

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

**TC7MA157FK**

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

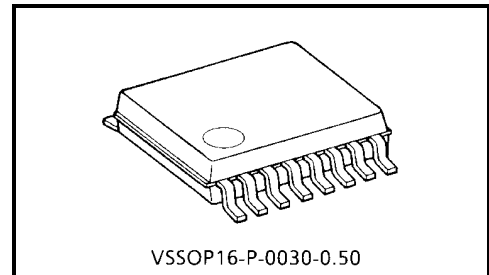
The TC7MA157FK is a high performance CMOS multiplexer. Designed for use in 1.8 , 2.5 or 3.3 V systems, it achieves high speed operation while maintaining the CMOS low power dissipation.

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 strobe inputs.

When the  $\overline{ST}$  input is held "H" level, selection of data is inhibited and all the outputs become "L" level. 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:  $V_{CC} = 1.8\sim 3.6\text{ V}$
- High speed operation:  $t_{pd} = 3.0\text{ ns (max) (}V_{CC} = 3.0\sim 3.6\text{ V)}$   
 $t_{pd} = 3.5\text{ ns (max) (}V_{CC} = 2.3\sim 2.7\text{ V)}$   
 $t_{pd} = 7.0\text{ ns (max) (}V_{CC} = 1.8\text{ V)}$
- 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.

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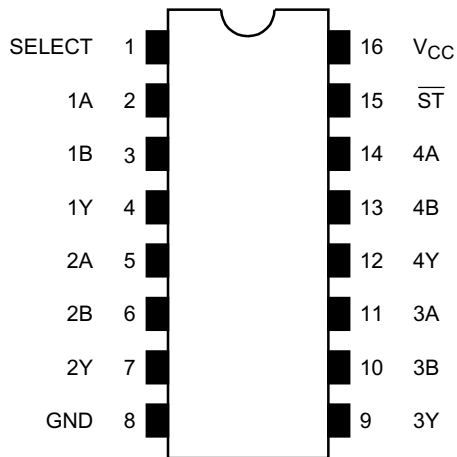
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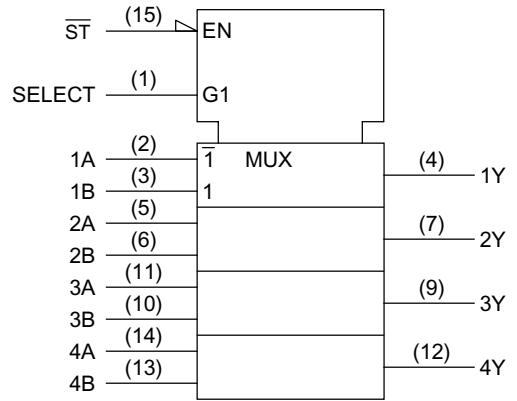
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**Pin Assignment (top view)**



**IEC Logic Symbol**

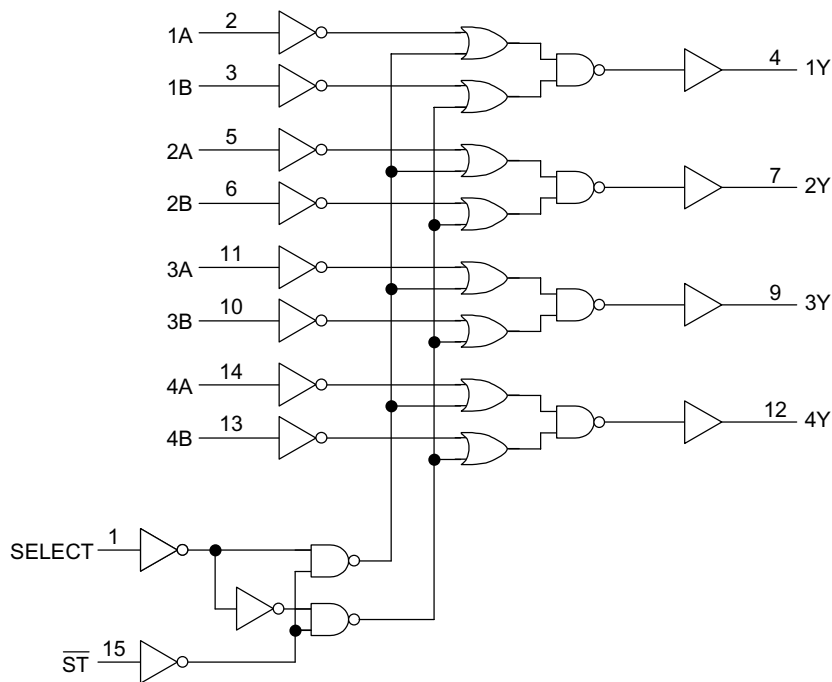


**Truth Table**

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

X: Don't care

## 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 (Note1)	V
		-0.5~ $V_{CC} + 0.5$ (Note2)	
Input diode current	$I_{IK}$	-50	mA
Output diode current	$I_{OK}$	$\pm 50$ (Note3)	mA
DC output current	$I_{OUT}$	$\pm 50$	mA
Power dissipation	$P_D$	180	mW
DC $V_{CC}$ /ground current	$I_{CC}/I_{GND}$	$\pm 100$	mA
Storage temperature	$T_{stg}$	-65~150	$^{\circ}C$

