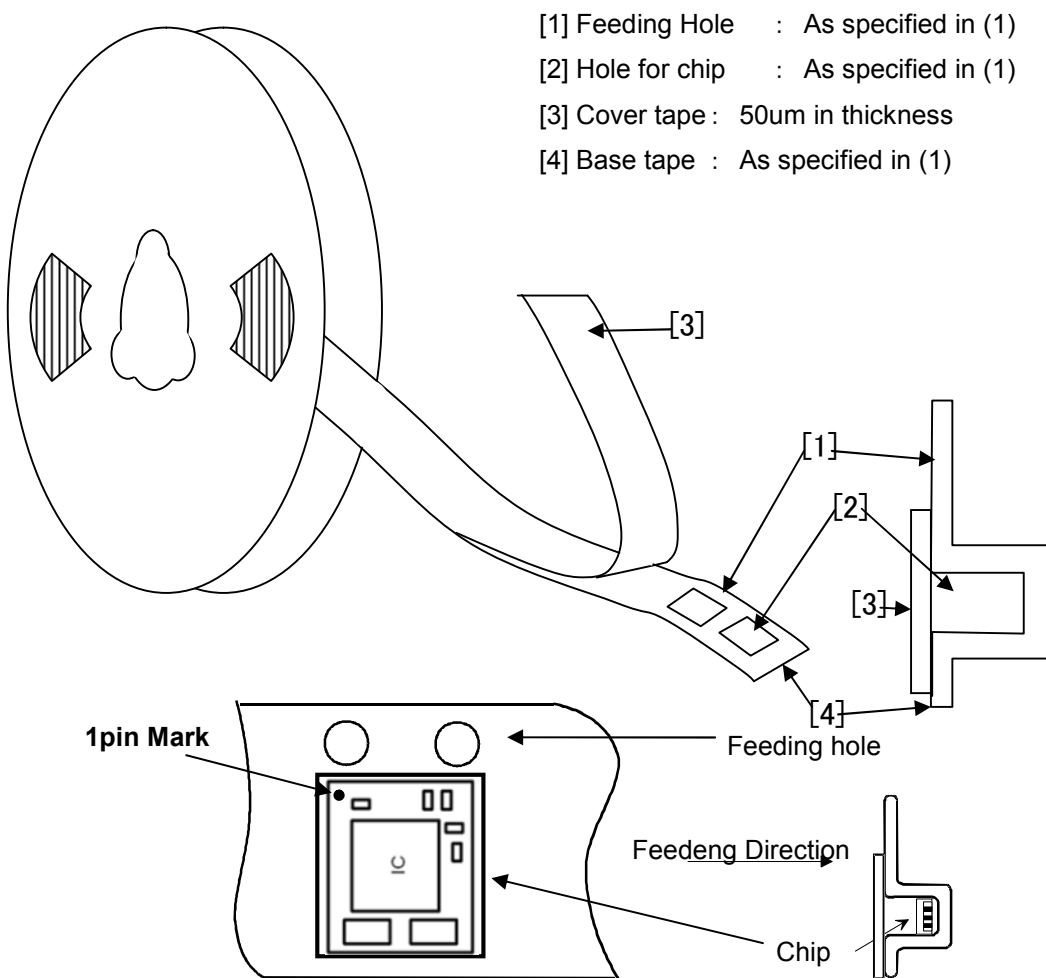


### 3) PACKAGE Diagrams (Humidity proof Packing)

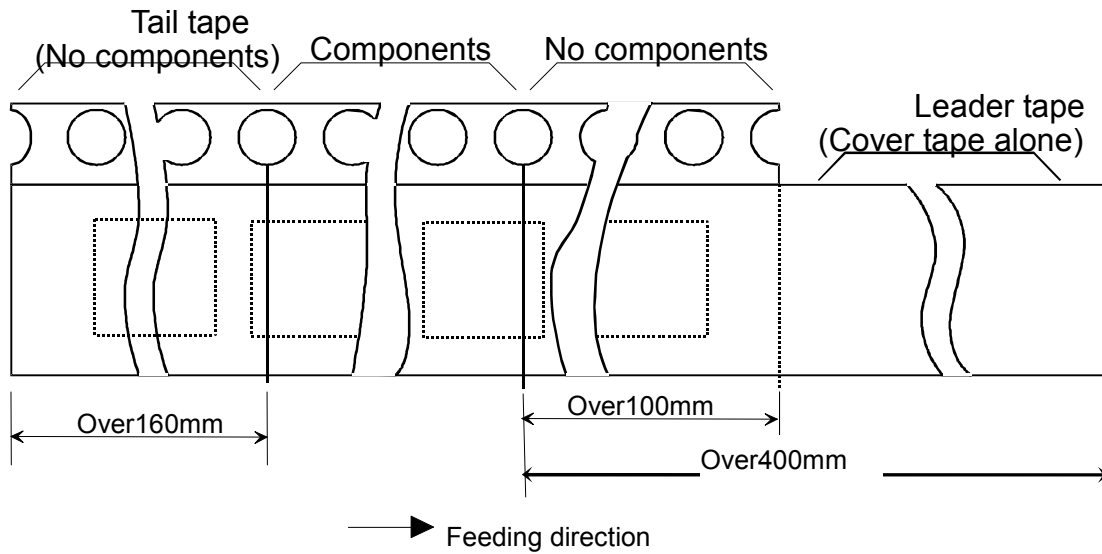
Tape and reel must be sealed with the anti-humidity plastic bag. The bag contains the desiccant and the humidity indicator.



