## USB Positive Overvoltage Protection Controller with Internal PMOS FET and Overcurrent Protection

The NCP361 disconnects systems at its output when wrong VBUS operating conditions are detected at its input. The system is positive over–voltage protected up to +20 V.

Thanks to an integrated PMOS FET, no external device is necessary, reducing the system cost and the PCB area of the application board.

The NCP361 is able to instantaneously disconnect the output from the input if the input voltage exceeds the overvoltage threshold (5.675 V). Thanks to an overcurrent protection, the integrated PMOS is turning off when the charge current exceeds current limit (see options in ordering information).

The NCP361 provides a negative going flag ( $\overline{FLAG}$ ) output, which alerts the system that voltage, current or overtemperature faults have occurred.

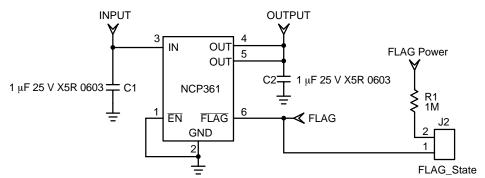


Figure 1. Typical Application Circuit (UDFN Pinout)

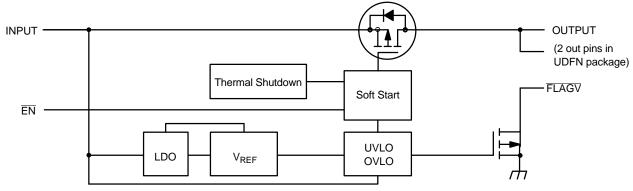


Figure 2. Functional Block Diagram

### PIN FUNCTION DESCRIPTION (UDFN Package)

Pin No.	Name	Туре	Description
1	ĒN	INPUT	Enable Pin. The device enters in shutdown mode when this pin is tied to a high level. In this case the output is disconnected from the input. To allow normal functionality, the EN pin shall be connected to GND or to a I/O pin. This pin does not have an impact on the fault detection.
2	GND	POWER	Ground
3	IN	POWER	Input Voltage Pin. This pin is connected to the VBUS. A 1 $\mu F$ low ESR ceramic capacitor, or larger, must be connected between this pin and GND.
4, 5	OUT	OUTPUT	Output Voltage Pin. The output is disconnected from the VBUS power supply when the input voltage is above OVLO threshold or below UVLO threshold. A 1 $\mu$ F capacitor must be connected to these pins. The two OUT pins must be hardwired to common supply.
6	FLAG	OUTPUT	Fault Indication Pin. This pin allows an external system to detect a fault on VBUS pin. The $\overline{FLAG}$ pin goes low when input voltage exceeds OVLO threshold. Since the $\overline{FLAG}$ pin is open drain functionality, an external pull up resistor to V <sub>CC</sub> must be added.

**PIN FUNCTION DESCRIPTION (TSOP** 

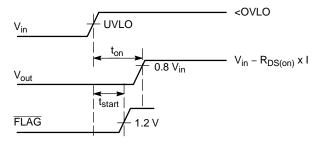
#### MAXIMUM RATINGS

Rating		Symbol	Value	Unit
Minimum Voltage (IN to GND)		Vmin <sub>in</sub>	-0.3	V
Minimum Voltage (All others to GND)		Vmin	-0.3	V
Maximum Voltage (IN to GND)		Vmax <sub>in</sub>	21	V
Maximum Voltage (All others to GND)		Vmax	7.0	V
Maximum DC Current from Vin to Vout (PMOS) (Note 1)		Imax	600	mA
Thermal Resistance, Junction-to-Air	TSOP-5 UDFN	$R_{ hetaJA}$	305 240	°C/W
Operating Ambient Temperature Range		T <sub>A</sub>	-40 to +85	°C
Storage Temperature Range		T <sub>stg</sub>	-65 to +150	°C
Junction Operating Temperature		TJ	150	°C
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ESD Withstand Voltage (IEC 61000-4

#### ELECTRICAL CHARACTERISTICS

(Min/Max limits values ( $-40^{\circ}C < T_A < +85^{\circ}C$ ) and V<sub>in</sub> = +5.0 V. Typical values are T<sub>A</sub> = +25°C, unless otherwise noted.)



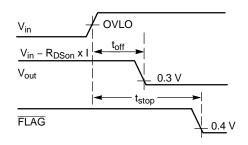
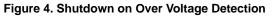
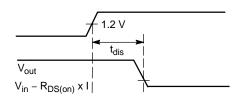


Figure 3. Start Up Sequence





FLAG

Figure 5. Disable on  $\overline{EN} = 1$ 

Figure 6.  $\overline{FLAG}$  Response with  $\overline{EN} = 1$ 

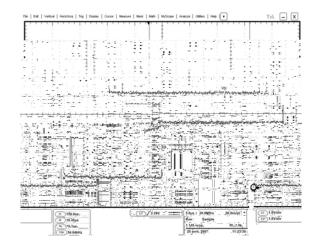


Figure 9. Start Up. Vin=Ch1, Vout=Ch2

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Figure 10. FLAG Going Up Delay. Vin=Ch1, FL:AG=Ch3

