FMLDC05503A1V2AMH Thru FMLDC05503A3V3AMH

List

FMLDC05503A1V2AMH Thru FMLDC05503A3V3AMH

300mA Low Voltage Difference CMOS Voltage Regulators

Features

- Power Supply Rejection Ratio : 90dB@1kHz, 75dB@10kHz.
- Output Noise Voltage : 30 × V_{OUT} μVRMS (10Hz ~ 100kHz).
- Inrush Current Protection.
- Input Voltage Range : 1.8V ~ 5.5V.
- Fixed Output Voltage : 1.2V, 1.8V, 2.5V, 2.8V, 3.0V, 3.3V.
- Output Tolerance : ±1%.
- Output Current : up to 300mA.
- Dropout Voltage : 135mV@300mA.
- Output active discharge.
- Enable Control.
- Complete protection : Current limiting protection Thermal Shutdown.
- Lead-free parts meet RoHS requirements.
- Halogen-free (IEC61249-2-21).

Applications

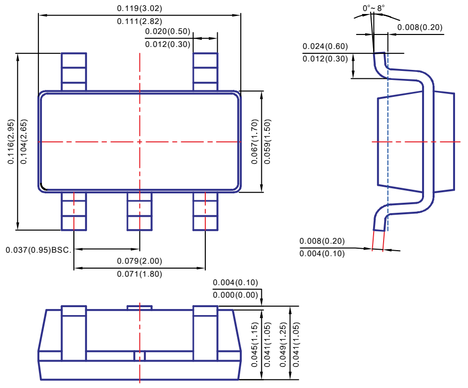
- Battery-powered Equipments.
- Cellular and Smart Phones.
- Digital Still and Video Cameras.

Mechanical data

- Epoxy:UL94-V0 rated flame retardant.
- Case : SOT-23-5.
- Weight : Approximated 13mg.

Package outline

SOT-23-5



Dimensions in inches and (millimeters)

Maximum ratings (T_A=25℃, unless otherwise specified) (Note 1)

Parameter	Symbol	Ratings	Unit
Input voltage (Note2)	V_{IN}	-0.3 ~ 6.0	V
Enable input voltage range (Note2)	V_{EN}, V_{BIAS}	V_{SS}-0.3 ~ (V_{IN} + 0.3) ≤ 6	V
Output voltage (Note2)	V_{OUT}	V_{SS}-0.3 ~ (V_{IN}+0.3)	V
Reference Power dissipation (Note 5)	P_D	0.4	W
Electrostatic discharge	$V_{ESD\text{-}HBM}$	2	KV
Thermal resistance, junction to ambient (Note 5)	$R_{\theta JA}$	249.5	℃/W
Thermal resistance, junction to case (Note 5)	$R_{\theta JC}$	64.8	℃/W
Operating junction temperature range	T_J	-40 to +125	℃
Storage temperature range	T_{STG}	-40 to +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.

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

(5)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.

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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}	T_A=25℃		1.8		5.5	V
DC Output voltage tolerance	$V_{OUT-TOL}$	I_{OUT}=1mA		-1		+1	%
Output Current (Note 7)	I_{OUT}				300		mA
Output current limit	I_{CL}	V_{OUT}=$V_{OUT(NOM)}$ x 90% (Note 8)			600		mA
Line regulation (Note 9)	LNR	I_{OUT} =10mA, V_{IN} = V_{OUT} +1V to 6V			0.01	0.3	%/V
Load regulation	LDR	1mA ≤ I_{OUT} ≤ 300mA			25	50	mV
Dropout voltage (Note 10)	V_{DO}	I_{OUT} =300mA	1.2V≤V_{OUT}<1.8V		400	800	mV
			1.8V≤V_{OUT}<2.5V		220	330	
			2.5V≤V_{OUT}<3.3V		140	210	
			V_{OUT}≥3.3V		120	180	
Quiescent current	I_Q	I_{OUT} = 0mA		15	45	90	μA
Shutdown current	I_{SHDN}	V_{EN} ≤ 0.4V			0.01	1	μA
EN logic low voltage	V_{ENH}	Turn on, stable output voltage		1.0			V
	V_{ENL}	Turn off, output voltage is low				0.4	V
EN Pull down current	I_{EN}	V_{EN}=5.5V			0.05	1	μA
Output noise voltage	Noise	f=10Hz ~ 100KHz, I_{OUT}=300mA			30xV_{OUT}		$μV_{rms}$
Ripple suppression ratio	PSRR	I_{OUT}=10mA, V_{IN}=3.8V, V_{OUT}=2.8V	f = 1KHz		90		dB
			f = 10KHz		75		
			f = 100KHz		60		
			f = 1MHz		62		
Thermal shutdown	T_{SD}	—			150		℃
Thermal shutdown hysteresis	ΔT_{SD}	—			20		℃
C_{OUT} auto-discharge resistance	R_{DIS}	V_{EN} < 0.4			500		Ω
Inrush Current	I_{RUSH}	V_{IN} = 5.5V, V_{EN} = 0 → 5.5V			200		mA
Load Transient	—	I_{OUT} = 1mA to 300mA in 1μs V_{OUT} = 2.8V			-30		mV
Short current	—	I_{OUT} = 300mA to 1mA in 1μs V_{OUT} = 2.8V			+29		

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Note :

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

(7)Maximum output current is affected by the PCB layout, metal trace width, number of layers, ambient temperature and other environmental factors. Thermal limitations of the system must be carefully considered.

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

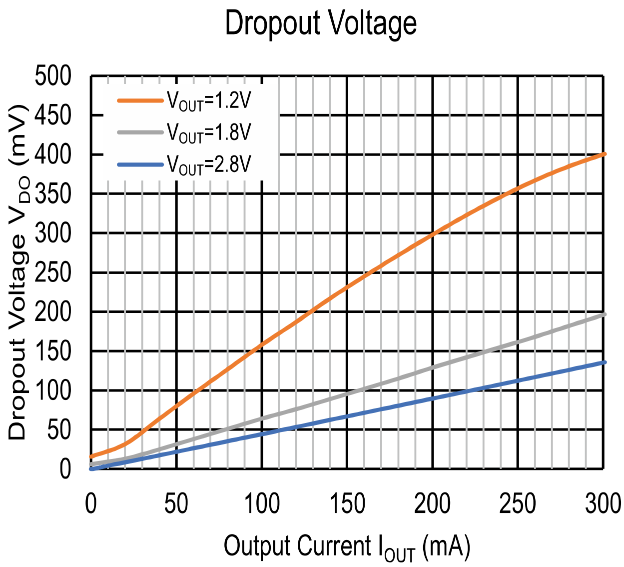
(9)The line regulation is calculated by the following formula :

