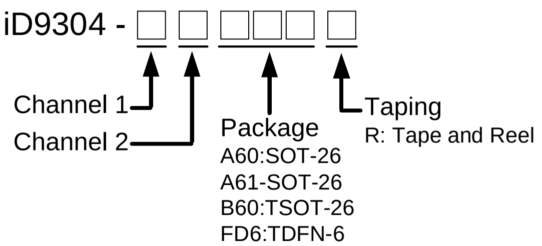
HIGH PSRR Dual LDO Regulator

General Description

The iD9304 is a high accuracy dual-channel, low noise, and low dropout regulator. It provides up to 200mA current at each channel.

The iD9304 uses a pass element which consumes low supply current with both channels on independent of load current and dropout conditions. The EN1 and EN2 pins control each output and allow the output of each regulator to be turned off independently, resulting in a reduced power consumption. The chip is suitable for battery-powered applications. Other features include a current limiting and over temperature protection.

Ordering Information



Output Voltage	Voltage Code
1.2	G
1.3	I
1.5	F
1.8	H
2.5	L
2.8	O
3.0	K
3.3	T

For Example:
Channel 1:2.8V ; Channel 2:3.3V
iD9304-OTA60R
*Preferred:CH1-Low Voltage; CH2-High Voltage

Other voltage outputs and combinations may be available. For further details, please contact an iDesyn sales or distributor.

Features

- Thermal Protection
- Up to 200mA Output Current for each LDO
- Dual EN/Shutdown Pins Control Each Output
- Low Noise Output
- Current Limiting Protection
- Short Circuit Protection
- High PSRR Dual LDO in SOT-26 Package
- Low Shutdown Current.
- High PSRR 70dB@100Hz
- Auto Discharge

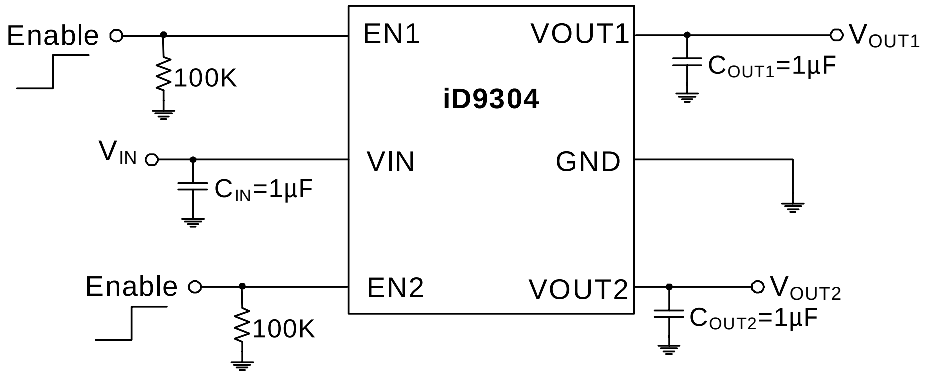
Applications

- Mobile Phone
- Laptop, Notebook, and Palmtop Computers
- Battery-powered Equipment
- Hand-held Equipment
- Wireless LAN

Marking Information

For marking information, contact our sales representative directly or through an iDESYN distributor located in your area, otherwise visit our website for details.

Typical Application Circuit



Absolute Maximum Ratings

Supply Voltage V_{IN}	6V
Power Dissipation, P_D @ T_A=25°C	
SOT-26/ TSOT-26	400mW
TDFN-6	1250mW
Thermal Resistance, θja	
SOT-26/ TSOT-26	250°C/W
TDFN-6	80°C/W
Output Current	
I_{OUT1} + I_{OUT2}	400mA
Lead Temperature	260 °C
Storage Temperature	-65°C to 150°C
ESD Susceptibility	
HBM (Human Body Mode)	2kV
MM (Machine Mode)	200V

Recommended Operating Conditions

Input Voltage V_{IN}	2.5V to 6V
EN Input Voltage	0V to 5.5V
Junction Temperature	-40°C to 125°C
Ambient Operating Temperature	-40°C to 85°C

Electrical Characteristics

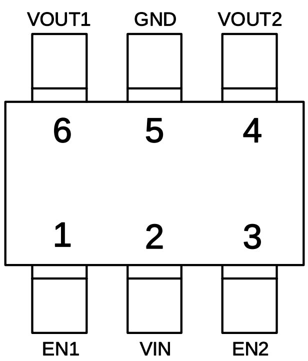
(For each LDO unless otherwise specified, V_{IN}=3.6V, C_{IN}= C_{OUT} =1μF, EN1=EN2= V_{IN},T_A=25°C)

