Winbond

13-MEMORY TONE/PULSE DIALER

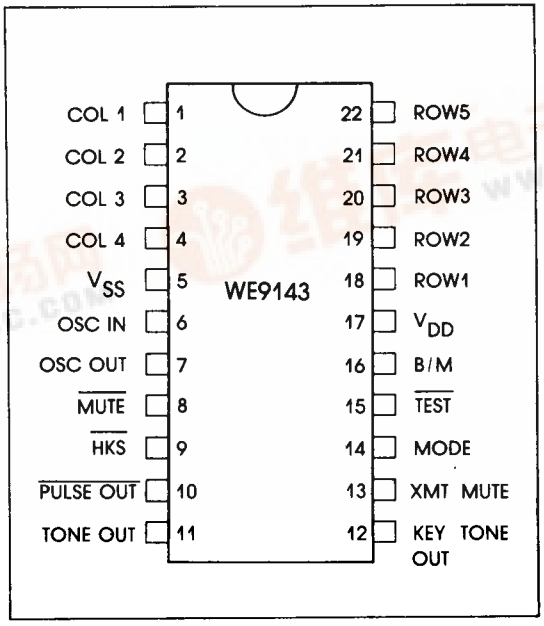
GENERAL DESCRIPTION

The WE9143 is a monolithic integrated circuit. It contains 13-Memories which can perform Tone/Pulse switchable dialing functions and Long Distance Service Company (Such as MCI, SPRINT) access codes operations for modern telephone set design. It is fabricated in CMOS technology thus has good performance in low voltage, low power operations. Three 16-digits direct dialing memories are added for convenient emergency calls (such as fire, police, doctor) 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
- Three 16-Digits Numbers for Emergency Calling.
- Pulse to Tone Keypad for Long Distance Call Operation.
- One 31-Digits for Last Number Redial Memory.
- Auto Pause Access for PABX Operation; 3.1 sec. per Pause.
- Dialing length is unlimited, but if the dialing length of normal-dialing overstep 31 digits then redial is inhibited.
- Easy Operation with Redial, Store, Auto & Pause Keypads.
- Key-Tone Output for Valid Keypad Entry Recognition.
- Uses Standard 2-of-9 Matrix Keyboard.
- Electronic Keypad Input is Available; Low Active.
- Uses Inexpensive 3.579545MHz Television Color-Burst Crystal.
- Pin Selectable for Break/Make Ratio.
- Memory Retention Current $< 0.2\mu A$ at $V_{DD} = 1.0V$, ON-HOOK.
- Wide Operation Voltage Range: 2.0V ~ 5.5V.
- 22-Pin Dual-in-Line Package.

PIN CONFIGURATION



KEYBOARD FUNCTION

R: Redial
S: Store
A: Auto Dialing

P: Pause
EM1-EM3: Emergency 1-3
P-T: Pulse to Tone Switch

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

ABSOLUTE MAXIMUM RATINGS

CHARACTERISTICS	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

DC. ELECTRICAL CHARACTERISTICS

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

CHARACTERISTICS	SYM	TEST CKT.	TEST CONDITION	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	
Operating Current	I_{OP}		Tone, Note 1,4,6	-	0.6	2	mA
			Pulse, Note 1,4,6	-	0.2	0.5	
Memory Retention Current	I_{MR}	B	$\overline{HKS}$=1, T_A=25°C, V_{DD}	-	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=10KΩ	130	150	170	mVrms
Pre-Emphasis		D	Column Group/Row Group, V_{DD}=2.0-5.5V	1	2	3	dB
DTMF Distortion	THD	D	R_L=10K, Note 7, 8	-	-30	-23	dB

CHARACTERISTICS	SYM	TEST CKT	TEST CONDITIOONS	LIMITS			UNIT
				MIN	TYPE	MAX	
Tone Output External Load Impedance	R_L		THD < −23dB	10	-	-	KΩ
Tone Output DC Level	V_{DC}	D	V_{DD}=2.0−5.5V	$0.5V_{DD}$	-	$0.6V_{DD}$	-
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}	E	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}	E	V_{LO}=2.0V	−0.2	-	-	mA
Sink Current	I_{IL}		V_{LO}=0.5V	0.2	-	-	

