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X I N B O L E

# Product Specification

XBL29502

5A Fast Response LDO Regulator

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## Descriptions

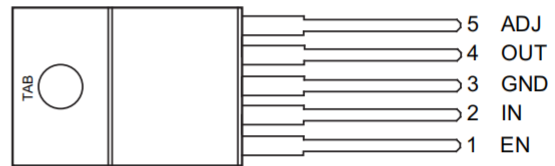
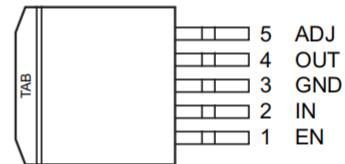
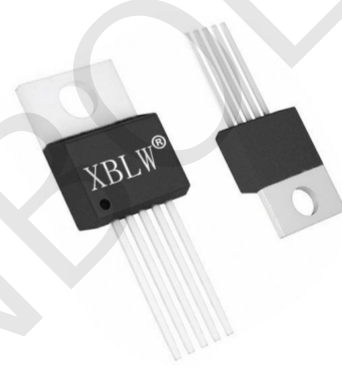
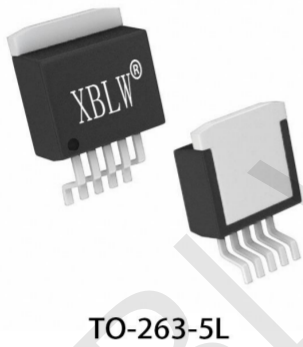
The XBL29502 is a high-current. The 5A LDO regulator features 560mV to 650mV (full load) dropout voltage and very low ground current. Designed for high-current loads, these devices also find applications in lower current, low-dropout critical systems, where their drop out voltages and ground current values are important attributes.

Along with a total accuracy of  $\pm 2\%$  (over temperature, line, and load regulation) the regulator features very fast transient recovery from input voltage surges and output load current changes.

The XBL29502 has an adjustable output that can be set by two external resistors to a voltage between 1.24V and 26V. In addition, the device is fully protected against over current faults, reversed input polarity, reversed lead insertion, and over temperature operation. A TTL/CMOS logic enable (EN) pin is available in the XBL29502 to shutdown the regulator. When not used, the device can be set to continuous operation by connecting EN to the input (IN).

## Features

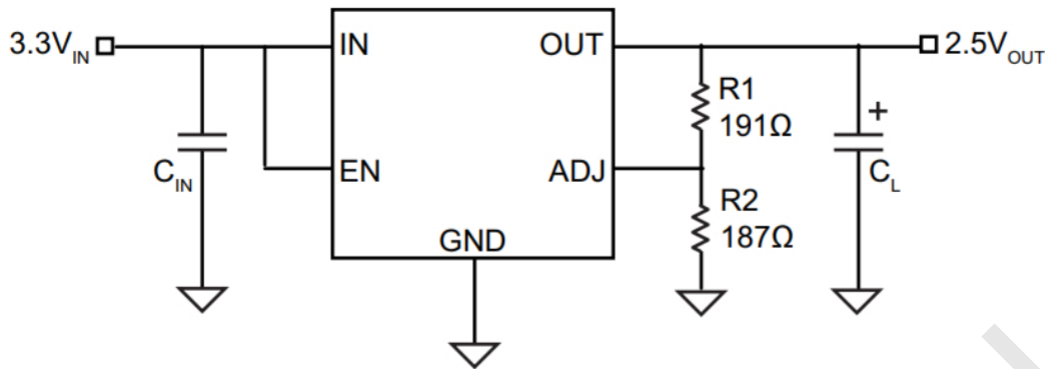
- High-Current Capability
- Operating Input Voltage Range: 3V to 26V
- Low Dropout Voltage
- Low Ground Current
- Accurate 1% Tolerance
- Fast Transient Response
- 1.24V to 26V Adjustable Output Voltage
- Packages: TO-263-5L and TO-220-5L