Parameters		Symbol	Condition		Min	Typ	Max	Units
Output Voltage Accuracy		ΔV_{OUT}	I_{OUT} =1mA		-2.5		2.5	%
Maximum Output Current		I_{MAX}	Continuous		200			mA
Supply Current Limit		I_{LIMIT}	R_{LOAD} = 1Ω		300		600	mA
Quiescent Current		I_Q	I_{OUT} = 0mA, EN1 ; EN2 pull high			160		μA
Dropout Voltage (Note 2)		V_{Drop}	I_{OUT} = 200mA	V_{OUT} = 1.2V		1000	1300	mV
				V_{OUT} = 1.8V		800	1000	mV
				V_{OUT} = 2.5V		320	500	mV
				V_{OUT} = 2.8V		200	300	mV
				V_{OUT} = 3.0V		180	260	mV
				V_{OUT} = 3.3V		150	200	mV
EN input Bias Current		I_{IBSD}	V_{EN} = GND or V_{IN}			10	100	nA
Line regulation		ΔV_{LINE}	V_{IN} = (V_{OUT} +V_{DROP}) to 5.5V I_{OUT} = 1mA		-0.2		0.2	%/V
Load Regulation		ΔV_{LOAD}	1mA < I_{OUT} < 100mA			15	40	mV
Fast Discharge N-MOSFET Turn On Resistance		$R_{DISCHARGE}$	V_{IN} = 4V, V_{EN} = 0V			35		Ω
Output Noise Voltage		eNO	10Hz to 100KHz, I_{OUT} = 1mA, C_{OUT} = 1μF			100		μV_{RMS}
Thermal Shutdown Temperature		T_{SD}				165		°C
Thermal Shutdown Temperature Hysteresis		ΔT_{SD}				30		°C
Shutdown Current		I_{SHDN}	V_{EN} = GND, Shutdown			0.01	1	μA
EN Threshold	Logic-Low V	V_{IL}	V_{IN} = 2.5V to 6V,Shutdown				0.4	V
	Logic-High V	V_{IH}	V_{IN} = 2.5V to 6V,Start-Up		1.6			V
Power Supply Rejection Rate	f = 100Hz	PSRR	C_{OUT} = 1μF, I_{OUT} = 10mA			-70		dB
	f = 10kHz					-55		dB

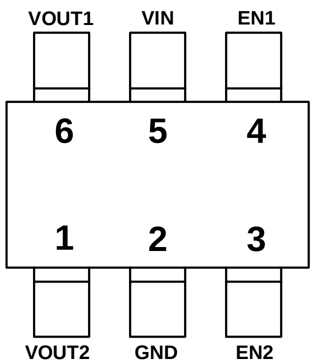
Note 1: Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may remain possibility to affect device reliability.

Note 2: The dropout voltage is defined as (V_{IN}-V_{OUT}) when V_{OUT} is 100mV below the target value of V_{OUT}.

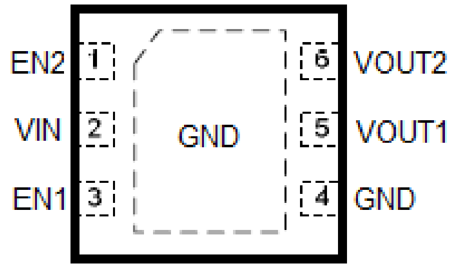
Pin Configurations (Top View)



SOT-26 (A60) / TSOT-26



SOT-26 (A61)

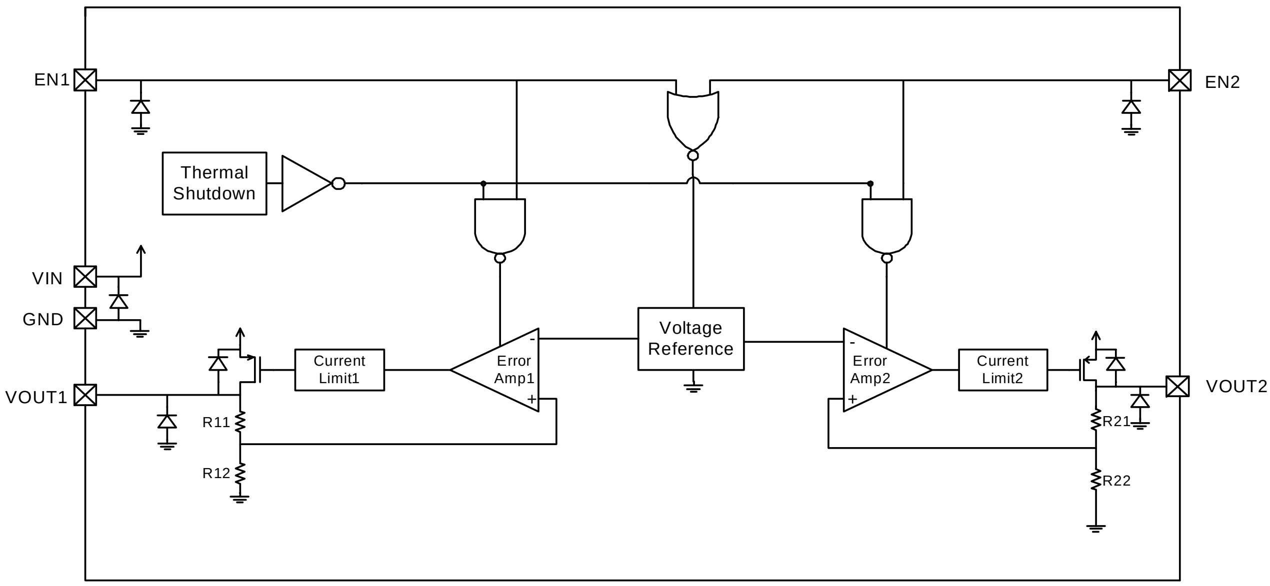


TDFN-6

Pin Description

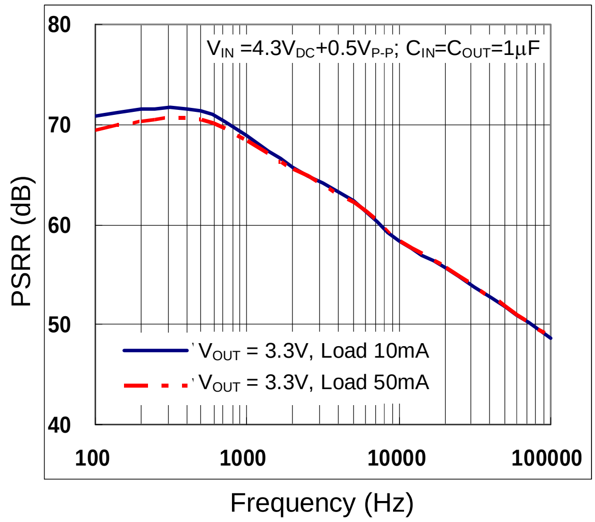
Pin Name	Pin Function
EN1	ON/OFF Control 1. Note that this pin is high impedance. There should be a pull low 100kΩresistor connected to GND when the control signal is floating.
VIN	Power Input
EN2	ON/OFF Control 2. Note that this pin is high impedance. There should be a pull low 100kΩresistor connected to GND when the control signal is floating.
VOUT2	Output 2
GND	Ground
VOUT1	Output1

