TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC7MH165FK

8-Bit Shift Register (P-In, S-Out)

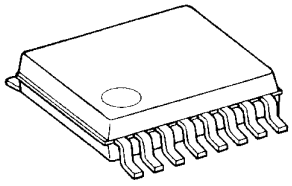
The TC7MH165FK is an advanced high speed CMOS 8-bit parallel/serial-in, serial-out shift register fabricated with silicon gate C^2MOS technology.

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

It consists of parallel-in or serial-in, serial-out 8-bit shift register with a gated clock input. When the SHIFT/$\overline{\text{LOAD}}$ input is held high, the serial data input is enabled and the eight flip-flops perform serial shifting with each clock pulse.

When the SHIFT/ $\overline{\text{LOAD}}$ input is held low, the parallel data is loaded synchronously into the register at positive going transition of the clock pulse.

The CK-INH input should be shifted high only when the CK input is held high.



VSSOP16-P-0030-0.50

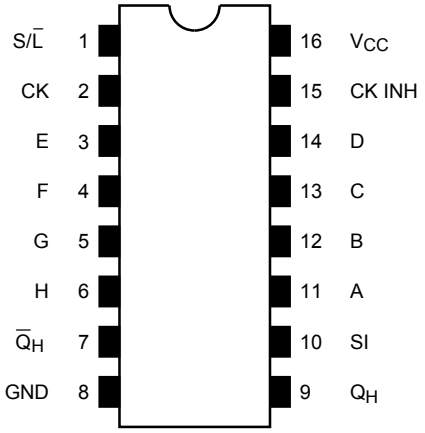
Weight: 0.02 g (typ.)

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 on two supply systems such as battery back up. This circuit prevents device destruction due to mismatched supply and input voltages.

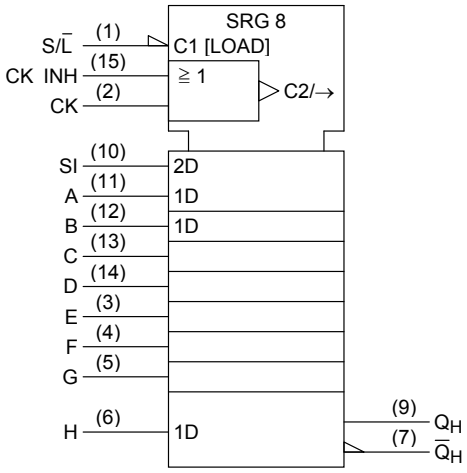
Features

- High speed: f_{max} = 150 MHz (typ.) (V_{CC} = 5 V)
- Low power dissipation: I_{CC} = 4 μA (max) (Ta = 25°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: $V_{CC\ (opr)}$ = 2~5.5 V
- Pin and function compatible with 74ALS165

Pin Assignment (top view)



