



ELECTRONICS, INC.  
 44 FARRAND STREET  
 BLOOMFIELD, NJ 07003  
 (973) 748-5089  
<http://www.nteinc.com>

## NTE4510B & NTE4510BT Integrated Circuit CMOS, Presetable Up/Down BCD Counter

**Description:**

The NTE4510B (16-Lead DIP) and NTE4510BT (SOIC-16) are up/down counters constructed with MOS P-channel and N-channel enhancement mode devices in a single monolithic structure. The counter consists of type D flip-flop stages with a gating structure to provide type T flip-flop capability. The counter can be cleared by applying a high level on the Reset line. These complementary MOS counters find primary use in up/down and difference counting and frequency synthesizer applications where low power and/or high noise immunity is desired. They are also useful in A/D and D/A conversion for magnitude and sign generation.

**Features:**

- Noise Immunity = 45% of  $V_{DD}$  (Typ)
- Diode Protection on All Inputs
- Supply Voltage Range = 3Vdc to 10Vdc
- Low Input Capacitance = 5pF (Typ)
- Internally Synchronous for High Speed
- Logic Edge-Clocked Design – Count Occurs on Positive Going Edge of Clock
- 5Mhz Counting Rate
- Asynchronous Preset Enable Operation
- 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
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. For proper operation it is recommended that  $V_{in}$  and  $V_{out}$  be constrained to the range  $V_{SS} \leq (V_{in} \text{ or } V_{out}) \leq V_{DD}$ .

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

**Electrical Characteristics:** (Voltages referenced to  $V_{SS}$ , Note 2)

Parameter	Symbol	$V_{DD}$ Vdc	-55°C		+25°C			+125°C		Unit
			Min	Max	Min	Typ	Max	Min	Max	
Output Voltage "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 4) "0" Level ( $V_O = 4.5$ or $0.5$ Vdc) ( $V_O = 9.0$ or $1.0$ Vdc) ( $V_O = 13.5$ or $1.5$ Vdc)  "1" Level ( $V_O = 0.5$ or $4.5$ Vdc) ( $V_O = 1.0$ or $9.0$ Vdc) ( $V_O = 1.5$ or $13.5$ Vdc)	$V_{IL}$	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
Output Drive Current Source ( $V_{OH} = 2.5$ Vdc) ( $V_{OH} = 4.6$ Vdc) ( $V_{OH} = 9.5$ Vdc) ( $V_{OH} = 13.5$ Vdc)  Sink ( $V_{OL} = 0.4$ Vdc) ( $V_{OL} = 0.5$ Vdc) ( $V_{OL} = 1.5$ Vdc)	$I_{OH}$	5.0	-1.2	-	-1.0	-1.7	-	-0.7	-	mAdc
		5.0	-0.25	-	-0.2	-0.36	-	-0.14	-	mAdc
		10	-0.62	-	-0.5	-0.9	-	-0.35	-	mAdc
		15	-1.8	-	-1.5	-3.5	-	-1.1	-	mAdc
	$I_{OL}$	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	-	$\pm 0.1$	-	$\pm 0.00001$	$\pm 0.1$	-	$\pm 0.1$	$\mu$ Adc
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	$\mu$ Adc
		10	-	10	-	0.010	10	-	300	$\mu$ Adc
		15	-	15	-	0.015	15	-	600	$\mu$ Adc
Total Supply Current (Dynamic plus Quiescent, Per Package, $C_L = 50$ pF on All Outputs, All Buffers Switching Note 3, Note 5)	$I_T$	5.0	$I_T = (0.58\mu A/kHz) f + I_{DD}$							$\mu$ Adc
		10	$I_T = (1.2\mu A/kHz) f + I_{DD}$							$\mu$ Adc
		15	$I_T = (1.7\mu A/kHz) f + I_{DD}$							$\mu$ Adc

Note 2. Data labeled "Typ" is not to be used for design purposes but is intended as an indication of the device's potential performance.

Note 3. The formulas given are for the typical characteristics only at +25°C.

Note 4. Noise immunity specified for worst-case input combination.

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

Note 5. To calculate total supply current at loads other than 50pF:

$$I_T(C_L) = I_T(50pF) + 1 \times 10^{-3}(C_L - 50) V_{DD}f$$

where:  $I_T$  is in  $\mu$ A (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 2)

