

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

**TC7MA257FK**

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

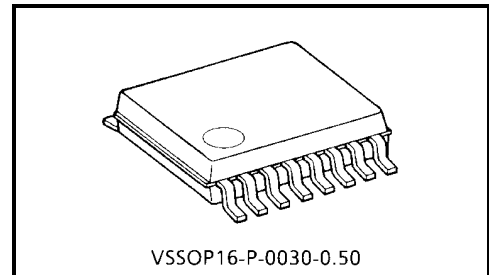
The TC7MA257FK is a high performance CMOS multiplexer. Designed for use in 1.8, 2.5 or 3.3 V systems, it achieves high speed operation while maintaining the CMOS low power dissipation.

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  $\overline{\text{SELECT}}$  and  $\overline{\text{OUTPUTENABLE}}$  ( $\overline{\text{OE}}$ ).

If  $\overline{\text{OE}}$  is set high the outputs are held in a high-impedance state. The  $\overline{\text{SELECT}}$  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**

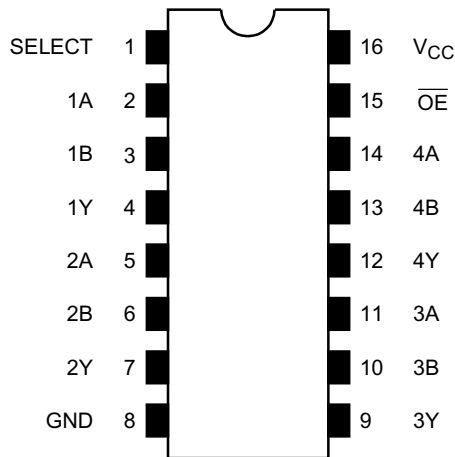
- Low voltage operation:  $V_{CC} = 1.8\sim 3.6\text{ V}$
- High speed operation:  $t_{pd} = 3.0\text{ ns (max)} (V_{CC} = 3.0\sim 3.6\text{ V})$   
 $t_{pd} = 4.0\text{ ns (max)} (V_{CC} = 2.3\sim 2.7\text{ V})$   
 $t_{pd} = 8.0\text{ ns (max)} (V_{CC} = 1.8\text{ V})$
- 3.6 V tolerant inputs and outputs.
- Output current:  $I_{OH}/I_{OL} = \pm 24\text{ mA (min)} (V_{CC} = 3.0\text{ V})$   
 $I_{OH}/I_{OL} = \pm 18\text{ mA (min)} (V_{CC} = 2.3\text{ V})$   
 $I_{OH}/I_{OL} = \pm 6\text{ mA (min)} (V_{CC} = 1.8\text{ V})$
- Latch-up performance:  $\pm 300\text{ mA}$
- ESD performance: Machine model  $> \pm 200\text{ V}$   
Human body model  $> \pm 2000\text{ V}$
- 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.

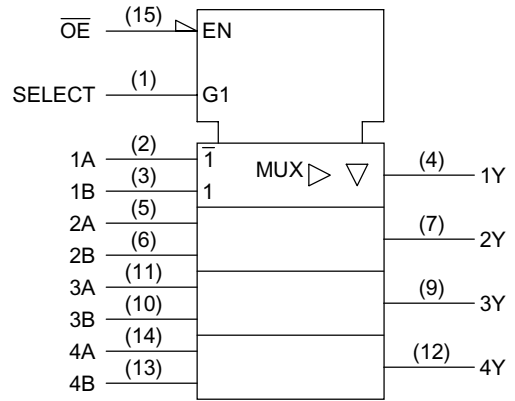
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**Pin Assignment (top view)**



