

TPIC6A595 Power Logic 8-Bit Shift Register

1 Features

- Low $r_{DS(on)}$: 1Ω (Typical)
- Output short-circuit protection
- Avalanche energy: 75mJ
- Eight 350mA DMOS outputs
- 50V switching capability
- Devices are cascadable
- Low power consumption

2 Applications

- Instrumentation Clusters
- Tell-Tale Lamps
- LED Illumination and Controls
- Automotive Relay or Solenoids Drivers

3 Description

The TPIC6A595 is a monolithic, high-voltage, high-current power logic 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. Each open-drain DMOS transistor features an independent chopping current-limiting circuit to prevent damage in the case of a short circuit.

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. Write data and read data are valid only when RCK is low. When SRCLR is low, the input shift register is cleared. When output enable (\bar{G}) is held high, all data in the output buffers is held low and all drain outputs are off. When \bar{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.

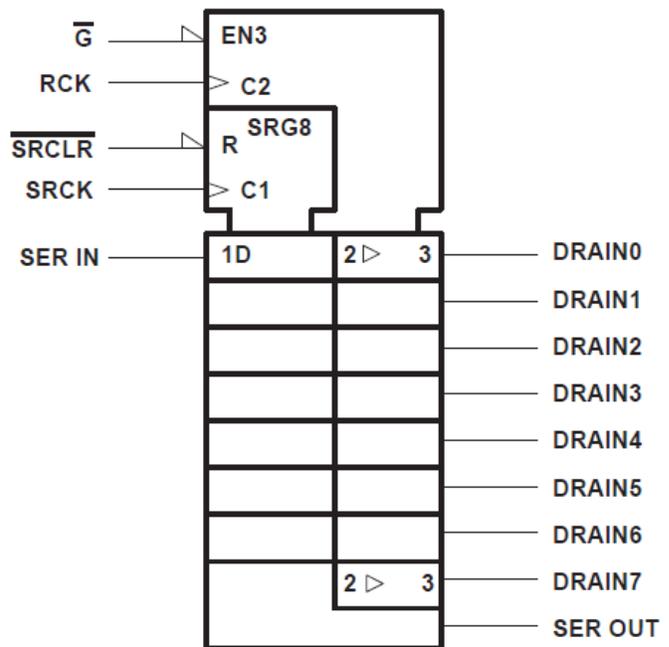
Outputs are low-side, open-drain DMOS transistors with output ratings of 50V and a 350mA continuous sink-current capability. When data in the output buffers is low, the DMOS-transistor outputs are off. When data is high, the DMOS-transistor outputs have sink current capability.

Separate power ground (PGND) and logic ground (LGND) terminals are provided to facilitate maximum system flexibility. All PGND terminals are internally connected, and each PGND terminal must be externally connected to power system ground in order to minimize parasitic impedance. A single-point connection between LGND and PGND must be made externally in a manner that reduces crosstalk between the logic and load circuits.

The TPIC6A595 is offered in a thermally-enhanced due-in-line (NE) package and a wide-body surface-mount (DW) package. The TPIC6A595 is characterized for operating over the operating case temperature range of -40 to 125°C.

Table 3-1. Device Information

PART NUMBER	PACKAGE	BODY SIZE(NOM)
TPIC6A595	PDIP(20)	24.00mm × 6.86mm
	SOIC(24)	15.40mm × 7.50mm



This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

Logic Symbol



Table of Contents

1 Features	1	7.2 Functional Block Diagram.....	12
2 Applications	1	7.3 Feature description.....	13
3 Description	1	8 Device Functional Modes	14
4 Pin Configuration and Functions	2	8.1 Operating with $V_{CC} < 4.5V$	14
5 Specifications	4	8.2 Operating with $5.5V < V_{CC} \leq 7V$	14
5.1 Absolute Maximum Ratings	4	9 Device and Documentation Support	15
5.2 Dissipation Rating Table	4	9.1 Documentation Support.....	15
5.3 Recommended Operating Conditions.....	4	9.2 Receiving Notification of Documentation Updates....	15
5.4 Electrical Characteristics.....	5	9.3 Support Resources.....	15
5.5 Switching Characteristics	6	9.4 Trademarks.....	15
5.6 Thermal Resistance.....	6	9.5 Electrostatic Discharge Caution.....	15
5.7 Typical Characteristics.....	6	9.6 Glossary.....	15
6 Parameter Measurement Information	8	10 Revision History	15
7 Detailed Description	12	11 Mechanical, Packaging, and Orderable Information	15
7.1 Overview.....	12		

