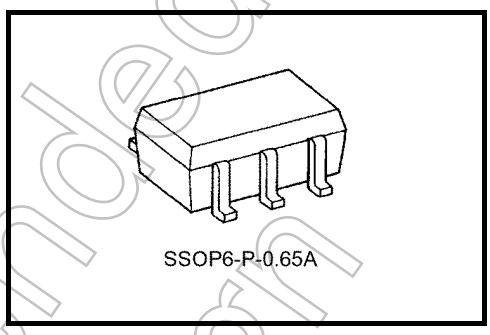
TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC7PA175FU

D-Type Flip-Flop with Clear

Features

- Operating voltage range: V_{CC} = 1.8 to 3.6 V
- High-speed operation: t_{pd} = 3.5 ns (max) at V_{CC} = 3.0 to 3.6 V
  t_{pd} = 4.6 ns (max) at V_{CC} = 2.3 to 2.7 V
  t_{pd} = 9.2 ns (max) at V_{CC} = 1.8 V
- High-level output current:
  I_{OH}/I_{OL} = ±24 mA (min) at V_{CC} = 3.0 V
  I_{OH}/I_{OL} = ±18 mA (min) at V_{CC} = 2.3 V
  I_{OH}/I_{OL} = ±6 mA (min) at V_{CC} = 1.8 V
- 3.6-V tolerant inputs
- 3.6-V power down protection output



Weight: 0.0068 g (typ.)

Absolute Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Supply voltage	V_{CC}	−0.5 to 4.6	V
DC input voltage	V_{IN}	−0.5 to 4.6	V
DC output voltage	V_{OUT}	−0.5 to 4.6 (Note 1) −0.5 to V_{CC} + 0.5 (Note 2)	V
Input diode current	I_{IK}	−50	mA
Output diode current	I_{OK}	−50 (Note 3)	mA
DC output current	I_{OUT}	±50	mA
Power dissipation	P_D	200	mW
DC V_{CC}/ground current	I_{CC}	±100	mA
Storage temperature	T_{stg}	−65 to 150	°C

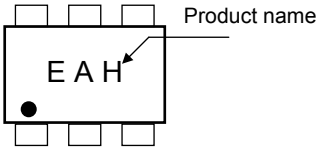
Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.
Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook (“Handling Precautions”/“Derating Concept and Methods”) and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Note 1: V_{CC} = 0 V

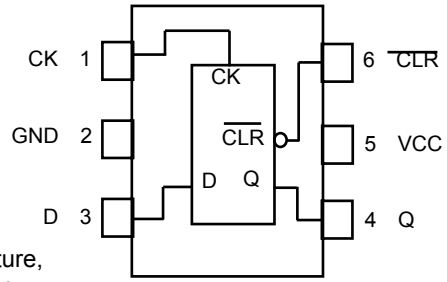
Note 2: High or Low state. The I_{OUT} absolute maximum rating must be adhered to.

Note 3: V_{OUT} < GND

Marking

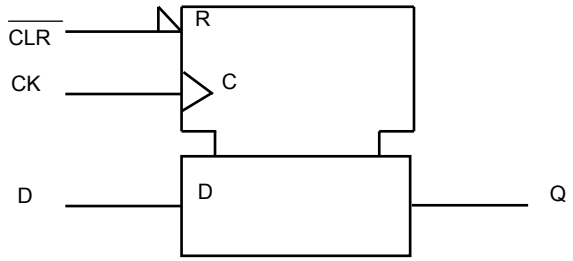


Pin Assignment (top view)



Start of commercial production
2003-07

IEC Logic Symbol



Truth Table

INPUTS			OUTPUT	FUNCTION
$\overline{CLR}$	D	CK	Q	
L	X	X	L	CLEAR
H	L	↑	L	—
H	H	↑	H	—
H	X	↓	Qn	NO CHANGE

X: Don't care

Operating Ranges

Characteristics	Symbol	Rating		Unit
Supply voltage	V_{CC}	1.8 to 3.6		V
		1.2 to 3.6	(Note 4)	
Input voltage	V_{IN}	−0.3 to 3.6		V
Output voltage	V_{OUT}	0 to 3.6	(Note 5)	V
		0 to V_{CC}	(Note 6)	
Output Current	I_{OH}/I_{OL}	±24	(Note 7)	mA
		±18	(Note 8)	
		±6	(Note 9)	
Operating temperature	T_{opr}	−40 to 85		°C
Input rise and fall time	d_t/d_v	0 to 10	(Note 10)	ns/V

