



A New Direction in Mixed-Signal

March 2014

XRP29302

3A Low Dropout Voltage Regulator

Rev. 1.4.0

GENERAL DESCRIPTION

The XRP29302 is a 3A, highly accurate voltage regulator with a low dropout voltage of 600mV (typical) at 3A.

This regulator is specifically designed for low voltage applications that require a low dropout voltage and a fast transient response. It is fully fault protected against over-current, reverse battery, and positive and negative voltage transients. On-Chip trimming adjusts the reference voltage to 1% initial accuracy.

The XRP29302 is offered in 5-pin TO-220 & TO-263 packages.

APPLICATIONS

- **Adjustable Power Supplies**
- **Constant Current Regulators**
- **Audio and Video/Graphic Cards**
- **Battery Chargers**

FEATURES

- **3A Guaranteed Output Current**
- **Low Dropout Voltage of 600mV @ 3A**
- **Adjustable Output down to 1.25V**
- **1% Output Accuracy**
- **Tight Load and Line Regulation**
- **Fast Transient Response**
- **Reverse Battery Protection**
- **Zero Current Shutdown**
- **Drop-in Replacement to SPX29302**
- **Lead Free 5-pin TO220 and TO263 Packages**

TYPICAL APPLICATION DIAGRAM

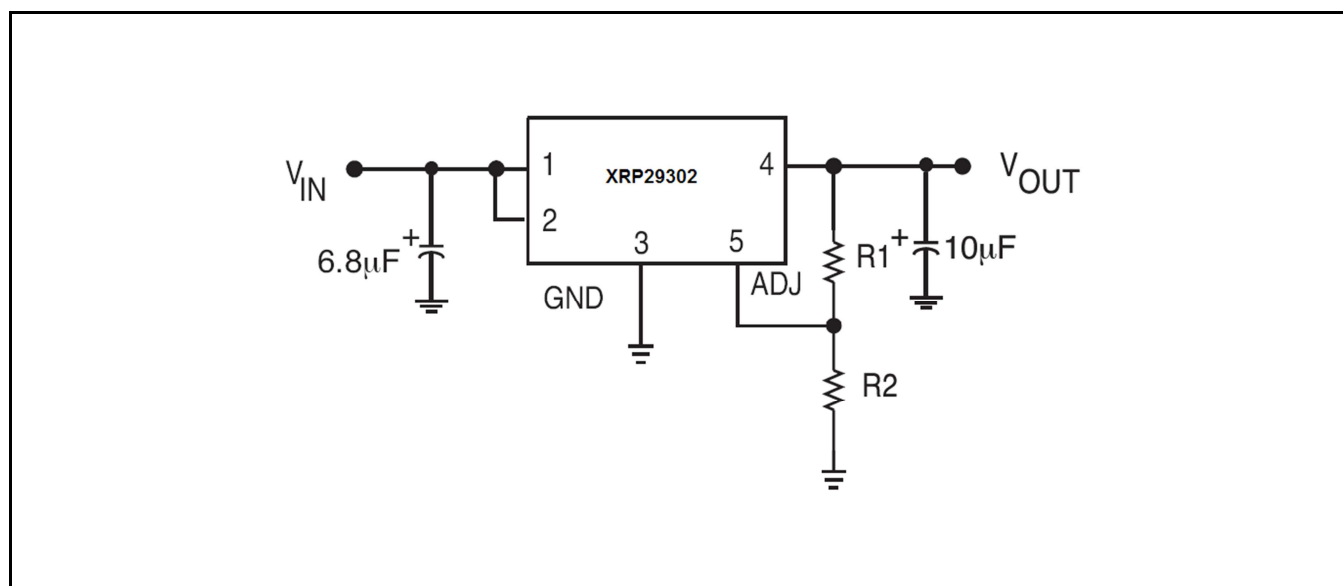


Fig. 1: XRP29302 Application Diagram

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ABSOLUTE MAXIMUM RATINGS

These are stress ratings only and functional operation of the device at these ratings or any other above those indicated in the operation sections of the specifications below is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability.

