

# Linear Voltage Regulator 2 A Low Noise Very Low Dropout with Charge Pump



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## Product Preview NCP59762

The NCP59762 is a 2 A, low noise, very low dropout linear regulator (VLDO) equipped with the NMOS pass transistor and internal charge pump (without external bias voltage).

The high output current capability with high accuracy, broad bandwidth high PSRR and low noise makes this VLDOs ideal for powering noise sensitive high speed communication devices, high end FPGAs, microprocessors, power demanding ADCs, DACs and RF components.

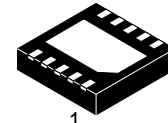
### Features

- High Output Current 2 A
- High Accuracy  $\pm 1\%$  Including Line/Load Regulation and Temperature Variation
- Input Voltage Range: 1.1 V to 3.6 V
- Fixed and Adjustable Voltage Versions Available
- Output Voltage Range: 0.5 V to 2.0 V (both Fixed and Adjustable)
- Dropout Voltage: 45 mV typ. at 2 A
- Very Low Output Voltage Noise:  $4.5 \mu\text{V}_{\text{RMS}}$  typ. (10 Hz – 100 kHz)
- Excellent Transient Response
- Low Quiescent Current Consumption: 1.1 mA typ.
- Programmable Soft Start
- Open Drain Power Good Output with Programmable Delay
- Stable with a 47  $\mu\text{F}$  or Larger Ceramic Output Capacitor
- DFN–10 3.0 x 3.0 mm Package
- These are Pb–Free Devices

### Typical Applications

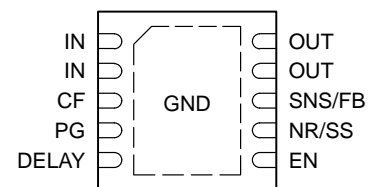
- High Speed Analog VCO, ADC, DAC
- FPGAs, DSPs, SerDes
- Imaging Sensors and ASICs
- Communications, Test, Measurement

This document contains information on a product under development. ON Semiconductor reserves the right to change or discontinue this product without notice.



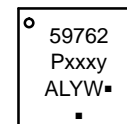
1  
DFN10 – 3 x 3  
CASE 506EH

### PIN ASSIGNMENT



(Top View)

### MARKING DIAGRAM



59762P = Specific Device Code  
xxx = Output Voltage Version  
y = Output Discharge Version  
A = Assembly Location  
L = Wafer Lot  
Y = Year  
W = Work Week  
▪ = Pb–Free Package

(Note: Microdot may be in either location)

### ORDERING INFORMATION

See detailed ordering and shipping information on page 7 of this data sheet.

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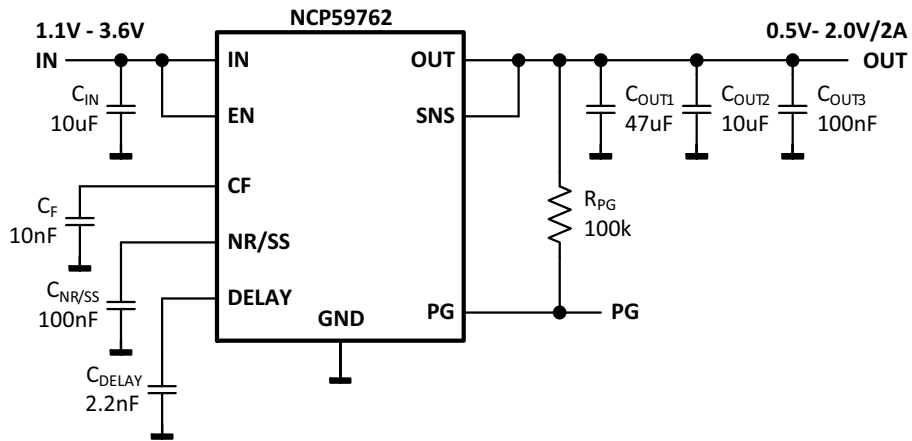


Figure 1. Typical Application Schematic (Fixed Voltage)

