

**SANYO**

No. 4998

**LC73872M****DTMF Receiver**

## Overview

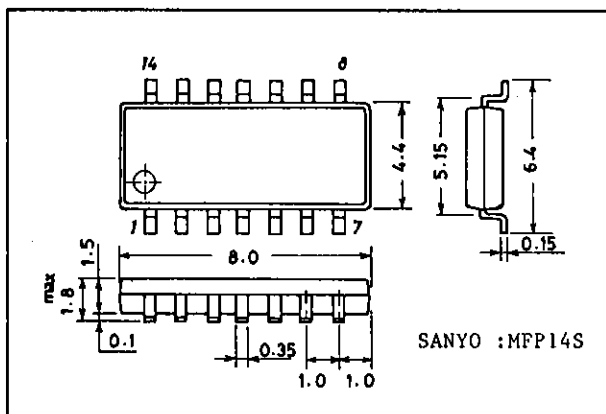
The LC73872M is a DTMF signal detection receiver IC for use in telephone answering machines. It includes the filters required for DTMF signal detection on chip.

## 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
- On-chip AGC circuit provides wide dynamic range.
- Serial data output
- 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.
- 3.579545 MHz oscillator
- 14-pin mini-flat package (MFP-14S)

## Package Dimensions

unit: mm

**3111-MFP14S**

## Specifications

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

| Parameter              | Symbol         | Conditions                  | Ratings                | 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      | $P_d\ max$     | $T_a \leq 85^\circ\text{C}$ | 120                    | mW   |
| Operating temperature  | $T_{opr}$      |                             | -40 to +85             | °C   |
| Storage temperature    | $T_{stg}$      |                             | -50 to +125            | °C   |

**SANYO Electric Co., Ltd. Semiconductor Business Headquarters**

TOKYO OFFICE Tokyo Bldg., 1-10, 1 Chome, Ueno, Taito-ku, TOKYO, 110 JAPAN

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

| Parameter                | Symbol    | Conditions        | Ratings       |        |               | Unit |
|--------------------------|-----------|-------------------|---------------|--------|---------------|------|
|                          |           |                   | min           | typ    | max           |      |
| Operating supply voltage | $V_{DD}$  |                   | 4.5           |        | 5.5           | V    |
| Input high level voltage | $V_{IH}$  | Pins ACK and LOAD | $0.7 V_{DD}$  |        |               | V    |
|                          |           | Pin PD            | $0.85 V_{DD}$ |        |               | V    |
| Input low level voltage  | $V_{IL}$  | Pins ACK and LOAD |               |        | $0.3 V_{DD}$  | V    |
|                          |           | Pin PD            |               |        | $0.15 V_{DD}$ | V    |
| Oscillator frequency     | $f_{OSC}$ |                   | 3.5759        | 3.5795 | 3.5831        | MHz  |

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

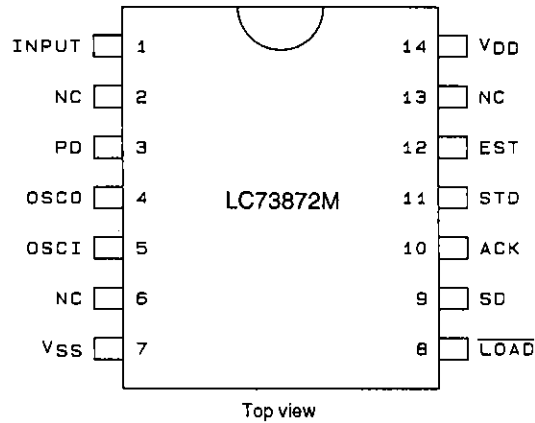
| Parameter                 | Symbol       | Conditions                                       | Ratings |      |      | Unit          |
|---------------------------|--------------|--------------------------------------------------|---------|------|------|---------------|
|                           |              |                                                  | 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 | $I_{OH}$     | $V_{OUT} = 4.6\text{ V}$ ; Pins SD, EST, and STD |         | -0.8 | -0.4 | mA            |
| Low level output current  | $I_{OL}$     | $V_{OUT} = 0.4\text{ V}$ ; Pins SD, EST, and STD | 1.0     | 2.5  |      | mA            |
| Input impedance           | $Z_{in}$     | Pin INPUT                                        | 10      |      |      | k $\Omega$    |

**AC Electrical Characteristics at  $T_a = 25^\circ\text{C}$ ,  $V_{DD} = 5\text{ V}$ ,  $V_{SS} = 0\text{ V}$ ,  $f_{OSC} = 3.579545\text{ MHz}$** 

| 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       |             | 6       |      | 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, 7, 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   |
| Guard time (present)           | $t_{GTP}$ | See the timing charts.           | 32.2        |         | 32.3 | ms   |
| Guard time (absent)            | $t_{GTA}$ | See the timing charts.           | 20.1        |         | 20.2 | 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   |
| Setup time delay               | $t_{DL}$  | See the timing charts.           | 0           |         |      | ns   |
| Data hold time                 | $t_{DH}$  | See the timing charts.           | 30          |         |      | ns   |
| 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  $\pm 2\text{ Hz}$   
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.