Note1:  $V_{CC} = 0\text{ V}$

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 (Note4)	
Input voltage	$V_{IN}$	-0.3~3.6	V
Output voltage	$V_{OUT}$	0~3.6 (Note5)	V
		0~ $V_{CC}$ (Note6)	
Output current	$I_{OH}/I_{OL}$	$\pm 24$ (Note7)	mA
		$\pm 18$ (Note8)	
		$\pm 6$ (Note9)	
Operating temperature	$T_{opr}$	-40~85	°C
Input rise and fall time	dt/dv	0~10 (Note10)	ns/V

Note4: Data retention only

Note5:  $V_{CC} = 0$  V

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 ( $T_a = -40\sim 85^\circ\text{C}$ , $2.7\text{ V} < V_{CC} \leq 3.6\text{ V}$ )

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 $V_{IL}$	$I_{OH} = -100\ \mu\text{A}$	2.7~3.6	$V_{CC} - 0.2$	—	V
				$I_{OH} = -12\ \text{mA}$	2.7	2.2	—	
				$I_{OH} = -18\ \text{mA}$	3.0	2.4	—	
				$I_{OH} = -24\ \text{mA}$	3.0	2.2	—	
	Low level	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 100\ \mu\text{A}$	2.7~3.6	—	0.2	
				$I_{OL} = 12\ \text{mA}$	2.7	—	0.4	
				$I_{OL} = 18\ \text{mA}$	3.0	—	0.4	
				$I_{OL} = 24\ \text{mA}$	3.0	—	0.55	
Input leakage current		$I_{IN}$	$V_{IN} = 0\sim 3.6\text{ V}$	2.7~3.6	—	$\pm 5.0$	$\mu\text{A}$	
Power off leakage current		$I_{OFF}$	$V_{IN}, V_{OUT} = 0\sim 3.6\text{ V}$	0	—	10.0	$\mu\text{A}$	
Quiescent supply current		$I_{CC}$	$V_{IN} = V_{CC}$ or GND	2.7~3.6	—	20.0	$\mu\text{A}$	
			$V_{CC} \leq V_{IN} \leq 3.6\text{ V}$	2.7~3.6	—	$\pm 20.0$		
Increase in $I_{CC}$ per input		$\Delta I_{CC}$	$V_{IH} = V_{CC} - 0.6\text{ V}$	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	—	
	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		2.3~2.7	—	±5.0	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> ≤ 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
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> ≤ 3.6 V		1.8	—	±20.0	

## AC Characteristics (Ta = -40~85°C, Input: tr = tf = 2.0 ns, CL = 30 pF, RL = 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	7.0	ns
			2.5 ± 0.2	0.8	3.5	
			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	9.0	ns
			2.5 ± 0.2	0.8	4.5	
			3.3 ± 0.3	0.6	3.5	
Propagation delay time ( $\overline{ST}$ -Y)	t <sub>pLH</sub> t <sub>pHL</sub>	Figure 1, Figure 2	1.8	1.0	9.0	ns
			2.5 ± 0.2	0.8	4.5	
			3.3 ± 0.3	0.6	3.5	
Output to output skew	t <sub>osLH</sub> t <sub>osHL</sub>	(Note11)	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.

Note11: 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	VCC (V)	Typ.	Unit
Quiet output maximum dynamic V <sub>OL</sub>	V <sub>OLP</sub>	V <sub>IH</sub> = 1.8 V, V <sub>IL</sub> = 0 V (Note12)	1.8	0.25	V
		V <sub>IH</sub> = 2.5 V, V <sub>IL</sub> = 0 V (Note12)	2.5	0.6	
		V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V (Note12)	3.3	0.8	
Quiet output minimum dynamic V <sub>OL</sub>	V <sub>OLV</sub>	V <sub>IH</sub> = 1.8 V, V <sub>IL</sub> = 0 V (Note12)	1.8	-0.25	V
		V <sub>IH</sub> = 2.5 V, V <sub>IL</sub> = 0 V (Note12)	2.5	-0.6	
		V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V (Note12)	3.3	-0.8	
Quiet output minimum dynamic V <sub>OH</sub>	V <sub>OHV</sub>	V <sub>IH</sub> = 1.8 V, V <sub>IL</sub> = 0 V (Note12)	1.8	1.5	V
		V <sub>IH</sub> = 2.5 V, V <sub>IL</sub> = 0 V (Note12)	2.5	1.9	
		V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V (Note12)	3.3	2.2	

Note12: This parameter is guaranteed by design.

