

MB87029 DTMF Pulse Dialer

DESCRIPTION

The Fujitsu MB87029 is a Dual Tone Multifrequency (DTMF) pulse dialer that is designed for pushbutton telephone sets and uses the Si-Gate CMOS process.

The MB87029 is used in both DTMF and PULSE modes and can be switched from PULSE mode to DTMF mode by a mode selection entry or by input from the keyboard. The MB87029 contains a 26-digit redial memory that permits the coexistence of PULSE and DTMF modes, enabling mixed redialing in both PULSE and DTMF modes by a signal key entry.

FEATURES

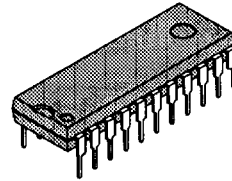
- Pulse 10 pps, 20 pps, or DTMF operation can be selected by the mode switch pin (MODEIN)
- On-chip 26 digits of redial memory (up to 25 digits can actually be written in the memory)
- Selectable make ratio by MA/BR: 39% or 33%
- Line Dial Tone (LDT) function is provided (switching from PULSE mode to DTMF mode by key entry)
- Output of a beep tone for input confirmation (for all effective key entry independently PULSE/DTMF modes)
- Redial inhibit function is included for redial memory overflow
- Mixed redialing of both PULSE and DTMF modes
- PAUSE function is provided and pause accumulation is possible
- Single-tone output is enabled by SCNT pin
- FLASH function is provided (ONHOOK mode is selected by keyboard input)
- FLASH output time, 0.1 second or 0.6 second, is selected by FCNT pin
- Crystal or ceramic oscillator (3.579545 MHz) can be used
- Pause release function is provided (two or more consecutive pauses can be released)
- Operating voltages:
PULSE mode: 2.0 V to 6.0 V
DTMF mode: 2.5 V to 6.0 V
(TA = -30 to 60°C)

ABSOLUTE MAXIMUM RATINGS (See Note)

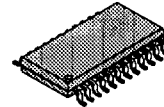
| Rating | Symbol | Pin Name | Value | Unit |
|-------------------------|------------------|-----------------|------------------------------------|------|
| Positive Supply Voltage | V _{DD} | V _{DD} | GND - 0.3 to 7.0 | V |
| Input Voltage | V _I | All inputs | GND - 0.3 to V _{DD} + 0.3 | V |
| Output Voltage | V _O | All outputs | GND - 0.3 to V _{DD} + 0.3 | V |
| Storage Temperature | T _{STG} | | -55 to +150 | °C |

Note: Permanent device damage may occur if absolute maximum ratings are exceeded. Functional operation should be restricted to the conditions as detailed in the operational sections of this data sheet. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

PRELIMINARY



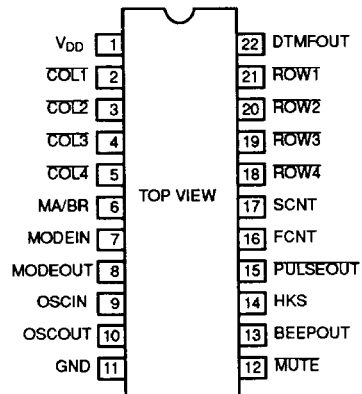
PLASTIC PACKAGE
DIP-22P-M03



PLASTIC PACKAGE
FPT-24P-M02

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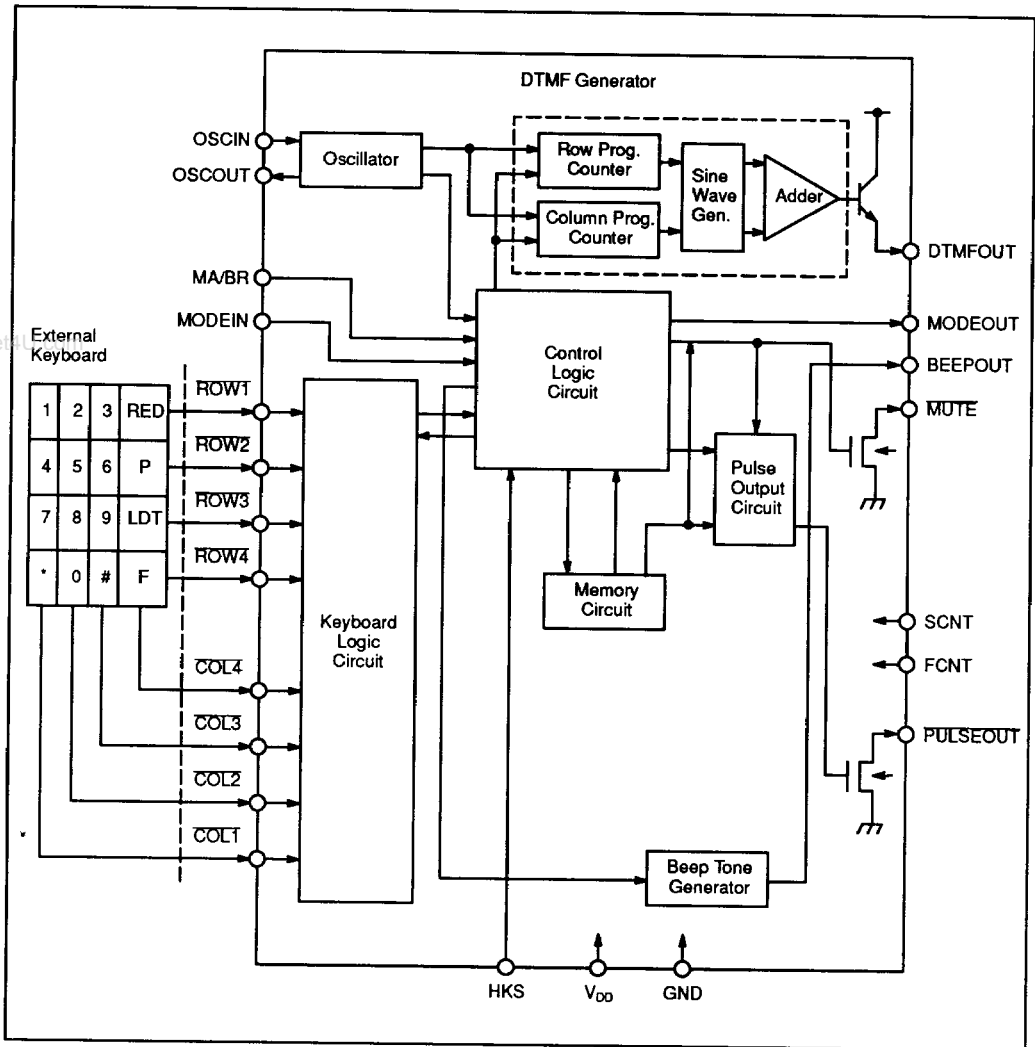
PIN ASSIGNMENT



FPT-24P-M02 PIN ASSIGNMENT
See Page 6-126

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields. However, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit.

