FMLDC3603A3V3ATH

List

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FMLDC3603A3V3ATH

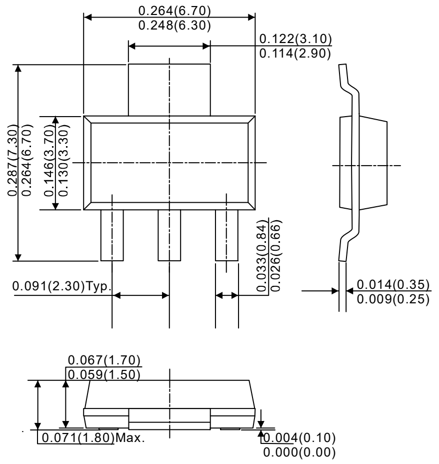
300mA Low Voltage Difference CMOS Voltage Regulators

Features

- Input Voltage Range : 2.5V ~ 36V.
- Fixed Output Voltage Available from 1.2V to 12V output.
- Output Voltage Tolerance : ±2% for Conventional device and ±1% can be customized .
- Dropout Voltage: 300mV@100mA (VOUT = 3.3V) .
- Power supply rejection ratio : 70dB @1KHz.
- Low Quiescent Current: 2.0μA (Typ.).
- Low Output Noise: 27×V_{OUT} μV_{RMS} (10Hz ~ 100kHz).
- Integrated fault protection : Fold-back current limit, short-circuit protection thermal shutdown.
- Lead-free pats meet RoHS requirement.
- Halogen-free (IEC61249-2-21).

Package Outline

SOT-223



Dimensions in inches and (millimeters)

Applications

- Car Navigation Systems, Cordless Phones, LAN Cards.
- Laptop, PC Peripherals with Memory, Palm tops and PDAs.
- Ultra Low Power Micro controllers, Wireless Communication Equipments.

Mechanical data

- Epoxy:UL94-V0 rated flame retardant.
- Case : Molded plastic, SOT-223.
- Terminals : Solder plated, solderable per MIL-STD-750, Method 2026.
- Weight : Approximated 205mg.

Maximum ratings (T$_{OPT}$=25℃, unless otherwise note)

Parameter	Symbol	Ratings	Unit
Input voltage (Note 2)	V_{IN}	-0.3 ~ 40	V
Enable input voltage range (Note 2)	V_{EN}	-0.3 ~ 40	V
Output voltage range (Note 2)	V_{OUT}	-0.3 ~ 13	V
Reference Power dissipation	$P_{D\ Ref}$	1.00	W
Electrostatic discharge (Note 4)	$V_{ESD-HBM}$	4	KV
	V_{ESD-MM}	200	V
Thermal resistance, junction to ambient (Note 5)	$R_{\theta JA}$	99.5	℃/W
Thermal resistance, junction to case (Note 5)	$R_{\theta JC}$	19.6	℃/W
Operating ambient temperature range	T_{OPT}	-40 to +85	℃
Junction temperature range	T_J	-40 to +125	℃
Storage temperature	T_{STG}	-60 ~ +150	℃
Soldering temperature and time (10s)	T_{Solder}	+260	℃

Note :

(1) Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions. Exposure to absolute maximum rated conditions for extended periods may affect device reliability.

(2) All voltages are with respect to network ground terminal.

(3) Refer to Thermal Information for details.

FMLDC3603A3V3ATH

Electrical characteristics

(V_{IN} = V_{OUT} +1V, C_{IN} = 1.0μF, C_{OUT} = 1.0μF, T_A = 25℃, unless otherwise specified)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Input voltage	V_{IN}			2.5		36	V
Output voltage (note 7)	V_{OUT}	T_J = 25°C, I_{OUT}=1mA		-2		2	%
				-1		1	
Output Current	I_{OUT}	T_J = 25°C		300			mA
Output Current Limit	I_{Limit}	V_{OUT} = 0.5 × V_{OUT} Normal, V_{IN} = 5.0V		350	600		mA
Quiescent current	I_Q	I_{OUT}=0mA	V_{OUT} <7.0V		2.0	5.0	μA
			V_{OUT} >7.0V		3.0	6.0	
Dropout voltage (note 8)	V_{DO}	V_{OUT}=3.3 to 3.6V	I_{OUT}=100mA		200		mV
		V_{OUT}=5.0V			170		
		V_{OUT}=12V			150		
Line regulation (note 9)	LNR	V_{IN} = V_{OUT} +1V to 36V, I_{OUT} = 10mA			0.01	0.3	%/V
Load regulation	ΔV_{LOAD}	V_{IN}= V_{OUT} +1V, I_{OUT} = 1 to 100mA			10		mV
Output voltage temperature Characteristics (note 10)	TR	I_{OUT} =10mA, T_A= -40 to 85 °C			50		ppm/℃
Short current	I_{SHORT}	V_{OUT} short to GND			100		mA
Standby current	I_{STBY}	V_{EN}=GND				0.5	μA
EN logic low voltage	V_{ENH}			1.5		V_{IN}	V
	V_{ENL}					0.3	V
Ripple suppression ratio	PSRR	I_{OUT} = 50mA, V_{IN}=(V_{OUT} +1.5V)$_{DC}$ + 1$V_{PP\ AC}$	f = 100Hz		75		dB
			f = 1kHz		70		
			f = 10kHz		55		
			f = 100kHz		40		
Output noise voltage	V_N	BW = 10 to 100k Hz			27xV_{OUT}		μV_{RMS}
Thermal shutdown	T_{SD}				160		℃
Thermal shutdown hysteresis	Δ T_{SD}				20		℃
Auto discharge resistance	$R_{discharge}$	V_{IN}=5V, V_{OUT}=3.0V, EN=GND			150		Ω

Note:

(4) ESD testing is conducted in accordance with the relevant specifications formulated by the Joint Electronic Equipment Engineering Commission (JEDEC). The human body model (HBM) electrostatic discharge test is based on the JESD22-114D test standard, using a 100pF capacitor and discharging to each pin of the device through a resistance of 1.5kΩ. The electrostatic discharge test in mechanical model (MM) is based on the JESD22-A115-A test standard and uses a 200pF capacitor to discharge directly to each pin of the device.

(5) Thermal metric is measured in still air with T_A = 25°C and installed on a 1 in^2 FR-4 board covered with 2 ounces of copper.

(6)Typical numbers are at 25°C and represent the most likely norm.

(7)Products with ±1% output tolerance can be customized.

