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NTE4513B **Integrated Circuit** **CMOS, BCD-to-Seven Segment Latch/Decoder/Driver**

Description:

The NTE4513B is a BCD-to-seven segment latch/decoder/driver in an 18-Lead DIP type package constructed with complementary MOS (CMOS) enhancement mode devices and NPN bipolar output drivers in a single monolithic structure. The circuit provides the functions of a 4-bit storage latch, an 8421 BCD-to-seven segment decoder, and an output drive capability. Lamp test (LT), blanking (BI), and latch enable (LE) inputs are used to test the display, to turn-off or pulse modulate the brightness of the display, and to store a BCD code, respectively. The Ripple Blanking Input (RBI) and Ripple Blanking Output (RBO) can be used to suppress either leading or trailing zeros. It can be used with seven-segment light emitting diodes (LED), incandescent, fluorescent, gas discharge, or liquid crystal readouts either directly or indirectly.

Applications include instrument (e.g., counter, DVM, etc.), display driver, computer/calculator display driver, cockpit display driver, and various clock, watch, and timer uses.

Features:

- Low Logic Circuit Power Dissipation
- High-Current Sourcing Outputs (Up to 25mA)
- Latch Storage of Binary Input
- Blanking Input
- Lamp Test Provision
- Readout Blanking on All Illegal Input Combinations
- Lamp Intensity Modulation Capability
- Time Share (Multiplexing) Facility
- Adds Ripple Blanking In, Ripple Blanking Out to NTE4511B
- Supply Voltage Range = 3Vcd to 10Vdc
- Capable of Driving Two Low-Power TTL Loads, One Low-Power Schottky TTL Load or Two HTL Loads Over the Rated Temperature Range

Absolute Maximum Ratings: (Voltages Referenced to V_{SS} , Note 1)

DC Supply Voltage, V_{DD}	-0.5 to +18.0V
Input Voltage (All Inputs), V_{in}	-0.5 to $V_{DD} + 0.5V$
DC Current Drain (Per Pin), I	10mA
Maximum Output Drive Current (Source) Per Output, I_{OHmax}	25mA
Maximum Continuous Output Power (Source) Per Output (Note 2), P_{OHmax}	50mW
Operating Temperature Range, T_A	-55 to +125°C
Storage Temperature Range, T_{stg}	-65 to +150°C

Note 1. These devices contain circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit. A destructive high current mode may occur if V_{in} and V_{out} is not constrained to the range $V_{SS} \leq (V_{in} \text{ or } V_{out}) \leq V_{DD}$.

Due to the sourcing capability of these circuits, damage can occur to the device if V_{DD} is applied, and the outputs are shorted to V_{SS} and are at a logical 1 (See Absolute Maximum Ratings)

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either V_{SS} or V_{DD}).

Note 2. $P_{OHmax} = I_{OH} (V_{DD} - V_{OH})$

Electrical Characteristics: (Voltages referenced to V_{SS} , Note 3)

Parameter	Symbol	V_{DD} Vdc	-55°C		+25°C			+125°C		Unit
			Min	Max	Min	Typ	Max	Min	Max	
Output Voltage (Segment Outputs) "0" Level $V_{in} = V_{DD}$ or 0 "1" Level $V_{in} = 0$ or V_{DD}	V_{OL}	5.0	-	0.05	-	0	0.05	-	0.05	Vdc
		10	-	0.05	-	0	0.05	-	0.05	Vdc
		15	-	0.05	-	0	0.05	-	0.05	Vdc
	V_{OH}	5.0	4.1	-	4.1	4.57	-	4.1	-	Vdc
		10	9.1	-	9.1	9.58	-	9.1	-	Vdc
		15	14.1	-	14.1	14.59	-	14.1	-	Vdc
Output Voltage (RBO Outputs) "0" Level $V_{in} = V_{DD}$ or 0 "1" Level $V_{in} = 0$ or V_{DD}	V_{OL}	5.0	-	0.05	-	0	0.05	-	0.05	Vdc
		10	-	0.05	-	0	0.05	-	0.05	Vdc
		15	-	0.05	-	0	0.05	-	0.05	Vdc
	V_{OH}	5.0	4.95	-	4.95	5.0	-	4.95	-	Vdc
		10	9.95	-	9.95	10	-	9.95	-	Vdc
		15	14.95	-	14.95	15	-	14.95	-	Vdc
Input Voltage (Note 5) "0" Level ($V_O = 3.8$ or $0.5Vdc$) ($V_O = 8.8$ or $1.0Vdc$) ($V_O = 13.8$ or $1.5Vdc$) "1" Level ($V_O = 0.5$ or $3.8Vdc$) ($V_O = 1.0$ or $8.8Vdc$) ($V_O = 1.5$ or $13.8Vdc$)	V_{IL}	5.0	-	1.5	-	2.25	1.5	-	1.5	Vdc
		10	-	3.0	-	4.50	3.0	-	3.0	Vdc
		15	-	4.0	-	6.75	4.0	-	4.0	Vdc
	V_{IH}	5.0	3.5	-	3.5	2.75	-	3.5	-	Vdc
		10	7.0	-	7.0	5.50	-	7.0	-	Vdc
		15	11.0	-	11.0	8.25	-	11.0	-	Vdc

