



T-75-07-07



## 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 cascable 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

Tone/Pulse Dialer

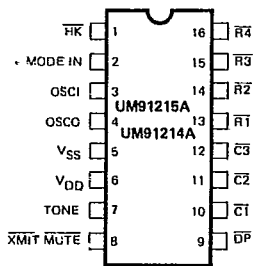
#### General Description

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 4 x 4 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.

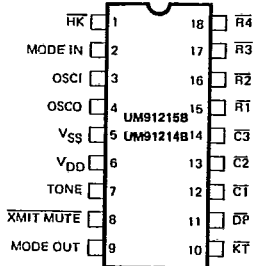
#### Pin Configurations

a. 16 Pin Package

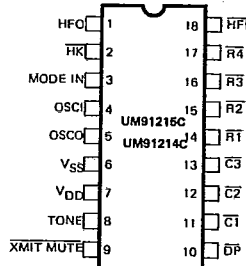


b. 18 Pin Packages

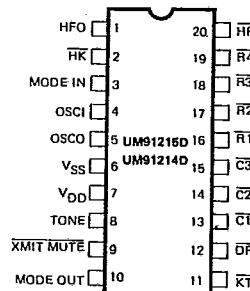
(i) Key tone output



(ii) Hands free control



c. 20 Pin Package





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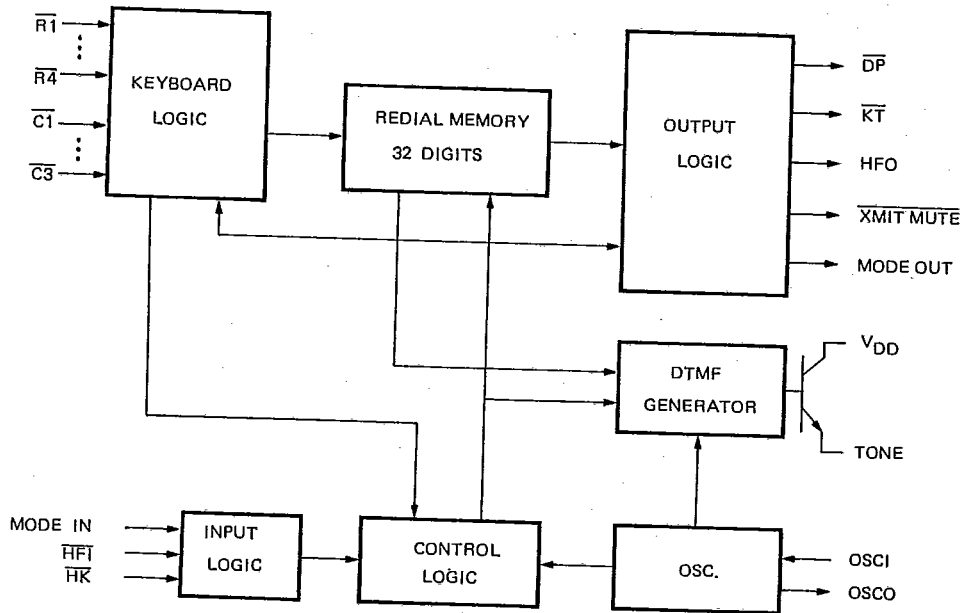
**Keyboard Assignment**

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1	2	3	F1	R1
4	5	6	F2	R2
7	8	9	P	R3
* / T	0	#	RD	R4
C1	C2	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**





