NCP786A

Linear Regulator - Wide Input Voltage Range, Ultra-Low Iq, High PSRR, Adjustable Output Voltage

10 mA

The NCP786A is high−performance linear regulator, offering a very wide operating input voltage range of up to 450 V DC, with an output current of up to 10 mA. Ideal for high input voltage applications such as industrial and home metering, home appliances. The NCP786A family offers ±3% initial accuracy, extremely high−power supply rejection ratio and ultra−low quiescent current. The NCP786A family is optimized for high−voltage line and load transients, making them ideal for harsh environment applications. The output voltage can be set by resistor divider in range from 1.27 V up to 15 V. DFN6 5x6 Pb−free package with high allowable power dissipation keep small footprint at space sensitive applications.

Features

- Wide Input Voltage Range:
  - DC: Up to 450 V
  - AC: 85 V to 260 V (half−wave rectifier and 4.7 μF capacitor)
- 10 mA Guaranteed Output Current
- Ultra Low Quiescent Current: Typ. 10 μA ($V_{OUT} \leq 15$ V)
- ±5% Accuracy Over Full Load, Line and Temperature Variations
- Ultra−high PSRR: 70 dB at 60 Hz, 90 dB at 100 kHz
- Stable with Ceramic Output Capacitor 2.2 μF MLCC
- Thermal Shutdown and Current Limit Protection
- Available in DFN6 5x6 Package
- This is a Pb−Free Device

Typical Applications

- Industrial Applications, Home Appliances
- Home Metering / Network Application
- Off−line Power Supplies

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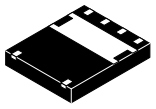


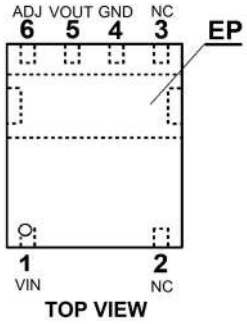
DFN6 5x6
ST SUFFIX
CASE 506DV

MARKING DIAGRAM

(Top View)

786A = Specific Device Marking
XXX = Voltage Version
(see page 7)
A = Assembly Location
LL = Wafer Lot
YY = Year
WW = Work Week
▪ = Pb−Free Package
(Note: Microdot may be in either location)

PIN CONNECTIONS



TOP VIEW

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 7 of this data sheet.

