Nuvoton

Maximum 3A, Ultra Low Dropout Regulator

NCT3730S/ NCT3730S-L

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1. GENERAL DESCRIPTION

The NCT3730S/S-L is a high performance positive voltage regulator designed for use in applications requiring very low input voltage and very low dropout voltage at up to 3A(peak). It operates with a VIN as low as 1.0V and control voltage 3V with output voltage programmable as low as 0.8V. The significant feature includes ultra low dropout, ideal for applications where VOUT is very close to VIN. Additionally, there is an enable pin to further reduce power dissipation while shutdown. The NCT3730S/S-L provides excellent regulation over variations in line, load and temperature, and provides a Power Good indicator to indicate if the voltage level of output voltage reaches 90% of its rating value.

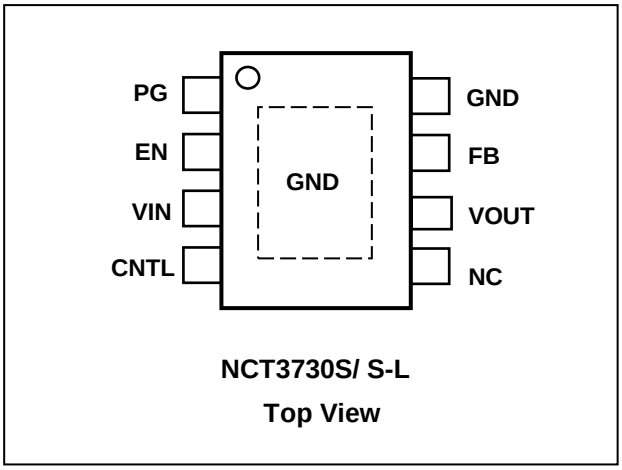
2. FEATURES

- Maximum 3A Ultra Low-Dropout Voltage Regulator
- High Accuracy Output Voltage ±1.5%
- Adjustable Output from 0.8V
- Typically 210mV Dropout at 3A
- Input Voltage as low as 1.0V
- Power Good Indicator
- Thermal and Over Current Protection
- EN internal Pull High (NCT3730S) and Internal Pull Low Available (NCT3730S-L)
- SOP-8 150mil with Exposed Pad Package
- Lead Free (ROHS Compliant) and Halogen Free Package

3. APPLICATIONS

- Desktop PCs, Notebooks, and Workstations
- Graphics Card
- Set Top Boxes, Digital TVs and Printers
- Portable instruments
- uP/ASIC/DSP/FPGA Core and I/O Supplies

