TOSHIBA CMOS Digital Integrated Circuit   Silicon Monolithic

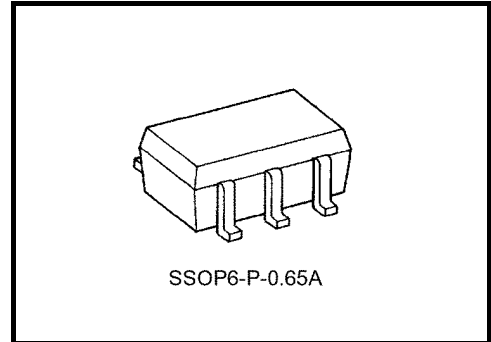# TC7PA175FU

D-Type Flip-Flop with Clear

Features

- Operating voltage range: V_{CC} = 1.8~3.6 V
- High-speed operation: t_{pd} = 3.5 ns (max) at V_{CC} = 3.0~3.6 V
  t_{pd} = 4.6 ns (max) at V_{CC} = 2.3~2.7 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

SSOP6-P-0.65A

Weight: 0.0068 g (typ.)

Absolute Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Value	Unit
Power supply voltage	V_{CC}	−0.5~4.6	V
DC input voltage	V_{IN}	−0.5~4.6	V
DC output voltage	V_{OUT}	−0.5~4.6 (Note 1)	V
		−0.5~V_{CC} + 0.5 (Note 2)	
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}	−65~150	°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).
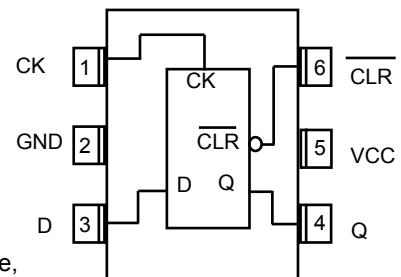
Note 1: V_{CC} = 0 V

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

Note 3: V_{OUT} < GND
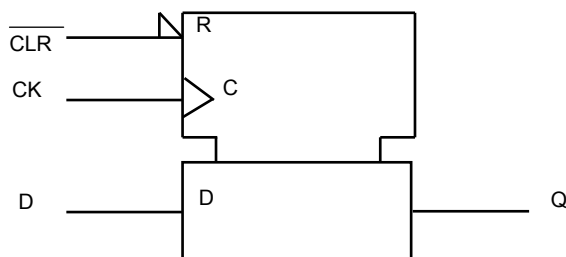
Marking

E A H

Product name
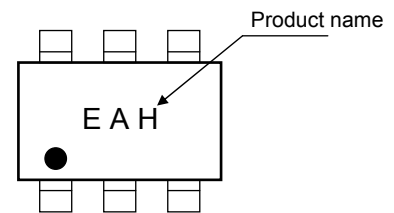
Pin Assignment (top view)

IEC Logic Symbol

Truth Table

INPUTS			OUTPUT	FUNCTION
$\overline{\text{CLR}}$	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	Value		Unit
Power supply voltage	V_{CC}	1.8~3.6		V
		1.2~3.6	(Note 4)	
Input voltage	V_{IN}	−0.3~3.6		V
Output voltage	V_{OUT}	0~3.6	(Note 5)	V
		0~V_{CC}	(Note 6)	
Output Current	I_{OH}/I_{OL}	±24	(Note 7)	mA
		±18	(Note 8)	
		±6	(Note 9)	
Operating temperature	T_{opr}	−40~85		°C
Input rise and fall time	d_t/d_v	0~10	(Note 10)	ns/V

