



TONE/PULSE SWITCHABLE DIALER WITH REDIAL

GENERAL DESCRIPTION

The WE9140 series are TONE/PULSE switchable telephone dialers with the last number redial memory. The ICs are enabled either DTMF or pulse dialing by selecting mode pin or P-T key. For preventing the mistake of dialing number caused by rapid key-in and for easily component with μC , the ICs set the minimum tone duration=100ms in normal dialing.

P-T and PAUSE keys are provided for PBX and LDC operation. The P-T key which will change pulse mode into tone mode is convenient for user in LDC operation. Pause lasts 3.1 sec which will be auto accessed per PAUSE or P-T during redialing.

The ICs work in wide operation voltage range (2.0V ~ 5.5V for both pulse mode and tone mode), and consume very low retention current ($\leq 0.2\mu A$, at $V_{DD}=1.0V$ and $\overline{HKS}=1$).

FEATURES

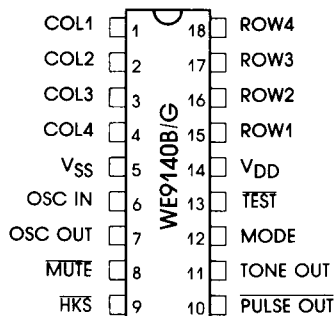
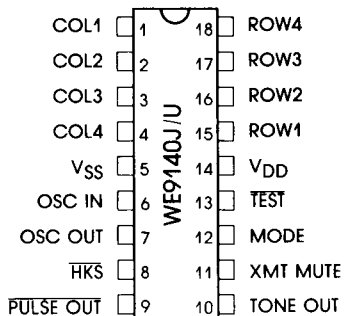
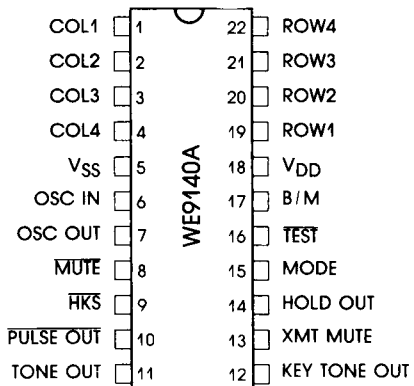
- Tone/pulse switchable.
- One 31 digits memory for the last number redial.
- Both key-in and key-released debounce are 20ms.
- Minimum tone duration=100ms for rapid key-in in normal dialing.
- PAUSE and P-T keys for PBX and LDC operation.
- Pause lasts 3.1 sec, per PAUSE or P-T during redialing.
- HOLD key for line held function.
- Internally power on reset.
- Electronic keypad input is available; low active.
- Use 3.579545 MHz crystal.
- Low operation voltage; 2.0V for both tone and pulse mode.
- Low memory retention current; $\leq 0.2\mu A$ at $V_{DD}=1.0V$, $\overline{HKS}=1$.
- Dual-in-line plastic package.
- The differences of the WE9140 series are listed in TABLE 1.

Table 1

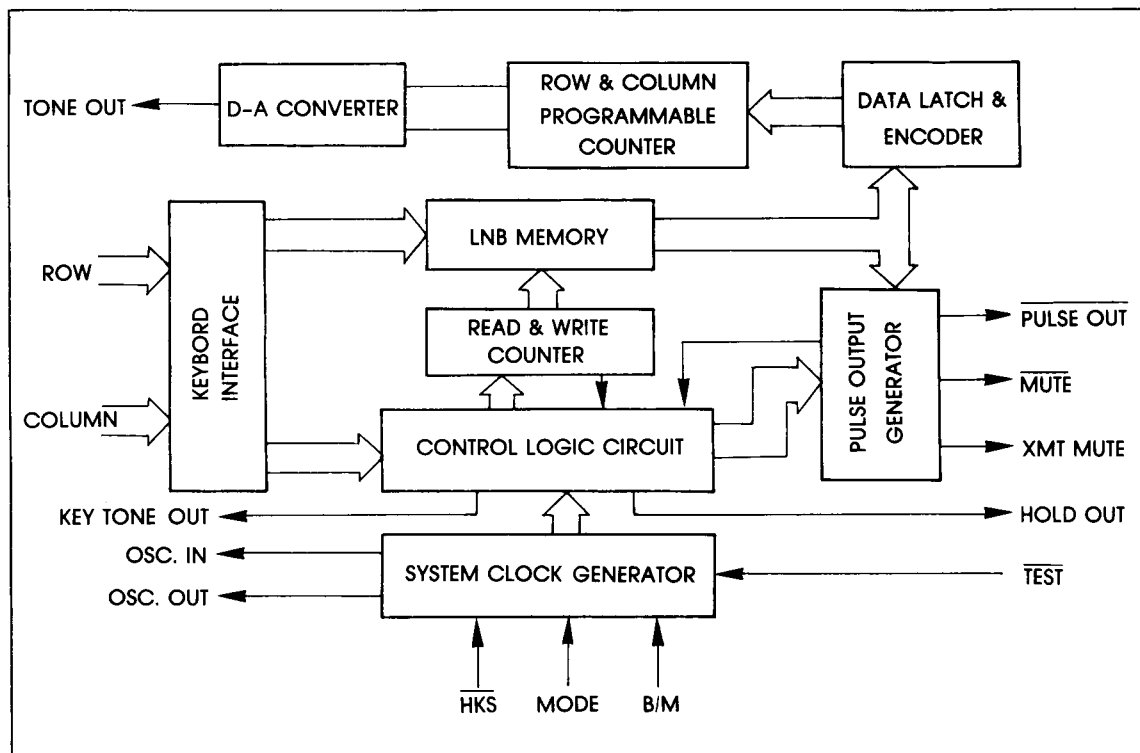
TYPE NO	MUTE	KEY TONE	XMT MUTE	B/M	PIN NUMBER
WE9140A	YES	YES	YES	PIN OPTION	22
WE9140B	YES	NO	NO	60:40	18
WE9140G	YES	NO	NO	66:33	18
WE9140J	NO	NO	YES	60:40	18
WE9140U	NO	NO	YES	66:33	18

TONE/PULSE DIALER

PIN CONFIGURATION



BLOCK DIAGRAM



KEYBOARD SCHEME

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

(Frequency Unit: Hz)

P-T : Pulse to Tone Switch

H : Hold, WE9140A only. (For the other type, this key is empty).

