Smart Electronic Load Using the MAX32630FTHR and MAX11311

MAXREFDES1213

Introduction

The MAXREFDES1213 is a reference design showcasing the MAX32630FTHR and MAX11311, as well as several other Maxim products, that demonstrates a small size, low-cost, portable electronic load (E-load) for testing power converters and PMICs. The MAX32630FTHR is an Arm®-core-based, low-power microcontroller board whose main purpose is to facilitate communication between the PC's graphical user interface (GUI) software and the E-load. The MAX11311 12-port programmable mixed-signal I/O (PIXI™) with 12-bit ADC, 12-bit DAC, analog switches, and GPIO is used to control the load currents and measure various parameters of the E-load.

Other Maxim components in this design include the MAX44251 20V, ultra-precision, low-noise op amp, which is used to control the load currents; the MAX8614 dual-output (+ and -) DC-DC converter for biasing the MAX11311; the MAX8881 12V, ultra-low-I_Q, low-dropout linear regulator with power-OK (POK), which is used to power different components on the E-load board; and the MAX44243 36V, low-noise, precision quad op amp, which is used for signal conditioning.

The power that is dissipated in the power MOSFETs is drained using a heatsink with a cooler fan (the Thermaltake® CLP0556). The MAX6645 automatic PWM fan-speed controller with overtemperature output controls the fan speed based on the heatsink temperature.

Hardware Specification

The MAXREFDES1213 connects to the power supply under test through two sets of input connectors: one for applying the load and another for remote sensing of the supply voltage. Remote sensing is optional and allows measurement of the voltage directly at the output of the supply under test. This improves the accuracy, since the voltage drop in the cables is not included in the measurement. This reference design includes the following primary components: a microcontroller, PIXI, op amps, and power converters. The microcontroller provides the interface between the PC and the PIXI, and the PIXI controls the analog front-end (AFE). Table 1 shows an overview of the design specification.

Table 1. Design Specification

PARAMETER	SYMBOL	MIN	MAX
Input Voltage	V_{IN}	1.2V	40V
Low-Range Current	I_{LR}	0mA	100mA
High-Range Current	I_{HR}	0A	10A
Ramp-Up High Range	T_RiseH	0.244A/ms	50A/ms
Ramp-Up Low Range	T_RiseL	2.44mA/ms	500mA/ms
Ramp-Down High Range	T_FallH	-0.244A/ms	-50A/ms
Ramp-Down Low Range	T_FallL	-2.44mA/ms	-500mA/ms
On-Time	T-On	50µs	100s
Off-Time	T-Off	50µs	100s
Power	P	0W	100W

Designed–Built–Tested

This document describes the hardware shown in Figure 1. It provides a detailed, systematic technical guide to use the small size, low-cost, portable E-load and run the accompanying PC software. The design has been built and tested, details of which follow later in this document. Figure 2 shows the functional diagram of the E-load.

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PIXI is a trademark of Maxim Integrated Products, Inc.
Thermaltake is a registered trademark of Thermaltake Technology Co.

