NCP2860

# 300 mA Very Low Noise, Low Dropout Linear Regulator

The NCP2860 is a low noise, low dropout linear regulator that is offered as a fixed output voltage regulator (2.77 V) and as an adjustable output regulator from 1.25 V to 5.80 V. It supplies 300 mA from a 3.0 V to 6.0 V input. The excellent performances that the NCP2860 features in terms of transient responses, PSRR and noise, make it an ideal solution for audio applications (e.g., audio amplifier drivers).

Features

- High Output Current (300 mA Max)
- Low Output Voltage Noise: 60 μVrms
- Low Dropout (150 mV @ I_{out} = 300 mA)
- Thermal Overload and Short Circuit Protections
- Very Low Consumption in Shutdown Mode (10 nA)
- High Power Supply Rejection Ratio (60 dB @ 1.0 kHz)
- $\overline{\text{FAULT}}$ Indicator
- Programmable Output Voltage
- Soft−Start
- Pb−Free Package is Available

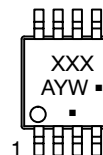## Typical Applications

- Cellular Phone
- Handheld Instruments

ON Semiconductor®

http://onsemi.com
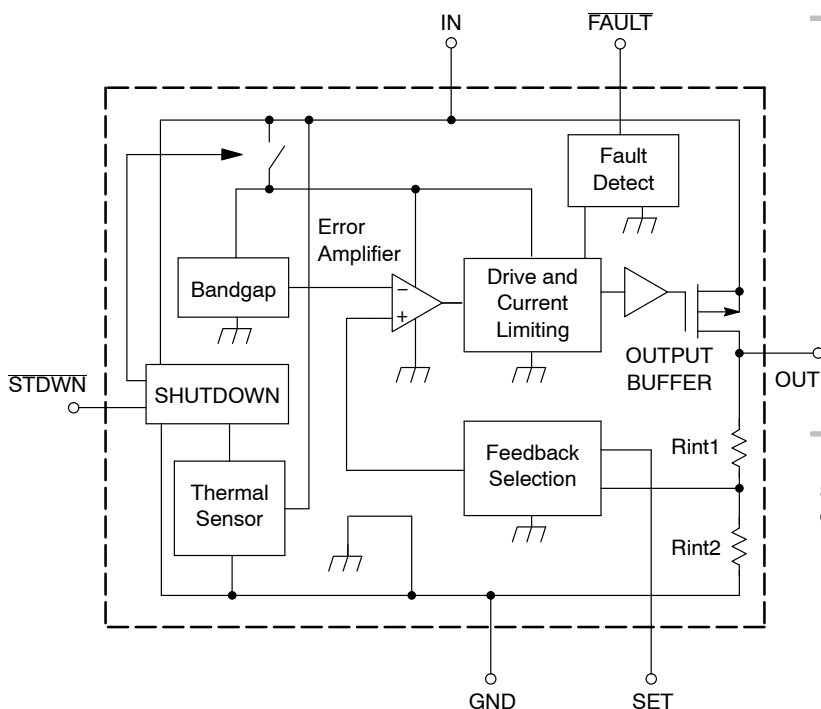
Micro8™
DM SUFFIX
CASE 846A

MARKING DIAGRAM

```
XXX
AYW ■
```

XXX = Specific Device Code
A = Assembly Location
Y = Year
W = Work Week
■ = Pb−Free Package
(Note: Microdot may be in either location)

