DLP3030-Q1 RGB LED Calibration for Automotive Display

User's Guide

Texas Instruments

Literature Number: DLPU066A
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TEXAS INSTRUMENTS

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Introduction

Trademarks

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Purpose

This document explains the purpose, theory, and procedure for calibrating a DLP3030-Q1 based head-up display PGU (picture generation unit).

Terms and Abbreviations

Terms and Abbreviations

Abbreviations	Description
ACP	Automotive Control Program
CM	Continuous Mode
DM	Discontinuous Mode
EVM	Evaluation Module
HUD	Head-Up Display
LUT	Look Up Table
PWM	Pulse Width Modulation used to generate analog target levels
PGU	Picture Generation Unit

References

Reference Documents

	Document Number	Document Name
1.	DLPU059	DLPC120 Automotive Control Program User's Guide
2.	DLPA084	LED Driver for DLP3030-Q1 Displays Application Note
3.	DLPU061	Piccolo Software Programmer's Guide for the DLPC120 ASIC
5.	DLPA094	Photodiode Selection and Placement Guide

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1.1 Calibration Purpose

DLP3030-Q1 based PGUs must be calibrated in order to ensure that the color point of the HUD is maintained across its operating conditions, which include a 5000:1 dimming ratio and –40°C to 105°C operating temperature. Additionally, the HUD must be calibrated to achieve smooth dimming, meaning the output brightness of the system should change linearly with the input brightness as in Figure 1-1.

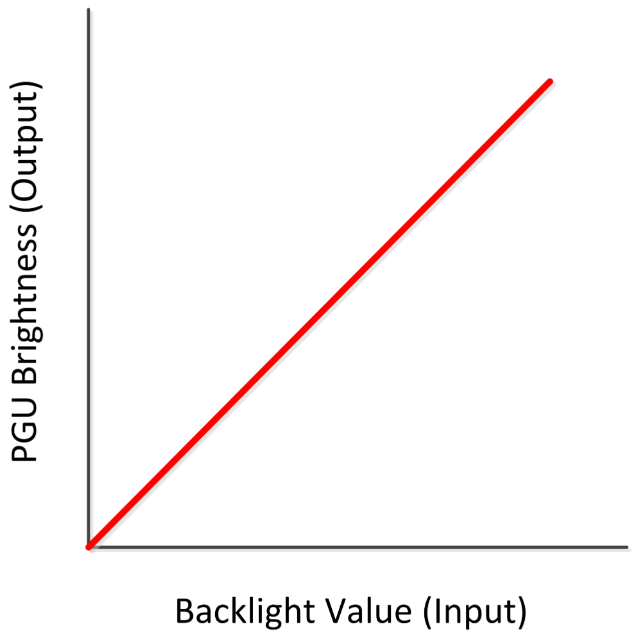

Figure 1-1. Backlight Value vs PGU Brightness

White point of a PGU determines the ratio of red, green, and blue for a desired output. The target white point is specified as an x,y coordinate pair in the CIE 1931 color space chromaticity diagram shown in Figure 1-2. The wavelength of light output from the LEDs changes as the junction temperature changes, so calibration is required to compensate for these shifts. Additionally, a tolerance is limit is provided on the x and y coordinates. The calibration procedure makes sure that the white point of the DLP HUD EVM stays within the tolerance as the input brightness level, referred to as backlight value, is adjusted.

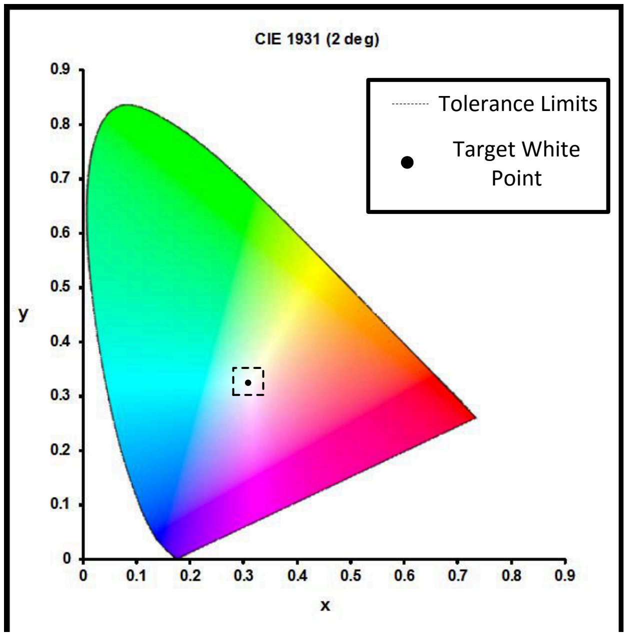

Figure 1-2. CIE 1931 Color Space Chromaticity Diagram

1.2 Goal of Calibration

The overall goal of the PGU calibration process is to generate a unique calibration file to be paired with each production PGU manufactured. This calibration file stores a series of look-up tables, each mapped to a different temperature, that are used by the Piccolo software to map input backlight values to system parameters. This calibration file will maintain an accurate color point for all brightness levels across temperature.

These calibration steps are completed using the following tools.

- Color Analyzer
- Neutral Density Filters
- Diffuser Screen
- USB to SPI Converter

The DLPC120 Automotive Control Program is configured to work with the Konica Minolta® CA-210, Total Phase® Cheetah™ SPI Host Adapter, and a Windows PC. See Chapter 3 for more details.

Calibration Software and Tools

2.1 Calibration Software and Tools

Table 2-1. Software and Tools

Software/Tool	Description	Reference Material/Lit Number
Embedded MCU Reference Design Software	• Maintains color point and smooth dimming using a calibration file that is stored on the C2000 Piccolo MCU • Details about this file are provided in Chapter 3 • Additional details about Piccolo Software and dimming can be found in the Piccolo Software Programmer's Guide for the DLPC120 ASIC • Designed to work with a discrete LED driver solution circuit	ACP Users Guide, Piccolo Reference Code, Piccolo Programmer's Guide, LED Driver App Note in Reference Documents
Automotive Control Program (ACP)	• Runs on a Windows PC, serves as the host controller for the Piccolo MCU • Includes a calibration process that can be used to generate the calibration file • Includes control functionality for testing and modifying system brightness and color point	ACP User's Guide
Konica Minolta CA-210 or CA-310	• Color analyzer used to measure color point and brightness output • Required for calibration	ACP User's Guide

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Calibration Setup

3.1 Calibration Setup

Figure 3-1 below shows the recommended calibration setup. This setup uses the CA-210 color analyzer by Konica Minolta and the Cheetah SPI adapter by Total Phase. The key points to note are:

- The probe of the CA-210 should be pointed at the diffuser screen illuminated by the DLP3030-Q1 based PGU
- There is room for Neutral Density (ND) filters to be inserted in between the diffuser screen and the CA-210 probe
- The PC is connected to the DLP3030-Q1 based PGU using a Cheetah SPI adapter
- The PC is also connected to the CA-210

Note: ND filters are needed because the CA-210 likely cannot measure the entire brightness range of the PGU. ND filters are necessary when the DLP3030-Q1 PGU output is too bright.

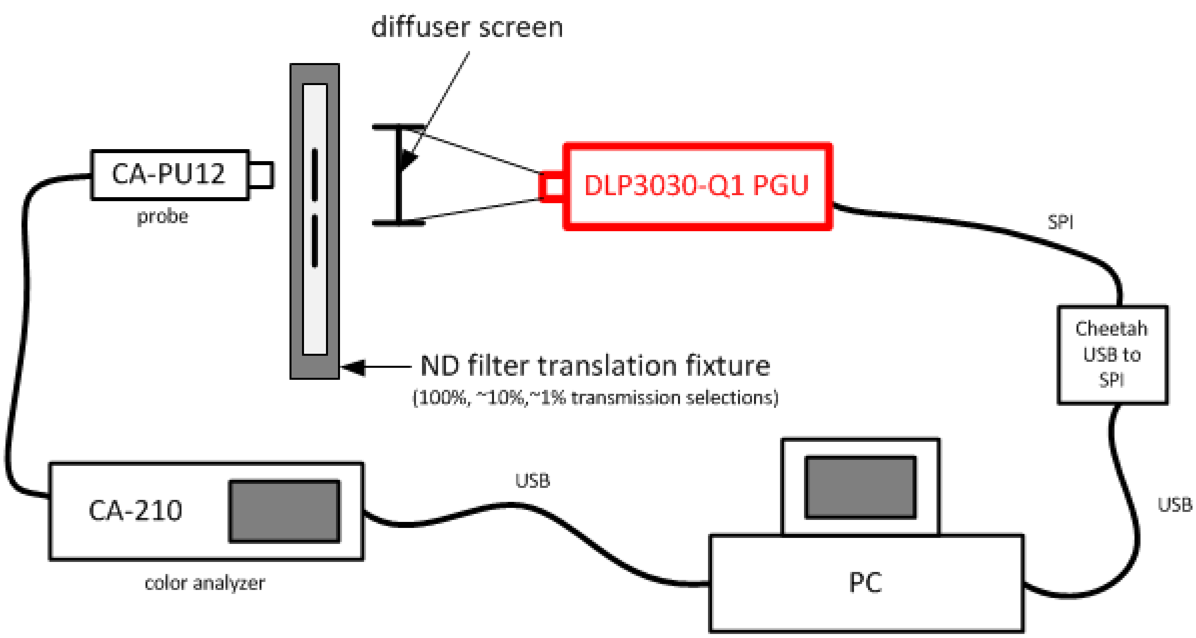

Figure 3-1. Calibration Setup

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Chapter 4

Calibration Overview and Theory

4.1 Goal of Calibration

The end goal of the PGU calibration process is to generate a unique calibration file to be paired with each production PGU manufactured. This calibration file stores a series of look-up tables, each mapped to a different temperature, that are used by the Piccolo software to map input backlight values to system parameters. This calibration file will maintain an accurate color point for all brightness levels across temperature.

The calibration process for a DLP3030-Q1 based PGU has 3 main steps that make up the process from prototype through production.

Pre-production steps:

- Calibration Pre-work: Coarse combination determination
- Temperature characterization

Production steps:

- Production PGU calibration

See Section 4.3 for more information, but it is helpful to understand background information on calibration file parameters before looking at the calibration procedure in more detail.

4.2 Calibration Background

4.2.1 Calibration File Parameters

For each input backlight value, a series of system parameters are set by the Piccolo microcontroller.Table 4-1 lists all of the parameters defined in the calibration file. The parameters can be divided into two categories: coarse adjustment and fine adjustment parameters.

Coarse adjustment parameters change the brightness of the system significantly. Therefore, a combination of these parameters is assigned to a range of backlight values.

Fine adjustment parameters provide very fine control of the system's brightness and color point. Therefore, once a combination of *coarse adjustment parameters* is assigned to a backlight range, the *fine adjustment parameters* can be modified to achieve the desired color point and brightness. Each backlight value has a unique set of *fine adjustment parameters*, but not all of these are stored in the calibration file. Interpolation is used to reduce the number of values that need to be stored.

Table 4-1. Calibration Parameters

Parameter Type	Parameter	Description
Coarse Adjustment	LDC Index	Total time the LEDs are on, calculated according to the following variables: **Continuous Mode:** LED sequence multiplied by time attenuation percentage. **Discontinuous Mode:** LED duty cycle and the number of pulses in each bit of the sequence. For more explanation, see the LED Driver for DLP3030-Q1 Displays Application Note (DLPA084).
	LED Driver Current Limit PWM	The maximum current allowed through the LEDs or the shunt FET.
	Optical Feedback Amplifier Gain	Amount of gain applied to the response of the photodiode used to sense LED light. Higher gain results in lower brightness. With a higher gain, less LED light is required to achieve the target.
Fine Adjustment	R/G/B PWM	The target optical response requested from each LED.

The final calibration file is a series of look up tables. Each table is associated with a specific temperature. Within each table there are rows that map backlight values to the coarse and fine adjustment parameters described in Table 4-1. A few example calibration rows are shown in Table 4-2 below. During calibration pre-work, the coarse parameter columns (LDC, Gain, Current Limit) are inputs from the user while the fine adjustment parameters (R/G/B PWM columns) are generated by the calibration algorithm of the ACP.

Table 4-2. Example Calibration Row

Calibration Row	Backlight Level	LDC	Gain	Current Limit	Red PWM	Green PWM	Blue PWM
1	65535	0	1x	59000	26872	56728	35698
2	35132	0	1x	59000	13475	23056	21443
3	35131	2	1x	59000	25436	54334	34756
4	22456	2	1x	59000	9004	13287	12449

4.2.2 Coarse Adjustment Parameter Combinations

Each coarse adjustment parameter combination, or coarse combination, consists of a unique combination of LDC Index, optical sensor amplifier gain, and current limit. Each coarse combination can achieve a certain range of brightness. A combination achieves its maximum brightness when all the fine adjustment parameters (LED PWMs) are set to their maximum values. Similarly, in order to achieve minimum brightness with this combination, the LED PWM levels should be set to their minimum values. By switching between several combinations of coarse adjustment parameters, the system is capable of achieving a very wide brightness range. Figure 4-1 below shows an example of the brightness range that is achievable using multiple coarse adjustment parameter combinations.

