

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC74VCX138FT

Low-Voltage 3-to-8 Line Decoder with 3.6-V Tolerant Inputs and Outputs

The TC74VCX138FT is a high-performance CMOS 3-to-8 decoder. Designed 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.

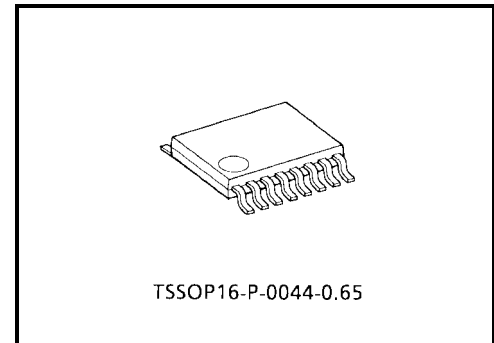
It is also designed with over voltage tolerant inputs and outputs up to 3.6 V.

When the device is enabled, 3 binary select inputs (A, B and C) determine which one of the outputs ($\bar{Y}0\sim\bar{Y}7$) will go low.

When enable input G1 is held low or either $\bar{G}2A$ or $\bar{G}2B$ is held high, decoding function is inhibited and all outputs go high.

G1, $\bar{G}2A$, and $\bar{G}2B$ 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.

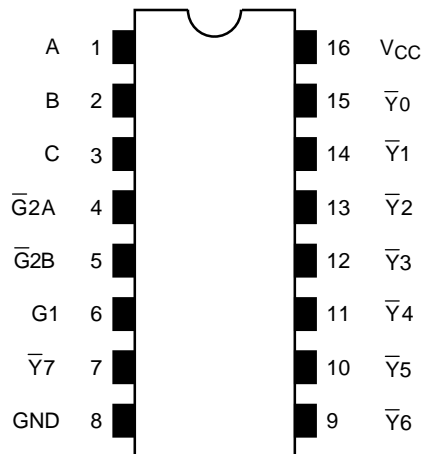


Weight: 0.06 g (typ.)

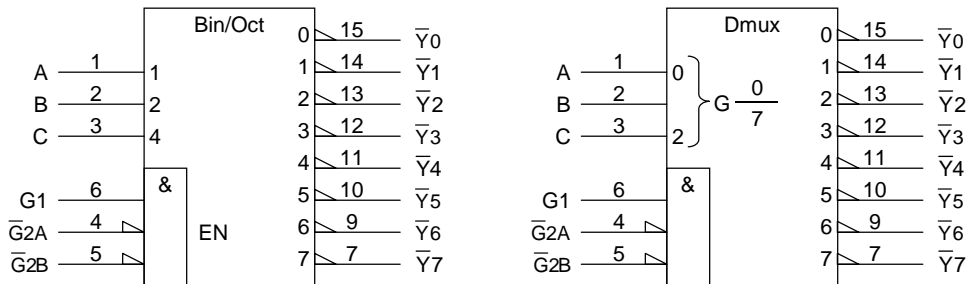
Features

- Low-voltage operation : $V_{CC} = 1.8\sim 3.6\text{ V}$
- High-speed operation : $t_{pd} = 3.5\text{ ns (max)}$ ($V_{CC} = 3.0\sim 3.6\text{ V}$)
: $t_{pd} = 4.1\text{ ns (max)}$ ($V_{CC} = 2.3\sim 2.7\text{ V}$)
: $t_{pd} = 8.2\text{ ns (max)}$ ($V_{CC} = 1.8\text{ V}$)
- 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 : Human body model $> \pm 2000\text{ V}$
: Machine model $> \pm 200\text{ V}$
- Package: TSSOP (thin shrink small outline package)
- Power-down protection provided on all inputs and outputs

Pin Assignment (top view)