4 Pin Configuration and Functions

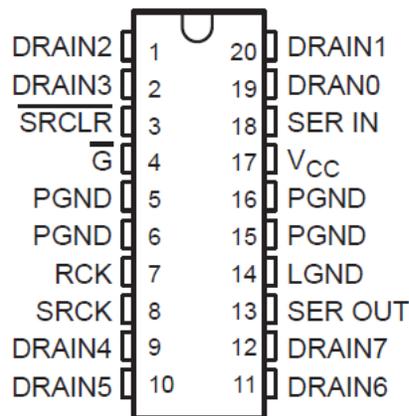


Figure 4-1. NE package 20-Pin PDIP Top View

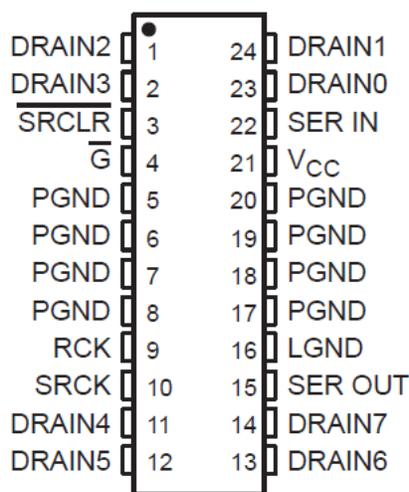


Figure 4-2. DW package 24-Pin SOIC Top View

Pin Function
Table 4-1. PDIP Pin Function

PIN		I/O	DESCRIPTION
Name	NO.		
DRAIN0	19	O	Open-drain output
DRAIN1	20		
DRAIN2	1		
DRAIN3	2		
DRAIN4	9		
DRAIN5	10		
DRAIN6	11		
DRAIN7	12		
\bar{G}	4	I	Output enable, active-low
PGND	5, 6, 15, 16	-	Power ground
LGND	14	-	Line ground
RCK	7	I	Register clock
SERIN	18	I	Serial data input
SEROUT	13	O	Serial data output
SRCK	8	I	Shift register clock
SRCLR	3	I	Shift register clear, active-low
VCC	17	I	Power supply

Table 4-2. SOIC Pin Function

PIN		I/O	DESCRIPTION
Name	NO.		
DRAIN0	23	O	Open-drain output
DRAIN1	24		
DRAIN2	1		
DRAIN3	2		
DRAIN4	11		
DRAIN5	12		
DRAIN6	13		
DRAIN7	14		
\bar{G}	4	I	Output enable, active-low
PGND	5, 6, 7, 8, 17, 18, 19, 20	-	Power ground
LGND	16	-	Line ground
RCK	9	I	Register clock
SERIN	22	I	Serial data input
SEROUT	15	O	Serial data output
SRCK	10	I	Shift register clock
SRCLR	3	I	Shift register clear, active-low
VCC	21	I	Power supply

5 Specifications

5.1 Absolute Maximum Ratings

over recommended operating case temperature range (unless otherwise noted)⁽¹⁾

		MIN	MAX	UNIT
V _{CC}	Logic supply voltage ⁽²⁾		7	V
V _I	Logic input voltage range	-0.3	7	V
V _{DS}	Power DMOS drain-to-source voltage ⁽³⁾		50	V
	Continuous source-drain diode anode current		1	A
	Pulsed source-drain diode anode current ⁽⁴⁾		2	A
I _{DN}	Pulsed drain current, each output, all outputs on ⁽⁴⁾	T _A = 25°C	1.1	A
I _{DN}	Continuous drain current, each output, all outputs on	T _A = 25°C	350	A
	Peak drain current, single output ⁽⁴⁾	T _A = 25°C	1.1	A
E _{AS}	Single-pulse avalanche energy (see Figure 6-6)		75	mJ
I _{AS}	Avalanche current ⁽⁵⁾		600	mA
	Continuous total dissipation	See Section 5.2		
T _C	Operating case temperature range	-40	125	°C
T _J	Operating virtual junction temperature range	-40	150	°C
T _{stg}	Storage temperature range	-65	150	°C
	Lead temperature 1,6mm (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.
- All voltage values are with respect to LGND and PGND.
- Each power DMOS source is internally connected to PGND.
- Pulse duration ≤ 100µs and duty cycle ≤ 2%.
- DRAIN supply voltage = 15V, starting junction temperature (T_{JS}) = 25°C, L = 210mH, I_{AS} = 600mA (see Figure 6-6).

5.2 Dissipation Rating Table

PACKAGE	T _C ≤ 25°C POWER RATING	DERATING FACTOR ABOVE T _C = 25°C	T _C = 125°C POWER RATING
DW	1750mW	14mW/°C	350mW
NE	2500mW	20mW/°C	500mW

5.3 Recommended Operating Conditions

		MIN	MAX	UNIT
V _{CC}	Logic supply voltage	4.5	5.5	V
V _{IH}	High-level input voltage	0.85 V _{CC}	V _{CC}	V
V _{IL}	Low-level input voltage	0	0.15 V _{CC}	V
	Pulsed drain output current, T _C = 25°C, V _{CC} = 5V ^{(1) (2)}	-1.8	0.6	A
t _{su}	Setup time, SER IN high before SRCK↑ (see Figure 6-2)	10		ns
t _h	Hold time, SER IN high after SRCK↑ (see Figure 6-2)	10		ns
t _w	Pulse duration (see Figure 6-2)	20		ns
T _C	Operating case temperature	-40	125	°C

- Pulse duration ≤ 100µs and duty cycle ≤ 2%.
- Technique should limit T_J - T_C to 10°C maximum.

