

# LC7365M, 7366M



3036B

CMOS LSI

## DTMF Tone Generator for Pushbutton Telephone Use

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The LC7365M, 7366M are DTMF tone generator LSIs for use in pushbutton telephones. The LC7365M contains a keyboard scan circuit and the LC7366M can accept the output direct from a microcomputer.

### Features

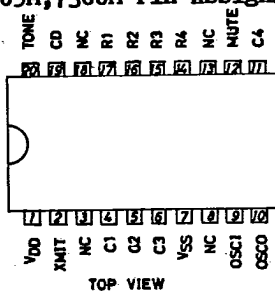
- Miniflat package version(MFP-20) facilitating high-density packaging.
- Low voltage CMOS process for direct operation from telephone line.
- The LC7365M can interface direct to a single contact or standard 2-of-7, 2-of-8 key pad.
- The LC7366M has an input configuration that facilitates interface to a microcomputer. (Positive logic input).
- Uses TV crystal standard ( $f_{osc}=3.58\text{MHz}$ ) to derive all frequencies.
- On-chip feedback resistor and capacitors to form the OSC circuit.
- Wide operating voltage range: 2.5 to 10.0V
- On-chip voltage reference to assure amplitude stability of the dual tones over the operating voltage and temperature range.
- Low output tone distortion (7% max.) over the whole supply voltage range ( $V_{DD}=2.5$  to 10.0V).
- On-chip MUTE output and XMIT output.
- Current dissipation at operating mode:  $I_{DD}=3\text{mAmax}/V_{DD}=2.5\text{V}$ ,  $16\text{mAmax}/V_{DD}=10\text{V}$ .
- Current dissipation at standby mode:  $I_{DD}=0.3\mu\text{Atyp}/V_{DD}=2.5\text{V}$ ,  $1\mu\text{Atyp}/V_{DD}=10\text{V}$ .

### Pin Assignment and Pin Connection

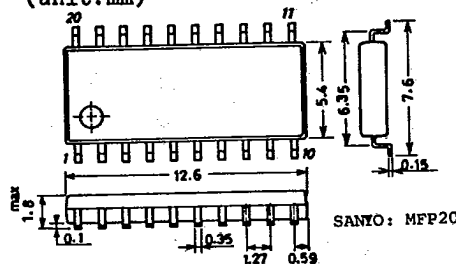
| Pin No. | Pin Name | Input/Output |         | Pin No. | Pin Name | Input/Output |         |
|---------|----------|--------------|---------|---------|----------|--------------|---------|
|         |          | LC7365M      | LC7366M |         |          | LC7365M      | LC7366M |
| 1       | VDD      | -            | -       | 11      | C4       | I/O          | I       |
| 2       | XMIT     | 0            | 0       | 12      | MUTE     | 0            | 0       |
| 4       | C1       | I/O          | I       | 14      | R4       | I/O          | I       |
| 5       | C2       | I/O          | I       | 15      | R3       | I/O          | I       |
| 6       | C3       | I/O          | I       | 16      | R2       | I/O          | I       |
| 7       | VSS      | -            | -       | 17      | R1       | I/O          | I       |
| 9       | OSCI     | I            | I       | 19      | CD       | I            | I       |
| 10      | OSCO     | 0            | 0       | 20      | TONE OUT | 0            | 0       |

