

SN54AHC138, SN74AHC138 3-LINE TO 8-LINE DECODERS/DEMULTIPLEXERS

SCLS2581 – DECEMBER 1995 – REVISED JANUARY 2000

- **EPIC™ (Enhanced-Performance Implanted CMOS) Process**
- **Operating Range 2-V to 5.5-V V_{CC}**
- **Designed Specifically for High-Speed Memory Decoders and Data-Transmission Systems**
- **Incorporate Three Enable Inputs to Simplify Cascading and/or Data Reception**
- **Latch-Up Performance Exceeds 250 mA Per JESD 17**
- **ESD Protection Exceeds 2000 V Per MIL-STD-883C, Method 3015; Exceeds 200 V Using Machine Model (C = 200 pF, R = 0)**
- **Package Options Include Plastic Small-Outline (D), Shrink Small-Outline (DB), Thin Very Small-Outline (DGV), Thin Shrink Small-Outline (PW), and Ceramic Flat (W) Packages, Ceramic Chip Carriers (FK), and Standard Plastic (N) and Ceramic (J) DIPs**

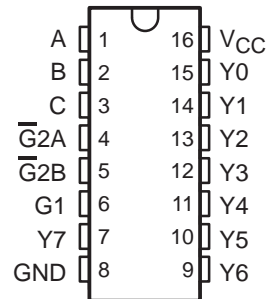
description

The 'AHC138 decoders/demultiplexers are designed for high-performance memory-decoding and data-routing applications that require very short propagation-delay times. In high-performance memory systems, these decoders can be used to minimize the effects of system decoding. When employed with high-speed memories utilizing a fast enable circuit, the delay times of these decoders and the enable time of the memory are usually less than the typical access time of the memory. This means that the effective system delay introduced by the decoders is negligible.

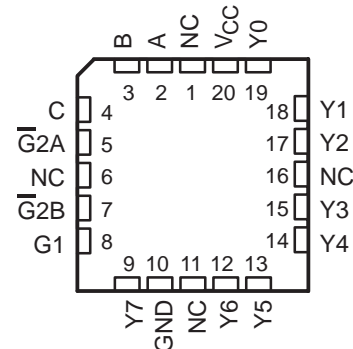
The conditions at the binary-select inputs and the three enable inputs select one of eight output lines. Two active-low and one active-high enable inputs reduce the need for external gates or inverters when expanding. A 24-line decoder can be implemented without external inverters and a 32-line decoder requires only one inverter. An enable input can be used as a data input for demultiplexing applications.

The SN54AHC138 is characterized for operation over the full military temperature range of -55°C to 125°C . The SN74AHC138 is characterized for operation from -40°C to 85°C .

SN54AHC138 . . . J OR W PACKAGE
SN74AHC138 . . . D, DB, DGV, N, OR PW PACKAGE
(TOP VIEW)



SN54AHC138 . . . FK PACKAGE
(TOP VIEW)



NC – No internal connection



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

EPIC is a trademark of Texas Instruments Incorporated.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

 **TEXAS
INSTRUMENTS**

POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

Copyright © 2000, Texas Instruments Incorporated
On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

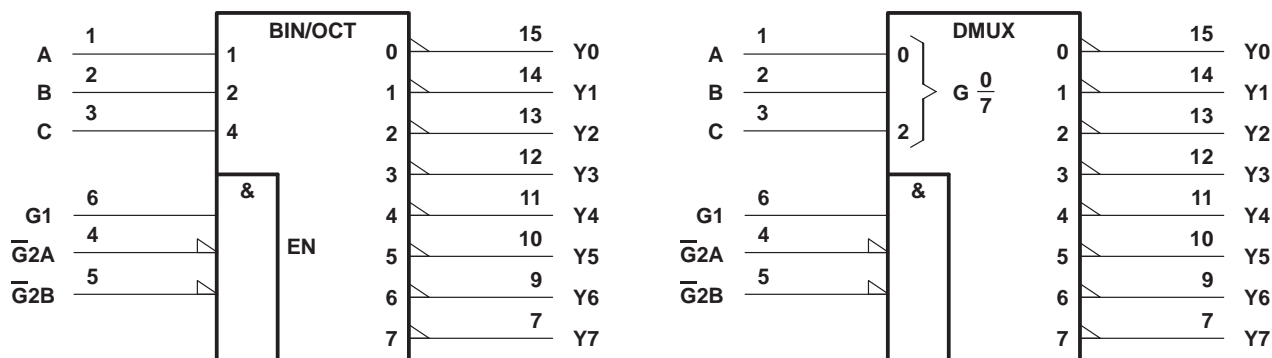
SN54AHC138, SN74AHC138 3-LINE TO 8-LINE DECODERS/DEMULTIPLEXERS

