

# NCP5500, NCV5500, NCP5501, NCV5501

## LDO Voltage Regulator

### 500 mA

These linear low drop voltage regulators provide up to 500 mA over a user-adjustable output range of 1.25 V to 5.0 V, or at a fixed output voltage of 1.5 V, 3.3 V or 5.0 V, with typical output voltage accuracy better than 3%. An internal PNP pass transistor permits low dropout voltage and operation at full load current at the minimum input voltage. NCV versions are qualified for demanding automotive applications that require extended temperature operation and site and change control. NCP5500 and NCV5500 versions include an Enable/Shutdown function and are available in a DPAK 5 and SOIC 8 packages. NCP5501 and NCV5501 versions are available in DPAK 3 for applications that do not require logical on/off control.

This regulator family is ideal for applications that require a broad input voltage range, and low dropout performance up to 500 mA load using low cost ceramic capacitors. Integral protection features include short circuit current and thermal shutdown.

#### Features

- Output Current up to 500 mA
- 2.9% Output Voltage Accuracy
- Low Dropout Voltage (230 mV at 500 mA)
- Enable Control Pin (NCP5500 / NCV5500)
- Reverse Bias Protection
- Short Circuit Protection
- Thermal Shutdown
- Wide Operating Temperature Range  
NCV5500 / NCV5501; -40°C to +125°C Ambient Temperature  
NCP5500 / NCP5501; -40°C to +85°C Ambient Temperature
- NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable
- Stable with Low Cost Ceramic Capacitors
- These are Pb-Free Devices

#### Typical Applications

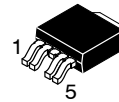
- Automotive
- Industrial and Consumer
- Post SMPS Regulation
- Point of Use Regulation



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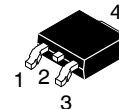
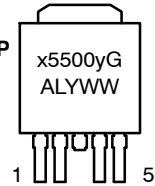
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#### MARKING DIAGRAMS



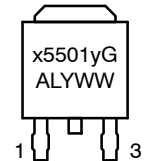
Pin 1. EN  
2.  $V_{in}$   
TAB, 3. GND  
4.  $V_{out}$   
5. NC/ADJ

DPAK 5  
CENTER LEAD CROP  
CASE 175AA



Pin 1.  $V_{in}$   
TAB, 2. GND  
3.  $V_{out}$

DPAK 3  
SINGLE GAUGE  
CASE 369C

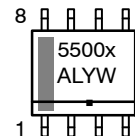


x = P (NCP), V (NCV)  
5500/1 = Device Code  
y = Output Voltage  
L = 1.5 V  
T = 3.3 V  
U = 5.0 V  
W = Adjustable  
A = Assembly Location  
L = Wafer Lot  
Y = Year  
WW = Work Week  
G = Pb-Free Package



Pin 1.  $V_{in}$   
2. GND  
3. GND  
4.  $V_{out}$   
5. NC/ADJ  
6. GND  
7. GND  
8. EN

SOIC-8  
CASE 751

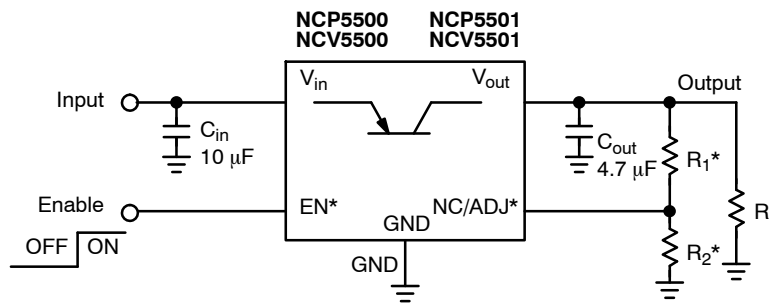


x = Output Voltage, NCP/NCV  
A = Adjustable, NCV  
B = Adjustable, NCP  
A = Assembly Location  
L = Wafer Lot  
Y = Year  
W = Work Week  
▪ = Pb-Free Package

#### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 10 of this data sheet.

## NCP5500, NCV5500, NCP5501, NCV5501

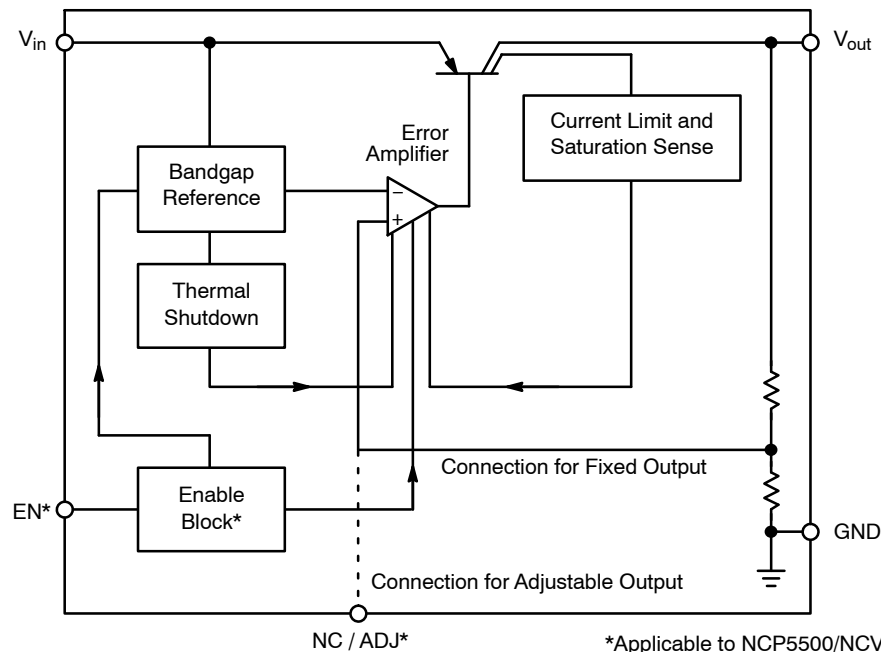


\*Applicable to NCP5500/NCV5500 only.

### Figure 1. Typical Application Circuit

## PIN FUNCTION DESCRIPTIONS

| DPAK 3  | DPAK 5  | SOIC-8     | Pin Name  | Description                                                                                                                                                                                  |
|---------|---------|------------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pin No. | Pin No. | Pin No.    |           |                                                                                                                                                                                              |
| –       | 1       | 8          | EN        | Enable. This pin allows for on/off control of the regulator. High level turns on the output. To disable the device, connect to ground. If this function is not in use, connect to $V_{in}$ . |
| 1       | 2       | 1          | $V_{in}$  | Positive power supply input voltage.                                                                                                                                                         |
| 2, Tab  | 3, Tab  | 2, 3, 6, 7 | GND       | Ground. This pin is internally connected to the Tab heat sink.                                                                                                                               |
| 3       | 4       | 4          | $V_{out}$ | Regulated output voltage.                                                                                                                                                                    |
| –       | 5       | 5          | NC/ADJ    | No connection (Fixed output versions).<br>Voltage-adjust input (Adjustable output version). Use an external voltage divider to set the output voltage over a range of 1.25 V to 5.0 V.       |



### Figure 2. Block Diagram

# NCP5500, NCV5500, NCP5501, NCV5501

## ABSOLUTE MAXIMUM RATINGS

| Rating                                                                            | Symbol             | Min           | Max                                         | Unit |
|-----------------------------------------------------------------------------------|--------------------|---------------|---------------------------------------------|------|
| Input Voltage (Note 1)                                                            | $V_{in}$           | -0.3 (Note 2) | +18                                         | V    |
| Output, Enable Voltage                                                            | $V_{out}$ , EN     | -0.3          | +16 or<br>$V_{in} + 0.3$<br>(Notes 2 and 5) | V    |
| Maximum Junction Temperature                                                      | $T_J$              | -             | 150                                         | °C   |
| Storage Temperature                                                               | $T_{Stg}$          | -55           | +150                                        | °C   |
| Moisture Sensitivity Level                                                        | MSL                | 1             |                                             | -    |
| Lead Temperature Soldering<br>Reflow (SMD Styles Only), Pb-Free Versions (Note 3) | $T_{sld}$          |               | 265 Peak                                    | °C   |
| ESD Capability, Human Body Model (Note 4)                                         | ESD <sub>HBM</sub> | 4000          | -                                           | V    |
| ESD Capability, Machine Model (Note 4)                                            | ESD <sub>MM</sub>  | 200           | -                                           | V    |
| ESD Capability, Charged Device Model (Note 4)                                     | ESD <sub>CDM</sub> | 1000          | -                                           | 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.

\*Latchup Current Maximum Rating:  $\leq 100$  mA per JEDEC standard: JESD78.