5.4 Electrical Characteristics

$V_{CC} = 5\text{ V}$, $T_C = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT	
$V_{(BR)DSX}$	Drain-to-source breakdown voltage	$I_D = 1\text{ mA}$		50			V	
V_{SD}	Source-to-drain diode forward voltage	$I_F = 350\text{ mA}$	See ⁽¹⁾		0.8	1.1	V	
V_{OH}	High-level output voltage, SER OUT	$I_{OH} = -20\mu\text{A}$		$V_{CC} - 0.1$	V_{CC}		V	
		$I_{OH} = -4\text{ mA}$		$V_{CC} - 0.5$	$V_{CC} - 0.2$			
V_{OL}	Low-level output voltage, SER OUT	$I_{OL} = 20\mu\text{A}$			0	0.1	V	
		$I_{OL} = 4\text{ mA}$			0.2	0.5		
I_{IH}	High-level input current	$V_I = V_{CC}$				1	μA	
I_{IL}	Low-level input current	$V_I = 0$				-1	μA	
$I_{O(chop)}$	Output current at which chopping starts	$T_C = 25^\circ\text{C}$, See Figure 6-3 and Figure 6-4 ⁽²⁾		0.6	0.8	1.1	A	
I_{CC}	Logic supply current	$I_O = 0$	$V_I = V_{CC}$ or 0		0.5	5	mA	
$I_{CC(FRQ)}$	Logic supply current at frequency	$f_{SRCK} = 5\text{ MHz}$, $V_I = V_{CC}$ or 0	$I_O = 0$, $V_{CC} = 5\text{ V}$	$C_L = 30\text{ pF}$, See Figure 5-1		1.3	mA	
$I_{(nom)}$	Nominal current	$V_{DS(on)} = 0.5\text{ V}$, $V_{CC} = 5\text{ V}$	$I_{(nom)} = I_D$ See ⁽²⁾ ⁽³⁾ ⁽⁴⁾	$T_C = 85^\circ\text{C}$		350	mA	
I_D	Drain current, off-state	$V_{DS} = 40\text{ V}$	$T_C = 25^\circ\text{C}$			0.1	1	μA
		$V_{DS} = 40\text{ V}$	$T_C = 125^\circ\text{C}$			0.2	5	
$r_{DS(on)}$	Static drain-source on-state resistance	$I_D = 350\text{ mA}$	$T_C = 25^\circ\text{C}$	See Figure 5-4 and Figure 5-5 ⁽²⁾ ⁽³⁾		1	1.5	Ω
		$I_D = 350\text{ mA}$	$T_C = 125^\circ\text{C}$			1.7	2.5	
		$I_D = 350\text{ mA}$	$T_C = 40^\circ\text{C}$					

- (1) Pulse duration $\leq 100\mu\text{s}$ and duty cycle $\leq 2\%$
- (2) Technique should limit $T_J - T_C$ to 10°C maximum.
- (3) These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts.
- (4) 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 $T_C = 85^\circ\text{C}$.

5.5 Switching Characteristics

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

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
t_{PHL}	Propagation delay time, high-to-low-level output from \bar{G}	$C_L = 30pF$	$I_D = 350mA$		30		ns
t_{PLH}	Propagation delay time, low-to-high-level output from \bar{G}	See Figure 6-1, Figure 6-2, and Figure 5-6			125		ns
t_r	Rise time, drain output				60		ns
t_f	Fall time, drain output				30		ns
t_a	Reverse-recovery-current rise time	$I_F = 350mA$	$di/dt = 20A/\mu s$		100		ns
t_{rr}	Reverse-recovery time	See Figure 6-5 (1) (2)			300		ns

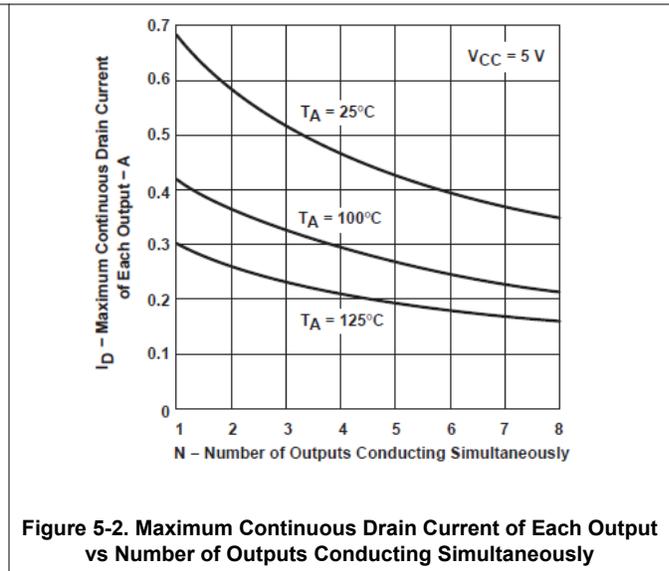
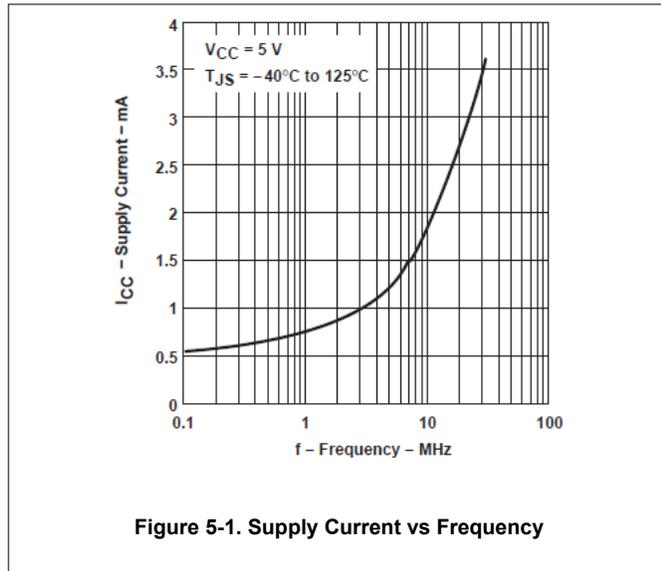
(1) Technique should limit $T_J - T_C$ to $10^\circ C$ maximum.

(2) These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts.