SCLS258I – DECEMBER 1995 – REVISED JANUARY 2000

FUNCTION TABLE

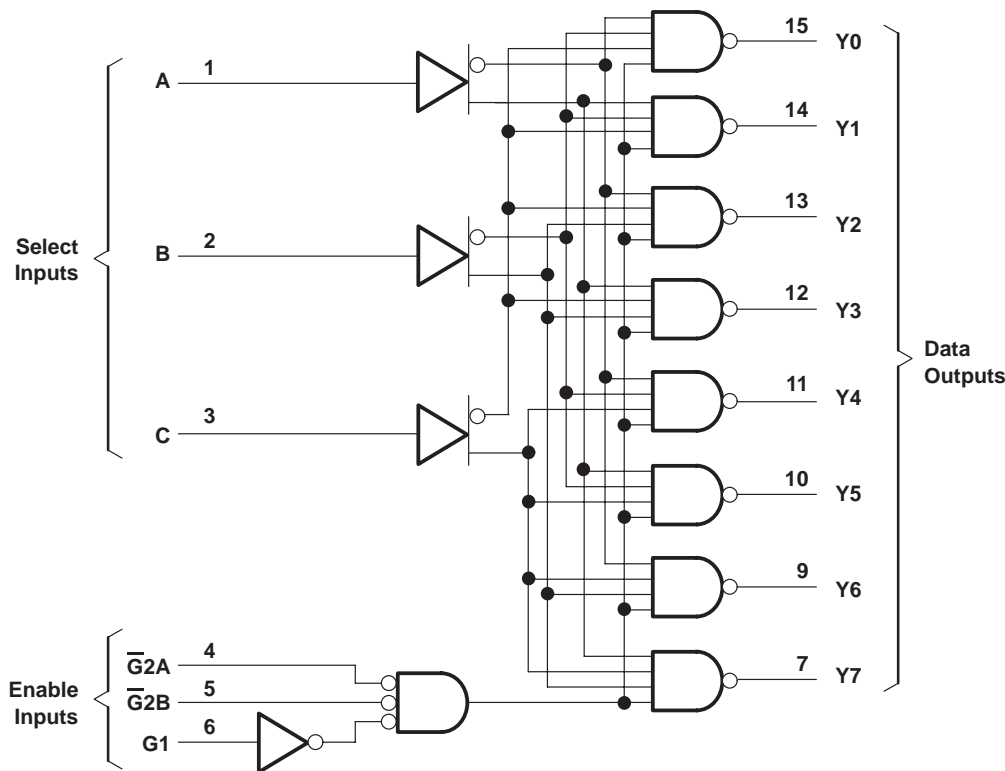
ENABLE INPUTS			SELECT INPUTS			OUTPUTS							
G1	$\overline{G2A}$	$\overline{G2B}$	C	B	A	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7
X	H	X	X	X	X	H	H	H	H	H	H	H	H
X	X	H	X	X	X	H	H	H	H	H	H	H	H
L	X	X	X	X	X	H	H	H	H	H	H	H	H
H	L	L	L	L	L	L	H	H	H	H	H	H	H
H	L	L	L	L	H	H	L	H	H	H	H	H	H
H	L	L	L	H	L	H	H	L	H	H	H	H	H
H	L	L	L	H	H	H	H	L	H	H	H	H	H
H	L	L	H	L	L	H	H	H	H	L	H	H	H
H	L	L	H	L	H	H	H	H	H	H	L	H	H
H	L	L	H	H	L	H	H	H	H	H	H	L	H
H	L	L	H	H	H	H	H	H	H	H	H	H	L

logic symbols (alternatives)†



† These symbols are in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12. Pin numbers shown are for the D, DB, DGV, J, N, PW, and W packages.

logic diagram (positive logic)



