NCP59302, NCV59302

3.0 A, Very Low-Dropout (VLDO) Fast Transient Response Regulator series

The NCP59302 is a high precision, very low dropout (VLDO), low ground current positive voltage regulator that is capable of providing an output current in excess of 3.0 A with a typical dropout voltage lower than 300 mV at 3.0 A load current. The device is stable with ceramic output capacitors. The device can withstand up to 18 V max input voltage.

Internal protection features consist of output current limiting, built−in thermal shutdown and reverse output current protection. Logic level enable pin is available. The NCP59302 is an adjustable voltage device and is available in D2PAK−5 package.

Features

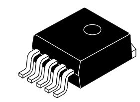
- Output Current in Excess of 3.0 A
- 300 mV Typical Dropout Voltage at 3.0 A
- Adjustable Output Voltage Range from 1.24 V to 13 V
- Low Ground Current
- Fast Transient Response
- Stable with Ceramic Output Capacitor
- Logic Compatible Enable Pin
- Current Limit, Reverse Current and Thermal Shutdown Protection
- Operation up to 13.5 V Input Voltage
- NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable
- These are Pb−Free Devices

Applications

- Consumer and Industrial Equipment Point of Regulation
- Servers and Networking Equipment
- FPGA, DSP and Logic Power supplies
- Switching Power Supply Post Regulation
- Battery Chargers
- Functional Replacement for Industry Standard MIC29300, MIC39300, MIC37300

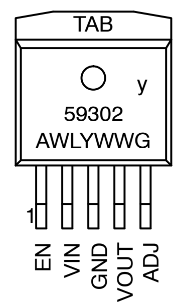
ON Semiconductor®

http://onsemi.com



D^{2}PAK
CASE 936A

MARKING DIAGRAMS



y	= P (NCP), V (NCV)
A	= Assembly Location
WL	= Wafer Lot
Y	= Year
WW	= Work Week
G	= Pb−Free Package

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 9 of this data sheet.

TYPICAL APPLICATIONS

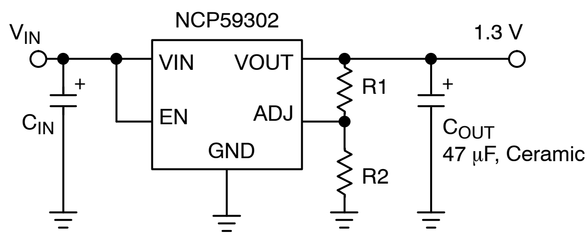


Figure 1. Adjustable Regulator

PIN FUNCTION DESCRIPTION

Pin Number	Pin Name	Pin Function
1	EN	Enable Input: CMOS and TTL logic compatible. Logic high = enable; Logic low = shutdown.
2	VIN	Input voltage which supplies both the internal circuitry and the current to the output load
3	GND	Ground
TAB	TAB	TAB is connected to ground.
4	VOUT	Linear Regulator Output.
5	ADJ	Adjustable Regulator Feedback Input. Connect to output voltage resistor divider central node.

ABSOLUTE MAXIMUM RATINGS

Symbol	Rating		Value	Unit
V_{IN}	Supply Voltage		0 to 18	V
V_{EN}	Enable Input Voltage		0 to 18	V
$V_{OUT} – V_{IN}$	Reverse $V_{OUT} – V_{IN}$ Voltage (EN = Shutdown or V_{IN} = 0 V) (Note 1)		0 to 6.5	V
P_D	Power Dissipation (Notes 2 and 3)		Internally Limited	
T_J	Junction Temperature		$–40 \le T_J \le +125$	°C
T_S	Storage Temperature		$–65 \le T_J \le +150$	°C
	ESD Rating (Notes 4 and 5)	Human Body Model Machine Model	2000 200	V

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

NOTE: All voltages are referenced to GND pin unless otherwise noted.
1. The ENABLE pin input voltage must be ≤ 0.8 V or V_{IN} must be connected to ground potential.
2. $P_{D(max)} = (T_{J(max)} – T_A) / R_{\theta JA}$, where $R_{\theta JA}$ depends upon the printed circuit board layout.
3. This protection is not guaranteed outside the Recommended Operating Conditions.
4. Devices are ESD sensitive. Handling precautions recommended..
5. This device series incorporates ESD protection and is tested by the following methods:
   ESD Human Body Model (HBM) tested per AEC – Q100 – 002 (EIA/JESD22 – A114C)
   ESD Machine Model (MM) tested per AEC – Q100 – 003 (EIA/JESD22 – A115C)
   This device contains latch – up protection and exceeds 100 mA per JEDEC Standard JESD78.

