

# AN-1778 LM2755 Charge Pump LED Controller with I<sup>2</sup>C Compatible Interface in $\mu$ SMD

---

## ABSTRACT

This application note discusses the LM2755 pump LED controller programmed via an I<sup>2</sup>C compatible interface.

---

## Contents

|     |                                                  |    |
|-----|--------------------------------------------------|----|
| 1   | Typical Application .....                        | 3  |
| 2   | Basic Description .....                          | 3  |
| 3   | Bill of Materials .....                          | 3  |
| 4   | LM2755 Evaluation Board Schematic .....          | 4  |
| 5   | LM2755 Evaluation Board Layout .....             | 4  |
| 6   | Board Operation .....                            | 6  |
| 6.1 | Basic Connections .....                          | 6  |
| 6.2 | <b>HWEN Pin</b> .....                            | 6  |
| 6.3 | <b>SYNC Pin</b> .....                            | 7  |
| 6.4 | <b>ADDR Pin</b> .....                            | 7  |
| 6.5 | External Control Interface Connection .....      | 7  |
| 6.6 | Operation Description .....                      | 7  |
| 7   | <b>I<sup>2</sup>C Compatible Interface</b> ..... | 8  |
| 7.1 | Data Validity .....                              | 8  |
| 7.2 | Start and Stop Conditions .....                  | 9  |
| 7.3 | Transferring Data .....                          | 9  |
| 7.4 | I <sup>2</sup> C Compatible Chip Address .....   | 10 |
| 7.5 | Internal Registers of LM2755 .....               | 10 |
| 8   | Software Interface Information .....             | 11 |
| 8.1 | Example Diode Current Waveforms .....            | 13 |

## List of Figures

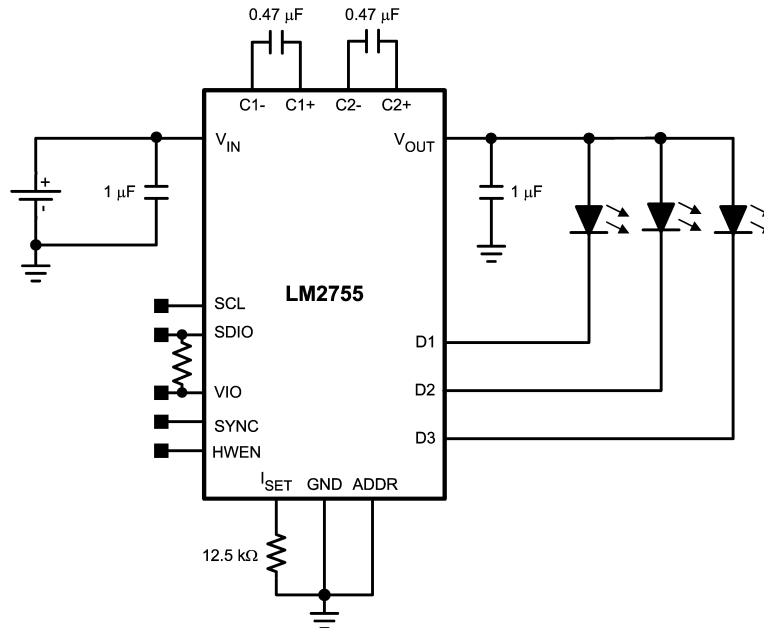
|    |                                                                                                                                                                                                                     |    |
|----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| 1  | Top Layer .....                                                                                                                                                                                                     | 4  |
| 2  | Middle Layer 1.....                                                                                                                                                                                                 | 5  |
| 3  | Middle Layer 2.....                                                                                                                                                                                                 | 5  |
| 4  | Bottom Layer (mirrored) .....                                                                                                                                                                                       | 6  |
| 5  | Data Validity Diagram .....                                                                                                                                                                                         | 8  |
| 6  | Start and Stop Conditions.....                                                                                                                                                                                      | 9  |
| 7  | Write Cycle w = write (SDIO = "0") r = read (SDIO = "1") ack = acknowledge (SDIO pulled down by either master or slave) rs = repeated start id = chip address, 18h if ADR = '0' or 67h if ADR = '1' for LM2755..... | 9  |
| 8  | Dimming Waveform .....                                                                                                                                                                                              | 10 |
| 9  | GUI Start-Up .....                                                                                                                                                                                                  | 11 |
| 10 | Generic Read/Write Field.....                                                                                                                                                                                       | 11 |
| 11 | Drop Down Menu .....                                                                                                                                                                                                | 11 |

All trademarks are the property of their respective owners.

---

|    |                                         |                    |
|----|-----------------------------------------|--------------------|
| 12 | Control and Configuration Buttons ..... | <a href="#">12</a> |
| 13 | Results of Pressing the Set Button..... | <a href="#">12</a> |
| 14 | Enable ALL .....                        | <a href="#">12</a> |
| 15 | Control Sliders .....                   | <a href="#">13</a> |

