High Voltage Low Power Consumption LDO — MD85XX Series

CMOS Voltage Regulator With ON/OFF Switch — 300mA

MD85XX is a high voltage (up to 40V) ultra-low quiescent current low dropout voltage regulator (LDO) manufactured in CMOS processes. It can deliver up to 300mA of current while consuming only 1.5uA of quiescent current. It consists of a reference voltage generator, an error amplifier, a current foldback circuit, and a phase compensation circuit plus a driver transistor. The MD85XX is designed specifically for applications where very-low I_Q is a critical parameter. This device maintains low quiescent current consumption even in dropout mode to further increase the battery life. When in shutdown or disabled mode, the device consumes less than 100-nA I_Q even with input voltage of 40V that helps increase the shelf life of the battery.

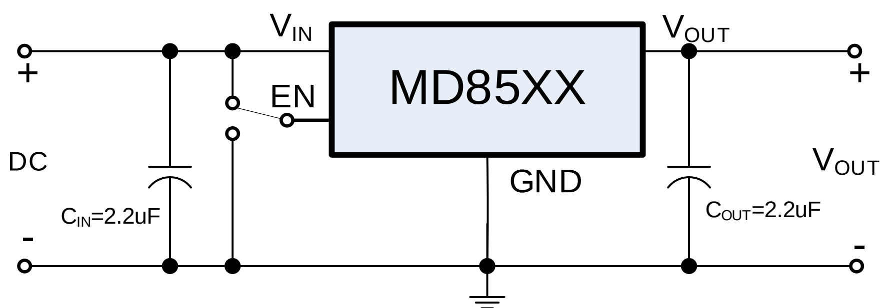
■ Features

- Ultra-low Quiescent Current: 1.5uA
- Maximum Input Voltage: 40V
- Output Voltage Highly Accurate: ±2%
- Maximum Output Current: 300mA
- Dropout Voltage: 4mV@I_{OUT}=1mA
- Temperature Stability: ±50ppm/℃
- ON/OFF Logic = Enable High
- Protections Circuits: Current Limiter, Short Circuit, Foldback, Thermal shutdown
- Output Capacitor: Low ESR Ceramic Capacitor Compatible

■ Applications

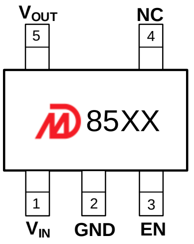
- Smart wearer
- Long-life battery-powered devices
- Portable mobile devices, such as mobile phones, cameras, and so on
- Wireless communication equipment

■ Typical Applications

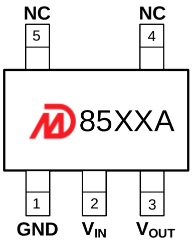


■ Pin Configuration and Functions

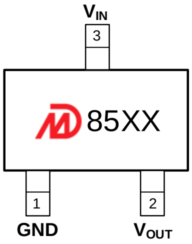
SOT23-5
Top View



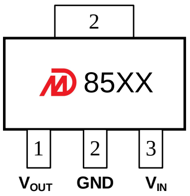
SOT23-5(A_Type)
Top View



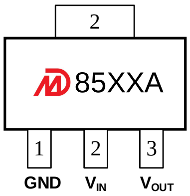
SOT23-3
Top View



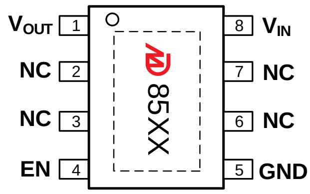
SOT89-3
Top View



SOT89-3(A_Type)
Top View



ESOP8
Top View



Pin Functions

NAME	DESCRIPTION
V_{IN}	Power Input Pin.
EN	Enable pin. Drive this pin high to enable the device. Drive this pin low to put the device into low current shutdown.
V_{OUT}	Regulated output voltage pin
GND	Ground
Thermal pad	The thermal pad is electrically connected to the GND node. Connect this pad to the GND plane for improved thermal performance.
NC	No internal connection

■ Product Selections

Product Name	V_{OUT} (V)	Package	Ordering Name	Marking	Package Information
MD8530	3.0	SOT23-5L	MD85E30QC3	8530	Tape and Reel, 3000pcs
MD8533	3.3	SOT23-5L	MD85E33QC3	8533	
MD8536	3.6	SOT23-5L	MD85E36QC3	8536	
MD8550	5.0	SOT23-5L	MD85E50QC3	8550	
MD8530A	3.0	SOT23-5L	MD85A30QC3	8530A	
MD8533A	3.3	SOT23-5L	MD85A33QC3	8533A	
MD8536A	3.6	SOT23-5L	MD85A36QC3	8536A	
MD8550A	5.0	SOT23-5L	MD85A50QC3	8550A	
MD8530	3.0	SOT23-3L	MD85E30QA3	8530	Tape and Reel, 3000pcs
MD8533	3.3	SOT23-3L	MD85E33QA3	8533	
MD8536	3.6	SOT23-3L	MD85E36QA3	8536	
MD8550	5.0	SOT23-3L	MD85E50QA3	8550	

MD8530	3.0	SOT89-3L	MD85E30PA1	8530	Tape and Reel, 1000pcs
MD8533	3.3	SOT89-3L	MD85E33PA1	8533	
MD8536	3.6	SOT89-3L	MD85E36PA1	8536	
MD8550	5.0	SOT89-3L	MD85E50PA1	8550	
MD8553	5.3	SOT89-3L	MD85E53PA1	8553	
MD8557	5.7	SOT89-3L	MD85E57PA1	8557	
MD85C0	12.0	SOT89-3L	MD85EC0PA1	85C0	
MD8530A	3.0	SOT89-3L	MD85A30PA1	8530A	Tape and Reel, 1000pcs
MD8533A	3.3	SOT89-3L	MD85A33PA1	8533A	
MD8536A	3.6	SOT89-3L	MD85A36PA1	8536A	
MD8550A	5.0	SOT89-3L	MD85A50PA1	8550A	
MD85C0A	12.0	SOT89-3L	MD85AC0PA1	85C0A	
MD8533	3.3	ESOP8	MD85E33SF4	8533	Tape and Reel, 4000pcs
MD8550	5.0	ESOP8	MD85E50SF4	8550	

Notes:

1* Customer can request to customize the output voltage ranged from 1.2V to 15V if desired voltage is not found in the selections.

