National Semiconductor

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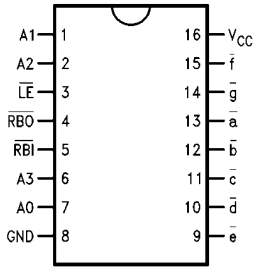
DM9370 7-Segment Decoder/Driver/Latch with Open-Collector Outputs

General Description

The DM9370 is a 7-segment decoder driver incorporating input latches and output circuits to directly drive incandescent displays. It can also be used to drive common anode LED displays in either a multiplexed mode or directly with the aid of external current limiting resistors.

Connection Diagram

Dual-in-Line Package



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Order Number DM9370N
See NS Package Number N16E

Pin Names	Description
A0–A3	Address Inputs
$\overline{LE}$	Latch Enable Input (Active LOW)
$\overline{RBI}$	Ripple Blanking Input (Active LOW)
$\overline{RBO}$	Ripple Blanking as Output (Active LOW) as Input (Active LOW)
$\overline{a}$–$\overline{g}$	Segment Outputs (Active LOW)

RRD-B30M115/Printed in U. S. A.

Absolute Maximum Ratings (Note)

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

Supply Voltage	7V
Input Voltage	5.5V
Operating Free Air Temperature Range	
Commercial	0°C to +70°C
Storage Temperature Range	−65°C to +150°C

Note: *The "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. The devic should not be operated at these limits. The parametric values defined in the "Electrical Characteristics" table are not guaranteed at the absolute maximum ratings. The "Recommended Operating Conditions" table will define the conditions for actual device operation.*

Recommended Operating Conditions

Symbol	Parameter	DM9370			Units
		Min	Nom	Max	
V_{CC}	Supply Voltage	4.75	5	5.25	V
V_{IH}	High Level Input Voltage	2			V
V_{IL}	Low Level Input Voltage			0.8	V
I_{OH}	High Level Output Current			−80	μA
I_{OL}	Low Level Output Current			3.2	mA
T_A	Free Air Operating Temperature	0		70	°C
t_s (H) t_s (L)	Setup Time HIGH or LOW A_n to $\overline{LE}$			30 20	ns
t_h (H) t_h (L)	Hold Time HIGH or LOW A_n to $\overline{LE}$			0 0	ns
t_w (L)	$\overline{LE}$ Pulse Width LOW			45	ns

Electrical Characteristics

Over recommended operating free air temperature range (unless otherwise noted)

Symbol	Parameter		Conditions		Min	Typ (Note 1)	Max	Units
V_I	Input Clamp Voltage		V_{CC} = Min, I_I = −12 mA				−1.5	V
V_{OH}	High Level Output Voltage		V_{CC} = Min, I_{OH} = Max V_{IL} = Max		2.4	3.4		V
V_{OL}	Low Level Output Voltage		V_{CC} = Min, I_{OL} = Max V_{IH} = Min			0.2	0.4	V
I_I	Input Current @ Max Input Voltage		V_{CC} = Max, V_I = 5.5V				1	mA
I_{IH}	High Level Input Current		V_{CC} = Max, V_I = 2.4V				40	μA
I_{IL}	Low Level Input Current		V_{CC} = Max, V_I = 0.4V				−1.6	mA
I_{OS}	Short Circuit Output Current		V_{CC} = Max (Note 2)	DM74	−20		−70	mA
V_{OH}	Output HIGH Voltage	$\overline{RBO}$	V_{CC} = Min, I_{OH} −80 μA		2.4			V
V_{OL}	Output LOW Voltage	$\overline{RBO}$	I_{OL} = 3.2 mA	V_{CC} = Min			0.4	V
		$\overline{a}$–$\overline{g}$	I_{OL} = 25 mA				0.4	
I_{OH}	Output HIGH Current, $\overline{a}$–$\overline{g}$						250	μA
I_{CC}	Power Supply Current		V_{CC} = Max				105	μA
			A_1, A_2, A_3, $\overline{LE}$ = GND V_{CC} = Max, Outputs Open				105	mA
			A_0, A_1, A_2, $\overline{LE}$ = GND V_{CC} = Max, Outputs Open				94	

Switching Characteristics

V_{CC} = +5.0V, T_A = +25°C (See Section 1 for waveforms and load configurations)

Symbol	Parameter	C_L = 15 PF, R_L = 500Ω		Units
		Min	Max	
t_{PLH} t_{PHL}	Propagation Delay A_n to $\overline{a}$–$\overline{g}$		75 50	ns
t_{PLH} t_{PHL}	Propagation Delay $\overline{LE}$ to $\overline{a}$–$\overline{g}$		90 70	ns

Functional Description

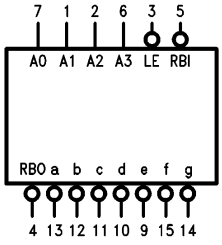
The ’70 has active LOW outputs capable of sinking in excess of 25 mA which allows it to drive a wide variety of 7-segment incandescent displays directly. It may also be used to drive common anode LED displays, multiplexed or directly with the aid of suitable current limiting resistors. This device accepts a 4-bit binary code and produces output drive to the appropriate segments of the 7-segment display. It has a hexadecimal decode format which produces numeric codes ‘‘0’’ through ‘‘9’’ and alpha codes ‘‘A’’ through ‘‘F’’ using upper and lower case fonts.

