# Application Guidelines for Non-Isolated Converters

AN04-005: Margining and Voltage Programming

Introduction

The OmniOn Power ™ Austin Lynx™, Lynx II, TLynx ™ and Naos Raptor ™ series of non-isolated modules all have the ability to adjust their output voltage by interfacing through the Trim pin. In addition to the output voltage set function, two other types of output voltage adjustment are frequently used. The first is margining, where the output voltage is adjusted a fixed percentage (typically ±5 or 10%) off the nominal during system level test. This adjustment is generally used for checking the operational margin of circuits and thereby assuring the robustness of the application. The second is voltage programming where an external voltage is provided to either provide more accurate adjustment of the output voltage of the module or to implement a margining-like function. This application note describes circuits and provides design guidelines for implementing margining or voltage programming.

To understand how margining or voltage programming are done, it is beneficial to understand the circuit used to scale down the output voltage in the Austin Lynx and Lynx II series of modules. Figure 1 shows a portion of the output voltage divider and feedback circuitry that is used in all Lynx and Lynx II series modules (except the fixed- output voltage 5/3.3V and 12V input Lynx modules – these come in different output voltage versions and do not have an wide-output voltage adjust capability).
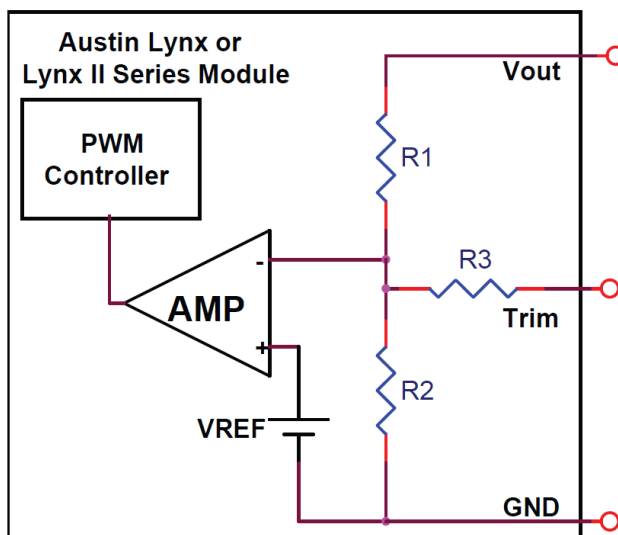

	R1	R2	R3	VREF
5Vin Austin Lynx or Lynx II	30.1K	402K	1K	0.7V
12Vin Austin Lynxor Lynx II	15K	200K	1K	0.7V
Austin MegaLynx	1.5K	Open	100	0.8V

Fig. 1. Circuit diagram of the output voltage divider and feedback circuitry used in the Austin Lynx and Lynx II series of modules (except fixed-output 5/3.3V in Austin Lynx and 12V in Austin Lynx modules).

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output voltage is scaled down by a divider consisting of resistors R1 and R2. The mid point of the divider is connected to the inverting input of the op-amp which is used to process the error voltage between the internal reference voltage V_{ref} (0.7V) and the divider midpoint voltage. The voltage control loop of the module regulates the output voltage so as to maintain the voltage at the mid point of the divider equal to the reference voltage. The trim pin is connected through a 1KΩ resistor to the mid point of the divider. By connecting an external resistor between the Trim pin and GND, the divider ratio is changed thus allowing adjustment of the output voltage. In both margining and voltage programming, the output voltage is adjusted by in essence effecting a change in the scaling between the output and voltage divider mid point voltages.

In the TLynx and Naos Raptor series of modules, a simpler circuit is used to divide down the voltage as shown in Fig. 2. However, the same functionality is obtained is obtained through the TRIM pin.
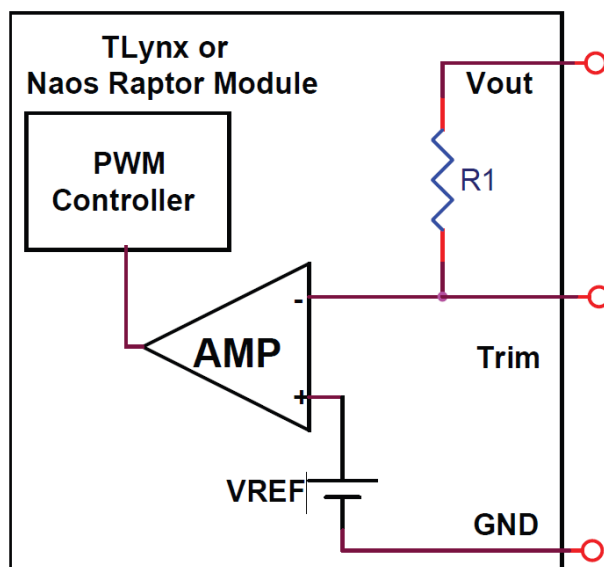
	R1	VREF
3.3Vin TLynx	2K	0.6V
12Vin TLynx	10K	0.591V
3A/6A/10A/20A Naos Raptor	2K	0.591V
40A/50A/60A Naos Raptor	2K	0.6V