AC. ELECTRICAL CHARACTERISTICS

CHARACTERISTICS	SYM	TEST CKT	TEST CONDITIOONS	LIMITS			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_{MD}		TEST=1, Note 2, 4, 10	-	20	-	mS
Pulse Mute Delay	T_{MD}		TEST=1, B/M=1	-	40	-	mS
			Note 8, 9 B/M=0	-	33.3	-	
Pre-Dgit Pause	T_{PDP}		TEST=1, B/M=1	-	40	-	mS
			Note 8, 9 B/M=0	-	33.3	-	
Pulse Rate	F_{PR}		TEST=1 Note 8	-	10	-	PPS
			TEST=0	-	600	-	

CHARACTERISTICS	SYM	CKT	TEST CONDITION	LIMIT			UNIT
				MIN	TYP	MAX	
Inter Digit Pause	T_{IDP}		TEST=1	-	800		mS
			TEST=0	-	13.3		
Break/Make Ratio	B:M		B/M=1 Note 8	-	60:40	-	%
			B/M=0 Note 8	-	66.6: 33.3	-	%
Tone Duration	T_{TD}		Auto Dialing Note 8	-	100	-	mS
Inter Tone Pause	T_{ITP}		Auto Dialing Note 8	-	105	-	mS
Row Group Frequency	F1	C	ROW 1, NOTE 8	-	699	-	Hz
	F2		ROW2, NOTE 8	-	766	-	
	F3		ROW3, NOTE 8	-	848	-	
	F4		ROW4, NOTE 8	-	948	-	
Column 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}		17 & 18-22	$0.7V_{DD}$	-	V_{DD}	
Keypad Input Drive Current	I_{KD}	F	V_I=0V	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, 17	-	$\pm 10^{-5}$	±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 Multi-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=18PF F < ±200PPM

Note 9 : Referred to Pulse Mode Time Diagram

Note 10 : Referred to DTMF Mode Time Diagram

FUNCTION 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	
	Signal (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	600pps
		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. $\overline{\text{MUTE}}$

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. $\overline{\text{HKS}}$

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

E. $\overline{\text{PULSE OUT}}$

In DTMF mode, the pulse out keeps high level regardless of leyboard entry. In pulse mode, this output sends a chain of pulses to correspond the address keypad input, but keeps high level for * and # entry.

