



**THE DATASHEET OF  
NCP1086D2T-ADJ**



# NCP1086

## 1.5 A Adjustable and 3.3 V Fixed Output Linear Regulator



ON Semiconductor®

<http://onsemi.com>

The NCP1086 linear regulator provides 1.5 A at 3.3 V or adjustable output voltage. The adjustable output voltage device uses two external resistors to set the output voltage within a 1.25 V to 5.5 V range.

The regulator is intended for use as post regulator and microprocessor supply. The fast loop response and low dropout voltage make this regulator ideal for applications where low voltage operation and good transient response are important.

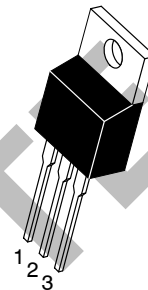
The circuit is designed to operate with dropout voltages less than 1.4 V at 1.5 A output current. Device protection includes overcurrent and thermal shutdown.

This device is pin compatible with LT1086 family of linear regulators and has lower dropout voltage.

The regulators are available in TO-220-3, surface mount D<sup>2</sup>PAK-3, and SOT-223 packages.

### Features

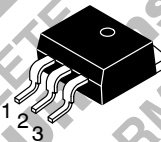
- Output Current to 1.5 A
- Output Accuracy to  $\pm 1\%$  Over Temperature
- Dropout Voltage (Typical) 1.05 V @ 1.5 A
- Fast Transient Response
- Fault Protection Circuitry
  - ◆ Current Limit
  - ◆ Thermal Shutdown
- Pb-Free Packages are Available



TO-220-3  
T SUFFIX  
CASE 221A

### Adjustable Output

Tab = V<sub>OUT</sub>  
Pin 1. Adj  
2. V<sub>OUT</sub>  
3. V<sub>IN</sub>



D<sup>2</sup>PAK-3  
DP SUFFIX  
CASE 418AB

### 3.3 V Fixed Output

Tab = V<sub>OUT</sub>  
Pin 1. GND  
2. V<sub>OUT</sub>  
3. V<sub>IN</sub>



SOT-223  
ST SUFFIX  
CASE 318E

### ORDERING INFORMATION

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

### DEVICE MARKING INFORMATION

See general marking information in the device marking section on page 10 of this data sheet.

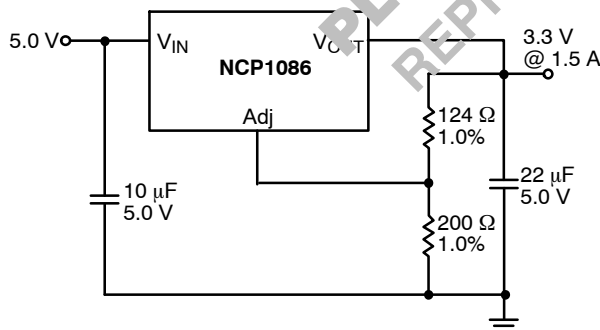


Figure 1. Application Diagram, Adjustable Output

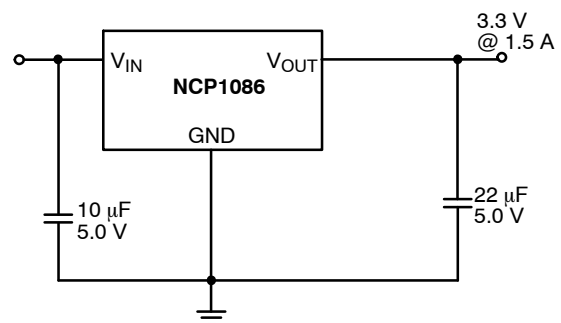


Figure 2. Application Diagram, 3.3 V Fixed Output

# NCP1086

## MAXIMUM RATINGS\*

| Parameter                   | Value  | Unit                 |    |
|-----------------------------|--|----------------------|----|
| Supply Voltage, $V_{CC}$    | 7.0  | V                    |    |
| Operating Temperature Range | -40 to +70   | °C                   |    |
| Junction Temperature        | 150  | °C                   |    |
| Storage Temperature Range   | -60 to +150  | °C                   |    |
| Lead Temperature Soldering: | Wave Solder (through hole styles only) Note 1<br>Reflow (SMD styles only) Note 2 | 260 Peak<br>230 Peak | °C |
| ESD Damage Threshold        | 2.0  | kV                   |    |

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.

- 10 second maximum.
- 60 second maximum above 183°C.

**ELECTRICAL CHARACTERISTICS** ( $C_{IN} = 10 \mu\text{F}$ ,  $C_{OUT} = 22 \mu\text{F}$  Tantalum,  $V_{OUT} + V_{DROPOUT} < V_{IN} < 7.0 \text{ V}$ ,  $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$ ,  $T_J \leq +150^\circ\text{C}$ , unless otherwise specified,  $I_{full load} = 1.5 \text{ A}$ .)

| Characteristic                       | Test Conditions   | Min            | Typ   | Max            | Unit          |
|--------------------------------------|---|----------------|-------|----------------|---------------|
| <b>ADJUSTABLE OUTPUT VOLTAGE</b>     |   |                |       |                |               |
| Reference Voltage (Notes 3 and 4)    | $V_{IN} - V_{OUT} = 1.5 \text{ V}$ ; $V_{Adj} = 0 \text{ V}$ ,<br>$10 \text{ mA} \leq I_{OUT} \leq 1.5 \text{ A}$                   | 1.241<br>(-1%) | 1.254 | 1.266<br>(+1%) | V             |
| Line Regulation                      | $1.5 \text{ V} \leq V_{IN} - V_{OUT} \leq 5.0 \text{ V}$ ; $I_{OUT} = 10 \text{ mA}$  | -              | 0.02  | 0.2            | %             |
| Load Regulation (Notes 3 and 4)      | $V_{IN} - V_{OUT} = 1.5 \text{ V}$ ; $10 \text{ mA} \leq I_{OUT} \leq 1.5 \text{ A}$  | -              | 0.04  | 0.4            | %             |
| Dropout Voltage (Note 5)             | $I_{OUT} = 1.5 \text{ A}$   | -              | 1.05  | 1.4            | V             |
| Current Limit                        | $V_{IN} - V_{OUT} = 3.0 \text{ V}$ ; $T_J \geq 25^\circ\text{C}$  | 1.6            | 3.1   | -              | A             |
| Minimum Load Current (Note 6)        | $V_{IN} - V_{OUT} = 1.5 \text{ V}$ ; $V_{Adj} = 0 \text{ V}$  | -              | 0.6   | 2.0            | mA            |
| Adjust Pin Current                   | $V_{IN} - V_{OUT} = 3.0 \text{ V}$ ; $I_{OUT} = 10 \text{ mA}$  | -              | 50    | 100            | $\mu\text{A}$ |
| Thermal Regulation (Note 7)          | 30 ms pulse; $T_A = 25^\circ\text{C}$   | -              | 0.002 | 0.02           | %/W           |
| Ripple Rejection (Note 7)            | $f_{RIPPLE} = 120 \text{ Hz}$ ; $I_{OUT} = 1.5 \text{ A}$ ; $V_{IN} - V_{OUT} = 3.0 \text{ V}$ ;<br>$V_{RIPPLE} = 1 \times V_{P-P}$ | -              | 80    | -              | dB            |
| Thermal Shutdown (Note 8)            |   | 150            | 180   | 210            | °C            |
| Thermal Shutdown Hysteresis (Note 8) |   | -              | 25    | -              | °C            |