PIN CONNECTIONS

OUT	1		8	FAULT
IN	2		7	STDWN
GND	3		6	N.C.
OUT	4		5	SET

(Top View)
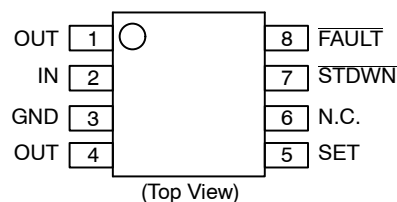
ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 10 of this data sheet.
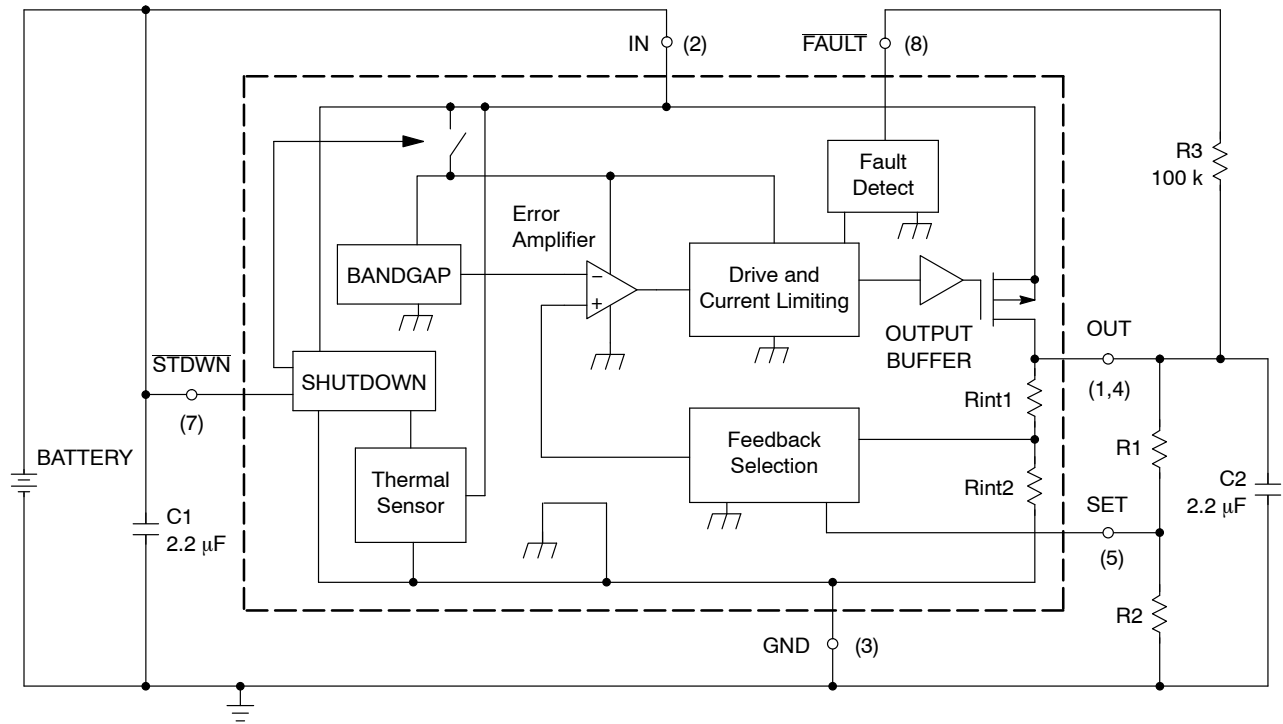
NCP2860
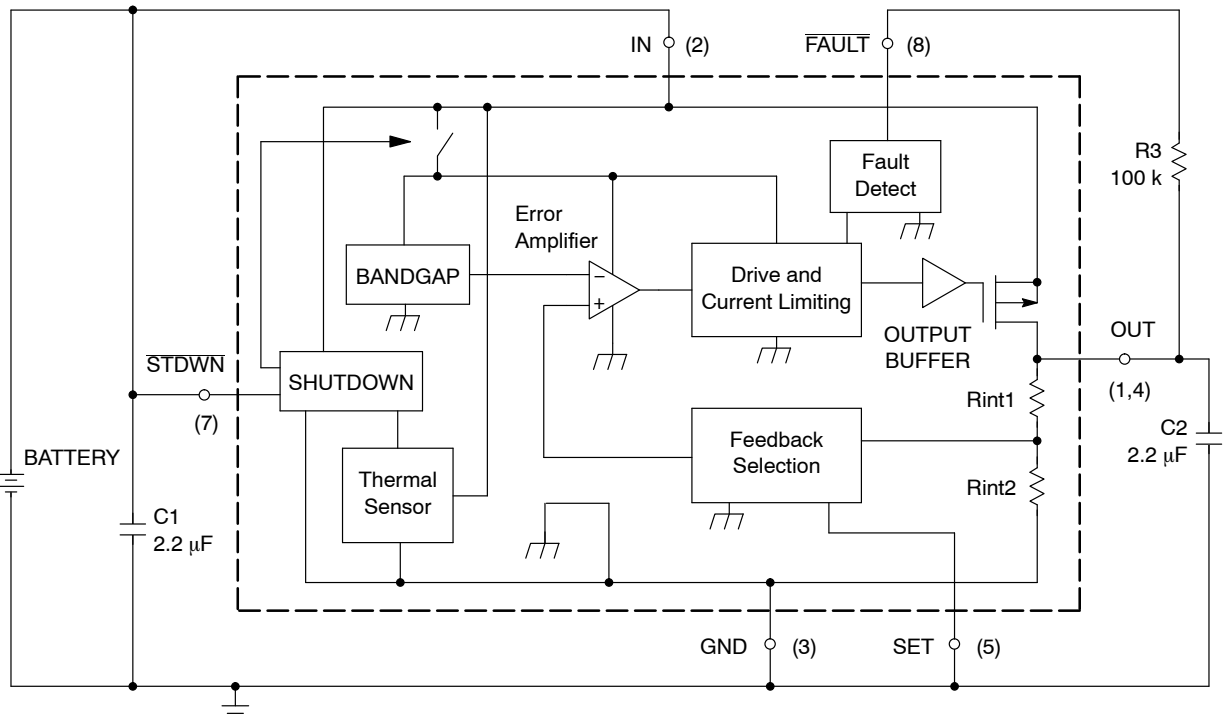

Figure 1. With External Output Voltage Adjustment

Figure 2. Application for 2.77 V Output Voltage

NCP2860

PIN DESCRIPTION

Pin	Name	Description
1, 4	OUT	"OUT" is the regulator output. A low ESR, bypass capacitor should be connected for stable operation.
2	IN	"IN" is the supply input that is connected to the power source (up to 6.0 V). Bypass with a 2.2 µF capacitor.
3	GND	Ground
5	SET	Ground the "SET" pin to set the output voltage to 2.77 V. Connect to resistor–divider for ADJ output voltage. Refer to the "output voltage setting" paragraph if you need to program another value.
6	N.C.	This pin is non–connected.
7	$\overline{STDWN}$	If the "$\overline{STDWN}$" pin is low, the circuit enters the shutdown mode.
8	$\overline{FAULT}$	The "$\overline{FAULT}$" terminal is a high impedance, open drain output. If the circuit is out of regulation, the voltage pin goes low. Otherwise (normal operation or shutdown mode), this pin is high impedance. Connect the pin to ground, if unused.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input Voltage, Shutdown Pin, Voltage Range (Note 1)	V_{inmax}	−0.3, +6.0	V
Thermal Resistance (Note 2)	–	230	°C/W
Maximum Junction Temperature	T_{Jmax}	150	°C
Storage Temperature Range	T_{Smax}	− 65 to +150	°C
Lead Temperature (Soldering, 10s)	T_{Lmax}	300	°C
ESD Capability Human Body Model Machine Model	– –	2.0 200	kV V
Latchup Capability @ 85°C	–	+/−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.
1. The recommended input voltage range for NCP2860 proper operation is 2.7 V to 6.0 V.
2. Circuit being mounted on a board that has no metal oxide traces attached to the leads. The addition of plated copper can lower the thermal resistance.

