

# NCP45526

## ecoSWITCH™ Advanced Load Management Controlled Load Switch with Low R<sub>ON</sub>

The NCP45526 load switch provides a component and area-reducing solution for efficient power domain switching with inrush current limit via soft start. This device is designed to integrate control and driver functionality with a high performance low on-resistance power MOSFET in a single package. This cost effective solution is ideal for power management and hot-swap applications requiring low power consumption in a small footprint.

### Features

- Advanced Controller with Charge Pump
- Integrated N-Channel MOSFET with Low R<sub>ON</sub>
- Input Voltage Range 0.5 V to 6 V
- Soft-Start via Controlled Slew Rate
- Power Good Signal
- Extremely Low Standby Current
- Load Bleed (Quick Discharge)
- This is a Pb-Free Device

### Typical Applications

- Portable Electronics and Systems
- Notebook and Tablet Computers
- Telecom, Networking, Medical, and Industrial Equipment
- Set-Top Boxes, Servers, and Gateways
- Hot-Swap Devices and Peripheral Ports

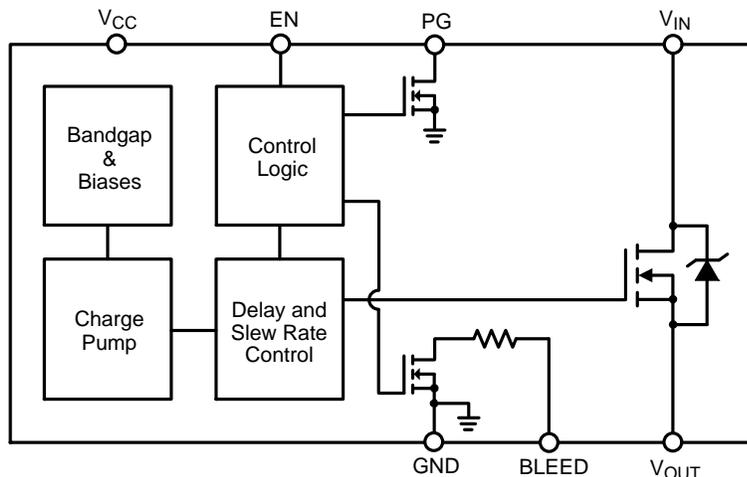


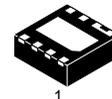
Figure 1. Block Diagram



ON Semiconductor®

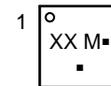
<http://onsemi.com>

R <sub>ON</sub> TYP	V <sub>CC</sub>	V <sub>IN</sub>	I <sub>MAX</sub>
18.0 mΩ	3.3 V	1.8 V	6 A
18.8 mΩ	3.3 V	5.0 V	



DFN8, 2x2  
CASE 506CC

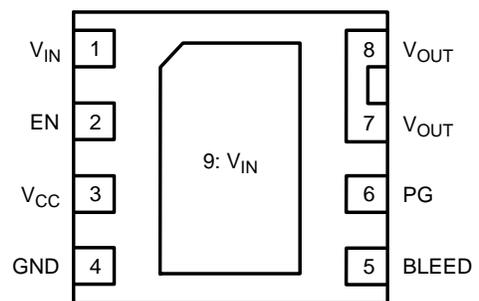
### MARKING DIAGRAM



XX = 4H for NCP45526-H  
= 4L for NCP45526-L  
M = Date Code  
▪ = Pb-Free Package

(Note: Microdot may be in either location)

### PIN CONFIGURATION



(Top View)

### ORDERING INFORMATION

See detailed ordering and shipping information on page 9 of this data sheet.