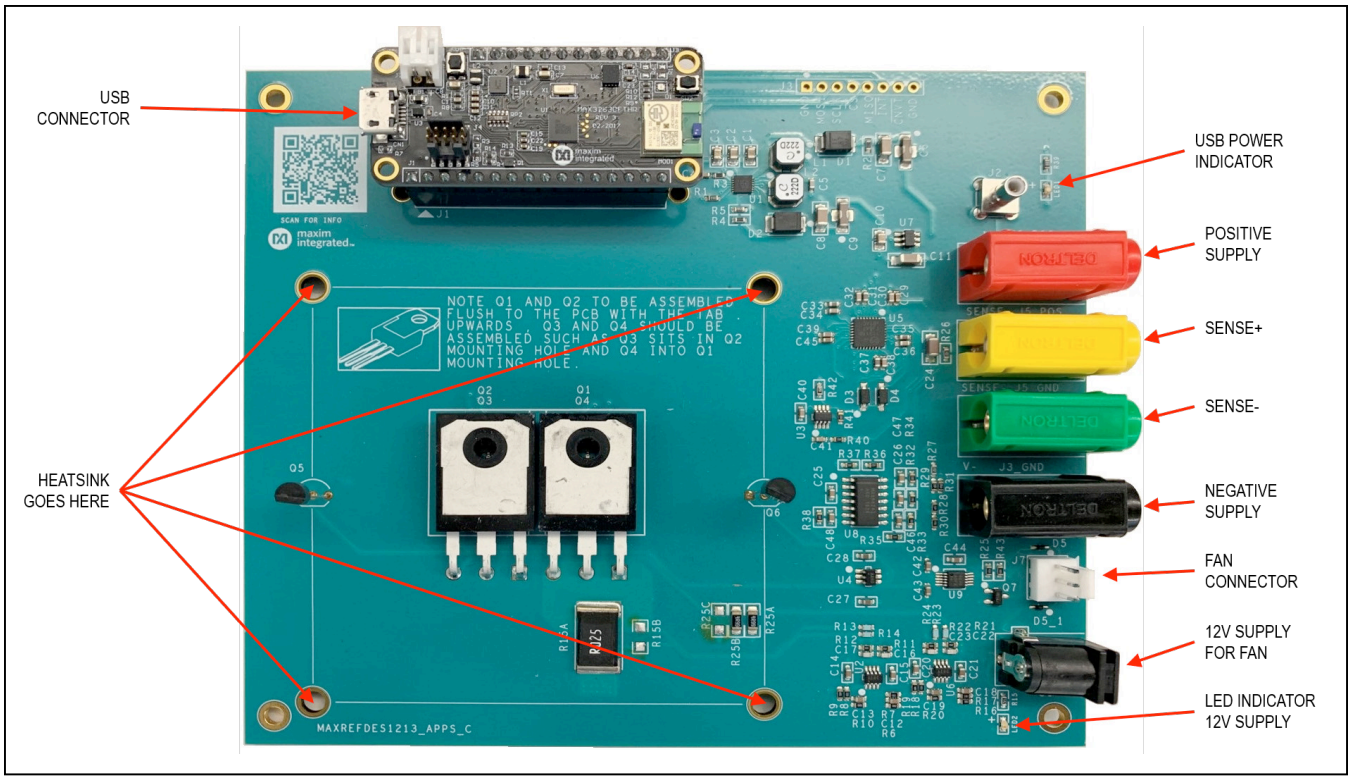

Figure 1. MAXREFDES1213 hardware.

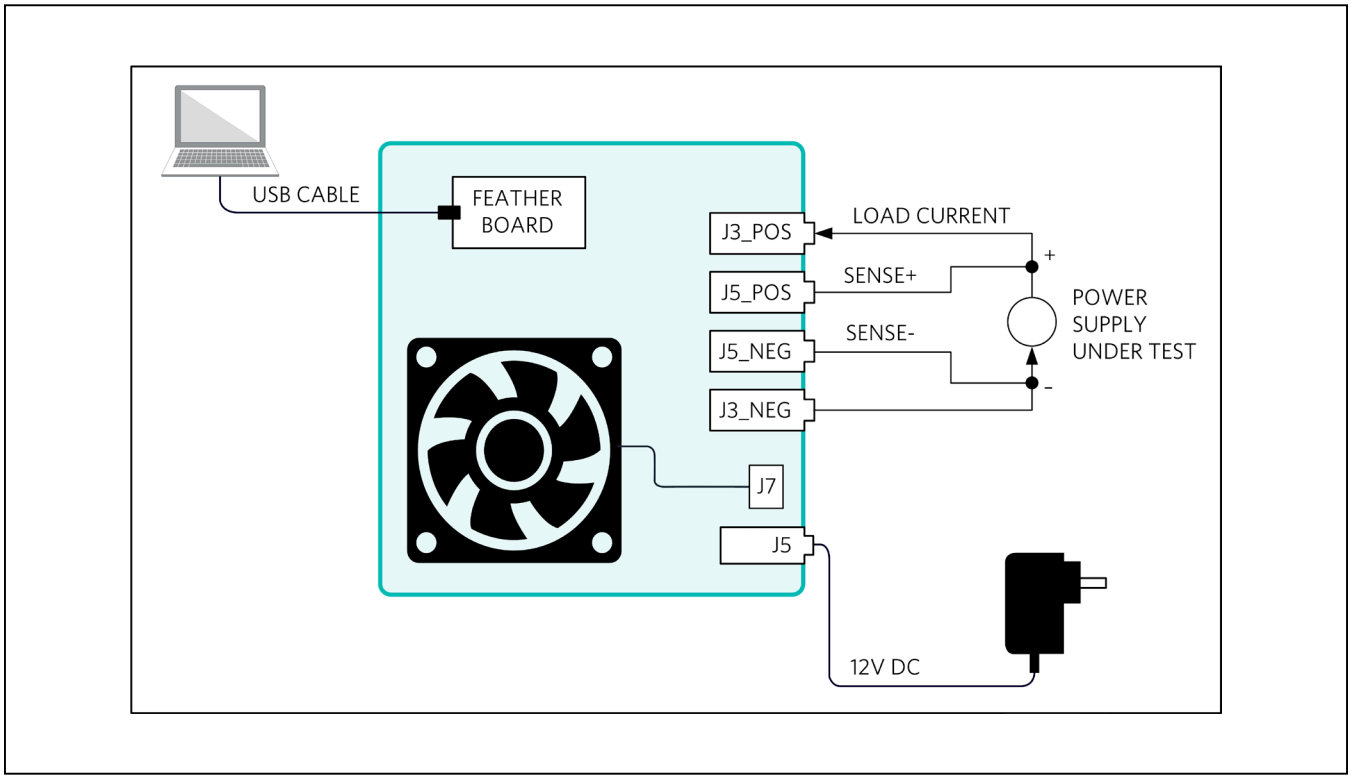

Figure 2. E-load functional diagram.

Required Equipment

Figure 1 highlights all of the connections for the following hardware components:

- MAXREFDES1213
- 0 to 40V, 10A DC Input Power Supply
- Digital Voltmeter (DVM)
- Connecting Cables
- CLP0556 Fan and Heat Sink
- 12V, 2A Power Adapter Supply AC to DC
- One USB Standard-A to Micro-B Cable
- Two Connecting Cables: Red and Black with Banana Jacks

Procedure

This reference design has been fully assembled and tested. Use the following the steps to verify board operation:

1) Connect the cable of the heatsink and fan to J7. The MAXREFDES1213 is USB powered, therefore connect one side of the USB cable to the PC and the other side to the MAX32630FTHR. LED1 on the MAXREFDES1213 will turn on, confirming that the board is functional. The fan will run at minimum speed.
2) Set the power supply at a voltage between 0 and 40V, then disable the power supply.
3) Connect the positive terminal of the power supply to J3_POS and the negative terminal to J3_GND.
4) Connect the external 12V and 2A power adapter to J6. LED2 should turn on, and the fan should rotate a little faster.