Latches on the four data inputs are controlled by an active LOW latch enable $\overline{LE}$. When the $\overline{LE}$ is LOW, the state of the outputs is determined by the input data. When the $\overline{LE}$ goes HIGH, the last data present at the inputs is stored in the latches and the outputs remain stable. The $\overline{LE}$ pulse width necessary to accept and store data is typically 30 ns which allows data to be strobed into the ’70 at normal TTL speeds. This feature means that data can be routed directly from high speed counters and frequency dividers into the display without slowing down the system clock or providing intermediate data storage.

The latch/decoder combination is a simple system which drives incandescent displays with multiplexed data inputs from MOS time clocks, DVMs, calculator chips, etc. Data inputs are multiplexed while the displays are in static mode. This lowers component and insertion costs since several circuits—seven diodes per display, strobe drivers, a separate display voltage source, and clock failure detect circuits—traditionally found in incandescent multiplexed display systems are eliminated. It also allows low strobing rates to be used without display flicker.

Another ’70 feature is the reduced loading on the data inputs when the Latch Enable is HIGH (only 10 μA typ). This allows many ’70s to be driven from a MOS device in multiplex mode without the need for drivers on the data lines. The ’70 also provides automatic blanking of the leading and/or trailing-edge zeroes in a multidigit decimal number, resulting in an easily readable decimal display conforming to normal writing practice. In an 8-digit mixed integer fraction decimal representation, using the automatic blanking capability, 0060.0300 would be displayed as 60.03. Leading-edge zero suppression is obtained by connecting the Ripple Blanking Output ($\overline{RBO}$) of a decoder to the Ripple Blanking Input ($\overline{RBI}$ of the next lower stage device. The most significant decoder stage should have the $\overline{RBI}$ input grounded; and since suppression of the least significant integer zero in a number is not usually desired, the $\overline{RBI}$ input of this decoder stage should be left open. A similar procedure for the fractional part of a display will provide automatic suppression of trailing-edge zeroes. The $\overline{RBO}$ terminal of the decoder can be OR-tied with a modulating signal via an isolating buffer to achieve pulse duration intensity modulation. A suitable signal can be generated for this purpose by forming a variable frequency multivibrator with a cross coupled pair of TTL or DTL gates.

Logic Symbol



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V_{CC} = Pin 16
GND = Pin 8

Truth Table

BINARY STATE	INPUTS						OUTPUTS								DISPLAY
	$\overline{LE}$	$\overline{RBI}$	A3	A2	A1	A0	$\overline{a}$	$\overline{b}$	$\overline{c}$	$\overline{d}$	$\overline{e}$	$\overline{f}$	$\overline{g}$	$\overline{RBO}$	
--	H	*	X	X	X	X	◄ STABLE ►							H	STABLE
0	L	L	L	L	L	L	H	H	H	H	H	H	H	L	BLANK
0	L	H	L	L	L	L	L	L	L	L	L	L	H	H	0
1	L	X	L	L	L	H	H	L	L	H	H	H	H	H	1
2	L	X	L	L	H	L	L	L	H	L	L	H	L	H	2
3	L	X	L	L	H	H	L	L	L	L	H	H	L	H	3
4	L	X	L	H	L	L	H	L	L	H	H	L	L	H	4
5	L	X	L	H	L	H	L	H	L	L	H	L	L	H	5
6	L	X	L	H	H	L	L	H	L	L	L	L	L	H	6
7	L	X	L	H	H	H	L	L	L	H	H	H	H	H	7
8	L	X	H	L	L	L	L	L	L	L	L	L	L	H	8
9	L	X	H	L	L	H	L	L	L	H	H	L	L	H	9
10	L	X	H	L	H	L	L	L	L	H	L	L	L	H	A
11	L	X	H	L	H	H	H	H	L	L	L	L	L	H	b
12	L	X	H	H	L	L	L	H	H	L	L	L	H	H	C
13	L	X	H	H	L	H	H	L	L	L	L	H	L	H	d
14	L	X	H	H	H	L	L	H	H	L	L	L	L	H	E
15	L	X	H	H	H	H	L	H	H	H	L	L	L	H	F
X	X	X	X	X	X	X	H	H	H	H	H	H	H	L**	BLANK

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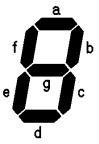

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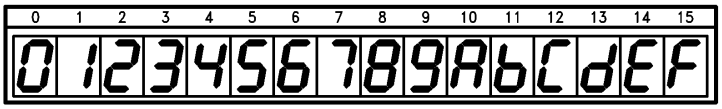
*The $\overline{RBI}$ will blank the display only if binary zero is stored in the latches.