Function Block Diagram

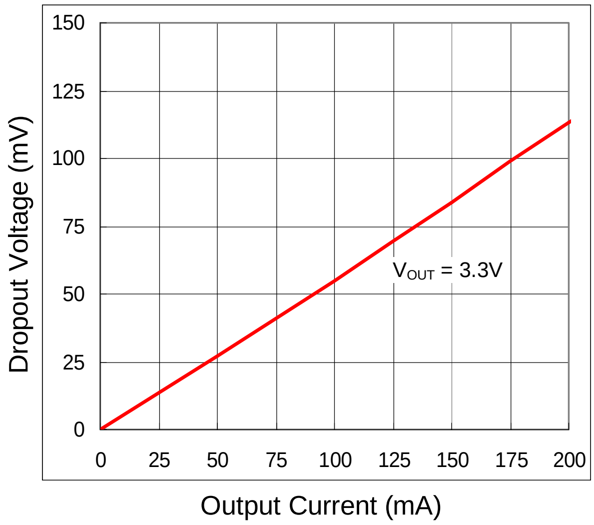


Typical Operating Characteristics

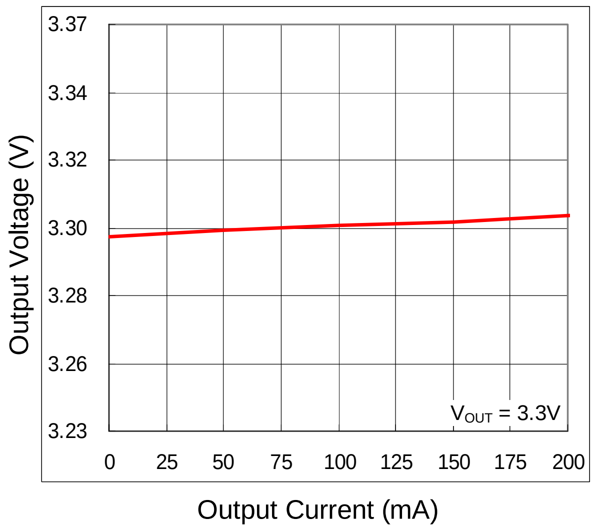
PSRR



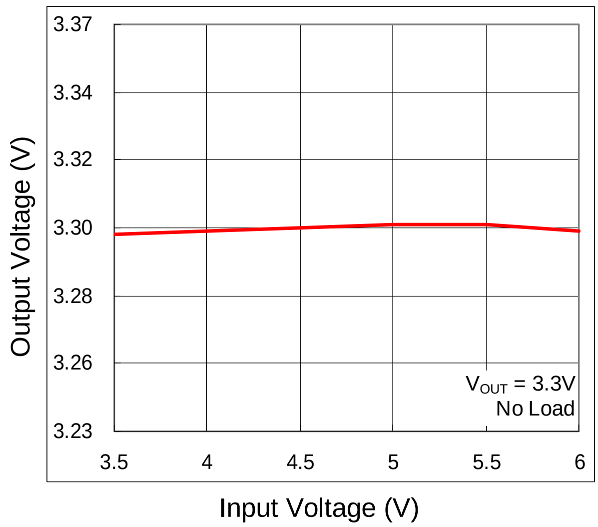
Dropout Voltage vs. Output Current



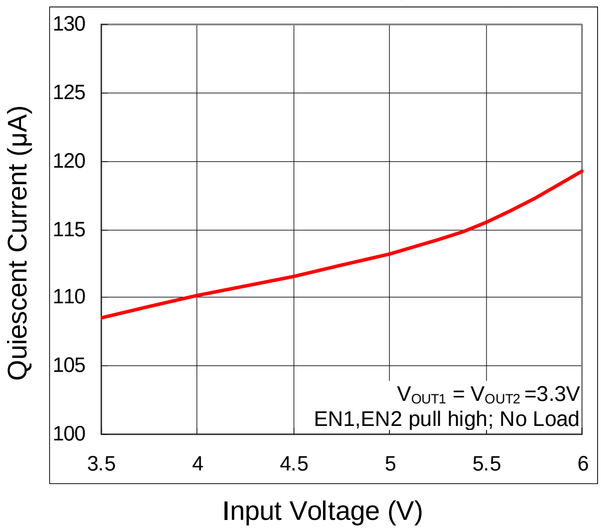
Load Regulation



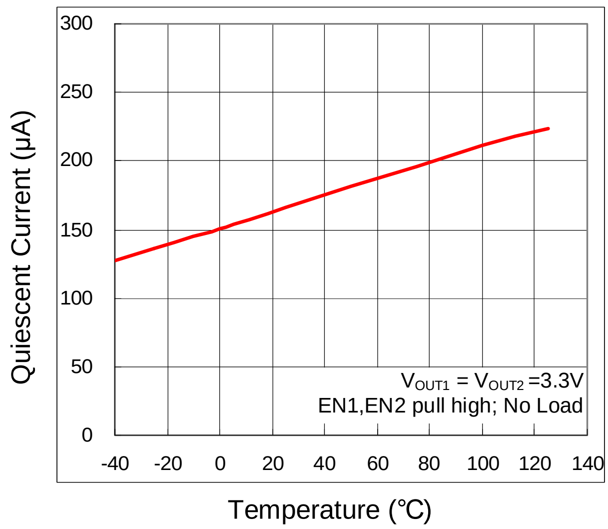
Line Regulation



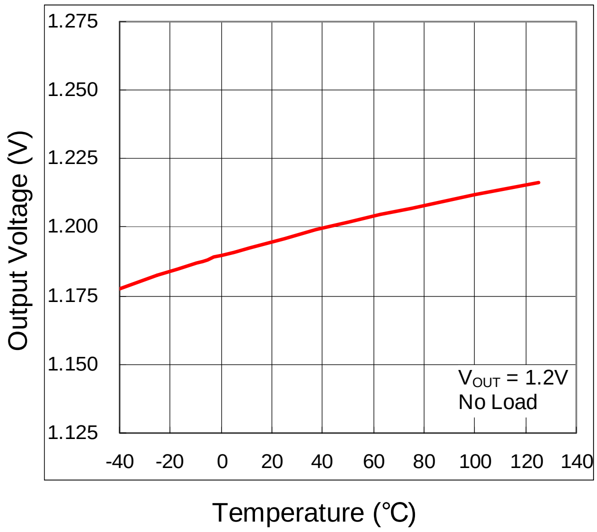
Quiescent Current vs. Input Voltage



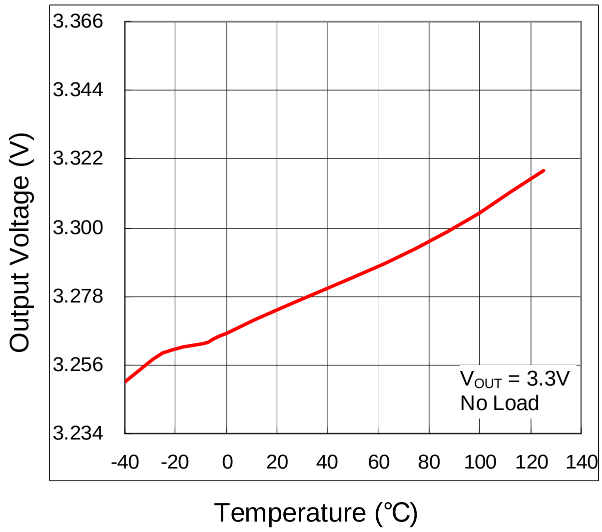
