Standalone Electronic Load for Constant Current and Transient Response Testing of DC-DC Converters

MAXREFDES1310

Introduction

The MAXREFDES1310 is an Electronic Load designed to test DC-DC converters without the need of large mains powered lab equipment. It can operate from 12V to 24V DC inputs supply voltage and sink up to 2.5A of current from a separate voltage input. A power metal-oxide semiconductor field-effect transistor (MOSFET) is used to sink current from the device under test, which is mounted to a heatsink with a cooling fan. The MAXREFDES1310 uses the MAX1837 buck converter to provide power to the cooling fan, and the MAX8881 low-dropout regulator (LDO) to generate a low noise voltage rail for the analog circuitry. The analog circuitry consists of the MAX44243, MAX44244, and the MAX4238 operational amplifiers which are used for an oscillator with DC offset, thermal protection with hysteresis, and current regulation of a MOSFET operating in its linear region. The MAXREFDES1310 is a standalone device which does not require a separate signal generator or microcontroller to set current values. Both the Constant Current and Transient Current mode values can be adjusted with a single potentiometer to any value within the 0A to 2.5A range. The Transient test is set to fixed 100Hz 50% step, which is suitable for most DC-DC converter load transient response testing.

Other features include the following:

- Standalone analog design
- Small form factor
- Simple control
- Proven PCB layout

Hardware Specification

The MAXREFDES1310 has two sets of connectors, one set is for the 12V to 24V DC input which supplies the onboard circuitry, and the other set is used to connect to the device under test. Table 1 provides an overview of the design specification.

Table 1. Design Specification

PARAMETER	SYMBOL	MIN	TYP	MAX
Supply Voltage Range	V_{IN}	12V	20V	24V
Load Voltage Range	V_{LOAD}	1V	12V	30V
Load Current Range	I_{LOAD}	0A	1A	2.5A
Maximum Power	P_D			30W
Transient Frequency	F_{TRANS}		100Hz	
Transient Duty Cycle	D_{TRANS}		50%	
Transient Load Step	ΔI_{OUT}		50%	

Warning

This reference design can dissipate the maximum power of 30W. Make sure that the product of the applied voltage and current is less than or equal to 30W.

Designed–Built–Tested

This document describes the hardware shown in Figure 1 and the operation of some key blocks in Figure 2.

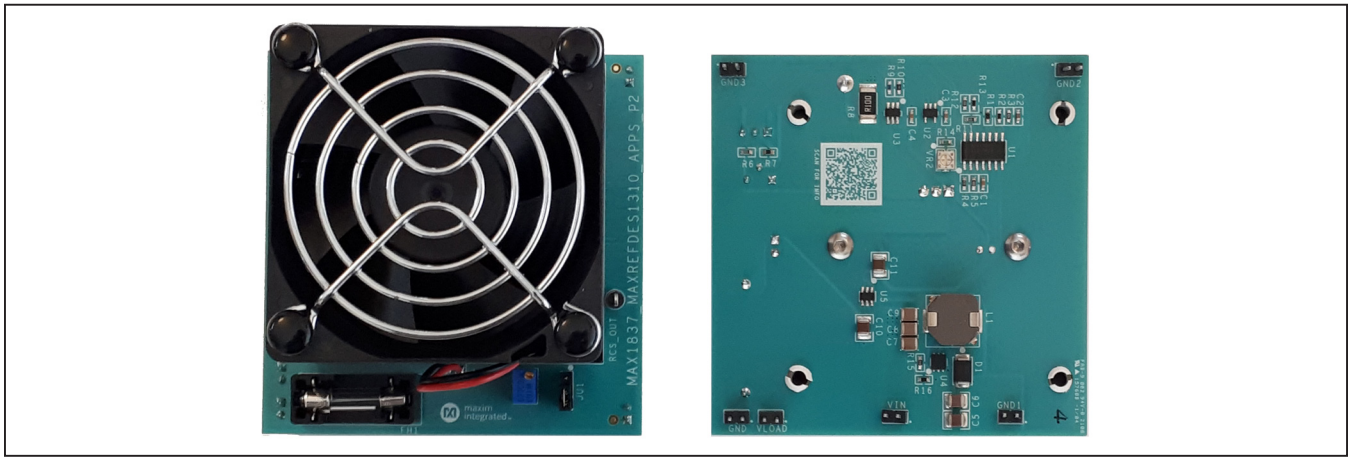

Figure 1. MAXREFDES1310 Hardware Top and Bottom view.