Warning

The maximum power consumption of the board is only 100W, so be sure to verify that the applied voltage multiplied by the current does not exceed 100W.

Detailed Description of Firmware

The firmware is designed using Arm's mbed online compiler, and the source code can be found on the MAXREFDES1213 **Design Resources** page. The procedure to program the .bin file is given as follows:

1) Connect the MAX32630FTHR (FTHR) to the MAXREFES1213, as shown in Figure 1. The MAX32630FTHR board is powered by the USB connection.
2) Connect the PICO board (programming board) to the FTHR board with the ribbon cable, then connect both the FTHR and PICO boards to the PC using USB cables.
3) Copy the file "Smart_E_Load_FM_rev2.bin" to the DAPLINK folder, and this should program the FTHR board.

Detailed Description of GUI (or Software)

1) Download the Smart Electronic Load GUI from the appropriate link on the MAXREFDES1213 **Design Resources** page.
2) Install the software.
3) Go to the Device Manager and check the port names and com port number; the E-load should show up as a USB serial device. Figure 3 shows an example serial port enumeration on COM5.
4) Click on the **Search** button and select the port from the **Port Selection** drop-down list, as shown in Figure 4 and Figure 5.

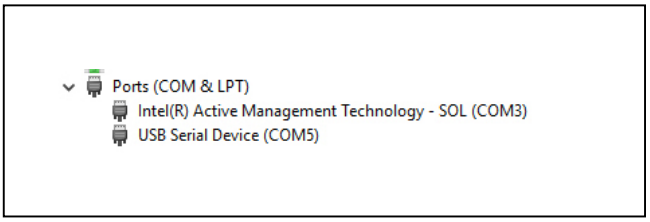

Figure 3. List of COM ports in Device Manager.

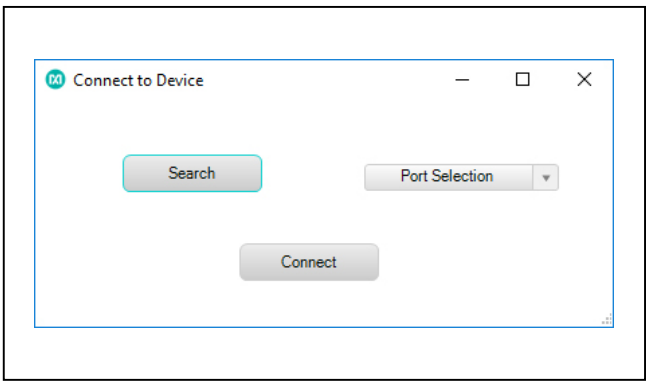

Figure 4. Smart Electronic Load GUI search options.

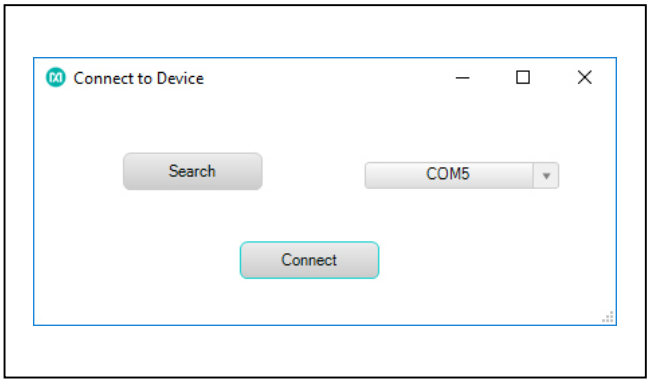

Figure 5. Select COM port 5 from the drop-down list.

5) Clicking the **Connect** button will cause the program's main window to appear, as shown in Figure 6. Of the two tabs in the window, the **Constant Current Mode** tab is selected by default. Using the controls on this tab sets the load to a constant current for one of the two current ranges shown. The following is a list of software controls followed by a short description for each:

   - **Voltmeter:** This displays the value of the applied voltage to the E-load. If the remote sensing feature is used, it displays the value of the voltage directly at the output of the supply under test.
   - **Constant Current Selection:** The customer has two current range options—**0 to 100mA** and **0 to 10A**—that can be selected by using the radio buttons. The option **0 to 100mA** is selected by default.
     a. **Low Current Ammeter:** This is only active when the 0 to 100mA range is selected.
     b. **High Current Ammeter:** This is only active when the 0 to 10A range is selected.
   - **Set-values:** This button loads the selected current values into the E-load. Make sure that **Load-On/Off** is turned on before setting the current values. The GUI starts reading the current values only after **Load-On/Off** is checked and the indicator turns green, as seen in Figure 7.

   The firmware version is shown on the bottom center of the GUI. The connection status and the baud rate are shown on the bottom right corner.

   If the user turns off the **Load-On/Off** button, this resets the currents to 0A and the GUI stops reading the current values.

6) When switching between tabs, the load is automatically turned off, as indicated by the popup window shown in Figure 8.

