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NTE980 **Integrated Circuit** **CMOS, Micropower Phase-Locked Loop (PLL)**

Description:

The NTE980 CMOS Micropower Phase-Locked Loop (PLL) consists 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 in a 16-Lead type package. 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 ^w/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 ±10mA
 Power Dissipation ($T_A = -40^\circ$ to $+60^\circ\text{C}$), P_D 500mW
 $T_A = +60^\circ$ to $+85^\circ\text{C}$ Derate Linearly at 12mW/°C to 200mW
 Device Dissipation Per Output Transistor ($T_A = -40^\circ$ to $+85^\circ\text{C}$) 100mW
 Operating Temperature Range, T_A -40° to $+85^\circ\text{C}$
 Storage Temperature Range, T_{stg} -65° to $+150^\circ\text{C}$
 Lead Temperature (During Soldering, 1/16" ±1/32" from case, 10sec Max), T_L $+265^\circ\text{C}$

Recommended Operating Conditions: ($T_A = -40^\circ$ to $+85^\circ\text{C}$)

| 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: ($T_A = +25^\circ\text{C}$ unless otherwise specified)

| Parameter | Symbol | Test Conditions | | | Min | Typ | Max | Unit |
|---|-------------|-------------------|----------|----------|-------|---------------|-----------|---------------|
| | | V_O | V_{IN} | V_{DD} | | | | |
| VCO Section | | | | | | | | |
| Output Low (Sink) Current | I_{OLMin} | 400mV | 0V, 5V | 5V | 0.51 | 1.0 | – | mA |
| | | 500mV | 0V, 10V | 10V | 1.3 | 2.6 | – | mA |
| | | 1.5V | 0V, 15V | 15V | 3.4 | 6.8 | – | mA |
| Output High (Source) Current | I_{OHMin} | 4.6V | 0V, 5V | 5V | –0.51 | –1.0 | – | mA |
| | | 2.5V | 0V, 5V | 5V | –1.6 | –3.2 | – | mA |
| | | 9.5V | 0V, 10V | 10V | –1.3 | –2.6 | – | mA |
| | | 13.5V | 0V, 15V | 15V | –3.4 | –6.8 | – | mA |
| Output Voltage: Low-Level | V_{OLMax} | Pin4 driving CMOS | 0V, 5V | 5V | – | 0 | 0.05 | V |
| | | | 0V, 10V | 10V | – | 0 | 0.05 | V |
| | | | 0V, 15V | 15V | – | 0 | 0.05 | V |
| Output Voltage: High-Level | V_{OHMax} | e.g. Pin3 | 0V, 5V | 5V | 4.95 | 5.0 | – | V |
| | | | 0V, 10V | 10V | 9.95 | 10.0 | – | V |
| | | | 0V, 15V | 15V | 14.95 | 15.0 | – | V |
| Input Current | I_{INMax} | – | 0V, 18V | 18V | – | $\pm 10^{-5}$ | ± 0.1 | μA |
| Phase Comparator Section | | | | | | | | |
| Total Device Current Pin14 = Open, Pin5 = V_{DD} Pin14 = V_{SS} or V_{DD} , Pin5 = V_{DD} | I_{DDMax} | – | 0V, 5V | 5V | – | 0.1 | 0.2 | mA |
| | | – | 0V, 10V | 10V | – | 0.5 | 1.0 | mA |
| | | – | 0V, 15V | 15V | – | 0.75 | 1.5 | mA |
| | | – | 0V, 20V | 20V | – | 2.0 | 4.0 | mA |
| | | – | 0V, 5V | 5V | – | 10.0 | 20.0 | μA |
| | | – | 0V, 10V | 10V | – | 20.0 | 40.0 | μA |
| | | – | 0V, 15V | 15V | – | 40.0 | 80.0 | μA |
| | | – | 0V, 20V | 20V | – | 80.0 | 160.0 | μA |
| Output Low (Sink) Current | I_{OLMin} | 400mV | 0V, 5V | 5V | 0.51 | 1.0 | – | mA |
| | | 500mV | 0V, 10V | 10V | 1.3 | 2.6 | – | mA |
| | | 1.5V | 0V, 15V | 15V | 3.4 | 6.8 | – | mA |
| Output High (Source) Current | I_{OHMin} | 4.6V | 0V, 5V | 5V | –0.51 | –1.0 | – | mA |
| | | 2.5V | 0V, 5V | 5V | –1.6 | –3.2 | – | mA |
| | | 9.5V | 0V, 10V | 10V | –1.3 | –2.6 | – | mA |
| | | 13.5V | 0V, 15V | 15V | –3.4 | –6.8 | – | mA |

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

| Parameter | Symbol | Test Conditions | | | Min | Typ | Max | Unit |
|--|--------------|-----------------|----------|----------|------|---------------|-----------|---------------|
| | | V_O | V_{IN} | V_{DD} | | | | |
| Phase Comparator Section (Cont'd) | | | | | | | | |
| DC Coupled Signal Input and Comparator Input Voltage Sensitivity Low Level | V_{ILMax} | 0.5V, 4.5V | – | 5V | – | – | 1.5 | V |
| | | 1V, 9V | – | 10V | – | – | 3.0 | V |
| | | 1.5V, 13.5V | – | 15V | – | – | 4.0 | V |
| High Level | V_{IHMax} | 0.5V, 4.5V | – | 5V | 3.5 | – | – | V |
| | | 1V, 9V | – | 10V | 7.0 | – | – | V |
| | | 1.5V, 13.5V | – | 15V | 11.0 | – | – | V |
| Input Current (Except Pin14) | I_{INMax} | – | 0V, 18V | 18V | – | $\pm 10^{-5}$ | ± 0.1 | μA |
| 3-State Leakage Current | I_{OUTMax} | 0V, 18V | 0V, 18V | 18V | – | $\pm 10^{-5}$ | ± 0.1 | μA |

