



## Overview

The LC7387M is a DTMF signal detection receiver IC for use in telephone answering machines. It includes the filters required for DTMF signal detection on chip.

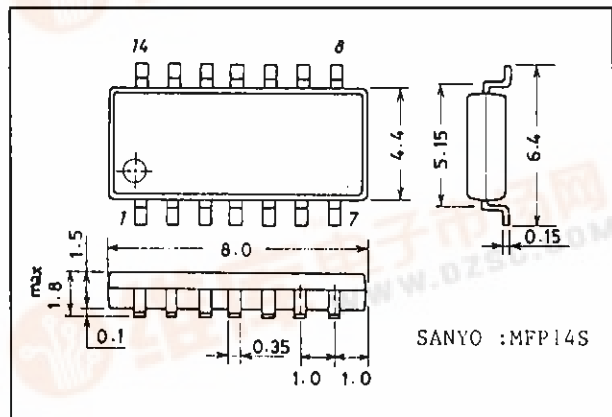
## Features

- Detects all 16 DTMF signals.
- Includes on-chip all filters required in a DTMF receiver.
  - Dial tone filter
  - High frequency group band pass filter
  - Low frequency group band pass filter
- Extended dynamic range
- Serial data output
- Supports microprocessor control guard time.
- Operating supply voltage range: 4.5 to 5.5 V
- Supports a low power mode that allows current dissipation to be reduced.
- Serial output data can be read out multiple times.

## Package Dimensions

unit: mm

3111-MFP14S



## Specifications

Absolute Maximum Ratings at  $T_a = 25^\circ\text{C}$

Parameter	Symbol	Condition	Rating	Unit
Maximum supply voltage	$V_{DD\ max}$		-0.3 to +6.0	V
Maximum input voltage	$V_{IN\ max}$		-0.3 to $V_{DD} + 0.3$	V
Maximum input current	$I_{IN\ max}$		-10 to +10	mA
Maximum output voltage	$V_{OUT\ max}$		-0.3 to $V_{DD} + 0.3$	V
Power dissipation	$P_d\ max$	$T_a \leq 85^\circ\text{C}$	300	mW
Operating temperature	$T_{opr}$		-40 to +85	$^\circ\text{C}$
Storage temperature	$T_{stg}$		-50 to +125	$^\circ\text{C}$

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### Allowable Operating Ranges at $T_a = -40$ to $+85^\circ\text{C}$ , $V_{SS} = 0$ V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Operating supply voltage	$V_{DD}$		4.5		5.5	V
High level input voltage	$V_{IH}$	Pins ACK and LOAD	$0.7 V_{DD}$			V
		Pin PD	$0.85 V_{DD}$			V
Low level input voltage	$V_{IL}$	Pins ACK and LOAD			$0.3 V_{DD}$	V
		Pin PD			$0.15 V_{DD}$	V

### DC Electrical Characteristics at $T_a = 25 \pm 2^\circ\text{C}$ , $V_{DD} = 5$ V, $V_{SS} = 0$ V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Operating supply current	$I_{DD}(op)$			3	7	mA
Standby supply current	$I_{DD}(st)$	Pin PD = 5 V			10	$\mu\text{A}$
High level output current	$I_{OH}$	$V_{OUT} = 4.6$ V; Pins SD, EST, and STD		-0.8	-0.4	mA
Low level output current	$I_{OL}$	$V_{OUT} = 0.4$ V; Pins SD, EST, and STD	1.0	2.5		mA
Input impedance	$Z_{in}$	Pin INPUT	10			k $\Omega$

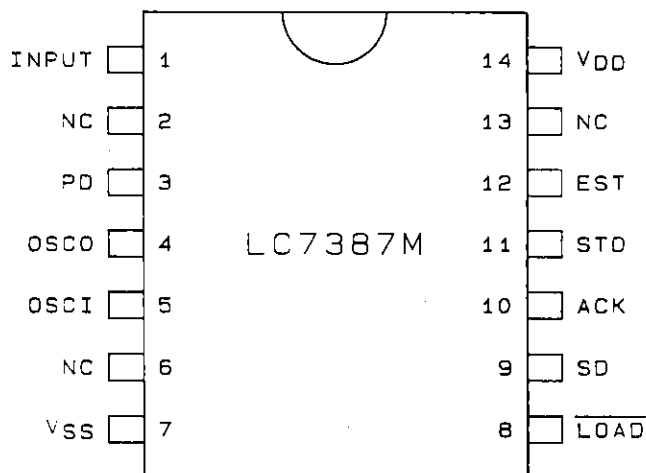
### AC Electrical Characteristics at $T_a = 25^\circ\text{C}$ , $V_{DD} = 5$ V, $V_{SS} = 0$ V, $f_{OSC} = 4.194304$ MHz

