

## LM567/LM567C Tone Decoder

### General Description

The LM567 and LM567C are general purpose tone decoders designed to provide a saturated transistor switch to ground when an input signal is present within the passband. The circuit consists of an I and Q detector driven by a voltage controlled oscillator which determines the center frequency of the decoder. External components are used to independently set center frequency, bandwidth and output delay.

### Features

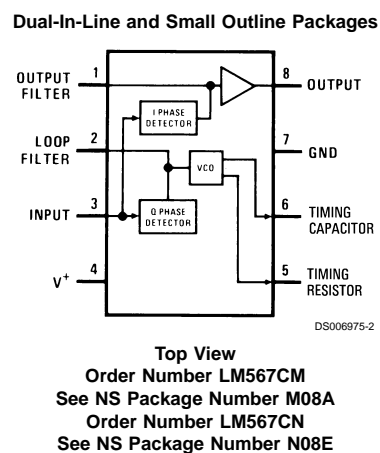
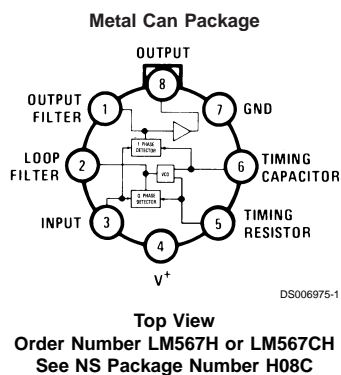
- 20 to 1 frequency range with an external resistor
- Logic compatible output with 100 mA current sinking capability
- Bandwidth adjustable from 0 to 14%

- High rejection of out of band signals and noise
- Immunity to false signals
- Highly stable center frequency
- Center frequency adjustable from 0.01 Hz to 500 kHz

### Applications

- Touch tone decoding
- Precision oscillator
- Frequency monitoring and control
- Wide band FSK demodulation
- Ultrasonic controls
- Carrier current remote controls
- Communications paging decoders

### Connection Diagrams



## Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage Pin	9V
Power Dissipation (Note 2)	1100 mW
$V_8$	15V
$V_3$	-10V
$V_3$	$V_4 + 0.5V$
Storage Temperature Range	-65°C to +150°C

## Operating Temperature Range

LM567H	-55°C to +125°C
LM567CH, LM567CM, LM567CN	0°C to +70°C

## Soldering Information

Dual-In-Line Package	
Soldering (10 sec.)	260°C
Small Outline Package	
Vapor Phase (60 sec.)	215°C
Infrared (15 sec.)	220°C

See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" for other methods of soldering surface mount devices.

