UMC

UM91214/15 Series

Tone/Pulse Dialer

Features

- One touch redial operation
- Tone/Pulse switchable
- 32-digit capacity for redialing
- Automatic mixed redialing (last number redial) of pulse to DTMF with multiple automatic access pauses
- PABX auto-pause is 2.2 seconds
- DTMF Timing:
  Manual dialing: minimum duration for bursts and pauses
  Redialing: calibrated timing
- Hands-Free control function
- Wide operating voltage range: 2V to 5.5V

- Key-in beep tone output
- Digits dialed manually after redialing are cascadable and stored as additional digits for the next redialing
- Uses inexpensive ceramic resonator (3.58 MHz)
- Two versions for different telephone systems
- Built-in power up reset circuit
- Four extra function keys: flash, pause, redial and DP or DTMF mixed dialing
- Four-by-four (or 2 of 8) keyboard can be used
- Low standby current

General Description

The UM91214/15 is a single-chip, silicon gate, CMOS integrated circuit with an on-chip oscillator for a 3.58 MHz crystal or ceramic resonator. It provides dialing pulse (DP) or dual tone multi-frequency (DTMF) dialing. A standard 4x4 matrix keyboard can be used to support either DP or DTMF modes. Up to 32 digits can be saved in the on-chip RAM for redialing. In the DTMF mode, minimum tone duration and minimum intertone pause provide for rapid dialing. Maximum tone duration is dependent upon the key depression time in manual dialing.
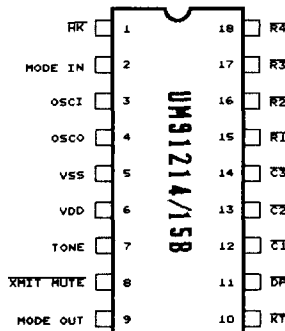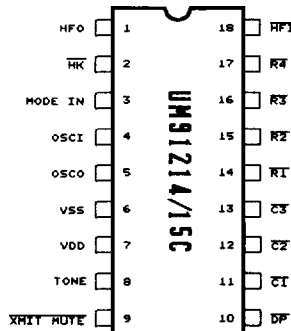
Pin Configurations

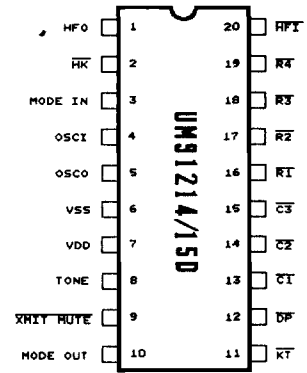a. 16-Pin Package
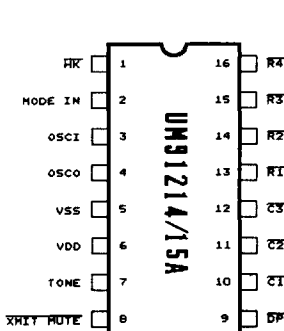
b. 18-Pin Package
(i) Key tone output

(ii) Hands-Free control

c. 20-Pin Package

Keyboard Assignments

1	2	3	F1	— $\overline{R1}$
4	5	6	F2	— $\overline{R2}$
7	8	9	P	— $\overline{R3}$
*/T	0	#	RD	— $\overline{R4}$

$\overline{C1}$ $\overline{C2}$ $\overline{C3}$ GND

1. */T – At Pulse mode this key works as Pulse –> DTMF key (T key), at DTMF mode the key works as * key. */T key will occupy one memory digit in either use.
2. F1 – Flash key. The break time is 297 ms or 96 ms (UM91214/15 respectively)
3. F2 – Flash key for break time 640 ms
4. P – Pause key (2.2 seconds)
5. RD – One key redial key
6. # – At pulse mode this key input is neglected, at DTMF mode this key works as # key.