## 1 Typical Application



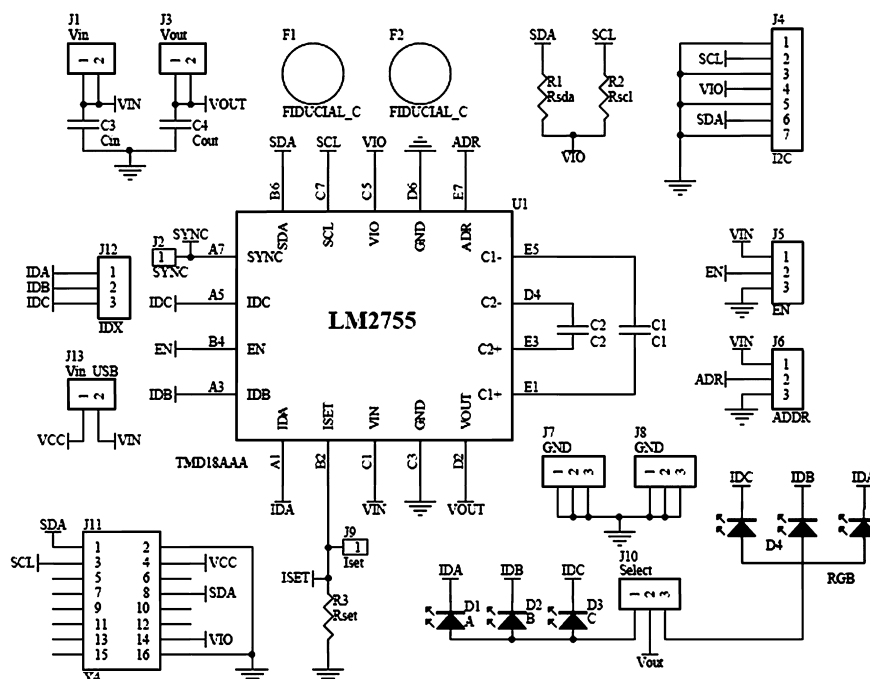
## 2 Basic Description

The LM2755 is a charge-pump-based, constant current LED driver capable of driving three LEDs with a total output current up to 90mA. The diode current waveforms of each LED can be trapezoidal with timing and level parameters (rise time, fall time, high level, low level, delay, high time, low time) programmed via an I<sup>2</sup>C compatible interface. The 32 brightness levels found on the LM2755 are exponentially spaced (as opposed to linearly spaced) to better match the response of the human eye to changing brightness levels.

## 3 Bill of Materials

| Component Symbol                | Value                 | Package            | Manufacturer                  | Part #             |
|---------------------------------|-----------------------|--------------------|-------------------------------|--------------------|
| LM2755                          | --                    | TMD18AAA<br>µSMD18 | Texas Instruments             | LM2755TMX          |
| LM2755 Evaluation Board         | --                    | --                 | Texas Instruments             | 551012853-001 RevA |
| DA                              | Blue LED              | --                 | OSRAM                         | LB M673-L1M2-35-Z  |
| DB                              | Green LED             | --                 | OSRAM                         | LG M676-N2Q1-24-Z  |
| DC                              | Amber LED             | --                 | OSRAM                         | LA M676-Q2S1-1-Z   |
| DRGB                            | RGB LED               | --                 | TT Electronics /<br>OptekTech | OVSTRGBAC6         |
| C <sub>IN</sub>                 | 1.0uF 10V X5R         | 0603               | TDK                           | C1005X5R1A105M     |
| C <sub>OUT</sub>                | 1.0uF 10V X5R         | 0603               | TDK                           | C1005X5R1A105M     |
| C <sub>1</sub> , C <sub>2</sub> | 0.47uF 10V X5R        | 0603               | TDK                           | C1005X5R1A474M     |
| R <sub>SET</sub>                | 12.4K OHM 1/10W<br>1% | 0603               | Vishay Dale                   | CRCW060312K4FKEA   |

