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## **NTE995 & NTE995M Integrated Circuit Frequency-to-Voltage Converter**

### **Description:**

The NTE995 (14-Lead DIP) and NTE995M (8-Lead DIP) are monolithic frequency to voltage converters with a high gain OP amp/comparator designed to operate a relay, lamp, or other load when the input frequency reaches or exceeds a selected rate. The tachometer uses a charge pump technique and offers frequency doubling for low ripple, full input protection, and its output swings to GND for a zero frequency input.

### **Advantages:**

- Output Swing to GND for Zero Frequency Input
- Easy to Use:  $V_{OUT} = f_{IN} \times V_{CC} \times R1 \times C1$
- Only One RC Network Provides Frequency Doubling
- Zener Regulator On Chip Allows Accurate and Stable Frequency to Voltage or Current Conversion

### **Features:**

- Ground Referenced Tachometer Input Interfaces Directly with Variable Reluctance Magnetic Pickups
- OP Amp/Comparator has Floating Transistor Output
- 50mA Sink or Source to Operate Relays, Solenoids, Meters, or LEDs
- Frequency Doubling for Low Ripple
- Tachometer has Built-In Hysteresis with Either Differential Input or Ground Referenced Input
- Built-In Zener Diode
- $\pm 0.3\%$  Linearity Typical
- Ground Referenced Tachometer is Fully Protected from damage Due to Swings Above  $V_{CC}$  and Below GND

### **Applications:**

- Over/Under Speed Sensing
- Frequency to Voltage Conversion (Tachometer)
- Speedometers
- Breaker Point Dwell Meters
- Hand-Held Tachometer
- Speed Governors
- Cruise Control
- Automotive Door Lock Control
- Clutch Control
- Horn Control
- Touch or Sound Switches

**Absolute Maximum Ratings:**

Supply Voltage, $V_{CC}$ .....	28V
Supply Current (Zener Options) .....	25mA
Collector Voltage .....	28V
Differential Input Voltage	
Tachometer .....	28V
OP Amp/Comparator .....	28V
Input Voltage Range	
Tachometer	
NTE995M .....	$\pm 28V$
NTE955 .....	0.0V to +28V
OP Amp/Comparator .....	0.0V to +28V
Power Dissipation (Note 1), $P_D$	
NTE995M .....	1200mW
NTE995 .....	1580mW
Operating Temperature Range, $T_{opr}$ .....	$-40^{\circ}$ to $+85^{\circ}C$
Storage Temperature Range, $T_{stg}$ .....	$-65^{\circ}$ to $+150^{\circ}C$
Lead Temperature, $T_L$	
NTE995, NTE995M (During Soldering, 10sec) .....	$+260^{\circ}C$
NTE995M	
(Vapor Phase, 60sec) .....	$+215^{\circ}C$
(Infrared, 15sec) .....	$+220^{\circ}C$

Note 1. For operation in ambient temperatures above  $25^{\circ}C$ , the device must be derated based on a  $+150^{\circ}C$  maximum junction temperature and a thermal resistance of  $+101^{\circ}C/W$  junction to ambient for the NTE995M, and  $+79^{\circ}C/W$  junction to ambient for the NTE995.

**Electrical Characteristics:** ( $V_{CC} = 12V$ ,  $T_A = +25^{\circ}C$  unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit	
<b>Tachometer</b>							
Input Thresholds		$V_{IN} = 250mV_{P-P}$ @ 1kHz, Note 2	$\pm 10$	$\pm 25$	$\pm 40$	mV	
Hysteresis		$V_{IN} = 250mV_{P-P}$ @ 1kHz, Note 2	-	30	-	mV	
Offset Voltage		$V_{IN} = 250mV_{P-P}$ @ 1kHz, Note 2	-	NTE995	3.5	10	mV
	NTE995M			5.0	15	mV	
Input Bias Current		$V_{IN} = \pm 50mV$	-	0.1	1.0	$\mu A$	
Output Voltage (High Level, Pin2)	$V_{OH}$	$V_{IN} = +125mV$ , Note 3	-	8.3	-	V	
Output Voltage (Low Level, Pin2)	$V_{OL}$	$V_{IN} = -125mV$ , Note 3	-	2.3	-	V	
Output Current	$I_2, I_3$	$V_2 = V_3 = 6V$ , Note 4	140	180	240	$\mu A$	
Leakage Current	$I_3$	$I_2 = 0, V_3 = 0$	-	-	0.1	$\mu A$	
Gain Constant	K	Note 3	0.9	1.0	1.1		
Linearity		$f_{IN} = 1kHz, 5kHz, 10kHz$ , Note 5	-1.0	0.3	+1.0	%	

Note 2. Hysteresis is the sum  $+V_{TH} - (-V_{TH})$ , offset voltage is their difference.

Note 3.  $V_{OH}$  is equal to  $\frac{3}{4} \times V_{CC} - 1 V_{BE}$ ,  $V_{OL}$  is equal to  $\frac{1}{4} \times V_{CC} - 1 V_{BE}$  therefore  $V_{OH} - V_{OL} = V_{CC}/2$ . The difference,  $V_{OH} - V_{OL}$ , and the mirror gain,  $I_2/I_3$ , are two factors that cause the tachometer gain constant to vary from 1.0.

