# Silan Semiconductors

SC91214/15 SERIES

TONE/PULSE DIALER

DESCRIPTION

The SC91214/15 Series is a single-chip, silicon gate, CMOS integrated circuit with an on-chip oscillator for a 3.58MHZ crystal or ceramic resonator. It provides a dialing pulse (DP) or dual tone multi-frequency (DTMF) dialing. A standard 4 X4 matrix keyboard can be used to support either DP or DTMF modes.

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
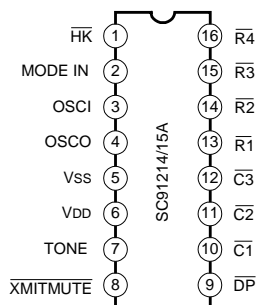* 4 X 4 (or 2 X 8) keyboard can be used
* Low standby current
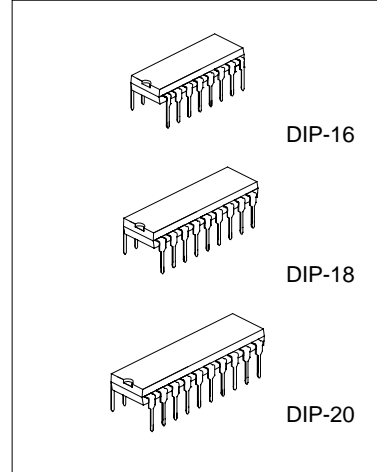
DIP-16

DIP-18

DIP-20

ORDERING INFORMATION

SC91214/15A	DIP-16 Package
SC91214/15B	DIP-18 Package
SC91214/15C	DIP-18 Package
SC91214/15D	DIP-20 Package

SC91214/15 SERIES

PIN CONFIGURATIONS

a. DIP-16 Package

```
           ┌───┐ ┌───┐
    HK ─ (1)      (16) ─ R4
MODE IN ─ (2)      (15) ─ R3
   OSCI ─ (3)      (14) ─ R2
   OSCO ─ (4)  SC91214/15A (13) ─ R1
    VSS ─ (5)      (12) ─ C3
    VDD ─ (6)      (11) ─ C2
   TONE ─ (7)      (10) ─ C1
XMITMUTE ─ (8)      (9) ─ DP
```

b. DIP-18Package

(i) Key tone output

```
           ┌───┐ ┌───┐
    HK ─ (1)      (18) ─ R4
MODE IN ─ (2)      (17) ─ R3
   OSCI ─ (3)      (16) ─ R2
   OSCO ─ (4)  SC91214/15B (15) ─ R1
    VSS ─ (5)      (14) ─ C3
    VDD ─ (6)      (13) ─ C2
   TONE ─ (7)      (12) ─ C1
XMITMUTE ─ (8)      (11) ─ DP
MODE OUT ─ (9)     (10) ─ KT
```

(ii) Hand-free control

```
           ┌───┐ ┌───┐
   HFO ─ (1)      (18) ─ HFI
    HK ─ (2)      (17) ─ R4
MODE IN ─ (3)      (16) ─ R3
   OSCI ─ (4)  SC91214/15C (15) ─ R2
   OSCO ─ (5)      (14) ─ R1
    VSS ─ (6)      (13) ─ C3
    VDD ─ (7)      (12) ─ C2
   TONE ─ (8)      (11) ─ C1
XMITMUTE ─ (9)     (10) ─ DP
```

c. DIP-20 Package

```
           ┌───┐ ┌───┐
   HFO ─ (1)      (20) ─ HFI
    HK ─ (2)      (19) ─ R4
MODE IN ─ (3)      (18) ─ R3
   OSCI ─ (4)      (17) ─ R2
   OSCO ─ (5)  SC91214/15D (16) ─ R1
    VSS ─ (6)      (15) ─ C3
    VDD ─ (7)      (14) ─ C2
   TONE ─ (8)      (13) ─ C1
XMITMUTE ─ (9)     (12) ─ DP
MODE OUT ─ (10)    (11) ─ KT
```

