National Semiconductor

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MM74HCA138 3-to-8 Line Decoder

General Description

This decoder utilizes advanced silicon-gate CMOS technology, and is well suited to memory address decoding or data routing applications. The circuit features high noise immunity and low power consumption usually associated with CMOS circuitry, yet has speeds comparable to low power Schottky TTL logic.

The MM74HCA138 has 3 binary select inputs (A, B, and C). If the device is enabled these inputs determine which one of the eight normally high outputs will go low. Two active low and one active high enables (G1, $\overline{G2A}$ and $\overline{G2B}$) are provided to ease the cascading of decoders.

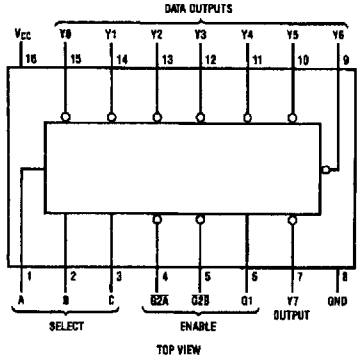
The decoder's outputs can drive 10 low power Schottky TTL equivalent loads, and are functionally and pin equivalent to the 54LS138/74LS138. All inputs are protected from damage due to static discharge by diodes to V_{CC} and ground.

Features

- Typical propagation delay: 17 ns
- Wide power supply range: 2V–6V
- Low quiescent current: 40 μA maximum
- Low input current: 1 μA maximum
- Fanout of 10 LS-TTL loads
- Low output noise generation
- QOS specifications V_{OLV}, V_{OLD}
- Identical pinout to HC
- Speed upgrade to HC

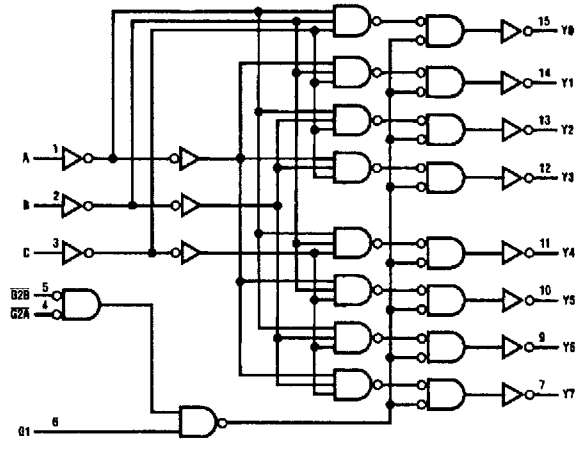
Connection and Logic Diagrams

Dual-In-Line Package



TL/F/10882–1

Order Number MM74HCA138



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Truth Table

Inputs					Outputs							
Enable		Select										
G1	$\overline{G2}$*	C	B	A	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7
X	H	X	X	X	H	H	H	H	H	H	H	H
L	X	X	X	X	H	H	H	H	H	H	H	H
H	L	L	L	L	L	H	H	H	H	H	H	H
H	L	L	L	H	H	L	H	H	H	H	H	H
H	L	L	H	L	H	H	L	H	H	H	H	H
H	L	L	H	H	H	H	H	L	H	H	H	H
H	L	H	L	L	H	H	H	H	L	H	H	H
H	L	H	L	H	H	H	H	H	H	L	H	H
H	L	H	H	L	H	H	H	H	H	H	L	H
H	L	H	H	H	H	H	H	H	H	H	H	L

*$\overline{G2}$ = G2A + G2B

H = high level, L = low level, X = don't care

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Absolute Maximum Ratings (Notes 1 & 2)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage (V_{CC})	−0.5 to +7.0V
DC Input Voltage (V_{IN})	−1.5 to V_{CC} +1.5V
DC Output Voltage (V_{OUT})	−0.5 to V_{CC} +0.5V
Clamp Diode Current (I_{IK}, I_{OK})	±20 mA
DC Output Current, per pin (I_{OUT})	±25 mA
DC V_{CC} or GND Current, per pin (I_{CC})	±50 mA
Storage Temperature Range (T_{STG})	−65°C to +150°C
Power Dissipation (P_D)	
(Note 3)	600 mW
S.O. Package only	500 mW
Lead Temp. (T_L) (Soldering 10 seconds)	260°C

