

8-BIT DMOS SINK DRIVER WITH LATCH

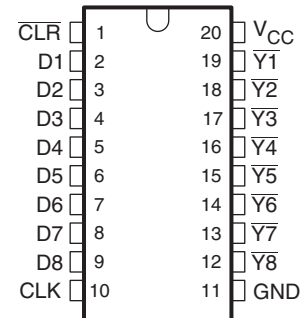
FEATURES

- DMOS Process
- High Voltage Output ($V_{ds} = 30\text{ V}$)
- Output Current on Each Channel ($I_{ds}\text{ Max} = 200\text{ mA}$)
- Latch-Up Performance Exceeds 250 mA Per JEDEC Standard JESD-17
- ESD Protection Exceeds JESD 22
 - 2000-V Human Body Model (A114-A)
 - 200-V Machine Model (A115-A)
 - 1000-V Charged Device Model (C101)
- LED Driver Application
- Output Clamp Diodes (Parasitic)
- Control Pins of $\overline{\text{CLR}}$ and CLK Inputs
- Clock Input up to 1 MHz

APPLICATIONS

- Lamp and Display (LED)
- Hammer
- Relay

N OR PW PACKAGE
(TOP VIEW)



DESCRIPTION

The TLC59210 is an 8-bit flip-flop driver for LED and solenoid with Schmitt-trigger buffers designed for 5-V V_{CC} operation.

These circuits are positive-edge-triggered D-type flip-flops with a direct clear ($\overline{\text{CLR}}$) input. Information at the data (D) input meeting the setup time requirements is transferred to the $\overline{\text{Y}}$ output on the positive-going edge of the clock (CLK) pulse. Clock triggering occurs at a particular voltage level and is not directly related to the transition time of the positive-going pulse. When CLK is at either the high or low level, the D input has no effect at the output.

The TLC59210 is characterized for operation from -40°C to 85°C .

ORDERING INFORMATION⁽¹⁾

| T_A | PACKAGE ⁽²⁾ | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|---|------------------------|--------------|-----------------------|------------------|
| -40°C to 85°C | PDIP – N | Reel of 1000 | TLC59210IN | Y59210 |
| | TSSOP – PW | Reel of 2000 | TLC59210IPWR | Y59210 |

- (1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.
- (2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.



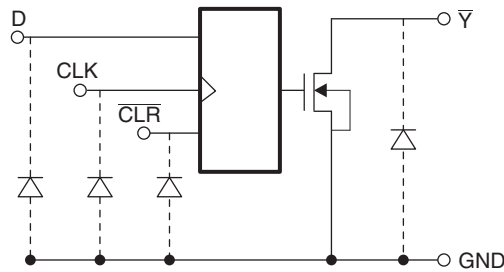
Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

**FUNCTION TABLE
(EACH LATCH)⁽¹⁾**

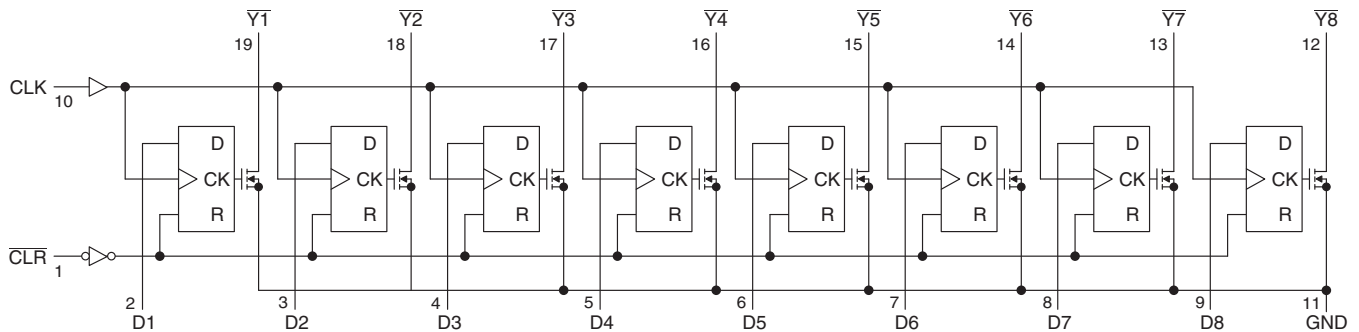
| INPUTS | | | OUTPUT Y |
|--------|-----|---|----------------|
| CLR | CLK | D | |
| L | X | X | H* |
| H | ↑ | L | H* |
| H | ↑ | H | L |
| H | L | X | Y ₀ |
| H | ↓ | X | Y ₀ |

- (1) L: Low-level
 H: High-level
 H*: with pullup resistor
 X: Irrelevant
 ↑: Rising edge
 ↓: Falling edge
 Z: High-impedance (OFF)

OUTPUT SCHEMATIC



LOGIC SYMBOL⁽¹⁾



(1) This symbol is in accordance with ANSI/IEEE Standard 91-1984 and IEC Publication 617-12.

