NH2D0245-004
Energy Harvesting PMIC

1. Description

The NH2D0245 is a high-performance energy harvesting solution for low-power applications. The NH2D0245 is designed to work efficiently in the range of microwatts (µW) to milliwatts (mW) of power, which is suitable for different IoT applications, such as smart wearables, electronic shelf labels, and wireless sensor networks (WSN). The NH2D0245 is designed to extract the low power output of an energy harvesting source, for instance, photovoltaic (solar), or a piezoelectric harvester with a rectifier to charge a variety of energy storage elements such as rechargeable batteries or supercapacitors. The PMIC can effectively extract power from energy harvesters, boosting the voltage by a factor of up to 2.3 with a power conversion efficiency of 80%.

Nowi's advanced maximum power point tracking (MPPT) uses an embedded hill-climbing algorithm to deliver the maximum power to the load. The MPPT is designed to be independent of specific characteristics of the harvesters. Therefore any harvester that fits the specifications of the chip can be used. Moreover, the MPPT circuit can detect the maximum power point with an interval of 1 second resulting in maximal efficiency in various environments where energy can rapidly change over time. The NH2D0245 is available in a 16-lead, 3mm × 3mm QFN package.

2. Features

- High-efficiency low power DC-DC converter
- Input power range >10 µW
- Advanced MPPT to maximize efficiency for low-power input range
- Ultra-fast MPPT interval in the range of 1 second
- Small BOM with no external coil required
- Multiple battery and storage elements compatibility

3. Applications

- Wearable devices
- Beacons and IoT sensor networks
- Industrial and environmental monitoring
- Consumer electronics
- Electronic Shelf Labels
- Smart remote controls

4. Pinouts

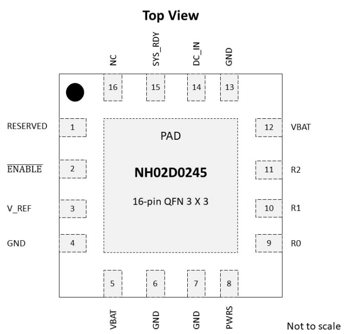

Figure 1: *QFN16 3x3 mm pinout*

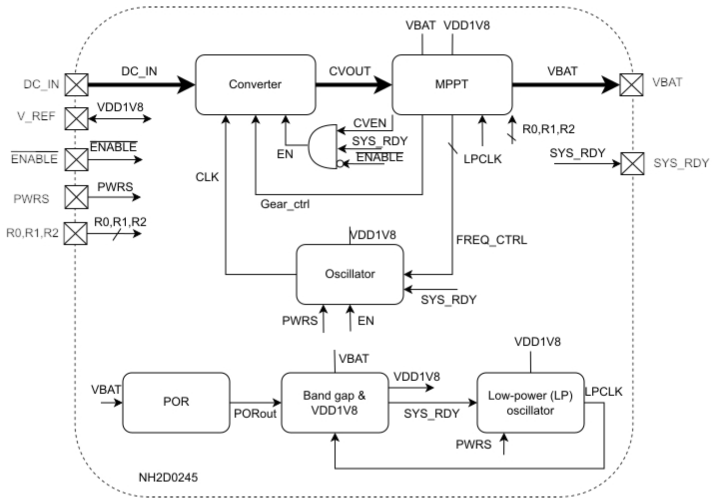

Figure 2: *NH2D0245 block diagram*

Table 1: *Pin configurations and function*

PIN NO	PIN NAME	DIRECTION	DESCRIPTION
1	RESERVED	NA	Connect to ground.
2	$\overline{\text{ENABLE}}$	In	Connect the $\overline{\text{ENABLE}}$ pin to ground to enable the chip. Connecting the $\overline{\text{ENABLE}}$ pin to VBAT level will force the PMIC to standby mode, meanwhile, the internal clock will be set to minimum frequency.
3	V_REF	Out	Internal power supply voltage. (Should not be used to supply other devices). 2.2 μF capacitor should be connected close to PMIC.
4	GND	0 V	Ground of the PMIC.
5	VBAT	VBAT	Connect to VBAT.
6	GND	0 V	Ground of the PMIC.
7	GND	0 V	Ground of the PMIC.
8	PWRS	In	Connect the PWRS pin to ground for the default setting.
9	R0	In	Connect the R0 pin to ground for the default setting.
10	R1	In	Connect the R1 pin to ground for the default setting.
11	R2	In	Connect the R2 pin to ground for the default setting.
12	VBAT	VBAT	Battery input voltage. Recommended using decoupling capacitor as close to this pin as possible.
13	GND	0 V	Ground of the PMIC.
14	DC_IN	In / 1.4 to 2.3 V	Harvester DC input voltage
15	SYS_RDY	Out	System ready flag indicating the IC started operation (VBAT). Initial value is 0 V after Reset is applied.
16	NC	NA	Leave it floating.
PAD	PAD	NA	Thermal pad of the PMIC. Connect it to ground.

