

Introduction

This application note provides an overview of the trim/margin capabilities of the Power/Platform Management devices from Lattice and detailed instructions on how to use the software tools of PAC-Designer® and Platform Designer to incorporate almost any adjustable DC-DC converter into a trimmed or margined power supply system.

Voltage margining is a circuit board functional test strategy in which one or more of the power supply rails are intentionally operated a few percent above or below their nominal voltages. This is used to simulate power supply voltage drift that may occur due to component aging, ambient temperature changes, or fluctuations in load current. Voltage trimming is a method of improving the accuracy of a power supply by providing a correction signal that makes fine adjustments to the power supply's output voltage.

DC-DC converters usually provide a mechanism to allow the user to adjust the output voltage by adding one or more external components. Typically, this mechanism is a single pin which can be left floating to allow the supply to run at its nominal output voltage or this pin can be pulled toward ground or toward the output via a resistor in order to adjust the output voltage up or down.

While this strategy for controlling supply outputs can be simple and very inexpensive to implement, some users will find that it has two principal shortcomings. The first shortcoming of this strategy is that in systems requiring more than one setpoint per supply, as in the case of voltage margining, multiple resistors and CMOS switches or digital potentiometers must be used; this can lead to increased PC board real estate usage and additional circuit complexity. The second is limited accuracy. Resistance errors due to component tolerances and due to the finite resolution of commonly available EIA-standard resistance values degrade the voltage accuracy of the system beyond the tolerance specification given by the DC-DC converter manufacturer.

Select members of the Lattice Semiconductor Power/Platform Management device family include a power supply margin/trim block that addresses both of these issues. These devices are shown in Table 1 below. The margin/trim block is composed of individual TrimCells, each of which can be configured to meet the trim or margining needs of a specific supply in the system. For designs requiring a high degree of accuracy, a closed-loop trim feature is available that automatically adjusts supplies against a high precision voltage reference built into the Power/Platform Management device. This closed loop trim feature is typically capable of bringing power supplies to an accuracy of 0.75%. Designs that need multiple setpoints for voltage scaling or margining can make use of the multiple voltage profiles that the device provides, or they can use the device's I²C interface to independently set each supply voltage.

The ispPAC-POWR6AT6, ispPAC-POWR1220AT8, and Platform Manager™ devices all share a common hardware implementation of the margin/trim block. This first generation margin/trim block is described in the Power Manager II / Platform Manager Trim Operation section below. This solution is configured using Lattice PAC-Designer software. The Platform Manager 2 and L-ASC10 devices feature an improved margin/trim block with increased functionality. This second generation margin/trim block is described in the ASC Trim Operation section. This solution is configured using the Platform Designer software, a part of Lattice Diamond® software.

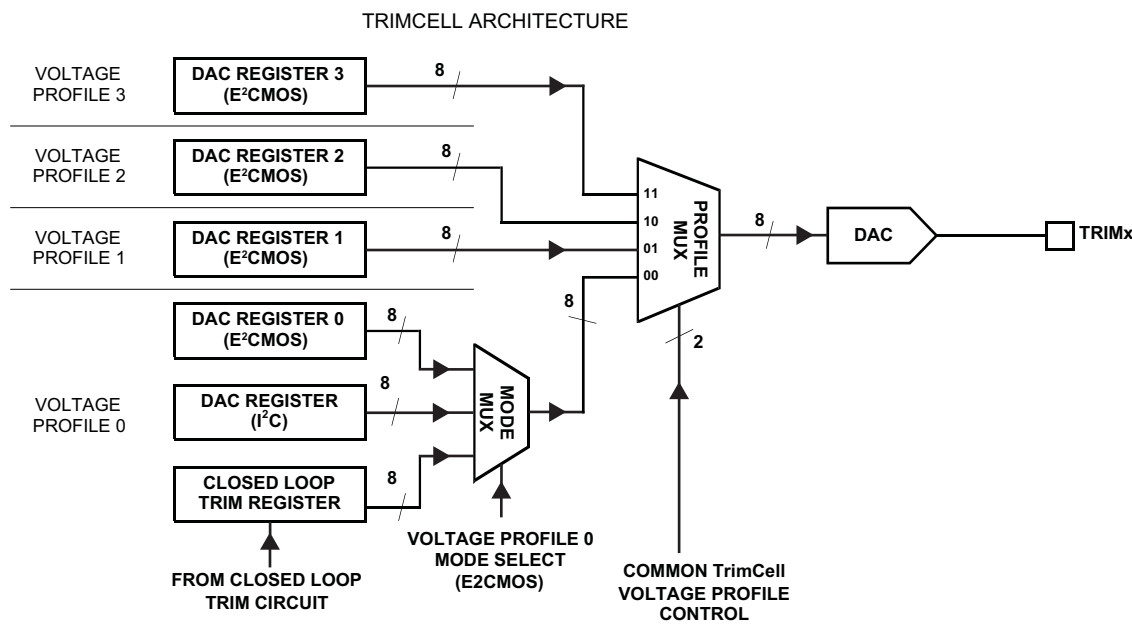
Table 1. Applicable Power/Platform Manager Device Summary

Device	VMONs	Trim DAC Outputs	TrimCell Implementation	CPLD Macrocells	FPGA LUTs
ispPAC-POWR6AT6	6	6	1st Generation	—	—
ispPAC-POWR1220AT8	12	8	1st Generation	48	—
LPTM10-1247	12	6	1st Generation	48	640
LPTM10-12107	12	8	1st Generation	48	640
LPTM21	10	4	2nd Generation	—	1280
L-ASC10	10	4	2nd Generation	—	—

Power Manager II/Platform Manager Trim Operation

The TrimCells in the Power Manager II/Platform Manager devices have four voltage profiles. Profiles 1-3 use non-volatile E²CMOS[®] memory to store their DAC output codes. These DAC codes are set during JTAG programming of the device. A typical use of these profiles is to perform voltage margining of a board or assembly. Profile 0 supports three operational modes: an E²CMOS controlled mode identical in its operation to that of profiles 1-3, an I²C controlled mode, and digital closed loop trim. The DAC output range (also called the bipolar zero voltage) for a given TrimCell is independent of the voltage profile setting and the profile 0 operating mode; this range setting is stored in E²CMOS memory. A block diagram of the TrimCell is shown in Figure 1.

Figure 1. First Generation TrimCell



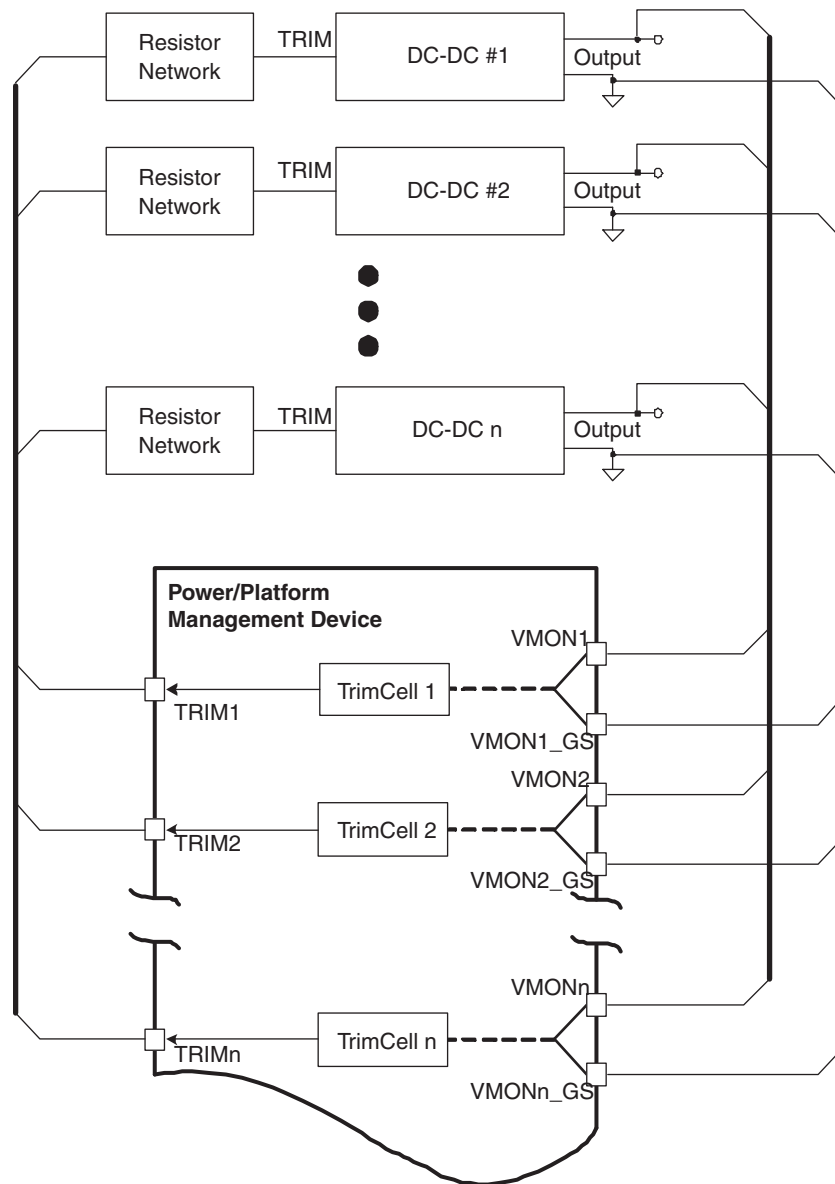
Of the three profile 0 operating modes, E²CMOS controlled mode is the most basic. In this mode, PAC-Designer calculates the DAC codes required to achieve the desired supply output voltages for each profile, and these codes are transferred to the device during JTAG programming.

In the I²C controlled mode, the DAC automatically loads hexadecimal value of 80 on power-up; this code corresponds to the bipolar zero voltage. An external microcontroller can then write to or read from the I²C register associated with that DAC. In this manner, the microcontroller can control the output voltage of the power supply, making adjustments as many times as necessary.

In digital closed loop trim mode, the TrimCell control logic compares the power supply output voltage, using a corresponding VMON input, against a target voltage stored in the Power Manager II's E²CMOS memory. A block dia-

gram of this closed loop system is shown in Figure 2. Any power supply that can be trimmed will achieve a typical accuracy of 0.75% or better. In digital closed loop trim mode, the DAC output assumes its programmed bipolar zero voltage, which may be 600 mV, 800 mV, 1.0 V, or 1.25 V, and stays there as long as the PLD_CLT_EN internal node is kept at a low logic state. To initiate closed loop trim, the sequence or a supervisory logic equation must set PLD_CLT_EN high. This single PLD_CLT_EN closed loop trim control signal is common to all of the TrimCells within the device. In the 6AT6 device, closed loop trim is enabled using a device pin called CLTENb; a logic low on this pin causes the closed loop trim to be enabled.

Figure 2. Using Closed Loop Trim with DC-DC Converters



If the power supplies to be closed-loop trimmed are also being sequenced, PLD_CLT_EN must be kept low until all of these supplies have been enabled. This prevents startup transients by allowing the power supplies start at a voltage that is relatively close to the desired target voltage. Once all of these power supplies have been enabled, setting PLD_CLT_EN high lets the closed loop trim logic make the adjustments necessary to compensate for component tolerances and resistive drops in the connections between the power supply and load. Once closed loop trim is running, temporarily reverting PLD_CLT_EN to a low state will pause all activity associated with closed loop trimming. As long as PLD_CLT_EN is held low, the Trim DACs will hold the output levels that they had immedi-