2* Customer can request customization of package choice.

3* Please pay attention to the MARKING of the product package type.

■ Absolute Maximum Ratings (Unless otherwise indicated: T_a=25℃)

PARAMETER	SYMBOL	RATINGS		UNITS
Input Voltage	V_{IN}	-0.3 ~ 45		V
Output Voltage	V_{OUT}	Vss-0.3 ~ VIN+0.3V		
Power Dissipation	P_D	SOT23-5	250	mW
		SOT23-3	250	
		ESOP8	1800	
		SOT89-3	1000	
Thermal Resistance	$R_{θJB}$ (1)	SOT23-5	180	℃/W
		SOT23-3	200	
		ESOP8	80	
		SOT89-3	100	
Operating Ambient Temperature	T_{opr}	-40 ~ +85		℃
Storage Temperature	T_{stg}	-40 ~ +125		
ESD Protection	ESD HBM	5000		V

Note: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device.

(1) Mounted on JEDEC standard 4layer (2s2p) PCB test board

■ Notes on Use

Input Capacitor (C_{IN}): 2.2µF above

Output Capacitor (C_{OUT}): 2.2µF above

■ Electrical Characteristics

MD85XX Series (Unless otherwise indicated：T_a=25℃)

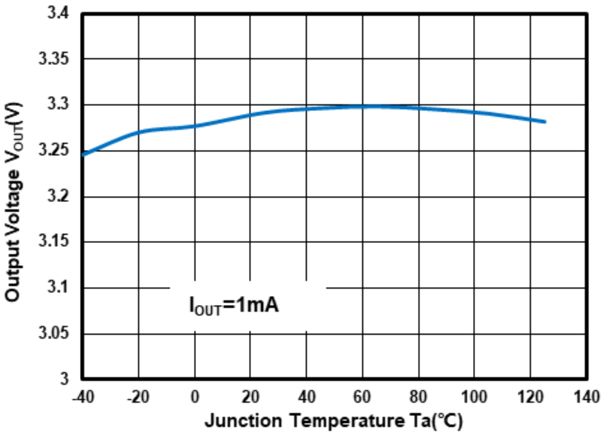
PARAMETER	SYMBOL	CONDITIONS		MIN.	TYP.	MAX.	UNIT
Output Voltage[*1]	$V_{OUT(S)}$	V_{IN}= $V_{OUT(S)}$+2V，I_{OUT}=1mA		$V_{OUT(S)}$× 0.98	$V_{OUT(S)}$	$V_{OUT(S)}$× 1.02	V
Dropout Voltage[*2]	V_{DROP}	V_{EN}=V_{IN}, $V_{OUT(S)}$=3.3V I_{OUT}=1mA			4	8	mV
		V_{EN}=V_{IN}, $V_{OUT(S)}$=3.3V I_{OUT}=300mA			1200	1800	
Line Regulation	$\frac{\Delta V_{OUT}}{\Delta V_{IN} \bullet V_{OUT(s)}}$	$V_{OUT(S)}$+2V≤V_{IN}≤40V I_{OUT} =1mA			0.01	0.02	%/V
Load Regulation	ΔV_{OUT2}	V_{IN} = $V_{OUT(S)}$+2V 1mA≤I_{OUT}≤300mA	$V_{OUT(S)}$≤5.3V		20	40	mV
			$V_{OUT(S)}$>5.3V		50	80	
Temperature Stability	$\frac{\Delta V_{OUT}}{\Delta T_a \bullet V_{OUT(s)}}$	V_{IN} = $V_{OUT(S)}$+2V，I_{OUT}=10mA -40℃≤T_a≤125℃			±50		ppm/℃
GND Current (V_{EN}=V_{IN})	I_{GND}	no load	$V_{OUT(S)}$<3.0V	0.8	1.2	2	uA
			3.0≤$V_{OUT(S)}$≤5.3V	1	1.5	2.5	
			$V_{OUT(S)}$>5.3V	1.5	2.3	3.5	
		I_{OUT}=100mA			420		
Shutdown Current (EN=0)	I_{SHUT}	V_{IN}=40.0V, V_{EN}=0			0.1	1	
Input Voltage	V_{IN}	---		2.2		40	V
Maximum Output Current	I_{OUTMAX}			300	350		mA
Current Limit[*3]	I_{LIM}	V_{IN}= $V_{OUT(S)}$+2V, V_{OUT} = 0.95 ×$V_{OUT(S)}$		350	550		
Short Circuit Current	I_{SHORT}	V_{IN}=V_{EN}=$V_{OUT(S)}$+2.0V V_{OUT}=0V			65		
Power Supply Rejection Ratio	PSRR	f=100Hz, I_{OUT} =10mA			79		dB
		f=1kHz, I_{OUT} =10mA			62		
		f=10kHz, I_{OUT} =10mA			48		
		f=100kHz, I_{OUT} =10mA			40		
EN 'H' Level Voltage	V_{ENH}			1.5		40.0	V
EN 'L' Level Voltage	V_{ENL}			0		0.6	
EN 'H' Level Current	I_{ENH}	V_{IN}=40V, V_{EN}=V_{IN}		-0.1		0.1	uA
EN 'L' Level Voltage	I_{ENL}	V_{IN}=40V, V_{EN}=0		-0.1		0.1	
Over Temperature Protection	OTP	I_{OUT}=1mA			170		℃

