HMC

Data Book

1989

TELECOM ICs

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Data Book

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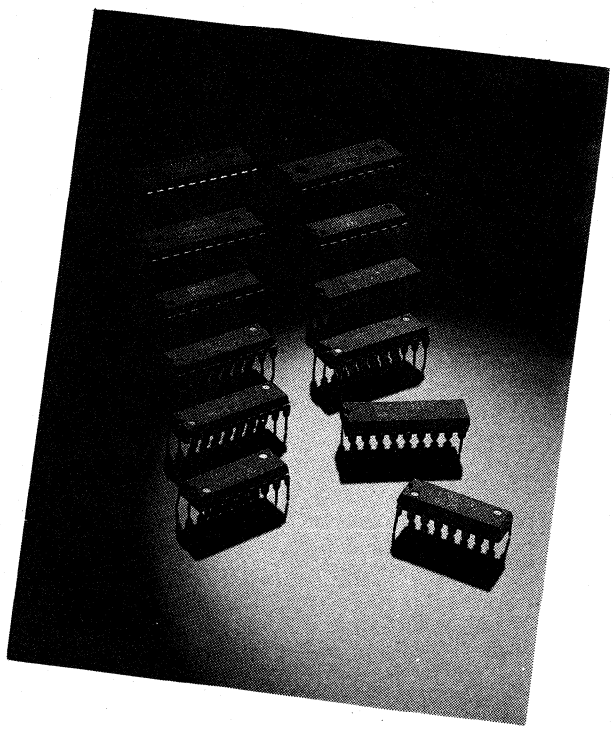


HUALON MICROELECTRONICS CORP.

TABLE OF CONTENTS

INDICES

★Under Development

FUNCTIONAL

★ Under Development

CROSS REFERENCE GUIDE

A. Dialer ICs:

HMC	ERSO	UMC	MOTOROLA	SHARP	SEIKOSHA	SEIKO	SANYO	TOSHIBA	ROHM	MOSTEK	PHILIPS	AMI	SGS	NS	MITEL	DESCRIPTION
HM9100 Series	CIC9102	UM9151		LR40981	S7221A/B	STC2560	LC7350	TC31003	BU8992	MK50981/2	PCD3320	S2560	M2560A	TP53190/3	MT4320	PULSE DIALER
	CIC9104/A	UM9151-3		LR40982		STC2565		TC31004		MK50991	PCD3322		M3326/27	TP50981/82	MT4325	
	*CIC9192 Series	*T40992		*LR40992				TC31005		*MK50992	PCD3326					
	*CIC9193	*T40993		*LR40993				TC31006		*MK50993	PCD3327					
HM9101 Series	*CIC9140 Series	UM91210	MC145409	LR4804	S7230/5		LC7360/3	TC31020/21	BU8302	MK53721	PCD3310					
HM9102 Series	CIC9140 Series	*UM91210	MC145409	LR4804	S7230/5		LC7362/3	TC31020/1	BU8302	MK53721	PCD3310					
HM9104	*CIC9146	UM91225		LR4807			LK3073/8									
HM9110 Series	CIC9142 Series	*UM91260 Series	MC145412/3	LR4801/2/3	S7240	STC2580				MK5375				TP5660		TONE/PULSE
HM9112/A	*CIC9142 Series	UM91260 Series	MC145412/3	LR4801/2/3	S7240	STC2580				MK5375				TP5660		DIALER
HM9113/A	*CIC9143 Series							TC31026/27								
HM9114/A	*CIC9145							TC31046/47								
HM9120/1 Series	CIC9148 Series	*UM91271		LR4806	*S7241				BU8320/1/2							
HM9187	CIC9187	UM9508/7/8/9		*LR4087			LC7365/6	TD31007	BU8101	*MK5087	PCD3311/12	*S2559E	M761	TP5087	*MT5087	TONE DIALER

B. Peripheral:

HMC	SSI	MITEL	SIERRA	RCA	MOTOLORA	SIGNETIC	TOSHIBA	ERSO	ELICAP		DESCRIPTION
HM9202	*SSI202	MT8870	*SC11202	*CD22202	MC145436						
HM9203	*SSI203	MT8870	*SC11203	*CD22203	MC145436						DTMF Receiver
HM9204	*SSI204	MT8870	*SC11204	*CD22204	MC145436						
HM9270	SSI202/3/4	*MT8870	*SC11202/3/4	*CD22202/3/4	MC145436						
HM9215								*CIC9215E	*ED-15		Programmable Manchester Code Encode/Decoder
HM9210								*CIC9210E			
HM9209								*CIC9209E	*ED-9		

Remark: "*" means directly replace

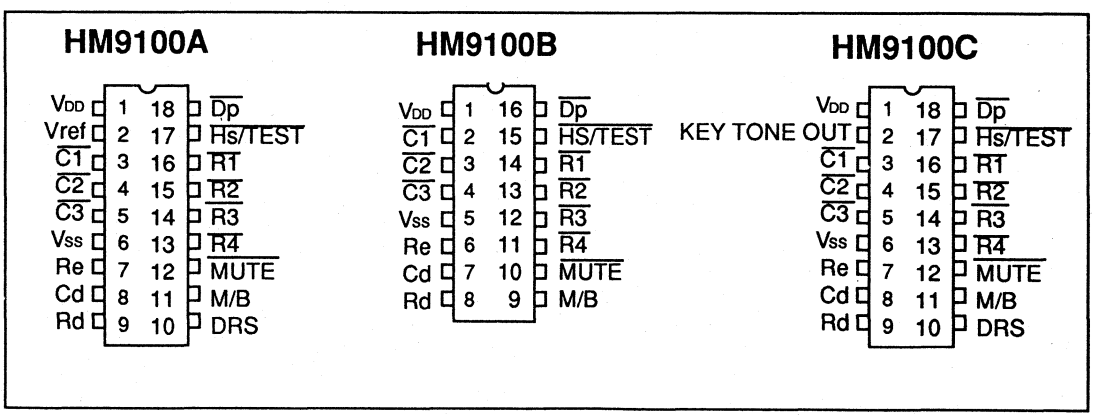
General Description

The HM 9100 pulse dialer is a CMOS monolithic integrated circuit and is designed to replace the traditional rotary telephone dialer. An RC oscillator is included in the HM 9100 as a frequency reference. When a key is depressed, the oscillator will generate a 4kHz frequence. "*" and "#" key are used as redial. The redial capacity is a 17-digit-FIFO memory. (First in First Out)

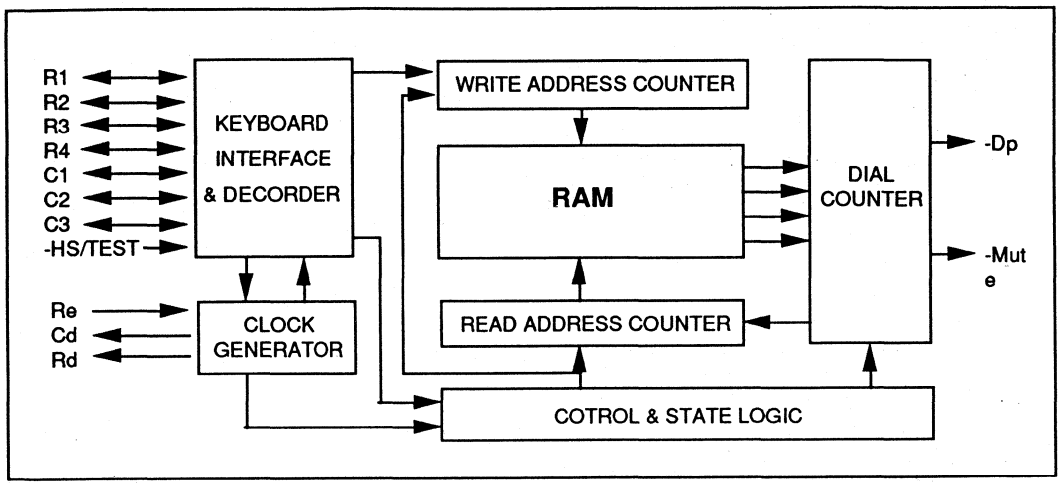
Features

* Key tone output: 1 kHz square wave (HM 9100C only)
* 2.0V to 5.5V supply voltage.
* Continuous mute.
* Redial with either a "*" or a "#" key depressed.
* On chip DP OUT and Mute OUT.
* 17 digits capacity for redialing.
* Uses either inexpensive single contact XY matrix keyboard or standard 2-of-7 keyboard with negative common.
* Inexpensive RC oscillator network.
* Low stand-by power consumption.
* Inter-Digit pause is 800ms/400ms depending on 10pps or 20pps. (HM 9100B: dial rate is 10pps)

Pin Assignment



Block Diagram



Pin Description

Pin No. 16 pin	Pin No. 18 pin	Designation	Function
1	1	V_{DD}	Positive power supply.
5	6	V_{ss}	Negative power supply.
	2	Vref	Vref output provides a reference voltage.
	2	Key Tone Out	The key tone out is a conventional CMOS inverter that is used to drive a piezo buzzer. When keypad is pressed, it outputs wave is a 1KHz square wave and ceases at the time of button released.
14	16	$\overline{R1}$	These are 3-column and 4-row inputs from the keyboard contacts. These inputs are open when the keyboard is not pressed. When a key is pushed an appropriate column and row input must go to Vss or connect with each other. Active pull up and pull down networks are presented when a key is pressed to start the oscillator. Debouncing is provided to avoid false entry.
13	15	$\overline{R2}$	
12	14	$\overline{R3}$	
11	13	$\overline{R4}$	
2	3	$\overline{C1}$	
3	4	$\overline{C2}$	
4	5	C3	
6	7	Re	These pins are provided to connect external resistors RD, RE and capacitor Cd to form an RC oscillator.
7	8	Cd	
8	9	Rd	
16	18	$\overline{Dp}$	Output drive is provided to turn on a transistor at the dial pulse rate. The normal output will be "Low" during "break" and "HZ" otherwise. (HZ: High impedence)
10	12	$\overline{MUTE}$	A pulse is available that can provide a drive to turn on an external transistor to mute the receiver during the dialer pulsing. (N-Channel open drain output structure)

Pin No. 16 pin	Pin No. 18 pin	Designation	Function
15	17	$\overline{HS}$/Test	This input detects the state of the switch contact; "off hook" corresponds to Vss condition.It has a built in pull up resistor. (Typical: 100 Kohm)
*	10	Dial Rate	A programable line allows selection of two different output rates(10pps/20pps when DRS pin connect to V_{SS}/V_{DD})
9	11	(M/B)	This input selection of the MAKE/BREAK ratio (34:66/40:60 when M/B pin connect to V_{DD}/V_{SS})

* 9100B: DIAL RATE IS 10PPS.

Absolute Maximum Ratings

Paramater	Rating
DC Supply Voltage	+6.0 Volts
Operaing Temperature	-20°C to +60°C
Storage Temperature	-55°C to +125°C

Static Electrical Characteristics (T_A=+25°C , V_{ss}=0V)

Parameter	Symbol	V_{DD}	Vin	Vout	Min.	Typ.	Max.	Units
Supply Voltage	V_{DD}				2.0		5.5	V
Input Current ($\overline{lis}$)	Ihs	2.0	0			20		µA
Key Contact Resistance	Rki	5.0					1	Kohm
Keyboard Capacitance	Rci	5.0					30	PF
MUTE Sink Current	Imos	2.0		0.5		3		mA
$\overline{DP}$ Out Sink Current	Is	2.0		0.5		1.5		mA
Key Input Level (R1-R4, C1-C3)	Kil				V_{SS}		$0.2V_{DD}$	V
2-of-7 Input Mode	KiH				$0.8V_{DD}$		V_{DD}	V
Keyboard Pull-Up Resistance	Kiru	2.0				170		K
Keyboard Pull-Down Resistance	Kird	2.0				6		K
Memory Retention Current	Imr	1.0				0.1	0.2	µA
$\overline{MUTE}$ off Leakage	Imlkg	5.5		5.5		0.01		µA
$\overline{DP}$ off Leakage	Ilkg	5.5		15		8		µA
Vref Output Source Current	Iref	5.0			1	7	10	mA

Dynamic Electrical Characteristics (T_A=+25°C , V_{SS}=0V)

Characteristics	Symbol	Test Conditions	Min.	Typ.	Max.	Units
Operating Current	Idd	V_{DD} =5.5V Vref= V_{SS}		5.8	10	mA
		Vref=OPEN		200	500	µA
Oscillator Frequency	fo	Re=2Mohm Rd=220K ohm Cd=390pF V_{DD}=3.0V-3.5V	3.74	4	4.26	KHz
Frequency Stability	Δf/f	V_{DD} =2.5-3.5 Re=2M Rd=220+/-5% Cd=390pF		±2.5	±4	%
Key Input Debounce Time	tDB	fosc=4KHz		10		mS
Oscillator Start-Up Time	tOS	V_{DD} =2.5V		1		mS
DP Dial Rate	Ldr	PIN 10 is tied to V_{SS}, fosc=4KHz		10		PPS
Inter-Digital Pause	tIDP	PIN 10 is tied to V_{SS}, fosc=4KHz				

Functional Description

Clock Oscillator

The clock oscillator consists of a NOR gate and two inverters. The frequency of oscillation is controlled by external components (two resistors and a capacitor). The oscillator is only enabled during key closures and during the dialing state. It is disabled at all other times including the "ON HOOK" condition. For a dialing rate of 10 PPS the oscillator frequency should be adjusted to 4KHz. It is recommended that values of external components for this are Re=2 Mohm, Rd=220K±5% and Cd=390pF±5%.

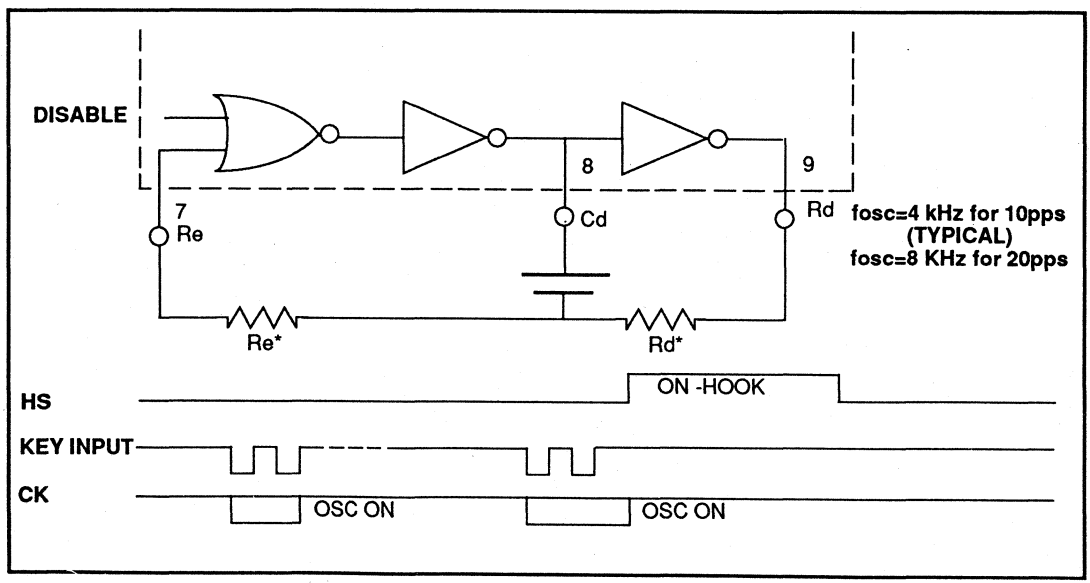


Figure 1.

Keyboard Interface

These are 3-column and 4-row inputs from the keyboard contacts. These inputs are open when the keyboard is inactive. When a key is pushed, an appropriate column and row input must go to V_{ss} or connect with each other. Active pull up and pull down networks are presented on these inputs when the device begins keyboard scaning. The keyboard scaning begins when a key is pressed and the oscillator starts. The user can enter one number up to 17 digits long from a single contact X Y matrix keypad or a standard 2-of-7 keyboard with the column connected to Vss. Debouncing circuitry is provided (TYPICAL 10ms) to prevent false entry. Any key depressions during the ON-HOOK condition are ignored and the oscillator is inhibited. This insures that the stand by current in the on-hook condition is very low and enough to retain the memory.

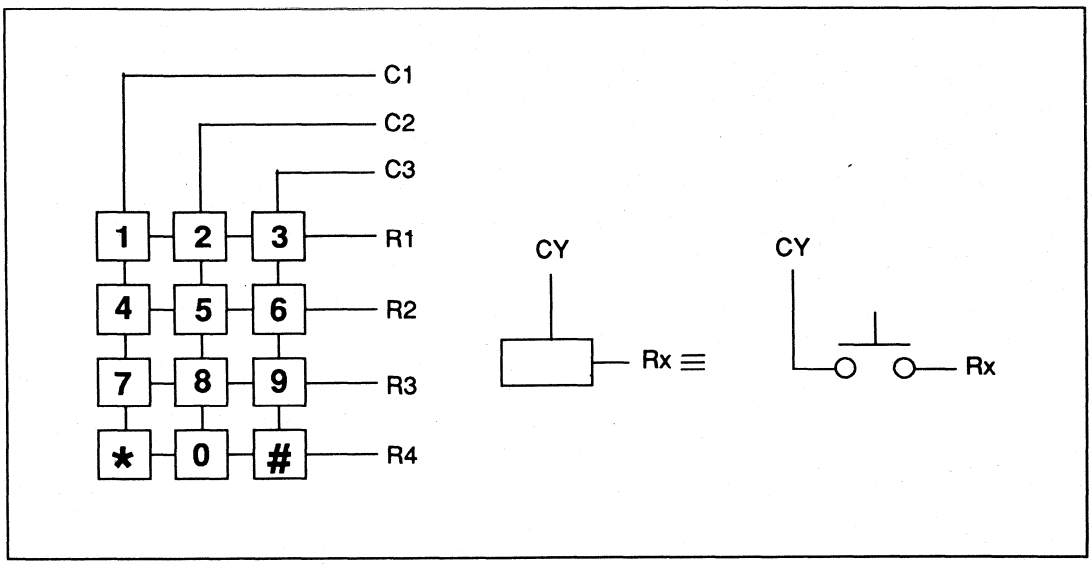


Figure 2. Single Contact X Y Matrix Keypads

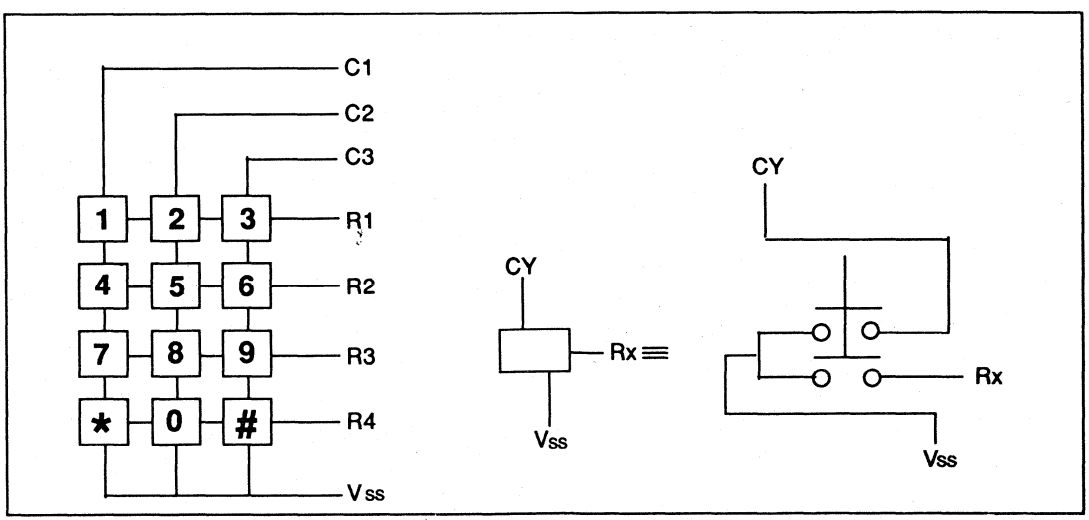


Figure 3. Standard 2-of-7 Keyboard with Negative Common

<V_{DD} Power Supply>
This is the positive supply. The supply voltage range is between 2.0 and 5.5 volts.

<V_{DD} Reference>
The Vref output provides a negative reference voltage relative to the V+ supply. Its magnitude is a function of the internal parameters which define the minimum operating voltage of each part. The Vref pin is simply tied to Vss (Pin 6). The internal circuit with its associated I-V characteristic is shown in Figure 4.

<$\overline{\text{Hook}}$ Switch Control and TEST>
External circuity connected to HANDSET/TEST PIN is used to indicate whether the telephone handset is ON-HOOK or OFF HOOK, these two states being represented by Logic Hi or floating and Logic Low respectively. In the off-hook mode, this pin normally held at logic Low. A change from off-hook mode to on-hook mode while the device is outpulsing causes the remaining digits to be outpulsed at 100 X the normal rate (M/B ration is then 50/50). When coming off-hook, pushing either a "*" or "#" key the memory number stored can be redialed.

<Redial>
The keyboard inputs are retained in the memory and therefore can be redialed out by going off-hook and pushing either "#" or "*" key.

Examples 1.

	KEY INPUTS	DP OUT PULSE	MEMORY	
OFF-HOOK	654321	654321	654321	GOING ON-HOOK
COME OFF-HOOK	#	654321	654321	GOING ON-HOOK
COME OFF-HOOK	*	654321	654321	

<$\overline{\text{DP}}$ and $\overline{\text{MUTE}}$ Output>
The loop disconnect dial pulses appear at DP OUTPUT ($\overline{\text{DP}}$) pin. The output stage consists of an open-drain N-channel transistor. During a dial pulse break period the output device is switched on and during the make period and IDP the device is switched off. The -Mute output is used to control the muting of the telephone network during dialling. The output is an open-drain N-channel transistor designed to drive an external bipolar transistor.

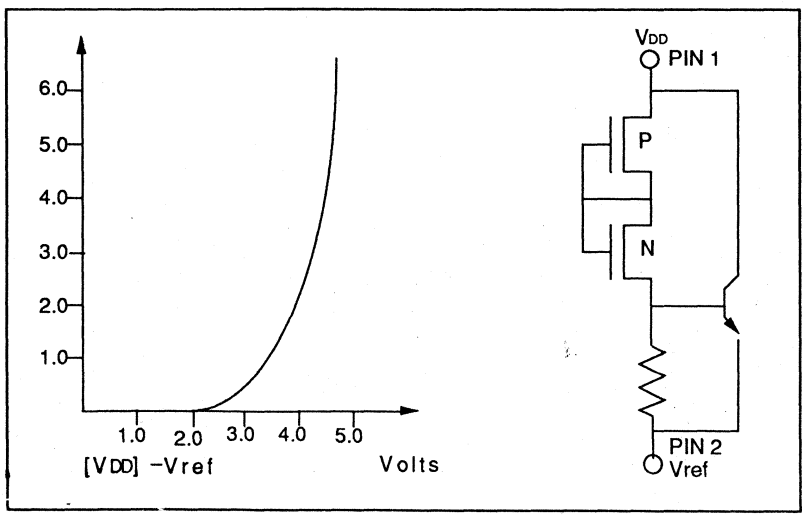


Fig. 4. Vref TYPICAL I-V CHARACTERISTICS

<Make/Break>
The Make/Break (M/B) pin controls the Make/Break ratio of the pulse output. The Make/Break ratio is controlled by connecting V_{DD} or V_{SS} to this pin as shown in the Fig 5.

	LINE OUTPUT	
INPUT M/B PIN	BREAK	MAKE
V_{DD}	66 %	34 %
V_{SS}	60 %	40 %

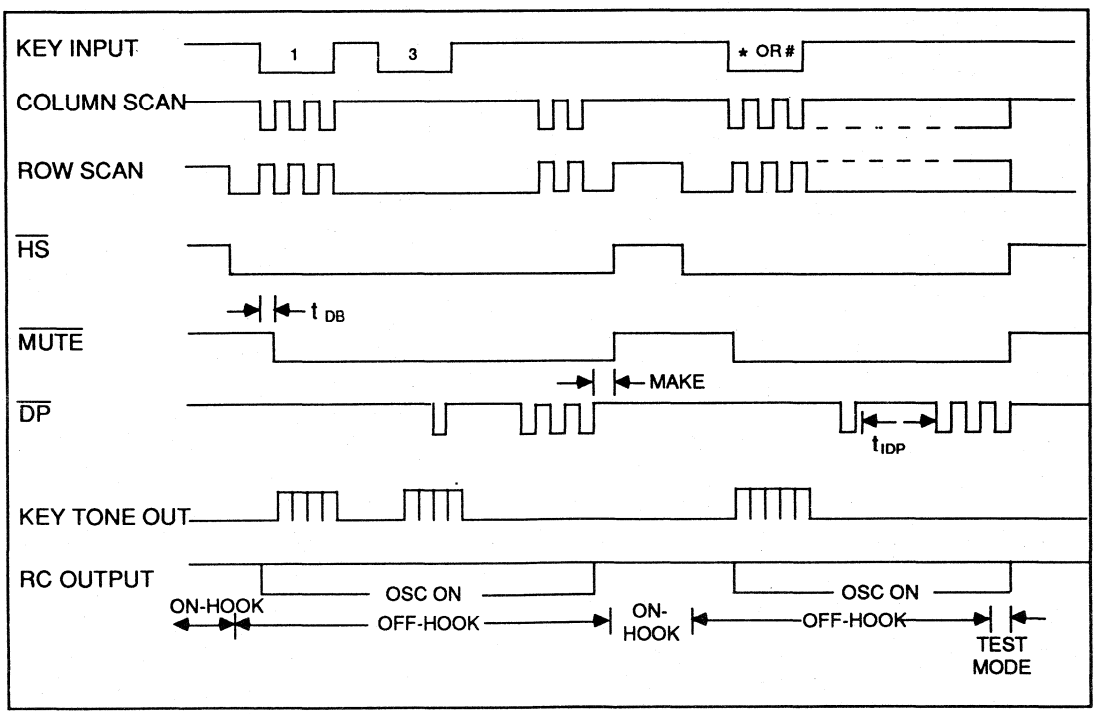
Figure 5. MAKE/BREAK Ratio Selection

<Dialing Rates>
The dialing rate is derived from the oscillator frequency. Fig.6 shows the relationship of the dialing rate and IDP with the OSC. Different dialing rates can be selected by connecting the pin. The V_{DD} or V_{SS} will select a pulse of either 20pps or 10pps respectively.

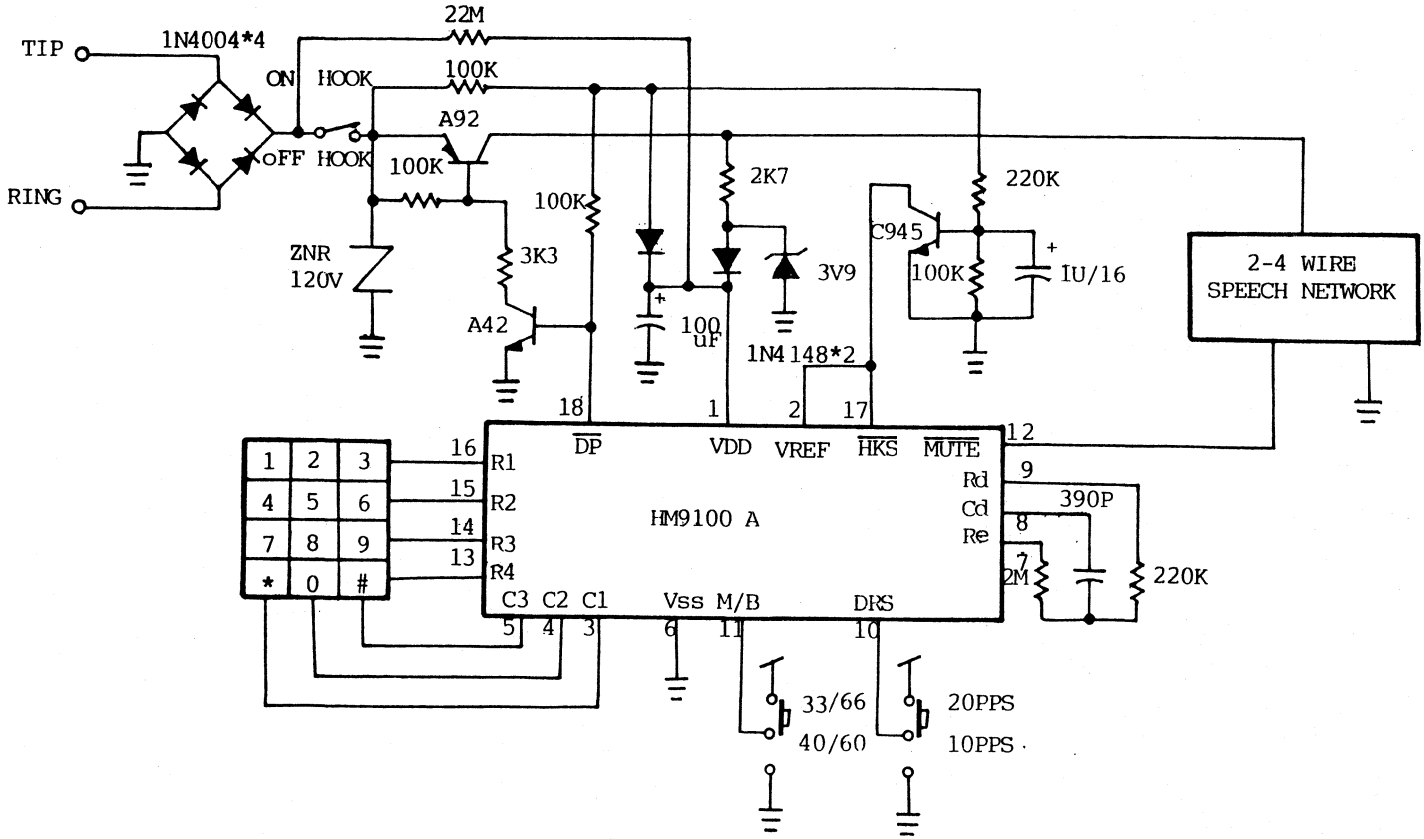
	LINE OUTPUT		NOTES
INPUT TO THE DR AND IDP PINS	DR(PPS)	IDP (ms)	
V_{DD}	20 PPS	400 ms	FOSC=4KHz
V_{SS}	10 PPS	800 ms	

Figure 6. Dialing Rate Selection

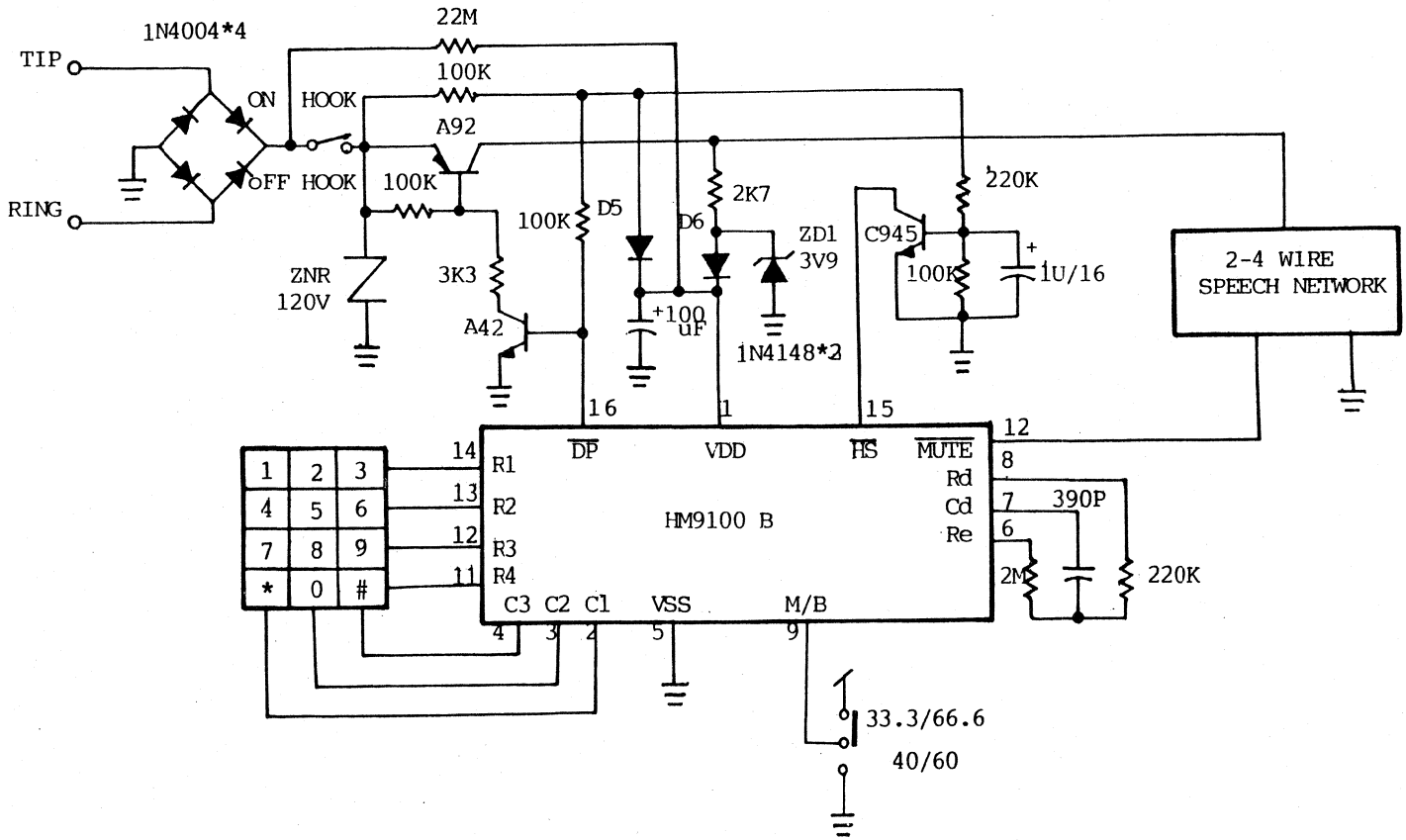
Timing Diagram



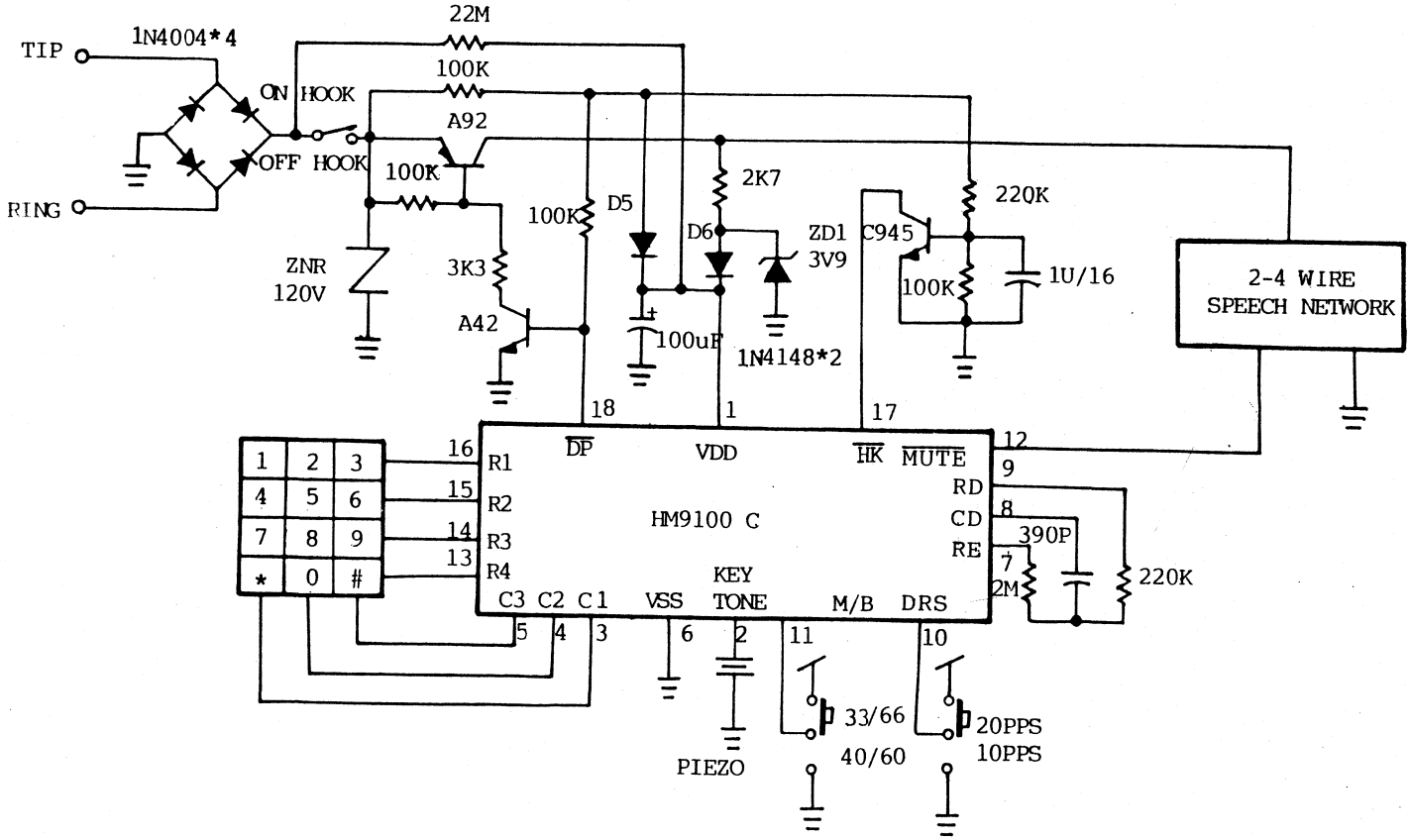
HM 9100A Application Example



HM 9100B Application Example



HM 9100C Application Example



General Description

The HM 9101 is a TONE/PULSE switchable dialer with one redial memory. It is specifically designed for low cost, high stability TONE/PULSE switchable telephone applications. Pause and P→T keys are provided for PBX and LDC operation. The chip works in a wide operating voltage range (2.0-5.5V for both TONE and PULSE mode), and consumes very low memory retention current (≤0.2μA at V_{DD} = 1.0V, HKS=1).

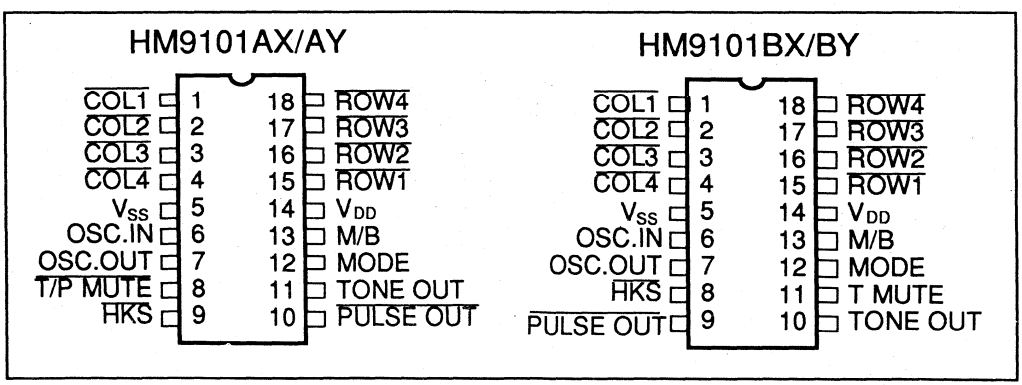
Features

* TONE/PULSE switchable.
* One 31-digit memory for the last number redial.
* Auto pause access for PBX operation; 3.6 sec per pause. But 2 sec, 3.2 sec pause time can be obtained by metal option.
* Pulse to tone key (P→T) for toll service operation. Automatically inserts a pause time per P→T.
* Electronic keypad input is available; low action.
* Use inexpensive 3.579545MHz crystal.
* Low operation voltage; 2.0V for both tone and pulse mode.
* Low memory retention current; ≤0.2μA at V_{DD} =1.0V, HKS=1.
* Flash Key is available in PBX, flash time is 600ms & 100ms by M/B controller.
* In pulse mode *, # can be used as pause & redial function.
* Both key-in and key-released debounce are 20ms.
* Minimum tone duration=100ms and minimum intertone pause=106ms for rapid key-in.
* M/B PIN SELECT TO 3 TYPES :

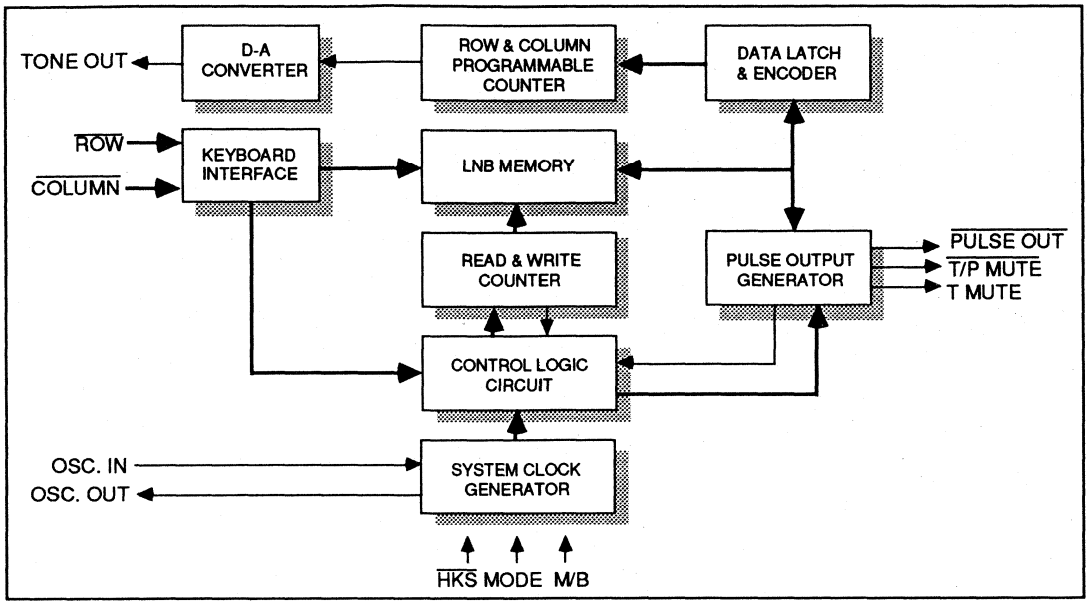
M/B	Pulse rate	Flash	M/B rate
Open	20PPS	600ms	33:66
V_{DD}	10PPS	600ms	40:60
V_{SS}	10PPS	100ms	33:66
↓	TEST MODE		

* MODE PIN SELECT TO 3 MODES:
* OPEN : PULSE MODE
* V_{DD} : PULSE mode
* V_{SS} : TONE mode

Pin Assignment



Block Diagram



Keyboard Scheme

Row Group \ Col. Group		C1 1216Hz	C2 1332Hz	C3 1472Hz	C4
R1	699Hz	1	2	3	P→T
R2	766Hz	4	5	6	F
R3	848Hz	7	8	9	P
R4	948Hz	*	0	#	R

(Frequency Unit : Hz)

P→T:Pulse to Tone Key
F : Flash
P : Pause
R : Redial
* : Pause(in pulse mode)
# : Redial(in pulse mode)

Pin Functional Description

Symbol	Pin No. AX AY	Pin No. BX BY	Name And Function
$\overline{\text{ROW-COLUMN}}$	1 2 3 4	18 17 16 15	The keypad input is compatible with the standard 2 of 8 keyboard the single contact (Form A) keyboard, and electronic input. In normal operation, any single button is pushed to produce dual tone, pulse or function. Activation of two or more buttons will result in no response, except for single tone,Table 1 illustrates address keypad function in detail.

Symbol	Pin No. AX AY	Pin No. BX BY	Name And Function
OSC.IN OSC.OUT	6 7	6 7	A built-in inverter provides oscillation with a 3.579545MHz crystal, which is disabled when no keypad input has been sensed. An on-board counter is used to decrease the frequency of oscillation and creates keypad debounce, mute delay, pre-digit pause, Make-Break ratio, tone duration, row group and column group frequency, and key tone frequency etc. Any crystal frequency deviation from 3.579545 MHz will be reflected in the time parameters above.Most crystals do not vary more than ±200PPM.
$\overline{\text{T/P MUTE}}$	8		The mute is a conventional MOS inverter. In pulse mode, it is at high level with no keypad entry; but goes low state when keypad is pushed during Tone/Pulse dial period.
$\overline{\text{HKS}}$	9	8	The hand hook switch input is used to detect the state of the handset in ON-HOOK or OFF-HOOK. In ON-HOOK state, $\overline{\text{HKS}}$=1, the key-board input is disabled in order to decrease the consumption of power. In OFF-HOOK state, $\overline{\text{HKS}}$=0, all of the function can be oper-ated.
$\overline{\text{PULSE OUT}}$	10	9	The $\overline{\text{PULSE OUT}}$ pin is an open-drain NMOS transistor output. In OFF-HOOK state, this NMOS transistor stays in ON-state only in break duration, but stays in OFF-state in make or normal duration, in order to send the pulses train of the address codes in pulse mode. The timing diagram of pulse mode is shown in fig. 3.
TONE OUT	11	10	In pulse mode, the tone output stays low state regardless of key-pads input. In DTMF mode, this pin outputs dual or single tone using the method illustrated in Table 1. In manual dialing, the tone duration equals the period of the button pushed minus the keypad debounce time. In auto dialing, the tone duration and inter-tone-pause is internally set to be 100 ms and 106 ms respectively. Figure 4 shows DTMF mode timing diagram.
T MUTE		11	The T MUTE is a conventional CMOS inverter. In spite of pulse or tone mode, it is always at low level with no keypad entry, but goes to high level when keyboard is pushed in Tone dialing only. Figure 3 and 4 show the waveform in detail.
MODE	12	12	There are two methods of switching the IC to pulse or tone dialer. Put MODE Selection pin to "OPEN" or V_{DD}, the dialer is in pulse mode. Put MODE to "V_{SS}", the dialer is in tone mode.
M/B	13	13	If M/B pin is tied to "OPEN", the pulse rate is 20pps, the flash time is 600 ms, and the M/B rate is 33:66. When M/B pin is tied to "V_{SS}", the pulse rate is 10 pps, the flash time is 100ms, and the M/B rate is 33:66. If M/B pin is tied to "V_{DD}", the pulse rate is 10pps, the flash time is 600 ms, and the M/B rate is 40:60. If M/B pin is provided a negative edge pulse.The IC is under test. ★To avoid from malfunction due to entering into test mode, a capacitor about 1000PF shall be connected between M/B and V_{SS}.

Absolute Maximum Ratings

(T_A = 25 °C)

Characteristics	Sym.	Ratings	Unit
DC Supply Voltage	V_{DD}	6.0	V
Input Voltage Range	V_{in}	-0.5 to V_{DD} + 0.5	V
Power Dissipation Per Package	P_o	500 (for T_A =-25°C to + 60°C)	mw
Operating Temperature	T_A	-25 to + 85	°C
Storage Temperate	T_{STG}	-65 to +150	°C

DC Characteristics

(V+ = 2.5V, T_A = 25°C , UNLESS OTHERWISE SPECIFIED)

Characteristics	Sym.	Test Ckt.	Test Conditions	Limit Min.	Typ.	Max.	Unit
Operating Voltage	V_{DD}		Tone	2.0	-	5.5	V
			Pulse	2.0	-	5.5	
			Memory	1.0	-	5.5	
Operation Current Tone	Iop	A	Unloaded and Keypad Entry	-	0.6	2	mA
Pulse				-	0.2	0.6	
Standby Current	Is	A	$\overline{HKS}$=0, Unloaded and No Keypad Entry	-	0.1	5	µA
Memory Retention Current	Im	B	$\overline{HKS}$=1, V_{DD}=1V	-	0.1	0.2	µA
Tone Output Voltage	Vto	C	Row Group, Rl=10kohm	-	150	-	mVrms
Pre-Emphasis		D	Column/Row V_{DD}=2.0-5.5V	1	2	3	dB
DTMF Distortion	THD	D	RL=10Kohm V_{DD}=2.0-5.5V	-	-30	-23	dB
Tone Output Load Impedance	R1		THD ≤-23dB	10	-	-	k
Tone Output DC Level	Vtdc	D	V_{DD}=2.0-5.5V,Keypad Entry	0.5V_{DD}	-	0.6V_{DD}	V
Tone Output Sink Current	Ito	E	Vto=0.5V,No Keypad Entry	0.2	-	-	mA
$\overline{Pulse\ Output}$			Vpi=5V	-	-	0.1	µA
Leakage Current	Iph	E	Vpi=12V	-	-	1.0	
Sink Current	Ipl	F	Vpo=0.5V	1.0	3.0	-	mA
$\overline{T/P\ Mute}$ Output							
Drive Current	Imh	E	Vmo = 2.0V	-0.5	-	-	mA
Sink Current	Iml		Vmo = 0.5V	1.0	-	-	
TONE MUTE							
Drive Current	Ixmh	E	Vmo = 2.0V	-0.5	-	-	mA
Sink Current	Ixml			0.5	-	-	

Characteristics	Sym.	Test Ckt.	Test Conditions	Limit Min.	Typ.	Max.	Unit
Keypad Input							
Drive Current	Ikh	H	Vki = 0V	4	10	30	µA
Sink Current	Ikl	E,G	Vki = 2.5V	200	400	-	
Control Pin Input Leakage Current	Iin		HKS, MODE, Pins	-	±10 **(-5)	±0.1	µA

Note 1: Dual Tone Multi-Frequency Distortion is measured in terms of total out-of-band power related to the sum of the row & column fundamental power.

AC Characteristics

Characteristics	Sym.	Test Conditions		Limit Min.	Typ.	Max.	Unit
Keypad Debounce	t_{DB}	mode = "Open" or "V_{DD}"		-	20	-	ms
Pulse Mute Delay	t_{MD}	mode = "V_{DD}"	M/B="V_{DD}"	-	40	-	ms
		or "Open"	M/B="V_{SS}" or "Open	-	33.3	-	
Pre-Digit Pause	t_{PDP}	mode = "V_{DD}"	M/B="V_{DD}"	-	40	-	ms
		or "Open"	M/B="V_{SS}" or "Open	-	33.3	-	
Pulse Rate	f_{PR}	M/B = "V_{DD}" or "V_{SS}"		-	10	-	pps
		M/B = "Open"		-	20	-	
Break/Make Ratio	M:B	M/B = "V_{DD}"		-	40:60	-	%
		M/B = "Open" or "V_{SS}"		-	33:66	-	
Inter Digit Pause	t_{IDP}	mode ="V_{DD}	10 PPS	-	800	-	ms
		or "Open"	20 PPS	-	600	-	
Tone Duration	t_{TD}	Redial		-	100	-	ms
Inter Tone Pause	t_{ITP}	Redial		-	106	-	ms
Row Group Frequency	f1	Use 3.579545 MHz Crystal	ROW1	-	699	-	Hz
	f2		ROW2	-	766	-	
	f3		ROW3	-	848	-	
	f4		ROW4	-	948	-	
Column Group Frequency	f5	Use 3.579545 MHz Crystal	COL1	-	1216	-	Hz
	f6		COL2	-	1332	-	
	f7		COL3	-	1472	-	

Note: Crystal parameters defined as Rs≤ 100 , Lm = 96mH, Cm = 0.25 pF
Ch = 5PF, F = 3.579545 MHz & Cl = 18 PF, F ≤ 200ppm

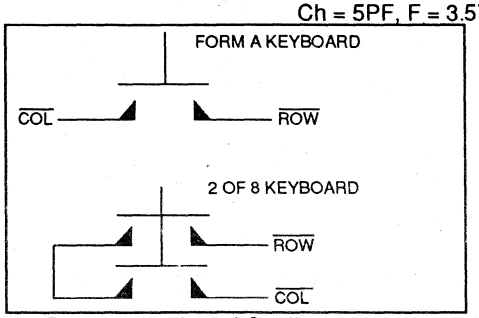


Figure 1. Keyboard Configuration

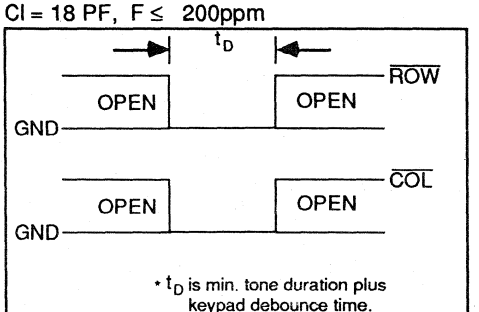


Figure 2. Electronic Input

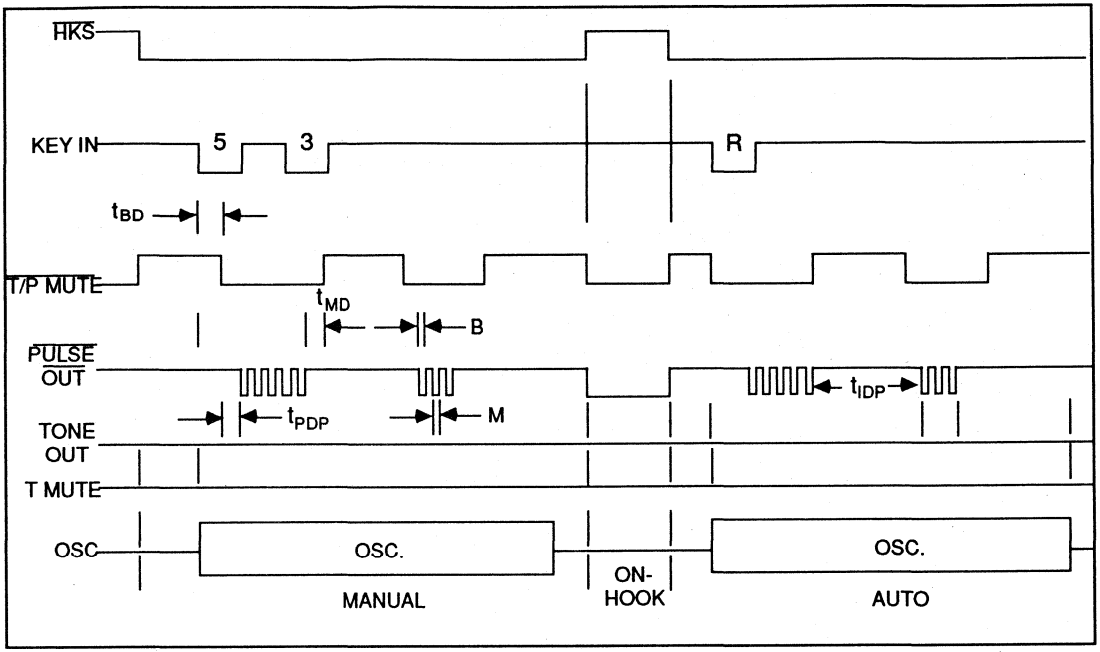


Figure 3. Pulse Mode Timing Diagram

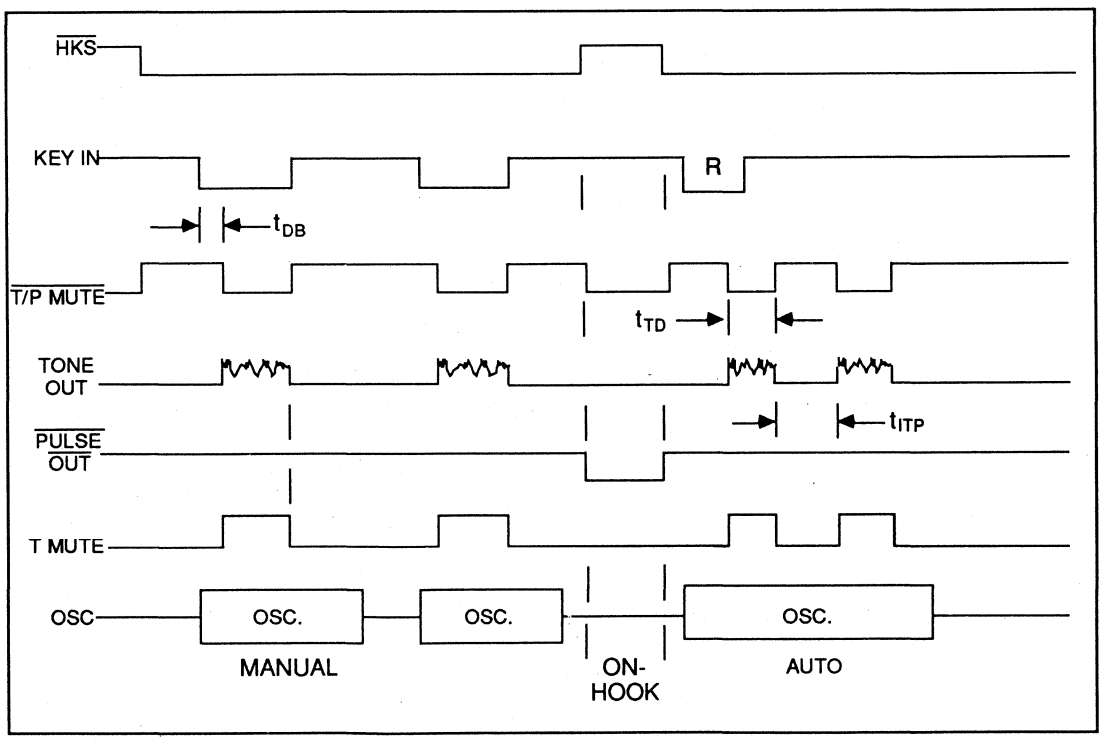


Figure 4. DTMF Mode Timing Diagram

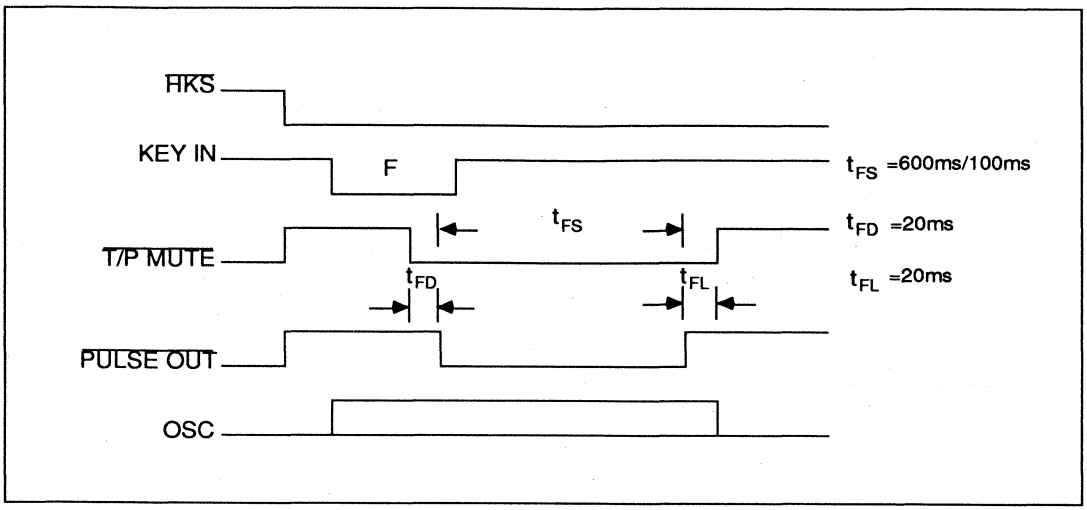


Figure 5. Flash Timing Diagram

M/B	Mode	Active Low Inputs ROW Pins	Active Low Inputs COLUMN Pins	Output Tone Out; PO
	V_{ss} (Normal) (Test mode)	One Two or More One Two or More	One One Two or More Two or More	Dual Tone V_{ss}
↓	V_{ss} (Normal) (Test mode)	One Two or More One Two or More	One One Two or More Two or More	Dual Tone Column Tone Row Tone V_{ss}
V_{DD} OPEN V_{ss}	V_{DD} OPEN (Normal) (pulse mode)	One Two or More One Two or More	One One Two or More Two or More	10 PPS, 20 PPS Open
↓	OPEN V_{DD} (Test mode)	One Two or More One Two or More	One One Two or More Two or More	600 PPS Open

Table 1 Address Keypads Truth Table (Continual)

Keyboard Operations

Note: All the keyboard operations should be under off-hook condition.

*** Normal Dialing**

1. Select Pulse or Tone mode
2. Push [D1] ,..., [Dn] ; D1...Dn : 0-9,*,#;n is unlimited.
   Then the number D1 - Dn will be dialed out in Pulse or Tone mode as selected.
   (Excluding of *, # in pulse mode)

*** Redialing**

Select Pulse or Tone mode
Push [D1] ,..., [Dn] ; n≤31; If busy, after ON-HOOK, Come OFF-HOOK, push [R] , the last number

*** Mix-Dialing**

[REDIAL] + [MANU] is allowable. ; MANU: [D1],..,[Dn] ; Dn : 0-9.

*** Pause And Pulse To Tone Key Operation**

In some cases, such as PABX or LDC service, a pause should be inserted in the dialing sequence and different dialing modes. The chip provides user with pause function and Pulse/Tone switchable, which facilitates flexible applications.

(a) Dialing with Pause
Select Pulse or Tone mode
Push [D1], [P], [D2], ... , [Dn] ; D1 - Dn : 0 - 9, * , #
Then the number will be dialed out in the following sequence:
D1, pause 3.6 sec. D2, ... , Dn.

(b) Redialing with Pause
When redialing, the chip outputs the same sequences as above, but all the timings are fixed internally.

(c) Dialing with [P→T] key
Select the Pulse or Tone mode
Push [D1], [D2], ... , [Dn], [P→T], [D1'] , [D2'] , ... , [Dn'] Then the number will be dialed out in the following sequence:

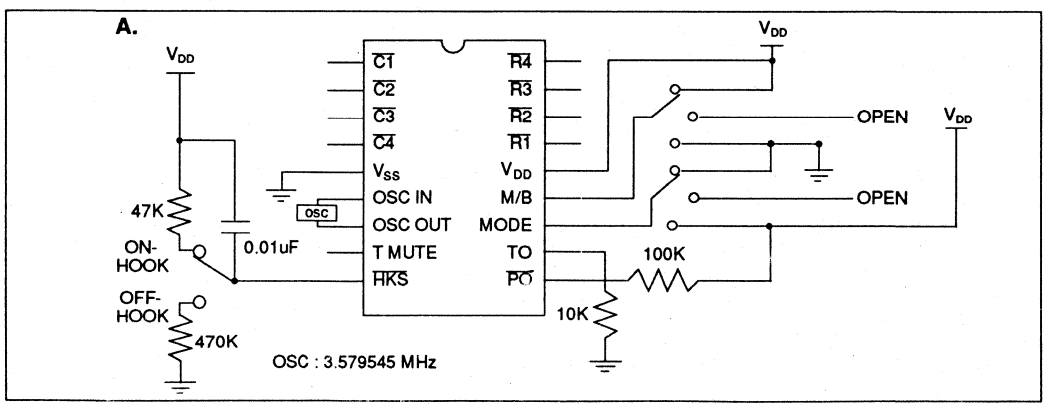
1. If the mode switch is set in pulse mode, then the output signal will be:
   D1, D2, ... , Dn, pause 3.6 sec. D1', D2', ... , Dn'.
   (Pulse mode) (Tone mode)
2. If the mode switch is set in Tone mode, then the output signal will be:
   D1, D2, ... , Dn, pause 3.6 sec. D1', D2', ... , Dn'.
   (Tone mode) (Tone mode)

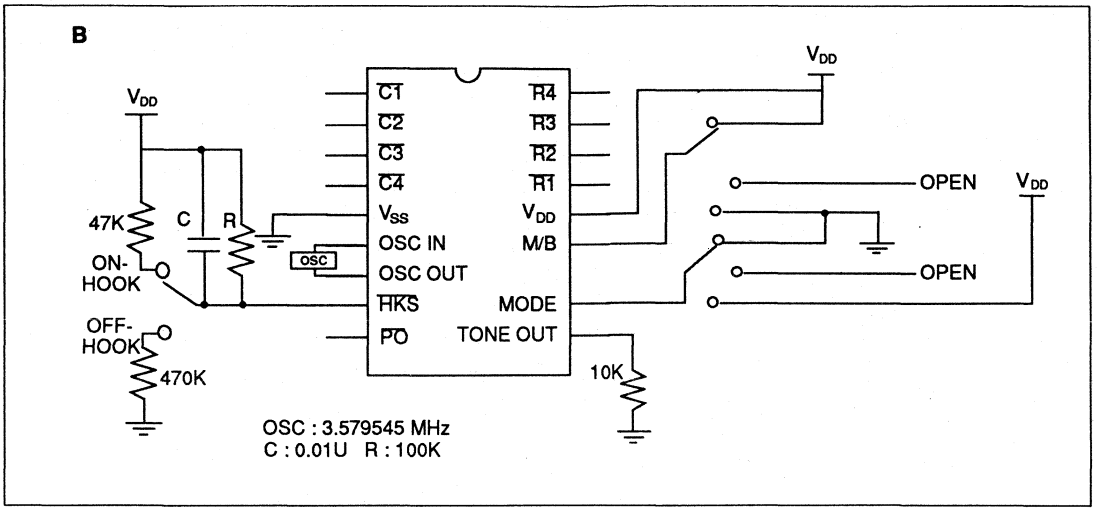
(d) Redialing with [P→T] Key
When redialing, the chip outputs the same sequences as above, but all the timing are fixed internally.