## FIXED OUTPUT VOLTAGE

|                                 |  |                 |       |                 |     |
|---------------------------------|--|-----------------|-------|-----------------|-----|
| Output Voltage (Notes 3 and 4)  | $V_{IN} - V_{OUT} = 1.5 \text{ V}$ , $0 \leq I_{OUT} \leq 1.5 \text{ A}$             | 3.25<br>(-1.5%) | 3.3   | 3.35<br>(+1.5%) | V   |
| Line Regulation                 | $2.0 \text{ V} \leq V_{IN} - V_{OUT} \leq 3.7 \text{ V}$ ; $I_{OUT} = 10 \text{ mA}$ | -               | 0.02  | 0.2             | %   |
| Load Regulation (Notes 3 and 4) | $V_{IN} - V_{OUT} = 2.0 \text{ V}$ ; $10 \text{ mA} \leq I_{OUT} \leq 1.5 \text{ A}$ | -               | 0.04  | 0.4             | %   |
| Dropout Voltage (Note 5)        | $I_{OUT} = 1.5 \text{ A}$  | -               | 1.05  | 1.4             | V   |
| Current Limit                   | $V_{IN} - V_{OUT} = 3.0 \text{ V}$   | 1.6             | 3.1   | -               | A   |
| Quiescent Current               | $I_{OUT} = 10 \text{ mA}$  | -               | 5.0   | 10              | mA  |
| Thermal Regulation (Note 7)     | 30 ms pulse; $T_A = 25^\circ\text{C}$  | -               | 0.002 | 0.02            | %/W |

- Load regulation and output voltage are measured at a constant junction temperature by low duty cycle pulse testing. Changes in output voltage due to thermal gradients or temperature changes must be taken into account separately.
- Specifications apply for an external Kelvin sense connection at a point on the output pin 1/4" from the bottom of the package.
- Dropout voltage is a measurement of the minimum input/output differential at full load.
- The minimum load current is the minimum current required to maintain regulation. Normally the current in the resistor divider used to set the output voltage is selected to meet the minimum requirement.
- Guaranteed by design, not 100% tested in production.
- Thermal shutdown is 100% functionally tested in production.

# NCP1086

**ELECTRICAL CHARACTERISTICS (continued)** ( $C_{IN} = 10 \mu\text{F}$ ,  $C_{OUT} = 22 \mu\text{F}$  Tantalum,  $V_{OUT} + V_{DROPOUT} < V_{IN} < 7.0 \text{ V}$ ,  $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$ ,  $T_J \leq +150^\circ\text{C}$ , unless otherwise specified,  $I_{full\ load} = 1.5 \text{ A}$ .)

| Characteristic                          | Test Conditions   | Min | Typ | Max | Unit             |
|---|---|-----|-----|-----|------------------|
| <b>FIXED OUTPUT VOLTAGE (continued)</b> |   |     |     |     |                  |
| Ripple Rejection (Note 9)               | $f = 120 \text{ Hz}$ ; $I_{OUT} = 1.5 \text{ A}$ ; $V_{IN} - V_{OUT} = 3.0 \text{ V}$ ;<br>$V_{RIPPLE} = 1.0 \text{ V}_{P-P}$ | -   | 80  | -   | dB               |
| Thermal Shutdown (Note 10)              | -   | 150 | 180 | 210 | $^\circ\text{C}$ |
| Thermal Shutdown Hysteresis (Note 10)   | -   | -   | 25  | -   | $^\circ\text{C}$ |

9. Guaranteed by design, not 100% tested in production.  
10. Thermal shutdown is 100% functionally tested in production.

## PACKAGE PIN DESCRIPTION, ADJUSTABLE OUTPUT

| Package Pin Number   |          |         | Pin Symbol       | Function   |
|----------------------|----------|---------|------------------|--|
| D <sup>2</sup> PAK-3 | TO-220-3 | SOT-223 |                  |  |
| 1                    | 1        | 1       | Adj              | Adjust pin (low side of the internal reference). |
| 2                    | 2        | 2       | V <sub>OUT</sub> | Regulated output voltage (case).                 |
| 3                    | 3        | 3       | V <sub>IN</sub>  | Input voltage.                                   |

## PACKAGE PIN DESCRIPTION, 3.3 V FIXED OUTPUT

| Package Pin Number   |          |         | Pin Symbol       | Function                         |
|----------------------|----------|---------|------------------|----------------------------------|
| D <sup>2</sup> PAK-3 | TO-220-3 | SOT-223 |                  |                                  |
| 1                    | 1        | 1       | GND              | Ground connection.               |
| 2                    | 2        | 2       | V <sub>OUT</sub> | Regulated output voltage (case). |
| 3                    | 3        | 3       | V <sub>IN</sub>  | Input voltage.                   |

