description

The TPIC6B595 is a monolithic, high-voltage, medium-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. 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. 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 50 V and 150-mA continuous sink-current capability. Each output provides a 500-mA typical current limit at \( T_C = 25^\circ C \). The current limit decreases as the junction temperature increases for additional device protection.

The TPIC6B595 is characterized for operation over the operating case temperature range of \(-40^\circ C \) to \(125^\circ C \).
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) .................. 50 V
Continuous source-to-drain diode anode current ........................ 500 mA
Pulsed source-to-drain diode anode current (see Note 3) ................. 1 A
Pulsed drain current, each output, all outputs on, \( I_D, T_C = 25^\circ C \) (see Note 3) ................. 500 mA
Continuous drain current, each output, all outputs on, \( I_D, T_C = 25^\circ C \) .................. 150 mA
Peak drain current single output, \( I_{DM}, T_C = 25^\circ C \) (see Note 3) .......................... 500 mA
Single-pulse avalanche energy, \( E_{AS} \) (see Figure 4) ......................... 30 mJ
Avalanche current, \( I_{AS} \) (see Note 4) ........................................ 500 mA
Continuous total dissipation .................................................. See Dissipation Rating Table
Operating virtual junction temperature range, \( T_J \) ...................... \(-40^\circ C \) to 150°C
Operating case temperature range, \( T_C \) .................................. \(-40^\circ C \) to 125°C
Storage temperature range ................................................. \(-65^\circ C \) to 150°C
Lead temperature 1.6 mm (1/16 inch) from case for 10 seconds ........ 260°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.
2. Each power DMOS source is internally connected to GND.
3. Pulse duration \( \leq 100 \mu s \) and duty cycle \( \leq 2\% \).
4. DRAIN supply voltage = 15 V, starting junction temperature \( (T_{JS}) = 25^\circ C \), \( L = 200 \) mH, \( I_{AS} = 0.5 \) A (see Figure 4).

DISSIPATION RATING TABLE

<table>
<thead>
<tr>
<th>PACKAGE</th>
<th>( T_C \leq 25^\circ C ) POWER RATING</th>
<th>DERATING FACTOR ABOVE ( T_C = 25^\circ C )</th>
<th>( T_C = 125^\circ C ) POWER RATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>DW</td>
<td>1389 mW</td>
<td>11.1 mW/°C</td>
<td>278 mW</td>
</tr>
<tr>
<td>N</td>
<td>1050 mW</td>
<td>10.5 mW/°C</td>
<td>263 mW</td>
</tr>
</tbody>
</table>
### recommended operating conditions

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>MIN</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logic supply voltage, $V_{CC}$</td>
<td>4.5</td>
<td>5.5</td>
<td>V</td>
</tr>
<tr>
<td>High-level input voltage, $V_{IH}$</td>
<td>0.85 $V_{CC}$</td>
<td>0.85 $V_{CC}$</td>
<td>V</td>
</tr>
<tr>
<td>Low-level input voltage, $V_{IL}$</td>
<td>0.15 $V_{CC}$</td>
<td>0.15 $V_{CC}$</td>
<td>V</td>
</tr>
<tr>
<td>Pulsed drain output current, $T_C = 25^\circ C$, $V_{CC} = 5$ V (see Notes 3 and 5)</td>
<td>$-500$</td>
<td>$500$</td>
<td>mA</td>
</tr>
<tr>
<td>Setup time, SER IN high before SRCK↑, $t_{SU}$ (see Figure 2)</td>
<td>20</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Hold time, SER IN high after SRCK↑, $t_{H}$ (see Figure 2)</td>
<td>20</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Pulse duration, $t_{W}$ (see Figure 2)</td>
<td>40</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Operating case temperature, $T_C$</td>
<td>$-40$</td>
<td>$125$</td>
<td>°C</td>
</tr>
</tbody>
</table>

### 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>$V_{(BR)}DSX$  Drain-to-source breakdown voltage</td>
<td>$I_D = 1$ mA</td>
<td>50</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{SD}$  Source-to-drain forward voltage</td>
<td>$I_F = 100$ mA</td>
<td>0.85</td>
<td>1</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{OH}$  High-level output voltage, SER OUT</td>
<td>$I_{OH} = -20$ μA, $V_{CC} = 4.5$ V</td>
<td>4.4</td>
<td>4.49</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{OL}$  Low-level output voltage, SER OUT</td>
<td>$I_{OL} = 20$ μA, $V_{CC} = 4.5$ V</td>
<td>0.005</td>
<td>0.1</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$I_{IH}$  High-level input current</td>
<td>$V_{CC} = 5.5$ V, $V_I = V_{CC}$</td>
<td>1</td>
<td></td>
<td>μA</td>
<td></td>
</tr>
<tr>
<td>$I_{IL}$  Low-level input current</td>
<td>$V_{CC} = 5.5$ V, $V_I = 0$</td>
<td>-1</td>
<td></td>
<td>μA</td>
<td></td>
</tr>
<tr>
<td>$I_{CC}$  Logic supply current</td>
<td>$V_{CC} = 5.5$ V</td>
<td>20</td>
<td>100</td>
<td>μA</td>
<td></td>
</tr>
<tr>
<td>$I_{CC(FRQ)}$  Logic supply current at frequency</td>
<td>$I_{SRCK} = 5$ MHz, $C_L = 30$ pF, All outputs off, See Figures 2 and 6</td>
<td>0.4</td>
<td>5</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>$I_{IN}$  Nominal current</td>
<td>$V_{DS(on)} = 0.5$ V, $I_N = I_D$, $T_C = 85^\circ C$</td>
<td>90</td>
<td></td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>$I_{DSX}$  Off-state drain current</td>
<td>$V_{DS} = 40$ V, $V_{CC} = 5.5$ V</td>
<td>0.15</td>
<td>5</td>
<td>μA</td>
<td></td>
</tr>
<tr>
<td>$r_{DS(on)}$  Static drain-source on-state resistance</td>
<td>$I_D = 100$ mA, $V_{CC} = 4.5$ V</td>
<td>4.2</td>
<td>5.7</td>
<td>Ω</td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**