RECOMMENDED OPERATING CONDITIONS (Note 6)

Symbol	Rating	Value	Unit
V_{IN}	Supply Voltage	2.24 to 13.5	V
V_{EN}	Enable Input Voltage	0 to 13.5	V
T_J	Junction Temperature	$–40 \le T_J \le +125$	°C

6. The device is not guaranteed to function outside it's Recommended operating conditions.

ELECTRICAL CHARACTERISTICS

T_J = 25°C with V_{IN} = $V_{OUT\ nominal}$ + 1 V; V_{EN} = V_{IN}; I_L = 10 mA; bold values indicate –40°C < T_J < +125°C, unless noted.

Parameter	Conditions	Min	Typ	Max	Unit
Output Voltage Accuracy	I_L = 10 mA	−1		+1	%
	10 mA < I_{OUT} < 3 A , $V_{OUT\ nominal}$ + 1 ≤ V_{IN} ≤ 13.5 V	**−2**		**+2**	%
Output Voltage Line Regulation	V_{IN} = $V_{OUT\ nominal}$ + 1.0 V to 13.5 V; I_L = 10 mA		0.02	0.5	%
Output Voltage Load Regulation	I_L = 10 mA to 3 A		0.2	1	%
V_{IN} – V_{OUT} Dropout Voltage (Note 7)	I_L = 1.5 A		175	**350**	mV
	I_L = 3 A		300	**500**	mV
Ground Pin Current (Note 8)	I_L = 3 A		60	90 **120**	mA
Ground Pin Current in Shutdown	V_{EN} ≤ 0.5 V		1.0	5	μA
Overload Protection Current Limit	V_{OUT} = 0 V (Note 9)		3.5	**5**	A
Start−up Time	V_{EN} = V_{IN}, V_{OUT} nominal = 2.5 V, I_{OUT} = 10 mA, C_{OUT} = 47 μF		100	500	μs
ENABLE INPUT					
Enable Input Signal Levels	Regulator enable	**1.8**			V
	Regulator shutdown			**0.8**	V
Enable pin Input Current	V_{EN} ≤ 0.8 V (Regulator shutdown)			2 **4**	μA
	6.5 V > V_{EN} ≥ 1.8 V (Regulator enable)	1	15	30 **40**	μA
Reference Voltage		1.228 **1.215**	1.240	1.252 **1.265**	V
Adjust Pin Bias Current			100	200 **350**	nA

7. V_{DO} = V_{IN} – V_{OUT} when V_{OUT} decreases to 98% of its nominal output voltage with V_{IN} = V_{OUT} + 1 V. For output voltages below 1.74 V, dropout voltage specification does not apply due to a minimum input operating voltage of 2.24 V.
8. I_{IN} = I_{GND} + I_{OUT}.
9. Device Power−on or Enable Start−up with output shorted to GND.

Package	Conditions / PCB Footprint	Thermal Resistance
D2PAK–5, Junction−to−Case		$R_{\theta JC}$ = 2.1°C/W
D2PAK–5, Junction−to−Air	PCB with 100 mm^2 2.0 oz Copper Heat Spreading Area	$R_{\theta JA}$ = 52°C/W