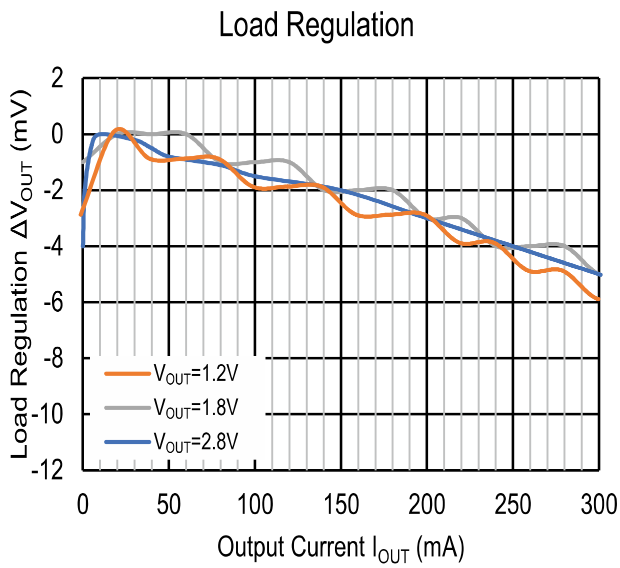
$$LNR = \frac{\Delta V_{OUT}}{V_{OUT} \times \Delta V_{IN}}$$

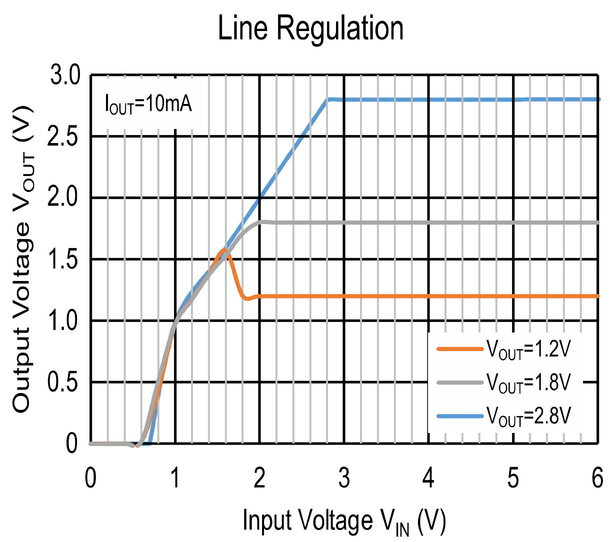
where, ΔV_{OUT} is the variation of the output voltage, ΔV_{IN} is the variation of the input voltage.

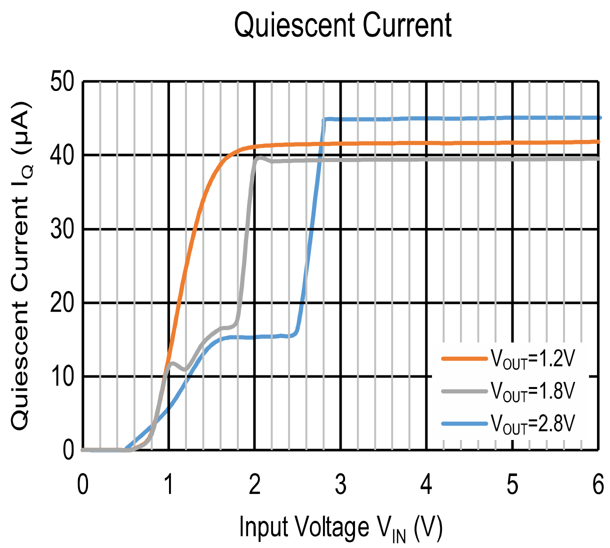
(10)Test the difference of output voltage and input voltage when input voltage is decreased gradually till output voltage equals to 98% of V_{OUT} Normal.

Typical characteristics (V_{IN}= $V_{OUT\ (NOM)}$ + 1V, C_{IN} = 1μF, C_{OUT} = 1μF, T_A = 25℃, unless otherwise specified)





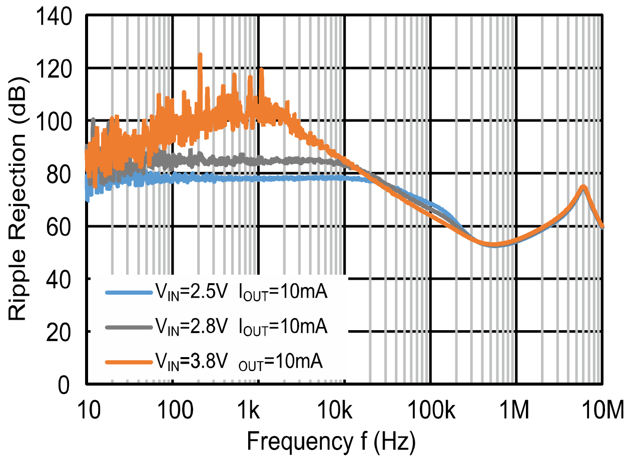




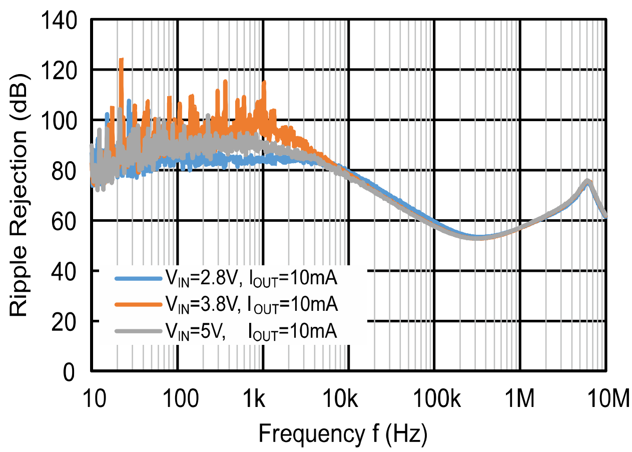
Typical characteristics (Continued)

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

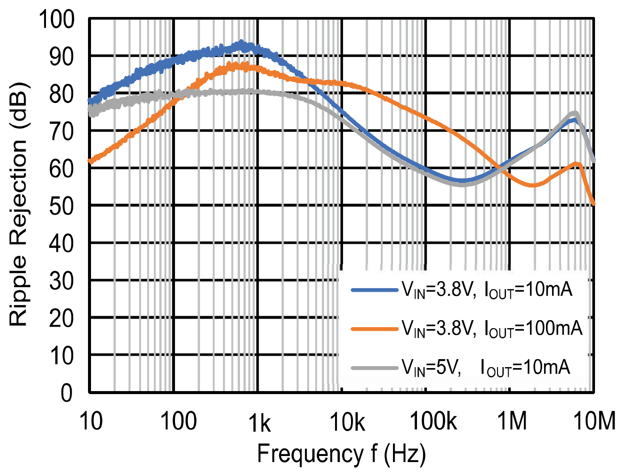
1.2V Output Ripple Rejection vs. Frequence



