200mA DUAL CHANNEL CMOS LDO REGULATOR AP2401

General Description

The AP2401 series are dual positive voltage regulator ICs fabricated by CMOS process. Each of these ICs consists of a voltage reference, two error amplifiers, two resistor networks for setting output voltages. Each channel has a current limit circuit for current protection.

The AP2401 series feature high ripple rejection, low dropout voltage, low noise, high output voltage accuracy, and low current consumption which make them ideal for use in various battery-powered devices. The chip enable function allows the output of each channel to be turned on/off independently, greatly reducing the power consumption.

The AP2401 series have 1.2V/1.8V, 1.8V/2.5V, 1.8V/2.8V, 1.8V/3.3V, 2.8V/1.8V and 2.8V/3.3V versions.

The AP2401 are available in standard SOT-23-6 and DFN-1.8x2-6 packages.

Features

- Maximum Output Current/Channel: More Than 200mA (300mA Limit)
- High Output Voltage Accuracy: ±2%
- Low Quiescent Current/Channel: 25μA Typical
- Low Standby Current: 0.1μA Typical
- High PSRR: 70dB Typical （f=1kHz)
- Extremely Low Noise: 30μVrms (10Hz to 100kHz)
- Operating Temperature: -40 to 85^{o}C
- Compatible with Low ESR Ceramic Capacitor

Applications

- Mobile Phones, Cordless Phones
- Wireless Communication Equipment
- Portable Games
- Cameras, Video Recorders
- Sub-board Power Supplies for Telecom Equipment
- Battery Powered Equipment

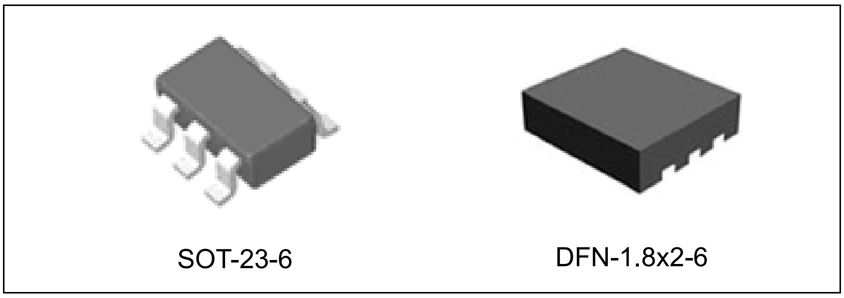
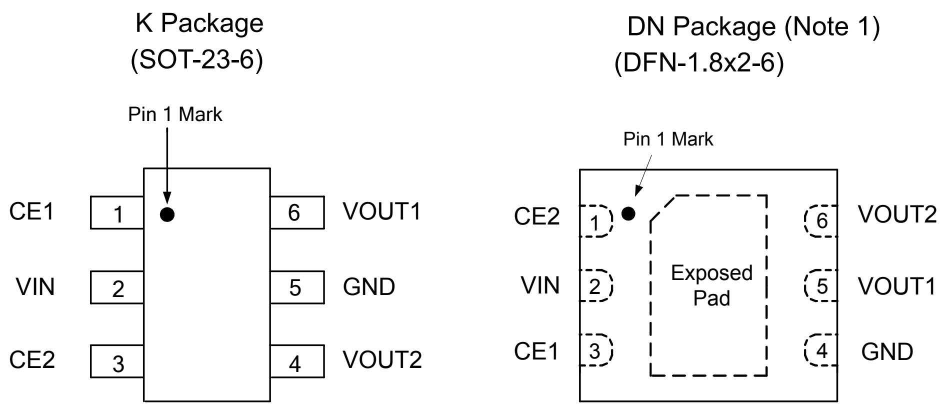


Figure 1. Package Types of AP2401

Pin Configuration



Note 1: The exposed pad should be connected to GND for better dissipation or left open.

Figure 2. Pin Configuration of AP2401 (Top View)

Pin Description

Pin Number		Pin Name	Function
SOT-23-6	**DFN-1.8x2-6**		
1	3	CE1	On/Off Control 1, Logic High=enable; Logic Low=Shutdown
2	2	VIN	Input Voltage
3	1	CE2	On/Off Control 2, Logic High=enable; Logic Low=Shutdown
4	6	VOUT2	Output Voltage 2
5	4	GND	Ground
6	5	VOUT1	Output Voltage 1

Functional Block Diagram

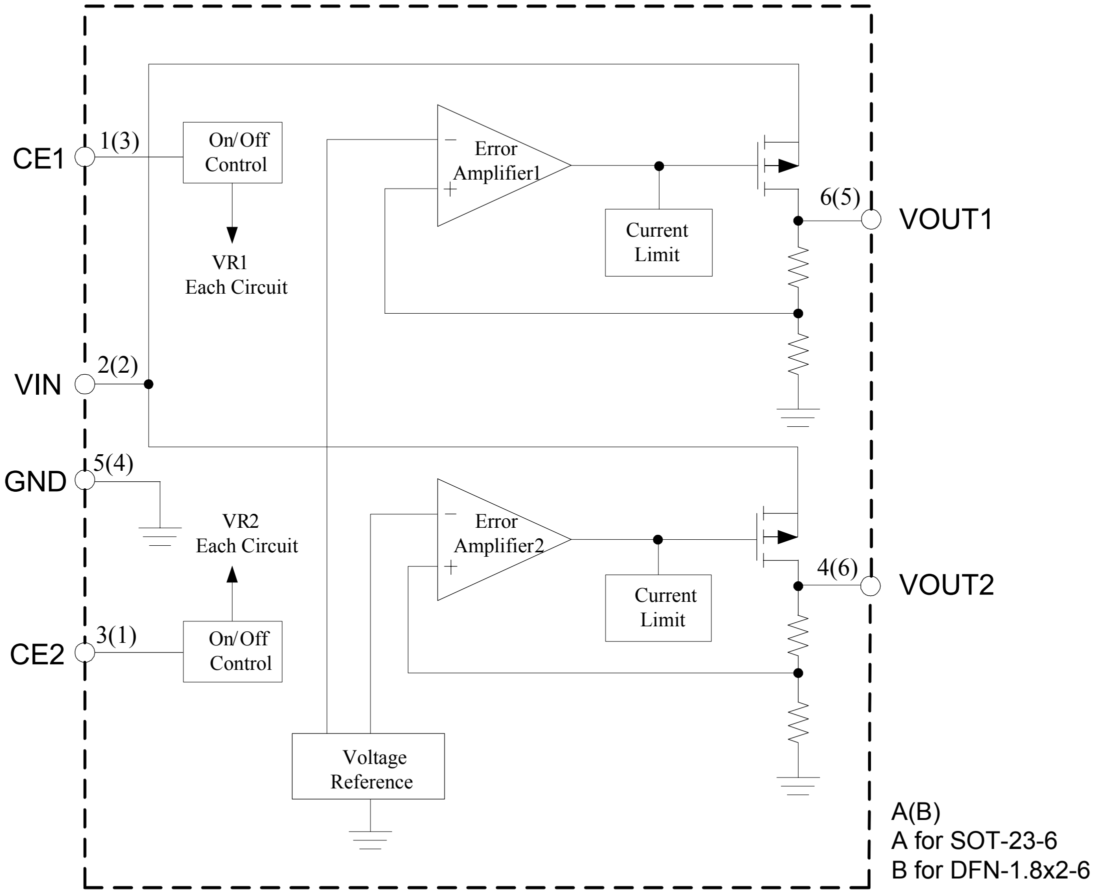


Figure 3. Functional Block Diagram of AP2401

Ordering Information

AP2401 □ □ □ □ □ - □

Circuit Type

B: Active High
(Without Built-in Pull-down Resistor)

0: Fixed Output 1.2V (Channel 1)
1: Fixed Output 1.8V (Channel 1)
3: Fixed Output 2.8V (Channel 1)

1: Fixed Output 1.8V (Channel 2)
2: Fixed Output 2.5V (Channel 2)
3: Fixed Output 2.8V (Channel 2)
4: Fixed Output 3.3V (Channel 2)

Package
K: SOT-23-6
DN: DFN-1.8x2-6

TR: Tape and Reel

E1: Lead Free
G1: Green

Package	Temperature Range	Condition	Output Voltages	Part Number		Marking ID		Packing Type
				Lead Free	Green	Lead Free	Green	
SOT-23-6	-40 to 85°C	Active High Without Built-in Pull-down Resistor	1.2V/1.8V	AP2401B01KTR-E1	AP2401B01KTR-G1	E8P	G7Q	Tape & Reel
		Active High Without Built-in Pull-down Resistor	1.8V/2.5V	AP2401B12KTR-E1	AP2401B12KTR-G1	E9P	G9P	Tape & Reel
		Active High Without Built-in Pull-down Resistor	1.8V/2.8V	AP2401B13KTR-E1	AP2401B13KTR-G1	E9Q	G9Q	Tape & Reel
		Active High Without Built-in Pull-down Resistor	1.8V/3.3V	AP2401B14KTR-E1	AP2401B14KTR-G1	E9R	G9R	Tape & Reel
		Active High Without Built-in Pull-down Resistor	2.8V/1.8V	AP2401B31KTR-E1	AP2401B31KTR-G1	E8R	G8R	Tape & Reel
		Active High Without Built-in Pull-down Resistor	2.8V/3.3V	AP2401B34KTR-E1	AP2401B34KTR-G1	E8Q	G8Q	Tape & Reel
DFN-1.8x2-6	-40 to 85°C	Active High Without Built-in Pull-down Resistor	1.2V/1.8V	AP2401B01DNTR-E1	AP2401B01DNTR-G1	3A	VA	Tape & Reel
		Active High Without Built-in Pull-down Resistor	1.8V/2.8V	AP2401B13DNTR-E1	AP2401B13DNTR-G1	3B	VB	Tape & Reel
		Active High Without Built-in Pull-down Resistor	2.8V/3.3V	AP2401B34DNTR-E1	AP2401B34DNTR-G1	3C	VC	Tape & Reel

BCD Semiconductor's Pb-free products, as designated with "E1" suffix in the part number, are RoHS compliant. Products with "G1" suffix are available in green packages.