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Pin Descriptions

Pin No.				I/O	Symbol	Description																																
UM91215A UM91214A	UM91215B UM91214B	UM91215C UM91214C	UM91215D UM91214D																																			
3 4	3 4	4 5	4 5	I	OSCI OSCO	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 OSKO pins.																																
2	2	3	3	I, Z	MODE IN	<p>Tri-State mode select pin. There are two versions of the UM91214/15.</p> <p>a. The UM91215 series is for European and American systems.</p> <table border="1"> <thead> <tr> <th>MODE IN</th> <th>Tone/Pulse</th> <th>Dial Rate</th> <th>M/B Ratio</th> </tr> </thead> <tbody> <tr> <td>V<sub>DD</sub></td> <td>Pulse</td> <td>10 pps</td> <td>2/3</td> </tr> <tr> <td>V<sub>SS</sub></td> <td>Tone</td> <td>—</td> <td>—</td> </tr> <tr> <td>Floating</td> <td>Pulse</td> <td>10 pps</td> <td>1/2</td> </tr> </tbody> </table> <p>b. The UM91214 series is for the Japanese system</p> <table border="1"> <thead> <tr> <th>MODE IN</th> <th>Tone/Pulse</th> <th>Dial Rate</th> <th>M/B Ratio</th> </tr> </thead> <tbody> <tr> <td>V<sub>DD</sub></td> <td>Pulse</td> <td>10 pps</td> <td>1/2</td> </tr> <tr> <td>V<sub>SS</sub></td> <td>Tone</td> <td>—</td> <td>—</td> </tr> <tr> <td>Floating</td> <td>Pulse</td> <td>20 pps</td> <td>1/2</td> </tr> </tbody> </table> <p>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.</p>	MODE IN	Tone/Pulse	Dial Rate	M/B Ratio	V <sub>DD</sub>	Pulse	10 pps	2/3	V <sub>SS</sub>	Tone	—	—	Floating	Pulse	10 pps	1/2	MODE IN	Tone/Pulse	Dial Rate	M/B Ratio	V <sub>DD</sub>	Pulse	10 pps	1/2	V <sub>SS</sub>	Tone	—	—	Floating	Pulse	20 pps	1/2
MODE IN	Tone/Pulse	Dial Rate	M/B Ratio																																			
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1	1	2	2	I	HK	Hook switch input. This inverter input pin detects the state of the hook switch contact. "Off Hook" is represented by a V <sub>SS</sub> condition. "On Hook" is represented by a V <sub>DD</sub> condition.																																

Tone/Pulse Dialer



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Pin Descriptions (Continued)

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Pin No.				I/O	Symbol	Description																																								
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(N. A.)	10	(N. A.)	11	O	$\overline{KT}$	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	O	$\overline{DP}$	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.																																								
(N. A.)	(N. A.)	1	1	O	HFO	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	I	$\overline{HFI}$																																									
<table border="1"> <thead> <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> </thead> <tbody> <tr> <td>—</td> <td>Low</td> <td><math>\overline{HFI}</math> ↓</td> <td>High</td> <td>Yes</td> </tr> <tr> <td>On Hook</td> <td>High</td> <td><math>\overline{HFI}</math> ↓</td> <td>Low</td> <td>No</td> </tr> <tr> <td>Off Hook</td> <td>High</td> <td><math>\overline{HFI}</math> ↓</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> </tbody> </table>							Current State		Next State			Hook sw.	HFO	Input	HFO	Dialing?	—	Low	$\overline{HFI}$ ↓	High	Yes	On Hook	High	$\overline{HFI}$ ↓	Low	No	Off Hook	High	$\overline{HFI}$ ↓	Low	Yes	On Hook	—	Off Hook	Low	Yes	Off Hook	Low	On Hook	Low	No	Off Hook	High	On Hook	High	Yes
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Off Hook	High	$\overline{HFI}$ ↓	Low	Yes																																										
On Hook	—	Off Hook	Low	Yes																																										
Off Hook	Low	On Hook	Low	No																																										
Off Hook	High	On Hook	High	Yes																																										
7	7	8	8	O	Tone	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 OUT is in the "OFF" state in pulse mode.																																								



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Pin Descriptions (Continued)

Pin No.				I/O	Symbol	Description
UM91215A UM91214A	UM91215B UM91214B	UM91215C UM91214C	UM91215D UM91214D			
8	8	9	9	O	XMITMUTE	Dialing transmission mute output. This is an N-channel open drain output. Normally, the transmission mute output is "OFF" during pulse or DTMF dialing this output is "ON".
(N. A.)	9	(N. A.)	10	O	MODE OUT	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		$\overline{R1}$	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, $\overline{c4}$ , should be connected to $V_{SS}$ .
14	16	15	17		$\overline{R2}$	
15	17	16	18		$\overline{R3}$	
16	18	17	19		$\overline{R4}$	
10	12	11	13		$\overline{C1}$	
11	13	12	14		$\overline{C2}$	
12	14	13	15		$\overline{C3}$	
6	6	7	7		$V_{DD}$	Power supply pins. This device is designed to operate from 2.0V to 5.5V
5	5	6	6		$V_{SS}$	

