

National Semiconductor is now part of  
Texas Instruments.

Search <http://www.ti.com/> for the latest technical  
information and details on our current products and services.

## 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

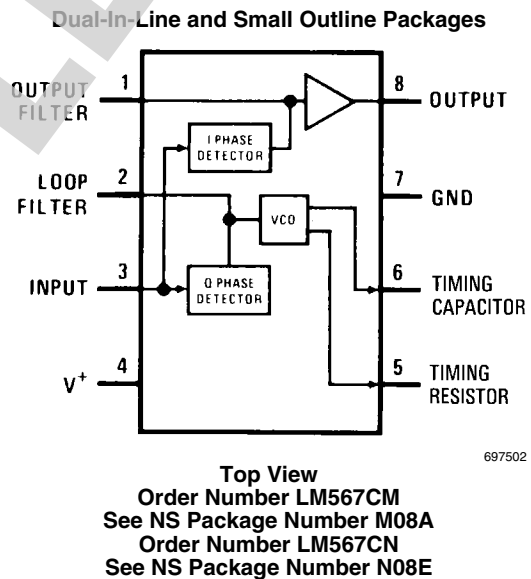
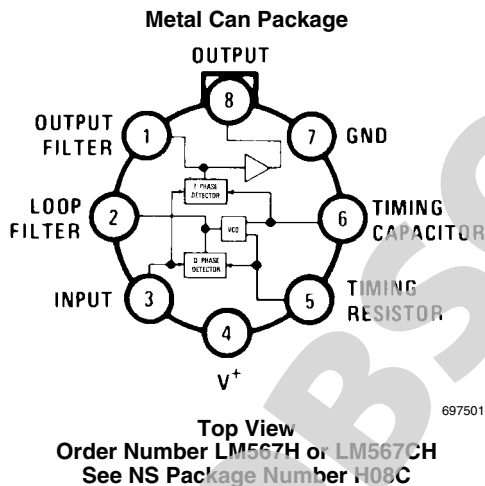
- 20 to 1 frequency range with an external resistor
- Logic compatible output with 100 mA current sinking capability
- Bandwidth adjustable from 0 to 14%

- 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 <i>(Note 2)</i>	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

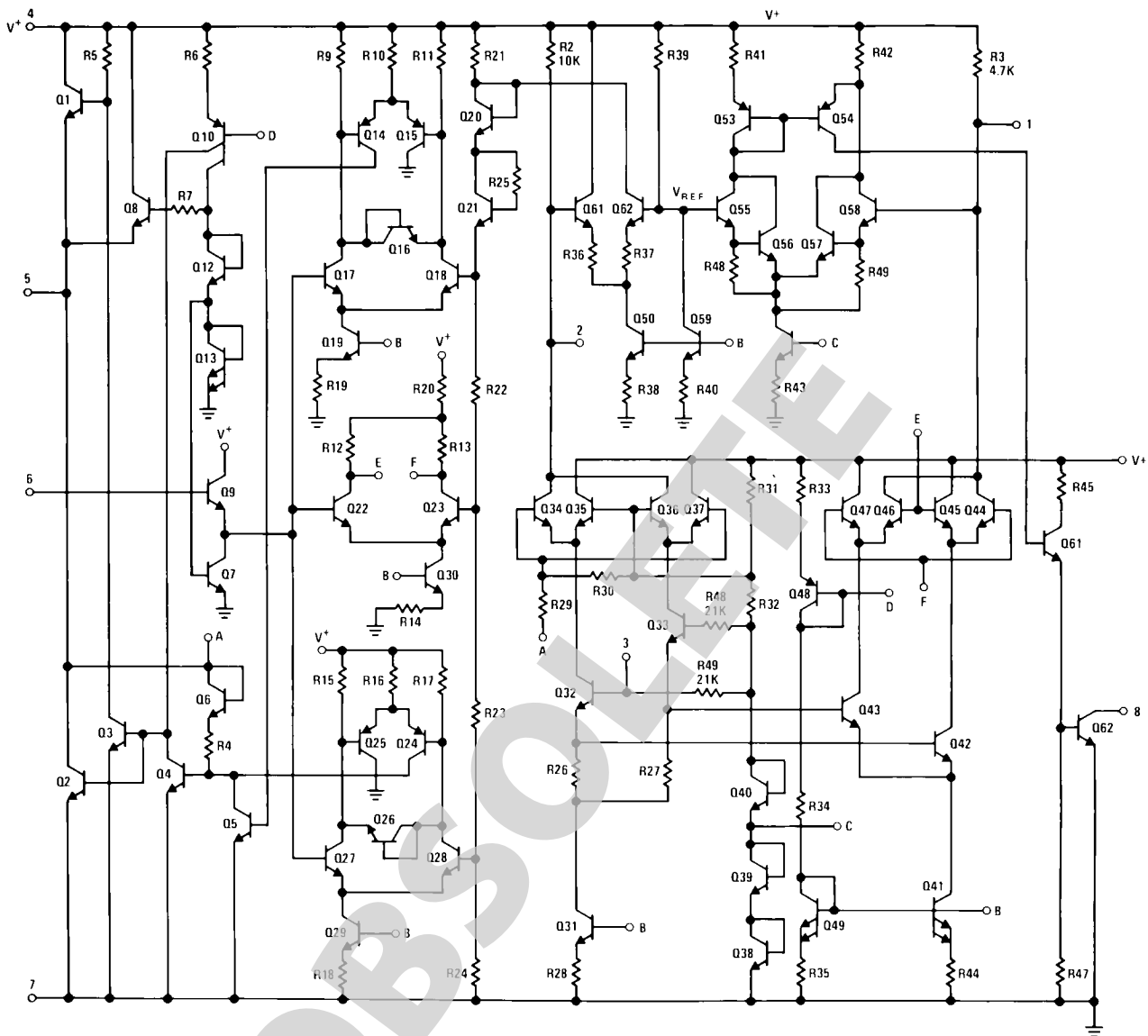
**Note 1:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits. Electrical Characteristics state DC and AC electrical specifications under particular 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