# NCP45526

**Table 1. PIN DESCRIPTION**

Pin	Name	Function
1, 9	V <sub>IN</sub>	Drain of MOSFET (0.5 V – 6.0 V), Pin 1 must be connected to Pin 9
2	EN	NCP45526–H – Active–high digital input used to turn on the MOSFET, pin has an internal pull down resistor to GND
		NCP45526–L – Active–low digital input used to turn on the MOSFET, pin has an internal pull up resistor to V <sub>CC</sub>
3	V <sub>CC</sub>	Supply voltage to controller (3.0 V – 5.5 V)
4	GND	Controller ground
5	BLEED	Load bleed connection; must be tied to V <sub>OUT</sub> either directly or through a resistor ≤ 100 MΩ.
6	PG	NCP45526 – Active–high, open–drain output that indicates when the gate of the MOSFET is fully charged, external pull up resistor ≥ 1 kΩ to an external voltage source required; tie to GND if not used
7, 8	V <sub>OUT</sub>	Source of MOSFET connected to load

**Table 2. ABSOLUTE MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Supply Voltage Range	V <sub>CC</sub>	–0.3 to 6	V
Input Voltage Range	V <sub>IN</sub>	–0.3 to 6	V
Output Voltage Range	V <sub>OUT</sub>	–0.3 to 6	V
EN Digital Input Range	V <sub>EN</sub>	–0.3 to (V <sub>CC</sub> + 0.3)	V
PG Output Voltage Range (Note 1)	V <sub>PG</sub>	–0.3 to 6	V
Thermal Resistance, Junction–to–Ambient, Steady State (Note 2)	R <sub>θJA</sub>	40.0	°C/W
Thermal Resistance, Junction–to–Ambient, Steady State (Note 3)	R <sub>θJA</sub>	72.7	°C/W
Thermal Resistance, Junction–to–Case (V <sub>IN</sub> Paddle)	R <sub>θJC</sub>	5.3	°C/W
Continuous MOSFET Current @ T <sub>A</sub> = 25°C	I <sub>MAX</sub>	6.0	A
Total Power Dissipation @ T <sub>A</sub> = 25°C (Notes 2 and 4) Derate above T <sub>A</sub> = 25°C	P <sub>D</sub>	2.50 24.9	W mW/°C
Total Power Dissipation @ T <sub>A</sub> = 25°C (Notes 3 and 4) Derate above T <sub>A</sub> = 25°C	P <sub>D</sub>	1.37 13.8	W mW/°C
Storage Temperature Range	T <sub>STG</sub>	–40 to 150	°C
Lead Temperature, Soldering (10 sec.)	T <sub>SLD</sub>	260	°C
ESD Capability, Human Body Model (Notes 5 and 6)	ESD <sub>HBM</sub>	3.0	kV
ESD Capability, Machine Model (Note 5)	ESD <sub>MM</sub>	200	V
ESD Capability, Charged Device Model (Note 5)	ESD <sub>CDM</sub>	1.0	kV
Latch–up Current Immunity (Notes 5 and 6)	LU	100	mA

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.

- PG is an open–drain output that requires an external pull up resistor ≥ 1 kΩ to an external voltage source.
- Surface–mounted on FR4 board using 1 sq–in pad, 1 oz Cu.
- Surface–mounted on FR4 board using the minimum recommended pad size, 1 oz Cu.
- Specified for derating purposes only, ensure that I<sub>MAX</sub> is never exceeded.
- Tested by the following methods @ T<sub>A</sub> = 25°C:
  - ESD Human Body Model tested per JESD22–A114
  - ESD Machine Model tested per JESD22–A115
  - ESD Charged Device Model tested per JESD22–C101
  - Latch–up Current tested per JESD78
- Rating is for all pins except for V<sub>IN</sub> and V<sub>OUT</sub> which are tied to the internal MOSFET's Drain and Source. Typical MOSFET ESD performance for V<sub>IN</sub> and V<sub>OUT</sub> should be expected and these devices should be treated as ESD sensitive.

# NCP45526

**Table 3. OPERATING RANGES**

Rating	Symbol	Min	Max	Unit
Supply Voltage	$V_{CC}$	3	5.5	V
Input Voltage	$V_{IN}$	0.5	6	V
Ground	GND		0	V
Ambient Temperature	$T_A$	-40	85	°C
Junction Temperature	$T_J$	-40	125	°C