Figure 1. MB87029 Block Diagram



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PIN DESCRIPTIONS

| I/O | Pin No. | | Symbol | Description | | | | | | | | | | |
|---------------------|-------------------|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-------------------|---------------------|-------------------|-----|-----------|-----|----|----|
| | DIP | FPT | | | | | | | | | | | | |
| Power Supply | 1 | 1 | V _{DD} | Power supply voltages: Pulse mode 2.0 V to 6.0 V DTMF mode 2.5 V to 6.0 V Memory Retention mode 2.0 V min. | | | | | | | | | | |
| | 11 | 12 | GND | Ground | | | | | | | | | | |
| Input | 2 | 2 | COL1 | <p>Uses key entries from 2 of 7 or 2 of 8 keyboards with common GND. This IC is available with a single contact from A type keyboard and electronic input (Low entry).</p> <p>Key input debouncing time is 23 ms typ. for both PULSE and DTMF modes. Key input release guard time is 23 ms typ. for both PULSE and DTMF modes.</p> <p>Key entry is accepted in PULSE/DTMF modes only when a single key (one key on the keyboard) is pressed longer than the debouncing time. If two or more keys are pressed, they are not accepted unless they are released one-by-one and the last key is held closed longer than the debouncing time, after all other keys are released.</p> <p>Key entry is accepted in DTMF mode only when either a single key (dual-tone key) is pressed or two or more keys in the same COL or ROW (single-tone keys) are pressed longer than the debouncing time. If one key in COL4 is pressed, the single-tone keys are ineffective. If multiple single-tone keys are pressed, and the last key is held closed longer than the debouncing time, after all other keys are released, the key is effective as the dual-tone key.</p> <p>Hereafter, key entries are described with the premise that keys are held closed longer than the debouncing time.</p> <p>Pauses between key entries in PULSE and DTMF modes must be 50 ms or more. However, up to 50 ms is necessary from key entry to output start for single-tone outputs.</p> <p>Key switch contact resistance up to 5kΩ is allowable.</p> | | | | | | | | | | |
| | 3 | 3 | COL2 | | | | | | | | | | | |
| | 4 | 5 | COL3 | | | | | | | | | | | |
| | 5 | 6 | COL4 | | | | | | | | | | | |
| | 21 | 23 | ROW1 | | | | | | | | | | | |
| | 20 | 22 | ROW2 | | | | | | | | | | | |
| | 19 | 21 | ROW3 | | | | | | | | | | | |
| | 18 | 20 | ROW4 | | | | | | | | | | | |
| | 6 | 7 | MA/BR | | <p>This pin selects the make rate.</p> <table border="1"> <thead> <tr> <th>MA/BR</th> <th>Make Rate (%)</th> <th>Break Rate (%)</th> </tr> </thead> <tbody> <tr> <td>V_{DD}</td> <td>39</td> <td>61</td> </tr> <tr> <td>GND</td> <td>33</td> <td>67</td> </tr> </tbody> </table> <p>Make ratio switching by MA/BR is inhibited during PULSE/DTMF transmission. The input level is in the CMOS level.</p> | MA/BR | Make Rate (%) | Break Rate (%) | V _{DD} | 39 | 61 | GND | 33 | 67 |
| | MA/BR | Make Rate (%) | Break Rate (%) | | | | | | | | | | | |
| V _{DD} | 39 | 61 | | | | | | | | | | | | |
| GND | 33 | 67 | | | | | | | | | | | | |
| 6 | 7 | MODEIN | <p>This pin selects the pulse mode, 10 pps, 20 pps, or the DTMF mode.</p> <table border="1"> <thead> <tr> <th>MODEIN</th> <th>Mode</th> </tr> </thead> <tbody> <tr> <td>V_{DD}</td> <td>Pulse Mode 20 pps</td> </tr> <tr> <td>Open (1 MΩ or more)</td> <td>Pulse Mode 10 pps</td> </tr> <tr> <td>GND</td> <td>DTMF Mode</td> </tr> </tbody> </table> <p>Mode switching is not accepted by MODEIN. After data transmission is completed, mode switching is honored by key entry. In the ONHOOK mode, this pin is set to a high impedance state.</p> | MODEIN | Mode | V _{DD} | Pulse Mode 20 pps | Open (1 MΩ or more) | Pulse Mode 10 pps | GND | DTMF Mode | | | |
| MODEIN | Mode | | | | | | | | | | | | | |
| V _{DD} | Pulse Mode 20 pps | | | | | | | | | | | | | |
| Open (1 MΩ or more) | Pulse Mode 10 pps | | | | | | | | | | | | | |
| GND | DTMF Mode | | | | | | | | | | | | | |

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PIN DESCRIPTIONS

| I/O | Pin No. | | Symbol | Description | | | | | |
|----------|--------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|------------------|--------------|-----|------------|
| | DIP | FPT | | | | | | | |
| Input | 14 | 15 | HKS | <p>Hook switch input pin.</p> <table border="1"> <tr> <td>ONHOOK Mode</td> <td>Open or V_{DD}</td> </tr> <tr> <td>OFFHOOK Mode</td> <td>GND</td> </tr> </table> <p>Output is inhibited in ONHOOK mode, and PULSEOUT, DTMFOUT, BEEPOUT, MUTE, and MODEOUT are set at a high impedance state. All key entries are set to HZ and the on-chip operational amplifier and oscillator (OSCIN = L, OSCOUT = L) become power down states. This pin is pulled up by a high resistance internally. The input level is in the CMOS level.</p> | ONHOOK Mode | Open or V_{DD} | OFFHOOK Mode | GND | |
| | ONHOOK Mode | Open or V_{DD} | | | | | | | |
| | OFFHOOK Mode | GND | | | | | | | |
| | 9 | 10 | OSCIN | <p>Oscillator input pin. In the ONHOOK mode, this pin is pulled to a low level by a high resistance.</p> | | | | | |
| 16 | 17 | FNCT | <p>This pin selects FLASH time period.</p> <table border="1"> <tr> <td>FNCT</td> <td>FLASH output time</td> </tr> <tr> <td>V_{DD}</td> <td>0.6 second</td> </tr> <tr> <td>GND</td> <td>0.2 second</td> </tr> </table> <p>Switching is prohibited during PULSE/DTMF transmission. Input level is in the CMOS level.</p> | FNCT | FLASH output time | V_{DD} | 0.6 second | GND | 0.2 second |
| FNCT | FLASH output time | | | | | | | | |
| V_{DD} | 0.6 second | | | | | | | | |
| GND | 0.2 second | | | | | | | | |
| 17 | 18 | SCNT | <p>This input enables a single-tone output.</p> <table border="1"> <tr> <td>SCNT</td> <td>Single tone output</td> </tr> <tr> <td>V_{DD}</td> <td>Output</td> </tr> <tr> <td>GND</td> <td>Not output</td> </tr> </table> <p>Switching is prohibited during a PULSE/DTMF transmission. Input level is in the CMOS level.</p> | SCNT | Single tone output | V_{DD} | Output | GND | Not output |
| SCNT | Single tone output | | | | | | | | |
| V_{DD} | Output | | | | | | | | |
| GND | Not output | | | | | | | | |
| Output | 10 | 11 | OSCOU | <p>Oscillator output pin. In the ONHOOK mode, this pin is pulled to a low level by a high resistance.</p> | | | | | |
| | 8 | 9 | MODEOUT | <p>The output is in the CMOS level and set to a high impedance state in the ONHOOK mode. Low level is output in the PULSE mode and high level is output in the DTMF mode, including the LDT function. MODEOUT blinks on and off at a frequency of 2.5 Hz typ., if there is no pause before and after mode switching in redial function. When the FLASH key is pressed in either PULSE or DTMF mode, High impedance is output for a 0.6 second (typical) following the BEEP tone output. The key acceptance state (OFFHOOK mode) is now entered.</p> | | | | | |

