Introduction

Breadboards are the preferred choice for electronic engineers, hobbyists, and students due to its low cost, simplicity, and ease of building/rebuilding circuits. However, a standard bulky power supply increases the complexity of fully utilizing the portability of the breadboard. The MAXREFDES1316 is designed for easy, on-the-go and affordable power supply solution for breadboards. You can utilize this reference design to provide symmetrical power supply to circuits that need voltages ranging from -11V to 20V.

This reference design can be powered from any micro-USB power source with micro-USB connector type B and a 5V/1A output capability. This could be a wall adapter or a PC/laptop USB port. Care should be taken to ensure that whatever source is used there is adequate power overload protection provided by the source.

Features of the board include the following:

- Fits exactly on MB102 breadboards
- Adjustable negative voltage from -1.8V to -11V (V_{INV})
- Adjustable positive voltage from +0.6V to +5V (V_{LDO})
- Adjustable positive voltage between +5V and +20V (V_{BST})
- Fixed positive voltage of +5V from the power supply (V_{PS})
- Can be powered with a standard 5V phone charger with micro-USB connector
- Protected against overload and short circuits

Hardware Specification

The low-cost flexible power supply uses MAX8614B dual-output DC-DC converter and MAX38903B 1A low-noise low-dropout (LDO) linear regulator. Table 1 shows an overview of the design specification.

Table 1. Design Specification

PARAMETER	SYMBOL	VOLTS
Input Voltage	V_{IN}	5V
Output Voltage	V_{INV}	Adjustable from -1.8V to -11V
Output Voltage	V_{LDO}	Adjustable from +0.6V to +5V
Output Voltage	V_{BST}	Adjustable from +5V to +20V
Output Voltage	V_{PS}	+5V

Designed–Built–Tested

This document describes the hardware shown in Figure 1. It provides a detailed systematic technical guide to designing a flexible breadboard power supply using the MAX8614B and MAX38903B. The power supply has been built and tested.

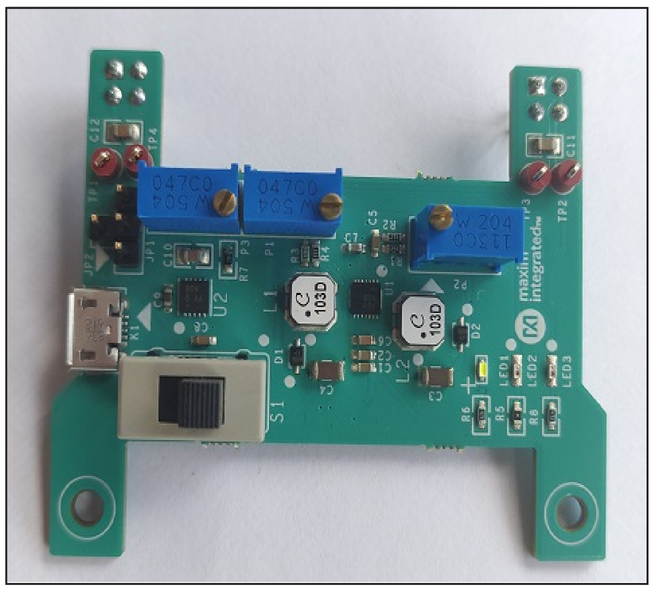

Figure 1. MAXREFDES1316 hardware.

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Quick Start

Required Equipment

- Power adaptor with micro-USB connector
- MAXREFDES1316 board
- MB102 breadboard
- Jumper wires
- Multimeter

Procedure

The reference design is fully assembled and tested. Follow the steps below to verify board operation:

1) Plug the MAXREFDES1316 reference design in the horizontal power rails of the MB102 breadboard as shown in Figure 2. Across connector J1, the outer rail corresponds to V+ whilst across connector J2, the outer rail corresponds to V- . Both the inner power rails correspond to a common GND.
2) Connect the micro-USB Type B power adaptor to the board.
3) Turn on switch S1 to turn the board on. LED 1 should light up green indicating the power status of the board.
4) You can measure V_{LDO}, V_{BST}, and V_{PS} on the V+ rail (across J1 connector) based on the connection of JP1 and JP2 jumpers whilst the V_{INV} directly on the V-rail (across J2 connector).

   To verify V_{LDO}: Place the jumper in position 2-3 (JP1) and check the output across J1 V+ rail.

   To verify V_{BST}: Place the jumper between JP2 and JP1 pin 2 and check the output across J1 V+ rail.

   To verify V_{PS}: Place the jumper in position 1-2 (JP1) and check the output across J1 V+ rail.

   Whilst the connector can be one position, the remaining two voltages can still be utilized directly from the jumper pins.
5) The voltages can be adjusted by multi-turn potentiometers P1 to P3. P1 adjusts V_{BST}, P2 adjusts V_{INV}, and P3 adjusts V_{LDO}.