TYPICAL ELECTRICAL CHARACTERISTICS (Note 3) (V_{in} = 3.6 V, T_A from −25°C to +85°C, unless otherwise noted.)

Characteristic for 2.77 V Fix Version SET = GND	Symbol	Min	Typ	Max	Unit
Output Voltage @ I_{out} = 100 µA, 300 mA, V_{in} = 3.2 V and T_A = 25°C T_A from −25°C to +85°C	V_{out}	2.73 2.70	2.77 2.77	2.81 2.84	V
Supply Current @ I_{out} = 0, V_{in} = 3.2 V	I_{cc-0}	–	355	700	µA
Supply Current @ I_{out} = 300 mA, V_{in} = 3.2 V	I_{cc-300}	–	1.1	–	mA
Supply Current in Shutdown Mode ($\overline{STDWN}$ Pin Grounded) @ T_A = 25°C	I_{stdwn}	–	0.01	1.0	µA
Dropout Voltage @ I_{out} = 1.0 mA (Note 4)	V_{drop-1}	–	0.6	–	mV
Dropout Voltage @ I_{out} = 150 mA (Note 4)	$V_{drop-150}$	–	75	150	mV
Dropout Voltage @ I_{out} = 300 mA (Note 4)	$V_{drop-300}$	–	150	250	mV
SET Input Leakage Current @ V_{SET} = (0 – 0.2) V and T_A = 25°C	I_{leak}	–	10	200	nA
Short Circuit Output Current Limitation @ V_{in} = 3.2 V	I_{max_cc}	310	465	700	mA
Start−Up Current Limitation @ T_A = 25°C, V_{in} = 3.2 V	I_{max_stup}	–	220	–	mA
Line Regulation, V_{in} varying between 3.0 V and 6.0 V @ I_{out} = 1.0 mA	$Line_{Reg1}$	−0.1	0.01	0.1	%/V
Line Regulation, V_{in} varying between 3.0 V and 6.0 V @ I_{out} = 10 mA	$Line_{Reg2}$	−0.1	0.01	0.1	%/V
Load Regulation, I_{out} varying from 0.1 mA to 300 mA @ V_{in} = 3.2 V	$Load_{Reg2}$	–	0.001	–	%/mA
Output Voltage Noise @ C_{out} = 22 µF (Note 5) 10 Hz < f < 10 kHz 10 Hz < f < 100 kHz	– – –	 	 35 60	 – –	µV$_{rms}$
Power Supply Rejection Ratio @ 1.0 kHz and I_{out} = 100 mA	PSRR	–	60	–	dB
Shutdown Threshold (with hysteresis) @ V_{in} = 5.0 V	V_{stdwn}	0.63	–	2.65	V
Shutdown Pin Bias Current @ $\overline{STDWN}$ = IN or GND and T_A = 25°C	I_{stdwn}	–	–	100	nA
$\overline{FAULT}$ Detection Voltage @ I_{out} = 200 mA	$V_{fault-th}$	–	120	280	mV
$\overline{FAULT}$ Output Low Voltage @ I_{sink} = 2.0 mA	$V_{fault-out}$	–	0.15	0.4	V
$\overline{FAULT}$ Output OFF Leakage Current @ T_A = 25°C	I_{fault}	–	0.1	100	nA
Start−Up Time @ C_{out} = 10 µF, I_{out} = 100 mA (Note 5)	T_{stup}	–	60	–	µs
Thermal Shutdown Threshold	T_{limit}	–	170	–	°C
Thermal Shutdown Hysteresis	H_{temp}	–	30	–	°C

3. The specification gives the targeted values. This specification may have to be slightly adjusted after the temperature characterization of the die.
4. The dropout voltage is defined as (V_{in}−V_{out}) when V_{out} is 100 mV below the value of V_{out} when V_{in} > 3 V.
5. Refer to characterization curves for more details.

TYPICAL ELECTRICAL CHARACTERISTICS (Note 3) (V_{in} = 3.6 V, T_A from −25°C to +85°C, unless otherwise noted.)

