General Description

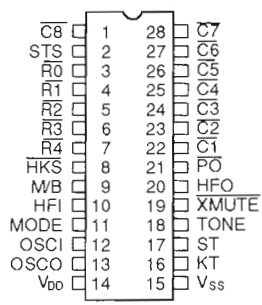
The HM9121/C are 20-memory tone/pulse switchable dialer with Last Number Redial(LNB) , which are fabricated in CMOS technology with wide operating voltage for both tone and pulse mode, and consumes very low memory retention current in on hook state.

Features

* 20-memory tone/pulse switchable dialer.
* Twenty 16-digit one touch memory.
  One 31-digit last number redial memory.
* PAGE key is provided.
* Pulse to tone (P→T) is provided for PBX operation.
* Flash key is available.
* Minimum tone duration is 100ms.
* Minimum intertone pause is 106ms.
* Uses 3.579545 MHz crystal or ceramic resonator.
* Many options can be selected.
  Mode (10 PPS ; 20 PPS ; Tone)
  M/B ratio (40 : 60 ; 33 : 66)
  Pause time (3.6s)
* Flash function (Digit)
  P→T pause time (3.6s)
  Flash time (100ms ; 600ms).
  Flash pause time (1000ms).
* Redial pause time (0ms).
* Memory store (on hook ; off hook).
* Mixed dialing is provided.
* Handfree function is provided for speaker phone application.
* Power on reset circuit is provided.
* Key tone is provided.
* Package in DIP 28.

Pin Configurations

HM9121/C

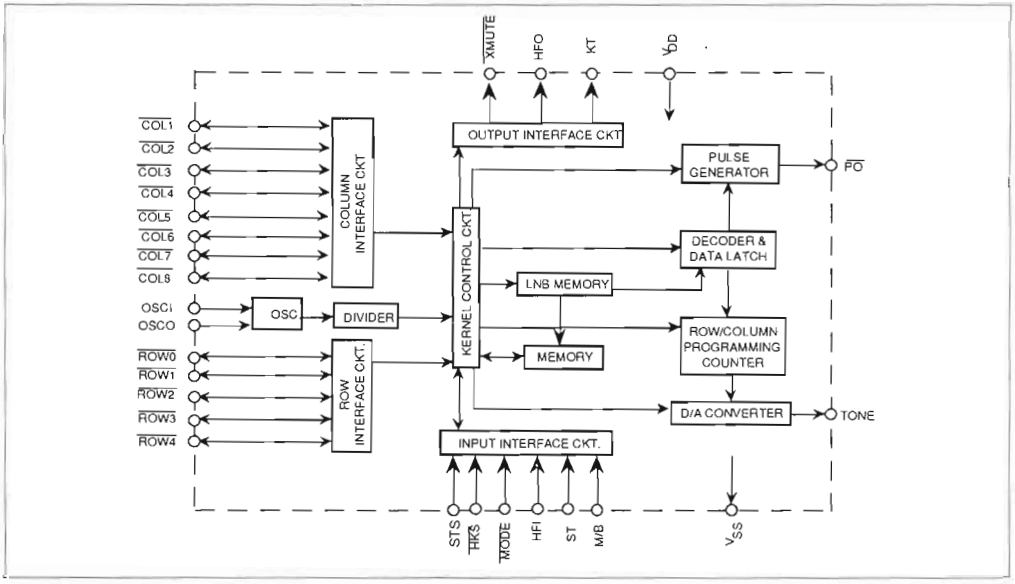


Keyboard Assignment

	C1	C2	C3	C4	C5	C6	C7	C8
R0		PAGE	CD	P→T	EM00	EM05	EM10	EM15
R1	1	2	3	F	EM01	EM06	EM11	EM16
R2	4	5	6		EM02	EM07	EM12	EM17
R3	7	8	9	ST	EM03	EM08	EM13	EM18
R4	*	0	#	RD/P	EM04	EM09	EM14	EM19

1). P→T : In pulse mode, execute P→T function.
2). F : Flash key.
3). RD/P : Redial key/Pause key.
4). ST : Store key.
5). EMn : One touch memory key.
6). PAGE : Memory page key.
7). CD : Call Disconnect key.

Functional Block Diagram



Dialing Signal Option :

	M/B Pin	M/B rate	Flash
HM9121	V_{DD}	33.3 : 66.6	100ms
	V_{SS}	40 : 60	600ms
HM9121C	V_{DD}	33.3 : 66.6	600ms
	V_{SS}	40 : 60	100ms

STS	Memore Store
V_{DD}	On hook Store
V_{SS}	Off hook Store

* Flash time is 600 ms not changeable in 20 pps.

Pin Description

Pin		Symbol	Function
HM9121	HM9121C		
22	22	$\overline{C1}$	* Provides keyboard scanning .
23	23	$\overline{C2}$	
24	24	$\overline{C3}$	**a. Keyboard scanning:**
25	25	$\overline{C4}$	* While $\overline{HKS}$ pin is LOW, the column group stays in "HIGH" state and row group stays in "LOW" state.
26	26	$\overline{C5}$	* The key pad is compatible with the standard dual contact matrix keyboard (as Figure 1b.), the inexpensive single contact keyboard (as Figure 1a.), and electronic input (as Figure 1c.).
27	27	$\overline{C6}$	* When $\overline{HKS}$ is "low", a valid key entry is defined by related Row & Column connection or by electronic input; (as show in Figure 1c).
28	28	$\overline{C7}$	* Activation of two or more keys will result in no response, except for single key.
1	1	$\overline{C8}$	* To avoid keyboard bouncing error, this chip provides built-in debounce circuit. (The debounce time = 20 ms.)
3	3	$\overline{R0}$	
4	4	$\overline{R1}$	
5	5	$\overline{R2}$	
6	6	$\overline{R3}$	
7	7	$\overline{R4}$	