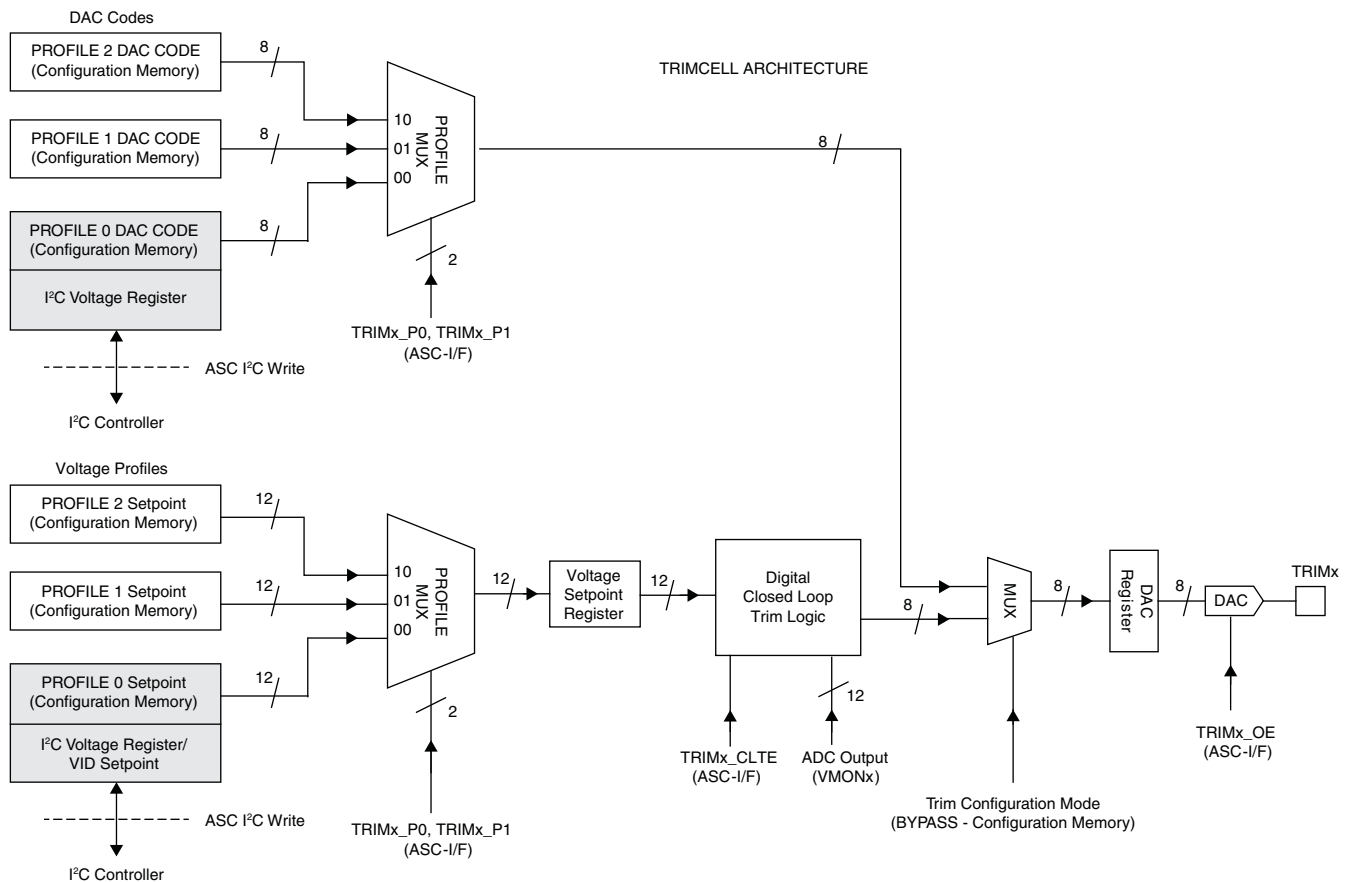
ately before closed loop trimming was paused. When PLD_CLT_EN is brought back to a high state, closed loop trimming resumes in a transient-free manner. If a sequence is designed to power-cycle one or more supplies that are being closed loop trimmed, then the closed loop trim action should be paused prior to power-cycling these supplies by setting PLD_CLT_EN low.

The DAC can be accessed via I²C when the TrimCell is in closed loop trimmed mode. Reading the DAC value gives an indication of the output voltage of the DAC at the time that the read took place. A microcontroller on the I²C bus could use this information as an indication that the closed loop trim is working properly; if the code approaches hexadecimal 00 or FF, then some fault is occurring that is preventing the closed loop trim from maintaining the power supply at its desired output. When closed loop trim is paused by setting PLD_CLT_EN low, the I²C interface can be used to write codes to the trim DACs without having to change the profile 0 mode to I²C.

Platform Manager 2 / ASC Trim Operation

The TrimCells in Platform Manager 2 and ASC devices have three voltage profiles. All three of the profiles are stored as either closed loop trim setpoints or DAC codes in the EEPROM memory of the devices. These profiles are copied to configuration shadow registers at device power on, and can be overwritten using I²C commands as detailed in the device datasheet. The DAC bipolar zero voltage for each TrimCell is independent of the voltage profile setting. The bipolar zero setting is stored in EEPROM memory and copied to a separate configuration shadow register at device power on. The block diagram of the Platform Manager 2/ ASC TrimCell is shown in Figure 3 below.

Figure 3. TrimCell Architecture



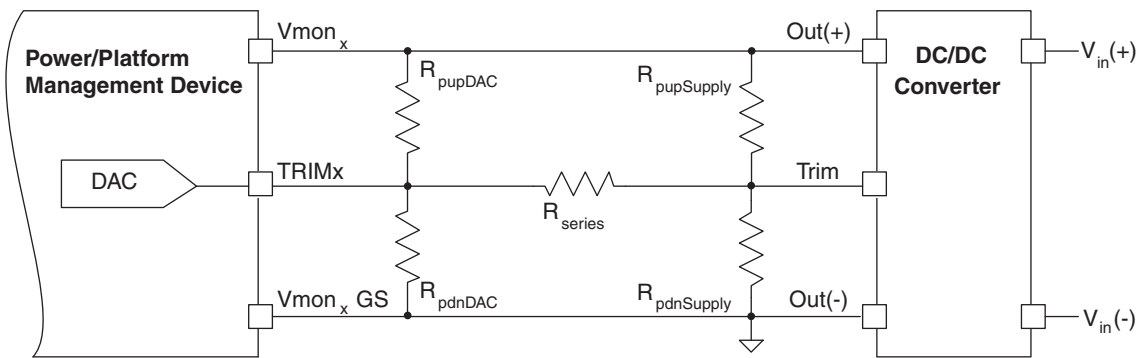
When digital closed loop trim mode is enabled, the TrimCell control logic will compare the power supply output voltage (monitored at the corresponding VMON channel) against the target input voltage of the active profile. This is the same closed loop system approach shown in Figure 2.

The DAC output in Figure 2 will be set to high impedance when the output enable signal (TRIMx_OE) is set to zero. Once the TRIMx_OE is first set to 1, the DAC will output the programmed bipolar zero voltage (either 600 mV, 800 mV, 1.0 V, or 1.25 V). The DAC voltage will stay at the programmed bipolar zero voltage while TRIMx_CLTE is set to 0. Once TRIMx_CLTE is set to 1, the DAC voltage will be updated by the Closed Loop Trim logic to trim the power supply towards the target voltage setpoint. If TRIMx_CLTE is set back to 0, the DAC voltage will pause at the current output value. The TRIMx_P0 and TRIMx_P1 settings are used to choose between voltage profile 0, 1 and 2 (setting TRIMx_P0 and TRIMx_P1 to 1 is not allowed and will result in unspecified behavior). The voltage profiles, closed loop trim enable, and output enable controls all operate on a per-TrimCell basis.

A Generic Trim DAC to DC-DC Converter Interface

Figure 4 shows all of the components that might be present in a network interfacing the Power/Platform Management device's Trim DAC to the trim input of a DC/DC converter.

Figure 4. Trim Pin Interface Circuit

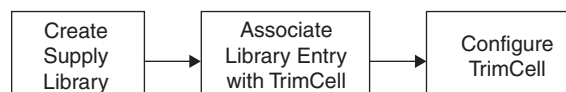


The design tool trim configuration dialog box determines which of the resistors need to be used and the values of these components. Actual trim networks contain between one and three resistors. Rseries is always needed to couple the DAC output to the trim pin of the DC/DC converter; in some cases, its value may be zero. For a given output voltage, the values of the resistors in this network will be different than those indicated by voltage programming tables or equations in the DC/DC converter data sheet.

Trim Setup Overview

Figure 5 illustrates the steps associated with setting up the trim/margin features of a Lattice hardware management device in PAC-Designer and Platform Designer. First, a library, containing information about the power supplies to be used, is created. Then, power supply entries from the library are associated with the TrimCells. The remaining TrimCell configuration tasks, such as entering target voltages, setting options, and calculating resistor values are done after a power supply has been selected.

Figure 5. Summary of Trim Setup



Building a DC-DC Converter Library

PAC-Designer and Platform Designer keep a user-defined library of the voltage trim characteristics of DC-DC converters. DC-DC converters must be entered into this library, using the Library Builder, before they can be used during TrimCell setup. Figure 6 illustrates the procedure for entering a new supply entry to the library or for modifying an existing entry.

Figure 6. Library Manager Usage

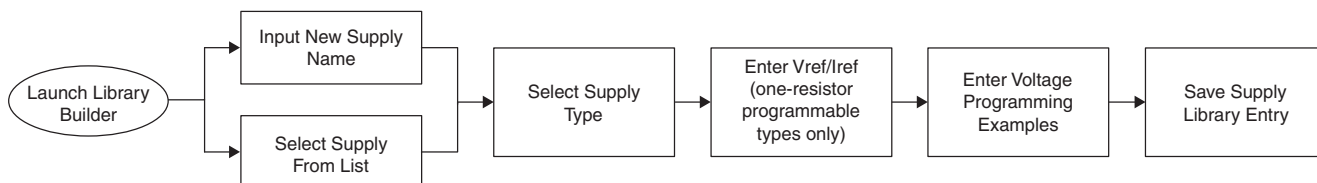


Figure 7 through Figure 15 show the dialog boxes associated with populating or editing the library. By default, the DC-DC Converter library files are stored in the directory “DCtoDC_Library,” which is a subdirectory of the PAC-Designer or Platform Designer installation directories. Figure 7 shows the launch button for accessing the DC-DC Library Builder in PAC-Designer. Figure 8, shows the location for accessing the DC-DC Library Builder in Platform Designer.

Figure 7. Library Builder Launch Button (part of PAC-Designer Toolbar)



Figure 8. DC-DC Library Builder Access (Platform Designer)

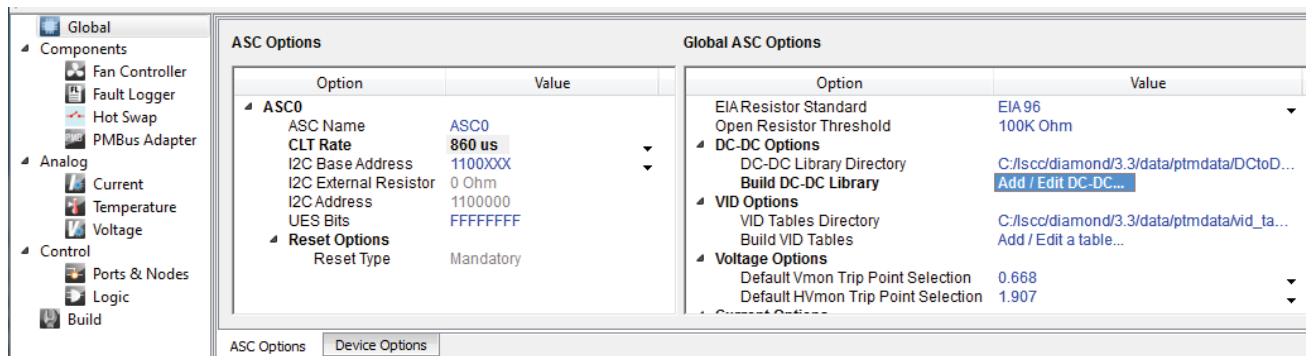
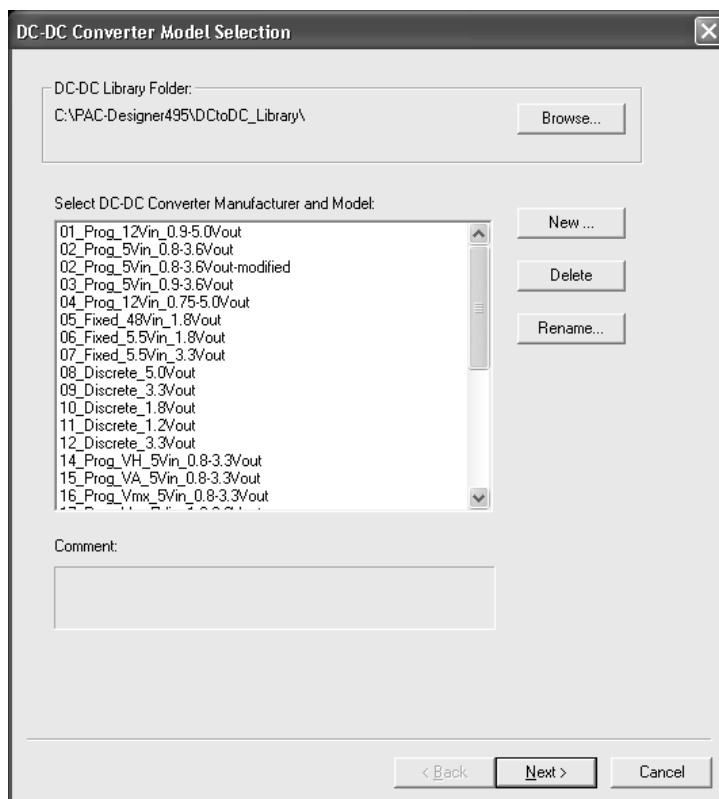


Figure 9. DC-DC Library Manager



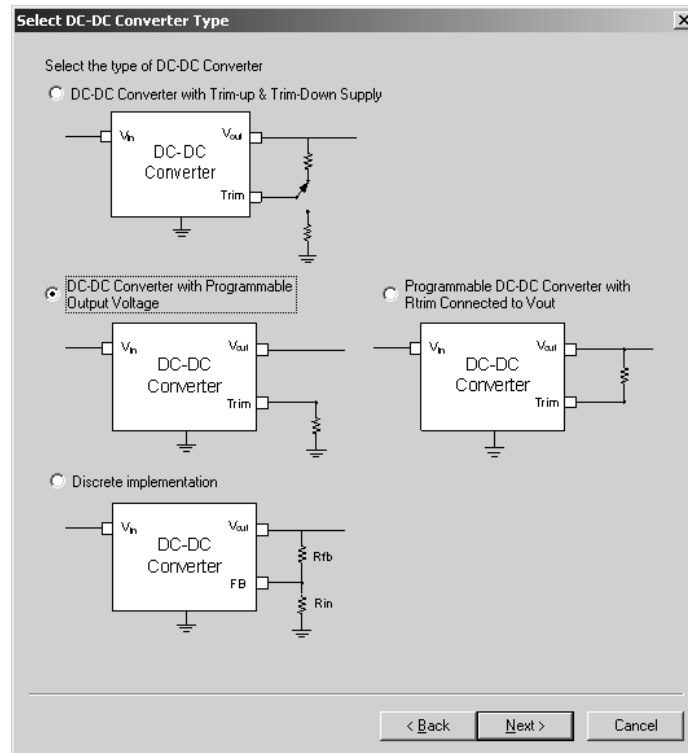
The Library Manager is launched by clicking on the **DC-DC** button on the toolbar in PAC-Designer (see Figure 7) or the **Add / Edit DC-DC** option in the Global > ASC Options > Global ASC Options section of Platform Designer (see Figure 8). The Library Manager dialog in Figure 9 is displayed. From here, a previously saved power supply configuration can be edited, a new configuration can be created, existing configurations can be renamed, or any unwanted entry can be deleted from the library. An existing configuration is selected by highlighting the desired entry from the list, using the mouse, and clicking **Next**. New entries are created by clicking **New**.