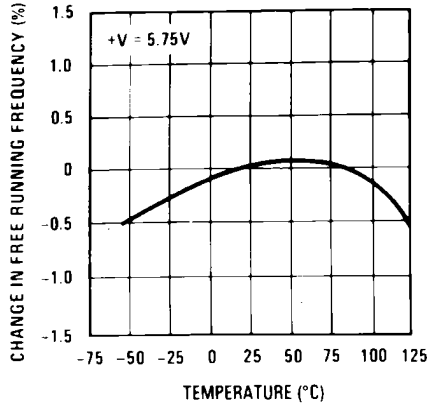
LM567/LM567C



697503

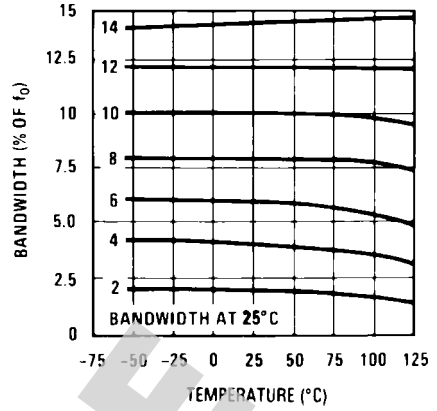
# Typical Performance Characteristics

Typical Frequency Drift



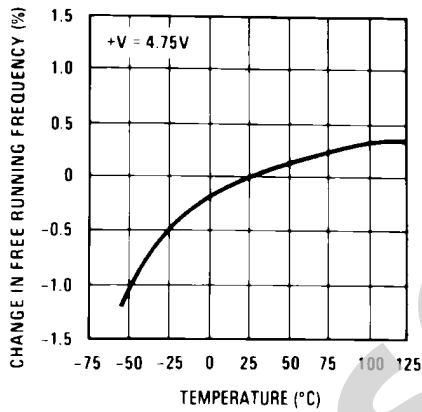
697510

Typical Bandwidth Variation



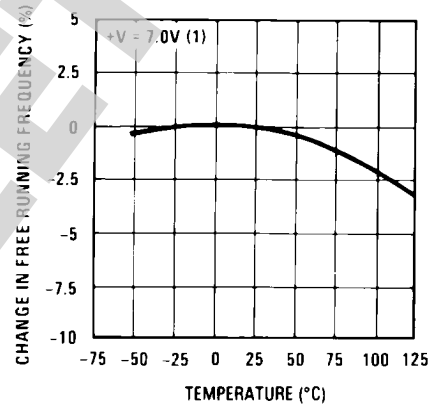
697511

Typical Frequency Drift



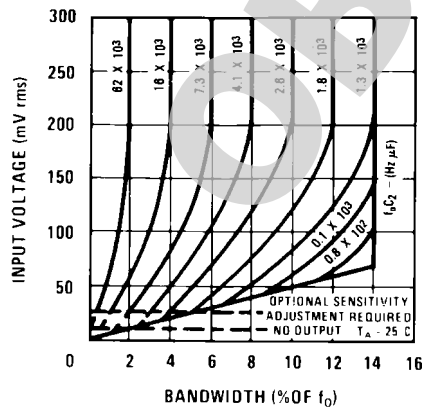