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PIN DESCRIPTIONS

| I/O | Pin No. | | Symbol | Description |
|--------|---------|-----|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | DIP | FPT | | |
| Output | 12 | 13 | MUTE | <p>N-channel open drain output.</p> <p>In both PULSE and DTMF modes, the MUTE pin is in a high impedance state for the following conditions:</p> <ol style="list-style-type: none"> 1. There is no key entry. 2. After the beep tone is output and the FLASH key is pressed, HZ is output for 0.6 second (typical). 3. During pause output state. (However, when key is pressed, MUTE is low level while beep tone is being output.) 4. During MODEOUT blinking. <p>After key entries become effective in the PULSE or DTMF modes, the MUTE pin is low during output of the beep tone, pulse output (according to numeric key entry), and output of DTMF.</p> |
| | 13 | 14 | BEEPOUT | <p>The output is in CMOS level and the pin is set to a high impedance state unless beep tone is output.</p> <p>In PULSE/DTMF modes, the beep tone is output according to effective key entries.</p> <p>Beep tone is output in 41 ms typ. at 1 kHz in rectangular pulse.</p> |
| | 13 | 14 | PULSEOUT | <p>N-channel open drain output.</p> <p>This pin is in a high impedance state in the ONHOOK mode or DTMF mode. In PULSE mode, this pin is at low for brakes (according to numerical key entries). When the FLASH key is pressed in the PULSE or DTMF mode, a low level is output for 600 ms typ. after the beep tone is sent (even during a PULSE/DTMF send). The key acceptance state (OFFHOOK mode) then returns.</p> |
| | 22 | 24 | DTMFOUT | <p>This DTMFOUT output pin is a bipolar follower that can drive a 100 Ω load between pin and GND.</p> <p>When a single key (numerical, * or #) is pressed in the DTMF modes, dual tone is output.</p> <p>Pressing two or more keys in the same ROW or COL on the keyboard outputs the signal tone in the ROW or COL.</p> <p>If a key in COL4 is pressed, then the DUAL TONE or single tone in the ROW or COL is not output. (Please see Electrical Characteristics.)</p> <p>If the FLASH key is pressed during DTMF sending, the beep tone is output at BEEPOUT and subsequent DTMF tones are not output. The ONHOOK mode is entered for 600 ms typ. after the key acceptance state (OFFHOOK mode) is entered.</p> <p>DUAL TONE output time conditions are as follows:</p> <ol style="list-style-type: none"> 1. 80 ms typ. for redial output 2. 80 ms typ. when the key entry time is within 130 ms typ. and more than the debouncing time 3. DUAL TONE output is stopped at once if a key is pressed longer than 130 ms typ. and released. 4. Signal tone is output from the end of debouncing time until the key is released. <p>This pin is set to a high impedance state unless DTMF tone is output.</p> |

FUNCTIONAL DESCRIPTIONS

Ordinal Dialing

In OFFHOOK mode, PULSE/DTMF signals are output according to the key input, regardless of the number of key input figures. For the PULSE mode, any number of digital entries with keys 0 to 9. For the DTMF mode, any number of digital entries with keys 0 to 9, ***** and **#**.

Up to 26 digits can be stored in the redial memory. In the PULSE mode, a redial digit is counted for any numeric, pause, and LDT entry. In the DTMF mode, a redial digit is counted for any numeric, *****, **#**, and **P** entry.

In both the PULSE and DTMF modes, one digit is counted as mode information when MODEIN is used for mode switching. After OFFHOOK, the first numeric entry is counted as a mode digit. In the PULSE mode the numeric key is counted as a mode digit. In the DTMF mode, a numeric key, *****, and **#** entry is counted as a mode digit. In either OFFHOOK or PULSE modes, the mode-information digit is written into the redial memory.

Redialing Function

The redial memory is read out to execute the redialing operation when a redial key is the first key pressed in OFFHOOK state. In the PULSE mode, the redial keys are **#** and *****. In the DTMF mode, only the **RED** key is accepted for redial.

When 27 or more digits are written into the redial memory, PULSE or DTMF signals that correspond to the key entries are output, but the redialing operation is ineffective because of memory overflow. At this time, even if the first key pressed after the state change from ONHOOK to OFFHOOK is the redial key, the entry is not accepted and the beep tone is not output in either mode of operation.

After OFFHOOK, if a numeric or LDT key is the first entry in PULSE mode, or the first entry in the DTMF mode is a numeric, *****, **#** or a single-tone key entry (excluding COL4), the redial memory is cleared and data is written into memory according to key entry information.

Mixed Redialing

Mixed redialing is executed when the mode is changed from the PULSE to DTMF mode (done by pressing the LDT key), or when MODE is changed during key entries.

If, at redialing, there is a pause before or after mode switching (including LDT), PULSE/DTMF is sent and PULSE/DTMF signals are transmitted after the pause. To redial when there is no pause before or after mode switching (including LDT), all operations must cease after mode switching and a HALT state is enabled. MODEOUT blinks (indicates that mode switching has no automatic pause) and prompts a pause release.

The pause release keys in PULSE mode are *****, **RED**, and the **P** key. In the DTMF mode, the **RED** and the **P** keys are used for pause release. PULSE and DTMF signals can now be sent by key entry. The FLASH key is the only other acceptable entry.

During redial output, the **F** key is the only key entry accepted. The pause release key is only accepted when MODEOUT is blinking or during a pause at redialing.

Mode Switching

During PULSE or TONE transmissions, mode switching by MODEIN is not permitted; after transmission is complete, MODEIN can be used for mode switching.

When PULSE or DTMF modes are switched by MODEIN, one digit is stored into redial memory as mode information. After OFFHOOK, if the first key entry is numeric in the PULSE mode, or a numeric ***** or **#** in the DTMF mode, the mode-information digit is written into redial memory.

In the PULSE mode, after the LDT key is accepted only one time, the DTMF mode is selected (regardless of MODEIN pin switching). The LDT key is not accepted in the DTMF mode. The MODEIN pin switching enables the desired mode of operation to be selected.

Line Dial Tone (LDT) Function

If the LDT key is pressed in the PULSE mode, the DTMF mode is selected and DTMF tones can be output. In PULSE mode, only the first LDT key is accepted after key acceptance state (OFFHOOK mode) is entered. Once LDT key is accepted, the following LDT key entries are ignored.

When the LDT key is used to enter the DTMF mode, all keys (excluding COL4 keys) provide dual-tone and single-tone outputs. (Note. If even one COL4 key is pressed, neither dual nor single tones are output.) The mode after that is not switched. If mode switching by LDT from memory is done during redialing, key entries after redialing are executed in DTMF mode regardless of the MODEIN state and the data is written into the redial memory. However, for effective keys (not the redial key) after ONHOOK changes to OFFHOOK, memory is reset and written in the current mode.

Pause Function

A pause state can be entered by pause key entry.

In the PULSE mode, a pause is introduced by pressing the # or P keys; in the DTMF mode (including LDT) only the P key is effective. If a pause key is the first key pressed after changing from ONHOOK to OFFHOOK, the entry is not accepted. One pause key entry introduces a pause state that is typically 4 seconds; contiguous pause (N X 4 seconds) can be executed by making consecutive key entries. The pause can be reduced by entering P or RED during a redialing pause time.

In the PULSE mode, the * key is used as a pause release key. Multiple pauses can be sent up to 500 times faster by entering a pause release key, that is, N X 4 seconds becomes N X 800 milliseconds.

Flash Function

Keyboard entries enable ONHOOK mode. Only the F key is used as a FLASH key in both PULSE and DTMF modes (including LDT).

When the F key is pressed, the ONHOOK mode is entered for 600 milliseconds (typical) after beep tone is sent. During this time, the key entry pin is not accepted. MODEIN, MUTE, MODEOUT, and DTMF/BEEPOUT pins are placed in the high-impedance state and the PULSEOUT pin is set low level. After 600 milliseconds (typical), the return of OFFHOOK is automatic and key entries can again be accepted.

Test (High-speed Mode)

A test mode circuit is built into the IC. In the ONHOOK state, pins OSCIN and OSCOUT are pulled down by a high resistance. To activate the test mode, tie the OSCIN high and apply clock signal to OSCOUT. The internal circuit operates up to 128 times faster than normal operation.

