1. DESCRIPTION

The XLMIC29302 is a high-current. The 3A LDO regulator features 560 mV (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 dropout voltages and ground current values are important attributes.

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

The XLMIC29302 has an adjustable output that can be set by two external resistors to a voltage between 1.24V and 15V. In addition, the device is fully protected against overcurrent faults, reversed input polarity, reversed lead insertion, and overtemperature operation. A TTL/CMOS logic enable (EN) pin is available in the XLMIC29302 to shutdown the regulator. When not used, the device can be set to continuous operation by connecting EN to the input (IN).

2. FEATURES

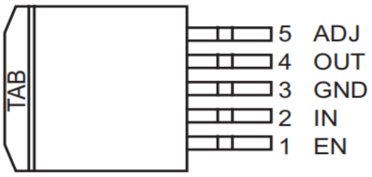
- High-Current Capability
- Operating Input Voltage Range: 3V to 16V
- Low Dropout Voltage
- Low Ground Current
- Accurate 1% Tolerance
- Fast Transient Response
- 1.24V to 15V Adjustable Output Voltage
- Packages: TO-263-5L

3. APPLICATIONS

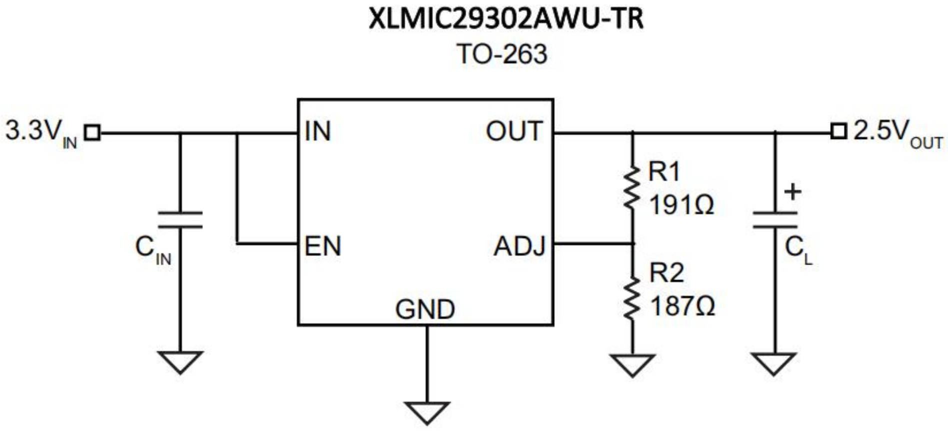
- Processor Peripheral and I/O Supplies
- High-Efficiency Green Computer Systems
- Automotive Electronics
- High-Efficiency Linear Lower Supplies
- Battery-Powered Equipment
- PC Add-In Cards
- High-Efficiency Post-Regulator for Switching Supply