Pin numbers shown are for the D, DB, DGV, J, N, PW, and W packages.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage range, V_{CC}	-0.5 V to 7 V
Input voltage range, V_I (see Note 1)	-0.5 V to 7 V
Output voltage range, V_O (see Note 1)	-0.5 V to $V_{CC} + 0.5$ V
Input clamp current, I_{IK} ($V_I < 0$)	-20 mA
Output clamp current, I_{OK} ($V_O < 0$ or $V_O > V_{CC}$)	± 20 mA
Continuous output current, I_O ($V_O = 0$ to V_{CC})	± 25 mA
Continuous current through V_{CC} or GND	± 75 mA
Package thermal impedance, θ_{JA} (see Note 2):	
D package	73°C/W
DB package	82°C/W
DGV package	120°C/W
N package	67°C/W
PW package	108°C/W
Storage temperature range, T_{stg}	-65°C to 150°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES: 1. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.
2. The package thermal impedance is calculated in accordance with JESD 51.

SN54AHC138, SN74AHC138 3-LINE TO 8-LINE DECODERS/DEMULTIPLEXERS

SCLS258I – DECEMBER 1995 – REVISED JANUARY 2000

recommended operating conditions (see Note 3)

		SN54AHC138		SN74AHC138		UNIT
		MIN	MAX	MIN	MAX	
V_{CC}	Supply voltage	2	5.5	2	5.5	V
V_{IH}	High-level input voltage	$V_{CC} = 2\text{ V}$		1.5		V
		$V_{CC} = 3\text{ V}$		2.1		
		$V_{CC} = 5.5\text{ V}$		3.85		
V_{IL}	Low-level input voltage	$V_{CC} = 2\text{ V}$		0.5		V
		$V_{CC} = 3\text{ V}$		0.9		
		$V_{CC} = 5.5\text{ V}$		1.65		
V_I	Input voltage	0	5.5	0	5.5	V
V_O	Output voltage	0	V_{CC}	0	V_{CC}	V
I_{OH}	High-level output current	$V_{CC} = 2\text{ V}$		-50		μA mA
		$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$		-4		
		$V_{CC} = 5\text{ V} \pm 0.5\text{ V}$		-8		
I_{OL}	Low-level output current	$V_{CC} = 2\text{ V}$		50		μA mA
		$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$		4		
		$V_{CC} = 5\text{ V} \pm 0.5\text{ V}$		8		
$\Delta t/\Delta v$	Input transition rise or fall rate	$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$		100		ns/V
		$V_{CC} = 5\text{ V} \pm 0.5\text{ V}$		20		
T_A	Operating free-air temperature	-55	125	-40	85	$^{\circ}\text{C}$

NOTE 3: All unused inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS	V_{CC}	$T_A = 25^{\circ}\text{C}$			SN54AHC138		SN74AHC138		UNIT
			MIN	TYP	MAX	MIN	MAX	MIN	MAX	
V_{OH}	$I_{OH} = -50\ \mu\text{A}$	2 V	1.9	2		1.9		1.9	V	
		3 V	2.9	3		2.9		2.9		
		4.5 V	4.4	4.5		4.4		4.4		
	$I_{OH} = -4\text{ mA}$	3 V	2.58			2.48		2.48		
	$I_{OH} = -8\text{ mA}$	4.5 V	3.94			3.8		3.8		
V_{OL}	$I_{OL} = 50\ \mu\text{A}$	2 V			0.1		0.1		0.1	V
		3 V			0.1		0.1		0.1	
		4.5 V			0.1		0.1		0.1	
	$I_{OL} = 4\text{ mA}$	3 V			0.36		0.5		0.44	
	$I_{OL} = 8\text{ mA}$	4.5 V			0.36		0.5		0.44	
I_I	$V_I = V_{CC}$ or GND	0 V to 5.5 V			± 0.1		$\pm 1^*$		± 1	μA
I_{CC}	$V_I = V_{CC}$ or GND, $I_O = 0$	5.5 V			4		40		40	μA
C_i	$V_I = V_{CC}$ or GND	5 V			2	10			10	pF

* On products compliant to MIL-PRF-38535, this parameter is not production tested at $V_{CC} = 0\text{ V}$.