(8)Test the difference of output voltage and input voltage when input voltage is decreased gradually till output voltage equals to 98% of V_{OUT} Normal.

(9)The line regulation is calculated by the following formula:

$$LNR = \frac{\Delta V_{OUT}}{V_{OUT} \times \Delta V_{IN}}$$

where, ΔV_{OUT} is the variation of the output voltage, ΔV_{IN} is the variation of the input voltage.

(10) The output voltage temperature characteristics (T_R) is calculated by the following formula:

$$TR = \frac{\Delta V_{OUT}}{V_{OUT} \times \Delta T}$$

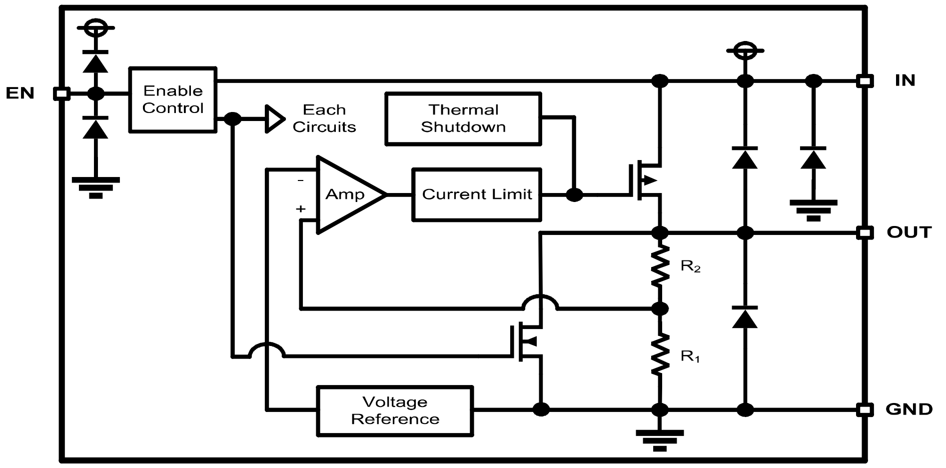
where, ΔV_{OUT} is the variation of the output voltage, ΔT is the variation of the ambient temperature.

Detailed Description

1. Description

The FMLDC3603A3V3ATH is a group of low voltage differential linear regulators with a maximum input voltage of 36V and an output current of 300mA. Their quiescent current is as low as 2μA, and internally integrated with fold-back current limit, output short circuit protection, and thermal shutdown protection. Therefore, they are very suitable for uninterrupted power supply system and battery powered devices.

2. Functional block diagram



The internal feedback resistors R_1 and R_2 form a voltage divider circuit to compare the V_{FB} input error amplifier with the reference voltage. The internal regulator tube (PMOS) will control its conduction degree through the grid voltage provided by the error amplifier output, which will make the output voltage V_{OUT} not affected by temperature changes or input voltage changes to a certain extent, thus maintaining the stability of the device output voltage.

3. Power Supply Input

When the input voltage is lower than the rated range of the data sheet, the device will lose the regulation function of stabilizing the output voltage, that is, it is unable to maintain the output voltage within the rated range. At this time, compared with normal operation, the quiescent current of the device may exceed the rated range, and the transient response performance may be seriously degraded. When the input voltage is higher than the rated range of the data sheet, the device may cause irreversible damage or failure due to exceeding the maximum rated range of electrical stress. For the rated input voltage of the device, see Recommended Operating Conditions and Dropout Voltage.

4. Output Current

When the circuit design is appropriate, the device can reach the maximum load capacity of at least 300mA. According to the power dissipation of the package and the effective connection thermal resistance with the environment, selecting the appropriate package for the circuit design can make the device emit more heat energy.

5. Enable Control

The enable pin of the device EN is active at high level. When the voltage of the EN is greater than the EN logic high voltage V_{ENH}, the device will be enabled and maintain the normal output. When the voltage of the EN is lower than the EN logic low voltage V_{ENL}, the internal circuit of the device will be disabled and the output will be turned off the device, the device will be in the standby mode until EN is turned to high level again. The V_{ENH} and V_{ENL} can be found in the Electrical Characteristics. Normal startup waveform and startup slope rate control can be ensured when the device starts from any low voltage lower than V_{ENL}, but the discharge time of output capacitor must be taken into account. EN can not be float, if EN is not required to control the output voltage independently, connect EN to IN.

6. Dropout Voltage

Dropout voltage V_{DO} refers to the minimum voltage difference between input and output V_{IN} - V_{OUT} to make the device output voltage reach the rated range at rated current. When the dropout voltage condition required by the device is reached, the internal MOSFET will be fully turned on, at this time, the MOSFET is equivalent to a switch for regulation.

The V_{DO} increases with the increase of load current. Since V_{IN} - V_{OUT} must be no less than the V_{DO}, the V_{DO} indirectly specifies the minimum input voltage of devices under different load current conditions. If the V_{IN} - V_{OUT} is less than the V_{DO}, the performance of the device may deteriorate, see Operation in Dropout Mode for details.

Auto-discharge Function

The device with enable control has an auto-discharge circuit. When the enable control is turned off, the device will be disabled. An internally integrated pull-down MOSFET (see Functional Block Diagram) will connect a resistor $R_{Discharge}$ to the ground to release the charge in the output capacitor, thus closing the entire device circuit. The value of $R_{Discharge}$ can be found in the Electrical Characteristics. The discharge time of the output capacitor after the device is disabled is determined by the output capacitance C_{OUT} and load resistance R_L in parallel with the $R_{Discharge}$. The time constant τ can be calculated by the following formula:

$$\tau = \mathrm{C} \times R_{Discharge} \quad (R_L = 0)$$

$$\tau = C \times \left(\frac{R_L \times R_{Discharge}}{R_L + R_{Discharge}}\right) \ (R_L \neq 0)$$

The output voltage after discharging through pull-down MOSFET can be calculated by the following formula:

$$V = V_{OUT} \times e^{-\frac{t}{\tau}}$$

$$t = \tau \times \ln\left(\frac{V}{V_{OUT}}\right)$$

Where, V is the output voltage after discharge, V_{OUT} is the output voltage, t is the discharge time, τ is the discharge time constant. Do not rely on the active discharge circuit to release a large amount of output capacitance after the input power supply crashes, because the reverse current can flow from the output to the input. This reverse current may damage the device. The limiting reverse current shall not exceed 5% of the rated current of the device.