**Table 4. ELECTRICAL CHARACTERISTICS** ( $T_J = 25^\circ\text{C}$  unless otherwise specified)

Parameter	Conditions (Note 7)	Symbol	Min	Typ	Max	Unit
<b>MOSFET</b>						
On-Resistance	$V_{CC} = 3.3\text{ V}; V_{IN} = 1.8\text{ V}$	$R_{ON}$		18.0	24.0	m $\Omega$
	$V_{CC} = 3.3\text{ V}; V_{IN} = 5\text{ V}$			18.8	25.0	
Leakage Current (Note 8)	$V_{EN} = 0\text{ V}; V_{IN} = 6\text{ V}$	$I_{LEAK}$		0.1	1	$\mu\text{A}$
<b>CONTROLLER</b>						
Supply Standby Current (Note 9)	$V_{EN} = 0\text{ V}; V_{CC} = 3\text{ V}$	$I_{STBY}$		0.65	2	$\mu\text{A}$
	$V_{EN} = 0\text{ V}; V_{CC} = 5.5\text{ V}$			3.2	4.5	
Supply Dynamic Current (Note 10)	$V_{EN} = V_{CC} = 3\text{ V}; V_{IN} = 5\text{ V}$	$I_{DYN}$		150	250	$\mu\text{A}$
	$V_{EN} = V_{CC} = 5.5\text{ V}; V_{IN} = 1.8\text{ V}$			475	680	
Bleed Resistance	$V_{EN} = 0\text{ V}; V_{CC} = 3\text{ V}$	$R_{BLEED}$	86	115	144	$\Omega$
	$V_{EN} = 0\text{ V}; V_{CC} = 5.5\text{ V}$		72	97	121	
EN Input High Voltage	$V_{CC} = 3\text{ V} - 5.5\text{ V}$	$V_{IH}$	2			V
EN Input Low Voltage	$V_{CC} = 3\text{ V} - 5.5\text{ V}$	$V_{IL}$			0.8	V
EN Input Leakage Current	NCP45526-H; $V_{EN} = 0\text{ V}$	$I_{IL}$		90	500	nA
	NCP45526-L; $V_{EN} = 5.5\text{ V}$	$I_{IH}$		90	500	
EN Pull Down Resistance	NCP45526-H	$R_{PD}$	76	100	124	k $\Omega$
EN Pull Up Resistance	NCP45526-L	$R_{PU}$	76	100	124	k $\Omega$
PG Output Low Voltage (Note 11)	$V_{CC} = 3\text{ V}; I_{SINK} = 5\text{ mA}$	$V_{OL}$			0.2	V
PG Output Leakage Current (Note 12)	$V_{CC} = 3\text{ V}; V_{TERM} = 3.3\text{ V}$	$I_{OH}$		5	100	nA

7.  $V_{EN}$  shown only for NCP45526-H (EN Active-High) unless otherwise specified.

8. Average current from  $V_{IN}$  to  $V_{OUT}$  with MOSFET turned off.

9. Average current from  $V_{CC}$  to GND with MOSFET turned off.

10. Average current from  $V_{CC}$  to GND after charge up time of MOSFET.

11. PG is an open-drain output that is pulled low when the MOSFET is disabled.

12. PG is an open-drain output that is not driven when the gate of the MOSFET is fully charged, requires an external pull up resistor  $\geq 1\text{ k}\Omega$  to an external voltage source,  $V_{TERM}$ .

