# PULSE/DTMF SWITCHABLE REPERTORY DIALER

The S-7241 Series is a CMOS dialer, which generates signals required for DTMF/PULSE dialing. It has a 20-number × 16-digit repertory memory and 32-digit redial memory, so one-touch dialing and abbreviated dialing are available.

## ■ Features

- Low operating current
- Low standby current
- Wide operating voltage range
- 3.579545-MHz oscillator
- Selectable make/break ratio of 33% and 40%
- Selectable dial speed of 10 pps and 20 pps in PULSE mode
- Built-in 20-number × 16-digit (or 15-digit including DTMF mode) repertory memory
- Built-in 32-digit (or 31-digit including DTMF mode) redial memory
- Key-in-tone output responding to a valid key-input in PULSE/DTMF mode

## ■ Functions

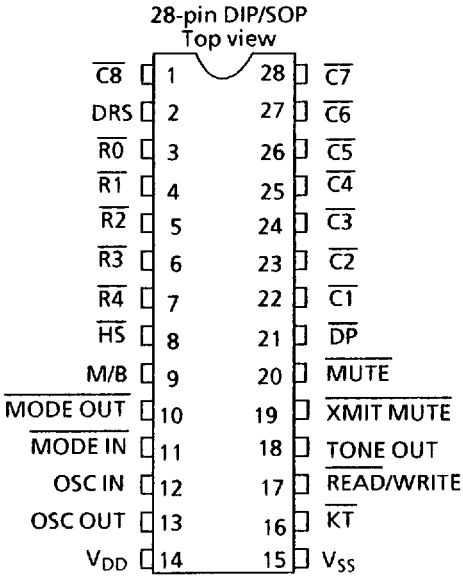
- Redialing inhibition
- Setting of pause time
- 20-key one-touch dialing and abbreviated dialing
- Repertory dialing and normal dialing after repertory dialing
- Mode selection of PULSE and DTMF modes and mode change from PULSE mode to DTMF mode
- Protection of memory misread or miswrite by $\overline{\text{READ}}$/WRITE
- Flash. Write to redial memory and repertory memories

## ■ Timing Selection

Table 1

| Item | Symbol | A2 | B2 | C2 | D2 | E2 | F2 |
|---|---|---|---|---|---|---|---|
| Memory registration | — | On-hook | Off-hook | On-hook | On-hook | On-hook | Off-hook |
| Flash time | $t_{FL}$ | 601.5 ms | 865.1 ms | 108.1 ms | 108.1 ms | 865.1 ms | 601.5 ms |
| Flash-pause time | $t_{FLP}$ | 1.0 s | 1.0 s | 1.0 s | 2.0 s | 1.0 s | 1.0 s |
| Auto-access pause time | $t_{AP}$ | 3.6 s | 2.0 s | 2.0 s | 3.6 s | 2.0 s | 3.6 s |
| DTMF signal inter-digital pause time | $t_{idp}$ | 67.6 ms | 67.6 ms | 67.6 ms | 81.1 ms | 67.6 ms | 67.6 ms |

## ■ Pin Arrangement




| | |
|---|---|
| R0 to R4, C1 to C8 | Key input |
| HS | Hook switch on/off input |
| M/B | Make ratio selection input |
| MODE OUT | Operation mode output |
| MODE IN | Mode change input |
| OSC IN | Oscillator connection input |
| OSC OUT | Oscillator connection output |
| DP | Dial pulse output |
| DRS | Dial speed selection input |
| MUTE | Mute output |
| XMUTE | Transmit mute output |
| TONE OUT | DTMF signal output |
| READ/WRITE | Memory read or write input |
| KT | Key-in-tone output |