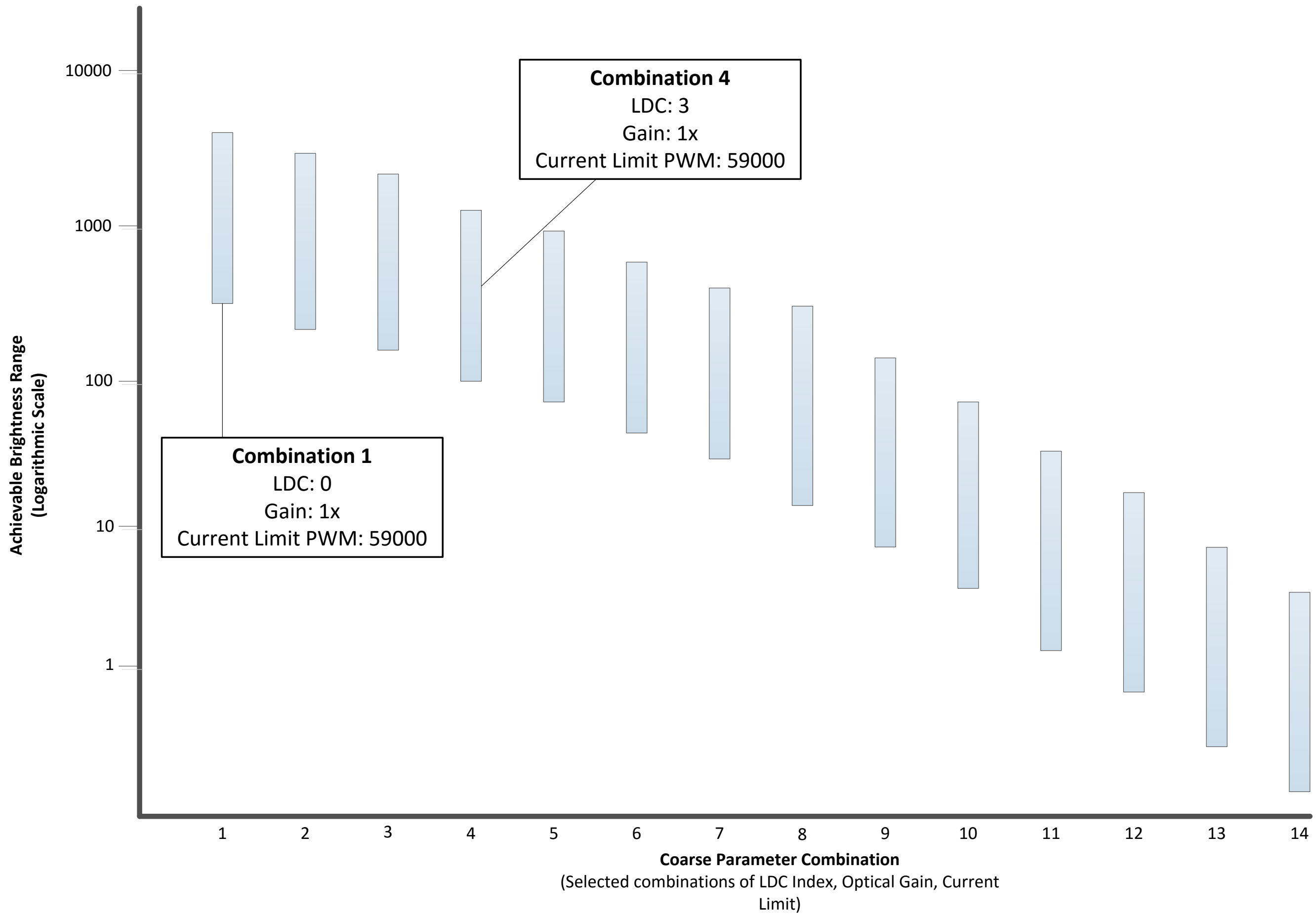

Figure 4-1. Logarithmic Brightness Ranges for Coarse Adjustment Parameter Combinations

Notice that the brightness ranges of many of the combinations overlap. This prevents gaps in the brightness range that can be covered. Additionally, it allows a brightness range to be achieved without approaching the minimum or maximum limit of a combination's range. This is beneficial because it may be difficult to achieve a desired color point using the minimum or maximum limit of a combination's brightness. For more information on picking the correct coarse combinations, see Section 5.2.

4.3 Calibration Process

The calibration process for a DLP PGU has 3 main steps that make up the process from prototype through production.

Pre-production steps:

- Calibration Pre-work: Coarse combination determination
- Temperature characterization

Production steps:

- Production PGU calibration

4.3.1 Calibration Pre-work: Coarse Combination Determination

The Automotive Control Program includes a calibration algorithm that is used to automatically generate the PWM values associated with each data row in the calibration file. This calibration process requires user provided coarse combinations that must be gathered before starting the calibration sweeps.

The calibration pre-work consists of determining the coarse combinations that will allow brightness outputs across the entire input dimming range.

Once coarse combinations have been found that adequately cover the entire brightness range of the PGU, the calibration procedure will map the maximum and minimum outputs of these coarse combinations and RGB PWM values to system backlight values, ranging 0 to 65535. These parameter combinations become individual rows in the calibration look up tables, ensuring that for every input backlight value, the PGU will choose the appropriate coarse combination and RGB PWM values to output the desired brightness level. If gaps in brightness output do exist with the entered coarse combinations, adjust the combination parameters accordingly to close the gaps. See Section 5.2 for more information.

These combinations define a brightness LUT for the system at one temperature. Since LED output changes over temperature, the system needs to be characterized across the operating temperature range of the system.

4.3.2 Temperature Charaterization

Once coarse combinations have been found that cover the entire brightness range at nominal temperatures, the PGU must be characterized across all operating temperatures. The goal is to maintain constant performance at all temperatures.

The light output from an LED at a given PWM value will vary predictably with temperature, so the system output must be measured and characterized across many temperatures to ensure consistent white point and PGU brightness at all times. Because coarse combinations stay the same across all temperature sweeps, temperature characterization involves sweeping the LED PWMs for each combination to let the calibration algorithm determine the minimum and maximum PWM values to be stored in the calibration file for each combination and temperature.

These temperature sweeps define the temperature shift characteristics of the LEDs used in the PGU. For the same LEDs, the temperature characteristics of one LED will very closely match those of a second LED. Whether each individual LED is brighter or dimmer at a given current level and temperature, light from all LEDs will change proportionally across all temperatures. This allows the temperature profile to be collected once on a single PGU and mathematically applied to all PGUs during production.

See Section 6.3 for more details on the temperature characterization procedure.

4.3.3 Production PGU Calibration

During production, each PGU needs to be calibrated to determine fine adjustment parameters to ensure smooth dimming and color point accuracy across all coarse combinations. This LED PWM sweep must be performed at one of the temperatures used in the temperature characterization portion (usually room temperature). Only one temperature calibration table needs to be measured, as the rest can be mathematically calculated from the pre-production calibration data. These calibration tables, calculated across the operating temperature range, are combined into the final calibration file and stored on each individual PGU, ensuring individual dimming and white point accuracy.

See Section 6.4 for more details on the production PGU calibration procedure.

5.1 Pre-work Overview

Calibration pre-work consists of determining the coarse combinations a system will use, and entering the combinations in the ACP calibration project, as in Figure 5-1. This serves as the outline for the automatically generated calibration file and is a starting point for the calibration procedure. Proper coarse combination determination will improve system calibration and ensure system performance.

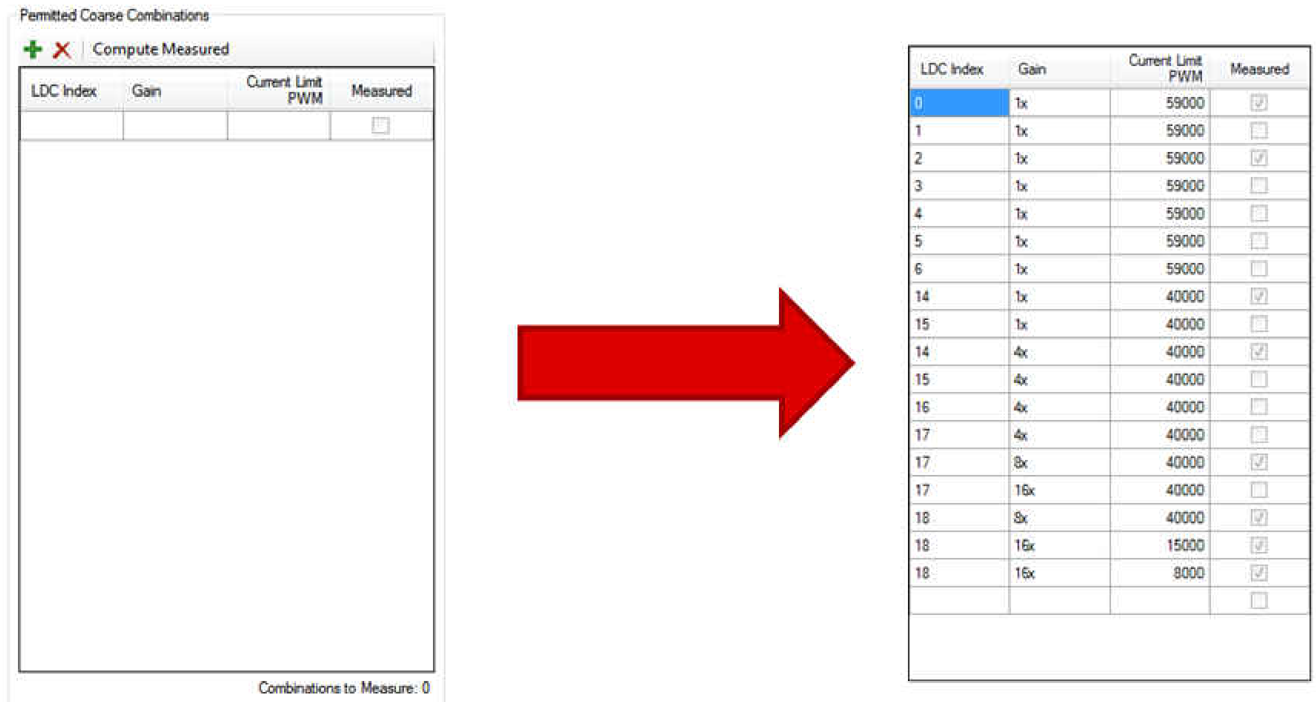

Figure 5-1. Populating coarse combination lists

5.2 Coarse Combination Determination

The ultimate goal in determining proper coarse combinations is to allow the system to achieve a 5000:1 dimming ratio while maintaining a constant color point. Enough unique coarse combinations should be chosen so there are no brightness gaps in the system output, but should in practice be as few as possible to decrease calibration time. Three main problems arise when determining coarse combinations on a new DLP3030-Q1 based PGU.

- Gaps in output brightness
- Too much overlap between adjacent coarse combinations
- Achieving minimum brightness targets

These issues can be addressed by strategically adjusting the coarse combinations.

