

Nuvoton

1.6 Times Linear Fan Driver

NCT3942S/S-A

NCT3942Y/Y-A

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1. GENERAL DESCRIPTION

The NCT3942 is a simply linear fan driver. It is designed for noise-sensitive or power-sensitive applications that require system cooling. The NCT3942 is a low quiescent current, low dropout linear regulator which is designed with a P-channel MOSFET to power a DC fan and delivers output current up to 500mA. It builds internal Soft-start to reduce the inrush current when power on. The output voltage follows the 1.6 times on the voltage of V_{SET} pin to dynamic adjust the DC fan speed. NCT3942 supports enable pin to control the output voltage. NCT3942S-A/Y-A is power-on by the VSET pin voltage threshold and supports fully turn-on function. The internal power MOSFET can be fully turned on directly when FON# is at low level. NCT3942S/S-A is available in SOP-8 package. NCT3942Y/Y-A is available in DFN-8 package.

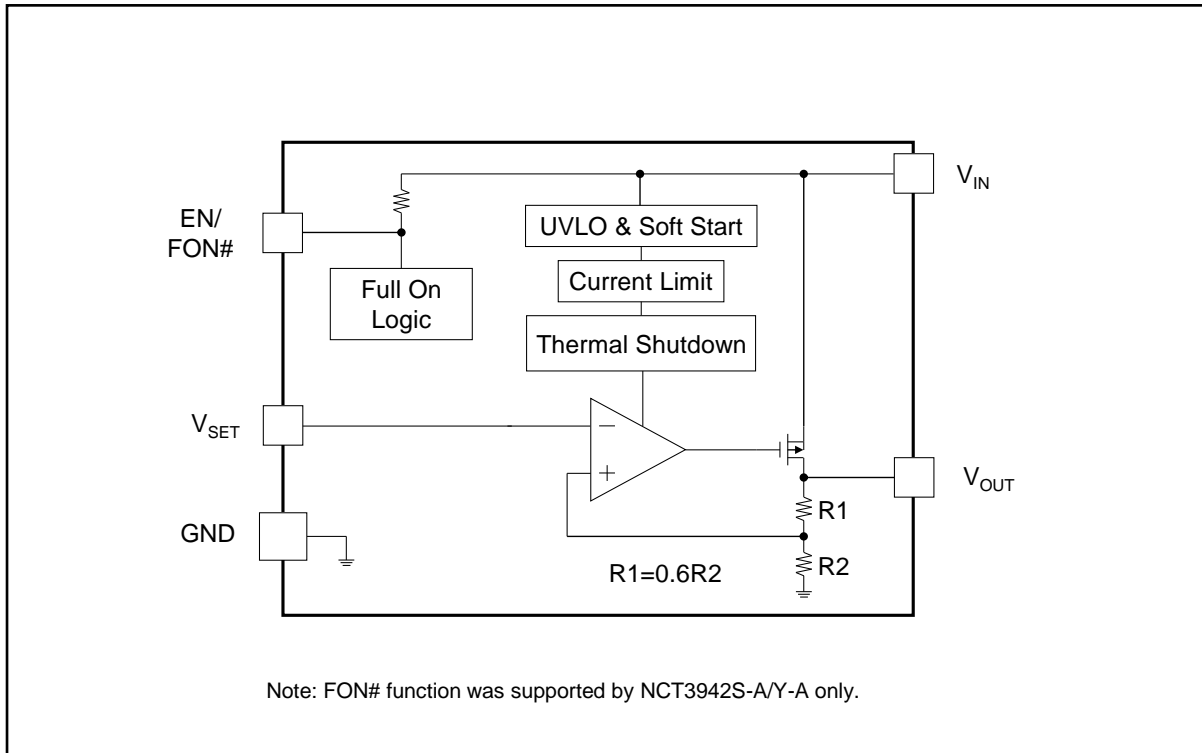
2. FEATURES

- VOUT Follows 1.6 Times of VSET
- 150mV Dropout @ 0.5A Output Current
- 5uA Quiescent Current in Shutdown Mode
- Internal Soft-Start
- UVLO Function
- Full On Function
- Over Current, Short Circuit and Over Temperature Protections
- Low External Component Count
- Low Cost and Easy to Use
- SOP-8 150mil Package
- DFN8 (2.0x 2.0 mm²) Package
- Lead Free (ROHS Compliant) and Halogen Free