Operating Conditions

	Min	Max	Units
Supply Voltage (V_{CC})	2	6	V
DC Input or Output Voltage (V_{IN}, V_{OUT})	0	V_{CC}	V
Operating Temp. Range (T_A)			
MM74HCA	−40	+85	°C
Input Rise or Fall Times			
(t_r, t_f) V_{CC} = 2.0V		1000	ns
V_{CC} = 4.5V		500	ns
V_{CC} = 6.0V		400	ns

DC Electrical Characteristics (Note 4)

Symbol	Parameter	Conditions	V_{CC}	T_A = 25°C	74HCA T_A = −40 to 85°C		Units
				Typ	Guaranteed Limits		
V_{IH}	Minimum High Level Input Voltage		2.0V		1.5	1.5	V
			3.0V		2.1	2.1	V
			4.5V		3.15	3.15	V
			6.0V		4.2	4.2	V
V_{IL}	Maximum Low Level Input Voltage		2.0V		0.5	0.5	V
			3.0V		0.9	0.9	V
			4.5V		1.35	1.35	V
			6.0V		1.8	1.8	V
V_{OH}	Minimum High Level Output Voltage	V_{IN} = V_{IH} or V_{IL} $\lvert I_{OUT}\rvert \le 20\ \mu A$	2.0V	2.0	1.9	1.9	V
			3.0V	3.0	2.9	2.9	V
			4.5V	4.5	4.4	4.4	V
			6.0V	6.0	5.9	5.9	V
		V_{IN} = V_{IH} or V_{IL} $\lvert I_{OUT}\rvert \le 4.0$ mA	3.0V	2.78	2.68	2.63	V
		$\lvert I_{OUT}\rvert \le 5.2$ mA	4.5V	4.28	4.18	4.13	V
			6.0V	5.78	5.68	5.63	V
V_{OL}	Maximum Low Level Output Voltage	V_{IN} = V_{IH} or V_{IL} $\lvert I_{OUT}\rvert \le 20\ \mu A$	2.0V	0	0.1	0.1	V
			3.0V	0	0.1	0.1	V
			4.5V	0	0.1	0.1	V
			6.0V	0	0.1	0.1	V
		V_{IN} = V_{IH} or V_{IL} $\lvert I_{OUT}\rvert \le 4.0$ mA	3.0V	0.2	0.26	0.33	V
		$\lvert I_{OUT}\rvert \le 5.2$ mA	4.5V	0.2	0.26	0.33	V
			6.0V	0.2	0.26	0.33	V
I_{IN}	Maximum Input Current	V_{IN} = V_{CC} or GND	6.0V		±0.1	±1.0	μA
I_{CC}	Maximum Quiescent Supply Current	V_{IN} = V_{CC} or GND I_{OUT} = 0 μA	6.0V		4.0	40.0	μA
V_{OLP}	Quiet Output Max Dynamic V_{OL}	*Figures 1, 2* (Note 5)	5.5V	0.550			V
V_{OLV}	Quiet Output Min Dynamic V_{OL}	*Figures 1, 2* (Note 5)	5.5V	−0.750			V

Note 1: Absolute Maximum Ratings are those values beyond which damage to the device may occur.

Note 2: Unless otherwise specified all voltages are referenced to ground.

Note 3: Power Dissipation temperature derating — plastic "N" package: −12 mW/°C from 65°C to 85°C; ceramic "J" package: −12 mW/°C from 100°C to 125°C.

Note 4: For a power supply of 5V ±10% the worst case output voltages (V_{OH}, and V_{OL}) occur for HCA at 4.5V. Thus the 4.5V values should be used when designing with this supply. Worst case V_{IH} and V_{IL} occur at V_{CC} = 5.5V and 4.5V respectively. (The V_{IH} value at 5.5V is 3.85V.) The worst case leakage current (I_{IN}, I_{CC}, and I_{OZ}) occur for CMOS at the higher voltage and so the 6.0V values should be used.

