# 23-MEMORY TONE/PULSE DIALER WITH AUTOREDIAL RTC AND LCD DISPLAY FUNCTIONS

## GENERAL DESCRIPTION

The W91570DN series ICs are Si-gate CMOS ICs that provide the signals needed for either pulse or tone dialing. They feature 23 number memories and a 16-digit LCD driver for displaying telephone numbers and calling time. A real time clock is included to display the time of day. The W91570DN series is fabricated using CMOS technology providing good performance in low voltage, low power applications.

## FEATURES

- Three by 32 digits for redial, save and mercury memory
- Twenty by 16 digits for one-touch direct or two-touch indirect repertory memory
- Uses 6 × 10 keyboard
- Pause, Pulse-to-tone (*/T) and flash can be stored as a digit in memory
- Minimum tone output duration: 87 mS
- Minimum intertone pause: 87 mS
- Tone/Pulse mode pin selectable
- Make/Break ratio pin selectable
- Dialing rate (10 or 20 ppS) pin selectable
- Pause time (2.0 or 3.6 Sec) selectable by keypad
- Flash break time (100, 300, or 600 mS) selectable by keypad
- Built-in 12 or 16-digit LCD driver (1/4 duty, 1/3 bias) selectable by mask option
- Built-in calling timer from [00:00] to [59:59]
- Uses 3.579545 MHz TV quartz crystal or ceramic resonator
- Uses 32768 Hz crystal as RTC frequency base
- Packaged in 80-pin plastic QFP with RTC
- Provides one-key-redial and auto-redial functions
- Switchable 24-hour clock or 12-hour clock with p.m. mode
- 0 or 9 dialing inhibition pin for PABX systems or long distance dialing lock out
- On-hook debounce: 150 msec in normal mode and 20 msec in lock mode
- Off-hook delay 300 mS in lock mode (i.e. $\overline{DP}$ will keep low for 300 mS while off hook)
- First key-in delay: 300 msec in lock mode
- MUTE key for speech mute
- Cascade and mixed dialing allowed
- The functions of the different dialers in the W91570DN series are shown in the following table:

| PRODUCT NO. | LCD DIGITS | LOCK | RTC BATTERY |
|---|---|---|---|
| W91572DNF | 16 | √ | 1.5V |
| W91574DNF | 16 | √ | 3V |
| W91576DNF | 12 | √ | 1.5V |
| W91578DNF | 12 | √ | 3V |

## PIN CONFIGURATION


| PIN NAME | QFP-80 | PIN NAME | QFP-80 | PIN NAME | QFP-80 | PIN NAME | QFP-80 |
|---|---|---|---|---|---|---|---|
| SEG29 | 1 | COL2 | 21 | $\overline{\text{TESTL}}$ | 41 | SEG9 | 61 |
| SEG30 | 2 | COL3 | 22 | APSET | 42 | SEG10 | 62 |
| SEG31 | 3 | COL4 | 23 | XT2 | 43 | SEG11 | 63 |
| SEG32 | 4 | COL5 | 24 | $\overline{\text{XT2}}$ | 44 | SEG12 | 64 |
| TEST | 5 | COL6 | 25 | VLCD | 45 | SEG13 | 65 |
| $\overline{\text{KMUTE}}$ | 6 | COL7 | 26 | VRTC2 | 46 | SEG14 | 66 |
| KT | 7 | COL8 | 27 | CN | 47 | SEG15 | 67 |
| $\overline{\text{TEST1}}$ | 8 | COL9 | 28 | CP | 48 | SEG16 | 68 |
| VDD | 9 | ROW1 | 29 | COM1 | 49 | SEG17 | 69 |
| NC/$\overline{\text{LOCK}}$ | 10 | ROW2 | 30 | COM2 | 50 | SEG18 | 70 |
| B/M | 11 | ROW3 | 31 | COM3 | 51 | SEG19 | 71 |
| DTMF | 12 | ROW4 | 32 | COM4 | 52 | SEG20 | 72 |
| $\overline{\text{SET}}$ RTC | 13 | ROW5 | 33 | SEG1 | 53 | SEG21 | 73 |
| VSS | 14 | XT1 | 34 | SEG2 | 54 | SEG22 | 74 |
| H/P MUTE | 15 | $\overline{\text{XT1}}$ | 35 | SEG3 | 55 | SEG23 | 75 |
| T/P $\overline{\text{MUTE}}$ | 16 | $\overline{\text{HKS}}$ | 36 | SEG4 | 56 | SEG24 | 76 |
| HFO | 17 | $\overline{\text{HFI}}$ | 37 | SEG5 | 57 | SEG25 | 77 |
| $\overline{\text{DP}}$ / $\overline{\text{C10}}$ | 18 | VRTC1 | 38 | SEG6 | 58 | SEG26 | 78 |
| MODE | 19 | $\overline{\text{TEST2}}$ | 39 | SEG7 | 59 | SEG27 | 79 |
| COL1 | 20 | ARD | 40 | SEG8 | 60 | SEG28 | 80 |

## PIN DESCRIPTION

| SYMBOL | PIN NO. | I/O | FUNCTION |
|---|---|---|---|
| Row, Column Inputs | 29–33 and 20–28 | I | The keyboard inputs may be used with either the standard 6×10 keyboard, an inexpensive single contact (form A) keyboard or electronic input.<br>A valid key entry is defined by a single row being connected to a single column. |
| XT1, $\overline{XT}$ | 34, 35 | I, O | A built-in inverter provides oscillation with an inexpensive 3.579545 MHz crystal or ceramic resonater.<br>The oscillator ceases when a keypad input is not sensed after chip enable and dialing is finished. The crystal frequency deviation is ±0.02%. |
| T/P $\overline{MUTE}$ | 16 | O | The T/P $\overline{MUTE}$ is a conventional CMOS N-channel open drain output.<br>The output transistor is switched on low level during the dialing sequence (both pulse and tone mode), one-key redial break, auto redial break and flash break. Otherwise, it is switched off. |
| H/P MUTE | 15 | O | The H/P MUTE is a conventional CMOS inverter output. During pulse dialing, one-key redial break, auto redial break, flash break, hold, and mercury functions, this pin will output an active high. It remains in a low state at all other times. |
| $\overline{KMUTE}$ | 6 | O | The $\overline{KMUTE}$ is a CMOS N-channel open drain output. The output transistor is switched on only during mute function. Otherwise, it is switched off. |
| $\overline{HKS}$ | 36 | I | Hook switch input.<br>$\overline{HKS}$ = $V_{DD}$ or floating: On-hook state. Chip in sleeping mode, no operation.<br>$\overline{HKS}$ = $V_{SS}$: Off-hook state. Chip enable for normal operation.<br>$\overline{HKS}$ pin is pulled to $V_{DD}$ by internal resistor. |