Figure 1a: Single contact form keyboard configuration

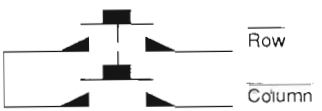


Figure 1b: Dual contact form keyboard configuration

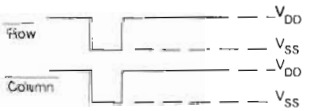


Figure 1c: Electronic signal input keyboard configuration

12	12	OSCI	* Oscillator input & Oscillator output pins.
13	13	OSCO	* The 3.579545 MHz oscillator is formed by a built-in inverter inside of this chip and by connecting a 3.579545 MHz crystal or a ceramic resonator across the OSCI and OSCO pins. (built-in feedback resistor and capacitor)
			* When $\overline{HKS}$ is "low", a valid key-in may turn on this oscillator and generates a 3.579545 MHz clock.
19	19	$\overline{XMUTE}$	* Mute output pins.
			* NMOS open drain output structure.
			* The output is in "low" state during dialing sequence (both Pulse and Tone mode) otherwise this pin is "high-impedance" .
			* Long (continue) Mute.
15	15	V_{SS}	* Negative power supply pin.
14	14	V_{DD}	* Positive power supply pin.

Pin HM9121	Pin HM9121C	Symbol	Function
8	8	$\overline{HKS}$	* Hook switch input pin. * When the handset is in ON-HOOK state, this pin must be pulled "high" in order to disable the dialing operation and decrease the power consumption. * When in OFF-HOOK state, the $\overline{HKS}$ pin must be pulled "low" state for all function operation.
21	21	$\overline{PO}$	* Pulse output signal pin. * Inverter output structure. * The output is "low" during pulse dialing and Flash operation, otherwise this output is "high".
18	18	TONE	* Dual Tone Multi-frequency output pin. * In TONE mode, when a entry of digit key (include * , # key), this pin will sent out a corresponding DTMF signal. * The TONE pin provides minimum tone duration (t_{TD}),& minimum intertone pause time to support rapid key-in. If key-in time is less than t_{TD} , DTMF signal will last for t_{TD} , otherwise the tone duration will last as long as the key is pressed.
11	11	MODE	* Mode select pin. * Tri-state input structure. * This pin can select following three modes.
10	10	HFI	* Handfree input control pin. * Toggle input sturcture, rising edge trigger. * It is used to enable and disable Handfree function. * With waveshaped by a built-in Schmit trigger, the bounce of input can be eliminated by external R, C debounce circuit. * A built-in pull down resistor is 100K typical.
20	20	HFO	* Handfree output pin. * Inverter output structure (normally "low", active "high"). * When a HFI pin is active, Handfree function will be enabled (HFO=1) or disabled (HFO=0). * When the Handfree function is enable (HFO=1), after OFF-HOOK action, it can reset Handfree function and HFO pin return to "low" state .
9	9	M/B	* Make/Break ratio select input.
2	2	STS	* Memory on/off hook store select input.
17	17	ST	* Master store pin, store key is no use when this pin active. * Internal pull down resistance 100K.

MODE	Dialing mode
V_{DD}	Pulse mode (10 pps)
Open	Pulse mode (20 pps)
V_{SS}	TONE mode

Pin		Symbol	Function
HM9121	HM9121C		
16	16	KT	* Key tone output pin. * CMOS inverter output structure * It will issue a 1.2 KHz, duty 50% signal with duration 30ms. * To prevent signal interference, while DTMF issue, it will disable key tone output.

Keyboard Operation

Symbol definitions:

a). ↑ : OFF-HOOK or enable Hand Free function.
b). ↓ : ON-HOOK or disable Hand Free function.
c). ⌐ : Input level from low to high.
d). ¬ : Input level from high to low.
e). D_1.....D_n : Digit key; 1,2,3,4,5,6,7,8,9,0,*,# (C_1.....C_n is same as D_1.....D_n).
f). D_{P1}... D_{Pn} : Pulse digit ; 1,2,3,4,5,6,7,8,9,0, (C_{P1}... C_{Pn} is same as D_{P1}... D_{Pn}).
g). D_{t1}....D_{tn} : Tone digit ; 1,2,3,4,5,6,7,8,9,0,*, # (C_{t1}....C_{tn} is same as D_{t1}....D_{tn}).
h). t_F : Flash time.
i). t_P : Pause time.
j). t_{PT} : Pulse to Tone wait time.
k). t_{FP} : Pause time for flash.
l). t_{RP} : Pause time for redial.
m). LNB : Last number redial buffer.
n). M_1 . ..Mm: Memory location ; 1, 2, 3, 4, 5, 6, 7, 8, 9, 0.
o). EMmn : One touch memory : EM00. . . . . EM19.

