

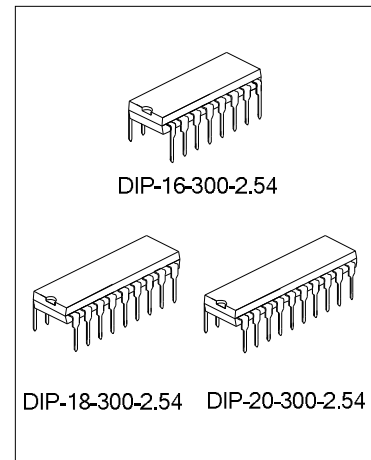
## T/P SWITCHABLE DIALER WITH REDIAL HANDFREE FUNCTION

### 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

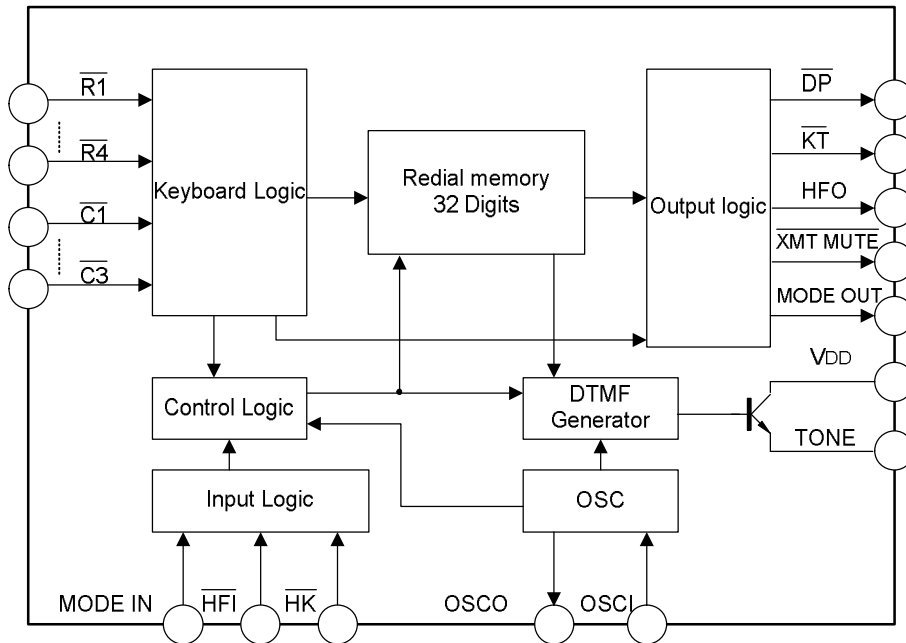
- \* One touch redial operation
- \* Tone/Pulse switchable
- \* 32 digit capacity for redialing
- \* Automatic mixed redialing (last number redial) of pulse to DTMF with multiple automatic access pauses
- \* PABX auto-pause is 2.2 seconds
- \* DTMF Timing:
  - Manual dialing: minimum duration for bursts 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 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
- \* 4 X 4 (or 2 X 8) keyboard can be used
- \* Low standby current



### ORDERING INFORMATION

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

**BLOCK DIAGRAM**



**ABSOLUTE MAXIMUM RATING** (Tamb=25°C, All voltage referenced to VSS, unless otherwise specified)

Characteristics	Symbol	Value	Unit
Power Supply Voltage	VDD	6.0	V
Input Voltage	VIN	-0.3~VDD+0.3	V
Output Voltage	VOUT	-0.3~VDD+0.3	V
Output Voltage (DP, XMIT MUTE)	VOUT	1.2	V
Tone Output Current	ITONE	50	mA
Power Dissipation	PD	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.

**AC ELECTRICAL CHARACTERISTICS** (T<sub>op</sub>=25°C, V<sub>DD</sub>=3.5V, V<sub>SS</sub>=0V, f<sub>osc</sub>=3.579545MHz, All voltage referenced to V<sub>SS</sub>, unless otherwise specified)

Characteristics	Symbol	Conditions	Min.	Typ.	Max.	Unit	Test KT.	
Operating Voltage	V <sub>DD</sub>	Tone mode	2.0	--	5.5	V	A	
		Pulse mode	2.0	--	5.5			
Memory Retention Voltage	V <sub>MR</sub>		1			V	--	
Memory Retention Current	I <sub>MR</sub>	V <sub>DD</sub> =1.0V, $\overline{HK}$ =V <sub>DD</sub> All outputs unloaded		0.05	0.4	μA	--	
Operating Current	I <sub>DDP</sub>	Pulse mode	All outputs unloaded	0.32	1.0	mA	A	
	I <sub>DDT</sub>	Tone mode		0.6	2.0			
Standby Current	I <sub>SO</sub>	$\overline{HK}$ =V <sub>DD</sub> =1.5V	All outputs unloaded, no key selected	0.03	0.05	μA	A	
		$\overline{HK}$ =V <sub>SS</sub>		0.5	10			
Input Voltage	V <sub>IH</sub>		0.8		1	V <sub>DD</sub>		
	V <sub>IL</sub>		0		0.2			
R1 - R4 Input Current	I <sub>R</sub>			115		μA	C	
Tone out Voltage	V <sub>OC</sub>	Column	V <sub>DD</sub> =3.5V, R <sub>L</sub> =5K	584	730	876	mV <sub>p-p</sub>	D
	V <sub>OR</sub>	Row		456	570	684		
$\overline{HFI}$ Pull Low Current	I <sub>HFI</sub>	V <sub>DD</sub> =3.5V (Note 1) $\overline{HFI}$ pin connected to 0V		5		μA	B	
HFO Drive Current	I <sub>OH1</sub>	V <sub>DD</sub> =3.5V V <sub>OH</sub> =V <sub>DD</sub> -0.4V	0.4	2		mA	B	
$\overline{HFO}$ , $\overline{KT}$ , $\overline{MODEOUT}$ $\overline{XMITMUTE}$ Sink Current	I <sub>OL1</sub>	V <sub>DD</sub> =3.5V V <sub>OL</sub> =0.4V	0.9	5.3		mA	B	
$\overline{DP}$ Sink Current	I <sub>OL2</sub>	V <sub>DD</sub> =3.5V, V <sub>OL</sub> =0.4V	1.1	5.3		mA	B	
Distortion	DIS%	* see note below		1	5	%		

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

- V<sub>1</sub> ... V<sub>n</sub> are the intermeditation or the harmonic frequencies in the 500Hz to 3400Hz band.
- V<sub>IL</sub> and V<sub>IH</sub> are the individual frequency components of the DTMF signal.

