FMLDC0605A1V2AMH Thru FMLDC0605A3V3AMH

List

FMLDC0605A1V2AMH Thru FMLDC0605A3V3AMH

500mA Low Voltage Difference CMOS Voltage Regulators

Features

- Operating voltage range : 2.0V ~ 6.0V.
- Output voltage : 1.2V to 5.0V .
- High Accuracy : ±2%(typ).
- Dropout voltage : 120mV @100mA (V_{OUT} = 3.3V).
- High Ripple rejection :75dB@1KHz.
- Low output noise : 40μ V_{RMS} (10Hz ~ 100kHz).
- TTL- Logic-Controlled Shutdown Input.
- Built-in Current Limiter, Short-Circuit Protection.
- Lead-free parts meet RoHS requirements.
- Halogen-free (IEC61249-2-21).

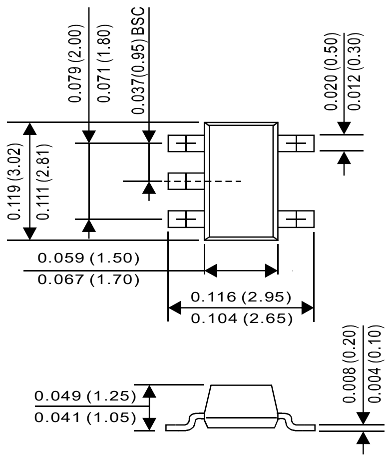
Applications

- Wearable Electronics.
- Laptop, Palmtops and PDA
- Digital Still and Video Cameras.

Mechanical data

- Epoxy:UL94-V0 rated flame retardant.
- Case : SOT-23-5.
- Weight : Approximated 12mg.

Package outline



Maximum ratings (T_{OPT}=25℃, unless otherwise note)

Parameter	Symbol	Ratings	Unit
Input voltage (Note2)	V_{IN}	-0.3~7.0	V
Output current	I_{OUT}	600	mA
Output voltage (Note2)	V_{OUT}	-0.3~ V_{IN}+0.3	V
Reference Power dissipation	$P_{D\ Ref}$	0.40	W
Thermal resistance, junction to ambient (Note3,6)	$R_{\theta JA}$	155.0	°C/W
Electrostatic discharge (Note 5)	$V_{ESD\text{-}HBM}$	2	KV
Thermal resistance, junction to case (Note3,6)	$R_{\theta JC}$	64.6	°C/W
Ambient temperature range (Note4)	T_A	-40 to +85	°C
Operating temperature range	T_{OPT}	-40 to +85	°C
Storage temperature range	T_{STG}	-40 to +125	°C
Soldering temperature and time (10s)	T_{Solder}	+260	°C

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.

(4) It is necessary to ensure that the operating junction temperature of the device does not exceed the rated value of the recommended operating conditions when using the device for design.

(5) 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 JS-001: 2017 test standard, using a 100pF capacitor and discharging to each pin of the device through a resistance of 1.5kΩ.

(6) Thermal metric is measured in still air with T_A = 25°C and installed on a 1 in2 FR-4 board covered with 2 ounces of copper.

FMLDC0605A1V2AMH Thru FMLDC0605A3V3AMH

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}			2.0		6.0	V
Output voltage	V_{OUT}	I_{OUT}=1mA		-2		2	%
Output Current	I_{OUT}			500			mA
Quiescent current	I_Q	I_{OUT} = 0mA			50	100	μA
Dropout voltage (Note 8)	V_{DO}	I_{OUT} =150mA, V_{OUT}≥2.8V			150		mV
Line regulation (Note 9)	LNR	I_{OUT} =10mA, V_{IN} = V_{OUT} +1V to 6V			0.01	0.2	%/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			100		ppm/℃
Standby current	I_{STBY}	V_{EN}=GND			0.1		μA
Short current	I_{SHORT}	V_{OUT}=GND			100		mA
EN logic low voltageM	V_{ENH}			1.5		V_{IN}	V
	V_{ENL}					0.3	V
Ripple suppression ratio	PSRR	I_{OUT}=50mA	f = 217Hz		80		dB
			f = 1kHz		75		
			f = 10kHz		70		
EN logic voltage	V_{ENH}			1.5		V_{IN}	V
	V_{ENL}					0.3	V
Auto discharge resistance	$R_{discharge}$	V_{IN}=5V, V_{OUT}=3.0V, EN=GND			100		Ω

