# NCP693

# 1A CMOS Low-Dropout Voltage Regulator

The NCP693 series of fixed output low dropout linear regulators are designed for portable battery powered applications with high output current requirement up to 1 A. Each device contains a voltage reference unit, an error amplifier, a PMOS power transistor, resistors for setting output voltage, a current limit circuits for over−current and thermal−shutdown. A standby mode with ultra low supply current can be realized with the chip enable function.

The device is housed in the DFN 1.8x2, 0.50P surface mount package. Standard voltage versions are 0.8 V, 1.0 V, 1.2 V, 2.5 V and 3.3 V.

### Features

- Maximum Operating Voltage of 6.5 V
- Low Output Voltage Option down to 0.8 V
- High Accuracy Output Voltage of 1.0%
- Built−in Auto Discharge Function for D Version
- These are Pb−Free Devices

### Typical Applications

- Battery Powered Instruments
- Hand−Held Instruments
- Camcorders and Cameras
- Portable communication equipments

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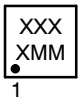
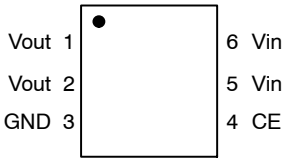
**MARKING DIAGRAM**

**UDFN6, 1.8x2, 0.5P**
**CASE 517BA**

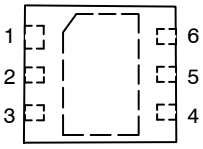



XXXX = Specific Device Code
MM = Lot Number

**PIN DESCRIPTION**




(Top View)




(Top View)

**ORDERING AND MARKING INFORMATION**

See detailed ordering and shipping information in the package dimensions section on page 11 of this data sheet.

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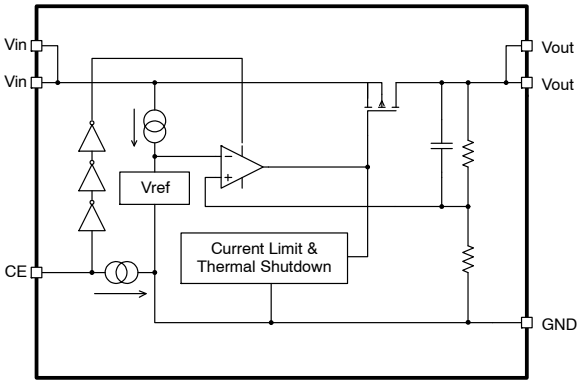
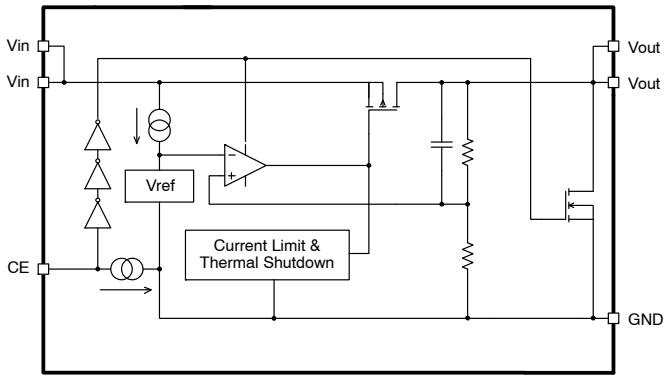
Publication Order Number:
NCP693/D




**Version H (NCP693HMNxxTCG)**




**Version D (NCP693DMNxxTCG)**

**Figure 1. Internal Block Diagram**

## PIN FUNCTION DESCRIPTION

| Pin No. | Pin Name | Description |
|---|---|---|
| 1 | $V_{out}$ | Regulated output voltage. |
| 2 | $V_{out}$ | Regulated output voltage. |
| 3 | GND | Power supply ground. |
| 4 | CE | This input is used to place the device into low−power standby. When this input is pulled low, the device is disabled. If this function is not used, Enable should be connected to $V_{in}$. |
| 5 | $V_{in}$ | Positive power supply input voltage. |
| 6 | $V_{in}$ | Positive power supply input voltage. |
| EP | GND | Power supply ground. |

## MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Input Voltage | $V_{in}$ | 7 | V |
| Enable Voltage | $V_{CE}$ | −0.3 to $V_{in}$ | V |
| Output Voltage | $V_{out}$ | −0.3 to $V_{in}$ + 0.3 | V |
| Operating Junction Temperature | $T_J$ | +150 | °C |
| Operating Ambient Temperature | $T_A$ | −40 to +85 | °C |
| Storage Temperature | $T_{stg}$ | −55 to +125 | °C |

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.

1. This device series contains ESD protection and exceeds the following tests:
   Human Body Model 2000 V per (JEDEC 22−A114−B)
   Machine Model Method 200 V

## THERMAL CHARACTERISTICS

| Rating | Symbol | Test Conditions | Typical Value | Unit |
|---|---|---|---|---|
| Junction−to−Ambient | $R_{\theta JA}$ | 1 oz Copper Thickness, 100 $mm^2$ | 114 | °C/W |
| PSIJ−Lead 2 | $\Psi_{J-L2}$ | 1 oz Copper Thickness, 100 $mm^2$ | 25 | °C/W |
| Power Dissipation | $P_D$ | | 880 | mW |

NOTE: Single component mounted on an 80 x 80 x 1.5 mm FR4 PCB with stated copper head spreading area. Using the following boundary conditions as stated in EIA/JESD 51−1, 2, 3, 7, 12.