1. Refer to Electrical Characteristics and Application Information for Safe Operating Area.
2. Reverse bias protection feature valid only if  $V_{out} - V_{in} \leq 7$  V.
3. Pb-Free, 60 sec -150 sec above 217°C, 40 sec max at peak temperature
4. This device series incorporates ESD protection and is tested by the following methods:  
ESD Human Body Model tested per AEC-Q100-002 (EIA/JESD22-A114)  
ESD Machine Model tested per AEC-Q100-003 (EIA/JESD22-A115)  
ESD Charged Device Model tested per EIA/JES D22/C101, Field Induced Charge Model
5. Maximum = +16 V or ( $V_{in} + 0.3$  V), whichever is lower.

## THERMAL CHARACTERISTICS

| Rating                                              | Symbol          | Min | Max                | Unit |
|-----------------------------------------------------|-----------------|-----|--------------------|------|
| Package Dissipation                                 | $P_D$           |     | Internally Limited | W    |
| Thermal Characteristics, DPAK 3 and DPAK 5 (Note 1) |                 |     |                    | °C/W |
| Thermal Resistance, Junction-to-Air (Note 6)        | $R_{\theta JA}$ |     | 60                 |      |
| Thermal Resistance, Junction-to-Case                | $R_{\theta JC}$ |     | 5.2                |      |
| Thermal Characteristics, SOIC-8 (Note 1)            |                 |     |                    | °C/W |
| Thermal Resistance, Junction-to-Air (Note 6)        | $R_{\theta JA}$ |     | 80                 |      |
| Thermal Reference, Junction-to-Lead                 | $R_{\psi JL}$   |     | 22                 |      |

6. As measured using a copper heat spreading area of 650 mm<sup>2</sup>, 1 oz copper thickness.

## OPERATING RANGES

| Rating                                                                      | Symbol    | Min                                    | Max       | Unit |
|-----------------------------------------------------------------------------|-----------|----------------------------------------|-----------|------|
| Operating Input Voltage (Note 1)                                            | $V_{in}$  | $V_{out} + V_{DO}$ , 2.5 V<br>(Note 7) | 16        | V    |
| Adjustable Output Voltage Range (Adjustable Version Only)                   | $V_{out}$ | 1.25                                   | 5.0       | V    |
| Operating Ambient Temperature Range<br>NCP5500, NCP5501<br>NCV5500, NCV5501 | $T_A$     | -40<br>-40                             | 85<br>125 | °C   |

7. Minimum  $V_{in} = 2.5$  V or ( $V_{out} + V_{DO}$ ), whichever is higher.

# NCP5500, NCV5500, NCP5501, NCV5501

**ELECTRICAL CHARACTERISTICS**  $V_{in} = 2.5 \text{ V}$  or  $V_{out} + 1.0 \text{ V}$  (whichever is higher),  $C_{in} = 10 \mu\text{F}$ ,  $C_{out} = 4.7 \mu\text{F}$ , for typical values  $T_A = 25^\circ\text{C}$ , for min/max values  $T_A = -40^\circ\text{C}$  to  $85^\circ\text{C}$  (NCP Version),  $T_A = -40^\circ\text{C}$  to  $125^\circ\text{C}$  (NCV Version) unless otherwise noted (Note 13).

| Characteristic                                                                                                                    | Symbol         | Test Conditions                                                                                                                                                                                                                                                                                                                                                                                                                                              | Min                                         | Typ                                        | Max                                                 | Unit                |
|-----------------------------------------------------------------------------------------------------------------------------------|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|--------------------------------------------|-----------------------------------------------------|---------------------|
| <b>OUTPUT</b>                                                                                                                     |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                             |                                            |                                                     |                     |
| Output Voltage (Note 14)<br>5 V Regulator<br>3.3 V Regulator<br>1.5 V Regulator<br>ADJ Regulator                                  | $V_{out}$      | $T_A = 25^\circ\text{C}$ , $I_{out} = 50 \text{ mA}$                                                                                                                                                                                                                                                                                                                                                                                                         |                                             | $V_{NOM} \pm 2.9\%$                        |                                                     | V<br>V<br>V<br>V    |
| Output Voltage (Note 8)<br>5 V Regulator<br>3.3 V Regulator<br>1.5 V Regulator<br>ADJ Regulator                                   | $V_{out}$      | $1.0 \text{ mA} < I_{out} < 500 \text{ mA}$                                                                                                                                                                                                                                                                                                                                                                                                                  | (-4.9%)<br>4.755<br>3.138<br>1.427<br>1.189 | $V_{NOM}$<br>5.0<br>3.3<br>1.5<br>1.25     | (+4.9%)<br>5.245<br>3.462<br>1.574<br>1.311         | V<br>V<br>V<br>V    |
| Line Regulation                                                                                                                   | $REG_{LINE}$   | $I_{out} = 50 \text{ mA}$<br>$2.5 \text{ V or } (V_{out} + 1.0 \text{ V}) < V_{in} < 16 \text{ V}$                                                                                                                                                                                                                                                                                                                                                           | -1.0                                        | 0.1                                        | 1.0                                                 | %                   |
| Load Regulation                                                                                                                   | $REG_{LOAD}$   | $1.0 \text{ mA} < I_{out} < 500 \text{ mA}$                                                                                                                                                                                                                                                                                                                                                                                                                  | -1.0                                        | 0.35                                       | 1.0                                                 | %                   |
| Dropout Voltage (Note 9)<br>5.0 V Version<br><br>3.3 V Version<br><br>1.5 V Version (Note 10)<br><br>Adjustable Version (Note 11) | $V_{DO}$       | $I_{out} = 1.0 \text{ mA}$ , $\Delta V_{out} = -2\%$<br>$I_{out} = 500 \text{ mA}$ , $\Delta V_{out} = -2\%$<br>$I_{out} = 1.0 \text{ mA}$ , $\Delta V_{out} = -2\%$<br>$I_{out} = 500 \text{ mA}$ , $\Delta V_{out} = -2\%$<br>$I_{out} = 1.0 \text{ mA}$ , $\Delta V_{out} = -2\%$<br>$I_{out} = 500 \text{ mA}$ , $\Delta V_{out} = -2\%$<br>$I_{out} = 1.0 \text{ mA}$ , $\Delta V_{out} = -2\%$<br>$I_{out} = 500 \text{ mA}$ , $\Delta V_{out} = -2\%$ | -<br>-<br>-<br>-<br>-<br>-<br>-<br>-        | 5<br>230<br>5<br>230<br>-<br>-<br>5<br>230 | 90<br>700<br>90<br>700<br>1073<br>1073<br>90<br>700 | mV                  |
| Ground Current                                                                                                                    | $I_{GND}$      | $I_{out} = 100 \mu\text{A}$<br>$I_{out} = 500 \text{ mA}$                                                                                                                                                                                                                                                                                                                                                                                                    |                                             | 300<br>10                                  | 500<br>20                                           | $\mu\text{A}$<br>mA |
| Disable Current in Shutdown<br>(NCP5500, NCV5500)                                                                                 | $I_{SD}$       | Adjustable and 1.5 V versions<br>All other versions                                                                                                                                                                                                                                                                                                                                                                                                          |                                             | 30<br>40                                   | 50<br>50                                            | $\mu\text{A}$       |
| Current Limit                                                                                                                     | $I_{out(LIM)}$ | $V_{out} = 90\%$ of $V_{out(nom)}$                                                                                                                                                                                                                                                                                                                                                                                                                           | 500                                         | 700                                        | 900                                                 | mA                  |
| Ripple Rejection Ratio (Notes 9 & 14)                                                                                             | RR             | 120 Hz<br>$I_{out} = 100 \text{ mA}$ , 1 kHz<br>10 kHz                                                                                                                                                                                                                                                                                                                                                                                                       | -<br>-<br>-                                 | 75<br>75<br>70                             | -<br>-<br>-                                         | dB                  |
| Output Noise Voltage (Notes 12 & 14)                                                                                              | $V_n$          | $f = 10 \text{ Hz to } 100 \text{ kHz}$ , $V_{in} = 2.5 \text{ V}$<br>$V_{out} = 1.25 \text{ V}$ , $I_{out} = 1.0 \text{ mA}$<br><br>$f = 10 \text{ Hz to } 100 \text{ kHz}$ , $V_{in} = 2.5 \text{ V}$<br>$V_{out} = 1.25 \text{ V}$ , $I_{out} = 100 \text{ mA}$                                                                                                                                                                                           |                                             | 18<br><br>35                               |                                                     | $\mu\text{V}_{rms}$ |

## ENABLE (NCP5500, NCV5500 Only)

|                         |                           |                                                |     |   |     |               |
|-------------------------|---------------------------|------------------------------------------------|-----|---|-----|---------------|
| Enable Voltage          | $V_{ENoff}$<br>$V_{ENon}$ | OFF (shutdown) State<br>ON (enabled) State     | 2.0 |   | 0.4 | V             |
| Enable Pin Bias Current | $I_{EN}$                  | $V_{EN} = V_{in}$ , $I_{out} = 1.0 \text{ mA}$ |     | - | 1.0 | $\mu\text{A}$ |

## ADJUST

|                              |           |                                                                             |  |   |    |    |
|------------------------------|-----------|-----------------------------------------------------------------------------|--|---|----|----|
| Adjust Pin Current (Note 14) | $I_{ADJ}$ | $V_{EN} = V_{in}$ , $V_{ADJ} = 1.25 \text{ V}$ , $V_{out} = 1.25 \text{ V}$ |  | - | 60 | nA |
|------------------------------|-----------|-----------------------------------------------------------------------------|--|---|----|----|

## THERMAL SHUTDOWN

|                                        |     |                             |     |   |     |                  |
|----------------------------------------|-----|-----------------------------|-----|---|-----|------------------|
| Thermal Shutdown Temperature (Note 14) | TSD | $I_{out} = 100 \mu\text{A}$ | 150 | - | 210 | $^\circ\text{C}$ |
|----------------------------------------|-----|-----------------------------|-----|---|-----|------------------|

8. Deviation from nominal. For adjustable versions, Pin ADJ connected to  $V_{out}$ .

9. See Typical Characteristics section for additional information.

10.  $V_{DO}$  is constrained by the minimum input voltage of 2.5 V.

