Winbond Electronics Corp.

10-MEMORY TONE/PULSE DIALER WITH SAVE, KEYTONE, LOCK, AND HANDFREE FUNCTIONS

GENERAL DESCRIPTION

The W91540N series are tone/pulse switchable telephone dialers with 10 memories, keytone or lock function, and handfree dialing control. These chips are fabricated using Winbond's high-performance CMOS technology and thus offer good performance in low-voltage and low-power operations.

FEATURES

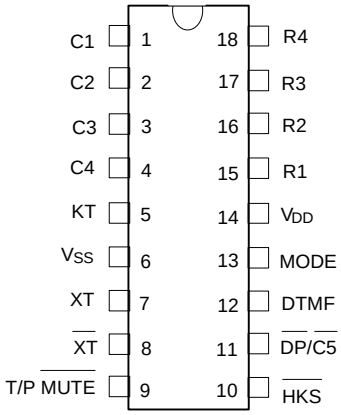
- DTMF/pulse switchable dialer
- Two by 32-digit redial and save memory
- Ten by 16 digit two-touch indirect repertory memory
- Pulse-to-tone (*/T) keypad for long distance call operation
- Cascaded dialing
- Uses 5 × 5 keyboard
- Easy operation with redial, flash, pause, and */T keypads
- Pause, P→T (pulse-to-tone) can be stored as a digit in memory
- 0 or 9 dialing inhibition pin for PABX system or long distance dialing lock out
- Dialing rate (10 ppS or 20 ppS) selected by bonding option
- Minimum tone output duration: 93 mS (W91544AN: 87 mS)
- Minimum intertone pause: 93 mS (W91544AN: 87 mS)
- Pause time: 3.6 sec
- 300 mS off-hook delay in lock mode ($\overline{DP}$ remains low for 300 mS while off-hook)
- Flash break time (73 mS, 100 mS, 300 mS, or 600 mS) selectable by keypad; pause time is 1.0 S
- Make/break ratio (2:3 or 1:2) selectable by Mode pin
- Key tone output for valid keypad entry recognition
- On-chip power-on reset
- Uses 3.579545 MHz crystal or ceramic resonator
- Packaged in 18 or 20-pin DIP

- The different dialers in the W91540N series are shown in the following table:

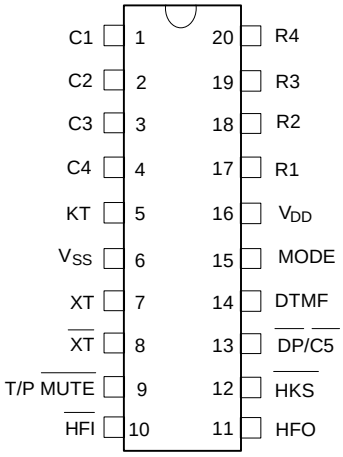
TYPE NO.	REPLACEMENT TYPE NO.	PULSE (ppS)	FLASH (mS)	M/B	KEY TONE	HANDFREE DIALING	LOCK	PACKAGE (PINS)
W91540N	W91540	10	600/300/73/100	Pin	Yes	-	-	18
	W91541							
W91540AN	W91540A	10	600/300/73/100	Pin	Yes	Yes	-	20
	W91541A							
W91541LN	W91541L	10	600/300/73/100	Pin	-	-	Yes	18
W91541ALN	W91541AL	10	600/300/73/100	Pin	-	Yes	Yes	20
W91542N	W91542	20	600/300/73/100	Pin	Yes	-	-	18
W91542AN	W91542A	20	600/300/73/100	Pin	Yes	Yes	-	20
W91544AN	New type	10	600/300/73/100	Pin	Yes	Yes	-	20

Note: The W91544AN is designed specifically for use in France. The pause time is not added in pulse-to-tone mode.

PIN CONFIGURATIONS

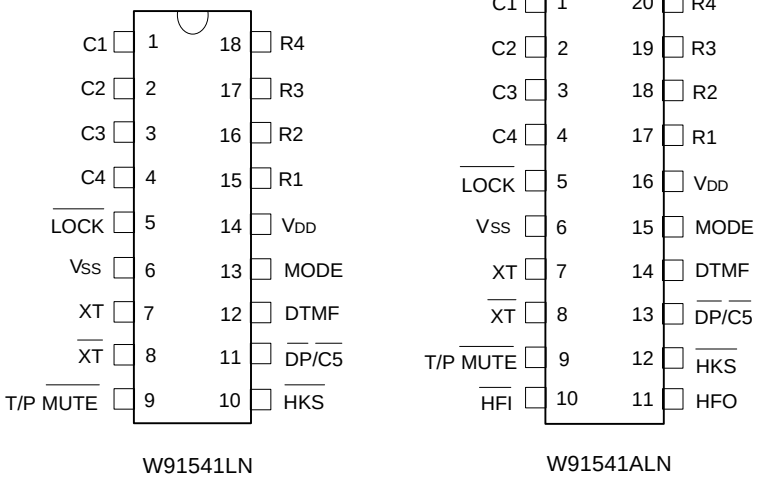


W91540N/542N



W91540AN/542AN/544AN

Pin Configurations, continued



PIN DESCRIPTION

SYMBOL	18-PIN	20-PIN	I/O	FUNCTION
Column-Row Inputs	1–4 & 15–18	1–4 & 17–20	I	The keyboard input is compatible with a standard 5 × 5 keyboard, an inexpensive single contact (Form A) keyboard, and electronic input. In normal operation, any single button can be pushed to produce a dual tone, pulses, or a function. Activation of two or more buttons will result in no response except for single tone.
XT	7	7	I	A built-in inverter provides oscillation with an inexpensive 3.579545 MHz crystal. The oscillator ceases when a keypad input is not sensed. The crystal frequency deviation is 0.02%.
$\overline{XT}$	8	8	O	Crystal oscillator output pin.
T/P $\overline{MUTE}$	9	9	O	The T/P $\overline{MUTE}$ is a conventional CMOS N-channel open drain output. The output transistor is switched on low level during dialing sequence (both pulse and tone mode). Otherwise, it is switched off.