Absolute Maximum Ratings (Note 2)

Parameter	Symbol	Value	Unit
Input Voltage	V_{IN}	6.5	V
Enable Input Voltage	V_{CE}	6.5	V
Output Current (T_A=25°C)	$I_{OUT}1+I_{OUT}2$	700	mA
Power Dissipation (T_A=25°C)	P_D	250	mW
Junction Temperature	T_J	150	°C
Storage Temperature Range	T_{STG}	-65 to 150	°C
Lead Temperature (Soldering, 10sec)	T_{LEAD}	260	°C
ESD (Human Body Model)	ESD	3000	V

Note 2: Stresses greater than those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "Recommended Operating Conditions" is not implied. Exposure to "Absolute Maximum Ratings" for extended periods may affect device reliability.

Recommended Operating Conditions

Parameter	Symbol	Min	Max	Unit
Input Voltage	V_{IN}		6	V
Operating Ambient Temperature Range	T_A	-40	85	°C

Electrical Characteristics

(Channel 1/Channel 2: $V_{IN}=V_{OUT}+1V$, $T_J=25^oC$, $C_{IN}=1\mu F$, $C_{OUT}=1\mu F$, unless otherwise specified.)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Output Voltage Accuracy	$\Delta V_{OUT}/V_{OUT}$	Variation from specified $V_{OUT,}$ $I_{OUT}=30mA$		-2		2	%
Input Voltage	V_{IN}					6	V
Maximum Output Current	I_{OUT}			200			mA
Load Regulation	V_{RLOAD}	$1mA\le I_{OUT}\le 200mA$			40	60	mV
Line Regulation	V_{RLINE}	$V_{OUT}+1V\le V_{IN}\le 6V$ $I_{OUT}=30mA$, $V_{CE}=V_{IN}$			0.01	0.2	%/V
Dropout Voltage	V_{DROP}	$I_{OUT}=30mA$	$V_{OUT}=1.2V$		700	750	mV
			$V_{OUT}=1.8V$		60	70	
			$V_{OUT}=2.5V$		45	55	
			$V_{OUT}=2.8V$		45	55	
			$V_{OUT}=3.3V$		35	45	
		$I_{OUT}=100mA$	$V_{OUT}=1.2V$		800	900	
			$V_{OUT}=1.8V$		175	195	
			$V_{OUT}=2.5V$		135	160	
			$V_{OUT}=2.8V$		135	160	
			$V_{OUT}=3.3V$		125	150	
		$I_{OUT}=200mA$	$V_{OUT}=1.2V$		1000	1200	
			$V_{OUT}=1.8V$		365	550	
			$V_{OUT}=2.5V$		275	500	
			$V_{OUT}=2.8V$		270	500	
			$V_{OUT}=3.3V$		230	500	
Quiescent Current	I_Q	$V_{CE}=V_{IN}=V_{OUT}+1V$, $I_{OUT}=0mA$			25	45	μA
Standby Current	I_{STD}	V_{CE} in OFF mode			0.1	1	μA
Power Supply Rejection Ratio	PSRR	Ripple 0.5Vp-p, f=1kHz $V_{IN}=V_{OUT}+1V$, $I_{OUT}=30mA$			70		dB
Output Voltage Temperature Coefficient	$(\Delta V_{OUT}/V_{OUT})/\Delta T$	$I_{OUT}=30mA$, $-40^oC\le T_J\le 85^oC$			±100		ppm/^{o}C
Current Limit	I_{LIMIT}	$V_{CE}=V_{IN}$			300		mA
Short Circuit Current	I_{SHORT}	$V_{CE}=V_{IN,}$ $V_{OUT}=0$			30		mA
RMS Output Noise	V_{NOISE}	$T_A=25^oC$ 10Hz ≤f≤100kHz			30		μVrms
CE "High" Voltage		CE input voltage "High"		1.3		6	V
CE "Low" Voltage		CE input voltage "Low"				0.25	V
Thermal Resistance (Junction to Case)	θ_{JC}	SOT-23-6			61.3		^{o}C/W
		DFN-1.8x2-6			20		

Typical Performance Characteristics

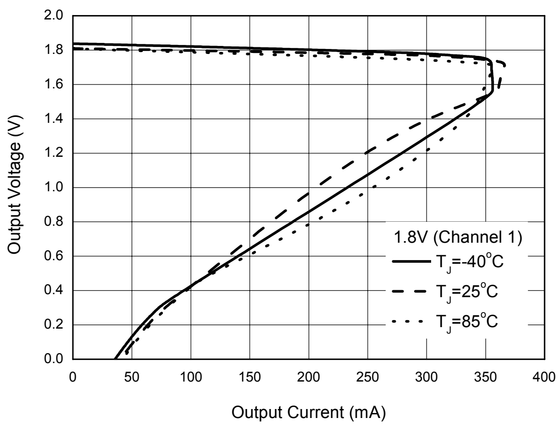


Figure 4. Output Voltage vs. Output Current

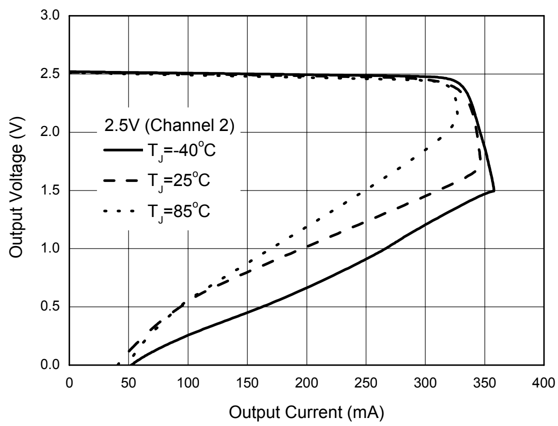


Figure 5. Output Voltage vs. Output Current

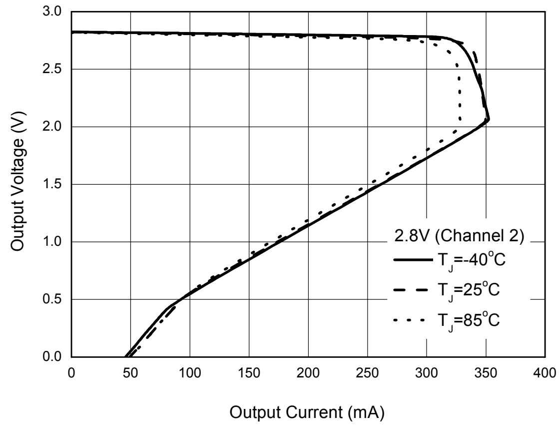


Figure 6. Output Voltage vs. Output Current

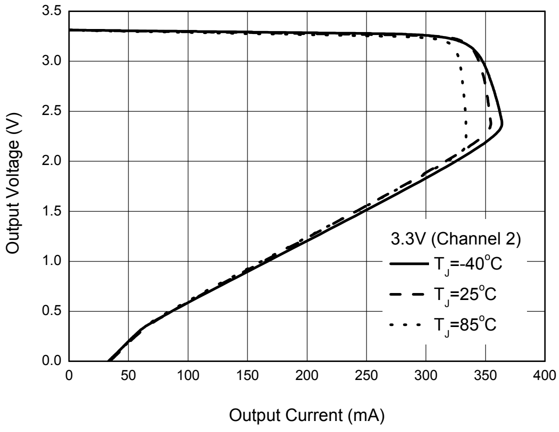


Figure 7. Output Voltage vs. Output Current

Typical Performance Characteristics (Continued)

