Interfacing the NCP1840 LED Driver to an I²C Serial EEPROM

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APPLICATION NOTE

INTRODUCTION

The NCP1840 LED driver allows for full programmability of 8 separate LED channels through a simple I²C serial communication interface. Programming is conveniently done by writing to internal registers via the serial interface. In addition to being able to write to the registers, the NCP1840 also allows these registers to be read. The constant current output and PWM duty cycle of each channel is determined by the value programmed into the associated register.

Each channel's constant current output is set via a 5-bit logarithmic current DAC. This provides the ability to obtain the desired brightness and color for each LED channel independent of the other channels and in a perceived linear fashion to the human eye. Likewise, the 6-bit PWM duty cycle of each channel can be set independently to achieve the desired dimming of each LED channel, without affecting the color integrity of the LEDs.

Once the desired output current and PWM settings have been achieved during a calibration mode, the register values of the NCP1840 can be read and loaded into an external EEPROM device for future use. This allows for these calibrated register settings to be restored to the NCP1840 at anytime, including upon power up. The I²C interface benefits from being a shared communication bus and therefore is the ideal interface to be used between the system processor, the NCP1840, and the EEPROM.

SYSTEM

The NCP1840 is only configured as an I²C Slave and therefore requires an I²C Master on the bus. Due to the simple, flexible, and universal protocol of the I²C interface, it is easy to implement this communication protocol into any system processor or MCU, even when it is not directly supported by the device. The system processor will act as the I²C Master in the system and will be responsible for generating the serial clock and all start and stop conditions on the bus.

In an effort to take advantage of the I²C bus that is already needed by the NCP1840 and to minimize the amount of connections to the system processor, the external EEPROM chosen should be able to support the I²C protocol. In addition, the size of the EEPROM chosen should be kept to a minimum since it only needs to store values for 16 different register bytes per NCP1840 device. The CAT24C01 CMOS Serial EEPROM is a great fit for this application, offering 1-Kb of memory and supporting the I²C protocol in a wide array of packaging options.

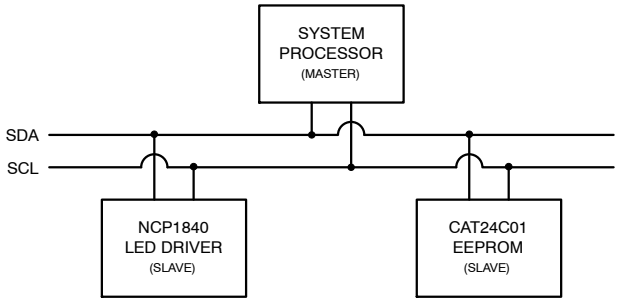

Figure 1. System Diagram

Figure 1 contains a diagram of the system and shows the shared communication bus between the system processor, the NCP1840, and the CAT24C01. Both of the Slave devices have 7-bit addresses that are used by the Master to identify which Slave device will be communicating with it. The NCP1840 has a factory programmed Slave address of 0011011 (1B hex). The CAT24C01 has the first 4 bits of the Slave address factory programmed at 1010 (A hex) and the last 3 bits are programmable address bits that correlate to pins 1-3. The state of these external address pins must match the last 3 bits in the Slave address.

The NCP1840 and the CAT24C01 devices support both read and write modes. The specific read and write sequences for both devices can be found in their respective datasheets.

DATA FLOW

1) Calibrate LED Channels

The first step in the data flow is to obtain the desired luminance, color, and/or dimming of each of the LEDs being driven by the NCP1840 during a calibration mode. This desired performance should correspond to the NCP1840 output current and/or PWM duty cycle register settings that the user wants to store in the CAT24C01 EEPROM for future use (i.e. to restore to the NCP1840 upon power up).

In order to accomplish this, the Master initiates a write to the NCP1840 via the I^2C interface and defines the register address that it wants to write to (one of the output current or PWM duty cycle register addresses). It then loads that register with data that yields the desired performance for that specific LED channel. This process continues until all of the output current and/or PWM duty cycle registers have been loaded with the appropriate data to obtain the desired luminance, color, and/or dimming of each LED being driven by the NCP1840. During this mode, the Master does not need to keep track of the values for each register since they can be read back once the calibration is complete.

2) Store Register Values in EEPROM

Once the LED channels have been calibrated, the values for the corresponding NCP1840 registers can be stored into the CAT24C01. In order to accomplish this, the Master initiates a read with the NCP1840 via the I^2C interface and defines the register address that it wants to read out (one of the output current or PWM duty cycle register addresses). Once this has been established, the NCP1840 will transmit to the Master the data that has previously been loaded into that particular register. Upon successful receipt of this data, the Master will then initiate a write with the CAT24C01 via the I^2C interface and define the address that will be used to store this NCP1840 register data. It then loads into that address the register data from the NCP1840. This process continues until all of the corresponding register data has been loaded into the CAT24C01.

Care must be taken by the Master to keep track of the CAT24C01 address that corresponds to each of the NCP1840 registers addresses. This can be accomplished in many ways: using available internal memory of the system processor (Master), ensuring that the NCP1840 register data is written to the CAT24C01 address that corresponds exactly to the NCP1840 register address, or writing the NCP1840 register address for each register data byte into the CAT24C01 exactly one address before or after the register data.

3) Normal Operation

Once all of the output current and/or PWM duty cycle register data from the NCP1840 have been loaded into the CAT24C01, the system can operate in a normal fashion. The NCP1840 can have any of the register settings changed to perform the functional task desired. Any unused memory in the CAT24C01 can be used for other purposes, including the storing of register values of another NCP1840 device.

4) Restore Register Values into LED Driver

If the supply voltage is removed from the NCP1840, all of the previous register values will be lost and the part will reset every register. Therefore, upon a power up, one would want to restore the register values that represent the calibrated LED performance back into the NCP1840. Also, if the system had changed any of the NCP1840 register settings but then wanted to reset back to the calibrated settings, the previously stored register data could be restored.

In order to accomplish this, the Master initiates a read with the CAT24C01 via the I^2C interface and defines the address that it wants to read data out of (this will be an address that contains NCP1840 register data corresponding to one of the output current and/or PWM duty cycle register addresses). Once this has been established, the CAT24C01 will transmit to the Master the data that has previously been loaded into that particular address. Upon successful receipt of this data, the Master will then initiate a write with the NCP1840 via the I^2C interface and define the register address that corresponds to this particular register data. It then loads into that register address the register data received from the CAT24C01. This process continues until all of the output current and/or PWM duty cycle register data has been restored to the appropriate NCP1840 registers.

Once all of the LED channels have been restored to their calibrated state, the NCP1840 will be able to once again operate in a normal fashion.

CONCLUSION

The NCP1840 can easily be interfaced with a serial EEPROM via the I2C interface. This allows for the settings that are achieved during calibration of the luminance, color, and/or dimming of each of LED channel to be stored for future use. In this way, the calibrated settings can be restored to the NCP1840 at anytime, including upon power up.

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