

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

## TC7MH595FK

### 8-Bit Shift Register/Latch (3-State)

The TC7MH595FK is an advanced high speed 8 bit shift register/latch fabricated with silicon gate C<sup>2</sup>MOS technology.

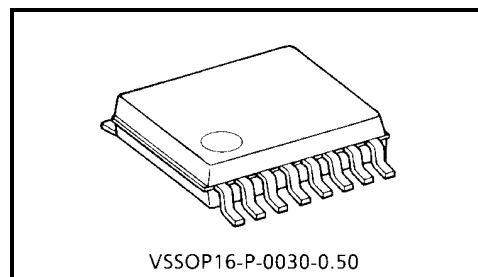
It achieves the high speed operation similar to equivalent bipolar schottky TTL while maintaining the CMOS low power dissipation.

The TC7MH595FK contains an 8 bit static shift register which feeds an 8 bit storage register.

Shift operation is accomplished on the positive going transition of the SCK input. The output register is loaded with the contents of the shift register on the positive going transition of the RCK input. Since RCK and SCK signal are independent, parallel

outputs can be held stable during the shift operation. And, since the parallel outputs are 3-state, it can be directly connected to 8 bit bus. This register can be used in serial-to-parallel conversion, data receivers, etc.

An input protection circuit ensures that 0 to 7 V can be applied to the input pins without regard to the supply voltage. This device can be used to interface 5 V to 3 V systems and two supply systems such as battery back up. This circuit prevents device destruction due to mismatched supply and input voltages.



VSSOP16-P-0030-0.50

Weight: 0.02 g (typ.)

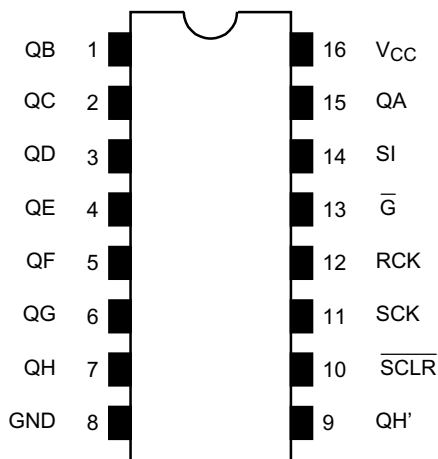
### Features

- High speed:  $f_{\max} = 185 \text{ MHz}$  (typ.) ( $V_{CC} = 5 \text{ V}$ )
- Low power dissipation:  $I_{CC} = 4 \mu\text{A}$  (max) ( $T_a = 25^\circ\text{C}$ )
- High noise immunity:  $V_{NIH} = V_{NIL} = 28\% V_{CC}$  (min)
- Power down protection is provided on all inputs.
- Balanced propagation delays:  $t_{pLH} \approx t_{pHL}$
- Wide operating voltage range:  $V_{CC}(\text{opr}) = 2 \sim 5.5 \text{ V}$
- Low noise:  $V_{OLP} = 1.0 \text{ V}$  (max)
- Pin and function compatible with 74ALS595

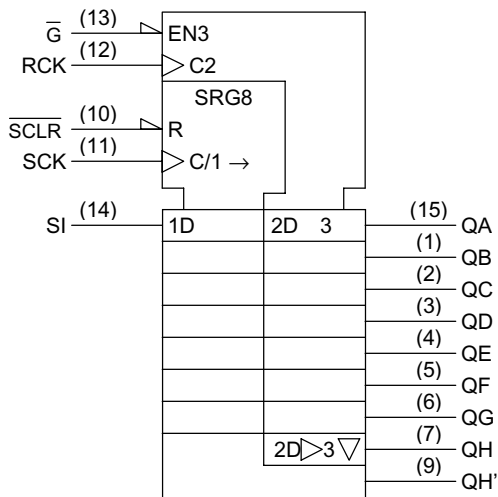
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Pin Assignment (top view)



