One Stop Analog Solution
Power IC Ltd.

300mA, Ultra-Low Noise, Ultra-Fast CMOS LDO Regulator

FEATURES

- Guaranteed 300mA output
- High output initial voltage accuracy: ±1%
- Ultra low output noise: 138μV_{RMS}
- Low ground current: 105μA
- Very low dropout: 160mV @300mA
- Zero shutdown supply current
- TTL-logic-controlled enable input
- Thermal and current limit protections
- Low ESR capacitor compatibility to achieve
- Ultra low droop load transient response
- Ultra fast line transient response
- Low profile 5-lead SOT25 and 3-lead SOT23 package
- Fixed options 1.5V, 1.8V, 2.5V, 2.8V, 3.0V and 3.3V

APPLICATIONS

- Cellular and cordless phones
- Wireless LAN cards
- Palmtop computers
- Personal communication equipment
- Pen drives
- Bluetooth devices

DESCRIPTION

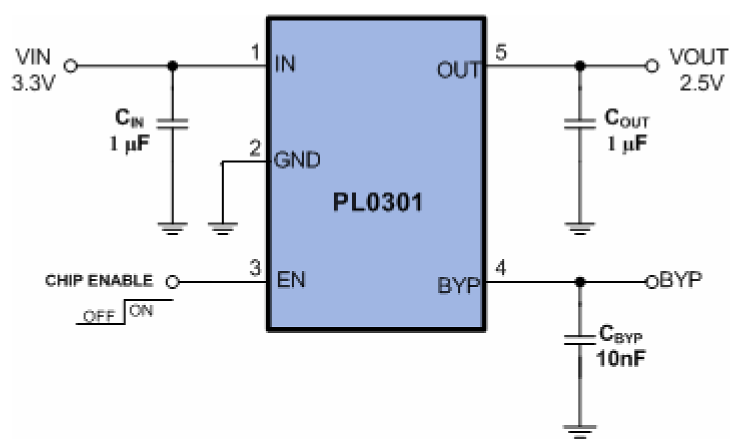
The PL0301 is a CMOS low dropout linear regulator with ultra-low-noise output, very low dropout voltage and very low ground current.

The PL0301 operates from a 2.5V to 5.5V input voltage range and delivers up to 300mA, with low dropout of 160 mV at 300mA. The other features of PL0301 include short-circuit protection and thermal-shutdown protection.

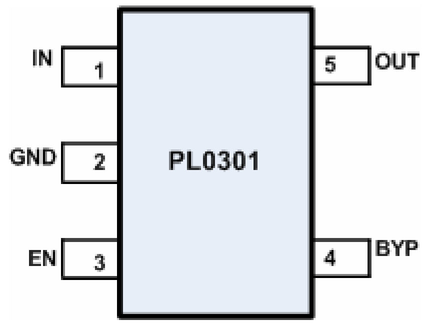
The PL0301 is designed especially for battery-powered portable devices. Its low noise feature makes PL0301 ideal for noise-sensitive personal communication applications. Other key application areas for PL0301 also include palmtop computers, PCMCIA cards and WLAN cards.

The PL0301 is available in small 5-lead SOT25 package and 3-lead SOT23 with fixed output voltage versions.

