Overview

This RFD199A-PCB is a compact energy harvesting system converts RF/microwave signals to DC voltages between 4.2V...5.2V for mobile phone charging applications. The RF199A-PCB can convert 10MHz to 2.5GHz signals to a regulated DC output voltage that may be pulsed in low power conditions or continuous in high power conditions. The design consists of an RF-DC converter and a power management system that switches the DC output (VOUT) on when the internal voltage of the RF-DC converter and storage capacitor reaches 5.2V. The DC output (VOUT) switches off when the RF-DC converter voltage and storage capacitor voltage falls below 4.2V. When connected to an antenna, the module can extract power from wireless sources and produce an intermittent or continuous DC output voltage depending upon how much power is available. The VOUT lines are isolated so these modules may be tied together in parallel to improve output current for high power charging applications such as smartphones.

In CW operation with a 100-Ohm load the RFD199A-PCB can deliver 30-50mA of current with 4V...5V at 30% RF-DC conversion efficiency at 2.4GHz. Efficiency increases with higher value loads and up to 50% RF-DC conversion efficiency is achievable with this design.

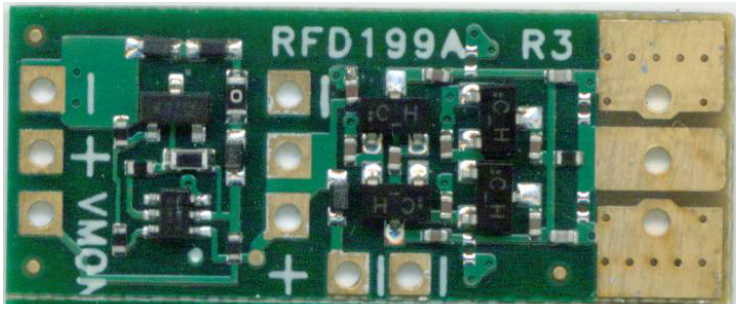


Figure 1. RFD199A-PCB photo. The RFD199A-PCB is gold plated and is 30mm x 12mm x 0.8mm in size.

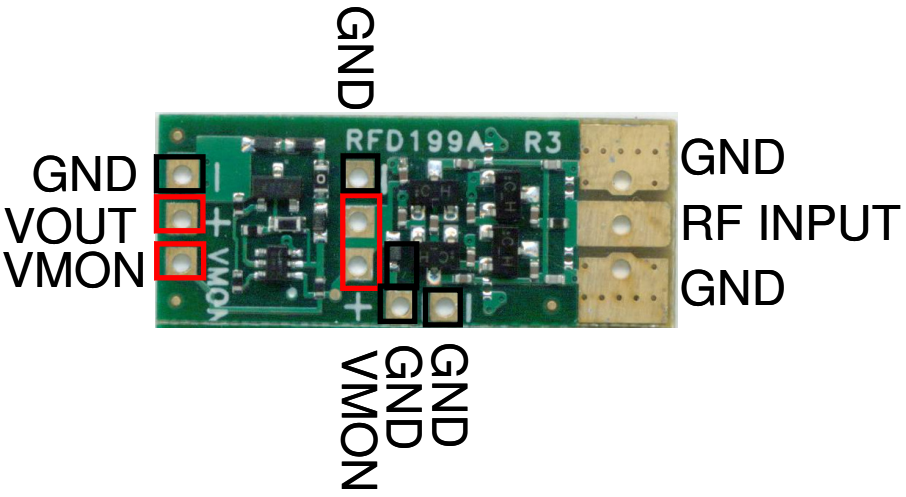


Figure 2. RFD199A-PCB connection diagram. Either an edge launch SMA connector for a 0.8mm (0.031 inch) thick PCB or a wire antenna may be connected to the RF INPUT and GND. A large value capacitor is connected to VMON and GND. The application circuit is connected to VOUT and GND. VOUT is a pulsed regulated output between 4.2V...5.2V at low powers and a DC output at high powers (25dBm...35dBm). The capacitor voltage can be monitored by connecting to VMON.