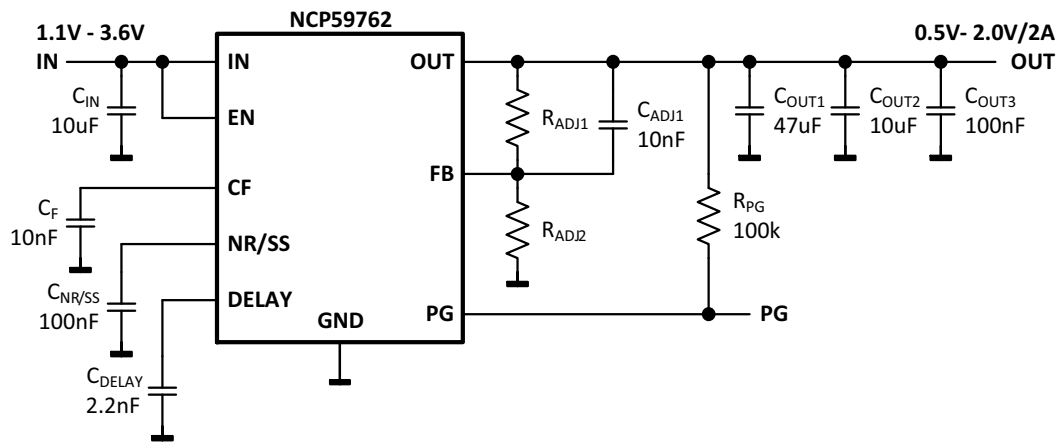
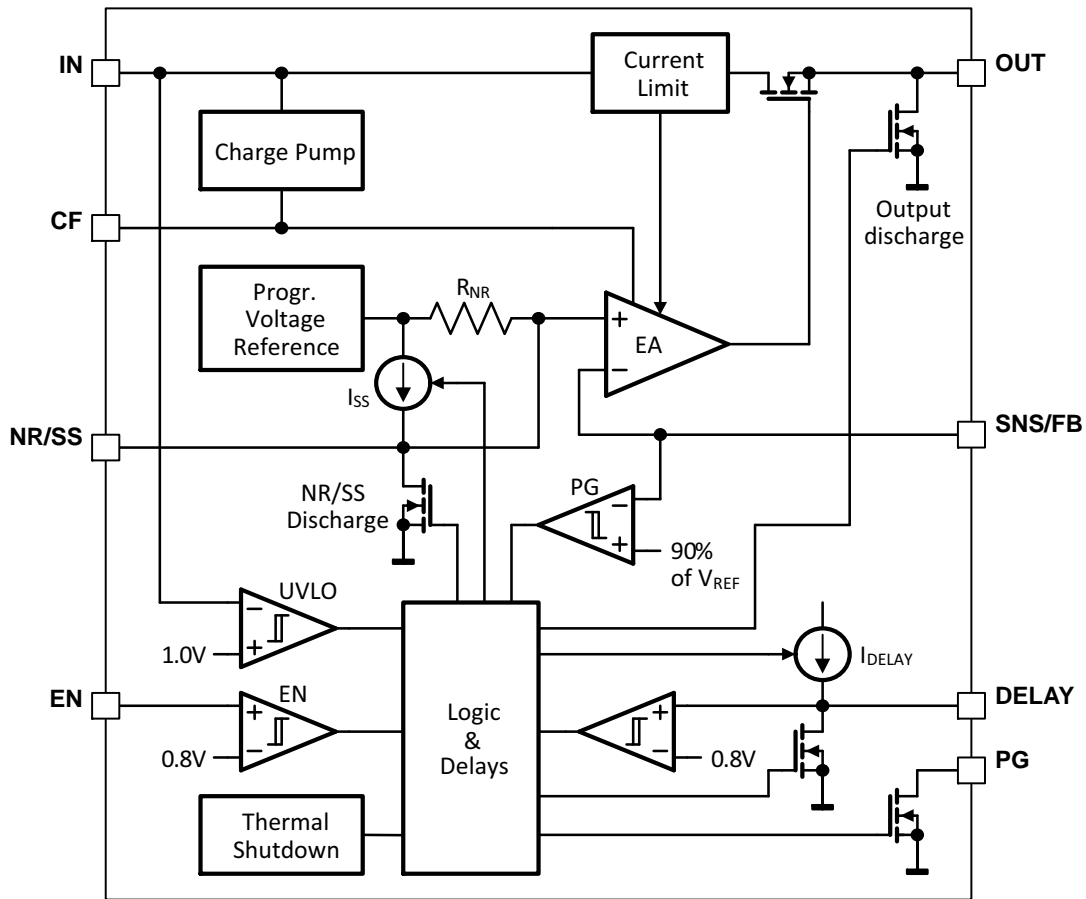


