

DACx3608 Delivers Programmable LED Array Biasing Solution at Ultra Low Cost and Smallest Footprint



Packed with a simple yet complete feature set the DAC53608 enables a biasing solution for LED arrays that is low-cost, compact, and adequate. Though it may be unobvious, meeting all these requirements needs careful design trade-offs.

Many imaging products that used technologies such as lasers and lamps are now adapting LED array based solutions. LEDs need to be forward biased in its linear region to operate. A resistive voltage divider can serve this purpose. But the biasing point of an LED changes with temperature and part-to-part variability. Hence, programmability of the biasing point is a must in precision circuits. Digital Potentiometers (DPOT), PWM, or Precision DACs are obvious options for this. These applications also need the solution to be low cost, small size, and high integration. Selecting the right architecture thus becomes non-trivial. This application note discusses different LED biasing topologies and the trade-offs. Only low-side LED biasing topologies are discussed.

DPOT Based Biasing

An LED is biased with current. The most basic implementation of a programmable current source is shown in Figure 1 that uses a DPOT and an adjustable shunt reference. This circuit changes the current by changing the voltage across the zener. The major drawback of this circuit is that it uses more number of components that will lead to an increased footprint and cost of the solution. This is especially true when biasing an array of LEDs. Also the V_{BE} of the transistor varies with temperature and collector current.

PWM Based Biasing

A PWM signal can be used in place of the DPOT and zener in Figure 1 to program the bias point. The bias point corresponds to the DC value of the PWM signal. The problem with this circuit is that it needs one PWM generator per channel, which might be difficult to get from an MCU. A continuous PWM also creates distortion and EMI issues.

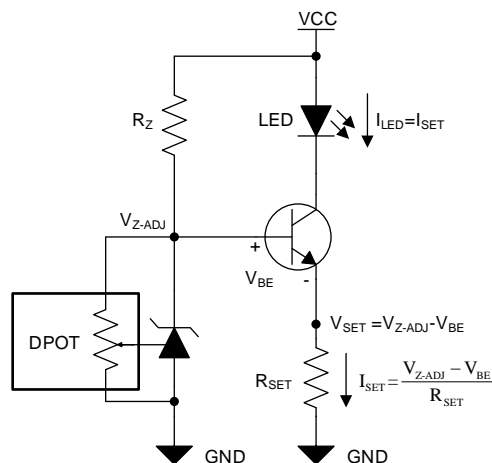


Figure 1. DPOT Based Biasing

Simple Biasing Method Using a Precision DAC

A precision DAC based biasing circuit is depicted in Figure 2. The DAC53608 family of DACs that come with 8-channels in a 3x3 QFN package, realizes this circuit with the smallest size and lowest cost. However, it still carries forward one draw back from the previous circuit that is the drift in V_{BE} of the transistor. Further, the output also requires a headroom near ground rail due to V_{BE} drop.

