



10-MEMORY TONE/PULSE SWITCHABLE DIALER

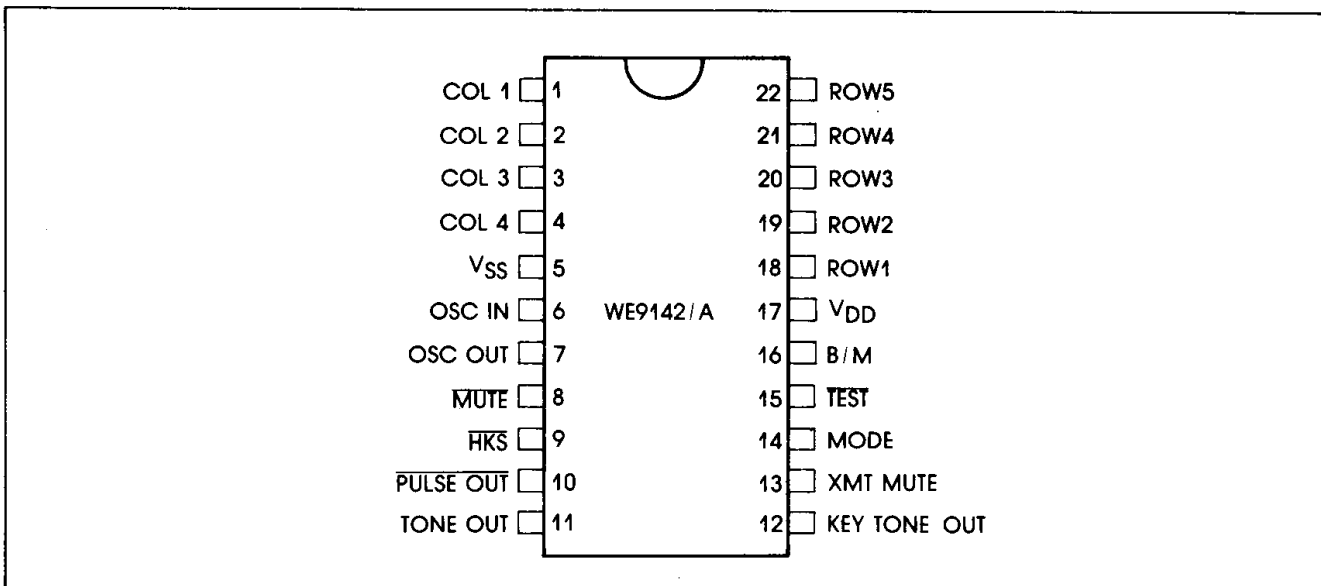
GENERAL DESCRIPTION

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 μ A at V=1.0V, ON-HOOK.
- Wide operation voltage range: 2.0V ~ 5.5V.
- 22-pin Dual-in-Line Package.

PIN CONFIGURATION



TONER/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 $\pm 0.02\%$.

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

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 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.