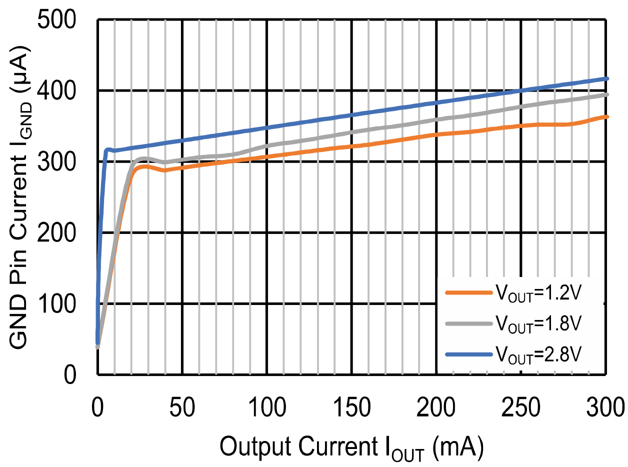
1.8V Output Ripple Rejection vs. Frequence



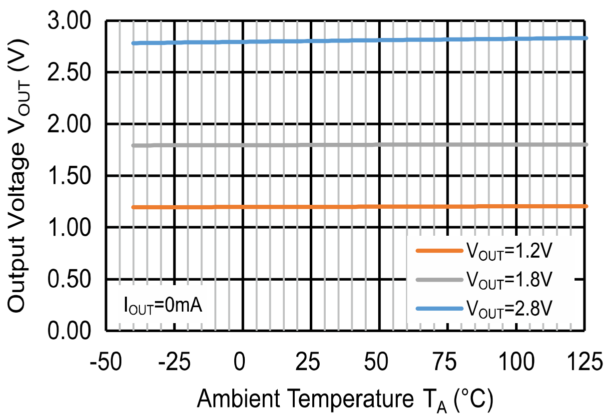
2.8V Output Ripple Rejection vs. Frequence



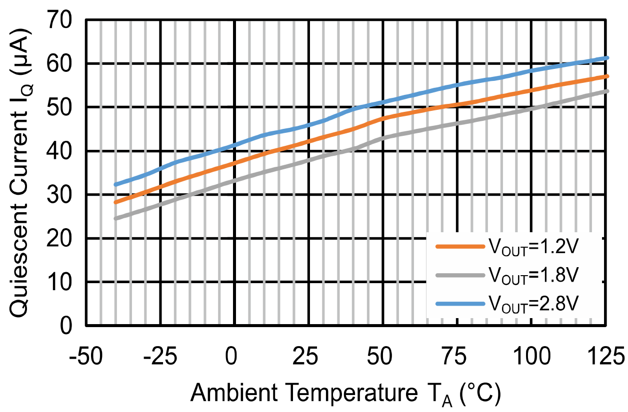
GND Pin Current



Output Voltage vs.Temperature



Quiescent Current vs. Temperature



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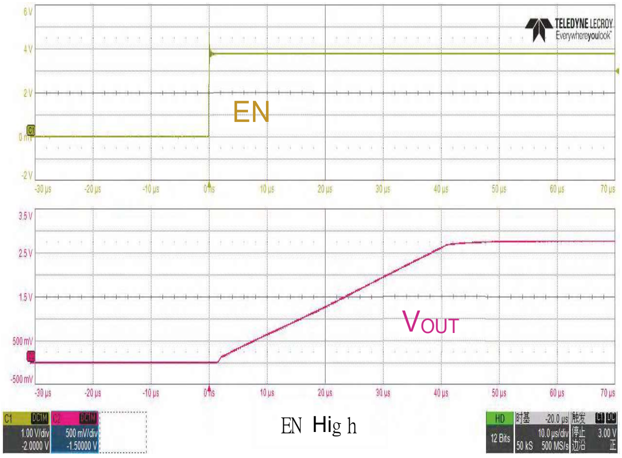
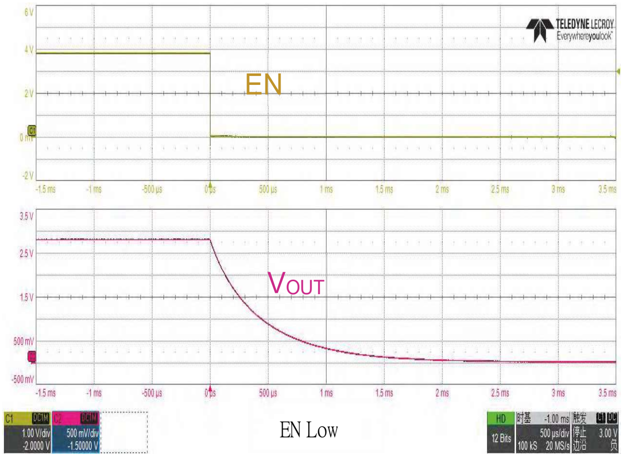
Typical characteristics (continued)

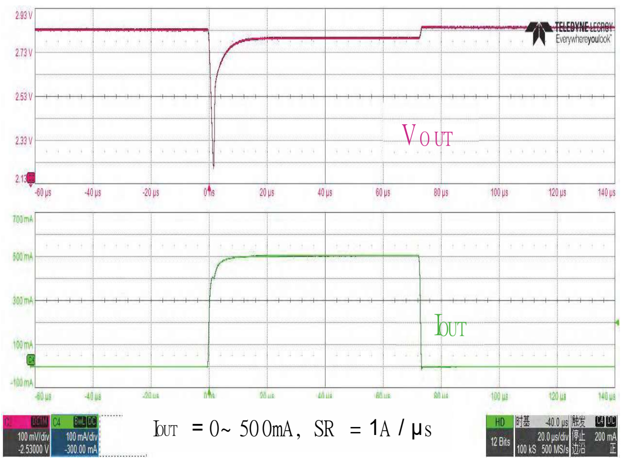
(V_{IN}= $V_{OUT\,(NOM)}$ + 1V, C_{IN} = 1μF, C_{OUT} = 1μF, T_A = 25℃, unless otherwise specified)

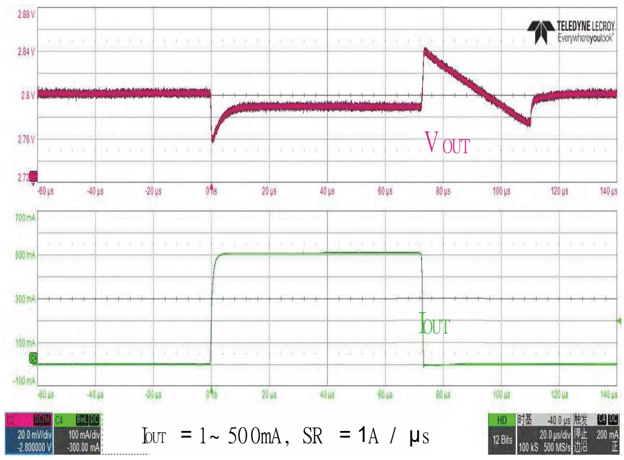
EN Response (V_{OUT} = 2.8V, V_{IN} = 3.8V, V_{EN} = 0 ~ 3.8V, I_{OUT} = 0mA)