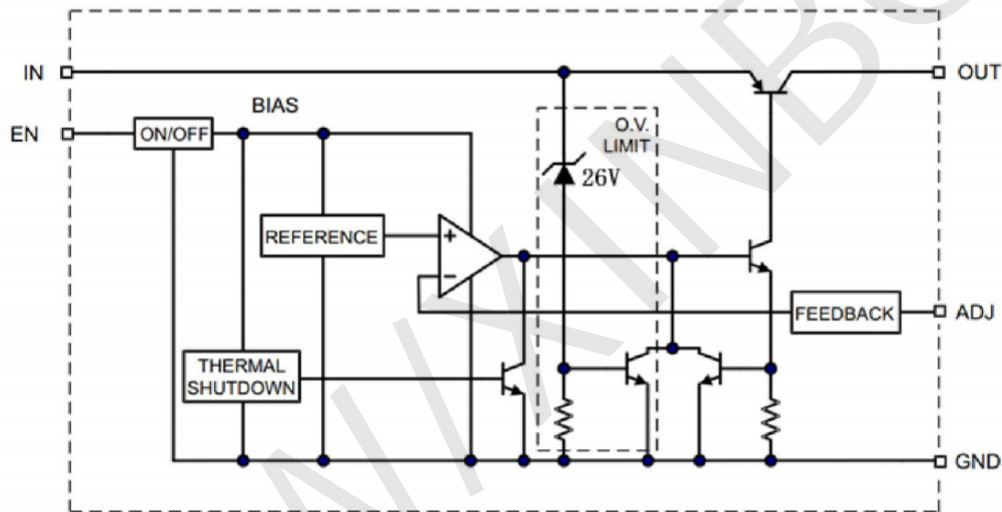
## Ordering Information

Product Model	Package Type	Marking	Packing	Packing Qty
XBL29502N	TO-220-5L	XBL29502N	Tube	1000Pcs/Box
XBL29502DTR	TO-263-5L	XBL29502	Tape	800Pcs/Reel

## Typical Application Circuit



## Functional Block Diagram



## Absolute Maximum Ratings (Ta=25 °C)

Rating	Symbol	Value	Unit
Input Supply Voltage	V <sub>IN</sub>	30	V
Enable Input Voltage	V <sub>EN</sub>	V <sub>IN</sub>	V
Operating Junction Temperature Range	T <sub>J</sub>	-40 to +125	°C
Storage Temperature Range	T <sub>stg</sub>	-65 to +150	°C
Operating Input Voltage	V <sub>OP</sub>	3~26	V
Package Thermal Resistances TO263-5L	θ <sub>JC</sub>	3	°C/W
Package Thermal Resistances TO263-5L	θ <sub>JA</sub>	28	°C/W

## Electrical Characteristics

$V_{IN} = 4.184V$ ;  $I_{OUT} = 100\text{ mA}$ ;  $T_A = +25^\circ\text{C}$ , bold values indicate  $-40^\circ\text{C} \leq T_J \leq +125^\circ\text{C}$ , unless noted. Note 1

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Output Voltage						
Output Voltage Accuracy	$\Delta V_{OUT}$	-2	—	2	%	$100\text{ mA} \leq I_{OUT} \leq 5A$ , $(V_{OUT} + 1V) \leq V_{IN} \leq 26V$
Line Regulation	$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	—	0.1	0.5	%	$I_{OUT} = 100\text{ mA}$ , $(V_{OUT} + 1V) \leq V_{IN} \leq 26V$
Load Regulation	$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	—	0.2	1	%	$V_{IN} = V_{OUT} + 1V$ , $100\text{ mA} \leq I_{OUT} \leq 5A$
Dropout Voltage (Note 2)	$V_{DO}$	—	100	200	mV	$I_{OUT} = 100\text{ mA}$ , $V_{IN} \geq 3.184V$
		—	300	—		$I_{OUT} = 1.5A$ , $V_{IN} \geq 3.184V$
		—	500	—		$I_{OUT} = 3.0A$ , $V_{IN} \geq 3.184V$
		—	560	800		$I_{OUT} = 5A$ , $V_{IN} \geq 3.4V$
Ground Current						
Ground Current	$I_{GND}$	—	5	20	mA	$I_{OUT} = 750\text{ mA}$ , $V_{IN} = V_{OUT} + 1V$
		—	15	—		$I_{OUT} = 1.5A$
		—	120	150		$I_{OUT} = 5A$
Ground Pin Current at Dropout	$I_{GNDDO}$	—	2	—	mA	$V_{IN} = 0.5V$ less than specified $V_{OUT}$ ; $I_{OUT} = 10\text{ mA}$
Current Limit	$I_{LIMIT}$	5	7	—	A	$V_{OUT} = 0V$ , Note 3
Output Noise Voltage (10 Hz to 100 kHz)	$e_n$	—	400	—	$\mu\text{VRMS}$	$C_L = 10\text{ }\mu\text{F}$
		—	260	—		$C_L = 33\text{ }\mu\text{F}$
Ground Pin Current in Shutdown	$I_{SHDN}$	—	32	—	$\mu\text{A}$	Input Voltage $V_{IN} = 16V$
Reference						
Reference Voltage	$V_{REF}$	1.215	—	1.267	V	Note 4
Adjust Pin Bias Current	$I_{ADJ}$	—	40	—	nA	—
		—	—	120		

## ELECTRICAL CHARACTERISTICS (CONTINUED)

$V_{IN} = 4.184V$ ;  $I_{OUT} = 100\text{ mA}$ ;  $T_A = +25^\circ\text{C}$ , bold values indicate  $-40^\circ\text{C} \leq T_J \leq +125^\circ\text{C}$ , unless noted. Note 1