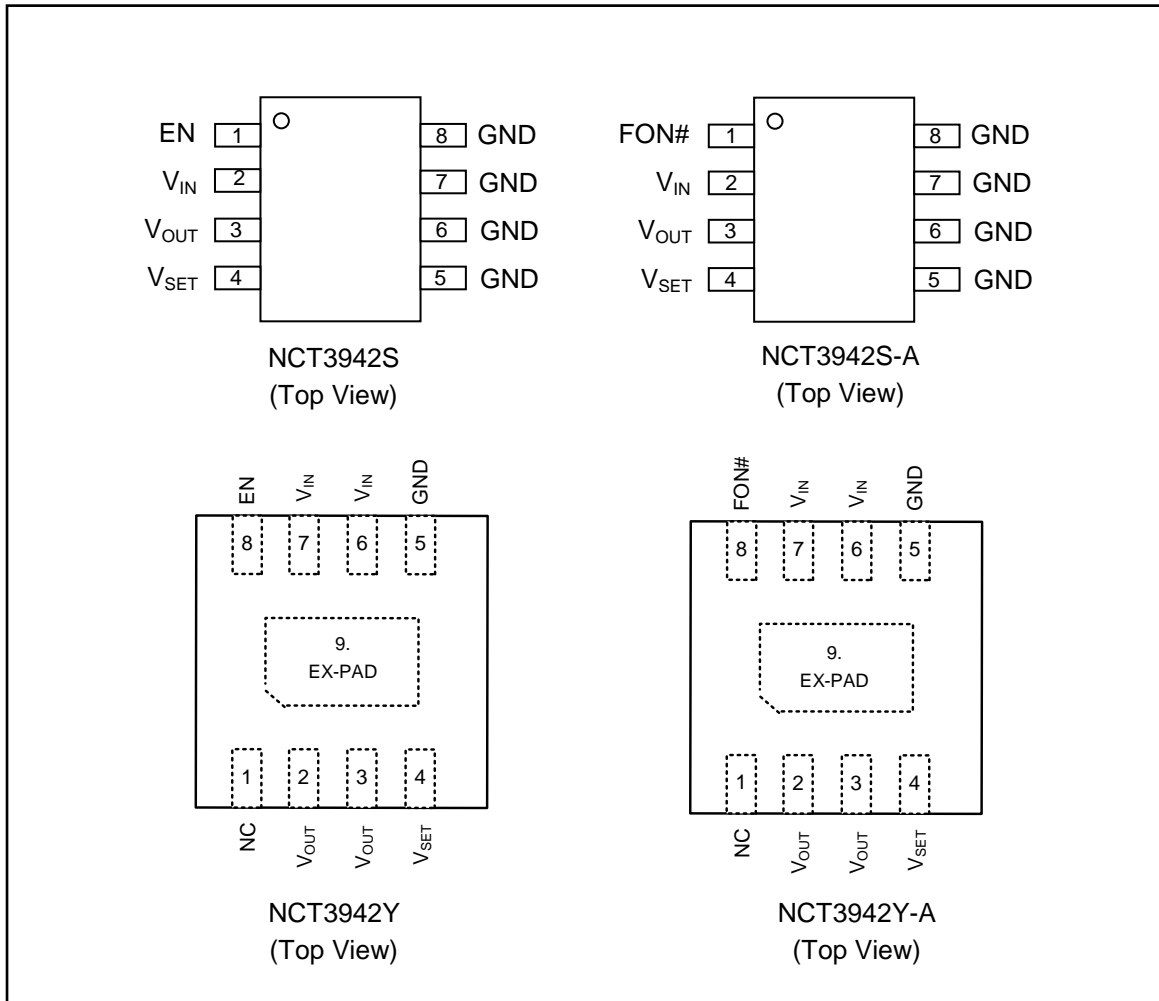
3. APPLICATIONS

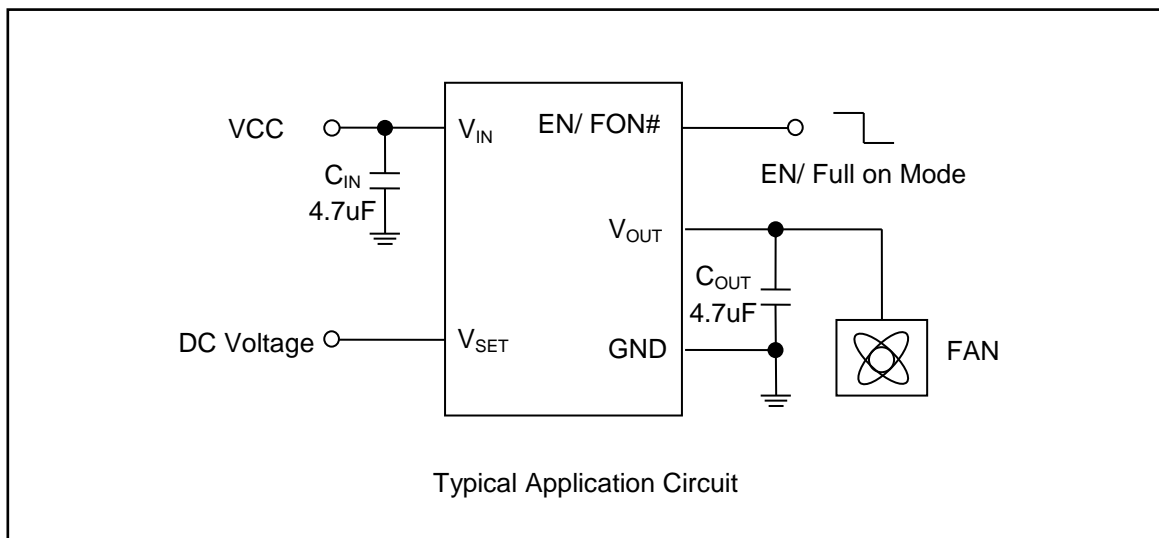
- PC Stick/ mini PC
- Notebook/ Netbook Fan Driver
- Peripheral Add-in Cards
- Motherboards
- Battery Powered Systems

4. BLOCK DIAGRAM



5. PIN CONFIGURATION AND TYPICAL APPLICATION CIRCUIT





6. PIN DESCRIPTION

PIN NAME	Number				DESCRIPTION
	S	S-A	Y	Y-A	
FON#	--	1	--	8	Only for NCT3942S-A/Y-A device. Full On mode selection pin. Output voltage follows 1.6 times of V_{SET} pin voltage when FON# pin at high level. The internal power MOSFET full turns on when FON# pin at low level. Internal pull up resistor connected to V_{IN} .
EN	1	--	8	--	Only for NCT3942S/Y device. Enable pin. Output voltage follows 1.6 times of V_{SET} pin voltage when Enable pin at high level. Internal pull up resistor connected to V_{IN} .
V_{IN}	2		6~7		DC power supply input. Connect a bypass capacitor (4.7uF, typically) is recommended.
V_{OUT}	3		2~3		Voltage output pin. Connect a low ESR ceramic capacitor (4.7uF, typically) to ground to assure stability.
V_{SET}	4		4		Output voltage setting pin. The inputs could be DC voltage. The input voltage must be larger than 1V.
GND	5~8		5		Power supply ground.
EX-PAD	9		9		Exposed Pad. Connect to ground for better thermal dissipation.

7. FUNCTIONAL DESCRIPTION

7.1 General Description

The NCT3942 is a low quiescent current, low dropout linear regulator which is designed with a P-channel MOSFET to power a DC fan. It can deliver output current up to 500mA. The output voltage follows the 1.6 times on the voltage of V_{SET} pin to dynamic adjust the DC fan speed. NCT3942S/Y supports enable pin to control the output voltage. NCT3942S-A/Y-A is power-on by the VSET pin and supports fully turn-on function.

