

# NCP1404 Series

## Product Preview

### 350 mA PWM/PFM Step-Up DC-DC Converter with Low Battery Detector

The NCP1404 series are monolithic PWM/PFM step-up DC to DC converters which can automatically change operation mode from PWM to PFM at light loads to improve efficiency at light loads. With only four external components, this series allow a simple means to implement highly efficient converters for powering up portable equipment up to 350 mA loading.

Additionally, this series is featured with a Low Battery Detector to monitor battery voltage. The NCP1404 device series are available in space-saving TSOP-6 package with five standard regulated output voltages. Additional voltages that range from 1.8 V to 5.0 V in 100 mV steps can be manufactured.

#### Features

- Low Start-Up Voltage of 0.8 V
- PWM Oscillator Frequency of 600 kHz at 20% Accuracy
- High Efficiency 85% at  $I_{OUT} = 200$  mA,  $V_{IN} = 2.5$  V,  $V_{OUT} = 3.3$  V
- Output Current up to 350 mA at  $V_{IN} = 2.5$  V,  $V_{OUT} = 3.3$  V
- Duty Ratio: 17% to 85% typ. PWM Control  
17% typ. PFM Control
- Output Voltage Accuracy  $\pm 2.5\%$
- Low Battery Detection with Open-drain Detector Output
- Separated Power Supply Pin
- Low Profile and Minimum External Parts
- Micro Miniature TSOP-6

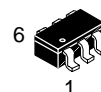
#### Typical Applications

- Digital Cameras
- Cellular Telephones
- Personal Digital Assistants (PDA)
- Camcorders
- Electronic Games
- Pagers
- Portable Audio (MP3)
- Handheld Instruments



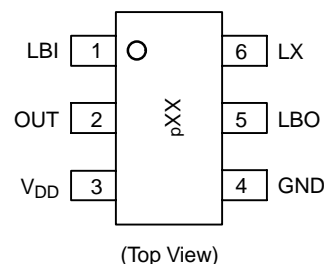
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TSOP-6  
SN SUFFIX  
CASE 318G

#### PIN CONNECTIONS AND MARKING DIAGRAM



XX = Specific Device Code  
<sup>d</sup> = Date Code

See specific marking information in the ordering information table on page 3 of this data sheet.

#### ORDERING INFORMATION

Device	Package	Shipping
NCP1404SN19T1	TSOP-6	3000/Tape & Reel
NCP1404SN27T1	TSOP-6	3000/Tape & Reel
NCP1404SN30T1	TSOP-6	3000/Tape & Reel
NCP1404SN33T1	TSOP-6	3000/Tape & Reel
NCP1404SN50T1	TSOP-6	3000/Tape & Reel