A. Normal Dialing

1. Digit Dialing
   Procedure : ↑ D1,D2 . . . . . , Dn↓
   Dial out : Dt1, Dt2 . . . . . , Dtn in tone mode
   Dial out : Dp1, Dp2 . . . . . , Dpn in pulse mode
   LNB : D1, D2 . . . . . Dn

2. Dialing with flash key
   Procedure : ↑ F,D1,D2 . . . . . , Dn↓
   Dial out : t_F, t_{FP}, Dt1,Dt1 . . . . . , Dtn in tone mode
   Dial out : t_F, t_{FP}, Dp1,Dp1 . . . . . , Dpn in pulse mode
   LNB : Un change

3. Dialing with P→T key
   Procedure : ↑ D1, D2 . . . . . ,P→T, ... , Dn↓
   Dial out : Dp1, Dp2, ... t_{PT}, ... , Dtn in pulse mode
   LNB : D1, D2 . . . . . ,P→T, ... Dn
   Note : If key in digit over maximum digit stored in LNB, then RD is inhibit even after on/off hook.

B. Mixed dialing

Procedure : ↑ D1, D2 . . . . . .,P→T, D9,D10, ... , Dn↓
Dial out : Dp1, Dp2, ... t_{PT}, Dt9,Dt10 . . . . . , Dtn
LNB : D1, D2 . . . . . ,P→T, D9,D10 . . . . Dn

C. Redial

LNB : D1, D2 . . . . . Dn
Procedure : ↑ RD ↓
Dial out : t_{RP}, Dt1, Dt2, ... Dtn in tone mode
Dial out : t_{RP}, Dp1, Dp2, ... Dpn in pulse mode
Note : If key in digit over maximum digit stored in LNB, then RD is inhibit.

D. Pause Function

Procedure : ↑ D1, D2, ...Dn, P, C1 . . . . .Cn ↓
Dial out : Dt1, Dt2, ... Dtn , Tp, Ct1 . . . . . Ctn in tone mode
Dial out : Dp1, Dp2, ... Dpn, Tp, Cp1 . . . . . .Cpn in pulse mode
LNB : D1, D2 . . . . . Dn, P, C1, C2 . . . . . .Cn

E. Flash Function

1. Digit
Procedure : ↑ D1, D2, ...Dn, F, C1 . . . . .Cn ↓
Dial out : Dt1, Dt2, ... Dtn , t_F, t_{FP}, Ct1 . . . . . Ctn in tone mode
Dial out : Dp1, Dp2, ... Dpn, t_F, t_{FP}, Cp1 . . . . . .Cpn in pulse mode
LNB : D1, D2 . . . . . Dn

F. One Touch Memory Function
for ST pin only

1. Store Memory (let ST pin active first)
Procedure : D1, D2, ...Dn, EMmn
Dial out : Nothing
EMn= D1, D2 . . . . . .Dn
Procedure : D1, D2, ..., P, ... Dn, EMmn
Dial out : Nothing
EMn= D1, D2 . . . . . ,P, ... Dn
Procedure : D1, D2, ..., P→T, ... Dn, EMmn
Dial out : Nothing
EMn= D1, D2 . . . . . ,P→T, ... Dn

2. Quickly Store
Procedure : ↑ , D1, D2, EM01, D3, D4, D5, EM02, EMmn ↓
Dial out : Nothing
EM01= D1, D2 ; EM02=D3, D4, D5, EMmn=D3, D4, D5
Note : Let ST pin inactive after memory store.

for ST ley only (ST pin is low)

1. Store Memory (needn't on/off hook if use on hook store mode)
   Procedure : ↑ ST, D1, D2, ...Dn, EMmn ↓
   Dial out : Nothing
   EMmn= D1, D2 . . . . . .Dn
   Procedure : ↑ ST, D1, D2, ..., P, ... Dn, EMmn ↓
   Dial out : Nothing
   EMmn= D1, D2 . . . . . ,P, ... Dn
   Procedure : ↑ ST, D1, D2, ..., P→T, ... Dn, EMmn ↓
   Dial out : Nothing
   EMmn= D1, D2 . . . . . ,P→T, ... Dn

2. Quickly Store
   Procedure : ↑ ST, D1, D2, ST, EM01, ST, D3, D4, D5, ST, EM02, ST, EMmn ↓
   Dial out : Nothing
   EM01= D1, D2 ; EM02=D3, D4, D5, EMmn=D3, D4, D5

3. Redial
   EMmn= D1, D2 . . . . . .Dn
   Procedure : ↑ EMmn ↓ or ↑ PAGE EM0n ↓
   Dial out : Dt1, Dt2, ... Dtn in tone mode
   Dial out : Dp1, Dp2 . . . . . Dpn in pulse mode
   LNB : Un change
   Note : Page key function as EM1n is equal to PAGE EM0n (n=0 . . . . . 9)

G. CD Key Operating

. The CD Call Disconnect. While CD key pressed, the function is the same asON-HOOK, Except $\overline{PO}$ is low and XMUTE is of high impedance, there is also a 1200 Hz, 30ms signal output on KT pin.

   LNB : D1, D2 . . . . . Dn
   Procedure : CD, RD ↓
   Dial out : D1, D2 . . . . . Dn

Handfree function operation:

A). Execute Handfree function : When HFO = "LOW", a raising edge trigger HFI pin, the Handfree function will be enabled (HFO="HIGH").

B). Reset Handfree function:

a. OFF-HOOK action.

b. When HFO="high", a raising edge trigger HFI pin, the Handfree function will be reset (HFO="LOW").

CURRENT STATE		INPUT		NEXT STATE
$\overline{HKS}$	HFO	HFI	$\overline{HKS}$	HFO
H	L	L	Qn	L
H	L	↑	Qn	H
H	H	↑	Qn	L
H	X	L	L	L
L	L	L	Qn	L
L	L	↑	Qn	H
L	H	↑	Qn	L
L	L	L	H	L
L	H	L	H	H

H:Logic "H".
L: Logic "L".
X: Don't care.
Qn: No change.
↑: Raising edge.

