

LTC3212
 RGB LED Driver and
 Charge Pump

DESCRIPTION

WARNING!
Do not look directly at operating LED.

This circuit produces light that can damage eyes.

Demonstration circuit 1187 is an RGB LED Driver and Charge Pump featuring the LTC3212.

The LTC3212 is a low noise charge pump capable of driving three LEDs up to 25mA each. This device requires only one flying capacitor, two by-pass capacitors, and one to three programming resistors. Each LED may be turned on individually, in combination with each other, or in white mode us-

ing a single wire interface. White mode optimizes the red, green, and blue current settings to provide the best white color.

LED currents are regulated using internal low dropout current sources. Automatic mode switching optimizes efficiency by switching modes only when a dropout is detected. Refer to the LTC3212 datasheet for more information on this device.

Design files for this circuit board are available. Call the LTC factory.

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 PERFORMANCE SUMMARY Specifications are at $T_A = 25^\circ\text{C}$

| PARAMETER | CONDITIONS | MIN | TYP | MAX | UNITS |
|--|--|-----|------|-----|---------------|
| Input Supply Range | | 2.7 | | 5.5 | V |
| I_{VIN} Shutdown Current | LEDEN = LOW | | 3 | 8 | μA |
| I_{VIN} Operating Current | $I_{CPO} = 0\text{mA}$, 1X Mode | | 0.4 | | mA |
| | $I_{CPO} = 0\text{mA}$, 2X Mode | | 2.0 | | mA |
| I_{LED} | $R_{ISET} = 33.87\text{K}\Omega$ (Not in White Mode) | | 5.24 | | mA |
| | $R_{ISET} = 58.87\text{K}\Omega$ (Not in White Mode) | | 3.0 | | mA |
| | $R_{ISET} = 8.87\text{K}\Omega$ (Not in White Mode) | | 20.0 | | mA |
| I_{LEDG} (WHITE MODE) | $R_{ISETG} = 33.87\text{K}\Omega$ | | 5.24 | | mA |
| | $R_{ISETG} = 58.87\text{K}\Omega$ | | 3.0 | | mA |
| | $R_{ISETG} = 8.87\text{K}\Omega$ | | 20.0 | | mA |
| I_{LEDB} (WHITE MODE) | $R_{ISETG} = 33.87\text{K}\Omega$ | | 3.93 | | mA |
| | $R_{ISETG} = 58.87\text{K}\Omega$ | | 2.62 | | mA |
| | $R_{ISETG} = 8.87\text{K}\Omega$ | | 15.0 | | mA |
| I_{LEDR} (WHITE MODE) | $R_{ISETG} = 33.87\text{K}\Omega$ | | 4.72 | | mA |
| | $R_{ISETG} = 58.87\text{K}\Omega$ | | 2.71 | | mA |
| | $R_{ISETG} = 8.87\text{K}\Omega$ | | 18.0 | | mA |
| I_{LED} Dropout Voltage (V_{ILED}) | Mode Switching Threshold, $I_{LED} = 15\text{mA}$ | | 150 | | mV |
| Charge Pump Output Clamp Voltage | | | 5.1 | | V |
| I_{CPO} | | 0 | | 75 | mA |

LTC3212

OPERATING PRINCIPLES

The DC1187 has a programmable IC on board that communicates to the DC590 USB to I²C board and drives the LTC3212 via a single wire interface. The current in each LED output is set by adjusting the resistance at the associated ISET pin. Each ISET pin is connected to an 8.87K Ω resistor in series with a 50K Ω potentiometer. This allows the user to adjust each ISET resistance between 8.87K Ω and 58.87K Ω to experiment with different

color variations and intensities. The current for LEDG is set by the RSETG potentiometer, R4. The currents for LEDR and/or LEDB are also set by the RSETG potentiometer when in white mode and when ISETR and/or ISETB are tied to VIN via JP2 and JP3 respectively. Otherwise, the LEDR and LEDB output currents are set by the RSETR potentiometer, R6, and RSETB potentiometer, R5, respectively.

