

AL87XX is ultra-low power consumption low dropout voltage regulator (LDO) manufactured in CMOS processes. It can deliver up to 500mA of current while consuming only 0.65 μ A 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 AL87XX 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.

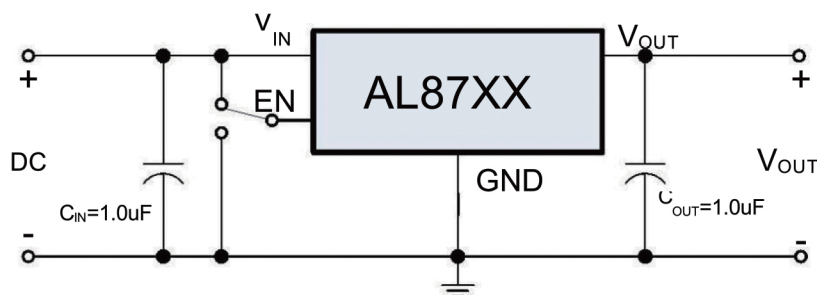
■ Features:

- Ultra-low Quiescent Current: 0.65 μ A
- Highly Accurate: $\pm 2\%$
- Dropout Voltage: 240mV@ $I_{OUT}=500$ mA
- Maximum Output Current: 500mA
- Input Voltage Range: 2.2V~7.0V
- Temperature Stability: ± 50 ppm/ $^{\circ}$ C
- ON/OFF Logic = Enable High
- Standby Current: 10nA
- C_{OUT} Discharge Circuit when EN Disable is Active
- Protections Circuits: Current Limiter, Short Circuit, Foldback
- Output Capacitor: Low ESR Ceramic Capacitor Compatible

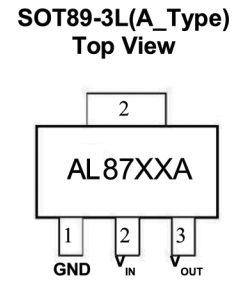
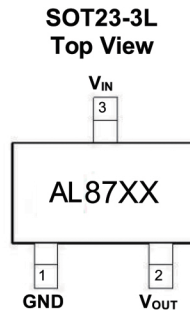
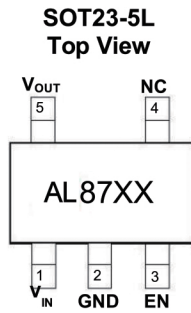
■ Applications:

- Smart meters
- 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:**



■ **Product Selections:**

Product Name	V _{OUT} (V)	Package	Ordering Name	Marking	Package Information
AL8712	1.2	SOT23-5L	AL87E12QC3	AL8712	Tape and Reel, 3000pcs
AL8715	1.5	SOT23-5L	AL87E15QC3	AL8715	
AL8718	1.8	SOT23-5L	AL87E18QC3	AL8718	
AL8721	2.1	SOT23-5L	AL87E21QC3	AL8721	
AL8725	2.5	SOT23-5L	AL87E25QC3	AL8725	
AL8728	2.8	SOT23-5L	AL87E28QC3	AL8728	
AL8730	3.0	SOT23-5L	AL87E30QC3	AL8730	
AL8733	3.3	SOT23-5L	AL87E33QC3	AL8733	
AL8736	3.6	SOT23-5L	AL87E36QC3	AL8736	
AL8737	3.7	SOT23-5L	AL87E37QC3	AL8737	
AL8740	4.0	SOT23-5L	AL87E40QC3	AL8740	
AL8750	5.0	SOT23-5L	AL87E50QC3	AL8750	
AL8712	1.2	SOT23-3L	AL87E12QA3	AL8712	
AL8715	1.5	SOT23-3L	AL87E15QA3	AL8715	
AL8718	1.8	SOT23-3L	AL87E18QA3	AL8718	
AL8721	2.1	SOT23-3L	AL87E21QA3	AL8721	
AL8725	2.5	SOT23-3L	AL87E25QA3	AL8725	
AL8728	2.8	SOT23-3L	AL87E28QA3	AL8728	
AL8730	3.0	SOT23-3L	AL87E30QA3	AL8730	
AL8733	3.3	SOT23-3L	AL87E33QA3	AL8733	
AL8736	3.6	SOT23-3L	AL87E36QA3	AL8736	
AL8737	3.7	SOT23-3L	AL87E37QA3	AL8737	
AL8740	4.0	SOT23-3L	AL87E40QA3	AL8740	
AL8750	5.0	SOT23-3L	AL87E50QA3	AL8750	
AL8712A	1.2	SOT89-3L	AL87A12PA1	AL8712A	Tape and Reel, 1000pcs
AL8715A	1.5	SOT89-3L	AL87A15PA1	AL8715A	
AL8718A	1.8	SOT89-3L	AL87A18PA1	AL8718A	

AL8721A	2.1	SOT89-3L	AL87A21PA1	AL8721A	
AL8725A	2.5	SOT89-3L	AL87A25PA1	AL8725A	
AL8728A	2.8	SOT89-3L	AL87A28PA1	AL8728A	
AL8730A	3.0	SOT89-3L	AL87A30PA1	AL8730A	
AL8733A	3.3	SOT89-3L	AL87A33PA1	AL8733A	
AL8736A	3.6	SOT89-3L	AL87A36PA1	AL8736A	
AL8737A	3.7	SOT89-3L	AL87A37PA1	AL8737A	
AL8740A	4.0	SOT89-3L	AL87A40PA1	AL8740A	
AL8750A	5.0	SOT89-3L	AL87A50PA1	AL8750A	

