# LR4809/LR4809N Pulse/Tone Dialer for Binary Code Input

## DESCRIPTION

The LR4809/LR4809N are CMOS pulse/tone dialer LSI which use 4-bit serial BCD data in place of standard keyboard inputs, and outputs standard DTMF tones. It can be directly interfaced witha microprocessor for external control of pulse/tone mode switching as well as flash and PBX pause storage.
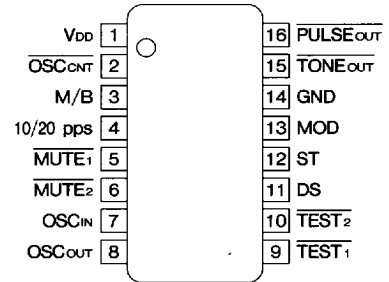
## FEATURES

- 4-bit serial binary code input control
- Make ratio : 33/40% pin-selectable
- Pulse rate : 10/20 pps pin-selectable
- Directly interfaced with a microcomputer
- Switchable pulse/tone mode by pin or binary code
- PABX pause storage with binary code
- Uses a 3.579545 MHz color-burst crystal as a frequency reference
- Flash signal output
- Packages :
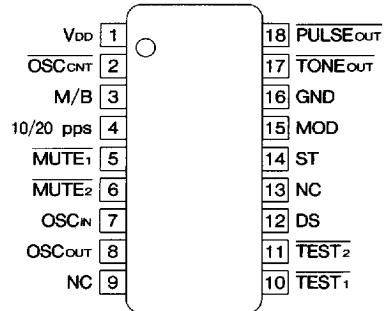  LR4809    : 16-pin DIP(DIP016-P-300B)
  LR4809N : 18-pin MFP(MFP018-P)

## PIN CONNECTIONS

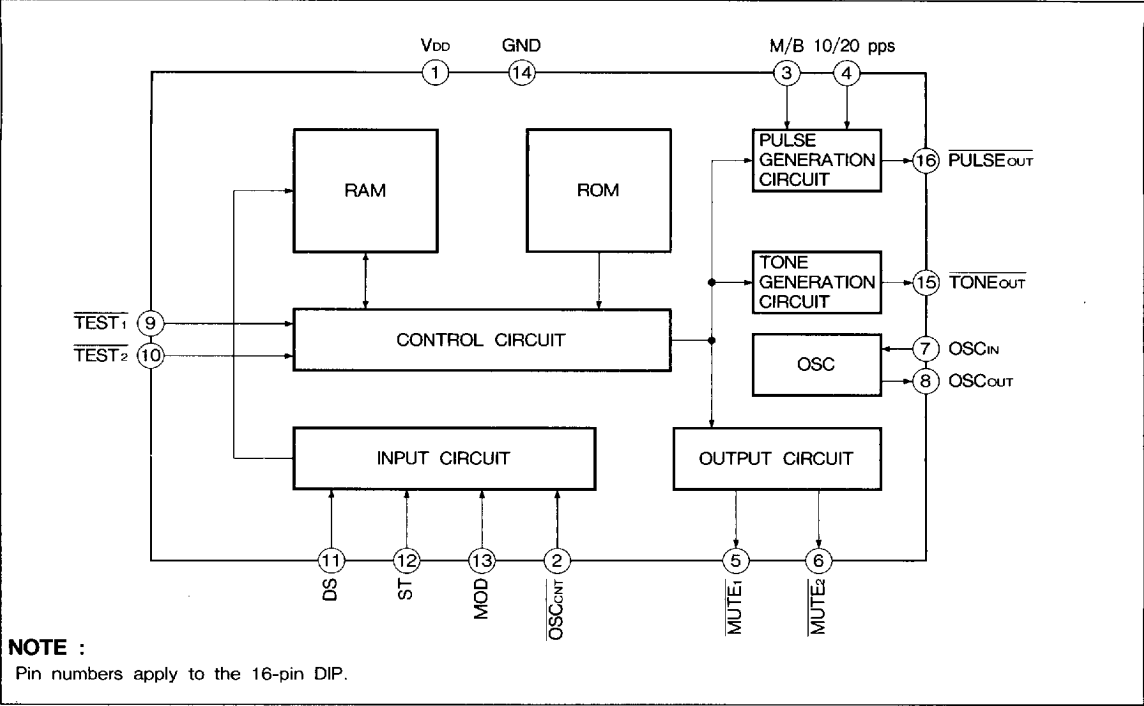### 16-PIN DIP                                TOP VIEW