TYPICAL APPLICATION CIRCUIT



PIN CONFIGURATION



PIN DESCRIPTION

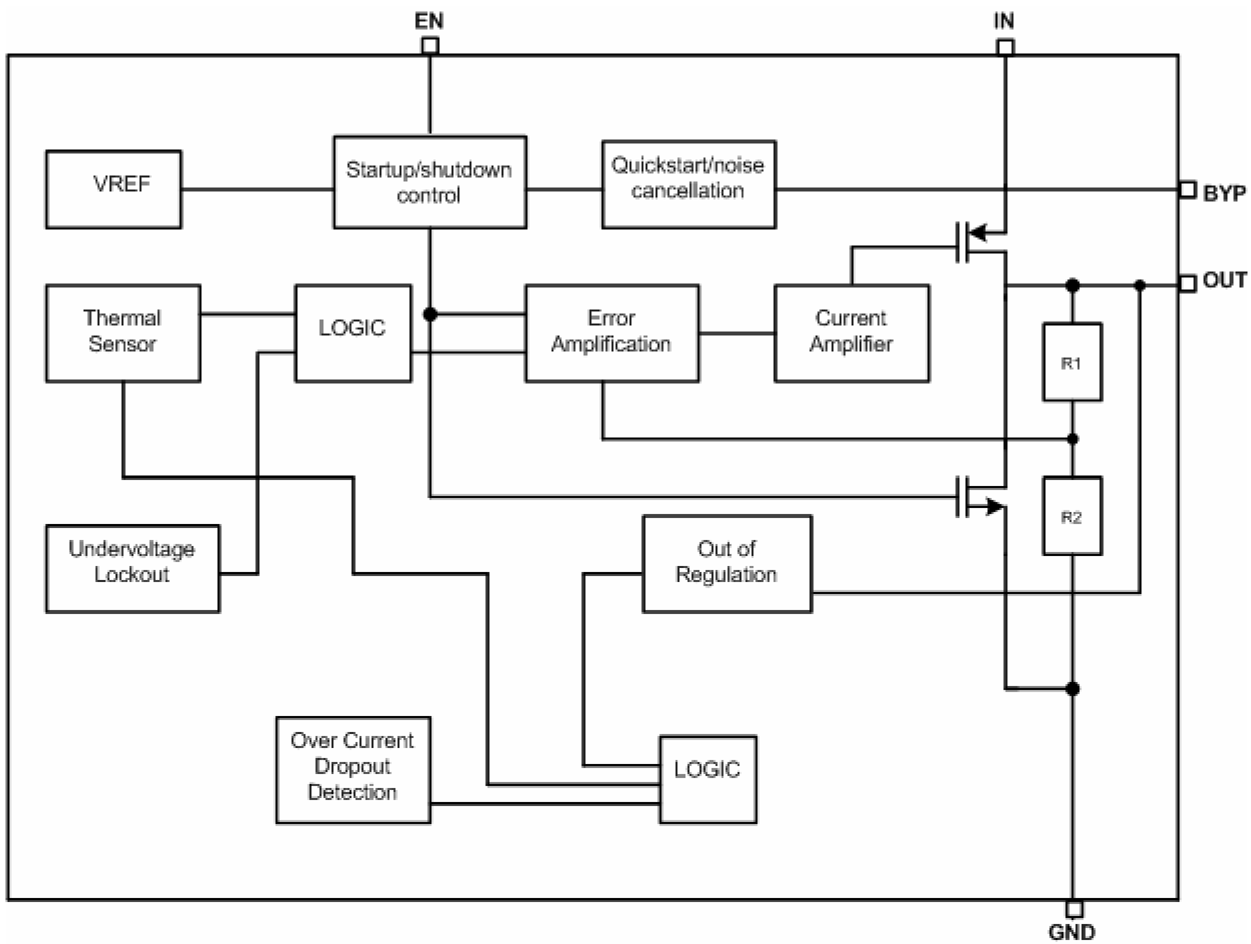
Name	Pin NO.		Type	Function
	SOT-25	SOT-23		
IN	1	3	Supply	Supply voltage. 2.5V ~ 5.5V.
GND	2	1	Ground	Ground pin
EN	3		Logic input	Enable/Shutdown. CMOS compatible input. Logic 'H' : enable, logic 'L' : shutdown.
BYP	4		Bypass	Reference voltage bypass pin. Connect 0.01uF ≦ C_{BYP} ≦ 0.1uF to GND to reduce output noise. May be left open.
OUT	5	2	Analog output	Regulator Output.

ORDERING INFORMATION

Part Number	Output Voltage	Marking	Package
PL0301 – 15VZ	1.5	DBAMW	SOT-23
PL0301 – 15UZ	1.5	DBBMW	SOT-25
PL0301 – 18VZ	1.8	DBCMW	SOT-23
PL0301 – 18UZ	1.8	DBDMW	SOT-25
PL0301 – 25VZ	2.5	DBEMW	SOT-23
PL0301 – 25UZ	2.5	DBFMW	SOT-25
PL0301 – 27VZ	2.7	DBGMW	SOT-23
PL0301 – 27UZ	2.7	DBHMW	SOT-25
PL0301 – 28VZ	2.8	DBIMW	SOT-23
PL0301 – 30VZ	3.0	DBKMW	SOT-23
PL0301 – 30UZ	3.0	DBLMW	SOT-25
PL0301 – 33VZ	3.3	DBMMW	SOT-23
PL0301 – 33UZ	3.3	DBNMW	SOT-25

Note 1: Contact the factory for other output voltages that are not in the above table