Notes: 1* Customer can request to customize the output voltage ranged from 1.2V to 5V 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: $T_a=25^{\circ}\text{C}$)

PARAMETER	SYMBOL	RATINGS		UNITS
Input Voltage	V _{IN}	-0.3 ~ 8		V
Output Voltage	V _{OUT}	V _{ss} -0.3 ~ V _{IN} +0.3V		
Power Dissipation	P _D	SOT23-5	260	mW
		SOT23-3	260	
		SOT89-3	1000	
Thermal Resistance	R _{θJB(1)}	SOT23-5	180	℃/W
		SOT23-3	200	
		SOT89-3	100	
Operating Ambient Temperature	T _{opr}	-40 ~ +85		℃
Storage Temperature	T _{stg}	-40 ~ +125		
ESD Protection	ESD HBM	5500		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}): 1.0 μF above

Output Capacitor (C_{OUT}): 1.0 μF above

■ Electrical Characteristics:

AL87XX Series

(Unless otherwise indicated: $T_a=25^{\circ}\text{C}$)

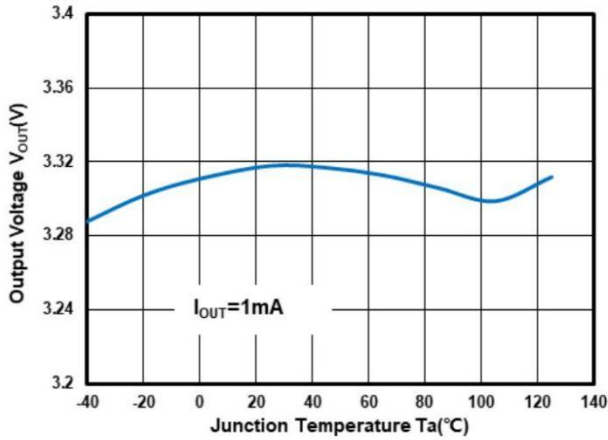
PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Output Voltage*1	$V_{\text{OUT(S)}}$	$V_{\text{IN}}=V_{\text{OUT(S)}}+2.0\text{V}$ $I_{\text{OUT}}=10\text{mA}$, $V_{\text{OUT(S)}}<2.0\text{V}$	$V_{\text{OUT(S)}}-0.03$	$V_{\text{OUT(S)}}$	$V_{\text{OUT(S)}}+0.03$	V
		$V_{\text{IN}}=V_{\text{OUT(S)}}+1.0\text{V}$ $I_{\text{OUT}}=10\text{mA}$, $V_{\text{OUT(S)}}\geq 2.0\text{V}$	$V_{\text{OUT(S)}}\times 0.98$		$V_{\text{OUT(S)}}\times 1.02$	
Dropout Voltage*2	V_{DROP}	$V_{\text{EN}}=V_{\text{IN}}$, $V_{\text{OUT}}<3\text{V}$ $I_{\text{OUT}}=500\text{mA}$		250		mV
		$V_{\text{EN}}=V_{\text{IN}}$, $V_{\text{OUT}}\geq 3\text{V}$ $I_{\text{OUT}}=500\text{mA}$		240		
Line Regulation*3	$\frac{\Delta V_{\text{OUT}}}{\Delta V_{\text{IN}} \bullet V_{\text{OUT(S)}}}$	$V_{\text{OUT(S)}}+0.5\text{V}\leq V_{\text{IN}}=V_{\text{EN}}\leq 7\text{V}$ $I_{\text{OUT}}=10\text{mA}$		0.05	0.1	%/V
Load Regulation	ΔV_{OUT2}	$V_{\text{IN}}=V_{\text{EN}}=V_{\text{OUT(S)}}+1.0\text{V}$ $1\text{mA}\leq I_{\text{OUT}}\leq 500\text{mA}$		50	90	mV
Temperature Stability	$\frac{\Delta V_{\text{OUT}}}{\Delta T_a \bullet V_{\text{OUT(S)}}}$	$V_{\text{IN}}=V_{\text{EN}}=V_{\text{OUT(S)}}+1.0\text{V}$ $I_{\text{OUT}}=1\text{mA}$ $-40^{\circ}\text{C}\leq T_a\leq 125^{\circ}\text{C}$		± 50		ppm/ $^{\circ}\text{C}$
GND Current ($V_{\text{EN}}=V_{\text{IN}}$)	I_{GND}	no load		0.65	0.9	μA
		$I_{\text{OUT}}=500\text{mA}$		210		μA
Shutdown Current ($V_{\text{EN}}=0$)	I_{SHUT}	$V_{\text{IN}}=7.0\text{V}$, $V_{\text{EN}}=0$		0.01	0.1	μA
Input Voltage	V_{IN}	---	2.2		7	V
Maximum Output Current	I_{OUTMAX}		450	500		mA
Current Limit*4	I_{LIM}	$V_{\text{IN}}=V_{\text{EN}}=V_{\text{OUT(S)}}+1.0\text{V}$ $I_{\text{OUT}} = 0.95 \times V_{\text{OUT(S)}}$		750		mA
Short Circuit Current	I_{SHORT}	$V_{\text{IN}}=V_{\text{EN}}=V_{\text{OUT(S)}}+1.0\text{V}$ $V_{\text{OUT}}=0\text{V}$		50		mA
C_{OUT} Auto Discharge	R_{DCHG}	$V_{\text{EN}}=0$, $V_{\text{OUT}}=V_{\text{OUT(S)}}$	280	450	640	Ω
Power Supply Rejection Ratio	PSRR	$f=10\text{Hz}$, $I_{\text{OUT}}=10\text{mA}$		64		dB
		$f=100\text{Hz}$, $I_{\text{OUT}}=10\text{mA}$		51		
		$f=1\text{kHz}$, $I_{\text{OUT}}=10\text{mA}$		34		
EN 'H' Level Voltage	V_{ENH}	---	1.0		7.0	V
EN 'L' Level Voltage	V_{ENL}	---	0		0.38	
EN 'H' Level Current	I_{ENH}	$V_{\text{IN}}=7.0\text{V}$, $V_{\text{EN}}=V_{\text{IN}}$	-0.1		0.1	μA
EN 'L' Level Current	I_{ENL}	$V_{\text{IN}}=7.0\text{V}$, $V_{\text{EN}}=0$	-0.1		0.1	