## 4 LM2755 Evaluation Board Schematic



## 5 LM2755 Evaluation Board Layout

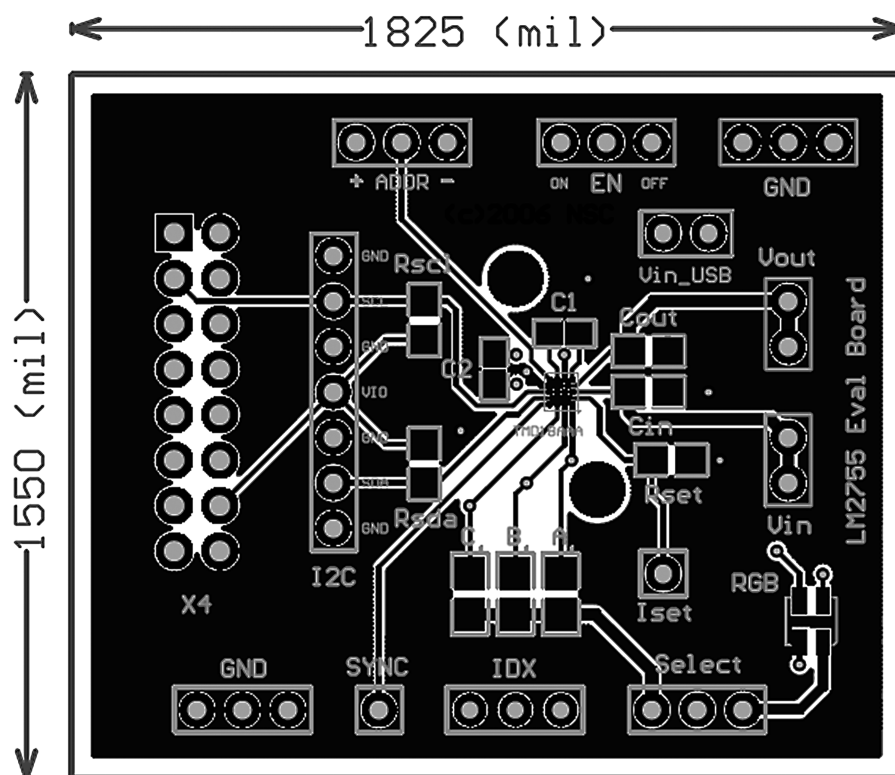


Figure 1. Top Layer

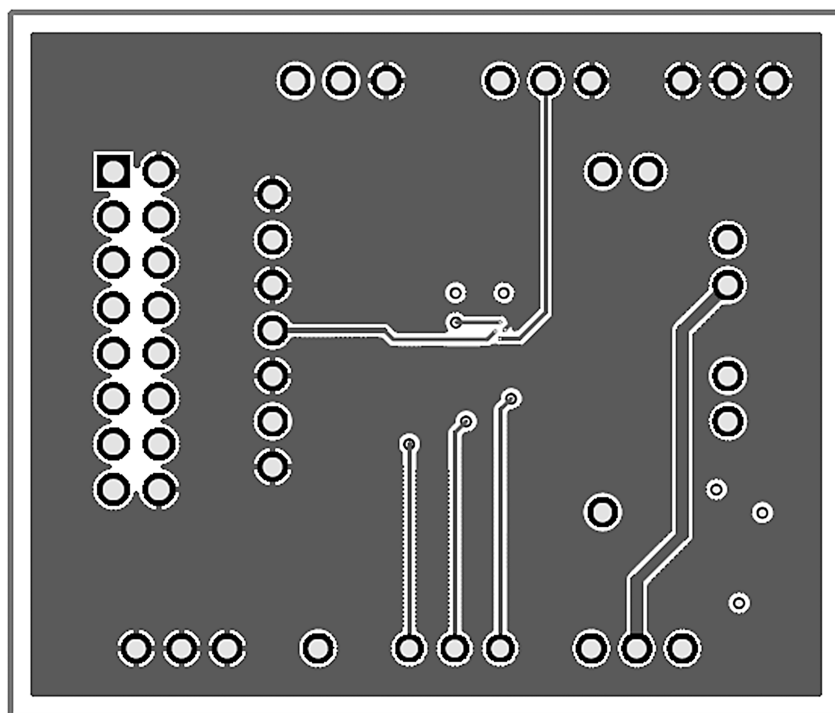


Figure 2. Middle Layer 1

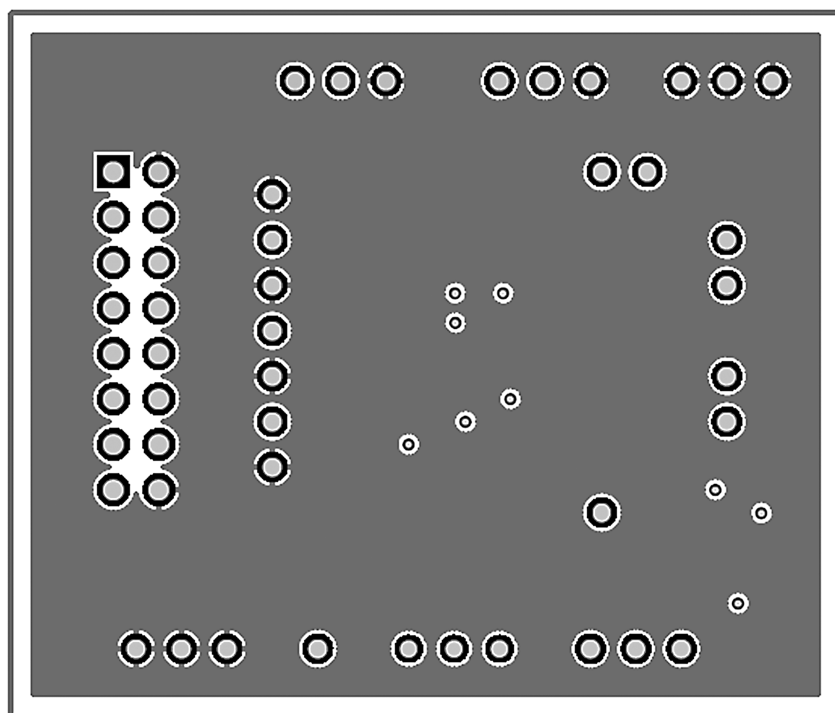
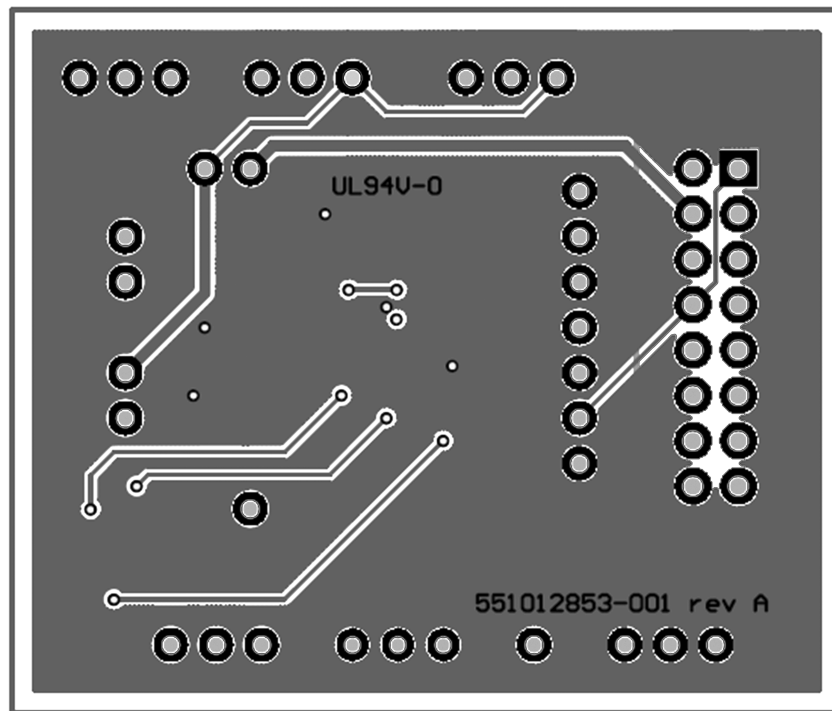


