

# LMZ12003 SIMPLE SWITCHER® Power Module Evaluation Module User's Guide



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## Trademarks

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## 1 Description

The LMZ12003 SIMPLE SWITCHER power module is a complete, easy to use, step-down DC-DC solution capable of driving up to 3-A load. The LMZ12003 is available in an innovative, easy-to-use package that enhances thermal performance and allows for hand or machine soldering.

The LMZ12003 demo board can accept an input voltage rail between 4.5 V and 20 V and deliver an adjustable and highly accurate output voltage as low as 0.8 V. The LMZ12003 only requires three external resistors and four external capacitors to complete the power solution. The LMZ12003 is a reliable and robust solution with the following protection features:

- Thermal shutdown
- Input under-voltage lockout (UVLO)
- Output over-voltage protection (OVP)
- Short-circuit protection
- Output current limit
- Allows start-up into a pre-biased output

A single resistor adjusts switching frequency up to 1 MHz.

## 2 Packaging Highlights

- 7-lead module package (similar to TO-263)
- Single exposed die attach pad for enhanced thermal performance
- 10.2-mm × 13.8-mm × 4.6-mm module package
- High power density
- 1.7-inch × 2.3-inch reduced size demo board form factor

## 3 Demo Board Features

- 4.5-V to 20-V power input voltage range
- UVLO programmed at 4.5 V
- 0.8-V to 6-V adjustable output voltage range
- Up to 3-A output current
- Integrated shielded inductor in module
- Efficiency up to 92%

- All ceramic capacitor design
- No loop compensation required
- Starts into pre-biased loads
- Short circuit protection
- Thermal shutdown
- Only nine external passives plus module
- 2-layer low-cost assembly

## 4 Typical Applications

- Point-of-load conversions from 5-V and 12-V input rails
- Space constrained applications
- Industrial controls
- Telecom
- Networking equipment

