February 2003

National Semiconductor

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

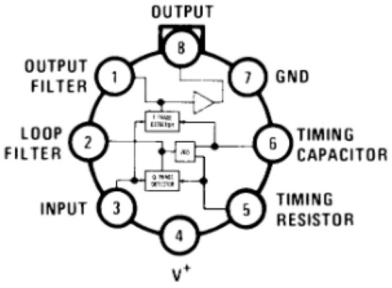
- 20 to 1 frequency range with an external resistor
- Logic compatible output with 100 mA current sinking capability
- Bandwidth adjustable from 0 to 14%
- High rejection of out of band signals and noise
- Immunity to false signals
- Highly stable center frequency
- Center frequency adjustable from 0.01 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



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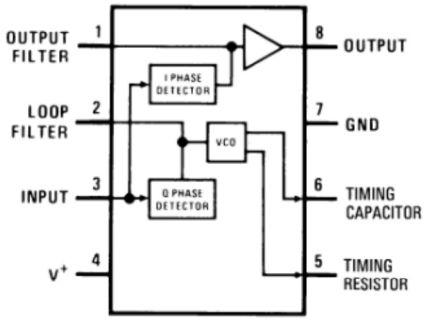
Top View
Order Number LM567H or LM567CH
See NS Package Number H08C

Dual-In-Line and Small Outline Packages



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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
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˚C, V^+ = 5V

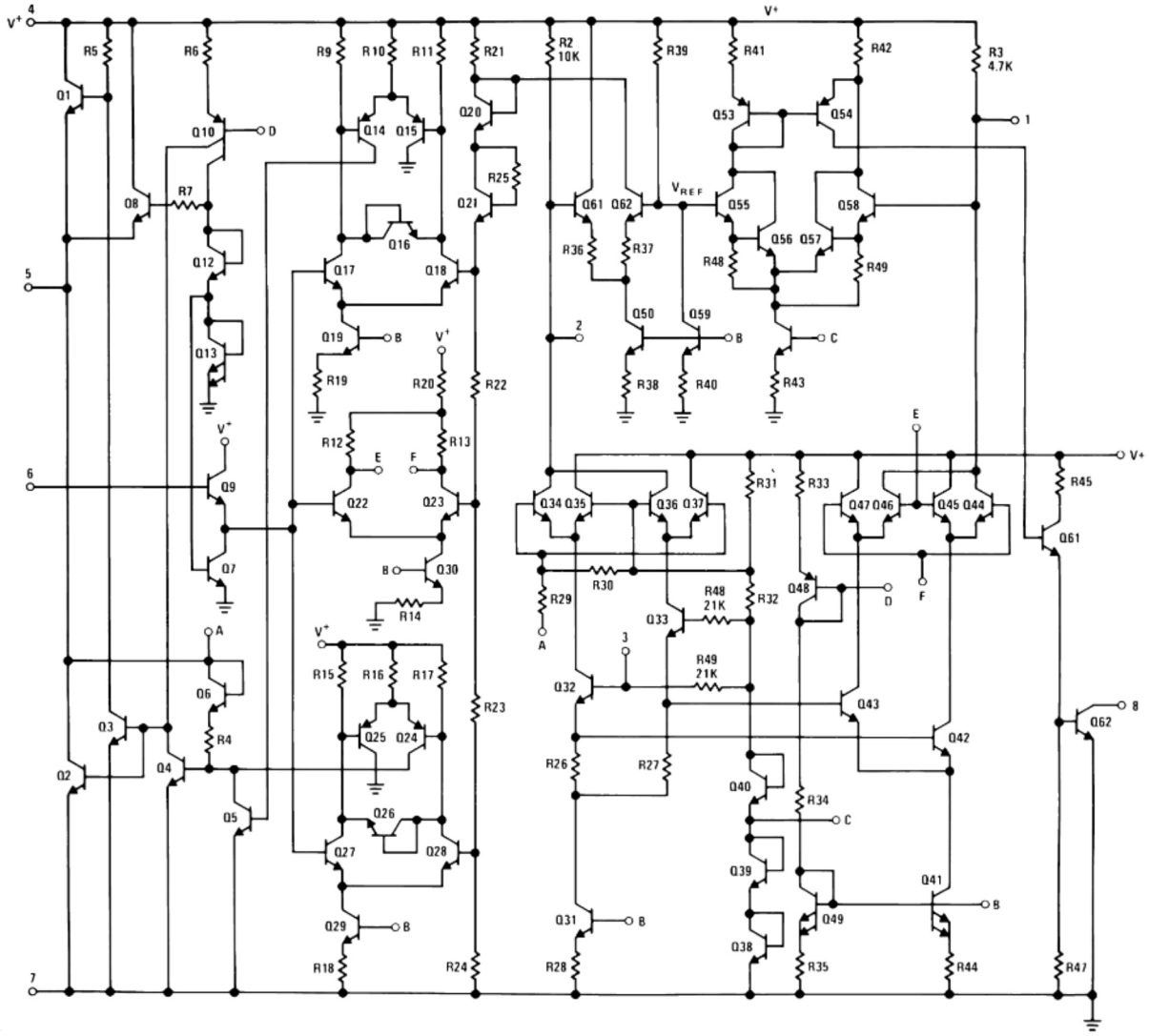
Parameters	Conditions	LM567			LM567C/LM567CM			Units
		Min	Typ	Max	Min	Typ	Max	
Power Supply Voltage Range		4.75	5.0	9.0	4.75	5.0	9.0	V
Power Supply Current Quiescent	R_L = 20k		6	8		7	10	mA
Power Supply Current Activated	R_L = 20k		11	13		12	15	mA
Input Resistance		18	20		15	20		kΩ
Smallest Detectable Input Voltage	I_L = 100 mA, $f_i = f_o$		20	25		20	25	mVrms
Largest No Output Input Voltage	I_C = 100 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 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			±0.1			±0.1		%/˚C
Largest Detection Bandwidth Variation with Supply Voltage	4.75–6.75V		±1	±2		±1	±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 ± 60 35 ± 140			35 ± 60 35 ± 140		ppm/˚C ppm/˚C
Center Frequency Shift with Supply Voltage	4.75V–6.75V 4.75V–9V		0.5	1.0 2.0		0.4	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	µA
Output Saturation Voltage	e_i = 25 mV, I_8 = 30 mA e_i = 25 mV, I_8 = 100 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.