Figure 1

## ■ Block Diagram

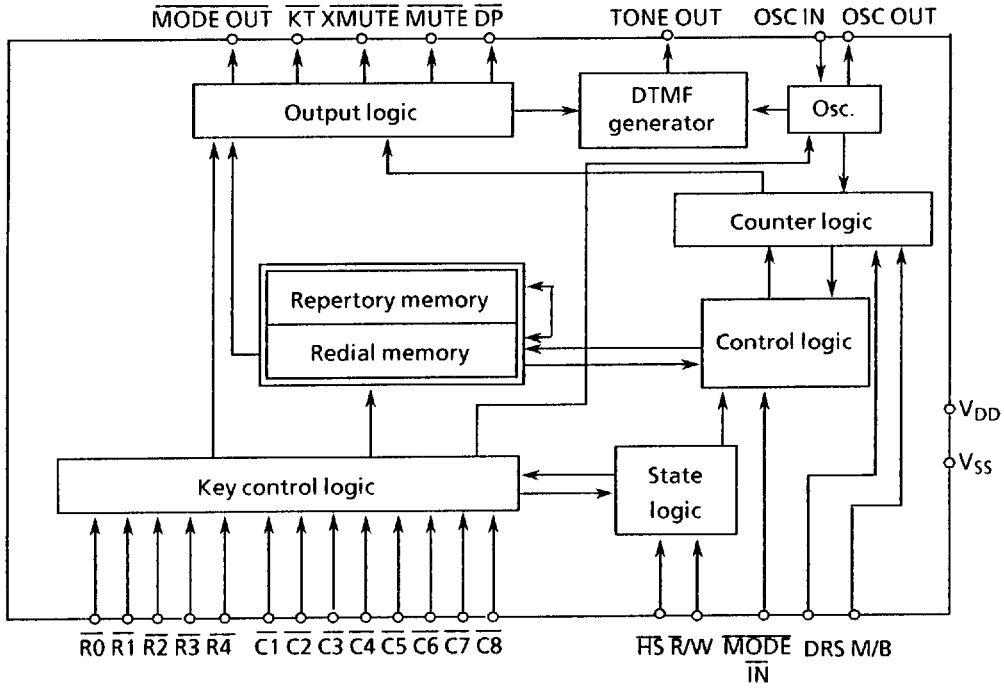



Figure 2

## ■ Application Circuit

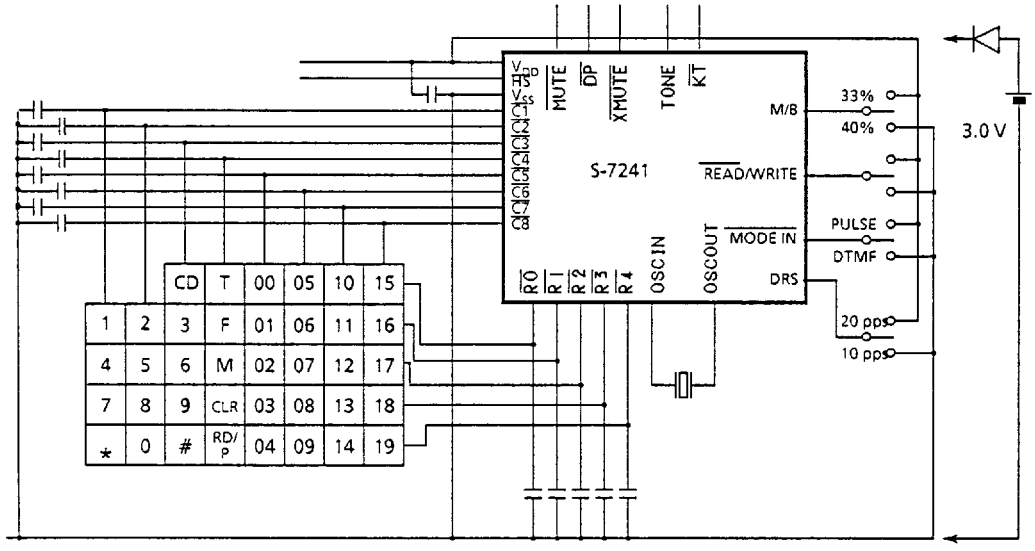
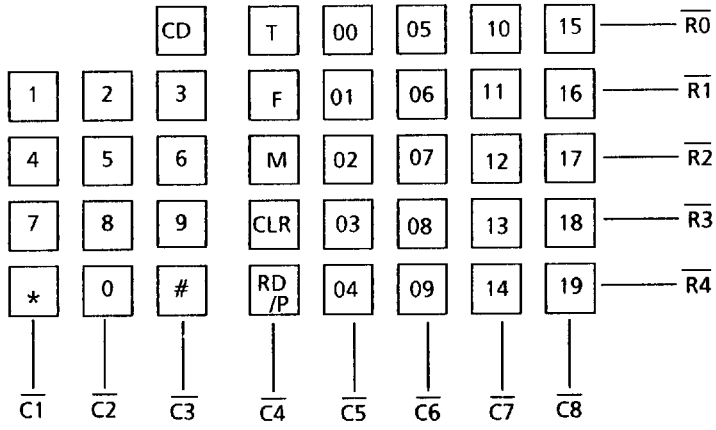



Figure 3

## ■ Keyboard Matrix




CD: Call disconnect
T: Mode change from PULSE to DTMF
F: Flash
M: Abbreviated dialing, and registration of abbreviated number
CLR: Redialing inhibition, and clear of repertory memory data
RD/P: Redial and pause
0 to 9: Data
#, *: Data (only in DTMF mode)
00 to 19: One-touch dialing address

## ■ Key Operation

[D] : Data

[P] : Access-pause

[RD] : Redialing

[Aij] : One-touch dialing address

[00] to [19]

[Aij] = [M][Di][Dj] : Abbreviated dialing data

↑ : Off-Hook($\overline{HS}$ = "L")

↓ : On-Hook($\overline{HS}$ = "H")

1. Normal dialing

↑ [$D_1$] to [$D_n$]

2. Access pause

↑ [$D_1$][P][$D'_1$] to [$D'_n$]

3. Redialing

↑ [RD]

When more than 33 digits (32 digits in DTMF mode) of key-in data are input, redialing is inhibited.

4. Redialing inhibition

↑ [$D_1$] to [$D_n$] ··· [CLR]

5. Repertory dialing

($\overline{READ}$/WRITE = "L") ↑ [Aij]

The second repertory dialing can be input after sending the signals of the first repertory dialing.

↑ [Aij] · · [Aik]

6. Registration of repertory data

6.1 S-7241A2, C2, D2, E2

($\overline{READ}$/WRITE = "H") ↓ [$D_1$] to [$D_n$][Aij] (Continuous registration is available)

Revision of number data while registration. The stored address cannot be revised.

↓ [$D_1$] to [$D_n$][M][M][$D'_1$] to [$D'_n$][Aij]

6.2 S-7241B2, F2

($\overline{READ}$/WRITE = "L" →"H") ↑ [$D_1$] to [$D_n$] ··· [Aij] (Continuous registration is available)

low high

($\overline{READ}$/WRITE = "H") ↑ [$D_1$] to [$D_n$] [Aij] ( [$D_1$] to [$D_n$] are not output)

Registration of first 16-digit redial memory data

($\overline{READ}$/WRITE = "H") ↑ [Aij]

7. Clear of repertory data

7.1 S-7241A2, C2, D2, E2 ($\overline{READ}$/WRITE = "H")

↓ [CLR] [Aij] ( [CLR] [Di] [Dj] continuous clear is available)

7.2 S-7241B2, F2 ($\overline{READ}$/WRITE = "H")

↑ [CLR] [Aij] ( [CLR] [Di] [Dj] continuous clear is available)

8. Mode change

8.1 Change by [T] ↑ [$D_1$] to [$D_n$] [T] [D'1] to [D'm]

8.2 Change by $\overline{MODE\ IN}$ ↑ [$D_1$] to [$D_n$] ··· [D'1] to [D'm]

($\overline{MODE\ IN}$ = "H" →"L") "H" "L"

When [D'1] is input during sending [$D_1$] to [$D_n$], access pause is executed before [D'1]. When [D'1] is input after sending [$D_1$] to [$D_n$], [D'1] to [D'm] are output. In both cases access pause is executed before [D'1] after mode change into DTMF in redialing.