Input Voltage V_{IN}^1 20V
 Storage Temperature -65°C to 150°C
 Lead Temperature (Soldering, 5 sec) 260°C
 ESD Rating (HBM - Human Body Model)
 All pins except EN 2kV
 En pin 1kV

OPERATING RATINGS

Input Voltage Range V_{IN} 16V
 Junction Temperature Range -40°C to 125°C
 Thermal Resistance
 TO-220 Junction to Case @ T_A 3°C/W
 TO-220 Junction to Ambient 60°C/W
 TO-263 Junction to Case @ T_A 3°C/W
 TO-263 Junction to Ambient 60°C/W

Note 1: Maximum positive supply voltage of 20V must be of limited duration (<100ms) and duty cycle of less than 1%. The maximum continuous supply voltage is 16V.

ELECTRICAL SPECIFICATIONS

Specifications with standard type are for an Operating Junction Temperature of $T_J = T_A = 25^\circ\text{C}$ only; limits applying over the full Operating Junction Temperature range are denoted by a "•". Minimum and Maximum limits are guaranteed through test, design, or statistical correlation. Typical values represent the most likely parametric norm at $T_J = 25^\circ\text{C}$, and are provided for reference purposes only. Unless otherwise indicated, $V_{IN} = V_{OUT} + 1\text{V}$ and $I_{OUT} = 10\text{mA}$, $C_{IN} = 6.8\mu\text{F}$, $C_{OUT} = 10\mu\text{F}$, $T_A = 25^\circ\text{C}$.

Parameter	Min.	Typ.	Max.	Units	Conditions
Line Regulation		0.06	0.5	%	$I_{OUT} = 10\text{mA}$, $(V_{OUT} + 1\text{V}) \leq V_{IN} \leq 16\text{V}$
Load Regulation		0.2	1	%	$V_{IN} = V_{OUT} + 1\text{V}$, $10\text{mA} \leq I_{OUT} \leq I_{FL}$ (note 2)
$\Delta V/\Delta T$		20	100	ppm/ $^\circ\text{C}$	• V_{OUT} Temp Coefficient (note 6)
Dropout Voltage (note 3)		120	300	mV	• $I_{OUT} = 100\text{mA}$
		380			• $I_{OUT} = 1.5\text{A}$
		525	650		• $I_{OUT} = 2.5\text{A}$, XRP29302A only
		600	800		• $I_{OUT} = 3\text{A}$
Ground Current (note 5)		30	60	mA	• $I_{OUT} = 1.5\text{A}$
		40			• $I_{OUT} = 3\text{A}$
Ground Pin Current at Dropout		0.9		mA	$V_{IN} = 0.5\text{V}$ less than specified V_{OUT} $I_{OUT} = 10\text{mA}$
Current Limit	3.0	4.5		A	$V_{OUT} = 0\text{V}$ (note 4)
Output Noise Voltage		400		μV_{RMS}	10Hz-100KHz, $I_{OUT} = 100\text{mA}$, $C_{OUT} = 10\mu\text{F}$
		260			10Hz-100KHz, $I_{OUT} = 100\text{mA}$, $C_{OUT} = 33\mu\text{F}$
Reference Voltage	1.228	1.24	1.252	V	
	1.215		1.265	V	•
Adjust Pin Bias Current		40	80	nA	
			120		•
Reference Voltage Temperature Coefficient		20		ppm/ $^\circ\text{C}$	Note 7
Adjust Pin Bias Current Temperature Coefficient		0.1		nA/ $^\circ\text{C}$	
Enable Input					
Input Logic Voltage Low (OFF)			0.8	V	• $V_{IN} < 10\text{V}$
Input Logic Voltage High (ON)	2.4				•
Enable Input Pin		100	600	μA	• $V_{EN} = 16\text{V}$
			750		•
			1		• $V_{EN} = 0.8\text{V}$
			2		•
Regulator Output Current in Shutdown		10	500	μA	• Note 8

Note 2: Full load current (I_{FL}) is defined as 3.0A.

Note 3: Dropout voltage is defined ($V_{IN} - V_{OUT}$) when the output voltage drops to 99% of its nominal value.

Note 4: $V_{IN} = V_{OUT}(\text{nom}) + 1\text{V}$. Use pulse-testing procedures to minimize temperature rise.

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Note 5: Ground pin current is the regulator quiescent current. The total current drawn from the source is the sum of the load current to the ground current.