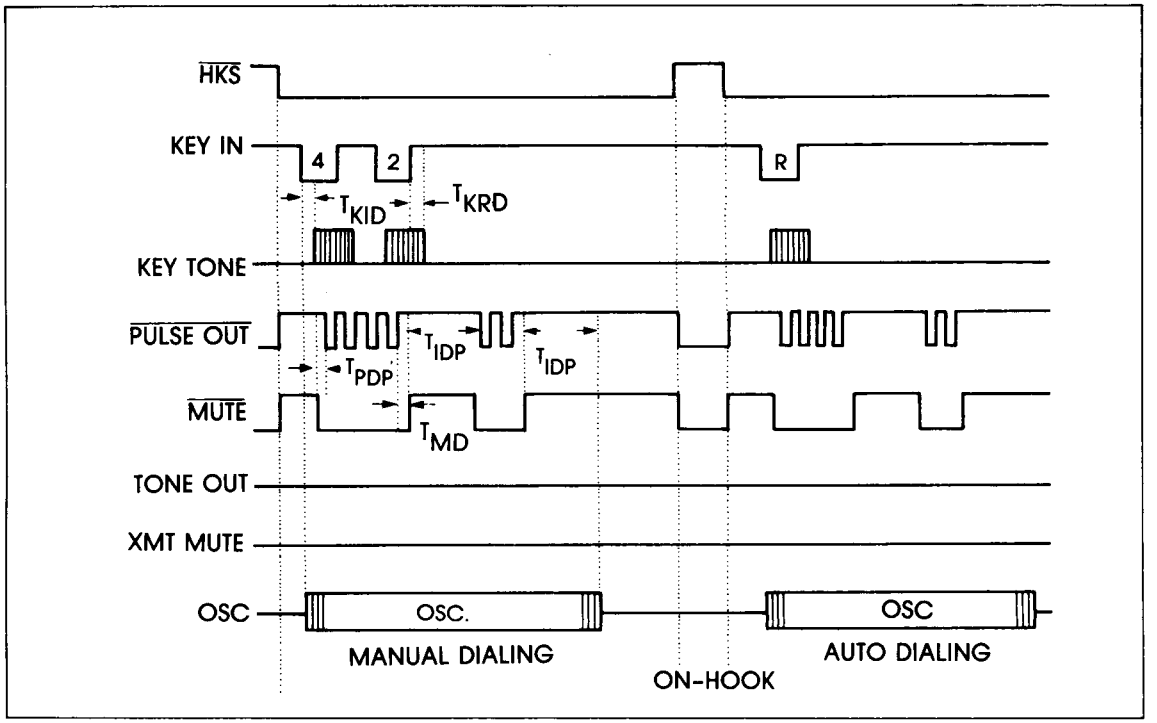


Figure 1 Pluse Mode Timing Diagram

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)

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 actuates 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 Application Circuit).