Pin Description, continued

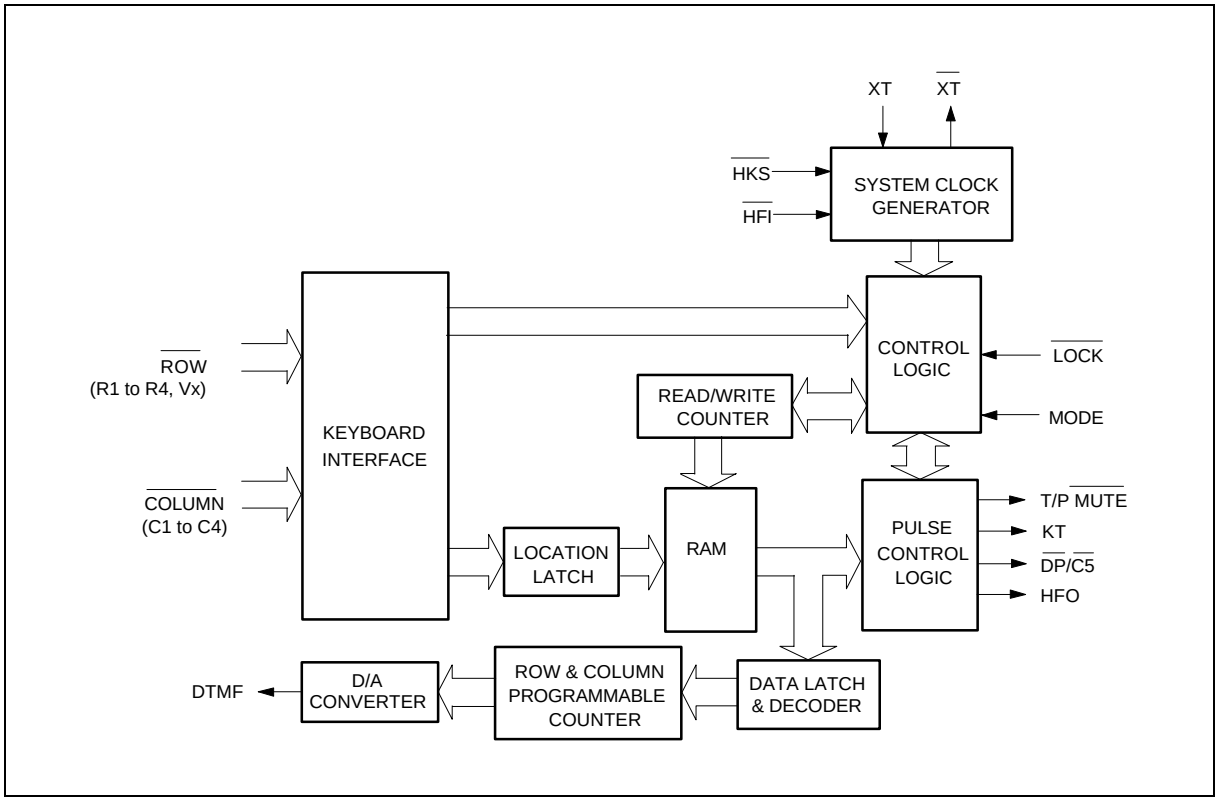
SYMBOL	18-PIN	20-PIN	I/O	FUNCTION
MODE	13	15	I	Pulling mode pin to V_{SS} places dialer in tone mode. Pulling mode pin to V_{DD} places dialer in pulse mode with M/B ratio of 40:60 (10 ppS, except for W91542N/542AN is 20 ppS). Leaving mode pin floating places dialer in pulse mode with M/B ratio of 33.3:66.7 (10 ppS, except for W91542N/542AN is 20 ppS).
$\overline{HKS}$	10	12	I	The $\overline{HKS}$ (hook switch) input is used to sense whether the handset is on-hook or off-hook. On-hook state, $\overline{HKS}$ = 1: chip is in sleeping mode, no operation. Off-hook state, $\overline{HKS}$ = 0: chip is enabled for normal operation. $\overline{HKS}$ pin is pulled to V_{DD} by an internal resistor.
KT	5 (except for W91541LN)	5 (except for W91541ALN)	O	The key tone output is a conventional CMOS inverter. The key tone is generated when any valid key is pressed; the KT pin generates a 1.2 KHz square wave at 35 mS. When no key is pressed, the KT pin remains in low state.
$\overline{LOCK}$	5 (only for W91541LN)	5 (only for W91541ALN)	I	The function of this terminal is to prevent "0" dialing and "9" dialing under PABX system long distance call control. When the first key input after reset is 0 or 9, all key inputs, including the 0 or 9 key, become invalid and the chip generates no output. The telephone is reinitialized by a reset. The function of the $\overline{LOCK}$ pin is shown below:
$\overline{DP}$ / $\overline{C5}$	11	13	O	N-channel open drain dialing pulse output. Flash key will cause $\overline{DP}$ to be active in either tone mode or pulse mode. In lock mode, $\overline{DP}$ remains low for 300 mS during off-hook delay time. The timing diagram for pulse mode is shown in Figure 1(a, b, c, d).

