

International
IR Rectifier

REFERENCE DESIGN

IRDCiP1001-B

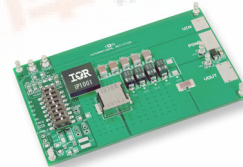
International Rectifier • 233 Kansas Street, El Segundo, CA 90245 USA

IRDCiP1001-B, 200kHz to 300kHz, 20A, 5V_{IN} to 12V_{IN} Single Phase Synchronous Buck Converter using iP1001

Overview

In this document, Table 1 and Figure 1 are provided to enable engineers to easily evaluate the iP1001 in a single phase configuration that is capable of providing up to 20A in a lab environment without airflow. Figures 3, 4, 5 and 6 and the complete bill of materials in Table 2 are provided as a reference design to enable engineers to very quickly and easily design a single phase converter. In order to optimize this design to your specific requirements, refer to the iP1001 data sheet for guidelines on external component selection and user adjustable limits and specifications for the iP1001. Custom designs may require layout modifications.

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| IRDCiP1001-B Demoboard Operating Conditions | | |
|--|-----------|------|
| | Min | Max |
| V _{IN} | 4.5V | 12V |
| V _{OUT} | 0.925V | 3.3V |
| I _{OUT} | See Fig.1 | |

Demoboard Quick Start Guide

Initial Settings:

- The output is set to 1.3V, but can be adjusted from 0.925V to 2.0V by setting SW1 according to the VID codes provided in Table 1. The output voltage can be adjusted to allow up to 3.3V_{OUT} by adding R3 & R4 with the DAC set to 2V_{OUT}. Refer to equation 1 for R3 & R4 values. R4 should be removed for output voltages below 2V, and R3 should be set to zero ohms (see Table 2).
- The switching frequency is centered around 300kHz with the Freq pin floating.
- The input voltage range can be extended below 5V_{IN} by populating the mini-boost circuit on the demo board. Refer to IRDCiP1001-A reference design documentation for direction on changing the configuration of the demo board.

Procedure for Connecting and Powering Up Demoboard:

1. Apply input voltage (5V - 12V) across V_{IN} and PGND. The input voltage (V_{IN}) pin and logic power pin (V_{DD}) are provided as separate inputs. For 5V_{IN} operation only, the V_{IN} and V_{DD} pins can be connected together. For logic power (V_{DD}), connect 5V power source across +5V (TP1) and PGND (TP2).
2. Apply load across VOUT pad and PGND pad.
3. The ENABLE pin is controlled via switch 8 on SW1. This pin is supplied in low state. Once pulled high the output is enabled.
4. Adjust load accordingly.

IRDCiP1001-B Recommended Operating Conditions

(refer to the iP1001 datasheet for maximum operating conditions)

Input voltage: 4.5 - 12V (V_{DD} = 4.5V to 5.5V)
 Output voltage: DAC selectable between 0.925V - 2.0V (with extended operating range to 3.3V with R3 & R4)
 Output current: Up to 20A depending on duty factor (refer to load line curve in Fig. 1).
 Switching Freq: 200kHz or 300kHz selectable.