Block Diagram

Absolute Maximum Ratings*

Supply Voltage (VDD) . . . . ≤ 6.0V
Input Voltage (V$_{IN}$) . . . . VSS -0.3V to VDD +0.3V
Output Voltage (V$_{OUT}$) . . . VSS -0.3V to VDD +0.3V
Output Voltage (V$_{OUT}$)($\overline{DP}$, $\overline{XMIT}$ $\overline{MUTE}$) . ≤1.2V
Tone Output Current (I$_{TONE}$) . . . . ≤ 50 mA
Power Dissipation (P$_D$) . . . . ≤ 500 mW
Operating Temperature (Top) . . . . . -20°C to +70°C
Storage Temperature (T$_{STG}$) . . . . -40°C to +125°C

*Comments

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only. Functional operation of this device at these or any other conditions above those indicated in the operational sections of this specification is not implied and exposure to absolute maximum rating conditions for extended periods may affect device reliability.

DC Electrical Characteristics   (VDD = 3.5V, VSS = 0V, Fosc = 3.579 MHz, Top = 25 °C)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions		Test CKT.
Operating Voltage	VDD	2.0		5.5	V	Pulse mode		A
		2.0		5.5		Tone mode		
Memory Retention Voltage	V$_{MR}$	1			V			--
Memory Retention Current	I$_{MR}$		0.05	0.4	μA	VDD = 1.0V, $\overline{HK}$ = VDD All outputs unloaded		--
Operation Current	I$_{DDP}$		0.32	1.0	mA	Pulse mode	All outputs unloaded	A
	I$_{DDT}$		0.6	2.0		Tone mode		
Standby Current	I$_{SO}$		0.03	0.05	μA	$\overline{HK}$ = VDD = 1.5V	All outputs unloaded, no key selected	A
			0.5	10		$\overline{HK}$ = VSS		
Input Voltage	V$_{IH}$	0.8		1	VDD			
	V$_{IL}$	0		0.2				
$\overline{R1}$ – $\overline{R4}$ Input Current	I$_R$		115		μA			C
Tone out Voltage	V$_{OC}$	584	730	876	mV$_{P-P}$	Column	VDD = 3.5V	D
	V$_{OR}$	456	570	684		Row	R$_L$ = 5K	
$\overline{HFI}$ Pull Low Current	|I$_{HFI}$|		5		μA	VDD = 3.5V. (Note 1) $\overline{HFI}$ pin connected to 0V		B

DC Electrical Characteristics (continued)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Test CKT.
HFO Source Current	|IOH1|	0.4	2		mA	VDD = 3.5V VOH = VDD - 0.4V	B
HFO, $\overline{KT}$, MODEOUT $\overline{XMITMUTE}$ Sink Current	IOL1	0.9	5.3		mA	VDD = 3.5V VOL = 0.4V	B
$\overline{DP}$ Sink Current	IOL2	1.1	5.3		mA	VDD = 3.5V VOL = 0.4V	B
Distortion	DIS%		1	5	%	* Note 1	

Note 1 :
$$DIS\% = \frac{100.(\ V_1{}^2 + V_2{}^2 + \ldots + V_n{}^2)^{\frac{1}{2}}}{(\ V_{IL}{}^2 + V_{IH}{}^2)^{\frac{1}{2}}}$$

a. $V_1 \ldots V_n$ are the intermodulation or the harmonic frequencies in the 500 Hz to 3400 Hz band, and
b. V_{IL} and V_{IH} are the individual frequency components of the DTMF signal.

AC Characteristics (VDD = 3.5V, VSS = 0V, FOSC = 3.579 MHz, TOP = 25°C, unless otherwise specified.)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	
Make Time	TM		33.3		ms	10 pps	M/B = 1/2
			40.0				M/B = 2/3
			16.7			20 pps	M/B = 1/2
			20.0				M/B = 2/3
Break Time	TB		66.6		ms	10 pps	M/B = 1/2
			60.0				M/B = 2/3
			33.3			20 pps	M/B = 1/2
			30.0				M/B = 2/3
Inter Digit Pause Time	TIDP		824		ms	10 pps	
			458			20 pps	
Pause Time	TPAU		2.2		sec		