## Electrical Characteristics

AC Test Circuit,  $T_A = 25^\circ\text{C}$ ,  $V^+ = 5V$

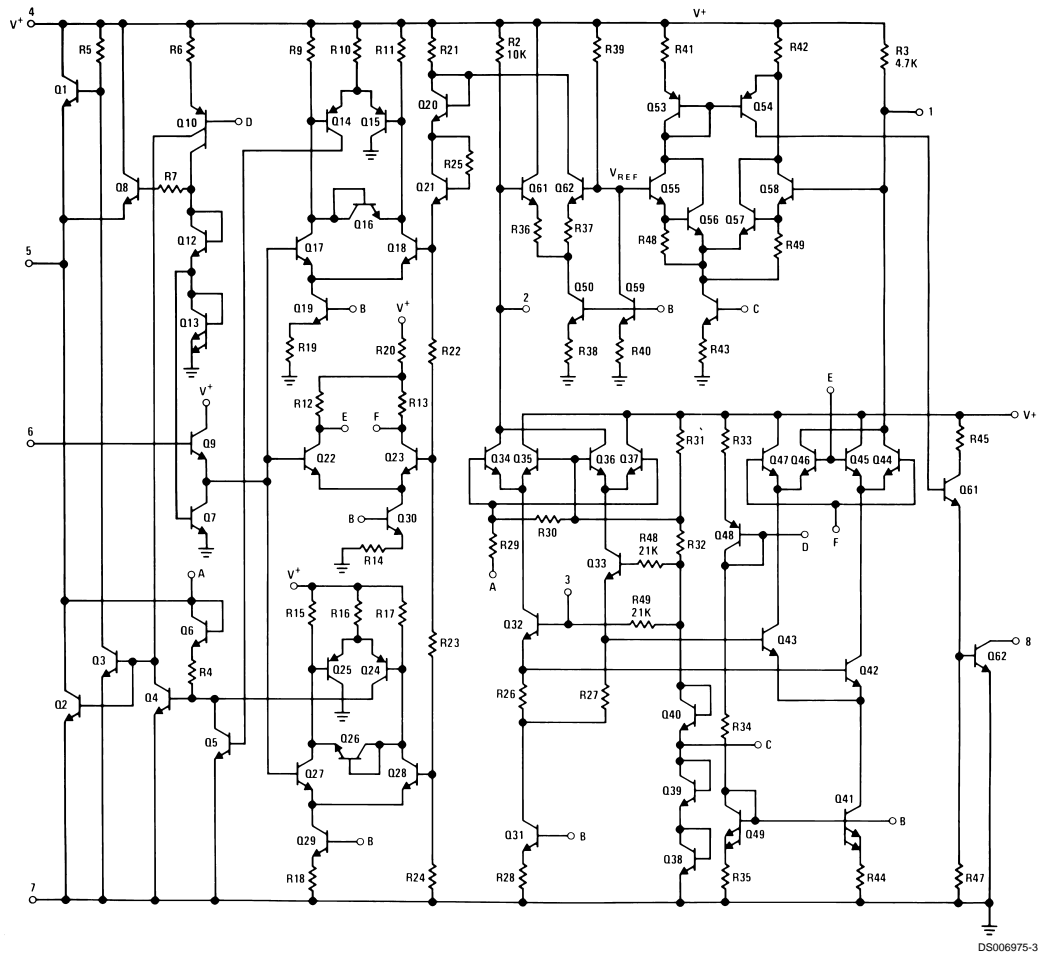
Parameters	Conditions	LM567			LM567C/LM567CM			Units
		Min	Typ	Max	Min	Typ	Max	
Power Supply Voltage Range		4.75	5.0	9.0	4.75	5.0	9.0	V
Power Supply Current Quiescent	$R_L = 20k$		6	8		7	10	mA
Power Supply Current Activated	$R_L = 20k$		11	13		12	15	mA
Input Resistance		18	20		15	20		k $\Omega$
Smallest Detectable Input Voltage	$I_L = 100\text{ mA}$ , $f_i = f_o$		20	25		20	25	mVrms
Largest No Output Input Voltage	$I_C = 100\text{ mA}$ , $f_i = f_o$	10	15		10	15		mVrms
Largest Simultaneous Outband Signal to Inband Signal Ratio			6			6		dB
Minimum Input Signal to Wideband Noise Ratio	$B_n = 140\text{ kHz}$		-6			-6		dB
Largest Detection Bandwidth		12	14	16	10	14	18	% of $f_o$
Largest Detection Bandwidth Skew			1	2		2	3	% of $f_o$
Largest Detection Bandwidth Variation with Temperature			$\pm 0.1$			$\pm 0.1$		%/ $^\circ\text{C}$
Largest Detection Bandwidth Variation with Supply Voltage	4.75–6.75V		$\pm 1$	$\pm 2$		$\pm 1$	$\pm 5$	%V
Highest Center Frequency		100	500		100	500		kHz
Center Frequency Stability (4.75–5.75V)	$0 < T_A < 70$ $-55 < T_A < +125$		$35 \pm 60$ $35 \pm 140$			$35 \pm 60$ $35 \pm 140$		ppm/ $^\circ\text{C}$ ppm/ $^\circ\text{C}$
Center Frequency Shift with Supply Voltage	4.75V–6.75V 4.75V–9V		0.5 2.0	1.0 2.0		0.4 2.0	2.0 2.0	%/V %/V
Fastest ON-OFF Cycling Rate			$f_o/20$			$f_o/20$		
Output Leakage Current	$V_8 = 15V$		0.01	25		0.01	25	$\mu\text{A}$
Output Saturation Voltage	$e_i = 25\text{ mV}$ , $I_8 = 30\text{ mA}$ $e_i = 25\text{ mV}$ , $I_8 = 100\text{ mA}$		0.2 0.6	0.4 1.0		0.2 0.6	0.4 1.0	V
Output Fall Time			30			30		ns
Output Rise Time			150			150		ns

**Note 1:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits. Electrical Characteristics state DC and AC electrical specifications under particular test conditions which guarantee specific performance limits. This assumes that the device is within the Operating Ratings. Specifications are not guaranteed for parameters where no limit is given, however, the typical value is a good indication of device performance.