Characteristic for Adjustable Version	Symbol	Min	Typ	Max	Unit
Adjustable Output Voltage Range @ V_{in} = V_{out} + 0.5 V and V_{in} > 3 V, I_{out} = (1 – 300) mA	V_{out}	1.25		5.80	V
Supply Current @ I_{out} = 0, V_{in} = 6 V, V_{out} = 3.3 V	I_{cc-0}		400	900	uA
Supply Current @ I_{out} = 300, V_{in} = 6 V, V_{out} = 3.3 V	I_{cc-300}	−	1180	1400	uA
Dropout Voltage @ I_{out} = 1.0 mA, V_{out} = 3.3 V	V_{drop-1}		0.7		mV
Dropout Voltage @ I_{out} = 150 mA, V_{out} = 3.3 V	$V_{drop-150}$		80	150	mV
Dropout Voltage @ I_{out} = 300 mA, V_{out} = 3.3 V	$V_{drop-300}$		155	200	mV
SET Threshold (SET = OUT) @ I_{out} = 1 mA and V_{in} = (3.0 – 6)V, T_A = 25°C T_A from −25°C to +85°C	V_{ref}	1.226 1.22	1.244 1.244	1.262 1.27	V
SET Input Leakage Current @ V_{SET} = 1.25 V and T_A = 25°C	I_{leak}		10	200	nA
Short Circuit Output Current Limitation @ V_{in} = V_{out} + 0.5 V, V_{out} = (2.5 – 3.3) V, T_A = 25°C	I_{max_cc}	310	495	700	mA
Start–Up Current Limitation @ T_A = 25°C, V_{in} = 3.8 V, V_{out} = 3.3 V	I_{max_stup}		200		mA
Line Regulation, V_{in} = (3.8 – 6) V @ I_{out} = 1.0 mA and (V_{out} = 3.3 V)	$Line_{Reg1}$		0.1		%/V
Line Regulation, V_{in} = (3.8 – 6) V @ I_{out} = 300 mA, V_{out} = 3.3 V	$Line_{Reg300}$	−	0.3	−	%/V
Load Regulation, I_{out} varying from 0.1 mA to 300 mA, V_{out} = 3.3 V, @ V_{in} = 3.8 V	$Load_{Reg3V3}$		0.001		%/mA
Load Regulation, I_{out} varying from 0.1 mA to 300 mA and V_{out} = 2.5 V, V_{in} = 3.0 V	$Load_{Reg2V5}$	−	0.0005	−	%/mA
Output Voltage Noise @ SET = GND, C_{out} = 22 μF (Note 5) 10 Hz < f < 10 kHz 10 Hz < f < 100 kHz	Adjustable	 −	 35 60		μVrms
Power Supply Rejection Ratio @ 1.0 kHz, V_{out} = 3.3 V and I_{out} = 10 mA	PSRR		69		dB
Shutdown Threshold (with hysteresis) @ V_{in} = 5.0 V	V_{stdwn}	0.63		2.65	V
Shutdown Pin Bias Current @ STDWN = IN or GND and T_A = 25°C	I_{stdwn}			100	nA
FAULT Detection Voltage @ I_{out} = 200 mA	$V_{fault-th}$		120	280	mV
FAULT Output Low Voltage @ I_{sink} = 2.0 mA	$Vf_{ault-out}$		0.15	0.4	V
FAULT Output OFF Leakage Current @ T_A = 25°C	I_{fault}		0.1	100	nA
Start–Up Time @ C_{out} = 10 μF, V_{out} = 3.3 V, I_{out} = 100 mA (Note 5)	T_{stup}		80		μs
Thermal Shutdown Threshold/Hysteresis	$T_{limit}/$ H_{temp}		170/ 30		°C

3. The specification gives the targeted values. This specification may have to be slightly adjusted after the temperature characterization of the die.
4. The dropout voltage is defined as (V_{in}−V_{out}) when V_{out} is 100 mV below the value of V_{out} when V_{in} > 3 V.
5. Refer to characterization curves for more details.

NCP2860

TYPICAL ELECTRICAL CHARACTERISTICS

(V_{in} = V_{out} + 0.5 V, C_{in} = C_{out} = 2.2 μF, SET = GND, T_A = 25°C, unless otherwise noted.)
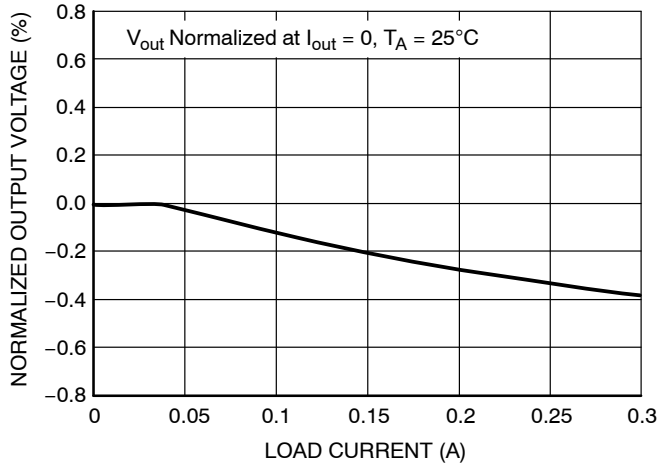
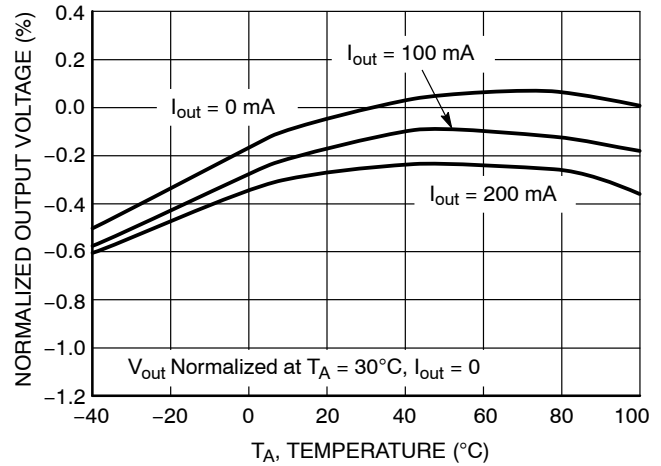Figure 1. Normalized Output Voltage vs. Load Current

