

Patent Number: 64097, 86474, 113235(R.O.C.), 5424740(U.S.A.)

Features

- Universal specification
- Operating voltage: 2.0V~5.5V
- Low standby current
- Low memory retention current: 0.1 μ A (Typ.)
- Tone/pulse switchable
- Interface with LCD driver
- 32 digits for redialing
- 32 digits for the SA memory dialing
- One-key redialing
- Pause and P \rightarrow T key for PBX
- 4 \times 5 keyboard matrix
- 3.58MHz crystal or ceramic resonator
- Hand-free control
- Hold-line control
- Pause, P \rightarrow T can be saved for redialing
- Lock function
- Keytone function
- Resistor options:
 - M/B ratio
 - Flash function and flash time(86ms~600ms)
 - Pause and P \rightarrow T duration
 - Pulse number
 - Keyboard operated IDD lock function
 - Keyboard form

General Description

The HT9312/3 series tone/pulse dialers are CMOS LSIs for telecommunication systems. They are designed to meet various dialing specifications through resistor option matrix.

The HT9312/3 series tone/pulse dialers are offered in four different versions. They are HT9312x/HT9313x normal version; HT9312xL/

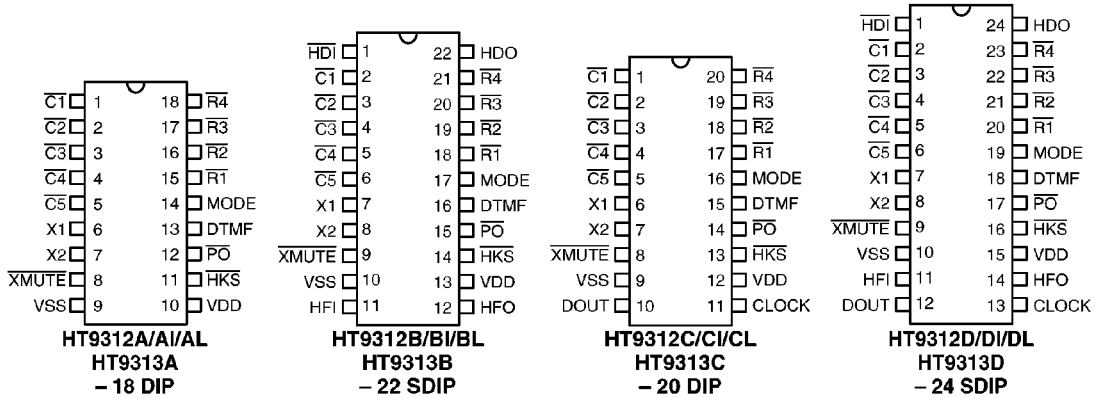
HT9312xI lock version, with keyboard-operated IDD lock function; HT9312xT keytone version; and HT9312xLT/HT9312xIT keytone/lock function version. The four versions also supply the following functions: Hold-line, Hand-free and LCD dialing number display interface, all of which are suitable for feature phone applications.

Selection Table

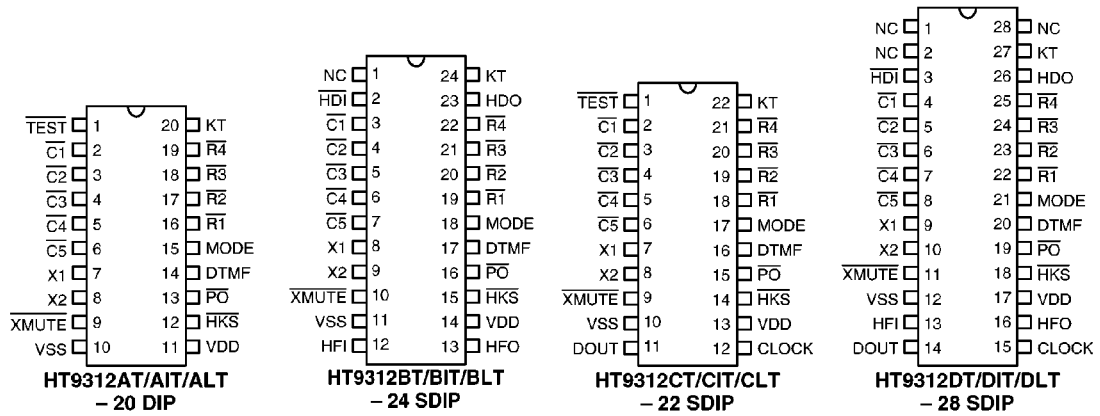
| Function Item | Keytone | Lock Function | Hold-Line | Hand-Free | LCD Interface | Min. Flash Time | Package |
|---------------|--|---|-----------|-----------|---------------|-----------------|---------|
| HT9312x | (Normal version) | | | | | | |
| HT9312A | — | — | — | — | — | 98 ms | 18 DIP |
| HT9312B | — | — | √ | √ | — | | 22 SDIP |
| HT9312C | — | — | — | — | √ | | 20 DIP |
| HT9312D | — | — | √ | √ | √ | | 24 SDIP |
| HT9312xI | (Mechanical Lock Version) | | | | | | |
| HT9312AI | — | Lock 0 Lock 0, 9 Lock All | — | — | — | 98 ms | 18 DIP |
| HT9312BI | — | | √ | √ | — | | 22 SDIP |
| HT9312CI | — | | — | — | √ | | 20 DIP |
| HT9312DI | — | | √ | √ | √ | | 24 SDIP |
| HT9312xL | (Mechanical and Keyboard Operated Lock Version) | | | | | | |
| HT9312AL | — | Lock 0 Lock 0, 9 Lock All Keyboard Operated Lock | — | — | — | 98 ms | 18 DIP |
| HT9312BL | — | | √ | √ | — | | 22 SDIP |
| HT9312CL | — | | — | — | √ | | 20 DIP |
| HT9312DL | — | | √ | √ | √ | | 24 SDIP |
| HT9312xT | (Keytone version) | | | | | | |
| HT9312AT | √ | — | — | — | — | 98 ms | 20 DIP |
| HT9312BT | √ | — | √ | √ | — | | 24 SDIP |
| HT9312CT | √ | — | — | — | √ | | 22 SDIP |
| HT9312DT | √ | — | √ | √ | √ | | 28 SDIP |
| HT9312xIT | (Mechanical Lock with keytone Version) | | | | | | |
| HT9312AIT | — | Lock 0 Lock 0, 9 Lock All | — | — | — | 98 ms | 20 DIP |
| HT9312BIT | — | | √ | √ | — | | 24 SDIP |
| HT9312CIT | — | | — | — | √ | | 22 SDIP |
| HT9312DIT | — | | √ | √ | √ | | 28 SDIP |
| HT9312xLT | (Mechanical and Keyboard Operated Lock with Keytone Version) | | | | | | |
| HT9312ALT | √ | Lock 0 Lock 0, 9 Lock All Keyboard Operated Lock | — | — | — | 98 ms | 20 DIP |
| HT9312BLT | √ | | √ | √ | — | | 24 SDIP |
| HT9312CLT | √ | | — | — | √ | | 22 SDIP |
| HT9312DLT | √ | | √ | √ | √ | | 28 SDIP |
| HT9313x | (Normal version) | | | | | | |
| HT9313A | — | — | — | — | — | 86 ms | 18 DIP |
| HT9313B | — | — | √ | √ | — | | 22 SDIP |
| HT9313C | — | — | — | — | √ | | 20 DIP |
| HT9313D | — | — | √ | √ | √ | | 24 SDIP |