P : Pause

R : Redial

TONE/PULSE DIALER

PIN/FUNCTIONAL DESCRIPTION

A. ROW-COLUMN:

The keypads inputs compatible with the standard 2 of 8 keyboard. The keypad debounce method will be acceptable only if it lasts longer than 20ms, and the next key-in will be unacceptable unless the key has been released longer than 20ms. In normal operation, any single button is pushed to produce dual tone, pulses, or function. Activation of two or more buttons

will result no response, except in test mode ($\overline{\text{TEST}} = 0$). TABLE 2 illustrates the address keypads function in detail.

B. OSC IN OSC OUT

A built-in inverter provides oscillation with a 3.579545MHz T.V. color-burst crystal. It will be disable when there is no keypad entry.

Table 2 Address Keypads Truth Table

		ACTIVE LOW INPUTS		OUTPUT TONE OUT: PULSE OUT
		ROW	COLUMN	
TONE MODE (MODE=0)	NORMAL ($\overline{\text{TEST}} = 1$)	One	One	Dual Tone
		Two or More	One	No Action
		One	Two or More	
		Two or More	Two or More	
	TEST ($\overline{\text{TEST}} = 0$)	One	One	Dual Tone
		Two or More	One	Column Tone
		One	Two or More	Row Tone
		Two or More	Two or More	No Action
PULSE MODE (MODE=1)	NORMAL ($\overline{\text{TEST}} = 1$)	One	One	10 PPS
		Two or More	One	No Action
		One	Two or More	
		Two or More	Two or More	
	TEST ($\overline{\text{TEST}} = 0$)	One	One	600 PPS
		Two or More	One	No Action
		One	Two or More	
		Two or More	Two or More	

C. $\overline{\text{MUTE}}$

The mute output is a CMOS inverter that is pulled high normally, but pulled low in the transmitting period of dialing.

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

The HOOK SWITCH input is used to detect the state of handset. In ON-HOOK state the input must be pulled high in order to disable the dialing operation and decrease the consumption of power. When OFF-HOOK, the input must be pulled low.

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

This pin is an open-drain NMOS transistor output. In OFF-HOOK state, this NMOS transistor keeps in ON-state only in break duration, but keeps in OFF-state in make or normal duration, in order to send the pulses train of the address codes in pulse mode.(See Figure 1).

F. $\overline{\text{TONE OUT}}$

This pin is used to output DTMF address code. During pulse mode, it keeps in low state. In tone mode, it will output dual or single tone. (See TABLE 2) In normal dialing, the tone duration depends on key-in duration. 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 is pressed. In auto-dialing, the tone duration and inter-tone-pause are internally set to 100ms and 106ms respectively.(See Figure 2-(a),(b)).

G. $\overline{\text{KEYTONE OUT}}$

This pin is a conventional CMOS inverter output. Both tone and pulse mode, after any valid key-in this pin outputs 1.2K Hz square wave.

H. $\overline{\text{XMT MUTE}}$

This pin is a CMOS inverter output which will be pulled high only in tone duration, and keeps low in the other state. It can be used to mute the speech circuit in tone mode or control a LED to indicate the tone duration.

I. $\overline{\text{HOLD OUT}}$ (WE9140A only)

The hold out is a conventional flip-flop. It is reset to low level by picking up the handset, and set to high level responding to push the "H" button, and go down if push the "H" button again. The "H" key is disabled and reset to low level when dialing.

J. $\overline{\text{B/M}}$

In pulse mode, when B/M = HIGH the BREAK/MAKE ratio is 3:2, and B/M=LOW the BREAK/MAKE ratio is 2:1.

K. $\overline{\text{MODE}}$

The input state of this pin will set the initial operation mode, high for pulse mode, low for tone mode. Note: The P→T key can change the operating mode into tone mode, after that if we want to reset the operating mode to pulse mode, the only way is ON-HOOK and let MODE=HIGH.

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

In normal operation, this pin always pulled high. When it is pulled LOW, this chip is set in testing mode(See TABLE 2).