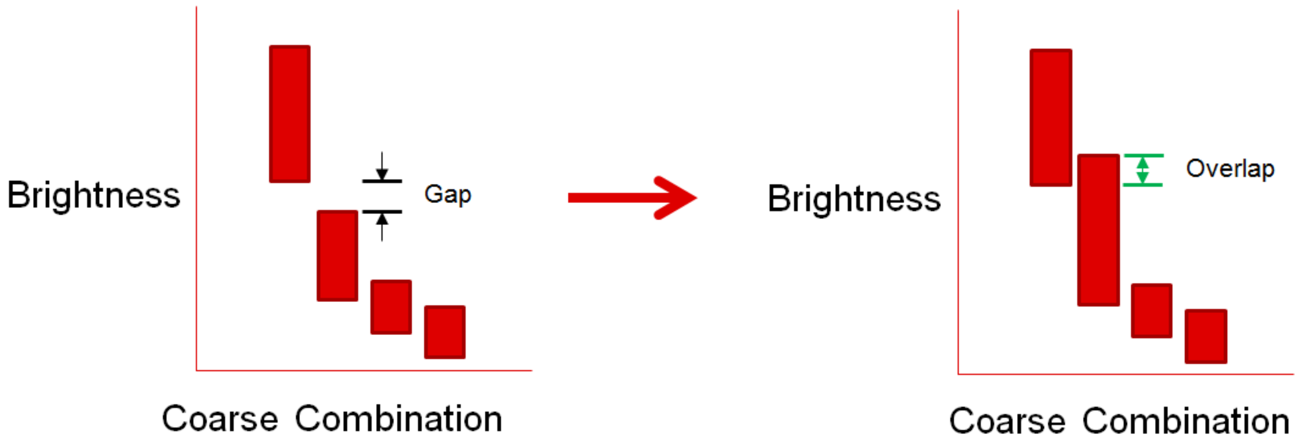

Figure 5-2. Closing brightness gaps between coarse combinations

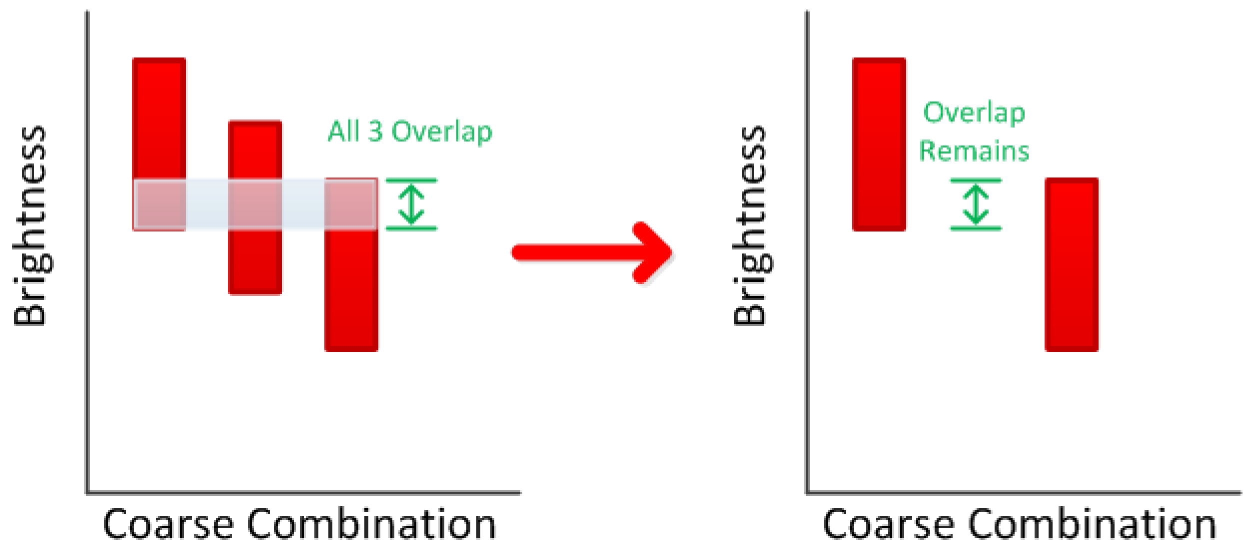

Figure 5-3. Removing heavily overlapping coarse combinations to decrease calibration time

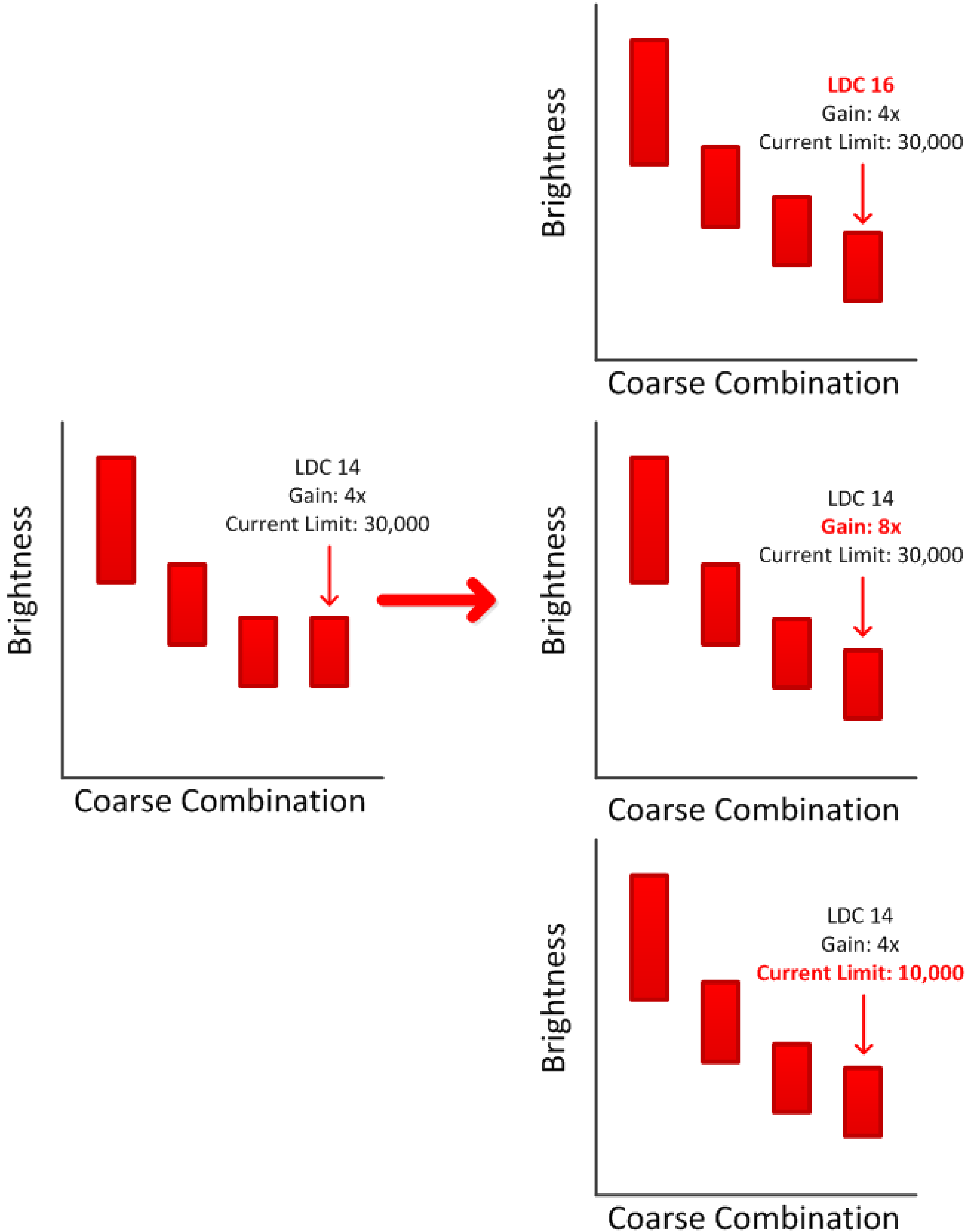

Figure 5-4. Changing coarse combination parameters to change the maximum and minimum brightness ranges. Increase LDC Index, increase optical feeback gain, or decrease current limit to decrease the minimum brightness for a single coarse combination.

5.3 Strategically Adjusting Coarse Combination Parameters

When brightness gaps occur in the PWM sweep output, coarse combination parameters must be strategically adjusted to close these brightness gaps and maintain smooth dimming. See Table 4-1 for a list and description of all the adjustment parameters.

See the LED Driver application note for more information on DLP3030-Q1 system electronics.

5.3.1 LDC Index

LDC Index is a measure of the time attenuation of LED pulses (in continuous mode) or the number of LED pulses (in discontinuous mode). The specific attenuation percentage and number of pulses can be viewed in the configuration file overview tab. See the ACP User Guide for more information.

Increasing the LDC index will decrease the amount of time the LEDs are on, decreasing brightness for that coarse combination. Decreasing the LDC index will increase the amount of time the LEDs are on, increasing brightness for that coarse combination. To close a brightness gap by changing LDC index, add or modify one coarse combination to use an intermediary LDC index and rerun the PWM sweep.

5.3.2 Optical Sensor Feedback Gain

Optical Sensor Feedback Gain controls the scale of the photocurrent response from the photodiode into the Piccolo MCU. Adjusting this parameter helps maintain high resolution of photocurrent response across all brightness levels.

At high brightness levels (continuous mode and some discontinuous mode LDC indexes), the sensor gain should be kept low to allow photodiode response to support high brightness outputs. At low brightness levels (dim discontinuous mode LDC indexes), sensor gain should be increased to increase resolution of the photocurrent response. This allows the Piccolo MCU to more accurately control lower brightness outputs from the LEDs. Increasing the optical sensor feedback gain of a desired coarse combination will decrease achievable minimum brightness outputs.

5.3.3 Current Limit

In continuous mode operation, current limit serves as a protection mechanism by setting the maximum current allowed through the LEDs. Since continuous mode is used for high brightness outputs, current limits should be set to the maximum value of 59,000 (corresponding to 6 A for the green and blue LEDs, 4.5 A for the red LED) for all continuous mode coarse combinations. Note: continuous and discontinuous modes are set by choosing LDC index. the configuration file overview has a list of which LDC indexes are continuous mode and which ones are discontinuous mode.

In discontinuous mode, current limit sets the current through the shunt FET, which is then used to create discontinuous mode pulses. Discontinuous mode current limit should be reduced to limit current overshoot through the LEDs. DM current limits should, at maximum, be set to 30,000.

Decreasing the current limit of a discontinuous mode coarse combination will decrease the minimum achievable brightness output. In some cases this may also increase the achievable brightness range of the coarse combination.

5.4 Coarse Combination Strategies

There are two general methods of determining the proper coarse combinations for a DLP PGU.

The first method of determining coarse combinations is to input many coarse combinations spanning all LDC indexes and perform a PWM sweep. This will likely give a nearly complete brightness range, but there may be some gaps in output brightness that aren't achievable, as well as heavily overlapping combinations that will ultimately be unnecessary. These can be fixed by going back to the coarse combination inputs and strategically adjusting the parameters, adding intermediate coarse combinations to close the gaps as in Figure 5-2, or removing coarse combinations that are not needed as in Figure 5-3. This gives a clear view of the achievable brightness range possible very quickly, and helps locate which areas need parameter adjustments. Because many coarse combinations are used, each successive sweep can take up to thirty minutes.

The second method of determining coarse combinations is to start at maximum brightness (LDC 0) and input only two or three coarse combinations (e.g. LDC 0 and LDC 1 with appropriate gain and current limit settings). This will not span the entire brightness output of the system, but each sweep will take a minimal amount of time. Once the two coarse combinations have been adjusted so they overlap slightly and give the largest brightness range for each combination, the combinations can be recorded and saved for entry later. Then, the next two coarse combinations (e.g. LDC 1 and LDC 2) can be entered and swept, again maintaining overlap and maximizing brightness range (Note: many LDC indexes will actually be omitted from the final coarse combination list). This can continue, two overlapping coarse combinations at a time, until the full brightness range has been achieved. Finally, one last sweep can be performed, with all recorded coarse combinations included, to show complete brightness range coverage while the coarse combination adjustment and determination is already solved.

Ultimately, these coarse combinations will differ slightly for each design of a DLP3030-Q1 based PGU. There will be some amount of trial and error involved in determining the optimal coarse combinations. Use Section 5.3 as a reference for adjusting coarse combination parameters as needed. Once desired coarse combinations have been found, the pre-work is finished and the PGU is ready to be calibrated. Chapter 6 goes through the step-by-step process of using the ACP to perform temperature compensation sweeps and production calibration.

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Calibration Procedure

6.1 Calibration Procedure Overview

The calibration process uses an automated calibration algorithm to determine the calibration tables stored on each PGU. Using several user inputs (coarse combinations, PWM range, DMD temperature, ND filters), the program sweeps through LED ranges for all desired course adjustment parameter combinations and temperatures, and outputs unique calibration files for each PGU, as well as visual representations of the brightness outputs of the PGU.

The following sections provide a step by step guide on how to perform a calibration sweep.

6.2 Calibration Sweep Setup and Coarse Combinations

1. Select "Calibration and Config File → Iterative Calibration" from the menu on the left.
2. Select "Create new project." Follow the prompts to choose file name and save location.