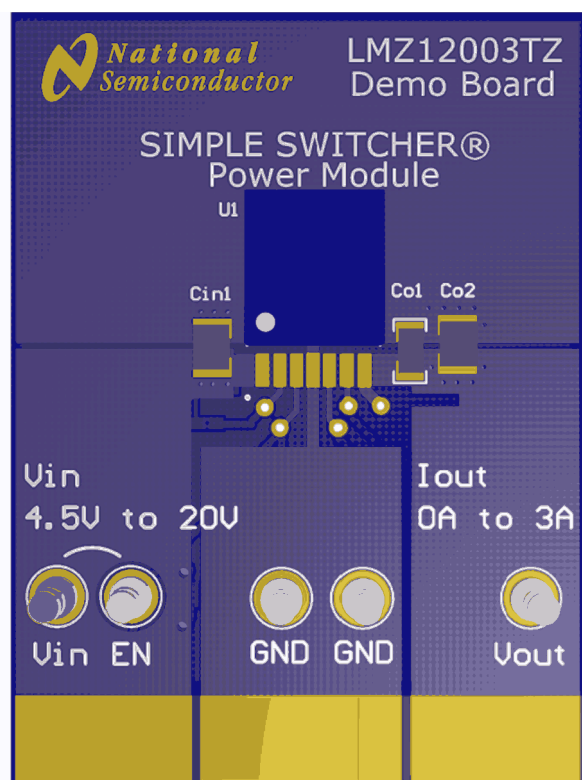


Figure 4-1. Front View

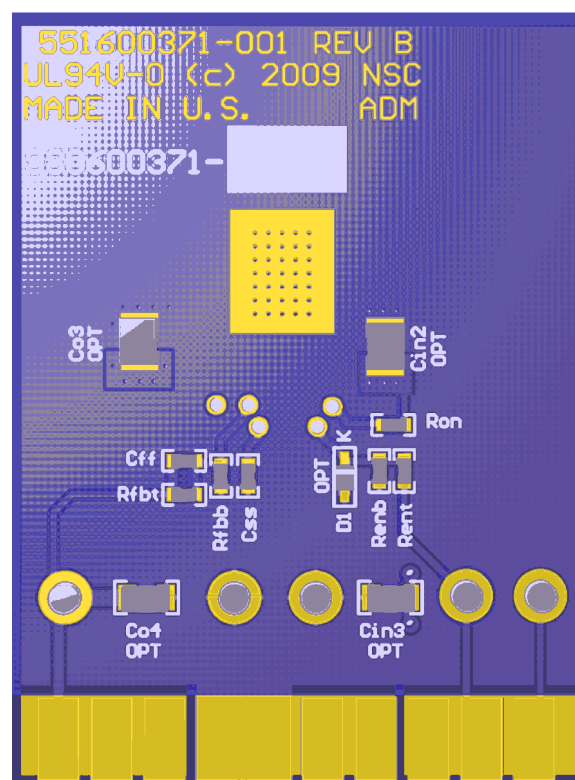


Figure 4-2. Back View

Table 4-1. Absolute Maximum Module Ratings

VIN, RON to GND	–0.3 V to 25 V
EN, FB, SS to GND	–0.3 V to 7 V

Table 4-2. Module Operating Ratings

VIN	4.5 V to 20 V
EN (Input on pin 3 module pin)	0 V to 6.5 V
Junction temperature range (T <sub>J</sub> )	–40°C to +125°C

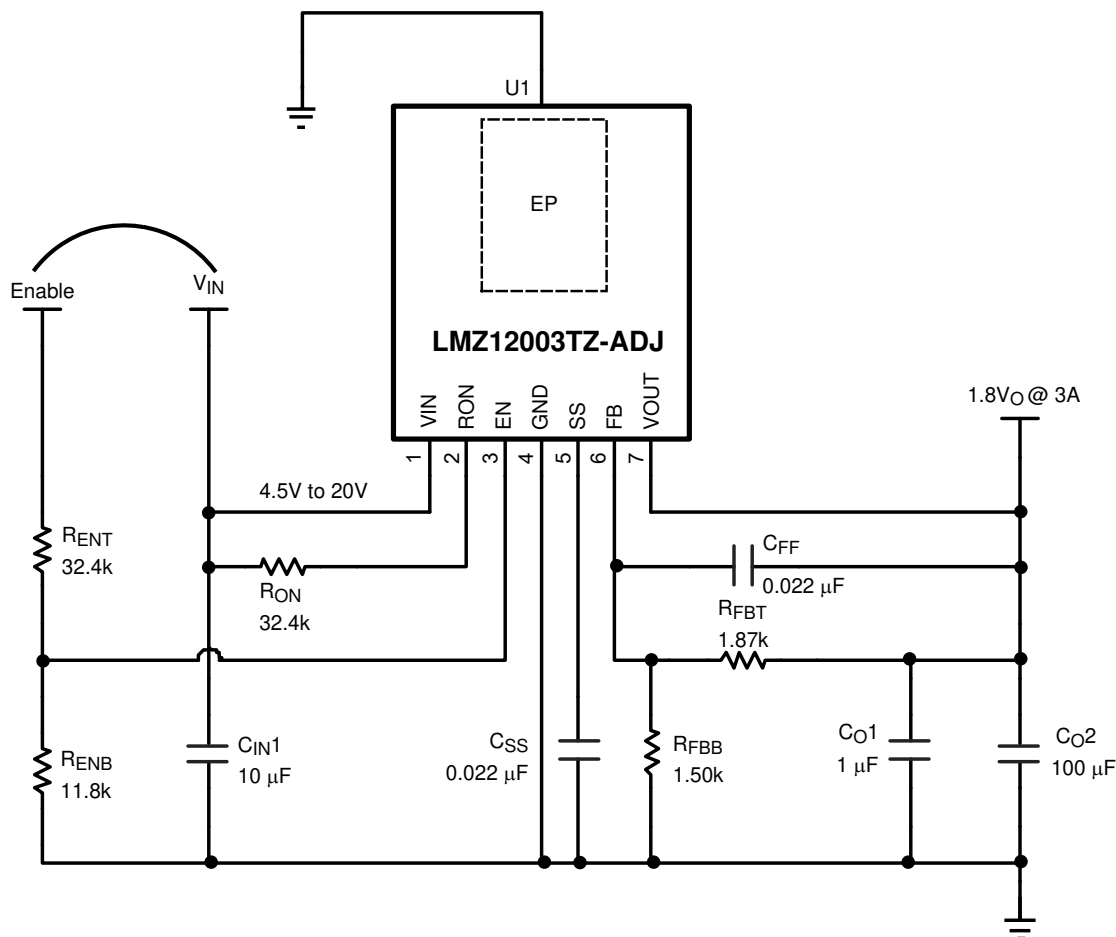
Table 4-3. Demo Board Operating Ratings

VIN	4.5 V to 20 V
VOUT (Default setting)	1.8 V
IOUT	0 A to 3 A
EN (Input on demo board post)	0 V to 20 V