When **Next** is clicked from the Library Builder, the dialog in Figure 10 appears, prompting for the selection of a supply type, which may be any one of the following.

- **DC-DC Converter with Trim-Up & Trim-Down Supply** – Refers to power supplies that are designed to output a standard voltage, such as 2.5 V, when no external voltage setting resistors are connected to the supply's TRIM pin. Connecting an external resistor from the power supply's TRIM pin to either ground or the output causes the supply's output voltage to change by up to a few percent.
- **DC-DC Converter with Programmable Output Voltage** – Refers to supplies that produce an output voltage near one end of the supply's output range when no resistors are connected to the TRIM pin. With this type of power supply, a resistor is connected between the TRIM pin and ground to set the supply's operating output voltage.
- **Programmable DC-DC Converter with Rtrim Connected to Vout** – Refers to a similar type of supply as the DC-DC Converter with Programmable Output Voltage, except that voltage programming is accomplished by connecting a resistor between the TRIM pin and Vout, as opposed to TRIM and ground.
- **Discrete implementation** – Refers to virtually any regulated power supply in which the feedback components to set its output voltage are user-defined.

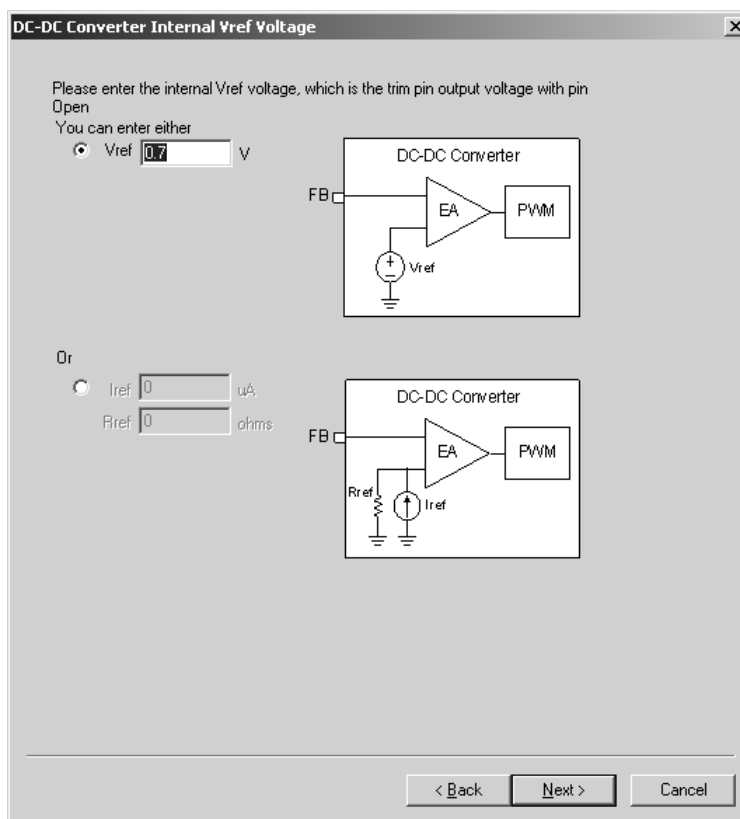
Depending on the type of supply selected, a corresponding dialog from Figures 14, 15, 16, or 17 will be displayed. The function of these four dialogs is similar: they gather the information required to describe the supply's voltage adjustment characteristics.

Figure 10. Select DC-DC Converter Type



With programmable and discrete supplies, the internal reference voltage or current must be entered into the dialog in Figure 11 (PAC-Designer Library Builder only) to guarantee accurate results. In Platform Designer the reference voltage is entered in the same screen as the other data sheet information (see Figure 12)

Figure 11. DC-DC Converter Internal Reference Dialog (PAC-Designer Only)



DC-DC Converter Internal Vref Voltage

Please enter the internal Vref voltage, which is the trim pin output voltage with pin Open

You can enter either

☒ Vref V

Or

☐ Iref μA

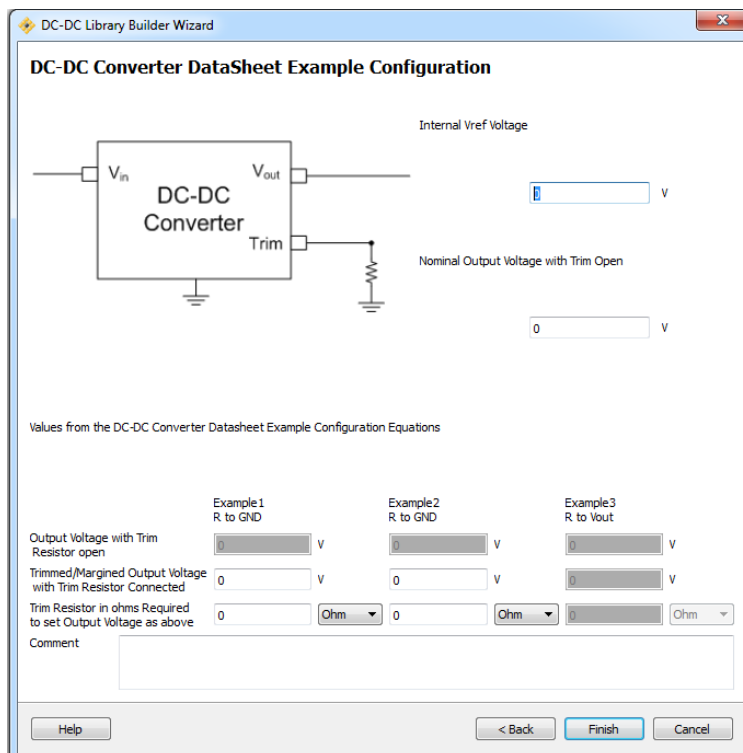
☐ Rref ohms

Diagram 1: DC-DC Converter block with FB input, EA (Error Amplifier), and PWM block. A voltage source Vref is connected to the EA input.

Diagram 2: DC-DC Converter block with FB input, EA (Error Amplifier), and PWM block. A resistor Rref is connected to the EA input, and a current source Iref is connected to the FB input.

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Figure 12. DC-DC Converter Data Sheet Example Configuration (Showing Internal Vref Entry) - Platform Designer Only



DC-DC Library Builder Wizard

DC-DC Converter DataSheet Example Configuration

Internal Vref Voltage

V

Nominal Output Voltage with Trim Open

V

Values from the DC-DC Converter Datasheet Example Configuration Equations

	Example1 R to GND	Example2 R to GND	Example3 R to Vout
Output Voltage with Trim Resistor open	0 V	0 V	0 V
Trimmed/Margined Output Voltage with Trim Resistor Connected	0 V	0 V	0 V
Trim Resistor in ohms Required to set Output Voltage as above	0 Ohm	0 Ohm	0 Ohm

Comment

Help < Back Finish Cancel

In some cases, the Vref voltage is specified in the Electrical Specification of the DC/DC converter. If this is not the case, and the supply is programmable with a single resistor to ground, search the DC-DC converter data sheet for a voltage programming equation in the form of Equations 1 or 2.

Equation 1. Rset Equation (Format 1)

$$R_{set} = R_f * \frac{V_{ref}}{V_{out}} - R_{buffer}$$

Equation 2. Rset Equation (Format 2)

$$R_{set} = R_f * \frac{V_{ref}}{V_{out} - V_{out_{min}}} - R_{buffer}$$

In Equations 1 and 2, Rf and Rbuffer are expressed in Ohms. Vref is the internal reference voltage, which should be entered into the dialog. Equation 3 shows an Rset equation from a POLA compliant DC/DC converter.

Equation 3. Rset Equation as Shown in PTH03030 Data Sheet

$$R_{set} = 10\text{ K} \times \frac{0.8\text{ V}}{V_{out} - 0.8\text{ V}} - 2.49\text{ k}\Omega$$

If the data sheet gives a similar formula but Rf and Vref do not appear as separate terms, then the reference voltage will have to be determined by another method. One such method is the formula for programming the output with an external voltage. Look for an equation in the form of Equation 4.

Equation 4. Vset Output Programming Equation

$$V_{set} = V_{ref} - \frac{(R_{buffer} + R_{set})(V_{out} - V_{out_{min}})}{R_f}$$

In Equation 4, Rtrim is the value of the external resistor between the supply's trim pin and the external Vset voltage source. Rbuffer and Rf are internal component values. Equation 5 shows a Vset equation in this form, taken from a Power-One YNM05S05 data sheet. In this data sheet excerpt, Rbuffer is 5.11 kΩ.

Equation 5. Vset Equation as Shown in YNM05S05 Data Sheet

$$V_{CTRL} = 0.7 - \frac{(5.11 + R_{EXT})(V_{O-REQ} - 0.7525)}{30.1} \text{ [V]}$$

where,

V_{CTRL} = CONTROL VOLTAGE [V]

R_{EXT} = External resistor between TRIM pin and voltage source; the value can be chosen depending on the required output voltage range [kΩ]

In the case of supplies that are programmable with a single resistor between the output and the trim pin, an equation in the form of Equation 6 should be in the DC-DC converter data sheet.

Equation 6. Rset Equation (Format 3)

$$R_{set} = \left(\frac{V_{out} - V_{ref}}{\Delta V_{out}} - 1 \right) R_f - R_{buffer}$$

In the event that the manufacturer does not provide any voltage programming equations that are in the appropriate form to determine V_{ref} , this voltage can be approximated using a voltmeter with an impedance of 10 megohms or greater. To perform this measurement, connect an appropriate load to the power supply but leave the trim pin open circuited. Apply an appropriate voltage to the input of the supply and measure the voltage at the trim pin.

Power supplies that use a current source as the reference tend to explicitly specify the value of the internal reference current source and the R_{ref} internal load resistance. An equation in the form of Equation 7 may be given.

Equation 7. Rset Equation (Format 4)

$$R_{set} = \frac{R_2 * R_{ref} * V_{out}}{(R_1 + R_2) * R_{ref} * I_{ref} - R_2 * V_{out}}$$

Note that in Equation 7, V_{out} refers to the desired output voltage, not the output voltage realized when the trim pin is left floating. Figure 13 shows this R_{set} information and a simplified schematic of the reference circuit associated with it as they appear in a Bellnix BSV-3.3S series data sheet. In this excerpt, the symbol R_3 is used in place of R_{ref} to identify the reference current source's internal load resistance.

Figure 13. Rset Information as Shown in Bellnix's BSV-3.3S Series Data Sheet

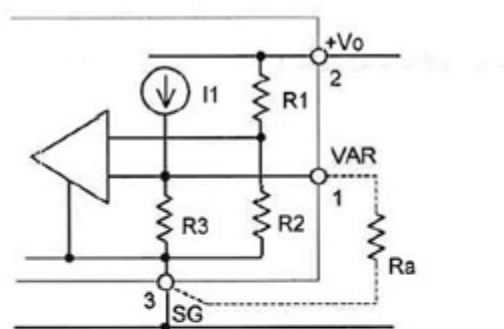


Figure 5 Connection when adjusting the output

Table 3

Trim Range Vo[V]	Ra[k ohm]
+1.0	37.60
+1.5	72.00
+1.8	103.61
+2.5	268.87
+3.3	Open

- Ra is calculated as follow

$$R_a = \frac{R_2 \times R_3 \times V_o}{[(R_1 + R_2) \times R_3 \times I_1 - R_2 \times V_o]} \text{ [ohm]}$$

In a discrete supply, the reference voltage is equal to the voltage at the feedback pin. This voltage can either be measured or it can be calculated from the values of the feedback resistors using Equation 8.