Tone/Pulse Dialer

Description of Operation

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

- $\overline{\text{Off Hook}}$  means the phone was taken off the hook.
- $\overline{\text{On Hook}}$  means that the receiver is on the hook.
- $\overline{D1}$  stands for the first digit dialed in a string of digits.
- $\overline{Dn}$  stands for the last digit dialed in a string of digits.
- $\overline{Dn+1}$  stands for the beginning of a new string of digits.
- $\overline{Dn+m}$  stands for the last digit in a new string of digits.
- $\overline{\text{HFI}}$  stand for the switch that activates the Hands Free dialing mode going low.
- $\overline{*T}$  is the Pulse-to-DTMF key.
- $\overline{\text{RD}}$  is the Redial key.
- $\overline{0}$  is the Zero key.
- $\overline{\text{P}}$  is the Pause key.
- $\overline{\text{F}}$  is the Flash key.

1. Pulse mode operation

- a.  $\overline{\text{Off Hook}} \overline{D1} \dots \overline{Dn}$

Pulse mode is defined as the initial mode, provided

the first keyboard input is not the  $\overline{*T}$  key following the  $\overline{\text{Off Hook}}$  condition and the mode selection pin is floating (MODE IN =  $V_{DD}$  or floating)

- b.  $\overline{\text{On Hook}} \overline{\text{HFI}} \overline{D1} \dots \overline{Dn}$

Pulse mode is defined as the initial mode, provided the key input  $\overline{D1}$  is not  $\overline{*T}$  while the mode selection pin is  $V_{DD}$  or floating. The chip will pause for 824 ms automatically after it detects an  $\overline{\text{Off Hook}}$  condition or the  $\overline{\text{HFI}}$  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

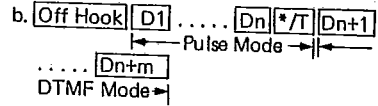
- a. Off Hook [D1] ..... [Dn] or  
On Hook [HFT] [D1] ..... [Dn]

DTMF mode is defined as the initial mode of the mode selection pin MODE IN is V<sub>SS</sub>.

- b. Off Hook [\*T] [D1] ..... [Dn] or  
On Hook [HFT] [\*T] [D1] ..... [Dn]

The initial mode is pulse mode if the mode selection pin, MODE IN, is V<sub>DD</sub> 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.

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.



Pulse mode is initially defined with the mode selection pin, MODE IN, equal to V<sub>DD</sub> 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 DTMF 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.

3. Manual dialing with automatic access pause

- Off Hook [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. Off Hook [RD] or On Hook [HFT] [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. Off Hook [RD] [D1] ..... [Dn] or  
On Hook [HFT] [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.

6. One-Key redialing

- Off Hook [D1] ..... [Dn] [RD] or  
On Hook [HFT] [D1] ..... [Dn] [RD]

If the dialing of [D1] to [Dn] is finished, pressing [RD] will cause the pulse dialing pin to go low for 2.2 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

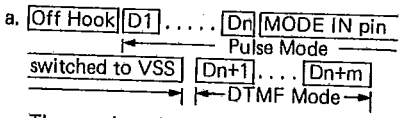
- Off Hook [F] [D1] ..... [Dn] or  
On Hook [HFT] [F] [D1] ..... [Dn]

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 DP output pin. Then, it pauses for 824 ms and continues dialing the digits, [D1] to [Dn]. These digits are then stored 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.