Pin Assignment

HT9312x/xL, HT9313x version

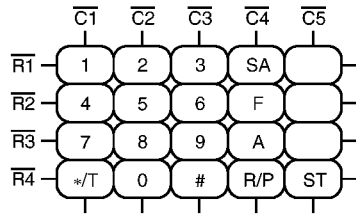


HT9312xT/xLT versions

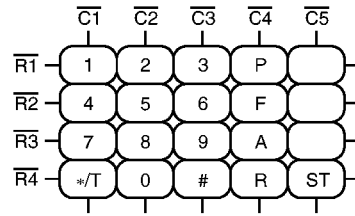


Keyboard Information

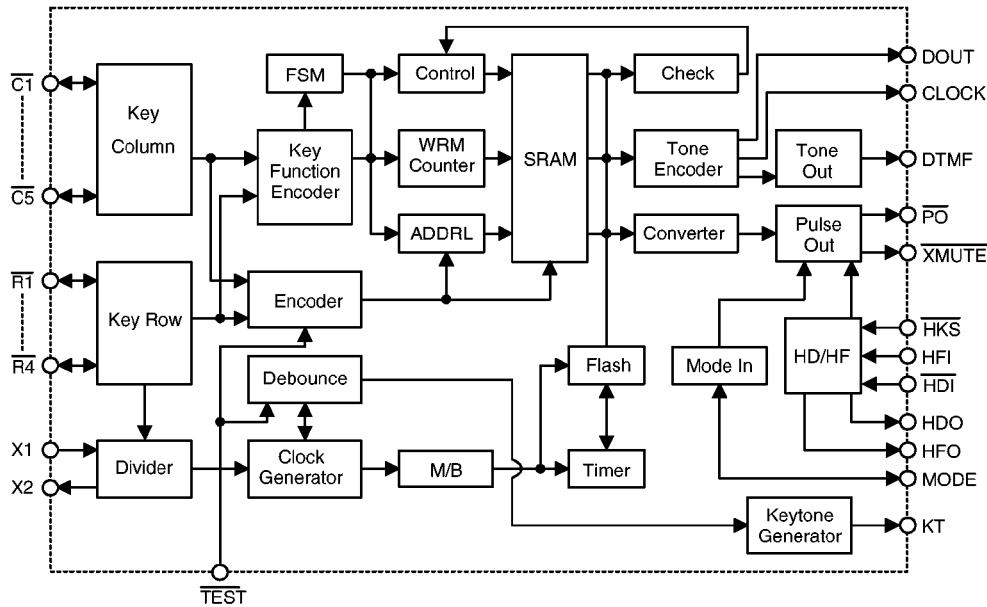
Form A



Form B



Block Diagram



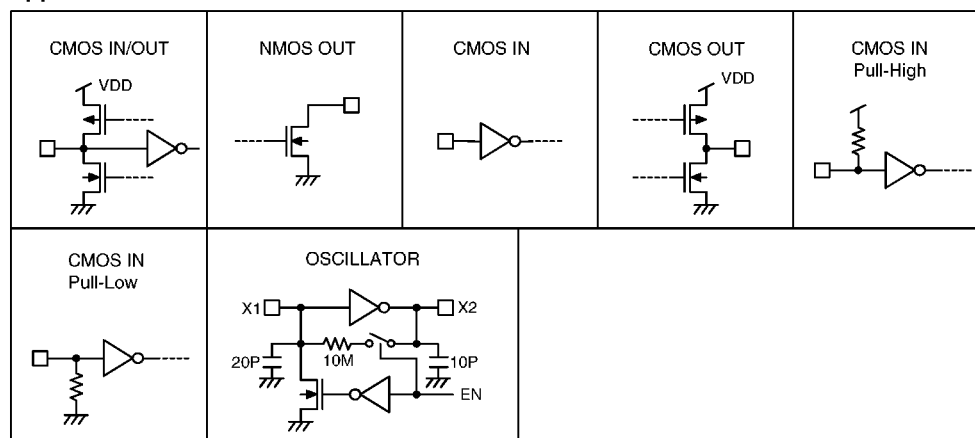
Pin Description

| Pin Name | I/O | Internal Connection | Description |
|--|-----|---------------------|---|
| $\overline{C1-C5}$ $\overline{R1-R4}$ | I/O | COMAS IN/OUT | <p>These pins form a 4×5 keyboard matrix which can perform keyboard input detection and dialing specification setting functions. When on-hook (\overline{HKS}=high) all the pins are set high. While off-hook the column group ($\overline{C1-C5}$) remains low and the row group ($\overline{R1-R4}$) is set high for key input detection.</p> <p>An inexpensive single contact 4×5 keyboard can be used as an input device. Pressing a key connects a single column to a single row, and actuates the system oscillator that results in a dialing signal output. If more than two keys are pressed at the same time, no response occurs. The key-in debounce time is 20ms. Refer to the keyboard information for keyboard arrangement and to the functional description for dialing specification selection.</p> |
| X1 | I | OSCILLATOR | <p>The system oscillator consists of an inverter, a bias resistor and the necessary load capacitor on chip. Connecting a standard 3.579545MHz crystal or ceramic resonator to the X1 and X2 terminals can implement the oscillator function. The oscillator is turned off in the standby mode, and is actuated whenever a keyboard entry is detected.</p> |
| X2 | O | | |
| \overline{XMUTE} | O | NMOS OUT | <p>\overline{XMUTE} is an NMOS open drain structure pulled to VSS during dialing signal transmission. Otherwise, it is an open circuit. \overline{XMUTE} is used to mute the speech circuit when transmitting the dial signal.</p> |
| \overline{HKS} | I | CMOS IN | <p>This pin is used to monitor the status of the hook-switch and its combination with $\overline{HFI/HDI}$ can control the \overline{PO} pin output to make or break the line.</p> <p>\overline{HKS}=VDD: On-hook state (\overline{PO}=low). Except for $\overline{HFI/HDI}$ (hand-free/hold-line control input), other functions are all disabled.</p> <p>\overline{HKS}=VSS: Off-hook state (\overline{PO}=high). The chip is in the standby mode and ready to receive the key input.</p> |
| \overline{TEST} | I | CMOS IN | <p>This is a test pin. It should be connected to VDD when in normal operation.</p> |
| \overline{PO} | O | CMOS OUT | <p>This pin is a CMOS output structure, which by receiving the \overline{HKS} and $\overline{HFO/HDO}$ signals, control the dialer to connect or disconnect the telephone line.</p> <p>\overline{PO} outputs a low to break line when \overline{HKS} is high (on-hook) and $\overline{HFO/HDO}$ is low. \overline{PO} outputs a high to make line when \overline{HKS} is low (off-hook) or \overline{HFO} is high or \overline{HDO} is high.</p> <p>During the off-hook state, this pin also outputs the dialing pulse train in pulse mode dialing. While in the tone mode, this pin is always high.</p> |

| Pin Name | I/O | Internal Connection | Description |
|-------------------------|-----|---------------------|---|
| MODE | I/O | CMOS IN/OUT | This is a three-state input/output pin, used for dialing mode selection, either Tone mode, or Pulse mode, 10pps/20pps MODE=VDD: Pulse mode, 10pps MODE=OPEN: Pulse mode, 20pps MODE=VSS: Tone mode During the pulse mode dialing, switching this pin to the tone mode changes the subsequent digit entry to tone mode. When the chips are in tone mode, switching to pulse mode will also be recognized. |
| DTMF | O | CMOS OUT | This pin is active only when the chip transmits tone dialing signals. Otherwise, it always outputs a low. The pin outputs tone signals to drive the external transmitter amplifier circuit. The load resistor should not be less than 5kΩ. |
| $\overline{\text{HDI}}$ | I | CMOS IN Pull-High | This pin is a schmitt trigger input structure. Active low. Applying a negative going pulse to this pin can toggle the HDO output once. An external RC network is recommended for input debouncing. The pull-high resistance is 200kΩ typ. |
| HDO | O | CMOS OUT | The HDO is a CMOS output structure. Its output is toggle-controlled by a negative transition on $\overline{\text{HDI}}$. When HDO is toggled high, $\overline{\text{PO}}$ keeps high to hold the line. The hold function can be released by setting $\overline{\text{HFO}}$ high or by an on-off hook operation or by another $\overline{\text{HDI}}$ input. The HDO pin can directly drive the HT9312/3 series melody generator to produce a hold-line background melody. Refer to the functional description for the hold-line function. |
| KT | O | CMOS OUT | Keytone output pin. Outputs a 1.2kHz tone carrier when any key is pressed in the pulse mode or when the function keys are pressed in the tone mode. |
| HFI | I | CMOS IN Pull-Low | This pin is a schmitt trigger input structure. Active high. Applying a positive going pulse to HFI can toggle the HFO once and hence control the hand-free function. The pull-low resistance of HFI is 200kΩ typ. An external RC network is recommended for input debouncing. |
| HFO | O | CMOS OUT | The HFO is a CMOS output structure. Its output is toggle-controlled by a positive transition on HFI pin. When HFO is high, the hand-free function is enabled and $\overline{\text{PO}}$ outputs a high to connect the line. The hand-free function can be released by setting HDO high or by an on-off-hook operation or by another HFI input. Refer to the functional description for the hand-free functional operation. |

| Pin Name | I/O | Internal Connection | Description |
|----------|-----|---------------------|--|
| DOUT | O | NMOS OUT | NMOS open drain output pin. It outputs the BCD code of the dialing digits to the LCD driver chip (HT16XX series) or μ C for dialing number display. Refer to the functional description for the detailed timing. |
| CLOCK | O | NMOS OUT | NMOS open drain output. When dialing, it outputs a series of pulse trains for DOUT data synchronization. DOUT data is valid at the falling edge of clock. |
| VDD | I | — | Positive power supply, 2.0V~5.5V for normal operation |
| VSS | I | — | Negative power supply |

Approximate internal connection circuits



Absolute Maximum Ratings*

| | | | |
|---------------------------|----------------|-----------------------------|-------------------------------|
| Supply Voltage | -0.3V to 6V | Input Voltage | $V_{SS}-0.3$ to $V_{DD}+0.3V$ |
| Storage Temperature | -50°C to 125°C | Operating Temperature | -20°C to 75°C |

*Note: Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only. Functional operation of this device at these or any other conditions above those indicated in the operational sections of this specification is not implied and exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Electrical Characteristics

 (F_{OSC}=3.5795MHz, T_a=25°C)

| Symbol | Parameter | Test Conditions | | Min. | Typ. | Max. | Unit | |
|-------------------|--|-----------------|--|-------------------------|--------|--------------------|------|----|
| | | V _{DD} | Conditions | | | | | |
| V _{DD} | Operating Voltage | — | — | 2 | — | 5.5 | V | |
| I _{DD} | Operating Current | 2.5V | Pulse | Off-hook | — | 0.2 | 1 | mA |
| | | | Tone | Keypad entry No load | — | 0.6 | 2 | mA |
| I _{STB} | Standby Current | 1V | On-hook, no load No entry | — | — | 1 | μA | |
| V _R | Memory Retention Voltage | — | — | 1 | — | 5.5 | V | |
| I _R | Memory Retention Current | 1V | On-hook | — | 0.1 | 0.2 | μA | |
| V _{IL} | Input Low Voltage | — | — | V _{SS} | — | 0.2V _{DD} | V | |
| V _{IH} | Input High Voltage | — | — | 0.8V _{DD} | — | V _{DD} | V | |
| I _{XMO} | $\overline{\text{XMUTE}}$ Leakage Current | — | V $\overline{\text{XMUTE}}$ =12V No entry | — | — | 1 | μA | |
| I _{OLXM} | $\overline{\text{XMUTE}}$ Sink Current | 2.5V | V $\overline{\text{XMUTE}}$ =0.5V | 1 | — | — | mA | |
| I _{HKS} | $\overline{\text{HKS}}$ Pin Input Current | 2.5V | V $\overline{\text{HKS}}$ =2.5V | — | — | 0.1 | μA | |
| R _{HFI} | HFI Pull-Low Resistance | 2.5V | V $\overline{\text{HFI}}$ =2.5V | — | 200 | — | kΩ | |
| R _{HDI} | $\overline{\text{HDI}}$ Pull-High Resistance | 2.5V | V $\overline{\text{HDI}}$ =0V | — | 200 | — | kΩ | |
| I _{OH1} | Keypad Pin Source Current | 2.5V | V _{OH} =0V | -4 | — | -40 | μA | |
| I _{OL1} | Keypad Pin Sink Current | 2.5V | V _{OL} =2.5V | 200 | 400 | — | μA | |
| I _{OH2} | HFO Pin Source Current | 2.5V | V _{OH} =2V | -1 | — | — | mA | |
| I _{OL2} | HFO Pin Sink Current | 2.5V | V _{OL} =0.5V | 1 | — | — | mA | |
| I _{OH3} | HDO Pin Source Current | 2.5V | V _{OH} =2V | -1 | — | — | mA | |
| I _{OL3} | HDO Pin Sink Current | 2.5V | V _{OL} =0.5V | 1 | — | — | mA | |
| T _{FP} | Pause Time After Flash | — | Control key | — | 0.2 | — | s | |
| | | | Digit key | — | 1 | — | | |
| T _{RP} | One-key Redialing Pause Time | — | One-key redialing | — | 1 | — | s | |
| T _{DB} | Key-in Debounce Time | — | — | — | 20 | — | ms | |
| T _{BRK} | Break Time for One-key Redialing | — | One-key redialing | — | 1.2 | — | s | |
| T _{KT} | Keytone Duration | — | — | — | 34 | — | ms | |
| F _{KTC} | Keytone Frequency | — | — | — | 1.2 | — | kHz | |
| F _{OSC} | System Frequency | — | Crystal=3.5795MHz | 3.5759 | 3.5795 | 3.5831 | MHz | |

