24-MEMORY TONE/PULSE SWITCHABLE DIALER WITH HANDFREE, HOLD AND LOCK FUNCTIONS

GENERAL DESCRIPTION

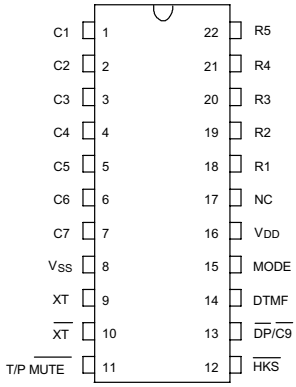
The W91590 series dialers Si-gate CMOS IC tone/pulse switchable dialers with a 24-channel automatic dialing memory, including a 16-digit × 3 emergency dialing memory, a 16-digit × 20 channel repertory memory that provides one-touch and three-touch dialing, and a 32-digit mercury memory. These dialers also provide flash, clear, hold, and one-key redial functions.

FEATURES

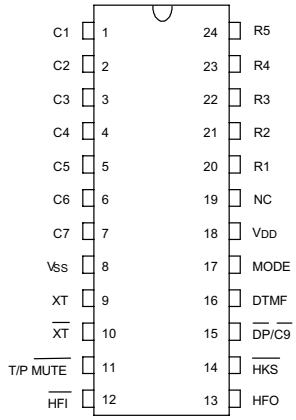
- DTMF/Pulse switchable dialer
- 32-digit LNB (last number buffer) memory (both tone and pulse mode)
- 32-digit mercury memory (tone/pulse mode)
- 16-digit × 3 one-touch direct repertory memory (tone/pulse mode)
- 16-digit × 20 direct or indirect repertory memory (tone/pulse mode)
- Uses 9 × 5 keyboard
- Flash time: 98 mS, 305 mS, or 600 mS (selectable by keypad option)
- Pause time: 3.6 sec.
- Pause P→T (pulse-to-tone) can be stored as a digit in memory
- Minimum tone output duration: 93 mS
- Minimum intertone pause: 93 mS
- On-chip power-on reset
- Uses 3.579545 MHz crystal or ceramic resonator
- Packaged in 22, 24 or 28-pin plastic DIP
- The different dialers in the W91590 series are shown in the following table:

TYPE NO.	PULSE (ppS)	MEMORY	MERCURY MEMORY	HOLD	HANDFREE	LOCK FUNCTION	PACKAGE
W91590	10	20	-	-	-	-	22
W91590L	10	20	-	-	-	Yes	22
W91590A	10	20	-	-	Yes	-	24
W91590AL	10	20	-	-	Yes	Yes	24
W91590B	10/20	24	Yes	Yes	Yes	-	28
W91590BL	10/20	24	Yes	Yes	Yes	Yes	28
W91590C	10/20	24	Save Memory	Yes	Yes	-	28
W91590CL	10/20	24	Save Memory	Yes	Yes	Yes	28

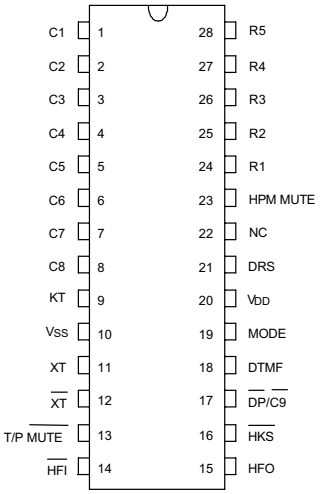
PIN CONFIGURATIONS



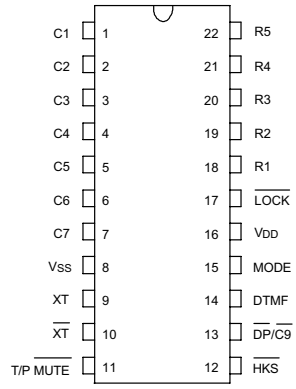
W91590



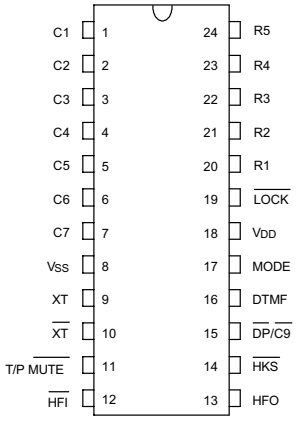
W91590A



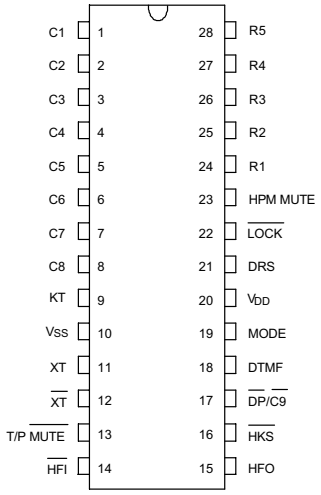
W91590B/C



W91590L



W91590AL



W91590BL/CL

PIN DESCRIPTION

SYMBOL	22-PIN	24-PIN	28-PIN	I/O	FUNCTION
Column-Row Inputs	1–7 & 18–22	1–7 & 20–24	1–8 & 24–28	I	The keyboard input may be from either the standard 9 × 5 keyboard or an inexpensive single contact (form A) keyboard. Electronic input from a μC can also be used. A valid key entry is defined by a single row being connected to a single column.
XT, $\overline{XT}$	9, 10	9, 10	11, 12	I, O	A built-in inverter provides oscillation with an inexpensive 3.579545 MHz crystal or ceramic resonator.
T/P $\overline{MUTE}$	11	11	13	O	The T/P $\overline{MUTE}$ is a conventional CMOS N-channel open drain output. The output transistor is switched on during pulse and tone mode dialing sequence and flash break. Otherwise, it is switched off.
HPM MUTE	-	-	23	O	The HPM MUTE is a conventional inverter output. During pulse dialing, flash, hold, and mercury mute functions, this pin will output an active high. It remains in a low state at all other times.
MODE	15	17	19	I	Pulling mode pin to V_{SS} places the dialer in tone mode. Pulling mode pin to V_{DD} places the dialer in pulse mode (M/B = 2:3). Leaving mode pin floating places the dialer in pulse mode (M/B = 1:2).
$\overline{HKS}$	12	14	16	I	Hook switch input. $\overline{HKS}$ = 1: On-hook state. Chip in sleeping mode, no operation. $\overline{HKS}$ = 0: Off-hook state. Chip enabled for normal operation. $\overline{HKS}$ pin is pulled to V_{DD} by internal resistor.
$\overline{DP}$/$\overline{C9}$	13	15	17	O	N-channel open drain dialing pulse output (Figure 1). Flash key causes $\overline{DP}$ to go active when in pulse mode and tone mode.
NC	17 (W91590)	19 (W91590A)	22 (W91590B/C)	-	No connection.

