

# 8-Bit Shift Registers With 3-State Output

## 1 FEATURES

- **8-Bit Serial Input, Parallel Output Shift**
- **Serial Output (Q7S)**
- **Power-Supply Range: 4.5V to 5.5V**
- **Low Power Consumption: 160 $\mu$ A(Max)**
- **Low Input Current: 1 $\mu$ A(Max)**
- **Shift Register has Direct Clear**
- **Storage Register with 3-State Outputs**
- **Extended Temperature: -40°C to +125°C**

## 2 APPLICATIONS

- **Enterprise and Communications**
- **Industrial**
- **Personal Electronics**
- **LED Displays**
- **Servers**

## 3 DESCRIPTIONS

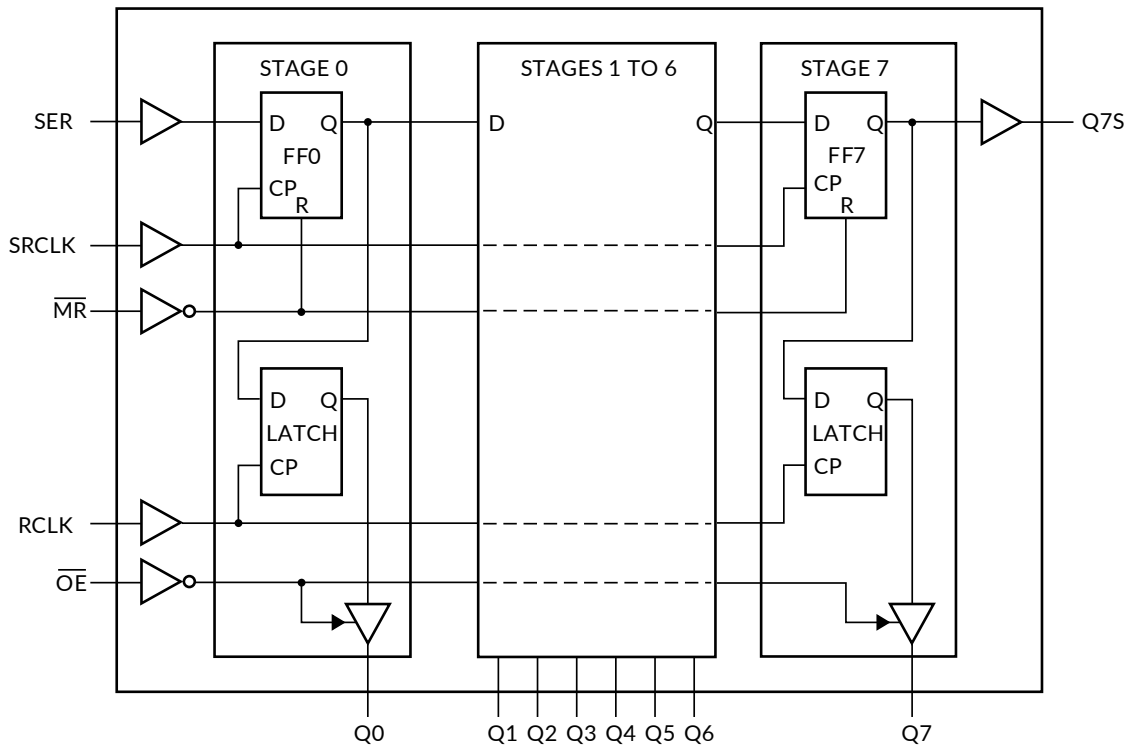
RS595T is an 8-bit serial-in/serial or parallel-out shift register with a storage register and 3-state outputs. Separate clocks are provided for both the shift register and storage register. The shift register has an asynchronous reset ( $\overline{MR}$ ) input, serial (SER) input, and serial outputs (Q7S) for cascading. A low on  $\overline{MR}$  will clear the shift register. Data is shifted on the LOW-to-HIGH transitions of the SRCLK input. The data in the shift register is transferred to the storage register on a LOW-to-HIGH transition of the RCLK input. If both clocks are connected together, the shift register will always be one clock pulse ahead of the storage register. Data in the storage register appears at the output whenever the output enable input ( $\overline{OE}$ ) is Low. A High on  $\overline{OE}$  causes the outputs to assume a high-impedance OFF-state. Operation of the  $\overline{OE}$  input does not affect the state of the registers.

**Device Information <sup>(1)</sup>**

PART NUMBER	PACKAGE	BODY SIZE (NOM)
RS595T	TSSOP16	5.00mm×4.40mm
	SOP16	9.90mm×3.90mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

## 4 FUNCTIONAL BLOCK DIAGRAM



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## 5 REVISION HISTORY

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

<b>VERSION</b>	<b>Change Date</b>	<b>Change Item</b>
A.1	2023/04/23	Initial version completed
A.2	2023/06/01	Add RS595TXS16 ORDERING NUMBER on Page 5@RevA.1
A.2.1	2024/02/29	Modify packaging naming
A.3	2024/04/28	Update PACKAGE note