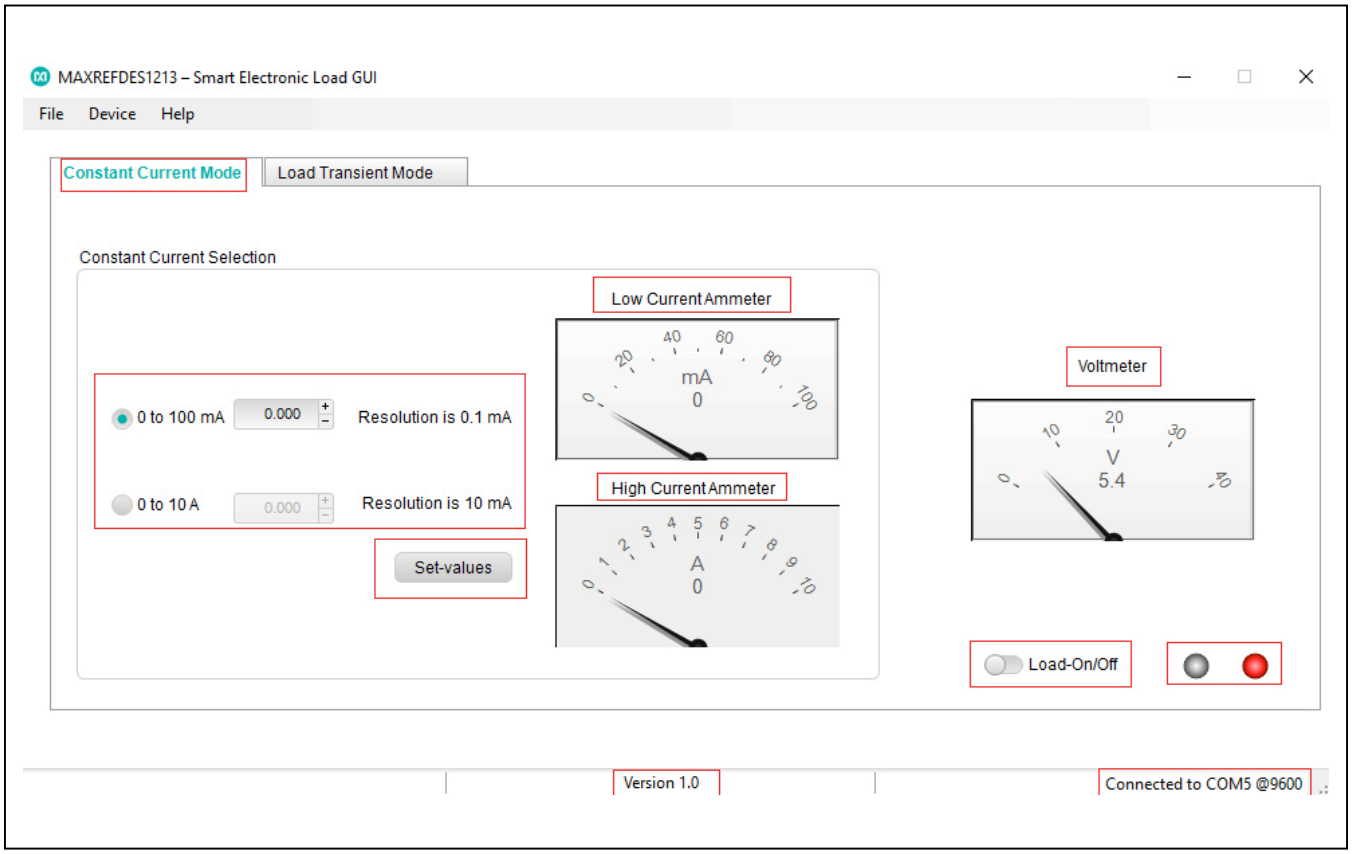

Figure 6. Constant Current Mode tab with the load turned off, and the indicator stays red.