697512

Typical Frequency Drift



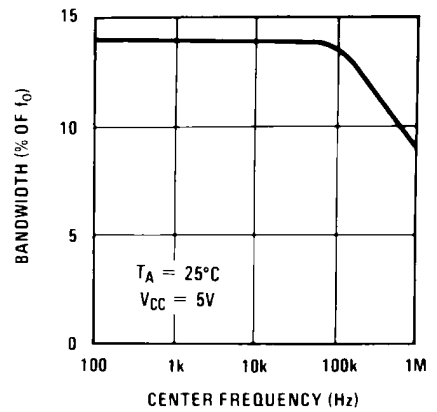
697513

Bandwidth vs Input Signal Amplitude



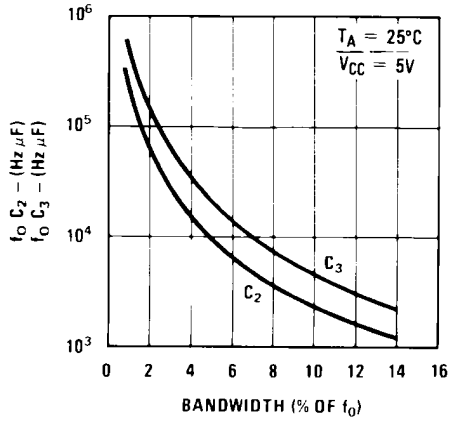
697514

Largest Detection Bandwidth



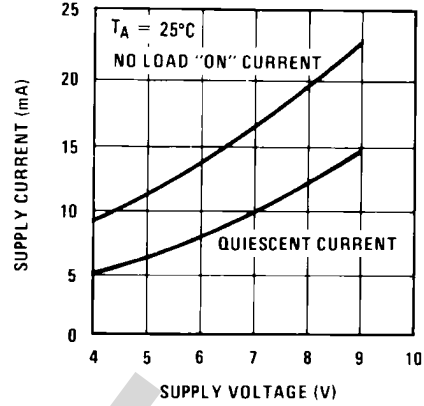
697515

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



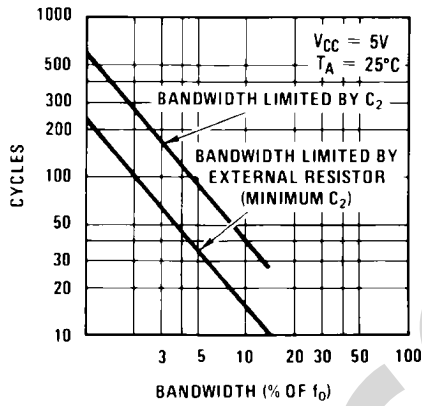