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{IN}	DC Supply Voltage at Pin 1	-0.3 to +6.0	V
V_{EN}	Enable Input Voltage at Pin 2	-0.3 to +6.0	V
PB_{DB}	Continuous Power Dissipation	Internally limited	W
T_{STG}	Storage Temperature Range	-65 to +150	℃
$R_{\theta JA}$	Thermal Resistance, Junction-To-Air	235	℃/W
$T_{J,MAX}$	Operating Junction Temperature	-40 to +125	℃
TB_{LB}	Lead Temperature (Soldering, 5sec)	260	℃
ESD	ESD Capability, HBM model	2	kV

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Value	Unit
V_{IN}	DC Supply Voltage at Pin 1	+2.5 to 5.5	V
V_{EN}	Enable Input Voltage at Pin 2	0 to V_{IN}	V
TB_{AB}	Operating Ambient Temperature	-40 to +85	℃

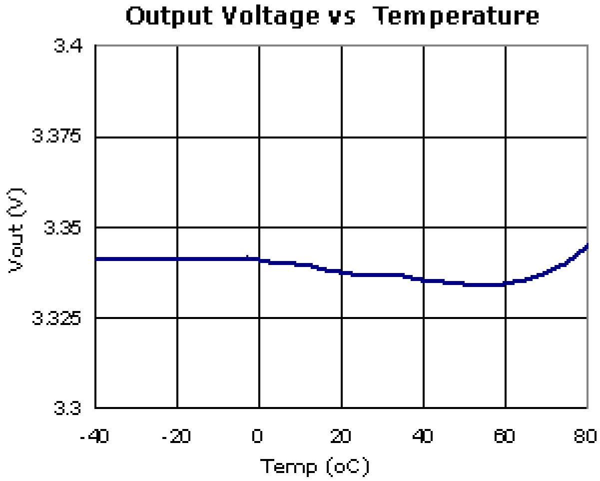
ELECTRICAL CHARACTERISTICS

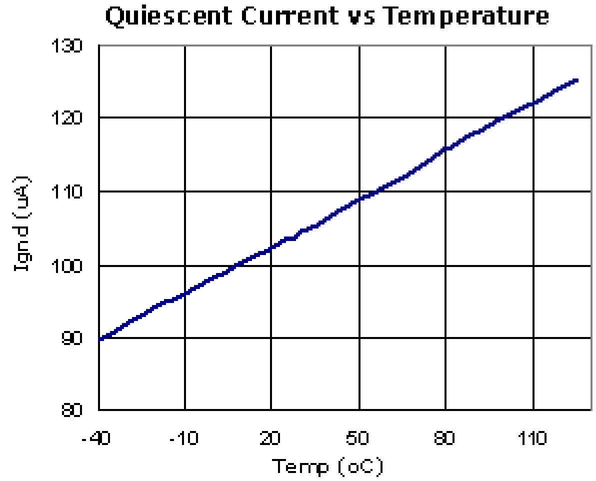
(V_{IN}=$V_{OUT(NOMINAL)}$+1V or 2.5V (whichever is greater), V_{EN}=V_{IN}, C_{IN}=C_{OUT}=1μF, I_O=1mA, **T_A=25°C**, unless otherwise specified)