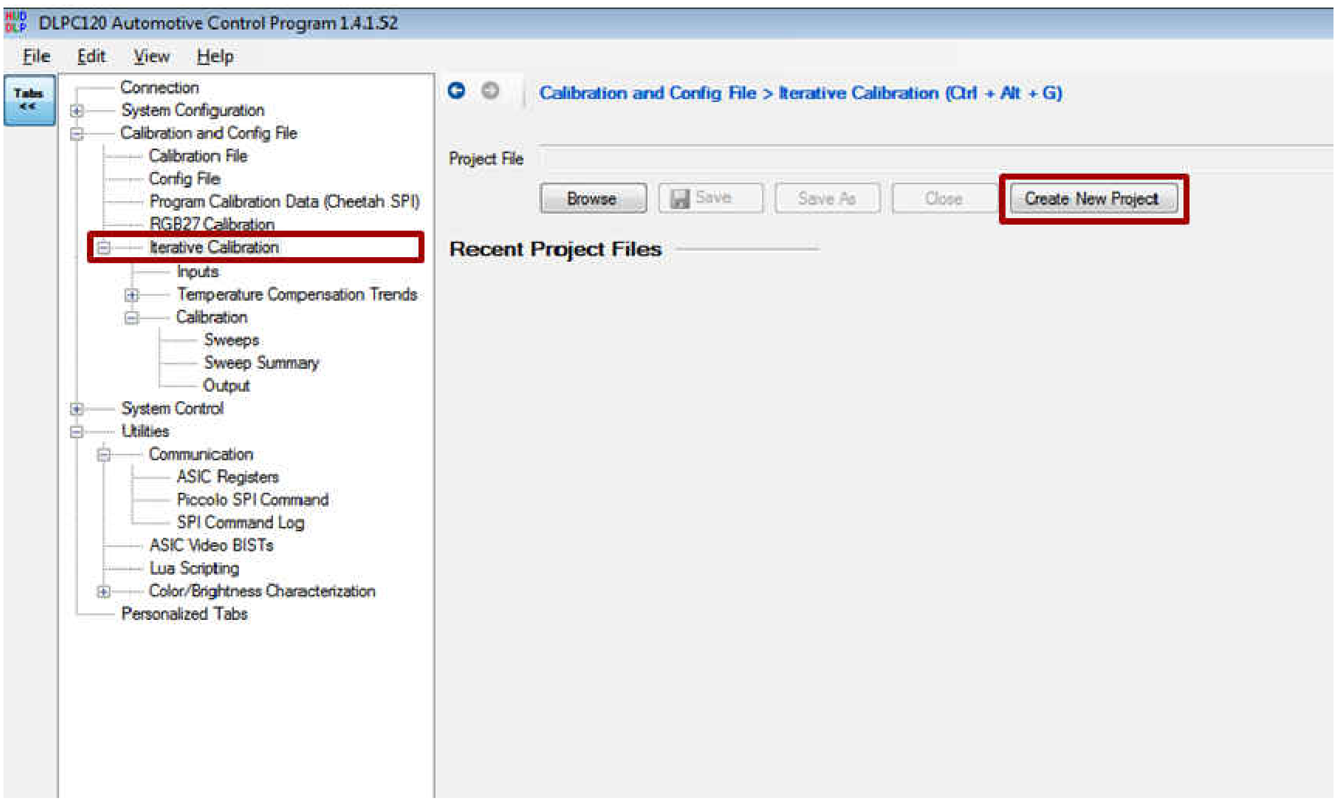


Figure 6-1. Iterative Calibration Projects

3. Select "Inputs" from the menu on the left.
4. Choose your input config file and calibration file. This should be the same config file stored in ASIC Flash. If they are different, a warning will be displayed before starting a sweep. If the files are different, either use the config file loaded in ASIC flash or reprogram the ASIC flash with the current config file before starting. See the ACP User's Guide for more information.

5. A calibration file is not required but can be loaded to quickly populate the "Permitted Coarse Combinations" list.

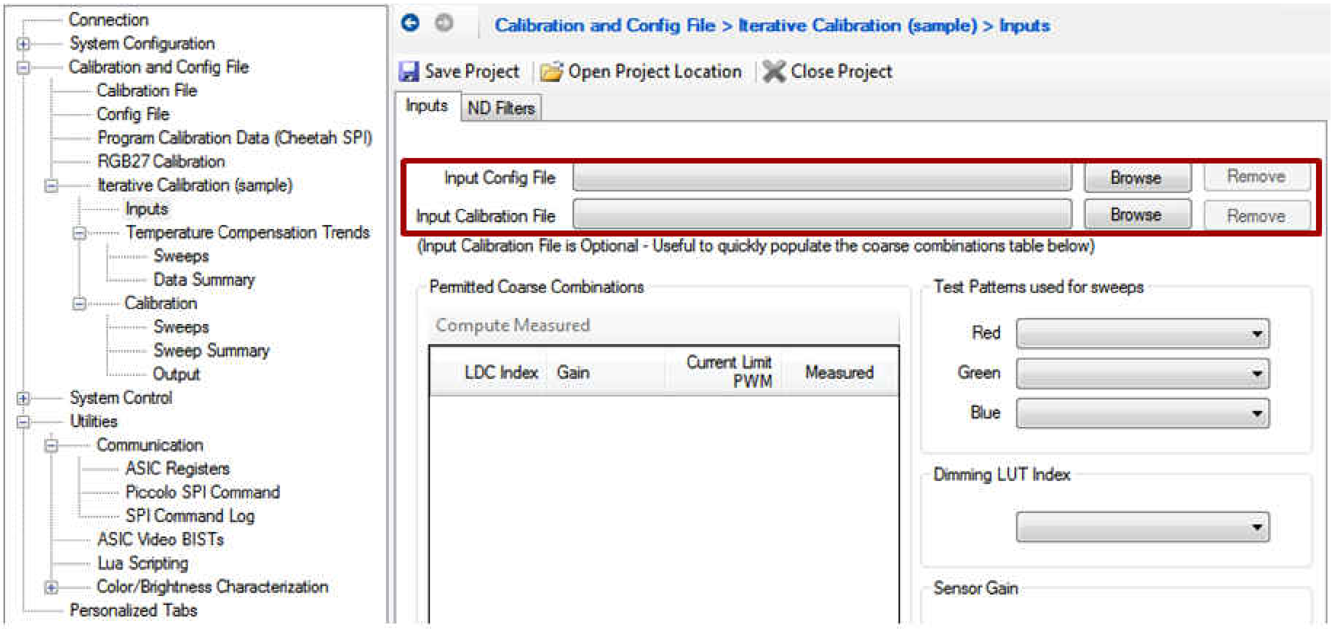


Figure 6-2. Iterative Calibration: Loading Config and Cal Files

6. If no calibration file containing coarse adjustment parameters is used then add desired coarse combinations to "Permitted Coarse Combinations" list. This is the list of coarse combinations determined in Chapter 5. **Note:** Once a temperature sweep has been completed the coarse parameters list cannot be changed.

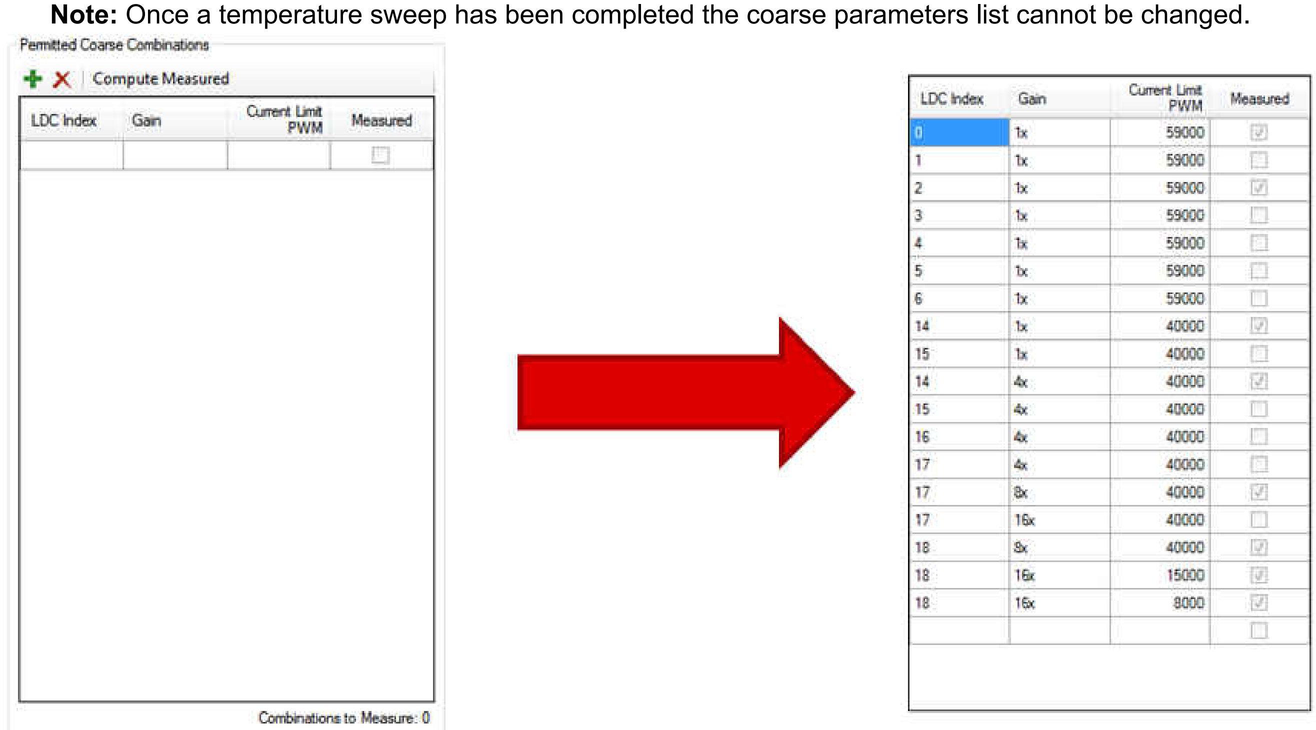


Figure 6-3. Iterative Calibration: Populating Course Combination List

7. Add the transmission percentage for the ND filters used to the "ND Filters" list. Make sure to have a range of ND filters suitable for your color analyzer and PGU design. **Note:** Once a temperature sweep has been completed the ND filter list cannot be changed.

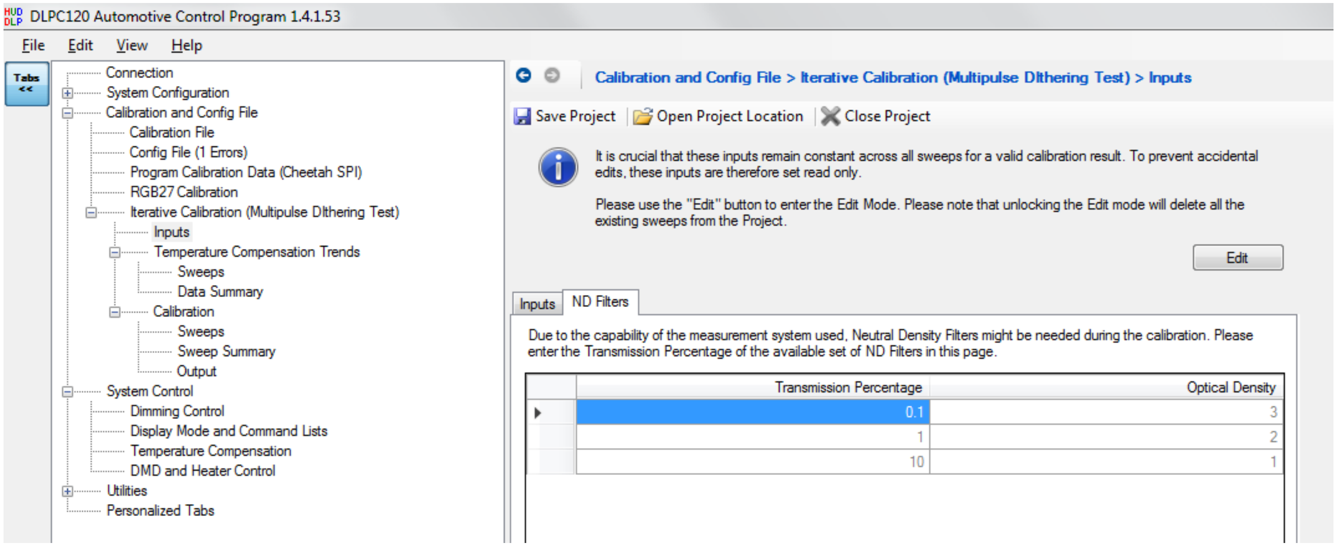


Figure 6-4. Iterative Calibration: Adding ND Filters

6.3 Temperature Characterization

1. Setup the reference system in the temperature chamber. The reference system will be used to gather temperature trend information that can then be applied to all systems during the calibration process. Data will be gathered from the reference system at multiple temperatures.
2. Select "Iterative Calibration" >> "Temperature Compensation Trends" >> "Sweeps" from the menu on the left.
3. In the sweep settings menu select your light meter from drop down menu.
4. Enter calibration temperature as the current temperature of the chamber. This should eventually be done for a cold temperature (–40°C), room temperature (25°C) ,and the max system temperature (105°C). At a minimum, two temperature sweeps are required in order to generate a calibration file, but typically several temperatures are calibrated for.
5. At a minimum room temperature and one other temperature are required in order to generate a calibration file.
6. Adjust minimum and maximum PWM values, increment values, number of averaged measurements, and measurement delay. The default values for all of these parameters are typically acceptable. Measurement delay must be at least 50 ms.