Figure 2. Typical Application Schematic (Adjustable Voltage)

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**Figure 3. Simplified Schematic Block Diagram**

**Table 1. PIN FUNCTION DESCRIPTION**

Name	DFN10	Description
IN	1,2	Input Voltage Supply pins.
CF	3	Internal supply filtering Capacitor.
PG	4	Power-Good (PG) is an open-drain, active-high output that indicates the status of $V_{OUT}$ . When $V_{OUT}$ exceeds the PG trip threshold, the PG pin goes into a high-impedance state. When $V_{OUT}$ is below this threshold the pin is driven to a low-impedance state. A pull-up resistor from 10 k $\Omega$ to 1 M $\Omega$ should be connected from this pin to a supply up to 3.6 V. The supply can be higher than the input voltage. Alternatively, the PG pin can be left floating if output monitoring is not necessary.
DELAY	5	This pin is intended for adjusting the delay for signaling “ $V_{OUT}$ is OK” according to the user application needs. Capacitor connected from this pin to GND with capacitance of 2.2 nF corresponds to 1 ms delay. The maximum delay applicable is 100 ms. If delay not necessary the DELAY pin can be left floating.
EN	6	Enable pin. Driving this pin high enables the regulator. Driving this pin low puts the regulator into shutdown mode. This pin must not be left floating.
NR/SS	7	Noise-reduction and soft-start pin. Connecting an external capacitor between this pin and ground reduces reference voltage noise and also enables the soft-start function. Although not required, a 10 nF or larger capacitor is recommended to be connected from NR/SS to GND (as close to the pin as possible) to maximize ac performance.
SNS (Fixed $V_{OUT}$ Device)	8	Output voltage Sensing Input. Connect to Output voltage node on the PCB.
FB (Adjustable $V_{OUT}$ device)	8	This pin is the feedback connection to the center tap of an external resistor divider network that sets the output voltage. This pin must not be left floating.
OUT	9,10	Regulated output voltage. It is recommended that the output capacitor effective capacitance $\geq 47 \mu\text{F}$ .
GND	TAB	Ground and Thermal Pad.

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**Table 2. ABSOLUTE MAXIMUM RATINGS**

Parameter	Symbol	Value	Unit
Input Voltage Range (Note 1)	$V_{IN}$	-0.3 to +3.6	V
Enable Voltage Range	$V_{EN}$	-0.3 to +3.6	V
Power-Good Voltage Range	$V_{PG}$	-0.3 to +3.6	V
PG Sink Current	$I_{PG}$	0 to +5.0	mA
NR/SS Pin Voltage Range	$V_{NR/SS}$	Connecting to external voltage not allowed	V
CF Pin Voltage Range	$V_{CF}$	Connecting to external voltage not allowed	V
DELAY Pin Voltage Range	$V_{DELAY}$	Connecting to external voltage not allowed	V
SNS Pin Voltage Range (Fixed Voltage Devices)	$V_{SNS}$	-0.3 to +3.6	V
FB Pin Voltage Range (Adjustable Devices)	$V_{FB}$	-0.3 to +3.6	V
Output Voltage Range	$V_{OUT}$	-0.3 to $(V_{IN} + 0.3) \leq 3.6$	V
Maximum Output Current	$I_{OUT}$	Internally Limited	
Output Short Circuit Duration		Indefinite	
Continuous Total Power Dissipation	$P_D$	See Thermal Characteristics Table and Formula	
Maximum Junction Temperature	$T_{JMAX}$	+150	°C
Storage Junction Temperature Range	$T_{STG}$	-55 to +150	°C
ESD Capability, Human Body Model (Note 2)	$ESD_{HBM}$	2000	V
ESD Capability, Charged Device Model (Note 2)	$ESD_{CDM}$	750	V

