



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

## NTE4046B and NTE4046BT Integrated Circuit CMOS, Micropower Phase-Locked Loop (PLL)

### **Description:**

The NTE4046B (16-Lead DIP) and NTE4046BT (SOIC-16) are CMOS Micropower Phase-Locked Loop (PLL) devices consisting of a low-power, linear voltage-controlled oscillator (VCO) and two different phase comparators having a common signal-input amplifier and a common comparator input. A 5.2V zener diode is provided for supply regulation if necessary.

### **Features:**

- Very Low Power Consumption: 70μW (Typ) @ VCO  $f_o = 10\text{kHz}$ ,  $V_{DD} = 5\text{V}$
- Operating Frequency Range up to 1.4MHz (Typ) @  $V_{DD} = 10\text{V}$ ,  $R_I = 5\text{k}\Omega$
- Low Frequency Drift: 0.04%/°C (Typ) @  $V_{DD} = 10\text{V}$
- Choice of Two Phase Comparators:
  - Exclusive-OR Network (I)
  - Edge-Controlled Memory Network <sup>w</sup>/Phase-Pulse Output for Lock Indication (II)
- High VCO Linearity: < 1% (Typ) @  $V_{DD} = 10\text{V}$
- VCO Inhibit Control for ON-OFF Keying and Ultra-Low Standby Power Consumption
- Source-Follower Output of VCO Control Input (Demod. Output)
- Zener Diode to Assist Supply Regulation
- Standardized, Symmetrical Output Characteristics
- 100% Tested for Quiescent Current at 20V
- 5V, 10V, and 15V Parametric Ratings

### **Applications:**

- FM Demodulator and Modulator
- Frequency Synthesis and Multiplication
- Frequency Discriminator
- Signal Conditioning
- FSK – Modems
- Data Synchronization
- Voltage-to-Frequency Conversion
- Tone Decoding

### **Absolute Maximum Ratings:**

DC Supply Voltage Range (Voltages referenced to  $V_{SS}$  terminal),  $V_{DD}$  ..... -0.5 to +20V  
 Input Voltage Range, All Inputs ..... -0.5 to  $V_{DD}+0.5\text{V}$   
 DC Input Current, Any One Input .....  $\pm 10\text{mA}$   
 Power Dissipation ( $T_A = -55^\circ$  to  $+100^\circ\text{C}$ ),  $P_D$  ..... 500mW  
      $T_A = +100^\circ$  to  $+125^\circ\text{C}$  ..... Derate Linearly at 12mW/°C to 200mW  
 Device Dissipation (Per Output Transistor)  
     For  $T_A =$  Full Package Temperature Range ..... 100mW  
 Operating Temperature Range,  $T_A$  .....  $-55^\circ$  to  $+125^\circ\text{C}$   
 Storage Temperature Range,  $T_{stg}$  .....  $-65^\circ$  to  $+150^\circ\text{C}$   
 Lead Temperature (During Soldering, 1/16"  $\pm$  1/32" from case, 10sec Max),  $T_L$  .....  $+265^\circ\text{C}$

**Recommended Operating Conditions:** ( $T_A = -55^\circ$  to  $+125^\circ\text{C}$ )

Parameter	Min	Typ	Max	Unit
Supply Voltage Range VCO Section: As Fixed Oscillator	3	–	18	V
Phase-Lock-Loop Operation	5	–	18	V
Supply Voltage Range Phase Comparator Section: Comparators	3	–	18	V
VCO Operation	5	–	18	V