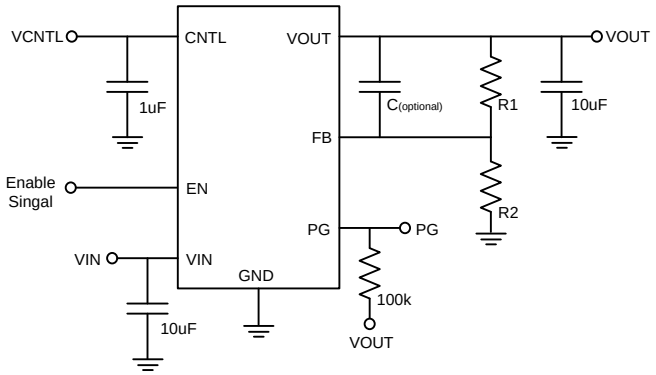
4. PIN CONFIGURATION AND DESCRIPTION



NCT3730S/ S-L
Top View

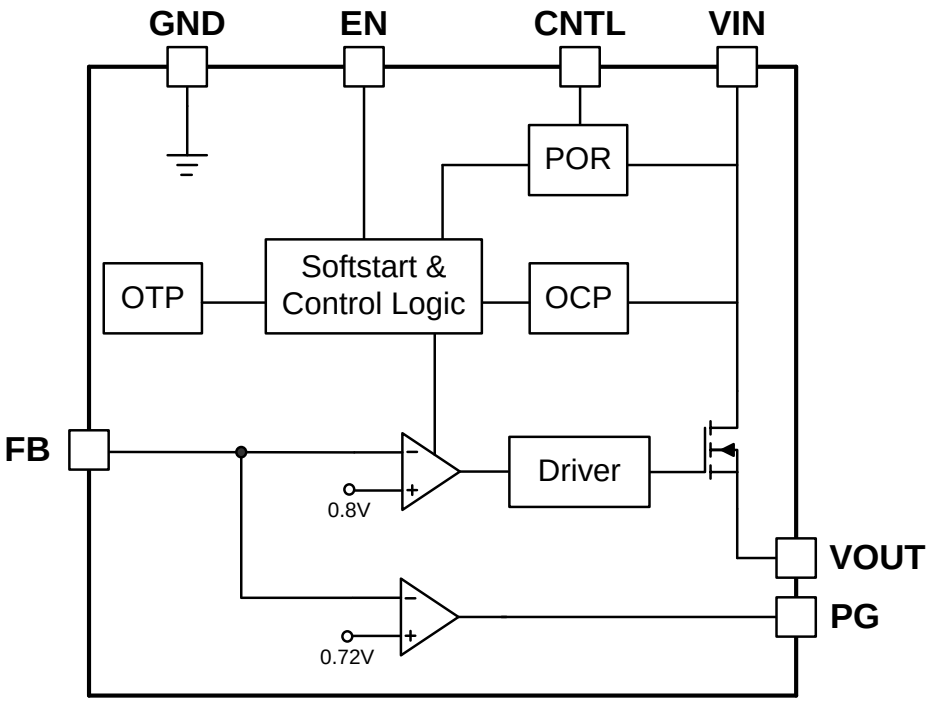
PIN NO.	PIN NAME	I/O	FUNCTION
1	**PG**	O	Power Good indicator.
2	**EN**	I	Chip Enable Input.
3	**VIN**	P	Supply Input Voltage.
4	**CNTL**	P	Supply Input Voltage for Control Circuit.
5	**NC**	N/A	No Internal Connection.
6	**VOUT**	P	Output Voltage. VOUT = 0.8*(1+R1/R2)
7	**FB**	I	Feedback Input.
8	**GND**	P	Ground.

5. TYPICAL APPLICATION CIRCUIT



VOUT = 0.8*(1+R1/R2)

6. BLOCK DIAGRAM



7. FUNCTIONAL DESCRIPTION

The NCT3730S/S-L is intended for applications where high current capability and very low dropout voltage are required. It provides a very simple, low cost solution that uses very little pcb real estate. Additional features include an enable pin to allow for a very low power consumption at disable, and a fully adjustable output.

Output Voltage Selection

The output voltage of NCT3730S/S-L is adjustable from 0.8V to (VIN-VDROP) by external voltage divider resisters as shown in Typical Application Circuit. The value of resisters R1 and R2 should be more than 10kΩ to reduce the power loss. The CNTL must be greater than (VOUT + 1.5V).

Input capacitor

A minimum of 10uF ceramic capacitor is recommended to be placed directly next to the VIN pin. This allows for the device being some distance from any bulk capacitance on the rail. Additionally, bulk capacitance of about ≧10uF may be added closely to the input supply pin of the NCT3730S/S-L to ensure that VIN does not sag, improving load transient response.

Output capacitor

A minmum bulk capacitance of ≧ 10uF, along with a 0.1uF ceramic decoupling capacitor is recommended. Increaseing the bulk capacitance will improve the overall transient response. The use of multiple lower value ceramic capacitors in parallel to achieve the desired bulk capacitance will not cause stability issues. Although designed for use with ceramic output capacitors, the NCT3730S/S-L is extremely tolerant of output capacitor ESR values and thus will also work comfortably with tantalum output capacitors.

Noise immunity

In very electrically noisy environments, it is recommended that 0.1uF ceramic capacitors be placed from VIN to GND and VOUT to GND as close to device pins as possible.

Power Good

The power good function is an open-drain output. Connects 100kΩ pull up resistor to VOUT to obtain an output voltage. The PG pin will output high immediately after the output voltage arrives 90% of normal output voltage. The PG pin will output high with typical 4ms delay time.