Parameter	Symbol	V <sub>DD</sub> Vdc	Min	Typ	Max	Unit
Output Rise Time $t_{TLH} = (3.0\text{ns/pf}) C_L + 30\text{ns}$ $t_{TLH} = (1.5\text{ns/pf}) C_L + 15\text{ns}$ $t_{TLH} = (1.1\text{ns/pf}) C_L + 10\text{ns}$	$t_{TLH}$	5.0	–	180	360	ns
		10	–	90	180	ns
		15	–	65	130	ns
Output Fall Time $t_{THL} = (1.5\text{ns/pf}) C_L + 25\text{ns}$ $t_{THL} = (0.75\text{ns/pf}) C_L + 12.5\text{ns}$ $t_{THL} = (0.55\text{ns/pf}) C_L + 9.5\text{ns}$	$t_{THL}$	5.0	–	100	200	ns
		10	–	50	100	ns
		15	–	40	80	ns
Propagation Delay Time Clock to Q $t_{PLH}, t_{PHL} = (1.7\text{ns/pf}) C_L + 230\text{ns}$ $t_{PLH}, t_{PHL} = (0.66\text{ns/pf}) C_L + 97\text{ns}$ $t_{PLH}, t_{PHL} = (0.5\text{ns/pf}) C_L + 75\text{ns}$	$t_{PLH}, t_{PHL}$	5.0	–	315	630	ns
		10	–	130	260	ns
		15	–	100	200	ns
Clock to Carry Out $t_{PLH}, t_{PHL} = (1.7\text{ns/pf}) C_L + 230\text{ns}$ $t_{PLH}, t_{PHL} = (0.66\text{ns/pf}) C_L + 97\text{ns}$ $t_{PLH}, t_{PHL} = (0.5\text{ns/pf}) C_L + 75\text{ns}$	$t_{PLH}, t_{PHL}$	5.0	–	315	630	ns
		10	–	130	260	ns
		15	–	100	200	ns
Carry In to Carry Out $t_{PLH}, t_{PHL} = (1.7\text{ns/pf}) C_L + 95\text{ns}$ $t_{PLH}, t_{PHL} = (0.66\text{ns/pf}) C_L + 47\text{ns}$ $t_{PLH}, t_{PHL} = (0.5\text{ns/pf}) C_L + 35\text{ns}$	$t_{PLH}, t_{PHL}$	5.0	–	180	360	ns
		10	–	80	160	ns
		15	–	60	120	ns
Preset or Reset to Q $t_{PLH}, t_{PHL} = (1.7\text{ns/pf}) C_L + 230\text{ns}$ $t_{PLH}, t_{PHL} = (0.66\text{ns/pf}) C_L + 97\text{ns}$ $t_{PLH}, t_{PHL} = (0.5\text{ns/pf}) C_L + 75\text{ns}$	$t_{PLH}, t_{PHL}$	5.0	–	315	630	ns
		10	–	130	260	ns
		15	–	100	200	ns
Preset or Reset to Carry Out $t_{PLH}, t_{PHL} = (1.7\text{ns/pf}) C_L + 465\text{ns}$ $t_{PLH}, t_{PHL} = (0.66\text{ns/pf}) C_L + 192\text{ns}$ $t_{PLH}, t_{PHL} = (0.6\text{ns/pf}) C_L + 125\text{ns}$	$t_{PLH}, t_{PHL}$	5.0	–	550	1100	ns
		10	–	225	450	ns
		15	–	150	300	ns
Clock Pulse Width	$t_{WH}$	5.0	350	200	–	ns
		10	170	100	–	ns
		15	140	75	–	ns
Clock Pulse Frequency	$f_{cl}$	5.0	–	3.0	1.5	MHz
		10	–	6.0	3.0	MHz
		15	–	8.0	4.0	MHz
Preset or Reset Removal Time (Note 6)	trem	5.0	650	325	–	ns
		10	230	115	–	ns
		15	180	90	–	ns
Clock Rise and Fall Time	$t_{TLH}, t_{THL}$	5.0	–	–	15	$\mu\text{s}$
		10	–	–	15	$\mu\text{s}$
		15	–	–	15	$\mu\text{s}$

Note 2. Data labeled “Typ” is not to be used for design purposes but is intended as an indication of the device’s potential performance.

Note 3. The formulas given are for the typical characteristics only at +25°C.

Note 6. The Preset or Reset Signal must be low prior to a positive-going transition of the clock.

**Switching Characteristics (Cont'd):** ( $C_L = 50\text{pF}$ ,  $T_A = +25^\circ\text{C}$ , Note 2)

Parameter	Symbol	$V_{DD}$ Vdc	Min	Typ	Max	Unit
Carry In Setup Time	$t_{SU}$	5.0	200	130	-	ns
		10	120	60	-	ns
		15	100	50	-	ns
Up/Down Setup Time	$t_{SU}$	5.0	500	250	-	ns
		10	200	100	-	ns
		15	175	75	-	ns
Preset Enable Pulse Width	$t_{WH}$	5.0	200	100	-	ns
		10	100	50	-	ns
		15	80	40	-	ns

Note 2. Data labeled “Typ” is not to be used for design purposes but is intended as an indication of the device’s potential performance.

Note 3. The formulas given are for the typical characteristics only at +25°C.