IEC Logic Symbol



Truth Table

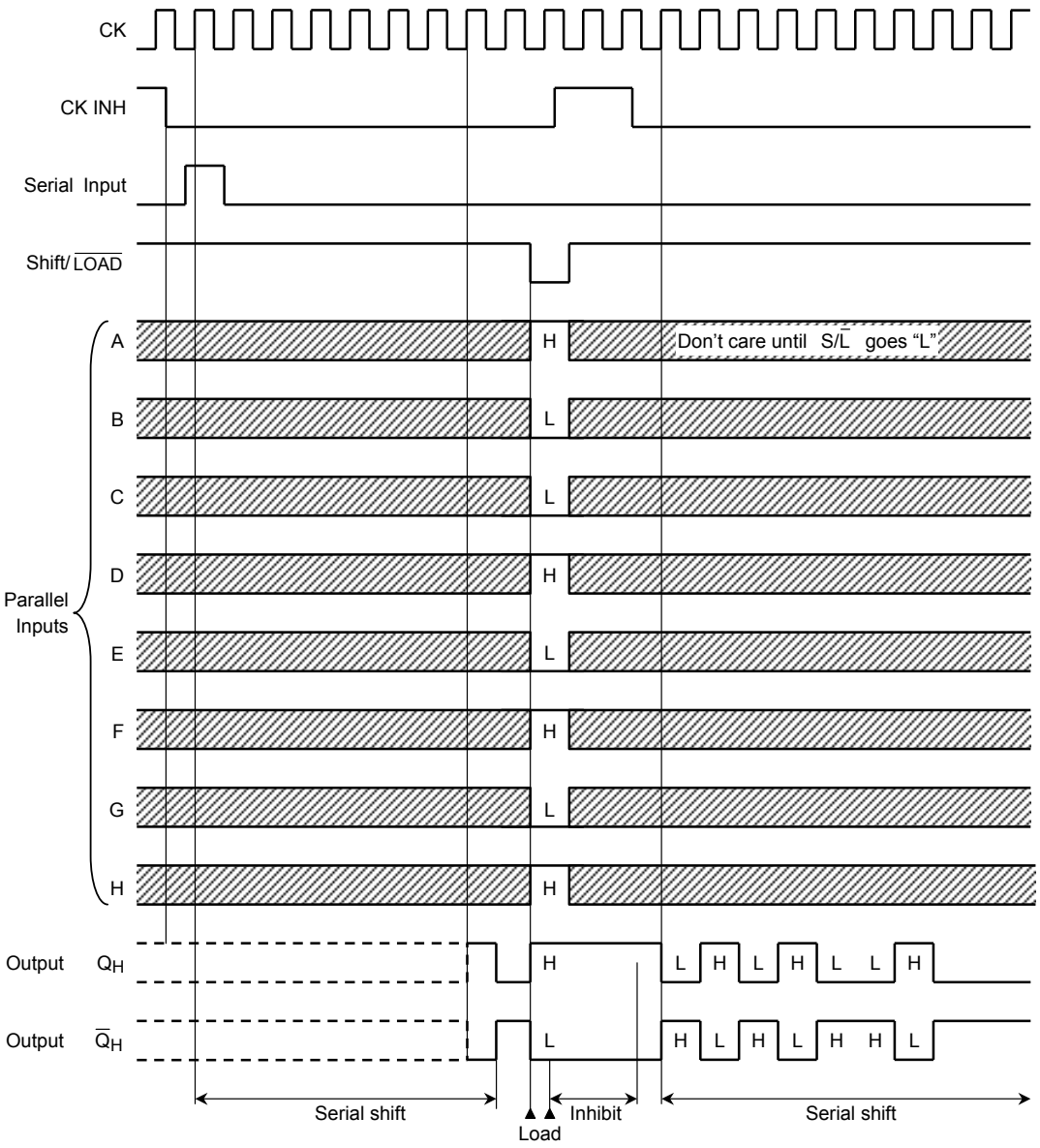
Inputs					Internal Outputs		Outputs	
Shift/$\overline{\text{LOAD}}$	CK INH	CK	Serial In	Parallel A.....H	Q_A	Q_B	Q_H	$\overline{Q}_H$
L	X	X	X	a ..... h	a	b	h	$\overline{h}$
H	L	↑	H	X	H	Q_{An}	Q_{Gn}	$\overline{Q}_{Gn}$
H	L	↑	L	X	L	Q_{An}	Q_{Gn}	$\overline{Q}_{Gn}$
H	↑	L	H	X	H	Q_{An}	Q_{Gn}	$\overline{Q}_{Gn}$
H	↑	L	L	X	L	Q_{An}	Q_{Gn}	$\overline{Q}_{Gn}$
H	X	H	X	X	No change			
H	H	X	X	X	No change			