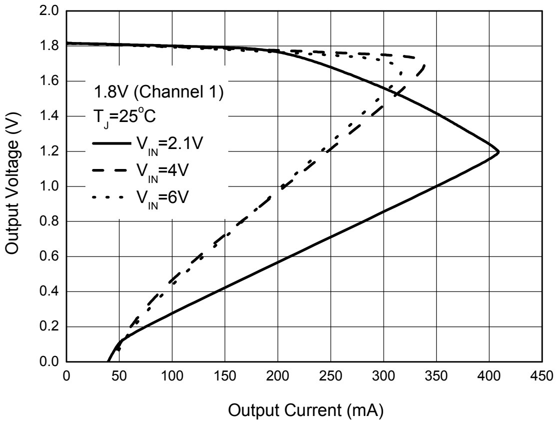


Figure 8. Output Voltage vs. Output Current

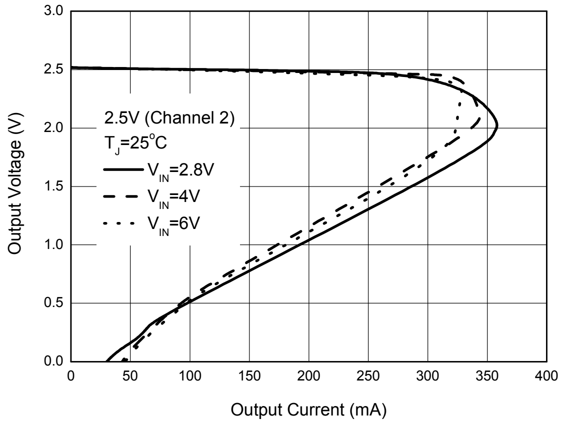


Figure 9. Output Voltage vs. Output Current

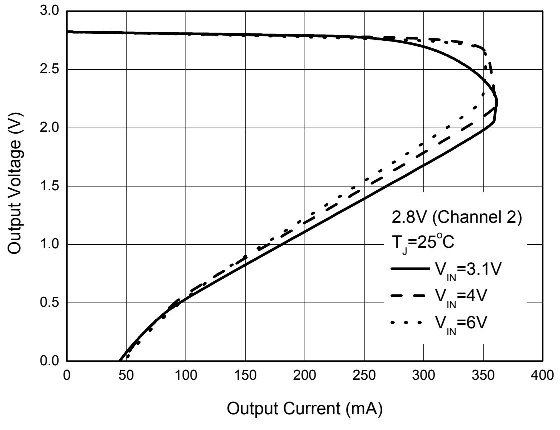


Figure 10. Output Voltage vs. Output Current

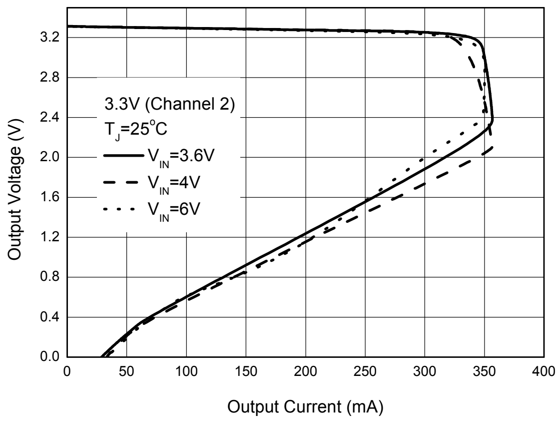


Figure 11. Output Voltage vs. Output Current

Typical Performance Characteristics (Continued)

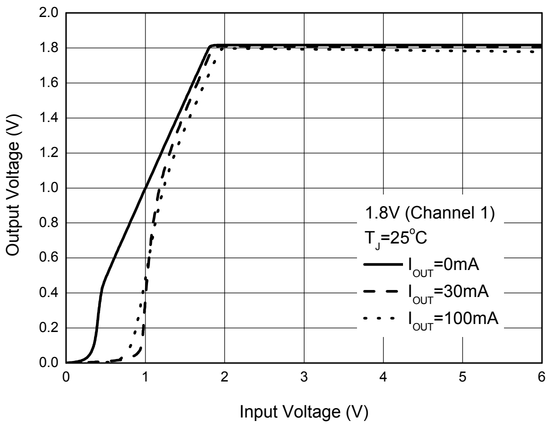


Figure 12. Output Voltage vs. Input Voltage

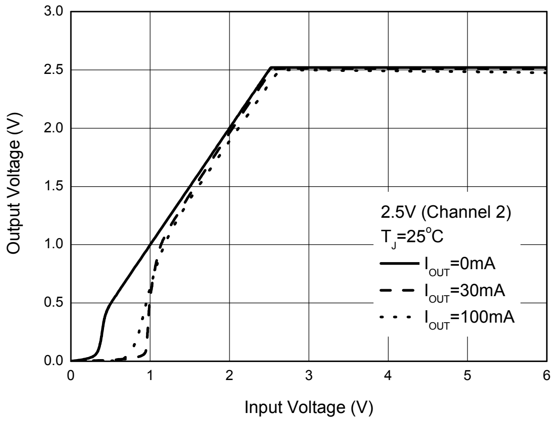


Figure 13. Output Voltage vs. Input Voltage

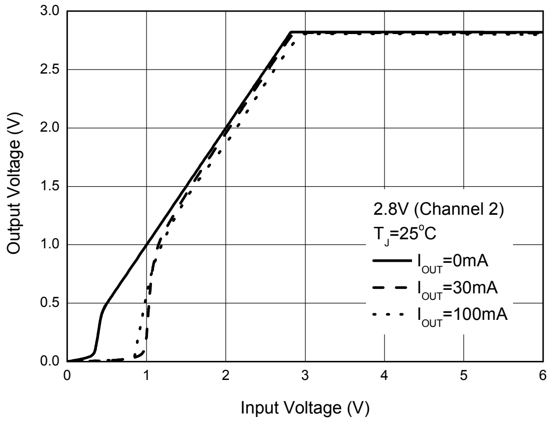


Figure 14. Output Voltage vs. Input Voltage

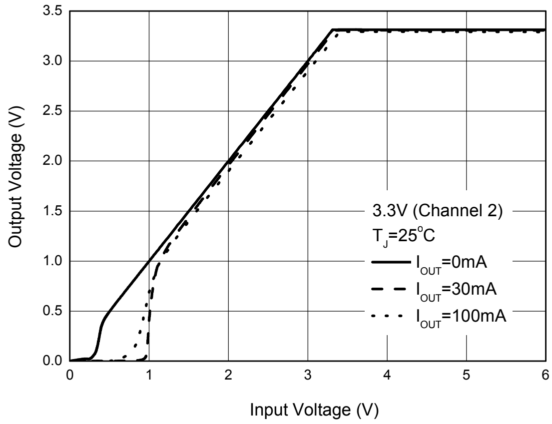


Figure 15. Output Voltage vs. Input Voltage

Typical Performance Characteristics (Continued)

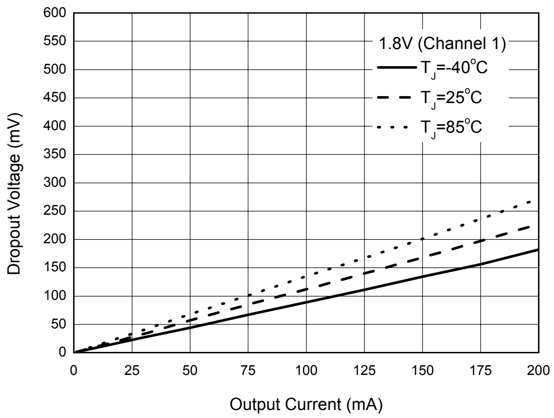


Figure 16. Dropout Voltage vs. Output Current

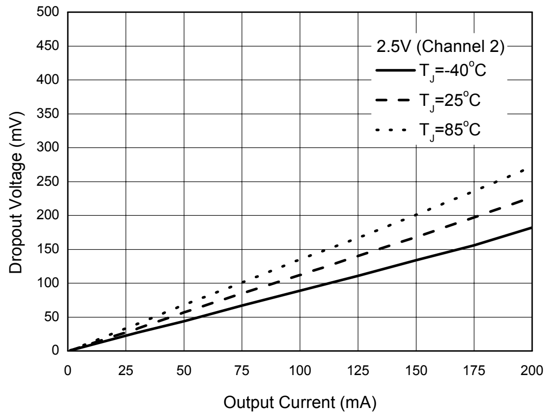


Figure 17. Dropout Voltage vs. Output Current

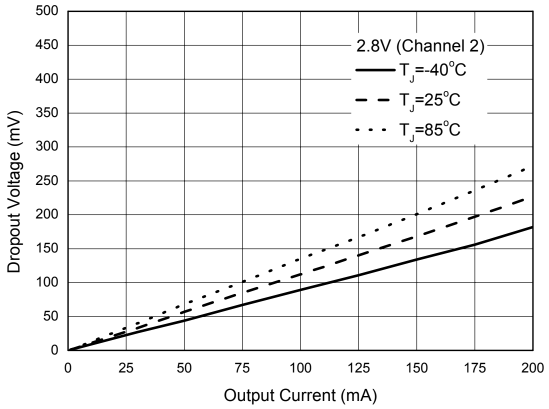


Figure 18. Dropout Voltage vs. Output Current

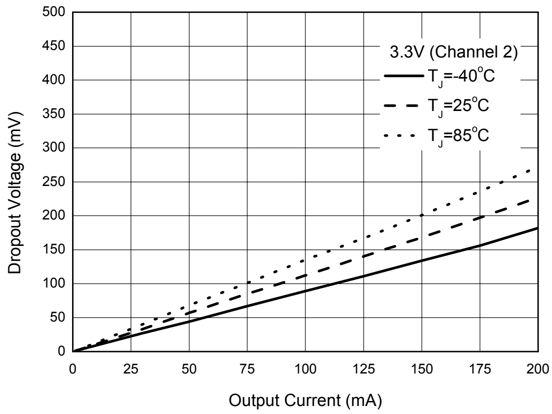


Figure 19. Dropout Voltage vs. Output Current

Typical Performance Characteristics (Continued)