Table. Handfree function truth table.

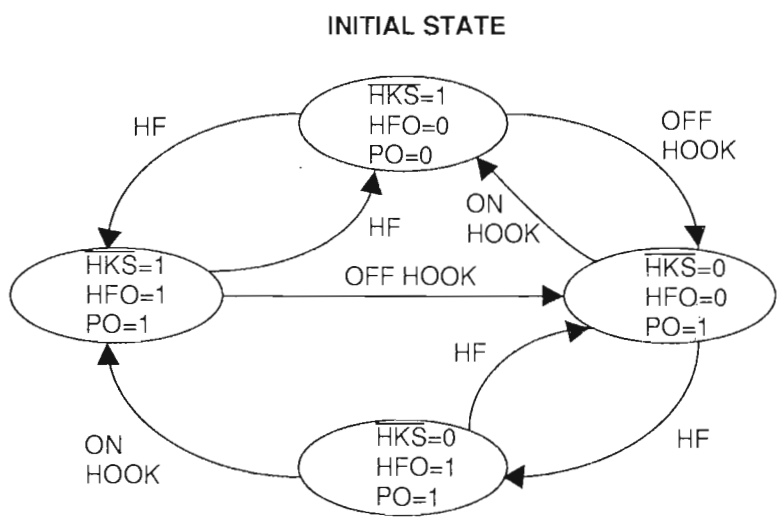
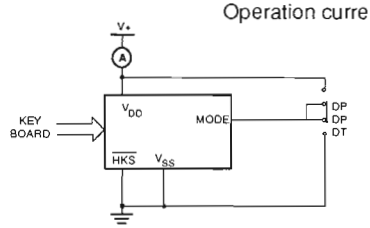


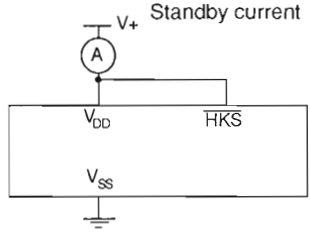
Figure. Handfree function flow chart

Test Circuit

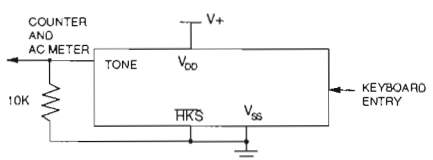
1 Operation current



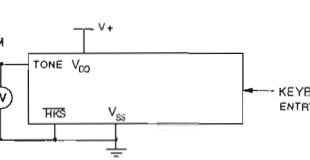
2 Standby current



3 Tone output voltage



4 Tone distortion



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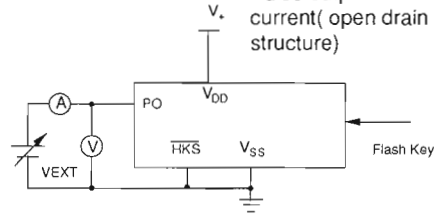
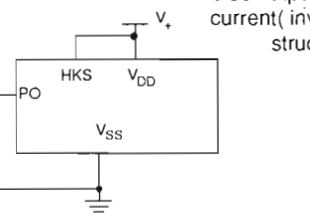
$$\text{DIST.(dB)} = 20\log \frac{\sqrt{(V1)^{**}2+(V2)^{**}2+..+(Vn)^{**}2}}{\sqrt{(VL)^{**}2+(VH)^{**}2}}$$

a. V1....Vn are extraneous frequencies (ie, inter modulation and harmonic) components in the 500Hz to 3400Hz band.
b. VL,VH are the individual frequency components of the DTMF signal
c. Whether keyboard is pushed refer to the TONE mode time diagram

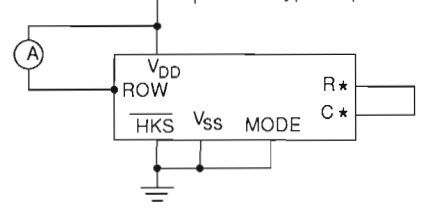
5 Pulse output sink current(open drain structure)



6 Pulse output sink current(inverter structure)



7 Keypad input



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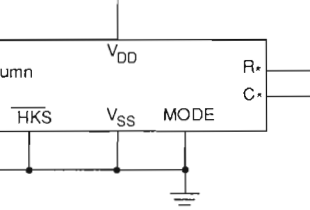

Isink=I/(1-Duty Cycle) I is the net DC current measured from ampere meter.

R* , C* mean others column and row.

Absolute Maximum Ratings (Ambient Temperature is 25°C, All voltage referenced to V_{SS}.)

Characteristics	Sym.	Ratings	Unit
Power Supply Voltage	V_{DD}	6.0	V
Input Voltage Range	V_{in}	-0.3 ~ V_{DD} + 0.3	V
Operating Temperature	T_{OPR}	-25 ~ 70	°C
Storage Temperate	T_{STO}	-55 ~150	°C
Power Dissipation	P_d	500	mw

Electrical Characteristics (I) (Ambient Temperature is 25°C, All voltage referenced to V_{SS} , V_{DD} = 2.5V, unless otherwise noted.)