Pins 3, 8, 13, 18: NC pins

### LC7365M, 7366M Pin Assignment



### Case Outline 3036B-M20IC (unit:mm)



8067KI/1097TA, TS No.2227-1/7

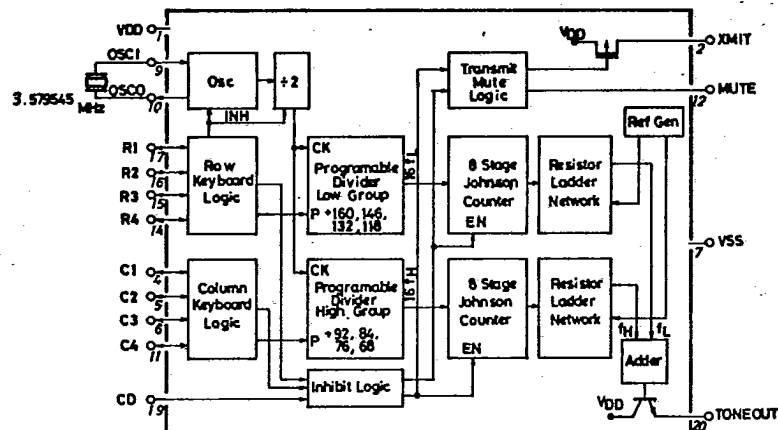
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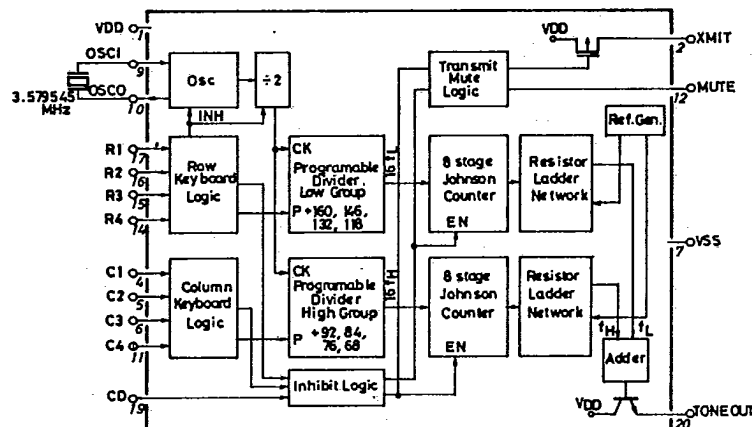
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## Equivalent Circuit Block Diagram

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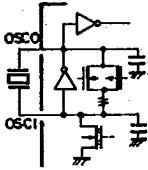
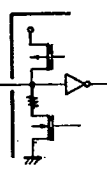
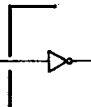
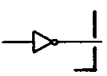
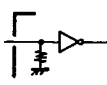
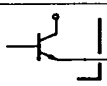


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## Pin Description

↓Applicable to both Type Nos. when no Type No. is indicated

| Pin Name                        | Pin No.                              | Input/Output Configuration                                                          | Function                                                                                                                                                                                                                            |
|---------------------------------|--------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VDD                             | 1                                    |                                                                                     | Power supply pin.                                                                                                                                                                                                                   |
| VSS                             | 7                                    |                                                                                     | V <sub>DD</sub> =2.5 to 10.0V                                                                                                                                                                                                       |
| OSCO                            | 10                                   |    | Reference frequency generation pin.<br>Uses a crystal resonator of 3.579545MHz.                                                                                                                                                     |
| OSCI                            | 9                                    |                                                                                     | With the feedback resistor and capacitors contained to form the OSC circuit, a crystal resonator is simply connected across the pins.                                                                                               |
| LC7365M<br>R1 to R4<br>C1 to C4 | 17<br>to<br>14<br>4<br>to<br>6<br>11 |    | Row and column input pin.<br>High-active input.<br>Contains a P-channel transistor for keyboard scan and an N-channel transistor for pull-down.                                                                                     |
| LC7366M<br>R1 to R4<br>C1 to C4 | 17<br>to<br>14<br>4<br>to<br>6<br>11 |    | Row and column input pin.<br>High-active input.                                                                                                                                                                                     |
| MUTE                            | 12                                   |   | "L" level with no key input.<br>"H" level with key input.<br>CMOS complementary output                                                                                                                                              |
| XMIT                            | 2                                    |  | "H" level with no key input.<br>High impedance with key input.<br>P-channel open drain output.                                                                                                                                      |
| CD                              | 19                                   |  | Chip disable pin.<br>When set to "H" level, the row input/column input are brought to high impedance state, OSC stops, tone output becomes V <sub>SS</sub> level, MUTE output becomes "L" level, and XMIT output becomes "H" level. |
| TONE                            | 20                                   |  | DTMF signal output pin.<br>npn transistor-used emitter-follower output.                                                                                                                                                             |