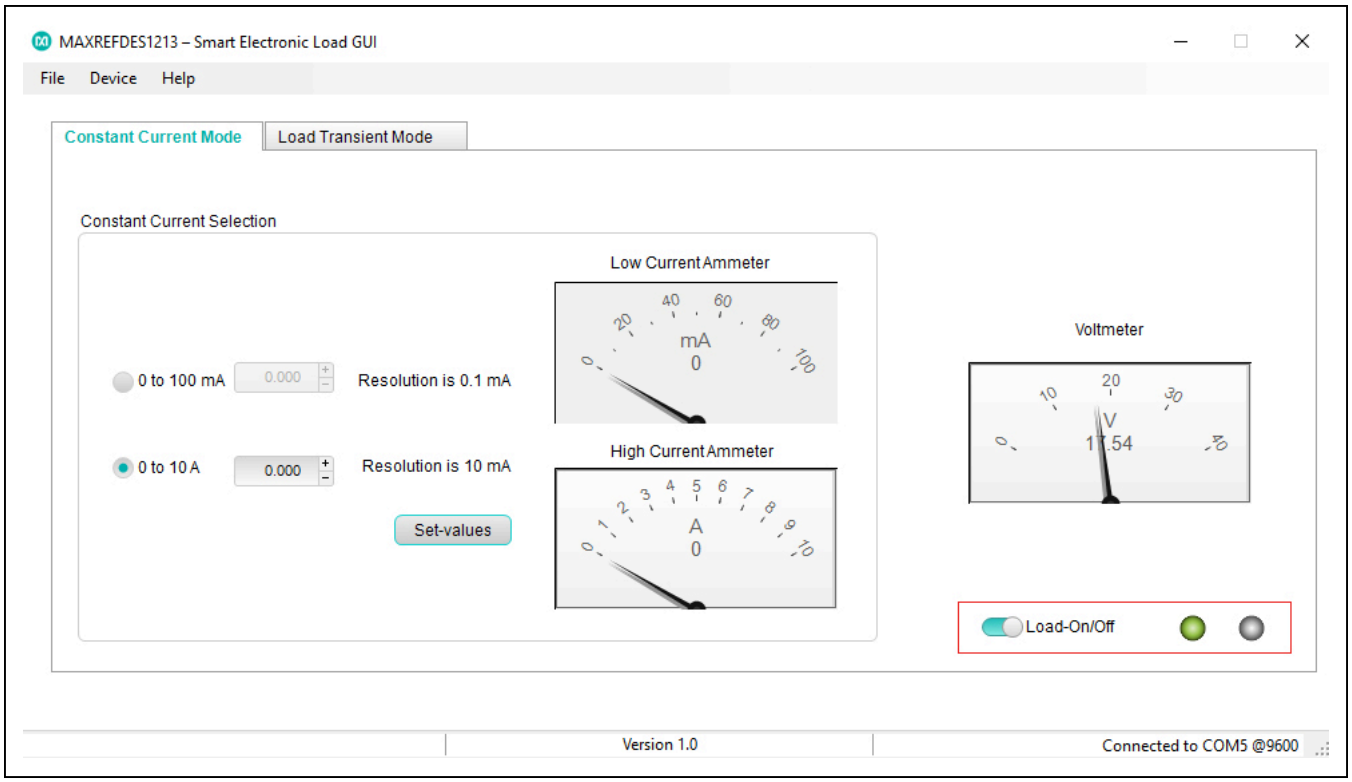

Figure 7. Constant Current Mode tab with the load turned on and the indicator turned green.

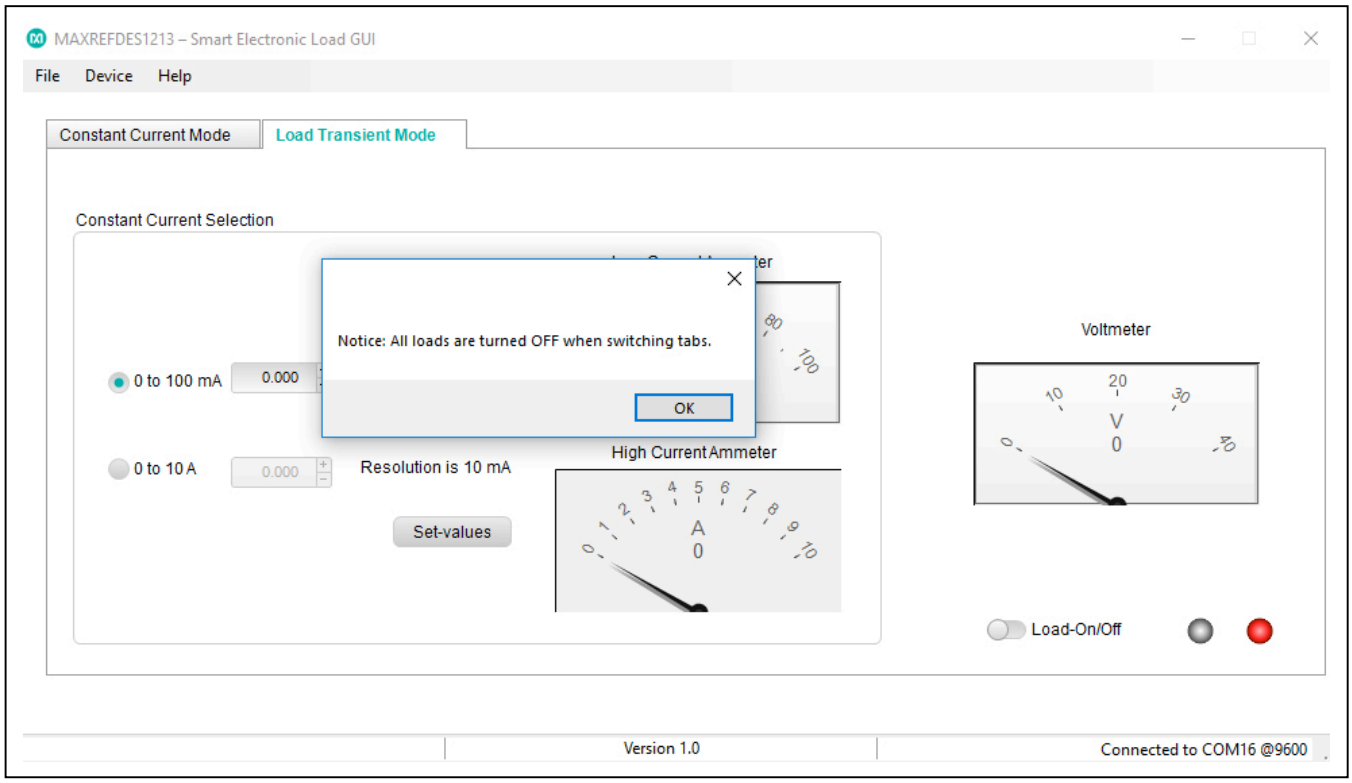

Figure 8. Switching tabs turns all loads off.