Pulse Mode Electrical Characteristics

 (F_{OSC}=3.5795MHz, T_a=25°C)

| Symbol | Parameter | Test Conditions | | Min. | Typ. | Max. | Unit |
|------------------|---------------------------------------|-----------------|---|------|--------------------------|------|------|
| | | V _{DD} | Conditions | | | | |
| I _{POH} | \overline{PO} Output Source Current | 2.5V | V _{OH} =2V | -0.2 | — | — | mA |
| I _{POL} | \overline{PO} Output Sink Current | 2.5V | V _{OL} =0.5V | 0.2 | 0.6 | — | mA |
| PR | Pulse Rate | — | MODE pin is connected to V _{DD} | — | 10 | — | pps |
| | | | MODE pin is opened | — | 20 | — | |
| M/B | Make/Break Ratio | — | A resistor is linked between $\overline{R2}$ and $\overline{C1}$ | — | 33:66 | — | % |
| | | | No resistor is linked between $\overline{R2}$ and $\overline{C1}$ | — | 40:60 | — | |
| T _{PDP} | Pre-digit-pause Time | — | M/B ratio=40:60 | — | 40 (10pps) 20 (20pps) | — | ms |
| | | | M/B ratio=33:66 | — | 33 (10pps) 17 (20pps) | — | |
| T _{IDP} | Inter-digit-pause Time | — | Pulse rate=10pps | — | 800 | — | ms |
| | | | Pulse rate=20pps | — | 500 | — | |
| T _M | Pulse Make Duration | — | A resistor is linked between $\overline{R2}$ and $\overline{C1}$ | — | 33 (10pps) 17 (20pps) | — | ms |
| | | | No resistor is linked between $\overline{R2}$ and $\overline{C1}$ | — | 40 (10pps) 20 (20pps) | — | |
| T _B | Pulse Break Duration | — | A resistor is linked between $\overline{R2}$ and $\overline{C1}$ | — | 66 (10pps) 33 (20pps) | — | ms |
| | | | No resistor is linked between $\overline{R2}$ and $\overline{C1}$ | — | 60 (10pps) 30 (20pps) | — | |

Tone Mode Electrical Characteristics

 (F_{OSC}=3.5795MHz, T_a=25°C)

| Symbol | Parameter | Test Conditions | | Min. | Typ. | Max. | Unit |
|------------------|----------------------|-----------------|--------------------------------|---------------------|-------|--------------------|------------------|
| | | V _{DD} | Conditions | | | | |
| V _{TDC} | DTMF Output DC Level | — | — | 0.45V _{DD} | — | 0.7V _{DD} | V |
| I _{TOL} | DTMF Sink Current | 2.5V | V _{DTMF} =0.5V | 0.1 | — | — | mA |
| V _{TAC} | DTMF Output AC Level | — | Row group, R _L =5kΩ | 0.12 | 0.155 | 0.18 | V _{rms} |
| R _L | DTMF Output Load | 2.5V | THD≤-23dB | 5 | — | — | kΩ |
| ACR | Column Pre-emphasis | 2.5V | Row group=0dB | 1 | 2 | 3 | dB |

| Symbol | Parameter | Test Conditions | | Min. | Typ. | Max. | Unit |
|-------------------|--------------------------|-----------------|---------------------|------|------|------|------|
| | | V _{DD} | Conditions | | | | |
| THD | Tone Signal Distortion | 2.5V | R _L =5kΩ | — | -30 | -23 | dB |
| T _{TMIN} | Minimum Tone Duration | — | Auto-redial | — | 82.5 | — | ms |
| T _{ITPM} | Minimum Inter-tone Pause | — | Auto-redial | — | 85.5 | — | ms |

$$THD \text{ (Distortion) (dB)} = 20 \log \left(\frac{\sqrt{V_1^2 + V_2^2 + \dots + V_n^2}}{\sqrt{V_i^2 + V_h^2}} \right)$$

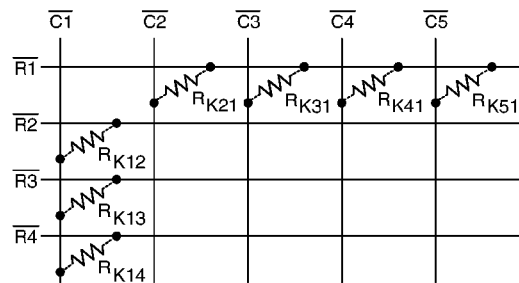
V_i, V_h: Row group and column group signals

V₁, V₂, ... V_n: Harmonic signals (BW=300Hz~3500Hz)

Functional Description

Keyboard matrix

C₁~C₅ and R₁~R₄ form a keyboard matrix. Together with a standard 4x5 keyboard, the keyboard matrix is used for dialing entries. In addition, the keyboard matrix provides resistor option for different dialing specification selections. The keyboard arrangement for each of the HT9312/3 series are shown in the **Keyboard Information**.



Tone frequency

| Tone Name | Output Frequency (Hz) | | % Error |
|----------------|-----------------------|--------|---------|
| | Specified | Actual | |
| R ₁ | 697 | 699 | +0.29% |
| R ₂ | 770 | 766 | -0.52% |
| R ₃ | 852 | 847 | -0.59% |
| R ₄ | 941 | 948 | +0.74% |
| C ₁ | 1209 | 1215 | +0.50% |
| C ₂ | 1336 | 1332 | -0.30% |
| C ₃ | 1477 | 1472 | -0.34% |

Note: % Error does not contain the crystal frequency drift

Dialing specification selection

Various dialing specifications can be selected by adding resistors across keyboard matrix pins. The allowable option resistor connections are shown on the table.

All the resistors are 330kΩ. The resistor option functions and the default specifications (without option resistors) are listed below.

| Option Resistor | Option Function | Default (No Resistor) |
|------------------|--|--|
| R _{K12} | Make/Break Ratio Selection | 40:60 |
| R _{K13} | Flash Function and Flash Time Selection | Flash= control function Flash time= 600ms |
| R _{K14} | | |
| R _{K21} | Pause & P→T Duration Selection | T _P = 3.6s T _{P→T} = 3.6s |
| R _{K31} | Pulse Number Selection or IDD Lock Selection | N or Keyboard operated lock |
| R _{K41} | | |
| R _{K51} | Keypad Form | FormA |

M/B ratio selection table

| R_{K12} | M/B Ratio (%) |
|------------------------|----------------------|
| No | 40:60 |
| Yes | 33.3:66.6 |

Flash function/time (duration) selection table

- HT9312x/xT series

| R_{K13} | R_{K14} | Flash Function | Flash Time (T_F) |
|------------------------|------------------------|-----------------------|-----------------------------------|
| No | No | Control | 600ms |
| No | Yes | Digit | 600ms |
| Yes | No | Digit | 98ms |
| Yes | Yes | Digit | 300ms |

- HT9312xL/xLT series

| R_{K13} | R_{K14} | Flash Function | Flash Time (T_F) |
|------------------------|------------------------|-----------------------|-----------------------------------|
| No | No | Control | 600ms |
| No | Yes | Control | 600ms |
| Yes | No | Control | 98ms |
| Yes | Yes | Control | 300ms |

- HT9313x series

| R_{K13} | R_{K14} | Flash Function | Flash Time (T_F) |
|------------------------|------------------------|-----------------------|-----------------------------------|
| No | No | Control | 600ms |
| No | Yes | Digit | 600ms |
| Yes | No | Digit | 86ms |
| Yes | Yes | Digit | 300ms |

Pause and P→T duration selection table

| R_{K21} | T_P (sec) | T_{P→T} (sec) |
|------------------------|----------------------------|------------------------------|
| No | 3.6 | 3.6 |
| Yes | 2 | 1 |

Pulse number selection table

- This table shows pulse number selections for HT9312x/HT9313x and HT9312xT. The table for HT9312xL/HT9312xI and HT9312xLT/HT9312xIT is used to select IDD lock function.

| R_{K31} | R_{K41} | Pulse Number |
|------------------------|------------------------|---------------------|
| No | No | N |
| No | Yes | N+1 |
| Yes | No | 10-N |
| Yes | Yes | — |