(General purpose specification, fosc. = 3.579545 MHz)

Parameter	Sym.	Conditions	Limit Min.	Typ.	Max.	Unit
Operating Voltage	V_{DD}	Tone	2.0	-	5.5	
		Pulse	2.0	-	5.5	V
		Memory retension	1.0	-	5.5	
Operating Current	Iop	Tone	-	0.6	2	mA
		Pulse OFF-HOOK, Keypad entry	-	0.2	0.5	mA
Standby Current	Is	ON-HOOK, No Keypad entry	-	0.1	5	μA
Memory retention current	Imr	ON-HOOK, V_{DD} = 1.0V	-	0.1	0.2	μA
Control pin input voltage	Vil		V_{SS}	-	$0.3V_{DD}$	V
	Vih		$0.7V_{DD}$	-	V_{DD}	V
XMute pin						
leakage current	Imth	Vxmute = 6V	-	-	1	μA
sink current	Imtl	Vxmute = 0.5V	1	-	-	mA
HKS pin input current	Ihks	Vhks = 2.5V	-	-	0.1	μA
Keyboard scanning pin						
drive current	Ikbd	*Vn = 0V,	4	10	30	μA
sink current	Ikbs	*Vn = 2.5V,	200	400	800	μA
Key-in debounce time	t_{DB}		-	20	-	ms
HFI pin input resistor	Rhfi	V_{DD} = 2.5V	-	100	-	KΩ
HFO pin						
drive current	Ihdoh	Vhfo = 2.0V	1	-	-	mA
sink current	Ihdol	Vhfo = 0.5V	1	-	-	mA

* Vn : Input voltage of any keyboard scanning pin (Row group, Column group).

Electrical Characteristics (II) (Ambient Temperature is 25°C, All voltage referenced to V_{SS} , V_{DD} = 2.5V, unless otherwise noted.)
(Pulse mode specification, fosc. = 3.579545 MHz)

Parameter	Sym.	Conditions	Limit Min.	Typ.	Max.	Unit
Pulse output pin						
drive current	Ipoh	Vpo = 2.0V	0.2	-	-	mA
sink current	Ipol	Vpo = 0.5V	0.2	-	-	mA
Pulse rate	fpr		-	10	-	pps
			-	20	-	pps
Make/Break ratio	TM:TB		-	40:60	-	%
			-	33:66	-	%
Pre-digit Pause	t_{PDP}	M/B ratio = 40:60	-	40	-	ms
		M/B ratio = 33:66	-	33	-	ms
Inter-digit Pause	t_{IDP}	Pulse rate = 10pps	-	800	-	ms
		Pulse rate = 20pps	-	500	-	ms

Electrical Characteristics (III) (Ambient Temperature is 25°C, All voltage referenced to V_{SS} , V_{DD} = 2.5V, unless otherwise noted.)
(TONE mode specification, fosc. = 3.579545 MHz)

Parameter	Sym.	Conditions	Limitation Min.	Typ.	Max.	Unit
TONE output pin						
DC level	Vdc	V_{DD} = 2.0V~5.5V	$0.5V_{DD}$	-0.6	V_{DD}	V
sink current	Itl	Vdtmf = 0.5V	0.2	-	-	mA
AC level	Vdtmf	Row group, RL = 10KΩ	130	155	180	mVrms
Load resistor	Rl	Dist.≤ -23dB	10	-	-	KΩ
DTMF signal:						
pre-emphasis	twist	V_{DD} = 2.0~5.5V, Column-Row group	1	2	3	dB
*distortion	Dist.	RL = 10KΩ	-	-30	-23	dB
Minimum tone duration	t_{TD}	Auto redial	-	100	-	ms
Minimum intertone pause	t_{ITP}	Auto redial	-	106	-	ms

* Distortion (dB) = 20 log { $[(V_1^2 + V_2^2 + V_3^2 + ... + V_n)^{1/2}] / [(V_L^2 + V_H^2)^{1/2}]$ }.
V_L , V_H : Row group and Column group signal.
V_1 ,V_2 ,...., V_n : Harmonic signal (BW = 300 Hz~ 3500 Hz).

*** Actual frequency output (fosc. = 3.579545 MHz)**

KEYBOARD SCANNING PIN		STANDARD (Hz)	OUTPUT (Hz)	DEVIATION (%)
R1	f1	697	699	+0.28
R2	f2	770	766	-0.52
R3	f3	852	848	-0.47
R4	f4	941	948	+0.74
C1	f5	1209	1216	+0.57
C2	f6	1336	1332	-0.30
C3	f7	1477	1472	-0.34