Figure 3. Middle Layer 2



**Figure 4. Bottom Layer (mirrored)**

## 6 Board Operation

### 6.1 Basic Connections

To operate the LM2755 Charge Pump LED Controller with I<sup>2</sup>C Compatible Interface in  $\mu$ SMD, connect a supply voltage (2.7V-5.5V) between board connectors VIN and GND and attach an I<sup>2</sup>C interface using one of the methods described in the *EXTERNAL CONTROL INTERFACE SECTION* of this document.

Default Jumper Connections:

- **EN:** Connects the "+" post to the middle post of the header strip. This connects VIN to the EN pin of the LM2755, enabling the part.
- **ADDR:** Connects the "-" post to the middle post of the header strip. This selects the I<sup>2</sup>C chip id to a 0x18 while the "+" sets the I<sup>2</sup>C chip ID to a 0x67.
- **SELECT:** This connects POUT to the anodes of the LEDs. Connecting the center post to the LEFT pin connects the individual Red, Green, and Blue LEDs while the RIGHT pin connects the combination RGB LED
- **Vin\_USB:** Connects the adjustable voltage supply of the USB Docking board to the VIN of the LM2755. If the USB board is not used, this jumper does not need to be placed. If the USB Docking board is going to be used for the I<sup>2</sup>C interface, but not for VIN, make sure the Vin\_EXT jumper is removed.

With the default jumper connections made, the board will be ready to operate once an input voltage and an I<sup>2</sup>C interface generator (external or USB docking board) are connected.

### 6.2 HWEN Pin

The LM2755 has a hardware enable/reset pin (HWEN) that allows the device to be disabled by an external controller without requiring an I<sup>2</sup>C write command. Under normal operation, the HWEN pin should be held high (logic '1') to prevent an unwanted reset. When the HWEN is driven low (logic '0'), all internal control registers reset to the default states and the part becomes disabled. Please see the *Electrical Characteristics* section of the datasheet for required voltage thresholds.

### 6.3 SYNC Pin

The SYNC pin allows the LM2755 to use an external clock to generate the timing within. This allows the LM2755's current-sinks to pulse-width modulate (PWM) and transition at a user controlled frequency. The PWM frequency and the step-time increment can be set by feeding a clock signal into the sync pin and enabling bit '6' in the general purpose register (See the I2C Compatible Interface section for more details.). The maximum frequency allowed to ensure current level accuracy is 1MHz. This external clock is divided down by 32x to create the minimum time-step and PWM frequency. For a 1MHz external clock, the PWM frequency becomes 31.25KHz and the minimum step time becomes 32 μseconds. If not used, it is recommended that the SYNC pin be tied to ground.

### 6.4 ADDR Pin

The ADDR pin allows the user to chose between two different I2C chip addresses for the LM2755. Tying the ADDR pin high sets the chip address to hex 67 (0x67 or 67h), while tying the ADDR pin low sets the chip address to hex 18(0x18 or 18h). This feature allows multiple LM2755's to be used within a system in addition to providing flexibility in the event another chip in the system has a chip address similar to the default LM2755 address (0x18).

### 6.5 External Control Interface Connection

The LM2755 Evaluation Board provides two ways to connect an I<sup>2</sup>C compatible interface to the LM2755 IC. The first method to connect the interface is through a set of connectors on the bottom of the evaluation board that allow the board to plug into TI's USB interface board directly. The second method of interface connection is through a header strip located on the left hand side of the evaluation board. There are pins available to connect VIO (contoller reference voltage), SCL (Interface Clock Line), and SDIO (Interface Data Line) each separated by a ground pin. The evaluation board has two external pull-ups that connect both SCL and SDIO to VIO to compliment the open drain inputs found on the LM2755. The *OPERATION DESCRIPTION* section of this application note describes the internal registers and I<sup>2</sup>C compatible interface in greater detail.

## 6.6 Operation Description

### 6.6.1 Application Information

#### 6.6.1.1 Setting Full-scale Led Current

The current through the LEDs connected to D1, D2 and D3 can be set to a desired level simply by connecting an appropriately sized resistor ( $R_{SET}$ ) between the  $I_{SET}$  pin of the LM2755 and GND. The LED currents are proportional to the current that flows through the  $I_{SET}$  pin and are a factor of 200 times greater than the  $I_{SET}$  currents. The feedback loop of the internal amplifier sets the voltage of the  $I_{SET}$  pin to 1.25V (typ.). The statement above is simplified in the equation below:

$$I_{Dx \text{ (Full-Scale)}} = 200 \times (V_{ISET} / R_{SET}) \quad (1)$$

Please refer to the I<sup>2</sup>C Compatible Interface section of this datasheet for detailed instructions on how to adjust the brightness control registers.