Pulse number table

| Keypad Digit Key | Output Pulse Number | | |
|-------------------------|----------------------------|---------------------------|-----------------------------|
| | Normal N | New Zealand (10-N) | Sweden/Denmark (N+1) |
| 1 | 1 | 9 | 2 |
| 2 | 2 | 8 | 3 |
| 3 | 3 | 7 | 4 |
| 4 | 4 | 6 | 5 |
| 5 | 5 | 5 | 6 |
| 6 | 6 | 4 | 7 |
| 7 | 7 | 3 | 8 |
| 8 | 8 | 2 | 9 |
| 9 | 9 | 1 | 10 |
| 0 | 10 | 10 | 1 |
| *T | P→T | P→T | P→T |
| # | Ignored | Ignored | Ignored |

The keyboard arrangement selection table

| R_{K51} | Keypad Form |
|------------------------|--------------------------------------|
| No | Form A (see keyboard information) |
| Yes | Form B (see keyboard information) |

Hand-free function operation

- Hand-free function execution
When HFO is low, a rising edge triggers the HFI, enabling the Hand-free function (HFO becomes high).
- Reset Hand-free function
When HFO is high, the Hand-free function is enabled and can be reset by:
 - Off-hook
 - Applying a rising edge to HFI
 - Changing the HDO pin from low to high
- Hand-free function table

| Current State | | | Input | | | Next State | |
|---------------|-----|-----|-------|-----|-----|------------|-----|
| HKS | HFO | HDO | HDI | HFI | HKS | HFO | HDO |
| H | L | X | H | L | An | L | An |
| H | L | X | H | ↑ | An | H | L |
| H | H | X | H | ↑ | An | L | An |
| H | X | L | H | L | L | L | L |
| L | L | X | H | L | An | L | An |
| L | L | X | H | ↑ | An | H | L |
| L | H | L | H | ↑ | An | L | An |
| L | X | X | H | L | H | An | An |
| X | X | L | ↓ | L | An | L | H |

H: Logic HIGH X: Don't care ↑: Rising edge
L: Logic LOW An: Unchanged ↓: Falling edge

Hold-line function operation

- Hold-line function execution
When HDO is low, a falling edge triggers the HDI, enabling the Hold-line function (HDO becomes high). The XMUTE remains low when HDO is high.
- Reset Hold-line function
When HDO is high, the Hold-line function is enabled and can be reset by:

- Off-hook
- Applying a falling edge to HDI
- Changing the HFO pin from low to high
- Hold-line function table

| Current State | | | Input | | Next State | | |
|---------------|-----|-----|-------|-----|------------|-----|-----|
| HKS | HDO | HFO | HFI | HDI | HKS | HDO | HFO |
| H | L | X | L | H | An | L | An |
| H | L | X | L | ↓ | An | H | L |
| H | H | L | L | ↓ | An | L | An |
| H | X | X | L | H | L | L | L |
| L | L | X | L | H | An | L | An |
| L | L | X | L | ↓ | An | H | L |
| L | H | L | L | ↓ | An | L | An |
| L | X | X | L | H | H | An | An |
| X | X | L | ↑ | H | An | L | H |

H: Logic HIGH X: Don't care ↑: Rising edge
L: Logic LOW An: Unchanged ↓: Falling edge

DOUT BCD code

When dialing, the corresponding 4-bit BCD codes are serially presented on DOUT from MSB to LSB. The data of DOUT is valid at the falling edge of the CLOCK pin. The following table lists the BCD codes corresponding to the keyboard input.

| Key-In | BCD Code | Key-In | BCD Code |
|--------|----------|--------|----------|
| 1 | 0001 | 8 | 1000 |
| 2 | 0010 | 9 | 1001 |
| 3 | 0011 | 0 | 1010 |
| 4 | 0100 | */T | 1101 |
| 5 | 0101 | # | 1100 |
| 6 | 0110 | F | 1011 |
| 7 | 0111 | P | 1110 |

LOCK function

The function aims to detect locked dialing number to prevent a long distance call. The dialing output of the chip is disabled if the first input key after on-off-hook is the locked number when the lock function is enabled. The lock function selection is listed below. This function is implemented in both the HT9312xL/HT9312xI and HT9312xLT/HT9312xIT. The HT9312x/HT9313x and HT9312xT do not support this function.

| R_{K31} | R_{K41} | Function |
|------------------------|------------------------|---|
| No | No | Keyboard operated IDD lock (not supported for HT9312xI and HT9312xIT) |
| No | Yes | Lock 0 |
| Yes | No | Lock 0, 9 |
| Yes | Yes | All keys are locked |

Key definition

- 0,1,2,3,4,5,6,7,8,9 keys
These are dialing number input keys for both the pulse mode and the tone mode operations.
- */T
This key executes the P→T function and waits a T_{P→T} duration in the pulse mode. On the other hand, the */T key executes the * function in the tone mode.
- #
This is a dialing signal key for the tone mode only, no response in the pulse mode.
- SA
Pressing this key can save the preceding dialing telephone numbers. The saved number is redialed if it is pressed again. SA will also redial the saved number if it is the first key pressed at the off-hook state. During the dialing signal transmission, the SA key is inhibited.

- F
The flash key can be selected as a digit or as a control key by the option resistors R_{K13} & R_{K14}. Pressing the flash key will force the \overline{PO} pin to be "low" for the T_F duration and is then followed by T_{FP} (sec). T_F can also be selected by R_{K13}, R_{K14}.
- P
Pause key. The execution of this key pauses the output for the T_P duration. T_P can be selected by R_{K21}.
- R
Redial key. Executes redialing as well as one-key redial function.
- ST
Store key. The execution of the key can actuate the store memory function with (or without) dialing output and it can store lock number with personal code in IDD lock operation. During the dialing signal transmission, the ST key is inhibited.
- R/P
Redial and pause function key. If it is pressed as the first key after off-hook, this key executes the redial function. Otherwise, it works as the pause key.
- A
Auto key. When this key is pressed before pressing any one of the digital keys (0~9) it executes the two-touch memory dialing function.

Keyboard operation

The following operations are all described under an on-off-hook or on-hook condition with the hand-free active condition.

- Normal dialing

- Pulse mode

- (a) without */T

Keyboard input: **D1** **D2** ... **Dn**

Dialing output: D1 D2 ... Dn

RM: D1 D2 ... Dn

SAM: Unchanged

- (b) with */T

Keyboard input: **D1** **D2** ... **Dn** ***/T** **Dn+1** ...
Dm

Dialing output: D1 D2 ... Dn $T_{P \rightarrow T}$ Dn+1 ... Dm
Pulse Tone

RM: D1 D2 ... Dn */T Dn+1 ... Dm

SAM: Unchanged

- Tone mode

- (a) without */T

Keyboard input: **D1** **D2** ... **Dn**

Dialing output: D1 D2 ... Dn

RM: D1 D2 ... Dn

SAM: Unchanged

- (b) with */T

Keyboard input: **D1** **D2** ... **Dn** ***/T** **Dn+1** ...
Dm

Dialing output: D1 D2 ... Dn * Dn+1 ... Dm

RM: D1 D2 ... Dn * Dn+1 ... Dm

SAM: Unchanged

Note: The maximum capacity of the RM memory is 32 digits. When more than 32 digits are entered, the signal is transmitted but the redial function is inhibited.

- Redial

- Pulse mode

- (a) without */T

RM content: D1 D2 ... Dn

Keyboard input: [**R**] or [**R/P**]

Dialing output: D1 D2 ... Dn

RM: Unchanged

SAM: Unchanged

- (b) with */T

RM content: D1 D2 ... Dn */T Dn+1 ... Dm

Keyboard input: [**R**] or [**R/P**]

Dialing output: D1 D2 ... Dn $T_{P \rightarrow T}$ Dn+1 ... Dm
Pulse Tone

RM: Unchanged

SAM: Unchanged

- Tone mode

- (a) without */T

RM content: D1 D2 ... Dn

Keyboard input: [**R**] or [**R/P**]

Dialing output: D1 D2 ... Dn

RM: Unchanged

SAM: Unchanged

- (b) with */T

RM content: D1 D2 ... Dn */T Dn+1 ... Dm

Keyboard input: [**R**] or [**R/P**]

Dialing output: D1 D2 ... Dn * Dn+1 ... Dm

RM: Unchanged

SAM: Unchanged

• One-key redial

- Pulse mode

(a) without */T

Keyboard input: **D1** **D2** ... **Dn** **R**
 Dialing output: D1 D2 ... Dn TBRK TRP
 D1 D2 ... Dn
 RM: D1 D2 ... Dn
 SAM: Unchanged

(b) with */T

Keyboard input: **D1** **D2** ... **Dn** ***/T** **Dn+1** ...
 Dm **R**
 Dialing output: D1 D2 ... Dn TP→T Dn+1 ... Dm
 Pulse Tone
 TBRK TRP D1 D2 ... Dn TP→T
 Pulse
 Dn+1 ... Dm
 Tone
 RM: D1 D2 ... Dn */T Dn+1 ... Dm
 SAM: Unchanged

- Tone mode

(a) without */T

Keyboard input: **D1** **D2** ... **Dn** **R**
 Dialing output: D1 D2 ... Dn TBRK TRP D1 D2
 ... Dn
 RM: D1 D2 ... Dn
 SAM: Unchanged

(b) with */T

Keyboard input: **D1** **D2** ... **Dn** ***/T** **Dn+1** ...
 Dm **R**
 Dialing output: D1 D2 ... Dn * Dn+1 ... Dm
 TBRK TRP D1 D2 ... Dn * Dn+1
 ... Dm
 RM: D1 D2 ... Dn * Dn+1 ... Dm
 SAM: Unchanged

Note: If the dialing number exceeds 32 digits, redialing is inhibited and $\overline{PO}=VDD$

• SA copy

- Pulse mode

(a) without */T

Keyboard input: **D1** **D2** ... **Dn** **SA**
 Dialing output: D1 D2 ... Dn
 RM: D1 D2 ... Dn
 SAM: D1 D2 ... Dn

(b) with */T

Keyboard input: **D1** **D2** ... **Dn** ***/T** **Dn+1** ...
 Dm **SA**
 Dialing output: D1 D2 ... Dn TP→T Dn+1 ... Dm
 Pulse Tone
 RM: D1 D2 ... Dn */T Dn+1 ... Dm
 SAM: D1 D2 ... Dn */T Dn+1 ... Dm

- Tone mode

(a) without */T

Keyboard input: **D1** **D2** ... **Dn** **SA**
 Dialing output: D1 D2 ... Dn
 RM: D1 D2 ... Dn
 SAM: D1 D2 ... Dn

(b) with */T

Keyboard input: **D1** **D2** ... **Dn** ***/T** **Dn+1** ...
 Dm **SA**
 Dialing output: D1 D2 ... Dn * Dn+1 ... Dm
 RM: D1 D2 ... Dn * Dn+1 ... Dm
 SAM: D1 D2 ... Dn * Dn+1 ... Dm

Note: The maximum capacity of the RM memory is 32 digits. When more than 32 digits plus the "SA" key are entered, the SAVE function will not be executed, and all the existing data in the save memory will not be changed.