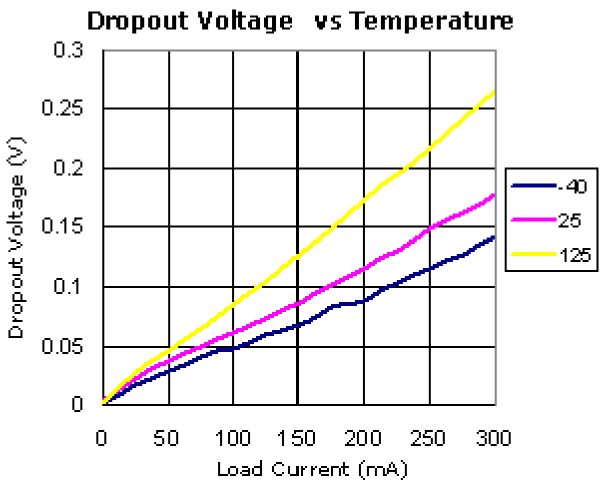
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_{IN}	Supply Voltage		2.5		5.5	V
ΔV_{OUT}	Output Voltage Accuracy	I_O = 1mA	-1.0		1.0	%
ΔV_{LOAD}	Load Regulation	I_O=1mA to 300mA		0.4	0.5	%
ΔV_{line}	Line Regulation dV_{OUT}/(dV_{IN}*$V_{OUT(NOMINAL)}$)*100%	V_{IN} =$V_{OUT(NOMINAL)}$ +0.1V (or 2.5V, whichever is greater) to 5.5V, I_O=1mA		0.015	0.05	%/V
V_{DP}	Dropout Voltage (Note 1)	I_{LOAD} = 300mA		160	220	mV
		I_{LOAD} = 100mA		56	100	mV
IB_{OB}	Maximum Output Current	Continuous	300			mA RMS
ILIM	Current Limit/Output Current	V_{IN}-V_{OUT} =1.3V	420	680		mA
IB_{QB}	Standby Current	V_{EN} = 0V			0.5	μA
IB_{GB}	Ground pin current	I_{LOAD} =1mA		105		μA
PSRR	Ripple Rejection, I_{OUT} = 50mA,	f = 100Hz, Cout= 1μF, C_{BYP} =10nF		62		dB
PSRR		f = 10KHz, Cout= 1μF, C_{BYP} =10nF		60		dB
e_{NO}	Output voltage noise	C_{OUT} = 1μF, C_{BYP} = 10nF, F = 10Hz to 100K Hz (Vp-p/2/√2)		138		μV_{RMS}
	Thermal Shutdown Temperature			165		°C
	Thermal Shutdown Hysteresis			20		°C
V_{IH}	Logic Input High Voltage (EN)		1.2			V
V_{IL}	Logic Input Low Voltage (EN\)				0.4	V
I_{EN}	Logic Input Current (SHDN\)		-1		1	μA
	Shutdown exit delay	V_{EN}= 0 to 5.5V, C_{BYP}=10nF C_{OUT}=1uF		135		μs
	Shutdown discharge resistance			400		Ω

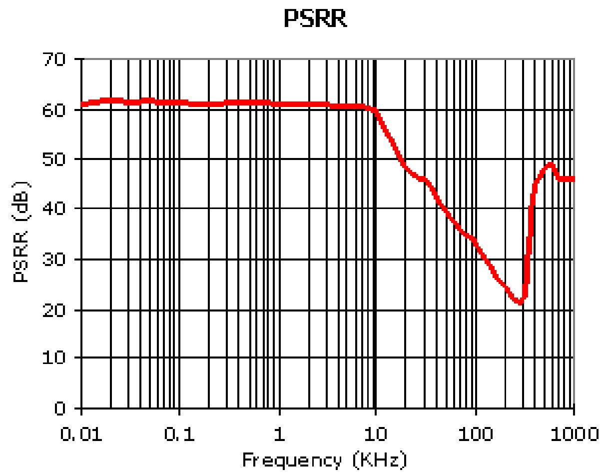
TYPICAL OPERATING CHARACTERSTICS

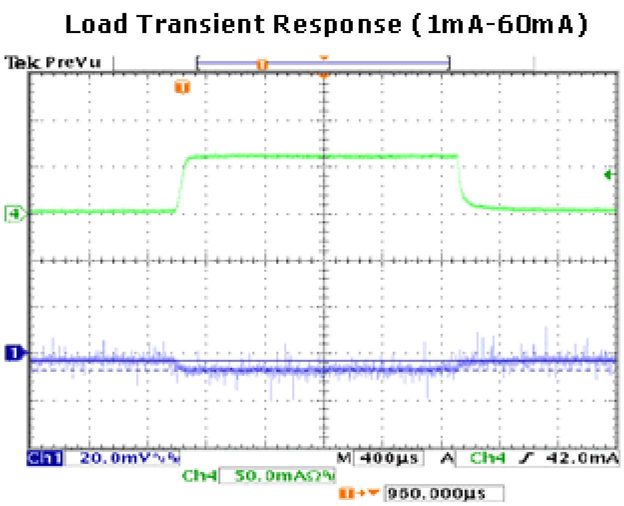
(All specifications are at T_A = 25°C , unless otherwise specified)