Pin Description, continued

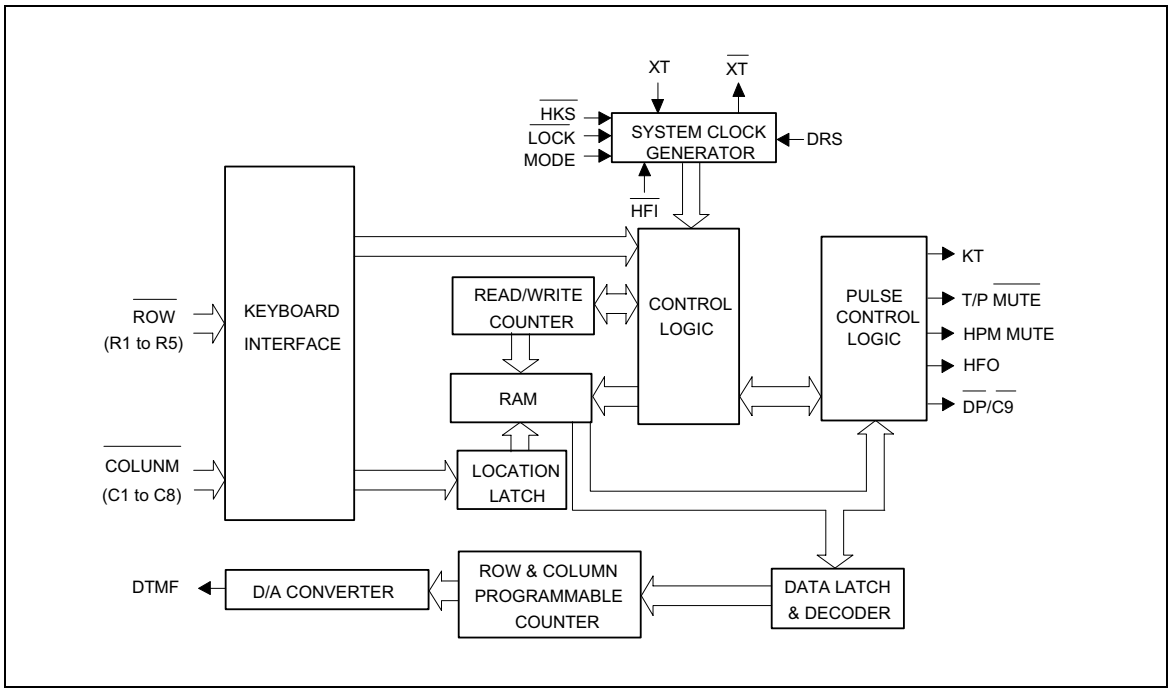
<table>
<tr><th>SYMBOL</th><th>22-PIN</th><th>24-PIN</th><th>28-PIN</th><th>I/O</th><th>FUNCTION</th></tr>
<tr><td>$\overline{\text{LOCK}}$</td><td>17
(For
W91590L)</td><td>19
(For
W91590AL)</td><td>22
(For
W91590BL/CL)</td><td>I</td><td>The function of this pin is as follows:
<table>
<tr><th>$\overline{\text{LOCK}}$ PIN</th><th>FUNCTION</th></tr>
<tr><td>V_{DD}</td><td>"0","9" dialing inhibited</td></tr>
<tr><td>Floating</td><td>Normal dialing</td></tr>
<tr><td>V_{SS}</td><td>"0" dialing inhibited</td></tr>
</table></td></tr>
<tr><td>DTMF</td><td>14</td><td>16</td><td>18</td><td>O</td><td>In pulse mode, remains in low state at all times. In tone mode, outputs a dual or single tone. Detailed timing diagram for tone mode is shown in Figure 2.
<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>V_{DD}, V_{SS}</td><td>16, 8</td><td>18, 8</td><td>20, 10</td><td>I</td><td>Power input pins.</td></tr>
<tr><td>$\overline{\text{HFI}}$, HFO</td><td>-</td><td>12, 13</td><td>14, 15</td><td>I, O</td><td>Handfree control pins. A low pulse on the $\overline{\text{HFI}}$ input pin toggles the handfree control state. Status of the handfree control state is listed in the following table:
<table>
<tr><th colspan="2">CURRENT STATE</th><th colspan="3">NEXT STATE</th></tr>
<tr><td>Hook SW.</td><td>HFO</td><td>Input</td><td>HFO</td><td>Dialing</td></tr>
<tr><td>–</td><td>Low</td><td>$\overline{\text{HFI}}$ ↓</td><td>High</td><td>Yes</td></tr>
<tr><td>On Hook</td><td>High</td><td>$\overline{\text{HFI}}$ ↓</td><td>Low</td><td>No</td></tr>
<tr><td>Off Hook</td><td>High</td><td>$\overline{\text{HFI}}$ ↓</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>
$\overline{\text{HFI}}$ pin is pulled to V_{DD} by internal resistor. The detailed timing is shown in Fig 3.</td></tr>
<tr><td>KT</td><td>-</td><td>-</td><td>9</td><td>O</td><td>Key tone signal output. A key tone will be generated whenever a valid keys is pressed. Frequency is 600 Hz and duration is 35 mS.</td></tr>
</table>

Pin Description, continued

SYMBOL	22-PIN	24-PIN	28-PIN	I/O	FUNCTION
DRS	-	-	21	I	Dial rate selection. This pin is pulled to V_{DD} by an internal resistor.

