



# LC73881M

## DTMF Receiver LSI

### Applications

- Remote controllers for telephone answering machines and other telephone products

### Features

- Detects 16 DTMF signals.
- Includes on-chip all filters required in a DTMF receiver
  - Dial-tone filter
  - High-frequency group bandpass filter
  - Low-frequency group bandpass filter
- Serial data output
- Supports microprocessor-controlled guard times.
- Wide operating power-supply voltage range: 2.7 to 5.5 V
- Supports a low power mode that allows current dissipation to be reduced.

### Specifications

#### Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	$V_{DD \text{ max}}$		-0.3 to +6.0	V
Input voltage	$V_{IN}$		-0.3 to $V_{DD} + 0.3$	V
Input current	$I_{IN}$		-10 to +10	mA
Output voltage	$V_{OUT}$		-0.3 to $V_{DD} + 0.3$	V
Allowable power dissipation	$P_{d \text{ max}}$	$T_a \leq 70^\circ\text{C}$	120	mW
Operating temperature	$T_{opr}$		-35 to +70	°C
Storage temperature	$T_{stg}$		-50 to +125	°C

#### Allowable Operating Ranges at Ta = -35 to +70°C, V<sub>SS</sub> = 0 V

Parameter	Symbol	Conditions	min	typ	max	Unit
Operating supply voltage	$V_{DD}$		2.7		5.5	V
Input high-level voltage	$V_{IH}$	Pin 7	$0.7 V_{DD}$			V
		Pin 2	$0.85 V_{DD}$			V
Input low-level voltage	$V_{IL}$	Pin 7			$0.3 V_{DD}$	V
		Pin 2			$0.15 V_{DD}$	V

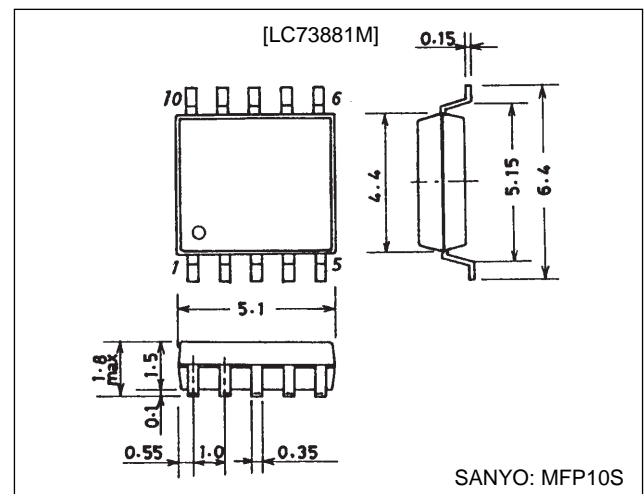
#### DC Electrical Characteristics at Ta = 25°C, V<sub>DD</sub> = 3 V, V<sub>SS</sub> = 0 V

Parameter	Symbol	Conditions	min	typ	max	Unit
Operating supply current	$I_{DD \text{ (op)}}$			1.6	2.8	mA
Standby supply current	$I_{DD \text{ (st)}}$	PD pin = 3 V			20	μA
Output high-level current	$I_{OH}$	Pins 6, 8 and 9, $V_{OUT} = 2.6 \text{ V}$			-0.3	mA
Output low-level current	$I_{OL}$	Pins 6, 8 and 9, $V_{OUT} = 0.4 \text{ V}$	0.6			mA
Input impedance	$Z_{in}$	Pin 1	10			kΩ
Pull-down resistor current	$I_{SI}$	PD = 3 V		1.2	3.0	μA

