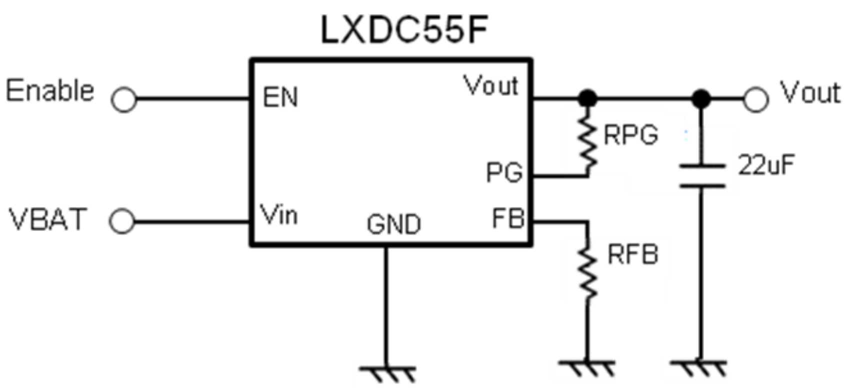
1. Features

- 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 µA (typ.)

2. Description

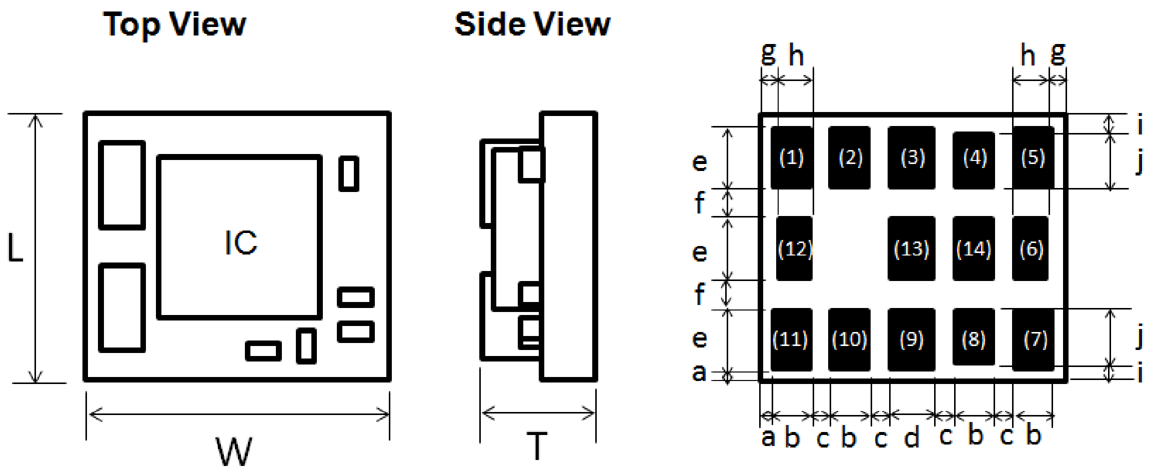
The LXDC55F series is an easy-to-use synchronous step-down dc-dc converter optimized for applications with high power density. The device utilizes an inductor-embedded ferrite substrate, and the substrate eliminates radiated EMI noise and conduction noise efficiently.
With its wide operating input voltage 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 a superior load transient response. It has a unique circuit that keeps the switching frequency nearly constant, which makes it easy to filter the switching noise.
The output voltage of the LXDC55F series can be adjusted from 0.8 V to 5.3 V by using a resistor (RFB) between the FB pin and the GND pin. The resistor value is calculated by the following equation: RFB = 7.28/(Vout-0.8V) – 1.6 [kohm]
The LXDC55F series has a Power Good Output function. This is used 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 a quiescent current of about 150 µA from VIN. It enters automatically into Power-save mode seamlessly if the load is small and maintains high efficiency over the entire load range.

3. Typical Application Circuit



4. Mechanical details

4-1 Outline



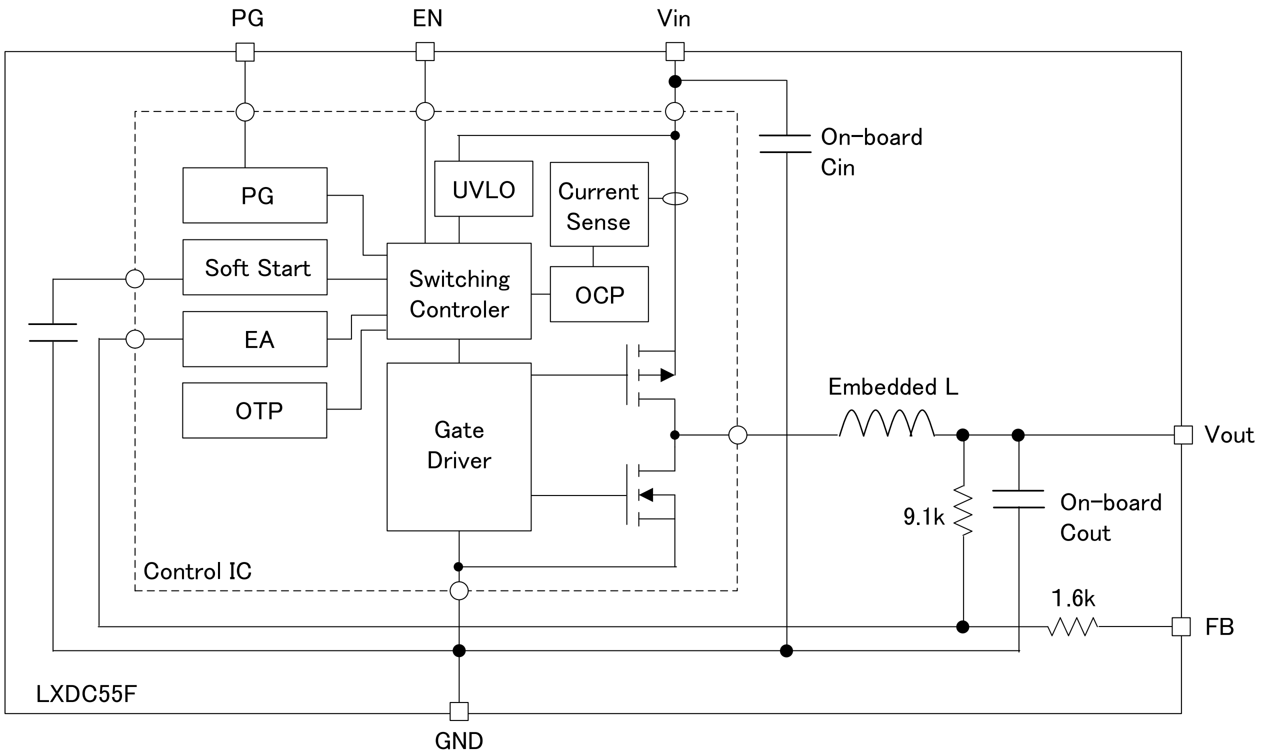
Unit:(mm)