Package Types

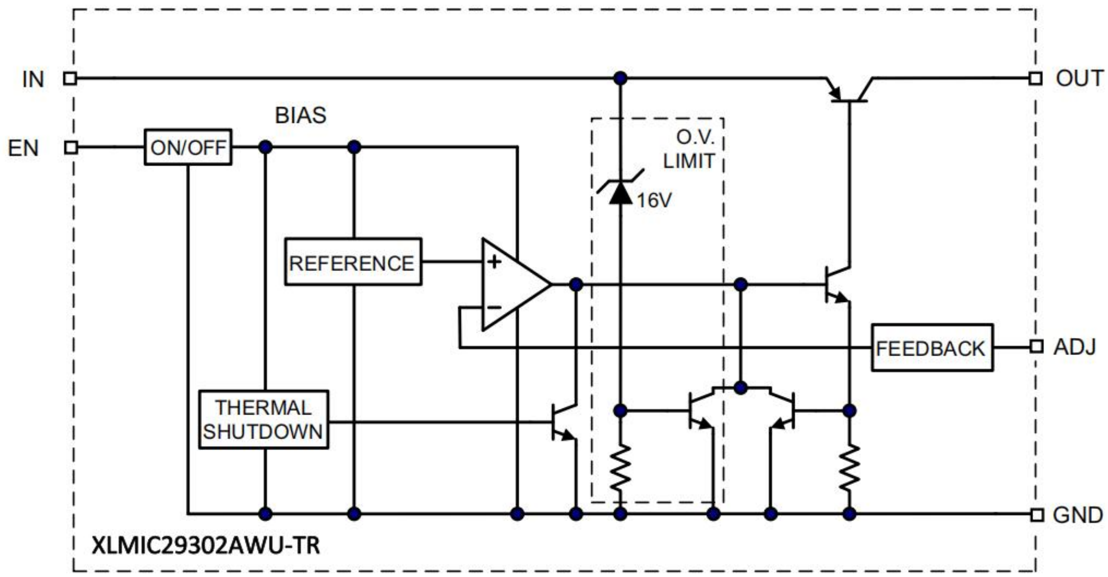
XLMIC29302AWU-TR
5-Lead TO-263



4. TYPICAL APPLICATION CIRCUIT



5. FUNCTIONAL BLOCK DIAGRAM



6. ELECTRICAL CHARACTERISTICS

6.1. Absolute Maximum Ratings(Note 1)

Input Supply Voltage (V_{IN}) .... –20V to +20V
Enable Input Voltage (V_{EN}) ....–0.3V to VIN
ESD Rating (All Pins)..Note 3

Operating Ratings (Note 2)

Operating Input Voltage .... +3V to +16V

Note 1: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational sections of this specification is not intended. Exposure to maximum rating conditions for extended periods may affect device reliability.
Note 2: The device is not guaranteed to function outside its operating ratings.
Note 3: Devices are ESD sensitive. Handling precautions recommended.

7. ELECTRICAL CHARACTERISTICS

TABLE 1-1:

Electrical Characteristics: V_{IN} = 4.184V; I_{OUT} = 100 mA; T_A = +25°C, bold values indicate –40°C ≤ T_J ≤ +85°C,

unless noted. Note 1

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Output Voltage						
Output Voltage Accuracy	ΔV_{OUT}	–2	—	2	%	100 mA ≤ I_{OUT} ≤ 3A, (V_{OUT} + 1V) ≤ V_{IN} ≤ 16V
Line Regulation	$\Delta V_{OUT}/\Delta V_{IN}$	—	0.1	0.5	%	I_{OUT} = 100 mA, (V_{OUT} + 1V) ≤ V_{IN} ≤ 16V
Load Regulation	$\Delta V_{OUT}/\Delta I_{OUT}$	—	0.2	1	%	V_{IN} = V_{OUT} + 1V, 100 mA ≤ I_{OUT} ≤ 3A
Dropout Voltage (Note 2)	V_{DO}	—	100	200	mV	I_{OUT} = 100 mA, V_{IN} ≥ 3.184V
		—	300	—		I_{OUT} = 1.5A, V_{IN} ≥ 3.184V
		—	500	—		I_{OUT} = 2.75A, V_{IN} ≥ 3.184V
		—	560	800		I_{OUT} = 3A, V_{IN} ≥ 3.4V
Ground Current						
Ground Current	I_{GND}	—	5	20	mA	I_{OUT} = 750 mA, VIN = VOUT + 1V
		—	15	—		I_{OUT} = 1.5A
		—	60	150		I_{OUT} = 3A
Ground Pin Current at Dropout	I_{GNDDO}	—	2	—	mA	V_{IN} = 0.5V less than specified V_{OUT}; I_{OUT} = 10 mA
Current Limit	I_{LIMIT}	3	4	—	A	V_{OUT} = 0V, Note 3
Output Noise Voltage (10 Hz to 100 kHz)	e_N	—	400	—	μV_{RMS}	C_L = 10 µF
		—	260	—		C_L = 33 µF
Ground Pin Current in Shutdown	I_{SHDN}	—	32	—	µA	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		

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	µA	V_{EN} = 4.2V
		—	—	75		
		—	—	2		V_{EN} = 0.8V
		—	—	4		
Regulator Output Current in Shutdown	$I_{OUT-SHDN}$	—	10	—	µA	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 nor mal 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: $V_{REF} \le V_{OUT} \le V_{IN} - 1$, $3V \le V_{OUT} \le 16V$, $10 mA \le I_L \le I_{FL}$, $T_J \le T_{J(MAX)}$.
5: $V_{EN} \le 0.8V$, $V_{IN} \le 16V$ and V_{OUT} = 0V.

8. TEMPERATURE SPECIFICATIONS (Note 1)

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Junction Operating Temperature Range	T_J	–40	—	+125	°C	—
Storage Temperature Range	T_S	–65	—	+150	°C	—
Package Thermal Resistances						
Thermal Resistance TO-263	θ_{JC}	—	3	—	°C/W	—
Thermal Resistance TO-263	θ_{JA}	—	28	—	°C/W	—

Note :
1.The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction to air (i.e., TA, TJ, θJA). Exceeding themaximum allowable power dissipation will cause the device operating junction temperature to exceed the maximum +125°C rating. Sustained junction temperatures above +125°C can impact the device reliability.