Note 3. Data labeled "Typ" is not to be used for design purposes but is intended as an indication of the device's potential performance.

Note 4. The formulas given are for the typical characteristics only at +25°C.

Note 5. Noise immunity specified for worst-case input combination.

Noise margin for both "1" and "0" = 1.0Vdc min @ $V_{DD} = 5Vdc$
 2.0Vdc min @ $V_{DD} = 10Vdc$
 2.5Vdc min @ $V_{DD} = 15Vdc$

Electrical Characteristics (Cont'd): (Voltages referenced to V_{SS}, Note 3)

Parameter	Symbol	V _{DD} Vdc	-55°C		+25°C			+125°C		Unit
			Min	Max	Min	Typ	Max	Min	Max	
Output Drive Voltage (Segments) (I _{OH} = 0mA) Source (I _{OH} = 5.0mA) (I _{OH} = 10mA) (I _{OH} = 15mA) (I _{OH} = 20mA) (I _{OH} = 25mA) (I _{OH} = 0mA) (I _{OH} = 5.0mA) (I _{OH} = 10mA) (I _{OH} = 15mA) (I _{OH} = 20mA) (I _{OH} = 25mA) (I _{OH} = 0mA) (I _{OH} = 5.0mA) (I _{OH} = 10mA) (I _{OH} = 15mA) (I _{OH} = 20mA) (I _{OH} = 25mA)	V _{OH}	5.0	4.10	–	4.10	4.57	–	4.1	–	Vdc
			–	–	–	4.24	–	–	–	Vdc
			3.90	–	3.90	4.12	–	3.5	–	Vdc
			–	–	–	3.94	–	–	–	Vdc
			3.40	–	3.40	3.75	–	3.0	–	Vdc
			–	–	–	3.54	–	–	–	Vdc
		10	9.10	–	9.10	9.58	–	9.1	–	Vdc
			–	–	–	9.26	–	–	–	Vdc
			9.00	–	9.00	9.17	–	8.6	–	Vdc
			–	–	–	9.04	–	–	–	Vdc
			8.60	–	8.60	8.90	–	8.2	–	Vdc
			–	–	–	8.75	–	–	–	Vdc
		15	14.1	–	14.1	14.59	–	14.1	–	Vdc
			–	–	–	14.27	–	–	–	Vdc
			14.0	–	14.0	14.18	–	13.6	–	Vdc
			–	–	–	14.07	–	–	–	Vdc
			13.6	–	13.6	13.95	–	13.2	–	Vdc
			–	–	–	13.80	–	–	–	Vdc
Output Drive Current (RBO Output) (V _{OH} = 2.5Vdc) Source (V _{OH} = 9.5Vdc) (V _{OH} = 13.5Vdc) (V _{OL} = 0.4Vdc) Sink (V _{OL} = 0.5Vdc) (V _{OL} = 1.5Vdc)	I _{OH}	5.0	-0.40	–	-0.32	-0.64	–	-0.22	–	mAdc
		10	-0.21	–	-0.17	-0.34	–	-0.12	–	mAdc
		15	-0.81	–	-0.66	-1.3	–	-0.46	–	mAdc
	I _{OL}	5.0	0.18	–	0.15	0.29	–	0.10	–	mAdc
		10	0.47	–	0.38	0.75	–	0.26	–	mAdc
		15	1.8	–	1.5	2.9	–	1.0	–	mAdc
Output Drive Current (Segments) (V _{OH} = 0.4Vdc) Sink (V _{OH} = 0.5Vdc) (V _{OH} = 1.5Vdc)	I _{OL}	5.0	0.64	–	0.51	0.88	–	0.36	–	mAdc
		10	1.6	–	1.3	2.25	–	0.9	–	mAdc
		15	4.2	–	3.4	8.8	–	2.4	–	mAdc
Input Current	I _{in}	15	–	±0.1	–	±0.00001	±0.1	–	±0.1	μAdc
Input Capacitance (V _{IN} = 0)	C _{in}	–	–	–	–	5.0	7.5	–	–	pF
Quiescent Current (Per Package)	I _{DD}	5.0	–	5.0	–	0.005	5.0	–	150	μAdc
		10	–	10	–	0.010	10	–	300	μAdc
		15	–	15	–	0.015	15	–	600	μAdc
Total Supply Current (Dynamic plus Quiescent, Per Package, C _L = 50pF on All Outputs, All Buffers Switching Note 4, Note 6)	I _T	5.0	I _T = (1.9μA/kHz) f + I _{DD}							μAdc
		10	I _T = (3.8μA/kHz) f + I _{DD}							μAdc
		15	I _T = (6.7μA/kHz) f + I _{DD}							μAdc