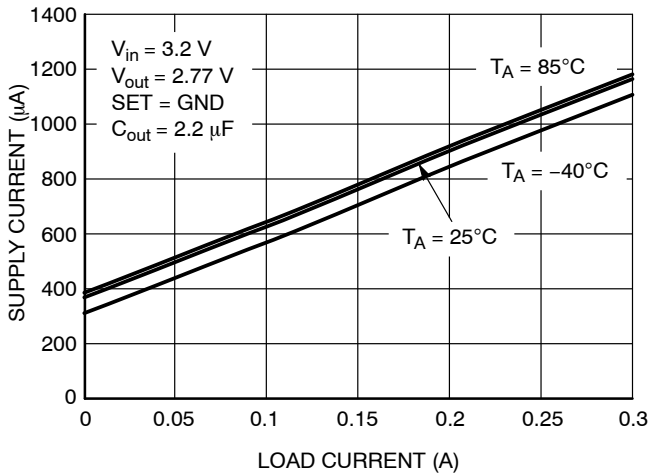Figure 2. Normalized Output Voltage vs. Temperature
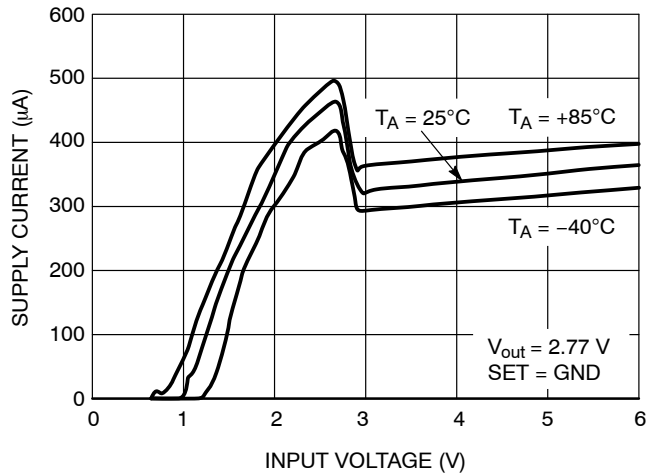
Figure 3. Supply Current vs. Load Current
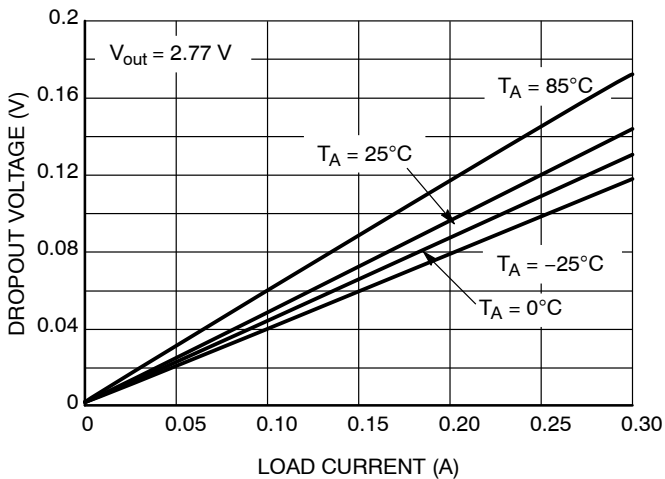
Figure 4. No Load Supply Current vs. Input Voltage
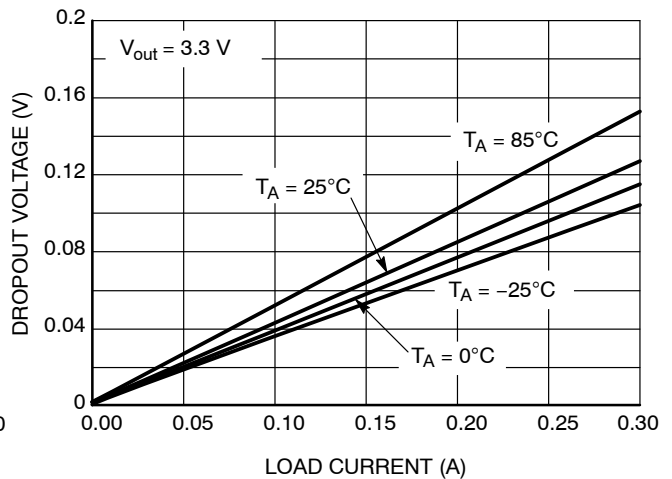
Figure 5. Dropout Voltage vs. Load Current