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
ENABLE Input						
Input Logic Voltage	$V_{ENABLE}$	—	—	0.8	V	Low (OFF)
		2.4	—	—		High (ON)
Enable Pin Input Current	$I_{ENABLE}$	—	15	30	$\mu\text{A}$	$V_{EN} = 4.2V$
		—	—	75		
		—	—	2		$V_{EN} = 0.8V$
		—	—	4		
Regulator Output Current in Shutdown	$I_{OUT-SHDN}$	—	10	—	$\mu\text{A}$	Note 5
		—	—	20		

**Note 1:** Specification for packaged product only

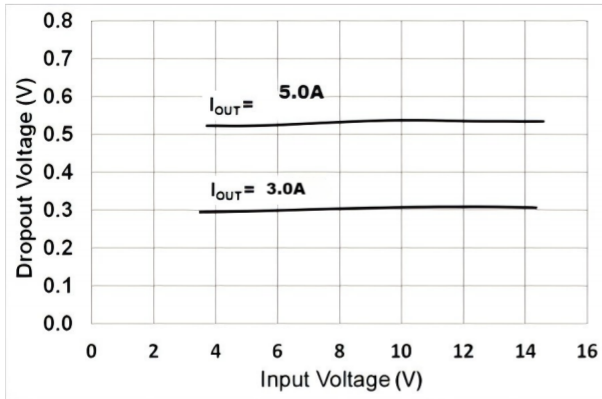
2: Dropout voltage is defined as the input-to-output differential when output voltage drops to 99% of its normal value with  $V_{OUT} + 1V$  applied to  $V_{IN}$ .

3:  $V_{IN} = V_{OUT}$  (nominal) + 1V. For example, use  $V_{IN} = 4.3V$  for a 3.3V regulator or use 6V for a 5V regulator. Employ pulse testing procedure for current-limit.

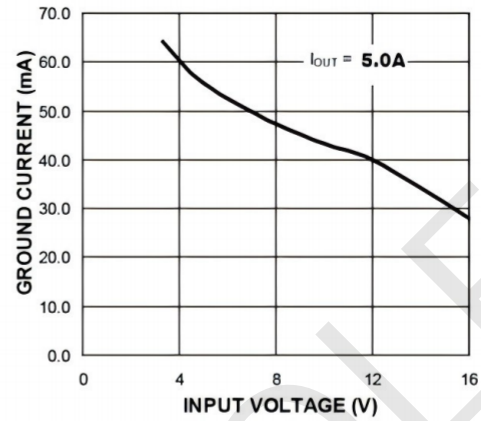
4:  $V_{REF} \leq V_{OUT} \leq V_{IN} - 1$ ,  $3V \leq V_{OUT} \leq 26V$ ,  $10\text{ mA} \leq I_L \leq I_{FL}$ ,  $T_J \leq T_{J(MAX)}$ .

5:  $V_{EN} \leq 0.8V$ ,  $V_{IN} \leq 26V$  and  $V_{OUT} = 0V$ .

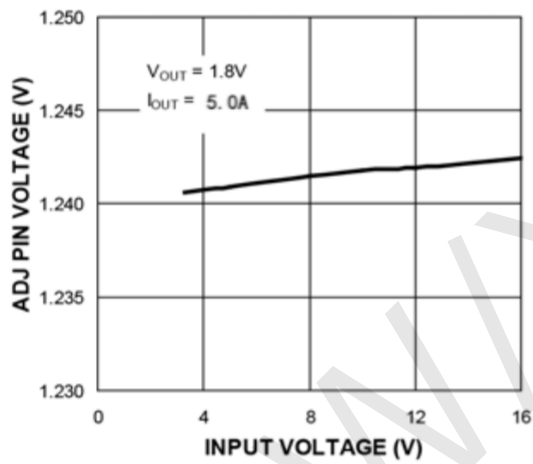
## Typical Characteristics



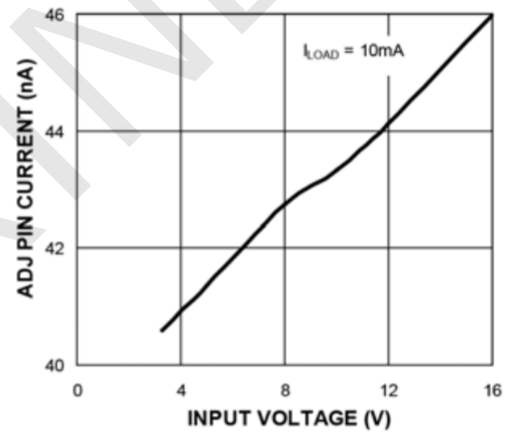
Dropout Voltage vs. Input Voltage.



GND Pin Current vs. Input Voltage.