**$\overline{RBO}$ used as an input overdrives all other input conditions.

H = HIGH Voltage Level
L = LOW Voltage Level
X = Immaterial

Numerical Designation



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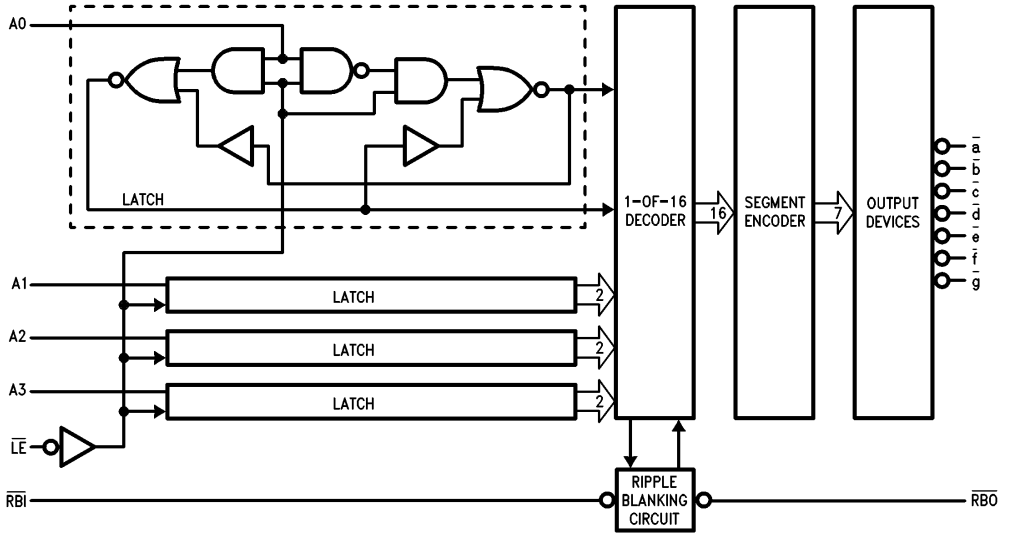
Logic Diagram



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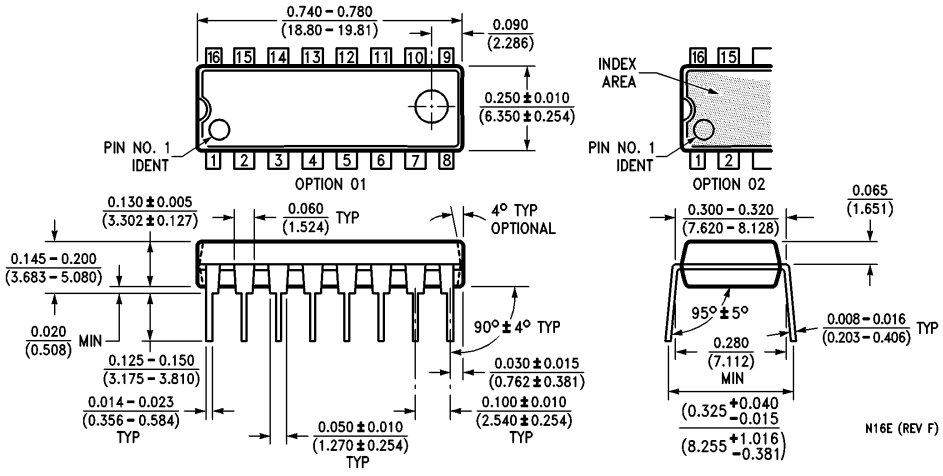
Physical Dimensions inches (millimeters)



16-Lead Molded Dual-In-Line Package (N)
Order Number DM9370N
NS Package Number N16E

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National Semiconductor Corporation
1111 West Bardin Road
Arlington, TX 76017
Tel: 1(800) 272-9959
Fax: 1(800) 737-7018

National Semiconductor Europe
Fax: (+49) 0-180-530 85 86
Email: cnjwge@tevm2.nsc.com
Deutsch Tel: (+49) 0-180-530 85 85
English Tel: (+49) 0-180-532 78 32
Français Tel: (+49) 0-180-532 93 58
Italiano Tel: (+49) 0-180-534 16 80

National Semiconductor Hong Kong Ltd.
13th Floor, Straight Block,
Ocean Centre, 5 Canton Rd.
Tsimshatsui, Kowloon
Hong Kong
Tel: (852) 2737-1600
Fax: (852) 2736-9960

National Semiconductor Japan Ltd.
Tel: 81-043-299-2309
Fax: 81-043-299-2408