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# ***AN-2027 Inverting Application for the LMZ14203 SIMPLE SWITCHER® Power Module***

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## **ABSTRACT**

This application report illustrates how to apply the LMZ14203 integrated buck module into the buck-boost configuration such that a positive input voltage can be used to create a regulated negative output voltage.

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## 1 Introduction

This application report shows how the conventional non-inverting demonstration and evaluation boards for the device can be connected into the inverting configuration without the need to acquire a new PCB to evaluate the application. For detailed descriptions on the PCB assemblies in the conventional buck topology, see the *AN-2024 LMZ1420x / LMZ1200x Evaluation Board User's Guide* ([SNVA422](#)), the *AN-2031 LMZ12003 3A Demo Board SIMPLE SWITCHER® Power Module Quick Start Guide User's Guide* ([SNVA427](#)), and the *AN-2032 LMZ14202 / LMZ14203 Demo Board SIMPLE SWITCHER® Power Module Quick Start Guide User's Guide* ([SNVA428](#)).

[Figure 1](#) illustrates the method of reassigning the terminals of the evaluation board (or demo board) for the inverting application. Careful labeling of leads is suggested to avoid confusion since the terminals formerly at ground potential are now connected to  $-V_{OUT}$ , and the connection formerly assigned to  $+V_{OUT}$  is now connected to ground. The three connections to the power path are straightforward. But there may be additional circuitry required for the enable signal to function as desired in the target system as the precision enable reference voltage is referred to ground while disabled and to  $-V_{OUT}$  once enabled. This adds a large and possibly undesirable amount of hysteresis to the simplest form of enable. To alleviate this situation several level shift methods are discussed in the following text.

It should also be noted that the maximum output current obtained from the module is decreased from that obtained in the conventional buck configuration (see the graphs in [Section 4](#)). Further, since the ground terminal of the module is connected to  $-V_{OUT}$  the maximum positive input voltage into the inverting application is decreased by the amplitude of the output voltage. Thus for a  $-5V$  output application the maximum input voltage will be  $37V$ .

This configuration can be applied to the whole family of LMZ1420x and LMZ1200x modules so long as the input voltage and output current limits are observed. Be aware that efficiency is lower in the inverting configuration resulting in higher dissipation for a given output power and that thermal derating may need to be observed when operating at maximum output current.