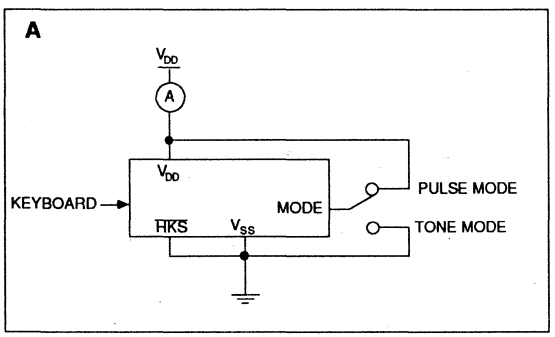
(e) Flash operation
This chip provides a convenient and precise flash function for PABX service. In the following operation; push F, then 600ms flash is supplied, and central unit will do service to caller, such as: transfer, wait - - - -. If after [P→T], F keypad be pushed then the state turn to pulse mode.
Figure 5. Show flash timing diagram.

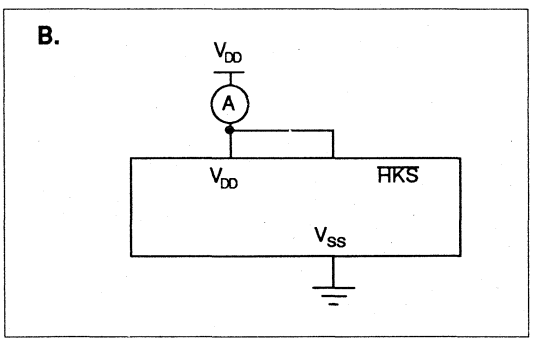
Note: **1.** The pause can be continuously stored for longer pause duration, but every pause will occupy one digit of memory size.
2. The [P→T] Key also can be stored for longer pause but always change he state from pulse to tone mode. It can be reset to pulse mode either in the operation of ON-HOOK or flash.

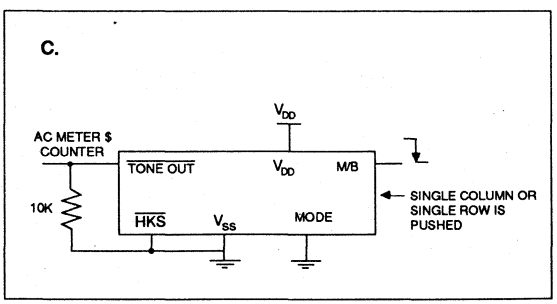
General Test Circuit

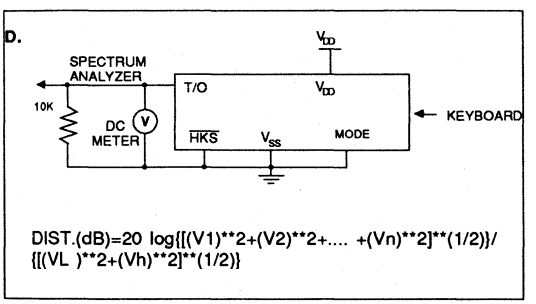






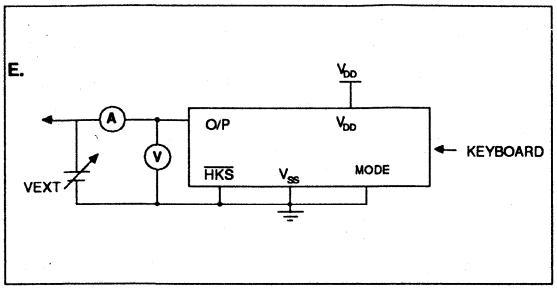




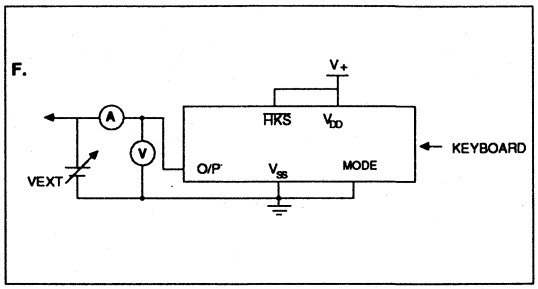


a. V1,..., Vn are extraneous frequencies (ie intermodulation and harmonic) components in the 500 Hz to 3400 Hz band.
b. VL , Vh are the individual frequency components of the DTMF signal.
c. Whether keyboard is pushed refer to the DTMF mode timing diagram.

E.

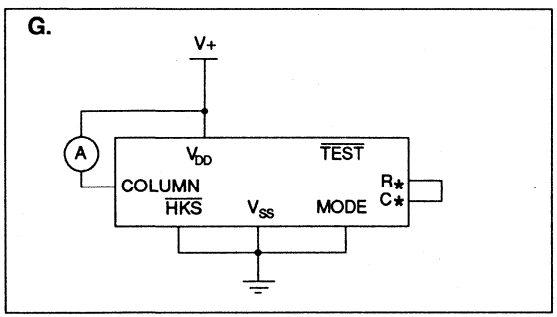


F.



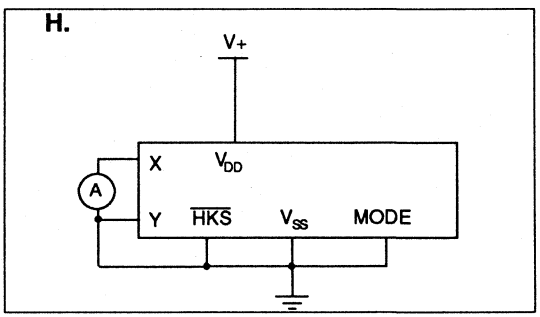
Note:Whether keyboard is pushed refer to the DTMF mode timing diagram.

G.



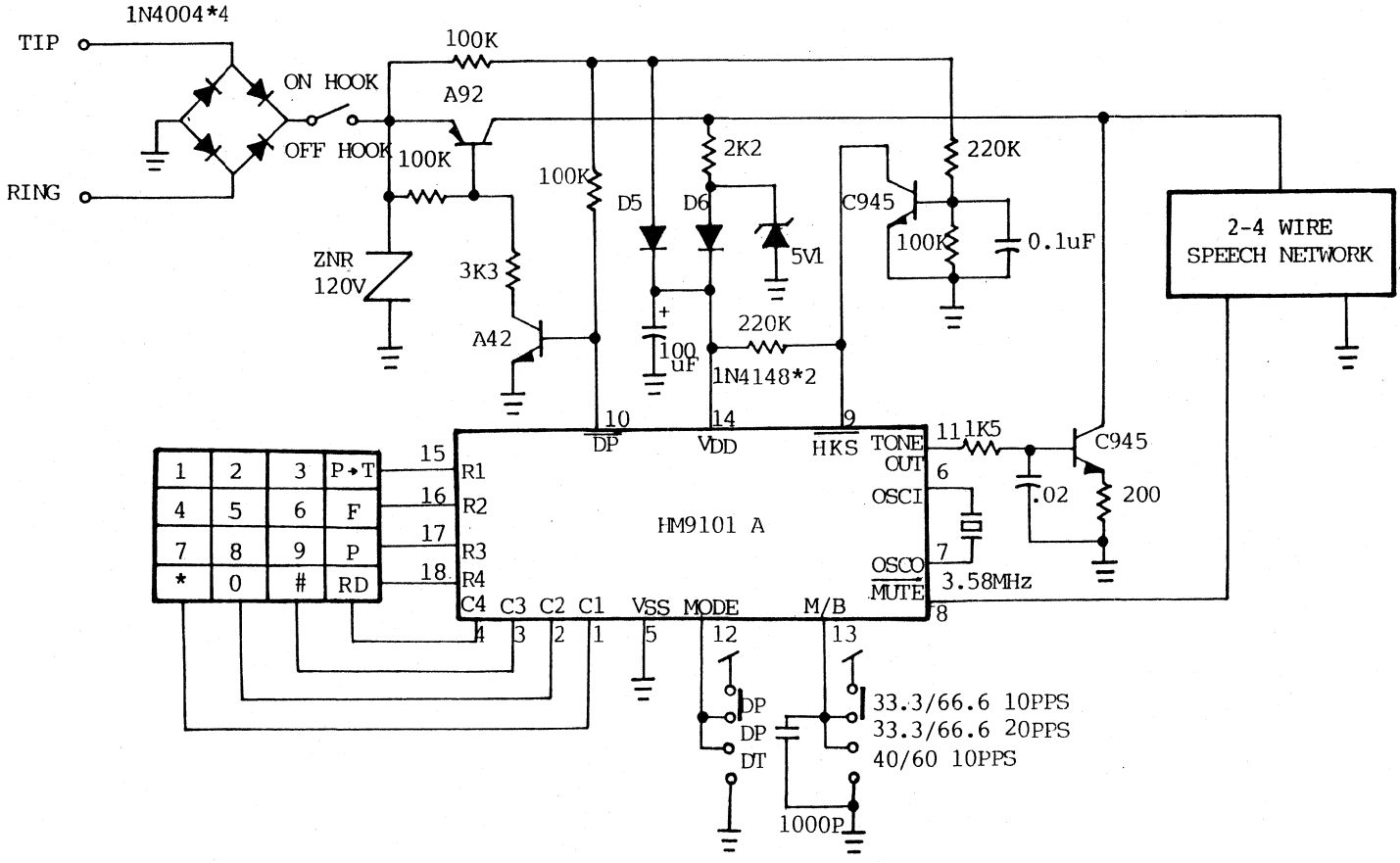
Note: R* any row of R1→R4.
C* any column of C1→C4.
Isink = I/(1 - Duty Cycle).
I is the net DC current measured from ampere meter.

H.



Note: When column drive current is tested, the X is column and Y is row. When row drive current is tested, they exchange. IDrive = I/Duty Cycle; I is the net DC current measured from ampere meter.

HM 9101A Application Example



General Description

The HM 9102/A are TONE/PULSE switchable dialers with one redial memory. They are specifically designed for low cost, high stability TONE/PULSE switchable telephone application. Pause and P→T keys are provided for PBX and LDC operation. The chip works in a wide operating voltage range (2.0-5.5V for both TONE and PULSE mode), and consumes very low memory retention current (≤0.2μ at V_{DD}=1.0V, $\overline{HKS}$=1).

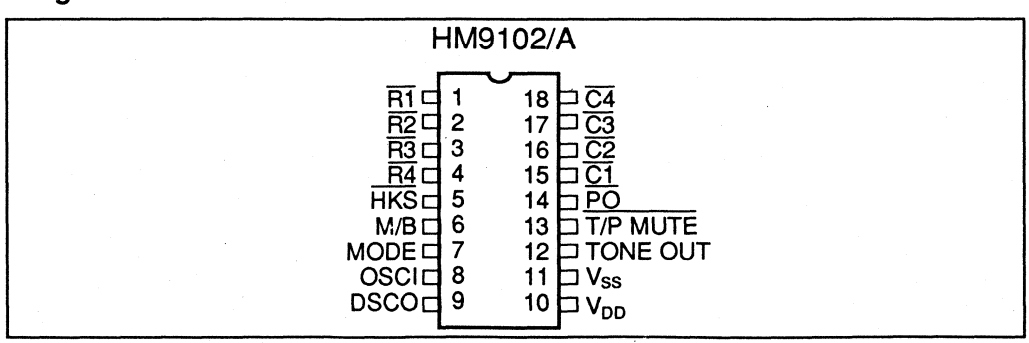
Features

* HM 9102 is fabricated with 2μm technology.
* HM 9102A is fabricated with 3.5μm technology.
* Tone/Pulse switchable.
* One 32-digit memory for the last number redial.(HM 9102 only)
* For HM 9102A, the redial capacitor is 31 digits.
* Auto pause access for PBX operation; 3.6sec. per pause. (2sec., 3.2sec. pause time can be obtained by metal option)
* Pulse to tone key (P→T) for toll service operation, automatically inserts a pause time per P→T.
* Electronic keypad input is available; low action.
* Use inexpensive 3.579545MHz crystal.
* Low operation voltage; 2.0V for both tone and pulse mode.
* Low memory retention current;≤0.2μ A at V_{DD}=1.0V, $\overline{HKS}$=1.
* Flash Key is available in PBX; Flash time is 600ms & 100ms by M/B controller.
* In pulse mode *, # can be used as pause & redial function.
* Both key-in and key-released debounce are 20ms.
* Minimum tone duration=100ms and minimum intertone pause=106ms for rapid key-in.
* M/B PIN SELECT TO 3 TYPES :

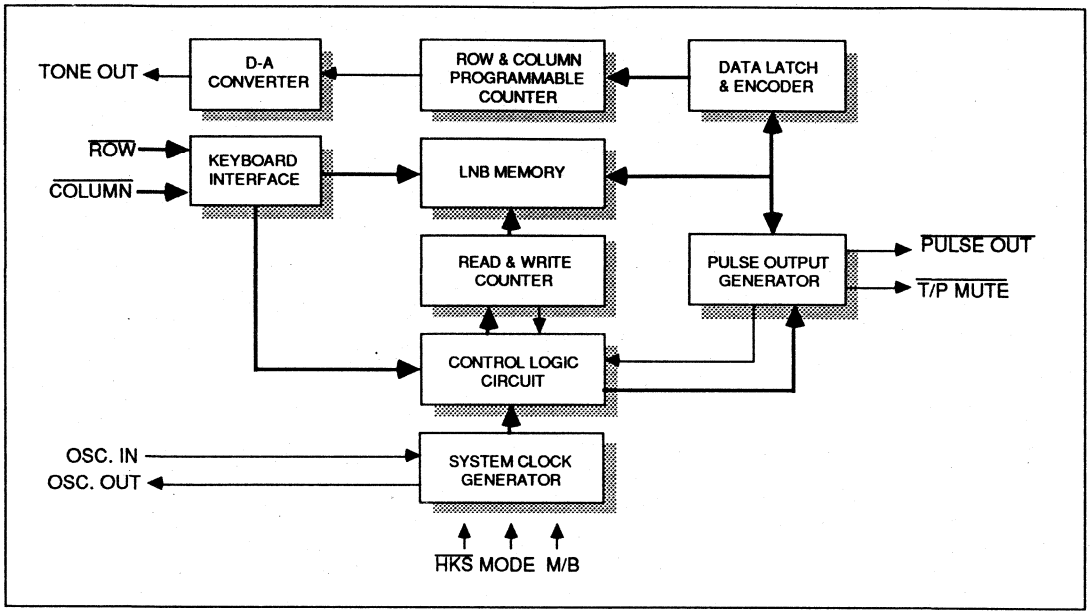
M/B	Pulse rate	Flash	M/B rate
OPEN	20 PPS	600 ms	33 : 66
V_{SS}	10 PPS	600 ms	40 : 60
V_{DD}	10 PPS	100 ms	33 : 66
	TEST MODE		

* MODE PIN SELECT TO 3 MODE:
* OPEN : PULSE mode
* V_{DD}: PULSE mode
* V_{SS} : TONE mode

Pin Assignment



Block Diagram



Keyboard Scheme

Col. Group / Row Group	C1 1216Hz	C2 1332Hz	C3 1472Hz	C4
R1 699Hz	1	2	3	P→T
R2 766Hz	4	5	6	F
R3 848Hz	7	8	9	P
R4 948Hz	*	0	#	R

P→T: Pulse to Tone
P : Pause
* : Pause(in pulse mode)
Key F : Flash
R : Redial
: Redial(in pulse mode)

Pin Functional Description

Symbol	Pin No.	Name And Function
ROW-COLUMN	1 18 2 17 3 16 4 15	The keypad input is compatible with the standard 2 of 8 keyboard the single contact (Form A) keyboard, and electronic input. In normal operation, any single button is pushed to produce dual tone, pulse or function. Activation of two or more buttons will result in no response, except for single tone,Table 1 illustrates address keypad function in detail.

Symbol	Pin No.	Name And Function
$\overline{HKS}$	5	The $\overline{HKS}$ hand hook switch input is used to detect the state of handset in ON-HOOK or OFF-HOOK. In ON-HOOK state, $\overline{HKS}$=1, the keyboard input is disabled in order to decrease the consumption of power. In OFF-HOOK state, $\overline{HKS}$=0, all of the function can be operated. On chip pull up resistor is built. (Typical 100K OHM)
M/B	6	If M/B pin is tied to "OPEN", the pulse rate is 20pps, the flash time is 600 ms, and the M/B rate is 33:66. When M/B pin is tied to "V_{DD}", the pulse rate is 10 pps, the flash time is 100ms, and the M/B rate is 33:66. If M/B pin is tied to "V_{SS}", the pulse rate is 10pps, the flash time is 600 ms, and the M/B rate is 40:60. If M/B pin is provided a negative edge pulse.The IC is under test. ☆To avoid from malfunction due to enter into test mode, a capacitor about 1000PF shall be connected between M/B and V_{SS}.
MODE	7	There are two methods of switching the IC to pulse or tone dialer. Put MODE Selection pin to "OPEN" or V_{DD}, the dialer is in pulse mode. Put MODE to "V_{SS}", the dialer is in tone mode.
OSC.IN OSC.OUT	8 9	A built-in inverter provides oscillation with a 3.579545 MHz crystal, which is disabled when no keypad input has been sensed. An on-board counter is used to decrease the frequency of oscillation and creates keypad debounce, mute delay, pre-digit pause,Make-Break ratio, tone duration, row group and column group frequency, and key tone frequency etc. Any crystal frequency deviation from 3.579545 MHz will be reflected in the time parameters above.Most crystals do not vary more than ±200PPM
TONE OUT	12	In pulse mode,the tone output stays low state regardless of keypad input. In DTMF mode, this pin outputs dual or single tone under the condition illustrated in Table 1. In manual dialing, the tone duration is equal to the period of button pushed minus the keypad debounce time. In auto dialing, the tone duration and inter-tone-pause is internally set to be 100 ms and 106 ms respectively. Figure 4 shows DTMF mode timing diagram.
$\overline{T/P\ MUTE}$	13	The mute is N-Channel open drain output. In pulse mode, it is at high impedence with no keypad entry;but goes low state when keypad is pushed during Tone/Pulse dial period.
$\overline{PULSE\ OUT}$	14	The PULSE OUT pin is an open-drain NMOS transistor output. In OFF-HOOK state, this NMOS transistor stays in ON-state only in break duration, but stays in OFF-state in make or normal duration, in order to send the pulses train of the address codes in pulse mode. The timing diagram of pulse mode is shown in fig. 3.

Absolute Maximum Ratings

(Ta = 25 ℃)

Characteristics	Sym.	Ratings	Unit
DC Supply Voltage	V_{DD}	6.0	V
Input Voltage Range	V_{in}	-0.5 to V_{DD} + 0.5	V
Power Dissipation Per Package	P_o	500 (for T_A =-25°C to + 60°C)	mw
Operating Temperature	T_A	-25 to + 85	°C
Storage Temperate	T_{STG}	-65 to +150	°C

DC Characteristics

($V+ = 2.5V$, $T_A = 25°c$, Unless otherwise specified)

Characteristics	Sym.	Test Ckt.	Test Conditions	Limit Min.	Typ.	Max.	Unit
Operating Voltage	V_{DD}		Tone	2.0	-	5.5	V
			Pulse	2.0	-	5.5	
			Memory	1.0	-	5.5	
Operation Current Tone	Iop	A	Unloaded and Keypad Entry	-	0.6	2	mA
Pulse				-	0.2	0.6	
Standby Current	Is	A	$\overline{HKS}$=0, Unloaded and No Keypad Entry	-	0.1	5	µA
Memory Retention Current	Im	B	$\overline{HKS}$=1, V_{DD}=1V	-	0.1	0.2	µA
Tone Output Voltage	Vto	C	Row Group, Rl=10kohm, HKS	-	150	-	mVrms
Pre-Emphasis		D	Column/Row V_{DD}=2.0-5.5V	1	2	3	dB
DTMF Distortion	THD	D	RL=10Kohm V_{DD}=2.0-5.5V	-	-30	-23	dB
Tone Output Load Impedance	R1		THD ≤-23dB	10	-	-	k
Tone Output DC Level	Vtdc	D	V_{DD}=2.0-5.5V,Keypad Entry	-	0.65V_{DD}	-	V
Tone Output Sink Current	Ito	E	Vto=0.5V,No Keypad Entry	0.2	-	-	mA
$\overline{Pulse}$ Output			Vpi=5V	-	-	0.1	µA
Leakage Current	Iph	E	Vpi=12V	-	-	1.0	
Sink Current	Ipl	F	Vpo=0.5V	1.0	3.0	-	mA
$\overline{T/P}$ Mute Output							
Drive Current	Imh	E	Input = 12.0V	-	-	1	mA
Sink Current	Iml		Vmo = 0.5V	1.0	-	-	
Keypad Input							
Drive Current	Ikh	H	Vki = 0V	4	10	30	µA
Sink Current	Ikl	E,G	Vki = 2.5V	200	400	-	
Control Pin Input Leakage Current	Iin		$\overline{HKS}$, MODE, Pins	-	±10 **(-5)	±0.1	µA

Note 1: Dual Tone Multi-Frequency Distortion is measured in terms of total out-of-band power related to the sum of the row & column fundamental power.

AC Characteristics

Characteristics	Sym.	Test Conditions		Limit Min.	Typ.	Max.	Unit
Keypad Debounce	t_{DB}	mode = "Open" or " V_{DD} "		-	20	-	ms
Pulse Mute Delay	t_{MD}	mode = "V_{DD}" or "Open"	M/B="V_{DD}"	-	40	-	ms
			M/B="V_{SS}" or "Open	-	33.3	-	
Pre-Digit Pause	t_{PDP}	mode = "V_{DD}" or "Open"	M/B="V_{DD}"	-	40	-	ms
			M/B="V_{SS}" or "Open	-	33.3	-	
Pulse Rate	f_{PR}	M/B = "V_{DD}" or "V_{SS}"		-	10	-	pps
		M/B = "Open"		-	20	-	
Make/Break Ratio	M:B	M/B = " V_{ss}"		-	40:60	-	%
		M/B = "Open" or "V_{DD}"		-	33:66	-	
Inter Digit Pause	t_{IDP}	10 PPS		-	800	-	ms
		20 PPS		-	600	-	
Tone Duration	t_{TD}	Redial		-	100	-	ms
Inter Tone Pause	t_{ITP}	Redial		-	106	-	ms
Row Group Frequency	f1	Use 3.579545 MHz Crystal	ROW1	-	699	-	Hz
	f2		ROW2	-	766	-	
	f3		ROW3	-	848	-	
	f4		ROW4	-	948	-	
Column Group Frequency	f5	Use 3.579545 MHz Crystal	COL1	-	1216	-	Hz
	f6		COL2	-	1332	-	
	f7		COL3	-	1472	-	

Note: Crystal parameters defined as Rs≤100 , Lm = 96mH, Cm = 0.25 pF
Ch = 5PF, F = 3.579545 MHz & Cl = 18 PF, F ≤200ppm

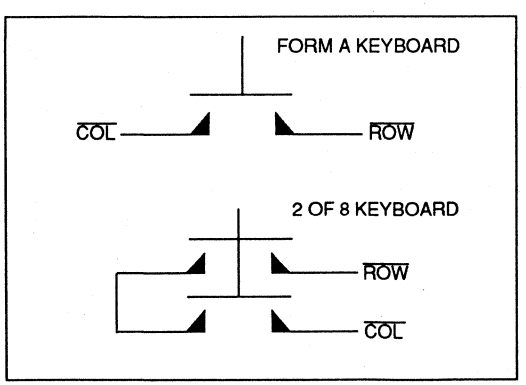


Figure 1. Keyboard Configuration

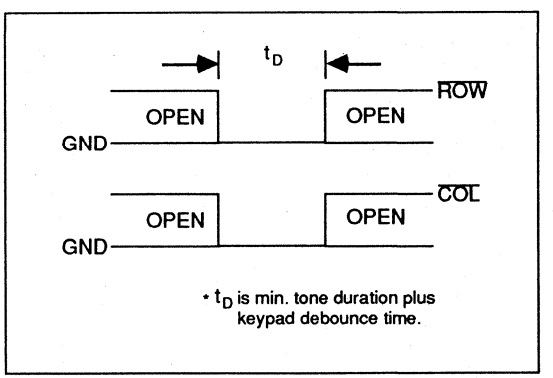


Figure 2. Electronic Input

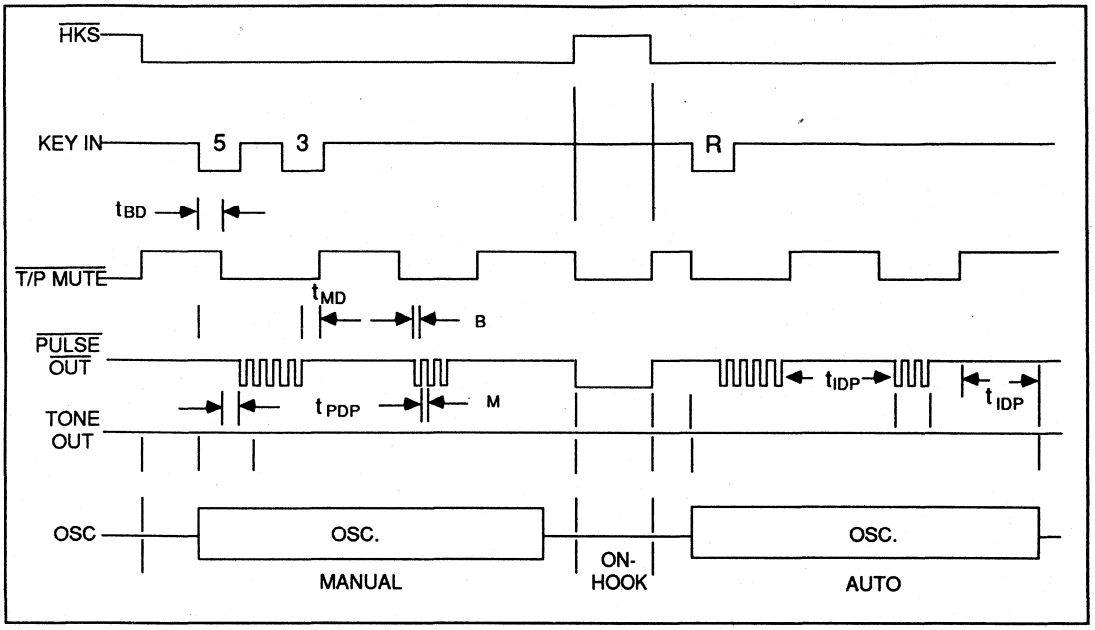


Figure 3. Pulse Mode Timing Diagram

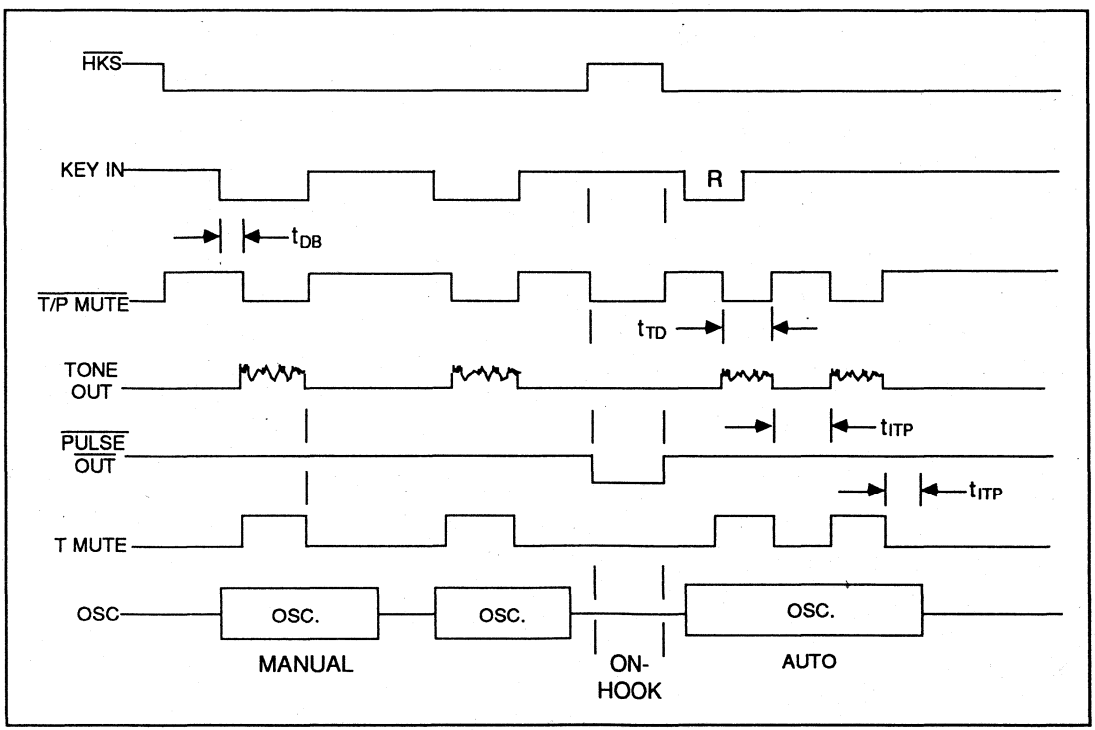


Figure 4. DTMF Mode Timing Diagram

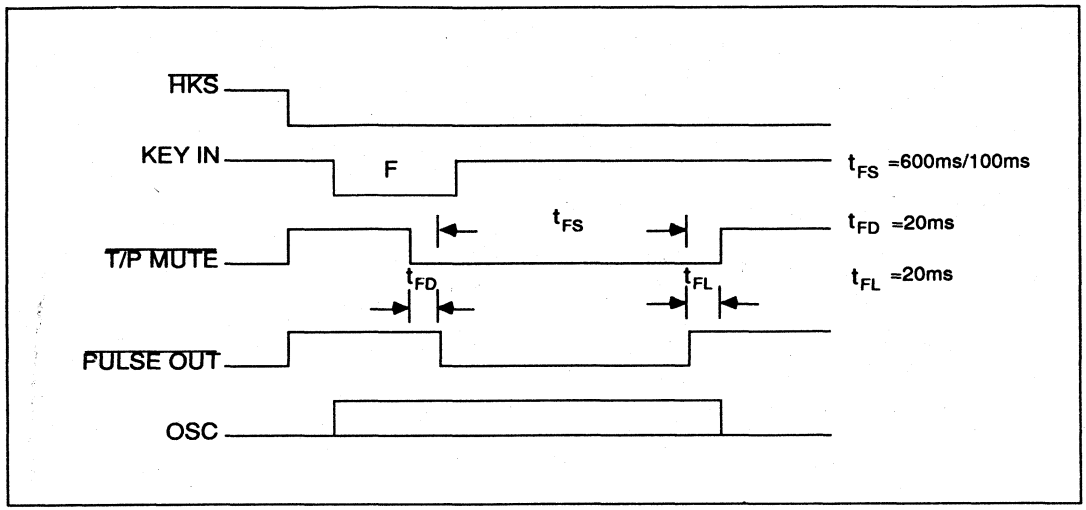


Figure 5. Flash Timing Diagram

M/B	Mode	Active Low Inputs ROW Pins	Active Low Inputs COLUMN Pins	Output Tone Out; PO
	V_{ss} (Normal) (Test mode)	One Two or More One Two or More	One One Two or More Two or More	Dual Tone V_{ss}
↓	V_{ss} (Normal) (Test mode)	One Two or More One Two or More	One One Two or More Two or More	Dual Tone Column Tone Row Tone V_{ss}
V_{DD} OPEN V_{ss}	V_{DD} OPEN (Normal) (pulse mode)	One Two or More One Two or More	One One Two or More Two or More	10 PPS, 20 PPS Open
↓	OPEN V_{DD} (Test mode)	One Two or More One Two or More	One One Two or More Two or More	600 PPS Open

Table 1 Address Keypads Truth Table (Continual)

Keyboard Operations

Note: All the keyboard operations should be under off-hook condition.

*** Normal Dialing**

1. Select Pulse or Tone mode
2. Push [D1] ,...,[Dn] ; D1...Dn : 0-9,*,#;n is unlimited.
   Then the number D1 - Dn will be dialed out in Pulse or Tone mode as selected.
   (Excluding of *, # in pulse mode)

*** Redialing**

Select Pulse or Tone mode
Push [D1] ,..., [Dn] ;n≤32 For HM 9102, n≤31 For HM 9102A; If busy, after ON-HOOK, Come OFF-HOOK, push [R] , the last number D1, D2, ... , Dn will be automatically dialed out in Pulse or Tone mode as selected again.

*** Mix-Dialing**

[REDIAL] + [MANU] is allowable. ; MANU: [D1] ,.., [Dn] ; Dn : 0-9.

*** Pause And Pulse To Tone Key Operation**

In some cases, such as PABX or LDC service, a pause should be inserted in the dialing sequence and different dialing modes. The chip provides user with pause function and Pulse/Tone switchable, which facilitates flexible applications.

(a) Dialing with Pause
Select Pulse or Tone mode
Push [D1] , [P] , [D2] , ... , [Dn] ; D1 - Dn : 0 - 9, * , #
Then the number will be dialed out in the following sequence:
D1, pause 3.6 sec. D2, ... , Dn.

(b) Redialing with Pause
When redialing, the chip outputs the same sequences as above, but all the timings are fixed internally.

(c) Dialing with [P→T] key
Select the Pulse or Tone mode
Push [D1] , [D2] , ... , [Dn] , [P→T] , [D1'] , [D2'] , ... , [Dn'] Then the number will be dialed out in the following sequence:

1. If the mode switch is set in pulse mode, then the output signal will be:
   D1, D2, ... , Dn, pause 3.6 sec. D1', D2', ... , Dn'.
   (Pulse mode) (Tone mode)
2. If the mode switch is set in Tone mode, then the output signal will be:
   D1, D2, ... , Dn, pause 3.6 sec. D1', D2', ... , Dn'.
   (Tone mode) (Tone mode)

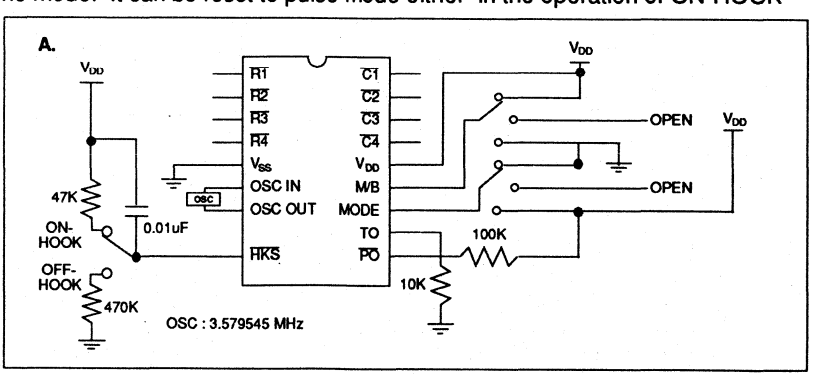
(d) Redialing with [P→T] Key
When redialing, the chip outputs the same sequences as above, but all the timing are fixed internally.

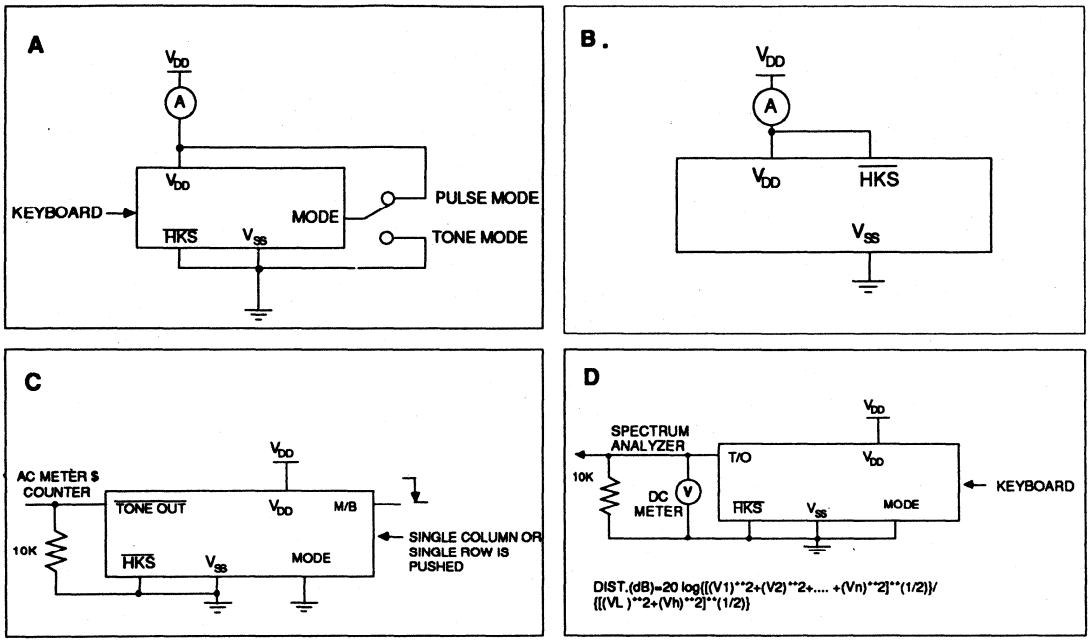
(e) Flash operation
This chip provides a convenient and precise flash function for PABX service. In the following operation; push F, then 600ms flash is supplied, and central unit will do service to caller, such as: transfer, wait - - - -. If after [P→T], F keypad be pushed then the state turn to pulse mode.
Figure 5. Show flash timing diagram.

Note: **1.** The pause can be continuously stored for longer pause duration, but every pause will occupy one digit of memory size.

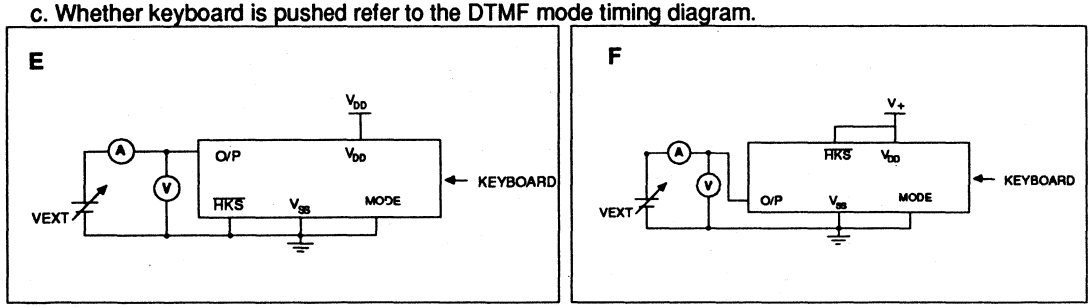
2. The [P→T] Key also can be stored for longer pause but always change he state from pulse to tone mode. It can be reset to pulse mode either in the operation of ON-HOOK or flash.

General Test Circuit

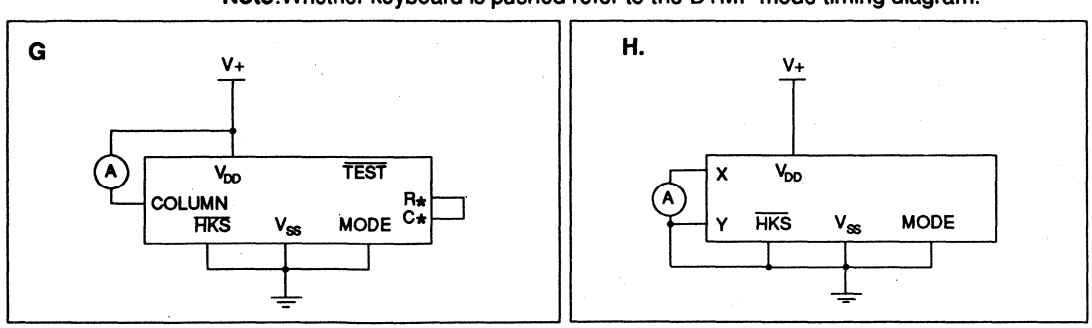




a. V1,..., Vn are extraneous frequencies (ie intermodulation and harmonic) components in the 500 Hz to 3400 Hz band.
b. VL , Vh are the individual frequency components of the DTMF signal.
c. Whether keyboard is pushed refer to the DTMF mode timing diagram.



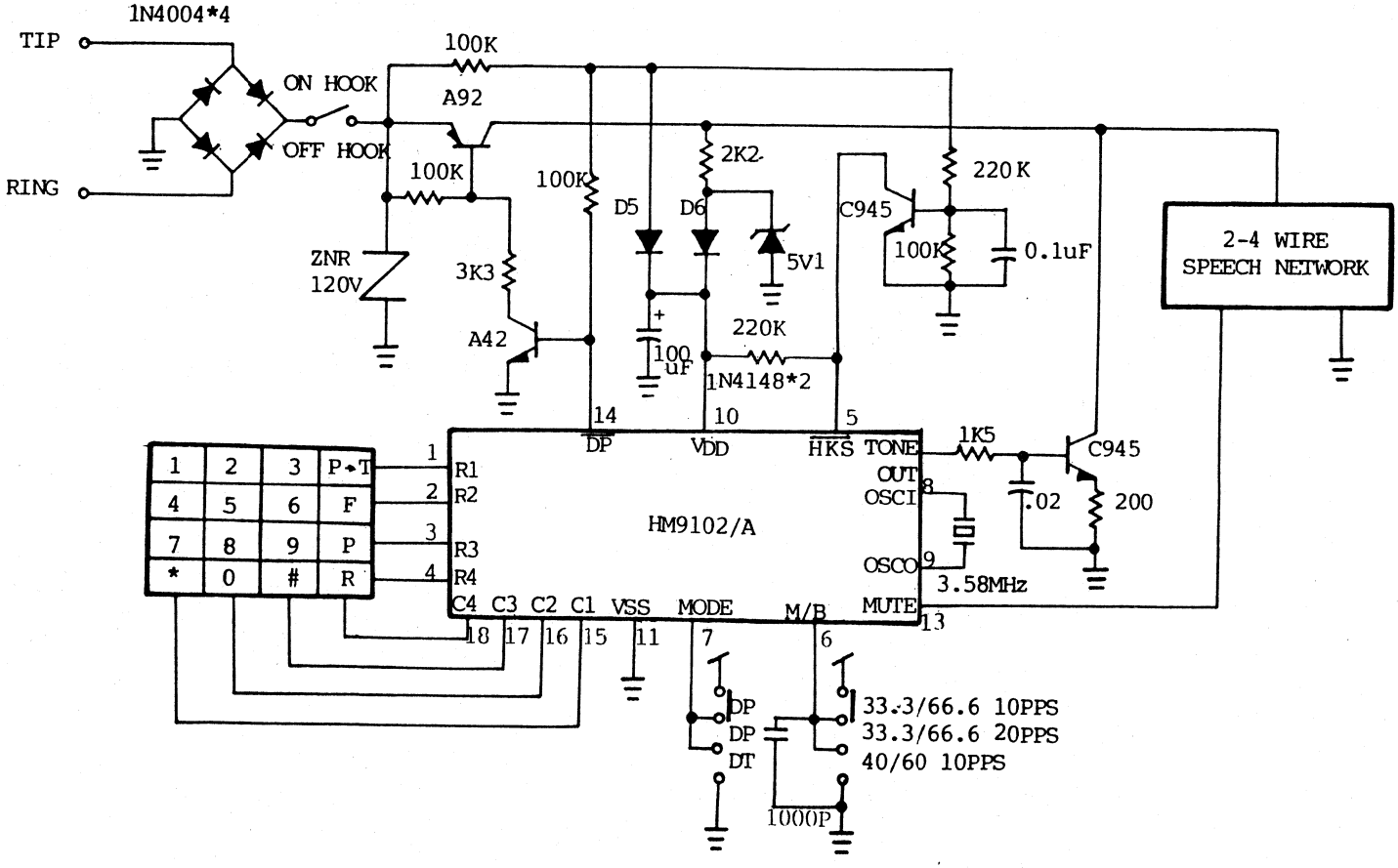
Note:Whether keyboard is pushed refer to the DTMF mode timing diagram.



Note: R* any row of R1→R4.
C* any column of C1→C4.
Isink = I/(1 - Duty Cycle).
I is the net DC current measured from ampere meter.

Note: When column drive current is tested, the X is column and Y is row. When row drive current is tested, they exchange. IDrive = I/Duty Cycle; I is the net DC current measured from ampere meter.

HM 9102A Application Example



General Description

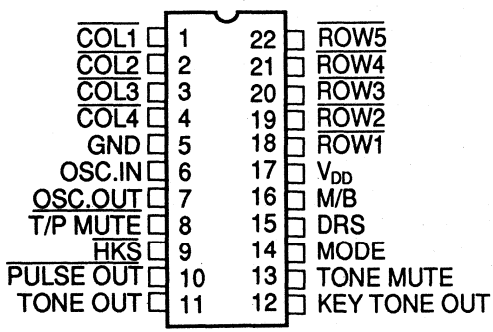
The HM 9104 is a 4-Memory Tone/Pulse switchable dialer which is fabricated in SACMOS technology with good performance in low voltage, low power operations. Four 16-digit one touch memories are used for convenient emergency calls (such as fire, police, hospital, home). The M/B and DRS pin are decoded to fit the different country's various telephone systems.

Features

* Tone/Pulse Switchable Dialer.
* Four 16-Digit Numbers for Emergency Calling Memory.
* One 31-Digit for Last Number Redial Memory.
* Auto Pause Access; 3.6 sec. per pause.
* Key-Tone Output for valid keypad Entry recognition for both pulse mode and tone mode.
* Both key-in and key-released debounce time are 20ms.
* Minimum tone duration=100ms and minimum intertone pause= 106ms for rapid key-in.
* Use 3.579545MHz crystal.
* Electronic Keypad Input is Available; Low Active.
* Pin selectable for M/B rate,flash time and pulse rate.
* Memory Retention Current ≤ 0.2μA at V_{DD}=1.0V, On Hook.
* Wide Operation Voltage Range: 2.0V-5.5V
* 22-pin Dual-in-Line Package.
* Keyboard switching from pulse to Tone mode.

Pin Assignment

HM9104



KEYBOARD FUNCTION

COL1	COL2	COL3	COL4	
1	2	3	EM1	ROW1
4	5	6	EM2	ROW2
7	8	9	EM3	ROW3
*	0	#	EM4	ROW4
R/P	S	P→T	F	ROW5

S: Store
EM1-EM4: Emergency 1-4 F: Flash;
R/P: First touch after off-hook is redial function.
Others are output Pause 3.6 sec.

Absolute Maximum Ratings

(T_A = 25 °C)

Characteristics	Sym.	Ratings	Unit
DC Supply Voltage	V_{DD}	6.0	V
Input Voltage Range	V_{in}	-0.5 to V_{DD} + 0.5	V
Power Dissipation Per Package	Po	500 (for T_A =-25°C to + 60°C)	mw
Operating Temperature	T_A	-25 to + 85	°C
Storage Temperate	T_{STG}	-65 to +150	°C

Electrical Characteristics (I) (V_{DD}=2.5V, T_A=25°C , unless otherwise noted)

Characteristics	Sym.	Test Ckt.	Test Conditions	Limit Min.	Typ.	Max.	Unit
Operating Voltage	V_{DD}		Tone	2.0	-	5.5	
			Pulse	2.0	-	5.5	V
			Memory	1.0	-	5.5	
Operating Current	Iop	1.	Tone	-	0.6	2	
			Note 1,4,6				mA
			Pulse	-	0.2	0.5	
Memory Retention Current	Imr	2.	$\overline{HKS}$=1,Ta=45°C,V+=1.0V	-	0.1	0.2	µA
Standby Current	Is	1.	Note 2, 3, 5, 6, 11	-	0.1	5	µA
Tone Output Voltage	Vto	3.	Row Group,RL=10KΩ	-	150	-	mVrms
Pre-Emphasis		4.	Column Group/Row Group V+ = 2.0 - 5.5V	1	2	3	dB
DTMF Distortion	THD	4.	RL=10K , Note 7,8	-	-30	-23	dB
Tone Output External Load Impedance	Rl		THD≤-23dB	10	-	-	KΩ
Tone Output DC Level	Vdc	4.	V+ = 2.5 -5.5V	0.5V+	-	0.6V+	-
Tone Output Sink Current	Itl	5.	Vto = 0.5V	0.2	-	-	mA
Pulse Output Drive Current	Iph	5.	Vpo = 2.0V	-0.2	-	-	mA
Sink Current	Ipl	6.	Vpo = 0.5V	0.2	-	-	mA
$\overline{T/P}$ Mute Output							
Drive Current	Imh	5	Vmo = 2.0V	-0.2	-	-	mA
Sink Current	Iml		Vmo = 0.5V	1	-	-	
Key Tone Output							
Drive Current	Ikh	8.	Vko = 2.0V	-0.5	-	-	mA
Sink Current	Ikl	5.	Vko = 0.5V	0.5	-	-	
Tone Mute Output Drive	Ilh	5	Vlo=2.0V	-0.5	-	-	mA
Sink Current	Ill	5.	Vlo = 0.5V	0.5	-	-	mA

(II)

Characteristics	Sym.	Test Ckt.	Test Conditions	Limit Min.	Typ.	Max.	Unit
Keypad Debounce	t_{DB}		* ,Note 8,9,10	-	20	-	ms
Pulse mute delay	t_{MD}		* ,Note 8,9 M/B=1	-	40	-	ms
			M/B=0	-	33.3	-	
Pre-digit Pause	t_{PDP}		* ,Note 8,9 M/B=1	-	40	-	ms
			M/B=0	-	33.3	-	
Pulse Rate	f_{PR}		* M/B=1,DRS=1	-	10	-	
			— Note 8, M/B=0,DRS=0	-	20	-	PPS
			** M/B=1,DRS=0	-	600	-	
Inter Digit Pause	t_{IDP}		* M/B=1,DRS=1	-	800	-	
			— Note 8, M/B=0,DRS=0	-	600	-	ms
			** M/B=1,DRS=0	-	13.3	-	
Flash Time	t_{FS}		(M/B=0,DRS=0)or(M/B=1,DRS=1)	-	600	-	ms
			M/B=0, DRS=1	-	100	-	
Flash Delay	t_{FD}			-	20	-	ms
Flash Lead	t_{FL}			-	20	-	ms
Make/Break Ratio	M:B		M/B=1 Note 8; *	-	40:60	-	%
			M/B=0	-	33.3:66.6	-	
Tone Duration	t_{TD}		Auto Dialing Note 8	-	100	-	ms
Inter Tone Pause	t_{ITP}		Auto Dialing Note 8	-	106	-	ms
Row Group Frequency	f1	3.	Row 1, Note 8	-	699	-	Hz
	f2		Row 2, Note 8	-	766	-	
	f3		Row 3, Note 8	-	848	-	
	f4		Row 4, Note 8	-	948	-	
Column Group Frequency	f5	3.	Col.1, Note 8	-	1216	-	Hz
	f6		Col.2, Note 8	-	1332	-	
	f7		Col.3, Note 8	-	1472	-	
Key Tone Frequency	fK		Note 8	-	1.2	-	KHz
Input Voltage Low	Vil		Pins, 1-4,9,14,15,7 &	GND	-	0.3V+	
Input Voltage High	Vih		18-22	0.7V+	-	V+	
Keypad Input Drive Curren	Ikd	6.	Vi = 0V	4	10	30	
Sink Current	Iks	5.7	VI = 2.5V	100	400	800	
Control Pin Input Leakage Current	Iin		Pins 9,14,15,17	-	0.001	0.1	µA

* M/B ≠ 1 and DRS≠ 0
** M/B = 1, DRS = 0 ; test mode.

Note 1 : $\overline{HKS}$=0
2 : In DTMF Mode
3 : In Pulse Mode
4 : Keyboard Entry, Including Auto Dialing
5 : No Keyboard Entry
6 : All Output Unloadaed
7 : Dual Tone Multi-Frequency Distortion is measured in terms of total out-of-band power related to the sum of the row & column fundamental power.
8 : Crystal parameters defined as Rs≤100, Lm=96mH Cm=0.25PF Ch=5PF, F=3.579545MHz & Cl=18PF F≤200 PPM
9 : Refer to Pulse Mode Time Diagram
10: Refer to DTMF Mode Time Diagram

Functional Description

* $\overline{ROW}$ —— $\overline{COLUMN}$ INPUTS (Pins 1-4 & 18-22)
The keypad input is compatible with the standard 2-of-9 keyboard, the inexpensive single-contact (Form A) keyboard, and electronic input.
In normal operation, any single button is pushed to produce dual tone, pulses or function. Activation of two or more buttons will result in no response, except for single tone.
Table 1 illustrates the address keypad function, in detail.

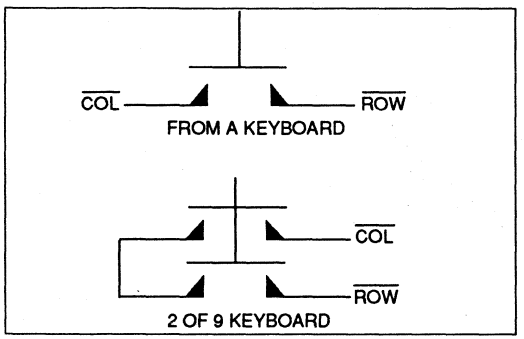


Fig. 1 Keyboard Configuration

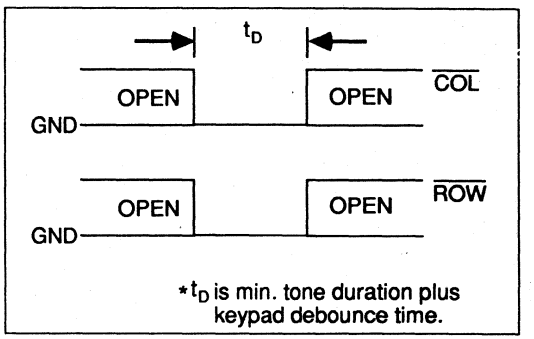


Fig. 2 Electronic Input

Table 1. Address Keypads Truth Table

Output		Active Low Inputs ROW (Pins 18-21)	COLUMN (Pin 1-3)	Output TONE (Pin 11) PULSE (Pin 10)
Tone Mode (Pin 14=0)	Normal	One	One	Dual Tone
		Two or More	One	Pin 11 = 0
		One	Two or More	
		Two or More	Two or More	
	Single Tone (Pin 15=Low) (Pin 16=High)	One	One	Dual Tone
		Two or More	One	Column Tone
		One	Two or More	Row Tone
		Two or More	Two or More	Pin 11 = 0
Pulse (Pin 14=V_{DD} or open	10 PPS (Pin 15& Pin 16) See Note 4.	One	One	10 PPS
		Two or More	One	Pin 10 =1
		One	Two or More	
		Two or More	Two or More	
	600 PPS (Pin 15 = Low Pin 16 = High)	One	One	600 PPS
		Two or More	One	Pin 10 = 1
		One	Two or More	
		Two or More	Two or More	

Note 1 : In pulse mode, pin 10=1 for * & # buttons
Note 2 : In pulse mode, always Pin 11=0, In DTMF mode, always Pin 10=1
Note 3 : Pin 10=1, Pin 11=0 for any button in Row 5 & Column 4, regardless of mode.

Note 4 :	**M/B**	**DRS**	**M/B Rate**	**Flash Time**	**Pulse Rate**
	1	1	2:3	600 ms	10 PPS
	0	1	1:2	100 ms	10 PPS
	0	0	1:2	600 ms	20 PPS
	1	0	test		

*** OSC. IN (Pin 6), OSC. OUT (Pin 7)**
A built-in inverter provides oscillation with a 3.579545MHz crystal. The oscillator ceases when a keypad input is not sensed.

*** $\overline{\text{T/P MUTE}}$**
The $\overline{\text{MUTE}}$ output pulls to V_{DD} with no keyboard input and pulls to GND when transmitting.(excluding the * & # Keys, in pulse mode). But, if row 5 and column 4 is pushed, then $\overline{\text{MUTE}}$ stays high level still.

*** $\overline{\text{HKS}}$**
The $\overline{\text{HKS}}$ (Hook Switch) input is used to sense the state of the handset in ON-HOOK or OFF-HOOK. In ON-HOOK state, $\overline{\text{HKS}}$=1, the keyboard input is disabled, there is no operation for any keyboard entry, to avoid the energy loss stored in capacitor. In OFF-HOOK state, $\overline{\text{HKS}}$=0, all of the function work.

*** $\overline{\text{PULSE OUT}}$**
In DTMF mode, the pulse out stays high level regardless of keyboard entry. In pulse mode, this output sends a chain of pulses to the corresponding address keypad input, but stays high level for * and # entry. Figure 3. shows the timing diagram in pulse mode. The pulse rate and inter digit pause are fixed, in normal condition Pin 15=1, to be 10pps and 800ms respectively.

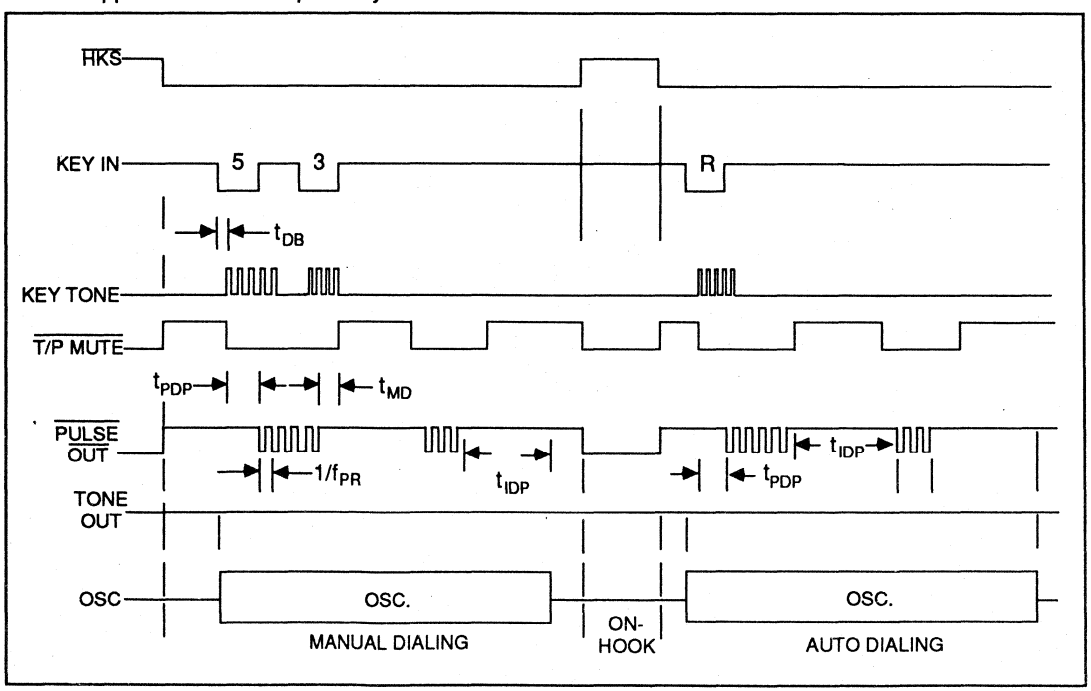


Fig. 3 Pulse Mode Time Diagram

*** TONE OUT**

In pulse mode, the tone output stays low state regardless of keypads input. In DTMF mode, the pin outputs dual tone or single tone, refer to Table 1. In normal dialing, the tone duration depends on key-in situation. When a valid key-in is less than 100 ms the tone duration will be fixed at 100ms. On the other hand, the tone duration will lasts as long as the key is pressed. As the same algorithm,the inter-tone-pause will be different under the following conditions: when key-release period continues less than 106ms, it will be fixed at 106ms. Otherwise, it will equal the the key- release duration. The tone duration and inter-tone-pause are internally set to be 100ms and 106ms respectively in auto dialing. Figure 4 illustrates the DTMF time diagram.

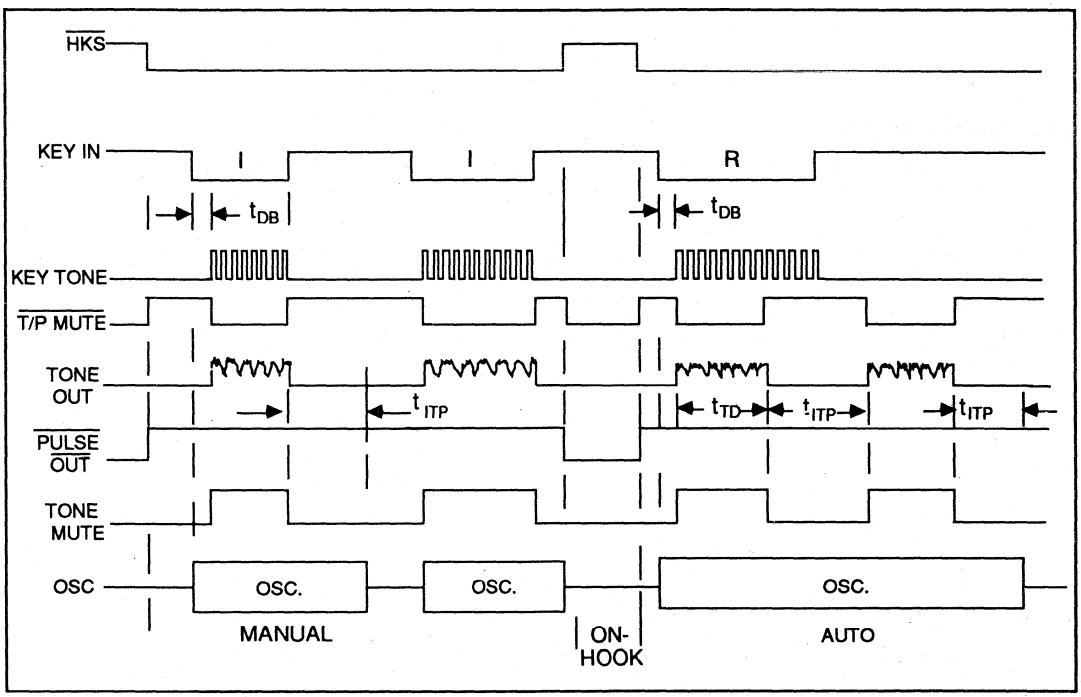


Fig. 4 DTMF Mode Timing Diagram

*** KEY TONE OUT**

The key tone output is a conventional CMOS inverter. A NPN transistor is needed to drive a piezo. The output frequency is 1.2KHz. In spite of DTMF or Pulse mode, the key tone actuate after any keypad (including row 5 and column 4)entry has been detected,and ceases at the time the button is released. There is no key tone output, whenever two or more keyboard buttons are pushed simultaneously.

*** TONE MUTE**

The T MUTE is a conventional CMOS inverter. In DP mode, the output always stays low in the duration of DP signal sending. But, the output presents a logic high in Tone mode. It can execute the muting operation in Tone mode.

*** MODE**

Pulls pin 14 to Vdd or unconnected, the dialer is in pulse mode. On the contrary, it is in DTMF mode.

*** M/B & DRS**

The M/B & DRS pin used to decode four selectable status as following

M/B	DRS	M/B rate	Flash	PPS
1	1	2:3	600ms	10pps
0	1	1:2	100ms	10pps
0	0	1:2	600ms	20pps
1	0	Test		

Keyboard Operations

Note : All the keyboard operations should be under OFF-HOOK conition.

I. Normal Dialing

Select Pulse or Tone mode.
Off-hook (n≤31)
Push [D1] .... [Dn] , D1 - Dn : 0-9, *, #
Then the number D1,... Dn will be dialed out in Pulse or Tone mode as selected.

II. Redialing

Select Pulse or Tone mode.
Off-hook
Push [D1].... [Dn] , busy, ON-HOOK.
Come OFF-HOOK, push [R/P] , THEN last number D1D2 ... Dn will be automatically dialed out in Pulse or Tone mode as selected.