**AC CHARACTERISTICS** (T<sub>op</sub>=25°C, V<sub>DD</sub>=3.5V, V<sub>SS</sub>=0V, f<sub>osc</sub>=3.579545MHz, All voltage referenced to V<sub>SS</sub>, unless otherwise specified)

Characteristics	Symbol	Conditions	Min.	Typ.	Max.	Unit
Make Time	T <sub>M</sub>	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	

(To be continued)

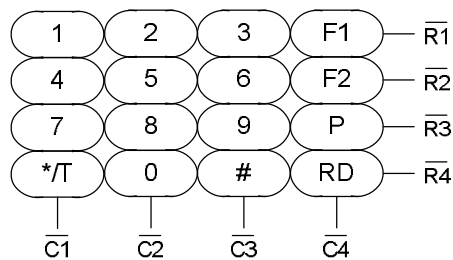
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Characteristics	Symbol	Conditions	Min.	Typ.	Max.	Unit
Break Time	T <sub>B</sub>	10pps	M/B=1/2	66.6		ms
			M/B=2/3	60.0		
		20pps	M/B=1/2	33.3		
			M/B=2/3	30.0		
Inter-digit Pause Time	T <sub>IDP</sub>	10pps		824		ms
		20pps		458		
Pause Time	T <sub>PAU</sub>			2.2		sec
Auto-redial Break Time	T <sub>AOBK</sub>			2.2		sec
Delay Time Key Valid to Signal Out	T <sub>D</sub>			0		ms
Key-in Debounce	T <sub>KD</sub>			21		ms
Key Release Debounce Time	T <sub>KLD</sub>			5.2		ms
Key-in Tone Duration	T <sub>KTD</sub>			23		ms
Key-in Tone Frequency	F <sub>KT</sub>			437		Hz
Minimum Tone Duration Time	T <sub>MFDR</sub>			90		ms
Min. Tone Inter-digit Pause	T <sub>TIDP</sub>			100		ms
Redial Tone Duration	T <sub>MFDR</sub>			90		ms
Redial Tone Inter-digit Duration	T <sub>TIDPR</sub>			100		ms

**COMPARISONS OF SPECIFIED VS ACTUAL TONE FREQUENCIES** ( $f_{osc}=3.579\text{MHz}$ )

R/C	Spec.	Actual	Error (%)	Unit
R <sub>1</sub>	697	699.1	+0.31	Hz
R <sub>2</sub>	770	771.5	+0.19	Hz
R <sub>3</sub>	852	852.3	+0.03	Hz
R <sub>4</sub>	941	942.0	+0.10	Hz
C <sub>1</sub>	1,29	1,215.7	+0.57	Hz
C <sub>2</sub>	1,336	1,331.7	-0.32	Hz
C <sub>3</sub>	1,477	1,471.9	-0.35	Hz

**KEYBOARD ASSIGNMENT**

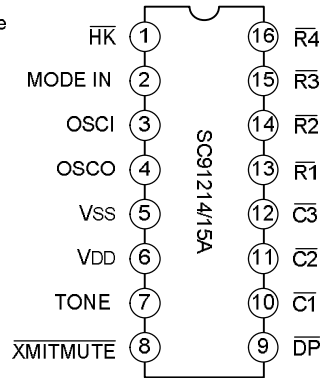


- 1) \*/T: In PULSE mode this key works as Pulse→DTMF key (T key). In DTMF mode the key works as \* key.  
\*/T key will occupy one memory digit in either use.

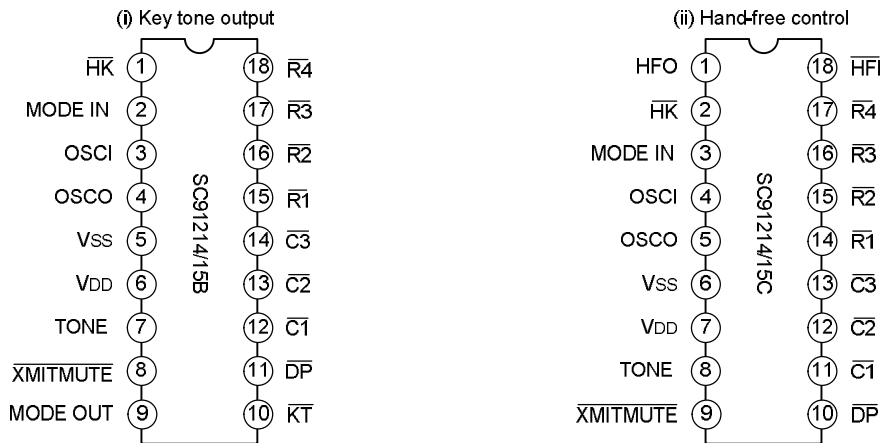
- 2) F1: Flash key. The break time is 297 ms or 96 ms (SC91214/15 respectively)
- 3) F2: Flash key for break time 640 ms
- 4) P: Pause key (2.2 seconds)
- 5) RD: One key redial key
- 6) EMn: One touch memory key
- 7) #: In PULSE mode this key input is neglected. In DTMF mode this key works as # key.