ABSOLUTE MAXIMUM RATINGS⁽¹⁾

over operating free-air temperature range (unless otherwise noted)

| | | | MIN | MAX | UNIT |
|---------------|--|-----------------------|---|-----|------|
| V_{CC} | Supply voltage range | | -0.5 | 7 | V |
| D | Input voltage range | | -0.5 | 7 | V |
| V_{ds} | Output voltage range | H output | -0.5 | 32 | V |
| I_{ds} | Output current range | 1 bit for output low, | $V_{CC} = 3\text{ V to }3.6\text{ V}$ | 100 | mA |
| | | | $V_{CC} = 4.5\text{ V to }5.5\text{ V}$ | 200 | |
| I_{IK} | Input clamp current | $V_I < 0\text{ V}$ | | -20 | mA |
| θ_{JA} | Package thermal impedance ⁽²⁾ | N package | | 69 | °C/W |
| | | PW package | | 83 | |
| | Operating free-air temperature range | | -40 | 85 | °C |
| T_{stg} | Storage temperature range | | -65 | 150 | °C |

- (1) 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.
- (2) The package thermal impedance is calculated in accordance with JESD 51-7.

RECOMMENDED OPERATING CONDITIONS

| | | CONDITIONS | MIN | MAX | UNIT |
|----------|--------------------------------|--|---------------------|---------------------|------|
| V_{CC} | Supply voltage | | 3 | 5.5 | V |
| V_{IH} | High-level input voltage | | $V_{CC} \times 0.7$ | V_{CC} | V |
| V_{IL} | Low-level input voltage | | 0 | $V_{CC} \times 0.3$ | V |
| V_{ds} | Output voltage | | | 30 | V |
| I_{ds} | Output current | N package, $V_{CC} = 4.5\text{ V to }5.5\text{ V}$ | Duty cycle < 42% | 200 | mA |
| | | | Duty cycle < 100% | 130 | |
| | | PW package, $V_{CC} = 4.5\text{ V to }5.5\text{ V}$ | Duty cycle < 24% | 200 | |
| | | | Duty cycle < 100% | 95 | |
| T_A | Operating free-air temperature | | -40 | 85 | °C |

ELECTRICAL CHARACTERISTICS

over recommended operating free-air temperature range, $V_{CC} = 4.5\text{ V to }5.5\text{ V}$, $T_A = -40^\circ\text{C to }85^\circ\text{C}$ (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT | |
|-----------|--------------------------------|---|------------------|-----|------|---------------|---------------|
| V_{T+} | Positive-going input threshold | D, $\overline{\text{CLR}}$, CLK | | | 3.5 | V | |
| V_{T-} | Negative-going input threshold | D, $\overline{\text{CLR}}$, CLK | 1.5 | | | V | |
| V_{HYS} | Hysteresis | D, $\overline{\text{CLR}}$, CLK | 0.5 | | 2 | V | |
| I_{IH} | High-level input current | $V_{CC} = 5.5\text{ V}$, $V_I = 5.5\text{ V}$ | | 0 | 1 | μA | |
| I_{IL} | Low-level input current | $V_{CC} = 5.5\text{ V}$, $V_I = 0\text{ V}$ | | 0 | -1 | μA | |
| I_{OZ} | Leakage current | $V_{ds} = 30\text{ V}$ | | | 5 | μA | |
| I_{off} | Leakage current | $V_I = 0\text{ to }5\text{ V}$, $V_O = 0\text{ to }30\text{ V}$, $V_{CC} = 0$ | | 0 | 5 | μA | |
| I_{CC} | Supply current | $V_I = 0\text{ to }5\text{ V}$, $V_O = 0\text{ to }30\text{ V}$, $V_{CC} = 0$ | Output = all OFF | | 0 | 5 | μA |
| | | | Output = all ON | | 0 | 5 | |
| V_{OL} | Low-level output voltage | $V_{CC} = 4.5\text{ V}$, $I_O = 100\text{ mA}$ | | 0.2 | 0.35 | V | |
| | | $V_{CC} = 4.5\text{ V}$, $I_O = 200\text{ mA}$ | | 0.5 | 0.7 | V | |
| r_{ON} | ON-state resistance | $V_{CC} = 4.5\text{ V}$, $I_O = 100\text{ mA}$ | | 2 | 3.5 | Ω | |
| C_i | Input capacitance | $V_I = V_{CC}$ or GND | | 5 | | pF | |