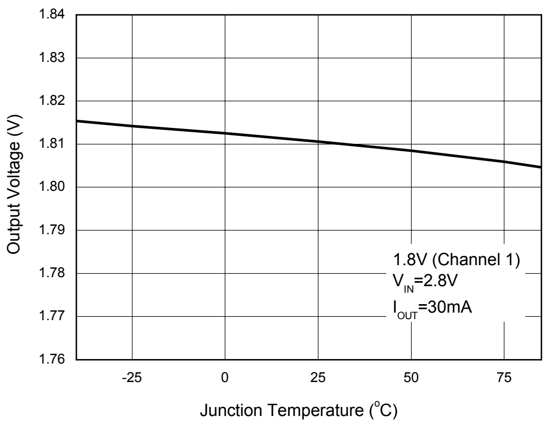


Figure 20. Output Voltage vs. Junction Temperature

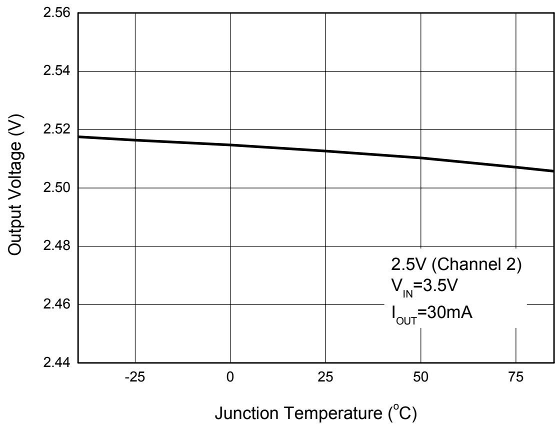


Figure 21. Output Voltage vs. Junction Temperature

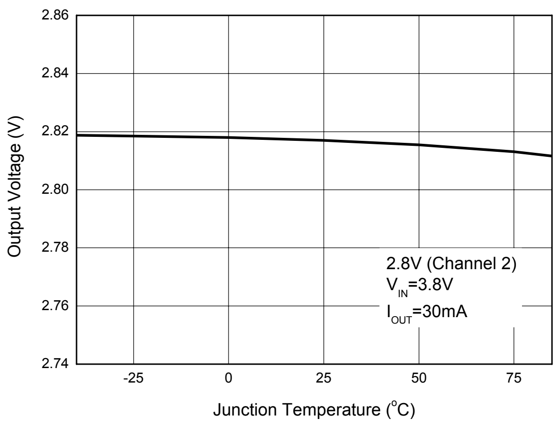


Figure 22. Output Voltage vs. Junction Temperature

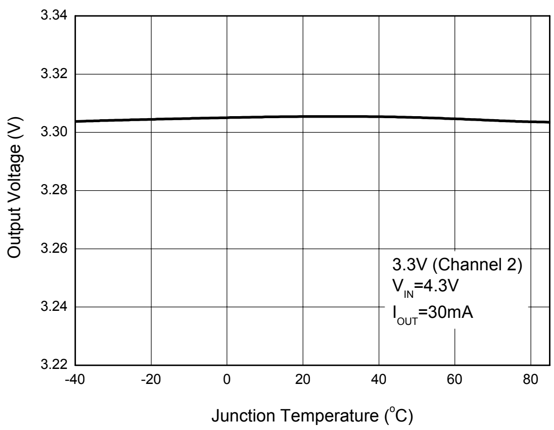


Figure 23. Output Voltage vs. Junction Temperature

Typical Performance Characteristics (Continued)

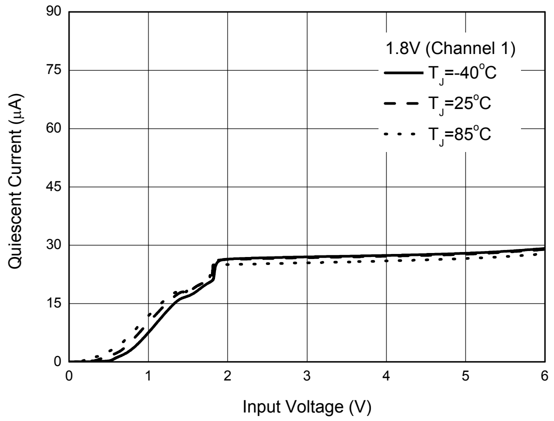


Figure 24. Quiescent Current vs. Input Voltage

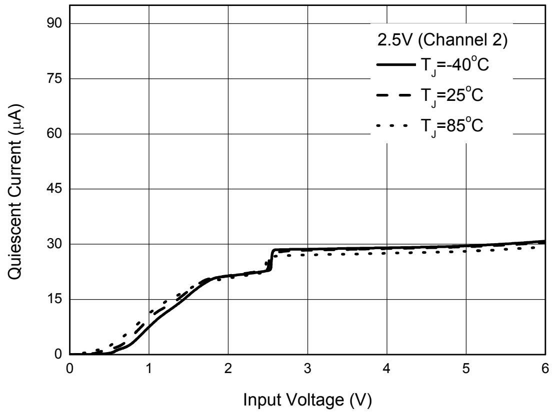


Figure 25. Quiescent Current vs. Input Voltage

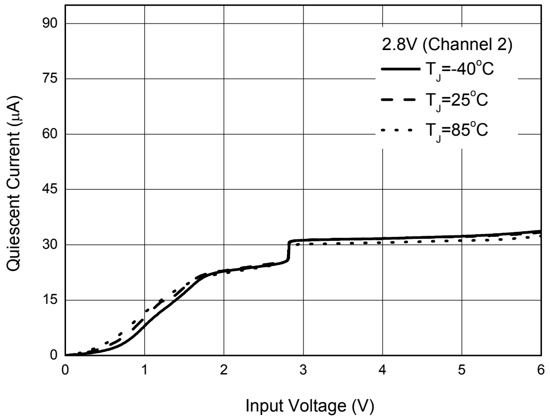


Figure 26. Quiescent Current vs. Input Voltage

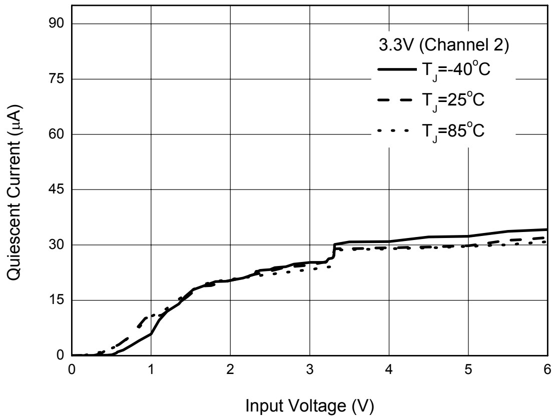


Figure 27. Quiescent Current vs. Input Voltage

Typical Performance Characteristics (Continued)