TIMING WAVEFORM

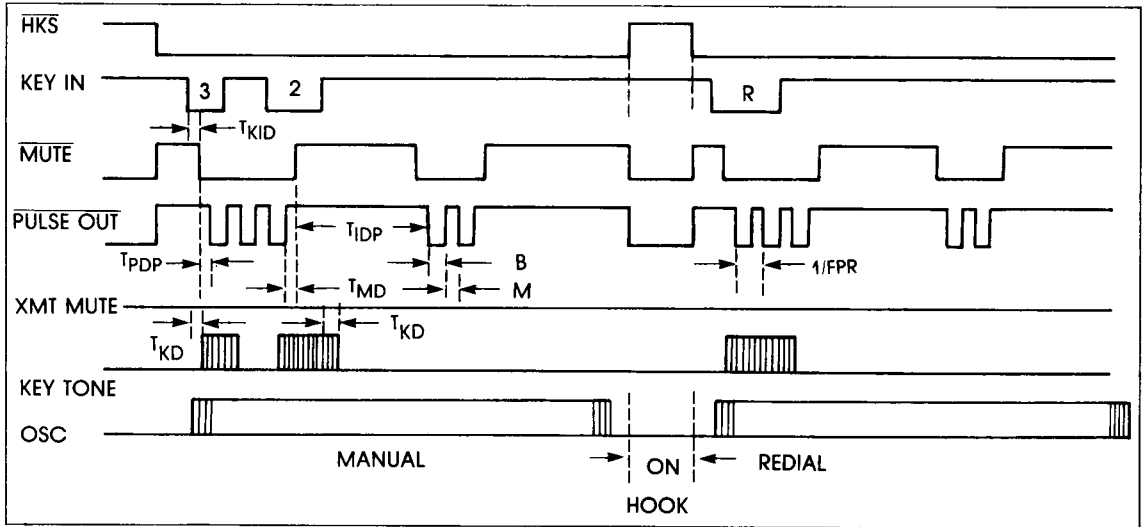


Figure 1. Pulse Mode Timing Diagram

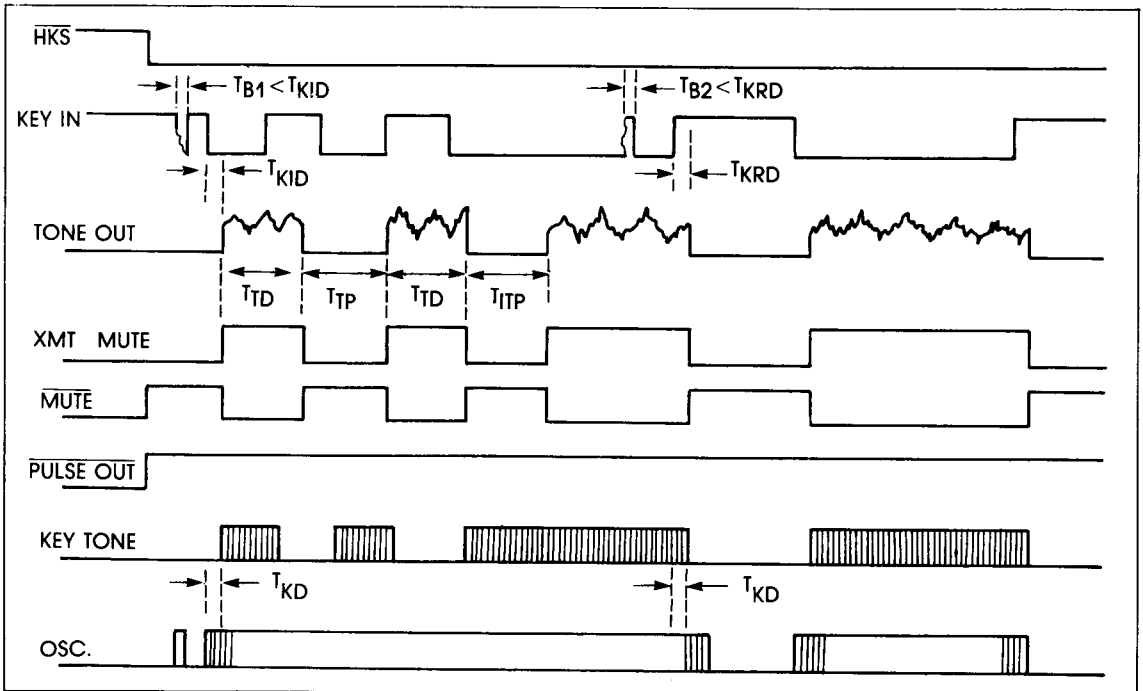


Figure 2 (a). Tone Mode Normal Dialing Timing Diagram

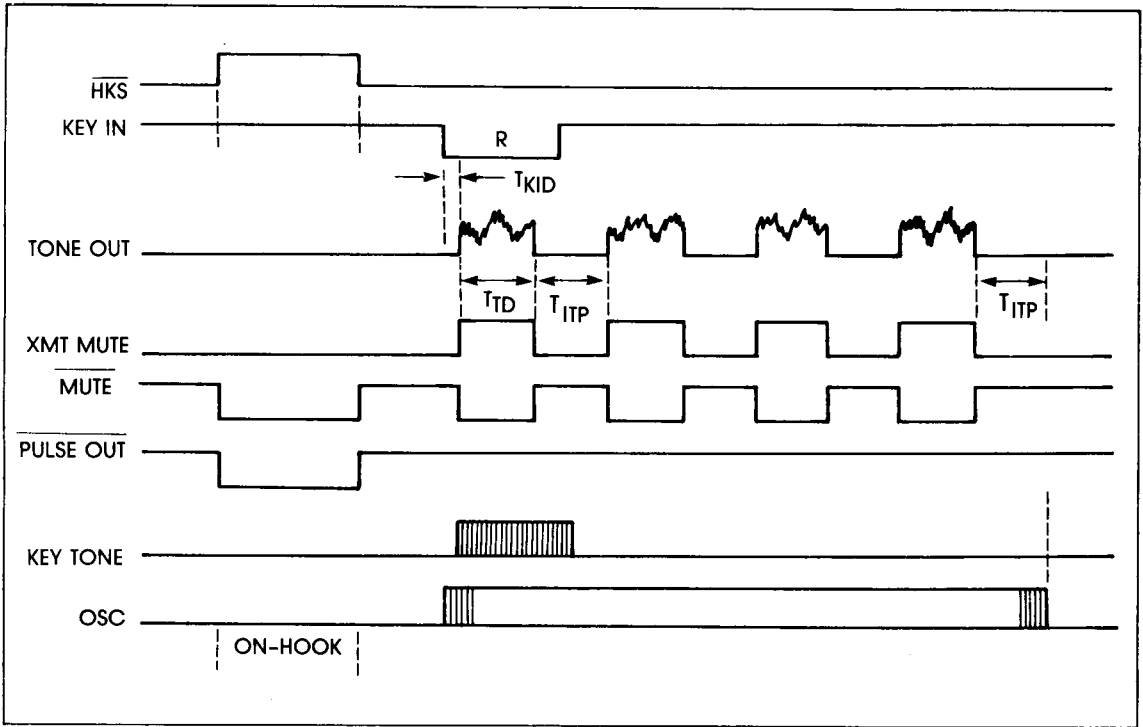


Figure 2(b).Tone Mode Redialing Timing Diagram

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. REDIAL

After normal dialing, $Dn \leq 31$; if busy, after ON-HOOK, Come OFF-HOOK, push **[R]** the last number will be dialed out automatically.

C. MIX-DIALING

[REDIAL] + **[MANUAL DIALING]** is allowable.

D. PAUSE AND PULSE TO TONE KEYS OPERAITON

In PABX or LDC service, both Pulse and Tone operation should inserted in dialing sequence and different dialing mode. Only in Redial, Pause and Pulse to Tone operation will auto insert 3.1 sec pause time.

(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 as following sequence: D1, D2, ..., Dn; without pause.

(b) Redialing with Pause

In Redial operation, the signal will be dialed out automatically as following sequence: D1, pause 3.1 sec., D2, ..., Dn.

(c) Dialing with Pulse to Tone key

Push **[D1]**, **[D2]**, ..., **[Dn]**, **[P-T]**, **[D1']**, **[D2']**, ..., **[Dn']**

1. If the switch is in pulse mode, then output D1, D2, ..., Dn, D1', D2', ..., Dn'; without pause

D1, D2, Dn = Pulse mode

D1', D2', Dn' = Tone mode

2. If the mode switch is set in Tone mode, then the output signal will be: D1, D2, ..., Dn, D1', D2', ..., Dn'; without pause

D1, D2, Dn = Tone mode

D1', D2', Dn' = Tone mode

(d) Redialing with Pulse to Tone key

After above operation, but busy, the excute redial operation the signal will be dialed out automatically as same sequence of dialing with Pulse to Tone key, but has a 3.1 sec pause during changing mode.

E. HOLD LINE (WE9140A only)

It provide Hold for music applicaiton (See application note).

ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYM	RATING	UNIT
DC Supply Voltage	V _{DD}	6.0	V