5. TONE/PULSE switching operation



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 V<sub>SS</sub> will cause the chip to store a [\*T] digit prior to the first tone digit in the redial me-



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**Absolute Maximum Ratings \***

Supply Voltage ( $V_{DD}$ ) .....  $\leq 6.0V$   
 Input Voltage ( $V_{IN}$ ) .....  $V_{SS} - 0.3V$  to  $V_{DD} + 0.3V$   
 Output Voltage ( $V_{OUT}$ ) .....  $V_{SS} - 0.3V$  to  $V_{DD} + 0.3V$   
 Output Voltage ( $V_{OUT}$ ) (DP, XMIT MUTE) .....  $\leq 1.2V$   
 Tone Output Current ( $I_{TONE}$ ) .....  $\leq 50$  mA  
 Power Dissipation ( $P_D$ ) .....  $\leq 500$  mW  
 Operating Temperature ( $T_{OP}$ ) .....  $-20^{\circ}C$  to  $+70^{\circ}C$   
 Storage Temperature ( $T_{STG}$ ) .....  $-40^{\circ}C$  to  $+125^{\circ}C$

**\*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**

( $V_{DD} = 3.5V$ ,  $V_{SS} = 0V$ ,  $F_{OSC} = 3.579545$  MHz,  $T_{OP} = 25^{\circ}C$ , unless otherwise specified)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Test CKT.	
Operating Voltage	$V_{DD}$	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	$\mu A$	$V_{DD} = 1.0V$ , $\overline{HK} = V_{DD}$ All outputs unloaded	-	
Operation Current	$I_{DDP}$ $I_{DDT}$		0.32	1.0	mA	Pulse mode	All outputs unloaded	A
			0.6	2.0		Tone mode		
Standby Current	$I_{SO}$		0.03	0.05	$\mu A$	$\overline{HK} = V_{DD} = 1.5V$	All outputs unloaded No key selected	A
			0.5	10		$\overline{HK} = V_{SS}$		
Input Voltage	$V_{IH}$	0.8		1	$V_{DD}$			
	$V_{IL}$	0		0.2				
$R1 \sim R4$ Input Current	$I_R$		115		$\mu A$		C	
Tone out Voltage	$V_{OC}$	584	730	876	mV <sub>p-p</sub>	Column	$V_{DD} = 3.5V$ $R_L = 5K$	D
	$V_{OR}$	456	570	684		Row		
HFI Pull Low Current	$I_{HFI}$		5		$\mu A$	$V_{DD} = 3.5V$ . (Note 1) HFI pin connected to 0V		
HFO Source Current	$I_{OH1}$	0.4	2		mA	$V_{DD} = 3.5V$ $V_{OH} = V_{DD} - 0.4V$	B	
HFO, $\overline{KT}$ , MODEOUT, XMUTE Sink Current	$I_{OL1}$	0.9	5.3		mA	$V_{DD} = 3.5V$ $V_{OL} = 0.4V$	B	
$\overline{DP}$ Sink Current	$I_{OL2}$	1.1	5.3		mA	$V_{DD} = 3.5V$ $V_{OL} = 0.4V$	B	
Distortion	DIS %			10	%	*Note 1		

Tone/Pulse Dialer

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

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



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**AC Electrical Characteristics**

( $V_{DD} = 3.5V$ ,  $V_{SS} = 0V$ ,  $F_{OSC} = 3.579545\text{ MHz}$ ,  $T_{OP} = 25^{\circ}C$ , unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Make Time	$T_M$	10 pps	M/B = 1/2		33.3	mS
			M/B = 2/3		40.0	
		20 pps	M/B = 1/2		16.7	
			M/B = 2/3		20.0	
Break Time	$T_B$	10 pps	M/B = 1/2		66.6	mS
			M/B = 2/3		60	
		20 pps	M/B = 1/2		33.3	
			M/B = 2/3		30	
Inter Digit Pause Time	$T_{IDP}$	10 pps		824	mS	
		20 pps		458		
Pause Time	$T_{PAU}$			2.2	S	
Auto-redial Break Time	$T_{ROBK}$	*Optional		2.2	S	
Delay time Key valid to Signal out	$T_d$			0	mS	
Key-in Debounce	$T_{KD}$			21	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	

R/C	Conditions	spec.	Actual	Error (%)	Unit
$\overline{R1}$	$F_{OSC} = 3.579545\text{ MHz}$	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
$\overline{C1}$		1209	1,215.7	+0.57	Hz
$\overline{C2}$		1336	1,331.7	-0.32	Hz
$\overline{C3}$		1477	1,471.9	-0.35	Hz



