

TLC5920 16x8 BIT LED DRIVER/CONTROLLER

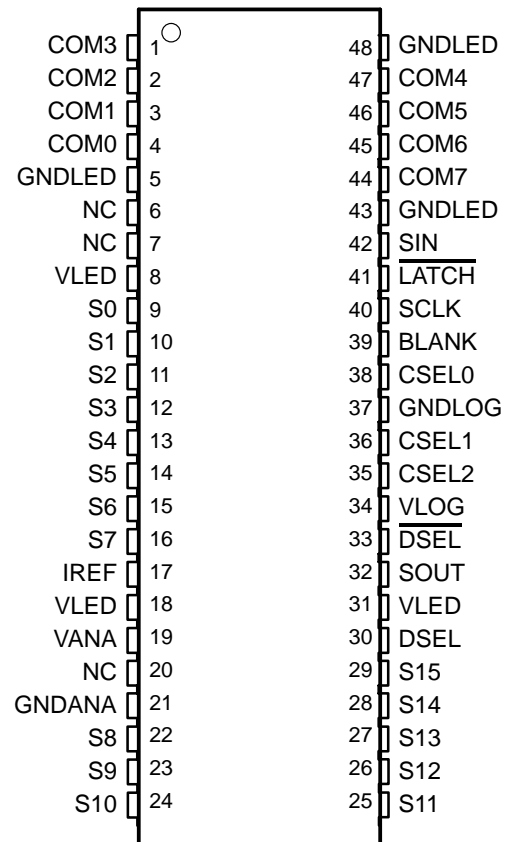
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- **Drive Capability:**
 - Segment . . . 30 mA × 16 Bits
 - Common . . . 640 mA
- **Constant Current Output . . . 3 mA to 30 mA (Current Value Setting for All Channels Using External Resistor)**
- **Constant Current Accuracy ±6% (Maximum Error Between Bits)**
- **Data Input: Clock Synchronized Serial Input**
- **LED Type Applied Cathode Common**
- **Logic Power Supply Voltage 4.5 V to 5.5 V**
- **LED Power Supply Voltage 4.5 V to 5.5 V**
- **Operating Frequency . . . 10 MHz**
- **Operating Free-Air Temperature Range –20°C to 85°C**
- **48-Pin SSOL Package**

description

The TLC5920 is an LED driver incorporating a 16-channel shift register, data latch, and constant current circuitry with current value control and 8-channel common driver into a single chip. The constant output current is capable of 30 mA for 16 bits simultaneously, and the current value can be set by one external register. This device also includes a 16-bit segment driver and 8-bit common driver; therefore, the monochrome LED array with 16 × 8 dots can be driven by only one TLC5920, and a two-color LED array with 16 x 16 dots can be driven by two TLC5920s.

DL PACKAGE
(TOP VIEW)



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

 **TEXAS
INSTRUMENTS**

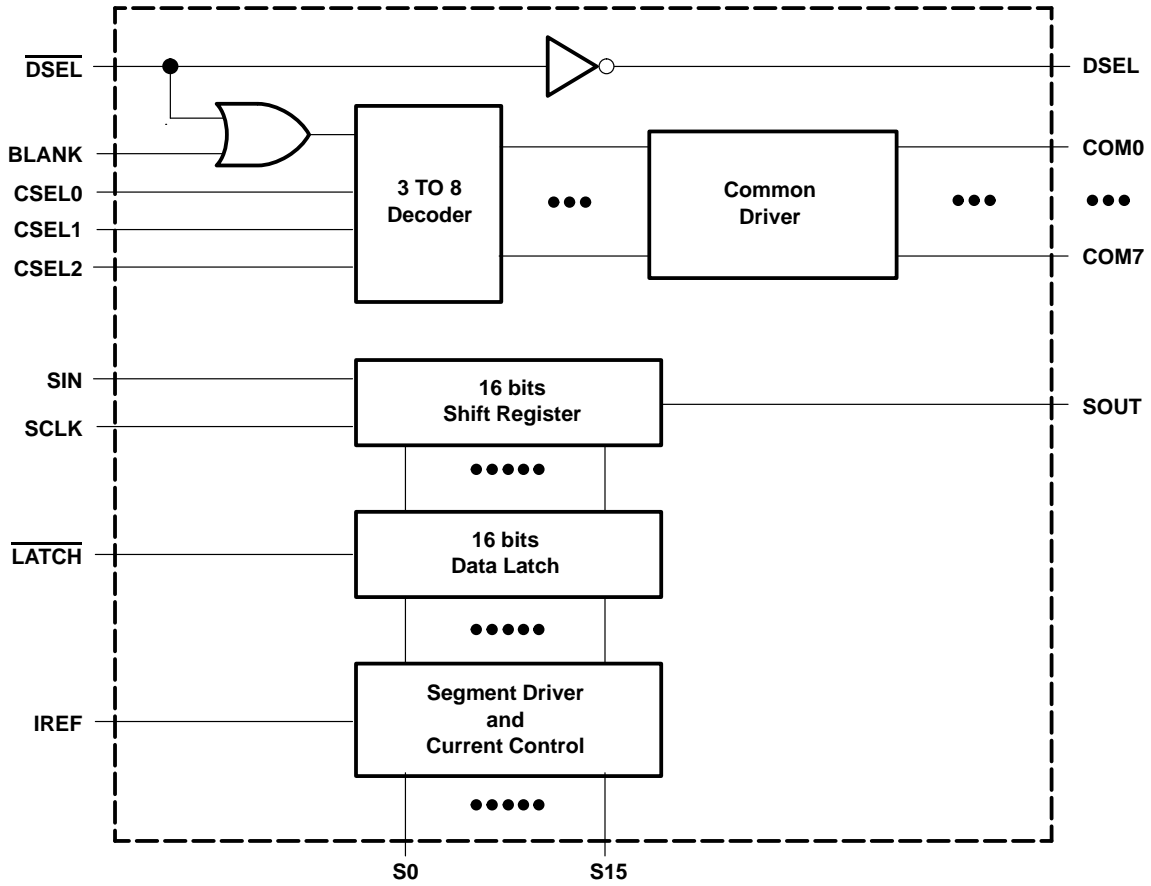
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functional block diagram