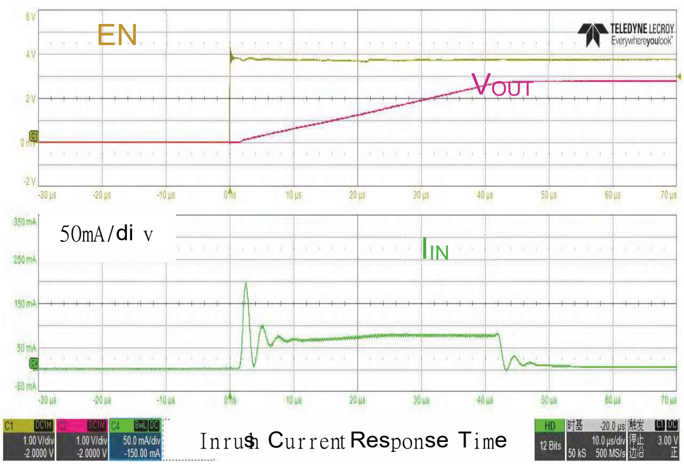


Load Transient (V_{OUT}=2.8V, V_{IN} = V_{EN} = 3.8V)



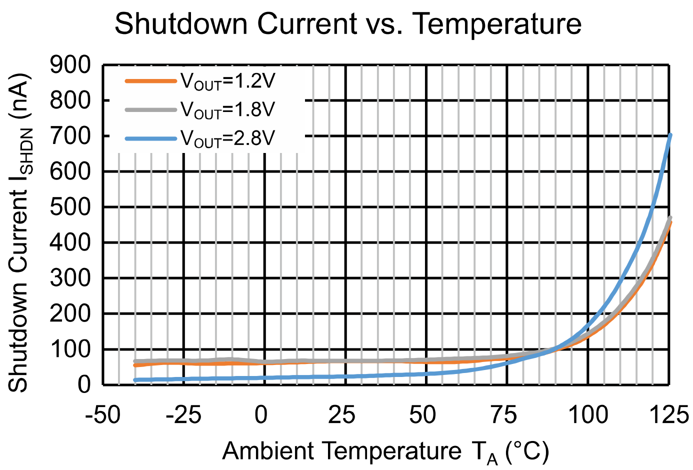


Inrush Current Response Time (V_{OUT}=2.8V, V_{IN} = V_{EN} = 3.8V, I_{OUT} = 0mA)

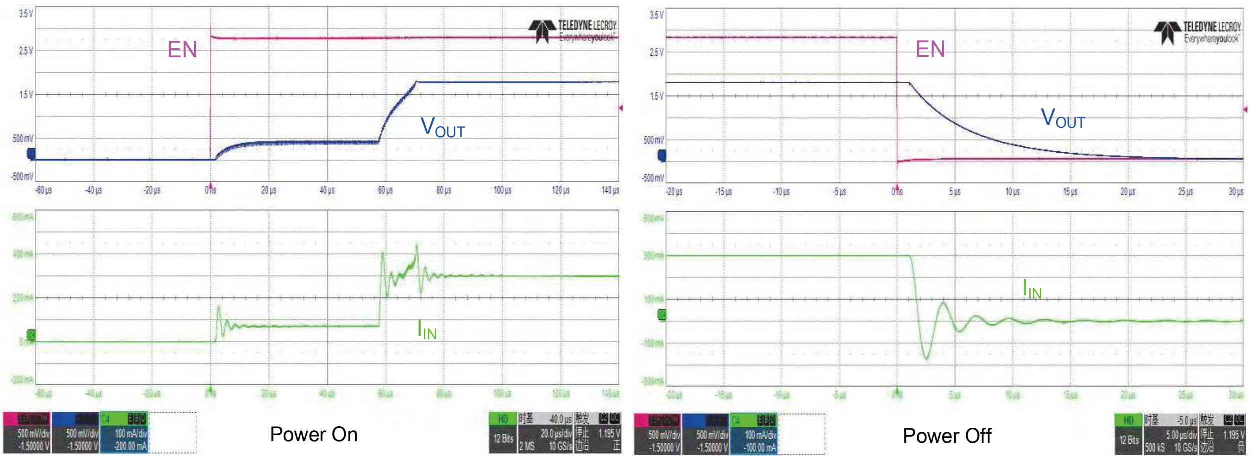


Typical characteristics (Continued)

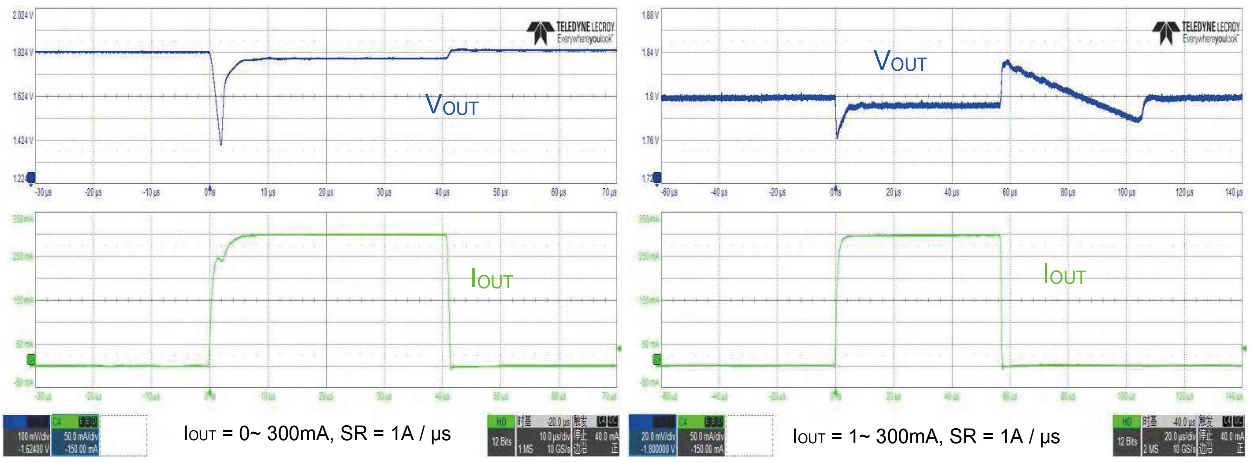
($V_{IN} = V_{OUT\,(NOM)} + 1V$, $C_{IN} = 1\mu F$, $C_{OUT} = 1\mu F$, $T_A = 25°C$, unless otherwise specified)



Inrush Current Response Time (V_{OUT}=1.8V, $V_{IN} = V_{EN}$ = 2.8V, I_{OUT}=300mA)



Load Transient (V_{OUT}=1.8V, $V_{IN} = V_{EN}$ = 2.8V)