**PIN CONFIGURATION**

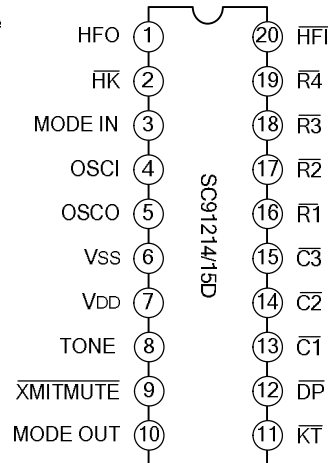
a. DIP-16 Package



b. DIP-18 Package



c. DIP-20 Package



**PIN DESCRIPTION**

Pin No.				Pin Name	Description																																
SC9121 4A	SC9121 4B	SC9121 4C	SC9121 4D																																		
3 4	3 4	4 5	4 5	OSCI OSCO	Oscillator Input and Output pins. 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	TRI-STATE mode select pin. There are two versions of the SC91214/15 as follows: a. SC91215 Series is for European and American systems. <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>VDD</td> <td>Pulse</td> <td>10pps</td> <td>2/3</td> </tr> <tr> <td>VSS</td> <td>Tone</td> <td>--</td> <td>--</td> </tr> <tr> <td>Floating</td> <td>Pulse</td> <td>10pps</td> <td>1/2</td> </tr> </tbody> </table> b. The SC91214 Series is for the Japanese system. <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>VDD</td> <td>Pulse</td> <td>10pps</td> <td>1/2</td> </tr> <tr> <td>VSS</td> <td>Tone</td> <td>--</td> <td>--</td> </tr> <tr> <td>Floating</td> <td>Pulse</td> <td>20pps</td> <td>1/2</td> </tr> </tbody> </table> The mode selection pin is checked for tone/pulse dialing as each digit key entry. In the PULSE mode, the dialing rate is checked, along with the make/break ratio, at first key entry.	MODE IN	Tone/ Pulse	Dial Rate	M/B Ratio	VDD	Pulse	10pps	2/3	VSS	Tone	--	--	Floating	Pulse	10pps	1/2	MODE IN	Tone/ Pulse	Dial Rate	M/B Ratio	VDD	Pulse	10pps	1/2	VSS	Tone	--	--	Floating	Pulse	20pps	1/2
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Floating	Pulse	20pps	1/2																																		
1	1	2	2	$\overline{\text{HK}}$	Hook switch input This inverter input pin detects the state of the hook switch contact. "Off Hook" is represented by a VDD condition.																																
(N.A.)	10	(N.A.)	11	$\overline{\text{KT}}$	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, an P keys). The tone output frequency is 437Hz and tone duration is 23 ms.																																

(To be continued)

(Continued)

Pin No.				Pin Name	Description																																								
SC9121 4A	SC9121 4B	SC9121 4C	SC9121 4D																																										
9	11	10	12	DP	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	Hands-Free Control I/O pins These pins enable and disable the Hands-Free control function. When input pin $\overline{\text{HFI}}$ 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	$\overline{\text{HFI}}$	<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{\text{HFI}} \downarrow</math></td> <td>High</td> <td>Yes</td> </tr> <tr> <td>On Hook</td> <td>High</td> <td><math>\overline{\text{HFI}} \downarrow</math></td> <td>Low</td> <td>No</td> </tr> <tr> <td>Off Hook</td> <td>High</td> <td><math>\overline{\text{HFI}} \downarrow</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	$\overline{\text{HFI}} \downarrow$	High	Yes	On Hook	High	$\overline{\text{HFI}} \downarrow$	Low	No	Off Hook	High	$\overline{\text{HFI}} \downarrow$	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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Hook SW.	HFO	Input	HFO	Dialing?																																									
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On Hook	High	$\overline{\text{HFI}} \downarrow$	Low	No																																									
Off Hook	High	$\overline{\text{HFI}} \downarrow$	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	TONE	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	$\overline{\text{XMITMUTE}}$	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	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	$\overline{\text{C1}}$																																									
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12	14	13	15	$\overline{\text{C3}}$																																									
6	6	7	7	VDD	Power supply pins																																								
5	5	6	6	VSS	These devices are designed to operate from 2.0V to 5.5V.																																								

## KEYBOARD OPERATION

### • Symbol definitions:

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

$\overline{\text{OFF Hook}}$	means the phone is off the hook.
$\overline{\text{ON Hook}}$	means the phone is on the hook.
$\text{D1}$	represents for the first digit dialed in a string of digits.
$\text{Dn (Dk)}$	represents for the last digit dialed in a string of digits.
$\text{Dn+1}$	represent for the beginning of a new string of digits.
$\text{Dn+m}$	represents for the last digit in a new string of digits.
$\overline{\text{HFI}} \downarrow$	represents for the switch that activates the HANDS-FREE DIALING mode going low.
$*/\text{T}$	is the Pulse-to-DTMF key.
$\text{RD}$	is the Redial key.
$0$	is the Zero key.
$\text{P}$	is the Pause key.
$\text{F}$	is the Flash key.

### • Recommended Operation

#### 1. PULSE mode operation

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

PULSE mode is defined as the INITIAL mode, provided the first keyboard input is not the  $*/\text{T}$  key following the  $\overline{\text{Off Hook}}$  condition and the mode selection pin is floating (MODE IN = VDD or floating).

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

Pulse mode is defined as the INITIAL mode, provided the key input  $\text{D1}$  is not  $*/\text{T}$  while the mode selection pin is VDD or floating. The chip will pause for 824 ms automatically after it detects an  $\overline{\text{Off-Hook}}$  condition or if the  $\overline{\text{HFI}} \downarrow$  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.  $\overline{\text{Off Hook}}$   $\text{D1}$  ...  $\text{Dn}$  or On Hook  $\overline{\text{HFI}} \downarrow$   $\text{D1}$  ...  $\text{Dn}$

DTMF mode is defined as the INITIAL mode if the mode selection pin MOD IN is Vss.

b.  $\overline{\text{Off Hook}}$   $\text{D1}$  ...  $\text{Dn}$  or On Hook  $\overline{\text{HFI}} \downarrow$   $*/\text{T}$   $\text{D1}$  ...  $\text{Dn}$



The INITIAL mode is PULSE mode if the mode selection pin, MODE IN, is VDD or floating. The  $\boxed{*/T}$  key can switch the DIALING mode to TONE mode. Unlike NORMAL mode switching, the  $\boxed{*/T}$  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,  $\boxed{*/T}$ , will occupy one digit of space.

### 3. Manual dialing with automatic access pause

a.  $\boxed{\text{Off Hook}} \boxed{O} \boxed{P} \boxed{D1} \dots \boxed{Dn}$

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 is being used.