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

Pin Description, continued

<table>
<tr><th>SYMBOL</th><th>18-PIN</th><th>20-PIN</th><th>I/O</th><th>FUNCTION</th></tr>
<tr><td>DTMF</td><td>12</td><td>14</td><td>O</td><td>During pulse dialing, this pin remains in low state regardless of keypad input. In tone mode, it will output a dual or single tone.
A detailed timing diagram for tone mode is shown in Figure 2(a, b, c, d)
<table>
<tr><th colspan="4">OUTPUT FREQUENCY</th></tr>
<tr><td></td><td>Specified</td><td>Actual</td><td>Error %</td></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>VDD, VSS</td><td>14, 6</td><td>16, 6</td><td>I</td><td>Power input pins for the dialer chip. VDD is the main power and VSS is the ground.</td></tr>
<tr><td>$\overline{\text{HFI}}$, HFO</td><td>-</td><td>10, 11</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 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>$\overline{\text{HFI}}$ ↓</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 VDD by an internal resistor.
Detailed timing diagram is shown in Figure 3.</td></tr>
</table>

BLOCK DIAGRAM



FUNCTIONAL DESCRIPTION

C1	C2	C3	C4	DP / C5	
1	2	3	S		R1
4	5	6	F4		R2
7	8	9	A		R3
∗/T	0	#	R/P	SAVE	R4
F1	F2	F3			Vx

- S: Store function key
- A: Indirect repertory memory dialing function key
- R/P: Redial and pause function key
- ∗/T: ∗ in tone mode and P→T in pulse mode
- SAVE: Save function key for one-touch 32-digit memory
- F1, ..., F4: Flash function keys; F1 = 600 mS, F2 = 300 mS, F3 = 73 mS, F4 = 100 mS, and flash pause time for each key is 1.0 mS

Note: Ln = 0, ..., 9; Dn = 0, ..., 9, */T, #, Pause.

Normal Dialing

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

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

Redialing Dialing

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

Come ON HOOK , OFF HOOK , (or ON HOOK & $\overline{\text{HFI}}$ i), R/P

1. The redial memory content will be D1, D2, ..., Dn.
2. The R/P key can execute the redial function only as the first key-in after off-hook; otherwise, it will execute pause function.

Number Store

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

1. If the sequence of the dialed digits D1, D2, …, Dn has not finished, S will be ignored.
2. D1, D2, ..., Dn will be dialed out and stored in memory location Ln.

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

3. D1, D2, …, Dn will be stored in memory location Ln but will not be dialed out.
4. R/P and */T keys can be stored as a digit in memory, but R/P key cannot be the first digit. In store mode, R/P is the pause function key.
5. The store mode is released after the store function is executed or when the state of the hook switch changes or the flash function is executed.

Save

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

1. D1, D2, ..., Dn will be dialed out.
2. If the dialing of D1 to Dn is finished, pressing SAVE will cause D1 to Dn to be duplicated to save memory.

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

3. D1 to Dn will be dialed out after SAVE key is pressed.

Repertory Dialing

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

1. The content of save memory location will be dialed out.

OFF HOOK , (or ON HOOK & $\overline{\text{HFI}}$ i), A , Ln

2. The content of memory location Ln will be dialed out.

Access Pause

OFF HOOK , (or ON HOOK & $\overline{\text{HFI}}$ i), D1 , D2 , R/P , D3 , ..., Dn

1. The pause function can be stored as a digit in memory.
2. The pause function is executed in normal dialing or redialing or memory dialing.
3. The pause function timing diagram is shown in Figure 4.

Pulse-to-tone (*/T)

OFF HOOK , (or ON HOOK & $\overline{\text{HFI}}$ i), D1 , D2 , ..., Dn , */T , D1' , D2' , ..., Dn'

1. If the mode switch is set to pulse mode, then the output signal will be as follows:

   All versions except W91544AN:

   D1, D2, ..., Dn, Pause, D1', D2', ..., Dn'

   (Pulse) (Tone)

   W91544AN:

   D1, D2, ..., Dn, *, D1', D2', ..., Dn'

   (Pulse) (Tone) (Tone)

2. If the mode switch is set to tone mode, then the output signal will be as follows:

   D1, D2, ..., Dn, *, D1', D2', ..., Dn'

   (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 function timing diagram is shown in Figure 5(a, b).

Flash

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

1. Fn = F1, ..., F4.
2. If Fn is pressed, the dialer will execute a flash break time of 600 mS (F1), 300 mS (F2), 73 mS (F3), or 100 mS (F4). In each case the flash pause time is 1.0 second.
3. Flash key cannot be stored as a digit in memory. The flash key has first priority among keyboard functions.

4. The system will return to the initial state after the flash pause time is finished.
5. The flash function timing diagram is shown in Figure 6.