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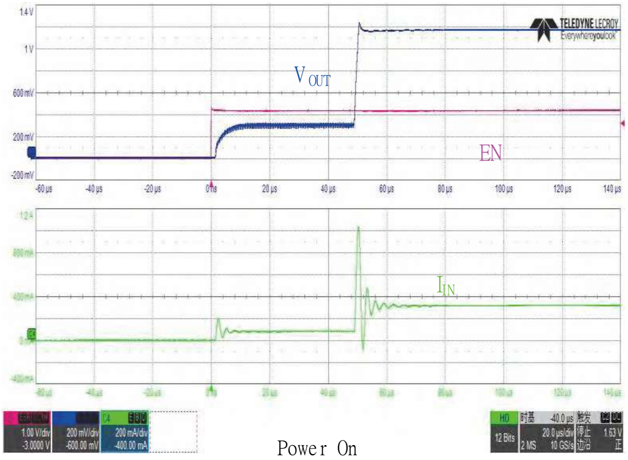
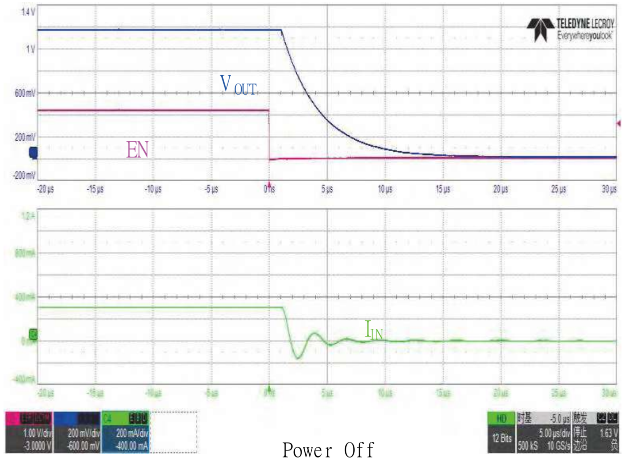
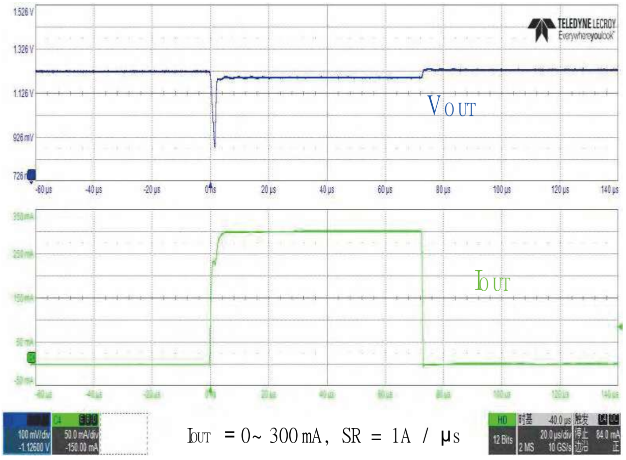
Typical characteristics curve (V_{IN}= $V_{OUT\,(NOM)}$ + 1V, C_{IN} = 1μF, C_{OUT} = 1μF, T_A = 25°C, unless otherwise specified)

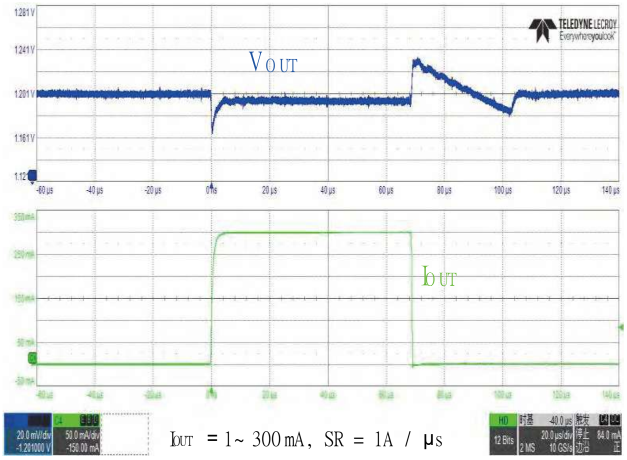
Inrush Current Response Time (V_{OUT}=1.2V, V_{IN} = V_{EN} = 2.2V, I_{OUT}=300mA)



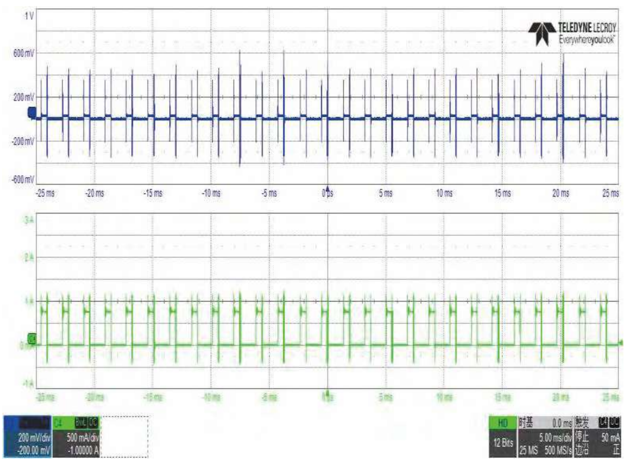


Load Transient (V_{OUT}=1.2V, V_{IN} = V_{EN} = 2.2V)

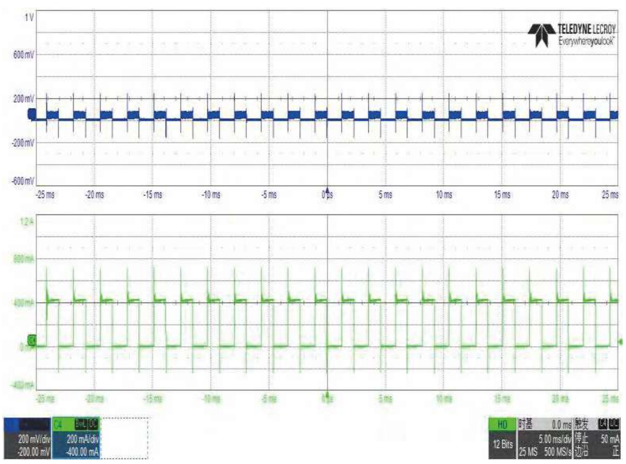




Short-Circuit Response (V_{OUT} = 1.2V, V_{EN} = V_{IN})



Short-Circuit Response (V_{OUT} = 1.2V, V_{EN} = V_{IN})

