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

Metal Can Package

Dual-In-Line and Small Outline Packages

Top View
Order Number LM567H or LM567CH
See NS Package Number H08C
### 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

V8 15V

V3 −10V

V4 V3 + 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, \( T_A = 25°C, V^+ = 5V \)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Conditions</th>
<th>LM567</th>
<th>LM567C/LM567CM</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply Voltage Range</td>
<td>RL = 20k</td>
<td>4.75</td>
<td>5.0</td>
<td>9.0</td>
</tr>
<tr>
<td>Power Supply Current Quiescent</td>
<td>RL = 20k</td>
<td>6</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>Power Supply Current Activated</td>
<td>RL = 20k</td>
<td>7</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Input Resistance</td>
<td>18</td>
<td>20</td>
<td>25</td>
<td>kΩ</td>
</tr>
<tr>
<td>Smallest Detectable Input Voltage</td>
<td>20</td>
<td>25</td>
<td>mVrms</td>
<td></td>
</tr>
<tr>
<td>Largest No Output Input Voltage</td>
<td>10</td>
<td>15</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Largest Simultaneous Outband Signal to Inband Signal Ratio</td>
<td>6</td>
<td>6</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>Minimum Input Signal to Wideband Noise Ratio</td>
<td>( B_n = 140 \text{ kHz} )</td>
<td>−6</td>
<td>−6</td>
<td>dB</td>
</tr>
<tr>
<td>Largest Detection Bandwidth</td>
<td>12</td>
<td>14</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>Largest Detection Bandwidth Skew</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>% of ( f_0 )</td>
</tr>
<tr>
<td>Largest Detection Bandwidth Variation with Temperature</td>
<td>±0.1</td>
<td>±0.1</td>
<td>%/°C</td>
<td></td>
</tr>
<tr>
<td>Largest Detection Bandwidth Variation with Supply Voltage</td>
<td>4.75–6.75V</td>
<td>±1</td>
<td>±2</td>
<td>±1</td>
</tr>
<tr>
<td>Highest Center Frequency</td>
<td>100</td>
<td>500</td>
<td>kHz</td>
<td></td>
</tr>
<tr>
<td>Center Frequency Stability (4.75–5.75V)</td>
<td>0 &lt; ( T_A &lt; 70 )</td>
<td>35</td>
<td>± 60</td>
<td>35</td>
</tr>
<tr>
<td>−55 &lt; ( T_A &lt; +125 )</td>
<td>35</td>
<td>± 140</td>
<td>35</td>
<td>± 140</td>
</tr>
<tr>
<td>Center Frequency Shift with Supply Voltage</td>
<td>4.75V–6.75V</td>
<td>0.5</td>
<td>1.0</td>
<td>0.4</td>
</tr>
<tr>
<td>4.75V–9V</td>
<td>2.0</td>
<td>2.0</td>
<td>%/V</td>
<td></td>
</tr>
<tr>
<td>Fastest ON-OFF Cycling Rate</td>
<td>( f_o/20 )</td>
<td>( f_o/20 )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Leakage Current</td>
<td>( V_8 = 15V )</td>
<td>0.01</td>
<td>25</td>
<td>µA</td>
</tr>
<tr>
<td>Output Saturation Voltage</td>
<td>( e_i = 25 \text{ mV}, I_e = 30 \text{ mA} )</td>
<td>0.2</td>
<td>0.4</td>
<td>0.2</td>
</tr>
<tr>
<td>( e_i = 25 \text{ mV}, I_e = 100 \text{ mA} )</td>
<td>0.6</td>
<td>1.0</td>
<td>0.6</td>
<td>1.0</td>
</tr>
<tr>
<td>Output Fall Time</td>
<td>30</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Rise Time</td>
<td>150</td>
<td>ns</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.
Typical Performance Characteristics

Typical Frequency Drift

![Graph of Typical Frequency Drift]

Typical Bandwidth Variation

![Graph of Typical Bandwidth Variation]

Bandwidth vs Input Signal Amplitude

![Graph of Bandwidth vs Input Signal Amplitude]

Largest Detection Bandwidth

![Graph of Largest Detection Bandwidth]
Detection Bandwidth as a Function of $C_2$ and $C_3$

$T_A = 25^\circ C$
$V_{CC} = 5V$

Greatest Number of Cycles Before Output

$V_{CC} = 5V$
$T_A = 25^\circ C$

Typical Supply Current vs Supply Voltage

Typical Output Voltage vs Temperature
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
Typical Applications (Continued)

Oscillator with Quadrature Output

Connect Pin 3 to 2.8V to Invert Output

Oscillator with Double Frequency Output

Precision Oscillator Drive 100 mA Loads
**Applications Information**

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

\[ f_0 \approx \frac{1}{1.1 \cdot R_1 \cdot C_1} \]

The bandwidth of the filter may be found from the approximation

\[ BW = 1070 \frac{V_i}{f_0 C_2} \text{ in } \% \text{ of } f_0 \]