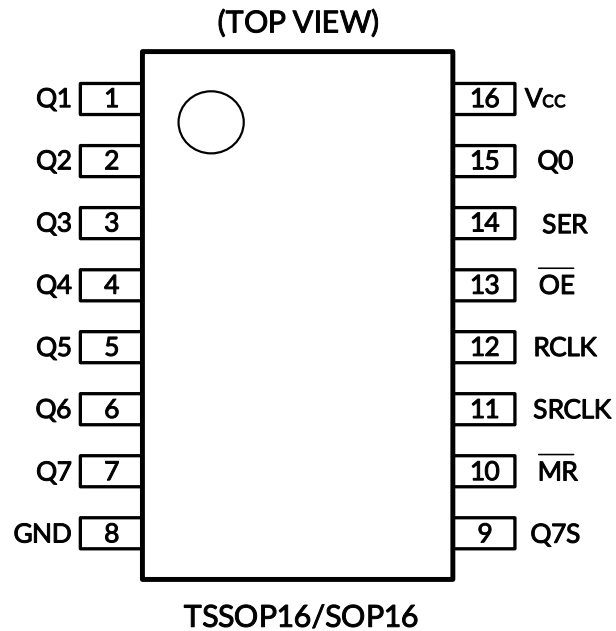
**6 PACKAGE/ORDERING INFORMATION <sup>(1)</sup>**

PRODUCT	ORDERING NUMBER	TEMPERATURE RANGE	PACKAGE LEAD	PACKAGE MARKING <sup>(2)</sup>	MSL <sup>(3)</sup>	PACKAGE OPTION
RS595T	RS595TXTSS16-G	-40°C ~+125°C	TSSOP16	RS595T	MSL1	Tape and Reel, 4000
	RS595TXS16-G	-40°C ~+125°C	SOP16	RS595T	MSL1	Tape and Reel, 4000
	RS595TXS16	-40°C ~+125°C	SOP16	RS595T	MSL3	Tape and Reel, 4000

## NOTE:

- (1) 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 right-hand navigation.
- (2) There may be additional marking, which relates to the lot trace code information (data code and vendor code), the logo or the environmental category on the device.
- (3) MSL, The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications.

## 7 PIN CONFIGURATIONS



### PIN DESCRIPTION

PIN	NAME	TYPE <sup>(1)</sup>	FUNCTION
<b>TSSOP16/SOP16</b>			
1~7	Q1~Q7	O	Parallel data output
8	GND	G	Ground.
9	Q7S	O	Serial data output
10	$\overline{\text{MR}}$	I	Master reset (active Low)
11	SRCLK	I	Shift register clock input
12	RCLK	I	Storage register clock input
13	$\overline{\text{OE}}$	I	Output enable input (active Low)
14	SER	I	Serial data input
15	Q0	I	Parallel data output
16	V <sub>CC</sub>	P	Supply voltage

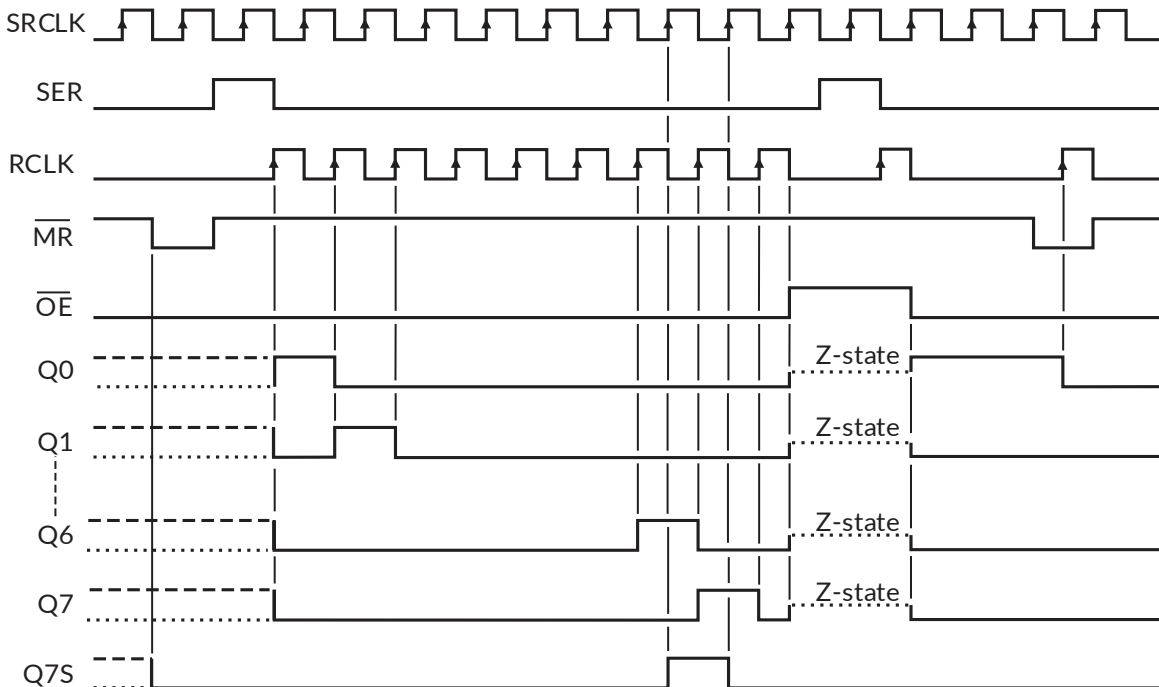
(1) I=input, O=output, P=power, G=Ground.