**ELECTRICAL CHARACTERISTICS** ($V_{in}$ = $V_{out(nom)}$ + 1.0 V, $V_{CE}$ = $V_{in}$, $C_{in}$ = 2.2 μF, $C_{out}$ = 2.2 μF, $T_A$ = 25°C, unless otherwise noted)

| Characteristic | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Output Voltage ($T_A$ = 25°C, $I_{out}$ = 10 mA)<br>0.8 V<br>1.0 V<br>1.2 V<br>2.5 V<br>3.3 V | $V_{out}$ | <br>0.785<br>0.985<br>1.185<br>2.475<br>3.267 | <br>0.8<br>1.0<br>1.2<br>2.5<br>3.3 | <br>0.815<br>1.015<br>1.215<br>2.525<br>3.333 | V |
| Output Voltage ($T_A$ = – 40°C to 85°C, $I_{out}$ = 10 mA)<br>0.8 V<br>1.0 V<br>1.2 V<br>2.5 V<br>3.3 V | $V_{out}$ | <br>0.760<br>0.960<br>1.160<br>2.435<br>3.214 | <br>0.8<br>1.0<br>1.2<br>2.5<br>3.3 | <br>0.827<br>1.027<br>1.227<br>2.545<br>3.359 | V |
| Output Current | $I_{out}$ | | 1 | | A |
| Input Voltage | $V_{in}$ | 1.6 | | 6.5 | V |
| Line Regulation ($V_{in}$ = $V_{out}$ + 1.0 V to 6.5 V, $I_{out}$ = 10 mA) | $Reg_{line}$ | – | 0.05 | 0.1 | %/V |
| Load Regulation ($I_{out}$ = 1 mA to 300 mA, $V_{in}$ = $V_{out}$ + 2.0 V) | $Reg_{load03}$ | – | 20 | 40 | mV |
| Load Regulation ($I_{out}$ = 1 mA to 1 A, $V_{in}$ = $V_{out}$ + 2.0 V) | $Reg_{load1}$ | – | 80 | 120 | mV |
| Supply Current ($I_{out}$ = 0 A, $V_{in}$ = 6.5 V) | $I_{ss}$ | | 65 | 90 | μA |
| Standby Current ($V_{CE}$ = 0 V, $V_{in}$ = 6.5 V) | $I_{stby}$ | | 0.15 | 0.6 | μA |
| Short Current Limit ($V_{out}$ = 0 V) | $I_{sh}$ | | 250 | | mA |
| Output Voltage Temperature Coefficient | $T_c$ | – | ±100 | – | ppm/°C |
| Enable Input Threshold Voltage<br>(Voltage Increasing, Output Turns On, Logic High)<br>(Voltage Decreasing, Output Turns Off, Logic Low) | $V_{thCE}$ | <br>1.0<br>– | <br>–<br>– | <br>–<br>0.4 | V |
| Enable Pulldown Current | | | 0.3 | | μA |
| Drop Output Voltage ($T_A$ = 25°C, $I_{out}$ = 300 mA)<br>0.8 V<br>1.0 V<br>1.2 V<br>2.5 V<br>3.3 V | $V_{in}$–$V_{out}$ | | <br>0.670<br>0.450<br>0.300<br>0.150<br>0.130 | <br>0.780<br>0.610<br>0.500<br>0.310<br>0.170 | V |
| Drop Output Voltage ($T_A$ = 25°C, $I_{out}$ = 1 A)<br>0.8 V<br>1.0 V<br>1.2 V<br>2.5 V<br>3.3 V | $V_{in}$–$V_{out}$ | | <br>1.150<br>1.000<br>0.870<br>0.500<br>0.430 | <br>1.650<br>1.450<br>1.380<br>1.100<br>0.650 | V |
| Ripple Rejection (Ripple 200 $mV_{pp}$, $I_{out}$ = 100 mA, f = 1 kHz) | PSRR | | 70 | | dB |
| Output Noise (BW = 10 Hz to 100 kHz, $I_{out}$ = 1 mA) | $V_{noise}$ | | 45 | | μVrms |
| Thermal Shutdown Temperature/Hysteresis | $T_{shd}$/Hyst | | 165/30 | | °C |
| $R_{DS(on)}$ of additional output transistor (D version only) | $R_{DS(on)}$ | | 30 | | Ω |

2. Maximum package power dissipation limits must be observed.
3. Low duty cycle pulse techniques are used during testing to maintain the junction temperature as close to ambient as possible.

## APPLICATIONS INFORMATION

A typical application circuit for the NCP693 series is shown in Figure 2.

### Input Decoupling (C1)

A 2.2 μF capacitor either ceramic or tantalum is recommended and should be connected as close as possible to the pins of NCP693 device. Higher values and lower ESR will improve the overall line transient response.

### Output Decoupling (C2)

The minimum decoupling value is 2.2 μF and can be augmented to fulfill stringent load transient requirements. The regulator accepts ceramic chip capacitors as well as tantalum devices. If a tantalum capacitor is used, and its ESR is large, the loop oscillation may result. Because of this, select C2 carefully considering its frequency characteristics. Larger values improve noise rejection and load regulation transient response.

### Enable Operation

The enable pin CE will turn on or off the regulator. These limits of threshold are covered in the electrical specification section of this data sheet. If the enable is not used then the pin should be connected to $V_{in}$. The D version devices (NCP693DMNxxTCG) have additional circuitry in order to reach the turn−off speed faster than normal type. When the mode is into standby with CE signal, auto discharge transistor turns on.

### Hints

Please be sure the $V_{in}$ and GND lines are sufficiently wide. If their impedance is high, noise pickup or unstable operation may result.

Set external components, especially the output capacitor, as close as possible to the circuit, and make leads as short as possible.

### Thermal

As power across the NCP693 increases, it might become necessary to provide some thermal relief. The maximum power dissipation supported by the device is dependent upon board design and layout. Mounting pad configuration on the PCB, the board material, and also the ambient temperature effect the rate of temperature rise for the part. This is stating that when the NCP693 has good thermal conductivity through the PCB, the junction temperature will be relatively low with high power dissipation applications.