AC Characteristics (continued)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Auto-redial Break Time	T_{AOBK}		2.2		sec	* Optional
Delay time Key valid to Signal out	T_D		0		ms	
Key-in Debounce	T_{KD}		21		ms	
Key Release Debounce Time	T_{KLD}		5.2		ms	
Key-in Tone Duration	T_{KTD}		23		ms	
Key-in Tone Frequency	F_{KT}		437		Hz	
Minimum Tone Duration Time	T_{MFD}		94		ms	
Min. Tone Inter-digit Pause	T_{TIDP}		96		ms	
Redial Tone Duration	T_{MFDR}		94		ms	
Redial Tone Inter-digit Duration	T_{TIDPR}		96		ms	

Comparisons of Specified vs. Actual Tone Frequencies

R/C	Spec.	Actual	Error (%)	Unit	Conditions
$\overline{R1}$	697	699.1	+ 0.31	Hz	
$\overline{R2}$	770	771.5	+ 0.19	Hz	
$\overline{R3}$	852	852.3	+ 0.03	Hz	
$\overline{R4}$	941	942.0	+ 0.10	Hz	$F_{OSC} = 3.579\,MHz$
$\overline{C1}$	1,209	1,215.7	+ 0.57	Hz	
$\overline{C2}$	1,336	1,331.7	- 0.32	Hz	
$\overline{C3}$	1,477	1,471.9	- 0.35	Hz	

Pin Descriptions

Pin No.				Designation	I/O	Description
UM91215A UM91214A	UM91215B UM91214B	UM91215C UM91214C	UM91215D UM91214D			
3 4	3 4	4 5	4 5	OSCI OSCO	I	Oscillator Input and Output pins The time base for the UM91214/15 is a crystal controlled on-chip oscillator, which is completed by connecting a 3.58 MHz crystal or ceramic resonator between the OSCI and OSCO pins
2	2	3	3	MODE IN	I, Z	Tri-State mode select pin There are two versions of the UM91214/15 a. UM91215 Series is for European and American Systems

MODE IN	Tone/ Pulse	Dial Rate	M/B Ratio
VDD	Pulse	10pps	2/3
VSS	Tone	–	–
Floating	Pulse	10pps	1/2

b. The UM91214 Series is for the Japanese system

MODE IN	Tone/ Pulse	Dial Rate	M/B Ratio
VDD	Pulse	10pps	1/2
VSS	Tone	-	-
Floating	Pulse	20pps	1/2

The mode selection pin is checked for tone/pulse dialing at each digit key entry. In pulse mode, the dialing rate is checked, along with the make/break ratio, at the first key entry

Pin Descriptions (continued)

Pin No.				Designation	I/O	Description
UM91215A UM91214A	UM91215B UM91214B	UM91215C UM91214C	UM91215D UM91214D			
1	1	2	2	$\overline{HK}$	I	Hook switch input This inverter input pin detects the state of the hook switch contact. "Off Hook" is represented by a VSS condition. "On Hook" is represented by a VDD condition
(N.A.)	10	(N.A.)	11	$\overline{KT}$	O	Key-in tone output This N-channel open drain pin sends out a "beep" tone for each pulse mode key entry, along with entries of accepted function keys (RD, T, F1 F2, and P keys). The tone output frequency is 437 Hz and tone duration is 23 ms
9	11	10	12	$\overline{DP}$	O	Dialing pulse output This is an N-channel open drain output. The normal output will be "ON" during break and "OFF" during make in the pulse dialing mode

Pin Descriptions (continued)

Pin No.				Designation	I/O	Description
UM91215A UM91214A	UM91215B UM91214B	UM91215C UM91214C	UM91215D UM91214D			
(N.A.)	(N.A.)	1	1	HFO	O	Hands-Free Control I/O pins These pins enable and disable the Hands-Free Control function. When input pin HFI goes low, the Hands-Free Control state is toggled on. Status of the Hands-Free Control state is listed in the following table:
		18	20	$\overline{\text{HFI}}$	I	(see state table below)
7	7	8	8	TONE	O	Tone dialing output When a valid keypress is detected in the DTMF mode, appropriate low group and high group, frequencies are generated which hybridize the dual tone output. TONE output is in the "OFF" state in pulse mode

State table for HFO/HFI:

Current State		Next State		
Hook sw.	HFO	Input	HFO	Dialing?
–	Low	$\overline{\text{HFI}}$ ⌐	High	Yes
On Hook	High	$\overline{\text{HFI}}$ ⌐	Low	No
Off Hook	High	$\overline{\text{HFI}}$ ⌐	Low	Yes
On Hook	–	Off Hook	Low	Yes
Off Hook	Low	On Hook	Low	No
Off Hook	High	On Hook	High	Yes

Pin Descriptions (continued)

Pin No.				Designation	I/O	Description
UM91215A UM91214A	UM91215B UM91214B	UM91215C UM91214C	UM91215D UM91214D			
8	8	9	9	$\overline{\text{XMIT MUTE}}$	O	Dialing transmission mute output This is an N-channel open drain output The $\overline{\text{XMITMUTE}}$ is normally "OFF" During pulse of DTMF dialing this output is "ON"
(N.A.)	9	(N.A.)	10	MODE OUT	O	Mode output pin This is an N-channel, open drain output It is "ON" during tone output and "OFF" during pulse output
13	15	14	16	$\overline{\text{R1}}$		Keyboard pins This input serves as the interface to an XY matrix keyboard. On a 4 x 4 matrix keyboard, the input from the fourth column, $\overline{\text{C4}}$, should be connected to VSS
14	16	15	17	$\overline{\text{R2}}$		
15	17	16	18	$\overline{\text{R3}}$		
16	18	17	19	$\overline{\text{R4}}$		
10	12	11	13	$\overline{\text{C1}}$		
11	13	12	14	$\overline{\text{C2}}$		
12	14	13	15	$\overline{\text{C3}}$		
6	6	7	7	VDD		Power supply pins These devices are designed to operate from 2.0V to 5.5V
5	5	6	6	VSS		

Operational Procedures

Symbol Definitions:

In the description below, signals are defined in terms of the key or switch which is activated.

Off Hook means the phone was taken off the hook.

On Hook means that the receiver is on the hook.

D1 stands for the first digit dialed in a string of digits.

Dn (Dk) stands for the last digit dialed in a string of digits.

Dn+1 stands for the beginning of a new string of digits.

Dn+m stands for the last digit in a new string of digits.

HFI ↓ stands for the switch that activates the Hands-Free dialing mode going low

*/T is the Pulse-to-DTMF key.

RD is the Redial key.

0 is the Zero key.

P is the Pause key.

F is the Flash key.

Recommended Operation:

1. Pulse mode operation

   a. OffHook   D1 . . . Dn

   Pulse mode is defined as the initial mode, provided the first keyboard input is not the */T key following the OffHook condition and the mode selection pin is floating (MODE IN = VDD or floating).

   b. On Hook   HFI ↓   D1 . . . Dn

   Pulse mode is defined as the initial mode, provided the key input D1 is not */T while the mode selection pin is VDD or floating. The chip will pause for 824 ms automatically after it detects an OffHook condition or the HFI ↓ key is depressed. It then proceeds with pulse or DTMF dialing if any keys have been depressed.

   The dialing rate or make/break ratio is decided at the first key entry by checking the MODE IN status and will not be altered. The MODE IN status can only switch the dialing mode from Pulse to DTMF after the first key entry.

2. DTMF mode operation

   a. OffHook   D1 . . . Dn or

   On Hook   HFI ↓   D1 . . . Dn

   DTMF mode is defined as the initial mode if the mode selection pin MODE IN is VSS.

   b. OffHook   */T   D1 . . . Dn or

   On Hook   HFI ↓   */T   D1 . . . Dn

   The initial mode is pulse mode if the mode selection pin, MODE IN, is VDD or floating. The */T key can switch the dialing mode to tone mode. Unlike normal mode switching, the */T key entry, as the first key pressed, will not produce any pause time. There are only 31 digits of redial memory available in the buffer to be used for operations a and b, since the mode switching key, */T , will occupy one digit of space.

3. Manual dialing with automatic access pause

a. `OffHook` `O` `P` `D1` . . . `Dn`

   Pause key entries can be accepted and stored in the redial memory. Each is stored as a digit. Each key-in will provide a pause of 3.57 seconds, depending on which model you are using.