Equation 8. Calculating Vref Based on Feedback Resistors

$$V_{\text{ref}} = V_{\text{out}} \times \frac{R_{\text{in}}}{R_{\text{fb}} + R_{\text{in}}}$$

Equation 9 shows an example discrete supply voltage programming equation.

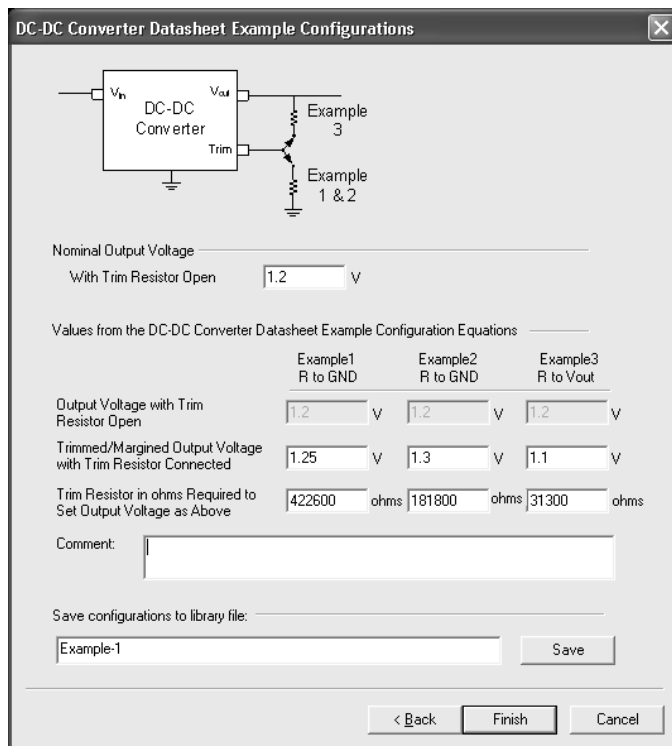
Equation 9. Discrete Supply Voltage Programming Equation

$$V_{\text{out}} = 0.6 \text{ V} \left(1 + \frac{R_{\text{fb}}}{R_{\text{in}}} \right)$$

In the case of the **DC-DC Converter with Trim-Up & Trim-Down Supply**, **DC-DC Converter with Programmable Output Voltage**, or **Programmable DC-DC Converter with Rtrim Connected to Vout** supplies, the data to be input is in the form of several voltage setting examples. These examples can be calculated using the formulae or tables provided in the DC/DC converter Data Sheet. In some cases, calculations are not necessary because the data sheet gives tables showing the resistances needed to achieve specific output voltages. In the case of supplies that can be adjusted by connecting a resistor from the TRIM pin to either ground or the output (Figure 14), three examples must be entered: two with different resistances to ground and one with a resistance to the output. Wide-range programmable supplies (Figures 15 and 16) need two examples.

Figure 14 shows an example of a “Trim Up & Trim-Down Supply,” which has been filled in with values for a Celestica NCF010 series 1.2 V supply. Library Manager Example 1 at the end of this application note demonstrates how the values in Figure 14 were calculated.

Figure 14. Trim Up/Down Supply



DC-DC Converter Datasheet Example Configurations

Nominal Output Voltage
With Trim Resistor Open: 1.2 V

Values from the DC-DC Converter Datasheet Example Configuration Equations

	Example1 R to GND	Example2 R to GND	Example3 R to Vout
Output Voltage with Trim Resistor Open	1.2 V	1.2 V	1.2 V
Trimmed/Margined Output Voltage with Trim Resistor Connected	1.25 V	1.3 V	1.1 V
Trim Resistor in ohms Required to Set Output Voltage as Above	422600 ohms	181800 ohms	31300 ohms

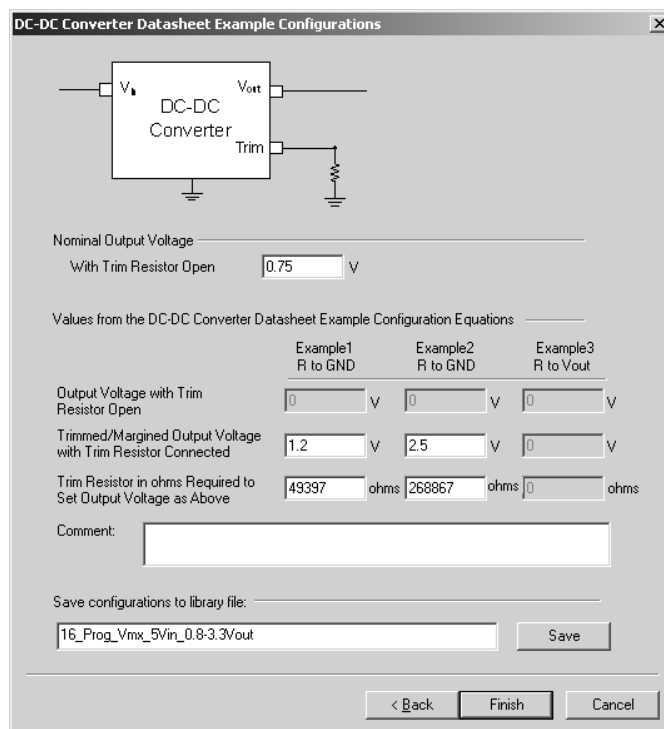
Comment:

Save configurations to library file:
Example-1 [Save]

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Figure 15 shows a “DC-DC Converter With Programmable Output Voltage.” Most wide-range programmable supplies, such as POLA-compliant units, fit into this category. Often, the manufacturer's data sheet provides a table of voltage programming examples so that no calculations are necessary. Library Manager Example 2 at the end of this application note covers this type of supply in more detail.

Figure 15. Programmable Supply Using Single Resistor to Ground



DC-DC Converter Datasheet Example Configurations

Nominal Output Voltage
With Trim Resistor Open: 0.75 V

Values from the DC-DC Converter Datasheet Example Configuration Equations

	Example1 R to GND	Example2 R to GND	Example3 R to Vout
Output Voltage with Trim Resistor Open	0 V	0 V	0 V
Trimmed/Margined Output Voltage with Trim Resistor Connected	1.2 V	2.5 V	0 V
Trim Resistor in ohms Required to Set Output Voltage as Above	49397 ohms	268867 ohms	0 ohms

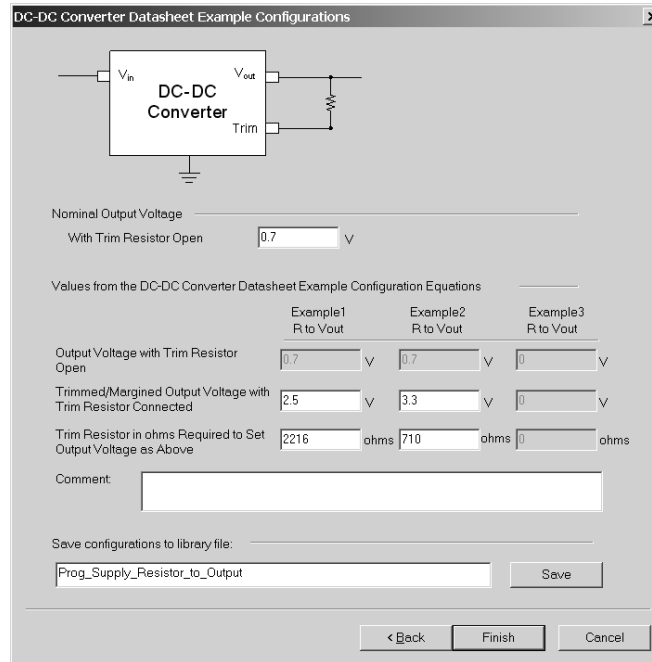
Comment:

Save configurations to library file: 16_Prog_Vmx_5Vin_0.8-3.3Vout

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Figure 16 shows a “Programmable DC-DC Converter with Rtrim Connected to Vout” supply. In this type of power supply, the power supply output voltage increases as the value of the programming resistor decreases.

Figure 16. Programmable Supply Using Single Resistor to V_{OUT}



DC-DC Converter Datasheet Example Configurations

V_{in} V_{out}
 DC-DC Converter
 Trim

Nominal Output Voltage
 With Trim Resistor Open 0.7 V

Values from the DC-DC Converter Datasheet Example Configuration Equations

	Example1 R to V_{out}	Example2 R to V_{out}	Example3 R to V_{out}
Output Voltage with Trim Resistor Open	0.7 V	0.7 V	0 V
Trimmed/Margined Output Voltage with Trim Resistor Connected	2.5 V	3.3 V	0 V
Trim Resistor in ohms Required to Set Output Voltage as Above	2216 ohms	710 ohms	0 ohms

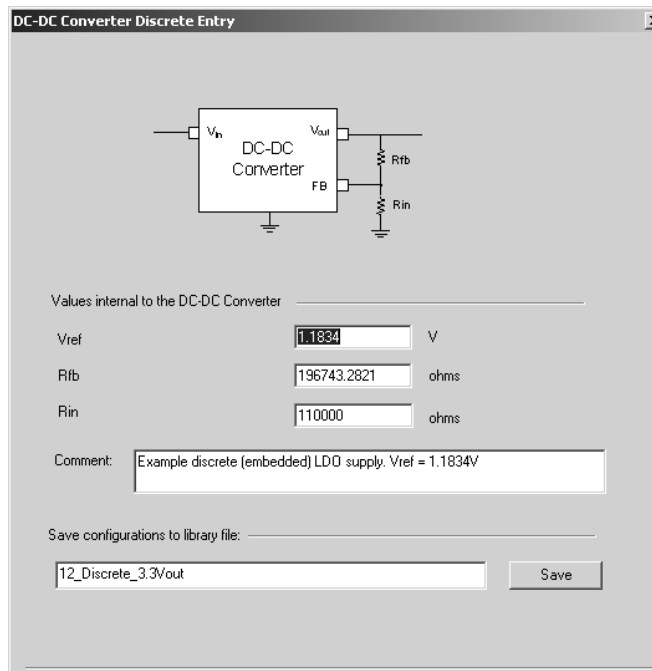
Comment:

Save configurations to library file:
 Prog_Supply_Resistor_to_Output Save

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Figure 17 shows a “Discrete Implementation” type power supply. In this type of supply, the reference voltage is specified in the data sheet, and the R_{fb} and R_{in} programming resistors are user-defined. In order to guarantee optimum stability and voltage accuracy, the recommendations set forth in the regulator data sheet should be followed when selecting these resistors. Library Manager Example 3 at the end of this application note gives an example of this type of power supply configuration, using a Texas Instruments low-dropout linear regulator.

Figure 17. Discrete Implementation



DC-DC Converter Discrete Entry

V_{in} V_{out}
 DC-DC Converter
 FB

R_{fb}
 R_{in}

Values internal to the DC-DC Converter

V_{ref} 1.1834 V
 R_{fb} 196743.2821 ohms
 R_{in} 110000 ohms

Comment: Example discrete (embedded) LDO supply. $V_{ref} = 1.1834V$

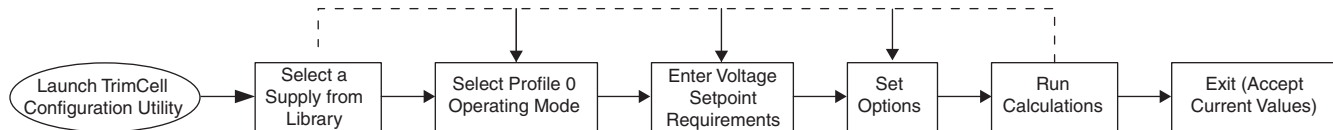
Save configurations to library file:
 12_Discrete_3.3Vout Save

Once all of the required information has been entered, the **Save** button should be clicked to save the newly created supply configuration into the library.

Configuring the TrimCells – PAC-Designer

The TrimCell configuration dialog is used to set up the TrimCells and calculate the component values required for the trim interface network discussed in the previous section. This section details the TrimCell configuration in PAC-Designer for the POWR6AT6, POWR1220AT8, and Platform Manager (LPTM1247 and LPTM12107) devices. Devices configured in Platform Designer (LPTM21 and L-ASC10) are covered in the Configuring the TrimCells - Platform Designer section. This utility's flow of operation is diagrammed in Figure 18. Once a supply has been selected from the library, it is easy to change any parameter or parameters and re-run the calculations.

Figure 18. Trim Configuration Dialog Usage



To launch the dialog, double-click the Margin/Trim sub-schematic and then double-click on the desired TrimCell, as shown in Figure 19.