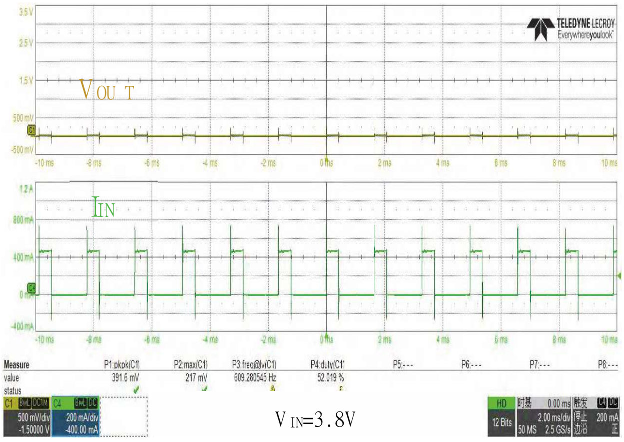


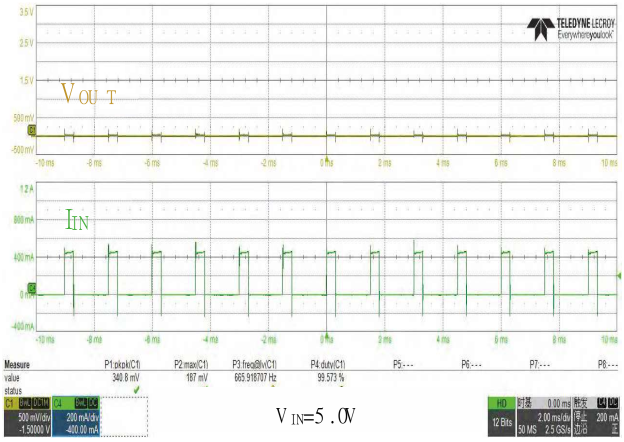
FMLDC05503A1V2AMH Thru FMLDC05503A3V3AMH

Typical characteristics curve

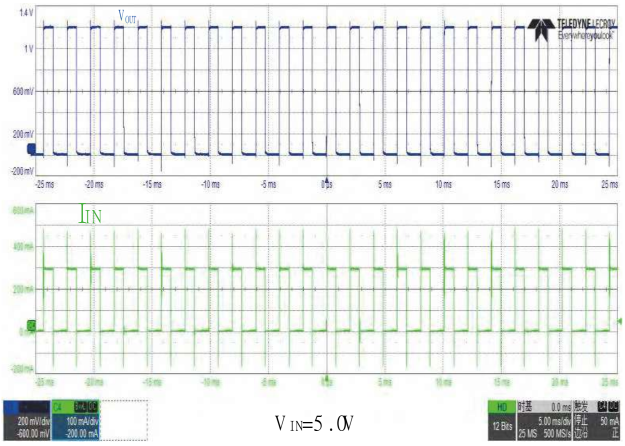
(V_{IN}= $V_{OUT\,(NOM)}$ + 1V, C_{IN} = 1μF, C_{OUT} = 1μF, T_A = 25°C, unless otherwise specified)

Short-Circuit Response (V_{OUT} = 2.8V, V_{EN} = V_{IN})

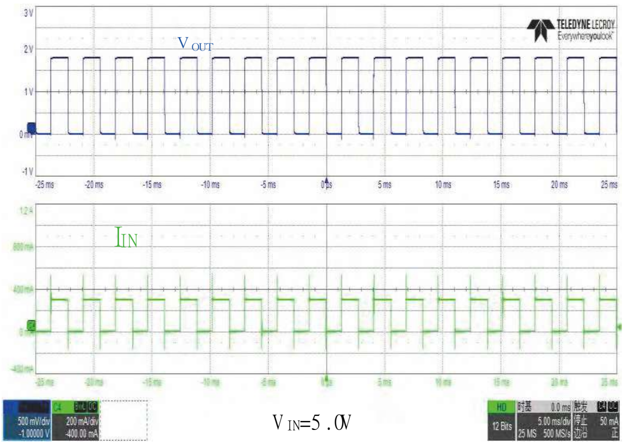




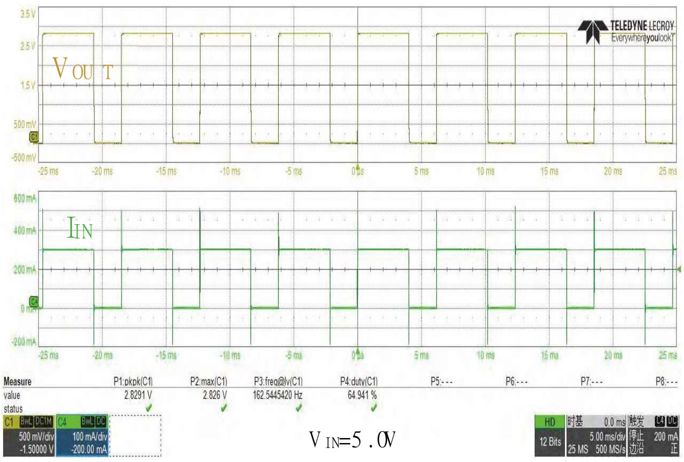
Thermal Shutdown (V_{OUT} = 1.2V, I_{OUT} = 300mA)



Thermal Shutdown (V_{OUT} = 1.8V, I_{OUT} = 300mA)



Thermal Shutdown (V_{OUT} = 2.8V, I_{OUT} = 300mA)

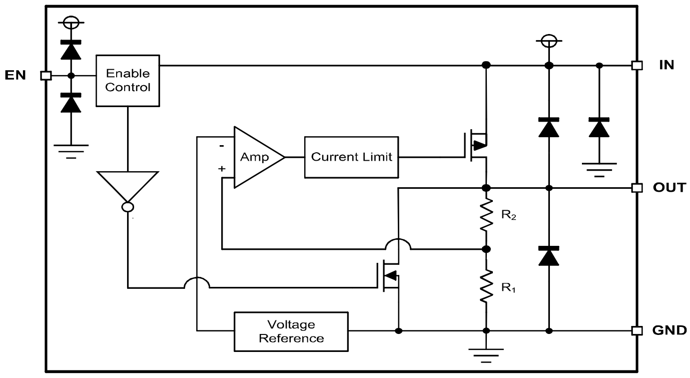


Detailed Description

1. Description

The FMLDC05503A series is a High speed LDO regulator that features high accuracy, low noise, high ripple rejection, low dropout and low power consumption. The series consists of a voltage reference, an error amplifier, a driver transistor, a current limiter, a phase compensation circuit. The inrush current protection limits the inrush current from input pin (V_{IN}) to output pin (V_{OUT}) to charge C_{OUT} capacitor. The output can be turned off by controlling the EN pin on the chip, and the power consumption after turning off is only below 0.1 μA.

2. Functional block diagram



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).

Enable Operation

The enable pin will turn the regulator on or off. The threshold limits are covered in the Electrical characteristics table in this data sheet. If the enable function is not to be used then the pin should be connected to V_{IN}.

Current Limitation

The internal Current Limitation circuitry allows the device to supply the full nominal current and surges but protects the device against Current Overload or Short.