IEC Logic Symbol

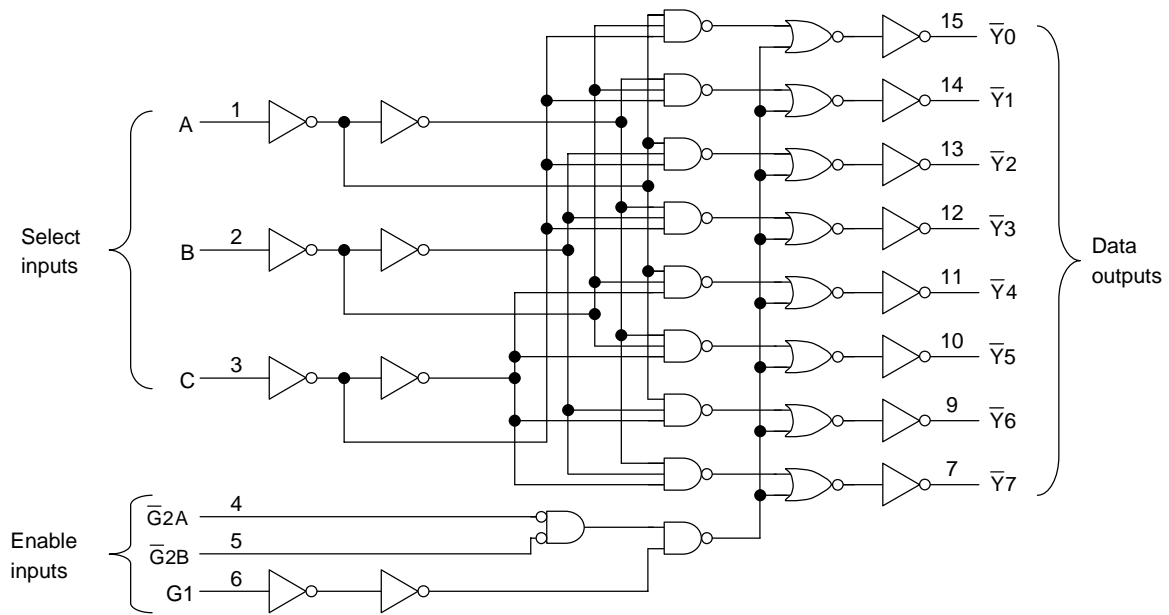


Truth Table

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
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}	± 50 (Note3)	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	$^{\circ}C$

Note 1: $V_{CC} = 0$ V

Note 2: High or low state. I_{OUT} absolute maximum rating must be observed.

Note 3: $V_{OUT} < GND, V_{OUT} > V_{CC}$

Recommended Operating Conditions

Characteristics	Symbol	Rating	Unit
Power 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}	± 24 (Note7)	mA
		± 18 (Note8)	
		± 6 (Note9)	
Operating temperature	T_{opr}	-40~85	°C
Input rise and fall time	dt/dv	0~10 (Note10)	ns/V

Note 4: Data retention only

Note 5: $V_{CC} = 0$ V

Note 6: High or low state

Note 7: $V_{CC} = 3.0\sim 3.6$ V

Note 8: $V_{CC} = 2.3\sim 2.7$ V

Note 9: $V_{CC} = 1.8$ V

Note 10: $V_{IN} = 0.8\sim 2.0$ 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	H-level	V_{IH}	—	2.7~3.6	2.0	—	V	
	L-level	V_{IL}	—	2.7~3.6	—	0.8		
Output voltage	H-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	—	
	L-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	—	± 5.0	μA	
Power OFF leakage current		I_{OFF}	$V_{IN}, V_{OUT} = 0\sim 3.6\text{ V}$	0	—	10.0	μA	
Quiescent supply current		I_{CC}	$V_{IN} = V_{CC}$ or GND	2.7~3.6	—	20.0	μA	
			$V_{CC} \leq V_{IN} \leq 3.6\text{ V}$	2.7~3.6	—	± 20.0		
Increase in I_{CC} per input		ΔI_{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	H-level	V _{IH}	—		2.3~2.7	1.6	—	V
	L-level	V _{IL}	—		2.3~2.7	—	0.7	
Output voltage	H-level	V _{OH}	V _{IN} = V _{IH} or V _{IL}	I _{OH} = -100 μA	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	—	
	L-level	V _{OL}	V _{IN} = V _{IH} or V _{IL}	I _{OL} = 100 μA	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
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} ≤ 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	H-level	V _{IH}	—		1.8~2.3	0.7 × V _{CC}	—	V
	L-level	V _{IL}	—		1.8~2.3	—	0.2 × V _{CC}	
Output voltage	H-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	—	
	L-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
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} ≤ 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
			1.8	1.0	8.2	
Propagation delay time (A, B, C- \bar{Y})	t _{pLH} t _{pHL}	(Fig. 1, 2)	2.5 ± 0.2	0.8	4.1	ns
			3.3 ± 0.3	0.6	3.5	
			1.8	1.0	8.2	
Propagation delay time (G1- \bar{Y})	t _{pLH} t _{pHL}	(Fig. 1, 2)	2.5 ± 0.2	0.8	4.1	ns
			3.3 ± 0.3	0.6	3.5	
			1.8	1.0	8.2	
Propagation delay time ($\bar{G}2$ - \bar{Y})	t _{pLH} t _{pHL}	(Fig. 1, 2)	2.5 ± 0.2	0.8	4.1	ns
			3.3 ± 0.3	0.6	3.5	
			1.8	1.0	8.2	

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

Dynamic Switching Characteristics (Ta = 25°C, Input: tr = tf = 2.0 ns, CL = 30 pF)

Characteristics	Symbol	Test Condition	VCC (V)	Typ.	Unit
			1.8	0.25	
Quiet output maximum dynamic VOL	VOLP	VIH = 1.8 V, VIL = 0 V (Note11)	2.5	0.6	V
			3.3	0.8	
			1.8	-0.25	
Quiet output minimum dynamic VOL	VOLV	VIH = 1.8 V, VIL = 0 V (Note11)	2.5	-0.6	V
			3.3	-0.8	
			1.8	1.5	
Quiet output minimum dynamic VOH	VOHV	VIH = 1.8 V, VIL = 0 V (Note11)	2.5	1.9	V
			3.3	2.2	
			1.8	1.5	

Note 11: This parameter is guaranteed by design.