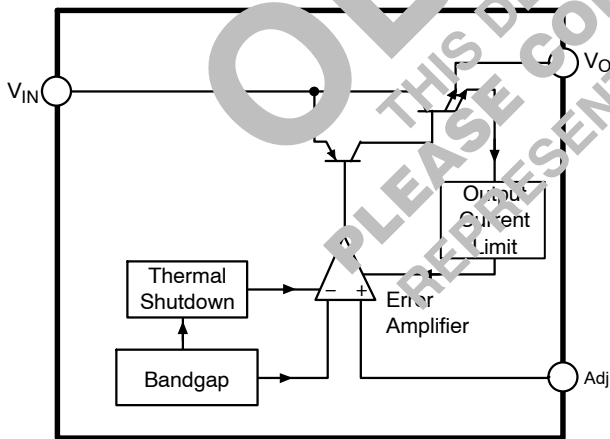


Figure 3. Block Diagram, Adjustable Output

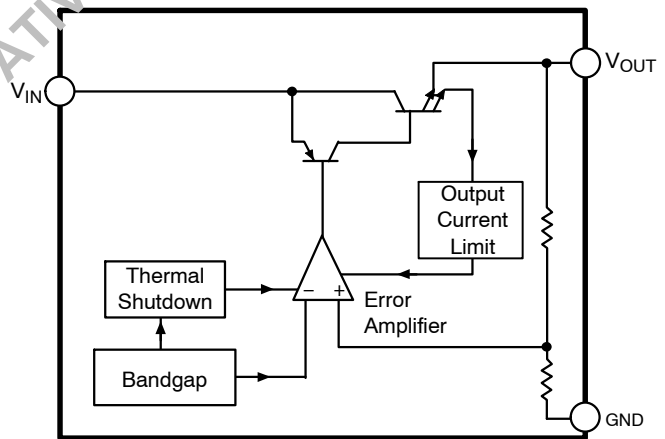


Figure 4. Block Diagram, 3.3 V Fixed Output

TYPICAL PERFORMANCE CHARACTERISTICS

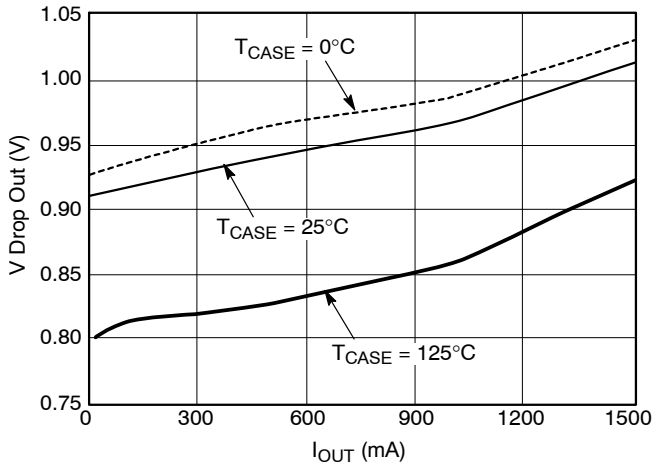


Figure 5. Dropout Voltage vs. Output Current

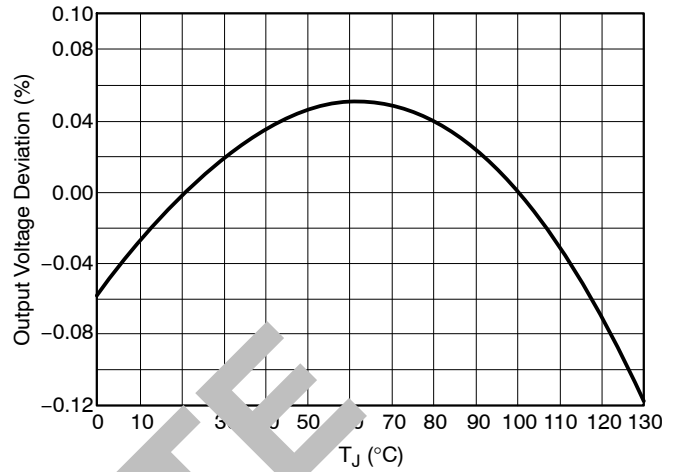


Figure 6. Reference Voltage vs. Temperature

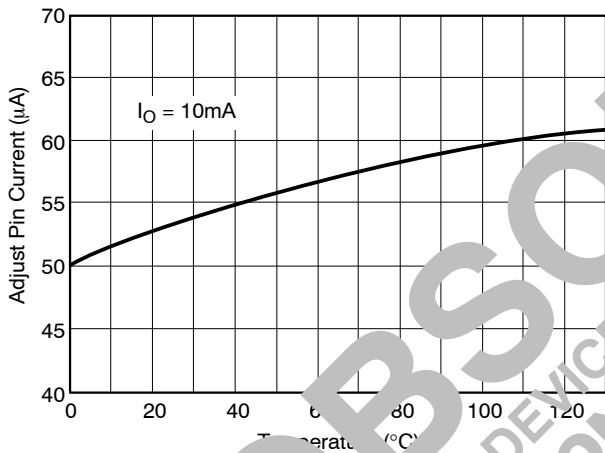


Figure 7. Adjust Pin Current vs. Temperature (Adjustable Output)

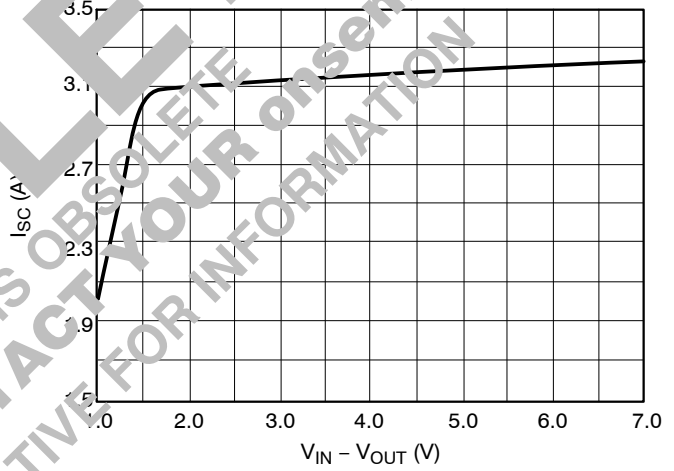


Figure 8. Short Circuit Current vs  $V_{IN} - V_{OUT}$

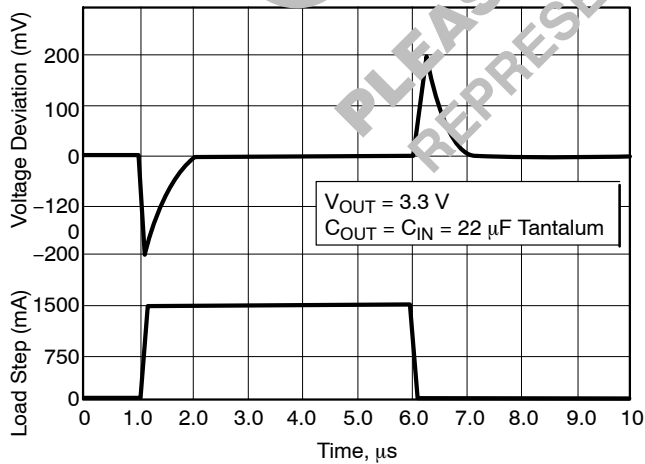


Figure 9. Transient Response (Adjustable Output)

