Adjusting LMZ3 Output Voltage with LM10010/1

This application note outlines the methods to pair an LMZ3 power module with an LM10010/1 VID voltage programmer to adjust the output voltage. The LMZ3 power module is an easy-to-use integrated power solution which combines a DC/DC converter with power MOSFETs, a shielded inductor, and passive components into a low profile QFN package, while still retaining flexibility and accessibility for end users. The LM10010/1 is a precision, digitally programmable device which outputs a DC current proportional to a 6-bit or 4-bit input word. By connecting the output pin of LM10010/1 to the VADJ pin of the LMZ3 power module as shown in Figure 1, the output voltage can be adjusted to a desired range and resolution.

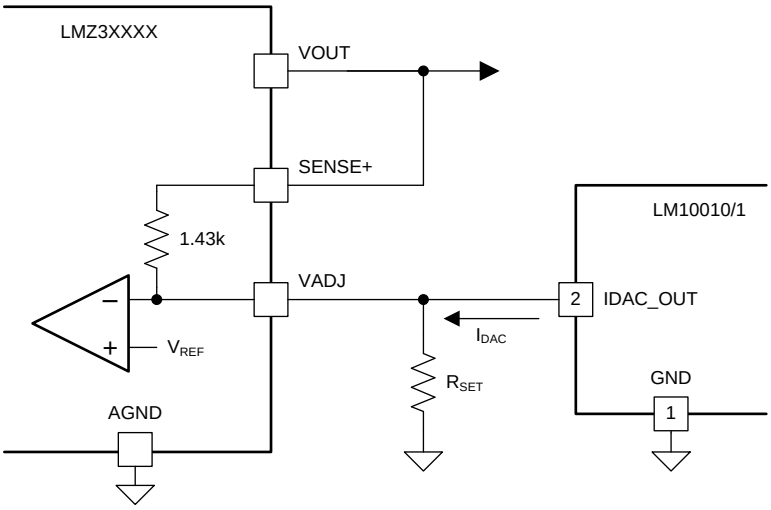

Figure 1.

The change range of output voltage is determined with the multiplication of 1.43kΩ and the scale of I_{DAC}. The full-scale output current I_{DAC} from LM10010/1 is 59.2µA (6-bit) or 56.4µA (4-bit). The maximum allowable change range of output voltage is then limited to less than 0.085V, which may not be adequate in some applications. In those cases, an additional external resistor is required to achieve a larger adjustable range of output voltage.

There are two possible configurations that add an external resistor R_{FB}. The first one is shown in Figure 2, where the 1.43kΩ internal resistor is bypassed.

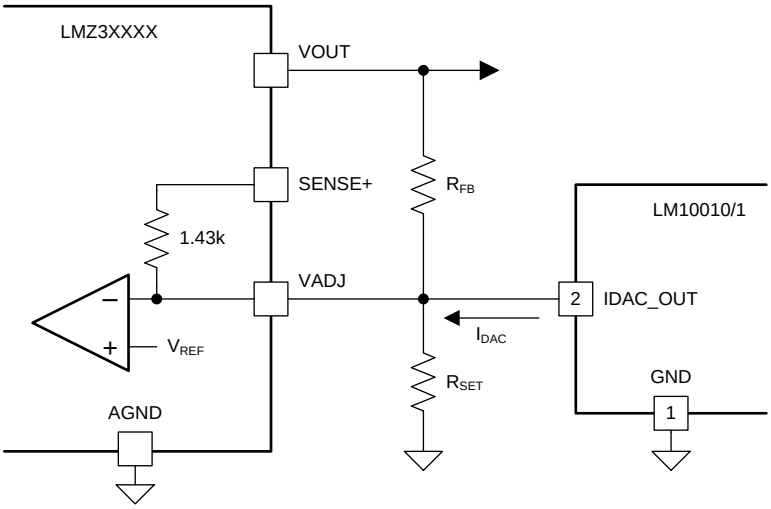

Figure 2.

1. Connect “IDAC_OUT” (pin 2 of LM10010/11) to the “VADJ” pin of LMZ3 module.
2. Insert a resistor “R_{FB}” between VOUT and the “VADJ” pin.
3. Leave the "SENSE" + pin open (DO NOT CONNECT to VOUT).

Given the resistor present from the “VADJ” pin to GND is R_{SET}, the following equation results:

$$V_{OUT} = V_{REF} \times \left(1 + \frac{R_{FB}}{R_{SET}}\right) - I_{DAC} \times R_{FB} \quad (1)$$

where V_{REF} is either 0.6V or 0.8V as shown in Table 1.

Table 1.

Part Number	V_{REF}	Part Number	V_{REF}
LMZ31503	0.6 V	LMZ30602	0.8 V
LMZ31506		LMZ30604	
LMZ31704		LMZ30606	
LMZ31707		LMZ31506H	
LMZ31710			

Since the output of LM10010/1 can only source current, the maximum V_{OUT} occurs when I_{DAC} is at minimum. Consequently, it is convenient to first select R_{FB} for the ΔV_{OUT}, and then adjust R_{SET} to meet the upper-bound of V_{OUT}.