8.Thermal Shutdown

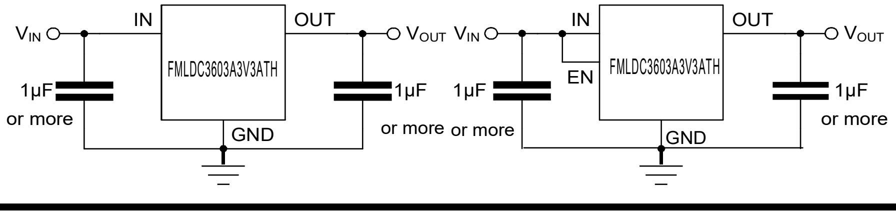
The FMLDC3603A3V3ATH is designed with thermal shutdown protection. When the junction temperature (T_J) of the internal main channel MOSFET exceeds the thermal shutdown threshold temperature (T_{SD}), thermal shutdown will be triggered. At this time, the output will be turned off to prevent catastrophic damage to the chip due to accidental heating. When the TJ drops to a certain range of thermal shutdown threshold temperature (ΔT_{SD}), the thermal shutdown will be released and the device will return to the normal output. The temperature threshold of device triggering thermal shutdown (T_{SD}) and temperature range to be lowered to released from thermal shutdown (ΔT_{SD}) can be found in the Electrical Characteristics. To ensure reliable operation, please limit the junction temperature to the specified range of Recommended Operating Conditions in the data sheet. Applications that exceed the recommended temperature range may cause the device to exceed its operating specifications. Although the internal protection circuit of the device is designed to prevent overall thermal conditions, it is not intended to replace proper power dissipation. Running the device continuously until thermal shutdown or higher than the recommended operating T_J will reduce long-term reliability.

9.Built-in Current Limit & Short Circuit Protection

The FMLDC3603A3V3ATH is designed with internal current limiting circuit, which can protect the device by limiting the load current value in case of instantaneous high load current. When the current limiting is triggered, the output voltage is not regulated. If the out pin of the regulator is short circuited, the internal current limiting circuit will be triggered, the output current of the device will maintain at a relatively small value to protect the device. The typical value of short current IShort can be found in Electrical Characteristics. The current limiting state will continue until the load current drops to the normal range. When the load current of the device is large, the device will generate more heat due to the increase of power consumption, which may cause the device to turn off its output due to the internal thermal shutdown protection before the current limit is triggered. In order to ensure the normal operation of current limit, the inductance of input and load shall be minimized. Continuous operation under current limit is not recommended. The current limit mode of these device is fold-back current limit. Please refer to the Fold-back Current Limit for more details.

Application and Implementation

1. Typical Application Circuit



2. Application Information

2.1. Selection of Bypass Capacitances(continued)

Output Capacitors (C_{OUT}):

Recommended 1μF or more output ceramic capacitor to keep the device output stable, and the capacitor position should be as close to the device pin as possible. The device needs an output capacitor to achieve loop stability. As with any regulator, a larger output capacitance reduces the peaks during a load transient but slows down the response time of the device. The proper capacitor can help to obtain better dynamic performance.

2.2. Transient Response

Transient response refers to the change of system output from initial state to stable state under the action of typical signal input. For LDO, the designer should pay attention to the possible impact of linear transient response and load transient response on the system: linear transient response refers to the transient response of output to change when the input voltage changes, while load transient response refers to the transient response of output to change when the output current changes. The specific phenomenon is that the output voltage of the device will have a short spike, especially when the input voltage or output current changes greatly in a short time. This change is not only related to the performance of the chip itself, but also related to the change of output current, change rate and output capacitance:

1. When the output current increases, the output voltage of the device will decrease to a certain extent, and the larger output current will provide a higher current discharge path for the output capacitor, which will affect the peak value generated by the transient spike and reduce the peak value
2. The output current or input voltage changes relatively slowly, and the output change of the device is relatively small, affecting the spike caused by the change;
3. The use of large input and output capacitors can reduce the spike caused by transient response to a certain extent to improve the transient performance, but large output capacitors can also affect the response time of devices.

For the selection of bypass capacitance value, refer to the Section of Bypass Capacitances selection.

2.3. Operation in Dropout Mode

The FMLDC3603A3V3ATH is internally integrated with a P-MOSFET to achieve low dropout voltage. The voltage difference between the input and the output (V_{IN} - V_{OUT}) of the device must not be lower than the corresponding dropout voltage (V_{DO}) to ensure that the output voltage tolerance is within the rated range of the data sheet. The dropout voltage will increase with the increase of load current. When the V_{IN} - V_{OUT} is less than the V_{DO}, the P-MOSFET inside the device is in a linear state, the resistance from the input pin to the output pin is equal to the resistance from the drain to the source of the P-MOSFET, and the device functions like a resistor. When operating in this state, the response time of the error amplifier inside the device will be limited, which will seriously degrade the transient performance of the device, when the external circuit has a transient change, the deviation of the output voltage will become larger than the normal operating state. In addition, the PSRR and noise performance of the device will be worse than that under normal operating conditions.

2.4.Recommended Continuous Operating Areas

For the FMLDC3603A3V3ATH, the working area is limited by dropout voltage, output current, junction temperature and input voltage under continuous working condition. The recommended areas for continuous operation are shown in Figure 9-5:

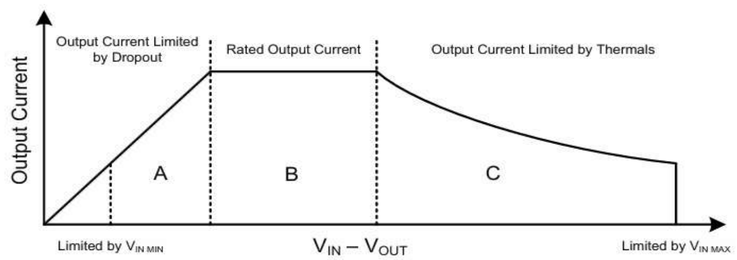
A. The LDO input and output voltage difference V_{IN} - V_{OUT} must meet the dropout voltage V_{DO} conditions. See Dropout Voltage for more details.

B. Rated output current range Irated.

C. The actual junction temperature T_J of LDO shall not exceed the rated junction temperature.

The product of voltage difference and current at both ends of LDO is power consumption, which determines the actual working junction temperature of LDO, so the curve is not linear.

In addition, the working area is limited by the rated $V_{IN\,MIN}$ and $V_{IN\,MAX}$.