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 mode when the voltage to this pin is below 0.3V. Pulling this pin above 0.9V turns on the device with a 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	The 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

6. Electrical Specification

6-1 Absolute maximum ratings

Parameter	symbol	rating	Unit
Input voltage	Vin, EN	16	V
Operating Ambient temperature	Ta	-40 to +85	^{o}C
Operating IC temperature	T_{IC}	-40 to +125	^{o}C
Storage temperature	T_{STO}	-40 to +85	^{o}C

6-2 Electrical characteristics (Ta=25℃)

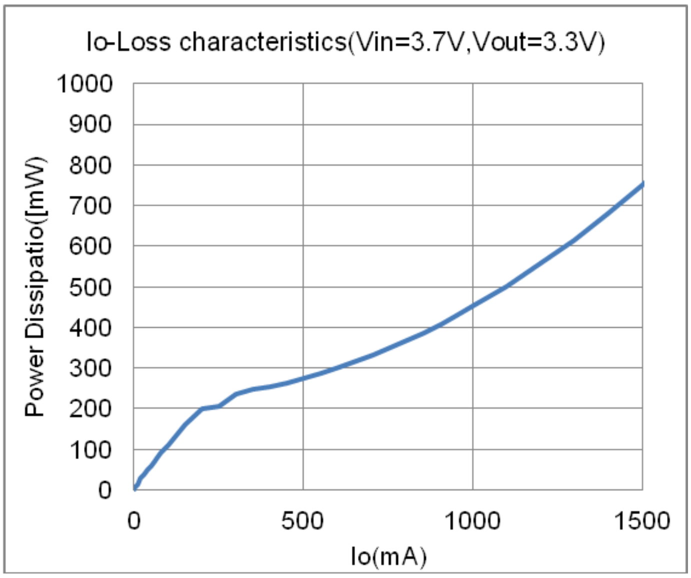
Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Input voltage	Vin		4		14	V
Output voltage range	Vout		0.8		5.3	V
UVLO	UVLO	Vin Falling	2.6	2.7	2.8	V
		Hysteresis		200		mV
Standby current	IinOFF	Vin=12V,,EN=0.3V		3	7	uA
Quiescent current	Iin0	Vin=12V, RFB=1312Ω (Vout=3.3V) Iout=0A		150	200	uA
Output voltage 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, BW=100MHz		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		%
Power good sink current	IPG				2	mA
External output capacitor(*1)	Cout		22		150	uF

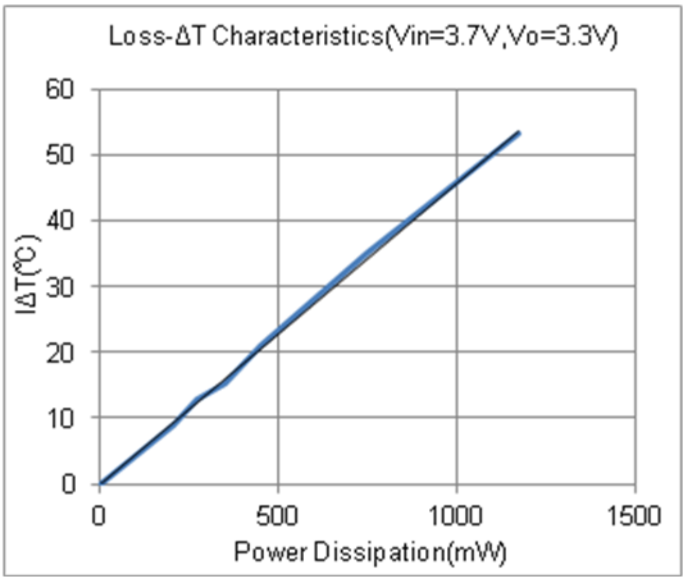
(*1) External capacitors (Cout≧22uF) should be placed near the module in order to properly operation.

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

6-3 Thermal and Current De-rating Information

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

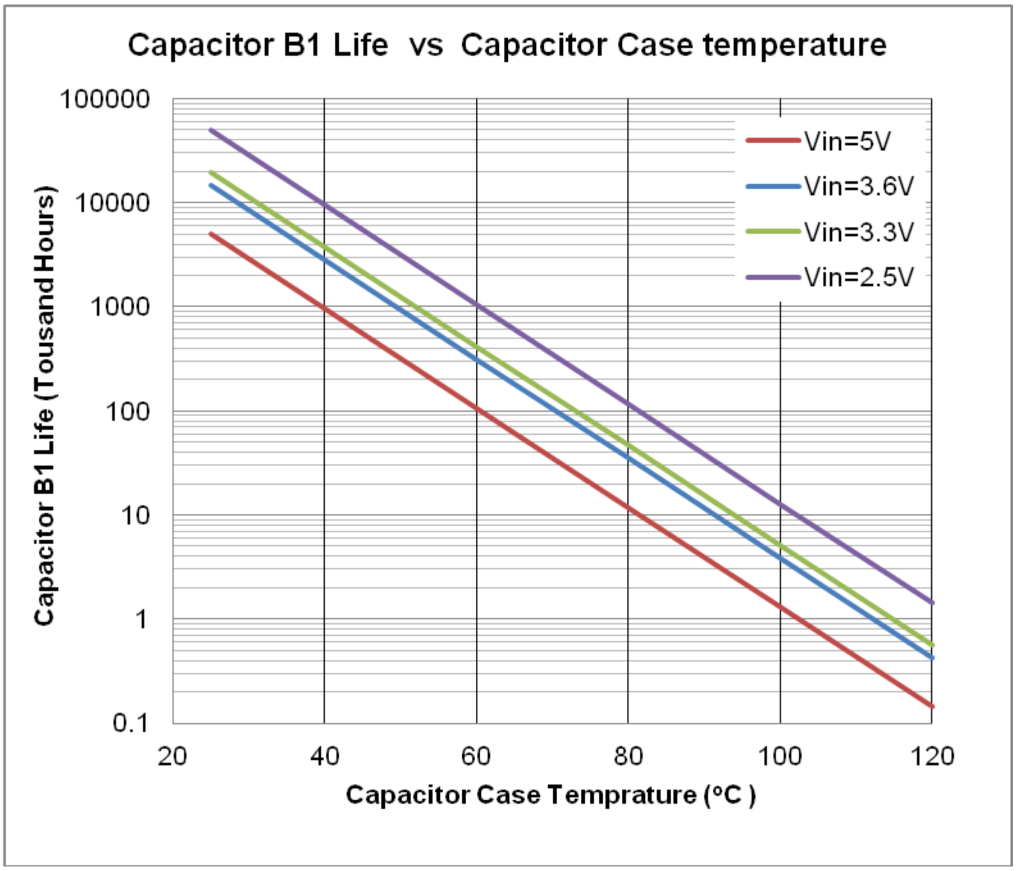




The output current of the device may need to be de-rated if it is operated in high ambient temperature or in an application that requires continuous power delivery. The amount of current de-rating is highly dependent on the environmental thermal conditions, e.g., PCB design, nearby components or effective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

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

MLCC capacitors' reliability and lifetime are also dependent on temperature and applied voltage stress. Higher temperature and/or higher voltage cause shorter lifetime of the 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 the MLCC capacitor is not reversible but cumulative over time.