697516

Typical Supply Current vs Supply Voltage



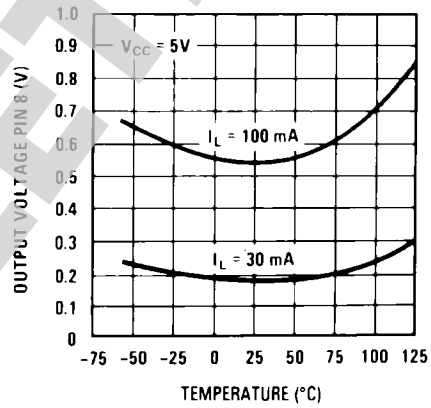
697517

Greatest Number of Cycles Before Output



697518

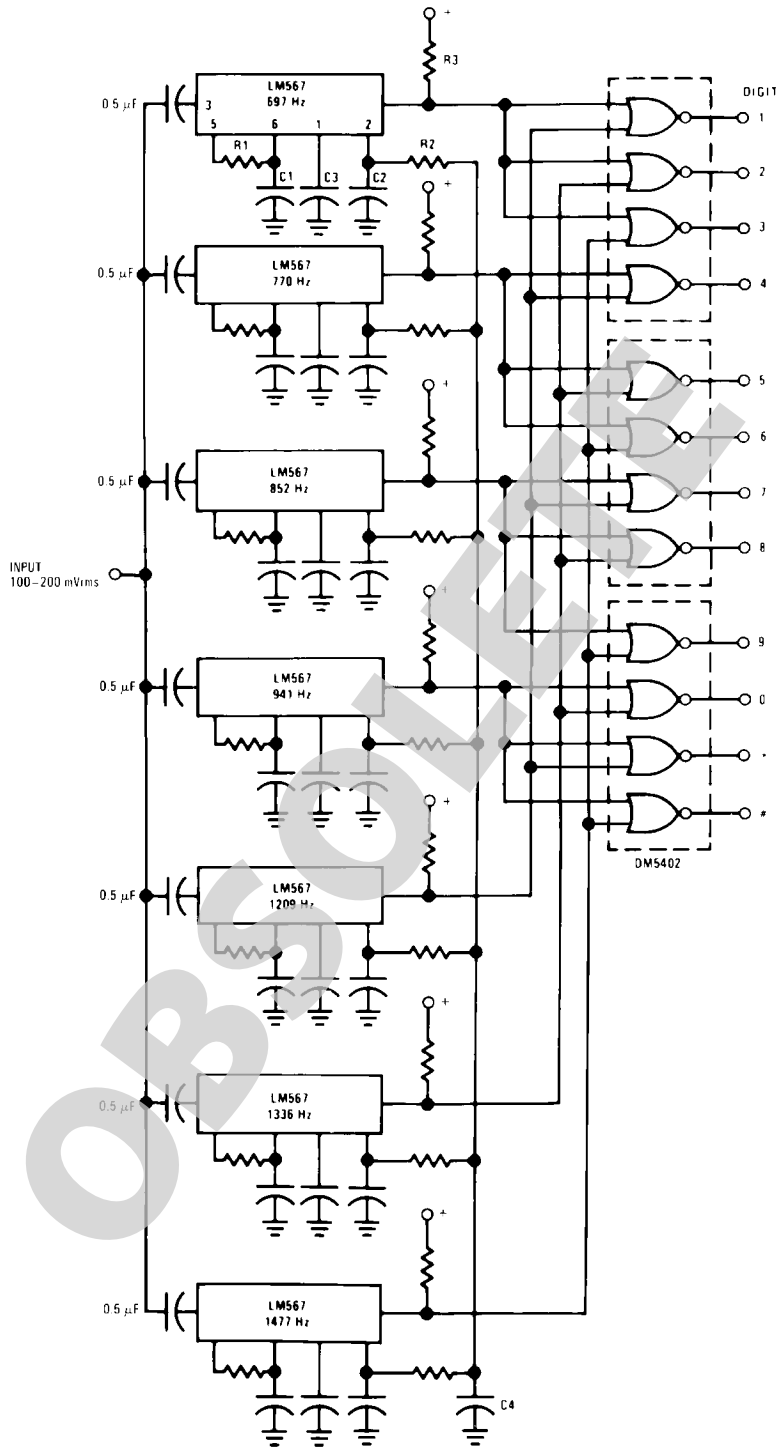
Typical Output Voltage vs Temperature



697519

# Typical Applications

## Touch-Tone Decoder

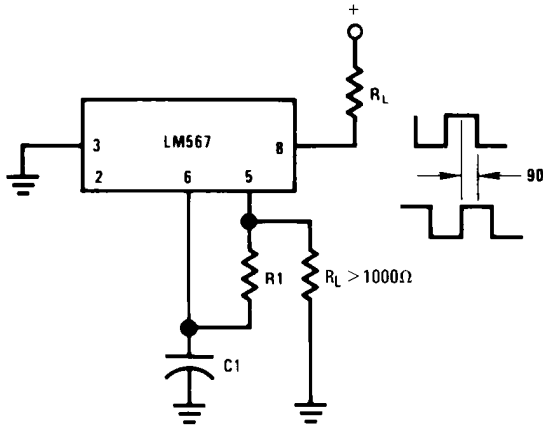


Component values (typ)