X: Don't care

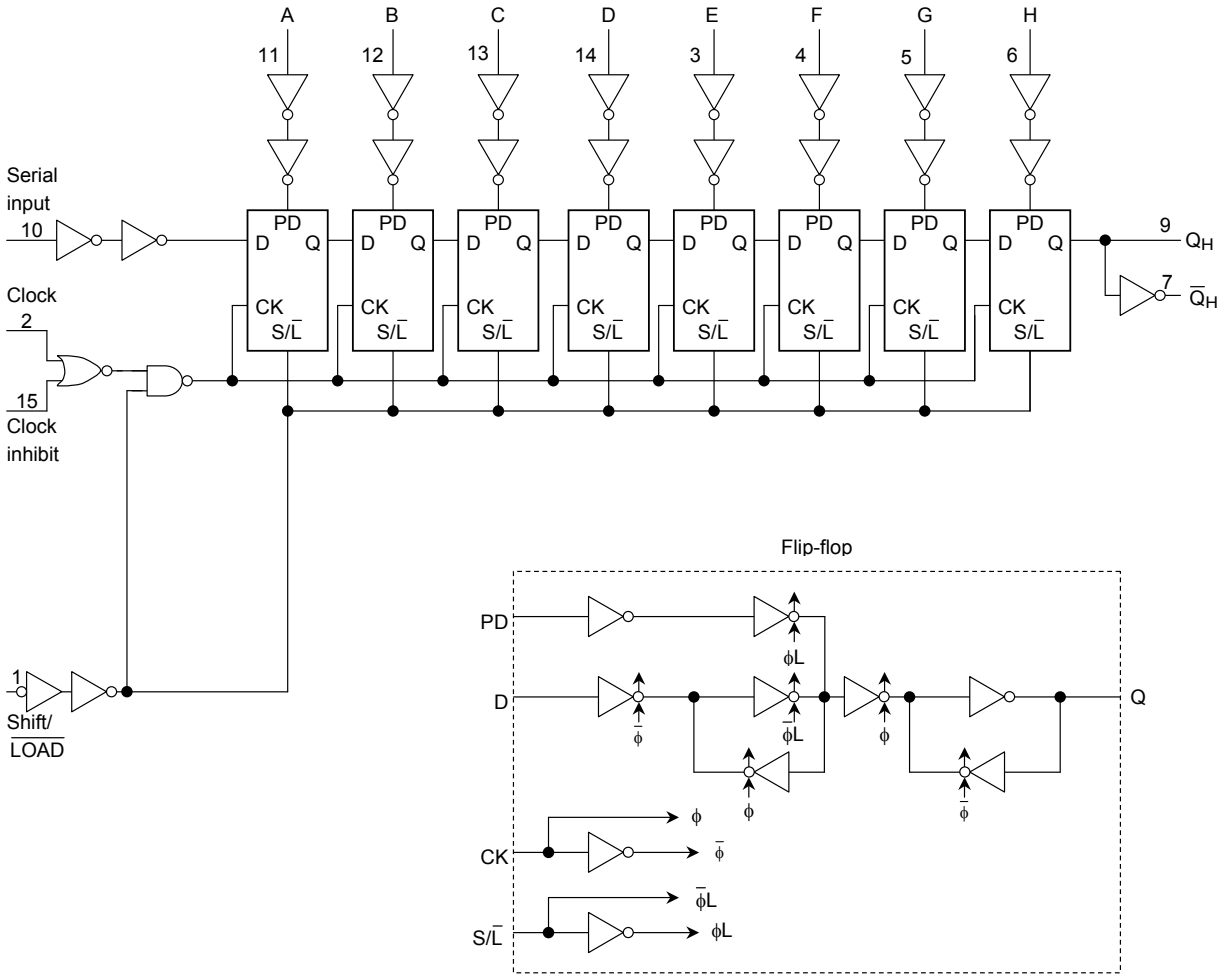
a.....h: The level of steady state input voltage at inputs A through H respectively

Q_{An}-Q_{Gn}: The level of Q_A~Q_G, respectively, before the most recent positive transition of the CK.

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}	±50	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 ± 0.3 V)	ns/V
		0~20 (V_{CC} = 5 ± 0.5 V)	

