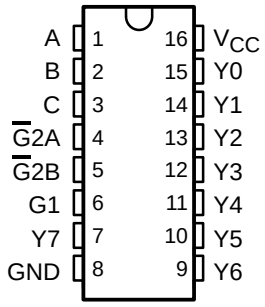
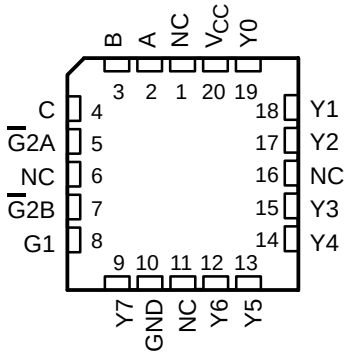
- **Operating Range 2-V to 5.5-V V_{CC}**
- **Designed Specifically for High-Speed Memory Decoders and Data-Transmission Systems**
- **Incorporate Three Enable Inputs to Simplify Cascading and/or Data Reception**
- **Latch-Up Performance Exceeds 250 mA Per JESD 17**
- **ESD Protection Exceeds JESD 22**
  - **2000-V Human-Body Model (A114-A)**
  - **200-V Machine Model (A115-A)**
  - **1000-V Charged-Device Model (C101)**

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



SN54AHC138 . . . FK PACKAGE
(TOP VIEW)



NC – No internal connection

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.

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.

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.

Copyright © 2002, 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.

ORDERING INFORMATION

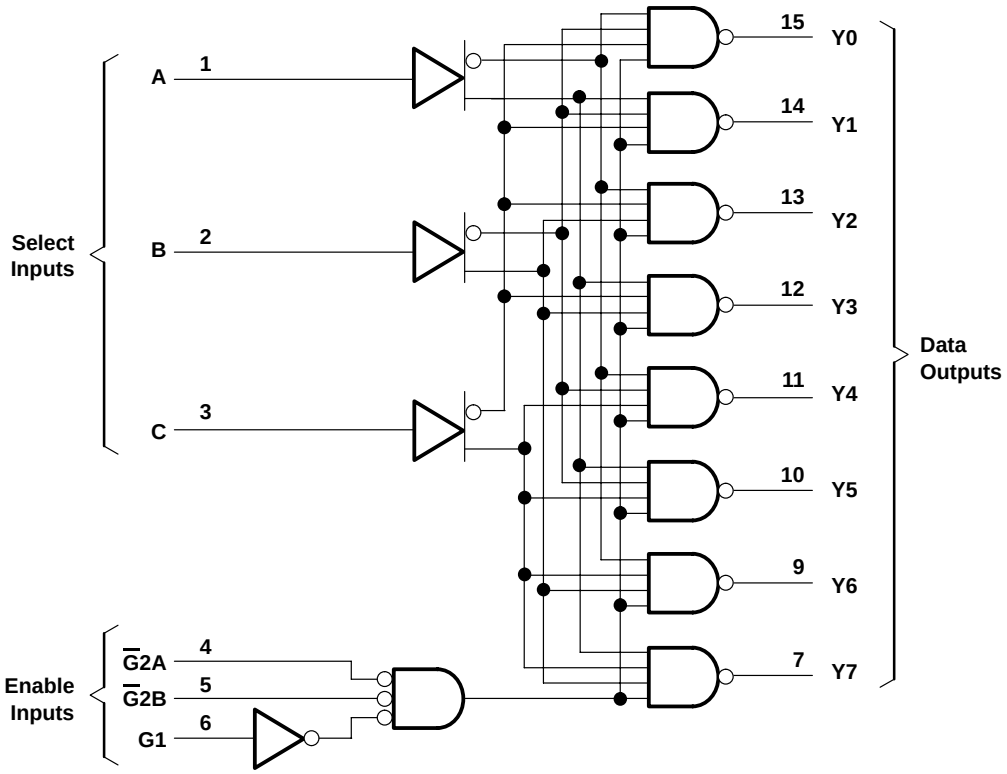
T_A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	PDIP – N	Tube	SN74AHC138N	SN74AHC138N
	SOIC – D	Tube	SN74AHC138D	AHC138
		Tape and reel	SN74AHC138DR	
	SOP – NS	Tape and reel	SN74AHC138NSR	AHC138
	SSOP – DB	Tape and reel	SN74AHC138DBR	HA138
	TSSOP – PW	Tape and reel	SN74AHC138PWR	HA138
	TVSOP – DGV	Tape and reel	SN74AHC138DGVR	HA138
–55°C to 125°C	CDIP – J	Tube	SNJ54AHC138J	SNJ54AHC138J
	CFP – W	Tube	SNJ54AHC138W	SNJ54AHC138W
	LCCC – FK	Tube	SNJ54AHC138FK	SNJ54AHC138FK