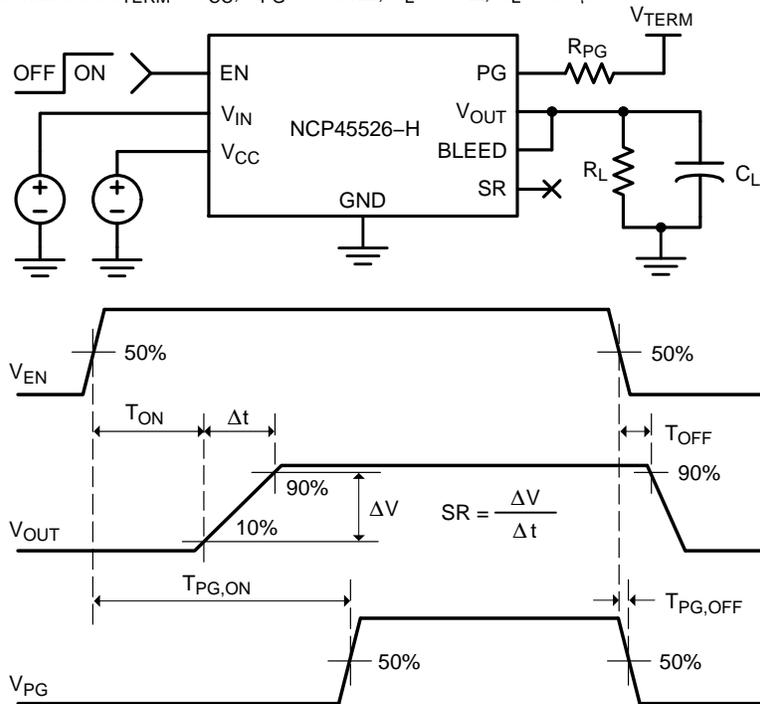
# NCP45526

**Table 5. SWITCHING CHARACTERISTICS** ( $T_J = 25^\circ\text{C}$  unless otherwise specified) (Notes 13 and 14)

Parameter	Conditions	Symbol	Min	Typ	Max	Unit
Output Slew Rate	$V_{CC} = 3.3\text{ V}; V_{IN} = 1.8\text{ V}$	SR		11.9		kV/s
	$V_{CC} = 5.0\text{ V}; V_{IN} = 1.8\text{ V}$			12.1		
	$V_{CC} = 3.3\text{ V}; V_{IN} = 5.0\text{ V}$			12.8		
	$V_{CC} = 5.0\text{ V}; V_{IN} = 5.0\text{ V}$			13.2		
Output Turn-on Delay	$V_{CC} = 3.3\text{ V}; V_{IN} = 1.8\text{ V}$	$T_{ON}$		220		$\mu\text{s}$
	$V_{CC} = 5.0\text{ V}; V_{IN} = 1.8\text{ V}$			185		
	$V_{CC} = 3.3\text{ V}; V_{IN} = 5.0\text{ V}$			230		
	$V_{CC} = 5.0\text{ V}; V_{IN} = 5.0\text{ V}$			205		
Output Turn-off Delay	$V_{CC} = 3.3\text{ V}; V_{IN} = 1.8\text{ V}$	$T_{OFF}$		1.2		$\mu\text{s}$
	$V_{CC} = 5.0\text{ V}; V_{IN} = 1.8\text{ V}$			0.9		
	$V_{CC} = 3.3\text{ V}; V_{IN} = 5.0\text{ V}$			0.8		
	$V_{CC} = 5.0\text{ V}; V_{IN} = 5.0\text{ V}$			0.5		
Power Good Turn-on Time	$V_{CC} = 3.3\text{ V}; V_{IN} = 1.8\text{ V}$	$T_{PG,ON}$		0.91		ms
	$V_{CC} = 5.0\text{ V}; V_{IN} = 1.8\text{ V}$			0.93		
	$V_{CC} = 3.3\text{ V}; V_{IN} = 5.0\text{ V}$			0.96		
	$V_{CC} = 5.0\text{ V}; V_{IN} = 5.0\text{ V}$			0.93		
Power Good Turn-off Time	$V_{CC} = 3.3\text{ V}; V_{IN} = 1.8\text{ V}$	$T_{PG,OFF}$		21		ns
	$V_{CC} = 5.0\text{ V}; V_{IN} = 1.8\text{ V}$			15		
	$V_{CC} = 3.3\text{ V}; V_{IN} = 5.0\text{ V}$			21		
	$V_{CC} = 5.0\text{ V}; V_{IN} = 5.0\text{ V}$			15		

13. See below figure for Test Circuit and Timing Diagram.

14. Tested with the following conditions:  $V_{TERM} = V_{CC}$ ;  $R_{PG} = 100\text{ k}\Omega$ ;  $R_L = 10\ \Omega$ ;  $C_L = 0.1\ \mu\text{F}$ .



**Figure 2. Switching Characteristics Test Circuit and Timing Diagram**

## APPLICATIONS INFORMATION

### Enable Control

The NCP45526 has two part numbers, NCP45526-H and NCP45526-L, that only differ in the polarity of the enable control.

The NCP45526-H device allows for enabling the MOSFET in an active-high configuration. When the  $V_{CC}$  supply pin has an adequate voltage applied and the EN pin is at a logic high level, the MOSFET will be enabled. Similarly, when the EN pin is at a logic low level, the MOSFET will be disabled. An internal pull down resistor to ground on the EN pin ensures that the MOSFET will be disabled when not being driven.