Note 4: Data retention only

Note 5: V_{CC} = 0 V

Note 6: High or Low state

Note 7: V_{CC} = 3.0 to 3.6 V

Note 8: V_{CC} = 2.3 to 2.7 V

Note 9: V_{CC} = 1.8 V

Note 10: V_{IN} = 0.8 to 2.0 V, V_{CC} = 3.0 V

DC Electrical Characteristics (Ta = –40 to 85°C, 2.7 V < V_{CC} ≤ 3.6 V)

Characteristics	Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
High-Level Input Voltage	V_{IH}	—		2.7 to 3.6	2.0	—	V
Low-Level Input Voltage	V_{IL}	—		2.7 to 3.6	—	0.8	
High-Level Output Voltage	V_{OH}	V_{IN} = V_{IH}	I_{OH} = –100 μA	2.7 to 3.6	V_{CC} – 0.2	—	V
			I_{OH} = –12 mA	2.7	2.2	—	
			I_{OH} = –18 mA	3.0	2.4	—	
			I_{OH} = –24 mA	3.0	2.2	—	
Low-Level Output Voltage	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 100 μA	2.7 to 3.6	—	0.2	
			I_{OL} = 12 mA	2.7	—	0.4	
			I_{OL} = 18 mA	3.0	—	0.4	
			I_{OL} = 24 mA	3.0	—	0.55	
Input Leakage Current	I_{IN}	V_{IN} = 0 to 3.6 V		2.7 to 3.6	—	±5.0	μA
Power-off Leakage Current	I_{OFF}	V_{IN}, V_{OUT} = 0 to 3.6 V		0	—	10.0	μA
Quiescent Supply Current	I_{CC}	V_{IN} = V_{CC} or GND		2.7 to 3.6	—	20.0	μA
		V_{CC} ≤ (V_{IN}, V_{OUT}) ≤ 3.6 V		2.7 to 3.6	—	±20.0	
Increase in I_{CC} per Input	ΔI_{CC}	V_{IH} = V_{CC} – 0.6 V		2.7 to 3.6	—	750	

DC Electrical Characteristics (Ta = –40 to 85°C, 2.3 V ≤ V_{CC} ≤ 2.7 V)

Characteristics	Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
High-Level Input Voltage	V_{IH}	—		2.3 to 2.7	1.6	—	V
Low-Level Input Voltage	V_{IL}	—		2.3 to 2.7	—	0.7	
High-Level Output Voltage	V_{OH}	V_{IN} = V_{IH}	I_{OH} = –100 μA	2.3 to 2.7	V_{CC} – 0.2	—	V
			I_{OH} = –6 mA	2.3	2.0	—	
			I_{OH} = –12 mA	2.3	1.8	—	
			I_{OH} = –18 mA	2.3	1.7	—	
Low-Level Output Voltage	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 100 μA	2.3 to 2.7	—	0.2	
			I_{OL} = 12 mA	2.3	—	0.4	
			I_{OL} = 18 mA	2.3	—	0.6	
Input Leakage Current	I_{IN}	V_{IN} = 0 to 3.6 V		2.3 to 2.7	—	±5.0	μA
Power-off Leakage Current	I_{OFF}	V_{IN}, V_{OUT} = 0 to 3.6 V		0	—	10.0	μA
Quiescent Supply Current	I_{CC}	V_{IN} = V_{CC} or GND		2.3 to 2.7	—	20.0	μA
		V_{CC} ≤ (V_{IN}, V_{OUT}) ≤ 3.6 V		2.3 to 2.7	—	±20.0	

DC Electrical Characteristics (Ta = –40 to 85°C, 1.8 V ≤ V_{CC} < 2.3 V)