Notes:

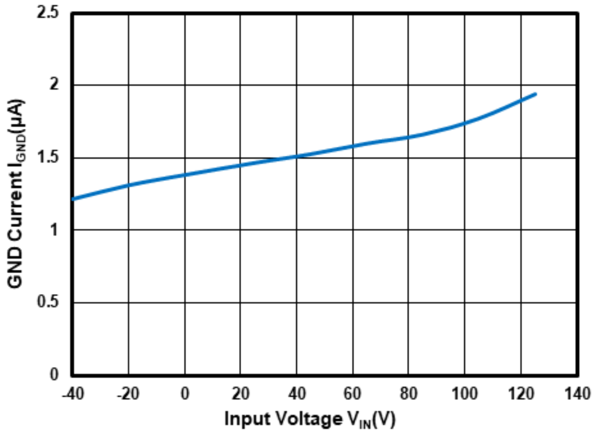
1. $V_{OUT(S)}$: Output voltage when V_{IN}=V_{OUT}+2V, I_{OUT}=1 mA.
2. V_{DROP}=V_{IN1} -（$V_{OUT(S)}$× 0.98）where V_{IN1} is the input voltage when V_{OUT} = $V_{OUT(S)}$× 0.98.
3. I_{LIM}: Output current when V_{IN}=$V_{OUT(S)}$+2V and V_{OUT} = 0.95*$V_{OUT(S)}$.

■ Typical Performance Characteristics

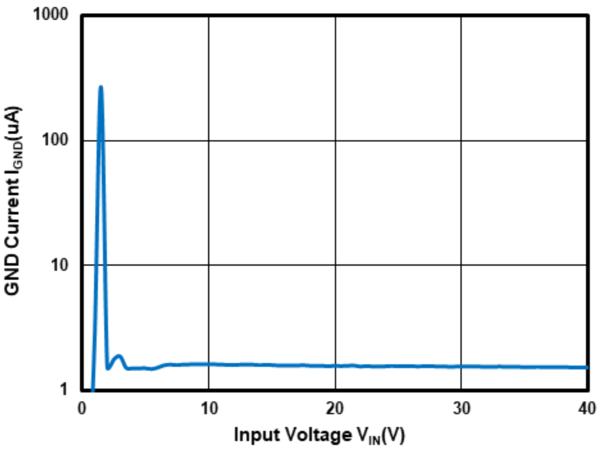
Test Conditions: $V_{IN}=V_{OUT}+2.0V$, $C_{IN}=2.2\mu F$, $C_{OUT}=2.2\mu F$, Ta=25℃, unless otherwise indicated.



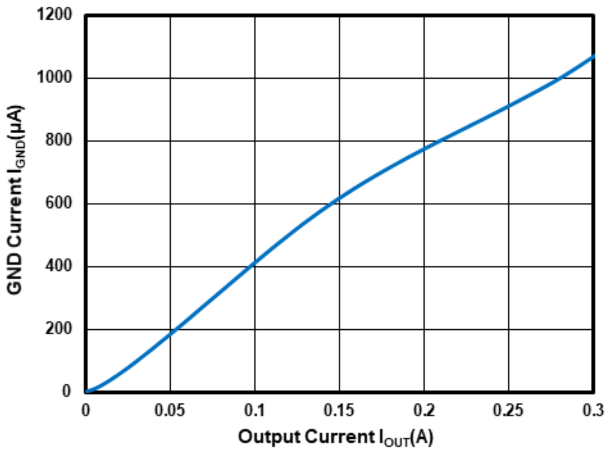
Output Voltage vs Temperature at V_{OUT}=3.3V



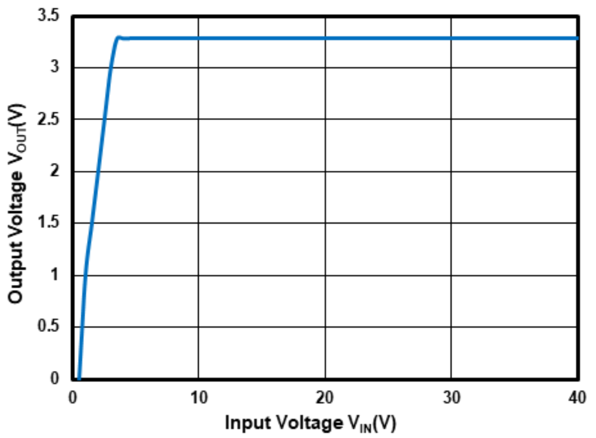
GND Current vs Temperature at V_{OUT}=3.3V



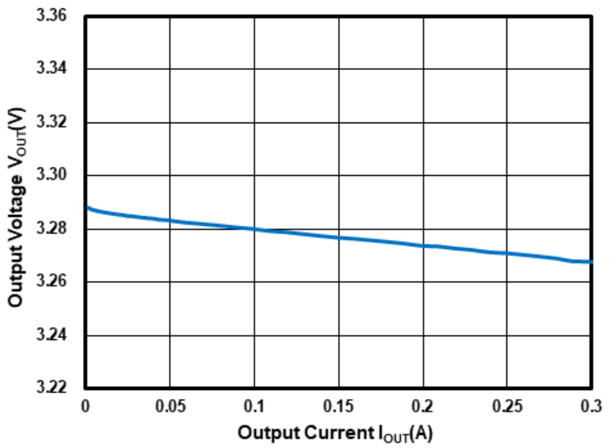
GND Current vs Input Voltage at V_{OUT}=3.3V