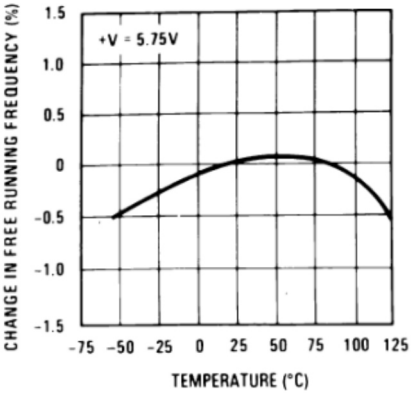
Note 3: Refer to RETS567X drawing for specifications of military LM567H version.

Schematic Diagram



Typical Performance Characteristics

Typical Frequency Drift



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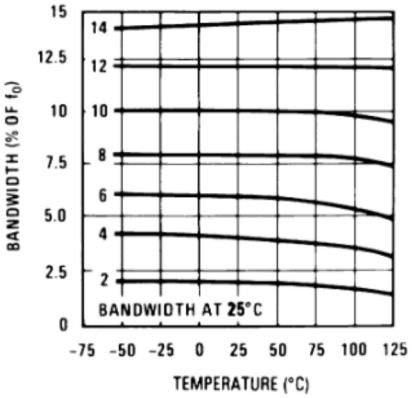
Typical Bandwidth Variation



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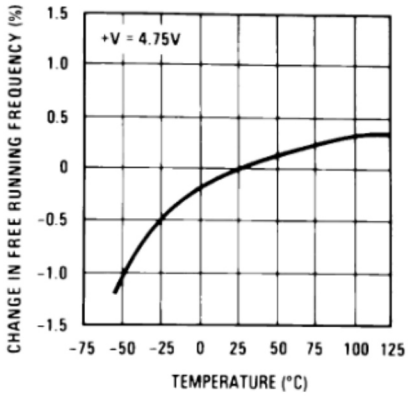
Typical Frequency Drift