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Refer to ELECTRICAL CHARACTERISTICS and APPLICATION INFORMATION for Safe Operating Area.
2. This device series incorporates ESD protection (except OUT pin) and is tested by the following methods:  
 ESD Human Body Model tested per ANSI/ESDA/JEDEC JS-001, EIA/JESD22-A114 (AEC-Q100-002)  
 ESD Charged Device Model tested per ANSI/ESDA/JEDEC JS-002, EIA/JESD22-C101 (AEC Q100-011D)  
 Latchup Current Maximum Rating tested per JEDEC standard: JESD78.

**Table 3. THERMAL CHARACTERISTICS** (Note 3)

Rating	Symbol	Value	Unit
Thermal Resistance, Junction-to-Ambient (Note 4)	$R_{\theta JA}$	34	°C/W
Thermal Resistance, Junction-to-Case (top)	$R_{\theta JC(top)}$	19	°C/W
Thermal Resistance, Junction-to-Case (bottom) (Note 5)	$R_{\theta JC(bot)}$	3.3	°C/W
Thermal Resistance, Junction-to-Board	$R_{\theta JB}$	3.3	°C/W
Characterization Parameter, Junction-to-Top	$\psi_{JT}$	0.4	°C/W
Characterization Parameter, Junction-to-Board	$\psi_{JB}$	3.2	°C/W

3. Thermal data based on thermal simulation methodology specified in the JEDEC JESD51 series standards. The following assumptions are used in the simulations:  
 These data were generated with only a single device at the center of a high-K (2s2p) board with 3 in x 3 in copper area which follows the JEDEC51.7 guidelines. Top and bottom layer 2 oz. copper, inner planes 1 oz. copper.  
 The GND pad connected to the PCB inner GND plane layer through a 2x3 thermal via array. All the vias are 0.3 mm diameter, plated.
4. The junction-to-ambient thermal resistance under natural convection is obtained in a simulation on a high-K board, following the JEDEC51.7 guidelines with assumptions as above, in an environment described in JESD51-2a.
5. The junction-to-case (bottom) thermal resistance is obtained by simulating a cold plate test on the IC exposed pad. Test description can be found in the ANSI SEMI standard G30-88.

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**Table 4. RECOMMENDED OPERATING CONDITIONS** (Note 6)

Rating	Symbol	Min	Max	Unit
Input Voltage	$V_{IN}$	1.1	3.6	V
Output Voltage	$V_{OUT}$	0.5	2.0	V
Power-Good Voltage	$V_{PG}$	0	3.6	V
Enable Voltage Range	$V_{EN}$	0	3.6	V
Junction Temperature	$T_J$	-40	125	°C