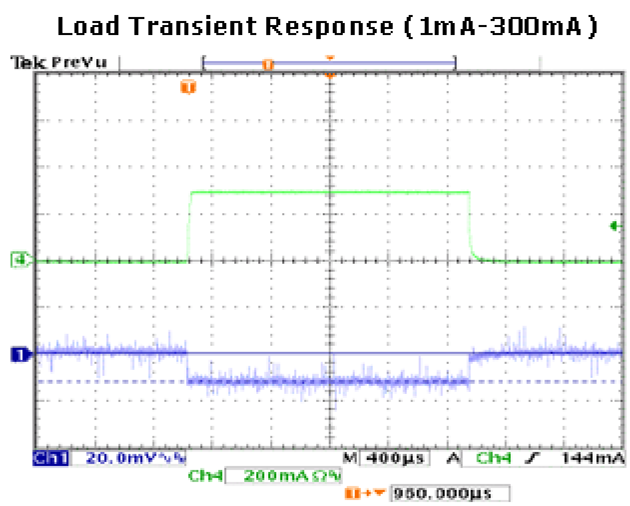








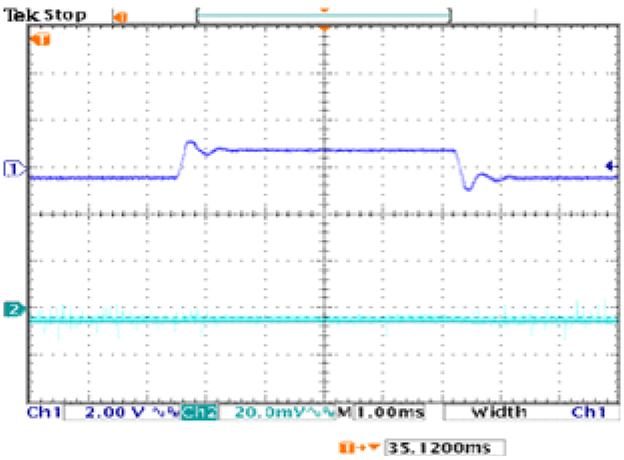




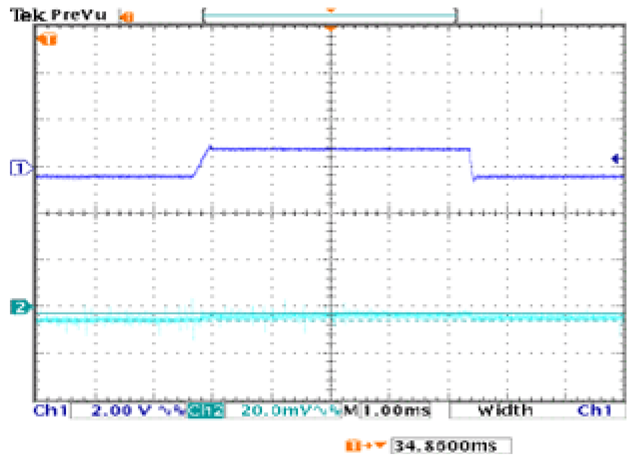
TYPICAL OPERATING CHARACTERISTICS (continued)

(All specifications are at T_A = 25°C , unless otherwise specified)