Note 5: n = number of device outputs, n−1 outputs switching, each driven 0V to 5.5V, one output at ground.

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AC Electrical Characteristics $V_{CC}=5V$, $T_A=25°C$, $C_L=15$ pF, $t_r=t_f=6$ ns

Symbol	Parameter	Conditions	Typ	Guaranteed Limit	Units
t_{PLH}	Maximum Propagation Delay, Binary Select to any Output		12	26	ns
t_{PHL}	Maximum Propagation Delay, Binary Select to any Output		17	26	ns
t_{PHL}	Maximum Propagation Delay $\overline{G2A}$ or $\overline{G2B}$ or G1 to Output		12	25	ns
t_{PLH}	Maximum Propagation Delay $\overline{G2A}$ or $\overline{G2B}$ or G1 to Output		10	25	ns

AC Electrical Characteristics $C_L=50$ pF, $t_r=t_f=6$ ns (unless otherwise specified)

Symbol	Parameter	Conditions	V_{CC}	$T_A=25°C$	74HCA $T_A=-40$ to 85°C		Units
				Typ	Guaranteed Limits		
t_{PLH}	Maximum Propagation Delay Binary Select to any Output Low to High		2.0V	75	150	189	ns
			3.3V	23	45	57	ns
			4.5V	15	30	38	ns
			6.0V	13	26	32	ns
t_{PHL}	Maximum Propagation Delay Binary Select to any Output High to Low		2.0V	100	150	189	ns
			3.3V	30	45	57	ns
			4.5V	20	30	38	ns
			6.0V	17	26	32	ns
t_{PHL}	Maximum Propagation Delay $\overline{G2A}$ or $\overline{G2B}$ or G1 to Output		2.0V	75	145	180	ns
			3.3V	23	42	54	ns
			4.5V	15	29	36	ns
			6.0V	13	25	31	ns
t_{PLH}	Maximum Propagation Delay $\overline{G2A}$ or $\overline{G2B}$ or G1 to Output		2.0V	60	145	180	ns
			3.3V	18	44	54	ns
			4.5V	12	29	36	ns
			6.0V	10	25	31	ns
t_{TLH}, t_{THL}	Output Rise and Fall Time		2.0V	30	75	95	ns
			3.3V	12	75	95	ns
			4.5V	8	15	19	ns
			6.0V	7	13	16	ns
C_{IN}	Maximum Input Capacitance			3	10	10	pF
C_{PD}	Power Dissipation Capacitance	(Note 5)		75			pF

Note 5: C_{PD} determines the no load dynamic power consumption, $P_D=C_{PD}V_{CC}^2f+I_{CC}V_{CC}$, and the no load dynamic current consumption, $I_S=C_{PD}V_{CC}f+I_{CC}$.

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HCA Noise Characteristics

The setup of a noise characteristics measurement is critical to the accuracy and repeatability of the tests. The following is a brief description of the setup used to measure the noise characteristics of HCA.

Equipment:

Word Generator
Printed Circuit Board Test Fixture
Dual Trace Oscilloscope

Procedure:

1. Verify Test Fixture Loading: Standard Load 50 pF, 500Ω.
2. Deskew the word generator so that no two channels have greater than 150 ps skew between them. This requires that the oscilloscope be deskewed first. Swap out the channels that have more than 150 ps of skew until all channels being used are within 150 ps. It is important to deskew the word generator channels before testing. This will ensure that the outputs switch simultaneously.
3. Terminate all inputs and outputs to ensure proper loading of the outputs and that the input levels are at the correct voltage.
4. Set V_{CC} to 5.0V.
5. Set the word generator to toggle all but one output at a frequency of 1 MHz. Greater frequencies will increase DUT heating and affect the results of the measurement.
6. Set the word generator input levels at 0V LOW and 5.5V HIGH for HCA devices. Verify levels with a digital volt meter.