IEC Logic Symbol

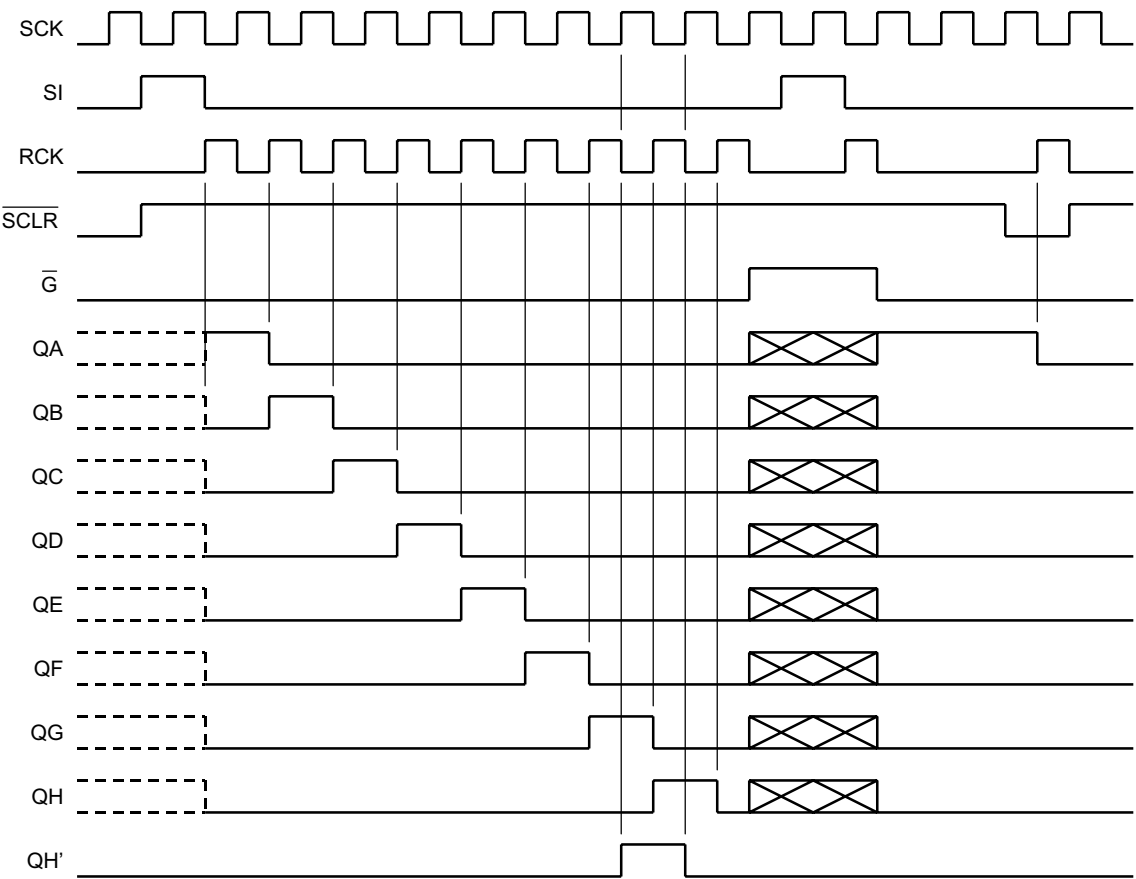


Truth Table

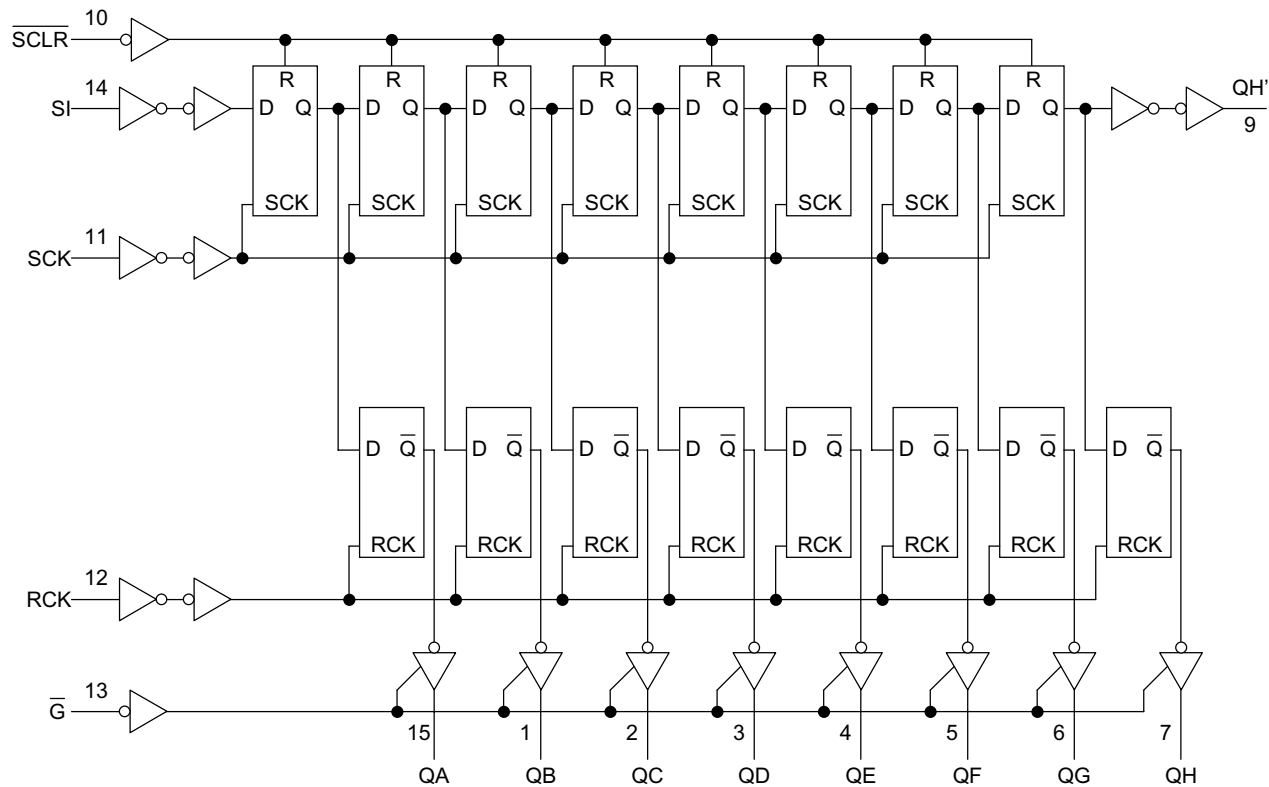
Inputs					Function
SI	SCK	SCLR	RCK	G	
X	X	X	X	H	QA thru QH outputs disable
X	X	X	X	L	QA thru QH outputs enable
X	X	L	X	X	Shift register is cleared.
L		H	X	X	First stage of S.R. becomes "L". Other stages store the data of previous stage, respectively.
H		H	X	X	First stage of S.R. becomes "H". Other stages store the data of previous stage, respectively.
X		H	X	X	State of S.R. is not changed.
X	X	X		X	S.R. data is stored into storage register.
X	X	X		X	Storage register stage is not changed.