Figure 19. Launching the Trim Configuration Dialog

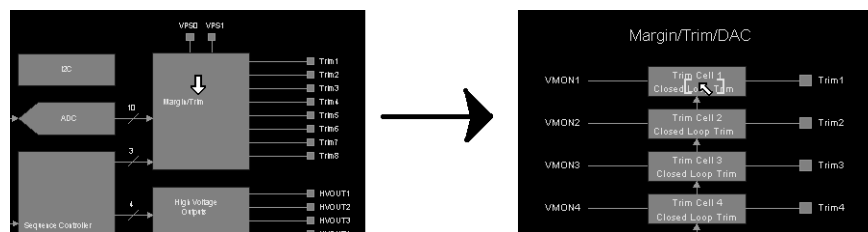
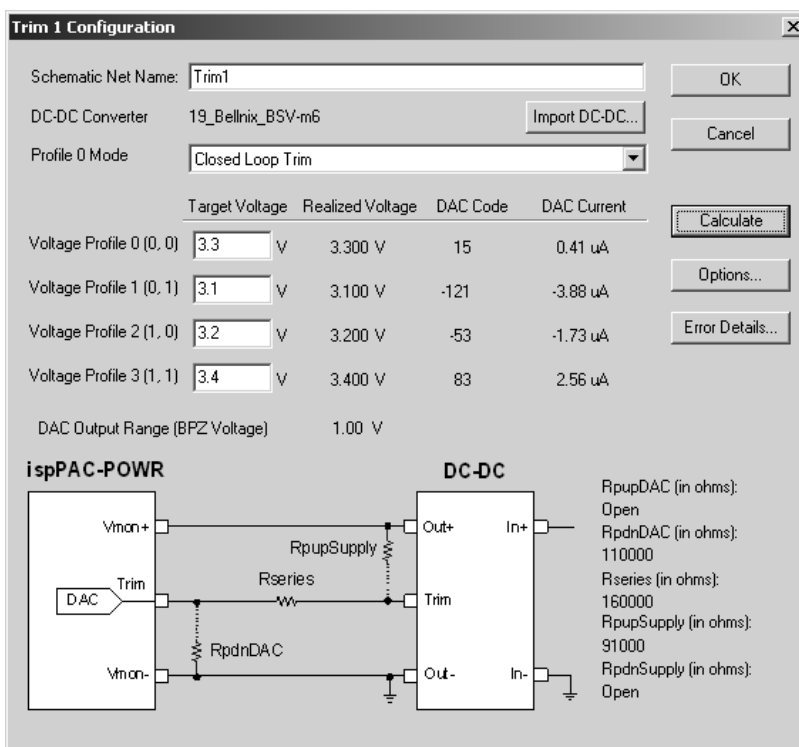


Figure 20 shows the TrimCell configuration dialog. The dialog allows for the DC-DC converter model and the Profile 0 operating mode to be selected from pull-down menus. Click the **Import DC-DC** button to select a power supply from the library to associate with the TrimCell. After a supply has been selected, the target voltages for each profile are entered in the text fields near the center. The association between a TrimCell and a power supply can be changed at any time by clicking **Import DC-DC** but the target voltages for all profiles will need to be re-entered each time that this association is changed.

Once all of the needed data have been entered, click the **Calculate** button. The results reported on this dialog are: the realized DC-DC converter output voltage and DAC code for each profile (to the right of the voltage entry fields), DAC bipolar zero voltage (immediately below the target voltage section), and resistor values (in the schematic at the bottom of the dialog).

Figure 20. TrimCell Configuration Dialog



Trim 1 Configuration

Schematic Net Name: Trim1

DC-DC Converter: 19_Bellnix_BSV-m6

Profile 0 Mode: Closed Loop Trim

	Target Voltage	Realized Voltage	DAC Code	DAC Current
Voltage Profile 0 (0, 0)	3.3 V	3.300 V	15	0.41 uA
Voltage Profile 1 (0, 1)	3.1 V	3.100 V	-121	-3.88 uA
Voltage Profile 2 (1, 0)	3.2 V	3.200 V	-53	-1.73 uA
Voltage Profile 3 (1, 1)	3.4 V	3.400 V	83	2.56 uA

DAC Output Range (BPZ Voltage): 1.00 V

ispPAC-POWER

DC-DC

RpupDAC (in ohms): Open
 RpdnDAC (in ohms): 110000
 Rseries (in ohms): 160000
 RpupSupply (in ohms): 91000
 RpdnSupply (in ohms): Open

The Trim Configuration Options dialog, which is launched by clicking on the **Options** button, allows access to advanced settings. Figure 21 shows this dialog with its default values. The parameters Maximum DAC Code Range and Max Supply Adjustment Range describe how sensitive the supply output voltage should be to changes in the values received by the DAC. The default values for these parameters cause the resistors to be calculated so that a DAC code magnitude of 110 (decimal) results in the power supply voltage being adjusted up or down by 5%. The reason that the full DAC range is not used is to leave some headroom in the event of inaccuracy due to supply or resistor tolerances and due to the temperature coefficients of these components. The Attenuation Crossover Voltage setting decides whether or not the attenuator will be used on this trim channel. If the profile 0 voltage is greater than the attenuation cross over voltage setting, then the attenuator will be engaged. The EIA Resistor Standard pull-down constrains the R_{PDN} value to the selected table. R_{PUP} and R_{SERIES} are always constrained to EIA24, which is the standard value table typically associated with 5% resistors.

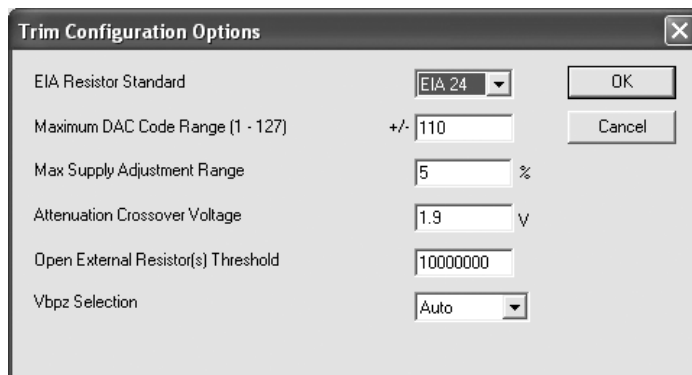
If an adjustment range smaller than 5% is needed, entering that value into the Max Supply Adjustment Range field will enhance the output voltage resolution of the trimmed power supply system. The default values for Maximum DAC Code Range and Attenuation Crossover Voltage are adequate for most systems and generally should not be changed.

Advanced User Options – PAC-Designer

The open external resistor threshold parameter, when set to 10,000 Ohms, results in replacing calculated resistor values above 10,000 Ohms with an open circuit. This parameter should be used to synthesize fewer resistors to be connected between the trim pin of the Power Manager and the DC-DC Converter. *Note: While using this method to reduce the number of resistors, one should pay attention to the DAC code in the profile 0. If it is very high, please contact the Lattice Applications group.*

The Vbpz selection field should be set to Auto for most of the supplies. Please contact the Lattice Applications group if changing of this setting is required.

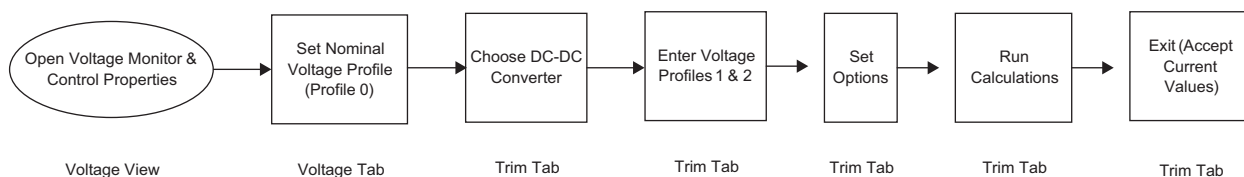
Figure 21. Trim Configuration Options Dialog



Configuring the TrimCells – Platform Designer

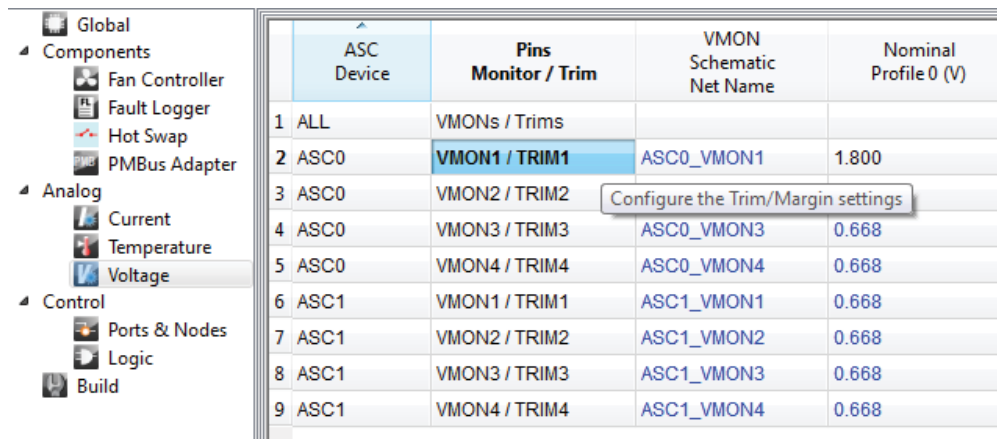
The Voltage Monitor & Control Properties dialog box is used to set up the TrimCells and calculate the component values required for the trim interface network discussed in the earlier section. This section details the TrimCell configuration in Platform Designer (LPTM21 and L-ASC10). Devices configured in PAC-Designer (POWR6AT6, POWR1220AT8, and Platform Manager – LPTM1247 and LPTM12107) are covered in the [Configuring the TrimCells – PAC-Designer](#) section. The flow of operation for configuring the TrimCell is shown in Figure 22. Once the supply has been chosen from the library, it is easy to change any parameter or parameters and re-run the calculations.

Figure 22. Trim Configuration – Voltage Monitor & Control Properties Usage



To launch the Voltage Monitor & Control Properties dialog box, double-click any TRIM pin cell from the Pins Monitor/Trim column in the Voltage view, as shown in Figure 23.

Figure 23. Launching the Voltage Monitor and Control Properties Dialog Box



The Voltage Monitor & Control Properties dialog box will open. The dialog box contains three different tabs – Voltage, Trim/Margin & VID. When the dialog box opens, the dialog box active tab will match the tab from the Voltage view used to launch the dialog box.

Figure 25 shows the Voltage Monitor & Control Properties dialog box open to the Voltage tab. The first step is to configure the Nominal Profile 0 in the Voltage tab. This profile is used as the nominal voltage for the given channel as well as the Profile 0 voltage for trimming. The rest of the configuration is completed in the Trim/Margin tab of the Voltage Monitor & Control Properties dialog box as shown in Figure 25.

Figure 24. Voltage Monitor & Control Properties Dialog Box - Voltage Tab

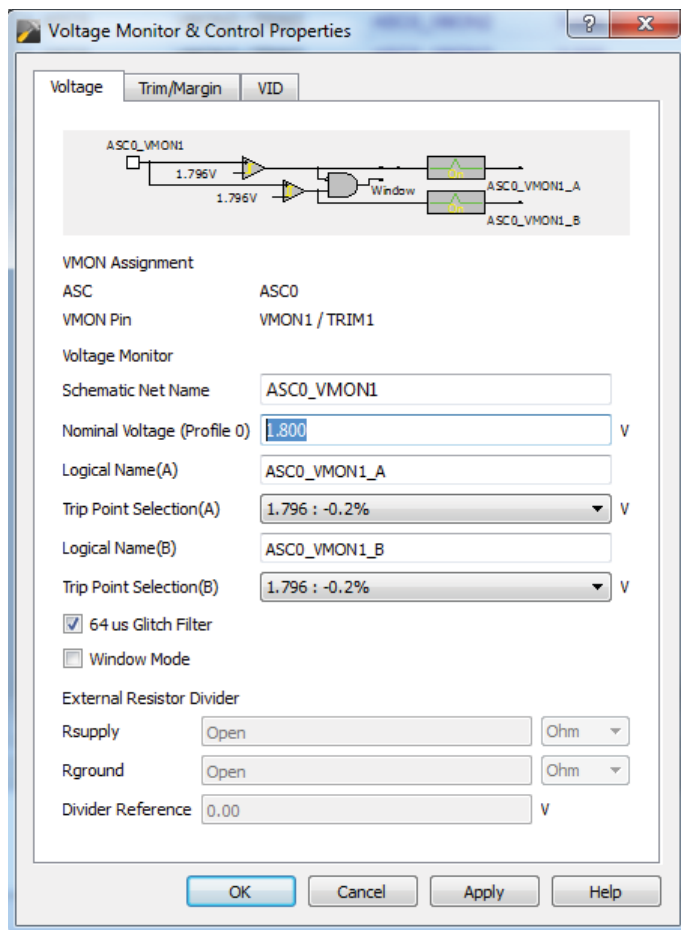
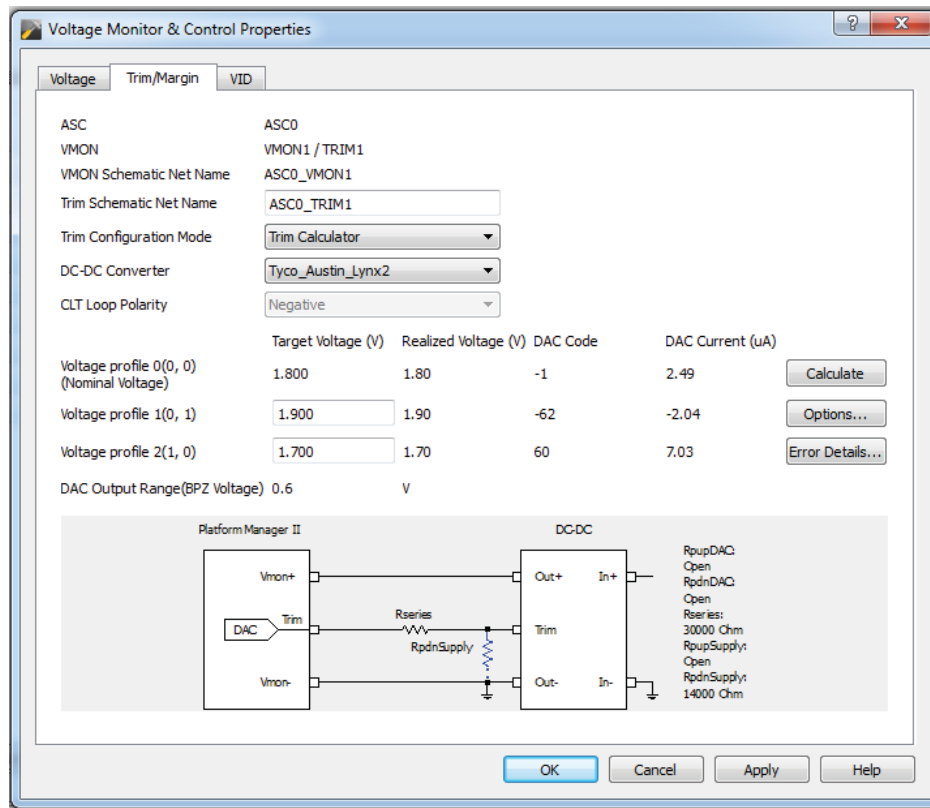