- 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

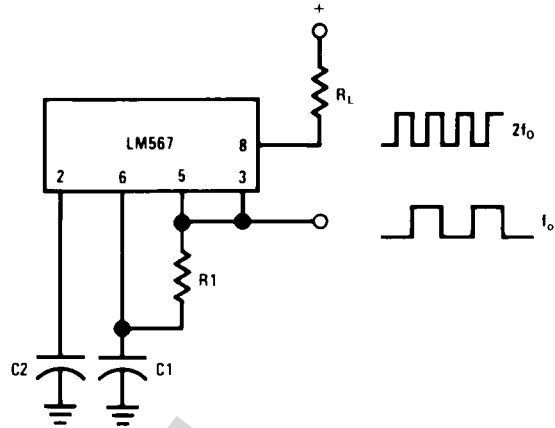
697505

Oscillator with Quadrature Output



697506

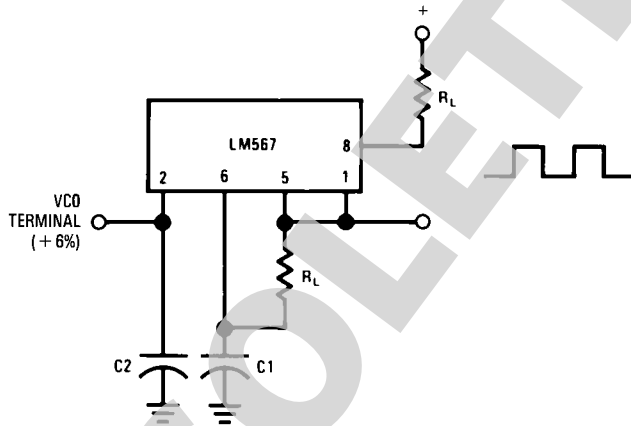
Oscillator with Double Frequency Output



697507

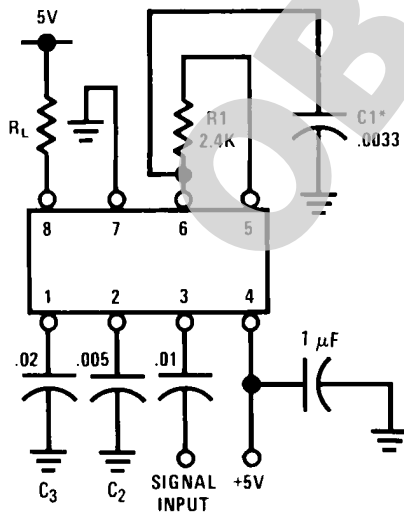
Connect Pin 3 to 2.8V to Invert Output

Precision Oscillator Drive 100 mA Loads



697508

AC Test Circuit



697509

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

\*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

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

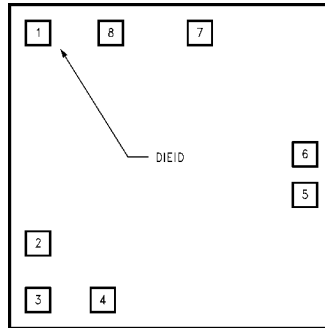
Where:

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

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



## LM567C MDC MWC Tone Decoder



Die Layout (C - Step) 697523

### Die/Wafer Characteristics

Fabrication Attributes		General Die Information	
Physical Die Identification	LM567C	Bond Pad Opening Size (min)	91 $\mu$ m x 91 $\mu$ m
Die Step	C	Bond Pad Metalization	0.5% COPPER_BAL. ALUMINUM
Physical Attributes		Passivation	VOM NITRIDE
Wafer Diameter	150mm	Back Side Metal	BARE BACK
Dise Size (Drawn)	1600 $\mu$ m x 1626 $\mu$ m 63.0mils x 64.0mils	Back Side Connection	Floating
Thickness	406 $\mu$ m Nominal		
Min Pitch	198 $\mu$ m Nominal		