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Valid input signal level		Conditions: 1, 2, 3, 5, 6, 9	-45		0	dBm
Positive twist accept		Conditions: 2, 3, 6, 9, 11		10		dB
Frequency detection accept		Conditions: 2, 3, 5, 9	$\pm 1.5\% \pm 2$			Hz
Frequency non-detection accept		Conditions: 2, 3, 5	$\pm 3.5$			%
Third tone tolerance		Conditions: 2, 3, 4, 5, 9, 10		-16		dB
Dial tone tolerance		Conditions: 2, 3, 4, 5, 8, 9, 10		22		dB
Noise tolerance		Conditions: 2, 3, 4, 5, 8, 9, 10		-12		dB
Tone present detection time	$t_{DP}$	See the timing charts	3		20	ms
Tone absent detection time	$t_{DA}$	See the timing charts	0.5		20	ms
Tone duration accept	$t_{REC}$	See the timing charts	20			ms
Tone duration reject	$t_{REC}$	See the timing charts			45	ms
Inter-digit pause accept	$t_{DO}$	See the timing charts	20			ms
Inter-digit pause reject	$t_{ID}$	See the timing charts			40	ms
Data shift speed					1	MHz
Data output delay time	$t_{PAD}$	See the timing charts		100		ns
Set up time delay	$t_{DL}$	See the timing charts	0			ns
Data hold time	$t_{DH}$	See the timing charts	30			ns
Oscillator frequency	$f_{OSC}$		4.152362	4.194304	4.236247	MHz
Load capacitance	$C_{XO}$	Pins OSC1 and OSC0			30	pF

- Notes: 1. The 0 dBm level is defined to be a 1 mW output into a 600  $\Omega$  load.  
 2. All 16 DTMF signals frequency  
 3. For a 40 ms DTMF signal period and a 40 ms pause period  
 4. Nominal DTMF frequency  
 5. Low group and high group signal levels are the same.  
 6. DTMF signal frequency deviations within  $\pm 1.5\%$  and  $\pm 2$  Hz  
 7. Bandwidth limited (0 to 3 kHz) Gaussian noise  
 8. 350 and 440 Hz dial tone frequencies  
 9. Error rate of less than 1 in 10,000  
 10. Referenced to the lowest component of the DTMF signal.  
 11. Twist = High-frequency group tone level + Low-frequency group tone level.

