300mA Adjustable CMOS Low Noise LDO Voltage Regulator

◆ DESCRIPTION

The MT506 is a positive, adjustable linear regulator. It features low quiescent current (65μA Typ.) and low dropout voltage, making it ideal for battery powered applications. The output voltage is adjustable from 1.2V through 5V. Its high PSRR makes it useful in applications that require AC noise suppression on the input power supply. Space-saving S0T-23-5 packages are attractive for portable and handheld applications. It has both thermal shutdown and a current limit features to prevent device failure under extreme operating conditions. It is stable with an output capacitor of 2.2μF or greater.

◆ FEATURES

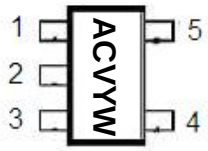
- Low Dropout Voltage: 180mV@ 300mA (V_O=3.3V)
- Accuracy within ±2%
- Quiescent Current: 65μA Typ.
- High PSRR: 67dB@100Hz
- Excellent Line/Load Regulation
- Fast Response
- Current Limiting
- Short Circuit Protection
- Low Temperature Coefficient
- Shutdown Current: 0.5μA
- Thermal Shutdown
- Space Saving Packages S0T-23-5
- Pb-Free Package

◆ APPLICATIONS

- Cordless Phone
- Cellular Phone
- Bluetooth Earphone
- Digital Camera
- Portable Electronics
- WLAN
- MP3 Player

◆ PIN CONFIGURATIONS AND MARKING INFORMATION

SOT-23-5L(Top View)



MT506N

1.VIN 2.GND 3.ENABLE 4.ADJ 5.VOUT

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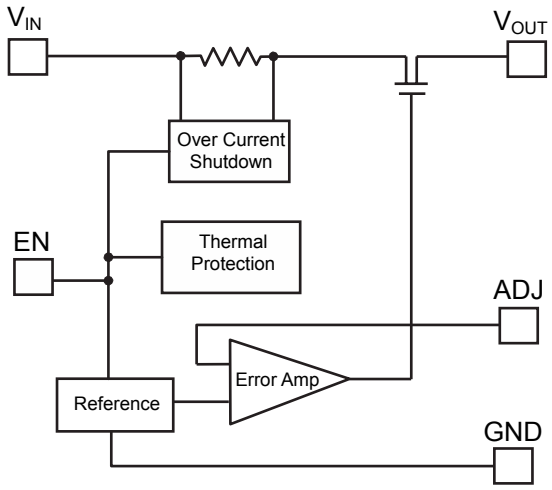
◆ Block Diagram



◆ ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Maximum	Unit
Input supply voltage	V_{IN}	6	V
Output current	I_O	300	mA
Enable voltage	V_{EN}	-0.3 to V_{IN}	V
Output voltage	V_{OUT}	-0.3 to V_{IN}-0.3	V
Storage temperature range	T_{STG}	- 65 to 150	°C
Lead temperature (soldering) 5sec	T_{LEAD}	300	°C

◆ ORDERING INFORMATION

Device	Package		Vout Volts	Shipping
MT506-X.XN	N	SOT-23-5L	ADJ	3,000 Units/Tape & Reel

◆ RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Operating Conditions			Units
		Min.	Typ.	Max.	
Input Voltage	V_{IN}	-	-	5.5	V
Junction temperature range	T_J	-40 ~ 125			°C
Thermal resistance junction to case	θ_{JC}	130			°C/W
Thermal resistance junction to ambient	θ_{JA}	250			°C/W
Internal power dissipation	P_D	400			mW

◆ ELECTRICAL CHARACTERISTICS

V_{IN} = 4V, Vo=3V, C_{IN} = 1μF, C_{OUT} = 2.2μF, I_{OUT} = 10mA; T_A = 25°C; unless otherwise noted