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

6. Refer to ELECTRICAL CHARACTERISTICS and APPLICATION INFORMATION for Safe Operating Area.

**Table 5. ELECTRICAL CHARACTERISTICS**

At  $V_{IN} = 1.2$  V or  $V_{IN} = V_{OUT(NOM)} + 0.4$  V whichever is greater,  $V_{EN} = 1.1$  V, FB/SNS connected to OUT,  $C_F = 10$  nF,  $C_{NR/SS} = 100$  nF,  $C_{IN} = 10$   $\mu$ F,  $C_{OUT} = 47$   $\mu$ F,  $I_{OUT} = 50$  mA,  $T_J = -40^\circ\text{C}$  to  $+125^\circ\text{C}$ , unless otherwise noted. Typical values are at  $T_J = +25^\circ\text{C}$ . (Note 7)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit	
$V_{UVLO-TH}$	Input voltage UVLO threshold	$V_{IN}$ Rising	0.9	1.00	1.09	V	
$V_{UVLO-HYS}$	Input voltage UVLO hysteresis	$V_{IN}$ Falling		0.17		V	
$V_{OUT}$	Output voltage range (Notes 8, 9, 10, 11) (Adjustable devices)	$V_{IN} \geq 1.2$ V, $V_{IN} \geq (V_{OUT(SET)} + 0.4$ V), $I_{OUT} = 50$ mA to 2 A	$V_{OUT(NOM)}$		2.0	V	
	Accuracy (Note 9, 10)	$V_{IN} \geq 1.2$ V, $V_{IN} \geq (V_{OUT(NOM)} + 0.4$ V), $I_{OUT} = 50$ mA to 2 A	-1.0		+1.0	%	
$\Delta V_{OUT}/\Delta V_{IN}$	Line regulation	$V_{IN} \geq 1.2$ V, $V_{IN} \geq (V_{OUT(NOM)} + 0.4$ V)		0.2		mV/V	
$\Delta V_{OUT}/\Delta I_{OUT}$	Load regulation	$0$ mA $\leq I_{OUT} \leq 2$ A		0.01		%/A	
$V_{DO}$	IN-OUT dropout voltage (ADJ)	$I_{OUT} = 2$ A, $V_{FB} = 0$ V, $V_{IN} = 1.2$ to 2.0 V		45	85	mV	
	IN-OUT dropout voltage (FIX)	$I_{OUT} = 2$ A, $V_{SNS} = 0$ V, $V_{IN} = V_{OUT(NOM)}$ , $V_{IN} \geq 1.2$ V					
$I_{CL}$	Output current limit	$V_{OUT} \geq 90\% \times V_{OUT(NOM)}$	2.2	3.0	4.2	A	
$I_Q$	Quiescent current	$I_{OUT} = 0$ to 2 A		1.1	1.8	mA	
$I_{SHDN}$	Shutdown supply current	$V_{EN} \leq 0.4$ V		1	15	$\mu$ A	
$I_{SNS/FB}$	SNS/FB pin current	$V_{SNS/FB} = V_{OUT}$	-250	10	250	nA	
PSRR	Power supply rejection ratio	$I_{OUT} = 1$ A	1 kHz		70		dB
			10 kHz		50		
			500 kHz		35		
Noise	Output noise voltage (Fix devices)	10 Hz to 100 kHz, $I_{OUT} = 2$ A		4.5		$\mu$ Vrms	
	Output noise voltage (Adjustable devices) (Note 11)	10 Hz to 100 kHz, $I_{OUT} = 2$ A		$5.0 \times V_{OUT(SET)}$		$\mu$ Vrms	
$dV_{OUT}/dI_{OUT}$	Output voltage load transient response	$I_{OUT} = 50$ mA to 2 A at 1 A/ $\mu$ s		$\pm 17$		mV	
$t_{START}$	Minimum startup time	$I_{OUT} = 2$ A, $C_{NR/SS} = \text{open}$		200		$\mu$ s	
$I_{SS}$	Soft-start charging current (Fix Volt devices)	$V_{NR/SS} = 0$ V	$V_{OUT(NOM)} \leq 0.9$ V		6.0	$\mu$ A	
			$V_{OUT(NOM)} > 0.9$ V		12.0		
	Soft-start charging current (Adjustable devices)	$V_{NR/SS} = 0$ V		6.0		$\mu$ A	
$V_{EN-HI}$	Enable input high level		0.8		3.6	V	
$V_{EN-LO}$	Enable input low level		0		0.4	V	
$V_{EN-HYS}$	Enable pin hysteresis			100		mV	
$T_{EN-DGL}$	Enable pin deglitch time			20		$\mu$ s	
$I_{EN}$	Enable pin current	$V_{EN} = 3.6$ V falling		0.3	1	$\mu$ A	

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**Table 5. ELECTRICAL CHARACTERISTICS**