The following steps should be taken before the designing 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

Adjustable output voltage

The output voltage of the LXDC55F series can be adjusted from 0.8 V to 5.3 V by using a resistor (RFB) between the FB pin and GND pin. The resistor value is calculated by the following equation: RFB = 7.28/(Vout-0.8V) – 1.6 [kohm].

Pulse-Width Modulation (PWM) Operation

The LXDC55F series operates in 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 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 (Vin) must reach or exceed the UVLO voltage (2.7Vtyp) before the device begins the start up sequence even when the EN pin stays high. The UVLO function limits unstable operation at a low Vin range

Enable

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

100% Duty Cycle Operation

The duty cycle of the buck converter is given by D = Vout/Vin and increases as the input voltage comes close to the output voltage. In this case, the device starts at 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 for the longest operation time of battery-powered applications. In 100% duty-cycle mode, the low-side FET is switched off.

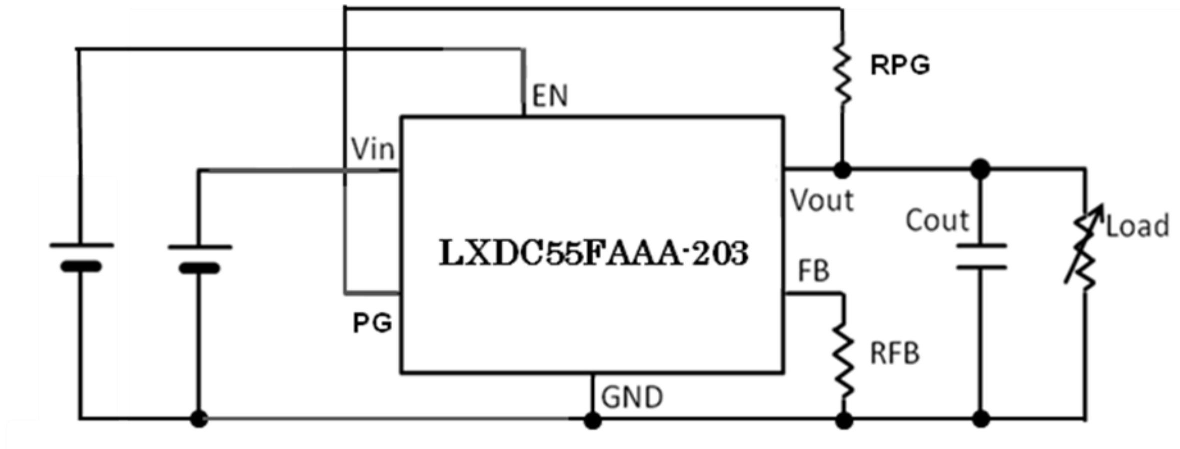
Over Current Protection

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

Thermal Shutdown

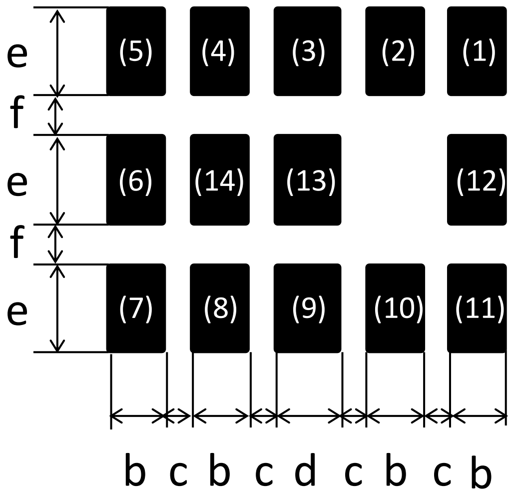
As soon as the internal IC's junction temperature exceeds 160℃ (typ), the device goes into thermal shutdown. The device continues its operation when the Internal IC's junction temperature again falls below 140℃ (typ).

8. Test Circuit



COUT: GRM21BB30J226 (22uF/6.3V MLCC)

9. Reference Land Pattern



unit (mm)

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

10. Output Voltage adjustment

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

RFB = 7.28/(Vout-0.8V) – 1.6 [kohm]

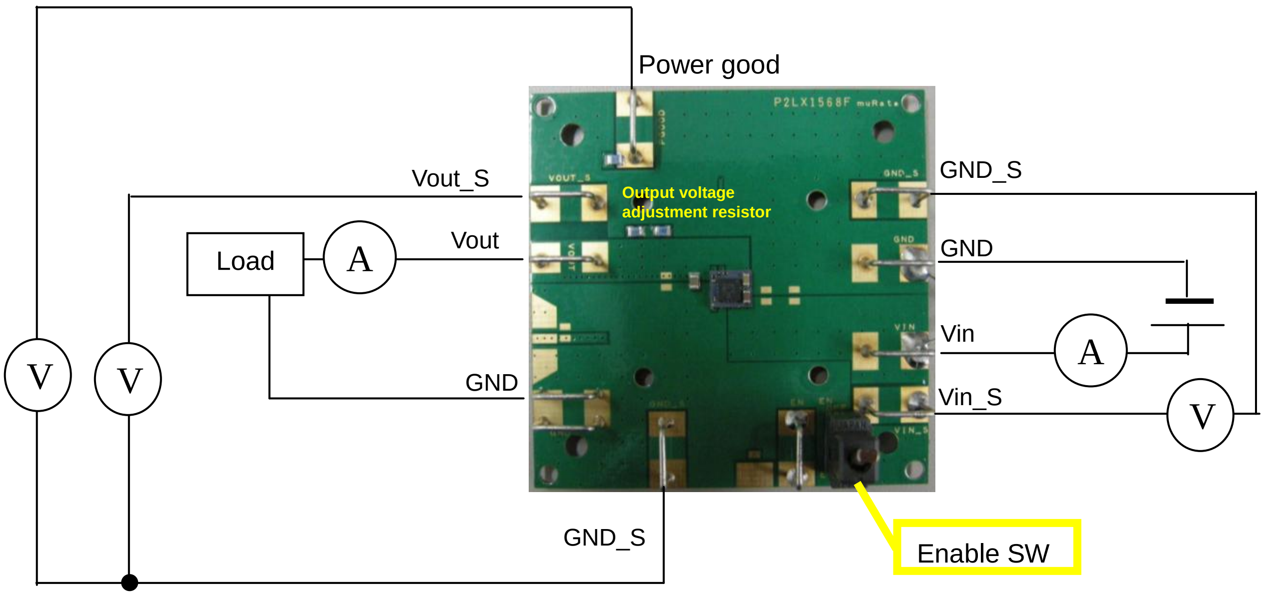
RFB Example

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

11. Measurement Data

Micro DC-DC Converter evaluation board (P2LX1568F)