**Static Electrical Characteristics:**

Characteristic	Conditions			Limits at Indicated Temperature ( $^\circ\text{C}$ )							Units
	$V_O$ (V)	$V_{IN}$ (V)	$V_{DD}$ (V)	$-55^\circ\text{C}$	$-40^\circ\text{C}$	$+85^\circ\text{C}$	$+125^\circ\text{C}$	$+25^\circ\text{C}$			
								Min.	Typ.	Max.	
<b>VCO Section</b>											
Output Low (Sink) Current $I_{OL}$ Min.	0.4	0,5	5	0.64	0.61	0.42	0.36	0.51	1.0	–	mA
	0.5	0,10	10	1.6	1.5	1.1	0.9	1.3	2.6	–	mA
	1.5	0,15	15	4.2	4.0	2.8	2.4	3.4	6.8	–	mA
Output High (Source) Current $I_{OH}$ Min.	4.6	0,5	5	-0.64	-0.61	-0.42	-0.36	-0.51	-1.0	–	mA
	2.5	0,5	5	-2.0	-1.8	-1.3	-1.15	-1.6	-3.2	–	mA
	9.5	0,10	10	-1.6	-1.5	-1.1	-0.9	-1.3	-2.6	–	mA
	13.5	0,15	15	-4.2	-4.0	-2.8	-2.4	-3.4	-6.8	–	mA
Output Voltage Low-Level $V_{OL}$ Max.	–	5	5	0.05				–	0	0.05	V
	–	10	10	0.05				–	0	0.05	V
	–	15	15	0.05				–	0	0.05	V
Output Voltage High-Level $V_{OH}$ Min.	–	5	5	4.95				4.95	5	–	V
	–	10	10	9.95				9.95	10	–	V
	–	15	15	14.95				14.95	15	–	V
Input Current, $I_{IN}$ Max.	–	0,18	18	$\pm 0.1$	$\pm 0.1$	$\pm 1.0$	$\pm 1.0$	–	$\pm 10^{-5}$	$\pm 0.1$	$\mu\text{A}$
<b>Phase Comparator Section</b>											
Total Device Current, $I_{DD}$ Max. (Pin14 Open, Pin5 = $V_{DD}$ )  (Pin14 = $V_{SS}$ or $V_{DD}$ , Pin5 = $V_{DD}$ )	–	0,5	5	0.2				–	0.1	0.2	mA
	–	0,10	10	1.0				–	0.5	1.0	mA
	–	0,15	15	1.5				–	0.75	1.5	mA
	–	0,20	20	4.0				–	2.0	4.0	mA
	–	0,5	5	20				–	10	20	$\mu\text{A}$
	–	0,10	10	40				–	20	40	$\mu\text{A}$
	–	0,15	15	80				–	40	80	$\mu\text{A}$
	–	0,20	20	160				–	80	160	$\mu\text{A}$
Output Low (Sink) Current $I_{OL}$ Min.	0.4	0,5	5	0.64	0.61	0.42	0.36	0.51	1.0	–	mA
	0.5	0,10	10	1.6	1.5	1.1	0.9	1.3	2.6	–	mA
	1.5	0,15	15	4.2	4.0	2.8	2.4	3.4	6.8	–	mA
Output High (Source) Current $I_{OH}$ Min.	4.6	0,5	5	-0.64	-0.61	-0.42	-0.36	-0.51	-1.0	–	mA
	2.5	0,5	5	-2.0	-1.8	-1.3	-1.15	-1.6	-3.2	–	mA
	9.5	0,10	10	-1.6	-1.5	-1.1	-0.9	-1.3	-2.6	–	mA
	13.5	0,15	15	-4.2	-4.0	-2.8	-2.4	-3.4	-6.8	–	mA

### Static Electrical Characteristics (Cont'd):

Characteristic	Conditions			Limits at Indicated Temperature (°C)							Units
	V <sub>O</sub> (V)	V <sub>IN</sub> (V)	V <sub>DD</sub> (V)	-55°C	-40°C	+85°C	+125°C	+25°C			
								Min.	Typ.	Max.	
<b>Phase Comparator Section (Cont'd)</b>											
DC-Coupled Signal Input and Comparator Input Voltage Sensitivity Low-Level V <sub>IL</sub> Max. High Level V <sub>IH</sub> Min.	0,5,4,5	-	5	-	-	1.5	-	-	-	1.5	V
	1,9	-	10	-	-	3.0	-	-	-	3.0	V
	1.5,13.5	-	15	-	-	4.0	-	-	-	4.0	V
	0,5,4,5	-	5	-	-	3.5	-	3.5	-	-	V
	1,9	-	10	-	-	7.0	-	7.0	-	-	V
	1.5,13.5	-	15	-	-	11.0	-	11.0	-	-	V
Input Current, I <sub>IN</sub> Max. (Except Pin14)	-	0,18	18	±0.1	±0.1	±1.0	±1.0	-	±10 <sup>-5</sup>	±0.1	µA
3-Stage Leakage Current, I <sub>OUT</sub> Max.	0,18	0,18	18	±0.1	±0.1	±0.2	±0.2	-	±10 <sup>-5</sup>	±0.1	µA