Capacitive Characteristics (Ta = 25°C)

Characteristics	Symbol	Test Condition	VCC (V)	Typ.	Unit
			1.8, 2.5, 3.3	6	
Power dissipation capacitance	CPD	fIN = 10 MHz (Note12)	1.8, 2.5, 3.3	40	pF

Note 12: 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:

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

Test Circuit

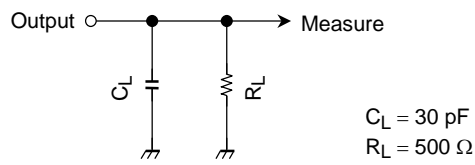
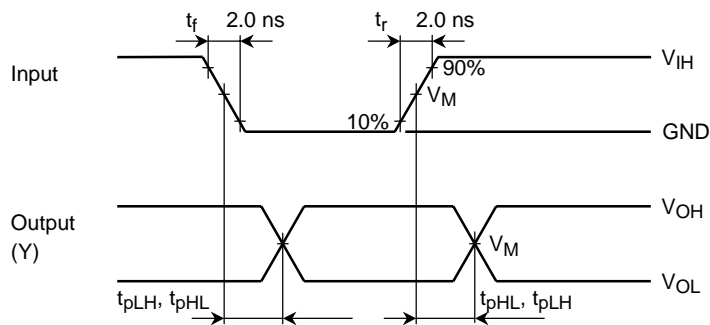


Figure 1

AC Waveform



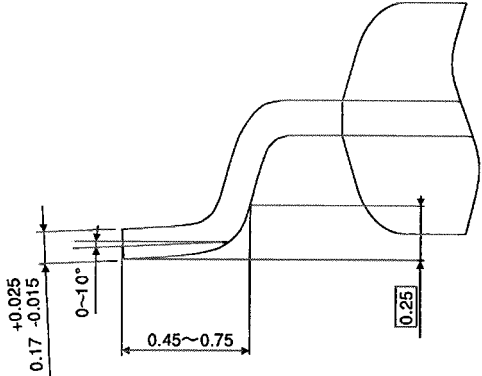
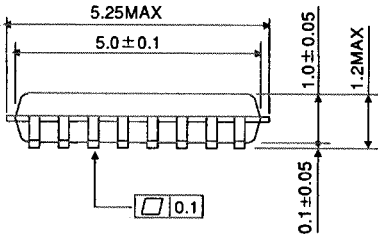
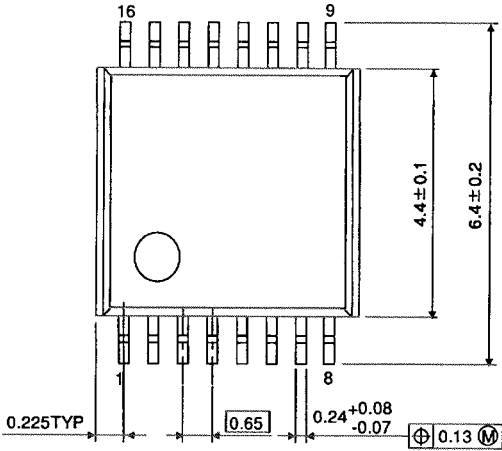
Symbol	V_{CC}		
	$3.3 \pm 0.3 \text{ V}$	$2.5 \pm 0.2 \text{ V}$	1.8 V
V_{IH}	2.7 V	V_{CC}	V_{CC}
V_M	1.5 V	$V_{CC}/2$	$V_{CC}/2$

Figure 2 t_{pLH}, t_{pHL}

Package Dimensions

TSSOP16-P-0044-0.65

Unit : mm



Weight: 0.06 g (typ.)

RESTRICTIONS ON PRODUCT USE

000707EBA

- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property.
In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the "Handling Guide for Semiconductor Devices," or "TOSHIBA Semiconductor Reliability Handbook" etc..
- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury ("Unintended Usage"). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer's own risk.
- The products described in this document are subject to the foreign exchange and foreign trade laws.
- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA CORPORATION for any infringements of intellectual property or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any intellectual property or other rights of TOSHIBA CORPORATION or others.
- The information contained herein is subject to change without notice.