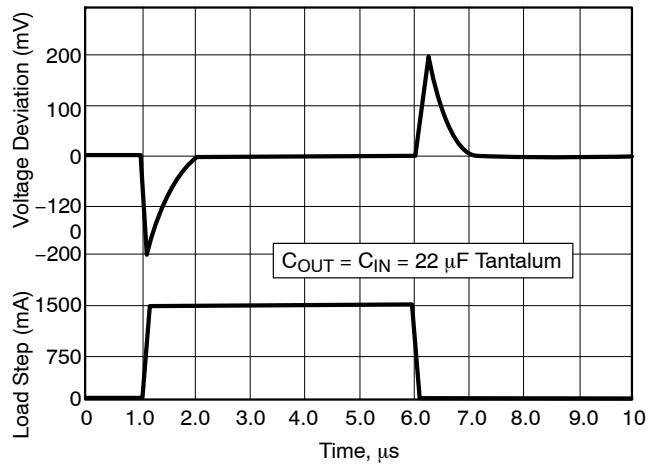


Figure 10. Transient Response (3.3 V Fixed Output)

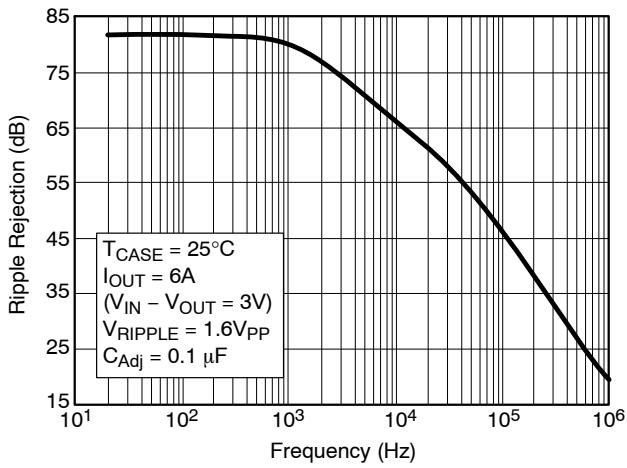


Figure 11. Ripple Rejection vs. Frequency (Adjustable Output)

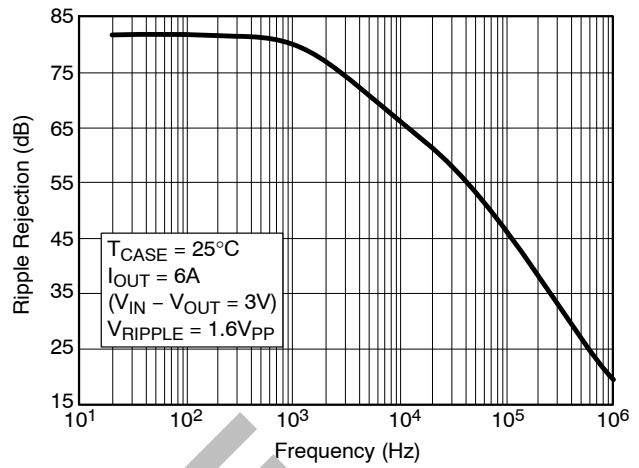


Figure 12. Ripple Rejection vs. Frequency (3.3V Fixed Output)

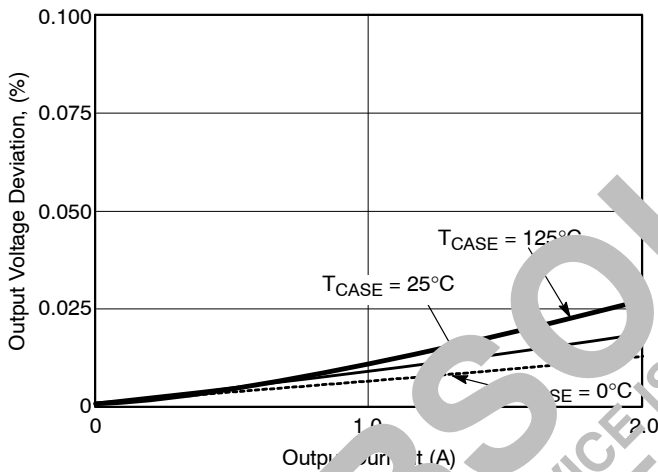


Figure 13. Load Regulation vs. Output Current (Adjustable Output)

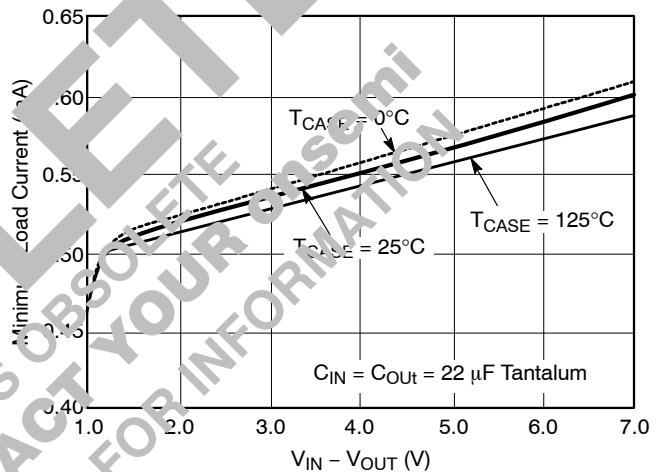


Figure 14. Minimum Load Current vs.  $V_{IN} - V_{OUT}$  (Adjustable Output)

### APPLICATIONS INFORMATION

The NCP1086 voltage regulator series provides adjustable and 3.3 V output voltages at currents up to 1.5 A. The regulator is protected against over-current conditions and includes thermal shutdown.

The NCP1086 series has a composite PNP-NPN output transistor and requires an output capacitor for stability. A detailed procedure for selecting this capacitor is included in the Stability Considerations section.

#### Adjustable Operation

The adjustable output device has an output voltage range of 1.25 V to 5.5 V. An external resistor divider sets the output voltage as shown in Figure 15. The regulator maintains a fixed 1.25 V (typical) reference between the output pin and the adjust pin.

A resistor divider network R1 and R2 causes a fixed current to flow to ground. This current creates a voltage across R2 that adds to the 1.25 V across R1 and sets the overall output voltage. The adjust pin current (typically 50  $\mu$ A) also flows through R2 and adds a small error that should be taken into account if precise adjustment of  $V_{OUT}$  is necessary.

The output voltage is set according to the formula:

$$V_{OUT} = V_{REF} \times \left( \frac{R1 + R2}{R1} \right) + I_{Adj} \times R2$$

The term  $I_{Adj} \times R2$  represents the error added by the adjust pin current.