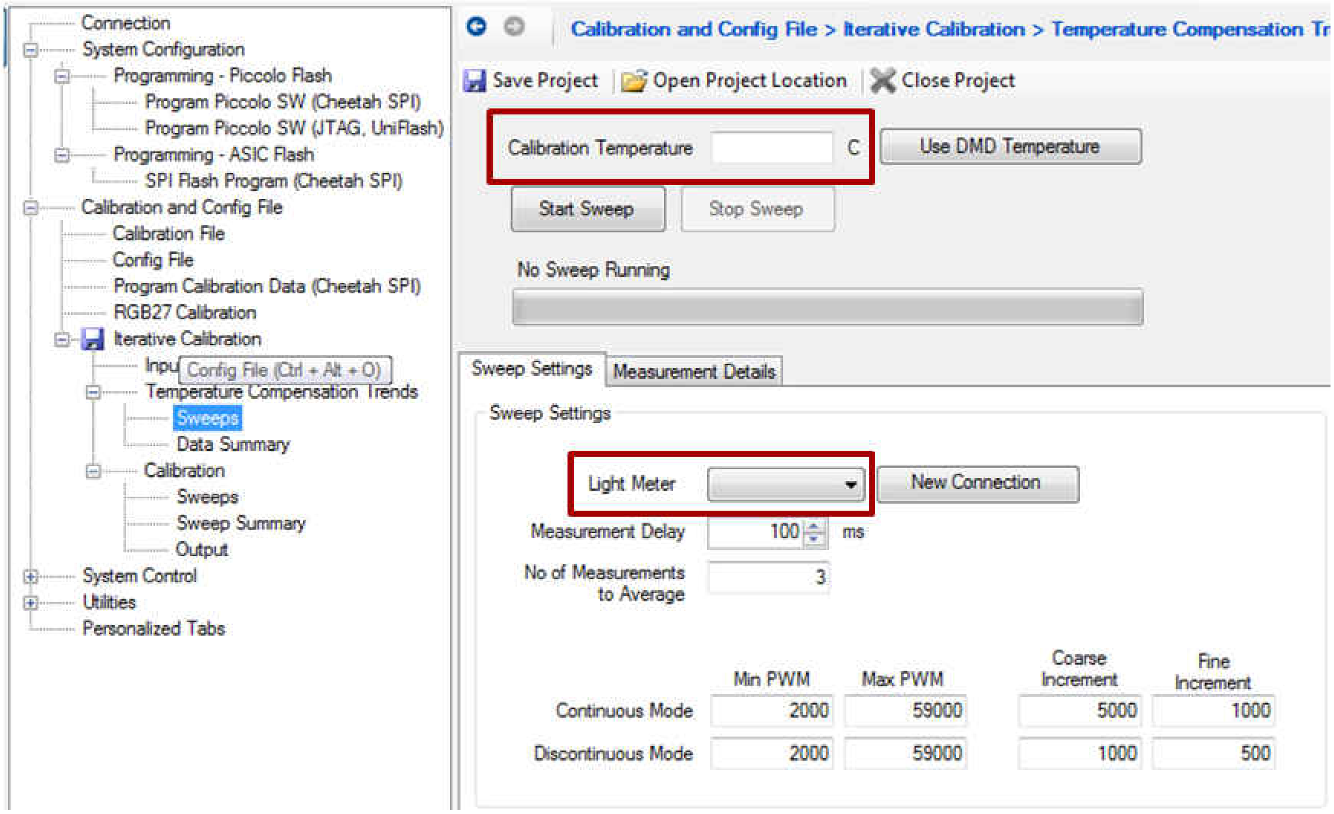
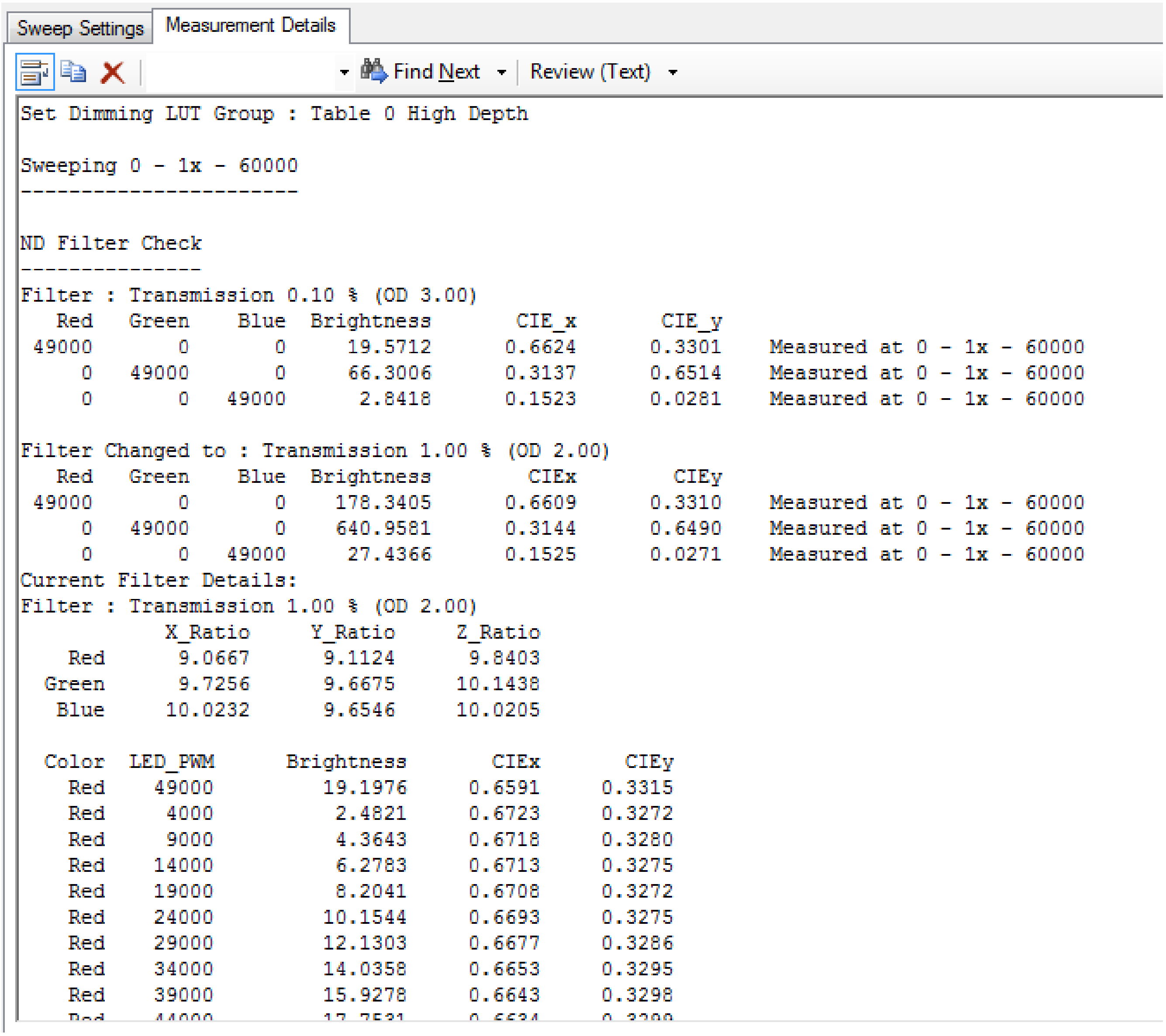


Figure 6-5. Iterative Calibration: Temperature Compensation Sweeps

7. Press "Start Sweep."
8. The Automotive Control Program will step through each coarse combination, sweep through the LED PWM ranges, and determine the minimum and maximum brightness for each LED (RGB). The program will prompt the user when it is appropriate to switch between ND filters.
9. Individual measurement details will be recorded for debugging purposes. This can be viewed in the "Measurement Details" tab and in the 'Log' folder in the Calibration project directory.




```
Set Dimming LUT Group : Table 0 High Depth

Sweeping 0 - 1x - 60000
-----------------------

ND Filter Check
---------------
Filter : Transmission 0.10 % (OD 3.00)
   Red   Green     Blue  Brightness      CIE_x       CIE_y
 49000       0        0     19.5712     0.6624      0.3301    Measured at 0 - 1x - 60000
     0   49000        0     66.3006     0.3137      0.6514    Measured at 0 - 1x - 60000
     0       0    49000      2.8418     0.1523      0.0281    Measured at 0 - 1x - 60000

Filter Changed to : Transmission 1.00 % (OD 2.00)
   Red   Green     Blue  Brightness       CIEx        CIEy
 49000       0        0    178.3405     0.6609      0.3310    Measured at 0 - 1x - 60000
     0   49000        0    640.9581     0.3144      0.6490    Measured at 0 - 1x - 60000
     0       0    49000     27.4366     0.1525      0.0271    Measured at 0 - 1x - 60000
Current Filter Details:
Filter : Transmission 1.00 % (OD 2.00)
            X_Ratio      Y_Ratio     Z_Ratio
    Red      9.0667       9.1124      9.8403
  Green      9.7256       9.6675     10.1438
   Blue     10.0232       9.6546     10.0205

  Color  LED_PWM      Brightness      CIEx       CIEy
    Red    49000         19.1976    0.6591     0.3315
    Red     4000          2.4821    0.6723     0.3272
    Red     9000          4.3643    0.6718     0.3280
    Red    14000          6.2783    0.6713     0.3275
    Red    19000          8.2041    0.6708     0.3272
    Red    24000         10.1544    0.6693     0.3275
    Red    29000         12.1303    0.6677     0.3286
    Red    34000         14.0358    0.6653     0.3295
    Red    39000         15.9278    0.6643     0.3298
```

Figure 6-6. Iterative Calibration: Measurement Details

10. Adjust the temperature of the system and repeat the temperature sweep procedure.
11. Data from the temperature sweeps can be viewed in the "Data Summary" menu on the left.
12. The "Sweep Characteristics" tab shows a visual representation of the recorded data. Brightness and color point information can be viewed for each LED at each temperature.

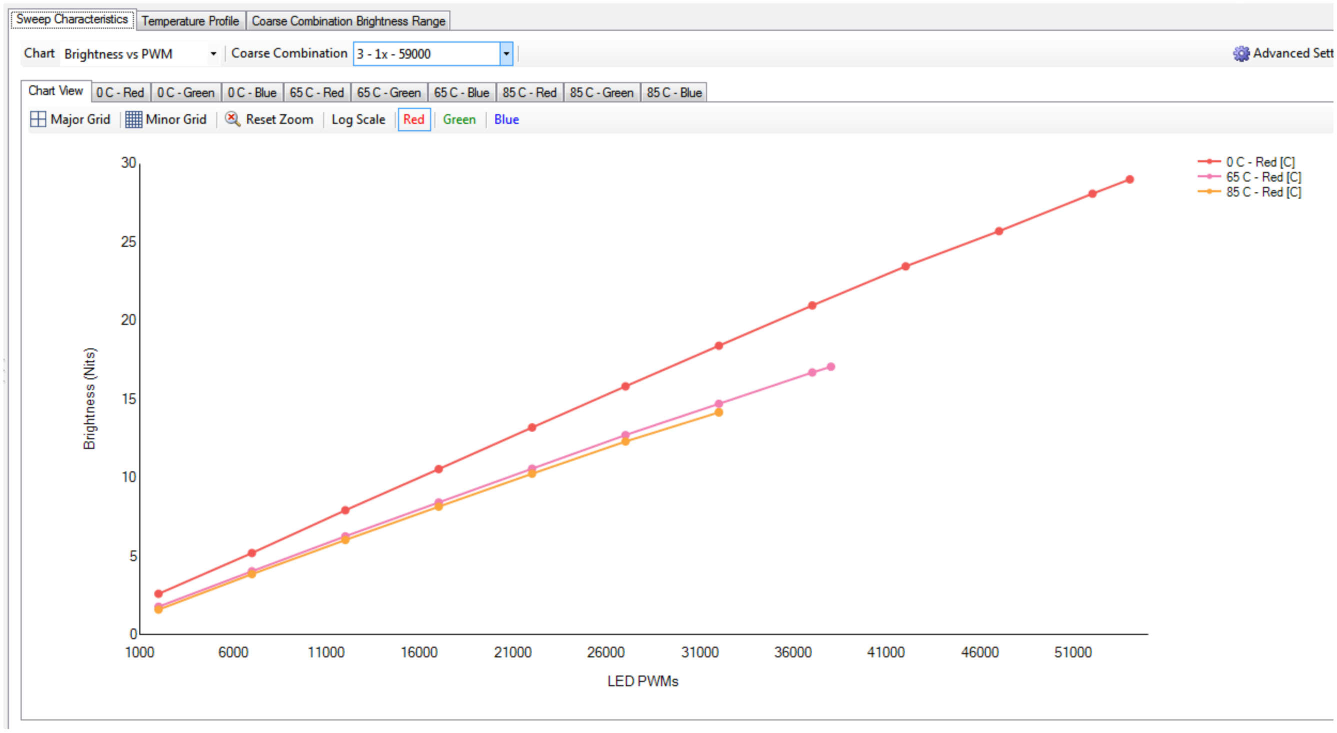


Figure 6-7. Brightness Output vs LED PWM Value

13. The "Temperature Profile" tab displays the maximum brightness achievable at a given color point and temperature in graph form. Figure 6-8 shows an example.