5.6 Thermal Resistance

PARAMETER		TEST CONDITIONS		MIN	MAX	UNIT
$R_{\theta JC}$	Thermal resistance, junction-to-case	DW	All eight outputs with equal power		10	$^\circ C/W$
		NE		10		
$R_{\theta JA}$	Thermal resistance, junction-to-ambient	DW	All eight outputs with equal power		50	$^\circ C/W$
		NE		50		

5.7 Typical Characteristics



5.7 Typical Characteristics (continued)

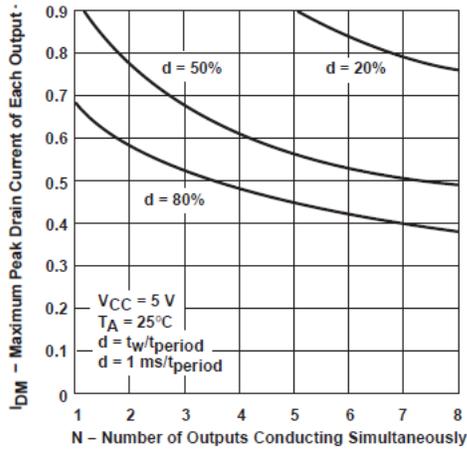


Figure 5-3. Maximum Peak Drain Current of Each Output vs Number of Outputs Conducting Simultaneously

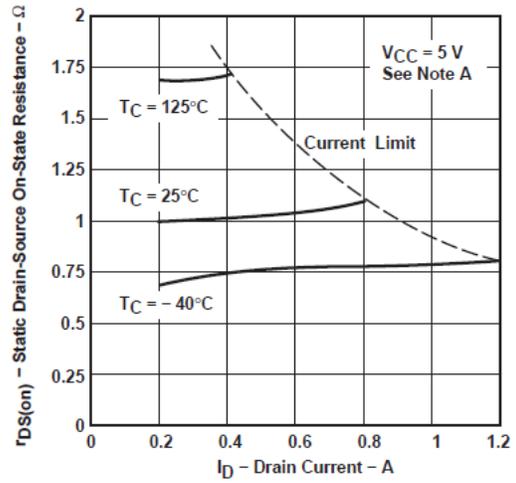


Figure 5-4. Static Drain-Source On-State Resistance vs Drain Current

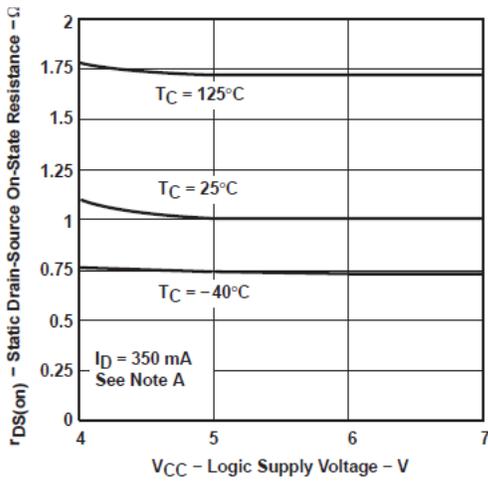


Figure 5-5. Static Drain-Source On-State Resistance vs Logic Supply Voltage

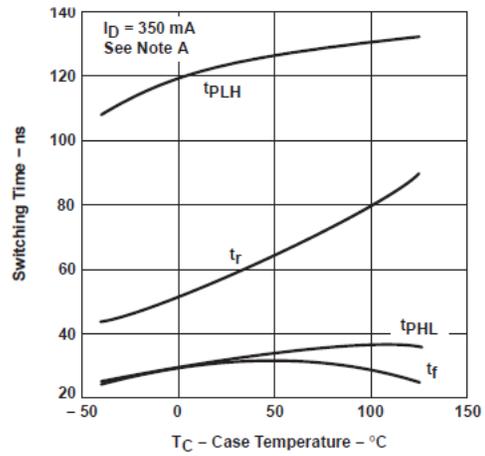
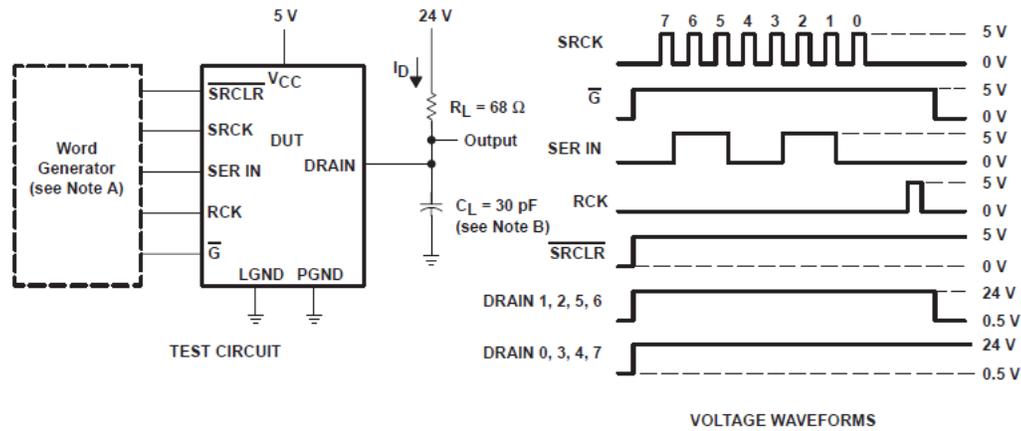