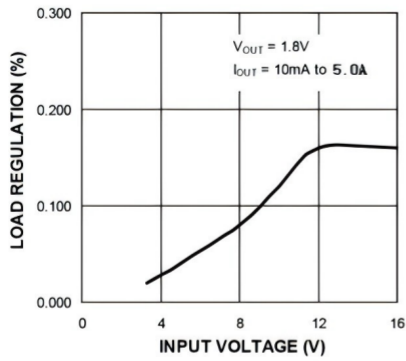


Adjust Pin Voltage vs. Input Voltage.

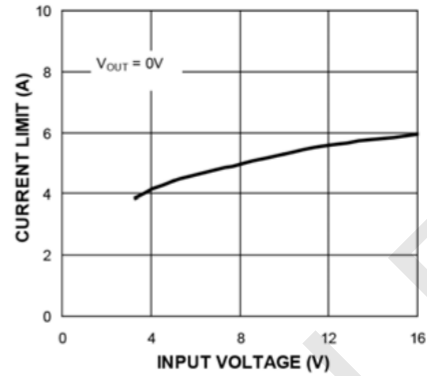


Adjust Pin Current vs. Input Voltage.

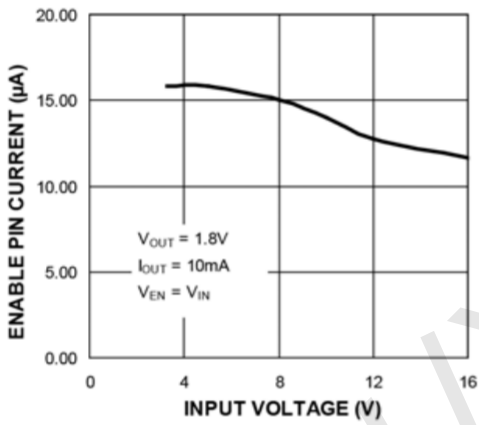
## Typical Characteristics



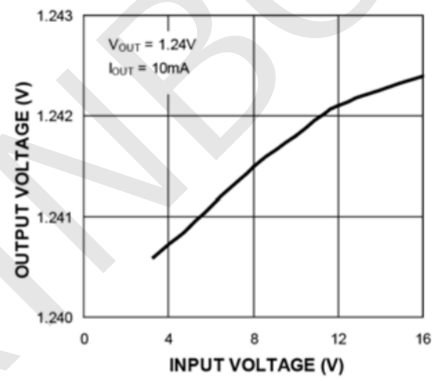
Load Regulation vs. Input Voltage.



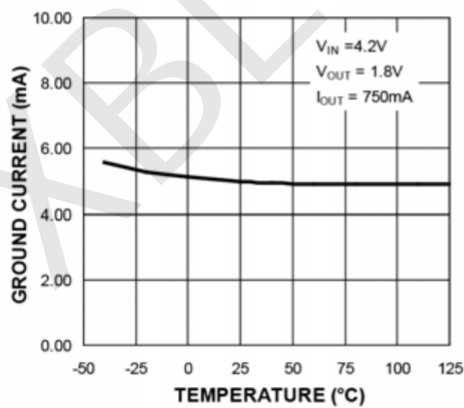
Short-Circuit Current vs. Input Voltage.



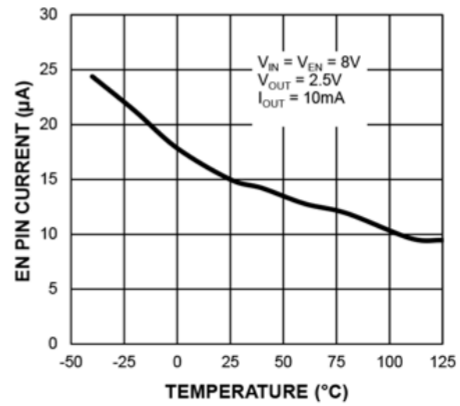
Enable Pin Current vs. Input Voltage.



Output Voltage vs. Input Voltage

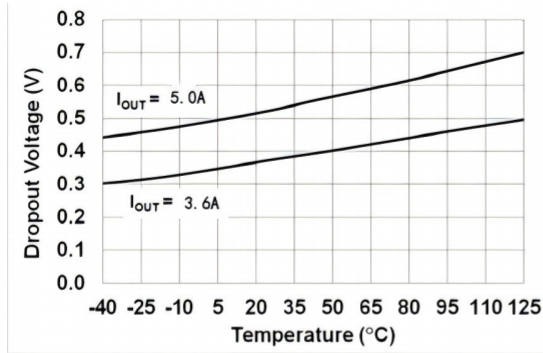


GND Pin Current vs. Temperature.

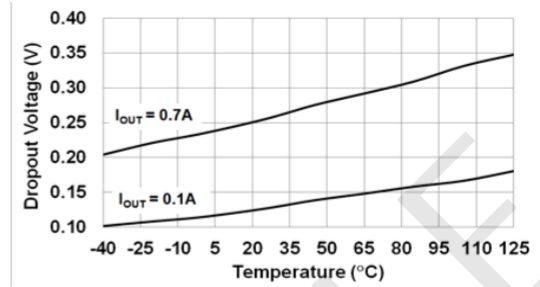


Enable Bias Current vs. Temperature.