## ■ Operation

1. Normal dialing

- After Off-Hook, a mode is set up depending upon the state of MODE IN. When any key of [0] to [9] is input in PULSE mode, a PULSE signal corresponding to that key is output. When any key of [0] to [9], [*], [#] in DTMF mode is input, a DTMF signal corresponding to that key is output.
- Redial memory has 32 digits and [0] to [9], [*], [#], [P], [T], [F] are stored in the redial memory each as one digit. Digits after the 32nd erase the old digits and rewrite the redial memory from digit 1.
- After Off-Hook, when the first key-input is [0] to [9], [F] in PULSE mode, or [0] to [9], [*], [#], [F] in DTMF mode, the redial memory is cleared and the key-input data is stored from digit 1 of the redial memory.

2. Mode change (Mixed dialing from PULSE mode to DTMF mode)

- Mixed dialing is available from PULSE mode to DTMF mode. There are two methods as follows:
  - MODE IN is set from PULSE mode ("H") to DTMF mode ("L") and normal dialing is executed.
  - [T] is input when MODE IN is in PULSE mode and normal dialing is executed.
- Mode change code and data code are input to the redial memory, and then successive DTMF data is output. When returning to PULSE mode, MODE IN is set to high or open and flash is executed.
- When DTMF data is input following mode change input, if the PULSE signal is being output, the mode is changed after PULSE signal output has been completed, and the input DTMF data is output after an access pause. At redialing, an access pause is executed and the DTMF signal is output.

3. Redialing

- By inputting [RD/P] initially after Off-hook, 32 digits of data in the redial memory is output in PULSE mode, and 31 digits of data is output in DTMF mode.
- [ Redialing inhibition ] Redialing is inhibited in the following cases:
  - When the redial memory overflows: data over 33 digits in PULSE mode or 32 digits in DTMF mode is input.
  - When [CLR] is input after normal dialing.
- Normal dialing is available after redialing inhibition.
- Regardless of [T] input or the MODE IN state, redialed data is output in a mode of the redial memory.

4. Access-pause

- When [P] is input before normal dialing, access-pause is executed at redialing. When a [P] is input, an access-pause is executed during the access-pause time ($t_{AP}$). [P] can be input n times to make an access-pause time of $n \times t_{AP}$.
- When [RD/P] is input while executing an access-pause during redialing or repertory dialing, the access-pause is reset.

5. Flash

- [F] input causes On-hook state temporarily. [F] is stored in the redial memory, and when [F] is dialed, flash is executed. After flash, flash-pause is executed.
- During flash or flash-pause, normal dialing is valid. Input data is dialed after flash-pause.
- During flash or flash-pause, MODE OUT is off, which means it is set to PULSE mode. Normal dialing mode is reset by MODE IN after flash. After reset, data code is input in PULSE mode in the redial memory, and mode change code and data code are input in DTMF mode.

6. Key-in tone

- The key-in tone is an audible signal that confirms that key-input has been executed. It is output after reading valid key-input in PULSE and DTMF modes, excluding address specifying key-input.
- The key-in tone is output in the following cases:
  When $\overline{\text{READ}}$/WRITE is "H"
  - 16 valid key-inputs (excluding invalid key-inputs)
  - [M] , [CLR] and [T] key-inputs after 16th digit

  When $\overline{\text{READ}}$/WRITE is "L"
  - All valid key-inputs

7. One-touch dialing and abbreviated dialing

- [ One-touch dialing ] In Off-hook read ($\overline{\text{READ}}$/WRITE = "L"), when one-touch dialing address ( [00] to [19] ) is input, one-touch dialing is executed.
- [ Abbreviated dialing ] In Off-hook read ($\overline{\text{READ}}$/WRITE = "L"), when [M] and address specifying key ( [00] to [19] ) are input, abbreviated dialing is executed.
- Continuous abbreviated dialing is available. In DTMF mode, however, if a repertory memory whose digit 1 is registered by dial pulse after data (D1) input, the repertory memory is not output. When D1 is [T] or [CLR] , it is output once, without changing the content of the repertory memory. Data is written in the redial memory and sent to the repertory memory.

8. Others

8.1 [RD/P]

- After Off-hook, when [RD/P] is input first, it functions as redialing; when [RD/P] is input second or later, it functions as access-pause. Access-pause can be repeated.

8.2 [CLR]

- [ Read ] Data input before [CLR] input is deleted, and the next key-input is written to digit 1 of the redial memory in PULSE mode, and digit 2 in DTMF mode.
- [ Write ] The repertory memory whose address is specified is deleted, but redial memory is not deleted.

8.3 [F] and [CD]

- [F] and [CD] make On-hook state in Off-hook state. They have the following differences.

  [F] The valid time is set and written in the redial memory. The [RD/P] which is input just after [F] is access-pause.

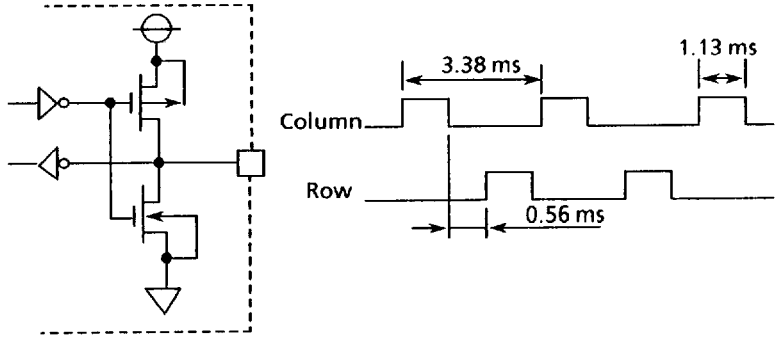
  [CD] The valid time is the duration for which the key is pressed. It is not written in the redial memory. The [RD/P] which is input just after [CD] is redial.