Figure 25. Voltage Monitor & Control Properties Dialog Box - Trim/Margin Tab



The Trim / Margin Tab includes the following settings:

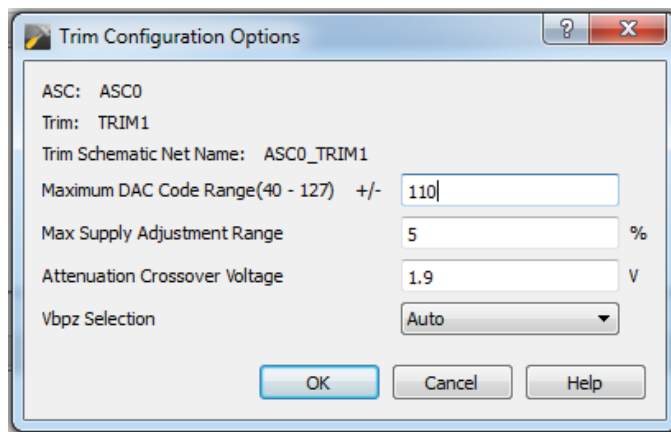
- **Trim Schematic Net Name** – This property is for user information only. The name can be updated to match the schematic net name from the design. Updating this property is optional.
- **Trim Configuration Mode** – Choose from Trim Calculator or Manual mode. Trim Calculator mode is used with Closed Loop Trimming. Manual mode is only used to apply open loop DAC codes at the Trim Output. Manual mode will disable closed loop trimming.
- **DC-DC Converter** – This drop-down menu is used to associate one of the library DC-DC converter models to the TrimCell. The DC-DC converter model is used by the Trim Calculator to determine the Trim resistors, optimal BPZ voltage setting, and confirm that the current and voltage range from the TrimCell are sufficient to trim to the Profiles 0, 1 and 2.
- **CLT Loop Polarity (Read Only)** – This property is read-only and provided for feedback to the user. The CLT Loop Polarity is set automatically based on the definition of the DC-DC converter model.
- **Voltage Profile 0 (0, 0) (Nominal Profile)** – This property is read-only in the Trim/Margin tab (set in the Voltage tab). This is the closed loop trim target voltage when the Profile is set to zero for the associated TrimCell. The realized voltage, DAC code, and DAC current are feedback values displayed by the trim calculator.
- **Voltage Profile 1 (0, 1)** – Closed loop trim target voltage when the Profile is set to one for the associated TrimCell. An error in the DAC code or DAC current means that the current DC-DC converter, Voltage Profiles, and Options are not compatible. Click the Error Details button for more information.
- **Voltage Profile 2 (1, 0)** – Closed loop trim target voltage when the Profile is set to two for the associated TrimCell. An error in the DAC code or DAC current means that the current DC-DC converter, Voltage Profiles, and Options are not compatible. Click the Error Details button for more information.
- **DAC Output Range (BPZ Voltage)** – Displays the Bi-Polar Zero (BPZ) Voltage of the TrimCell under the current configuration. This value is automatically selected by the calculator, or selected manually by the user, depending on the settings in the Options menu of the Trim/Margin tab.

Once all the necessary data has been entered, the Calculate button can be used to check the target voltages and generate resistor values for the TrimCell configuration. The voltage profiles will display the realized voltages, DAC codes, and DAC current to the right of the profile value. The resistor values will be shown in the schematic view at the bottom of the Properties dialog box.

Advanced User Options – Platform Designer

The Trim/Margin Configuration Options dialog box, which is launched by clicking on the Options button, allows access to advanced settings. These settings – shown in Figure 26 – are configured on an individual TrimCell basis.

Figure 26. Trim Configuration Options



The Trim Configuration Options dialog box includes the following settings:

- **Maximum DAC Code Range** – Used by Trim Calculator (along with Max Supply Adjustment Range) to calculate the resistor values in the trim network. The default value of 110 is used to leave some headroom in the event of inaccuracy due to supply or resistor tolerances and due to the temperature coefficients of these components.
- **Max Supply Adjustment Range** – Used by Trim Calculator (along with Maximum DAC Code Range) to calculate the resistor values in the trim network. The default value is 5%. In systems where the adjustment range is smaller than 5%, the Max Supply Adjustment Range can be reduced. This will enhance the output resolution of the trimmed power supply system. If the adjustment range is greater than 5%, the Max Supply Adjustment Range must be increased. Increasing the adjustment range is a common solution to errors in the calculator, especially for wider trim or margin ranges (such as 10%).
- **Attenuation Crossover Voltage** – This setting decides whether the ADC attenuator will be enabled for this trim channel. If the profile 0 (nominal) voltage is greater than the attenuation crossover voltage settings, then the attenuator will be enabled. The default value of 1.9 V is adequate for most systems.
- **Vbpz Selection** – This setting determines the DAC Bi-Polar Zero (BPZ) voltage used by the TrimCell. The default selection is automatic – under this setting the trim calculator will choose the optimal setting for the given DC-DC model and profile target voltages. The drop down menu also allows you to manually select the Vbpz value. Some Vbpz values will not be compatible with a given DC-DC and set of target voltages, therefore it is normally best to leave this settings to Auto.

There are also options associated with the Trim calculator which affect the calculator behavior for all trim channels. These options are found in the Global View of Platform Designer (near the same location as the option to launch the DC-DC Library Builder). In the Global > ASC Options > Global ASC Options (shown in Figure 27) are these settings which affect the calculator behavior:

Figure 27. Global ASC Trimming Options

Global ASC Options	
Option	Value
EIA Resistor Standard	EIA 96
Open Resistor Threshold	100K Ohm
DC-DC Options	
DC-DC Library Directory	C:/lsc/diamond/3.3/data/ptmdata/DCtoD...
Build DC-DC Library	Add / Edit DC-DC...

- **EIA Resistor Standard** – The EIA Resistor Standard is used to constrain the resistor values used by the calculator. The default setting is EIA96 (standard value table typically associated with 1% resistor). There are settings available for several of the EIA standards as well as an exact setting (the exact setting will output an exact resistance value, rather than matching it to an available resistor from the EIA tables).
- **Open Resistor Threshold** – The Open Resistor Threshold parameter is used to replace resistors above the defined threshold with an open circuit. This parameter can be used to force the calculator to select fewer resistors in the trim network. The default value is 100K. Most DC-DC converters will still have at least two resistors generated. Certain resistors are mandatory even if their value is above the open resistor threshold, in these cases the calculator will keep the resistors regardless of their value.
- **DC-DC Library Directory** – This is the directory location of the DC-DC Library used in the project.
- **Build DC-DC Library** – The Add/Edit DC-DC button is used to open the DC-DC Library Builder, as described in the earlier section on Building a DC-DC converter library.

Library Manager Example #1: “Fixed” (Narrow-Range Adjustable) Power Supply, Celestica NCF0100120B0

The following examples describe the generation of DC-DC Converter Models for use in PAC-Designer software. The steps described are largely the same in Platform Designer, with slight differences in the method for launching the DC-DC Library. See the section on building a DC-DC converter library for more details.

A 1.2 V DC-DC converter will be added to the library. Start PAC-Designer and either begin a new design or open an existing design with an ispPAC-POWR6AT6 or ispPAC-POWR1220AT8 device. This will make the Library Manager launch button (labelled “DC-DC”) active. Click the **Launch** button. When the Select DC-DC Converter Type dialog box appears, select **DC-DC Converter with Trim-up & Trim-Down Supply** and click **Next**.

The manufacturer’s data sheet provides Equations 10 and 11.

Equation 10

$$R_{\text{trim-up}} = \frac{V_r - R1}{\Delta V} - R_t$$

Equation 11

$$R_{\text{trim-down}} = \left(\frac{V_{\text{out}} - V_r}{\Delta V} - 1 \right) \times R1 - R_t$$

Where:

- $V_r = 0.8 \text{ V}$ (V_r is the internal reference voltage used in this supply)
- $R1 = 30,100 \text{ Ohms}$
- $R_t = 59,000 \text{ Ohms}$
- $V_{\text{out}} = 1.2 \text{ V}$ (This is the supply’s nominal output, not the trimmed output)

ΔV is the amount of voltage change desired

The “DC-DC Converter Datasheet Example Configuration” dialog box will be displayed. This dialog box needs the nominal output voltage of the supply with the TRIM pin unconnected (1.2 V), as well as three voltage programming examples, two using resistances from TRIM to ground and one for a resistor connected between Vout and TRIM. Target voltages must be selected for the examples; the only requirement for these voltage levels is that they should be within the supply’s trimming capability. For the trim-up examples, 1.25 V and 1.3 V will be used:

$$(1.25 \text{ V}) R_{\text{trim-up}} = (0.8 \times 30100 / .05) - 59000 = 422,600 \text{ Ohms}$$

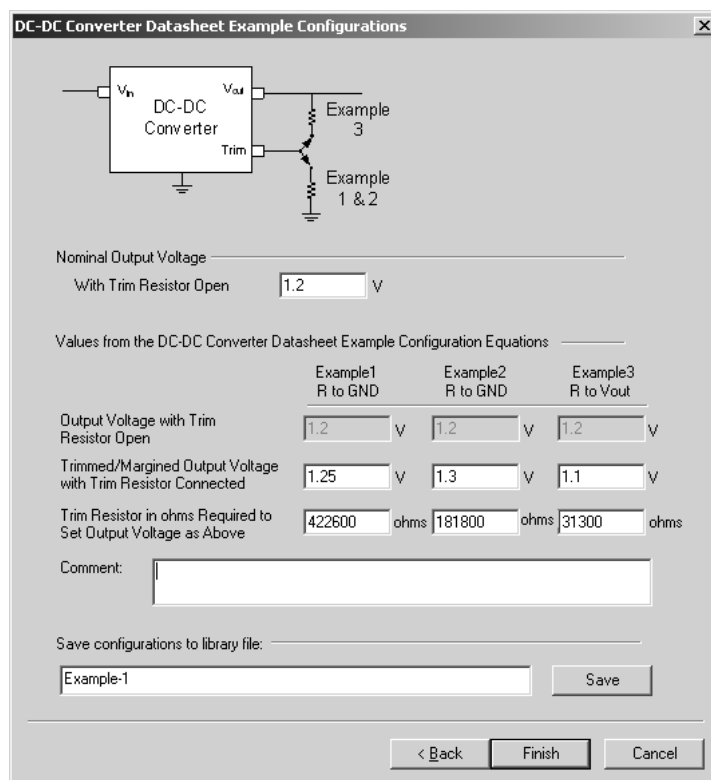
$$(1.3 \text{ V}) R_{\text{trim-up}} = (0.8 \times 30100 / .1) - 59000 = 181,800 \text{ Ohms}$$

For the trim-down example, we will use 1.1 V:

$$R_{\text{trim-down}} = [(1.2 - 0.8) / 0.1 - 1] \times 30100 - 59000 = 31,300 \text{ Ohms}$$

Once the voltage programming examples from Equations 9, 10, and 11 have been entered into the DC-DC Converter Datasheet Example Configurations dialog box, as shown in Figure 28, click the **Save** button and then click the **Finish** button.