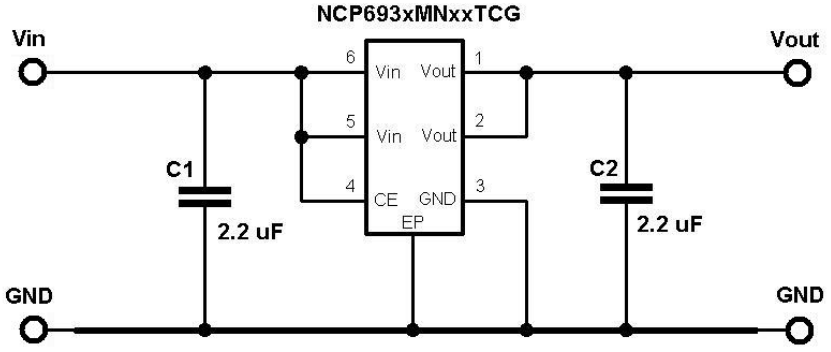



**Figure 2. Typical Application Circuit**

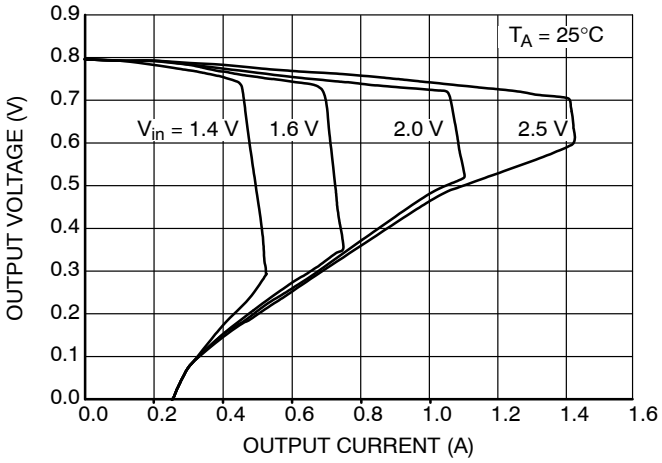



**Figure 3. Output Voltage vs. Output Current NCP693xMN08TCG**

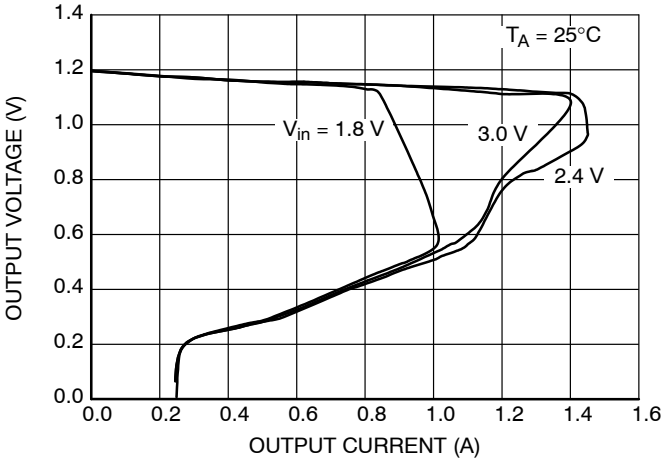



**Figure 4. Output Voltage vs. Output Current NCP693xMN12TCG**

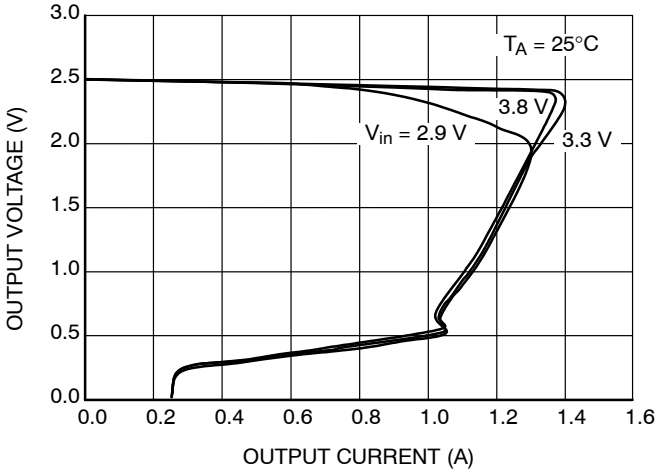



**Figure 5. Output Voltage vs. Output Current NCP693xMN25TCG**

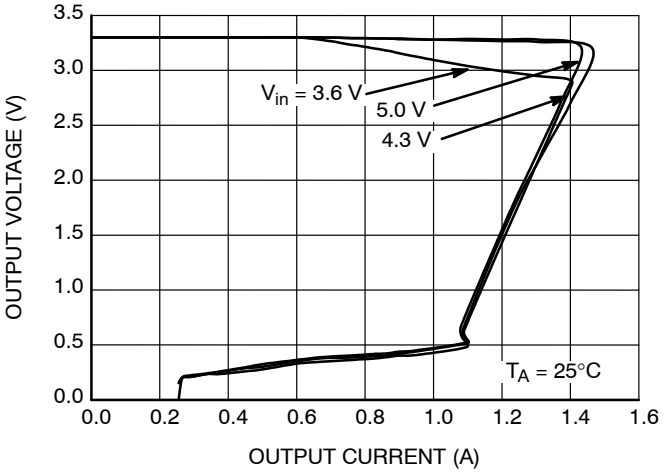



**Figure 6. Output Voltage vs. Output Current NCP693xMN33TCG**

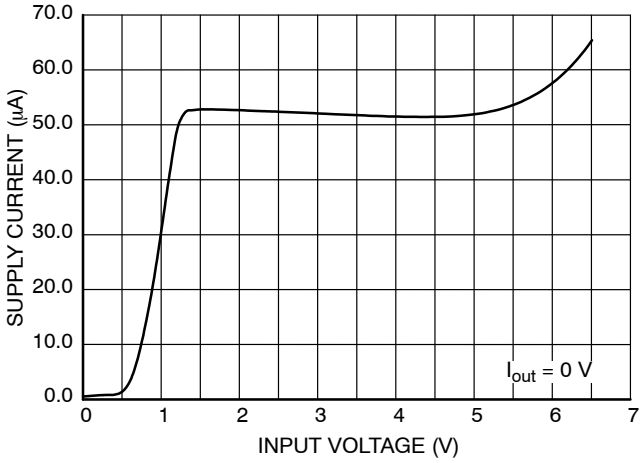



**Figure 7. Supply Current vs. Input Voltage NCP693xMN08TCG**

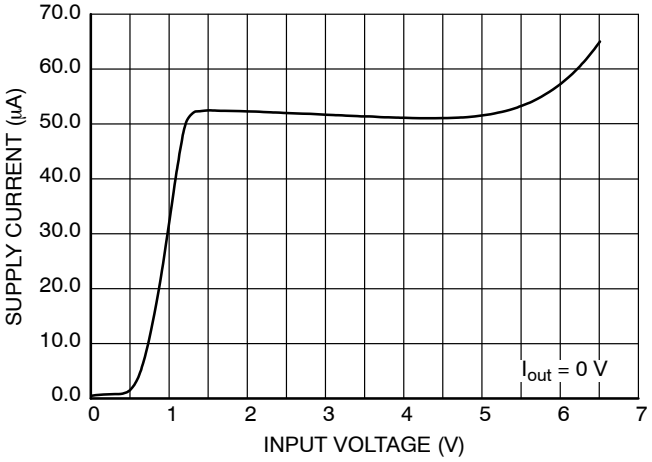



**Figure 8. Supply Current vs. Input Voltage NCP693xMN12TCG**

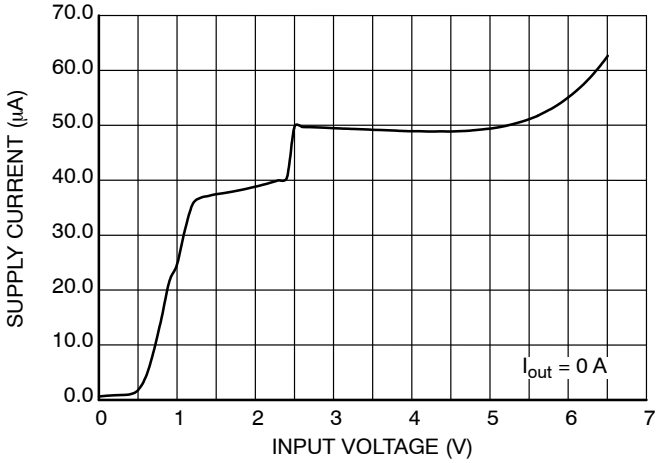



**Figure 9. Supply Current vs. Input Voltage NCP693xMN25TCG**

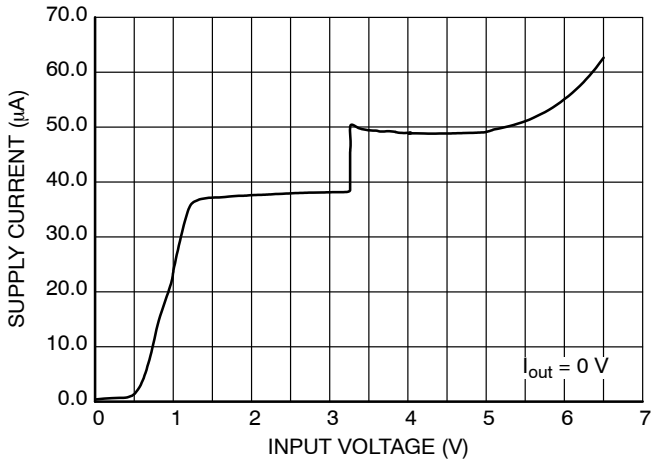