R1 is chosen so that the minimum load current is at least 2.0 mA. R1 and R2 should be the same type, e.g. metal film for best tracking over temperature.

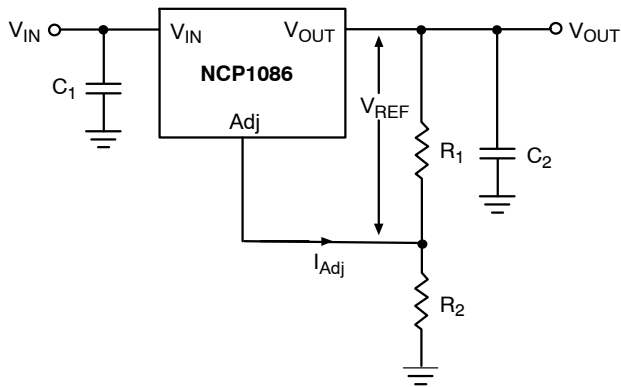


Figure 15. Resistor Divider Scheme

The adjustable output linear regulator has an absolute maximum specification of 7.0 V for the voltage difference between V<sub>IN</sub> and V<sub>OUT</sub>. However, the IC may be used to regulate voltages in excess of 7.0 V. The main considerations in such a design are powerup and short circuit capability.

In most applications, ramp-up of the power supply V<sub>IN</sub> is fairly slow, typically on the order of several tens of milliseconds, while the regulator responds in less than one microsecond. In this case, the linear regulator begins charging the load as soon as the V<sub>IN</sub> to V<sub>OUT</sub> differential is large enough that the pass transistor conducts current. The load at this point is essentially a short, and the supply voltage is on the order of several hundred mV, with the result that the pass transistor is in dropout. As the supply to V<sub>IN</sub> increases, the pass transistor will remain in dropout, and current is passed to the load until V<sub>OUT</sub> reaches the point at which the IC is in regulation. Further increase in the supply voltage brings the pass transistor out of dropout. The result is that the output voltage follows the power supply ramp-up, staying in dropout until the regulation point is reached. In this manner, any output voltage may be regulated. There is no theoretical limit to the regulated voltage as long as the V<sub>IN</sub> to V<sub>OUT</sub> differential of 7.0 V is not exceeded.

However, the possibility of destroying the IC in a short circuit condition is very real for this type of design. Short circuit conditions will result in the immediate operation of the pass transistor outside of its safe operating area. Overvoltage stresses will then cause destruction of the pass transistor before overcurrent or thermal shutdown circuitry can become active. Additional circuitry may be required to clamp the V<sub>IN</sub> to V<sub>OUT</sub> differential to less than 7.0 V if fail-safe operation is required. One possible clamp circuit is illustrated in Figure 16; however, the design of clamp circuitry must be done on an application by application basis. Care must be taken to ensure the clamp actually protects the design. Components used in the clamp design

must be able to withstand the short circuit condition indefinitely while protecting the IC.

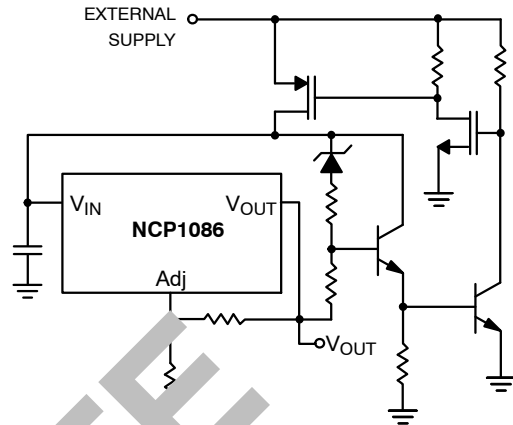


Figure 16. Short Circuit Protection Circuit for High Voltage Application

**Stability Considerations**

The output or compensation capacitor helps determine three main characteristics of a linear regulator: startup delay, load transient response and loop stability.

The capacitor value and type is based on cost, availability, size and temperature constraints. A tantalum or aluminum electrolytic capacitor is best, since a film or ceramic capacitor with almost zero ESR can cause instability. The aluminum electrolytic capacitor is the least expensive solution. However, when the circuit operates at low temperatures, both the value and ESR of the capacitor will vary considerably. The capacitor manufacturers' data sheet provides this information.

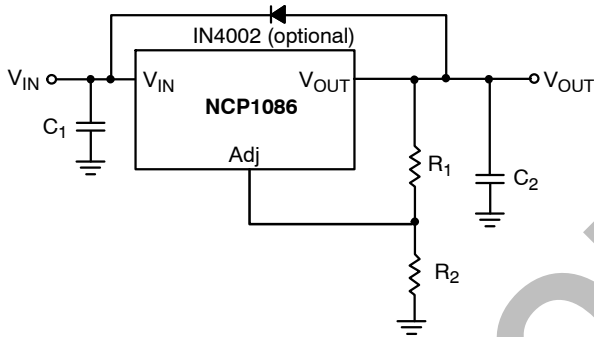
A 22 μF tantalum capacitor will work for most applications, but with high current regulators such as the NCP1086 series the transient response and stability improve with higher values of capacitance. The majority of applications for this regulator involve large changes in load current, so the output capacitor must supply the instantaneous load current. The ESR of the output capacitor causes an immediate drop in output voltage given by:

$$\Delta V = \Delta I \times ESR$$

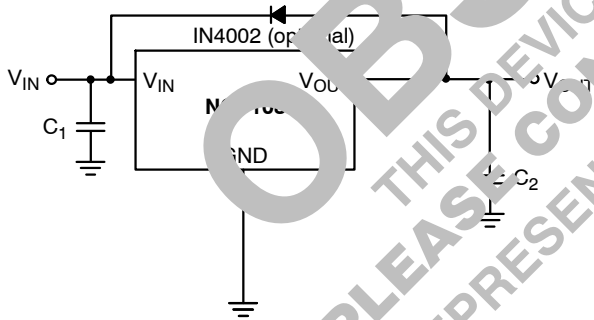
For microprocessor applications it is customary to use an output capacitor network consisting of several tantalum and ceramic capacitors in parallel. This reduces the overall ESR and reduces the instantaneous output voltage drop under load transient conditions. The output capacitor network should be as close as possible to the load for the best results.

**Protection Diodes**

When large external capacitors are used with a linear regulator it is sometimes necessary to add protection diodes. If the input voltage of the regulator gets shorted, the output capacitor will discharge into the output of the regulator. The discharge current depends on the value of the capacitor, the output voltage and the rate at which  $V_{IN}$  drops. In the NCP1086 series linear regulator, the discharge path is through a large junction and protection diodes are not usually needed. If the regulator is used with large values of output capacitance and the input voltage is instantaneously shorted to ground, damage can occur. In this case, a diode connected as shown in Figure 17 or Figure 18 is recommended.