Figure 28. 1.2 V Fixed Supply Entered into Library Manager



	Example1 R to GND	Example2 R to GND	Example3 R to Vout
Output Voltage with Trim Resistor Open	1.2 V	1.2 V	1.2 V
Trimmed/Margined Output Voltage with Trim Resistor Connected	1.25 V	1.3 V	1.1 V
Trim Resistor in ohms Required to Set Output Voltage as Above	422600 ohms	181800 ohms	31300 ohms

Library Manager Example #2: Single-Resistor Programmable Supply, POLA-Compliant PTH03030

In this example, a wide range programmable DC-DC converter will be added to the library. This supply’s output is set with a single resistor from the TRIM pin to ground. The manufacturer’s data sheet provides an output voltage vs. trim resistance table, but the trim resistor formulae are written in a form that does not reveal the value of Vref, the internal reference voltage. This voltage must therefore be measured by connecting a small load to the output and applying power to the input. The reference voltage is equal to the voltage present on the TRIM pin when it is allowed to float.

Any two entries from the output voltage vs. trim resistor table, an excerpt of which is shown in Figure 29, may be used as voltage programming examples. For this example, the entries, $V_{out} = 0.800$ Volt when R_{trim} is not connected, $V_{out} = 1$ Volt @ $R_{trim} = 37.5$ k Ω and $V_{out} = 2.5$ Volts @ $R_{trim} = 2.22$ k Ω were arbitrarily selected. The reference voltage was measured at 800 mV.

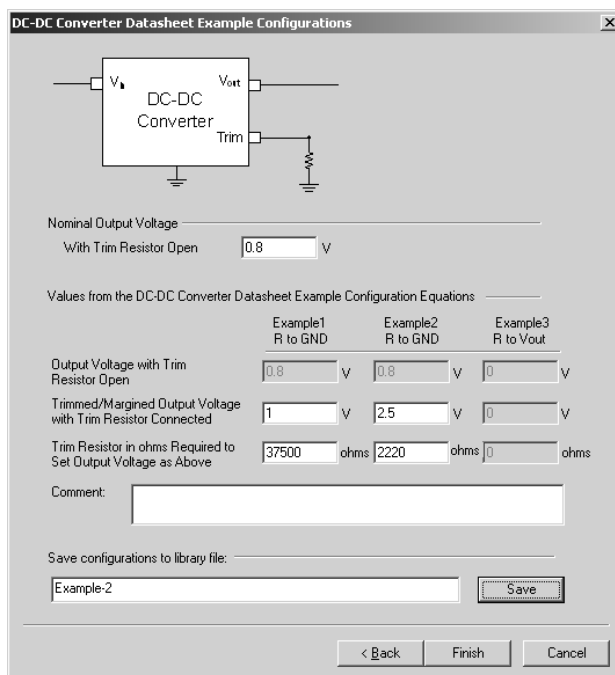
Figure 29. Excerpt from PTH03030 Voltage Programming Table

Table 2-2; Output Voltage Set-Point Resistor Values

V_a Req'd	R_{set}	V_a Req'd	R_{set}
0.800	Open	2.00	4.18 k Ω
0.825	318 k Ω	2.05	3.91 k Ω
0.850	158 k Ω	2.10	3.66 k Ω
0.875	104 k Ω	2.15	3.44 k Ω
0.900	77.5 k Ω	2.20	3.22 k Ω
0.925	61.5 k Ω	2.25	3.03 k Ω
0.950	50.8 k Ω	2.30	2.84 k Ω
0.975	43.2 k Ω	2.35	2.67 k Ω
1.000	37.5 k Ω	2.40	2.51 k Ω
1.025	33.1 k Ω	2.45	2.36 k Ω
1.050	29.5 k Ω	2.50	2.22 k Ω
1.075	26.6 k Ω	2.55	2.08 k Ω

Launch the Library Manager (refer to Example #1). Select **DC-DC Converter with Programmable Output Voltage** from the **Select DC-DC Converter Type** dialog box. Click **Next**. The “DC-DC Converter Internal Vref Voltage” dialog box will be displayed. Enter the measured Vref voltage (0.8 V) and click **Next**. The DC-DC Converter Data-sheet Example Configurations dialog box will be displayed, wherein the voltage programming examples are entered, as shown in Figure 30.

Figure 30. Programmable DC-DC Supply Entry



DC-DC Converter Datasheet Example Configurations

Nominal Output Voltage
With Trim Resistor Open: 0.8 V

Values from the DC-DC Converter Datasheet Example Configuration Equations

	Example1 R to GND	Example2 R to GND	Example3 R to Vout
Output Voltage with Trim Resistor Open	0.8 V	0.8 V	0 V
Trimmed/Margined Output Voltage with Trim Resistor Connected	1 V	2.5 V	0 V
Trim Resistor in ohms Required to Set Output Voltage as Above	37500 ohms	2220 ohms	0 ohms

Comment:

Save configurations to library file: Example-2 Save

< Back Finish Cancel

Library Manager Example #3: Discrete Implementation (LDO-Type Linear Supply with External Feedback Components), Texas Instruments TPS73701

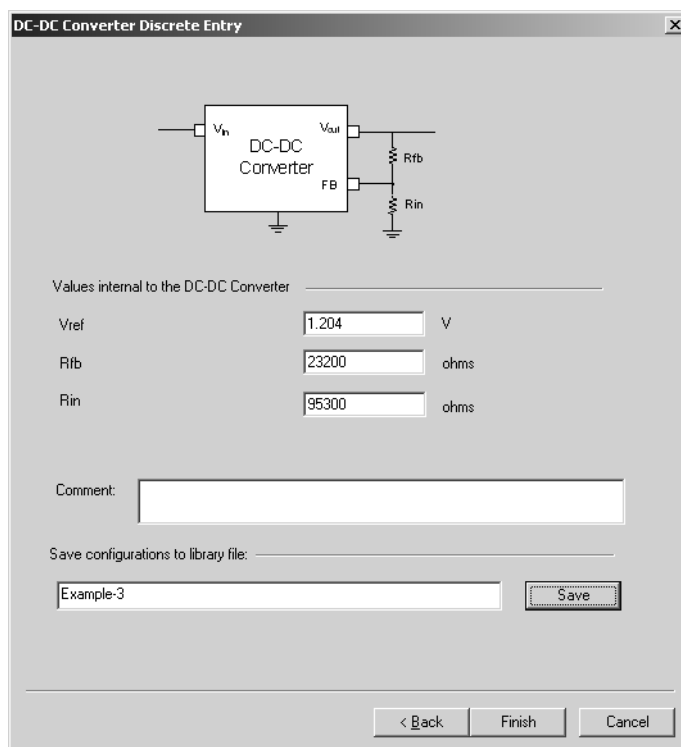
Adding discrete supplies to the library is slightly different than adding modular supplies with a TRIM pin in that a separate library entry has to be created for each output voltage of interest. In this example, we wish to create an entry for an output voltage of 1.5 V. The manufacturer's data sheet provides the formula:

$$V_{out} = \frac{R_{in} + R_{fb}}{R_{in}} \times 1.204$$

In addition, a table is provided that recommends that $R_{fb} = 23.2 \text{ k}\Omega$ and $R_{in} = 95.3 \text{ k}\Omega$ in order to achieve a 1.5 V output.

Examining the form of the voltage programming equation shows that it consists of the reciprocal of the voltage divider equation for R_{in} and R_{fb} multiplied by the reference voltage, which is 1.204 V. Thus, this voltage should be entered into the dialog box as V_{ref} , and the values from the table should be entered for R_{fb} and R_{in} . See Figure 31.

Figure 31. Discrete DC-DC Entry



DC-DC Converter Discrete Entry

Values internal to the DC-DC Converter

V_{ref} 1.204 V

R_{fb} 23200 ohms

R_{in} 95300 ohms

Comment:

Save configurations to library file:

Example-3 Save

< Back Finish Cancel

Library Manager Example #4: Power Supply Employing Iref and Rref, Bellnix BSV-3.3S3R0M

A wide-range programmable DC-DC converter employing an internal constant-current reference (Iref) and load resistor (Rref) will be added to the library. This DC-DC converter is programmable using a single resistor between the trim pin and ground. Figure 32 shows an excerpt from the power supply data sheet. The Iref current, identified as I1 in the data sheet, is 28.6 μ A. Rref, identified as R3 in the data sheet excerpt, is 86.7 k Ω .

Figure 32. Excerpt from Bellnix BSV-3.3S3R0M Data Sheet

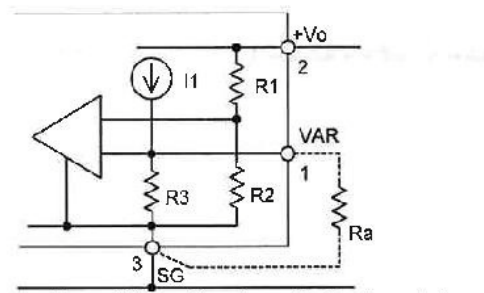


Figure 5 Connection when adjusting the output

Table 3

Trim Range Vo[V]	Ra[k ohm]
+1.0	37.60
+1.5	72.00
+1.8	103.61
+2.5	268.87
+3.3	Open

- Ra is calculated as follow

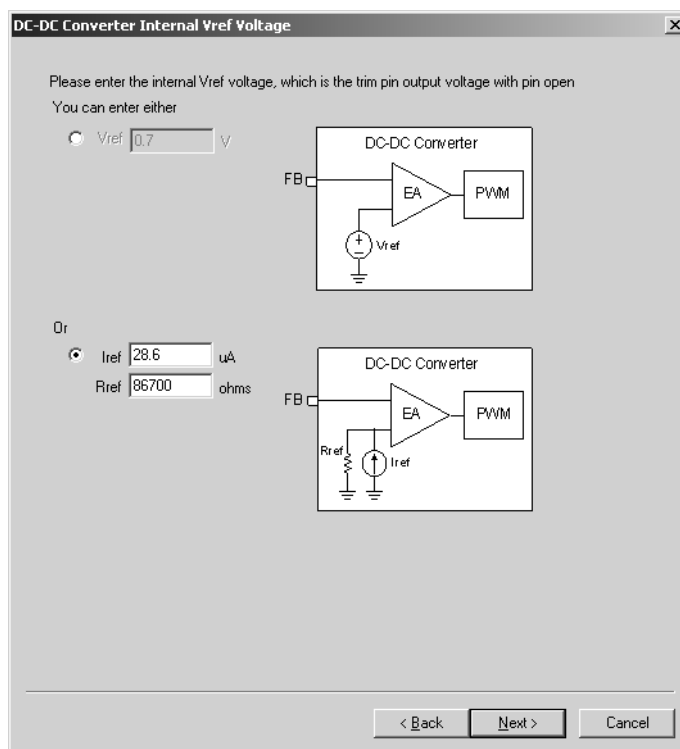
$$R_a = R_2 \times R_3 \times V_o / \{ (R_1 + R_2) \times R_3 \times (1 - R_2 \times V_o) \} \text{ [ohm]}$$

In this equation, Vo[V]=desired output voltage.

$$R_1 = 100 \text{ ohm}, R_2 = 300 \text{ ohm}, R_3 = 86.7 \text{ Kohm}, I_1 = 0.0286 \text{ mA}$$

These values are entered into the DC-DC Converter Internal Reference dialog box, as shown in Figure 33. The DC-DC Converter Data Sheet Example Configuration dialog box then asks for two programming examples. In this case, the data sheet provides a table with values that may be entered directly into the dialog box: R=37.6 k Ω for 1.0 V output and R=268.87 k Ω for 2.5 V output, as shown in Figure 34.

Figure 33. Entering Iref and Rref



DC-DC Converter Internal Vref Voltage

Please enter the internal Vref voltage, which is the trim pin output voltage with pin open
You can enter either

☐ Vref 0.7 V

Or

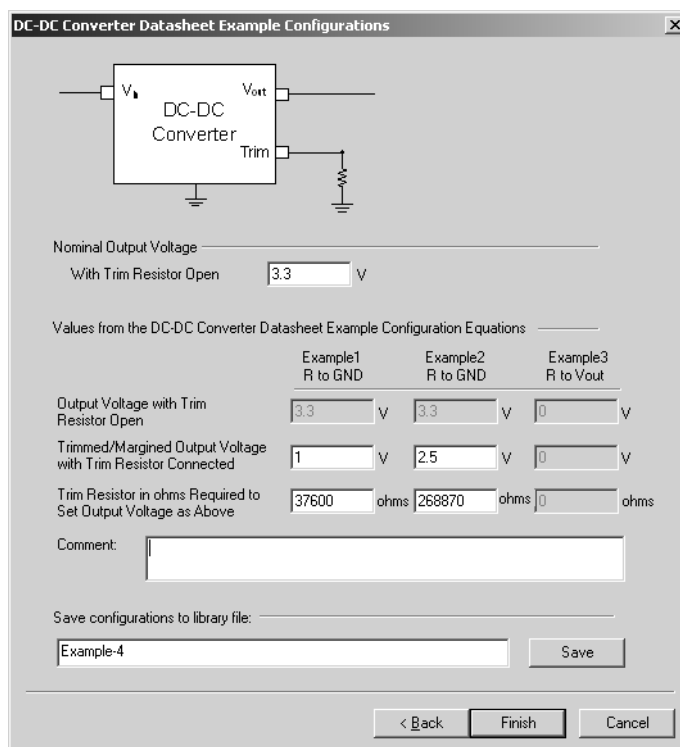
☒ Iref 28.6 uA
Rref 86700 ohms

Diagram 1: DC-DC Converter block with FB input, EA (Error Amplifier), and PWM (Pulse Width Modulator). A voltage source Vref is connected to the FB input.