**Figure 10. Supply Current vs. Input Voltage NCP693xMN33TCG**

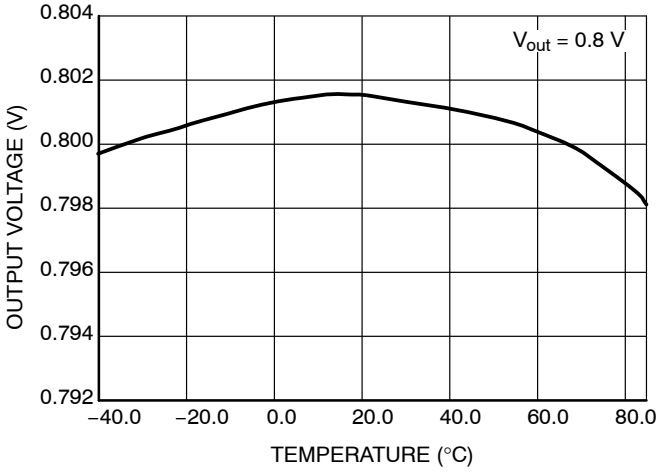



**Figure 11. Output Voltage vs. Temperature NCP693xMN08TCG**

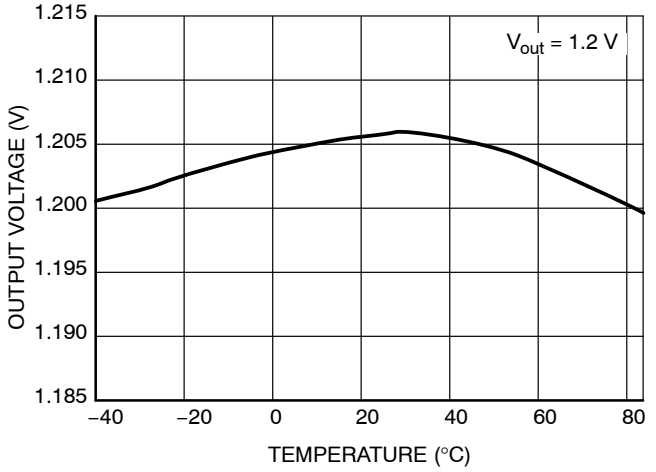



**Figure 12. Output Voltage vs. Temperature NCP693xMN12TCG**

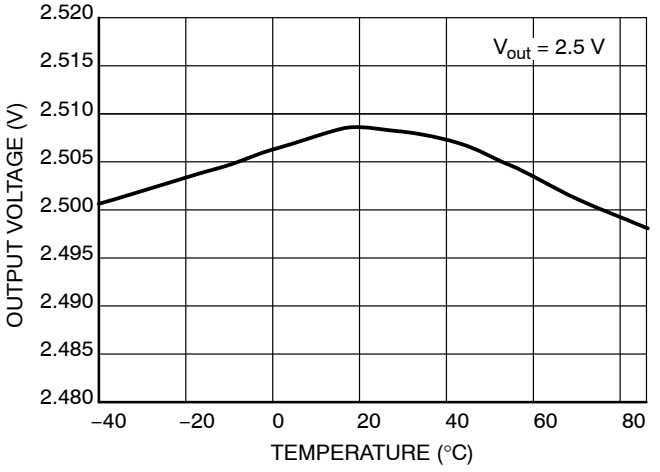



**Figure 13. Output Voltage vs. Temperature NCP693xMN25TCG**

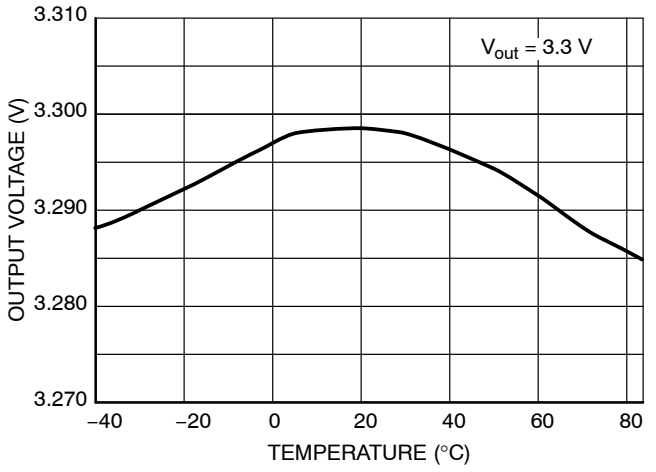



**Figure 14. Output Voltage vs. Temperature NCP693xMN33TCG**

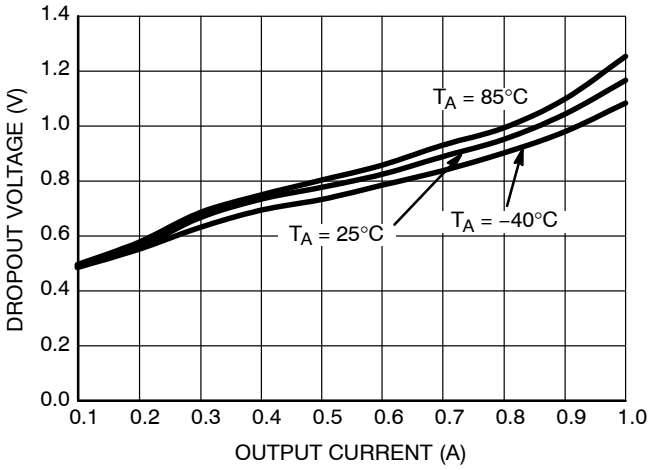



**Figure 15. Dropout Voltage vs. Output Current NCP693xMN08TCG**

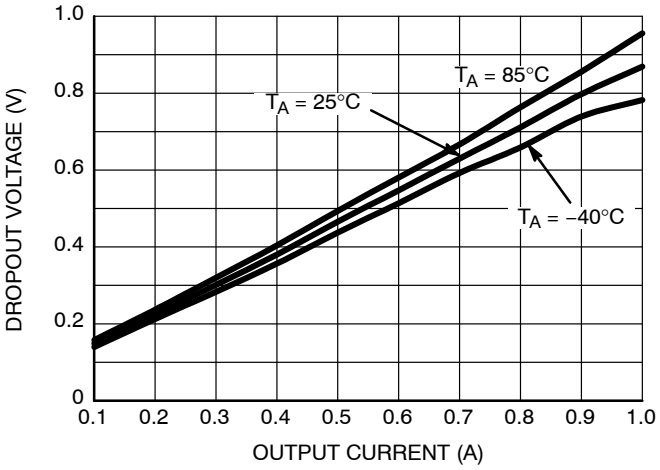



**Figure 16. Dropout Voltage vs. Output Current NCP693xMN12TCG**

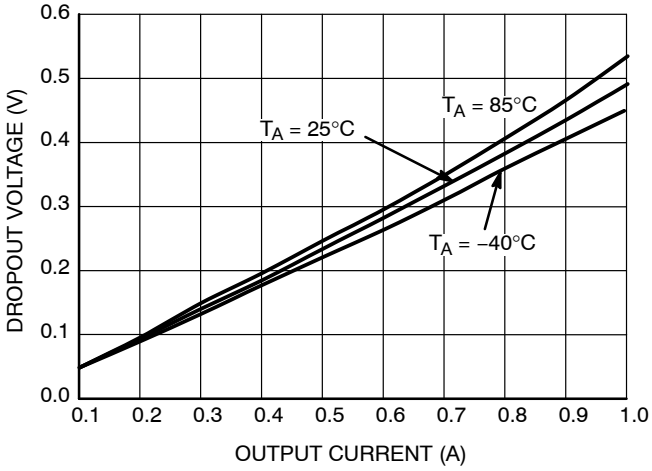



**Figure 17. Dropout Voltage vs. Output Current NCP693xMN25TCG**

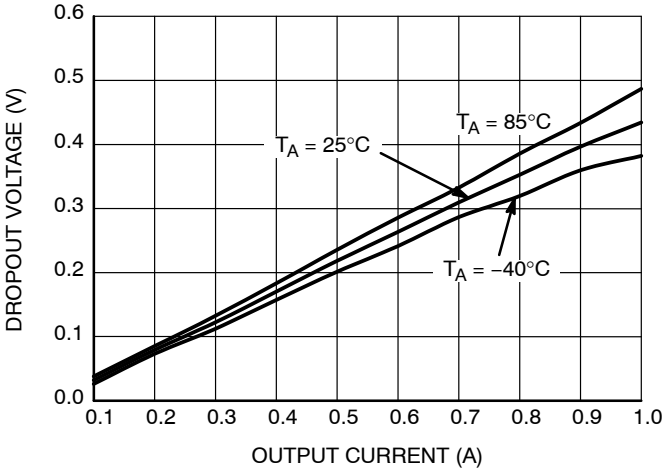



