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# DC/DC Converters for Energy Harvesting

- R1800: Buck
- R1801: Buck + PG + Adjustable Output Voltage
- R1810: Boost + PG

PG:Power Good Output

Nisshinbo Micro Devices Inc.

# DC/DC Converters for Energy Harvesting

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| Harvesters | DC/DC Converter for Energy Harvesting | SLB (for energy storage) |
|---|---|---|
| Indoor Multi-Cell Solar Panel | **R1800** Buck, VMP* |  |
| WPT Rectenna | **R1801** Buck, VMP*, PG, Adjustable Output Voltage | |
| Vibration +AC/DC | **R1810 :** Boost, VMP*, PG | |

VMP* : Maximum Power Point Control

**SLB**
- Nominal Voltage: 2.4V
- Voltage Range: 1.8V to 2.8V
- Capacity: 0.35mAh to 150mAh

**R1800 Series**
- Vin: 2.0V to 5.5V
- Vout: 2.7V (for SLB charging)
- Current Consumption: 144nA
- VMP: 2.0V to 5.5V

**R1801 series**
- Vin: 2.3V to 5.5V
- Vout: 2.7V (for SLB charging)
- Current Consumption: 200nA
- VMP: 2.7V to 5.3V
- Features: PG (out)

**R1810 Series**
- VIN: 0.35V to 2.1V
- Start-up Voltage: 0.50V
- VOUT: 2.7V (for SLB charging)
- Current Consumption: 600nA
- VMP: 0.35V to 2.1V
- Features: PG (in, out)

# Maximum Power Point Control (VMP)

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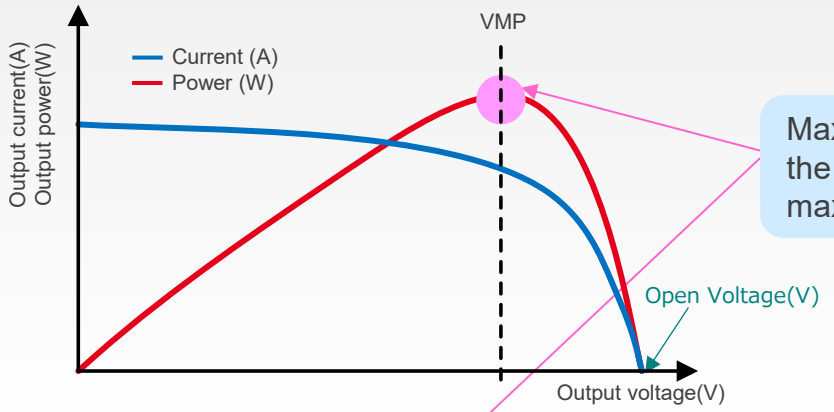
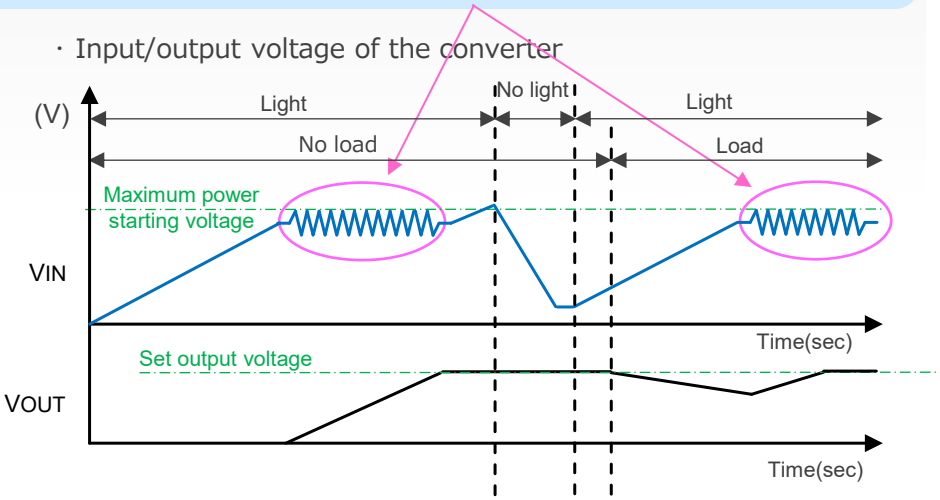
## What is maximum power method ?