GND Current vs Output Current at V_{OUT}=3.3V



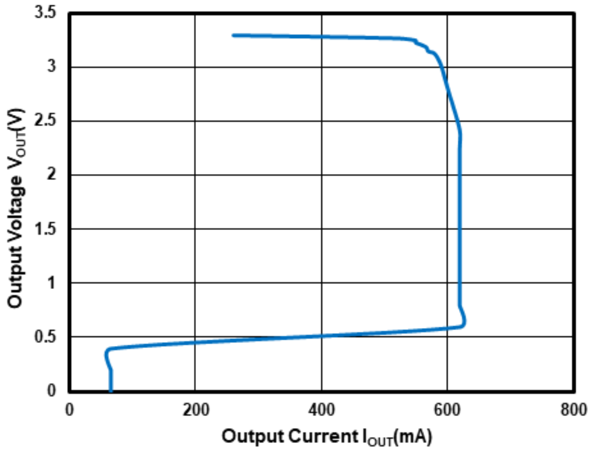
Output Voltage vs Input Voltage at V_{OUT}=3.3V



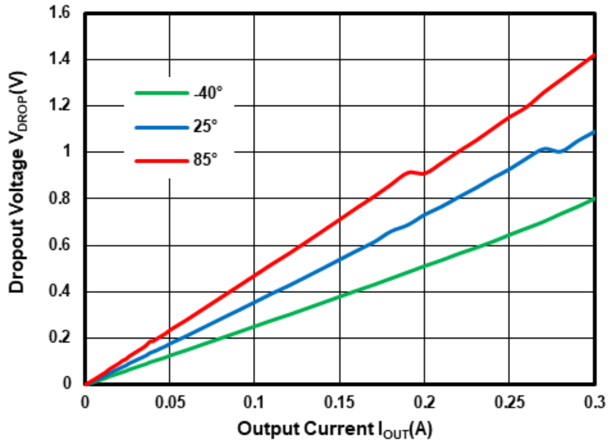
Output Voltage vs Output Current at V_{OUT}=3.3V

■ Typical Performance Characteristics (Continued)

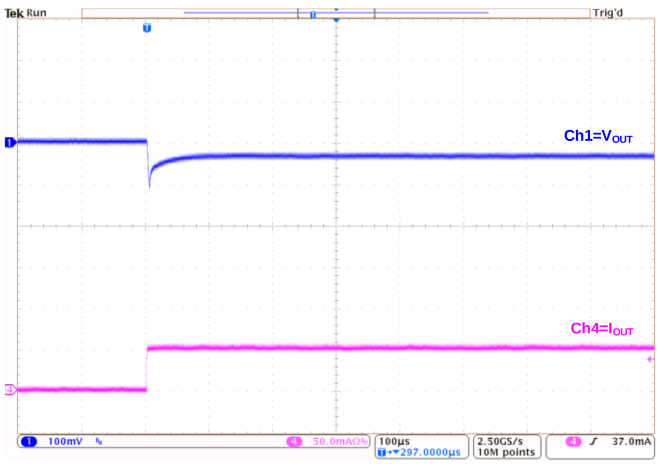
Test Conditions: $V_{IN}=V_{OUT}+2.0V$, $C_{IN}=2.2\mu F$, $C_{OUT}=2.2\mu F$, unless otherwise indicated.



Output Current Fold-back at V_{OUT}=3.3V

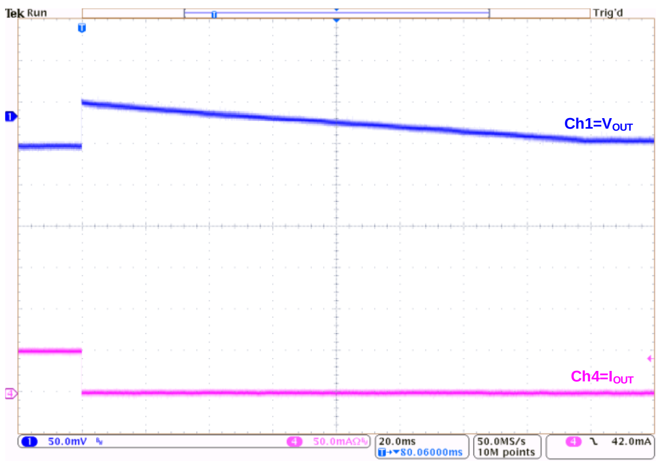


Dropout Voltage vs Temperature at V_{OUT}=3.3V



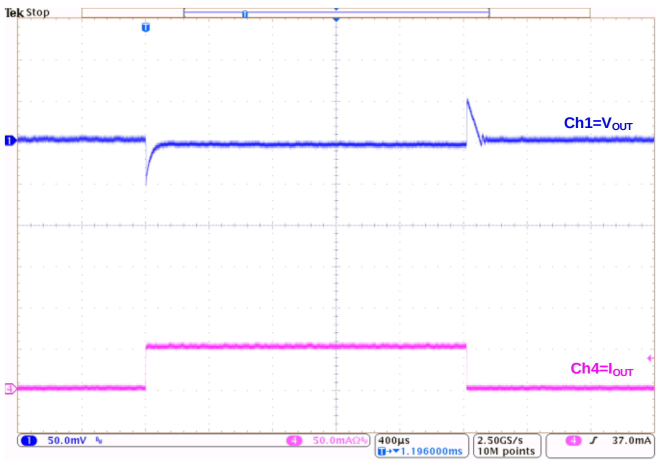
Load Transient at V_{OUT}=3.3V:

(I_{OUT}=0mA~50mA)



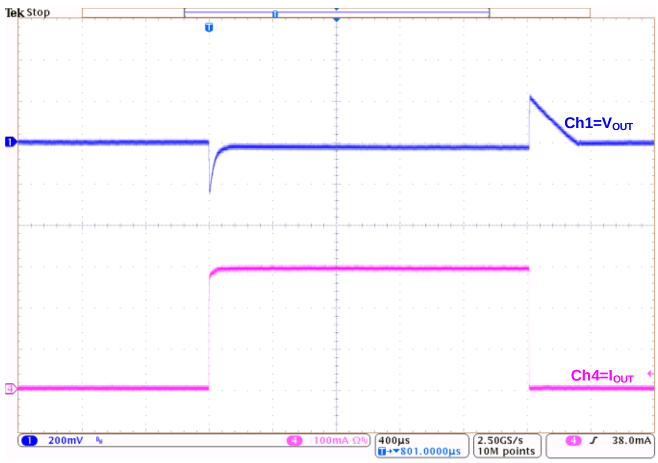
Load Transient at V_{OUT}=3.3V:

(I_{OUT}=50mA~0mA)



Load Transient at V_{OUT}=3.3V:

(I_{OUT}=1mA~50mA~1mA)

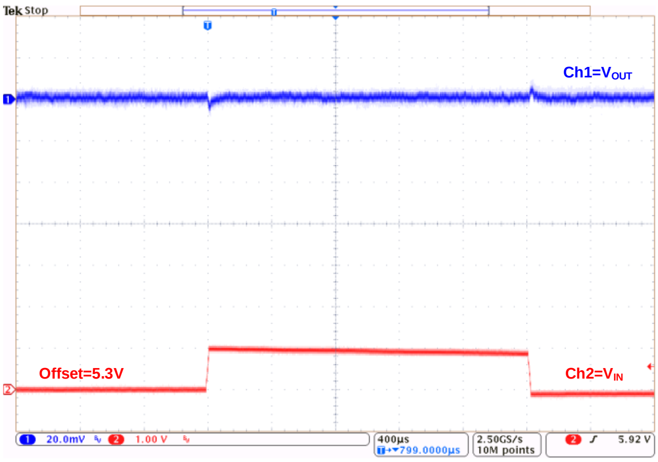


Load Transient at V_{OUT}=3.3V:

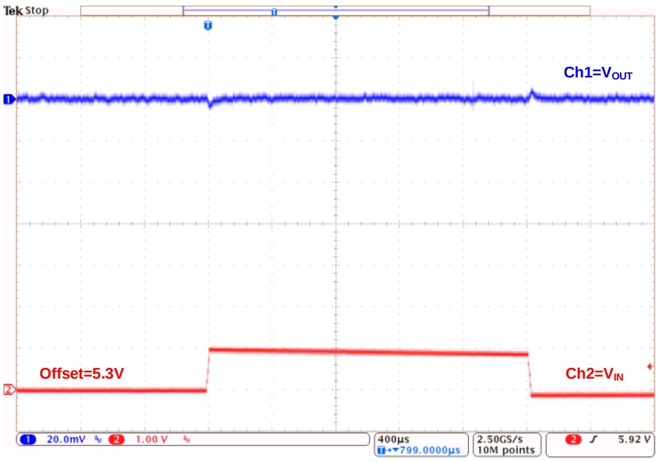
(I_{OUT}=1mA~300mA~1mA)

■ Typical Performance Characteristics (Continued)

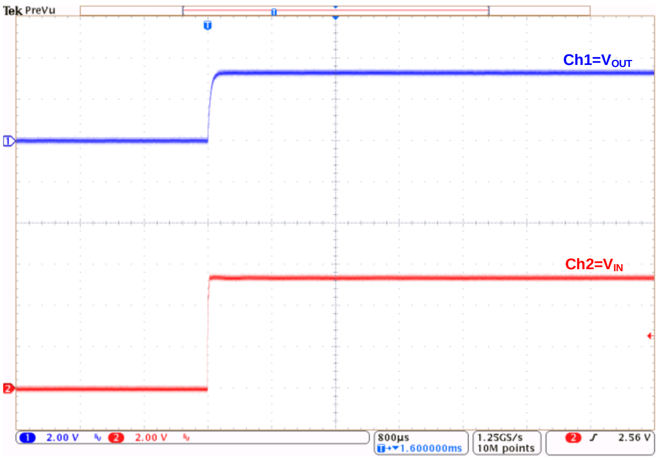
Test Conditions: $V_{IN}=V_{OUT}+2.0V$, $C_{IN}=2.2\mu F$, $C_{OUT}=2.2\mu F$, Ta=25℃, unless otherwise indicated.



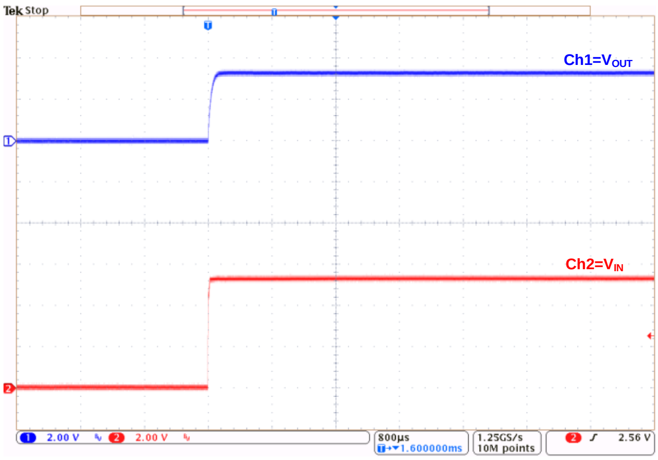
Line Transient at V_{OUT}=3.3V:
(I_{OUT}=1mA)