Figure 2. Keyboard Configuration

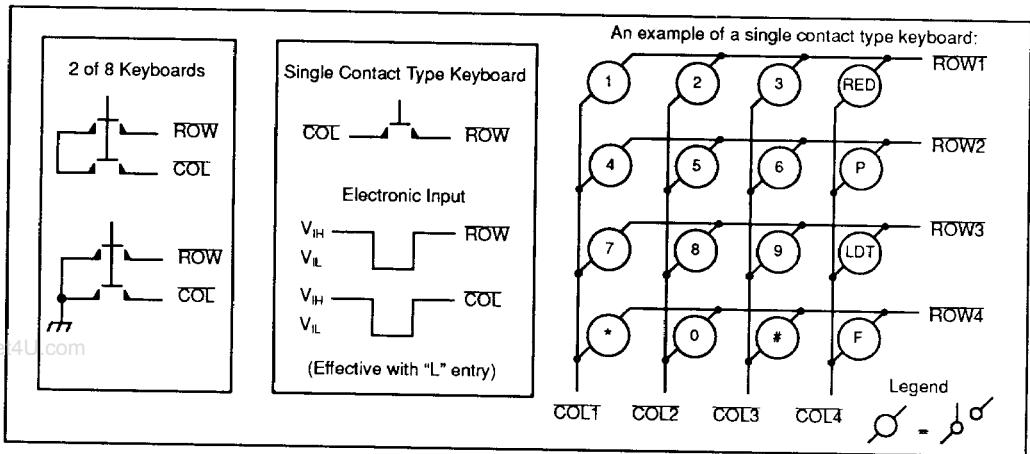
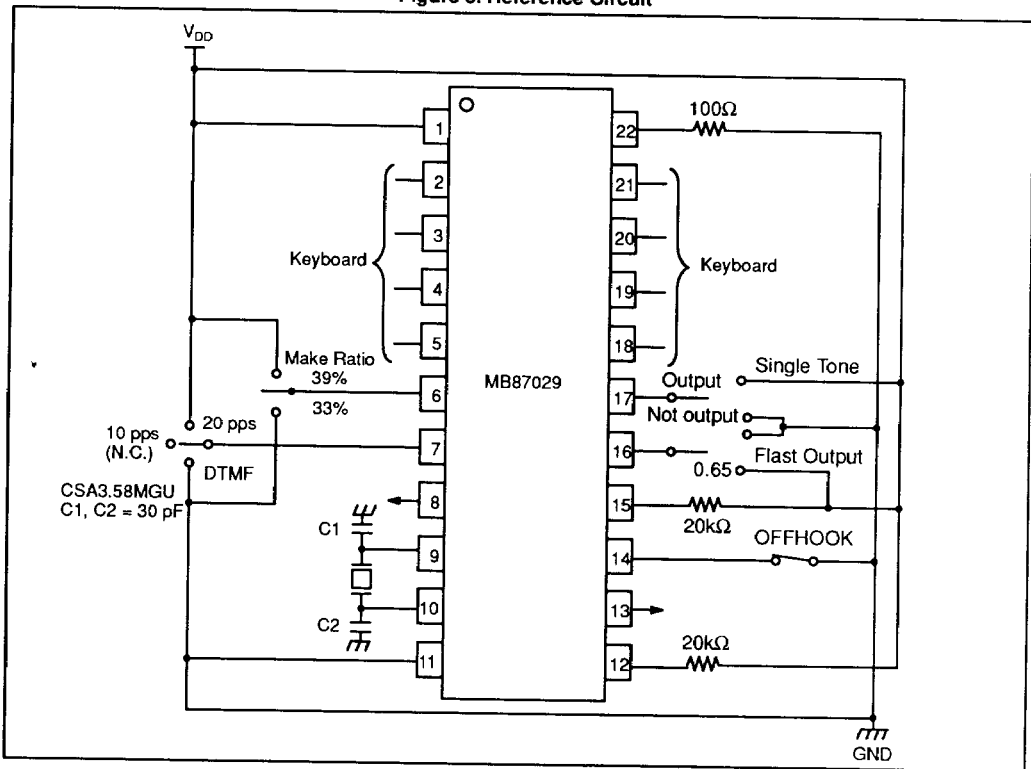


Figure 3. Reference Circuit



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KEY OPERATION DIAGRAM

| | | | | | | |
|---------------------------------|---|---------|---|-------|----|----------|
| Redial key for PULSE mode | : | RED (P) | = | RED | or | # |
| Redial key for DTMF mode | : | RED (D) | = | RED | | |
| Pause key for PULSE mode | : | P (P) | = | P | or | # |
| Pause key for DTMF mode | : | P (D) | = | P | | |
| Pause release key of PULSE mode | : | PR (P) | = | RED | , | P , or * |
| Pause release key of DTMF mode | : | PR (D) | = | RED | or | P |
| Pause output | : | P | = | Pause | | |

KEY ENTRIES IN PULSE MODE

When MODEIN is set to 10 pps

| HOOK | MODEIN | Key Entry | PULSE Output | | DTMF Output |
|------|-----------------|-----------|--------------|-------|-------------|
| | | | 10pps | 20pps | |
| ON | | 1 2 | 1-2 | | |
| OFF | OPEN | RED (P) | 1-2 | | |
| ON | | 3 | 3 | | |
| OFF | OPEN | RED (P) | 1-2-3 | | |
| ON | V _{DD} | RED (P) | 1-2-3 | | |
| OFF | GND | RED (D) | 1-2-3 | | |
| ON | | 4 | | | 4 |
| OFF | | | | | |

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KEY ENTRIES IN PULSE MODE

When MODEIN is set to 20 pps

| HOOK | MODEIN | Key Entry | PULSE Output | | DTMF Output |
|------|-----------------|-----------|--------------|-------|-------------|
| | | | 10pps | 20pps | |
| ON | V _{DD} | 1 2 | | | |
| OFF | | | | | 1-2 |
| ON | V _{DD} | RED (P) | | | |
| OFF | | | | | 1-2 |
| | | 3 | | | 3 |
| ON | V _{DD} | RED (P) | | | |
| OFF | | | | | 1-2-3 |
| ON | OPEN | RED (P) | | | |
| OFF | | | | | 1-2-3 |
| ON | GND | RED (D) | | | |
| OFF | | | | | 1-2-3 |
| | | 4 | | | 4 |

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KEY ENTRIES IN DTMF MODE

| HOOK | MODEIN | Key Entry | PULSE Output | | DTMF Output |
|------|--------|-----------|--------------|-------|-------------|
| | | | 10pps | 20pps | |
| ON | GND | 1 2 | | | |
| OFF | | | | | 1-2 |
| ON | GND | RED (D) | | | |
| OFF | | | | | 1-2 |
| | | 3 | | | 3 |
| ON | GND | RED (D) | | | |
| OFF | | | | | 1-2-3 |
| ON | OPEN | RED (P) | | | |
| OFF | | | | | 1-2-3 |
| ON | GND | RED (P) | | | |
| OFF | | | | | 1-2-3 |
| | | 4 | | | 4 |

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KEY ENTRIES WHEN THE LDT KEY IS USED

When there is a pause before LDT

| HOOK | MODEIN | Key Entry | PULSE Output | | DTMF Output |
|------------------------|-----------------|--------------------|--------------|-------|-------------|
| | | | 10pps | 20pps | |
| ON OFF ON | OPEN | 1 2 P (P) LDT 3 | 1-2-Ⓟ | | 3 |
| OFF ON ON OFF | GND | RED (P) 4 | 1-2-Ⓟ | | 3 4 |
| ON OFF ON | V _{DD} | RED (P) | 1-2-Ⓟ | | 3-4 |
| OFF | GND | RED (D) | 1-2-Ⓟ | | 3-4 |

KEY ENTRIES WHEN THE LDT KEY IS USED

When there is a pause after LDT

| HOOK | MODEIN | Key Entry | PULSE Output | | DTMF Output |
|------------------------|-----------------|--------------------|--------------|-------|-------------|
| | | | 10pps | 20pps | |
| ON OFF ON | OPEN | 1 2 LDT P (D) 3 | 1-2 | | Ⓟ-3 |
| OFF ON ON OFF | GND | RED (P) 4 | 1-2 | | Ⓟ-3 4 |
| ON OFF ON | V _{DD} | RED (P) | 1-2 | | Ⓟ-3-4 |
| OFF | GND | RED (D) | 1-2 | | Ⓟ-3-4 |