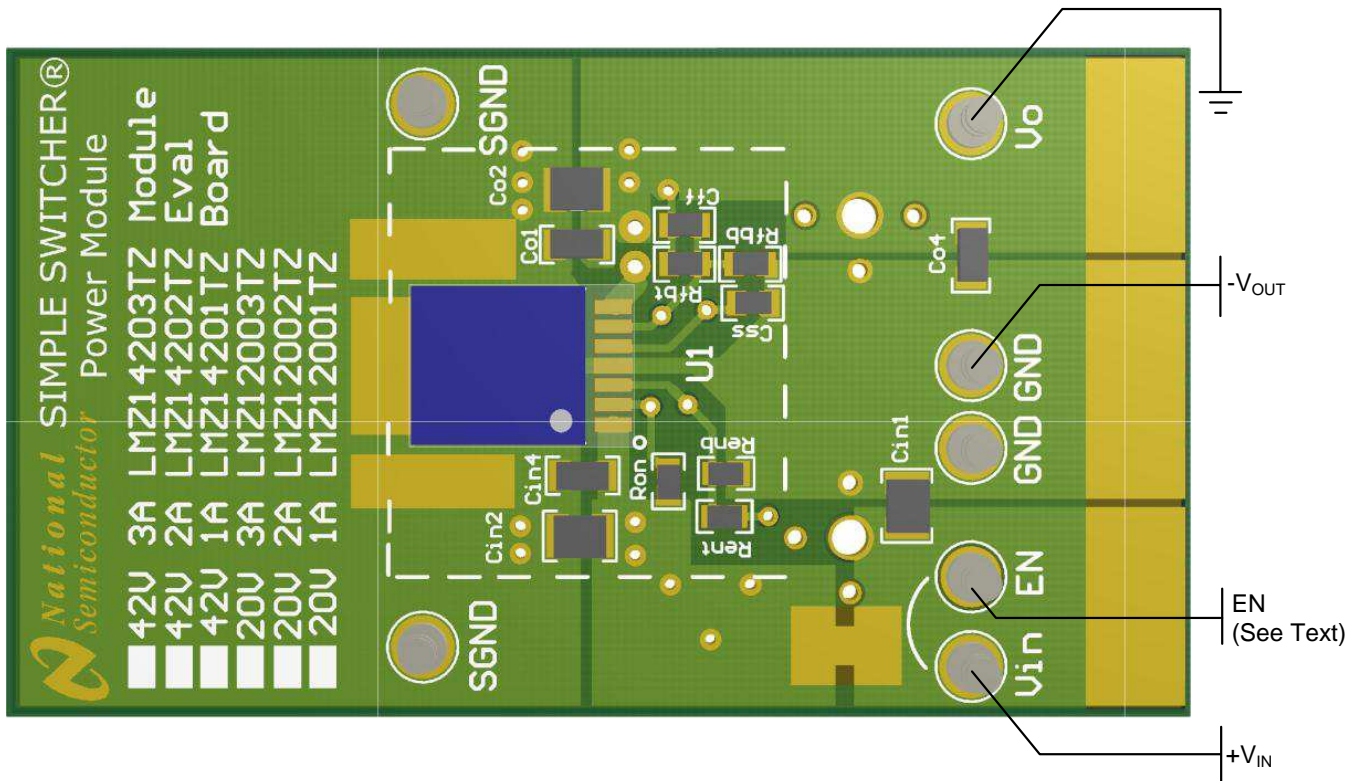
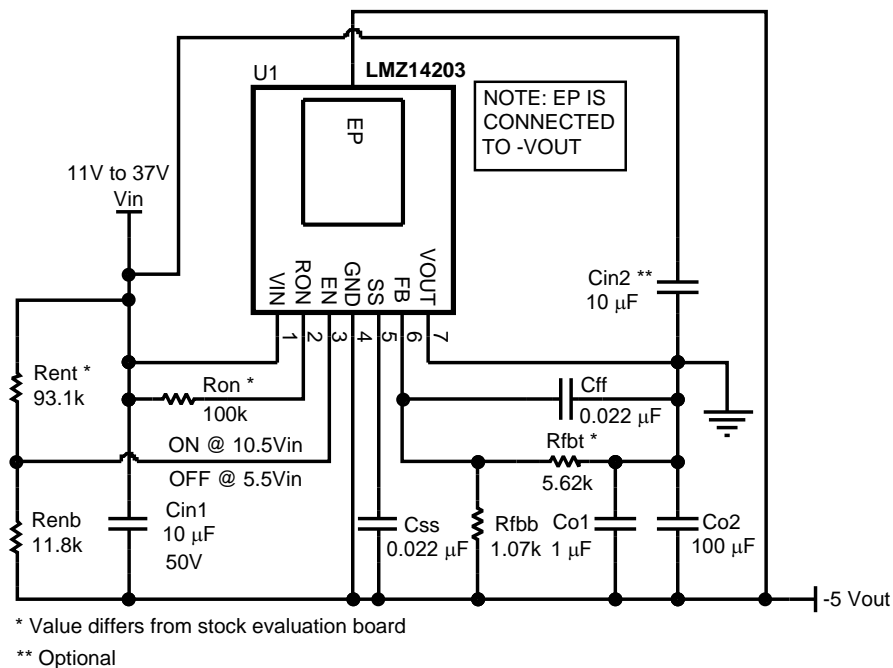


Figure 1. Evaluation Board Connections for Inverting Application



A For the Bill of Materials (BOM), see the *AN-2024 LMZ1420x / LMZ1200x Evaluation Board User's Guide* ([SNVA422](#)).

**Figure 2. Inverting Application Schematic for Simple Enable and  $-5V_{OUT}$**

## 2 Enable Options

Essentially there are three methods for enabling the module in the inverting application. The first is the precision threshold shown in [Figure 2](#). Under-voltage lock-out (UVLO) is determined by the values of RENT and RENB in the same manner as described in the device-specific data sheet. Once the module is enabled  $-V_{OUT}$  goes from its initial ground potential to the regulated negative  $V_{OUT}$  level at a rate determined by the soft-start capacitor. Since RENB is also tied to  $-V_{OUT}$  a reinforcing action occurs that increases the 90 mV hysteresis level substantially such that the total hysteresis is essentially the magnitude of  $V_{OUT}$ . As previously suggested, a hysteresis level this large may be undesirable in certain system situations so two other methods are described as alternatives.

Many systems have ground referred control or supervisory logic signals that need to be level shifted for compatibility with the enable input of the LMZ14203 which in this application is referenced to  $-V_{OUT}$ . The level shift is quite straight forward and can be accomplished with a single transistor. The transistor type can either be small signal PNP or low level P-channel mosfet. The transistor terminal connections are essentially identical. These circuits are shown in [Figure 3](#) and [Figure 4](#).