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

|                               |                     |                                                               | unit |
|-------------------------------|---------------------|---------------------------------------------------------------|------|
| Maximum Supply Voltage        | V <sub>DD</sub> max | -0.3 to +10.5                                                 | V    |
| Maximum Input Voltage         | V <sub>I</sub> max  | V <sub>SS</sub> -0.3 ≤ V <sub>IN</sub> ≤ V <sub>DD</sub> +0.3 | V    |
| XMIT Pin Load Resistance      | R <sub>X</sub>      | 1.0min.                                                       | kohm |
| MUTE Pin Load Resistance      | R <sub>M</sub>      | 3.3min.                                                       | kohm |
| Tone Pin Max. Load Resistance | R <sub>T</sub>      | 240min.                                                       | ohm  |
| Allowable Power Dissipation   | P <sub>d</sub> max  | 255                                                           | mW   |
| Operating Temperature         | Topg                | -30 to +70                                                    | °C   |
| Storage Temperature           | Tstg                | -40 to +125                                                   | °C   |

**Allowable Operating Conditions at Ta=-30 to +70°C**

|                         |                 |                                           | unit                                  |
|-------------------------|-----------------|-------------------------------------------|---------------------------------------|
| Supply Voltage          | V <sub>DD</sub> | Tone output mode                          | 2.5 to 10.0                           |
|                         |                 | Non-tone output mode                      | 1.6 to 10.0                           |
| Input "H"-Level Voltage | V <sub>IH</sub> | R1 to R4, CD, C1 to C4                    | 0.7V <sub>DD</sub> to V <sub>DD</sub> |
| Input "L"-Level Voltage | V <sub>IL</sub> | "                                         | V <sub>SS</sub> to 0.3V <sub>SS</sub> |
| Key Contact Resistance  |                 |                                           | 1 kohm                                |
| Crystal Resonator Spec. | f               | 3.579545MHz±0.02%                         |                                       |
|                         | R <sub>S</sub>  | [Examples of crystal resonator] up to 100 | ohm                                   |
|                         |                 | Nihon Denpa LN-A10-12                     |                                       |
|                         |                 | Kinsekisha HC-43U                         |                                       |
|                         |                 | Tokyo Denpa TDC-3                         |                                       |