Fig. 2. Circuit diagram of the output voltage divider and feedback circuitry used in the TLynx and Naos Raptor series of modules

Implementing Margining

Margining is implemented by essentially changing the divider by small amounts to obtain the desired margining voltages. One method to accomplish this is shown in Fig. 3. This scheme connects a pre-determined resistor with a small FET in series between the trim pin and ground (to margin up or slightly increase the output voltage), and a similar FET+resistor combination in series between TRIM and Vout to margin down (or slightly decrease the output voltage). Under normal operation, both FETs are kept off. To margin up, the lower FET (Q1) would be turned on, while to margin down the upper FET (Q2) would be turned on. Table 1 shows a summary of the various states and their effect on the output voltage. Another scheme to implement margining is shown in Fig. 4, where two FET+resistor combinations are shown connected in parallel between the Trim and Ground pins. For normal operation, one of the FETs (say Q1) is kept on while the other one is kept off. To margin up, both FETs would be on, while to margin down, both FETs would be off. The summary of the various states and effect on output voltage are shown in Table 2. Similar results are obtained using either scheme.

The POL Programming Tool (free download from **omnionpower.com**) can calculate the values of resistors to be used with the margining schemes shown in Fig. 3 for different POL modules.
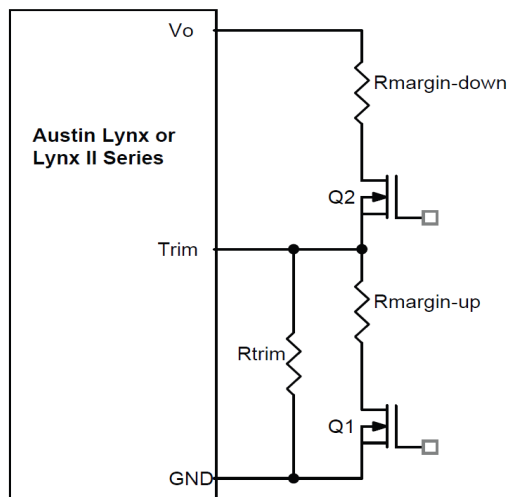
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Fig. 3. Circuit for implementing margining capability in the Lynx, Lynx II, TLynx and Naos Raptor series of modules.

Action	Q1	Q2
Normal	OFF	OFF
Margin-up	ON	OFF
Margin-down	OFF	ON

Table 1.

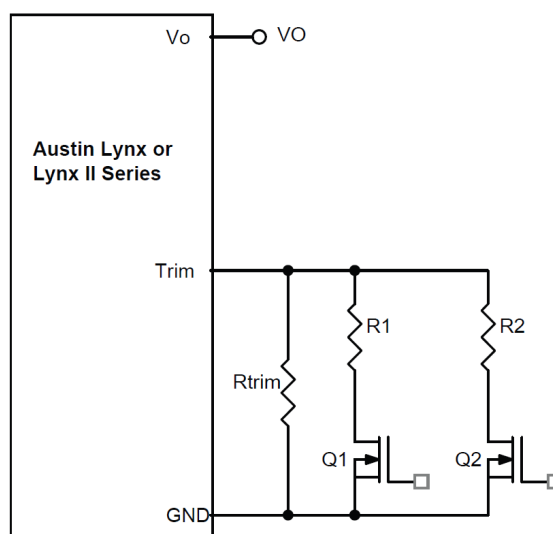| Action	Q1	Q2
Normal	ON	OFF
Margin-up	ON	ON
Margin-down	OFF	OFF

Table 2.

Fig. 4. Alternate circuit for implementing margining capability in the Lynx and Lynx II series modules.