Diagram 2: DC-DC Converter block with FB input, EA (Error Amplifier), and PWM (Pulse Width Modulator). A resistor Rref is connected to the FB input, and a current source Iref is connected to the EA input.

< Back Next > Cancel

Figure 34. Entering Programming Examples



DC-DC Converter Datasheet Example Configurations

Diagram: DC-DC Converter block with Vin, Vout, and Trim pins. The Trim pin is connected to a resistor and ground.

Nominal Output Voltage
With Trim Resistor Open 3.3 V

Values from the DC-DC Converter Datasheet Example Configuration Equations

	Example1 R to GND	Example2 R to GND	Example3 R to Vout
Output Voltage with Trim Resistor Open	3.3 V	3.3 V	0 V
Trimmed/Margined Output Voltage with Trim Resistor Connected	1 V	2.5 V	0 V
Trim Resistor in ohms Required to Set Output Voltage as Above	37600 ohms	268870 ohms	0 ohms

Comment:

Save configurations to library file: Example-4 Save

< Back Finish Cancel

Trim Setup Example #1: Setting Up a Narrow-Range Programmable Supply for $\pm 5\%$ Margining and Closed-Loop Trim

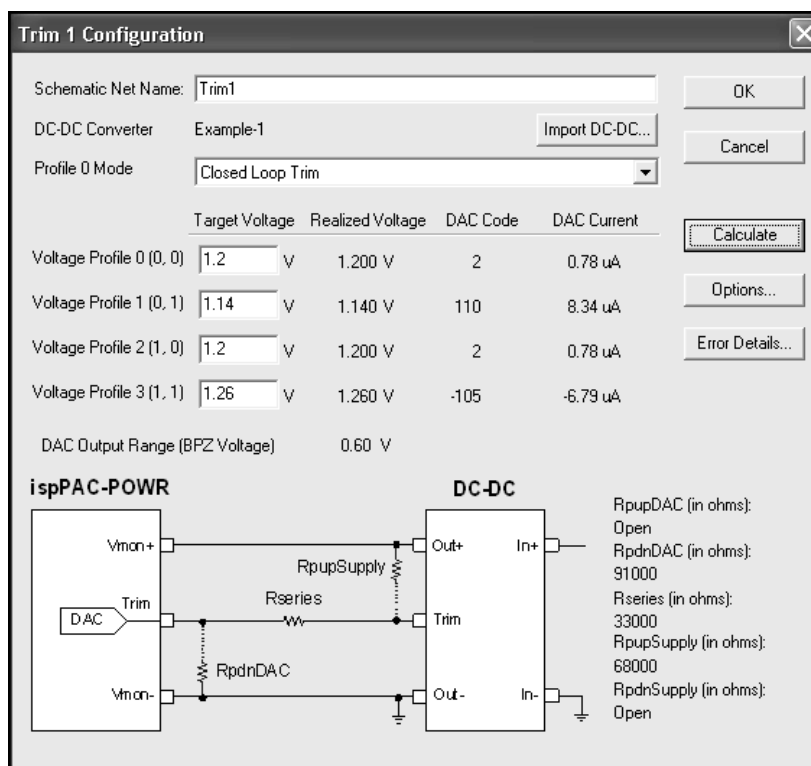
The following Trim Setup examples are described for use with the PAC-Designer trim configuration dialog box. The same steps will apply in general to trim setup in Platform Designer. The key differences are the lack of Profile 3 in Platform Designer and the increased flexibility of the closed loop trim for all three profiles in Platform Designer. See the section on Configuring the TrimCells - Platform Designer, for details on the Platform Designer specific entry options.

The 1.2 V narrow-range programmable supply that was previously entered into the library will be set up with closed loop trim at 1.2 V, as well as with open loop voltage profiles 5% above and below this nominal value. The voltage profiles will be as follows:

- Profile 0: 1.2 V, closed loop trim mode
- Profile 1: 1.14 V
- Profile 2: 1.2 V
- Profile 3: 1.26 V

Since the desired adjustment range is not greater than $\pm 5\%$, there is no need to go into the **Options** dialog box. The only things that need to be done are to select the appropriate supply from the library and the “Closed Loop Trim” mode for profile 0 and enter the voltages listed above. Clicking the **Calculate** button yields the results illustrated in Figure 35.

Figure 35. 1.2 V Narrow Range Programmable Supply Trim Setup and Results



The calculator reports that all of the requested voltages could be achieved within a DAC code range of ± 110 . Clicking **OK** accepts these values and returns to the schematic window.

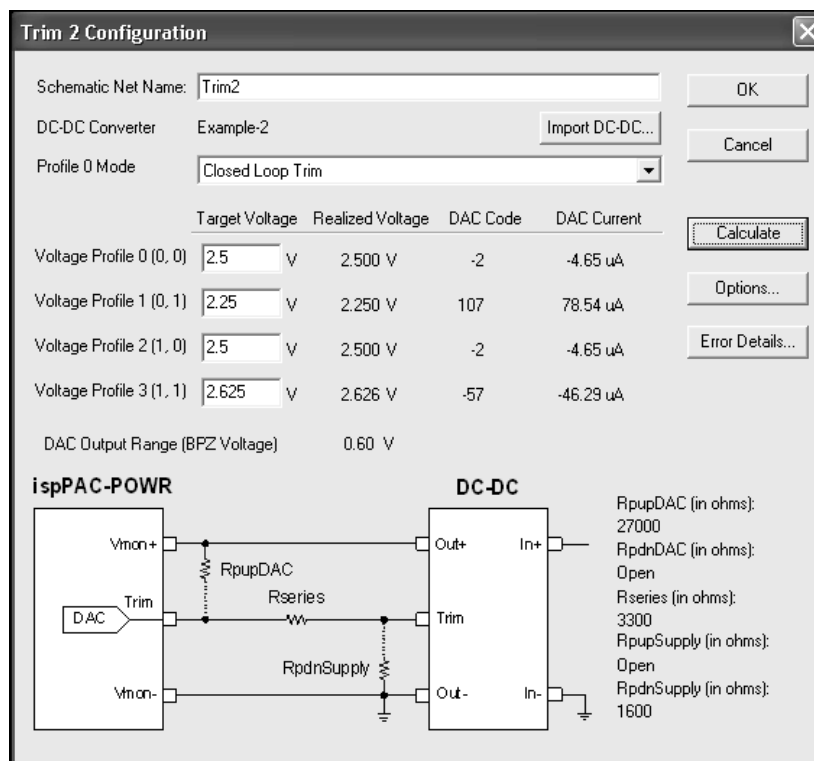
Trim Setup Example #2: Setting Up a Wide-Range Programmable Supply for +5% –10% Margining and Closed-Loop Trim

The wide-range programmable supply that was entered into the library manager tool will be set up for closed loop trim output voltage of 2.5 V, as well as open loop trim voltage profiles 10% lower and 5% higher than this nominal value. The voltage profiles will be as follows:

- Profile 0: 2.5 V, closed loop trim mode
- Profile 1: 2.25 V
- Profile 2: 2.5 V
- Profile 3: 2.625 V

Since the desired adjustment range is wider than $\pm 5\%$, the Max Supply Adjustment Range setting in the options dialog box will have to be changed to 10%. The appropriate supply must be selected from the pull-down list, and the profile 0 mode must be set to “Closed Loop Trim.” Clicking **Calculate** yields the results illustrated in Figure 36.

Figure 36. Wide Range Programmable Supply Trim Setup and Results



Clicking **OK** accepts the values and returns to the schematic window.

Trim Setup Example #3: Setting up a Discrete Supply for 1.5 V Output with Margining Range up to $\pm 20\%$ and Closed-Loop Trim

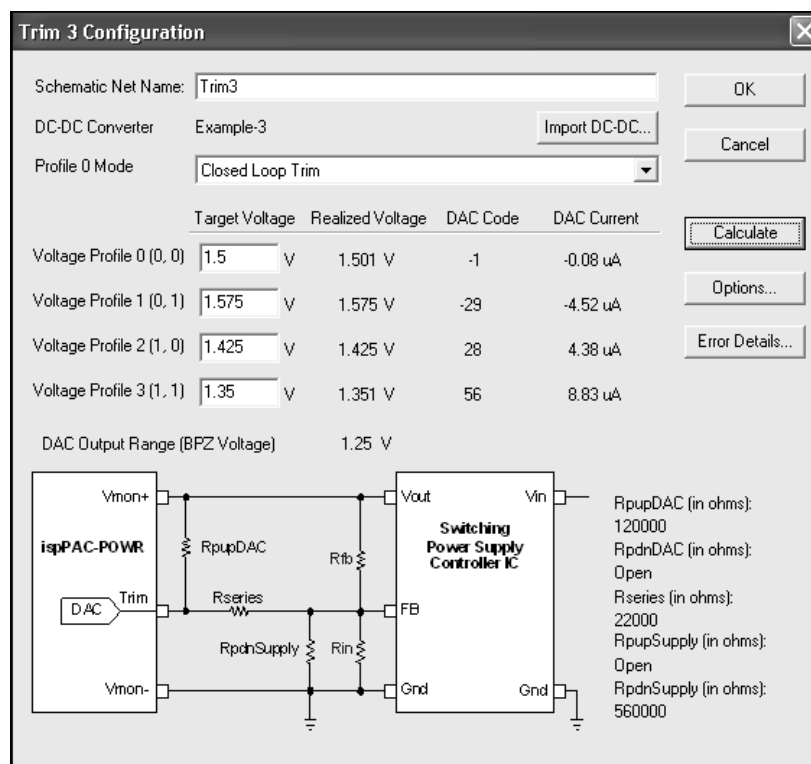
The linear regulator that was entered into the library for operation as a 1.5 V supply will be configured to perform closed loop trim and to be able to be margined over a wide range. Wide-range margining is needed in systems that require margin testing to failure. The ability to control the trim DACs directly from the I²C bus makes it simple for a microcontroller on this bus to find the voltage at which system components start to behave erratically.

The profiles will be set up as follows:

- Profile 0: 1.5 Volts, closed loop trim mode
- Profile 1: 1.575 V (+5%)
- Profile 2: 1.425 V (–5%)
- Profile 3: 1.35 V (–10%)

The Max Supply Adjustment Range will have to be changed. From the Trim Configuration dialog box, click the **Options...** button. Enter **20** for the Maximum Supply Adjustment Range and click **OK**. Clicking **Calculate** yields the results illustrated in Figure 37.

Figure 37. Discrete Supply Trim Setup and Results



Clicking **OK** accepts these values and returns to the schematic window.

This example has deliberately been set up such that the four voltage profiles only cover a fraction of the total adjustment range that the trim system can achieve. If the voltage needs to be set outside of the –10% to +5% adjustment range provided by the voltage profiles, the I²C interface must be used. I²C control of the output voltage is achieved by selecting Profile 0 and disabling closed loop trim by setting the internal signal PLD_CLT_EN low (ispPAC-POWR1220AT8) or by setting the pin CLTENb high (ispPAC-POWR6AT6). The desired code is then loaded into the DAC via I²C. In this system, a DAC value of 80h produces the nominal voltage of 1.5 V. 80 h is the

value that all DACs default to when the device is powered up or reset; each LSB change from this value represents a power supply output voltage change of 20%/110 codes or 0.182%.

Summary

The Lattice Power/Platform Management devices offer the power supply system designer a great deal of flexibility and control. This application note has discussed how the supply margin/trim circuitry of this device can be used to adjust the output voltages of DC-DC converters and regulators. Operation of the easy-to-use power supply trim software utility in PAC-Designer and Platform Designer has been demonstrated through the use of several examples.

The examples given in this application note are only an introduction to the capabilities of the Lattice Power/Platform Management devices. Many of the more complex examples, such as those involving control of a supply's voltage through the I²C bus, can be built upon the examples given in this application note and the power supply trim utility.

Related Literature

- DS1016, [ispPAC-POWR6AT6 Data Sheet](#)
- DS1015, [ispPAC-POWR1220AT8 Data Sheet](#)
- DS1036, [Platform Manager Data Sheet](#)
- DS1043, [Platform Manager 2 Data Sheet](#)
- DS1042, [L-ASC10 Data Sheet](#)

Technical Support Assistance

Submit a technical support case via www.latticesemi.com/techsupport.

Revision History

Date	Version	Change Summary
April 2015	1.2	Updated accuracy of 0.75% with typical.
		Updated Technical Support Assistance information.
November 2014	1.1	Updated to include Platform Manager, Platform Manager II, and L-ASC10 devices.
		Updated to include Platform Designer instructions.
		Updated Technical Support Assistance information.
December 2007	01.0	Initial release.