Cascaded Dialing

1. [Normal Dialing] + [Repertory Dialing] + [Normal Dialing]
   (1st sequence) (2nd sequence)

2. [Repertory Dialing] + [Normal Dialing] + [Repertory Dialing]
   (1st sequence) (2nd sequence)

3. [Redialing] + [Normal Dialing] + [Repertory Dialing]
   (1st sequence) (2nd sequence)

4. Redialing and save dialing are valid only as the first key-in.

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 temperature	T_{SIG}	-55 to +150	°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, Fosc. = 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	-	0.4	0.6	mA
		Pulse	-	0.2	0.4	mA
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
Tone Output Voltage	V_{TO}	Row group, R_L = 5 KΩ	130	150	170	mVrms
Pre-emphasis		Col/Row V_{DD} = 2.0–5.5V	1	2	3	dB
DTMF Distortion	THD	R_L = 5 KΩ V_{DD} = 2.0–5.5V	-	-30	-23	dB
DTMF Output DC Level	V_{TDC}	R_L = 5 KΩ V_{DD} = 2.0–5.5V	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
KT Drive/Sink Current	I_{KTH}	V_{KTH} = 2.0V	0.5	-	-	mA
	I_{KTL}	V_{KTL} = 0.5V	0.5	-	-	mA
HFO Drive/Sink Current	I_{HFH}	V_{HFH} = 2.0V	0.5	-	-	mA
	I_{HFL}	V_{HFL} = 0.5V	0.5	-	-	mA
Keypad Input Drive Current	I_{KD}	V_I = 0V	4	-	-	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
Key-in Debounce	TKID	-	-	20	-	mS
Key Release Debounce	TKRD	-	-	20	-	mS
On-hook Debounce	TOHD	Lock Mode	-	20	-	mS
		Unlock Mode	-	150	-	mS
Pre-digit Pause[1]	TPDP1	Mode Pin = VDD	-	40	-	mS
	10 ppS	Mode Pin = Floating	-	33.3	-	mS
Pre-digit Pause[2]	TPDP2	Mode Pin = VDD	-	20	-	mS
	20 ppS	Mode Pin = Floating	-	16.7	-	mS
Inter-digit Pause	TIDP	10 ppS	-	800	-	mS
(Auto Dialing)		20 ppS	-	500	-	mS
Make/Break Ratio	M:B	Mode Pin = VDD	-	40:60	-	%
		Mode Pin = Floating	-	33.3:66.7	-	%
Tone Output Duration	TTD	Except for W91544AN	-	93	-	mS
Intertone Pause	TITP	Except for W91544AN	-	93	-	mS
Tone Output Duration	TTD	W91544AN Only	-	87	-	mS
Intertone Pause	TITP	W91544AN Only	-	87	-	mS
Flash Break Time	TFB	F1	-	600	-	mS
		F2	-	300	-	
		F3	-	73	-	
		F4	-	100	-	
Flash Pause Time	TFP	-	-	1.0	-	S
Pause Time	TP	-	-	3.6	-	S
Key Tone Frequency	FKT	-	-	1.2	-	KHz
Key Tone Duration	TKTD	-	-	35	-	mS
One-key Redialing Pause Time	TRP	-	-	600	-	mS
One-key Redialing Break Time	TRB	-	-	2.2	-	S
Off-hook Delay	TOFD	Lock Only	-	300	-	mS
First Key-in Delay	TFKD	Lock Only	-	300	-	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, Fosc. = 3.579545 MHz ±0.02%.
2. Crystal oscillator accuracy directly affects these times.

TIMING WAVEFORMS

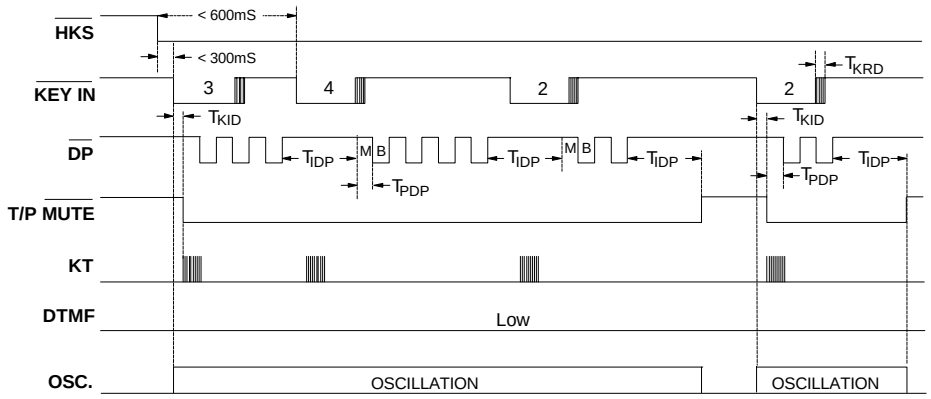


Figure 1(a). Normal Dialing Timing Diagram (Pulse Mode Without Lock Function)