Quiescent Current vs. Temperature



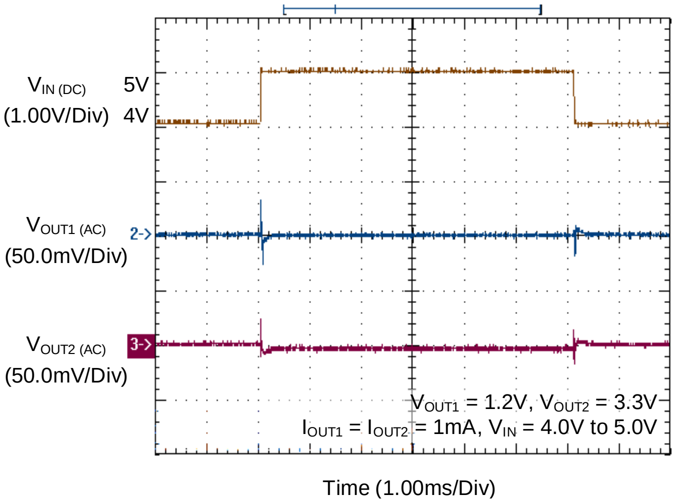
Output Voltage vs. Temperature



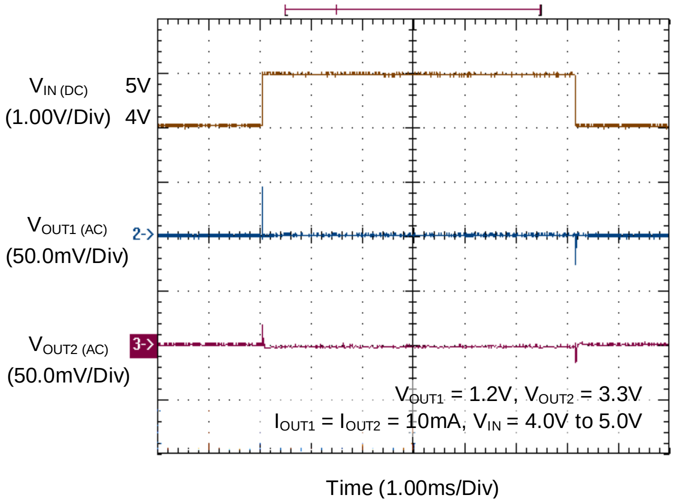
Output Voltage vs. Temperature



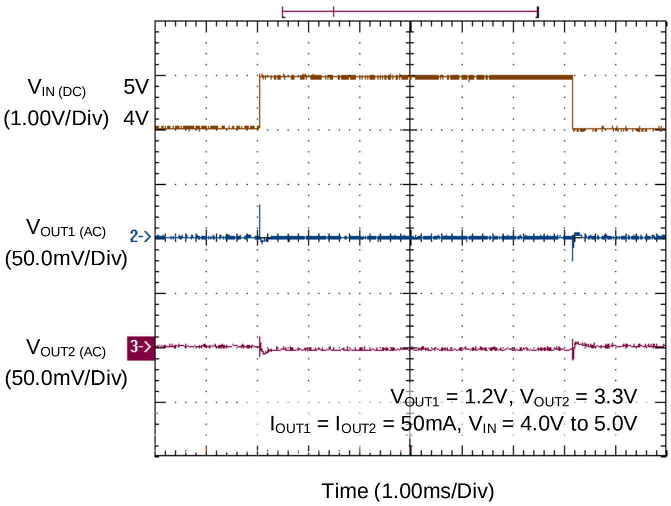
Line Transient Response



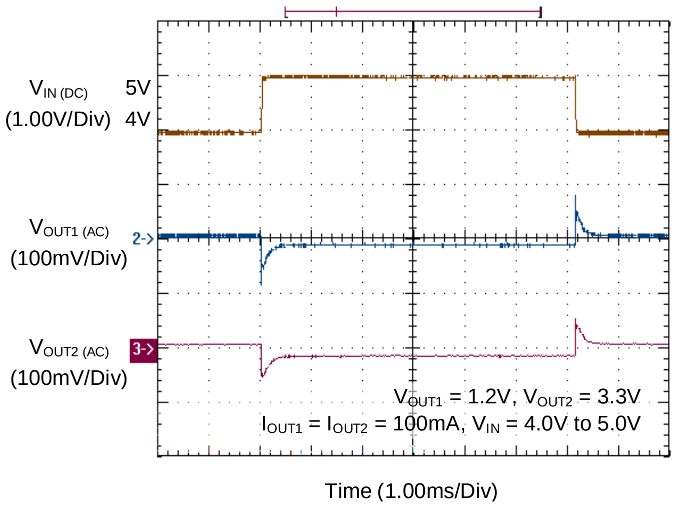
Line Transient Response



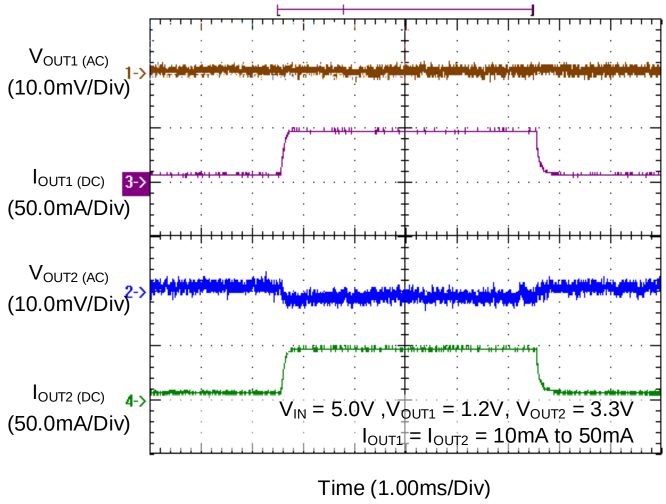
Line Transient Response



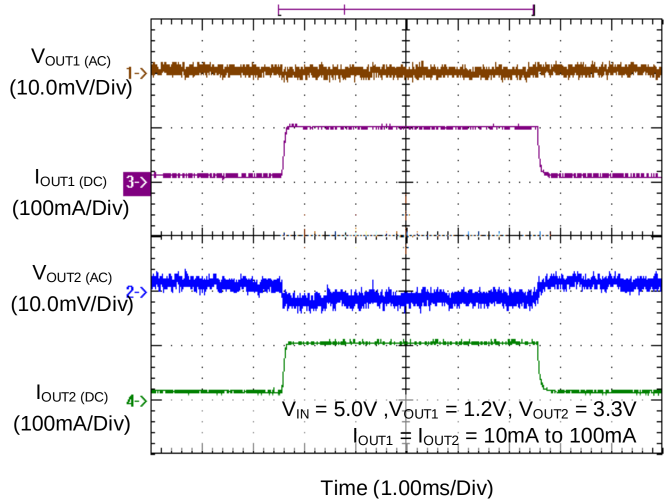
Line Transient Response



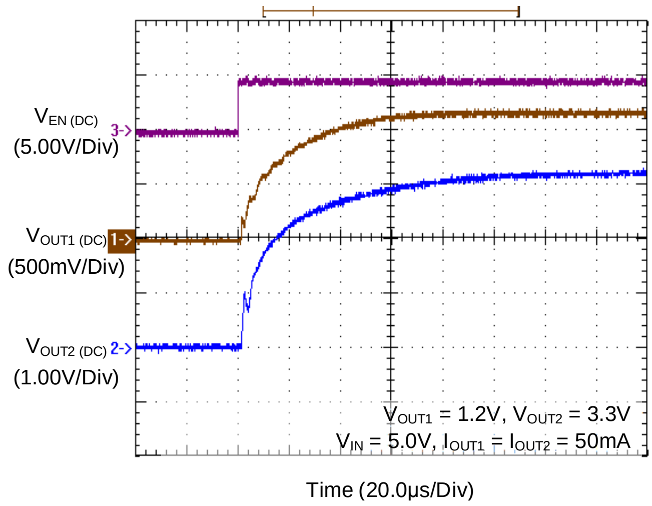