#### Special Assembly Requirements:

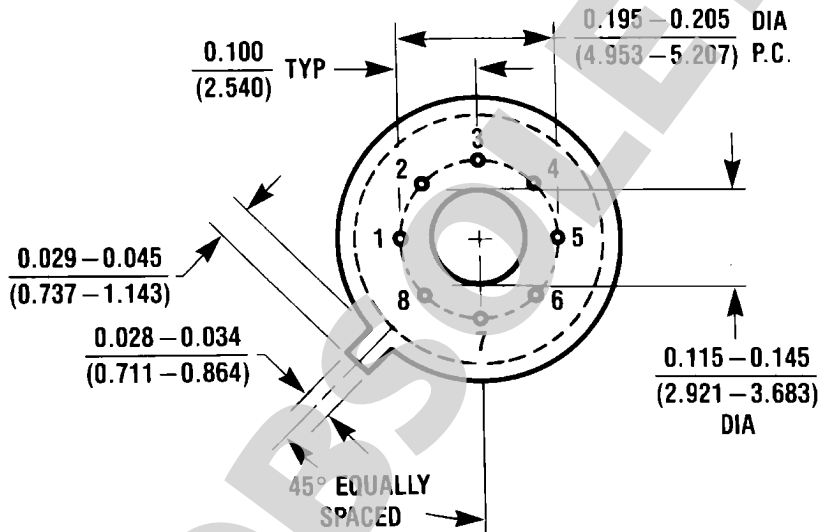
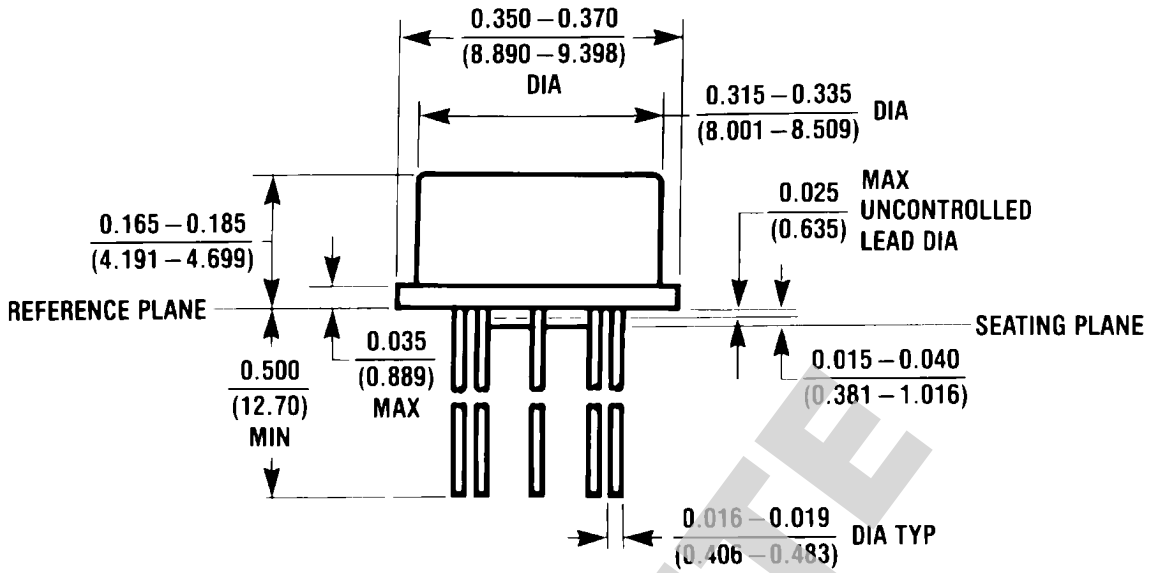
**Note:** Actual die size is rounded to the nearest micron.

Die Bond Pad Coordinate Locations (C - Step)						
(Referenced to die center, coordinates in $\mu$ m) NC = No Connection, N.U. = Not Used						
SIGNAL NAME	PAD# NUMBER	XY COORDINATES		PAD SIZE		
		X	Y	X		Y
OUTPUT FILTER	1	-673	686	91	x	91
LOOP FILTER	2	-673	-419	91	x	91
INPUT	3	-673	-686	91	x	91
V+	4	-356	-686	91	x	91
TIMING RES	5	673	-122	91	x	91
TIMING CAP	6	673	76	91	x	91
GND	7	178	686	117	x	91
OUTPUT	8	-318	679	117	x	104

<b>IN U.S.A</b>	
Tel #:	1 877 Dial Die 1 877 342 5343
Fax:	1 207 541 6140
<b>IN EUROPE</b>	
Tel:	49 (0) 8141 351492 / 1495
Fax:	49 (0) 8141 351470
<b>IN ASIA PACIFIC</b>	
Tel:	(852) 27371701
<b>IN JAPAN</b>	
Tel:	81 043 299 2308

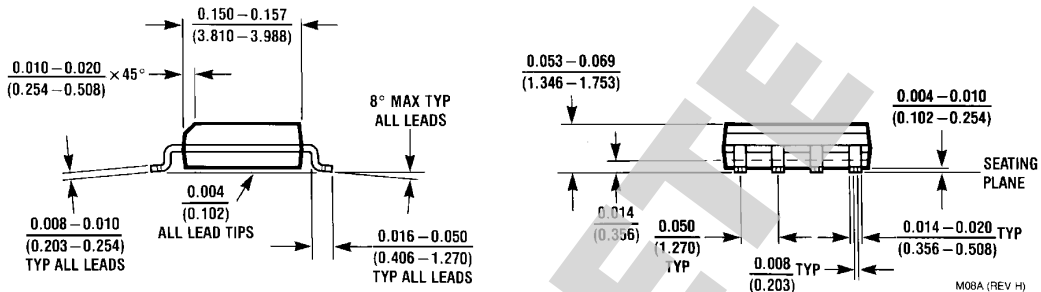
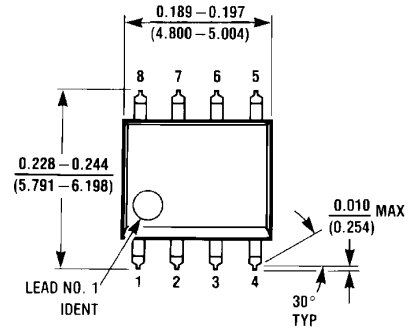
OBSOLETE

