# Features

## Speech Circuit
- **Adjustable DC Characteristic**
- **Symmetrical Input of Microphone Amplifier**
- **Receiving Amplifier for Dynamic or Piezo-electric Earpieces**
- **Automatic Line-loss Compensation**

## Dialer
- **DTMF/Pulse Switchable**
- **Pulse Dialing 66/33 or 60/40 or DTMF Dialing Selectable by Pin**
- **Selectable Flashing Duration by Key Pad**
- **Pause Function**
- **Optical Indication of Temporary DTMF Mode**
- **Keytone for Pulse Dialing**
- **Last Number Redial up to 32 Digits**
- **Three by 17 Digits Direct (One-touch) Memory**
- **Ten by 17 Digits Indirect (Two-touch) Memory**
- **Notice Function up to 32 Digits**
- **Standard Low-cost Crystal 3.58 MHz or Ceramic Resonator**
- **Handset Mute (Privacy) with Optical Indication**
- **Additional Toggle Flipflop**
- **Internal Loop Interrupt Detection**

## Tone Ringer
- **2-tone Ringer**
- **Adjustable Volume**
- **RC Oscillator**
- **Adjustable Threshold**

# Benefits
- **Low Number of External Components**
- **High Quality through One IC Solution**

Electrostatic sensitive device.
Observe precautions for handling.