**Electrical Characteristics at Ta=25°C ; Applicable pin**

|                      |                  | V <sub>CC</sub>                                          | min | typ  | max  | unit  |
|----------------------|------------------|----------------------------------------------------------|-----|------|------|-------|
| Supply Voltage       | V <sub>DD</sub>  |                                                          | 2.5 |      | 10   | V     |
|                      |                  |                                                          |     |      | 1.6  | V     |
| Current Dissipation  | I <sub>DD</sub>  | Non-tone outut mode; V <sub>DD</sub>                     | 2.5 | 0.3  | 30   | uA    |
|                      |                  | " ; "                                                    | 10  | 1.0  | 100  | uA    |
|                      |                  | Tone output mode; V <sub>DD</sub>                        | 2.5 | 1.5  | 3    | mA    |
|                      |                  | " ; "                                                    | 10  | 8    | 16   | mA    |
| Single Tone          | V <sub>OR</sub>  | Row tone, R <sub>L</sub> =390ohms; TONE OUT              | 2.5 | 160  | 200  | mVrms |
| Output Voltage       |                  | " ; " ; "                                                | 5   | 170  | 220  | mVrms |
|                      |                  | " , R <sub>L</sub> =240ohms; "                           | 10  | 170  | 220  | mVrms |
| Ratio of Column to   | dB <sub>CR</sub> | 2.5 to 10                                                | 1   | 2    | 3    | dB    |
| Row Tone             |                  |                                                          |     |      |      |       |
| Total Harmonic       | THD              | f <sub>out</sub> =0.5 to 3.5kHz, R <sub>L</sub> =10kohms |     |      | 7    | %     |
| Distortion           |                  | 2.5 to 10                                                |     |      |      |       |
| XMIT Output Voltage  | V <sub>OH1</sub> | I <sub>OH</sub> =5mA; XMIT                               | 2.5 | 1.5  | 1.8  | V     |
|                      |                  | I <sub>OH</sub> =10mA; XMIT                              | 10  | 8.5  | 8.8  | V     |
| XMIT Leakage Current | I <sub>OF</sub>  | " ; XMIT                                                 | 10  |      | 100  | uA    |
| MUTE Output Voltage  | V <sub>OL</sub>  | Output open; MUTE                                        | 2.5 |      | 0    | 0.5   |
|                      |                  | " ; "                                                    | 10  |      | 0    | 0.5   |
|                      | V <sub>OH2</sub> | " ; "                                                    | 2.5 | 2.25 | 2.5  | V     |
|                      |                  | " ; "                                                    | 10  | 9.5  | 10.0 | V     |
| MUTE Output Current  | I <sub>OL1</sub> | V <sub>OL</sub> =0.5V; MUTE                              | 2.5 | 0.4  |      | mA    |
|                      |                  | " ; "                                                    | 10  | 2.0  |      | mA    |
|                      | I <sub>OH2</sub> | V <sub>OH</sub> =2.0V; MUTE                              | 2.5 | 0.17 |      | mA    |
|                      |                  | V <sub>OH</sub> =9.5V; "                                 | 10  | 0.57 |      | mA    |
| OSC Output Current   | I <sub>OL2</sub> | V <sub>OL</sub> =0.5V; OSCO                              | 2.5 | 0.18 |      | mA    |
|                      |                  | " ; "                                                    | 10  | 0.8  |      | mA    |
|                      | I <sub>OH3</sub> | V <sub>OH</sub> =2.0V; OSCO                              | 2.5 | 0.13 |      | mA    |
|                      |                  | V <sub>OH</sub> =9.5V; "                                 | 10  | 0.42 |      | mA    |
| OSC Start Voltage    | t <sub>st</sub>  |                                                          | 2.5 |      | 5    | ms    |
|                      |                  |                                                          | 10  |      | 4    | ms    |
| Input/Output         | c <sub>I/O</sub> | ; OSC1, OSCO                                             | 2.5 |      | 16   | pF    |
| Capacitance          |                  | " ; "                                                    | 10  |      | 14   | pF    |

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|                      |               |                 | $V_{CC}$                                | min       | typ                      | max | unit    |
|----------------------|---------------|-----------------|-----------------------------------------|-----------|--------------------------|-----|---------|
| Colum/Row            | $I_{IHOF}$    | $V_{IH}=2.5V$ ; | R1 to R4,<br>C1 to C4,<br>LC7366M alone | 2.5       |                          | 1   | $\mu A$ |
|                      | Input Current | $V_{IH}=10V$ ;  |                                         | 10        |                          | 2   | $\mu A$ |
|                      | $I_{ILOF}$    | $V_{OH}=2V$ ;   | LC7366M alone                           | 2.5       |                          | 1   | $\mu A$ |
|                      |               | $V_{OH}=9.5V$ ; |                                         | 10        |                          | 2   | $\mu A$ |
| Key Pin Current      | $I_{IH1}$     | $V_{IH}=2.5V$ ; | R1 to R4,<br>C1 to C4,<br>LC7365M alone | 2.5       | 4                        |     | $\mu A$ |
|                      |               | $V_{IH}=10V$ ;  |                                         | 10        | 9.2                      |     | $\mu A$ |
|                      | $I_{OH4}$     | $V_{OH}=2V$ ;   |                                         | 2.5       | 70                       |     | $\mu A$ |
|                      |               | $V_{OH}=9.5V$ ; |                                         | 10        | 280                      |     | $\mu A$ |
| CD Pin Input Current | $I_{IH2}$     | $V_{IH}=2.5V$ ; | CD<br>"                                 | 2.5       | 2.5                      |     | $\mu A$ |
|                      |               | $V_{IH}=10V$ ;  |                                         | 10        | 55                       |     | $\mu A$ |
| OSC Frequency        | $f_{OSC}$     | ; OSCI, OSC0    |                                         | 2.5 to 10 | $3.579545MHz \pm 0.26\%$ |     |         |