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### Pin Assignment



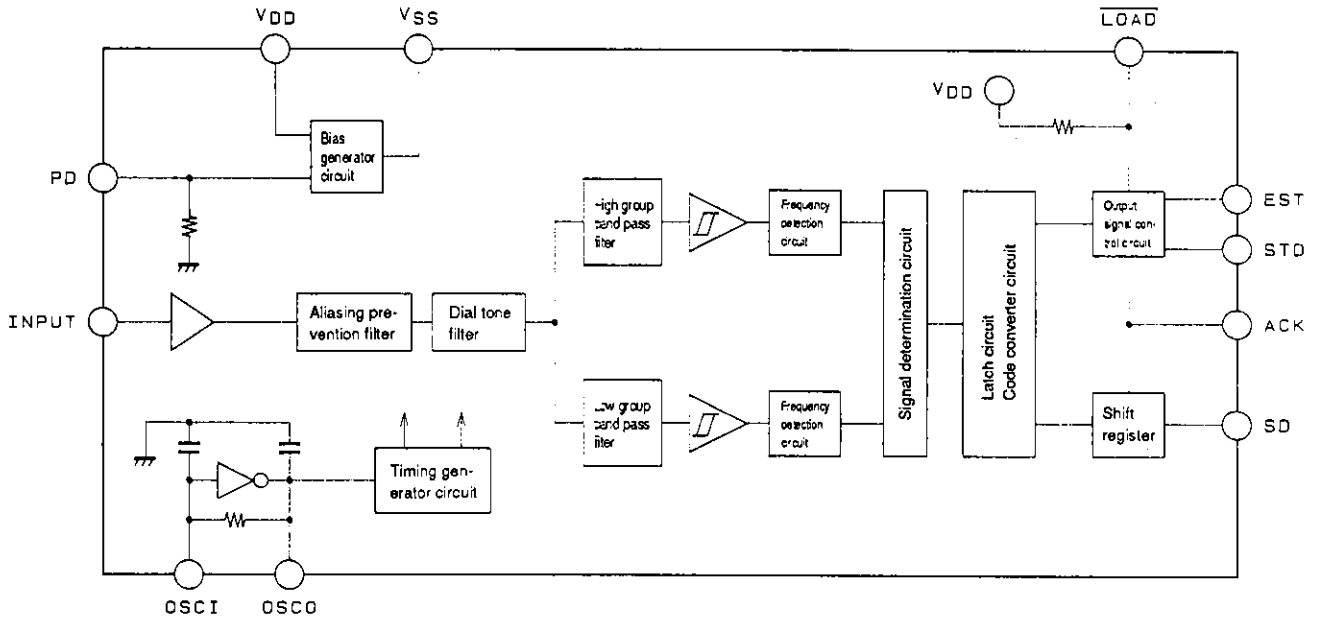
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### Pin Functions

Pin No.	Symbol	I/O	Function
1	INPUT	I	An input coupling capacitor is required. Biased to $V_{DD}/2$ internally.
2	NC		No connection
3	PD	I	The IC goes to low power mode when this pin is pulled high.
4	OSCO	O	Connect a 4.194304 MHz crystal oscillator or ceramic resonator to these pins to form an oscillator circuit.
5	OSCI	I	When using a ceramic resonator, a capacitor of approximately 30 pF must be connected to each pin.
6	NC		No connection
7	$V_{SS}$		Power supply pin: Normally 0 V.
8	LOAD	I	Inputting a clock to this pin allows the serial data to be output two or more times.
9	SD	O	The decoded DTMF signal is output, this pin in a 4-bit LSB first format.
10	ACK	I	The ACK pin is used to shift out data from the SD pin. Four pulses are required to shift out the DTMF character, which consists of 4 bits. The rising edge of the first pulse latches the data (before shifting) into the shift register.
11	STD	O	A high level indicates the presence of a DTMF signal. The rise of this signal is delayed with respect to that of the EST signal, but it is less sensitive to burst waveforms and other anomalies.
12	EST	O	A high level indicates the presence of a DTMF signal. Monitor this pin externally, and after an appropriate waiting time has passed, apply 4 pulses to the ACK pin to access the data.
13	NC		No connection
14	$V_{DD}$		Power supply pin: normally 4.5 to 5.5 V

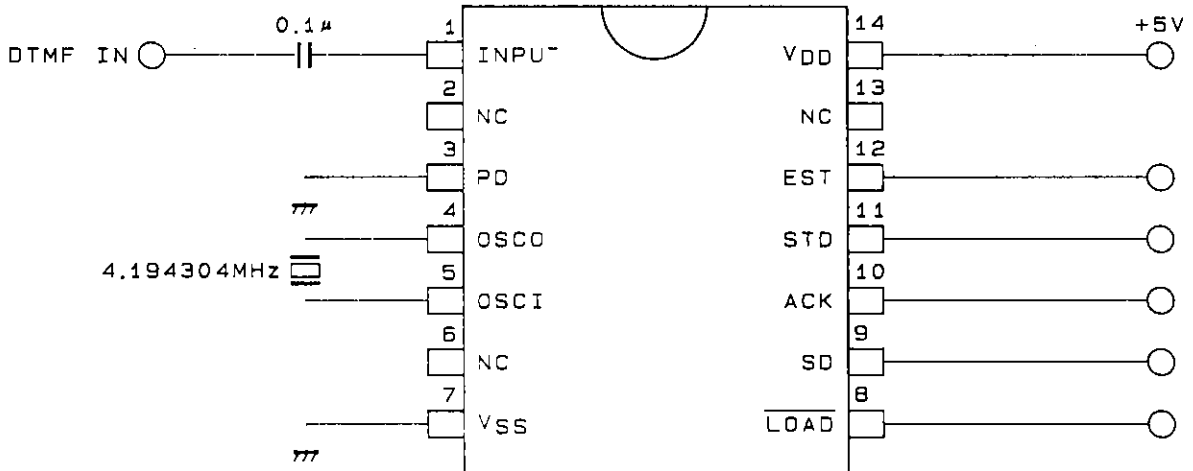
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## Equivalent Circuit Block Diagram



