The TPIC6595 is a monolithic, high-voltage, high-current power 8-bit shift register designed for use in systems that require relatively high load power. The device contains a built-in voltage clamp on the outputs for inductive transient protection. Power driver applications include relays, solenoids, and other medium-current or high-voltage loads.

This device contains an 8-bit serial-in, parallel-out shift register that feeds an 8-bit D-type storage register. Data transfers through both the shift and storage registers on the rising edge of the shift-register clock (SRCK) and the register clock (RCK) respectively. The storage register transfers data to the output buffer when shift-register clear (SRCLR) is high. When SRCLR is low, the input shift register is cleared. When output enable (G) is held high, all data in the output buffers is held low and all drain outputs are off. When G is held low, data from the storage register is transparent to the output buffers. The serial output (SER OUT) allows for cascading of the data from the shift register to additional devices.

Outputs are low-side, open-drain DMOS transistors with output ratings of 45 V and 250-mA continuous sink current capability. When data in the output buffers is low, the DMOS-transistor outputs are off. When data is high, the DMOS-transistor outputs have sink current capability.

Separate power and logic level ground pins are provided to facilitate maximum system flexibility. Pins 1, 10, 11, and 20 are internally connected, and each pin must be externally connected to the power system ground in order to minimize parasitic inductance. A single-point connection between pin 19, logic ground (LGND), and pins 1, 10, 11, and 20, power grounds (PGND), must be externally made in a manner that reduces crosstalk between the logic and load circuits.

The TPIC6595 is characterized for operation over the operating case temperature range of −40°C to 125°C.
logic diagram (positive logic)
schematic of inputs and outputs

absolute maximum ratings over recommended operating case temperature range (unless otherwise noted)†

Logic supply voltage, $V_{CC}$ (see Note 1) .................................................. 7 V
Logic input voltage range, $V_I$ .............................................................. $-0.3$ V to 7 V
Power DMOS drain-to-source voltage, $V_{DS}$ (see Note 2) ................................. 45 V
Continuous source-drain diode anode current ..................................... 1 A
Pulsed source-drain diode anode current ........................................ 2 A
Pulsed drain current, each output, all outputs on, $I_{Dn}, T_A = 25^\circ C$ (see Note 3) 750 mA
Continuous drain current, each output, all outputs on, $I_{Dn}, T_A = 25^\circ C$ .... 750 mA
Peak drain current single output, $I_{DM}, T_A = 25^\circ C$ (see Note 3) ................. 2 A
Single-pulse avalanche energy, $E_{AS}$ (see Note 4) ................................. 75 mJ
Avalanche current, $I_{AS}$ (see Note 4) .................................................. 1 A
Continuous total power dissipation .............................................. See Dissipation Rating Table
Operating virtual junction temperature range, $T_J$ ..................................... $-40^\circ C$ to 150$^\circ C$
Storage temperature range, $T_{stg}$ ...................................................... $-65^\circ C$ to 150$^\circ C$
Lead temperature 1.6 mm (1/16 inch) from case for 10 seconds ................... 260$^\circ C$

† 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 LGND and PGND.
2. Each power DMOS source is internally connected to PGND.
3. Pulse duration ≤ 100 µs, duty cycle ≤ 2 %
4. DRAIN supply voltage = 15 V, starting junction temperature ($T_{JS}$) = 25$^\circ C$, L = 100 mH, $I_{AS}$ = 1 A (see Figure 4).