2.5.Power Supply Recommendation

The FMLDC3603A3V3ATH is designed to operate within the input power supply voltage range of 2.5V to 36V. The input power supply should be well adjusted and have low noise. If the input power supply has high noise, it is recommended to use an additional bypass capacitor at the input to improve the output noise performance of the device. It is recommended to use an input capacitor of 1μF or higher to reduce the impedance of the input power supply, especially during transients.

2.6.Layout Guidelines

To achieve the best operational performance, the following are some suggestions:

- Place the input and output capacitors as close to the pins of the device as possible;
- The device is connected by copper plane and the heat sink (or back pad) of the device is fully welded with PCB to obtain better heat dissipation performance and lower on resistance;
- Heat sink holes are placed around the device to help the circuit dissipate more heat energy. However, attention should be paid to the position of the heat sink holes to prevent the solder (or solder paste) on the IC pad from being absorbed by the heat sink holes and being damaged during welding.

2.7.Fold-back Current Limit

The FMLDC3603A3V3ATH is adopt the fold-back current limit. The following is some application information of the fold-back current limit.

Current Limit Type: Current limit can impose certain restrictions on the current value provided by the device. Compared with the socalled "brick-wall" current limiting mode, the significant difference of the fold-back current limit is that overload and short circuit are obviously different. Figure 9-1 and Figure 9-2 show the typical operating characteristics of these two current limiting mechanisms.

1. Operating characteristic curve R_1 represents the curve of linear resistance as load under normal working condition;
2. When the linear resistance as the load gradually decreases and causes the device to enter the overload state, the operating characteristic curve is shown in R_2;
3. When the linear resistance decreases to 0Ω, the device will enter the short-circuit state, and the operating characteristic curve is shown in R_3.

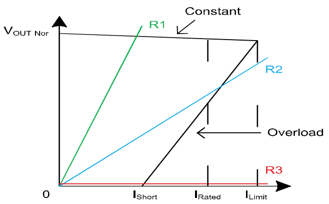


Figure 9-1. Fold-back Current Limit

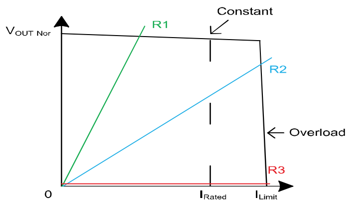


Figure 9-2. Brick-wall Current Limit

After entering the short circuit state, the short-circuit current of the "brick-wall" type current limiting mechanism is limited to I_{Limit}, and the reliability and stability of the voltage regulator may be affected due to the large amount of heat generated during the short circuit, while the I_{Short} of fold-back current limit in the short circuit state is far lower than I_{Limit}, which can reduce the heat energy generated due to power dissipation during the device short circuit. The fold back current limit allows the device to limit the short circuit current to a small current value without losing the rated range of output current. This is very important if continuous short circuit faults need to be solved. The current limiting mechanism limits the maximum load current of the device, and the internal transmission transistor of the device will not move outside its safe operation area (SOA) during operation. See Recommended Continuous Operating Areas for details.

Usage and Precautions: When using the voltage regulator with the fold-back current limit, it should be noted that the device cannot be started normally under certain loads because the short-circuit current of the fold-back current limit is obviously different from the maximum load current. As shown in the curves S_1 and S_2 in Figure 9-3, the nonlinear load S_1 is distributed in the range of the load curve region where the device can work, because the current provided by the device is always greater than the requirements of the load under all voltage conditions, the device can start normally, and the output will reach the ideal operating point P1; The situation of nonlinear load S_2 is different, during actual startup, when the voltage and current are gradually rising, the output of S_2 will be limited at P2, because the device cannot provide more current under the voltage at P_2, which will make the output stuck at the intersection and maintain at this level, and the device cannot reach the ideal operating point P_3 for normal startup.