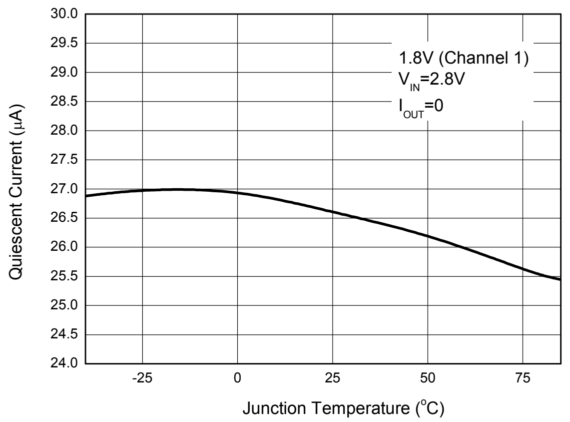


Figure 28. Quiescent Current vs. Junction Temperature

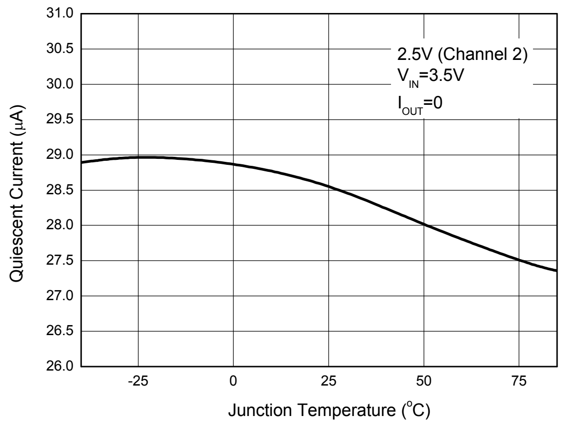


Figure 29. Quiescent Current vs. Junction Temperature

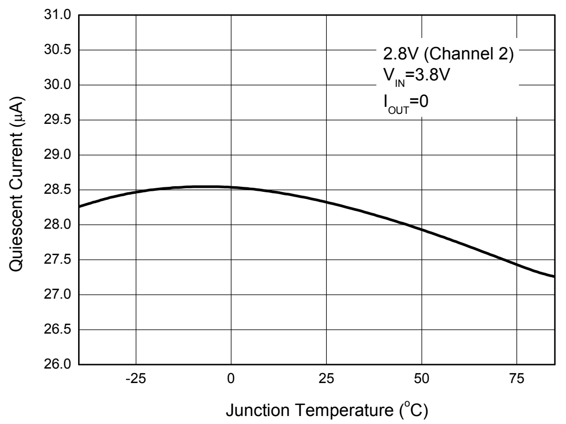


Figure 30. Quiescent Current vs. Junction Temperature

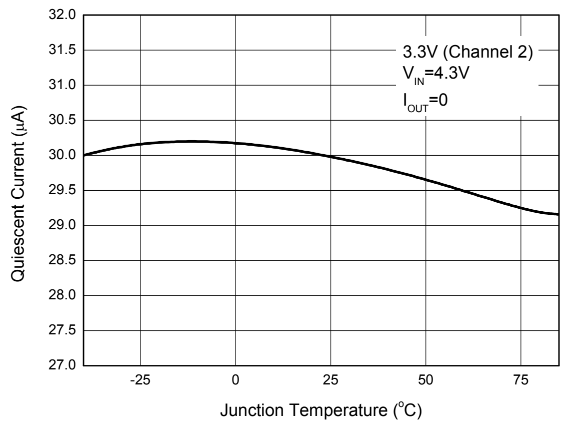


Figure 31. Quiescent Current vs. Junction Temperature

Typical Performance Characteristics (Continued)

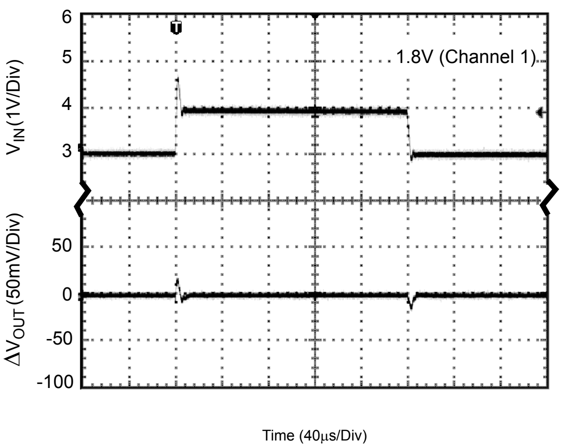


Figure 32. Line Transient
(Conditions: I_{OUT}=30mA, C_{IN}=100nF, C_{OUT}=1µF)

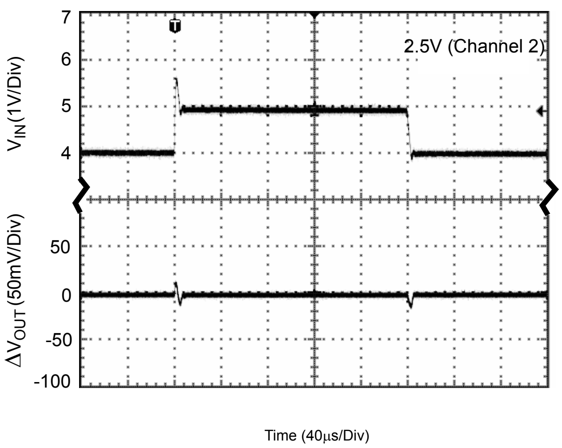


Figure 33. Line Transient
(Conditions: I_{OUT}=30mA, C_{IN}=100nF, C_{OUT}=1µF)

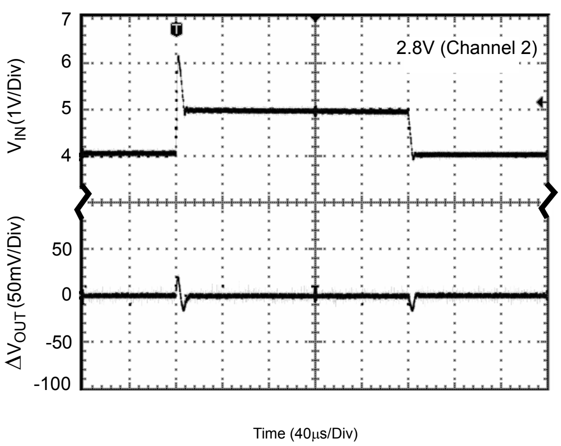


Figure 34. Line Transient
(Conditions: I_{OUT}=30mA, C_{IN}=100nF, C_{OUT}=1µF)

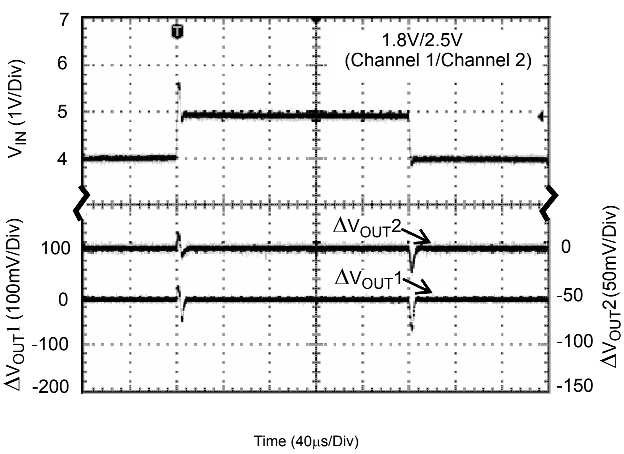


Figure 35. Line Transient
(Conditions: channel 1 and 2 on, I_{OUT}=30mA,
C_{IN}=100nF, C_{OUT}=1µF)

Typical Performance Characteristics (Continued)

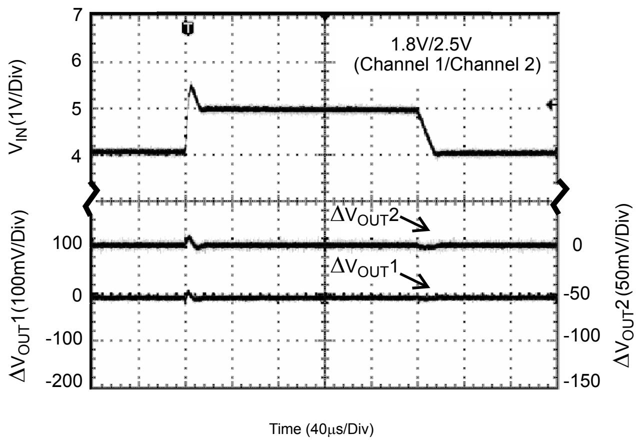


Figure 36. Line Transient
(Conditions: channel 1 and 2 on, I_{OUT}=30mA, C_{IN}=C_{OUT}=1μF)

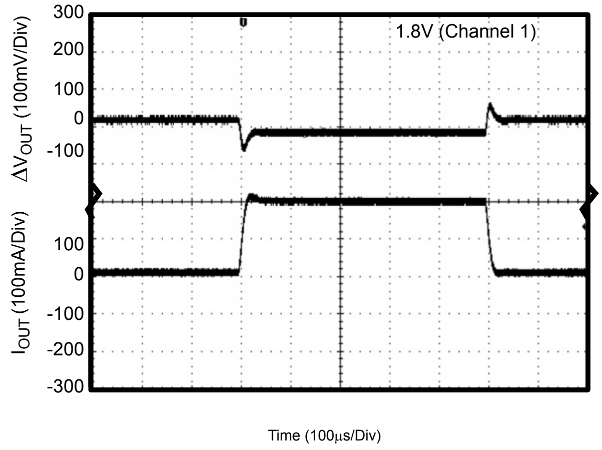


Figure 37. Load Transient
(Conditions: I_{OUT}=10 to 200mA, C_{IN}=C_{OUT}=1μF)