QUICK START PROCEDURE

Demonstration circuit 1187 is easy to set up to evaluate the performance of the LTC3212. Refer to Figure 1 for proper measurement equipment setup and follow the procedure below:

NOTE. When measuring the input or output voltage ripple, care must be taken to avoid a long ground lead on the oscilloscope probe. Measure the input or output voltage ripple by touching the probe tip directly across the VIN or CPO and GND terminals. See Figure 2 for proper scope probe technique.

1. Place jumpers in the following positions:

JP1 LEDEN: Up, DC590 position.

JP2 ISETR: Down, RSETR position.

JP3 ISETB: Down, RSETB position.

2. Make sure that the RSETG, RSETR, and RSETB potentiometers are set approximately to the center position (adjustment slot is perpendicular to top of board).

3. Refer to the DC590 Quick Start Guide for QuikEval™ setup and software installation details.

4. If using the DC590B board, make sure the VCCIO jumper, JP6, on the DC590B board is set to the 5V position. The microcontroller on the DC1187 board needs 5V to operate properly.

5. Make sure the USB cable is connected between the computer and the DC590 controller board.

6. Connect DC1187 to the DC590 USB Serial Controller using the supplied 14-conductor ribbon cable as shown in Figure 1.

7. With power off, connect the input power supply to VIN and GND with a series ammeter and a voltmeter as shown in Figure 1.

8. Turn on the input power supply and set the VIN voltage to 3.6V.

NOTE. Make sure that the input voltage does not exceed 6V.

9. Run the QuikEval program. The program detects the DC1187 and displays the LTC3212 control window (shown in Figure 3).

10. Select the Green/Red option button on the LTC3212 control window and observe that the RGB LED illuminates light greenish.

11. Adjust RSETG fully counterclockwise and observe that the RGB LED changes to a yellowish green color.

12. Adjust RSETR fully clockwise and observe that the RGB LED color changes to light orange.

13. Move the ISETR jumper from the RSETR position to the RSETG position and observe that the RGB LED color changes to light green.

14. Select the Blue/Green option button on the LTC3212 control window and observe that the RGB LED illuminates light blue.

- 15.** Slowly adjust RSETB fully counterclockwise then adjust RSETG fully clockwise. Observe that the RGB LED changes from light blue to greenish blue.
- 16.** Move the ISETB jumper from RSETB to RSETG and observe the RGB LED color change.
- 17.** Select the Blue/Red option button on the LTC3212 control window and observe that the RGB LED illuminates bluish red.
- 18.** Move the ISETR jumper to the RSETR position and the ISETB jumper to the RSETB position. Observe that the LED illuminates pink.
- 19.** Select the White Mode option button on the LTC3212 control window. Observe that the RGB illuminates a whitish color.
- 20.** Slowly adjust the RSETG potentiometer fully counter-clockwise and observe that the LED changes intensity but not color.
- 21.** Select the LEDs OFF option button and turn off power when done.