Electrical Characteristics

DC Characteristics

Characteristics		Symbol	Test Condition		V_{CC} (V)	Ta = 25°C Min	Ta = 25°C Typ.	Ta = 25°C Max	Ta = −40~85°C Min	Ta = −40~85°C Max	Unit
Input voltage	High level	V_{IH}	—		2.0	1.50	—	—	1.50	—	V
					3.0~5.5	V_{CC} × 0.7	—	—	V_{CC} × 0.7	—	
	Low level	V_{IL}	—		2.0	—	—	0.50	—	0.50	
					3.0~5.5	—	—	V_{CC} × 0.3	—	V_{CC} × 0.3	
Output voltage	High level	V_{OH}	V_{IN} = V_{IH} or V_{IL}	I_{OH} = −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_{OH} = −4 mA	3.0	2.58	—	—	2.48	—	
				I_{OH} = −8 mA	4.5	3.94	—	—	3.80	—	
	Low level	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 50 μA	2.0	—	0	0.1	—	0.1	
					3.0	—	0	0.1	—	0.1	
					4.5	—	0	0.1	—	0.1	
				I_{OL} = 4 mA	3.0	—	—	0.36	—	0.44	
				I_{OL} = 8 mA	4.5	—	—	0.36	—	0.44	
Input leakage current		I_{IN}	V_{IN} = 5.5 V or GND		0~5.5	—	—	±0.1	—	±1.0	μA
Quiescent supply current		I_{CC}	V_{IN} = V_{CC} or GND		5.5	—	—	4.0	—	40.0	μA

Timing Requirements (Input: $t_r = t_f = 3$ ns)

Characteristics	Symbol	Test Condition		Ta = 25°C		Ta = −40~85°C	Unit
			V_{CC} (V)	Typ.	Limit	Limit	
Minimum pulse width (CK, CK INH)	$t_{w(L)}$ $t_{w(H)}$	—	3.3 ± 0.3	—	6.0	7.0	ns
			5.0 ± 0.5	—	4.0	4.0	
Minimum pulse width ($S/\overline{L}$)	$t_{W(L)}$	—	3.3 ± 0.3	—	7.5	9.0	ns
			5.0 ± 0.5	—	5.0	6.0	
Minimum set-up time (A~H- $S/\overline{L}$)	t_s	—	3.3 ± 0.3	—	7.5	8.5	ns
			5.0 ± 0.5	—	5.0	5.0	
Minimum set-up time (SI-CK, CK INH)	t_s	—	3.3 ± 0.3	—	5.0	6.0	ns
			5.0 ± 0.5	—	4.0	4.0	
Minimum set-up time ($S/\overline{L}$ -CK, CK INH)	t_s	—	3.3 ± 0.3	—	5.0	6.0	ns
			5.0 ± 0.5	—	4.0	4.0	
Minimum hold time (A~H- $S/\overline{L}$)	t_h	—	3.3 ± 0.3	—	0.5	0.5	ns
			5.0 ± 0.5	—	1.0	1.0	
Minimum hold time (SI-CK, CK INH)	t_h	—	3.3 ± 0.3	—	0	0	ns
			5.0 ± 0.5	—	0.5	0.5	
Minimum hold time ($S/\overline{L}$ -CK, CK INH)	t_h	—	3.3 ± 0.3	—	0	0	ns
			5.0 ± 0.5	—	0.5	0.5	
Minimum removal time (CK INH-CK) (CK-CK INH)	t_{rem}	—	3.3 ± 0.3	—	5.0	5.0	ns
			5.0 ± 0.5	—	3.5	3.5	

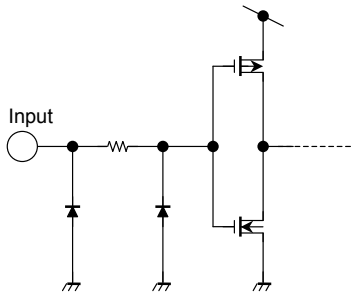
AC Characteristics (Input: $t_r = t_f = 3$ ns)

Characteristics	Symbol	Test Condition			Ta = 25°C			Ta = −40~85°C		Unit
			V_{CC} (V)	C_L (pF)	Min	Typ.	Max	Min	Max	
Propagation delay time (CK, CK INH-Q_H, $\overline{Q}_H$)	t_{pLH} t_{pHL}	—	3.3 ± 0.3	15	—	9.9	15.4	1.0	18.0	ns
				50	—	12.4	18.9	1.0	21.5	
			5.0 ± 0.5	15	—	6.6	9.9	1.0	11.5	
				50	—	8.1	11.9	1.0	13.5	
Propagation delay time (S/L-Q_H, $\overline{Q}_H$)	t_{pLH} t_{pHL}	—	3.3 ± 0.3	15	—	9.9	15.8	1.0	18.5	ns
				50	—	12.4	19.3	1.0	22.0	
			5.0 ± 0.5	15	—	6.7	9.9	1.0	11.5	
				50	—	8.2	11.9	1.0	13.5	
Propagation delay time (H-Q_H, $\overline{Q}_H$)	t_{pLH} t_{pHL}	—	3.3 ± 0.3	15	—	9.2	14.1	1.0	16.5	ns
				50	—	11.7	17.6	1.0	20.0	
			5.0 ± 0.5	15	—	5.9	9.0	1.0	10.5	
				50	—	7.4	11.0	1.0	12.5	
Maximum clock frequency	f_{max}	—	3.3 ± 0.3	15	65	85	—	55	—	MHz
				50	60	105	—	50	—	
			5.0 ± 0.5	15	110	150	—	90	—	
				50	95	130	—	85	—	
Input capacitance	C_{IN}	—			—	4	10	—	10	pF
Power dissipation capacitance	C_{PD}	(Note)			—	50	—	—	—	pF