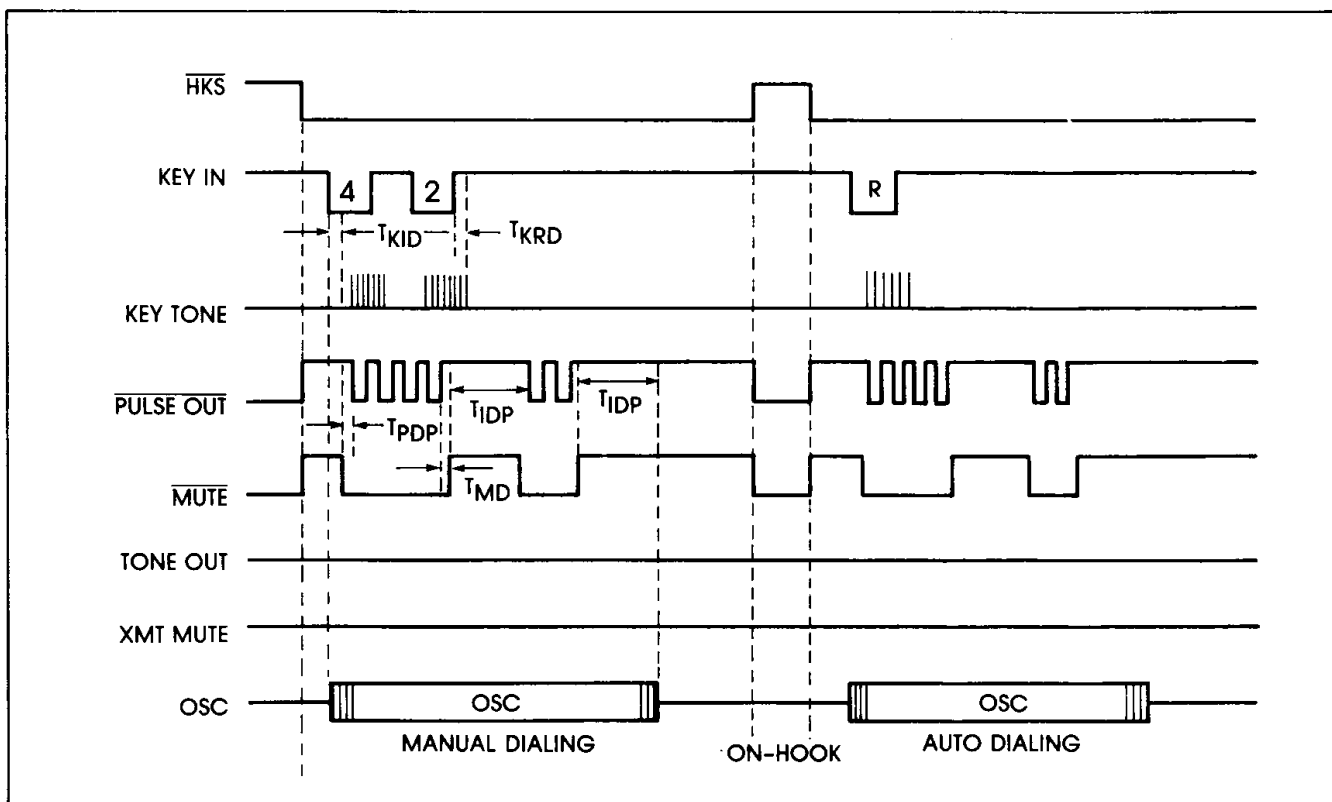


Figure 1. Pulse Mode Timing Waveform.

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)