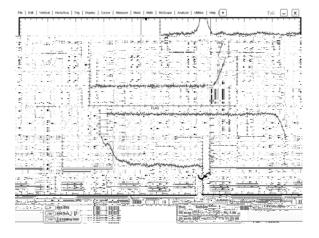


Figure 12. Alert Delay. Vout=Ch1, FLAG=Ch3



Figure 14. Thermal Shutdown. Vin=Ch1, Vout=Ch2, FLAG=Ch3

Figure 11. Output Turn Off time. Vin=Ch1, Vout=Ch2

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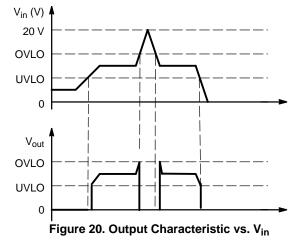
Figure 13. Disable Time. EN=Ch4, Vin=Ch1, Vout=Ch2

#### Operation

NCP361 provides overvoltage protection for positive voltage, up to 20 V. A PMOS FET protects the systems (i.e.: VBUS) connected on the  $V_{out}$  pin, against positive overvoltage. The Output follows the VBUS level until OVLO threshold is overtaken.

#### Undervoltage Lockout (UVLO)

To ensure proper operation under any conditions, the device has a built-in undervoltage lock out (UVLO) circuit. During  $V_{in}$  positive going slope, the output remains disconnected from input until  $V_{in}$  voltage is above 3.0 V nominal. The FLAGV output is pulled to low as long as  $V_{in}$  does not reach UVLO threshold. This circuit has a 70 mV hysteresis to provide noise immunity to transient condition.



#### Overvoltage Lockout (OVLO)

To protect connected systems on  $V_{out}$  pin from overvoltage, the device has a built-in overvoltage lock out (OVLO) circuit. During overvoltage condition (OVLO exceeds), the output remains disabled and FLAG is tied low, as long as the input voltage is higher than OVLO – hysteresis. This circuit has a 100 mV hysteresis to provide noise immunity to transient conditions.

#### **Overcurrent Protection (OCP)**

The NCP361 integrates overcurrent protection to prevent system/battery overload or defect. The current limit threshold is internally set at 750 mA. This value can be changed from 150 mA to 750 mA by a metal tweak, please contact your ON Semiconductor representative for availability. During current fault, the internal PMOS FET is automatically turned off (5  $\mu$ s) if the charge current exceeds I<sub>lim</sub>. NCP361 goes into turn on and turn off mode as long as defect is present. The internal ton delay (4 ms typical) allows limiting thermal dissipation. The Flag pin goes to low level when an overcurrent fault appears. That allows the microcontroller to count defect events and turns off the PMOS with EN pin.

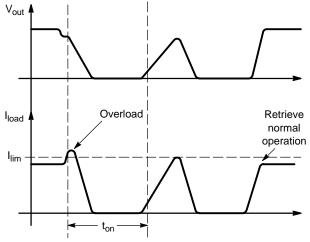


Figure 21. Overcurrent Event Example

#### **FLAG** Output

NCP361 provides a FLAG output, which alerts external systems that a fault has occurred.

This pin is tied to low as soon as:  $1.2 \text{ V} < V_{in} < UVLO$ ,  $V_{in} > OVLO$ ,  $I_{charge} > I_{limit}$ ,  $T_J > 150^{\circ}C$ . When NCP361 recovers normal condition, FLAG is held high. The pin is an open drain output, thus a pull up resistor (typically 1 M $\Omega$  – Minimum 10 k $\Omega$ ) must be provided to  $V_{CC}$ . FLAG pin is an open drain output.

#### **EN** Input

To enable normal operation, the  $\overline{\text{EN}}$  pin shall be forced to low or connected to ground. A high level on the pin disconnects OUT pin from IN pin.  $\overline{\text{EN}}$  does not overdrive an OVLO or UVLO fault.

#### Internal PMOS FET

The NCP361 includes an internal PMOS FET to protect the systems, connected on OUT pin, from positive overvoltage. Regarding electrical characteristics, the  $R_{DS(on)}$ , during normal operation, will create low losses on  $V_{out}$  pin, characterized by  $V_{in}$  versus  $V_{out}$  dropout.

#### ESD Tests

The NCP361 fully supports the IEC61000–4–2, level 4 (Input pin, 1  $\mu$ F mounted on board). That means, in Air condition, V<sub>in</sub> has a ±15 kV ESD protected input. In Contact condition, V<sub>in</sub> has ±8 kV ESD protected input. Please refer to Figure 22 to see the IEC61000–4–2 electrostatic discharge waveform.

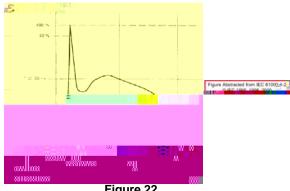


Figure 22.