11.  $V_{out}$  is set by external resistor divider to 5 V.

12.  $V_n$  for other fixed voltage versions, as well as adjustable versions set to other output voltages, can be calculated from the following formula:  
 $V_n = V_{n(x)} * V_{out} / 1.25$ , where  $V_{n(x)}$  is the typical value from the table above.

13. Performance guaranteed over specified operating conditions by design, guard banded test limits, and/or characterization, production tested at  $T_J = T_A = 25^\circ\text{C}$ . Low duty cycle pulse techniques are used during testing to maintain the junction temperature as close to ambient as possible.

14. Values are based on design and/or characterization.

TYPICAL CHARACTERISTICS

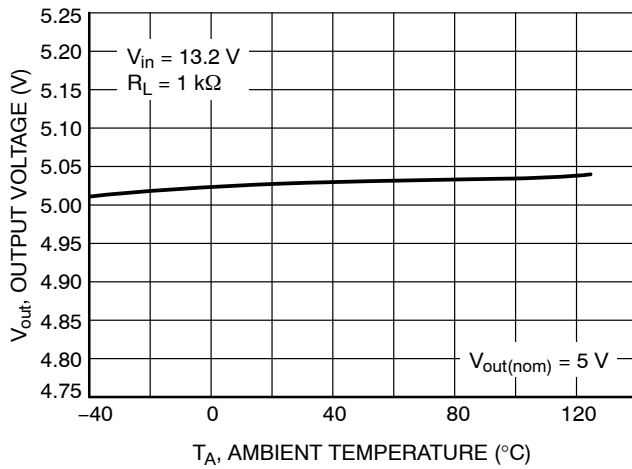


Figure 3. Output Voltage vs. Ambient Temperature

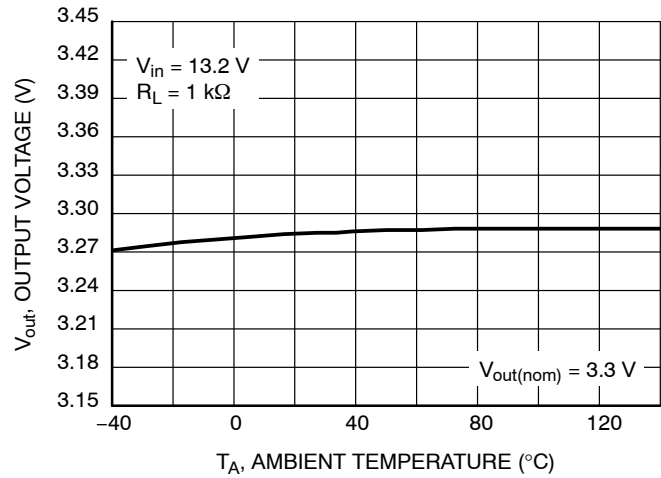


Figure 4. Output Voltage vs. Ambient Temperature

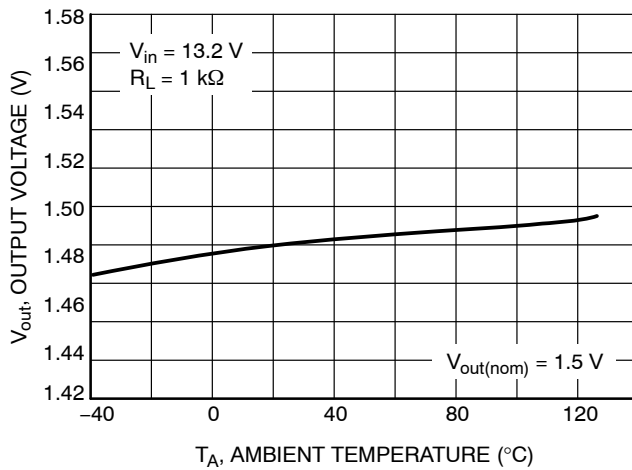


Figure 5. Output Voltage vs. Ambient Temperature

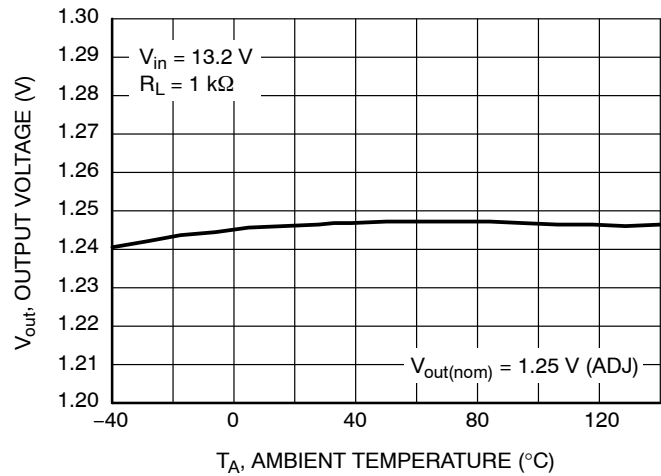


Figure 6. Output Voltage vs. Ambient Temperature

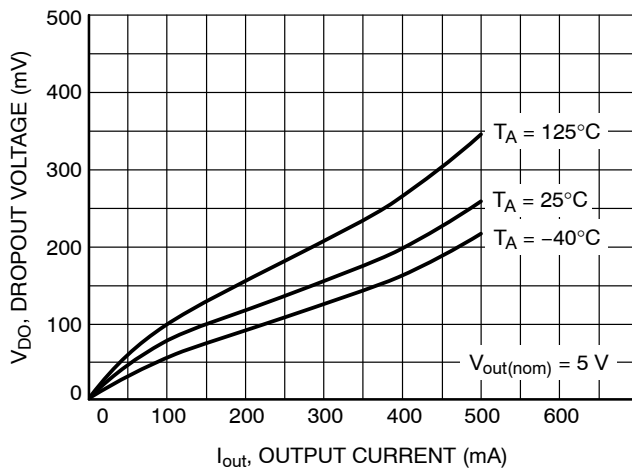


Figure 7. Dropout Voltage vs. Output Current

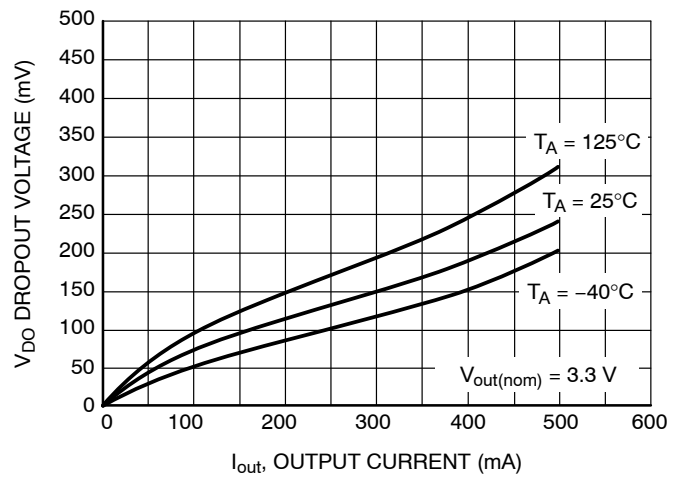


Figure 8. Dropout Voltage vs. Output Current

TYPICAL CHARACTERISTICS

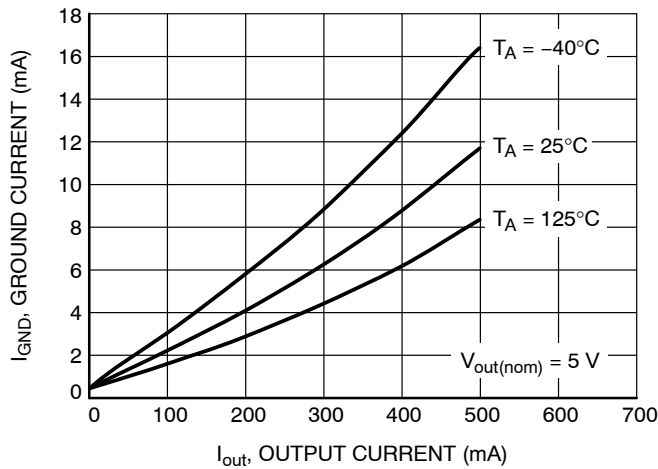


Figure 9. Ground Current vs. Output Current

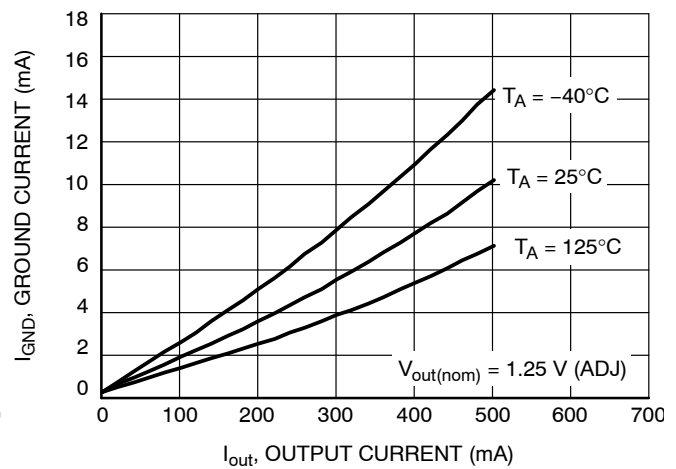


Figure 10. Ground Current vs. Output Current

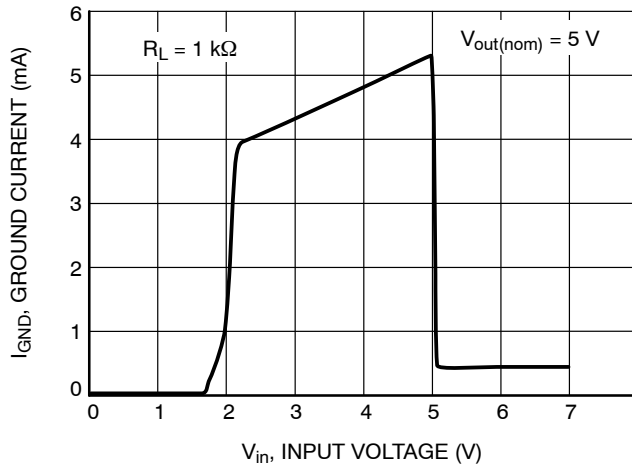


Figure 11. Ground Current vs. Input Voltage

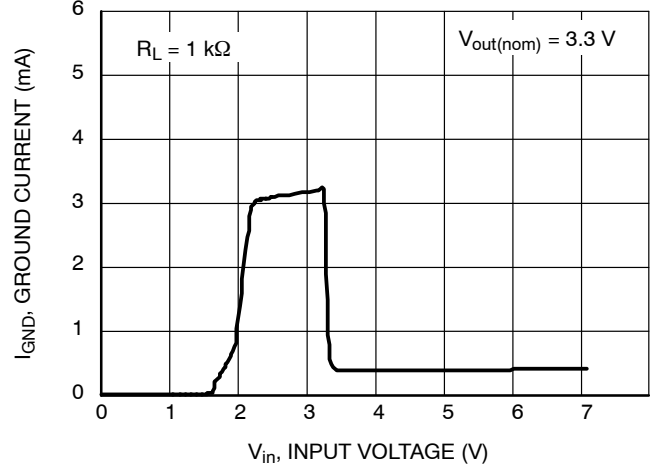


Figure 12. Ground Current vs. Input Voltage

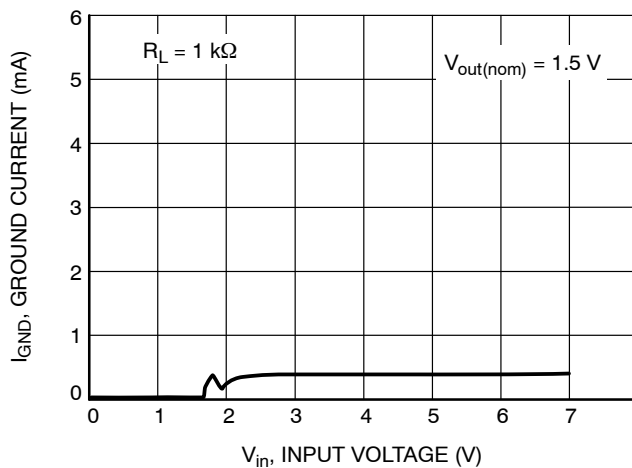


Figure 13. Ground Current vs. Input Voltage

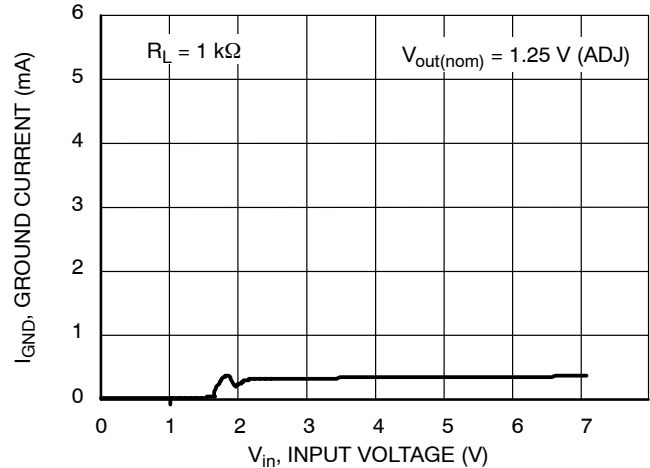


Figure 14. Ground Current vs. Input Voltage

TYPICAL CHARACTERISTICS

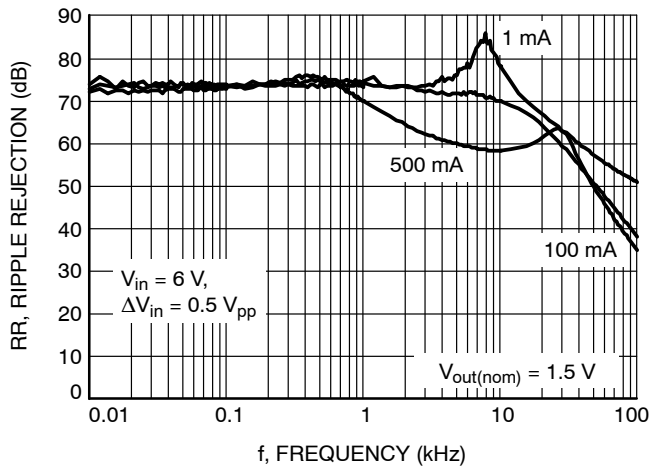


Figure 15. Ripple Rejection vs. Frequency

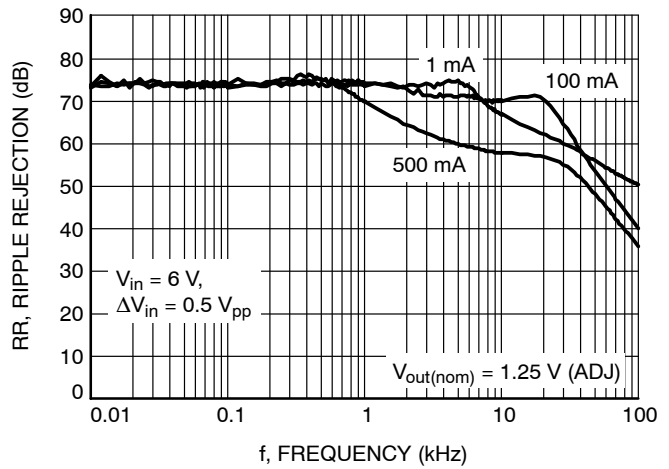


Figure 16. Ripple Rejection vs. Frequency

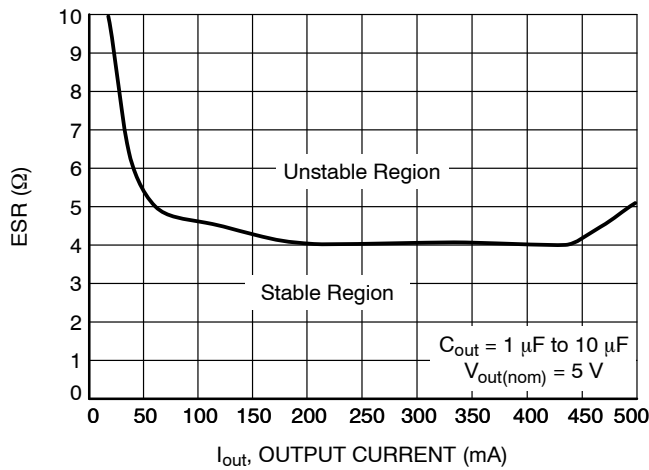


Figure 17. Output Capacitor ESR Stability vs. Output Current

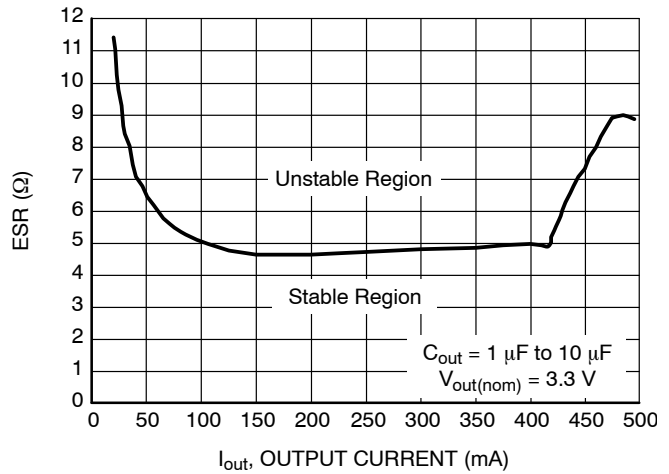