Terminal Functions

| TERMINAL NAME | NO. | I/O | DESCRIPTION | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---------------------------|---|----------|---|----------|----------|----------|----------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BLANK | 39 | I | Blank(light off). By turning all the output for the common driver off, the LED is turned off. When BLANK is high, the LED is turned off. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COM0 – COM7 | 4, 3, 2, 1, 47, 46, 45, 44 | O | LED common driver output | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| CSEL0 – 2 | 38, 36, 35 | I | Common driver select. One terminal out of COM0 through COM7 is selected. <table style="margin-left: auto; margin-right: auto; border-collapse: collapse;"> <tr> <td style="text-align: center;">2</td> <td style="text-align: center;">1</td> <td style="text-align: center;">0</td> <td style="text-align: center;">Common Driver</td> </tr> <tr> <td style="text-align: center;">L</td> <td style="text-align: center;">L</td> <td style="text-align: center;">L</td> <td style="text-align: center;">0</td> </tr> <tr> <td style="text-align: center;">L</td> <td style="text-align: center;">L</td> <td style="text-align: center;">H</td> <td style="text-align: center;">1</td> </tr> <tr> <td style="text-align: center;">L</td> <td style="text-align: center;">H</td> <td style="text-align: center;">L</td> <td style="text-align: center;">2</td> </tr> <tr> <td style="text-align: center;">L</td> <td style="text-align: center;">H</td> <td style="text-align: center;">H</td> <td style="text-align: center;">3</td> </tr> <tr> <td style="text-align: center;">H</td> <td style="text-align: center;">L</td> <td style="text-align: center;">L</td> <td style="text-align: center;">4</td> </tr> <tr> <td style="text-align: center;">H</td> <td style="text-align: center;">L</td> <td style="text-align: center;">H</td> <td style="text-align: center;">5</td> </tr> <tr> <td style="text-align: center;">H</td> <td style="text-align: center;">H</td> <td style="text-align: center;">L</td> <td style="text-align: center;">6</td> </tr> <tr> <td style="text-align: center;">H</td> <td style="text-align: center;">H</td> <td style="text-align: center;">H</td> <td style="text-align: center;">7</td> </tr> </table> | 2 | 1 | 0 | Common Driver | L | L | L | 0 | L | L | H | 1 | L | H | L | 2 | L | H | H | 3 | H | L | L | 4 | H | L | H | 5 | H | H | L | 6 | H | H | H | 7 |
| 2 | 1 | 0 | Common Driver | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| L | L | L | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| L | L | H | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| L | H | L | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| L | H | H | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| H | L | L | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| H | L | H | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| H | H | L | 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| H | H | H | 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| $\overline{\text{DSEL}}$ | 33 | I | Display select. When $\overline{\text{DSEL}}$ is high, the LED is turned off. Note that, when BLANK is high, the LED is turned off with no regard to the $\overline{\text{DSEL}}$ input. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| DSEL | 30 | O | Display select output. The inverted data of $\overline{\text{DSEL}}$ is clocked out. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| GNDANA | 21 | | Analog ground | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| GNDLED | 5, 43, 48 | | LED driver ground | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| GNDLOG | 37 | | Logic ground | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| IREF | 17 | I | Constant current control setting. The LED current is set to the desired value by connecting an external resistor between IREF and GND. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| $\overline{\text{LATCH}}$ | 41 | I | Latch. When $\overline{\text{LATCH}}$ is high, data on the shift register goes through latch. When $\overline{\text{LATCH}}$ is low, data is latched. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SIN | 42 | I | Serial input for display | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SOUT | 32 | O | Serial output for display | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SCLK | 40 | I | Synchronous clock input for serial data transfer. The input data of SIN is synchronized to the rising edge of SCLK, and transferred to SOUT. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| S0 – S15 | 9, 10, 11, 12, 13, 14, 15, 16, 22, 23, 24, 25, 26, 27, 28, 29 | O | LED segment driver output | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VANA | 19 | | Analog power supply voltage | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VLOG | 34 | | Logic power supply voltage | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| VLED | 8, 18, 31 | | LED driver power supply voltage | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