PARAMETER	SYMBOL	Test Conditions		MIN	TYP	MAX	UNITS
Input Voltage	V_{IN}			Note 1	-	5.5	V
Output Voltage	V_O			1.2	-	5	V
Reference Voltage	V_{REF}			-	1.235	-	V
Output Voltage Accurac y	V_O	I_O=1mA		-2	-	2	%
Output Current	I_O			300	-	Note 2	mA
Short Circuit Current	I_{SC}	V_O =0V		-	150	-	mA
Dropout Voltage	V_{drop}	I_O =300mA	2.5V≤Vo<3.3V	-	370	450	mV
			Vo≥3.3V	-	180	230	
Quiescent Current	I_Q	I_O =0mA		-	35	-	μA
Line Regulation	LNR	I_O =1mA, V_{IN} =3Vto 5V		-0.4	0.2	0.4	%/V
Load Regulation	LDR	I_O =1mA to 300mA		-1	0.2	1	%
Temperature Coefficient	Tc			-	40	-	ppm/ ^{O}C
Over Temperature Shutdown	OTS	I_O =1mA		-	150	-	^{O}C
Over Temperature Hysteresis	OTH	I_O =1mA		-	30	-	^{O}C
Power Supply Ripple Rejection	PSRR	I_O=100mA, V_O =1.2V	f=100Hz	-	67	-	dB
			f=1kHz	-	65	-	dB
			f=10kHz	-	42	-	dB
Output Noise	Vn	f =10Hz to 100kHz		-	50	-	μVrms
EN Input High Threshold	V_{IH}	V_{IN} =2.5V to 5V		1.5	-	-	V
EN Input Low Threshold	V_{IL}	V_{IN} =2.5V to 5V		-	-	0.3	V
Shutdown Current	I_{SD}	V_{EN} =0V		-	0.01	1	μA

NOTES:

(1): The minimum input voltage ($V_{IN(MIN)}$) of the MT506 is determined by output voltage and dropout voltage. The minimum input voltage is defined as:

$V_{IN(MIN)}=V_O+V_{drop}$

(2): Output current is limited by P_D, maximum $I_O=P_D/(V_{IN(MAX)}-V_O)$.

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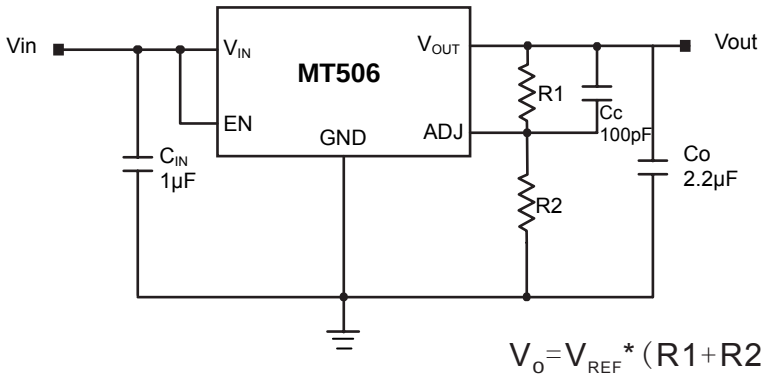
◆ TYPICAL APPLICATIONS



$$V_O = V_{REF} * (R1 + R2) / R2$$

◆ APPLICATION INFORMATION

Capacitor Selection and Regulator Stability

Similar to any low dropout regulator, the external capacitors used with t he MT506 must be carefully selected for regulator stability and performance.

A capacitor C_{IN} of more than 1μF can be employed in the input pin, while there is no upper limit for the capacitance of C_{IN}. Please note that the distance between CIN and the input pin of the MT506 should not exceed 0.5 inch. Ceramic capacitors are suitable for the MT506. Capacitors with larger values and lower ESR (equivalent series resistance) provide better PSRR and line-transient response.

The MT506 is designed specifically to work with low ESR ceramic output capacitors in order to save space and improve performance. Using an output ceramic capacitor whose value is >2.2μF with ESR>5mΩ ensures stability.

ADJ Output Voltage Programming

The output voltage of the MT506 adjustable regulator is programed by using an external resistor divider as shown in Figure1. The output voltage is calculated as below:

$$V_O = V_{REF}(1+R1/R2)$$

Resistor R1 and R2 should be chosen for approximately 7μA divider current. Lower value resistors can be used but offer no advantage and waste more power. Higher value should be avoided as leakage current at ADJ pin increase the output voltage error. Cc is unnecessary when R1 or R2 <20kΩ. The recommended design procedure is to choose R2=169kΩ to set the divider current at 7μA and then calculate R1 as below:

$$R1 = (V_O / V_{REF} - 1)R2$$

Load Transient Considerations

Curve 7 of the MT506 load-transient response on page 7 shows two components of the output response: a DC shift from the output impedance due to the load current change and transient response. The DC shift is quite small due to excellent load regulation of the MT506. The transient spike, resulting from a step change in the load current from 1mA to 300mA, is 20mV. The ESR of the output capacitor is critical to the transient spike. A larger capacitance along with smaller ESR results in a smaller spike.