Characteristics	Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
High-Level Input Voltage	V_{IH}	—		1.8 to 2.3	0.7 × V_{CC}	—	V
Low-Level Input Voltage	V_{IL}	—		1.8 to 2.3	—	0.2 × V_{CC}	V
High-Level Output Voltage	V_{OH}	V_{IN} = V_{IH}	I_{OH} = –100 μA	1.8	V_{CC} – 0.2	—	V
			I_{OH} = –6 mA	1.8	1.4	—	
Low-Level Output Voltage	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 100 μA	1.8	—	0.2	
			I_{OL} = 6 mA	1.8	—	0.3	
Input Leakage Current	I_{IN}	V_{IN} = 0 to 3.6 V		1.8	—	±5.0	μA
Power-off Leakage Current	I_{OFF}	V_{IN}, V_{OUT} = 0 to 3.6 V		0	—	10.0	μA
Quiescent Supply Current	I_{CC}	V_{IN} = V_{CC} or GND		1.8	—	20.0	μA
		V_{CC} ≤ (V_{IN}, V_{OUT}) ≤ 3.6 V		1.8	—	±20.0	

AC Electrical Characteristics (Ta = –40 to 85°C, input t_r = t_f = 2.0 ns, C_L =30 pF, R_L =500 Ω)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Min	Max	Unit
Maximam Clock Frequency	f_{max}		1.8	100	—	MHz
			2.5 ± 0.2	200	—	
			3.3 ± 0.3	250	—	
Propagation Delay Time (CK-Q)	t_{pLH} t_{pHL}	(Figure 1 and 2)	1.8	1.0	9.2	ns
			2.5 ± 0.2	0.8	4.6	
			3.3 ± 0.3	0.6	3.5	
Propagation Delay Time ($\overline{CLR}$-Q)	t_{pHL}	(Figure 1 and 3)	1.8	1.0	9.2	ns
			2.5 ± 0.2	0.8	4.6	
			3.3 ± 0.3	0.6	3.5	
Minimum Set-up Time	t_s	(Figure 1 and 2)	1.8	3.0	—	ns
			2.5 ± 0.2	1.5	—	
			3.3 ± 0.3	1.5	—	
Minimum Hold time	t_h	(Figure 1 and 2)	1.8	3.0	—	ns
			2.5 ± 0.2	1.7	—	
			3.3 ± 0.3	1.7	—	
Minimun Pulse Width (CK)	t_w(H) t_w(L)	(Figure 1 and 2)	1.8	4.0	—	ns
			2.5 ± 0.2	2.3	—	
			3.3 ± 0.3	2.3	—	
Minimun Pulse Width ($\overline{CLR}$)	t_w(L)	(Figure 1 and 3)	1.8	4.0	—	ns
			2.5 ± 0.2	2.3	—	
			3.3 ± 0.3	2.3	—	
Minimum Removal Time	t_{rem}	(Figure 1 and 3)	1.8	3.1	—	ns
			2.5 ± 0.2	2.0	—	
			3.3 ± 0.3	1.5	—	

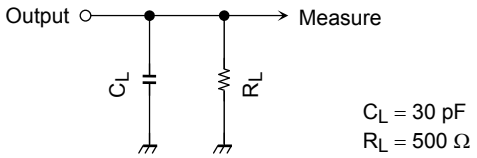
For C_L = 50 pF, add approximately 300 ps to the AC maximum specification.

Capacitive Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Typ.	Unit
Input Capacitance	C_{IN}	—	1.8, 2.5, 3.3	2.4	pF
Power Dissipation Capacitance	C_{PD}	f_{IN} = 10 MHz (Note 11)	1.8, 2.5, 3.3	11	pF