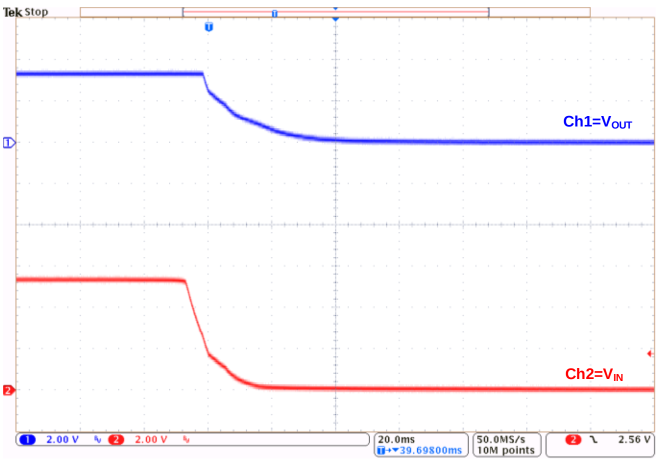
Line Transient at V_{OUT}=3.3V:
(I_{OUT}=10mA)



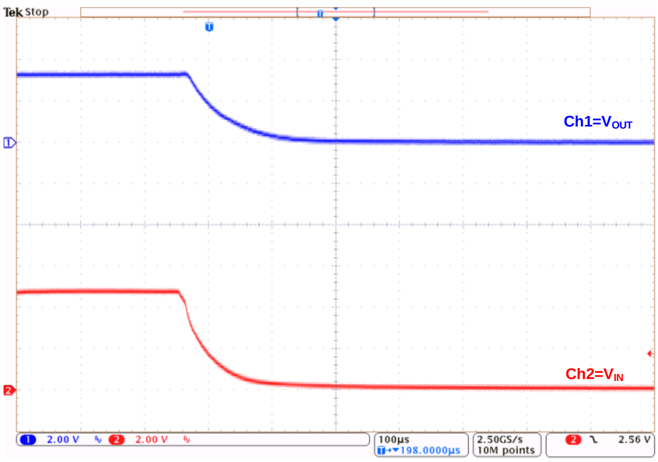
Power-Up at V_{OUT}=3.3V:
(I_{OUT}=1mA)



Power-Up at V_{OUT}=3.3V:
(I_{OUT}=300mA)



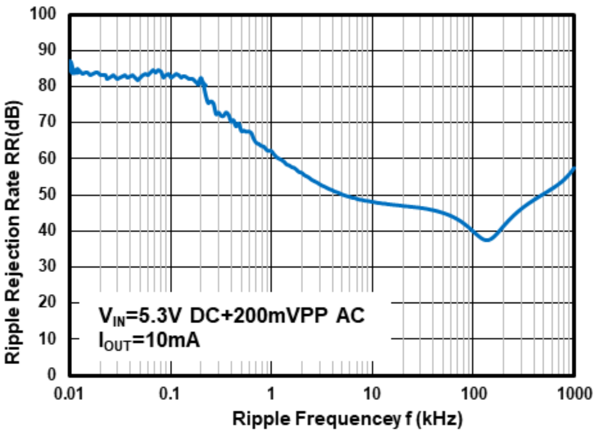
Power-Down at V_{OUT}=3.3V:
(I_{OUT}=1mA)



Power-Down at V_{OUT}=3.3V:
(I_{OUT}=300mA)

■ Typical Performance Characteristics (Continued)

Test Conditions: $V_{IN}=V_{OUT}+2.0V$, $C_{IN}=2.2\mu F$, $C_{OUT}=2.2\mu F$, Ta=25℃, unless otherwise indicated.

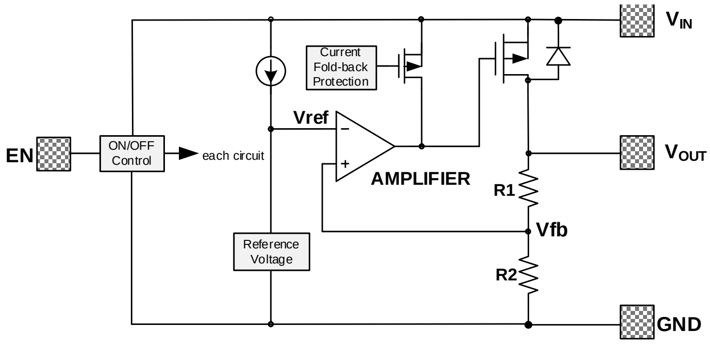


Power Supply Rejection Ratio at $V_{OUT}=3.3V$

■ Operational Explanation

1. Output voltage control

The voltage divided by resistors R1 and R2 is compared with the internal reference voltage by the error amplifier. The amplifier output then drives the P-channel MOSFET connected to the V_{OUT} pin. The output voltage at the V_{OUT} pin is regulated by this negative feedback system. The current limit circuit and short protect circuit operate in relation to output current level. Further, the IC's internal circuitry can be in operation or shutdown modes controlled by the CE pin's signal.



2. Pass transistor

The pass transistor with low turn-on resistance used in MD85XX is a P-channel MOSFET. If the potential on V_{OUT} pin is higher than VIN, it is possible that IC will be destroyed due to reverse current which is caused by parasitic diodes between V_{IN} and V_{OUT}. Therefore, the V_{OUT} pin potential exceeds V_{IN}+0.3V is not allowed.