#### **PCB** Recommendations

The NCP361 integrates a 500 mA rated PMOS FET, and the PCB rules must be respected to properly evacuate the heat out of the silicon. The UDFN PAD1 must be connected to ground plane to increase the heat transfer if necessary

from an application standpoint. Of course, in any case, this pad shall be not connected to any other potential.

By increasing PCB area, the  $R_{\theta JA}$  of the package can be decreased, allowing higher charge current to fill the battery.

Taking into account that internal bondings (wires between package and silicon) can handle up to 1 A (higher than thermal capability), the following calculation shows two different example of current capability, depending on PCB area:

- With 305°C/W (without PCB area), allowing DC current is 500 mA
- With 260°C/W (200 mm<sup>2</sup>), the charge DC current allows with a 85°C ambient temperature is:

 $I = \sqrt{(T_J - T_A)/(R_{\theta JA} \times R_{DSON})}$ 

I = 625 mA

In every case, we recommend to make thermal measurement on final application board to make sure of the final Thermal Resistance.

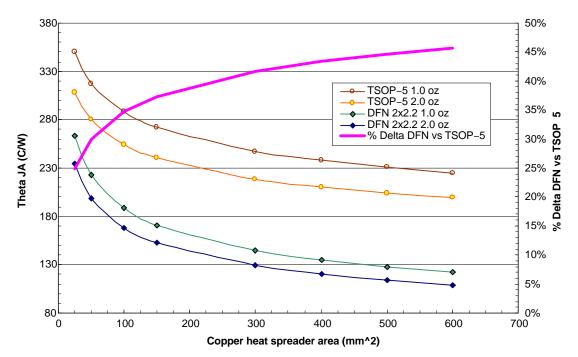


Figure 23. Thermal Resistance of UDFN 2x2 and TSOP Packages as a Function of PCB Area and Thickness

#### **ORDERING INFORMATION**

Device	Marking	Package	Shipping <sup>†</sup>
NCP361MUTBG	AD	UDFN6 (Pb-Free)	3000 / Tape & Reel
NCP361SNT1G	ACD	TSOP-5 (Pb-Free)	3000 / Tape & Reel
NCV361SNT1G*	VET	TSOP-5 (Pb-Free)	3000 / 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. \*NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements

#### **SELECTION GUIDE**

Part number is designated as follows:

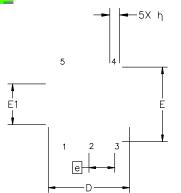
NCP361xxxxxTxG a b c d e

Code	Contents	
а	Overcurrent Threshold –: 750 mA	
b	Package MU: UDFN SN: TSOP–5	
с	UVLO Typical Threshold –: 3.00 V	
d	OVLO Typical Threshold -: 5.675 V	
e	Tape & Reel Type B: = 3000 1: = 3000	

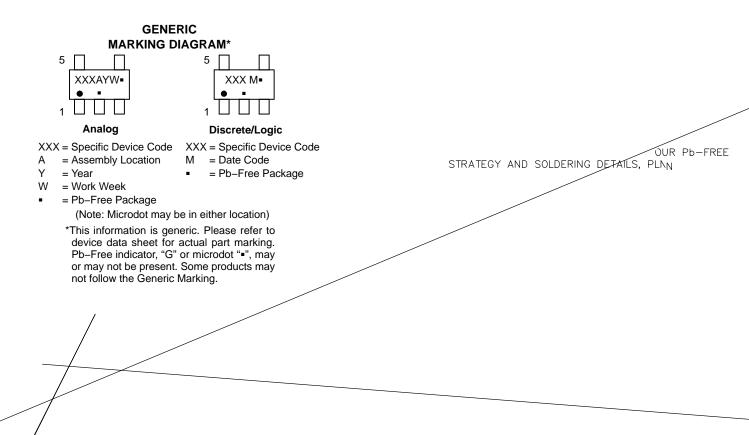


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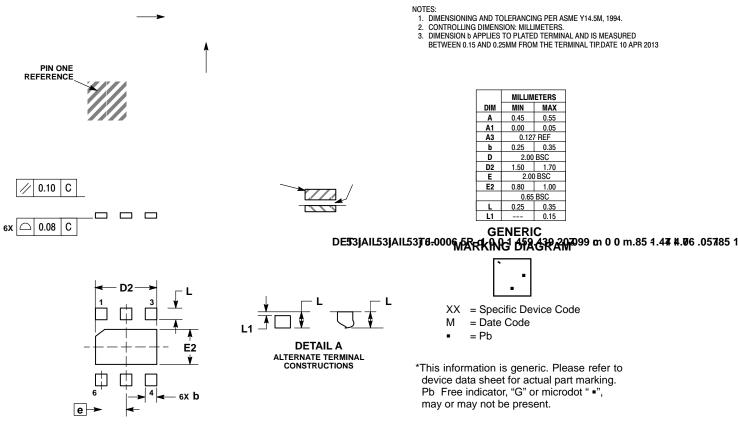






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**BOTTOM VIEW** 

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