4. Redial

a. `On Hook` `RD` or `On Hook` `HFI ↓` `RD`

   Up to 32 digits (in pulse mode) or 31 digits (in tone mode) can be dialed using the `RD` key. The `RD` key is disabled while pulse or tone signals are being transmitted. Redial will also be inhibited if the last number dialed exceeds 32 digits because the redial memory can only hold 32 digits.

b. `OffHook` `RD` `D1` . . . `Dn` or

   `On Hook` `HFI ↓` `RD` `D1` . . . `Dn`

   After pressing the `RD` key, we can add digits to the number in redial memory. When finished dialing, the redial memory will contain the original digits plus the digits dialed after pressing `RD`. Each time the redial key is pressed, the stored number will be dialed exactly the same as it was previously, regardless of the status of the MODE IN pin.

5. TONE/PULSE switching operation

a. `On Hook` `D1` . . . `Dn` `MODE IN pin`

   |←———————— Pulse Mode ————————

   `switched to VSS` `Dn +1` . . . `Dn + m`

   ———————————→| |←——— DTMF Mode ———→|
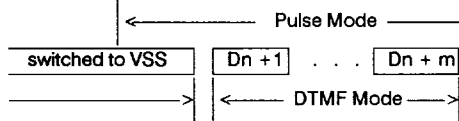
The mode selection pin is always checked for tone or pulse mode key entry. Dialing can be switched from pulse to tone mode, but not from tone to pulse mode. Switching the MODE IN pin to VSS will cause the chip to store a `*/T` digit prior to the first tone digit in the redial memory and will automatically insert a 2.2 second pause before the tone digits are dialed out. After the mode has been switched, the status of the mode selection pin will no longer be checked. Therefore, it will not be possible to switch from tone to pulse mode.

b. `OffHook` `D1` . . . `Dn` `*/T` `Dn +1`

   |←——— Pulse Mode ——→| |←———————
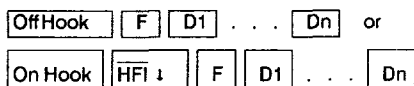
   . . . `Dn + m`
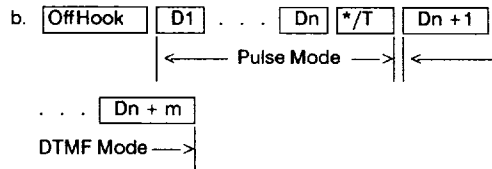
   DTMF Mode ——→|

Pulse mode is initially defined with the mode selection pin, MODE IN, equal to VDD or floating. At this time, the mode can be switched to DTMF by pressing the `*/T` key. DTMF mode will begin as soon as the last pulse has been transmitted. In this mode, `Dn + 1` through `Dn + m` are sent through the TONE OUT pin as DTF signals. If a `P` key entry is contained in the series of digits before or after the `*/T` entry, or the MODE IN switch is depressed, 2.2 second pause will be added to the automatically inserted pause time, which is also 3.57 seconds. Both of the above switching modes can store as many as 31 digits in the redial memory.

6. One-Key redialing

| OffHook | D1 | . . . | Dn | RD | or

| On Hook | HFI ↓ | D1 | . . . | Dn | RD
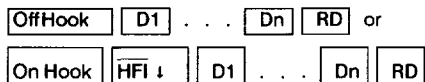
If the dialing of [D1] to [Dn] is finished, pressing [RD] will cause the pulse dialing pin to go low for 1.67 seconds of break time and an 824 ms pause will automatically be added. If the pulses of the number dialed with [D1] to [Dn] have not finished, the pressing of the redial key will be ignored.

7. Flash dialing

| OffHook | F | D1 | . . . | Dn | or

| On Hook | HFI ↓ | F | D1 | . . . | Dn

The flash keys emulate quick On-Off Hook operations.

Pressing the flash keys, [F1] or [F2], will cause a break of 96 ms or 640 ms (or, 297 ms or 640 ms, depending on the model) on the $\overline{DP}$ output pin. Then, it pauses for 824 ms and continues dialing the digits, [D1] to [Dn]. These digits are then store in the redial memory.

Each time the flash key is pressed, the redial memory will be cleared to store a new entry. In addition, the MODE IN status will be checked again for the setting of the Tone/Pulse dialing mode.