Figure 6. Dropout Voltage vs. Load Current

TYPICAL ELECTRICAL CHARACTERISTICS

(V_{in} = V_{out} + 0.5 V, C_{in} = C_{out} = 2.2 μF, SET = GND, T_A = 25°C, unless otherwise noted.)
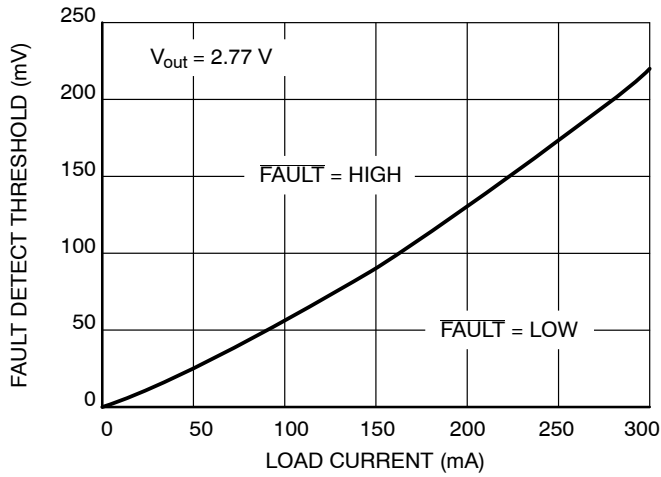
Figure 7. Fault Detect Threshold vs. Load Current
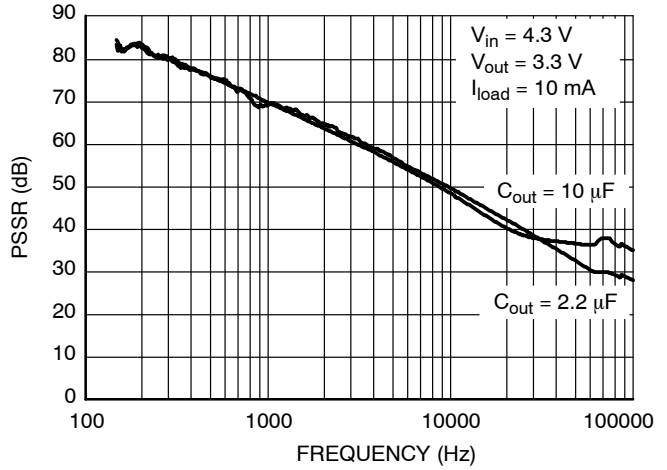
Figure 8. Power Supply Rejection Ratio
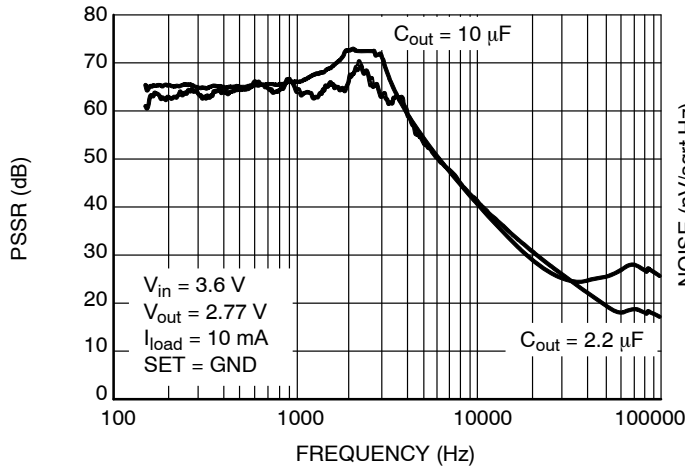
Figure 9. Power Supply Rejection Ratio
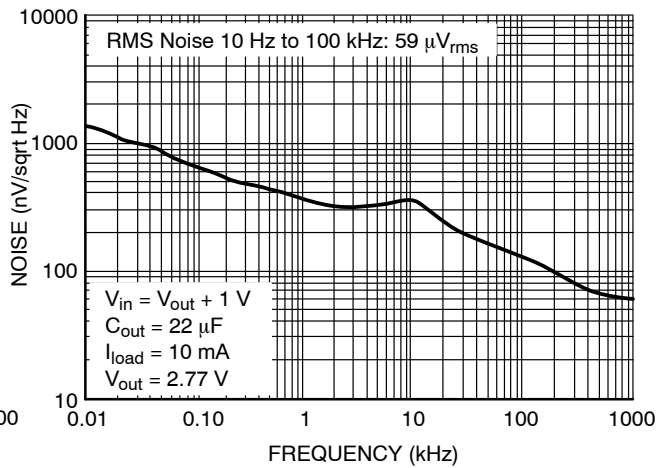
Figure 10. Output Noise Spectral Density
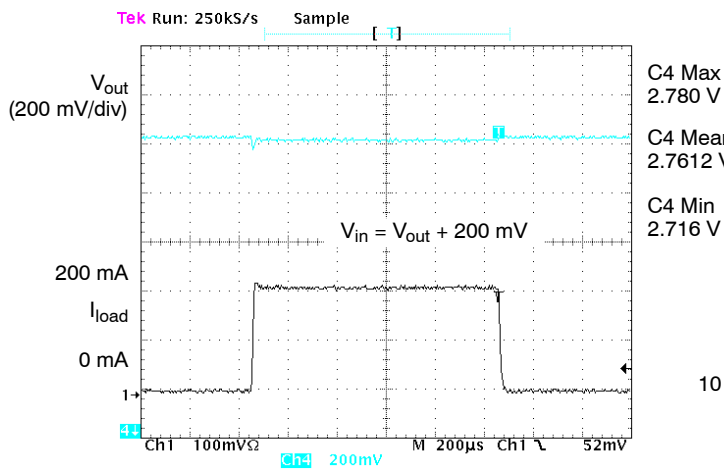
Figure 11. Load Transient Response
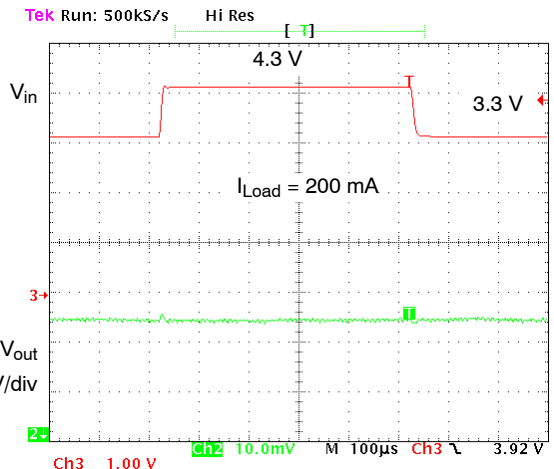
Figure 12. Line Transient