| Pin | Signal | | Pin | Signal |
|---|---|---|---|---|
| 1 | $V_{DD}$ | | 16 | $\overline{PULSE_{OUT}}$ |
| 2 | $\overline{OSC_{CNT}}$ | | 15 | $\overline{TONE_{OUT}}$ |
| 3 | M/B | | 14 | GND |
| 4 | 10/20 pps | | 13 | MOD |
| 5 | $\overline{MUTE_1}$ | | 12 | ST |
| 6 | $\overline{MUTE_2}$ | | 11 | DS |
| 7 | $OSC_{IN}$ | | 10 | $\overline{TEST_2}$ |
| 8 | $OSC_{OUT}$ | | 9 | $\overline{TEST_1}$ |

### 18-PIN MFP

| Pin | Signal | | Pin | Signal |
|---|---|---|---|---|
| 1 | $V_{DD}$ | | 18 | $\overline{PULSE_{OUT}}$ |
| 2 | $\overline{OSC_{CNT}}$ | | 17 | $\overline{TONE_{OUT}}$ |
| 3 | M/B | | 16 | GND |
| 4 | 10/20 pps | | 15 | MOD |
| 5 | $\overline{MUTE_1}$ | | 14 | ST |
| 6 | $\overline{MUTE_2}$ | | 13 | NC |
| 7 | $OSC_{IN}$ | | 12 | DS |
| 8 | $OSC_{OUT}$ | | 11 | $\overline{TEST_2}$ |
| 9 | NC | | 10 | $\overline{TEST_1}$ |

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## BLOCK DIAGRAM



NOTE :
Pin numbers apply to the 16-pin DIP.

## ABSOLUTE MAXIMUM RATINGS

| PARAMETER | SYMBOL | RATING | UNIT | NOTE |
|---|---|---|---|---|
| Supply voltage | $V_{DD}$ | 6.5 | V | 1 |
| Operating temperature | Topr | $-30$ to $+60$ | ℃ | |
| Storage temperature | Tstg | $-55$ to $+150$ | ℃ | |
| Power dissipation | $P_D$ | 500 | mW | 2 |
| Pin voltage | $V_{IN1}$ | $-0.3$ | V | 3 |
| Pin voltage | $V_{IN2}$ | $+0.3$ | V | 4 |

NOTES :
1. Referenced to GND.
2. Ta = 25℃
3. The maximum applicable voltage on any pin with respect to GND.
4. The maximum applicable voltage on any pin with respect to $V_{DD}$.

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## DC CHARACTERISTICS

(Ta=25℃, GND=0 V)

| PARAMETER | SYMBOL | CONDITIONS | MIN. | TYP. | MAX. | UNIT | NOTE |
|---|---|---|---|---|---|---|---|
| Supply voltage | $V_{DD}$ | | 2.0 | | 6.0 | V | |
| Standby current | $I_{SB}$ | $V_{DD}=3.0$ V | | 0.5 | 1.0 | $\mu$A | 1 |
| Operating current | $I_{OPP}$ | $V_{DD}=3.0$ V, pulse mode | | | 1.0 | mA | 2 |
| | $I_{OPT}$ | $V_{DD}=3.0$ V, tone mode | | | 1.5 | mA | |
| Input voltage | $V_{IL}$ | | GND | | $0.2V_{DD}$ | V | 3 |
| | $V_{IH}$ | | $0.8V_{DD}$ | | $V_{DD}$ | V | |
| Sink current | $I_{OL}$ | $V_{DD}=2.0$ V, $V_{OL}=0.5$ V | 1.0 | 2.0 | | mA | 4 |
| OSC$_{CNT}$ input current | $I_{OC}$ | $V_{DD}=3.5$ V, $V_{IL}=0$ V | 40 | 80 | 120 | $\mu$A | |

NOTES :
1. Current for memory retention; no load on all outputs.
2. Current during operation; no load on all outputs.
3. Applicable to all input pins.
4. Applicable to $\overline{\text{MUTE}_1}$, $\overline{\text{MUTE}_2}$, $\overline{\text{PULSE}_{OUT}}$ pins.

