Application Report
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# LED Display System Module Using Cascading TLC5940 Devices

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**ABSTRACT**

Described in this document are application ideas and reference designs for the TLC5940 LED driver. The following application example shows the building of a basic module of an LED display system using a cascading connection of *n* TLC5940 devices connected to a controller. The reference design implements three TLC5940 devices to drive 16 LEDs.

## 1 Features

- 16 Channels
- 12 bit (4096 Steps) Grayscale PWM Control
- Dot Correction
  - 6 bit (64 Steps)
  - Storable in Integrated EEPROM
- Drive Capability (Constant Current Sink)
  - 0 mA to 60 mA ($V_{CC}$ < 3.6 V)
  - 0 mA to 120 mA ($V_{CC}$ > 3.6 V)
- LED Power Supply Voltage up to 17 V
- $V_{CC}$ = 3 V to 5.5 V
- Serial Data Interface
- Controlled In-Rush Current
- 30-MHz Data Transfer Rate
- CMOS Level I/O
- Error Information
  - LOD: LED Open Detection
  - TEF: Thermal Error Flag

## 2 TLC5940 Typical Application Example

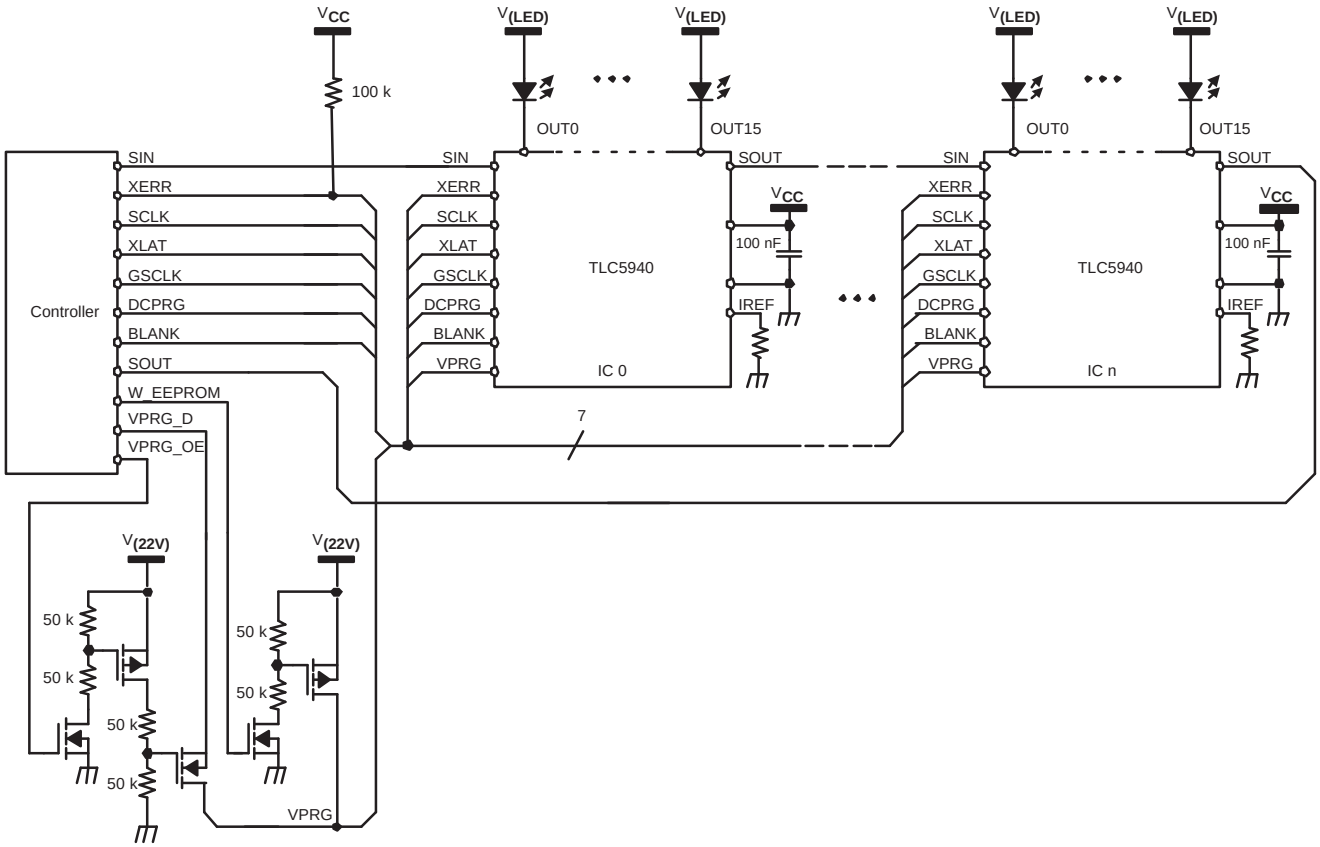


**Figure 1. Cascading Devices**

The maximum number of cascading TLC5940 devices depends on the application system and is in the range of 40 devices. The following equation calculates the minimum frequency required:

$$f_{(GSCLK)} = 4096 \times f_{(update)}$$

$$f_{(SCLK)} = 193 \times f_{(update)} \times n$$

where:

$f_{(GSCLK)}$: minimum frequency needed for GSCLK

$f_{(SCLK)}$: minimum frequency needed for SCLK and SIN

$f_{(update)}$: update rate of whole cascading system

n: number of cascaded TLC5940 devices

## 3 TLC5940 Reference Design

This EVM contains three TLC5940 ICs that are connected in series. The three TLC5940 ICs drive 16 red-green-blue light emitting diodes (RGB LEDs). Each TLC5940 drives a separate color. Each TLC5940 has 16 outputs and each output is connected to a different LED. Using the software, the user individually controls the DOT correction and grayscale values for each color of each LED.

The following reference design contains three TLC5490 ICs that are connected in series. The three TLC5490 ICs drive 16 red-green-blue light-emitting diodes (RGB LEDs). Each TLC5490 drives a separate color and has 16 outputs and is connected to a different LED.

# 4 TLC5940 Schematics

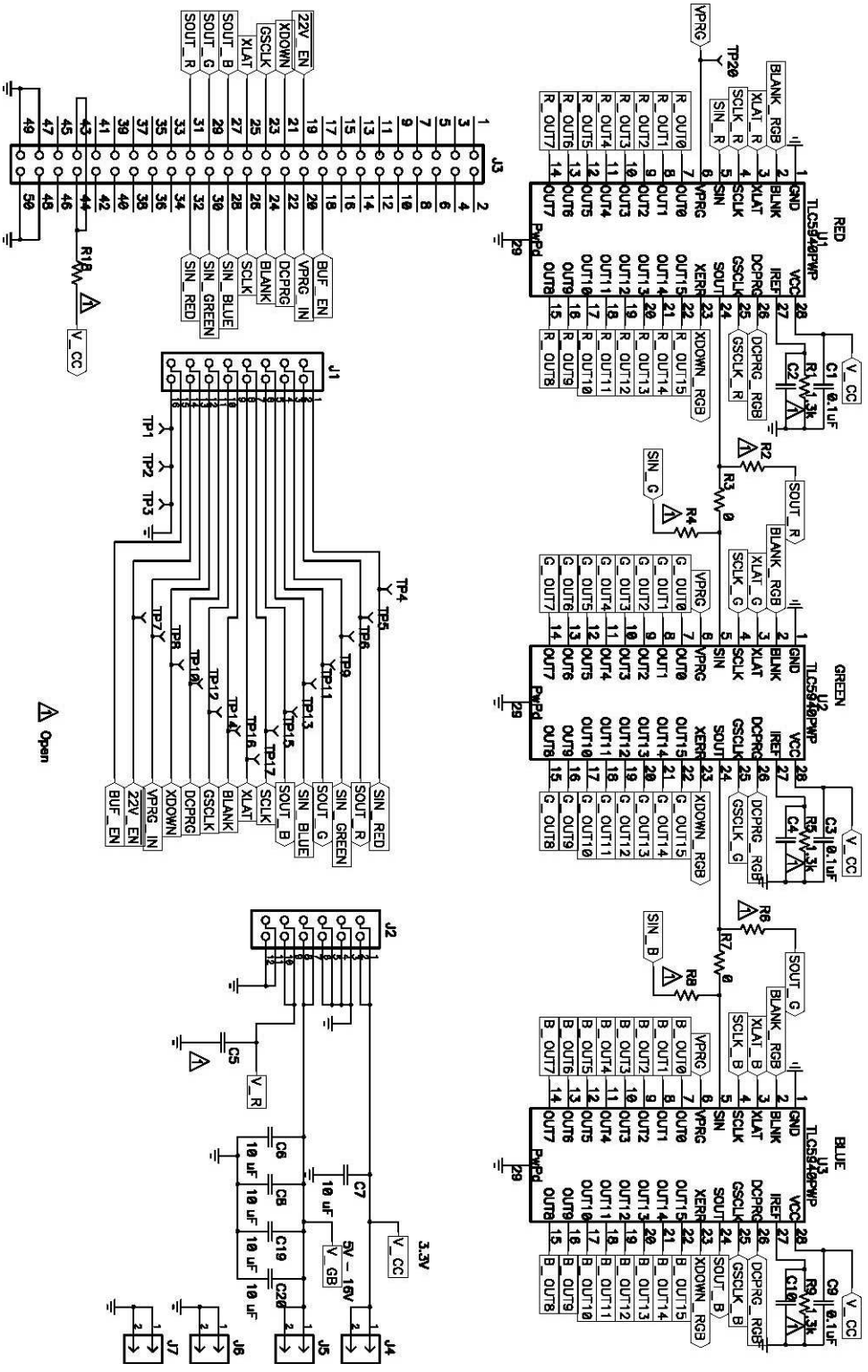


**Figure 2. TLC5940EVM-106 Schematic**

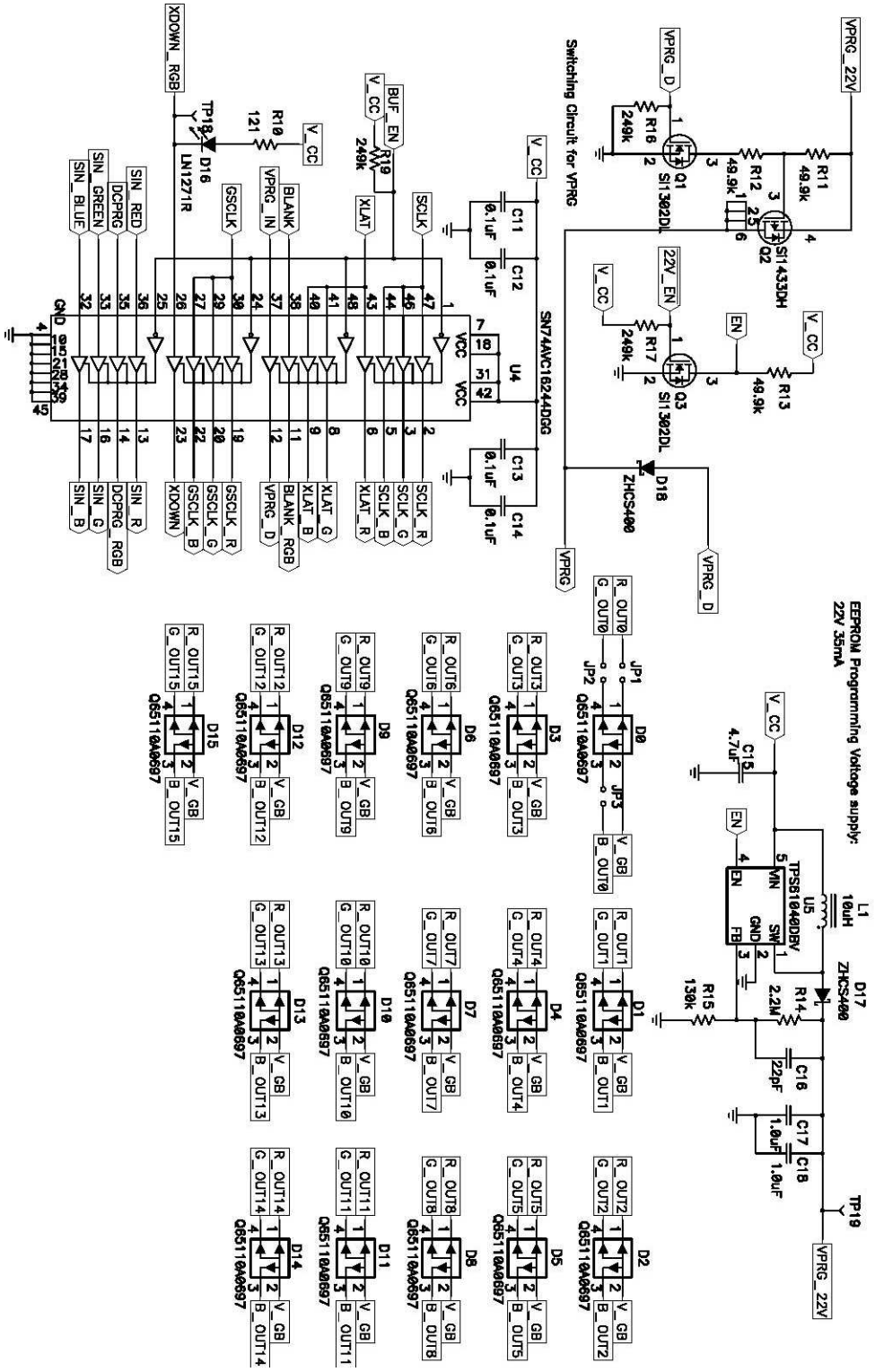


**Figure 3. TLC5940EVM-106 Schematic (Continued)**

# 5 Bill of Materials

**Table 1. Bill of Materials**

| Qty | Ref | Description | Size | Part Number | MFR |
|---|---|---|---|---|---|
| 7 | C1, C3, C9, C11, C12, C13, C14 | Capacitor, ceramic, 0.1µF, 25V, X7R, 10% | 0603 | C1608X7R1H104KT | TDK |