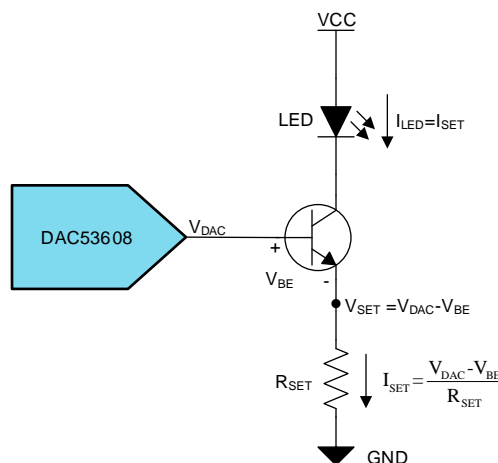


Figure 2. Programmable LED Biasing Circuit

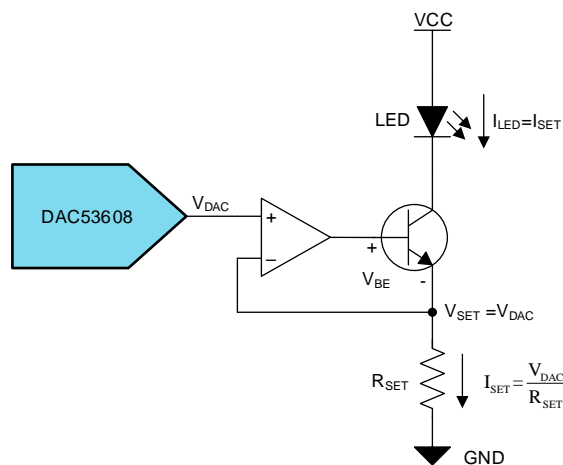


Figure 3. V_{BE} Compensation Using Buffer

The V_{BE} varies with temperature and collector current. This variation and the headroom may be ignored in few applications that places this circuit inside a larger feedback loop with gain. But it can be of concern for applications that are open-loop and do not employ temperature calibration. This drift will consequently lead to gain error and full scale error at system level.

Compensating V_{BE}

A robust way of compensating the V_{BE} variation is by putting it inside the feedback loop of an amplifier as shown in Figure 3. This circuit is very suitable for applications that require high accuracy. The only drawback of this circuit is that it requires an additional amplifier.

Another approach for compensating V_{BE} can be considered as shown in Figure 4 that uses a matched pair of PNP and NPN transistors in order to cancel out the voltage variations and headroom. As can be seen this circuit balances accuracy, solution size, and cost.

DACx3608 Family of Precision DACs

The DACx3608 family of DACs is an 8-channel buffered voltage output DAC with a tiny 3x3 QFN package. It has a single supply operation and comes in 8-bit and 10-bit pin-compatible versions. The DAC provides an I2C interface whose device address can be configured to four different values using a single hardware pin. This will allow use of 32 channels without using any I2C buffer. All these features combined with tiny footprint makes DAC53608 an excellent choice for programmable LED biasing.

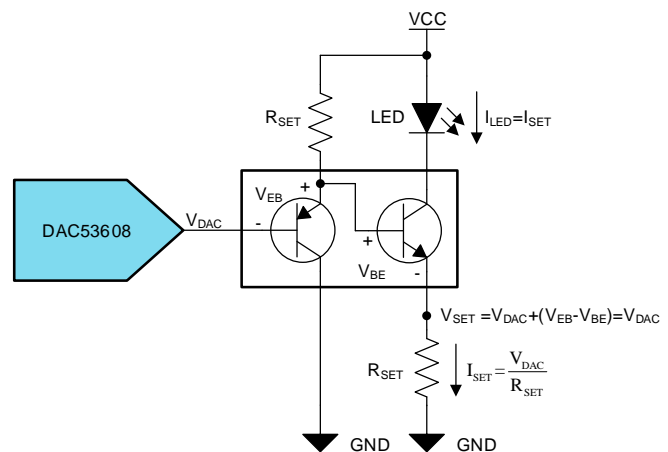


Figure 4. V_{BE} Compensation Without Buffer

Discussion

Table 1 provides a summarized comparison of the topologies discussed in this document. It can be noticed that the precision DAC based solutions excel other approaches in many aspects. General purpose precision DACs in 8- and 10-bit resolutions have been flooding the market for a long time. But the DAC53608 comes with the latest semiconductor technologies that enable the ultra low cost and size, much differentiated from the competition. Hence, it is perfectly suitable for LED biasing applications and geared to meet highly competitive requirements of the end equipment. Powered with the DAC53608 family, the topologies discussed above can provide both low precision and high precision functionality with ease of implementation.

Table 1. Comparison of LED Biasing Topologies

Topology	Trade-off
DPOT Based Circuit	More components leading to extra cost and space, No V_{BE} compensation
PWM Based Circuit	Difficult to generate multi-channel PWM. Also creates distortion and EMI issues
DAC Based Circuit without V_{BE} Compensation	Very simple implementation suitable for applications not concerned about V_{BE}
DAC Based Circuit with Buffer	Suitable for high accuracy applications, needs an additional amplifier
DAC Based Circuit with Matched Transistor Pair	Best trade-off between cost and accuracy

Related End Equipment

- Printers
- Projectors
- Electronic Point of Sale (EPOS)
- Visible Light Communication (VLC)

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