Measurement setup



*** Evaluation board initial output Voltage setting : 3.3V (resistor : 1.3kΩ + 12Ω)**

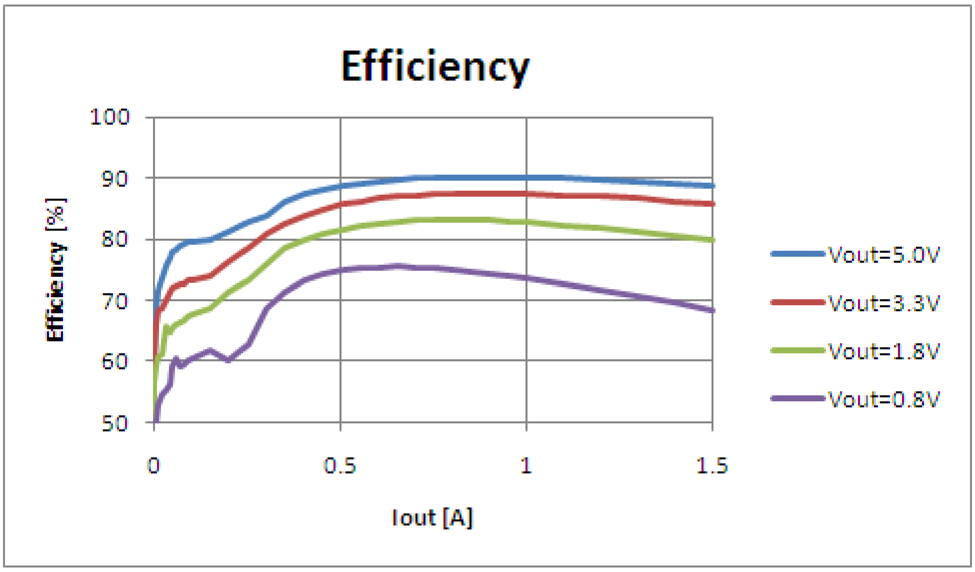
The enable switch has three positions.

1. When it is toggled “ON”, the device starts operation.
2. When it is toggled “OFF”, the device stops operation and shuts down.
3. When it is set to the middle of “ON” and “OFF”, the EN pin becomes floating and can have an external voltage applied through the EN terminal pin on the EVB. If you don’t apply an external voltage to the EN pin, the enable switch should not to be set to the middle position.

Typical Measurement Data (reference purpose only)　(Ta=25℃)

