TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

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Low Voltage Quad 2-Channel Multiplexer with 3.6 V Tolerant Inputs and Outputs

The TC7MA257FK is a high performance CMOS multiplexer. Designed for use in 1.8 , 2.5 or 3.3 V systems, it achieves high speed operation while maintaining the CMOS low power dissipation.

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

It consists of four 2-input digital multiplexers with common SELECT and $\overline{\text{OUTPUTENABLE}}$ ($\overline{\text{OE}}$).

If $\overline{\text{OE}}$ is set high the outputs are held in a high-impedance state. The SELECT decoding determines whether the A or B inputs get routed to their corresponding Y outputs.

All inputs are equipped with protection circuits against static discharge.
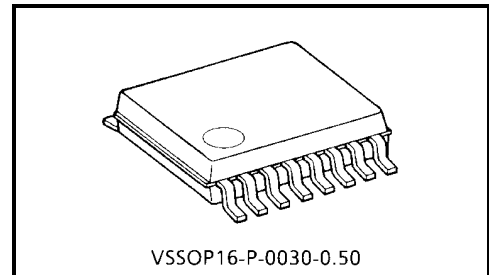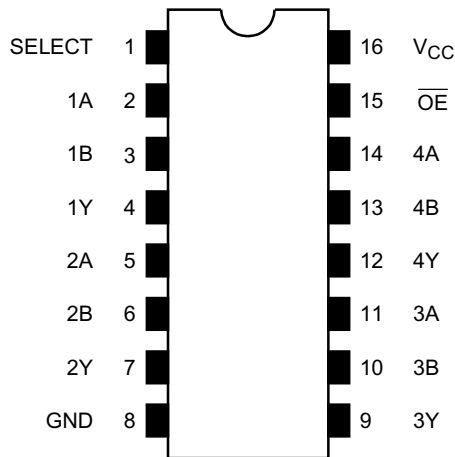
VSSOP16-P-0030-0.50

Weight: 0.02 g (typ.)

Features

- Low voltage operation: V_{CC} = 1.8~3.6 V
- High speed operation: t_{pd} = 3.0 ns (max) (V_{CC} = 3.0~3.6 V)
  t_{pd} = 4.0 ns (max) (V_{CC} = 2.3~2.7 V)
  t_{pd} = 8.0 ns (max) (V_{CC} = 1.8 V)
- 3.6 V tolerant inputs and outputs.
- Output current: I_{OH}/I_{OL} = ±24 mA (min) (V_{CC} = 3.0 V)
  I_{OH}/I_{OL} = ±18 mA (min) (V_{CC} = 2.3 V)
  I_{OH}/I_{OL} = ±6 mA (min) (V_{CC} = 1.8 V)
- Latch-up performance: ±300 mA
- ESD performance: Machine model > ±200 V
  Human body model > ±2000 V
- Package: VSSOP (US16)
- Power down protection is provided on all inputs and outputs.
- Supports live insertion/withdrawal (*)

  *: To ensure the high-impedance state during power up or power down, $\overline{\text{OE}}$ should be tied to V_{CC} through a pullup resistor; the minimum value of the resistor is determined by the current-sourcing capability of the driver.
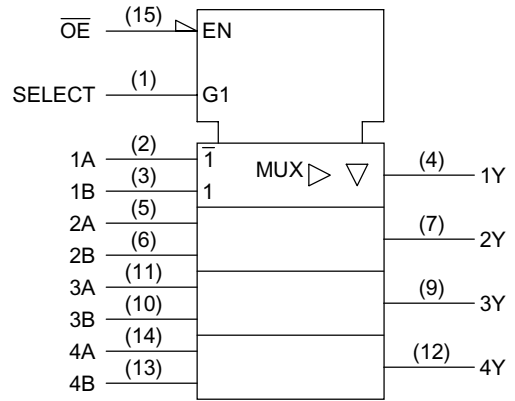
Pin Assignment (top view)

SELECT	1		16	V_CC
1A	2		15	$\overline{OE}$
1B	3		14	4A
1Y	4		13	4B
2A	5		12	4Y
2B	6		11	3A
2Y	7		10	3B
GND	8		9	3Y

