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
Order Number LM567H or LM567CH
See NS Package Number H08C

Dual-In-Line and Small Outline Packages
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.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply Voltage Range</td>
<td>4.75</td>
<td>5.0</td>
<td>9.0</td>
</tr>
<tr>
<td>Power Supply Current Quiescent R_L = 20k</td>
<td>6</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Power Supply Current Activated R_L = 20k</td>
<td>11</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>Input Resistance</td>
<td>18</td>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>Smallest Detectable Input Voltage I_L = 100 mA, f_i = f_o</td>
<td>20</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>Largest No Output Input Voltage I_C = 100 mA, f_i = f_o</td>
<td>6</td>
<td>6</td>
<td>dB</td>
</tr>
<tr>
<td>Largest Simultaneous Outband Signal to Inband Signal Ratio</td>
<td>10</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Minimum Input Signal to Wideband Noise Ratio B_n = 140 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>
</tr>
<tr>
<td>Largest Detection Bandwidth Skew</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Largest Detection Bandwidth Variation with Temperature ±0.1</td>
<td>±0.1</td>
<td>%/°C</td>
<td></td>
</tr>
<tr>
<td>Largest Detection Bandwidth Variation with Supply Voltage 4.75–6.75V</td>
<td>±1</td>
<td>±2</td>
<td>±1</td>
</tr>
<tr>
<td>Center Frequency Stability (4.75–5.75V) 0 &lt; T_A &lt; 70</td>
<td>35 ± 60</td>
<td>35 ± 140</td>
<td>ppm/°C</td>
</tr>
<tr>
<td>Center Frequency Shift with Supply Voltage 4.75V–6.75V</td>
<td>0.5</td>
<td>1.0</td>
<td>0.4</td>
</tr>
<tr>
<td>Fastest ON-OFF Cycling Rate</td>
<td>0.01</td>
<td>25</td>
<td>0.01</td>
</tr>
<tr>
<td>Output Leakage Current</td>
<td>0.2</td>
<td>0.4</td>
<td>0.2</td>
</tr>
<tr>
<td>Output Saturation Voltage e_i = 25 mV, I_B = 30 mA</td>
<td>0.6</td>
<td>1.0</td>
<td>0.6</td>
</tr>
<tr>
<td>Output Saturation Voltage e_i = 25 mV, I_B = 100 mA</td>
<td>0.2</td>
<td>0.4</td>
<td>0.2</td>
</tr>
<tr>
<td>Output Fall Time</td>
<td>30</td>
<td>30</td>
<td>ns</td>
</tr>
<tr>
<td>Output Rise Time</td>
<td>150</td>
<td>150</td>
<td>ns</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: If 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 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

Bandwidth vs Input Signal Amplitude

Largest Detection Bandwidth

Detection Bandwidth as a Function of C2 and C3

Typical Supply Current vs Supply Voltage

Greatest Number of Cycles Before Output

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

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**Typical Applications** (Continued)

**Oscillator with Quadrature Output**

- **Input Voltage**: \( V_i \leq 200 \text{ mV} \)
- **Capacitance at Pin 2**: \( C_2 = \mu\text{F} \)

**Oscillator with Double Frequency Output**

- **Input Voltage**: \( V_i = 100 \text{ kHz} + 5\text{V} \)

**Applications Information**

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

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

The bandwidth of the filter may be found from the approximation

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

Where:

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