| 1 | C15 | Capacitor, ceramic, 4.7µF, 10V, X5R, 10% | 0805 | C2012X5R1A475KT | muRata |
| 1 | C16 | Capacitor, ceramic, 22pF, 50V, C0G, 5% | 0603 | C1608C0G1H220JB | TDK |
| 2 | C17, C18 | Capacitor, ceramic, 1.0µF, 50V, X7R, 10% | 1206 | C3216X7R1H105KT | TDK |
| 0 | C2, C4, C10 | Capacitor, ceramic, xxxµF, vvV | 0603 | | |
| 0 | C5 | Capacitor, ceramic, xxxµF, vvV | 0805 | | |
| 5 | C6, C7, C8, C19, C20 | Capacitor, ceramic, 10µF, 25V, X5R, 20% | 1206 | C3216X5R1E106MT | TDK |
| 16 | D0 - D15 | Diode, LED, 20mA, common anode | 0.118 x 0.134 | Q65110A0697<br>HSMF-A341-A00J1 | Osram<br>Agilent |
| 1 | D16 | Diode, LED, red, 20mA, 5mcd | 0.114 x 0.049 | LN1271RALTRP | Panasonic |
| 2 | D17, D18 | Diode, Schottky, 400mA, 40V | SOD323 | ZHCS400 | Zetex |
| 1 | J1 | Header, 2x8 pin, 100mil spacing (36 pin strip) | 0.100 x 2X8 | PTC36DAAN | Sullins |
| 1 | J2 | Header, 2x6 pin, 100mil spacing (36 pin strip) | 0.100 x 2X6 | PTC36DAAN | Sullins |
| 1 | J3 | Header, low profile, straight 2x25 pin, 100mil spacing | 0.100 x 25 x 2 | 2550-6002UB | 3M |
| 4 | J4, J5, J6, J7 | Header, 2 pin, 100mil spacing, (36 pin strip) | 0.100 x 2 | PTC36SAAN | Sullins |
| 3 | JP1, JP2, JP3 | Header, 2 pin, 100mil spacing, (36 pin strip) | 0.100 x 2 | PTC36SAAN | Sullins |
| 1 | L1 | Inductor, SMT, 10µH, 0.55A, 210mΩ | 0.205 x 0.160 | CDRH3D16-100 | Sumida |