The NCP45526-L device allows for enabling the MOSFET in an active-low configuration. When the  $V_{CC}$  supply pin has an adequate voltage applied and the EN pin is at a logic low level, the MOSFET will be enabled. Similarly, when the EN pin is at a logic high level, the MOSFET will be disabled. An internal pull up resistor to  $V_{CC}$  on the EN pin ensures that the MOSFET will be disabled when not being driven.

### Power Sequencing

The NCP45526 device will function with any power sequence, but the output turn-on delay performance may vary from what is specified. To achieve the specified performance, there are two recommended power sequences:

- 1)  $V_{CC} \rightarrow V_{IN} \rightarrow V_{EN}$
- 2)  $V_{IN} \rightarrow V_{CC} \rightarrow V_{EN}$

### Load Bleed (Quick Discharge)

The NCP45526 device has an internal bleed resistor,  $R_{BLEED}$ , which is used to bleed the charge off of the load to ground after the MOSFET has been disabled. In series with the bleed resistor is a bleed switch that is enabled whenever

the MOSFET is disabled. The MOSFET and the bleed switch are never concurrently active.

Is it required that the BLEED pin be connected to  $V_{OUT}$  either directly (as shown in Figure 4) or through an external resistor,  $R_{EXT}$  (as shown in Figure 3).  $R_{EXT}$  should not exceed 100 M $\Omega$  and can be used to increase the total bleed resistance and decrease the load bleed rate.

Care must be taken to ensure that the power dissipated across  $R_{BLEED}$  is kept at a safe level. The maximum continuous power that can be dissipated across  $R_{BLEED}$  is 0.4 W.  $R_{EXT}$  can be used to decrease the amount of power dissipated across  $R_{BLEED}$ .

### Power Good

The NCP45526 devices have a power good output (PG) that can be used to indicate when the gate of the MOSFET is fully charged. The PG pin is an active-high, open-drain output that requires an external pull up resistor,  $R_{PG}$ , greater than or equal to 1 k $\Omega$  to an external voltage source,  $V_{TERM}$ , that is compatible with input levels of all devices connected to this pin (as shown in Figures 3 and 4).

The power good output can be used as the enable signal for other active-high devices in the system (as shown in Figure 5). This allows for guaranteed by design power sequencing and reduces the number of enable signals needed from the system controller. If the power good feature is not used in the application, the PG pin should be tied to GND.

### Slew Rate Control

The NCP45526 devices are equipped with controlled output slew rate which provides soft start functionality. This limits the inrush current caused by capacitor charging and enables these devices to be used in hot swap applications.