9. YPICAL PERFORMANCE CURVES

Note:

The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

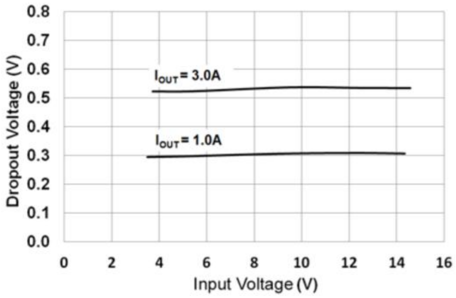


FIGURE 2-1:
Dropout Voltage vs. Input Voltage.

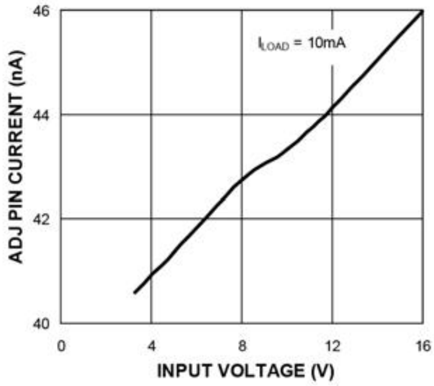


FIGURE 2-4:
Adjust Pin Current vs. Input Voltage.

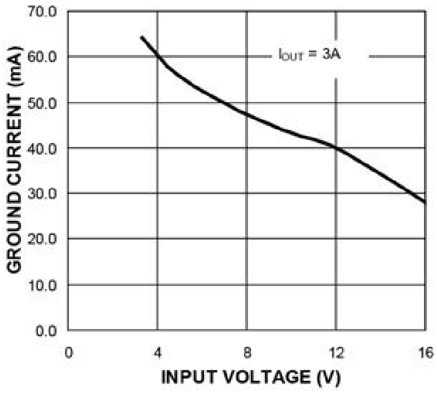


FIGURE 2-2:
GND Pin Current vs. Input Voltage.

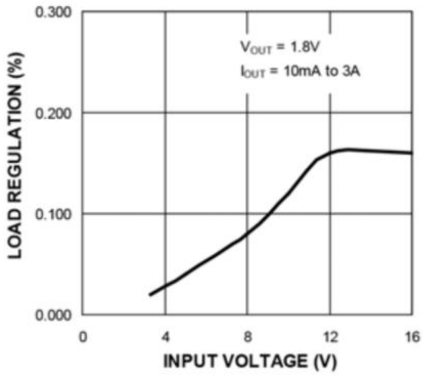


FIGURE 2-5:
Load Regulation vs. Input Voltage.

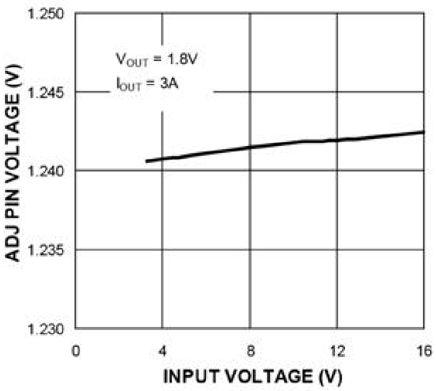


FIGURE 2-3:
Adjust Pin Voltage vs. Input Voltage.

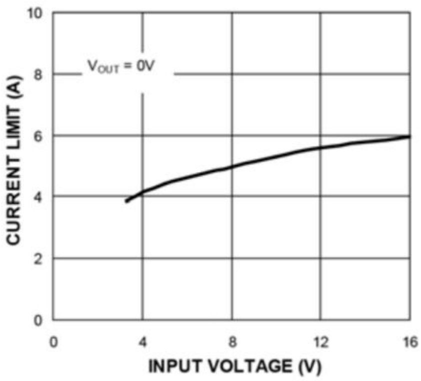


FIGURE 2-6:
Short-Circuit Current vs. Input Voltage.

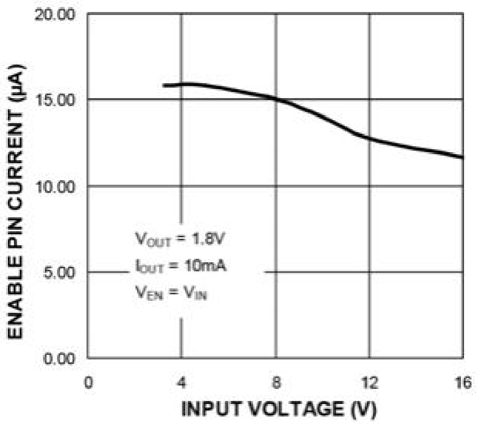


FIGURE 2-7:
Enable Pin Current vs. Input Voltage.