3. Current foldback, short circuit protection and over temperature protection

The MD85XX series includes a combination of a fixed current limiter circuit and a foldback circuit, which aid the operations of the current limiter and circuit protection. When the load current reaches the current limit level, the fixed current limiter circuit operates and output voltage drops. As a result of this drop in output voltage, the foldback circuit operates, output voltage drops further and output current decreases. The short circuit current is about 65mA (typical value). This design can prevent the chip be damaged due to over temperature, moreover, the heat dissipation is limited by the package type.

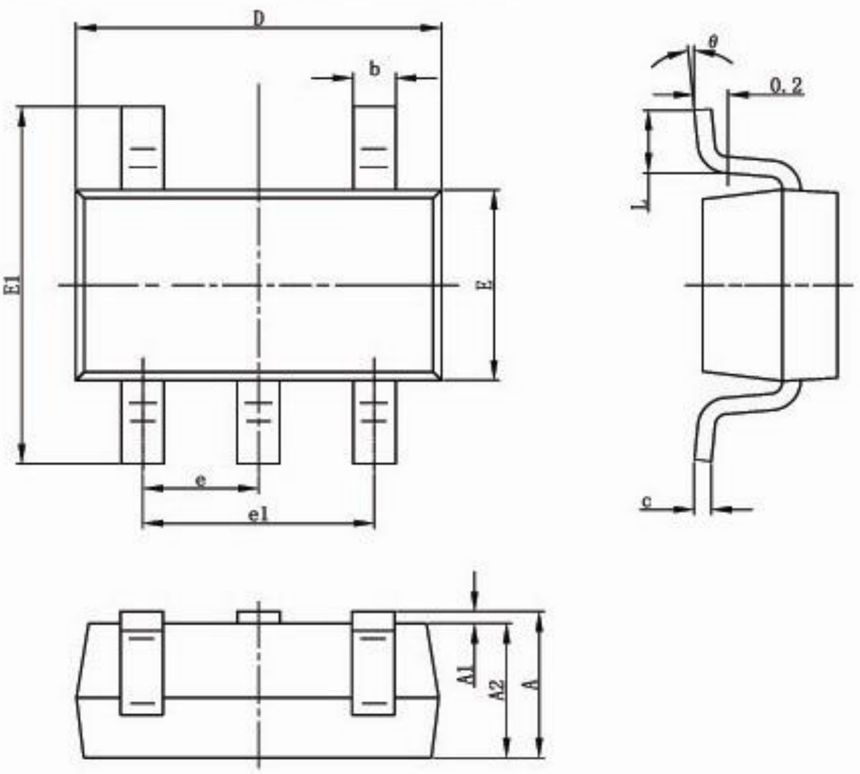
Special attention should be paid to that the product of the dropout voltage on the chip and the output current must be smaller than the heat dissipation. If power consumption on the chip is more than the heat dissipation, OTP will protect the chip from damaging due to over temperature.

■ Notes:

1. The input and output capacitors should be placed as close as possible to the IC.
2. If the impedance of the power supply is high, which is caused by forgetting installing input capacitor or installing too small value capacitor, the oscillation may occur.
3. Pay attention to the operation conditions of input and output voltage and load current, such that the power consumption in the IC should not exceed the allowable power consumption of the package even though the chip has short circuit protection.
4. IC has a built-in anti-static protection (ESD) circuit, but please do not add excessive stress to the IC.

■ Packaging Information

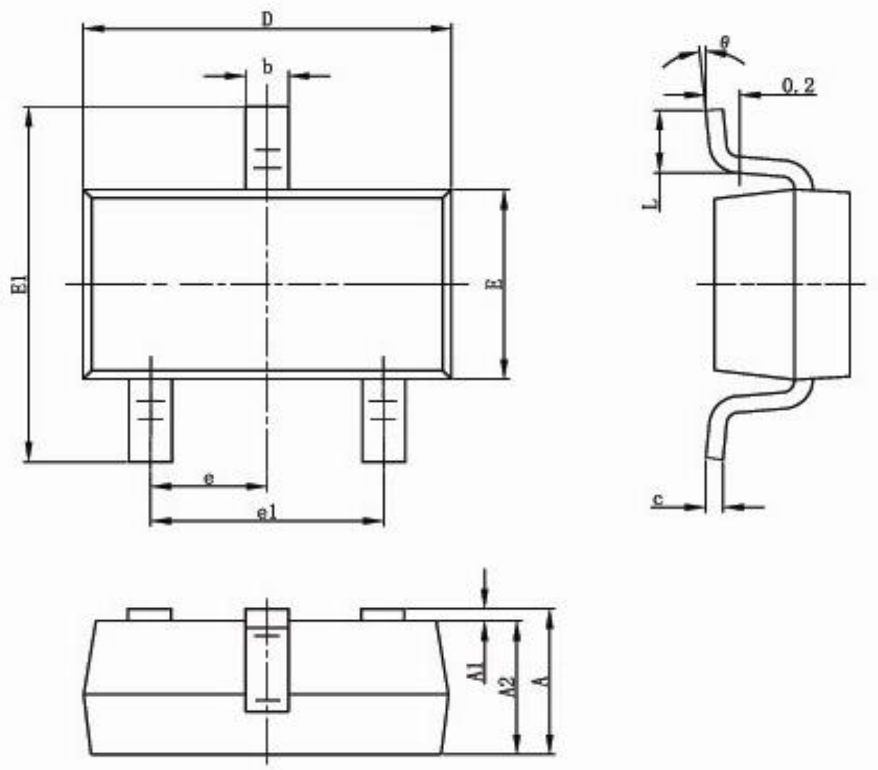
SOT-23-5L PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