#### 6.6.1.2 Brightness Level Control

Once the desired  $R_{SET}$  value has been chosen, the LM2755 has the ability to internally dim the LEDs by modulating the currents with an internally set 20kHz PWM signal. The PWM duty cycle percentage is independently set for each LED through the I<sup>2</sup>C compatible interface. The 32 brightness levels follow a exponentially increasing pattern rather than a linearly increasing one in order to better match the human eyes response to changing brightness. The brightness level response is modeled in the following equations.:

$$I_{Dx \text{ LOW}} = (0.9)^{(31-n_{LOW})} \times I_{Dx \text{ Fullscale}} \quad (2)$$

$$I_{Dx \text{ HIGH}} = (0.9)^{(31-n_{HIGH})} \times I_{Dx \text{ Fullscale}} \quad (3)$$

$n_{\text{HIGH}}$  and  $n_{\text{LOW}}$  are numbers between 0 and 31 stored in the brightness level registers. When the waveform enable bits are set to '1',  $n_{\text{HIGH}}$  and  $n_{\text{LOW}}$  are the brightness level boundaries. These equations apply to all Dx outputs and their corresponding registers. A '0' code in the brightness control register sets the current to an "off-state" (0mA).

### 6.6.1.3 Time Step Control

Bit 0-Bit 2: The value of the 3 bits is equal to N, which is used in the timing control equations.  $0 \leq N \leq 7$ . The minimum internal time step (N=0) is 50μs. Setting the time-step to N=7 results in a minimum time step of 400μsec. Time step = 50μsec × (N+1)

Bit 3-Bit 7: Not used

### 6.6.1.4 Delay Control

The LM2755 allows the programmed current waveform on each diode pin to independantly start with a delay upon enabling the waveform dimming bits in the general purpose register. There are 256 delay levels available. The delay time is set by the following equation:

$$t_{\text{delay}} = N \times n_{\text{delay}} \quad n_{\text{delay}} \text{ is stored in the Dx delay registers and N is stored in the Time Step Control register. By default, } n_{\text{delay}} = 0 \text{ with a range of } 0 \leq n_{\text{delay}} \leq 255. \quad (4)$$

### 6.6.1.5 Timing Control

$T_{\text{PWM INTERNAL}} = 50\mu\text{s}$ , N is a value stored in the Time Step register, and  $n_{\text{Trise}}$ ,  $n_{\text{Tfall}}$ ,  $n_{\text{Thigh}}$ ,  $n_{\text{Tlow}}$  are numbers between 0 and 255, stored in the timing control registers. The durations of the rise, high, fall and low times are given by:

$$t_{\text{rise/fall Total}} = t_{\text{PWM INTERNAL}} \times 2^N \times (n_{\text{high}} - n_{\text{low}}) \times n_{\text{Trise/fall}} \quad \text{where } 0 \leq n_{\text{Trise/fall}} \leq 255 \quad (5)$$

$$t_{\text{rise or fall Total}} = 50\mu\text{s} \times (n_{\text{high}} - n_{\text{low}}) \quad \text{when } n_{\text{Trise/fall}} = 0 \quad (6)$$

$$t_{\text{high or low}} = t_{\text{PWM INTERNAL}} \times 2^N \times (n_{\text{high/low}} + 1) \quad \text{where } 0 \leq n_{\text{High/low}} \leq 255 \quad (7)$$

### 6.6.1.6 Sync Pin Timing Control

It is possible to replace the internal clock with an external one placed on the external SYNC pin. Writing a '1' to bit6 in the general purpose register switches the system clock from being internally generated to externally generated. The period of the PWM modulating signal becomes:

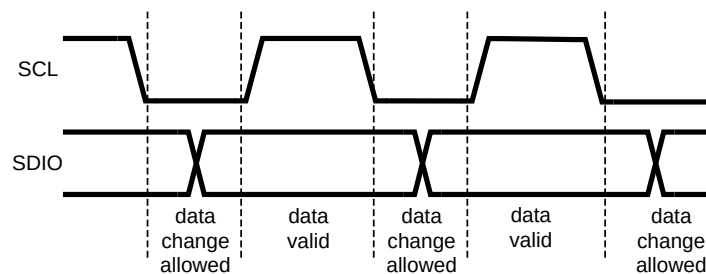
$$t_{\text{PWM}} = t_{\text{SYNC}} / 32 \quad (8)$$

The maximum recommended SYNC frequency is 1MHz. This frequency yields a PWM frequency of 31.25KHz and the minimum step time of 32 μsec.

## 7 I<sup>2</sup>C Compatible Interface

### 7.1 Data Validity

The data on SDIO line must be stable during the HIGH period of the clock signal (SCL). In other words, state of the data line can only be changed when CLK is LOW.



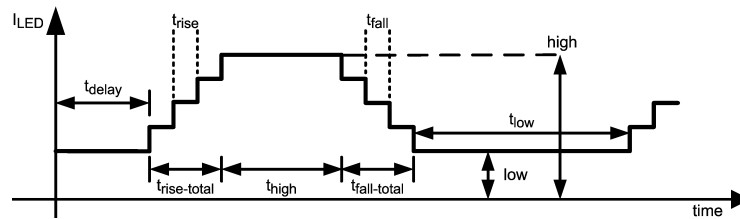
**Figure 5. Data Validity Diagram**





## 7.4 I<sup>2</sup>C Compatible Chip Address

The chip address for LM2755 is 0011000 (0x18) when ADDR = '0' or 1100111(0x67) when ADDR = '1'.



