TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

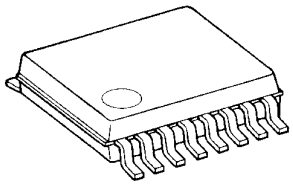
TC7MP01FK

Low-Voltage Triple Gate(6-input AND + 4-input OR + inverter)

The TC7MP01FK is a high-performance CMOS triple gate (6-input AND + 4-input OR + inverter). Desinged for use in 1.8 V, 2.5 V, or 3.3 V systems, it achieves high-speed operation while maintaining the CMOS low power dissipation.

It is also designed with overvoltage tolerant inputs and outputs up to 3.6V.

All inputs are equipped with protection circuits against static discharge.



VSSOP16-P-0030-0.50

Weight : 0.03 g (typ.)

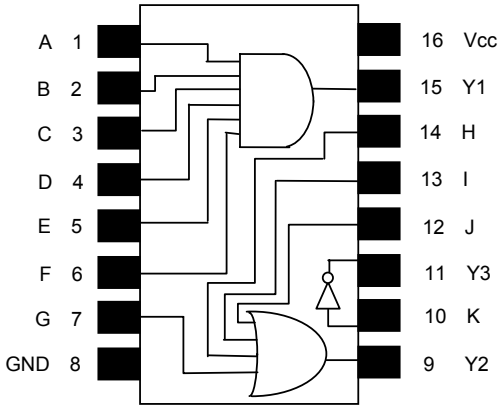
Features

- Low-voltage operation : V_{CC} = 1.65 to 3.6V
- Quiescent supply current : I_{CC} = 2 μA (max) (Vcc=3.6V)
- High-speed operation : 6 input AND
  tpd=3.7ns (max) (Vcc=3.3±0.3V)
  tpd=5.5ns (max) (Vcc=2.5±0.2V)
  tpd=11.0ns (max) (Vcc=1.8±0.15V)

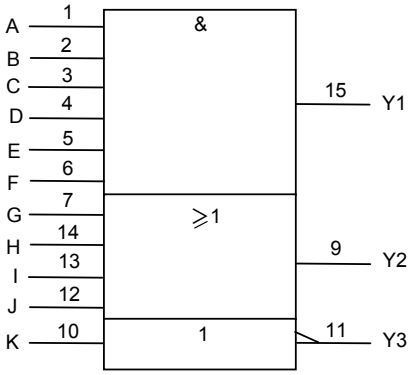
  4 input OR
  tpd=3.5ns (max) (Vcc=3.3±0.3V)
  tpd=5.0ns (max) (Vcc=2.5±0.2V)
  tpd=10.0ns (max) (Vcc=1.8±0.15V)

  INV.
  tpd=3.8ns (max) (Vcc=3.3±0.3V)
  tpd=5.2ns (max) (Vcc=2.5±0.2V)
  tpd=9.5ns (max) (Vcc=1.8±0.15V)
- Output current : I_{OH}/I_{OL}=±12mA (min) (Vcc=3.0V)
  : I_{OH}/I_{OL}=±9mA (min) (Vcc=2.3V)
  : I_{OH}/I_{OL}=±2mA (min) (Vcc=1.65V)
- Latch-up performance : ±300mA
- ESD performance : Machine model > ±200V
  : Human body model > ±2000V
- Ultra-small package : VSSOP (US16)
- Power-down protection provided on all inputs and outputs.