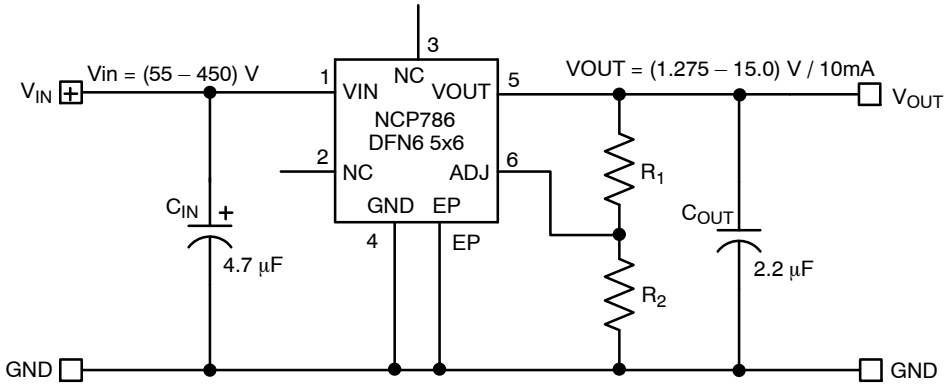


Figure 1. Typical Applications

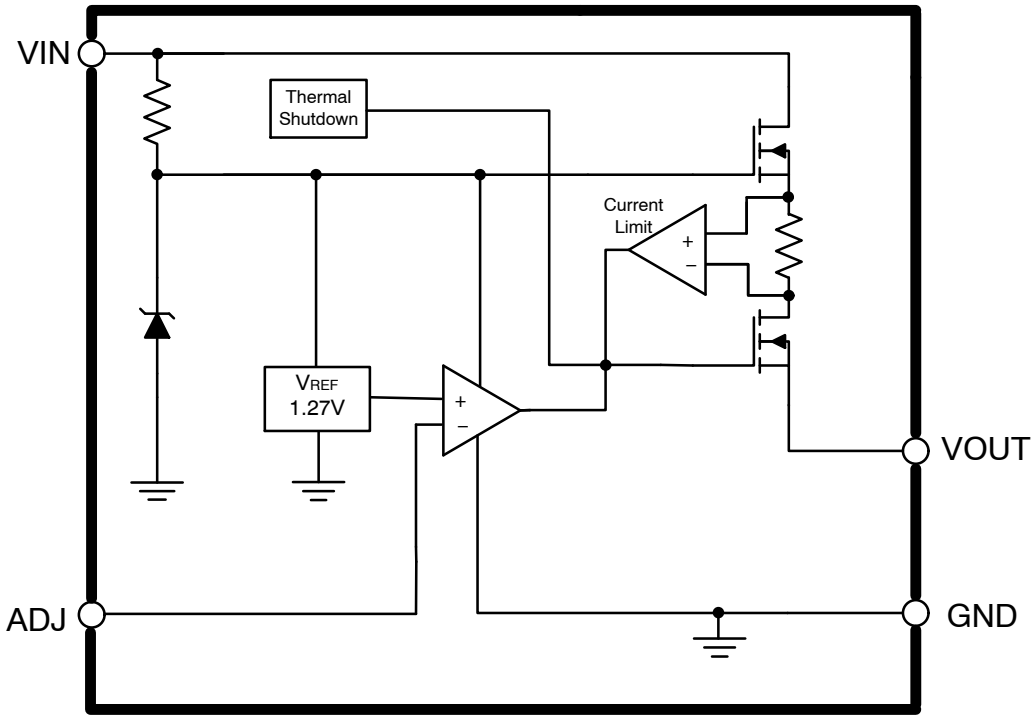


Figure 2. Simplified Internal Block Diagram

Table 1. PIN FUNCTION DESCRIPTION

Pin No.	Pin Name	Description
1	VIN	Supply Voltage Input. Connect 4.7 μF capacitor from VIN to GND.
2	NC	Not connected.
3	NC	Not connected.
4	GND	Ground connection.
5	VOUT	Regulator Output. Connect 2.2 μF or higher MLCC capacitor from VOUT to GND.
6	ADJ	ADJ pin for output voltage setting via resistors divider.
EP	EP	EP should be connected to GND potential.

Table 2. ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input Voltage (Note 1)	V_{IN}	−0.3 to 700	V
Output Voltage	V_{OUT}	−0.3 to 18	V
Maximum Junction Temperature	$T_{J(MAX)}$	125	°C

Table 2. ABSOLUTE MAXIMUM RATINGS

Storage Temperature	T_{STG}	−55 to 150	°C
ESD Capability, Human Body Model (All pins except HV pin no.1) (Note 2)	ESD_{HBM}	2000	V
ESD Capability, Machine Model (Note 2)	ESD_{MM}	200	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. Peak 650 V max 1 ms non repeated for 1 s
2. 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)
   Latch−up Current Maximum Rating tested per JEDEC standard: JESD78.

Table 3. THERMAL CHARACTERISTICS

Rating	Symbol	Value	Unit
Thermal Characteristics, DFN6 Thermal Resistance, Junction−to−Air JEDEC 51.3, One side, 600 sq mm PCB	$R_{\theta JA}$	82	°C/W

Table 4. ELECTRICAL CHARACTERISTICS NCP786A Adj. (−40°C ≤ T_J ≤ 85°C; V_{IN} = 340 V; I_{OUT} = 100 μA, C_{IN} = 4.7 μF, C_{OUT} = 10 μF, unless otherwise noted. Typical values are at T_J = +25°C.) (Note 3)