Input Voltage Range	V _{IN}	-0.5 ~ V _{DD} +0.5	V
Power Dissipation Per Package	P _D	500 (for T _A = -25 ~ +60°C)	mW
Operating Temperature	T _A	-25 ~ +85	°C
Storage Temperature	T _{STG}	-65 ~ +150	°C

D.C. CHARACTERISTICS

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

PARAMETER	SYM	TEST CKT	TEST CONDITIONS	LIMIT			UNIT
				MIN	TYP	MAX	
Operating Voltage	V _{DD}		Tone/Pulse	2.0	—	5.5	V
			Memory	1.0	—	5.5	
Operating Current	I _{OP}	A	Keypad Entry and All output Unload	Tone	—	0.6	mA
				Pulse	—	0.2	
Standby Current	I _S	A	No keypad Entry, and All Output Unload	—	0.1	5	μA
Memory Retention Current	I _{MR}	A	H _{KS} = 1, V _{DD} = 1.0V	—	0.01	0.2	μA
Tone Output	V _{TO}	C	Row Group, R _L = 10KΩ	120	150	180	mV
Pre-Empasis		D	Column Group Row Group	1	2	3	dB
DTMF Distortion	THD	D	R _L = 10KΩ, Note 2	—	-30	-23	dB

(Continued)

PARAMETER		SYM	TEST CKT	TEST CONDITIONS	LIMITS			UNIT
					MIN	TYPE	MAX	
Tone Output Load Impedance		R _L		THD ≤ -23dB	10	—	—	KΩ
Tone Output DC Level		V _{TDC}	D	Keypad Entry, V _{DD} = 2.0~5.5V	0.5	—	0.6	V _{DD}
Tone Output Sink Current		I _{TL}	E	No Keypad Entry V _{TO} =0.5V	0.2	—	—	mA
Pulse Output Input Current	Leakage	I _{PH}	E	V _{PI} =5.0V	—	—	0.1	μA
				V _{PI} =12.0V	—	—	1.0	
Mute Output Current	Sink	I _{PL}	F	V _{PI} =0.5V	1.0	—	—	mA
	Drive	I _{MH}	E	V _{MO} =2.0V	0.5	—	—	mA
Sink	I _{ML}	V _{MO} =0.5V		2.0	—	—		
XMT Mute Output Current	Drive	I _{XMH}	E	V _{XMO} =2.0V	0.5	—	—	mA
	Sink	I _{XML}		V _{XMO} =0.5V	0.5	—	—	
Keystone Output Current	Drive	I _{KIM}	E	V _{KTO} =2.0V	0.5	—	—	mA
	Sink	I _{KTL}		V _{KTO} =0.5V	0.5	—	—	
Hold Output Current	Drive	I _{HH}	E	V _{HO} =2.0V	0.5	—	—	mA
	Sink	I _{HL}		V _{HO} =0.5V	0.5	—	—	
Keypad Input	Drive	I _{KH}	G	V _{KI} =0V	4	10	20	μA
	Sink	I _{KL}	E,H	V _{KI} =2.5V	200	400	—	
Input Voltage	Low	V _{IL}		Pin:1-6, 11, 15, 16, 17, 19-24	V _{SS}	—	0.3	V _{DD}
	High	V _{IH}			0.7	—	1.0	
Control Pin Input Leakage Current		I _{IN}		Pin:11, 15, 16, 17	—	±10 ⁵	±0.1	μA