・Current, power-voltage characteristics of the photovoltaic element

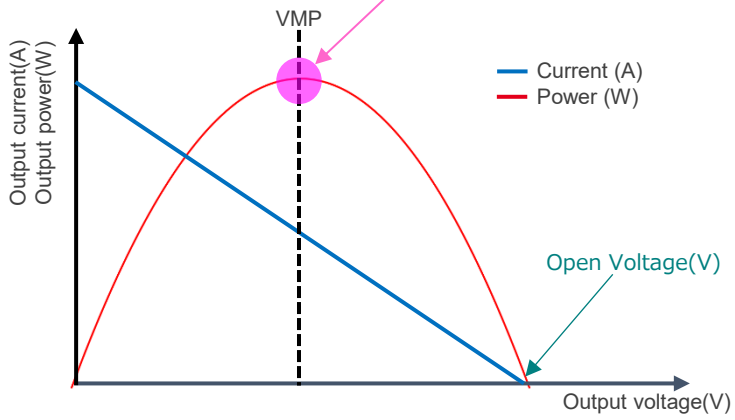



Maximum power method operates a converter at the pink point in the figure so that the output power of the photovoltaic cell is maximized.

・Input/output voltage of the converter



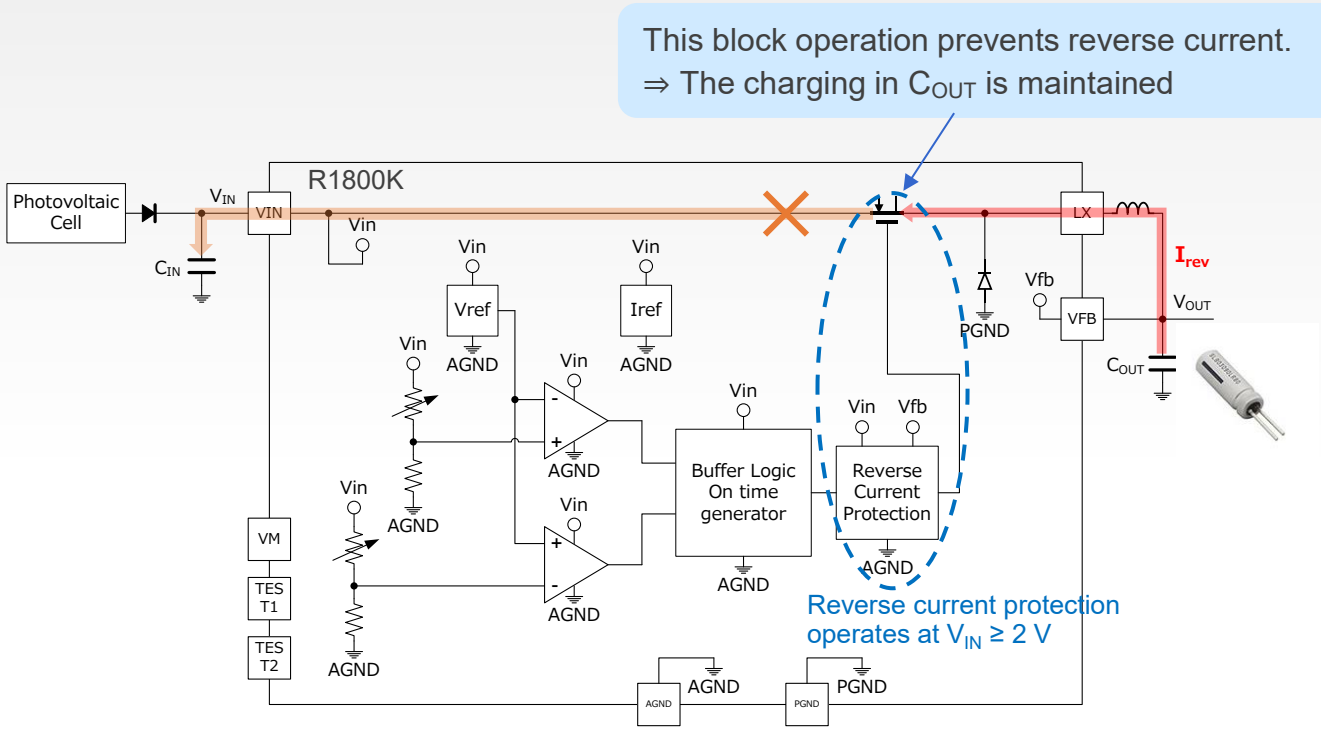

・Current, power-voltage characteristics of WPT Rectenna

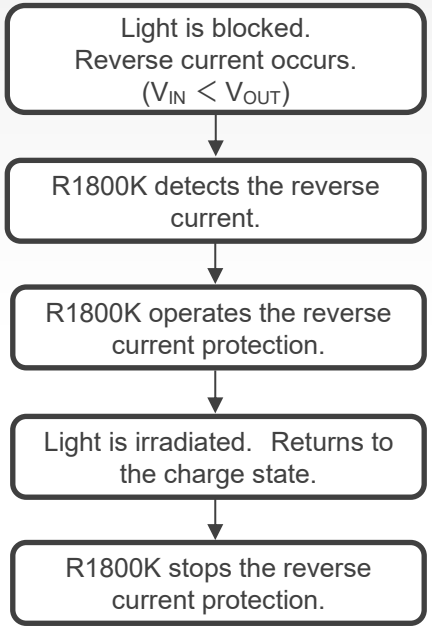



**Operates the DC/DC converter at the voltage where the power output from the energy source is maximized.**

# Reverse Current Protection in R1800/R1801

## Reverse current protection




The R1800 and R1801 maintain the charge on Cout even when Vin is lost during system operation, contributing to stable and highly efficient system operation.

# DC/DC Converters for Energy Harvesting

| PN | Product type | Photovoltaic | WPT | Vibration | Operating Voltage | $V_{MP}$ internally fixed | $V_{SET}$ | Iq | Function |
|---|---|---|---|---|---|---|---|---|---|
| **R1800** | Buck | ◎ Multi-cell | ◎ | ○ +external AC/DC | 2.0～5.5V | 2.0～5.5V | 2.0～4.5V | **144nA** | – |
| **R1801** | Buck | ◎ Multi-cell | ◎ | ○ +external AC/DC | 2.3～5.5V | 2.7～5.3V | 2.3～4.5V (Adjustable) | **200nA** | PG(OUT) |