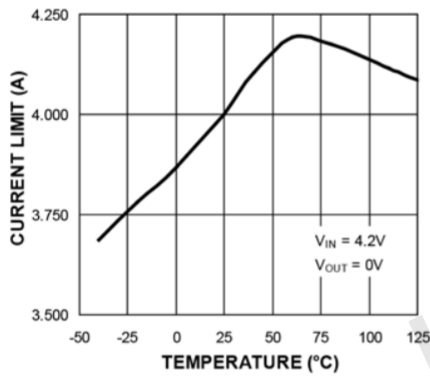
## Typical Characteristics



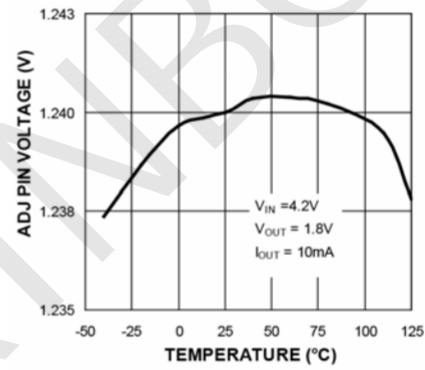
Dropout Voltage vs. Temperature.



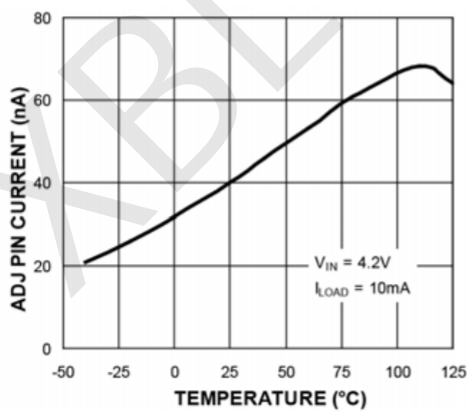
Dropout Voltage vs. Temperature.



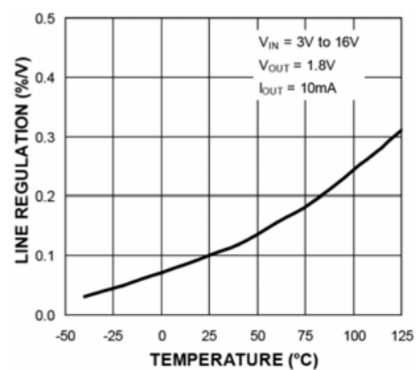
Short-Circuit Current vs. Temperature.



Short-Circuit Current vs. Temperature.

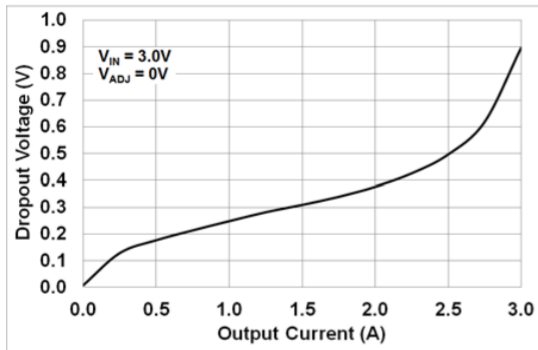


Adjust Pin Current vs. Temperature.

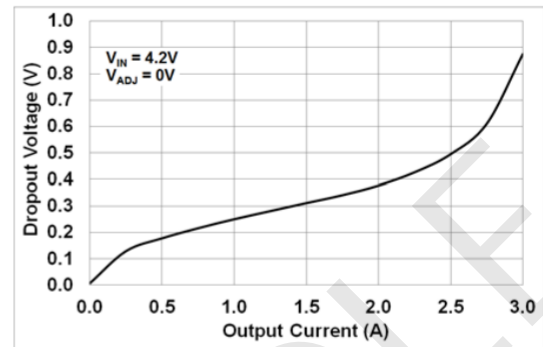


Line Regulation vs. Temperature.

