NCP57302, NCV57302

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

The NCP57302 is a high precision, very low dropout (VLDO), low minimum input voltage and 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 of 315 mV at 3.0 A load current and input voltage from 1.8 V and up. 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 NCP57302 is an adjustable voltage device and is available in D2PAK-5 package.

Features
- Output Current in Excess of 3.0 A
- Minimum Operating Input Voltage 1.8 V for Full 3 A Output Current
- 315 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 with Improved Minimum Input Voltage Specification
NCP57302, NCV57302

TYPICAL APPLICATIONS

Figure 1. Adjustable Regulator

PIN FUNCTION DESCRIPTION

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

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Rating</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIN</td>
<td>Supply Voltage</td>
<td>0 to 18</td>
<td>V</td>
</tr>
<tr>
<td>VEN</td>
<td>Enable Input Voltage</td>
<td>0 to 18</td>
<td>V</td>
</tr>
<tr>
<td>VOUT - VIN</td>
<td>Reverse VOUT – VIN Voltage (EN = Shutdown or VIN = 0 V) (Note 1)</td>
<td>0 to 6.5</td>
<td>V</td>
</tr>
<tr>
<td>PD</td>
<td>Power Dissipation (Notes 2 and 3)</td>
<td>Internally Limited</td>
<td></td>
</tr>
<tr>
<td>TJ</td>
<td>Junction Temperature</td>
<td>–40 ≤ TJ ≤ +125</td>
<td>°C</td>
</tr>
<tr>
<td>TS</td>
<td>Storage Temperature</td>
<td>–65 ≤ TS ≤ +150</td>
<td>°C</td>
</tr>
<tr>
<td>ESD</td>
<td>ESD Rating (Notes 4 and 5)</td>
<td>Human Body Model Machine Model</td>
<td></td>
</tr>
</tbody>
</table>

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 VIN must be connected to ground potential.
2. PD(max) = (TJ(max) – TA) / RJA, where RJA 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)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Rating</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIN</td>
<td>Supply Voltage</td>
<td>1.8 to 13.5</td>
<td>V</td>
</tr>
<tr>
<td>VEN</td>
<td>Enable Input Voltage</td>
<td>0 to 13.5</td>
<td>V</td>
</tr>
<tr>
<td>TJ</td>
<td>Junction Temperature</td>
<td>–40 ≤ TJ ≤ +125</td>
<td>°C</td>
</tr>
</tbody>
</table>

6. The device is not guaranteed to function outside its Recommended operating conditions.
ELECTRICAL CHARACTERISTICS

$T_J = 25^\circ C$ with $V_{IN} = V_{OUT\_nominal} + 0.6\ V$; $V_{EN} = V_{IN}$; $I_L = 10\ mA$; bold values indicate $-40^\circ C < T_J < +125^\circ C$, unless noted. (Note 7)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Voltage Accuracy</td>
<td>$I_L = 10\ mA$</td>
<td>$-1.5$</td>
<td>$+1.5$</td>
<td></td>
<td>%</td>
</tr>
<tr>
<td></td>
<td>$10\ mA &lt; I_{OUT} &lt; 3\ A$ , $V_{OUT_nominal} + 0.6\ V \leq V_{IN} \leq 13.5\ V$</td>
<td>$-2.5$</td>
<td>$+2.5$</td>
<td></td>
<td>%</td>
</tr>
<tr>
<td>Output Voltage Line Regulation</td>
<td>$V_{IN} = V_{OUT_nominal} + 0.6\ V$ to $13.5\ V$; $I_L = 10\ mA$</td>
<td></td>
<td>$0.02$</td>
<td>$0.5$</td>
<td>%</td>
</tr>
<tr>
<td>Output Voltage Load Regulation</td>
<td>$I_L = 10\ mA$ to $3\ A$</td>
<td></td>
<td>$0.2$</td>
<td>$1$</td>
<td>%</td>
</tr>
<tr>
<td>$V_{IN} - V_{OUT}$ Dropout Voltage</td>
<td>$I_L = 1.0\ A$ (Note 10)</td>
<td>$182$</td>
<td>$295$</td>
<td>mV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$I_L = 1.5\ A$</td>
<td>$220$</td>
<td>$350$</td>
<td>mV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$I_L = 2.0\ A$ (Note 10)</td>
<td>$250$</td>
<td>$410$</td>
<td>mV</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$I_L = 3.0\ A$</td>
<td>$315$</td>
<td>$520$</td>
<td>mV</td>
<td></td>
</tr>
<tr>
<td>Ground Pin Current (Note 9)</td>
<td>$I_L = 3.0\ A$</td>
<td>$60$</td>
<td>$90$</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Ground Pin Current in Shutdown</td>
<td>$V_{EN} \leq 0.5\ V$</td>
<td>$1.0$</td>
<td>$5$</td>
<td>μA</td>
<td></td>
</tr>
<tr>
<td>Overload Protection Current Limit</td>
<td>$V_{OUT} = 0\ V$</td>
<td>$3.5$</td>
<td>$5$</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Start–up Time</td>
<td>$V_{EN} = V_{IN}$, $V_{OUT_nominal} = 2.5\ V$, $I_{OUT} = 10\ mA$, $C_{OUT} = 47\ μF$</td>
<td>$100$</td>
<td>$500$</td>
<td>μs</td>
<td></td>
</tr>
<tr>
<td>Reference Voltage</td>
<td></td>
<td>$1.221$</td>
<td>$1.240$</td>
<td>$1.259$</td>
<td>$1.271$</td>
</tr>
<tr>
<td>Adjust Pin Bias Current</td>
<td></td>
<td>$100$</td>
<td>$200$</td>
<td>$350$</td>
<td>nA</td>
</tr>
</tbody>
</table>