Similarly, to make sure that the IC is working properly, new flash key inputs will be ignored as long as the digits that were dialed have not finished.
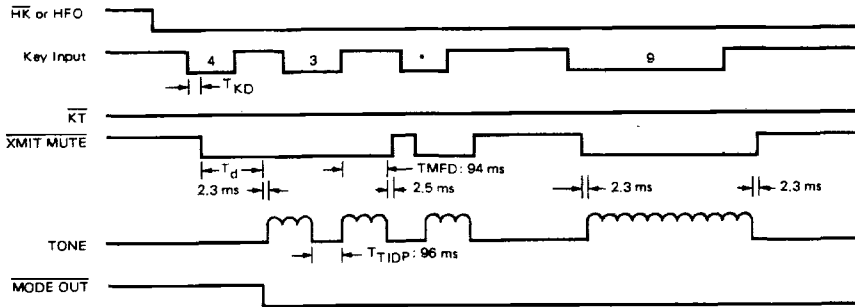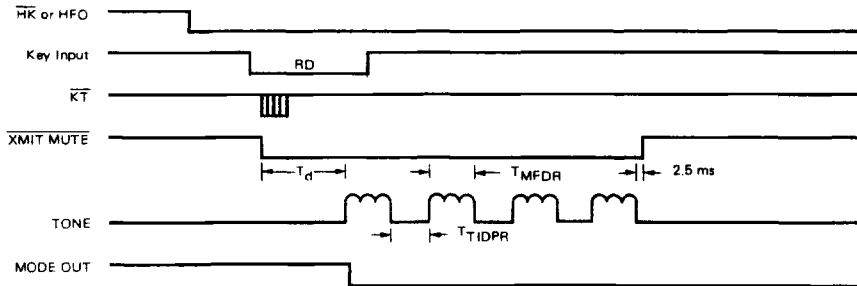
Timing Waveforms

1. Timing Waveform in Pulse Mode:
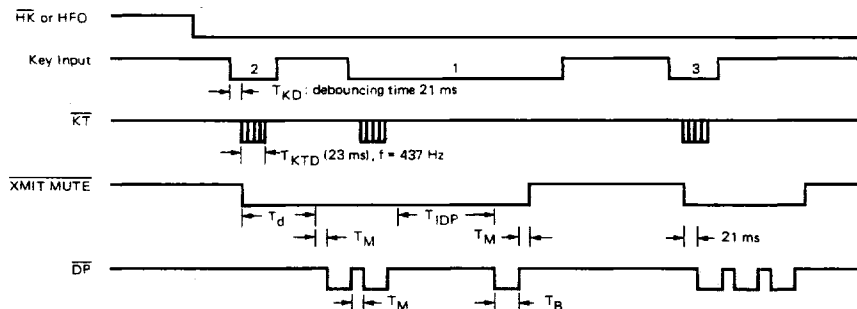
Td: Delay time of Key valid to dialing signal out, typically 0ms
TIDP: Inter digit pause time
TKTO: Key in tone duration
TKD: Debouncing time
Note: " $\overline{HK}$ " or "HFO" indicates chip works when hook switch $\overline{HK}$ goes low or hands free control output HFO goes high.
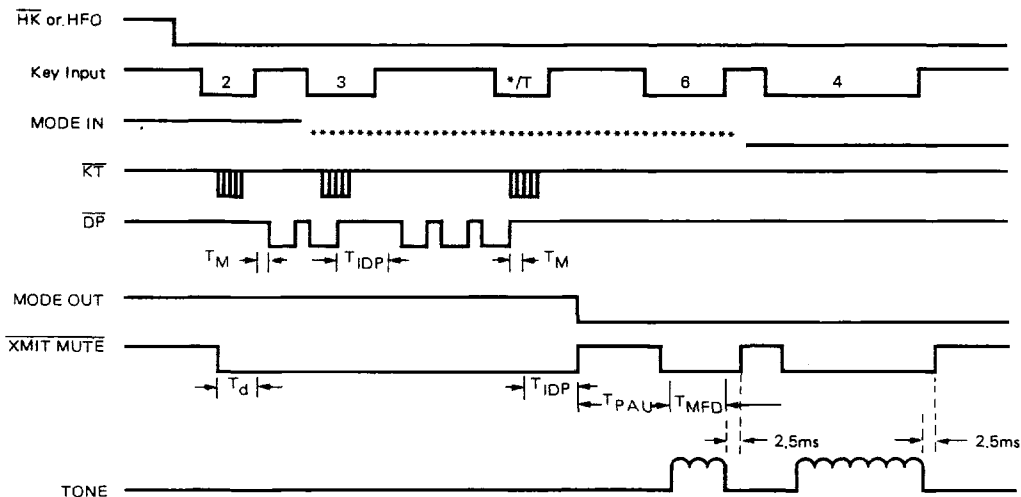
Timing Waveforms (continued)