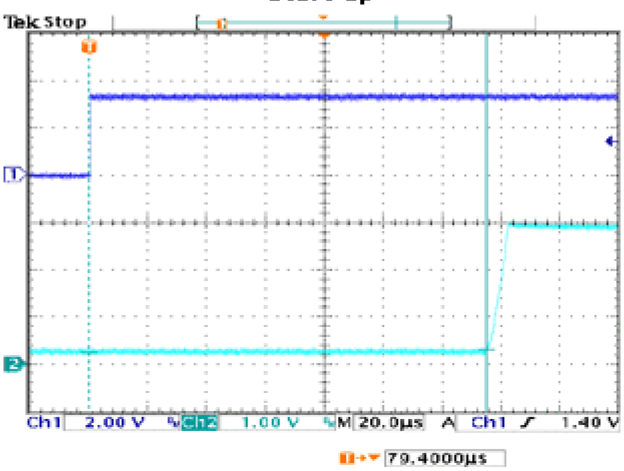
Line Transient Response Load 1 mA



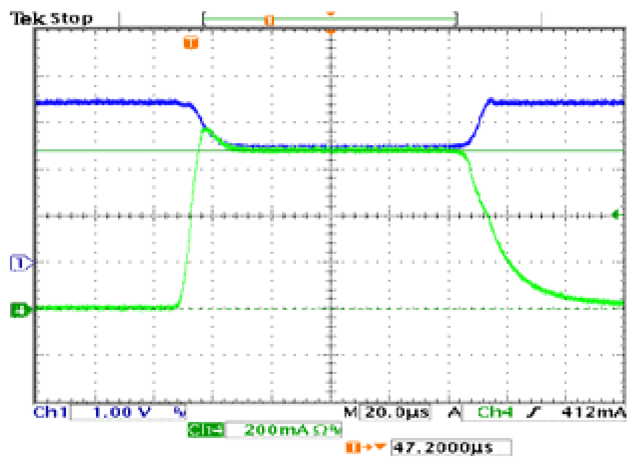
Line Transient Response Load 100 mA



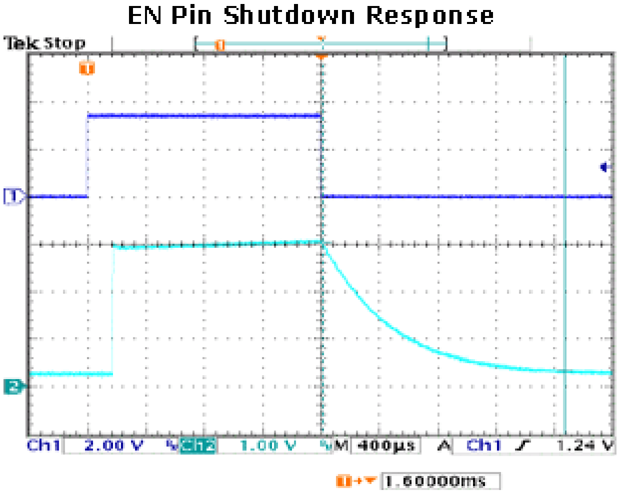
Start up



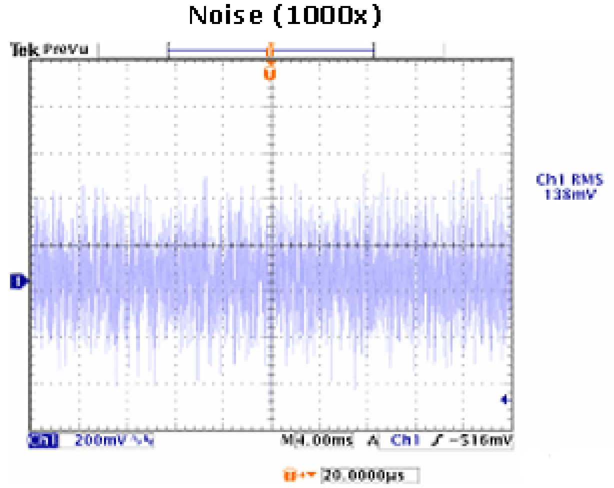
Current Limit



EN Pin Shutdown Response



Noise (1000x)



OPERATION

The PL0301 are ultra-low-noise, low-dropout, low-quiescent current linear regulators designed for space-restricted applications. These devices can supply loads up to 300mA. As shown in the Block Diagram, the PL0301 consists of a highly accurate band gap core, noise bypass circuit, error amplifier, P-channel pass transistor and an internal feedback voltage divider. The 1.0V band gap reference is connected to the error amplifier's inverting input. The error amplifier compares this reference with the feedback voltage and amplifies the difference. If the feedback voltage is lower than the reference voltage, the pass transistor gate is pulled low. This allows more current to pass to the output and increases the output voltage. If the feedback voltage is too high, the pass transistor gate is pulled high, allowing less current to pass to the output. The output voltage is feedback through an internal resistor voltage divider connected to the OUT pin. An external bypass capacitor connected to BYP reduces noise at the output. Additional blocks include a current limiter, over temperature protection, and shutdown logic.

Internal P-Channel Pass Transistor

The PL0301 feature a 1Ω (typ) P-channel MOSFET pass transistor. This provides several advantages over similar designs using a PNP pass transistor, including longer battery life. The P-channel MOSFET requires no base drive, which considerably reduces quiescent current. PNP-based regulators waste considerable current in dropout when the pass transistor saturates. They also use high base-drive current under heavy loads. The PL0301 does not suffer from these problems and consume only 90μA of quiescent current in light load and 220μA in dropout condition.

Current Limit

The PL0301 includes a current limiter. It monitors the output current and controls the pass transistor's gate voltage to limit the output current under 676mA (typ). The output can be shorted to ground for an indefinite amount of time without damaging the part.

Enable Input

The PL0301 features an active-high Enable input (EN) pin that allows on/off control of the regulator. The PL0301 bias current reduces to less than microampere of leakage current when it is shutdown. The Enable input is TTL/CMOS compatible threshold for simple logic interfacing. When EN is 'H,' the output voltage startup rising time is 135us typically at 300mA output current. Connect EN pin to IN pin for normal operation.

Under Voltage Lockout

When the input supply goes too low (below 2.0V) the PL0301 produces an internal UVLO (under voltage lockout) signal that generates a fault signal and shuts down the chip. This mechanism protects the chip from producing false logic due to low input supply.