## ■ Pin Functions

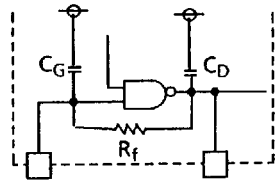
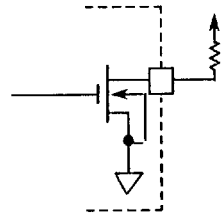
| Pin name | Functions |
|---|---|
| $\overline{R0}$ to $\overline{R4}$<br>$\overline{C1}$ to $\overline{C8}$ | • Key inputs and key scan signal outputs. Interfaces with single contact keyboard.<br>• At Off-hook or On-hook write (A2, C2, D2, E2), columns are set to "L", and rows are set to "H". Key-input is read by connecting a column and a row each other in a matrix corresponding to input key or by connecting them to $V_{SS}$. Once a key is input, the oscillating circuits start to operate, and columns and rows become "L" to output scan signals. During key-debounce time ($t_{kind}$) after key-input, and while columns are "L", key-input is acceptable.<br>• Simultaneous key-inputs are ignored when key-input is acceptable after key-debounce time ($t_{kind}$).<br>• When two keys of the same column or same row of [0] to [9], [#], [*] in DTMF mode, a single tone is output. The high frequency group is output when same column, and the low group when same row. They are not written in the redial memory. |

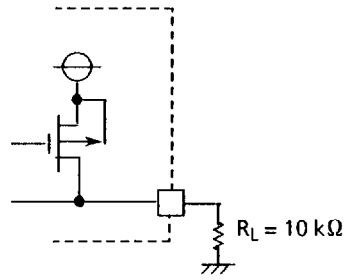
| $\overline{HS}$ | $\overline{R/W}$ | Column | A2, C2, D2, E2 | | B2, F2 | |
|---|---|---|---|---|---|---|
| | | | Row | Operation | Row | Operation |
| H | H | L | H | Memory registration | L | Memory retention, Standby |
| | L | | L | Memory retention, Standby | | |
| L | H | | L | Off-hook Standby | H | Memory registration |
| | L | | H | Normal, Repertory, Redialing | | Normal, Repertory, Redialing |

• Valid key-input is detected by outputting a scan signal after key-input.



| Pin name | Functions |
|---|---|
| $\overline{HS}$ | • Hook switch signal input in CMOS input<br>$\overline{HS}$ = "H" : On-hook mode<br>$\overline{HS}$ = "L" : Off-hook mode<br>• After accepting key-input, when data is sent between redial memory and repertory memory, it takes 52.8 ms. $\overline{HS}$ is acceptable after data transmission.<br>• It does not have a noise-free nor a chatter-free circuit. |
| M/B | • Dial pulse make/break ratio selection signal input<br>M/B = "H" : 33.3%<br>M/B = "L" : 40% |
| DRS | • Dial speed selection signal input. Inter-digital pause time ($t_{idp}$) is decided according to the DRS.<br>DRS = $V_{SS}$ : 9.86 pps<br>DRS = $V_{DD}$ : 19.7 pps |
| $\overline{MODE\ IN}$ | • PULSE/DTMF mode selection input<br>$\overline{MODE\ IN}$ = "H" : PULSE mode<br>$\overline{MODE\ IN}$ = "L" : DTMF mode |
| $\overline{MODE\ OUT}$ | • PULSE/DTMF mode selection output in CMOS output<br>PULSE mode : $\overline{MODE\ OUT}$ = "H"<br>DTMF mode : $\overline{MODE\ OUT}$ = "L"<br>• $\overline{MODE\ OUT}$ indicates $\overline{MODE\ IN}$ state in write condition.<br>• When the DTMF mode is set by [T] in $\overline{MODE\ IN}$ = "H", PULSE mode ($\overline{MODE\ IN}$ = "H") is set again after executing flash. $\overline{MODE\ OUT}$ outputs "H" after [F] input. |

| Pin name | Functions |
|---|---|
| OSC IN<br>OSC OUT | • Input/output for connecting 3.579545-MHz oscillator<br>• Since it has a feedback resistance ($R_f$), a gate capacitor ($C_G$), and a drain capacitor ($C_D$), an oscillating circuit is configured simply by connecting an oscillator. The circuit starts to oscillate with key-input, stops its oscillation after key release time or sending output signal, and goes into standby mode of key acceptance.<br>  |
| $V_{DD}$ | • Positive power supply voltage |
| $V_{SS}$ | • Negative power supply voltage, usually connected to GND |
| $\overline{KT}$ | • Key-in-tone output in Nch opendrain output. The signal is output for valid key-input in PULSE/DTMF mode.<br>Output duration : 31.4 ms typ.<br>Output frequency : 1.78 kHz (Duty 50%)<br>• It is off when the signal is not output.<br>  |
| $\overline{XMUTE}$ | • Transmit mute output in CMOS output<br>• It outputs "L" (mute) during PULSE/DTMF output in Off-hook and On-hook. It outputs "H" at standby mode in Off-hook. |
| $\overline{MUTE}$ | • Mute output in CMOS output<br>• It outputs "L" (mute) during PULSE signal output in Off-hook and On-hook. It outputs "H" at standby mode during PULSE mode and at DTMF mode in Off-hook. |
| $\overline{DP}$ | • Dial pulse output in CMOS output<br>• It outputs "H" at make and "L" at break during dial pulse output in Off-hook. Also, it outputs "H" in standby mode during PULSE and DTMF modes in Off-hook, and "L" in On-hook. |

