# 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 $\mu$C, 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).

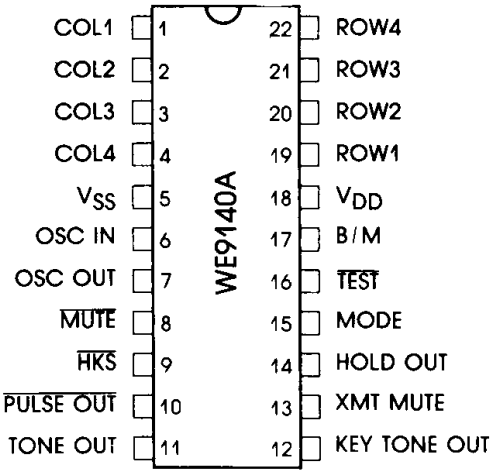
## FEATURES

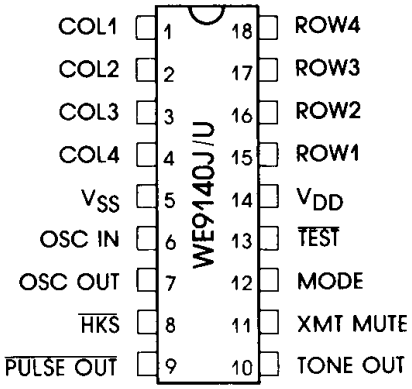
- Tone/pulse switchable.
- One 31 digits memory for the last number redial.
- Both key-in and key-released debounce are 20ms.
- Minimum tone duration=100ms for rapid key-in in normal dialing.
- PAUSE and P→T keys for PBX and LDC operation.
- Pause lasts 3.1 sec, per PAUSE or P→T during redialing.
- HOLD 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.

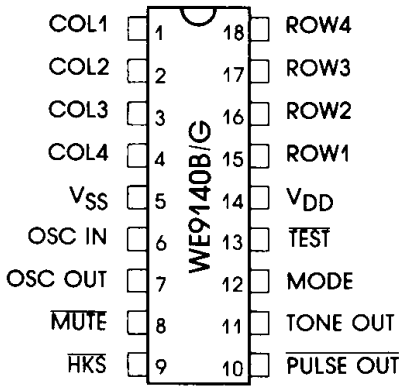
Table 1

| TYPE NO | $\overline{MUTE}$ | 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 |