At  $V_{IN} = 1.2\text{ V}$  or  $V_{IN} = V_{OUT(NOM)} + 0.4\text{ V}$  whichever is greater,  $V_{EN} = 1.1\text{ V}$ , FB/SNS connected to OUT,  $C_F = 10\text{ nF}$ ,  $C_{NR/SS} = 100\text{ nF}$ ,  $C_{IN} = 10\text{ }\mu\text{F}$ ,  $C_{OUT} = 47\text{ }\mu\text{F}$ ,  $I_{OUT} = 50\text{ mA}$ ,  $T_J = -40^\circ\text{C}$  to  $+125^\circ\text{C}$ , unless otherwise noted. Typical values are at  $T_J = +25^\circ\text{C}$ . (Note 7)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$V_{PG-TH}$	PG trip threshold	$V_{OUT}$ falling	86.5	90	93.5	$\%V_{OUT(NOM)}$
$V_{PG-HYS}$	PG trip hysteresis	$V_{OUT}$ rising		3		$\%V_{OUT(NOM)}$
$V_{PG-LO}$	PG output low voltage	$I_{PG} = 1\text{ mA}$ (sinking), $V_{OUT} < V_{PG-TH}$			0.3	V
$I_{PG-LK}$	PG leakage current	$V_{PG} = 3.6\text{ V}$ , $V_{OUT} > V_{PG-TH}$		0.01	1	$\mu\text{A}$
$I_{DELAY}$	DELAY pin charging current	$V_{DELAY} = 0\text{ V}$		1.76		$\mu\text{A}$
$V_{DELAY-TH}$	DELAY trip threshold	$V_{DELAY}$ rising		800		mV
$V_{DELAY-HYS}$	DELAY trip hysteresis	$V_{DELAY}$ falling		30		mV
$R_{AD}$	Output Active Discharge Resistance (A-option only)	$V_{EN} = 0\text{ V}$ , $V_{IN} = 3.3\text{ V}$ , $V_{OUT} = 2.0\text{ V}$		100		$\Omega$
TSD	Thermal shutdown temperature threshold high	Temperature rising		165		$^\circ\text{C}$
	Thermal shutdown temperature threshold low	Temperature falling		140		

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

7. Performance guaranteed over the indicated operating temperature range by design and/or characterization. Production tested at  $T_A = 25^\circ\text{C}$ .
8. For adjustable devices the  $V_{OUT(NOM)}$  is the output voltage specified by OPN. It could be seen at the output pin when FB pin is connected to OUT pin directly (without resistor divider).
9. Low duty cycle pulse techniques are used during the testing to maintain the junction temperature as close to ambient as possible.
10. The device is not tested under conditions where the power dissipation is higher than the maximum rating of the package.
11.  $V_{OUT(SET)}$  is the output voltage set by external resistor divider (adjustable version only). In case FB pin is shorted to OUT pin the  $V_{OUT(SET)} = V_{OUT(NOM)}$ .

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## APPLICATIONS INFORMATION

Power-Good (PG) is an open-drain, active-high output that indicates the status of  $V_{OUT}$ . When  $V_{OUT}$  exceeds the PG trip threshold, the PG pin goes into a high-impedance state with user adjustable delay. This high-impedance state is signaling “ $V_{OUT}$  is OK.”

When  $V_{OUT}$  is below the PG trip threshold the pin is driven to a low-impedance state immediately. A pull-up resistor should be connected from this pin to a supply up to 3.6 V. The supply can be higher than the input voltage.

Alternatively, the PG pin can be left floating if output monitoring is not necessary.

DELAY pin is intended for adjusting the delay for signaling “ $V_{OUT}$  is OK” according the user application needs. Capacitor connected from this pin to GND with capacitance of 2.2 nF corresponds to 1 ms delay. The maximum delay applicable is 100 ms. If delay not necessary the DELAY pin can be left floating.