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

FUNCTION TABLE

ENABLE INPUTS			SELECT INPUTS			OUTPUTS							
G1	$\overline{G}$2A	$\overline{G}$2B	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	H	L	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 diagram (positive logic)



Pin numbers shown are for the D, DB, DGV, J, N, NS, 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
NS package . . . . . 64°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 51-7.

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 V	1.5		1.5		V
		V_{CC} = 3 V	2.1		2.1		
		V_{CC} = 5.5 V	3.85		3.85		
V_{IL}	Low-level input voltage	V_{CC} = 2 V		0.5		0.5	V
		V_{CC} = 3 V		0.9		0.9	
		V_{CC} = 5.5 V		1.65		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 V		–50		–50	μA
		V_{CC} = 3.3 V ± 0.3 V		–4		–4	mA
		V_{CC} = 5 V ± 0.5 V		–8		–8	
I_{OL}	Low-level output current	V_{CC} = 2 V		50		50	μA
		V_{CC} = 3.3 V ± 0.3 V		4		4	mA
		V_{CC} = 5 V ± 0.5 V		8		8	
$\Delta t/\Delta v$	Input transition rise or fall rate	V_{CC} = 3.3 V ± 0.3 V		100		100	ns/V
		V_{CC} = 5 V ± 0.5 V		20		20	
T_A	Operating free-air temperature		–55	125	–40	85	°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°C			SN54AHC138		SN74AHC138		UNIT
			MIN	TYP	MAX	MIN	MAX	MIN	MAX	
V_{OH}	I_{OH} = –50 μA	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 mA	3 V	2.58			2.48		2.48		
	I_{OH} = –8 mA	4.5 V	3.94			3.8		3.8		
V_{OL}	I_{OL} = 50 μA	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 mA	3 V			0.36		0.5		0.44	
	I_{OL} = 8 mA	4.5 V			0.36		0.5		0.44	
I_I	V_I = 5.5 V or GND	0 V to 5.5 V			±0.1		±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 V.

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)

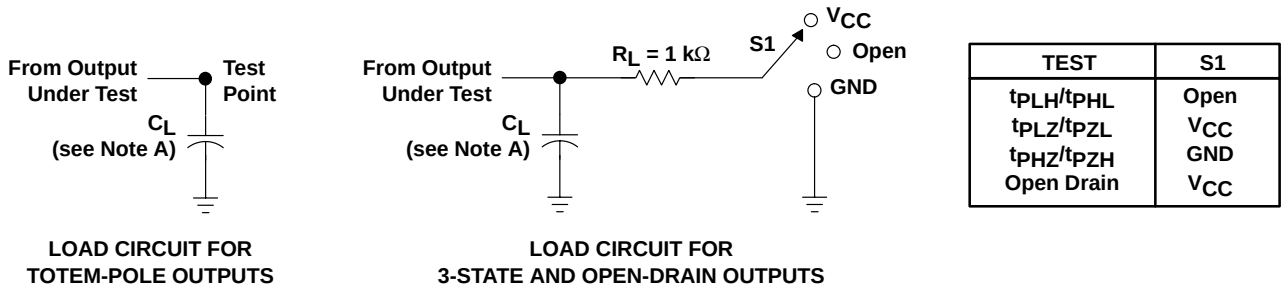
PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	T_A = 25°C			SN54AHC138		SN74AHC138		UNIT
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
t_{PLH}	A, B, C	Any Y	C_L = 15 pF		5.7*	8.1*	1*	9.5*	1	9.5	ns
t_{PHL}					5.7*	8.1*	1*	9.5*	1	9.5	
t_{PLH}	G1	Any Y	C_L = 15 pF		5.6*	8.1*	1*	9.5*	1	9.5	ns
t_{PHL}					5.6*	8.1*	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