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KEY ENTRIES WHEN THE LDT KEY IS USED

When there is no pause before and after LDT

| HOOK | MODEIN | Key Entry | PULSE Output | | DTMF Output |
|-----------|-----------------|--------------------------|-----------------------|-------|-------------|
| | | | 10pps | 20pps | |
| ON OFF | OPEN | (1) (2) LDT (3) | 1-2 | | 3 |
| ON OFF | OPEN | RED (P) PR (D) (4) | 1-2-MODEOUT blinks | | 3 4 |
| ON OFF | V _{DD} | RED (P) PR (D) | 1-2-MODEOUT blinks | | 3-4 |
| ON OFF | GND | RED (D) PR (D) | 1-2-MODEOUT blinks | | 3-4 |

KEY ENTRIES WHEN PULSE/DTMF MODE IS SWITCHED (MIXED REDIAL)

When there is a pause before mode switching

| HOOK | MODEIN | Key Entry | PULSE Output | | DTMF Output |
|-----------|----------------------------------------|----------------------------------------------------------|----------------|---------|-------------|
| | | | 10pps | 20pps | |
| ON OFF | OPEN V _{DD} GND OPEN | (1) (2) P (P) (3) (4) P (P) (5) * P (D) (6) (7) | 1-2-(P) | 3-4-(P) | 5-*(P) |
| ON OFF | OPEN | RED (P) | 1-2-(P) 6-7 | 3-4-(P) | 5-*(P) |
| ON OFF | V _{DD} | RED (P) | 1-2-(P) 6-7 | 3-4-(P) | 5-*(P) |
| ON OFF | GND | RED (D) | 1-2-(P) 6-7 | 3-4-(P) | 5-*(P) |

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KEY ENTRIES WHEN PULSE/DTMF MODE IS SWITCHED (MIXED REDIAL)

When there is a pause after mode switching

| HOOK | MODEIN | Key Entry | PULSE Output | | DTMF Output |
|-----------|----------------------------------------|--------------------------------------------|----------------------------------|-------------------------------|-------------------------------|
| | | | 10pps | 20pps | |
| ON OFF | OPEN V _{DD} GND OPEN | 1 2 P (P) 3 4 P (D) 5 * P (P) 6 7 | 1-2 P-6-7 | P-3-4 | P-5-* |
| ON OFF | OPEN V _{DD} | RED (P) RED (P) | 1-2 P-6-7 1-2 P-6-7 | P-3-4 P-3-4 | P-5-* |
| ON OFF | GND | RED (D) | 1-2 P-6-7 | P-3-4 | P-5-* |
| ON OFF | OPEN V _{DD} GND OPEN | 1 2 3 4 5 * 6 7 | 1-2 6-7 | 3-4 | 5-* |
| ON OFF | OPEN V _{DD} | RED (P) PR (P) PR (D) PR (P) | 1-2-MODEOUT blinks 6-7 | 3-4-MODEOUT blinks | 5-*-MODEOUT blinks |
| ON OFF | GND | RED (D) PR (P) PR (D) PR (P) | 1-2-MODEOUT blinks 6-7 | 3-4-MODEOUT blinks | 5-*-MODEOUT blinks |

REDIAL MEMORY INHIBIT FUNCTION

| HOOK | MODEIN | Key Entry | PULSE Output | | DTMF Output |
|------|-----------------|---------------------------------------------|---------------------------------|-------|---------------------------------|
| | | | 10pps | 20pps | |
| ON | | | | | |
| OFF | OPEN | $\underbrace{1\ 1 \dots 1\ 1}_{25}$ | $\underbrace{1-1\dots1-1}_{25}$ | | |
| ON | OPEN | RED (P) | | | |
| OFF | OPEN | | $\underbrace{1-1\dots1-1}_{25}$ | | |
| ON | OPEN | $\underbrace{1\ 1 \dots 1\ 1}_{26}$ | $\underbrace{1-1\dots1-1}_{26}$ | | |
| OFF | OPEN | RED (P) | No output | | |
| | | 2 | 2 | | |
| ON | OPEN | RED (P) | 2 | | |
| ON | V _{DD} | RED (P) | 2 | | |
| ON | GND | RED (D) | 2 | | |
| OFF | | 3 | | | 3 |
| ON | OPEN | LDT 1 1 ... $\underbrace{1\ 1}_{25}$ | | | $\underbrace{1-1\dots1-1}_{25}$ |
| ON | OPEN | RED (P) | | | $\underbrace{1-1\dots1-1}_{25}$ |
| OFF | OPEN | 1 1 LDT 1 1 ... $\underbrace{1\ 1}_{23}$ | 1-1 | | $\underbrace{1-1\dots1-1}_{23}$ |
| ON | OPEN | | No output | | No output |
| OFF | OPEN | RED (P) | | | |

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RECOMMENDED OPERATING CONDITIONS

| Parameter | Symbol | Pin Name | Condition | Value | | | Unit |
|------------------------|----------|------------|--------------------------------------|-------|-----|----------|-------------|
| | | | | Min | Typ | Max | |
| Power Supply Voltage | V_{DD} | V_{DD} | PULSE mode and memory retention mode | 2.0 | | 6.0 | V |
| | | | DTMF mode | 2.5 | | 6.0 | V |
| Input Voltage | V_I | All Inputs | | 0 | | V_{DD} | V |
| Output Load Resistance | R_O | DTMFOUT | Between output pin and GND | 0.1 | | 20 | $k\Omega$ |
| Operating Temperature | T_A | | | -30 | | 60 | $^{\circ}C$ |

ELECTRICAL CHARACTERISTICS

V_{DD}: PULSE mode = 2.0 to 6.0 V, V_{DD}: DTMF mode = 2.5 to 6.0 V, TA = -30 to 60°C

| Parameter | Symbol | Pin Name | Condition | Value | | | Unit | |
|---------------------------------|------------------|------------------------------------|--------------------------------------------------------|-------------------------------------|-----|----------------------|------|----|
| | | | | Min | Typ | Max | | |
| Power Supply Current | I _{DD} | V _{DD} | All output pins are open in DTMF mode | | 2.5 | 5.0 | mA | |
| | I _{DP} | | All output pins are open in PULSE mode | | 1.0 | 2.0 | mA | |
| | I _{DST} | | All output pins, HKS pin open in Standby | | 1.5 | 10 | μA | |
| | I _{DD1} | | V _{DD} = 2.5V TA = 25°C | All output pins open in DTMF | | 1.0 | 2.0 | mA |
| | I _{DP1} | | | All output pins open in PULSE | | 0.3 | 0.6 | mA |
| | TDST1 | | | All output pins HKS open in Standby | | 0.2 | 1.0 | μA |
| Digital Input Voltage 1 | V _{IH1} | COL1 to COL4 ROW1 to ROW4 | | 0.8 V _{DD} | | V _{DD} | V | |
| | V _{IL1} | | | 0 | | 1/5 V _{DD} | V | |
| Digital Input Voltage 2 | V _{IH2} | HKS, FCNT MODEIN, SCNT MA/BR | | 0.8 V _{DD} | | V _{DD} | V | |
| | V _{IL2} | | | 0 | | 1/5 V _{DD} | V | |
| Digital Input Current 1 | I _{IH1} | COL1 to COL4 ROW1 to ROW4 | V _I = V _{DD} | -0.01 | | 1/5 V _{DD} | mA | |
| | I _{IL1} | | V _I = GND | -0.01 V _{DD} | | 0.01 | mA | |
| Digital Input Leakage current 1 | I _{Iz1} | | Key entry HZ GND ≤ V _I ≤ V _{DD} | -10 | | 10 | μA | |
| Digital Input Current 2 | I _{IH2} | MODEIN | V _I = V _{DD} | -0.01 | | 1/75 V _{DD} | mA | |
| | I _{IL2} | | V _I = GND | -1/75 V _{DD} | | 0.01 | mA | |
| Digital Input Leakage current 2 | I _{Iz2} | | MODEIN HZ GND ≤ V _I ≤ V _{DD} | -10 | | 10 | μA | |
| Digital Input Current 3 | I _{IL3} | MA/BR, SCNT, FCNT | V _I = GND | -10 | | 10 | μA | |
| | I _{IH3} | HKS, MA/BR, SCNT, FCNT | V _I = V _{DD} | -10 | | 10 | μA | |