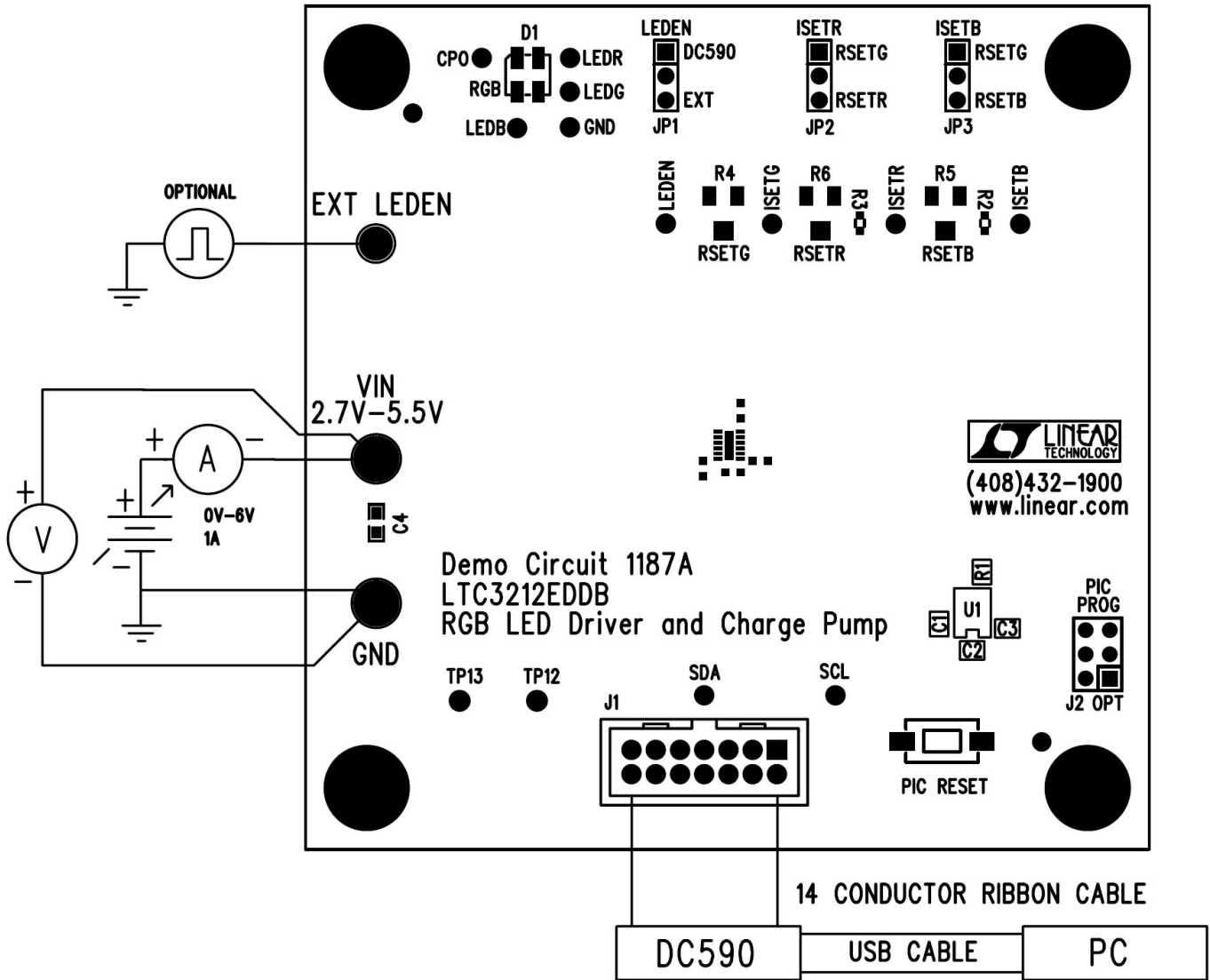


Figure 1. Proper Measurement Equipment Setup

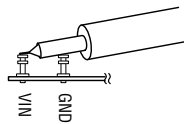


Figure 2. Measuring Input or Output Ripple

LTC3212 SOFTWARE CONTROL WINDOW

The LTC3212 software control window consists of 7 LED Enable Mode option buttons, which allow the user to select which LEDs to turn on or off, or

select white mode. White mode turns on the three LEDs at an optimal intensity to display white light. A Pulse text box displays how many pulses were

sent to the LTC3212. The Update button updates the microcontroller with the proper timing information and updates the LTC3212 to match the selected LED Enable mode option button. The Update button will need to be selected if whenever VIN applied, the 14 conductor ribbon cable is connected, if the DC590 board is connected, or if the PIC RESET button on the DC1187 board was depressed. The PIC RESET button resets the PIC microcontroller on the demo board. The “View LTC3212 Product Page” button searches the LTC

web site for the LTC3212, providing an internet connection is available.