For applications where precision UVLO is needed with a small and controllable amount of hysteresis, then an adjustable shunt reference can be configured as a precision comparator to meet the requirements. Suggested circuitry is detailed in [Figure 5](#). The first is based on the common LMV431 type device with a PNP inverter output section. The other circuit uses the similar LM4041 that differs in that it has high side feedback reference and the inversion is not required. Either circuit is both low cost and compact.

### 3 External Enable Logic Level Shifters

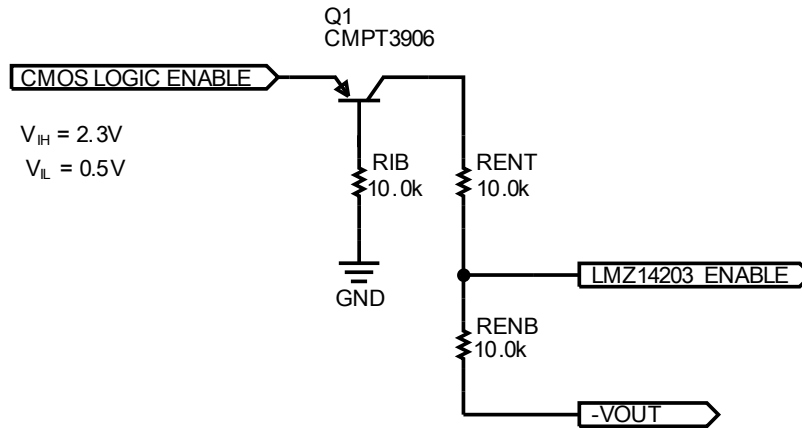


Figure 3. PNP Level Shifter

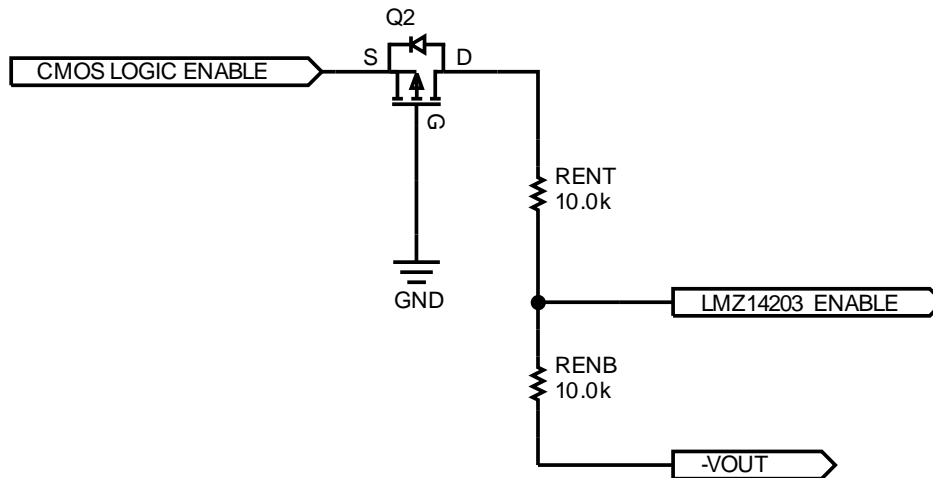


Figure 4. P-ch MOSFET Level Shifter

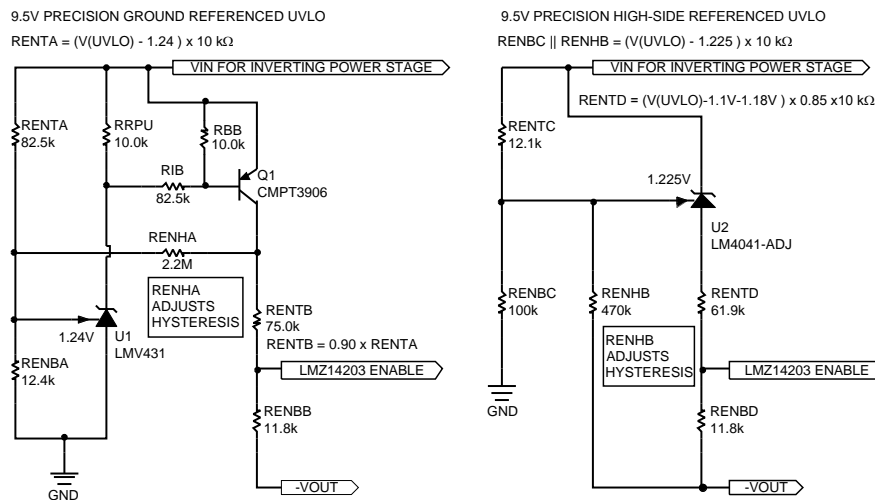
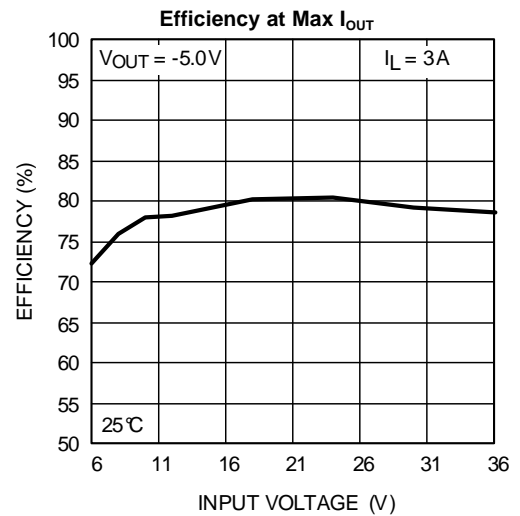
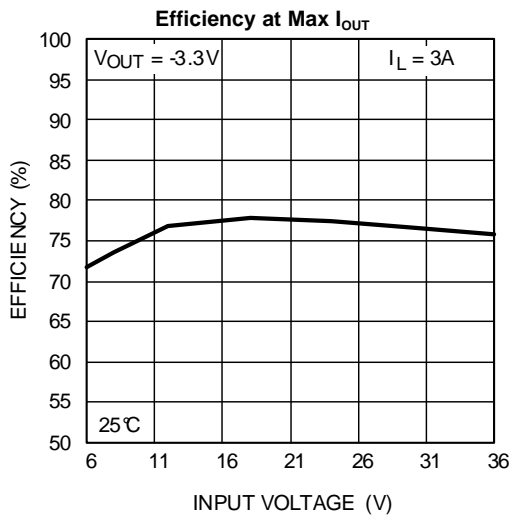
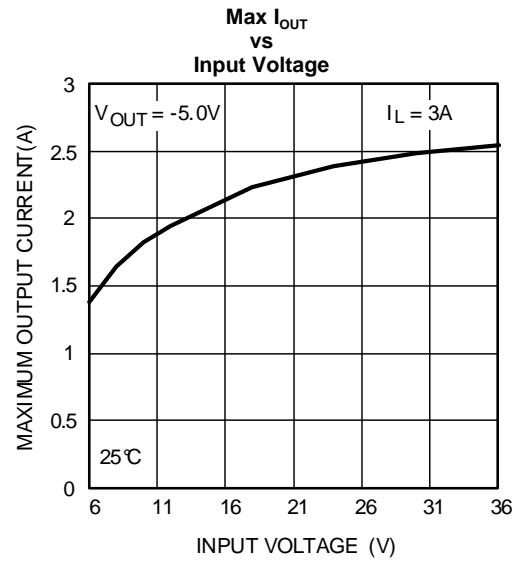
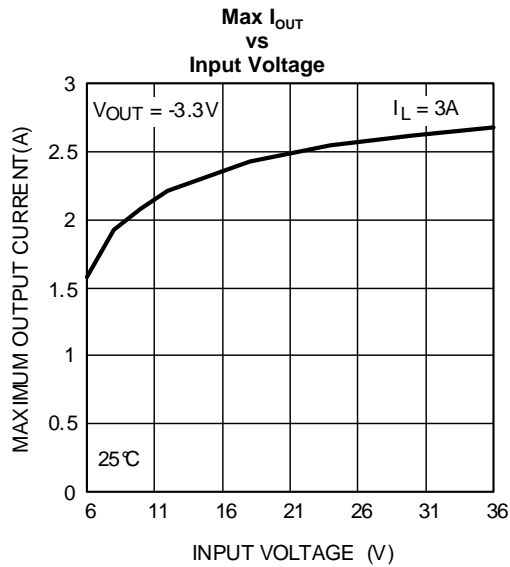
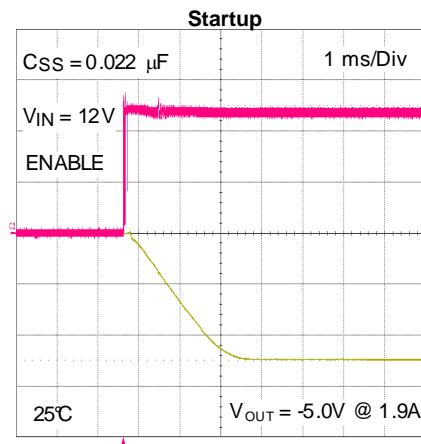
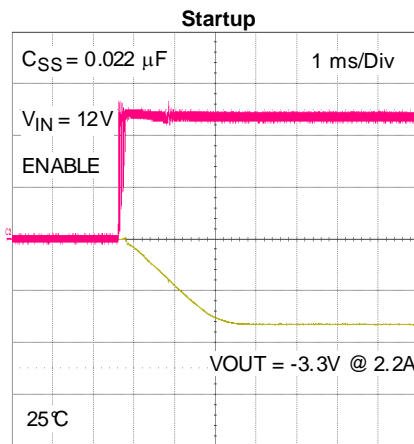
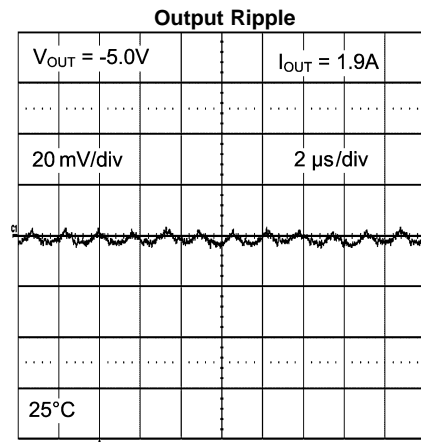
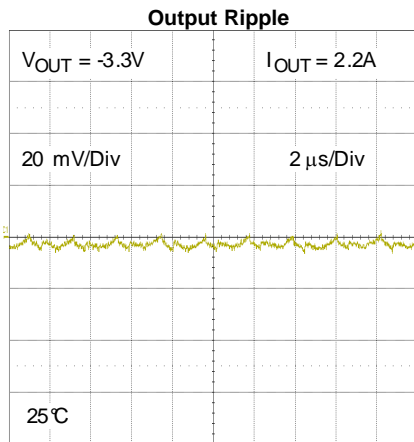