7) The **Load Transient Mode** tab (also known as Dynamic mode) is like the **Load** step in **EE-Sim**—the user can specify the two current ranges, both high and low, followed by the rise and fall speed and the on and off times of the signal. The following is a list of software controls on the tab (see Figure 9) followed by a short description:

   - **Voltmeter:** This displays the value of the applied voltage to the E-load.
   - **Transient Current Selection:** The customer is presented with two current range options—**0 to 100mA** and **0 to 10A**—that can be selected using the radio buttons. The **0 to 100mA** range is selected by default.
   - **T_Rise** and **T_Fall**: These define the slew rates of the signal. The default values are based on the **Transient Current Selection**. The minimum and maximum values are shown in Table 1.
   - **T-On** and **T-Off**: These define the on and off times of the signal. The minimum and maximum values are shown in Table 1. These values do not refer to the times the current is at I_High and I_Low, but they do include the time it takes to ramp down and ramp up.
   - **I_High**: Known as the peak current of the transient wave form, the maximum value is based on the **Transient Current Selection** and is shown in Table 1.
   - **I_Low**: Known as the valley current of the transient wave form, the maximum value is based on the **Transient Current Selection** and is shown in Table 1.
   - **Set-Values**: This button allows the user to load the values into the E-load. Make sure **Load-On/Off** is turned on before setting the current values as shown in Figure 10.

   If the user turns off the **Load-On/Off** button, the currents reset to 0A.

8) The **Device** menu option on the GUI shown in Figure 11 lets the user reconnect to the E-load, as seen in Figure 12.

Design Resources

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

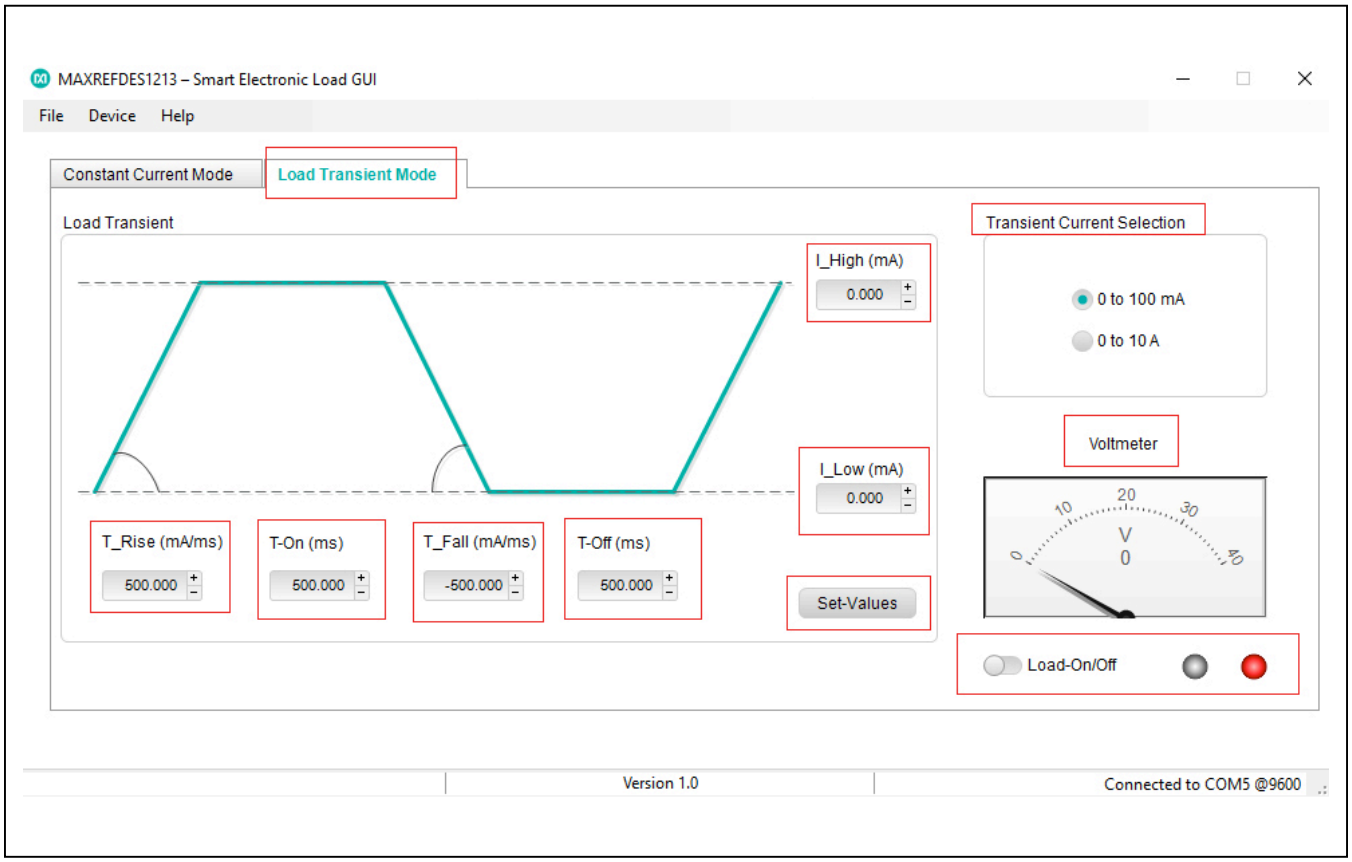

Figure 9. Load Transient Mode tab with the load turned off.