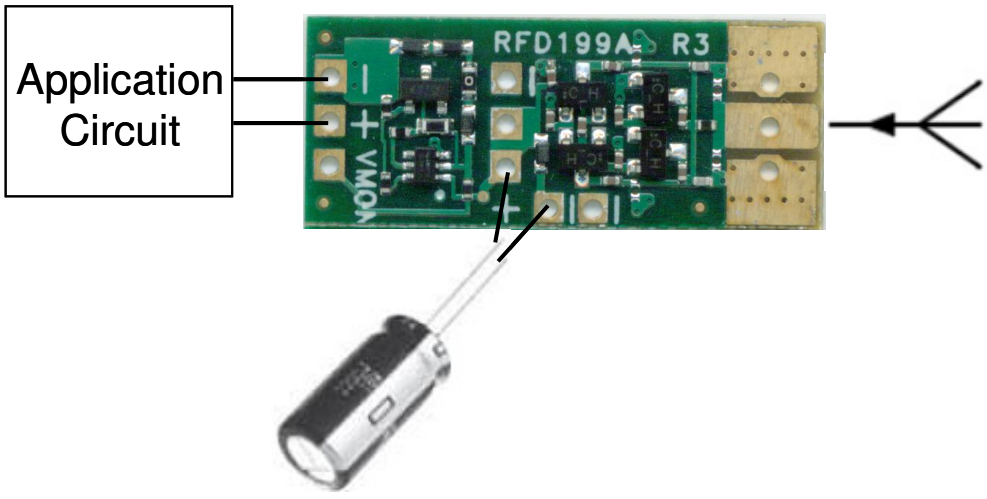


Figure 3. RFD199A-PCB typical energy harvesting system block diagram.

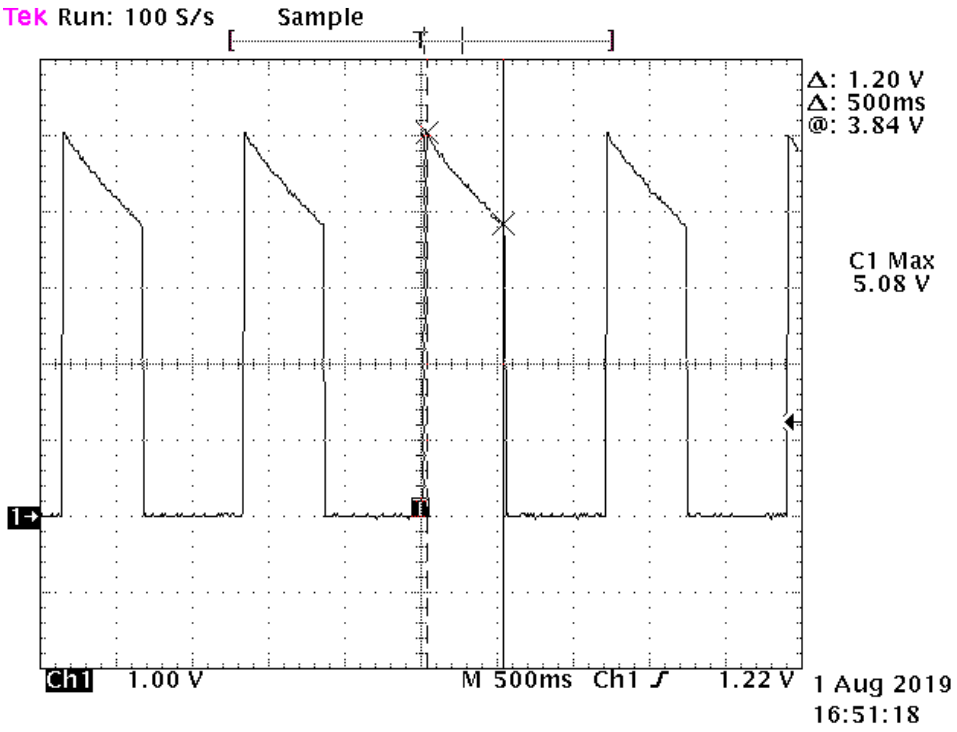


Figure 4a. RFD199A-PCB DC output waveform into a 200-Ohm load with 20dBm input power at 2.4GHz using a 5100uF capacitor.