7.2 Under Voltage Lockout, UVLO

The NCT3942 was built-in a UVLO protection to keep the output off until the internal circuitry is operating properly. The UVLO function initiates a soft start process after input voltage exceeds its rising UVLO threshold during power on. Typical UVLO threshold is 2.5V with 0.15V hysteresis.

7.3 Full On Function

The function is for NCT3942S-A/Y-A only. The input voltage level of FON# can control the internal regulator fully turn on or following 1.6 times of V_{SET} voltage. When pulling this pin below 0.4V, the regulator will be fully turned on. When pulling this pin above 1.6V, the output voltage will follow 1.6 times of V_{SET} voltage. The FON# is internal pull-high.

7.4 EN Function

The NCT3942S/Y goes into shutdown mode when the EN pin is in the logic low condition. During this condition, the pass transistor, error amplifier are turned off, reducing the supply current. The EN pin is internal pull-high, So the NCT3942S/Y will be turned on when EN pin is floating.

7.5 VSET Setting

The output voltage is 1.6 times of V_{SET} pin voltage. If the input voltage of V_{SET} is under 1V, the internal regulator will be turned off. When the V_{SET} voltage exceeds 1V, the output voltage will follow 1.6 times of V_{SET} voltage with soft start.

7.6 Current Limit

The NCT3942 provides a current limit circuitry, which monitors the output current and controls PMOS gate voltage to limit the output current at a specific value.

7.7 Soft-start

The NCT3942 builds internal Soft-start to reduce the inrush current and eliminate the voltage drop at V_{in} supply voltage when enabling. The soft-start interval is typically 150us.