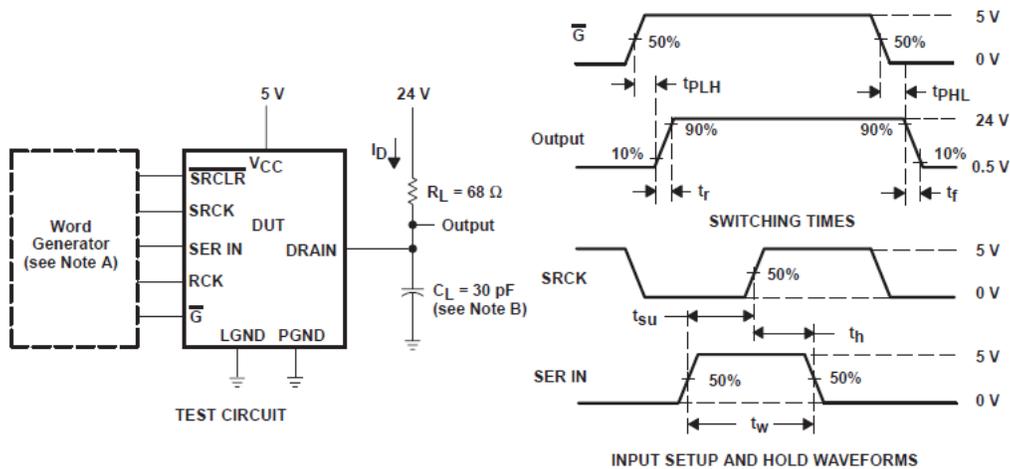
Figure 5-6. Switching Time vs Case Temperature

6 Parameter Measurement Information



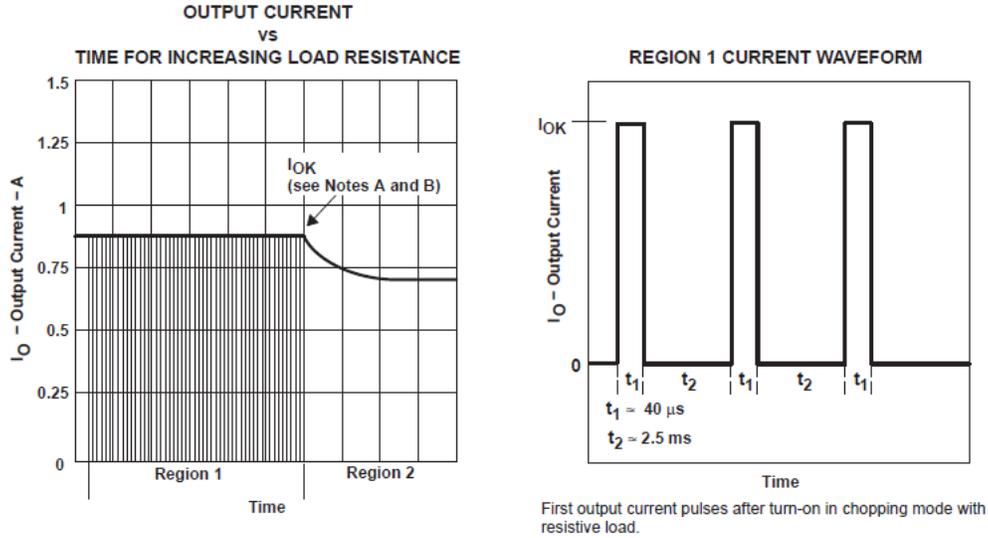
- A. The word generator has the following characteristics: $t_r \leq 10\text{ns}$, $t_f \leq 10\text{ns}$, $t_w = 300\text{ns}$, pulsed repetition rate (PRR) = 5kHz, $Z_O = 50\Omega$.
- B. C_L includes probe and jig capacitance.
- C. Write data and read data are valid only when RCK is low

Figure 6-1. Resistive Load Operation



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

Figure 6-2. Test Circuit, Switching Times, and Voltage Waveforms



- A. Figure 6-4 illustrates the output current characteristics of the device energizing a load having initially low, increasing resistance, for example, an incandescent lamp. In region 1, chopping occurs and the peak current is limited to I_{OK} . In region 2, output current is continuous. The same characteristics occur in reverse order when the device energizes a load having an initially high, decreasing resistance.
- B. Region 1 duty cycle is approximately 2%.