Note 6: Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range

Note 7: Thermal regulation is defined as the change in output voltage at time T after a change in power dissipation is applied, excluding load/line regulation effects. Specifications for a 200mA load pulse as $V_{IN}=20V$ (a 4W pulse) for $t=10ms$.

Note 8: $V_{EN} \leq 0.8V$ and $V_{IN} \leq 16V$, $V_{OUT} = 0$.

BLOCK DIAGRAM

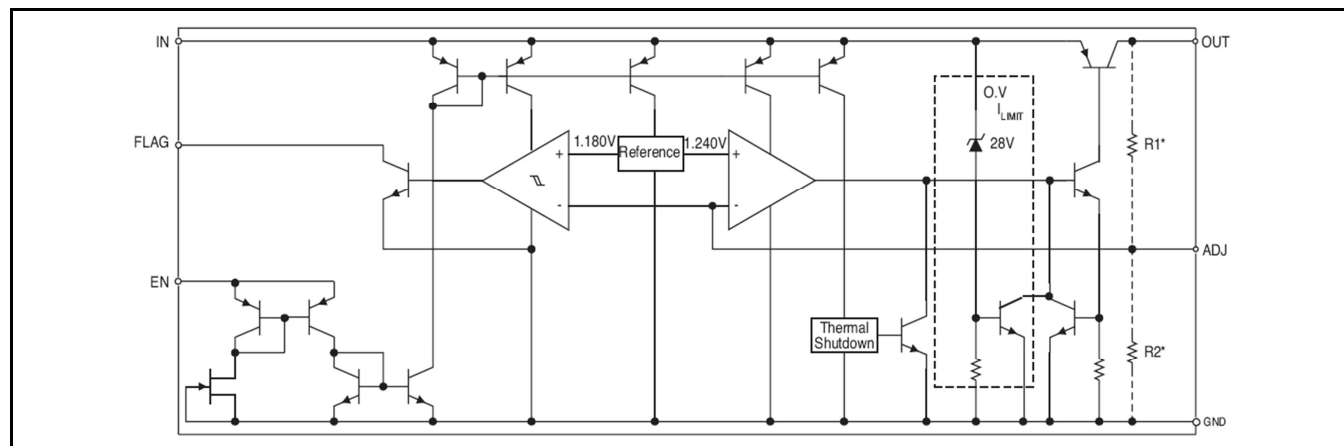


Fig. 2: XRP29302 Block Diagram

PIN ASSIGNMENT

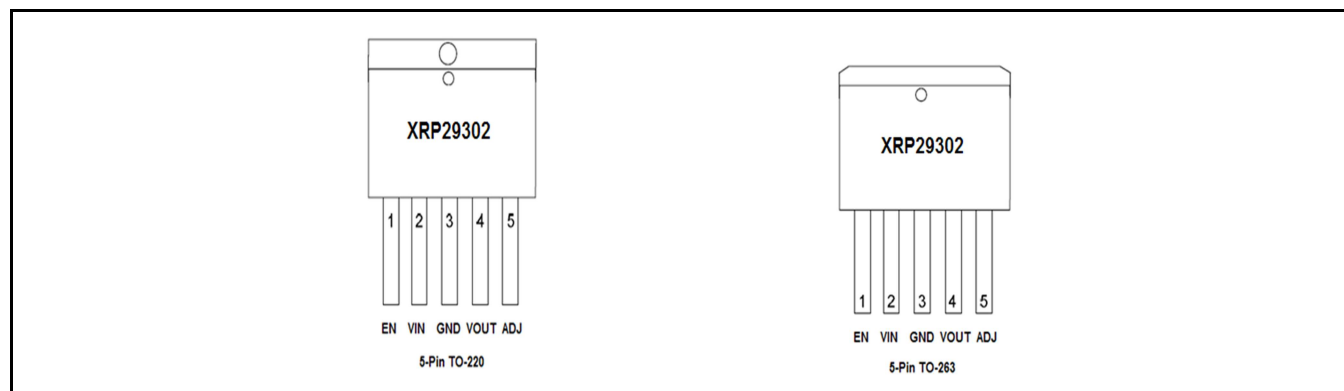


Fig. 3: XRP29302 Pin Assignment

ORDERING INFORMATION

Part Number	Junction Temperature Range	Marking	Package	Packing Quantity	Note 1	Note 2
XRP29302ET-L	$-40^{\circ}\text{C} \leq T_J \leq +125^{\circ}\text{C}$	XRP29302E YYWW X	5-pin TO220	Bulk	Lead Free	
XRP29302ETB-L	$-40^{\circ}\text{C} \leq T_J \leq +125^{\circ}\text{C}$	XRP29302E YYWW X	5-pin TO263	Bulk	Lead Free	
XRP29302ETBTR-L	$-40^{\circ}\text{C} \leq T_J \leq +125^{\circ}\text{C}$	XRP29302E YYWW X	5-pin TO263	500/Tape & Reel	Lead Free	