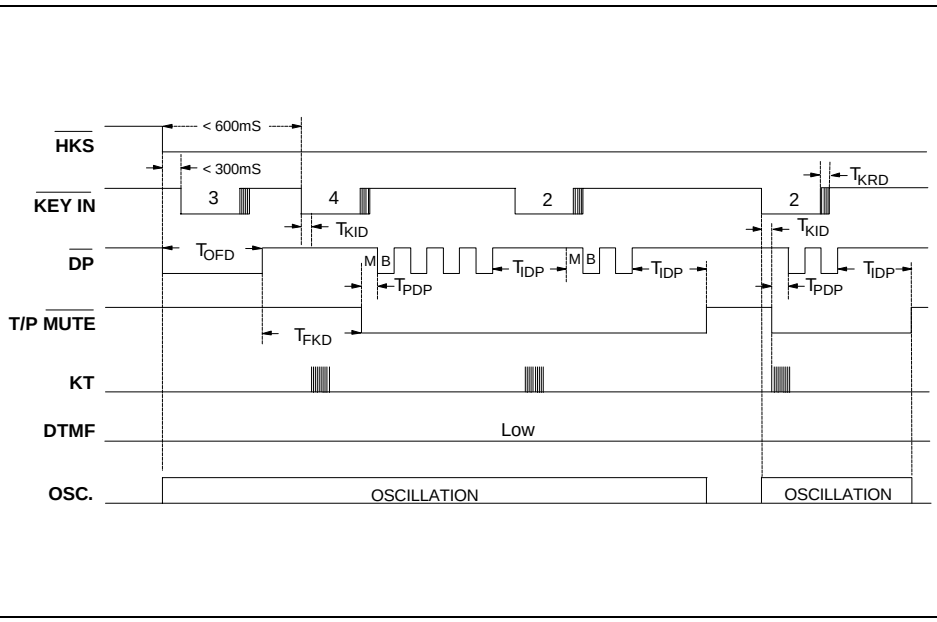


Figure 1(b). Normal Dialing Timing Diagram (Pulse Mode with Lock Function)

Timing Waveforms, continued

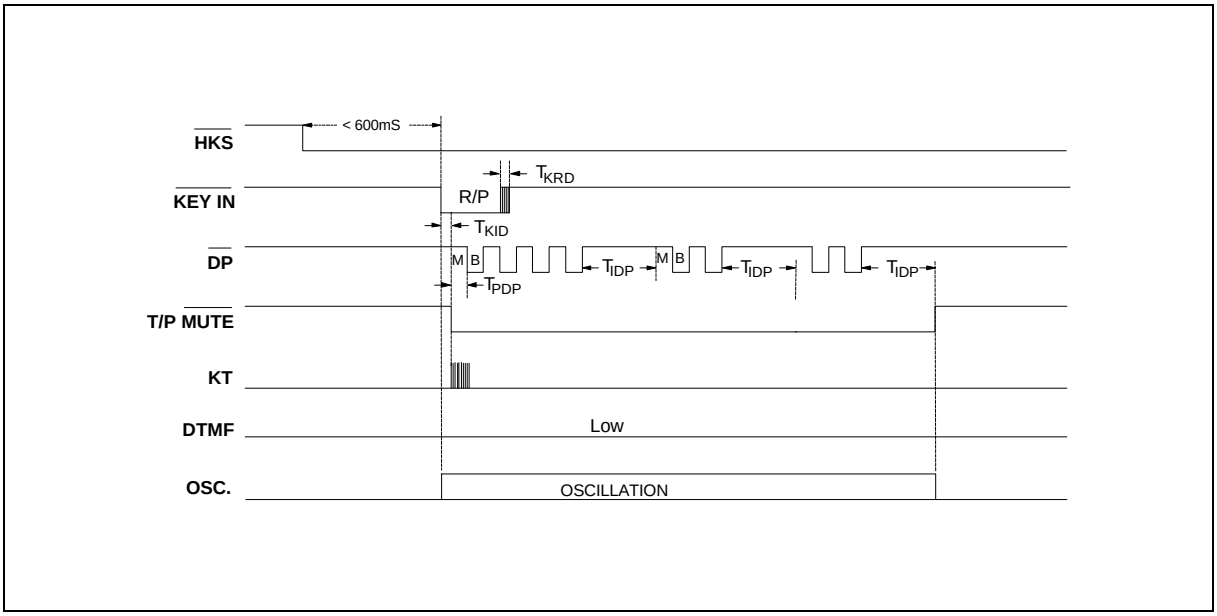


Figure 1(c). Auto Dialing Timing Diagram (Pulse Mode Without Lock Function)