<table>
<tr><th>Pin Name</th><th>Functions</th></tr>
<tr><td>TONE OUT</td><td>
• DTMF signal output in Pch opendrain output.<br>
• It is off when DTMF signal or single tone is not being output.<br>


</td></tr>
<tr><td>$\overline{\text{READ}}$/WRITE</td><td>
• Memory read control input. It controls active or standby mode of the internal circuit. When oscillation starts, terminal state is read in the internal timing and input by key-input. Operation is as follows.<br>
A2, C2, D2, E2
<table>
<tr><th>Operation</th><th>$\overline{\text{HS}}$</th><th>$\overline{\text{R/W}}$</th><th>Memory</th><th>Clear</th><th>Col.</th><th>Row</th><th>Output</th></tr>
<tr><td>On-hook Memory retention</td><td>H</td><td>L</td><td>—</td><td>—</td><td>L</td><td>L</td><td>Inhibit</td></tr>
<tr><td>On-hook Memory write</td><td>H</td><td>H</td><td>Store</td><td>Delete</td><td>L</td><td>H</td><td>Inhibit</td></tr>
<tr><td>Normal, Repertory, Redialing</td><td>L</td><td>L</td><td>Recall</td><td>Redialing inhibition</td><td>L</td><td>H</td><td>Enable</td></tr>
<tr><td>Off-hook Standby</td><td>L</td><td>H</td><td>—</td><td>—</td><td>L</td><td>L</td><td>Inhibit</td></tr>
</table>
B2, F2
<table>
<tr><th>Operation</th><th>$\overline{\text{HS}}$</th><th>$\overline{\text{R/W}}$</th><th>Memory</th><th>Clear</th><th>Col.</th><th>Row</th><th>Output</th></tr>
<tr><td>On-hook Memory retention</td><td>H</td><td>L or H</td><td>—</td><td>—</td><td>L</td><td>L</td><td>Inhibit</td></tr>
<tr><td>Normal , Repertory, Redialing</td><td>L</td><td>L</td><td>Recall</td><td>Redialing inhibition</td><td>L</td><td>H</td><td>Enable</td></tr>
<tr><td>Memory registration</td><td>L</td><td>H</td><td>Store</td><td>Delete</td><td>L</td><td>H</td><td>Inhibit</td></tr>
</table>
</td></tr>
</table>

## ■ PULSE Signals

Table 2

($V_{DD}$ = 3.0 V, $f_{OSC}$ = 3.579545MHz, Ta = 25°C)

| M/B | Make ratio | DRS | Dial speed | $t_{idp}$ | $t_B$ | $t_M$ |
|---|---|---|---|---|---|---|
| H | 33.3% | L | 9.86 pps | 760.3 ms | 67.6 ms | 33.8 ms |
| | | H | 19.7 pps | 435.9 ms | 33.8 ms | 16.9 ms |
| L | 40.0% | L | 9.86 pps | 760.3 ms | 60.8 ms | 40 6 ms |
| | | H | 19.7 pps | 435.9 ms | 30 4 ms | 20.3 ms |

## ■ Tone Output Frequency

Table 3

($V_{DD}$ = 3.0 V, $f_{OSC}$ = 3.579545MHz, Ta = 25°C)

| Key-in | Std. freq. (Hz) | Tone freq. (Hz) | Δf (Hz) | Error (%) |
|---|---|---|---|---|
| R1 | 697 | 699.1 | + 2.1 | + 0.31 |
| R2 | 770 | 766.2 | -3.8 | -0.49 |
| R3 | 852 | 847.4 | -4.6 | -0.54 |
| R4 | 941 | 948.0 | + 7.0 | + 0.74 |
| C1 | 1209 | 1215.9 | + 6.9 | + 0.57 |
| C2 | 1336 | 1331.7 | -4.3 | -0.32 |
| C3 | 1477 | 1471.9 | -5.1 | -0.35 |

Table 4 Tone auto-output timing

| | | | |
|---|---|---|---|
| Pre-digital pause time | $t_{pdp}$ | | 33.8 ms |
| DTMF output duration | $t_{tone}$ | | 101.4 ms |
| Inter-digital pause time | $t_{idp}$ | A2, B2, C2, E2, F2 | 67.6 ms |
| | | D2 | 81.1 ms |
| Mute overlap time | $t_{mo}$ | | 33.8 ms |