Quick Charging Mode

The PL0301 has a quick charge block to get the reference up very quickly by charging the BYP capacitor with very high current when the chip comes out of shut down. This quick charge block stops charging the BYP capacitor when the reference reaches 95% of its nominal value and then the chip switches out of quick charging mode to normal operating mode.

Over Temperature Protection

Over temperature protection limits total power dissipation in the PL0301. When the junction temperature exceeds T_j= +165°C, the thermal sensor signals the shutdown logic and turns off the pass transistor. The thermal sensor turns the pass transistor on again after the IC's junction temperature drops by 20°C, resulting in a pulsed output during continuous thermal-overload conditions.

Thermal-Overload protection is design to protect the PL0301 in the event of a fault condition. For continual operation, do not exceed the absolute maximum junction temperature rating of Tj = +150°C.

APPLICATION INFORMATION

Operating Region and Power Dissipation

The PL0301 maximum power dissipation depends on 1) the thermal resistance of the case and circuit board, 2) the temperature difference between the die junction and ambient, and 3) the rate of airflow. The power dissipation across the device is:

$$P = I_{out} (V_{in} – V_{out})$$

The maximum power dissipation is:

$$P_{max} = (T_j – T_a) / (\theta_{jc} + \theta_{ca})$$

Where $(T_j – T_a)$ is the temperature difference between the PL0301 die junction and the ambient air; θjc is the thermal resistance of the package; and θca is the thermal resistance through the PC board, copper traces, and other materials to the surrounding air.

The GND pin of the PL0301 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.

Noise Reduction

For the PL0301, an external 0.01µF bypass capacitor between BYP and GND with innovative noise bypass scheme reduces output noises dramatically, exhibiting 138µVrms of output voltage noise with Cbyp = 0.01µF and Cout = 1µF.

Capacitor Selection and Regulator Stability

Use a 1µF capacitor on the PL0301 input and a 1µF capacitor on the output. Large input capacitor values and lower ESRs provide better noise rejection and line-transient response.

Reduce output noise and improve load-transient response, stability, and power-supply rejection by using large output capacitors. Note that some ceramic dielectrics exhibit large capacitance and ESR variation with temperature. With dielectrics such as Z5U and Y5V, it may be necessary to use a 1µF or larger output capacitor to ensure stability at temperatures below -10°C. With X7R or X5R dielectrics, 1µF is sufficient at all operating temperatures. A graph of the region of stable Cout ESR vs. load current is shown in the Typical Characteristics.

Use a 0.01µF bypass capacitor at BYP for low-output voltage noise. The leakage current going into the BYP pin should be less than 10nA.

Noise, PSRR, and Transient Response

The PL0301 are designed to deliver ultra-low noise and high PSRR, as well as low dropout and low quiescent currents in battery-powered systems. The PL0301 PSRR is 62dB at 100Hz and 60dB at 10kHz (see the Power-Supply Rejection Ratio vs. Frequency graph in the Typical Characteristic).

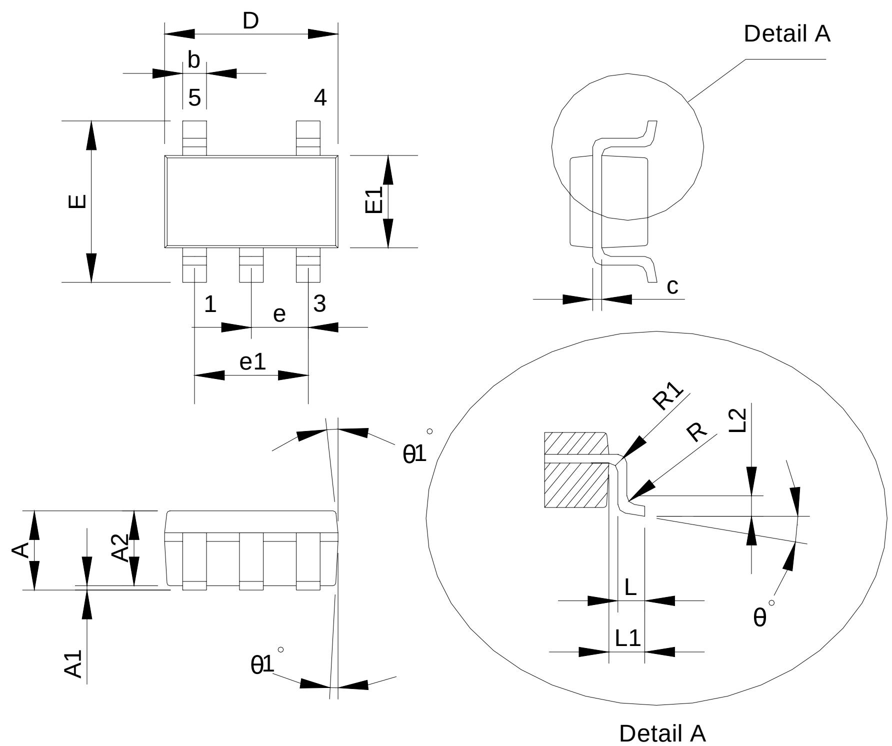
When operating from sources other than batteries, improved supply-noise rejection and transient response can be achieved by increasing the values of the input and output bypass capacitors, and through passive filtering techniques. The Typical Characteristics show the PL0301 line and load transient responses.