## 8 FUNCTIONAL DESCRIPTION <sup>(1)</sup>

CONTROL				INPUT	OUTPUT		FUNCTION
SRCLK	RCLK	$\overline{OE}$	$\overline{MR}$	SER	Q7S	Qn	
X	X	L	L	X	L	NC	a Low-level on $\overline{MR}$ only affects the shift registers
X	↑	L	L	X	L	L	empty shift register loaded into storage register
X	X	H	L	X	L	Z	shift register clear; parallel outputs in high-impedance OFF-state
↑	X	L	H	H	Q6S	NC	logic High-level shifted into shift register stage 0. Contents of all shift register stages shifted through, e.g. previous state of stage 6 (internal Q6S) appears on the serial output (Q7S).
X	↑	L	H	X	NC	QnS	contents of shift register stages (internal QnS) are transferred to the storage register and parallel output stages
↑	↑	L	H	X	Q6S	QnS	contents of shift register shifted through; previous contents of the shift register is transferred to the storage register and the parallel output stages

- (1) H = HIGH voltage state;  
 L = LOW voltage state;  
 ↑ = LOW-to-HIGH transition;  
 X = don't care;  
 NC = no change;  
 Z = high-impedance OFF-state.

### 8.1 Timing Diagram



## 9 SPECIFICATIONS

### 9.1 Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted) <sup>(1)</sup>

SYMBOL	PARAMETER	CONDITION	MIN	MAX	UNIT
V <sub>CC</sub>	Supply Voltage Range		-0.5	6.5	V
I <sub>IK</sub>	Input Clamp Current	V <sub>I</sub> < -0.5 V or V <sub>I</sub> > V <sub>CC</sub> + 0.5 V		±20	mA
I <sub>OK</sub>	Output Clamp Current	V <sub>O</sub> < -0.5V or V <sub>O</sub> > V <sub>CC</sub> +0.5V		±20	mA
I <sub>O</sub>	Output Current	V <sub>O</sub> = -0.5V to (V <sub>CC</sub> +0.5V)			
		Pin Q7S		±25	mA
		Pin Qn		±35	mA
I <sub>CC</sub>	Supply Current			70	mA
I <sub>GND</sub>	Ground Current		-70		mA
θ <sub>JA</sub>	Package thermal impedance <sup>(2)</sup>	TSSOP16		45	°C/W
		SOP16		150	
T <sub>J</sub>	Junction Temperature <sup>(3)</sup>		-40	150	°C
T <sub>stg</sub>	Storage Temperature		-65	150	

(1) Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions. 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.

(3) The maximum power dissipation is a function of T<sub>J(MAX)</sub>, R<sub>θJA</sub>, and T<sub>A</sub>. The maximum allowable power dissipation at any ambient temperature is P<sub>D</sub> = (T<sub>J(MAX)</sub> - T<sub>A</sub>) / R<sub>θJA</sub>. All numbers apply for packages soldered directly onto a PCB.

### 9.2 ESD Ratings

The following ESD information is provided for handling of ESD-sensitive devices in an ESD protected area only.

			VALUE	UNIT
V <sub>(ESD)</sub>	Electrostatic discharge	Human-Body Model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>	±2000	V
		Charged-Device Model (CDM), per ANSI/ESDA/JEDEC JS-002 <sup>(2)</sup>	±1000	
		Machine Model (MM)	±200	

(1) JEDEC document JEP155 states that 500 V HBM allows safe manufacturing with a standard ESD control process.

(2) JEDEC document JEP157 states that 250 V CDM allows safe manufacturing with a standard ESD control process.



#### ESD SENSITIVITY CAUTION

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.



### 9.3 Recommended Operating Conditions

Voltages are reference to GND(0V).

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Supply Voltage	V <sub>CC</sub>		4.5		5.5	V
PIN SER HIGH-level Input Voltage	V <sub>IH</sub>	V <sub>CC</sub> =4.5V-5.5V	2			V
PIN SER LOW-level Input Voltage	V <sub>IL</sub>	V <sub>CC</sub> =4.5V-5.5V			0.8	V
other PIN HIGH-level Input Voltage	V <sub>IH</sub>	V <sub>CC</sub> =4.5V-5.5V	3.85			V
other PIN LOW-level Input Voltage	V <sub>IL</sub>	V <sub>CC</sub> =4.5V-5.5V			1.35	V
Input Voltage	V <sub>I</sub>		0		V <sub>CC</sub>	V
Output Voltage	V <sub>O</sub>		0		V <sub>CC</sub>	V
Input Transition Rise or Fall Rate( $\Delta t/\Delta v$ )	Data inputs	V <sub>CC</sub> =4.5V			139	ns/V
		V <sub>CC</sub> =5.5V			83	
Operating Temperature	T <sub>A</sub>		-40		125	°C