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Margining through Voltage Programming

Another method of adjusting the output voltage of the module is through programming using an external voltage source. Recall that the output voltage is scaled down by a voltage divider network, and this voltage is then fed back to compare with a fixed reference voltage inside the module. The Trim point represents the mid point of this divider. By injecting an additional voltage through a resistor into the Trim pin, the scaling between the output voltage and the voltage at the Trim pin is changed, effectively changing the output voltage. This method of adjustment is referred to as voltage programming of the module output voltage. The voltage programming equation for the 12V input Austin Lynx and Lynx II modules is

$$V_{out} = V_{ref} + 15000 \times \left[\frac{V_{ref}}{200,000} + \frac{V_{ref} - V_t}{1000} \right]$$

$$V_{out} = (16.075 \times V_{ref}) - (15 \times V_t)$$

where, V_t is the voltage at the Trim pin. This equation shows that the output voltage is highly sensitive to tolerances in V_{ref} and V_t, since these terms are multiplied by 16.075 and 15, respectively. Similar considerations apply to the 5/3.3V in Austin Lynx and Lynx II modules as well.

To reduce the sensitivity to tolerances in the reference and programming voltages, a modified circuit as shown in Fig. 4 needs to be used. The external output voltage V_s is fed to the module's trim pin through a resistor network to cause the change in the output voltage. When the external voltage V_s is increased, a larger current flows through Rext and R3 into the inverting terminal of the opamp, thereby reducing the current that flows from V_{out} through resistor R1. This effectively reduces the scaling of the output voltage and results in a decrease of V_{out}. The reverse occurs when V_s is reduced resulting in an increase in V_{out}. Table 3 shows values of various circuit parameters for the case of the 5/3.3V input Lynx and Lynx II series modules, while Table 4 shows a similar set of data for the 12V input series modules.

If margining is implemented along with voltage programming, both functions can be implemented together by adjusting the source voltage V_s to perform the margining. Figure 5 shows a slightly modified version of Figure 4 that can be used. Table 5 provides the values of V_s needed to margin either +/-5% or +/-10% for the 5/3.3V in Lynx and Lynx II Series modules, while Table 6 provides a similar set of data for 12V in Lynx and Lynx II Series of modules.

For the Austin MegaLynx, TLynx and NSR series of modules, the POL Programming tool can be used to select external voltage source and series resistor values for programming the module output voltage over a range.
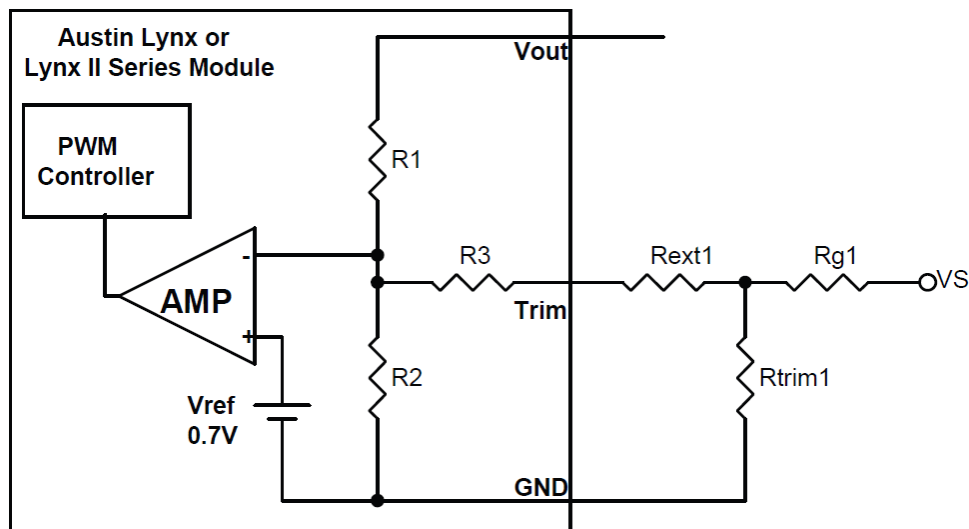

Fig. 4. Recommended circuit to be used in voltage programming of the Austin Lynx Series of modules.