ENABLE INPUT

| Enable Input Signal Levels         | Regulator enable                                                            | $1.4$ | V |
|                                   | Regulator shutdown                                                          | $0.8$ | V |
| Enable pin Input Current          | $V_{EN} \leq 0.8\ V$ (Regulator shutdown)                                  | $2$   | μA |
|                                    | $6.5\ V > V_{EN} \geq 1.4\ V$ (Regulator enable)                           | $15$  | μA |

7. $V_{OUT\_nominal}$ can be set by external resistor divider in the application. Tested for $V_{OUT\_nominal} = 1.240\ V$ unless noted.
8. $V_{DO} = V_{IN} - V_{OUT}$ when $V_{OUT}$ decreases to 98% of its nominal output voltage with $V_{IN} = V_{OUT} + 1\ V$. Tested for $V_{OUT\_nominal} = 2.5\ V$.
9. $I_{IN} = I_{GNDD} + I_{OUT}$
10. Guaranteed by design.

<table>
<thead>
<tr>
<th>Package</th>
<th>Conditions / PCB Footprint</th>
<th>Thermal Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>D2PAK–5, Junction–to–Case</td>
<td></td>
<td>$R_{JUC} = 2.1^\circ C/W$</td>
</tr>
<tr>
<td>D2PAK–5, Junction–to–Air</td>
<td>PCB with 100 mm$^2$ 2.0 oz Copper Heat Spreading Area</td>
<td>$R_{JUA} = 52^\circ C/W$</td>
</tr>
</tbody>
</table>

http://onsemi.com
TYPICAL CHARACTERISTICS

$T_J = 25^\circ C$ if not otherwise noted

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**Figure 2. Power Supply Rejection Ratio**

- $V_{IN} = 3.5$ V, $V_{OUT} = 2.5$ V, $I_{OUT} = 3$ A, $C_{IN} = 0$
- $C_{OUT} = 100$ µF, Ceramic
- $C_{OUT} = 47$ µF, Ceramic

**Figure 3. Power Supply Rejection Ratio**

- $V_{IN} = 3.5$ V, $V_{OUT} = 2.5$ V, $I_{OUT} = 1$ A, $C_{IN} = 0$
- $C_{OUT} = 100$ µF, Ceramic
- $C_{OUT} = 47$ µF, Ceramic

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**Figure 4. Dropout Voltage vs. Output Current**

- $V_{OUTnom} = 2.5$ V

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**Figure 5. Dropout Voltage vs. Temperature**

- $V_{OUTnom} = 2.5$ V

---

**Figure 6. Dropout Characteristics**

- $V_{OUTnom} = 1.24$ V

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**Figure 7. Dropout Characteristics**

- $V_{OUTnom} = 2.5$ V

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TYPICAL CHARACTERISTICS

\[ T_J = 25^\circ C \text{ if not otherwise noted} \]