**IEC Logic Symbol**



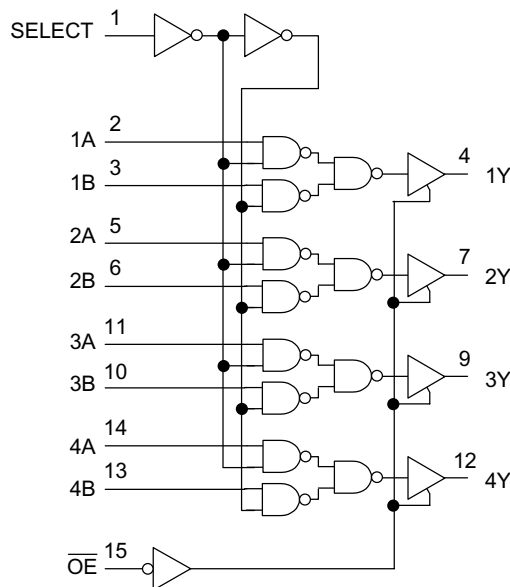
**Truth Table**

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**



## 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:  $V_{CC} = 3.0\sim 3.6$  V

Note8:  $V_{CC} = 2.3\sim 2.7$  V

Note9:  $V_{CC} = 1.8$  V

Note10:  $V_{IN} = 0.8\sim 2.0$  V,  $V_{CC} = 3.0$  V

## Electrical Characteristics

### DC Characteristics (Ta = -40~85°C, 2.7 V < VCC ≤ 3.6 V)

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Input voltage	High level	V <sub>IH</sub>	—		2.7~3.6	2.0	—	V
	Low level	V <sub>IL</sub>	—		2.7~3.6	—	0.8	
Output voltage	High level	V <sub>OH</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OH</sub> = -100 μA	2.7~3.6	V <sub>CC</sub> - 0.2	—	V
				I <sub>OH</sub> = -12 mA	2.7	2.2	—	
				I <sub>OH</sub> = -18 mA	3.0	2.4	—	
				I <sub>OH</sub> = -24 mA	3.0	2.2	—	
	Low level	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OL</sub> = 100 μA	2.7~3.6	—	0.2	
				I <sub>OL</sub> = 12 mA	2.7	—	0.4	
				I <sub>OL</sub> = 18 mA	3.0	—	0.4	
				I <sub>OL</sub> = 24 mA	3.0	—	0.55	
Input leakage current		I <sub>IN</sub>	V <sub>IN</sub> = 0~3.6 V		2.7~3.6	—	±5.0	μA
3-state output off-state current		I <sub>OZ</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = 0~3.6 V		2.7~3.6	—	±10.0	μA
Power off leakage current		I <sub>OFF</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0~3.6 V		0	—	10.0	μA
Quiescent supply current		I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND		2.7~3.6	—	20.0	μA
			V <sub>CC</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V		2.7~3.6	—	±20.0	
Increase in I <sub>CC</sub> per input		ΔI <sub>CC</sub>	V <sub>IH</sub> = V <sub>CC</sub> - 0.6 V		2.7~3.6	—	750	

### DC Characteristics (Ta = -40~85°C, 2.3 V ≤ VCC ≤ 2.7 V)

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Input voltage	High level	V <sub>IH</sub>	—		2.3~2.7	1.6	—	V
	Low level	V <sub>IL</sub>	—		2.3~2.7	—	0.7	
Output voltage	High level	V <sub>OH</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OH</sub> = -100 μA	2.3~2.7	V <sub>CC</sub> - 0.2	—	V
				I <sub>OH</sub> = -6 mA	2.3	2.0	—	
				I <sub>OH</sub> = -12 mA	2.3	1.8	—	
				I <sub>OH</sub> = -18 mA	2.3	1.7	—	
	Low level	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OL</sub> = 100 μA	2.3~2.7	—	0.2	
				I <sub>OL</sub> = 12 mA	2.3	—	0.4	
				I <sub>OL</sub> = 18 mA	2.3	—	0.6	
				Input leakage current		I <sub>IN</sub>	V <sub>IN</sub> = 0~3.6 V	
3-state output off-state current		I <sub>OZ</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = 0~3.6 V		2.3~2.7	—	±10.0	μA
Power off leakage current		I <sub>OFF</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0~3.6 V		0	—	10.0	μA
Quiescent supply current		I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND		2.3~2.7	—	20.0	μA
			V <sub>CC</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V		2.3~2.7	—	±20.0	

## DC Characteristics (Ta = -40~85°C, 1.8 V ≤ VCC < 2.3 V)

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Input voltage	High level	V <sub>IH</sub>	—		1.8~2.3	0.7 × V <sub>CC</sub>	—	V
	Low level	V <sub>IL</sub>	—		1.8~2.3	—	0.2 × V <sub>CC</sub>	
Output voltage	High level	V <sub>OH</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OH</sub> = -100 μA	1.8	V <sub>CC</sub> - 0.2	—	V
				I <sub>OH</sub> = -6 mA	1.8	1.4	—	
	Low level	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OL</sub> = 100 μA	1.8	—	0.2	
				I <sub>OL</sub> = 6 mA	1.8	—	0.3	
Input leakage current		I <sub>IN</sub>	V <sub>IN</sub> = 0~3.6 V		1.8	—	±5.0	μA
3-state output off-state current		I <sub>OZ</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = 0~3.6 V		1.8	—	±10.0	μA
Power off leakage current		I <sub>OFF</sub>	V <sub>IN</sub> , V <sub>OUT</sub> = 0~3.6 V		0	—	10.0	μA
Quiescent supply current		I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND		1.8	—	20.0	μA
			V <sub>CC</sub> ≤ (V <sub>IN</sub> , V <sub>OUT</sub> ) ≤ 3.6 V		1.8	—	±20.0	