### Electrical Characteristics: (T<sub>A</sub> = +25°C)

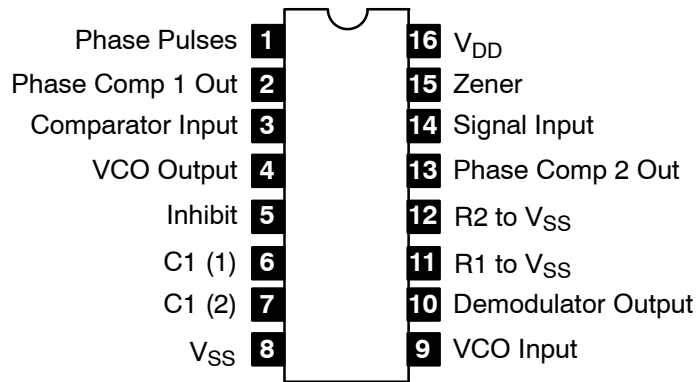
Parameter	Symbol	Test Conditions		V <sub>DD</sub>	Min	Typ	Max	Unit
<b>VCO Section</b>								
Operating Power Dissipation	P <sub>D</sub>	f <sub>o</sub> = 10kHz, R <sub>2</sub> = ∞	R <sub>1</sub> = 1MΩ, VCO <sub>IN</sub> = $\frac{V_{DD}}{2}$	5V	-	70	140	µW
				10V	-	800	1600	µW
				15V	-	3000	6000	µW
Maximum Operating Frequency	f <sub>max</sub>	C <sub>1</sub> = 50pF, R <sub>2</sub> = ∞, VCO <sub>IN</sub> = V <sub>DD</sub>	R <sub>1</sub> = 10kΩ	5V	0.3	0.6	-	MHz
				10V	0.6	1.2	-	MHz
				15V	0.8	1.6	-	MHz
			R <sub>1</sub> = 5kΩ	5V	0.5	0.8	-	MHz
				10V	1.0	1.4	-	MHz
				15V	1.4	2.4	-	MHz
Linearity		VCO <sub>IN</sub> = 2.5V±0.3V	R <sub>1</sub> = 10kΩ	5V	-	1.7	-	%
			R <sub>1</sub> = 100kΩ	10V	-	0.5	-	%
			R <sub>1</sub> = 400kΩ	10V	-	4.0	-	%
			R <sub>1</sub> = 100kΩ	15V	-	0.5	-	%
			R <sub>1</sub> = 1MΩ	15V	-	7.0	-	%
Temperature-Frequency Stability: No Frequency Offset	f <sub>MIN</sub> = 0			5V	-	±0.12	-	%/°C
				10V	-	±0.04	-	%/°C
				15V	-	±0.015	-	%/°C
Frequency Offset	f <sub>MIN</sub> ≠ 0			5V	-	±0.09	-	%/°C
				10V	-	±0.07	-	%/°C
				15V	-	±0.03	-	%/°C
Output Duty Cycle				5, 10, 15V	-	50	-	%
Output Transition Times	t <sub>THL</sub> , t <sub>TLH</sub>			5V	-	100	200	ns
				10V	-	50	100	ns
				15V	-	40	80	ns