I. MODE

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

J. $\overline{\text{TEST}}$

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

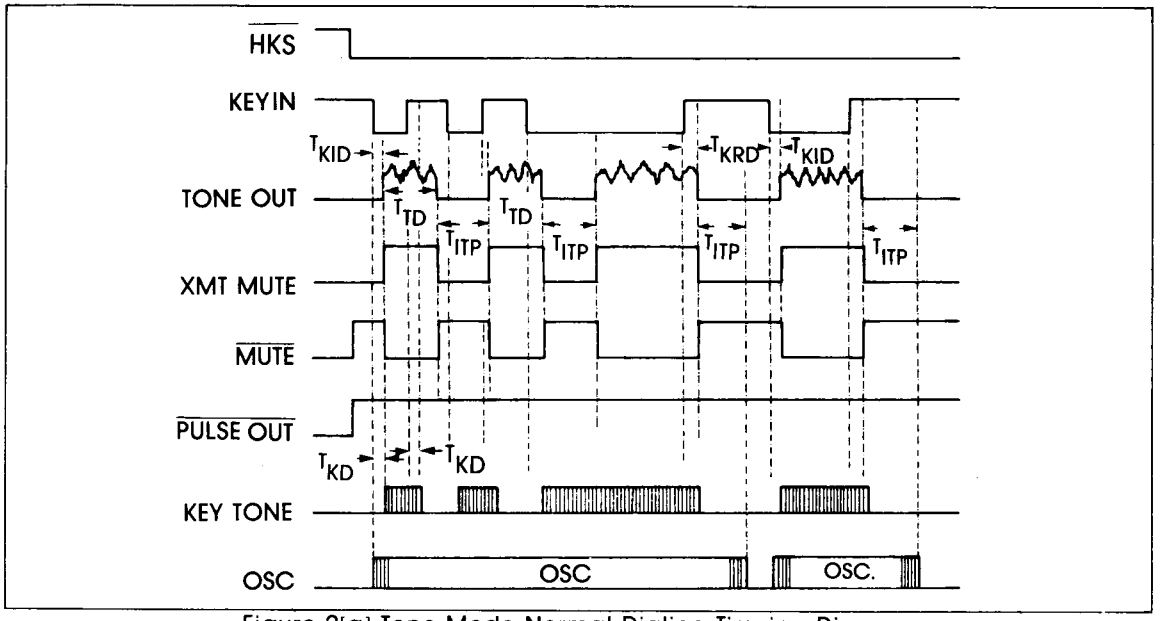


Figure 2[a] Tone Mode Normal Dialing Tim-ing Diagram

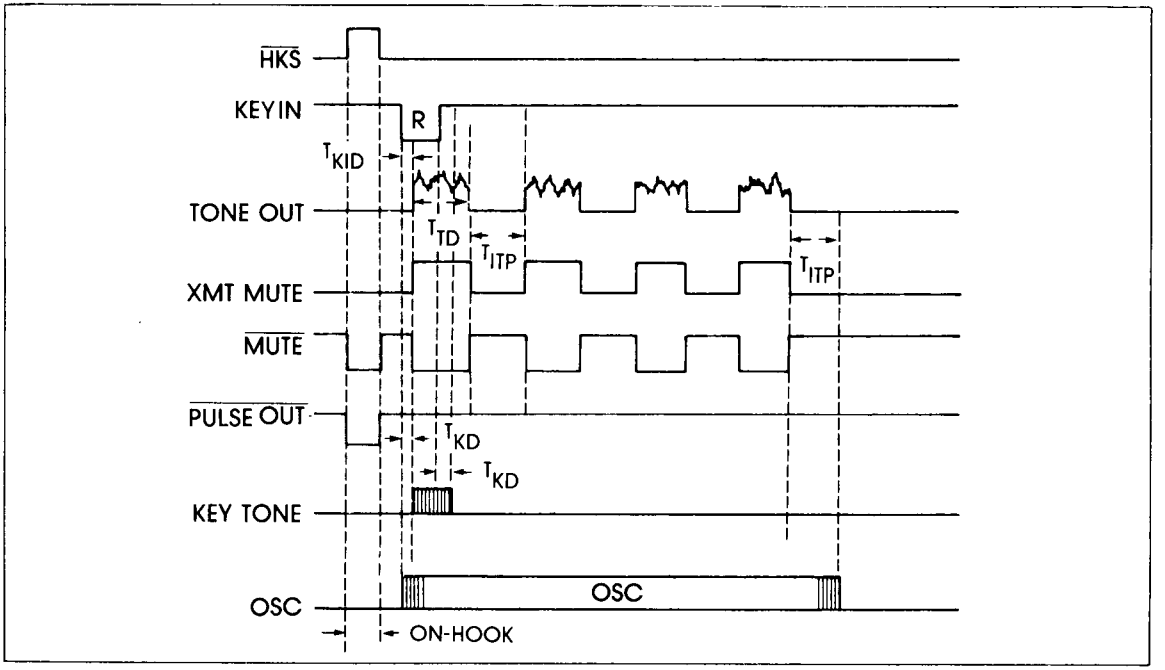


Figure 2[b] Tone Mode Redialing Timing Diagram

KEYBOARD OPERATIONS

Note: 1. All the keyboard operations should be under OFF-HOOK condition.
2. D1 ~ Dn: 0-9, *, #

A. NORMAL DIALING

[D1], [D2] ,..., Dn

B. REDIALING

[R], the last number will be dialed out automatically.

C. STORE

[S], [D1], [D2] ,..., [Dn], [S], [Ln] Ln: 0 ~ 9 Then, D1, D2, ... Dn will be stored in location Ln.

D. MEMORY DIALING

[A], [Ln], then the number stored in location [Ln] will be diales out automatically.

E. PAUSE KEY OPERATION

In some PABX or Long Distance Service, pause should be inserted in dialing sequence. The WE9143 provides stackable pause function (3.1 sec/Pause) which facillitates flexible applications.

a. Dialing with Pause Key
   1. [D1], [P], [D2] ,..., [DN]
      Then the number will be dialed out as following sequence; D1 , D2 , ... Dn; without pause.
   2. Redialing with Pause Key
      OFF-HOOK, [R], then the signal will be dialed out automatically D1, pause 3.1 sec., D2 , ...Dn.

b. Storing with Pause Key
   1. [S], [D1], [P], [D2] ,.. [Dn] [S] [Ln] then the number D1 , P , D2 , ... Dn will be stored in [Ln]
   2. Memory Dialing with Pause Key
      [A] [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. EMERGENCY DIALING

WE9143 provides three memories for storing emergency numbers such as fire, police and doctor.

a. Storing Emergency Numbers
   [S] [D1] [D2] ... [Dn] [S] [EMn] EMn:EM1-EM3
   Then the number D1, D2, ... Dn will be stored in EMn.

b. Emergency Dialing
   Push [EMn], the EMn will be dialed out in Pulse or Tone mode as selected.