### 4. Redial

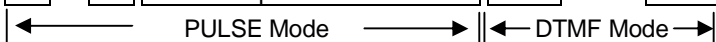
a.  $\boxed{\text{Off Hook}} \boxed{RD}$  or  $\boxed{\text{On Hook}} \boxed{HFI\downarrow} \boxed{RD}$

Up to 32 digits (in PULSE mode) or 31 digits (in TONE mode) can be dialed using the  $\boxed{RD}$  key. The  $\boxed{RD}$  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.

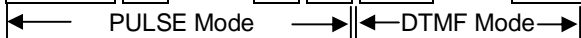
b.  $\boxed{\text{Off Hook}} \boxed{RD} \boxed{D1} \dots \boxed{Dn}$  or  $\boxed{\text{On Hook}} \boxed{HFI\downarrow} \boxed{RD} \boxed{D1} \dots \boxed{Dn}$

After pressing the  $\boxed{RD}$  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  $\boxed{RD}$ , 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.  $\boxed{\text{Off Hook}} \boxed{D1} \dots \boxed{Dn} \boxed{\text{MODE IN pin switched to VSS}} \boxed{Dn+1} \dots \boxed{Dn+m}$   


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  $\boxed{*/T}$  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.  $\boxed{\text{Off Hook}} \boxed{D1} \dots \boxed{Dn} \boxed{*/T} \boxed{Dn+1} \dots \boxed{Dn+m}$   


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  $\boxed{*/T}$  key. DTMF mode will begin as soon as the last pulse has been transmitted. In this mode,  $\boxed{Dn+1}$  through  $\boxed{Dn+m}$  are sent through the TONE OUT pin as DTMF signals. If a  $\boxed{P}$  key entry is contained in the series of digits before or after the  $\boxed{*/T}$  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

$\boxed{\text{Off-Hook}} \boxed{D1} \dots \boxed{Dn} \boxed{RD}$  or  $\boxed{\text{On Hook}} \boxed{HFI\downarrow} \boxed{D1} \dots \boxed{Dn} \boxed{RD}$

If the dialing of  $\overline{D1}$  to  $\overline{Dn}$  is finished, pressing  $\overline{RD}$  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  $\overline{D1}$  to  $\overline{Dn}$  have not finished, the pressing of the redial key will be ignored.

### 7. Flash dialing

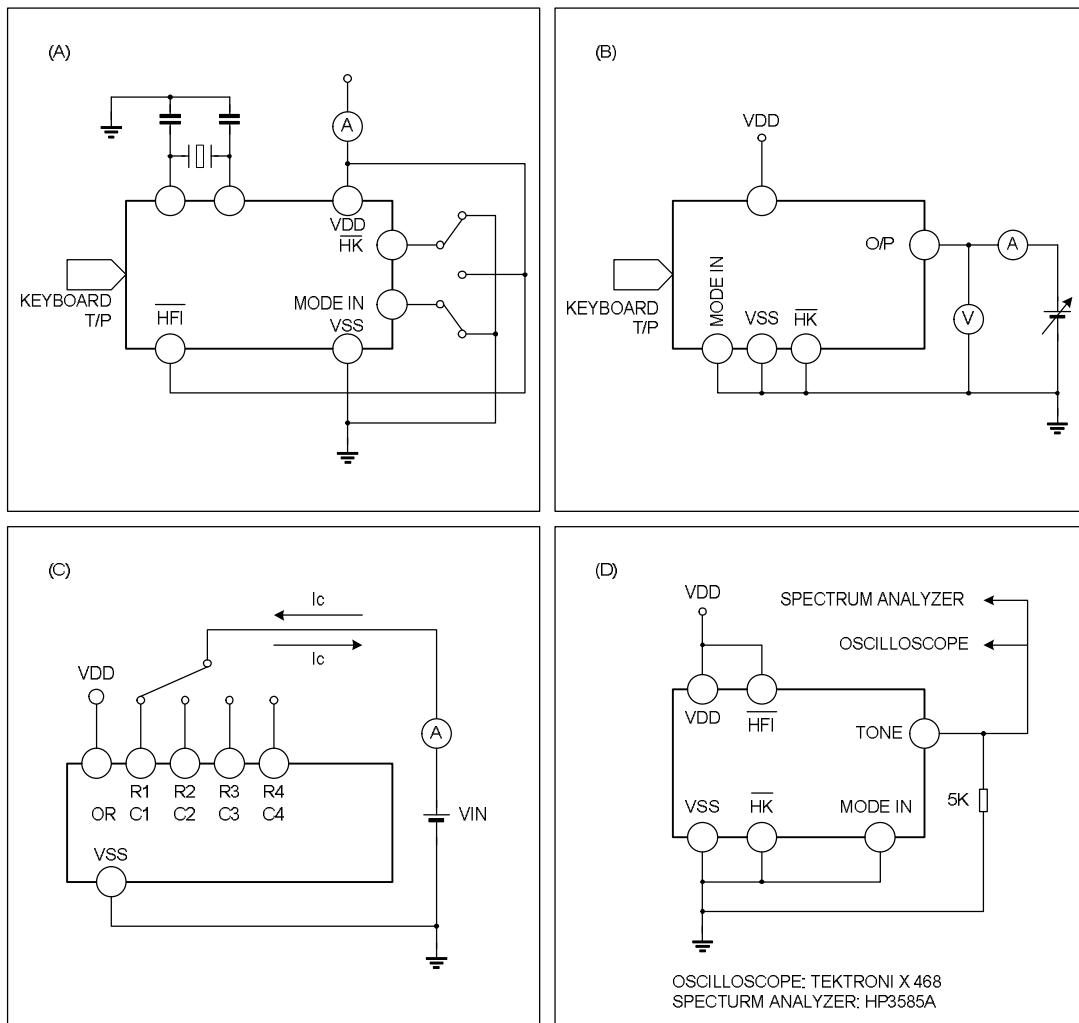
Off Hook  $\overline{F}$   $\overline{D1}$  ...  $\overline{Dn}$  or On Hook  $\overline{HF1}$   $\overline{F}$   $\overline{D1}$  ...  $\overline{Dn}$

The flash key emulate quick On-Off Hook operations. Pressing the flash keys,  $\overline{F1}$  or  $\overline{F2}$ , 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,  $\overline{D1}$  to  $\overline{Dn}$ . 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.