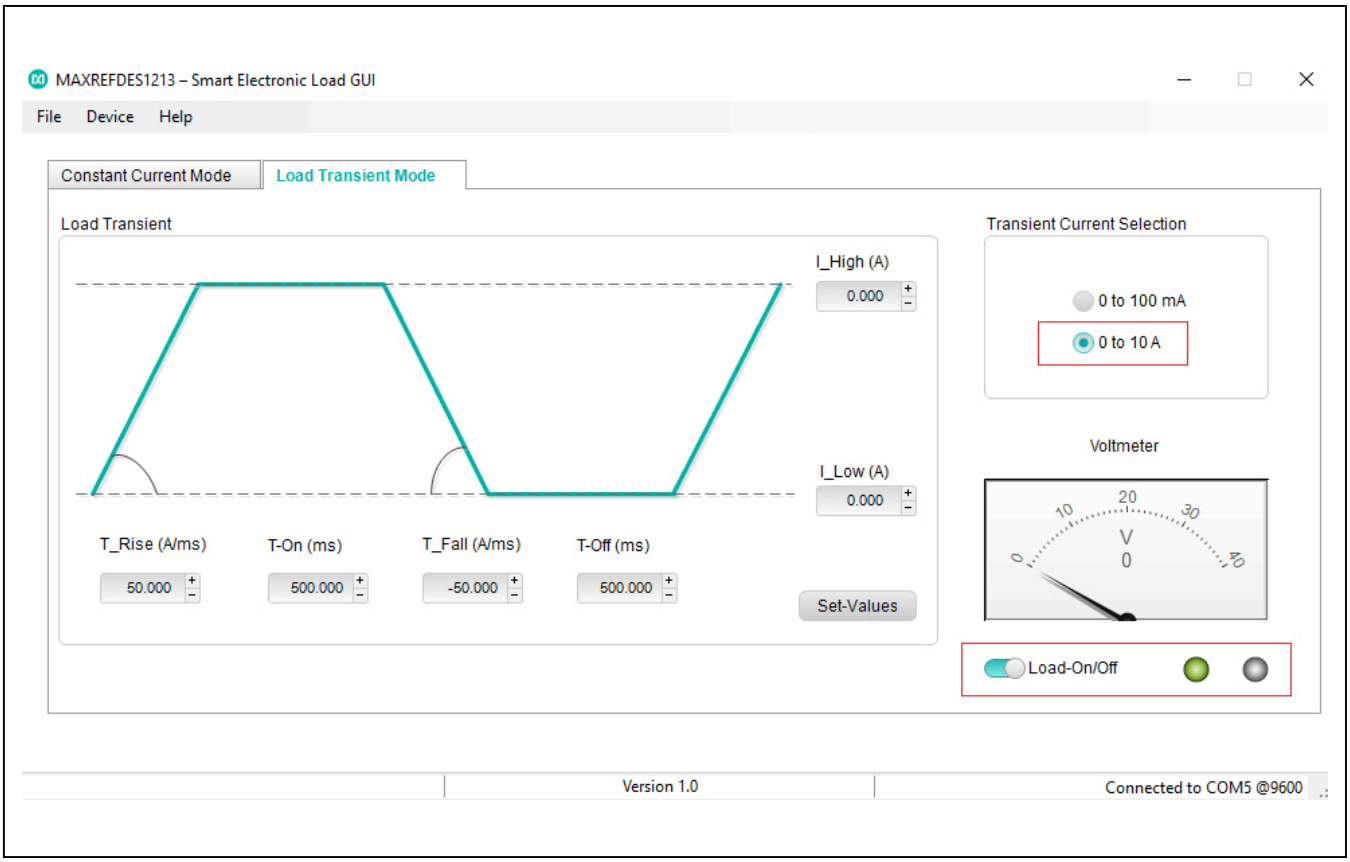

Figure 10. Load Transient Mode tab with load turned on.