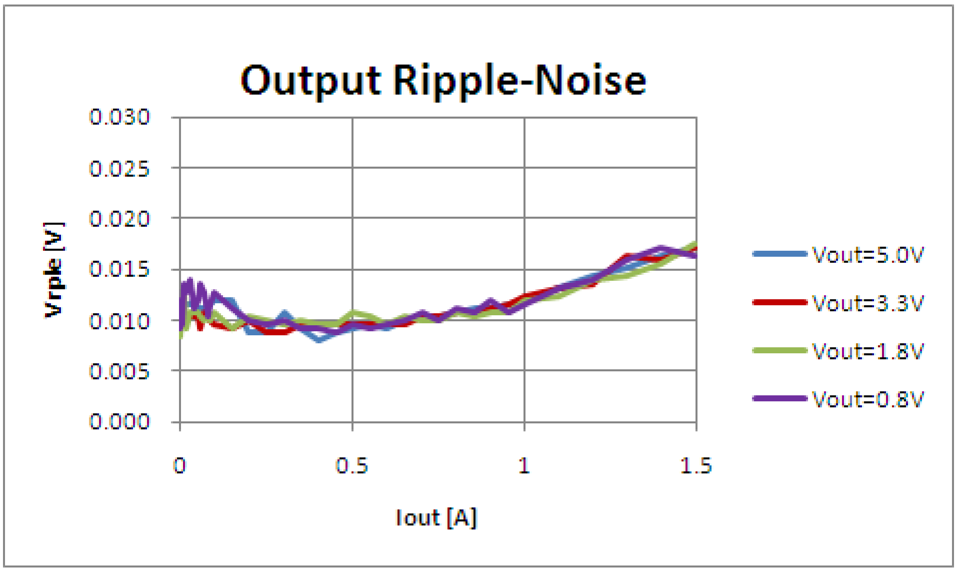
Efficency

Vin=12.0V,



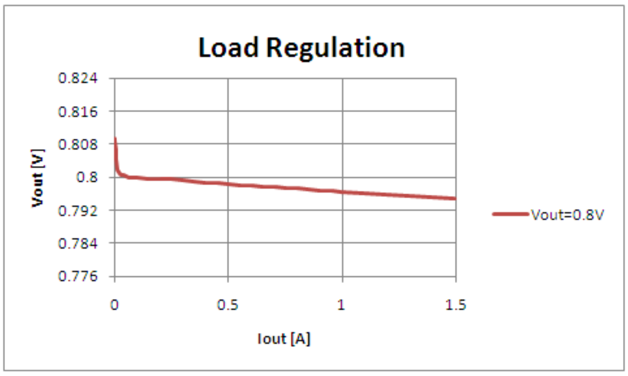
Output Ripple-Noise

Vin=12.0V,　BW : 100MHz

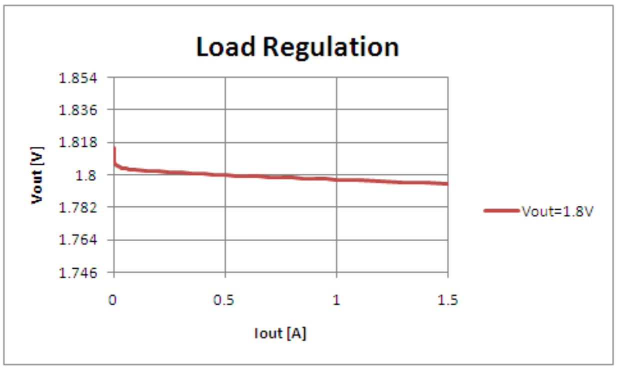


Load Regulation

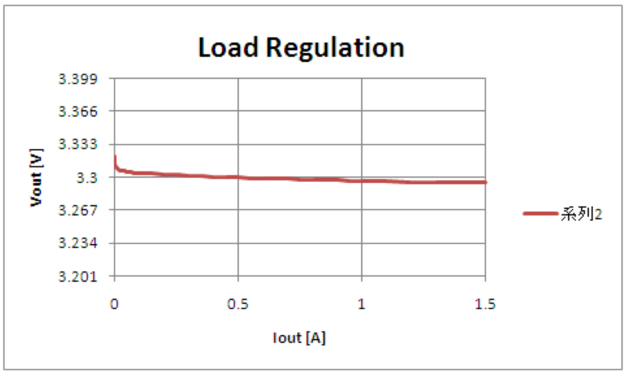
Vin=12.0V, Vout=0.8V



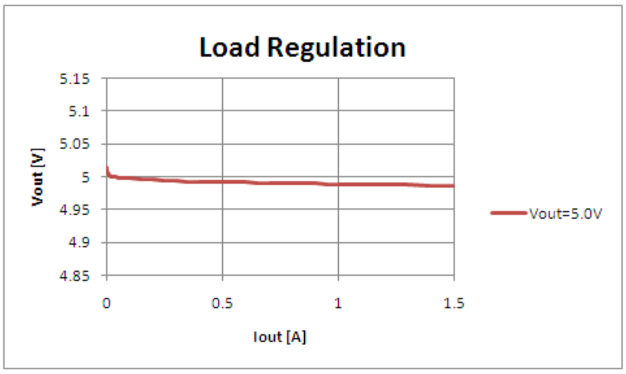
Vin=12.0V, Vout=1.8V



Vin=12.0V, Vout=3.3V

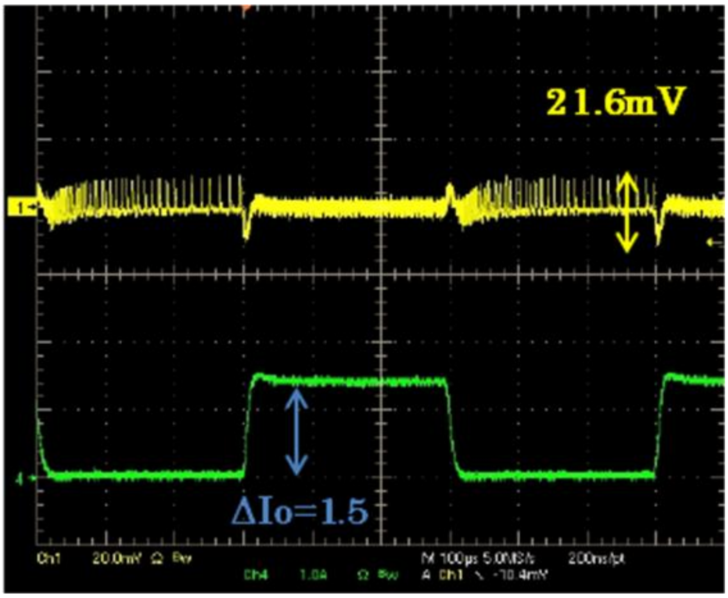


Vin=12.0V, Vout=5.0V

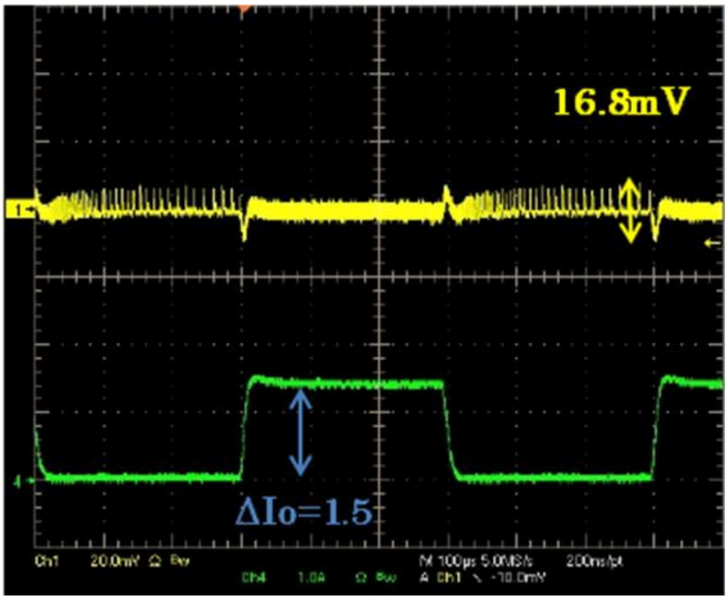


Load Transient Response

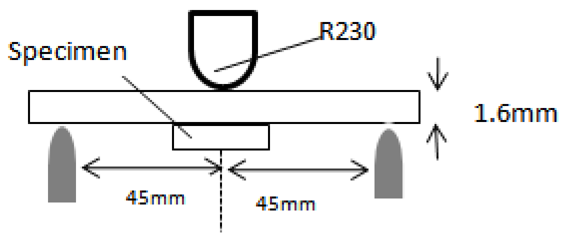
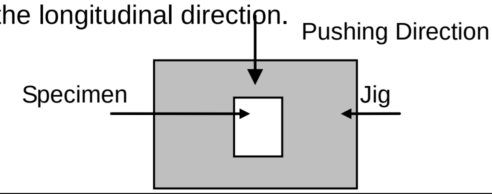
・Vin=12V, Vout=5V