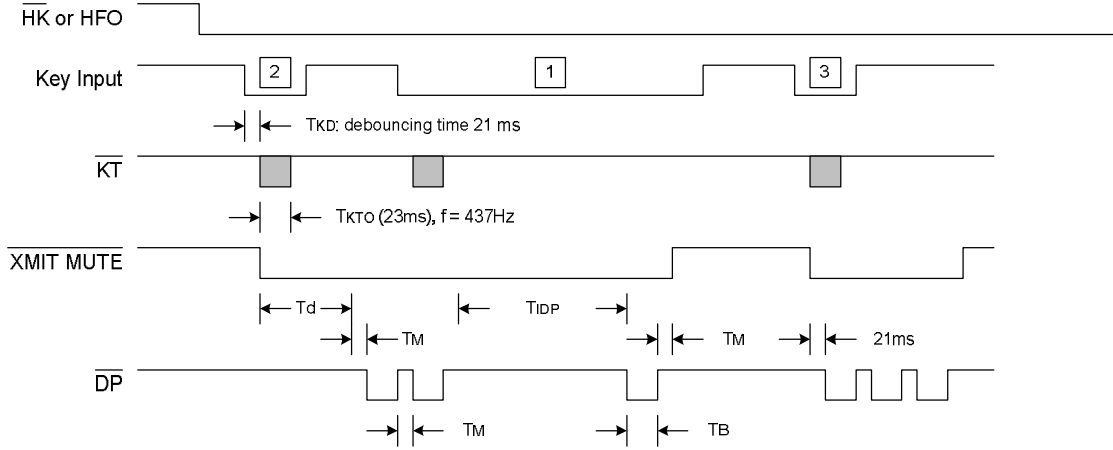
Similarly, to make sure that the IC is working properly, new flash key inputs will be ignored as long as the digits that were dialed have not finished.