* All voltages are in the domain of VBAT except for DC_IN and V_Ref

5. Typical configuration

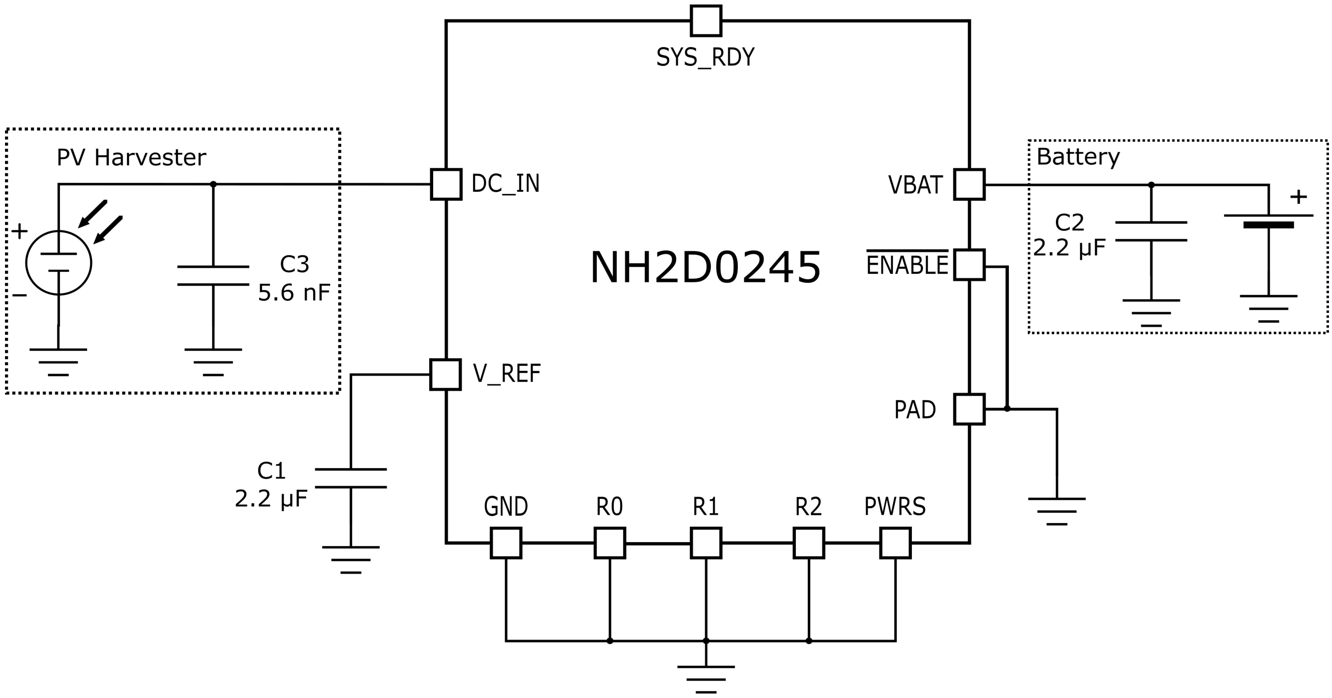

Figure 3: *Typical configuration indoor solar harvesting*

6. PMIC Characteristics

The NH2D0245 Electrical Parameters have been tested at typical 25°C at PWRS = 0, unless stated differently.