III. Pause Key Operation

In some cases, such as PABX or long distance service, pauses should be inserted in the dialing sequence. The HM 9104 provides stackable pause function (3.6 sec/pause) which facilitates flexible applications. For examples:

a. Dialing with Pause Key

1. Select Pulse or Tone Mode.
   Off-hook
   Push [D1] ,[R/P] , [D2] ,...., [Dn] ; D1-Dn : 0 -9 , *, #.
   then the number will be dialed out in the following sequence:
   D1, pause 3.6 sec, D2, ... , Dn;

2. Redialing with Pause Key
   When redialing, the chip outputs the same sequences as above, but all the timings are fixed internally.

b. Storing with Pause Key

1. Select Pulse or Tone Mode
   Off-hook
   Push [S] [D1] [R/P] [D2] ,..., [Dn] [S] [EMn] .
   then the number D1, Pause 3.6 sec., D2....Dn will be stored in [EMn]

2. Dialing with Pause Key.
Select Pulse or Tone mode.
1) Push [EMn] then the output signal will be dialed in the following sequence. D1, pause 3.6 seconds, D2,...Dn.

IV. Emergency Dialing

The HM 9104 provides four memories for storing emergency numbers such as fire, police and doctor. Convenient one-key dialing operation is designed for these emergency memories hich are important in easy operation:

a. Storing Emergency Numbers.
Off-hook
Select Pulse or Tone Mode.
Push [S] [D1] [D2] ..... [Dn] [S] [EMn] EMn : EM1 - EM4 Then the number D1, D2,...Dn will be stored in [EMn].

b. Emergency Dialing
Off-hook
Select Pulse or Tone Mode.
Push [EMn] , then the number stored in EMn will be automatically dialed out in Pulse or Tone mode as selected.

V. Pulse To Tone Key Operation

a. Dialing with Pulse to Tone Key
Push [D1] , [D1] ..... [Dn] , [P→T] , [D1'] , [D2'] ,..... [Dn'], Then the numbers will be dialed out in the following sequence:
If the mode switch is set in pulse mode, then the output signal will be:
D1, D2, ..., Dn, pause 3.6sec. D1', D2', ..., Dn'.
(Pulse) (Tone)

b. Redialing with pulse to Tone Key

Push R/P , then the numbers will be dialed out in the following sequence:
If the mode switch is set in pulse mode, then the output signal will be:
D1, D2, ..., pause 3.6sec., D1', D2', ..., Dn'.
(Pulse) (Tone)

c. Storing [P→T] In Memory
Select Pulse or Tone Mode.
Push [S] , [D1] , [D2] , .., [Dn] , [P→T] , [D1'] , [D2'] ,..... [Dn'] , [S], [EMn]
EMn:EM1—EM4.
Then the number sequence D1, D2,.., Dn. [P→T] , D1', D2', ..., Dn' will be stored in location [EMn]

d. Memory Dialing with Pulse to Tone Key
Select Pulse or Tone Mode.
Push [EMn] Then the number stored in EMn will be automatically dialed out as following seqence:

1. If the mode switch is set in Pulse mode, then the output signal will be:

D1, D2, .., Dn, pause 3.6 sec., D1', D2', ..., Dn'
(Pulse) (Tone)

2. If the mode switch is set in Tone mode, then the output signal will be:
D1, D2, .., Dn, pause 3.6 sec., D1', D2', ..., Dn'
(Tone) (Tone)

VI. Flash Operation

This chip provides a convenient and precise flash function for PABX service. In The following operation; push F, then 600 ms flash is supplied, and the central unit will service the caller, such as: transfer, wait - - - -.

Figure 5. shows flash timing diagram.

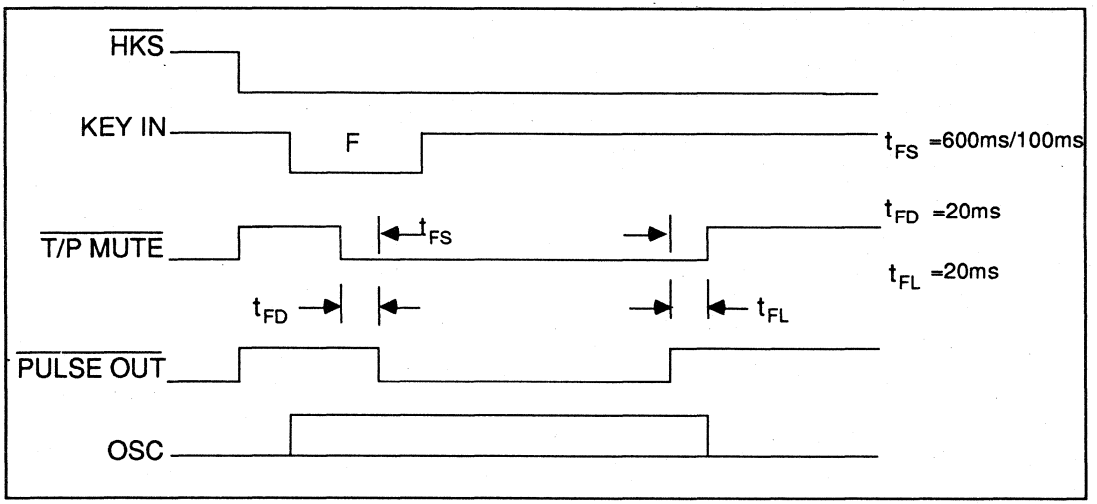
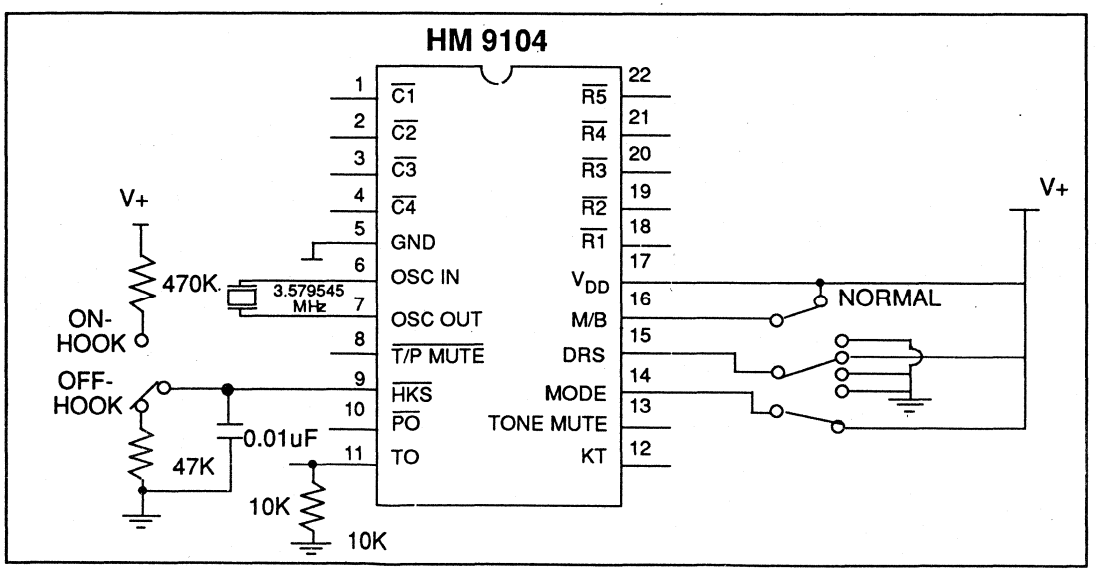
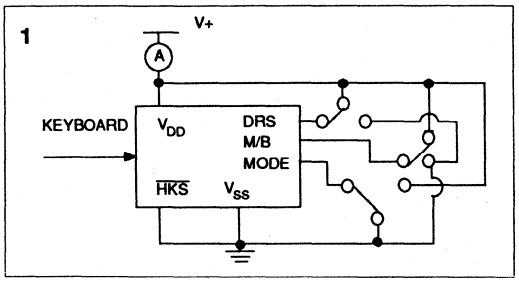


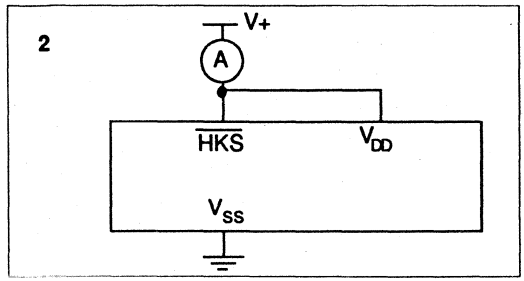
Fig. 5 Flash Timing Diagram

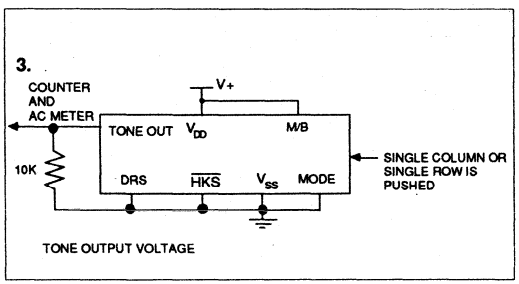
General Test Circuit

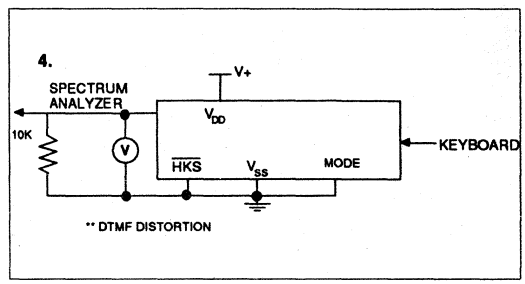


Test Circuit







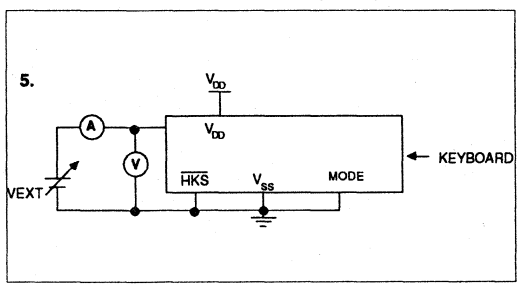


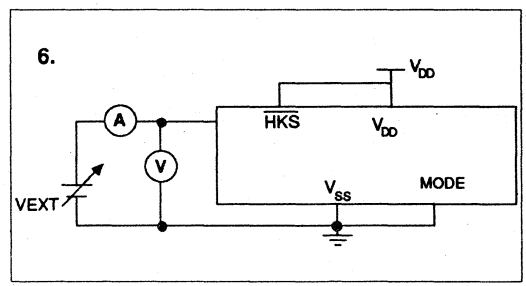
**

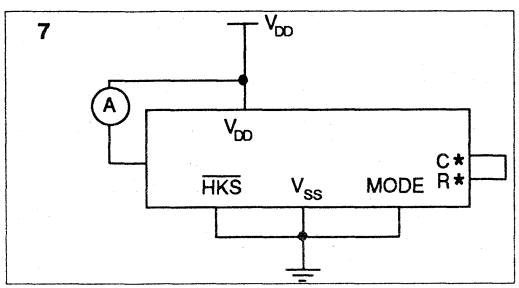
$$\text{DIST.(dB)} = 20\log \frac{\sqrt{(V1)^{**}2+(V2)^{**}2+..+(Vn)^{**}2}}{\sqrt{(VL)^{**}2+(VH)^{**}2}}$$

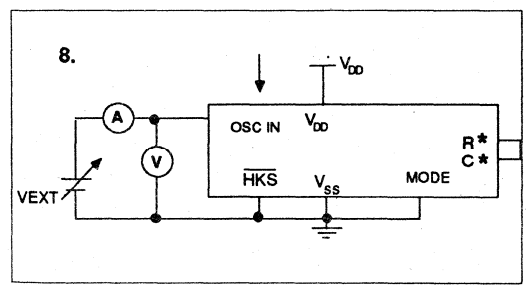
a. V1....Vn are extraneous frequencies (ie, inter modulation and harmonic) components in the 500Hz to 3400Hz band.

b. VL,VH are the individual frequency components of the DTMF signal





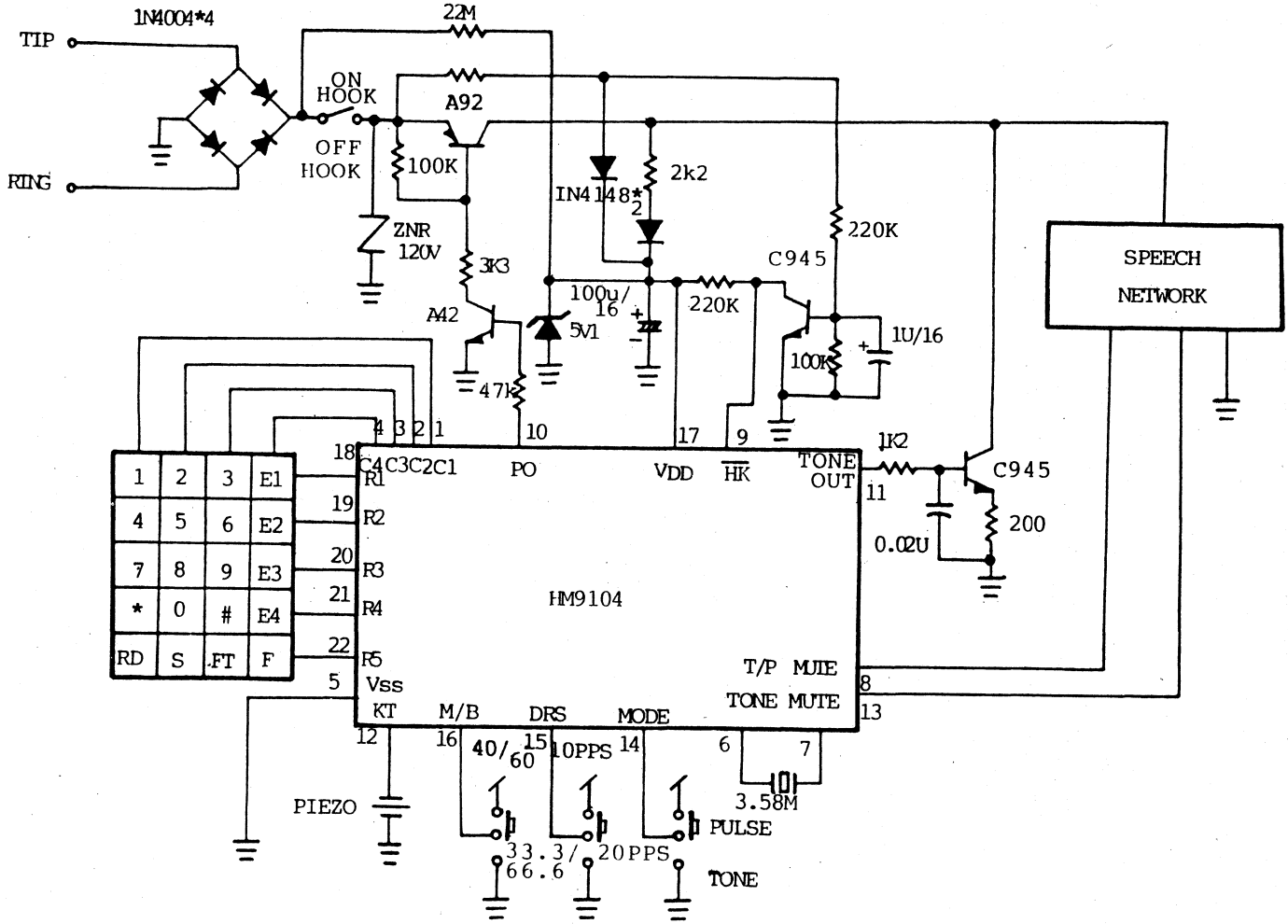




R* : anyone row of R1-R5
C* : anyone column of C1-C4
Isink=I/(1-Duty Cycle) I is the net DC current measured from ampere meter.

Procedure:
1 Provide clocks until output change to high.
2 Test its current.

HM 9104 Application Example



General Description

The HM 9110B is a TONE/PULSE switchable dialer with one redial memory. It is specifically designed for low cost, high stability TONE/PULSE switchable telephone applications. Pause and P→T keys are provided for PBX and LDC operation. The chips work in a wide operating voltage range (2.0-5.5V for both TONE and PULSE mode), and consume very low memory retention current(≤0.2μA at V =1.0V, $\overline{HKS}$=1). This IC consists of a 10-numbers X 16-digit repertory memory and a 31-digit redial memory to execute the easy calling function.

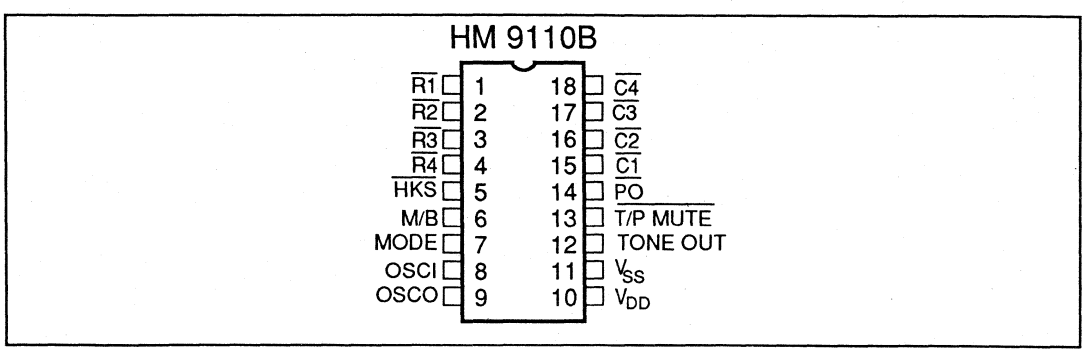
Features

* Tone/Pulse switchable.
* One 31-digit memory for last number redial.
* Auto pause access for PBX operation; 3.6 sec per pause. (2 sec, 3.2 sec pause time can be obtained by metal option)
* Pulse to tone key (P→T) for toll service operation.
* Electronic keypad input is available; low action.
* Use inexpensive 3.579545MHz crystal.
* Low operation voltage; 2.0V for both tone and pulse mode.
* Low memory retention current; ≤ 0.2μA at V_{DD} =1.0V, $\overline{HKS}$=1.
* Flash Key is available on PBX, flash time is 600ms & 100ms by M/B controller.
* In pulse mode, # can be used as P→T key.
* Both key-in and key-released debounce are 20ms.
* Minimum tone duration=100ms and minimum intertone pause=106ms for rapid key-in.
* M/B PIN SELECT TO 3 TYPES :

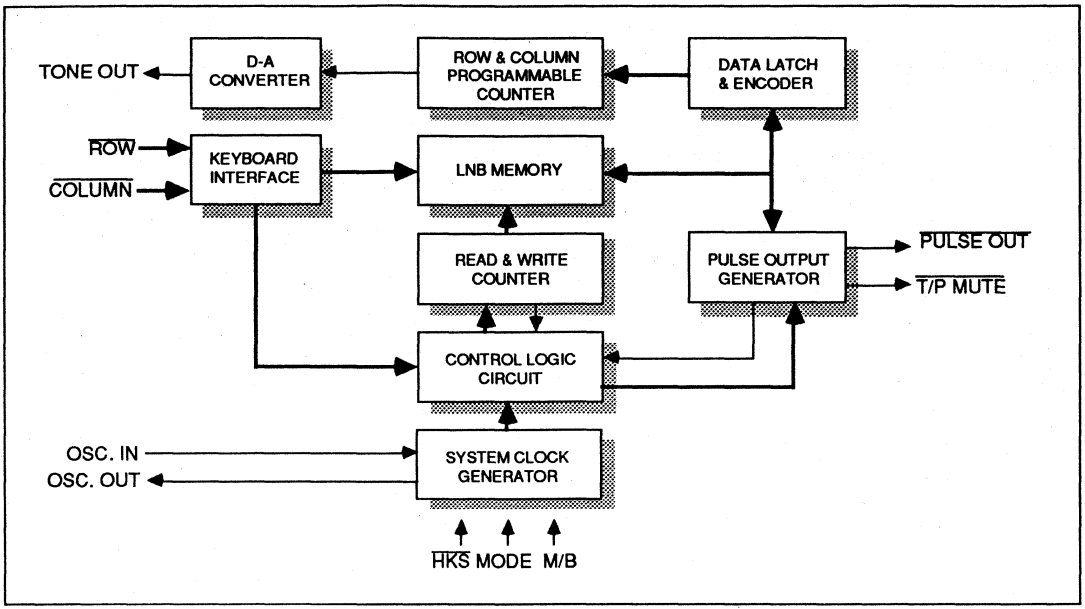
M/B	Pulse rate	Flash	M/B rate
OPEN	20 PPS	600 ms	33 : 66
V_{SS}	10 PPS	600 ms	40 : 60
V_{DD}	10 PPS	100 ms	33 : 66
	TEST MODE		

* MODE PIN SELECT TO 3 MODE:
* OPEN : PULSE mode
* V_{DD} : PULSE mode
* V_{SS} : TONE mode

Pin Assignment



Block Diagram



Keyboard Scheme

Row Group \ Col. Group	C1 1216Hz	C2 1332Hz	C3 1472Hz	C4
R1 699Hz	1	2	3	ST
R2 766Hz	4	5	6	MEMO
R3 848Hz	7	8	9	F
R4 948Hz	*	0	#	RD/P

F:Flash

MEMO:Memory Recalling
RD : Redial
: Redial(in pulse mode)

Note 1: In pulse mode, "#" can be used as P→T key.

Pin Functional Description

Symbol	Pin No.		Name And Function
$\overline{\text{ROW-COLUMN}}$	1	18	The keypad input is compatible with the standard 2 of 8 keyboard the single contact (Form A) keyboard, and electronic input. In normal operation, any single button is pushed to produce dual tone, pulse or function. Activation of two or more buttons will result in no response, except for single tone,Table 1 illustrates address keypad function in detail.
	2	17	
	3	16	
	4	15	

Symbol	Pin No.	Name And Function
$\overline{HKS}$	5	The $\overline{HKS}$ hand hook switch input is used to detect the state of hand-set in ON-HOOK or OFF-HOOK. In ON-HOOK state, $\overline{HKS}$=1, the keyboard input is disabled in order to decrease the consumption of power. In OFF-HOOK state, $\overline{HKS}$=0, all of the function can be operated. On chip pull up resistor is built. (Typical 100K OHM)
M/B	6	If M/B pin is tied to "OPEN", the pulse rate is 20pps, the flash time is 600 ms, and the M/B rate is 33:66. When M/B pin is tied to "V_{DD} ", the pulse rate is 10 pps, the flash time is 100ms, and the M/B rate is 33:66. If M/B pin is tied to "V_{SS}", the pulse rate is 10pps, the flash time is 600 ms, and the M/B rate is 40:60. If M/B pin is provided a negative edge pulse.The IC is under test. ☆To avoid from malfunction due to enter into test mode, a capacitor about 1000PF shall be connected between M/B and V_{SS}.
MODE	7	There are two methods of switching the IC to pulse or tone dialer. Put MODE Selection pin to "OPEN" or V_{DD}, the dialer is in pulse mode. Put MODE to "V_{SS}", the dialer is in tone mode.
OSC.IN OSC.OUT	8 9	A built-in inverter provides oscillation with a 3.579545 MHz crystal, which is disabled when no keypad input has been sensed. An on-board counter is used to decrease the frequency of oscillation and creates keypad debounce, mute delay, pre-digit pause,Make-Break ratio, tone duration, row group and column group frequency, and key tone frequency etc. Any crystal frequency deviation from 3.579545 MHz will be reflected in the time parameters above.Most crystals do not vary more than ±200PPM
TONE OUT	12	In pulse mode,the tone output stays low state regardless of key-pad input. In DTMF mode, this pin outputs dual or single tone under the condition illustrated in Table 1. In manual dialing, the tone duration is equal to the period of button pushed minus the keypad debounce time. In auto dialing, the tone duration and inter-tone-pause is internally set to be 100 ms and 106 ms respectively. Figure 4 shows DTMF mode timing diagram.
$\overline{T/P\ MUTE}$	13	The mute is N-Channel open drain output. In pulse mode, it is at high impedence with no keypad entry;but goes low state when keypad is pushed during Tone/Pulse dial period.
$\overline{PULSE\ OUT}$	14	The PULSE OUT pin is an open-drain NMOS transistor output. In OFF-HOOK state, this NMOS transistor stays in ON-state only in break duration, but stays in OFF-state in make or normal duration, in order to send the pulses train of the address codes in pulse mode. The timing diagram of pulse mode is shown in fig. 3.

Absolute Maximum Ratings

(T_A = 25 °C)

Characteristics	Sym.	Ratings	Unit
DC Supply Voltage	V_{DD}	6.0	V
Input Voltage Range	V_{in}	-0.5 to V_{DD} + 0.5	V
Power Dissipation Per Package	P_o	500 (for T_A =-25°C to + 60°C)	mw
Operating Temperature	T_A	-25 to + 85	°C
Storage Temperate	T_{STG}	-65 to +150	°C

DC Characteristics

(V+ = 2.5V, T_A = 25°C , Unless otherwise specified)

Characteristics	Sym.	Test Ckt.	Test Conditions	Limit Min.	Limit Typ.	Limit Max.	Unit
Operating Voltage	V_{DD}		Tone	2.0	-	5.5	V
			Pulse	2.0	-	5.5	
			Memory	1.0	-	5.5	
Operation Current Tone	Iop	A	Unloaded and Keypad Entry	-	0.6	2	mA
Pulse				-	0.2	0.6	
Standby Current	Is	A	$\overline{HKS}$=0, Unloaded and No Keypad Entry	-	0.1	5	µA
Memory Retention Current	Im	B	$\overline{HKS}$=1, V_{DD}=1V	-	0.1	0.2	µA
Tone Output Voltage	Vto	C	Row Group, Rl=10kohm, HKS	-	150	-	mVrms
Pre-Emphasis		D	Column/Row V_{DD}=2.0-5.5V	1	2	3	dB
DTMF Distortion	THD	D	RL=10Kohm V_{DD}=2.0-5.5V	-	-30	-23	dB
Tone Output Load Impedance	R1		THD ≤-23dB	10	-	-	k
Tone Output DC Level	Vtdc	D	V_{DD}=2.0-5.5V,Keypad Entry	-	0.65V_{DD}	-	V
Tone Output Sink Current	Ito	E	Vto=0.5V,No Keypad Entry	0.2	-	-	mA
$\overline{Pulse\ Output}$			Vpi=5V	-	-	0.1	µA
Leakage Current	Iph	E	Vpi=12V	-	-	1.0	
Sink Current	Ipl	F	Vpo=0.5V	1.0	3.0	-	mA
$\overline{T/P\ Mute\ Output}$							
Drive Current	Imh	E	Input = 12.0V	-	-	1	mA
Sink Current	Iml		Vmo = 0.5V	1.0	-	-	
Keypad Input							
Drive Current	Ikh	H	Vki = 0V	4	10	30	µA
Sink Current	Ikl	E,G	Vki = 2.5V	200	400	-	
Control Pin Input Leakage Current	Iin		$\overline{HKS}$, MODE, Pins	-	±10 **(-5)	±0.1	µA

Note 1: Dual Tone Multi-Frequency Distortion is measured in terms of total out-of-band power related to the sum of the row & column fundamental power.

AC Characteristics

Characteristics	Sym.	Test Conditions		Limit Min.	Typ.	Max.	Unit
Keypad Debounce	t_{DB}	mode = "Open" or " V_{DD} "		-	20	-	ms
Pulse Mute Delay	t_{MD}	mode = "V_{DD}" or "Open"	M/B="V_{DD}"	-	40	-	ms
			M/B="V_{SS}".or "Open	-	33.3	-	
Pre-Digit Pause	t_{PDP}	mode = "V_{DD}" or "Open"	M/B="V_{DD}"	-	40	-	ms
			M/B="V_{SS}"or "Open	-	33.3	-	
Pulse Rate	f_{PR}	M/B = "V_{DD}" or "V_{SS}"		-	10	-	pps
		M/B = "Open"		-	20	-	
Make/Break Ratio	M:B	M/B = " V_{ss}"		-	40:60	-	%
		M/B = "Open" or "V_{DD}"		-	33:66	-	
Inter Digit Pause	t_{IDP}	M/B=Open		-	800	-	ms
		M/B="V_{DD}"or "V_{ss}"		-	600	-	
		M/B=Test mode		-	13.3	-	
Tone Duration	t_{TD}	Redial		-	100	-	ms
Inter Tone Pause	t_{ITP}	Redial		-	106	-	ms
Row Group Frequency	f1	Use 3.579545 MHz Crystal	ROW1	-	699	-	Hz
	f2		ROW2	-	766	-	
	f3		ROW3	-	848	-	
	f4		ROW4	-	948	-	
Column Group Frequency	f5	Use 3.579545 MHz Crystal	COL1	-	1216	-	Hz
	f6		COL2	-	1332	-	
	f7		COL3	-	1472	-	

Note: Crystal parameters defined as Rs ≤100 , Lm = 96mH, Cm = 0.25 pF
Ch = 5PF, F = 3.579545 MHz & Cl = 18 PF, F ≤±200ppm

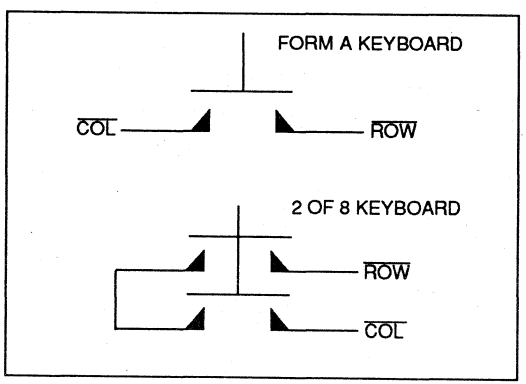


Figure 1. Keyboard Configuration

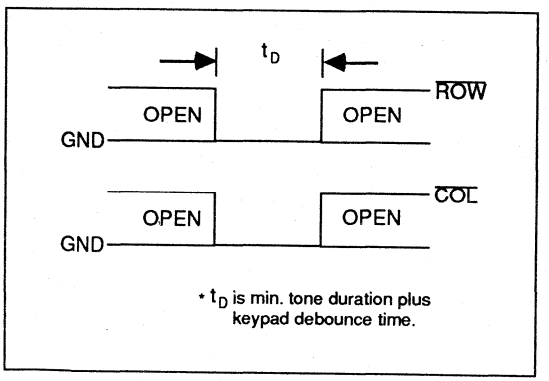


Figure 2. Electronic Input

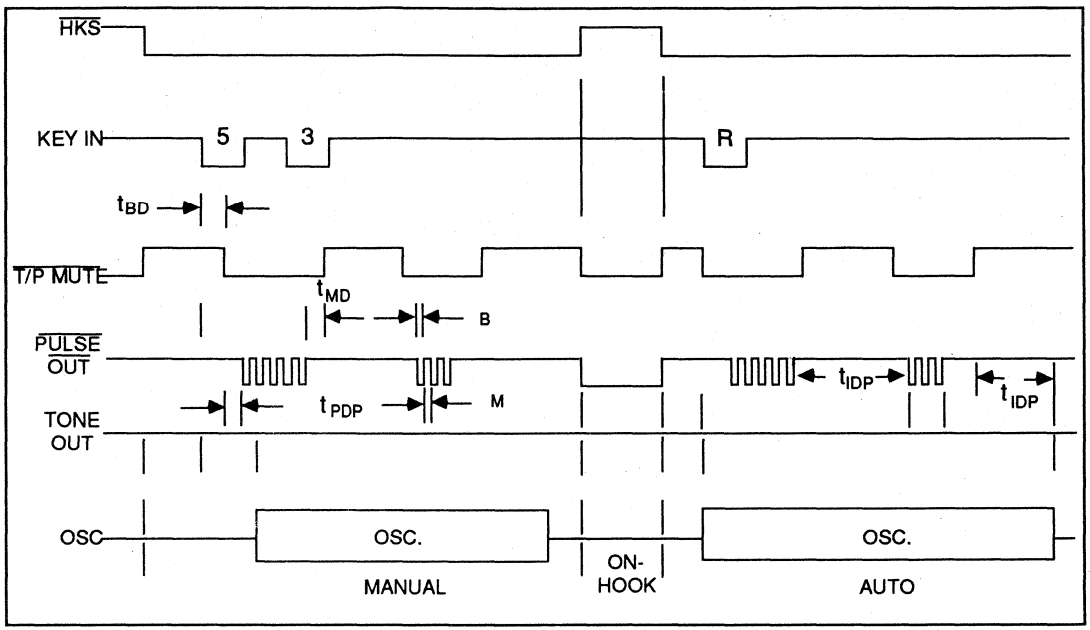


Figure 3. Pulse Mode Timing Diagram

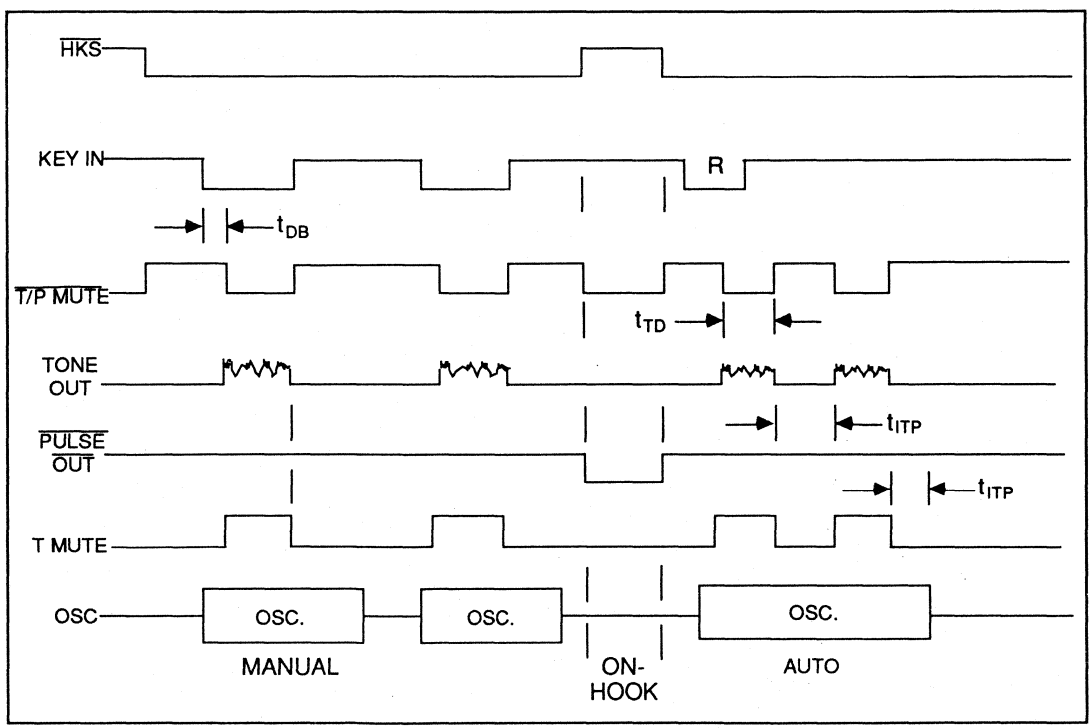


Figure 4. DTMF Mode Timing Diagram

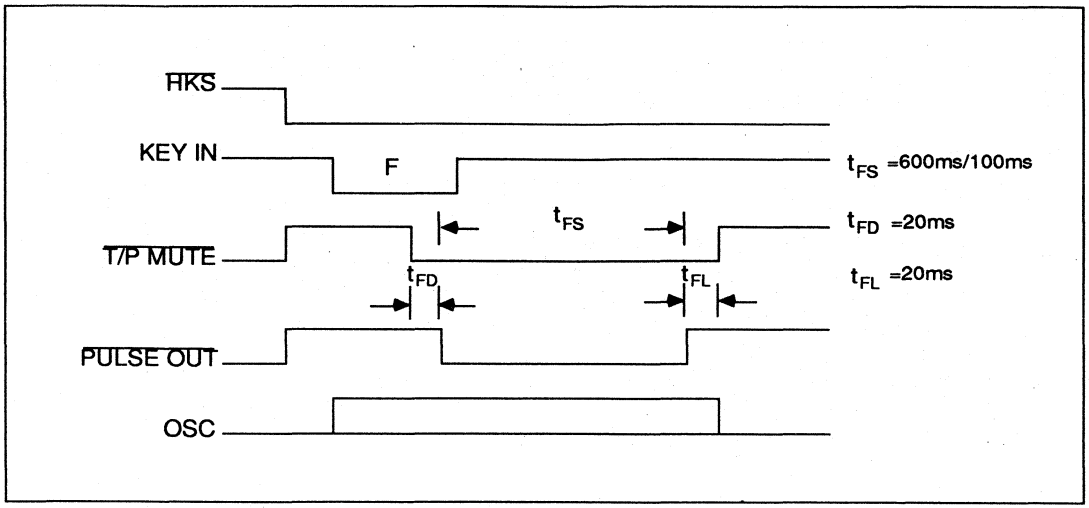


Figure 5. Flash Timing Diagram

M/B	Mode	Active Low Inputs ROW Pins	Active Low Inputs COLUMN Pins	Output Tone Out; PO
	V_{SS} (Normal) (Test mode)	One	One	Dual Tone
		Two or More	One	
		One	Two or More	V_{SS}
		Two or More	Two or More	
↓	V_{SS} (Normal) (Test mode)	One	One	Dual Tone
		Two or More	One	Column Tone
		One	Two or More	Row Tone
		Two or More	Two or More	V_{SS}
V_{DD} OPEN V_{SS}	V_{DD} OPEN (Normal) (pulse mode)	One	One	10 PPS, 20 PPS
		Two or More	One	
		One	Two or More	Open
		Two or More	Two or More	
	OPEN	One	One	600 PPS
↓	V_{DD} (Test mode)	Two or More	One	
		One	Two or More	Open
		Two or More	Two or More	

Table 1 Address Keypads Truth Table (Continual)

Keyboard Operations

Note: All the keyboard operations should be under off-hook condition.

*** Normal Dialing**

1. Select Pulse or Tone mode
2. Push [D1] ,..., [Dn] ; D1...Dn : 0-9,*,#; n is unlimited.
   Then the number D1 - Dn will be dialed out in Pulse or Tone mode as selected.
   (Excluding of * , # in pulse mode)

*** Redialing**

Select Pulse or Tone mode

Push [D1] ,..., [Dn] ;n≤31 If busy, after ON-HOOK, Come OFF-HOOK, push [R] , the last number D1, D2, ... , Dn will be automatically dialed out in Pulse or Tone mode as selected again.

*** Mix-Dialing**

[REDIAL] + [MANU] is allowable. ; MANU: [D1] ,.., [Dn] ; Dn : 0-9.

*** Pause And Pulse To Tone Key Operation**

In some cases, such as PABX or LDC service, a pause should be inserted in the dialing sequence and different dialing modes. The chip provides user with pause function and Pulse/Tone switchable, which facilitates flexible applications.

(a) Dialing with Pause

Select Pulse or Tone mode

Push [D1] , [P] , [D2] , ... , [Dn] ; D1 - Dn : 0 - 9, * , #

Then the number will be dialed out in the following sequence:

D1, pause 3.6 sec. D2, ... , Dn.

(b) Redialing with Pause

When dialing operation as above, but busy , then ON-HOOK. Come OFF-HOOK, push [R] then the signal will be dialed out automatically as in the above sequences.

(c) Dialing with [P→T] key (# key=P→T key at pulse mode.)

Select the Pulse or Tone mode

Push [D1], [D2] , ... , [Dn] , [P→T] , [D1'] , [D2'] , ... , [Dn'] Then the number will be dialed out in the following sequence:

1. If the mode switch is set in pulse mode, then the output signal will be:
   D1, D2, ... , Dn, pause 3.6 sec. D1', D2', ... , Dn'.
   (Pulse mode) (Tone mode)
2. If the mode switch is set in Tone mode, then the output signal will be:
   D1, D2, ... , Dn, pause 3.6 sec. D1', D2', ... , Dn'.
   (Tone mode) (Tone mode)

(d) Redialing with [P→T] Key

When redialing, the chip outputs the same sequences as above, but all the timing are fixed internally.

(e) Flash operation

This chip provides a convenient and precise flash function for PABX service. In the following operation; push F, then 600ms flash is supplied, and central unit will do service to caller, such as: transfer, wait - - - -. If after P→T , F keypad be pushed then the state turn to pulse mode.

Figure 5. Show flash timing diagram.

Note: The pause can be continuously stored for longer pause duration, but every pause will occupy one digit of memory size.

***Repertory Memory Storing**

(a) Select PULSE or TONE mode.

(b) SET OFF HOOK state. Input [ST] D1, D2,...Dn, [ST] , j [ST] , Dn+1,...,Dn+m, [ST], K,....

D = 0,..., 9, P. j, K=0,..., 9. n≤16, m≤16.

Note 1. Depressing FLASH key or ON/OFF HOOK once will make "memory storing" procedure return to initial state.

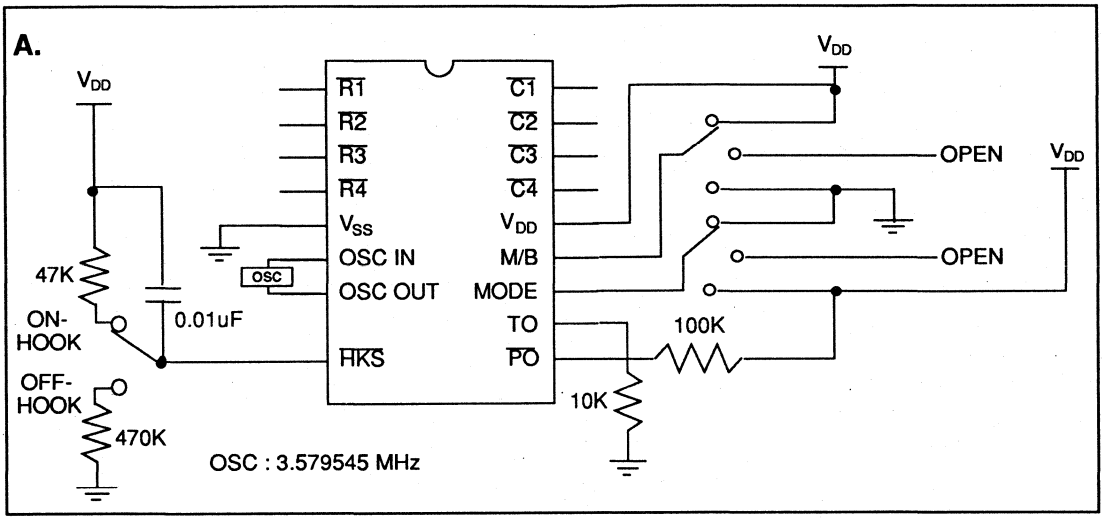
2. The new data entering the memory will replace the previous data.

*** Repertory Memory Recalling**

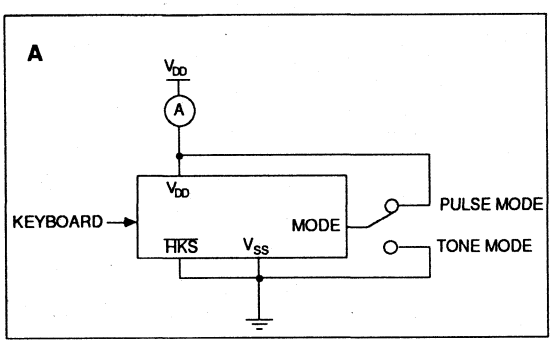
(a) Set OFF HOOK state.

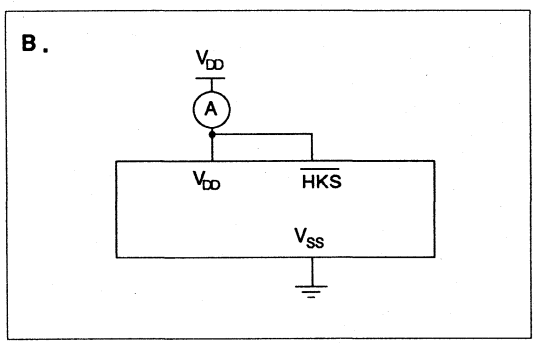
(b) Input [MEMO] j, [MEMO] , K.

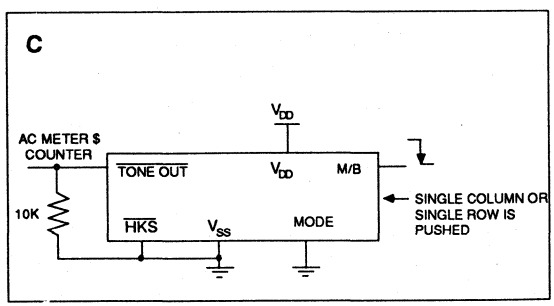
General Test Circuit

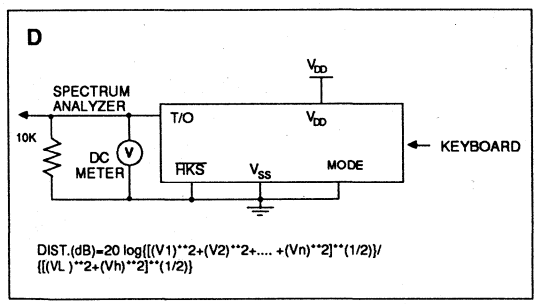


Test Circuit



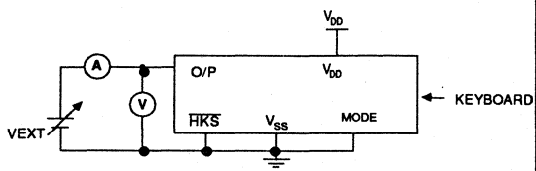




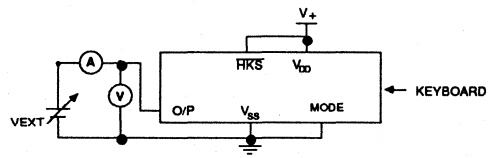


a. V1,..., Vn are extraneous frequencies (ie intermodulation and harmonic) components in the 500 Hz to 3400 Hz band.
b. VL , Vh are the individual frequency components of the DTMF signal.
c. Whether keyboard is pushed refer to the DTMF mode timing diagram.

E

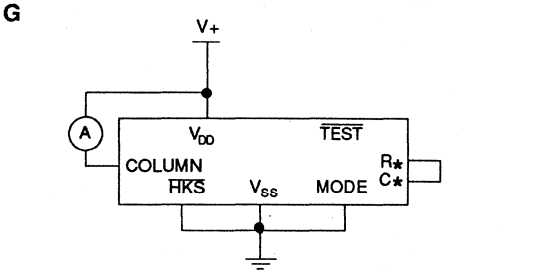


F



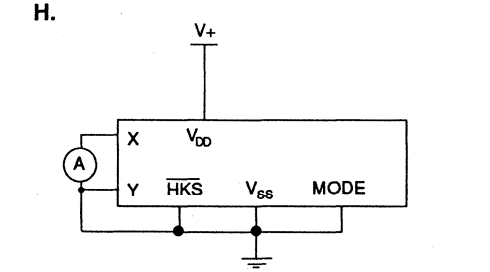
Note:Whether keyboard is pushed refer to the DTMF mode timing diagram.

G



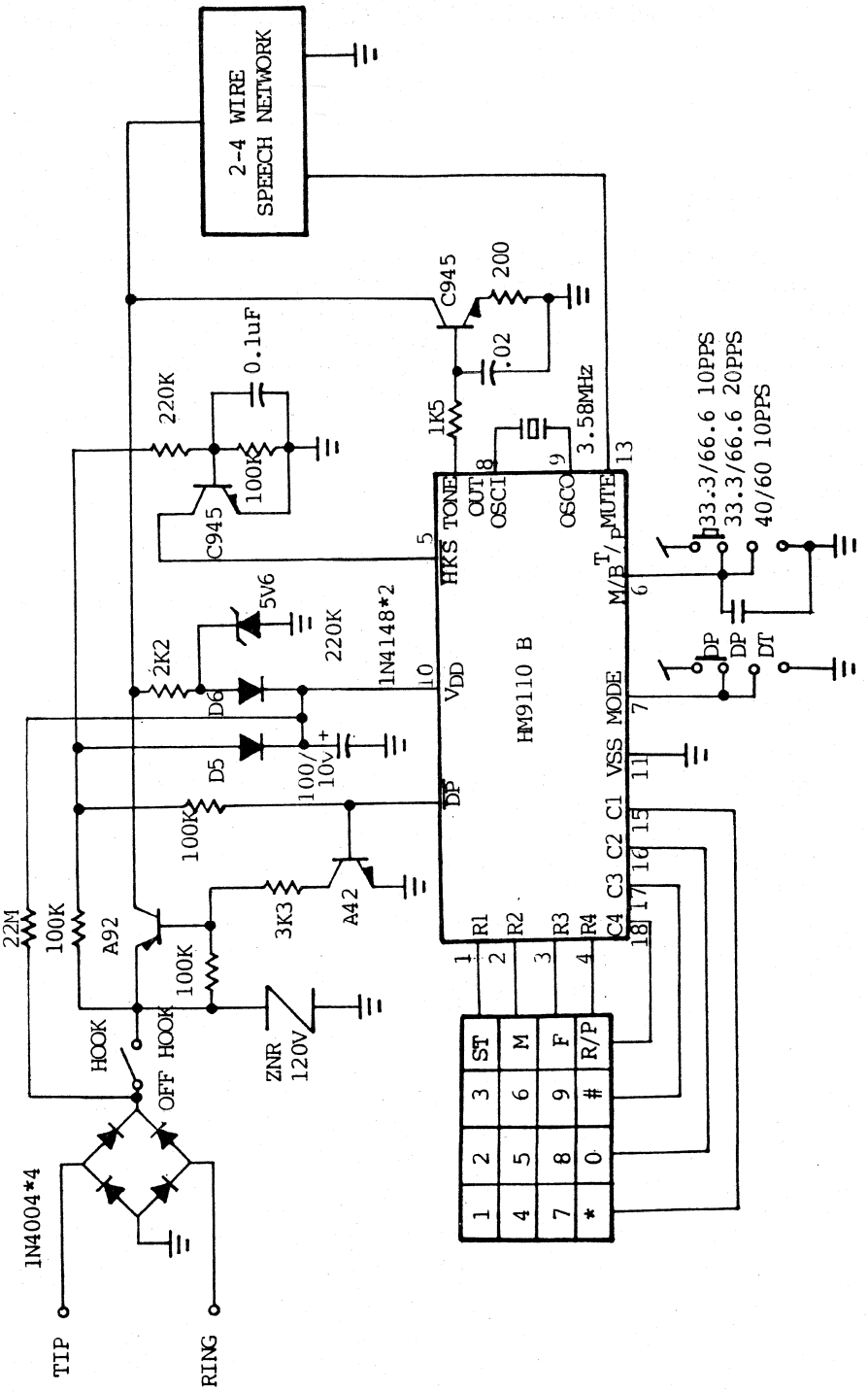
Note: R* any row of R1→R4.
C* any column of C1→C4.
Isink = I/(1 - Duty Cycle).
I is the net DC current measured from ampere meter.

H.



Note: When column drive current is tested, the X is column and Y is row. When row drive current is tested, they exchange. IDrive = I/Duty Cycle; I is the net DC current measured from ampere meter.

HM 9110B Application Example



General Description

The HM 9110C is a TONE/PULSE switchable dialer with one redial memory. It is specifically designed for low cost, high stability TONE/PULSE switchable telephone applications. Pause and P→T keys are provided for PBX and LDC operation. The chips work in a wide operating voltage range (2.0-5.5V for both TONE and PULSE mode), and consume very low memory retention current(≤0.2μA at V_{DD} =1.0V, $\overline{HKS}$=1). This IC consists of a 10-numbers X 16-digit repertory memory and a 31-digit redial memory to execute the easy calling function.

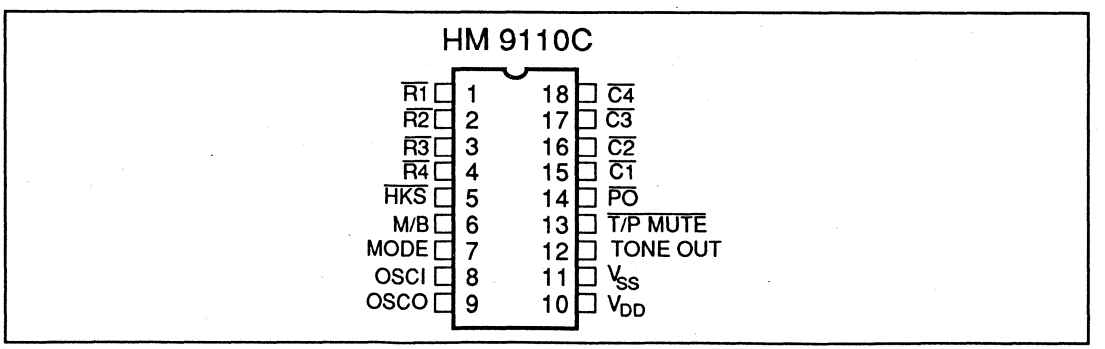
Features

* Tone/Pulse switchable.
* One 31-digit memory for last number redial.
* Auto pause access for PBX operation; 3.6 sec per pause. (2 sec, 3.2 sec pause time can be obtained by metal option)
* Pulse to tone key (P→T) for toll service operation.
* Electronic keypad input is available; low action.
* Use inexpensive 3.579545MHz crystal.
* Low operation voltage; 2.0V for both tone and pulse mode.
* Low memory retention current; ≤ 0.2μA at V_{DD} =1.0V, $\overline{HKS}$=1.
* Flash Key is available on PBX, flash time is 600ms & 100ms by M/B controller.
* In pulse mode, # can be used as P→T key.
* Both key-in and key-released debounce are 20ms.
* Minimum tone duration=100ms and minimum intertone pause=106ms for rapid key-in.
* M/B PIN SELECT TO 3 TYPES :

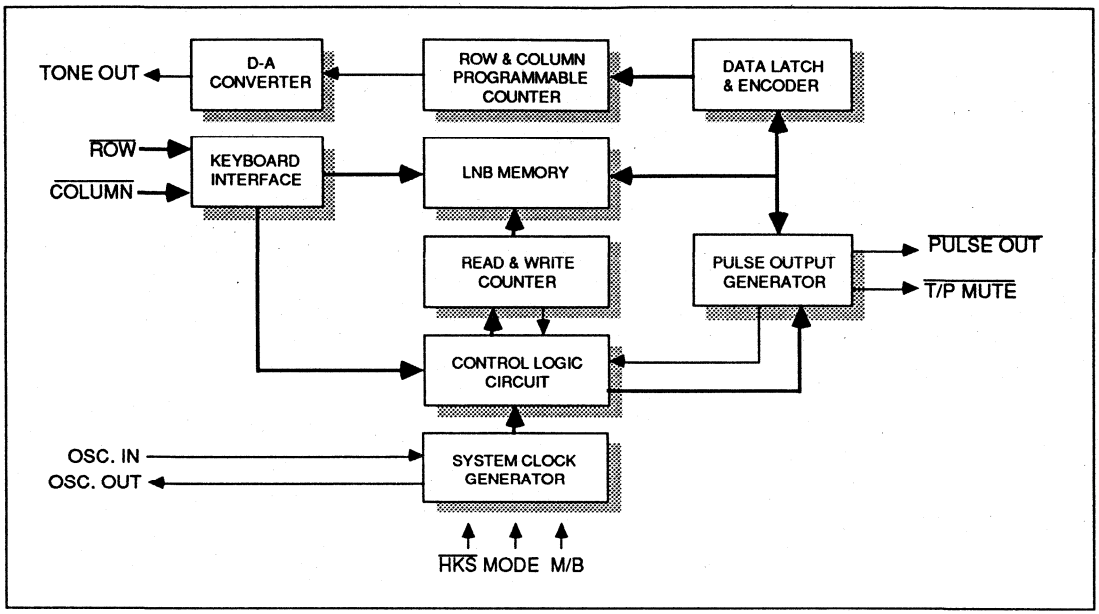
M/B	Pulse rate	Flash	M/B rate
OPEN	20 PPS	600 ms	33 : 66
V_{SS}	10 PPS	100 ms	40 : 60
V_{DD}	10 PPS	600 ms	33 : 66
	TEST MODE		

* MODE PIN SELECT TO 3 MODE:
* OPEN : PULSE mode
* V_{DD} : PULSE mode
* V_{SS} : TONE mode

Pin Assignment



Block Diagram



Keyboard Scheme

Row Group \ Col. Group	C1 1216Hz	C2 1332Hz	C3 1472Hz	C4
R1 699Hz	1	2	3	ST
R2 766Hz	4	5	6	MEMO
R3 848Hz	7	8	9	F
R4 948Hz	*	0	#	RD/P

F:Flash
ST:Memory Storing
MEMO:Memory Recalling
RD : Redial
: Redial(in pulse mode)

Note : In pulse mode, "#" can be used as P→T key.

Pin Functional Description

Symbol	Pin No.		Name And Function
ROW-COLUMN	1	18	The keypad input is compatible with the standard 2 of 8 keyboard the single contact (Form A) keyboard, and electronic input. In normal operation, any single button is pushed to produce dual tone, pulse or function. Activation of two or more buttons will result in no response, except for single tone,Table 1 illustrates address keypad function in detail.
	2	17	
	3	16	
	4	15	

Symbol	Pin No.	Name And Function
$\overline{HKS}$	5	The $\overline{HKS}$ hand hook switch input is used to detect the state of hand-set in ON-HOOK or OFF-HOOK. In ON-HOOK state, $\overline{HKS}$=1, the keyboard input is disabled in order to decrease the consumption of power. In OFF-HOOK state, $\overline{HKS}$=0, all of the function can be operated. On chip pull up resistor is built. (Typical 100K OHM)
M/B	6	If M/B pin is tied to "OPEN", the pulse rate is 20pps, the flash time is 600 ms, and the M/B rate is 33:66. When M/B pin is tied to "V_{DD}.", the pulse rate is 10 pps, the flash time is 600ms, and the M/B rate is 33:66. If M/B pin is tied to "V_{SS}", the pulse rate is 10pps, the flash time is 100 ms, and the M/B rate is 40:60. If M/B pin is provided a negative edge pulse.The IC is under test. ☆To avoid from malfunction due to enter into test mode, a capacitor about 1000PF shall be connected between M/B and V_{SS}.
MODE	7	There are two methods of switching the IC to pulse or tone dialer. Put MODE Selection pin to "OPEN" or V_{DD}, the dialer is in pulse mode. Put MODE to "V_{SS}", the dialer is in tone mode.
OSC.IN OSC.OUT	8 9	An built-in inverter provides oscillation with a 3.579545 MHz crystal, which is disabled when no keypad input has been sensed. An on-board counter is used to decrease the frequency of oscillation and creates keypad debounce, mute delay, pre-digit pause,Make-Break ratio, tone duration, row group and column group frequency, and key tone frequency etc. Any crystal frequency deviation from 3.579545 MHz will be reflected in the time parameters above.Most crystals do not vary more than ±200PPM
TONE OUT	12	In pulse mode,the tone output stays low state regardless of key-pad input. In DTMF mode, this pin outputs dual or single tone under the condition illustrated in Table 1. In manual dialing, the tone duration is equal to the period of button pushed minus the keypad debounce time. In auto dialing, the tone duration and inter-tone-pause is internally set to be 100 ms and 106 ms respectively. Figure 4 shows DTMF mode timing diagram.
$\overline{T/P\ MUTE}$	13	The mute is N-Channel open drain output. In pulse mode, it is at high impedence with no keypad entry;but goes low state when keypad is pushed during Tone/Pulse dial period.
$\overline{PULSE\ OUT}$	14	The PULSE OUT pin is an open-drain NMOS transistor output. In OFF-HOOK state, this NMOS transistor stays in ON-state only in break duration, but stays in OFF-state in make or normal duration, in order to send the pulses train of the address codes in pulse mode. The timing diagram of pulse mode is shown in fig. 3.

Absolute Maximum Ratings

(T_A = 25 °C)

Characteristics	Sym.	Ratings	Unit
DC Supply Voltage	V_{DD}	6.0	V
Input Voltage Range	V_{in}	-0.5 to V_{DD} + 0.5	V
Power Dissipation Per Package	P_o	500 (for T_A =-25°C to + 60°C)	mw
Operating Temperature	T_A	-25 to + 85	°C
Storage Temperate	T_{STG}	-65 to +150	°C

DC Characteristics

(V_{DD} = 2.5V, T_A = 25°C , Unless otherwise specified)

Characteristics	Sym.	Test Ckt.	Test Conditions	Limit Min.	Typ.	Max.	Unit
Operating Voltage	V_{DD}		Tone	2.0	-	5.5	V
			Pulse	2.0	-	5.5	
			Memory	1.0	-	5.5	
Operation Current Tone	Iop	A	Unloaded and Keypad Entry	-	0.6	2	mA
Pulse				-	0.2	0.6	
Standby Current	Is	A	$\overline{HKS}$=1, Unloaded and No Keypad Entry	-	0.1	5	µA
Memory Retention Current	Im	B	$\overline{HKS}$=1, V_{DD}=1V	-	0.1	0.2	µA
Tone Output Voltage	Vto	C	Row Group, Rl=10kohm,	-	150	-	mVrms
Pre-Emphasis		D	Column/Row V_{DD}=2.0-5.5V	1	2	3	dB
DTMF Distortion	THD	D	RL=10Kohm V_{DD}=2.0-5.5V	-	-30	-23	dB
Tone Output Load Impedance	R1		THD ≤-23dB	10	-	-	k
Tone Output DC Level	Vtdc	D	V_{DD}=2.0-5.5V,Keypad Entry	-	0.65V_{DD}	-	V
Tone Output Sink Current	Ito	E	Vto=0.5V,No Keypad Entry	0.2	-	-	mA
$\overline{Pulse}$ Output			Vpi=5V	-	-	0.1	µA
Leakage Current	Iph	E	Vpi=12V	-	-	1.0	
Sink Current	Ipl	F	Vpo=0.5V	1.0	3.0	-	mA
$\overline{T/P}$ Mute Output							
Leakage Current	Imh	E	Input = 12.0V	-	-	1	µA
Sink Current	Iml		Vmo = 0.5V	1.0	-	-	mA
Keypad Input							
Drive Current	Ikh	H	Vki = 0V	4	10	30	µA
Sink Current	Ikl	E,G	Vki = 2.5V	200	400	-	
Control Pin Input Leakage Current	Iin		$\overline{HKS}$, MODE, M/B Pins	-	±10 **(-5)	±0.1	µA

Note 1: Dual Tone Multi-Frequency Distortion is measured in terms of total out-of-band power related to the sum of the row & column fundamental power.