TYPICAL CHARACTERISTICS

$T_J = 25°C$ if not otherwise noted

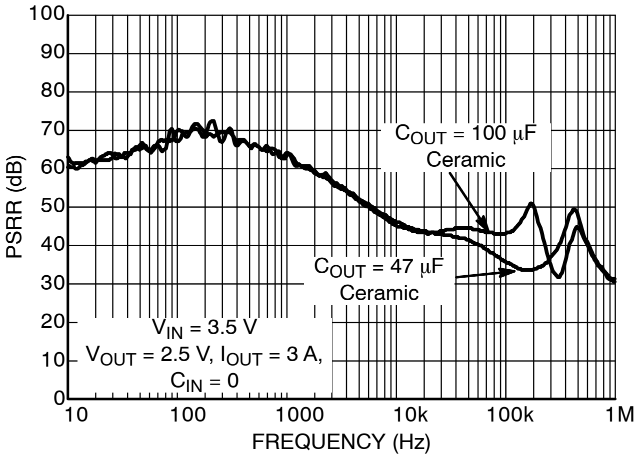


Figure 2. Power Supply Rejection Ratio

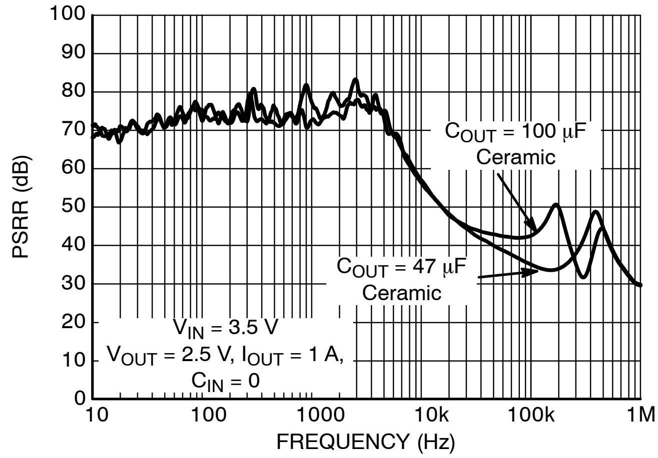


Figure 3. Power Supply Rejection Ratio

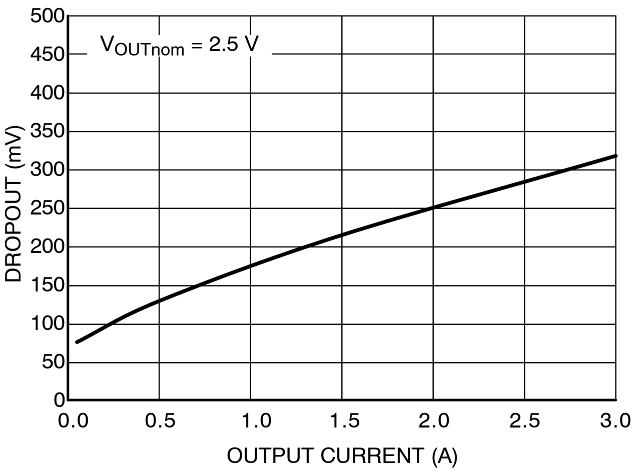


Figure 4. Dropout Voltage vs. Output Current

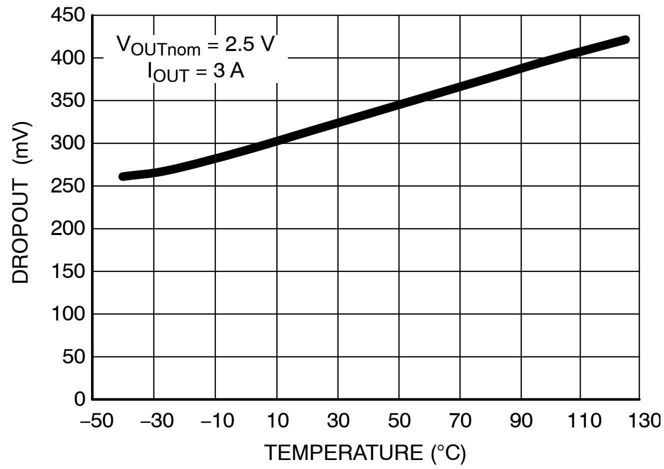


Figure 5. Dropout Voltage vs. Temperature

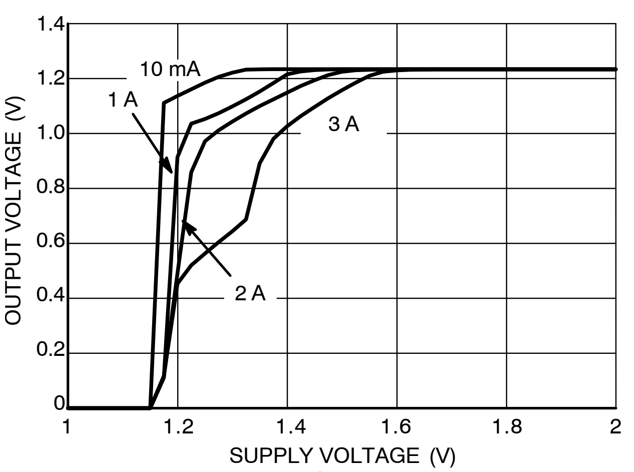


Figure 6. Dropout Characteristics (1.24 V)