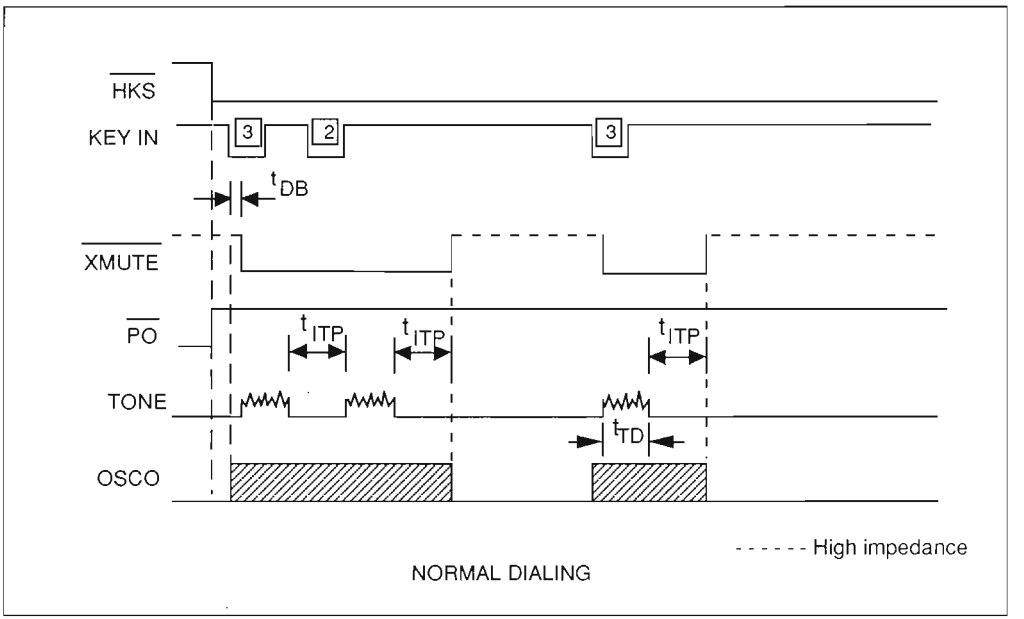

Figure 2: Tone Mode Timing Diagram

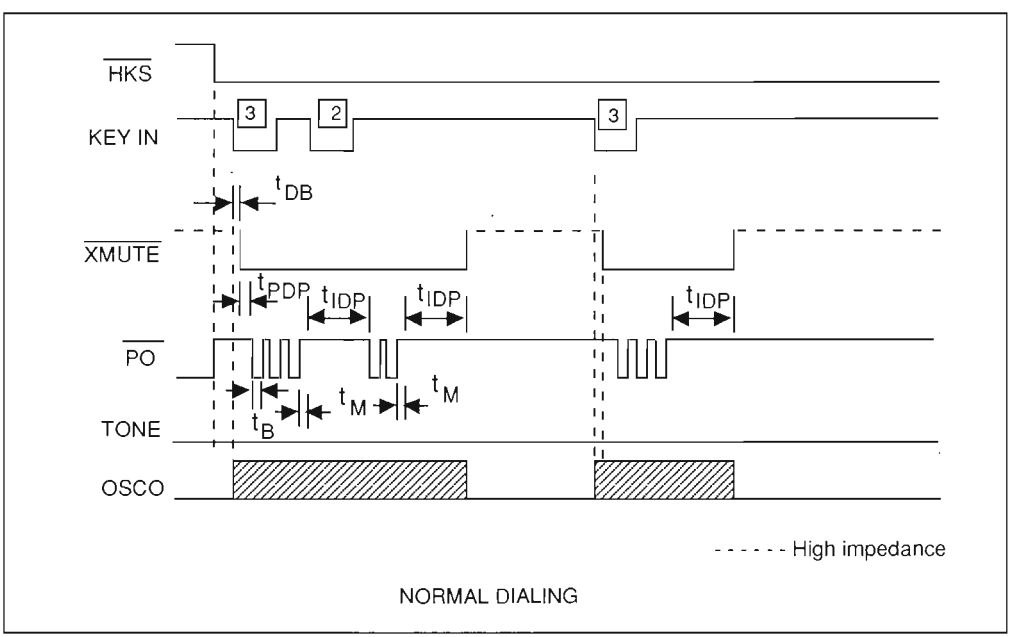

Figure 3: Pulse Mode Timing Diagram

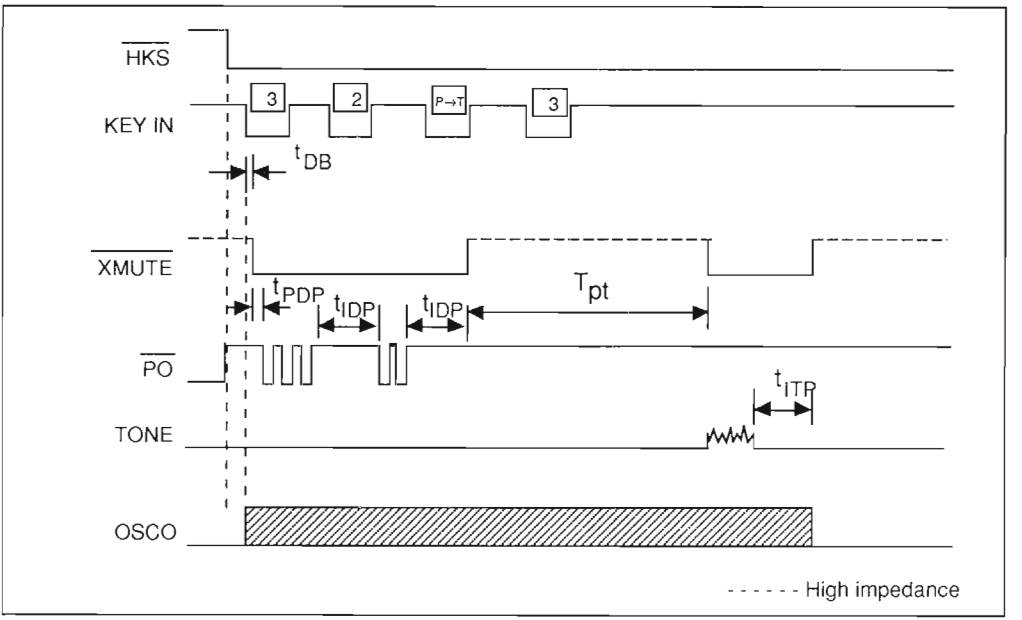

Figure 4: Timing Waveform for mixed dialing Operation (by P→T key entry)