## TONE OUTPUT CHARACTERISTICS

| PARAMETER | | SYMBOL | CONDITIONS | MIN. | TYP. | MAX. | UNIT | NOTE |
|---|---|---|---|---|---|---|---|---|
| Tone output voltage | ROW | $V_{OR}$ | $R_L=10$ k$\Omega$, $V_{DD}=4.0$ V | 100 | 140 | 180 | mVrms | |
| | COLUMN | $V_{OC}$ | $R_L=10$ k$\Omega$, $V_{DD}=4.0$ V | 130 | 180 | 230 | mVrms | |
| Output distortion | | DIS | $R_L=10$ k$\Omega$, $V_{DD}=2.5$ V | | | $-20$ | dB | 1 |
| Pre-emphasis | | $PE_{HB}$ | $R_L=10$ k$\Omega$, $V_{DD}=2.5$ V | 1.0 | 2.0 | 3.0 | dB | |
| Inter-digital pause | | $t_{IDP}$ | | 100 | | 130 | ms | |
| Tone output time | | $t_{OD}$ | | 100 | | 130 | ms | |
| Tone output rate | | $t_{OR}$ | | 200 | | 260 | ms | |

NOTE :
1. Unwanted frequency components in the 20 Hz to 80 kHz frequency range with respect to fundamental tone signals of ROW and COLUMN.

## AC CHARACTERISTICS

| PARAMETER | SYMBOL | CONDITIONS | | MIN. | TYP. | MAX. | UNIT | NOTE |
|---|---|---|---|---|---|---|---|---|
| Oscillation start time | tos | | | | | 8 | ms | 1 |
| Pulse rate | Pr | 10/20 = GND | | | 10 | | pps | |
| | | 10/20 = VDD | | | 20 | | pps | |
| Break time | tB | M/B = GND | | | 67 | | ms | 2 |
| | | M/B = VDD | | | 60 | | ms | |
| Inter-digital pause time | tIDP | 10 pps mode | | | 850 | | ms | |
| | | 20 pps mode | | | 500 | | ms | |
| Mute overlap time | tMOLT | | | | 2 | | ms | |
| Pre-digital pause time | tPDP | M/B = GND | | | 33 | | ms | 2 |
| | | M/B = VDD | | | 40 | | ms | |

### NOTES :
1. Crystal resonator parameters : $Rs=100$ $\Omega$, $L_M=96$ mH, $C_M=0.02$ pF, $C_h=5$ pF, $f=3.579\,545$ MHz.
2. During 10 pps pulse mode (1/2 during 20 pps mode).

## SERIAL DATA INPUT CHARACTERISTICS

| PARAMETER | SYMBOL | MIN. | MAX. | UNIT | NOTE |
|---|---|---|---|---|---|
| Data input | td | 4 | 1000 | $\mu$s | |
| Data off | tdoff | 4 | 1000 | $\mu$s | |
| Strobe | tst | 2 | 800 | $\mu$s | 1 |
| Data strobe overlap | tdso | 1 | 100 | $\mu$s | |
| Strobe off | tsoff | 6 | 1200 | $\mu$s | 1 |
| Inter-data interval | tdt | 500 | | $\mu$s | |
| Standby interval | tsb | 200 | | ms | 2 |

### NOTES :
1. The strobe time and the strobe off time should be constant at one cycle of operation.
2. A minimum of 200 ms of standby time is required between the time that oscillation starts and the time that the first bit of data is received, and between the time that the 32nd bit is output and the 33rd bit is input.

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## TEST CIRCUIT
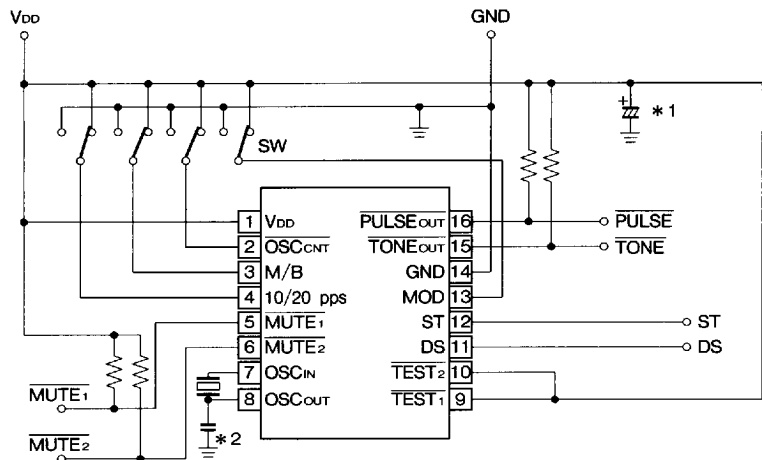