Notes:

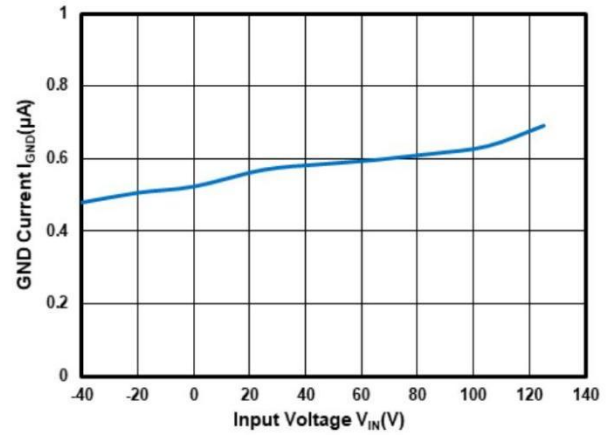
1. $V_{\text{OUT(S)}}$: Output voltage when $V_{\text{IN}}=V_{\text{OUT}}+1\text{V}$, $I_{\text{OUT}}=1\text{mA}$.
2. $V_{\text{DROP}}=V_{\text{IN1}} - (V_{\text{OUT(S)}}\times 0.98)$ where V_{IN1} is the input voltage when $V_{\text{OUT}} = V_{\text{OUT(S)}}\times 0.98$.
3. Minimum $V_{\text{IN}}=V_{\text{OUT}}+0.5\text{V}$ or 2.2V , whichever is greater.
4. I_{LIM} : Output current when $V_{\text{IN}}=V_{\text{OUT(S)}}+1\text{V}$ and $V_{\text{OUT}} = 0.95\times V_{\text{OUT(S)}}$.

■ Typical Performance Characteristics:

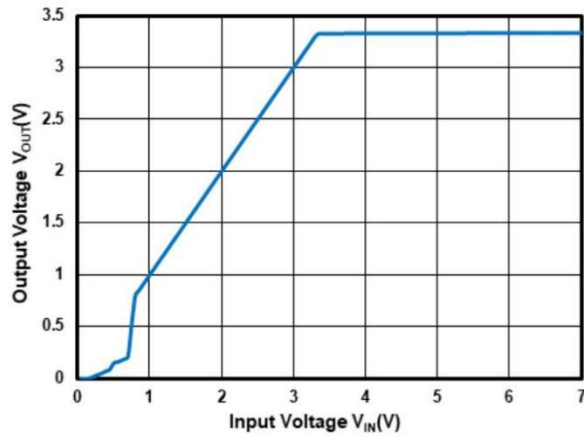
Test Conditions: $V_{IN}=V_{OUT}+1.0V$, $C_{IN}=1.0\mu F$, $C_{OUT}=1.0\mu F$, $T_a=25^\circ C$, unless otherwise indicated.



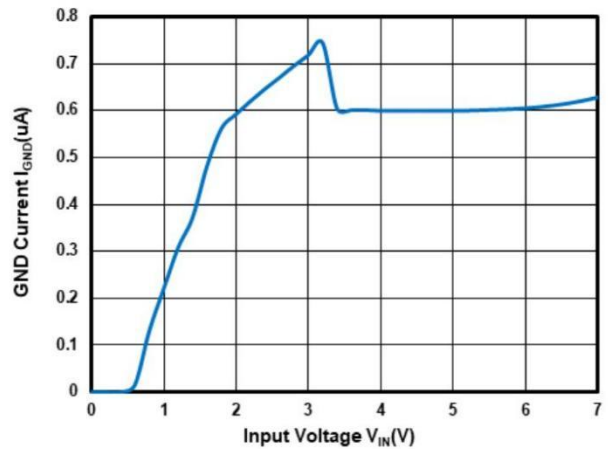
Output Voltage vs. Temperature at $V_{OUT}=3.3V$