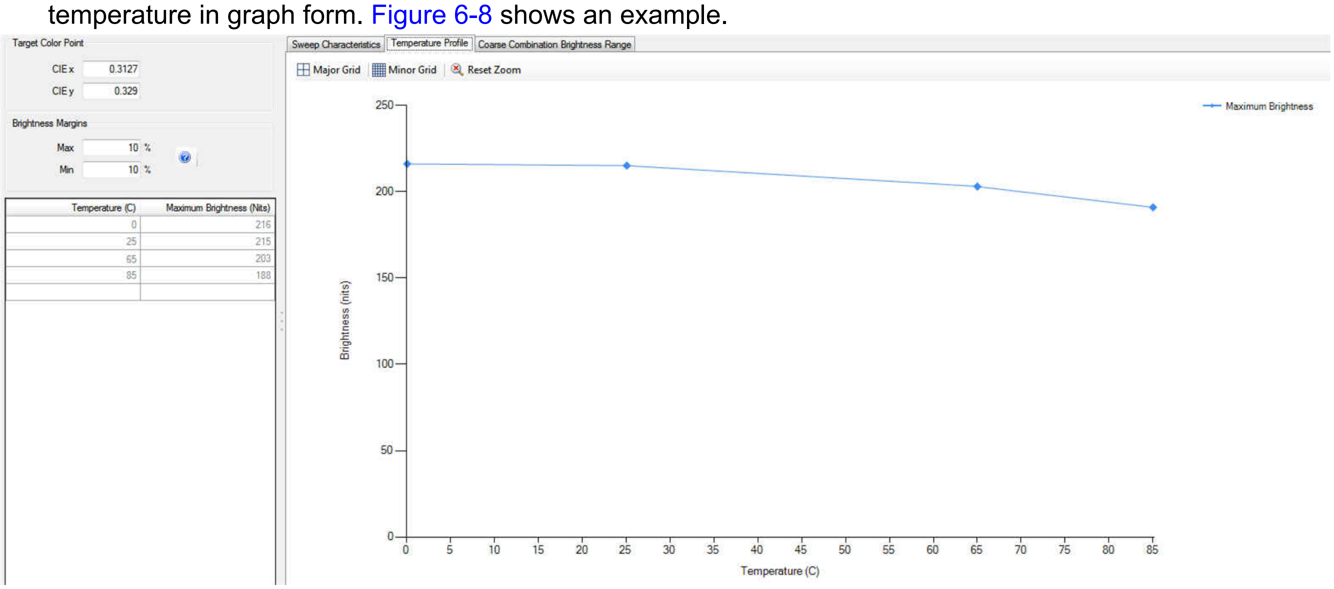


Figure 6-8. Brightness Output vs Temperature

14. The "Coarse Combination Brightness Range" tab displays the maximum brightness achievable for a given coarse combination. Data can be viewed per temperature or transition region.

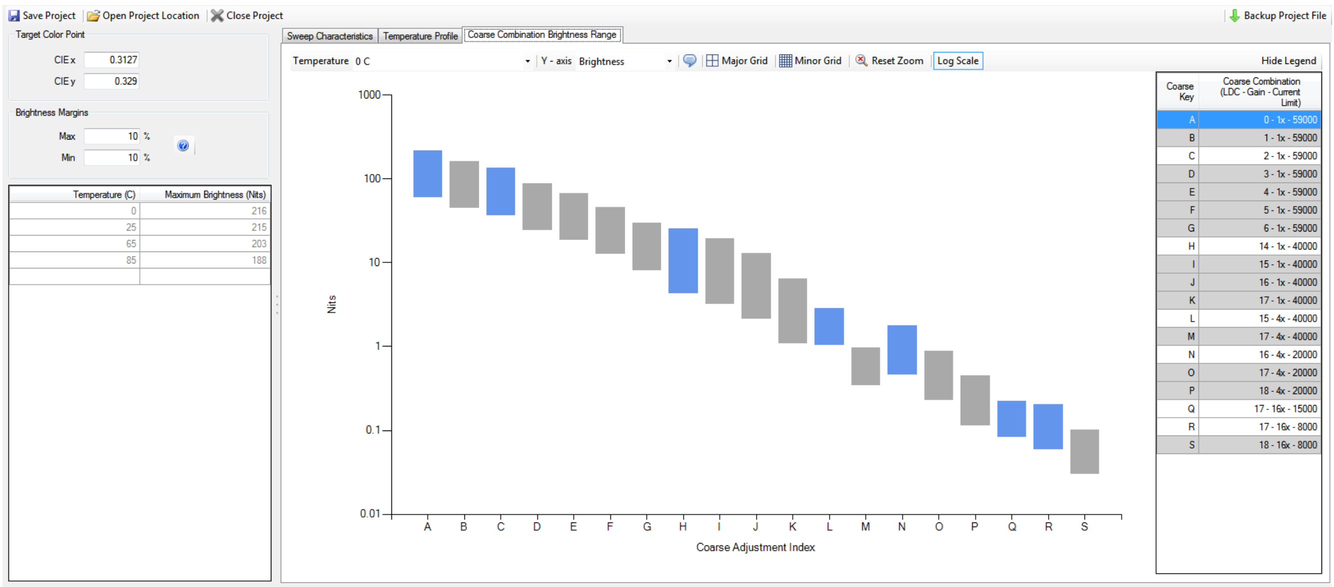


Figure 6-9. Brightness Output vs Coarse Combination

15. When reviewing the ranges there are options for adjusting the view including temperature, brightness or backlight, zooming into particular regions, adding notifications regarding discontinuities, and scale (log vs standard).

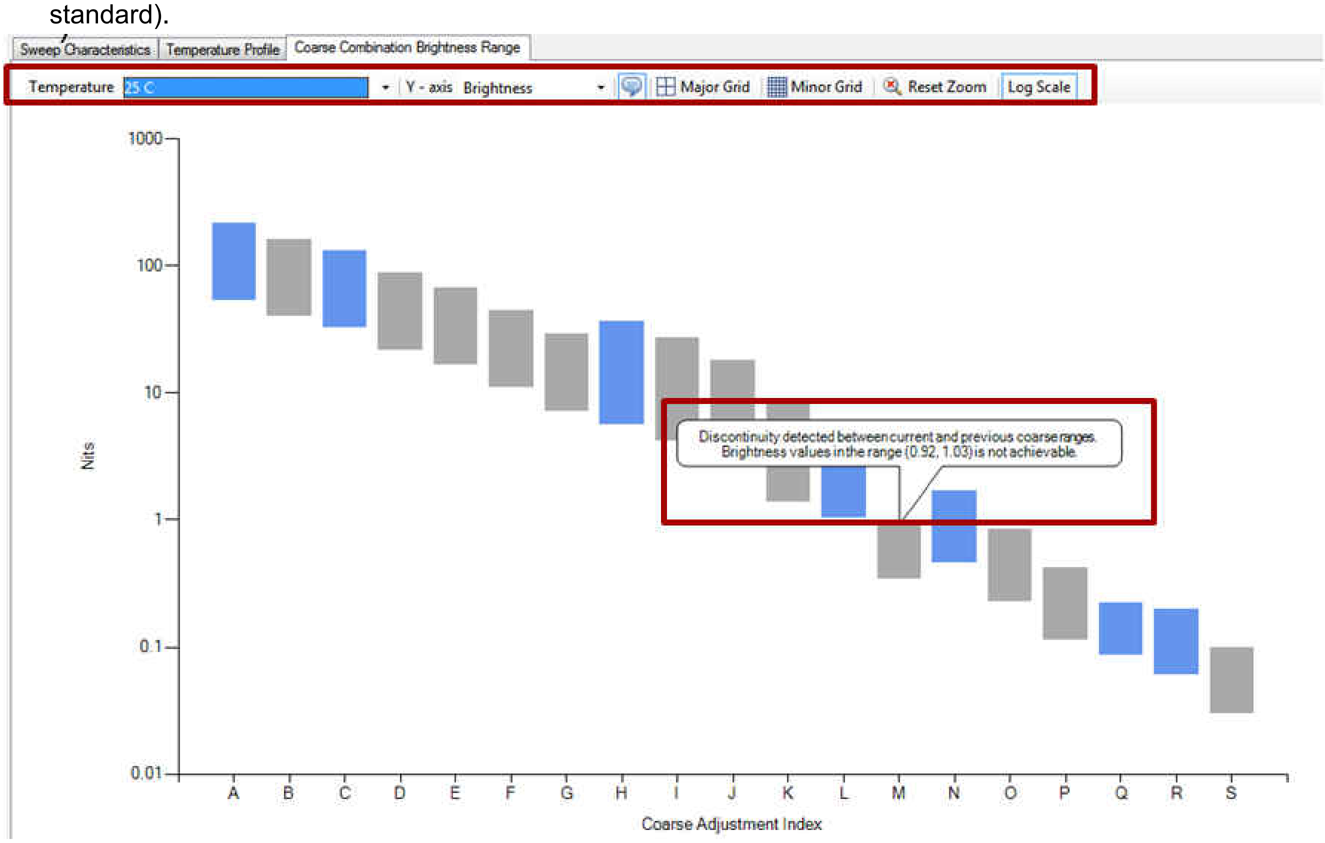


Figure 6-10. Brightness Discontinuities

16. If discontinuities do exist at any brightness ranges, return to Section 6.2 and adjust the coarse combinations as described in Chapter 5, then rerun the temperature sweeps.

6.4 Production PGU Calibration

The process for the production PGU calibration sweep is the same as for the pre-production temperature calibration sweeps, but it only needs to be done at one temperature (typically room temperature) for each PGU being calibrated.

1. Select "Iterative Calibration" >> "Calibration" >> "Sweeps" from the menu on the left.
2. Set the PGU name.
3. Set the calibration temperature.
4. Select the connected light meter.

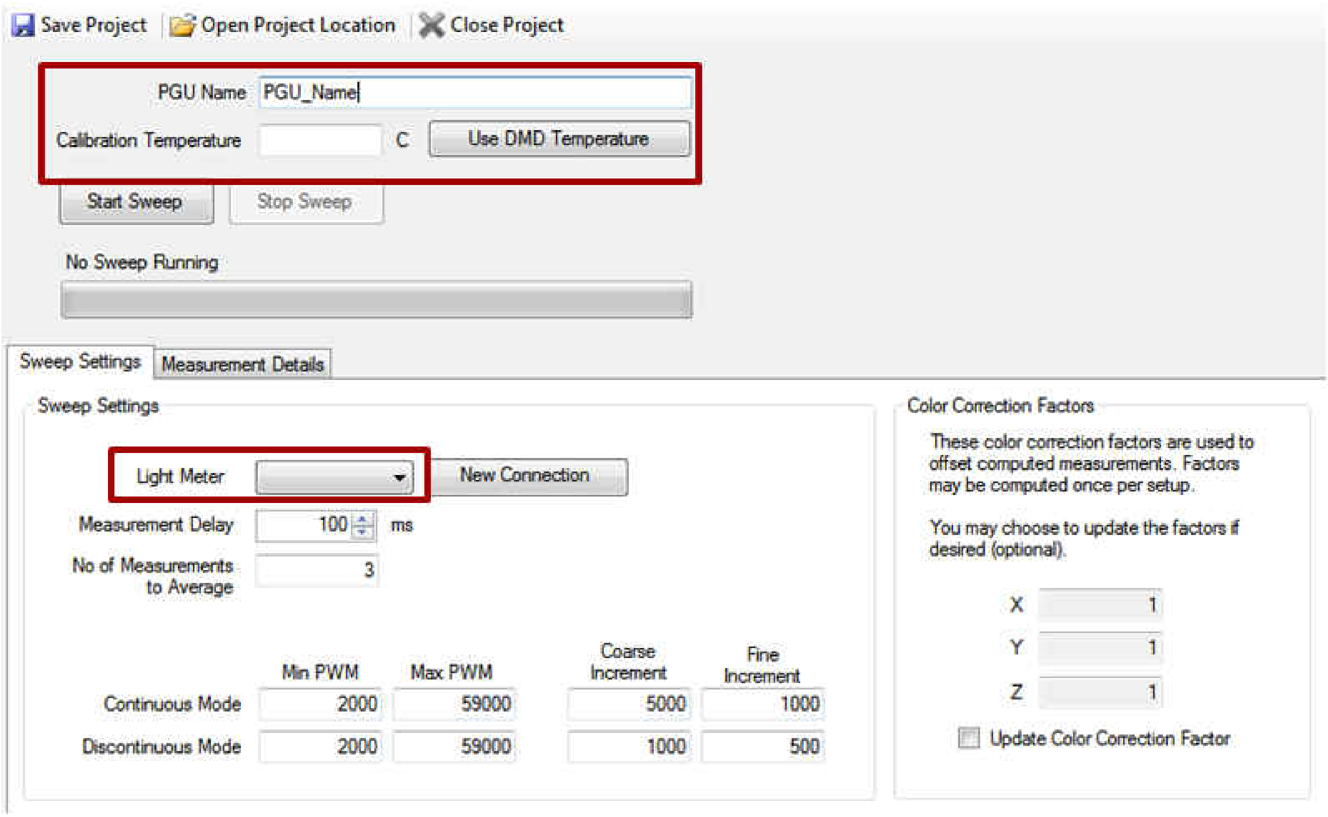


Figure 6-11. Iterative Calibration: Individual PGU Sweeps

5. If using ND filters, the software can automatically correct for color offset introduced by the filter. Color correction data can be recorded during the first per PGU sweep and used in following sweeps.
6. Enter desired values for measurement delay, number of averaged measurements, min/max PWM values, and increment values. Default values are typically acceptable.
7. To start the sweep press the "Start Sweep" button.