7.8 Thermal Shutdown

The NCT3942 has a thermal shutdown circuitry to limit the junction temperature. When the junction temperature exceeds 150° C, the thermal shutdown circuits disable the output, allowing the device to cool down. The output circuitry is enabled again with soft start after the junction temperature cools down by 30° C, resulting in a pulsed output during continuous thermal overload conditions. The thermal protection is designed to protect the IC in the event of over temperature conditions. For reliable operation, the junction temperature cannot exceed 125° C.

7.9 VIN Decoupling

To achieve the best results when using the NCT3942, decouple the power supply with a 2.2uF capacitor. Use a high quality ceramic surface mount capacitor if possible. Surface mount components minimize lead inductance, which improves performance, and ceramic capacitors tend to have adequate high frequency response for decoupling applications.

7.10 VOUT Stability

To maintain circuit stability and improve transient response over temperature and current, the NCT3942 needs a suitable output capacitor. In order to insure the circuit stability, the suitable output capacitor should be larger than 4.7uF.

8. TYPICAL WAVEFORM

($V_{SET} = 2V$, $V_{EN} = V_{IN}$, $V_{IN} = 5V$, $I_O = 0.5A$, $C_{IN} = C_{OUT} = 4.7\mu F$, $T_A = T_J = 25^\circ C$, unless otherwise specified)