**Note 2:** The maximum junction temperature of the LM567 and LM567C is 150°C. For operating at elevated temperatures, devices in the TO-5 package must be derated based on a thermal resistance of 150°C/W, junction to ambient or 45°C/W, junction to case. For the DIP the device must be derated based on a thermal resistance of 110°C/W, junction to ambient. For the Small Outline package, the device must be derated based on a thermal resistance of 160°C/W, junction to ambient.

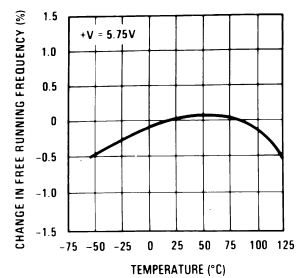
**Note 3:** Refer to RETS567X drawing for specifications of military LM567H version.

## Schematic Diagram

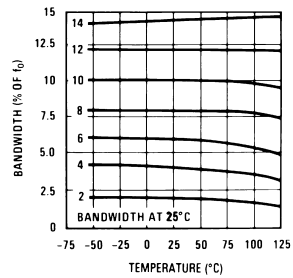


## Typical Performance Characteristics

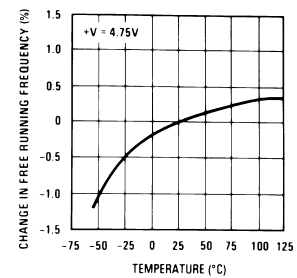
Typical Frequency Drift



Typical Bandwidth Variation

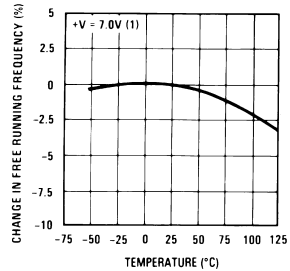


Typical Frequency Drift



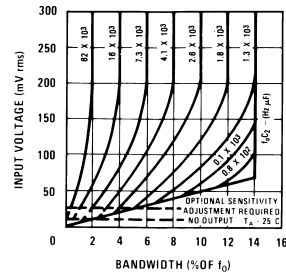
## Typical Performance Characteristics (Continued)