Figure 18. Output Capacitor ESR Stability vs. Output Current

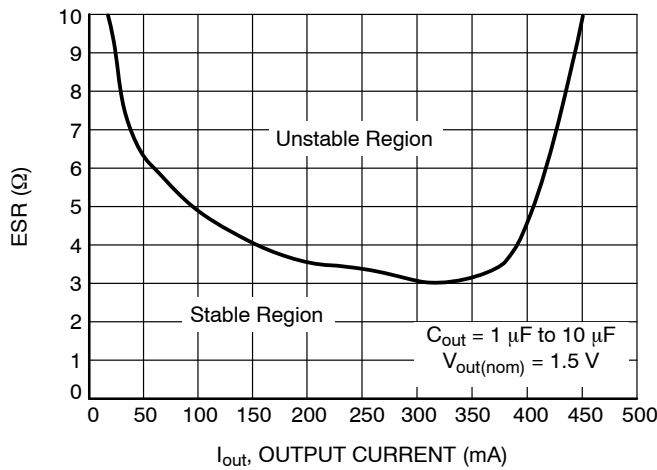


Figure 19. Output Capacitor ESR Stability vs. Output Current

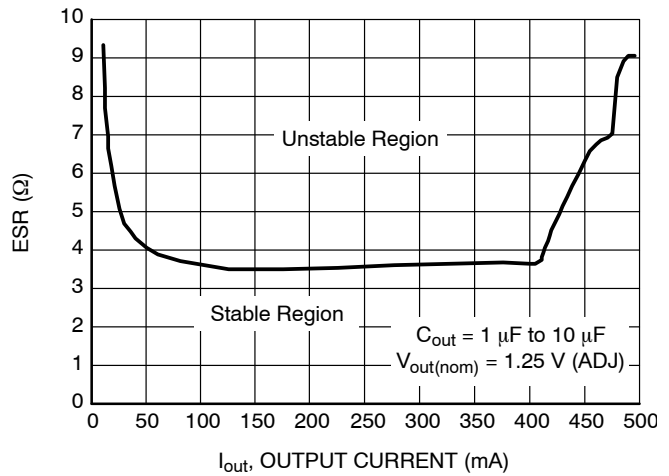


Figure 20. Output Capacitor ESR Stability vs. Output Current

NOTE: Typical characteristics were measured with the same conditions as electrical characteristics, unless otherwise noted.

## NCP5500, NCV5500, NCP5501, NCV5501

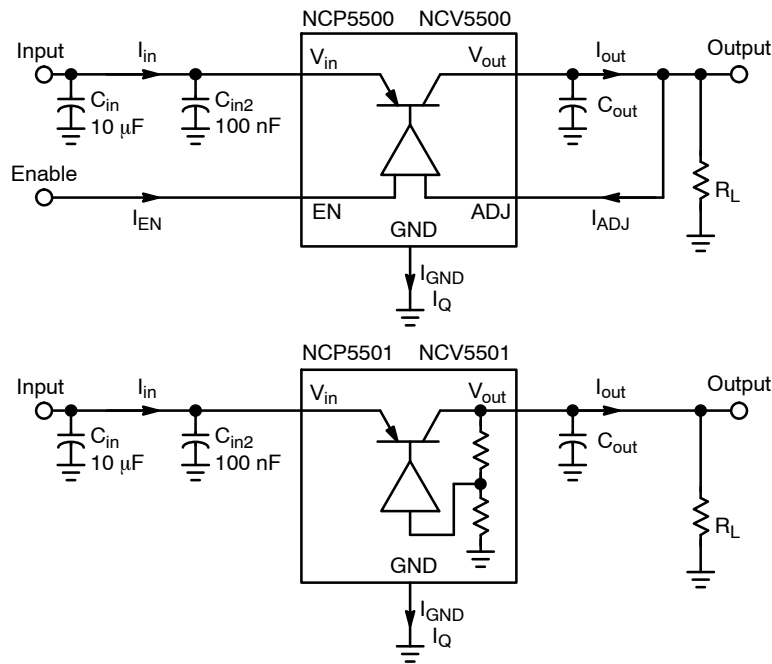


Figure 21. Measuring Circuits

### Circuit Description

The NCP5500/NCP5501/NCV5500/NCV5501 are integrated linear regulators with a DC load current capability of 500 mA. The output voltage is regulated by a PNP pass transistor controlled by an error amplifier and band gap reference. The choice of a PNP pass element provides the lowest possible dropout voltage, particularly at reduced load currents. Pass transistor base drive current is controlled to prevent oversaturation. The regulator is internally protected by both current limit and thermal shutdown. Thermal shutdown occurs when the junction temperature exceeds 150°C. The NCV5500 includes an enable/shutdown pin to turn off the regulator to a low current drain standby state.

### Regulator

The error amplifier compares the reference voltage to a sample of the output voltage ( $V_{out}$ ) and drives the base of a PNP series pass transistor via a buffer. The reference is a bandgap design for enhanced temperature stability. Saturation control of the PNP pass transistor is a function of the load current and input voltage. Oversaturation of the output power device is prevented, and quiescent current in the ground pin is minimized.

### Regulator Stability Considerations

The input capacitor is necessary to stabilize the input impedance to reduce transient line influences. The output capacitor helps determine three main characteristics of a

linear regulator: startup delay, load transient response and loop stability. The capacitor value and type should be based on cost, availability, size and temperature constraints. Refer to Typical Operating Characteristics for stability regions.