2. Timing Waveform in Tone Mode:

(i) Normal Dialing
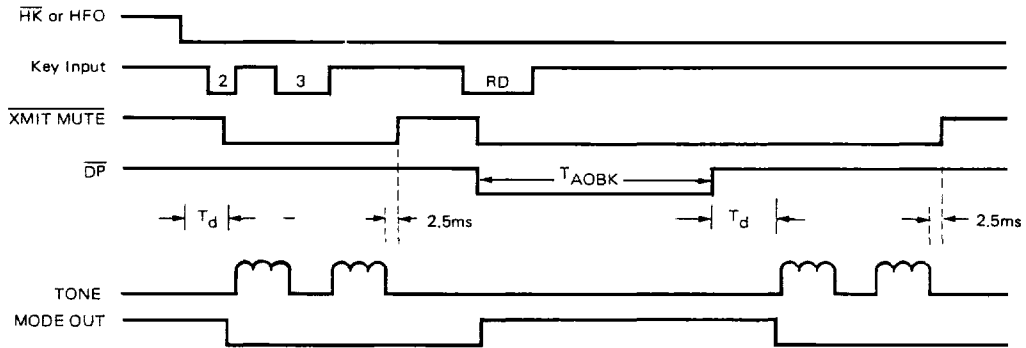

(ii) After (i), Redialing

Timing Waveforms (continued)

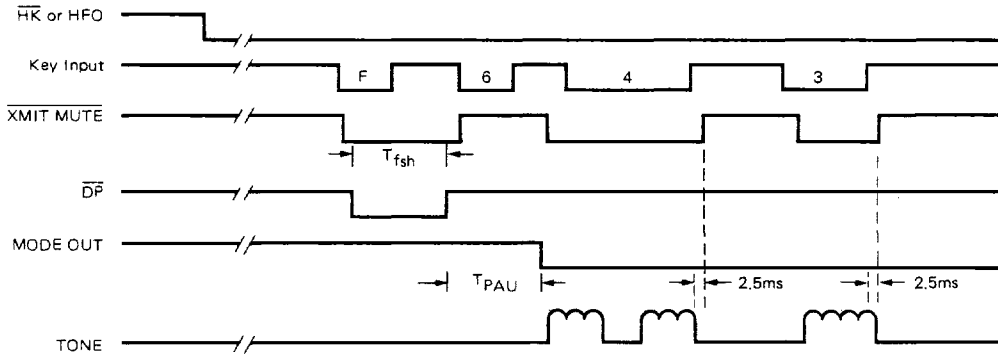### 3. Timing Waveform for Switching Mode Operation:

(i) By mode selection pin switches
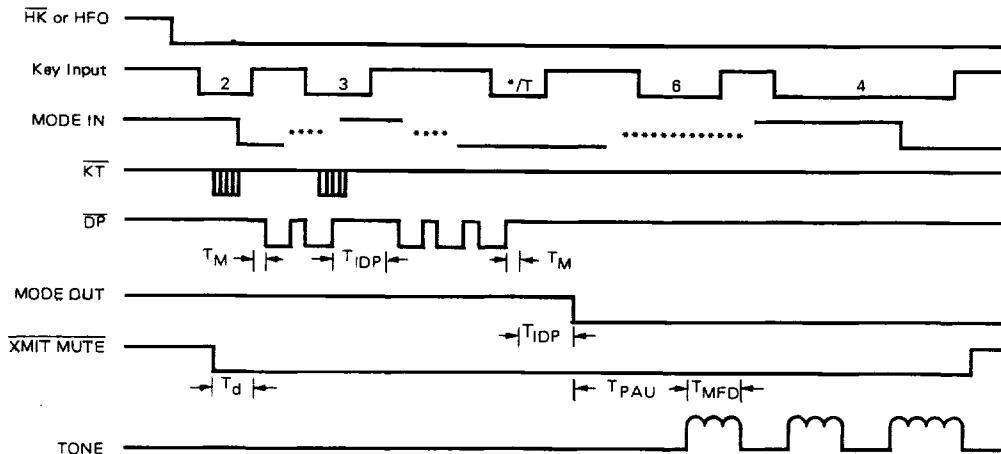
(ii) By */T key entry
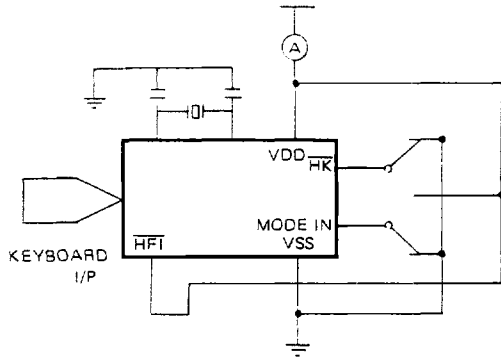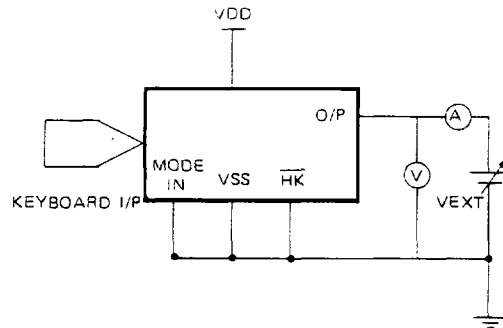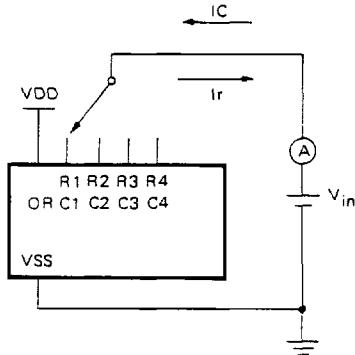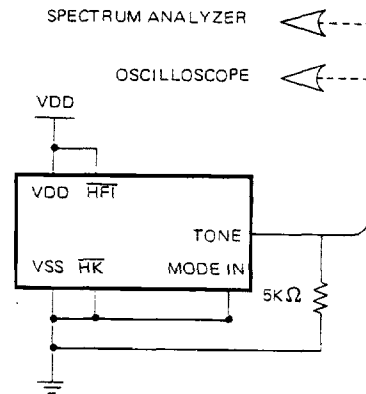

T_{PAU}: Pause time (2.2 secs)

Timing Waveforms (continued)

4. One Key Redial (DTMF mode used as example):

T$_{AOBK}$: Break time (2.2 secs)

5. Flash Dialing (DTMF mode used as example):

T$_{fsh}$: flash time 96 or 640 ms (F1 or F2 respectively) for UM91215
flash time 297 or 640 ms (F1 or F2 respectively) for UM91214

Application Circuit (for reference only)

Test Circuits

(A)

(B)

(C)

(D)

OSCILLOSCOPE: TEKTRONIX 468
SPECTRUM ANALYZER: HP 3585A

Ordering Information

Part No.	Key Tone	Hands Free Control	Dial Rate	M/B Ratio	Flash		Package
					F1	F2	
UM91214A	N.A.	N.A.	10/20 pps	1/2	297 ms	640 ms	16L DIP
UM91214B	A	N.A.					18L DIP
UM91214C	N.A.	A					18L DIP
UM91214D	A	A					20L DIP
UM91215A	N.A.	N.A.	10 pps	1/2 2/3 selectable	96 ms	640 ms	16L DIP
UM91215B	A	N.A.					18L DIP
UM91215C	N.A.	A					18L DIP
UM91215D	A	A					20L DIP