### Package Dimensions

unit: mm

3086A-MFP10S



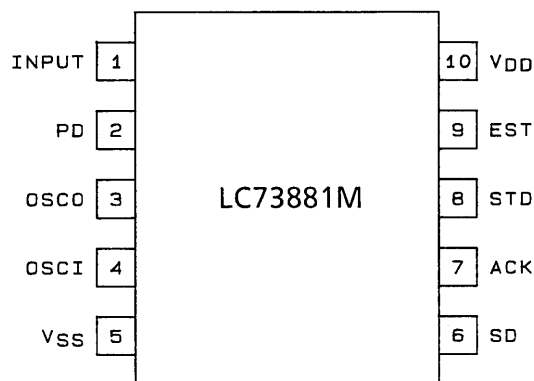
## LC73881M

### AC Electrical Characteristics at $T_a = 25^\circ\text{C}$ , $V_{DD} = 3\text{ V}$ , $V_{SS} = 0\text{ V}$ , $f_{OSC} = 4.194304\text{ MHz}$

Parameter	Symbol	Conditions	min	typ	max	Unit
Input signal valid level	—	*1, 2, 3, 5, 6, 9	-45		-20	dBm
Positive twist accept	—	*2, 3, 6, 9, 11		±10		dB
Frequency detection accept	—	*2, 3, 5, 9	±1.5% ± 2			Hz
Frequency rejection accept	—	*2, 3, 5	±3.5			%
Third tone tolerance	—	*2, 3, 4, 5, 9, 10		-16		dB
Dial tone tolerance	—	*2, 3, 4, 5, 8, 9, 10		+22		dB
Noise tolerance	—	*2, 3, 4, 5, 7, 9, 10		-8		dB
Tone present detection time	$t_{DP}$	See the timing chart.	3		20	ms
Tone absent detection time	$t_{DA}$	See the timing chart.	0.5		20	ms
Tone duration accept	$t_{REC}$	See the timing chart.			20	ms
Tone duration reject	$t_{REC}$	See the timing chart.	45			ms
Inter-digit pause invalid time	$t_{DO}$	See the timing chart.			20	ms
Inter-digit pause valid time	$t_{ID}$	See the timing chart.	40			ms
Data shift speed	—				1	MHz
Data output delay time	$t_{PAD}$	See the ACK/SD timing chart		100		ns
Setup time delay	$t_{DL}$	See the ACK/SD timing chart	4			µs
Data hold time	$t_{DH}$	See the ACK/SD timing chart	30			ns
Oscillator frequency	$f_{OSC}$		4.190109	4.194304	4.198498	MHz
Load capacitance	$C_{XO}$	The OSC1 and OSC0 pins			30	pF

- Note: 1. The dBm values are defined such that 0 dBm is the 1 mW power level for a 600 Ω load.  
 2. All 16 DTMF signals frequency  
 3. With a 40 ms DTMF signal period and a 40 ms pause period  
 4. Nominal DTMF signal frequencies  
 5. Low-group and high-group signal levels are the same.  
 6. DTMF signal frequency deviations within ±1.5% ± 2 Hz  
 7. Gaussian noise with a 0 to 3 kHz bandwidth  
 8. 350 and 440 Hz dial tone frequencies  
 9. Error rate of less than 1 error in 10,000 events  
 10. Referenced to the lowest component of the DTMF signal.  
 11. Twist =  $\frac{\text{High-frequency group tone level}}{\text{Low-frequency group tone level}}$