### Enable Input (NCP5500, NCV5500)

The enable pin is used to turn the regulator on or off. By holding the pin at a voltage less than 0.4 V, the output of the regulator will be turned off to a minimal current drain state. When the voltage at the Enable pin is greater than 2.0 V, the output of the regulator will be enabled and rise to the regulated output voltage. The Enable pin may be connected directly to the input pin to provide a constant enable to the regulator.

### Active Load Protection in Shutdown (NCP5500, NCV5500)

When a linear regulator is disabled (shutdown), the output (load) voltage should be zero. However, stray PC board leakage paths, output capacitor dielectric absorption, and inductively coupled power sources can cause an undesirable regulator output voltage if load current is low or zero. The NCV5500 features a load protection network that is active only during Shutdown mode. This network switches in a shunt current path (~500  $\mu$ A) from  $V_{out}$  to Ground. This feature also provides a controlled (“soft”) discharge path for the output capacitor after a transition from Enable to Shutdown.

### Calculating Resistors for the ADJ Versions

The adjustable version uses feedback resistors to adjust the output to the desired output voltage. With  $V_{out}$  connected to ADJ, the adjustable version will regulate at 1.25 V  $\pm 4.9\%$  (1250  $\pm$  61.25 mV).

Output voltage formula with an external resistor divider:

$$V_{out} = \left( 1.25 \text{ V} - \left[ 60\text{E}-9 \cdot \frac{(R_1 \cdot R_2)}{(R_1 + R_2)} \right] \right) \cdot \left( \frac{(R_1 + R_2)}{R_2} \right)$$

Where

$R_1$  = value of the divider resistor connected between  $V_{out}$  and ADJ,

$R_2$  = value of the divider resistor connected between ADJ and GND,

The term “1.25 V” has a tolerance of  $\pm 4.9\%$ ; the term “60E-9” can vary in the range 15E-9 to 60E-9.

For values of  $R_2$  less than 15 K $\Omega$ , the term within brackets ( [ ] ) will evaluate to less than 1 mV and can be ignored. This simplifies the output voltage formula to:

$V_{out} = 1.25 \text{ V} \cdot ((R_1 + R_2) / R_2)$  with a tolerance of  $\pm 4.9\%$ , which is the tolerance of the 1.25 V output when delivering up to 500 mA of output current.