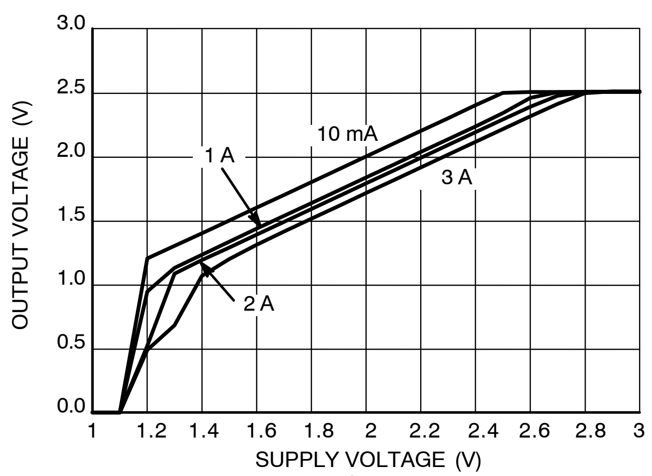


Figure 7. Dropout Characteristics (2.5 V)

TYPICAL CHARACTERISTICS

T_J = 25°C if not otherwise noted

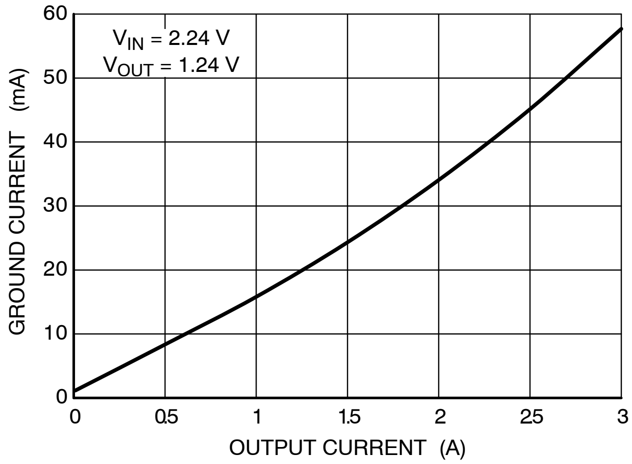


Figure 8. Ground Current vs. Output Current

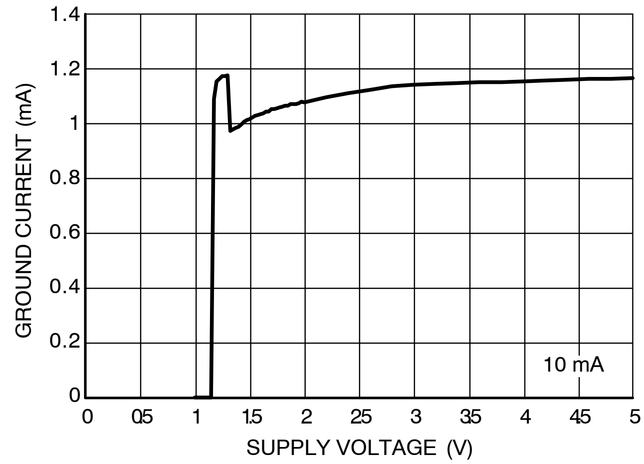


Figure 9. Ground Current vs. Supply Voltage (1.24 V)

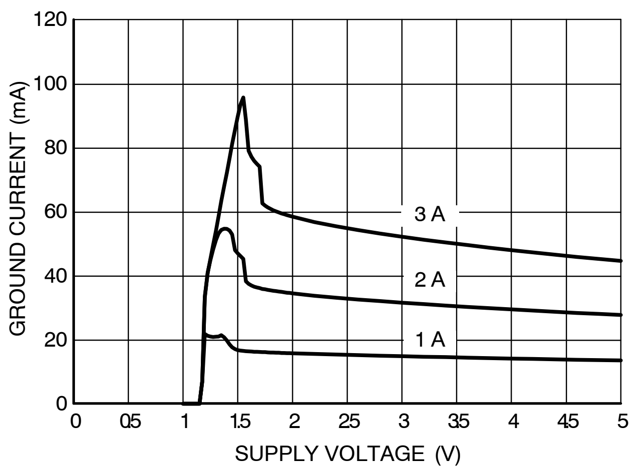


Figure 10. Ground Current vs. Supply Voltage (1.24 V)

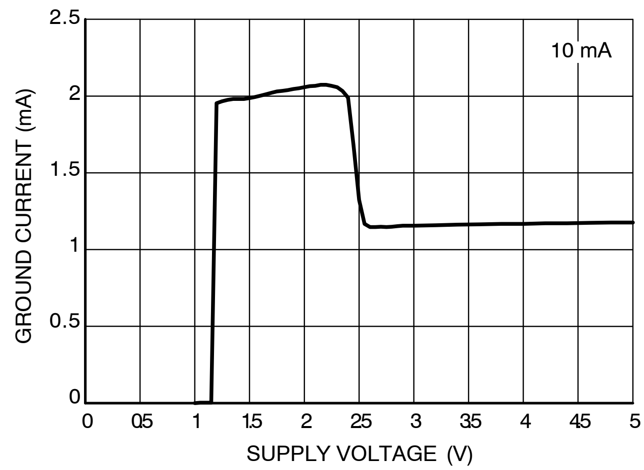


Figure 11. Ground Current vs. Supply Voltage (2.5 V)

