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
Metal Can Package
Dual-In-Line and Small Outline Packages

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

Top View
Order Number LM567CM
See NS Package Number M08A
Order Number LM567CN
See NS Package Number N08E
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
V₃ V₄ +0.5V
Storage Temperature Range −65˚C to +150˚C
Operating Temperature Range

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, TᵥA = 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></td>
<td>4.75</td>
<td>5.0</td>
<td>9.0</td>
</tr>
<tr>
<td>Power Supply Current Quiescent</td>
<td>R₈ = 20k</td>
<td>6</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Power Supply Current Activated</td>
<td>R₈ = 20k</td>
<td>11</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>Input Resistance</td>
<td></td>
<td>18</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>Smallest Detectable Input Voltage</td>
<td>I₈ = 100 mA, fᵢ = fₒ</td>
<td>20</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>Largest No Output Input Voltage</td>
<td>I₈ = 100 mA, fᵢ = fₒ</td>
<td>10</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Largest Simultaneous Outband Signal to Inband Signal Ratio</td>
<td></td>
<td>6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Minimum Input Signal to Wideband Noise Ratio</td>
<td>Bᵢ = 140 kHz</td>
<td>−6</td>
<td>−6</td>
<td></td>
</tr>
<tr>
<td>Largest Detection Bandwidth</td>
<td></td>
<td>12</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>Largest Detection Bandwidth Skew</td>
<td></td>
<td>1</td>
<td>2</td>
<td>2</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></td>
<td>100</td>
<td>500</td>
<td>100</td>
</tr>
<tr>
<td>Center Frequency Stability (4.75–5.75V)</td>
<td>0 &lt; TᵥA &lt; 70</td>
<td>35 ± 60</td>
<td>35 ± 140</td>
<td></td>
</tr>
<tr>
<td></td>
<td>−55 &lt; TᵥA &lt; +125</td>
<td>35 ± 60</td>
<td>35 ± 140</td>
<td></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></td>
<td>4.75V–9V</td>
<td>2.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fastest ON-OFF Cycling Rate</td>
<td>fₒ/20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Leakage Current</td>
<td>V₈ = 15V</td>
<td>0.01</td>
<td>25</td>
<td>0.01</td>
</tr>
<tr>
<td>Output Saturation Voltage</td>
<td>eᵢ = 25 mV, I₈ = 30 mA</td>
<td>0.2</td>
<td>0.4</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>eᵢ = 25 mV, I₈ = 100 mA</td>
<td>0.6</td>
<td>1.0</td>
<td>0.6</td>
</tr>
<tr>
<td>Output Fall Time</td>
<td></td>
<td>30</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Output Rise Time</td>
<td></td>
<td>150</td>
<td>150</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

Typical Bandwidth Variation

Bandwidth vs Input Signal Amplitude

Largest Detection Bandwidth

www.national.com
Typical Performance Characteristics (Continued)

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

![Detection Bandwidth Graph](image)

$T_A = 25^\circ C$

$V_{CC} = 5V$

Greatest Number of Cycles Before Output

![Greatest Number of Cycles Graph](image)

$V_{CC} = 5V$

$T_A = 25^\circ C$

Typical Supply Current vs Supply Voltage

![Supply Current Graph](image)

$T_A = 25^\circ C$

No Load "On" Current

Quiescent Current

Typical Output Voltage vs Temperature

![Output Voltage Graph](image)

$V_{CC} = 5V$

$I_1 = 100$ mA

$I_2 = 30$ mA
Typical Applications

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

Precision Oscillator Drive 100 mA Loads

Oscillator with Double Frequency Output
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

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

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

*Note: Adjust for \( f_0 \approx 100 \text{ kHz} \).
Die Layout (C - Step)

DIE/WAFER CHARACTERISTICS

<table>
<thead>
<tr>
<th>Fabrication Attributes</th>
<th>General Die Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Die Identification</td>
<td>LM567C</td>
</tr>
<tr>
<td>Bond Pad Opening Size (min)</td>
<td>91µm x 91µm</td>
</tr>
<tr>
<td>Die Step</td>
<td>C</td>
</tr>
<tr>
<td>Bond Pad Metalization</td>
<td>0.5% COPPER_BAL. ALUMINUM</td>
</tr>
<tr>
<td>Physical Attributes</td>
<td>Passivation</td>
</tr>
<tr>
<td>Wafer Diameter</td>
<td>150mm</td>
</tr>
<tr>
<td>Back Side Metal</td>
<td>BARE BACK</td>
</tr>
<tr>
<td>Disc Size (Drawn)</td>
<td>1600µm x 1626µm</td>
</tr>
<tr>
<td>Back Side Connection</td>
<td>Floating</td>
</tr>
<tr>
<td>Thickness</td>
<td>406µm Nominal</td>
</tr>
<tr>
<td>Min Pitch</td>
<td>198µm Nominal</td>
</tr>
<tr>
<td>Special Assembly Requirements:</td>
<td></td>
</tr>
<tr>
<td>Note: Actual die size is rounded to the nearest micron.</td>
<td></td>
</tr>
</tbody>
</table>

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>-673 686</td>
<td>X Y</td>
</tr>
<tr>
<td>LOOP FILTER</td>
<td>2</td>
<td>-673 -419</td>
<td>91 x 91</td>
</tr>
<tr>
<td>INPUT</td>
<td>3</td>
<td>-673 -686</td>
<td>91 x 91</td>
</tr>
<tr>
<td>V+</td>
<td>4</td>
<td>-356 -686</td>
<td>91 x 91</td>
</tr>
<tr>
<td>TIMING RES</td>
<td>5</td>
<td>673 -122</td>
<td>91 x 91</td>
</tr>
<tr>
<td>TIMING CAP</td>
<td>6</td>
<td>673 76</td>
<td>91 x 91</td>
</tr>
<tr>
<td>GND</td>
<td>7</td>
<td>178 686</td>
<td>117 x 91</td>
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<tr>
<td>OUTPUT</td>
<td>8</td>
<td>-318 679</td>
<td>117 x 104</td>
</tr>
</tbody>
</table>
## LM567C MDC MWC TONE DECODER (Continued)

<p>| | | | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td><strong>IN U.S.A</strong></td>
<td><strong>Tel #:</strong> 1 877 Dial Die 1 877 342 5343</td>
<td><strong>Fax:</strong> 1 207 541 6140</td>
<td></td>
</tr>
<tr>
<td><strong>IN EUROPE</strong></td>
<td><strong>Tel:</strong> 49 (0) 8141 351492 / 1495</td>
<td><strong>Fax:</strong> 49 (0) 8141 351470</td>
<td></td>
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<tr>
<td><strong>IN ASIA PACIFIC</strong></td>
<td><strong>Tel:</strong> (852) 27371701</td>
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<tr>
<td><strong>IN JAPAN</strong></td>
<td><strong>Tel:</strong> 81 043 299 2308</td>
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</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
Physical Dimensions inches (millimeters) unless otherwise noted (Continued)

LM567/LM567C Tone Decoder

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

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