Note: C_{PD} 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:

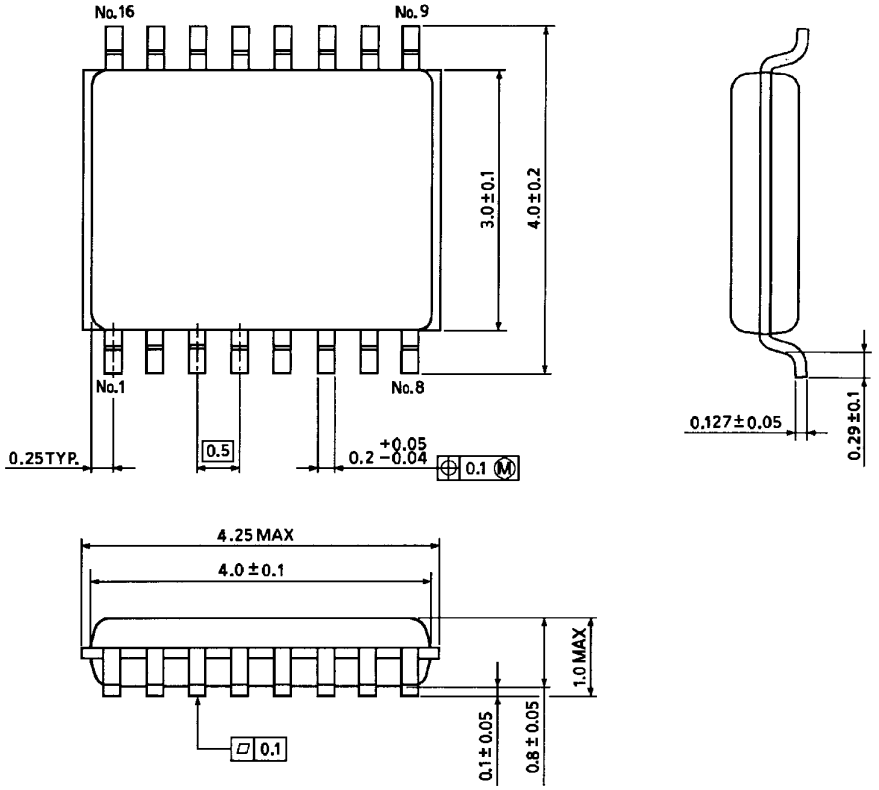
$$I_{CC\ (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$$

Input Equivalent Circuit



Package Dimensions

VSSOP16-P-0030-0.50 Unit : mm



Weight: 0.02 g (typ.)

RESTRICTIONS ON PRODUCT USE

20070701-EN

- The information contained herein is subject to change without notice.
- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property.
  In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the “Handling Guide for Semiconductor Devices,” or “TOSHIBA Semiconductor Reliability Handbook” etc.
- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.).These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury (“Unintended Usage”). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of TOSHIBA products listed in his document shall be made at the customer’s own risk.
- The products described in this document shall not be used or embedded to any downstream products of which manufacture, use and/or sale are prohibited under any applicable laws and regulations.
- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA for any infringements of patents or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any patents or other rights of TOSHIBA or the third parties.
- Please contact your sales representative for product-by-product details in this document regarding RoHS compatibility. Please use these products in this document in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances. Toshiba assumes no liability for damage or losses occurring as a result of noncompliance with applicable laws and regulations.