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ELECTRICAL CHARACTERISTICS

| Parameter | Symbol | Pin Name | Condition | Value | | | Unit |
|--------------------------------------------------------------------|-------------------|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|-----------------------|------------------------------|-----------------|------------------|
| | | | | Min | Typ | Max | |
| Pull-up Resistor | RPLU | HKS | | 100 | 200 | 400 | kΩ |
| Digital Output Voltage | V _{OH} | MODEOUT BEEPOUT | I _{OH} = -0.2mA | V _{DD} - 0.5 | | V _{DD} | V |
| | V _{OL} | MODEOUT, PULSEOUT, MUTE, BEEPOUT | I _{OL} = 0.5mA | 0 | | 0.5 | V |
| Digital Output Off Leakage Current | I _{OL} | MUTE, PULSEOUT, MODEOUT, BEEPOUT | GND ≤ V _O ≤ V _{DD} | -10 | | 10 | μA |
| External Resistance when digital input is open | R _{DIO} | ROW1 TO ROW4 COL1 to COL4 HKS, MODEIN | Resistance connected to external circuit when input is open. The other end of the resistance must be between 0 V and V _{DD} . | 1 | | | MΩ |
| Pull-down Resistance | R _{PLD} | OSCIN, OSCOUT | ONHOOK mode | 75 | 150 | 300 | kΩ |
| Oscillator Frequency | O _{SCIN} | | | | | 3.579545 | |
| DTMF Output Voltage 100Ω placed between output pin and GND. | A _{OUT} | DTMFOUT | No signal is output | | 0 | | V |
| | | | Offset voltage when signals are output | | 0.6 V _{DD} -0.75 | | V |
| | | | DTMF TONE output voltage | | 1.44 | | V _{p-p} |
| | | | ROW single tone output voltage | | 0.64 | | V _{p-p} |
| | | | COLUMN single tone output voltage | | 0.80 | | V _{p-p} |
| | | | COLUMN/ROW tone ratio | | 2.0 | | dB |
| Redial Memory Digit | N _{RKEY} | COL1 to COL4 ROW1 to ROW4 | | | | 26 | digits |
| Make Ratio | W _{MAKE} | PULSEOUT | MA/BR = V _{DD} | | 39 | | % |
| | | | MA/BR = GND | | 33 | | % |
| Oscillation Start time | t _{OSS} | OSCIN, OSCOUT | | 0 | 8 | 16 | ms |
| Oscillation Stop time | t _{OSSP} | | | 0 | 8 | 16 | ms |

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ELECTRICAL CHARACTERISTICS

| Parameter | Symbol | Pin Name | Condition | Value | | | Unit | |
|------------------------------------------------------|-------------|------------------------------|-----------------|-----------------|------|------|------|----|
| | | | | Min | Typ | Max | | |
| Key Entry HZ Hold time | t_{HZKH} | COL1 to COL4 ROW1 TO ROW4 | | 0 | | 5 | ms | |
| MODEIN HZ Hold time | t_{HZMIH} | MODEIN | | 0 | | 5 | ms | |
| MODEOUT HZ Hold time | t_{HZMOH} | MODEOUT | | 0 | | 5 | ms | |
| Key Entry HZ Start time | t_{HZKS} | COL1 to COL4 ROW1 TO ROW4 | | 0 | | 5 | ms | |
| MODEIN HZ Start time | t_{HZMIS} | MODEIN | | 0 | | 5 | ms | |
| MODEOUT HZ Start time | t_{HZMOS} | MODEOUT | | 0 | | 5 | ms | |
| Pause Time | t_{PAS} | PULSEOUT, DTMFOUT | | 3.85 | 4.0 | 4.15 | s | |
| MODEOUT Switch Start time 1 | t_{MOC1} | MODEOUT | | | 12 | | ms | |
| MODEOUT Switch Start time 2 | t_{MOC2} | | | 2 | 5 | 8 | ms | |
| MODEOUT HZ Start Time by F key entry | t_{MOSF} | | | | 72 | | ms | |
| MODEOUT HZ Hold Time by F key entry | t_{MOFH} | | FCNT = V_{DD} | 0.59 | 0.6 | 0.61 | s | |
| | | | FCNT = GND | 0.09 | 0.1 | 0.11 | | |
| MODEOUT Blinking Period | t_{MOSI} | | | 0.39 | 0.4 | 0.41 | s | |
| MODEOUT Change Start time by pause release key entry | t_{MOPS} | | | | 28 | | ms | |
| DTMFOUT Output Start time when mode is switched | t_{MST} | | DTMFOUT | | 2 | 10 | 15 | ms |
| DTMF Output Start time by pause release key entry | t_{PDT} | | | | | 39 | | ms |
| PULSEOUT Output Hold time by F key entry | t_{PUFH} | | PULSEOUT | FCNT = V_{DD} | 0.59 | 0.6 | 0.61 | s |
| | | FCNT = GND | | 0.09 | 0.1 | 0.11 | | |
| PULSEOUT OUTPUT Start time by F key entry | t_{PUFS} | | | 72 | | ms | | |

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ELECTRICAL CHARACTERISTICS

| Parameter | Symbol | Pin Name | Condition | Value | | | Unit | |
|-------------------------------|-------------|------------------------------|------------------|-------------|-------|-------|------|----|
| | | | | Min | Typ | Max | | |
| Key Entry Width1 | t_{WK1} | COL1 to COL4 ROW1 TO ROW4 | | 50 | | | ms | |
| Key Entry Width2 | t_{WK2} | | | 50 | | | ms | |
| Key Input Pause Time | t_{PK} | | | 50 | | | ms | |
| Key Entry Debouncing time | t_{CH} | | | 21 | 23 | 25 | ms | |
| Key Entry Release Guard time | t_{RE} | | | 21 | 23 | 25 | ms | |
| BEEP TONE Output Start time | t_{BES} | DTMF/BEEPOUT | | | 31 | | ms | |
| BEEP TONE Output Width | t_{WBE} | | | 39 | 41 | 43 | ms | |
| MUTE LOW Output Start time | t_{MUS} | MUTE | | | 31 | | ms | |
| MUTE LOW Output Hold time 1 | t_{MUSP1} | | 10 pps | 26 | 30 | 34 | ms | |
| | | | 20 pps | 13 | 15 | 17 | | |
| | | | Dual Tone Output | 100 | 110 | 120 | | |
| Pulse Predigital Pause Time | t_{PDP} | PULSEOUT | MA/BR = V_{DD} | 10 pps mode | 950 | 980 | 1016 | ms |
| | | | | 20 pps mode | 480 | 510.5 | 556 | |
| | | | MA/BR = GND | 10 pps mode | 950 | 974 | 1016 | ms |
| | | | | 20 pps mode | 480 | 507.5 | 556 | |
| Pulse Make Width | t_{WMA} | | MA/BR = V_{DD} | 10 pps mode | 38 | 39 | 40 | ms |
| | | | | 20 pps mode | 19 | 19.5 | 20 | |
| | | | MA/BR = GND | 10 pps mode | 32 | 33 | 34 | ms |
| | | | | 20 pps mode | 16 | 16.5 | 17 | |
| Pulse Break Width | t_{WBR} | | MA/BR = V_{DD} | 10 pps mode | 60 | 61 | 62 | ms |
| | | | | 20 pps mode | 30 | 30.5 | 31 | |
| | | | MA/BR = GND | 10 pps mode | 66 | 67 | 68 | ms |
| | | | | 20 pps mode | 33 | 33.5 | 34 | |
| Pulse Interdigital Pause Time | t_{IDP} | | MA/BR = V_{DD} | 10 pps mode | 900 | 939 | 960 | ms |
| | | | | 20 pps mode | 450 | 469.5 | 480 | |
| | | MA/BR = GND | 10 pps mode | 900 | 933 | 960 | ms | |
| | | | 20 pps mode | 450 | 466.5 | 480 | | |