**NOTES :**

*1 Insert a capacitor of 47 μF to smooth the power supply and prevent latch-up.

*2 Insert a capacitor of 33 pF to keep a stable oscillation.

## PIN FUNCTION

| SYMBOL | I/O | FUNCTION |
|---|---|---|
| DS | I | Binary data input |
| ST | I | Strobe input |
| $\overline{OSC_{CNT}}$ | I | Oscillator control |
| $\overline{PULSE_{OUT}}$ | O | Pulse output |
| $\overline{TONE_{OUT}}$ | O | DTMF tone output |
| $\overline{MUTE_1}$ | O | Mute output |
| $MUTE_2$ | O | Pulse mute output |
| $TEST_1$, $TEST_2$ | I | Test |
| $V_{DD}$ | I | Supply voltage |
| GND | I | Supply voltage |
| $OSC_{IN}$ | I | Oscillator circuit |
| $OSC_{OUT}$ | O | Oscillator circuit |
| 10/20 pps | I | Pulse rate select |
| MOD | I | Pulse/Tone mode select |
| M/B | I | Make/Break select |

## PIN DESCRIPTIONS (Applied to LR4809)

### Oscillator Control (Pin 2)

The $\overline{OSC_{CNT}}$ pin starts and stops oscillation. It is connected to $V_{DD}$ by a pull-up resistor.

| $\overline{OSC_{CNT}}$ PIN | MODE |
|---|---|
| GND | Oscillation enabled |
| $V_{DD}$ or open | Oscillation inhibited |

### Make/Break Ratio Select (Pin 3)

The M/B pin is used to select the Make/Break Ratio for pulse dialing operation. By connecting this pin to GND or $V_{DD}$, the ratios indicated below can be selected.

| M/B PIN | M/B RATIO |
|---|---|
| GND | 33/67% |
| $V_{DD}$ | 40/60% |

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## Mute Output (Pin 5)

The $\overline{MUTE_1}$ pin consists of an N-channel open-drain transistor. The voltage level of this pin goes low during pulse or tone output.

## Pulse Mute Output (Pin 6)

The $\overline{MUTE_2}$ pin consists of an N-chanel open-drain transistor. When a pulse is being output, the voltage level of this pin goes low.

## Pulse Rate Select (Pin 4)

For pulse dialing operations, the pulse rate can be selected with the 10/20 pps pin, as shown in the table below.

| 10/20 pps PIN | PULSE RATE |
|---|---|
| GND | 10 pps |
| $V_{DD}$ | 20 pps |

## Test Inputs (Pin 9 and 10)

The $TEST_1$ and $TEST_2$ pins are pulled-up to $V_{DD}$. For normal usage, they should be either connected to $V_{DD}$ or left open.

## Data (Pin 11) and Strobe (Pin 12) Inputs

4-bit serial BCD input is received through the DS pin. This input, which is accepted when ST is "High", causes output of the corresponding tone levels indicated in the table below.
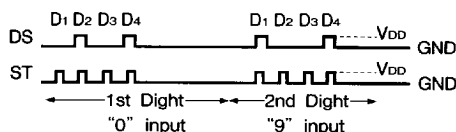


| BCD | | | | OUTPUT |
|---|---|---|---|---|
| $D_4$ | $D_3$ | $D_2$ | $D_1$ | |
| 0 | 0 | 0 | 0 | FLASH |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 | 2 |
| 0 | 0 | 1 | 1 | 3 |
| 0 | 1 | 0 | 0 | 4 |
| 0 | 1 | 0 | 1 | 5 |
| 0 | 1 | 1 | 0 | 6 |
| 0 | 1 | 1 | 1 | 7 |
| 1 | 0 | 0 | 0 | 8 |
| 1 | 0 | 0 | 1 | 9 |
| 1 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 | * (Tone mode only) |
| 1 | 1 | 0 | 0 | # (Tone mode only) |
| 1 | 1 | 0 | 1 | Pause |
| 1 | 1 | 1 | 0 | ※1 Pulse→Tone Switch |
| 1 | 1 | 1 | 1 | ※2 Not Permitted |

※1 Immediately after oscillations are started (i.e., after the $\overline{OSC_{CNT}}$ pin has been brought to GND level), the mode is determined by the state of the MOD pin.