| **R1810** | Boost | ◎ 1cell | ◎ | ○ +external AC/DC | 0.35～2.1V | 0.35～2.1V | 2.3～4.5V | **600nA** | PG (IN/OUT) |

# R1800K Series

## Low Quiescent Current ($I_Q$ 144nA) Buck DC/DC Converter for Energy Harvester

- Providing a low operating quiescent current ($I_Q$ 144 nA) and a high efficiency (approx. 90%@10 µA)
- Maximum power optimizes a power supply from an energy harvester
- Reverse current protection helps stable operation and high efficiency operation of the System

## KEY SPECIFICATIONS

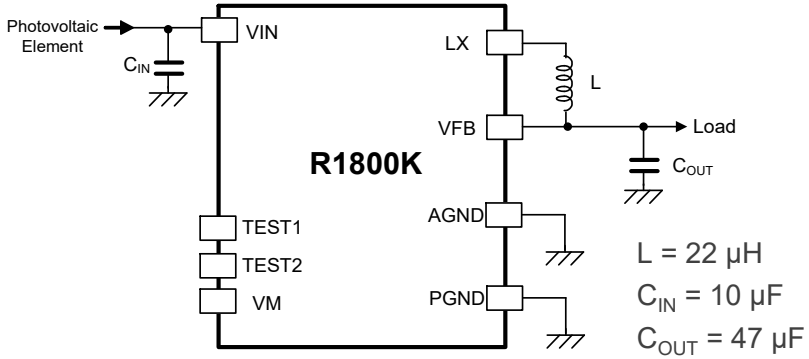
- Input Voltage Range: 2.0 V to 5.5 V
- Output Voltage Range: 2.0 V to 4.5 V (0.1 V step)
- Output Voltage Accuracy : ±3.0%
- Operating Quiescent Current: Typ. 144 nA (Ta = 25 ℃, at no load)
- Starting Power: 720 nW
- Accuracy of Maximum Power Voltage: 200 mV
- Protect Function: Reverse Current Protection ($V_{IN}$ ≥ 2.0 V)

## PACKAGE

**DFN(PL)2730-12**

2.7 mm x 3.0 mm x 0.6 mm

## TYPICAL APPLICATIONS




L = 22 µH
$C_{IN}$ = 10 µF
$C_{OUT}$ = 47 µF

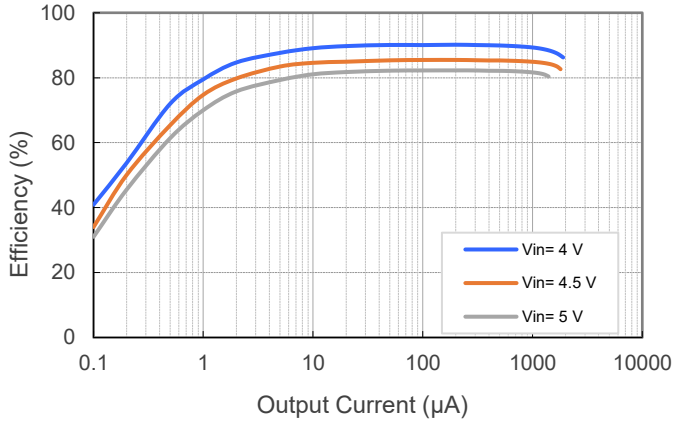
## OPTIONAL FUNCTIONS

| Product Name | Package | Quantity per reel |
|---|---|---|
| R1800KxxxA-TR | DFN(PL)2730-12 | 5,000 pcs |

