

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC7MZ138FK

## Low Voltage 3-to-8 Line Decoder with 5 V Tolerant Inputs and Outputs

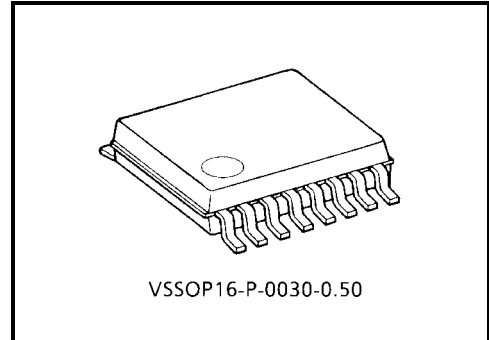
The TC7MZ138FK is a high performance CMOS 3-to-8 decoder. Designed for use in 3.3 V systems, it achieves high speed operation while maintaining the CMOS low power dissipation.

The device is designed for low-voltage (3.3 V) VCC applications, but it could be used to interface to 5 V supply environment for inputs.

When the device is enabled, 3 binary select inputs (A, B and C) determine which one of the outputs ( $\overline{Y0} - \overline{Y7}$ ) will go low.

When enable input G1 is held low or either  $\overline{G2A}$  or  $\overline{G2B}$  is held high, decoding function is inhibited and all outputs go high. G1,  $\overline{G2A}$ , and  $\overline{G2B}$  inputs are provided to ease cascade connection and for use as an address decoder for memory systems.

All inputs are equipped with protection circuits against static discharge.

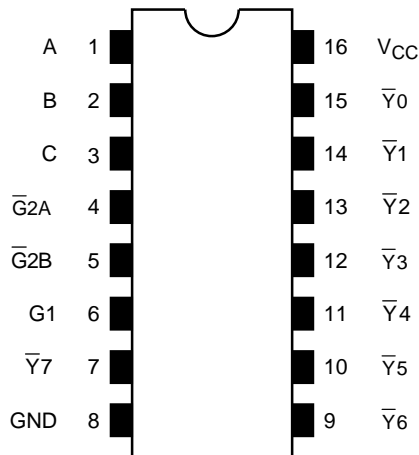


Weight: 0.02 g (typ.)

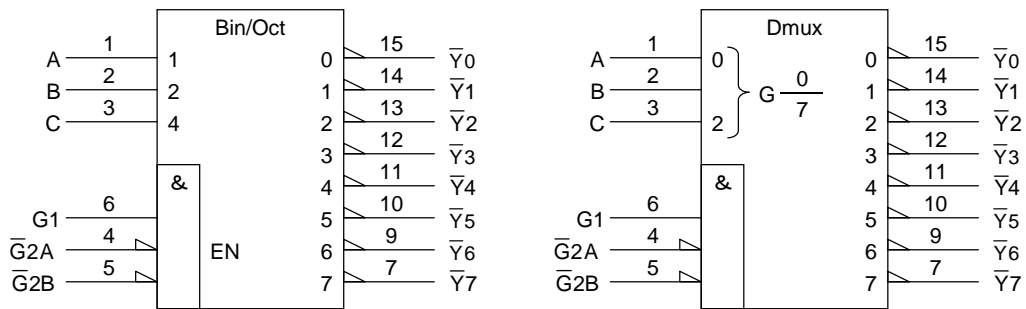
### Features

- Low voltage operation:  $V_{CC} = 2.0 \sim 3.6$  V
- High speed operation:  $t_{pd} = 6.0$  ns (max) ( $V_{CC} = 3.0 \sim 3.6$  V)
- Output current:  $|I_{OH}|/I_{OL} = 24$  mA (min) ( $V_{CC} = 3.0$  V)
- Latch-up performance:  $\pm 500$  mA
- Package: VSSOP (US16)
- Power down protection is provided on all inputs and outputs.
- Pin and function compatible with the 74 series (74AC/VHC/HC/F/ALS/LS etc.) 138 type.