**Figure 8. Dimming Waveform**

## 7.5 Internal Registers of LM2755

| Register Name                             | Internal Hex Address | Power On Value |
|-------------------------------------------|----------------------|----------------|
| General Purpose                           | x10                  | 0000 0000      |
| Time Step                                 | x20                  | 1000 1000      |
| D1 High Level                             | xA9                  | 1110 0000      |
| D1 Low Level                              | xA8                  | 1110 0000      |
| D1 Delay: $t_{\text{delay}}$              | xA1                  | 0000 0000      |
| D1 Ramp-Up Step Time: $t_{\text{rise}}$   | xA5                  | 0000 0000      |
| D1 Time High: $t_{\text{high}}$           | xA3                  | 0000 0000      |
| D1 Ramp-Down Step Time: $t_{\text{fall}}$ | xA4                  | 0000 0000      |
| D1 Timing: $t_{\text{low}}$               | xA2                  | 0000 0000      |
| D2 High Level                             | xB9                  | 1110 0000      |
| D2 Low Level                              | xB8                  | 1110 0000      |
| D2 Delay: $t_{\text{delay}}$              | xB1                  | 0000 0000      |
| D2 Ramp-Up Step Time: $t_{\text{rise}}$   | xB5                  | 0000 0000      |
| D2 Time High: $t_{\text{high}}$           | xB3                  | 0000 0000      |
| D2 Ramp-Down Step Time: $t_{\text{fall}}$ | xB4                  | 0000 0000      |
| D2 Timing: $t_{\text{low}}$               | xB2                  | 0000 0000      |
| D3 High Level                             | xC9                  | 1110 0000      |
| D3 Low Level                              | xC8                  | 1110 0000      |
| D3 Delay: $t_{\text{delay}}$              | xC1                  | 0000 0000      |
| D3 Ramp-Up Step Time: $t_{\text{rise}}$   | xC5                  | 0000 0000      |
| D3 Time High: $t_{\text{high}}$           | xC3                  | 0000 0000      |
| D3 Ramp-Down Step Time: $t_{\text{fall}}$ | xC4                  | 0000 0000      |
| D3 Timing: $t_{\text{low}}$               | xC2                  | 0000 0000      |

### General Purpose Register Description

- Bit 0: enable output D1 with high current level.
- Bit 1: enable output D2 with high current level.
- Bit 2: enable output D3 with high current level.
- Bit 3: enable dimming waveform on output D1.
- Bit 4: enable dimming waveform on output D2.
- Bit 5: enable dimming waveform on output D3.
- Bit 6: enable external clock. '1' = External Clock Sync, '0' = Internal Clock Used
- Bit 7: If Bit 7 = 0 the charge pump is powered on before any dimming waveform is enabled. If Bit7 = 1 the dimming waveform can be enabled before charge pump is powered on.

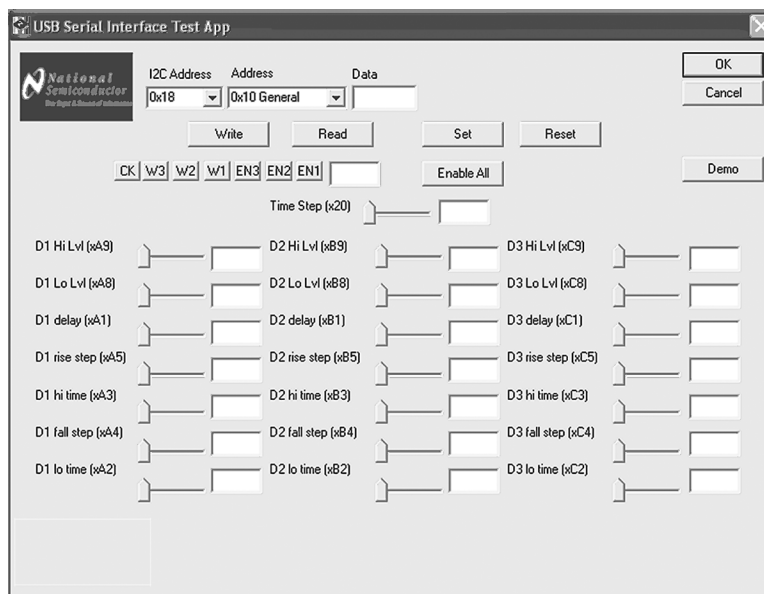
## 8 Software Interface Information

In order to fully evaluate the LM2755 part, an “I<sup>2</sup>C Compatible” interface must be used for any functionality to occur. A detailed description of the interface control is described in the LM2755 datasheet.

TI has created an I<sup>2</sup>C compatible interface generation program and USB docking board that can help exercise the part in a simple way. Contained in this document is a description of how to use the USB docking board and interface software.

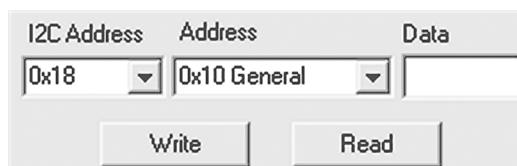
The LM2755 evaluation board has the means to “plug into” the USB docking board. The USB docking board can provide all of the control signals and power required to operate the evaluation board. A standard USB cable must be connected to the board from a PC.

The I<sup>2</sup>C compatible interface program provides all of the control that the LM2755 part requires. For proper operation, the USB docking board should be plugged into the PC before the interface program is opened. Once connected, and the program is executed, a basic interface window will open.