### Pin Assignment



Top view

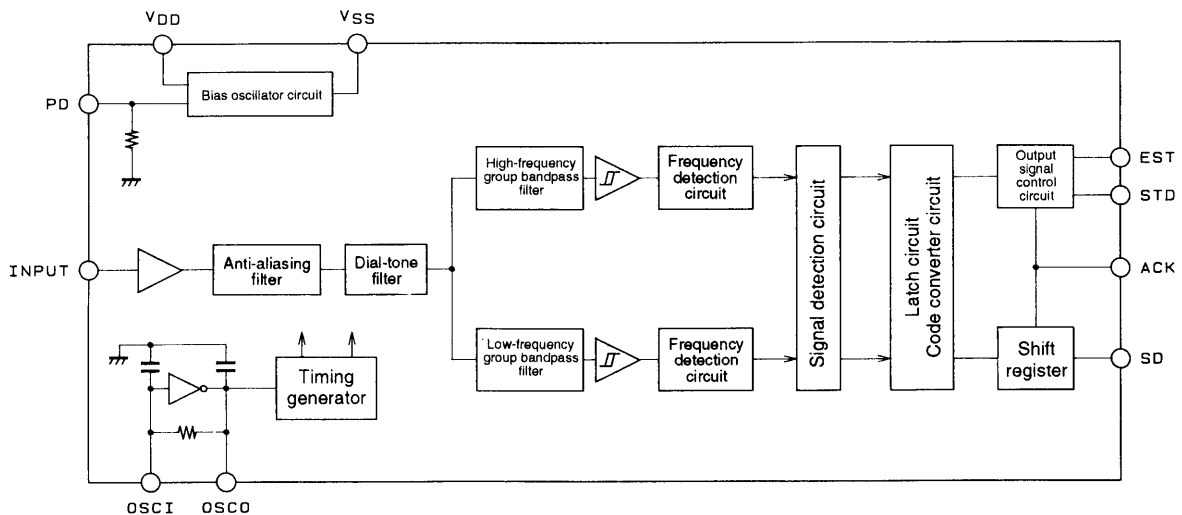
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## LC73881M

### Pin Functions

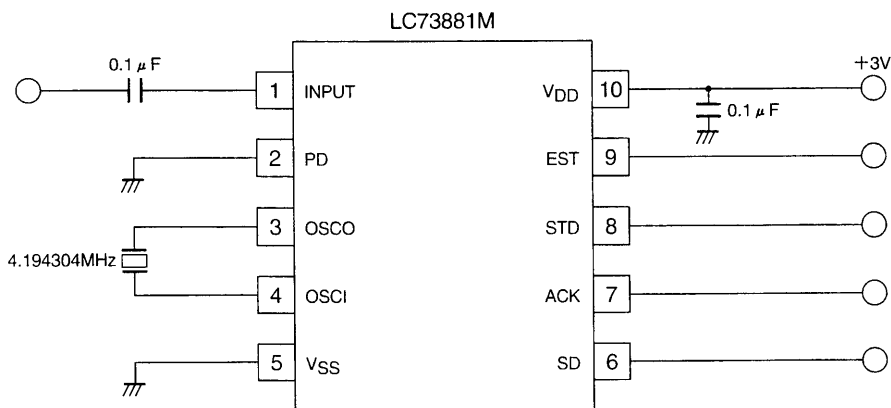
Pin No.	Symbol	I/O	Function
1	INPUT	I	The input must be capacitor coupled. This signal is biased to $V_{DD}/2$ internally.
2	PD	I	The LC73881M goes to low power mode when this pin is set high.
3	OSCO	O	Connect a 4.194304 MHz crystal oscillator or ceramic resonator to these pins to form an oscillator circuit. When using a ceramic resonator, a capacitor of approximately 30 pF must be connected to each pin.
4	OSCI	I	
5	$V_{SS}$		Power supply pin. Normally 0 V.
6	SD	O	The decoded DTMF signal is output, this pin in a 4-bit LSB first format.
7	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 four bits. The rising edge of the first pulse latches the data (before shifting) into the shift register.
8	STD	O	A high level indicates the presence of a DTMF signal. Although the rise of this signal is later than that of the EST pin, it is less sensitive to burst waveforms and other noise.
9	EST	O	A high level indicates the presence of a DTMF signal. Applications should monitor this pin and, after waiting an appropriate period, apply four pulses to the ACK pin to access the data.
10	$V_{DD}$		Power supply pin. Normally 2.7 to 5.5 V.