Figure 6-3. Chopping-Mode Characteristics

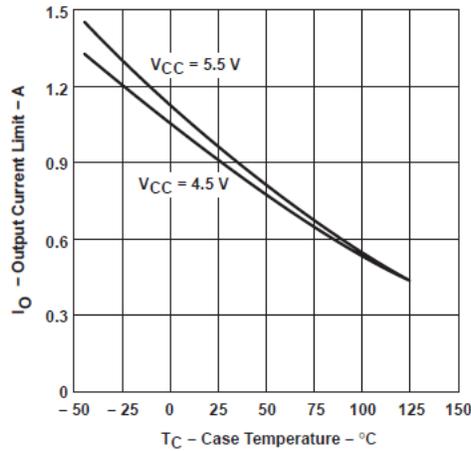
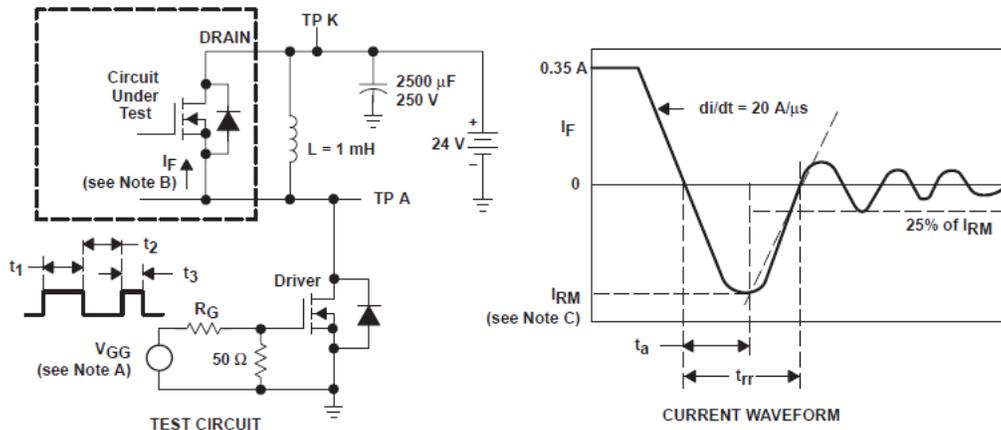
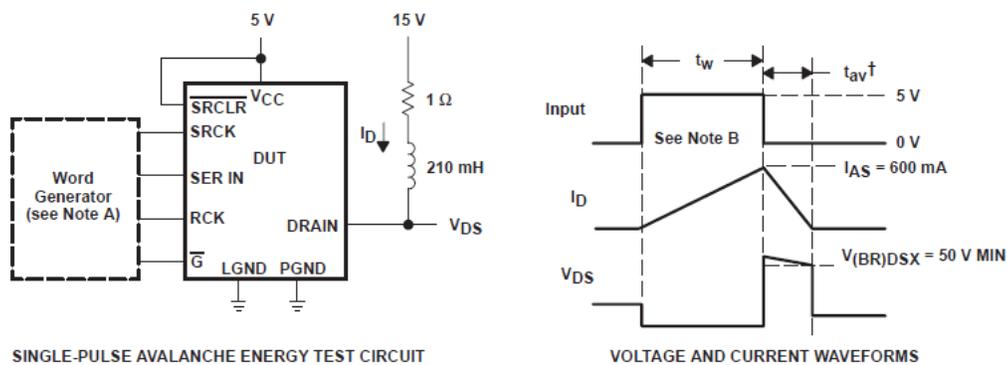


Figure 6-4. Output Current Limit vs Case Temperature



- A. The V_{GG} amplitude and R_G are adjusted for $di/dt = 20A/\mu s$. A V_{GG} double-pulse train is used to set $I_F = 0.35A$, 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.
- C. I_{RM} = maximum recovery current.

Figure 6-5. Reverse-Recovery-Current Test Circuit and Waveforms of Source-Drain Diode



- A. † Non-JEDEC symbol for avalanche time.
- B. The word generator has the following characteristics: $t_r \leq 10ns$, $t_f \leq 10ns$, $Z_O = 50\Omega$.
- C. Input pulse duration, t_w , is increased until peak current $I_{AS} = 600mA$. Energy test level is defined as $E_{AS} = (I_{AS} \times V_{(BR)DSX} \times t_{av})/2 = 75mJ$.

Figure 6-6. Single-Pulse Avalanche Energy Test Circuit and Waveforms

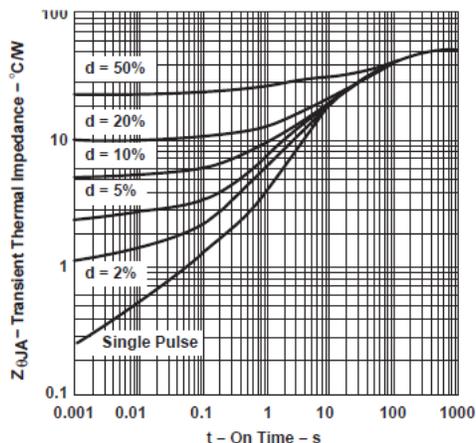


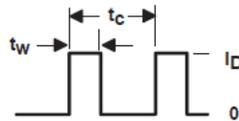
Figure 6-7. NE Package Transient Thermal Impedance vs On Time

The single-pulse curve represents measured data. The curves for various pulse durations are based on the following equation:

$$Z_{\theta JA} = \left| \frac{t_w}{t_c} \right| R_{\theta JA} + \left| 1 - \frac{t_w}{t_c} \right| Z_{\theta}(t_w + t_c) + Z_{\theta}(t_w) - Z_{\theta}(t_c) \tag{1}$$

where:

- $Z_{\theta}(t_w)$ = the single-pulse thermal impedance for $t = t_w$ seconds
- $Z_{\theta}(t_c)$ = the single-pulse thermal impedance for $t = t_c$ seconds
- $Z_{\theta}(t_w+t_c)$ = the single-pulse thermal impedance for $t = t_w + t_c$ seconds
- $d = t_w/t_c$