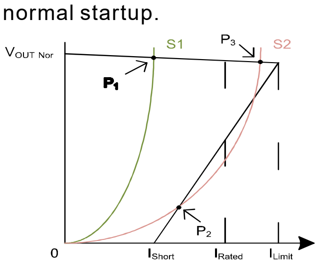


Figure 9-3. Nonlinear Load Example

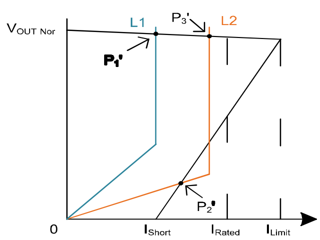


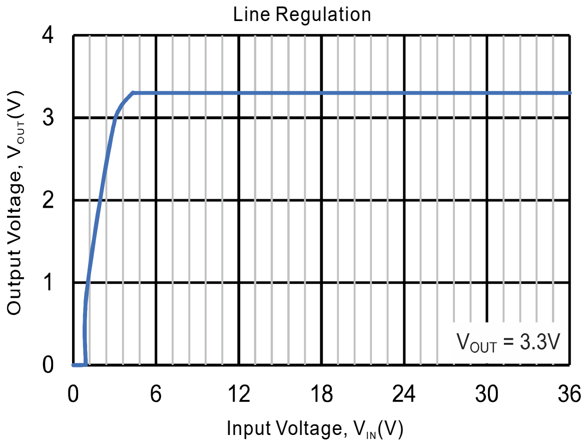
Figure 9-4. Active Load Profile

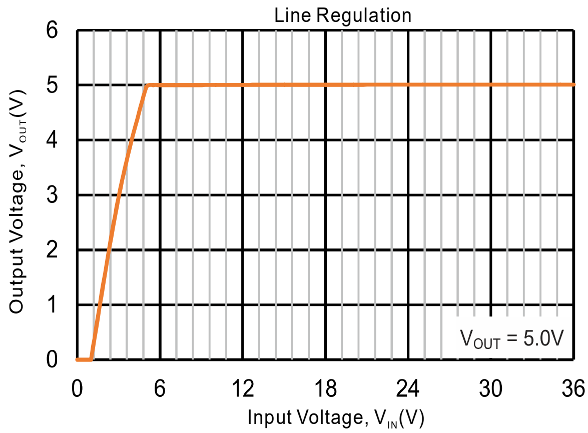
FMLDC3603A3V3ATH

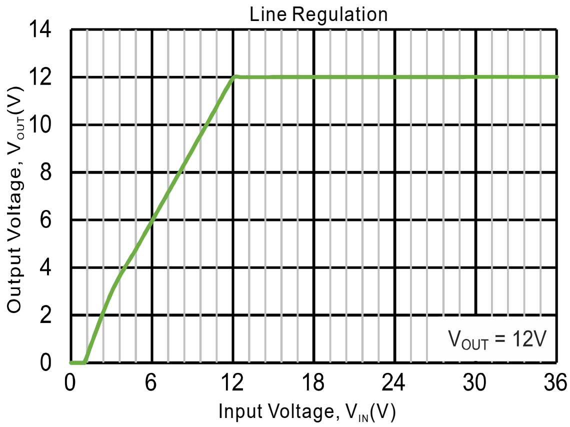
In addition, many typical cases of actual loads have operating characteristics as shown in L_1 and L_2 curves in Figure 9-4. When the device starts from zero with L_1 and L_2 as loads, the load will behave as a linear resistance, and the load current will change to a constant value after reaching the inflection point voltage. Like nonlinear loads S_1 and S_2, when L1 is used as the load, the device can start normally and reach the ideal working point P_1', while when L_2 is used as the load, the device cannot start normally, and the output will be stuck at P_2' and cannot reach the ideal working point P3'. As an active load, the electronic load has the same operating characteristics as L_1 and L_2. Some problems may occur when using the electronic load to test the voltage regulator with a fold-back current limit. See Test Current Limit for more details. For the load with specific operating characteristics as shown in S_2 and L_2 curves, it is necessary to use a fold-back current limiting device with a higher I_{Short}, or a voltage stabilizing device with a "brick-wall" type current limiting.

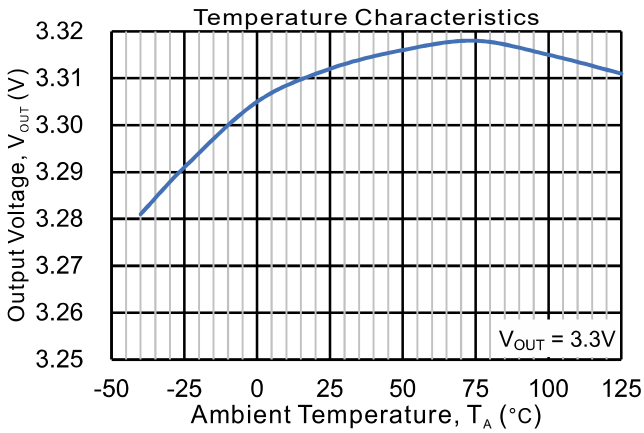
Rating and characteristic curves

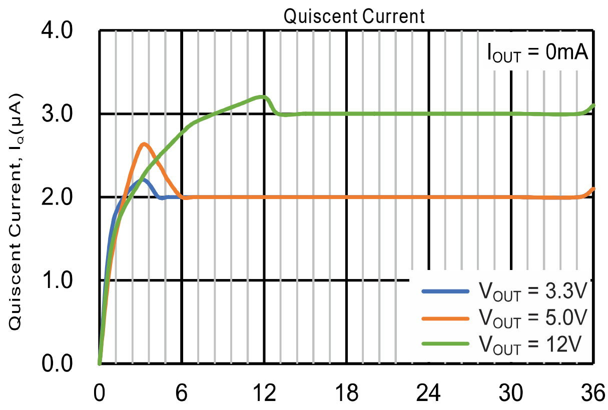
(V_{IN} = V_{OUT} +1V, I_{OUT} = 10mA, C_{IN} = 1.0μF, C_{OUT} = 1.0μF, T_A = 25℃, unless otherwise specified)