### DEFINITION OF TERMS

**Dropout Voltage:** The input-to-output voltage differential at which the circuit ceases to regulate against further reduction input voltage. Measured when the output voltage has dropped 2% relative to the value measured at nominal input voltage. Dropout voltage is dependent upon load current and junction temperature.

**Input Voltage:** The DC voltage applied to the input terminals with respect to ground.

**Line Regulation:** The change in output voltage for a change in the input voltage. The measurement is made under conditions of low dissipation or by using pulse techniques such that the average chip temperature is not significantly affected.

**Load Regulation:** The change in output voltage for a change in load current at constant chip temperature. Pulse loading techniques are employed such that the average chip temperature is not significantly affected.

**Quiescent and Ground Current:** The quiescent current is the current which flows through the ground when the LDO operates without a load on its output: internal IC operation, bias, etc. When the LDO becomes loaded, this term is called the Ground current. It is actually the difference between the input current (measured through the LDO input pin) and the output current.

**Ripple Rejection:** The ratio of the peak-to-peak input ripple voltage to the peak-to-peak output ripple voltage.

**Current Limit:** Peak current that can be delivered to the output.

### Calculating Power Dissipation

The maximum power dissipation for a single output regulator (Figure 21) is:

$$P_{D(max)} = [V_{in(max)} - V_{out(min)}] I_{out(max)} + V_{in(max)} I_{GND} \quad (\text{eq. 1})$$

Where

$V_{in(max)}$  is the maximum input voltage,

$V_{out(min)}$  is the minimum output voltage,

$I_{out(max)}$  is the maximum output current for the application,

$I_{GND}$  is the ground current at  $I_{out(max)}$ .

Once the value of  $P_{D(max)}$  is known, the maximum permissible value of  $R_{\theta JA}$  can be calculated:

$$R_{\theta JA} = \frac{(150^\circ\text{C} - T_A)}{P_D} \quad (\text{eq. 2})$$

The value of  $R_{\theta JA}$  can then be compared with those in the Thermal Characteristics table. Those packages with  $R_{\theta JA}$  less than the calculated value in Equation 2 will keep the die temperature below 150°C.

In some cases, none of the packages will be sufficient to dissipate the heat generated by the IC, and an external heat sink will be required.

### Heat Sinks

A heat sink effectively increases the surface area of the package to improve the flow of heat away from the IC and into the surrounding air.

Each material in the heat flow path between the IC and the outside environment will have a thermal resistance. Like series electrical resistances, these resistances are summed to determine the value of  $R_{\theta JA}$ :

$$R_{\theta JA} = R_{\theta JC} + R_{\theta CS} + R_{\theta SA} \quad (\text{eq. 3})$$

where

$R_{\theta JC}$  is the junction-to-case thermal resistance,

$R_{\theta CS}$  is the case-to-heatsink thermal resistance,

$R_{\theta SA}$  is the heatsink-to-ambient thermal resistance.

$R_{\theta JC}$  appears in the Thermal Characteristics table. Like  $R_{\theta JA}$ , it too is a function of package type.  $R_{\theta CS}$  and  $R_{\theta SA}$  are functions of the package type, heat sink and the interface between them. These values appear in data sheets of heat sink manufacturers.

Thermal, mounting, and heat sink considerations are further discussed in ON Semiconductor Application Note AN1040/D.

# NCP5500, NCV5500, NCP5501, NCV5501

## ORDERING INFORMATION

| Device            | Nominal Output Voltage* | Package Marking | Package          | Shipping†          |
|-------------------|-------------------------|-----------------|------------------|--------------------|
| NCP5500DT15RKG    | 1.5                     | P5500LG         | DPAK 5 (Pb-Free) | 2500 / Tape & Reel |
| NCV5500DT15RKG**  |                         | V5500LG         | DPAK 5 (Pb-Free) | 2500 / Tape & Reel |
| NCP5501DT15RKG    |                         | P5501LG         | DPAK 3 (Pb-Free) | 2500 / Tape & Reel |
| NCV5501DT15RKG**  |                         | V5501LG         | DPAK 3 (Pb-Free) | 2500 / Tape & Reel |
| NCP5501DT15G      |                         | P5501LG         | DPAK 3 (Pb-Free) | 75 Units / Rail    |
| NCV5501DT15G**    |                         | V5501LG         | DPAK 3 (Pb-Free) | 75 Units / Rail    |
| NCP5500DT33RKG    | 3.3                     | P5500TG         | DPAK 5 (Pb-Free) | 2500 / Tape & Reel |
| NCV5500DT33RKG**  |                         | V5500TG         | DPAK 5 (Pb-Free) | 2500 / Tape & Reel |
| NCP5501DT33RKG    |                         | P5501TG         | DPAK 3 (Pb-Free) | 2500 / Tape & Reel |
| NCV5501DT33RKG**  |                         | V5501TG         | DPAK 3 (Pb-Free) | 2500 / Tape & Reel |
| NCP5501DT33G      |                         | P5501TG         | DPAK 3 (Pb-Free) | 75 Units / Rail    |
| NCV5501DT33G**    |                         | V5501TG         | DPAK 3 (Pb-Free) | 75 Units / Rail    |
| NCP5500DT50RKG    | 5.0                     | P5500UG         | DPAK 5 (Pb-Free) | 2500 / Tape & Reel |
| NCV5500DT50RKG**  |                         | V5500UG         | DPAK 5 (Pb-Free) | 2500 / Tape & Reel |
| NCP5501DT50RKG    |                         | P5501UG         | DPAK 3 (Pb-Free) | 2500 / Tape & Reel |
| NCV5501DT50RKG**  |                         | V5501UG         | DPAK 3 (Pb-Free) | 2500 / Tape & Reel |
| NCP5501DT50G      |                         | P5501UG         | DPAK 3 (Pb-Free) | 75 Units / Rail    |
| NCV5501DT50G**    |                         | V5501UG         | DPAK 3 (Pb-Free) | 75 Units / Rail    |
| NCP5500DTADJRKG   | Adjustable              | P5500WG         | DPAK 5 (Pb-Free) | 2500 / Tape & Reel |
| NCV5500DTADJRKG** |                         | V5500WG         | DPAK 5 (Pb-Free) | 2500 / Tape & Reel |
| NCP5500DADJR2G    | Adjustable              | 5500B           | SO-8 (Pb-Free)   | 2500 / Tape & Reel |
| NCV5500DADJR2G**  | Adjustable              | 5500A           | SO-8 (Pb-Free)   | 2500 / 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.

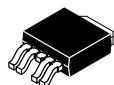
\*Contact ON Semiconductor for other fixed voltages.

\*\*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

ON Semiconductor®



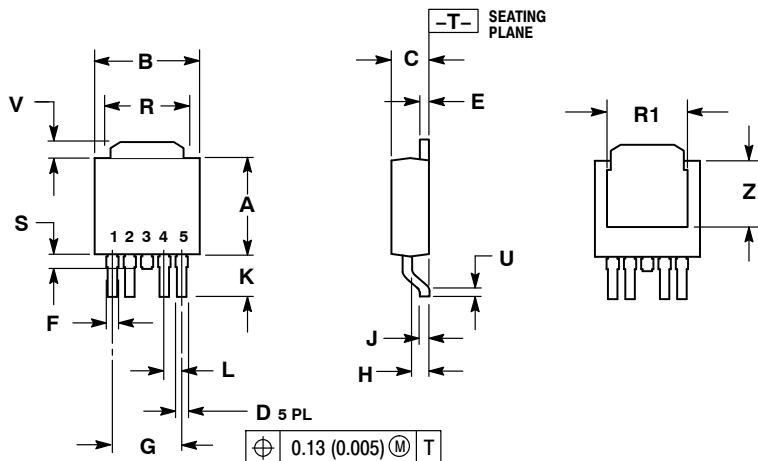
SCALE 1:1

### DPAK-5, CENTER LEAD CROP

#### CASE 175AA

#### ISSUE B

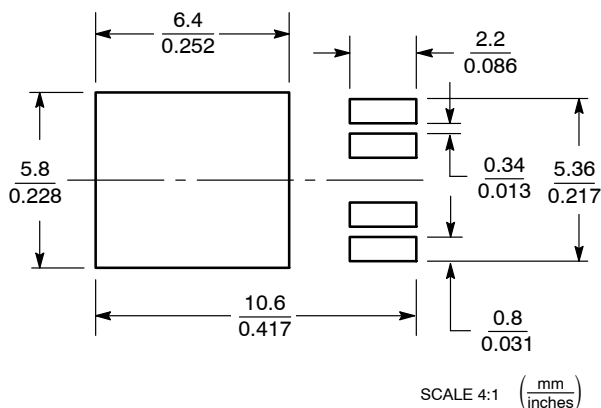
DATE 15 MAY 2014



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH.