・Vin=12V, Vout=3.3V



12.Reliability Tests

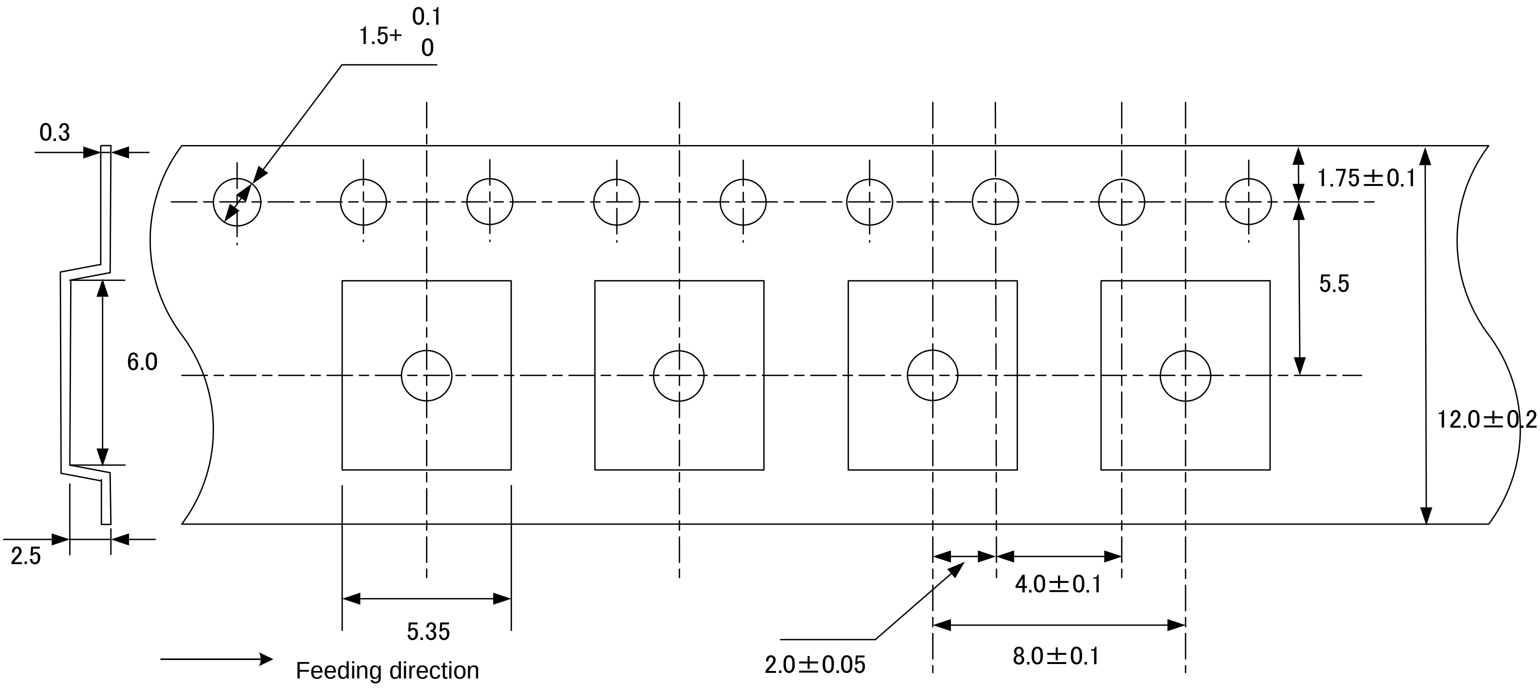
No.	Items	Condition	Number	Result (Fail)
1	Vibration Resistance	Frequency : 10~2000 Hz Acceleration : 196 m/s2 Direction : X,Y,Z 3 axis Period : 2.5h on each	18	G (0)
2	Shock	Acceleration : 980m/s2 Period : 6 ms. Cycle : 6direction x 3 times	18	G (0)
3	Deflection	Solder specimens on the testing jig (glass epoxy boards) are shown in the figure. No damage with 1.6mm deflection 	18	G (0)
4	Soldering strength (Push Strength)	Solder specimens on the test jig are shown below. Apply pushing force at 10N and increase the force until the electrode pads are peeled off or the ceramics are broken. The pushing force is applied in the longitudinal direction. 	18	G (0)
5	Solderability of Termination	75% of the terminations are to be soldered evenly and continuously.	18	G (0)
6	Heat Shock	Temperature: -40°C 30min , 85°C 30min Period :30min on each Cycle :100 times	18	G (0)
7	High Temp Exposure	Temperature:85°C Period :1000h	18	G (0)
8	Low Temp Exposure	Temperature:-40°C Period :1000h	18	G (0)
9	Humidity（Steady State）	Temperature:85°C Humidity:85%RH Period :1000h	18	G (0)

No	Items	Condition	Number	Result (Fail)
10	ESD(Machine Model)	C：200pF、R：0Ω TEST Voltage ：+/-200V	18	G (0)
11	ESD(Human Body Model)	C：100pF、R：1500Ω TEST Voltage ：+/-2000V	18	G (0)
12	ESD(Charged Machine Model)	Confirming to JEITA4701 300-2 TEST Voltage ：+/-500V	18	G (0)

13. Tape and Reel Packing

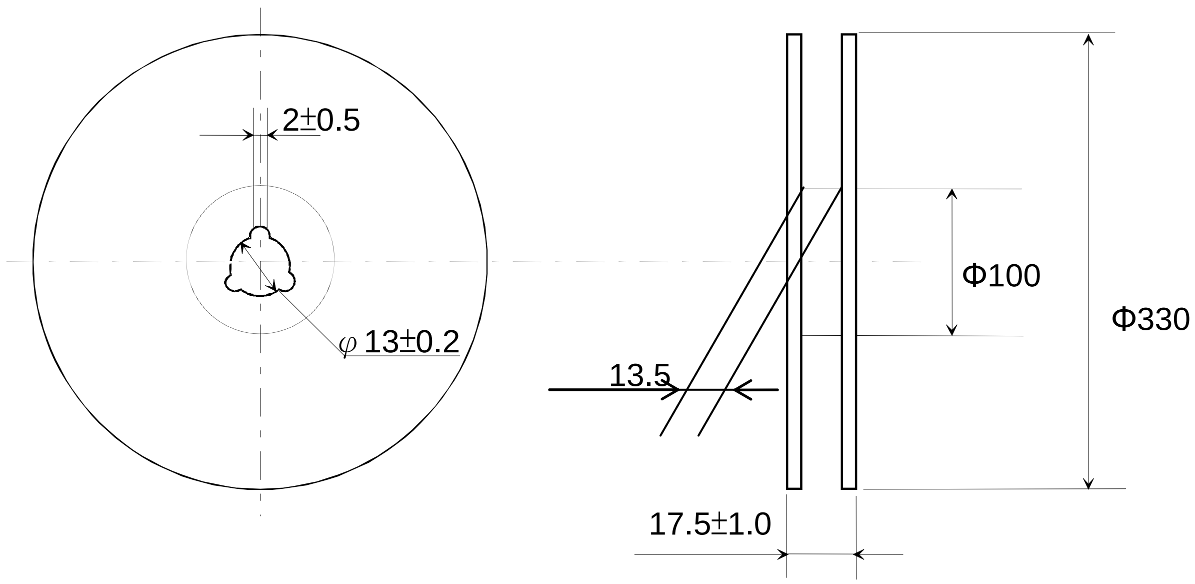
1) Dimensions of Tape (Plastic tape)

(Unit : mm)