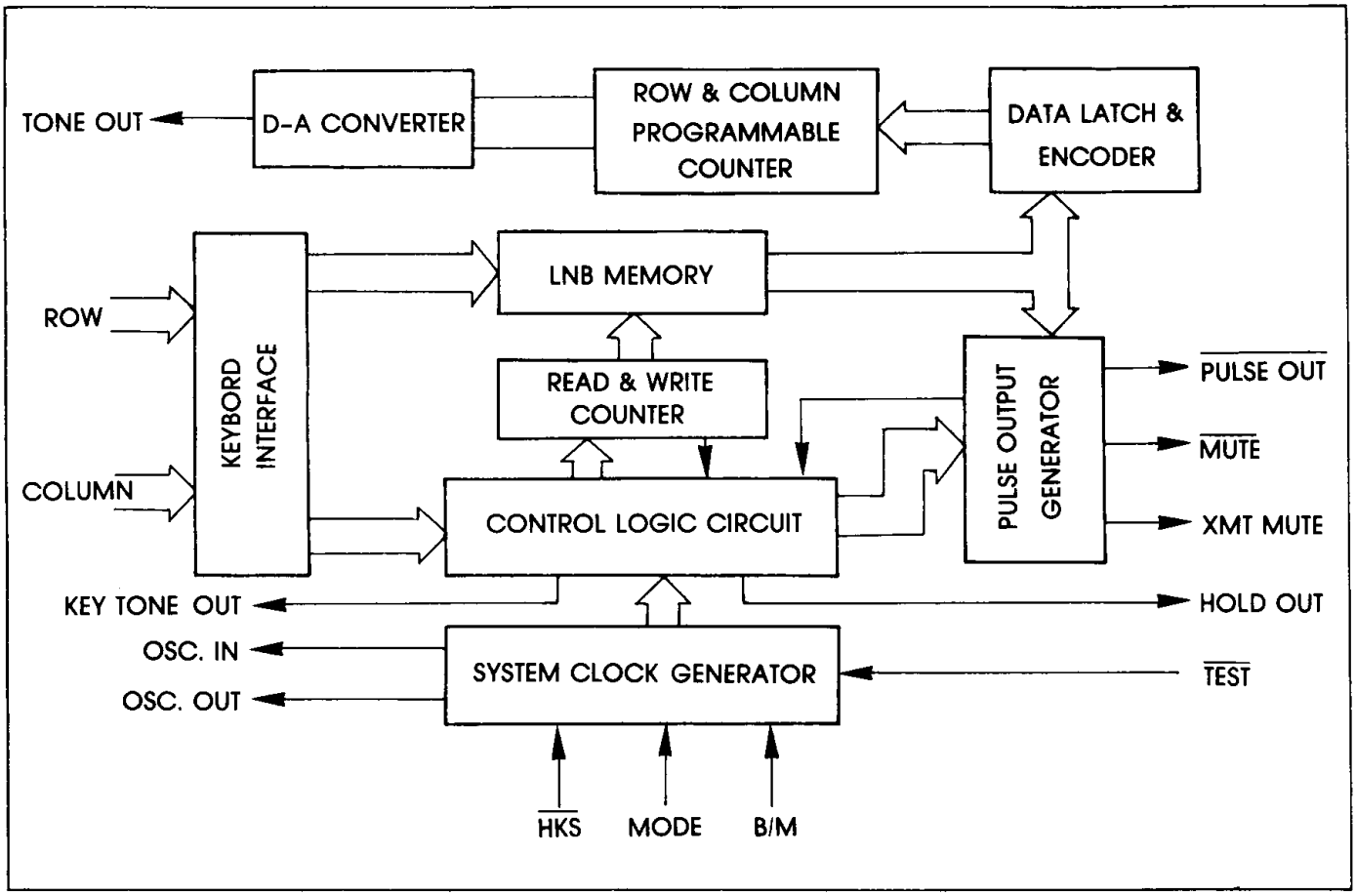
## PIN CONFIGURATION



## 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

## 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 ($\overline{TEST}$ = 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 $\overline{TONE}$ OUT: $\overline{PULSE}$ $\overline{OUT}$ |
|---|---|---|---|---|
| | | ROW | COLUMN | |
| TONE MODE (MODE=0) | NORMAL ($\overline{TEST}$=1) | One | One | Dual Tone |
| | | Two or More | One | No Action |
| | | One | Two or More | |
| | | Two or More | Two or More | |
| | TEST ($\overline{TEST}$=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 ($\overline{TEST}$=1) | One | One | 10 PPS |
| | | Two or More | One | No Action |
| | | One | Two or More | |
| | | Two or More | Two or More | |
| | TEST ($\overline{TEST}$=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. TONE OUT

This pin is used to output DTMF adress 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 duation. 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. 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. XMT MUTE

This pin is a CMOS inveter 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. 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. 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. 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