xx: Set output voltage ($V_{SET}$), set maximum power voltage ($V_{MPSET}$)
Output Voltage: 2.0 V to 4.5 V, 0.1 V step
Maximum power voltage: 2.0 V to 5.3 V, 0.1 V step

## TYPICAL CHARACTERISTICS

Efficiency vs. Output Current $V_{SET}$ = 3.3V




## APPLICATIONS

- Energy harvesting module of a photovoltaic and vibration energy harvester

# R1801K Series

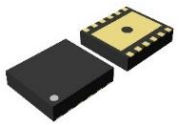
## Buck DC/DC Converter for Energy Harvester with Adjustable Maximum Power Point Control, Adjustable Output Voltage and PG Function

- Providing low operating quiescent current ($I_Q$ 200nA) and high efficiency (80%@10μA)
- Power good (PG) output as an output voltage indicator
- Adjust output voltage and maximum power point control voltage with input pins

## KEY SPECIFICATIONS

- Input Voltage Range (Maximum rating): 2.3V to 5.5V (6.5V)
- Output Voltage Range: 2.3V to 4.5V
- Maximum Power Point Control Voltage Range: 2.7V to 5.3V
- Output Voltage Tolerance: ±3.0%
- Operating Quiescent Current: Typ. 200nA (Ta = 25°C, at no load)
- Starting Power: 1μW ($V_{IN}$ = 4V, $V_{OUT}$ = 3.0V)
- Adjustable Maximum Power Point Control, Adjustable Output Voltage, PG Function
- Protect Function: Reverse Current Protection ($V_{IN}$ ≥ 2.0V)

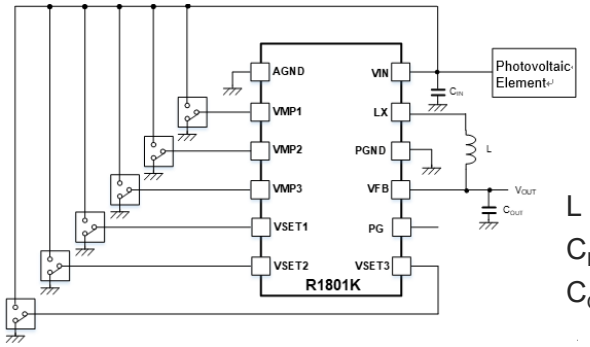
## PACKAGE



**DFN(PL)2730-12**

3.0mm x 2.7mm x 0.6mm

## TYPICAL APPLICATION CIRCUIT




L = 22μH

$C_{IN}$ = 10μF

$C_{OUT}$ = 47μF

## SELECTION GUIDE

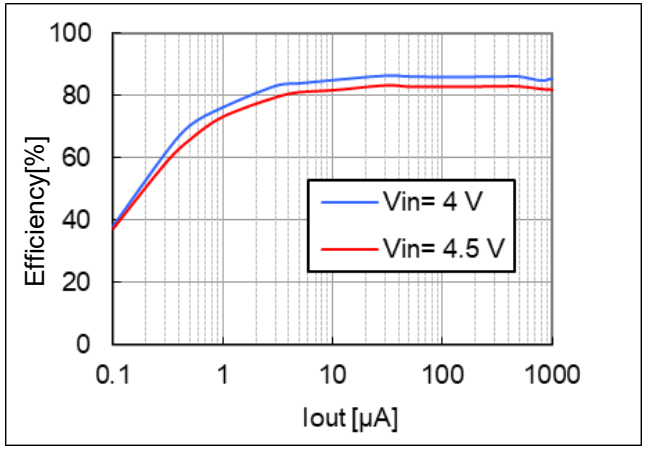
| Product Name | Package | Quantity per Reel |
|---|---|---|
| R1801KxxxA-TR | DFN(PL)2730-12 | 5,000 pcs |

xxx: Select the ideal combination of the set output voltage ($V_{SET}$) and the set maximum power point control voltage ($V_{MPSET}$) from the code number starting from 001. (For details, refer to the electrical characteristics table by product datasheet.)