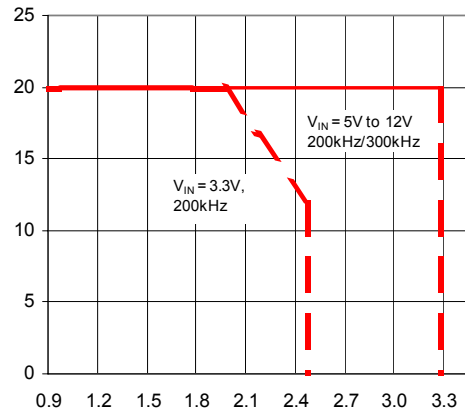


Fig. 1 - Load line curve

| D4 | D3 | D2 | D1 | D0 | Output Voltage (V) | D4 | D3 | D2 | D1 | D0 | Output Voltage (V) |
|----|----|----|----|----|--------------------|----|----|----|----|----|--------------------|
| 0 | 0 | 0 | 0 | 0 | 2.00 | 1 | 0 | 0 | 0 | 0 | 1.275 |
| 0 | 0 | 0 | 0 | 1 | 1.95 | 1 | 0 | 0 | 0 | 1 | 1.250 |
| 0 | 0 | 0 | 1 | 0 | 1.90 | 1 | 0 | 0 | 1 | 0 | 1.225 |
| 0 | 0 | 0 | 1 | 1 | 1.85 | 1 | 0 | 0 | 1 | 1 | 1.200 |
| 0 | 0 | 1 | 0 | 0 | 1.80 | 1 | 0 | 1 | 0 | 0 | 1.175 |
| 0 | 0 | 1 | 0 | 1 | 1.75 | 1 | 0 | 1 | 0 | 1 | 1.150 |
| 0 | 0 | 1 | 1 | 0 | 1.70 | 1 | 0 | 1 | 1 | 0 | 1.125 |
| 0 | 0 | 1 | 1 | 1 | 1.65 | 1 | 0 | 1 | 1 | 1 | 1.100 |
| 0 | 1 | 0 | 0 | 0 | 1.60 | 1 | 1 | 0 | 0 | 0 | 1.075 |
| 0 | 1 | 0 | 0 | 1 | 1.55 | 1 | 1 | 0 | 0 | 1 | 1.050 |
| 0 | 1 | 0 | 1 | 0 | 1.50 | 1 | 1 | 0 | 1 | 0 | 1.025 |
| 0 | 1 | 0 | 1 | 1 | 1.45 | 1 | 1 | 0 | 1 | 1 | 1.000 |
| 0 | 1 | 1 | 0 | 0 | 1.40 | 1 | 1 | 1 | 0 | 0 | 0.975 |
| 0 | 1 | 1 | 0 | 1 | 1.35 | 1 | 1 | 1 | 0 | 1 | 0.950 |
| 0 | 1 | 1 | 1 | 0 | 1.30 | 1 | 1 | 1 | 1 | 0 | 0.925 |
| 0 | 1 | 1 | 1 | 1 | Shutdown* | 1 | 1 | 1 | 1 | 1 | Shutdown* |

* Shutdown : Upon receipt of the shutdown code (per VID code table above), both FETs are turned OFF and the output is discharged as it enters UVP fault mode.

Table 1 - PWM IC Voltage Identification Codes

For output voltages above the DAC maximum setting of 2V, refer to Equation 1 below to calculate the required resistor values for R3 & R4 (needed in order to achieve the extended output voltage range).

$$\text{Equation 1 : } V_{out} = V_F \times (1 + R3/R4)$$

where V_F is equal to the DAC setting and R4 is recommended to be $\sim 1k\Omega$

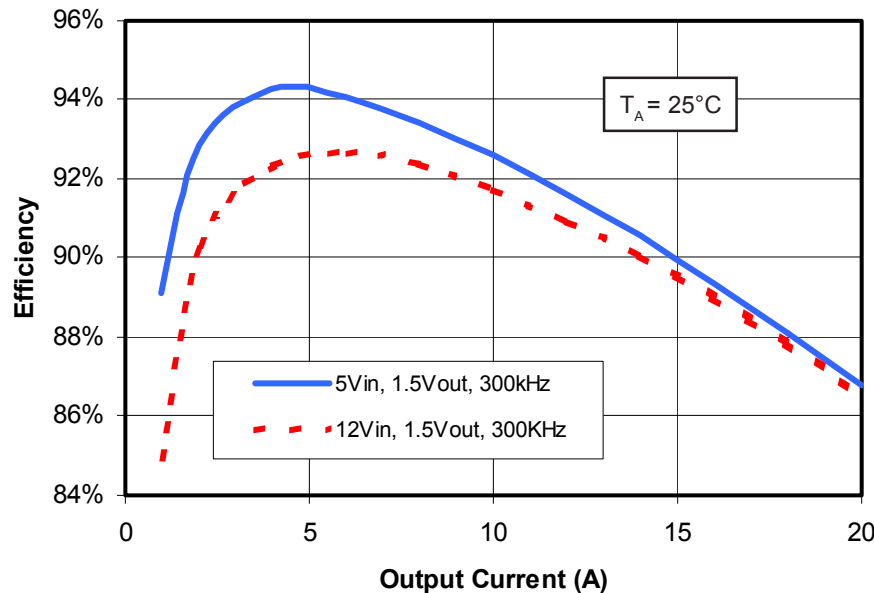


Fig. 2 - Typical Efficiency vs. Current

Refer to the following application notes for detailed guidelines and suggestions when implementing iPOWIR Technology products:

AN-1028: Recommended Design, Integration and Rework Guidelines for International Rectifier's iPOWIR Technology BGA Packages

This paper discusses the assembly considerations that need to be taken when mounting iPOWIR BGA's on printed circuit boards. This includes soldering, pick and place, reflow, inspection, cleaning and reworking recommendations.

AN-1029: Optimizing a PCB Layout for an iPOWIR Technology Design

This paper describes how to optimize the PCB layout design for both thermal and electrical performance. This includes placement, routing, and via interconnect suggestions.

AN-1030: Applying iPOWIR Products in Your Thermal Environment

This paper explains how to use the Power Loss and SOA curves in the data sheet to validate if the operating conditions and thermal environment are within the Safe Operating Area of the iPOWIR product.

IRDCiP1001-B

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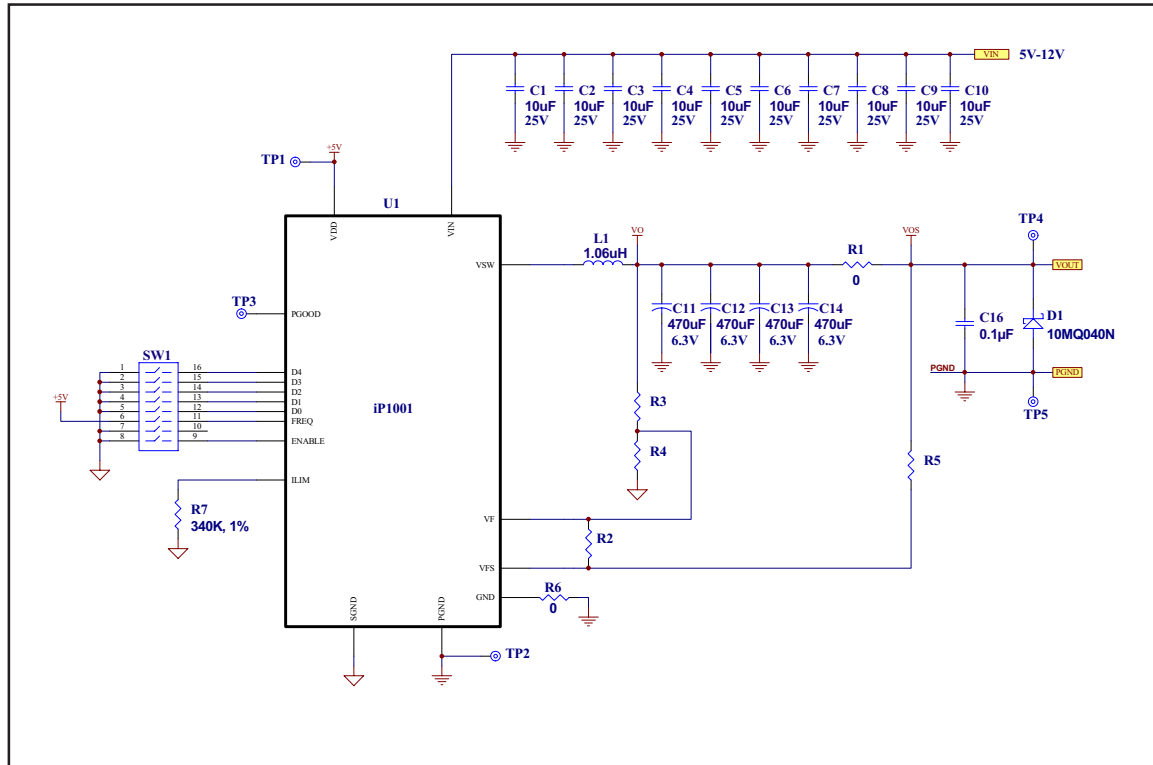


