LM567/LM567C Tone Decoder
Check for Samples: LM567, LM567C

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

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.

Connection Diagram

Metal Can Package

Figure 1. Top View
Order Number LM567H or LM567CH
See NS Package Number H08C

OBSOLETE

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These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

**Absolute Maximum Ratings**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage Pin</td>
<td>9V</td>
</tr>
<tr>
<td>Power Dissipation</td>
<td>1100 mW</td>
</tr>
<tr>
<td>V₈</td>
<td>15V</td>
</tr>
<tr>
<td>V₃</td>
<td>-10V</td>
</tr>
<tr>
<td>V₃</td>
<td>V₄ + 0.5V</td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td>-65°C to +150°C</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>-55°C to +125°C</td>
</tr>
<tr>
<td>LM567H</td>
<td>0°C to +70°C</td>
</tr>
<tr>
<td>LM567CH, LM567CM, LM567CN</td>
<td></td>
</tr>
</tbody>
</table>

**Soldering Information**

<table>
<thead>
<tr>
<th>Package</th>
<th>Method</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dual-In-Line Package</td>
<td>Soldering (10 sec.)</td>
<td>260°C</td>
</tr>
<tr>
<td>Small Outline Package</td>
<td>Vapor Phase (60 sec.)</td>
<td>215°C</td>
</tr>
<tr>
<td></td>
<td>Infrared (15 sec.)</td>
<td>220°C</td>
</tr>
</tbody>
</table>

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

(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 the parameters where no limit is given, however, the typical value is a good indication of device performance.

(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.
## Electrical Characteristics

**AC Test Circuit, \( T_A = 25^\circ C, V^+ = 5V \)**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Conditions</th>
<th>LM567</th>
<th>LM567C/LM567CM</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power Supply Voltage Range</strong></td>
<td></td>
<td>4.75</td>
<td>5.0</td>
<td>9.0</td>
</tr>
<tr>
<td><strong>Power Supply Current Quiescent</strong></td>
<td>( R_L = 20k )</td>
<td>6</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td><strong>Power Supply Current Activated</strong></td>
<td>( R_L = 20k )</td>
<td>11</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td><strong>Input Resistance</strong></td>
<td></td>
<td>18</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td><strong>Smallest Detectable Input Voltage</strong></td>
<td>( I_L = 100 \ mA, f_i = f_o )</td>
<td>20</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td><strong>Largest No Output Input Voltage</strong></td>
<td>( I_C = 100 \ mA, f_i = f_o )</td>
<td>10</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td><strong>Largest Simultaneous Outband Signal to Inband Signal Ratio</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Minimum Input Signal to Wideband Noise Ratio</strong></td>
<td>( B_n = 140 \ kHz )</td>
<td>-6</td>
<td>-6</td>
<td></td>
</tr>
<tr>
<td><strong>Largest Detection Bandwidth</strong></td>
<td></td>
<td>12</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td><strong>Largest Detection Bandwidth Skew</strong></td>
<td></td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Largest Detection Bandwidth Variation with Temperature</strong></td>
<td></td>
<td>±0.1</td>
<td>±0.1</td>
<td></td>
</tr>
<tr>
<td><strong>Largest Detection Bandwidth Variation with Supply Voltage</strong></td>
<td>4.75–6.75V</td>
<td>±1</td>
<td>±2</td>
<td>±1</td>
</tr>
<tr>
<td><strong>Highest Center Frequency</strong></td>
<td></td>
<td>100</td>
<td>500</td>
<td>100</td>
</tr>
<tr>
<td><strong>Center Frequency Stability (4.75–5.75V)</strong></td>
<td>( 0 &lt; T_A &lt; 70 ) \ -55 &lt; T_A &lt; +125 )</td>
<td>35 ± 60</td>
<td>35 ± 140</td>
<td>35 ± 60</td>
</tr>
<tr>
<td><strong>Center Frequency Shift with Supply Voltage</strong></td>
<td>4.75V–6.75V</td>
<td>0.5</td>
<td>1.0</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>Fastest ON-OFF Cycling Rate</strong></td>
<td>( f_o/20 )</td>
<td>f_o/20</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Output Leakage Current</strong></td>
<td>( V_8 = 15V )</td>
<td>0.01</td>
<td>25</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>Output Saturation Voltage</strong></td>
<td>( e_i = 25 \ mV, I_8 = 30 \ mA )</td>
<td>0.2</td>
<td>0.6</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>( e_i = 25 \ mV, I_8 = 100 \ mA )</td>
<td>0.2</td>
<td>0.6</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>Output Fall Time</strong></td>
<td></td>
<td>30</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td><strong>Output Rise Time</strong></td>
<td></td>
<td>150</td>
<td>150</td>
<td></td>
</tr>
</tbody>
</table>
Schematic Diagram
Typical Performance Characteristics