### 9.4 Electrical Characteristics

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

PARAMETER		TEST CONDITIONS	V <sub>CC</sub>	TEMP	MIN <sup>(1)</sup>	TYP <sup>(2)</sup>	MAX <sup>(1)</sup>	UNIT
V <sub>OH</sub>	all outputs		4.5V	FULL	4.4			V
	I <sub>O</sub> = -20 $\mu$ A							
	Q7S output		4.5V	FULL	3.8			
	I <sub>O</sub> = -4 mA							
	Qn bus driver outputs		4.5V	FULL	3.7			
I <sub>O</sub> = -6 mA								
V <sub>OL</sub>	all outputs		4.5V	FULL			0.1	V
	I <sub>O</sub> = 20 $\mu$ A							
	Q7S output		4.5V	FULL			0.25	
	I <sub>O</sub> = 4 mA							
	Qn bus driver outputs		4.5V	FULL			0.3	
I <sub>O</sub> = 6 mA								
I <sub>I</sub>	Input Leakage Current	V <sub>I</sub> =V <sub>CC</sub> or GND	5.5V	FULL			$\pm 1$	$\mu$ A
I <sub>OZ</sub>	OFF-State Output Current	V <sub>I</sub> =V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>O</sub> =V <sub>CC</sub> or GND	5.5V	FULL			$\pm 10$	
I <sub>CC</sub>	Supply Current	V <sub>I</sub> =V <sub>CC</sub> or GND; I <sub>O</sub> =0A	5.5V	FULL			160	
$\Delta$ I <sub>CC</sub>	Additional Supply Current	pin SER; I <sub>O</sub> = 0A; V <sub>I</sub> = V <sub>CC</sub> -2.1V; other inputs at V <sub>CC</sub> or GND;	4.5V-5.5V	FULL			200	$\mu$ A
		other per input pin; I <sub>O</sub> = 0A; V <sub>I</sub> = V <sub>CC</sub> - 0.6V; other inputs at V <sub>CC</sub> or GND;	4.5V-5.5V	FULL			100	
C <sub>I</sub>	Input Capacitance	V <sub>I</sub> =V <sub>CC</sub> or GND	5.5V	FULL		6		pF

(1) Limits are 100% production tested at 25°C. Limits over the operating temperature range are ensured through correlations using statistical quality control (SQC) method.

(2) Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration.

## 9.5 Switching Characteristics

over recommended operating free-air temperature range, Full=-40°C to 125°C. <sup>(1)</sup>

PARAMETER	-40°C to +125°C			UNIT
	V <sub>CC</sub> =4.5V - 5.5V <sup>(2)</sup>			
	MIN	TYP <sup>(3)</sup>	MAX	
Propagation Delay, t <sub>pd</sub> <sup>(4)</sup> SRCLK to Q7S			20	ns
Propagation Delay, t <sub>pd</sub> RCLK to Qn			23	ns
High to Low Propagation, $\overline{MR}$ to Q7S, t <sub>PHL</sub> <sup>(5)</sup>			18	ns
Enable Time, t <sub>en</sub> <sup>(6)</sup> $\overline{OE}$ to Qn			23	ns
Disable Time, t <sub>dis</sub> <sup>(7)</sup> $\overline{OE}$ to Qn			46	ns
Pulse Width, t <sub>w</sub> SRCLK High or Low			22	ns
Pulse Width, t <sub>w</sub> RCLK High or Low			22	ns
Pulse Width, t <sub>w</sub> $\overline{MR}$ Low			22	ns
Hold Width, t <sub>h</sub> SER to SRCLK	3			ns
Set-up Time, t <sub>su</sub> SER to SRCLK	18			ns
Set-up Time, t <sub>su</sub> SRCLK to RCLK	22			ns
Recovery Time t <sub>rec</sub> $\overline{MR}$ to SRCLK	15			ns
Maximum frequency f <sub>max</sub> SRCLK/RCLK C <sub>L</sub> =15pF	20			MHz

(1) All unused inputs of the device must be held at V<sub>CC</sub> or GND to ensure proper device operation.

(2) This parameter is ensured by design and/or characterization and is not tested in production.

(3) Typical values are measured at nominal supply voltage.

(4) t<sub>pd</sub> is the same as t<sub>PHL</sub> and t<sub>PLH</sub>.

(5) t<sub>pd</sub> is the same as t<sub>PHL</sub> only.

(6) t<sub>en</sub> is the same as t<sub>PZL</sub> and t<sub>PZH</sub>.

(7) t<sub>dis</sub> is the same as t<sub>PLZ</sub> and t<sub>PHZ</sub>.

## 9.6 Operating Characteristics

T<sub>A</sub>=25°C

PARAMETER	TEST CONDITIONS	TYP	UNIT
C <sub>pd</sub> <sup>(1)</sup>	SER = 1 MHz; SRCL = RCLK = 10MHz; V <sub>I</sub> = GND to V <sub>CC</sub> <sup>(2)(3)</sup>	115	pF

(1) Power dissipation capacitance per transceiver.

(2) C<sub>PD</sub> is used to determine the dynamic power dissipation (P<sub>D</sub> in μW).

