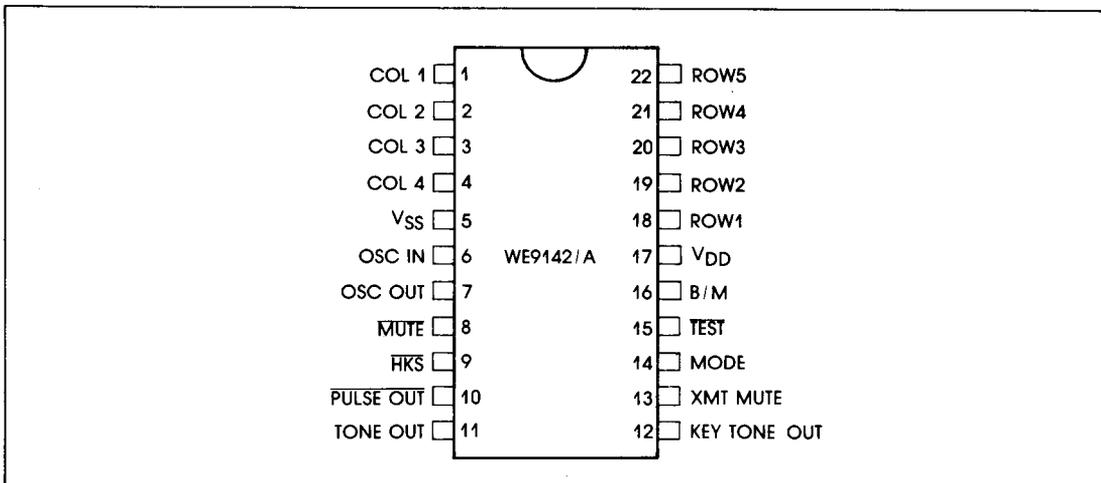# Winbond

10-MEMORY TONE/PULSE SWITCHABLE DIALER

GENERAL DESCRIPTION

WE9142/A are monolithic integrated circuit which performs 10-Memory Tone/Pulse switchable dialing functions for modern telephone set design. It is fabricated in CMOS technology thus has good performance in low voltage, low power operations. Wide operating voltage range and low memory retention current facilitate this chip excellent for battery-free direct line powered operation.

FEATURES

- DTMF/Pulse Switchable Dialer.
- Stores Ten 16-Digits Numbers for Repertory Dialing.
- One 31-Digits for Redial Memory.
- Dialing length is unlimited, but if the dialing length of normal-dialing overstep 31 digits then redial is inhibited.
- Auto Pause Access for PBX and Toll Service Operations; 3.1 second per pause.
- Easy Operation with Redial, Store, Auto & Pause Keypads.
- Key-Tone Output for valid keypad Entry recognition.

- Uses Form A Keyboard or the Standard 2-of-9 Matrix Keyboard.
- Electronic Keypad Input is Available; Low Action.
- Uses Inexpensive 3.57954MHz Television Color-Burst Crystal.
- Pin Selectable for Break/Make Ratio.
- Power on reset is internally generated.
- Memory Retention Current $0.2\mu A$ at $V = 1.0V$, ON-HOOK.
- Wide operation voltage range: 2.0V~5.5V.
- 22-pin Dual-in-Line Package.

PIN CONFIGURATION

	WE9142/A	
COL 1	1	22 ROW5
COL 2	2	21 ROW4
COL 3	3	20 ROW3
COL 4	4	19 ROW2
Vss	5	18 ROW1
OSC IN	6	17 VDD
OSC OUT	7	16 B/M
MUTE	8	15 TEST
HKS	9	14 MODE
PULSE OUT	10	13 XMT MUTE
TONE OUT	11	12 KEY TONE OUT

TONE/PULSE DIALER

FUNCTIONAL DESCRIPTION

A. ROW-COLUMN INPUT (PIN 1~4 & 18~22)

The keypads input is compatible with the standard 2-of-9 keyboard. 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 keypads function, in detail.

OUTPUT			ACTIVE LOW INPUTS		OUTPUT TONE (Pin 11) PULSE (Pin 10)
			ROW (Pin 18-21)	COLUMN (Pin 1-3)	
TONE (Pin 14=0)	Normal (Pin 15=1)		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=0)		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=1)	10 pps (Pin 15=1)		One	One	10pps
			Two or More	One	Pin 10=1
			One	Two or More	
			Two or More	Two or More	
	600 pps (Pin 15=0)		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.

B. OSC IN, OSC OUT

An built-in inverter provides oscillation with an inexpensive 3.579545MHz television color-burst crystal. The oscillator ceases when a keypad input is not sensed. Most crystals do not vary more than ±0.02%.

C. MUTE

The mute output is a conventional CMOS inverter that pulls to V_{DD} with no keyboard input and pulls to V_{SS} when an address keypads entry is sensed (excluding the * & # keypads, in pulse mode), that is, any keypad in row 5 and column 4 is pushed, then mute out keeps high level still.

D. $\overline{HKS}$

The $\overline{HKS}$ (Hook Switch) input is used to detect the handset in ON-HOOK or OFF-HOOK. In ON-HOOK state, $\overline{HKS}=1$, the keyboard input is disabled. In OFF-HOOK state, $\overline{HKS}=0$.