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Rev: 1.0   2001.01.03

BLOCK DIAGRAM

ABSOLUTE MAXIMUM RATINGS

(Tamb=25°C, All voltage referenced to V_{SS}, unless otherwise specified)

Characteristic	Symbol	Value	Unit
Power Supply Voltage	V_{DD}	6.0	V
Input Voltage	V_{IN}	-0.3~V_{DD}+0.3	V
Output Voltage	V_{OUT}	-0.3~V_{DD}+0.3	V
Output Voltage (DP, XMIT MUTE)	V_{OUT}	1.2	V
Tone Output Current	I_{TONE}	50	mA
Power Dissipation	P_D	500	mW
Operating Temperature	Topr	-25~+70	°C
Storage Temperature	Tstg	-55~+150	°C

Note: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to this 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 or intended. Exposure to the absolute maximum rating conditions for extended periods may affect device reliability.

SC91214/15 SERIES

AC ELECTRICAL CHARACTERISTICS

(Top=25°C, VDD=3.5V, VSS=0V, fosc=3.579545MHz, All voltage referenced to VSS, unless otherwise specified)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit	Test KT.
Operating Voltage	VDD	Tone mode		2.0	--	5.5	V	A
		Pulse mode		2.0	--	5.5		
Memory Retention Voltage	VMR			1			V	--
Memory Retention Current	IMR	VDD=1.0V, $\overline{HK}$=VDD All outputs unloaded			0.05	0.4	µA	--
Operating Current	IDDP	Pulse mode	All outputs unloaded		0.32	1.0	mA	A
	IDDT	Tone mode			0.6	2.0		
Standby Current	ISO	$\overline{HK}$=VDD=1.5V	All outputs unloaded, no key selected		0.03	0.05	µA	A
		$\overline{HK}$=VSS			0.5	10		
Input Voltage	VIH			0.8		1	VDD	
	VIL			0		0.2		
$\overline{R1}$ - $\overline{R4}$ Input Current	IR				115		µA	C
Tone out Voltage	VOC	Column	VDD=3.5V, RL=5K	584	730	876	mVp-p	D
	VOR	Row		456	570	684		
$\overline{HFI}$ Pull Low Current	| IHFI |	VDD=3.5V (Note 1) $\overline{HFI}$ pin connected to 0V			5		µA	B
HFO Drive Current	| IOH1 |	VDD=3.5V VOH=VDD-0.4V		0.4	2		mA	B
HFO, $\overline{KT}$, MODEOUT $\overline{XMITMUTE}$ Sink Current	IOL1	VDD=3.5V VOL=0.4V		0.9	5.3		mA	B
$\overline{DP}$ Sink Current	IOL2	VDD=3.5V, VOL=0.4V		1.1	5.3		mA	B
Distortion	DIS%	* see note below			1	5	%	

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

1. V_1 … V_n are the intermediation or the harmonic frequencies in the 500Hz to 3400Hz band.

2. V_{IL} and V_{IH} are the individual frequency components of the DTMF signal.

AC CHARACTERISTICS

(Top=25°C, VDD=3.5V, VSS=0V, fosc=3.579545MHz, All voltage referenced to VSS, unless otherwise specified)

Parameter	Symbol	Conditions		Min	Typ	Max	Unit
Make Time	TM	10pps	M/B=1/2		33.3		ms
			M/B=2/3		40.0		
		20pps	M/B=1/2		16.7		
			M/B=2/3		20.0		
Break Time	TB	10pps	M/B=1/2		66.6		ms
			M/B=2/3		60.0		
		20pps	M/B=1/2		33.3		
			M/B=2/3		30.0		
Inter-digit Pause Time	TIDP	10pps			824		ms
		20pps			458		
Pause Time	TPAU				2.2		sec
Auto-redial Break Time	TAOBK				2.2		sec
Delay Time Key Valid to Signal Out	TD				0		ms
Key-in Debounce	TKD				21		ms
Key Release Debounce Time	TKLD				5.2		ms
Key-in Tone Duration	TKTD				23		ms
Key-in Tone Frequency	FKT				437		Hz
Minimum Tone Duration Time	TMFD				90		ms
Min. Tone Inter-digit Pause	TTIDP				100		ms
Redial Tone Duration	TMFDR				90		ms
Redial Tone Inter-digit Duration	TTIDPR				100		ms