TIMING WAVEFORM

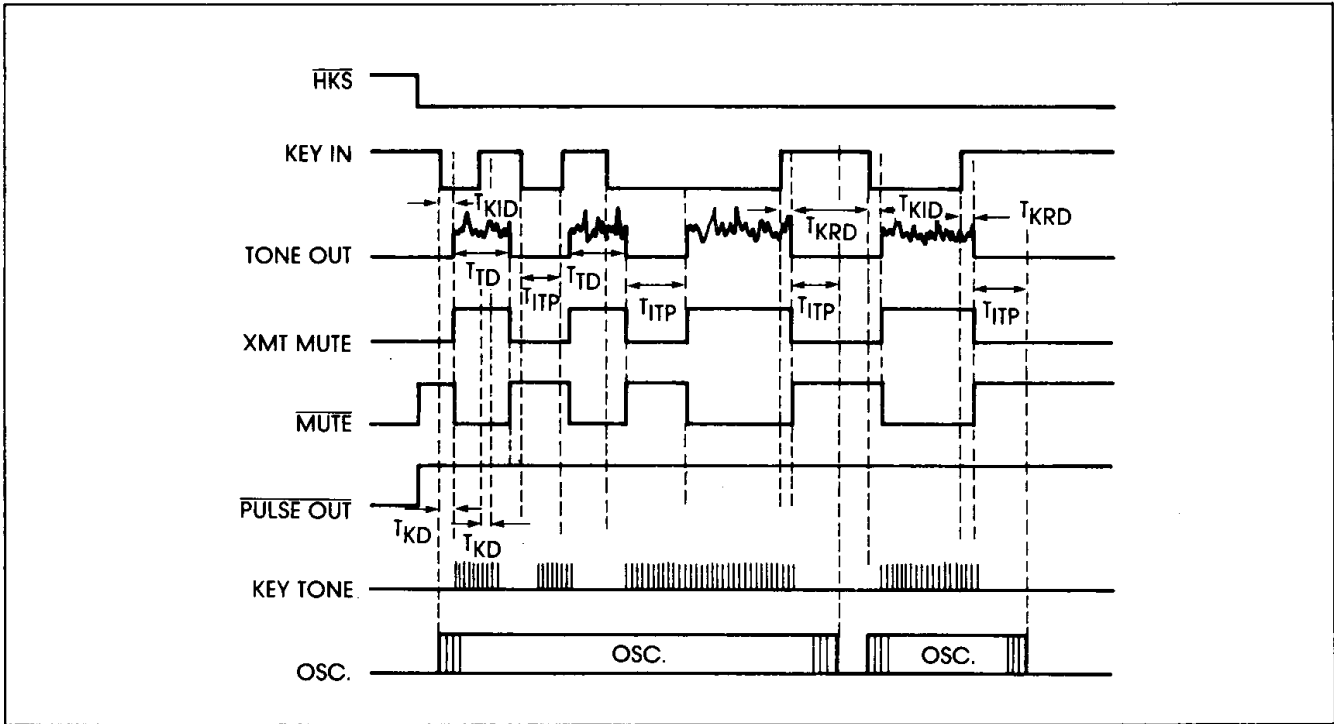


Figure 2(a) Tone Mode Normal Dialing

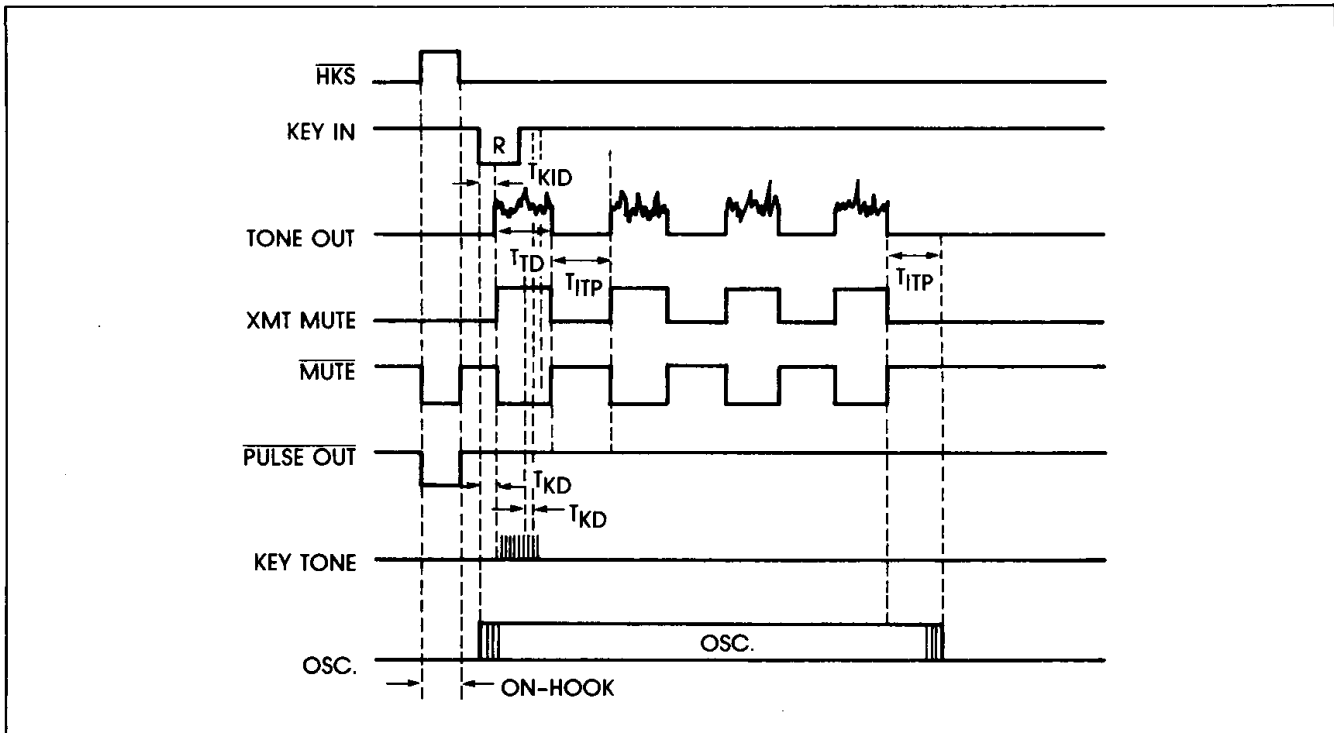


Figure 2(b) Tone Mode Redialing

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. TEST

In normal operation, ties the TEST Pin to V_{DD}, the single tone is inhibited and pulse rate is 10 pps. In testing operation, ties the 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 | | ROW 1 |
| 4 | 5 | 6 | | ROW 2 |
| 7 | 8 | 9 | | ROW 3 |
| * | 0 | # | | ROW 4 |
| R | S | A | P | ROW 5 |