G. PULSE TO TONE KEY OPERATION

The WE9143 provides one special function for long distance service company (such as MCI, SPRINT) access codes operations,

a. Dialing with Pulse to Tone Key [D1], [D2], ..., [Dn], [P-T], [D1′], [D2′] ,... [Dn′] D1, D2, ..., Dn, D1′, D2′, ... Dn′, without pause.

b. with Pulse to Tone Key
   OFF-HOOK, [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 only in the operation of ON-HOOK.

c. Storing the Long Distance Service Company Code to Memory [S], [D1], [D2], ..., [Dn], [P-T][D1'], [D1'], [D2'], ..., [Dn'], [S], [Ln] Then the number sequence will be stored in location Ln'.

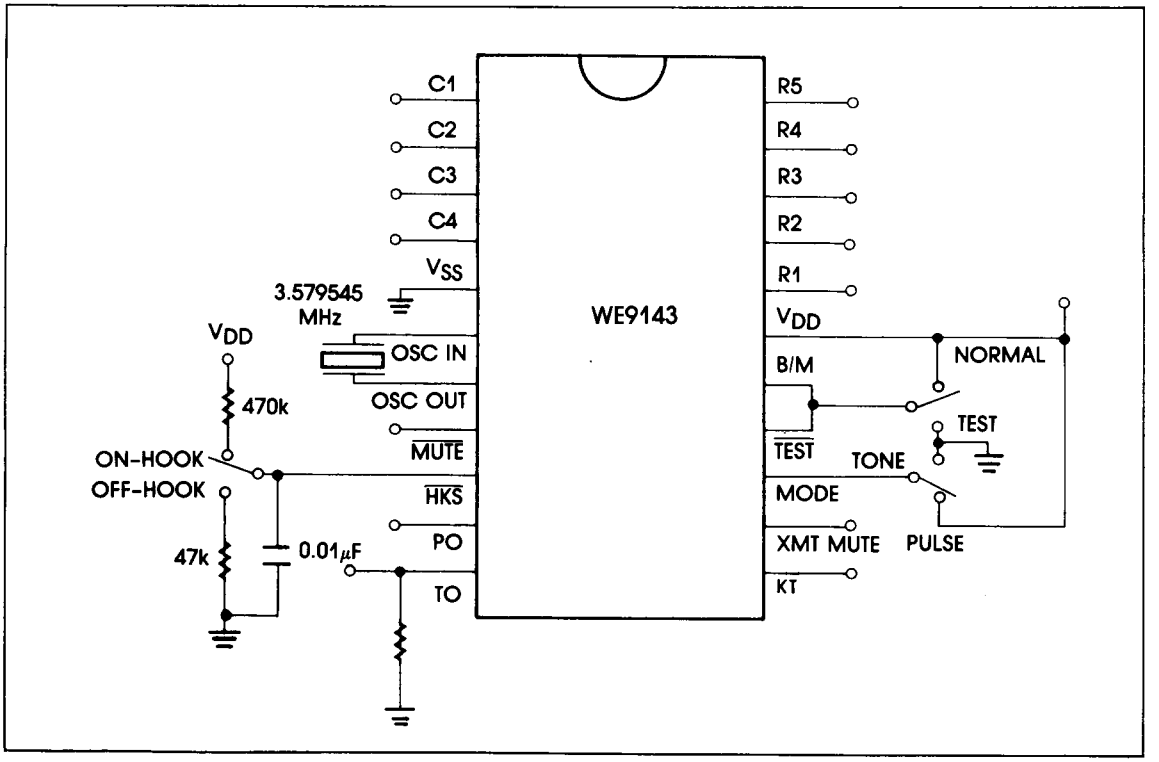
d. Memory Dialing with Pulse to Tone Key Select Pulse mode.
[A], [Ln] D1, D2,..., Dn, pause 3.1 sec., D1', D2', ..., Dn'