## Pin Assignment (top view)



## IEC Logic Symbol

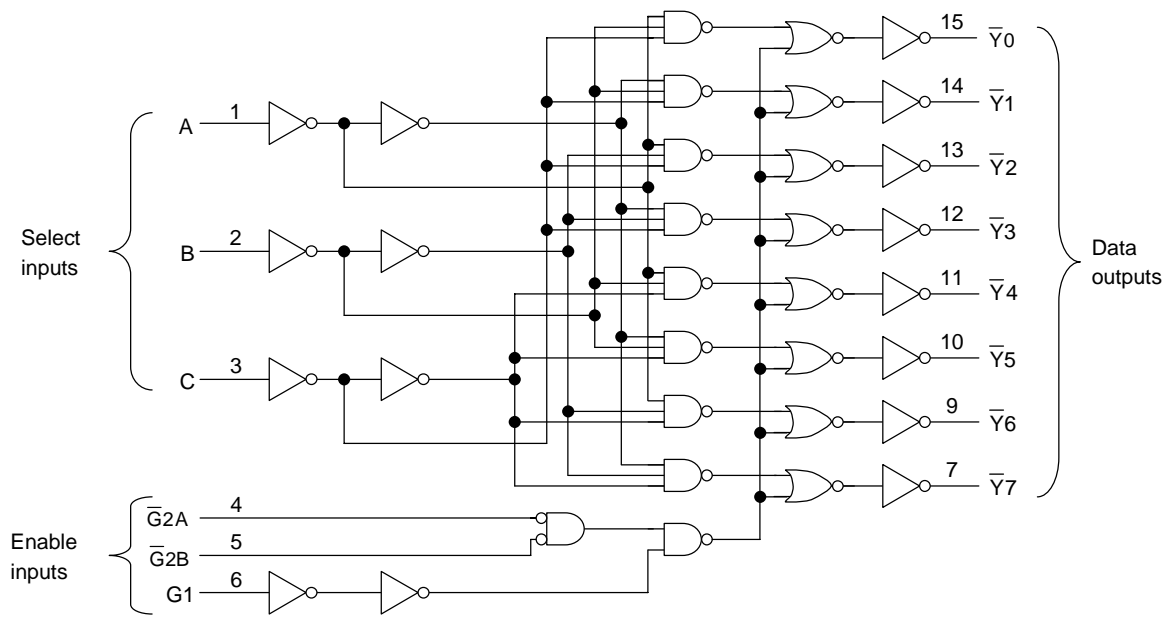


## Truth Table

Inputs						Outputs								Selected Output
Enable			Select			$\bar{Y}0$	$\bar{Y}1$	$\bar{Y}2$	$\bar{Y}3$	$\bar{Y}4$	$\bar{Y}5$	$\bar{Y}6$	$\bar{Y}7$	
G1	$\bar{G}2A$	$\bar{G}2B$	C	B	A									
L	X	X	X	X	X	H	H	H	H	H	H	H	H	None
X	H	X	X	X	X	H	H	H	H	H	H	H	H	None
X	X	H	X	X	X	H	H	H	H	H	H	H	H	None
H	L	L	L	L	L	L	H	H	H	H	H	H	H	$\bar{Y}0$
H	L	L	L	L	H	H	L	H	H	H	H	H	H	$\bar{Y}1$
H	L	L	L	H	L	H	H	L	H	H	H	H	H	$\bar{Y}2$
H	L	L	L	H	H	H	H	H	L	H	H	H	H	$\bar{Y}3$
H	L	L	H	L	L	H	H	H	H	L	H	H	H	$\bar{Y}4$
H	L	L	H	L	H	H	H	H	H	H	L	H	H	$\bar{Y}5$
H	L	L	H	H	L	H	H	H	H	H	H	L	H	$\bar{Y}6$
H	L	L	H	H	H	H	H	H	H	H	H	H	L	$\bar{Y}7$

X: Don't care

**System Diagram**



**Maximum Ratings**

Characteristics	Symbol	Rating	Unit
Supply voltage range	$V_{CC}$	-0.5~7.0	V
DC input voltage	$V_{IN}$	-0.5~7.0	V
DC output voltage	$V_{OUT}$	-0.5~7.0 (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 Conditions