## ■ Dimensions (Unit:mm)

1. 28-pin DIP

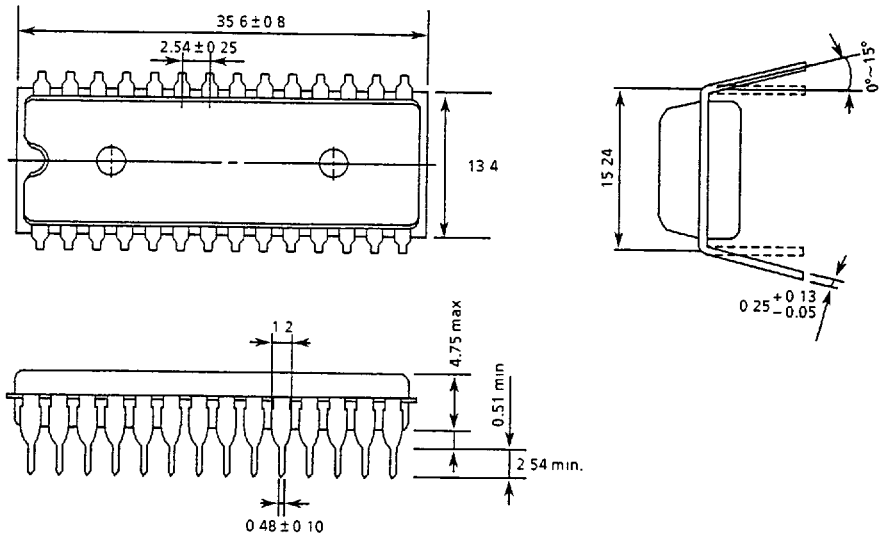



Figure 4

2. 28-pin SOP

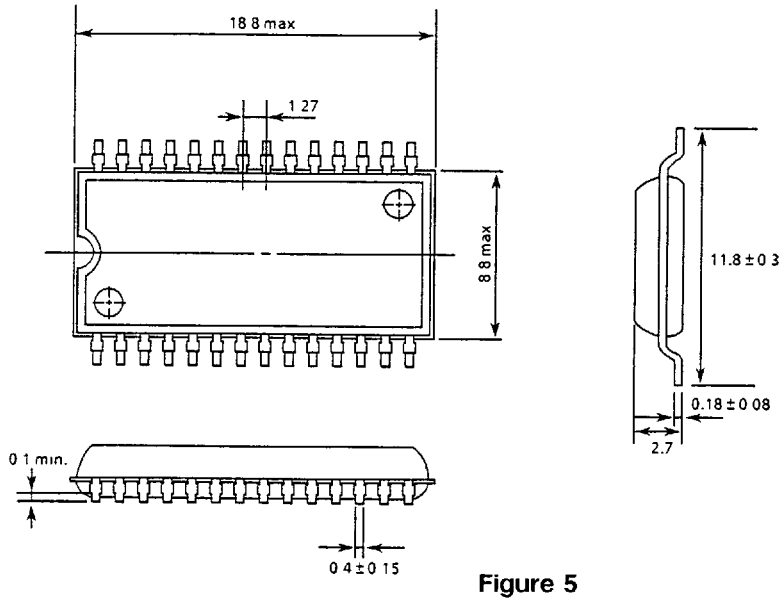



Figure 5

Material: Plastics
No radiation resistant

## ■ Absolute Maximum Ratings

Table 5

| Item | Symbol | Ratings | Unit |
|---|---|---|---|
| Power supply voltage | $V_{DD}$ | 6.0 | V |
| Input voltage | $V_{IN}$ | $V_{SS}$-0.3 to $V_{DD}$ + 0.3 | V |
| Output voltage | $V_{OUT}$ | $V_{SS}$-0.3 to $V_{DD}$ + 0.3 | V |
| KT output voltage | $V_{OUT}$ | 12 | V |
| Power dissipation | $P_D$ | 300 | mW |
| Operating temperature | $T_{opr}$ | -20 to + 70 | °C |
| Storage temperature | $T_{stg}$ | -40 to + 125 | °C |

## ■ Operating Conditions

Table 6

| Item | Symbol | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Operating voltage range | $V_{DDP}$ | PULSE mode* | 1.5 | — | 5.5 | V |
| | $V_{DDT}$ | DTMF mode* | 2.0 | — | 5.5 | V |
| Load resistance | $R_L$ | Between TONE OUT and $V_{SS}$ | 5 | 10 | 50 | kΩ |
| Oscillating frequency | $f_{OSC}$ | | — | 3.579545 | — | MHz |

* Ceramic Murata Mfg. Co., Ltd. CST 3.58 MGU 300AB (CG and CD are built in)
Matsushita Electronic Components Co., Ltd. EFO – FC3584A (CG and CD are built in)
Fujitsu Ltd. FAR-C3SA-03580000-K01 (CG and CD are built in)

## ■ Electrical Characteristics

### 1. DC characteristics

**Table 7**

(Unless otherwise specified : $V_{DD}$ = 3.0 V, $f_{osc}$ = 3.579545MHz, $T_{opr}$ = 25°C)

| Item | Sym. | Conditions | | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|---|
| Data retention voltage | $V_{DR}$ | | | | 1.0 | — | — | V |
| Operating current consumption | $I_{SSP1}$ | $\overline{HS}$ = $V_{SS}$ All outputs open at [1] key-input | PULSE mode | $V_{DD}$ = 3.0 V | — | 200 | 500 | μA |
| | $I_{SSP2}$ | | | $V_{DD}$ = 5.5 V | — | 0.4 | 1.0 | mA |
| | $I_{SST1}$ | | DTMF mode | $V_{DD}$ = 3.0 V | — | 0.3 | 1.0 | mA |
| | $I_{SST2}$ | | | $V_{DD}$ = 5.5 V | — | 0.5 | 1.5 | mA |
| Data retention current | $I_{DR1}$ | No key-input, $\overline{HS}$ = $V_{DD}$ All outputs open | | $V_{DD}$ = 3.0 V | — | 0.05 | 0.5 | μA |
| | $I_{DR2}$ | | | $V_{DD}$ = 5.5 V | — | — | 20 | μA |
| Standby current | $I_{SD1}$ | No key-input, $\overline{HS}$ = $V_{SS}$ All outputs open | | $V_{DD}$ = 3.0 V | — | — | 10 | μA |
| | $I_{SD2}$ | | | $V_{DD}$ = 5.5 V | — | — | 30 | μA |
| Input voltage | $V_{IH}$ | $\overline{R0}$ to $\overline{R4}$, $\overline{C1}$ to $\overline{C8}$, $\overline{HS}$, M/B $\overline{MODE\ IN}$, R/$\overline{W}$, DRS | | | 0.8 × $V_{DD}$ | — | $V_{DD}$ | V |
| | $V_{IL}$ | | | | 0 | — | 0.2 × $V_{DD}$ | V |
| Input leakage current | $I_{IHL}$ | $V_{DD}$ = 5.5V, $\overline{HS}$, M/B $\overline{MODE\ IN}$, R/$\overline{W}$, DRS | | $V_{IH}$ = $V_{DD}$ | — | 0.001 | 1.0 | μA |
| | $I_{ILL}$ | | | $V_{IL}$ = $V_{SS}$ | — | 0.001 | 1.0 | μA |
| Output voltage | $V_{OH}$ | $\overline{R0}$ to $\overline{R4}$, $\overline{C1}$ to $\overline{C8}$, $\overline{MODE\ OUT}$ $\overline{DP}$, $\overline{MUTE}$, $\overline{XMUTE}$, No load | | | 2.95 | 3.0 | — | V |
| | $V_{OL}$ | | | | — | 0 | 0.05 | V |
| Input current | $I_{IH}$ | $\overline{R0}$ to $\overline{R4}$ $\overline{C1}$ to $\overline{C8}$ | | $V_{DD}$ = 1.5 V, $V_{IH}$ = 0.3 V | 20 | 50 | 150 | μA |
| | | | | $V_{DD}$ = 3.0 V, $V_{IH}$ = 0.6 V | 100 | 250 | 400 | μA |
| | $I_{IL}$ | | | $V_{DD}$ = 1.5 V, $V_{IL}$ = 0.3V | -7.0 | -2.5 | -0.5 | μA |
| | | | | $V_{DD}$ = 3.0 V, $V_{IL}$ = 0.6V | -40 | -15 | -7.0 | μA |
| Output current | $I_{OH}$ | $\overline{MODE\ OUT}$, $\overline{DP}$, $\overline{MUTE}$, $\overline{XMUTE}$, $\overline{KT}$ | | $V_{OH}$ = 2.6V | — | — | -0.5 | mA |
| | $I_{OL}$ | | | $V_{OL}$ = 0.4V | 0.5 | — | — | mA |
| Output leakage current | $I_{OFF}$ | $\overline{KT}$, $V_{OUT}$ = 10V | | | — | — | 1.0 | μA |
| | | TONE OUT, $V_{DD}$ = 5.5 V, $V_{OUT}$ = 0 V | | | — | — | 2.0 | μA |