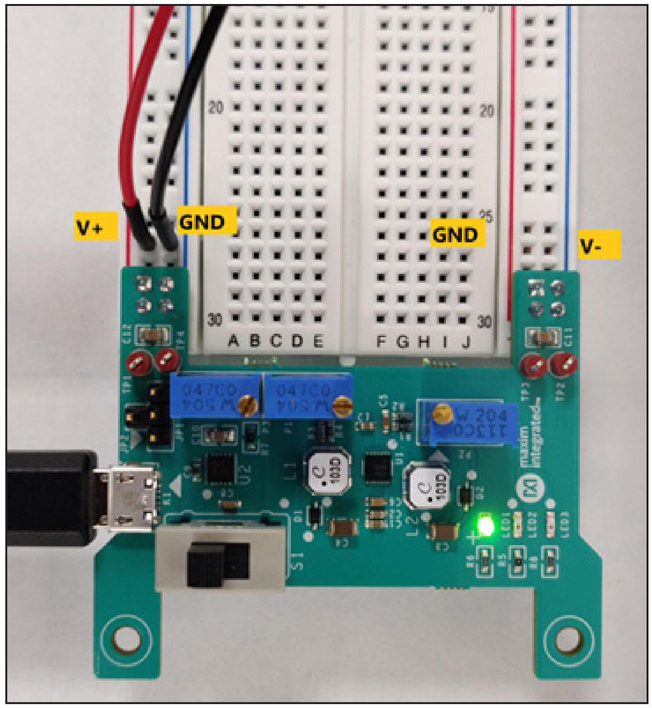

Figure 2. MAXREFDES1316 connections.

Note 1: The board has mounting holes and allows to be supported by two 12mm M3 spacers or bolts in order to improve the mechanical stability of the connection.

Note 2: There are test points on the board to measure V+ and V- during adjustment through potentiometers.

Note 3: Overload/short circuits are indicated by the fault LEDs. These are LED2 for MAX8614B DC-DC converter (for V_{BST} and V_{INV}) and LED3 for MAX38903B LDO (for V_{LDO}).

Both chips limit the output current at overload and upon any increase beyond the thermal limits, the outputs are switched off and the LEDs are lit. To reset the fault condition and restore output voltage, power-cycle the supply with switch S1 ensuring that there is no short circuit.

There is no overload indication for the fixed +5V VPS as this output is fetched directly from the short-circuit-proof input supply.

Design Overview

Figure 3 shows the block diagram of the breadboard power supply. The MAX8614B is a dual-output step-up DC-DC Converter which generates both a positive (V_{BST}) and negative (V_{INV}) supply voltage that are each independently regulated using potentiometers P1 and P2, respectively.

The output limits can be calculated as follows:

$$V_{BST} = V_{FBP}\left(\frac{R_3 + P_1}{R_4} + 1\right);\ \text{where } V_{FBV} = 1.01V$$

Also,

$$V_{INV} = -\left(\frac{R_1 + P_2}{R_2}\right) \times \left(\frac{V_{REF}\text{-}V_{FBP}}{V_{FBP}}\right);$$

$$\text{where } V_{FBV} = 0V \text{ and } V_{REF} = 1.25V$$

The maximum output power is about 2W for the boost converter and 1W for the buck-boost converter. Subsequently, higher output voltages yield lower I_{OUTMAX} with increased ripple voltage.

An output bypass capacitor of low effective series resistance (ESR) can be placed for reduced amplitude ripple on the output voltage. Bypass with an electrolytic capacitor of few 100µF on the power rails of the breadboard.

The MAX38903B is a low-noise linear regulator that delivers up to 1A of output current with only 5.5µV_{RMS} of output noise from 10Hz to 100kHz. The V_{LDO} output on the breadboard can be adjusted with potentiometer P3.

This IC also uses the feedback resistors to set the output regulation voltage given by:

$$V_{LDO} = V_{FB}\left(\frac{P_3}{R_7} + 1\right)$$

The output voltage of MAX38903B is always lower than the input supply voltage of 5V. The maximum voltage the LDO can deliver to the breadboard is 4.5V. The output voltage from MAX38903B is dependent on the supply, the cable losses, and the drop-out voltage.

It should be noted that at lower output voltages, the power dissipation in the chip increases significantly. Even though the circuit is equipped with protection circuitry, care should be taken to not exceed the dissipated power beyond 2W. Thus, to maintain 1A output current, the output voltage should be kept higher than 3V. This can be understood from the equation below:

$$P_{DISS} = I_{OUT}(V_{MAX} - V_{OUT});\ \text{where } V_{MAX} = 5V$$

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	6/22	Initial release	—

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