NCP2860

TYPICAL ELECTRICAL CHARACTERISTICS

(V_{in} = V_{out} + 0.5 V, C_{in} = C_{out} = 2.2 μF, SET = GND, T_A = 25°C, unless otherwise noted.)
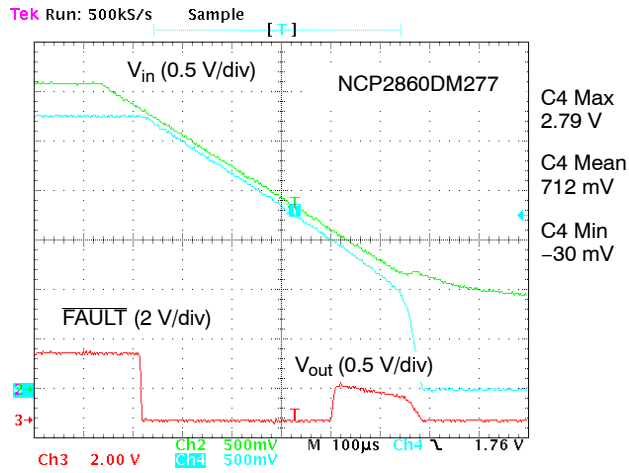
Figure 13. Power−Down Response (I$_{load}$ = 100 mA)
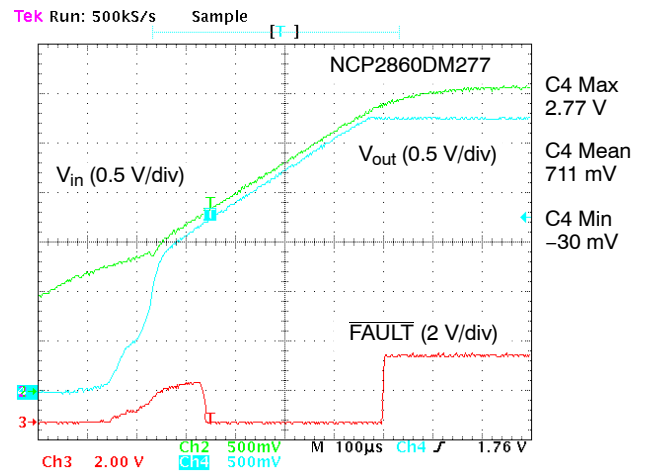
Figure 14. Power−Up Response (I$_{load}$ = 100 mA)
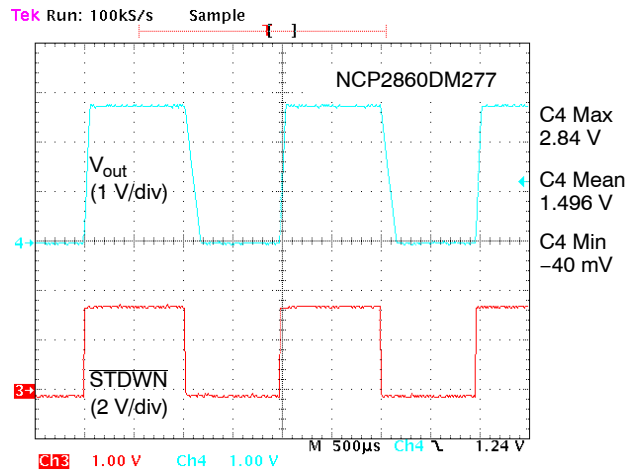
Figure 15. Shutdown/Power−Up
(V$_{in}$ = V$_{out}$ + 0.5 V, I$_{load}$ = 50 mA)
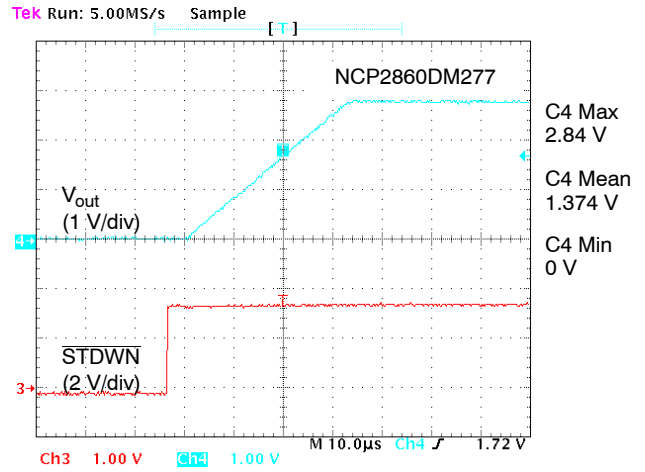
Figure 16. Shutdown/Power−Up
(V$_{in}$ = V$_{out}$ + 0.5 V, I$_{load}$ = 0 mA)

DETAILED OPERATING DESCRIPTION

Internal Pass Transistor

The NCP2860 incorporates a 0.5 Ω typical P−channel MOSFET pass transistor. The P−channel MOSFET requires no drive current and then compared to the PNP based regulators, this solution drastically reduces the quiescent current and associated losses.

Shutdown Block

The circuit turns into shutdown mode when the shutdown pin is in low state. In this mode, the internal biasing current sources are disconnected so that the pass transistor is off and the consumption reduced to a minimum value. Practically, the shutdown consumption is in the range of 10 nA. When this function is unused, "IN" is generally applied to the shutdown pin.

Current Limitation

The NCP2860 incorporates a short circuit protection that prevents the pass transistor current from exceeding 465 mA typically. The current limit is set to 220 mA during the start−up phase.

Thermal Protection

The thermal protection protects the die against excessive overheating. Practically, when the junction temperature exceeds 170°C for the 2.77 V option and 150°C for the 3.0 V option, an internal thermal sensor sends a logical signal to the shutdown block so that the circuit enters the shutdown mode. Once the die has cooled enough (typically 30°C), the circuit enters a new working phase.

Output Voltage Setting

a) The output voltage is set by internal resistor divider to 2.77 V for NCP2860DM277R2 device. The "SET" pin must be grounded or pulled below 0.2 V.

b) The output voltage can also be programmed to a different value for NCP2860DMADJR2G device. In this case a portion of the output voltage acquired by the external resistor divider must be applied to the "SET" pin. Do not leave the "SET" pin unconnected. If a (R1, R2) external resistors divider is used, then output voltage is given by equation:
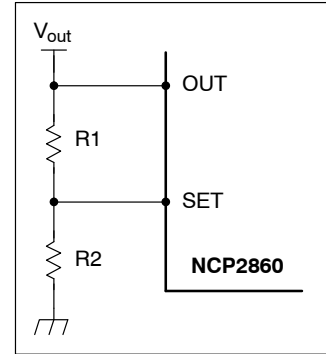
$$V_{out} = (1 + R1/R2) * V_{ref}$$

Therefore, as V_{ref} typically equals 1.244 V:

$$V_{out} = 1.244 * (1 + R1/R2).$$

Now if R1 and R2 are high impedance resistors, the leakage current that is absorbed by the "SET" pin, may have to be taken into account as follows:

$V_{out} = [1.244 * (1 + R1/R2)] + (R1*I_{lk})$ where I_{lk} is the "SET" pin leakage current.