XRP29302AETB-L	$-40^{\circ}\text{C} \leq T_J \leq +125^{\circ}\text{C}$	XRP29302E YYWW X	5-pin TO263	Bulk	Lead Free	Adjustable
XRP29302AETBTR-L				500/Tape & Reel		

"YY" = Year – "WW" = Work Week – "X" = Lot Number

Note: XRP29302AETB-L has the same package marking as XRP29302ETB-L. The "A" designator is only provided on the packaging label.

TYPICAL PERFORMANCE CHARACTERISTICS

All data taken at $V_{IN} = V_{OUT} + 1V$, $T_J = T_A = 25^\circ C$, unless otherwise specified.

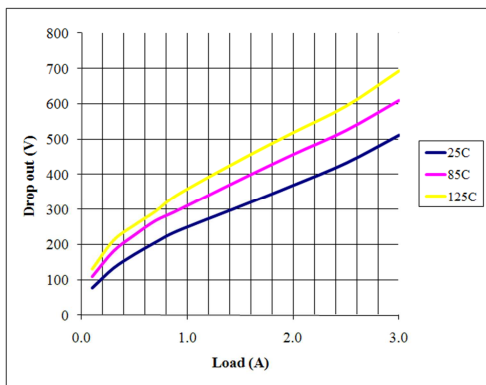


Fig. 4: Dropout Voltage vs Load Current

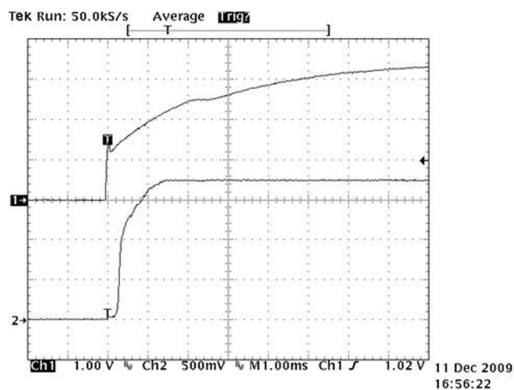


Fig. 5: Startup

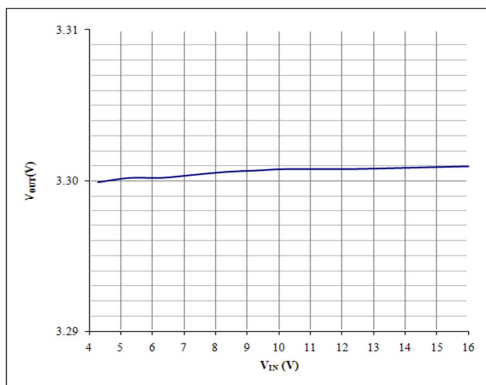


Fig. 6: Line Regulation
 $I_{OUT}=10mA$, $V_{OUT}=3.3V$

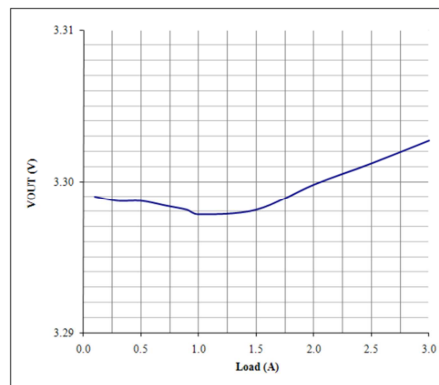


Fig. 7: Load Regulation
 $V_{OUT}=3.3V$

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THEORY OF OPERATION

The XRP29302 incorporates protection against over-current faults, reversed load insertion, over temperature operation, and positive and negative transient voltage.