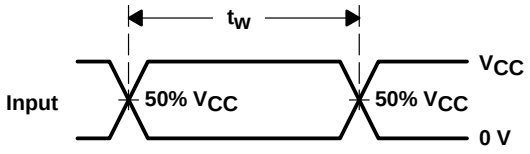
PARAMETER		TEST CONDITIONS		TYP	UNIT
C_{pd}	Power dissipation capacitance	No load,	f = 1 MHz	13	pF

PARAMETER MEASUREMENT INFORMATION

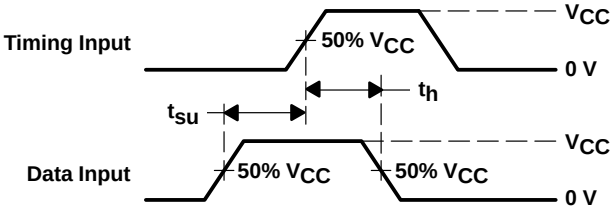


LOAD CIRCUIT FOR TOTEM-POLE OUTPUTS

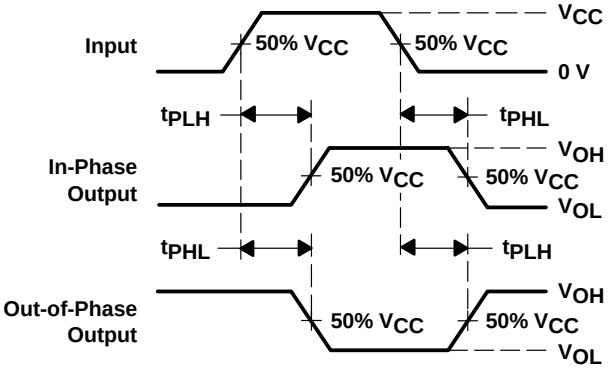
LOAD CIRCUIT FOR 3-STATE AND OPEN-DRAIN OUTPUTS



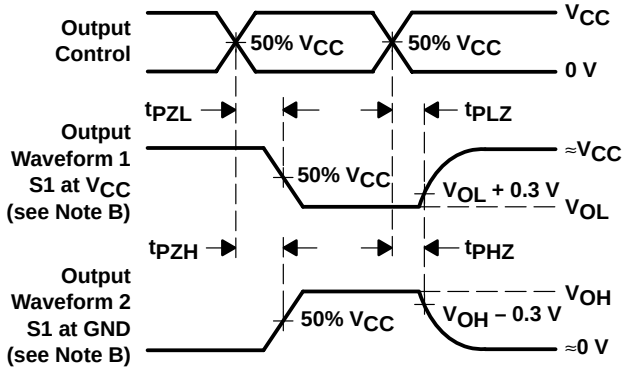
VOLTAGE WAVEFORMS PULSE DURATION



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 ≤ 1 MHz, Z_O = 50 Ω, t_r ≤ 3 ns, t_f ≤ 3 ns.
D. The outputs are measured one at a time with one input transition per measurement.