SWITCHING CHARACTERISTICS

over recommended operating free-air temperature range, $V_{CC} = 4.5\text{ V to }5.5\text{ V}$, $T_A = -40^\circ\text{C to }85^\circ\text{C}$ (unless otherwise noted), see [Figure 1](#)

| PARAMETER | TEST CONDITIONS | LOAD CAPACITANCE | $T_A = 25^\circ\text{C}$ | | | $T_A = -40^\circ\text{C to }85^\circ\text{C}$ | | UNIT |
|------------|---------------------------------|--|--------------------------|-----|-----|---|-----|------|
| | | | MIN | TYP | MAX | MIN | MAX | |
| t_{TLH} | Output = low to high | $C_L = 30\text{ pF}$, $R_L = 240\ \Omega$, 24-V pullup | | 180 | 230 | | 260 | ns |
| t_{THL} | Output = high to low | $C_L = 30\text{ pF}$, $R_L = 240\ \Omega$, 24-V pullup | | 300 | 450 | | 500 | ns |
| t_{PLH} | Output = low to high | $C_L = 30\text{ pF}$, $R_L = 240\ \Omega$, 24-V pullup | | 320 | 480 | | 550 | ns |
| t_{PHL} | Output = high to low | $C_L = 30\text{ pF}$, $R_L = 240\ \Omega$, 24-V pullup | | 320 | 480 | | 550 | ns |
| t_{PHLR} | $\overline{\text{CLR}}-\bar{Y}$ | $C_L = 30\text{ pF}$, $R_L = 240\ \Omega$, 24-V pullup | | 320 | 480 | | 550 | ns |

TIMING REQUIREMENTS

over recommended operating free-air temperature range, $V_{CC} = 4.5\text{ V to }5.5\text{ V}$, O/C to Y (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | $T_A = -40^\circ\text{C to }85^\circ\text{C}$ | | UNIT |
|-----------|-------------|------------------------------|---|-----|------|
| | | | MIN | MAX | |
| t_{su} | Setup time | CLK \uparrow | $V_{DD} = 4.5\text{ V}$ | 10 | ns |
| t_h | Hold time | CLK \uparrow | $V_{DD} = 4.5\text{ V}$ | 10 | ns |
| t_w | Pulse width | CLK, $\overline{\text{CLR}}$ | $V_{DD} = 4.5\text{ V}$ | 30 | ns |

ELECTRICAL CHARACTERISTICS

over recommended operating free-air temperature range, $V_{CC} = 3\text{ V to }3.6\text{ V}$, $T_A = -40^\circ\text{C to }85^\circ\text{C}$ (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT | |
|-----------|--------------------------------|--|------------------|------|------|---------------|---------------|
| V_{T+} | Positive-going input threshold | D, $\overline{\text{CLR}}$, CLK | | | 2.52 | V | |
| V_{T-} | Negative-going input threshold | D, $\overline{\text{CLR}}$, CLK | 0.9 | | | V | |
| V_{HYS} | Hysteresis | D, $\overline{\text{CLR}}$, CLK | 0.33 | | 1.32 | V | |
| I_{IH} | High-level input current | $V_{CC} = 3.6\text{ V}$, $V_I = 3.6\text{ V}$ | | 0 | 1 | μA | |
| I_{IL} | Low-level input current | $V_{CC} = 3.6\text{ V}$, $V_I = 0\text{ V}$ | | 0 | -1 | μA | |
| I_{OZ} | Leakage current | $V_O = 30\text{ V}$ | | | 5 | μA | |
| I_{off} | Leakage current | $V_{CC} = 0\text{ V}$, $V_I = 0\text{ to }3.6\text{ V}$, $V_O = 0\text{ to }30\text{ V}$ | | 0 | 5 | μA | |
| I_{CC} | Supply current | $V_{CC} = 3.6\text{ V}$, $V_I = 0\text{ to }3.6\text{ V}$, $V_O = 0\text{ to }30\text{ V}$ | Output = all OFF | | 0 | 5 | μA |
| | | | Output = all ON | | 0 | 5 | |
| V_{OL} | Low-level output voltage | $V_{CC} = 3\text{ V}$, $I_O = 100\text{ mA}$ | | 0.35 | 0.7 | V | |
| r_{ON} | ON-state resistance | $V_{CC} = 4.5\text{ V}$, $I_O = 100\text{ mA}$ | | 3.5 | 7 | Ω | |
| C_i | Input capacitance | $V_I = V_{CC}\text{ or GND}$ | | 5 | | pF | |