$P_D = C_{PD} \times V_{CC}^2 \times f_i + \sum (C_L \times V_{CC}^2 \times f_o)$  where:

f<sub>i</sub> = input frequency in MHz;

f<sub>o</sub> = output frequency in MHz;

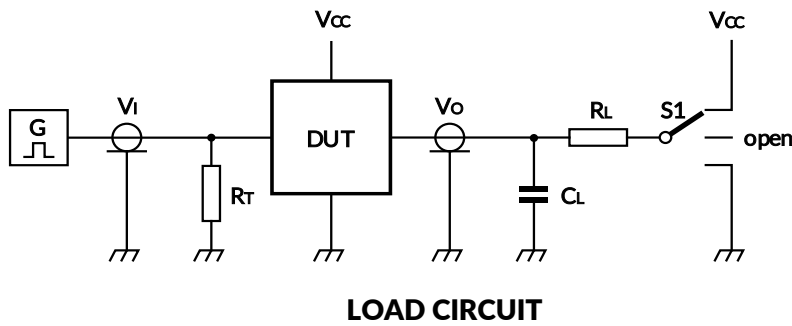
$\sum (C_L \times V_{CC}^2 \times f_o)$  = sum of outputs;

C<sub>L</sub> = output load capacitance in pF;

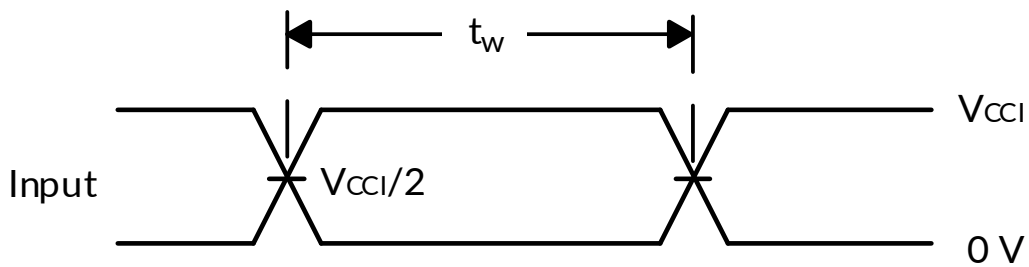
V<sub>CC</sub> = supply voltage in V.

(3) All 9 outputs switching.

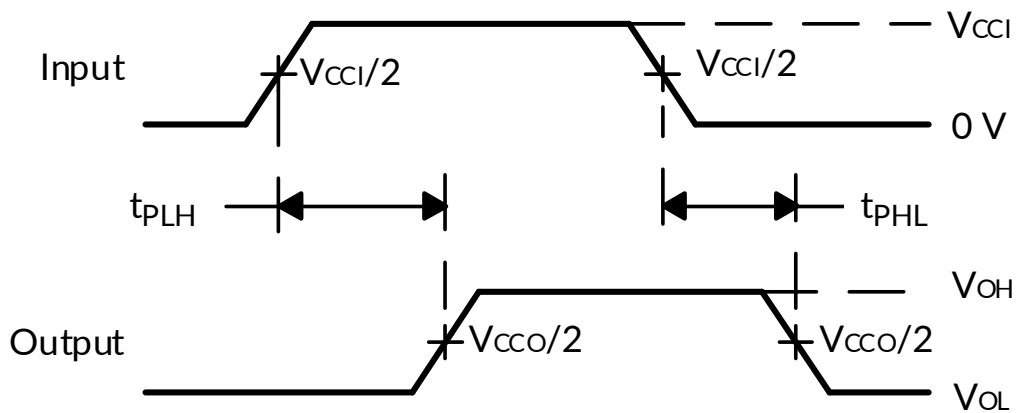
### 10 PARAMETER MEASUREMENT INFORMATION



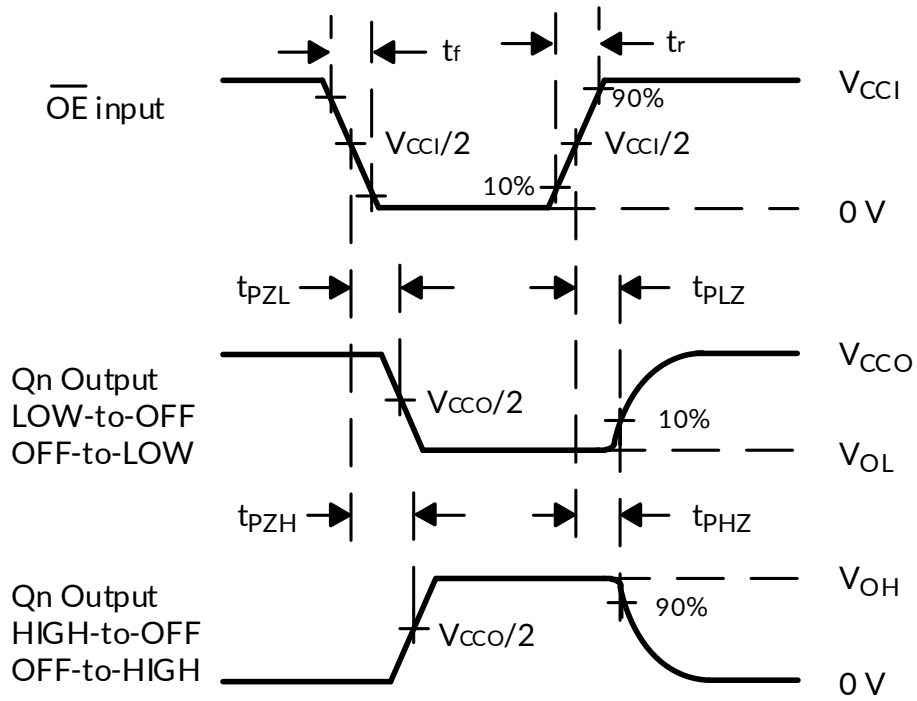
TEST	S1
$t_{PHL}/t_{PLH}$	Open
$t_{PLZ}/t_{PZL}$	$V_{CC}$
$t_{PHZ}/t_{PZH}$	GND
$V_I$	$V_{CC}$
$t_r/t_f$	9ns
$C_L$	50pF
$R_L$	1K $\Omega$