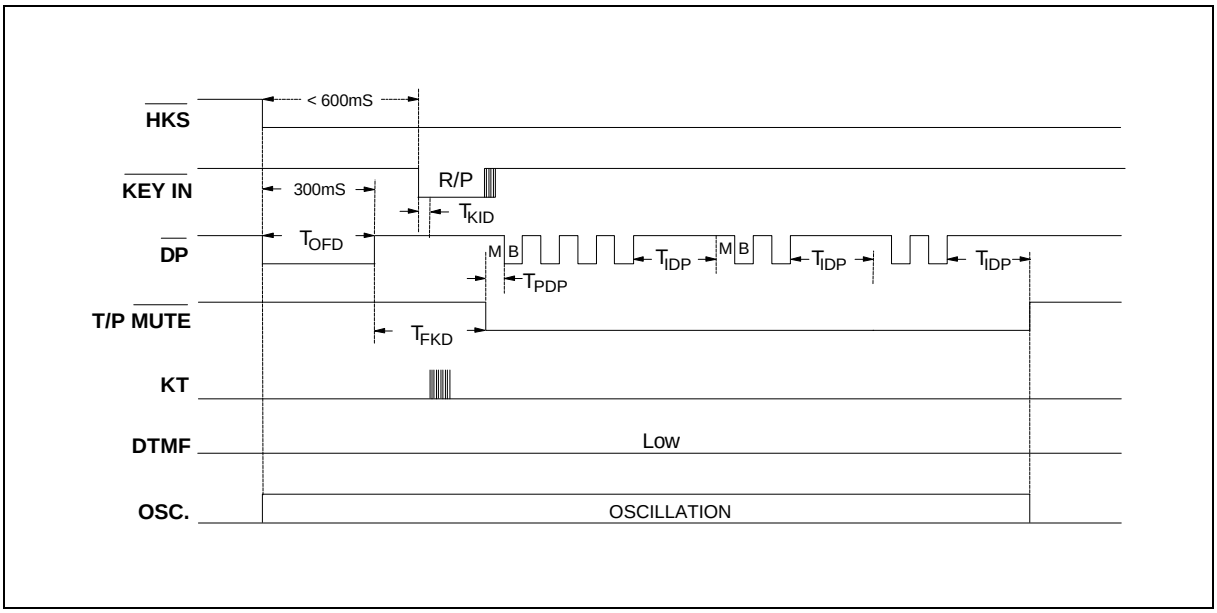


Figure 1(d). Auto Dialing Timing Diagram (Pulse Mode with Lock Function)

Timing Waveforms, continued

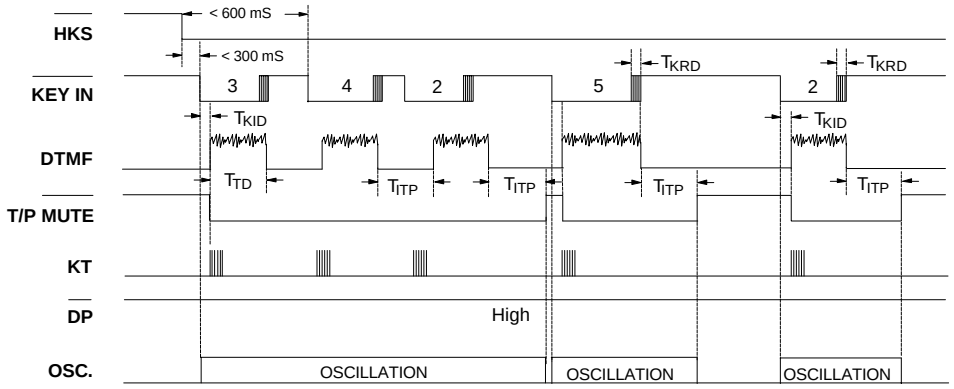


Figure 2(a). Normal Dialing Timing Diagram (Tone Mode Without Lock Function)

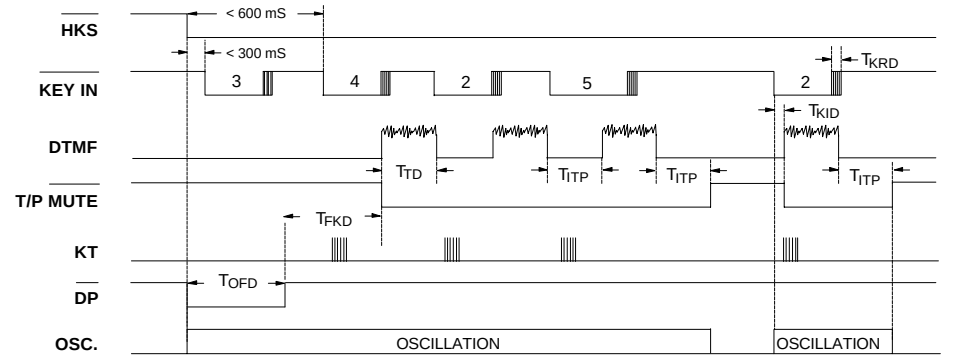


Figure 2(b). Normal Dialing Timing Diagram (Tone Mode with Lock Function)