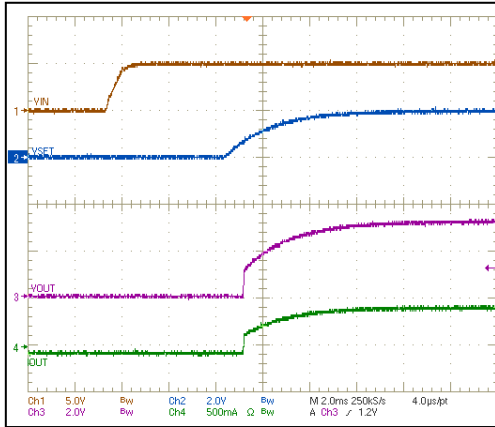


Figure 01. Power on by VIN

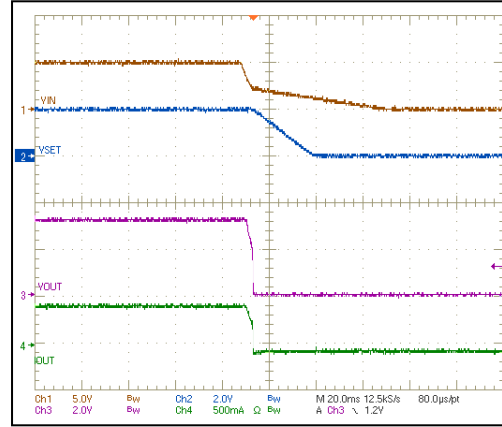


Figure 02. Power off by VIN

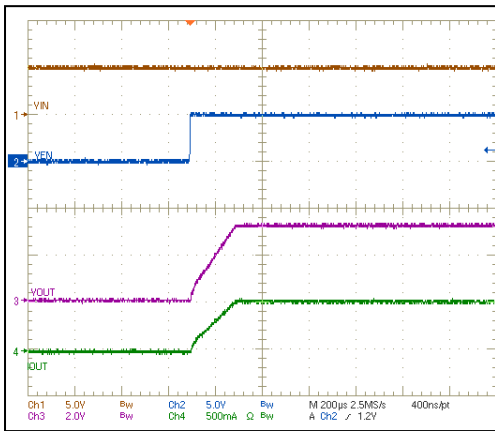


Figure 03. Power on by EN

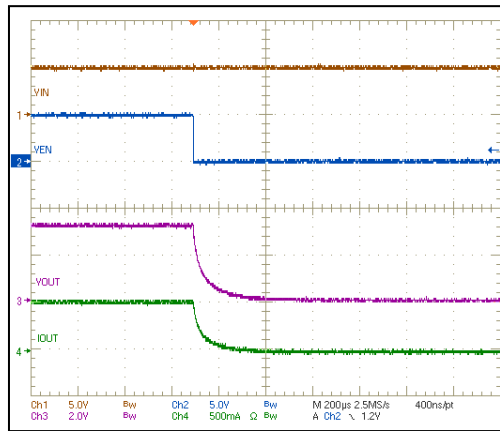


Figure 04. Power on by EN

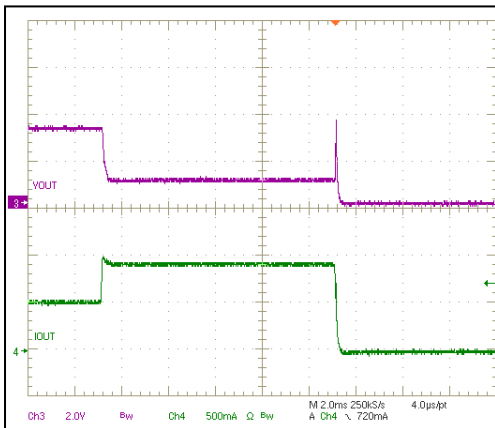


Figure 05. Current limit & OTP

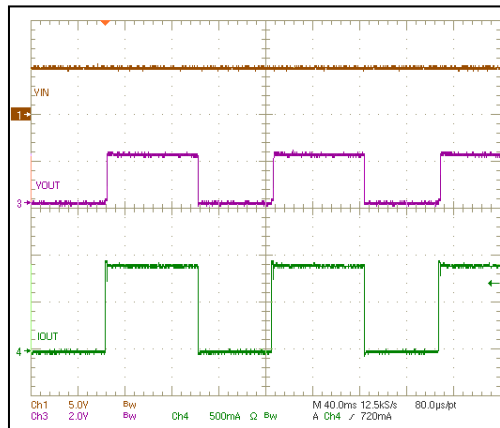


Figure 06. OTP

($V_{SET} = 2V$, $V_{EN} = V_{IN}$, $V_{IN} = 5V$, $I_O = 0.5A$, $C_{IN} = C_{OUT} = 4.7\mu F$, $T_A = T_J = 25^\circ C$, unless otherwise specified)