Note: 1. If in Tone mode, it will auto insert a pause at P-T position.
2. If the LDC codes are stored in EM1-EM3, the operation will

H. MIXED DIALING

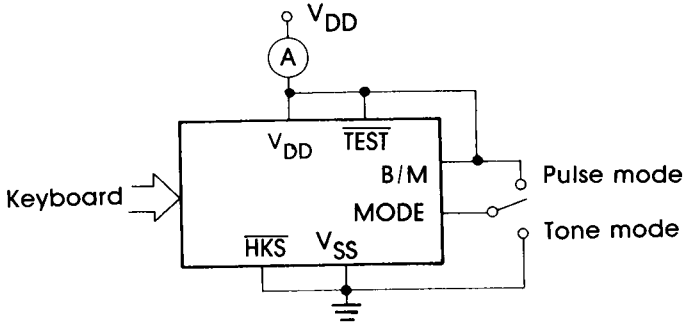
Mix-dialing is acceptable and has no limit on the dialing length of above listed items operation.

GENERAL TEST CIRCUIT

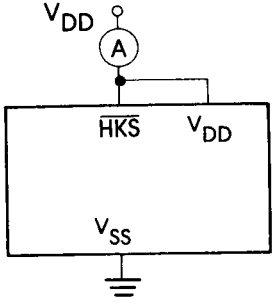


TEST CIRCUIT

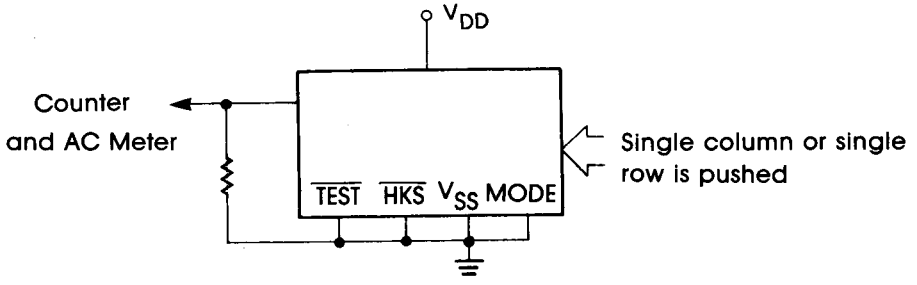
A.



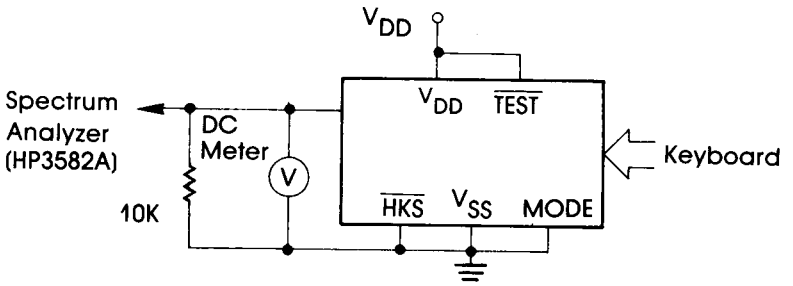
B.



C.



D.