Typical Frequency Drift

Bandwidth vs Input Signal Amplitude

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

Greatest Number of Cycles Before Output

Typical Bandwidth Variation

Largest Detection Bandwidth

Typical Supply Current vs Supply Voltage

Typical Output Voltage vs Temperature
Typical Applications

Figure 3. 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
Figure 4. Oscillator with Quadrature Output

Connect Pin 3 to 2.8V to Invert Output

Figure 5. Oscillator with Double Frequency Output

Figure 6. Precision Oscillator Drive 100 mA Loads
AC Test Circuit

![AC Test Circuit Diagram]

\[ f_i = 100 \text{ kHz} + 5V \]

*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

\[ f_o \approx \frac{1}{1.1 R_1 C_1} \]  

(1)

The bandwidth of the filter may be found from the approximation

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

(2)

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) Diagram]

Table 1. 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>91( \mu \text{m} \times 91\mu \text{m} )</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>
</tbody>
</table>
Table 1. Die/Wafer Characteristics (continued)

<table>
<thead>
<tr>
<th>Physical Attributes</th>
<th>Passivation</th>
<th>VOM NITRIDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wafer Diameter</td>
<td>150mm</td>
<td>Back Side Metal</td>
</tr>
<tr>
<td>Dise Size (Drawn)</td>
<td>1600µm x 1626µm 63.0mils x 64.0mils</td>
<td>Back Side Connection</td>
</tr>
<tr>
<td>Thickness</td>
<td>406µm Nominal</td>
<td></td>
</tr>
<tr>
<td>Min Pitch</td>
<td>198µm Nominal</td>
<td></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>-673 686</td>
<td>x 91</td>
</tr>
<tr>
<td>LOOP FILTER</td>
<td>2</td>
<td>-673 -419</td>
<td>x 91</td>
</tr>
<tr>
<td>INPUT</td>
<td>3</td>
<td>-673 -686</td>
<td>x 91</td>
</tr>
<tr>
<td>V+</td>
<td>4</td>
<td>-356 -686</td>
<td>x 91</td>
</tr>
<tr>
<td>TIMING RES</td>
<td>5</td>
<td>673 -122</td>
<td>x 91</td>
</tr>
<tr>
<td>TIMING CAP</td>
<td>6</td>
<td>673 76</td>
<td>x 91</td>
</tr>
<tr>
<td>GND</td>
<td>7</td>
<td>178 686</td>
<td>x 91</td>
</tr>
<tr>
<td>OUTPUT</td>
<td>8</td>
<td>-318 679</td>
<td>x 104</td>
</tr>
</tbody>
</table>

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## PACKAGING INFORMATION

<table>
<thead>
<tr>
<th>Orderable Device</th>
<th>Status (1)</th>
<th>Package Type</th>
<th>Package Drawing</th>
<th>Pins</th>
<th>Package Qty</th>
<th>Eco Plan (2)</th>
<th>Lead/Ball Finish</th>
<th>MSL Peak Temp (3)</th>
<th>Samples</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>LM567CM</td>
<td>ACTIVE</td>
<td>SOIC</td>
<td>D</td>
<td>8</td>
<td>95</td>
<td>TBD</td>
<td>CU SNPB</td>
<td>Level-1-235C-UNLIM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LM567CM/NOPB</td>
<td>ACTIVE</td>
<td>SOIC</td>
<td>D</td>
<td>8</td>
<td>95</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU SN</td>
<td>Level-1-260C-UNLIM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LM567CMX/NOPB</td>
<td>ACTIVE</td>
<td>SOIC</td>
<td>D</td>
<td>8</td>
<td>2500</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>CU SN</td>
<td>Level-1-260C-UNLIM</td>
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</tr>
<tr>
<td>LM567CN</td>
<td>ACTIVE</td>
<td>PDIP</td>
<td>P</td>
<td>8</td>
<td>40</td>
<td>TBD</td>
<td>Call TI</td>
<td>Level-1-NA-UNLIM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LM567CN/NOPB</td>
<td>ACTIVE</td>
<td>PDIP</td>
<td>P</td>
<td>8</td>
<td>40</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>Call TI</td>
<td>Level-1-NA-UNLIM</td>
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<td></td>
</tr>
<tr>
<td>NE567V</td>
<td>ACTIVE</td>
<td>PDIP</td>
<td>P</td>
<td>8</td>
<td>40</td>
<td>TBD</td>
<td>Call TI</td>
<td>Level-1-NA-UNLIM</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Fall within JEDEC MS-001 variation BA.

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NOTES:

A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.

⚠️ Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0.15) each side.

⚠️ Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0.43) each side.

E. Reference JEDEC MS-012 variation AA.
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