Pin Description, continued

<table>
<tr><th>SYMBOL</th><th>PIN NO.</th><th>I/O</th><th>FUNCTION</th></tr>
<tr><td>$\overline{HFI}$, HFO</td><td>37, 17</td><td>I, O</td><td>Handfree control pins. A low pulse on the $\overline{HFI}$ input pin toggles the handfree control state.<br>Status of the handfree control is listed in the following table:
<table>
<tr><th colspan="2">CURRENT STATE</th><th colspan="3">NEXT STATE</th></tr>
<tr><th>Hook SW.</th><th>HFO</th><th>Input</th><th>HFO</th><th>Dialing</th></tr>
<tr><td>–</td><td>Low</td><td>$\overline{HFI}$ ↓</td><td>High</td><td>Yes</td></tr>
<tr><td>On Hook</td><td>High</td><td>$\overline{HFI}$ ↓</td><td>Low</td><td>No</td></tr>
<tr><td>Off Hook</td><td>High</td><td>$\overline{HFI}$ ↓</td><td>Low</td><td>Yes</td></tr>
<tr><td>On Hook</td><td>–</td><td>Off Hook</td><td>Low</td><td>Yes</td></tr>
<tr><td>Off Hook</td><td>Low</td><td>On Hook</td><td>Low</td><td>No</td></tr>
<tr><td>Off Hook</td><td>High</td><td>On Hook</td><td>High</td><td>Yes</td></tr>
</table>
The $\overline{HFI}$ pin is pulled to $V_{DD}$ by internal resistor.<br>Detailed timing diagrams are shown in Figure 4(a), 4(b).</td></tr>
<tr><td>$\overline{DP}$ / $\overline{C10}$</td><td>18</td><td>O</td><td>This pin is a CMOS N-channel open drain output. The flash key will cause $\overline{DP}$ / $\overline{C10}$ to go active in either pulse mode or tone mode. In lock mode, the $\overline{DP}$ / $\overline{C10}$ keeps low for 300 mS during off-hook delay time (If first off-hook occured after power-on reset, the $\overline{DP}$ / $\overline{C10}$ will keep high for 100ms then go low 200 mS. It will be recovered when first key-in was accepted). The timing diagram is shown as Figure 1(a), 1(b), 1(c), 1(d).</td></tr>
<tr><td>DTMF</td><td>12</td><td>O</td><td>In pulse mode, this pin remains in low state at all times.<br>In tone mode, it will output a dual or single tone. Detailed timing diagram for tone mode is shown in Figure 2(a), 2(b), 2(c), 2(d).
<table>
<tr><th colspan="4">OUTPUT FREQUENCY</th></tr>
<tr><th></th><th>Specified</th><th>Actual</th><th>Error %</th></tr>
<tr><td>R1</td><td>697</td><td>699</td><td>+0.28</td></tr>
<tr><td>R2</td><td>770</td><td>766</td><td>-0.52</td></tr>
<tr><td>R3</td><td>852</td><td>848</td><td>-0.47</td></tr>
<tr><td>R4</td><td>941</td><td>948</td><td>+0.74</td></tr>
<tr><td>C1</td><td>1209</td><td>1216</td><td>+0.57</td></tr>
<tr><td>C2</td><td>1336</td><td>1332</td><td>-0.30</td></tr>
<tr><td>C3</td><td>1477</td><td>1472</td><td>-0.34</td></tr>
</table></td></tr>
<tr><td>MODE</td><td>19</td><td>I</td><td>Pulling the mode pin to $V_{SS}$ places the dialer in tone mode.<br>Pulling the mode pin to $V_{DD}$ places the dialer in pulse mode and the dialing rate is 10 ppS.<br>Floating the mode pin places the dialer in pulse mode and the dialing rate is 20 ppS.</td></tr>
</table>

Pin Description, continued

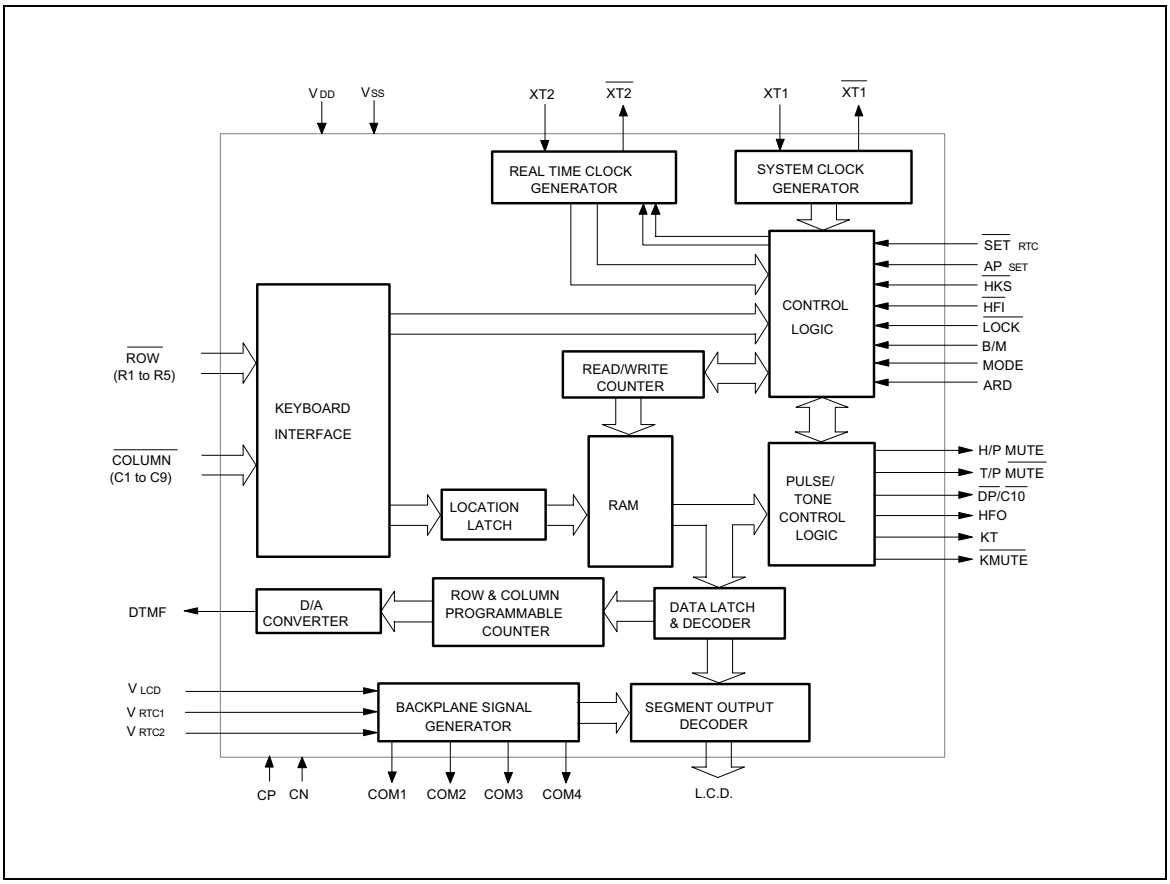
| SYMBOL | PIN NO. | I/O | FUNCTION |
|---|---|---|---|
| B/M | 11 | I | Make:Break ratio select pin.<br>If B/M = $V_{DD}$, the M/B ratio is 40:60.<br>If B/M = $V_{SS}$, the M/B ratio is 33.3:66.7.<br>The B/M pin is pulled to $V_{DD}$ by internal resistor. |
| $\overline{LOCK}$ | 10<br>(for all lock version) | I | The $\overline{LOCK}$ pin is used to prevent "0" or "9" dialing under PABX system long distance call control. When the first key input after reset is "0" or "9", all the key inputs, including "0" or "9" key, become invalid, and the chip generates no output.<br>The telephone is reinitialized by a reset.<br>The following table describes the functions of the $\overline{LOCK}$ pin: |
| COM1 to COM4 | 49 to 52 | O | COM1 to COM4 are the common signal output terminal for the 1/4 duty LCD. |
| SEG1 to SEG32 | 53 to 80, 1 to 4 | O | SEG1 to SEG32 are the 16-digit segment signal outputs. |
| $V_{LCD}$ | 45 | O | Power supply pin for LCD driver.<br>A 0.1 μF capacitor is connected between $V_{LCD}$ and $V_{SS}$. |
| CP, CN | 48, 47 | I | CP is the voltage control capacitor positive pin.<br>CN is the voltage control capacitor negative pin.<br>A 0.1μF capacitor is connected between these two pins. |
| $V_{DD}$, $V_{SS}$ | 9, 14 | I | Power input pins. |
| XT2, $\overline{XT2}$ | 43, 44 | I, O | A quartz crystal oscillator provides an RTC frequency time base of 32.768 KHz. |
| $V_{RTC1}$, $V_{RTC2}$ | 38, 46 | I | Either $V_{RTC1}$ should be connected to a 1.5V battery (W91572DN/576DN) or $V_{RTC2}$ should be connected to a 3.0V battery(W91574DN/578DN), which supplies the power source for the RTC. |
| $\overline{SET}_{RTC}$ | 13 | I | In the chip enable state, pulling $\overline{SET}_{RTC}$ to $V_{SS}$ toggles the RTC set function on/off, when the set function is toggled on, the RTC can be set using the "HOUR" and "MIN" keypads. |