R: Redial
S: Store
A: Auto Dialing

WE9142A

| COL1 | COL2 | COL3 | COL4 | |
|------|------|------|------|-------|
| 1 | 2 | 3 | | ROW 1 |
| 4 | 5 | 6 | | ROW 2 |
| 7 | 8 | 9 | | ROW 3 |
| * | 0 | # | P-T | ROW 4 |
| R | S | A | P | ROW 5 |

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

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

B. REDIALING

Push **[D1]**, **[D2]**, ..., **[Dn]**, busy, ON-HOOK. Come OFF-HOOK, push **[REDIAL]**, the last number D1.D2...Dn will be dialed out automatically.

C. NUMBER STORING

Don't care Pulse or Tone mode. Push **[S]** **[D1]**, **[D2]** ... **[Dn]**, **[S]**, **[Ln]** Ln:0-9 then the number D1.D2 ... Dn will be stored in location **[Ln]**

D. MEMORY DIALING

Select Pulse or Tone mode. Push keypad **[A]** **[Ln]**, then the number stored in location **[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 facilitates 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. 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 **[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 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} , $\boxed{P-T}$ $\boxed{D1'}$, $\boxed{D1'}$, $\boxed{D2'}$, ..., $\boxed{Dn'}$ \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 $+60^\circ\text{C}$) | mW |
| Operating Temperature | T_A | -25 to +85 | $^\circ\text{C}$ |
| Storage Temperature | T_{STG} | -65 to +150 | $^\circ\text{C}$ |

D.C. CHARACTERISTICS

($V_{DD} = 2.5\text{V}$, $T_A = 25^\circ\text{C}$, Unless otherwise noted)

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

| 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 | f ₁ | C | ROW1, NOTE 8 | — | 699 | — | Hz |
| | f ₂ | | ROW2, NOTE 8 | — | 766 | — | |
| | f ₃ | | ROW3, NOTE 8 | — | 848 | — | |
| | f ₄ | | ROW4, NOTE 8 | — | 948 | — | |
| Colum Group Frequency | f ₅ | C | COL1, NOTE 8 | — | 1216 | — | Hz |
| | f ₆ | | COL2, NOTE 8 | — | 1332 | — | |
| | f ₇ | | 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 | — | ±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