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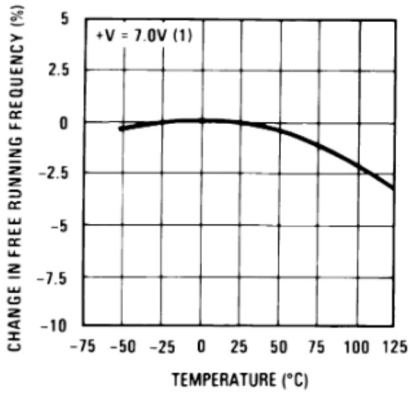
Typical Frequency Drift



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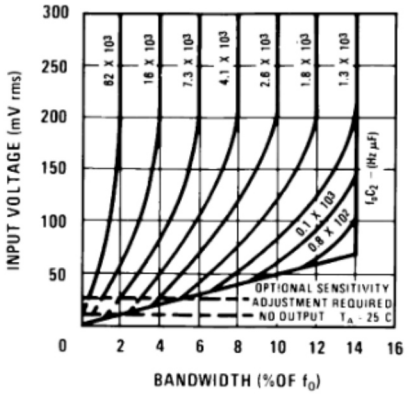
Bandwidth vs Input Signal Amplitude



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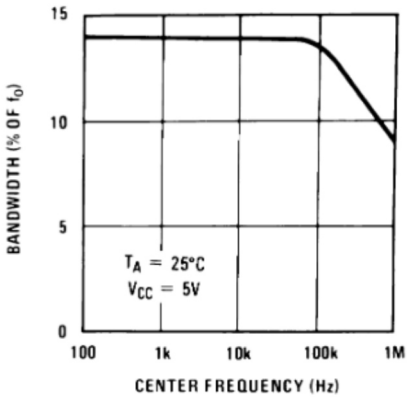
Largest Detection Bandwidth



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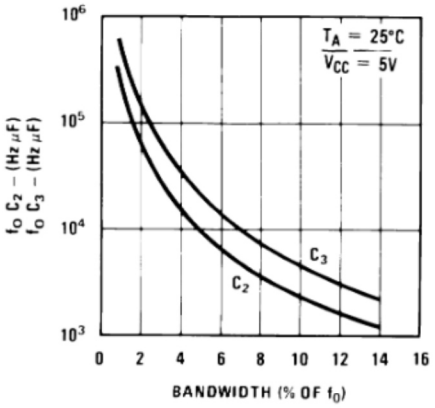
Typical Performance Characteristics (Continued)

Detection Bandwidth as a Function of C_2 and C_3



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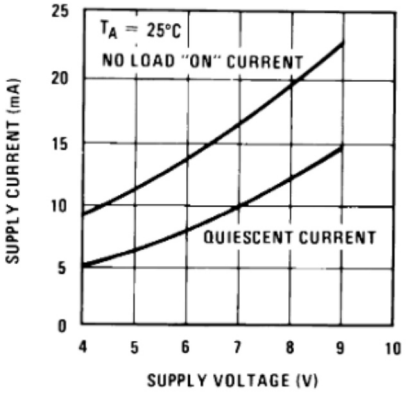
Typical Supply Current vs Supply Voltage



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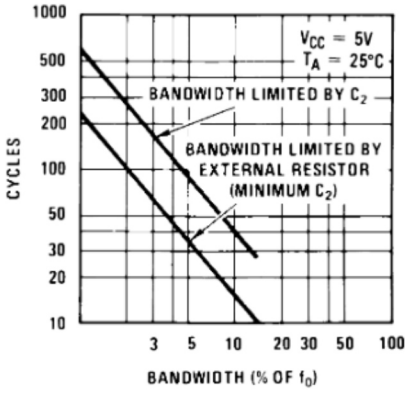
Greatest Number of Cycles Before Output