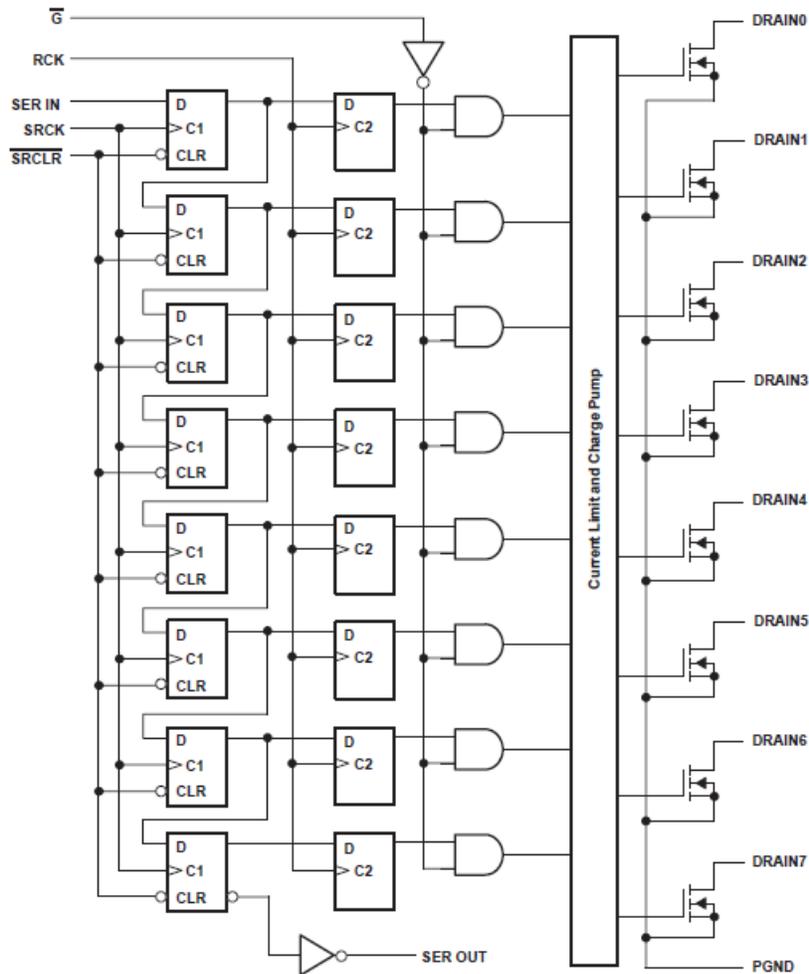


7 Detailed Description

7.1 Overview

The TPIC6A595 device 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, so it can also drive relays, solenoids, and other medium-current or high-voltage loads.

7.2 Functional Block Diagram



Functional Block Diagram

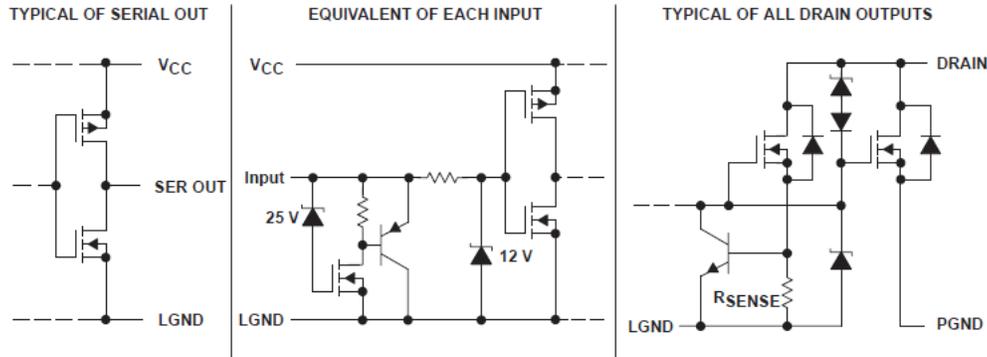


Figure 7-1. Functional Block Diagram (continued)

7.3 Feature description

7.3.1 Serial-In Interface

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. Write data and read data are valid only when RCK is low. The storage register transfers data to the output buffer when shift register clear ($\overline{\text{SRCLR}}$) is high.

7.3.2 Clear Register

A logical low on ($\overline{\text{SRCLR}}$) clears all registers in the device. TI suggests clearing the device during power up or initialization.

7.3.3 Output Control

Holding the output enable ($\overline{\text{G}}$) high holds all data in the output buffers low, and all drain outputs are off. Holding ($\overline{\text{G}}$) low makes data from the storage register 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. This pin can also be used for global PWM dimming.

7.3.4 Cascaded Application

The serial output (SER OUT) allows for cascading of the data from the shift register to additional devices. Connect the device (SER OUT) pin to the next device (SER IN) for daisy Chain.

7.3.5 Current Limit Function

Outputs are low-side, open-drain DMOS transistors with output ratings of 50V and a 350mA continuous sink current capability. Each open-drain DMOS transistor features an independent chopping current-limiting circuit to prevent damage in the case of a short circuit.

8 Device Functional Modes

8.1 Operating with $V_{CC} < 4.5V$

This device works normally during $4.5V \leq V_{CC} \leq 5.5V$, when operation voltage is lower than 4.5V, correct behavior of the device, including communication interface and current capability, is not assured.

8.2 Operating with $5.5V < V_{CC} \leq 7V$

The device works normally in this voltage range, but reliability issues can occur if the device works for a long time in this voltage range.

9 Device and Documentation Support

TI offers an extensive line of development tools. Tools and software to evaluate the performance of the device, generate code, and develop solutions are listed below.

9.1 Documentation Support

9.1.1 Related Documentation

9.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Notifications* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

9.3 Support Resources

[TI E2E™ support forums](#) are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

9.4 Trademarks

TI E2E™ is a trademark of Texas Instruments.
All trademarks are the property of their respective owners.

9.5 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

9.6 Glossary

[TI Glossary](#) This glossary lists and explains terms, acronyms, and definitions.