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# NCP1404 Series

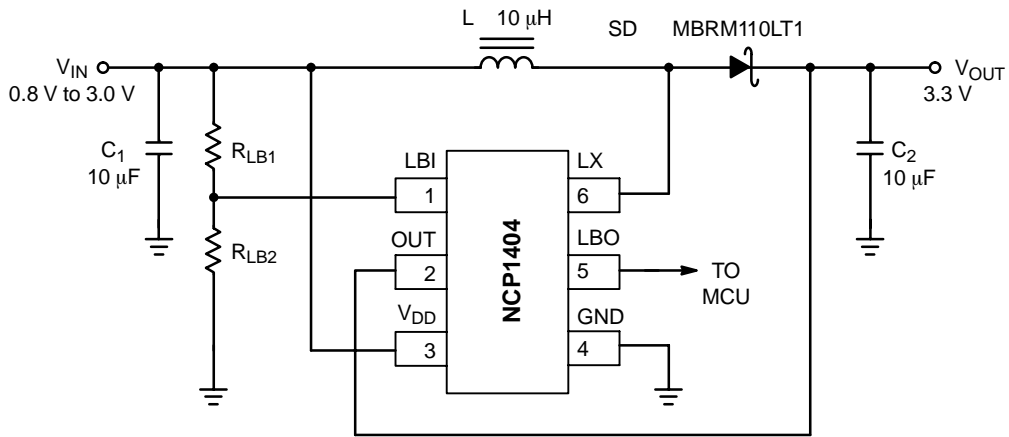


Figure 1. Typical Step-Up Converter Application

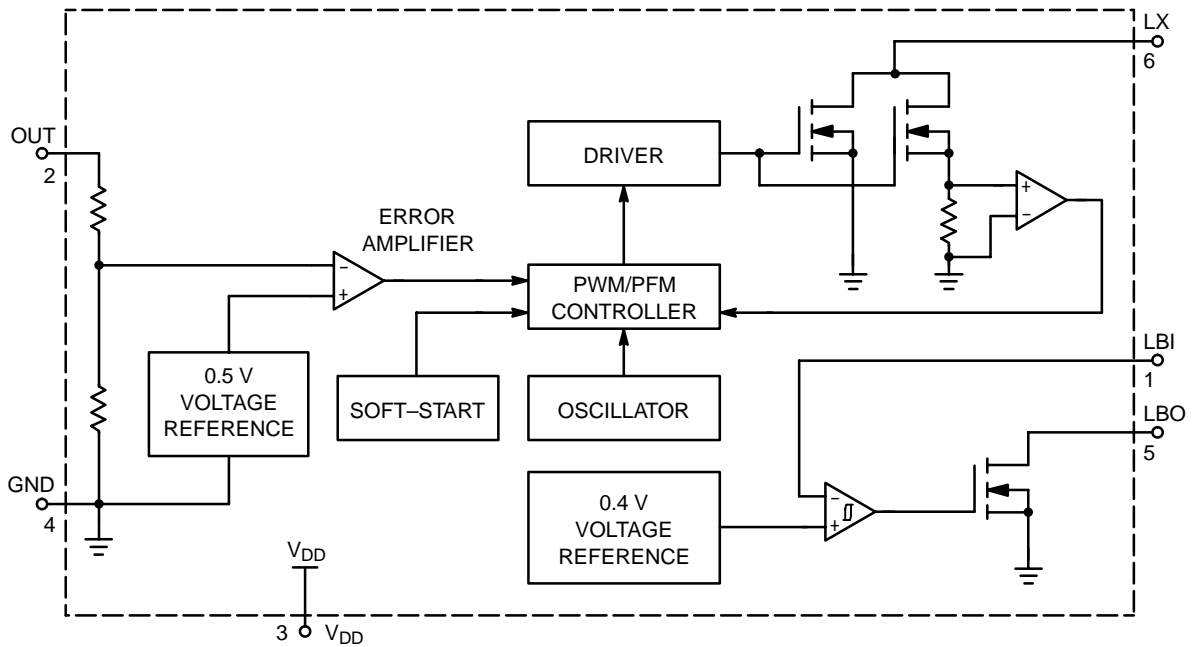


Figure 2. Representative Block Diagram

# NCP1404 Series

## PIN FUNCTION DESCRIPTIONS

Pin	Symbol	Description
1	LBI	Low battery detection input pin
2	OUT	Output voltage monitor pin
3	V <sub>DD</sub>	Power supply pin
4	GND	Ground pin
5	LBO	Low battery detection output pin
6	LX	External inductor connection pin to power switch drain

## ORDERING INFORMATION

Device	Output Voltage	Frequency	Device Marking	Package	Shipping
NCP1404SN19T1	1.9 V	600 kHz	DB?	TSOP-6	3000 Units per 7 Inch Reel
NCP1404SN27T1	2.7 V	600 kHz	DB?		
NCP1404SN30T1	3.0 V	600 kHz	DB?		
NCP1404SN33T1	3.3 V	600 kHz	DB?		
NCP1404SN50T1	5.0 V	600 kHz	DB?		

NOTE: The ordering information lists five standard output voltage device options. Additional device with output voltage ranging from 1.8 V to 5.0 V in 100 mV increments can be manufactured. Contact your ON Semiconductor representative for availability.

## MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Power Supply Voltage (Pin 3)	V <sub>DD</sub>	-0.3 to 6.0	V
Input/Output Pins Pin 1, Pin 2, Pin 5, Pin 6 Voltage	V <sub>IO</sub>	-0.3 to 6.0	V
LX Pin Peak Sink Current	I <sub>LX</sub>	1000	mA
Thermal Resistance Junction to Air	R <sub>θJA</sub>	250	°C/W
Operating Ambient Temperature Range	T <sub>A</sub>	-40 to + 85	°C
Operating Junction Temperature Range	T <sub>J</sub>	-40 to + 125	°C
Storage Temperature Range	T <sub>stg</sub>	-55 to +150	°C

1. This device series contains ESD protection and exceeds the following tests:  
Human Body Model (HBM) ±2.0 kV per JEDEC standard: JESD22-A114.  
Machine Model (MM) ±200 V per JEDEC standard: JESD22-A115.
2. Latch-up Current Maximum Rating: ±150 mA per JEDEC standard: JESD78.
3. Moisture Sensitivity Level (MSL): 1 per IPC/JEDEC standard: J-STD-020A.

# NCP1404 Series

## ELECTRICAL CHARACTERISTICS (For all values $T_A = 25^\circ\text{C}$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>OSCILLATOR</b>					
Frequency ( $V_{OUT} = V_{SET} \times 0.96$ ) (Note 4)	$f_{OSC}$	480	600	720	kHz
Frequency Temperature Coefficient ( $T_A = -40$ to $+85^\circ\text{C}$ )	$\Delta f$	–	0.11	–	%/ $^\circ\text{C}$
Maximum PWM Duty Cycle ( $V_{OUT} = V_{SET} \times 0.96$ )	$D_{MAX}$	70	78	86	%
PFM Duty Cycle	$D_{PFM}$	12	17	22	%
Minimum Start-up Voltage ( $I_O = 0$ mA, $V_{DD} = V_{OUT} = V_{SET}$ )	$V_{start}$	–	0.8	0.95	V
Minimum Start-up Voltage Temperature Coefficient ( $T_A = -40$ to $+85^\circ\text{C}$ )	$\Delta V_{start}$	–	–1.6	–	mV/ $^\circ\text{C}$
Soft-Start Time ( $V_{OUT} = V_{SET}$ )	$t_{SS}$	0.3	2.0	–	ms

### LX (PIN 6)

Internal Switching N-Channel FET Drain Voltage	$V_{LX}$	–	–	6.0	V
LX On-State Current ( $V_{DD} = V_{OUT} = V_{SET} \times 0.96$ , $V_{LX} = 0.6$ V) Device Suffix: 19T1 27T1 30T1 33T1 50T1	$V_{LX}$	350 550 550 550 600	400 600 600 600 650	– – – – –	mA
Current Limit	$I_{LXLIM}$	700	750	800	mA
Off-State Leakage Current ( $V_{LX} = 6.0$ V, $T_A = -40$ to $+85^\circ\text{C}$ )	$I_{LKG}$	–	0.5	1.0	mA

### LBI (PIN 1)

LBI Threshold Voltage Falling	$V_{LBI}$	0.396	0.400	0.404	V
LBI Hysteresis	$V_{HYS}$	–	30	–	mV
LBI Input Current	$I_{LBI}$	–	1.5	8.0	nA

### LBO (PIN 5)

LBO Low Output Voltage	$V_{LBO(low)}$	–	–	0.05	V
LBO Off-State Leakage Current	$I_{LBOLKG}$	–	1	100	nA

### TOTAL DEVICE

Supply Voltage	$V_{DD}$	0.8		5.5	V
Output Voltage Device Suffix: 19T1 27T1 30T1 33T1 50T1	$V_{OUT}$	1.853 2.632 2.925 3.218 4.875	1.9 2.7 3.0 3.3 5.0	1.948 2.768 3.075 3.383 5.125	V
Output Voltage Temperature Coefficient ( $T_A = -40$ to $+85^\circ\text{C}$ )	$\Delta V_{OUT}$	–	100	–	ppm/ $^\circ\text{C}$
Operating Current ( $V_{OUT} = V_{SET} \times 0.96$ , $V_{DD} = V_{SET} \times 0.6$ ) (Note 5)	$I_{DD1}$	–	220	300	$\mu\text{A}$
No Switching Operating Current ( $V_{OUT} = V_{SET} + 0.5$ V)	$I_{DD2}$	–	40	55	$\mu\text{A}$
No Load Operating Current ( $V_{DD} = V_{SET} \times 0.6$ , $I_{OUT} = 0$ mA) (Note 7)	$I_{DD(no load)}$	–	65	80	$\mu\text{A}$
Maximum Output Current ( $V_{DD} = V_{OUT}$ , $V_{IN} = V_{SET} \times 0.8$ , Voltage Regulation < 3%) Device Suffix: 19T1 27T1 30T1 33T1 50T1	$I_{OUT}$	150 300 300 300 350	200 350 350 350 400	– – – – –	mA

4.  $V_{SET}$  means setting of output voltage.