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absolute maximum ratings† (see Note 1)

| | |
|--|--------------------------------|
| Logic supply voltage, $V_{(LOG)}$ | – 0.3 V to 7 V |
| LED supply voltage, $V_{(LED)}$ | – 0.3 V to 7 V |
| Analog supply voltage, $V_{(ANA)}$ | – 0.3 V to 7 V |
| Output current, $I_{OH(S)}$ | – 32 mA |
| Output current, $I_{OL(C)}$ | 650 mA |
| Input voltage range, V_I | – 0.3 V to $V_{(LOG)} + 0.3$ V |
| Output voltage range, V_O | – 0.3 V to $V_{(LOG)} + 0.3$ V |
| Continuous total power dissipation | 1500 mW |
| Thermal resistance | 83°C/W |
| Operating free-air temperature range (see Note 2), T_A | – 20 to 85°C |
| Storage temperature range, T_{stg} | –40°C to 125°C |

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES: 1. All voltage values are with respect to GND terminal.
2. $T_J \leq 150^\circ\text{C}$ (refer to appendix thermal condition).

recommended operating conditions

dc characteristics (see Note 3)

| PARAMETER | TEST CONDITIONS | MIN | NOM | MAX | UNIT |
|--|---|---------------|-----|-------------|------|
| Logic supply voltage, $V_{(LOG)}$ | | 4.5 | 5 | 5.5 | V |
| LED supply voltage, $V_{(LED)}$ | | 4.5 | 5 | 5.5 | V |
| Analog power supply, $V_{(ANA)}$ | | 4.5 | 5 | 5.5 | V |
| Voltage between GND and $V_{(DEF)}$, $G_{(DEF)}$ | $G_{(DEF)} = GND_{(LOG)} - GND_{(LED)}$ | –0.3 | 0 | 0.3 | V |
| High-level input voltage, V_{IH} | | 2.0 | | $V_{(LOG)}$ | V |
| Low-level input voltage, V_{IL} | | $GND_{(LOG)}$ | | 0.8 | V |
| High-level output current, I_{OH} | $V_{(LOG)} = 4.5\text{V}$, SOUT, DSEL | | | –1 | mA |
| High-level output current, $I_{OH(S)}$ | S0 to S15 | | | –30 | |
| Low-level output current, I_{OL} | $V_{(LOG)} = 4.5\text{V}$, SOUT, DSEL | | | 1.6 | mA |
| Low-level output current, $I_{OL(C)}$ | DUTY = 1/16, COM0 to COM7 | | | 640 | |
| Operating free-air temperature range, T_A (see Note 2) | | –20 | | 85 | °C |

- NOTES: 2. $T_J \leq 150^\circ\text{C}$ (refer to appendix thermal condition).
3. V_{ANA} must be same as V_{LED} .

ac characteristics ($T_A = -20^\circ\text{C}$ to 85°C)

| PARAMETER | TEST CONDITIONS | MIN | NOM | MAX | UNIT |
|--|-----------------|-----|-----|-----|------|
| $f_{(SCLK)}$ Shift clock frequency | | | | 10 | MHz |
| $t_{w(H)}/t_{w(L)}$ SCLK pulse duration (high- or low-level) | | 40 | | | ns |
| t_r/t_f Rise/fall time | | | | 100 | ns |
| t_{su} Setup time | SIN – SCLK | 10 | | | ns |
| | SCLK – LATCH | 10 | | | |
| t_h Hold time | LATCH – SCLK | 10 | | | ns |
| | SIN – SCLK | 10 | | | |



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electrical characteristics (unless otherwise noted),

MIN/MAX: $V_{(LOG)} = V_{(ANA)} = V_{(LED)} = 4.5\text{ V to }5.5\text{ V}$, $T_A = -20^\circ\text{C to }85^\circ\text{C}$

TYP: $V_{(LOG)} = V_{(ANA)} = V_{(LED)} = 5\text{ V}$, $T_A = 25^\circ\text{C}$

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--------------------|------------------------------------|--|-------|-----------|-----------|---------------|
| V_{OH} | High-level output voltage | $I_{OH} = -1\text{ mA}$, SOUT, DSEL | 3.6 | | | V |
| V_{OL} | Low-level output voltage | $I_{OL} = 1.6\text{ mA}$, SOUT, DSEL | | | 0.6 | V |
| | | $I_{OL} = 640\text{ mA}$, COM0 to COM7 | | 0.6 | 0.9 | |
| I_I | Input current | $V_I = V_{(LOG)}$ or $GND_{(LOG)}$ | | | ± 1 | μA |
| $I_{(LOG)}$ | Supply current | Data transfer, SCLK = 10 MHz | | | 0.1 | mA |
| $I_{(LED)}$ | | LED is turned off | | 0.8 | 1.6 | |
| $I_{(ANA)}$ | | LED is turned off | | 0.8 | 1.6 | |
| $I_{OH(S03)}$ | Segment current | $V_{(Sn)} = 2.5\text{ V}$, $R_{(IREF)} = 4200\ \Omega$ | -2.1 | -3 | -3.9 | mA |
| $I_{OH(S10)}$ | | $V_{(Sn)} = 2.5\text{ V}$, $R_{(IREF)} = 1260\ \Omega$ | -8.5 | -10 | -11.5 | |
| $I_{OH(S20)}$ | | $V_{(Sn)} = 2.5\text{ V}$, $R_{(IREF)} = 630\ \Omega$ | -17 | -20 | -23 | |
| $I_{OH(S30)}$ | | $V_{(Sn)} = 2.5\text{ V}$, $R_{(IREF)} = 420\ \Omega$ | -25.5 | -30 | -34.5 | |
| $\Delta I_{OH(S)}$ | Segment current error between bits | $V_{(LED)} = 5\text{ V}$, $R_{(IREF)} = 630\ \Omega$, $V_{(Sn)} = 2.5\text{ V}$ | | $\pm 3\%$ | $\pm 6\%$ | |
| V_{REF} | Voltage reference | | 1.2 | 1.26 | 1.3 | V |