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ELECTRICAL CHARACTERISTICS

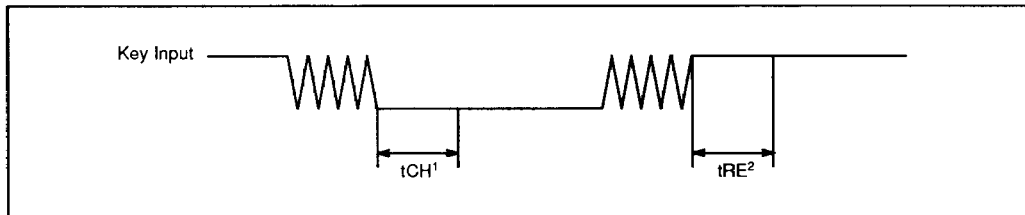
| Parameter | Symbol | Pin Name | Condition | Value | | | Unit |
|-------------------------------------|--------------------|---------------|------------------------|-------|-----|-----|------|
| | | | | Min | Typ | Max | |
| MUTE LOW Output Hold time 2 | t _{MUSP2} | MUTE | Single Tone Output | 0 | | 8 | ms |
| DUAL TONE Output Time | t _{WDT} | DTMF/BEEP/OUT | | 78 | 80 | 82 | ms |
| DTMF Interpause Time | t _{DTP} | | | 78 | 80 | 82 | ms |
| Single Tone Output start time | t _{SIS} | | SCNT = V _{DD} | | 31 | | ms |
| Single Tone Output stop time | t _{SISP} | | | 0 | | 45 | ms |
| DUAL TONE Output start time | t _{DTS} | | | | 39 | | ms |
| DUAL TONE Output stop time | t _{DTSP} | | | 0 | | 5 | ms |
| MUTE Hold Time 1 by PAUSE key entry | t _{PSM1} | | MUTE | | 0 | 10 | 20 |
| MUTE Hold Time 2 by PAUSE key entry | t _{PSM2} | | | 75 | 90 | 105 | ms |
| MODEOUT Blinking Start time | t _{MOST} | MODEOUT | | 0 | 5 | 10 | ms |

DTMF OUTPUT SIGNALS

| Item | Symbol | Standard DTMF (Hz) | DTMF Output Signal* (Hz) | Error to standard TDMF (%) |
|------|--------|--------------------|--------------------------|----------------------------|
| ROW1 | FR1 | 697 | 696.95 | -0.01 |
| ROW2 | FR2 | 770 | 770.13 | +0.02 |
| ROW3 | FR3 | 852 | 852.27 | +0.03 |
| ROW4 | FR4 | 941 | 940.99 | -0.01 |
| COL1 | FC1 | 1209 | 1209.31 | +0.03 |
| COL2 | FC2 | 1336 | 1335.65 | -0.03 |
| COL3 | FC3 | 1477 | 1476.71 | -0.02 |

Note: *Oscillation frequency 3.579545 MHz

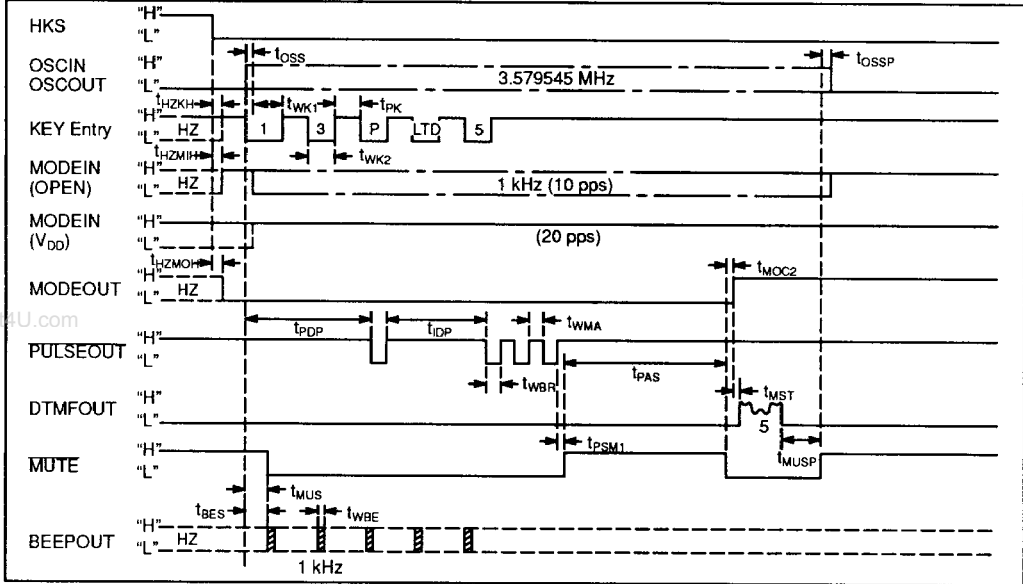
Figure 4. Key Input Timing



- Notes:** ¹ Key Input Debouncing Time t_{CH}
Key entry is accepted if low level is longer than 23 ms typ.
² Key Input Release Guard Time t_{RE}
Key release is recognized if low level is longer than 23 ms typ.