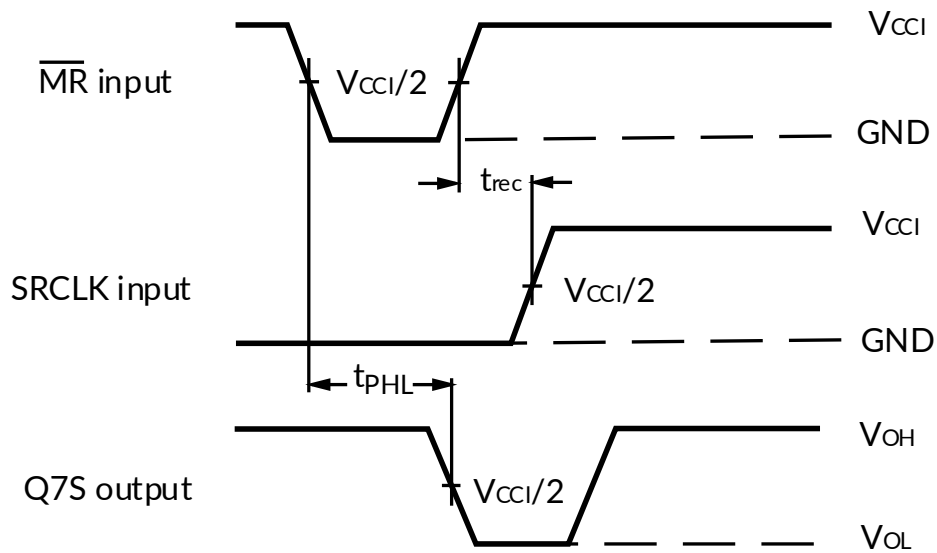
**Figure 1. Voltage Waveforms Pulse Duration**



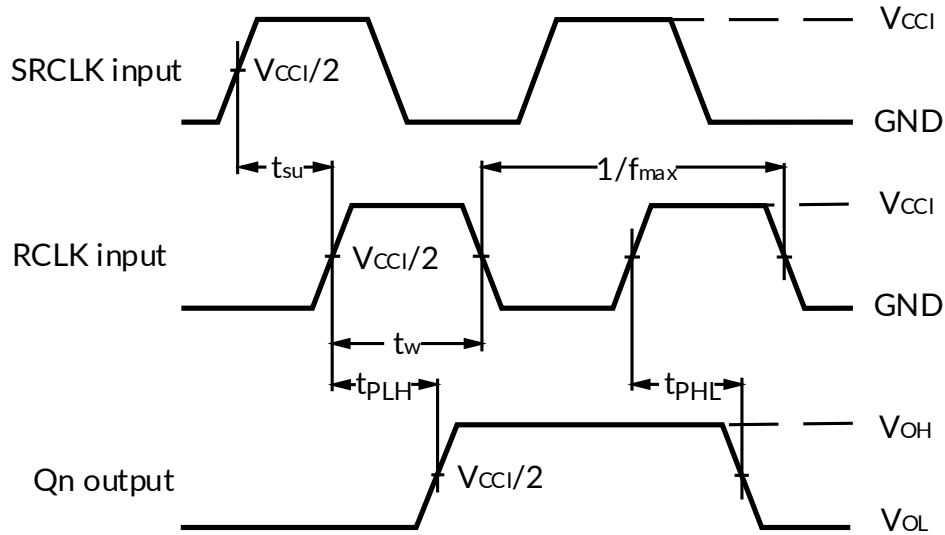
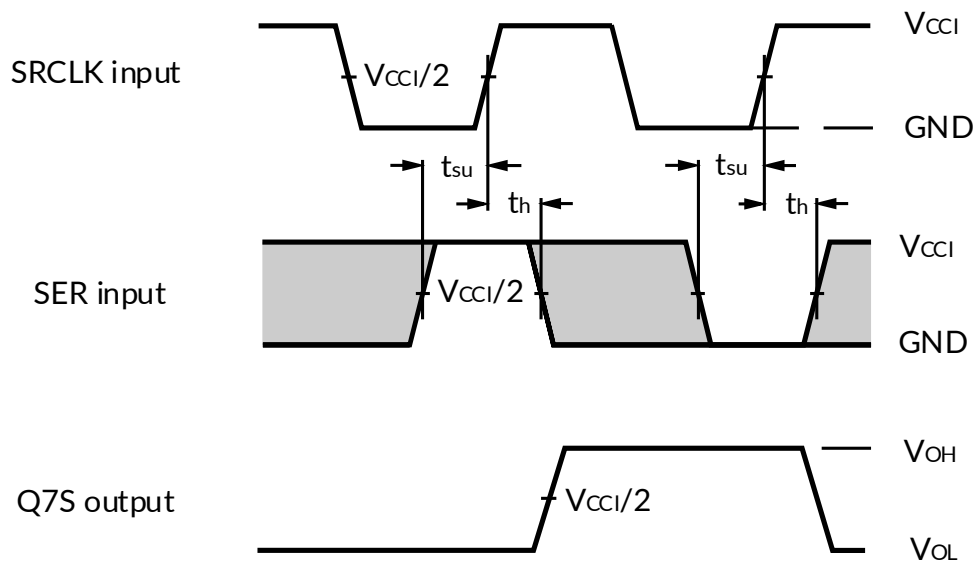
**Figure 2. Voltage Waveforms Propagation Delay Times**