## Comparison between Tone Output Frequency and DTMF Signal Spec.

| Input Pin | Output Frequency [Hz] |                     | Error [%] |
|-----------|-----------------------|---------------------|-----------|
|           | Spec.                 | LC7365M, 66M Output |           |
| R1        | 697                   | 699.1               | +0.30     |
| R2        | 770                   | 766.2               | -0.49     |
| R3        | 852                   | 847.4               | -0.54     |
| R4        | 941                   | 948.0               | +0.74     |
| C1        | 1209                  | 1215.9              | +0.57     |
| C2        | 1336                  | 1331.7              | -0.32     |
| C3        | 1477                  | 1471.9              | -0.35     |
| C4        | 1633                  | 1645.0              | +0.73     |

(Note) OSC drift: 0

## Relation between Input and DTMF Signal

| Desired<br>DTMF<br>Signal | Input |    |    |    |    |    |    |    |
|---------------------------|-------|----|----|----|----|----|----|----|
|                           | R1    | R2 | R3 | R4 | C1 | C2 | C3 | C4 |
| 1                         | 1     | 0  | 0  | 0  | 1  | 0  | 0  | 0  |
| 2                         | 1     | 0  | 0  | 0  | 0  | 1  | 0  | 0  |
| 3                         | 1     | 0  | 0  | 0  | 0  | 0  | 1  | 0  |
| 4                         | 0     | 1  | 0  | 0  | 1  | 0  | 0  | 0  |
| 5                         | 0     | 1  | 0  | 0  | 0  | 1  | 0  | 0  |
| 6                         | 0     | 1  | 0  | 0  | 0  | 0  | 1  | 0  |
| 7                         | 0     | 0  | 1  | 0  | 1  | 0  | 0  | 0  |
| 8                         | 0     | 0  | 1  | 0  | 0  | 1  | 0  | 0  |
| 9                         | 0     | 0  | 1  | 0  | 0  | 0  | 1  | 0  |
| 0                         | 0     | 0  | 0  | 1  | 0  | 1  | 0  | 0  |
| *                         | 0     | 0  | 0  | 1  | 1  | 0  | 0  | 0  |
| #                         | 0     | 0  | 0  | 1  | 0  | 0  | 1  | 0  |
| A                         | 1     | 0  | 0  | 0  | 0  | 0  | 0  | 1  |
| B                         | 0     | 1  | 0  | 0  | 0  | 0  | 0  | 1  |
| C                         | 0     | 0  | 1  | 0  | 0  | 0  | 0  | 1  |
| D                         | 0     | 0  | 0  | 1  | 0  | 0  | 0  | 1  |

## How to Output a Single Tone

Select a row (or column) input according to your desired tone output frequency (set to '1' level) and two or more column (or row) inputs in that row (or column).

When two or more row (or column) inputs are selected, output of that row (or column) tone is inhibited.