## Pin Assignment

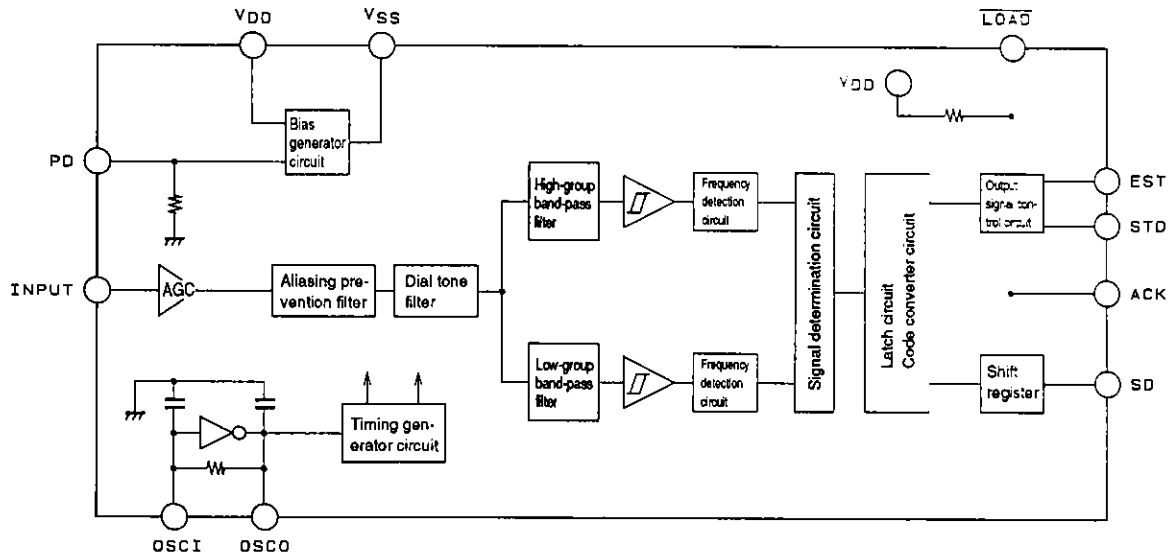


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## Pin Functions

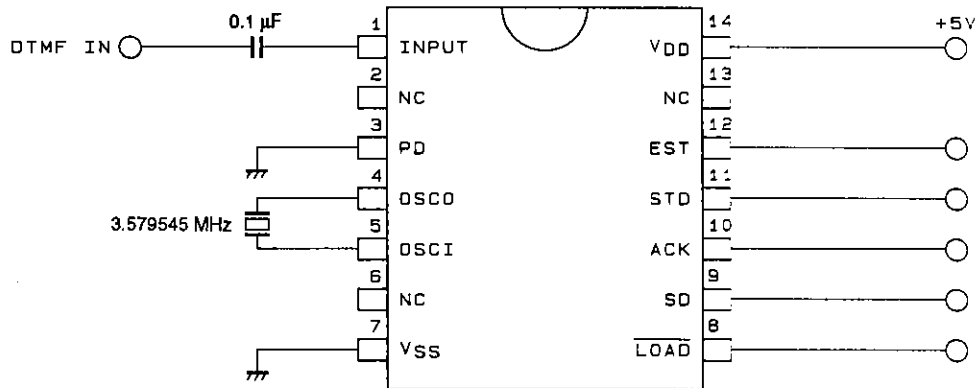
| Pin No. | Symbol   | I/O | Function                                                                                                                                                                                                                                                            |
|---------|----------|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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 3.579545 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.                                                       |
| 5       | OSCI     | I   |                                                                                                                                                                                                                                                                     |
| 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. Due to operation of the on-chip digital guard timer, the EST pin will go high after being held high continuously for about 30 ms. Likewise, it will go low after being held low continuously for about 20 ms. |
| 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                                                                                                                                                                                                                             |

