# AND8412/D

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# Digital Potentiometer (POT) to Control LED Brightness

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**APPLICATION NOTE**

Light-emitting diodes (LEDs) require a regulated current, and their brightness is proportional to the current that flows through them. Some LED drivers use an external resistor to set the LED current. A digital POT can replace a discrete resistor with the advantage of providing an adjustable value allowing the LED brightness to dynamically change. Most digital POT circuits have the ability to store permanently the resistor value in non-volatile memory.

This application brief shows a digital POT circuit used in combination with the CAT32 white LED driver. The digital POT is connected as a 2-terminal variable resistor, as shown in Figure 1. The potentiometer Wiper-to-Low resistor (between W and L pins) is connected in series with the $R_{SET}$ resistor to adjust the LED brightness. This example uses a 100-tap linear potentiometer, the CAT5113, with an end-to-end resistance of 50 kΩ. The wiper terminal (W) position is controlled through a 3-wire interface. The INC input increments the wiper in the direction which is determined by the logic state of the Up/Down input. The CS input is used to select the device and also store the wiper position prior to power down.

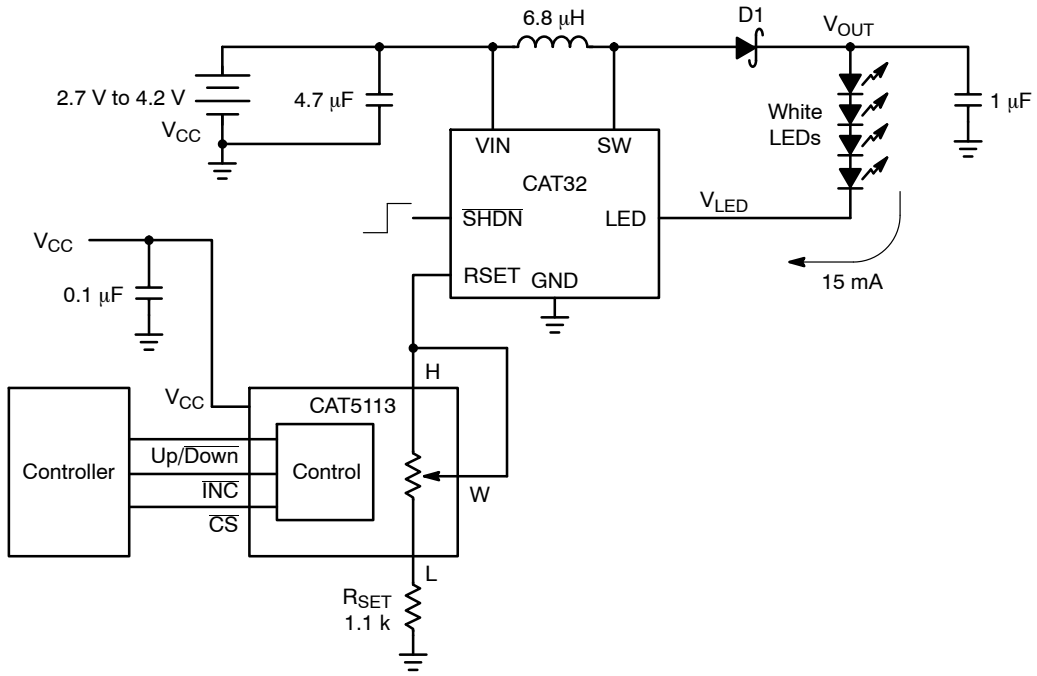


**Figure 1. CAT32 LED Driver with CAT5113 Potentiometer Circuit Diagram**

### LED Current

The LED current is a function of the total resistance connected to the $R_{SET}$ pin, and is calculated as follows:

$$I_{LED} = \frac{22.5}{R_{SET} + R_{W-L}}$$

$R_{SET}$ defines the minimum resistance and therefore the maximum LED current, for example with RSET = 1.13 kΩ, the LED current is 20 mA. The lowest LED current is obtained with the largest $R_{W-L}$ of 50 kΩ, which results in an LED current of about 1 mA.

The number of taps define the resolution of the potentiometer or the minimum increment in the resistance. A larger number of taps gives more resolution. Table 1 lists a selection of ON Semiconductor digital POTs with their characteristics.

**Table 1. DIGITAL POT SELECTION**

| Part Number | Number of Taps | Resistor Options (kΩ) | Digital Interface | Resistor Scale | Wiper Memory |
|---|---|---|---|---|---|
| CAT5113 | 100 | 10, 50, 100 | Increment | Linear | 1 position |
| CAT5116 | 100 | 32 | Increment | Log | 1 position |
| CAT5115 | 32 | 10, 50, 100 | Increment | Linear | Volatile |

In applications where the LEDs backlight an LCD, such as in cellular phones or PDAs, the LEDs are either turned ON or OFF. The potentiometer can be used to generate a soft fading between those two states.

Information on the digital POT products and the LED drivers are available on the ON Semiconductor web site at http://www.onsemi.com.



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