### TEST CIRCUIT



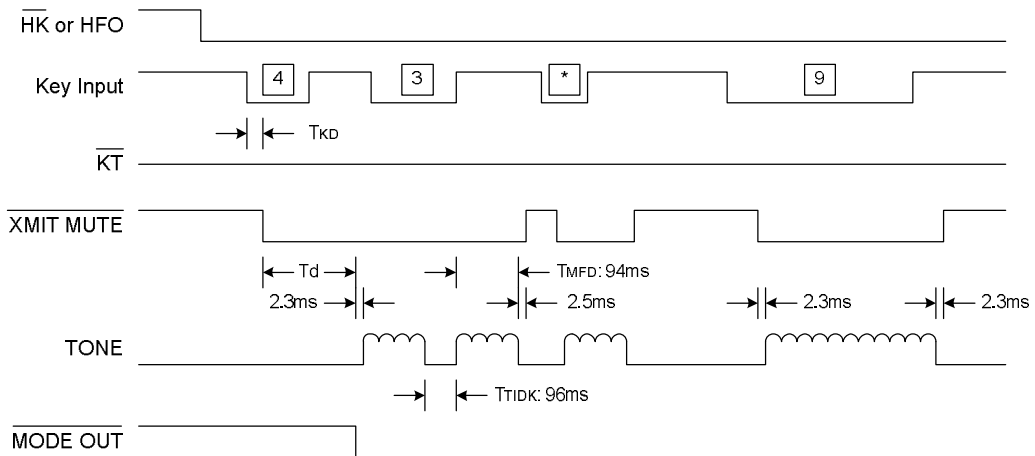
**TIMING DIAGRAMS**

**1. Timing diagram in PULSE mode:**

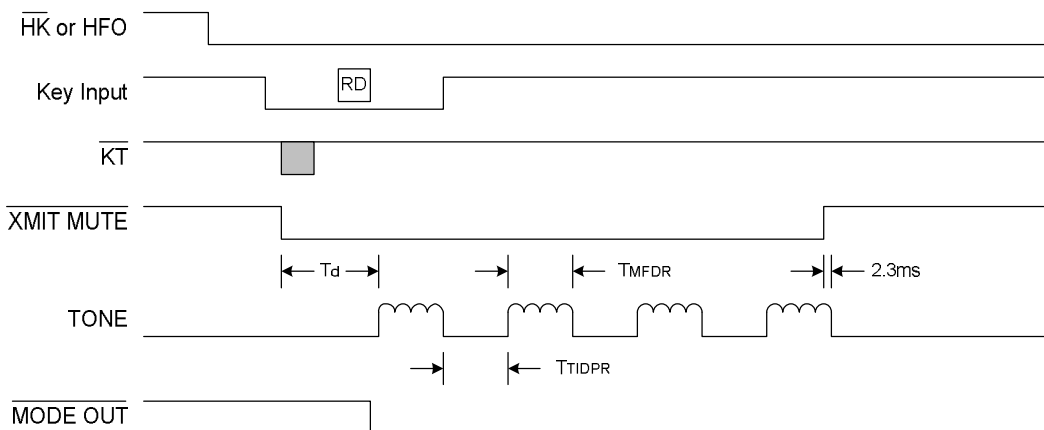


**2. Timing diagram in TONE mode**

**(i) Normal dialing**

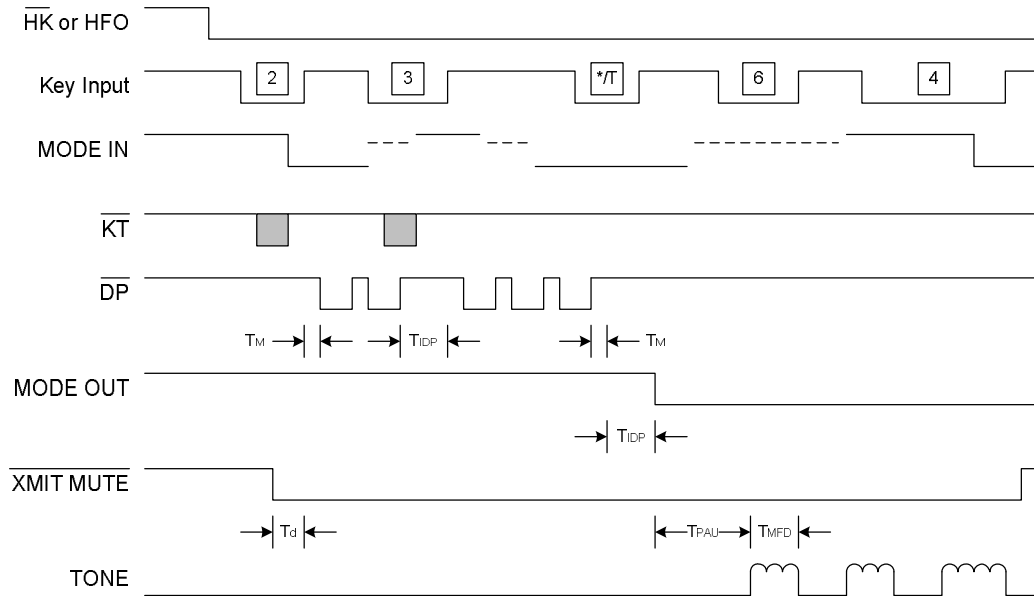


**(ii) After (i), redialing**

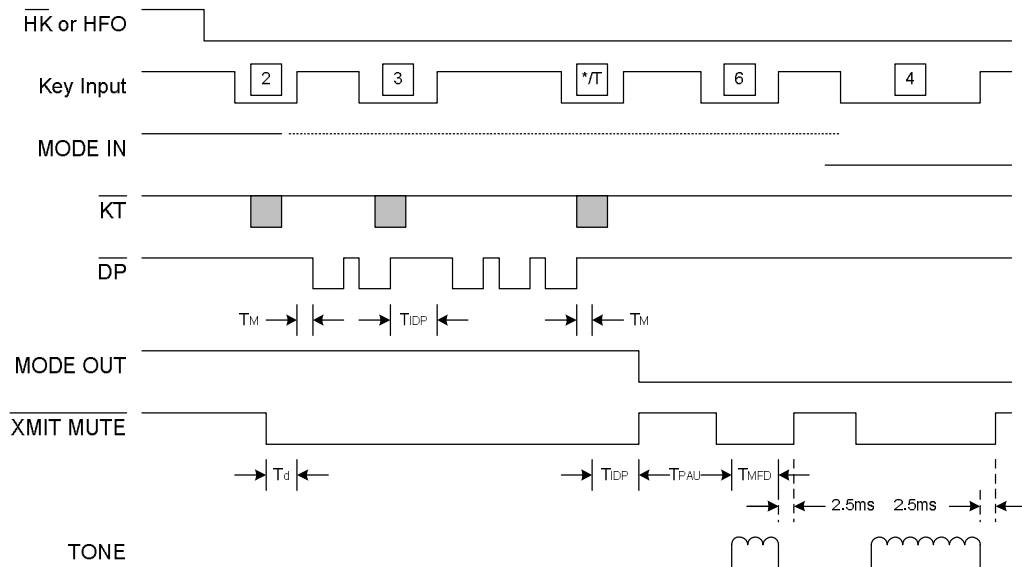


3. Timing diagram for SWITCHING mode operation:

(i) By mode selection pin switches

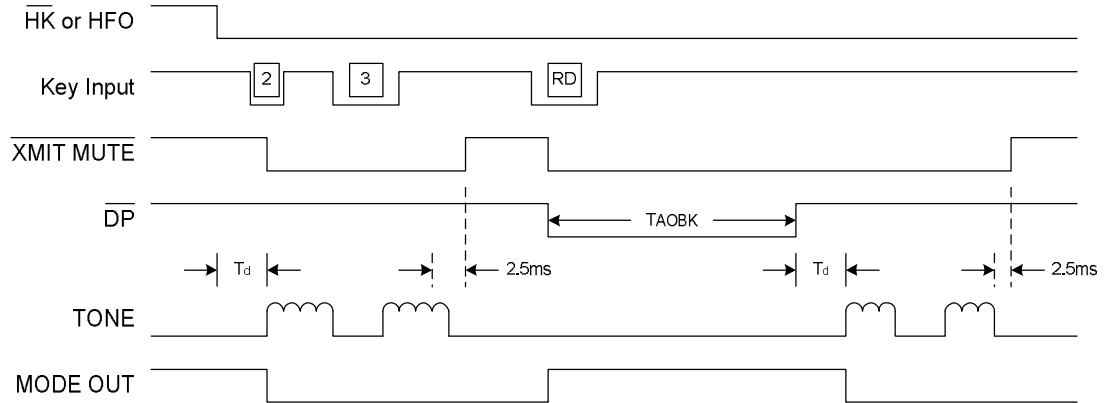


(ii) By \*/T key entry



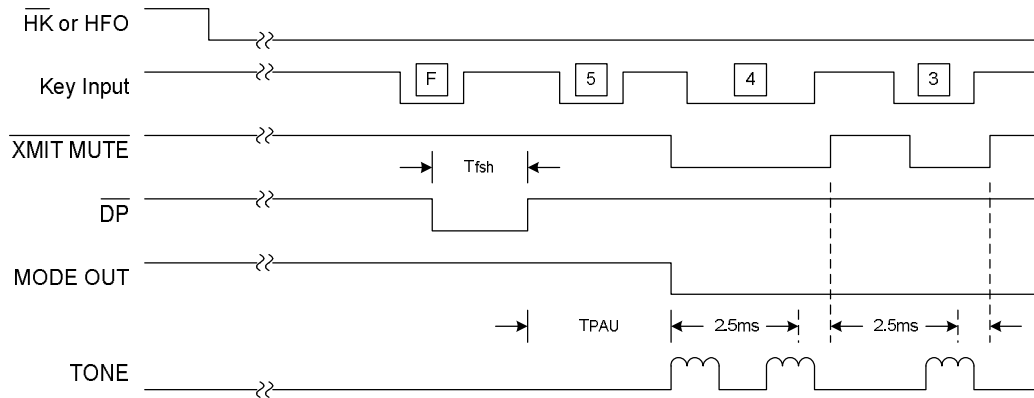
TPAU: Pause time (2.2 secs)