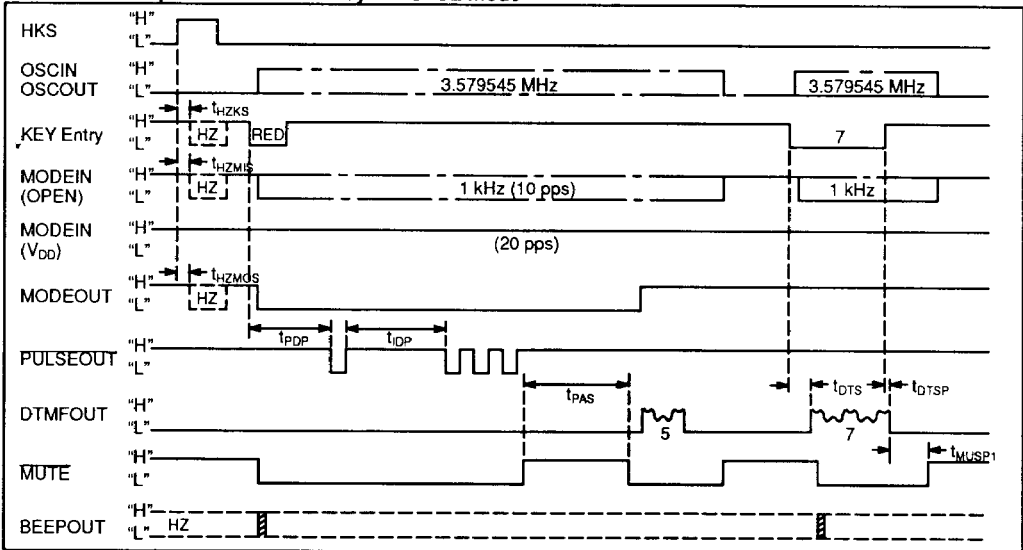
TIMING CHART 1-A

When there is a pause before LDT key in PULSE mode



TIMING CHART 1-B

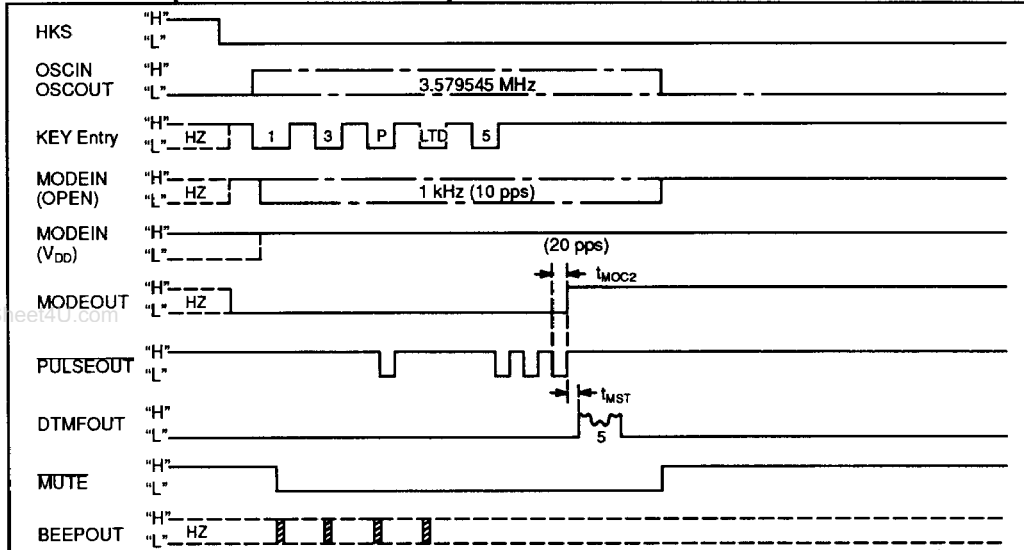
When there is a pause before LDT key in PULSE mode



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TIMING CHART 2-A

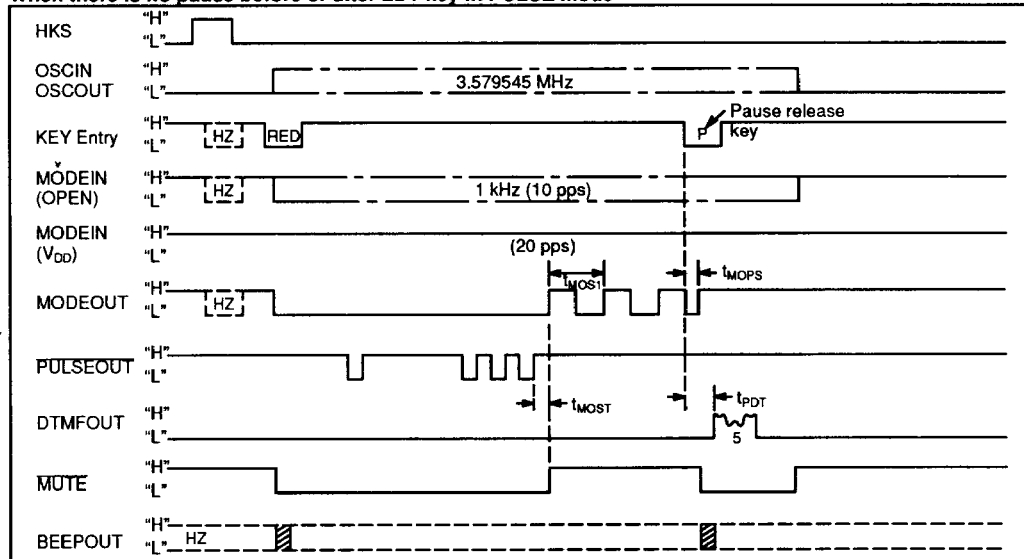
When there is no pause before or after LDT key in PULSE mode



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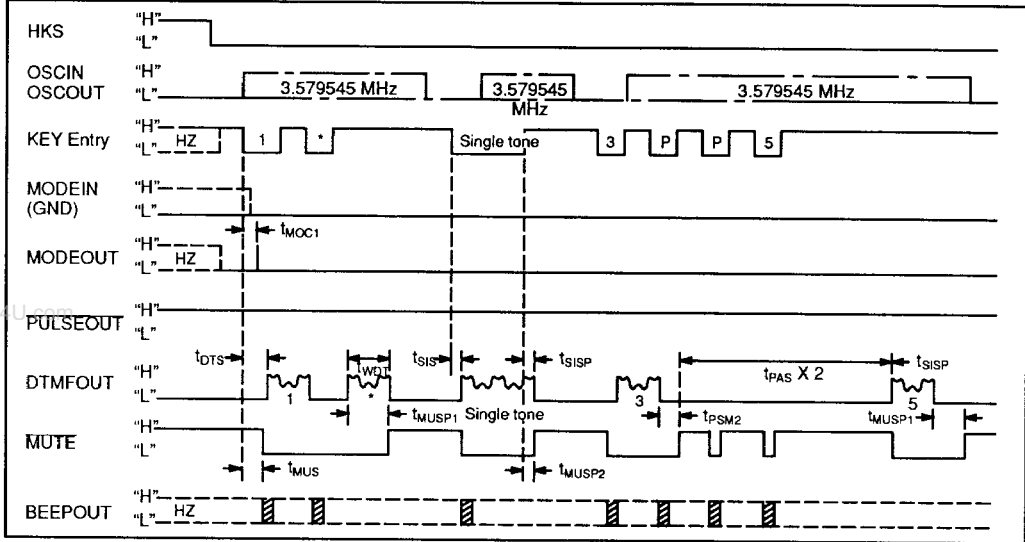
TIMING CHART 2-B

When there is no pause before or after LDT key in PULSE mode



TIMING CHART 3-A

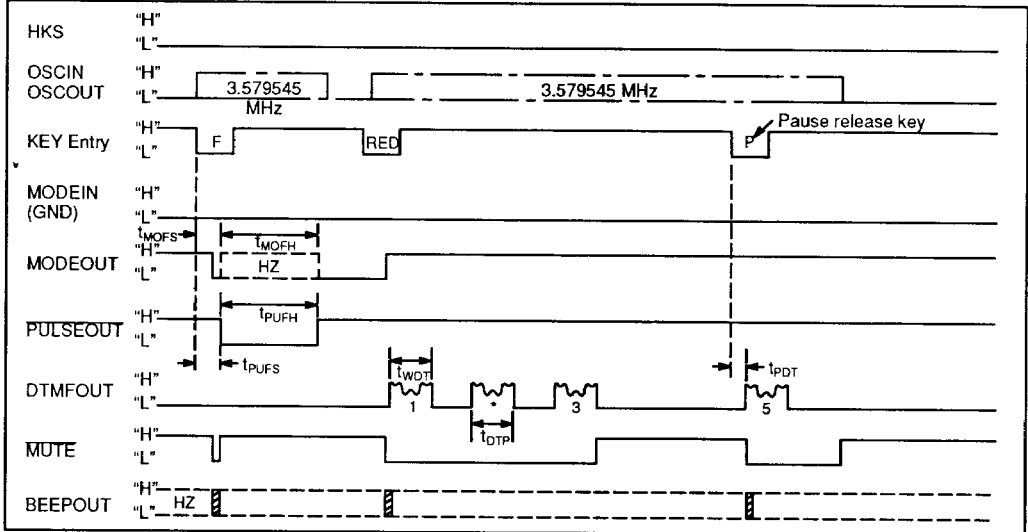
In DTMF mode



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TIMING CHART 3-B

In DTMF mode



PACKAGE DIMENSIONS