Pin Assighment (top view)



IEC Logic Symbol



Truth Table (AND Logic)

A	B	C	D	E	F	Y1
L	x	x	x	x	x	L
x	L	x	x	x	x	L
x	×	L	x	x	x	L
x	×	×	L	x	x	L
x	×	×	×	L	x	L
x	x	x	x	x	L	L
H	H	H	H	H	H	H

Truth Table (OR Logic)

G	H	I	J	Y2
H	x	x	x	H
x	H	x	x	H
x	x	H	x	H
x	x	x	H	H
L	L	L	L	L

Truth Table (INV. Logic)

K	Y3
L	H
H	L

Maximum Ratings

Characteristics	Symbol	Rating	Unit
Power supply voltage	Vcc	−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)	V
		−0.5 to Vcc+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
DC Vcc/ground current	I_{CC}/I_{GND}	±100	mA
Power dissipation	P_D	180	mW
Storage temperature	Tstg	−65 to 150	°C

(Note 1) Vcc = 0V

(Note 2) High or low state.

(Note 3) $V_{OUT} < GND$, $V_{OUT} > Vcc$

Recommended Operating Range

Characteristics	Symbol	Rating	Unit
Power supply voltage	Vcc	1.65 to 3.6	V
		1.2 to 3.6(Note 4)	
DC input voltage	V_{IN}	−0.3 to 3.6	V
DC output voltage	V_{OUT}	0 to 3.6 (Note 5)	V
		0 to Vcc (Note 6)	
Output current	I_{OH}/I_{OL}	±12 (Note 7)	mA
		±9 (Note 8)	
		±2 (Note 9)	
Operating Temperature	Topr	−40 to 85	°C
Input rise and fall time	dt / dv	0 to 10 (Note 10)	ns/V

(Note 4) Data retention only

(Note 5) Vcc = 0V

(Note 6) High or low state

(Note 7) Vcc = 3.0 to 3.6V

(Note 8) Vcc = 2.3 to 2.7V

(Note 9) Vcc = 1.65 to 1.95V

(Note 10) VIN=0.8 to 2.0V,Vcc=3.0V

Electrical Characteristics

DC Characteristics (Ta=-40 to 85℃, 2.7V＜Vcc≦3.6V)

Characteristics		Symbol	Test condition		Vcc(V)	Min	Max	Unit
Input Voltage	H-level	V_{IH}	—		2.7 to 3.6	2.0	—	V
	L-level	V_{IL}	—		2.7 to 3.6	—	0.8	
Output voltage	H-level	V_{0H}	V_{IN}= V_{IH} orV_{IL}	I_{OH}= -100uA	2.7 to 3.6	Vcc-0.2	—	V
				I_{OH}= -6mA	2.7	2.2	—	
				I_{OH}= -9mA	3.0	2.4	—	
				I_{OH}= -12mA	3.0	2.2	—	
	L-level	V_{0L}	V_{IN}= V_{IH} orV_{IL}	I_{OL}= 100uA	2.7 to 3.6	—	0.2	
				I_{OL}= 6mA	2.7	—	0.4	
				I_{OL}= 9mA	3.0	—	0.4	
				I_{OL}= 12mA	3.0	—	0.55	
Input leakage current		I_{IN}	V_{IN}=0 to 3.6V		2.7 to 3.6	—	±2.0	μA
Power-off leakage current		I_{OFF}	V_{IN},V_{OUT}=0 to 3.6V		0	—	2.0	μA
Quiescent supply current		I_{CC}	V_{IN}=V_{CC} or GND		2.7 to 3.6	—	2.0	μA
		ΔI_{CC}	V_{IN}=V_{CC}-0.6V (per input)		2.7 to 3.6	—	750	μA

DC Characteristics (Ta=-40 to 85℃, 2.3V≦Vcc≦2.7V)