THERMAL CONSIDERATIONS

Although the XRP29302 offers limiting circuitry for overload conditions, it is still necessary to insure that the maximum junction temperature is not exceeded in the application. Heat will flow through the lowest resistance path, the junction-to-case path. In order to insure the best thermal flow of the component, proper mounting is required.

TO-220 DESIGN EXAMPLE:

Assume that $V_{IN} = 10V$, $V_{OUT} = 5V$, $I_{OUT} = 1.5A$, $T_A = 50^\circ C$, $\theta_{HA} = 1^\circ C/W$, $\theta_{CH} = 2^\circ C/W$, and $\theta_{JC} = 3^\circ C/W$, where:

T_A = ambient temperature,

θ_{HA} = heatsink to ambient thermal resistance

θ_{CH} = case to heatsink thermal resistance

θ_{JC} = junction to case thermal resistance

The power calculated under these conditions is:

$$P_D = (V_{IN} - V_{OUT}) \times I_{OUT} = 7.5W$$

And the junction temperature is calculated as

$$T_J = T_A + P_D \times (\theta_{HA} + \theta_{CH} + \theta_{JC})$$

or

$$T_J = 50 + 7.5 \times (1 + 2 + 3) = 95^\circ C$$

Reliable operation is insured.

CAPACITOR REQUIREMENTS

The output capacitor is needed to insure stability and minimize the output noise. The value of the capacitor varies with the load. However, a minimum value of 10 μ F aluminum capacitor will guarantee stability over all load conditions.

A tantalum capacitor is recommended if a faster load transient response is needed. If the power source has high AC impedance, a 0.1 μ F ceramic capacitor between input & ground is recommended.

MINIMUM LOAD CURRENT

To ensure a proper behavior of the regulator under light load, a minimum load of 5mA for XRP29302 is required.

ADJUSTABLE REGULATOR DESIGN

The XRP29302 is an adjustable regulator that can be programmed to any value between 1.25V and 16V using 2 external resistors, R1 and R2. The relationship between the resistors and the output voltage is:

$$R_1 = R_2 \times \left(\frac{V_{OUT}}{1.240} - 1 \right)$$

ENABLE INPUT

The XRP29302 has an Enable function that switches the regulator on and off. Their thresholds are TTL compatible. When the regulator is active, approximately 20 μ A flows through the Enable pin.