**Figure 17. Protection Diode Scheme for Large Output Capacitors (Adjustable Output)**

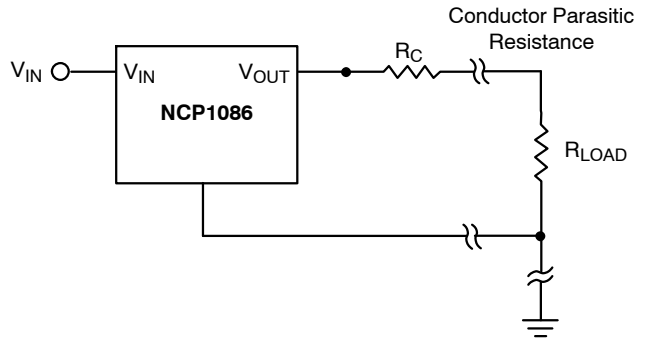


**Figure 18. Protection Diode Scheme for Large Output Capacitors (3.3 V Fixed Output)**

**Output Voltage Sensing**

Since the NCP1086 is a three terminal regulator, it is not possible to provide true remote load sensing. Load regulation is limited by the resistance of the conductors connecting the regulator to the load.

For best results the fixed output regulator should be connected as shown in Figure 19.

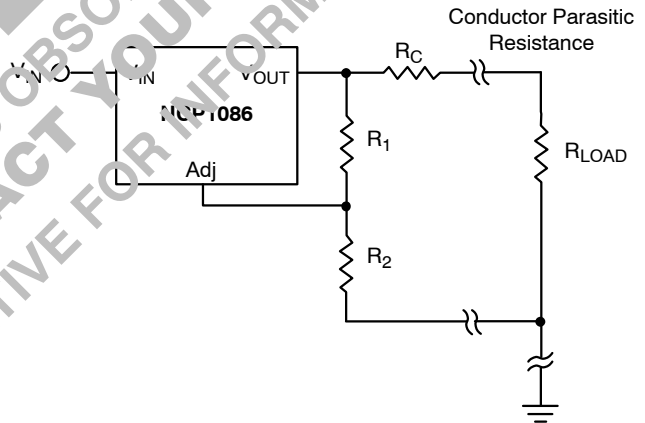


**Figure 19. Conductor Parasitic Resistance Effects Can Be Minimized with the Above Grounding Scheme for Fixed Output Regulators**

For the adjustable regulator, the best load regulation occurs when  $R1$  is connected directly to the output pin of the regulator as shown in Figure 20. If  $R1$  is connected to the load,  $R_C$  is multiplied by the divider ratio and the effective resistance between the regulator and the load becomes

$$R_C \times \frac{(R1 + R2)}{R1}$$

where  $R_C$  = conductor parasitic resistance.



**Figure 20. Grounding Scheme for the Adjustable Output Regulator to Minimize Parasitic Resistance Effects**

**Calculating Power Dissipation and Heatsink Requirements**

The NCP1086 linear regulator includes thermal shutdown and current limit circuitry to protect the device. High power regulators such as these usually operate at high junction temperatures so it is important to calculate the power dissipation and junction temperatures accurately to ensure that an adequate heatsink is used.

The case is connected to  $V_{OUT}$ , and electrical isolation may be required for some applications. Thermal compound should always be used with high current regulators such as these.

The thermal characteristics of an IC depend on the following four factors:

1. Maximum Ambient Temperature  $T_A$  ( $^{\circ}C$ )
2. Power dissipation  $P_D$  (W)
3. Maximum junction temperature  $T_J$  ( $^{\circ}C$ )
4. Thermal resistance junction to ambient  $R_{\theta JA}$  ( $^{\circ}C/W$ )

These four are related by the equation

$$T_J = T_A + P_D \times R_{\theta JA} \quad (\text{eq. 1})$$

The maximum ambient temperature and the power dissipation are determined by the design while the maximum junction temperature and the thermal resistance depend on the manufacturer and the package type.

The maximum power dissipation for a regulator is:

$$P_{D(\max)} = \{V_{IN(\max)} - V_{OUT(\min)}\}I_{OUT(\max)} + V_{IN(\max)}I_Q \quad (\text{eq. 2})$$

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.

$I_Q$  is the maximum quiescent current at  $I_{OUT(\max)}$ .

A heatsink 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 has a thermal resistance. Like series electrical resistances, these resistances are summed to determine  $R_{\theta JA}$ , the total thermal resistance between the junction and the surrounding air.

1. Thermal Resistance of the junction to case,  $R_{\theta JC}$  ( $^{\circ}C/W$ )
2. Thermal Resistance of the case to Heatsink,  $R_{\theta CS}$  ( $^{\circ}C/W$ )
3. Thermal Resistance of the Heatsink to the ambient air,  $R_{\theta SA}$  ( $^{\circ}C/W$ )

These are connected by the equation:

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

The value for  $R_{\theta SA}$  is calculated using Equation 3 and the result can be substituted in Equation 1.

The value for  $R_{\theta JC}$  is  $5^{\circ}C/W$ . For a high current regulator such as the NCP1086 the majority of the heat is generated in the power transistor section. The value for  $R_{\theta CS}$  depends on the heatsink type, while  $R_{\theta CS}$  depends on factors such as package type, heatsink interface (is an adhesive or another thermal grease used?), and the contact area between the heatsink and the package. Once these calculations are complete, the maximum permissible value of  $R_{\theta JA}$  can be calculated and the proper heatsink selected. For further discussion on heatsink selection, see application note "Thermal Management," document number AN180301D via our website at [www.onsemi.com](http://www.onsemi.com).