DRS	MODE PIN	TONE/PULSE	DIAL RATE	M/B
1	V_{DD}	Pulse	10 ppS	2:3
	Floating	Pulse	10 ppS	1:2
	V_{SS}	Tone	—	—
2	V_{DD}	Pulse	10 ppS	1:2
	Floating	Pulse	20 ppS	1:2
	V_{SS}	Tone	—	—

BLOCK DIAGRAM



FUNCTIONAL DESCRIPTION

Keyboard Operation

C1	C2	C3	C4	C5	C6	C7	$\overline{DP}/\overline{C9}$	C8	
1	2	3	S	M00	M05	M10	M15	EM1	R1
4	5	6	MEMO	M01	M06	M11	M16	EM2	R2
7	8	9	CLR	M02	M07	M12	M17	EM3	R3
*/T	0	#	R/P	M03	M08	M13	M18	H	R4
F1	F2	F3	R	M04	M09	M14	M19	*MER	R5

MER location in W91590C/CL is SAVE memory.

- S: Store function key
- F1, F2, F3: Flash keys
- R: One-key redial
- H: Hold function key
- $\overline{C9}$: This key is connected to pin $\overline{DP}/\overline{C9}$ via a bipolar switching transistor and a diode
- M0j: Direct or indirect (MEMO + M0j = M1j) repertory memory
- M1j: Direct repertory dialing
- EMi: One-touch memory for emergency call
- */T: * & P→T
- CLR: Clear key
- R/P: Redial and pause function key
- MER: One-touch memory for mercury code dialing
- MEMO: Indirect repertory dialing function key

Note: Dn = 0 to 9, *, #, Mij = M00 to M19 (i = 0, 1; j = 0 to 9).

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 length oversteps 32 digits.

Redialing

1. [OFF HOOK] , [D1] , [D2] , …, [Dn] BUSY, Come [ON HOOK] , [OFF HOOK]

   (or [ON HOOK] & [$\overline{HFI}$↓]), [R/P]

   or [ON HOOK] & [$\overline{HFI}$↓] , [D1] , [D2] , …, [Dn] , BUSY, [$\overline{HFI}$↓] Come [$\overline{HFI}$↓] , [R/P]

The [R/P] key can execute redial function only as first key-in after off-hook. Otherwise, it will execute pause function.

2. [OFF HOOK] (or [ON HOOK] & [$\overline{HFI}$↓]), [D1] , [D2] , …, [Dn] , [R]

   a. The one-key redial function timing diagram is shown in Figure 4.

   b. If dialing [D1] to [Dn] is completed, pressing the [R] key will cause the pulse output of pin to go low for 2.2 seconds. Break time and a 600 mS pause will automatically be added.

   c. If the pulses of the dialed number [D1] to [Dn] have not finished, [R] will be ignored.

Number Store

1. [OFF HOOK] (or [ON HOOK] & [$\overline{HFI}$↓]), [S] , [D1] , [D2] , …, [Dn]

   [S] , [Mij] , [EMi] or [MER]

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

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

The store mode can be released after the store function is executed or the state of the hook switch is changed.

2. [S] , [D1] , [D2] , …, [Dn] , [S] , [i] , [j]

D1, D2, ..., Dn will be stored in memory location Mij and will not be dialed out.

3. [S] , [D1] , [D2] , …, [Dn] , [S] , [MEMO] , [M0j]

   a. D1, D2, ..., Dn will be stored in memory location M10 to M19 and will not be dialed out.

   b. MEMO + M0j = M1j.

4. [OFF HOOK] (or [ON HOOK] & [$\overline{HFI}$↓]), [D1] , [D2] , …, [Dn] , [S] , [S] , [Mn]
   or [Ln]

   a. D1, D2, ..., Dn will be stored in memory location and will be dialed out.
   b. The [S] key must be pressed after completion of the dialing sequence.

5. [D1] , [D2] , …, [Dn] , [S] , [S] , [i] , [j]

D1, D2, ..., Dn will be stored in memory location Mij and will be dialed out.

6. [D1] , [D2] , …, [Dn] , [S] , [S] , [MEMO] , [M0j]

   a. D1, D2, ..., Dn will be stored in memory location M10 to M19 and will be dialed out.
   b. MEMO + M0j = M1j.

Repertory Dialing

1. [OFF HOOK] (or [ON HOOK] & [$\overline{HFI}$↓]), [Mij] or [EMi] or [MER]
2. [OFF HOOK] (or [ON HOOK] & [$\overline{HFI}$↓]), [MEMO] , [i] , [j]
3. [OFF HOOK] (or [ON HOOK] & [$\overline{HFI}$↓]), [MEMO] , [M0j]

Access Pause

[OFF HOOK] (or [ON HOOK] & [$\overline{HFI}$↓]), [D1] , [D2] , [R/P] , [D3] , …, [Dn]

1. The pause function can be stored in memory.
2. The pause function is executed in normal dialing, redialing, or memory dialing.
3. The pause function timing diagram is shown in Figure 5.

Pulse-to-Tone (*/ T)

[OFF HOOK] (or [ON HOOK] & [$\overline{HFI}$↓]), [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 (3.6s) , 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) (Tone)

3. The dialer remains in tone mode when the digits have been dialed out and can be reset to pulse mode only by going on-hook.
4. The P→T function timing diagram is shown in Figure 6.
5. */ T key can be stored as a digit in memory

Flash (F = F1, F2, F3)

[OFF HOOK] (or [ON HOOK] & [$\overline{HFI}$ ↓]), [F]

1. Flash key cannot be stored as a digit in memory, and has first priority among keyboard functions.
2. The system will return to the initial state after the break time is finished.
3. The flash function timing diagram is shown in Figure 7.

Clear key

1. [CLR] , [R/P] (or [R])

Redial and one-key redial buffer will be cleared.

2. [CLR] , [Mij]

Location Mij buffer content will be cleared.

3. [CLR] , [i] , [j]

Location Mij buffer content will be cleared.

4. [CLR] , [MEMO] , [M0j]

Location Mij buffer content will be cleared.

Save

1. [OFF HOOK] (or [ON HOOK] & [$\overline{HFI}$ ↓]), D1, D2, …, Dn [S] , [S] , [SAVE]

D1, D2, …, Dn will be stored in save memory and dialed out.