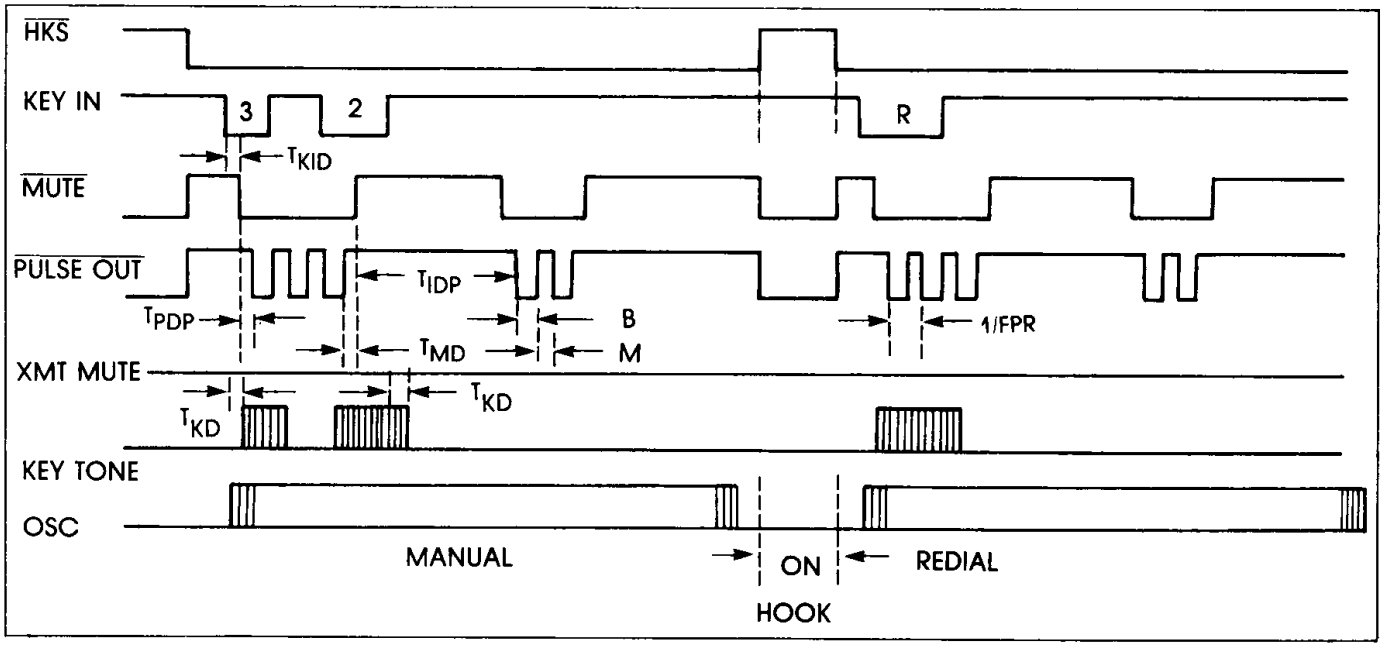



Figure 1. Pulse Mode Timing Diagram

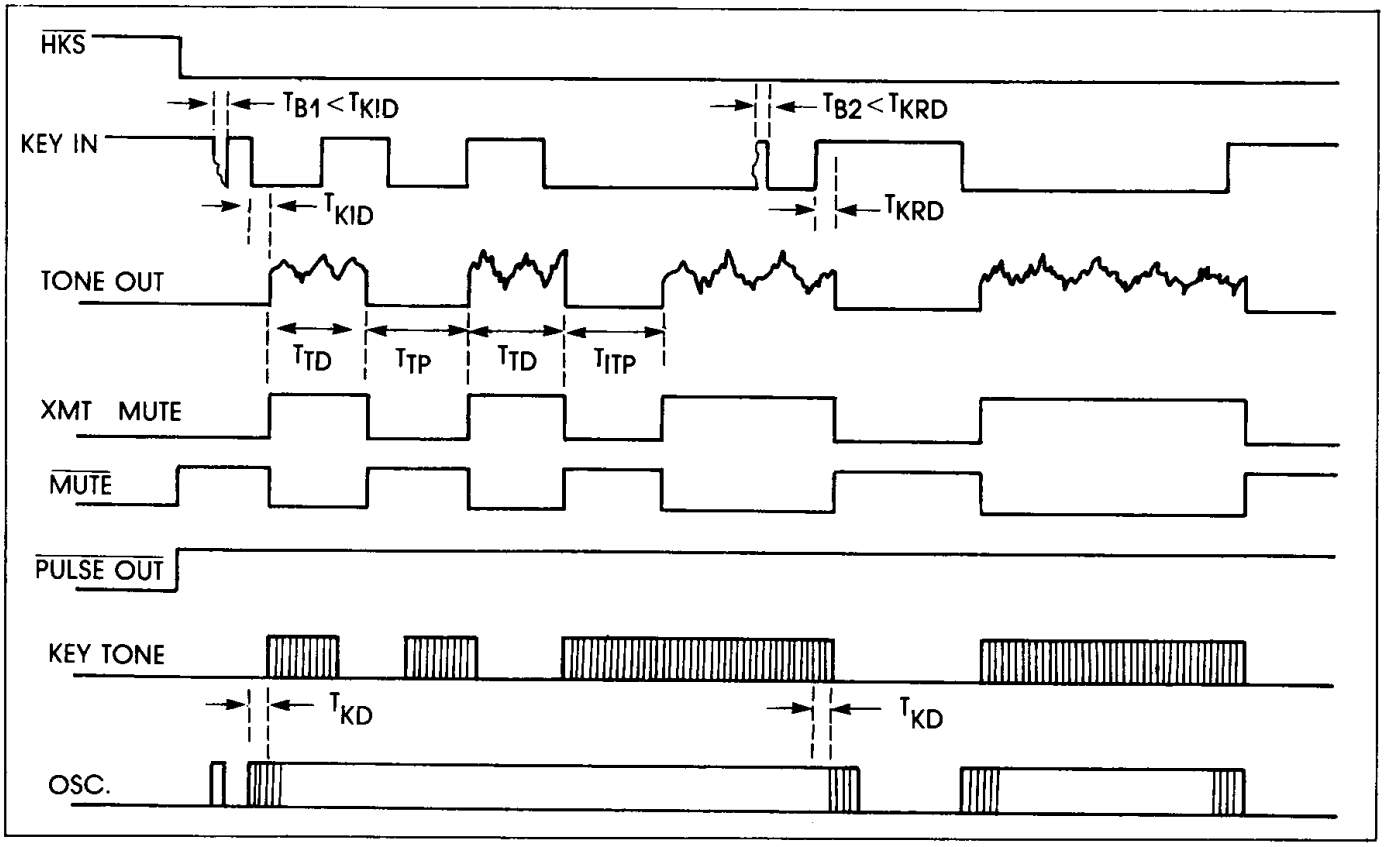



Figure 2 (a). Tone Mode Normal Dialing Timing Diagram

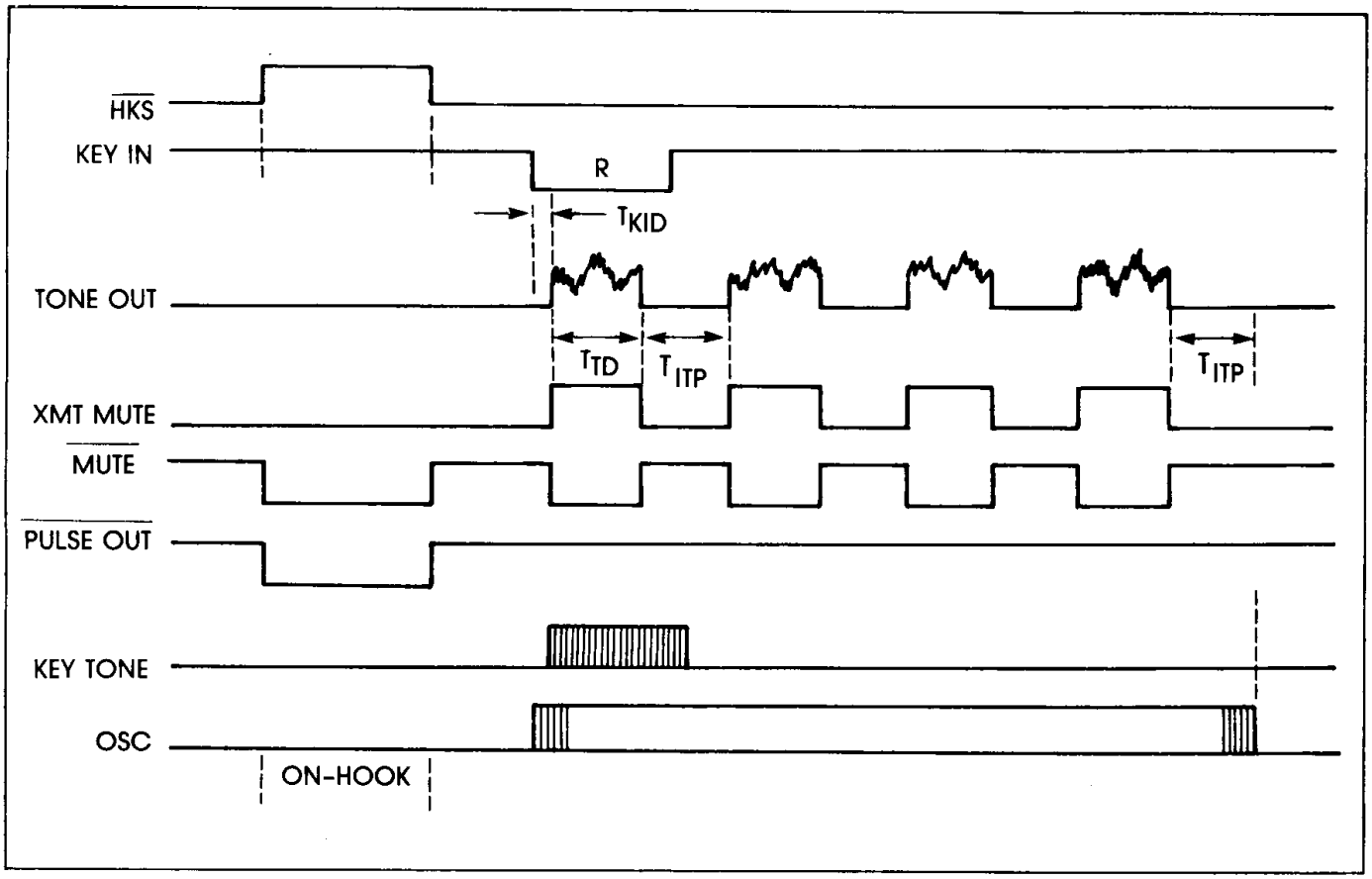



Figure 2(b).Tone Mode Redialing Timing Diagram

## 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 | $V_{IN}$ | $-0.5 \sim V_{DD}+0.5$ | V |
| Power Dissipation Per Package | $P_D$ | 500 (for $T_A=-25 \sim +60°C$) | mW |
| Operating Temperature | $T_A$ | $-25 \sim +85$ | °C |
| Storage Temperature | $T_{STG}$ | $-65 \sim +150$ | °C |

## D.C. CHARACTERISTICS

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

| PARAMETER | SYM | TEST CKT | TEST CONDITIONS | | LIMIT MIN | LIMIT TYP | LIMIT MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| 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 | 2.0 | mA |
| | | | | Pulse | — | 0.2 | 0.6 | |
| Standby Current | $I_S$ | A | No keypad Entry, and All Output Unload | | — | 0.1 | 5 | μA |
| Memory Retention Current | $I_{MR}$ | A | $\overline{HKS}=1$, $V_{DD}=1.0V$ | | — | 0.01 | 0.2 | μA |
| Tone Output | $V_{TO}$ | C | Row Group, $R_L=10K\Omega$ | | 120 | 150 | 180 | mV |
| Pre-Empasis | | D | Column Group / Row Group | | 1 | 2 | 3 | dB |
| DTMF Distortion | THD | D | $R_L=10K\Omega$, Note 2 | | — | −30 | −23 | dB |

(Continued)

| PARAMETER | | SYM | TEST CKT | TEST CONDITIONS | LIMITS MIN | LIMITS TYPE | LIMITS MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| 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 |