X: Don't care

Timing Chart



System Diagram



**Maximum Ratings**

Characteristics	Symbol	Rating	Unit
Supply voltage range	$V_{CC}$	-0.5~7.0	V
DC input voltage	$V_{IN}$	-0.5~7.0	V
DC output voltage	$V_{OUT}$	-0.5~ $V_{CC} + 0.5$	V
Input diode current	$I_{IK}$	-20	mA
Output diode current	$I_{OK}$	±20	mA
DC output current	$I_{OUT}$	±25	mA
DC $V_{CC}$ /ground current	$I_{CC}$	±75	mA
Power dissipation	$P_D$	180	mW
Storage temperature	$T_{stg}$	-65~150	°C

**Recommended Operating Conditions**

Characteristics	Symbol	Rating	Unit
Supply voltage	$V_{CC}$	2.0~5.5	V
Input voltage	$V_{IN}$	0~5.5	V
Output voltage	$V_{OUT}$	0~ $V_{CC}$	V
Operating temperature	$T_{opr}$	-40~85	°C
Input rise and fall time	dt/dv	0~100 ( $V_{CC} = 3.3 \pm 0.3$ V) 0~20 ( $V_{CC} = 5 \pm 0.5$ V)	ns/V

## Electrical Characteristics

## DC Characteristics

Characteristics		Symbol	Test Condition		V <sub>CC</sub> (V)	Ta = 25°C			Ta = -40~85°C		Unit
					Min	Typ.	Max	Min	Max		
Input voltage	High level	V <sub>IH</sub>	—		2.0 3.0~5.5	1.50 V <sub>CC</sub> × 0.7	— —	— —	1.50 V <sub>CC</sub> × 0.7	— —	V
	Low level	V <sub>IL</sub>	—		2.0 3.0~5.5	— —	— V <sub>CC</sub> × 0.3	0.50 —	0.50 V <sub>CC</sub> × 0.3		
Output voltage	High level	V <sub>OH</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OH</sub> = -50 μA	2.0	1.9	2.0	—	1.9	—	V
					3.0	2.9	3.0	—	2.9	—	
					4.5	4.4	4.5	—	4.4	—	
				I <sub>OH</sub> = -4 mA	3.0	2.58	—	—	2.48	—	
					I <sub>OH</sub> = -8 mA	4.5	3.94	—	—	3.80	
	Low level	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OL</sub> = 50 μA	2.0	—	0	0.1	—	0.1	
					3.0	—	0	0.1	—	0.1	
					4.5	—	0	0.1	—	0.1	
				I <sub>OL</sub> = 4 mA	3.0	—	—	0.36	—	0.44	
					I <sub>OL</sub> = 8 mA	4.5	—	—	0.36	—	
3-state output off-state current		I <sub>OZ</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = V <sub>CC</sub> or GND		5.5	—	—	±0.25	—	±2.50	μA
Input leakage current		I <sub>IN</sub>	V <sub>IN</sub> = 5.5 V or GND		0~5.5	—	—	±0.1	—	±1.0	μA
Quiescent supply current		I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND		5.5	—	—	4.0	—	40.0	μA

Timing Requirements (Input: t<sub>r</sub> = t<sub>f</sub> = 3 ns)

Characteristics	Symbol	Test Condition	Ta = 25°C			Ta = -40~85°C	Unit
			V <sub>CC</sub> (V)	Typ.	Limit	Limit	
Minimum pulse width (SCK, RCK)	t <sub>w</sub> (H) t <sub>w</sub> (L)	—	3.3 ± 0.3	—	5.0	5.0	ns
			5.0 ± 0.5	—	5.0	5.0	
Minimum pulse width ( $\overline{\text{SCLR}}$ )	t <sub>w</sub> (L)	—	3.3 ± 0.3	—	5.0	5.0	ns
			5.0 ± 0.5	—	5.0	5.0	
Minimum set-up time (SI-SCK)	t <sub>s</sub>	—	3.3 ± 0.3	—	3.5	3.5	ns
			5.0 ± 0.5	—	3.0	3.0	
Minimum set-up time (SCK-RCK)	t <sub>s</sub>	—	3.3 ± 0.3	—	8.0	8.5	ns
			5.0 ± 0.5	—	5.0	5.0	
Minimum set-up time ( $\overline{\text{SCLR}}$ -RCK)	t <sub>s</sub>	—	3.3 ± 0.3	—	8.0	9.0	ns
			5.0 ± 0.5	—	5.0	5.0	
Minimum hold time (SI-SCK)	t <sub>h</sub>	—	3.3 ± 0.3	—	1.5	1.5	ns
			5.0 ± 0.5	—	2.0	2.0	
Minimum hold time (SCK-RCK, $\overline{\text{SCLR}}$ -RCK)	t <sub>h</sub>	—	3.3 ± 0.3	—	0	0	ns
			5.0 ± 0.5	—	0	0	
Minimum removal time ( $\overline{\text{SCLR}}$ )	t <sub>rem</sub>	—	3.3 ± 0.3	—	3.0	3.0	ns
			5.0 ± 0.5	—	2.5	2.5	