LED ENABLE SETTINGS

| PULSES | R | G | B |
|--------|------------|---|---|
| 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 |
| 2 | 0 | 1 | 0 |
| 3 | 0 | 1 | 1 |
| 4 | 1 | 1 | 0 |
| 5 | 1 | 0 | 1 |
| 6 | 1 | 0 | 0 |
| 7+ | WHITE MODE | | |

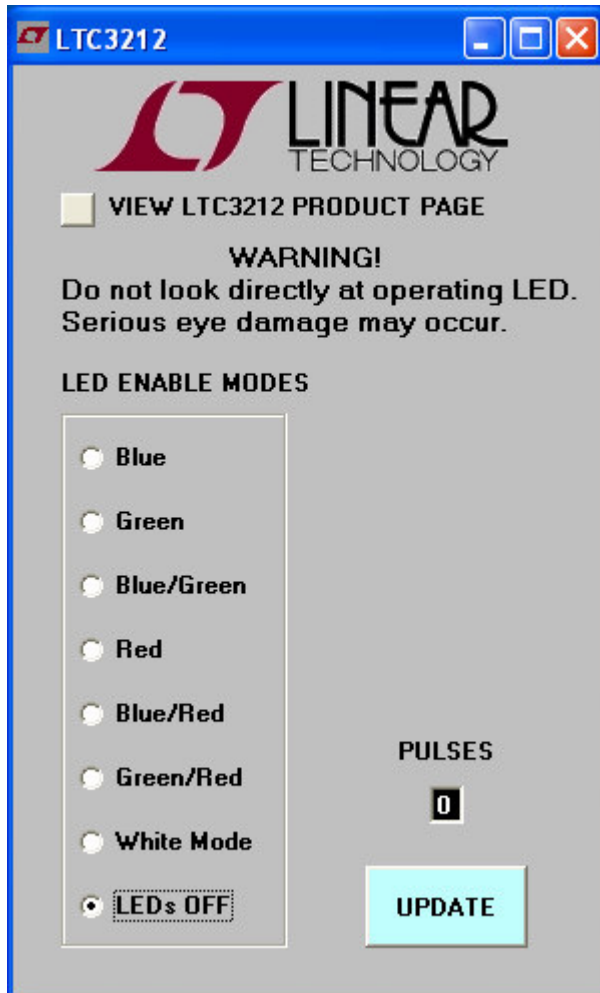
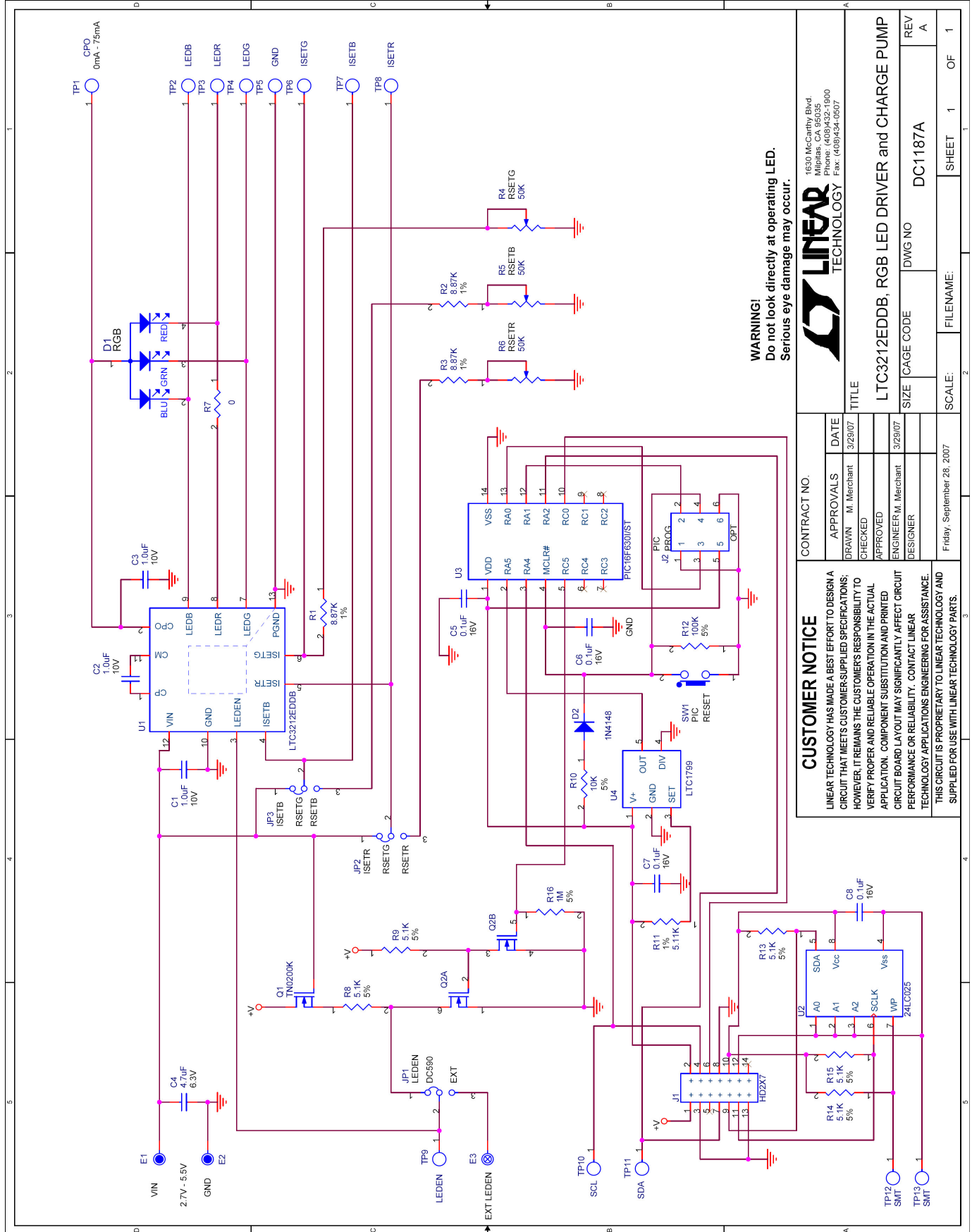