| $\overline{\text{Pulse Output}}$ Input Current | Leakage | $I_{PH}$ | E | $V_{PI}$ = 5.0V | — | — | 0.1 | μA |
| | | | | $V_{PI}$ = 12.0V | — | — | 1.0 | |
| | Sink | $I_{PL}$ | F | $V_{PI}$ = 0.5V | 1.0 | — | — | mA |
| Mute Output Current | 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 | — | — | |
| Keytone 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 | — | ±10⁵ | ±0.1 | μA |

## A.C. CHARACTERISTICS

| PARAMETER | SYM | TEST CKT | TEST CONDITION | | LIMIT MIN | LIMIT TYP | LIMIT MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| Key-in Debounce | $T_{KID}$ | | $\overline{TEST}=1$ | | — | 20 | — | mS |
| Key-released Debounce | $T_{KRD}$ | | $\overline{TEST}=1$ | | — | 20 | — | mS |
| Pulse Mute Delay | $T_{MD}$ | | $\overline{TEST}=1$ | B:M=60:40 | — | 40 | — | mS |
| | | | | B:M=66:33 | — | 33.3 | — | |
| Pre-Digit Pause | $T_{PDP}$ | | $\overline{TEST}=1$ | 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 | $T_{IDP}$ | | $\overline{TEST}=1$ | | — | 800 | — | mS |
| | | | $\overline{TEST}=0$ | | — | 13.6 | — | |
| Pulse Rate | $F_{PR}$ | | $\overline{TEST}=1$ | | — | 10 | — | pps |
| | | | $\overline{TEST}=0$ | | — | 600 | — | |
| Keytone Frequency | $F_{KT}$ | | $\overline{TEST}=1$ | | — | 1200 | — | Hz |
| Keytone Delay | $T_{KD}$ | | $\overline{TEST}=1$ | | — | 20 | — | mS |
| Tone Duration | $T_{TD}$ | | | | 100 | | — | mS |
| Inter-Tone Pause | $T_{IDP}$ | | | | — | 106 | — | mS |
| Pause Time | Tp | | 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 | |