10 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision B (May 2005) to Revision C (March 2025)	Page
• Added Applications.....	1

Changes from Revision A (January 1995) to Revision B (May 2005)	Page
• Changed \overline{SRCLR} timing diagram and changed title on Drain timing diagrams on Figure 6-1	8

11 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
TPIC6A595DW	Obsolete	Production	SOIC (DW) 24	-	-	Call TI	Call TI	-40 to 125	TPIC6A595
TPIC6A595DWG4	Obsolete	Production	SOIC (DW) 24	-	-	Call TI	Call TI	-40 to 125	TPIC6A595
TPIC6A595DWR	Active	Production	SOIC (DW) 24	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	TPIC6A595
TPIC6A595DWR.A	Active	Production	SOIC (DW) 24	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	TPIC6A595
TPIC6A595NE	Active	Production	PDIP (NE) 20	20 TUBE	Yes	NIPDAU	N/A for Pkg Type	-40 to 125	TPIC6A595NE
TPIC6A595NE.A	Active	Production	PDIP (NE) 20	20 TUBE	Yes	NIPDAU	N/A for Pkg Type	-40 to 125	TPIC6A595NE

(1) **Status:** For more details on status, see our [product life cycle](#).

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

(4) **Lead finish/Ball material:** Parts 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.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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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
TPIC6A595DWR	SOIC	DW	24	2000	330.0	24.4	10.75	15.7	2.7	12.0	24.0	Q1
TPIC6A595DWR	SOIC	DW	24	2000	330.0	24.4	10.75	15.7	2.7	12.0	24.0	Q1

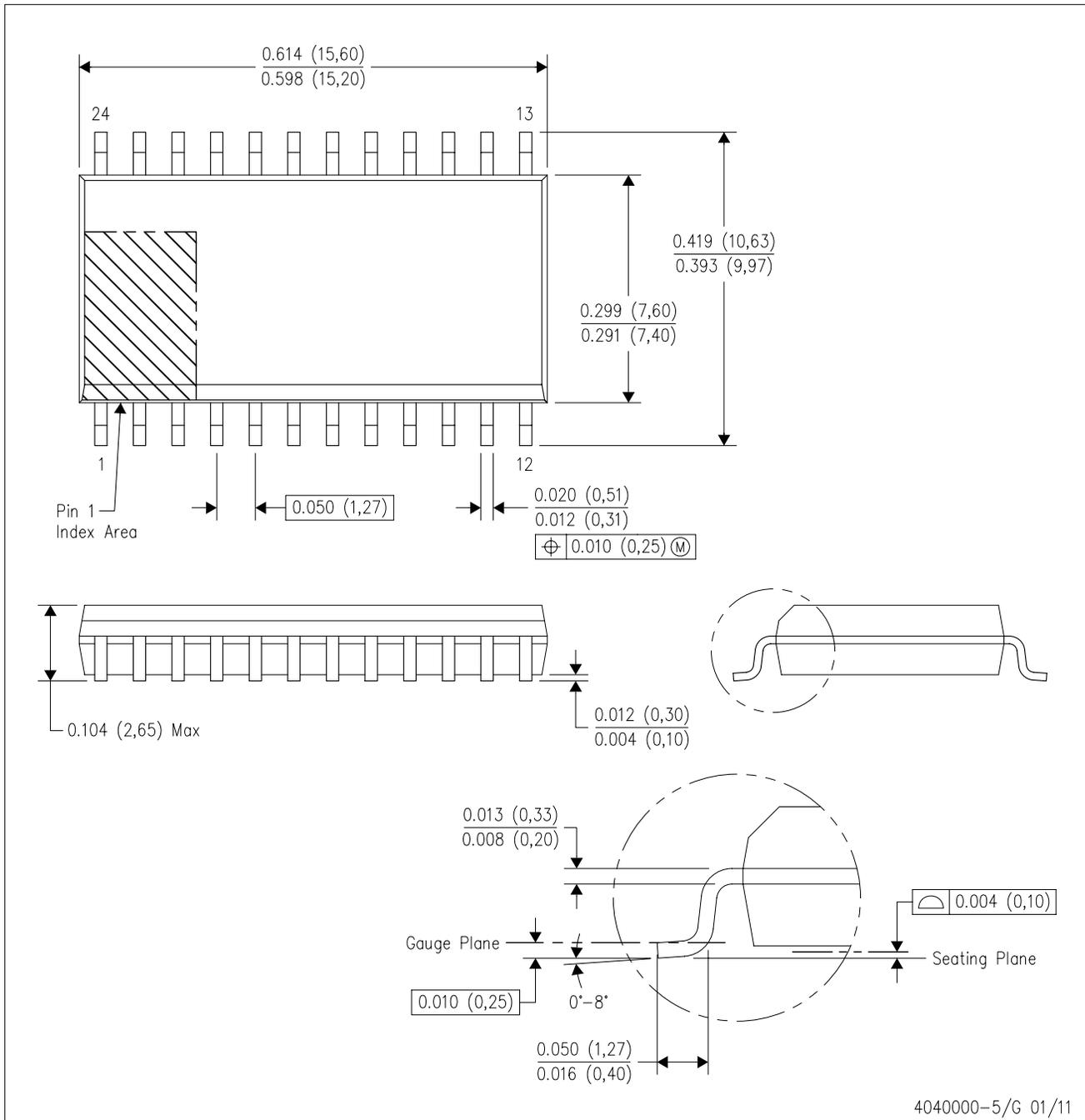
TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPIC6A595DWR	SOIC	DW	24	2000	350.0	350.0	43.0
TPIC6A595DWR	SOIC	DW	24	2000	350.0	350.0	43.0

DW (R-PDSO-G24)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters). Dimensioning and tolerancing per ASME Y14.5M-1994.
 - 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 MS-013 variation AD.

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