| $\overline{LOCK}$ PIN | FUNCTION |
|---|---|
| Floating | Normal dialing |
| $V_{DD}$ | "0", "9" dialing inhibited |
| $V_{SS}$ | "0" dialing inhibited |

Pin Description, continued

<table>
<tr><th>SYMBOL</th><th>PIN NO.</th><th>I/O</th><th>FUNCTION</th></tr>
<tr><td>APSET</td><td>42</td><td>I</td><td>If APSET = VDD or floating, 24-hour clock mode.<br>If APSET = VSS, 12-hour clock with p.m. mode.</td></tr>
<tr><td>ARD</td><td>40</td><td>I</td><td>Auto redial function selection.
<table>
<tr><th>ARD</th><th>BREAK</th><th>PAUSE</th><th>WAIT INTERVAL</th><th>REPEAT TIMES</th></tr>
<tr><td>$V_{DD}$</td><td>4 secs</td><td>1 sec</td><td>25 secs</td><td>10</td></tr>
<tr><td>$V_{SS}$</td><td>30 secs</td><td>1 sec</td><td>30 secs</td><td>10</td></tr>
<tr><td>Floating</td><td>4 secs</td><td>1 sec</td><td>-</td><td>1</td></tr>
</table>
When ARD is left floating, the one-key redial function is enabled.</td></tr>
<tr><td>KT</td><td>7</td><td>O</td><td>The key tone output is a conventional CMOS inverter.<br>The key tone is generated as any valid key pressed, as the KT pin generates a 1.2 KHz square wave which keeps on 35 mS; otherwise, it remain in low state.</td></tr>
<tr><td>TEST, $\overline{\text{TEST1}}$, $\overline{\text{TEST2}}$, $\overline{\text{TESTL}}$</td><td>5, 8, 39, 41</td><td>I</td><td>For testing only.</td></tr>
<tr><td>NC</td><td>10<br>(for W91572/574/ W91576/578)</td><td>-</td><td>No connection.</td></tr>
</table>

## BLOCK DIAGRAM




## FUNCTIONAL DESCRIPTION

### Keyboard Operation

| C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 | DP / C10 | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | E | HOUR | M0 | M5 | M10 | M15 | HOLD1 | R1 |
| 4 | 5 | 6 | MUTE | MIN | M1 | M6 | M11 | M16 | HOLD2 | R2 |
| 7 | 8 | 9 | A2 | SAVE | M2 | M7 | M12 | M17 | MER | R3 |
| */T | 0 | # | R/P1 | OKR | M3 | M8 | M13 | M18 | A1 | R4 |
| F1 | F2 | F3 | CHK | TIM | M4 | M9 | M14 | M19 | RTC | R5 |
| R/P2 | - | ICON12 | ICON13 | ICON14 | ICON15 | ICON16 | | | | VDD/Vx/R6 |

- E: Store digit
- MUTE: Mute key
- F1, F2, F3: Flash keys
- SAVE: Save memory key
- MER: Mercury memory key
- OKR: One-key redial function
- RTC: Real time clock toggle key
- HOLD1, HOLD2: Hold function keys
- R/P1, R/P2: Redial and pause function keys, P1 is 3.6 sec. and P2 is 2.0 sec.
- TIM: a. Display last calling time
  b. Start and/or stop counting up calling time
- HOUR and MIN: Active when setting mode is operated after off-hook
- A1, A2: Indirect repertory memory dialing function keys, A1 for page 1 and A2 for page 2
  If Lp = 0 to 9, Mp = M0 to M9, and Mq = M10 to M19, then
  a. A1 + Lp (or Mp) the memory location M0 to M9 will be selected
  b. A2 + Lp (or Mp) the memory location M10 to M19 will be selected
  c. A1 (or A2) + Mq the memory location M10 to M19 will be selected
- */T: * in tone mode and P→T in pulse mode
- CHK: a. Check dialing number
  b. Check last dialing time
  c. Memory check (except mercury)
- ICON12, ..., ICON16: Keys reserved for user, can be toggled on any time when the chip is enabled

Notes: D1, ..., Dn, D1', ..., Dn': 0, ..., 9, */T, #
R/P: R/P1 or R/P2
An: A1, A2
Ln: 0, ..., 9, map to indirect memory location 0, ..., 9
Mn: Direct memory location M0, ..., M19

### Normal Dialing

OFF HOOK (or ON HOOK & $\overline{HFI}$ ), D1 , D2 , ..., Dn

1. D1, D2, ..., Dn will be dialed out.
2. Dialing length is unlimited, but redial is inhibited if the length oversteps 32 digits in normal dialing.

### Redialing

If ARD pin = floating, the one-key redial function is selected:

1. OFF HOOK (or ON HOOK & $\overline{HFI}$ ), D1 , D2 , Check Memory (or Number Store ), D3 , ..., Dn , Busy, ON HOOK , OFF (or

Come HOOK

ON HOOK & HFI ), R/P

a. The R/P key can execute the redial function only as the first dialing after off-hook; otherwise, it will invoke the pause function.

b. The redial memory contents will be D3, ..., Dn.

c. Redial memory can be checked in memory check mode.

d. If redialing length oversteps 32 digits, the redialing function will be inhibited.

2. OFF HOOK (or ON HOOK & HFI ), D1 , D2 , ..., Dn , Busy, OKR

a. If the dialing of D1 to Dn is finished, pressing the OKR key will cause the pulse output pin DP / C10 to go low for 2.2 seconds break time and 0.6 seconds pause time will be added automatically.

b. If the pulses of the dialed digits D1 to Dn have not finished, OKR will be ignored.

c. The one-key redialing function timing diagram is shown in Figure 3.

**Number Entry**

1. OFF HOOK (or ON HOOK & HFI ), D1 , D2 , ..., Dn , E (many times same as one time), Mn (or An , Ln ), ON HOOK

D1, D2, ..., Dn will be stored in memory location Mn (or Ln) and will be dialed out.