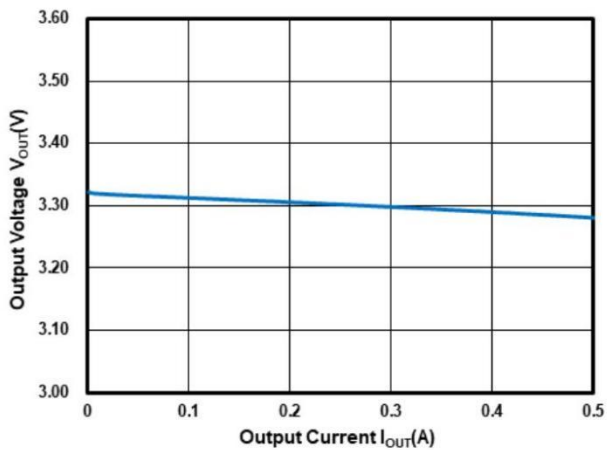
GND Current vs. Temperature at $V_{OUT}=3.3V$



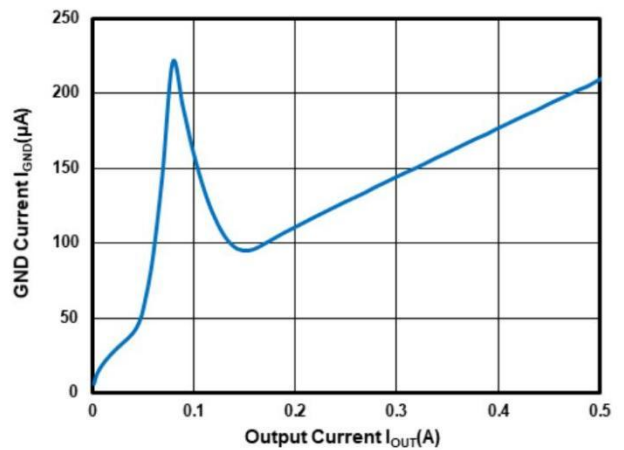
Output Voltage vs. Input Voltage at $V_{OUT}=3.3V$



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



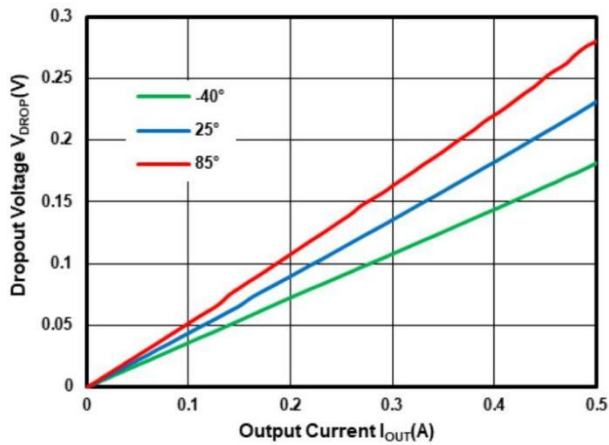
Output Voltage vs Output Current at $V_{OUT}=3.3V$



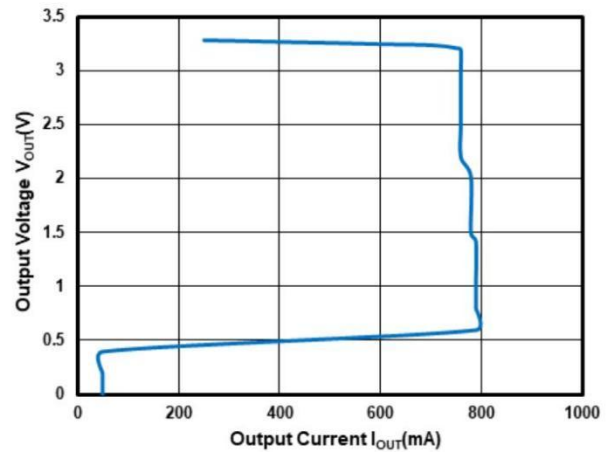
GND Current vs Output Current at $V_{OUT}=3.3V$

■ Typical Performance Characteristics (Continued):

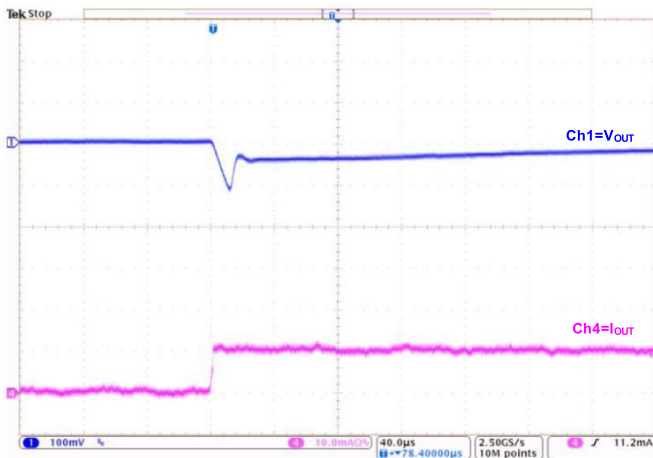
Test Conditions: $V_{IN}=V_{OUT}+1.0V$, $C_{IN}=1.0\mu F$, $C_{OUT}=1.0\mu F$, $T_a=25^\circ C$, unless otherwise indicated.