A.C. CHARACTERISTICS

PARAMETER	SYM	TEST CKT	TEST CONDITION	LIMIT			UNIT	
				MIN	TYP	MAX		
Key-in Debounce	T _{KID}		$\overline{\text{TEST}}=1$	—	20	±	mS	
Key-released Debounce	T _{KRD}		$\overline{\text{TEST}}=1$	—	20	—	mS	
Pulse Mute Delay	T _{MD}		$\overline{\text{TEST}}=1$	B:M=60:40	—	40	—	mS
				B:M=66:33	—	33.3	—	
Pre-Digit Pause	T _{PDP}		$\overline{\text{TEST}}=1$	B:M=60:40	—	40	—	mS
				B:M=66:33	—	33.3	—	
Break/Make Ratio	B:M		B/M=1 or WE9140B/J	—	60:40	—		
			B/M=0 or WE9140G/U	—	66:33	—		
Inter-Digit Pause	T _{IDP}		$\overline{\text{TEST}}=1$	—	800	—	mS	
			$\overline{\text{TEST}}=0$	—	13.6	—		
Pulse Rate	F _{PR}		$\overline{\text{TEST}}=1$	—	10	—	pps	
			$\overline{\text{TEST}}=0$	—	600	—		
Keytone Frequency	F _{KT}		$\overline{\text{TEST}}=1$	—	1200	—	Hz	
Keytone Delay	T _{KD}		$\overline{\text{TEST}}=1$	—	20	—	mS	
Tone Duration	T _{TD}			100		—	mS	
Inter-Tone Pause	T _{IDP}			—	106	—	mS	
Pause Time	T _p		Redial	—	3.1		Sec	
Row Group Frequency	f1	C	Note 1	697	699	701	Hz	
	f2			764	766	768		
	f3			846	848	850		
	f4			946	948	950		
Column Group Frequency	f5	C	Note 1	1213	1216	1219	Hz	
	f6			1329	1332	1335		
	f7			1469	1472	1475		

Notes:

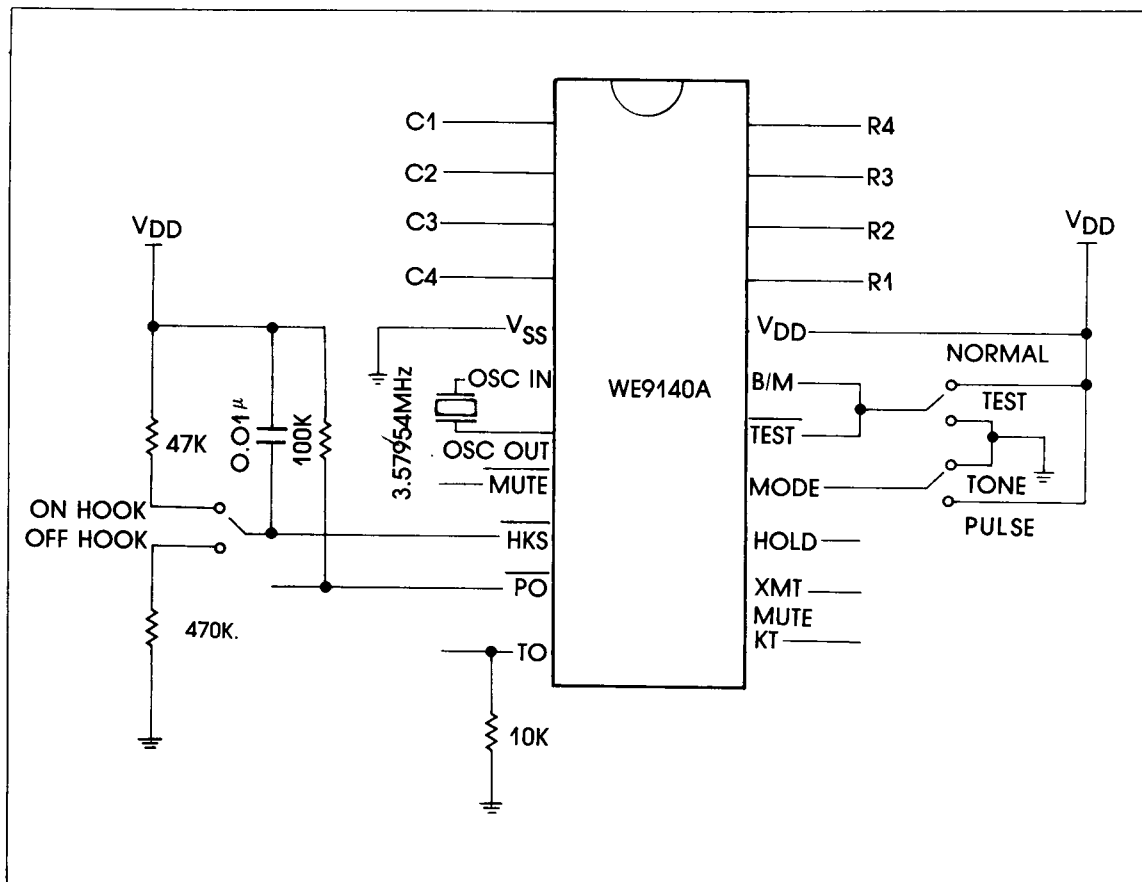
1. Crystal parameters defined as $R_S \leq 100\Omega$, $L_m = 96\text{mH}$, $C_m = 0.25\text{PF}$, $c_h = 5\text{PF}$, $f = 3.579545\text{MHz}$ & $C_L = 18\text{PF}$, $\Delta F < \pm 200\text{PPM}$.
2. Dual Tone multi-frequency distortion is measured in terms of total out-of-band power related to sum of row and column fundamental power.