**Figure 18. Dropout Voltage vs. Output Current NCP693xMN33TCG**

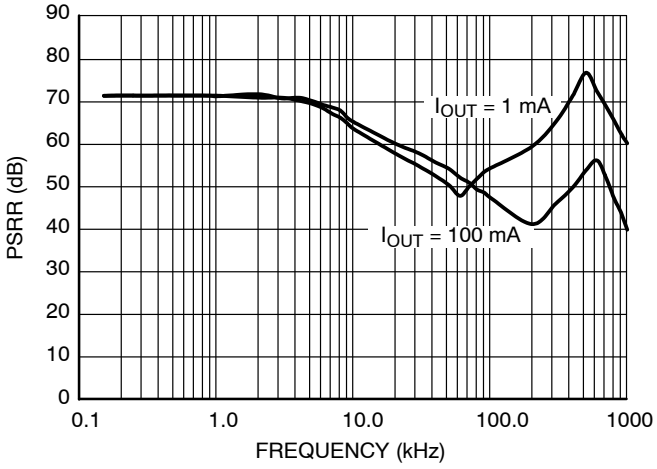



**Figure 19. PSRR vs. Frequency NCP693xMN08TCG**

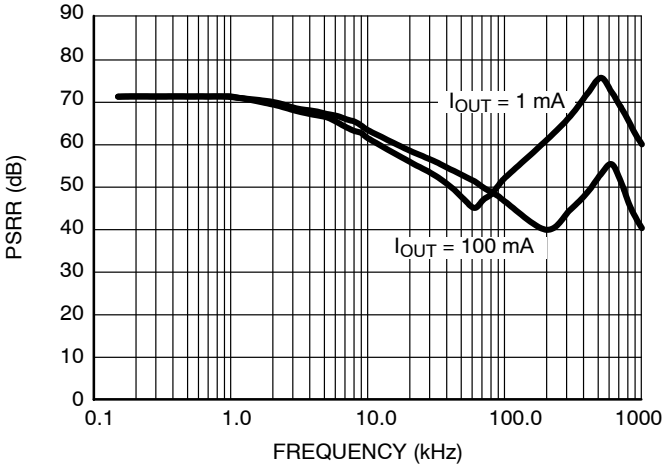



**Figure 20. PSRR vs. Frequency NCP693xMN12TCG**

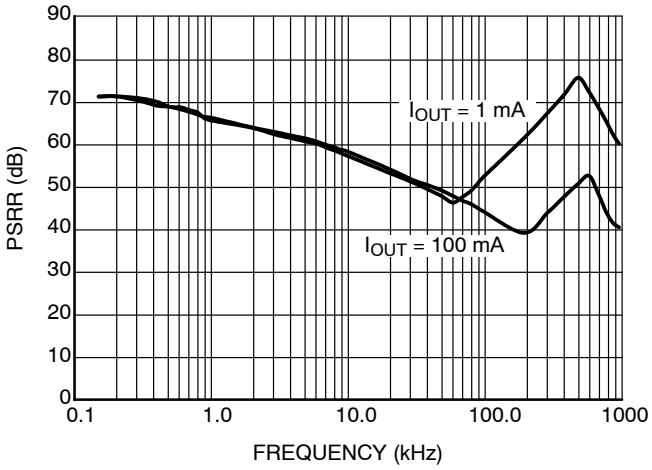



**Figure 21. PSRR vs. Frequency NCP693xMN25TCG**

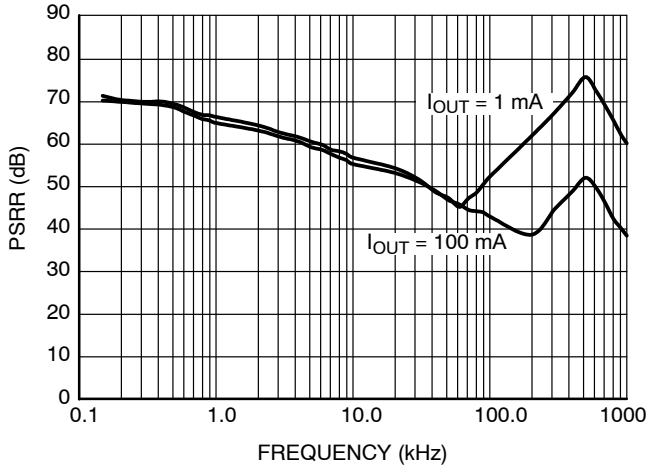



**Figure 22. PSRR vs. Frequency NCP693xMN33TCG**

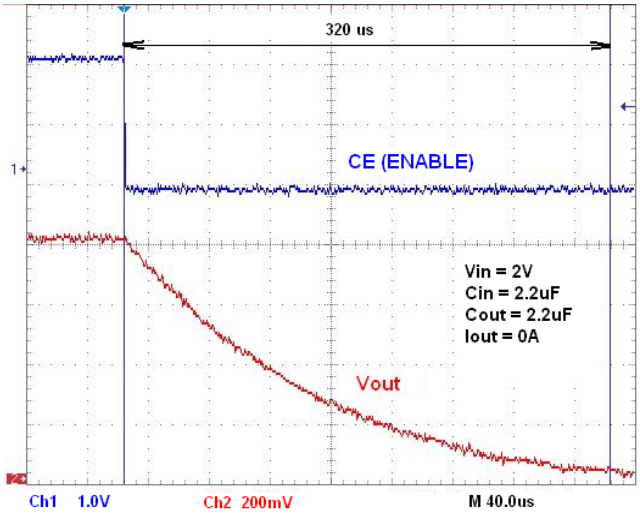



**Figure 23. Turn Off Speed NCP693DMN08TCG**

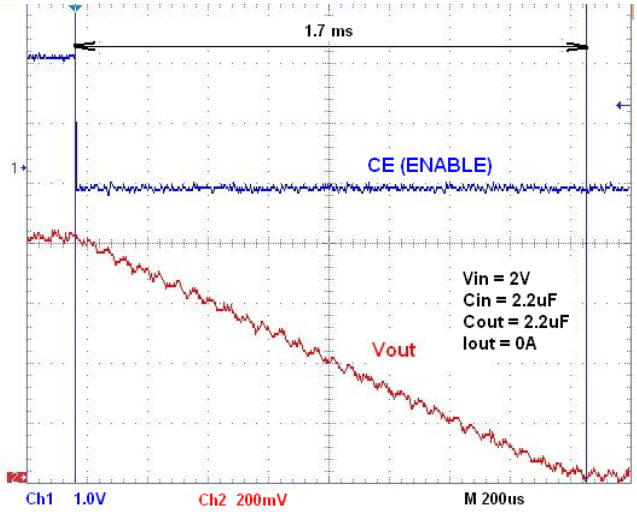



**Figure 24. Turn Off Speed NCP693HMN08TCG**

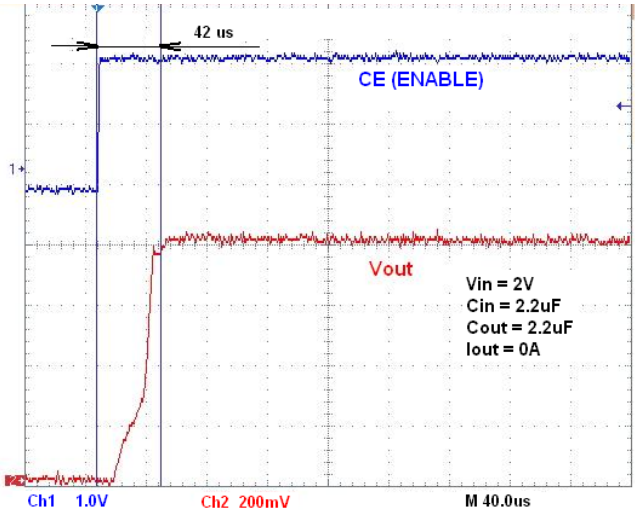



**Figure 25. Turn On Speed NCP693xMN08CTG**

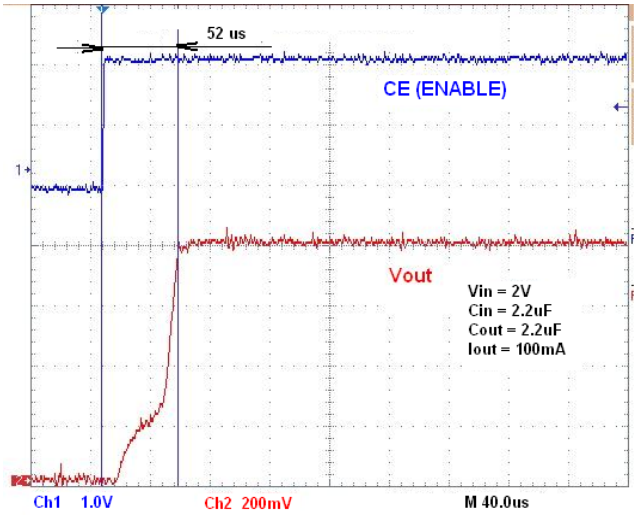



**Figure 26. Turn On Speed NCP693xMN08CTG**

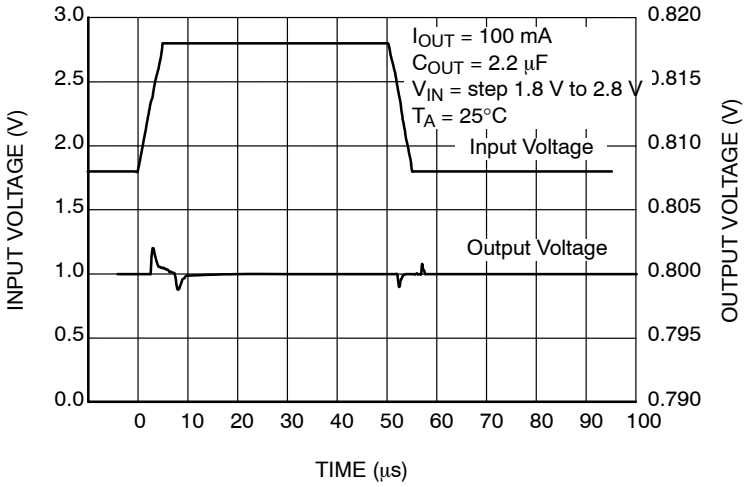