6.1. System

Table 2: *System specifications*

PARAMETER	CONDITIONS	MIN	NOM	MAX	UNIT	NOTE
Boosting Factor	-	-	2x/2.3x	-	-	2x or 2.3x
DC_IN	-		1.4		V	
P_IN	-	11	-	2000	μW	Maximum conversion efficiency up to 2000uW. Conversion up to 30mW is possible with lower efficiency.
MPPT Interval	-	1	1.2	1.4	s	
Supply voltage (VBAT)	-	2.5	-	4.5	V	
Startup VBAT voltage	-		2.5		V	
Standby mode Current	Standby mode	500	-	1300	nA	
Low power detection level	-	-	10	-	μW	
V_REF	-	1.7	-	1.93	V	Internal voltage reference
OSC HF	-	-	800	-	kHz	Average over validation measurements.
OSC LF	-	-	28	-	kHz	Average over validation measurements.
Operating temperature	-	-40°	-	85°	C	

6.2. Startup sequence

Figure 4 shows the startup sequence of the signals VBAT (Blue), V_REF (Red), SYSRDY (Green).

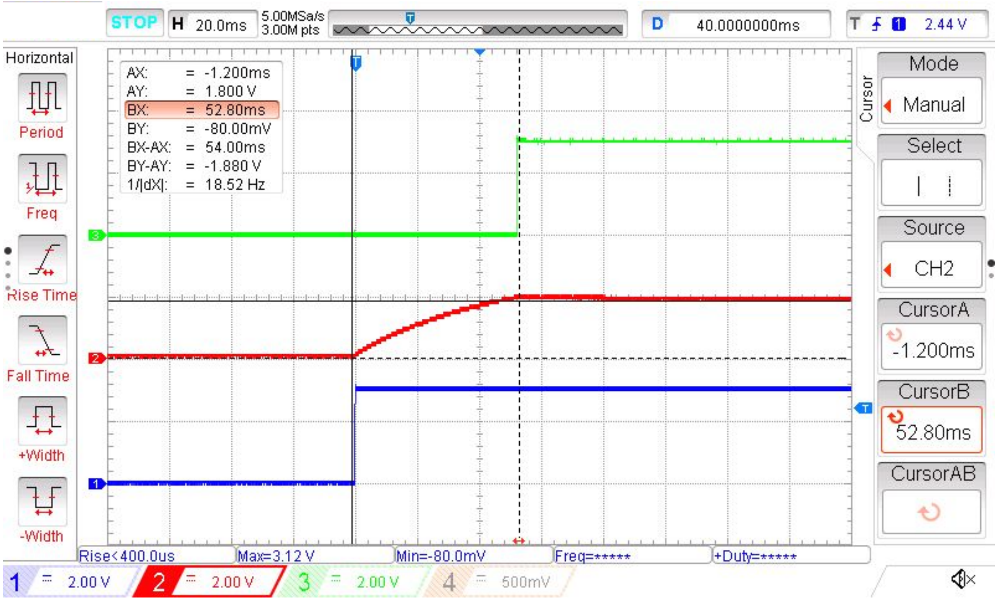

Figure 4: *Startup 40ms/div*

6.3. MPPT interval

The oscilloscope measurement in figure 5 shows the voltage at DC_IN. The spikes show a search for the best maximum power point, and the interval between the spikes indicate the MPPT interval.