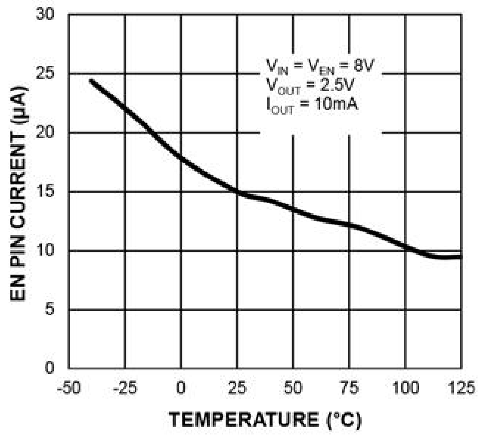


FIGURE 2-10:
Enable Bias Current vs. Temperature

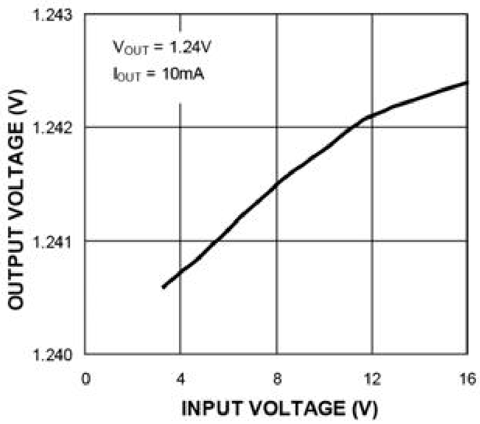


FIGURE 2-8:
Output Voltage vs. Input Voltage

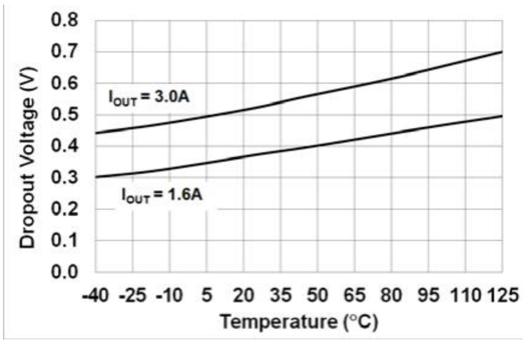


FIGURE 2-11:
Dropout Voltage vs. Temperature.

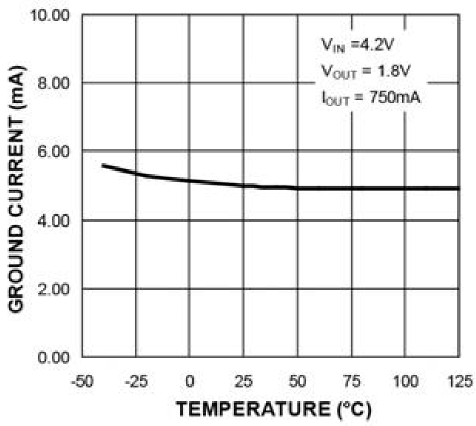


FIGURE 2-9:
GND Pin Current vs. Temperature.