COMPARISONS OF SPECIFIED VS ACTUAL TONE FREQUENCIES (Fosc=3.579MHz)

R/C	Spec.	Actual	Error (%)	Unit
R1	697	699.1	+0.31	Hz
R2	770	771.5	+0.19	Hz
R3	852	852.3	+0.03	Hz
R4	941	942.0	+0.10	Hz
C1	1,29	1,215.7	+0.57	Hz
C2	1,336	1,331.7	-0.32	Hz
C3	1,477	1,471.9	-0.35	Hz

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KEYBOARD ASSIGNMENT
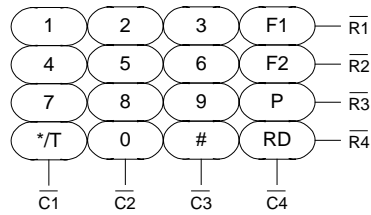
1) */T: In PULSE mode this key works as Pulse→DTMF key (T key). In DTMF mode the key works as * key.

   */T key will occupy one memory digit in either use.

2) F1: Flash key. The break time is 297 ms or 96 ms (SC91214/15 respectively)

3) F2: Flash key for break time 640 ms

4) P: Pause key (2.2 seconds)

5) RD: One key redial key

6) EMn: One touch memory key

7) #: In PULSE mode this key input is neglected. In DTMF mode this key works as # key.

PIN DESCRIPTION

Pin No.				Pin Name	I/O	Description
SC91214A	**SC91214B**	**SC91214C**	**SC91214D**			
3	3	4	4	OSCI	I	Oscillator Input and Output pins.
4	4	5	5	OSCO		The time base for the SC91214/15 is a crystal controlled on-chip oscillator, which is completed by connecting a 3.58MHz crystal or ceramic resonator between the OSCI and OSCO pins.
2	2	3	3	MODE IN	I, Z	TRI-STATE mode select pin. There ate two versions of the SC91214/15 as follows: a. SC91215 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 SC91214 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 as each digit key entery. In the PULSE mode, the dialing rate is checked, along with the make/break ratio, at first key entry.

Pin No.				Pin Name	I/O	Description
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 VDD condition.

(To be continued)

(Continued)

Pin No.				Pin Name	I/O	Description
SC91214A	**SC91214B**	**SC91214C**	**SC91214D**			
(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, an P keys). The tone output frequency is 437Hz 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 an "OFF" during make in the PULSE DIALING mode.
(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 $\overline{HFI}$ goes low, the Hands-Free Control state is toggled on. The status of the Hands-Free control state is listed in the following table:
		18	20	$\overline{HFI}$	I	

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

(To be continued)
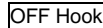
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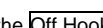| Pin No.				Pin Name	I/O	Description
SC91214A	SC91214B	SC91214C	SC91214D			
7	7	8	8	TONE	O	Tone dialing output When a valid key-press is detected in the DTMF mode, appropriate low group and high group, frequencies the dual tone output. TONE output is in the "OFF" state in PULSE mode.
8	8	9	9	$\overline{\text{XMITMUTE}}$	O	Dialing transmission mute output This is an N-channel open drain output. The $\overline{\text{XMITMUTE}}$ is normally "OFF". During pulse or 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		

KEYBOARD OPERATION

- **Symbol definitions:**

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

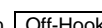|	
OFF Hook	means the phone is off the hook.
ON Hook	means the phone is on the hook.
D1	represents for the first digit dialed in a string of digits.
Dn (Dk)	represents for the last digit dialed in a string of digits.
Dn+1	represent for the beginning of a new string of digits.
Dn+m	represents for the last digit in a new string of digits.
HFI↓	represents 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. Off Hook   D1 …   Dn

    PULSE mode is defined as the INTIAL mode, provided the first keyboard input is not the */T key following the Off Hook 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   Off-Hook condition or if 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 ectry.

  2. DTMF mode operation

    a. Off Hook   D1 …   Dn or   On Hook   HFI↓   D1 …   Dn

    DTMF mode is defined as the INTIAL mode if the mode selection pin MOD IN is VSS.