2. OFF HOOK (or ON HOOK & HFI ), E , D1 , D2 , ..., Dn , E (could be skipped), Mn (or An , Ln ), ON HOOK

3. OFF HOOK (or ON HOOK & HFI ), E , D1 , D2 , ..., Dn , Mn (or An , Ln ), ON HOOK

a. D1, D2, ..., Dn will be stored in memory location Mn (or Ln) but will not be dialed out.

b. R/P and */T keys can be stored as a digit in memory, in store mode, R/P is the pause function key.

c. The store mode is released after the store function is executed or when the state of the hook

switch changes is executed.

4. OFF HOOK , E , Mn (or An , Ln )

The redial content excluding memory dialing will be copied to memory location Mn (or Ln).

5. The first 16 digits will be stored into memory, if the key-in number over 16 digits.

**Save**

1. OFF HOOK (or ON HOOK & $\overline{\text{HFI}}$ ), D1 , D2 , ..., Dn , CONVERSATION,

E , D1' , D2' , ..., Dn' , SAVE

D1', D2', ..., Dn' will be stored in save memory but will not be dialed out.

2. OFF HOOK (or ON HOOK & $\overline{\text{HFI}}$ ), D1 , D2 , ..., Dn , SAVE

a. If the dialing sequence D1, D2, ..., Dn has not finished, SAVE will be ignored.

b. If the sequence off hook, D1, D2, ..., Dn (dialing finish), SAVE, SAVE is keyed in, D1, D2, ..., Dn will be copied to save memory and D1, D2, ..., Dn will be dialed out again.

c. If the sequence off hook, D1, D2 (dialing finish), SAVE, D3, D4 (dialing finish), SAVE is keyed in, D1, D2 will be copied to save memory and D3, D4 will not be copied to save memory.

d. All above sequences will be displayed on LCD.

**Mercury**

1. OFF HOOK (or ON HOOK & $\overline{\text{HFI}}$ ), D1 , D2 , ..., Dn , CONVERSATION,

E , D1' , D2' , ..., Dn' , MER

D1', D2', ..., Dn' will be stored in mercury memory and display on the LCD, but will not be dialed out.

2. MERCURY memory content = D1', D2', ..., Dn'

OFF HOOK (or ON HOOK & $\overline{\text{HFI}}$ ), D1 , D2 , ..., Dn , MER ,

ON HOOK , Come, OFF HOOK (or ON HOOK & $\overline{\text{HFI}}$ ), MER

a. The dialing sequence will be D1, D2, ... Dn, on hook, off hook, D1', D2', ..., Dn'.

b. The MER key can be used to execute the mercury function only when it is the first key-in in dialing

mode after off-hook or first priority flash operation.

c. The contents of mercury memory will not be displayed on the LCD except for mercury mark.

d. If the sequence D1, D2, ..., Dn, MER, on-hook, off-hook, MER is keyed in, D1, D2, ..., Dn will not be copied to mercury memory, D1', D2', ..., Dn' will be dialed out, and the mercury mark (icon 10) will be blinking after off-hook. Detailed timing diagram is shown in Figure 5.

e. Mercury memory cannot be checked in memory check mode.

### Repertory Dialing

1. One-touch direct repertory dialing.
   a. [OFF HOOK] (or [ON HOOK] & [HFI]), [Mn] (or [R/P])
   b. [OFF HOOK] (or [ON HOOK] & [HFI]), [SAVE] (or [MER])
   c. [OFF HOOK] (or [ON HOOK] & [HFI]), [Mn] (or [R/P]), [SAVE]
2. Two-touch indirect repertory dialing.
   [OFF HOOK] (or [ON HOOK] & [HFI]), [An], [Ln] (or [Mn])

### Access Pause

[OFF HOOK] (or [ON HOOK] & [HFI]), [D1], [D2], [R/P], [D3], ..., [Dn], Busy, Come, [ON HOOK], [OFF HOOK] (or [ON HOOK] & [HFI]), [R/P]

1. The first R/P functions as a pause key and the second as a first key-in redial key.
2. The pause function can be stored in memory, and only one R/P key can be released to the user.
3. The pause function is executed in normal dialing, redialing, or memory dialing.
4. The pause duration of 2.0 or 3.6 seconds per pause is selected through the keypad.
5. The default pause duration is 3.6 seconds after power on.
6. The pause function timing diagram is shown in Figure 6.

### Pulse- to-tone (*/T)

[OFF HOOK] (or [ON HOOK] & [HFI]), [D1], [D2], ..., [Dn], [*/T], [D1'], [D2'], ..., [Dn']

1. If the mode switch is set to pulse mode, then the output signal will be:
   D1, D2, ... Dn, Pause (2.0 sec/3.6 sec), D1', D2', ..., Dn'
   (Pulse) (Tone)
2. If the mode switch is set to tone mode, then the output signal will be:
   D1, D2, ... Dn, *, D1', D2', ..., Dn'
   (Tone) (Tone)
3. The dialer remains in tone mode after the digits have been dialed out and can be reset to pulse mode only by going on-hook.
4. The pause time of pulse-to-tone is default to 3.6 seconds.
5. The pulse-to-tone function timing diagram is shown in Figure 7.

### Flash (F = F1, F2, F3)

OFF HOOK (or ON HOOK & $\overline{\text{HFI}}$ ), F

1. The dialer will execute a flash break time of 600 mS (F1), 300 mS (F2), or 100 mS (F3) and pause time of 1S before the next digit (except flash key) is dialed out.
2. Flash keeps first priority in normal dialing but insert flash can be stored into memory when flash is the first digit in memory. In this condition, only one flash key can be released to the user.
   a. E, F1, D1, D2, D3, E, Mn then the digit stored in Mn will be F1, D1, D2, D3.
   b. E, D1, F1, D2, D3, E, Mn then the digit stored in Mn will be D1, D2, D3.
   c. F1, D1, D2, D3, E, Mn then the digit stored in Mn will be D1, D2, D3.
3. The system will return to the initial state after the flash pause time is finished.
4. Keyboard functions are inhibited when flash break is being executed.
5. The flash timing diagram is shown in Figure 8.

### Mute

OFF HOOK (or ON HOOK & $\overline{\text{HFI}}$ ), MUTE

1. The MUTE is switched on and off by a toggle switch.
2. The function timing diagram is shown in Figure 9.

### Hold Key

OFF HOOK (or ON HOOK & $\overline{\text{HFI}}$ ), HOLD1 (or HOLD2 )

1. The hold function is toggled on and off by Hold1 or Hold2 key. When the hold function is toggled on, the hold mark (icon 4) will be lit and all key-ins (except hold keys and icon keys) will be ignored.
2. The following are examples of hold function toggled on and off:
   a. OFF HOOK , HOLD1 (or HOLD2 ), HOLD1 (or HOLD2 )
   b. OFF HOOK , HOLD1 (or HOLD2 ), $\overline{\text{HFI}}$
   c. OFF HOOK , HOLD1 (or HOLD2 ), ON HOOK , $\overline{\text{HFI}}$
   d. ON HOOK & $\overline{\text{HFI}}$ , HOLD1 (or HOLD2 ), $\overline{\text{HFI}}$

3. Hold1 and Hold2 have the same function in off-hook state. The difference between Hold1 and Hold2 are shown as follows:
   a. If OFF HOOK , HOLD1 (or HOLD2 ), ON HOOK , HOLD1 is entered, then the dialer will be off-line.