IEC Logic Symbol

$\overline{OE}$ — (15) — EN
SELECT — (1) — G1

1A — (2) — 1
1B — (3) — 1
2A — (5)
2B — (6)
3A — (11)
3B — (10)
4A — (14)
4B — (13)

MUX

(4) — 1Y
(7) — 2Y
(9) — 3Y
(12) — 4Y

Truth Table

Inputs				Outputs
$\overline{OE}$	SELECT	A	B	Y
H	X	X	X	Z
L	L	L	X	L
L	L	H	X	H
L	H	X	L	L
L	H	X	H	H

X: Don't care

Z: High impedance

System Diagram

SELECT 1

1A 2
1B 3
1Y 4

2A 5
2B 6
2Y 7

3A 11
3B 10
3Y 9

4A 14
4B 13
4Y 12

$\overline{OE}$ 15
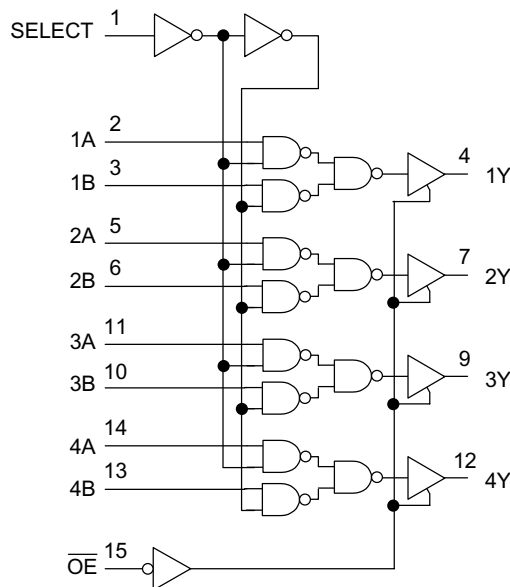
Maximum Ratings

Characteristics	Symbol	Rating	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	180	mW
DC V_{CC}/ground current	I_{CC}/I_{GND}	±100	mA
Storage temperature	T_{stg}	−65~150	°C

Note1: Off-state

Note2: High or low state. I_{OUT} absolute maximum rating must be observed.

Note3: $V_{OUT} < GND$, $V_{OUT} > V_{CC}$

Recommended Operating Range

Characteristics	Symbol	Rating	Unit
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	dt/dv	0~10 (Note 10)	ns/V

Note4: Data retention only

Note5: Off-state

Note6: High or low state

Note7: V_{CC} = 3.0~3.6 V

Note8: V_{CC} = 2.3~2.7 V

Note9: V_{CC} = 1.8 V

Note10: V_{IN} = 0.8~2.0 V, V_{CC} = 3.0 V

Electrical Characteristics

DC Characteristics (Ta = −40~85°C, 2.7 V < V_{CC} ≦ 3.6 V)

Characteristics		Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
Input voltage	High level	V_{IH}	—		2.7~3.6	2.0	—	V
	Low level	V_{IL}	—		2.7~3.6	—	0.8	
Output voltage	High level	V_{OH}	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OH} = -100\ \mu A$	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	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}	$V_{IN} = 0~3.6\ V$		2.7~3.6	—	±5.0	μA
3-state output off-state current		I_{OZ}	$V_{IN} = V_{IH}$ or V_{IL} $V_{OUT} = 0~3.6\ V$		2.7~3.6	—	±10.0	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		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 Characteristics (Ta = −40~85°C, 2.3 V ≦ V_{CC} ≦ 2.7 V)

Characteristics		Symbol	Test Condition		V_{CC} (V)	Min	Max	Unit
Input voltage	High level	V_{IH}	—		2.3~2.7	1.6	—	V
	Low level	V_{IL}	—		2.3~2.7	—	0.7	
Output voltage	High level	V_{OH}	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OH} = -100\ \mu A$	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	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}	$V_{IN} = 0~3.6\ V$		2.3~2.7	—	±5.0	μA
3-state output off-state current		I_{OZ}	$V_{IN} = V_{IH}$ or V_{IL} $V_{OUT} = 0~3.6\ V$		2.3~2.7	—	±10.0	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		2.3~2.7	—	20.0	μA
			$V_{CC} ≦ (V_{IN}, V_{OUT}) ≦ 3.6\ V$		2.3~2.7	—	±20.0	