SWITCHING CHARACTERISTICS

over recommended operating free-air temperature range, $V_{CC} = 3\text{ V to }3.6\text{ V}$, $T_A = -40^\circ\text{C to }85^\circ\text{C}$ (unless otherwise noted), see [Figure 1](#)

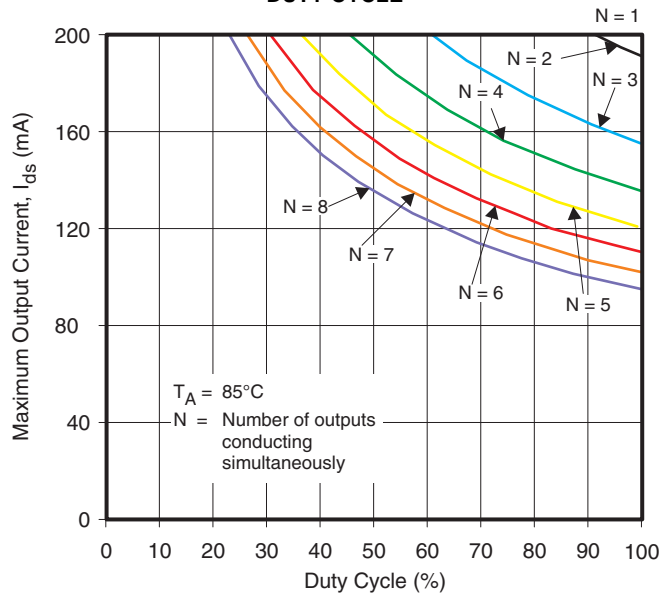
| PARAMETER | TEST CONDITIONS | LOAD CAPACITANCE | $T_A = 25^\circ\text{C}$ | | | $T_A = -40^\circ\text{C to }85^\circ\text{C}$ | | UNIT |
|------------|---------------------------------|--|--------------------------|-----|-----|---|-----|------|
| | | | MIN | TYP | MAX | MIN | MAX | |
| t_{TLH} | Output = low to high | $C_L = 30\text{ pF}$, $R_L = 240\ \Omega$, 24-V pullup | | 300 | 450 | | 500 | ns |
| t_{THL} | Output = high to low | $C_L = 30\text{ pF}$, $R_L = 240\ \Omega$, 24-V pullup | | 300 | 450 | | 500 | ns |
| t_{PLH} | Output = low to high | $C_L = 30\text{ pF}$, $R_L = 240\ \Omega$, 24-V pullup | | 500 | 700 | | 850 | ns |
| t_{PHL} | Output = high to low | $C_L = 30\text{ pF}$, $R_L = 240\ \Omega$, 24-V pullup | | 500 | 700 | | 850 | ns |
| t_{PHLR} | $\overline{\text{CLR}}-\bar{Y}$ | $C_L = 30\text{ pF}$, $R_L = 240\ \Omega$, 24-V pullup | | 500 | 700 | | 850 | ns |

TIMING REQUIREMENTS

over recommended operating free-air temperature range, $V_{CC} = 3\text{ V to }3.6\text{ V}$, O/C to Y (unless otherwise noted)