Where:
- \( V_i \) = Input voltage (volts rms), \( V_i \leq 200\text{mV} \)
- \( C_2 \) = Capacitance at Pin 2(\( \mu F \))

\( f_i = 100 \text{ kHz} + 5V \)

*Note: Adjust for \( f_o = 100 \text{ kHz} \).*
**LM567C MDC MWC TONE DECODER**

![Die Layout (C - Step)](image)

## DIE/WAFER CHARACTERISTICS

<table>
<thead>
<tr>
<th>Fabrication Attributes</th>
<th>General Die Information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical Die Identification</strong></td>
<td>LM567C</td>
</tr>
<tr>
<td><strong>Die Step</strong></td>
<td>C</td>
</tr>
<tr>
<td><strong>Bond Pad Opening Size (min)</strong></td>
<td>91µm x 91µm</td>
</tr>
<tr>
<td><strong>Bond Pad Metalization</strong></td>
<td>0.5% COPPER_BAL. ALUMINUM</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Physical Attributes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wafer Diameter</strong></td>
<td>150mm</td>
</tr>
<tr>
<td><strong>Back Side Metal</strong></td>
<td>BARE BACK</td>
</tr>
<tr>
<td><strong>Dise Size (Drawn)</strong></td>
<td>1600µm x 1626µm 63.0mils x 64.0mils</td>
</tr>
<tr>
<td><strong>Back Side Connection</strong></td>
<td>Floating</td>
</tr>
<tr>
<td><strong>Thickness</strong></td>
<td>406µm Nominal</td>
</tr>
<tr>
<td><strong>Min Pitch</strong></td>
<td>198µm Nominal</td>
</tr>
</tbody>
</table>

### 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 µm) **NC = No Connection, N.U. = Not Used**

<table>
<thead>
<tr>
<th>SIGNAL NAME</th>
<th>PAD# NUMBER</th>
<th>X/Y COORDINATES</th>
<th>PAD SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>OUTPUT FILTER</td>
<td>1</td>
<td>-673</td>
<td>686</td>
</tr>
<tr>
<td>LOOP FILTER</td>
<td>2</td>
<td>-673</td>
<td>-419</td>
</tr>
<tr>
<td>INPUT</td>
<td>3</td>
<td>673</td>
<td>686</td>
</tr>
<tr>
<td>V+</td>
<td>4</td>
<td>-356</td>
<td>-686</td>
</tr>
<tr>
<td>TIMING RES</td>
<td>5</td>
<td>673</td>
<td>-122</td>
</tr>
<tr>
<td>TIMING CAP</td>
<td>6</td>
<td>673</td>
<td>76</td>
</tr>
<tr>
<td>GND</td>
<td>7</td>
<td>178</td>
<td>686</td>
</tr>
<tr>
<td>OUTPUT</td>
<td>8</td>
<td>-318</td>
<td>679</td>
</tr>
<tr>
<td></td>
<td>IN U.S.A</td>
<td>IN EUROPE</td>
<td>IN ASIA PACIFIC</td>
</tr>
<tr>
<td>------------------------</td>
<td>-------------------------</td>
<td>-------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Tel #:</td>
<td>1 877 Dial Die 1 877 342 5343</td>
<td>49 (0) 8141 351492 / 1495</td>
<td>(852) 27371701</td>
</tr>
<tr>
<td>Fax:</td>
<td>1 207 541 6140</td>
<td>49 (0) 8141 351470</td>
<td></td>
</tr>
</tbody>
</table>
Physical Dimensions  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

www.national.com
LM567/LM567C Tone Decoder

Physical Dimensions

inches (millimeters) unless otherwise noted (Continued)

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

National does not assume any responsibility for use of any circuitry described, no circuit patent licenses are implied and National reserves the right at any time without notice to change said circuitry and specifications.

For the most current product information visit us at www.national.com.

LIFE SUPPORT POLICY
NATIONAL'S PRODUCTS ARE NOT AUTHORIZE 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.

BANNED SUBSTANCE COMPLIANCE
National Semiconductor certifies that the products and packing materials meet the provisions of the Customer Products Stewardship Specification (CSP-9-111C2) and the Banned Substances and Materials of Interest Specification (CSP-9-111S2) and contain no "Banned Substances" as defined in CSP-9-111S2.

National Semiconductor
Americas Customer Support Center
Email: new.feedback@nsc.com
Tel: 1-800-272-9959
www.national.com

National Semiconductor
Europe Customer Support Center
Fax: +49 (0) 180-530 85 86
Email: europe.support@nsc.com
Deutsch Tel: +49 (0) 69 9508 6208
English Tel: +44 (0) 870 24 0 2171
Français Tel: +33 (0) 1 41 91 8790

National Semiconductor
Asia Pacific Customer Support Center
Email: ap.support@nsc.com

National Semiconductor
Japan Customer Support Center
Fax: 81-3-5639-7507
Email: jpn.feedback@nsc.com
Tel: 81-3-5639-7560