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

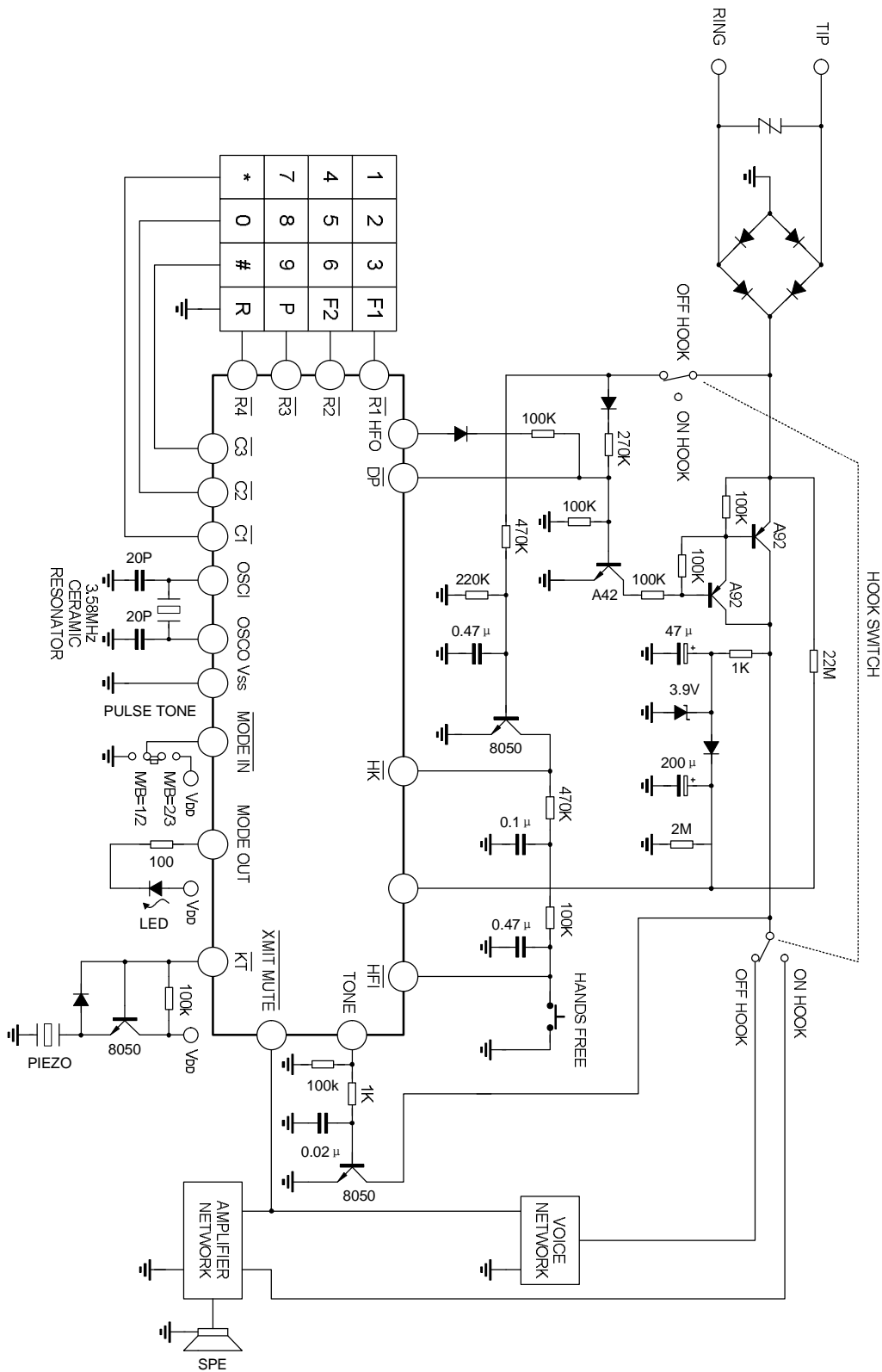


TAOBK: Break time (2.2 secs)