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

Characteristics		Symbol	Test Condition		V$_{CC}$ (V)	Min	Max	Unit
Input voltage	High level	V$_{IH}$	—		1.8~2.3	0.7 × V$_{CC}$	—	V
	Low level	V$_{IL}$	—		1.8~2.3	—	0.2 × V$_{CC}$	
Output voltage	High level	V$_{OH}$	V$_{IN}$ = V$_{IH}$ or V$_{IL}$	I$_{OH}$ = −100 μA	1.8	V$_{CC}$ − 0.2	—	V
				I$_{OH}$ = −6 mA	1.8	1.4	—	
	Low level	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
3-state output off-state current		I$_{OZ}$	V$_{IN}$ = V$_{IH}$ or V$_{IL}$ V$_{OUT}$ = 0~3.6 V		1.8	—	±10.0	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 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
Propagation delay time (A, B-Y)	t$_{pLH}$ t$_{pHL}$	Figure 1, Figure 2	1.8	1.0	8.0	ns
			2.5 ± 0.2	0.8	4.0	
			3.3 ± 0.3	0.6	3.0	
Propagation delay time (SELECT-Y)	t$_{pLH}$ t$_{pHL}$	Figure 1, Figure 2	1.8	1.0	9.6	ns
			2.5 ± 0.2	0.8	4.8	
			3.3 ± 0.3	0.6	4.0	
3-state output enable time	t$_{pZL}$ t$_{pZH}$	Figure 1, Figure 3	1.8	1.0	9.2	ns
			2.5 ± 0.2	0.8	4.6	
			3.3 ± 0.3	0.6	3.5	
3-state output disable time	t$_{pLZ}$ t$_{pHZ}$	Figure 1, Figure 3	1.8	1.0	6.8	ns
			2.5 ± 0.2	0.8	3.8	
			3.3 ± 0.3	0.6	3.5	
Output to output skew	t$_{osLH}$ t$_{osHL}$	(Note 11)	1.8	—	0.5	ns
			2.5 ± 0.2	—	0.5	
			3.3 ± 0.3	—	0.5	

For C$_L$ = 50 pF, add approximately 300 ps to the AC maximum specification.

Note 11: This parameter is guaranteed by design.

$(t_{osLH} = |t_{pLHm} − t_{pLHn}|, t_{osHL} = |t_{pHLm} − t_{pHLn}|)$

Dynamic Switching Characteristics (Ta $= 25°C$, Input: $t_r = t_f = 2.0$ ns, $C_L = 30$ pF)

Characteristics	Symbol	Test Condition		V_{CC} (V)	Typ.	Unit
Quiet output maximum dynamic V_{OL}	V_{OLP}	$V_{IH} = 1.8$ V, $V_{IL} = 0$ V	(Note 12)	1.8	0.25	V
		$V_{IH} = 2.5$ V, $V_{IL} = 0$ V	(Note 12)	2.5	0.6	
		$V_{IH} = 3.3$ V, $V_{IL} = 0$ V	(Note 12)	3.3	0.8	
Quiet output minimum dynamic V_{OL}	V_{OLV}	$V_{IH} = 1.8$ V, $V_{IL} = 0$ V	(Note 12)	1.8	−0.25	V
		$V_{IH} = 2.5$ V, $V_{IL} = 0$ V	(Note 12)	2.5	−0.6	
		$V_{IH} = 3.3$ V, $V_{IL} = 0$ V	(Note 12)	3.3	−0.8	
Quiet output minimum dynamic V_{OH}	V_{OHV}	$V_{IH} = 1.8$ V, $V_{IL} = 0$ V	(Note 12)	1.8	1.5	V
		$V_{IH} = 2.5$ V, $V_{IL} = 0$ V	(Note 12)	2.5	1.9	
		$V_{IH} = 3.3$ V, $V_{IL} = 0$ V	(Note 12)	3.3	2.2	

Note 12: This parameter is guaranteed by design.