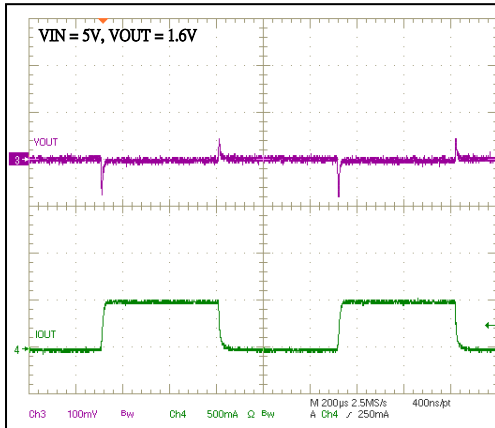


Figure 07. Load Regulation

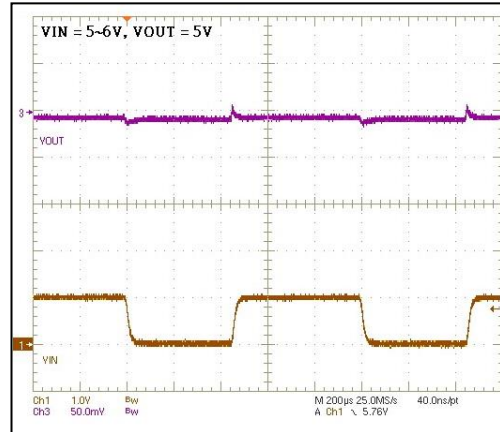


Figure 08. Line Regulation

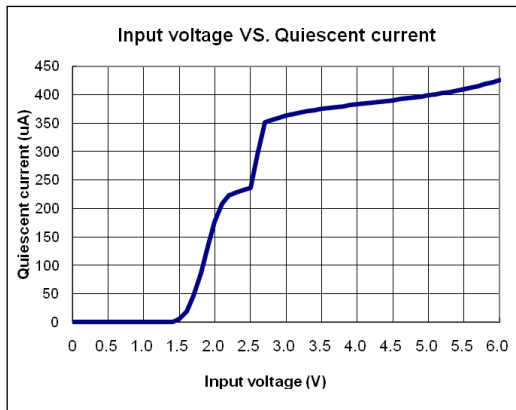


Figure 09. Input voltage vs. Quiescent current

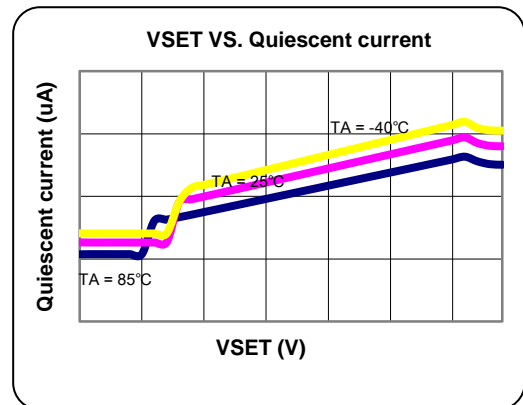


Figure 10. VSET vs. Quiescent current

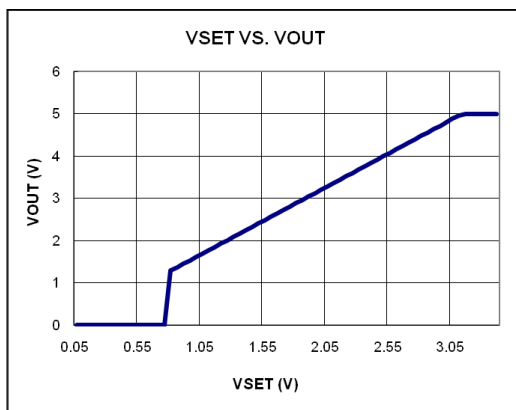


Figure 11. VSET vs. VOUT

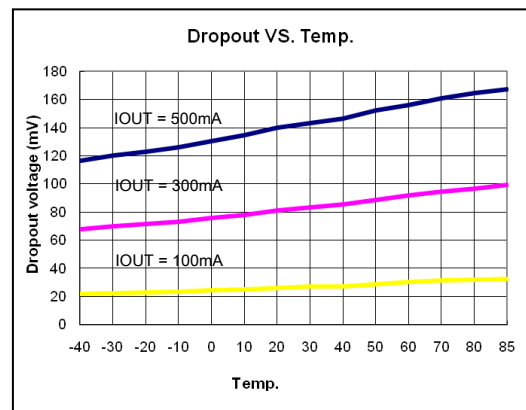


Figure 12. Dropout vs. Temp

9. ELECTRICAL CHARACTERISTIC

9.1 Absolute Maximum Ratings

PARAMETER		RATING	UNIT
Power Supply Voltage		-0.3 to 7V	V
Voltage on Other Pins		-0.3 to 7V	V
Storage Temperature		-50 to 150	°C
Soldering Temperature		Refer to IPC/JEDEC J-STD-020 Specification	
ESD Protection	Human Body Mode	2	kV
	Machine Mode	200	V
	Latch-up	100	mA

Note: Exposure to conditions beyond those listed under Absolute Maximum Ratings may adversely affect the life and reliability of the device.

9.2 Thermal Information

ITEM	RATING	UNIT
Power Dissipation, P_D @ $T_A=25^\circ\text{C}$	Internal Limited	W
Package Thermal Resistance, SOP8, θ_{JA}	160	°C/W
Package Thermal Resistance, DFN8, θ_{JA}	TBD	°C/W

9.3 Recommended operating conditions

PARAMETER	RATING	UNIT
Operating Temperature	-40 to 85	°C
Junction Temperature	-40 to 125	°C
Supply Voltage, VCC	$5 \pm 10\%$	V