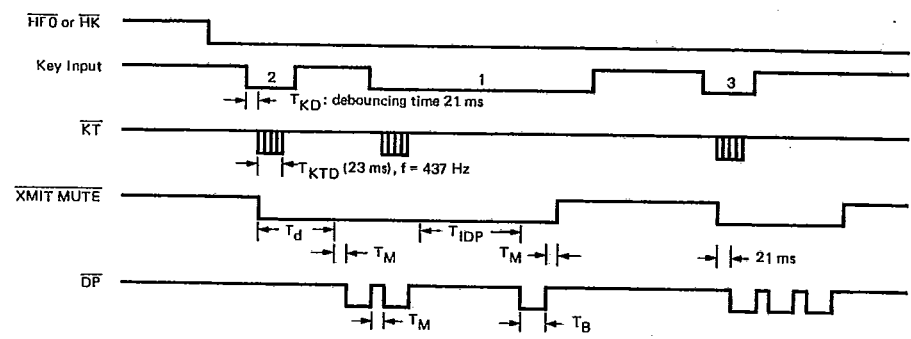


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Timing Waveform

1. Timing Waveform in pulse mode:

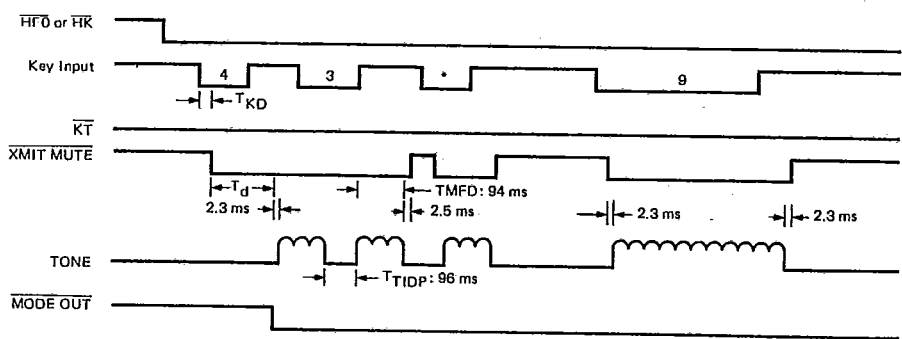


$T_d$  : Delay time of Key valid to dialing signal out, typically 0 ms  
 $T_{IDP}$  : Inter digit pause time  
 $T_{KTD}$  : Key in tone duration  
 $T_{KD}$  : Debouncing time  
 Note: "HK or HFO" indicates chip works when hook switch HK goes low or hands free control output HFO goes high.