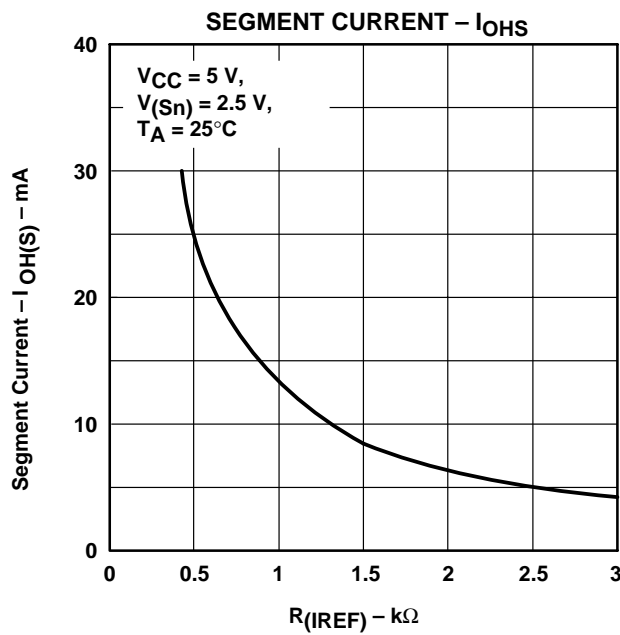
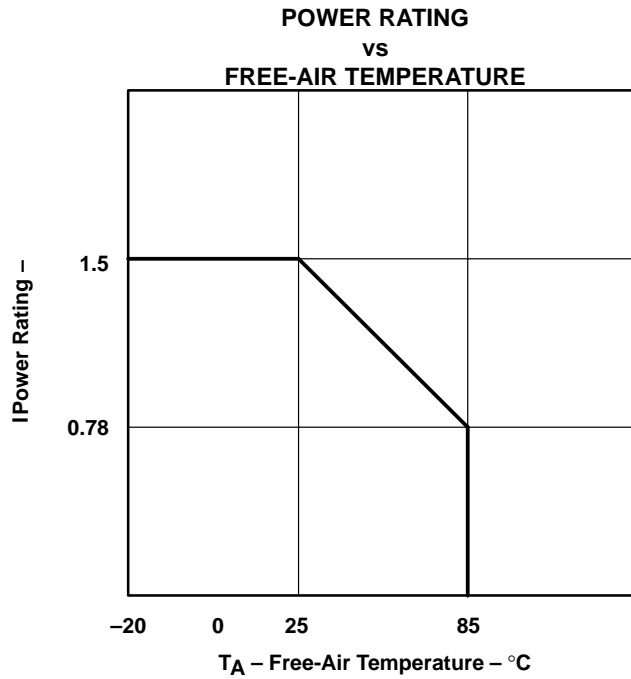
switching characteristics, $C_L = 15\text{ pF}$

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|-------------|------------------------|--|-----|-----|-----|------|
| t_r | Rise time | SOUT | | | 40 | ns |
| | | DSEL | | | 40 | |
| | | COMn | | | 80 | |
| | | Sn | | | 80 | |
| t_f | Fall time | SOUT | | | 40 | ns |
| | | DSEL | | | 40 | |
| | | COMn | | | 40 | |
| | | Sn | | | 40 | |
| t_d | Propagation delay time | $\overline{\text{LATCH}} - \text{Sn}$ | | | 40 | ns |
| | | SCLK - Sn | | | 40 | |
| | | SCLK - SOUT | | | 40 | |
| | | $\overline{\text{DSEL}} - \text{DSEL}$ | | | 40 | |
| $t_{(DLH)}$ | Propagation delay time | CSELn - COMn | | | 120 | ns |
| | | $\overline{\text{DSEL}} - \text{COMn}$ | | | 120 | |
| | | BLANK - COMn | | | 120 | |
| $t_{(DHL)}$ | Propagation delay time | CSELn - COMn | | | 40 | ns |
| | | $\overline{\text{DSEL}} - \text{COMn}$ | | | 40 | |
| | | BLANK - COMn | | | 40 | |

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PARAMETER MEASUREMENT INFORMATION