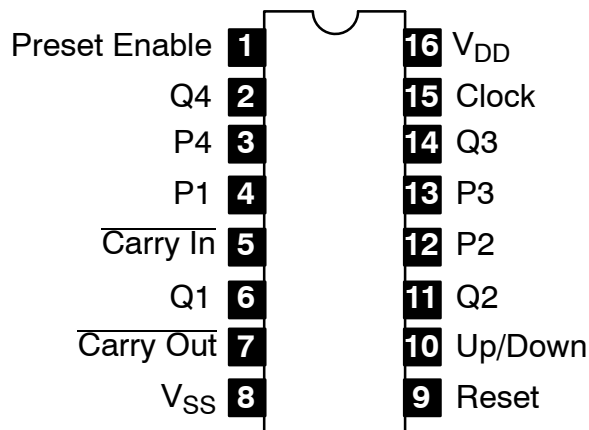
Note 6. The Preset or Reset Signal must be low prior to a positive-going transition of the clock.

**Truth Table:**

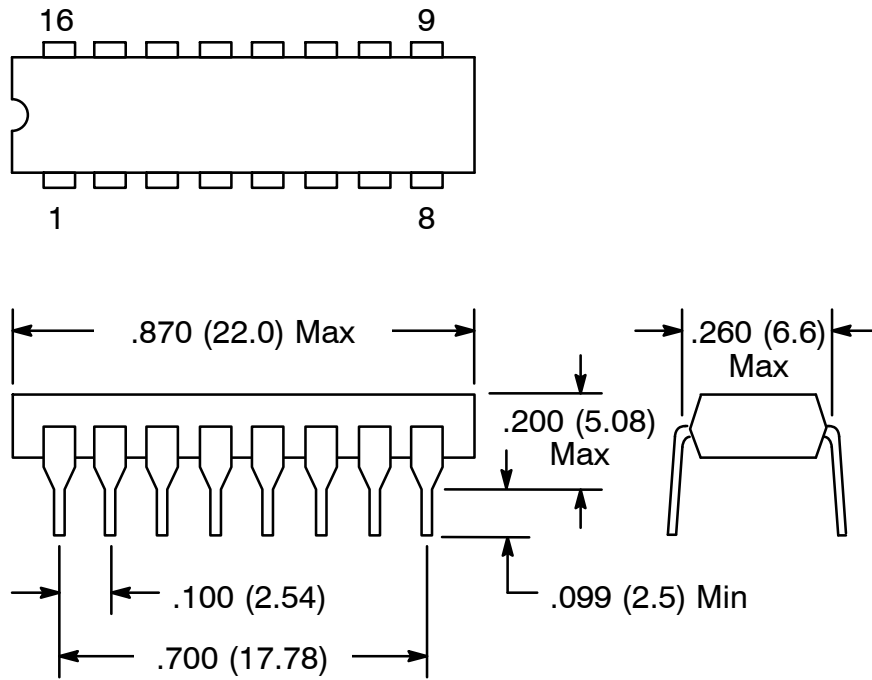
Carry In	Up/Down	Preset Enable	Reset	Action
1	X	0	0	No Count
0	1	0	0	Count Up
0	0	0	0	Count Down
X	X	1	0	Preset
X	X	X	1	Reset

X = Don't Care

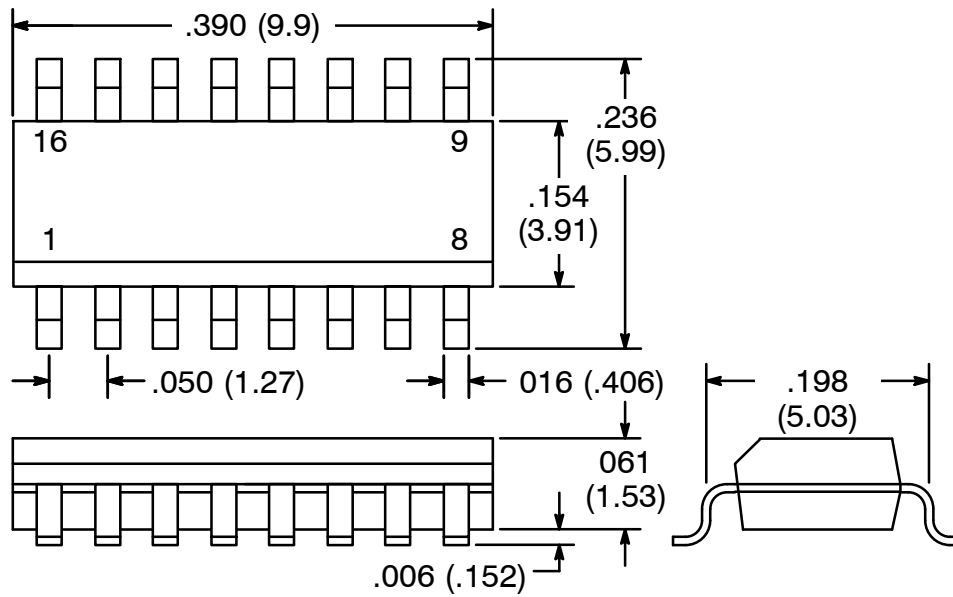
**Pin Connection Diagram**



### NTE4510B



### NTE4510BT



NOTE: Pin1 on Beveled Edge