## ORDERING INFORMATION

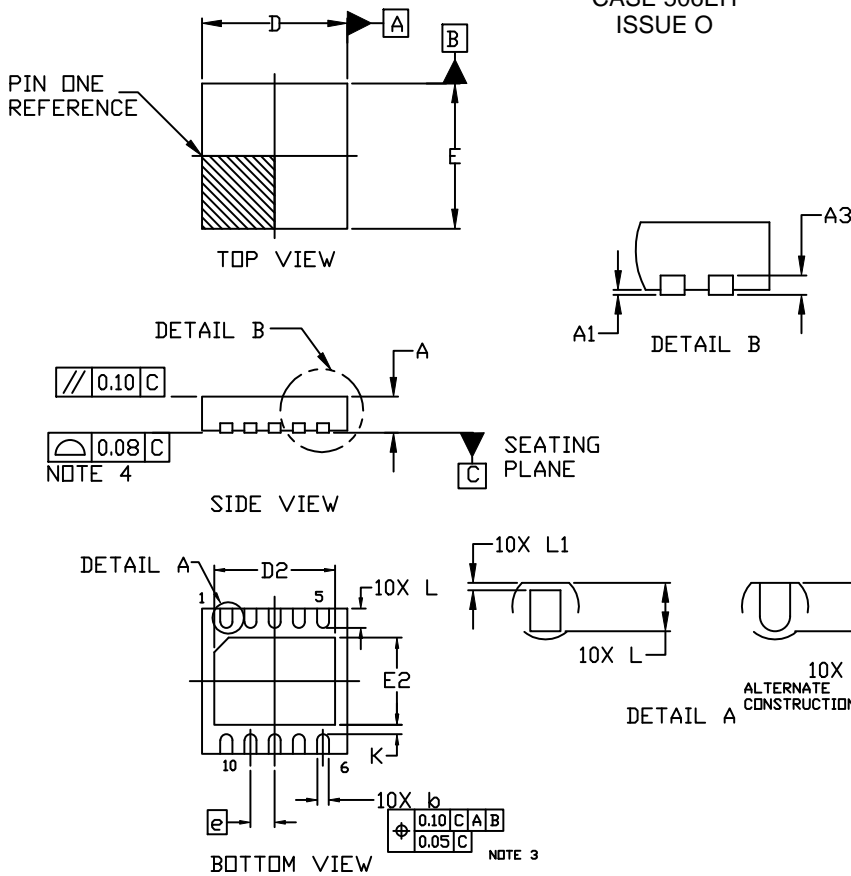
Device	ADJ / FIX version	Output Voltage $V_{OUT(NOM)}$	Output Discharge Version	Marking	Package	Shipping†
NCP59762AMN100TBG	FIX	1.0 V	Output Active Discharge	59762 P100A	DFN10 (Pb-Free)	3000 Tape & Reel
NCP59762BMN100TBG	FIX	1.0 V	Non – Active Discharge	59762 P100B		
NCP59762AMN05ADJTBG	ADJ	0.5 V	Output Active Discharge	59762 P050A		
NCP59762BMN05ADJTBG	ADJ	0.5 V	Non – Active Discharge	59762 P050B		
NCP59762AMN08ADJTBG	ADJ	0.8 V	Output Active Discharge	59762 P080A		
NCP59762BMN08ADJTBG	ADJ	0.8 V	Non – Active Discharge	59762 P080B		

†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.

# NCP59762

## PACKAGE DIMENSIONS

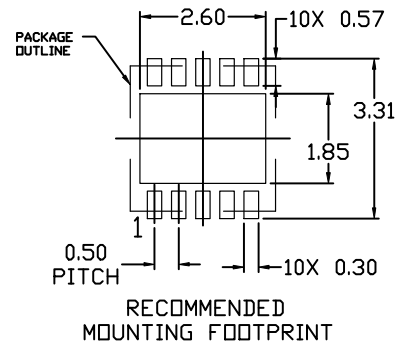
DFN10 3x3, 0.5P  
CASE 506EH  
ISSUE O



NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSION **b** APPLIES TO PLATED TERMINALS AND IS MEASURED BETWEEN 0.15 AND 0.30MM FROM THE TERMINAL TIP.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

DIM	MILLIMETERS		
	MIN.	NOM.	MAX.
A	0.80	0.90	1.00
A1	---	---	0.05
A3	0.20 REF		
b	0.20	0.25	0.30
D	2.90	3.00	3.10
D2	2.40	2.50	2.60
E	2.90	3.00	3.10
E2	1.70	1.80	1.90
e	0.50 BSC		
K	0.20 REF		
L	0.30	0.40	0.50
L1	---	---	0.10



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