Note 4: Data retention only

Note 5: $V_{CC} = 0$ V

Note 6: High or Low state

Note 7: $V_{CC} = 3.0$~3.6 V

Note 8: $V_{CC} = 2.3$~2.7 V

Note 9: $V_{CC} = 1.8$ V

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

DC Electrical Characteristics (Ta = −40~85°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}	—		2.7~3.6	2.0	—	V
Low-Level Input Voltage	V_{IL}	—		2.7~3.6	—	0.8	
High-Level Output Voltage	V_{OH}	$V_{IN} = V_{IH}$	$I_{OH} = -100\ \mu A$	2.7~3.6	$V_{CC} - 0.2$	—	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}	$I_{OL} = 100\ \mu A$	2.7~3.6	—	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}	$V_{IN} = 0\text{~}3.6\ V$		2.7~3.6	—	±5.0	μA
Power-off Leakage Current	I_{OFF}	$V_{IN}, V_{OUT} = 0\text{~}3.6\ V$		0	—	10.0	μA
Quiescent Supply Current	I_{CC}	$V_{IN} = V_{CC}$ or GND		2.7~3.6	—	20.0	μA
		$V_{CC} ≦ (V_{IN}, V_{OUT}) ≦ 3.6\ V$		2.7~3.6	—	±20.0	
Increase in I_{CC} per Input	ΔI_{CC}	$V_{IH} = V_{CC} - 0.6\ V$		2.7~3.6	—	750	

DC Electrical Characteristics (Ta = −40~85°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}	—		2.3~2.7	1.6	—	V
Low-Level Input Voltage	V_{IL}	—		2.3~2.7	—	0.7	
High-Level Output Voltage	V_{OH}	$V_{IN} = V_{IH}$	$I_{OH} = -100\ \mu A$	2.3~2.7	$V_{CC} - 0.2$	—	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}	$I_{OL} = 100\ \mu A$	2.3~2.7	—	0.2	
			$I_{OL} = 12\ mA$	2.3	—	0.4	
			$I_{OL} = 18\ mA$	2.3	—	0.6	
Input Leakage Current	I_{IN}	$V_{IN} = 0\text{~}3.6\ V$		2.3~2.7	—	±5.0	μA
Power-off Leakage Current	I_{OFF}	$V_{IN}, V_{OUT} = 0\text{~}3.6\ V$		0	—	10.0	μA
Quiescent Supply Current	I_{CC}	$V_{IN} = V_{CC}$ or GND		2.3~2.7	—	20.0	μA
		$V_{CC} ≦ (V_{IN}, V_{OUT}) ≦ 3.6\ V$		2.3~2.7	—	±20.0	

DC Electrical Characteristics (Ta = −40~85°C, 1.8 V ≦ V$_{CC}$ < 2.3 V)

Characteristics	Symbol	Test Condition		V$_{CC}$ (V)	Min	Max	Unit
High-Level Input Voltage	V$_{IH}$	—		1.8~2.3	0.7 × V$_{CC}$	—	V
Low-Level Input Voltage	V$_{IL}$	—		1.8~2.3	—	0.2 × V$_{CC}$	
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$_{IN}$ = 0~3.6 V		1.8	—	±5.0	μA
Power-off Leakage Current	I$_{OFF}$	V$_{IN}$, V$_{OUT}$ = 0~3.6 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 = −40~85°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.
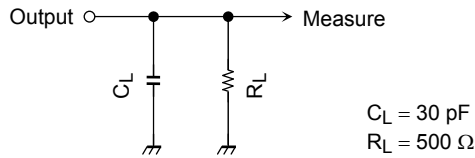
Capacitive Characteristics (Ta = 25°C)