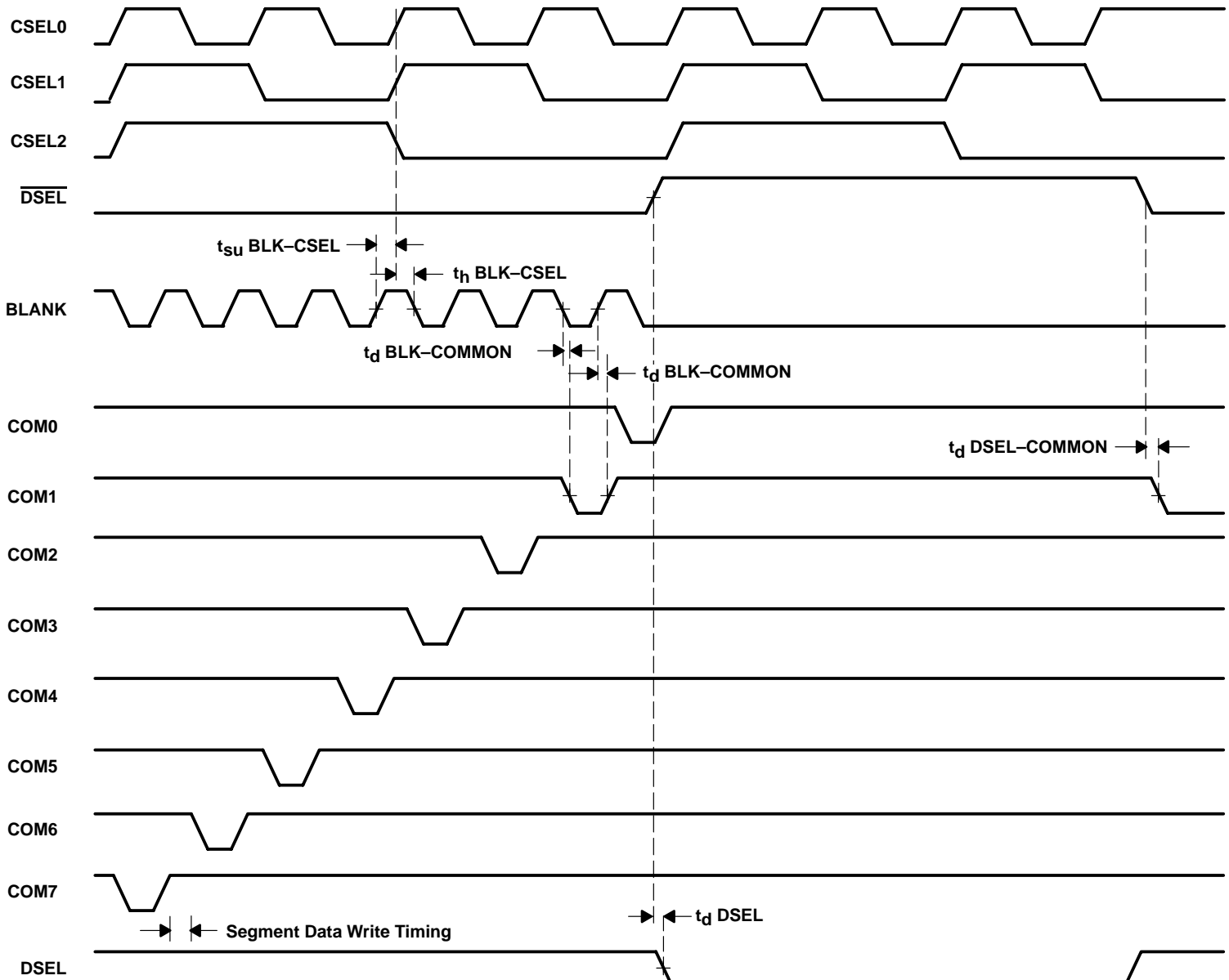


$$I_{OH(S)} = \frac{V_{REF}}{R(IREF)} \times 10$$



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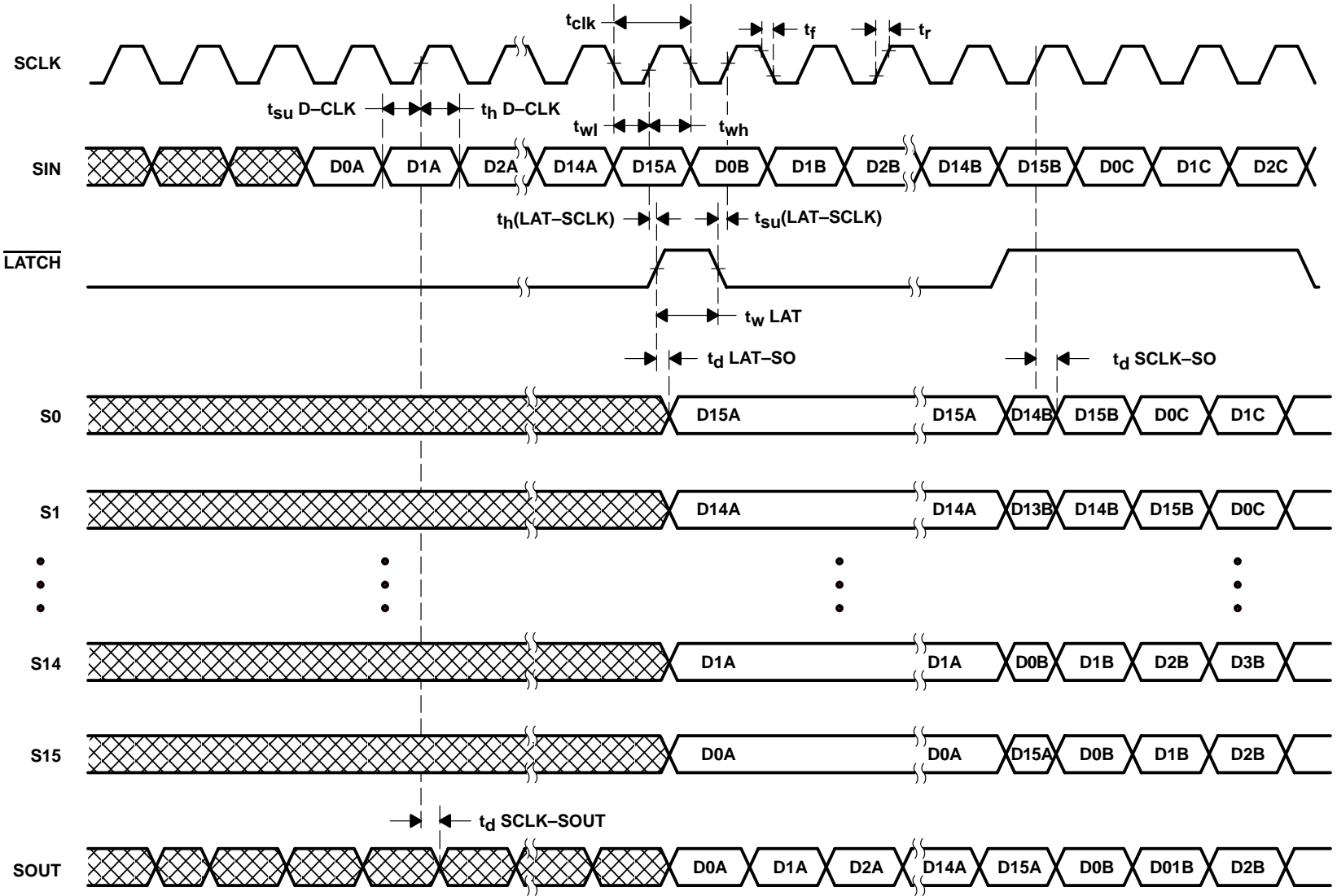
timing diagram (common driver)



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timing diagram (segment driver)



APPLICATION INFORMATION

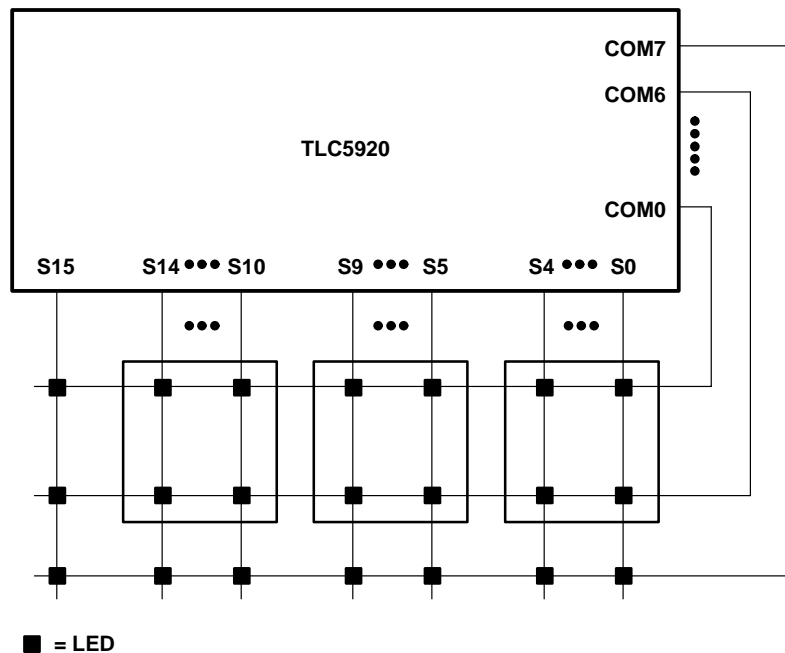
example 1

The other remaining terminals used for dot matrix LED drive can be utilized for LED lamp drive and other displays.

LEDs driven by TLC5920

cathode common type

| LED | | | TLC5920 QUANTITY | DUTY | DRIVE CURRENT (mA) |
|-----------|--------------|----------|---------------------|--------|-----------------------|
| TYPE | NO. OF COLOR | QUANTITY | | | |
| LAMP | Mono | 16 | 1 | Static | 30 |
| | Two | 8 | 1 | Static | 30 |
| 7 SEGMENT | Mono | 16 | 1 | 1/8 | 30 |
| | Two | 8 | 1 | 1/8 | 30 |
| 5 x 7 | Mono | 3 | 1 | 1/8 | 30 |
| | Two | 1 | 1 | 1/8 | 30 |
| 8 x 8 | Mono | 2 | 1 | 1/8 | 30 |
| | Two | 1 | 1 | 1/8 | 30 |
| 16 x 16 | Mono | 2 | 2 | 1/16 | 20 |
| | Two | 1 | 2 | 1/16 | 20 |
| | Three | 1 | 3 | 1/16 | 13 |
| 24 x 24 | Mono | 2 | 3 | 1/24 | 13 |
| | Two | 1 | 3 | 1/24 | 13 |