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b. | Off Hook | | 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 operation a and b, since the mode switching key, | */T |, will occupy one digit of space.

3. Manual dialing with automatic access pause

a. | Off Hook | | O | | P | | D1 | … | Dn |

Pause key entries can be accepted and stored 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 is being used.

4. Redial

a. | Off 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. | Off Hook | | RD | | D1 | … | Dn | or | On Hook | | HFI↓ | | RD | | D1 | … | Dn |

After pressing the | RD | key, digits may be added 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 switch operation

a. | Off Hook | | D1 | … | Dn | | MODE IN pin switched to VSS | | Dn+1 | … | Dn+m |
   |◄——— PULSE Mode ———►| |◄— 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 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. | Off Hook | | D1 | … | Dn | | */T | | Dn+1 | … | Dn+m |

|◄— PULSE Mode —►||◄— 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 being 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.

6. One-key redialing

| Off-Hook | | D1 | … | Dn | | RD | or | On Hook | | $\overline{HFI}\downarrow$ | | D1 | … | Dn | | RD |

If the dialing of | D1 | to | Dn | is finished, pressing | RD | will cause the pulse dialing pin to go low for 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.
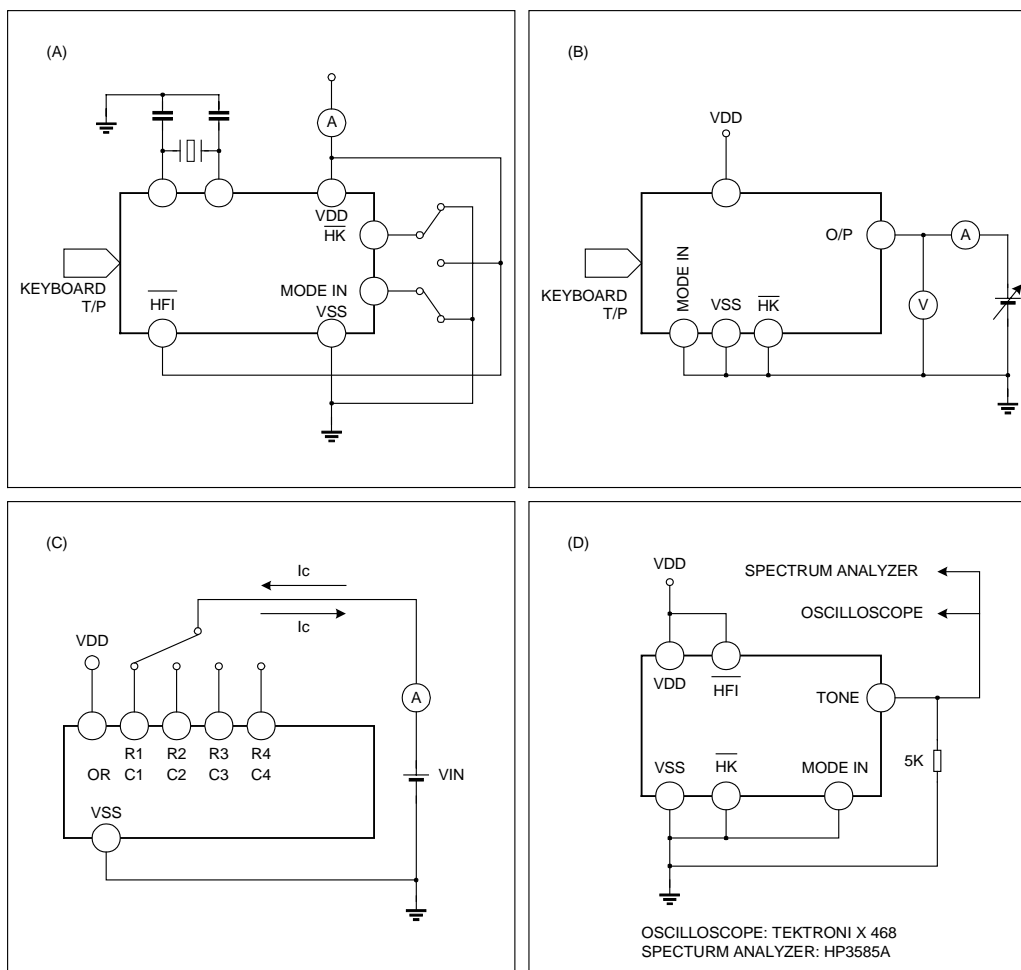
7. Flash dialing

| Off Hook | | F | | D1 | … | Dn | or | On Hook | | $\overline{HFI}\downarrow$ | | F | | D1 | … | Dn |