■ Packaging Information (Continued)

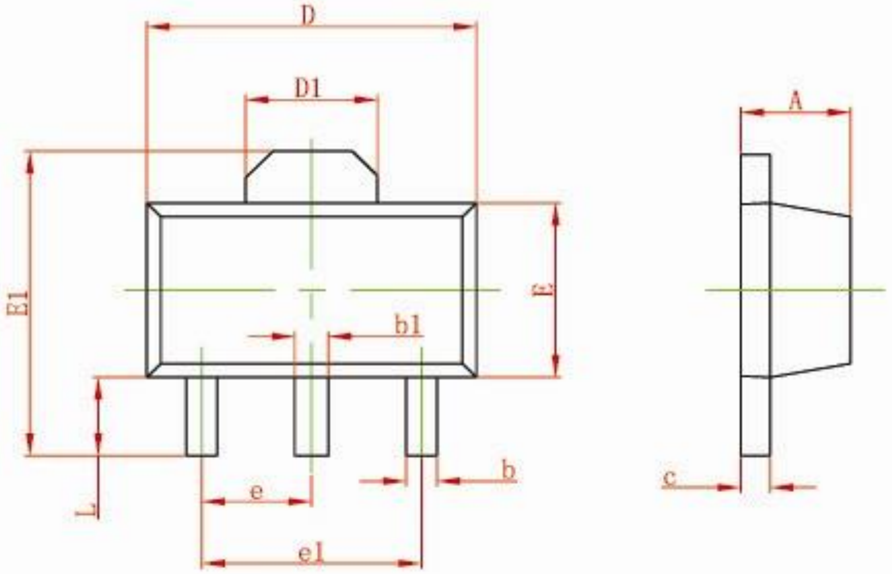
SOT-23-3L PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

■ Packaging Information (Continued)

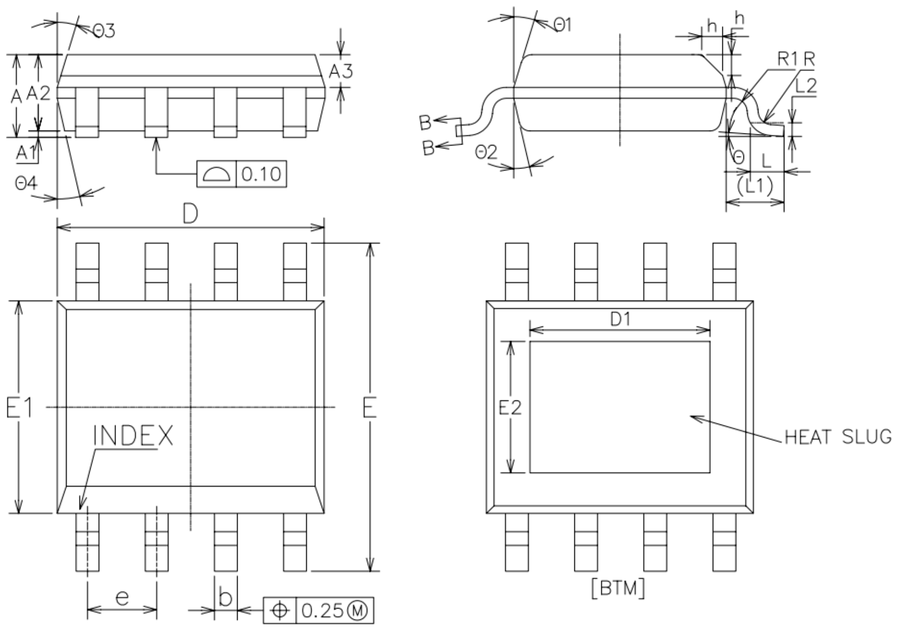
SOT-89-3L PACKAGE OUTLINE DIMENSIONS

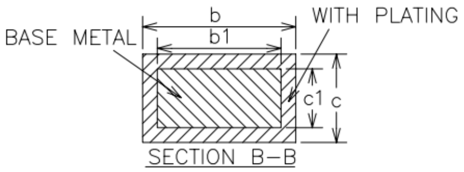


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.400	1.600	0.055	0.063
b	0.320	0.520	0.013	0.197
b1	0.400	0.580	0.016	0.023
c	0.350	0.440	0.014	0.017
D	4.400	4.600	0.173	0.181
D1	1.550 REF		0.061 REF	
E	2.300	2.600	0.091	0.102
E1	3.940	4.250	0.155	0.167
e	1.500 TYP		0.060TYP	
e1	3.000 TYP		0.118TYP	
L	0.900	1.200	0.035	0.047

■ Packaging Information (Continued)

ESOP8 PACKAGE OUTLINE DIMENSIONS





COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL		MIN	NOM	MAX
A		1.35	1.55	1.70
A1		0	0.10	0.15
A2		1.25	1.40	1.65
A3		0.50	0.60	0.70
b		0.38	–	0.51
b1		0.37	0.42	0.47
c		0.17	–	0.25
c1		0.17	0.20	0.23
D		4.80	4.90	5.00
D1	Option 1	3.10	3.30	3.50
	Option 2	2.09	2.29	2.49
E		5.80	6.00	6.20
E1		3.80	3.90	4.00
E2	Option 1	2.20	2.40	2.60
	Option 2	2.09	2.29	2.49
e		1.17	1.27	1.37
L		0.45	0.60	0.80
L1			1.04REF	
L2			0.25BSC	
R		0.07	–	–
R1		0.07	–	–
h		0.30	0.40	0.50
Θ		0°	–	8°
Θ1		15°	17°	19°
Θ2		11°	13°	15°
Θ3		15°	17°	19°
Θ4		11°	13°	15°