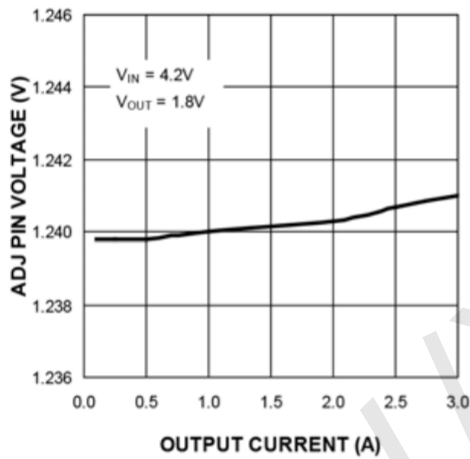
## Typical Characteristics



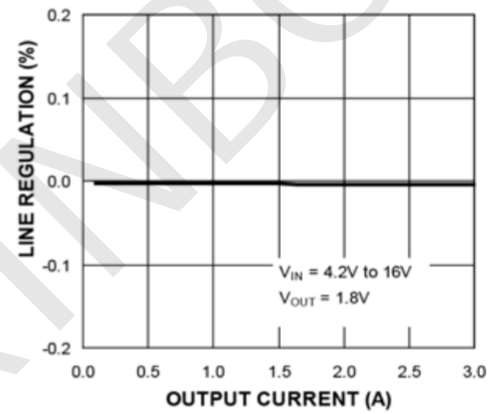
Dropout Voltage vs. Output Current.



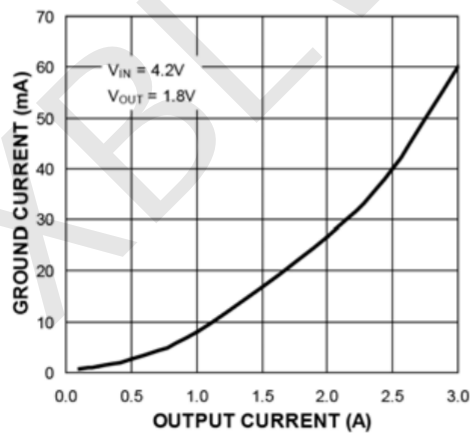
Dropout Voltage vs. Output Current.



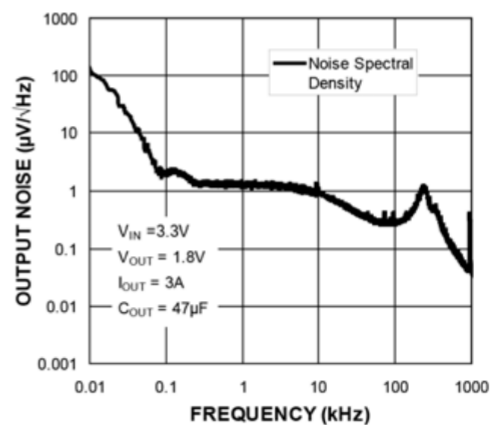
Adjust Pin Voltage vs. Output Current.



Line Regulation vs. Output Current.



GND Pin Current vs. Output Current.



Output Noise vs. Frequency.

## APPLICATION INFORMATION

The XBL29502 is a high-performance, low-dropout voltage regulator suitable for all moderate to high-current voltage regulation applications. Its 560 mV typical dropout voltage at full load makes it especially valuable in battery-powered systems and as high efficiency noise filters in post-regulator applications.

Unlike older NPN-pass transistor designs, where the minimum dropout voltage is limited by the base-emitter voltage drop and collector-emitter saturation voltage, dropout performance of the PNP output is limited merely by the low  $V_{CE}$  saturation voltage.

A trade-off for the low dropout voltage is a varying base driver requirement. But the Super  $\beta$  PNP process reduces this drive requirement to merely 1% of the load current.

The XBL29502 regulator is fully protected from damage due to fault conditions. Current limiting is linear; output current under overload conditions is constant. Thermal shutdown disables the device when the die temperature exceeds the +125°C maximum safe operating temperature. The output structure of the regulators allows voltages in excess of the desired

output voltage to be applied without reverse current flow. The XBL29502 offers a logic-level ON/OFF control. When disabled, the device draws 32  $\mu$ A at maximum 26V input.

### 1 Capacitor Requirements

For stability and minimum output noise, a capacitor on the regulator output is necessary. The value of this capacitor is dependent upon the output current; lower currents allow smaller capacitors. The XBL29502 is stable with a 10  $\mu$ F capacitor at full load.

This capacitor need not be an expensive low-ESR type; aluminum electrolytics are adequate. In fact, extremely low-ESR capacitors may contribute to instability. Tantalum capacitors are recommended for systems where fast load transient response is important.

When the regulator is powered from a source with high AC impedance, a 0.1  $\mu$ F capacitor connected between input and GND is recommended.

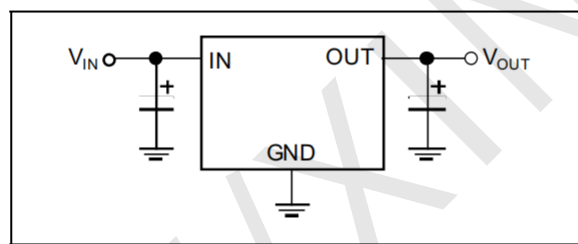


FIGURE 1: Linear Regulators Require Only Two Capacitors for Operation.

### 2. Transient Response and 5V to 3.3V Conversion

The XBL29502 has excellent response to variations in input voltage and load current. By virtue of its low dropout voltage, the device does not saturate in dropout as readily as similar NPN-based designs.