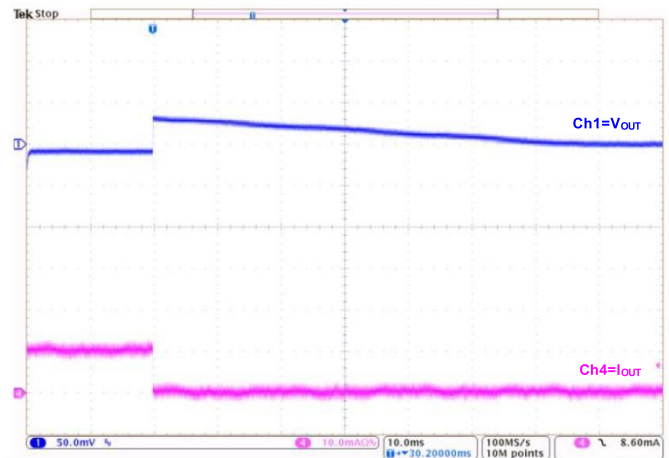
Dropout Voltage vs. Output Current at $V_{OUT}=3.3V$



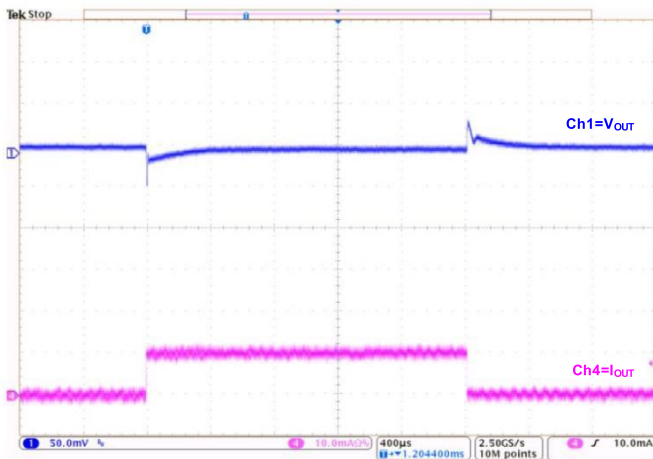
Output Current Fold-back at $V_{OUT}=3.3V$



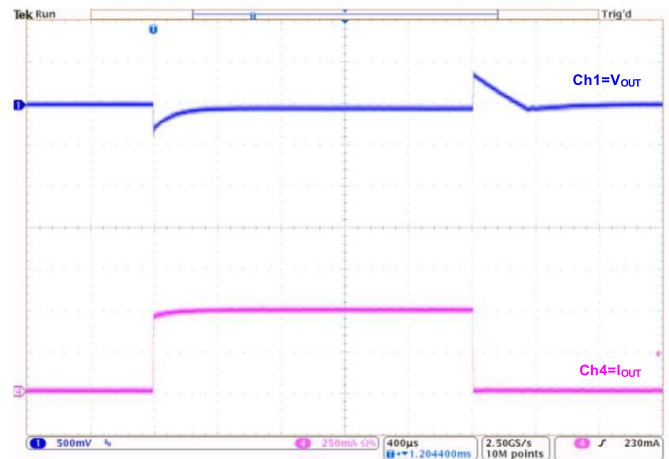
Load Transient at $V_{OUT}=3.3V$:
($I_{OUT}=0mA \sim 10mA$)



Load Transient at $V_{OUT}=3.3V$:
($I_{OUT}=10mA \sim 0mA$)



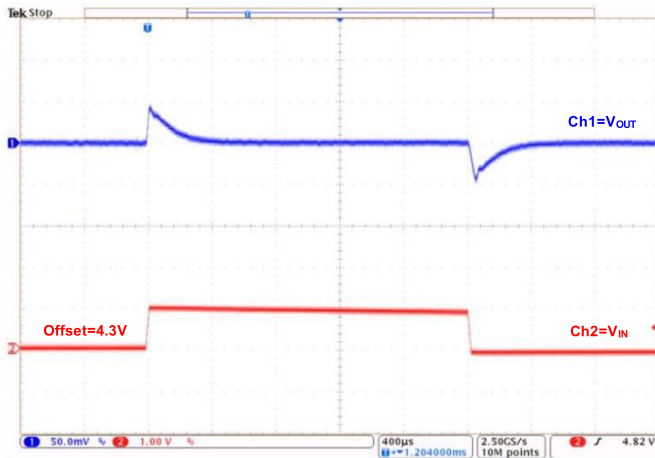
Load Transient at $V_{OUT}=3.3V$:
($I_{OUT}=1mA \sim 10mA \sim 1mA$)



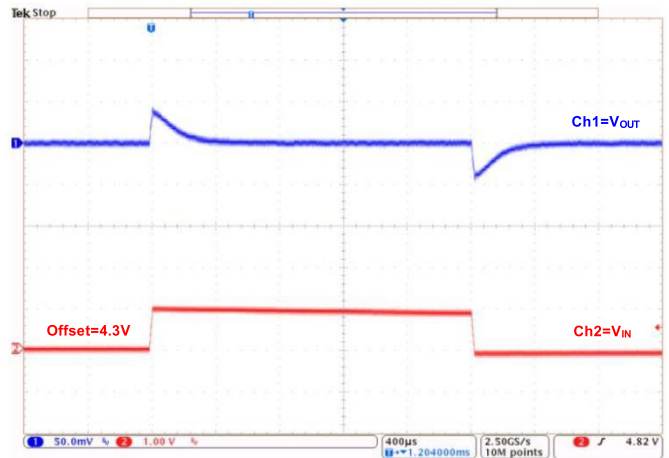
Load Transient at $V_{OUT}=3.3V$:
($I_{OUT}=1mA \sim 500mA \sim 1mA$)

■ Typical Performance Characteristics (Continued):