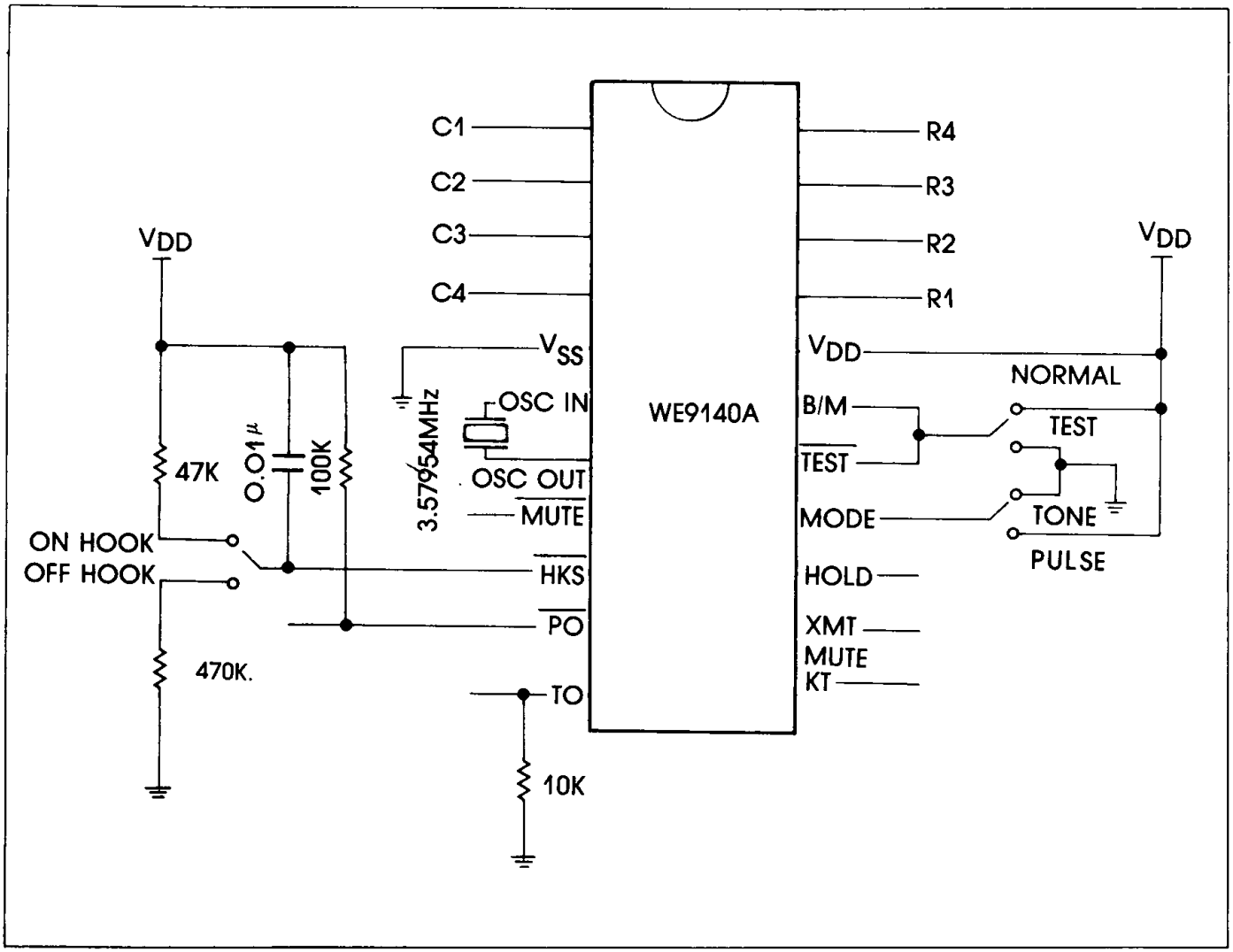
Notes:

1. Crystal parameters defined as $R_S \leq 100\Omega$, Lm=96mH, Cm=0.25PF ch=5PF, f=3.579545MHz & $C_L$=18PF, $\triangle F < \pm 200$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.