### Block Diagram



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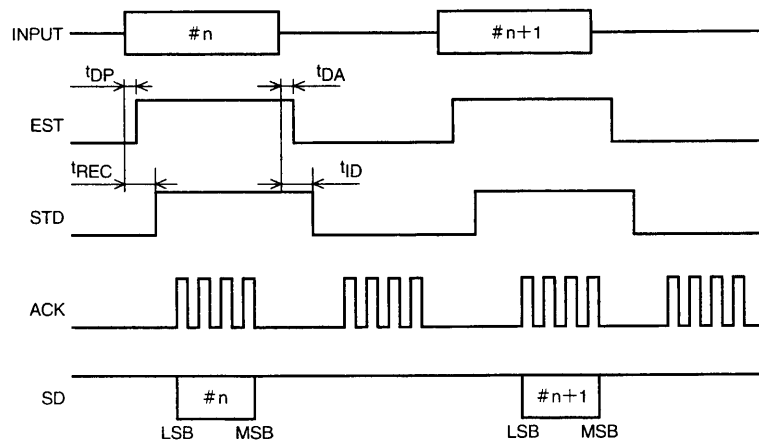
### Test Circuit, Sample Application Circuit



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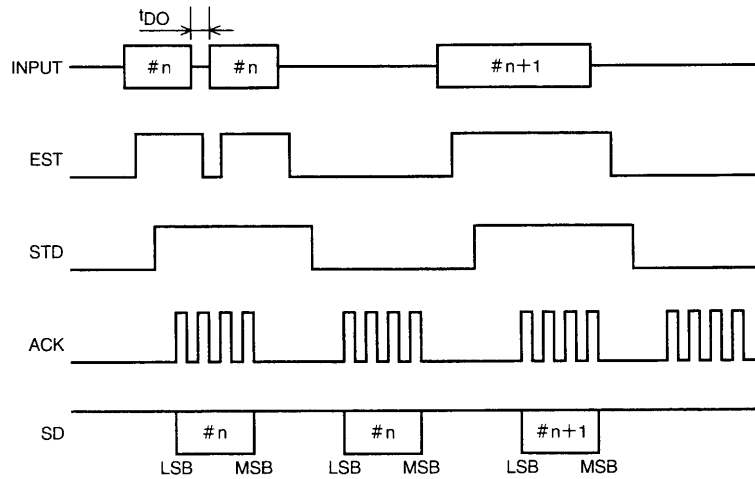
Timing Chart

Normal State Timing Chart



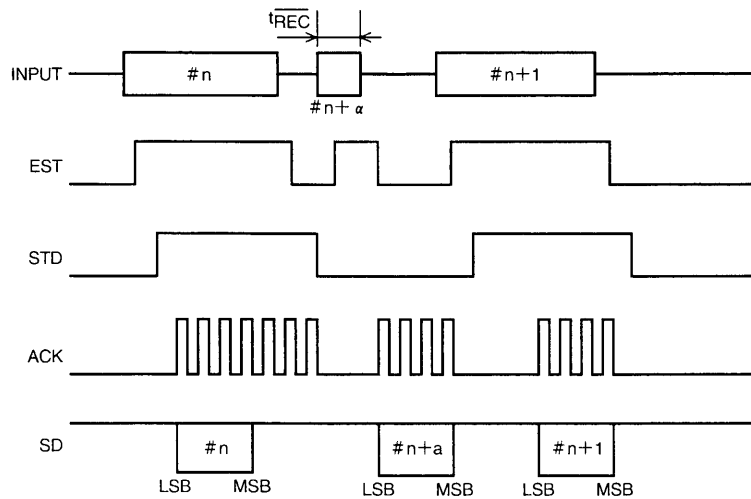
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When the DTMF signal (#n) is split due to, for example, the burst signal