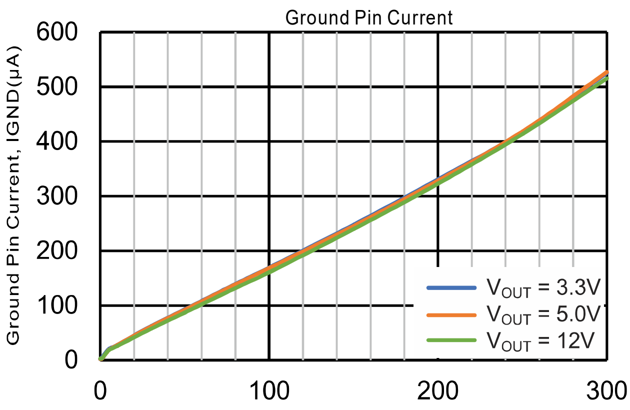






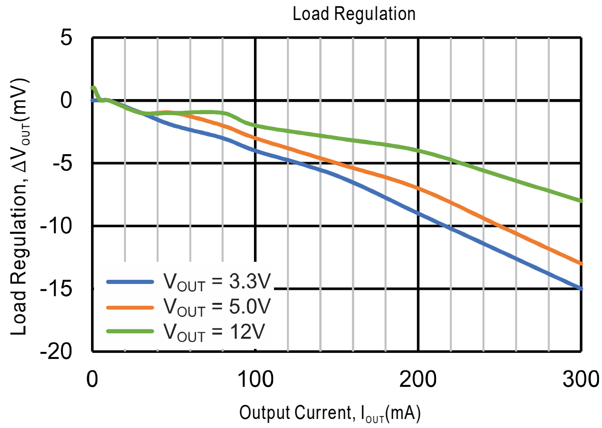


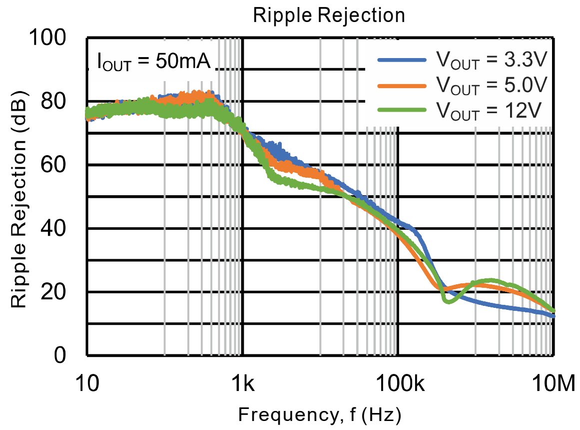


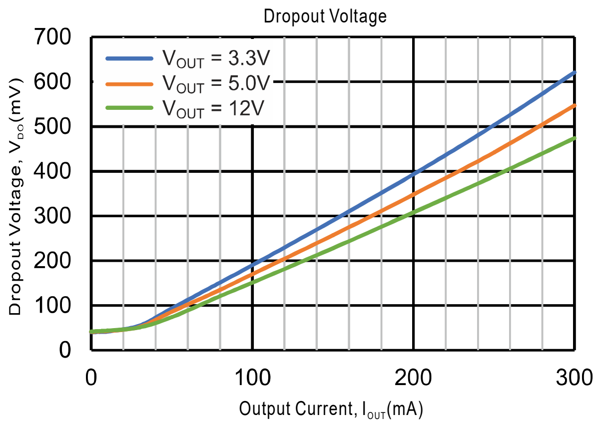


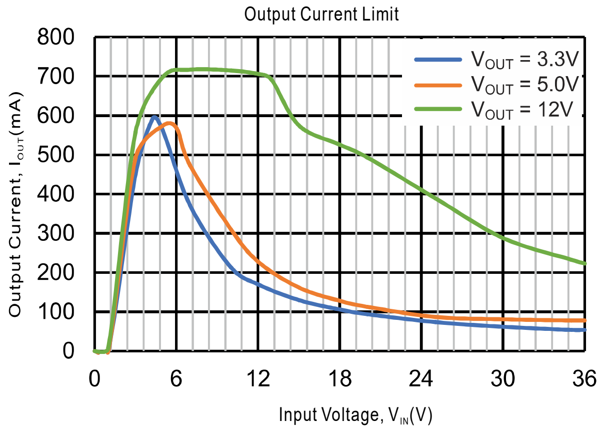
FMLDC3603A3V3ATH

Rating and characteristic curves
(V_{IN} = V_{OUT} +1V, I_{OUT} = 10mA, C_{IN} = 1.0μF, C_{OUT} = 1.0μF, T_A = 25℃, unless otherwise specified)





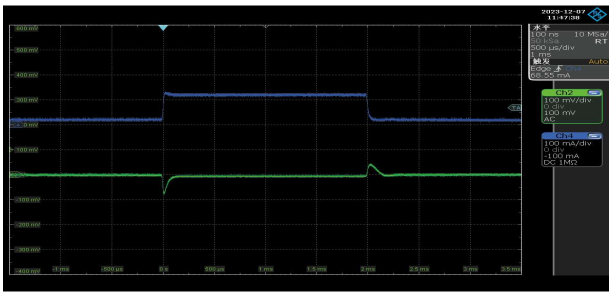




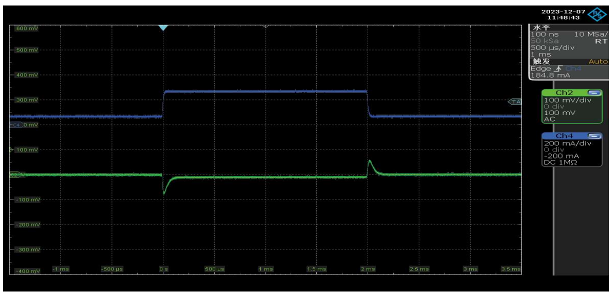
Load Transient

V_{OUT} = V_{IN} , V_{IN} = V_{OUT} +1V, CH_2: V_{OUT}, CH_4: I_{OUT}

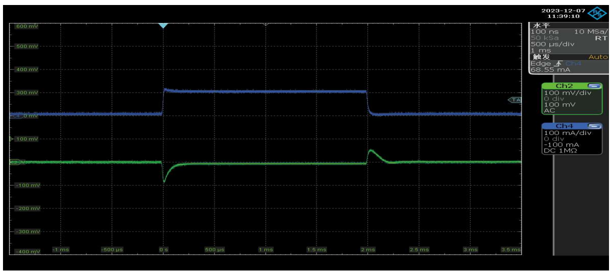
V_{OUT} = 3.3V, I_{OUT} = 1 ~ 100mA



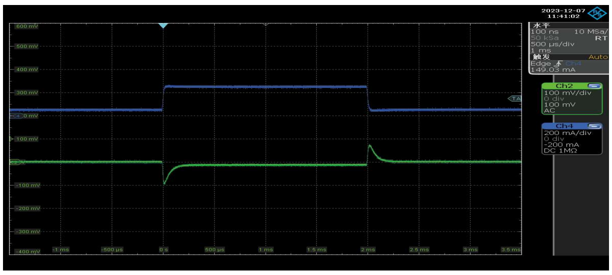
V_{OUT} = 3.3V, I_{OUT} = 50 ~ 250mA



V_{OUT} = 5.0V, I_{OUT} = 1 ~ 100mA



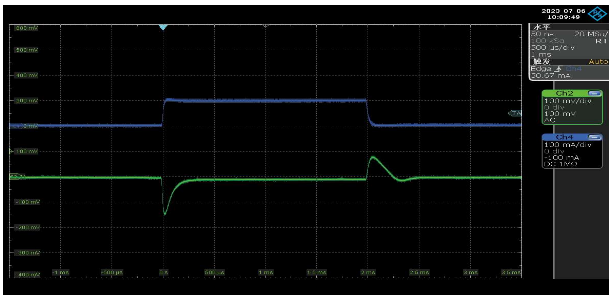
V_{OUT} = 5.0V, I_{OUT} = 50 ~ 250mA



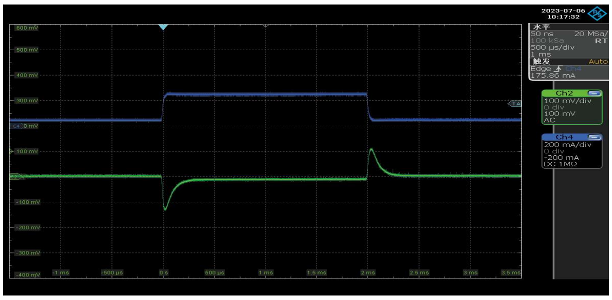
FMLDC3603A3V3ATH

Rating and characteristic curves (V_{IN} = V_{OUT} +1V, I_{OUT} = 10mA, C_{IN} = 1.0μF, C_{OUT} = 1.0μF, T_A = 25℃, unless otherwise specified)