3. Pulse duration ≤ 100 μs and 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 $T_C = 85^\circ C$. 
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>150</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{PHL}$</td>
<td>Propagation delay time, high-to-low-level output from G</td>
<td>90</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_r$</td>
<td>Rise time, drain output</td>
<td>200</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_f$</td>
<td>Fall time, drain output</td>
<td>200</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{a}$</td>
<td>Reverse-recovery-current rise time</td>
<td>100</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{rr}$</td>
<td>Reverse-recovery time</td>
<td>300</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTES: 5. Technique should limit $T_J - T_C$ to $10^\circ C$ maximum.
6. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts.

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>$R_{q,JA}$</td>
<td>Thermal resistance, junction-to-ambient</td>
<td></td>
<td>90</td>
<td>°C/W</td>
</tr>
<tr>
<td></td>
<td>DW package</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>N package</td>
<td></td>
<td>95</td>
<td>°C/W</td>
</tr>
<tr>
<td></td>
<td>All 8 outputs with equal power</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PARAMETER MEASUREMENT INFORMATION

NOTES: A. The word generator has the following characteristics: $t_r \leq 10\, ns$, $t_f \leq 10\, ns$, $t_w = 300\, ns$, pulsed repetition rate (PRR) = $5\, kHz$, $Z_O = 50\, \Omega$.
B. $C_L$ includes probe and jig capacitance.

Figure 1. Resistive-Load Test Circuit and Voltage Waveforms
PARAMETER MEASUREMENT INFORMATION

NOTES: A. The word generator has the following characteristics: $t_r \leq 10$ ns, $t_f \leq 10$ ns, $t_w = 300$ ns, pulsed repetition rate (PRR) = 5 kHz, $Z_O = 50 \, \Omega$.
B. $C_L$ includes probe and jig capacitance.

Figure 2. Test Circuit, Switching Times, and Voltage Waveforms

NOTES: A. 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.
B. The $V_{GG}$ amplitude and $R_G$ are adjusted for $di/dt = 20$ A/µs. A $V_{GG}$ double-pulse train is used to set $I_F = 0.1$ A, where $t_1 = 10$ µs, $t_2 = 7$ µs, and $t_3 = 3$ µs.

Figure 3. Reverse-Recovery-Current Test Circuit and Waveforms of Source-to-Drain Diode
PARAMETER MEASUREMENT INFORMATION

SINGLE-PULSE AVALANCHE ENERGY TEST CIRCUIT

VOLTAGE AND CURRENT WAVEFORMS

NOTES:
A. The word generator has the following characteristics: \( t_r \leq 10 \text{ ns} \), \( t_f \leq 10 \text{ ns} \), \( Z_O = 50 \text{ \( \Omega \)} \).
B. Input pulse duration, \( t_w \), is increased until peak current \( I_{AS} = 0.5 \text{ \( A \)} \).
Energy test level is defined as \( E_{AS} = I_{AS} \times V_{(BR)DSX} \times t_{av}/2 = 30 \text{ \( mJ \)} \).

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

TYPICAL CHARACTERISTICS

PEAK AVALANCHE CURRENT vs TIME DURATION OF AVALANCHE

SUPPLY CURRENT vs FREQUENCY

Figure 5

Figure 6
TYPICAL CHARACTERISTICS

DRAIN-TO-SOURCE ON-STATE RESISTANCE
VS DRAIN CURRENT

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

$T_C = 125^\circ C$

$T_C = 25^\circ C$

$T_C = -40^\circ C$

Figure 7

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

$ID = 100 \text{ mA}$
See Note A

$T_C = 125^\circ C$

$T_C = 25^\circ C$

$T_C = -40^\circ C$

Figure 8

SWITCHING TIME
VS CASE TEMPERATURE

$ID = 100 \text{ mA}$
See Note A

$T_F$

$t_{PHL}$

$t_{PLH}$

$50 -25 0 25 50 75 100 125$

$t_{PHL}$

$t_{PLH}$

$t_F$

$t_PHL$

$t_{PLH}$

Figure 9

NOTE C: Technique should limit $T_J - T_C$ to 10°C maximum.
THERMAL INFORMATION

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

\[ I_D \] – Maximum Continuous Drain Current of Each Output – A

\[ V_{CC} = 5 \text{ V} \]

\[ T_C = 25^\circ \text{C} \]

\[ T_C = 100^\circ \text{C} \]

\[ T_C = 125^\circ \text{C} \]

\[ N \] – Number of Outputs Conducting Simultaneously

Figure 10

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

\[ I_D \] – Maximum Peak Drain Current of Each Output – A

\[ V_{CC} = 5 \text{ V} \]

\[ T_C = 25^\circ \text{C} \]

\[ d = 10\% \]

\[ d = 20\% \]

\[ d = 50\% \]

\[ d = 80\% \]

\[ d = \frac{t_w}{t_{period}} = 1 \text{ ms}/t_{period} \]

\[ N \] – Number of Outputs Conducting Simultaneously

Figure 11
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