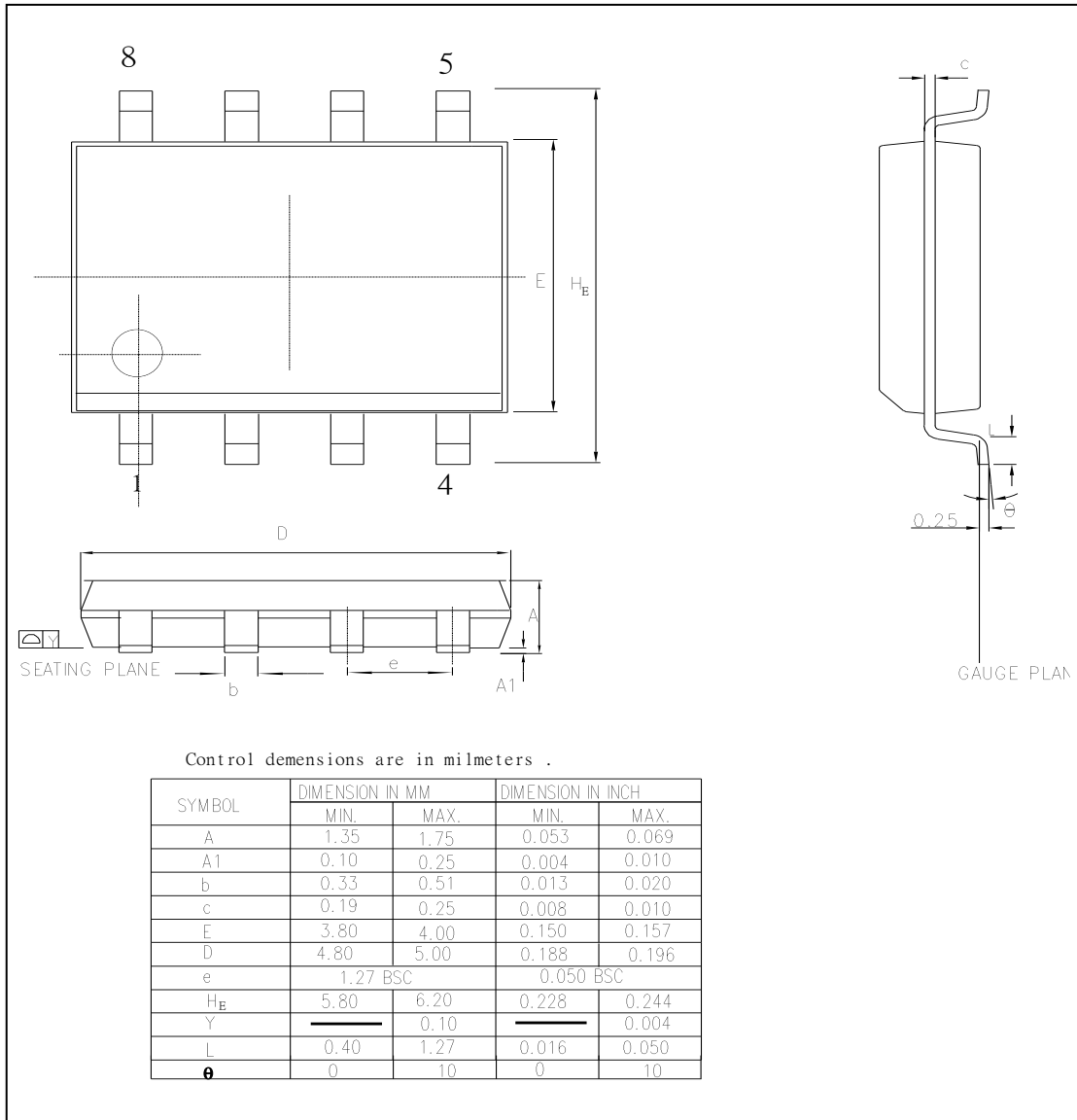
9.4 Electrical CHARACTERISTICS

($V_{IN}=5V$, $V_{SET}=2V$, $C_{IN}=C_{OUT}=4.7\mu F$, $T_a=25^\circ C$, unless otherwise specified)

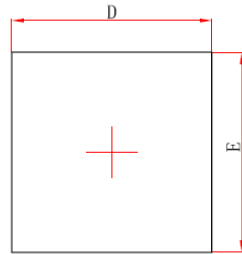
PARAMETER	SYM.	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Supply Input Voltage						
Supply Input Voltage	V_{IN}	4.5		5.5	V	
Under Voltage Lockout (UVLO)						
V_{IN} UVLO Threshold		2.1	2.5	2.9	V	V_{IN} rising
V_{IN} UVLO Hysteresis			0.15		V	
EN Pin						
EN Voltage High		2.0			V	
EN Voltage Low				0.4	V	
EN Pin Bias Current			1.5	10	μA	EN=0V
FON# Pin						
Low Voltage	V_{IL}			0.4	V	
High Voltage	V_{IH}	1.6			V	
FON# Pin Bias Current	$I_{FON\#}$		1.5	10	μA	FON#=0V
Supply Input Current						
Quiescent Current	I_Q		0.5	1	mA	$V_{OUT} = 5V$
Output Voltage						
V_{OUT} Voltage / V_{SET} Voltage		1.552	1.6	1.648	V/V	$V_{IN}=5.5V$, $V_{SET}=1V\sim 3.2V$
Load Regulation			30	40	mV	$10mA \leq I_{OUT} \leq 500mA$
Line Regulation			0.2	0.5	%	$V_{in}=4.5V$ to $5.5V$
Output Resistance			0.3	0.4	Ω	$I_{OUT}=500mA$, $V_{SET}=3.4V$
Output Leakage			0	1	μA	$V_{SET} < 1V$
V_{SET} Pin						
Minimum V_{SET} Voltage			1		V	
Current Limit Protection						
Current Limit	I_{LIMIT}	0.7	1.0		A	
Softstart						
Softstart Time	T_{SS}		130	300	μs	
Over Temperature Protection						
Thermal Shutdown Temperature		145	150	160	$^\circ C$	
Thermal Shutdown Hysteresis		20	30	40	$^\circ C$	

10. PACKAGE DIMENSION

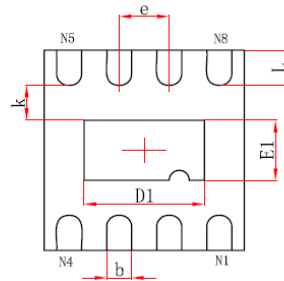
- NCT3942S/S-A: SOP-8 (150mil)