DISSIPATION RATING TABLE

<table>
<thead>
<tr>
<th>PACKAGE</th>
<th>$T_A \leq 25^\circ C$ POWER RATING</th>
<th>DERATING FACTOR ABOVE $T_A = 25^\circ C$</th>
<th>$T_A = 125^\circ C$ POWER RATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>DW</td>
<td>1125 mW</td>
<td>9.0 mW/°C</td>
<td>225 mW</td>
</tr>
<tr>
<td>N</td>
<td>1150 mW</td>
<td>9.2 mW/°C</td>
<td>230 mW</td>
</tr>
</tbody>
</table>
### recommended operating conditions over recommended operating temperature range (unless otherwise noted)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logic supply voltage, $V_{CC}$</td>
<td></td>
<td>4.5</td>
<td>5.5</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>High-level input voltage, $V_{IH}$</td>
<td></td>
<td>0.85 $V_{CC}$</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Low-level input voltage, $V_{IL}$</td>
<td></td>
<td>0.15 $V_{CC}$</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Pulsed drain output current, $T_C = 25^\circ C$, $V_{CC} = 5 V$ (see Notes 3 and 5)</td>
<td></td>
<td>-1.8</td>
<td>1.5</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Setup time, SER IN high before SRCK↑, $t_{SU}$ (see Figure 2)</td>
<td></td>
<td>10</td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Hold time, SER IN high after SRCK↑, $t_{H}$ (see Figure 2)</td>
<td></td>
<td>10</td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Pulse duration, $t_{p}$ (see Figure 2)</td>
<td></td>
<td>20</td>
<td></td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Operating case temperature, $T_C$</td>
<td></td>
<td>-40</td>
<td></td>
<td>125</td>
<td>°C</td>
</tr>
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### electrical characteristics, $V_{CC} = 5 V$, $T_C = 25^\circ C$ (unless otherwise noted)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V(BR)_{DSX}$</td>
<td>Drain-source breakdown voltage</td>
<td>$I_D = 1 mA$, $V_{DS(on)} = 0.5 V$, $I_N = I_D$, $T_C = 85^\circ C$</td>
<td>45</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{SD}$</td>
<td>Source-drain diode forward voltage</td>
<td>$I_F = 250 mA$, $V_{SD} = 15 V$</td>
<td>0.85</td>
<td>1</td>
<td>V</td>
</tr>
<tr>
<td>$V_{OH}$</td>
<td>High-level output voltage, SER OUT</td>
<td>$I_{OH} = -20 mA$, $V_{CC} = 4.5 V$, $V_I = V_{CC}$</td>
<td>4.4</td>
<td>4.49</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{OH} = -4 mA$, $V_{CC} = 4.5 V$</td>
<td>4.1</td>
<td>4.3</td>
<td></td>
</tr>
<tr>
<td>$V_{OL}$</td>
<td>Low-level output voltage, SER OUT</td>
<td>$I_{OH} = 20 mA$, $V_{CC} = 4.5 V$, $V_I = 0$</td>
<td>0.002</td>
<td>0.1</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{OH} = 4 mA$, $V_{CC} = 4.5 V$</td>
<td>0.2</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>$V_{(hys)}$</td>
<td>Input hysteresis</td>
<td>$V_{DS} = 15 V$, $V_{DS(on)} = 0.5 V$, $I_D = 250 mA$, $V_{CC} = 4.5 V$, $C_L = 30 pF$, $T_C = 85^\circ C$</td>
<td>1.3</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$I_{IH}$</td>
<td>High-level input current</td>
<td>$V_{CC} = 5.5 V$, $V_I = V_{CC}$</td>
<td>1</td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>$I_{IL}$</td>
<td>Low-level input current</td>
<td>$V_{CC} = 5.5 V$, $V_I = 0$</td>
<td>-1</td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>$I_{CCL}$</td>
<td>Logic supply current</td>
<td>$I_O = 0$, $V_{DS} = 40 V$, $I_D = 250 mA$, $V_{CC} = 4.5 V$, $C_L = 30 pF$, $I_F = 250 mA$, $C_L = 30 pF$, $T_C = 85^\circ C$</td>
<td>15</td>
<td>100</td>
<td>µA</td>
</tr>
<tr>
<td>$I_{CC}(FRQ)$</td>
<td>Logic supply current frequency</td>
<td>$I_{SRCK} = 5 MHz$, $I_O = 0$, $C_L = 30 pF$, $T_C = 85^\circ C$, $I_F = 250 mA$, $C_L = 30 pF$, $T_C = 85^\circ C$</td>
<td>0.6</td>
<td>5</td>
<td>mA</td>
</tr>
<tr>
<td>$I_N$</td>
<td>Nominal current</td>
<td>$V_{DS(on)} = 0.5 V$, $V_{DS} = 40 V$, $I_D = 250 mA$, $V_{CC} = 4.5 V$, $C_L = 30 pF$, $I_F = 250 mA$, $C_L = 30 pF$, $T_C = 85^\circ C$</td>
<td>250</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>$I_{DSX}$</td>
<td>Off-state drain current</td>
<td>$I_D = 250 mA$, $V_{CC} = 4.5 V$, $T_C = 85^\circ C$, $C_L = 30 pF$, $I_F = 250 mA$, $C_L = 30 pF$, $T_C = 85^\circ C$, $I_F = 250 mA$, $C_L = 30 pF$, $T_C = 85^\circ C$</td>
<td>1.3</td>
<td>2</td>
<td>Ω</td>
</tr>
<tr>
<td>$r_{DS(on)}$</td>
<td>Static drain-source on-state resistance</td>
<td>$I_D = 500 mA$, $V_{CC} = 4.5 V$, $T_C = 85^\circ C$, $C_L = 30 pF$, $I_F = 250 mA$, $C_L = 30 pF$, $T_C = 85^\circ C$, $I_F = 250 mA$, $C_L = 30 pF$, $T_C = 85^\circ C$</td>
<td>1.3</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