Note :

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

(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:

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

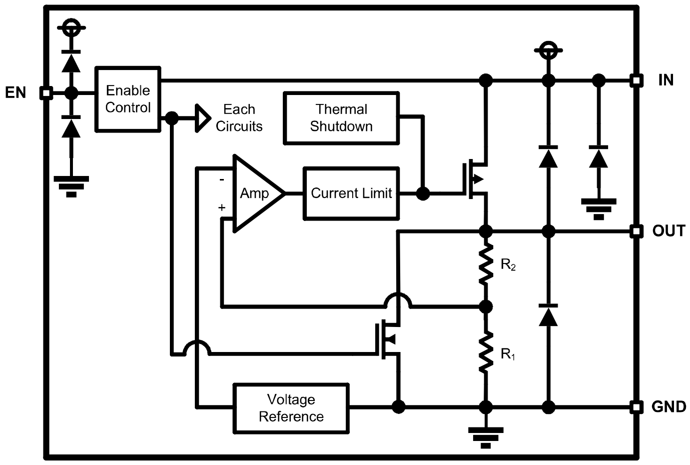
where, ΔV_{OUT} is the variation of the output voltage, ΔT is the variation of the ambient temperature.

Detailed Description

1. Description

The FMLDC0605A series are a group of positive voltage regulators manufactured by CMOS technologies with high ripple rejection, ultra low noise, low power consumption and low dropout voltage, which can prolong battery life in portable electronics. The FMLDC0605A series work with low-ESR ceramic capacitors, reducing the amount of board space necessary for power applications. The FMLD0605A series consume less than 0.1uA in shutdown mode and have fast turn-on time less than 50us.The series are very suitable for the battery-powered equipments, such as RF applications and other systems requiring a quiet voltage source.

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.

4. Output Current

When the circuit design is appropriate, the FMLDC0605A series can reach the maximum load capacity of up to 500mA. 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 ($V_{EN\,H}$), the device will be enabled and maintain the normal output. When the voltage of the EN is lower than the EN logic low voltage ($V_{EN\,L}$), 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 $V_{EN\,H}$ and $V_{EN\,L}$ 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 $V_{EN\,L}$, 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).

7. 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:

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

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

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. Built-in Current Limit & Short Circuit Protection

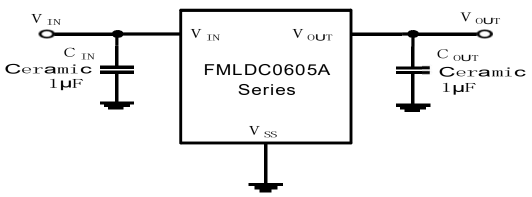
The FMLDC0605A series has an internal current limiting circuit, which can protect the device by limiting the load current value in case of instantaneous high load current. When the current limiting is triggered, the output voltage is not regulated. If the out pin of the regulator is short circuited, 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 I_{Short} can be found in Electrical Characteristics.

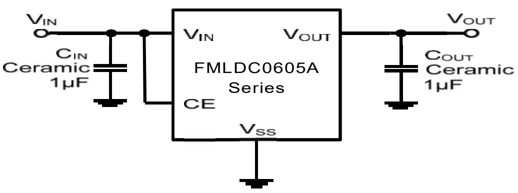
The current limiting state will continue until the load current drops to the normal range. In order to ensure the normal operation of current limit, the inductance of input and load shall be minimized. Continuous operation under current limit is not recommended.

The current limit mode of the FMLDC0605A series is fold-back current limit. Using electronic load to test the starting characteristics may cause the device to fail to start normally.