Load Transient Response



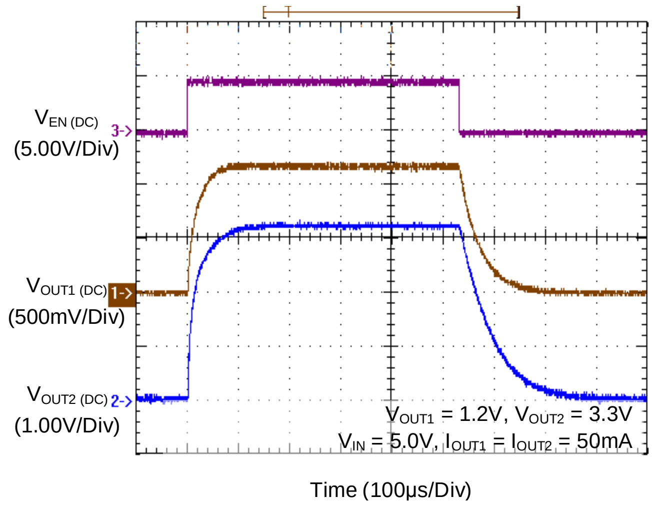
Load Transient Response



Start-Up



EN Pin Shutdown Response



Application Information

Capacitor Selection and Regulator

Stability

The iD9304 combines two low noise, low dropout, and low quiescent current linear regulators designed primarily for battery-powered applications. Output voltages are optional ranging from 1.5V to 3.3V, and each channel can supply current up to 200mA.