Note11: 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}

Figure 1 Test Circuit



AC Waveforms

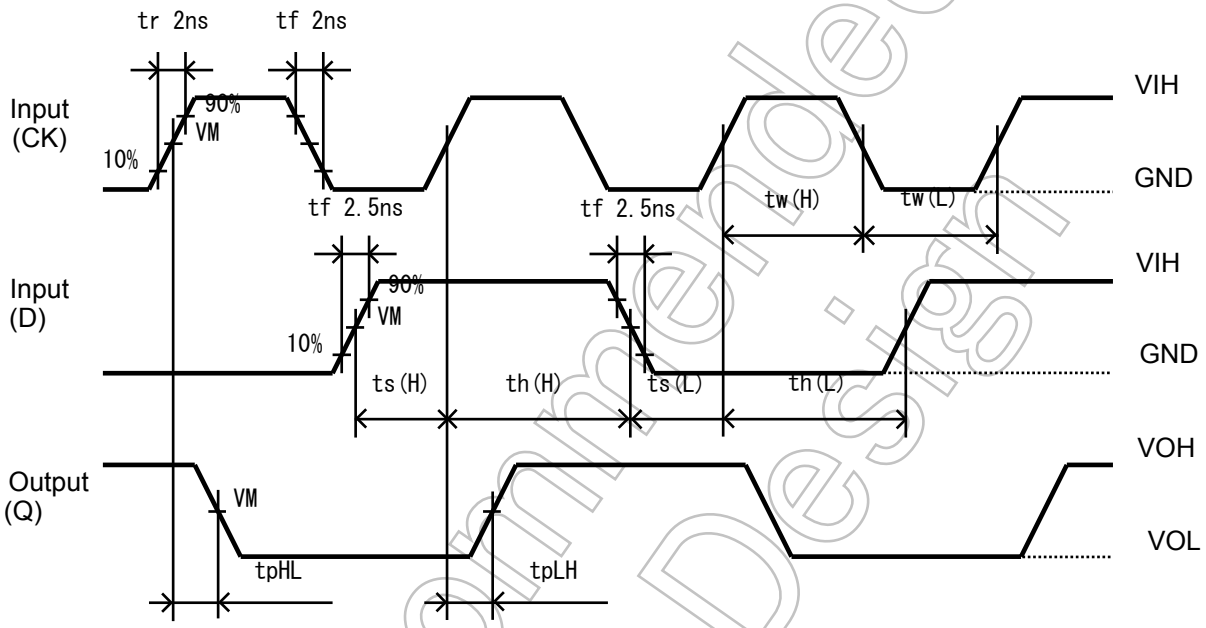
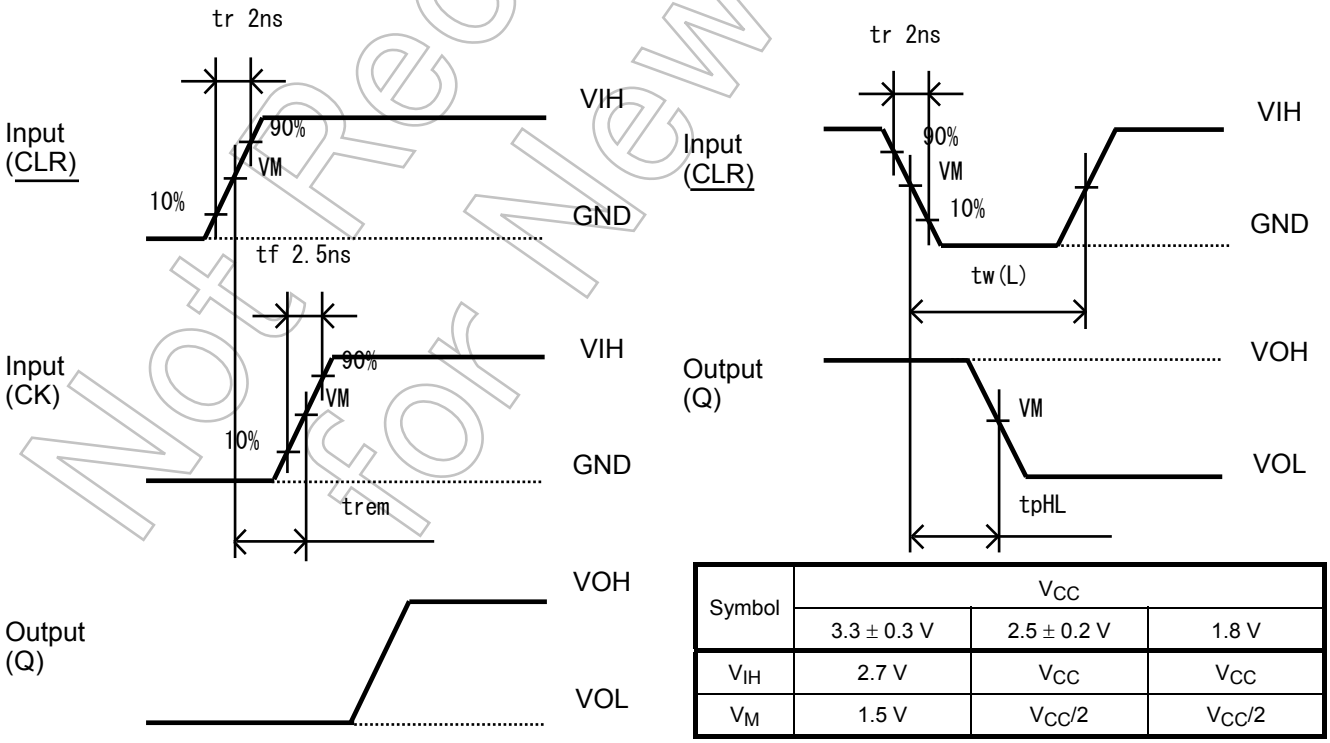