AC Characteristics (Input:  $t_r = t_f = 3 \text{ ns}$ )

Characteristics	Symbol	Test Condition			Ta = 25°C			Ta = -40~85°C		Unit
			V <sub>CC</sub> (V)	C <sub>L</sub> (pF)	Min	Typ.	Max	Min	Max	
Propagation delay time (SCK-QH')	$t_{pLH}$ $t_{pHL}$	—	$3.3 \pm 0.3$	15	—	8.8	13.0	1.0	15.0	ns
				50	—	11.3	16.5	1.0	18.5	
			$5.0 \pm 0.5$	15	—	6.2	8.2	1.0	9.4	
				50	—	7.7	10.2	1.0	11.4	
Propagation delay time (SCLR-QH')	$t_{pHL}$	—	$3.3 \pm 0.3$	15	—	8.4	12.8	1.0	13.7	ns
				50	—	10.9	16.3	1.0	17.2	
			$5.0 \pm 0.5$	15	—	5.9	8.0	1.0	9.1	
				50	—	7.4	10.0	1.0	11.1	
Propagation delay time (RCK-Q <sub>n</sub> )	$t_{pLH}$ $t_{pHL}$	—	$3.3 \pm 0.3$	15	—	7.7	11.9	1.0	13.5	ns
				50	—	10.2	15.4	1.0	17.0	
			$5.0 \pm 0.5$	15	—	5.4	7.4	1.0	8.5	
				50	—	6.9	9.4	1.0	10.5	
Output enable time	$t_{pZL}$ $t_{pZH}$	R <sub>L</sub> = 1 kΩ	$3.3 \pm 0.3$	15	—	7.5	11.5	1.0	13.5	ns
				50	—	9.0	15.0	1.0	17.0	
			$5.0 \pm 0.5$	15	—	4.8	8.6	1.0	10.0	
				50	—	8.3	10.6	1.0	12.0	
Output disable time	$t_{pLZ}$ $t_{pHZ}$	R <sub>L</sub> = 1 kΩ	$3.3 \pm 0.3$	50	—	12.1	15.7	1.0	16.2	ns
			$5.0 \pm 0.5$	50	—	7.6	10.3	1.0	11.0	
Maximum clock frequency	$f_{\max}$	—	$3.3 \pm 0.3$	15	80	150	—	70	—	MHz
				50	55	130	—	50	—	
			$5.0 \pm 0.5$	15	135	185	—	115	—	
				50	95	155	—	85	—	
Input capacitance	C <sub>IN</sub>	—	—	—	—	4	10	—	10	pF
Output capacitance	C <sub>OUT</sub>	—	—	—	—	6	—	—	—	pF
Power dissipation capacitance	C <sub>PD</sub>	(Note)	—	—	—	87	—	—	—	pF