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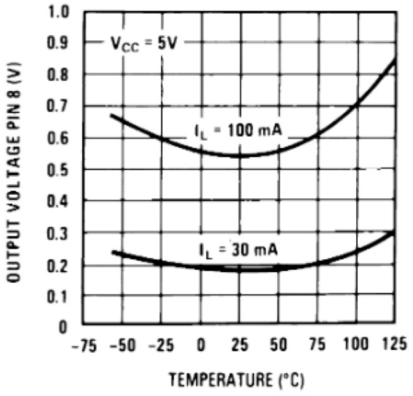
Typical Output Voltage vs Temperature



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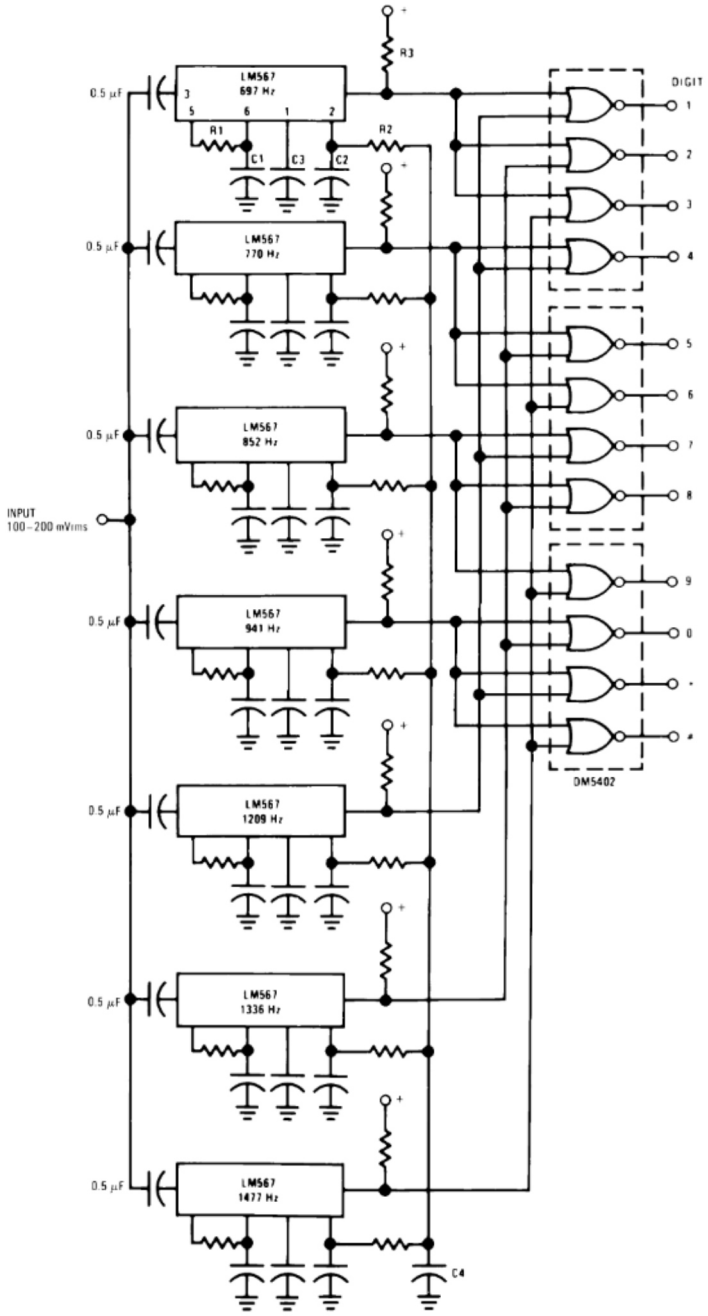
Typical Applications

Touch-Tone Decoder



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Component values (typ)

R1 6.8 to 15k

R2 4.7k

R3 20k

C1 0.10 mfd

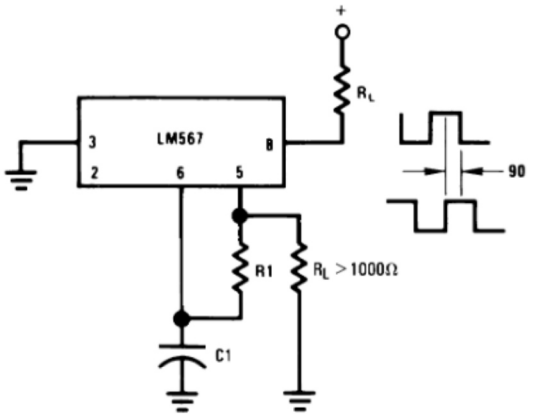
C2 1.0 mfd 6V

C3 2.2 mfd 6V

C4 250 mfd 6V

Typical Applications (Continued)