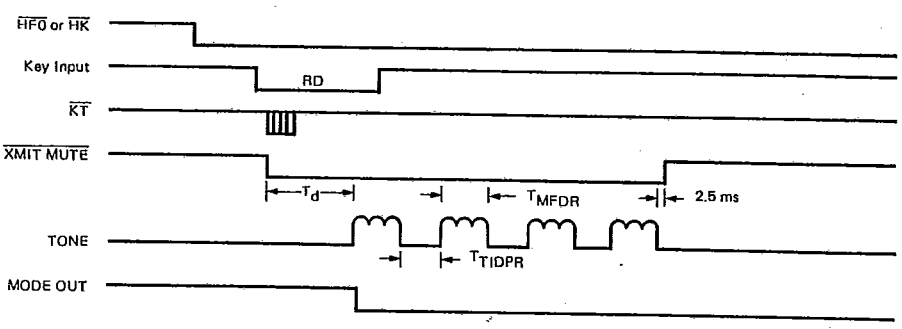


2. Timing Waveform in tone mode:

(i) Normal dialing



(ii) After (i), redialing



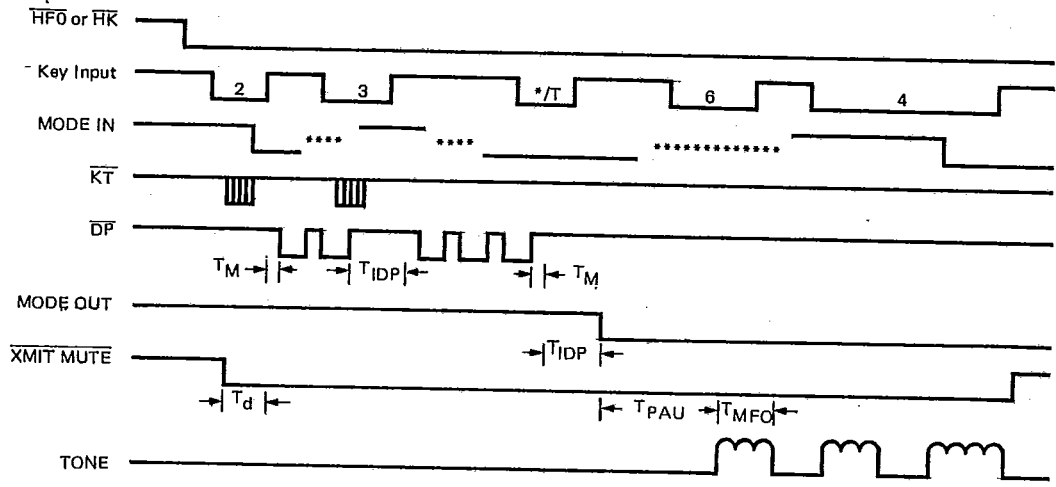


**UM91214/15 Series**

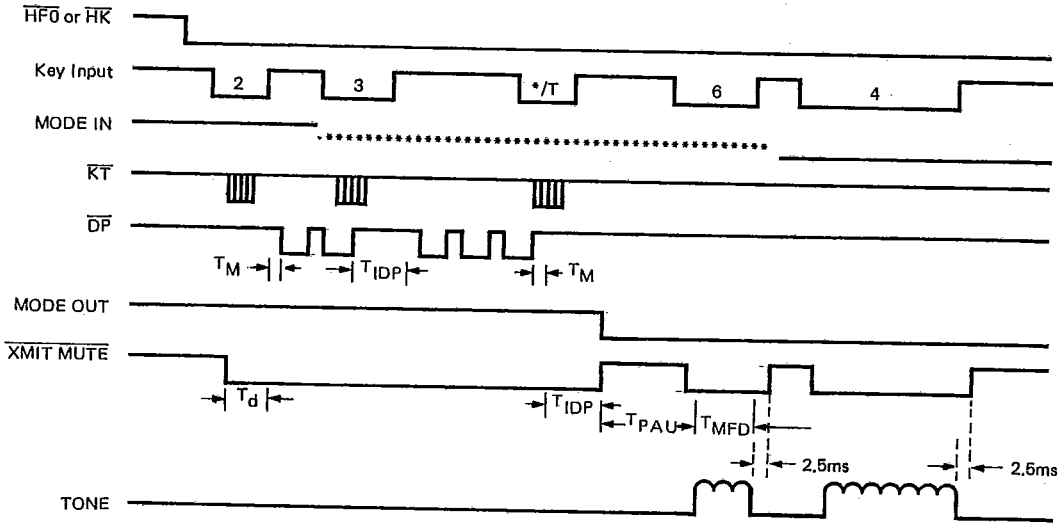
T-75-07-07

3. Timing Waveform for switching mode operation:

(i) By mode selection pin switches



(ii) By \*/T key entry



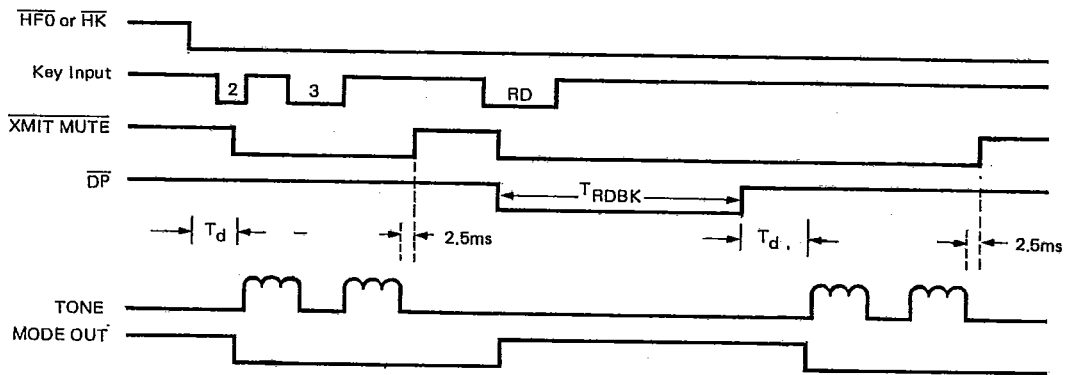
$T_{PAD}$ : Pause time (2.2 secs)