Parameter	Test Conditions	Symbol	Min	Typ	Max	Unit
Operating Input Voltage DC		V_{IN}	55		450	V
Maximum output voltage	−40°C ≤ T_J ≤ 85°C, Iout = 100 μA, 55 V ≤ Vin ≤ 450 V	Voutmax		15		V
Reference Voltage Accuracy	T_J = 25°C, Iout = 100 μA, 55 V ≤ Vin ≤ 450 V	V_{REF}	−3%	1.275	+3%	V
	−40°C ≤ T_J ≤ 85°C, Iout = 100 μA, 55 V ≤ Vin ≤ 450 V	V_{REF}	−5%	1.275	+5%	V
Line Regulation	V_{IN} = 55 V to 450 V, Iout = 100 μA	Reg_{LINE}	−0.5	0.1	+0.5	%
Load Regulation	I_{OUT} = 100 μA to 10 mA, Vin = 55 V	Reg_{LOAD}	−1.0	0.7	+1.0	%
Maximum Output Current	55 V ≤ Vin ≤ 450 V, (Note 4)	I_{OUT}	11			mA
Quiescent Current	I_{OUT} = 0, 55 V ≤ Vin ≤ 450 V	I_{GND}		10	15	μA
Ground current	55 V ≤ Vin ≤ 450 V, (Note 4) 0 < I_{OUT} ≤ 10 mA				25	μA
ADJ Pin current				150		nA
Power Supply Rejection Ratio	Vin = 340 VDC +1 Vpp modulation, f = 1 kHz, Iout = 100 μA	PSRR		65		dB
Noise	f = 10 kHz to 1 MHz Vin = 340 VDC, Iout = 1 mA, C_{OUT} = 10 μF	V_{NOISE}		150		μVrms
Thermal Shutdown Temperature (Note 5)	Temperature increasing from T_J = +25°C	T_{SD}		145		°C
Thermal Shutdown Hysteresis (Note 5)	Temperature falling from T_{SD}	T_{SDH}	–	10	–	°C

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.

3. Performance guaranteed over the indicated operating temperature range by design and/or characterization production tested at T_J = T_A = 25°C. Low duty cycle pulse techniques are used during testing to maintain the junction temperature as close to ambient as possible.
4. Respect to Safe Operating Area
5. Guaranteed by design