TYPICAL APPLICATION CIRCUITS

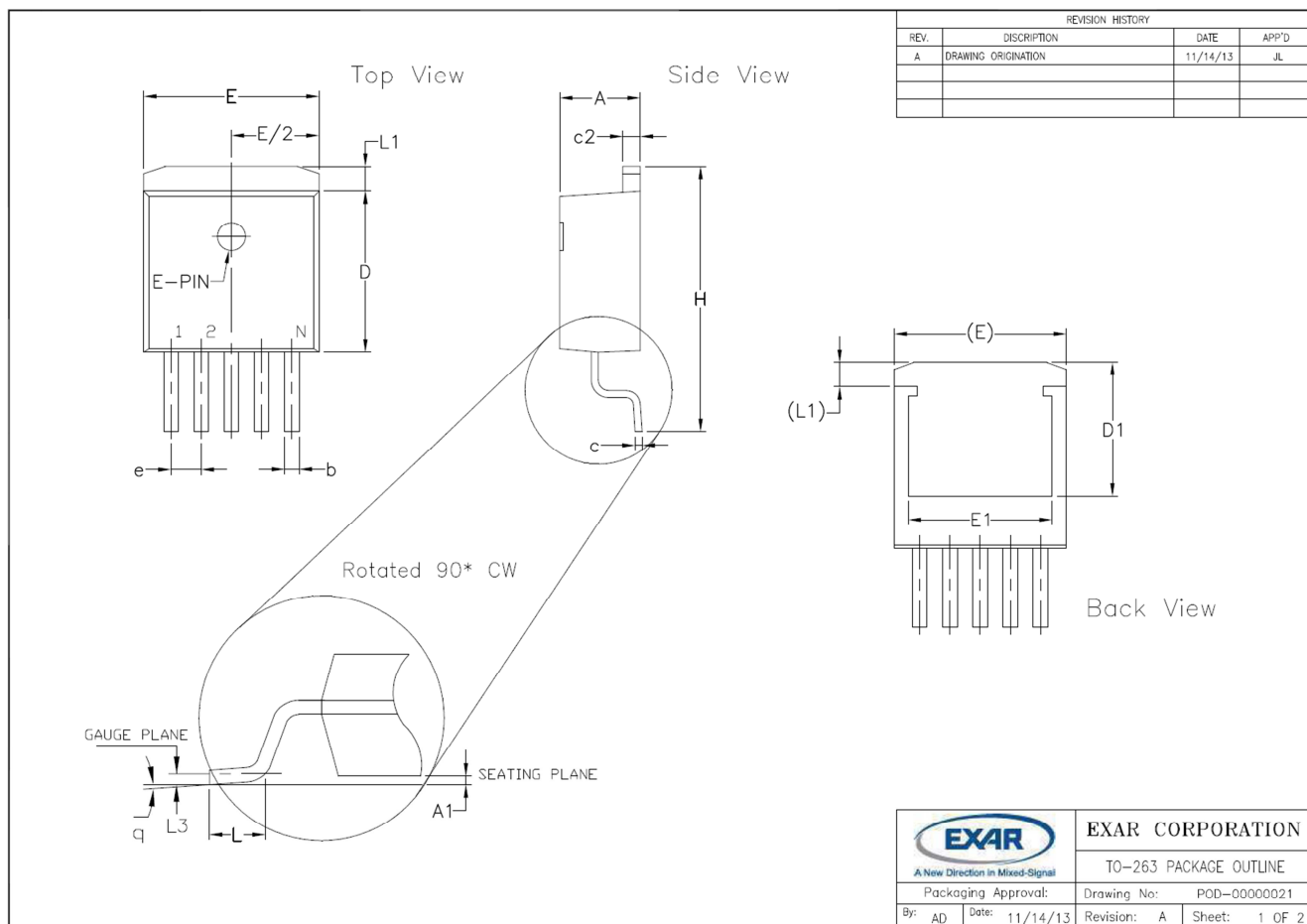
Figure 1 represents the typical implementation for an adjustable output regulator. The values of R1 and R2 set the output voltage value as follows:

$$V_{OUT} = V_{REF} \times \left(1 + \frac{R_1}{R_2} \right)$$

A minimum value of 10kohms is recommended for R2 with a range between 10k Ω and 47k Ω .