### switching characteristics, $V_{CC} = 5 V$, $T_C = 25^\circ C$

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t_{PLH}$</td>
<td>Propagation delay time, low-to-high-level output from $G$</td>
<td>$C_L = 30 pF$, $I_D = 250 mA$, $I_F = 250 mA$, $di/dt = 20 A/\mu s$, $T_C = 85^\circ C$, $I_F = 250 mA$, $C_L = 30 pF$, $T_C = 85^\circ C$</td>
<td>650</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_{PHL}$</td>
<td>Propagation delay time, high-to-low-level output from $G$</td>
<td>$C_L = 30 pF$, $I_D = 250 mA$, $I_F = 250 mA$, $di/dt = 20 A/\mu s$, $T_C = 85^\circ C$, $I_F = 250 mA$, $C_L = 30 pF$, $T_C = 85^\circ C$</td>
<td>150</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_r$</td>
<td>Rise time, drain output</td>
<td>$C_L = 30 pF$, $I_D = 250 mA$, $I_F = 250 mA$, $di/dt = 20 A/\mu s$, $T_C = 85^\circ C$, $I_F = 250 mA$, $C_L = 30 pF$, $T_C = 85^\circ C$</td>
<td>750</td>
<td>ns</td>
<td></td>
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<tr>
<td>$t_f$</td>
<td>Fall time, drain output</td>
<td>$C_L = 30 pF$, $I_D = 250 mA$, $I_F = 250 mA$, $di/dt = 20 A/\mu s$, $T_C = 85^\circ C$, $I_F = 250 mA$, $C_L = 30 pF$, $T_C = 85^\circ C$</td>
<td>425</td>
<td>ns</td>
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<tr>
<td>$t_{RH}$</td>
<td>Reverse-recovery-current rise time</td>
<td>$I_F = 250 mA$, $di/dt = 20 A/\mu s$, $T_C = 85^\circ C$, $C_L = 30 pF$, $I_F = 250 mA$, $C_L = 30 pF$, $T_C = 85^\circ C$</td>
<td>100</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>$t_{RR}$</td>
<td>Reverse-recovery time</td>
<td>$C_L = 30 pF$, $I_D = 250 mA$, $I_F = 250 mA$, $di/dt = 20 A/\mu s$, $T_C = 85^\circ C$, $I_F = 250 mA$, $C_L = 30 pF$, $T_C = 85^\circ C$</td>
<td>300</td>
<td></td>
<td></td>
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</tbody>
</table>

**NOTES:**
3. Pulse duration ≤ 100 µs, duty cycle ≤ 2%
5. Technique should limit $T_J - T_C$ to 10°C maximum.
6. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts.
7. Nominal current is defined for a consistent comparison between devices from different sources. It is the current that produces a voltage drop of 0.5 V at $T_C = 85^\circ C$. 
thermal resistance

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>MIN</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{ja}$ Thermal resistance, junction-to-ambient</td>
<td>DW package All 8 outputs with equal power</td>
<td>111</td>
<td>108</td>
<td>°C/W</td>
</tr>
<tr>
<td>$R_{θ}$ Thermal resistance, junction-to-ambient</td>
<td>N package</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PARAMETER MEASUREMENT INFORMATION

**TEST CIRCUIT**

- Word Generator (see Note A)
- $V_{CC}$
- $V_{DD}$
- $R_{L}$ = 95 Ω
- $C_{L}$ = 30 pF (see Note B)

**OUTPUTS**

- $R_{CLK}$
- $R_{CK}$
- $R_{CLK}$
- $R_{DRAIN}$
- $R_{GND}$
- $R_{PGND}$

**VOLTAGE WAVEFORMS**

- $V_{CC}$
- $V_{DD}$
- $0.5 V$
- $24 V$

**SWITCHING TIMES**

- $t_{PLH}$
- $t_{PHL}$
- $t_{f}$
- $t_{r}$

**INPUT SETUP AND HOLD WAVEFORMS**

- $t_{su}$
- $t_{sh}$
- $t_{w}$

---

**NOTES:**

A. Outputs DRAIN 1, 2, 5, and 6 low (PGND), all other DRAIN outputs are at 24 V. The word generator has the following characteristics:

- $t_{f} \leq 10 \text{ ns}$
- $t_{r} \leq 10 \text{ ns}$
- $C_{L} = 30 \text{ pF}$
- Pulsed repetition rate (PRR) = 5 kHz
- $Z_{O} = 50 \text{ Ω}$

B. $C_{L}$ includes probe and jig capacitance.
PARAMETER MEASUREMENT INFORMATION

NOTES:
A. The $V_{GG}$ amplitude and $R_G$ are adjusted for $\frac{dI}{dt} = 20 \, A/\mu s$. A $V_{GG}$ double-pulse train is used to set $I_F = 0.25 \, A$, where $t_1 = 10 \, \mu s$, $t_2 = 7 \, \mu s$, and $t_3 = 3 \, \mu s$.
B. The DRAIN terminal under test is connected to the TP K test point. All other terminals are connected together and connected to the TP A test point.

Figure 3. Reverse-Recovery-Current Test Circuit and Waveforms of Source-Drain Diode

NOTES:
A. The word generator has the following characteristics: $t_r \leq 10 \, ns$, $t_f \leq 10 \, ns$, $Z_O = 50 \, \Omega$.
B. Input pulse duration, $t_w$, is increased until peak current $I_{AS} = 1 \, A$.
Energy test level is defined as $E_{AS} = I_{AS} \times V_{(BR)DSX} \times t_{av}/2 = 75 \, mJ$, where $t_{av} =$ avalanche time.

Figure 4. Single-Pulse Avalanche Energy Test Circuit and Waveforms
TYPICAL CHARACTERISTICS

**Figure 5**

PEAK AVALANCHE CURRENT vs TIME DURATION OF AVALANCHE

- $I_{AS}$ - Peak Avalanche Current - A
- $t_{av}$ - Time Duration of Avalanche - ms

- $T_{JS} = 25^\circ C$

**Figure 6**

SUPPLY CURRENT vs FREQUENCY

- $I_{CC}$ - Supply Current - mA
- $f$ - Frequency - MHz

- $V_{CC} = 5 \text{ V}$
- $T_{JS} = -40^\circ C \text{ to } 125^\circ C$

**Figure 7**

MAXIMUM CONTINUOUS DRAIN CURRENT OF EACH OUTPUT vs NUMBER OF OUTPUTS CONDUCTING SIMULTANEOUSLY

- $I_D$ - Maximum Continuous Drain Current of Each Output - mA
- $V_{CC} = 5 \text{ V}$
- $T_A = 25^\circ C$
- $T_A = 100^\circ C$
- $T_A = 125^\circ C$

**Figure 8**

MAXIMUM PEAK DRAIN CURRENT OF EACH OUTPUT vs NUMBER OF OUTPUTS CONDUCTING SIMULTANEOUSLY

- $I_D$ - Maximum Peak Drain Current of Each Output - A
- $d = t_w/t_{period} = 1 \text{ ms}/t_{period}$
- $d = 5\%$
- $d = 10\%$
- $d = 50\%$
- $d = 80\%$
TYPICAL CHARACTERISTICS

Figure 9

**STATIC DRAIN-SOURCE ON-STATE RESISTANCE VS DRAIN CURRENT**

![Graph showing DS(on) vs ID with curves for TC = 25°C, 125°C, and -40°C.]

- $V_{CC} = 5 \text{ V}$
- See Note A

**Figure 10**

**STATIC DRAIN-SOURCE ON-STATE RESISTANCE VS LOGIC SUPPLY VOLTAGE**

![Graph showing DS(on) vs VCC with curves for TC = 25°C, 125°C, and -40°C.]

- $I_D = 250 \text{ mA}$
- See Note A

**Figure 11**

**SWITCHING TIME VS FREE-AIR TEMPERATURE**

![Graph showing Switching Time (t_PHL, t_R, t_PLH) vs TA with curves for IPH = 250 mA.]