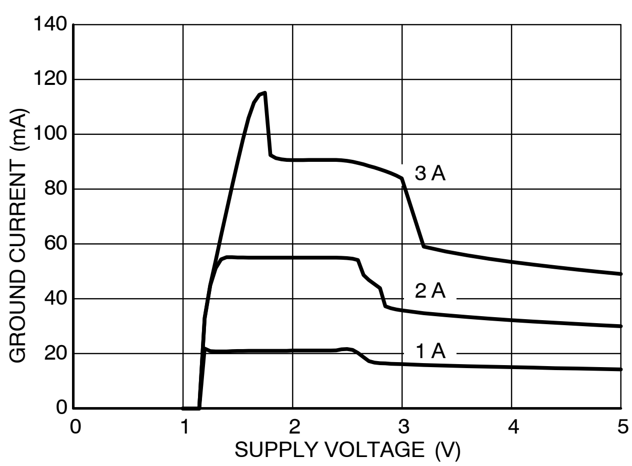


Figure 12. Ground Current vs. Supply Voltage (2.5 V)

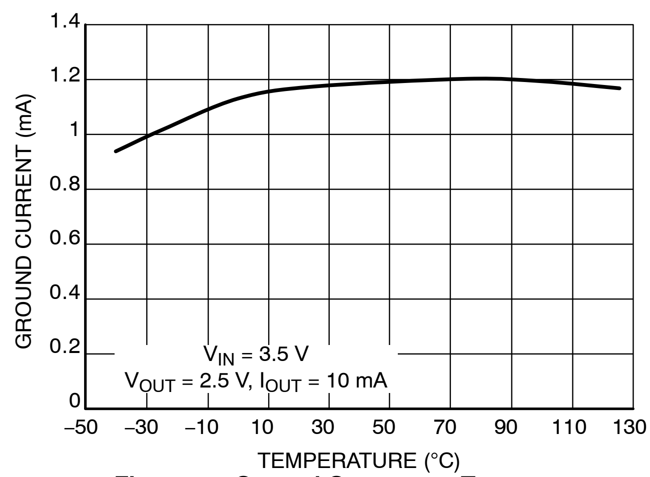


Figure 13. Ground Current vs. Temperature

TYPICAL CHARACTERISTICS

T_J = 25°C if not otherwise noted

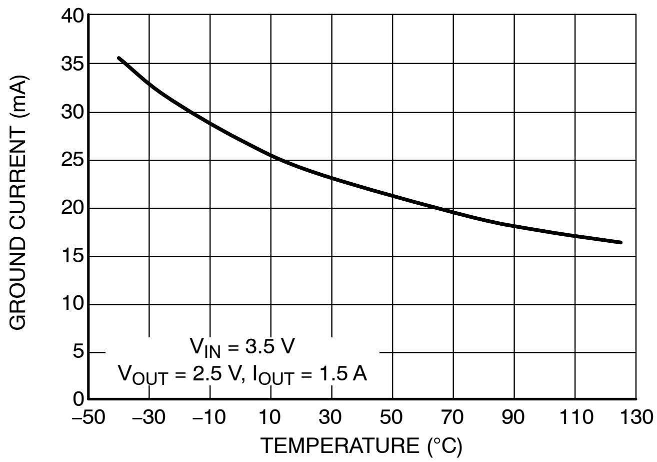


Figure 14. Ground Current vs. Temperature

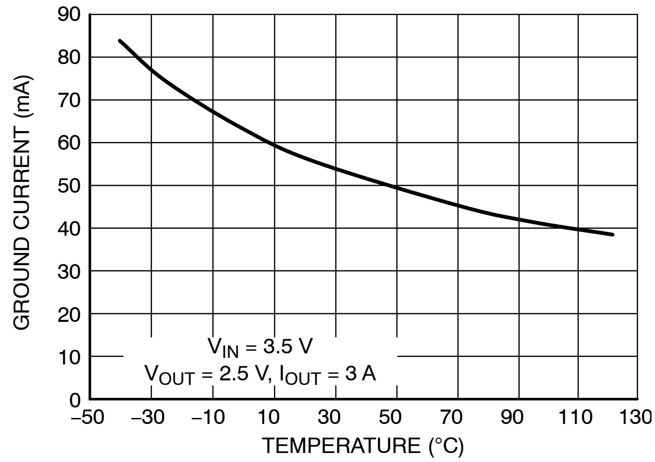


Figure 15. Ground Current vs. Temperature

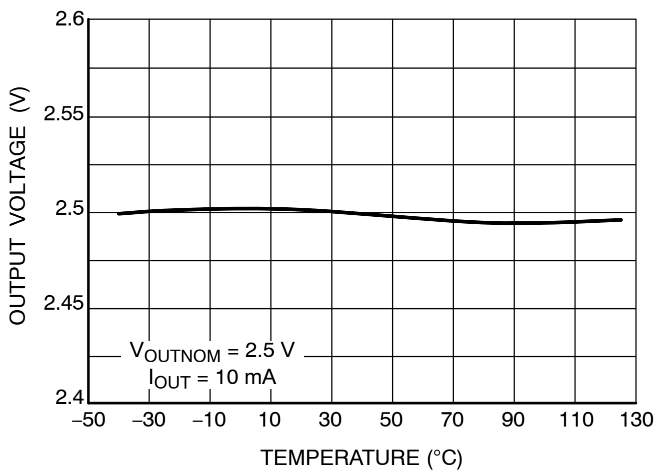


Figure 16. Output Voltage vs. Temperature

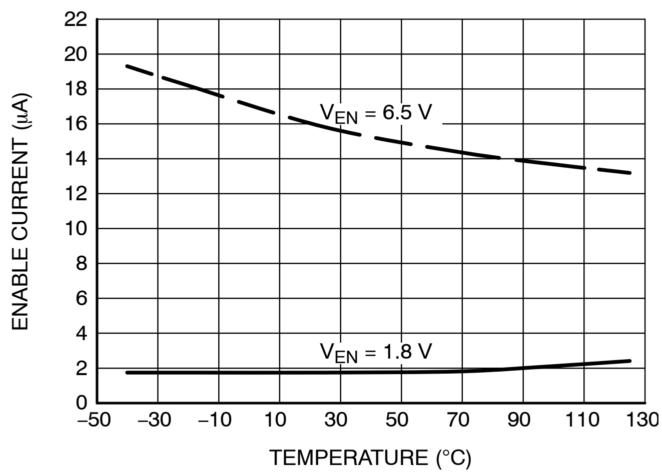


Figure 17. Enable Pin Input Current vs. Temperature

FUNCTIONAL CHARACTERISTICS

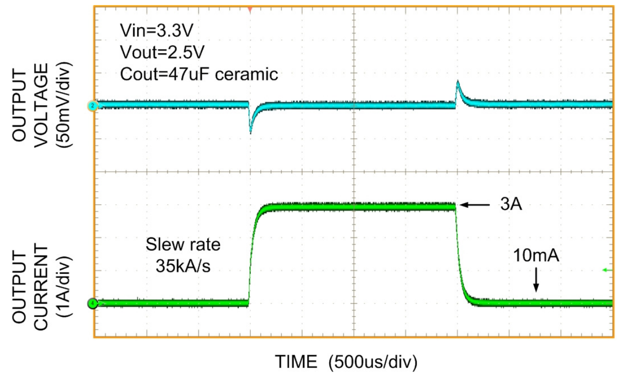


Figure 18. Load Transient Response

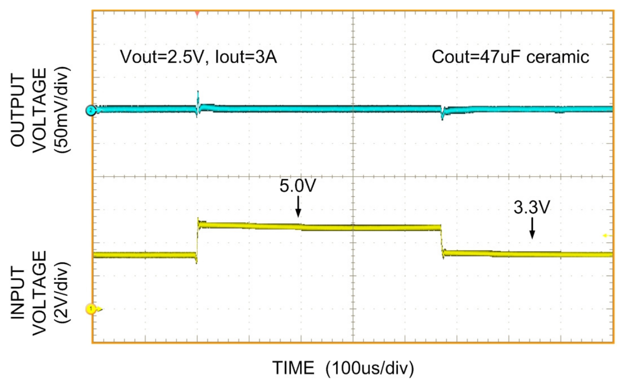


Figure 19. Line Transient Response

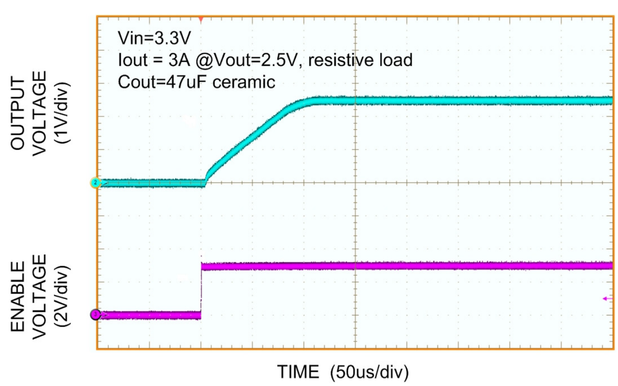


Figure 20. Enable Transient Response

APPLICATIONS INFORMATION

Output Capacitor and Stability

The NCP59302 device requires an output capacitor for stable operation. The NCP59302 is designed to operate with ceramic output capacitors. The recommended output capacitance value is 47 μF or greater. Such capacitors help to improve transient response and noise reduction at high frequency.

Input Capacitor

An input capacitor of 1.0 μF or greater is recommended when the device is more than 4 inches away from the bulk supply capacitance, or when the supply is a battery. Small, surface−mount chip capacitors can be used for the bypassing. The capacitor should be place within 1 inch of the device for optimal performance. Larger values will help to improve ripple rejection by bypassing the input of the regulator, further improving the integrity of the output voltage.