Characteristics	Symbol	Rating	Unit
Supply voltage	$V_{CC}$	2.0~3.6	V
		1.5~3.6 (Note4)	
Input voltage	$V_{IN}$	0~5.5	V
Output voltage	$V_{OUT}$	0~5.5 (Note5)	V
		0~ $V_{CC}$ (Note6)	
Output current	$I_{OH}/I_{OL}$	$\pm 24$ (Note7)	mA
		$\pm 12$ (Note8)	
Operating temperature	$T_{opr}$	-40~85	°C
Input rise and fall time	dt/dv	0~10 (Note9)	ns/V

Note4: Data retention only

Note5:  $V_{CC} = 0\text{ V}$

Note6: High or low state

Note7:  $V_{CC} = 3.0\sim 3.6\text{ V}$

Note8:  $V_{CC} = 2.7\sim 3.0\text{ V}$

Note9:  $V_{IN} = 0.8\sim 2.0\text{ V}$ ,  $V_{CC} = 3.0\text{ V}$

## Electrical Characteristics

### DC Characteristics ( $T_a = -40\sim 85^\circ\text{C}$ )

Characteristics		Symbol	Test Condition		Min	Max	Unit	
				$V_{CC}$ (V)				
Input voltage	High level	$V_{IH}$	—		2.7~3.6	2.0	V	
	Low level	$V_{IL}$	—		2.7~3.6	—		
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	
				$I_{OL} = 16\ \text{mA}$	3.0	—	0.4	
				$I_{OL} = 24\ \text{mA}$	3.0	—	0.55	
Input leakage current		$I_{IN}$	$V_{IN} = 0\sim 5.5\text{ V}$		2.7~3.6	—	$\pm 5.0$	$\mu\text{A}$
Power off leakage current		$I_{OFF}$	$V_{IN}/V_{OUT} = 5.5\text{ V}$		0	—	10.0	$\mu\text{A}$
Quiescent supply current		$I_{CC}$	$V_{IN} = V_{CC}$ or GND		2.7~3.6	—	10.0	$\mu\text{A}$
			$V_{IN} = 3.6\sim 5.5\text{ V}$		2.7~3.6	—	$\pm 10.0$	
Increase in $I_{CC}$ per input		$\Delta I_{CC}$	$V_{IH} = V_{CC} - 0.6\text{ V}$		2.7~3.6	—	500	

## AC Characteristics (Ta = -40~85°C)

Characteristics	Symbol	Test Condition	V <sub>CC</sub> (V)	Min	Max	Unit
Propagation delay time (A, B, C- $\bar{Y}$ )	$t_{pLH}$	Figure 1, Figure 2	2.7	—	7.0	ns
	$t_{pHL}$		3.3 ± 0.3	1.5	6.0	
Propagation delay time (G1- $\bar{Y}$ )	$t_{pLH}$	Figure 1, Figure 2	2.7	—	8.0	ns
	$t_{pHL}$		3.3 ± 0.3	1.5	7.0	
Propagation delay time ( $\bar{G}2$ - $\bar{Y}$ )	$t_{pLH}$	Figure 1, Figure 2	2.7	—	7.0	ns
	$t_{pHL}$		3.3 ± 0.3	1.5	6.0	
Output to output skew	$t_{osLH}$	(Note10)	2.7	—	—	ns
	$t_{osHL}$		3.3 ± 0.3	—	1.0	

Note10: 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:  $t_r = t_f = 2.5$  ns, C<sub>L</sub> = 50 pF, R<sub>L</sub> = 500 Ω)

Characteristics	Symbol	Test Condition	V <sub>CC</sub> (V)	Typ.	Unit	
Quiet output maximum dynamic	V <sub>OL</sub>	V <sub>OLP</sub>	V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V	3.3	0.8	V
Quiet output minimum dynamic	V <sub>OL</sub>	V <sub>OLV</sub>	V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V	3.3	0.8	V