• SA dialing

– Pulse mode

(a) without */T

SAM content: D1 D2 ... Dn
 Keyboard input: **SA**
 Dialing output: D1 D2 ... Dn
 RM: Unchanged
 SAM: Unchanged

(b) with */T

SAM content: D1 D2 ... Dn */T Dn+1 ... Dm
 Keyboard input: **SA**
 Dialing output: $\underbrace{D1 D2 \dots Dn}_{\text{Pulse}} \text{ TP} \rightarrow \text{T} \underbrace{Dn+1 \dots Dm}_{\text{Tone}}$
 RM: Unchanged
 SAM: Unchanged

– Tone mode

(a) without */T

SAM content: D1 D2 ... Dn
 Keyboard input: **SA**
 Dialing output: D1 D2 ... Dn
 RM: Unchanged
 SAM: Unchanged

(b) with */T

SAM content: D1 D2 ... Dn * Dn+1 ... Dm
 Keyboard input: **SA**
 Dialing output: D1 D2 ... Dn * Dn+1 ... Dm
 RM: Unchanged
 SAM: Unchanged

• Flash

– Flash as a digital key

(a) The intervenient key

Keyboard input: **D1 D2 ... Dn F Dn+1 ... Dm**
 Dialing output: D1 D2 ... Dn T_F T_{FP} Dn+1 ... Dm
 RM: D1 D2 ... Dn
 SAM: Unchanged

(b) The first key

Keyboard input: **F D1 D2 ... Dn**
 Dialing output: T_F T_{FP} D1 D2 ... Dn
 RM: Unchanged
 SAM: Unchanged

– Flash as a control key

Keyboard input: **D1 D2 ... Dn F Dn+1 ... Dm**
 Dialing output: D1 D2 ... Dn T_F T_{FP} Dn+1 ... Dm
 RM: Dn+1 ... Dm
 SAM: Unchanged

Note: T_F: break a flash time

• Pause

Keyboard input: **D1 D2 ... Dn ([P] or [R/P]) Dn+1 ... Dm**
 Dialing output: D1 D2 ... Dn T_P Dn+1 ... Dm
 RM: D1 D2 ... Dn P Dn+1 ... Dm
 SAM: Unchanged

- Memory store

- Memory store without dialing output

Keyboard input: **ST** **D1** **D2** ... **Dn** **ST** **EMa**
 Dialing output: D1 D2 ... Dn
 RM: D1 D2 ... Dn
 SAM: Unchanged

- Memory store with dialing output

Keyboard input: **D1** **D2** ... **Dn** **ST** **ST** **EMa**
 Dialing output: D1 D2 ... Dn
 RM: D1 D2 ... Dn
 SAM: Unchanged

Note: If the dialing number exceeds 32 digits, the memory store is inhibited.
 However, if the dialing number is not more than 32 digits the memory will store a max. of 16 digits.
 EMa=EM1~EM3

- Memory dialing

EMa content: D1 D2 ... Dn
 Keyboard input: **EMa**
 Dialing output: D1 D2 ... Dn
 RM: D1 D2 ... Dn
 SAM: Unchanged

Note: EMa=EM1~EM3.

- Chain dialing

EM1 content: D1 D2 ... Dn
 EM2 content: Dn+1 ... Dm
 Keyboard input: **D1** **D2** **D3** **EM1** **EM2**
 Dialing output: D1 D2 ... D3 D1 D2 ... Dn Dn+1 ... Dm
 EM1: Unchanged
 EM2: Unchanged
 RM: D1 D2 ... Dn
 SAM: Unchanged

Note: The maximum capacity of the RM memory is 32 digits. When the dialing number exceeds 32 digits, redialing is inhibited and $\overline{PO}=VDD$

- Note:

RM: Redial memory
 SAM: Save dialing memory
 D1 D2 ... Dn: 0~9
 Dn+1 ... Dm: 0~9, *, #

- IDD lock operation by the keyboard (2 lock numbers, 3 digits/number at maximum)

– Personal/Lock No.1/Lock No.2 input operation

(a) Personal code doesn't exist

Stores Personal Code: ST D1 D2 D3 ST * 0

Stores Lock No.1: ST D4 D5 D6 ST * 1

Stores Lock No.2: ST D7 D8 D9 ST * 2

(b) Personal code exist

Changes Personal Code: ST D1 D2 D3 ST # ST D4 D5 D6 ST * 0

(Old personal code) (New personal code)

Changes Lock No.1: ST D1 D2 D3 ST # ST D4 D5 D6 ST * 1

(Personal code) (Lock No.1)

Changes Lock No.2: ST D1 D2 D3 ST # ST D7 D8 D9 ST * 2

(Personal code) (Lock No.2)

Changes Personal Code, Lock No.1 and Lock No.2 at one time

ST D1 D2 D3 ST # ST D4 D5 D6 ST * 0 (continued)

(Old personal code) (New personal code)

ST D7 D8 D9 ST * 1 ST D10 D11 D12 ST * 2

(Lock No.1) (Lock No.2)

– Personal/Lock No.1/Lock No.2 cancel operation

Cancels Personal code: ST D1 D2 D3 ST # ST # 0

Cancels Lock No.1: ST D1 D2 D3 ST # ST # 1

Cancels Lock No.2: ST D1 D2 D3 ST # ST # 2

– Temporary release both of the lock numbers (Lock No.1, Lock No.2):

ST D1 D2 D3 ST # Dm Dm+1 Dm+2 DI ... Dn

(Personal code)

Note: D1~D12 = 0~9

Dm Dm+1 Dm+2 = 0~9

DI ... Dn = 0~9, *, #

- Note:

RM: Redial memory

SAM: Save dialing memory

D1 D2 ... Dn: 0~9

Dn+1 ... Dm: 0~9, *, #

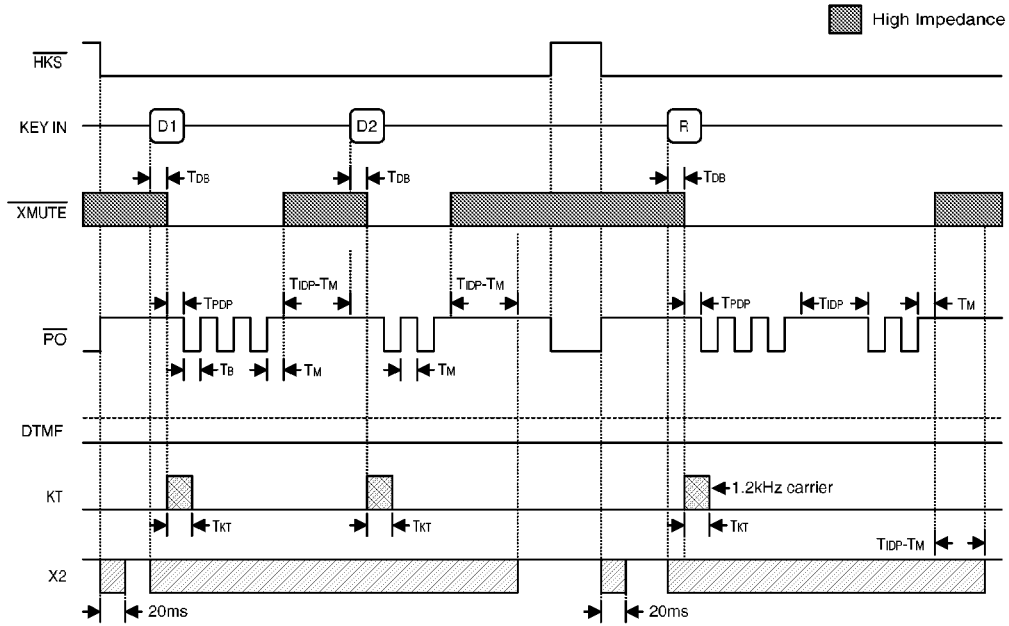
Dm+1 ... DI: 0~9, *, #

DI+1 ... DK: 0~9, *, #

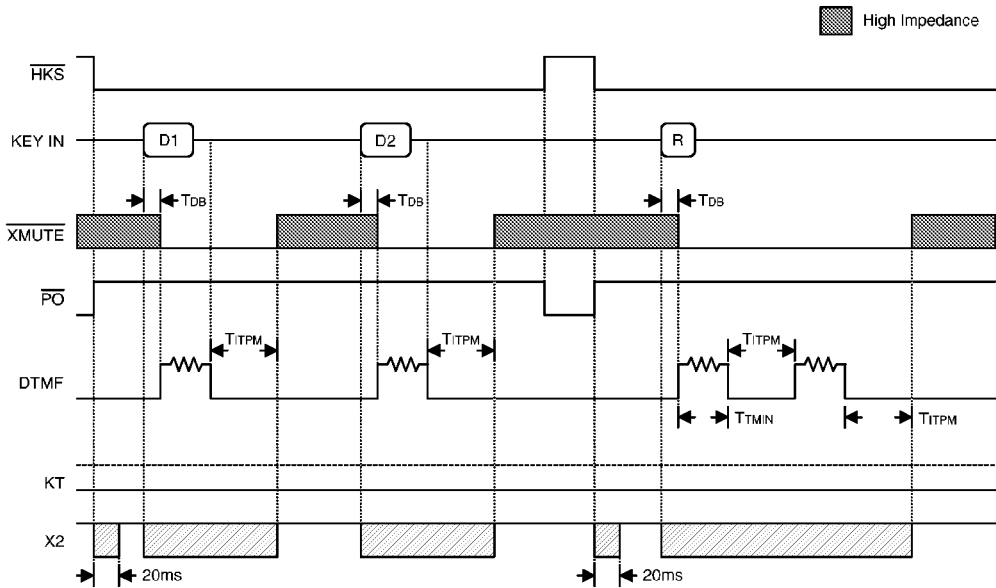
Timing Diagrams

Normal dialing

- Pulse mode

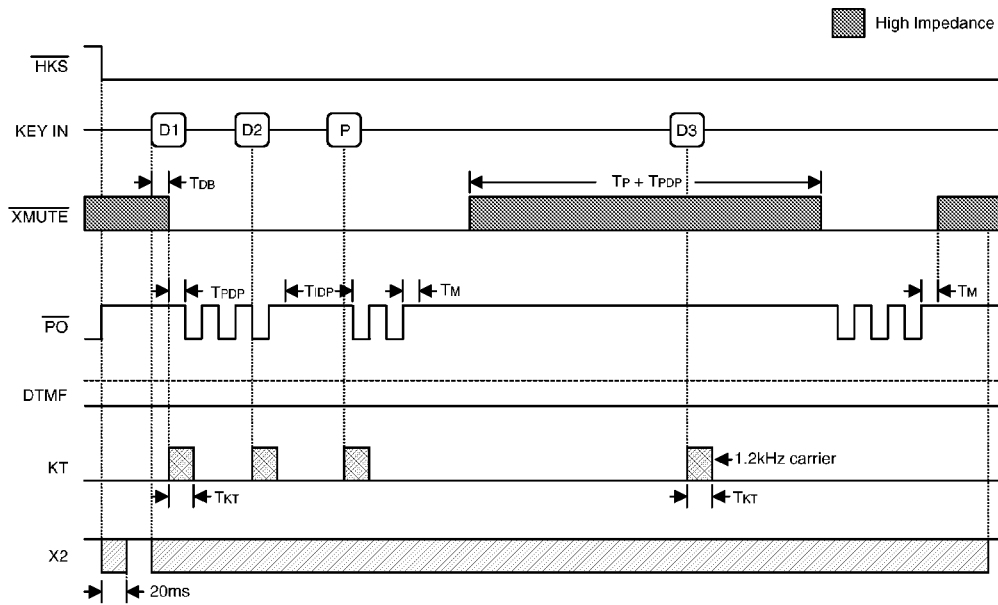


- Tone mode

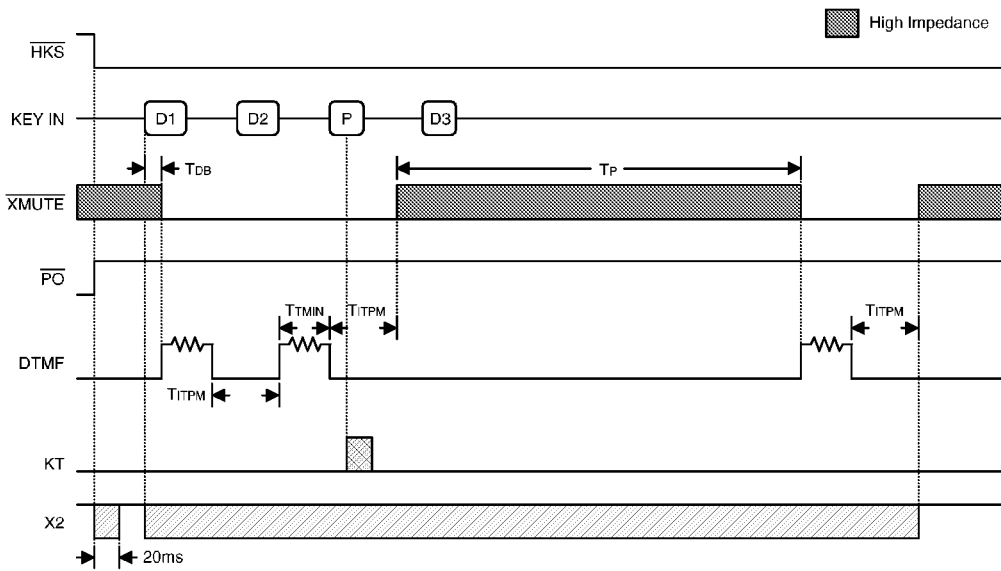


Dialing with pause key

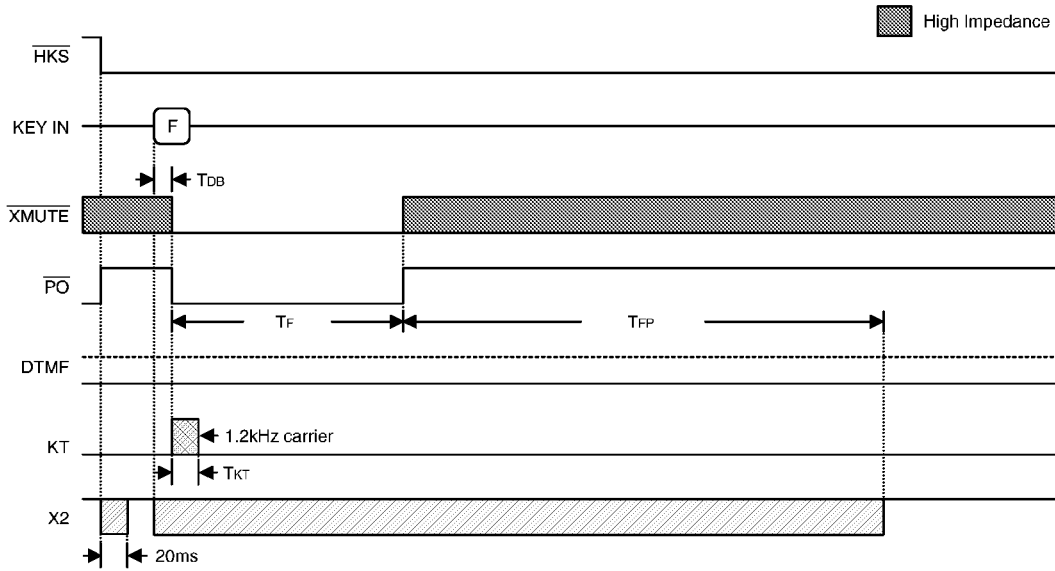
- Pulse mode



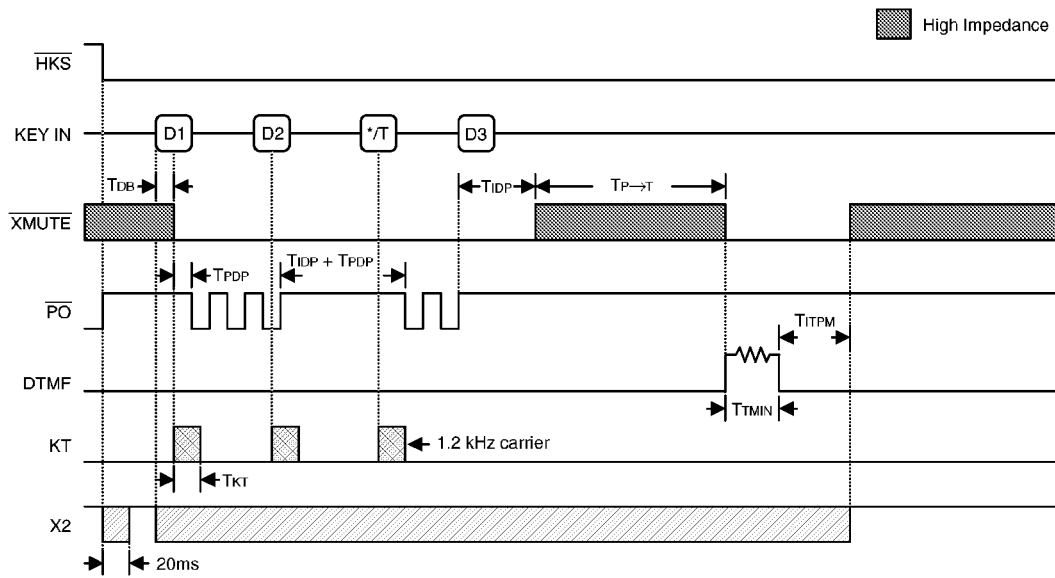
- Tone mode



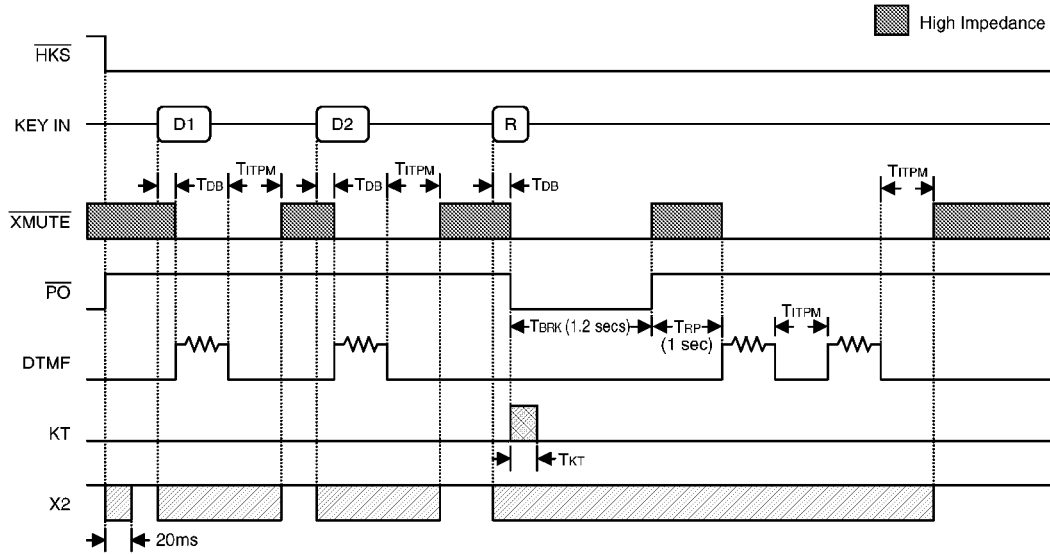
Flash key operation



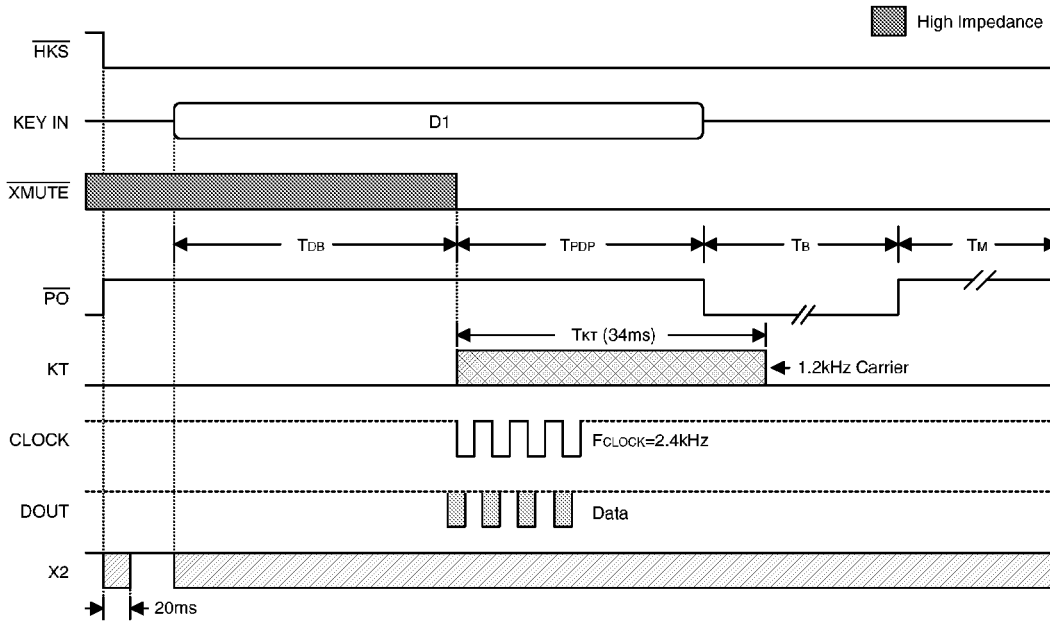
Pulse→Tone operation



One key redial operation