**Figure 8. Ground Current vs. Output Current**

**Figure 9. Ground Current vs. Supply Voltage**

**Figure 10. Ground Current vs. Supply Voltage**

**Figure 11. Ground Current vs. Supply Voltage**

**Figure 12. Ground Current vs. Supply Voltage**

**Figure 13. Ground Current vs. Temperature**
TYPICAL CHARACTERISTICS

$T_J = 25^\circ C$ if not otherwise noted

Figure 14. Ground Current vs. Temperature

VIN = 3.5 V
VOUT = 2.5 V,
IOUT = 1.5 A

Figure 15. Ground Current vs. Temperature

VIN = 3.5 V
VOUT = 2.5 V,
IOUT = 3 A

Figure 16. Output Voltage vs. Temperature

VOUTNOM = 2.5 V
IOUT = 10 mA

Figure 17. Enable Pin Input Current vs. Temperature

VEN = 6.5 V
VEN = 1.4 V
FUNCTIONAL CHARACTERISTICS

Figure 18. Load Transient Response

Figure 19. Line Transient Response

Figure 20. Enable Transient Response
Output Capacitor and Stability
The NCP57302 device requires an output capacitor for stable operation. The NCP57302 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 placed 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 NCP57302 regulator is specified between finite loads. A 10 mA minimum load current is necessary for proper operation.

Enable Input
NCP57302 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 NCP57302 regulator is fully protected from damage due to output current overload and output short conditions. When NCP57302 output is overloaded, Output Current limiting is provided. This limiting is linear; output current during overload or output short conditions is constant. These features are advantageous for powering FPGAs and other ICs having current consumption higher than nominal during their startup.

Thermal shutdown disables the NCP57302 device when the die temperature exceeds the maximum safe operating temperature.

When NCP57302 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/NCV57302 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.

\[
V_{OUT} = 1.24 \cdot \frac{R1}{R2} + I_{ADJ} \cdot R1
\]  

Figure 21. Adjustable Voltage Operation

For the R2 resistor value up to 15 kΩ the I_{ADJ} current impact can be neglected and the R1 resistor value can be calculated by:

\[
R1 = R2 \times \left( \frac{V_{OUT}}{1.24} - 1 \right)
\]  

Where V_{OUT} is the desired nominal output voltage.

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.

\[
P_D = (V_{IN} - V_{OUT}) \cdot I_{OUT} + V_{IN} \cdot I_{GND}
\]  

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

\[
T_J = T_A + P_D \cdot R_{JA}
\]  

where T_A is ambient temperature and R_{JA} is the Junction to Ambient Thermal Resistance of the NCP/NCV57302 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

<table>
<thead>
<tr>
<th>Device</th>
<th>Output Current</th>
<th>Output Voltage</th>
<th>Junction Temp. Range</th>
<th>Package</th>
<th>Shipping†</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCP57302DSADJR4G</td>
<td>3.0 A</td>
<td>ADJ</td>
<td>−40°C to +125°C</td>
<td>D2PAK−5 (Pb−Free)</td>
<td>800 / Tape &amp; Reel</td>
</tr>
<tr>
<td>NCV57302DSADJR4G*</td>
<td>3.0 A</td>
<td>ADJ</td>
<td>−40°C to +125°C</td>
<td>D2PAK−5 (Pb−Free)</td>
<td>800 / Tape &amp; Reel</td>
</tr>
</tbody>
</table>

†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.
MECHANICAL CASE OUTLINE

PACKAGE DIMENSIONS

D²PAK 5–LEAD
CASE 936A–02
ISSUE E

DATE 28 JUL 2021

SCALE 1:1

TOP VIEW

SIDE VIEW

BOTTOM VIEW

SIDE VIEW

OPTIONAL CHAMFER

TIP LEADFORM

ROTATED 90° CW

DETAIL C

GENERAL MARKING DIAGRAM

xxxxxx = Device Code
A = Assembly Location
WL = Wafer Lot
Y = Year
WW = Work Week
G = Pb−Free Package

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, “G” or microdot “/C0071”, may or may not be present. Some products may not follow the Generic Marking.

NOTES:
2. CONTROLLING DIMENSION IN INCHES
3. TAB CONTOUR OPTIONAL WITHIN DIMENSIONS A AND K.
4. DIMENSIONS U AND V ESTABLISH A MINIMUM MOUNTING SURFACE FOR TERMINAL 4.
5. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH OR GATE PROTRUSIONS. MOLD FLASH AND GATE PROTRUSIONS NOT TO EXCEED 0.0065 MINIMUM.

RECOMMENDED MOUNTING FOOTPRINT

• For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SDSC0001.

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DESCRIPTION: D²PAK 5–LEAD

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