※2 An input of a BCD "1111" causes subsequent data input to be ignored.

## Pulse/Tone Mode Select (Pin 13)

Once oscillation begins, the mode is determined by the setting of the MOD pin, as shown in the table below. If a MOD code is entered while dialing in Pulse Mode, subsequent dialing will be done in Tone Mode. MOD codes are stored in buffer memory as single data values, just as if they were regular data codes.

| MOD PIN | MODE |
|---|---|
| GND | Tone |
| $V_{DD}$ | Pulse |

## Tone Output (Pin 15)

In Tone Mode, the $\overline{\text{TONE}}$OUT pin outputs a DTMF signal. Internal circuitry is illustrated in the figure below. Although the output signal frequencies are actually based on the values of 4-bit serial codes received through the DS pin, the correspondence to standard keyboard row and column inputs is shown below.
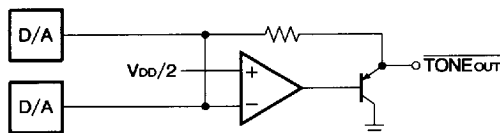


#### Table 1   DTMF Output Frequencies

|  |  | STANDARD DTMF (Hz) | LR4809 (Hz) | DEVIATION (%) |
|---|---|---|---|---|
| Low group output | R₁ | 697 | 701.3 | +0.62 |
|  | R₂ | 770 | 771.4 | +0.19 |
|  | R₃ | 852 | 857.2 | +0.61 |
|  | R₄ | 941 | 935.1 | −0.63 |
| High group output | C₁ | 1209 | 1215.9 | +0.57 |
|  | C₂ | 1336 | 1331.7 | −0.32 |
|  | C₃ | 1477 | 1471.9 | −0.35 |

#### Table 2   Output Rrequency Level Corresopondence to Row and Column Inputs

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

## Pulse Output (Pin 16)

The $\overline{\text{PULSE}}$OUT pin consists of an N-channel open-drain transistor. It outputs a pulse signal in Pulse Mode.

## FUNCTIONAL DESCRIPTION

### Normal Dialing

If a BCD code is input at least 200 ms after the start of oscillation (initiated by the $\overline{\text{OSC}}$CNT pin going low), a dial signal will be output. Up to 32 bits of input data is stored in a FIFO (First-In-First-Out) memory buffer. Flash, pause and mode data is also stored in the buffer.

When more than 32 bits are input, the 33rd and subsequent bits will not be stored until 200 ms elapses after the initial buffer contents have been dialed, thereby clearing the buffer. The LR4809/LR4809N operate on input data in blocks of 32 bits.

### Mixed Dialing

In Pulse mode, a BCD input code of "1110" causes a transition to Tone mode. This kind of mode change also causes a pause to be automatically inserted.
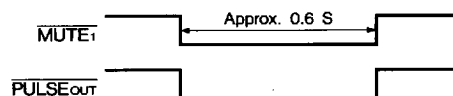
### Pause Storage

When a BCD value of "1101" is entered, a pause of about 4 s is inserted.

### Flash Signal Output

When Off-Hook, a BCD "0000" input causes the $\overline{\text{PULSE}}$OUT and $\overline{\text{MUTE}}$1 pins to output the signals shown in the diagram below. Since flash input is stored in buffer memory just as if it were regular input data, flash operations are like that of normal dialing. (No mode change is effected by the flash function).

During flash operation, even if oscillator control is exerted through the $\overline{\text{OSC}}$CNT pin, oscillation can not be halted until the flash is over.

## TIMING DIAGRAMS

### (Dailing timing)



### (Serial data input timing)



## SYSTEM CONFIGURATION EXAMPLE



LR4809