SN54AHC138, SN74AHC138 3-LINE TO 8-LINE DECODERS/DEMULTIPLEXERS

SCLS258I – DECEMBER 1995 – REVISED JANUARY 2000

**switching characteristics over recommended operating free-air temperature range,
V_{CC} = 3.3 V ± 0.3 V (unless otherwise noted) (see Figure 1)**

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	T _A = 25°C			SN54AHC138		SN74AHC138		UNIT
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
t _{PLH}	A, B, C	Any Y	C _L = 15 pF	8.2*	11.4*	1*	13*	1	13	ns	
t _{PHL}				8.2*	11.4*	1*	13*	1	13		
t _{PLH}	G1	Any Y	C _L = 15 pF	8.1*	12.8*	1*	15*	1	15	ns	
t _{PHL}				8.1*	12.8*	1*	15*	1	15		
t _{PLH}	$\overline{G}2A, \overline{G}2B$	Any Y	C _L = 15 pF	8.2*	11.4*	1*	13.5*	1	13.5	ns	
t _{PHL}				8.2*	11.4*	1*	13.5*	1	13.5		
t _{PLH}	A, B, C	Any Y	C _L = 50 pF	10	15.8	1	18	1	18	ns	
t _{PHL}				10	15.8	1	18	1	18		
t _{PLH}	G1	Any Y	C _L = 50 pF	10.6	16.3	1	18.5	1	18.5	ns	
t _{PHL}				10.6	16.3	1	18.5	1	18.5		
t _{PLH}	$\overline{G}2A, \overline{G}2B$	Any Y	C _L = 50 pF	10.7	14.9	1	17	1	17	ns	
t _{PHL}				10.7	14.9	1	17	1	17		

* On products compliant to MIL-PRF-38535, this parameter is not production tested.

**switching characteristics over recommended operating free-air temperature range,
V_{CC} = 5 V ± 0.5 V (unless otherwise noted) (see Figure 1)**

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	T _A = 25°C			SN54AHC138		SN74AHC138		UNIT
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
t _{PLH}	A, B, C	Any Y	C _L = 15 pF	5.7*	8.1*	1*	9.5*	1	9.5	ns	
t _{PHL}				5.7*	8.1*	1*	9.5*	1	9.5		
t _{PLH}	G1	Any Y	C _L = 15 pF	5.6*	8.1*	1*	9.5*	1	9.5	ns	
t _{PHL}				5.6*	8.1*	1*	9.5*	1	9.5		
t _{PLH}	$\overline{G}2A, \overline{G}2B$	Any Y	C _L = 15 pF	5.8*	8.1*	1*	9.5*	1	9.5	ns	
t _{PHL}				5.8*	8.1*	1*	9.5*	1	9.5		
t _{PLH}	A, B, C	Any Y	C _L = 50 pF	7.2	10.1	1	11.5	1	11.5	ns	
t _{PHL}				7.2	10.1	1	11.5	1	11.5		
t _{PLH}	G1	Any Y	C _L = 50 pF	7.1	10.1	1	11.5	1	11.5	ns	
t _{PHL}				7.1	10.1	1	11.5	1	11.5		
t _{PLH}	$\overline{G}2A, \overline{G}2B$	Any Y	C _L = 50 pF	7.3	10.1	1	11.5	1	11.5	ns	
t _{PHL}				7.3	10.1	1	11.5	1	11.5		

* On products compliant to MIL-PRF-38535, this parameter is not production tested.