# NCP45526

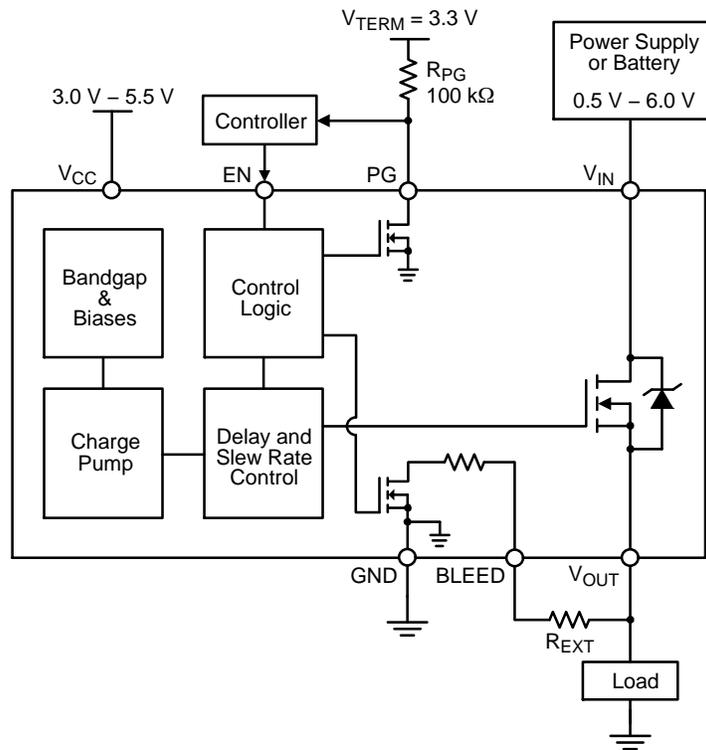


Figure 3. NCP45526 Typical Application Diagram – Load Switch

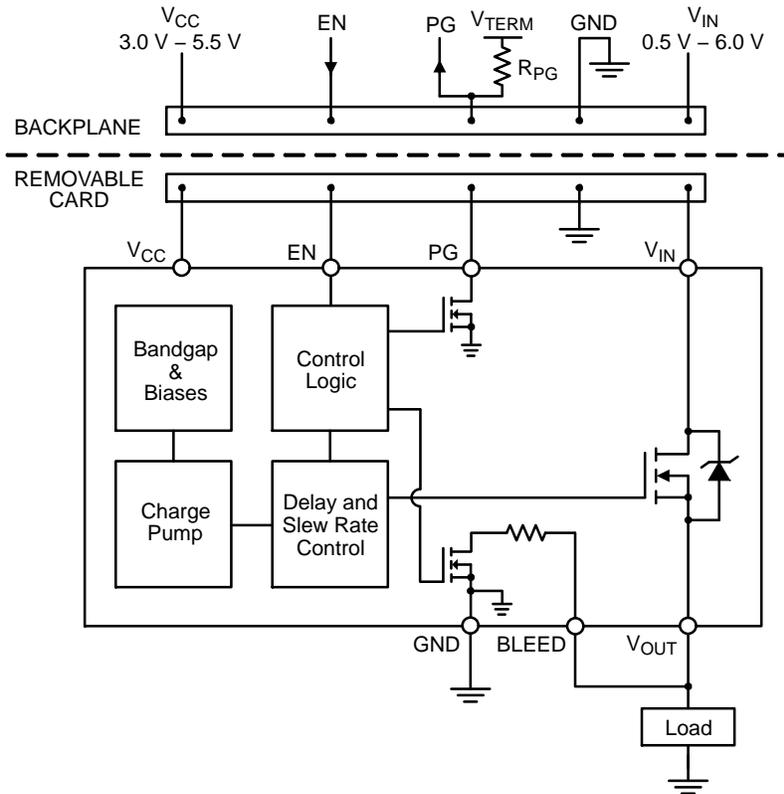


Figure 4. NCP45526 Typical Application Diagram – Hot Swap

# NCP45526

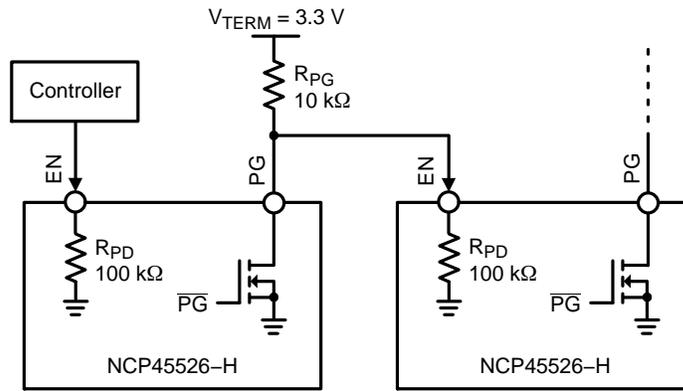
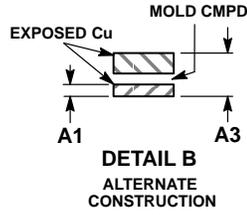
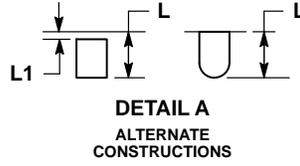
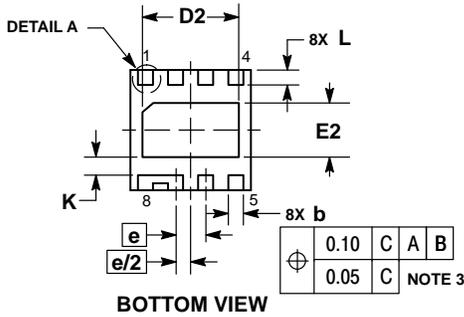
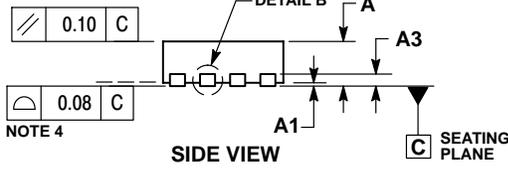
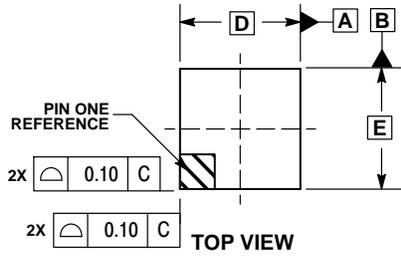