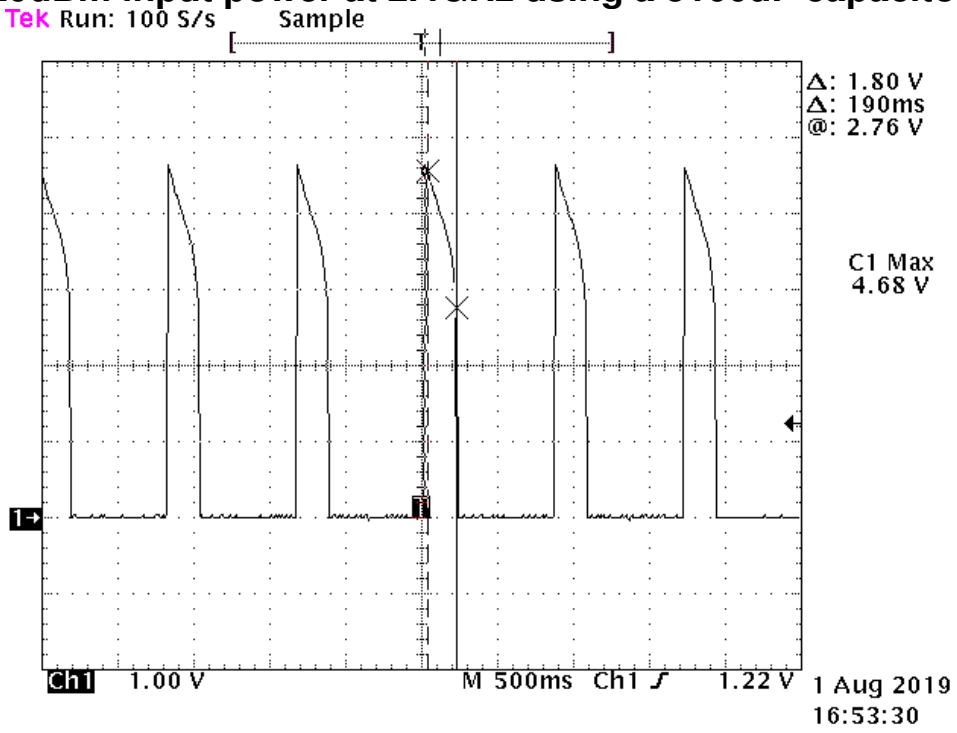
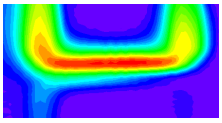


Figure 4b. RFD199A-PCB DC output waveform into a 100-Ohm load



with 20dBm input power at 2.4GHz using a 5100uF capacitor.

Typical Data at 20C, 915MHz, 5100uF Capacitance, 200-Ohm Load. DC Output Range: 4.7V...2.7V.

Input Power For 50% Duty Cycle: 21.1dBm, 39% RF-DC Conversion Efficiency (312ms duration, 3.7Vavg/37mA)

Minimum Input Power For Continuous DC Output: 26.1dBm, 2.7V/27mA, 18% RF-DC Efficiency.

Typical Data at 20C, 915MHz, 5100uF Capacitance, 100-Ohm Load. DC Output Range: 4.7V...2.7V.

Input Power For 50% Duty Cycle: 24.1dBm, 27% RF-DC Conversion Efficiency (312ms duration, 3.7Vavg/37mA)

Minimum Input Power For Continuous DC Output: 26.1dBm, 2.7V/27mA, 18% RF-DC Efficiency.

Typical Data at 20C, 2400MHz, 5100uF Capacitance, 200-Ohm Load. DC Output Range: 5.3V...3.8V.

Input Power For 50% Duty Cycle: 20.5dBm, 45% RF-DC Conversion Efficiency (600ms duration, 4.5Vavg/22.5mA)

Minimum Input Power For Continuous DC Output: 22.8dBm, 3.8V/19mA, 38% RF-DC Efficiency.

Typical Data at 20C, 2400MHz, 5100uF Capacitance, 100-Ohm Load. DC Output Range: 4.7V...2.7V.

Input Power For 50% Duty Cycle: 23.1dBm, 33% RF-DC Conversion Efficiency (400ms duration, 3.7Vavg/37mA)

Minimum Input Power For Continuous DC Output: 24.5dBm, 2.7V/27mA,

26% RF-DC Efficiency.

Typical Data at 20C, 2400MHz, 5100uF Capacitance, 200-Ohm Load.

DC Output Range: 5.3V...3.8V.

Input Power For 50% Duty Cycle: 20.5dBm, 45% RF-DC Conversion Efficiency (600ms duration, 4.5Vavg/22.5mA)

Minimum Input Power For Continuous DC Output: 22.8dBm, 3.8V/19mA, 38% RF-DC Efficiency.