AC Characteristics

Characteristics	Sym.	Test Conditions		Limit Min.	Typ.	Max.	Unit
Keypad Debounce	t_{DB}	mode = "Open" or " V_{DD} "		-	20	-	ms
Pulse Mute Delay	t_{MD}	mode = "V_{DD}" or "Open"	M/B="V_{SS}"	-	40	-	ms
			M/B="V_{DD}".or "Open	-	33.3	-	
Pre-Digit Pause	t_{PDP}	mode = "V_{DD}" or "Open"	M/B="V_{SS}"	-	40	-	ms
			M/B="V_{DD}"or "Open	-	33.3	-	
Pulse Rate	f_{PR}	M/B = "V_{DD}" or "V_{SS}"		-	10	-	pps
		M/B = "Open"		-	20	-	
Make/Break Ratio	M:B	M/B = " V_{SS}"		-	40:60	-	%
		M/B = "Open" or "V_{DD}"		-	33:66	-	
Inter Digit Pause	t_{IDP}	M/B=Open		-	600	-	ms
		M/B="V_{DD}"or "V_{SS}"		-	800	-	
		M/B=Test mode		-	13.3	-	
Tone Duration	t_{TD}	Redial		-	100	-	ms
Inter Tone Pause	t_{ITP}	Redial		-	106	-	ms
Row Group Frequency	f1	Use	ROW1	-	699	-	
	f2	3.579545 MHz	ROW2	-	766	-	Hz
	f3	Crystal	ROW3	-	848	-	
	f4		ROW4	-	948	-	
Column Group Frequency	f5	Use	COL1	-	1216	-	
	f6	3.579545 MHz	COL2	-	1332	-	Hz
	f7	Crystal	COL3	-	1472	-	

Note: Crystal parameters defined as Rs ≤100 , Lm = 96mH, Cm = 0.25 pF
Ch = 5PF, F = 3.579545 MHz & Cl = 18 PF, F ≤±200ppm

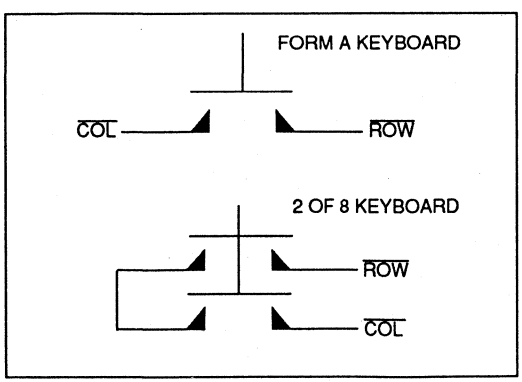


Figure 1. Keyboard Configuration

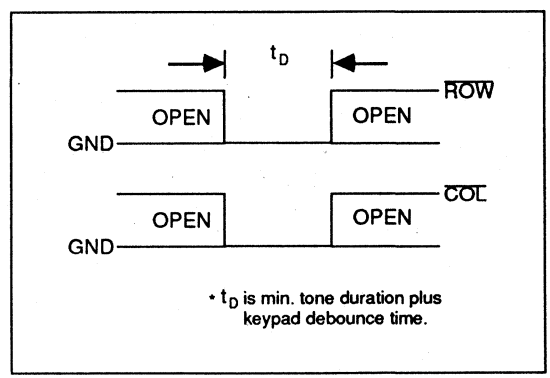


Figure 2. Electronic Input

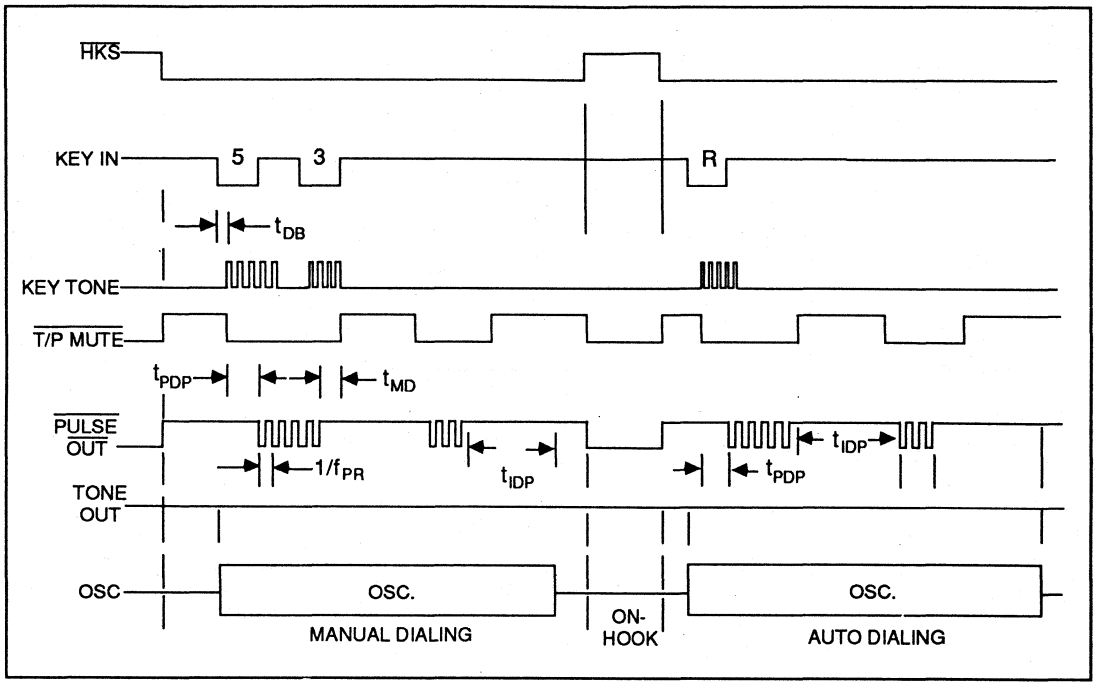


Figure 3. Pulse Mode Timing Diagram

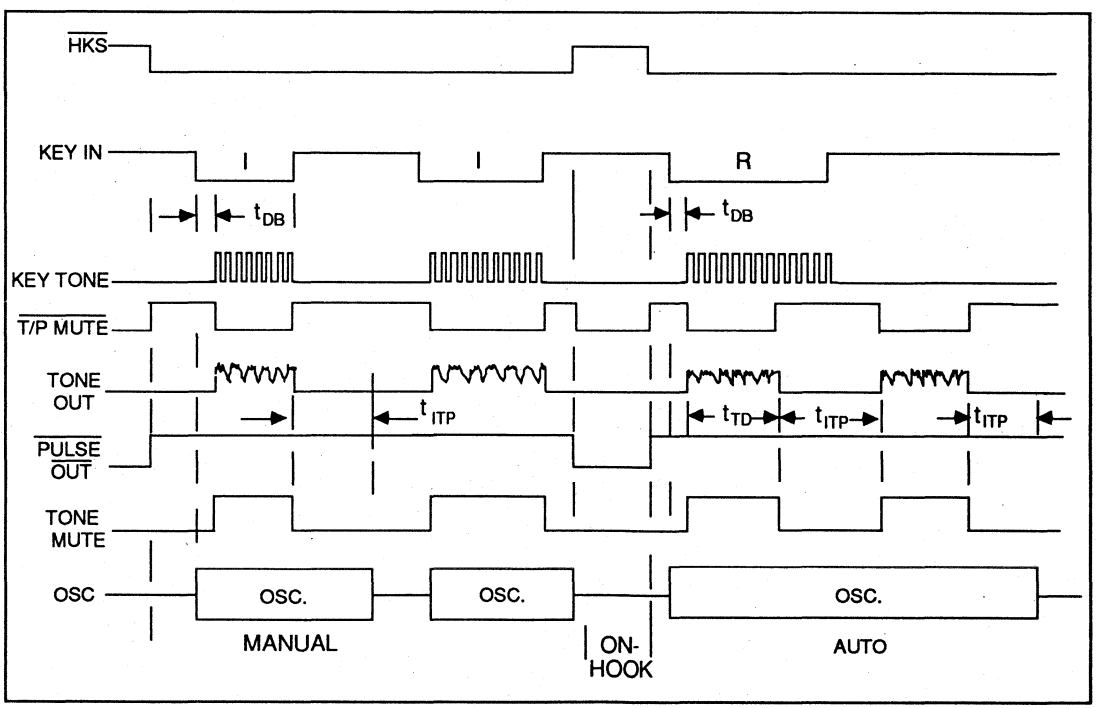


Figure 4. DTMF Mode Timing Diagram

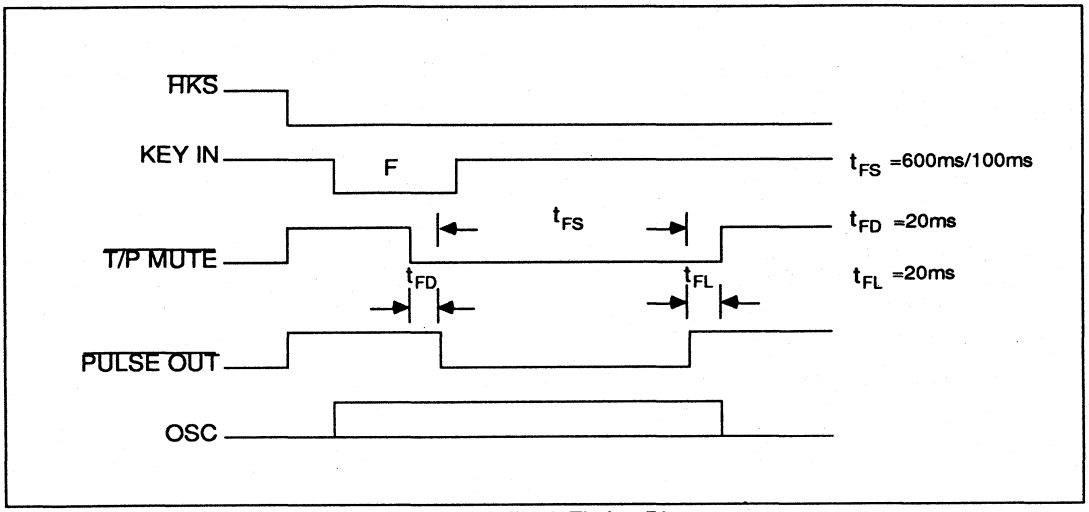


Figure 5. Flash Timing Diagram

M/B	Mode	Active Low Inputs ROW Pins	Active Low Inputs COLUMN Pins	Output Tone Out; PO
	V_{ss} (Normal) (Tone mode)	One	One	Dual Tone
		Two or More	One	
		One	Two or More	V_{ss}
		Two or More	Two or More	
↓	V_{ss} (Test mode)	One	One	Dual Tone
		Two or More	One	Column Tone
		One	Two or More	Row Tone
		Two or More	Two or More	V_{ss}
V_{DD} OPEN V_{ss}	V_{DD} OPEN (Normal) (pulse mode)	One	One	10 PPS, 20 PPS
		Two or More	One	
		One	Two or More	Open
		Two or More	Two or More	
↓	OPEN V_{DD} (Test mode)	One	One	600 PPS
		Two or More	One	
		One	Two or More	Open
		Two or More	Two or More	

Table 1 Address Keypads Truth Table (Continual)

Keyboard Operations

Note: All the keyboard operations should be under off-hook condition.

*** Normal Dialing**

1. Select Pulse or Tone mode
2. Push [D1] ,..., [Dn] ; D1...Dn : 0-9,*,#; n is unlimited.
   Then the number D1 - Dn will be dialed out in Pulse or Tone mode as selected.
   (Excluding of *, # in pulse mode)

*** Redialing**

Select Pulse or Tone mode

Push [D1] ,..., [Dn] ;n≤31 If busy, after ON-HOOK, Come OFF-HOOK, push [R] , the last number D1, D2, ... , Dn will be automatically dialed out in Pulse or Tone mode as selected again.

*** Mix-Dialing**

[REDIAL] + [MANU] is allowable. ; MANU: [D1] ,.., [Dn] ; Dn : 0-9.

*** Pause And Pulse To Tone Key Operation**

In some cases, such as PABX or LDC service, a pause should be inserted in the dialing sequence and different dialing modes. The chip provides user with pause function and Pulse/Tone switchable, which facilitates flexible applications.

(a) Dialing with Pause

Select Pulse or Tone mode

Push [D1] , [P] , [D2] , ... , [Dn] ; D1 - Dn : 0 - 9, * , #

Then the number will be dialed out in the following sequence:

D1, pause 3.6 sec. D2, ... , Dn.

(b) Redialing with Pause

When dialing operation as above, but busy , then ON-HOOK. Come OFF-HOOK, push [R] then the signal will be dialed out automatically as in the above sequences.

(c) Dialing with [P→T] key (# key=P→T key at pulse mode.)

Select the Pulse or Tone mode

Push [D1] , [D2] , ... , [Dn] , [P→T] , [D1'] , [D2'] , ... , [Dn'] Then the number will be dialed out in the following sequence:

1. If the mode switch is set in pulse mode, then the output signal will be:
   D1, D2, ... , Dn, pause 3.6 sec. D1', D2', ... , Dn'.
   (Pulse mode) (Tone mode)
2. If the mode switch is set in Tone mode, then the output signal will be:
   D1, D2, ... , Dn, pause 3.6 sec. D1', D2', ... , Dn'.
   (Tone mode) (Tone mode)

(d) Redialing with [P→T] Key

When redialing, the chip outputs the same sequences as above, but all the timing are fixed internally.

(e) Flash operation

This chip provides a convenient and precise flash function for PABX service. In the following operation; push F, then 600ms flash is supplied, and central unit will do service to caller, such as: transfer, wait - - - -. If after P→T , F keypad be pushed then the state turn to pulse mode.

Figure 5. Show flash timing diagram.

Note: The pause can be continuously stored for longer pause duration, but every pause will occupy one digit of memory size.

***Repertory Memory Storing**

(a) Select PULSE or TONE mode.

(b) SET OFF HOOK state. Input [ST] D1, D2,...Dn, [ST] , j [ST] , Dn+1,...,Dn+m,[ST], K,....
D = 0,..., 9, P. j, K=0,..., 9. n≤16, m≤16.

Note 1. Depressing FLASH key or ON/OFF HOOK once will make "memory storing" procedure return to initial state.

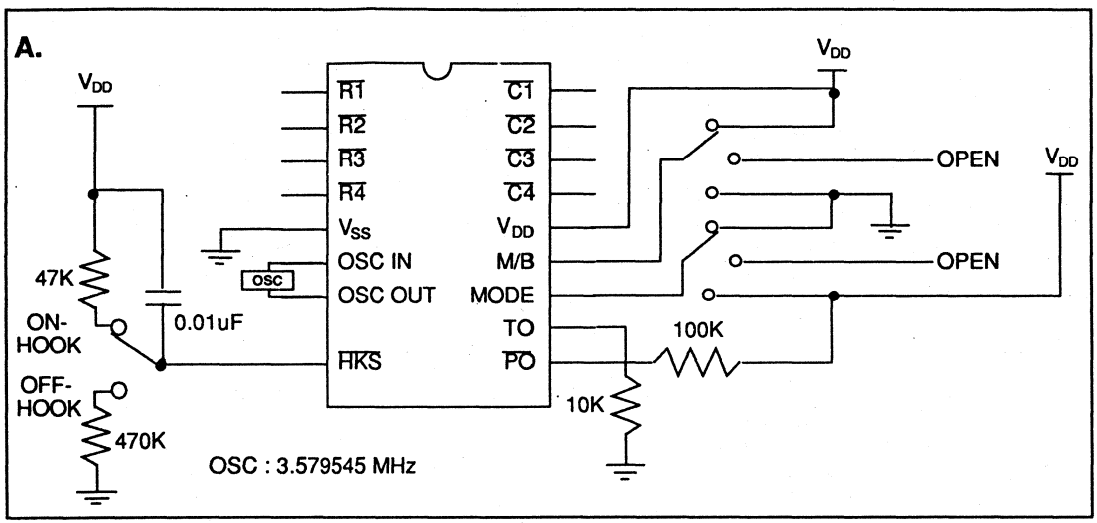
2. The new data entering the memory will replace the previous data.

*** Repertory Memory Recalling**

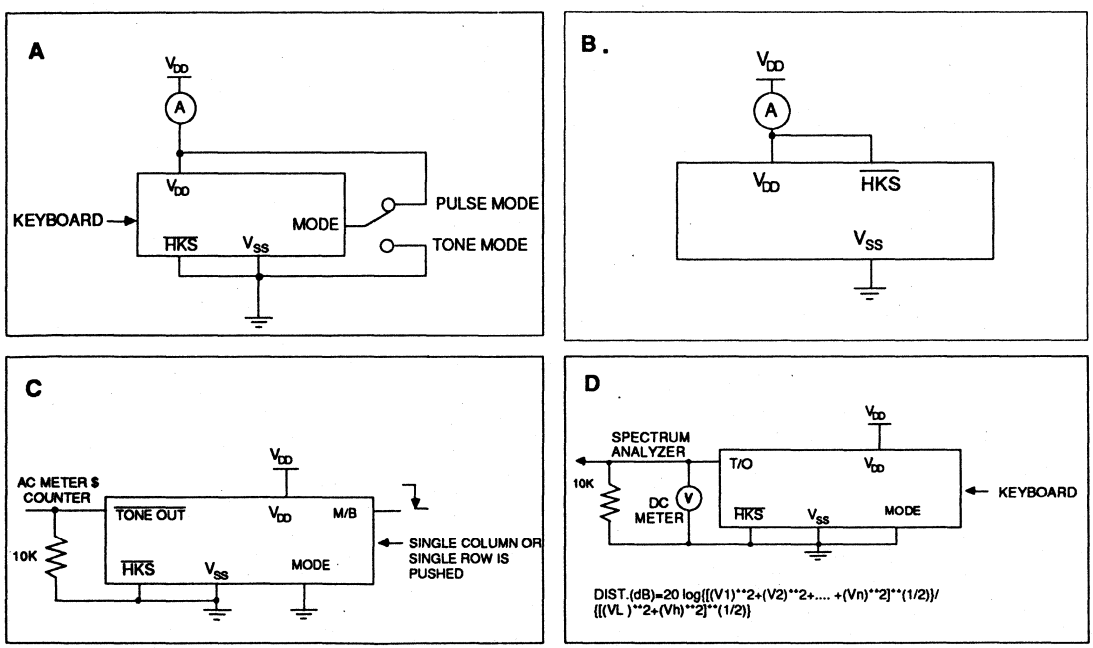
(a) Set OFF HOOK state.

(b) Input [MEMO] j, [MEMO] , K.

General Test Circuit

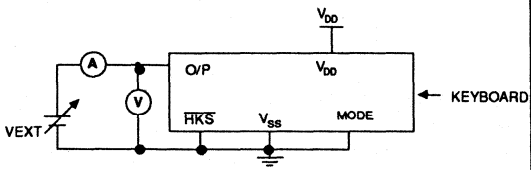


Test Circuit

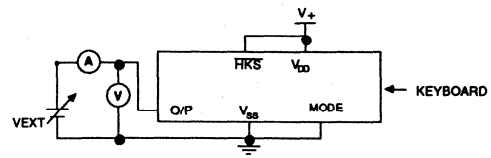


a. V1,..., Vn are extraneous frequencies (ie intermodulation and harmonic) components in the 500 Hz to 3400 Hz band.
b. VL , Vh are the individual frequency components of the DTMF signal.
c. Whether keyboard is pushed refer to the DTMF mode timing diagram.

E

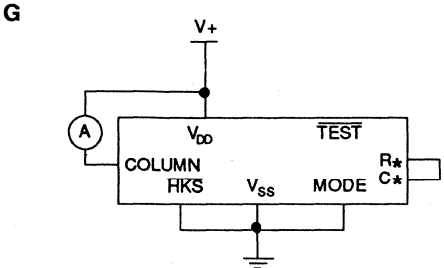


F

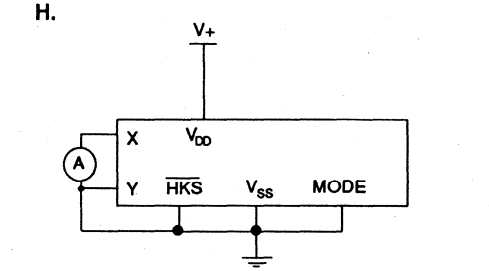


Note:Whether keyboard is pushed refer to the DTMF mode timing diagram.

G



H.



Note: R* any row of R1→R4.
C* any column of C1→C4.
Isink = I/(1 - Duty Cycle).
I is the net DC current measured from ampere meter.

Note: When column drive current is tested, the X is column and Y is row. When row drive current is tested, they exchange. IDrive = I/Duty Cycle; I is the net DC current measured from ampere meter.

General Description

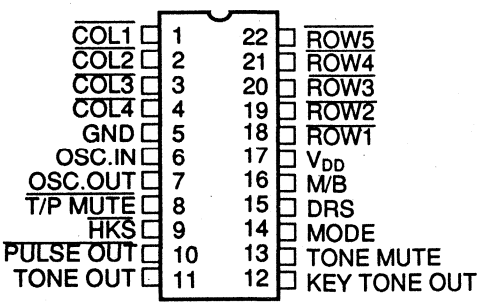
The HM 9112/A are 10-Memory Tone/Pulse switchable dialer which are fabricated in SACMOS technology with good performance in low voltage, low power operation. The M/B and DRS pins are decoded to fit the different country's various telephone systems. The HM 9112/A are pin to pin compatible with HM 9104, 9113A, 9114/A.

Features

* Tone/Pulse Switchable Dialer.
* Stores Ten 16-Digit Numbers for Repertory Dialing.
* One 31-Digit for Last Number Redial Memory.
* Auto Pause Access; 3.1 sec. per pause for HM 9112.
  3.6 sec per pause for HM 9112A (2 sec pause time can be obtained by metal option.)
**The differences between HM 9112 and HM 9112A are listed in Table 2.
* Key-Tone Output for valid keypad entry recognition for both pulse mode and tone mode.
* Both key-in and key-released debounce are 20ms.
* Minimun tone duration=100ms and minimum intertone pause=106ms for rapid key-in.
* Use 3.579545MHz crystal.
* Electronic Keypad Input is Available; Low Active.
* Pin selectable for M/B rate, flash time and pulse rate.
* Memory Retention Current≤0.2μA at V_{DD}=1.0V, On Hook.
* Wide Operation Voltage Range: 2.0V-5.5V
* 22-pin Dual-in-Line Package.
* Pin to Pin compatible with HM 9104, 9113A, 9114/A.

Pin Assignment

HM 9112/A



KEYBOARD FUNCTION

COL1	COL2	COL3	COL4	
1	2	3		ROW1
4	5	6		ROW2
7	8	9		ROW3
*	0	#		ROW4
R/P	S	A	F	ROW5

S: Store A: Auto Dialing F: Flash
R/P: First touch after off-hook is redial function.
Others are excute Pause.

Absolute Maximum Ratings

(T_A = 25 °C)

Characteristics	Sym.	Ratings	Unit
DC Supply Voltage	V_{DD}	6.0	V
Input Voltage Range	V_{in}	-0.5 to V_{DD} + 0.5	V
Power Dissipation Per Package	P_d	500 (for T_A =-25°C to + 60°C)	mw
Operating Temperature	T_A	-25 to + 85	°C
Storage Temperate	T_{STG}	-65 to +150	°C

DC Characteristics

(V_{DD} = 2.5V, T_A = 25°c , Unless otherwise specified)

Characteristics	Sym.	Test Ckt.	Test Conditions	Limit Min.	Typ.	Max.	Unit
Operating Voltage	V_{DD}		Tone	2.0	-	5.5	V
			Pulse	2.0	-	5.5	
			Memory	1.0	-	5.5	
Operation Current	Iop	1	Tone	-	0.6	2	mA
			Pulse Note 1,4,6	-	0.2	0.5	
Memory Retention Current	Imr	2	$\overline{HKS}$=1, T_A=45°C,V+=1.0V	-	0.1	0.2	µA
Standby Current	Is	1	Note 2,3,5,6,11	-	0.1	5	µA
Tone Output Voltage	Vto	3	Row Group, RL=10kΩ.	-	150	-	mVrms
Pre-Emphasis		4	Column/Row Group V_{DD}=2.0-5.5V	1	2	3	dB
DTMF Distortion	THD	4	RL=10KΩ, Note 7,8	-	-30	-23	dB
Tone Output Load Imped ance	R1		THD≤ -23dB	10	-	-	kΩ
Tone Output DC Level	Vdc	4	V_{DD}=2.5-5.5V	0.5V_{DD}	-	0.6V_{DD}	-
Sink Current	Itl	5	Vto=0.5V	0.2	-	-	mA
Pulse Output Drive Current	Iph	5	Vpo=2.0V	-0.2	-	-	mA
Sink Current	Ipl	6	Vpo=0.5V	0.2	-	-	
$\overline{T/P}$ Mute Output Drive Current	Imh	5	Vmo = 2.0V	-0.2	-	-	mA
Sink Current	Iml		Vmo = 0.5V	1.0	-	-	
Key Tone Output Drive Current	Ikh	8	Vko = 2.0V	-0.5	-	-	mA
Sink Current	Ikl	5	Vko= 0.5V	0.5	-	-	
Tone Mute Output Drive Current	Ilh	5	Vlo=2.0V	-0.5	-	-	mA
Sink Current	Ill		Vlo=0.5V	0.5	-	-	

(II)

Characteristics	Sym.	Test Ckt.	Test Conditions	Limit Min.	Typ.	Max.	Unit
Keypad Debounce	t_{DB}		* ,Note 8,9,10	-	20	-	ms
Pulse mute delay	t_{MD}		* ,Note 8,9 M/B=1	-	40	-	ms
			M/B=0	-	33.3	-	
Pre-digit Pause	t_{PDP}		* ,Note 8,9 M/B=1	-	40	-	ms
			M/B=0	-	33.3	-	
Pulse Rate	f_{PR}		* M/B=1,DRS=1	-	10	-	
			— Note 8,M/B=0,DRS=0	-	20	-	PPS
			** M/B=1,DRS=0	-	600	-	
Inter Digit Pause	t_{IDP}		* M/B=1,DRS=1	-	800	-	
			— Note 8,M/B=0,DRS=0	-	600	-	ms
			** M/B=1,DRS=0	-	13.3	-	
Make/Break Ratio	M:B		M/B=1 / M/B=0 Note 8;*	-	40:60	-	%
				-	33.3:66.6	-	
Tone Duration	t_{TD}		Auto Dialing, Note 8	-	100	-	ms
Inter Tone Pause	t_{ITP}		Auto Dialing, Note 8	-	106	-	ms
Row Group Frequency	f1		Row 1, Note 8	-	699	-	
	f2	3.	Row 2, Note 8	-	766	-	
	f3		Row 3, Note 8	-	848	-	Hz
	f4		Row 4, Note 8	-	948	-	
Column Group Frequency	f5		Col.1, Note 8	-	1216	-	
	f6	3.	Col.2, Note 8	-	1332	-	Hz
	f7		Col.3, Note 8	-	1472	-	
Key Tone Frequency	fK		Note 8	-	1.2	-	KHz
Input Voltage Low	Vil		Pins, 1-4,9,14,15,7 &	GND	-	$0.3V_{DD}$	
Input Voltage High	Vih		18-22	$0.7V_{DD}$	-	V_{DD}	V
Keypad Input							
Drive Current	Ikd	6.	Vi = 0V	4	10	30	
Sink Current	Iks	5.7	Vl = 2.5V	100	400	800	µA
Control Pin Input Leakage Current	Iin		Pins 9,14,15,17	-	0.001	0.1	µA

* M/B ≠ 1 and DRS≠ 0

** M/B = 1, DRS = 0 ; test mode.

Note 1 : HKS=0
2 : In DTMF Mode
3 : In Pulse Mode
4 : Keyboard Entry, Including Auto Dialing
5 : No Keyboard Entry
6 : All Output Unloadaed
7 : Dual Tone Multi-Frequency Distortion is measured in terms of total out-of-band power related to the sum of the row & column fundamental power.
8 : Crystal parameters defined as Rs≤100, Lm=96mH Cm=0.25PF Ch=5PF, F=3.579545MHz & Cl=18PF F≤200 PPM
9 : Refer to Pulse Mode Time Diagram
10: Refer to DTMF Mode Time Diagram

Functional Description

* $\overline{\text{ROW}}$ —— $\overline{\text{COLUMN}}$ INPUTS (Pins 1-4 & 18-22)
The keypad input is compatible with the standard 2-of-9 keyboard, the inexpensive single-contact (Form A) keyboard, and electronic input.
In normal operation, any single button is pushed to produce dual tone, pulses or function. Activation of two or more buttons will result in no response, except for single tone.
Table 1 illustrates the address keypad function, in detail.

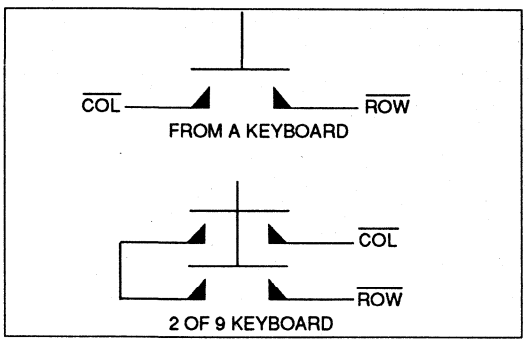


Fig. 1 Keyboard Configuration

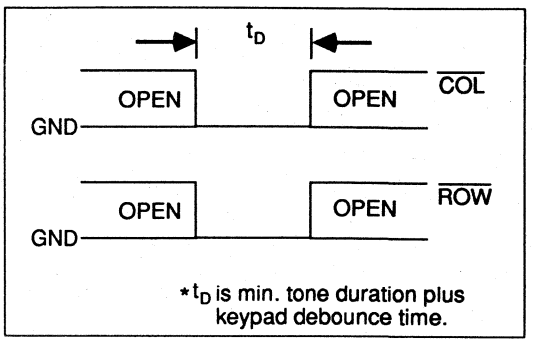


Fig. 2 Electronic Input

Table 1. Address Keypads Truth Table

Output		Active Low Inputs ROW (Pins 18-21)	COLUMN (Pin 1-3)	Output TONE (Pin 11) PULSE (Pin 10)
Tone Mode (Pin 14=0)	Normal	One	One	Dual Tone
		Two or More	One	Pin 11 = 0
		One	Two or More	
		Two or More	Two or More	
	Single Tone (Pin 15=Low) (Pin 16=High)	One	One	Dual Tone
		Two or More	One	Column Tone
		One	Two or More	Row Tone
		Two or More	Two or More	Pin 11 = 0
Pulse (Pin 14=V_{DD} or open)	10 PPS (Pin 15& Pin 16) See Note 4.	One	One	10 PPS
		Two or More	One	Pin 10 =1
		One	Two or More	
		Two or More	Two or More	
	600 PPS (Pin 15 = Low Pin 16 = High)	One	One	600 PPS
		Two or More	One	Pin 10 = 1
		One	Two or More	
		Two or More	Two or More	

Note 1 : In pulse mode, pin 10=1 for * & # buttons
Note 2 : In pulse mode, always Pin 11=0, In DTMF mode, always Pin 10=1
Note 3 : Pin 10=1, Pin 11=0 for any button in Row 5 & Column 4, regardless of mode.
Note 4 :

M/B	DRS	M/B Rate	Flash Time	Pulse Rate
1	1	2:3	600 ms	10 PPS
0	1	1:2	100 ms	10 PPS
0	0	1:2	600 ms	20 PPS
1	0	test		

*** OSC. IN (Pin 6), OSC. OUT (Pin 7)**

A built-in inverter provides oscillation with a 3.579545MHz crystal. The oscillator ceases when a keypad input is not sensed.

*** $\overline{\text{T/P MUTE}}$**

The $\overline{\text{MUTE}}$ output pulls to V_{DD} with no keyboard input and pulls to GND when transmitting.(excluding the * & # Keys, in pulse mode). But, if row 5 and column 4 is pushed, then $\overline{\text{MUTE}}$ stays high level still.

*** $\overline{\text{HKS}}$**

The $\overline{\text{HKS}}$ (Hook Switch) input is used to sense the state of the handset in ON-HOOK or OFF-HOOK. In ON-HOOK state, $\overline{\text{HKS}}$=1, the keyboard input is disabled, there is no operation for any keyboard entry, to avoid the energy loss stored in capacitor. In OFF-HOOK state, HKS=0, all of the function work.

*** $\overline{\text{PULSE OUT}}$**

In DTMF mode, the pulse out stays high level regardless of keyboard entry. In pulse mode, this output sends a chain of pulses to the corresponding address keypad input, but stays high level for * and # entry. Figure 3. shows the timing diagram in pulse mode. The pulse rate and inter digit pause are fixed, in normal condition Pin 15=1, to be 10pps and 800ms respectively.

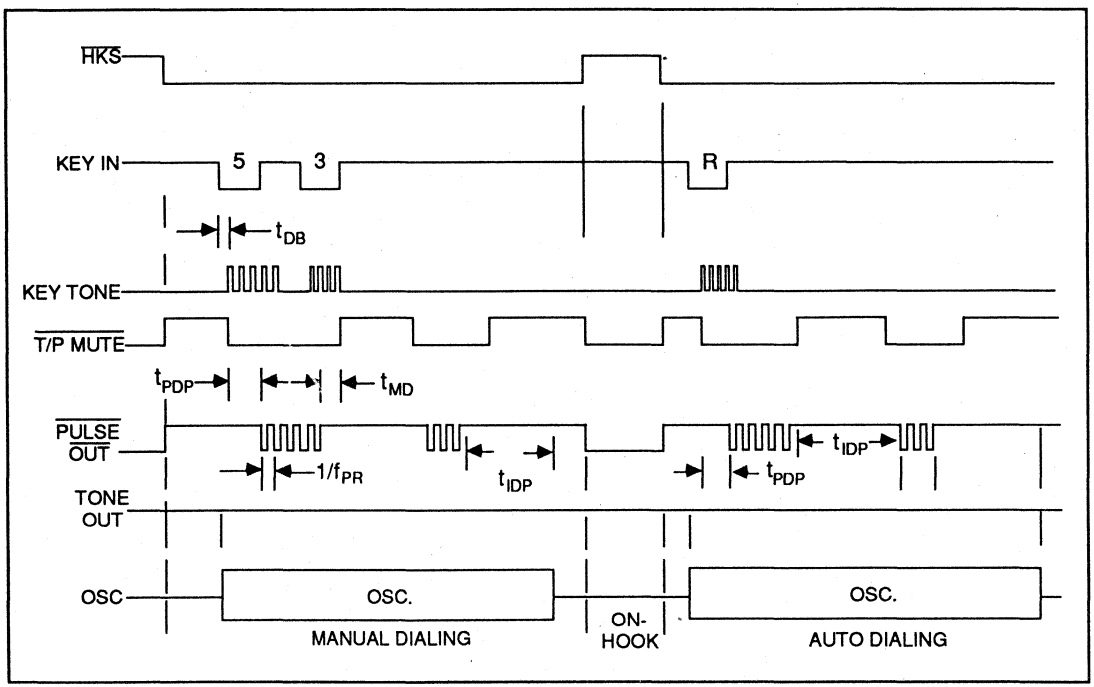


Fig. 3 Pulse Mode Time Diagram

*** TONE OUT**

In pulse mode, the tone output stays low state regardless of keypads input. In DTMF mode, the pin outputs dual tone or single tone, refer to Table 1. In normal dialing, the tone duration depends on key-in situation. When a valid key-in is less than 100 ms the tone duration will be fixed at 100ms. On the other hand, the tone duration will lasts as long as the key is pressed. As the same algorithm,the inter-tone-pause will be different under the following conditions: when key-release period continues less than 106ms, it will be fixed at 106ms. Otherwise, it will equal the the key- release duration. The tone duration and inter-tone-pause are internally set to be 100ms and 106ms respectively in auto dialing. Figure 4 illustrates the DTMF time diagram.

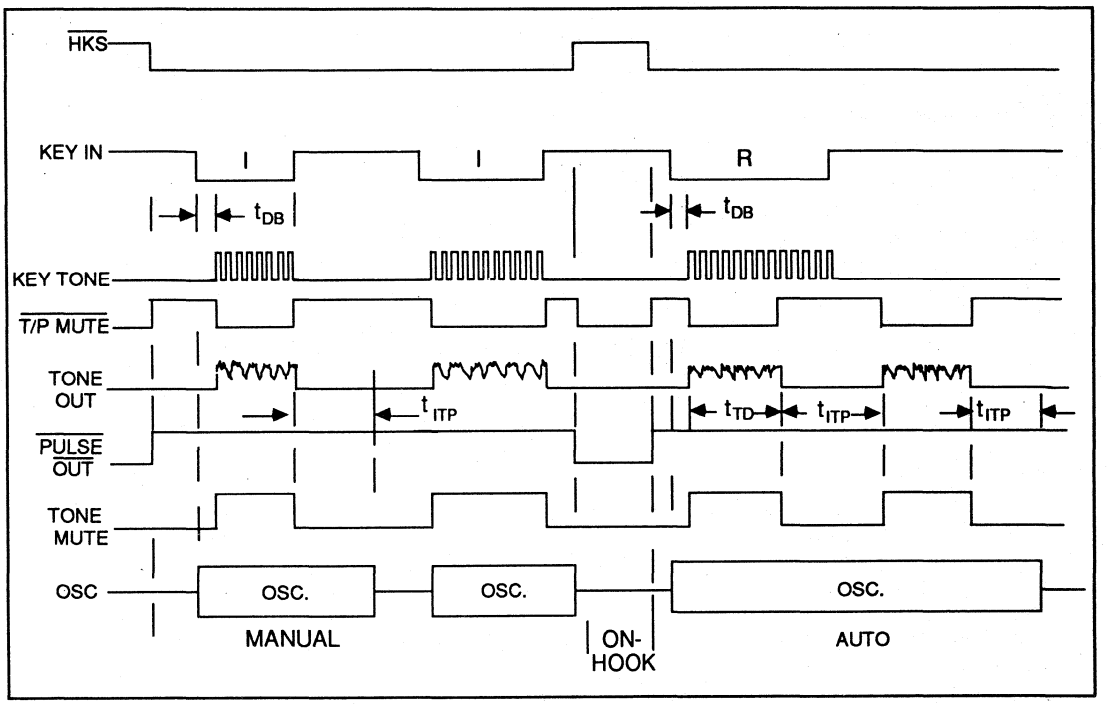


Fig. 4 DTMF Mode Timing Diagram

*** KEY TONE OUT**

The key tone output is a conventional CMOS inverter. A NPN transistor is needed to drive a piezo. The output frequency is 1.2KHz. In spite of DTMF or Pulse mode, the key tone actuate after any keypad (including row 5 and column 4)entry has been detected,and ceases at the time the button is released. There is no key tone output, whenever two or more keyboard buttons are pushed simultaneously.

*** TONE MUTE**

The T MUTE is a conventional CMOS inverter. In DP mode, the output always stays low in the duration of DP signal sending. But, the output presents a logic high in Tone mode. It can execute the muting operation in Tone mode.

*** MODE**

Pulls pin 14 to Vdd or unconnected, the dialer is in pulse mode. On the contrary, it is in DTMF mode.

*** M/B & DRS**

The M/B & DRS pin used to decode four selectable status as following

M/B	DRS	M/B rate	Flash	PPS
1	1	2:3	600ms	10pps
0	1	1:2	100ms	10pps
0	0	1:2	600ms	20pps
1	0	Test		

Keyboard Operations

Note : All the keyboard operations should be under OFF-HOOK conition.

I. Normal Dialing

Select Pulse or Tone mode.
Off-hook (n≤31)
Push [D1]—[Dn] , D1 - Dn : 0-9, *, #
Then the number D1,... Dn will be dialed out in Pulse or Tone mode as selected.

II. Redialing

Select Pulse or Tone mode.
Off-hook
Push [D1]—[Dn] , busy, ON-HOOK.
Come OFF-HOOK. push [R/P] , THEN last number D1D2....Dn will be automatically dialed out in Pulse or Tone mode as selected.

III. Number Storing

Select pulse or Tone mode.
Off-hook
Push [S] [D1]— [Dn] [S] [Ln] Ln: 0 - 9
then the number D1,..,Dn will be stored in location [Ln]

IV. Memory Dialing

Select Pulse or Tone mode.
Off-hook
Push [A], [Ln] , then the number stored in location [Ln] will be automatically dialed out in Pulse or Tone mode as selected.

V. Pause Key Operation

In some cases, such as PABX or long distance service, pauses should be inserted in the dialing sequence. The HM 9112A provides stackable pause function which facilitates flexible applications. For examples:

a. Dialing with Pause Key
1. Select Pulse or Tone Mode.
Off-hook
Push [D1] , [R/P] , [D2] , , [Dn] ; D1-Dn : 0 -9 , *, #.
then the number will be dialed out in the following sequence:
D1, without pause , D2, ... , Dn. (for HM 9112 : no pause time in normal dialing)
D1, PAUSE TIME, D2,... , Dn. (for HM 9112A : with 3.6sec pause time in normal dialing)

2. Redialing with Pause Key
When redialing, the chip outputs following sequences:
D1, pause time, D2,.....Dn.

b. Storing with Pause Key

1. Select Pulse or Tone Mode
Off-hook
Push [S] [D1] [R/P] [D2] ,., [Dn] [S] [Ln]
then the number D1, Pause time, D2...Dn will be stored in [Ln]

2. Dialing with Pause Key.
Select Pulse or Tone mode.
Push [A] [Ln], then the output signal will be dialed in the following sequence.
D1, pause time, D2,...Dn.

Note :Pause time HM 9112 : 3.1 sec/Pause
HM 9112A: 3.6 sec/Pause

VI. Flash Operation

This chip provides a convenient and precise flash function for PABX service. In the following operation; push F, then 600ms flash is supplied, and central unit will service the caller, such as: transfer, wait - - - -.
Figure 5. Shows flash timing diagram.

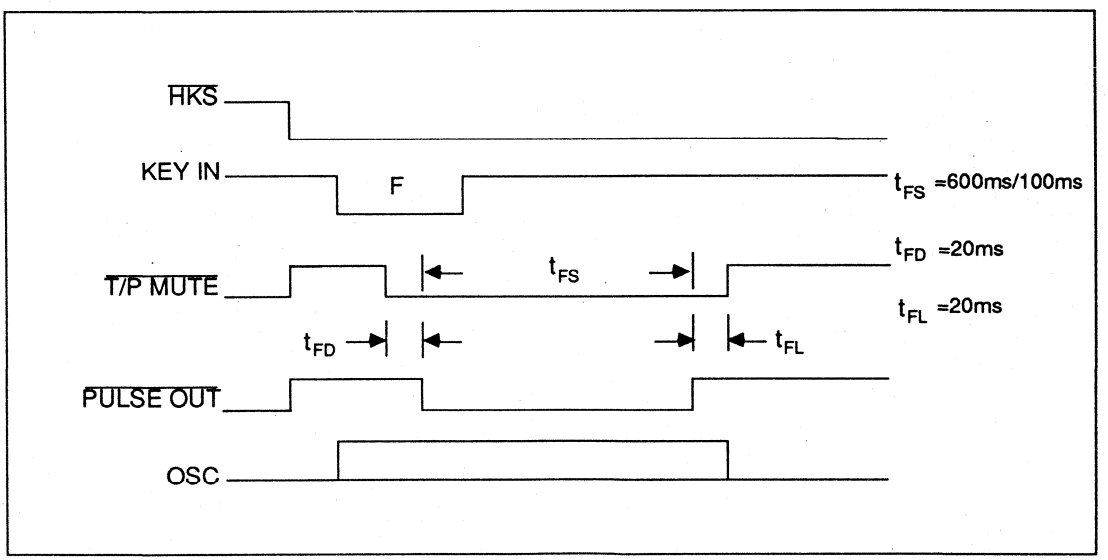
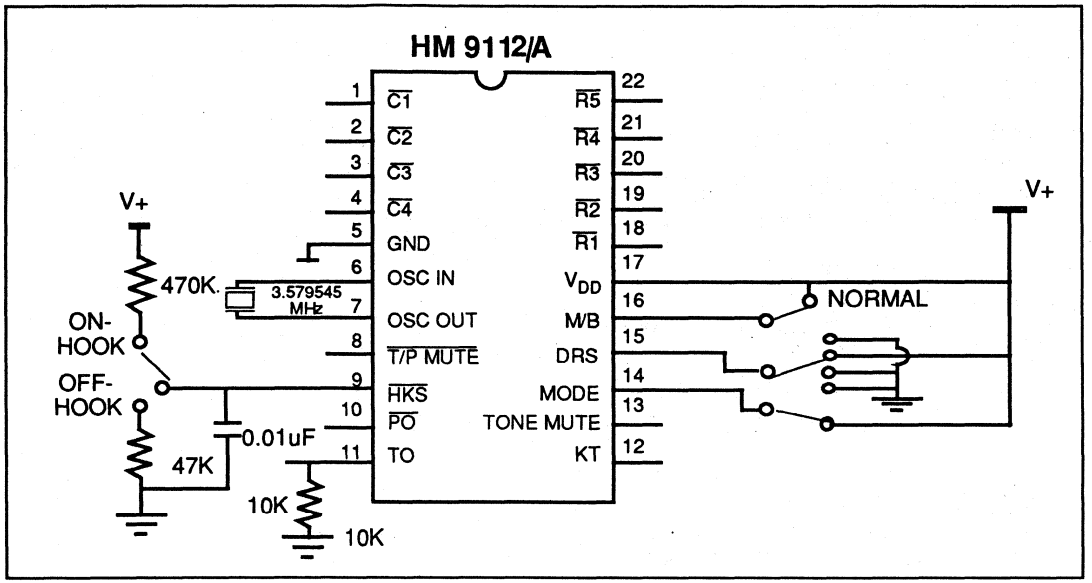
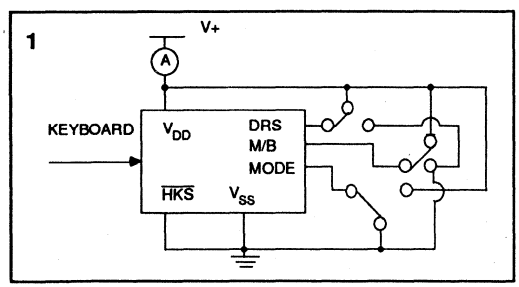


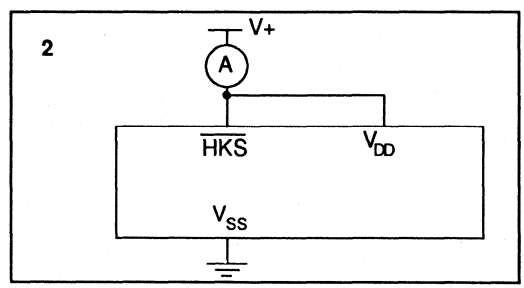
Fig. 5 Flash Timing Diagram

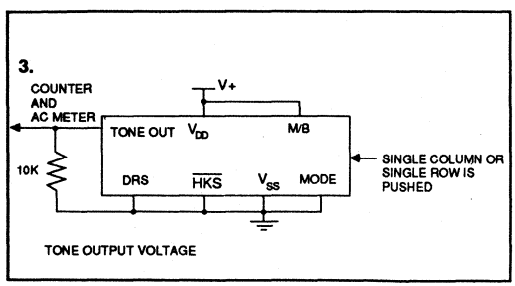
General Test Circuit

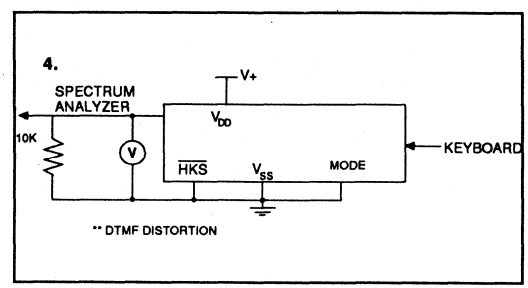


Test Circuit









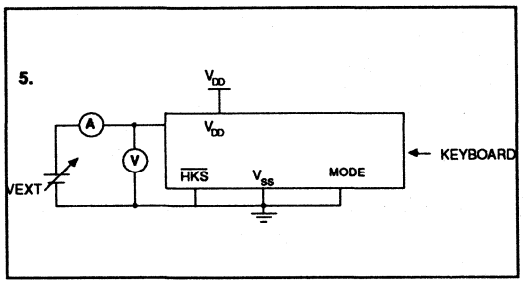
**

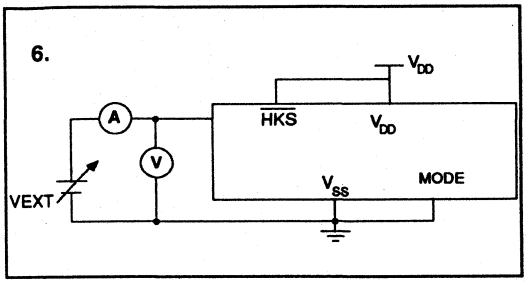
$$DIST.(dB) = 20\log \frac{\sqrt{(V1)^{**}2+(V2)^{**}2+..+(Vn)^{**}2}}{\sqrt{(VL)^{**}2+(VH)^{**}2}}$$

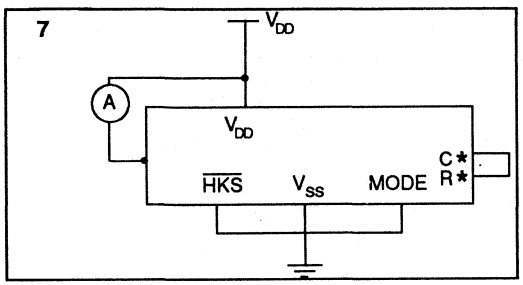
a. V1....Vn are extraneous frequencies (ie, inter modulation and harmonic) components in the 500Hz to 3400Hz band.

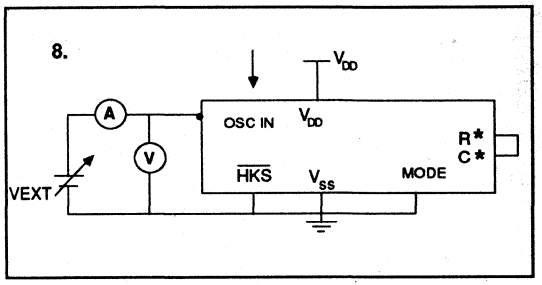
b. VL,VH are the individual frequency components of the DTMF signal

Test Circuit









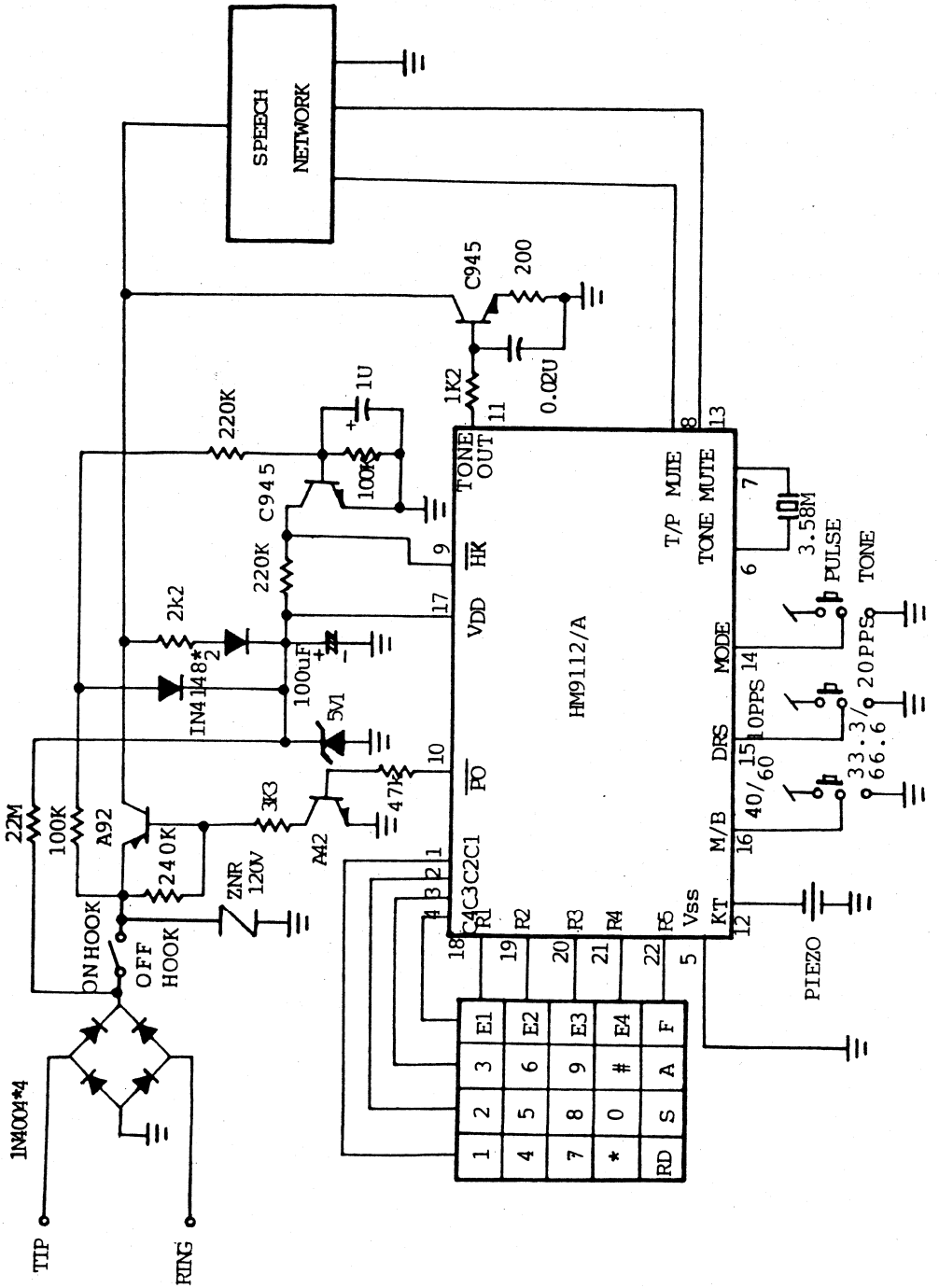
R* : anyone row of R1-R5
C* : anyone column of C1-C4
Isink=I/(1-Duty Cycle) I is the net DC current measured from ampere meter.

Procedure:
1 Provide clocks until output change to high.
2 Test its current.

Table 2. The differences between HM 9112 and HM 9112A

HM 9112	HM 9112A
(a) IDP of 20pps: 400ms	(a) IDP of 20pps: 600ms
(b) Pause Time : 3.1 sec.	(b) Pause Time: 3.6 sec. but 2 sec can be obtained by metal option.
(c) Depress "PAUSE" key under normal dialing. It won't pause 3.1sec.	(c) Depress "PAUSE" key under normal dialing. It will pause 3.6 sec.

HM 9112A Application Example



General Description

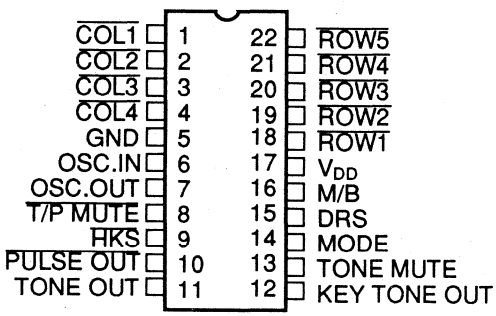
HM 9113A is an improved version of 9113. The HM 9113A is a 14-Memory Tone/Pulse switchable dialer which is fabricated in SACMOS technology with good performance in low voltage, low power operation. Three 16-digit one touch memories are used for convenient emergency calls (such as fire, police, hospital). The M/B and DRS pin are decoded to fit the different country's various telephone systems.

Features

* Tone/Pulse Switchable Dialer.
* Stores Ten 16-Digit Numbers for Repertory Dialing.
* Three 16-Digit Numbers for Emergency Calling Memory.
* One 31-Digit for Last Number Redial Memory.
* Auto Pause Access; 3.6 sec. per pause. (2sec, 3.2sec pause time can be obtained by metal option.)
* Key-Tone Output for valid keypad Entry recognition for both pulse mode and tone mode.
* Both key-in and key-released debounce are 20ms.
* Minimun tone duration=100ms and minimum intertone pause=106ms for rapid key-in.
* Use 3.579545MHz crystal.
* Electronic Keypad Input is Available; Low Active.
* Pin selectable for M/B rate,flash time and pulse rate.
* Keyboard switching from pulse mode to TONE mode.
* Memory Retention Current≤0.2 A at V =1.0V, On Hook.
* Wide Operation Voltage Range: 2.0V-5.5V
* 22-pin Dual-in-Line Package.

Pin Assignment

HM9113A



KEYBOARD FUNCTION

COL1	COL2	COL3	COL4	
1	2	3	EM1	ROW1
4	5	6	EM2	ROW2
7	8	9	EM3	ROW3
*	0	#	P→T	ROW4
R/P	S	A	F	ROW5

S: Store A: Auto Dialing
EM1-EM3: Emergency 1-3 F: Flash;
P→T: Pulse to tone switching.
R/P: First touch after off-hook is redial function.
Others are output Pause 3.6 sec.

Absolute Maximum Ratings

(T_A = 25 °C)

Characteristics	Sym.	Ratings	Unit
DC Supply Voltage	V_{DD}	6.0	V
Input Voltage Range	V_{in}	-0.5 to V_{DD} + 0.5	V
Power Dissipation Per Package	P_d	500 (for T_A =-25°C to + 60°C)	mw
Operating Temperature	T_A	-25 to + 85	°C
Storage Temperate	T_{STG}	-65 to +150	°C

DC Characteristics

(V+ = 2.5V, T_A = 25°c , Unless otherwise specified)

Characteristics	Sym.	Test Ckt.	Test Conditions	Limit Min.	Typ.	Max.	Unit
Operating Voltage	V_{DD}		Tone	2.0	-	5.5	V
			Pulse	2.0	-	5.5	
			Memory	1.0	-	5.5	
Operation Current	Iop	1	Tone	-	0.6	2	mA
			Pulse Note 1,4,6	-	0.2	0.5	
Memory Retention Current	Imr	2	$\overline{HKS}$=1, T_A=45°C,V+=1.0V	-	0.1	0.2	µA
Standby Current	Is	1	Note 2,3,5,6,11	-	0.1	5	µA
Tone Output Voltage	Vto	3	Row Group, RL=10Ω.	-	150	-	mVrms
Pre-Emphasis		4	Column/Row Group V+=2.0-5.5V	1	2	3	dB
DTMF Distortion	THD	4	RL=10K, Note 7,8	-	-30	-23	dB
Tone Output Load Imped ance	R1		THD≤ -23dB	10	-	-	kΩ
Tone Output							
DC Level	Vdc	4	V+=2.5-5.5V	0.5V+	-	0.6V+	-
Sink Current	ItL	5	Vto=0.5V	0.2	-	-	mA
Pulse Output							
Drive Current	Iph	5	Vpo=2.0V	-0.2	-	-	mA
Sink Current	Ipl	6	Vpo=0.5V	0.2	-	-	
$\overline{T/P}$ Mute Output							
Drive Current	Imh	5	Vmo = 2.0V	-0.2	-	-	mA
Sink Current	Iml		Vmo = 0.5V	1.0	-	-	
Key Tone Output							
Drive Current	Ikh	8	Vko = 2.0V	-0.5	-	-	mA
Sink Current	Ikl	5	Vko= 0.5V	0.5	-	-	
Tone Mute Output Drive	Ilh	5	Vlo=2.0V	-0.5	-	-	mA
Sink Current	Ill	5	Vlo=0.5V	0.5	-	-	mA

(II)

Characteristics	Sym.	Test Ckt.	Test Conditions	Limit Min.	Typ.	Max.	Unit
Keypad Debounce	t_{DB}		* ,Note 8,9,10	-	20	-	ms
Pulse mute delay	t_{MD}		* ,Note 8,9 M/B=1	-	40	-	ms
			M/B=0	-	33.3	-	
Pre-digit Pause	t_{PDP}		* ,Note 8,9 M/B=1	-	40	-	ms
			M/B=0	-	33.3	-	
Pulse Rate	f_{PR}						
			* M/B=1,DRS=1	-	10	-	
			— Note 8,M/B=0,DRS=0	-	20	-	PPS
			** M/B=1,DRS=0	-	600	-	
Inter Digit Pause	t_{IDP}						
			* M/B=1,DRS=1	-	800	-	
			— Note 8,M/B=0,DRS=0	-	600	-	ms
			** M/B=1,DRS=0	-	13.3	-	
Make/Break Ratio	M:B		M/B=1 / M/B=0 Note 8;*	-	40:60	-	%
				-	33.3:66.6	-	
Tone Duration	t_{TD}		Auto Dialing Note 8	-	100	-	ms
Inter Tone Pause	t_{ITP}		Auto Dialing Note 8	-	106	-	ms
Row Group Frequency	f1		Row 1, Note 8	-	699	-	
	f2	3.	Row 2, Note 8	-	766	-	Hz
	f3		Row 3, Note 8	-	848	-	
	f4		Row 4, Note 8	-	948	-	
Column Group Frequency	f5		Col.1, Note 8	-	1216	-	
	f6	3.	Col.2, Note 8	-	1332	-	Hz
	f7		Col.3, Note 8	-	1472	-	
Key Tone Frequency	fK		Note 8	-	1.2	-	KHz
Input Voltage Low	Vil		Pins, 1-4,9,14,15,7 &	GND	-	0.3V+	
Input Voltage High	Vih		18-22	0.7V+	-	V+	
Keypad Input Drive Current	Ikd	6.	Vi = 0V	4	10	30	
Sink Current	Iks	5.7	VI = 2.5V	100	400	800	
Control Pin Input Leakage Current	Iin		ins 9,14,15,17	-	0.001	0.1	µA

* M/B ≠ 1 and DRS≠ 0
** M/B = 1, DRS = 0 ; test mode.

Note 1 : HKS=0
2 : In DTMF Mode
3 : In Pulse Mode
4 : Keyboard Entry, Including Auto Dialing
5 : No Keyboard Entry
6 : All Output Unloadaed
7 : Dual Tone Multi-Frequency Distortion is measured in terms of total out-of-band power related to the sum of the row & column fundamental power.
8 : Crystal parameters defined as Rs≤100, Lm=96mH Cm=0.25PF Ch=5PF, F=3.579545MHz & Cl=18PF F≤200 PPM
9 : Refer to Pulse Mode Time Diagram
10: Refer to DTMF Mode Time Diagram

Functional Description

* $\overline{\text{ROW}}$ —— $\overline{\text{COLUMN}}$ INPUTS (Pins 1-4 & 18-22)
The keypad input is compatible with the standard 2-of-9 keyboard, the inexpensive single-contact (Form A) keyboard, and electronic input.
In normal operation, any single button is pushed to produce dual tone, pulses or function.
Activation of two or more buttons will result in no response, except for single tone.
Table 1 illustrates the address keypad function, in detail.

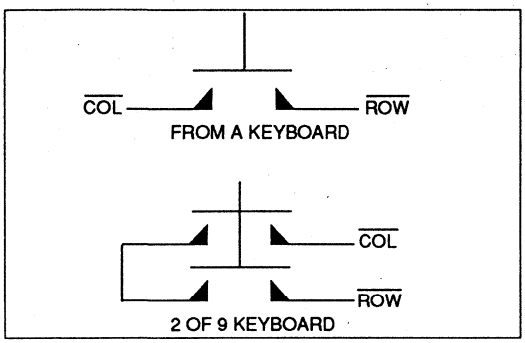


Fig. 1 Keyboard Configuration

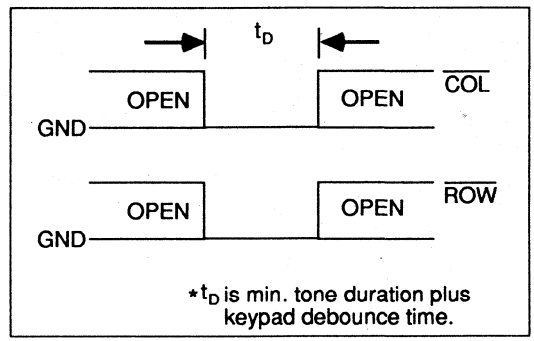


Fig. 2 Electronic Input

Table 1. Address Keypads Truth Table

Output		Active Low Inputs ROW (Pins 18-21)	COLUMN (Pin 1-3)	Output TONE (Pin 11) PULSE (Pin 10)
Tone Mode (Pin 14=0)	Normal	One	One	Dual Tone
		Two or More	One	Pin 11 = 0
		One	Two or More	
		Two or More	Two or More	
	Single Tone (Pin 15=Low) (Pin 16=High)	One	One	Dual Tone
		Two or More	One	Column Tone
		One	Two or More	Row Tone
		Two or More	Two or More	Pin 11 = 0
Pulse (Pin 14=V_{DD} or open	10 PPS (Pin 15& Pin 16) See Note 4.	One	One	10 PPS
		Two or More	One	Pin 10 =1
		One	Two or More	
		Two or More	Two or More	
	600 PPS (Pin 15 = Low Pin 16 = High)	One	One	600 PPS
		Two or More	One	Pin 10 = 1
		One	Two or More	
		Two or More	Two or More	

Note 1 : In pulse mode, pin 10=1 for * & # buttons
Note 2 : In pulse mode, always Pin 11=0, In DTMF mode, always Pin 10=1
Note 3 : Pin 10=1, Pin 11=0 for any button in Row 5 & Column 4, regardless of mode.
Note 4 :

M/B	DRS	M/B Rate	Flash Time	Pulse Rate
1	1	2:3	600 ms	10 PPS
0	1	1:2	100 ms	10 PPS
0	0	1:2	600 ms	20 PPS
1	0	test		

*** OSC. IN (Pin 6), OSC. OUT (Pin 7)**
A built-in inverter provides oscillation with a 3.579545MHz crystal. The oscillator ceases when a keypad input is not sensed.

*** $\overline{\text{T/P MUTE}}$**
The $\overline{\text{MUTE}}$ output pulls to V_{DD} with no keyboard input and pulls to GND when transmitting.(excluding the * & # Keys, in pulse mode). But, if row 5 and column 4 is pushed, then $\overline{\text{MUTE}}$ stays high level still.

*** $\overline{\text{HKS}}$**
The HKS (Hook Switch) input is used to sense the state of the handset in ON-HOOK or OFF-HOOK. In ON-HOOK state, $\overline{\text{HKS}}$=1, the keyboard input is disabled, there is no operation for any keyboard entry, to avoid the energy loss stored in capacitor. In OFF-HOOK state, $\overline{\text{HKS}}$=0, all of the function work.