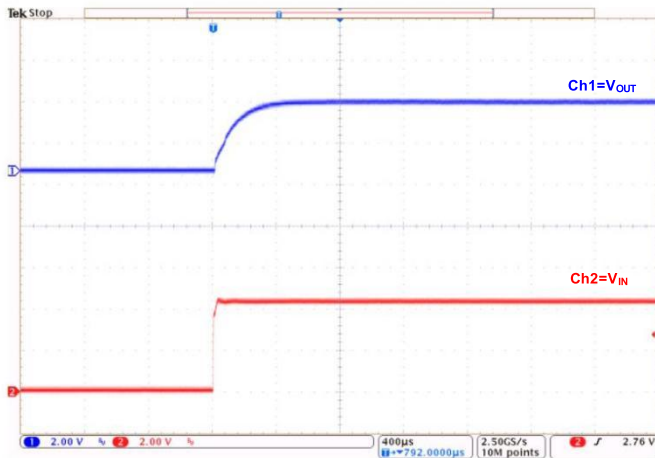
Test Conditions: $V_{IN}=V_{OUT}+1.0V$, $C_{IN}=1.0\mu F$, $C_{OUT}=1.0\mu F$, $T_a=25^\circ C$, unless otherwise indicated.



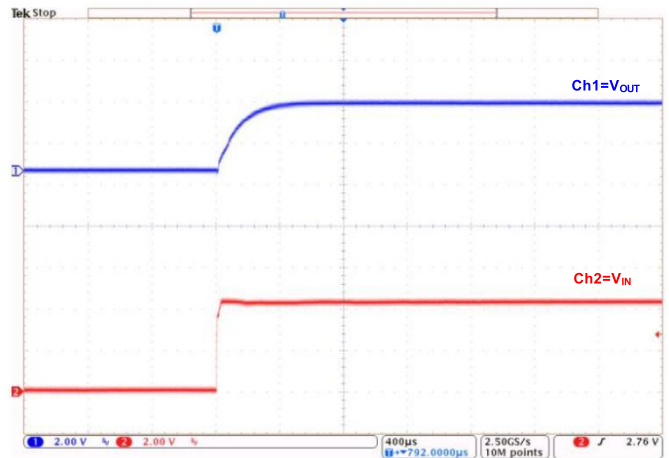
Line Transient at $V_{OUT}=3.3V$:
($I_{OUT}=1mA$)



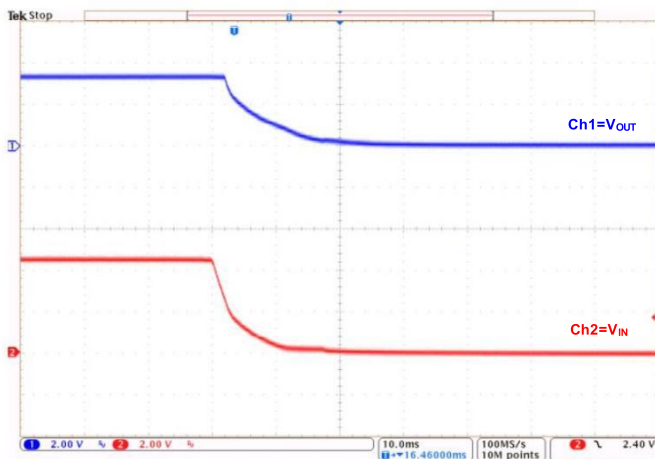
Line Transient at $V_{OUT}=3.3V$:
($I_{OUT}=10mA$)



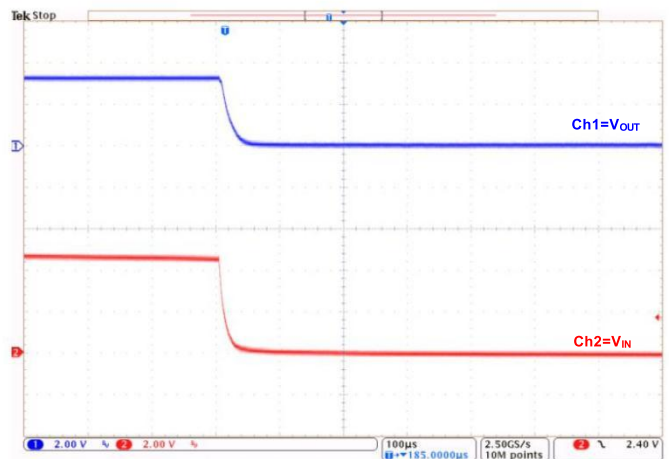
Power Up at $V_{OUT}=3.3V$:
($I_{OUT}=1mA$)



Power Up at $V_{OUT}=3.3V$:
($I_{OUT}=500mA$)



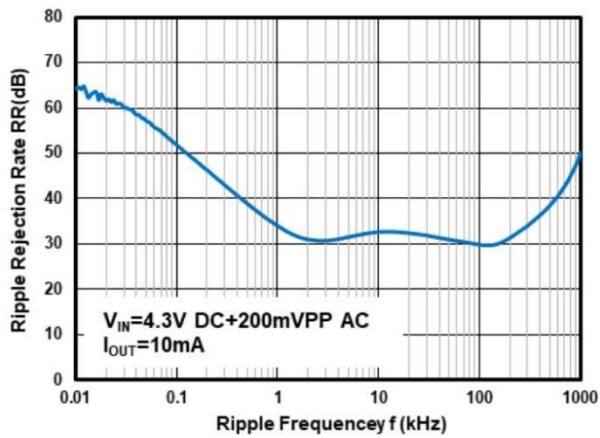
Power Down at $V_{OUT}=3.3V$:
($I_{OUT}=1mA$)



Power Down at $V_{OUT}=3.3V$:
($I_{OUT}=500mA$)

■ **Typical Performance Characteristics (Continued):**

Test Conditions: $V_{IN}=V_{OUT}+1.0V$, $C_{IN}=1.0\mu F$, $C_{OUT}=1.0\mu F$, $T_a=25^\circ C$, unless otherwise indicated.