Application and Implementation

1. Typical Application Circuit





2. Application Information

2.1. Selection of Bypass Capacitances

It is recommended to use 1μF input and output ceramic capacitors to keep the device stable, and the position ofthe capacitor should be as close to the pin of the chip as possible.Ceramic capacitors with low equivalent series resistance (ESR) are recommended. In such application scenarios, chip multilayer ceramic capacitor (MLCC) is a good choice, but the appropriate type of capacitor must be selected. Ceramic capacitors with X7R-, X5R- and C0G- rated dielectric materials can provide relatively good capacitancestability for the equipment in the temperature range. However, due to the large change of Y5V- capacitance value,Y5V- capacitor is not recommended.

However, no matter which kind of ceramic capacitor is selected, the effectivecapacitance may vary with the working voltage and temperature.In general, the use of appropriate input capacitors can help offset reactive input sources and improve transientresponse, input ripple and PSRR. If the power impedance is greater than 0.5Ω, it is recommended to use inputcapacitors. Higher value capacitors may be required if large, fast rise time load or line transients are expected, or ifthe device is located a few inches from the input power supply.Also, the dynamic performance of the device can be improved by using a suitable output capacitor.

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 tochange 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

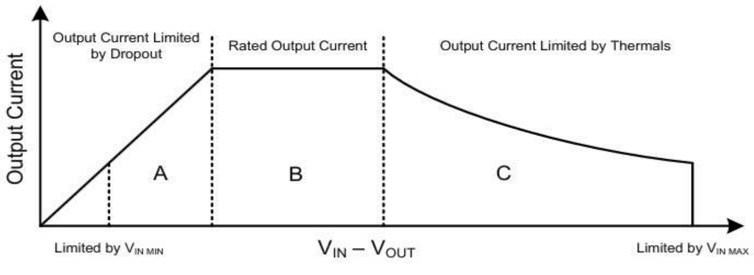
The FMLDC0605A series is internally integrated with a P-MOSFET to achieve low dropout voltage. The voltage difference between the input and the output (V_{IN} - V_{OUT}) of the device must not be lower than the corresponding dropout voltage (V_{DO}) to ensure that the output voltage tolerance is within 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

As an LDO, the working area of FMLDC0605A series 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 8-1:

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 I_{rated}.
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 of FMLDC0605A series is limited by the rated $V_{IN\,MIN}$ and $V_{IN\,MAX}$.



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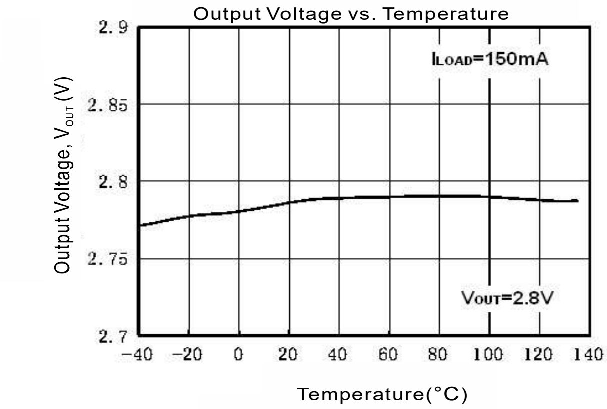
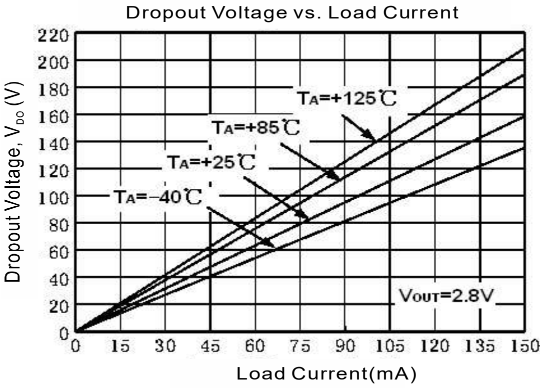
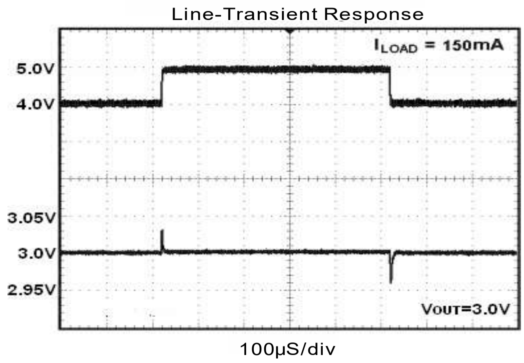
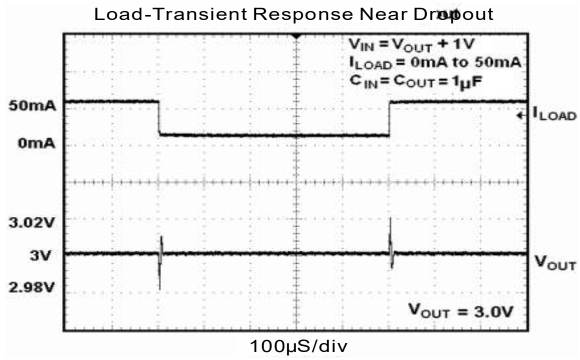
Rating and characteristic curves