Note: C<sub>PD</sub> is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

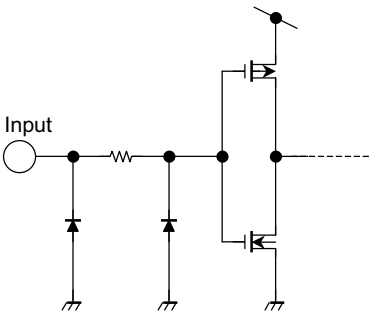
Average operating current can be obtained by the equation:

$$I_{CC(\text{opr})} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$$

Noise Characteristics (Input:  $t_r = t_f = 3\text{ ns}$ )

Characteristics	Symbol	Test Condition	Ta = 25°C			Unit
			V <sub>CC</sub> (V)	Typ.	Limit	
Quiet output maximum dynamic V <sub>OL</sub>	V <sub>OLP</sub>	C <sub>L</sub> = 50 pF	5.0	0.8	1.0	V
Quiet output minimum dynamic V <sub>OL</sub>	V <sub>OLV</sub>	C <sub>L</sub> = 50 pF	5.0	-0.8	-1.0	V
Minimum high level dynamic input voltage V <sub>IH</sub>	V <sub>IHD</sub>	C <sub>L</sub> = 50 pF	5.0	—	3.5	V
Maximum low level dynamic input voltage V <sub>IL</sub>	V <sub>ILD</sub>	C <sub>L</sub> = 50 pF	5.0	—	1.5	V

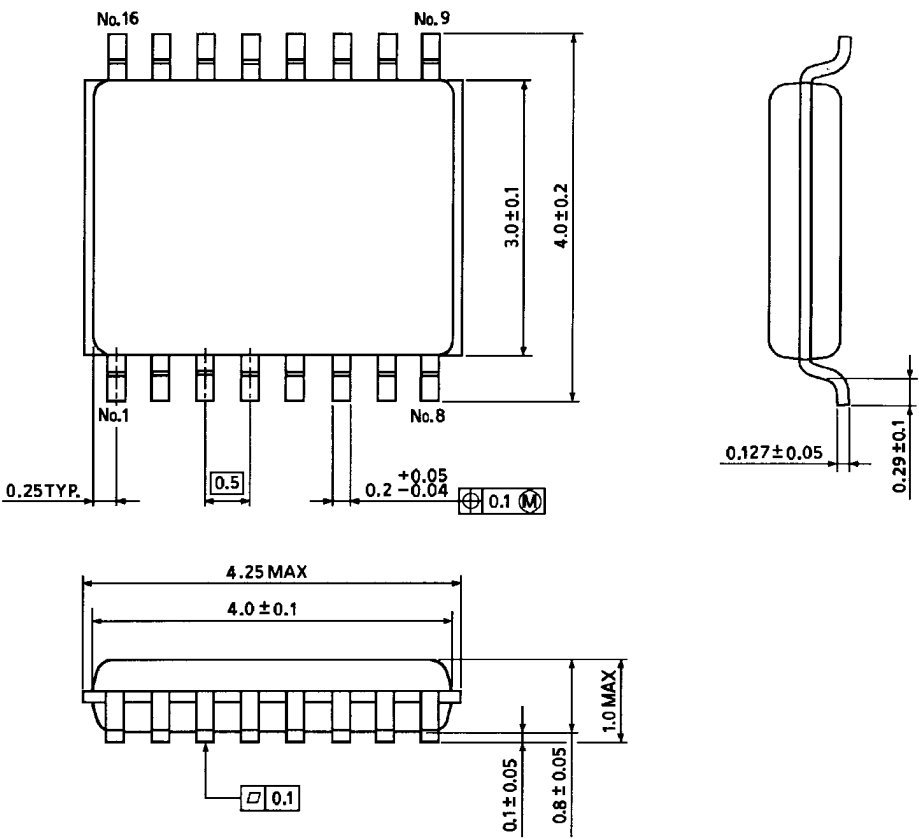
Input Equivalent Circuit



Package Dimensions

VSSOP16-P-0030-0.50

Unit : mm



Weight: 0.02 g (typ.)