Enable

The NCT3730S/S-L goes into shutdown mode when the EN pin is in the logic low condition. During this condition, the pass transistor, error amplifier, and band gap are turned off, reducing the supply current to 10uA typical. If the EN pin is floating, NCT3730S and NCT3730S-L operating behaviors are different. For NCT3730S, the EN pin function pulls high level internally. So the regulator will be turn on when EN pin is floating. As for NCT3730S-L, the EN pin function pulls low level internally. So the regulator will be turn off when EN pin is floating.

Current Limit

The NCT3730S/S-L contains an independent current limit and the short circuit current protection to prevent unexpected applications. The current limit monitors and controls the pass transistor's gate voltage, limiting the output current while higher than 4.5A typical. When the output voltage is less than 0.25V, the short circuit current protection starts the current fold back function and maintains the loading current 1.5A. The output can be shorted to ground indefinitely without damaging the part.

Thermal Consideration

The NCT3730S/S-L has a thermal shutdown circuitry to limit the junction temperature. When the junction temperature exceeds 150°C, the thermal shutdown circuit disables the output, allowing the device to cool down. The output circuitry is enabled again after the junction temperature cools down by 50°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 reliabile operation, the junction temperature cannot exceed 125°C.

The definition of power dissipation in chip is as following equation:

$P_D = (V_{IN} - V_{OUT}) \times I_{OUT} + V_{IN} \times I_Q$

P_D represents the power dissipation.

The power dissipation depends on the thermal resistance of chip package, PCB layout, the airflow and temperature difference between junction and ambient. Refers to JEDEC51-1, The power dissipation can be calculated by following equation:

$P_{D(MAX)} = (T_{J(MAX)} - T_A) / \theta_{JA}$

Where $T_{J(MAX)}$ is the maximum operation junction temperature 125℃, TA is the ambient temperature and the θ_{JA} is the junction to ambient thermal resistance. θ_{JA} for ESOP-8 package is 75℃/W on JEDEC51-7 (4 layers, 2S2P) thermal test board with minimum copper area. The maximum power dissipation at T_A = 25℃ can be calculated as:

$P_{D(MAX)}$ = (125℃ - 25℃) / 75℃/W = 1.33W

θ_{JA} highly depends on IC package, PCB layout, the aireflow. Thermal resistance θ_{JA} can be improved by adding copper under the exposed pad of ESOP-8 while the IC package is fixed. The copper under the exposed pad of ESOP-8 is an effective heatsink and is useful for improving thermal conductivity. Figure show the relationship between thermal resistance θ_{JA} vs. copper area on a standard JEDEC 51-7 (4 layers, 2S2P) thermal test board at TA = 25℃, PCB copper thickness = 2oz. The 70mm^2 copper plane reduce θ_{JA} from 75℃/W to 45℃/W and increases maximum power disspation from 1.33W to 2.22W.