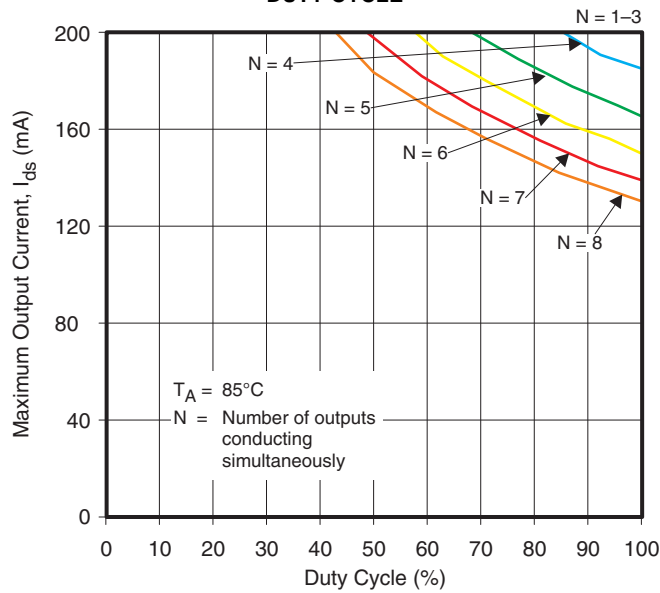
| PARAMETER | | TEST CONDITIONS | $T_A = -40^\circ\text{C to }85^\circ\text{C}$ | | UNIT |
|-----------|-------------|------------------------------|---|-----|------|
| | | | MIN | MAX | |
| t_{su} | Setup time | CLK \uparrow | $V_{DD} = 3\text{ V}$ | 10 | ns |
| t_h | Hold time | CLK \uparrow | $V_{DD} = 3\text{ V}$ | 10 | ns |
| t_w | Pulse width | CLK, $\overline{\text{CLR}}$ | $V_{DD} = 3\text{ V}$ | 30 | ns |

THERMAL INFORMATION
MAXIMUM OUTPUT CURRENT
vs
DUTY CYCLE



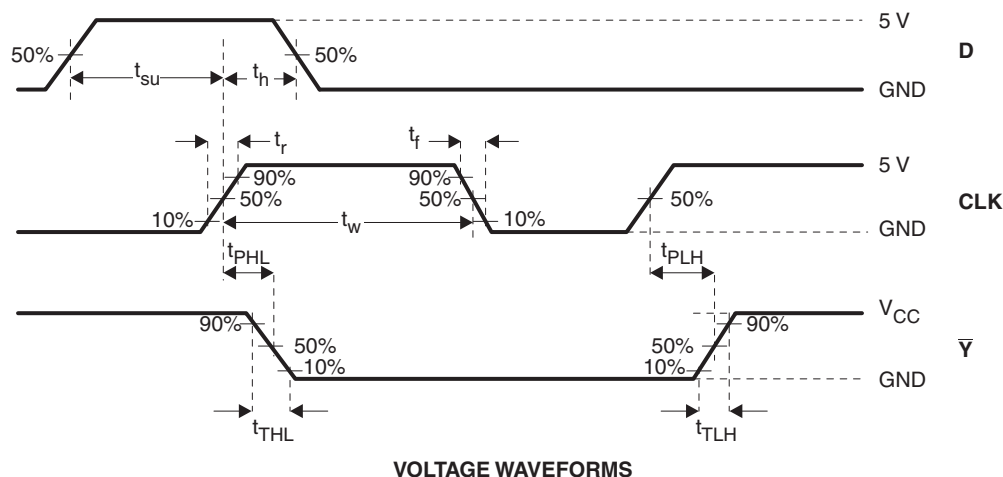
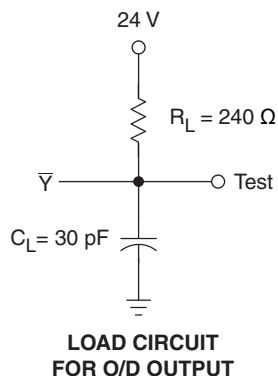
TSSOP (PW) PACKAGE