TONE/PULSE
DIALER

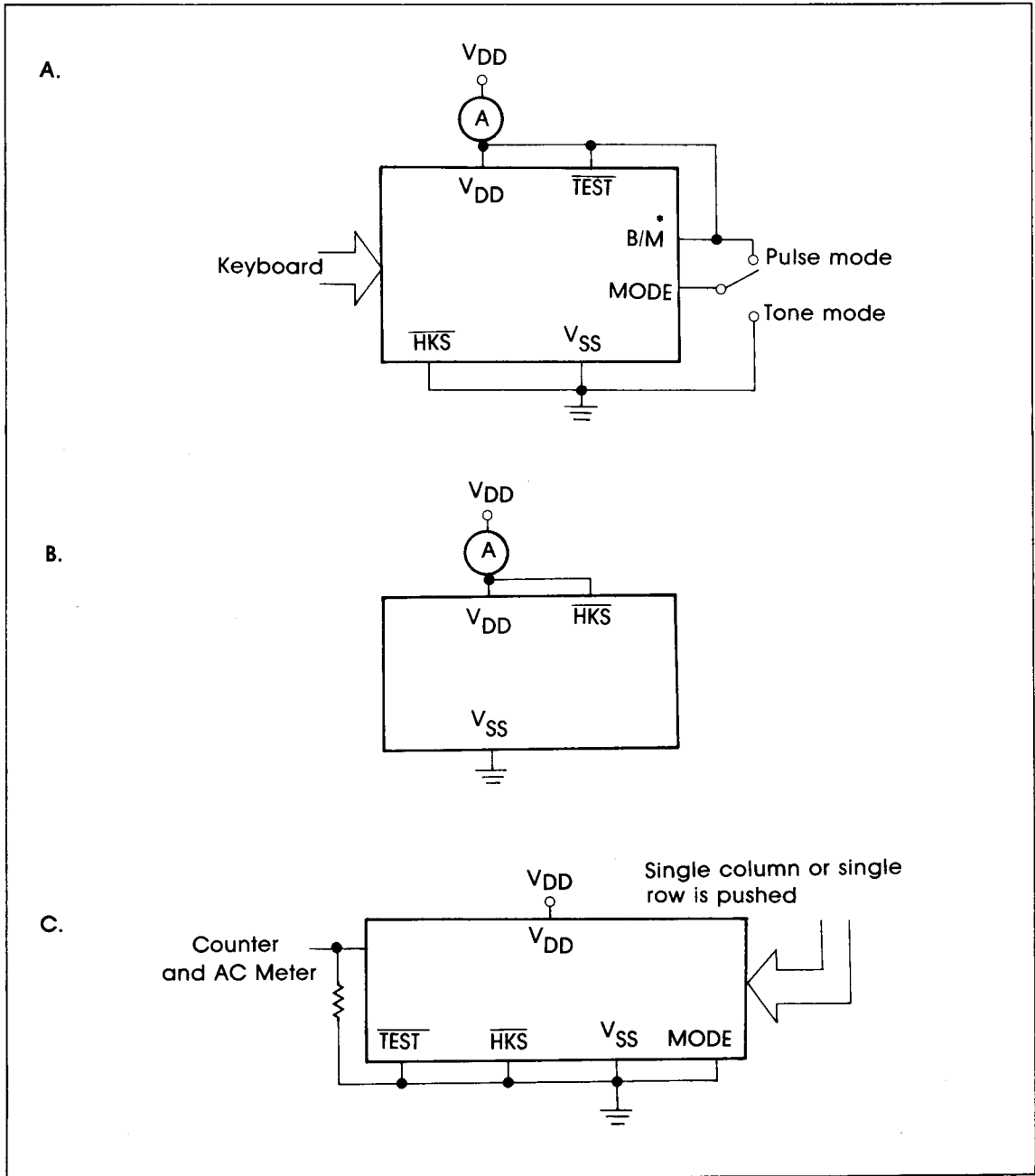
COMPARISON OF SPECIFIED VS. ACTUAL TONE FREQUENCIES

ACTIVE INPUT	OUTPUT FREQUENCY Hz		ERROR %
	SPECIFIED	ACTUAL	
ROW 1	697	699	+0.29
ROW 2	770	766	-0.52
ROW 3	852	848	-0.47
ROW 4	941	948	+0.74
COLUMN 1	1209	1216	+0.58
COLUMN 2	1339	1332	-0.52
COLUMN 3	1477	1472	-0.34

GENERAL TEST CIRCUIT



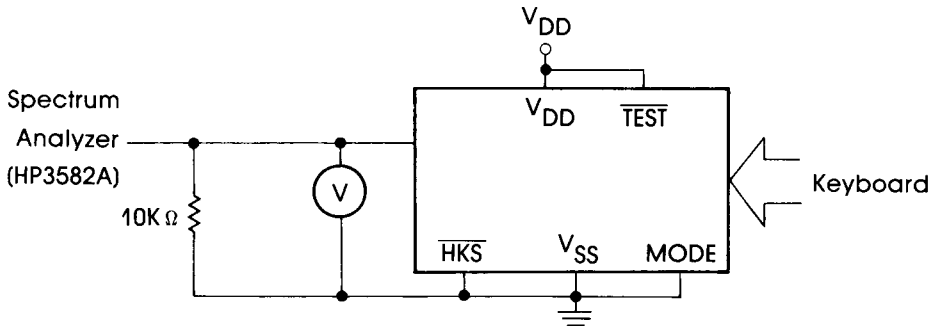
TEST CIRCUIT



TONE/PULSE
DIALER

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D.