Thermal Protection

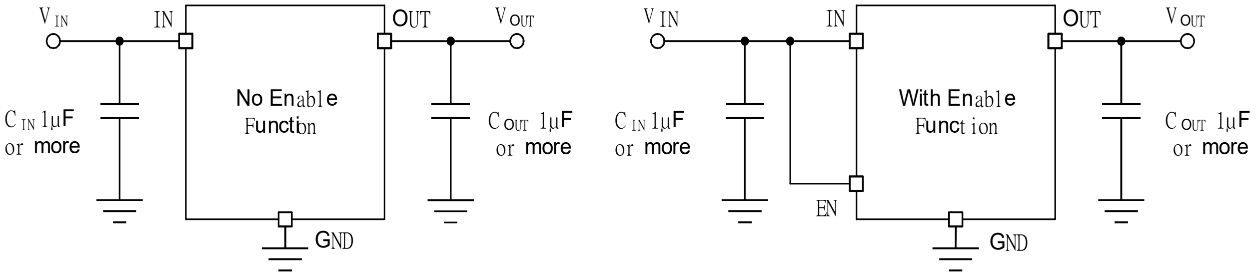
Internal thermal shutdown (TSD) circuitry is provided to protect the integrated circuit in the event that the maximum junction temperature is exceeded. When TSD activated, the regulator output turns off. When cooling down under the low temperature threshold, device output is activated again. This TSD feature is provided to prevent failures from accidental overheating. Activation of the thermal protection circuit indicates excessive power dissipation or inadequate heat sinking. For reliable operation, junction temperature should be limited to +150℃ maximum .

Inrush Current Protection

The inrush current protection circuit is built in the FMLDC05503A. When the IC starts to operate, the protection circuit limits the inrush current from input pin (V_{IN}) to output pin (V_{OUT}) to charge C_{OUT} capacitor.

Application and Implementation

1. Typical Application Circuits



2. Application Information

Selection of Bypass Capacitances

For the FMLDC05503A series, it is recommended to use 1μF input C_{IN} and output C_{OUT} ceramic capacitors.

Type of Capacitors:

Since any leakage of the capacitor will increase the quiescent power consumption of the whole circuit, attention should be paid to selecting capacitors with low leakage. When designing the circuit of portable equipment including FMLDC05503A series, due to the hostage of tantalum capacitors, it is a good choice to use small size, low equivalent series resistance (ESR) and high RMS current capacity multilayer ceramic capacitors (MLCC) in the DC to DC voltage conversion. The designer must choose the appropriate capacitor type for circuit design: X7R- Ceramic capacitors of X5R- and COG- rated dielectric materials can provide relatively good capacitance stability within the temperature range, Y5V- type capacitors are not recommended because of large changes in capacitance values. However, no matter which type of ceramic capacitor is selected, the effective capacitance may vary with the operating voltage and temperature. The designer must consider the influence of the change of the effective value of capacitance according to the circuit design and application conditions.

Input Capacitors CIN:

It is recommended to use a 1μF capacitor at the input pin of the device, and the position of the input capacitor should be as close to the device input pin as possible. For the FMLDC05503A series, the input capacitor is not necessary to maintain the output stability, but it can offset the reactive input source and improve the transient response, input ripple and PSRR performance of the device. It should be noted that although many types of capacitors can be used for input bypass, using ceramic capacitors for input filtering may cause problems. Due to the self-resonance and high Q characteristics of some types of ceramic capacitors, under certain starting conditions, applying voltage steps to ceramic capacitors may lead to large current surges (such as directly connecting the input pin of LDO to the power supply), which may cause some energy stored in the parasitic inductance of the power lead. When the stored energy is transferred from these inductors to ceramic capacitors, large voltage spikes may occur in the circuit. These voltage spikes are easily twice the step amplitude of the input voltage, and are likely to bring potential risks to the normal operation and reliability of the device. Therefore, the selection of ceramic capacitors as input capacitors must be careful. Adding 3Ω resistors and X5R- type ceramic capacitors will minimize voltage transients during startup. A higher value capacitor may be necessary if large, fast rise time load or line transients are anticipated or if the device is located several inches from the input power source.

Selection of Bypass Capacitances (continued)

Output Capacitors C_{OUT} :

Recommended 1μF output ceramic capacitor to keep the device output stable, and the capacitor position should be as close to the device pin as possible. For FMLDC05503A series, 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.

Application and Implementation (continued)

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.

Operation in Dropout Mode

The FMLDC05503A 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 VIN - 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.

Recommended Continuous Operating Areas

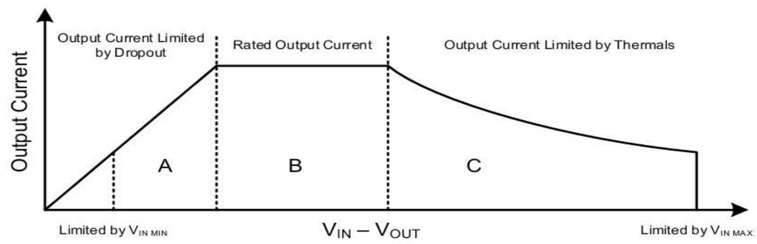
As an LDO, the working area of FMLDC0605A series is limited by dropout voltage, output current, junction temperature and input voltage under continuous working condition. The recommended areas for continuous operation are shown in Figure 8-1:

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 FMLDC05503A series is limited by the rated $V_{IN\,MIN}$ and $V_{IN\,MAX}$.



Region Description for Continuous Operation

Power Supply Recommendation

The FMLDC05503A series is designed to operate within the input power supply voltage range of 1.8V to 5.5V. 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.

FMLDC05503A1V2AMH Thru FMLDC05503A3V3AMH

Application and Implementation

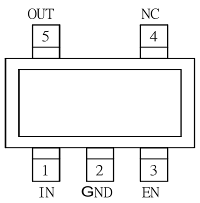
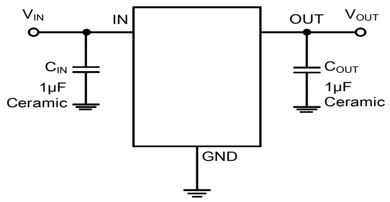
Application Information (continued)

Layout Guide lines :

When designing the circuit including CJ6214 series, the following matters should be noted:

1. Place the input and output capacitors as close to the pins of the device as possible;
2. 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;
3. 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.

Pinning information

Pin	Simplified outline	Symbol
Pin 1 IN Pin 2 GND Pin 3 EN Pin 4 NC Pin 5 OUT		

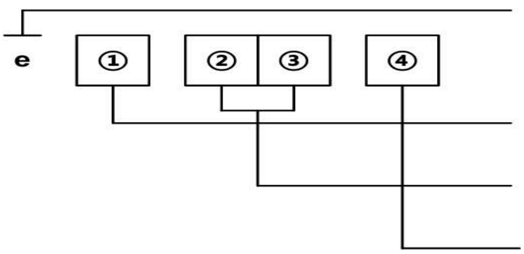
1. GND : Regulator ground.
2. OUT : Output of the regulator. An output capacitor is required for stability and help device obtain the best transient response. Use the capacitor with the recommended value and place it as close as possible to the output.
3. IN : Input to the device. Use the recommended 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. 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.
5. Thermal Pad: Connect the thermal pad to a large-area ground plane. The thermal pad is internally connected to GND.