Shutdown Input Operation

The MT506 can be shut down by pulling the EN input low, and turned on by tying the EN input to VIN or leaving the EN input floating.

Internal P-Channel Pass Transistor

The MT506 features a 0.75Ω P-Channel MOSFET device as a pass transistor. The P-MOS pass transistor enables the MT506 to consume only 65μA of ground current during low dropout, light-load, or heavy-load operation. This feature increases the battery operation life time.

Input-Output (Dropout) Voltage

A regulator's minimum input-output voltage differential (or dropout voltage) determines the lowest usable supply voltage. The MT506 has a typical 300mV dropout voltage. In battery- powered systems, this will determine the useful end-of-life battery voltage.

Current Limit and Short Circuit Protection

The MT506 features a current limit, which monitors and controls the gate voltage of the pass transistor. The output current can be limited to 400mA by regulating the gate voltage. The MT506 also has a built-in short circuit current limit.

Thermal considerations

Thermal protection limits power dissipation in the MT506. When the junction temperature exceeds 150°C, the OTP (Over Temperature Protection) starts the thermal shutdown and turns the pass transistor off. The pass transistor resumes operation after the junction temperature drops below 120°C.

For continuous operation, the junction temperature should be maintained below 125°C. The power dissipation is defined as below:

$$P_D = (V_{IN}-V_{OUT})*I_O+V_{IN}*I_{GND}$$

The maximum power dissipation depends on the thermal resistance of IC package, PCB layout, the rate of surrounding airflow and temperature difference between junction and ambient. The maximum power dissipation can be calculated by the following formula:

$$P_{D(MAX)} = (T_{J(MAX)}-T_A)/\theta_{JA}$$

.

Where $T_{J(MAX)}$ is the maximum allowable junction temperature 125°C, T_A is the ambient temperature and θ_{JA} is the thermal resistance from the junction to the ambient.

For example, as θ_{JA} is 250°C/W for the SOT-23 package based on the standard JEDEC 51-3 for a single-layer thermal test board, the maximum power dissipation at T_A=25°C can be calculated by following formula:

$$P_{D(MAX)} = (125°C-25°C)/250=0.4W$$

It is also useful to calculate the junction temperature of the MT506 under a set of specific conditions. Suppose the input voltage V_{IN}=3.3V, the output current I_O=300mA and the case temperature T_A=40°C measured by a thermal couple during operation, the power dissipation is defined as:

$$P_D = (3.3V-2.8V)*300mA+3.3V*70uA \backsimeq 150mW$$

And the junction temperature T_J can be calculated as follows:

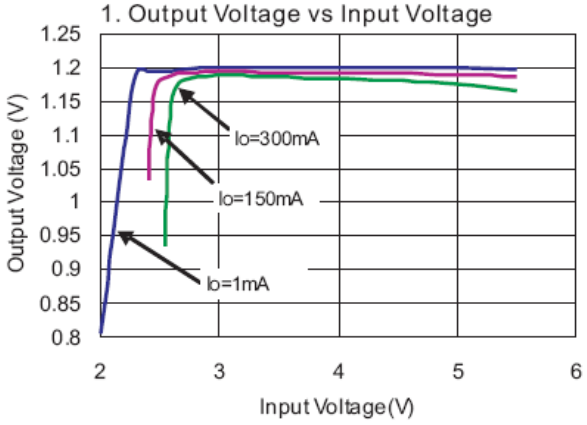
$$T_J = T_A + P_D * \theta_{JA}$$
$$T_J = 40°C+0.15W*250°C/W$$
$$=40°C+37.5°C$$
$$=77.5°C<T_{J(MAX)} = 125°C$$

For this application, T_J is lower than the absolute maximum operating junction temperature 125°C, so it is safe to use the MT506 in this configuration.