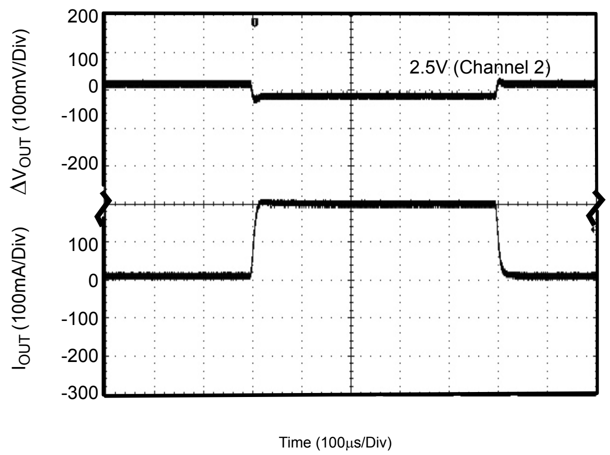


Figure 38. Load Transient
(Conditions: I_{OUT}=10 to 200mA, C_{IN}=C_{OUT}=1μF)

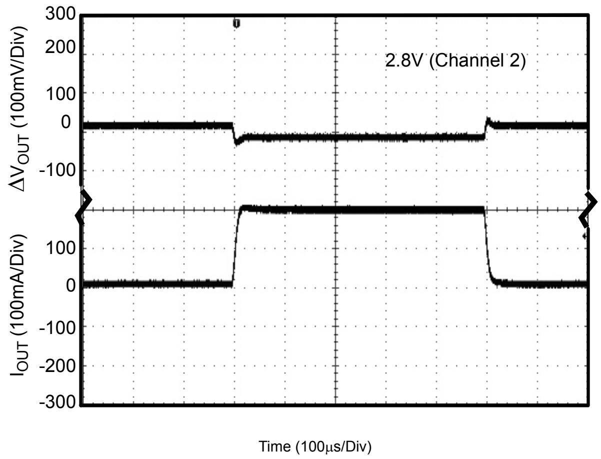


Figure 39. Load Transient
(Conditions: I_{OUT}=10 to 200mA, C_{IN}=C_{OUT}=1μF)

Typical Performance Characteristics (Continued)

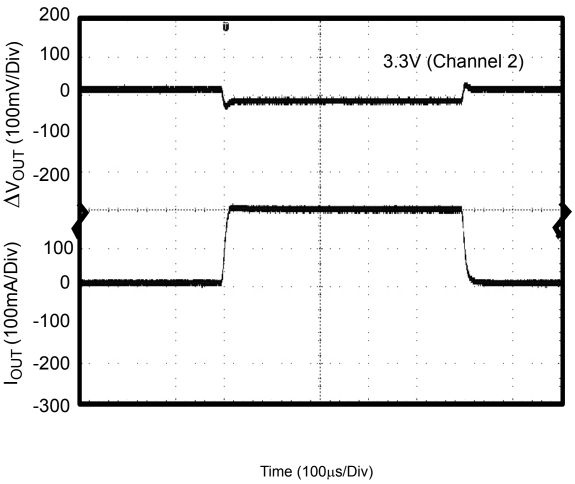


Figure 40. Load Transient
(Conditions: I_{OUT}=10 to 200mA, C_{IN}=C_{OUT}=1μF)

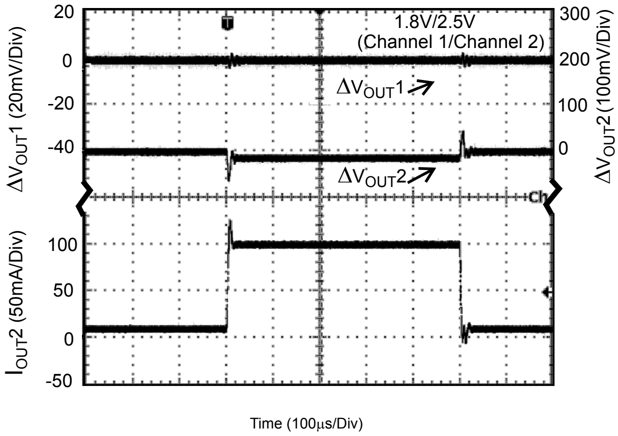


Figure 41. Cross Talk 1
(Conditions: channel 1 and 2 on, $I_{OUT}1$=30mA,
$I_{OUT}2$=10 to 100mA, C_{IN}=C_{OUT}=1μF)

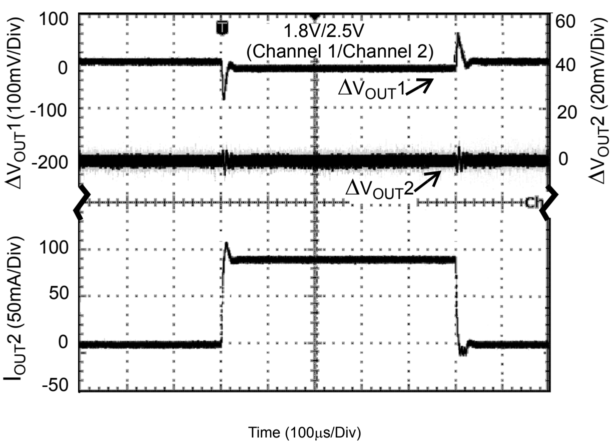


Figure 42. Cross Talk 2
(Conditions: channel 1 and 2 on, $I_{OUT}1$=10 to 100mA,
$I_{OUT}2$=30mA, C_{IN}=C_{OUT}=1μF)

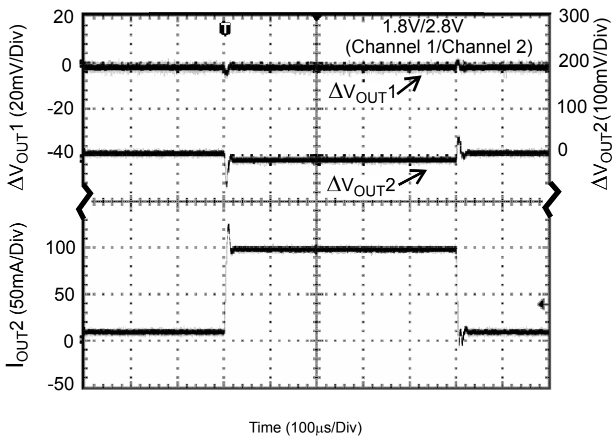


Figure 43. Cross Talk 3
(Conditions: channel 1 and 2 on, $I_{OUT}1$=30mA,
$I_{OUT}2$=10 to 100mA, C_{IN}=C_{OUT}=1μF)

Typical Performance Characteristics (Continued)

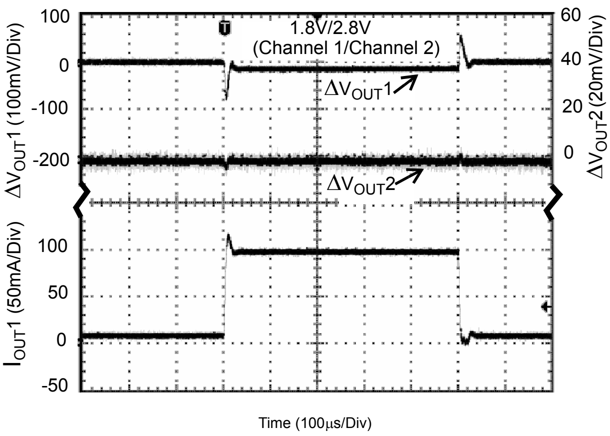


Figure 44. Cross Talk 4
(Conditions: channel 1 and 2 on, $I_{OUT}1$=10 to 100mA, $I_{OUT}2$=30mA, C_{IN}=C_{OUT}=1μF)

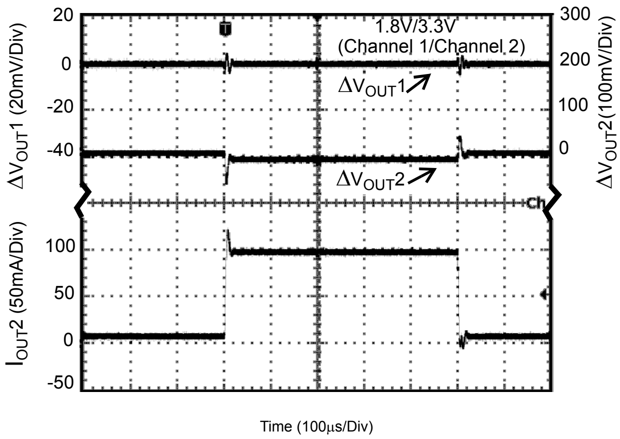


Figure 45. Cross Talk 5
(Conditions: channel 1 and 2 on, $I_{OUT}1$=30mA, $I_{OUT}2$=10 to 100mA, C_{IN}=C_{OUT}=1μF)