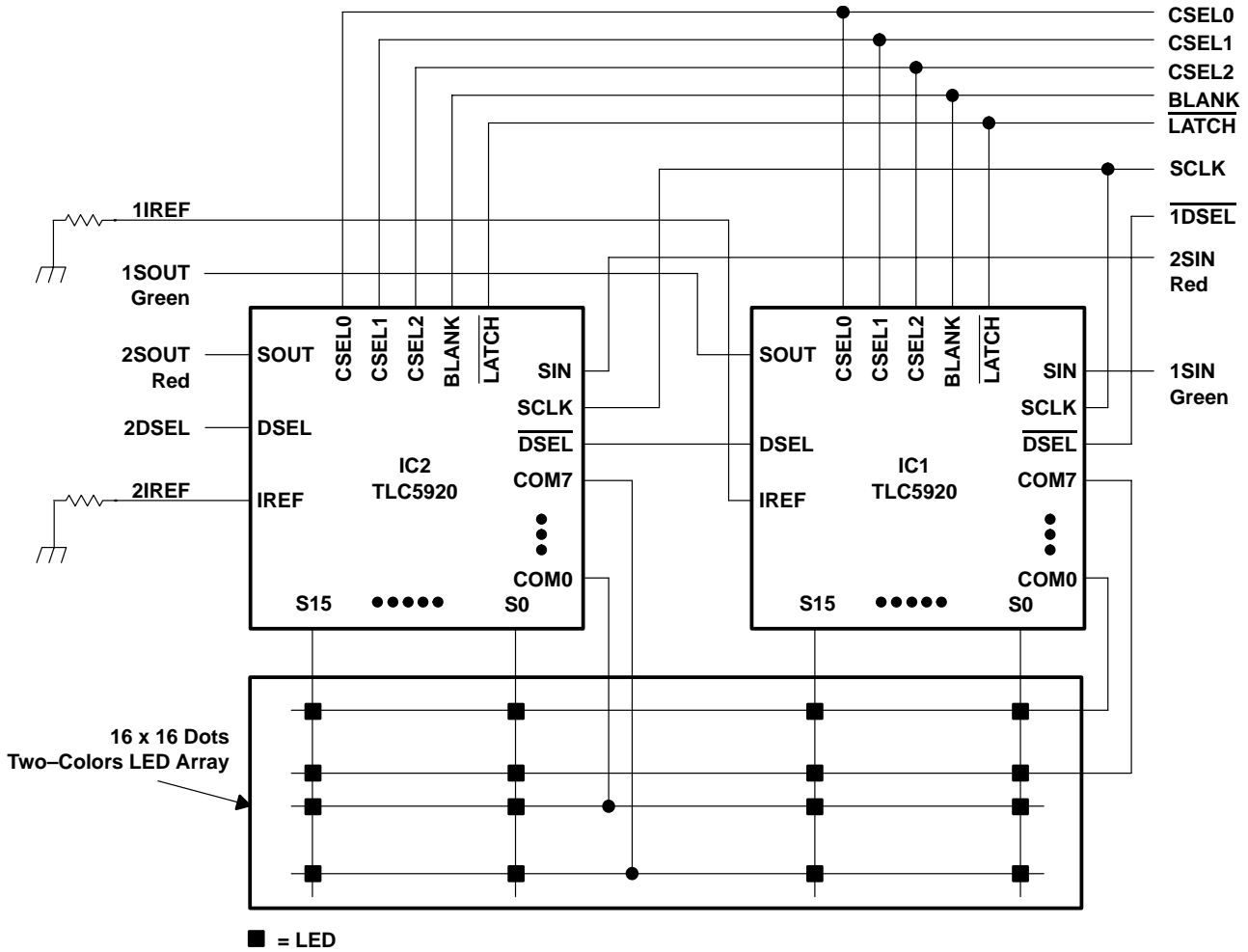
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APPLICATION INFORMATION

example 2

Using two TLC5920s, an LED with two colors and 16 x 16 dots can be driven. The number of LED arrays can also be increased by making a cascade connection in the application circuit.