2. [OFF HOOK] (or [ON HOOK] & [$\overline{HFI}$ ↓]), [SAVE]

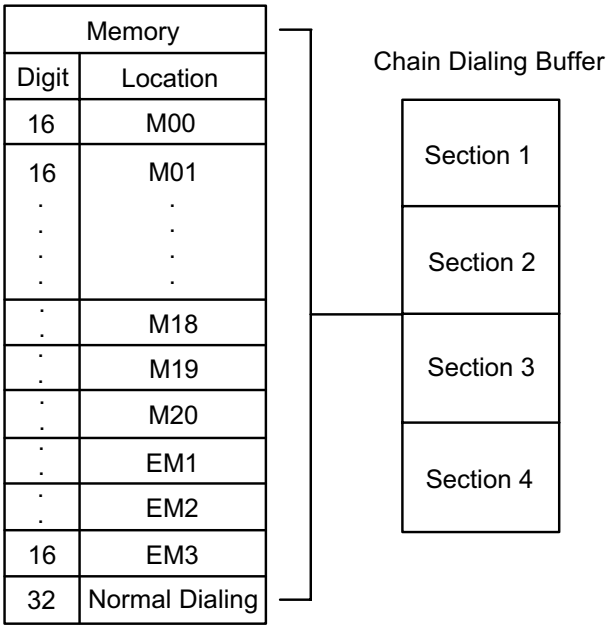
D1, D2, …, Dn will be stored in save memory but will not be dialed out.

3. [OFF HOOK] (or [ON HOOK] & [$\overline{HFI}$ ↓]), D1, D2, …, Dn [S] , [S] , [SAVE]

D1, D2, …, Dn will be stored in save memory and dialed out.

CHAIN DIALING

Relationship between the memory and the chain dialing buffer:



The chain dialing buffer may be divided into four sections, allowing up to four numbers to be dialed out in sequence. For example, if the user enters M01, M03, EM1, and normal dialing (manual dialing), the content of sections 1 to 4 will be M01, M03, EM1, and normal dialing (manual dialing). When numbers are entered into the chain dialing buffer, there is no need to wait until the previous dialing sequence has been completed. Numbers may be entered directly, one after the other, even while previous numbers are being dialed out.

1. [Manual Dialing] + [Repertory Dialing]
   Redial buffer content = Manual dialing + Repertory dialing
2. [Repertory Dialing] + [Manual Dialing]
   Redial buffer content = Repertory dialing + Manual dialing
3. [Repertory Dialing] + [Repertory Dialing]
   Redial buffer content = Repertory dialing + Repertory dialing
4. [Redialing] + [Manual Dialing]
   Redial buffer content = Redialing + Manual dialing

   The primary redial content may not be manual dialing, or else the last redial content will be overwritten.

5. [Redialing] + [Repertory Dialing]

Redial buffer content = Redialing + Repertory dialing

Redialing is valid only as the first key-in after off-hook or after the handfree dialing function is toggled on.

The second sequence should not be performed until the first sequence is completely dialed out.

6. [Manual Dialing] + [One-Key Redialing]

Redial buffer content = Manual dialing

The One-key redial may only be used after dialing out of a manual dialing sequence is completed.

7. [Repertory Dialing 1 (M1)] + [One Key Redialing] +

[Repertory Dialing 2 (M2)] + [One Key Redialing]

or

[Repertory Dialing 1 (M1)] + [One Key Redialing] +

[Repertory Dialing 2 (M2)] , [ON HOOK] , [OFF HOOK] , [Redialing]

M1 and M2 represent any of the repertory dialing memories.

The first redialing will dial out M1; the second will dial out M1, M2.

If dialing out of the repertory dialing memories has not been completed, the one-key redial key will be ignored.

Dialing of the second repertory dialing memory (M2) should not be performed until the one-key redialing operation is completed.

Notes:

1. Chain dialing (cascaded dialing) allows for memory or manual dialing while a previous dialing sequence is still being dialed out.

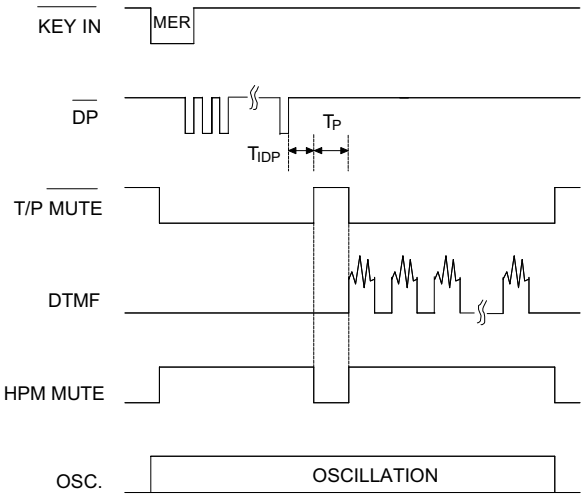
2. More than one sequence of manual dialing is not permitted.
   Entering more than one manual dialing sequence will inhibit redialing.
   Chain dialing of more than four sections is not permitted.
   [Manual Dialing] + [M1] + [Manual Dialing] (two sections of manual dialing)

3. If more than four sections are entered, all sections after the fourth section will be ignored and redialing will be inhibited.
   [Manual Dialing] + [M1] + [M2] + [M3] + [M4] (over 4 sections, ignore [M4] and inhibit redial)

4. There is a 2.0 sec. inter-chain dialing pause for cascaded dialing.

MERCURY DIALING

1. Up to 32 digits may be stored.
2. Mercury dialing is activated only as the first key-in after off-hook or handfree dialing is activated.
3. The timing diagram for the mercury memory function is given below.



Mercury Function Timing Diagram

ABSOLUTE 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
	V_{OL}	V_{SS} -0.3	V
	V_{OH}	V_{DD} +0.3	V
Power Dissipation	P_D	120	mW
Operating Temperature	T_{OPR}	-20 to +70	°C
Storage Temprature	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.