V_{OUT} = 12V, I_{OUT} = 1 ~ 100mA

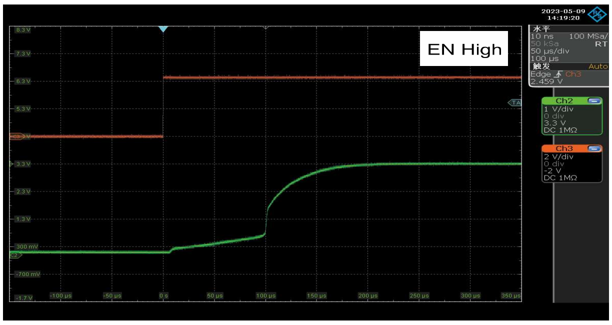


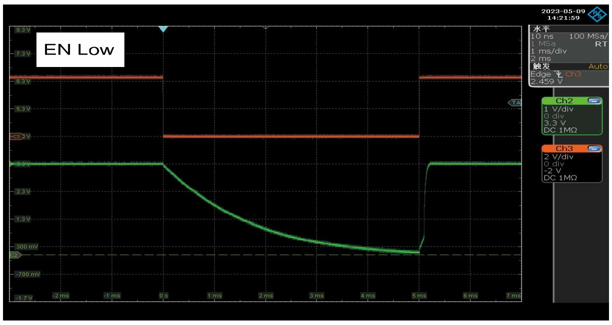
V_{OUT} = 12V, I_{OUT} = 50 ~ 250mA



EN High & Low

V_{OUT} = 3.3V, V_{IN} = 4.3V, V_{EN} = 0 ~ 4.3V, I_{OUT} = 0mA, CH2: V_{OUT}, CH3: V_{EN}

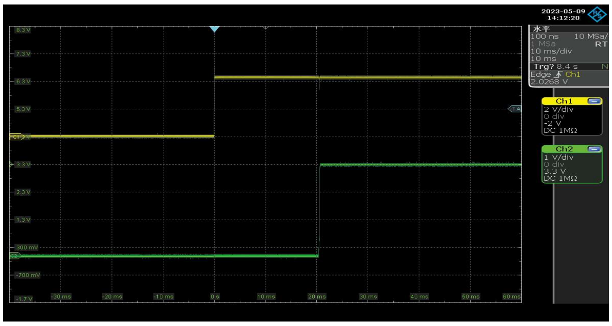




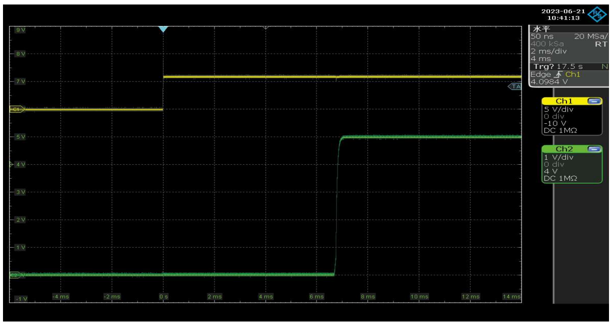
Power on Response

V_{EN} = V_{IN}, I_{OUT} = 10mA, V_{IN} = 0 ~ V_{OUT} +1V, CH1: V_{IN}, CH2: V_{OUT}

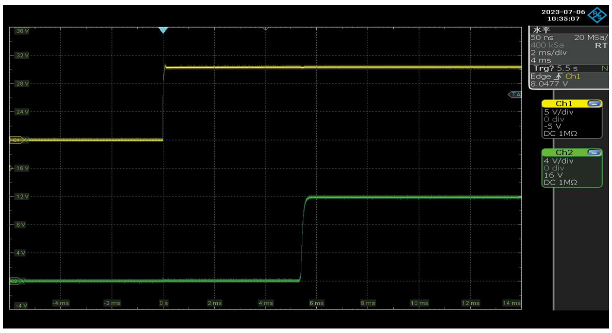
V_{OUT} = 3.3V, V_{IN} = 0 ~ 4.3V



V_{OUT} = 5.0V, V_{IN} = 0 ~ 6.0V

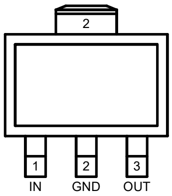
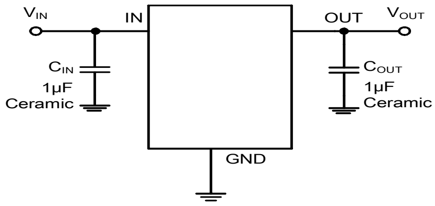


V_{OUT} = 12V, V_{IN} = 0 ~ 13V



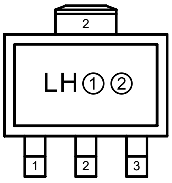
FMLDC3603A3V3ATH

Pinning information

Type Number	Simplified outline	Symbol
FMLDC3603A3V3ATH		

1. GND : Regulator ground.
2. OUT : Output of the regulator. An output capacitor is required for stability and help device obtain the best transient response. Use the capacitor with the recommended value and place it as close as possible to the output.
3. IN : Input to the device. Use the recommended value of the input capacitor and place it as close to the input of the device as possible to reduce the impedance of the input supply.
4. NC : No internal connection. This pin can float, but when this pin is connected to GND, the device has better thermal performance.
5. EN : Enable pin. Driving this pin to logic high enables the device; driving this pin to logic low disables the device. Don't float this pin. If enable functionality is not required, this pin must be connected to IN.
6. Thermal Pad: Connect the thermal pad to a large-area ground plane. The thermal pad is internally connected to GND.

Marking

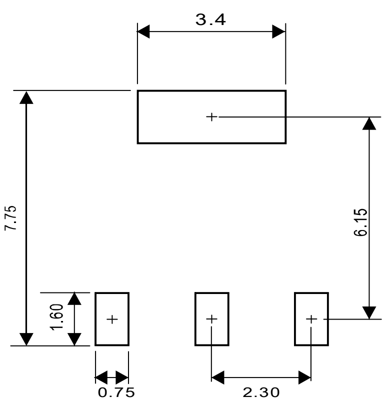


	Marking code	Description
①②	XX	Code, indicates weekly record information of wafer lot code

X : Represents any character.

