144 nA I_Q Low Quiescent Current Buck DC/DC Converter for Energy Harvester Evaluation Board

No. EEV-414-K009A-230403

R1800K009A-EV is the evaluation board for R1800 which has the below features, benefits and specification.

OVERVIEW

R1800K is a power-storing buck DC/DC converter for a photovoltaic and vibration energy harvester. A low operating quiescent current allows a harvester to be used under a low-illumination environment, and it is suitable for power management of an energy harvester with a low power sensor system.

KEY BENEFITS

- Providing a low operating quiescent current (I_Q 144 nA) and a high efficiency (approximately 90%@10 µA).
- A Control function that enables a maximum power optimizes a power supply from an energy harvester.

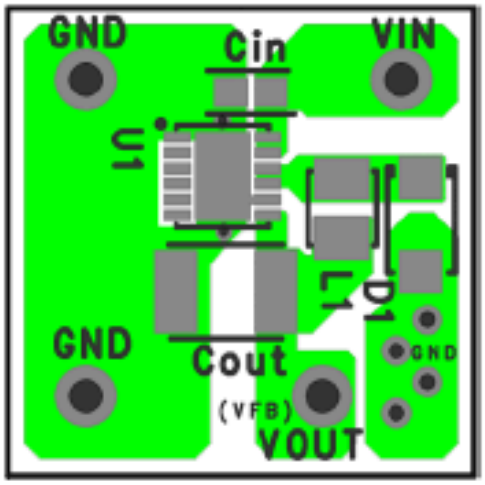
KEY SPECIFICATIONS

- Input Voltage Range: 2.0 V to 5.5 V
- Output Voltage Range: 2.0 V to 4.5 V
- Output Voltage Accuracy: ±3.0%
- Operating Quiescent Current: Typ.144 nA (Ta = 25°C, at no load)
- Starting Power: 720 nW
- Reverse Current Protection (V_{IN} ≥ 2.0 V)
- Accuracy of Maximum Power Voltage: 200 mV
- For more details on R1800 IC, please refer to
  https://www.nisshinbo-microdevices.co.jp/en/products/dc-dc-switching-regulator/spec/?product=r1800

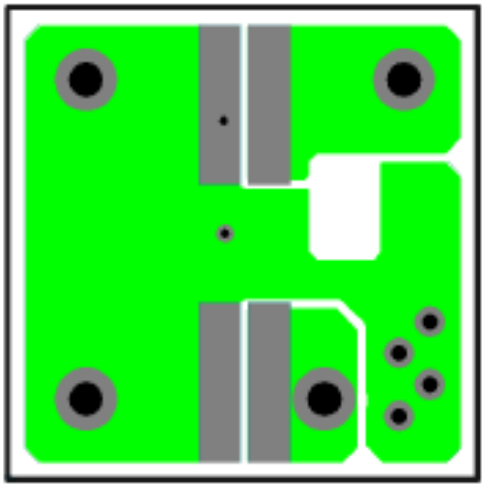
PCB LAYOUT

R1800KxxxA-TR (PKG: DFN(PL)2730-12)

Top Layer



Bottom Layer



ABSOLUTE MAXIMUM RATINGS

Absolute Maximum Ratings (GND = 0 V)

Symbol	Parameter	Rating	Unit
V_{IN}	VIN Pin Voltage	−0.3 to 6.5	V
V_{LX}	LX Pin Voltage	−0.3 to V_{IN} + 0.3	V
V_{VFB}	VFB Pin Voltage	−0.3 to 6.5	V
P_D	Power Dissipation (1) [DFN(PL)2730-12, JEDEC STD. 51-7 Test Land Pattern]	1850	mW
Tj	Junction Temperature Range	−40 to 85	°C
Tstg	Storage Temperature Range	−55 to 125	°C

ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause permanent damage and may degrade the lifetime and safety for both device and system using the device in the field. The functional operation at or over these absolute maximum ratings is not assured.

RECOMMENDED OPERATING CONDITIONS

Recommended Operating Conditions

Symbol	Parameter	Rating	Unit
V_{IN}	Input Voltage	2.0 to 5.5	V
Ta	Operating Temperature Range	−40 to 85	°C

RECOMMENDED OPERATING CONDITIONS

All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

(1) Refer to *POWER DISSIPATION* for detailed information.

ELECTRICAL CHARACTERISTICS

The specifications surrounded by [ ] are guaranteed by design engineering at −40°C ≤ Ta ≤ 85°C.