Fig. 3 - Reference Design Schematic



IRDCiP1001-B

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IRDCiP1001-B (For operation $5V_{IN}$ to $12V_{IN}$)

| Designator | Value | Part Type | Footprint | Mfr. | Mfr. P/N |
|--------------------------------|---------------|--|--------------------|-------------------------|-------------------|
| C1 C2 C3 C4 C5 C6 C7 C8 C9 C10 | 10.0uF | Capacitor, 25V, 10%, X5R | 1812 | MuRata | GRM43-2X5R106K25A |
| C11 C12 C13 C14 | 470uF | Capacitor, 6.3V, 20%, Tantalum | 7343 | Sanyo | 6TPB470M |
| C16 | 0.100uF | Capacitor, 50V, 10%, X7R | 1206 | Novacap | 1206B104K500N |
| C15, C17, C18, C19, C20, C21 | - | Not Installed | - | - | - |
| D1 | 40V | Schottky Diode, 40V, 2.1A | D-64 | International Rectifier | 10MQ040N |
| JP1, JP2, JP3 | - | Not Installed | - | - | - |
| JP1-1, JP2-1, JP3-1 | - | Not Installed | - | - | - |
| L1 | 1.06uH | Inductor, 16A, 20%, Ferrite | SMT | Panasonic | ETQP6F1R1BFA |
| L2 | - | Not Installed | - | - | - |
| R1 | 0 Ω | Resistor, 0 Ω Jumper | 2716 | Isotek Corp | SMT-R000 |
| R2 | - | For <2Vout, Not installed For >2Vout, Resistor, 0 Ω Jumper | SMT | - | - |
| R3 | - | For <2Vout, Resistor, 0 Ω Jumper For >2Vout see formula for value | SMT | - | - |
| R4 | - | For <2Vout, Not installed For >2Vout recommend 1k Ω see formula for detail | SMT | - | - |
| R5 | - | For <2Vout, Resistor, 0 Ω Jumper For >2Vout, Not installed | 1206 | Panasonic | ERJ-8GEY0R00 |
| R6 | 0 Ω | Resistor, 0 Ω Jumper | 1206 | - | - |
| R7 | 340k Ω | Resistor, 340k Ω , 1% 340k Ω sets for 20A limit. See ILIM formula for other values | 1206 | ROHM | MCR18EZH3403 |
| R8, R9 | - | Not Installed | - | - | - |
| SW1 | - | 8-position DIP switch | SMT | C&K Components | SD08H0SK |
| TP1 TP2 TP4 TP5 | - | Test Point | - | Keystone | 1502-2 |
| TP3 | - | Not Installed | - | - | - |
| U1 | - | Power Block | SSBGA 14mmx14mm | International Rectifier | iP1001 |
| U2 | - | Not Installed | - | - | - |

Table 2 - Reference Design Bill of Materials

Adjusting the Current Limit

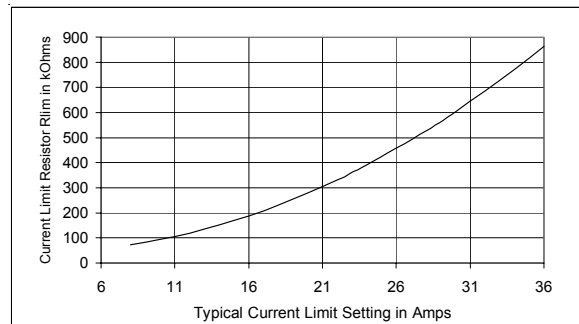


Fig. 6 Current Limit Adjustment using R_{LIM}

Use of this design for any application should be fully verified by the customer. International Rectifier cannot guarantee suitability for your applications, and is not liable for any result of usage for such applications including, without limitation, personal or property damage or violation of third party intellectual property rights.

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