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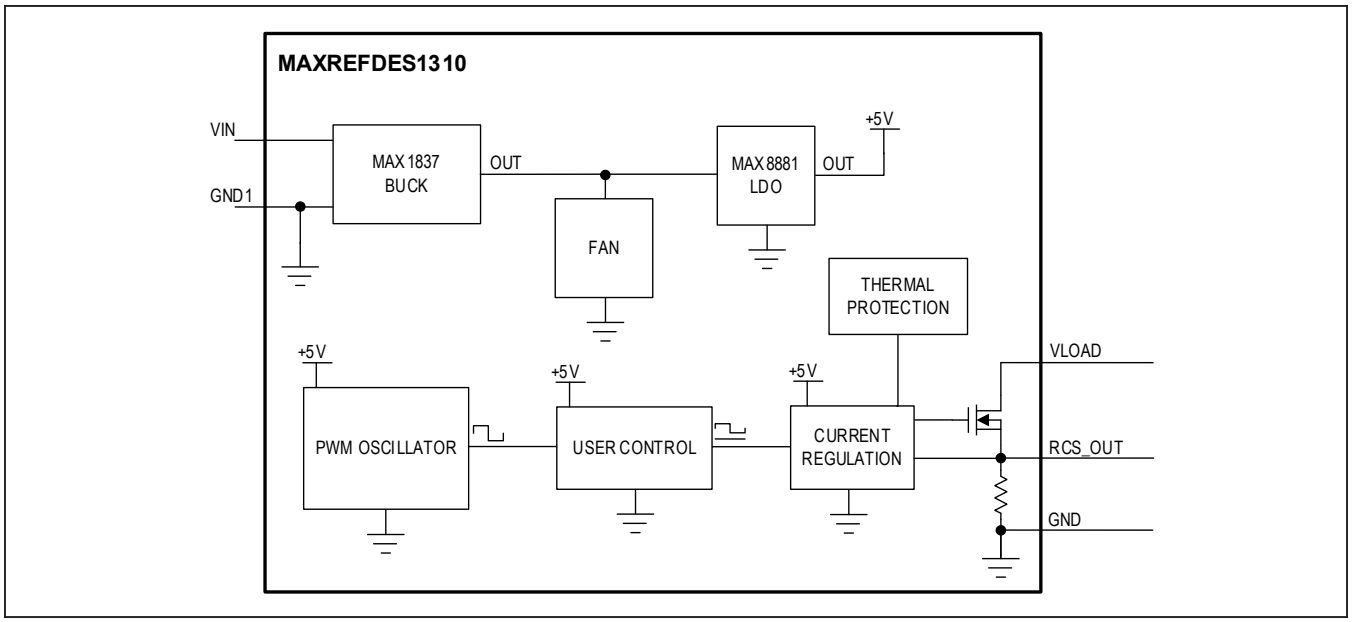

Figure 2. MAXREFDES1310 Block Diagram.

Detailed Description of Hardware

The MAXREFDES1310 is comprised of multiple subcircuits as shown in Figure 2. The following sections describe the operation and function of these subcircuits in the design.

Pulse-width Modulation (PWM) Oscillator

The PWM Oscillator generates a 100Hz 50% duty cycle PWM signal, with the low-level set at 50% of the high-level. The amplitude of the PWM signal is controlled via the potentiometer VR1 when jumper JU1 is in position 1:2. This serves as the control signal for transient response testing, and it is generated by using the MAX44243 and MAX44244 ICs following the Application Note 3201.

MOSFET Current Regulation

The current through the power MOSFET Q1 is regulated by the MAX4238 operational amplifier which drives the gate voltage of Q1. The current sense resistor connects to the negative input of the MAX4238 via a compensation network. This allows a control signal to drive the positive input terminal, and the MAX4238 adjusts the gate voltage until the same voltage can be seen across the current sense resistor. The compensation network ensures the load current remains stable even under worst-case transient conditions.

Buck Converter & LDO

The MAX1837 Buck converter IC with an internal MOSFET is used to provide power to the cooling fan from 12V to 24V DC source. The component choices for this section are made by following the design equations described in the MAX1837 Datasheet. The analog circuitry for both the oscillator and current regulator subcircuits require a low noise 5V source. This is achieved with the MAX8881 LDO linear regulator, which is connected to the output of the MAX1837 Buck converter circuit.

Thermal Protection

The MAXREFDES1310 has thermal protection in the form of a negative temperature coefficient (NTC) thermistor and a hysteresis circuit, which uses one of the four channels on the MAX44243 operational amplifier IC. In the event of the heatsink temperature passing the set threshold, the MAX4238 is put into shutdown, which prevents current to flow in MOSFET Q1 while still allowing the cooling fan to operate. The MAX4238 remains in its shutdown state until the temperature reduces below the falling threshold of the hysteresis circuit.

User Control

The MAXREFDES1310 has a potentiometer (VR1) and a three-pin header (JU1) to control the current amplitude as well as to choose between constant current or transient current modes. With a two-way jumper, the user can select constant current mode by shorting pins 2 and 3 of JU1, or the user can select transient current mode by shorting pins 1 and 2 of JU1. In the open jumper position, no current flows as the current regulation input is pulled to the ground. VR1 is a 12-turn potentiometer which allows for fine adjustment across the entire settable current range, in either constant current or transient current modes.

Design Resources

Download the complete set of **Design Resources** including schematics, bill of materials, PCB layout, and test files.

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	10/21	Initial release	—