Note 3. Data labeled “Typ” is not to be used for design purposes but is intended as an indication of the device’s potential performance.

Note 4. The formulas given are for the typical characteristics only at +25°C.

Note 5. Noise immunity specified for worst–case input combination.

Noise margin for both “1” and “0” = 1.0Vdc min @ V_{DD} = 5Vdc
 2.0Vdc min @ V_{DD} = 10Vdc
 2.5Vdc min @ V_{DD} = 15Vdc

Note 6. To calculate total supply current at loads other than 50pF:

$$I_T(C_L) = I_T(50pF) + 3.5 \times 10^{-3}(C_L - 50) V_{DD}f$$

where: I_T is in μA (per package), C_L in pF, V_{DD} in volts and f in kHz is input frequency.

Switching Characteristics: ($C_L = 50\text{pF}$, $T_A = +25^\circ\text{C}$, Note 3)

Parameter	Symbol	V _{DD} Vdc	Min	Typ	Max	Unit
Output Rise Time (Segment Outputs)	t_{TLH} ,	5.0	–	40	80	ns
		10	–	30	60	ns
		15	–	25	60	ns
Output Rise Time (RBO Outputs)	t_{TLH} ,	5.0	–	480	960	ns
		10	–	240	480	ns
		15	–	190	380	ns
Output Fall Time (Segment Outputs) $t_{THL} = (1.5\text{ns/pf}) C_L + 50\text{ns}$ $t_{THL} = (0.75\text{ns/pf}) C_L + 37.5\text{ns}$ $t_{THL} = (0.55\text{ns/pf}) C_L + 37.5\text{ns}$	t_{THL}	5.0	–	125	250	ns
		10	–	75	150	ns
		15	–	65	130	ns
Output Fall Time (RBO Outputs) $t_{THL} = (1.5\text{ns/pf}) C_L + 50\text{ns}$ $t_{THL} = (0.75\text{ns/pf}) C_L + 37.5\text{ns}$ $t_{THL} = (0.55\text{ns/pf}) C_L + 37.5\text{ns}$	t_{THL}	5.0	–	270	540	ns
		10	–	135	270	ns
		15	–	110	220	ns
Propagation Delay Time (A, B, C, D Inputs) $t_{PLH} = (0.40\text{ns/pf}) C_L + 620\text{ns}$ $t_{PLH} = (0.25\text{ns/pf}) C_L + 237.5\text{ns}$ $t_{PLH} = (0.20\text{ns/pf}) C_L + 165\text{ns}$ $t_{PHL} = (1.3\text{ns/pf}) C_L + 655\text{ns}$ $t_{PHL} = (0.60\text{ns/pf}) C_L + 260\text{ns}$ $t_{PHL} = (0.35\text{ns/pf}) C_L + 182.5\text{ns}$	t_{PLH}	5.0	–	640	1280	ns
		10	–	250	500	ns
		15	–	175	350	ns
	t_{PHL}	5.0	–	720	1440	ns
		10	–	290	580	ns
		15	–	200	400	ns
Propagation Delay Time (RBI Input) $t_{PLH} = (0.30\text{ns/pf}) C_L + 305\text{ns}$ $t_{PLH} = (0.25\text{ns/pf}) C_L + 117.5\text{ns}$ $t_{PLH} = (0.15\text{ns/pf}) C_L + 92.5\text{ns}$ $t_{PHL} = (0.85\text{ns/pf}) C_L + 442.5\text{ns}$ $t_{PHL} = (0.45\text{ns/pf}) C_L + 177.5\text{ns}$ $t_{PHL} = (0.35\text{ns/pf}) C_L + 142.5\text{ns}$	t_{PLH}	5.0	–	600	750	ns
		10	–	200	300	ns
		15	–	150	220	ns
	t_{PHL}	5.0	–	485	970	ns
		10	–	200	400	ns
		15	–	160	320	ns
Propagation Delay Time (BI Input) $t_{PLH} = (0.30\text{ns/pf}) C_L + 305\text{ns}$ $t_{PLH} = (0.25\text{ns/pf}) C_L + 117.5\text{ns}$ $t_{PLH} = (0.15\text{ns/pf}) C_L + 92.5\text{ns}$ $t_{PHL} = (0.85\text{ns/pf}) C_L + 442.5\text{ns}$ $t_{PHL} = (0.45\text{ns/pf}) C_L + 177.5\text{ns}$ $t_{PHL} = (0.35\text{ns/pf}) C_L + 142.5\text{ns}$	t_{PLH}	5.0	–	600	750	ns
		10	–	200	300	ns
		15	–	150	220	ns
	t_{PHL}	5.0	–	485	970	ns
		10	–	200	400	ns
		15	–	160	320	ns
Propagation Delay Time (LT Input) $t_{PLH} = (0.45\text{ns/pf}) C_L + 290.5\text{ns}$ $t_{PLH} = (0.25\text{ns/pf}) C_L + 112.5\text{ns}$ $t_{PLH} = (0.20\text{ns/pf}) C_L + 80\text{ns}$ $t_{PHL} = (1.3\text{ns/pf}) C_L + 248\text{ns}$ $t_{PHL} = (0.45\text{ns/pf}) C_L + 102.5\text{ns}$ $t_{PHL} = (0.35\text{ns/pf}) C_L + 72.5\text{ns}$	t_{PLH}	5.0	–	313	625	ns
		10	–	125	250	ns
		15	–	90	180	ns
	t_{PHL}	5.0	–	313	625	ns
		10	–	125	250	ns
		15	–	90	180	ns