## Capacitive Characteristics (Ta = 25°C)

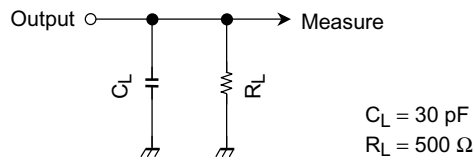
Characteristics	Symbol	Test Condition	VCC (V)	Typ.	Unit
Input capacitance	C <sub>IN</sub>	—	1.8, 2.5, 3.3	6	pF
Power dissipation capacitance	C <sub>PD</sub>	f <sub>IN</sub> = 10 MHz (Note13)	1.8, 2.5, 3.3	20	pF

Note13: C<sub>PD</sub> 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:

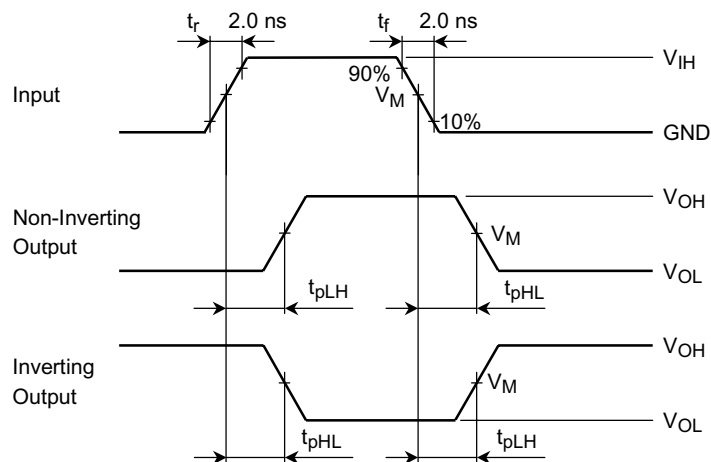
$$I_{CC (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$$

**AC Test Circuit**



**Figure 1**

**AC Waveform**



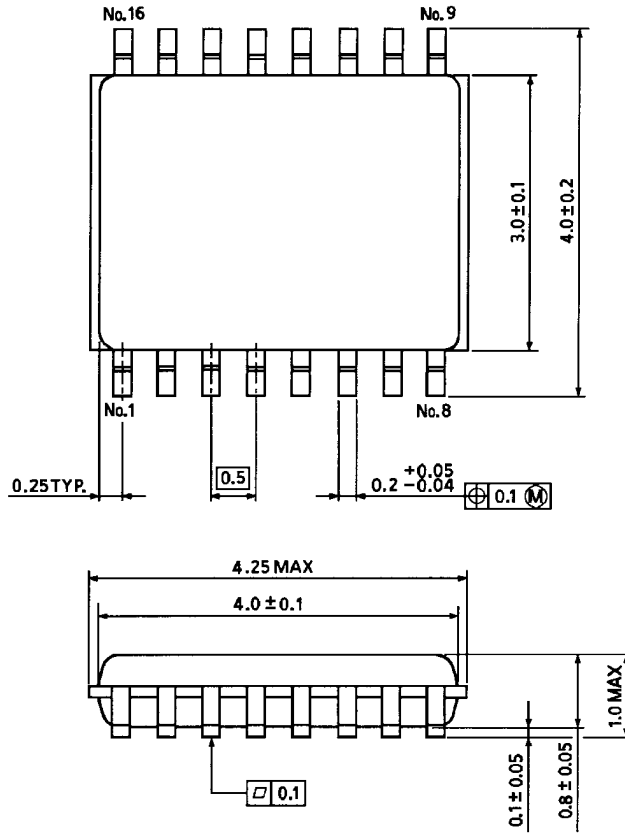
Symbol	$V_{CC}$		
	$3.3 \pm 0.3 \text{ V}$	$2.5 \pm 0.2 \text{ V}$	$1.8 \text{ V}$
$V_{IH}$	$2.7 \text{ V}$	$V_{CC}$	$V_{CC}$
$V_M$	$1.5 \text{ V}$	$V_{CC}/2$	$V_{CC}/2$

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

**Package Dimensions**

VSSOP16-P-0030-0.50

Unit : mm



Weight: 0.02 g (typ.)