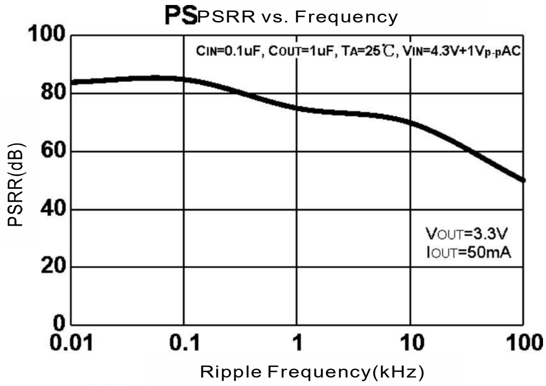
(C_{IN}=1.0μF, C_{OUT} = 1.0μF, T_A=25℃, unless otherwise specified)

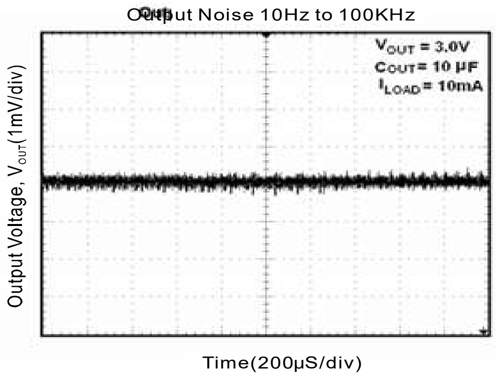


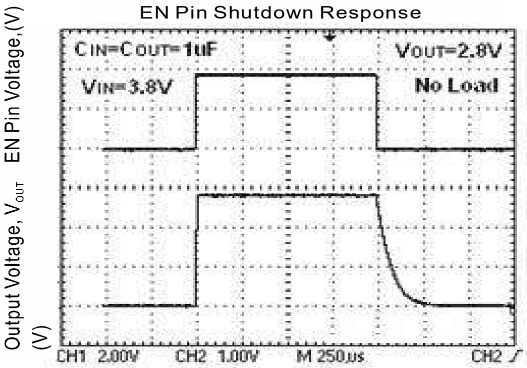


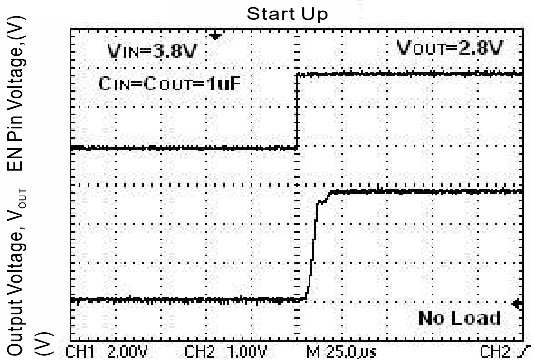






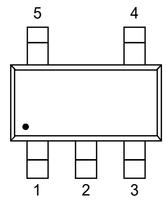
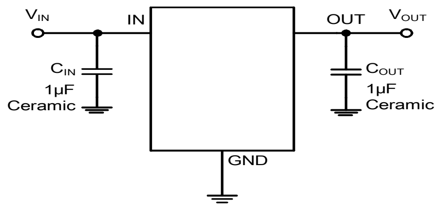