Figure 2 t_{pLH}, t_{pHL}



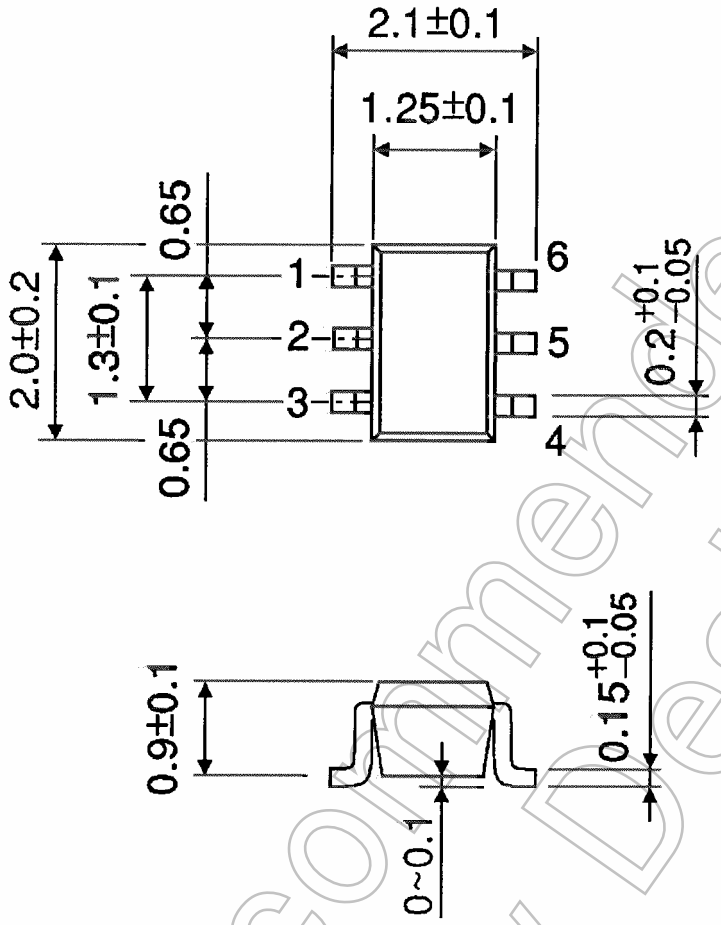
Symbol	V_{CC}		
	3.3 ± 0.3 V	2.5 ± 0.2 V	1.8 V
V_{IH}	2.7 V	V_{CC}	V_{CC}
V_M	1.5 V	$V_{CC}/2$	$V_{CC}/2$

Figure 3 t_{rem} , t_{pHL} , t_w (L)

Package Dimensions

SSOP6-P-0.65A

Unit: mm



Weight: 0.0068 g (typ.)

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