If [OFF HOOK] , [HOLD1] (or [HOLD2] ), [ON HOOK] , [HOLD2] is entered, then the dialer stay at hold function.

b. If [ON HOOK] & [$\overline{\text{HFI}}$ ī] , [HOLD1] (or [HOLD2] ), [HOLD1] is entered, then the dialer will be off-line.

If [ON HOOK] & [$\overline{\text{HFI}}$ ī] , [HOLD1] , (or [HOLD2] ), [HOLD2] is entered, then the dialer stay at hold function.

4. The function timing diagram is shown in Figure 10(a), 10(b), 10(c).

### Adjusting Time Setting

[OFF HOOK] (or [ON HOOK] & [$\overline{\text{HFI}}$ ī] ), [$\overline{\text{SET}}_{\text{RTC}}$ ī] , [HOUR] , [MIN] , [$\overline{\text{SET}}_{\text{RTC}}$ ī] (or [ON HOOK] )

1. Only HOUR and MIN keys are valid in set RTC mode.
2. Hours and minutes count forward as long as the HOUR or MIN key is pressed.
3. The on/off function of $\overline{\text{SET}}_{\text{RTC}}$ is toggled, and the dialer will go back to a previous state after the toggle off $\overline{\text{SET}}_{\text{RTC}}$ function.
4. If the dialing sequence D1, D2, ..., Dn (including flash and pause) has not finished, $\overline{\text{SET}}_{\text{RTC}}$ (or 'RTC' key pressed) will be ignored.

### RTC Display Mode

[OFF HOOK] (or [ON HOOK] & [$\overline{\text{HFI}}$ ī] ), [RTC]

1.The real time clock display mode can be toggled on and off by RTC key.
2. The icon display will not be changed when enter RTC display mode and set RTC mode.

### Check Key

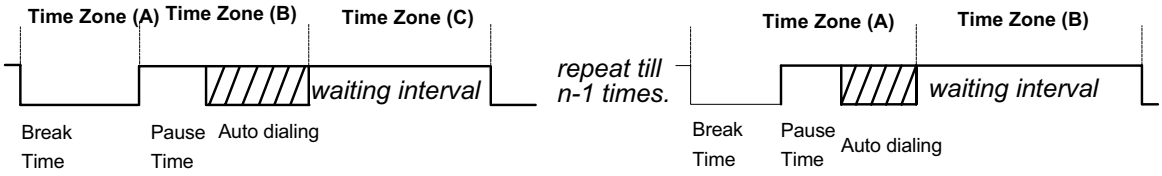
[OFF HOOK] (or [ON HOOK] & [$\overline{\text{HFI}}$ ī] ), [CHK] , [R/P] (or [OKR] , [SAVE] , [Mn] , ..., etc.)

The redial (or memory) content will be displayed on the LCD when either [R/P] or [OKR] is keyed in.

### Auto Redial

If ARD pin = $V_{DD}$ or $V_{SS}$, the auto redial function is selected:

OFF HOOK (or ON HOOK & $\overline{HFI}$ ), OKR




1. During time zone (B) the keypads are inhibited, and in time zone (A), (C) the auto redial can be interrupted by pressing any keypad or by going off-hook.
2. The visible dialing number will be blinking during the waiting time interval.
3. If OKR is the first key-in after off-hook or handfree then the first break and pause time will be ignored.
4. The following show examples to interrupt auto redial function:

   OFF HOOK (or ON HOOK & $\overline{HFI}$ ), OKR , Any Keypad (at break time and waiting interval)

5. If ON HOOK & $\overline{HFI}$ , OKR , OFF HOOK

   a. When in time zome (A) or (C), the auto-redial function will be interrupted and changed to hook mode after OFF HOOK

   b. When in time zome (B), the auto-redial functiion will continue and changed to hook mode after OFF HOOK

6. If ON HOOK & $\overline{HFI}$ , OKR , $\overline{HFI}$ (any time) is entered, the dialer will be off-line.
7. The auto redial function timing diagram is shown in Figure 11(a), 11(b).
8. The calling time will auto-count when the auto-redial function is interrupted in break time zone (A) and (C).

### TIM

OFF HOOK (or ON HOOK & $\overline{HFI}$ ), D1 , D2 , ..., Dn (or Redialing or Repertory dialing 1 ), CONVERSATION

1. If no key is pressed after dialing is finished, the LCD will display counting time after 6 seconds.
2. If the dialing sequence D1, D2, ..., Dn has not finished, TIM will be ignored.
3. The timer will be initialized by flash and auto redial.

## Cascaded and Mixed Dialing

### Cascaded Dialing

1. Definition of cascaded dialing:

   In cascaded dialing, a new sequence may be pressed before the previous sequence has been sent out completely. The following are examples of cascaded dialing:

   Example 1: [Normal dialing] + [Repertory dialing 1] + [Repertory dialing 2] +...

   Example 2: [Repertory dialing 1] + [Normal dialing] + [Repertory dialing 2] +...

   Example 3: [Redialing] + [Normal dialing] + [Repertory dialing 1] +...

2. Normal dialing, redialing, or repertory dialing as represented by each rectangle above is treated as one sequence.
3. At most 64 digits are allowed in cascaded dialing, but there is no limitation on the number of sequences.
4. The content of cascaded dialing may a combination of normal dialing, redialing, and repertory dialing. Redialing is vaild only as the first key-in, however.
5. If [ON HOOK] , [OFF HOOK] , [OKR] is entered, then the cascaded dialing sequence described in the above examples will be dialed out only if there are not more than 32 digits. If the sequence exceeds 32 digits then the redialing is inhibited.

### Mixed Dialing

1. Definition of mixed dialing:

   The examples of cascaded dialing given above are also examples of mixed dialing except that in mixed dialing a new sequence may be accepted only when the previous sequence has been dialed out completely.

2. There is no limitation on the number of digits and sequences in the mixed dialing.
3. The content of mixed dialing may be a combination of normal dialing, memory dialing, or one-key redialing.
4. If [ON HOOK] , [OFF HOOK] , [OKR] is entered, then the mixed dialing sequence described in the above examples will be dialed out only if the total number of digits does not exceed 32. If the total exceeds 32 digits, then redialing is inhibited.

## Combining of Cascaded and Mixed Dialing

1. Cascaded dialing and mixed dialing may be combined, and each follows the rules described above.
2. To apply redialing to combinations of cascaded and mixed dialing:

   [ON HOOK] , [OFF HOOK] , [OKR] then redialing will be executed only if the total number of digits does not exceed 32. Otherwise, the redialing is inhibited.

3. If there had been n cascaded sequences with a total of 60 digits dialed, then for the (n+1)th cascaded sequence, one 4-digit normal dialing sequence or one complete repertory dialing sequence (length up to 32 digits) can be dialed. The (n+2)th sequence will not be accepted for cascaded dialing.
4. After a total of 64 digits of cascaded dialing have been completed, mixed dialing can be added.