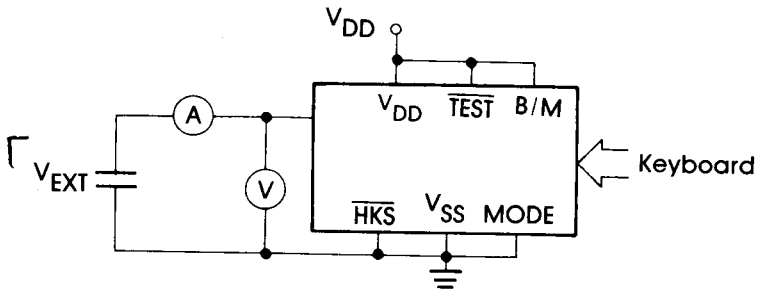
$$DIST_{db} = 20 \log \frac{\sqrt{[V_1]^2+[V_2]^2+....+[Vn]^2}}{\sqrt{[V_L]^2+[V_H]^2}}$$

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

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

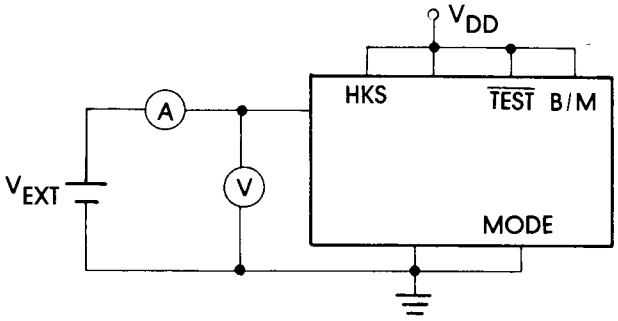
Note: Whether keyboard is pushed refer to the DTMF mode timing diagram.

E.

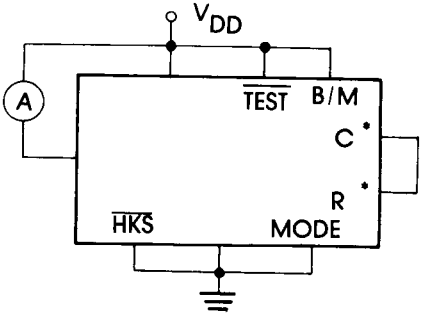


Note: Whether keyboard is pushed refer to the DTMF mode timing diagram.