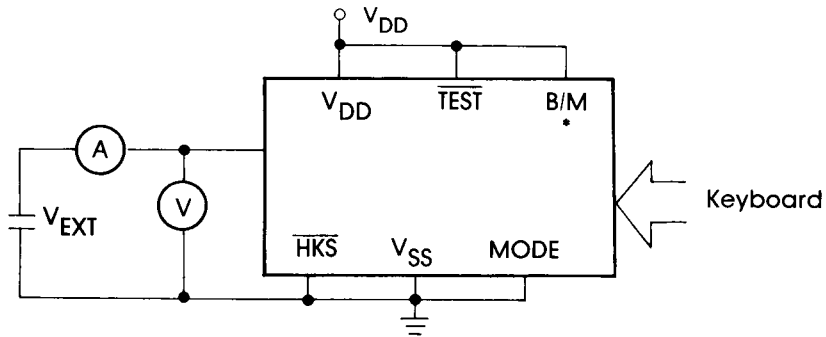
$$DISTdb = 20 \log \frac{\sqrt{(V_1)^2 + (V_2)^2 + \dots + (V_n)^2}}{\sqrt{(V_L)^2 + (V_H)^2}}$$

* V_1, \dots, V_n 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.

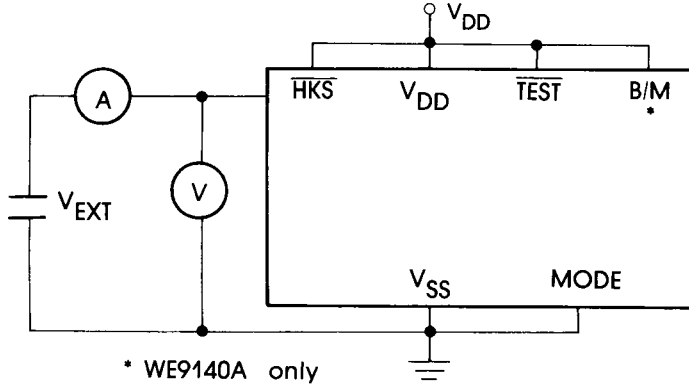
E.



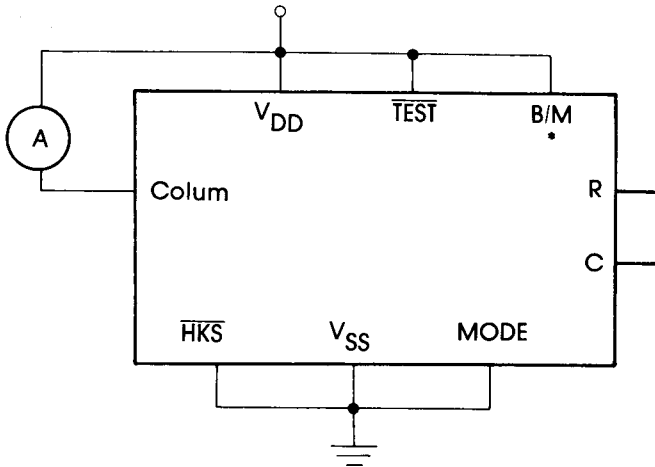
Note: Whether keyboard is pushed refer to the DTMF mode timing diagram.

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F.



G.



Notes:

R*: anyone row of R1-R4.

C*: anyone column opt C1-C4

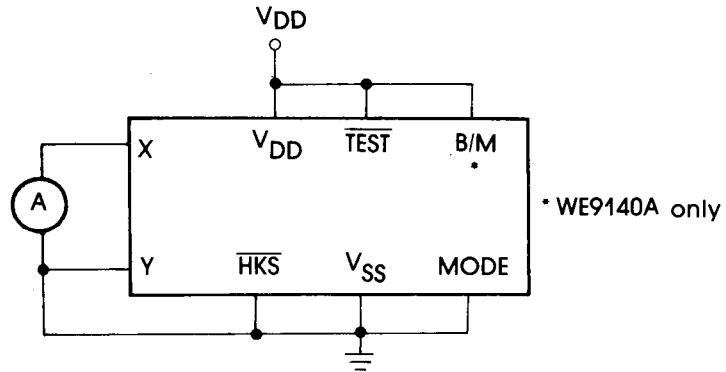
$I_{\text{sink}} = I / (1 - \text{Duty Cycle})$

I is the net DC current measured from ampere meter.

*: WE9140A only.

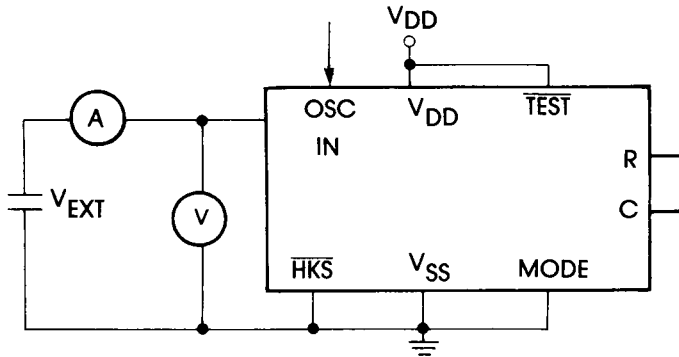
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H



Notes:

1. When column drive current is tested, the X is column and Y is row. When row drive current is measured, they are changed mutually.
2. $I_{\text{Drive}} = I / \text{Duty Cycle}$; I is the net DC current measured from ampere meter.