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Output Voltage	Rext	Rtrim	Rg	Vs,nom	% Error
1.2V	8k	33.9k	73.2k	0.505	1.74 %
1.5V	3.5k	19.6k	55k	0.485	1.75 %
1.8V	2k	13k	39.2k	0.453	1.74 %
2.5V	1k	5.94k	14.5k	0.345	1.75 %
3.3V	0.6k	2.56k	1.685k	0.217	1.85 %

Table 3. Programming Voltage Values for 5/3.3V Lynx Modules

Output Voltage	Rext	Rtrim	Rg	Vs,nom	% Error
1.2	9.53k	22.464k	73.2k	0.385	2.4%
1.5V	6.34k	6.71k	10.0k	0.335	2.4 %
1.8V	6.19k	2.834k	1.58k	0.198	2.4 %
2.5V	2.21k	2.8k	6.19k	0.326	2.4 %
3.3V	1.47k	1.652k	3.19k	0.280	2.4 %
5.0V	0.32k	1.15k	3.19k	0.325	2.4 %

Table 4. Programming Voltage Values for 12V Lynx Modules

Summary

Margining and output voltage programming are useful features of the Lynx series of modules. Along with simple external circuits, they allow versatile output voltage adjustment of the module to fit various application needs. Margining is used for checking the robustness of the circuits, as well as ensuring the proper functionality of the module under a noisy environment. Voltage programming can be used to provide a precise adjustment of the module output voltage in demanding applications or provide dynamic voltage adjustment when needed.
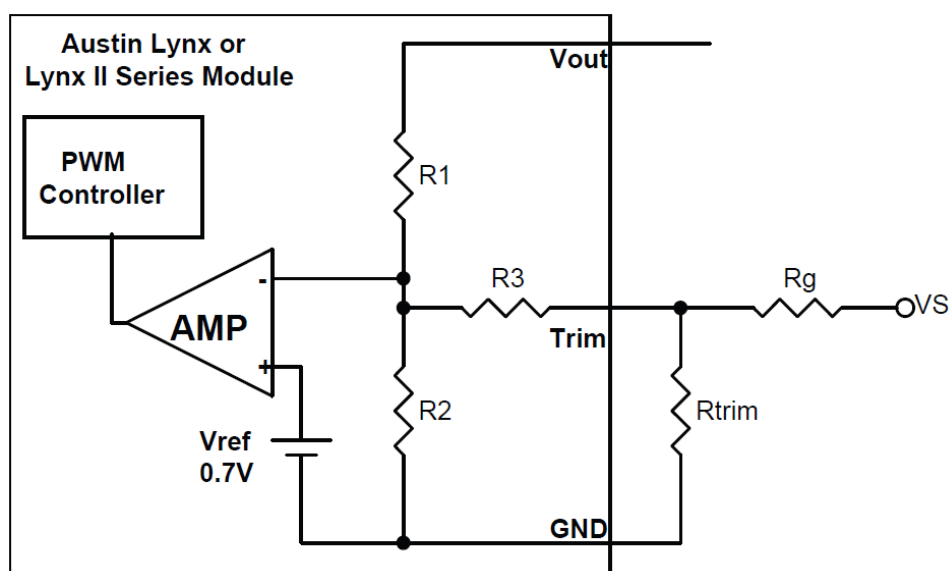

Fig. 5. Recommended circuit to be used in voltage programming along with margining of the Austin Lynx Series of modules.

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Output Voltage	Rtrim	Rg	Vs,nom	Vs,up (+10%)	Vs,down (-10%)	Vs,up (+5%)	Vs,down (-5%)
1.2	41.96k	124k	0.624	0.05	1.2	0.335	0.91
1.5V	23.07k	82k	0.573	0.05	1.095	0.310	0.835
1.8V	15.004k	55k	0.522	0.05	0.995	0.287	0.757
2.5V	6.947k	21.6k	0.403	0.05	0.758	0.226	0.58
3.3V	3.161k	5.6k	0.2675	0.05	0.485	0.159	0.376

Table 5. External Source Value for Margining 5/3.3V Lynx Series Modules

Output Voltage	Rtrim	Rg	Vs,nom	Vs,up (+10%)	Vs,down (-10%)	Vs,up (+5%)	Vs,down (-5%)
1.2	22.464k	73.2k	0.67	0.05	1.29	0.365	0.98
1.5V	13.047k	54.9k	0.65	0.05	1.25	0.350	0.950
1.8V	9.024k	42.2k	0.63	0.05	1.20	0.345	0.918
2.5V	5.009k	26.1k	0.58	0.05	1.12	0.315	0.855
3.3V	3.122k	15.8k	0.53	0.05	1.01	0.290	0.770
5.0V	1.472k	6.04k	0.417	0.05	0.79	0.231	0.603

Table 6. External Source Value for Margining 12V Lynx Series Modules

Contact Us

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