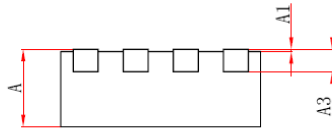
- NCT3942Y/Y-A: DFN8 2.0 x 2.0 mm²



Top View



Bottom View

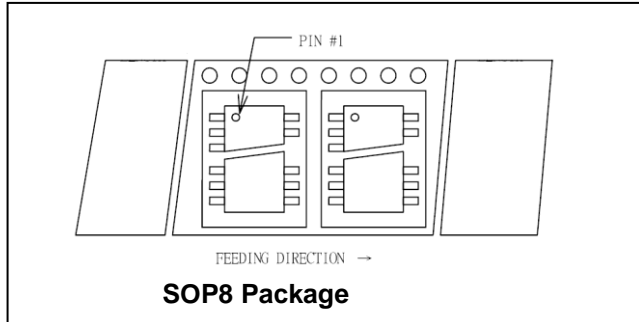


Side View

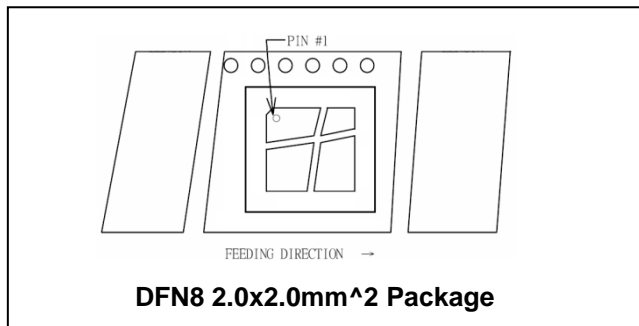
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.700/0.800	0.800/0.900	0.028/0.031	0.031/0.035
A1	0.000	0.050	0.000	0.002
A3	0.203REF.		0.008REF.	
D	1.900	2.100	0.075	0.083
E	1.900	2.100	0.075	0.083
D1	1.100	1.300	0.043	0.051
E1	0.500	0.700	0.020	0.028
k	0.200MIN.		0.008MIN.	
b	0.180	0.300	0.007	0.012
e	0.500TYP.		0.020TYP.	
L	0.250	0.450	0.010	0.018

➤ **Taping Specification**

NCT3942S/ S-A



NCT3942Y/ Y-A

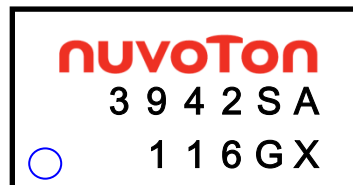
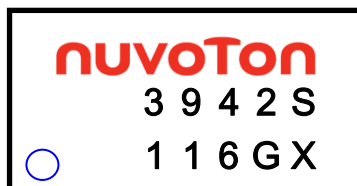


11. ORDERING INFORMATION

Part Number	Package Type	Supplied as	Production Flow
NCT3942S	SOP8 Green Package	2,500 units/T&R	Commercial, -40°C to +85°C
NCT3942S-A			
NCT3942Y	DFN8 (2.0x 2.0 mm ²) Green Package	3,000 units/ T&R	
NCT3942Y-A			

12. TOP MARKING SPECIFICATION

- NCT3942S/ S-A

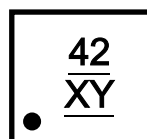
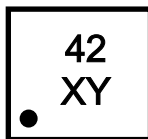


1st Line: 3942S/ 3942S-A

2nd Line: Tracking code

- 116: packages assembled in Year 2011, week 16
- A: assembly house ID.
- X: Internal use only.

- NCT3942Y/ Y-A



1st Line: 42 (NCT3942Y)

2nd Line: XY (Tracking Code)

- X means the last code of calendar year.
- Y means month (1: Jan., 2: Feb., 3: Mar., 4: Apr., 5: May, 6: Jul., 7: Jul., 8: Aug., 9: Sep., A: Oct., B: Nov., C: Dec.)

1st Line: 42 (w/ under line, NCT3942Y-A)

2nd Line: XY (w/ under line, Tracking Code)

- X means the last code of calendar year.
- Y means month (1: Jan., 2: Feb., 3: Mar., 4: Apr., 5: May, 6: Jul., 7: Jul., 8: Aug., 9: Sep., A: Oct., B: Nov., C: Dec.)

13. REVISION HISTORY

VERSION	DATE	PAGE	DESCRIPTION
A1	04/03/2011	All	New Create
A2	04/26/2011	7-8	Added waveform
A3	12/04/2015	All	Added DFN8 package information
A4	03/10/2016	1, 12-13	Change DFN8 package outline

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Insecure usage includes, but is not limited to: equipment for surgical implementation, atomic energy control instruments, airplane or spaceship instruments, the control or operation of dynamic, brake or safety systems designed for vehicular use, traffic signal instruments, all types of safety devices, and other applications intended to support or sustain life.

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