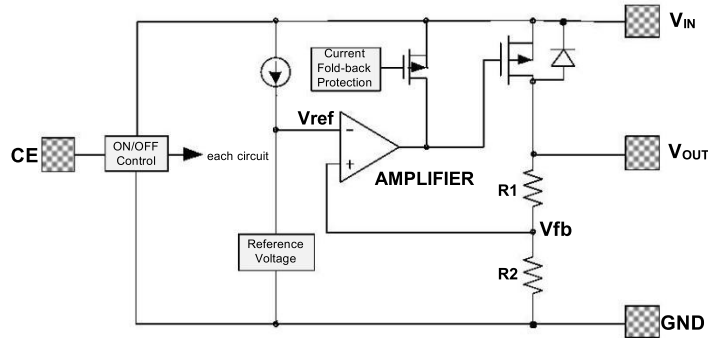


Power Supply Rejection Ratio at $V_{OUT}=3.3V$

■ 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 EN pin's signal.



2. Pass transistor

The pass transistor with low turn-on resistance used in AL87XX is a P-channel MOSFET. If the potential on V_{OUT} pin is higher than V_{IN}, 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 and short circuit protection

The AL87XX 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.

4. C_{OUT} Auto-Discharge Function

The AL87XX series can quickly discharge the electric charge at the output capacitor (C_{OUT}), when a low signal is set to the EN pin, which puts the whole IC into OFF state. The discharge function is achieved by an internal switch located between the V_{OUT} pin and the GND pin. In this state, the application is protected from a glitch operation caused by the electric charge at the output capacitor (C_{OUT}).

Moreover, discharge time of the output capacitor (C_{OUT}) is set by the C_{OUT} auto-discharge resistance (R_{DCHG}) and the output capacitor (C_{OUT}). By setting time constant of a C_{OUT} auto-discharge resistance value

(R_{DCHG}) and an output capacitor value (C_{OUT}) as $\tau (\tau = C_{OUT} \times R_{DCHG})$, the output voltage after discharge via the internal switch is calculated by the following formulas.