# Universal Telephone IC - All Functions Integrated

# U3761MB-T

Rev. 4744A–CORD–09/03

# Description

Atmel's low-voltage telephone circuit U3761MB-T performs all the speech and line interface functions required in an electronic telephone set, a tone ringer, a pulse and DTMF dialing with redial, notice function, and 13 memories. Operation below 15 mA is possible with reduced performance.
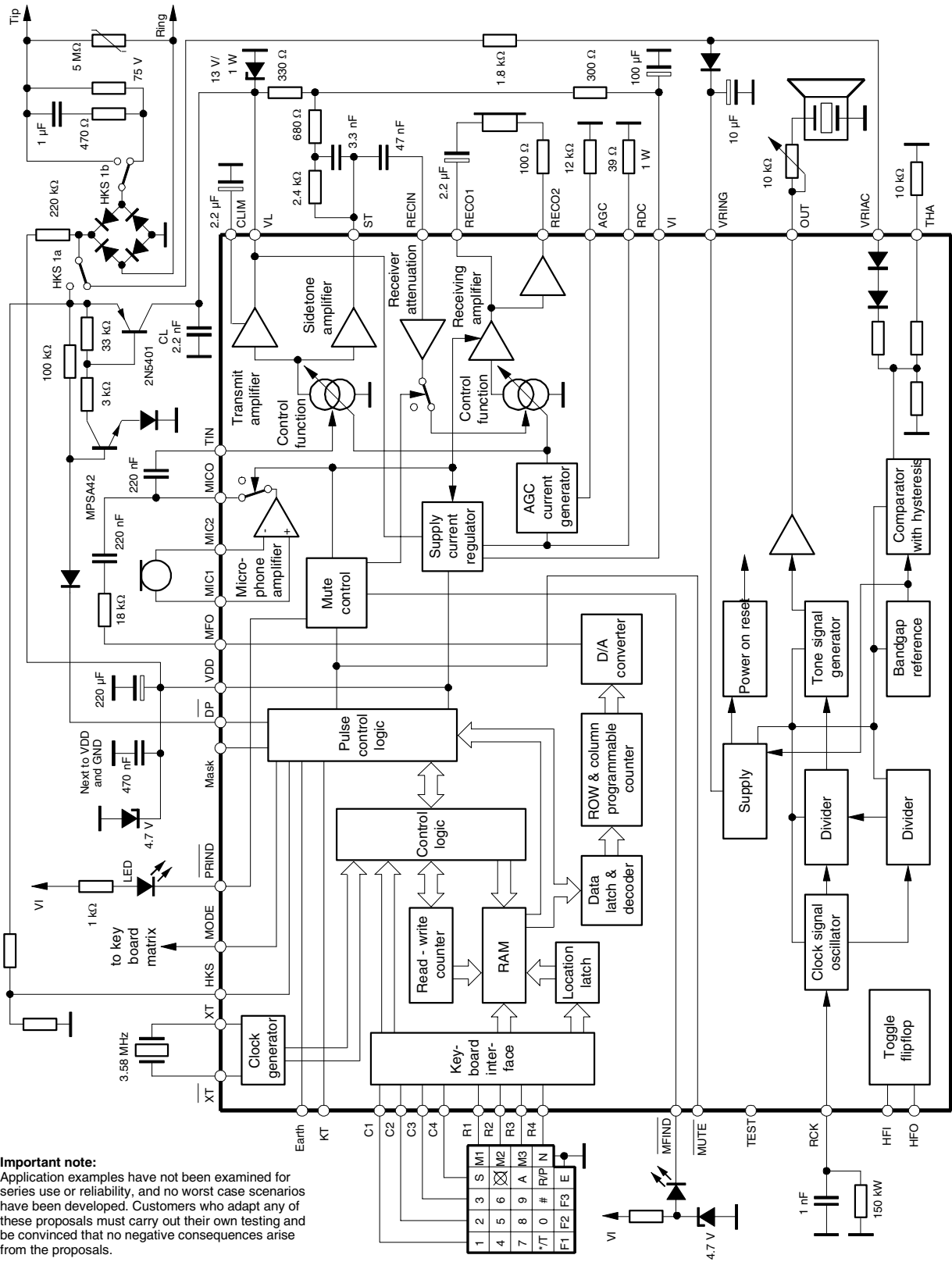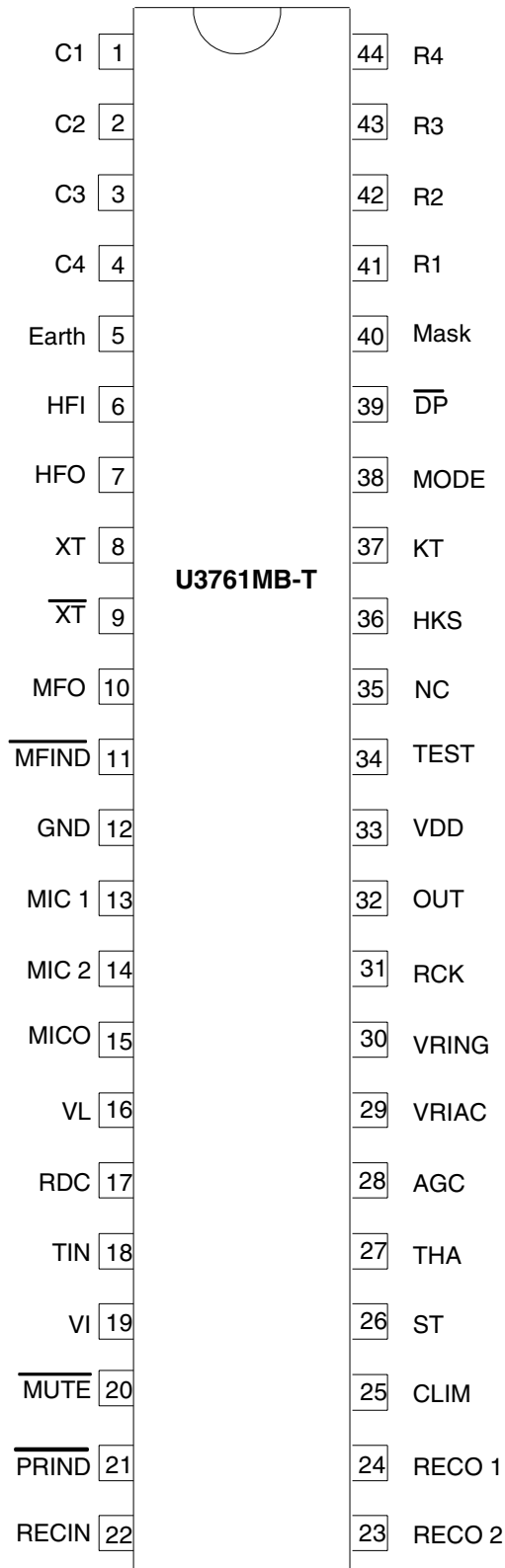
**Figure 1.** Block Diagram



**Important note:**
Application examples have not been examined for series use or reliability, and no worst case scenarios have been developed. Customers who adapt any of these proposals must carry out their own testing and be convinced that no negative consequences arise from the proposals.

