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.

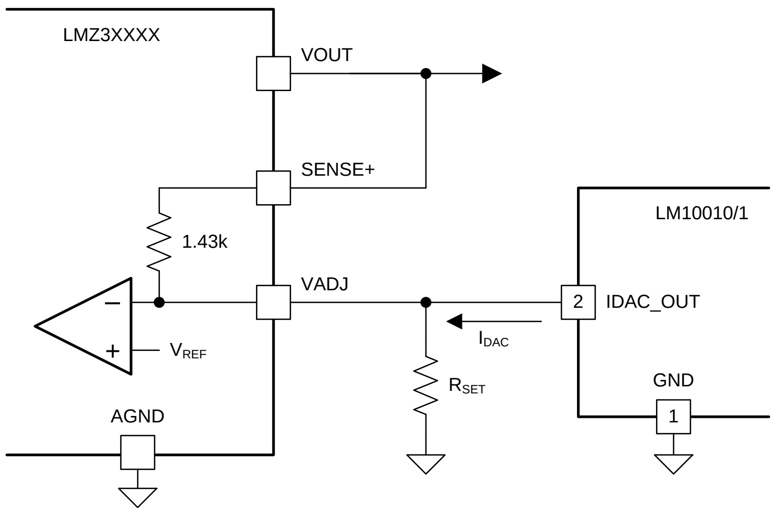

Figure 1.

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.

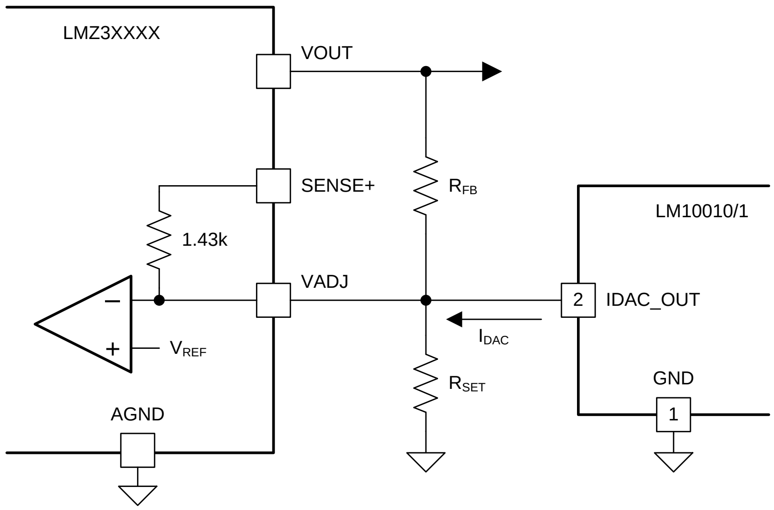

Figure 2.

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.

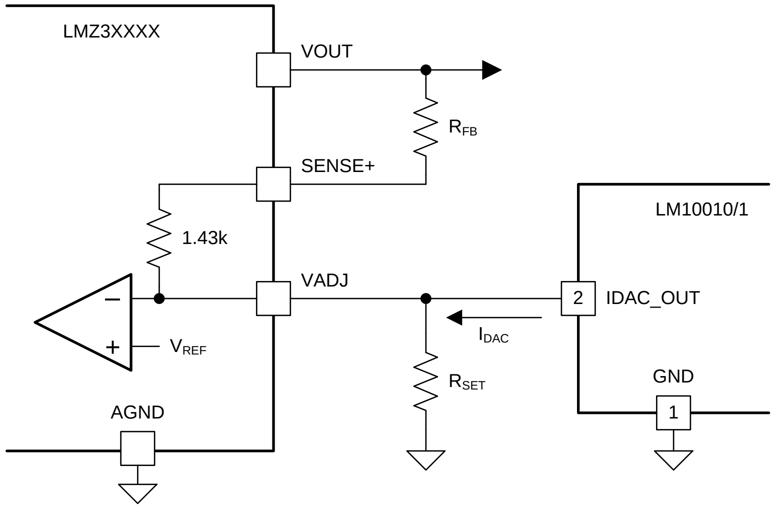

Figure 3.

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:

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

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:

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

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.