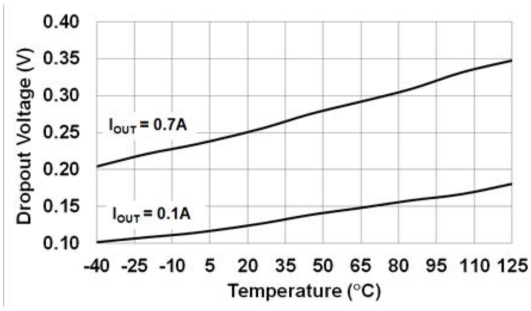
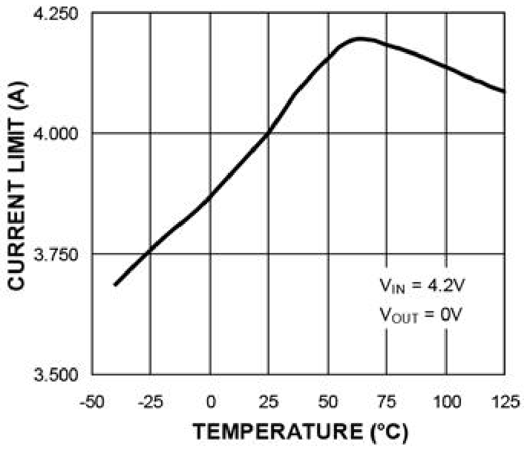
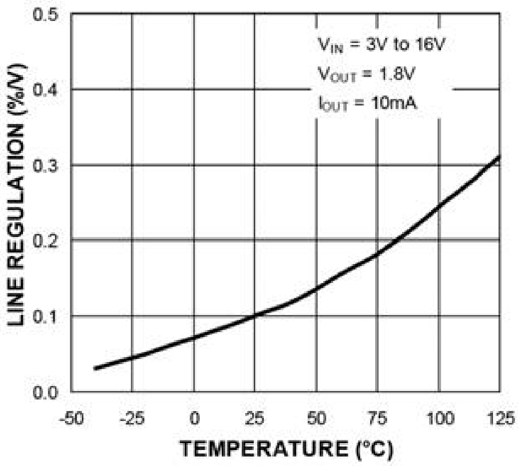
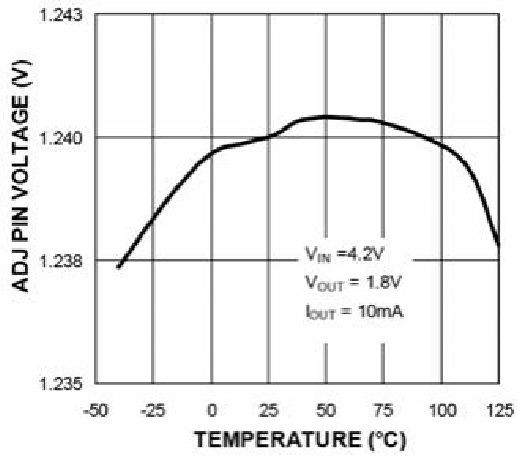
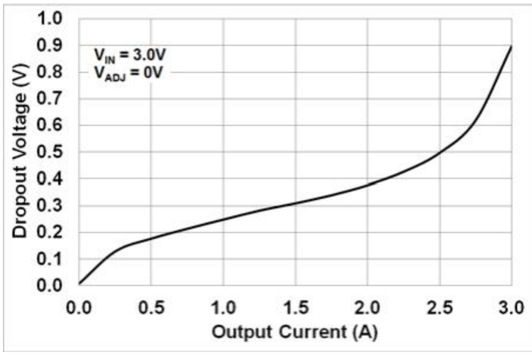
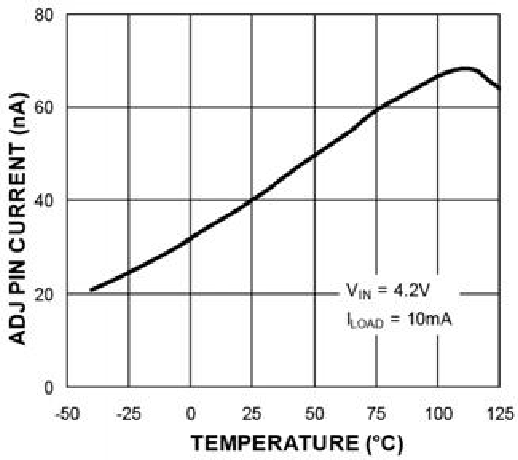
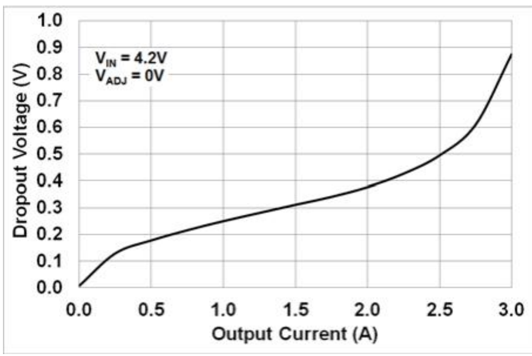


FIGURE 2-12:
Dropout Voltage vs. Temperature.

 FIGURE 2-13: Short-Circuit Current vs. Temperature.	 FIGURE 2-16: Line Regulation vs. Temperature
 FIGURE 2-14: Adjust Pin Voltage vs. Temperature.	 FIGURE 2-17:Dropout Voltage vs. Output Current.
 FIGURE 2-15:Adjust Pin Current vs. Temperature.	 FIGURE 2-18: Dropout Voltage vs. Output Current.

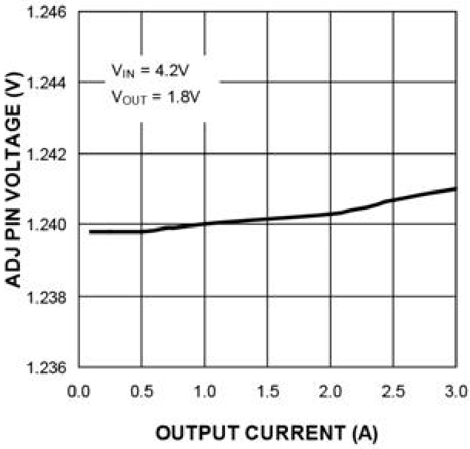


FIGURE 2-19:
Adjust Pin Voltage vs.Output Current.