5. Operating current is the current consumption of the device in PWM mode.

6. No switching operating current is the current consumption of the device when there is no switching.

7. No load operating current is the current consumption of the device in PFM mode at no load.

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## Other Application Circuit

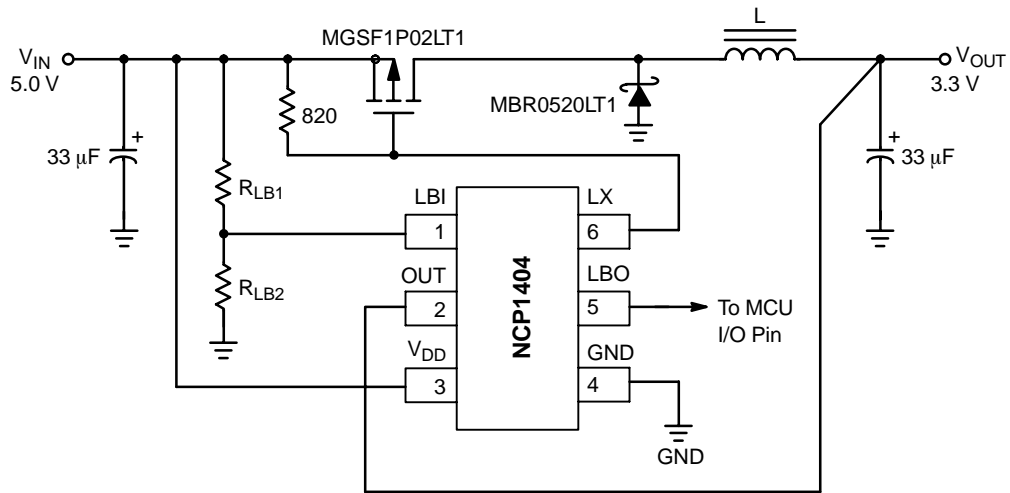
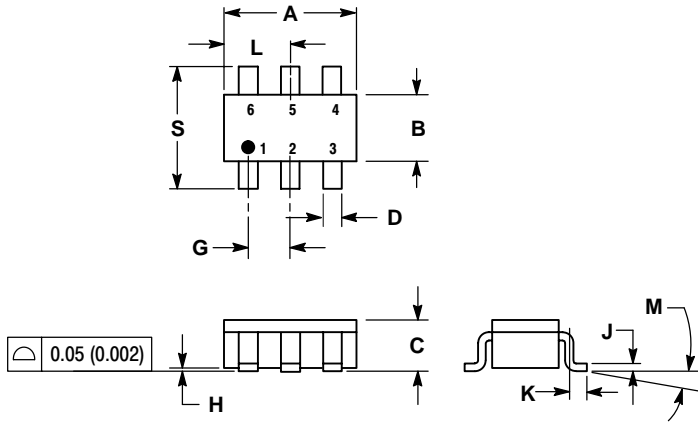


Figure 3. Step-down Application

# NCP1404 Series

## PACKAGE DIMENSIONS

TSOP-6  
CASE 318G-02  
ISSUE H




NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. MAXIMUM LEAD THICKNESS INCLUDES LEAD FINISH THICKNESS. MINIMUM LEAD THICKNESS IS THE MINIMUM THICKNESS OF BASE MATERIAL.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.90	3.10	0.1142	0.1220
B	1.30	1.70	0.0512	0.0669
C	0.90	1.10	0.0354	0.0433
D	0.25	0.50	0.0098	0.0197
G	0.85	1.05	0.0335	0.0413
H	0.013	0.100	0.0005	0.0040
J	0.10	0.26	0.0040	0.0102
K	0.20	0.60	0.0079	0.0236
L	1.25	1.55	0.0493	0.0610
M	0°	10°	0°	10°
S	2.50	3.00	0.0985	0.1181

**Notes**

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