The flash key 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 mode) on the $\overline{DP}$ 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.
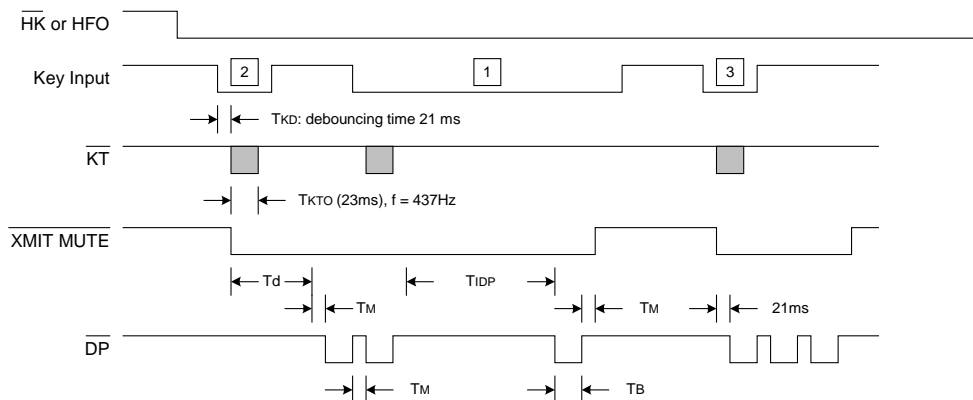
Similarly, to make sure that the IC is working properly, new flash key inputs will be ignored as long as the digits that were dialed have not finished.
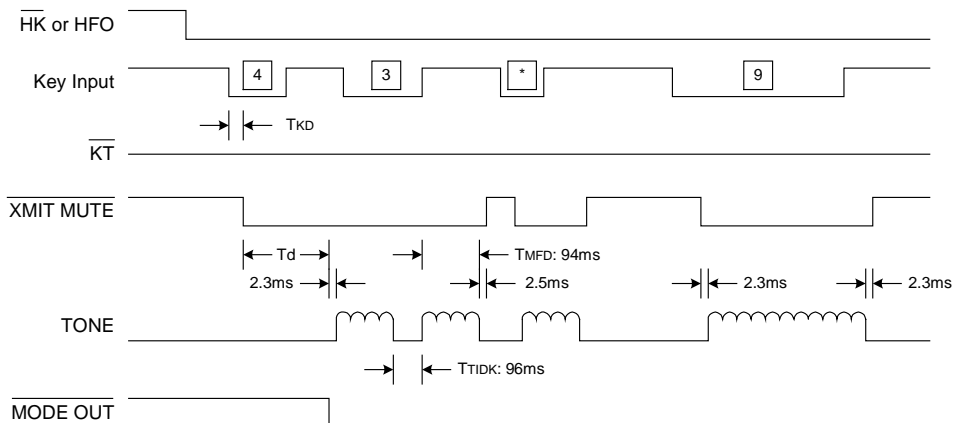
TEST CIRCUIT

(A)

(B)

(C)

(D)

OSCILLOSCOPE: TEKTRONI X 468
SPECTURM ANALYZER: HP3585A

TIMING DIAGRAMS

1.Timing diagram in PULSE mode:

$\overline{HK}$ or HFO

Key Input

T_{KD}: debouncing time 21 ms

$\overline{KT}$

T_{KTO} (23ms), f = 437Hz

XMIT MUTE

Td T_{IDP} T_M 21ms
T_M

$\overline{DP}$

T_M T_B

2. Timing diagram in TONE mode

(i) Normal dialing

$\overline{HK}$ or HFO

Key Input

T_{KD}

$\overline{KT}$

XMIT MUTE

Td T_{MFD}: 94ms
2.3ms   2.5ms   2.3ms   2.3ms

TONE

T_{TIDK}: 96ms

MODE OUT

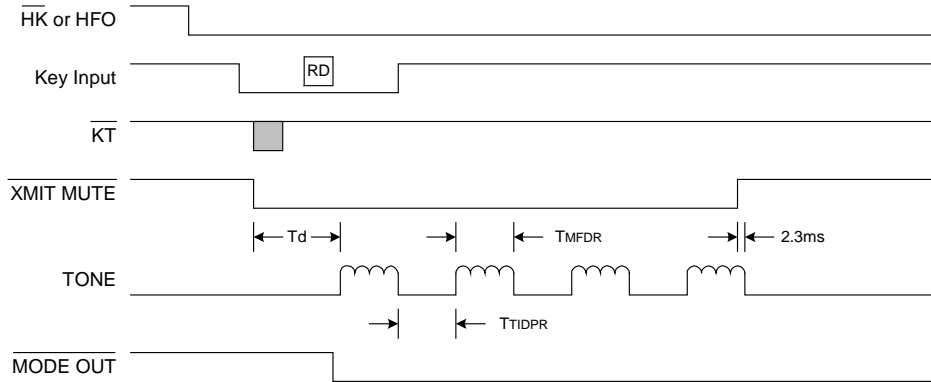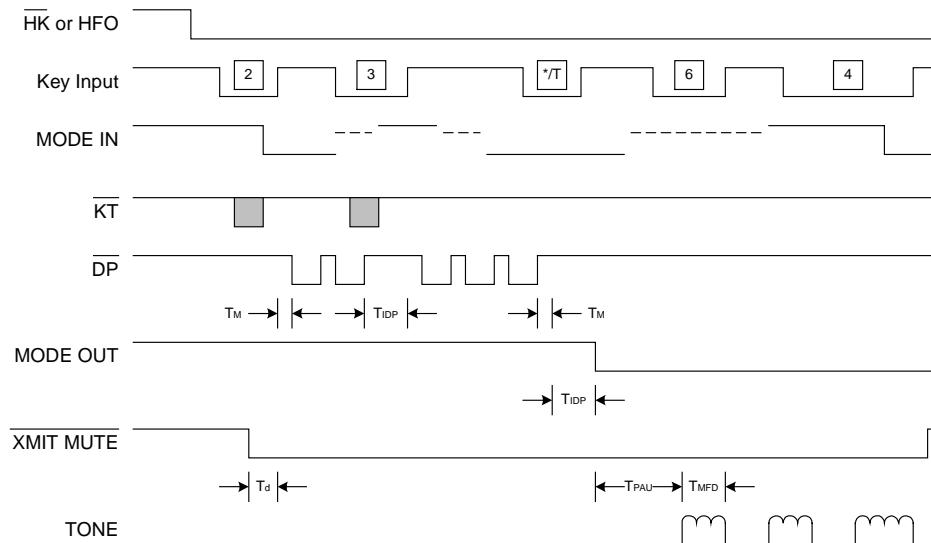## TIMING DIAGRAMS (Continued)
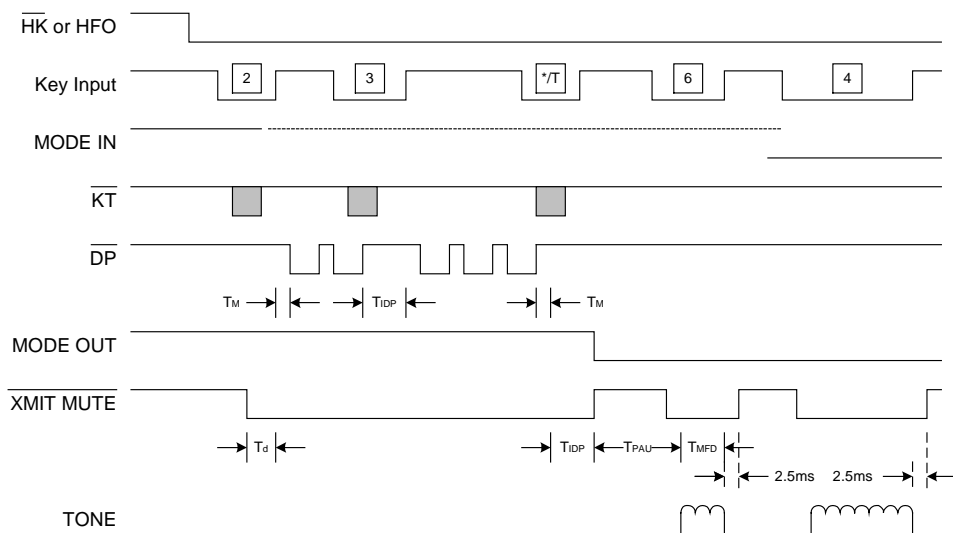
(ii) After (i), redialing