| 2 | Q1, Q3 | MOSFET, Nch, 25V, 0.75A, 66mΩ | SOT323 | SI1302DL | Vishay |
| 1 | Q2 | MOSFET, Pch, -20V, -1.5A, 180mΩ | SC-70 | Si1433DH | Vishay |
| 3 | R1, R5, R9 | Resistor, chip, 1.3kΩ, 1/16W, 1% | 0603 | Std | Std |
| 1 | R10 | Resistor, chip, 121Ω, 1/16W, 1% | 0603 | Std | Std |
| 3 | R11, R12, R13 | Resistor, chip, 49.9kΩ, 1/16W, 1% | 0603 | Std | Std |
| 1 | R14 | Resistor, chip, 2.2MΩ, 1/16W, 1% | 0603 | Std | Std |
| 1 | R15 | Resistor, chip, 130kΩ, 1/16W, 1% | 0603 | Std | Std |
| 3 | R16, R17, R19 | Resistor, chip, 249kΩ, 1/16W, 1% | 0603 | Std | Std |
| 0 | R2, R4, R6, R8, R18 | Resistor, chip, xxΩ, 1/16W, 1% | 0603 | | |
| 2 | R3, R7 | Resistor, chip, 0Ω, 1/16W, 5% | 0603 | Std | Std |
| 3 | TP1, TP2, TP3 | Test point, black, thru hole color keyed | 0.038 | 5001 | Keystone |
| 17 | TP4 - TP20 | Test point, red, thru hole color keyed | 0.038 | 5000 | Keystone |
| 3 | U1, U2, U3 | IC, 16 Chan LED driver with dot correction/grayscale PWM control | TSSOP-28 | TLC5940PWP | TI |
| 1 | U4 | IC, 16 Bit buffer driver, 3-state outputs | 48P TSSOP (DGG) | SN74AVC16244DGG | TI |
| 1 | U5 | IC, High efficiency boost converter, 250mA, 1.8- 6V Vin | SOT23-5 (DBV) | TPS61040DBV | TI |
| 1 | -- | PCB, 5.5 In x 3.35 In x 0.062 In | | HPA106 | Any |
| 3 | -- | Shunt, 100mil, black | 0.100 | 929950-00 | 3M |

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