TYPICAL CHARACTERISTICS

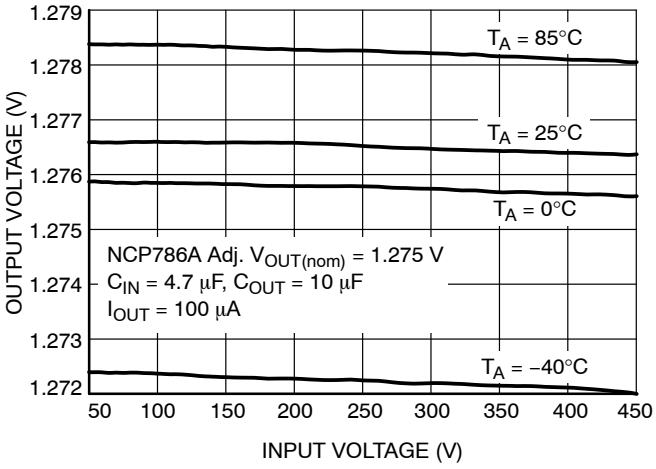


Figure 3. Output Voltage vs. Input Voltage

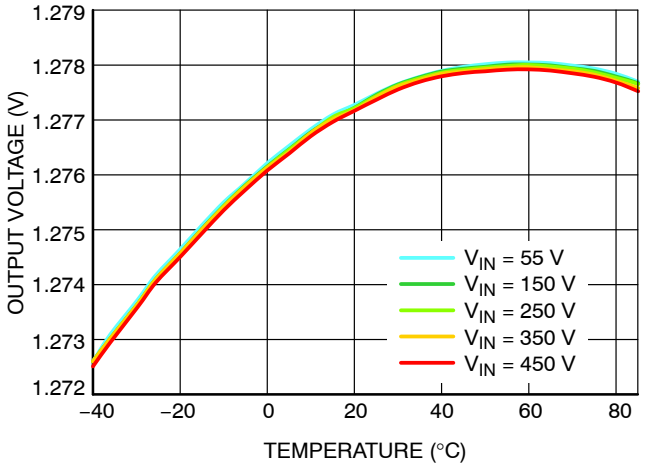


Figure 4. Output Voltage vs. Temperature

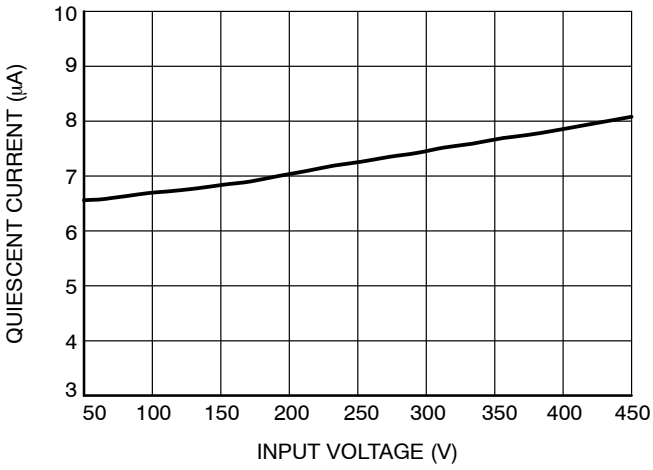


Figure 5. Quiescent Current vs. Input Voltage

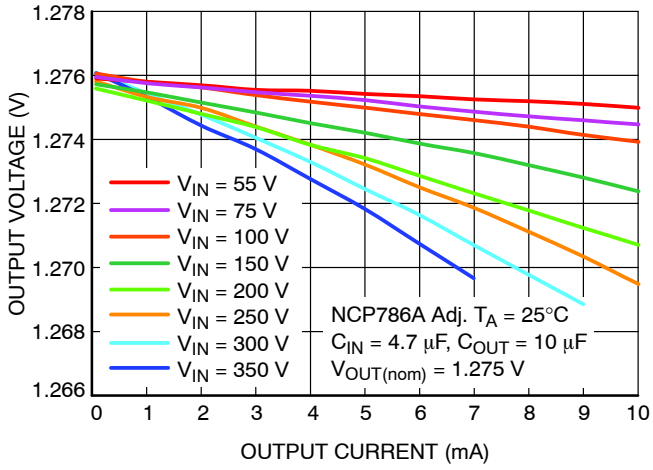


Figure 6. Output Voltage vs. Output Current

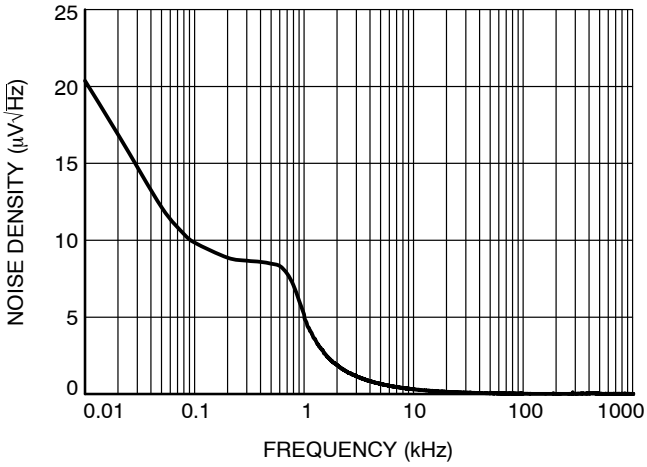


Figure 7. Noise Density vs. Frequency

APPLICATION INFORMATION

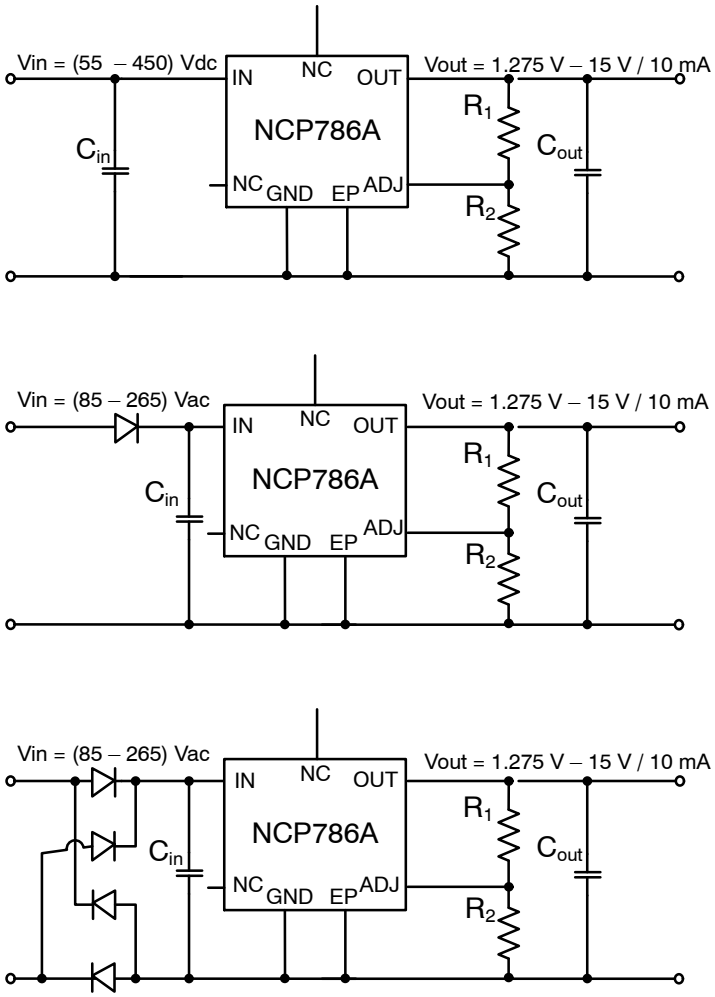


Figure 8. Typical Application Schematics

Input Decoupling (C1)

A 4.7 μF capacitor either ceramic or electrolytic is recommended and should be connected close to the input pin of NCP786A. Higher value 4.7 μF is necessary to keep the input voltage above the required minimum input voltage at full load for AC voltage as low as 85 V with half wave rectifier. The capacitor 2.2 μF or 1 μF could be acceptable for DC input voltage or AC input voltage 235 V ±20%. There must be assured minimum Input Voltage more than 55 V at input pin of NCP786A regulator in order to keep stable desired output voltage with guaranteed parameters.

Output Decoupling (C2)

The NCP786A Regulator does not require any specific Equivalent Series Resistance (ESR). Thus capacitors exhibiting ESRs ranging from a few mΩ up to 0.5 Ω can be used safely. The minimum decoupling value is 2.2 μF. The regulator accepts ceramic chip capacitors as well as tantalum devices or low ESR electrolytic capacitors. Larger values improve noise rejection and especially load transient response.