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

| Parameter | Symbol | Test Conditions | | | Min | Typ | Max | Unit |
|---|-----------------------|--|--|------------|-----|-------------|------|-----------------------|
| | | | | V_{DD} | | | | |
| VCO Section | | | | | | | | |
| Operating Power Dissipation | P_D | $f_o = 10\text{kHz}$, $R_2 = \infty$ | $R_1 = 1\text{M}\Omega$, $V_{COIN} = \frac{V_{DD}}{2}$ | 5V | – | 70 | 140 | μW |
| | | | | 10V | – | 800 | 1600 | μW |
| | | | | 15V | – | 3000 | 6000 | μW |
| Maximum Operating Frequency | f_{max} | $C_1 = 50\text{pF}$, $R_2 = \infty$, $V_{COIN} = V_{DD}$ | $R_1 = 10\text{k}\Omega$ | 5V | 0.3 | 0.6 | – | MHz |
| | | | | 10V | 0.6 | 1.2 | – | MHz |
| | | | | 15V | 0.8 | 1.6 | – | MHz |
| | | | $R_1 = 5\text{k}\Omega$ | 5V | 0.5 | 0.8 | – | MHz |
| | | | | 10V | 1.0 | 1.4 | – | MHz |
| | | | | 15V | 1.4 | 2.4 | – | MHz |
| Linearity | | $V_{COIN} = 2.5\text{V} \pm 0.3\text{V}$ | $R_1 = 10\text{k}\Omega$ | 5V | – | 1.7 | – | % |
| | | | $R_1 = 100\text{k}\Omega$ | 10V | – | 0.5 | – | % |
| | | | $R_1 = 400\text{k}\Omega$ | 10V | – | 4.0 | – | % |
| | | | $R_1 = 100\text{k}\Omega$ | 15V | – | 0.5 | – | % |
| | | | $R_1 = 1\text{M}\Omega$ | 15V | – | 7.0 | – | % |
| Temperature-Frequency Stability: No Frequency Offset | $f_{MIN} = 0$ | | | 5V | – | ± 0.12 | – | $\% / ^\circ\text{C}$ |
| | | | | 10V | – | ± 0.04 | – | $\% / ^\circ\text{C}$ |
| | | | | 15V | – | ± 0.015 | – | $\% / ^\circ\text{C}$ |
| Frequency Offset | $f_{MIN} \neq 0$ | | | 5V | – | ± 0.09 | – | $\% / ^\circ\text{C}$ |
| | | | | 10V | – | ± 0.07 | – | $\% / ^\circ\text{C}$ |
| | | | | 15V | – | ± 0.03 | – | $\% / ^\circ\text{C}$ |
| Output Duty Cycle | | | | 5, 10, 15V | – | 50 | – | % |
| Output Transition Times | t_{THL} , t_{TLH} | | | 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 _{DD} | Min | Typ | Max | Unit | |
|--|-------------------------------------|---|------------------------|----------------------|------|------|------|-------|----|
| | | | | | | | | | |
| VCO Section (Cont'd) | | | | | | | | | |
| Source-Follower Output (Demodulated Output): Offset Voltage | VCO _{IN} -V _{DEM} | R _S > 10kΩ | | 5V | - | 1.8 | 2.5 | V | |
| | | | | 10V | - | 1.8 | 2.5 | V | |
| | | | | 15V | - | 1.8 | 2.5 | V | |
| Linearity | | VCO _{IN} = 2.5V±0.3V | R _S = 100kΩ | 5V | - | 0.3 | - | % | |
| | | VCO _{IN} = 5.0V±2.5V | R _S = 300kΩ | 10V | - | 0.7 | - | % | |
| | | VCO _{IN} = 7.5V±5.0V | R _S = 500kΩ | 15V | - | 0.9 | - | % | |
| Zener Diode Voltage | V _Z | I _Z = 50μA | | - | 4.45 | 5.50 | 6.15 | V | |
| Zener Dynamic Resistance | R _Z | I _Z = 1mA | | - | - | 40 | - | Ω | |
| Phase Comparator Section | | | | | | | | | |
| Pin14 (Signal In) Input Resistance | R ₁₄ | | | 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 _{IN} = 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 _{PHL} | | | 5V | - | 225 | 450 | ns | |
| | | | | 10V | - | 100 | 200 | ns | |
| | | | | 15V | - | 65 | 130 | ns | |
| Low to High Level | t _{PLH} | | | 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 _{PHZ} | | | 5V | - | 225 | 450 | ns | |
| | | | | 10V | - | 100 | 200 | ns | |
| | | | | 15V | - | 95 | 190 | ns | |
| Low Level to High Impedance | t _{PLZ} | | | 5V | - | 285 | 570 | ns | |
| | | | | 10V | - | 130 | 260 | ns | |
| | | | | 15V | - | 95 | 190 | ns | |
| Input Rise or Fall Times Comparator Input (Pin3) | t _r , t _f | | | 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 _{THL} , t _{TLH} | | | 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