Capacitive Characteristics (Ta $= 25°C$)

Characteristics	Symbol	Test Condition		V_{CC} (V)	Typ.	Unit
Input capacitance	C_{IN}	—		1.8, 2.5, 3.3	6	pF
Output capacitance	C_O	—		1.8, 2.5, 3.3	7	pF
Power dissipation capacitance	C_{PD}	$f_{IN} = 10$ MHz	(Note 13)	1.8, 2.5, 3.3	20	pF

Note 13: 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:

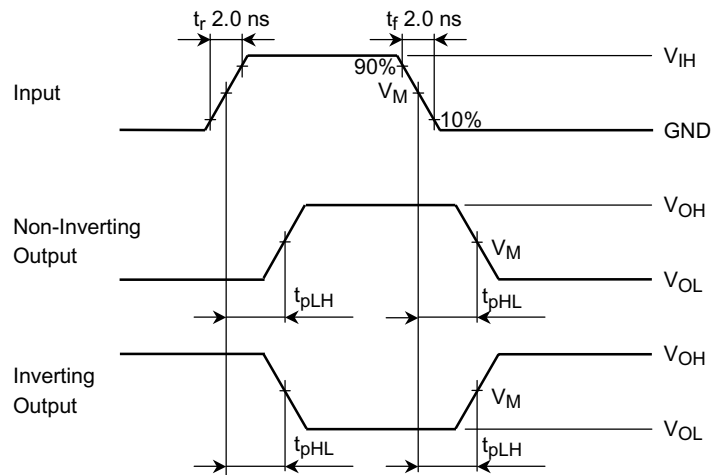$$I_{CC\,(opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$$
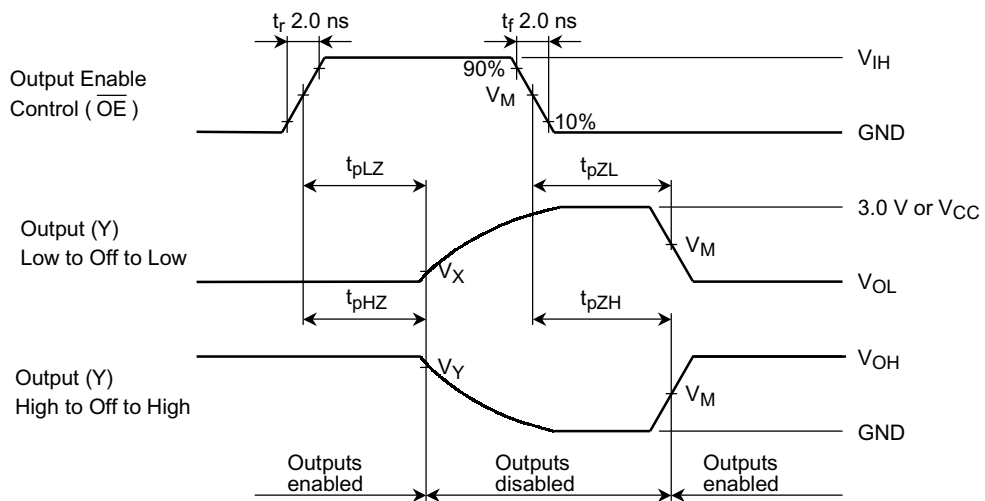
AC Test Circuit
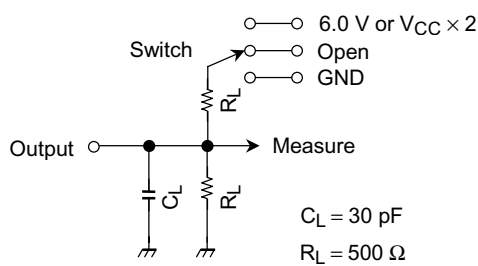
Parameter	Switch	
t_{pLH}, t_{pHL}	Open	
t_{pLZ}, t_{pZL}	6.0 V $V_{CC} \times 2$	@$V_{CC} = 3.3 \pm 0.3$ V @$V_{CC} = 2.5 \pm 0.2$ V @$V_{CC} = 1.8$ V
t_{pHZ}, t_{pZH}	GND	

$C_L = 30$ pF
$R_L = 500$ Ω

Figure 1

AC Waveform

Figure 2   t_pLH, t_pHL

Figure 3   t_pLZ, t_pHZ, t_pZL, t_pZH

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
V_X	V_OL + 0.3 V	V_OL + 0.15 V	V_OL + 0.15 V
V_Y	V_OH − 0.3 V	V_OH − 0.15 V	V_OH − 0.15 V

Package Dimensions

VSSOP16-P-0030-0.50   Unit : mm

Weight: 0.02 g (typ.)