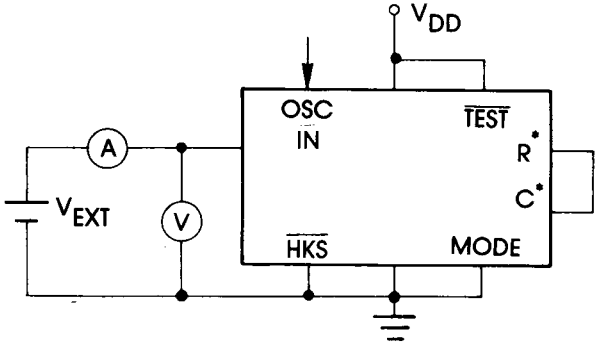
F



G



H



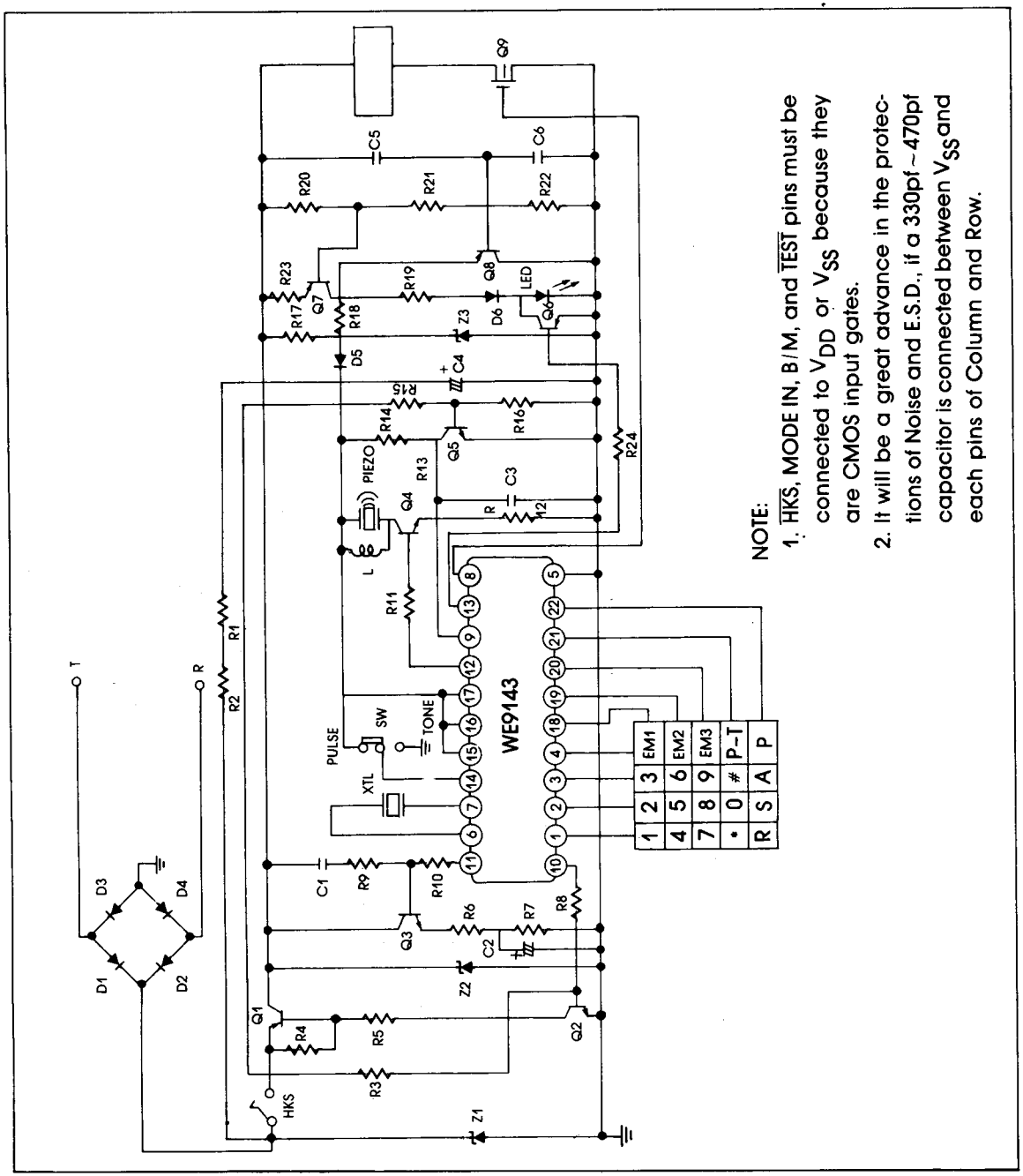
Note:

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 changes to high.
2. Test its current.

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

APPLICATION CIRCUIT DIAGRAM



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 siguals. 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 prodect the whole circuit from surge voltage and over-large signal on telephone line when off hook. Z3 limits the eoltage supplied to WE9143 .

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.

R1	22M	R18	110Ω	D5-D6	IN4148
R2	22M	R19	330Ω	Z1	IN5379
R3	910KΩ	R20	1.6Ω	Z2	1N4743
R4	33KΩ	R21	1.2KΩ	Z3	RD4.3EB3
R5	4.7KΩ	R22	5.1Ω	Q1	2SA640
R6	36Ω	R23	10Ω	Q2	2N5551
R7	62Ω	R24	33KΩ	Q3	FC8050
R8	10KΩ	C1	0.02μF	Q4 ~ Q6	2N9014
R9	100KΩ	C2	4.7μF/16V	Q7 ~ Q8	2N4403
R10	5.1KΩ	C3	0.5μF	Q9	AVN1106
R11	33KΩ	C4	100μF/16V	XTL	3.579545MHz
R12	1.2KΩ	C5	2.2μF/25V	ICI	WE9143
R13	10KΩ	C6	0.01μF		
R14	330KΩ	D1	1N4004		
R15	330KΩ	D2	1N4004		
R16	82KΩ	D3	1N4004		
R17	10KΩ	D4	1N4004		