| DIM | INCHES    |       | MILLIMETERS |      |
|-----|-----------|-------|-------------|------|
|     | MIN       | MAX   | MIN         | MAX  |
| A   | 0.235     | 0.245 | 5.97        | 6.22 |
| B   | 0.250     | 0.265 | 6.35        | 6.73 |
| C   | 0.086     | 0.094 | 2.19        | 2.38 |
| D   | 0.020     | 0.028 | 0.51        | 0.71 |
| E   | 0.018     | 0.023 | 0.46        | 0.58 |
| F   | 0.024     | 0.032 | 0.61        | 0.81 |
| G   | 0.180 BSC |       | 4.56 BSC    |      |
| H   | 0.034     | 0.040 | 0.87        | 1.01 |
| J   | 0.018     | 0.023 | 0.46        | 0.58 |
| K   | 0.102     | 0.114 | 2.60        | 2.89 |
| L   | 0.045 BSC |       | 1.14 BSC    |      |
| R   | 0.170     | 0.190 | 4.32        | 4.83 |
| R1  | 0.185     | 0.210 | 4.70        | 5.33 |
| S   | 0.025     | 0.040 | 0.63        | 1.01 |
| U   | 0.020     | ---   | 0.51        | ---  |
| V   | 0.035     | 0.050 | 0.89        | 1.27 |
| Z   | 0.155     | 0.170 | 3.93        | 4.32 |

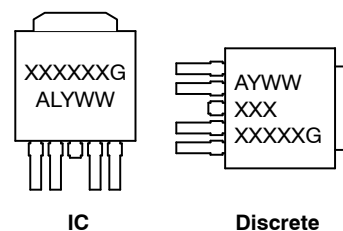
### RECOMMENDED SOLDERING FOOTPRINT\*



SCALE 4:1 (mm/inches)

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

### GENERIC MARKING DIAGRAMS\*



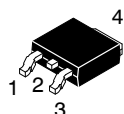
XXXXXX = Device Code  
 A = Assembly Location  
 L = Wafer Lot  
 Y = Year  
 WW = Work Week  
 G = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "▪", may or may not be present.

|                  |                         |                                                                                                                                                                                  |
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| DESCRIPTION:     | DPAK-5 CENTER LEAD CROP | PAGE 1 OF 1                                                                                                                                                                      |

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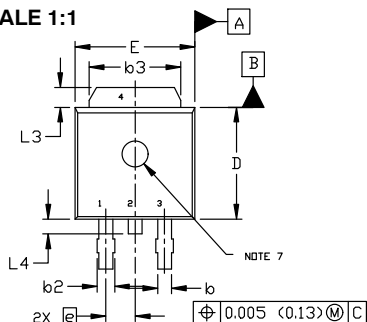
# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



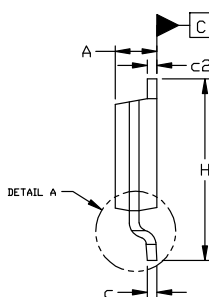
## DPAK (SINGLE GAUGE) CASE 369C ISSUE G

DATE 31 MAY 2023

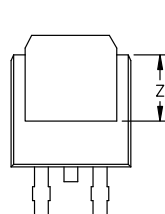
SCALE 1:1



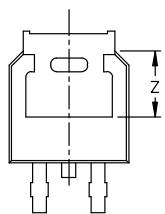
TOP VIEW



SIDE VIEW

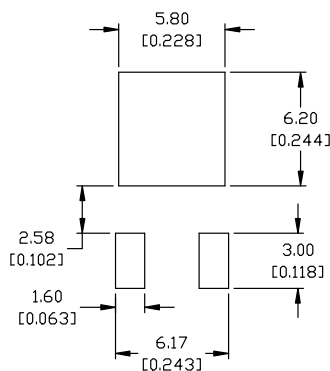


BOTTOM VIEW



BOTTOM VIEW

ALTERNATE  
CONSTRUCTIONS



### 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, SOLDERRM/D.

#### STYLE 1:

PIN 1. BASE  
2. COLLECTOR  
3. EMITTER  
4. COLLECTOR

#### STYLE 2:

PIN 1. GATE  
2. DRAIN  
3. SOURCE  
4. DRAIN

#### STYLE 3:

PIN 1. ANODE  
2. CATHODE  
3. ANODE  
4. CATHODE

#### STYLE 4:

PIN 1. CATHODE  
2. ANODE  
3. GATE  
4. ANODE

#### STYLE 5:

PIN 1. GATE  
2. ANODE  
3. CATHODE  
4. ANODE

#### STYLE 6:

PIN 1. MT1  
2. MT2  
3. GATE  
4. MT2

#### STYLE 7:

PIN 1. GATE  
2. COLLECTOR  
3. EMITTER  
4. COLLECTOR

#### STYLE 8:

PIN 1. N/C  
2. CATHODE  
3. ANODE  
4. CATHODE

#### STYLE 9:

PIN 1. ANODE  
2. CATHODE  
3. RESISTOR ADJUST  
4. CATHODE

#### STYLE 10:

PIN 1. CATHODE  
2. ANODE  
3. CATHODE  
4. ANODE

### NOTES:

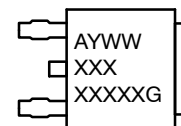
1. DIMENSIONING AND TOLERANCING ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCHES
3. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS b3, L3, AND Z.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.006 INCHES PER SIDE.
5. DIMENSIONS D AND E ARE DETERMINED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
6. DATUMS A AND B ARE DETERMINED AT DATUM PLANE H.
7. OPTIONAL MOLD FEATURE.

| DIM | INCHES |       | MILLIMETERS |       |
|-----|--------|-------|-------------|-------|
|     | MIN.   | MAX.  | MIN.        | MAX.  |
| A   | 0.086  | 0.094 | 2.18        | 2.38  |
| A1  | 0.000  | 0.005 | 0.00        | 0.13  |
| b   | 0.025  | 0.035 | 0.63        | 0.89  |
| b2  | 0.028  | 0.045 | 0.72        | 1.14  |
| b3  | 0.180  | 0.215 | 4.57        | 5.46  |
| c   | 0.018  | 0.024 | 0.46        | 0.61  |
| c2  | 0.018  | 0.024 | 0.46        | 0.61  |
| D   | 0.235  | 0.245 | 5.97        | 6.22  |
| E   | 0.250  | 0.265 | 6.35        | 6.73  |
| e   | 0.090  | BSC   | 2.29        | BSC   |
| H   | 0.370  | 0.410 | 9.40        | 10.41 |
| L   | 0.055  | 0.070 | 1.40        | 1.78  |
| L1  | 0.114  | REF   | 2.90        | REF   |
| L2  | 0.020  | BSC   | 0.51        | BSC   |
| L3  | 0.035  | 0.050 | 0.89        | 1.27  |
| L4  | ----   | 0.040 | ---         | 1.01  |
| Z   | 0.155  | ----  | 3.93        | ---   |

### GENERIC MARKING DIAGRAM\*



IC



Discrete

XXXXXX = Device Code  
A = Assembly Location  
L = 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 "•", may or may not be present. Some products may not follow the Generic Marking.

|                  |                     |                                                                                                                                                                                     |
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| DESCRIPTION:     | DPAK (SINGLE GAUGE) | PAGE 1 OF 1                                                                                                                                                                         |

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# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



SCALE 1:1

SOIC-8 NB  
CASE 751-07  
ISSUE AK

DATE 16 FEB 2011



## NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. 751-01 THRU 751-06 ARE OBSOLETE. NEW STANDARD IS 751-07.

| DIM | MILLIMETERS |      | INCHES    |       |
|-----|-------------|------|-----------|-------|
|     | MIN         | MAX  | MIN       | MAX   |
| A   | 4.80        | 5.00 | 0.189     | 0.197 |
| B   | 3.80        | 4.00 | 0.150     | 0.157 |
| C   | 1.35        | 1.75 | 0.053     | 0.069 |
| D   | 0.33        | 0.51 | 0.013     | 0.020 |
| E   | 1.27 BSC    |      | 0.050 BSC |       |
| F   | 0.10        | 0.25 | 0.004     | 0.010 |
| G   | 0.19        | 0.25 | 0.007     | 0.010 |
| H   | 0.40        | 1.27 | 0.016     | 0.050 |
| J   | 0°          | 8°   | 0°        | 8°    |
| K   | 0.25        | 0.50 | 0.010     | 0.020 |
| S   | 5.80        | 6.20 | 0.228     | 0.244 |

## GENERIC MARKING DIAGRAM\*



SCALE 6:1 (mm/inches)



XXXXXX = Specific Device Code  
A = Assembly Location  
L = Wafer Lot  
Y = Year  
W = Work Week  
■ = Pb-Free Package

XXXXXX = Specific Device Code  
A = Assembly Location  
Y = Year  
WW = Work Week  
■ = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "■", may or may not be present. Some products may not follow the Generic Marking.