E. $\overline{PULSE\ OUT}$

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 * and # entry.
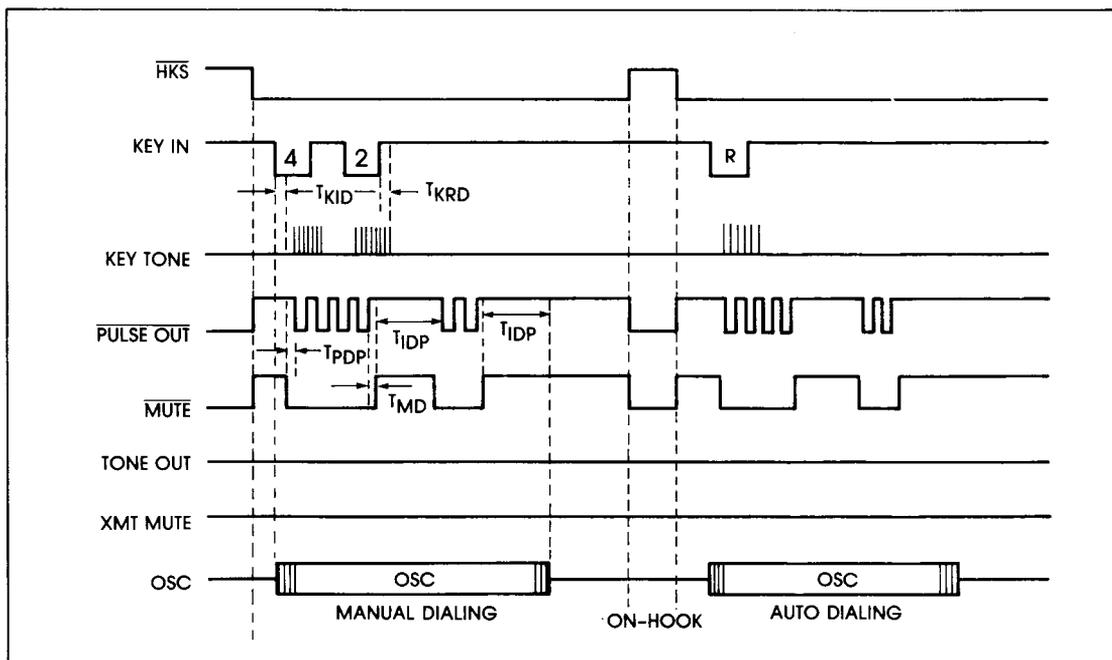

Figure 1. Pulse Mode Timing Waveform.

F. TONE OUT

In normal dialing, the tone duration depends on key-in lasting. When keypad is pressed less than 100ms, the tone duration will be fixed to 100ms. In opposite, the tone duration will last as long as key-in continuance. The inter-tone-pause will be different under following condition: when key-released duration continues less than 105ms, it will be fixed to 105ms, otherwise it will be equal the duration of key-released. When redialing and memory dialing, the tone duration and inter-tone-pause are internally set to be 100ms and 105ms respectively. During pulse dialing, it always keeps at low state regardless of keypad input. (See Figure 2)
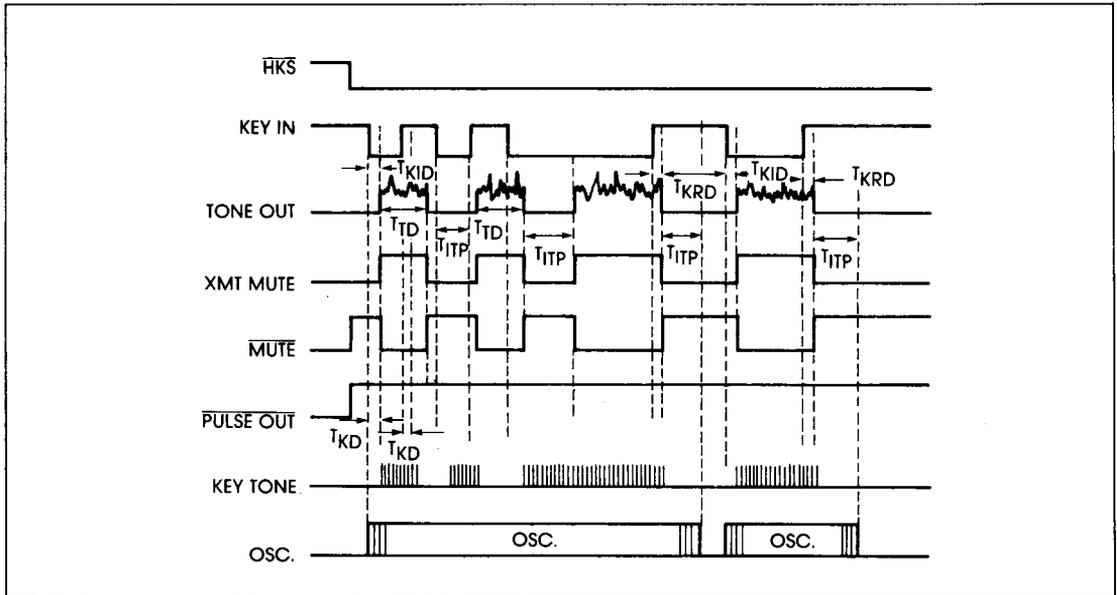
TONE/PULSE DIALER