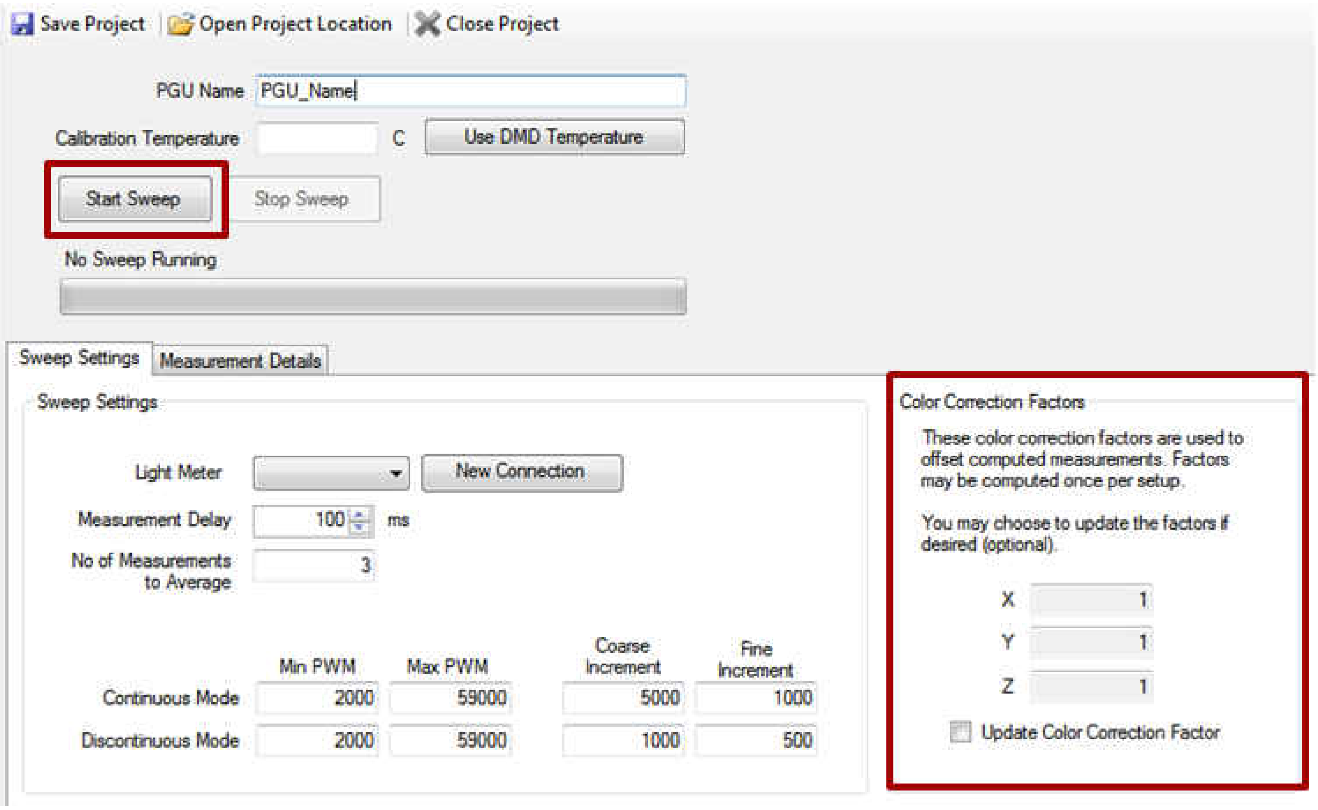


Figure 6-12. Iterative Calibration: PGU Color Correction Factors

8. As in the temperature sweeps, data from the per PGU sweep can be viewed in the "Sweep Summary" section.
9. Different PGU sweeps can be compared against each other.

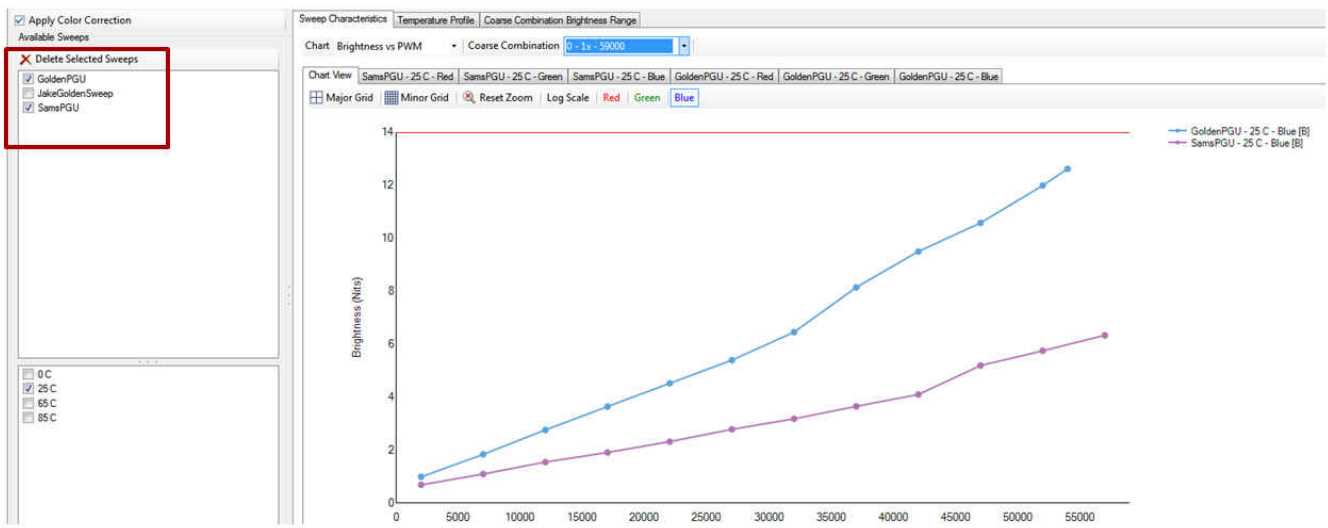


Figure 6-13. Iterative Calibration: PGU Brightness Sweeps

6.5 Generating a Calibration File

1. Once the temperature trend sweeps and per PGU sweep is complete and calibration file can be generated.
2. The brightness margin can be used to remove a portion of the range of a coarse combination. This is done because it may be difficult to achieve the target color point at the minimum and maximum brightness of a combination

3. The tradeoff is that you can introduce discontinuities or reduce the maximum brightness achievable if the margins are set too aggressively.
4. Select the brightness margins you would like for each coarse combination.