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## Test Circuit/Application Circuit Example



Unit (capacitance: F)

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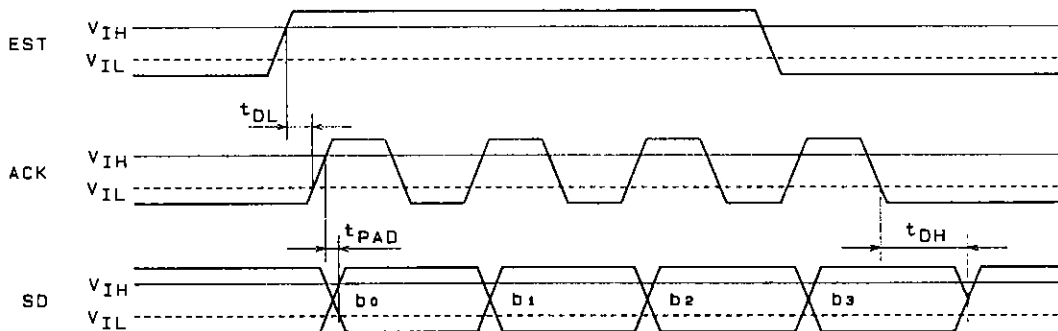
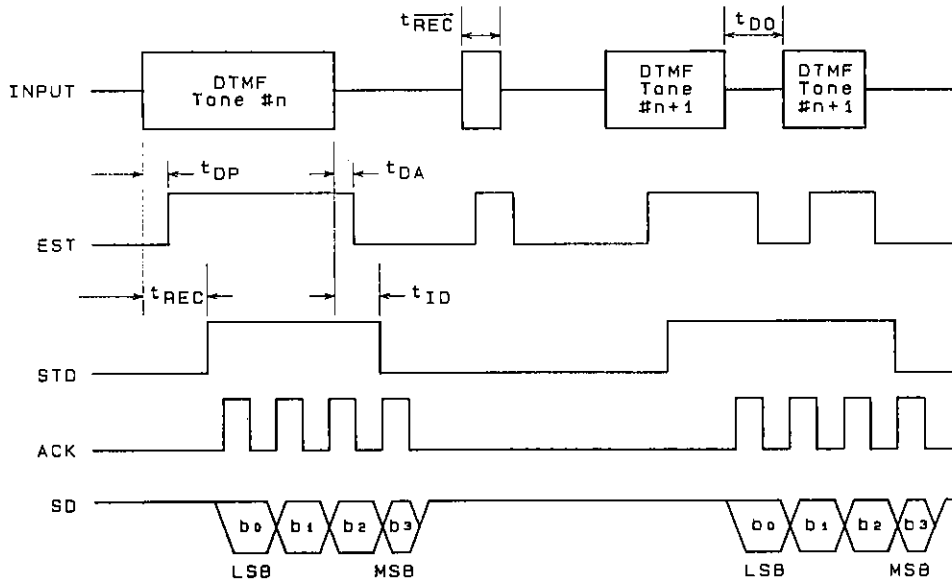
Output Code Table

F <sub>L</sub>	F <sub>H</sub>	KEY	b3	b2	b1	b0
697	1209	1	L	L	L	H
697	1336	2	L	L	H	L
697	1477	3	L	L	H	H
770	1209	4	L	H	L	L
770	1336	5	L	H	L	H
770	1477	6	L	H	H	L
852	1209	7	L	H	H	H
852	1336	8	H	L	L	L
852	1477	9	H	L	L	H
941	1336	0	H	L	H	L
941	1209	*	H	L	H	H
941	1477	#	H	H	L	L
697	1633	A	H	H	L	H
770	1633	B	H	H	H	L
852	1633	C	H	H	H	H
941	1633	D	L	L	L	L