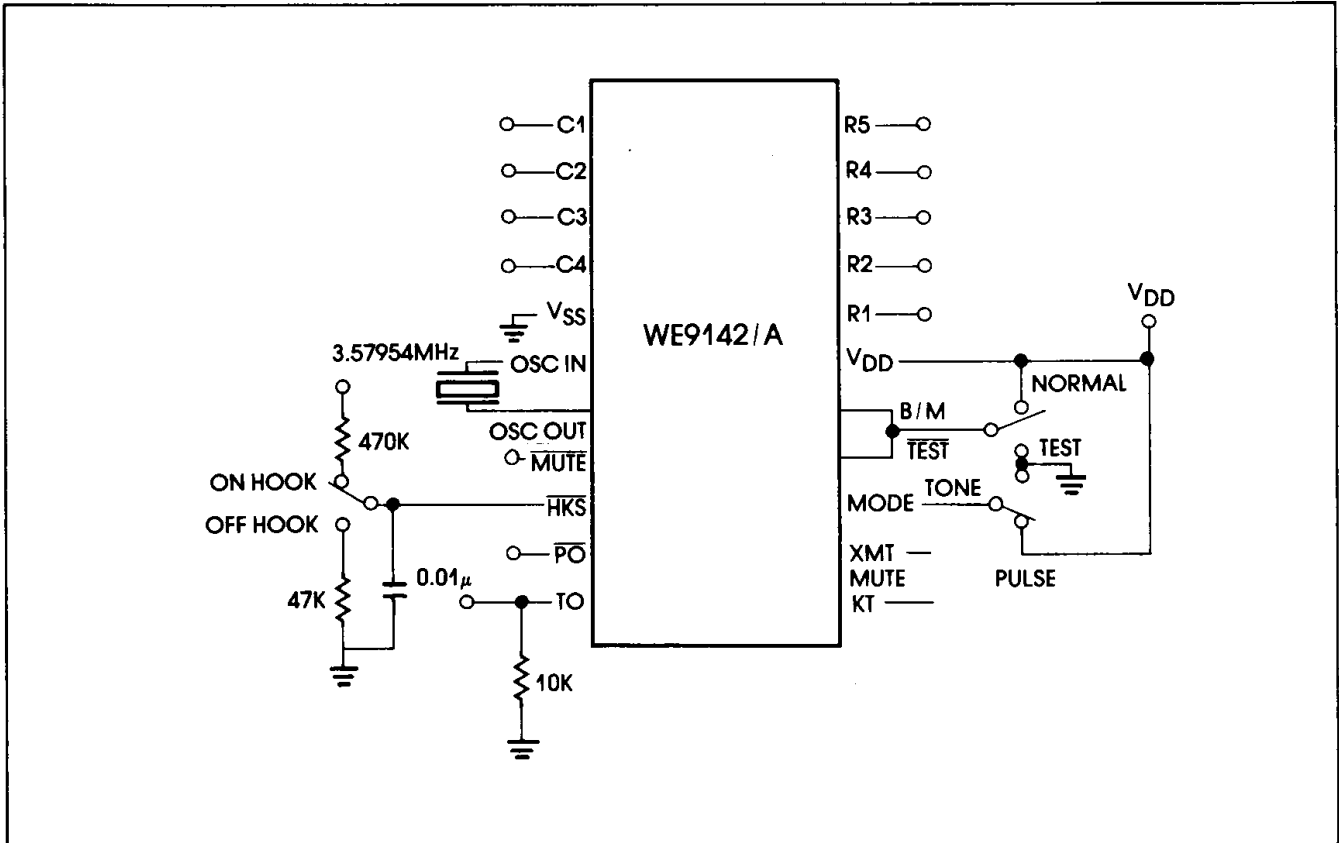
Note 7 : Dual Tone Mutli-Frequency Distortion is measured in terms of total out-of band power related to sum of row & column fundamental power

Note 8 : Crystal parameters defined as $R_s < 100\Omega$, $L_m = 96mH$, $C_m = 0.25PF$, $C_h = 5PF$, $F = 3.579545MHz$ & $CL = 18P$
 $FF < \pm 200PPM$

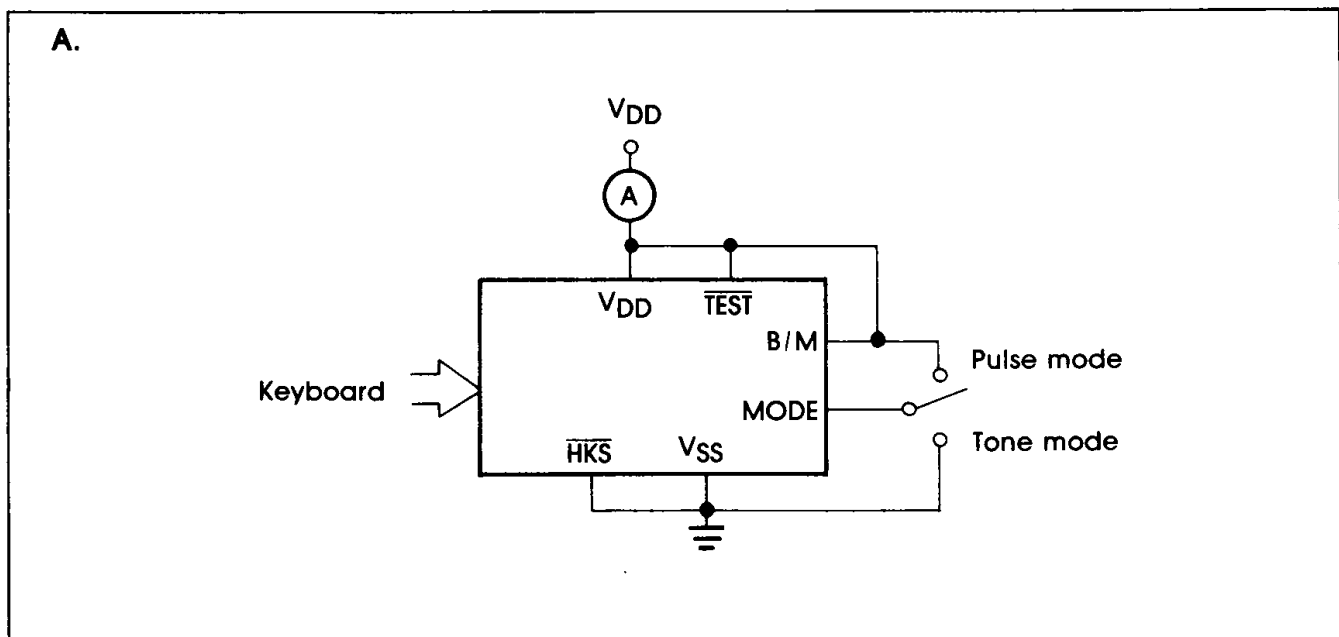
Note 9 : Referred to Pulse Mode Time Diagram