DC CHARACTERISTICS

(V_{DD}-V_{SS} = 2.5V, $F_{OSC.}$ = 3.58 MHz, Ta = 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	-	0.3	0.5	mA
		Pulse	-	0.15	0.3	
Standby Current	I_{SB}	$\overline{HKS}$ = 0, No load & No key entry	-	-	15	µA
Memory Retention Current	I_{MR}	$\overline{HKS}$ = 1, V_{DD} = 1.0V	-	-	0.2	µA
DTMF Output Voltage	V_{TO}	Row group, R_L = 5K	130	150	170	VrmS
Pre-emphasis	-	Col/Row, V_{DD} = 2.0 to 5.5V	1	2	3	dB
DTMF Distortion	THD	R_L = 5 KΩ, V_{DD} = 2.0 to 5.5V	-	-30	-23	dB
DTMF Output DC Level	V_{TDC}	R_L = 5 KΩ, 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
T/P $\overline{MUTE}$ Output Sink Current	I_{ML}	V_{MO} = 0.5V	0.5	-	-	mA
HPM MUTE Output Sink Current	I_{HPML}	V_{TO} = 0.5V	0.5	-	-	mA
HPM MUTE Output drive Current	I_{HPMH}	V_{TH} = 2.0V	0.5	-	-	mA
$\overline{HKS}$ I/P Pull High Resistor	R_{KH}		-	300	500	KΩ
Key Tone Output Current	I_{KTH}	V_{KTH} = 2.0V	0.5	-	-	mA
	I_{KTL}	V_{KTH} = 0.5V	0.5	-	-	
HFO Drive/Sink Current	I_{HFH}	V_{HFH} = 2.0V	0.5	-	-	mA
	I_{HFL}	V_{HFL} = 0.5V	0.5	-	-	
Keypad Input Drive Current	I_{KD}	V_I = 0V	30	-	-	µA
Keypad Input Sink Current	I_{KS}	V_I = 2.5V	200	400	-	µA
Keypad Resistance			-	-	5.0	KΩ

AC CHARACTERISTICS

PARAMETER	SYM.	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Keypad Active in Debounce	T_{KID}	-	-	20	-	mS
Key Release Debounce	T_{KRD}	-	-	20	-	mS
Pre-digit Pause[1]	T_{PDP1}	MODE Pin = 1	-	40	-	mS
	10 ppS	MODE Pin = Floating	-	33.3	-	
Pre-digit Pause[2]	T_{PDP2}	MODE Pin = 1	-	20	-	mS
	20 ppS	MODE Pin = Floating	-	16.7	-	
Interdigit Pause (Auto dialing)	T_{IDP}	10 ppS	-	800	-	mS
		20 ppS	-	500	-	
Make/Break Ratio	M/B	MODE Pin = 1	-	40:60	-	%
		MODE Pin = Floating	-	33:67	-	
Tone Output Duration	T_{TD}	Auto Dialing	-	93	-	mS
Intertone Pause	T_{ITP}	Auto Dialing	-	93	-	mS
Flash Break Time	T_{FB}	-	-	98	-	mS
			-	305	-	
			-	600	-	
Pause Time	T_P	-	-	3.6	-	S
Key Tone Frequency	F_{KT}	-	-	600	-	Hz
Key Tone Duration	T_{KTD}	-	-	35	-	mS
One-key Redialing Pause Time	T_{PR}	-	-	600	-	mS
One-key Redialing Break Time	T_{RB}	-	-	2.2	-	S
First Key-in Pause Time	T_{FKP}	-	-	600	-	mS

Notes:

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

2. Crystal oscillator accuracy directly affects these times.

TIMING WAVEFORMS

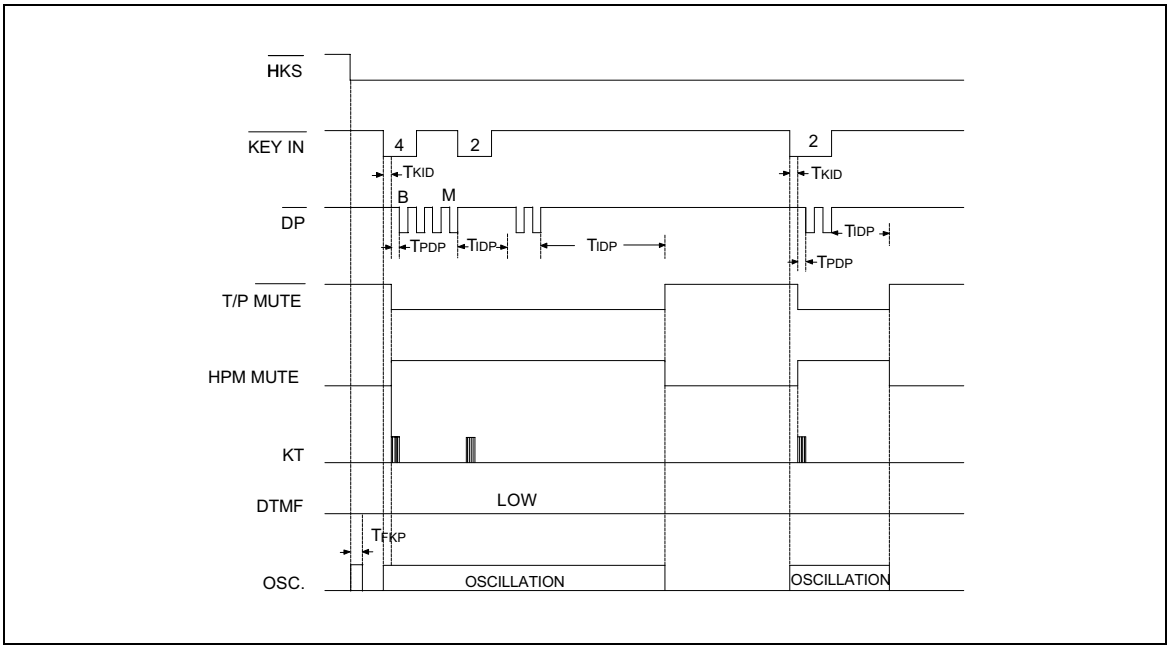


Figure 1. Pulse Mode Diagram (Normal Dialing)