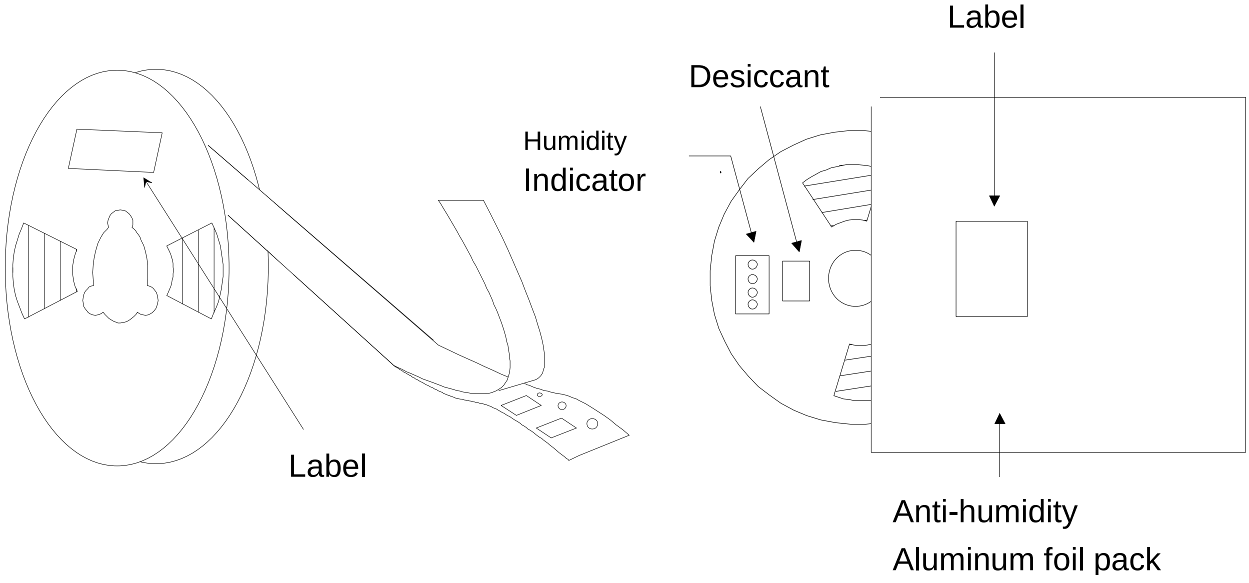
2) Dimensions of Reel

(Unit : mm)



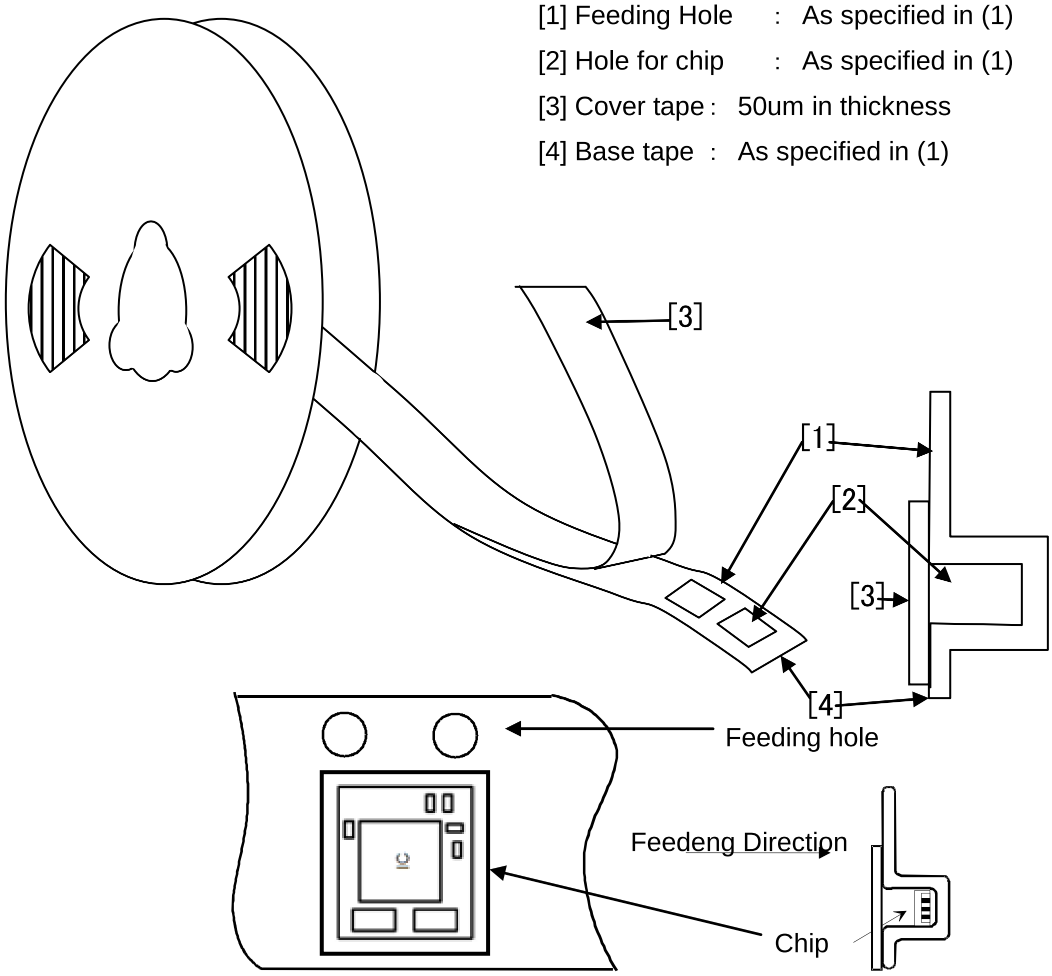
3) PACKAGE Diagrams (Humidity proof Packing)

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

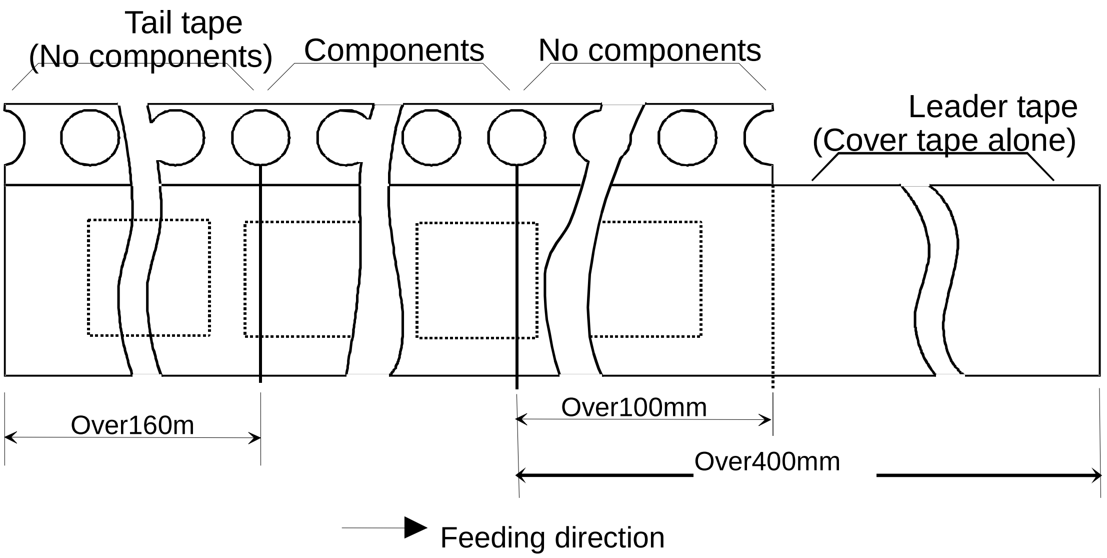


4) Taping Diagrams**(LXDC55F)**

[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)