**Electrical Characteristics (Cont'd):** ( $T_A = +25^\circ\text{C}$ )

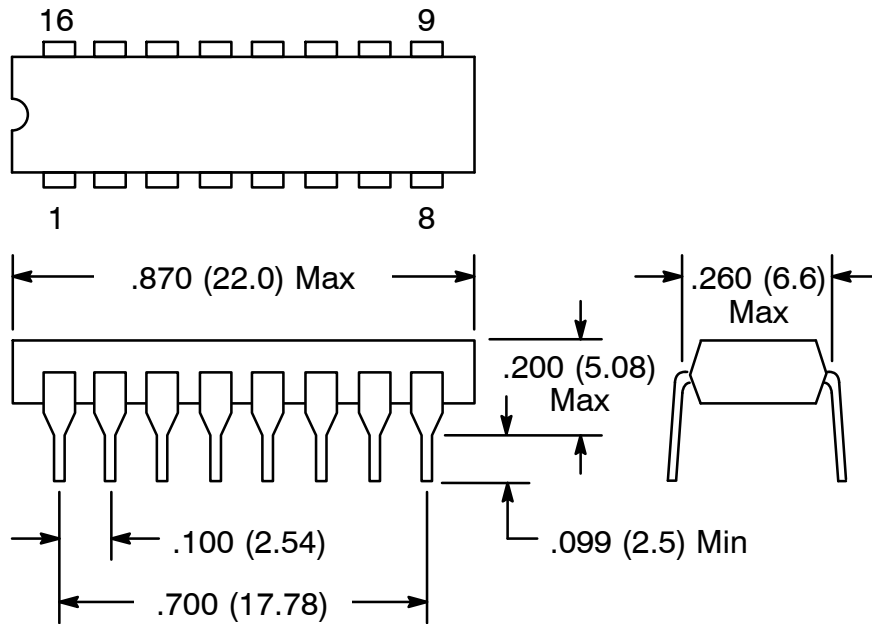
Parameter	Symbol	Test Conditions		V <sub>DD</sub>	Min	Typ	Max	Unit	
<b>VCO Section (Cont'd)</b>									
Source-Follower Output (Demodulated Output): Offset Voltage	VCO <sub>IN</sub> -V <sub>DEM</sub>	R <sub>S</sub> > 10kΩ		5V	-	1.8	2.5	V	
				10V	-	1.8	2.5	V	
				15V	-	1.8	2.5	V	
Linearity		VCO <sub>IN</sub> = 2.5V±0.3V	R <sub>S</sub> = 100kΩ	5V	-	0.3	-	%	
		VCO <sub>IN</sub> = 5.0V±2.5V	R <sub>S</sub> = 300kΩ	10V	-	0.7	-	%	
		VCO <sub>IN</sub> = 7.5V±5.0V	R <sub>S</sub> = 500kΩ	15V	-	0.9	-	%	
Zener Diode Voltage	V <sub>Z</sub>	I <sub>Z</sub> = 50μA		-	4.45	5.50	6.15	V	
Zener Dynamic Resistance	R <sub>Z</sub>	I <sub>Z</sub> = 1mA		-	-	40	-	Ω	
<b>Phase Comparator Section</b>									
Pin14 (Signal In) Input Resistance	R <sub>14</sub>			5V	1.0	2.0	-	MΩ	
				10V	0.2	0.4	-	MΩ	
				15V	0.1	0.2	-	MΩ	
AC Coupled Signal Input Voltage Sensitivity (Peak-to-Peak)		f <sub>IN</sub> = 100kHz, Sine Wave, Note 1		5V	-	180	360	mV	
				10V	-	330	660	mV	
				15V	-	900	1800	mV	
Propagation Delay Time (Pin14 to Pin13) High to Low Level	t <sub>PHL</sub>			5V	-	225	450	ns	
				10V	-	100	200	ns	
				15V	-	65	130	ns	
Low to High Level	t <sub>PLH</sub>			5V	-	350	700	ns	
				10V	-	150	300	ns	
				15V	-	100	200	ns	
3-State Propagation Delay Time (Pin14 to Pin13) High Level to Low Impedance	t <sub>PHZ</sub>			5V	-	225	450	ns	
				10V	-	100	200	ns	
				15V	-	95	190	ns	
Low Level to High Impedance	t <sub>PLZ</sub>			5V	-	285	570	ns	
				10V	-	130	260	ns	
				15V	-	95	190	ns	
Input Rise or Fall Times Comparator Input (Pin3)	t <sub>r</sub> , t <sub>f</sub>			5V	-	-	50.0	μs	
				10V	-	-	1.0	μs	
				15V	-	-	0.3	μs	
				Signal Input (Pin14)	5V	-	-	500.0	μs
					10V	-	-	20.0	μs
					15V	-	-	2.5	μs
Output Transition Times	t <sub>THL</sub> , t <sub>TLH</sub>			5V	-	100	200	ns	
				10V	-	50	100	ns	
				15V	-	40	80	ns	

Note 1. For sine wave, the frequency must be greater than 10kHz for Phase Comparator II.

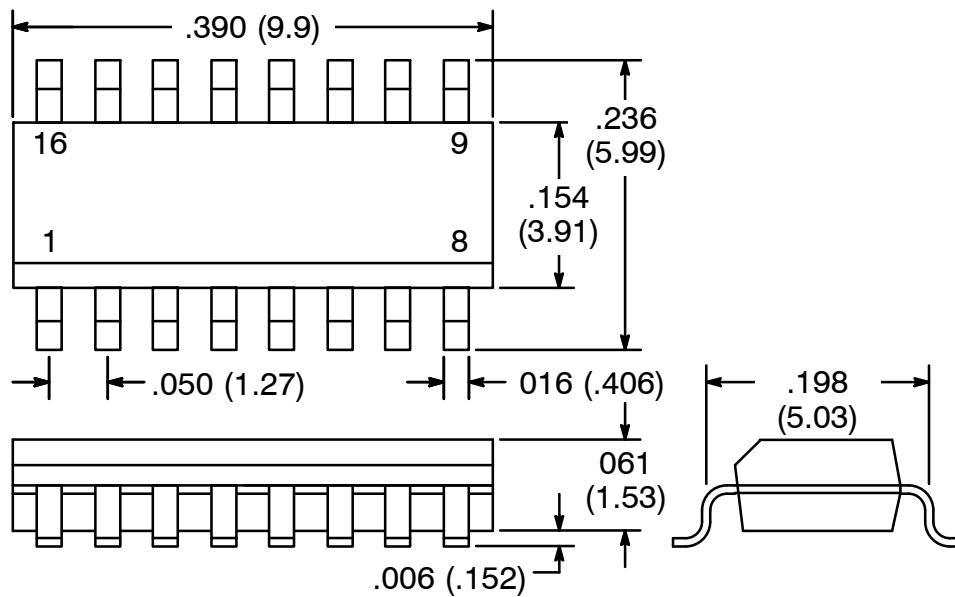
### Pin Connection Diagram



### NTE4046B



### NTE4046BT



NOTE: Pin1 on Beveled Edge