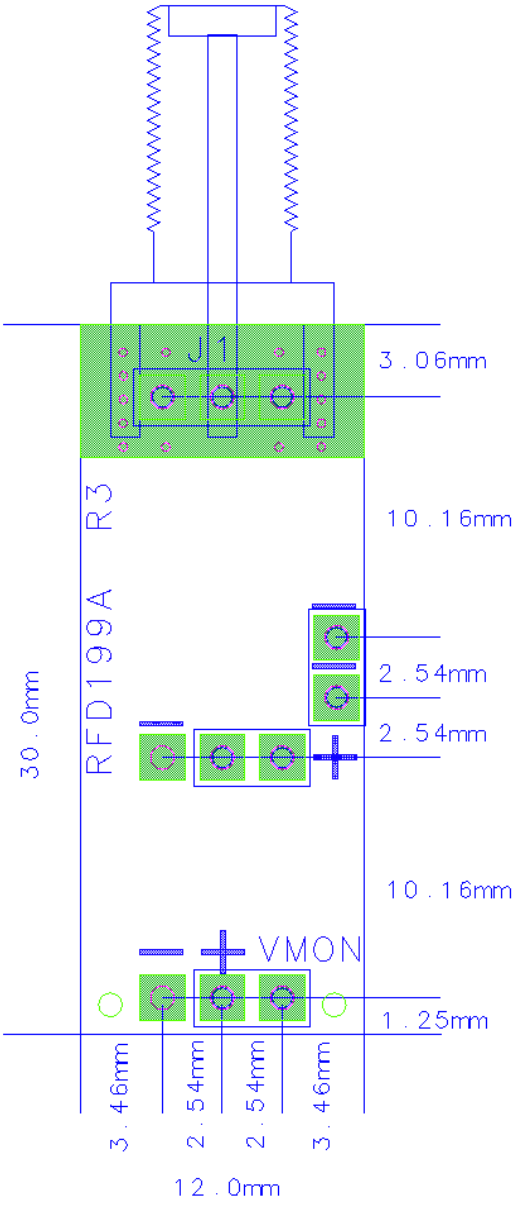


Figure 5. Mechanical drawing for the RFD199A-PCB. Header holes are on a uniform 2.54mm (0.1 inch) grid for ease of testing in a breadboard. An SMA connector is not supplied with the RFD199A-PCB.

Design Notes

The DC outputs of the RFD199A-PCB can be connected in parallel if several units are used for energy harvesting. The solar engine circuit

used presents a high impedance when it is off so it will not load another RFD199A-PCB if it is in discharge mode.

The typical input power operating range for the RFD199A-PCB is from +3dBm...+33dBm but depends on the frequency. VMON must reach 5.3V in order for the solar engine circuit to switch on. Additional matching may be required to optimize power transfer to the RF-DC converter circuit.

At low input powers (3dBm...10dBm) and with low output loads the RFD199A-PCB will output a pulsed signal. As the input power increases the design can output continuous DC. If the input power becomes high enough and the load cannot dissipate the DC power then a 5.6V Zener diode from VMON to GND will dissipate the input power.

Users may discover a situation where a high pulsed current is desired but that the part is outputting CW DC at slightly higher than 4.2V. This is normal operation for a solar engine circuit which stays on between the VLOW (4.2V) and VHIGH (5.3V) range. A lower load resistance may be needed to make sure that the system will go lower than VLOW in order for the solar engine to shut off and recharge the capacitor.

The RFD199A-PCB is also available in a 1x5 array as shown below in figure 6.

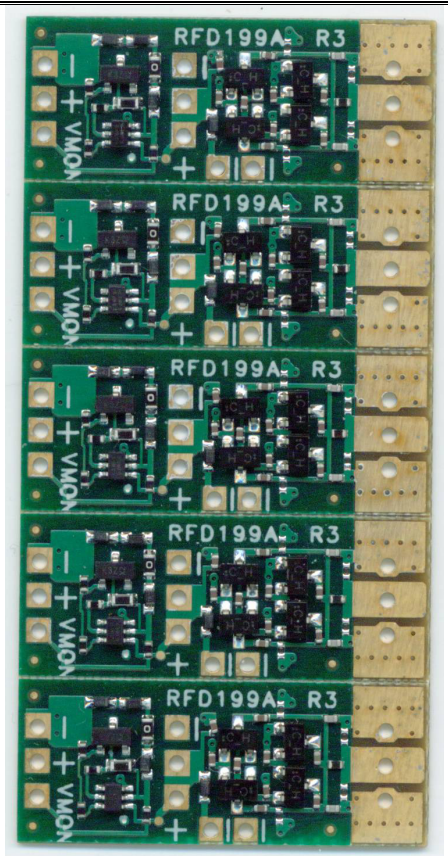


Figure 6. RFD199A-PCB-5X is a 1x5 array of RFD199A-PCB modules. This configuration can be used to harvest more power with multiple antennas. The DC outputs can be connected together into a single DC output. Up to 250mA can be delivered to higher power applications such as mobile phone charging.

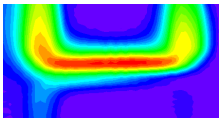
Disclaimer

This module is guaranteed to be defect free upon shipment. However the module is not intended for use in critical applications such as medical devices, automotive safety, or anywhere else where poor performance can result in injury, loss of life or property. The user agrees to assume all risks arising from use of the module and releases RF Diagnostics from all liability for its malfunction or misuse. Specifications listed on datasheets are subject to change without notice.

RFD199A-PCB

Wireless Energy Harvesting System

30.0mm x 12.0mm x 0.8mm RF to DC converter with Output Voltage Regulator



RF Diagnostics, LLC

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