**Physical Dimensions** inches (millimeters) unless otherwise noted

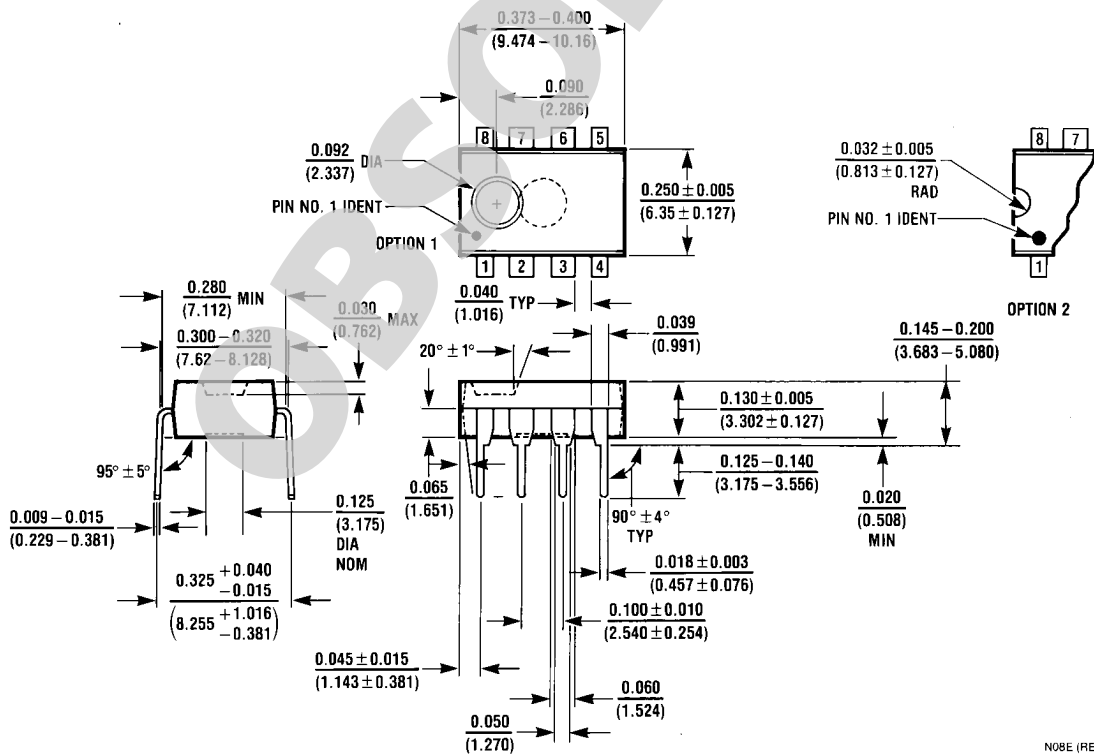


Metal Can Package (H)  
 Order Number LM567H or LM567CH  
 NS Package Number H08C

H08C (REV E)



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



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

## Notes

For more National Semiconductor product information and proven design tools, visit the following Web sites at:  
[www.national.com](http://www.national.com)