R1800K Electrical Characteristics (Ta = 25°C)

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	$V_{IN} \geq V_{SET}$ + 0.5 V, at no load	x 0.97		x 1.03	V
I_Q	Operating Quiescent Current	V_{IN} = 5.0 V, V_{SET} = 3.0 V, device not switching		144	300	nA
P_{ST}	Minimum Starting Power	Ta = 25°C, V_{IN} = 4 V, V_{SET} = 3.3 V, when constant current is applied		720		nW
V_{MP}	Accuracy of Maximum Power Voltage				200	mV
I_{REV}	Reverse Current	$V_{IN} \geq$ 2.0 V, V_{FB} = 4.5 V (When VIN drops from 2.5 V or more) Charging current to C_{IN} and C_{OUT} are not included(1)		10	100	nA

All test items listed under Electrical Characteristics are done under the pulse load condition (Tj ≈ Ta = 25°C).
Test circuit is operated with “Open Loop Control” (GND = 0 V), unless otherwise specified.

Product-specific Electrical Characteristics

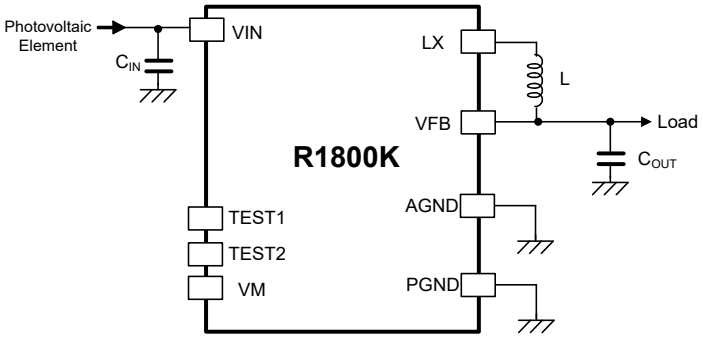
Product Name	V_{OUT} [V]			V_{MP} [V]	
	Min.	Typ.	Max.	Typ.	Max.
R1800K019A	3.201	3.3	3.999	4.0	4.2

V_{OUT}: the set output voltage, V_{MP}: the set maximum power voltage

(1) Reverse current protection operates at $V_{IN} \geq$ 2 V. It does not function with the voltage under 2 V. Set as $V_{MPSET} > V_{SET}$ + 0.5 V. Due to having a hysteresis in the reverse current protection, a state may be detected as a reverse current even if $V_{IN} = V_{OUT}$.

APPLICATION INFORMATION

Typical Application Circuit



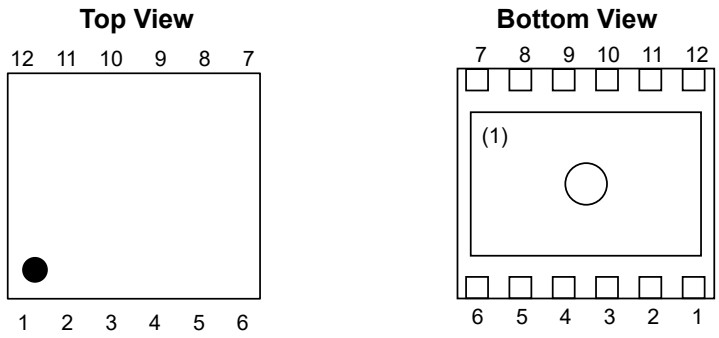
R1800K Typical Application Circuit

Recommended External Components(1)

Symbol	Value
L	22 µH
C_{IN}	10 µF
C_{OUT}	47 µF

(1)The bill of materials will be attached on the shipment of each purchased evaluation board.

PIN DESCRIPTION



DFN(PL)2730-12 Pin Configuration

DFN(PL)2730-12 Pin Description

Pin No.	Symbol	Description
1	AGND	AGND Pin
2	TEST1	Pin for Testing (Must not be connected)
3	TEST2	Pin for Testing (Must not be connected)
4	VM	Pin for Testing (Must not be connected)
5	NC	No Connection (Must not be connected)
6	NC	No Connection (Must not be connected)
7	VFB	Feedback Pin
8	PGND	PGND Pin
9, 10	LX	DC/DC Switching Pin
11, 12	VIN	Pin for Connecting Photovoltaic Element

(1) The tab on the bottom of the package enhances thermal performance and is electrically connected to GND (substrate level). It is recommended that the tab be connected to the ground plane on the board, or otherwise be left floating.

TECHNICAL NOTES

The performance of a power source circuit using this device is highly dependent on a peripheral circuit. A peripheral component or the device mounted on PCB should not exceed a rated voltage, a rated current or a rated power. When designing a peripheral circuit, please be fully aware of the following points.

- External components must be connected as close as possible to the IC and make wiring as short as possible. Especially, the capacitor connected in between V_{IN} pin and GND pin must be wiring the shortest.
- If their impedance is high, internal voltage of the IC may shift by the switching current, and the operating may be unstable. Make the power supply and GND lines sufficient.
- As for wirings of the power, the ground, the inductor, the LX and the VFB pins, due consideration must be given to large current occurred by switching.
- Please choose inductors which have low direct-current resistance, enough allowable current and low magnetic saturation. Current-limited circuit may operate with LX peak current before reaching expected load current in case of low allowable current and extremely low inductance value under load condition.
- Note that the current-limited circuit is self-heating and radiation environment sensitive.

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