- $I_D = 250 \text{ mA}$
- See Note A

**NOTE A:** Technique should limit $T_J - T_C$ to 10°C maximum.
# Revision History

<table>
<thead>
<tr>
<th>DATE</th>
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<th>PAGE</th>
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<tr>
<td>5/18/05</td>
<td>B</td>
<td>5</td>
<td>Figure 1</td>
<td>Changed SRCLR timing diagram</td>
</tr>
<tr>
<td>10/1/96</td>
<td>A</td>
<td>—</td>
<td>—</td>
<td>—</td>
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<td>4/1992</td>
<td>*</td>
<td>—</td>
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**NOTE:** Page numbers for previous revisions may differ from page numbers in the current version.
## Packaging Information

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<th>Orderable Device</th>
<th>Status (1)</th>
<th>Package Type</th>
<th>Drawing</th>
<th>Pins</th>
<th>Package Qty</th>
<th>Eco Plan (2)</th>
<th>Lead finish/Ball material (6)</th>
<th>MSL Peak Temp (3)</th>
<th>Op Temp (°C)</th>
<th>Device Marking (4/5)</th>
<th>Samples</th>
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</thead>
<tbody>
<tr>
<td>TPIC6595DW</td>
<td>ACTIVE</td>
<td>SOIC</td>
<td>DW</td>
<td>20</td>
<td>25</td>
<td>RoHS &amp; Green</td>
<td>NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
<td>-40 to 125</td>
<td>TPIC6595</td>
<td>Samples</td>
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<tr>
<td>TPIC6595DWRG4</td>
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<td>SOIC</td>
<td>DW</td>
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<td>2000</td>
<td>RoHS &amp; Green</td>
<td>NIPDAU</td>
<td>Level-1-260C-UNLIM</td>
<td>-40 to 125</td>
<td>TPIC6595</td>
<td>Samples</td>
</tr>
<tr>
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<td>PDIP</td>
<td>N</td>
<td>20</td>
<td>20</td>
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<td>N / A for Pkg Type</td>
<td>-40 to 125</td>
<td>TPIC6595N</td>
<td>Samples</td>
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</tr>
</tbody>
</table>

(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) RoHS: TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
- **RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
- **Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.
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TAPE AND REEL INFORMATION

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<thead>
<tr>
<th>Device</th>
<th>Package Type</th>
<th>Pin Assignments</th>
<th>Pins</th>
<th>SPQ</th>
<th>Reel Diameter (mm)</th>
<th>Reel Width W1 (mm)</th>
<th>A0 (mm)</th>
<th>B0 (mm)</th>
<th>K0 (mm)</th>
<th>P1 (mm)</th>
<th>W (mm)</th>
<th>Pin1 Quadrant</th>
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<td>TPIC6595DWR</td>
<td>SOIC</td>
<td>Q1 Q2 Q3 Q4</td>
<td>20</td>
<td>2000</td>
<td>330.0</td>
<td>24.4</td>
<td>10.8</td>
<td>13.3</td>
<td>2.7</td>
<td>12.0</td>
<td>24.0</td>
<td>Q1</td>
</tr>
<tr>
<td>TPIC6595DWRG4</td>
<td>SOIC</td>
<td>Q1 Q2 Q3 Q4</td>
<td>20</td>
<td>2000</td>
<td>330.0</td>
<td>24.4</td>
<td>10.8</td>
<td>13.3</td>
<td>2.7</td>
<td>12.0</td>
<td>24.0</td>
<td>Q1</td>
</tr>
</tbody>
</table>

*All dimensions are nominal.

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[www.ti.com](http://www.ti.com) 5-Jul-2019
**TAPE AND REEL BOX DIMENSIONS**

*All dimensions are nominal*

<table>
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<tr>
<th>Device</th>
<th>Package Type</th>
<th>Package Drawing</th>
<th>Pins</th>
<th>SPQ</th>
<th>Length (mm)</th>
<th>Width (mm)</th>
<th>Height (mm)</th>
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</thead>
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<td>DW</td>
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<td>2000</td>
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<td>350.0</td>
<td>43.0</td>
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N (R–PDIP–T**)  PLASTIC DUAL–IN–LINE PACKAGE

16 PINS SHOWN

<table>
<thead>
<tr>
<th>PIN</th>
<th>DIM</th>
<th>14</th>
<th>16</th>
<th>18</th>
<th>20</th>
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<tbody>
<tr>
<td>A MAX</td>
<td>0.775 (19.69)</td>
<td>0.775 (19.69)</td>
<td>0.920 (23.37)</td>
<td>1.060 (26.92)</td>
<td></td>
</tr>
<tr>
<td>A MIN</td>
<td>0.745 (18.92)</td>
<td>0.745 (18.92)</td>
<td>0.850 (21.59)</td>
<td>0.940 (23.88)</td>
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</tr>
</tbody>
</table>

MS–001 VARIATION: AA, BB, AC, AD

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001, except 18 and 20 pin minimum body length (Dim A).
D. The 20 pin end lead shoulder width is a vendor option, either half or full width.
NOTES:

1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.43 mm per side.
5. Reference JEDEC registration MS-013.
NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.
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