PACKAGE SPECIFICATION

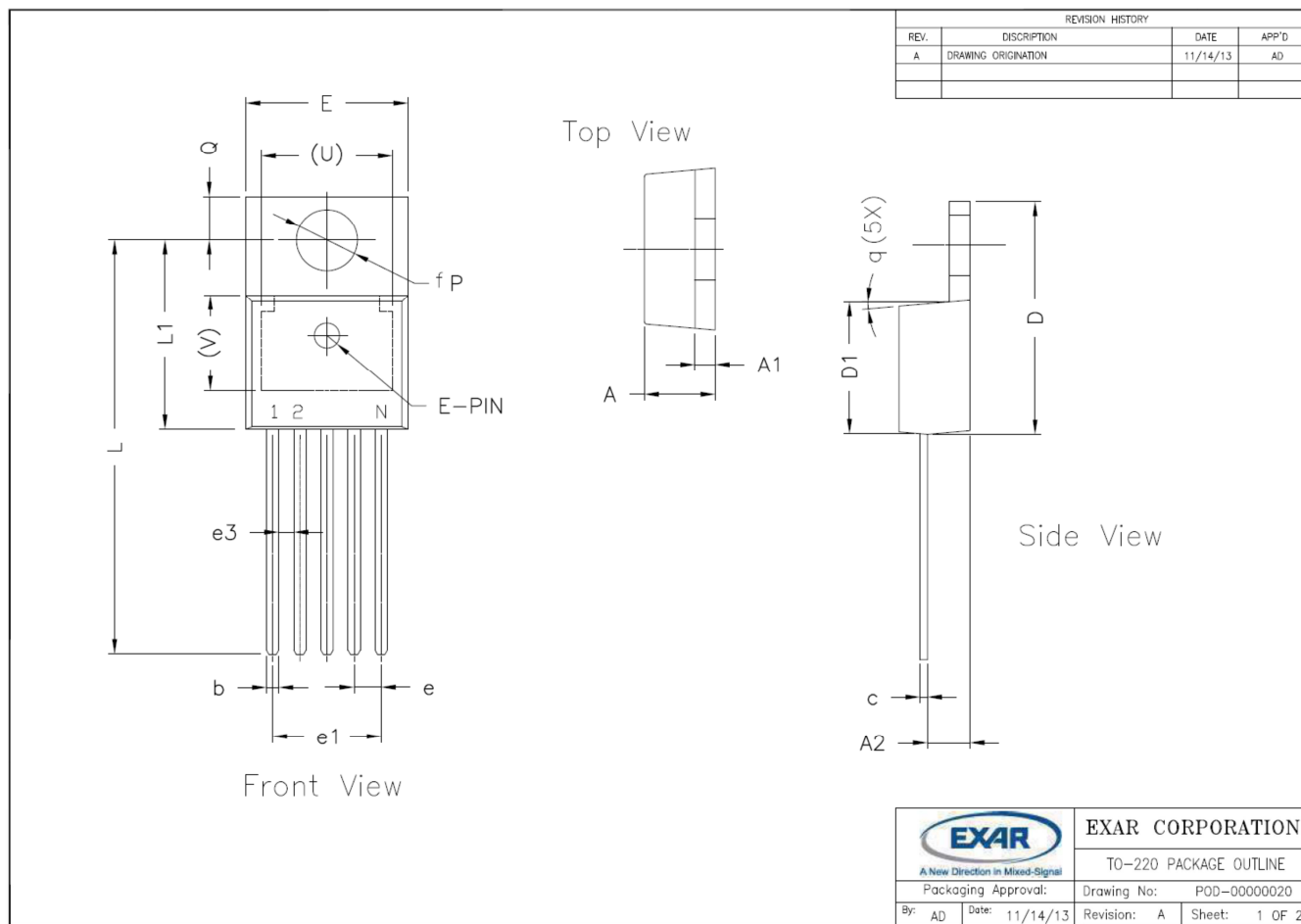
5-PIN TO263



3 Pin TO-263 JEDEC TO-263 Variation AA						
SYMBOLS	DIMENSIONS IN INCH (Control Unit)			DIMENSIONS IN MM (Reference Unit)		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.160	—	0.190	4.06	—	4.83
A1	0.000	—	0.010	0.00	—	0.25
b	0.020	—	0.039	0.51	—	0.99
b/2	0.045	—	0.070	1.14	—	1.78
c	0.015	—	0.029	0.38	—	0.74
c2	0.045	—	0.065	1.14	—	1.65
D	0.330	—	0.380	8.38	—	9.65
D1	0.270	—	—	6.86	—	—
E	0.380	—	0.420	9.65	—	10.67
E1	0.245	—	—	6.22	—	—
e	0.100 BSC			2.54 BSC		
H	0.575	—	0.625	14.61	—	15.88
L	0.070	—	0.110	1.78	—	2.79
L1	—	—	0.066	—	—	1.68
L3	0.010 BSC			0.25 BSC		
Q	0"	—	8"	0"	—	8"
N	3			3		

5 Pin TO-263 JEDEC TO-263 Variation BA						
SYMBOLS	DIMENSIONS IN INCH (Control Unit)			DIMENSIONS IN MM (Reference Unit)		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.160	—	0.190	4.06	—	4.83
A1	0.000	—	0.010	0.00	—	0.25
b	0.020	—	0.039	0.51	—	0.99
c	0.015	—	0.029	0.38	—	0.74
c2	0.045	—	0.065	1.14	—	1.65
D	0.330	—	0.380	8.38	—	9.65
D1	0.270	—	—	6.86	—	—
E	0.380	—	0.420	9.65	—	10.67
E1	0.245	—	—	6.22	—	—
e	0.067 BSC			1.70 BSC		
H	0.575	—	0.625	14.61	—	15.88
L	0.070	—	0.110	1.78	—	2.79
L1	—	—	0.066	—	—	1.68
L3	0.010 BSC			0.25 BSC		
Q	0"	—	8"	0"	—	8"
N	5			5		

*: Dimension "A" (overall package thickness) is controlled to 0.181" maximum for XRP29302 only. Typical dimension "A" guaranteed for any other device in a 5-pin TO263 is 0.190" inch maximum.