## Equivalent Circuit Block Diagram



A01052

## Test Circuit/Application Circuit Example



A01053

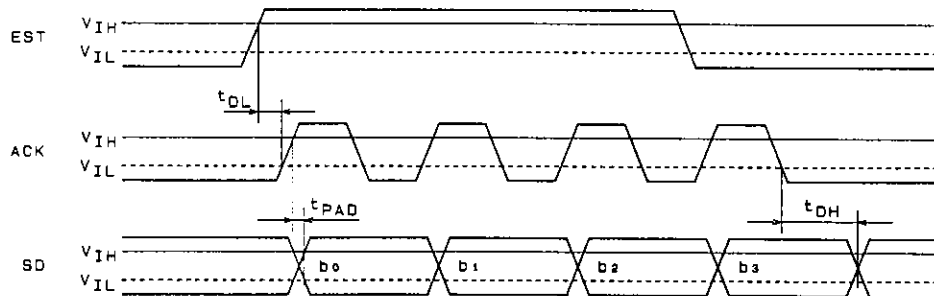
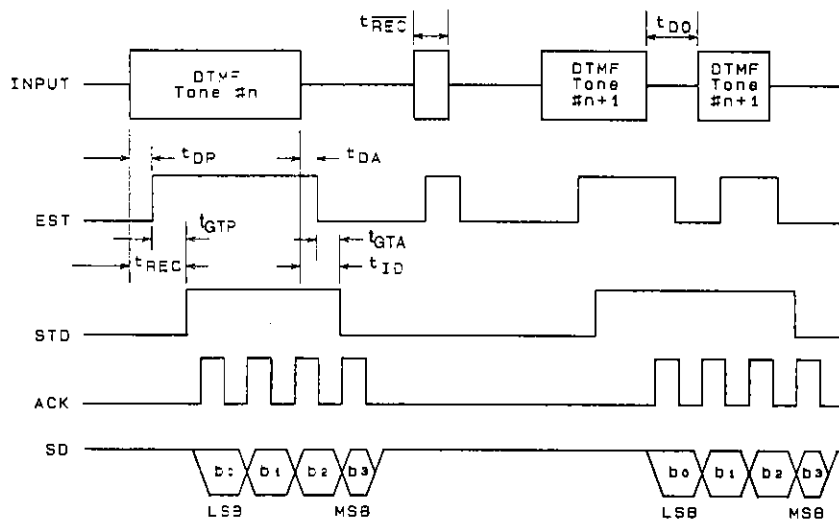
## Output Code Table

| 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

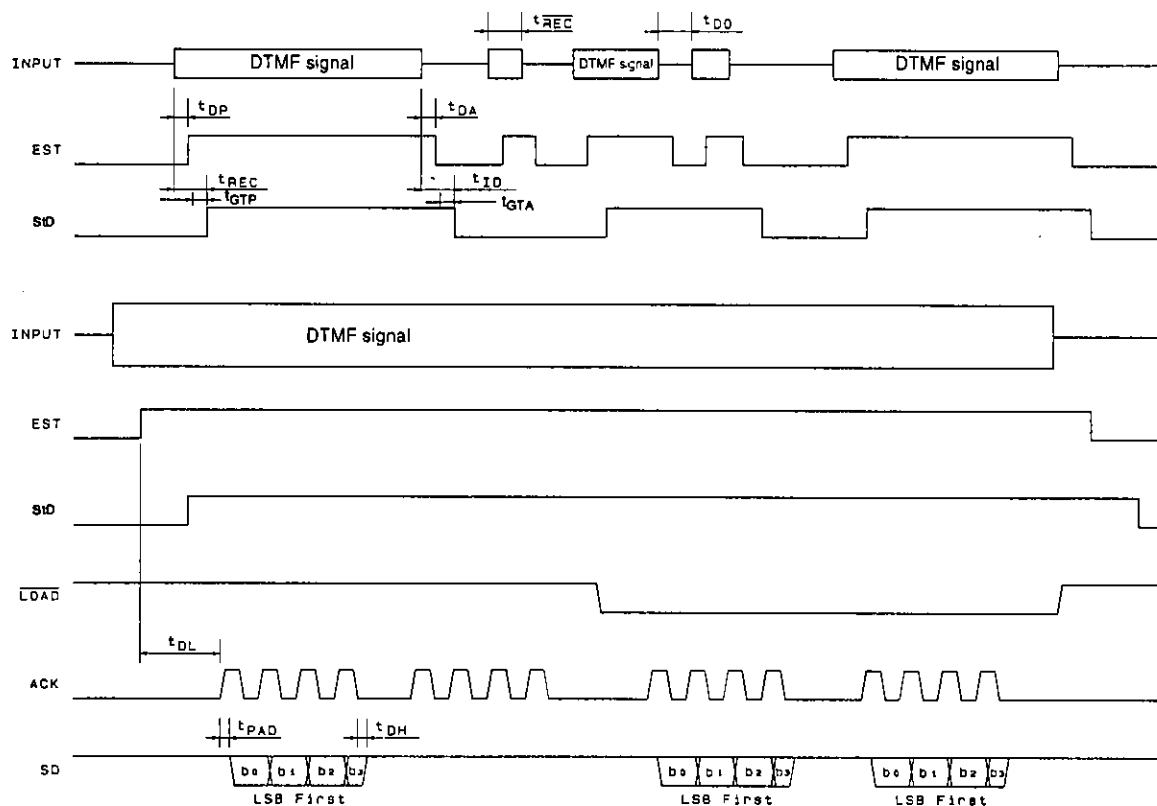
|    | C1 | C2 | C3 | C4 |
|----|----|----|----|----|
| R1 | 1  | 2  | 3  | A  |
| R2 | 4  | 5  | 6  | B  |
| R3 | 7  | 8  | 9  | C  |
| R4 | *  | 0  | #  | D  |

## Timing Charts (Approximate)



A01597

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



A01054

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