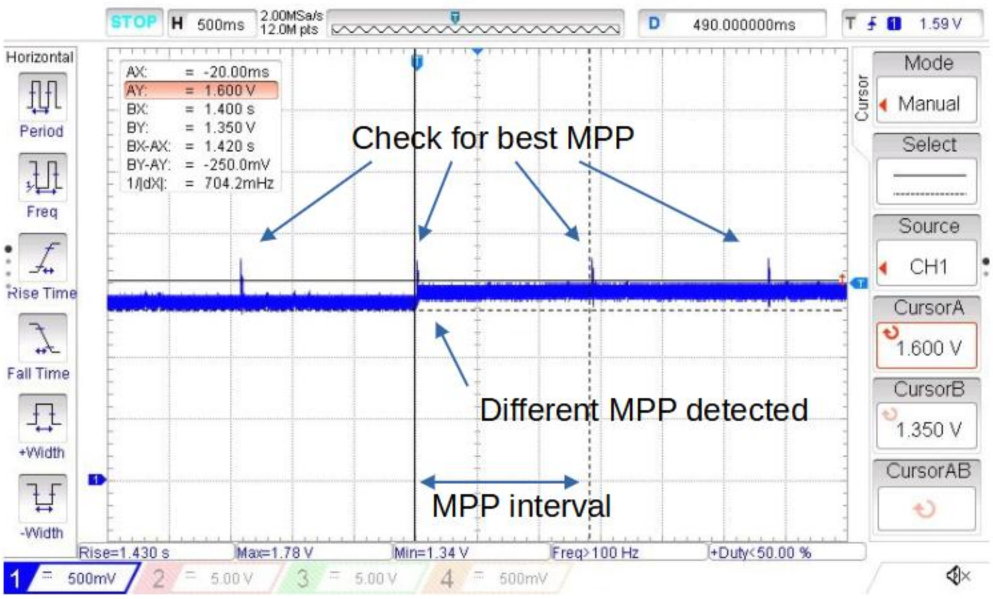

Figure 5: *MPPT interval*

6.4. PMIC Efficiency

Table 3 shows the simulated efficiency data of the device.
Note that these values represent final production silicon and measurements on intermediary pre-production samples can vary.
Efficiency data is based on following conditions:

- Operating blocks
  - Voltage References
  - POR
  - Oscillators
  - Converter
  - MPPT
- Pad leakage is estimated
- TT, T=27^{o}C

Table 3: *Overall Efficiency*

CONDITIONS	EFFICIENCY	UNIT
Vin=1.4 V, Vbat=2.5 V, Pin=160μW	84.13	%
Vin=1.5 V, Vbat=3.2 V, Pin=239μW	79.19	%
Vin=1.5 V, Vbat=3.2 V, Pin=464μW	78.69	%
Vin=1.6 V, Vbat=3 V, Pin=238.4μW	85.12	%
Vin=1.7 V, Vbat=3.2 V, Pin=13μW	69.61	%
Vin=1.7 V, Vbat=3.2 V, Pin=52.4μW	79.16	%
Vin=1.7 V, Vbat=3.2 V, Pin=129.2μW	81.15	%
Vin=2.2 V, Vbat=4.1 V, Pin=51.3μW	77.9	%
Vin=2.2 V, Vbat=4.1 V, Pin=953μW	84.57	%

7. Absolute Maximum Ratings

Table 4: *Absolute maximum rating specifications*

PARAMETER	MAX	UNIT	NOTE
IDC_IN	15	mA	Maximal Input Current on pin DC_IN
VDC_IN	5	V	Maximal Input Voltage on pin DC_IN
VBAT	5	V	DC-DC OFF
ESD	1500	V	

8. Thermal Information

Table 5: *Thermal specifications*

THERMAL METRIC		UNIT
$R_{\theta JA}$ Junction-to-ambient thermal resistance	30	°C/W
$R_{\theta JC(top)}$ Junction-to-case (top) thermal resistance	49	°C/W
$R_{\theta JB}$ Junction-to-board thermal resistance	11	°C/W
ψ_{JT} Junction-to-top characterization parameter	0.5	°C/W
ψ_{JB} Junction-to-board characterization parameter	12	°C/W
$R_{\theta JC(bot)}$ Junction-to-case (bottom) thermal resistance	1	°C/W