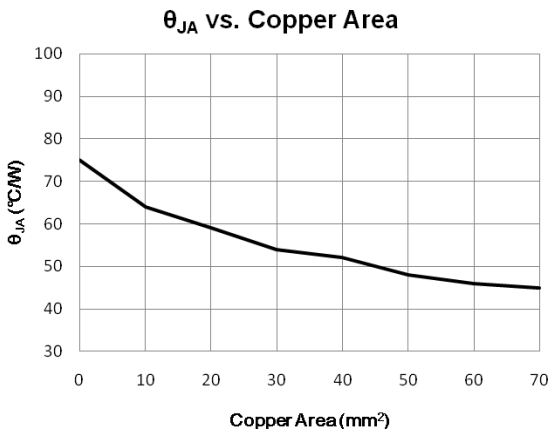


Figure01. Thermal Resistance θ_{JA} vs. Copper Area of ESOP Packages

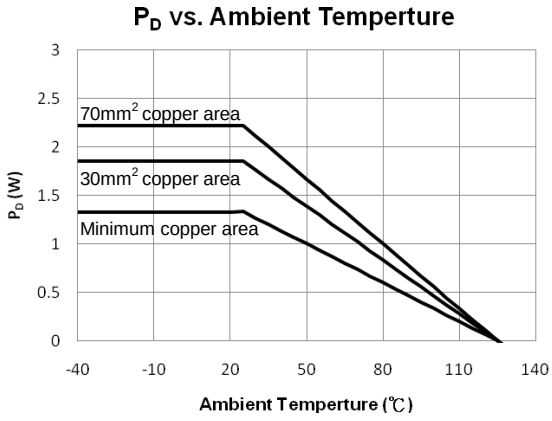


Figure02. Power dissipation vs. ambient temperature

8. ELECTRICAL CHARACTERISTIC

8.1 Absolute Maximum Ratings

PARAMETER	RATING	UNIT
Input Supply Voltage, VCNTL and VIN	-0.3 to 6V	V
Other Pins	-0.3 to 6V	V
Power Dissipation, PD @ TA=25℃	Internal Limited	W
Package Thermal Resistance, SOP8-EP, θ_{JA}	75	℃/W
θ_{JC}	15	℃/W
Storage Temperature	-50 to 150	℃
Junction Temperature	150	℃

PARAMETER		RATING	UNIT
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.

8.2 Recommended Operating Conditions

PARAMETER	RATING	UNIT
CNTL Voltage, VCNTL	3.0 to 5.5	V
Supply Voltage, VIN	1.0 to VCNTL	V
Output Current, IOUT	0 to 3	A
Operating Temperature	-40 to 85	℃
Junction Temperature	-40 to 125	℃

8.3 DC Electrical Characteristics

(VIN = VOUT + 500mV, VEN = VIN = 5V, CIN = COUT = 10uF, T_A = TJ = 25° C, unless otherwise specified)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
Supply voltage						
Control Input Voltage	V_{CNTL}	VOUT = VREF	3.0		5.5	V
POR Threshold		VCNTL Rising		2.7		V
POR Hysteresis				0.2		
Power Input Voltage	V_{IN}	VOUT = VREF	1.0		5.5	V
Control Input Current in shutdown	I_{CNTL_SD}	VCNTL = VIN = 5.0V, IOUT = 0A, VOUT = VREF		20	30	uA
Control Input Current	I_{CNTL}	VCNTL = VIN = VEN = 5.0V, IOUT = 0A, VOUT = VREF		400	600	uA
Quiescent Current	I_Q	VCNTL = VIN = VEN = 5.0V, IOUT = 0A, VOUT = VREF		0.6	1	mA
Feedback Voltage						
Reference Voltage	V_{FB}	VCNTL = VIN = VEN = 5.0V, IOUT = 0A, VOUT = VREF	0.788	0.8	0.812	V
Feedback Input Current	I_{FB}			20		nA
VIN Line Regulation		1.2V < VIN < 5.0V, VCNTL = VEN = 5.0V, IOUT = 0A, VOUT = VREF		0.01	0.1	%/V
VCNTL Line Regulation		3.0V < VCNTL < 5.0V, VIN = 1.2V, IOUT = 0A, VOUT = VREF		0.2	0.6	%/V