## ABSOLUTION MAXIMUM RATINGS

| PARAMETER | SYMBOL | RATING | UNIT |
|---|---|---|---|
| DC Supply Voltage | $V_{DD}$–$V_{SS}$ | -0.3 to +7.0 | V |
| Input/Output Voltage | $V_{IL}$ | $V_{SS}$ – 0.3 | V |
| | $V_{IH}$ | $V_{DD}$ + 0.3 | |
| | $V_{OL}$ | $V_{SS}$ – 0.3 | |
| | $V_{OH}$ | $V_{DD}$ + 0.3 | |
| Power Dissipation | $P_D$ | 120 | mW |
| Operating Temperature | $T_{OPR}$ | -0.5 to +70 | °C |
| Storage Temperature | $T_{STG}$ | -55 to +125 | °C |

Note: Exposure to conditions beyond those listed under Absolute Maximum Ratings may adversely affect the life and reliability of the device.

## ELECTRICAL CHARACTERISTICS

### DC CHARACTERISTICS

($V_{DD}$–$V_{SS}$ = 2.5V. $F_{OSC}$ = 3.58 MHz, $T_A$ = 25° C, all outputs unloaded.)

| PARAMETER | SYM. | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| Operating Voltage | $V_{DD}$ | - | 2.0 | - | 5.5 | V |
| Operating Current | $I_{OP}$ | Tone, Unloaded | - | 0.5 | 0.7 | mA |
| | | Pulse, Unloaded | - | 0.4 | 0.5 | |
| Standby Current | $I_{SB}$ | $\overline{HKS}$ = 0, Unloaded and no key entry | - | - | 15 | µA |
| Memory Retention Current | $I_{MR}$ | $\overline{HKS}$ = 1<br>$V_{DD}$ = 1.0V | - | - | 0.5 | µA |
| Tone Output Voltage | $V_{TO}$ | Row group<br>$R_L$ = 10 KΩ | 130 | 150 | 170 | mVrms |
| Pre-emphasis | | Col/Row<br>$V_{DD}$ = 2.0 to 5.5V | - | 2 | 3 | dB |

DC Characteristics, continued

| PARAMETER | SYM. | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| DTMF Distortion | THD | $R_L$ = 10 KΩ<br>$V_{DD}$ = 2.0 to 5.5V | - | -30 | -23 | dB |
| DTMF Output DC Level | $V_{TDC}$ | $V_{DD}$ = 2.0 to 5.5V | 1.0 | - | 3.0 | V |
| DTMF Output Sink Current | $I_{TL}$ | $V_{TO}$ = 0.5V | 0.2 | - | - | mA |
| $\overline{DP}$ Output Sink Current | $I_{PL}$ | $V_{PO}$ = 0.5V | 0.5 | - | - | mA |
| Common Output Voltage | $V_{CH}$ | - | 4.2 | 4.5 | 4.8 | V |
| | $V_{CL}$ | - | - | 0 | 0.3 | |
| Common Output Current | $I_{CH}$ | - | -20 | - | - | µA |
| | $I_{CL}$ | - | 20 | - | - | |
| Segment Output Voltage | $V_{SH}$ | - | 4.2 | 4.5 | 4.8 | V |
| | $V_{SL}$ | | - | 0 | 0.3 | |
| Segment Output Current | $I_{SH}$ | - | -5 | - | - | µA |
| | $I_{SL}$ | - | 5 | - | - | |
| RMS Voltage Across a Segment | $V_{ON}$ | - | 2.34 | 2.6 | - | Vrms |
| | $V_{OFF}$ | - | - | 1.5 | 1.65 | |
| Average DC Offset Voltage | $V_{DC}$ | - | - | - | 100 | mV |
| $\overline{HFI}$ High Voltage | $V_{HFIH}$ | - | 0.8 $V_{DD}$ | - | $V_{DD}$ | V |
| $\overline{HFI}$ Low Voltage | $V_{HFIL}$ | - | - | - | 0.2 $V_{DD}$ | V |
| T/P $\overline{MUTE}$ Output Sink Current | $I_{TML}$ | $V_{TMO}$ = 0.5V | 0.5 | - | - | mA |
| H/P MUTE Output Drive Current | $I_{HMH}$ | $V_{HMO}$ = 2.5V | 0.5 | - | - | mA |
| H/P MUTE Output Sink Current | $I_{HML}$ | $V_{HMO}$ = 0.5V | 0.5 | - | - | mA |
| $\overline{K MUTE}$ Output Sink Current | $I_{KML}$ | $V_{TMO}$ = 0.5V | 0.5 | - | - | mA |
| Keypad Input Drive Current | $I_{KD}$ | $V_I$ = 0V | 4 | - | 80 | µA |
| Keypad Input Sink Current | $I_{KS}$ | VI = 2.5V | 200 | - | 400 | µA |
| Keypad Resistance | $R_K$ | - | - | - | 5 | KΩ |
| Control Input Pull Up/Down Resistor | $R_{CIP}$ | B/M, $\overline{HFI}$ | 100 | - | - | KΩ |
| $\overline{HKS}$ Input Pull High Resistor | $R_{HK}$ | - | - | 500 | 2000 | KΩ |

## AC CHARACTERISTICS

(VDD–VSS = 2.5V, FOSC. = 3.58 MHz, TA = 25° C, all outputs unloaded.)

| PARAMETER | SYM. | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| Key-in Debounce | TKID | - | - | 20 | - | mS |
| Key Release Debounce | TKRD | - | - | 20 | - | mS |
| Off Hook Delay Time | TOFD | - | - | 300 | - | mS |
| First Key-in Delay Time | TFKD | - | - | 300 | - | mS |
| On Hook Debounce Time | TOHD | Unlock | - | 150 | - | mS |
| | | Lock | - | 20 | - | |
| Key Tone Frequency | FKT | - | - | 1.2 | - | KHz |
| Key Tone Duration | TKTD | - | - | 35 | - | mS |
| Key Tone Delay | TKD | - | - | 20 | - | mS |
| Pulse Mute Delay | TMD | B/M = VDD | - | 40 | - | mS |
| | | B/M = VSS | - | 33.3 | - | |
| Pre-digit-pause (1) | TPDP1 | B/M = VDD | - | 40 | - | mS |
| 10 ppS | | B/M = VSS | - | 33.3 | - | |
| Pre-digit-pause (2) | TPDP2 | B/M = VDD | - | 20 | - | mS |
| 20 ppS | | B/M = VSS | - | 16.7 | - | |
| Inter-digit Pause | TIDP1 | 10 ppS | - | 800 | - | mS |
| (Auto Dialing) | TIDP2 | 20 ppS | - | 500 | - | |
| Make/Break Ratio | M:B | B/M = VDD | - | 40:60 | - | % |
| | | B/M = VSS | - | 33:67 | - | |
| Tone Output Duration | TTD | - | - | 87 | - | mS |
| Inter-tone Pause | TITP | | - | 87 | - | mS |
| Flash Break Time | TFB | F1 | - | 600 | - | mS |
| | | F2 | - | 300 | - | |
| | | F3 | - | 100 | - | |
| Flash Pause Time | TFP | F1, F2, F3 | - | 1 | - | S |
| Pause Time | TP | R/P1 | - | 3.6 | - | S |
| | | R/P2 | - | 2.0 | - | |
| One Key Redialing Break Time | TRB | - | - | 4 | - | S |
| One Key Redialing Pause Time | TRP | - | - | 1 | - | S |