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## Pin Configuration

**Figure 2.** Pinning SSO44

| Pin | | | Pin |
|---|---|---|---|
| C1 | 1 | 44 | R4 |
| C2 | 2 | 43 | R3 |
| C3 | 3 | 42 | R2 |
| C4 | 4 | 41 | R1 |
| Earth | 5 | 40 | Mask |
| HFI | 6 | 39 | $\overline{DP}$ |
| HFO | 7 | 38 | MODE |
| XT | 8 | 37 | KT |
| $\overline{XT}$ | 9 | 36 | HKS |
| MFO | 10 | 35 | NC |
| $\overline{MFIND}$ | 11 | 34 | TEST |
| GND | 12 | 33 | VDD |
| MIC 1 | 13 | 32 | OUT |
| MIC 2 | 14 | 31 | RCK |
| MICO | 15 | 30 | VRING |
| VL | 16 | 29 | VRIAC |
| RDC | 17 | 28 | AGC |
| TIN | 18 | 27 | THA |
| VI | 19 | 26 | ST |
| $\overline{MUTE}$ | 20 | 25 | CLIM |
| $\overline{PRIND}$ | 21 | 24 | RECO 1 |
| RECIN | 22 | 23 | RECO 2 |

**U3761MB-T**

## Pin Description

| Pin | Symbol | Function | Configuration |
|-----|--------|----------|---------------|
| 1 | C1 | Keyboard input |  |
| 2 | C2 | | |
| 3 | C3 | | |
| 4 | C4 | | |
| 5 | Earth | Earth key (604 ms high pulse, 1 s pause) |  |
| 6 | HFI | Toggle flipflop input<br>Input with 200 kΩ pull-down resistor<br>HFI triggers HFO with each LOW/HIGH edge |  |
| 7 | HFO | Output will be toggled by each LOW/HIGH edge at HFI |  |

## Pin Description

| Pin | Symbol | Function | Configuration |
|-----|--------|----------|---------------|
| 8<br>9 | XT<br>$\overline{XT}$ | A built-in inverter provides oscillation with an inexpensive 3.579545-MHz crystal or ceramic resonator |  |
| 10 | MFO | Output of DTMF<br>DTMF output frequency<br>Specified (Hz) Actual (Hz) Error (%)<br>$R_1$  697       699       +0.28<br>$R_2$  770       766       -0.52<br>$R_3$  852       848       -0.47<br>$R_4$  941       940       -0.10<br>$C_1$  1209      1216      +0.57<br>$C_2$  1336      1332      -0.30<br>$C_3$  1477      1472      -0.34 |  |
| 11 | $\overline{MFIND}$ | During the temporary DTMF mode the output switches to low<br>Reset by on hook condition<br>Maximum voltage at $\overline{MFIND}$ = 5.5 V |  |
| 12 | GND | Ground | |
| 13<br>14 | MIC 1<br>MIC 2 | Inverting input of microphone amplifier<br><br>Non-inverting input of microphone amplifier |  |

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## Pin Description

| Pin | Symbol | Function | Configuration |
|-----|--------|----------|---------------|
| 15 | MICO | Transmit pre-amp output which is normally capacitively coupled to Pin TIN |  |
| 16 | VL | Positive supply voltage input to the device. The current through this pin is modulated by the transmit signal. |  |
| 17 | RDC | An external resistor (1 W) is required from this pin to GND to control the DC input impedance of the circuit. It has a nominal value of 39 $\Omega$ for low-voltage operation. Values up to 100 $\Omega$ may be used to increase the available transmit output voltage swing at the expense of low-voltage operation. |  |
| 18 | TIN | Input to the line output driver amplifier. Transmit AGC applied to this stage. |  |
| 19 | $V_I$ | This internal voltage bias line must be connected to VL via an external resistor which dominates the AC input impedance of the circuit and should be 680 $\Omega$ for an 600-$\Omega$ input impedance or 1.2 k$\Omega$ for a 900-$\Omega$ input impedance. |  |