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



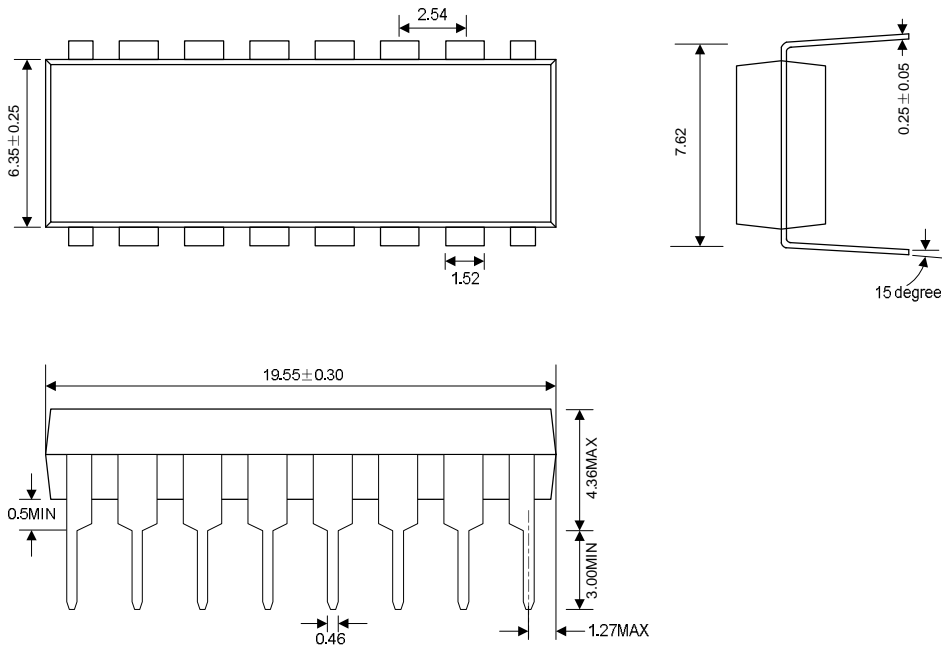
**TYPICAL APPLICATION CIRCUIT**



PACKAGE OUTLINE

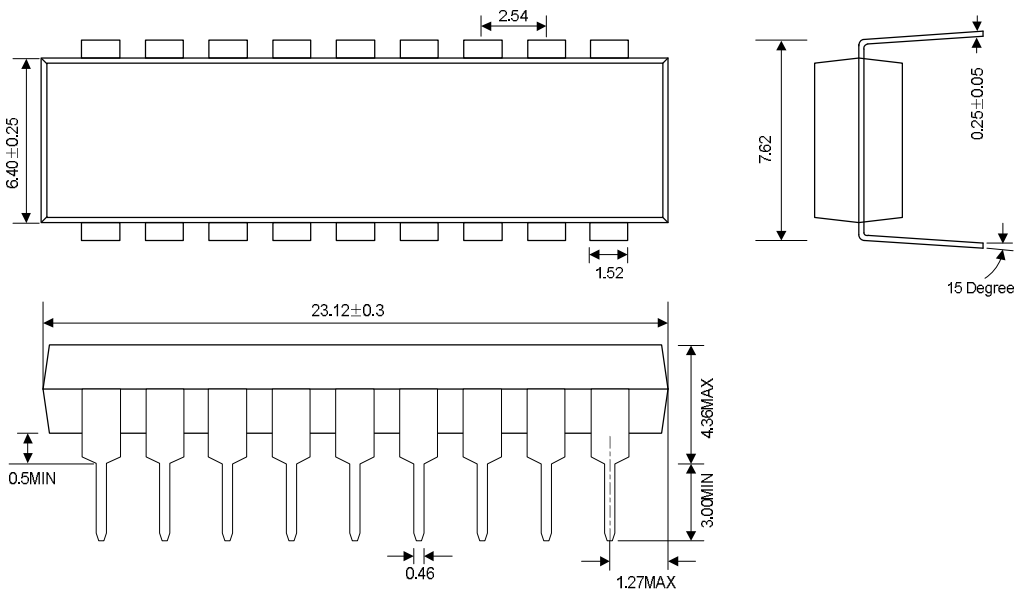
DIP-16-300-2.54

UNIT: mm

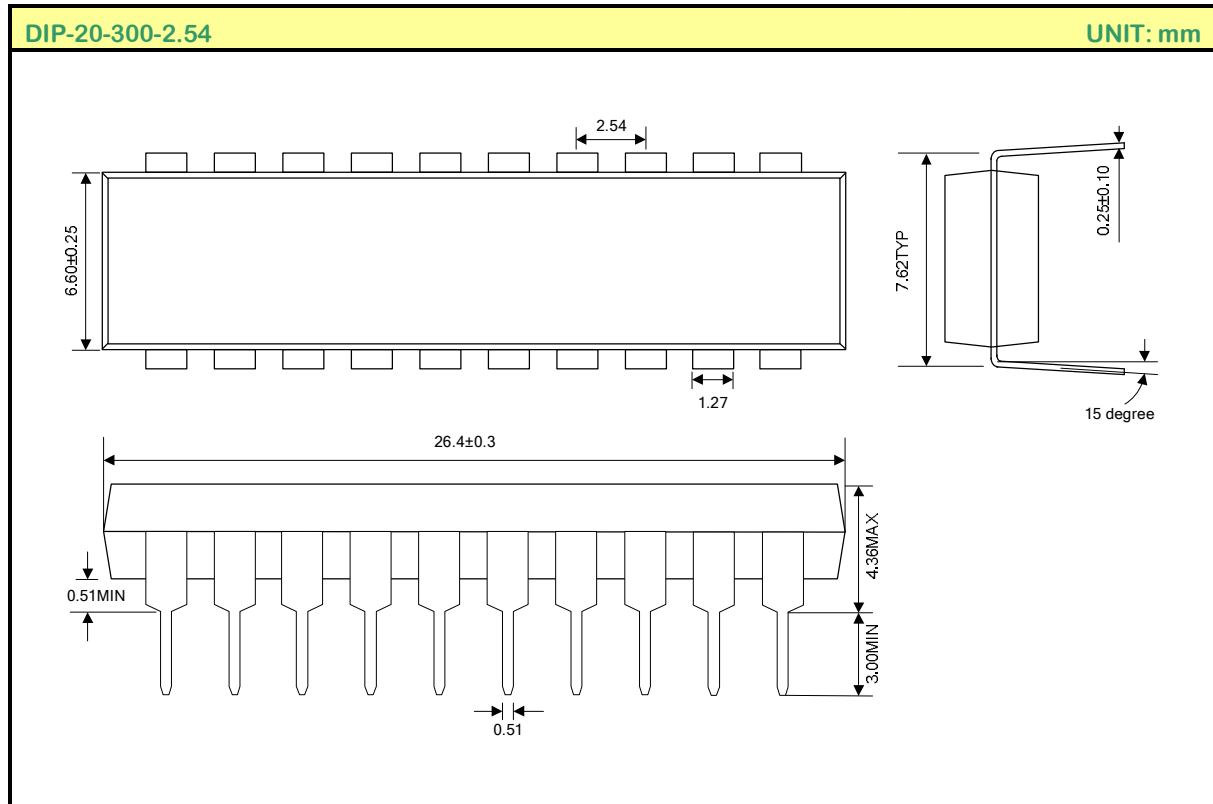


DIP-18-300-2.54

UNIT: mm



PACKAGE OUTLINE(continued)



**HANDLING MOS DEVICES:**

Electrostatic charges can exist in many things. All of our MOS devices are internally protected against electrostatic discharge but they can be damaged if the following precautions are not taken:

- Persons at a work bench should be earthed via a wrist strap.
- Equipment cases should be earthed.
- All tools used during assembly, including soldering tools and solder baths, must be earthed.
- MOS devices should be packed for dispatch in antistatic/conductive containers.