**Figure 3. Voltage Waveforms Enable and Disable Times**



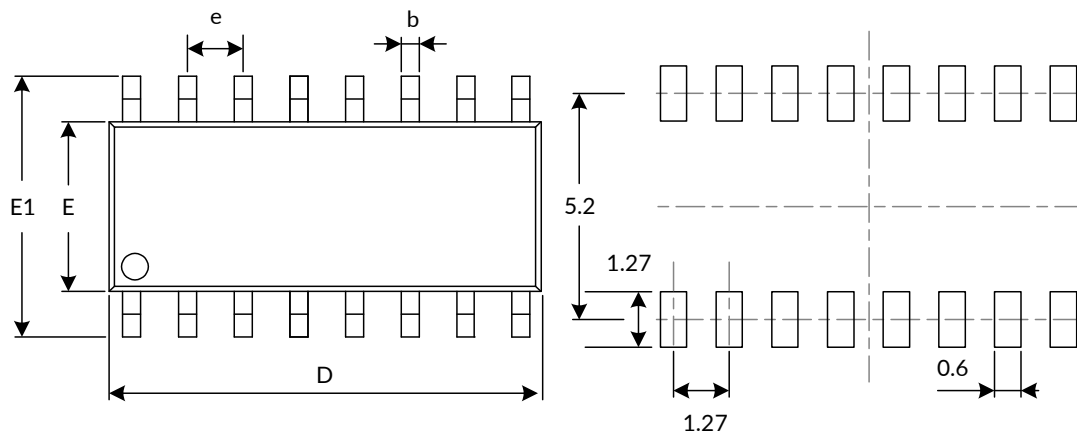
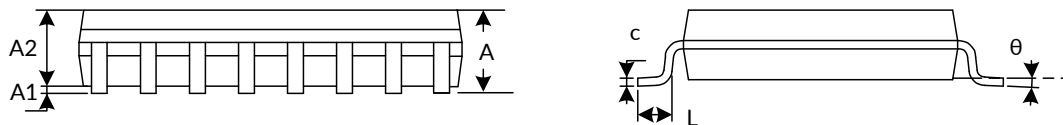
**Figure 4. Master Reset to Output Propagation Delays**


**Figure 5. Storage Clock to Output Propagation Delays**

**Figure 6. Data Set-up and Hold Times**

- NOTES:
- A.  $C_L$  includes probe and jig capacitance.
  - B. All input pulses are supplied by generators having the following characteristics:  $PRR \leq 10$  MHz,  $Z_o = 50 \Omega$ ,  $dv/dt \geq 1V/ns$ .
  - C. The outputs are measured one at a time, with one transition per measurement.
  - D.  $t_{PLZ}$  and  $t_{PHZ}$  are the same as  $t_{dis}$ .
  - E.  $t_{PZL}$  and  $t_{PZH}$  are the same as  $t_{en}$ .
  - F.  $t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$ .
  - G. All parameters and waveforms are not applicable to all devices.
  - H. The shaded areas indicate when the input is permitted to change for predictable output performance.
  - I.  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

# 11 PACKAGE OUTLINE DIMENSIONS

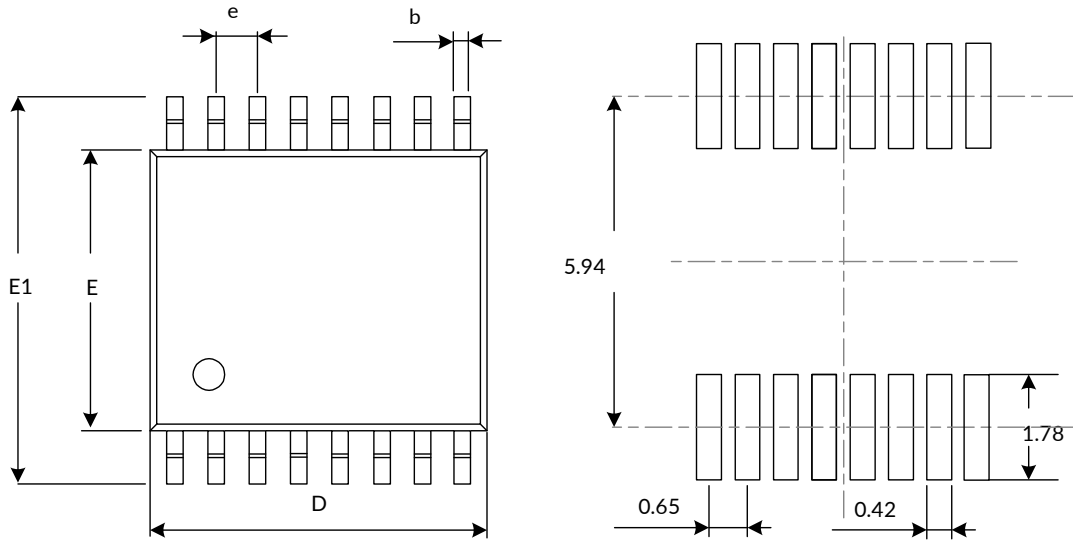
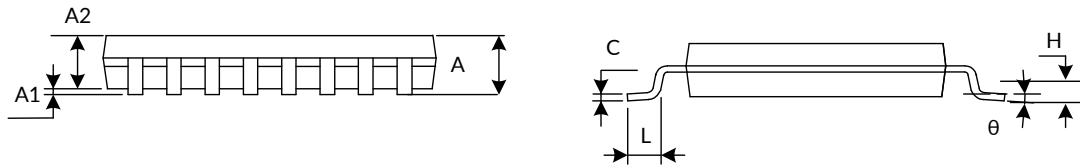
## SOP16<sup>(3)</sup>