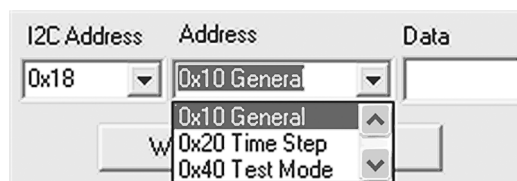


**Figure 9. GUI Start-Up**

At the top of the interface, the user can read or write to any of the data registers on the LM2755 part using the two pull down menus (for the slave i.d. and the desired data address), the data field, and the read and write buttons.



**Figure 10. Generic Read/Write Field**



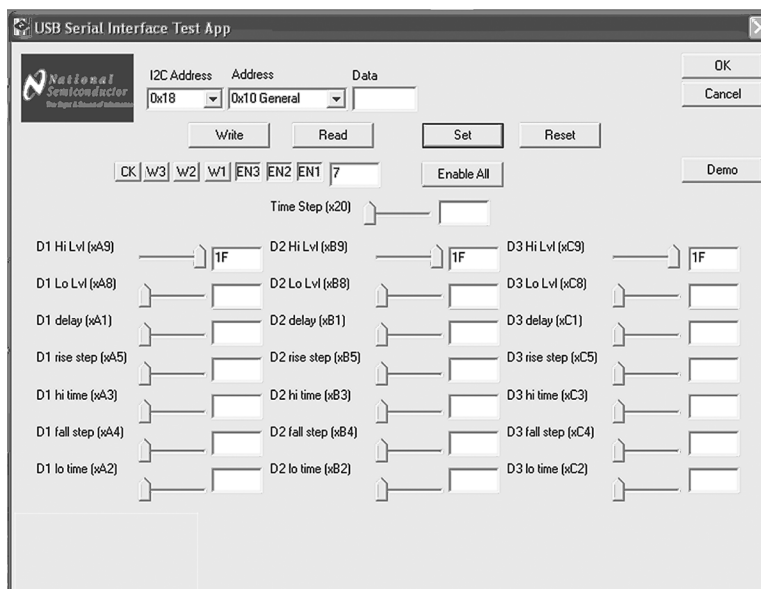
**Figure 11. Drop Down Menu**

Just below the pull down menus are convenient toggle buttons to set/reset the control bits in the General Purpose Register.



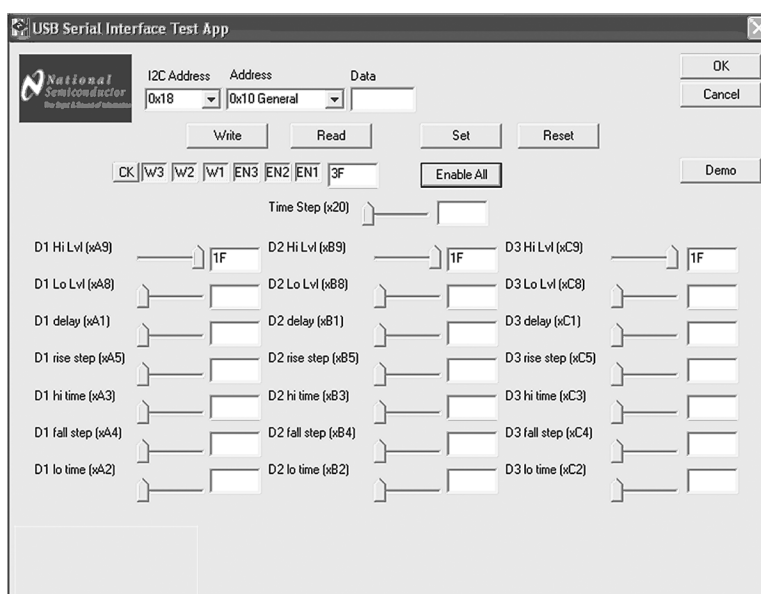
**Figure 12. Control and Configuration Buttons**

- CK: When depressed, the external clock is used to set the timing for all of the waveform control.
- W3-W1: When depressed, the waveforms profile for the drivers are enabled
- EN3-EN1: These bits, when depressed, enable BankA, BankB and BankC.



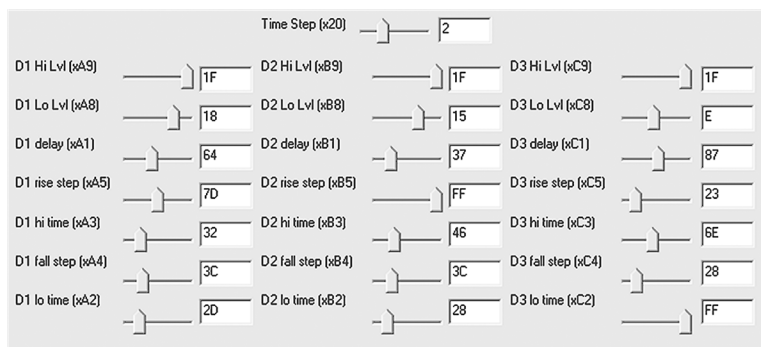
**Figure 13. Results of Pressing the Set Button**

Pressing the Set button enables D1, D2 and D3 on the LM2755 and sets the brightness levels in each bank to full-scale.