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

## STYLES ON PAGE 2

|                  |             |                                                                                                                                                                                  |
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| DESCRIPTION:     | SOIC-8 NB   | PAGE 1 OF 2                                                                                                                                                                      |

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**SOIC-8 NB**  
**CASE 751-07**  
**ISSUE AK**

DATE 16 FEB 2011

|                                                                                                                                                                                                   |                                                                                                                                                                                          |                                                                                                                                                                                    |                                                                                                                                                                                                        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>STYLE 1:</b><br>PIN 1. EMITTER<br>2. COLLECTOR<br>3. COLLECTOR<br>4. EMITTER<br>5. EMITTER<br>6. BASE<br>7. BASE<br>8. EMITTER                                                                 | <b>STYLE 2:</b><br>PIN 1. COLLECTOR, DIE, #1<br>2. COLLECTOR, #1<br>3. COLLECTOR, #2<br>4. COLLECTOR, #2<br>5. BASE, #2<br>6. EMITTER, #2<br>7. BASE, #1<br>8. EMITTER, #1               | <b>STYLE 3:</b><br>PIN 1. DRAIN, DIE #1<br>2. DRAIN, #1<br>3. DRAIN, #2<br>4. DRAIN, #2<br>5. GATE, #2<br>6. SOURCE, #2<br>7. GATE, #1<br>8. SOURCE, #1                            | <b>STYLE 4:</b><br>PIN 1. ANODE<br>2. ANODE<br>3. ANODE<br>4. ANODE<br>5. ANODE<br>6. ANODE<br>7. ANODE<br>8. COMMON CATHODE                                                                           |
| <b>STYLE 5:</b><br>PIN 1. DRAIN<br>2. DRAIN<br>3. DRAIN<br>4. DRAIN<br>5. GATE<br>6. GATE<br>7. SOURCE<br>8. SOURCE                                                                               | <b>STYLE 6:</b><br>PIN 1. SOURCE<br>2. DRAIN<br>3. DRAIN<br>4. SOURCE<br>5. SOURCE<br>6. GATE<br>7. GATE<br>8. SOURCE                                                                    | <b>STYLE 7:</b><br>PIN 1. INPUT<br>2. EXTERNAL BYPASS<br>3. THIRD STAGE SOURCE<br>4. GROUND<br>5. DRAIN<br>6. GATE 3<br>7. SECOND STAGE Vd<br>8. FIRST STAGE Vd                    | <b>STYLE 8:</b><br>PIN 1. COLLECTOR, DIE #1<br>2. BASE, #1<br>3. BASE, #2<br>4. COLLECTOR, #2<br>5. COLLECTOR, #2<br>6. EMITTER, #2<br>7. EMITTER, #1<br>8. COLLECTOR, #1                              |
| <b>STYLE 9:</b><br>PIN 1. EMITTER, COMMON<br>2. COLLECTOR, DIE #1<br>3. COLLECTOR, DIE #2<br>4. EMITTER, COMMON<br>5. EMITTER, COMMON<br>6. BASE, DIE #2<br>7. BASE, DIE #1<br>8. EMITTER, COMMON | <b>STYLE 10:</b><br>PIN 1. GROUND<br>2. BIAS 1<br>3. OUTPUT<br>4. GROUND<br>5. GROUND<br>6. BIAS 2<br>7. INPUT<br>8. GROUND                                                              | <b>STYLE 11:</b><br>PIN 1. SOURCE 1<br>2. GATE 1<br>3. SOURCE 2<br>4. GATE 2<br>5. DRAIN 2<br>6. DRAIN 2<br>7. DRAIN 1<br>8. DRAIN 1                                               | <b>STYLE 12:</b><br>PIN 1. SOURCE<br>2. SOURCE<br>3. SOURCE<br>4. GATE<br>5. DRAIN<br>6. DRAIN<br>7. DRAIN<br>8. DRAIN                                                                                 |
| <b>STYLE 13:</b><br>PIN 1. N.C.<br>2. SOURCE<br>3. SOURCE<br>4. GATE<br>5. DRAIN<br>6. DRAIN<br>7. DRAIN<br>8. DRAIN                                                                              | <b>STYLE 14:</b><br>PIN 1. N-SOURCE<br>2. N-GATE<br>3. P-SOURCE<br>4. P-GATE<br>5. P-DRAIN<br>6. P-DRAIN<br>7. N-DRAIN<br>8. N-DRAIN                                                     | <b>STYLE 15:</b><br>PIN 1. ANODE 1<br>2. ANODE 1<br>3. ANODE 1<br>4. ANODE 1<br>5. CATHODE, COMMON<br>6. CATHODE, COMMON<br>7. CATHODE, COMMON<br>8. CATHODE, COMMON               | <b>STYLE 16:</b><br>PIN 1. EMITTER, DIE #1<br>2. BASE, DIE #1<br>3. EMITTER, DIE #2<br>4. BASE, DIE #2<br>5. COLLECTOR, DIE #2<br>6. COLLECTOR, DIE #2<br>7. COLLECTOR, DIE #1<br>8. COLLECTOR, DIE #1 |
| <b>STYLE 17:</b><br>PIN 1. VCC<br>2. V2OUT<br>3. V1OUT<br>4. TXE<br>5. RXE<br>6. VEE<br>7. GND<br>8. ACC                                                                                          | <b>STYLE 18:</b><br>PIN 1. ANODE<br>2. ANODE<br>3. SOURCE<br>4. GATE<br>5. DRAIN<br>6. DRAIN<br>7. CATHODE<br>8. CATHODE                                                                 | <b>STYLE 19:</b><br>PIN 1. SOURCE 1<br>2. GATE 1<br>3. SOURCE 2<br>4. GATE 2<br>5. DRAIN 2<br>6. MIRROR 2<br>7. DRAIN 1<br>8. MIRROR 1                                             | <b>STYLE 20:</b><br>PIN 1. SOURCE (N)<br>2. GATE (N)<br>3. SOURCE (P)<br>4. GATE (P)<br>5. DRAIN<br>6. DRAIN<br>7. DRAIN<br>8. DRAIN                                                                   |
| <b>STYLE 21:</b><br>PIN 1. CATHODE 1<br>2. CATHODE 2<br>3. CATHODE 3<br>4. CATHODE 4<br>5. CATHODE 5<br>6. COMMON ANODE<br>7. COMMON ANODE<br>8. CATHODE 6                                        | <b>STYLE 22:</b><br>PIN 1. I/O LINE 1<br>2. COMMON CATHODE/VCC<br>3. COMMON CATHODE/VCC<br>4. I/O LINE 3<br>5. COMMON ANODE/GND<br>6. I/O LINE 4<br>7. I/O LINE 5<br>8. COMMON ANODE/GND | <b>STYLE 23:</b><br>PIN 1. LINE 1 IN<br>2. COMMON ANODE/GND<br>3. COMMON ANODE/GND<br>4. LINE 2 IN<br>5. LINE 2 OUT<br>6. COMMON ANODE/GND<br>7. COMMON ANODE/GND<br>8. LINE 1 OUT | <b>STYLE 24:</b><br>PIN 1. BASE<br>2. EMITTER<br>3. COLLECTOR/ANODE<br>4. COLLECTOR/ANODE<br>5. CATHODE<br>6. CATHODE<br>7. COLLECTOR/ANODE<br>8. COLLECTOR/ANODE                                      |
| <b>STYLE 25:</b><br>PIN 1. VIN<br>2. N/C<br>3. REXT<br>4. GND<br>5. IOUT<br>6. IOUT<br>7. IOUT<br>8. IOUT                                                                                         | <b>STYLE 26:</b><br>PIN 1. GND<br>2. dv/dt<br>3. ENABLE<br>4. ILIMIT<br>5. SOURCE<br>6. SOURCE<br>7. SOURCE<br>8. VCC                                                                    | <b>STYLE 27:</b><br>PIN 1. ILIMIT<br>2. OVLO<br>3. UVLO<br>4. INPUT+<br>5. SOURCE<br>6. SOURCE<br>7. SOURCE<br>8. DRAIN                                                            | <b>STYLE 28:</b><br>PIN 1. SW_TO_GND<br>2. DASIC_OFF<br>3. DASIC_SW_DET<br>4. GND<br>5. V_MON<br>6. VBULK<br>7. VBULK<br>8. VIN                                                                        |
| <b>STYLE 29:</b><br>PIN 1. BASE, DIE #1<br>2. EMITTER, #1<br>3. BASE, #2<br>4. EMITTER, #2<br>5. COLLECTOR, #2<br>6. COLLECTOR, #2<br>7. COLLECTOR, #1<br>8. COLLECTOR, #1                        | <b>STYLE 30:</b><br>PIN 1. DRAIN 1<br>2. DRAIN 1<br>3. GATE 2<br>4. SOURCE 2<br>5. SOURCE 1/DRAIN 2<br>6. SOURCE 1/DRAIN 2<br>7. SOURCE 1/DRAIN 2<br>8. GATE 1                           |                                                                                                                                                                                    |                                                                                                                                                                                                        |

|                         |                    |                                                                                                                                                                                     |
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