*** $\overline{\text{PULSE OUT}}$**
In DTMF mode, the pulse out stays high level regardless of keyboard entry. In pulse mode, this output sends a chain of pulses to the corresponding address keypad input, but stays high level for * and # entry. Figure 3. shows the timing diagram in pulse mode. The pulse rate and inter digit pause are fixed, in normal condition Pin 15=1, to be 10pps and 800ms respectively.

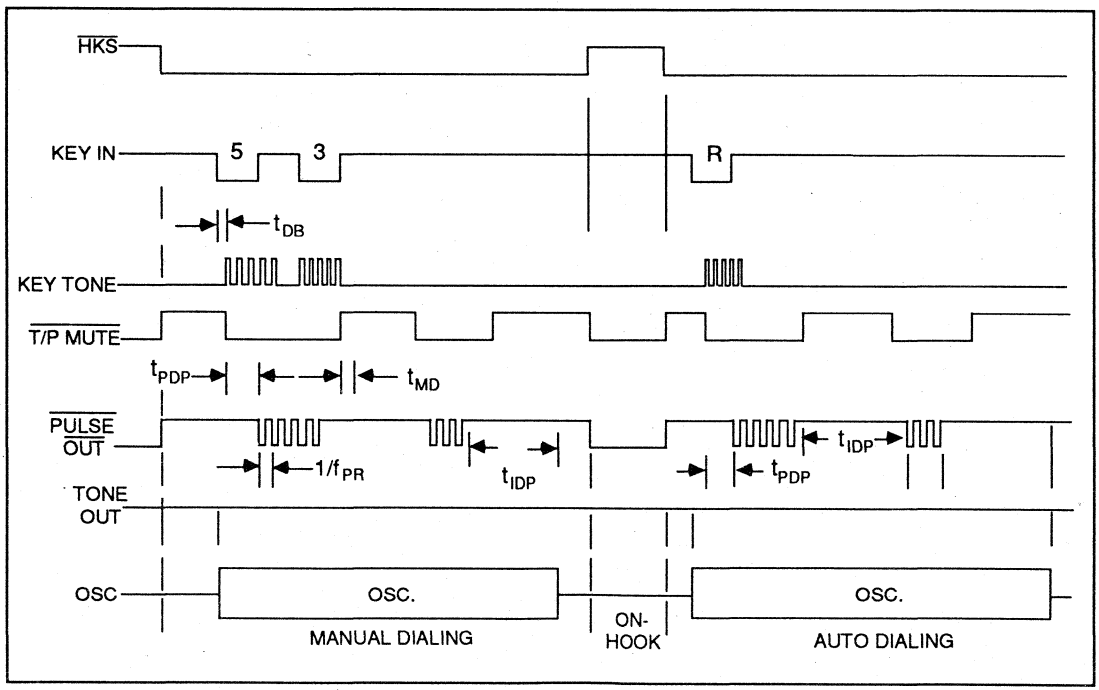


Fig. 3 Pulse Mode Time Diagram

*** TONE OUT**

In pulse mode, the tone output stays low state regardless of keypads input. In DTMF mode, the pin outputs dual tone or single tone, refer to Table 1. In normal dialing, the tone duration depends on key-in situation. When a valid key-in is less than 100 ms the tone duration will be fixed at 100ms. On the other hand, the tone duration will lasts as long as the key is pressed. As the same algorithm,the inter-tone-pause will be different under the following conditions: when key-release period continues less than 106ms, it will be fixed at 106ms. Otherwise, it will equal the the key- release duration. The tone duration and inter-tone-pause are internally set to be 100ms and 106ms respectively in auto dialing. Figure 4 illustrates the DTMF time diagram.

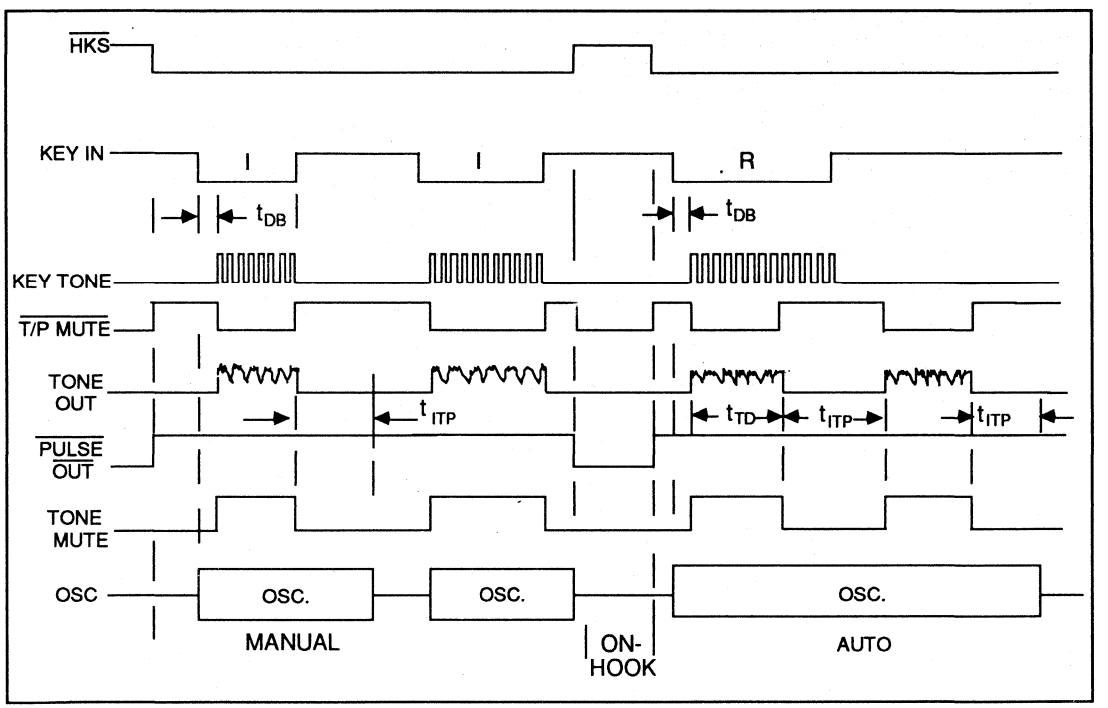


Fig. 4 DTMF Mode Timing Diagram

*** KEY TONE OUT**

The key tone output is a conventional CMOS inverter. A NPN transistor is needed to drive a piezo. The output frequency is 1.2KHz. In spite of DTMF or Pulse mode, the key tone actuate after any keypad (including row 5 and column 4)entry has been detected,and ceases at the time the button is released. There is no key tone output, whenever two or more keyboard buttons are pushed simultaneously.

*** TONE MUTE**

The T MUTE is a conventional CMOS inverter. In DP mode, the output always stays low in the duration of DP signal sending. But, the output presents a logic high in Tone mode. It can execute the muting operation in Tone mode.

*** MODE**

Pulls pin 14 to V_{DD} or unconnected, the dialer is in pulse mode. On the contrary, it is in DTMF mode.

*** M/B & DRS**

The M/B & DRS pin used to decode four selectable status as following

M/B	DRS	M/B rate	Flash	PPS
1	1	2:3	600ms	10pps
0	1	1:2	100ms	10pps
0	0	1:2	600ms	20pps
1	0	Test		

Keyboard Operations

Note : All the keyboard operations should be under OFF-HOOK conition.

I. Normal Dialing

Select Pulse or Tone mode.
Off-hook (n≤31)
Push [D1]—[Dn] , D1 - Dn : 0-9, *, #
Then the number D1,... Dn will be dialed out in Pulse or Tone mode as selected.

II. Redialing

Select Pulse or Tone mode.
Off-hook
Push [D1]—[Dn] , busy, ON-HOOK.
Come OFF-HOOK. push [R/P] , THEN last number D1D2....Dn will be automatically dialed out in Pulse or Tone mode as selected.

III. Number Storing

Select pulse or Tone mode.
Off-hook
Push [S] [D1]—[Dn] [S] [Ln] Ln: 0 - 9
then the number D1,..,Dn will be stored in location [Ln]

IV. Memory Dialing

Select Pulse or Tone mode.
Off-hook
Push [A], [Ln] , then the number stored in location [Ln] will be automatically dialed out in Pulse or Tone mode as selected.

V. Pause Key Operation

In some cases, such as PABX or long distance service, pauses should be inserted in the dialing sequence. The HM 9114A provides stackable pause function (3.6 sec/pause)which facilitates flexible applications. For examples:

a. Dialing with Pause Key
1. Select Pulse or Tone Mode.
Off-hook
Push [D1] , [R/P] , [D2] , , [Dn] ; D1-Dn : 0 -9 , *, #.
then the number will be dialed out in the following sequence: D1, without pause , D2, ... , Dn.
2. Redialing with Pause Key
When redialing, the chip outputs following sequences: D1, pause 3.6 sec, D2,.....Dn.

b. Storing with Pause Key

1. Select Pulse or Tone Mode
   Off-hook
   Push [S] [D1] [R/P] [D2] ,., [Dn] [S] [Ln] or [EMn] .
   then the number D1, Pause 3.6sec., D2...Dn will be stored in [Ln] or [EMn]

2. Dialing with Pause Key.
   Select Pulse or Tone mode.
   1)Push [A] [Ln], or [EM1] - [EM3] , then the output signal will be dialed in the following sequence. D1, pause 3.6 seconds, D2,...Dn.
   2)Push [EM4] , then the output signal will be dialed in the following sequence: D1, pause 3.6 sec, (PULSE)
   D2,...., Dn.
   (TONE)

Note :1. The HM 9114A provides one special memory location EM4 for automatic switching function from pulse mode to tone mode after the pause duration.
2.The pause duration is 3.6 sec/pause, it can be continuously stored for longer pause duration. But every pause will occupy one digit of memory size.

VI. Emergency Dialing

The HM 9113A provides three memories for storing emergency numbers such as fire, police and doctor. Convenient one-key dialing operation is designed for these emergency memories which is important in easy operation:

a. Storing Emergency Numbers.
   Off-hook
   Select Pulse or Tone Mode.
   Push [S] [D1] [D2] ..... [Dn] [S] [EMn] EMn :[EM1] - [EM3] Then the number D1, D2 ...Dn will be stored in EMn.

b. Emergency Dialing
   Off-hook
   Select Pulse or Tone Mode.
   Push [EMn] , then the number stored in EMn will be automatically dialed out in Pulse or Tone mode as selected.

VII. Pulse To Tone Key Operation

a. Dialing with Pulse to Tone mode.
   Push [D1] , [D1] ,..... [Dn] , [P→T] , [D1'] , [D2'] ,... [Dn']
   Then the numbers will be dialed out in the following sequence: If the mode switch is set in pulse mode, then the output signal will be: D1, D2, ..., Dn, pause 3.6 sec. D1', D2', ..., Dn'.
   (Pulse) (Tone)

b. Redialing or memory dialing with Pulse to Tone Key
   Push [R/P], Then the numbers will be dialed out in the following sequence: If the mode switch is set in pulse mode, then the output signal will be: D1, D2, ..., pause 3.6 sec, D1', D2', ..., Dn';
   (Pulse) (Tone)

VIII. Flash Operation

This chip provides a convenient and precise flash function for PABX service. In the following operation; push F, then 600ms flash is supplied, and central unit will service the caller, such as: transfer, wait - - - -.
Figure 5. Shows flash timing diagram.

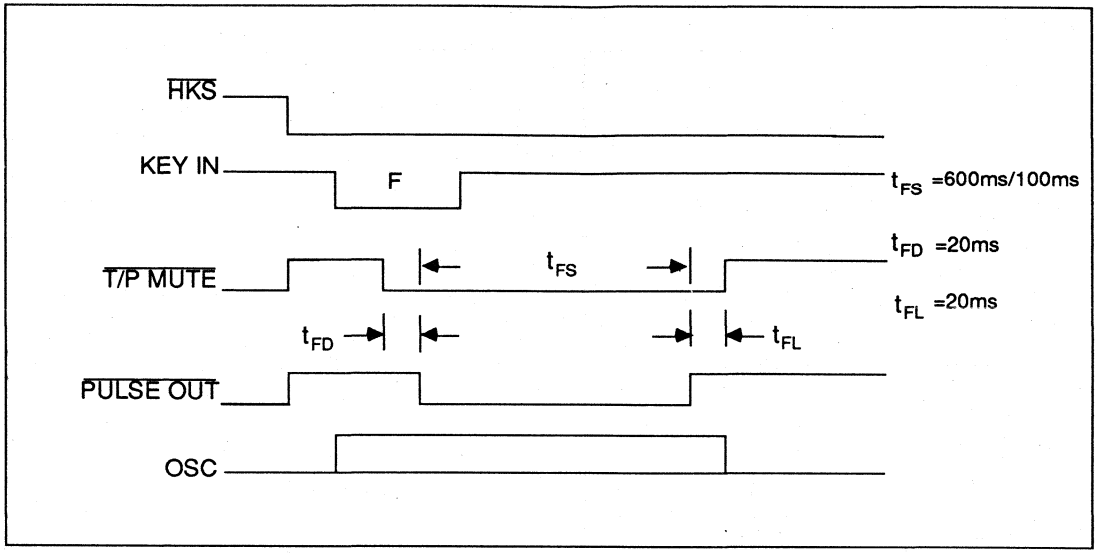
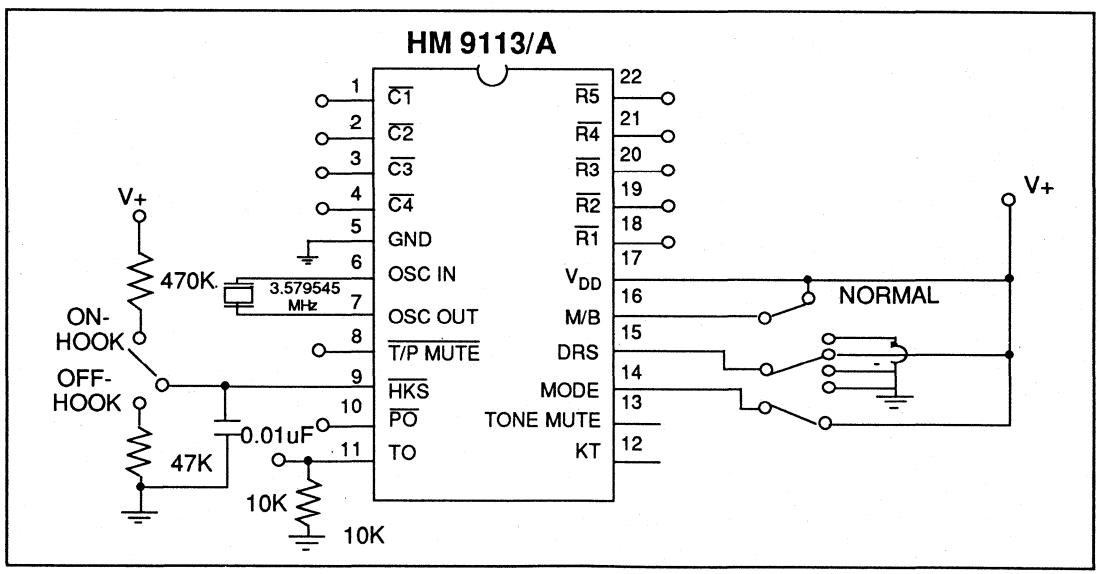
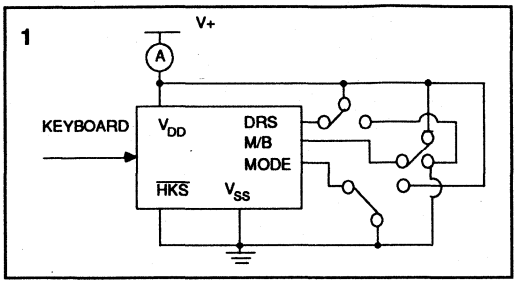


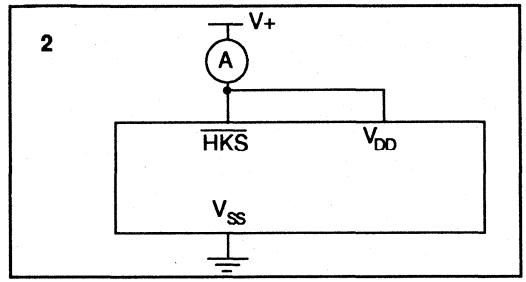
Fig. 5 Flash Timing Diagram

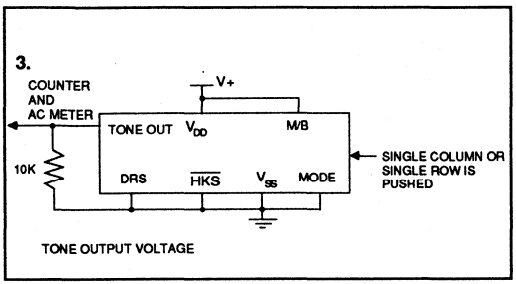
General Test Circuit

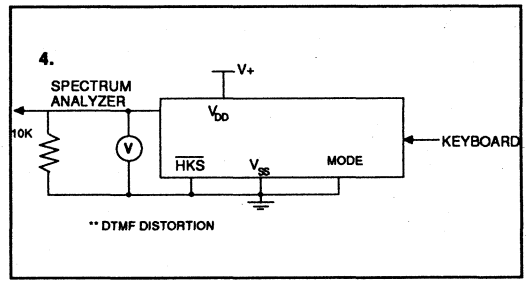


Test Circuit







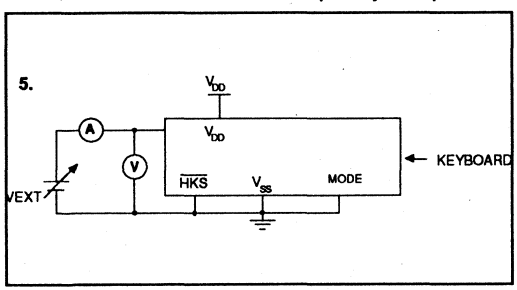


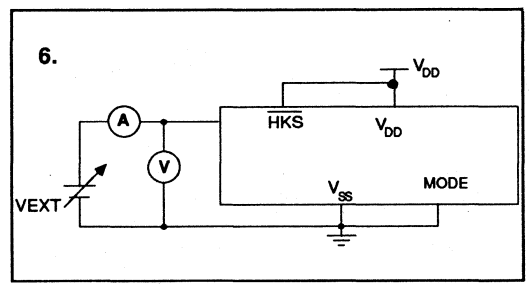
**

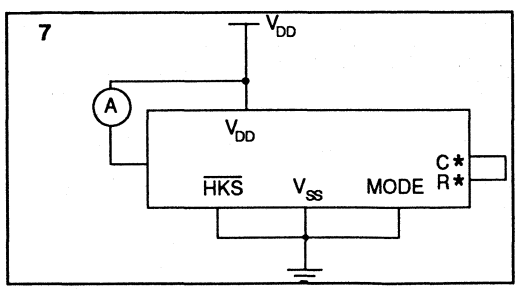
$$\text{DIST.(dB)} = 20\log \frac{\sqrt{(V1)^{**}2+(V2)^{**}2+..+(Vn)^{**}2}}{\sqrt{(VL)^{**}2+(VH)^{**}2}}$$

a. V1....Vn are extraneous frequencies (ie, inter modulation and harmonic) components in the 500Hz to 3400Hz band.

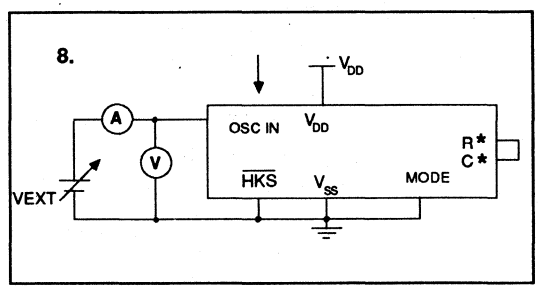
b. VL,VH are the individual frequency components of the DTMF signal





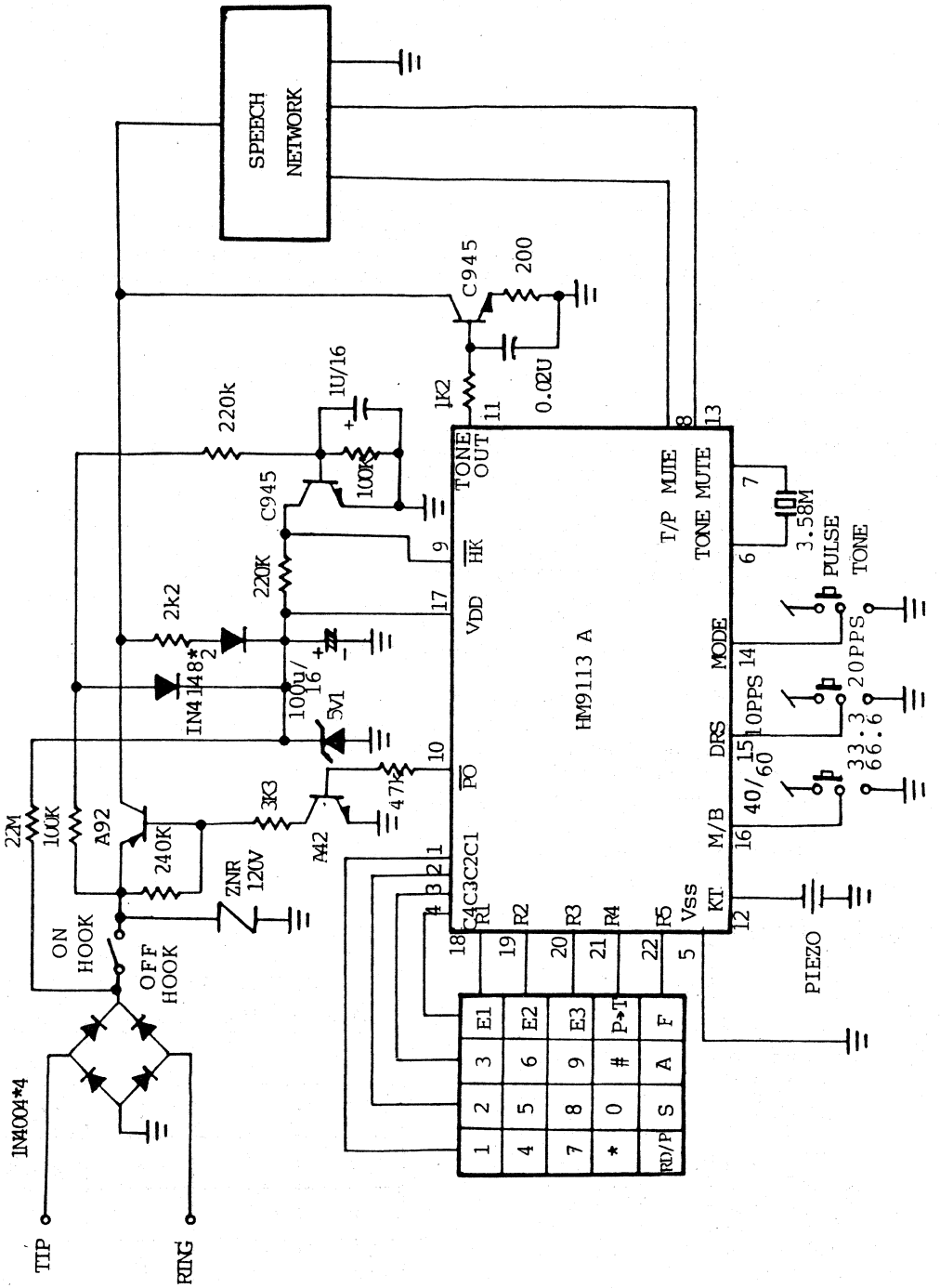


R* : anyone row of R1-R5
C* : anyone column of C1-C4
Isink=I/(1-Duty Cycle) I is the net DC current measured from ampere meter.



Procedure:
1 Provide clocks until output change to high.
2 Test its current.

HM 9113A Application Example



General Description

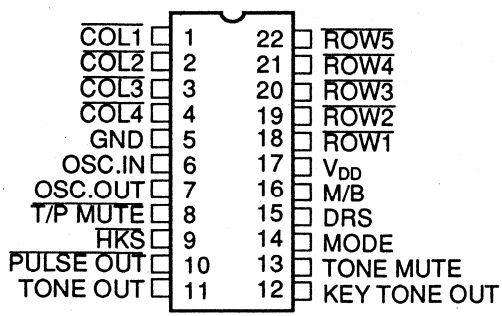
HM 9114A is an improved version of 9114. The HM 9114/A are 15-Memory Tone/Pulse switchable dialer which is fabricated in SACMOS technology with good performance in low voltage, low power operation. Four 16-digit, touch memories are used for convenient emergency calls (such as fire, police, hospital, home). The M/B and DRS pins are decoded to fit the different country's various telephone systems.

Features

* Tone/Pulse Switchable Dialer.
* Stores Ten 16-Digit Numbers for Repertory Dialing.
* Four 16-Digit Numbers for Emergency Calling Memory.
* One 31-Digit for Last Number Redial Memory.
* Auto Pause Access; 3.1 sec. per pause for HM 9114, 3.6 sec per for HM 9114A (2 sec pause time can be obtained by metal option.)
** The differences between HM 9114 and HM 9114A are listed in Table 2.
* Key-Tone Output for valid keypad entry recognition for both pulse mode and tone mode.
* Both key-in and key-released debounce are 20ms.
* Minimun tone duration=100ms and minimum intertone pause=106ms for rapid key-in.
* Use 3.579545MHz crystal.
* Electronic Keypad Input is Available; Low Active.
* Pin selectable for M/B rate, flash time and pulse rate.
* Keyboard switching from pulse mode to TONE mode.
* Memory Retention Current≤0.2μ A at V_{DD}=1.0V, On Hook.
* Wide Operation Voltage Range: 2.0V-5.5V
* 22-pin Dual-in-Line Package.
*Automatic Switching from Pulse mode to tone mode in EM4.

Pin Assignment

HM9114/A



KEYBOARD FUNCTION

$\overline{COL1}$	$\overline{COL2}$	$\overline{COL3}$	$\overline{COL4}$	
1	2	3	EM1	$\overline{ROW1}$
4	5	6	EM2	$\overline{ROW2}$
7	8	9	EM3	$\overline{ROW3}$
*	0	#	P→T	$\overline{ROW4}$
R/P	S	A	F	$\overline{ROW5}$

S: Store A: Auto Dialing
EM1-EM4: Emergency 1-4 F: Flash
R/P: First touch after off-hook is redial function.
Others are output Pause 3.6 sec.

Absolute Maximum Ratings

(T_A = 25 °C)

Characteristics	Sym.	Ratings	Unit
DC Supply Voltage	V_{DD}	6.0	V
Input Voltage Range	V_{in}	-0.5 to V_{DD} + 0.5	V
Power Dissipation Per Package	P_d	500 (for T_A =-25°C to + 60°C)	mw
Operating Temperature	T_A	-25 to + 85	°C
Storage Temperate	T_{STG}	-65 to +150	°C

DC Characteristics

(V+ = 2.5V, T_A = 25°c , Unless otherwise specified)

Characteristics	Sym.	Test Ckt.	Test Conditions	Limit Min.	Typ.	Max.	Unit
Operating Voltage	V_{DD}		Tone	2.0	-	5.5	V
			Pulse	2.0	-	5.5	
			Memory	1.0	-	5.5	
Operation Current	Iop	1	Tone	-	0.6	2	mA
			Pulse Note 1,4,6	-	0.2	0.5	
Memory Retention Current	Imr	2	$\overline{HKS}$=1, T_A=45°C,V+=1.0V	-	0.1	0.2	µA
Standby Current	Is	1	Note 2,3,5,6,11	-	0.1	5	µA
Tone Output Voltage	Vto	3	Row Group, RL=10Ω.	-	150	-	mVrms
Pre-Emphasis		4	Column/Row Group V+=2.0-5.5V	1	2	3	dB
DTMF Distortion	THD	4	RL=10K, Note 7,8	-	-30	-23	dB
Tone Output Load Imped ance	R1		THD≤ -23dB	10	-	-	kΩ
Tone Output							
DC Level	Vdc	4	V+=2.5-5.5V	0.5V+	-	0.6V+	-
Sink Current	ItL	5	Vto=0.5V	0.2	-	-	mA
Pulse Output							
Drive Current	Iph	5	Vpo=2.0V	-0.2	-	-	mA
Sink Current	Ipl	6	Vpo=0.5V	0.2	-	-	
$\overline{T/P}$ Mute Output							
Drive Current	Imh	5	Vmo = 2.0V	-0.2	-	-	mA
Sink Current	Iml		Vmo = 0.5V	1.0	-	-	
Key Tone Output							
Drive Current	Ikh	8	Vko = 2.0V	-0.5	-	-	mA
Sink Current	Ikl	5	Vko= 0.5V	0.5	-	-	
Tone Mute Output Drive	Ilh	5	Vlo=2.0V	-0.5	-	-	mA
Sink Current	Ill	5	Vlo=0.5V	0.5	-	-	mA

(II)

Characteristics	Sym.	Test Ckt.	Test Conditions	Limit Min.	Typ.	Max.	Unit
Keypad Debounce	t_{DB}		* ,Note 8,9,10	-	20	-	ms
Pulse mute delay	t_{MD}		* ,Note 8,9 M/B=1	-	40	-	ms
			M/B=0	-	33.3	-	
Pre-digit Pause	t_{PDP}		* ,Note 8,9 M/B=1	-	40	-	ms
			M/B=0	-	33.3	-	
Pulse Rate	f_{PR}						
			* M/B=1,DRS=1	-	10	-	
			— Note 8,M/B=0,DRS=0	-	20	-	PPS
			* * M/B=1,DRS=0	-	600	-	
Inter Digit Pause	t_{IDP}						
			* M/B=1,DRS=1	-	800	-	
			— Note 8,M/B=0,DRS=0	-	600	-	ms
			* * M/B=1,DRS=0	-	13.3	-	
Make/Break Ratio	M:B		M/B=1 / M/B=0 Note 8;*	-	40:60	-	%
				-	33.3:66.6	-	
Tone Duration	t_{TD}		Auto Dialing Note 8	-	100	-	ms
Inter Tone Pause	t_{ITP}		Auto Dialing Note 8	-	106	-	ms
Row Group Frequency	f1		Row 1, Note 8	-	699	-	
	f2	3.	Row 2, Note 8	-	766	-	Hz
	f3		Row 3, Note 8	-	848	-	
	f4		Row 4, Note 8	-	948	-	
Column Group Frequency	f5		Col.1, Note 8	-	1216	-	
	f6	3.	Col.2, Note 8	-	1332	-	Hz
	f7		Col.3, Note 8	-	1472	-	
Key Tone Frequency	fK		Note 8	-	1.2	-	KHz
Input Voltage Low	Vil		Pins, 1-4,9,14,15,7 &	GND	-	0.3V+	
Input Voltage High	Vih		18-22	0.7V+	-	V+	
Keypad Input Drive Current	Ikd	6.	Vi = 0V	4	10	30	
Sink-Current	Iks	5.7	VI = 2.5V	100	400	800	
Control Pin Input Leakage Current	Iin		ins 9,14,15,17	-	0.001	0.1	µA

* M/B ≠ 1 and DRS≠ 0

** M/B = 1, DRS = 0 ; test mode.

Note 1 : HKS=0
2 : In DTMF Mode
3 : In Pulse Mode
4 : Keyboard Entry, Including Auto Dialing
5 : No Keyboard Entry
6 : All Output Unloadaed
7 : Dual Tone Multi-Frequency Distortion is measured in terms of total out-of-band power related to the sum of the row & column fundamental power.
8 : Crystal parameters defined as Rs≤100, Lm=96mH Cm=0.25PF Ch=5PF, F=3.579545MHz & Cl=18PF F≤200 PPM
9 : Refer to Pulse Mode Time Diagram
10: Refer to DTMF Mode Time Diagram

Functional Description

* $\overline{\text{ROW}}$ —— $\overline{\text{COLUMN}}$ INPUTS (Pins 1-4 & 18-22)
The keypad input is compatible with the standard 2-of-9 keyboard, the inexpensive single-contact (Form A) keyboard, and electronic input.
In normal operation, any single button is pushed to produce dual tone, pulses or function.
Activation of two or more buttons will result in no response, except for single tone.
Table 1 illustrates the address keypad function, in detail.

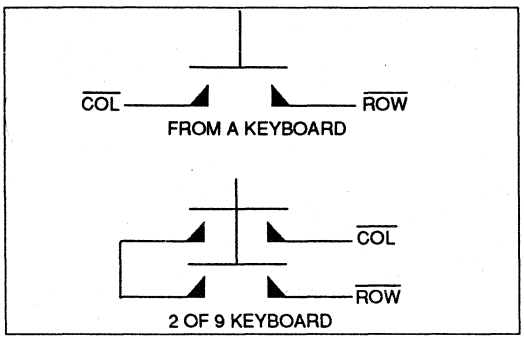


Fig. 1 Keyboard Configuration

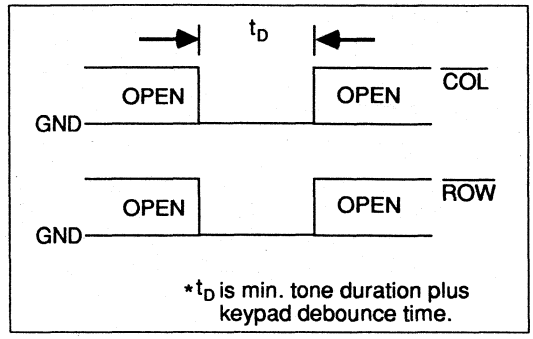


Fig. 2 Electronic Input

Table 1. Address Keypads Truth Table

Output		Active Low Inputs ROW (Pins 18-21)	COLUMN (Pin 1-3)	Output TONE (Pin 11) PULSE (Pin 10)
Tone Mode (Pin 14=0)	Normal	One	One	Dual Tone
		Two or More	One	Pin 11 = 0
		One	Two or More	
		Two or More	Two or More	
	Single Tone (Pin 15=Low) (Pin 16=High)	One	One	Dual Tone
		Two or More	One	Column Tone
		One	Two or More	Row Tone
		Two or More	Two or More	Pin 11 = 0
Pulse (Pin 14=V_{DD} or open	10 PPS (Pin 15& Pin 16) See Note 4.	One	One	10 PPS
		Two or More	One	Pin 10 =1
		One	Two or More	
		Two or More	Two or More	
	600 PPS (Pin 15 = Low Pin 16 = High)	One	One	600 PPS
		Two or More	One	Pin 10 = 1
		One	Two or More	
		Two or More	Two or More	

Note 1 : In pulse mode, pin 10=1 for * & # buttons
Note 2 : In pulse mode, always Pin 11=0, In DTMF mode, always Pin 10=1
Note 3 : Pin 10=1, Pin 11=0 for any button in Row 5 & Column 4, regardless of mode.

Note 4 :

M/B	DRS	M/B Rate	Flash Time	Pulse Rate
1	1	2:3	600 ms	10 PPS
0	1	1:2	100 ms	10 PPS
0	0	1:2	600 ms	20 PPS
1	0	test		

*** OSC. IN (Pin 6), OSC. OUT (Pin 7)**

A built-in inverter provides oscillation with a 3.579545MHz crystal. The oscillator ceases when a keypad input is not sensed.

*** $\overline{\text{T/P MUTE}}$**

The $\overline{\text{MUTE}}$ output pulls to V_{DD} with no keyboard input and pulls to GND when transmitting.(excluding the * & # Keys, in pulse mode). But, if row 5 and column 4 is pushed, then $\overline{\text{MUTE}}$ stays high level still.

*** $\overline{\text{HKS}}$**

The $\overline{\text{HKS}}$ (Hook Switch) input is used to sense the state of the handset in ON-HOOK or OFF-HOOK. In ON-HOOK state, $\overline{\text{HKS}}$=1, the keyboard input is disabled, there is no operation for any keyboard entry, to avoid the energy loss stored in capacitor. In OFF-HOOK state, $\overline{\text{HKS}}$=0, all of the function work.

*** $\overline{\text{PULSE OUT}}$**

In DTMF mode, the pulse out stays high level regardless of keyboard entry. In pulse mode, this output sends a chain of pulses to the corresponding address keypad input, but stays high level for * and # entry. Figure 3. shows the timing diagram in pulse mode. The pulse rate and inter digit pause are fixed, in normal condition Pin 15=1, to be 10pps and 800ms respectively.

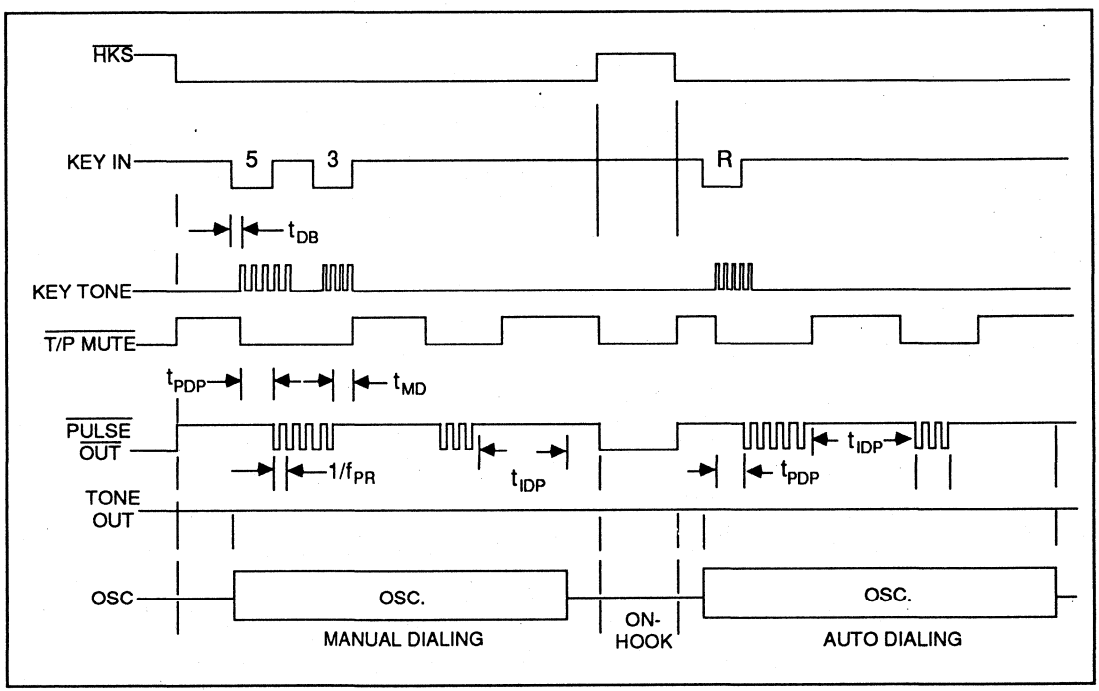


Fig. 3 Pulse Mode Time Diagram

*** TONE OUT**

In pulse mode, the tone output stays low state regardless of keypads input. In DTMF mode, the pin outputs dual tone or single tone, refer to Table 1. In normal dialing, the tone duration depends on key-in situation. When a valid key-in is less than 100 ms the tone duration will be fixed at 100ms. On the other hand, the tone duration will lasts as long as the key is pressed. As the same algorithm,the inter-tone-pause will be different under the following conditions: when key-release period continues less than 106ms, it will be fixed at 106ms. Otherwise, it will equal the the key- release duration. The tone duration and inter-tone-pause are internally set to be 100ms and 106ms respectively in auto dialing. Figure 4 illustrates the DTMF time diagram.

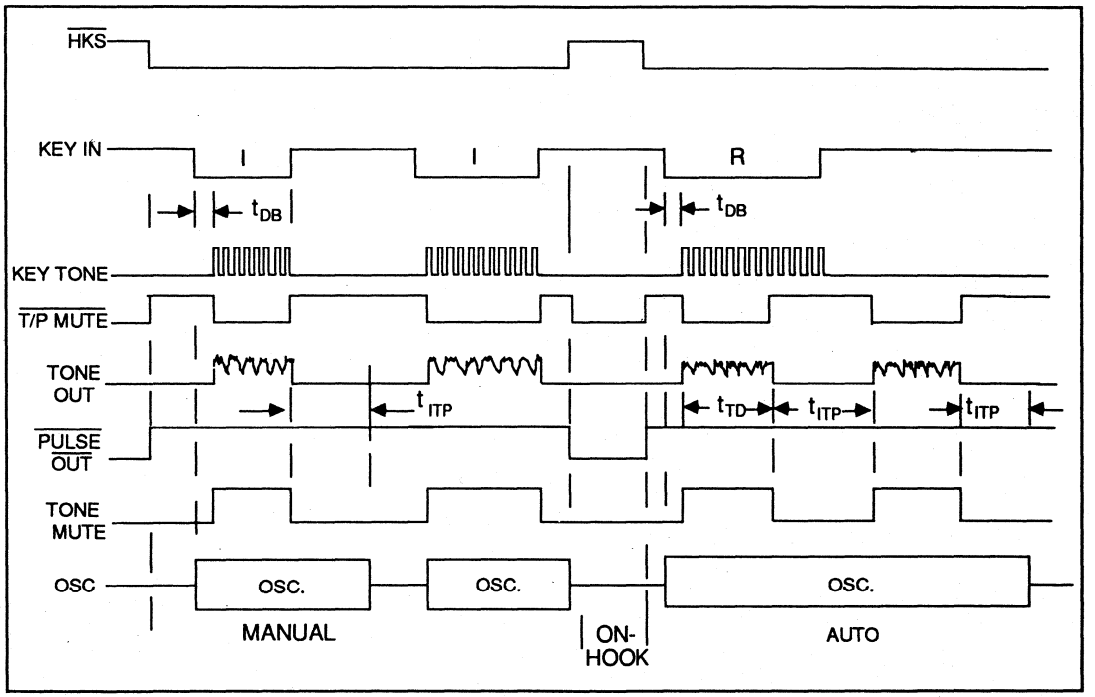


Fig. 4 DTMF Mode Timing Diagram

*** KEY TONE OUT**

The key tone output is a conventional CMOS inverter. A NPN transistor is needed to drive a piezo. The output frequency is 1.2KHz. In spite of DTMF or Pulse mode, the key tone actuate after any keypad (including row 5 and column 4)entry has been detected,and ceases at the time the button is released. There is no key tone output, whenever two or more keyboard buttons are pushed simultaneously.

*** TONE MUTE**

The T MUTE is a conventional CMOS inverter. In DP mode, the output always stays low in the duration of DP signal sending. But, the output presents a logic high in Tone mode. It can execute the muting operation in Tone mode.

*** MODE**

Pulls pin 14 to Vdd or unconnected, the dialer is in pulse mode. On the contrary, it is in DTMF mode.

*** M/B & DRS**

The M/B & DRS pin used to decode four selectable status as following

M/B	DRS	M/B rate	Flash	PPS
1	1	2:3	600ms	10pps
0	1	1:2	100ms	10pps
0	0	1:2	600ms	20pps
1	0	Test		

Keyboard Operations

Note : All the keyboard operations should be under OFF-HOOK conition.

I. Normal Dialing

Select Pulse or Tone mode.
Off-hook (n≤31)
Push [D1]—[Dn] , D1 - Dn : 0-9, *, #
Then the number D1,... Dn will be dialed out in Pulse or Tone mode as selected.

II. Redialing

Select Pulse or Tone mode.
Off-hook
Push [D1]—[Dn] , busy, ON-HOOK.
Come OFF-HOOK. push [R/P] , THEN last number D1D2....Dn will be automatically dialed out in Pulse or Tone mode as selected.

III. Number Storing

Select pulse or Tone mode.
Off-hook
Push [S] [D1]—[Dn] [S] [Ln] Ln: 0 - 9
then the number D1,..,Dn will be stored in location [Ln]

IV. Memory Dialing

Select Pulse or Tone mode.
Off-hook
Push [A], [Ln] , then the number stored in location [Ln] will be automatically dialed out in Pulse or Tone mode as selected.

V. Pause Key Operation

In some cases, such as PABX or long distance service, pauses should be inserted in the dialing sequence. The HM 9114A provides stackable pause function (3.6 sec/pause)which facilitates flexible applications. For examples:

a. Dialing with Pause Key
1. Select Pulse or Tone Mode.
Off-hook
Push [D1] , [R/P] , [D2] , , [Dn] ; D1-Dn : 0 -9 , *, #.
then the number will be dialed out in the following sequence: D1, without pause , D2, ... , Dn.
2. Redialing with Pause Key
When redialing, the chip outputs following sequences: D1, pause 3.6 sec, D2,.....Dn.

b. Storing with Pause Key

1. Select Pulse or Tone Mode
   Off-hook
   Push [S] [D1] [R/P] [D2] ,., [Dn] [S] [Ln] or [EMn] .
   then the number D1, Pause 3.6sec., D2...Dn will be stored in [Ln] or [EMn]

2. Dialing with Pause Key.
   Select Pulse or Tone mode.
   1)Push [A] [Ln], or [EM1] - [EM3] , then the output signal will be dialed in the following sequence. D1, pause 3.6 seconds, D2,...Dn.
   2)Push [EM4] , then the output signal will be dialed in the following sequence: D1, pause 3.6 sec, D2,...., Dn.
   (PULSE)
   (TONE)

Note :1. The HM 9114A provides one special memory location EM4 for automatic switching function from pulse mode to tone mode after the pause duration.
2.The pause duration is 3.6 sec/pause, it can be continuously stored for longer pause duration. But every pause will occupy one digit of memory size.

VI. Emergency Dialing

The HM 9114A provides three memories for storing emergency numbers such as fire, police and doctor. Convenient one-key dialing operation is designed for these emergency memories which is important in easy operation:

a. Storing Emergency Numbers.
   Off-hook
   Select Pulse or Tone Mode.
   Push [S] [D1] [D2] ..... [Dn] [S] [EMn] EMn :[EM1] - [EM3] Then the number D1, D2 ...Dn will be stored in EMn.

b. Emergency Dialing
   Off-hook
   Select Pulse or Tone Mode.
   Push [EMn] , then the number stored in EMn will be automatically dialed out in Pulse or Tone mode as selected.

VII. Flash Operation

This chip provides a convenient and precise flash function for PABX service. In the following operation; push F, then 600ms flash is supplied, and central unit will service the caller, such as: transfer, wait - - - -.
Figure 5. Shows flash timing diagram.

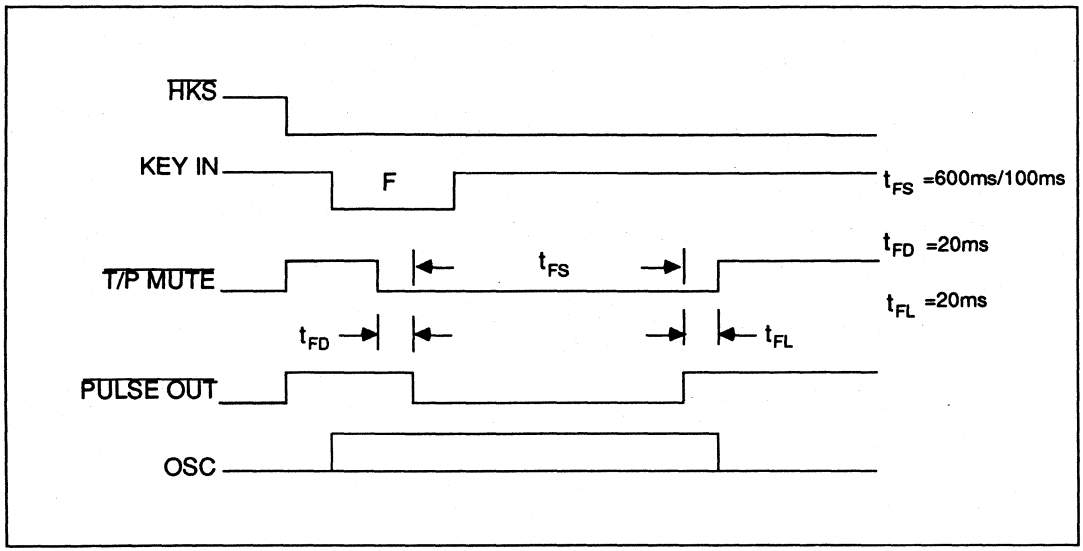
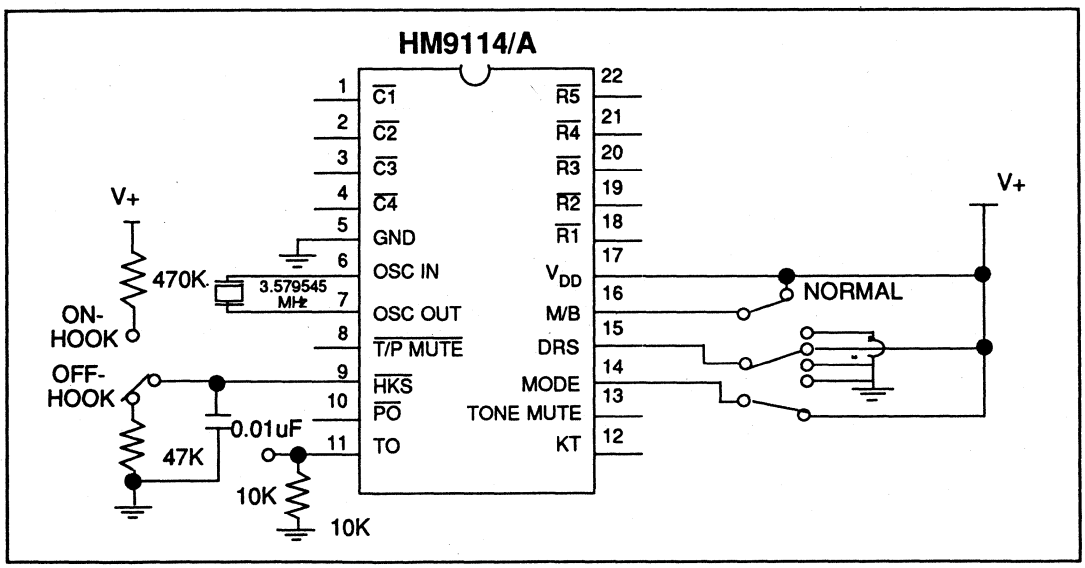
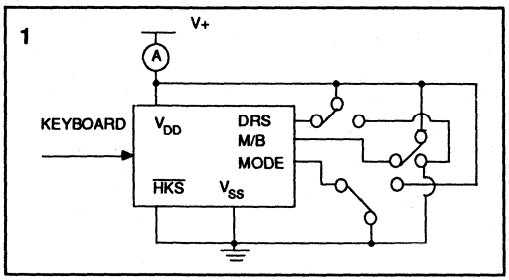


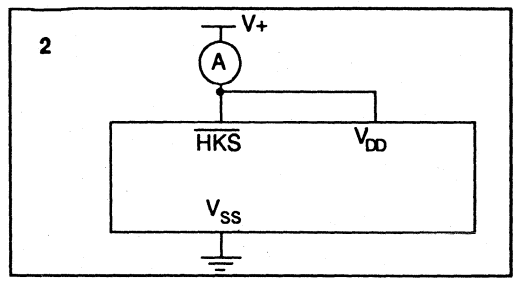
Fig. 5 Flash Timing Diagram

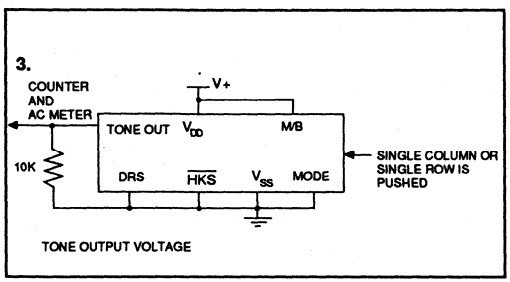
General Test Circuit

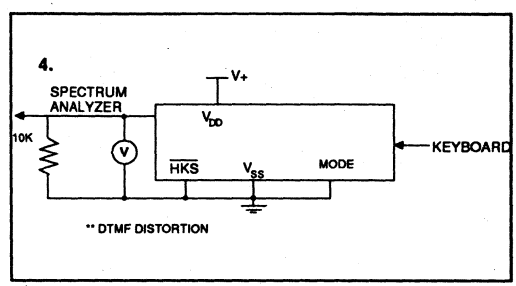


Test Circuit







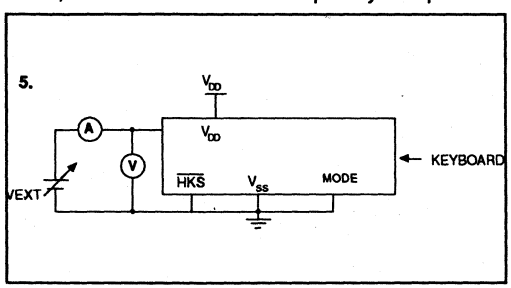


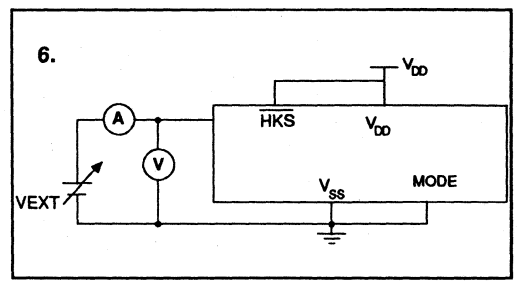
**

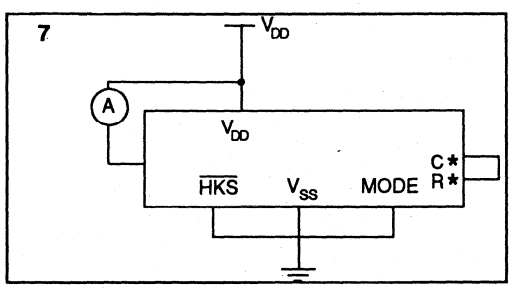
$$DIST.(dB)= 20\log \frac{\sqrt{(V1)^{**}2+(V2)^{**}2+..+(Vn)^{**}2}}{\sqrt{(VL)^{**}2+(VH)^{**}2}}$$

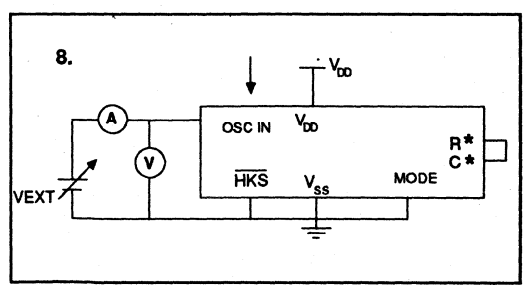
a. V1....Vn are extraneous frequencies (ie, inter modulation and harmonic) components in the 500Hz to 3400Hz band.

b. VL,VH are the individual frequency components of the DTMF signal









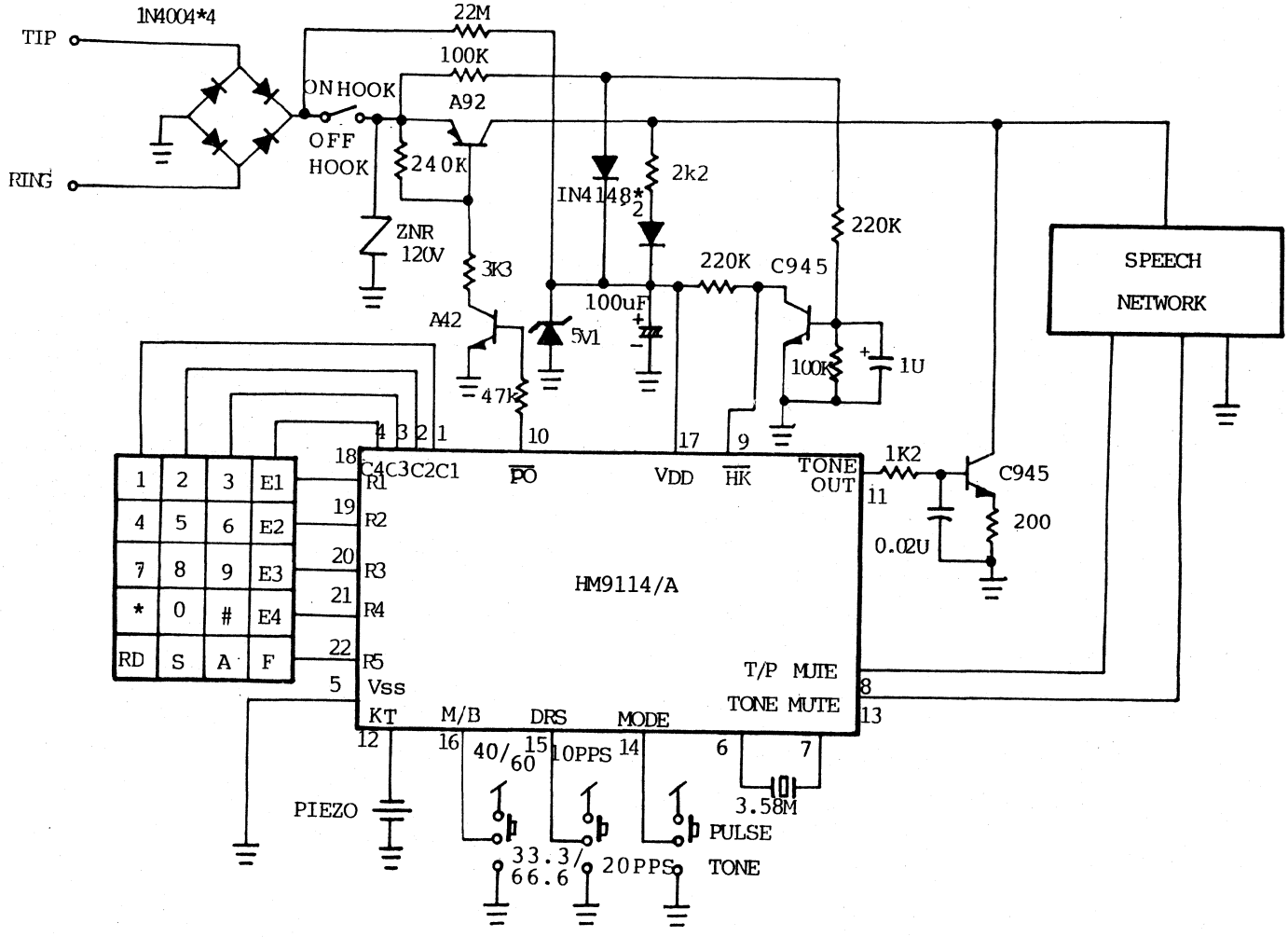
R* : anyone row of R1-R5
C* : anyone column of C1-C4
Isink=I/(1-Duty Cycle) I is the net DC current measured from ampere meter.

Procedure:
1 Provide clocks until output change to high.
2 Test its current.

Table 2. The differences between HM 9114 and HM 9114A

HM 9114	HM9114A
(a) IDP of 20pps: 400ms	(a) IDP of 20pps: 600ms
(b) Pause Time : 3.1 sec.	(b) Pause Time: 3.6 sec. but 2 sec., 3.2 sec can be obtained by metal option.
(c) Depress "PAUSE" key under normal dialing. It won't pause 3.1sec.	(c) Depress "PAUSE" key under normal dialing. It will pause 3.6 sec.

HM 9114A Application Example



General Description

The HM 9120 is a Tone/Pulse switchable dialers with 20 numbers X16 digits repertory and 31 digits redial memory. For PABX operation, PAUSE, P→T and FLASH keys are implemented. This chip also provides on chip HANDFREE DIALING control ckt.

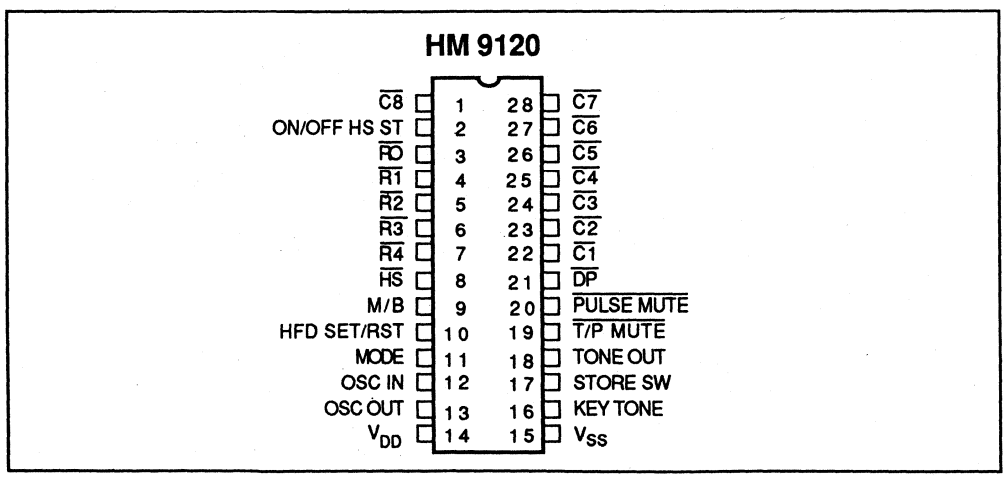
Features

* Tone/Pulse switchable.
* One 31 digits memory for the last number redial.
* Auto access pause: 3.6 sec. per pause.
* 1 sec. pause auto added after FLASH.
* FLASH key available. FLASH time is 600ms or 100ms by M/B pin controller.
* FLASH can be stored in redial and memory.
* Minimum tone duration= 100ms and minimum inter tone pause=106ms for rapid KEY-IN.
* Use 3.579545 MHz crystal.
* Both KEY-IN and KEY-RELEASED debounce time are 20 ms.
* Operating VOLTABE RANGE: 2.0V - 5.5V
* Memory retention current ≤0.2μA at V_{DD}= 1V on hook.
* M/B pin selectable type.

M/B	Flash	M/B rate
V_{SS}	600ms	40:60
V_{DD}	100ms	33:66
↓	TEST MODE	

*Key tone output is provided for pulse mode, function keys and repertory keys. tKT=30ms, fKT=1.2kHz.

Pin Assignment



Keyboard Scheme

	C1	C2	C3	C4	C5	C6	C7	C8
R0			CD	P→T	M1	M6	M11	M16
R1	1	2	3	FLASH	M2	M7	M12	M17
R2	4	5	6		M3	M8	M13	M18
R3	7	8	9	STORE	M4	M0	M14	M19
R4	*	0	#	RD/P	M5	M0	M15	M20

Absolute Maximum Ratings (T_A = 25 °C)

Characteristics	Sym.	Ratings	Unit
DC Supply Voltage	V_{DD}	6.0	V
Input Voltage Range	V_{in}	-0.5 to V_{DD} + 0.5	V
Power Dissipation Per Package	P_d	500 (for T_A =-25°C to + 60°C)	mw
Operating Temperature	T_o	-25 to + 85	°C
Storage Temperate	T_{STG}	-65 to +150	°C

Electrical Characteristics (I) (V_{DD}=2.5V, T_A=25°C , unless otherwise noted)

Characteristics	Sym.	Test Ckt.	Test Conditions	Limit Min.	Typ.	Max.	Unit
Operating Voltage	V_{DD}		Tone	2.0	-	5.5	
			Pulse	2.0	-	5.5	V
			Memory	1.0	-	5.5	
Operating Current	Iop	1.	Tone Note 1,4,6	-	0.6	2	
			Pulse	-	0.2	0.5	
Memory Retention Current	Imr	2.	$\overline{HKS}$=1,T_A=45 ,V+=1.0V	-	0.1	0.2	µA
Standby Current	Is	1.	Note 2, 3, 5, 6, 11	-	0.1	5	µA
Tone Output Voltage	Vto	3.	Row Group, R_L=10KΩ	-	150	-	mVrms
Pre-Emphasis		4.	Column Group/Row Group V+ = 2.0 - 5.5V	1	2	3	dB
DTMF Distortion	THD	4.	R_L=10K , Note 7,8	-	-30	-23	dB
Tone Output External Load Impedance	Rl		THD≤-23dB	10	-	-	KΩ
Tone Output DC Level	Vdc	4.	V+ = 2.5 -5.5V	0.5V+	-	0.6V+	-
Tone Output Sink Current	Itl	5.	Vto = 0.5V	0.2	-	-	mA
Pulse Output:							
Drive Current	Iph	5.	Vpo = 2.0V	-0.2	-	-	mA
Sink Current	Ipl	6.	Vpo = 0.5V	0.2	-	-	

Characteristics	Sym.	Test Ckt.	Test Conditions	Limit Min.	Typ.	Max.	Unit
$\overline{T/P}$ Mute Output :							
Drive Current	Imh	5	Vmo = 2.0V	-0.2	-	-	mA
Sink Current	Iml		Vmo = 0.5V	1	-	-	
Key Tone Output:							
Leakage Current	Ilk	5.	Input = 12V	-	-	1	mA
Sink Current	Isk		Vmo = 0.5V	1	-	-	
Pulse Mute Output:							
Drive Current	Ipmh		Vmo= 2V	0.5	-	-	mA
Sink Current	Ipml		Vmo = 0.5V	1	-	-	

(II)

Characteristics	Sym.	Test Ckt.	Test Conditions	Limit Min.	Typ.	Max.	Unit
Keypad Debounce	t_{DB}		* ,Note 8,9,10	-	20	-	ms
Pulse mute delay	t_{MD}		* ,Note 8,9 M/B=0	-	40	-	ms
			M/B=1	-	33.3	-	
Pre-digit Pause	t_{PDP}		* ,Note 8,9 M/B=0	-	40	-	ms
			M/B=1	-	33.3	-	
Pulse Rate	f_{FR}		Mode=V_{DD}	-	10	-	
			Mode=Open	-	20	-	PPS
Inter Digit Pause	t_{IDP}		10pps	-	800	-	
			20pps	-	500	-	ms
Make/Break Ratio	M:B		M/B=0 Note 8	-	40:60	-	ms
			M/B=1	-	33.3:66.6	-	
Tone Duration	t_{TD}		Auto Dialing Note 8	-	100	-	ms
Inter Tone Pause	t_{ITP}		Auto Dialing Note 8	-	106	-	ms
Key Tone Output Duration	t_{KT}			-	30	-	ms
Key Tone Frequency	f_K		Note 8	-	1.2	-	kHz
Auto Access Pause Time after FLASH Key-in	t_{FP}			-	1	-	sec
nput Voltage Low	V_{IL}			GND	-	0.3V+	
Input Voltage High	V_{IH}		Pins, 1-11,17,22-28	0.7V+	-	V+	
Keypad Input Drive Current	I_{KD}	6.	Vi = 0V	4	10	30	µA
Sink Current	I_{KS}	5.7	Vi = 2.5V	100	400	800	
Control Pin Input Leakage Current	I_{IN}		Pins 2,8,9,10,11,17	-	0.001	0.1	µA

* M/B ≠ 1 and DRS≠ 0
** M/B = 1, DRS = 0 ; test mode.