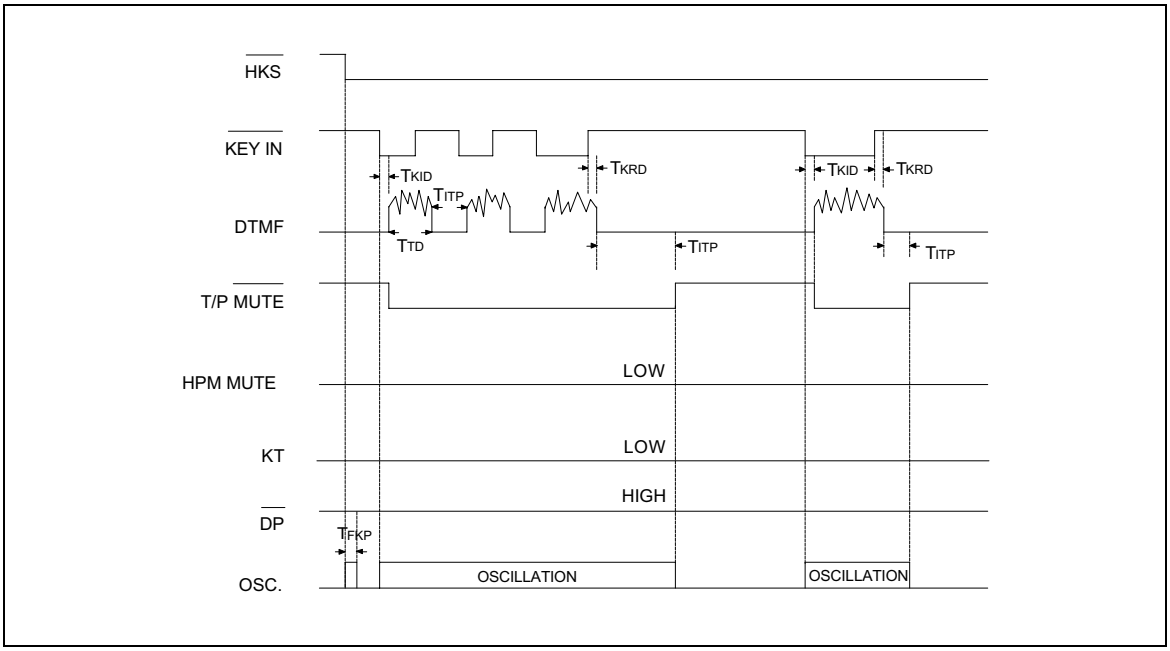


Figure 2. Tone Mode Diagram (Normal Dialing)

Timing Waveforms, continued

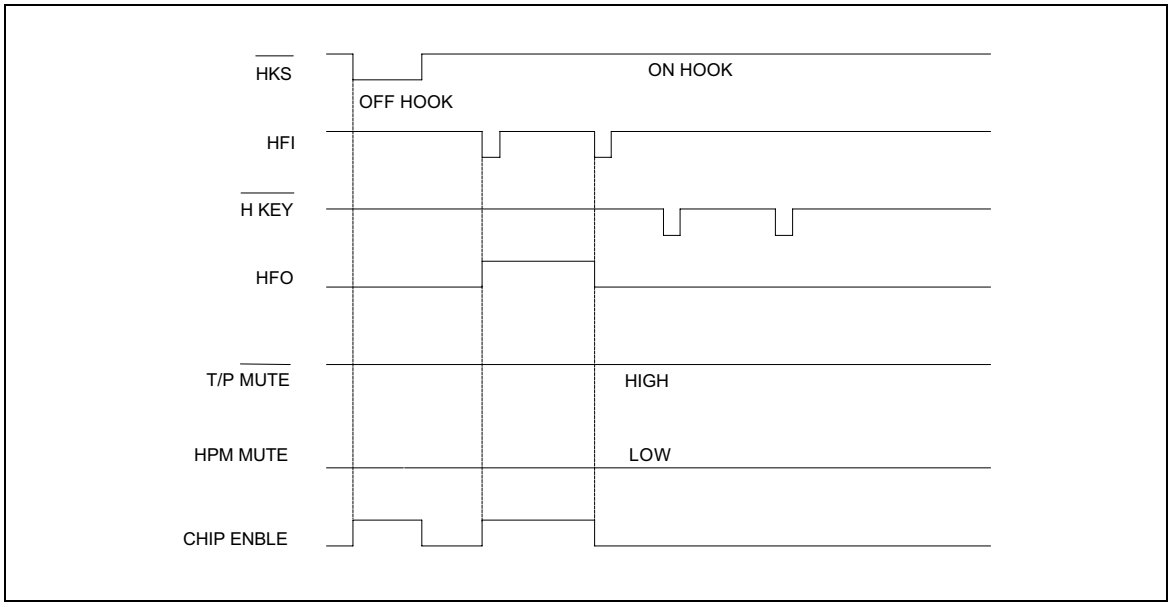


Figure 3(a).

Note: The $\overline{\text{H KEY}}$ cannot be enabled when chip is disabled.

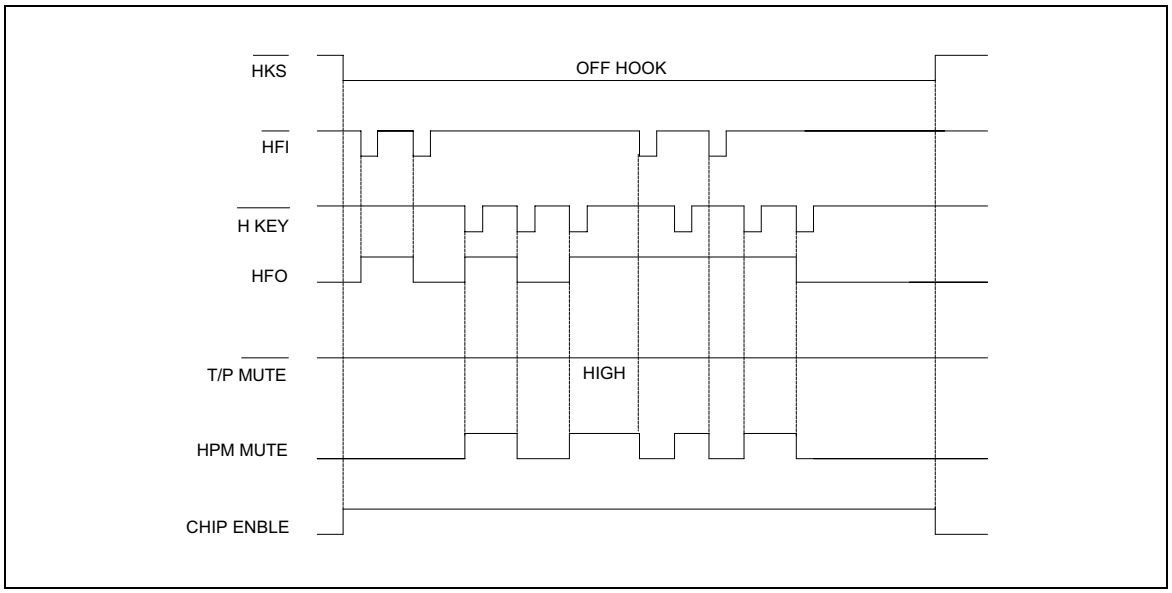


Figure 3(b).