# NCP1086

## ORDERING INFORMATION

| Device           | Type       | Package                         | Shipping†        |
|------------------|------------|---------------------------------|------------------|
| NCP1086D2T-ADJ   | Adjustable | D <sup>2</sup> PAK              | 50 Units/Rail    |
| NCP1086D2T-ADJG  |            | D <sup>2</sup> PAK<br>(Pb-Free) | 50 Units/Rail    |
| NCP1086D2T-ADJR4 |            | D <sup>2</sup> PAK              | 750 Tape & Reel  |
| NCP1086D2TADJR4G |            | D <sup>2</sup> PAK<br>(Pb-Free) |                  |
| NCP1086ST-ADJT3  |            | SOT-223                         | 2500 Tape & Reel |
| NCP1086ST-ADJT3G |            | SOT-223<br>(Pb-Free)            |                  |
| NCP1086T-ADJ     |            | TO220                           | 50 Units/Rail    |
| NCP1086T-ADJG    |            | TO220<br>(Pb-Free)              |                  |
| NCP1086D2T-033   | 3.3 V      | D <sup>2</sup> PAK              | 50 Units/Rail    |
| NCP1086D2T-33R4  |            | D <sup>2</sup> PAK              | 750 Tape & Reel  |
| NCP1086D2T-33R4G |            | D <sup>2</sup> PAK<br>(Pb-Free) |                  |
| NCP1086ST-33T3   |            | SOT-223                         | 2500 Tape & Reel |
| NCP1086ST-33T3G  |            | SOT-223<br>(Pb-Free)            |                  |
| NCP1086T-033     |            | TO220                           | 50 Units/Rail    |
| NCP1086T-033G    |            | TO220<br>(Pb-Free)              |                  |

†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.

OBSOLETE

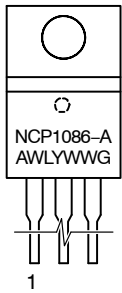
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REPRESENTATIVE FOR INFORMATION

# NCP1086

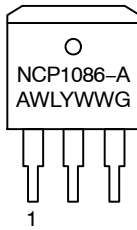
## MARKING DIAGRAMS

### Adjustable Output

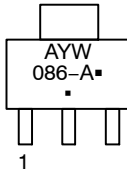
TO-220-3  
T SUFFIX  
CASE 221A



D<sup>2</sup>PAK-3  
D2T SUFFIX  
CASE 418AB

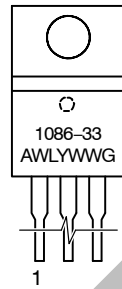


SOT-223  
ST SUFFIX  
CASE 318E

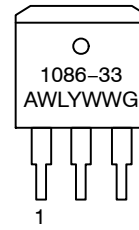


### 3.3 V Fixed Output

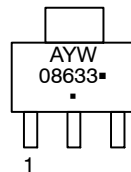
TO-220-3  
T SUFFIX  
CASE 221A



D<sup>2</sup>PAK-3  
D2T SUFFIX  
CASE 418AB



SOT-223  
ST SUFFIX  
CASE 318E



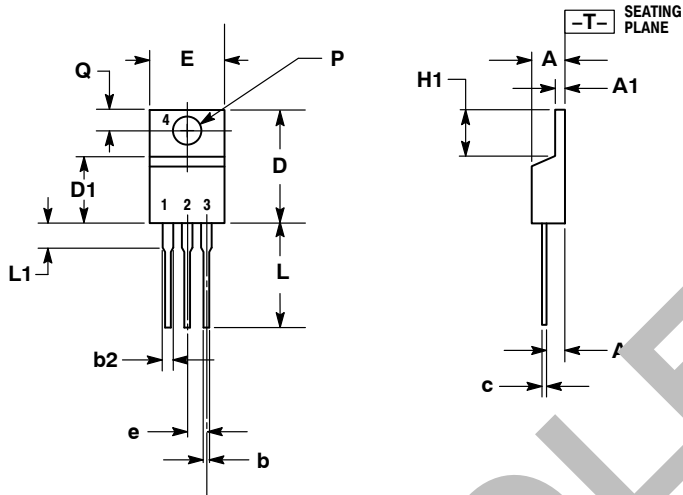
A = Assembly Location  
WL, L = Wafer Lot  
YY, Y = Year  
WW, W = Work Week  
G or ▪ = Pb-Free Package

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# NCP1086

## PACKAGE DIMENSIONS

TO-220 3-LEAD  
T SUFFIX  
CASE 221AF-01  
ISSUE A



**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCHES.
3. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH AND GATE PROTRUSIONS. MOLD FLASH AND GATE PROTRUSIONS NOT TO EXCEED 0.005 PER SIDE. THESE DIMENSIONS ARE TO BE MEASURED AT OUTERMOST EXTREME OF THE PLASTIC BODY.
3. DIMENSION b2 DOES NOT INCLUDE DAMBAR PROTRUSION. LEAD WIDTH INCLUDING PROTRUSION SHOULD NOT EXCEED 0.080.

| DIM | INCHES |       | MILLIMETERS |       |
|-----|--------|-------|-------------|-------|
|     | MIN    | MAX   | MIN         | MAX   |
| A   | 0.140  | 0.150 | 3.56        | 4.83  |
| A1  | 0.045  | 0.055 | 1.14        | 1.40  |
| A2  | 0.040  | 0.115 | 2.03        | 2.92  |
| b   | 0.040  | 0.040 | 0.64        | 1.02  |
| b2  | 0.045  | 0.070 | 1.14        | 1.78  |
| c   | 0.014  | 0.025 | 0.36        | 0.64  |
| D   | 0.560  | 0.625 | 14.22       | 15.88 |
| D1  | 0.320  | 0.390 | 8.13        | 9.91  |
| E   | 0.380  | 0.420 | 9.65        | 10.67 |
| e   | 0.100  | 0.100 | 2.54        | 2.54  |
| H1  | 0.235  | 0.255 | 5.97        | 6.48  |
| L   | 0.500  | 0.580 | 12.70       | 14.73 |
| L1  | 0.280  | 0.280 | 7.11        | 7.11  |
| P   | 0.139  | 0.151 | 3.53        | 4.09  |
| Q   | 0.100  | 0.100 | 2.54        | 3.43  |

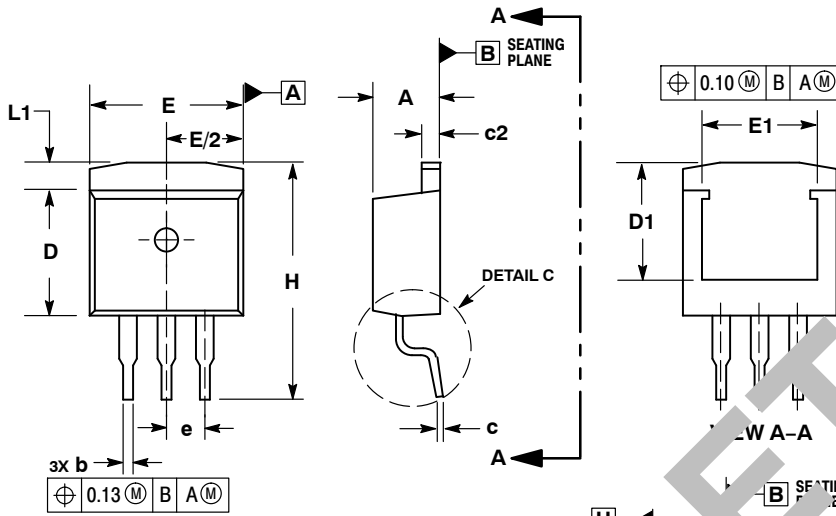
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# NCP1086