Order able information

Part No.	Output voltage (V)
FMLDC05503A1V2AMH	1.2
FMLDC05503A1V8AMH	1.8
FMLDC05503A2V5AMH	2.5
FMLDC05503A2V8AMH	2.8
FMLDC05503A3V0AMH	3.0
FMLDC05503A3V3AMH	3.3

FMLDC05503A1V2AMH Thru FMLDC05503A3V3AMH

Marking



Serial code for CJ6214 series.

Representative output voltage.
B: Fixed output 1.2V F: Fixed output 2.8V
D: Fixed output 1.8V G: Fixed output 3.0V
E: Fixed output 2.5V H: Fixed output 3.3V

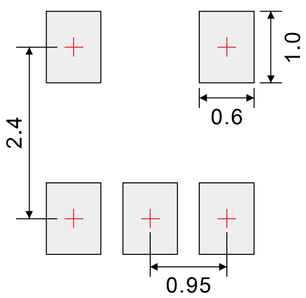
(Other products are customized)

Code, indicates weekly record information of production.

Code, special pin arrangement sequence.
(blank): Normal

Suggested solder pad layout

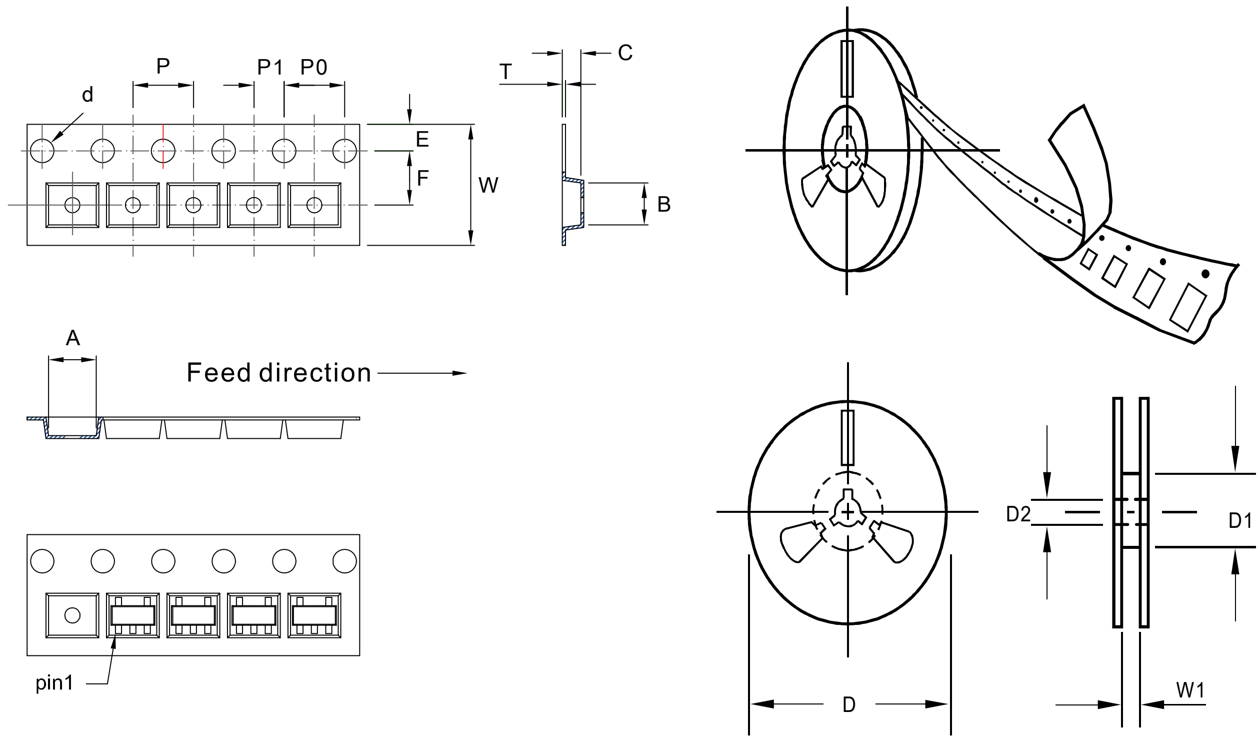
SOT-25



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

FMLDC05503A1V2AMH Thru FMLDC05503A3V3AMH

Packing information



Unit : mm

Item	Symbol	Tolerance	SOT-23-5
Carrier width	A	±0.1	3.17
Carrier length	B	±0.1	3.23
Carrier depth	C	±0.1	1.37
Sprocket hole	d	±0.1	1.55
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	8.00
Reel width	W1	±0.2	9.50

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

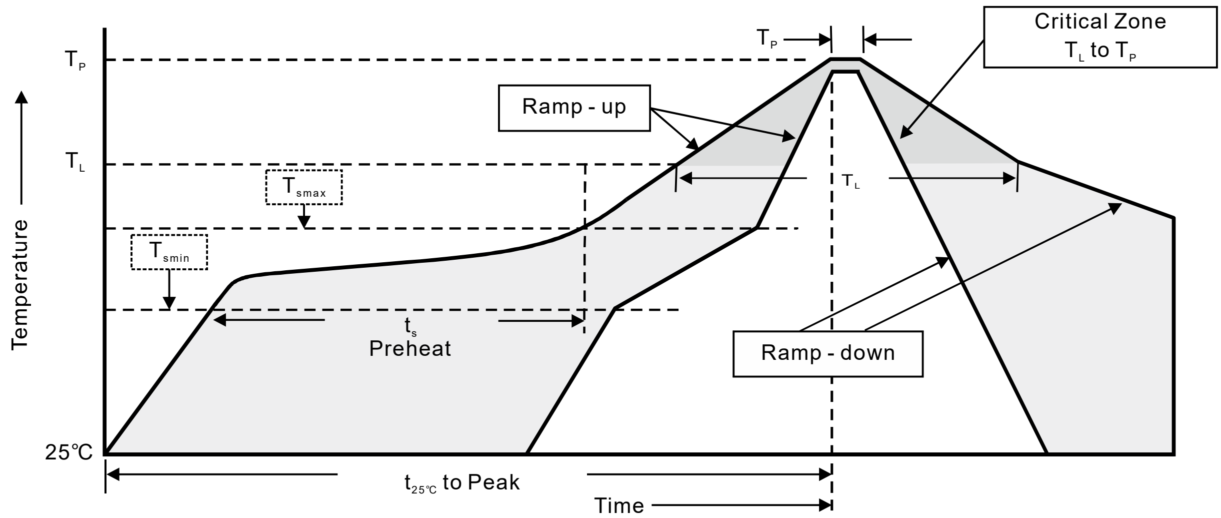
FMLDC05503A1V2AMH Thru FMLDC05503A3V3AMH

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