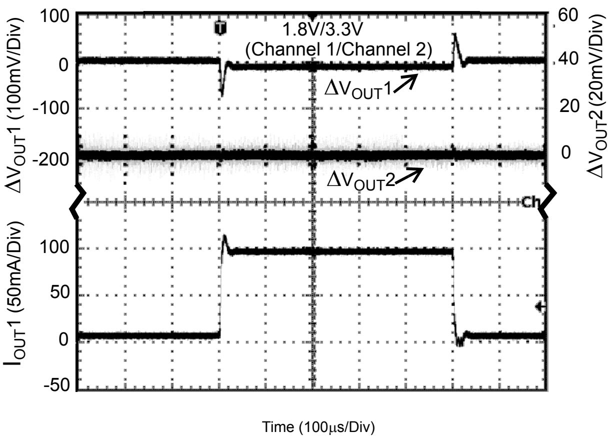


Figure 46. Cross Talk 6
(Conditions: channel 1 and 2 on, $I_{OUT}1$=10 to 100mA, $I_{OUT}2$=30mA, C_{IN}=C_{OUT}=1μF)

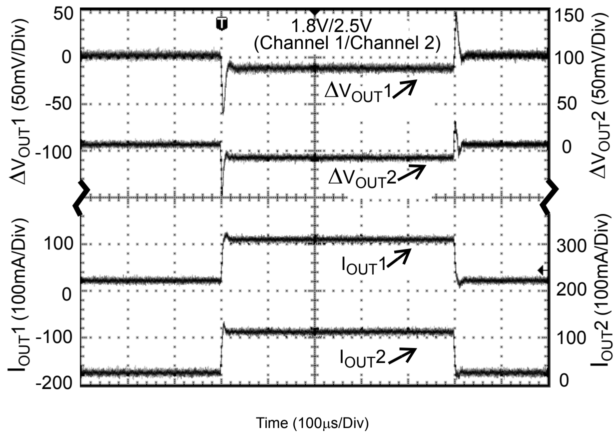


Figure 47. Cross Talk 7
(Conditions: channel 1 and 2 on, $I_{OUT}1$=$I_{OUT}2$=10 to 100mA, C_{IN}=C_{OUT}=1μF)

Typical Performance Characteristics (Continued)

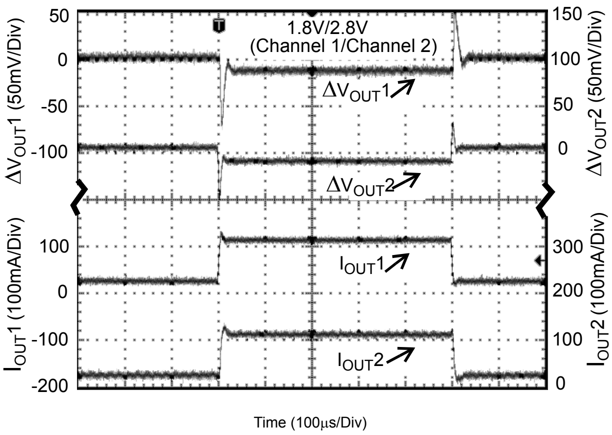


Figure 48. Cross Talk 8
(Conditions: channel 1 and 2 on, $I_{OUT}1=I_{OUT}2=10$ to 100mA, $C_{IN}=C_{OUT}=1\mu F$)

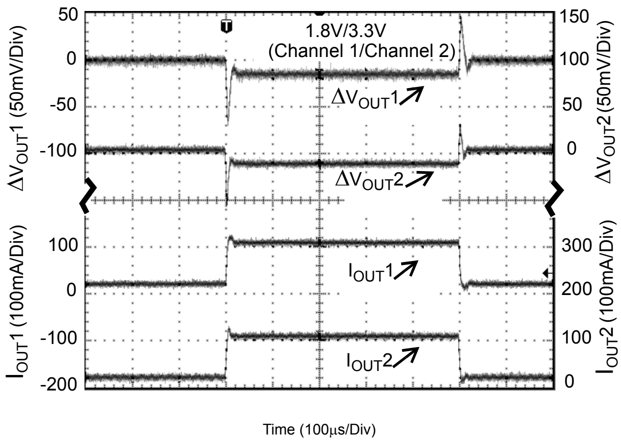


Figure 49. Cross Talk 9
(Conditions: channel 1 and 2 on, $I_{OUT}1=I_{OUT}2=10$ to 100mA, $C_{IN}=C_{OUT}=1\mu F$)

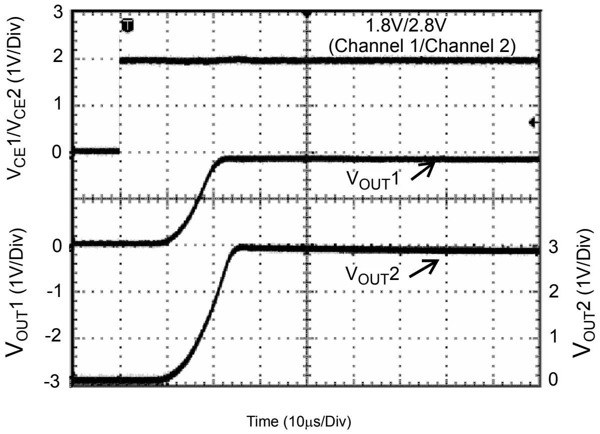


Figure 50. Enable Voltage vs. Output Voltage
(Conditions: $V_{CE}1=V_{CE}2=0$ to 2V, $I_{OUT}=0mA$, $C_{IN}=C_{OUT}=1\mu F$)

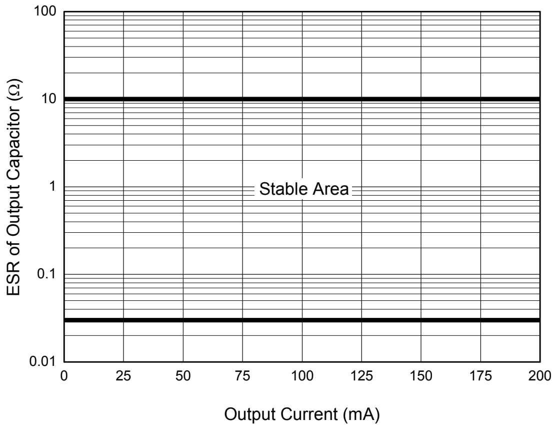


Figure 51. ESR vs. Output Current

Typical Performance Characteristics (Continued)