## 2. AC characteristics

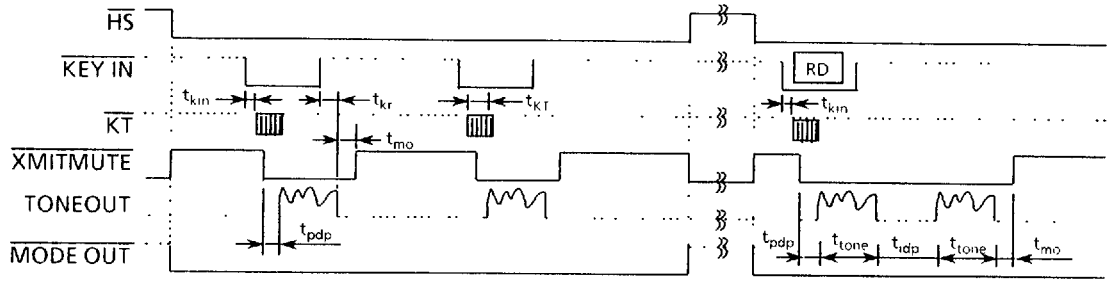
**Table 8**

($V_{DD}$ = 3.0 V, $f_{OSC}$ = 3.579545 MHz, Ta = 25°C)

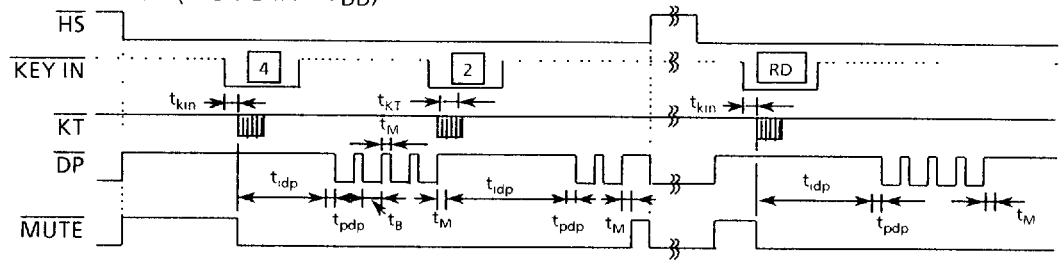
| Item | Sym. | Conditions | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| Key debounce time | $t_{kind}$ | | | 9.3 | — | 12.6 | ms |
| Key release debounce time | $t_{krd}$ | | | 27.9 | — | 34.7 | ms |
| Key-in time | $t_{kin}$ | | | 12.4 | — | 15.7 | ms |
| Key scanning frequency | $f_{CR}$ | | | — | 296 | — | Hz |
| Key-in-tone frequency | $f_{KT}$ | | | — | 1.78 | — | kHz |
| Key-in-tone output time | $t_{KT}$ | | | — | 31.4 | — | ms |
| Auto-access pause time | $t_{AP}$ | A2, D2, F2 | | — | 3.6 | — | s |
| | | B2, C2, E2 | | — | 2.0 | — | s |
| Tone output freq. deviation | Δf | $V_{DD}$ = 2.0 to 5.5 V | | — | — | 0.75 | % |
| Tone distortion | %DIS | $V_{DD}$ = 2.0 to 5.5 V, $R_L$ = 10 kΩ | | — | — | 10 | % |
| Tone output level | $V_{TR}$ | Low group $R_L$ = 10 kΩ | $V_{DD}$ = 3.5 V | 160 | 220 | 290 | mVrms |
| | | | $V_{DD}$ = 2.0 V | 120 | 145 | 170 | mVrms |
| Column to row tone ratio | dBc-R | | | 2.0 | — | 3.0 | dB |
| Oscillating frequency | $f_{OSC}$ | | | — | 3.579545 | — | MHz |
| Oscillation startup time | $t_{OSC}$ | $V_{DD}$ = 1.5 V | | — | 5.0 | — | ms |
| | | $V_{DD}$ = 3.0 V | | — | 2.0 | — | ms |
| Flash time | $t_{FL}$ | A2, F2 | | — | 601.5 | — | ms |
| | | B2, E2 | | — | 865.1 | — | ms |
| | | C2, D2 | | — | 108.1 | — | ms |
| Flash-pause time | $t_{FLP}$ | A2, B2, C2, E2, F2 | | — | 1.0 | — | s |
| | | D2 | | — | 2.0 | — | s |
| Pre-digital pause time | $t_{pdp}$ | PULSE mode | | — | $t_M$ | — | ms |
| | | DTMF mode | | — | 33.8 | — | ms |
| Mute overlap time | $t_{mo}$ | PULSE mode | | — | $t_M$ | — | ms |
| | | DTMF Mode | | — | 33.8 | — | ms |
| DTMF output duration | $t_{tone}$ | DTMF mode | | 101.4 | — | — | ms |
| Inter-digital pause time | $t_{idp}$ | DTMF mode auto-dialing | A2,B2,C2,E2,F2 | — | 67.6 | — | ms |
| | | | D2 | — | 81.1 | — | ms |