Note: The $\overline{\text{HFI}}$ and $\overline{\text{HFI}}$ inputs will toggle the HFO signal; as soon as either $\overline{\text{HFI}}$ or $\overline{\text{H KEY}}$ is activated the HFO signal will go high and previous inputs will be ignored.

Timing Waveforms, continued

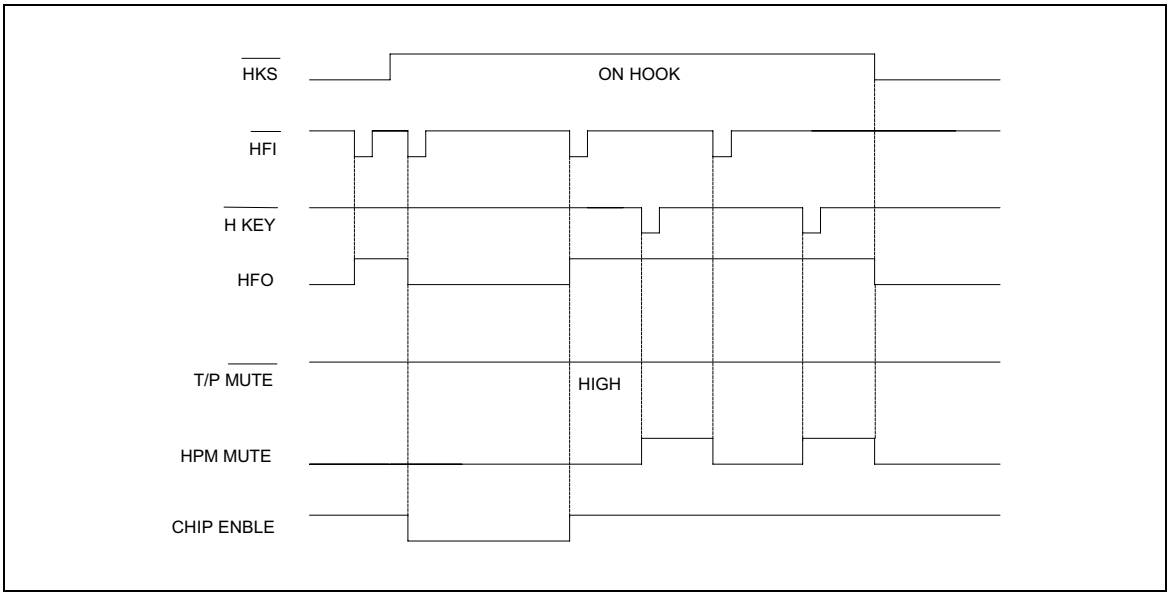


Figure 3(c).

Note: Changing the state of the $\overline{\text{HKS}}$ signal from high to low will initialize the HFO and HPM MUTE signals.

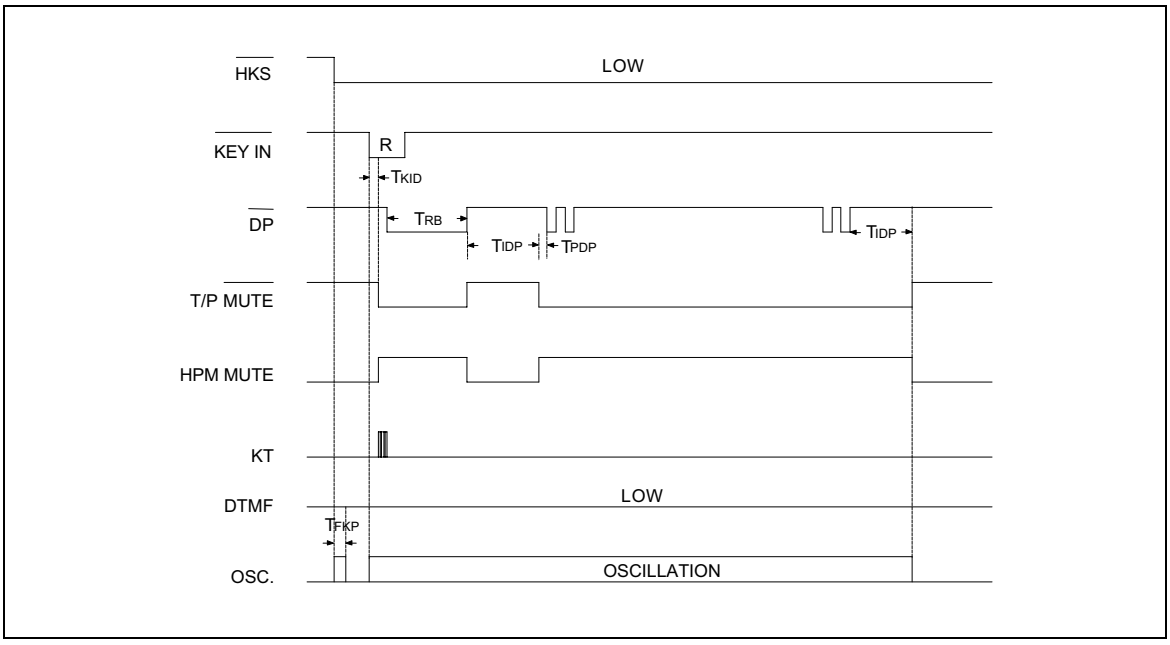


Figure 4. Pulse Mode One-key Redialing Timing Diagram (when not first key)