Note 1 : $\overline{HKS}$=0
2 : In DTMF Mode
3 : In Pulse Mode
4 : Keyboard Entry, Including Auto Dialing.
5 : No Keyboard Entry.
6 : All Output Unloadaed.
7 : Dual Tone Multi-Frequency Distortion is measured in terms of total out-of-band power related to the sum of the row & column fundamental power.
8 : Crystal parameters defined as Rs≤100, Lm=96mH Cm=0.25PF Ch=5PF, F=3.579545MHz & Cl=18PF F≤±200 PPM.
9 : Refer to Pulse Mode Time Diagram.
10: Refer to DTMF Mode Time Diagram.

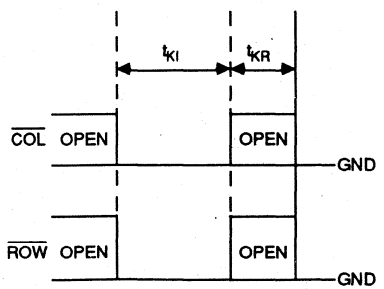
Table 1. Comparisons of Specified vs Actual Tone Frequencies Generated By HM 9120.

Active Input	Output Frequency Hz Specified	Actual	%Error See Note
R1	697	699.1	+0.30
R2	770	766.2	-0.49
R3	852	847.4	-0.54
R4	941	948.0	+0.74
C1	1,209	1,215.9	+0.57
C2	1,336	1,331.7	-0.32
C3	1,477	1,471.9	-0.35
C4	1,633	1,645.0	+0.73

Note: % Error does not include oscillator drift.

Pin Function Description

Symbol	Pin No. 9120	Description
ROW COLUMN	1,3-7 22-28	The keyborad functioning as followings: * Active low when connected.



tKI>tKID,tDR>tKRD. Figure 1. Electronic Input The keypad debounce method is improved in the best way: key-in debounce-tKID= 20ms, key-released debounce-tRD= 20ms. That means the key-in will be acceptable only if it lasts longer than 20 ms and the next key-in will be unacceptable unless the key has been released longer than 20ms. In normal operation, any single button is pressed to produce dual tone, pulses, or function. Activation of two or more buttons will result no response, except in test mode.Table 2. illus trates the address keypads function in detail.

Symbol	Pin No. 9120	Description
OSC IN OSC OUT	12, 13	A built-in inverter provides oscillation with an 3.579545 MHz crystal. It will be disabled when there is no entry of keypads in order to decrease the cosumption of power.
$\overline{\text{PULSE MUTE}}$	20	The mute output is a CMOS inverter. It is high normally, but active low during pulse dialing period.
$\overline{\text{HS}}$	8 6	The HOOK SWITCH input is used to detect the state of telephone handset. In ON-HOOK state the must be pulled high in order to disable the dialing opera tion & decrease the consumption of power. When OFF-HOOK the input must be pulled low, so that, all the function can be operated.
TONE OUT	18	This pin is used to output DTMF address code. During pulse dialing,it always keeps in low state regardless of keypad input. In tone mode, it will output dual or single tone, for detail description please refer to Table 2. In normal dialing, the tone duration depends on key-in duration. When keypad is pressed less than 100ms. In opposite, the tone duration will last as long as key is pressed. When redialing, the tone duration & inter-tone -pause are internally set to 100ms & 106ms respectively. Figure 3. illustarates the DTMF timing diagram.
$\overline{\text{T/P MUTE}}$	19	The mute output pulls to V_{DD} with no keyboard in-put and pull to V_{SS} during Tone/Pulse dialing period. (excluding the * & # keypads,in pulse mode)
M/B	9	The M/B pin used to decode for selectable status as following: **M/B** **Flash** **M/B rate** V_{SS} 600ms 40:60 V_{DD} 100ms 33:66
MODE	11	★ Pulse(10 pps/20 pps) / DTMF mode select Input (Three state CMOS Input/ Output) MODE = OPEN : PULSE 20pps MODE = V_{SS} : PULSE 10pps MODE = V_{SS} : DTMF In "20pps" mode, the FLASH time is 600ms.
KEY TONE	16	KEY TONE is N-channel open drain output (normally high imped ance). KEY TONE is Output for valid key-in in PULSE mode. KEY TONE Output duration is 30msec (typ.), and Key-in tone frequency is 1.2kHz (duty ratio 50%).
$\overline{\text{DP}}$	21	In DTMF mode, the pulse out keeps high level regardless of keyboard entry. In pulse mode, this output sends a chain of pulses to correspond the address keypad input,but keeps high level for * & # entry.Figure 4. shows the time diagram in pulse mode.(CMOS inverter output.)
ON/OFF HOOK ST	2	When this pin is connected to V_{DD} it is in ON-HOOK STORE mode. When connected to V_{SS}, it is in OFF-HOOK STORE mode.

Symbol	Pin No. 9120	Description
HFD SET/ RST	10	This iput is a toggle flip-flop input.It consists of on chip pull down resistor (Typical 100K OHM). This input can be triggered by logic high. The circuit structure please refer to Figuge 5. The hand free dialing feature can be implemented via this input operation.(schmitt trigger input.)
ST SWITCH	17	Chip's store function can be executed by this in-put or store key and storing input is master control for all function. A logic high input to this pin can trigger this chip get into store mode. On chip pull down resistor is provided (TYPICAL 100KΩ)

M/B	Mode	Active Low Inputs ROW Pins	Active Low Inputs COLUMN Pins	Output Tone Out; PO
	V_{ss} (Normal) (Test mode)	One Two or More One Two or More	One One Two or More Two or More	Dual Tone V_{ss}
↓	V_{ss} (Normal) (Test mode)	One Two or More One Two or More	One One Two or More Two or More	Dual Tone Column Tone Row Tone V_{ss}
V_{DD} OPEN V_{ss}	V_{DD} OPEN (Normal) (pulse mode)	One Two or More One Two or More	One One Two or More Two or More	10 PPS, 20 PPS Open
↓	OPEN V_{DD} (Test mode)	One Two or More One Two or More	One One Two or More Two or More	600 PPS Open

Table 2 Address Keypads Truth Table (Continual)

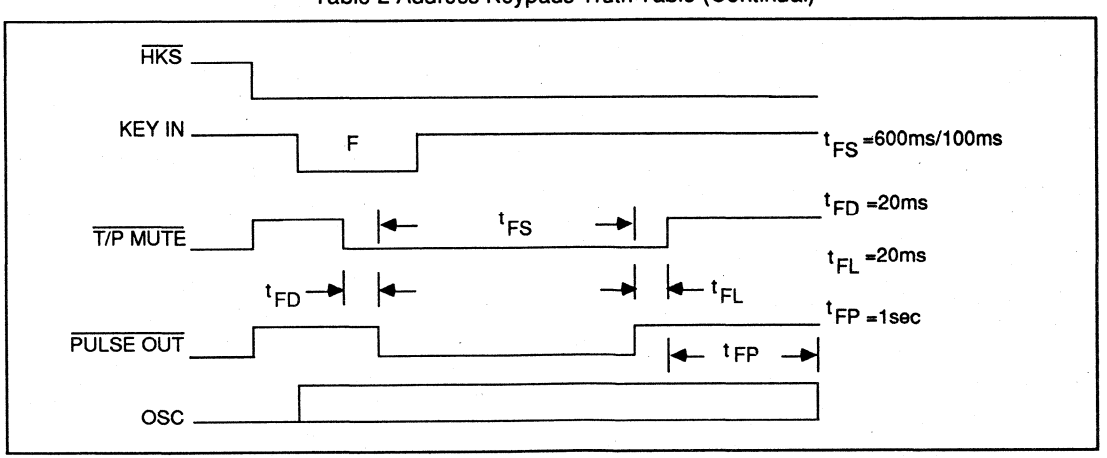


Fig. 2 Flash Timing Diagram

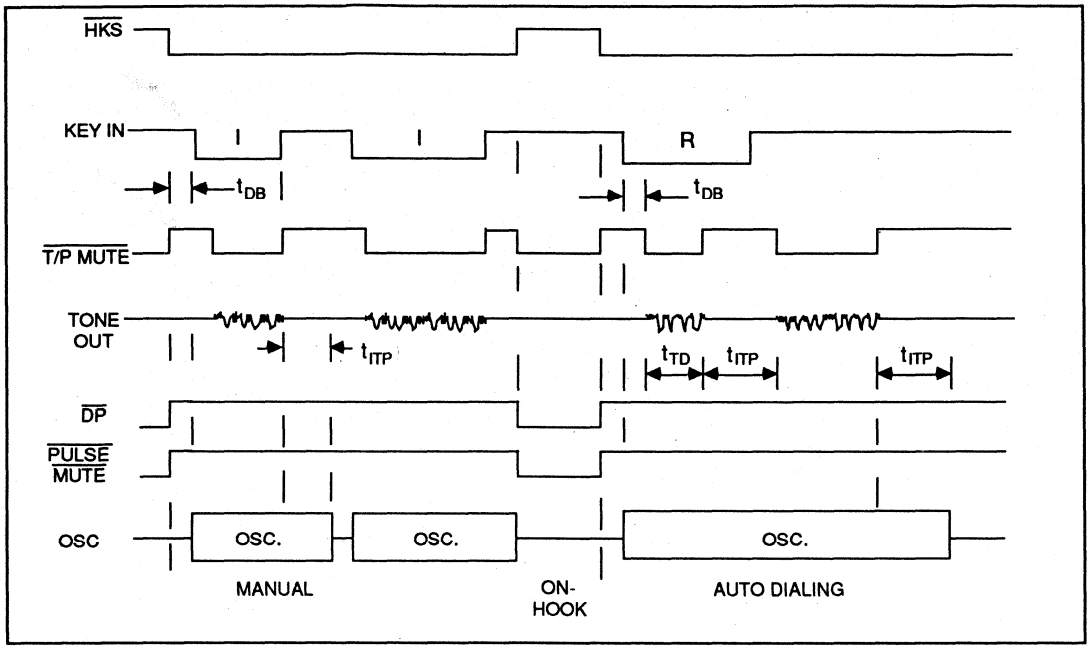


Figure 3. Tone Mode Timing Diagram

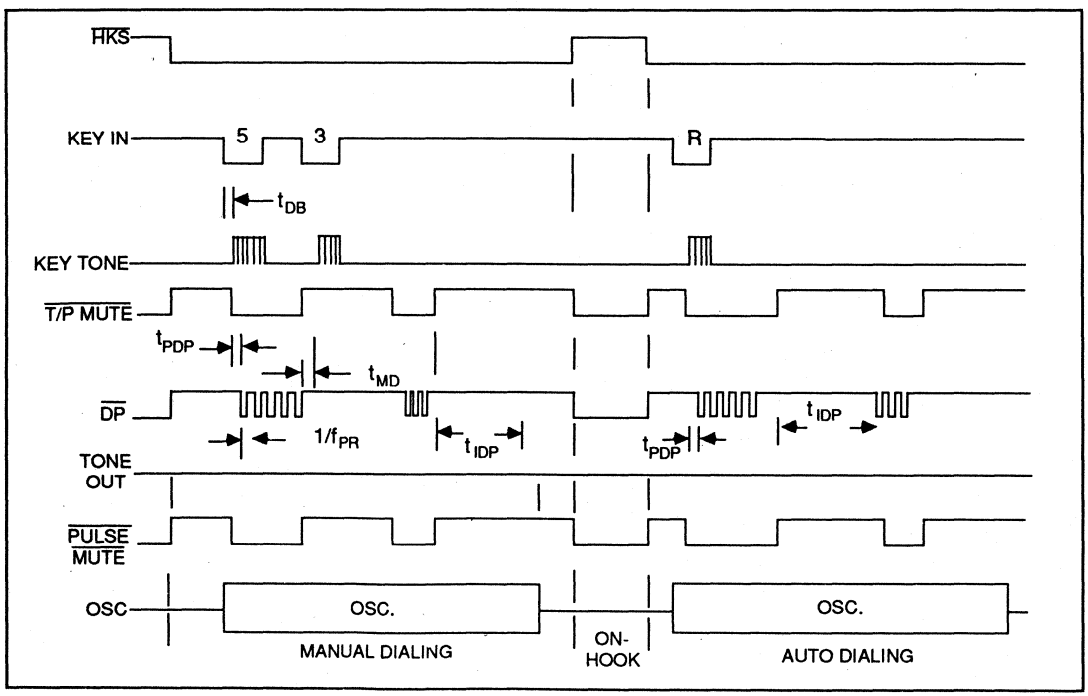


Figure 4. Pulse Mode Timing Diagran

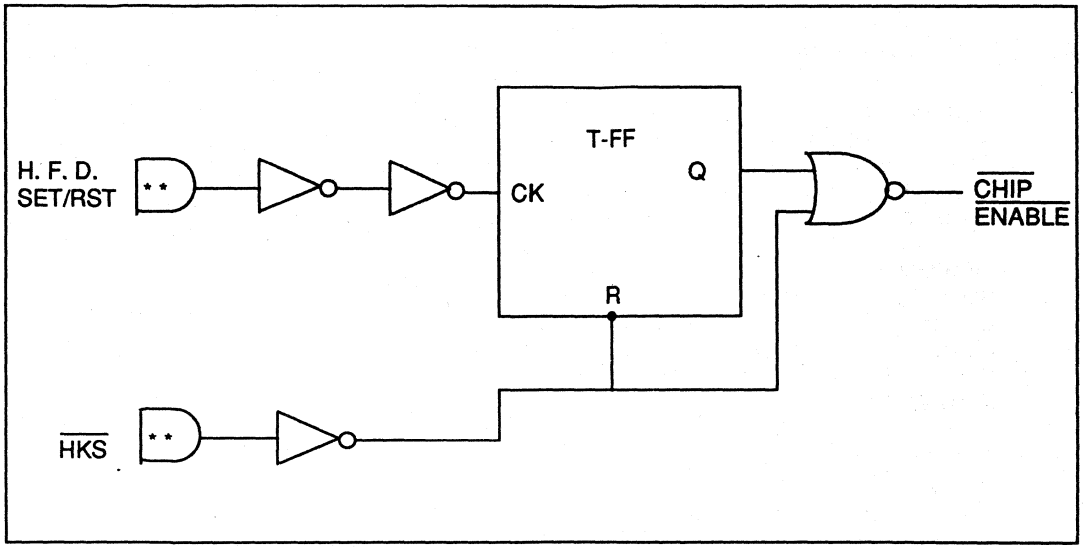


Figure 5. Hand Free Dialing Circuit Structure.

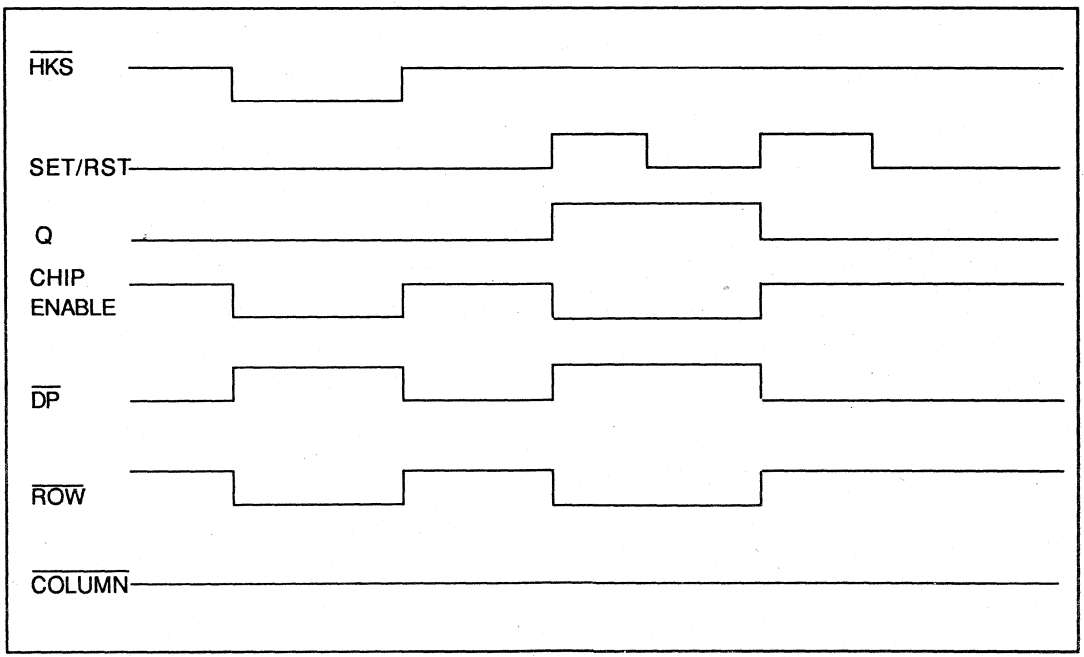


Figure 6. Hand Free Dialing SET/RST Timing Relation.

Keyboard Operations

I. Normal Dialing

Select Pulse or Tone mode.
Off-hook (n≤31)
Push [D1]—[Dn], D1 - Dn : 0-9, *, #
Then the number D1,... Dn will be dialed out in Pulse or Tone mode as selected.

II. Redialing

Select Pulse or Tone mode.
Off-hook
Push [D1]—[Dn], busy, ON-HOOK.
Come OFF-HOOK. push [R/P], then ast number D1,D2....Dn will be automatically dialed out in Pulse or Tone mode as selected.

III. Number Storing

Select pulse or Tone mode.
* By Store Key
Off-hook Store (On/Off Hook ST Pin=Low, HKS Pin=Low, STORE SW=Low.)
Push [ST] [D1]—[Dn] [Ln]
then the number D1,..,Dn will be stored in location [Ln]. Successive storing is available.
[Ln]: [M1], [M2], ... [M20].

** BY STORE SWICTH (FOR ON HOOK STORE MODE OR OFF HOOK STORE MODE)
(a) Set "Store" pin "Hi".
(b) Press [D1]—[Dn] [Ln] then the number will be stoted in location [Ln]. Successive storing is available.
(c) After finishing above procedure, set "store" pin "low".

IV. Memory Dialing

Select Pulse or Tone mode.
Don't care OFF-HOOK dialing or hand free dialing, push [Ln], then the numbers stored in the memory will be dialed out.

V. Pause Key Operation

In some cases, such as PABX or long distance service, pauses should be inserted in the dialing sequence. The HM 9120 provides stackable pause function (3.6 sec/pause)which facilitates flexible applications. For examples:

a. Dialing with Pause Key
1. Select Pulse or Tone Mode.
Off-hook
Push [D1], [R/P], —, [Dn]; D1-Dn : 0 -9, *, #.
then the number will be dialed out in the following sequence: D1, pause 3.6 sec, D2, ..., Dn.

2. Redialing with Pause Key
When redialing, the chip outputs the same sequences as above, but all the timings are fixed internally.

b. Storing with Pause Key

1. Select Pulse or Tone Mode
   Off-hook
   Push [ST][D1][R/P][D2],.,[Dn][Ln].
   then the number D1, Pause 3.6sec., D2...Dn will be stored in [Ln].

2. Dialing with Pause Key.
   Select Pulse or Tone mode.
   Push A [Ln], then the output signal will be dialed in the following sequence. D1, pause 3.6 seconds, D2,...Dn.

Note : The pause duration is 3.6 sec/pause, it can be continuously stored for longer pause duration. But every pause will occupy one digit of memory size.

VI. Pulse To Tone Key Operation

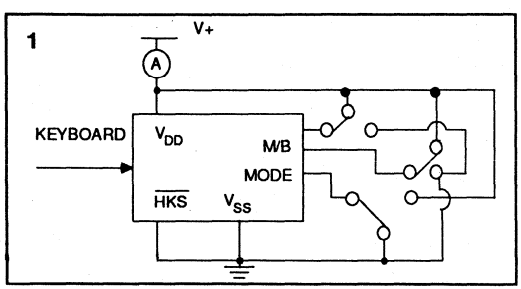
a. Dialing with Pulse to Tone mode.
   Push [D1],[D1],.....[Dn],[P→T],[D1'],[D2],...[Dn']
   Then the numbers will be dialed out in the following sequence: If the mode switch is set in pulse mode, then the output signal will be: D1, D2, ..., Dn, pause 3.6 sec. D1', D2', ..., Dn'.
   (Pulse) (Tone)

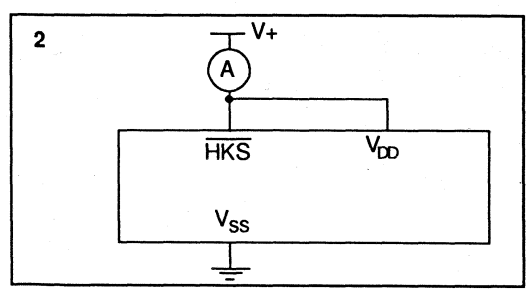
b. Redialing or memory dialing with Pulse to Tone Key
   Push [R/P], Then the numbers will be dialed out in the following sequence: If the mode switch is set in pulse mode, then the output signal will be: D1, D2, ..., pause 3.6 sec, D1', D2', ..., Dn';
   (Pulse) (Tone)

VII. Flash Operation

This chip provides a convenient and precise flash function for PABX service. Push F, then 600 ms flash is supplied, and the central unit will service the caller, such as : transfer, wait-----.
FLASH can be stored in redial and memory. Key input for normal dialing is acceptable during a period of FLASH and FLASH PAUSE. Successive data of normal dialing will be output after execution fo FLASH PAUSE.
Figure 2. shows flash timing diagram.

Test Circuit





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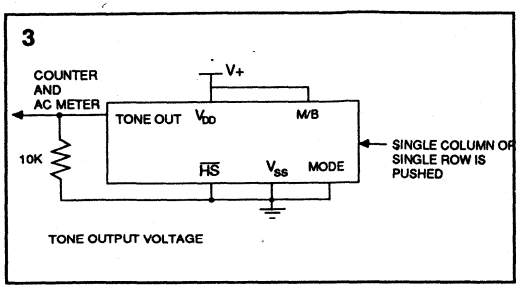

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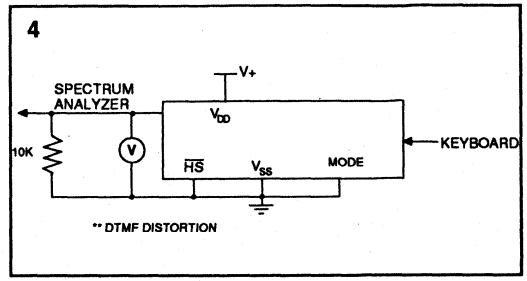
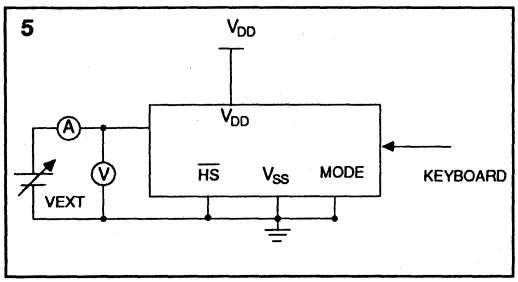


$$DIST.(dB)= 20\log \frac{\sqrt{(V1)^{**}2+(V2)^{**}2+..+(Vn)^{**}2}}{\sqrt{(VL)^{**}2+(VH)^{**}2}}$$

a. V1....Vn are extraneous frequencies (ie, inter modulation and harmonic) components in the 500Hz to 3400Hz band.
b. VL,VH are the individual frequency components of the DTMF signal

Note:
Whether keyboard is pushed refer to the DTMF mode time diagram of HM 9113 product spec.

5



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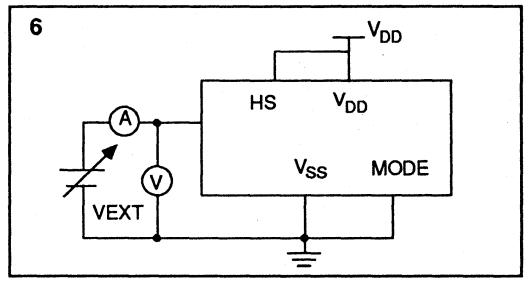
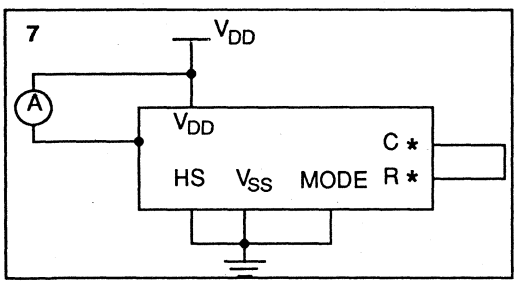


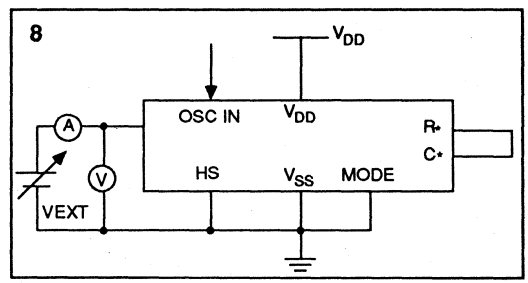
Note: Whether keyboard is pushed refer to the DTMF mode time diagram0f HM 9114 product spec.

7



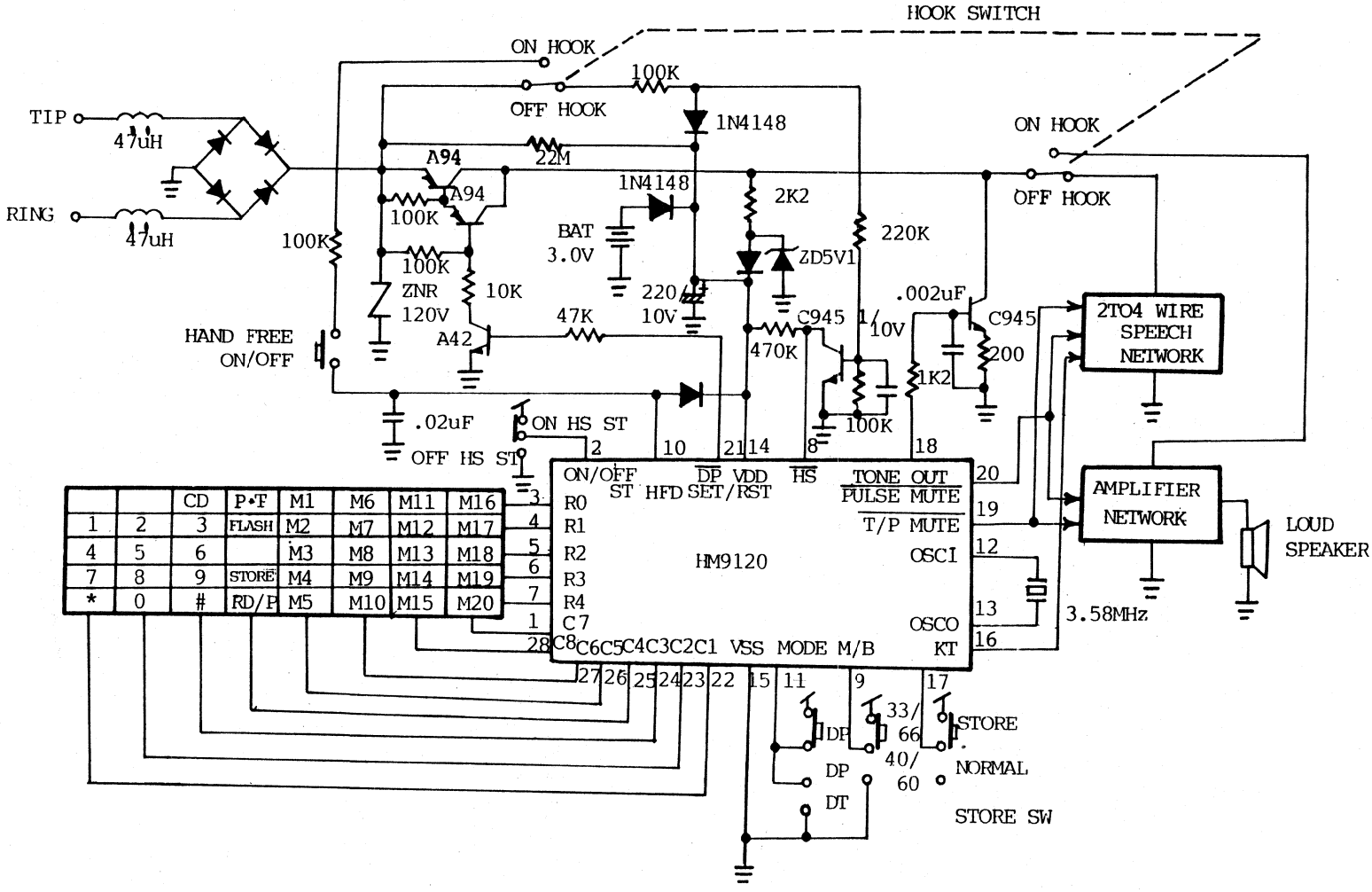
Isink=I/(1-Duty Cycle) I is the net DC current measured from ampere meter.

8



Procddure:
1. provide clocks until output change to high.
2. Test its current.

HM 9120 Application Example



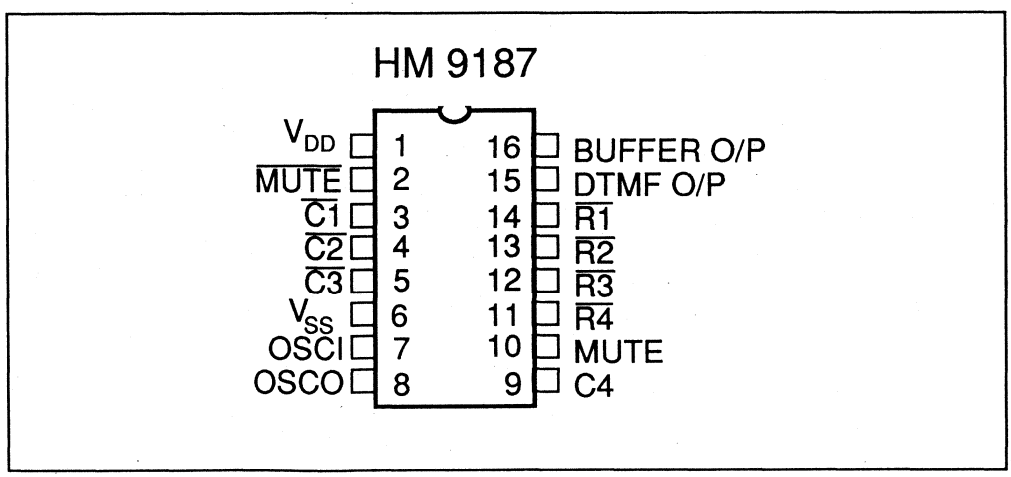
General Description

The HM 9187 DTMF TONE GENERATOR is specially designed to implement a dual tone telephone dialing system. The device can interface directly to a standard pushbutton telephone keyboard or calculator type XY keyboard and operates directly from the telephone lines. All necessary dual-tone frequencies are derived from the widely used TV crystal providing very high accuracy and stability. The waveform so generated has very low total harmonic distortion (7%). A voltage reference is generated on the chip which is stable over the operating voltage and temperature range and regulates the signal levels of the dual tones to meet the recommended telephone industry specifications.

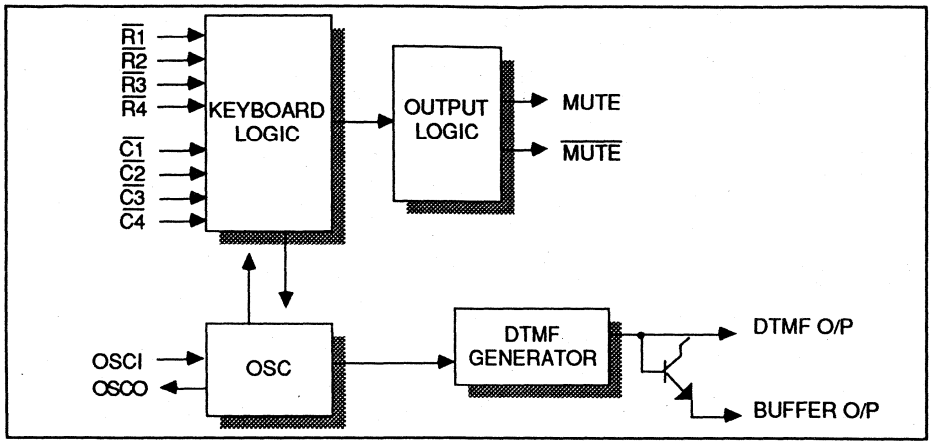
Features

* Low output tone distortion: 7%.
* Wide operating supply voltage range: 2.0 to 5.5V
* Oscillator bias resistor on-chip.
* Can be powered directly from telephone line or from small batteries.
* Use 3.579545MHz crystal.
* Mute drivers on-chip.
* On-chip generation of a reference voltage to assure amplitude stability.
* Interfaces directly to a standard telephone push-button or calcuator type XY keyboard.

Pin Assignment



Block Diagram



Absolute Maximum Ratings

(T_A = 25 °C)

Characteristics	Sym.	Ratings	Unit
DC Supply Voltage	V_{DD}-V_{ss}	6.0	V
Operating Temperature		-25 to + 70	°C
Storage Temperate		-30 to +125	°C
Power Dissipation at 25°C		1000	mW
Digital Input		V_{ss}-0.3≤Vin≤V_{DD}+0.3	V
Analog Input		V_{ss}-0.3≤Vin≤V_{DD}+0.3	V

* Comments: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operations of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

Electrical Characteristics

(Specifications apply over the operating temperature range of -25°C to +70°C unless otherwise noted. Absolute values of measured parameters are specified.)

Parameter	Symbol	Min	Typ	Max	Units	Conditions
Operating Voltage:						
Tone Out Mode	V_{DD}	2.0		5.5	V	Valid Key Depressed
Non Tone Out Mode	V_{DD}	2.0		5.5	V	No Key Depressed
Operating Current:						
Standby Mode	Idd		0.3	10	µA	V_{DD}=3.0V No Key Selected,Tone. MUTE and MUTE Output Unloaded
	Idd		1.0	20	µA	V_{DD} =5.0V No key Selected, Tone. MUTE and MUTE Output Unloaded

Parameter	Symbol	Min	Typ	Max	Units	Conditions
Operating Mode	Idd		1.0	2.0	mA	V_{DD} =3.0V One Key Selected, Tone. $\overline{MUTE}$ and MUTE Output Unloaded
	Idd		2.0	4.0	mA	V_{DD} =5.0V One Key Selected, Tone. $\overline{MUTE}$ and MUTE Output Unloaded
Single Row Tone Output Voltage	Vor	150		220	mVrms	V_{DD} =2.5-5.5V, Rl=5K
Ratio of Column to Row Tone	dBcr	1.0	2.0	3.0	dB	V_{DD} =2.0-5.5V
Distortion	%DIS			7	%	V_{DD} =2.0-5.5V
$\overline{MUTE}$ Output:						
Output Sink Current	Isk	1.0	1.5		mA	V_{DD}=3.0V Key Depressed, Vo=0.5V
Output Leakage Current	Iof			5	µA	I/P=12V

Table 1. Comparisons of Specified vs Actual Tone

Active Input	Output Frequency Hz Specified	Actual	% Error See Note
R1	697	699.1	+0.30
R2	770	766.2	-0.49
R3	852	847.4	-0.54
R4	941	948.0	+0.74
C1	1,209	1,215.9	+0.57
C2	1,336	1,331.7	-0.32
C3	1,477	1,471.9	-0.35
C4	1,633	1,645.0	+0.73

Note:
% Error does not include oscillator drift.

Table 2. MUTE and MUTE Output

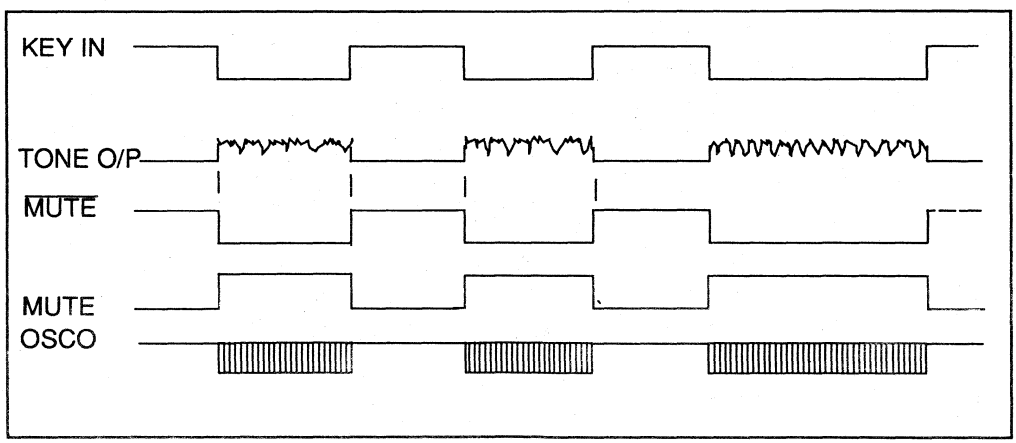
Output	'Digit'Key Released	'Digit'Key Depressed	Comment
$\overline{MUTE}$	High Impedence	V_{ss}	
MUTE	V_{ss}	V_{DD}	Can source or sink current

Pin Functional Description

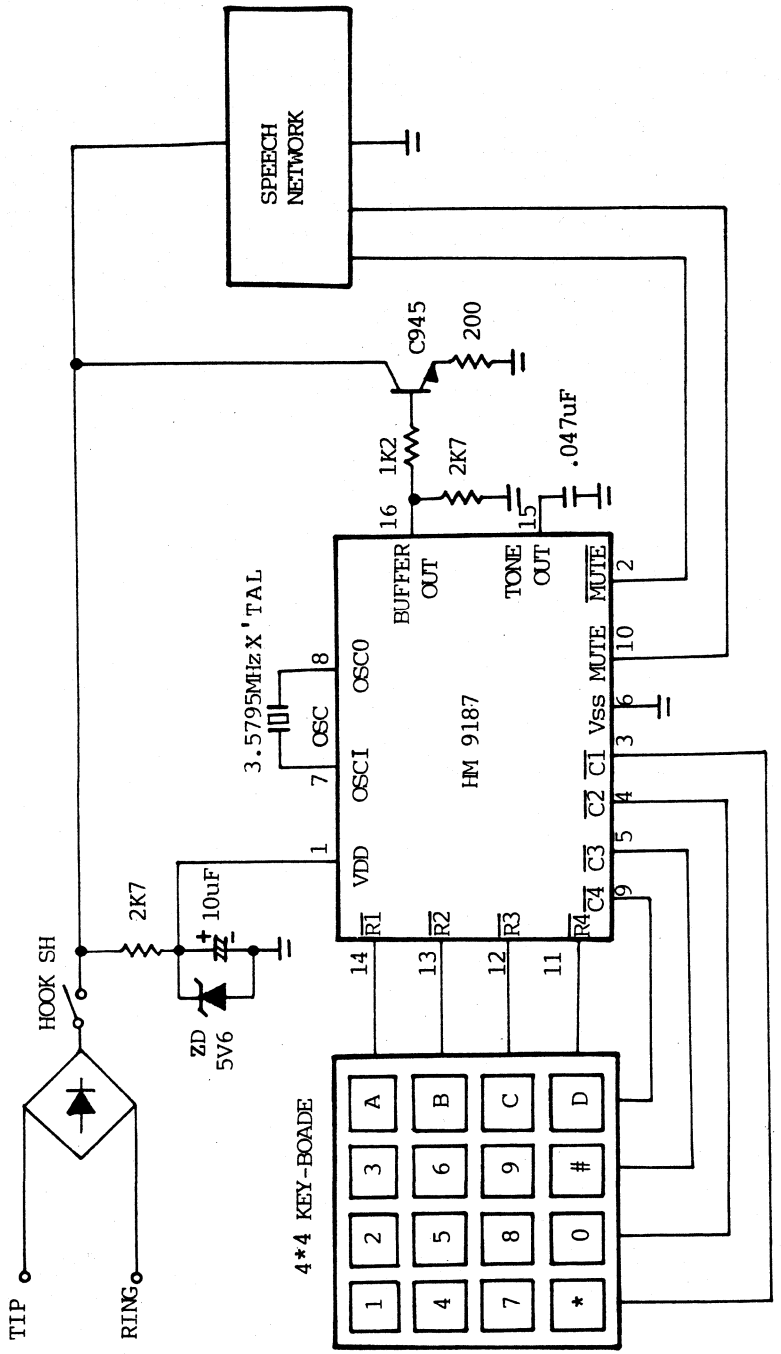
Symbol	Pin No	Name And Function
V_{DD} , V_{ss}	1, 6	These are the power supply inputs HM 9187 is designed to operate from 2.0 to 5.5 Volts.
$\overline{MUTE}$	2	HM 9187 has N. Channel open drain transistor as the negative mute output. With no keys depressed, the output is in the high impedence state. When a key is depressed, the output goes into a low state.

Symbol	Pin No	Name And Function
$\overline{R1}$, $\overline{R2}$, $\overline{R3}$, $\overline{R4}$, $\overline{C1}$, $\overline{C2}$, $\overline{C3}$, $\overline{C4}$,	3, 4 5, 9 14, 13 12, 11	HM 9187 functions as active pull-down on the column inputs and active pull-up on the row inputs when no key is depressed. When a key is pushed a low level is sensed on one of the row imputs, the oscillator starts and the keyboard scanning logic determines the column inputs that are selected. The advantage of the scanning technique is that a keyboard arrangement of SPST keyboard (4 rows X 3 or 4 columns) can be used. It can also interface with CMOS logic outputs directly. HM 9187 requires active "low" logic levels. Debounce circuit is provided to prevent the keyboard chattering.
OSCI, OSC0	7, 8	HM 9187 contains on ocscillator circuit with the necessary parasitic capacitances and bias resistor on chip so that it is only necessary to connect the standard 3.58 MHz TV Crystal a cross the OSCI and OSC0 terminals to implement the oscillator function.
MUTE	10	HM 9187 have a CMOS buffer for the Mute output. With no keys depressed, the Mute output is "low". When a key is depressed, the Mute output goes high.
DTMF O/P BUFFER O/P	15,16	HM 9187 uses the Johnson counters and resistor. Adder networks to synthesize the desired two frequencies in sinewaves and then uses the adder network to add these two frequencies and then drive a bipolar NPN transistor connected as emitter follower to allow proper impedance transformation, at the same time preserving signal level. Choose the DTF output or BUFFER output depending on the application requirement.

Timimg Diagram



HM 9187 Application Example



General Description

HM 9200 call progress tone decoder & dial controller is built on the 3.5microm CMOS process and implemented with switched capacitors. It provides two operating modes to support a diverse application field:

(1) Standard call progress tone decoder:
it detects the input signal of specifications and then outputs relative envelopes. By counting the transitions of envelope during the 2.27 sec. interval, the decoding circuit distinguishes what kind of tone input signal is. Three tri-state output pins(Bit 1,Bit 2 & bit 3) indicate the presence of dial tone, ringback tone or busy/reorder tone respectively, so it provides information to permit microprocessors to decide whether to initiate, continue, or terminate calls.

(2) Dial controller:
It implements busy, redial function. With the decoded results, if busy, this chip forces dialer to break for 23 sec., then triggers the redial key after dial tone has been received. If the called party is still busy, the redial sequence will be repeated 11 times (or 10 times by mask option).

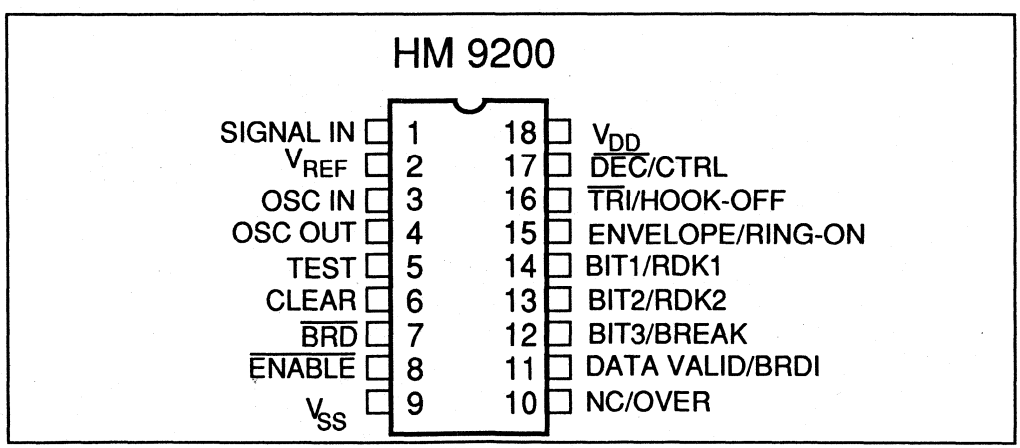
Features

* Low cost 3.58MHz crystal or clock.
* Low power consumption.
* Fully decoded tri-state call progress status output.
* Work with traditional, precision or PBX call progress tones.
* Logic compatible with TTL. CMOS. NMOS.
* Busy Redial function: repeated 10 or 15 times by mask option.
* Auto-terminate after 31 times (mask option) ringback tone has been received.
* Internal power on reset.
* Supply voltage: 4.5 to 5.5V
* 18 pins DIP package.

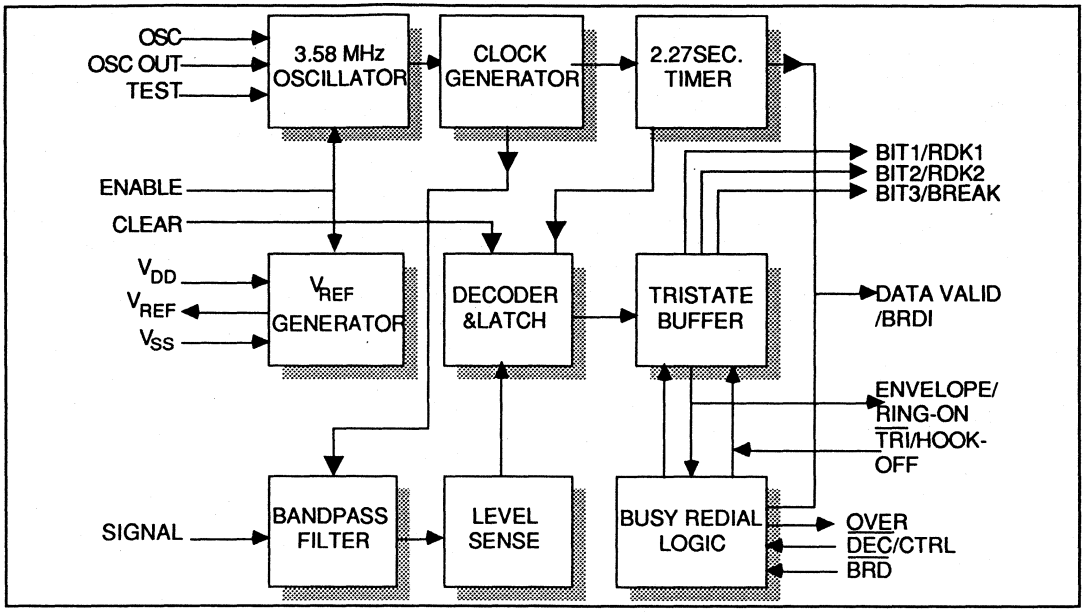
Applications

* PABXs.
* Modems.
* Feature telephones.
* Answering machines.
* Billing systems.

Pin Assignment



Block Diagram



Pin Functional Description

<A> GENERAL-PURPOSE AND DETECTOR

Symbol	Pin No	Name And Function
V_{DD} ,V_{SS}	18,9	Supply Voltage: 4.5 to 5.5V. While functions are disabled in the following cases, the V_{REF} will be turned off and output will be pulled low to decrease the cosumption of power. Case 1. ENABLE = 1, Case 2. ENABLE = 0, DEC/CTRL = 1 and BRDI = 0.
V_{REF}	2	Provide voltage at half V_{DD} for voltage reference.
OSC IN, OSC OUT	3 4	Crystal Oscillator input and output. A 3.58MHz crystal is connected between these pins in parallel with a built-in inverter with R,C feed back & loading components.While functions are disabled,the oscillator will be disabled to decrease the consumption of power.
SINGAL IN	1	Accept the analog input. This pin is internally biased at V_{REF} so that the input signal should be AC coupled.
TEST	5	In normal operation, this pin is always pulled low. If TEST=1, this chip is set in testing mode. The input of decoder is fed externally from ENABLE pin and the clock of decoder & dial controller is fed externally from OSC-OUT pin.
$\overline{\text{ENABLE}}$	8	$\overline{\text{ENABLE}}$=0, this chip is defined in normal state,then all of the functions can be operated.When ENABLE=1, this chip is disabled, oscillator stops and all the logic outputs are pulled low or high impedance.
$\overline{\text{DEC/CTRC}}$	17	Define the operation mode of this chip.If $\overline{\text{DEC/CTRL}}$=0, this chip acts as a standard call progress tone decoder. But if DEC/CTRL=1, it is a dial controller which is used to implement BUSY REDIAL function.

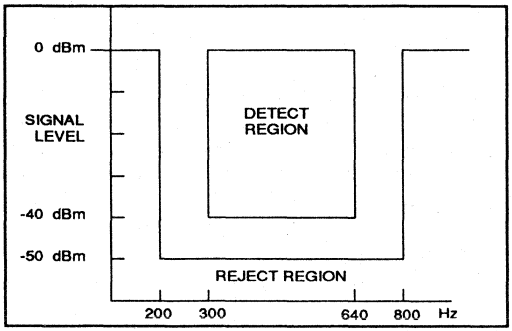


FIGURE 1. DETECTED RANGE

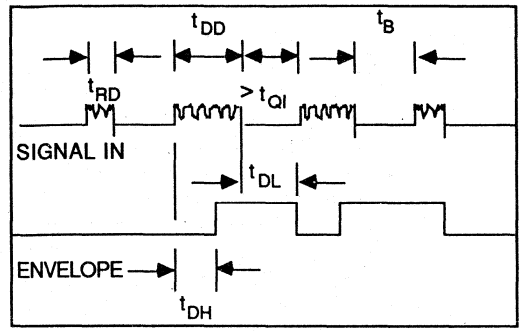


FIGURE 2. DETECTED TIMING DIAGRAM

<B> DECODER

Symbol	Pin No	Name And Function
		Prior condition : $\overline{DEC}$/CTRL=0 (call progress tone decoder)
$\overline{TRI}$/ HOOK-OFF	16	For call progress tone decoder, this is a control pin for tri-state outputs. If $\overline{TRI}$/ HOOK OFF=1, it influences nothing. But if $\overline{TRI}$/HOOK OFF=0, it makes BIT1, BIT2, BIT3 & ENVELOPE high impedance.
CLEAR	6	CLEAR=0, it influences nothing. But if CLEAR=1, the decoder is reset and all the decoding outputs & ENVELOPE are pulled low.
BIT1, BIT2, BIT3, DATA VALID	14 13 12 11	Digital outputs that provide the code corressponding to the decoded signal. They are normally low, active high.At the start of an inband tone (envelope output goes high), a 2.27 sec interval starts. Transitions of the envelope during this interval are counted to determine the signal presents. At the end of 2.27 sec interval, these three bits of data representing this decision are stored in the latch and appear at Bit1,Bit2 & Bit3. DATA VALID goes high at the same time and can be used to trigger a microprocessor to access this data. The decoded truth table is shown in Table 1. The operating timing diagram is shown in figure 5.
ENVELOPE	15	If the input signal is within specifications (V_{IN}=-40 to 0 dbBm, frequency within 300 to 640 Hz, and lasts longer than 40ms), this pin will output relative envelope with delay time=40ms typically. The detected range and timing diagram are shown in figure 1 and 2.

Tones	Transition Number	Bit1	Bit2	Bit3	DATA VALID	TRI/HOOK-OFF
INITIAL		0	0	0	0	1
DIAL	1	1	0	0	1	1
RINGBACK	2 TO 4	0	1	0	1	1
BUSY/REORDER	5 TO 16	0	0	1	1	1
OVERFLOW	> 16	0	0	0	1	1
OUTPUT		HIGH	HIGH	HIGH	*	0
DISABLED		Z	Z	Z		

Note : 1. "*" means previous state.
2. The high level of ENVELOPE on the positive edge of window is counted as a transition.

TABLE 1

Description Of Operation

the HM 9200 call progress tone decoder was designed to accommodate the various call progress tone systems which are presently in use in the U.S. and many other parts of the world.To identify dial tone, ringback, busy signals, or reorder tones, the HM 9200 uses a cadence counting technique. This eliminates the problem of identifying the specific tones by their individual frequencies, which are not standard from system to system.

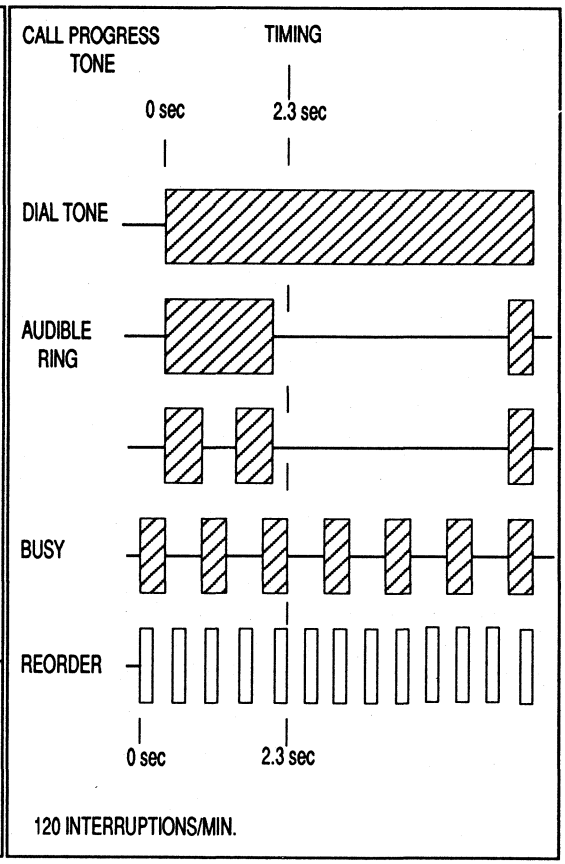
Figure 3. shows some of the call progress tones which can be encountered when calling from phone system to system within the U.S. Note that although the frequencies are not standardized. The cadence or interruption rate doesn't vary. Even the three types of reorder tones share the same period of 0.5 sec.

Figure 4. shows a profile of the tone energy described in Figure 3. Note the double ring (audible ringback) which can be encountered with PBXs.

FIGURE 3. CALL PROGRESS TONES

Tone	Frequency(Hz)	Cadence
Precision Dial Tone	350 +440	Continuous
Old Dial Tones	600+120 Or 133, And Other Combinations	Continuous
Precision busy	480 +620	0.5 sec On 0.5 sec Off
Old Busy	600 +120	0.5 sec On 0.5 sec Off
Precision Reorder	480 +620	0.3 sec On LOCAL 0.2 sec Off REORDER
Old Reorder	600 +120	0.2 sec On TOLL 0.3 sec Off REORDER 0.25sec On TOLL 0.25sec Off LOCAL
Precision Audible Ringback	440 +480	2 sec On 4 sec Off
Old Audible Ringback	420 +40 And Other Combinations	2 sec On 4 sec Off

FIGURE 4. ENERGY PROFILE OF CALL PROGRESS TIMING



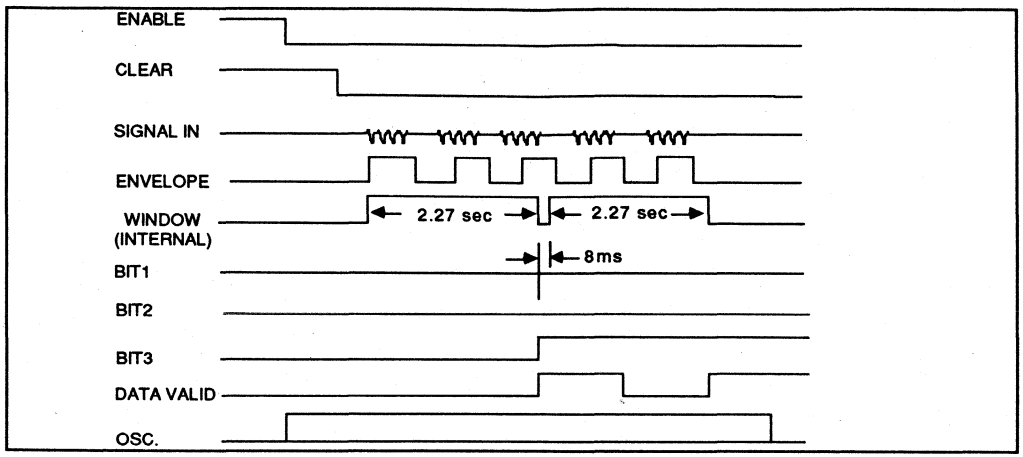
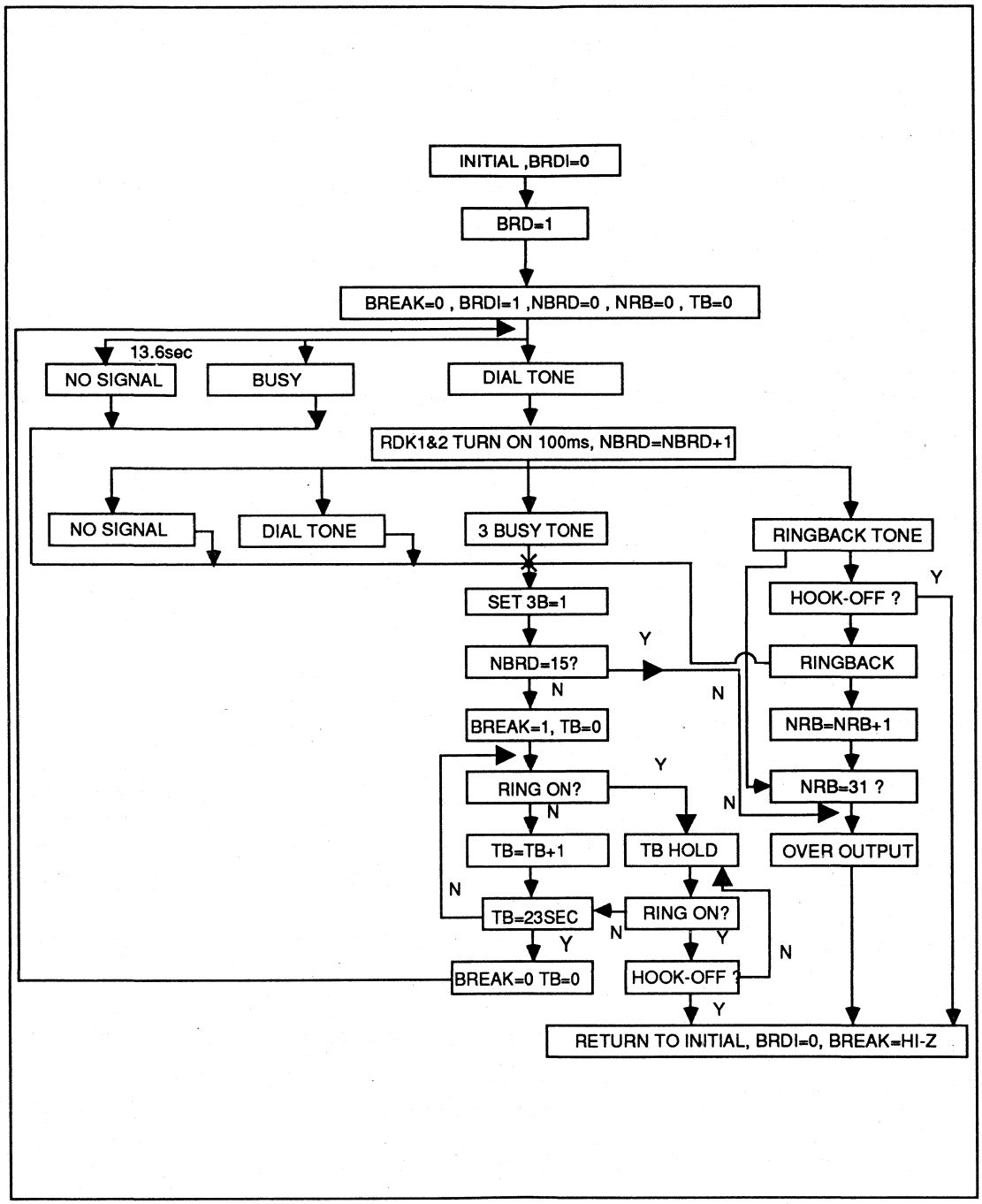


FIGURE 5. DECODED TIMING DIAGRAM

<C> DIAL CONTROLLER

Symbol	Pin No	Description
Prior condition : $\overline{DEC}$/CTRL=1		
$\overline{BRD}$	7	Toggle input of negative transition which is used to enable and disable BUSY REDIAL function. With waveshaped by a built-in Schmitt trigger, the chatter of input can be eliminated by R, C debounce circuit. **Note**: the pull-up resistor has been built-in. (its value is 100K typical.)
BIT1/RDK BIT2/RDK	14 13	Both input & output nodes of a transmission gate. This transmission gate is normally off. But while dial tone has been received, it will be turned on to trigger redial key for 100ms.
BIT 3 /BREAK	12	This output pin is an open drain NMOS transistor which is normally Hi -Z. It is used as a hook control output which forces the dialer to disconnect after busy or reorder tones have been received.
DATA VALID/ BRDI	11	Inverter output pin which is normally low, active high. It indicates the operating state of dial controller. It is also used to mute the microphone of the speech circuit for elimination of the voice interference.
OVER	10	Inverter output which is normally low. After having finished 15th redial and if the called party is still busy, or 31 ringback tones have been received, the OVER pin will output an one-shot pulse for 100 ms. This pulse can be used to reset the latch of handfree circuit.etc.
CLEAR	6	If CLEAR=0 or BREAK=1 (LOW), it influences nothing. But if CLEAR=1 and BREAK=0 (Hi-Z), it will reset tones decoder and its result.
$\overline{TRI}$/ HOOK-OFF	16	Detect the HOOK-OFF swith of the calling party.If there is a positive transition, the dial controller will be reset and BUSY REDIAL function will be disabled.
ENVELOPE /RING-ON	15	Detect the ringer input of calling party. If there is negative transition on this pin during BREAK=1 (BIT 3 pull low), the 23 sec. the timer will stop counting until TRI/HOOK-OFF=1 or the ringer input disappears.