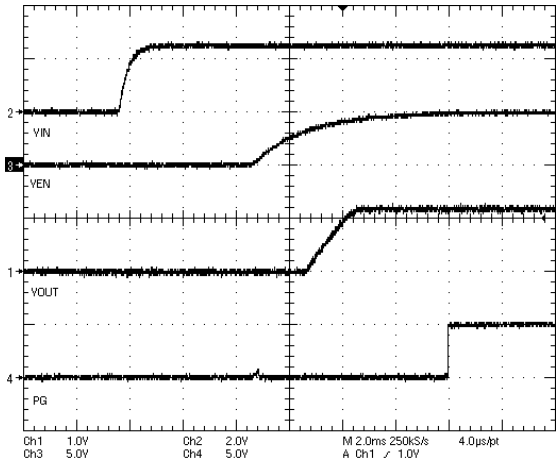
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
Load Regulation		0A < I_{LOAD} < 3A, VCNTL = VIN = VEN = 5.0V, VOUT = VREF		0.8	1.5	%/A
Load Regulation over Temperature		0mA < ILOAD < 3A, VCNTL = VIN = VEN = 5.0V, VOUT = VREF, -40 < TJ < 125, by design		1.4	3	%
Dropout Voltage	V_{DROP}	IOUT = 2.0A, VCNTL = VEN = 5.0V, VOUT = VREF		150	250	mV
Dropout Voltage	V_{DROP}	IOUT = 3.0A, VCNTL = VEN = 5.0V, VOUT = VREF		210	350	mV
VOUT Pull Low Resistance		VCNTL = VIN = 5.0V, VEN = 0V		90		Ω
Enable						
Enable High Level	V_{EN}		1.4			V
Enable Low Level	V_{SD}				0.4	V
Enable Current	I_{EN}	VEN = 0V or 5V for NCT3730S/S-L, VCNTL = 5.0V		12	20	uA
Softstart Time			1.5	3.0	4.5	ms
PG						
FB Power OK Threshold	V_{POKTH}	IOUT = 0A, VCNTL = VIN = VEN = 5.0V, VOUT = VREF		90		%
Power OK Hysteresis	V_{POKHYS}	IOUT = 0A, VCNTL = VIN = VEN = 5.0V, VOUT = VREF		8		%
PG sink Capability		IPG = 10mA		0.2	0.4	V
PG Delay Time		From VOUT >92% VNOM to PG rising		4		ms
Overcurrent Protection						
OCP Threshold Level	I_{OCP}	VCNTL = VIN = VEN = 5.0V, VOUT = VREF		4.5		A
Short Circuit Output Current		VCNTL = VIN = VEN = 5.0V, VOUT = 0V		1.5		A
Thermal Protection						
Themal Shutdown Temperature	T_{SD}	IOUT = 0A, VCNTL = VIN = VEN = 5.0V, VOUT = VREF		150		℃
Thermal Shutdown Hysteresis	T_{SDHYS}	IOUT = 0A, VCNTL = VIN = VEN = 5.0V, VOUT = VREF		50		℃

Note1. The dropout voltage is defined as VIN – VOUT, which is measured when VOUT is VOUT(normal) – 100mV.

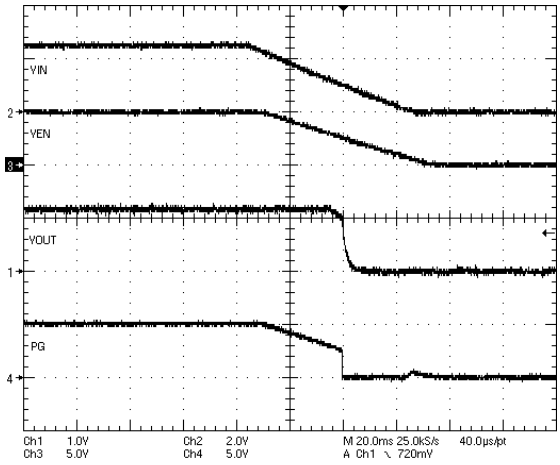
Note2. The device is not guaranteed to function ouside its operating conditions.