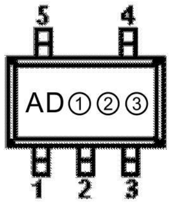
FMLDC0605A1V2AMH Thru FMLDC0605A3V3AMH

Pinning information

Pin	Simplified outline	Symbol
Pin 1 IN Pin 2 GND Pin 3 EN Pin4 NC Pin5 OUT		

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.

Marking

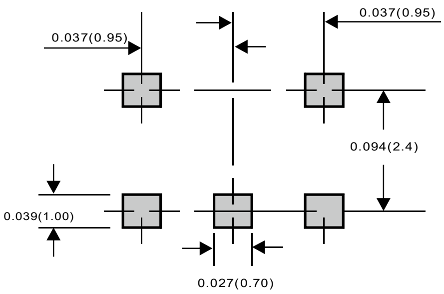


	Marking code	Description
①	d	FMLDC0605A1V2AMH
	j	FMLDC0605A1V8AMH
	q	FMLDC0605A2V5AMH
	t	FMLDC0605A2V8AMH
	v	FMLDC0605A3V0AMH
	y	FMLDC0605A3V3AMH
②③	XX	Code, indicates weekly record information of wafer lot code

X : Represents any character.

Suggested solder pad layout

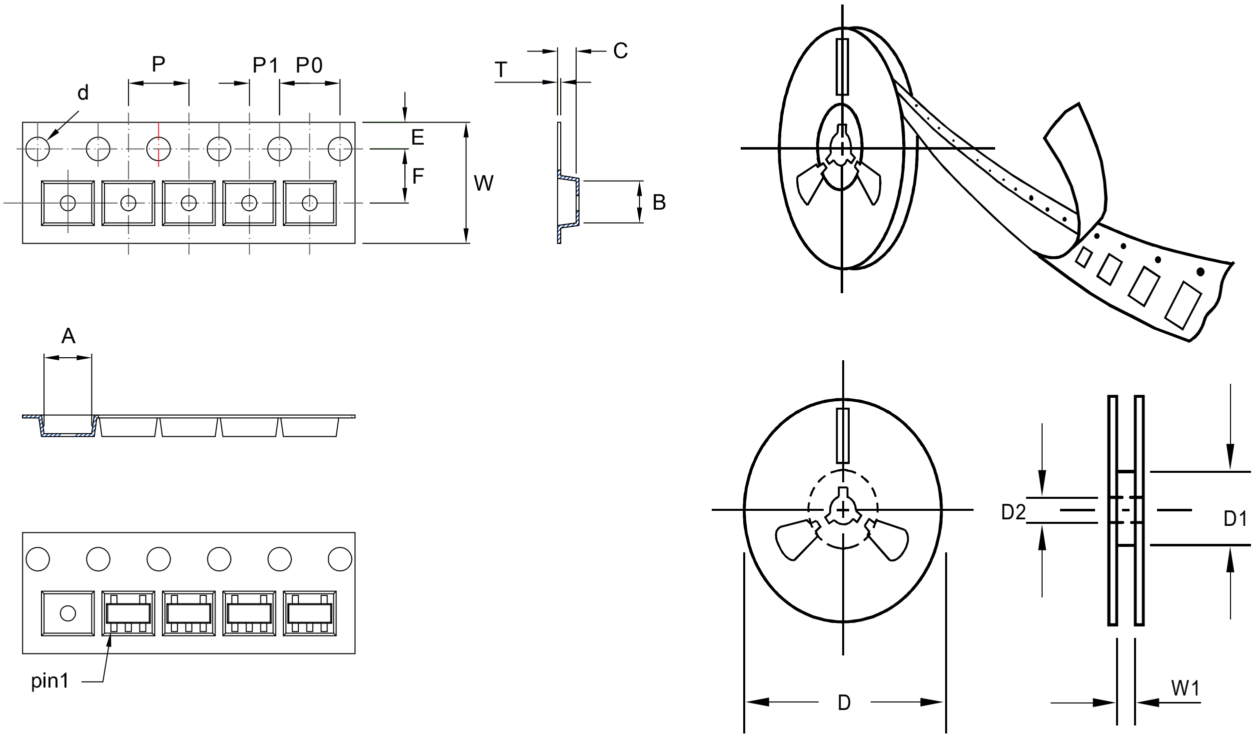
SOT-23-5



Dimensions in inches and (millimeters)

FMLDC0605A1V2AMH Thru FMLDC0605A3V3AMH

Packing information



Unit : mm

Item	Symbol	Tolerance	SOT-23-5
Carrier width	A	±0.1	3.18
Carrier length	B	±0.1	3.28