A 3.3V output XBL LDO will maintain full speed and performance with an input supply as low as 4.2V, and will still provide some regulation with supplies down to 3.8V, unlike NPN devices that require 5.1V or more for good performance and become nothing more than a resistor under 4.6V of input. XBL's PNP regulators provide superior performance in "5V to 3.3V" conversion applications than NPN regulators, especially when all tolerances are considered.

### 3. Minimum Load Current

The XBL29502 regulator operates within a specified load range. If the output current is too small, leakage currents dominate and the output voltage rises.

A minimum load current of 10 mA is necessary for proper regulation and to swamp any expected leakage current across the operating temperature range.

For best performance the total resistance ( $R_1+R_2$ ) should be small enough to pass the minimum regulator load current of 10 mA.

#### 4 .Adjustable Regulator Design

The output voltage can be programmed anywhere between 1.25V and the 15V. Two resistors are used. The resistor values are calculated by:

EQUATION 4-1:

$$R1 = R2 \times \left( \frac{V_{OUT}}{1.240} - 1 \right)$$

Where:

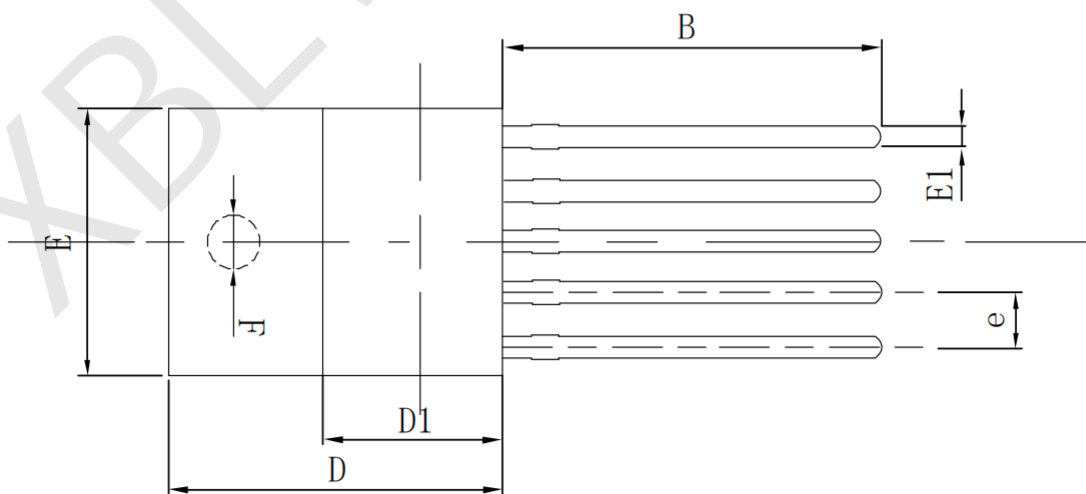
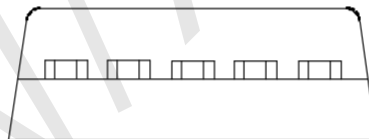
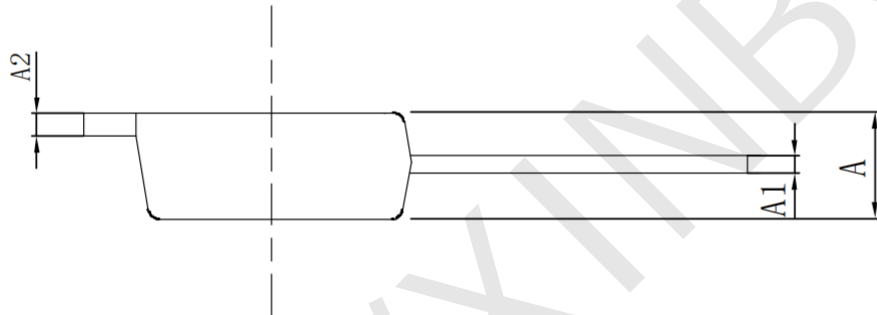
$V_{OUT}$  = Desired output voltage.

shows component definition. Applications with widely varying load currents may scale the resistors to draw the minimum load current required for proper operation (see the Minimum Load Current section).