**Figure 27. Input Response NCP693xMN08TCG**

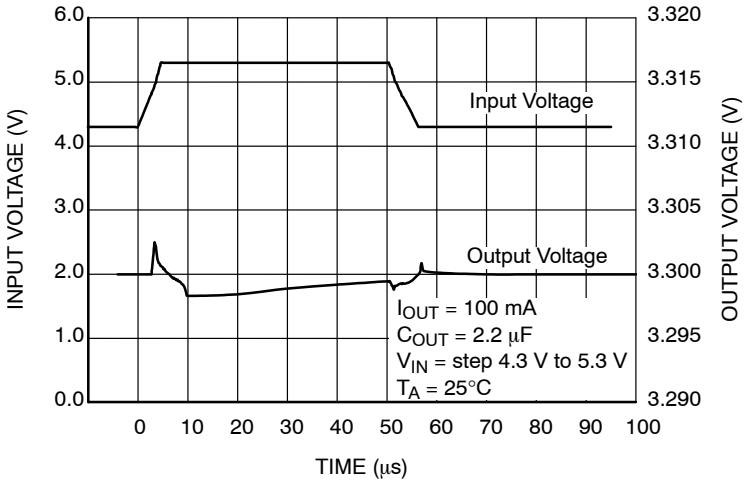



**Figure 28. Input Response NCP693xMN33TCG**

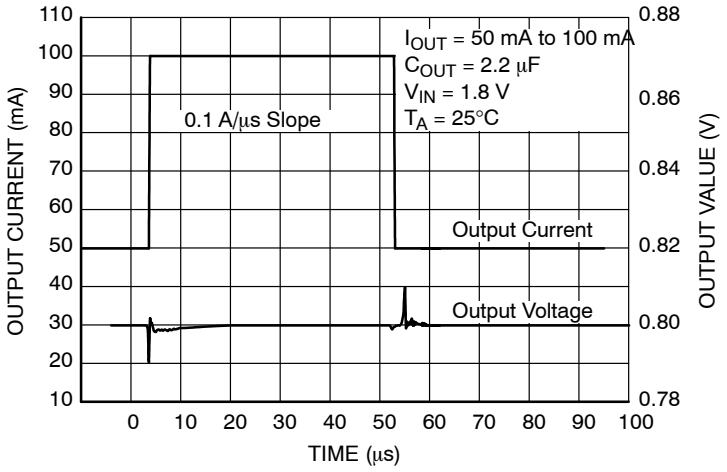



**Figure 29. Input Response NCP693xMN08TCG**

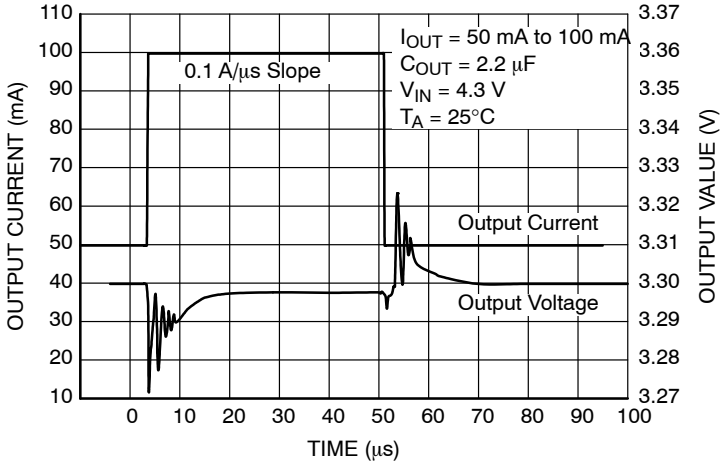



**Figure 30. Input Response NCP693xMN33TCG**

## ORDERING INFORMATION

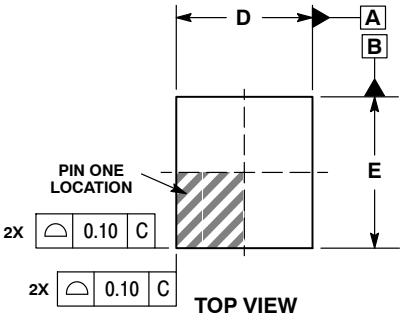
| Device | Nominal Output Voltage | Marking | Package | Shipping† |
|---|---|---|---|---|
| NCP693HMN08TCG | 0.8 | AM01 | DFN (Pb−Free) | 5000 / Tape & Reel |
| NCP693HMN10TCG | 1.0 | AM03 | DFN (Pb−Free) | 5000 / Tape & Reel |
| NCP693HMN12TCG | 1.2 | AM06 | DFN (Pb−Free) | 5000 / Tape & Reel |
| NCP693HMN25TCG | 2.5 | AM20 | DFN (Pb−Free) | 5000 / Tape & Reel |
| NCP693HMN33TCG | 3.3 | AM29 | DFN (Pb−Free) | 5000 / Tape & Reel |