9. Packaging information

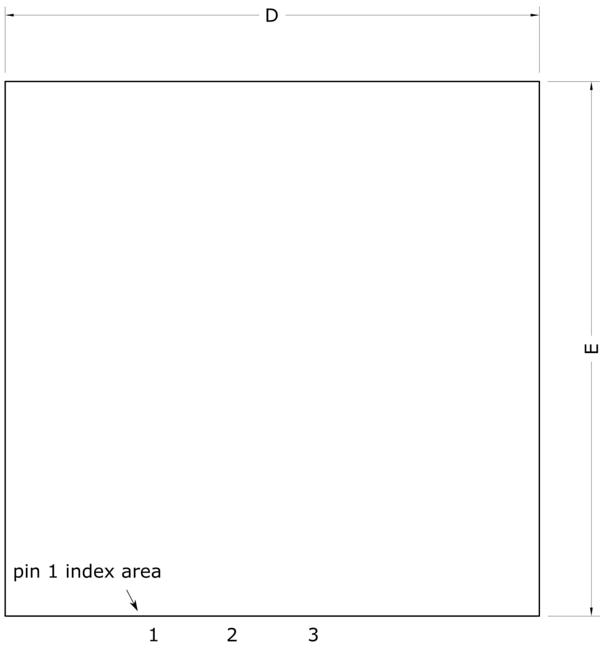

Figure 6: *Top view*

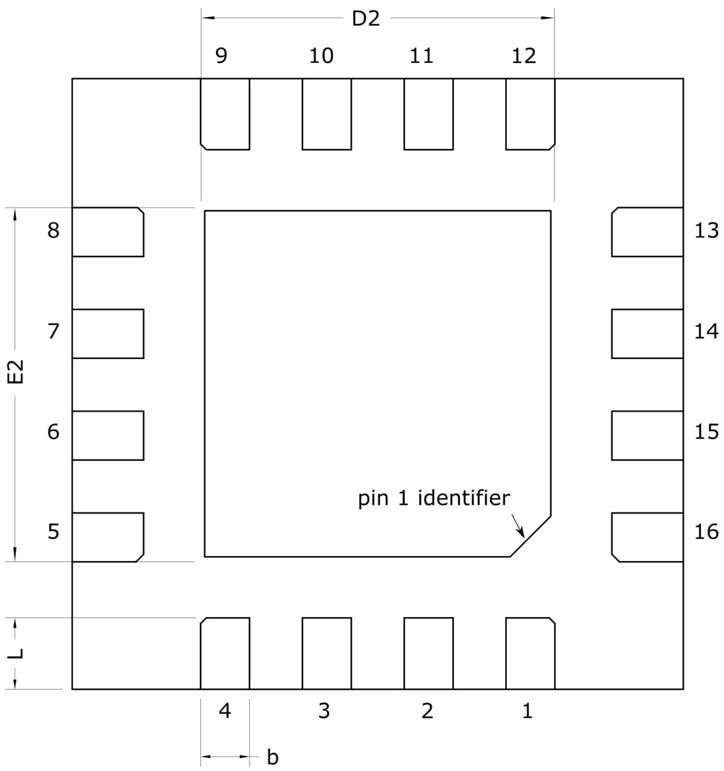

Figure 7: *Bottom view*

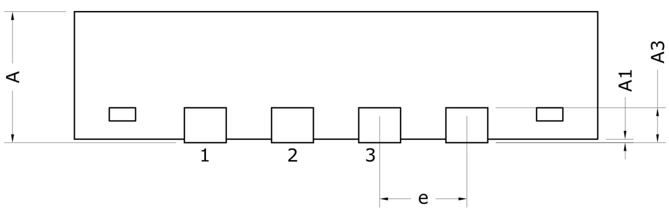

Figure 8: *Side view*

Table 6: *Dimensions in millimeters (mm)*

SYMBOL	MIN.	NOM.	MAX.
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
A3		0.203 REF	
b	0.18	0.24	0.30
D	2.90	3.00	3.10
E	2.90	3.00	3.10
D2	1.65	1.70	1.75
E2	1.65	1.70	1.75
e		0.50	
L	0.30	0.35	0.40

10. Disclaimer

Any information in this datasheet is preliminary and subject to changes without prior notice. Any information in this document is Nowi B.V. proprietary property and is protected by copyright and trademark laws and other intellectual property rights. The document can be used for individual non-commercial and informational purposes only. Any other use, including commercial use, is strictly prohibited. Nowi technology is available for licensing. A range of licensing models are possible and can be discussed upon request.

As stipulated in Nowi's distribution and/or supply agreements, the warranty linked to the NH2D0245 is depending on the qualification and certification procedure. During the test-phase Nowi is not able to give a warranty. After the test-phase for full qualification, Nowi will inform its co-contracting parties about the qualification and the warranty linked thereto. This warranty will have retroactive effect and therefore also applies to the NH2D0245 products which have been sold to the co-contracting parties during the test-phase.

More product information (data sheets, silicon errata, application notes and reference designs) can be found on www.nowi-energy.com.