Layout Recommendations

Please be sure that the V_{IN} and GND lines are sufficiently wide. When the impedance of these lines is high, there is a chance to pick up noise or to cause the malfunction of regulator.

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 NCP786A increases, it might become necessary to provide some thermal relief. The maximum power dissipation supported by the device is dependent upon board design layout and used package. Mounting pad configuration on the PCB, the board material, and also the ambient temperature affect the rate of temperature rise for the part. This is stating that when the NCP786A has good thermal conductivity through the PCB, the junction temperature will be relatively low with high power dissipation applications.

Output Voltage

The output voltage can be set by using a resistor divider as shown in Figure 1 in range from 1.275 V up to 15 V. The appropriate resistor divider can be found by solving the equation below.

$$V_{OUT} = 1.275 \times \left(1 + \frac{R1}{R2}\right) + \left(I_{ADJ} \times R1\right) \quad \text{(eq. 1)}$$

The recommended current through the resistor divider is from 1 μA to 3 μA in order to keep negligible ADJ pin consumption. In this case we can simplify Equation 1 to:

$$V_{OUT} = 1.275 \times \left(1 + \frac{R1}{R2}\right) \quad \text{(eq. 2)}$$

ORDERING INFORMATION

Part Number	Output Voltage	Marking	Package	Shipping†
NCP786AMNADJTBG	Adjustable	ADJ	DFN6 5x6 (Pb−Free)	1000 / 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.