When use the PG function, use $V_{SET}$ = 2.5V or higher.
Recommend to set $V_{MP}$>$V_{SET}$+0.5V or higher.

## TYPICAL CHARACTERISTICS

Efficiency vs. Output Current $V_{OUT}$=3.0V




## APPLICATIONS

- Energy harvesting module of a photovoltaic and vibration energy harvester

# R1810x Series

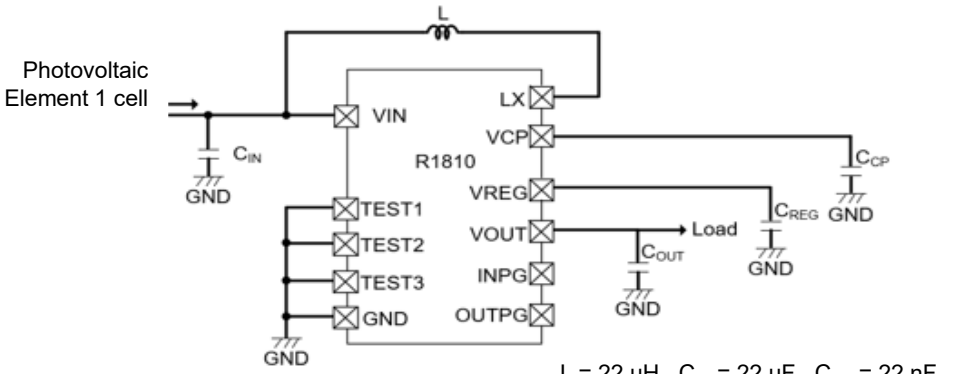
## 600nA $I_Q$ Low Quiescent Current Boost DC/DC Converter for Energy Harvester

- **Providing a low quiescent current (Typ.600nA)、and high efficiency.**
- **The power can be taken out with low start-up power, 9μW.**
- **Optimization of power supply from the power generation element is possible by the function of the maximum power point control.**
- **Equipped with input / output power good function**

## KEY SPECIFICATIONS

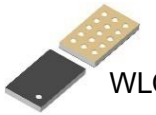
- Start-up Voltage: 0.35 V (Ta = 25 ℃)
- Input Voltage Range: 0.2 V to 2.1 V ($V_{SET}$ = 2.7 V)
- Output Voltage Range: 2.3 V to 4.5 V (0.1 V step)
- Maximum Power Point Control Voltage Setting: 0.2 V to 2.1 V
- Output Voltage Accuracy: ± 5.0 %
- Operating Quiescent Current: Typ. 600 nA (Ta = 25 ℃ , at no load)
- Start-up Power: 9 μW ($V_{MPSET}$ = 0.5 V , $V_{SET}$ = 2.6 V)
- Maximum Power Point Control Voltage Setting: 50 mV
- OUTPG = H setting (accuracy): Can be set of 90 %
- OUTPG = L setting (accuracy): Can be set of 80 % to 50 %

## TYPICAL APPLICATIONS




L = 22 μH , $C_{IN}$ = 22 μF , $C_{CP}$ = 22 nF , $C_{REG}$ = 4.7 μF , $C_{OUT}$ = 4.7 μF

## PACKAGE



WLCSP-15-P1

2.88 x 1.68 x 0.36 (mm)

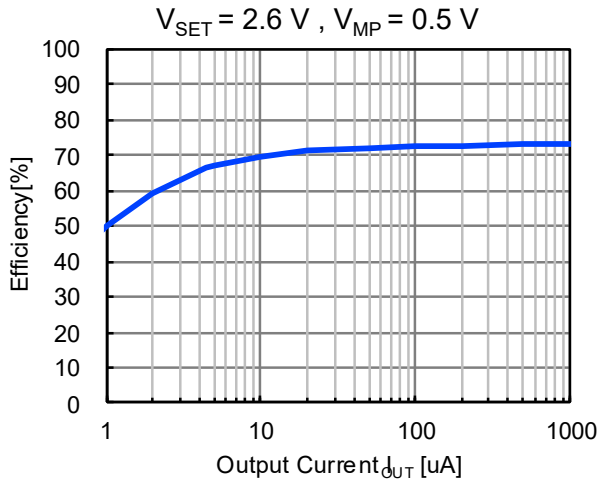
DFN2735-14

3.5 x 2.7 x 0.6 (mm)

## APPLICATIONS

- Photovoltaic element single cell,
  Energy harvesting module such as thermoelectric generation.

## TYPICAL CHARACTERISTICS

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