## COMPARISON OF SPECIFIED VS. ACTUAL TONE FREQUENCIES

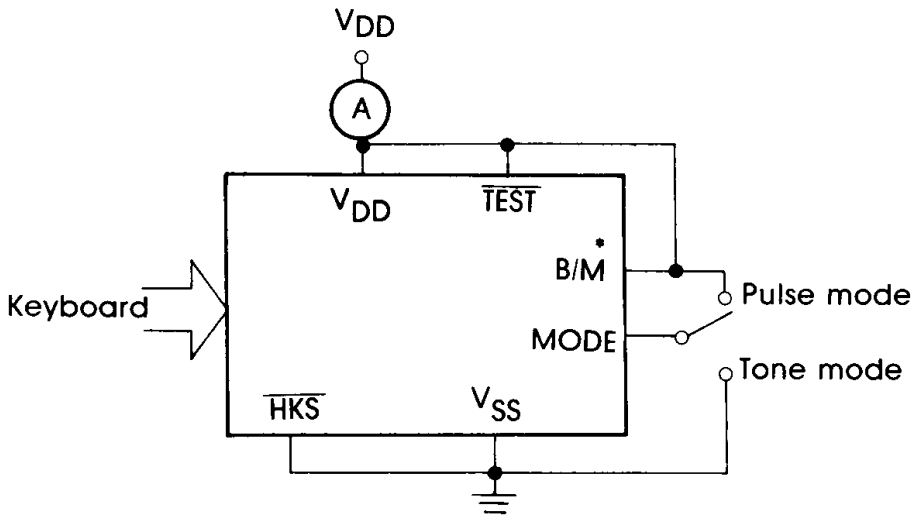
| ACTIVE INPUT | OUTPUT FREQUENCY Hz | | ERROR |
|---|---|---|---|
| | SPECIFIED | ACTUAL | % |
| ROW 1 | 697 | 699 | +0.29 |
| ROW 2 | 770 | 766 | −0.52 |
| ROW 3 | 852 | 848 | −0.47 |
| ROW 4 | 941 | 948 | +0.74 |
| COLUMN 1 | 1209 | 1216 | +0.58 |
| COLUMN 2 | 1339 | 1332 | −0.52 |
| COLUMN 3 | 1477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

## GENERAL TEST CIRCUIT

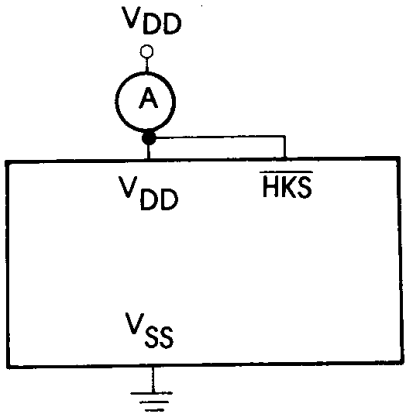


## TEST CIRCUIT

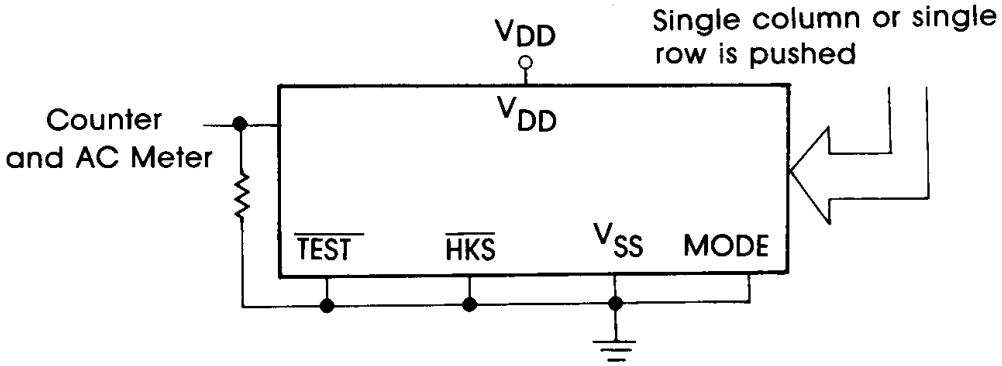
A.




B.




C.



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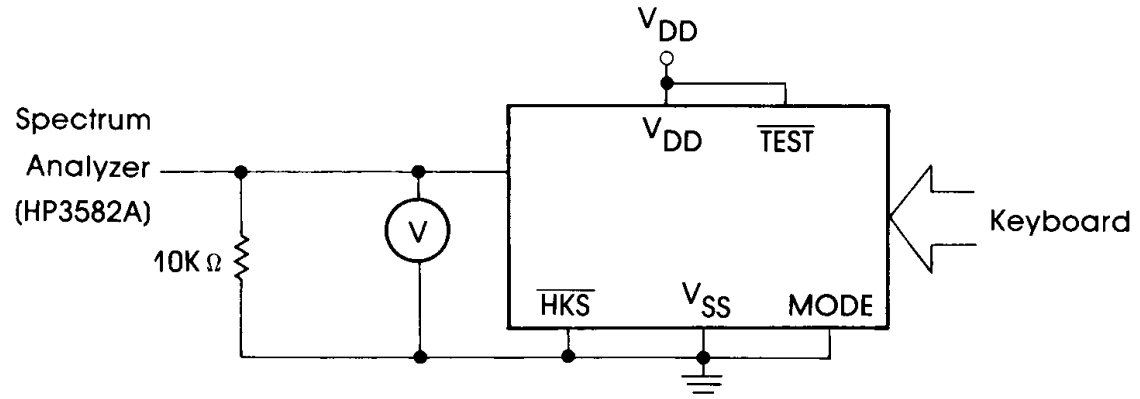
D.