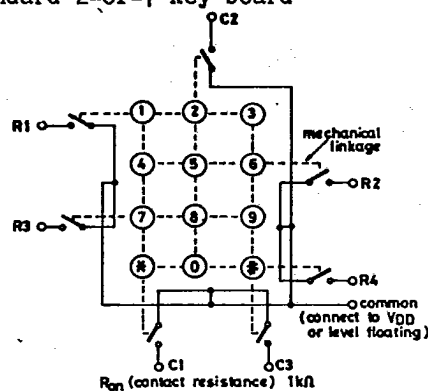
It should be noted that when all of four inputs in any row are set to '1' level a signal 16 times the corresponding column tone is outputted at the MUTE pin.

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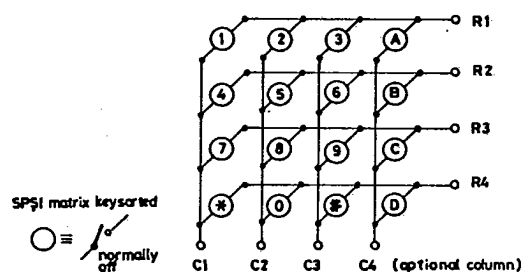
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**Sample Connections to Key Board, Microcomputer**

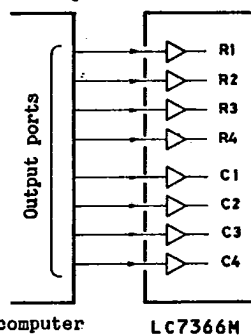
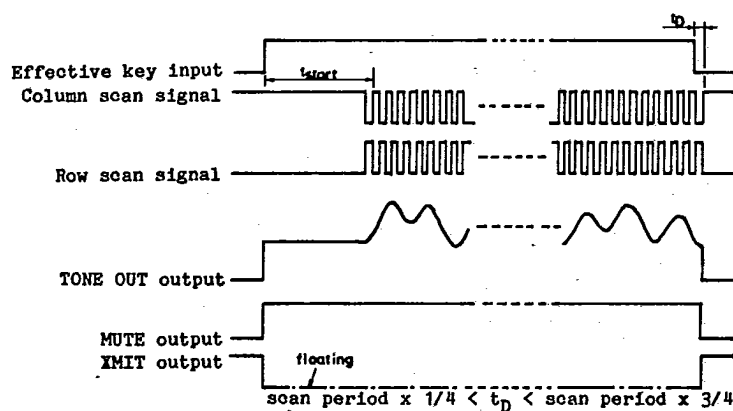
(1) Connection of LC7365M to standard 2-of-7 key board



(2) Connection of LC7365M to single contact key



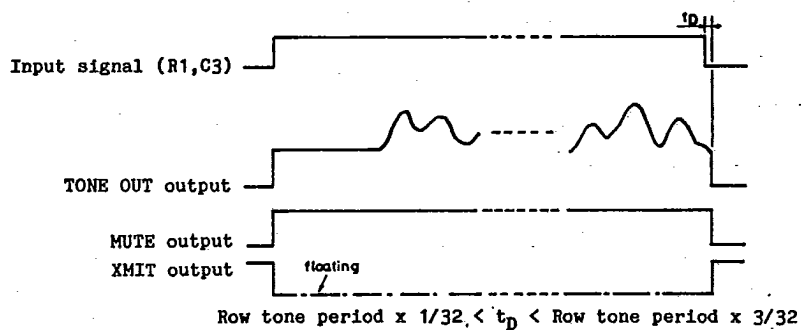
(3) Connection of LC7366M to microcomputer

**LC7365M Timing Chart**

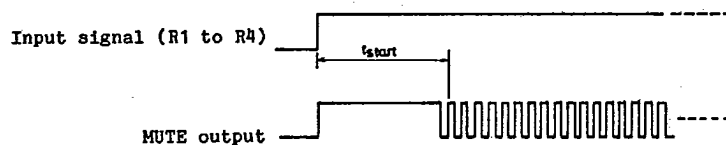
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**LC7365M, 7366M**

### LC7366M Timing Chart



### LC7366M $t_{start}$ Timing Chart



### Sample Application Circuit of LC7365M