Characteristics		Symbol	Test condition		Vcc(V)	Min	Max	Unit
Input voltage	H-level	V_{IH}	—		2.3 to 2.7	1.6	—	V
	L-level	V_{IL}	—		2.3 to 2.7	—	0.7	
Output voltage	H-level	V_{0H}	V_{IN}= V_{IH} orV_{IL}	I_{OH}=-100uA	2.3 to 2.7	Vcc-0.2	—	V
				I_{OH}= -3mA	2.3	2.0	—	
				I_{OH}= -6mA	2.3	1.8	—	
				I_{OH}= -9mA	2.3	1.7	—	
	L-level	V_{0L}	V_{IN}= V_{IH} orV_{IL}	I_{OL}= 100uA	2.3 to 2.7	—	0.2	
				I_{OL}= 6mA	2.3	—	0.4	
				I_{OL}= 9mA	2.3	—	0.6	
Input leakage current			V_{IN}=0 to 3.6V		2.3 to 2.7	—	±2.0	μA
Power-off leakage current		I_{OFF}	V_{IN},V_{OUT}=0 to 3.6V		0	—	2.0	μA
Quiescent supply current		I_{CC}	V_{IN}=V_{CC} or GND		2.3 to 2.7	—	2.0	μA

DC Characteristics (Ta=-40 to 85℃, 1.65V≦Vcc＜2.3V)

Characteristics		Symbol	Test condition		Vcc(V)	Min	Max	Unit
Input voltage	H-Level	V_{IH}	―		1.65 to 2.3	0.7×Vcc	―	V
	L-Level	V_{IL}	―		1.65 to 2.3	―	0.13×Vcc	
Output voltage	H-Level	V_{0H}	V_{IN}= V_{IH} orV_{IL}	I_{OH}=-100uA	1.65	Vcc-0.2	―	V
				I_{OH}=-2mA	1.65	1.3	―	
	L-Level	V_{0L}	V_{IN}= V_{IH} orV_{IL}	I_{OL}=2mA	1.65	―	0.2	
Input leakage current		I_{IN}	V_{IN}=0 to 3.6V		1.65	―	±2.0	μA
Power-off leakage current		I_{OFF}	V_{IN},V_{OUT}=0 to 3.6V		0	―	2.0	μA
Quiescent supply current		I_{CC}	V_{IN}=V_{CC} or GND		1.65	―	2.0	μA

AC Characteristics (Ta=-40 to 85℃,Input: tr=tf=2.0ns, CL=30pF, RL=500Ω)

Characteristics	Symbol	Test condition		Vcc(V)	Min	Max	Unit
Propagation delay time	tpLH tpHL	6 input AND	Figure 1, Figure 2	1.8±0.15	1.0	11.0	ns
				2.5±0.2	0.8	5.5	
				3.3±0.3	0.6	3.7	
		4 input OR		1.8±0.15	1.0	10.0	
				2.5±0.2	0.8	5.0	
				3.3±0.3	0.6	3.5	
		INV.		1.8±0.15	1.0	9.5	
				2.5±0.2	0.8	5.2	
				3.3±0.3	0.6	3.8	
Output to output skew	tosLH tosHL	(Note 11)		1.8±0.15	―	0.5	ns
				2.5±0.2	―	0.5	
				3.3±0.3	―	0.5	

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

Note 11: Parameter guaranteed by design.

(tosLH＝|t_{pLHm}－t_{pLHn}|, tosHL＝|t_{pHLm}－t_{pHLn}|)

Capacitive Characteristics(Ta=25℃)

Characteristics	Symbol	Test Condition		Vcc(V)	Typ.	Unit
Input Capacitance	C_{IN}	—		1.8, 2.5, 3.3	6	pF
Power dissipation capacitance	C_{PD}	6 input AND	fin=10MHz Table 1、(Note12)	1.8, 2.5, 3.3	18	pF
		4 input OR		1.8, 2.5, 3.3	17	
		INV.		1.8, 2.5, 3.3	14	

Note12: 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.

$I_{CC(opr)} = C_{PD} \cdot V_{CC} \cdot V_{IN} + I_{CC}/3$ (per gate)

Table1 C_{PD} Test Condition

Function	Pin															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
6 input AND	P	H	H	H	H	H	X	G	O	X	O	X	X	X	C	V
4 input OR	X	X	X	X	X	X	P	G	C	X	O	L	L	L	O	V
INV.	X	X	X	X	X	X	X	G	O	P	C	X	X	X	O	V

—Symbol explanation—

V=V_{CC}(+3.3V)	X=Don't care(Fixed to V_{CC} or GND)
G=GND(0V)	O=Open
H=Logic1(VCC)	C=Connect a condenser(30pF) between output terminal and GND.
L=Logic0(GND)	P=Input pulse with 50% duty cycle.