Shutdown

The iD9304 is shutdown by pulling the EN input low, and can be turned on by driving the input high. If this feature is not to be used, the EN input should be tied to V_{IN} to keep the regulator on all the time. Note that the EN input must not be floating.

Internal P-Channel Pass Transistor

The iD9304 integrates two typical P-channel MOSFET pass transistors. It provides battery with longer life by using P-Channel MOSFET, which requires no base drive. The quiescent current is considerably reduced. The iD9304 consumes only 160μA quiescent current whether in dropout, light-load, or heavy-load applications.

Current Limit and Thermal Protection

The iD9304 has two independent current limiting structures which control each pass transistor's gate voltages limiting the guaranteed maximum output current to 200mA. Thermal-overload protection limits total power dissipation in the iD9304. When the junction temperature exceeds T_J = 165°C, the thermal sensor signals the shutdown logic turning off the pass transistor and allowing the IC to cool. The thermal sensor will turn on the pass transistor again after the IC's junction temperature is lowered by 30°C. Thermal protection is designed to protect the iD9304 in the event of continuous thermal-overload conditions. Do not exceed the absolute maximum junction temperature rating of T_J = 125°C for continuous operation. The output can be shorted to ground for an indefinite amount of time without damaging the part by cooperation of current limit and thermal protection.

Capacitor Selection and Regulator Stability

Like any low-dropout regulator, the external capacitors used with the iD9304 must be carefully selected for regulator stability and performance. Use a capacitor whose value is > 1μF on the iD9304 input. The amount of capacitance can be increased without limit. The input capacitor must be located in a distance of no more than 0.5 inches from the input pin of the IC and returned to a clean analog ground. Any high quality ceramic can be used for this capacitor. Capacitor with larger value and lower ESR (Equivalent Series Resistance) provides better PSRR performance and better line-transient response.

The output capacitor must meet both requirements for minimum amount of capacitance and ESR in all LDO applications. The iD9304 is designed specifically to work with low ESR ceramic output capacitor in space-saving and performance consideration. Using a ceramic capacitor whose value is at least 1μF with ESR is > 5mΩ on the iD9304 output ensures stability. Having the wide stable range of ESR tolerance, the iD9304 works well with output capacitor of other types. Output capacitor with a larger capacitance can reduce noise and improve load-transient response, stability, and PSRR. The output capacitor should be located no more than 0.5 inches from the V_{OUT} pin of the iD9304 and returned to a clean analog ground.

Note that some ceramic dielectrics exhibit large capacitance and ESR variation with temperature. It may be necessary to use 1μF or more to ensure stability at temperatures below -10°C in this case.

Load-Transient Considerations

The iD9304 load-transient response graphs show two components of the output response: a DC shift from the output impedance due to the load current change and the transient response. The DC shift is quite small due to the excellent load regulation of the IC. Typical output voltage transient spike for a step change in the load current from 0mA to 200mA is only tens mV, depending on the ESR of the output capacitor. Increasing the output capacitor's value and decreasing the ESR attenuates the overshoot.

Dropout Voltage

A regulator's dropout voltage determines the lowest stably usable supply voltage. In battery-powered systems, this determines the useful end-of-life battery voltage. The dropout voltage is a function of drain-to-source resistance multiplied by the load current.

Reverse Current Path

The power transistor used in the iD9304 has an inherent diode connected between each regulator input and output. If the output is forced above the input by more than a diode-drop, this diode will become forward biased and current will flow from the V_{OUT} terminal to V_{IN}. This diode will also be turned on by abruptly stepping the input voltage to a value below the output voltage. To prevent regulator mis-operation, a Schottky diode may be used in applications where input/output voltage conditions can cause the internal diode to be turned on. As shown, the Schottky diode is connected in parallel with the internal parasitic diode and prevents it from being turned on by limiting the voltage drop across it to about 0.3V < 100mA to prevent damage to the part.

Operating Region and Power Dissipation

The maximum power dissipation of iD9304 depends on the thermal resistance of the case and circuit board, the temperature difference between the die junction and ambient air, and the rate of airflow.

The power dissipation across the device is

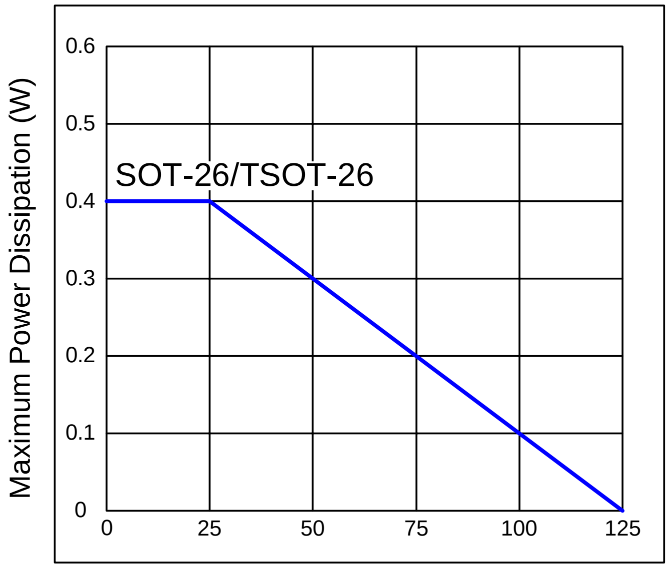
$P = I_{OUT} (V_{IN} - V_{OUT})$.