**Figure 14. Enable ALL**

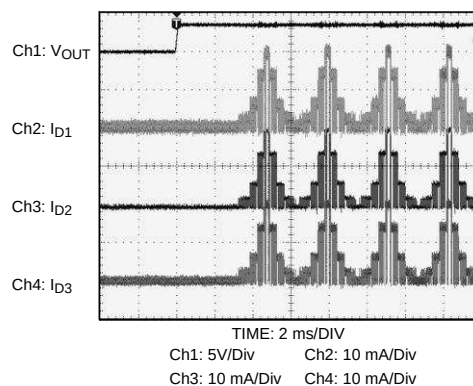
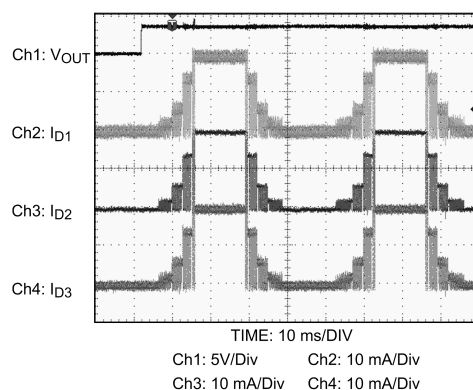
- Pressing the Enable ALL button enables D1, D2 and D3 on the LM2755 and sets the brightness levels in each bank to full-scale. The waveforms stored in the other registers are also enabled on each of the Dx Drivers

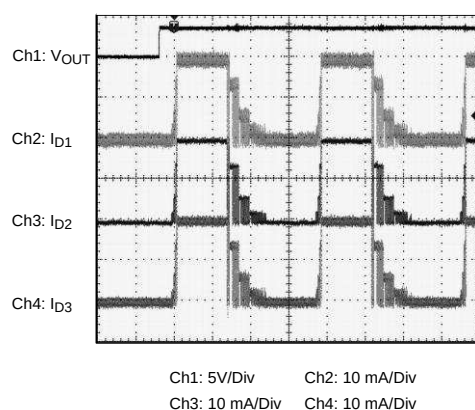
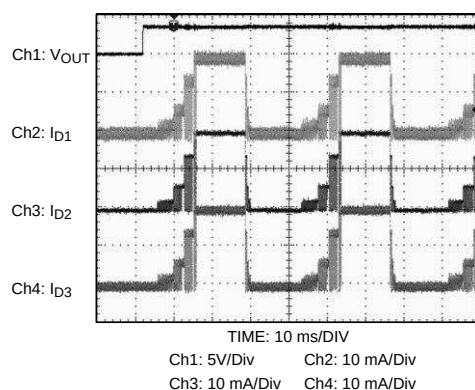
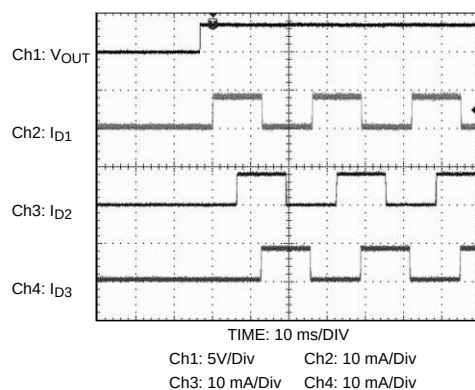


**Figure 15. Control Sliders**

- Time Step: Sets the base time unit for all timing control
- D1 Sliders: Sets the waveform profile for D1
- D2 Sliders: Sets the waveform profile for D2
- D3 Sliders: Sets the waveform profile for D3

## 8.1 Example Diode Current Waveforms







## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### Products

|                              |                                                                                      |
|------------------------------|--------------------------------------------------------------------------------------|
| Audio                        | <a href="http://www.ti.com/audio">www.ti.com/audio</a>                               |
| Amplifiers                   | <a href="http://amplifier.ti.com">amplifier.ti.com</a>                               |
| Data Converters              | <a href="http://dataconverter.ti.com">dataconverter.ti.com</a>                       |
| DLP® Products                | <a href="http://www.dlp.com">www.dlp.com</a>                                         |
| DSP                          | <a href="http://dsp.ti.com">dsp.ti.com</a>                                           |
| Clocks and Timers            | <a href="http://www.ti.com/clocks">www.ti.com/clocks</a>                             |
| Interface                    | <a href="http://interface.ti.com">interface.ti.com</a>                               |
| Logic                        | <a href="http://logic.ti.com">logic.ti.com</a>                                       |
| Power Mgmt                   | <a href="http://power.ti.com">power.ti.com</a>                                       |
| Microcontrollers             | <a href="http://microcontroller.ti.com">microcontroller.ti.com</a>                   |
| RFID                         | <a href="http://www.ti-rfid.com">www.ti-rfid.com</a>                                 |
| OMAP Applications Processors | <a href="http://www.ti.com/omap">www.ti.com/omap</a>                                 |
| Wireless Connectivity        | <a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a> |

### Applications

|                               |                                                                                          |
|-------------------------------|------------------------------------------------------------------------------------------|
| Automotive and Transportation | <a href="http://www.ti.com/automotive">www.ti.com/automotive</a>                         |
| Communications and Telecom    | <a href="http://www.ti.com/communications">www.ti.com/communications</a>                 |
| Computers and Peripherals     | <a href="http://www.ti.com/computers">www.ti.com/computers</a>                           |
| Consumer Electronics          | <a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>                   |
| Energy and Lighting           | <a href="http://www.ti.com/energy">www.ti.com/energy</a>                                 |
| Industrial                    | <a href="http://www.ti.com/industrial">www.ti.com/industrial</a>                         |
| Medical                       | <a href="http://www.ti.com/medical">www.ti.com/medical</a>                               |
| Security                      | <a href="http://www.ti.com/security">www.ti.com/security</a>                             |
| Space, Avionics and Defense   | <a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a> |
| Video and Imaging             | <a href="http://www.ti.com/video">www.ti.com/video</a>                                   |

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)