TIMING WAVEFORM

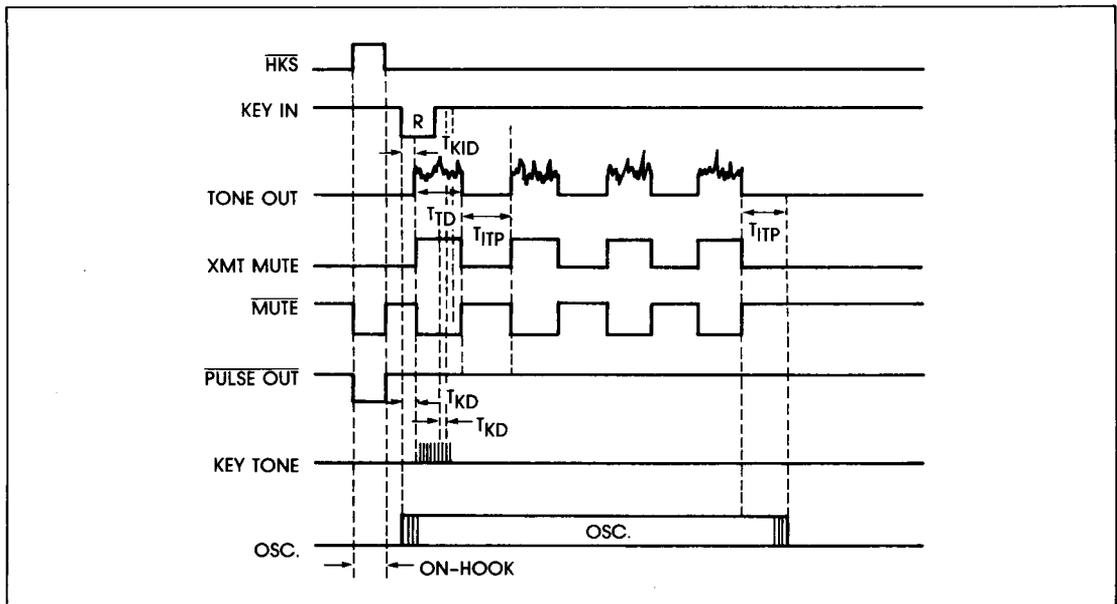Figure 2(a) Tone Mode Normal Dialing

Figure 2(b) Tone Mode Redialing

G. 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. The key tone acturates, after valid key entry has been detected, and ceases at the time of button released.

H. XMT MUTE

The XMT MUTE is a conventional CMOS inverter. In DTMF mode, the output acturates in the duration of DTMF signal is sending. But, the output always keeps low in pulse mode. It can be used for muting operation in Tone mode or control LED for indicating (See Applicatin Circuit).

I. MODE

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

J. $\overline{TEST}$

In normal operation, ties the $\overline{TEST}$ Pin to V_{DD}, the single tone is.inhibited and pulse rate is 10 pps. In testing operation, ties the $\overline{TEST}$ pin to V_{SS}, single tone can be created with the method shown in TABLE 1, and all of the time parameter in pulse dialing is faster by 60 times.

K. B/M

The Break/Make ratio is 60:40, if B/M = 1, and is 66.6:33.3 if B/M = 0. This pin influences nothing in DTMF mode.

KEYBOARD FUNCTION

WE9142

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

R: Redial
S: Store
A: Auto Dialing

WE9142A

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

P: Pause
P→T: Pulse to Tone Switch

TONE/PULSE DIALER

OPERATION DESCRIPTION

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

D1 ~ Dn: 0-9, *, #

A. NORMAL DIALING

$\boxed{\text{D1}}$, $\boxed{\text{D2}}$,...., $\boxed{\text{Dn}}$

B. REDIAING

Push $\boxed{\text{D1}}$, $\boxed{\text{D2}}$ ..., $\boxed{\text{Dn}}$, busy, ON-HOOK. Come OFF-HOOK, push $\boxed{\text{REDIAL}}$, the last number D1.D2...Dn will be dialled out automatically.

C. NUMBER STORING

Don't care Pulse or Tone mode. Push $\boxed{\text{S}}$ $\boxed{\text{D1}}$, $\boxed{\text{D2}}$ ... $\boxed{\text{Dn}}$, $\boxed{\text{S}}$, $\boxed{\text{Ln}}$ Ln:0-9 then the number D1.D2 ... Dn will be stored in location $\boxed{\text{Ln}}$

D. MEMORY DIALING

Select Pulse or Tone mode. Push keypad $\boxed{\text{A}}$ $\boxed{\text{Ln}}$, then the number stored in location $\boxed{\text{Ln}}$ will be automatically dialed out in Pulse or Tone mode as selected.

E. PAUSE KEY OPERATION

In some PABX or Long Distance Service, pause should be inserted in dialing sequence. The WE9142/A provide stackable pause function (3.1 sec/Pause) which facillitates flexible applications.

a. DIALING WITH PAUSE KEY

1. $\boxed{\text{D1}}$, $\boxed{\text{P}}$, $\boxed{\text{D2}}$,...., $\boxed{\text{Dn}}$

Then the number will be dialed out as following sequence; D1, D2, ... Dn; without pause.