MECHANICAL CASE OUTLINE
PACKAGE DIMENSIONS

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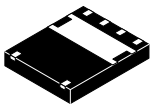
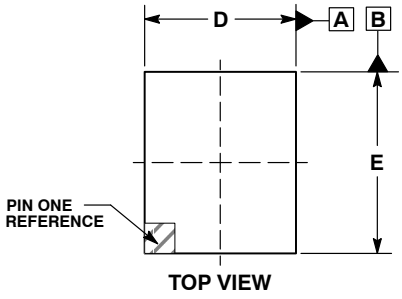


SCALE 2:1

DFN6 5x6, 1.27P
CASE 506DV
ISSUE O

DATE 12 OCT 2016

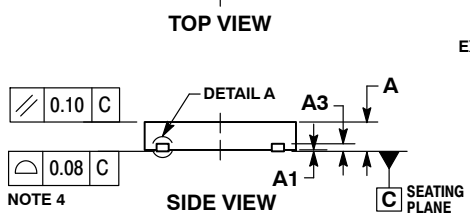


TOP VIEW

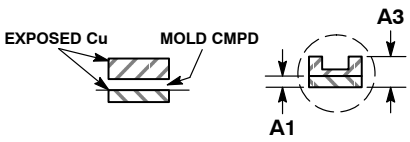
DETAIL A
ALTERNATE TERMINAL CONSTRUCTIONS

NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.20 AND 0.25 MM FROM THE TERMINAL TIP.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.
5. FOR DEVICE OPN CONTAINING W OPTION, DETAIL B ALTERNATE B–1 AND DETAIL A ALTERNATE A–1 CONSTRUCTIONS ARE NOT APPLICABLE.

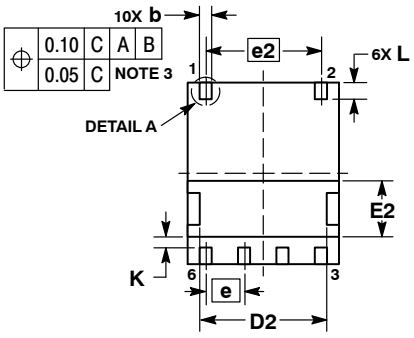
	MILLIMETERS		
DIM	MIN	NOM	MAX
A	0.80	0.90	1.00
A1	---	---	0.05
A3		0.20 REF	
b	0.30	0.40	0.50
D	4.90	5.00	5.10
D2	4.10	4.20	4.30
E	5.90	6.00	6.10
E2	1.75	1.85	1.95
e		1.27 BSC	
e2		3.81 BSC	
K	0.25	---	---
L	0.45	0.55	0.65



SIDE VIEW

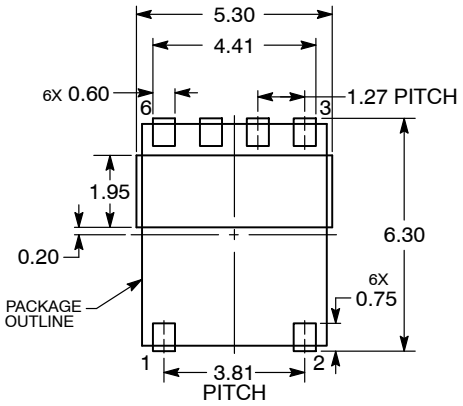


DETAIL B
ALTERNATE CONSTRUCTIONS



BOTTOM VIEW

RECOMMENDED SOLDERING 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.

GENERIC MARKING DIAGRAM*

A = Assembly Location
LL = Wafer Lot
YY = Year
WW = Work Week
▪ = Pb–Free Package

(Note: Microdot may be in either location)

*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.

DOCUMENT NUMBER:	98AON16235G	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.
DESCRIPTION:	DFN6 5X6, 1.27P	PAGE 1 OF 1

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