AC Characteristics, continued

| PARAMETER | SYMBOL | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| Auto Redialing Break Time | $T_{ARB}$ | ARD = $V_{DD}$ | - | 4 | - | S |
| | | ARD = $V_{SS}$ | - | 30 | - | |
| Auto Redialing Pause Time | $T_{APR}$ | ARD = $V_{DD}$ | - | 1 | - | S |
| | | ARD = $V_{SS}$ | - | 1 | - | |
| Auto Redialing Waiting Interval | $T_{WI}$ | ARD = $V_{DD}$ | - | 25 | - | S |
| | | ARD = $V_{SS}$ | - | 30 | - | |
| LCD Frame Frequency | $F_{LCD}$ | - | - | 32 | - | Hz |

## RTC DC CHARACTERISTICS

($V_{RTC}$ = 1.5V, $V_{SS}$ = 0V , $F_{OSC.}$ = 32,768 Hz, $T_A$ = 25° C, all outputs unloaded.)

| PARAMETER | SYMBOL | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| Supply Voltage | $V_{RTC}$ | - | 1.2 | 1.5 | 1.8 | V |
| Supply Current | $I_{RTC}$ | No Load | - | 2.0 | 4.0 | μA |
| OSC. Starting Time | $T_{OSC}$ | - | - | - | 3 | S |
| OSC. Output Built-in Cap. | $C_O$ | Cl = 12.5 pF | - | 25 | - | pF |
| OSC. in Trimmer Cap. | $C_{TRIM}$ | - | 5 | - | 35 | pF |
| Frequency Stability | Δf/f | $V_{DD}$–$V_{SS}$ = 1.3 to 1.6V | - | - | 1 | ppM |
| $\overline{SET}_{RTC}$ Input High Voltage | $V_{SETH}$ | - | $V_{DD}$ -0.3 | - | $V_{DD}$ | V |
| $\overline{SET}_{RTC}$ Input Low Voltage | $V_{SETL}$ | - | $V_{SS}$ | - | $V_{SS}$ +0.3 | V |

Notes :

1. Crystal parameters suggested for proper operation are Rs < 100Ω, Lm = 96 mH , Cm = 0.02 pF , Cn = 5 pF , Cl = 18 pF, and Fosc. = 3.579545 MHz ±0.02%

2. Crystal oscillator accuracy directly affects these times.

## TIMING WAVEFORMS

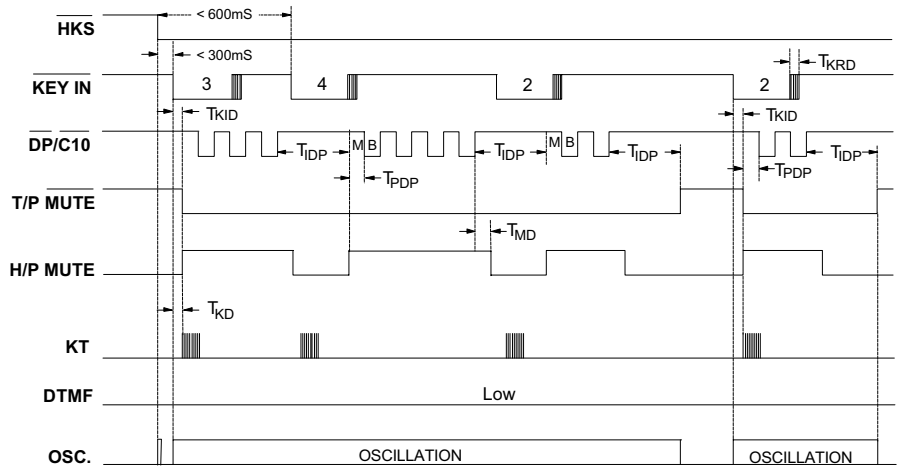



Figure 1(a). Normal Dialing Timing Diagram (Pulse Mode without Lock Function)

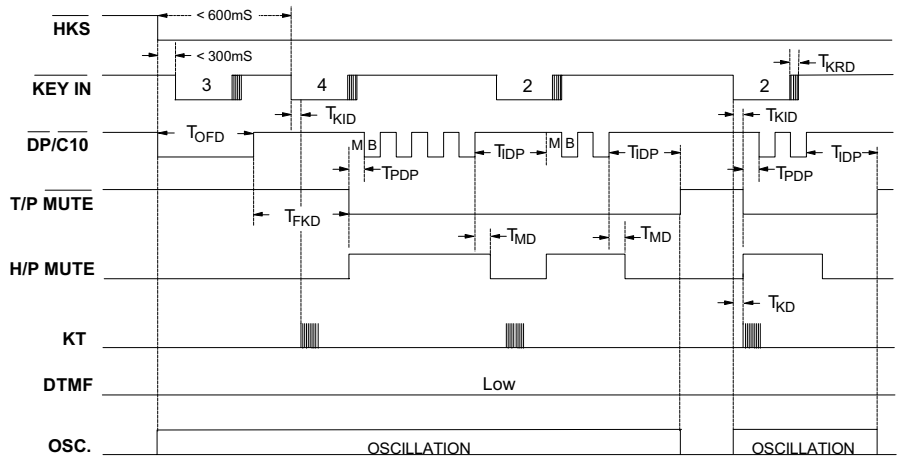



Figure 1(b). Normal Dialing Timing Diagram (Pulse Mode with Lock Function)

Timing Waveforms, continued

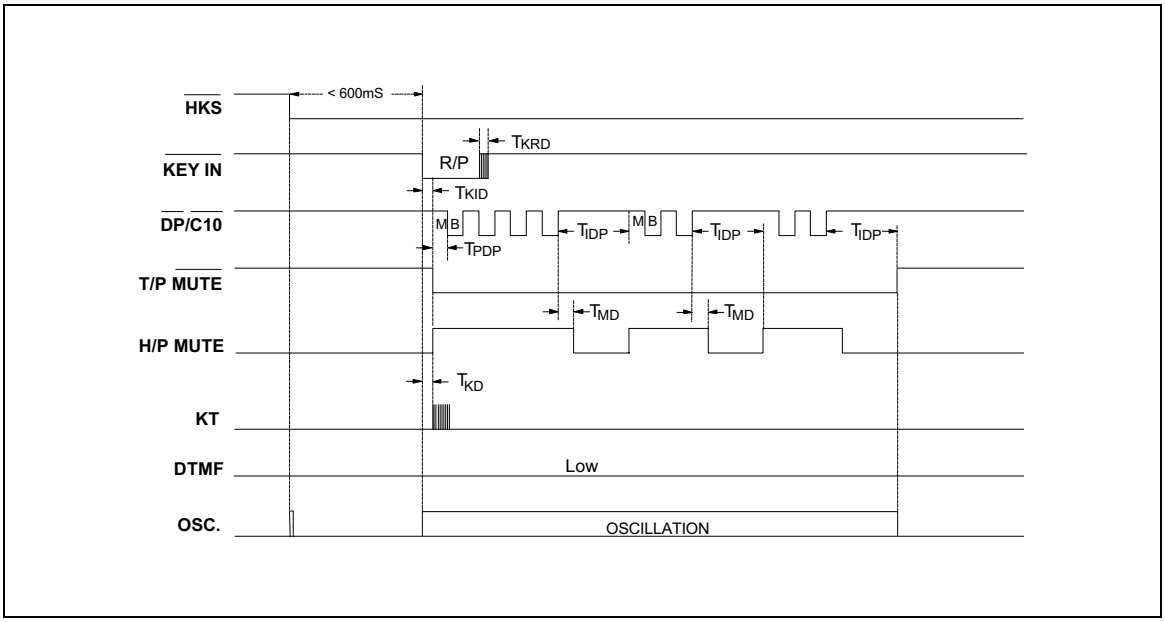



Figure 1(c). Auto Dialing Timing Diagram (Pulse Mode without Lock Function)