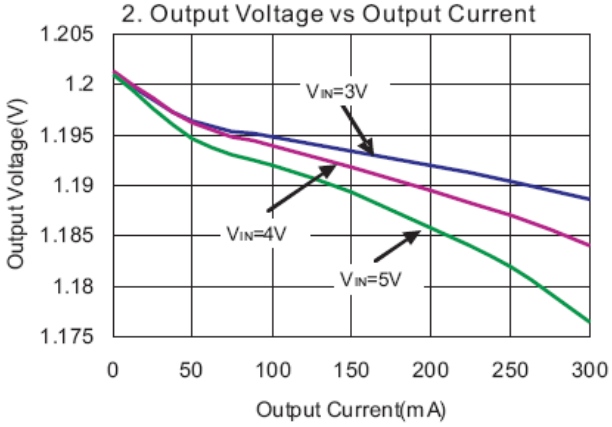
◆ TYPICAL PERFORMANCE CHARACTERISTICS

T_A=25°C, V_O=1.2V, C_{IN}=1μF, C_O=2.2μF, unless otherwise noted

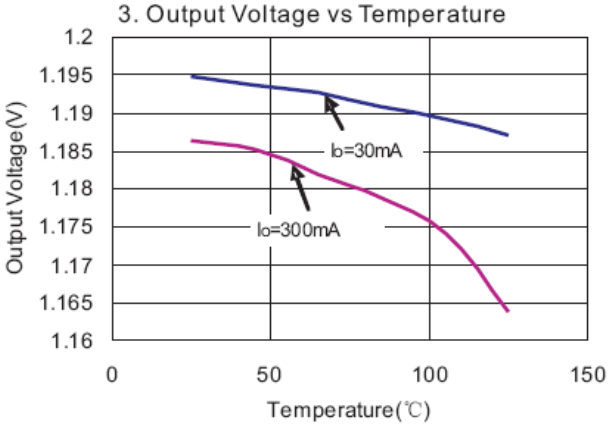
1. Output Voltage vs Input Voltage



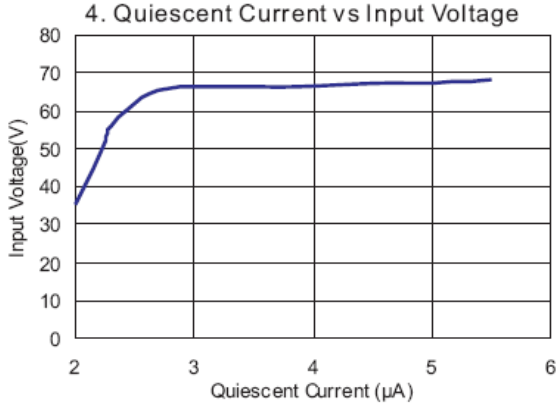
2. Output Voltage vs Output Current



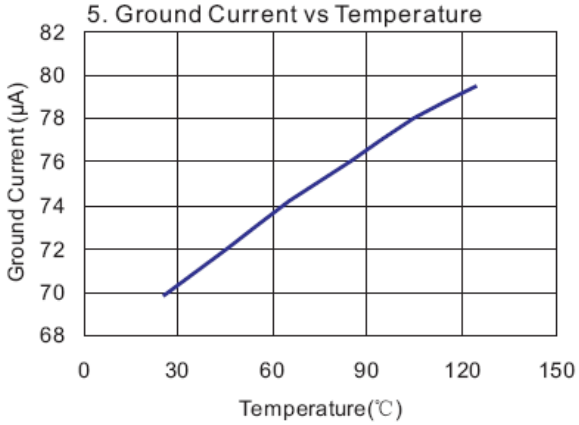