Note 10 : Referred to DTMF Mode Time Diagram

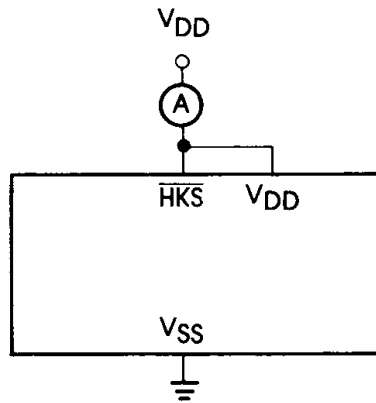
GENERAL TEST CIRCUIT



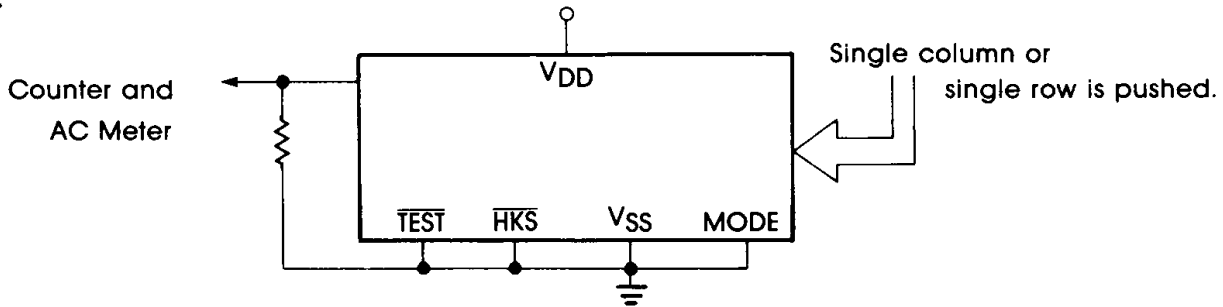
TEST CIRCUIT



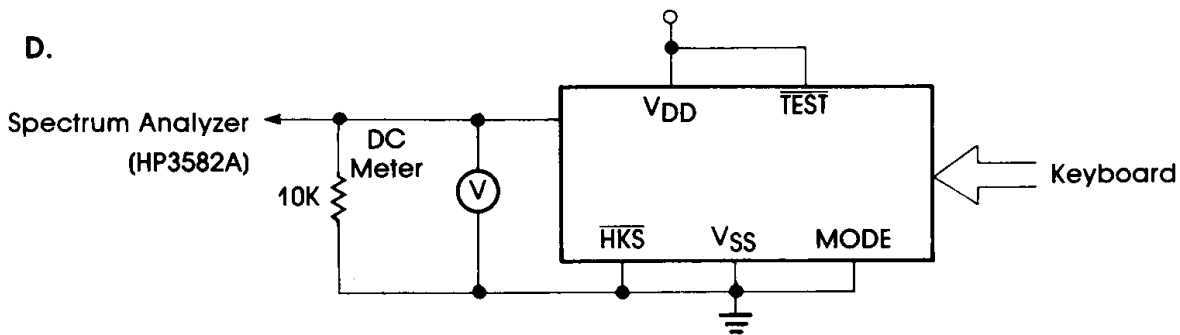
B.