2. Redialing with Pause Key

OFF-HOOK, $\boxed{\text{R}}$ then the signal will be dialed out automatically D1, pause 3.1 sec., D2, ...Dn.

b. STORING WITH PAUSE KEY

1. $\boxed{\text{S}}$, $\boxed{\text{D1}}$, $\boxed{\text{P}}$, $\boxed{\text{D2}}$,... $\boxed{\text{Dn}}$ $\boxed{\text{S}}$ $\boxed{\text{Ln}}$ then the number D1, P, D2,... Dn will be stored in Ln.

2. Memory Dialing with Pause Key

$\boxed{\text{A}}$ $\boxed{\text{Ln}}$, then the output signal will be dialed as: D1, pause 3.1 sec., D2, ... Dn.

Note: Every Pause will occupy one digit of memory size.

F. MIXED DIALING

WE9142/A provide remote control function such as computer or appliance electric after the call has been put through. Mix-dialing is acceptable and has no limit on the digits of above-listed items operation.

G. PULSE TO TONE KEY OPERATION

WE9142A provides one special function for long distance service company (such as MCI, SPRINT) access codes operations,

a. DIALING WITH PULSE TO TONE KEY $\boxed{\text{D1}}$, $\boxed{\text{D2}}$, ..., $\boxed{\text{Dn}}$, $\boxed{\text{P-T}}$, $\boxed{\text{D1'}}$, $\boxed{\text{D2'}}$,... $\boxed{\text{Dn'}}$ D1, D2, ..., Dn, D1', D2', ... Dn', without pause.

b. WITH PULSE TO TONE KEY

OFF-HOOK, $\boxed{\text{R}}$, then the signal will be dialing out automatically as same sequence of dialing with Pulse to Tone key, but has a 3.1 sec pause during changing mode.

Note: 1. If in Tone mode P→T as pause function.

2. It can be reset to Pulse mode on-

ly in the operation of ON-HOOK.

c. Storing the Long Distance Service Company Code to Memory $\boxed{S}$, $\boxed{D1}$, $\boxed{D2}$, ..., $\boxed{Dn}$, $\boxed{P\text{-}T}$ $\boxed{D1'}$, $\boxed{D1'}$, $\boxed{D2'}$, ..., $\boxed{Dn'}$ $\boxed{S}$ $\boxed{Ln}$

Then the number sequence will be stored in location $\boxed{Ln}$

d. Memory Dialing with Pulse to Tone Key Select Pulse mode.

$\boxed{A}$, $\boxed{Ln}$ then D1, D2, ..., Dn, pause 3.1 sec., D1', D2', ..., Dn' will be dialed out.

Note: 1. If in Tone mode, it will auto insert a pause at P-T position.

ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYM.	RATING	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 $T_A = -25$ to $+60°C$)	mW
Operating Temperature	T_A	-25 to $+85$	°C
Storage Temperature	T_{STG}	-65 to $+150$	°C

D.C. CHARACTERISTICS

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

PARAMETER	SYM.	TEST CKT	TEST CONDITIONS	LIMITS MIN.	LIMITS TYPE	LIMITS MAX.	UNIT
Operating Voltage	V_{DD}		Tone	2.0	—	5.5	V
			Pulse	2.0	—	5.5	
			Memory	1.0	—	5.5	
Operating Current	I_{OP}	A	Tone Note 1,4,6	—	0.6	2	mA
			Pulse	—	0.2	0.5	
Memory Retention Current	I_{MR}	B	$\overline{HKS} = 1$, $T_A = 45°C$, $V_{DD} = 1.0V$	—	0.1	0.2	μA
Standby Current	I_S	A	Note 1,2,3,5,6	—	0.1	5	μA
Tone Output	V_{TO}	C	Row Group, $R_L = 10K\Omega$	130	150	170	mVrms
Pre-Empasis		D	Column Group/Row Group, $V_{DD} = 2.0 - 5.5V$	1	2	3	dB
DTMF Distortion	T_{HD}	D	$R_L = 10K$, Note 7,8	—	-30	-23	dB
Tone output External Impedance	R_L		$THD < -23dB$	10	—	—	$K\Omega$
Tone Output DC Level	V_{DC}	D	$V_{DD} = 2.0 - 5.5V$	0.5 V_{DD}	—	0.6 V_{DD}	—

TONE/PULSE DIALER

PARAMETER	SYM.	TEST CKT	TEST CONDITIONS	LIMIT			UNIT
				MIN.	TYPE	MAX.	
Tone Output Sink Current	I_{TL}	E	$V_{TO}=0.5V$	0.2	—	—	mA
Pulse Output Drive Current	I_{PH}	E	$V_{PO}=2.0V$	−0.2	—	—	mA
Sink Current	I_{PL}	F	$V_{PO}=0.5V$	0.2	—	—	
Mute Output Drive Current	I_{MH}		$V_{MO}=2.0V$	−0.2	—	—	mA
Sink Current	I_{ML}		$V_{MO}=0.5V$	2	—	—	
Key Tone Output Drive Current	I_{KH}	H	$V_{KO}=2.0V$	−0.5	—	—	mA
Sink Current	I_{KL}	E	$V_{KO}=0.5V$	0.5	—	—	
XMT Mute Drive Current	I_{LH}		$V_{LO}=2.0V$	−0.2	—	—	mA
Sink Current	I_{IL}		$V_{LO}=0.5V$	0.2	—	—	