Taking the LMZ31710 as an example, where the V_{OUT} ranging from 0.7V to 1.8V (ΔV_{OUT} = 1.1V) is desired. Assume that the highest I_{DAC} for the application is 55.5µA with the 6-bit option, the minimum required R_{FB} will be about 19.8kΩ (= 1.1V / 55.5µA). A close standard resistor 20kΩ is chosen for R_{FB}. Furthermore, the value of R_{SET} can be determined as 10kΩ using the following equation:

$$R_{SET} = \frac{R_{FB}}{\frac{V_{OUT(MAX)}}{V_{REF}} - 1} \quad (2)$$

where $V_{OUT(MAX)}$ is 1.8V and V_{REF} 0.6V.

Since I_{DAC} from LM10010/1 scales from 0.06 µA to 59.2 µA (6-bit), therefore

V_{OUT} = 1.80 V, when I_{DAC} = 0.06 µA (VID code: 63d)

V_{OUT} = 0.69 V, when I_{DAC} = 55.5 µA (VID code: 4d)

The second configuration is to place R_{FB} in series with the internal 1.43k resistor, as shown in Figure 3.

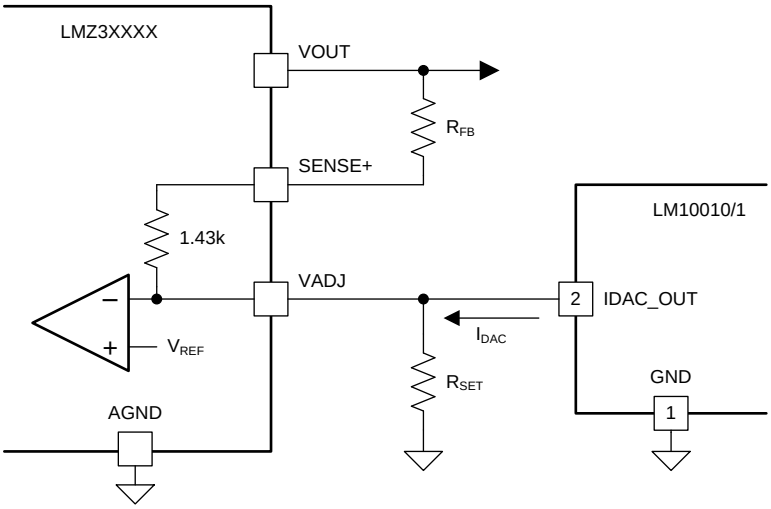

Figure 3.

1. Connect “IDAC_OUT” (pin 2 of LM10010/11) to the “VADJ” pin of LMZ3 module.
2. Insert a resistor “R_{FB}” between VOUT and the “SENSE+” pin.

Similarly , the following equation results:

$$V_{OUT} = V_{REF} \times \left(1 + \frac{R_{FB} + 1.43\,k}{R_{SET}}\right) - I_{DAC} \times (R_{FB} + 1.43\,k) \quad (3)$$

The only difference of equation (3) from (1) is that R_{FB} was replaced with (R_{FB} + 1.43k).

Again, if the V_{OUT} range from 0.7V to 1.8V is needed for a LMZ31710, the minimum required (R_{FB} +1.43k) will be about 19.8kΩ (= 1.1V / 55.5μA), or R_{FB} is 18.4kΩ (= 19.8kΩ - 1.43kΩ). A close standard resistor for R_{FB} will be 18.7kΩ. A 10kΩ resistor can then be chosen for R_{SET} due to:

$$R_{SET} = \frac{R_{FB} + 1.43\,k}{\frac{V_{OUT(MAX)}}{V_{REF}} - 1} \quad (4)$$

Consequently,

V_{OUT} = 1.81 V, when I_{DAC} = 0.06 μA (VID code: 63d)

V_{OUT} = 0.69 V, when I_{DAC} = 55.5 μA (VID code: 4d)

Revision History

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

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as “components”) are sold subject to TI’s terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI’s terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers’ products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers’ products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products		**Applications**	
Audio	www.ti.com/audio	Automotive and Transportation	www.ti.com/automotive
Amplifiers	amplifier.ti.com	Communications and Telecom	www.ti.com/communications
Data Converters	dataconverter.ti.com	Computers and Peripherals	www.ti.com/computers
DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps
DSP	dsp.ti.com	Energy and Lighting	www.ti.com/energy
Clocks and Timers	www.ti.com/clocks	Industrial	www.ti.com/industrial
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Applications Processors	www.ti.com/omap	**TI E2E Community**	e2e.ti.com
Wireless Connectivity	www.ti.com/wirelessconnectivity		

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265