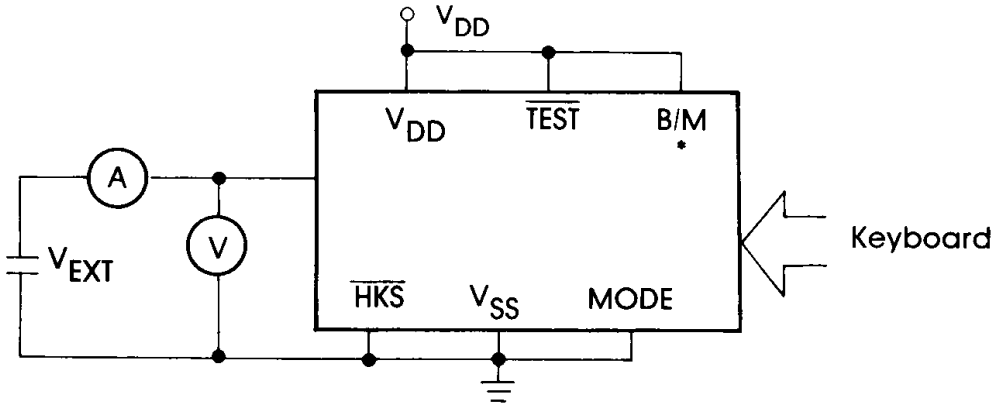



$$DISTdb = 20\log \frac{\sqrt{(V_1)^2 + (V_2)^2 + .... + (Vn)^2}}{\sqrt{(V_L)^2 + (V_H)^2}}$$

* V1, ..., Vn are extraneous frequency (ie intermodulation and harmonic) com- ponents in the 500 Hz to 3400 Hz band.
* $V_L$ $V_H$ are the individual frequency com- ponents 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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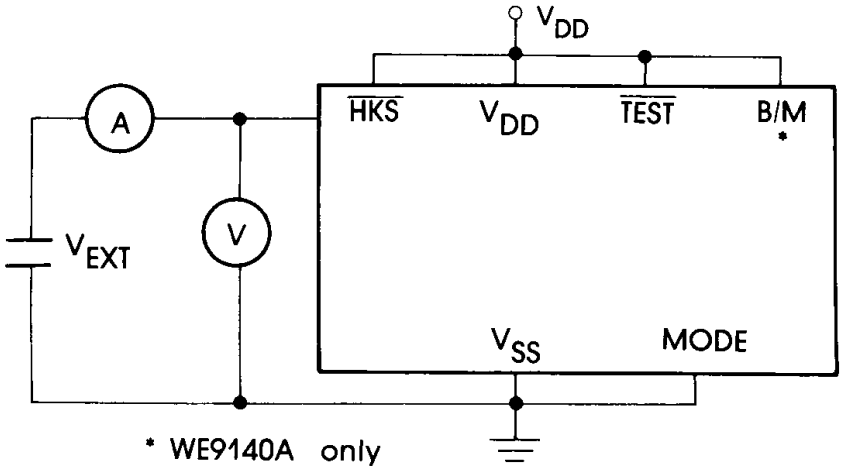
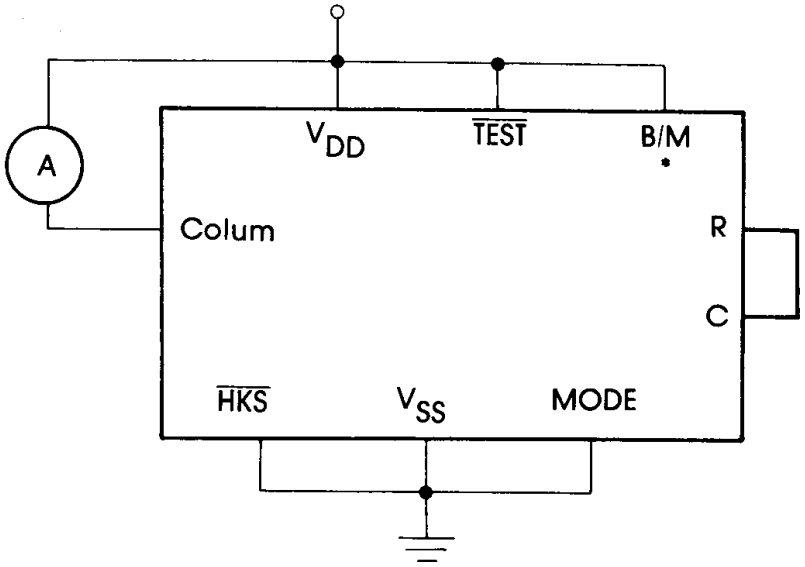
F.




* WE9140A only

G.




Notes:

R*: anyone row of R1-R4.

C*: anyone column opf C1-C4

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

I is the net DC current measured from ampere meter.

*: WE9140A only.