The maximum power dissipation is:

$P_{(MAX)} = (T_J - T_A) / \theta_{JA}$

where $T_J - T_A$ is the temperature difference between the iD9304 die junction and the surrounding environment, θ_{JA} is the thermal resistance from the junction to the surrounding environment. The GND pin of the iD9304 performs the dual function of providing an electrical connection to ground and channeling heat away. Connect the GND pin to ground using a large pad or ground plane.

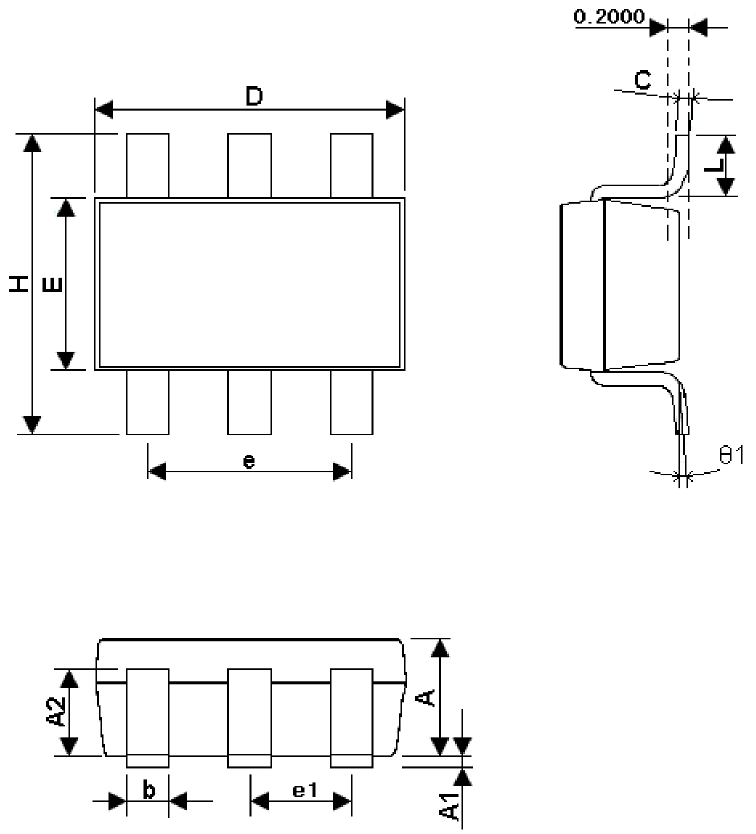
Maximum Power Dissipation



Ambient Temperature (°C)