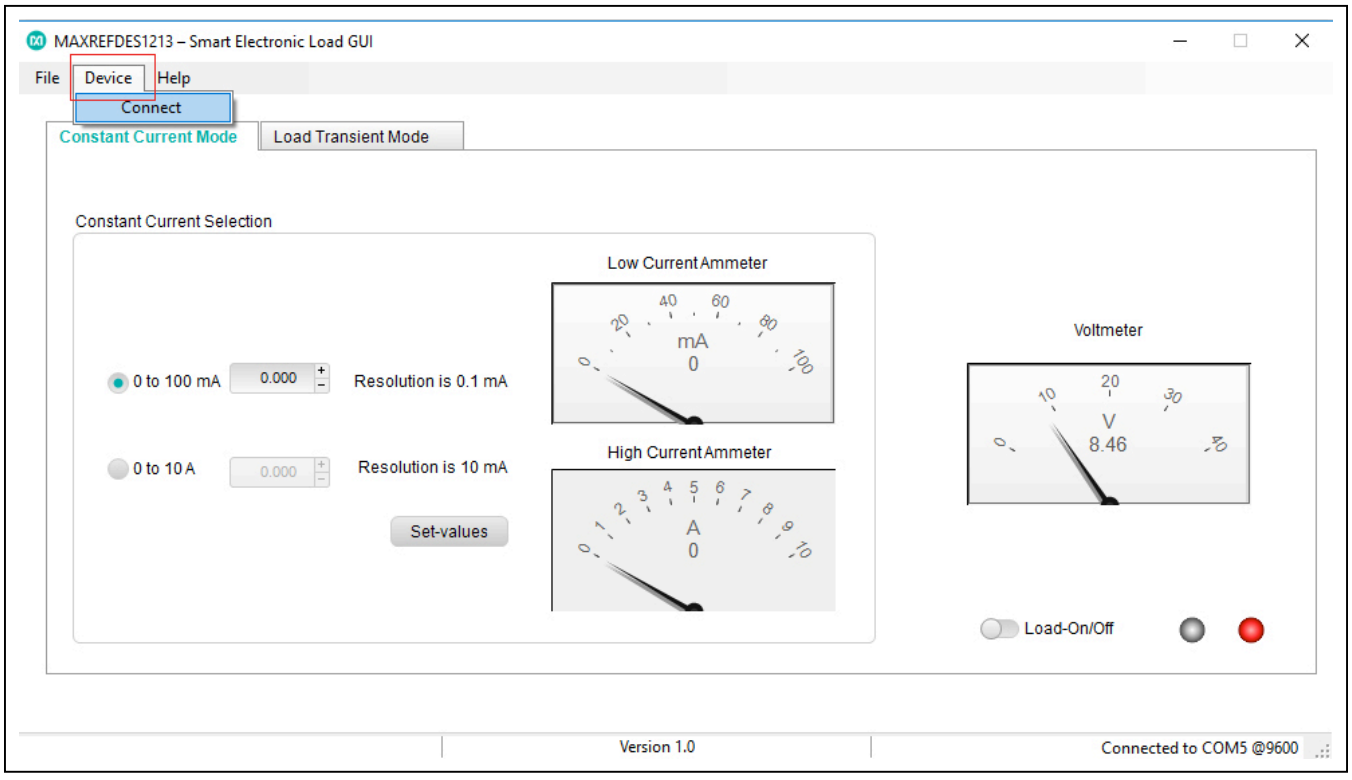

Figure 11. The Device menu option for connecting/reconnecting the GUI to the E-load.

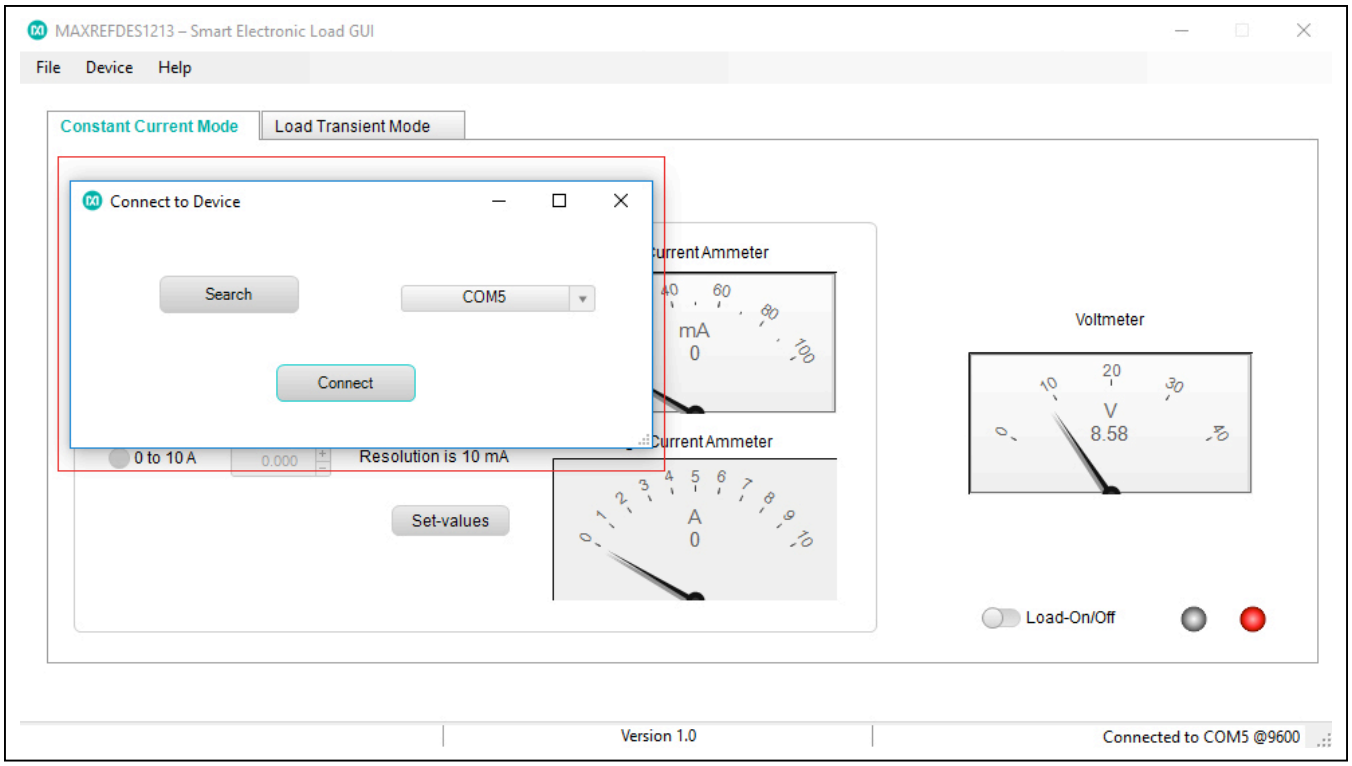

Figure 12. The Connect to Device window appears when the Device menu option is clicked.

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	2/20	Initial release	—