Minimum Load Current

The NCP59302 regulator is specified between finite loads. A 10 mA minimum load current is necessary for proper operation.

Enable Input

NCP59302 regulators also feature an enable input for on/off control of the device. It's shutdown state draws "zero" current from input voltage supply (only microamperes of leakage). The enable input is TTL/CMOS compatible for simple logic interface, but can be connected up to V_{IN}.

Overcurrent and Reverse Output Current Protection

The NCP59302 regulator is fully protected from damage due to output current overload conditions. When NCP59302 output is overloaded, Output Current limiting is provided. This limiting is linear; output current during overload conditions is constant. The device is also capable to withstand power−on or enable start−up with output shorted to ground for the full Recommended Operating Conditions range. These features are advantageous for powering FPGAs and other ICs having current consumption higher than nominal during their startup.

Thermal shutdown disables the NCP59302 device when the die temperature exceeds the maximum safe operating temperature.

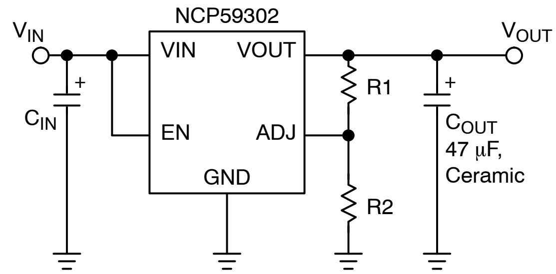
When NCP59302 is disabled and (V_{OUT} – V_{IN}) voltage difference is less than 6.5 V in the application, the output structure of these regulators is able to withstand output voltage (backup battery as example) to be applied without reverse current flow.

Adjustable Voltage Design

The NCP/NCV59302 Adjustable voltage Device Output voltage is set by the ratio of two external resistors as shown in Figure 21.