V_{OLP}/V_{OLV} and V_{OHP}/V_{OHV}:

- Determine the quiet output pin that demonstrates the greatest noise levels. The worst case pin will usually be the furthest from the ground pin. Monitor the output voltages using a 50Ω coaxial cable plugged into a standard SMB type connector on the test fixture. Do not use an active FET probe.
- Measure V_{OLP} and V_{OLV} on the quiet output during the HL transition. Measure V_{OHP} and V_{OHV} on the quiet output during the LH transition.
- Verify that the GND reference recorded on the oscilloscope has not drifted to ensure the accuracy and repeatability of the measurements.

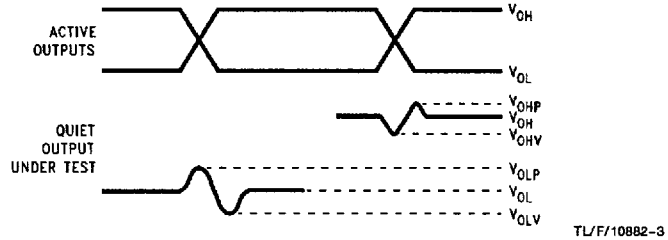

FIGURE 1. Quiet Output Noise Voltage Waveforms

Note A: V_{OLV} and V_{OLP} are measured with respect to ground reference.

Note B: Input pulses have the following characteristics: f = 1 MHz, t_r = 3 ns, t_f = 3 ns, skew < 150 ps.

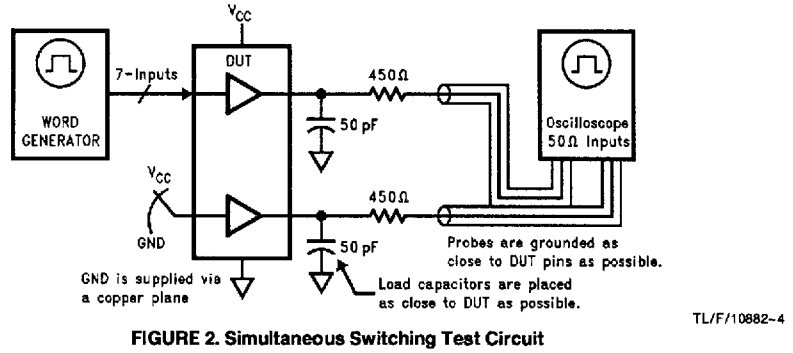

FIGURE 2. Simultaneous Switching Test Circuit

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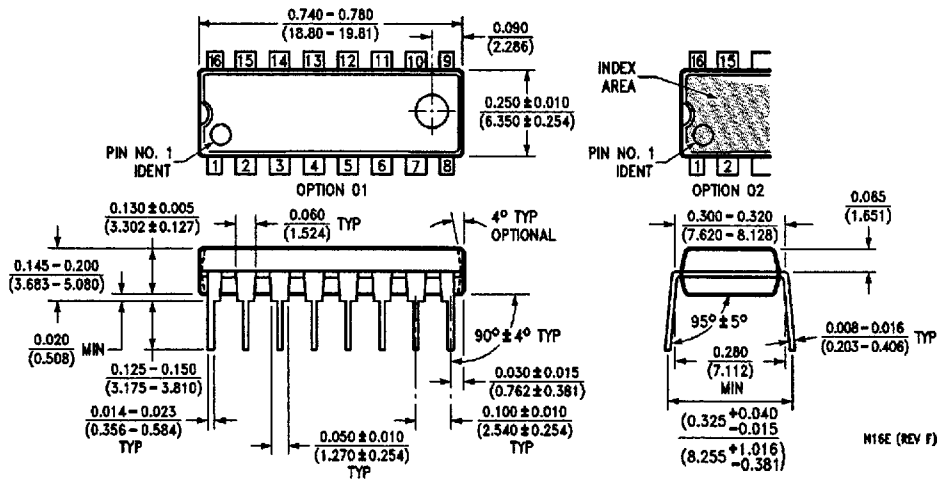
Physical Dimensions inches (millimeters)



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NS Package Number N16E

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