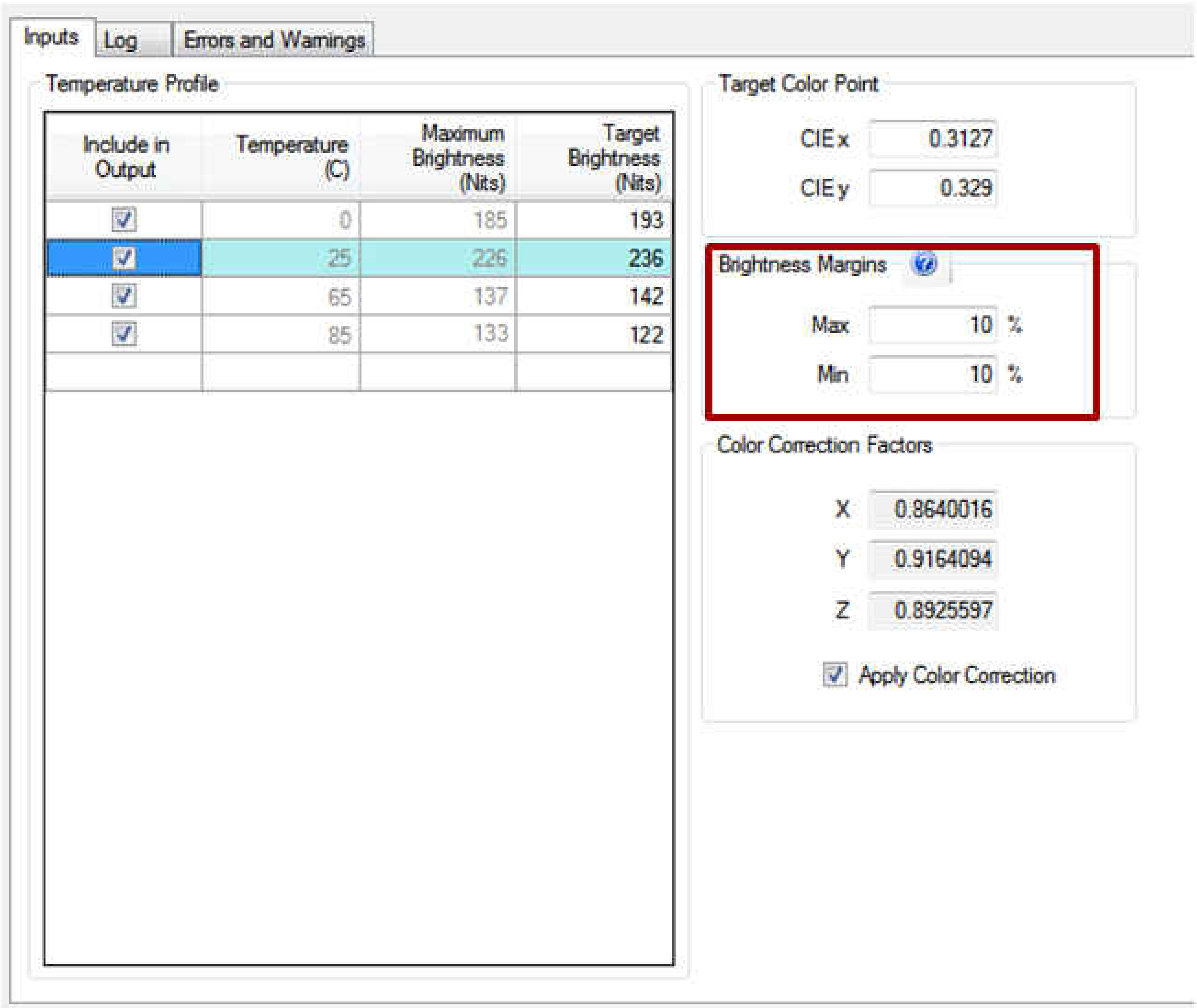


Figure 6-14. Cal File Brightness Margins

5. Select target color point.

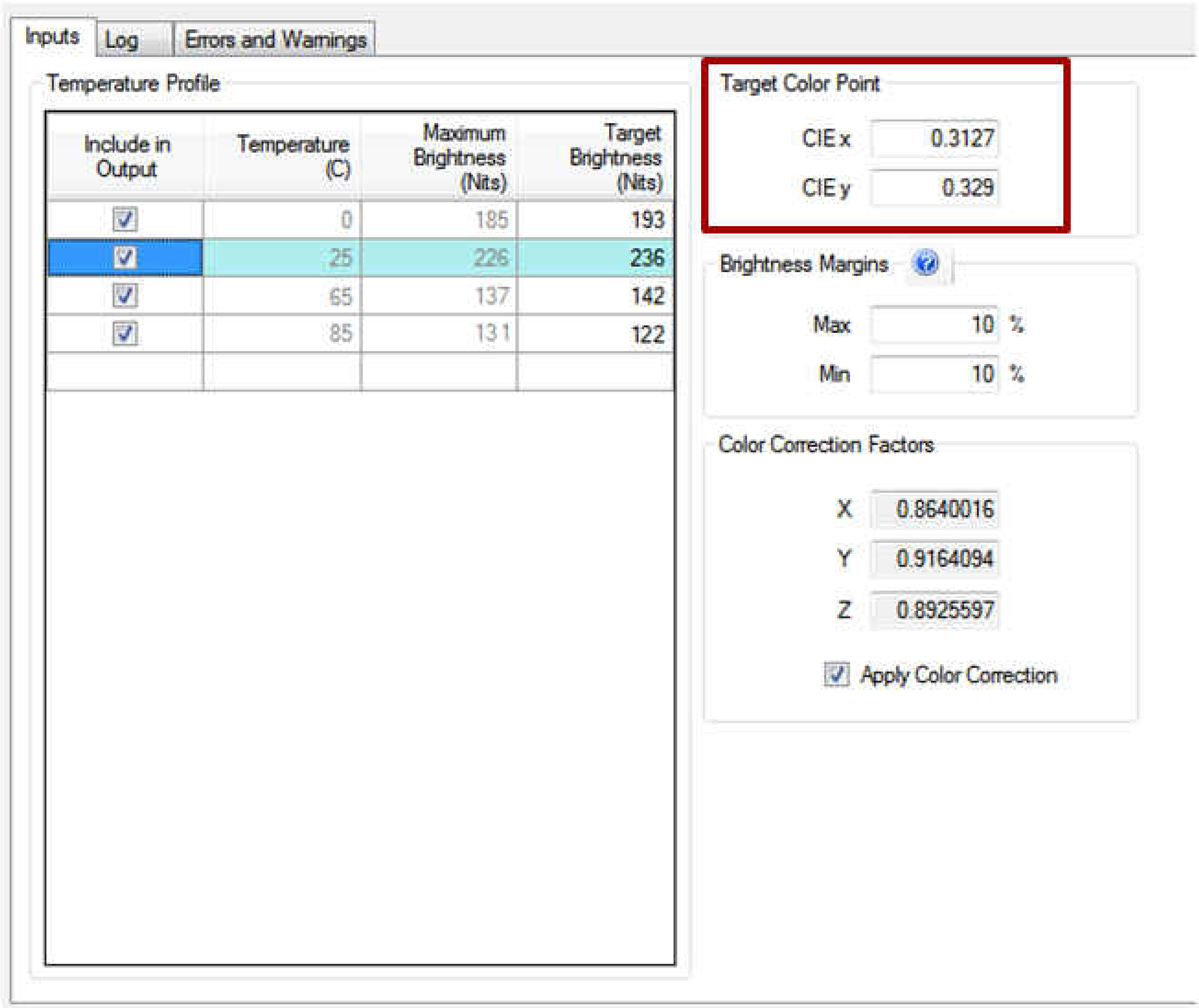


Figure 6-15. Cal File Target Color Point

6. If color correction factors were recorded for your calibration procedure the can be applied by selecting the "Apply Color Correction" option.

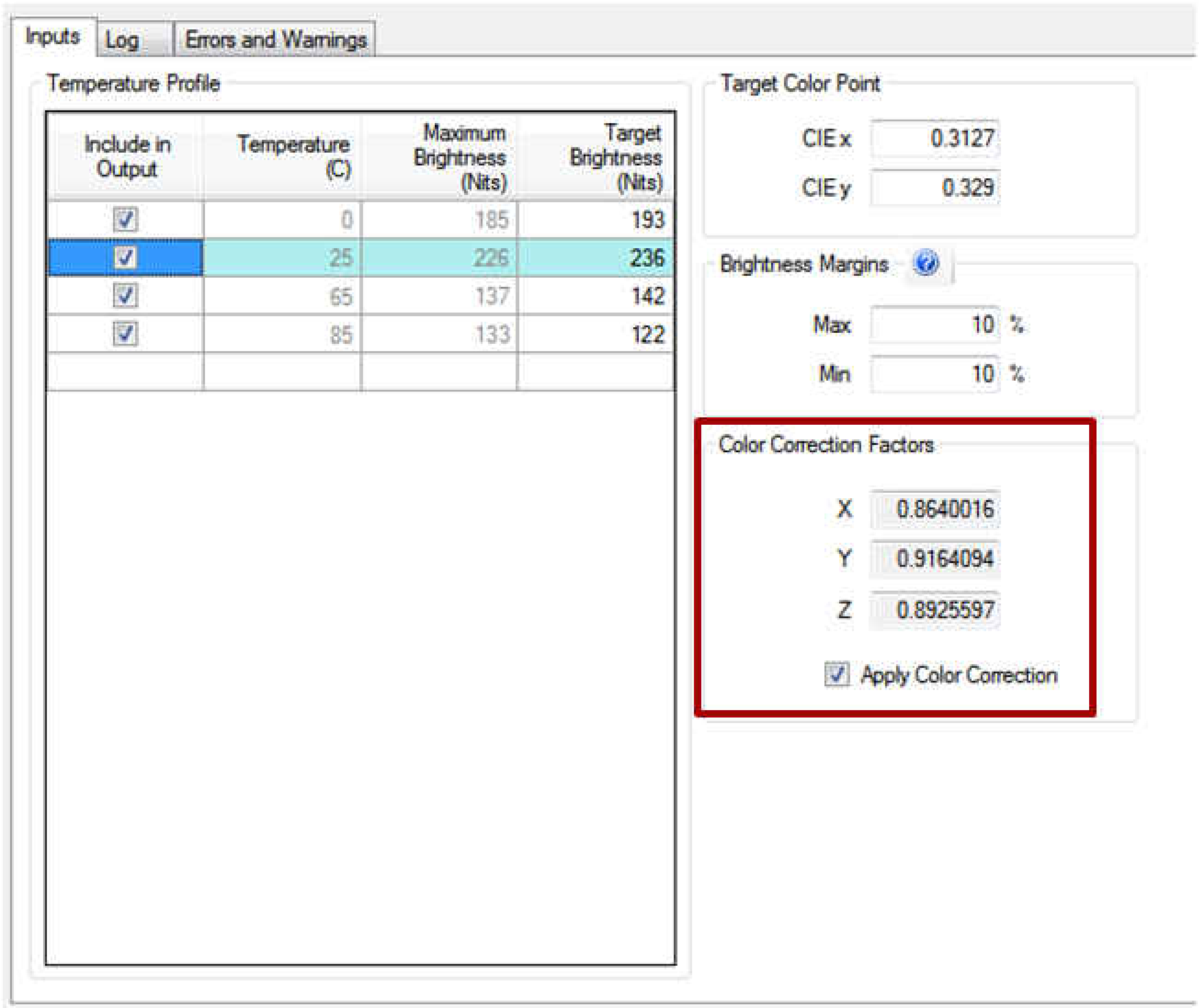


Figure 6-16. Cal File Color Correction Factors

7. Select and input target brightness for each temperature range. Target brightness is dependent on color point, brightness margins and use of color correction factors. Target brightness should remain constant for each PGU calibrated.

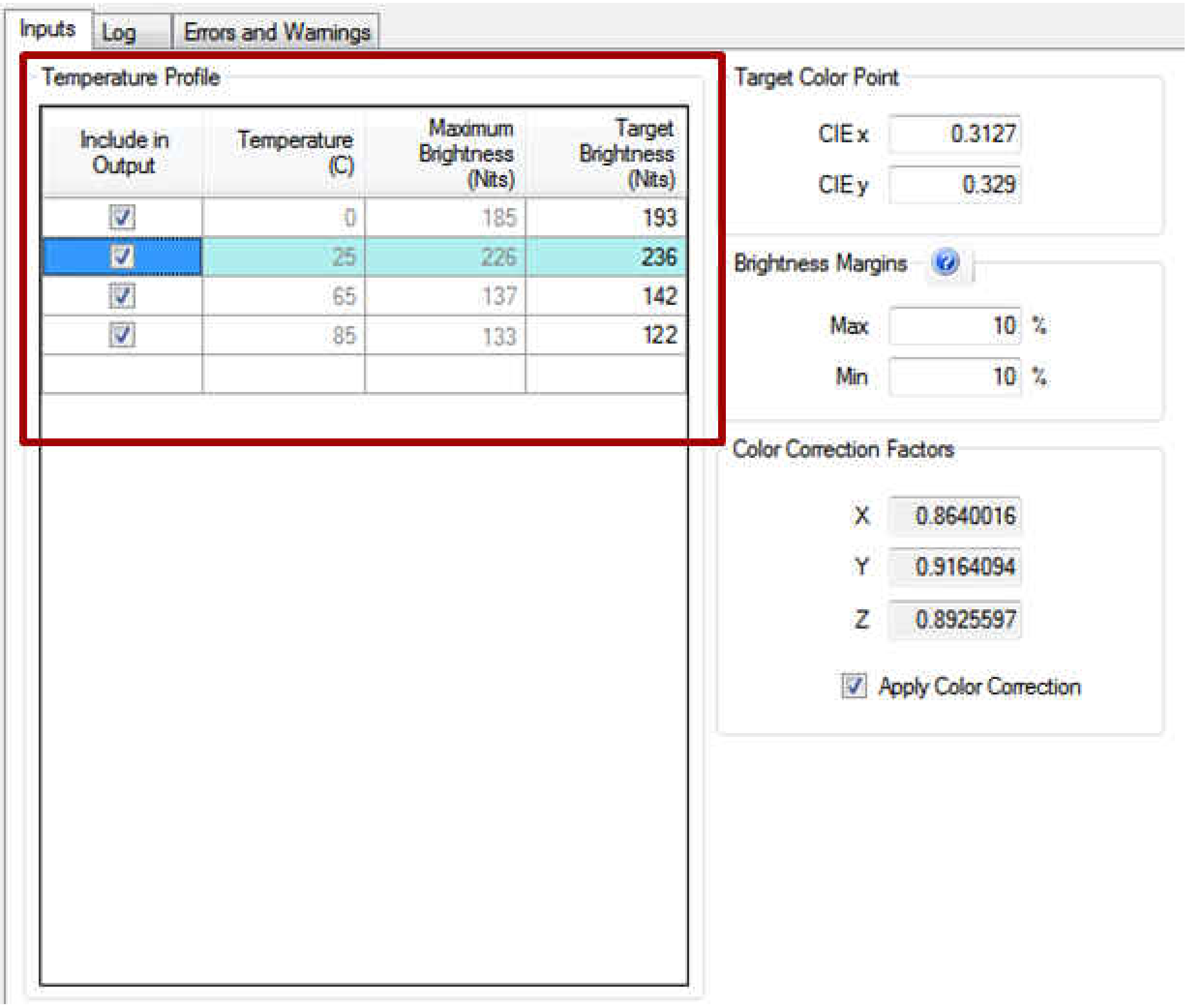


Figure 6-17. Included Calibration Temperature Tables

8. Once all options have been set, press "Generate Calibration File" and a cal file will be generated.
9. During the generation of the cal file, feedback will be provided to the user.
10. If there are errors or warnings during the generation of the cal, the errors should be reviewed and corrective action can be taken. In most cases the cal file will still be generated but may have some discontinuities in the dimming range.
11. In the case where a continuous dimming range cannot be achieved you may reduce the brightness margins. Often times a small discontinuity is imperceptible.

Backlight	LDC Index	Gain	Current Limit PWM	Red PWM	Green PWM	Blue PWM
65535	0	1x	59000	38302	41887	36745
39726	0	1x	59000	22384	24817	21510
13916	0	1x	59000	6386	7427	6061
13915	2	1x	59000	15371	17227	14738
10388	2	1x	59000	10884	12365	10428
6860	2	1x	59000	6380	7447	6063
6859	4	1x	59000	15120	16959	14498
5145	4	1x	59000	10759	12229	10310
3430	4	1x	59000	6380	7447	6063
3429	6	1x	59000	17492	19504	16769
3222	6	1x	59000	16299	18222	15625
3014	6	1x	59000	15098	16934	14476
3013	14	1x	30000	35742	26190	27735
1852	14	1x	30000	30089	19199	22291
691	14	1x	30000	16137	8150	11325
690	14	4x	30000	54809	23586	35770
459	14	4x	30000	37076	13052	22787
228	14	4x	30000	16186	3865	8845
227	16	4x	30000	36635	12837	22487

Figure 6-18. Example Calibration Table Output

Revision History

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

Changes from Revision * (March 2018) to Revision A (April 2022) **Page**

- Updated the numbering format for tables, figures, and cross-references throughout the document..................7
- First public release...7

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