$$V = V_{OUT(S)} \times e^{-t/\tau} \text{ or } t = \tau \ln (V_{OUT(S)} / V)$$

V: Output voltage after discharge

V_{OUT(S)}: Output voltage

t: Discharge time

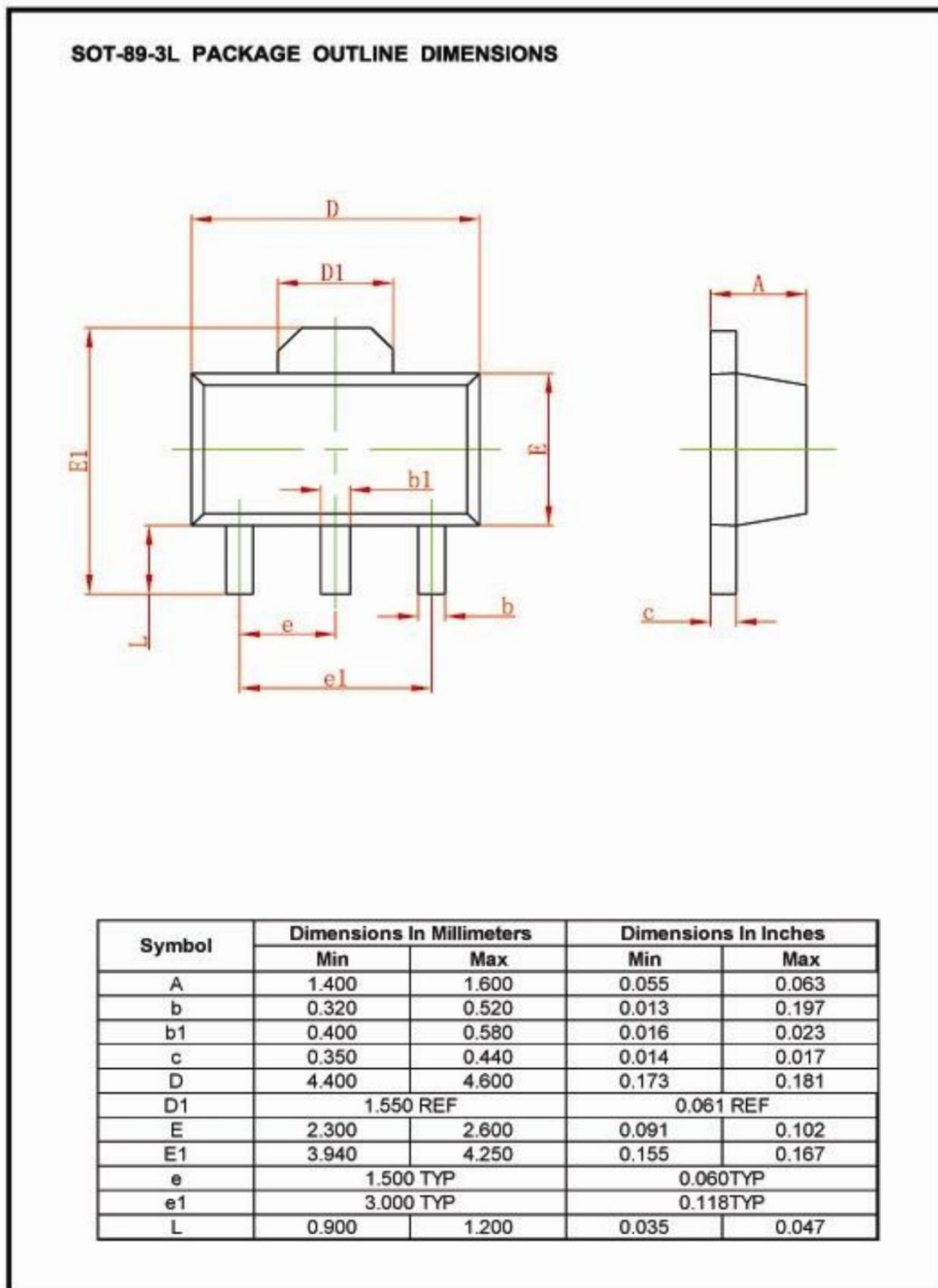
$$\tau: C_{OUT} \times R_{DCHG}$$

Please also note R_{DCHG} is depended on V_{IN} and When V_{IN} is high, R_{DCHG} is low.

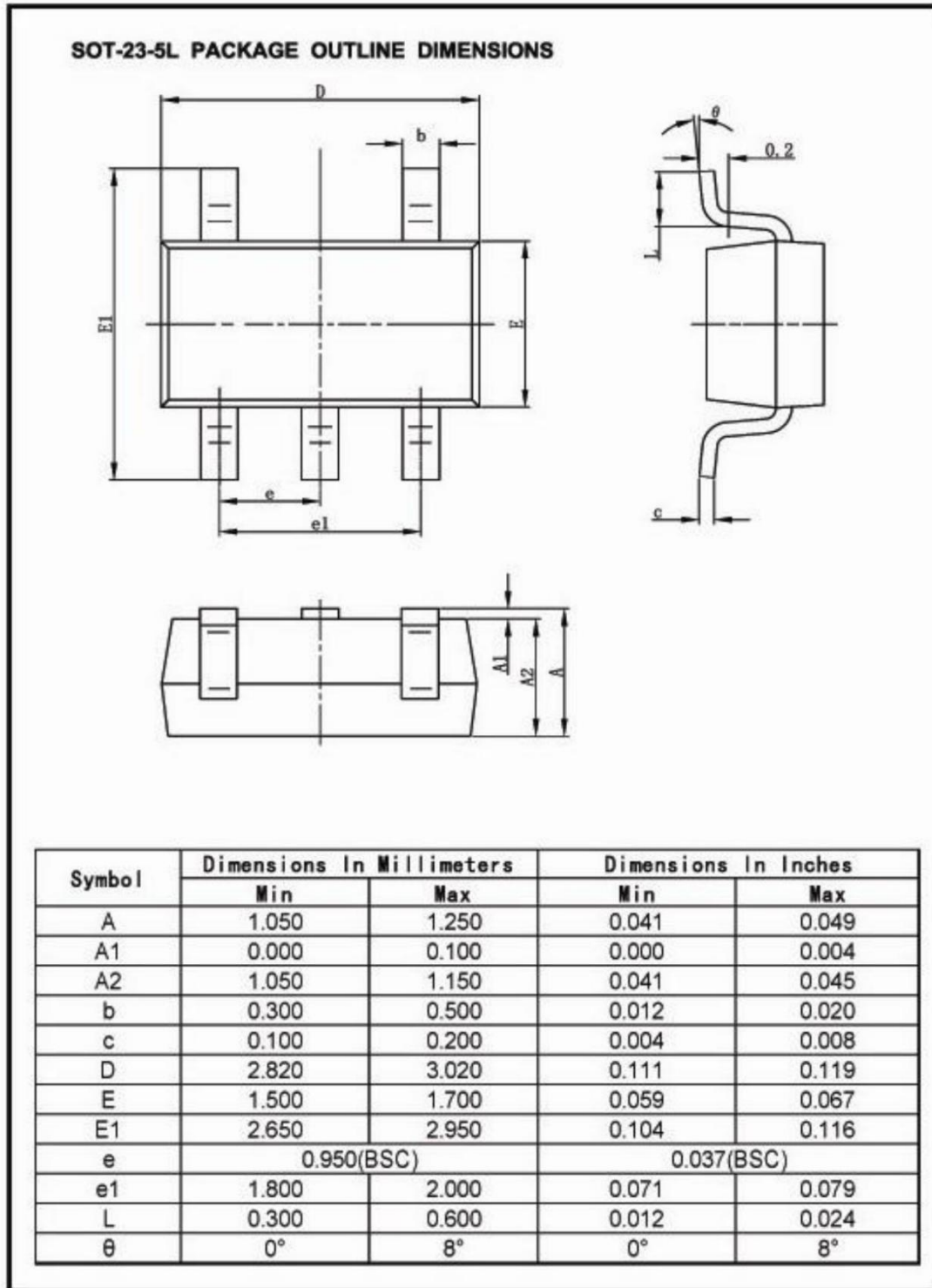
■ **Notes:**

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(Continued):



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