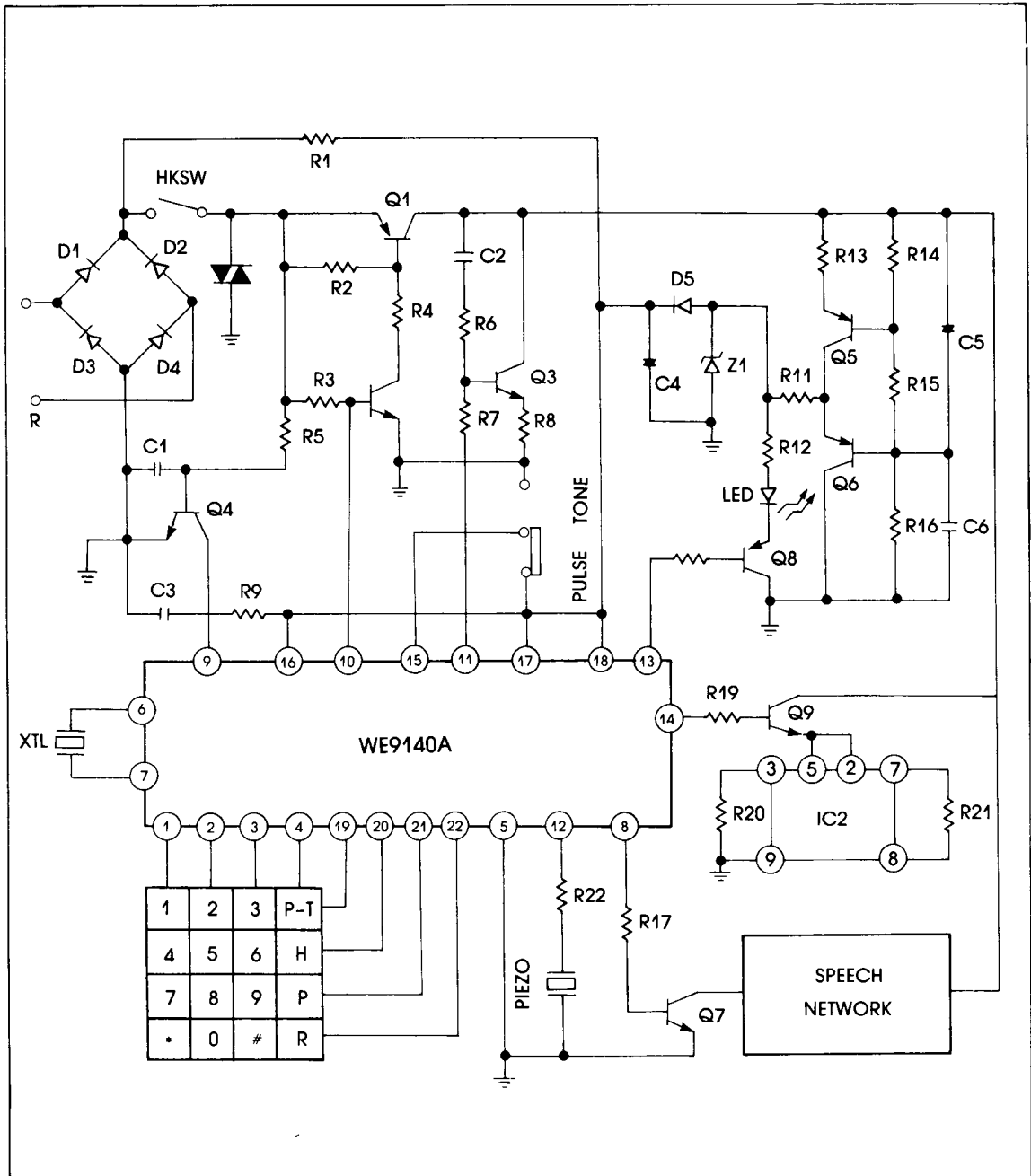


Procedure:

1. Provide clocks until output changes to high.
2. Test its current.

Note: TEST pin can be combined with VSS in order to speed up testing.

APPLICATION CIRCUIT DIAGRAM



TONE/PULSE DIALER

COMPONENT SELECTION TABLE

R1	20M Ω	R17	10K Ω	D5	1N4148
R2	33K Ω	R18	4.7K Ω	TNR	TNR680K
R3	220K Ω	R19	10K Ω	Z1	1N4731
R4	3.9K Ω	R20	1.5K Ω	Q1	MPSA92
R5	1M Ω	R21	68K Ω	Q2	2N5551
R6	100K Ω	R22	1.5K Ω	Q3	2N5551
R7	10K Ω	C1	0.1 μ F	Q4	2N9014
R8	68 Ω	C2	0.01 μ F	Q5	2N4403
R9	470K Ω	C3	0.1 μ F	Q6	2N4403
R10	22M Ω	C4	100 μ F / 10V	Q7	MPSA13
R11	100 Ω	C5	2.2 μ F / 10V	Q8	2N4405
R12	100 Ω	C6	0.01 μ F	Q9	2N9014
R12b	180 Ω	D1	1N4002	Q10	2N9014
R13	10 Ω	D2	1N4002	XTL	3.579545MHz
R14	1.5K Ω	D3	1N4002	IC1	WE9140
R15	1.2 Ω	D4	1N4002	IC2	WE285
R16	4.7 Ω	D5	1N4148		