### 4) Taping Diagrams(LXDC55F)



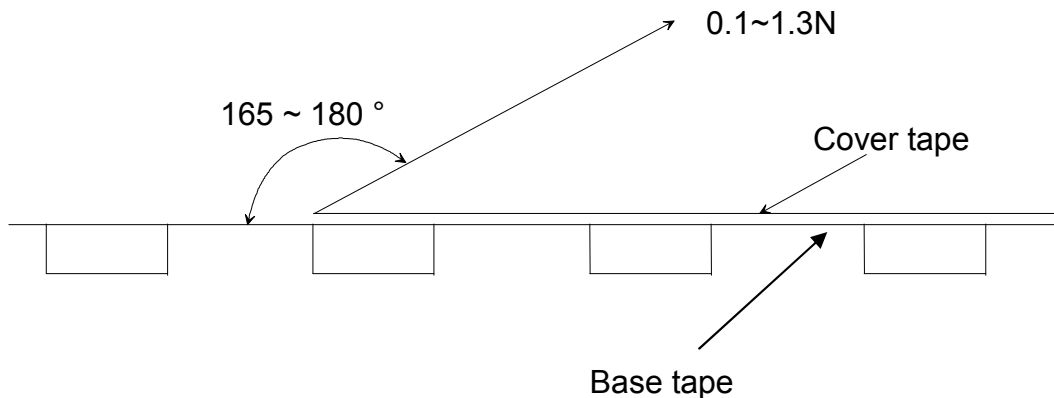
5) Leader and Tail tape



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

7) Material : Base tape ..... Plastic  
 Reel and Cover tape ..... Plastic  
 Base tape, Reel and Cover tape have an anti-ESD function.

8) Peeling of force : 0.1~1.3 N in the direction of peeling as shown below.



## 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 (Cl<sub>2</sub>, NH<sub>3</sub>, SO<sub>2</sub>, NO<sub>x</sub>, 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  $\leq 30$  deg.C /  $\leq 60$  %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.

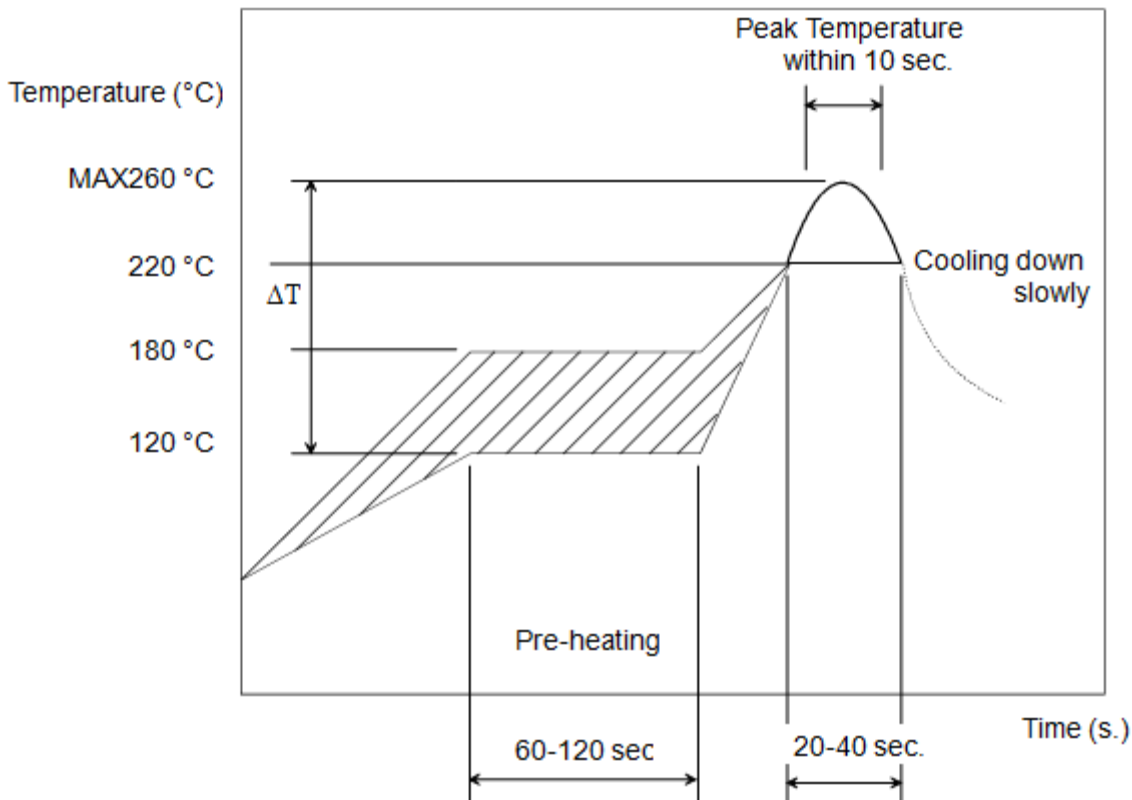
## 4. Soldering Conditions:

Soldering is allowed up through 2 times.

Carefully perform preheating :  $\Delta T$  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 ( Cl<sub>2</sub>, NH<sub>3</sub>, SO<sub>x</sub>, NO<sub>x</sub> 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.