3. Output Voltage vs Temperature



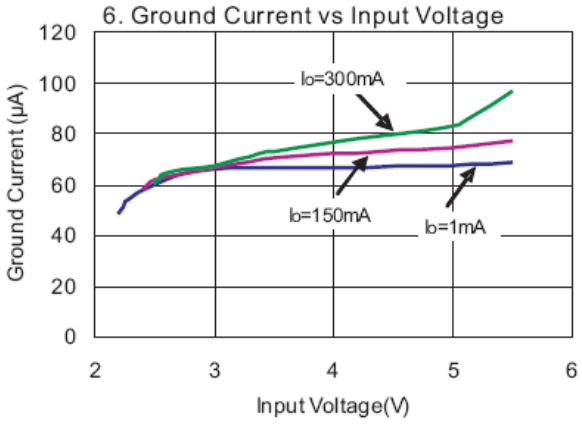
4. Quiescent Current vs Input Voltage



5. Ground Current vs Temperature

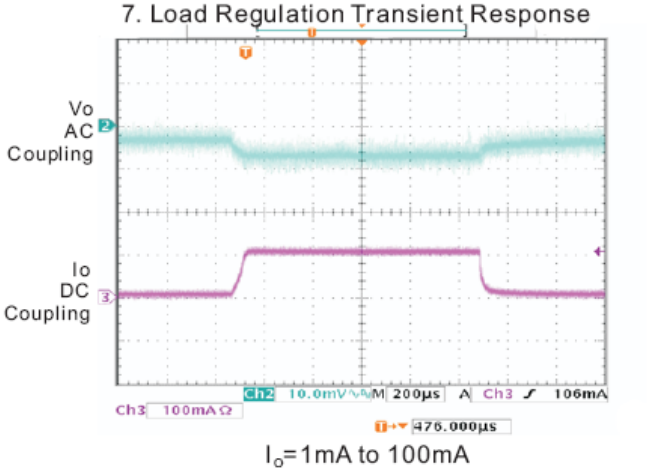


6. Ground Current vs Input Voltage

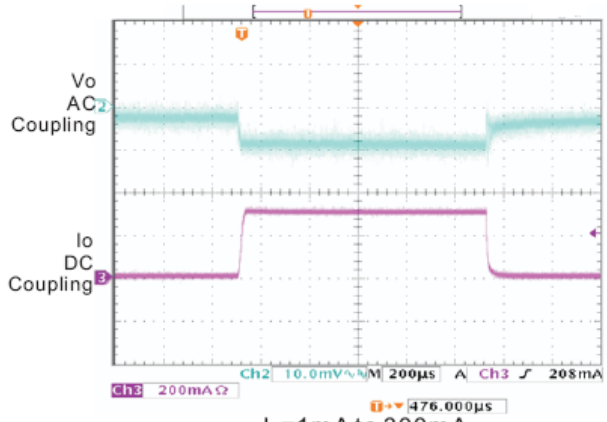


◆ TYPICAL PERFORMANCE CHARACTERISTICS(Continued)