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

$C_L = 30$ pF
$R_L = 500$ Ω

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	$V_{CC}/2$	$V_{CC}/2$
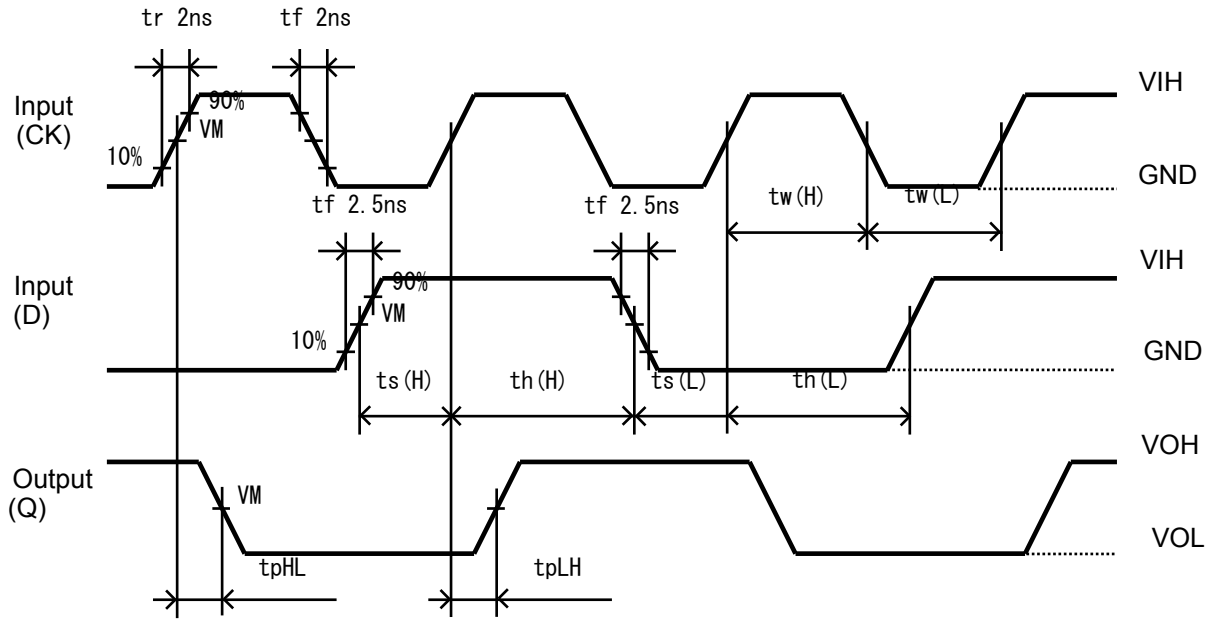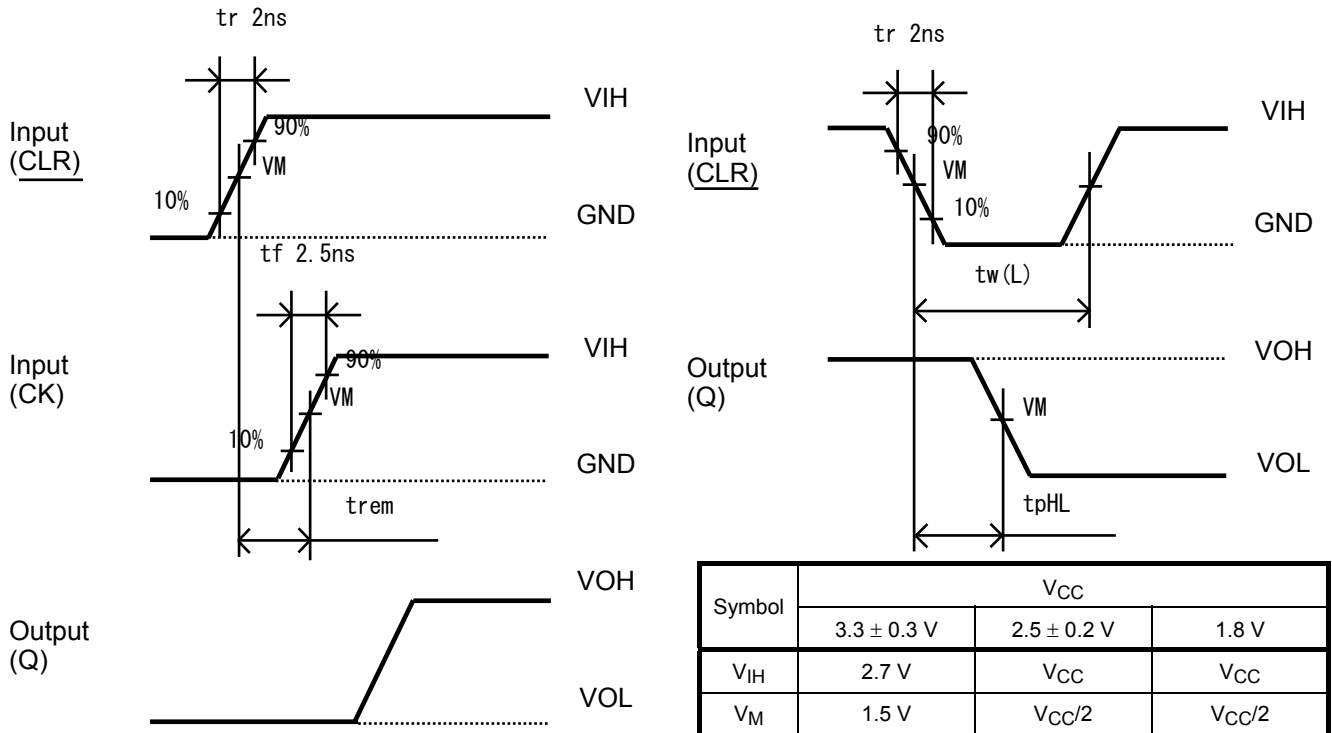
Figure 3 t_{rem} , t_{pHL} , t_w (L)