AC Test Circuit

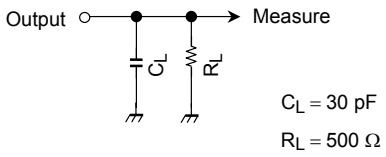
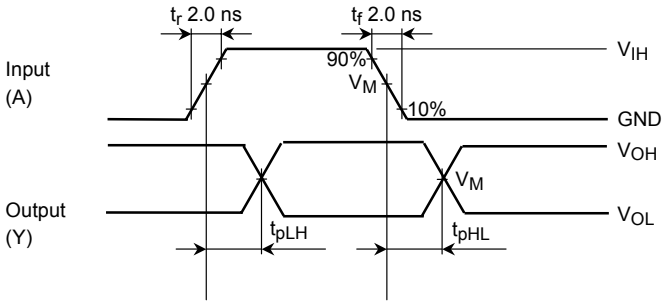


Figure 1

AC Waveform

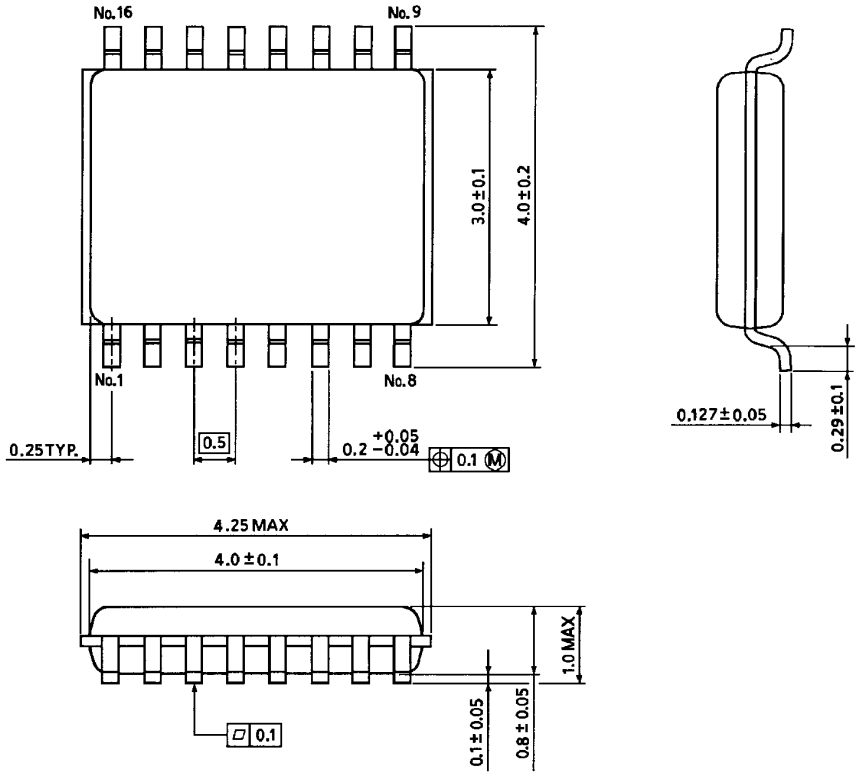


Symbol	Vcc		
	3.3±0.3V	2.5±0.2V	1.8±0.15V
V_{IH}	2.7V	Vcc	Vcc
V_M	1.5V	Vcc/2	Vcc/2

Figure 2 t_{pLH}, t_{pHL}

Package Dimensions

VSSOP16-P-0030-0.50 Unit : mm



Weight: 0.03 g (typ.)

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