## AC Characteristics (Ta = -40~85°C, Input: t<sub>r</sub> = t<sub>f</sub> = 2.0 ns, C<sub>L</sub> = 30 pF, R<sub>L</sub> = 500 Ω)

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit
Propagation delay time (A, B-Y)	t <sub>pLH</sub> t <sub>pHL</sub>	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 <sub>pLH</sub> t <sub>pHL</sub>	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 <sub>pZL</sub> t <sub>pZH</sub>	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 <sub>pLZ</sub> t <sub>pHZ</sub>	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 <sub>osLH</sub> t <sub>osHL</sub>	(Note 11)	1.8	—	0.5	ns		
			2.5 ± 0.2	—	0.5			
			3.3 ± 0.3	—	0.5			

For C<sub>L</sub> = 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: tr = tf = 2.0 ns, CL = 30 pF)**

Characteristics	Symbol	Test Condition		Typ.	Unit
			VCC (V)		
Quiet output maximum dynamic VOL	VOLP	VIH = 1.8 V, VIL = 0 V	(Note 12) 1.8	0.25	V
		VIH = 2.5 V, VIL = 0 V	(Note 12) 2.5	0.6	
		VIH = 3.3 V, VIL = 0 V	(Note 12) 3.3	0.8	
Quiet output minimum dynamic VOL	VOLV	VIH = 1.8 V, VIL = 0 V	(Note 12) 1.8	-0.25	V
		VIH = 2.5 V, VIL = 0 V	(Note 12) 2.5	-0.6	
		VIH = 3.3 V, VIL = 0 V	(Note 12) 3.3	-0.8	
Quiet output minimum dynamic VOH	VOHV	VIH = 1.8 V, VIL = 0 V	(Note 12) 1.8	1.5	V
		VIH = 2.5 V, VIL = 0 V	(Note 12) 2.5	1.9	
		VIH = 3.3 V, VIL = 0 V	(Note 12) 3.3	2.2	

Note 12: This parameter is guaranteed by design.

**Capacitive Characteristics (Ta = 25°C)**

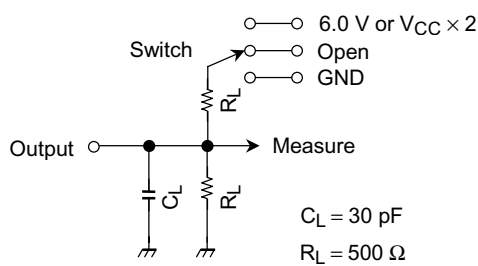
Characteristics	Symbol	Test Condition		Typ.	Unit
			VCC (V)		
Input capacitance	CIN	—	1.8, 2.5, 3.3	6	pF
Output capacitance	CO	—	1.8, 2.5, 3.3	7	pF
Power dissipation capacitance	CPD	fIN = 10 MHz	(Note 13) 1.8, 2.5, 3.3	20	pF

Note 13: CPD 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:

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

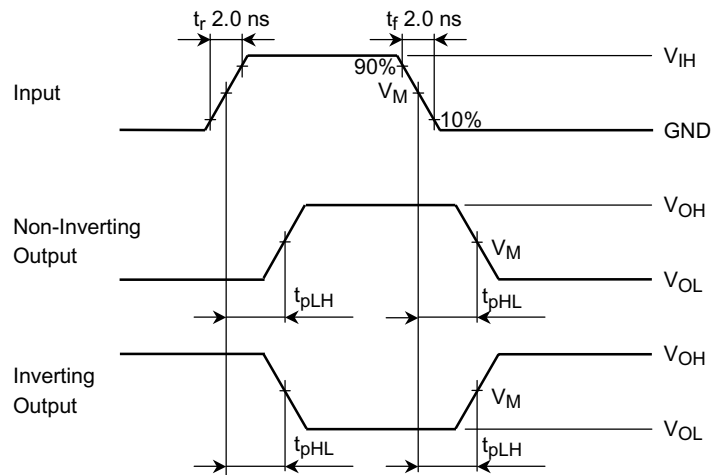
**AC Test Circuit**



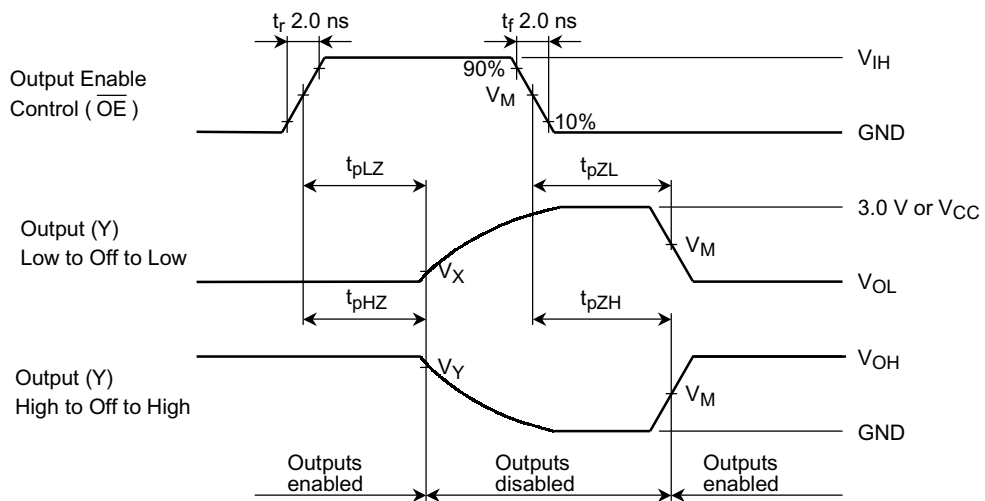
Parameter	Switch
tpLH, tpHL	Open
tpLZ, tpZL	6.0 V @VCC = 3.3 ± 0.3 V VCC × 2 @VCC = 2.5 ± 0.2 V @VCC = 1.8 V
tpHZ, tpZH	GND

**Figure 1**

**AC Waveform**



**Figure 2  $t_{pLH}$ ,  $t_{pHL}$**



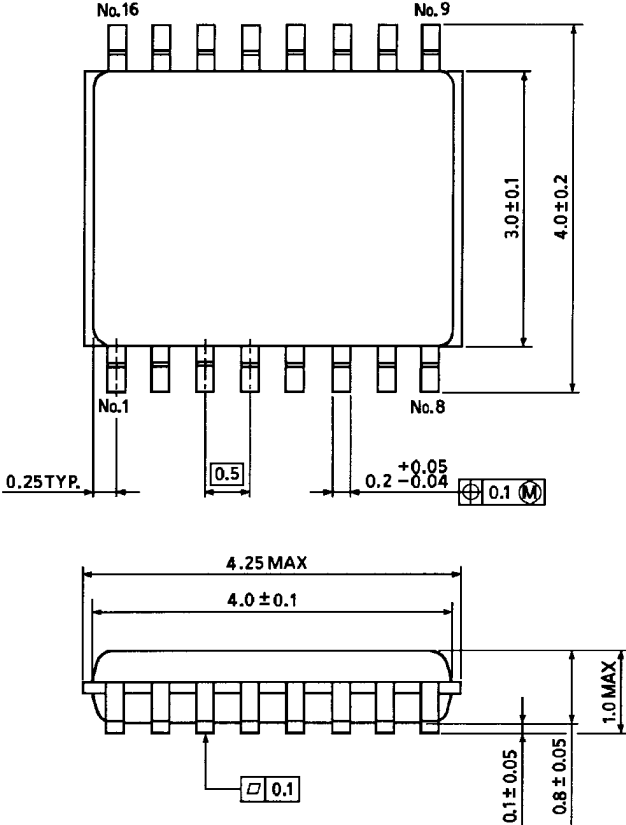
**Figure 3  $t_{pLZ}$ ,  $t_{pHZ}$ ,  $t_{pZL}$ ,  $t_{pZH}$**

Symbol	$V_{CC}$		
	$3.3 \pm 0.3 \text{ V}$	$2.5 \pm 0.2 \text{ V}$	$1.8 \text{ V}$
$V_{IH}$	$2.7 \text{ V}$	$V_{CC}$	$V_{CC}$
$V_M$	$1.5 \text{ V}$	$V_{CC}/2$	$V_{CC}/2$
$V_X$	$V_{OL} + 0.3 \text{ V}$	$V_{OL} + 0.15 \text{ V}$	$V_{OL} + 0.15 \text{ V}$
$V_Y$	$V_{OH} - 0.3 \text{ V}$	$V_{OH} - 0.15 \text{ V}$	$V_{OH} - 0.15 \text{ V}$

Package Dimensions

VSSOP16-P-0030-0.50

Unit : mm



Weight: 0.02 g (typ.)