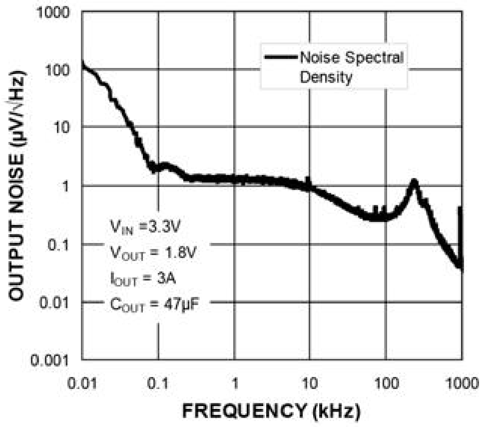


FIGURE 2-22:
Output Noise vs. Frequency.

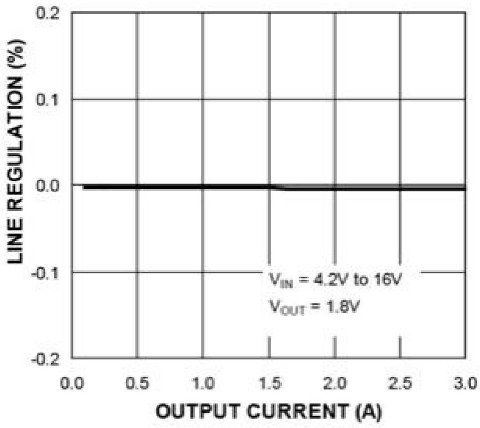


FIGURE 2-20:
Line Regulation vs. OutputCurrent.

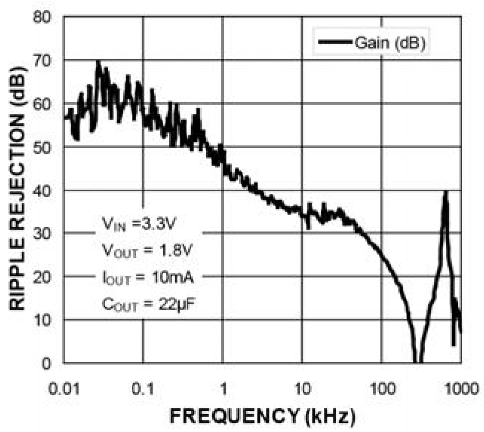


FIGURE 2-23:
Ripple Rejection (IOUT =10 mA) vs. Frequency

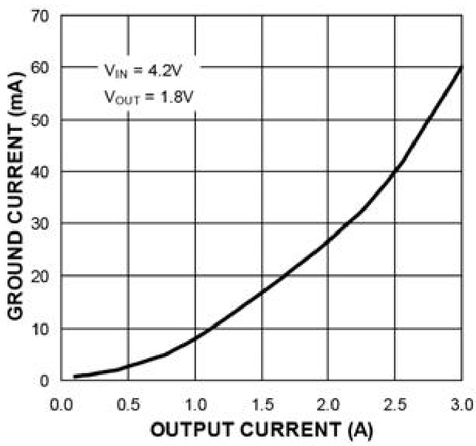


FIGURE 2-21:
GND Pin Current vs. OutputCurrent.

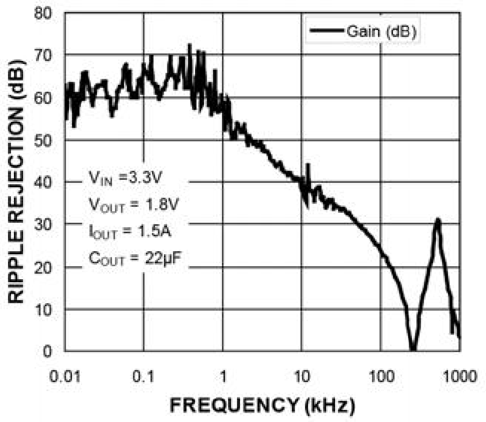


FIGURE 2-24:
Ripple Rejection (IOUT =1.5A) vs. Frequency

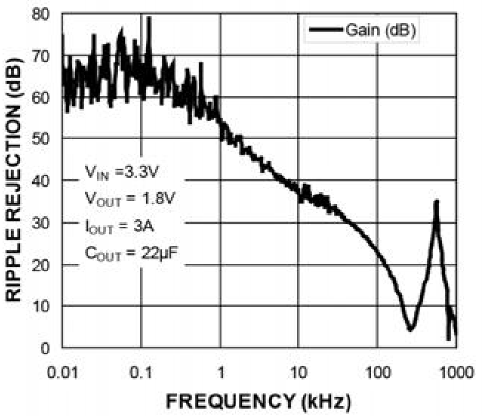


FIGURE 2-25:
Ripple Rejection (I_{OUT} = 3A) vs. Frequency.