Figure 3. LTC3212 Control Window



WARNING!
Do not look directly at operating LED.
Serious eye damage may occur.

| | | | | | |
|--|--|--|--|---|--|
| <p>CUSTOMER NOTICE</p> <p>LINEAR TECHNOLOGY HAS MADE A BEST EFFORT TO DESIGN A CIRCUIT THAT MEETS CUSTOMER-SUPPLIED SPECIFICATIONS; HOWEVER, IT REMAINS THE CUSTOMER'S RESPONSIBILITY TO VERIFY PROPER AND RELIABLE OPERATION IN THE ACTUAL APPLICATION. COMPONENT SUBSTITUTION AND PRINTED CIRCUIT BOARD LAYOUT MAY SIGNIFICANTLY AFFECT CIRCUIT PERFORMANCE OR RELIABILITY. CONTACT LINEAR TECHNOLOGY APPLICATIONS ENGINEERING FOR ASSISTANCE.</p> <p>THIS CIRCUIT IS PROPRIETARY TO LINEAR TECHNOLOGY AND SUPPLIED FOR USE WITH LINEAR TECHNOLOGY PARTS.</p> | | <p>CONTRACT NO.</p> <p>APPROVALS DATE</p> <p>DRAWN M. Merchant 3/29/07</p> <p>CHECKED</p> <p>APPROVED</p> <p>ENGINEER M. Merchant 3/29/07</p> <p>DESIGNER</p> <p>Friday, September 28, 2007</p> | | <p>LINEAR TECHNOLOGY</p> <p>1630 McCarthy Blvd. Milpitas, CA 95035 Tel: (408)434-2000 Fax: (408)434-2507</p> | |
| <p>TITLE</p> <p>LTC3212EDDB, RGB LED DRIVER and CHARGE PUMP</p> | | | | <p>SIZE CAGE CODE DWG NO DC1187A REV A</p> | |
| <p>FILENAME:</p> | | <p>SCALE:</p> | | <p>SHEET 1 OF 1</p> | |