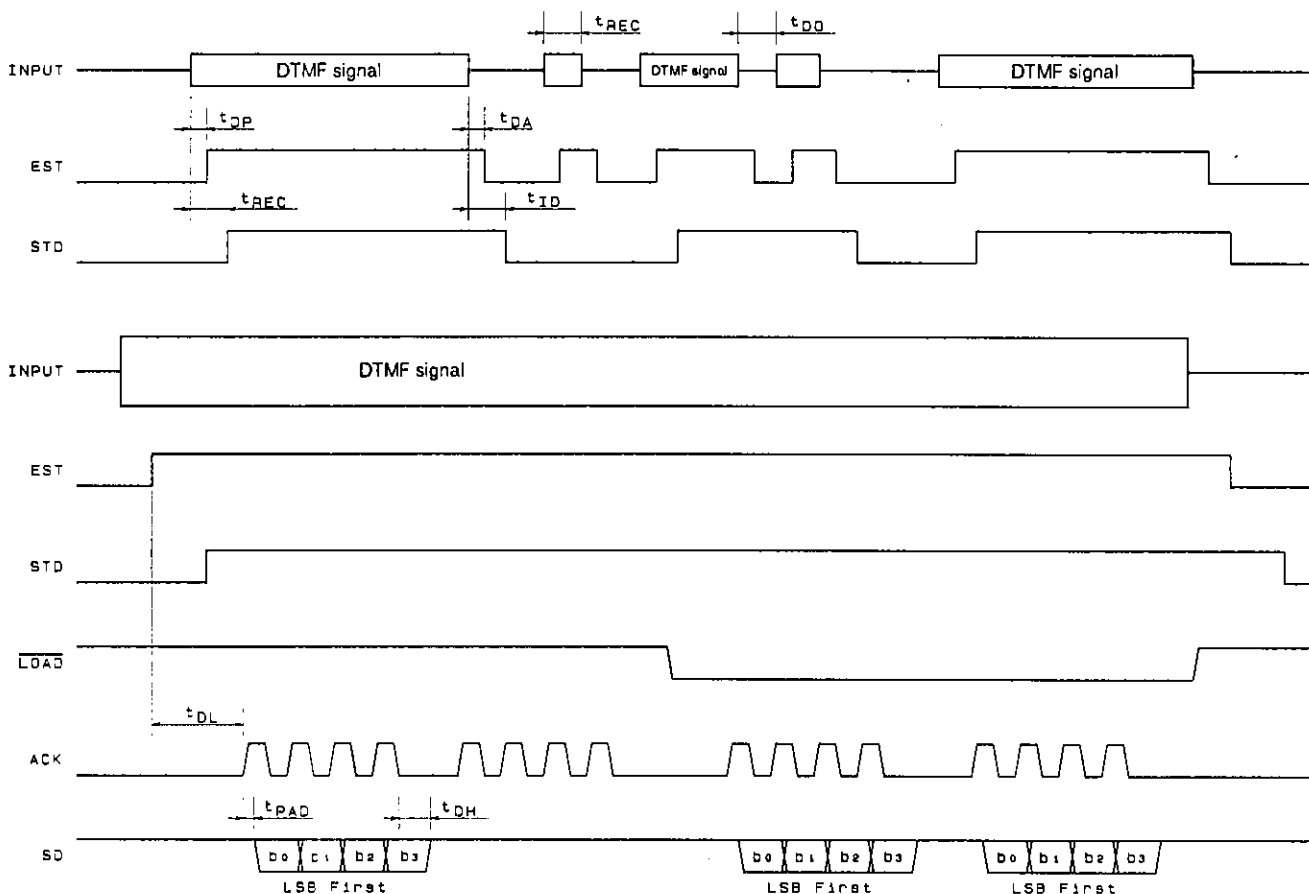
DTMF Dialing Matrix

	C1	C2	C3	C4
R1	1	2	3	A
R2	4	5	6	B
R3	7	8	9	C
R4	*	0	#	D

Timing Charts



## Serial Data Read Out Timing for Second and Later Accesses



A01054

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