9. TYPICAL OPERATING WAVEFORMS

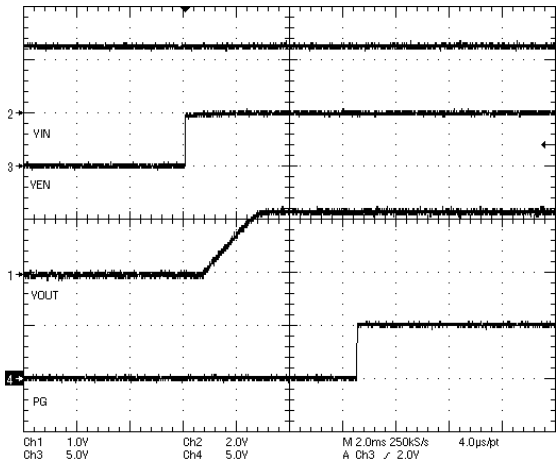
Power On



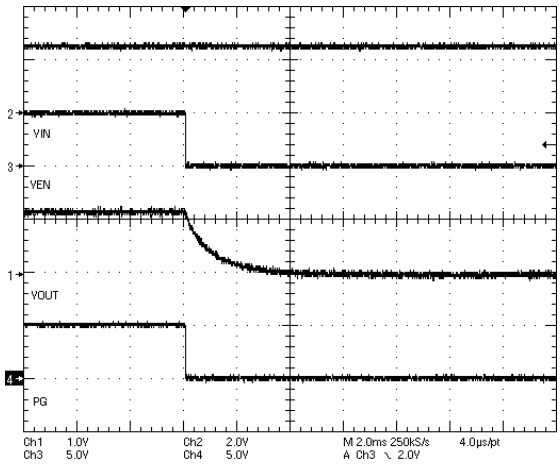
Power Off



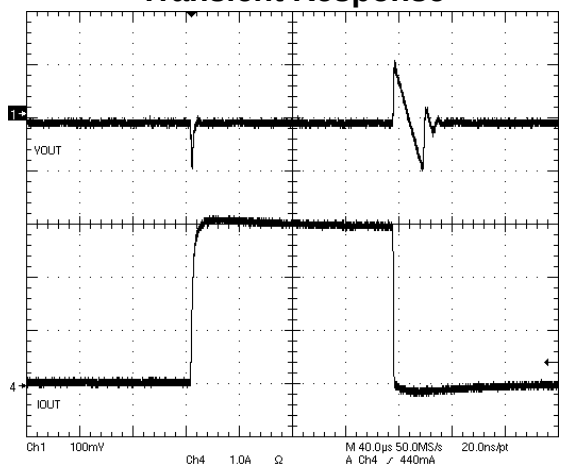
Enable



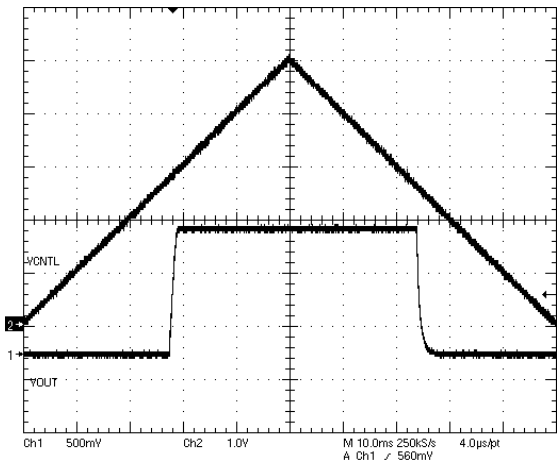
Disable



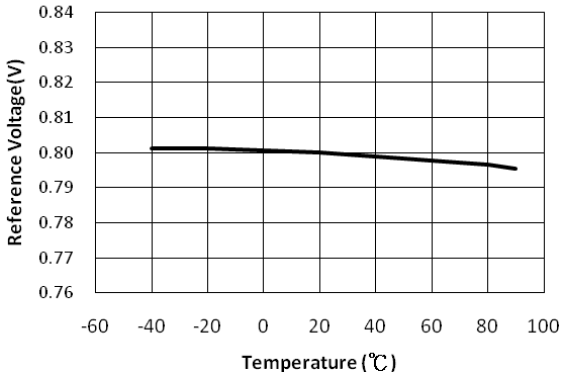
Transient Response



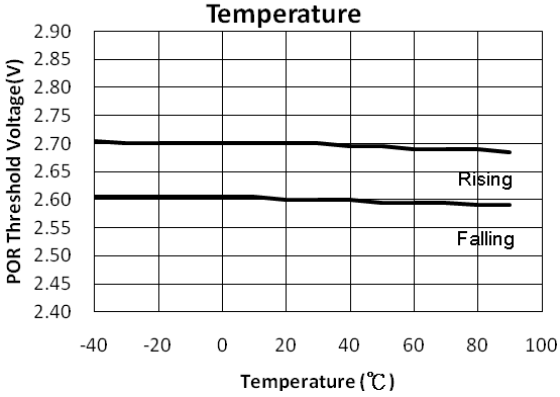
UVLO



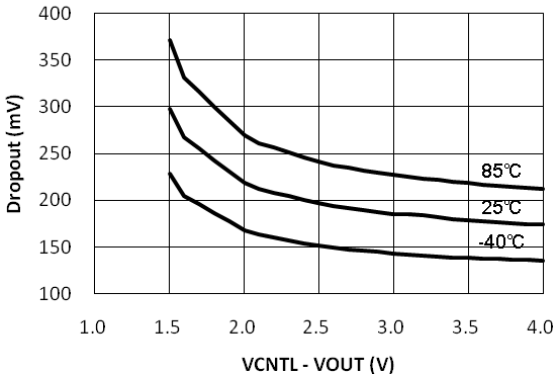
Reference Voltage vs. Temperature



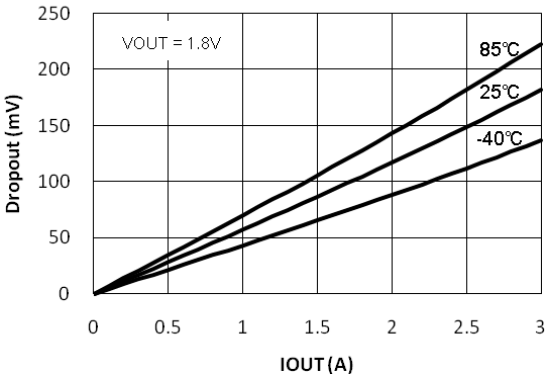
CNTL POR Threshold Voltage vs. Temperature