Timing Waveforms, continued

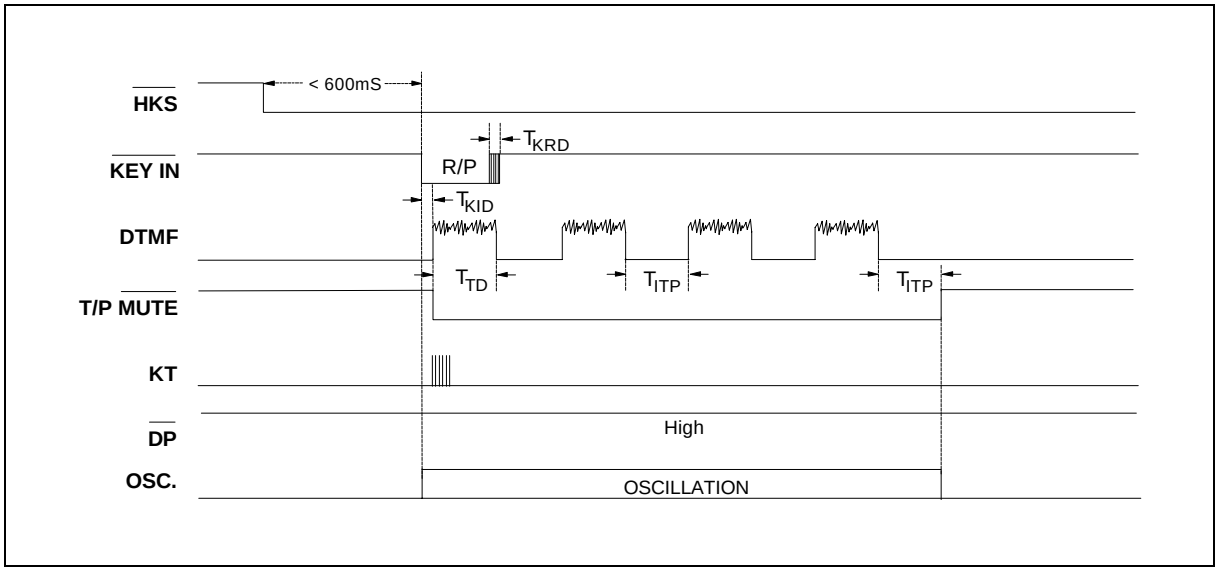


Figure 2(c). Auto Dialing Timing Diagram (Tone Mode Without Lock Function)

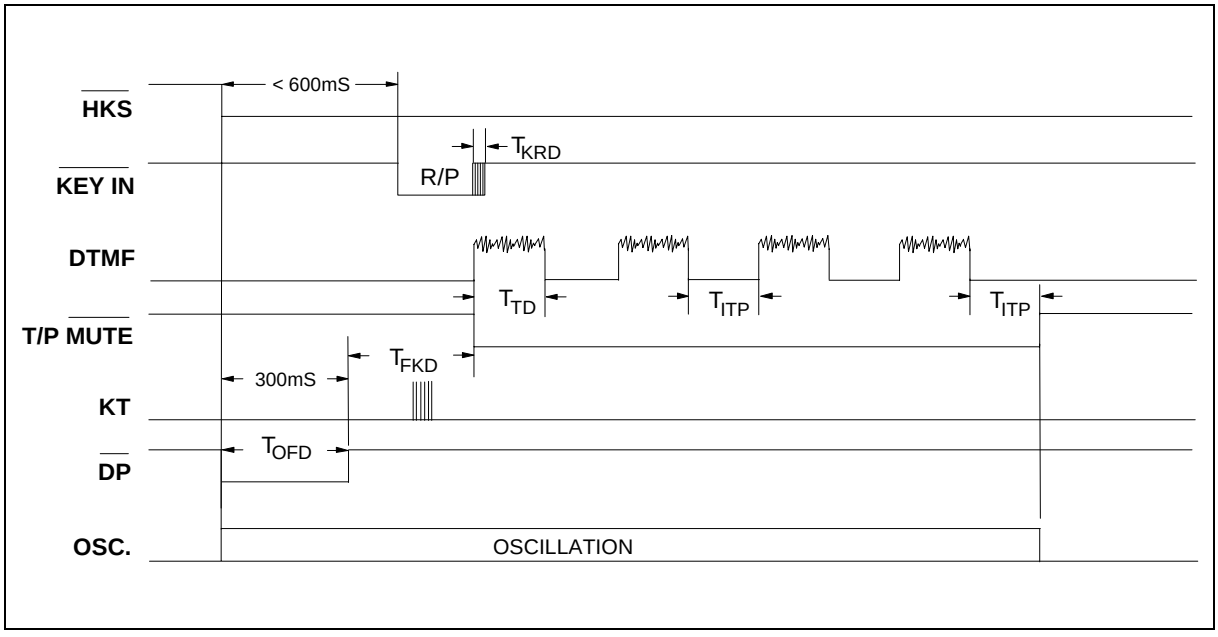


Figure 2(d) Auto Dialing Timing Diagram (Tone Mode with Lock Function)