| Item | Qty | Ref - Des | Desc | Manufacturer's Part Number |
|--|-----|-----------------------|------------------------------|-------------------------------|
| REQUIRED CIRCUIT COMPONENTS: | | | | |
| 1 | 3 | C1,C2,C3 | CAP, 1.0uF X5R 10% 10V 0402 | MURATA, GRM155R61A105K |
| 2 | 1 | D1 | LED, SMT RGB | NICHIA, NSCM315C |
| 3 | 1 | R1 | RES, 8.87K CHIP 1% 1/8W | VISHAY, CRCW04028K87FKED |
| 4 | 1 | U1 | IC, RGB LED DRIVER | LINEAR TECH, LTC3212EDDB |
| ADDITIONAL DEMO BOARD CIRCUIT COMPONENTS: | | | | |
| 1 | 4 | C5,C6,C7,C8 | CAP, 0.1uF X7R 10% 10V 0402 | MURATA, GRM155R71A104K |
| 2 | 1 | C4 | CAP, 4.7uF X5R 10% 6.3V 0603 | TDK, C1608X5R0J475K |
| 3 | 2 | R2,R3 | RES, 8.87K CHIP 1% 1/8W | VISHAY, CRCW04028K87FKED |
| 4 | 3 | R4,R5,R6 | POT, 50K SMT 20% 1/8W | BOURNS, 3313J-1-503E |
| 5 | 1 | R7 | RES., 0.0 CHIP 1% 1/8W | VISHAY, CRCW04020000Z0ED |
| 6 | 6 | R8,R9,R11,R13,R14,R15 | RES, 5.11K CHIP 1% 1/8W | VISHAY, CRCW04025K11FKED |
| 7 | 1 | R10 | RES, 10K CHIP 5% 1/8W | VISHAY, CRCW040210K0JNED |
| 8 | 1 | R12 | RES, 100K CHIP 5% 1/8W | VISHAY, CRCW0402100KJNED |
| 9 | 1 | R16 | RES, CHIP 1M OHM 5% 0402 | VISHAY, CRCW04021M00JNED |
| 10 | 1 | D2 | DIODE, 1N4148 | DIODES INC., 1N4148WS |
| 11 | 1 | U2 | IC, SERIAL EEPROM | MICROCHIP, 24LC025-I/ST |
| 12 | 1 | U3 | IC, FLASH 8-BIT MCU | MICROCHIP, PIC16F630I/ST |
| 13 | 1 | U4 | IC, OSCILLATOR | LINEAR TECHNOLOGY, LTC1799IS5 |
| 14 | 1 | Q1 | MOSFET, N-CHANNEL | VISHAY, TN0200K |
| 15 | 1 | Q2 | MOSFET, DUAL N-CHANNEL | VISHAY, Si1912EDH |
| | | Q2 (Second Source) | MOSFET, DUAL N-CHANNEL | FAIRCHILD, FDG6303N |
| HARDWARE FOR DEMO BOARD ONLY: | | | | |
| 1 | 1 | J1 | HEADER, 2X7 2MM STRAIGHT | MOLEX/WALDOM, 87831-1420 |
| 2 | 0 | J2 | HEADER, 2X3 2MM | |
| 3 | 2 | E1,E2 | TURRET, TESTPOINT | MILL MAX, 2501-2 |
| 4 | 1 | E3 | TURRET, TESTPOINT | MILL MAX, 2308-2 |
| 5 | 3 | JP1,JP2,JP3 | HEADER, 3 POS, 2MM | SAMTEC, TMM-103-02-L-S |
| 6 | 3 | JP1,JP2,JP3 | SHUNT, 2MM | SAMTEC, 2SN-BK-G |
| 7 | 1 | SW1 | SWITCH, PUSH BUTTON | PANASONIC, EVQPPFA25 |
| 8 | 4 | | STANDOFFS | KEYSTONE, 8831 |
| 9 | 1 | | CABLE ASSY, 8" STRIP | LINEAR RIBBON CABLE, CA-2440 |

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