## Capacitive Characteristics (Ta = 25°C)

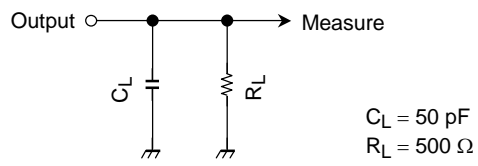
Characteristics	Symbol	Test Condition	V <sub>CC</sub> (V)	Typ.	Unit	
Input capacitance	C <sub>IN</sub>	—	3.3	7	pF	
Output capacitance	C <sub>OUT</sub>	—	0	8	pF	
Power dissipation capacitance	C <sub>PD</sub>	f <sub>IN</sub> = 10 MHz	(Note11)	3.3	25	pF

Note11: 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:

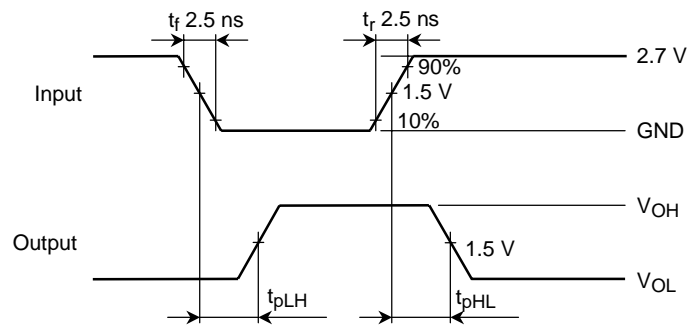
$$I_{CC (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$$

**AC Test Circuit**



**Figure 1**

**AC Waveform**

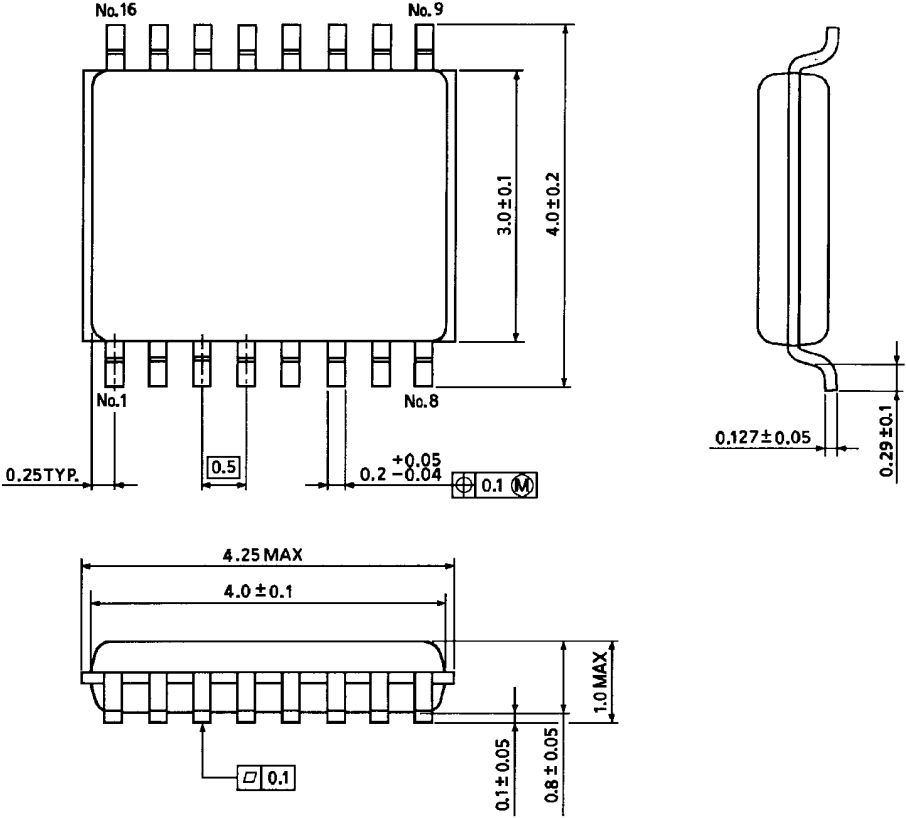


**Figure 2  $t_{pLH}$ ,  $t_{pHL}$**

Package Dimensions

VSSOP16-P-0030-0.50

Unit : mm



Weight: 0.02 g (typ.)

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