Symbol	Pin No	Description
BUSY REDIAL FUNCTION	7	After power on, this chip is set in initial state. That is, the BUSY REDIAL function has been disabled; RDK1, RDK2 and BREAK are high impedence and BRDI is Low. If there is negative transition input on BRD, BUSY REDIAL function is enabled and BRDI is pulled high. The chip observes the presence of standard call progress tone and executes the programmed operation for different conditions. **1**.If it is dial tone, this chip will turn on the transmission gate of RDK 1 & RDK 2 for 100 ms to trigger the redial key of the dialer. The input of dial tone after redial key has been triggered will be ignored until BREAK=1. **2**.if it is busy/reorder tone of three successive windows or the line is dead (no signal) for 13.6 sec or a dial tone appears for more than 6.8sec. after the number has been redialed,this chip will turn on the NMOS of BREAK (BREAK=1) for 23 sec. (mask option).That will force the dialer to send a disconnect signal to call party for a new call request then the chip will return to condition 1 for redial. If there is ring (Negative transition appears on the ENVELOPE/RING-ON) during BREAK=1, the 23 sec. timer will stop count until TRI/HOOK-OFF=1 or the ring disappears. If it is the same condition after redial has been finished, the previous operation will be repeated for 15 times (mask option). If it is still busy at the end of 15th redial, this chip will output a one-shot pulse for 100 ms at OVER and then reset itself to initial state. The pulse can be used to reset the latch or flipflop of handfree circuit to disconnect from telephone line automatically, too. **3**.If it is a ringback tone, the chip will count the input cycle. However, if the called party does not answer within 31 cycles(mask option) of ringback tone, this chip will output a one-shot pulse for 100ms at OVER and then reset itself to initial state, too. **4**.However, if the called party answers, the $\overline{\text{TRI}}$/HOOK-OFF pin will detect the transition according to the HOOK-OFF of calling party and then reset this chip to initial state automatically. **5**.The flow chart of dial controller is shown in figure 6.


INITIAL ,BRDI=0
BRD=1
BREAK=0 , BRDI=1 ,NBRD=0 , NRB=0 , TB=0
13.6sec
NO SIGNAL
BUSY
DIAL TONE
RDK1&2 TURN ON 100ms, NBRD=NBRD+1
NO SIGNAL
DIAL TONE
3 BUSY TONE
RINGBACK TONE
SET 3B=1
HOOK-OFF ?
NBRD=15?
RINGBACK
BREAK=1, TB=0
NRB=NRB+1
RING ON?
NRB=31 ?
TB=TB+1
TB HOLD
OVER OUTPUT
TB=23SEC
RING ON?
BREAK=0 TB=0
HOOK-OFF ?
RETURN TO INITIAL, BRDI=0, BREAK=HI-Z
Y
N

<D> Summary: The Usage Of Duplex Pins

	Tones Decoder DEC/CTRL=0	Dial Controller $\overline{DEC}$/CTRL=1
$\overline{TRI}$/ HOOK-OFF	$\overline{Tri}$-State Control 1 : Output Enabled 0 : Output Disabled	HOOK-OFF Detect Positive Transition Input
BIT1/RDK1 BIT2/RDK2	Dial Tone Ringback Tone	Redial Control (I/O Terminals Of Transmission Gate)
BIT3/BREAK	Busy/Reorder Tone	Hook Control
DATA VALID /BRDI	Data Valid	State Indicator 1 : Function Enabled 0 : Function Disabled
ENVELOPE /RING-ON	Envelope Out	Ring-On Detect

Table 2.

Absolute Maximum Ratings

Characteristics	Sym.	Ratings	Unit
DC Supply Voltage	V_{DD}	9.0	V
Input Voltage Range	V_{IN}	- 0.5 to V + 0.5	V
Input Current of TX. Gate	I_{TG}	±10	mA
Power Dissipation Per Package	P_O	500 (T_A= -25 -- +60°C)	mW
Operating Temperature	T_A	- 25 to 85	°C
Storage Temperature	T_{STG}	-65 to 165	°C

Electrical Characteristics

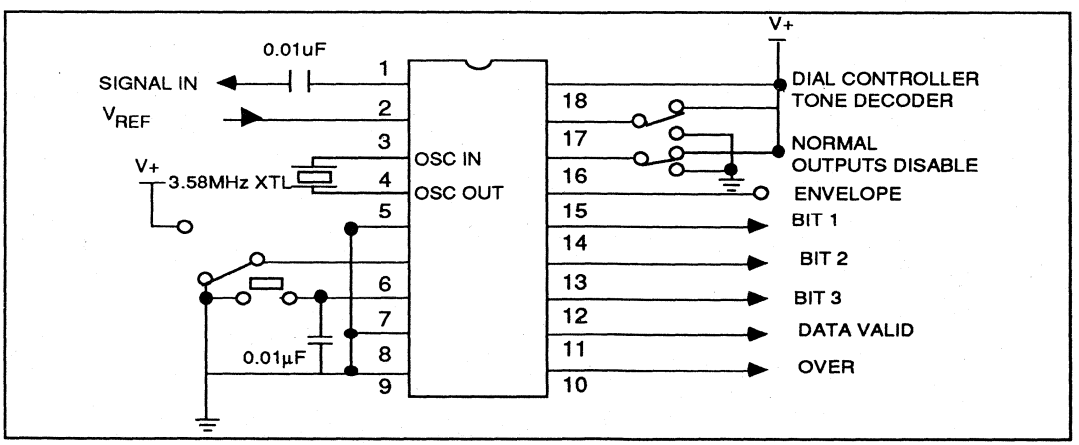
Unless otherwise stated V_{DD} =5.0V fOSC=3.58MHz.

Characteristics	Sym.	Test Ckt.	Conditions	Limits Min.	Type	Max.	Unit
Operating Voltage	V_{DD}		Functional	4.5	-	5.5	V
Operating Current	IOP	A	Functions enabled; Output unloaded.	-	-	10	mA
Quiescent Current	IQS	A	Functions disabled	-	-	10	mA
Detection Level			fIN=300 to 640Hz ENVELOPE=1	-40	-	0	dBm
Rejection level			All frequency. ENVELOPE=0	-	-	-50	dBm
Rejection Out-band Frequency	fRL fRH		V≤0 dBm, LOW ENVELOPE=0 HIGH	- 800	-	200 -	Hz
Detection Signal Duration	tDD		In-band Signal Input, ENVELOPE=1	40	-	-	ms
Rejection Noise Duration	tRD		Any Signal input, ENVELOPE=0	-	-	20	ms
Detection Quiet Interval	tQI		VI≤-50dBm, ENVELOPE=0	40	-	-	ms
Rejection Bridge Time	tB		VI≤-50dBm, ENVELOPE=1	-	-	20	ms

Characteristics	Sym.	Test Ckt.	Conditions	Limits Min.	Type	Max.	Unit
ENVELOPE Output Delay Time	tDH		Time to output high	-	40	-	ms
	tDL		Time to output low	-	40	-	
SIGNAL IN Input Impedance	ZI		fIN= 200 -3.4KHz	1.0	-	-	Mohm
Reference Voltage	V_{REF}		Unloaded	2.4	2.5	2.6	V
Output Impedance	V_{REF}			-	5.0	10	Kohm
Logic Input High Voltage	VIH			2.0	-	5.0	
Low	VIL			0	-	0.8	V
Logic Input High Current	IIH		VIH=5.0V	-	-	0.1	µA
Low	IIL	B	VIL=0V	-	0.1	-	
Logic High Output Curren	IOH	B,C	VOH=4.5V	-	-	-0.5	mA
Logic Low Output Current	IOL	B,C	VOL=0.5V	2.0	-	-	mA
Output Disabled Leakage Current	ILKH		$\overline{DEC}$/CTLR=0 VLKH=5.0V	-	-	0.1	µA
	ILKL	D	$\overline{TRI}$/HOOK-OFF VLKL=0V	-0.1	-	-	
Transmission On Gate Output Resister	RON	E	VRDK1=5.0V, VRDK2=0V OR	-	500	1000	ohm
Off Resister	ROFF		VRDK1=0V, VRDK2=5.0V	10	-	-	Mohm
NMOS Sink	INSK		VNI=0.4V	1.6	-	-	mA
Output CurrentLeakage	INLK	B	VN=5.0V	-	-	0.1	µA
Disconnect Duration	tDSC		$\overline{DEC}$/CTRL = BRDI = 1 BREAK = 1 (LOW)	-	23	-	sec

Note: 0dBm=0.775 Vrms.

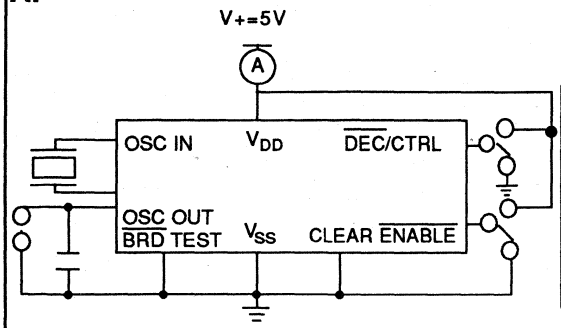
General Test Circuit



Note : 1 If PIN17=1, PIN16 is a transition input.
2 BRD: BUSY REDIAL function.

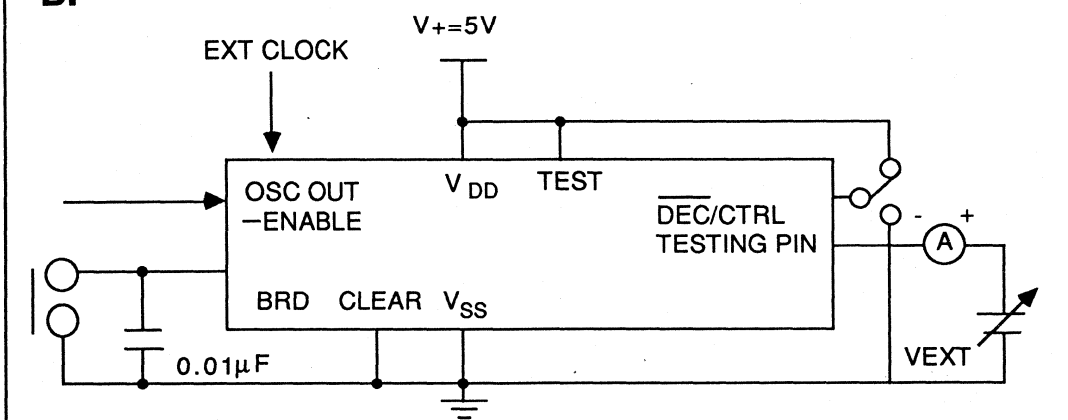
Test Circuit

A.



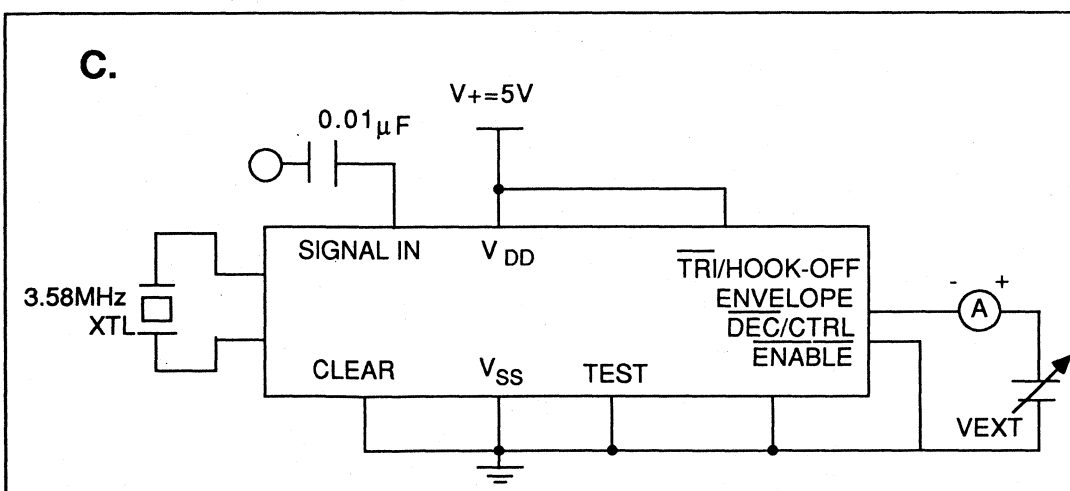
ITEMS		CONDITIONS
IOP	1	ENABLE=0 DEC/CTRL=0
	2	ENABLE=0 DEC/CTRL=1 BRDI=1 , PIN 16="LO"
IQS	1	ENABLE=1, PIN 16="HI"
	2	ENABLE=0, DEC/CTRL=1 BRDI=0 , PIN 16 ="LO"

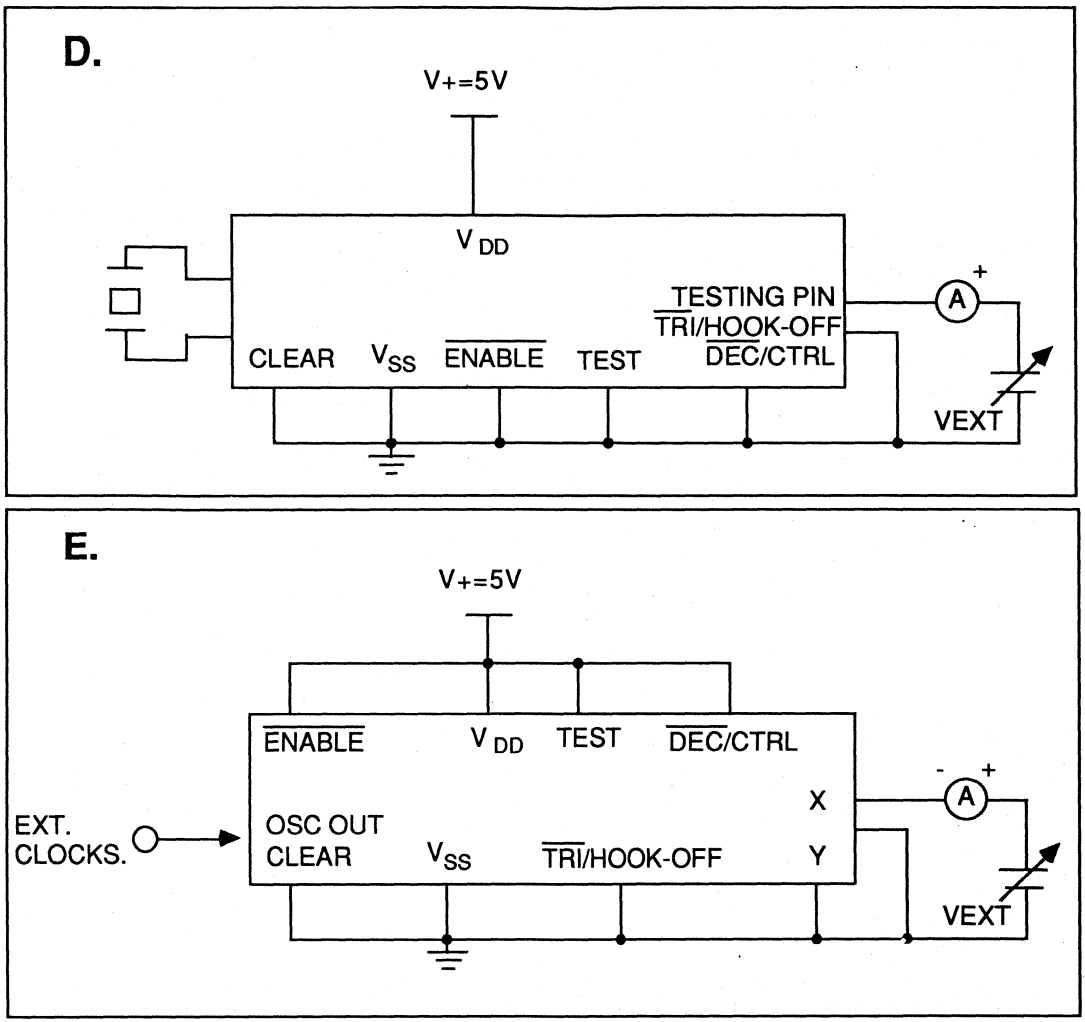
B.



Note : For output current testing, provide clocks until output state is desired.

C.

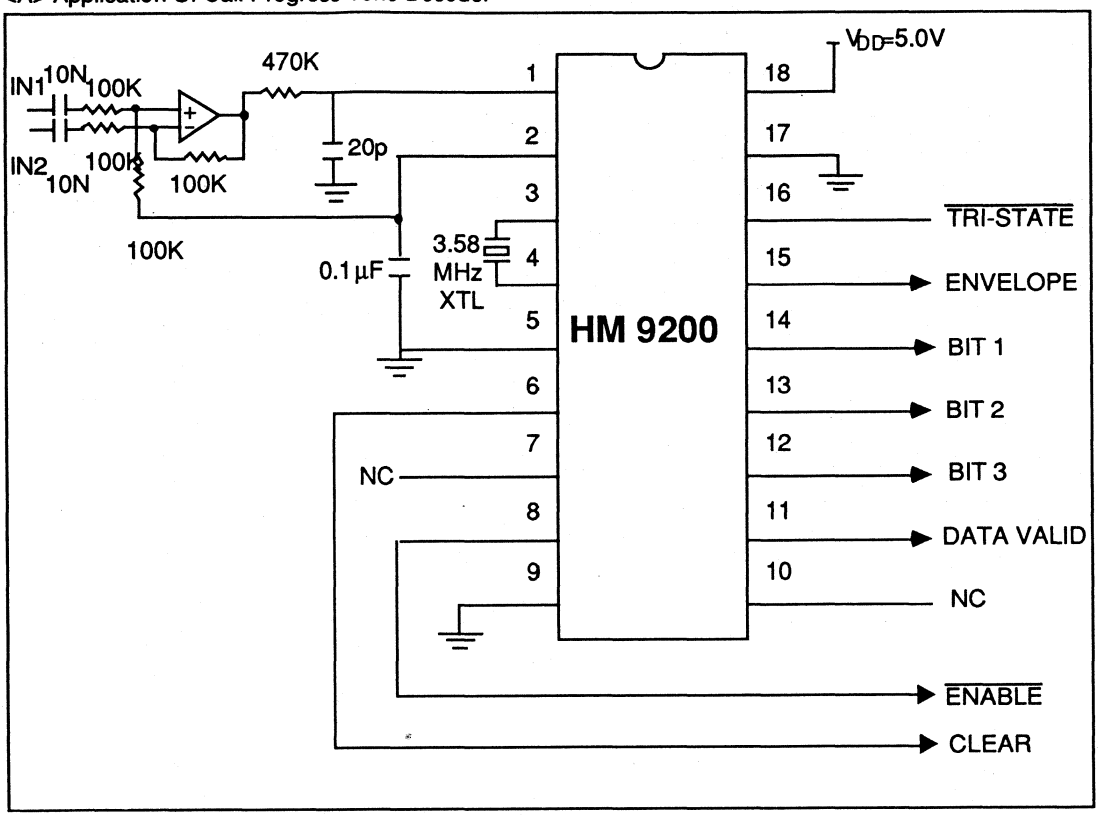




Note: 1. For R_{ON} testing, provide clocks until transmission gate is turned on.
2. $R_{ON}1$, $R_{OFF}1$: X=RDK1, Y=RDK2.
3. $R_{ON}2$, $R_{OFF}2$: X=RDK2, Y=RDK1.
4. R_{ON}=MAX ($R_{ON}1$, $R_{ON}2$).
5. R_{OFF}=MIN ($R_{OFF}1$, $R_{OFF}2$).
6. Where Rindex=Vext / IAI

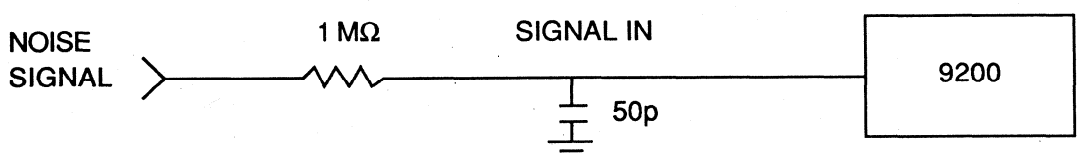
Application Circuit

<A> Application Of Call Progress Tone Decoder



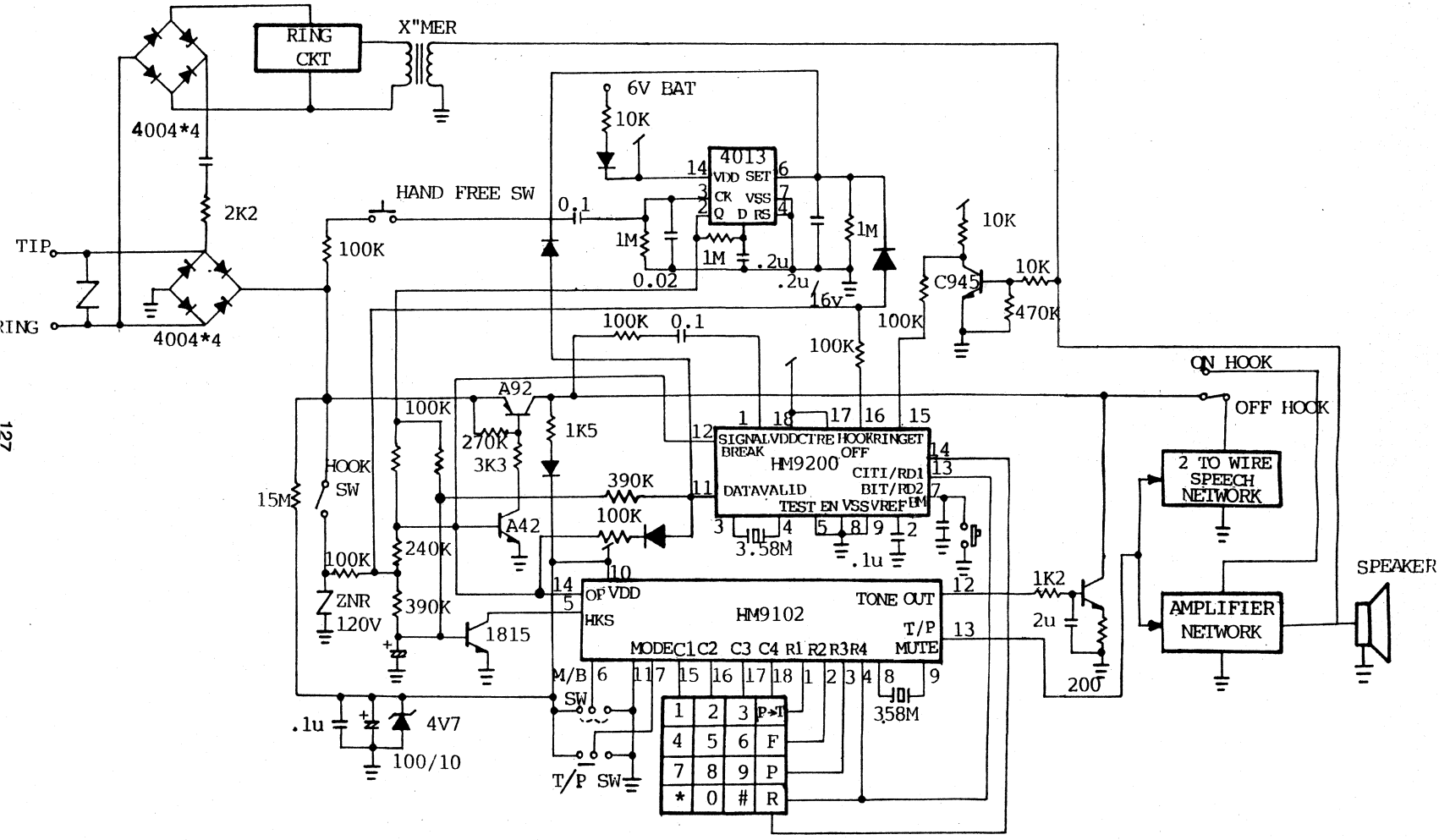
Application Note:

HM 9200 call progress tone decoder & dial controller will tolerate total input rms noise up to 10dB below the lowest amplitude tone. For most telephone applications, the combination of high frequency attenuation of the telephone line and internal However, noise near the 40.677 KHz internal sampling frequency will be aliased (folded back) into the in-band spectrum; if excessive noise is present above 20.338 KHz, the simple RC filter shown below can be employed to band limit the incoming signal.



For use in extreme high frequency input noise enviroment.

HM 9200 Application Example



General Description

HM 9201 call progress tone decoder is built on the 3.5μm CMOS process and implemented with switched capacitors. it detects the input signal of specifications and then outputs relative envelopes. By counting the transitions of envelope during the 2.27 sec. interval, the decoding circuit distinguishes what kind of tone input signal is. Three tri-state output pins(Bit 1,Bit 2 & bit 3) indicate the presence of dial tone, ringback tone or busy/reorder tone respectively, so it provides information to permit microprocessors to decide whether to initiate, continue, or terminate calls.

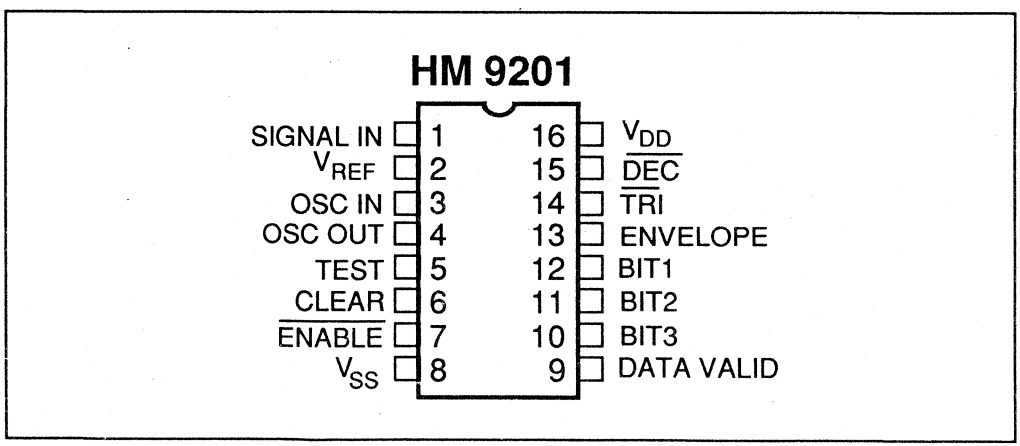
Features

* Low cost 3.58MHz crystal or clock.
* Low power consumption.
* Fully decoded tri-state call progress status output.
* Work with traditional, precision or PBX call progress tones.
* Logic compatible with TTL. CMOS. NMOS.
* Internal power on reset.
* Supply voltage: 4.5 to 5.5V
* 16 pins DIP package.

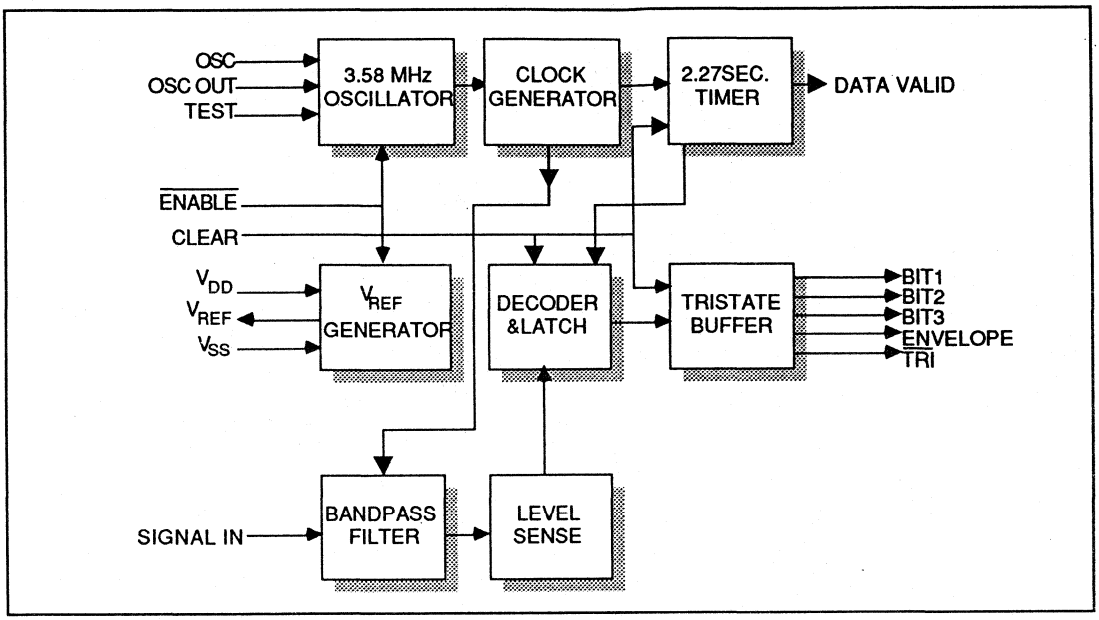
Applications

* PABXs.
* Modems.
* Feature telephones.
* Answering machines.
* Billing systems.

Pin Assignment



Block Diagram



Pin Functional Description

Symbol	Pin No	Name And Function
V_{DD} ,V_{SS}	16,8	Supply Voltage: 4.5 to 5.5V. While $\overline{ENABLE}$ = 1, the V_{REF} will be turned off and output will be pulled low to decrease the cosumption of power.
V_{REF}	2	Provide voltage at half V_{DD} for voltage reference.
OSC IN, OSC OUT	3,4	Crystal Oscillator input and output. A 3.58MHz crystal is connected between these pins in parallel with a built-in inverter with R,C feed back & loading components.While functions are disabled,the oscillator will be disabled to decrease the consumption of power.
SINGAL IN	1	Accept the analog input. This pin is internally biased at V_{REF} so that the input signal should be AC coupled.
TEST	5	In normal operation, this pin is always pulled low. If TEST=1, this chip is set in testing mode. The input of decoder is fed externally from ENABLE pin and the clock of decoder & dial controller is fed externally from OSC-OUT pin.
$\overline{ENABLE}$	7	$\overline{ENABLE}$=0, this chip is defined in normal state,then all of the functions can be operated.When $\overline{ENABLE}$=1, this chip is disabled, oscillator stops and all the logic outputs are pulled low or high impedance.
$\overline{DEC}$	15	Internal connection must be tied to V_{SS}.

Symbol	Pin No	Name And Function
$\overline{TRI}$	14	For call progress tone decoder, this is a control pin for tri-state outputs. If $\overline{TRI}$=1 , it influences nothing. But if $\overline{TRI}$=0, it makes BIT1, BIT2, BIT3 & ENVELOPE high impedance.
CLEAR	6	CLEAR=0, it influences nothing. But if CLEAR=1, the decoder is reset and all the decoding outputs & ENVELOPE are pulled low.
BIT1, BIT2, BIT3, DATA VALID	12 11 10 9	Digital outputs that provide the code corressponding to the decoded signal. They are normally low, active high.At the start of an inband tone (envelope output goes high), a 2.27 sec interval starts. Transitions of the envelope during this interval are counted to determine the signal presents. At the end of 2.27 sec interval, these three bits of data representing this decision are stored in the latch and appear at Bit1,Bit2 & Bit3. DATA VALID goes high at the same time and can be used to trigger a microprocessor to access this data. The decoded truth table is shown in Table 1. The operating timing diagram is shown in figure 5.
ENVELOPE	13	If the input signal is within specifications (V_{IN}=-40 to 0 dbBm, frequency within 300 to 640 Hz, and lasts longer than 40ms), this pin will output relative envelope with delay time=40ms typically. The detected range and timing diagram are shown in figure 1 and 2.

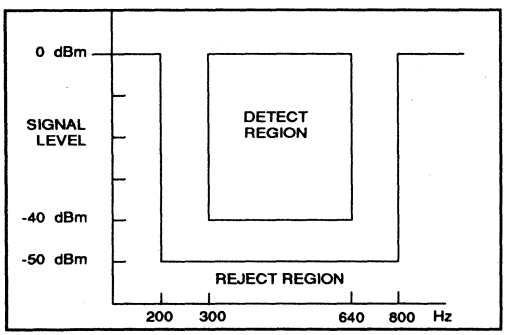


FIGURE 1. DETECTED RANGE

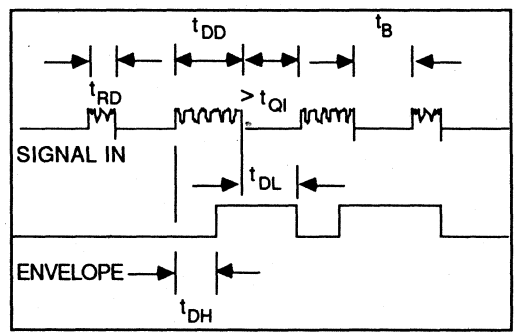


FIGURE 2. DETECTED TIMING DIAGRAM

Tones	Transition Number	Bit1	Bit2	Bit3	DATA VALID	TRI/HOOK-OFF
INITIAL		0	0	0	0	1
DIAL	1	1	0	0	1	1
RINGBACK	2 TO 4	0	1	0	1	1
BUSY/REORDER	5 TO 16	0	0	1	1	1
OVERFLOW	> 16	0	0	0	1	1
OUTPUT		HIGH	HIGH	HIGH	*	0
DISABLED		Z	Z	Z		

Note : 1. "* " means previous state.
2. The high level of ENVELOPE on the positive edge of window is counted as a transition.

TABLE 1

Description Of Operation

the HM 9201 call progress tone decoder was designed to accommodate the various call progress tone systems which are presently in use in the U.S. and many other parts of the world.To identify dial tone, ringback, busy signals, or reorder tones, the HM 9200 uses a cadence counting technique.. This eliminates the problem of identifying the specific tones by their individual frequencies, which are not standard from system to system.

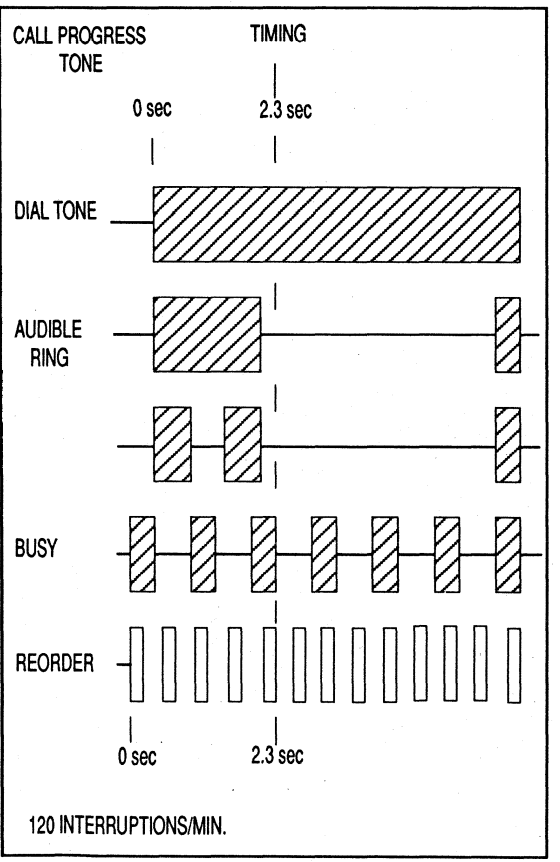
Figure 3. shows some of the call progress tones which can be encountered when calling from phone system to system within the U.S. Note that although the frequencies are not standardized. The cadence or interruption rate doesn't vary. Even the three types of reorder tones share the same period of 0.5 sec.

Figure 4. shows a profile of the tone energy described in Figure 3. Note the double ring (audible ringback) which can be encountered with PBXs.

FIGURE 3. CALL PROGRESS TONES

Tone	Frequency(Hz)	Cadence
Precision Dial Tone	350 +440	Continuous
Old Dial Tones	600+120 Or 133, And Other Combinations	Continuous
Precision busy	480 +620	0.5 sec On 0.5 sec Off
Old Busy	600 +120	0.5 sec On 0.5 sec Off
Precision Reorder	480 +620	0.3 sec On LOCAL 0.2 sec Off REORDER
Old Reorder	600 +120	0.2 sec On TOLL 0.3 sec Off REORDER 0.25sec On TOLL 0.25sec Off LOCAL
Precision Audible Ringback	440 +480	2 sec On 4 sec Off
Old Audible Ringback	420 +40 And Other Combinations	2 sec On 4 sec Off

FIGURE 4. ENERGY PROFILE OF CALL PROGRESS TIMING



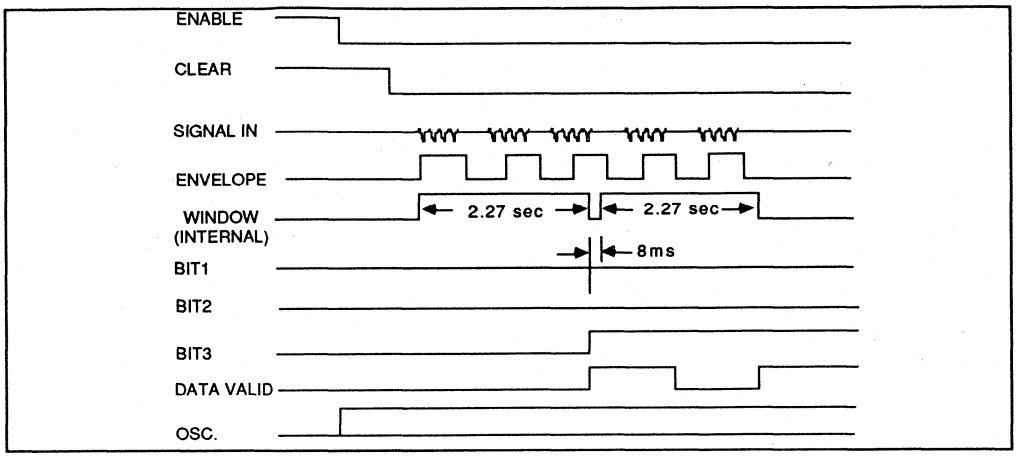


FIGURE 5. DECODED TIMING DIAGRAM

Absolute Maximum Ratings

Characteristics	Sym.	Ratings	Unit
DC Supply Voltage	V_{DD}	9.0	V
Input Voltage Range	V_{IN}	- 0.5 to V_{DD} + 0.5	V
Input Current of TX. Gate	I_{TG}	±10	mA
Power Dissipation Per Package	P_D	500 (T_A= -25 ±60°C)	mW
Operating Temperature	T_A	- 25 to 85	°C
Storage Temperature	T_{STG}	-65 to 165	°C

Electrical Characteristics

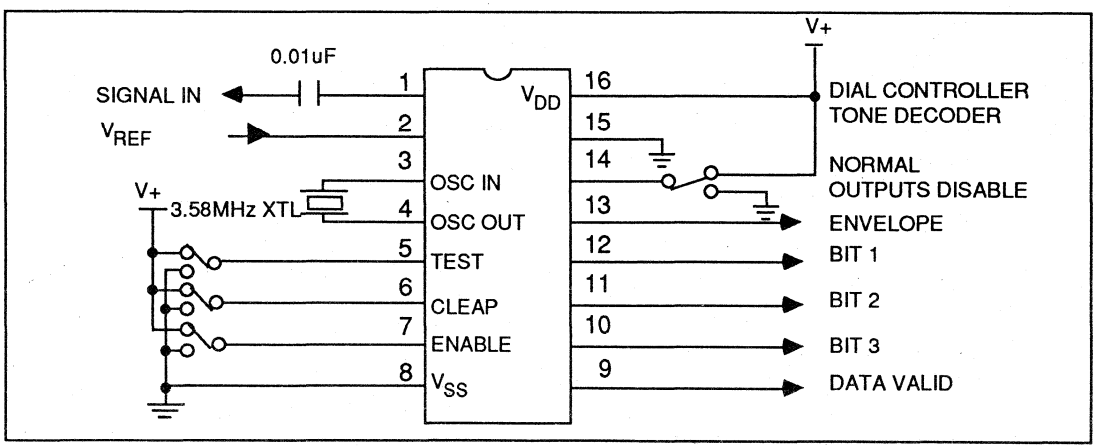
Unless otherwise stated V_{DD} =5.0V F_{OSC}=3.58MHz.

Characteristics	Sym.	Test Ckt.	Conditions	Limits Min.	Type	Max.	Unit
Operating Voltage	V_{DD}		Functional	4.5	-	5.5	V
Operating Current	I_{OP}	A	Functions enabled; Output unloaded.	-	-	10	mA
Quiescent Current	I_{QS}	A	Functions disabled	-	-	10	mA
Detection Level			f_{IN}=300 to 640Hz, ENVELOPE=1	-40	-	0	dBm
Rejection level			All frequency. ENVELOPE=0	-	-	-50	dBm
Rejection Out-band Frequency	f_{RL} f_{RH}		V≤0 dBm, LOW ENVELOPE=0 HIGH	- 800	-	200 -	Hz
Detection Signal Duration	t_{DD}		In-band Signal Input, ENVELOPE=1	40	-	-	ms
Rejection Noise Duration	t_{RD}		Any Signal input, ENVELOPE=0	-	-	20	ms
Detection Quiet Interval	t_{QI}		VI≤-50dBm, ENVELOPE=0	40	-	-	ms
Rejection Bridge Time	t_B		VI≤-50dBm, ENVELOPE=1	-	-	20	ms

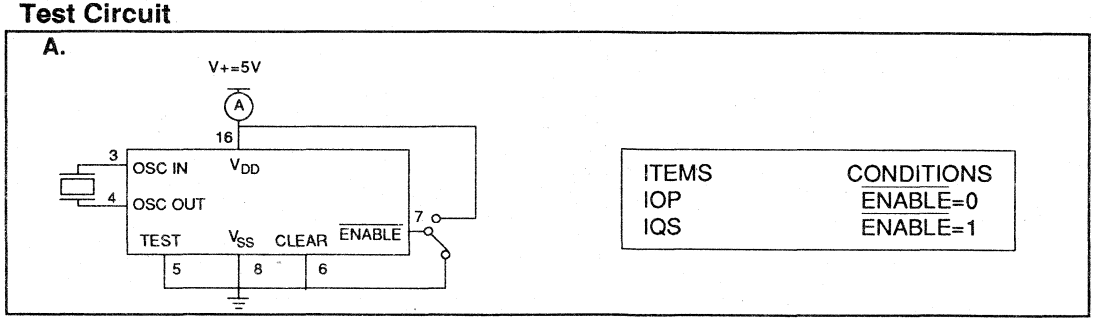
Characteristics	Sym.	Test Ckt.	Conditions	Limits Min.	Type	Max.	Unit
ENVELOPE Output Delay Time	t_{DH}		Time to output high	-	40	-	ms
	t_{DL}		Time to output low	-	40	-	
SIGNAL IN Input Impedance	Z_I		f_{IN}= 200 -3.4KHz	1.0	-	-	MΩ
Reference Voltage	V_{REF}		Unloaded	2.4	2.5	2.6	V
Output Impedance	Z_{REF}			-	5.0	10	KΩ
Logic Input High	V_{IH}			2.0	-	5.0	
Voltage Low	V_{IL}			0	-	0.8	V
Logic Input High	I_{IH}		V_{IH}=5.0V	-	-	0.1	μA
Current Low	I_{IL}	B	V_{IL}=0V	0.1	-	-	
Logic High Output Curren	I_{OH}	B,C	V_{OH}=4.5V	-	-	-0.5	mA
Logic Low Output Current	I_{OL}	B,C	V_{OL}=0.5V	2.0	-	-	mA
Output Disabled Leakage Current	I_{LKH}		V_{LKH}=5.0V	-	-	0.1	μA
	I_{LKL}	D	$\overline{TRI}$ V_{LKL}=0V	-0.1	-	-	

Note: 0dBm=0.775 Vrms.

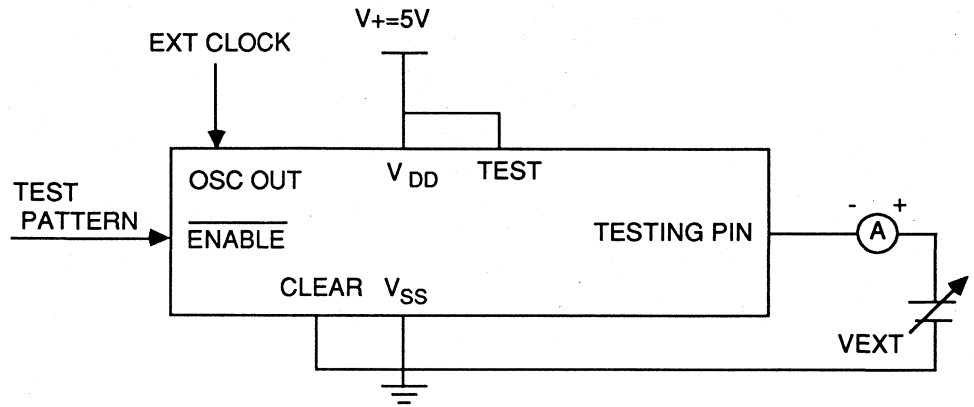
General Test Circuit



Test Circuit

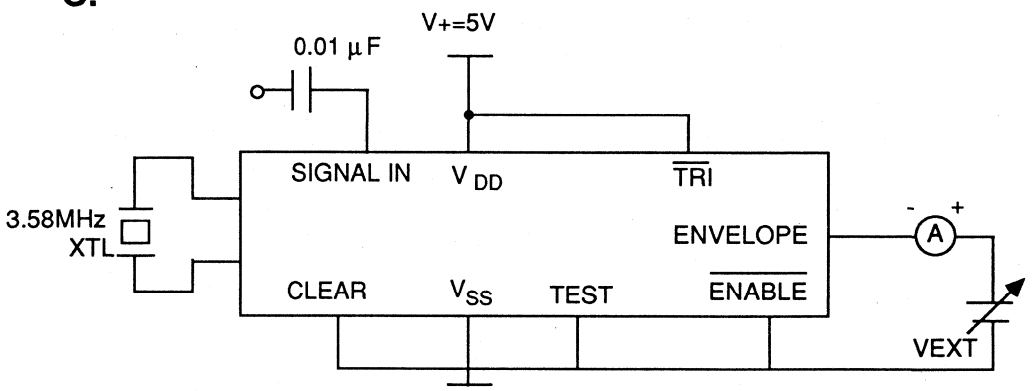


B.

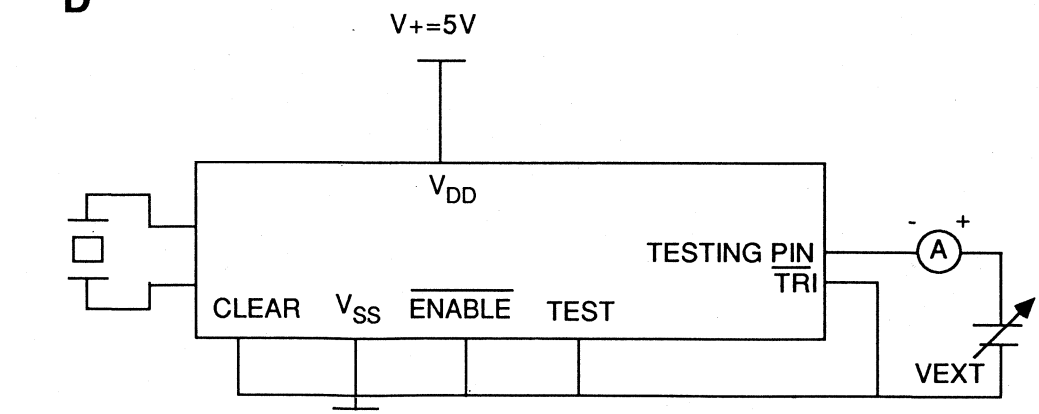


Note : For output current testing, provide clocks until output state is desired.

C.

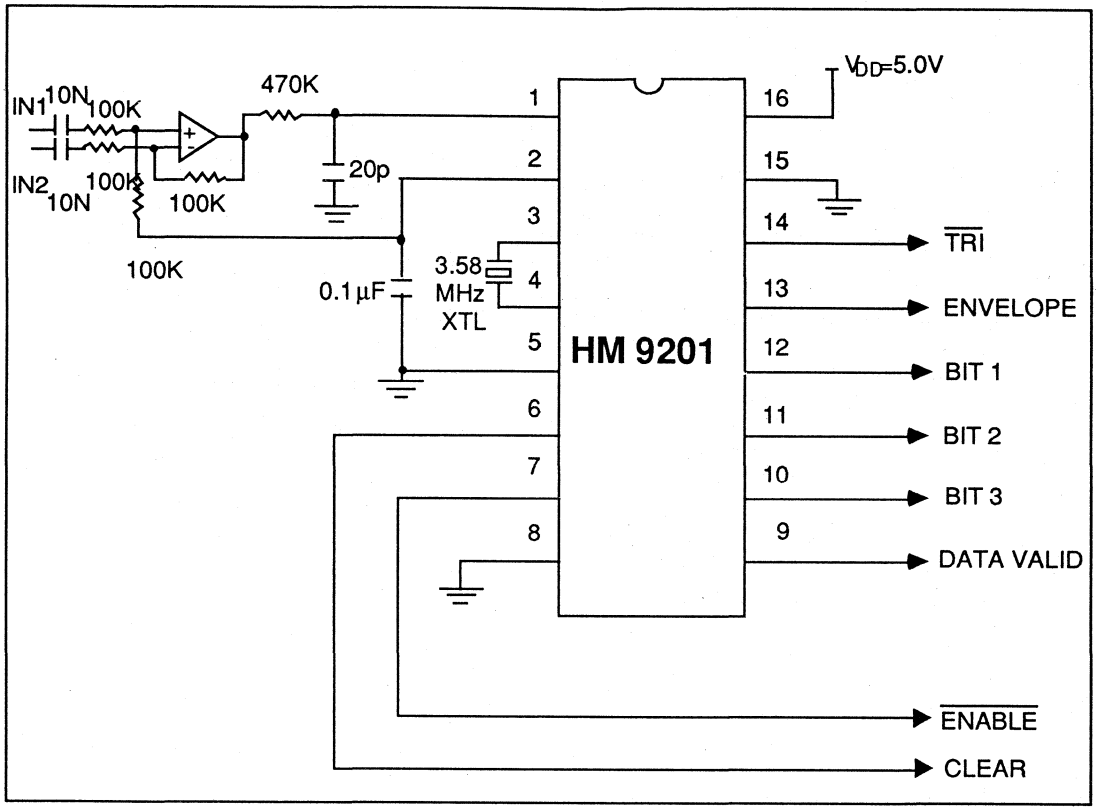


D



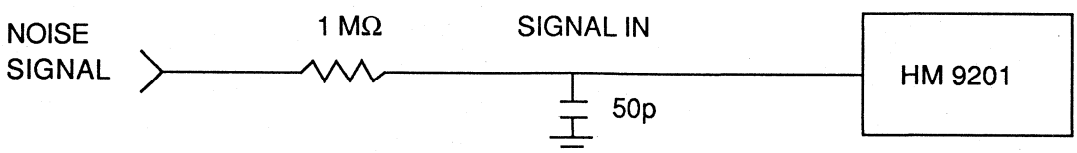
Application Circuit

<A> Application Of Call Progress Tone Decoder



Application Note:

HM 9201 call progress tone decoder will tolerate total input rms noise up to 10dBm below the lowest amplitude tone. For most telephone applications, the combination of high frequency attenuation of the telephone line and internal band-limiting make special circuity at the input to the HM 9201 unnecessary. However, noise near the 40.677 KHz internal sampling frequency will be aliased (folded back) into the in-band spectrum; if excessive noise is present above 20.338 KHz, the simple RC filter shown below can be employed to band limit the incoming signal.



For use in extreme high frequency input noise enviroment.

General Description

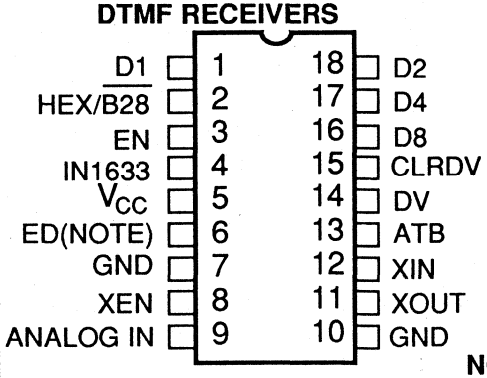
The HM 9202, HM 9203 and HM 9204 are central office quality dual-tone, multi-frequency (DTMF) touch tone receivers. They receive analog DTMF signals and decode them into the 16 standard digits. The HM 9202 and HM9203 provide either a 4-bit hexadecimal code or binary coded 2 of 8, while the HM 9204 provides 4-bit hex code only. The outputs are three state, CMOS logic compatible, facilitating bus interfaces. A built-in dial-tone rejection circuit eliminates the need for any front -end or prefiltering. The only external components required are an inexpensive 3.58 MHz crystal and a bias resistor for the time base. Up to ten DTMF receivers may be operated from a single crystal through the Alternate Time Base (ATB) pin.
The HM 9202, 9203 and 9204 are pin and funtion compatible with SSI's 202,203 and 204 respectively. Applications include central office switches, PBXs, auto dialers for redialing a number over an alternate carrier, subscriber equipment such as telephone answering machines, remote banking or other ransaction systems that employ DTMF signals for remote operation and voice/DTMF response systems.

Features

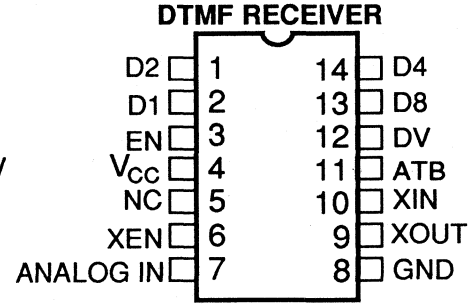
* Built-in dial tone rejection.
* single 5-volt supply.
* Three-state outputs.
* Narrow 14 or 18 pin package.
* No external filters required.
* Minimum system overhead.
* Simple bus interface.
* Minimum board space.

Pin Assignment

HM 9202 AND HM 9203
DTMF RECEIVERS

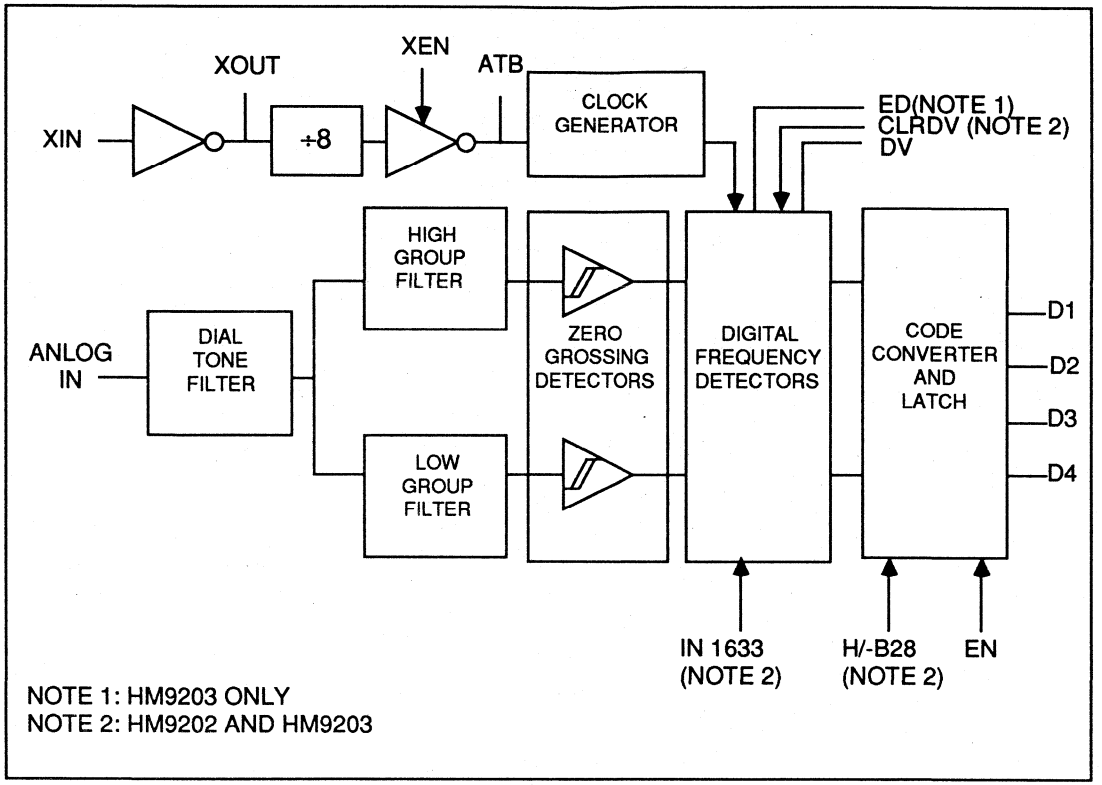


HM 9204
DTMF RECEIVER



NOTE : HM 9203 ONLY , WHILE 9202 IT IS "NC"

Block Diagram



Pin Description

9202 9203	9204	Pin Name	Function
1, 16, 17, 18,	1, 2, 13, 4,	D1, D2, D4, D8,	These digital outputs provide the code corresponding to the detected digit. These outputs are push-pull CMOS when EN (pin 3) is high and are a high impedance, open circuit, when EN is low. In the HM 9202 and HM 9203, the digital output format is programmed by the HEX/$\overline{B28}$ pin. In the HM 9204, the outputs are hexadecimal. These outputs become valid after a tone pair has been detected and they are cleared when a valid pause is timed.
2		HEX/ $\overline{B28}$	Selects the digital output format on the HM 9202 and HM 9203. When HEX/ $\overline{B28}$ is high, the outputs on D1, D2, D4 and D8 are hexadecimal; when it is low, the outputs are binary coded 2 of 8. See table 3 for the hexadecimal and binary 2 of 8 codes.
3	3	EN	Enables the digital outputs DI, D2, D4 and D8.
4		IN1633	When tied high, this pin inhibits the detection of tone pairs containing the 1633 Hz component. To detect all 16 standard digits, in 1633 must be tied low. It has an internal pull-down to ground.
5	4	V_{∞}	Positive supply; 5 volts.

9202 9203	9204	Pin Name	Function
6		ED	Provided only on the HM 9203, the ED output goes high as soon as a DTMF tone pair begins to be detected, and goes low when a pause begins to be detected. DI, D2, D4 and D8 outputs are guaranteed to be valid when DV is high, but are not necessarily vaild when ED high.
7, 10	8	GND	Ground; 0 volts (for HM 9202, 9203. Pin 10 must be tied to ground; pin 7 is optional.)
8	6	XEN	Enables the crystal oscillator. When high, the crystal oscillator is enabled. This pin should be tied low if the device is driven by an external oscillator through the ATB input.
9	7	Analog IN	Accepts the analog input. This pin is internaly biased so that the the input signal may be AC coupled through a 0.01μF capacitor. The input may be DC coupled as long as it does not exceed the positive supply.
11, 12,	9, 10,	XOUT, XIN	Crystal oscillator output and input. A 3.58MHz crystal in parallel with a 1 megohm, 10% resistor is connected between these pins. The oscillator is enabled by tying XEN high. In this mode, the clock frequency is also provided at the ATB output.
13	11	ATB	Altermate time-base. For a device with a crystal and a resistor connected between XOUT and XIN, and XEN tied high, ATB is a 447.5 kHz clock output that can be used to drive up to ten other DTMF receivers. For these devices, XEN must be tied low and ATB is an input.
14, 15,	12	DV, CLRDV	Data valid and clear data valid. DV goes high after a valid tone pair is sensed and decoded at the output of pins D1, D2, D4 and D8. DV remains high until a valid pause occurs or until the CLRDV input is taken high, whichever occurs first.
	5	NC	NC indicates that no internal connection is made to the pin and it may be left floating.

TABLE 1. DTMF DIALING MATRIX

	Col 0	Col 1	Col 2	Col 3
Row 0	1	2	3	A
Row 1	4	5	6	B
Row 2	7	8	9	C
Row 3	*	0	#	D

TABLE 2. DETECTION FREQUENCY

Low Group fo	High Group fo
Row 0 = 697 Hz	Column 0 = 1209 Hz
Row 1 = 770 Hz	Column 1 = 1336 Hz
Row 2 = 852 Hz	Column 2 = 1477 Hz
Row 3 = 941 Hz	Column 3 = 1633 Hz

TABLE 3. HEX/$\overline{B28}$ OUTPUT CODES

Digit	Hexadecimal				Binary Coded 2 of 8			
	D8	D4	D2	D1	D8	D4	D2	D1
1	0	0	0	1	0	0	0	0
2	0	0	1	0	0	0	0	1
3	0	0	1	1	0	0	1	0
4	0	1	0	0	0	1	0	0
5	0	1	0	1	0	1	0	1
6	0	1	1	0	0	1	1	0
7	0	1	1	1	1	0	0	0
8	1	0	0	0	1	0	0	1
9	1	0	0	1	1	0	1	0
0	1	0	1	0	1	1	0	1
*	1	0	1	1	1	1	0	0
#	1	1	0	0	1	1	1	0
A	1	1	0	1	0	0	1	1
B	1	1	1	0	0	1	1	1
C	1	1	1	1	1	0	1	1
D	0	0	0	0	1	1	1	1

Absolute Maximum Ratings

Parameter	Ratings	Unit
Supply Voltage, V_{CC}	7	V
DC Input Voltage	-0.5 to V_{CC} + 0.5	V
Analog Input Voltage	V_{CC} - 10 to V_{CC} + 0.5	V
Storage Temperature Range	- 65 to 150	°C
Power Disspation (Note 3)	500	mW
Lead Temperature (soldering, 10 sec.)	300	°C

Note 1. Absolute maximum ratings are those values beyond which damage to the device may occur.
2. Unless otherwise specified, all voltages are referenced to ground.
3. Power dissipation temperature deration Plastic package: 12mW/C from 65°C to 85°C
Ceramic package: 12mW/C from 100°C to 125°C

Operating Conditions

Parameter	Description	Min.	Typ.	Max.	Units
T_A	Ambient Temperature	0		70	°C
V_{CC}	Positive Supply	4.5		5.5	V
GND	Ground		0		V
FC	Crystal Frequency	3.576	3.579545	3.583	MHz

Electrical Characteristics

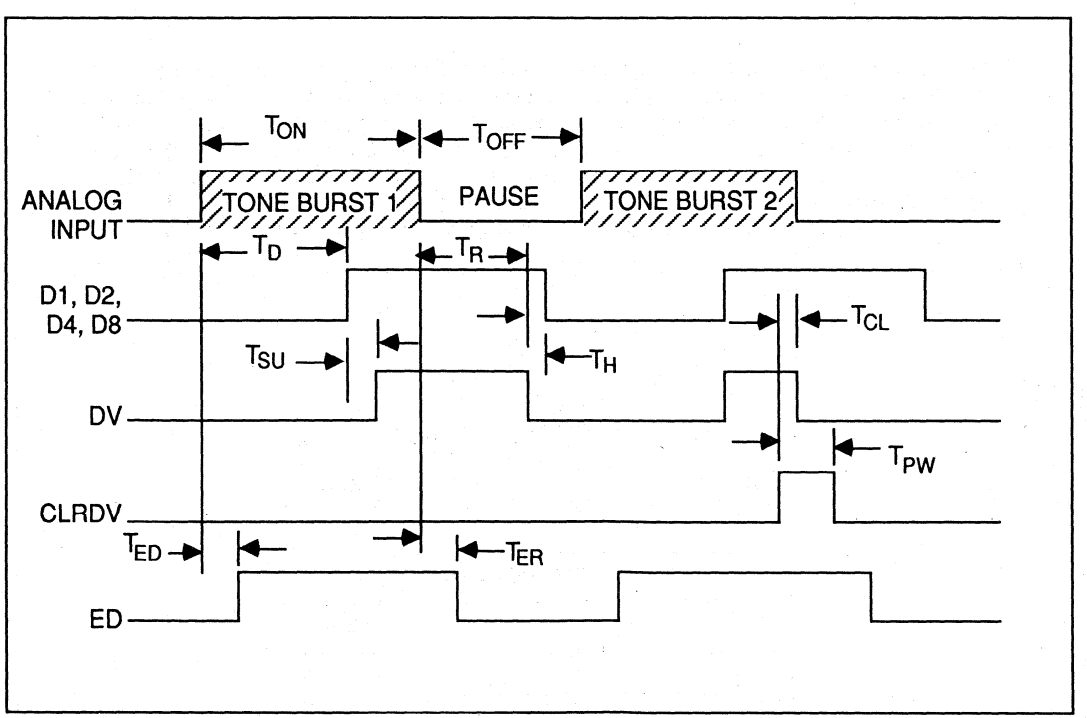
Parameter	Conditions	Min.	TYP.	Max.	Unit
Frequency Detect Bandwidth		±(1.5+2Hz)	±2.3	±3.5	% of fo
Amplitude for Detection	Each Tone HM 9202 & HM 9203	-32		-2	dBm Referenced to 600Ω
Amplitude for Detection	Each Tone HM 9204	-18		-2	dBm Referenced to 600Ω
Minimum Acceptable Twist	Twist= High Tone / Low Tone	-10		+10	dB
60 Hz Tolerance				0.8	Vrms
Dial Tone Tolerance	"Precise"Dial Tone			0dB	dB referenced to Lower Amplitude Tone
Talk Off	MITEL Tape #CM7291		2		Hits
Digital Outputs (except XOUT)	"0" Level, 400 µA Load "1" Level, 200 µA Load	0 V_{CC}-0.5		0.5 V_{CC}	Volts Volts
Digital Inputs	"0" Level "1" Level	0 0.7V_{CC}		0.3V_{CC} V_{CC}	Volts Volts
Power Supply Noise	Wide Band			10	mV_{P-P}
Supply Current	T_A = 25°C		10	16	mA
Noise Tolerance	MITEL Tape #CM 7291			-12	dB referenced to Lowest AmplitudeTone
Input Impedance	$V_{CC} \geq V_{IN} \geq V_{CC}$-10	100kΩ//15pF			

Note 4. Min and max values are valid over the full temperature and operating voltage range. Typical values are for 25 and 5 volt operation.