| NCP693DMN08TCG | 0.8 | AN01 | DFN (Pb−Free) | 5000 / Tape & Reel |
| NCP693DMN10TCG | 1.0 | AN03 | DFN (Pb−Free) | 5000 / Tape & Reel |
| NCP693DMN12TCG | 1.2 | AN06 | DFN (Pb−Free) | 5000 / Tape & Reel |
| NCP693DMN25TCG | 2.5 | AN20 | DFN (Pb−Free) | 5000 / Tape & Reel |
| NCP693DMN33TCG | 3.3 | AN29 | DFN (Pb−Free) | 5000 / 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.

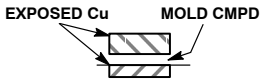
**UDFN6, 1.8x2, 0.5P**
CASE 517BA−01
ISSUE A

DATE 08 SEP 2009

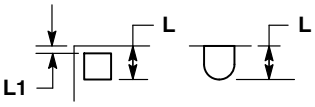
**SCALE 4:1**



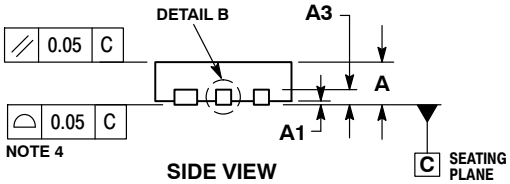

**TOP VIEW**



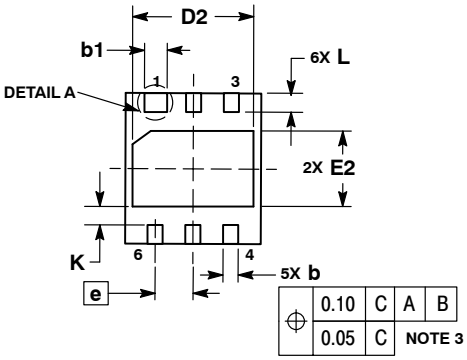

**DETAIL B**
**OPTIONAL CONSTRUCTIONS**




**DETAIL A**
**OPTIONAL CONSTRUCTIONS**




**SIDE VIEW**

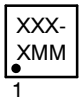



**BOTTOM VIEW**

NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.20mm FROM THE TERMINAL TIP.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