5) Leader and Tail tape

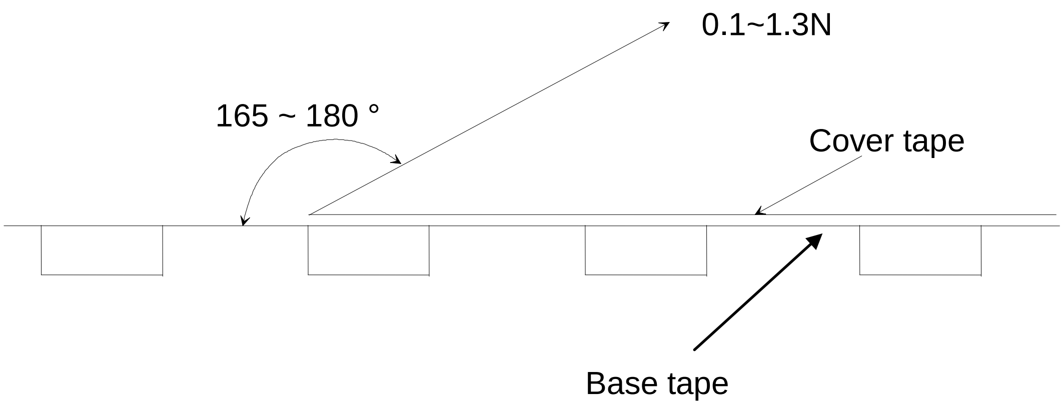


6) The tape for modules is wound clockwise with the feeding holes to the right side as the tape is pulled towards the user.

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

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

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



NOTICE

1. Storage Conditions:

To maintain the solderability of the external electrodes, be sure to observe the following points.

- The product should be stored unopened under the following conditions.
  Ambient temperature : from 5 to 30 ^{o}C
  Humidity : below 60%RH.
  (Packing materials, in particular, may be deformed at temperatures over 40 ^{o}C .)
  - In case the product is left more than 6 months after reception, the solderability of the product needs to be checked before using.
- The product shall NOT be stored in corrosive gas condition (Cl_2, NH_3, SO_2, No_x, etc.).
- This product is applicable to MSL1 (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):

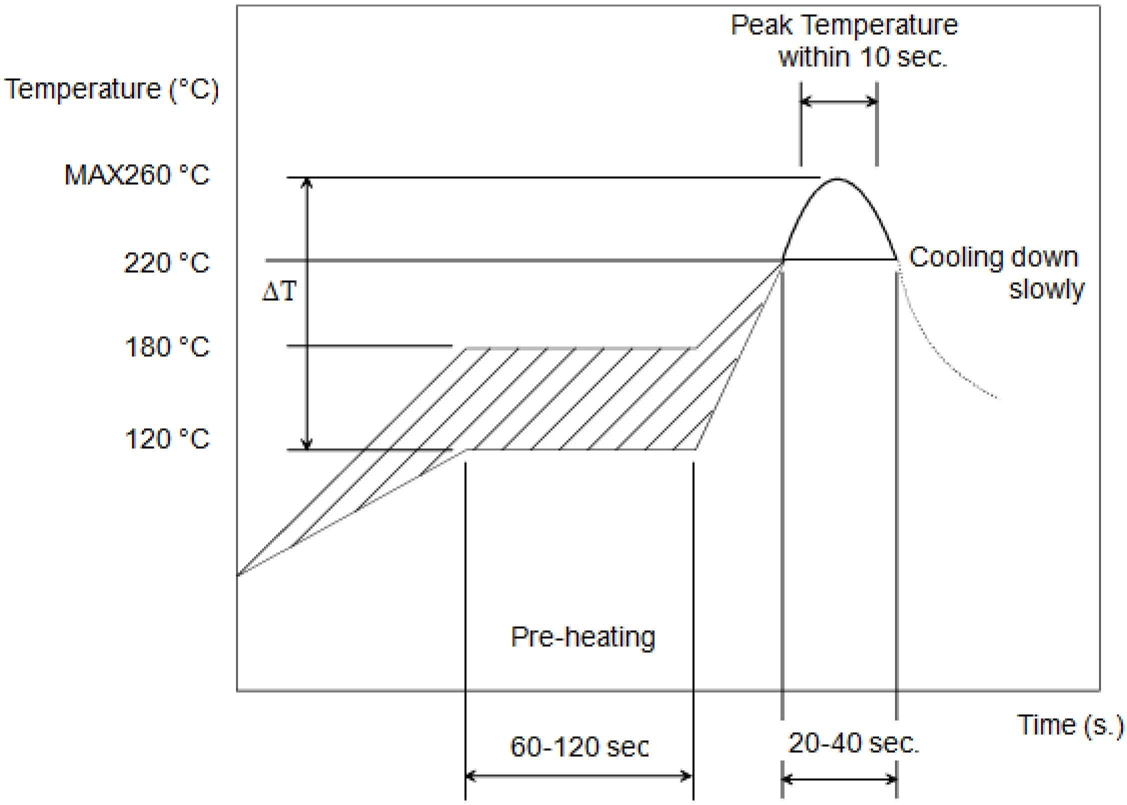
All the ground terminals should be connected to ground patterns. Furthermore, the ground pattern should be provided between the IN and OUT terminals. Please refer to the specifications for the standard land dimensions.

The recommended land pattern and dimensions are shown for a reference purpose only.
Electrical, mechanical, and thermal characteristics of the product 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 should not exceed 2 times.
Carefully preheat the product : ΔT less than 130 °C.
If the product is cooled down rapidly like being immersed in liquid, it might be damaged by a rapid temperature change. Excessive thermal shock should be avoided.
Soldering should be carried out in the conditions shown below to prevent damaging the product.
Contact a Murata representative in case there is a concern about 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:

The product is designed to work under normal environmental conditions e.g., (ambient temperature, humidity, and pressure). If the product is used under the following circumstances, it may not work properly and/or be damaged. Be sure not to use the product in such places.

- In an atmosphere containing corrosive gas (Cl_2, NH_3, SO_x, NO_x etc.).
- In an atmosphere containing combustible and volatile gases.
- In a dusty environment.
- Direct sunlight
- Where the product can be exposed to water.
- A humid environment where water condenses.

7. Input Voltage and Output Current limitation:

The product should only be used within the input voltage and output current range specified in this datasheet.
Even when the product is used beyond the specification limitations, it might continue working for a short period of time. But the reliability of the product would be significantly deteriorated and the expected product life time will be diminished.

8. Limitation of Applications:

The product is designed and manufactured for consumer applications and is not available for the applications listed below which require extremely high reliability for the prevention of such defects that may directly cause damage to the third party's life, body or property.

- Aircraft equipment.
- Aerospace equipment
- Undersea equipment.
- Power plant control equipment.
- Medical equipment.
- Transportation equipment (vehicles, trains, ships, etc.).
- Traffic signal equipment.
- Disaster prevention / crime prevention equipment.
- Application of similar complexity and/ or reliability requirements to the applications listed in the above.

⚠ Note:

Murata assumes no liability for applications assistance or the design of your products. You are responsible for your products and application. To minimize the risk, you should provide adequate design, evaluation and operating safeguards.