If the output voltage is directly applied to the "SET" pin, $V_{out} = V_{ref} = 1.244$ V.

Regulation

The circuit incorporates a transconductance error amplifier. The error amplifier output varies in response to load and input voltage variations to control the pass transistor current so that the "OUT" pin delivers the wished voltage. No compensation capacitor is required.

Fault Detection Circuitry

The circuit detects when the input−output differential voltage is too low to ensure a correct load and line regulation at the output. The input−output differential threshold scales proportionally with the load current to be always just higher than the dropout.

When the circuit detects a fault condition, an internal switch connects "$\overline{FAULT}$" to ground. In normal operation, the "$\overline{FAULT}$" terminal is an open−drain−N−channel MOSFET and if a pull−up resistor is connected between "OUT" and "$\overline{FAULT}$", "$\overline{FAULT}$" goes high. The pullup resistor is generally selected in the range of 100 kΩ to minimize the current consumption.

Application Information

It is recommended to use 2.2 μF capacitors on the input and on the output of the NCP2860. Capacitor type is not very critical. Simply the ESR should be lower than 0.5 Ω to ensure a stable operation over the temperature and output current ranges. It could be convenient to increase the capacitor size and its quality (lower ESR) only if it was necessary to further improve the noise performances, the Power Supply Rejection Ratio or the fast transient response.

NCP2860

ORDERING INFORMATION

Device	Output Voltage (V)	Marking Code	Package	Shipping†
NCP2860DM277R2G	2.77	LC2	Micro8 (Pb−Free)	4000 / Tape & Reel
NCP2860DMADJR2G	Adjustable	AAA	Micro8 (Pb−Free)	4000 / 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.
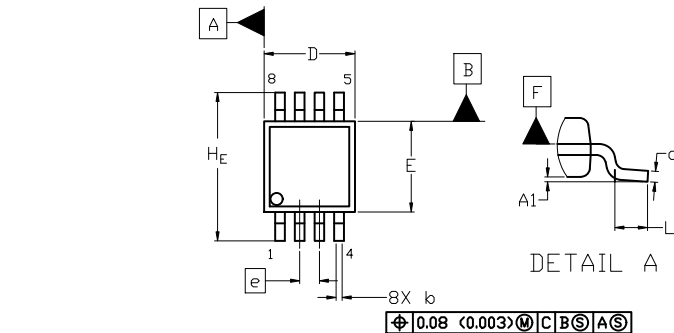
Micro8
CASE 846A−02
ISSUE K

SCALE 2:1

DATE 16 JUL 2020

TOP VIEW

NOTE 3

DETAIL A

SIDE VIEW

END VIEW

DETAIL A

RECOMMENDED
MOUNTING FOOTPRINT

8X 0.48

8X 0.80

5.25

0.65
PITCH

8X b

⌖ 0.08 (0.003) Ⓜ C B Ⓢ A Ⓢ

⌂ 0.038 (0.0015) C

NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.

2. CONTROLLING DIMENSION: MILLIMETERS

3. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE PROTRUSION SHALL BE 0.10 mm IN EXCESS OF MAXIMUM MATERIAL CONDITION.

4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSION OR GATE BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.15 mm PER SIDE. DIMENSION E DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 mm PER SIDE. DIMENSIONS D AND E ARE DETERMINED AT DATUM F.

5. DATUMS A AND B ARE TO BE DETERMINED AT DATUM F.

6. A1 IS DEFINED AS THE VERTICAL DISTANCE FROM THE SEATING PLANE TO THE LOWEST POINT ON THE PACKAGE BODY.

DIM	MILLIMETERS		
	MIN.	NOM.	MAX.
A	---	---	1.10
A1	0.05	0.08	0.15
b	0.25	0.33	0.40
c	0.13	0.18	0.23
D	2.90	3.00	3.10
E	2.90	3.00	3.10
e	0.65 BSC		
H_E	4.75	4.90	5.05
L	0.40	0.55	0.70

※ For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

GENERIC
MARKING DIAGRAM*

8

XXXX
AYW▪

1
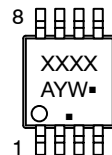
XXXX = Specific Device Code
A = Assembly Location
Y = Year
W = Work Week
▪ = Pb−Free Package

(Note: Microdot may be in either location)

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

STYLE 1:
PIN 1. SOURCE
2. SOURCE
3. SOURCE
4. GATE
5. DRAIN
6. DRAIN
7. DRAIN
8. DRAIN

STYLE 2:
PIN 1. SOURCE 1
2. GATE 1
3. SOURCE 2
4. GATE 2
5. DRAIN 2
6. DRAIN 2
7. DRAIN 1
8. DRAIN 1

STYLE 3:
PIN 1. N−SOURCE
2. N−GATE
3. P−SOURCE
4. P−GATE
5. P−DRAIN
6. P−DRAIN
7. N−DRAIN
8. N−DRAIN

DOCUMENT NUMBER:	98ASB14087C	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.	
DESCRIPTION:	MICRO8		PAGE 1 OF 1

ADDITIONAL INFORMATION

◊