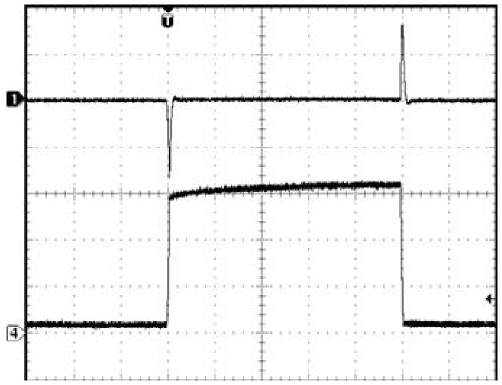


FIGURE 2-28:
Line Transient Response with 3A Load, 10 µF Output Capacitance.

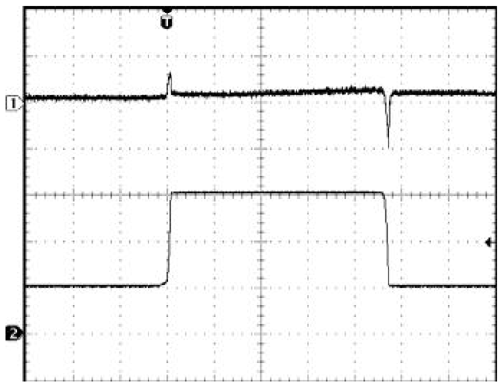


FIGURE 2-26:
Line Transient Responsewith 3A Load, 1000 µF Output Capacitance.

FIGURE 2-29:
Load Transient Response with 3A Load, 1000 µF Output Capacitance.

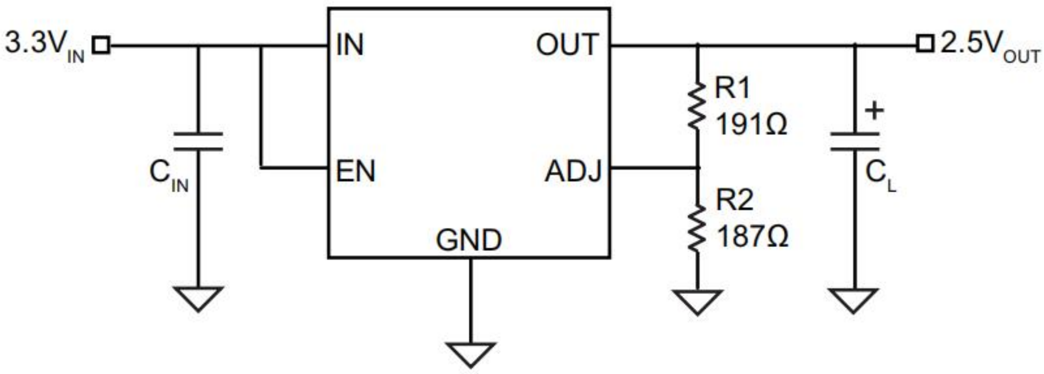


FIGURE 2-27:
XLMIC29302 Load Transient Response Test Circuit.

10. PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 3-1.

TABLE 3-1: PIN FUNCTION TABLE

Pin Number TO-263	Pin Name	Description
1	EN	Enable (Input): Active-high TTL/CMOS-compatible control input. Do not float.
2	IN	INPUT: Unregulated input, +3V to +16V maximum.
3, TAB	GND	GND: TAB is also connected internally to the IC's ground on both packages.
4	OUT	OUTPUT: The regulator output voltage.
5	ADJ	Feedback Voltage: 1.24V feedback from external resistor divider.

11. APPLICATION INFORMATION

The XLMIC29302 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 ßeta PNP process reduces this drive requirement to merely 1% of the load current.

The XLMIC29302 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 +85°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 XLMIC29302 offers a logic-level ON/OFF control. When disabled, the device draws 32 µA at maximum 16V input.

11.1. 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 XLMIC29302 is stable with a 10 µF 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 µF capacitor connected between input and GND is recommended.

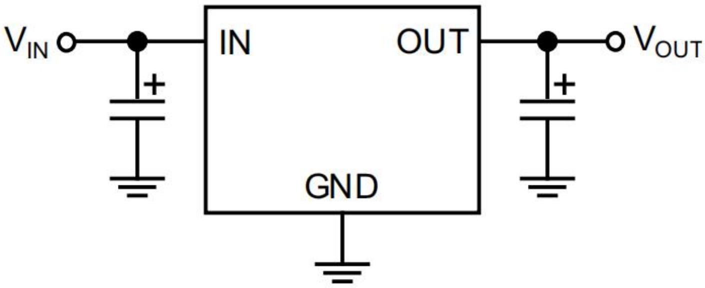


FIGURE 4-1: Linear Regulators Require Only Two Capacitors for Operation.