MAXIMUM OUTPUT CURRENT
vs
DUTY CYCLE



DIP (N) PACKAGE

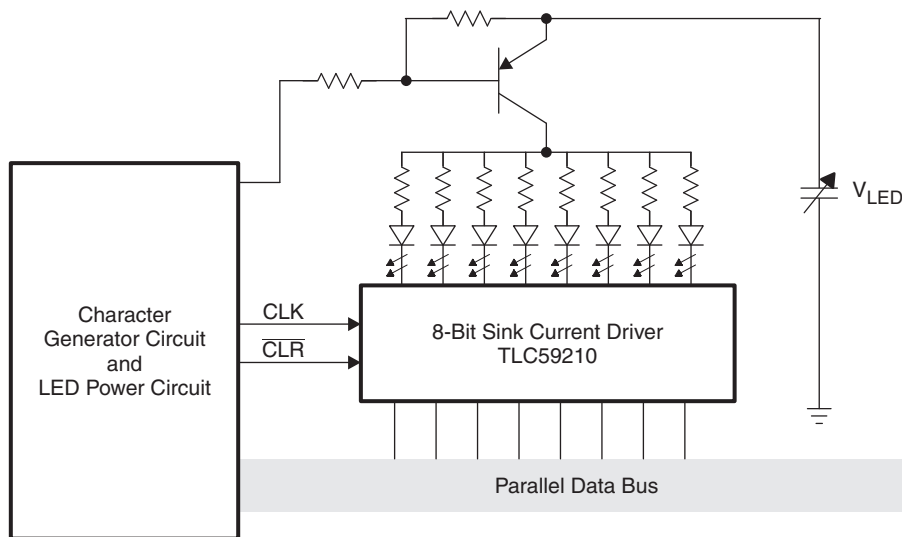
PARAMETER MEASUREMENT INFORMATION



- A. C_L includes probe and jig capacitance.
- B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
- C. All input pulses are supplied by generators having the following characteristics: $PRR \leq 1$ MHz, $Z_O = 50 \Omega$, $t_r \leq 3$ ns, and $t_f \leq 3$ ns.
- D. The outputs are measured one at a time with one transition per measurement.
- E. t_{PLH} and t_{PHL} are the same as t_{pd} .

Figure 1. Test Circuit and Voltage Waveforms

APPLICATION INFORMATION



PACKAGING INFORMATION

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TLC59210IN | ACTIVE | PDIP | N | 20 | 20 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| TLC59210IPWR | ACTIVE | TSSOP | PW | 20 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |

⁽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)

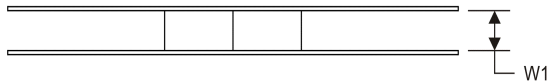
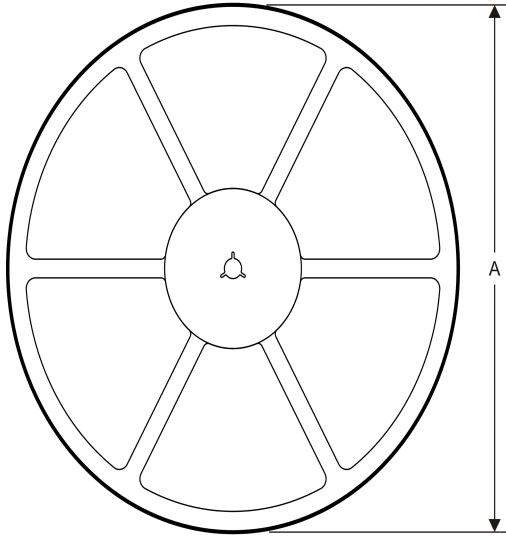
⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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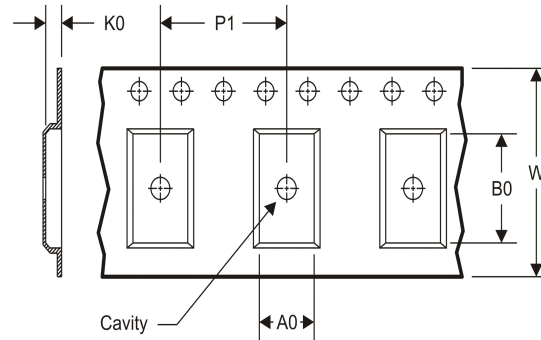
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TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



| | |
|----|---|
| A0 | Dimension designed to accommodate the component width |
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

TAPE AND REEL INFORMATION

*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 |
|--------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TLC59210IPWR | TSSOP | PW | 20 | 2000 | 330.0 | 16.4 | 6.95 | 7.1 | 1.6 | 8.0 | 16.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS

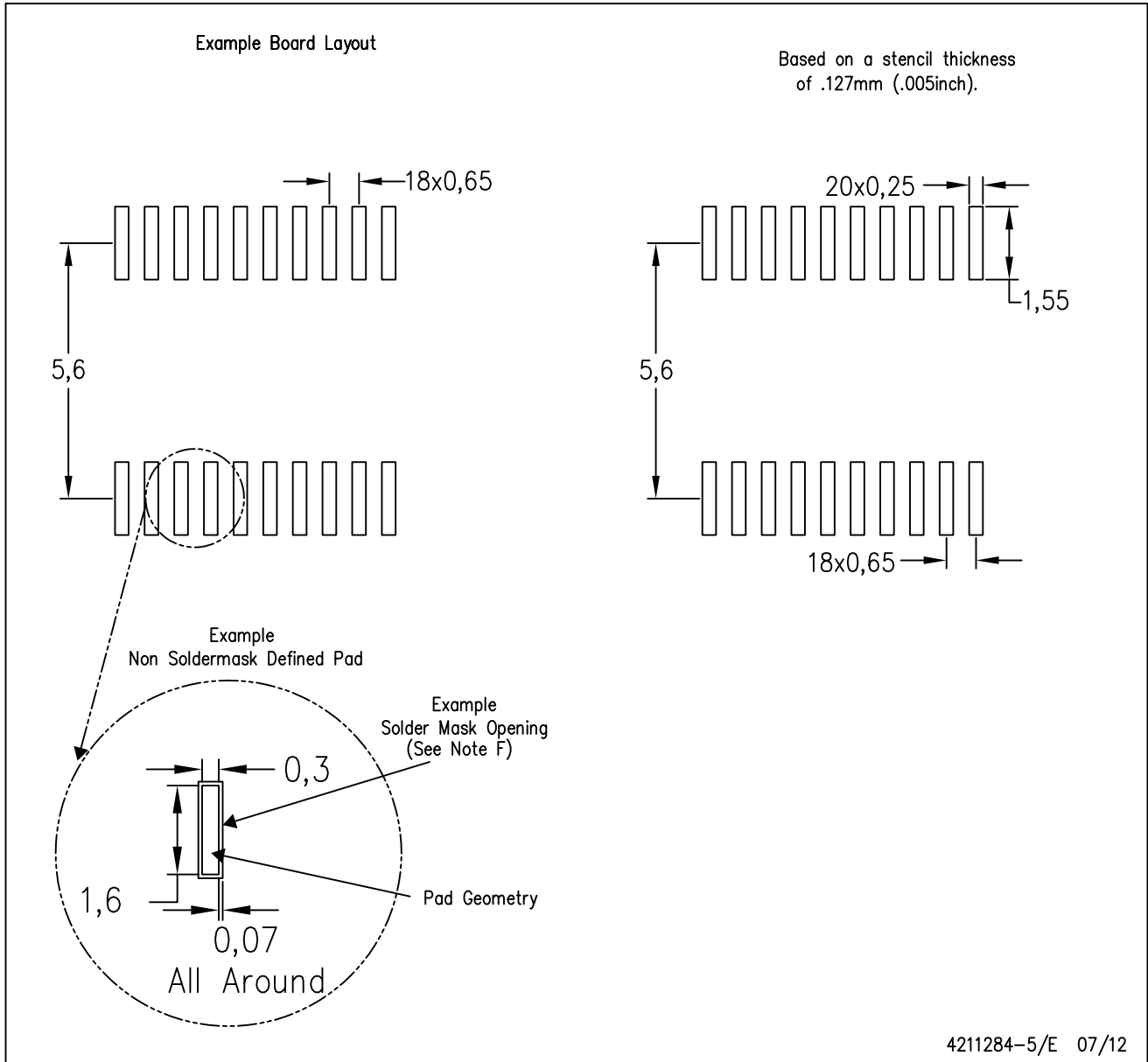


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|--------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TLC59210IPWR | TSSOP | PW | 20 | 2000 | 367.0 | 367.0 | 38.0 |

PW (R-PDSO-G20)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Publication IPC-7351 is recommended for alternate design.
 - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
 - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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Products

| | |
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| DSP | dsp.ti.com |
| Clocks and Timers | www.ti.com/clocks |
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| OMAP Mobile Processors | www.ti.com/omap |
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Applications

| | |
|-------------------------------|--|
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| Computers and Peripherals | www.ti.com/computers |
| Consumer Electronics | www.ti.com/consumer-apps |
| Energy and Lighting | www.ti.com/energy |
| Industrial | www.ti.com/industrial |
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