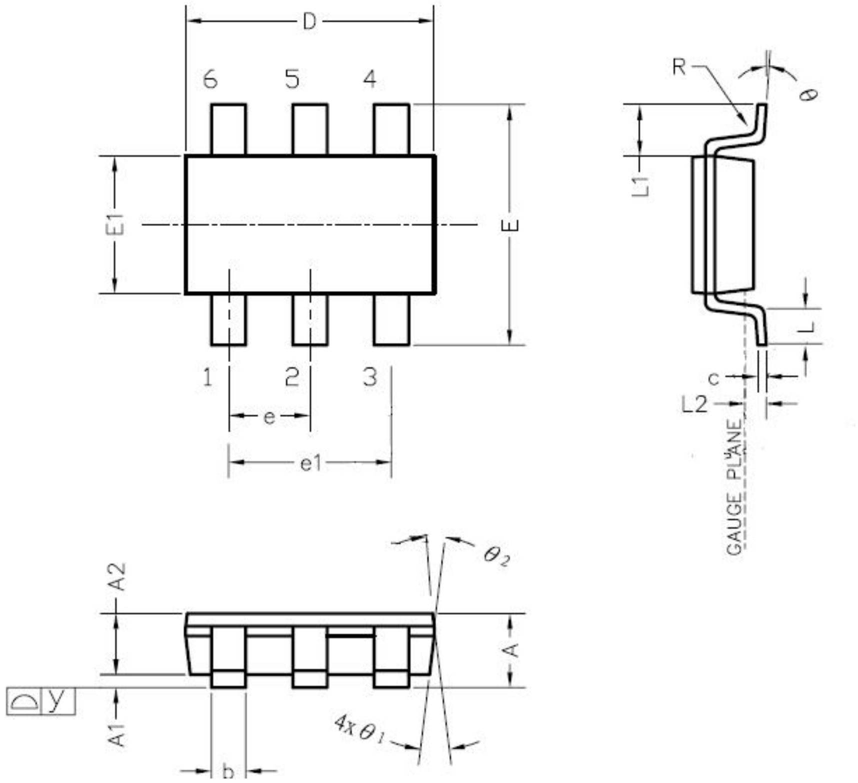
Packaging

SOT-26



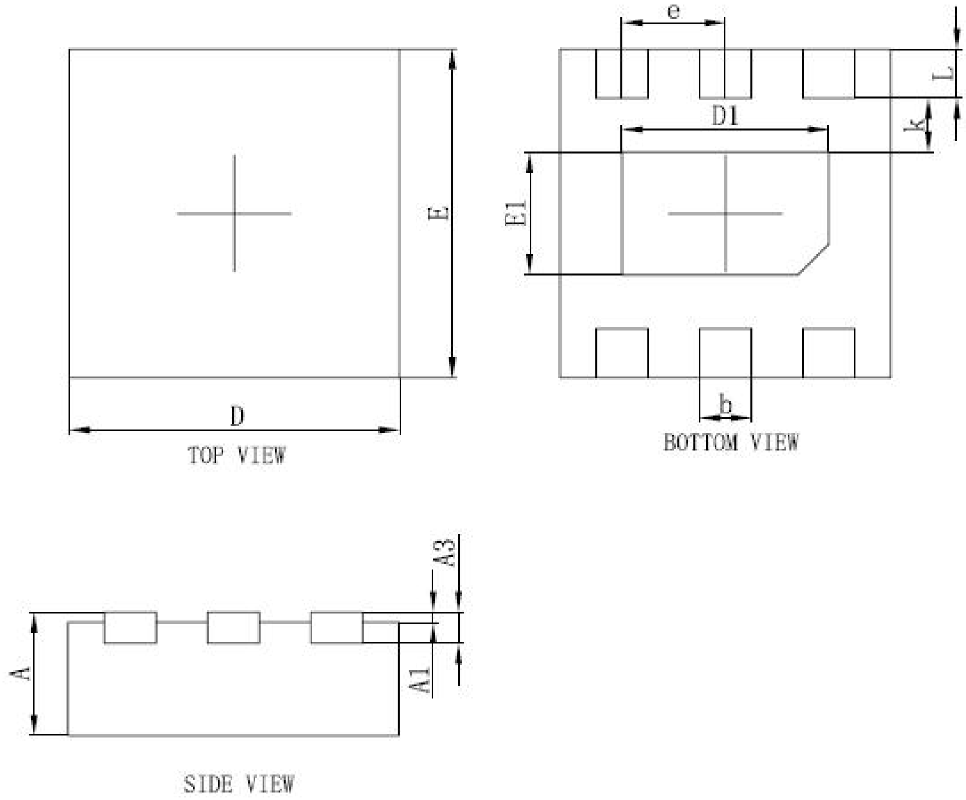
SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCH		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.00	1.10	1.30	0.039	0.043	0.051
A1	0.00	---	0.10	0.000	---	0.004
A2	0.70	0.80	0.90	0.027	0.031	0.035
b	0.35	0.40	0.50	0.013	0.016	0.020
C	0.10	0.15	0.25	0.004	0.006	0.010
D	2.70	2.90	3.10	0.106	0.114	0.122
E	1.40	1.60	1.80	0.055	0.063	0.071
e	---	1.9(TYP)	---	---	0.075	---
H	2.60	2.80	3.00	0.102	0.110	0.118
L	0.37	---	---	0.015	---	---
Θ1	1°	5°	9°	1°	5°	9°
e1	---	0.95(TYP)	---	---	0.037	---

TSOT-26



SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCH		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.75	---	0.90	0.030	---	0.035
A1	0.00	---	0.10	0.000	---	0.004
A2	0.70	0.75	0.80	0.028	0.030	0.031
b	0.35	---	0.51	0.014	---	0.020
c	0.10	---	0.25	0.004	---	0.010
D	2.80	2.90	3.00	0.110	0.114	0.118
E	2.60	2.80	3.00	0.102	0.110	0.118
E1	1.50	1.60	1.70	0.059	0.063	0.067
e	0.95 BSC			0.0374 BSC		
e1	1.90 BSC			0.0748 BSC		
L	0.37	---	---	0.015	---	---
L1	0.60 REF			0.0236 REF		
L2	0.25 BSC			0.0098 BSC		
y	---	---	0.10		---	0.004
R	0.10	---	---	0.004	---	---
θ	0°	---	8°	0°	---	8°
θ1	7° NOM			7° NOM		
θ2	8° NOM			8° NOM		

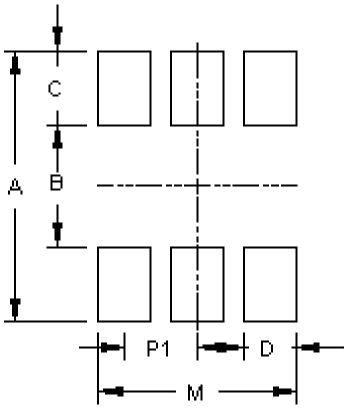
TDFN-6



SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCH		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.700	0.75	0.800	0.028	0.030	0.032
A1	0.000		0.050	0.000		0.002
A3		0.152			0.006REF.	
D	1.550		1.650	0.061		0.065
E	1.550		1.650	0.061		0.065
E1	0.500		0.700	0.020		0.028
D1	0.9		1.100	0.035		0.043
k		0.200MIN			0.008REF.	
b	0.180		0.280	0.007		0.011
e		0.500BSC			0.020BSC.	
L	0.164		0.316	0.006		0.012

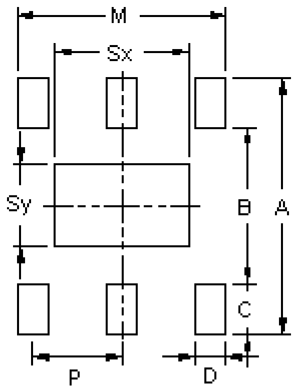
Footprints

SOT-26 / TSOT-26



Package	Number of PIN	Footprint Dimension (mm)							Tolerance
		P1	P2	A	B	C	D	M	
(T)SOT-26	6	0.95	-	3.60	1.60	1.00	0.70	2.60	±0.10

TDFN-6 (1.6mm x 1.6mm)
Pitch=0.5



Package	Number of PIN	Footprint Dimension (mm)								Tolerance
		P	A	B	C	D	Sx	Sy	M	
TDFN-6 1.6x1.6	6	0.5	1.8	1.00	0.40	0.35	1.00	0.60	1.35	±0.050