**Table 4-3. Demo Board Operating Ratings (continued)**

UVLO setting on Enable input	4.5 V
Soft-start time	2.2 mS
Operating temperature range (T <sub>J</sub> )	–40°C to +70°C (at full 3-A load)

## 5 Demo Board Schematic



## 6 Demo Board Bill of Materials (BOM)

**Table 6-1. Board Bill of Materials (BOM)**

Ref Des	Description	Case	Manufacturer Part Number
Ron	32.4 k $\Omega$ 1% resistor	603	
Rent	32.4 k $\Omega$ 1% resistor	603	
Renb	11.8 k $\Omega$ 1% resistor	603	
Rfbt	1.87 k $\Omega$ 1% resistor	603	
Rfbb	1.50 k $\Omega$ 1% resistor	603	
Cff	0.022- $\mu$ F, 50-V, X7R ceramic capacitor	603	
Css	0.022- $\mu$ F, 50-V, X7R ceramic capacitor	603	
Cin	10- $\mu$ F, 50-V, X5R ceramic capacitor	1210	UMK325BJ106MM-T
Cout1	1.0- $\mu$ F, 50-V, X7R ceramic capacitor	1206	UMK316B7105KL-T
Cout2	100- $\mu$ F, 6.3-V, X5R ceramic capacitor	1210	JMK325BJ107MM-T
U1	LMZ12003 SIMPLE SWITCHER Power Module	TO-PMOD	LMZ12003TZ-ADJ
<b>Alternate resistor values for alternative output voltages</b>			
VOUT	RFBT	RFBB	RON
6	2.49 k	383 $\Omega$	124 k
5	5.62 k	1.07 k	100 k
3.3	3.32 k	1.07 k	61.9 k
2.5	2.26 k	1.07 k	47.5 k
1.8	1.87 k	1.50 k	32.4 k
1.5	1.00 k	1.13 k	28.0 k
1.2	4.22 k	8.45 k	22.6 k
0.8	0.0 K	39.2 k	24.9 k

## 7 Demo Board Hookup

**VOUT:** Connect the load to  $V_{OUT}$  and one of the GND posts. The module can source up to a 3-A load current.

Connect  $V_{IN}$  to a positive voltage in the 4.5-V to 20-V range. Connect the negative terminal of the source supply to one of the posts labeled GND.

The Enable input post is configured for direct connection to the  $V_{IN}$  post. With the chosen resistor values, this results in an undervoltage lockout level of 4.5-V input. The top enable resistor is RENT (aka REN1) and the bottom enable resistor is RENB (aka REN2).

If the Enable post is disconnected, the module will be disabled and about 20  $\mu$ A of supply current will flow from  $V_{IN}$  to ground while in the disabled mode. With the enable input connected to  $V_{IN}$  through the resistor divider, there will be about 1.5 mA of no-load quiescent current into the  $V_{IN}$  input. Additional current flows into the enable divider string.

## 8 Demo Board Passive Components

**Soft-start capacitor:** The soft-start capacitor controls the rise time of the output voltage when power is first applied and following the clearing of a fault mode.

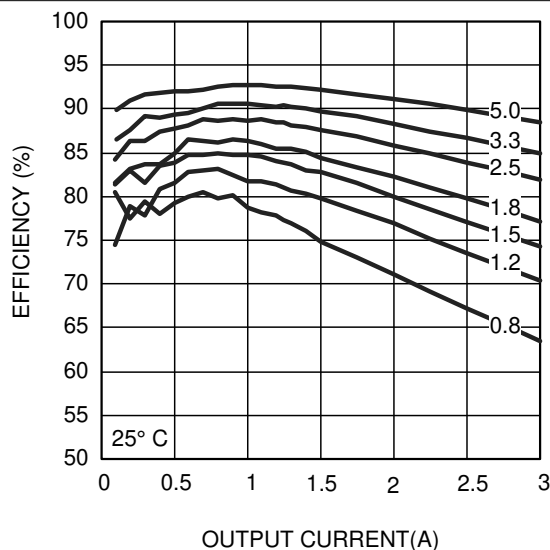
**Feedback divider:** Regulator output voltage is programmed through the selection of the two resistors, RFBT (aka RFB1) and RFB (aka RFB2). A feedforward capacitor (CFF) is located in parallel with the upper feedback divider resistor. This capacitor improves the step response to abrupt changes in load current. For a different output voltage, see [Table 6-1](#) when modifying the board. Resistor values shown will minimize error in output voltage setting.