A.C. CHARACTERISTICS

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

PARAMETER	SYM.	TEST CKT	TEST CONDITIONS		LIMIT			UNIT
					MIN.	TYPE	MAX.	
Key-in Debounce	T_{KID}		TEST = 1, Note 8, 9, 10		—	20	—	mS
Key-released Debounce	T_{KRO}		TEST = 1, Note 8, 9, 10		—	20	—	mS
Key-Tone Delay	T_{KD}		TEST = 1, Note 2, 4, 10		—	20	—	mS
Pulse Mute Delay	T_{MD}		TEST = 1, Note 8, 9	B/M = 1	—	40	—	mS
				B/M = 0	—	33.3	—	
Pre-Digit Pause	T_{PDP}		TEST = 1, Note 8, 9	B/M = 1	—	40	—	mS
				B/M = 0	—	33.3	—	
Pulse Rate	F_{PR}		TEST = 1 Note 8		—	10	—	pps
			TEST = 0		—	600	—	
Inter Digit Pause	T_{IDP}		TEST = 1 Note 8		—	800		mS
			TEST = 0		—	13.3		
Break/Make Ratio	B:M		B/ = 1 Note 8		—	60:40	—	%
			B/M = 0		—	66.6: 33.3	—	
Tone Duration	T_{TD}		Auto Dialing Note 8		—	100	—	mS

PARAMETER	SYM.	TEST CKT	TEST CONDITIONS	LIMIT			UNIT
				MIN.	TYPE	MAX.	
Inter Tone Pause	T_{ITP}		Auto Dialing Note 8	—	105	—	mS
Row Group Frequency	f1	C	ROW1, NOTE 8	—	699	—	Hz
	f2		ROW2, NOTE 8	—	766	—	
	f3		ROW3, NOTE 8	—	848	—	
	f4		ROW4, NOTE 8	—	948	—	
Colum Group Frequency	f5	C	COL1, NOTE 8	—	1216	—	Hz
	f6		COL2, NOTE 8	—	1332	—	
	f7		COL3, NOTE 8	—	1472	—	
Key Tone Frequency	F_K		Note 8	—	1.2	—	KHz
Input Voltage Low	V_{IL}		Pins, 1-4, 9, 14, 15	GND	—	$0.3V_{DD}$	
Input Voltage High	V_{IH}		16 & 18-22	$0.7V_{DD}$	—	V_{DD}	
Keypad Input Drive Current	I_{KD}	F	$V_I = 0\,V$	4	10	30	μA
Sink Current	I_{KS}	E,G	$V_I = 2.5V$	200	400		
Control Pin Input	I_{IN}		Pins 9, 14, 15, 16	—	$\pm 10^{-5}$	± 0.1	μA

Note 1 : $\overline{HKS} = 0$

Note 2 : In DTMF Mode

Note 3 : In Pulse Mode

Note 4 : Keyboard Entry, including Auto Dialing

Note 5 : No Keyboard Entry

Note 6 : All Output Unloaded

Note 7 : Dual Tone Mutli-Frequency Distortion is measured in terms of total out-of band power related to sum of row & column fundamental power

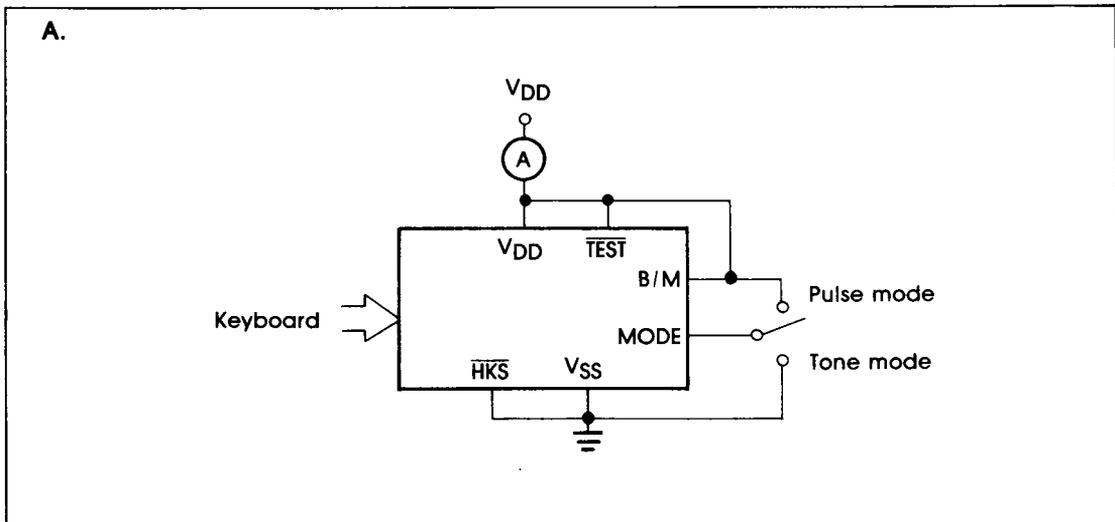Note 8 : Crystal parameters defined as Rs< 100Ω, Lm=96mH Cm=0.25PF Ch=5PF, F=3.579545MHz & CL=18P FF< ±200PPM