Timing Waveforms, continued

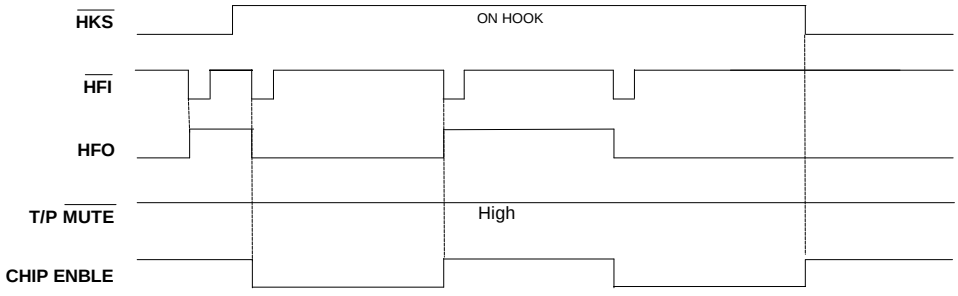


Figure 3. Handfree Timing Diagram

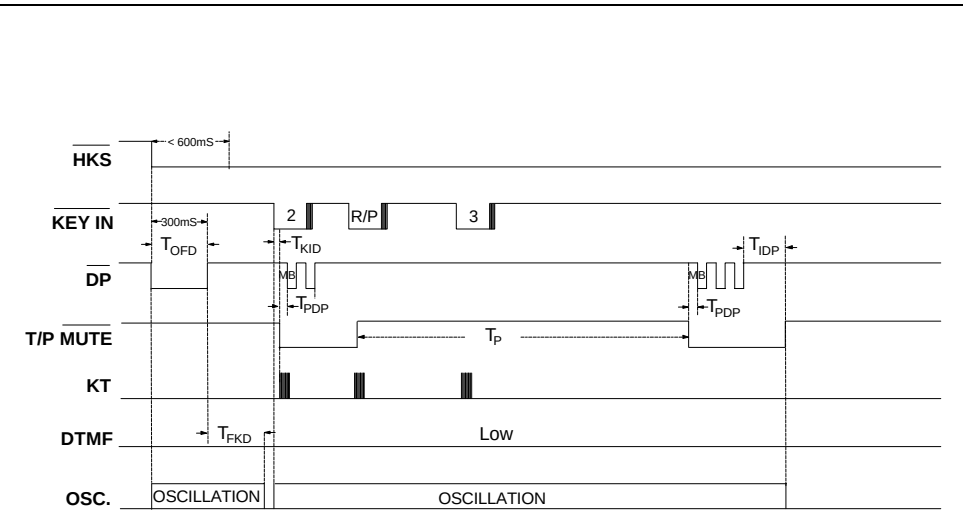


Figure 4. Pause Function Timing Diagram

Timing Waveforms, continued

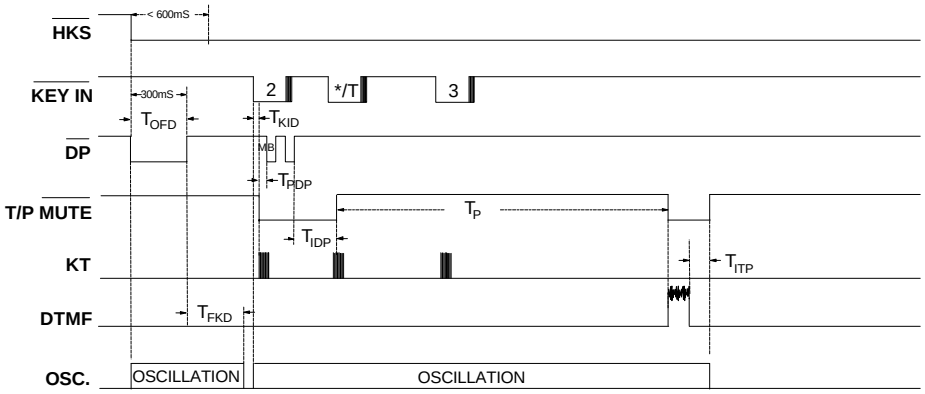


Figure 5(a). Pulse-to-tone Timing Diagram (All Versions Except W91544AN)

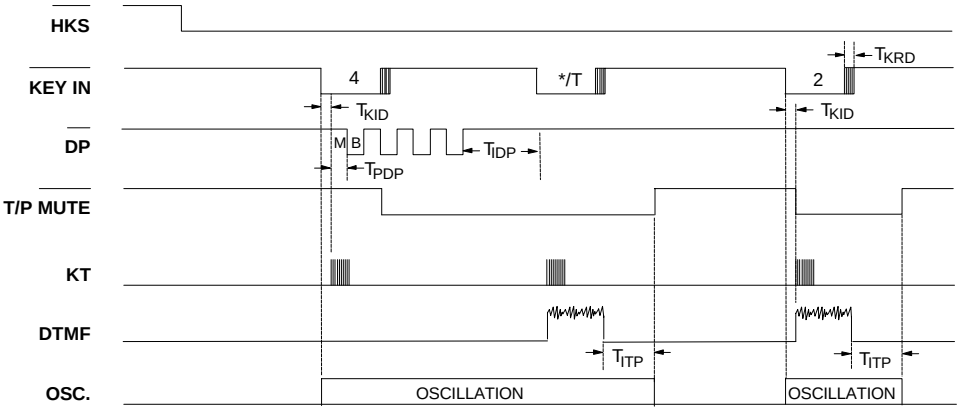


Figure 5(b). Pulse-to-tone Timing Diagram (W91544AN Only)

Timing Waveforms, continued

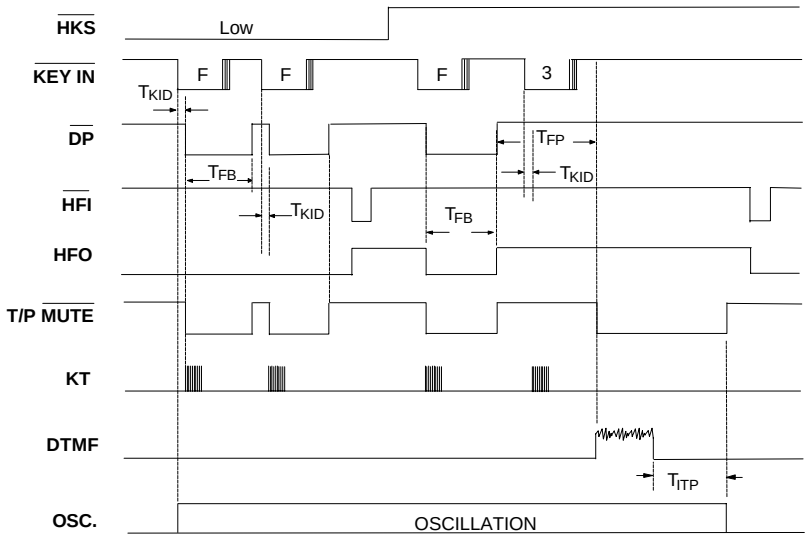


Figure 6. Flash Timing Diagram

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