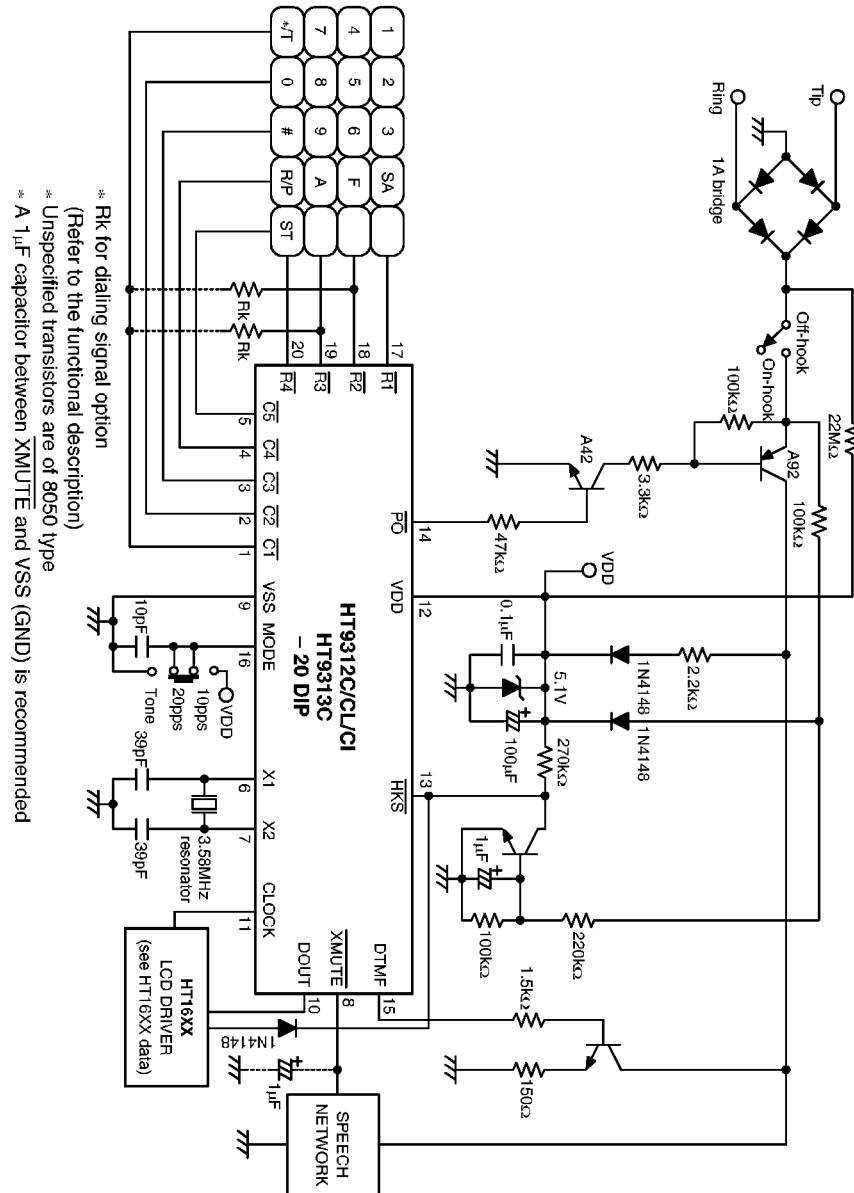


CLOCK & DOUT operation



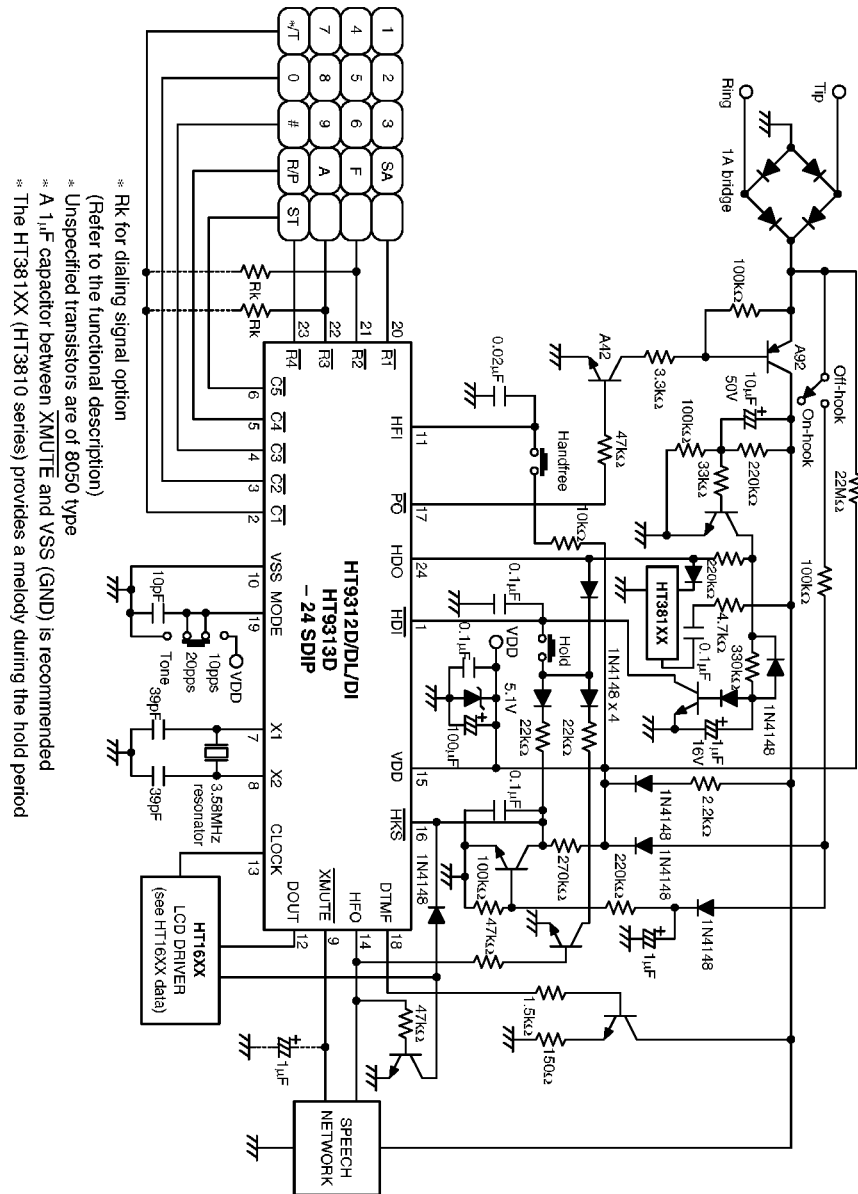
Note: D1=D3=3
D2=2

Application circuit 3



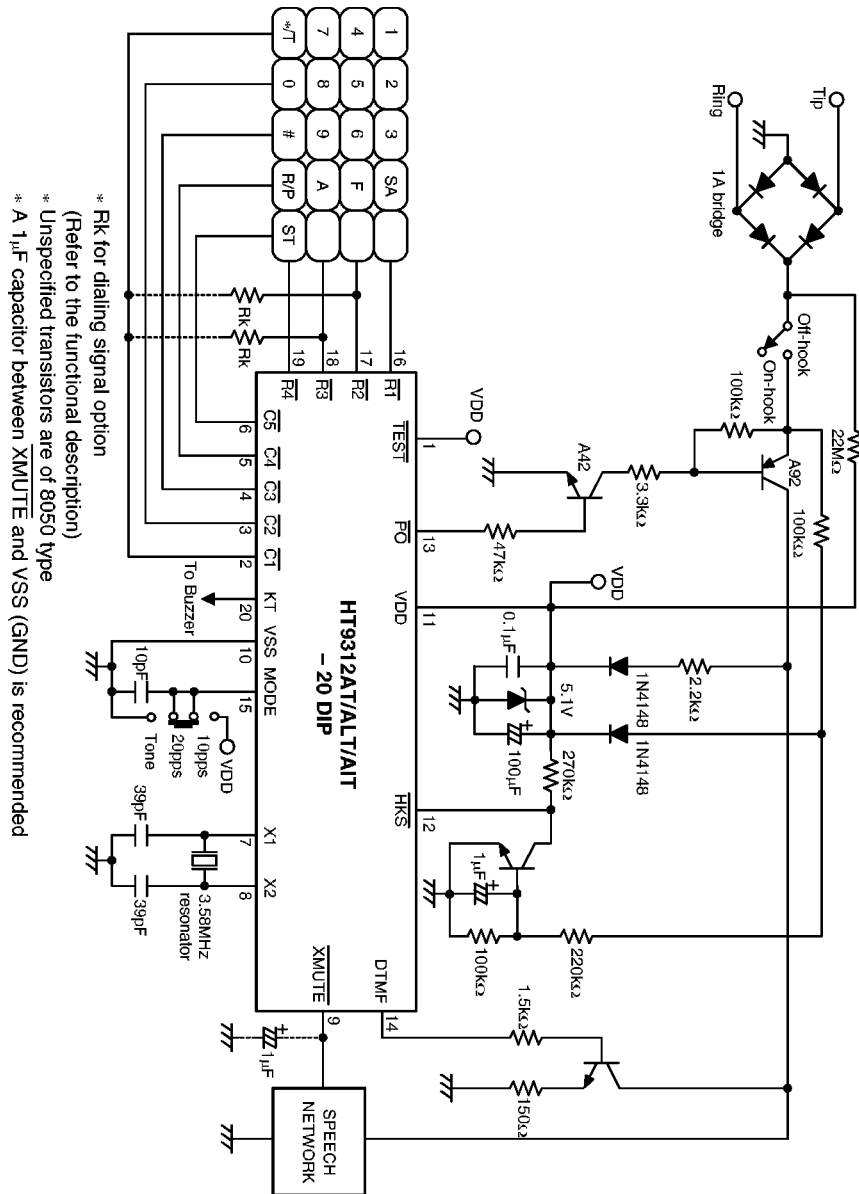
* Rk for dialing signal option
 (Refer to the functional description)
 * Unspecified transistors are of 8050 type
 * A 1µF capacitor between XMUTE and VSS (GND) is recommended

Application circuit 4

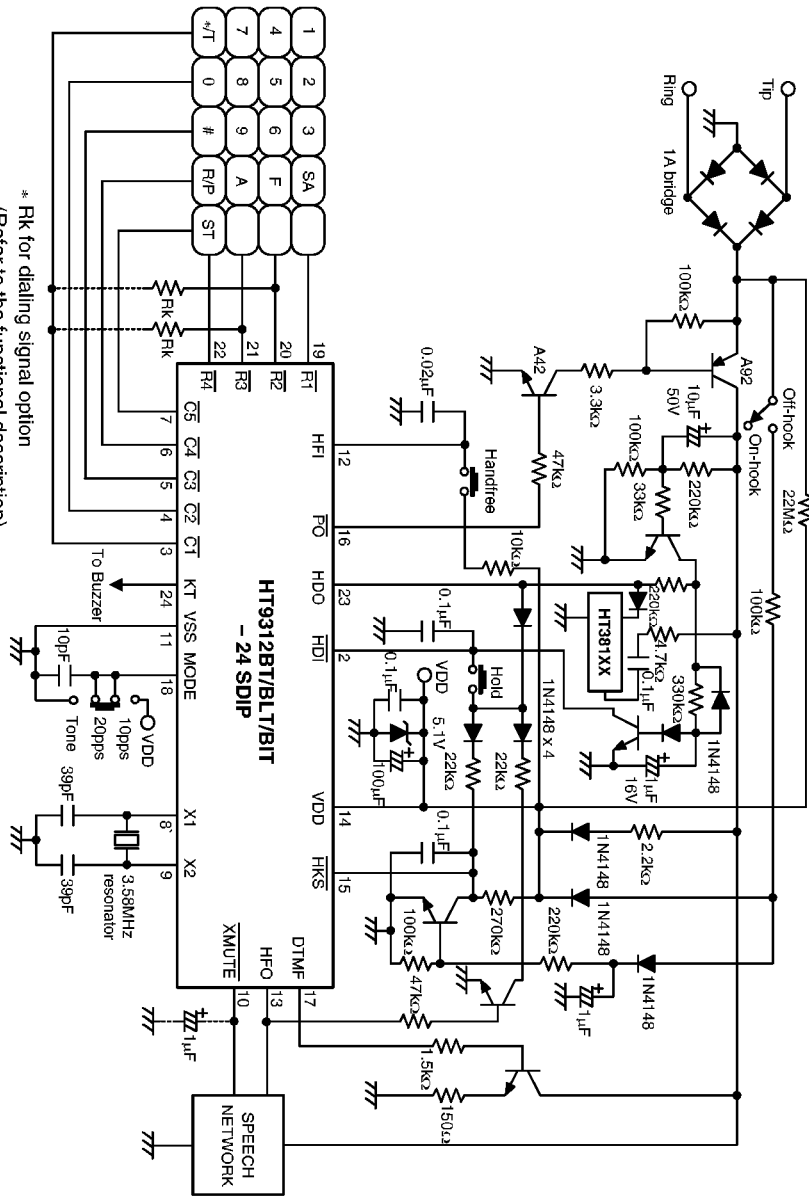


* Rk for dialing signal option
 (Refer to the functional description)
 * Unspecified transistors are of 8050 type
 * A 1µF capacitor between XMUTE and VSS (GND) is recommended
 * The HT381XX (HT3810 series) provides a melody during the hold period