C.



D.



$$\text{DIST dB} = 20 \log \frac{\sqrt{[V_1]^2 + [V_2]^2 + \dots + [V_n]^2}}{\sqrt{[V_L]^2 + [V_H]^2}}$$

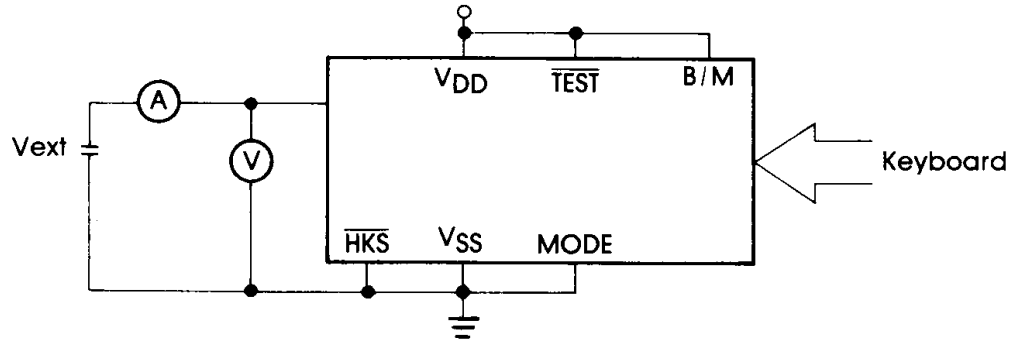
* V_L, V_H , are the individual frequency components of the DTMF signal.

* V_1, \dots, V_n are extraneous frequency (ie inter-modulation and harmonic) components in the 500 Hz to 3400 Hz band.

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

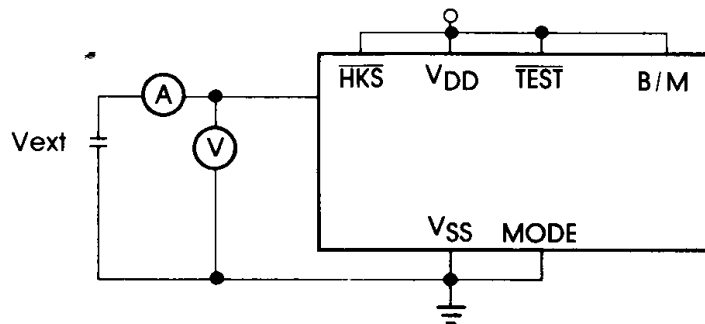
TONE/PULSE
DIALER

E.

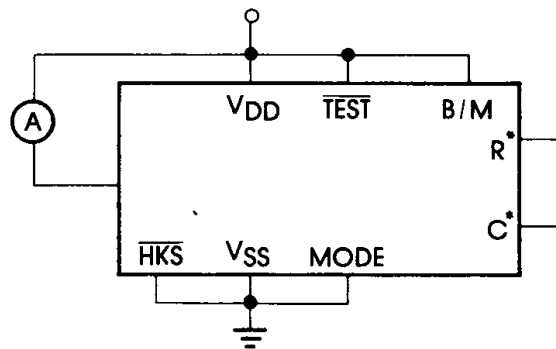


Note: Whether keyboard is pushed refer to the DTMF mode timing diagram.

F.



G.



Note:

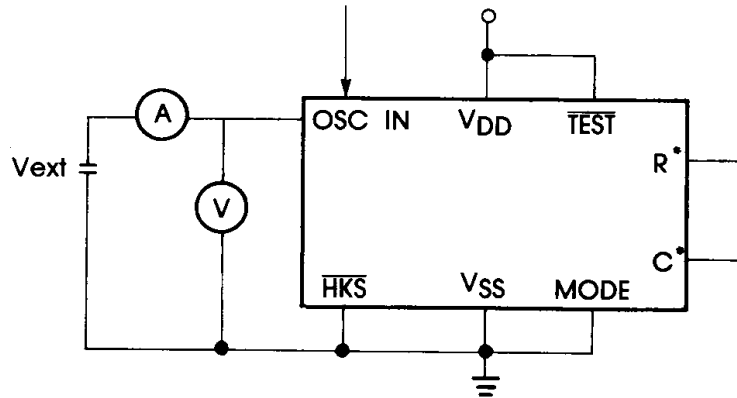
R^* : anyone row of R1-R5

C^* : anyone column of C1-C4

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

I is the net DC current measured from ampere meter.