Figure 1. Load Circuit and Voltage Waveforms

APPLICATION INFORMATION

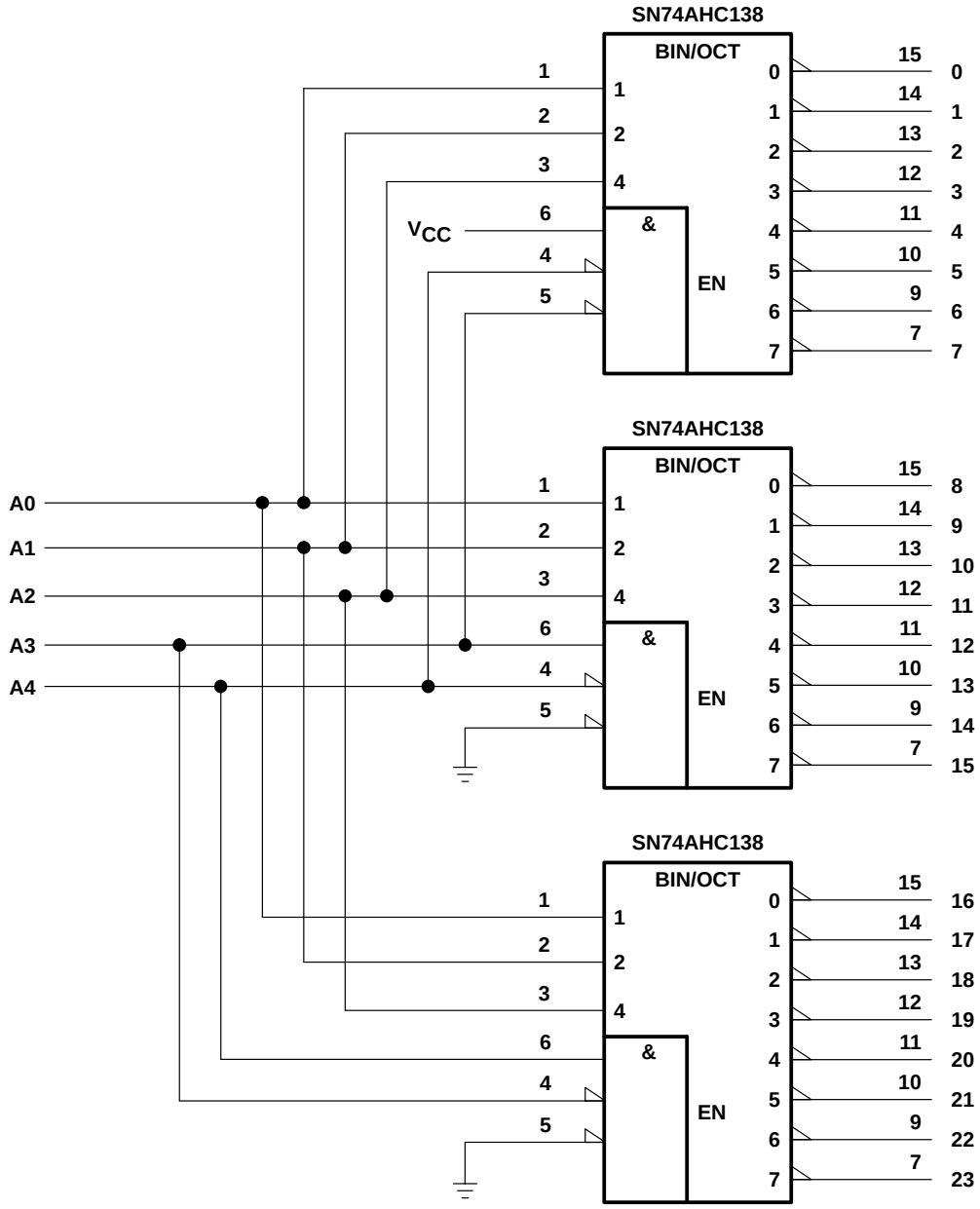


Figure 2. 24-Bit Decoding Scheme

APPLICATION INFORMATION

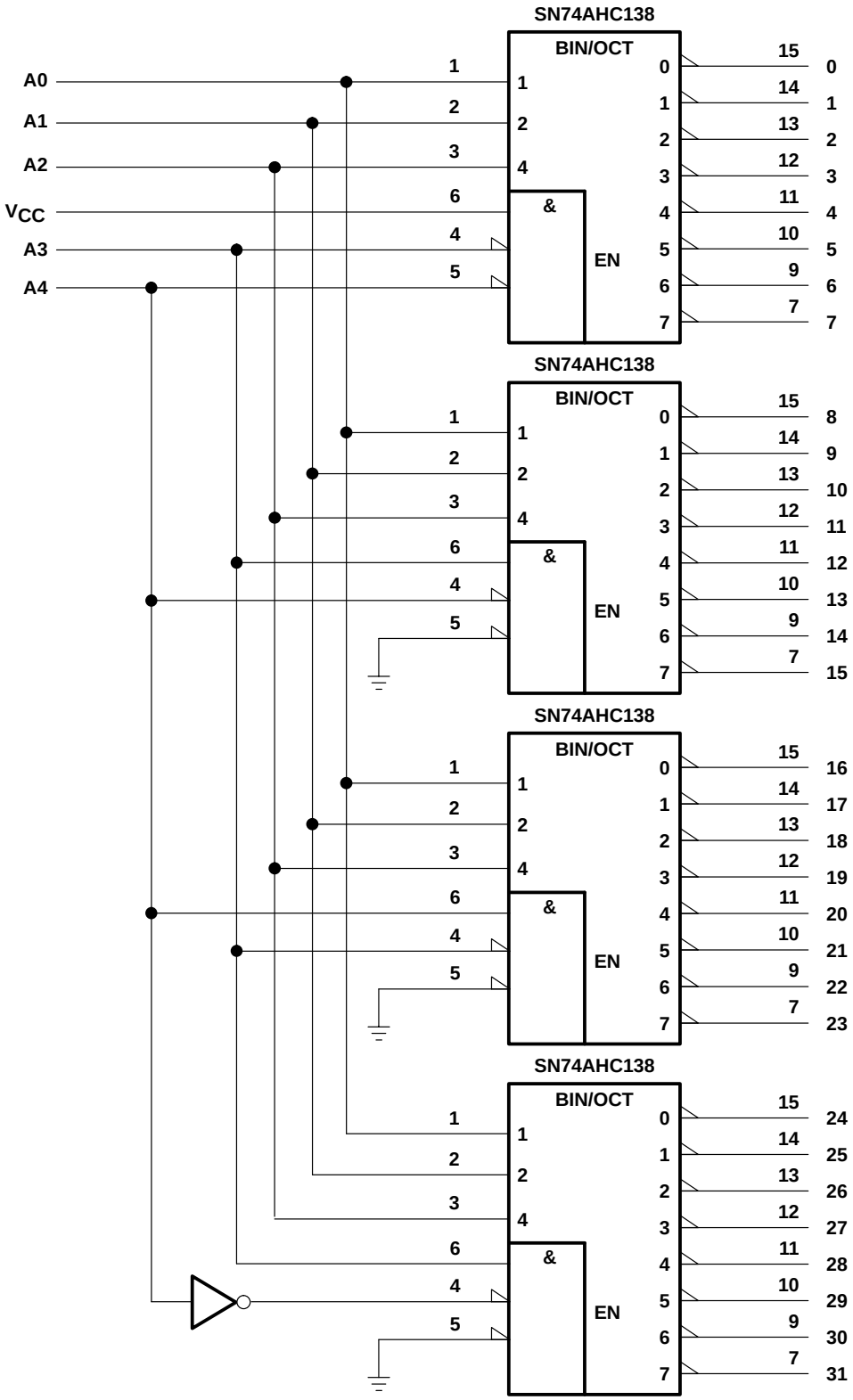


Figure 3. 32-Bit Decoding Scheme

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

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

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third–party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Mailing Address:

Texas Instruments
Post Office Box 655303
Dallas, Texas 75265

Copyright © 2002, Texas Instruments Incorporated