Package Dimensions

SSOP6-P-0.65A

Unit: mm
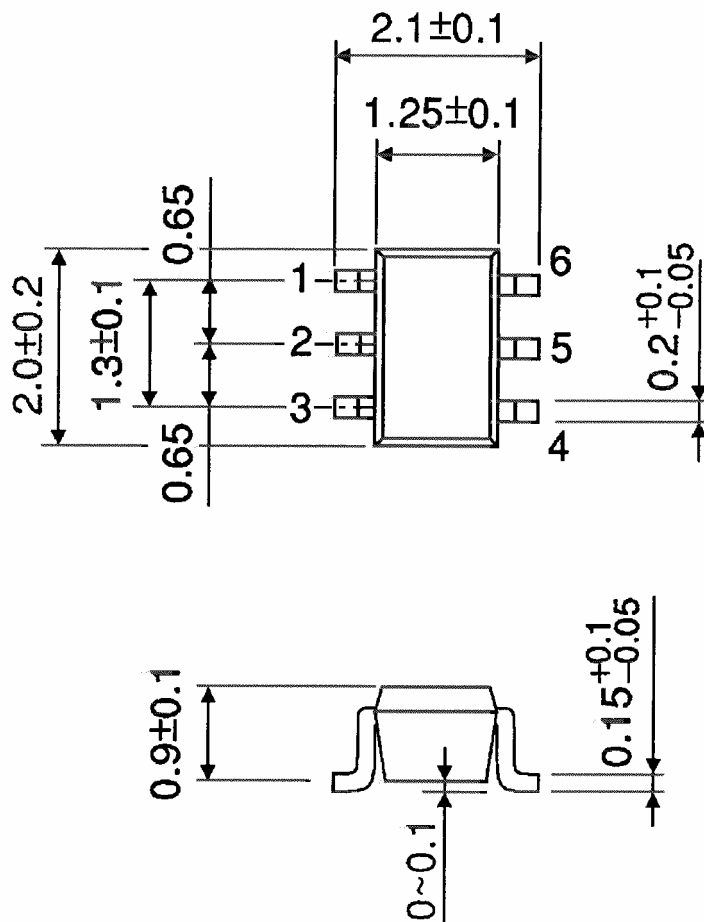
Weight: 0.0068 g (typ.)

RESTRICTIONS ON PRODUCT USE