UM91214/15 Series

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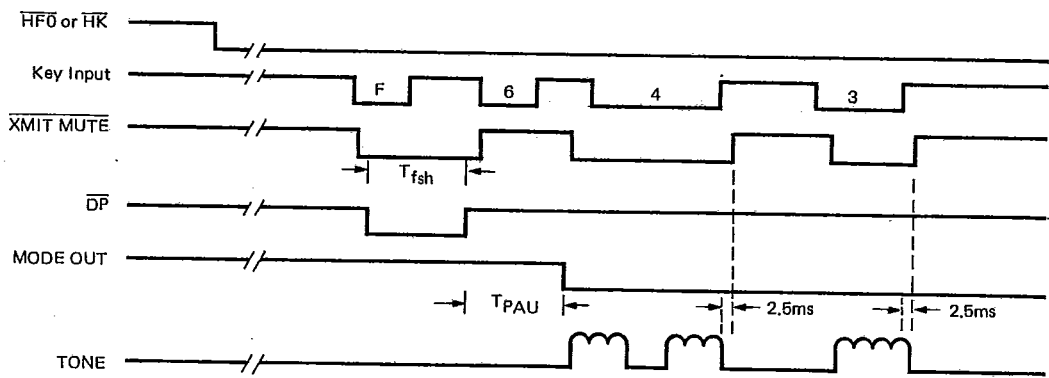
4. One key redial (DTMF mode for example):



$T_{RDBK}$ : Break time (2.2 secs)



5. Flash dialing (DTMF mode for example):



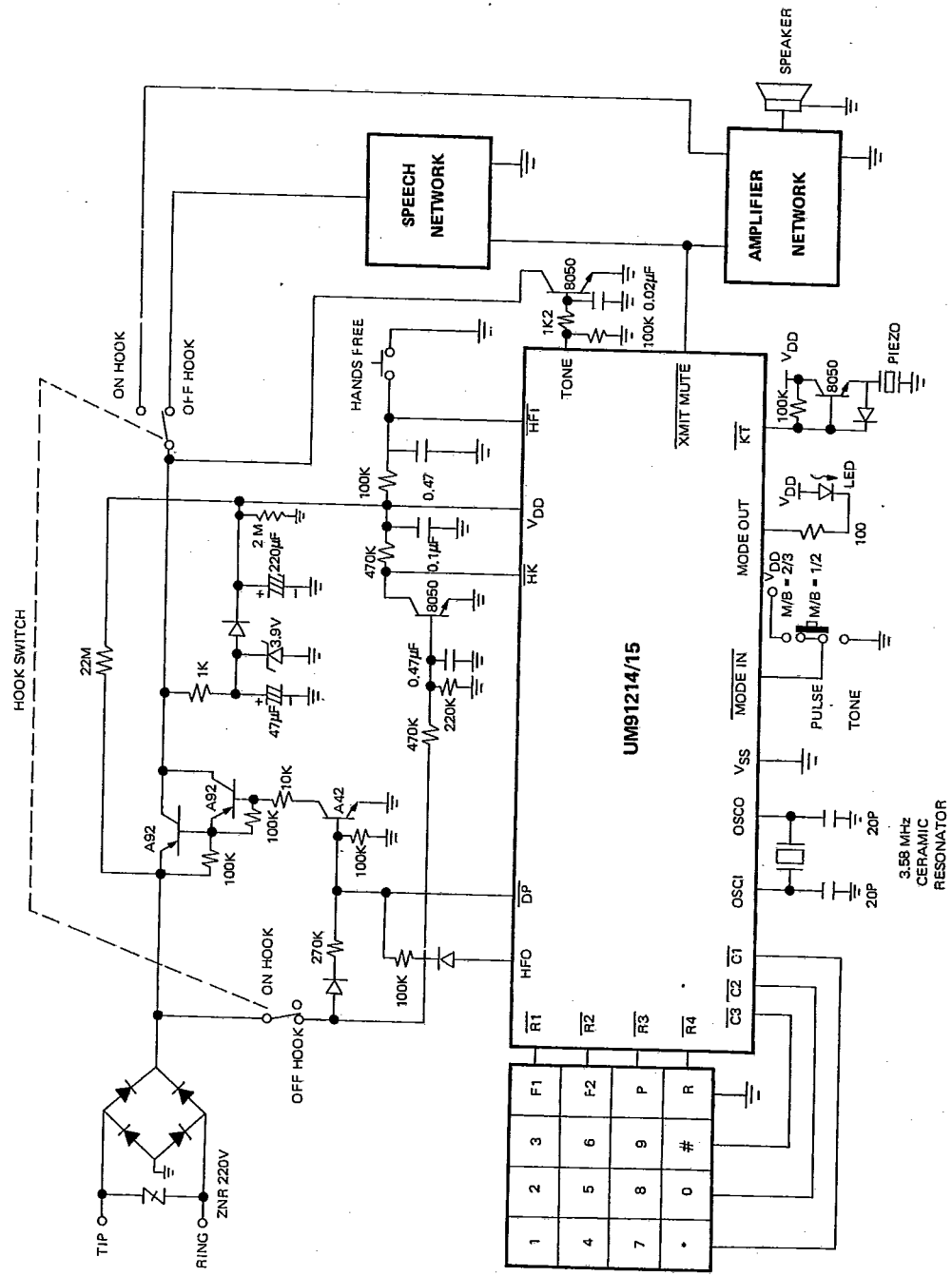
$T_{fsh}$ : flash time 96 or 640 ms ( F1. or F2. respectively) for UM91215  
 flash time 297 or 640 ms ( F1 or F2 respectively) for UM91214