11.2. Transient Response and 5V to 3.3V Conversion

The XLMIC29302 has excellent response to variations in input voltage and load current. By virtue of its low dropout voltage, the device does not saturate into dropout as readily as similar NPN-based designs. A 3.3V output Microchip 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. PNP regulators provide superior performance in "5V to 3.3V" conversion applications than NPN regulators, especially when all tolerances are considered.

11.3. Minimum Load Current

The XLMIC29302 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 (R1+R2) should be small enough to pass the minimum regulator load current of 10 mA.

11.4. 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.

Figure 4-2 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).

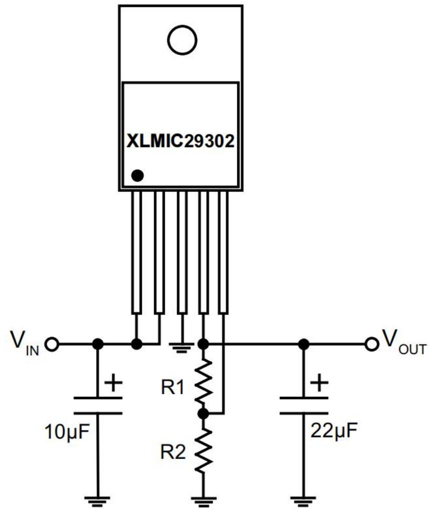


FIGURE 4-2: Adjustable Regulator withResistors.

11.5. Enable Input

XLMIC29302 features an enable (EN) input that allows ON/OFF control of the device. The EN input has TTL/CMOS-compatible thresholds for simple interfacing with logic, or may be directly tied to VIN. Enabling the regulator requires approximately 20 µA of current into the EN pin.

11.6. Thermal Design

Linear regulators are simple to use. The most complicated set of design parameters to consider are thermal characteristics. Thermal design requires the following application-specific parameters:

- Maximum Ambient Temperature, T_A
- Output Current, I_{OUT}
- Output Voltage, V_{OUT}
- Input Voltage, V_{IN}

First, calculate the power dissipation of the regulator from these numbers and the device parameters from this data sheet:

EQUATION 4-2:

$$P_D = I_{OUT}(1.05V_{IN} - V_{OUT})$$

Ground current is, in the worst case, 5% of IOUT. Then the heatsink thermal resistance is determined with this formula:

EQUATION 4-3:

$$\theta_{SA} = \frac{T_{J(MAX)} - T_A}{P_D} - (\theta_{JC} + \theta_{CS})$$

Where:

$T_{J(MAX)}$ = Less than or equal to +125°C.
θ_{CS} = Between 0°C/W and 2°C/W.
θ_{JC} = Selected from Temperature Specifications table for selected package

The heatsink may be significantly increased in applications where the minimum input voltage is known and is large compared to the dropout voltage. A series input resistor can be used to drop excessive voltage anddistribute the heat between this resistor and the regulator. The low-dropout properties of Microchip Super βeta PNP regulators allow very significant reductions in regulator power dissipation and the associated heatsink without compromising performance. When this technique is employed, a capacitor of at least 0.1 µF is needed directly between the input and regulator ground.

With no heatsink in the application, calculate the junction temperature to determine the maximum power dissipation that will be allowed before exceeding the maximum junction temperature of the XLMIC29302.

For example, given an expected maximum ambient temperature (TA) of +75°C with V_{IN} = 3.3V, V_{OUT} = 2.5V, and I_{OUT} = 3A, first calculate the expected PD using Equation 4-4.

EQUATION 4-4:

$$P_D = 3.0A(1.05 \times 3.3V - 2.5V) = 2.9W$$

Next, calculate the junction temperature for the expected power dissipation:

EQUATION 4-5:

$$T_J = (\theta_{JA} \times P_D) + T_A = (35°C/\mathrm{W} \times 2.9W) + 75°C = 176.5°C$$

Now determine the maximum power dissipation allowed that would not exceed the IC's maximum junction temperature (125°C) without the use of a heatsink by:

EQUATION 4-6:

$$P_{D(MAX)} = (T_{J(MAX)} - T_A)/\theta_{JA}$$

$$= (125°C - 75°C)/(35°C/W)$$

$$= 1.428W$$

12. ORDERING INFORMATION

Ordering Information

Part Number	Device Making	Package type	Body size (mm)	Temperate (°C)	MSL	Transpo Rt	Package Quantit
XLMIC29302AWU-TR	XL29302	TO-263	10.00*8.80	-40 to +85	MSL3	T&R	750

13.DIMENSIONAL DRAWINGS