## ■ Timing Charts (Dotted lines mean high-impedance)

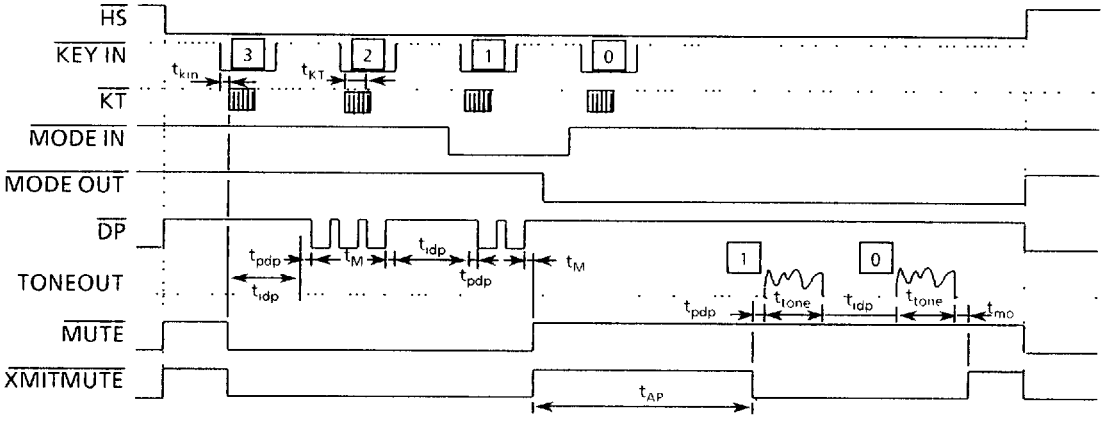
1. DTMF mode ($\overline{\text{MODE IN}} = V_{SS}$)



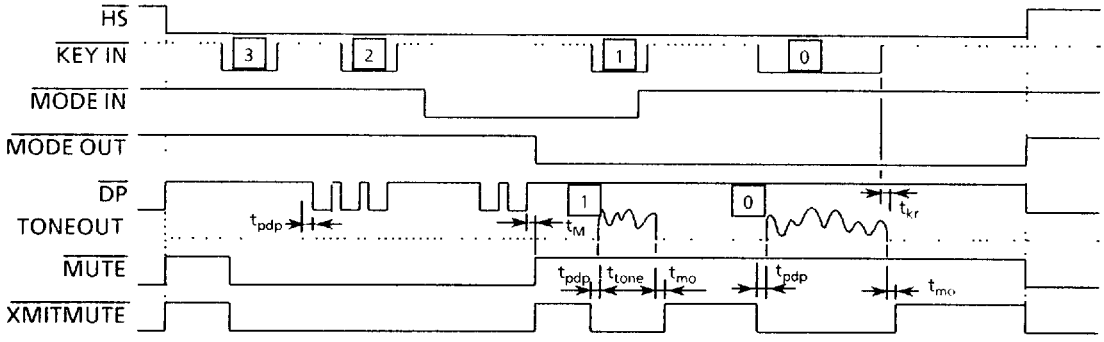

2. PULSE mode ($\overline{\text{MODE IN}} = V_{DD}$)



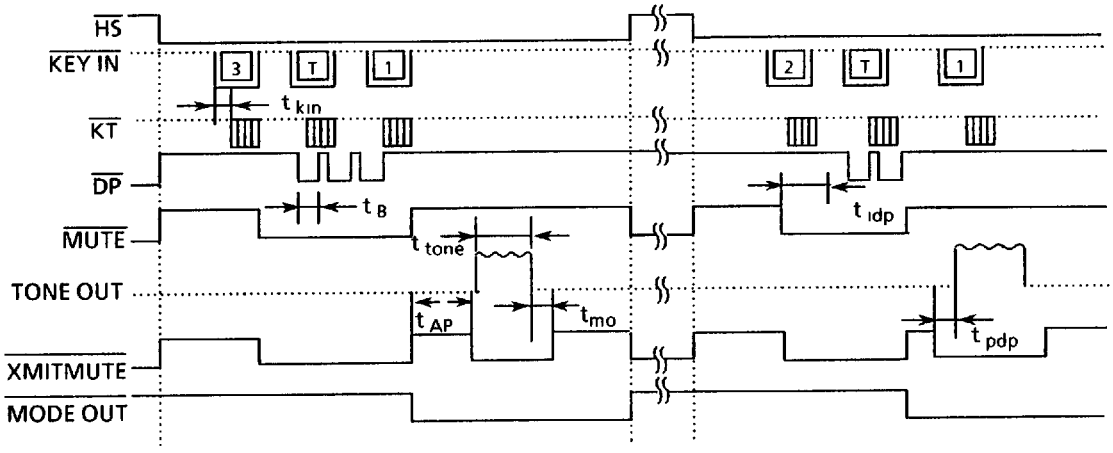

3. PULSE/DTMF 1 (including auto-access pause)




4. PULSE/DTMF 2 (excluding auto-access pause)



5. Mode change by T ($\overline{\text{MODE IN}} = V_{DD}$)




6. Flash