UM91214/15 Series

Application Circuit

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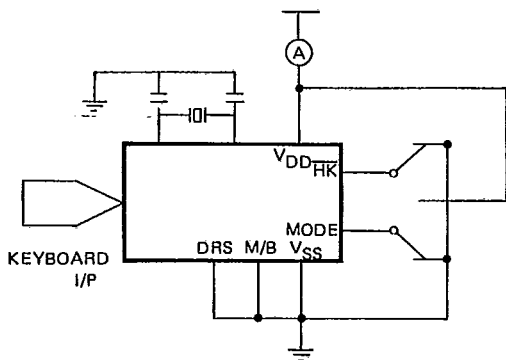


UM91214/15 Series

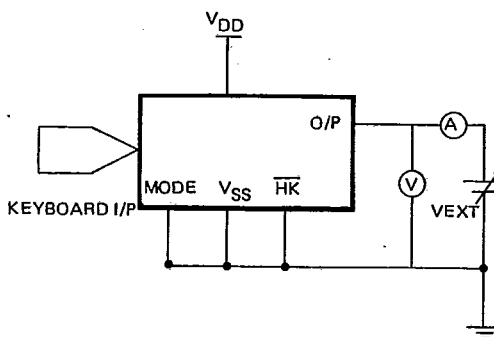
T-75-07-07

Test Circuits

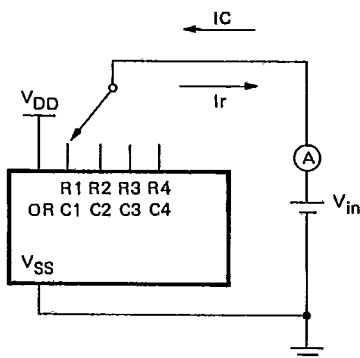
(A)



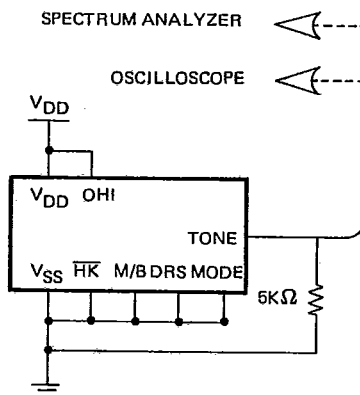
(B)



(C)



(D)



OSCILLOSCOPE: TEKTRONIX 468  
SPECTRUM ANALYZER: HP 3585A

Tone/Pulse Dialer

Ordering Information

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

N.A.: Not Available      A: Available