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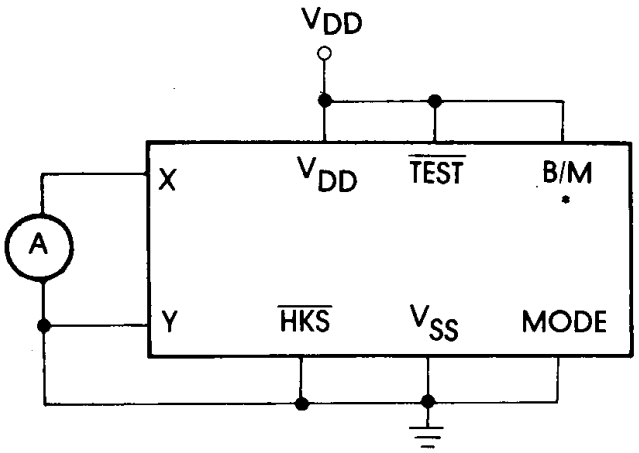
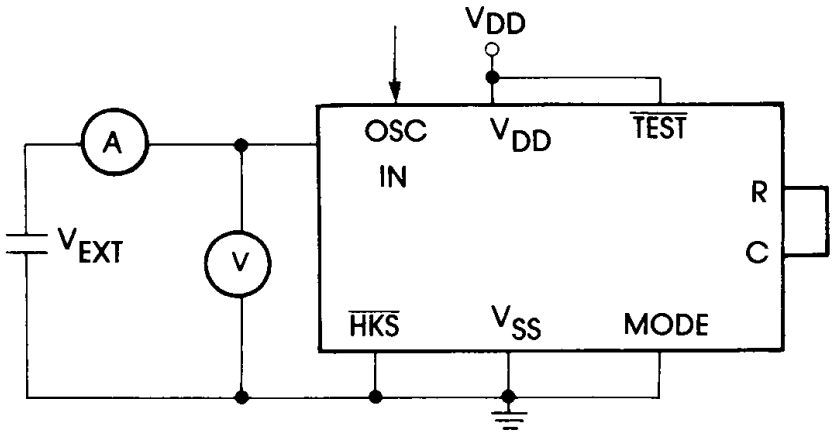
H




* WE9140A only

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. $I_{Drive}$ = I / Duty Cycle; I is the net DC current measured from ampere meter.

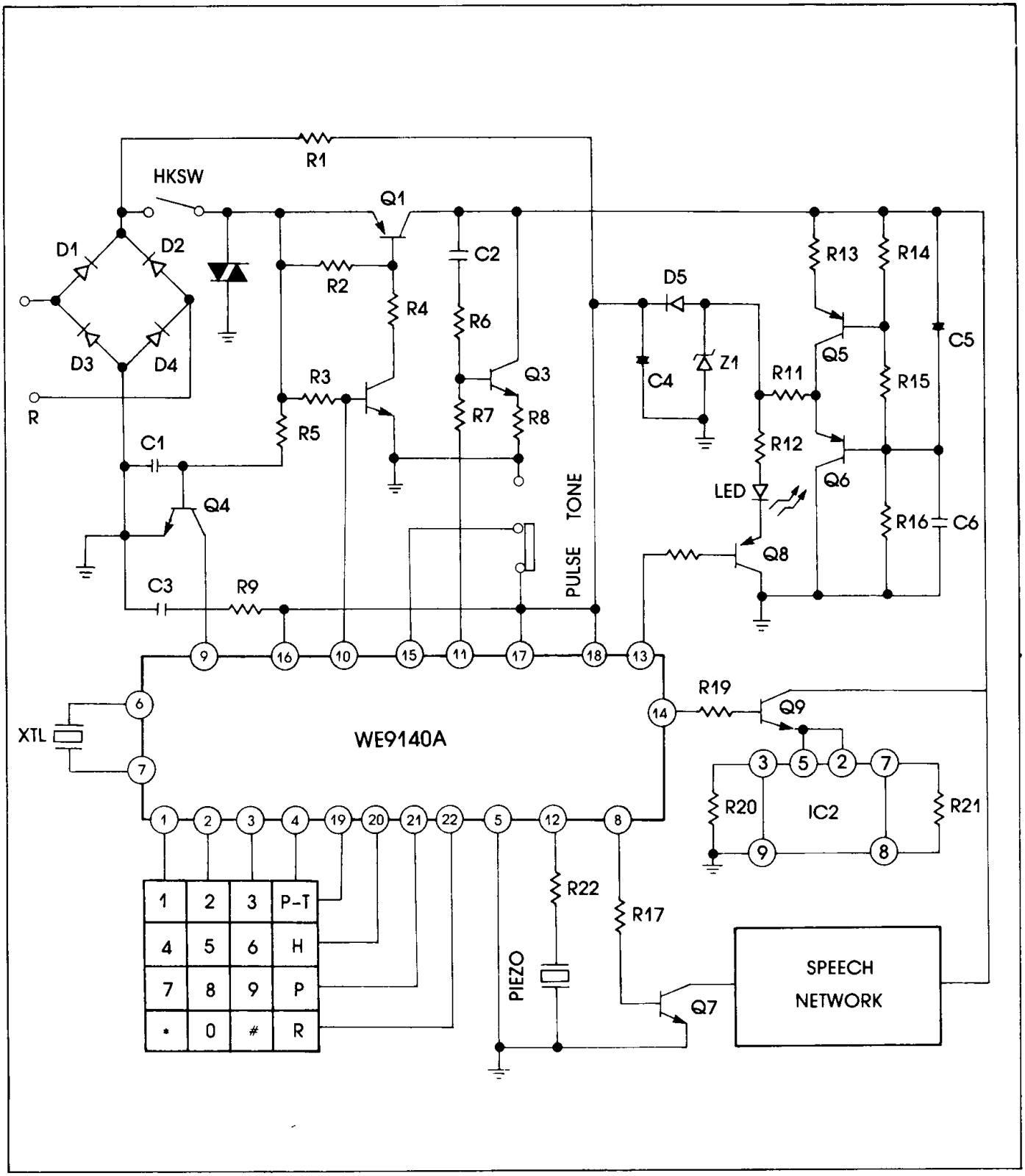



Procedure:

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



## COMPONENT SELECTION TABLE

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