Timing Characteristics

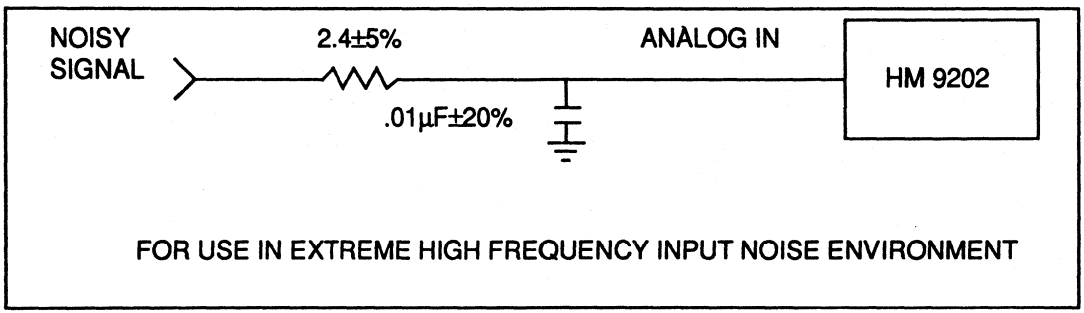
(AT 25°C AND 5V SUPPLY)

Parameter	Description	Conditions	Min.	Typ.	Max.	Units
T_{ON}	Tone Time for Detection		40			ms
T_{ON}	Tone Time for Rejection				20	ms
T_{OFF}	Pause Time for Detection		40			ms
T_{OFF}	Pause Time for Rejection				20	ms
T_D	Detect Time		25		46	ms
T_R	Release Time		35		50	ms
T_{SU}	Data Setup Time		7			µs
T_H	Data Hold Time		4.2		5.0	ms
T_{CL}	DV Clear Time			160	250	ns
T_{PW}	CLRDV Pulse Width		200			ns
T_{ED}	ED Detect Time		7		22	ms
T_{ER}	ED Release Time		2		18	ms
T_{OE}	Output Enable Time	C_L = 50 pF RL = 1 k		200	300	ns
T_{OD}	Output Disable Time	C_L = 35 pF RL = 500Ω		150	200	ns
T_{OR}	Output Rise Time	C_L = 50 pF		200	300	ns
T_{OF}	Output fall Time	R_L = 50 pF		160	250	ns



Applications

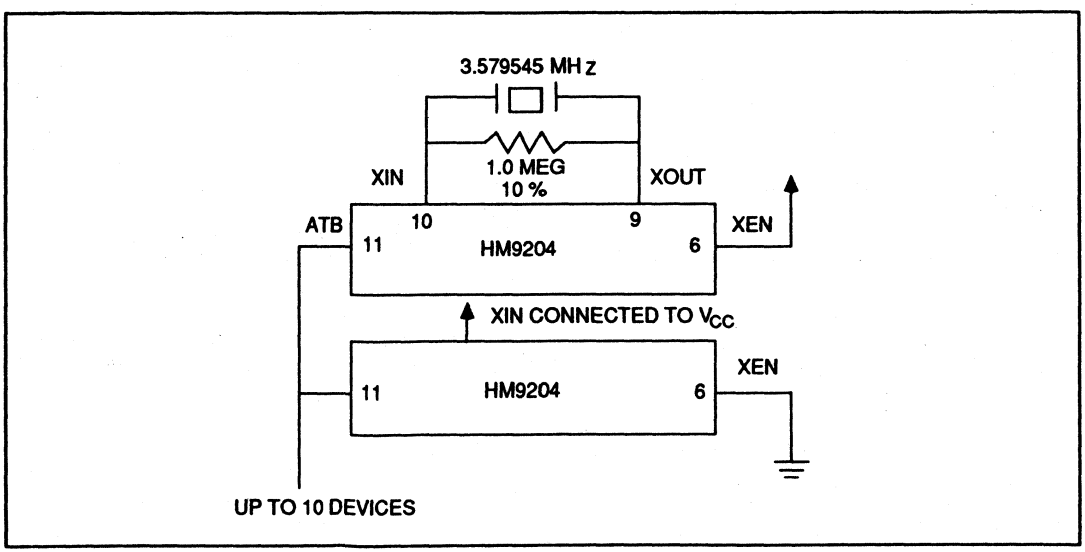
The DTMF receiver will tolerate total in-put rms noise up to 12dB below the lowest amplitude tone. For most telephone applications, the combination of the high frequency attenuation of the telephone line and internal band-limiting make special circuitry at the input to the DTMF receiver unnecessary. However, noise near the 74.6 kHz internal sampling frequency will be aliased (folded back) into the audio spectrum; if excessive noise is present above 37.3 kHs, the simple RC filter shown below can be employed to band limit the incoming signal. Noise will also be reduced by placing a ground trace around the XIN and XOUT pins on the circuit board layout when using a crystal . XOUT is not intended to drive an additional device. XIN may be driven externally in which case XOUT must be left floating.



FOR USE IN EXTREME HIGH FREQUENCY INPUT NOISE ENVIRONMENT

Crystal Oscillator

The DTMF receivers contain an onboard inverter with sufficient gain to provide oscillation when connected to a low-cost television color-burst crystal. The crystal oscillator is enabled by tying XEN high. The crystal is connected between XIN and XOUT. A 1 megohm 10% resistor is also con nected between these pins. In this mode, ATB is a clock frequency output. Other DTMF receivers may use the same frequency reference by tying their ATB pins to the ATB of a crystal connected device. XIN and XEN of the auxiliary devices must then be tied high and low respectively. Ten devices may run off a single DTMF receiver with a crystal as shown below.



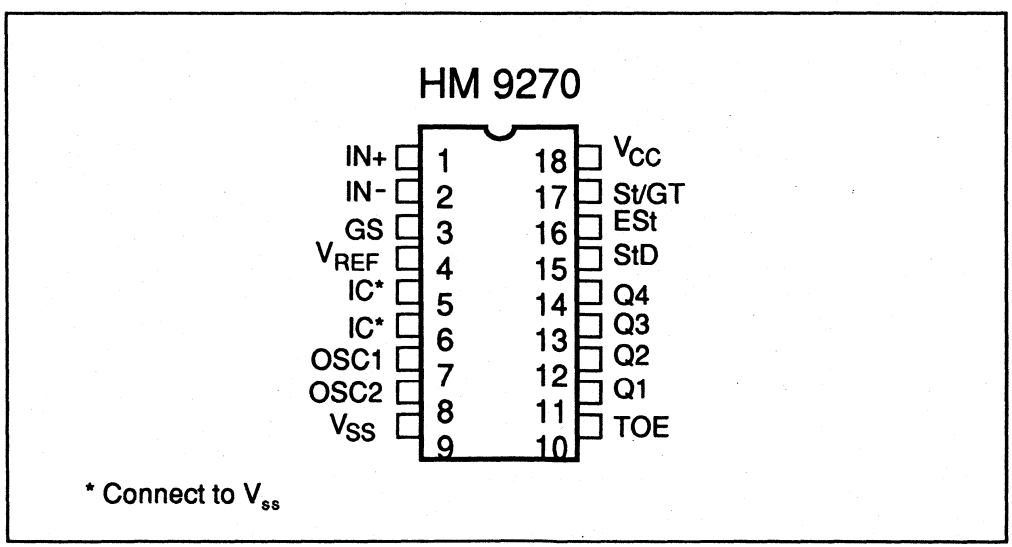
General Description

The HM 9270 is a complete DTMF receiver integrating both the bandsplit filter and digital decoder functions. The filter section uses switched capacitor techniques for high- and low-group filters and dial-tone rejection. Digital counting techniques are employed in the decoder to detect and decode all 16 DTMF tone-pairs into a 4-bit code. External component count is minimized by on-chip provision of a differential input amplifier, clock-oscillator and latched 3-state bus interface.

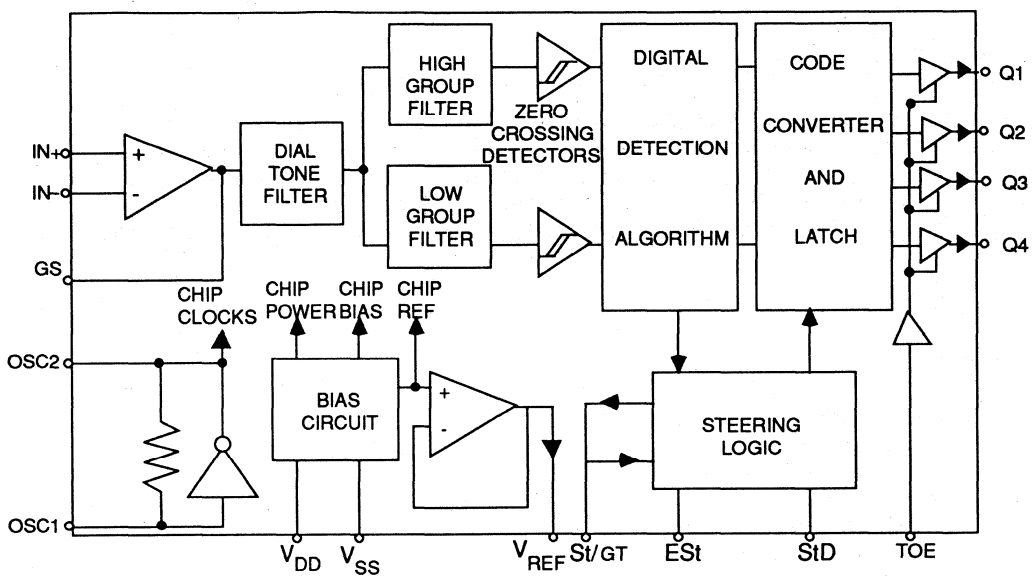
Features

* Complete receiver in an 18-pin package.
* Excellent performance.
* CMOS, single 5 volt operation.
* Minimum board area.
* Central office quality.
* Low power consumption.

Pin Assignment



Block Diagram (Figure 1)



Pin Description

Pin	Name	Function
1	IN+	Non-Inverting input
2	IN-	Invering Input — Connections to the front-end differential amplifier.
3	GS	Gain select. Gives access to output of front-end differential amplifier for connection of feedback resistor.
4	V_{REF}	Reference voltage output,nominally $V_{cc}/2$. May be used to bias the inputs at midrail (see application diagram).
5	IC	Internal connection. Must be tied to V_{ss}.
6	IC	Internal connection. Must be tied to V_{ss}.
7	OSC1	Clock Input
8	OSC2	Clock Output — 3.579545 MHz crystal connected between these pins completes internal oscillator.
9	V_{ss}	Negative power supply, normally connected to 0V.
10	TOE	3-state data output enable (input). Logic high enables the outputs Q1-Q4. Internal pull-up.

Pin	Name	Function
11 12 13 14	Q1 Q2 Q3 Q4	3-state data outputs. When enabled by TOE, provide the code corresponding to the last valid tone-pair received (see code table).
15	StD	Delayed steering output. Presents a logic high when a received tone-pair has been registered and the output latch updated; returns to logic low when the voltage on St/GT falls below V_{TSt}.
16	ESt	Early steering output. Presents a logic high immediately when the digital algorithm detects a recognizable tone-pair (signal condition). Any momen tary loss of signal condition will cause ESt to return to a logic low.
17	St/GT	Steering input/guard time output (bi-directional). A voltage greater than V_{TSt} detected at St causes the device to register the detected tone-pair and update the output latch. A voltage less than V_{TSt} frees the device to accept a new tone-pair. The GT output acts to reset the external steering time-constant; its state is a function of ESt and the voltage on St (see truth table).
18	V_{cc}	Positive power supply, +5Volts.

Absolute Maximum Ratings (Notes 1, 2 and 3)

Parameters	Min.	Max.	Units
Power Supply Voltage, V_{cc} - V_{ss}		6	V
Voltage on any pin	V_{ss} - 0.3	V_{cc} + 0.3	V
Current at any pin		10	mA
Operating temperature	-40	+85	°C
Storage temperature	-65	+150	°C
Package power dissipation*2		500	mW

Note 1. Absolute maximum ratings are those values beyond which damage to the device may occur.
2. Unless otherwise specified, all voltages are referenced to ground.
3. Power dissipation temperature derating

DC Electrical Characteristics

Parameter	Description	Test Conditions	Min.	Typ.	Max.	Units
SUPPLY:						
V_{cc}	Operating Supply Voltage		4.75		5.25	V
I_{cc}	Operating Supply Current			3.0	7	mA
P_o	Power Consumption	f=3.579MHz; V_{cc}=5V		15	35	mW
NPUTS:						
V_{IL}	Low Level Input Voltage				1.5	V
V_{IH}	High Level Input Voltage		3.5			V
I_{IH}/I_{IL}	Input Leakage Current	V_{IN}=V_{ss} or V_{cc}		0.1		uA
I_{so}	Pull Up (Source) Current	TOE (Pin 10)=OV		7.5	15	uA
R_{IN}	Input Signal Impedance Inputs 1,2	@ 1kHz		10		MegΩ
V_{TSt}	Steering Threshold Voltage			2.35		V

Parameter	Description	Test Conditions	Min.	Typ.	Max.	Units
OUTPUTS:						
V_{OL}	Low Level Output Voltage	No Load		0.03		V
V_{OH}	High Level Output Voltage	No Load		4.97		V
I_{OL}	Output Low (Sink) Current	V_{OUT}=0.4V	1.0	2.5		mA
I_{OH}	Output High (Source) Current	V_{OUT}=4.6V	0.4	0.8		mA
V_{REF}	Output Voltage V_{REF}	No Load	2.4		2.7	V
R_{OR}	Output Resistance			10		KΩ

Operating Characteristics
Gain Setting Amplifier

Parameter	Description	Test Conditions	Min.	Typ.	Max.	Units
I_{IN}	Input Leakage Current	$V_{SS} < V_{IN} < V_{CC}$		±100		nA
R_{IN}	Input Resistance			10		mΩ
V_{os}	Input Offset Voltage			±25		mV
PSRR	Power Supply Rejection	1kHz		60		dB
CMRR	Common Mode Rejection	-3.0V <V_{IN}< 3.0V		60		dB
A_{VOL}	DC Open Loop Voltage Gain			65		dB
f_C	Open Loop Unity Gain Bandwidth			1.5		MHz
V_O	Output Voltage Swing	R_L≥100KΩ to V_{SS}		4.5		V_{PP}
C_L	Tolerable capacitive load(GS)			100		pF
R_L	Tolerable resistive load(GS)			50		KΩ
V_{CM}	Common Mode Range	No Load		3.0		V_{PP}

Notes : 1.All voltages referenced to V_{SS} unless otherwise noted.
2.V_{CC} = 5.0V, V_{SS} = 0V, T_A = 25°C .

AC Characteristics

All voltages referenced to V_{SS} unless otherwise noted. V_{CC}=5.0V, V_{SS}=0V, T_A = 25°C, F_{CLK}=3.579545 MNz, using test circuit of figure 2.

Parameter	Description	Min.	Typ.	Max.	Units	Notes
SIGNAL COITIONS:						
	Valid Input Signal level (each tone signal):MIN			-29	dBm	1,2,3,5,6,9
				27.5	mV_{RMS}	1,2,3,5,6,9
	MAX	+1			dBm	1,2,3,5,6,9
		883			mV_{RMS}	
	Twist Accept Limit: Positive		10		dB	2,3,6,9
	Negative		10		dB	
	Freq. Deviation Accept Limit		±1.5%±2 Hz		Nom.	2,3,5,9
	Freq. Deviation Reject Limit	±3.5%			Nom.	2,3,5
	Third Tone Tolerance		-16			2,3,4,5,9,10
	Noise Tolerance		-12		dB	2,3,4,5,7,9,10
	Dial Tone Tolerance		+18		dB	2,3,4,5,8,9,10

Parameter	Description	Min.	Typ.	Max.	Units	Notes
TIMING:						
t_{DP}	Tone Present Detection Time	5	14	16	ms	Refer to Fig. 4
t_{DA}	Tone Absent Detection Time	0.5	4	8.5	ms	
t_{REC}	Tone Duration Accept			40	ms	
t_{REC}	Tone Duration Reject	20			ms	(User Adjustable)
t_{ID}	Interdigit Pause Accept			40	ms	Refer to "Guard
t_{DO}	Interdigit Pause Reject	20			ms	
OUTPUTS:						
t_{PQ}	Propagation Delay (St to Q)		8	11	µs	TOE= V_{CC}
t_{PSED}	Propagation Delay (St to StD)		12		µs	
t_{QSED}	Output Data Set Up (Q to Std)		4.5		µs	
t_{PTE}	Propagation ENABLE		50	60	ns	R_L=10kΩ
t_{PTD}	Delay (TOE to Q) DISABLE		300		ns	C_L=50pf
CLOCK:						
f_{CLK}	Crystal/Clock Frequency	3.5759	3.5795	3.581	MHz	
C_{LO}	Clock Output Capacitive (OSC2) Load			30	pf	

Notes: 1.dBm = decibels above or below a reference power of 1mW into a 600 Ohm load.
2.Digit sequences consists of all 16 DTMF tones.
3.Tone duration = 40mS Tone pause = 40mS.
4.Nominal DTMF frequencies are used.
5.Both tones in the composite signal have an equal amplitude.
6.Tone pair is deviated by ±1.5% ±2Hz.
7.Bandwidth limited (3kHz) Gaussian Noise.
8.The precise dial tone frequencies are (350Hz and 440Hz) ±2%.
9.For an error rate of less than 1 in 10,000.
10.Referenced to the lowest level frequency component in DTMF signal.

Function Description

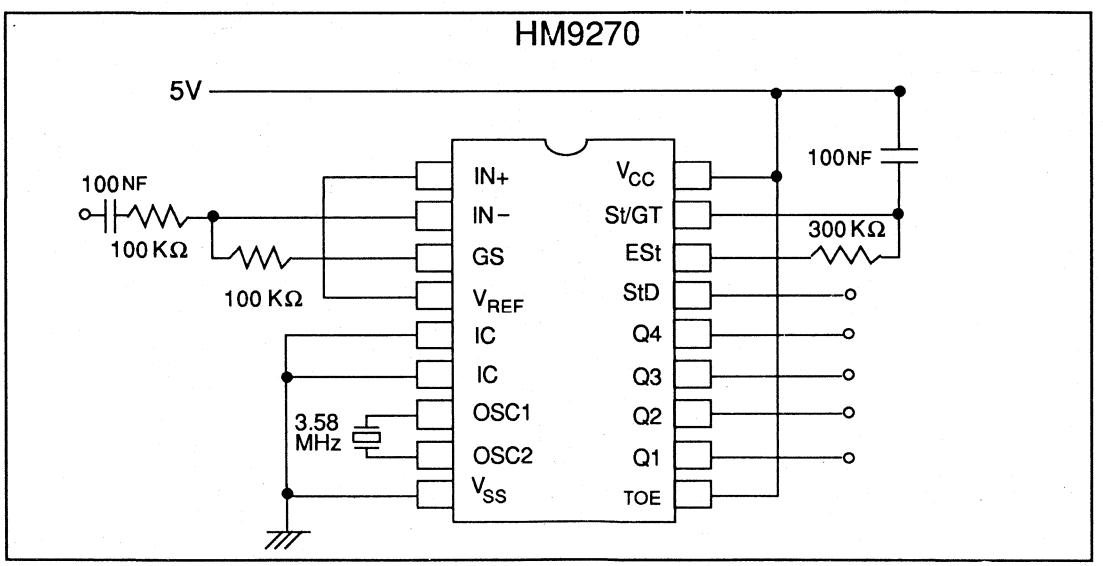


FIGURE 2. SINGLE ENDED INPUT CONFIGURATION

The HM 9270 monolithic DTMF receiver offers small size, low power consumption and high performance. Its architecture consists of a bandsplit filter section, which separates the high and low tones of receiver pair, followed by a digital counting section which verifies the frequency and duration of the received tones before passing the corresponding code to the output bus.

FILTER SECTION

Separation of the low-group and high-group tones is achieved by applying the dualtone signal to the inputs of two filtersówa sixth order for the high group and an eighth order for the low group. The bandwidths of which correspond to the bands enclosing the low-group and high-group tones (see Fig. 5). The filter section also in corporates notches at 350Hz and 440 Hz for exceptional dial-tone rejection. Each filter output is followed by a second-order switched-capacitor section which smooths the signals prior to limiting. Limiting is performed by high-gain comparators which are provided with hysteresis to prevent detection of unwanted low-level signals and noise; the outputs of the comparators provide full-rail logic swings at the frequencies of the incoming tones.

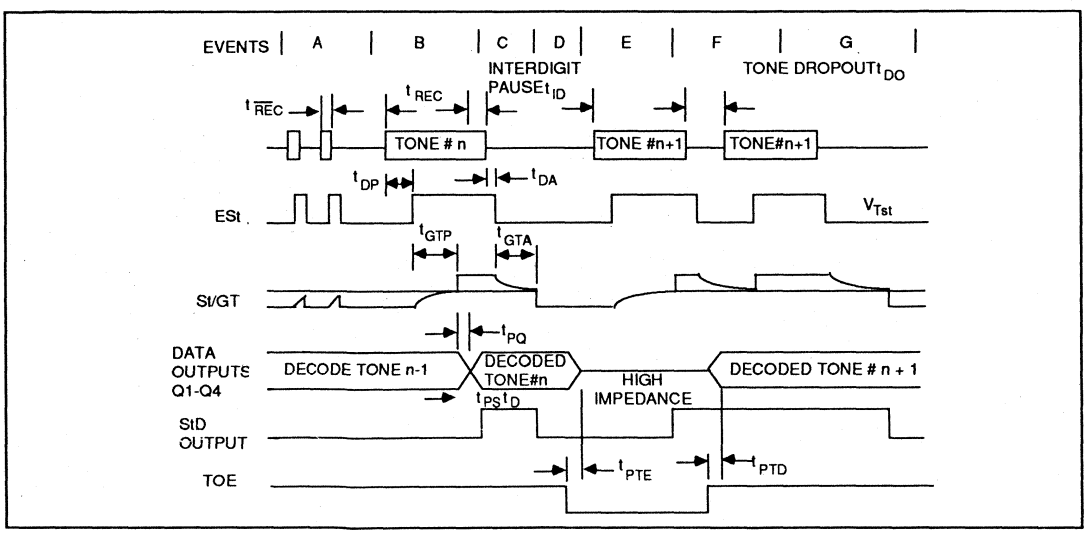
Decoder Section

The decoder used digital counting techniques to determine the frequencies of the limited tones and to verify that they correspond to standard DTMF frequencies. A complex averaging algorithmpro-tects against tone simulation by extraneous signals, such as voice, while providing tolerance to smalll frequency deviations and variations. This averaging algorithm has been developed to ensure an optimum combination of immunity to "talk-off" and tolerance to the presence of interfering signals ("third tones") and noise. When the detector recog-nizes the simultaneous presence of two valid tones (referred to as "signal condition" in some industry specifications), it raises the "early steering"flag (ESt). Any subsequent loss of signal condition will cause ESt to fall.

Flow	Fhigh	KEY	TOE	Q4	Q3	Q2	Q1
697	1209	1	H	0	0	0	1
697	1336	2	H	0	0	1	0
697	1477	3	H	0	0	1	1
770	1209	4	H	0	1	0	0
770	1336	5	H	0	1	0	1
770	1477	6	H	0	1	1	0
852	1209	7	H	0	1	1	1
852	1336	8	H	1	0	0	0
852	1477	9	H	1	0	0	1
941	1336	0	H	1	0	1	0
941	1209	*	H	1	0	1	1
941	1477	#	H	1	1	0	0
697	1633	A	H	1	1	0	1
770	1633	B	H	1	1	1	0
852	1633	C	H	1	1	1	1
941	1633	D	H	0	0	0	0
-	-	ANY	L	Z	Z	Z	Z

L = LOGIC LOW , H = LOGIC HIGH, Z = HIGH IMPEDANCE

FIGURE 3. LOGIC TABLE



A. Short tone bursts: detected. Tone duration is invalid.
B. Tone #n is detected. Tone duration is valid. Decoded to outputs.
C. End of tone #n is dectected and validated.
D. 3 State outputs disabled (high impedance).
E. Tone #n + 1 is detected. Tone duration is valid. De coded to outputs.
F. Tristate outputs are enabled. Acceptable drop out of

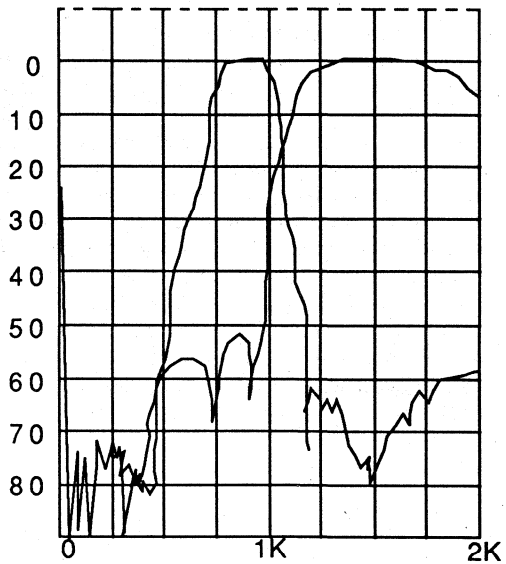


FIGURE 4. Timing Diagram

FIGURE 5. TYPICAL FILTER CHARACTERISTIC

STEERING CIRCUIT

Before registration of a decoded tone-pair, the receiver checks for a valid signal duration (referred to as "character-recognition-condition"). This check is performed by an external RC time-constant driven by ESt. A logic high on ESt causes V_c (see Fig. 6) to rise as the capacitor discharges. Provided signal-condition is maintained (ESt remains high) for the validation period (t_{GTP}), Vc reaches the threshold (V_{TSt}) of the steering logic to register the tone-pain, latching its corresponding 4-bit code (see Fig. 3) into the output latch. At this point, the GT output is activated and drives V_c to V_{cc}. GT continues to drive high as long as ESt remains high. Finally after a short delay to allow the output latch to settle, the "delayed-steering" output flag, StD, goes high, signaling that a recieved tone-pair has been registered. The contents of the output lacth are made available on the 4-bit output bus by raising the 3-state control input (TOE) to a logic high. The steering circuit works in reverse to validate the interdigit paues between signals. Thus, as well as rejecting signals too short to be considered valid, the receiver will tolerate signal interruptions ("drop-out") too short to be considered a valid pause. The facility, together with the capability of selecting the steering time-constants externally, allows the designer to tailor performance to meet a wide variety of system requiremetns.

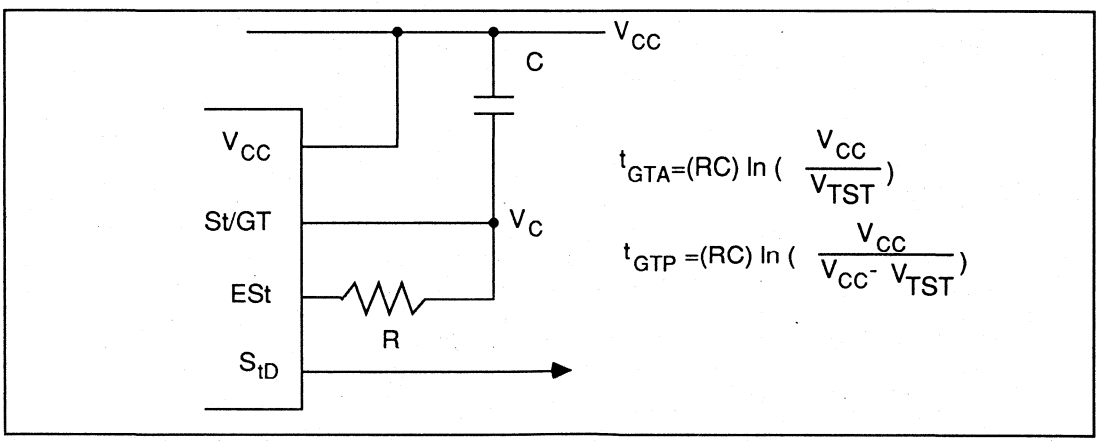


FIGURE 6. BASIC STEERING CIRCUIT

Guard Time Adjustmetn

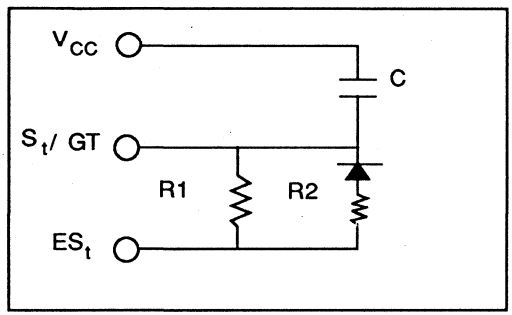
In many situations not requiring independent selection of receive and pause, the simple steering circuit of Fig. 6 is applicable. Component values are chosen according to the following formulae:

$t_{REC} = t_{DP} + t_{GTP}$ $t_{ID} = t_{DA} + t_{GTA}$

The value of t_{DP} is a parameter of the device (see table) and t_{REC} is the minimum signal duration to be recognized by the receiver. A value for C of 0.1 µF is recommended for most applications, leaving R to be selected by the designer. For example, a suitable value of R for a t_{REC} of 40mS would be 300k.

Different steering arrangements may be used to select independently the guard-times for tone-present (t_{GTP}) and tone-absent (t_{GTA}). This may be necessary to meet system specifications which place both accept and reject limits on both tone duration and interdigital pause.

Guard-time adjustment also allows the designer to tailor system parameters such as talk off and noise immunity. Increasing t_{REC} improves talk-off performance, since it reduces the probability that tones simulated by speech will mainain signal condition for long enough to be registered. On the other hand, a relatively short t_{REC} with a long t_{DO} would be appropriate for extremely noisy environments where fast acquirequirements. Design information for guard-time adjustment is shown in Fig. 7.

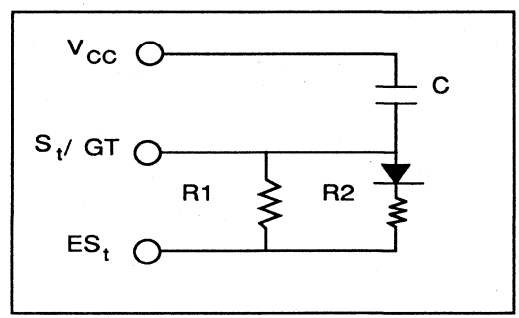


$$tGTP=(Rp\ C)\ \ln\left(\frac{V_{cc}}{V_{cc}-V_{TST}}\right)$$

$$tGTA=(R1\ C)\ \ln\left(\frac{V_{cc}}{V_{TST}}\right)$$

$$Rp=\frac{R1R2}{R1+R2}$$

a) Decreasing t_{GTP} ($t_{GTP} < t_{GTA}$)



$$tGTP=(Rp\ C)\ \ln\left(\frac{V_{cc}}{V_{cc}-V_{TST}}\right)$$

$$tGTA=(R1\ C)\ \ln\left(\frac{V_{CC}}{V_{TST}}\right)$$

$$Rp=\frac{R1R2}{R1+R2}$$

a) Decreasing t_{GTP} ($t_{GTP} > t_{GTA}$)

FIGURE 7. GUARD TIME ADJUSTMENT

Input Configuration

The input arrangement of the HM 9270 provides a differential-input operational amplifier as well as a bias source (V_{REF}) which is used to bias the inputs at mid-rail.

Provision is made for connection of a feedback resistor to the op-amp output (GS) for adjustment of gain. In a single-ended configuration, the input pins are connected as shown in Fig. 2 with the op-amp connected for unity gain and V_{REF} biasing the input at $1/2V_{cc}$.

Fig. 8 shows the differential configuration, which permits the adjustment of gain with the feedback resistor R5.

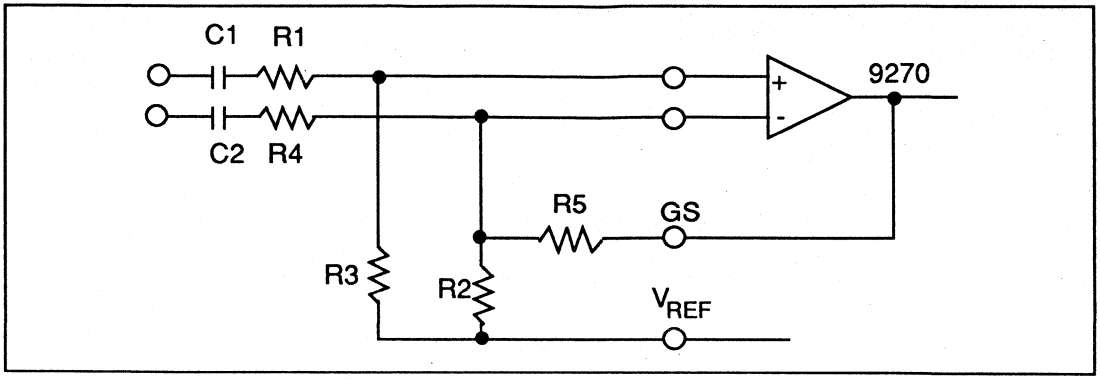


FIGURE 8. DIFFERENTIAL INPUT CONFIGURATION

GENERAL INFORMATION

Handling
Quality/Reliability
Packaging Information

HANDING

Even though the oxide breakdown may be far beyond the voltage levels encountered in normal operation, excessive voltage may cause permanent damage. We recognize that is not 100 percent effective despite our evolving the best designed protective device possible.

A large number of failed returns have been due to misapplication of biases. In particular forward bias conditions cause excessive current through the protective devices, which in turn will vaporize metal lines to the inputs. Careful inspection of the device data sheets and proper pin designation should help reduce this failure mode.

Gate ruptures caused by static discharge have also accounted for a large percentage of device failures in custoemrs' manufacturing areas. Precaution should be taken to minimize the possibility of static charges which occur during handling and assembly of MOS circuits.

The following guidelines for handling MOS are offered to MOS circuits. Precautions listed herein are used at HMC.

A. Cover all benches used for assembly or test of MOS circuits with conductive sheets. Warning: Never expose and operate directly to a hard electrical ground. For safety reasons, the operator must have a resistance of at least 100K Ohms between himself and hard electrical ground.

B. Have grounding plates on door and/or floor of all entrances to work areas. This must be contacted by people entering the area.

C. Wear conductive straps inside and outside of employees' shoes so that body charges are grounded when entering work area.

D. Wear Anti-static neutralized smocks to eliminate the possibility of static charges being generated by friction of normal wear. The two types available are Dupont anti-static nylon and Dupont neutralized 65 percent polyester/35 percent cotton.

E. Wear cotton gloves while handling parts. Nylon gloves and rubber finger cots are not allowed.

F. To help reduce generation of static voltages, humidity is controlled at a minimum of 35 percent.

G. Transport all parts in conductive trays. Do not use plastic containers, Store axial leaded parts in conductive foam, e.g. Velofoam #7611.

H. All equipment used in the assembly area must be thoroughly grounded. Attention should be given to equipment that may be inductively coupled and generate stray voltages. Soldering irons must have grounded tips. Grounding must also be provided for solder posts, reflow soldering equipment, etc.

I. It is advisable to place a grounding clip across the finger of the board to ground all leads and line on the board during assembly of ICs to printed circuit boards.

J. Use of carpets is discouraged in work areas, but in other areas, carpets may be treated with anti-static solution to reduce static generation.

K. Handle MOS parts on conductive surfaces and the handler must touch the conductive surface first before touching the parts.

L. Furthermore, no power should be applied to the socket or board when the MOS device is being inserted. This permits any static charge accumulated on the MOS device to be safely removed before power is applied.

M. Do not handle MOS leads by their leads unless absolutely necessary. Handle MOS devices by their packages as much as possible.

N. In general, materials prone to static charge accumulation should not come in contact with MOS devices.

Observe these precautions even when an MOS device is suspected of being defective. The real cause of failure cannot be accurately determined if the device is damaged because of static charge build-up.

IMPORTANT REMINDER: EVEN THE MOST ELABORATE PHYSICAL PREVENTION TECHNIQUES WILL NOT ELIMINATE DEVICE FAILURE IF PERSONNEL ARE NOT FULLY TRAINED IN PROPER HANDLING OF MOS DEVICES.

For further information, please keep contact with us.

QUALITY/RELIABILITY

Quality Assurance Operations:

It is the policy of HMC to design, manufacture, and deliver products that not only meet our specified standards, but also satisfy our customer standards. To this end, Quality Assurance at HMC has the authority to exercise control of quality over very phase of the design and manufacturing process.

Each step in the production process has clear lines of responsibility showing each employee to identify his task in relation to the overall quality program. Customer feedback is an important phase in the Quality Assurance System: it serves as a barometer of our progress and makes us strive to provide products which meet our customers' requirements and needs.

Reliability Program:

The key to establishing a new product process or package, or to changing an existing one is meeting the rigid qualification requirements. Qualification must be run and approved by the appropriate reliability department before any revenue shipment may be made. The reliability goals which has been set during the concept stage must be demonstrated by the qualification. Controlling product quality and reliability is a complex task requiring a high degree of integration, organizational involvement and use of specialized disciplines.

Design control through part selection and application, design rules, circuit analysis, derating requirements and environmental and reliability qualification testing.

Procured material quality through a rigorous supplier selection, qualification and monitoring process. Our computerized control system automatically assures procurement only from selected and approved sources. The right for any supplier to be on the approved list must be earned!

Product quality level monitoring and control through our automated reported and analysis systems, and improvement through a corrective action system including impositions of extensive product failure free burn-in requirements. But the final measure of outgoing quality is our continuous product sampling program, where a significant percentage of finished products is subjected to "customer audit". Only products which meet the stipulated quality levels may ship.

PACKAGE INFORMATION

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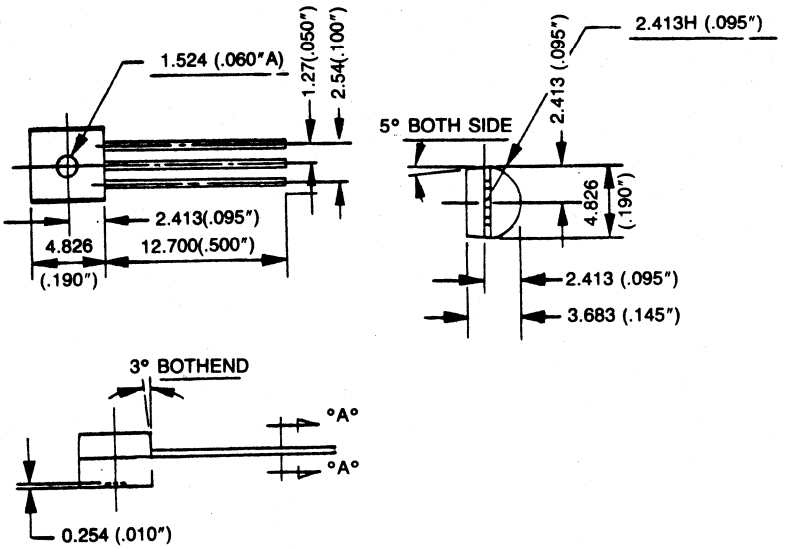

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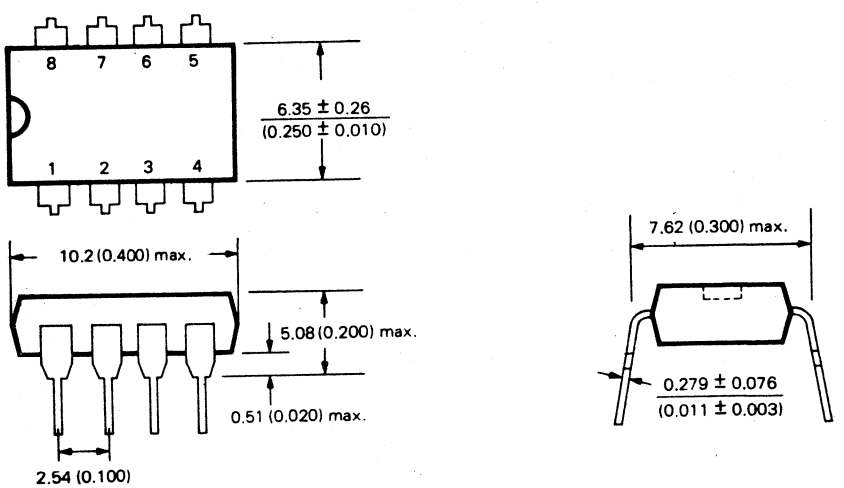
8-Lead



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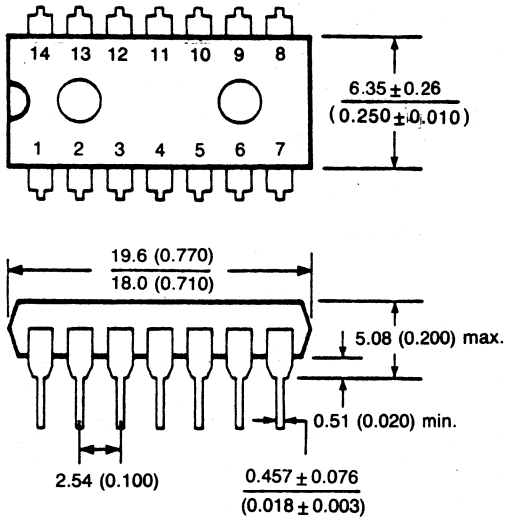

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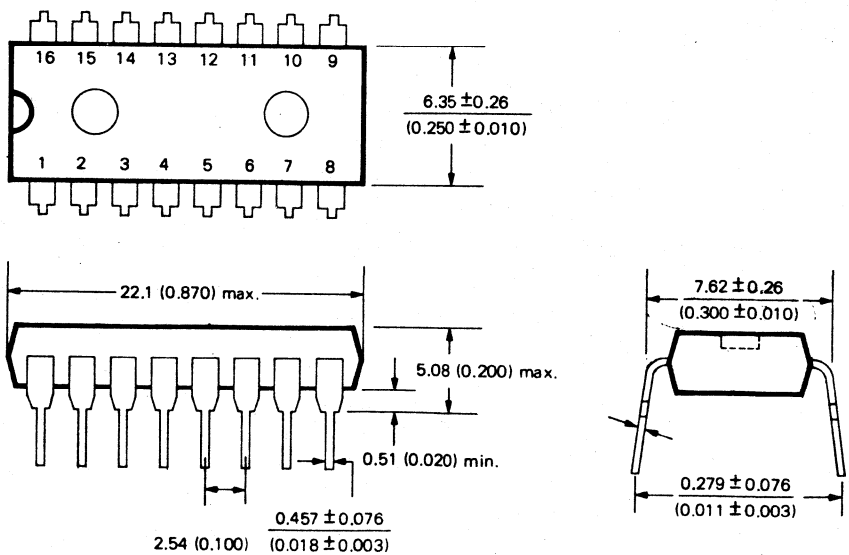

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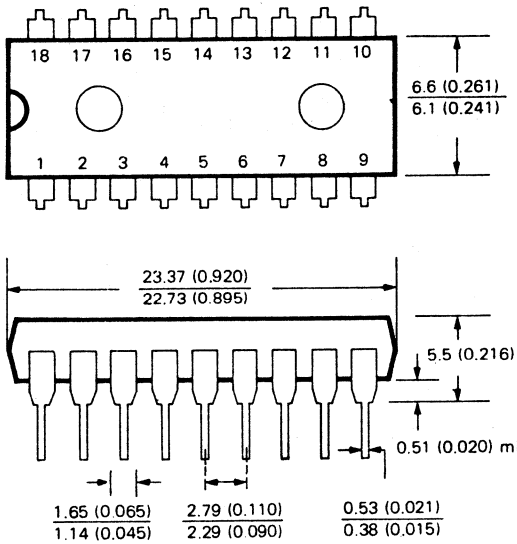
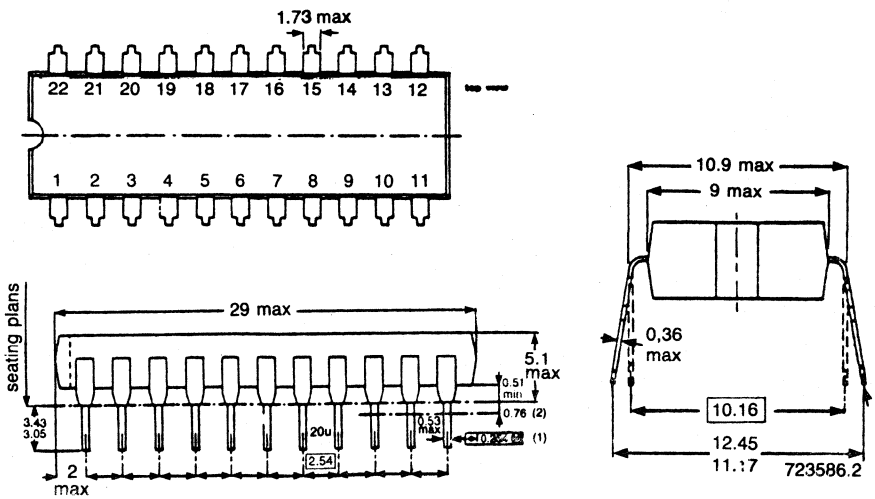


Plastic dual in Line
22-Lead



PACKAGE INFORMATION

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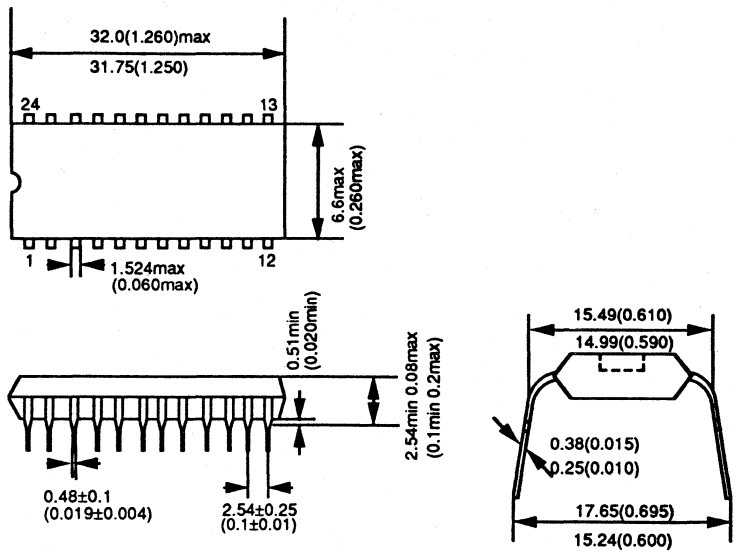

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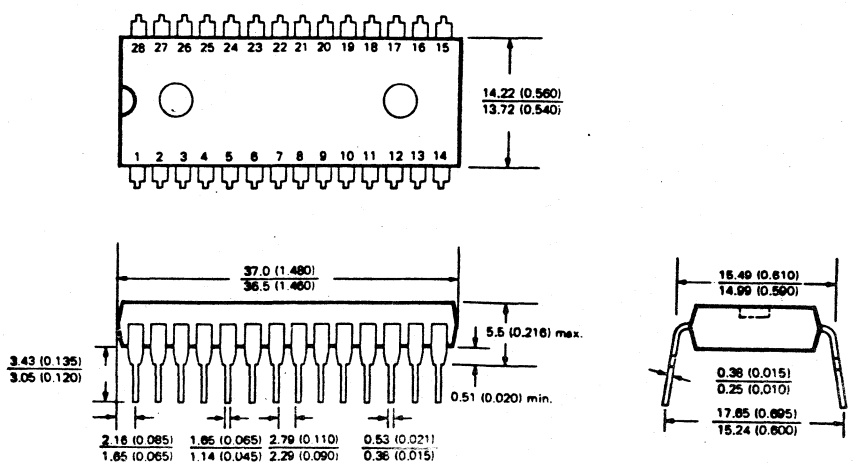

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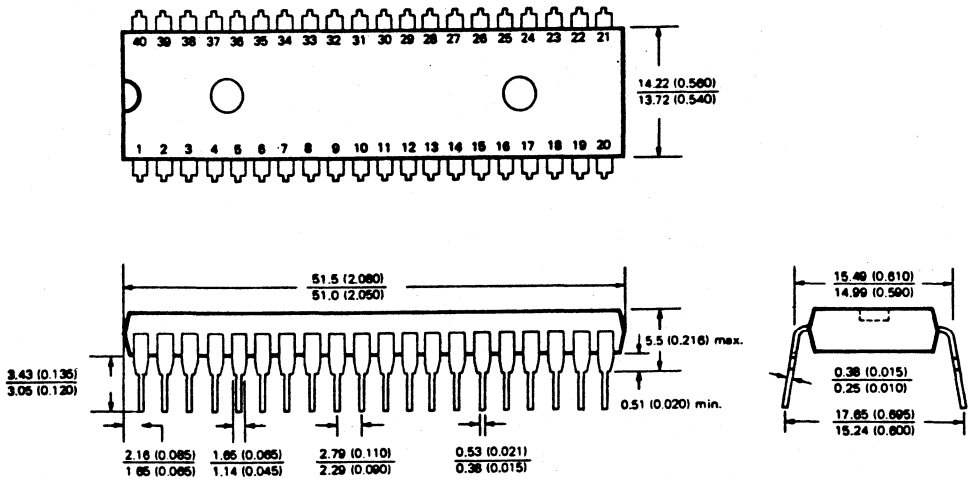

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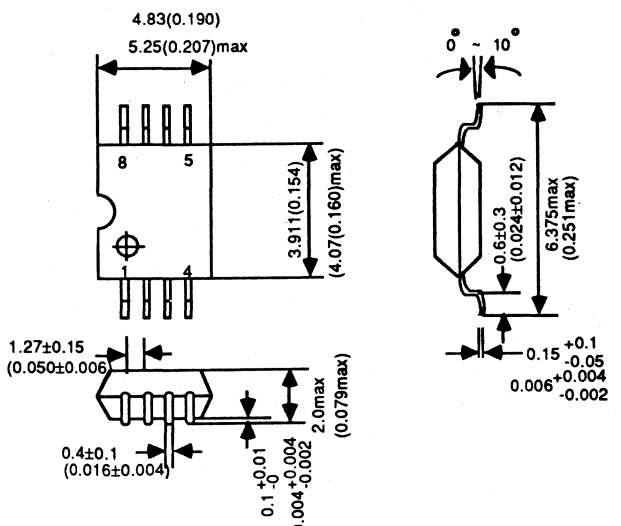

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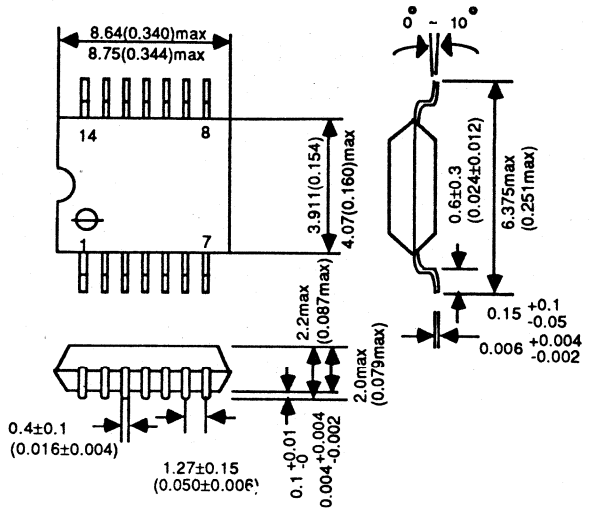

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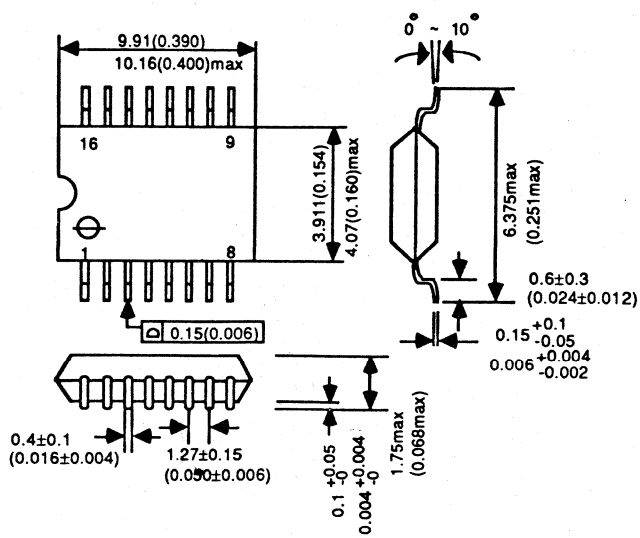

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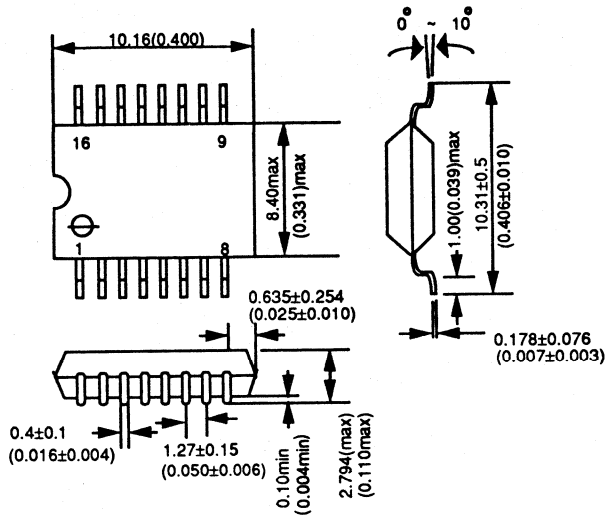

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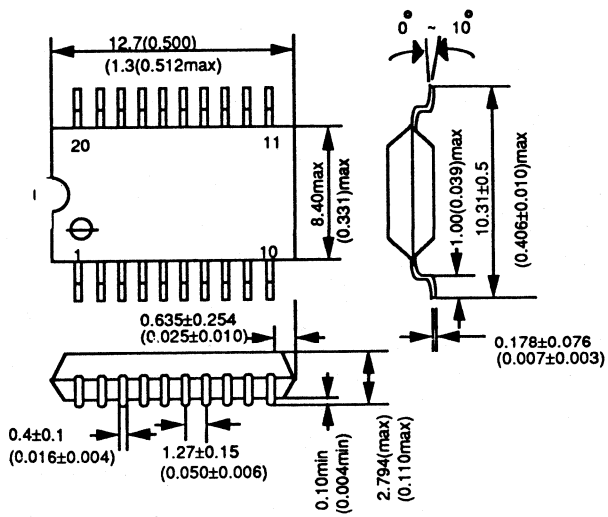

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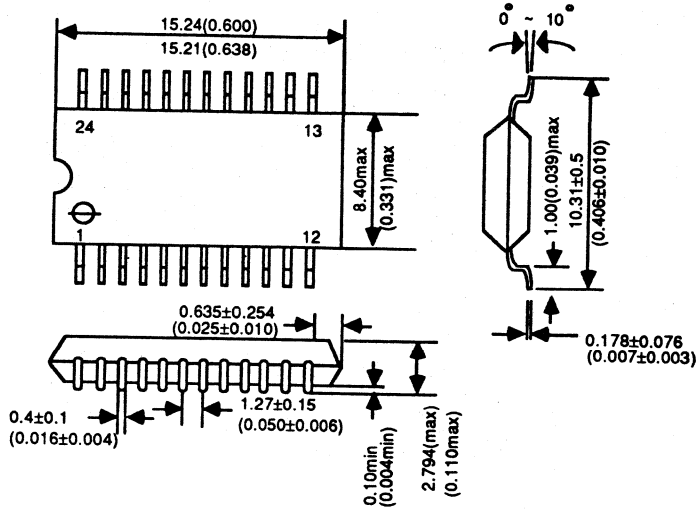

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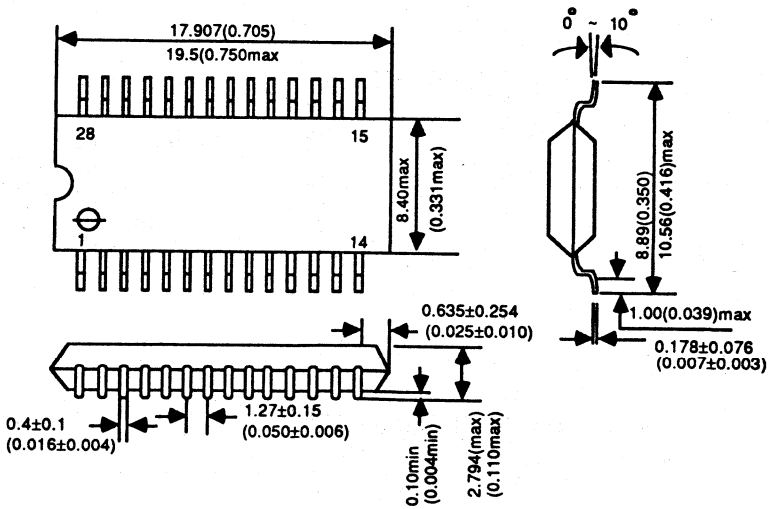

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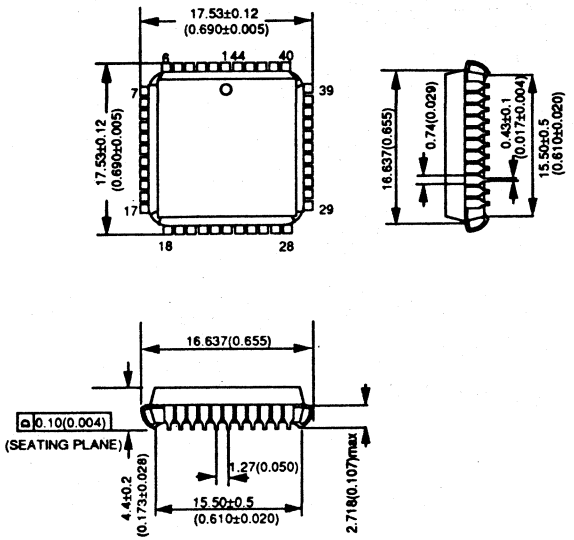

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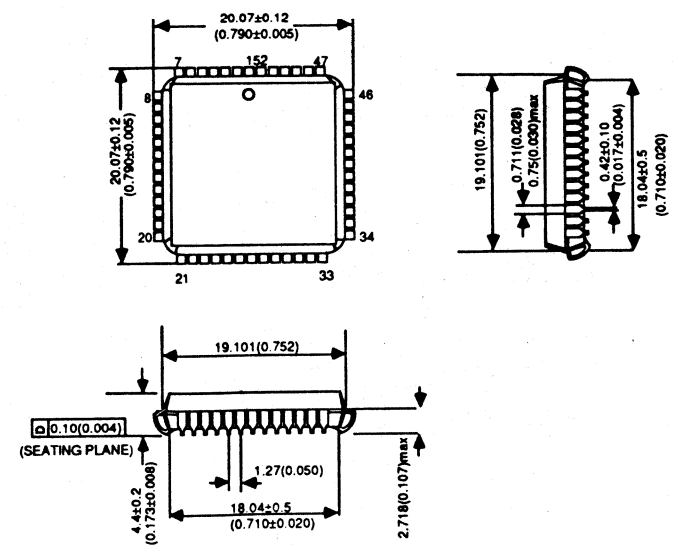

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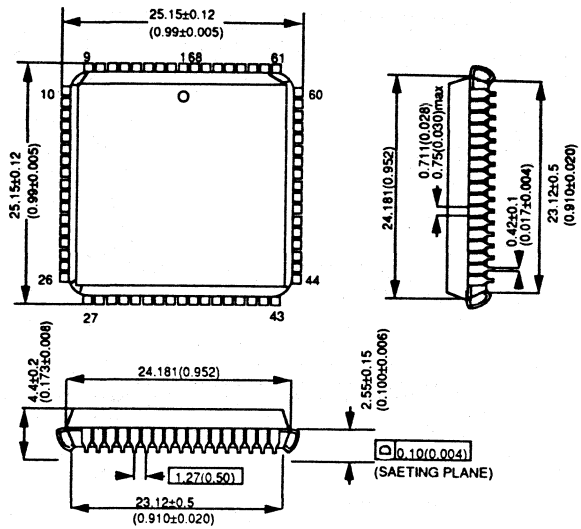

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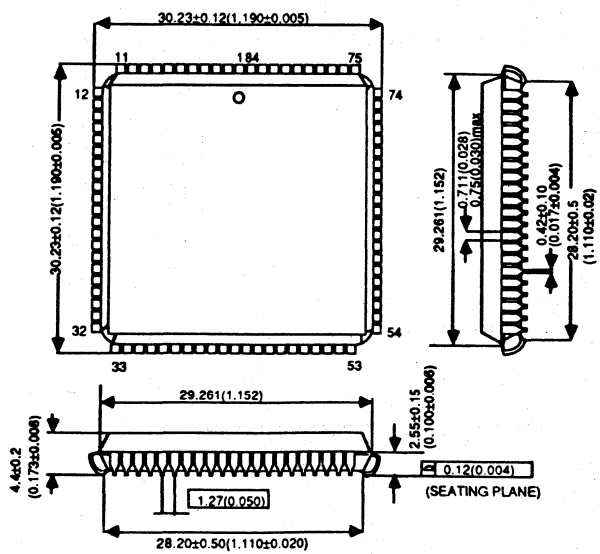

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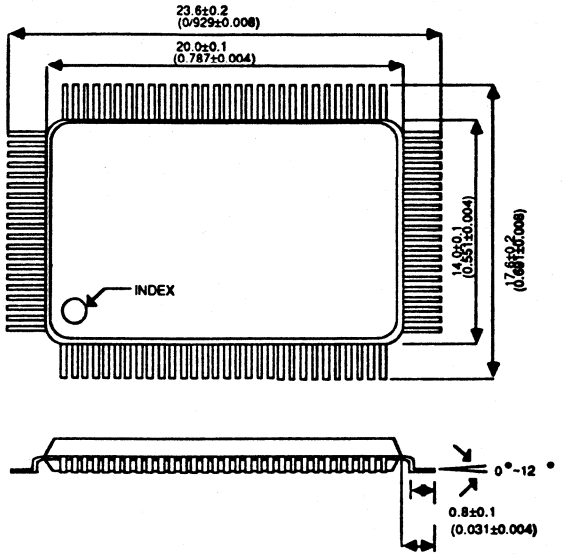

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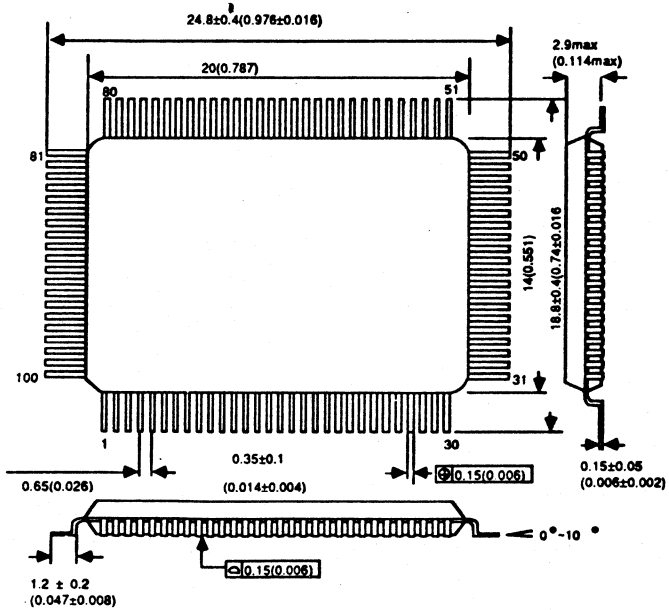

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