Dropout Voltage

A regulator's minimum dropout voltage determines the lowest usable supply voltage. In battery-powered systems, this determines the useful end-of-life battery voltage. Because the PL0301 use a P-channel MOSFET pass transistor, their dropout voltage is a function of drain-to-source on resistance (RDS (on)) multiplied by the load current (see the Typical Characteristics).

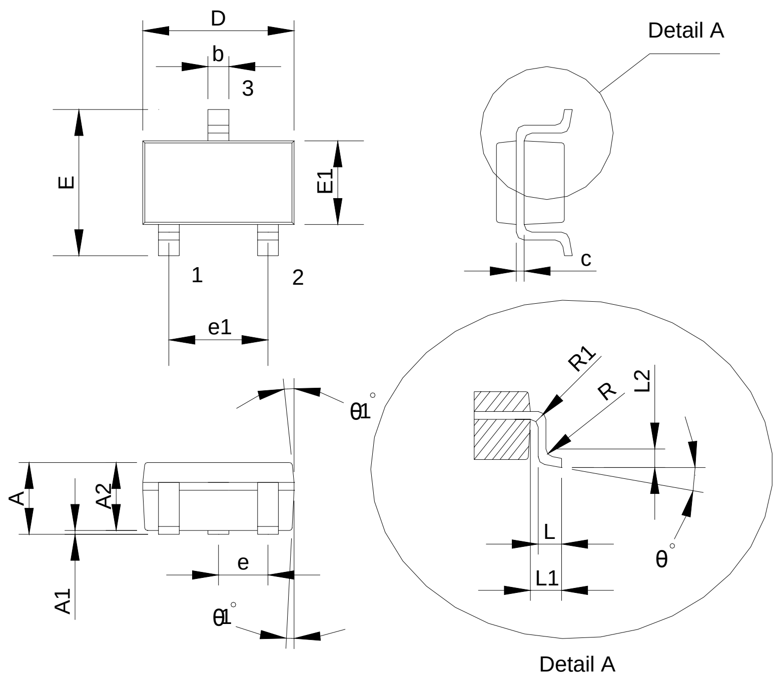
PACKAGE INFORMATION

5-PIN SOT-252 OUTLINE DIMENSION



Dimension

Symbol	Millimeter			Inch		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.45			0.057
A1			0.15			0.006
A2	0.90	1.15	1.30	0.036	0.045	0.051
b	0.30		0.50	0.011		0.020
c	0.08		0.22	0.003		0.009
D		2.90			0.114	
E		2.80			0.110	
E1		1.60			0.063	
e		0.95			0.037	
e1		1.90			0.075	
L	0.30	0.45	0.60	0.020	0.018	0.024
L1		0.60			0.024	
L2		0.25			0.010	
R	0.10			0.004		
R1	0.10		0.25	0.004		0.010
θ°	0°	4°	8°	0°	4°	8°
θ1°	5°	10°	15°	5°	10°	15°



Symbol	Millimeter			Inch		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.45			0.057
A1			0.15			0.006
A2	0.90	1.15	1.30	0.036	0.045	0.051
b	0.30		0.50	0.011		0.020
c	0.08		0.22	0.003		0.009
D		2.90			0.114	
E		2.80			0.110	
E1		1.60			0.063	
e		0.95			0.037	
e1		1.90			0.075	
L	0.30	0.45	0.60	0.020	0.018	0.024
L1		0.60			0.024	
L2		0.25			0.010	
R	0.10			0.004		
R1	0.10		0.25	0.004		0.010
θ°	0°	4°	8°	0°	4°	8°
θ1°	5°	10°	15°	5°	10°	15°

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