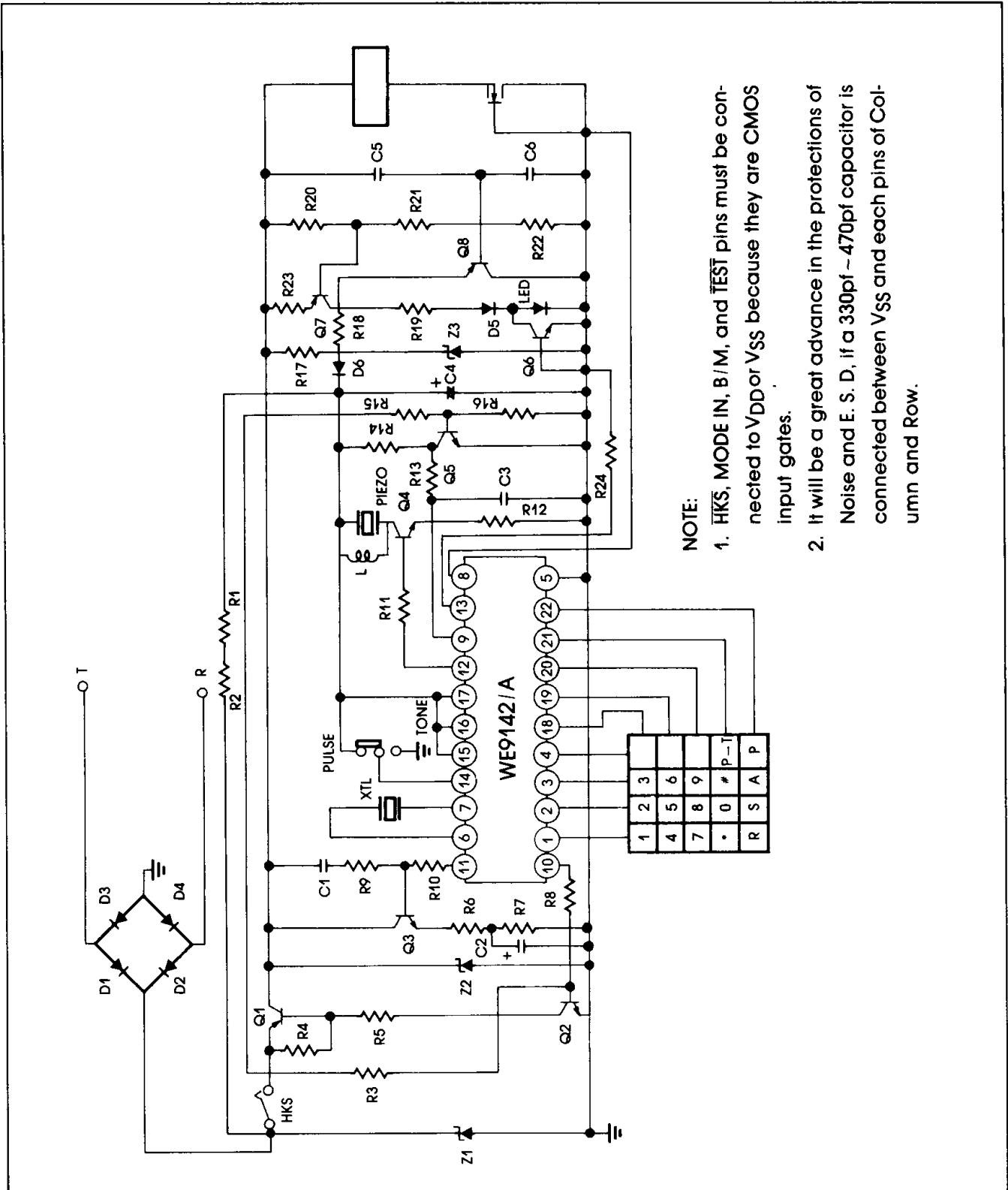
H.



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

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

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 $10M\Omega$. R1 and R2 are $22M\Omega$ separately when used in parallel 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 protect the whole circuit from surge voltage and over-large signal on telephone line when off hook. Z3 limits the voltage 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 furnishes the selection of dialing mode for user.

COMPONENT SELECTION TABLE

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