The device maintains the voltage at the ADJ pin at 1.24 V referenced to ground. The current in R2 is then equal to 1.24 V / R2, and the current in R1 is the current in R2 plus the ADJ pin bias current. The ADJ pin bias current flows from V_{OUT} through R1 into the ADJ pin.

The output voltage can be calculated using the formula shown in Figure 21.



$$V_{OUT} = 1.24\ V \cdot \left(1 + \frac{R1}{R2}\right) + I_{ADJ} \cdot R1$$

Figure 21. Adjustable Voltage Operation

Thermal Considerations

The power handling capability of the device is limited by the maximum rated junction temperature (125°C). The P_D total power dissipated by the device has two components, Input to output voltage differential multiplied by Output current and Input voltage multiplied by GND pin current.

$$P_D = \left(V_{IN} - V_{OUT}\right) \cdot I_{OUT} + V_{IN} \cdot I_{GND} \qquad \text{(eq. 1)}$$

The GND pin current value can be found in Electrical Characteristics table and in Typical Characteristics graphs.

The Junction temperature T_J is

$$T_J = T_A + P_D \cdot R_{\theta JA} \qquad \text{(eq. 2)}$$

where T_A is ambient temperature and $R_{\theta JA}$ is the Junction to Ambient Thermal Resistance of the NCP/NCV59302 device mounted on the specific PCB.

To maximize efficiency of the application and minimize thermal power dissipation of the device it is convenient to use the Input to output voltage differential as low as possible.

The static typical dropout characteristics for various output voltage and output current can be found in the Typical Characteristics graphs.