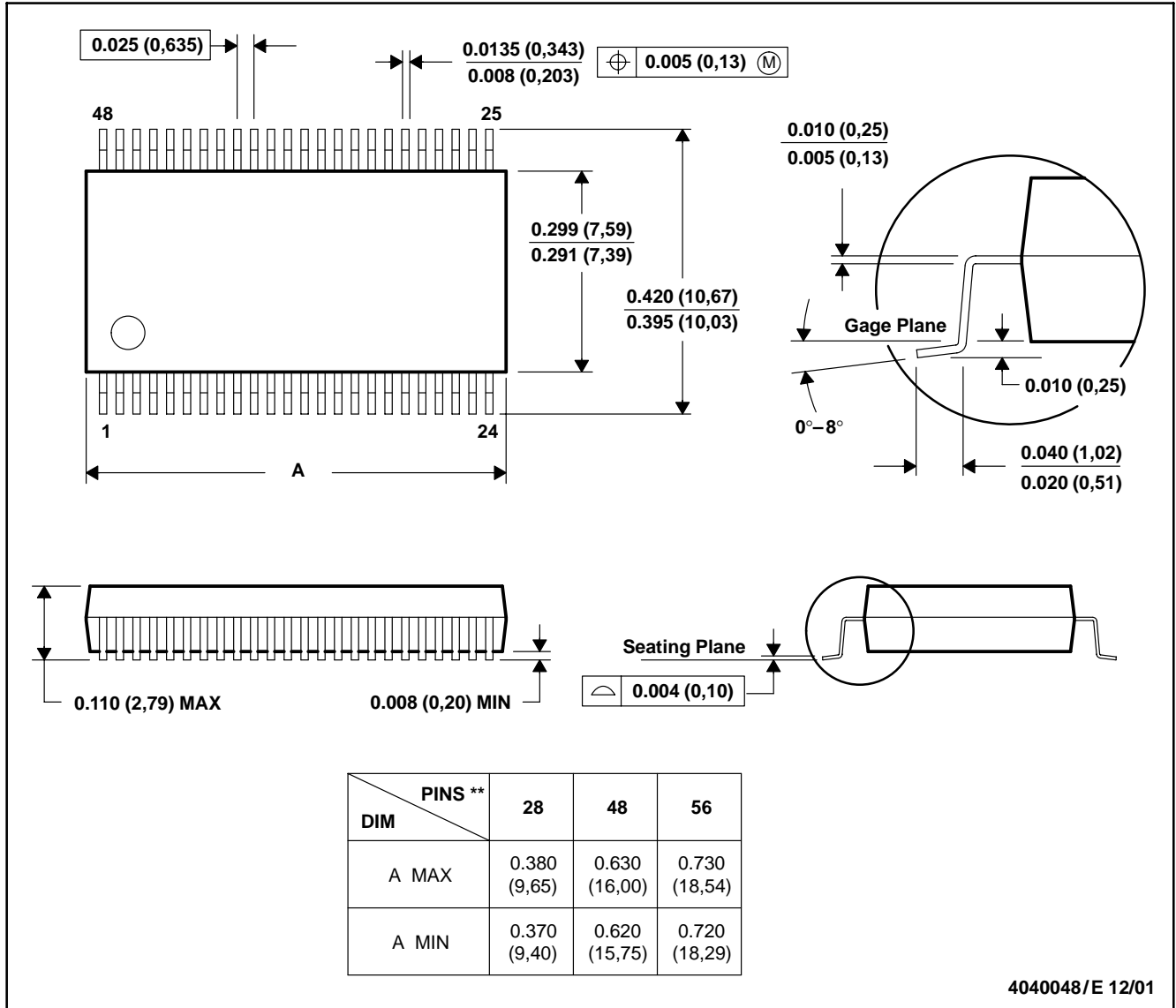


MECHANICAL DATA

DL (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

48 PINS SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
 D. Falls within JEDEC MO-118

PACKAGING INFORMATION

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TLC5920DL | ACTIVE | SSOP | DL | 48 | 25 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TLC5920DLG4 | ACTIVE | SSOP | DL | 48 | 25 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TLC5920DLR | ACTIVE | SSOP | DL | 48 | 1000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |
| TLC5920DLRG4 | ACTIVE | SSOP | DL | 48 | 1000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-2-260C-1 YEAR |

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

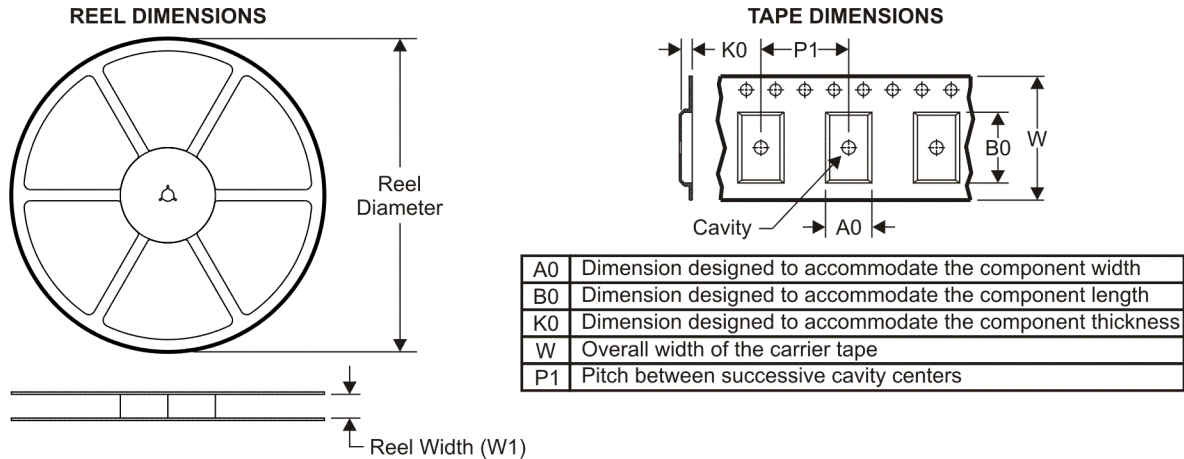
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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TAPE AND REEL INFORMATION



QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TLC5920DLR | SSOP | DL | 48 | 1000 | 330.0 | 32.4 | 11.35 | 16.2 | 3.1 | 16.0 | 32.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TLC5920DLR | SSOP | DL | 48 | 1000 | 346.0 | 346.0 | 49.0 |

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