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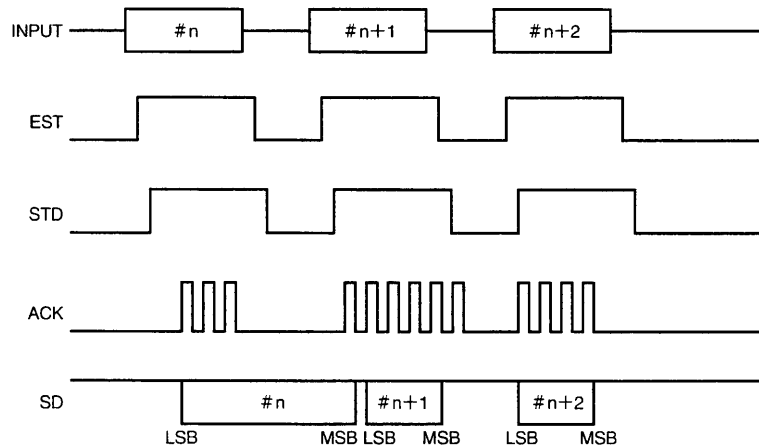
When noise (#n+a) similar to a DTMF signal is input



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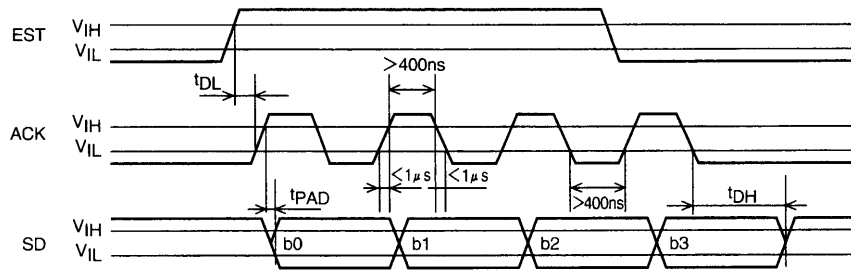
When the data output is disrupted due to input clock displacement.



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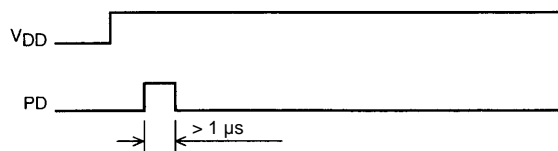
Data is output from the SD pin after 4 pulses are input to the ACK pin. However, note that if 5 or more pulses are input between one rising edge on the EST pin and the next rising edge on the EST pin, the fifth and later pulses will be ignored.

### ACK/SD Timing Chart



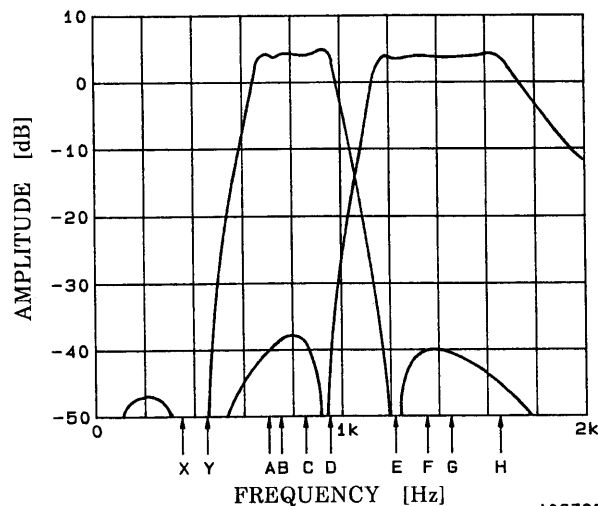
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### Reset Timing at Power On



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### Filter Characteristics



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**PRECISE  
DIAL TONES**

X = 350Hz  
Y = 440Hz

**DTMF TONES**

A = 697Hz  
B = 770Hz  
C = 852Hz  
D = 941Hz  
E = 1209Hz  
F = 1336Hz  
G = 1477Hz  
H = 1633Hz

**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

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