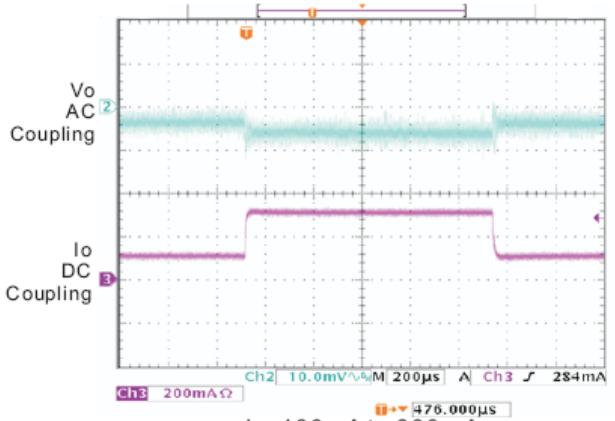
7. Load Regulation Transient Response



I_o=1mA to 100mA

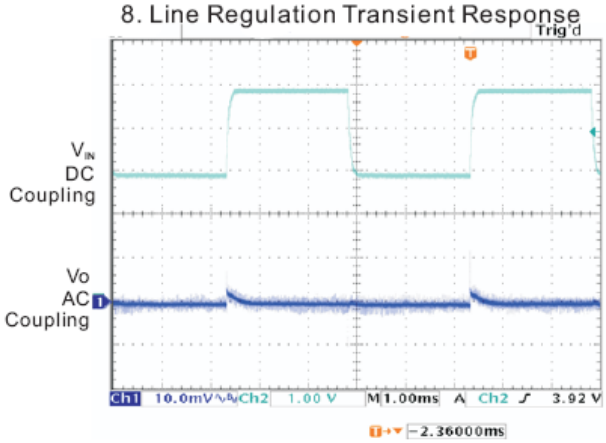


I_o=1mA to 300mA



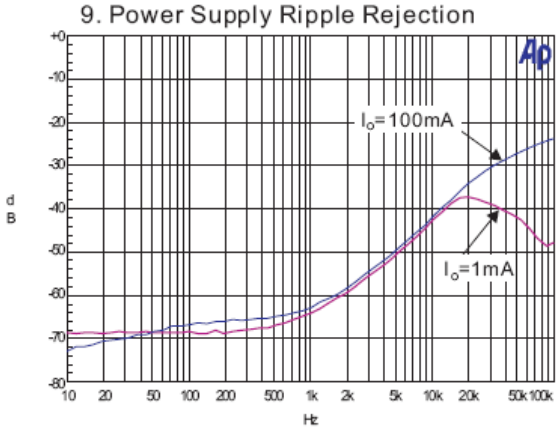
I_o=100mA to 300mA

8. Line Regulation Transient Response



Io=1mA,V_{IN}=3V to 5V

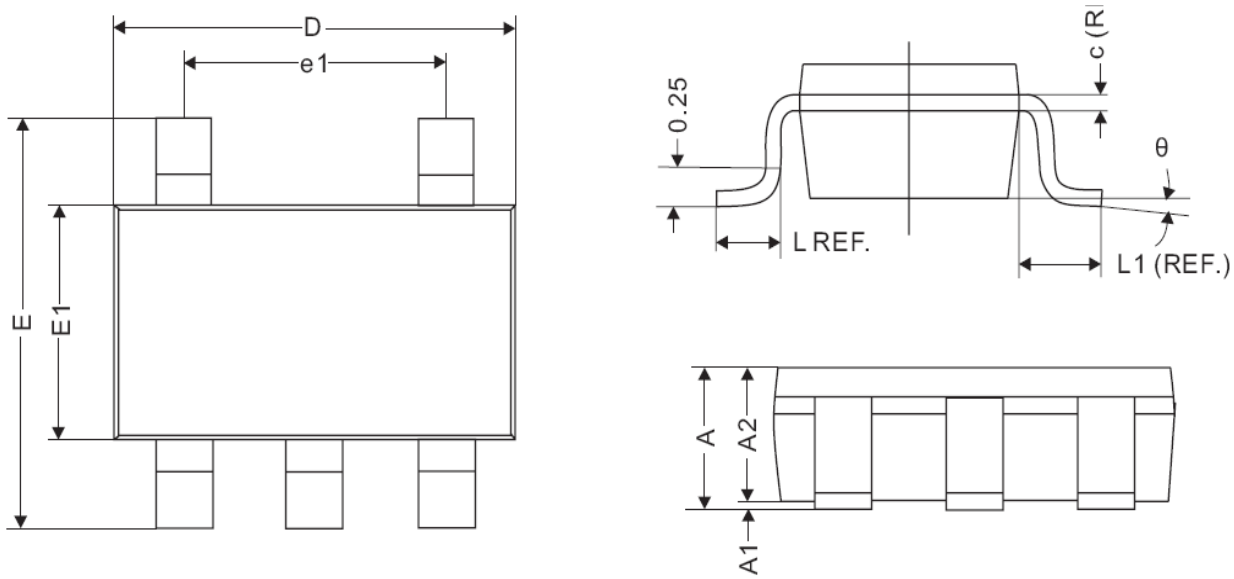
9. Power Supply Ripple Rejection



V_{IN}=3V,Vpp=1V

◆ PHYSICAL DIMENSIONS

5-Pin surface Mount SOT-23(N)



REF.	Millimeter		
	Min	Nom	Max
A		1.10MAX	
A1	0	0.05	0.10
A2	0.70	1.00	1.295
c		0.12REF.	
D	2.70	2.90	3.10
E	2.60	2.80	3.00
E1	1.40	1.60	1.80
L		0.45REF.	
L1		0.60REF.	
θ	0°	5°	10°
b	0.30	0.40	0.50
e		0.95REF.	
e1		1.90REF.	