operating characteristics, V_{CC} = 5 V, T_A = 25°C

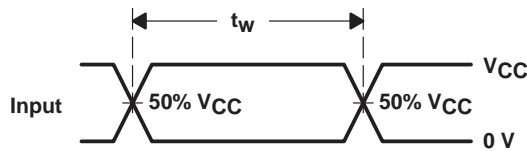
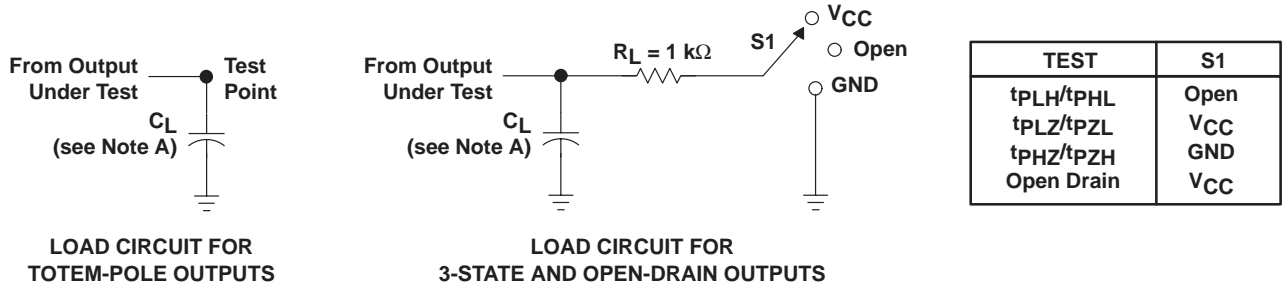
PARAMETER	TEST CONDITIONS	TYP	UNIT
C _{pd} Power dissipation capacitance	No load, f = 1 MHz	13	pF



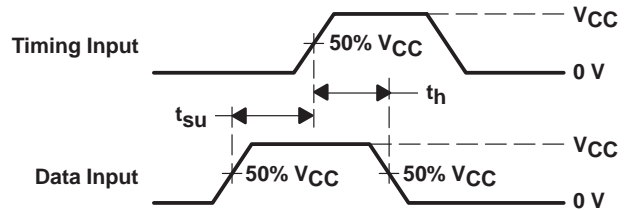
SN54AHC138, SN74AHC138 3-LINE TO 8-LINE DECODERS/DEMULTIPLEXERS

SCLS258I – DECEMBER 1995 – REVISED JANUARY 2000

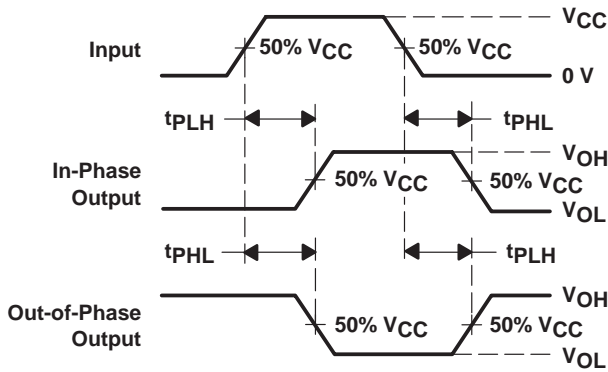
PARAMETER MEASUREMENT INFORMATION



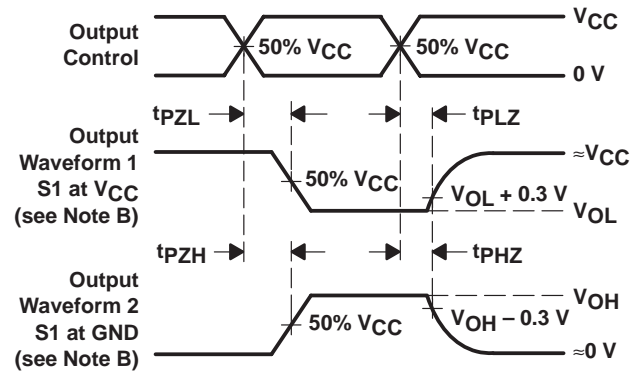
VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
INVERTING AND NONINVERTING OUTPUTS



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES
LOW- AND HIGH-LEVEL ENABLING

- NOTES: A. C_L includes probe and jig capacitance.
 B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
 C. All input pulses are supplied by generators having the following characteristics: PRR \leq 1 MHz, $Z_O = 50\ \Omega$, $t_r \leq 3\text{ ns}$, $t_f \leq 3\text{ ns}$.
 D. The outputs are measured one at a time with one input transition per measurement.