Note 9 : Referred to Pulse Mode Time Diagram
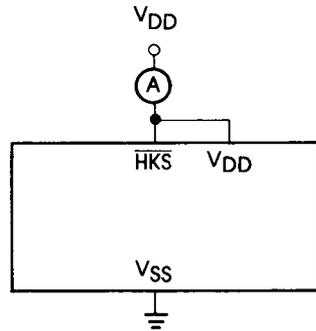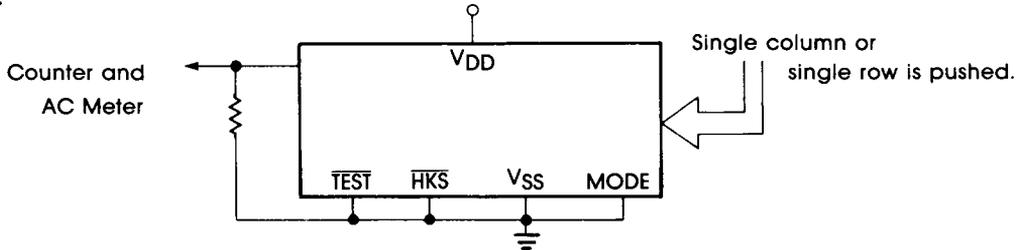
Note 10 : Referred to DTMF Mode Time Diagram

TONE/PULSE DIALER

GENERAL TEST CIRCUIT

TEST CIRCUIT

A.

B.

C.

Counter and AC Meter

Single column or single row is pushed.

D.

Spectrum Analyzer (HP3582A)

DC Meter

10K
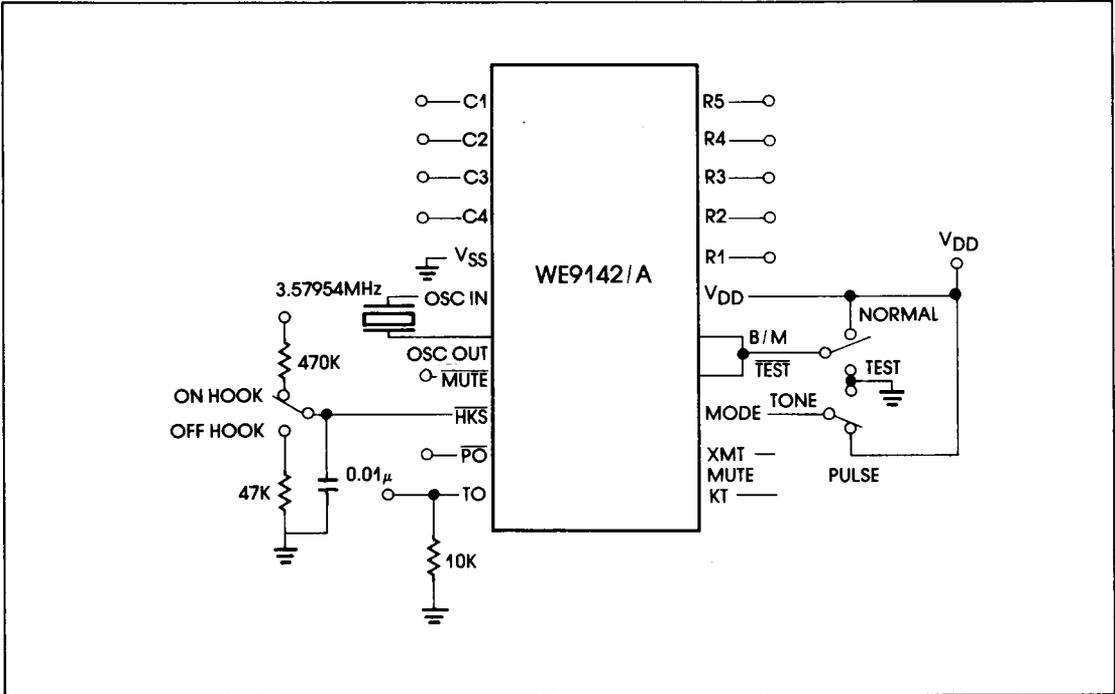
Keyboard
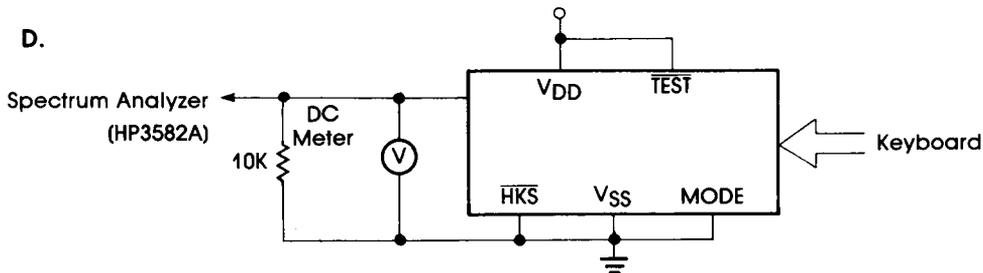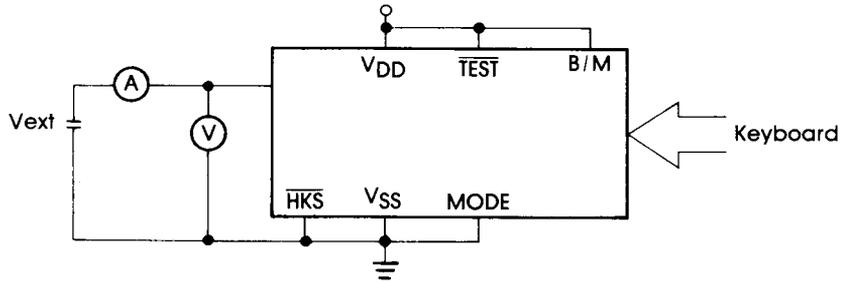
$$\text{DIST dB} = 20 \log \frac{\sqrt{[V_1]^2 + [V_2]^2 + \ldots + [Vn]^2}}{\sqrt{[V_L]^2 + [V_H]^2}}$$