## PACKAGE DIMENSIONS

### D<sup>2</sup>PAK-3 CASE 418AB-01 ISSUE A

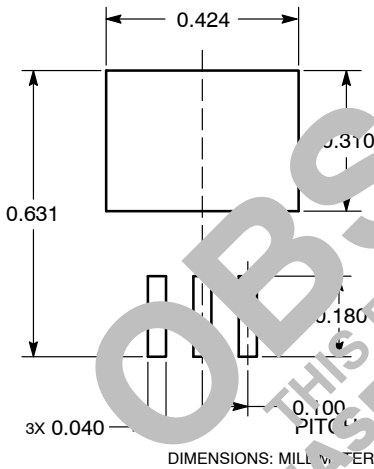


**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCHES.
3. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH AND GATE PROTRUSIONS. MOLD FLASH AND GATE PROTRUSIONS NOT TO EXCEED 0.005 MAXIMUM PER SIDE. THESE DIMENSIONS TO BE MEASURED AT DATUM H.
4. THERMAL PAD CONTOUR OPTIONAL WITHIN DIMENSIONS E, L1, D1, AND E1. DIMENSIONS D1 AND E1 ESTABLISH A MINIMUM MOUNTING SURFACE FOR THE THERMAL PAD.

| DIM | INCHES    |       | MILLIMETERS |          |
|-----|-----------|-------|-------------|----------|
|     | MIN       | MAX   | MIN         | MAX      |
| A   | 0.170     | 0.180 | 4.32        | 4.57     |
| A1  | 0.000     | 0.010 | 0.00        | 0.25     |
| A2  | 0.026     | 0.036 | 0.66        | 0.91     |
| A3  | 0.017     | 0.026 | 0.43        | 0.66     |
| c2  | 0.045     | 0.055 | 1.14        | 1.40     |
| D   | 0.325     | 0.338 | 8.25        | 9.53     |
| D1  | 0.270     | ---   | 6.86        | ---      |
| E   | 0.380     | 0.420 | 9.65        | 10.67    |
| E1  | 0.225     | ---   | 6.22        | ---      |
| e   | 0.100 BSC | ---   | 2.54 BSC    | ---      |
| H   | 0.580     | 0.620 | 14.73       | 15.75    |
| H1  | 0.090     | 0.110 | 2.29        | 2.79     |
| L1  | ---       | 0.066 | ---         | 1.68     |
| L3  | ---       | 0 BSC | ---         | 0.25 BSC |
| M   | 0°        | 8°    | 0°          | 8°       |

**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.

**PACKAGE THERMAL DATA**

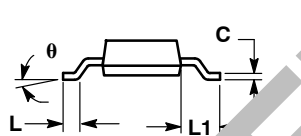
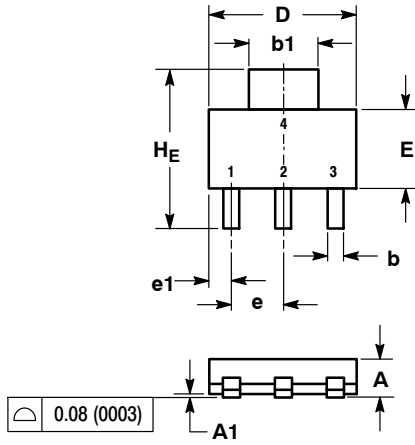
| Parameter        |         | TO-220-3 | D <sup>2</sup> PAK-3 | SOT-223 | Unit |
|------------------|---------|----------|----------------------|---------|------|
| R <sub>θJC</sub> | Typical | 3.5      | 3.5                  | 15      | °C/W |
| R <sub>θJA</sub> | Typical | 50       | 10-50*               | 156     | °C/W |

\* Depending on thermal properties of substrate. R<sub>θJA</sub> = R<sub>θJC</sub> + R<sub>θCA</sub>

# NCP1086

## PACKAGE DIMENSIONS

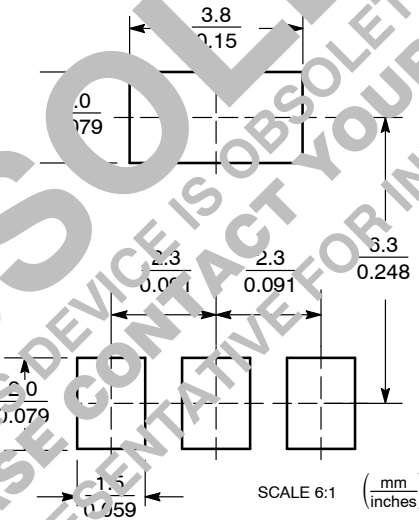
SOT-223 (TO-261)  
ST SUFFIX  
CASE 318E-04  
ISSUE N



- NOTES:  
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.  
2. CONTROLLING DIMENSION: INCH.

| DIM   | MILLIMETERS |      |      | INCHES |       |       |
|-------|-------------|------|------|--------|-------|-------|
|       | MIN         | NOM  | MAX  | MIN    | NOM   | MAX   |
| A     | 1.50        | 1.63 | 1.75 | 0.060  | 0.064 | 0.068 |
| A1    | 0.02        | 0.06 | 0.10 | 0.001  | 0.002 | 0.004 |
| b     | 0.60        | 0.75 | 0.89 | 0.024  | 0.030 | 0.035 |
| b1    | 2.90        | 3.06 | 3.20 | 0.115  | 0.121 | 0.126 |
| c     | 0.24        | 0.29 | 0.35 | 0.009  | 0.012 | 0.014 |
| D     | 6.70        | 6.70 | 6.70 | 0.249  | 0.256 | 0.263 |
| E     | 3.70        | 3.70 | 3.70 | 0.130  | 0.138 | 0.145 |
| e     | 2.30        | 2.30 | 2.40 | 0.087  | 0.091 | 0.094 |
| e1    | 0.80        | 0.94 | 1.05 | 0.033  | 0.037 | 0.041 |
| e2    | 0.20        | ---  | ---  | 0.008  | ---   | ---   |
| H     | 1.50        | ---  | 2.00 | 0.060  | 0.069 | 0.078 |
| H1    | 6.70        | 7.00 | 7.30 | 0.264  | 0.276 | 0.287 |
| theta | 0°          | ---  | 10°  | 0°     | ---   | 10°   |

### SOLDERING FOOTPRINT



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