ECN 1346-06 11/14/2013

3 Pin TO-220 (Option 1)* JEDEC TO-220-AB				
SYMBOLS	DIMENSIONS IN INCH (Control Unit)		DIMENSIONS IN MM (Reference Unit)	
	MIN	MAX	MIN	MAX
A	0.140	0.190	3.56	4.82
A1	0.020	0.055	0.51	1.40
A2	0.080	0.115	2.03	2.92
b	0.015	0.040	0.38	1.02
c	0.014	0.024	0.36	0.61
D	0.560	0.650	14.22	16.51
D1	0.330	0.355	8.38	9.02
D2	0.480	0.507	12.19	12.88
E	0.380	0.420	9.65	10.67
E1	0.270	0.350	6.86	8.89
e	0.100	BSC	2.54	BSC
e1	0.200	BSC	5.08	BSC
H1	0.230	0.270	5.84	6.86
L	0.500	0.580	12.70	14.73
L1	—	0.250	—	6.35
P	0.139	0.156	3.53	3.96
Q	0.103	0.113	2.62	2.87
V	0.240	REF	6.10	REF
q	3"	7"	3"	7"
N	3	7	3	7

* Refer to product datasheet for POD option being used

3 Pin TO-220 (Option 2)*				
SYMBOLS	DIMENSIONS IN INCH (Control Unit)		DIMENSIONS IN MM (Reference Unit)	
	MIN	MAX	MIN	MAX
A	0.140	0.190	3.56	4.82
A1	0.020	0.055	0.51	1.40
A2	0.080	0.115	2.03	2.92
b	0.015	0.040	0.38	1.02
c	0.014	0.024	0.36	0.61
D	0.560	0.650	14.22	16.51
D1	0.330	0.355	8.38	9.02
D2	0.480	0.507	12.19	12.88
E	0.380	0.420	9.65	10.67
E1	0.270	0.350	6.86	8.89
e	0.100	BSC	2.54	BSC
e1	0.200	BSC	5.08	BSC
H1	0.230	0.270	5.84	6.86
L	0.500	0.580	12.70	14.73
L1	0.345	BSC	8.76	BSC
P	0.139	0.156	3.53	3.96
Q	0.103	0.113	2.62	2.87
V	0.240	REF	6.10	REF
q	3"	7"	3"	7"
N	3	7	3	7

* Refer to product datasheet for POD option being used

5 Pin TO-220 JEDEC TS-001 Variation AA				
SYMBOLS	DIMENSIONS IN INCH (Control Unit)		DIMENSIONS IN MM (Reference Unit)	
	MIN	MAX	MIN	MAX
A	0.165	0.190	4.19	4.82
A1	0.035	0.055	0.89	1.39
A2	0.085	0.115	2.16	2.92
b	0.020	0.040	0.51	1.01
c	0.012	0.025	0.31	0.63
D	0.570	0.625	14.48	15.87
D1	0.330	0.370	8.39	9.39
E	0.390	0.415	9.91	10.54
e	0.067	BSC	1.70	BSC
e1	0.263	0.273	6.68	6.93
e3	0.030	0.040	0.76	1.02
L	0.945	1.045	24.00	26.54
L1	0.465	0.539	11.81	13.69
P	0.139	0.156	3.53	3.96
Q	0.103	0.113	2.62	2.87
U	0.300	REF	7.62	REF
V	0.240	REF	6.10	REF
q	3"	7"	3"	7"
N	3	7	3	7

EXAR CORPORATION
TO-220 PACKAGE OUTLINE
Packaging Approval: Drawing No: POD-00000020
By: AD Date: 11/14/13 Revision: A Sheet: 2 OF 2

ECN 1346-06 11/14/2013

REVISION HISTORY

Revision	Date	Description
1.0.0	12/17/2009	Initial Release of Datasheet
1.1.0	12/23/2009	Addition of ESD data
1.2.0	10/19/2010	Corrected Adjustable Regulator Design paragraph equation
1.3.0	11/25/2013	Added XRP29302A with 2.5A dropout specification Updated Package Outline Drawing. ECN 1348-10
1.4.0	03/25/2014	Corrected pin out drawings where EN was shown as VIN. [ECN 1414-12 4/1/14]

FOR FURTHER ASSISTANCE

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Exar Technical Documentation:

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