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

* V_L, V_H, are the individual frequency components of the DTMF signal.

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

TONE/PULSE DIALER

347

E.
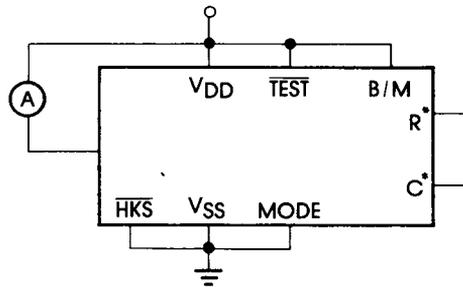

Note: Whether keyboard is pushed refer to the DTMF mode timing diagram.

F.
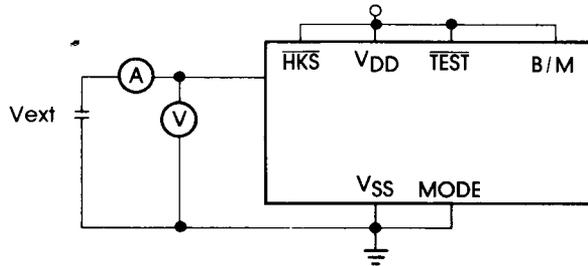
G.

Note:
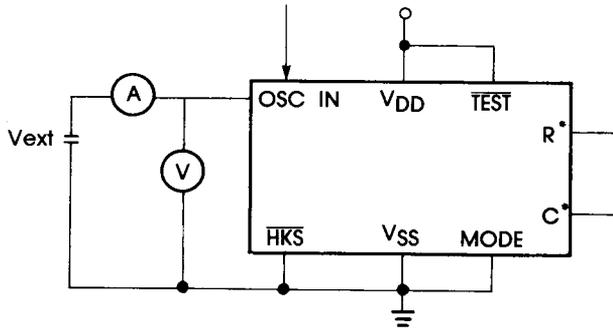
R*: anyone row of R1-R5

C*: anyone column of C1-C4

Isink $= I/(1-\text{Duty Cycle})\, V_{SS}$
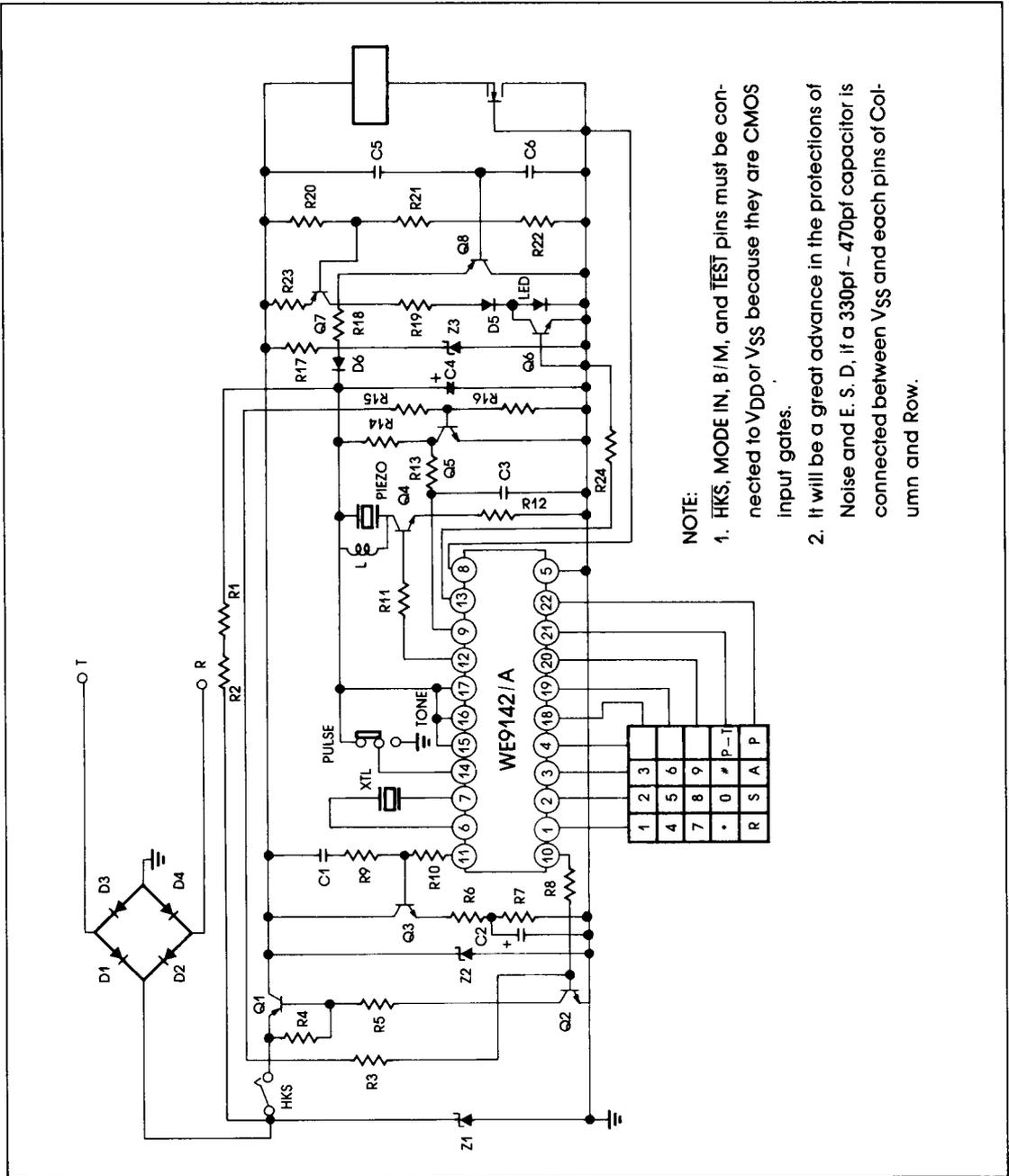
I is the net DC current measured from ampere meter.