Typical Frequency Drift



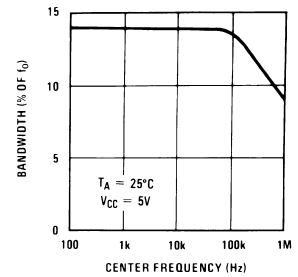
DS006975-13

Bandwidth vs Input Signal Amplitude



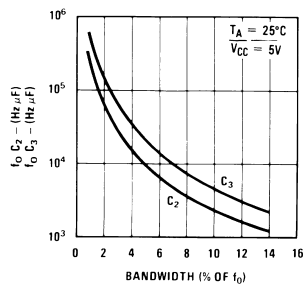
DS006975-14

Largest Detection Bandwidth



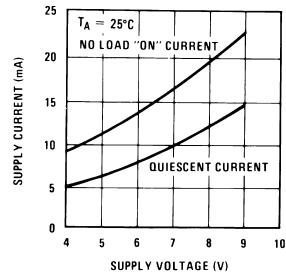
DS006975-15

Detection Bandwidth as a Function of  $C_2$  and  $C_3$



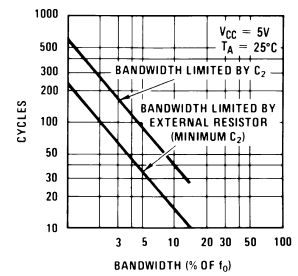
DS006975-16

Typical Supply Current vs Supply Voltage



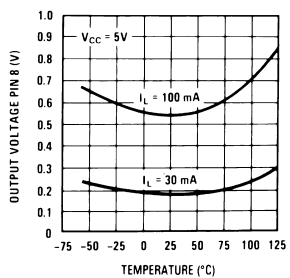
DS006975-17

Greatest Number of Cycles Before Output



DS006975-18

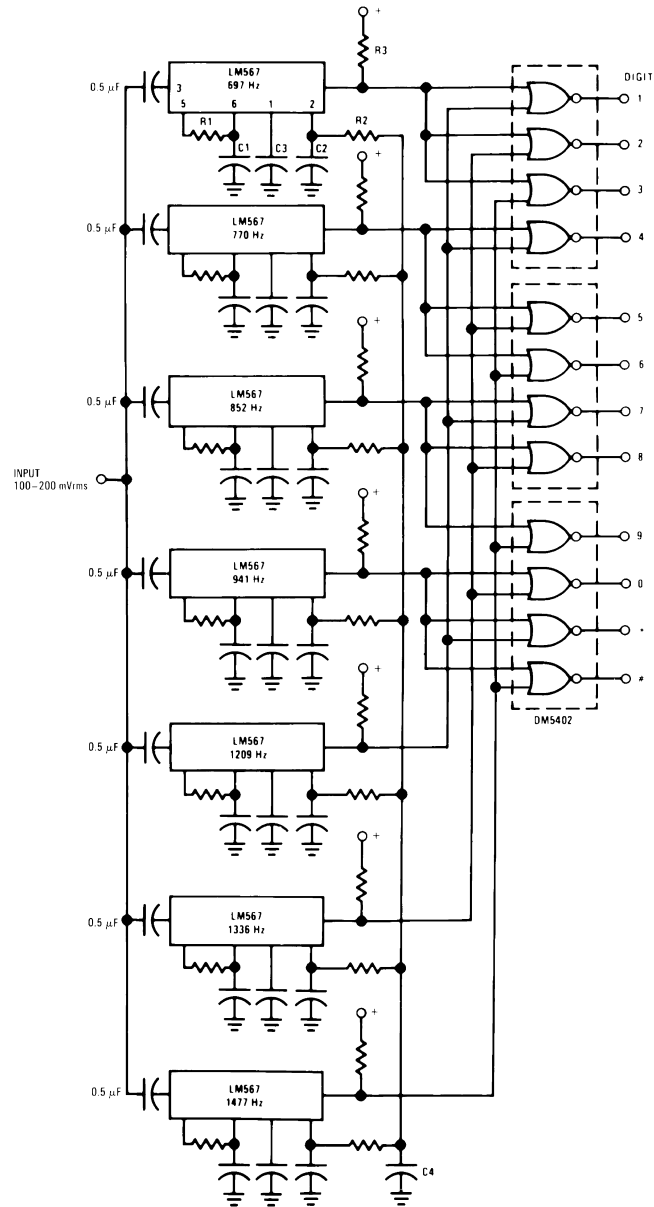
Typical Output Voltage vs Temperature



DS006975-19

## Typical Applications

Touch-Tone Decoder



Component values (typ)