| | MILLIMETERS | |
|---|---|---|
| DIM | MIN | MAX |
| A | 0.50 | 0.60 |
| A1 | 0.00 | 0.05 |
| A3 | 0.20 REF | |
| b | 0.15 | 0.30 |
| b1 | 0.20 | 0.40 |
| D | 1.80 BSC | |
| D2 | 1.50 | 1.70 |
| E | 2.00 BSC | |
| E2 | 0.90 | 1.10 |
| e | 0.50 BSC | |
| K | 0.20 | --- |
| L | 0.15 | 0.35 |
| L1 | --- | 0.10 |

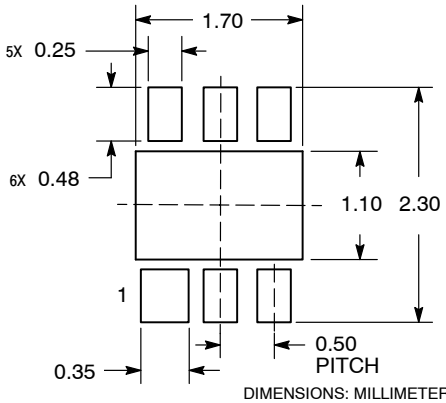
**GENERIC MARKING DIAGRAM***




XXXX = Specific Device Code
MM = Lot Number

*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.

**RECOMMENDED MOUNTING FOOTPRINT***




DIMENSIONS: MILLIMETERS

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

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|---|---|---|
| DESCRIPTION: | UDFN6 1.8X2, 0.5P | PAGE 1 OF 1 |


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