Timing Waveforms, continued

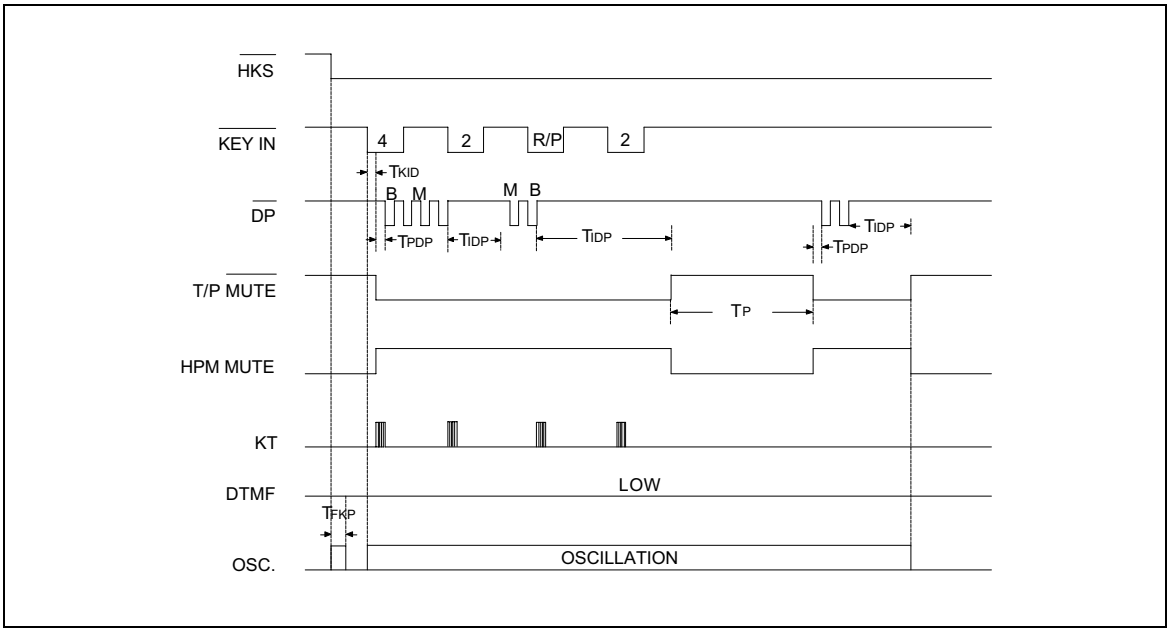


Figure 5. Pause Function Timing Diagram

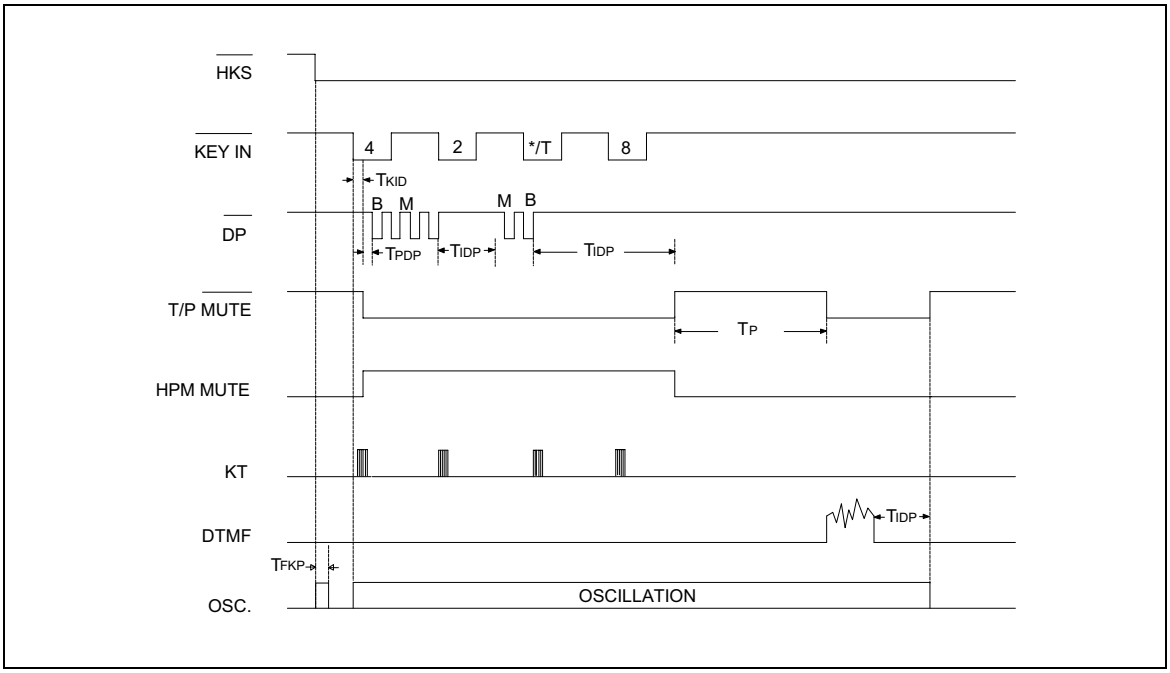


Figure 6. Pulse-to-Tone Function Timing Diagram

Timing Waveforms, continued

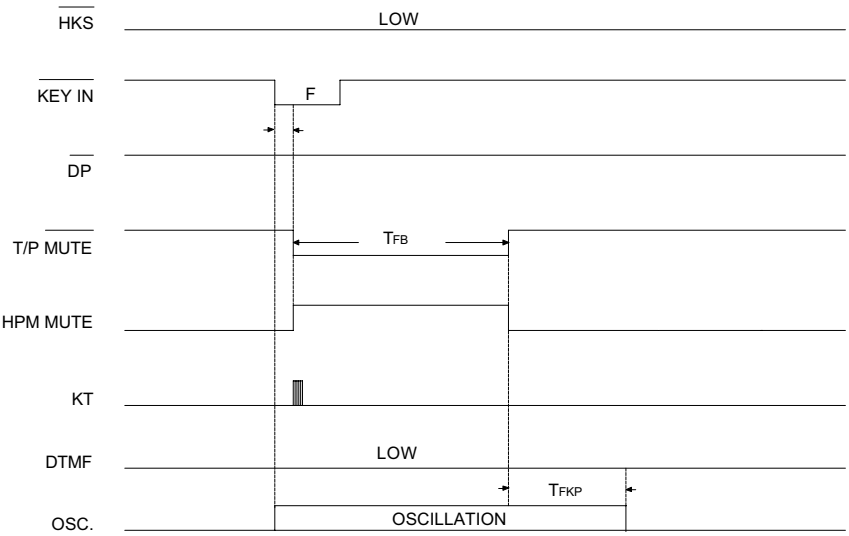


Figure 7. Flash Operation Timing Diagram

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Note: All data and specifications are subject to change without notice.