3. Timing diagram for SWITCHING mode operation:
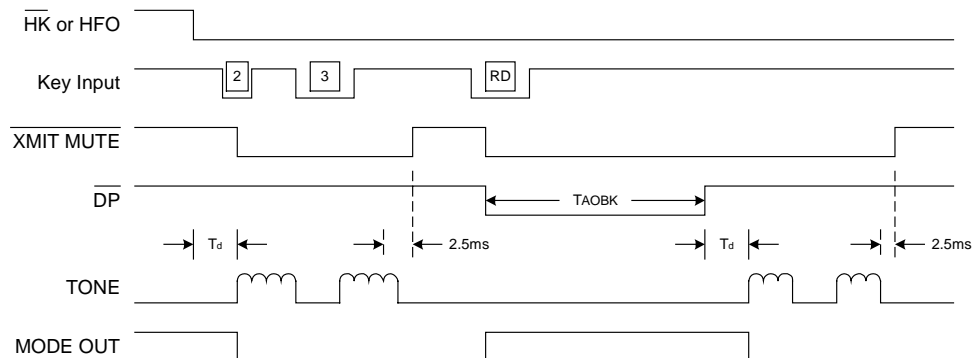
(i) By mode selection pin switches
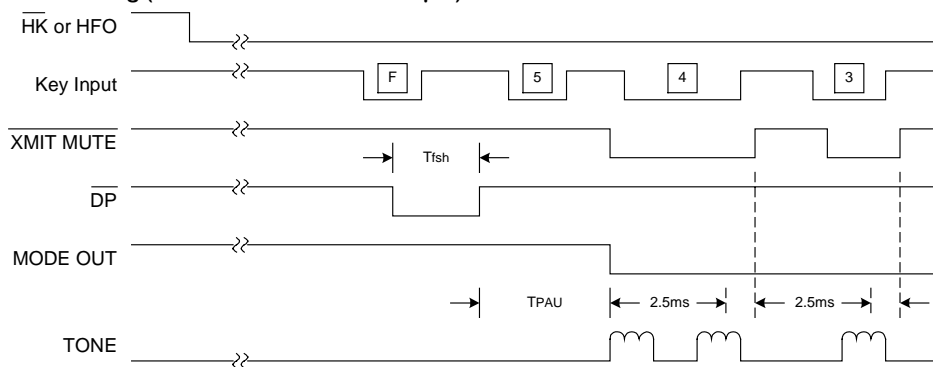
TIMING DIAGRAM (Continued)

*(ii) By */T key entry*

TPAU: Pause time (2.2 secs)