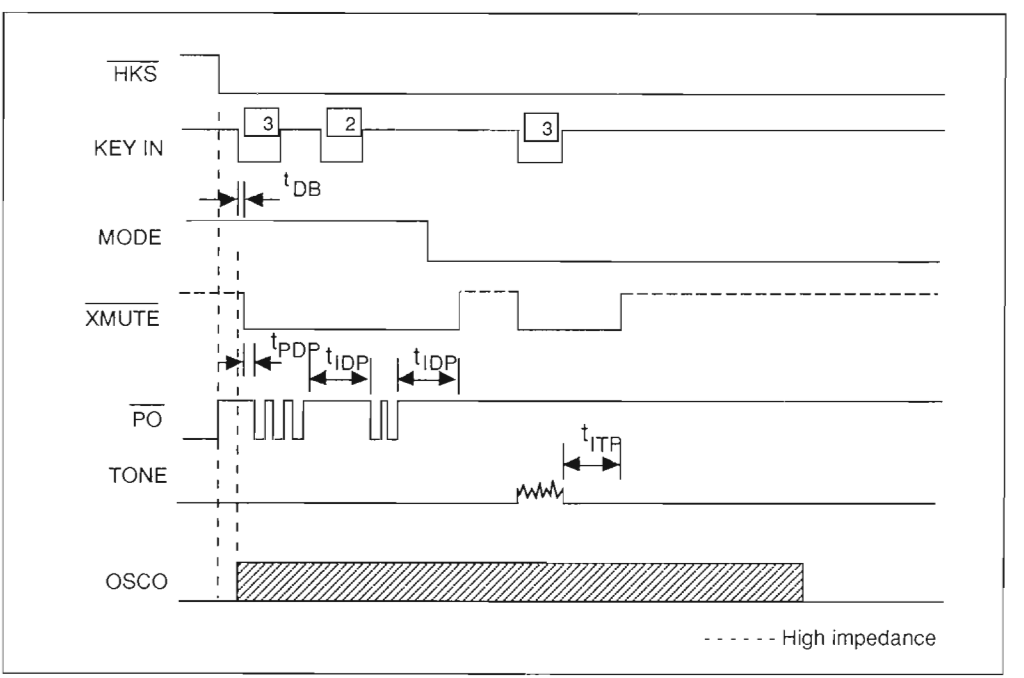

Figure 5: Timing Waveform for mixed dialing (by mode selection pin switches)