Products		Design Support	
Amplifiers	<a href="http://www.national.com/amplifiers">www.national.com/amplifiers</a>	WEBENCH® Tools	<a href="http://www.national.com/webench">www.national.com/webench</a>
Audio	<a href="http://www.national.com/audio">www.national.com/audio</a>	App Notes	<a href="http://www.national.com/appnotes">www.national.com/appnotes</a>
Clock and Timing	<a href="http://www.national.com/timing">www.national.com/timing</a>	Reference Designs	<a href="http://www.national.com/refdesigns">www.national.com/refdesigns</a>
Data Converters	<a href="http://www.national.com/adc">www.national.com/adc</a>	Samples	<a href="http://www.national.com/samples">www.national.com/samples</a>
Interface	<a href="http://www.national.com/interface">www.national.com/interface</a>	Eval Boards	<a href="http://www.national.com/evalboards">www.national.com/evalboards</a>
LVDS	<a href="http://www.national.com/lvds">www.national.com/lvds</a>	Packaging	<a href="http://www.national.com/packaging">www.national.com/packaging</a>
Power Management	<a href="http://www.national.com/power">www.national.com/power</a>	Green Compliance	<a href="http://www.national.com/quality/green">www.national.com/quality/green</a>
Switching Regulators	<a href="http://www.national.com/switchers">www.national.com/switchers</a>	Distributors	<a href="http://www.national.com/contacts">www.national.com/contacts</a>
LDOs	<a href="http://www.national.com/ldo">www.national.com/ldo</a>	Quality and Reliability	<a href="http://www.national.com/quality">www.national.com/quality</a>
LED Lighting	<a href="http://www.national.com/led">www.national.com/led</a>	Feedback/Support	<a href="http://www.national.com/feedback">www.national.com/feedback</a>
Voltage References	<a href="http://www.national.com/vref">www.national.com/vref</a>	Design Made Easy	<a href="http://www.national.com/easy">www.national.com/easy</a>
PowerWise® Solutions	<a href="http://www.national.com/powerwise">www.national.com/powerwise</a>	Applications & Markets	<a href="http://www.national.com/solutions">www.national.com/solutions</a>
Serial Digital Interface (SDI)	<a href="http://www.national.com/sdi">www.national.com/sdi</a>	Mil/Aero	<a href="http://www.national.com/milaero">www.national.com/milaero</a>
Temperature Sensors	<a href="http://www.national.com/tempensors">www.national.com/tempensors</a>	SolarMagic™	<a href="http://www.national.com/solarmagic">www.national.com/solarmagic</a>
PLL/VCO	<a href="http://www.national.com/wireless">www.national.com/wireless</a>	PowerWise® Design University	<a href="http://www.national.com/training">www.national.com/training</a>

THE CONTENTS OF THIS DOCUMENT ARE PROVIDED IN CONNECTION WITH NATIONAL SEMICONDUCTOR CORPORATION ("NATIONAL") PRODUCTS. NATIONAL MAKES NO REPRESENTATIONS OR WARRANTIES WITH RESPECT TO THE ACCURACY OR COMPLETENESS OF THE CONTENTS OF THIS PUBLICATION AND RESERVES THE RIGHT TO MAKE CHANGES TO SPECIFICATIONS AND PRODUCT DESCRIPTIONS AT ANY TIME WITHOUT NOTICE. NO LICENSE, WHETHER EXPRESS, IMPLIED, ARISING BY ESTOPPEL OR OTHERWISE, TO ANY INTELLECTUAL PROPERTY RIGHTS IS GRANTED BY THIS DOCUMENT.

TESTING AND OTHER QUALITY CONTROLS ARE USED TO THE EXTENT NATIONAL DEEMS NECESSARY TO SUPPORT NATIONAL'S PRODUCT WARRANTY. EXCEPT WHERE MANDATED BY GOVERNMENT REQUIREMENTS, TESTING OF ALL PARAMETERS OF EACH PRODUCT IS NOT NECESSARILY PERFORMED. NATIONAL ASSUMES NO LIABILITY FOR APPLICATIONS ASSISTANCE OR BUYER PRODUCT DESIGN. BUYERS ARE RESPONSIBLE FOR THEIR PRODUCTS AND APPLICATIONS USING NATIONAL COMPONENTS. PRIOR TO USING OR DISTRIBUTING ANY PRODUCTS THAT INCLUDE NATIONAL COMPONENTS, BUYERS SHOULD PROVIDE ADEQUATE DESIGN, TESTING AND OPERATING SAFEGUARDS.

EXCEPT AS PROVIDED IN NATIONAL'S TERMS AND CONDITIONS OF SALE FOR SUCH PRODUCTS, NATIONAL ASSUMES NO LIABILITY WHATSOEVER, AND NATIONAL DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY RELATING TO THE SALE AND/OR USE OF NATIONAL PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

#### LIFE SUPPORT POLICY

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

Life support devices or systems are devices 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. A critical component is any component in 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 and the National Semiconductor logo are registered trademarks of National Semiconductor Corporation. All other brand or product names may be trademarks or registered trademarks of their respective holders.

Copyright© 2011 National Semiconductor Corporation

For the most current product information visit us at [www.national.com](http://www.national.com)



[www.national.com](http://www.national.com)

**National Semiconductor  
Americas Technical  
Support Center**  
Email: [support@nsc.com](mailto:support@nsc.com)  
Tel: 1-800-272-9959

**National Semiconductor Europe  
Technical Support Center**  
Email: [europe.support@nsc.com](mailto:europe.support@nsc.com)

**National Semiconductor Asia  
Pacific Technical Support Center**  
Email: [ap.support@nsc.com](mailto:ap.support@nsc.com)

**National Semiconductor Japan  
Technical Support Center**  
Email: [jpn.feedback@nsc.com](mailto:jpn.feedback@nsc.com)