Note 4. Be sure when choosing the time constant  $R1 \times C1$  that  $R1$  is such that the maximum anticipated output voltage at Pin3 can be reached with  $I_3 \times R1$ . The maximum value for  $R1$  is limited by the output resistance of Pin3 which is greater than  $10M\Omega$  typically.

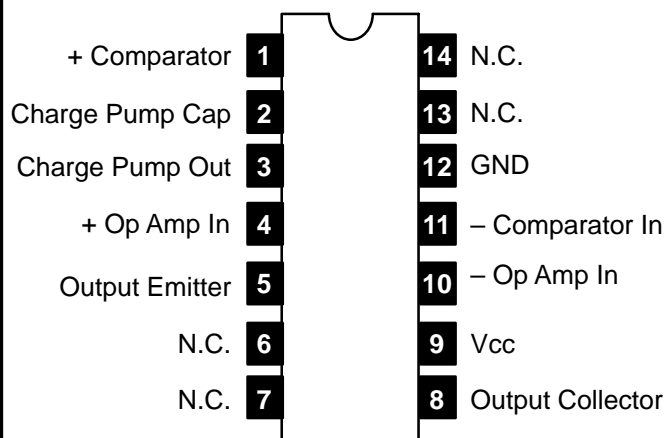
Note 5. Nonlinearity is defined as the deviation of  $V_{OUT}$  (@ Pin3) for  $f_{IN} = 5kHz$  from a straight line defined by the  $V_{OUT}$  @ 1kHz and  $V_{OUT}$  @ 10kHz.  $C1 = 1000pF$ ,  $R1 = 68k$  and  $C2 = 0.22mFd$ .

**Electrical Characteristics (Cont'd):** ( $V_{CC} = 12V$ ,  $T_A = +25^\circ C$  unless otherwise specified)

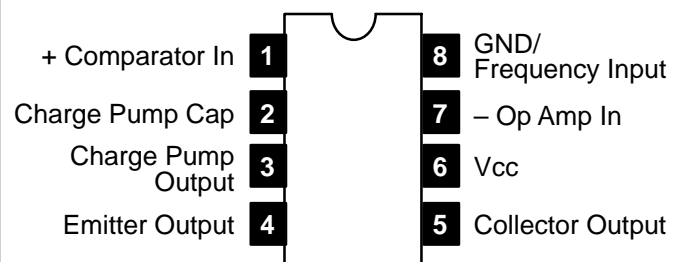
Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
<b>OP Amp/Comparator</b>						
	$V_{OS}$	$V_{IN} = 6V$	–	3	10	mV
	$I_{BIAS}$	$V_{IN} = 6V$	–	50	500	nA
Input Common-Mode Voltage			0	–	$V_{CC}-1.5V$	V
Voltage Gain			–	200	–	V/mV
Output Sink Current		$V_C = 1.0$	40	50	–	mA
Output Source Current		$V_E = V_{CC} - 2.0$	–	10	–	mA
Saturation Voltage		$I_{SINK} = 5mA$	–	0.1	0.5	V
		$I_{SINK} = 20mA$	–	–	1.0	V
		$I_{SINK} = 50mA$	–	1.0	1.5	V
<b>Zener Regulator</b>						
Regulator Voltage		$R_{DROP} = 470\Omega$	–	7.56	–	V
Series Resistance			–	10.5	15.0	$\Omega$
Temperature Stability			–	+1	–	mV/ $^\circ C$
Total Supply Current			–	3.8	6.0	mA

**Pin Connection Diagram**

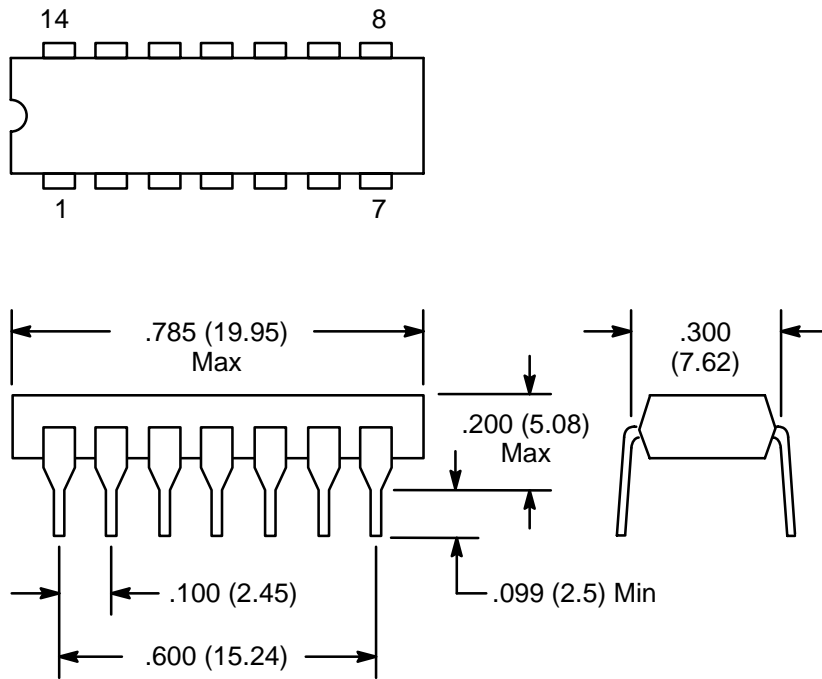
**NTE995**



**NTE995M**



### NTE995



### NTE995M