Note 3. Data labeled “Typ” is not to be used for design purposes but is intended as an indication of the device’s potential performance.

Note 4. The formulas given are for the typical characteristics only at +25°C.

Switching Characteristics (Cont'd): ($C_L = 50\text{pF}$, $T_A = +25^\circ\text{C}$, Note 3)

Parameter	Symbol	V_{DD} Vdc	Min	Typ	Max	Unit
Minimum Setup Time	tsu	5.0	–	90	180	ns
		10	–	38	76	ns
		15	–	20	40	ns
Minimum Hold Time	th	5.0	–	–90	0	ns
		10	–	–38	0	ns
		15	–	–20	0	ns
Minimum Latch Enable Pulse Width	t _{WL}	5.0	–	260	520	ns
		10	–	110	220	ns
		15	–	65	130	ns

Note 3. Data labeled “Typ” is not to be used for design purposes but is intended as an indication of the device’s potential performance.

Note 4. The formulas given are for the typical characteristics only at +25°C.

Truth Table:

Inputs								Outputs								
RBI	LE	$\overline{\text{BI}}$	$\overline{\text{LT}}$	D	C	B	A	RBO	a	b	c	d	e	f	g	Display
X	X	X	0	X	X	X	X	**	1	1	1	1	1	1	1	8
X	X	0	1	X	X	X	X	**	0	0	0	0	0	0	0	Blank
1	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	Blank
0	0	1	1	0	0	0	0	0	1	1	1	1	1	1	0	0
X	0	1	1	0	0	0	1	0	0	1	1	0	0	0	0	1
X	0	1	1	0	0	1	0	0	1	1	0	1	1	0	1	2
X	0	1	1	0	0	1	1	0	1	1	1	1	0	0	1	3
X	0	1	1	0	1	0	0	0	0	1	1	0	0	1	1	4
X	0	1	1	0	1	0	1	0	1	0	1	1	0	1	1	5
X	0	1	1	0	1	1	0	0	0	0	1	1	1	1	1	6
X	0	1	1	0	1	1	1	0	1	1	1	0	0	0	0	7
X	0	1	1	1	0	0	0	0	1	1	1	1	1	1	1	8
X	0	1	1	1	0	0	1	0	1	1	1	0	0	1	1	9
X	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0	Blank
X	0	1	1	1	0	1	1	0	0	0	0	0	0	0	0	Blank
X	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	Blank
X	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	Blank
X	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	Blank
X	1	1	1	X	X	X	X	**	*						*	

X = Don't Care

** RBO • RBI ($\overline{\text{D}} \overline{\text{C}} \overline{\text{B}} \overline{\text{A}}$), indicated by other rows of table

* Depends upon the BCD code previously applied when LE = 0

Pin Connection Diagram