**RECOMMENDED LAND PATTERN (Unit: mm)**


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A <sup>(1)</sup>		1.750		0.069
A1	0.100	0.225	0.004	0.009
A2	1.300	1.500	0.051	0.059
b	0.390	0.470	0.015	0.019
c	0.200	0.240	0.007	0.010
D <sup>(1)</sup>	9.800	10.00	0.386	0.394
E <sup>(1)</sup>	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270 (BSC) <sup>(2)</sup>		0.050 (BSC) <sup>(2)</sup>	
L	0.500	0.800	0.020	0.032
$\theta$	0°	8°	0°	8°

**NOTE:**

1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

**TSSOP16 (3)**

**RECOMMENDED LAND PATTERN (Unit: mm)**


Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A <sup>(1)</sup>		1.200		0.047
A1	0.050	0.150	0.002	0.006
A2	0.900	1.050	0.035	0.041
b	0.200	0.280	0.007	0.011
c	0.130	0.170	0.005	0.007
D <sup>(1)</sup>	4.900	5.100	0.193	0.201
E <sup>(1)</sup>	4.300	4.500	0.169	0.177
E1	6.200	6.600	0.244	0.260
e	0.650(BSC) <sup>(2)</sup>		0.026(BSC) <sup>(2)</sup>	
L	0.450	0.750	0.017	0.030
H	0.250 TYP		0.010 TYP	
θ	1°	8°	8°	8°

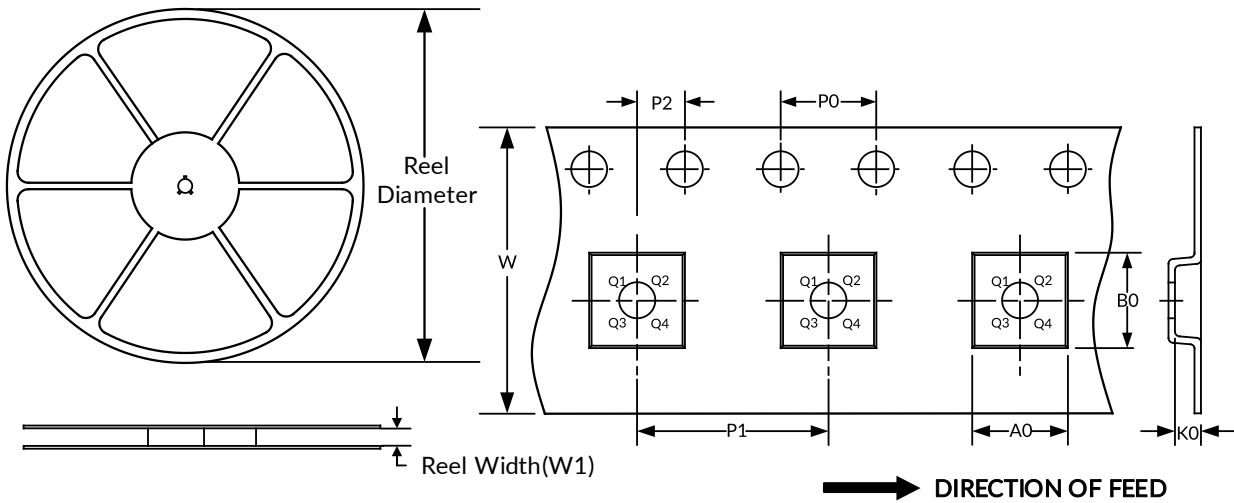
**NOTE:**

1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. BSC (Basic Spacing between Centers), "Basic" spacing is nominal.
3. This drawing is subject to change without notice.

## 12 TAPE AND REEL INFORMATION

### REEL DIMENSIONS

### TAPE DIMENSION



NOTE: The picture is only for reference. Please make the object as the standard.

### KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width(mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
SOP16	13"	16.4	6.50	10.30	2.10	4.0	8.0	2.0	16.0	Q1
TSSOP16	13"	12.4	6.90	5.60	1.20	4.0	8.0	2.0	12.0	Q1

NOTE:

1. All dimensions are nominal.
2. Plastic or metal protrusions of 0.15mm maximum per side are not included.



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