Figure 5. NCP45526 Simplified Application Diagram – Power Sequencing with PG Output

# NCP45526

## PACKAGE DIMENSIONS

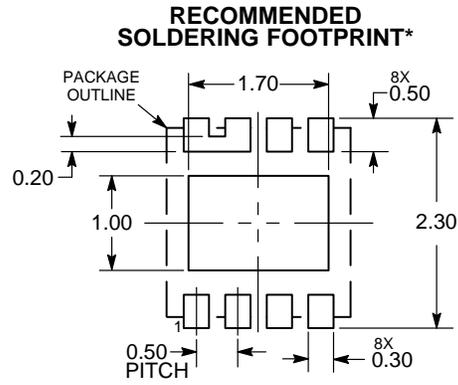
DFN8 2x2, 0.5P  
CASE 506CC  
ISSUE O



**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 0.30 MM FROM TERMINAL TIP.
4. COPLANARITY APPLIES TO THE EXPOSED PAD AS WELL AS THE TERMINALS.

MILLIMETERS		
DIM	MIN	MAX
A	0.80	1.00
A1	0.00	0.05
A3	0.20 REF	
b	0.20	0.30
D	2.00 BSC	
D2	1.50	1.70
E	2.00 BSC	
E2	0.80	1.00
e	0.50 BSC	
K	0.27 REF	
L	0.18	0.38
L1	--- 0.15	



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.

# NCP45526

## ORDERING INFORMATION

Device	EN Polarity	Package	Shipping†
NCP45526IMNTWG-H	Active-High	DFN8 (Pb-Free)	3000 / Tape & Reel
NCP45526IMNTWG-L	Active-Low		

†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.

ecoSWITCH is a trademark of Semiconductor Components Industries, LLC (SCILLC).

**ON Semiconductor** and  are registered trademarks of Semiconductor Components Industries, LLC (SCILLC). SCILLC owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of SCILLC's product/patent coverage may be accessed at [www.onsemi.com/site/pdf/Patent-Marking.pdf](http://www.onsemi.com/site/pdf/Patent-Marking.pdf). SCILLC reserves the right to make changes without further notice to any products herein. SCILLC makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does SCILLC assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. "Typical" parameters which may be provided in SCILLC data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. SCILLC does not convey any license under its patent rights nor the rights of others. SCILLC products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the SCILLC product could create a situation where personal injury or death may occur. Should Buyer purchase or use SCILLC products for any such unintended or unauthorized application, Buyer shall indemnify and hold SCILLC and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that SCILLC was negligent regarding the design or manufacture of the part. SCILLC is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

## PUBLICATION ORDERING INFORMATION

### LITERATURE FULFILLMENT:

Literature Distribution Center for ON Semiconductor  
P.O. Box 5163, Denver, Colorado 80217 USA  
**Phone:** 303-675-2175 or 800-344-3860 Toll Free USA/Canada  
**Fax:** 303-675-2176 or 800-344-3867 Toll Free USA/Canada  
**Email:** [orderlit@onsemi.com](mailto:orderlit@onsemi.com)

**N. American Technical Support:** 800-282-9855 Toll Free  
USA/Canada  
**Europe, Middle East and Africa Technical Support:**  
Phone: 421 33 790 2910  
**Japan Customer Focus Center**  
Phone: 81-3-5817-1050

**ON Semiconductor Website:** [www.onsemi.com](http://www.onsemi.com)  
**Order Literature:** <http://www.onsemi.com/orderlit>  
For additional information, please contact your local Sales Representative