H.

Procedure: 1. Provide clocks until output changes to high.

2. Test its current.

Note: TEST pin can be combined with V_{SS} in order to speed up testing.

TONE/PULSE
DIALER

TYPICAL APPLICATION

NOTE:

1. HKS, MODE IN, B/M, and TEST pins must be connected to V_{DD} or V_{SS} because they are CMOS input gates.

2. It will be a great advance in the protections of Noise and E. S. D, if a 330pf ~ 470pf capacitor is connected between V_{SS} and each pins of Column and Row.

CIRCUIT DESCRIPTION

A. The circuit is line powered through a diode bridge for rectifying and regulated by a regulation circuit which consists of Q7, Q8, R18-R23, D5 and C5, C6, Q7, Q8 are always in active region. C5 ensures a high regulator impedance for AC signals. This capacitor value should not be too large in order to have short response time of system. C6 is a compensatory capacitor. C4 must be a low leakage capacitor and D5 blocks up the path from C4 to Q8 for holding the voltage in C4.

B. In ON-HOOK state, R1, R2 provide the flow path for memory data retention current and make the circuit to satisfy the requirement of EIA-RS470 which require DC input impedance to be higher than 10MΩ. R1 and R2 are 22MΩ separately when used in paraillel with other three same telephone sets. The memory data retention current of dialer is furnished through R1, R2, and C1, all other circuits are floated to decrease the need of data retention current in ON-HOOK state.

C. Dialing pulses are sent by controlling the states of Q1 and Q2. In DTMF mode, Q1 and Q2 are always saturated, and dialing tone is sent through the amplifier which consists of R6, R7, R9, R10, C1, C2 and Q3, R9, C1 is a RC feedback circuit, it keeps the tone output unaffected by different transistor.

D. Z1 and Z2 ptodect the whole circuit from surge voltage and over-large signal on telephone line when off hook. Z3 limits the eoltage supplied to WE9142/A.

E. L, Q4 and piezo make a tuning circuit and generate a key tone when the keypad is pushed. R12 is a current-limited resistor.

F. Q9 provides the muting for receiver and transmitter when dialing. R19, R24, D6, Q6 and LED implement the dialing indication.

G. R13-R16, C3 and Q5 make a detecting circuit of hook-switch. When ON-HOOK, Q5 is turned off, R13 is pulled high in a short time. In OFF-HOOK state, C3 protects HKS from spikes effect and R13 is pulled low while Q5 is turned on.

H. SW furnishs the selection of dialing mode for user.

TONE/PULSE DIALER

COMPONENT SELECTION TABLE

R1	22MΩ	R18	110Ω	D5–D6	IN4148
R2	22MΩ	R19	330Ω	Z1	IN5379
R3	910KΩ	R20	1.6Ω	Z2	IN4743
R4	33KΩ	R21	1.2KΩ	Z3	RD4, 3ESB
R5	4.7KΩ	R22	5.1Ω	Q1	2SA640
R6	36Ω	R23	10Ω	Q2	2N5551
R7	62Ω	R24	33KΩ	Q3	FC8058
R8	10KΩ	C1	$0.02\mu F$	Q5 ~ Q6	2N9014
R9	100KΩ	C2	$4.7\mu / 16V$	Q7 ~ Q8	2N4403
R10	5.1KΩ	C3	$0.5\mu F$	Q9	AVN1106
R11	33KΩ	C4	$100\mu F / 16V$	XTL	3.579545MHz
R12	1.2KΩ	C5	$2.2\mu F / 25V$	IC1	WE9142/A
R13	10KΩ	C6	$0.01\mu F$		
R14	330KΩ	D1	1N4004		
R15	330KΩ	D2	1N4004		
R16	82KΩ	D3	1N4004		
R17	10KΩ	D4	1N4004		