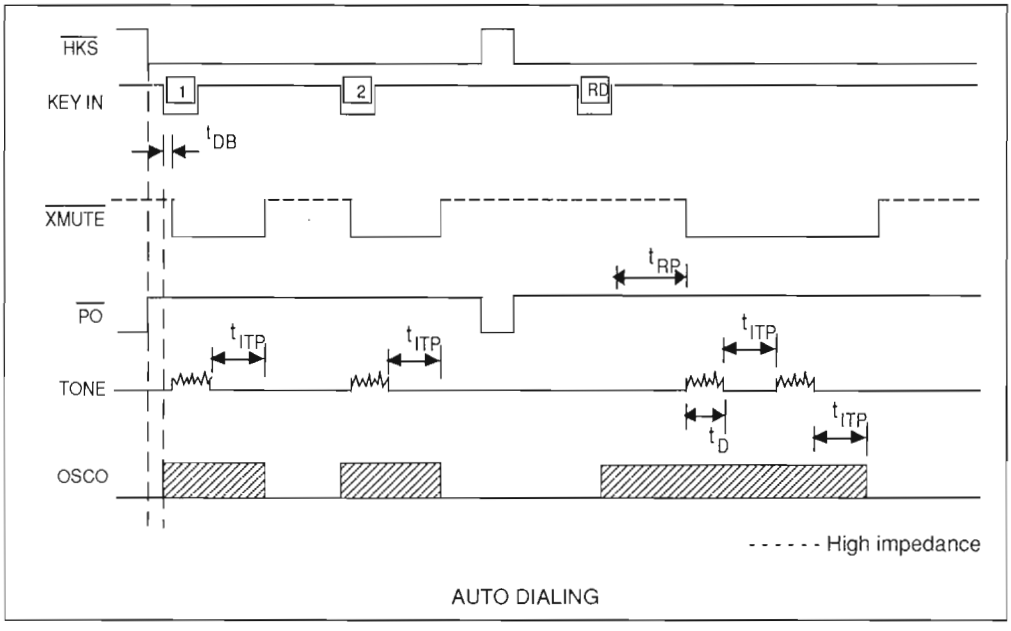

Figure 6: Tone Mode Redial Timing Diagram

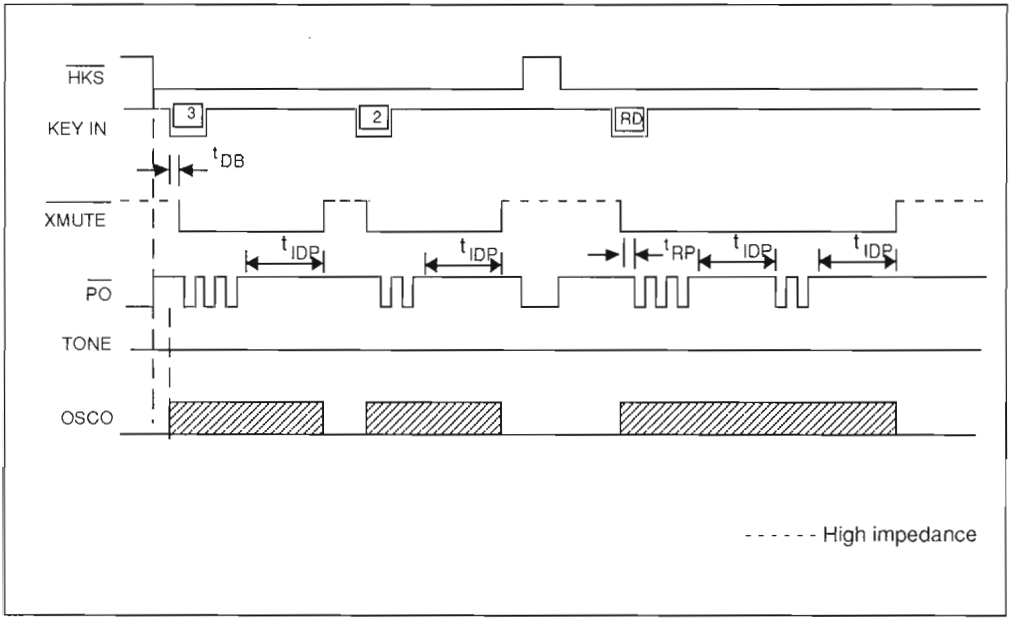

Figure 7: Pulse Mode Redial Timing Diagram

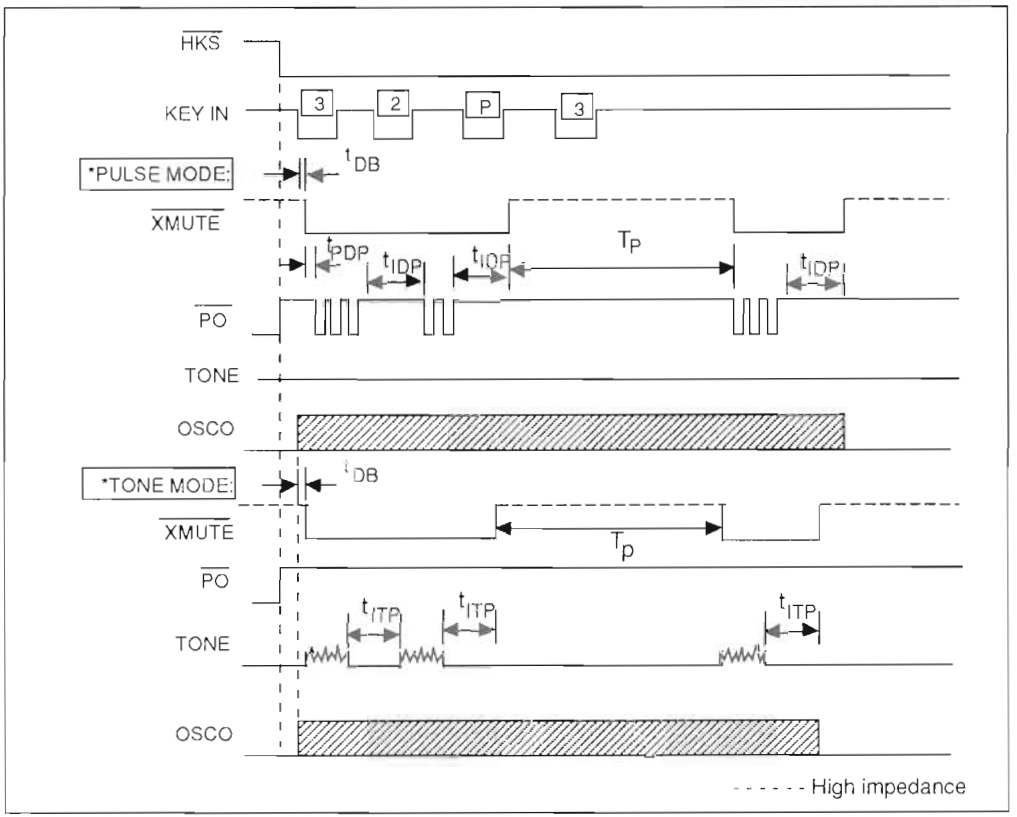

Figure 8: Pause key operating timing

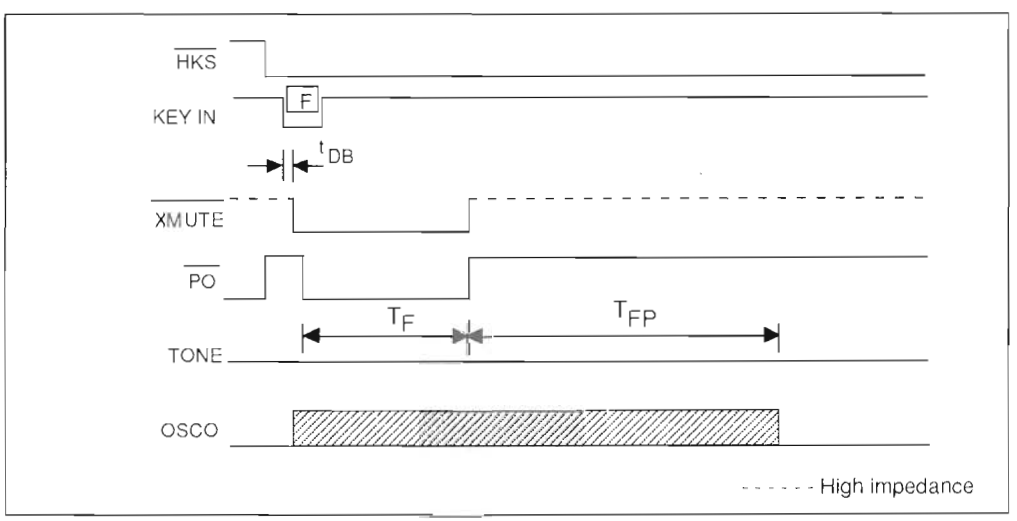

Figure 9: Flash key operation timing

Application Circuit