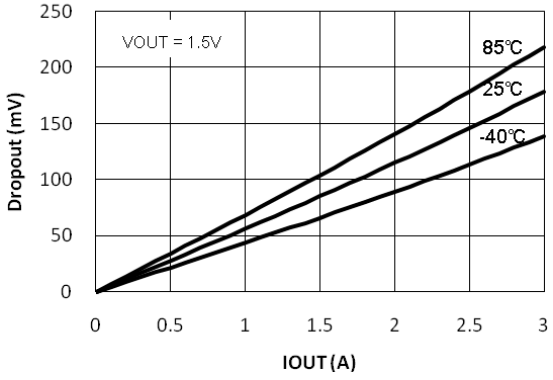
Dropout vs. VCNTL-VOUT



Dropout vs. IOUT

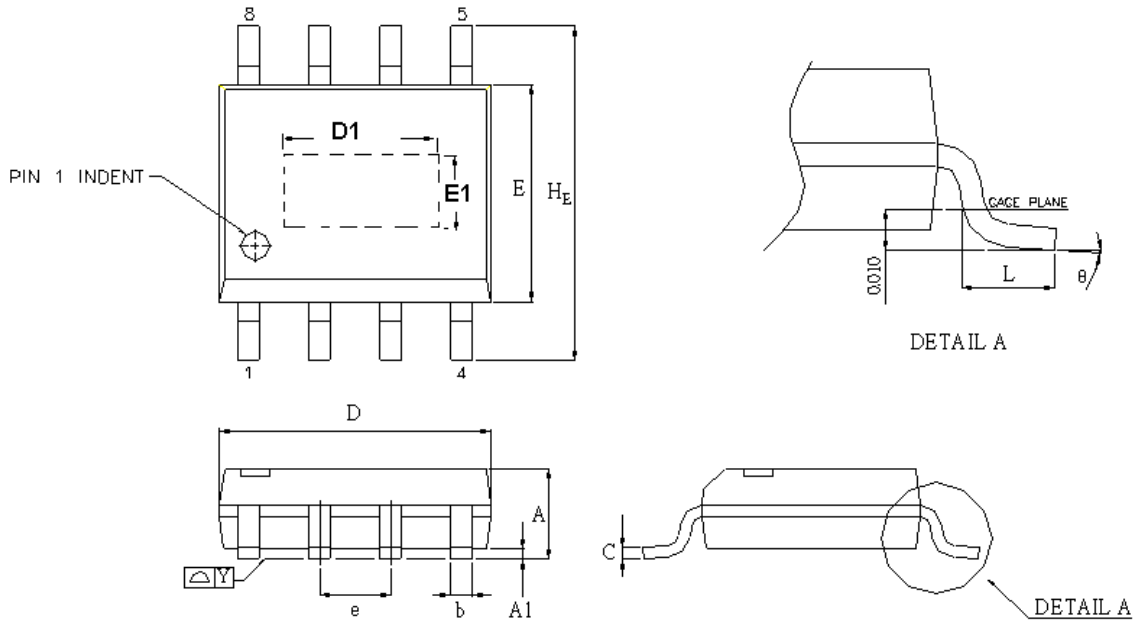


Dropout vs. IOUT



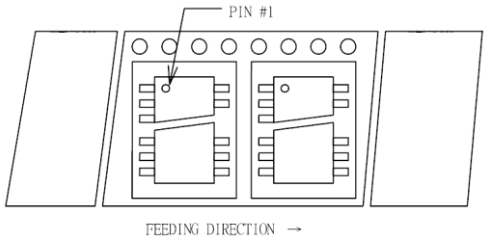
10. PACKAGE DIMENSION

SOP8-EP (150mil)



SYMBOLS	Dimensions In Millimeters		Dimensions In Inched	
	Min	Max	Min	Max
A	1.35	1.75	0.05	0.07
A1	0.05	0.25	0.00	0.01
b	0.31	0.51	0.01	0.02
c	0.1	0.25	0.00	0.01
D	4.7	5.10	0.19	0.2
E	3.8	4.00	0.15	0.16
e	1.27 BASIC		0.05 BASIC	
He	5.8	6.20	0.23	0.24
Y	-	0.10	-	0.00
L	0.4	1.27	0.02	0.05
θ	0°	10°	0°	10°
D1	3.10	3.50	0.12	0.14
E1	2.20	2.60	0.09	0.10

10.1 Taping Specification



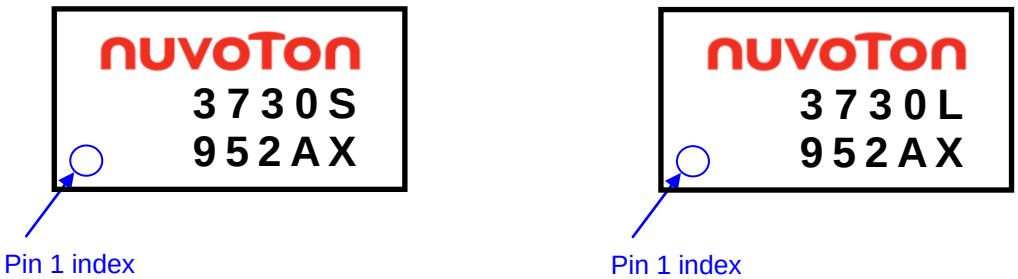
SOP8-EP Package

11. ORDERING INFORMATION

Part Number	Package Type	Supplied as	Production Flow
NCT3730S	SOP8-EP (Green Package)	2,500 units/T&R	Commercial, -40℃ to 85℃
NCT3730S-L	SOP8-EP (Green Package)	2,500 units/T&R	Commercial, -40℃ to 85℃

12. 6TOP MARKING SPECIFICATION

12.1 Adjustable Output Voltage



1st Line: Nuvoton logo

2nd Line: 3730S (Part number NCT3730S); 3730L (Part number NCT3730S-L)

3rd line: Tracking code

- 952: packages assembled in Year 2009, week 52
- A: assembly house ID
- X: internal use only

13. REVISION HISTORY

VERSION	DATE	PAGE	DESCRIPTION
A0	01/04/2010	All	New Create.
A1	07/20/2010	P4, 5, 6	Add Thermal consideration & modify some typos.
A2	09/30/2010	P3, 8, 9	Add waveform & modify some description.
A3	11/26/2010	All	Add NCT3730S-L part number and relative data.
A4	02/18/2011	All	Revised some description.

Important Notice

Nuvoton Products are neither intended nor warranted for usage in systems or equipment, any malfunction or failure of which may cause loss of human life, bodily injury or severe property damage. Such applications are deemed, "Insecure Usage".

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.

All Insecure Usage shall be made at customer's risk, and in the event that third parties lay claims to Nuvoton as a result of customer's Insecure Usage, customer shall indemnify the damages and liabilities thus incurred by Nuvoton.