Carrier depth	C	±0.1	1.32
Sprocket hole	d	±0.1	1.50
7" Reel outside diameter	D	±1.0	180.0
7" Reel inner diameter	D1	±0.5	60.0
Feed hole diameter	D2	±0.3	13.0
Sprocket hole position	E	±0.1	1.75
Punch hole position	F	±0.1	3.50
Punch hole pitch	P	±0.1	4.00
Sprocket hole pitch	P0	±0.1	4.00
Embossment center	P1	±0.1	2.00
Over all tape thinkness	T	±0.1	0.20
Tape width	W	±0.2	8.10
Reel width	W1	±0.2	9.50

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

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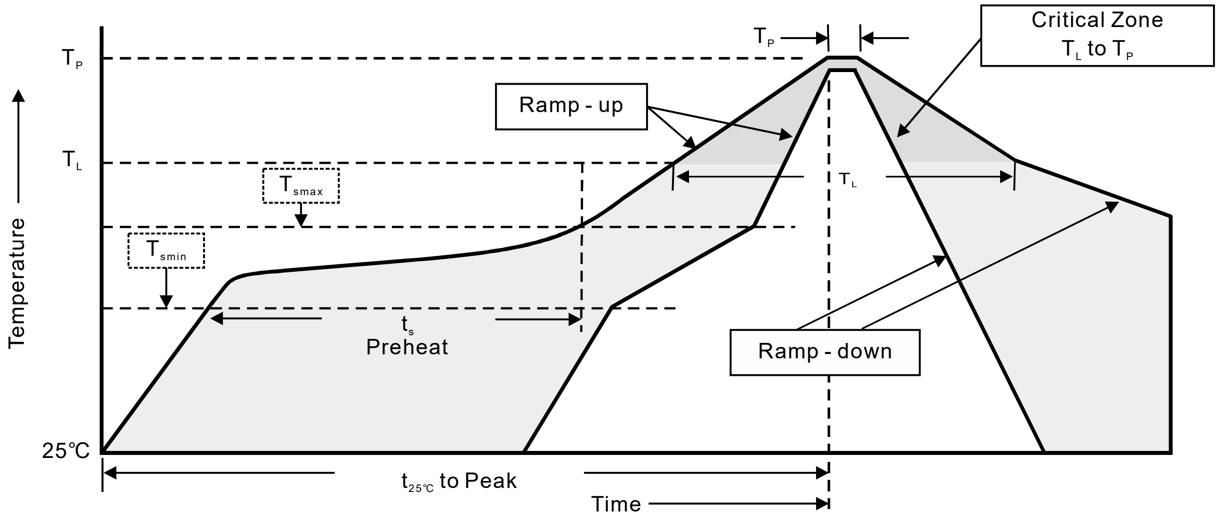
Reel packing

Package	Units (pcs)			Dimension (Unit : mm^3)		
	Reel	Inner Box	Outer Box	Reel DIA,	Inner Box	Outer Box
SOT-23-5	3,000	30,000	120,000	178 (7")	210 x 205 x 205	445 x 230 x 435

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