Figure 1. Load Circuit and Voltage Waveforms

SN54AHC138, SN74AHC138 3-LINE TO 8-LINE DECODERS/DEMULTIPLEXERS

SCLS258I – DECEMBER 1995 – REVISED JANUARY 2000

APPLICATION INFORMATION

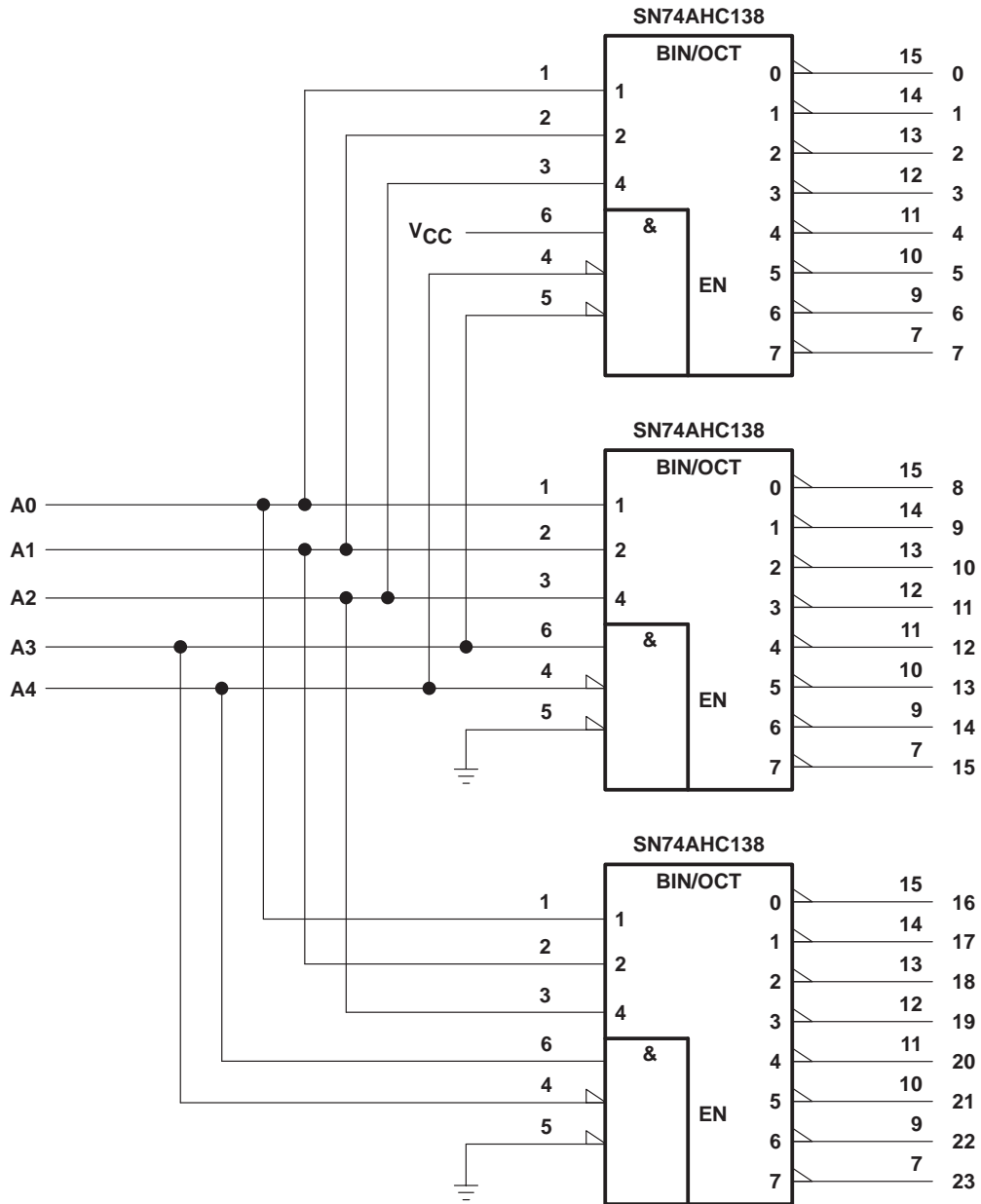


Figure 2. 24-Bit Decoding Scheme

SN54AHC138, SN74AHC138 3-LINE TO 8-LINE DECODERS/DEMULTIPLEXERS

SCLS258I – DECEMBER 1995 – REVISED JANUARY 2000

APPLICATION INFORMATION

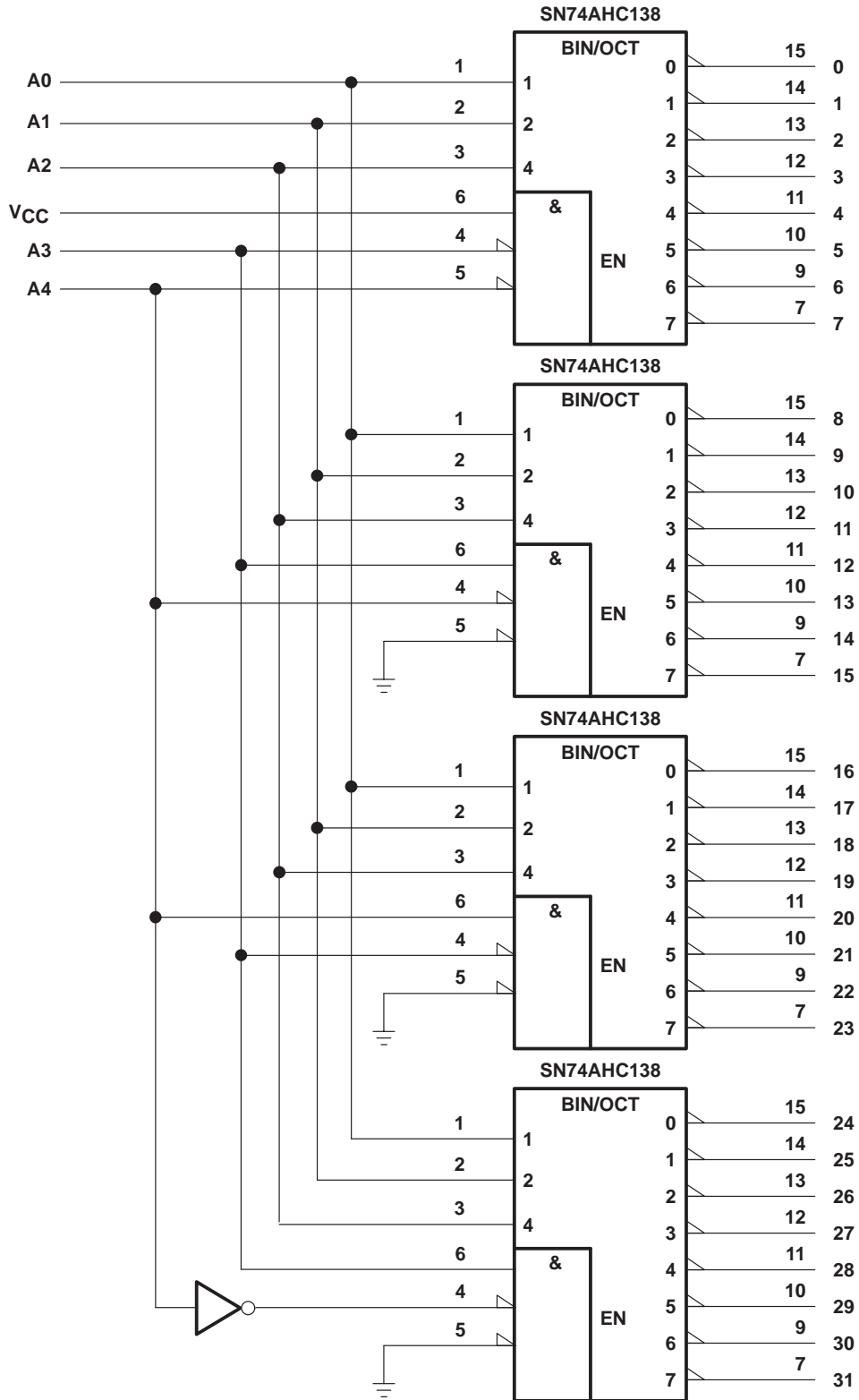


Figure 3. 32-Bit Decoding Scheme

IMPORTANT NOTICE

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgement, including those pertaining to warranty, patent infringement, and limitation of liability.

TI warrants performance of its semiconductor products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

CERTAIN APPLICATIONS USING SEMICONDUCTOR PRODUCTS MAY INVOLVE POTENTIAL RISKS OF DEATH, PERSONAL INJURY, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE ("CRITICAL APPLICATIONS"). TI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS. INCLUSION OF TI PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE FULLY AT THE CUSTOMER'S RISK.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used. TI's publication of information regarding any third party's products or services does not constitute TI's approval, warranty or endorsement thereof.