**RON Resistor:** The primary function of the RON resistor is to set the on-time interval of the internal control section switching cycle. The secondary function of the RON resistor is to create a nearly constant operating frequency over the input operating voltage range. If the output voltage of the regulator is changed by adjusting the feedback divider, then it is generally required that the RON resistor value also be changed in order to maintain the same operating frequency.

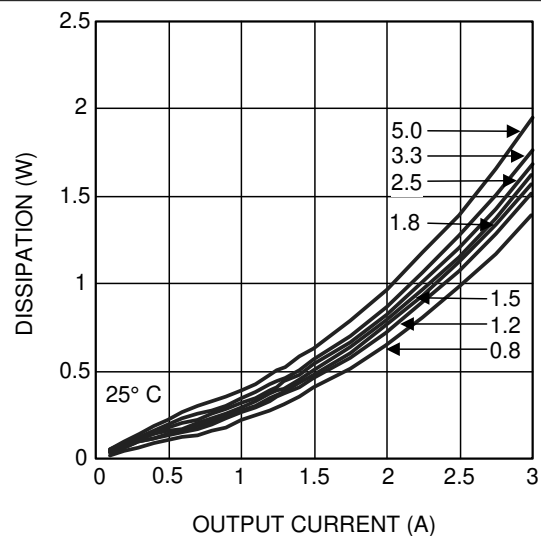
**Cout:** A parallel connection of a 1- $\mu$ F, 50-V and a 100- $\mu$ F, 6.3-V multilayer ceramic are used for the output capacitor. Locations are provided on the PCB assembly for experimenting with additional output capacitors..

**Cin:** A 10- $\mu$ F, 50-V multilayer ceramic is connected as the input filter. Locations are provided on the PCB assembly for experimenting with additional input capacitors.

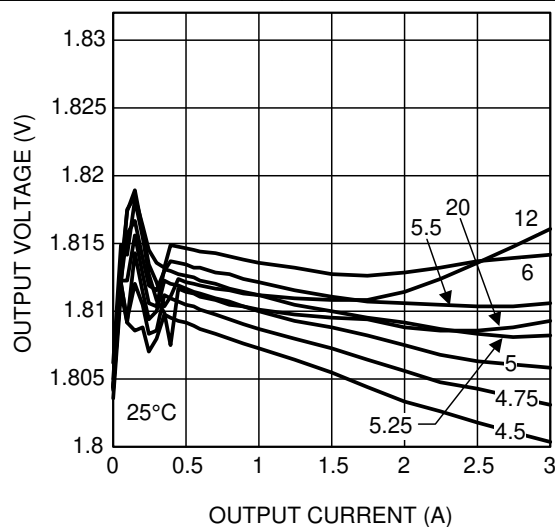
## 9 Performance Characteristics



**Figure 9-1. Efficiency, 12 V Input at 25°C**



**Figure 9-2. Dissipation, 12 V Input at 25°C**



**Figure 9-3. Line and Load Regulation at 25°C**

## 10 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision B (April 2013) to Revision C (December 2021)	Page
• Updated the numbering format for tables, figures, and cross-references throughout the document.....	1
• Updated the user's guide title.....	1
• Edited the user's guide for clarity.....	1

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##### 3.1.2 For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:

#### **CAUTION**

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

#### **FCC Interference Statement for Class A EVM devices**

*NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.*

#### **FCC Interference Statement for Class B EVM devices**

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- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

#### 3.2 Canada

##### 3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247

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This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

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Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

#### **Concerning EVMs Including Detachable Antennas:**

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.



### Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

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2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
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