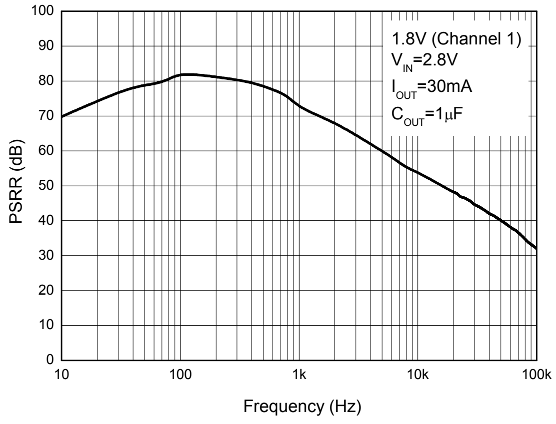


Figure 52. PSRR vs. Frequency

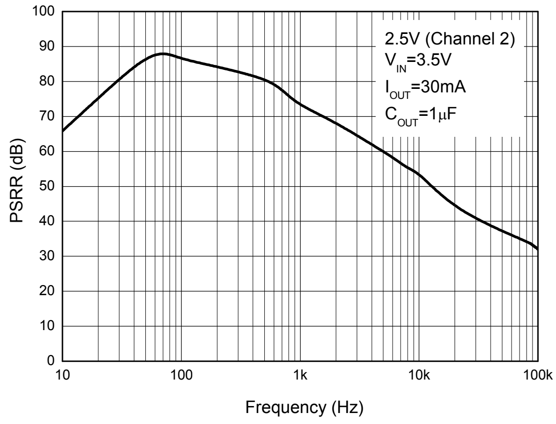


Figure 53. PSRR vs. Frequency

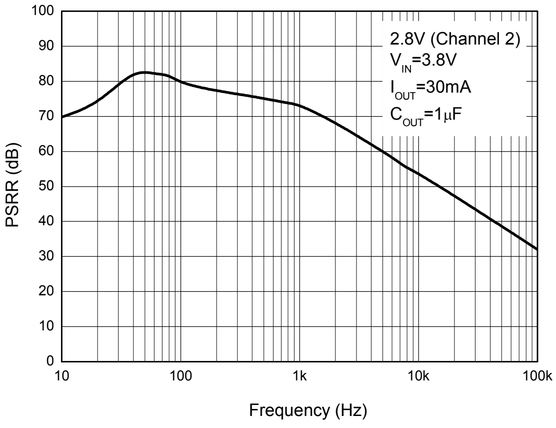


Figure 54. PSRR vs. Frequency

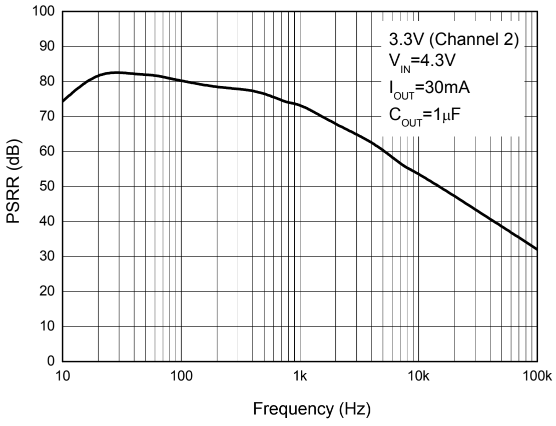


Figure 55. PSRR vs. Frequency

Typical Application

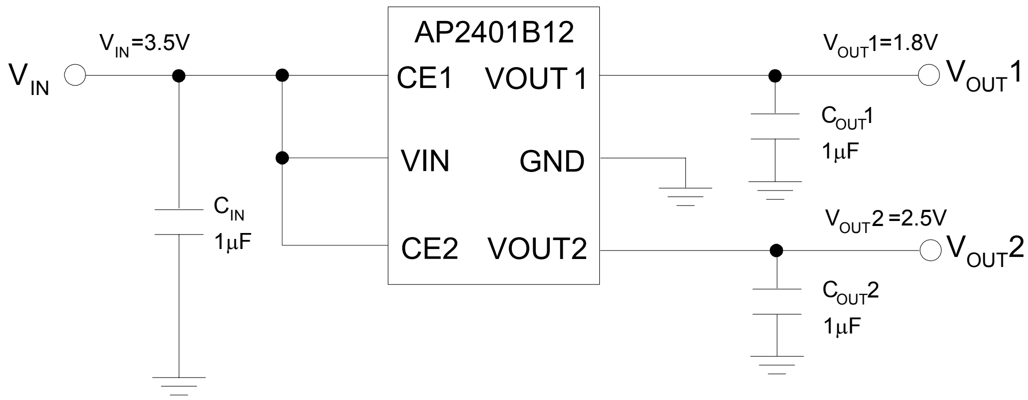
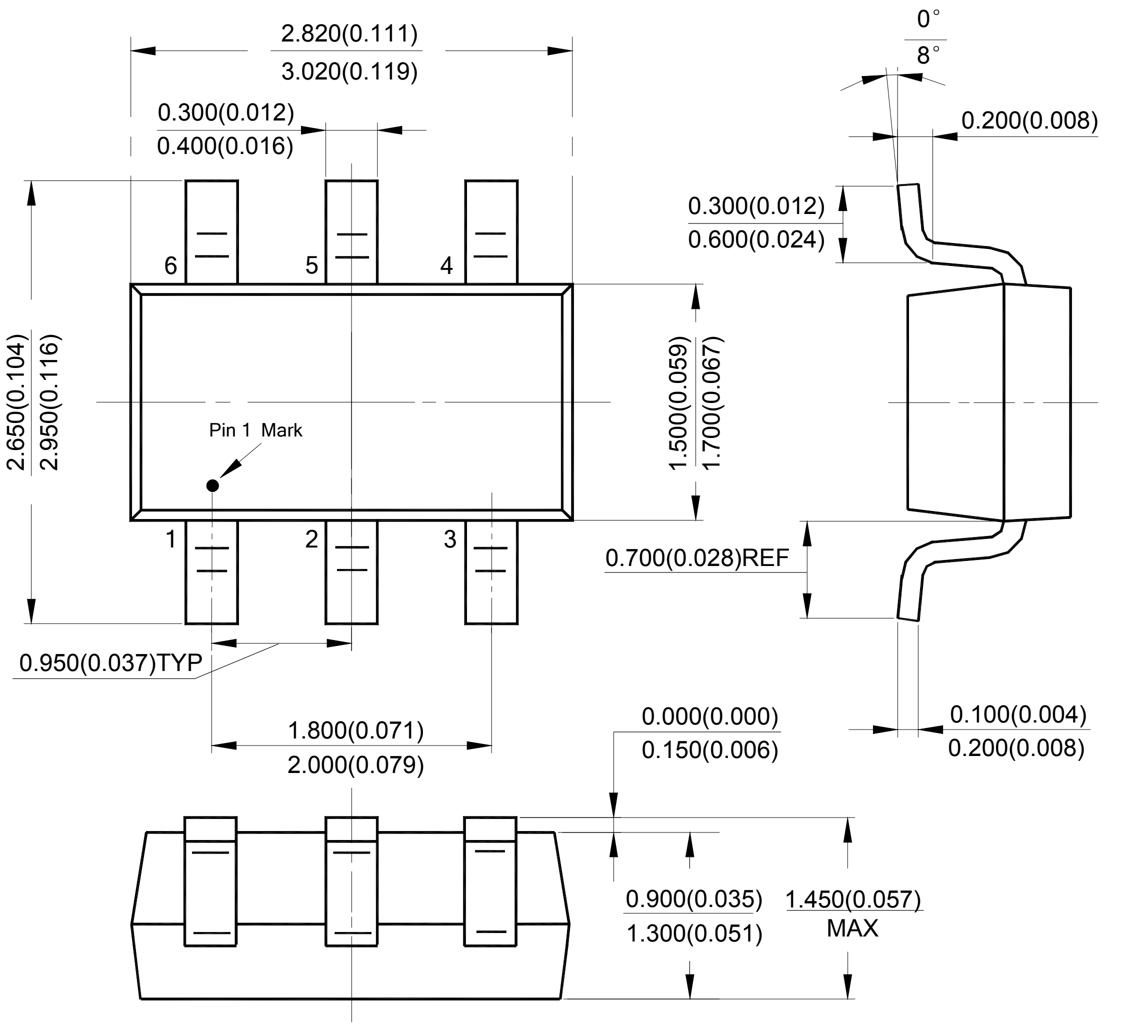


Figure 56. Typical Application of AP2401

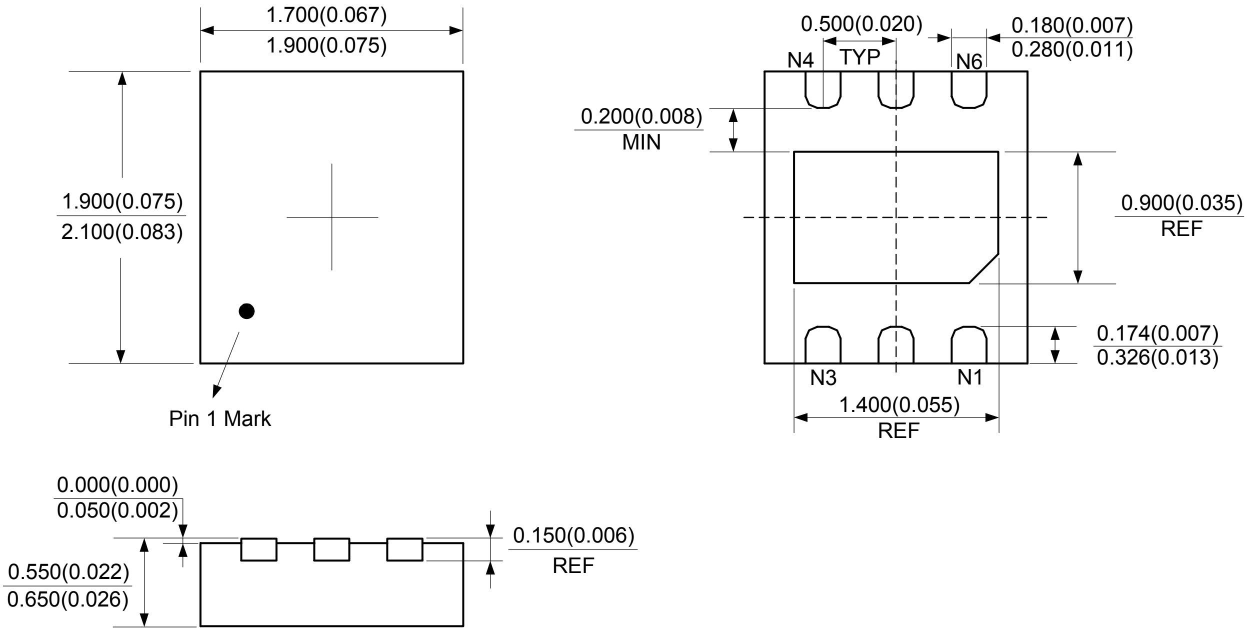
Mechanical Dimensions

SOT-23-6 **Unit: mm(inch)**



Mechanical Dimensions (Continued)

DFN-1.8x2-6 **Unit: mm(inch)**



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