**Package Information**

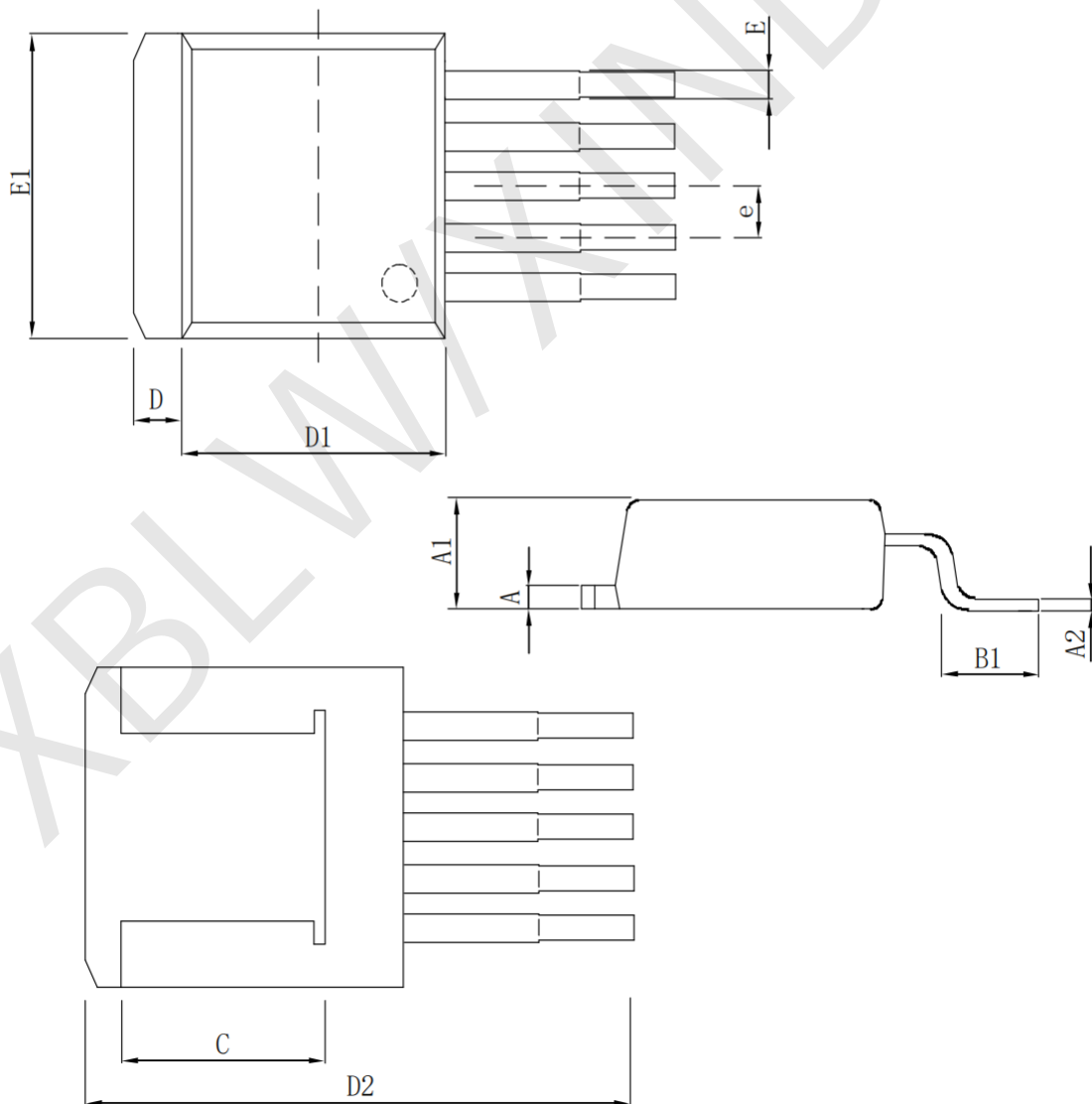
· T0-220-5L

Symbol	Size	Dimensions In Millimeters		Symbol	Size	Dimensions In Inches	
		Min (mm)	Max (mm)			Min (in)	Max (in)
A		4.300	4.700	A		0.169	0.185
A1		0.450	0.600	A1		0.017	0.023
A2		1.250	1.400	A2		0.049	0.055
B		12.88	13.38	B		0.507	0.527
D		15.50	15.90	D		0.610	0.626
D1		9.000	9.400	D1		0.354	0.370
E		9.700	10.10	E		0.381	0.398
E1		0.660	0.914	E1		0.025	0.036
e		1.702 (BSC)		e		0.670 (BSC)	
F		Φ3.500	Φ3.700	F		Φ0.137	Φ0.146



· T0-263-5L

Symbol	Dimensions In Millimeters		Symbol	Dimensions In Inches	
	Min(mm)	Max(mm)		Min(in)	Max(in)
A	1.170	1.370	A	0.046	0.054
A1	4.470	4.670	A1	0.176	0.184
A2	0.310	0.530	A2	0.012	0.021
B1	2.340	2.740	B1	0.092	0.108
C	5.080 (REF)		C	0.200 (REF)	
D	1.170	1.370	D	0.046	0.054
D1	8.500	8.900	D1	0.335	0.350
D2	14.55	15.55	D2	0.572	0.612
E	0.660	0.860	E	0.025	0.034
E1	10.01	10.31	E1	0.394	0.406
e	1.700 (BSC)		e	0.067 (BSC)	



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