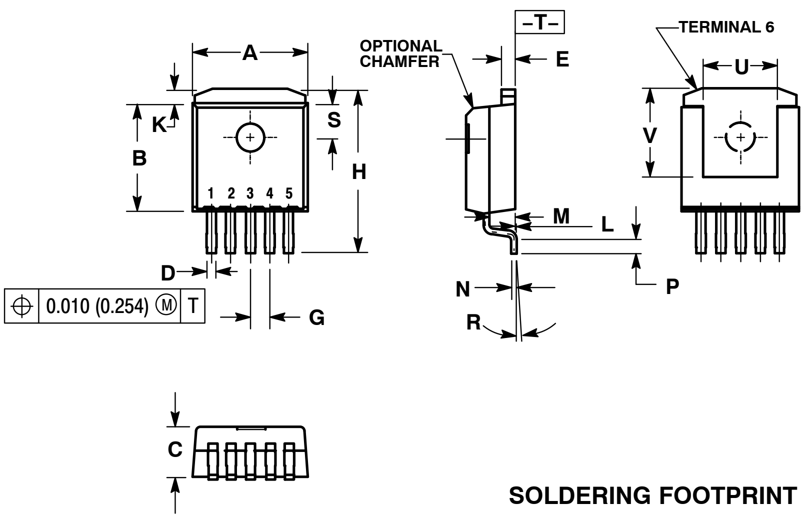
ORDERING INFORMATION

Device	Output Current	Output Voltage	Junction Temp. Range	Package	Shipping†
NCP59302DSADJR4G	3.0 A	ADJ	−40°C to +125°C	D2PAK−5 (Pb−Free)	800 / Tape & Reel
NCV59302DSADJR4G*	3.0 A	ADJ	−40°C to +125°C	D2PAK−5 (Pb−Free)	800 / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.
*NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable.

PACKAGE DIMENSIONS

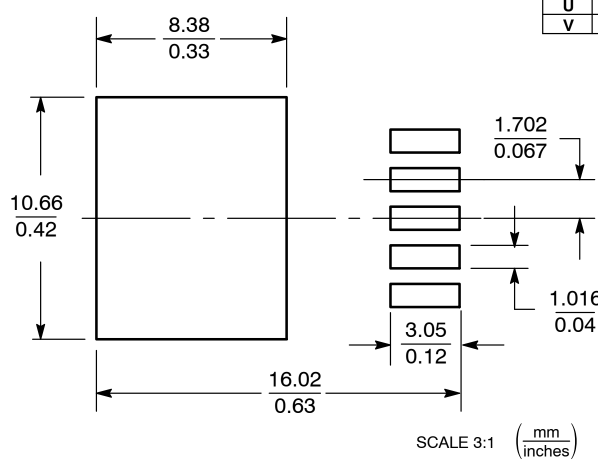
D2PAK 5
CASE 936A−02
ISSUE C



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. TAB CONTOUR OPTIONAL WITHIN DIMENSIONS A AND K.
4. DIMENSIONS U AND V ESTABLISH A MINIMUM MOUNTING SURFACE FOR TERMINAL 6.
5. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH OR GATE PROTRUSIONS. MOLD FLASH AND GATE PROTRUSIONS NOT TO EXCEED 0.025 (0.635) MAXIMUM.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.386	0.403	9.804	10.236
B	0.356	0.368	9.042	9.347
C	0.170	0.180	4.318	4.572
D	0.026	0.036	0.660	0.914
E	0.045	0.055	1.143	1.397
G	0.067 BSC		1.702 BSC	
H	0.539	0.579	13.691	14.707
K	0.050 REF		1.270 REF	
L	0.000	0.010	0.000	0.254
M	0.088	0.102	2.235	2.591
N	0.018	0.026	0.457	0.660
P	0.058	0.078	1.473	1.981
R	5° REF		5° REF	
S	0.116 REF		2.946 REF	
U	0.200 MIN		5.080 MIN	
V	0.250 MIN		6.350 MIN	

SOLDERING FOOTPRINT



5−LEAD D2PAK

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
P.O. Box 5163, Denver, Colorado 80217 USA
Phone: 303−675−2175 or 800−344−3860 Toll Free USA/Canada
Fax: 303−675−2176 or 800−344−3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800−282−9855 Toll Free USA/Canada
Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910
Japan Customer Focus Center
Phone: 81−3−5817−1050

ON Semiconductor Website: **www.onsemi.com**

Order Literature: http://www.onsemi.com/orderlit

For additional information, please contact your local Sales Representative