R1 6.8 to 15k

R2 4.7k

R3 20k

C1 0.10 mfd

C2 1.0 mfd 6V

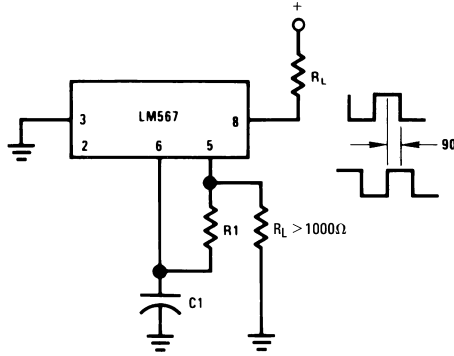
C3 2.2 mfd 6V

C4 250 mfd 6V

DS006975-5

## Typical Applications (Continued)

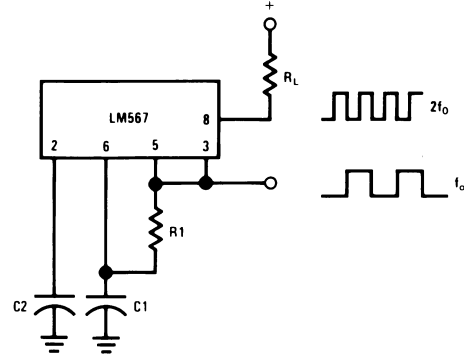
### Oscillator with Quadrature Output



DS006975-6

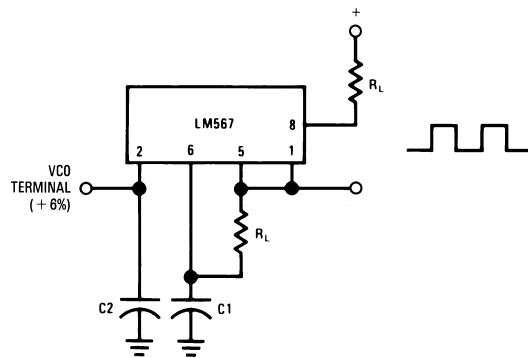
Connect Pin 3 to 2.8V to Invert Output

### Oscillator with Double Frequency Output



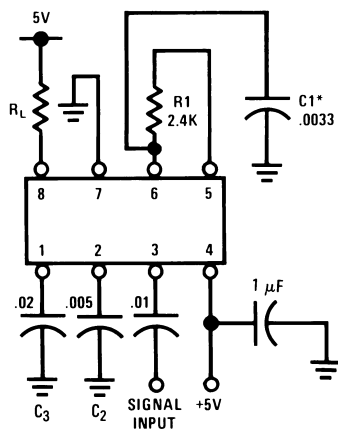
DS006975-7

### Precision Oscillator Drive 100 mA Loads



DS006975-8

## AC Test Circuit



DS006975-9

$f_i = 100 \text{ kHz} + 5V$

\*Note: Adjust for  $f_o = 100 \text{ kHz}$ .

## Applications Information

The center frequency of the tone decoder is equal to the free running frequency of the VCO. This is given by

$$f_o \cong \frac{1}{1.1 R_1 C_1}$$

The bandwidth of the filter may be found from the approximation

$$BW = 1070 \sqrt{\frac{V_i}{f_o C_2}} \text{ in } \% \text{ of } f_o$$

Where:

$V_i$  = Input voltage (volts rms),  $V_i \leq 200 \text{ mV}$

$C_2$  = Capacitance at Pin 2 ( $\mu\text{F}$ )

inches (millimeters) unless otherwise noted

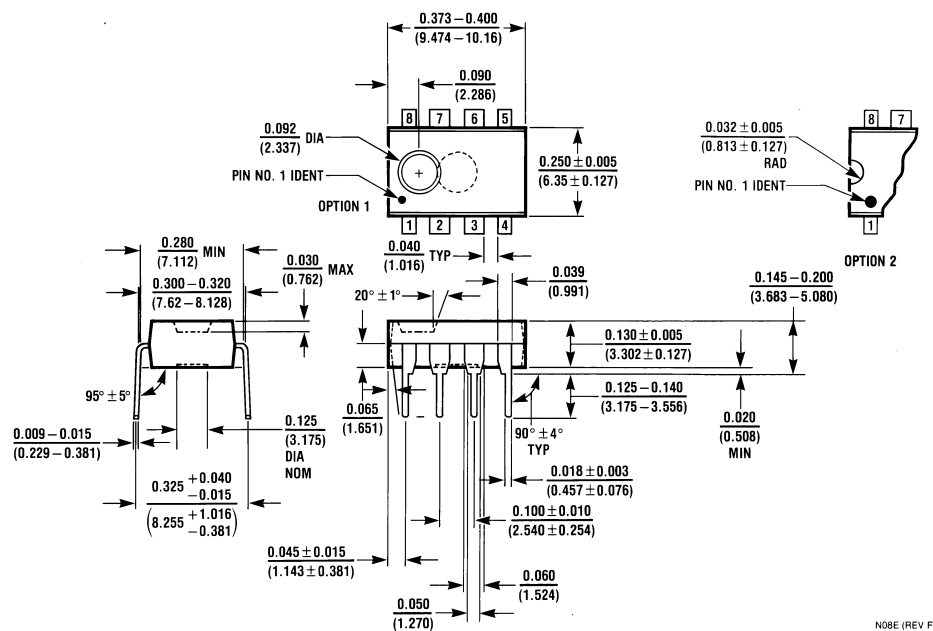


**Metal Can Package (H)**  
**Order Number LM567H or LM567CH**  
**NS Package Number H08C**



**Small Outline Package (M)**  
**Order Number LM567CM**  
**NS Package Number M08A**

## Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



**Molded Dual-In-Line Package (N)**  
**Order Number LM567CN**  
**NS Package Number N08E**

### LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT AND GENERAL COUNSEL OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.



**National Semiconductor Corporation**  
Americas  
Tel: 1-800-272-9959  
Fax: 1-800-737-7018  
Email: support@nsc.com

www.national.com

**National Semiconductor Europe**

Fax: +49 (0) 1 80-530 85 86  
Email: europe.support@nsc.com  
Deutsch Tel: +49 (0) 1 80-530 85 85  
English Tel: +49 (0) 1 80-532 78 32  
Français Tel: +49 (0) 1 80-532 93 58  
Italiano Tel: +49 (0) 1 80-534 16 80

**National Semiconductor Asia Pacific Customer Response Group**

Tel: 65-2544466  
Fax: 65-2504466  
Email: sea.support@nsc.com

**National Semiconductor Japan Ltd.**

Tel: 81-3-5639-7560  
Fax: 81-3-5639-7507