Oscillator with Quadrature Output



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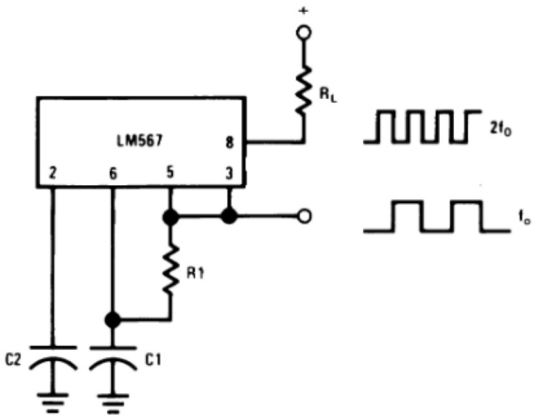
Connect Pin 3 to 2.8V to Invert Output

Oscillator with Double Frequency Output



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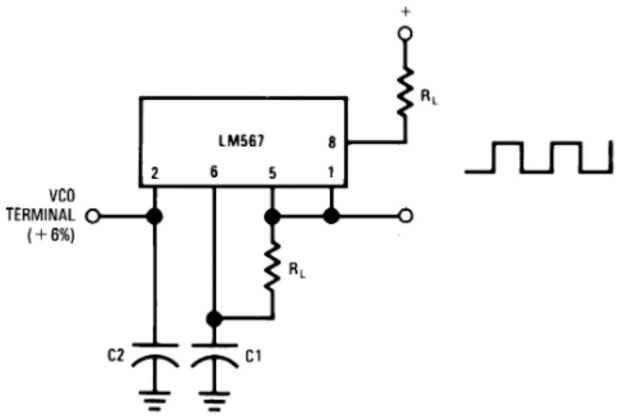
Precision Oscillator Drive 100 mA Loads



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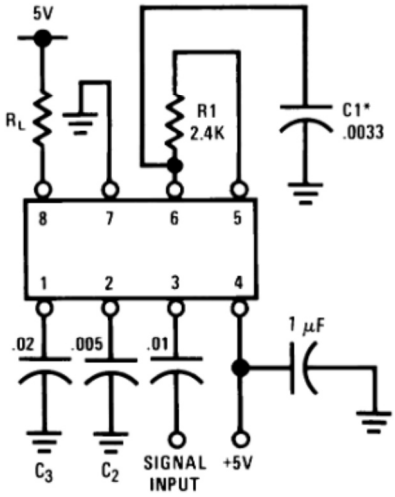
AC Test Circuit



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f_i = 100 kHz + 5V

***Note:** Adjust for f_o = 100 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

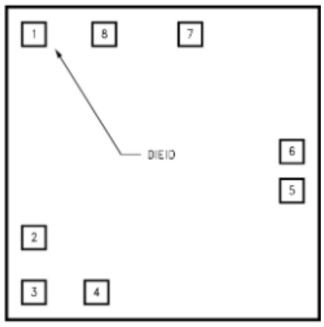
$$BW = 1070 \sqrt{\frac{V_i}{f_o C_2}} \text{ in \% of } f_o$$

Where:

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

C_2 = Capacitance at Pin 2(μF)

LM567C MDC MWC
TONE DECODER



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Die Layout (C - Step)

DIE/WAFER CHARACTERISTICS

Fabrication Attributes		General Die Information	
Physical Die Identification	LM567C	Bond Pad Opening Size (min)	91µm x 91µm
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)	1600µm x 1626µm 63.0mils x 64.0mils	Back Side Connection	Floating
Thickness	406µm Nominal		
Min Pitch	198µm 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 µm) NC = No Connection, N.U. = Not Used						
SIGNAL NAME	PAD# NUMBER	X/Y 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