Suggested solder pad layout

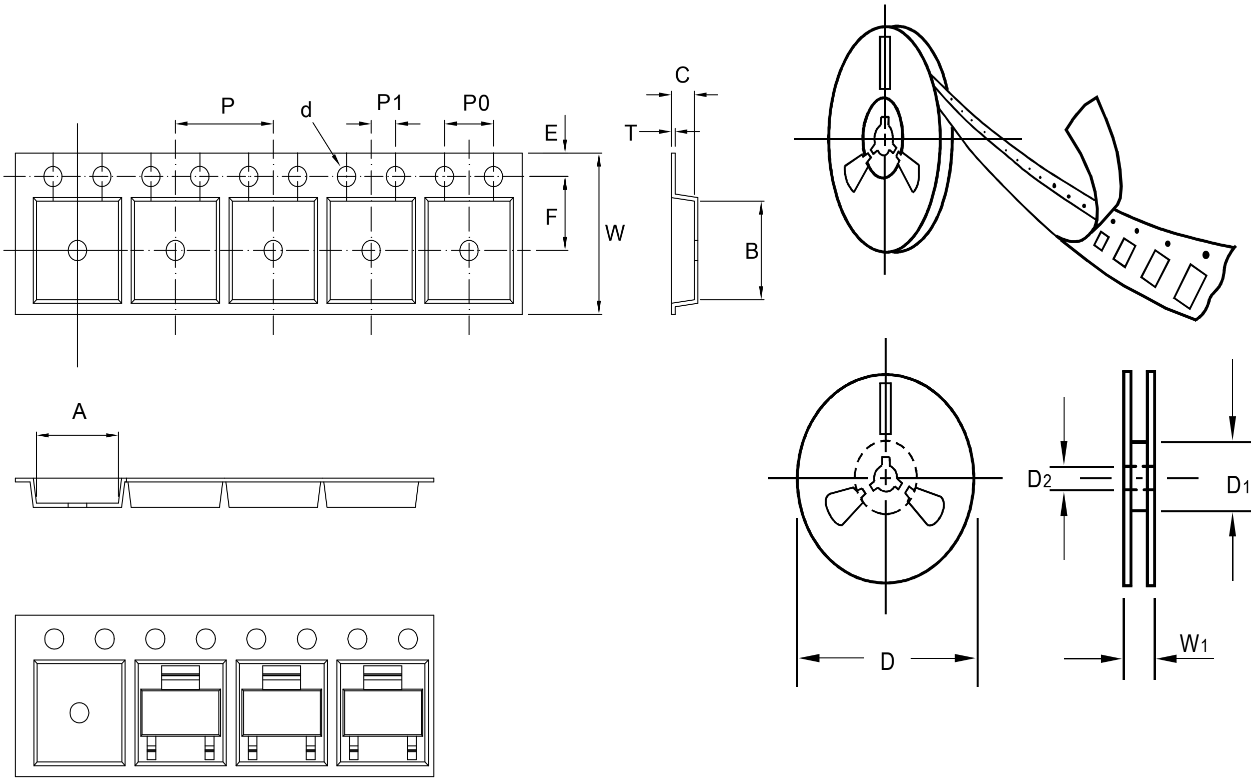
SOT-223



Note :
1. Controlling dimension : In millimeters.
2. General tolerance : ±0.05mm.
3. The pad layout is for reference purposes only.

FMLDC3603A3V3ATH

Packing information



Unit : mm

Item	Symbol	Tolerance	SOT-223
Carrier width	A	±0.1	6.76
Carrier length	B	±0.1	7.33
Carrier depth	C	±0.1	1.88
Sprocket hole	d	±0.1	1.50
13" Reel outside diameter	D	±1.0	330.0
13" Reel inner diameter	D1	±0.5	99.0
Feed hole diameter	D2	±0.3	13.1
Sprocket hole position	E	±0.1	1.75
Punch hole position	F	±0.1	5.50
Punch hole pitch	P	±0.1	8.00
Sprocket hole pitch	P0	±0.1	4.00
Embossment center	P1	±0.1	2.00
Over all tape thinkness	T	±0.1	0.25
Tape width	W	±0.5	12.00
Reel width	W1	±0.5	12.80

Note : Devices are packed in accordance with EIA standard RS-481-A and specifications listed above.

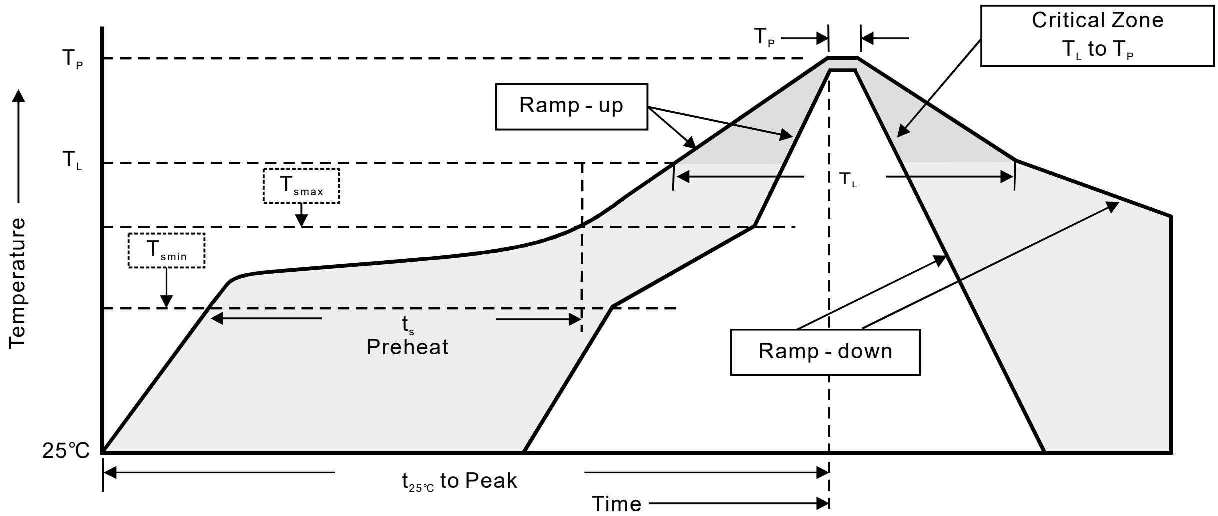
FMLDC3603A3V3ATH

Reel packing

Package	Units (pcs)			Dimension (Unit : mm[3])		
	Reel	Inner Box	Outer Box	Reel DIA,	Inner Box	Outer Box
SOT-223	2,500	2,500	20,000	330 (13")	336 x 336 x 48	445 x 355 x 365

Suggested thermal profiles for soldering processes

1. Storage environment : Temperature = 5℃ ~ 40℃, Humidity = 55%, ±25%.
2. Reflow soldering of surface - Mount devices.



3.Reflow soldering

Profile feature	Soldering condition
Average ramp-up rate (T_L to T_P)	< 3 ℃/sec
Preheat - Temperature Min (T_{smin}) - Temperature Max (T_{smax}) - Time (Min to Max) (t_s)	150℃ 200℃ 60 ~ 120 sec
T_{smax} to T_L - Ramp-up rate	< 3 ℃ / sec
Time maintained above : - Temperature (T_L) - Time (T_L)	217℃ 60 ~ 260 sec
Peak temperature (T_P)	255 ℃ -0 / +5℃
Time with 5℃ of actual peak temperature (T_P)	10 ~ 30 sec
Ramp-down rate	< 6℃ / sec
Time 25℃ to peak temperature	< 6 minutes