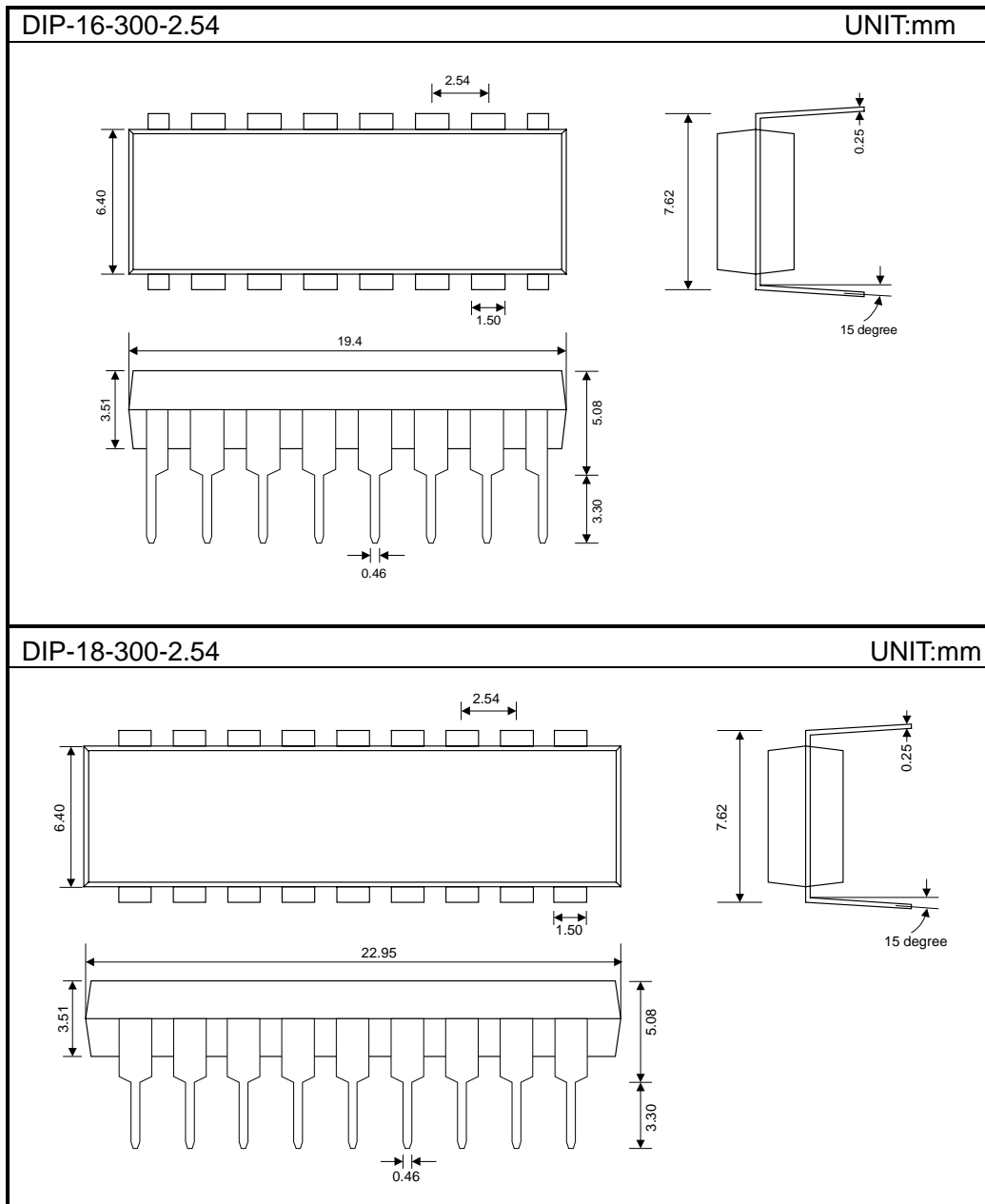### 4. One key redial (DTMF mode used as example):

TAOBK: Break time (2.2 secs)

TIMING DIAGRAM (Continued)

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

TYPACAL APPLICATION CIRCUIT

PACKAGE OUTLINE

DIP-16-300-2.54   UNIT:mm

2.54

6.40

1.50

7.62

0.25

15 degree

19.4

3.51

5.08

3.30

0.46

DIP-18-300-2.54   UNIT:mm

2.54

6.40

1.50

7.62

0.25

15 degree

22.95

3.51

5.08

3.30

0.46

PACKAGE OUTLINE

DIP-20-300-2.54	UNIT: mm

2.54

6.40

7.62

0.25

1.50

15 degree

22.95

3.51

5.08

3.30

0.46