Application circuit 5

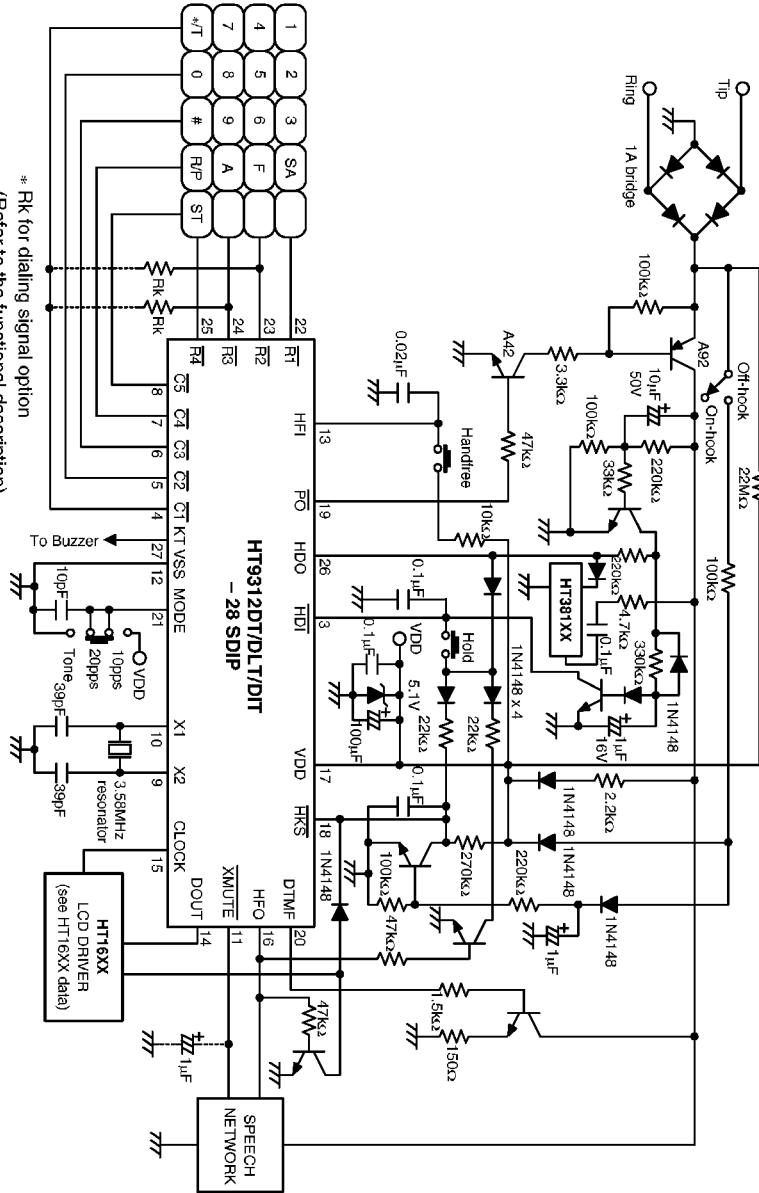


Application circuit 6



- * Rk for dialling signal option
(Refer to the functional description)
- * Unspecified transistors are of 8050 type
- * A 1.μF capacitor between XMUTE and VSS (GND) is recommended
- * The HT381XX (HT3810 series) provides a melody during the hold period

Application circuit 8



- * Rk for dialling signal option
(Refer to the functional description)
- * Unspecified transistors are of 8050 type
- * A 1.1µF capacitor between XMUTE and VSS (GND) is recommended
- * The HT381XX (HT3810 series) provides a melody during the hold period