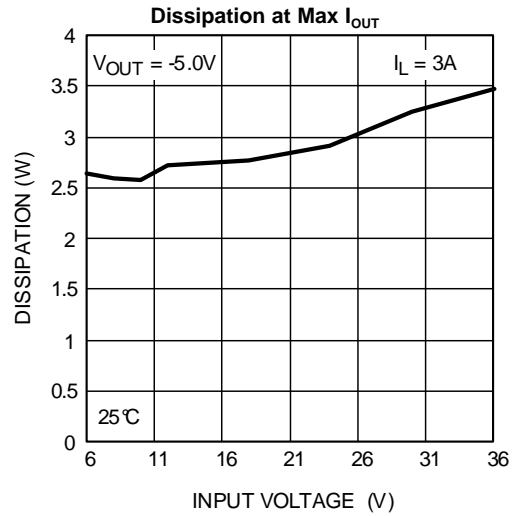
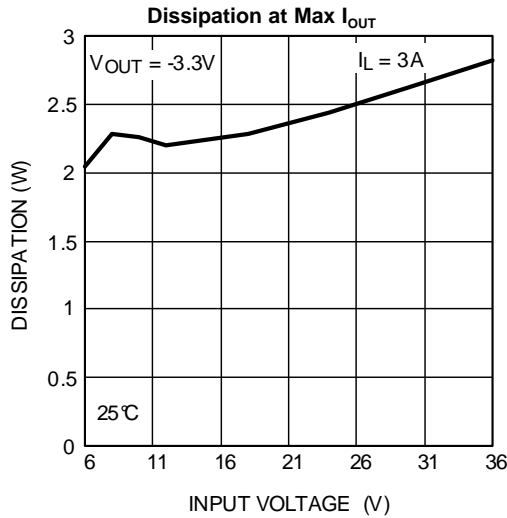


Figure 5. Adjustable Shunt Reference-Based Precision UVLO Circuits

## 4 Typical Performance Characteristics





## 5 References

- AN-2024 LMZ1420x / LMZ1200x Evaluation Board User's Guide ([SNVA422](#))
- AN-2031 LMZ12003 3A Demo Board SIMPLE SWITCHER® Power Module Quick Start Guide User's Guide ([SNVA427](#))
- AN-2032 LMZ14202 / LMZ14203 Demo Board SIMPLE SWITCHER® Power Module Quick Start Guide User's Guide ([SNVA428](#))

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