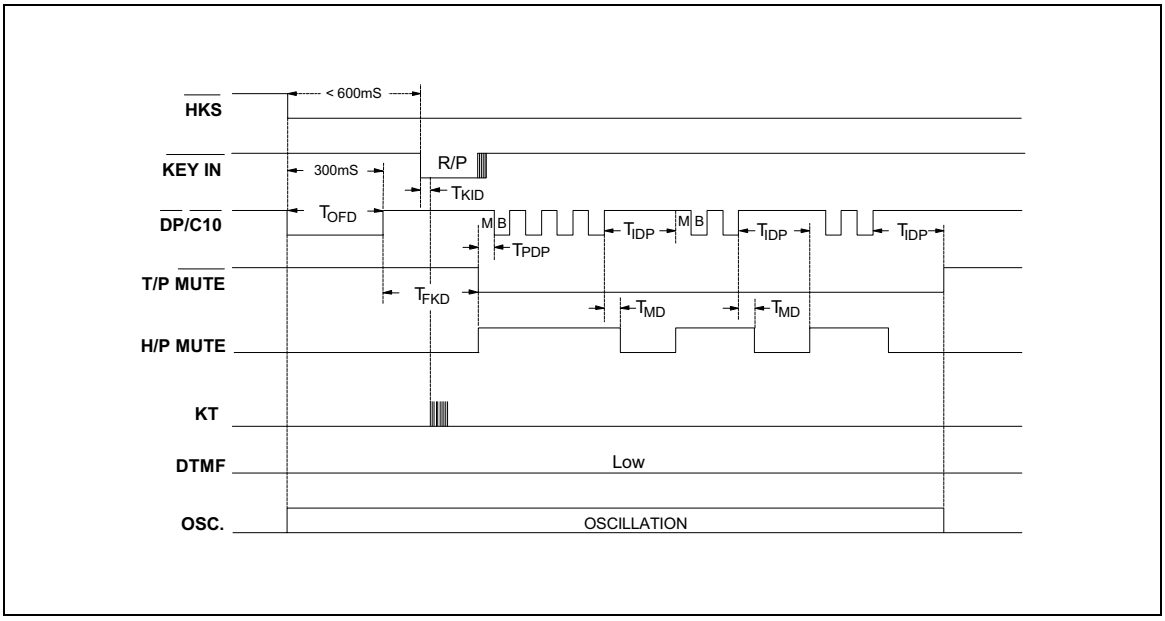



Figure 1(d). Auto Dialing Timing Diagram (Pulse Mode with Lock Function)

Timing Waveforms, continued

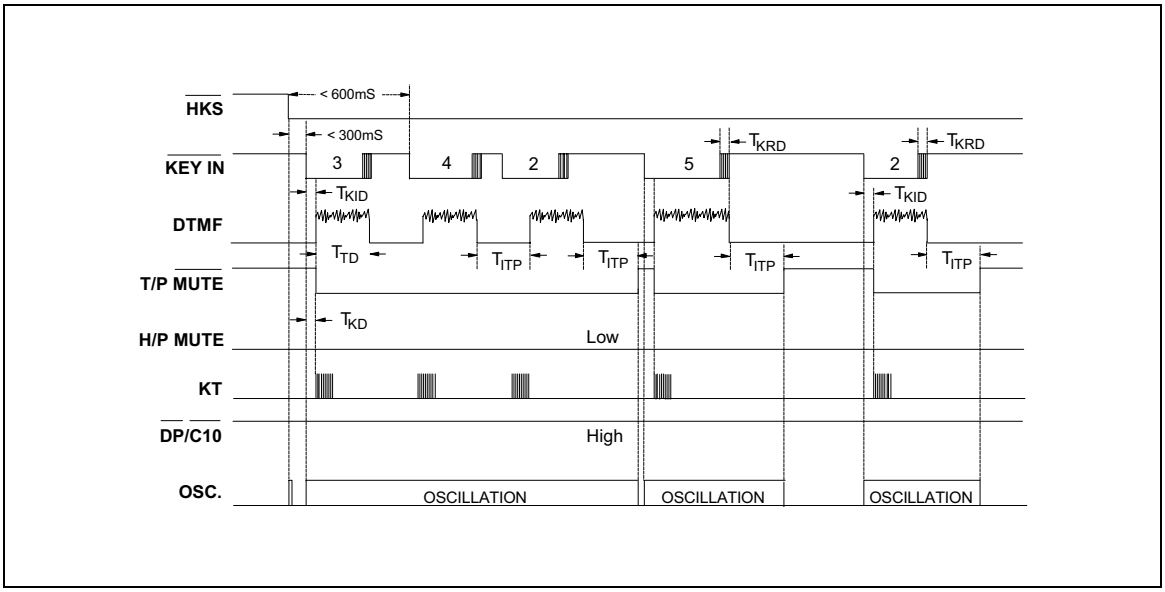



Figure 2(a). Normal Dialing Timing Diagram (Tone Mode without Lock Function)

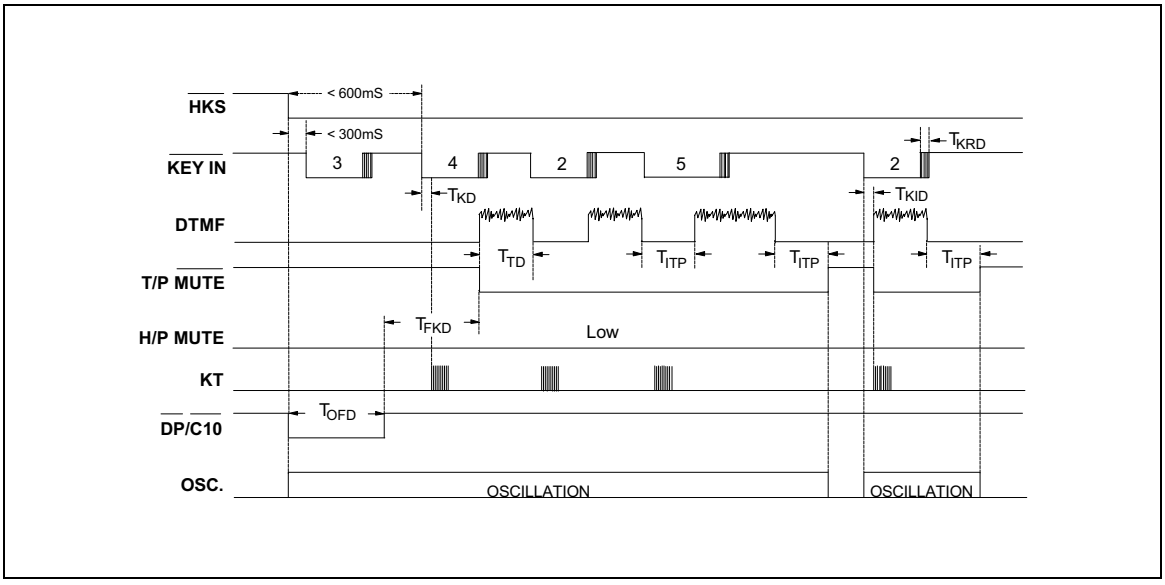



Figure 2(b). Normal Dialing Timing Diagram (Tone Mode with Lock Function)