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## Pin Description

| Pin | Symbol | Function | Configuration |
|-----|--------|----------|---------------|
| 20 | $\overline{\text{MUTE}}$ | Pin for testing<br>Forcing $\overline{\text{MUTE}}$ to GND mutes the microphone and decreases the earpiece signal by typically 29 dB; no pull up circuit allowed | |
| 21 | $\overline{\text{PRIND}}$ | PRIVACY indication pin<br>Open collector with minimum 1 mA drive current to GND when PRIVACY = active | |
| 22 | RECIN | Receive amplifier input. The receiving amplification is regulated by an AGC. | |
| 23<br><br>24 | RECO2<br><br>RECO1 | Output of the receive amplifier. Dynamic transducers with a minimum impedance of 100 Ω can be directly driven by these outputs. | |
| 25 | CLIM | Time constant of anticlipping in transmit path.<br>CLIM ≥ 2.2 µF<br>CLIM = GND: anticlipping inactive | |
| 26 | ST | The output of the sidetone cancellation signal, which requires a balanced impedance of 8 to 10 times the subscriber's line impedance to be connected to pin VL. | |

## Pin Description

| Pin | Symbol | Function | Configuration |
|-----|--------|----------|---------------|
| 27 | THA | Ringer threshold adjustment |  |
| 28 | AGC | The range of transmit and receive gain variations between short and long loops may be adjusted by connecting a resistor $R_{AGC}$ from this pin to (GND). This pin can be left open to set AGC out of action. |  |
| 29 | VRIAC | Ringing supply |  |
| 30 | VRING | DC supply voltage for the tone ringer is limited to 30 V with integrated Z-diode. |  |
| 31 | RCK | RC clock oscillator for ringer |  |

## Pin Description

| Pin | Symbol | Function | Configuration |
|---|---|---|---|
| 32 | OUT | Buzzer output |  |
| 33 | VDD | Supply output for dialer part |  |
| 34 | Test | Test input with 6.25 kΩ pull-up resistor |  |
| 35 | NC | Not connected | |
| 36 | HKS | Hook switch input<br>HKS = 0: On-hook state. Chip in sleep mode, no operation (external pull-down resistor recommended)<br>HKS = 1: Off-hook state. Chip enable for normal operation<br>$I_{HKS} \leq 0.5$ mA |  |
| 37 | KT | Keytone output signal which is sent out in pulse dialing mode with a keytone frequency of 582 Hz.<br>KT sink/drive current is about 100 µA at $V_{DD} = 2.5$ V |  |

## Pin Description

| Pin | Symbol | Function | Configuration |
|---|---|---|---|
| 38 | MODE | Pulling MODE pin to:<br>C3: tone mode with 87 ms burst time and 140 ms pause<br>C4: tone mode with 87 ms DTMF burst and 87 ms pause<br>R1: pulse mode with 20 pps, Make/Break = 40/60<br>R2: pulse mode with 20 pps, Make/Break = 33/66<br>R3: pulse mode with 10 pps, Make/Break = 40/60<br>R4: pulse mode with 10 pps, Make/Break = 33/66<br>C1: pulse mode with 10 pps, Make/Break = 33/66 and temp.<br>DTMF with 87 ms DTMF burst, 140 ms pause<br>MODE pin pulled to R4: with temporary DTMF, 87 ms DTMF burst and 87 ms pause |  |
| 39 | $\overline{DP}$ | Pulse dialing output. Flash key will cause $\overline{DP}$ to be active in either DTMF mode or pulse mode.<br>In on-hook state is $\overline{DP}$ = VDD |  |
| 40 | Mask | Short mute during pulse dialing, active high<br>During MASK an internal NPN transistor shortens VL against VI. |  |
| 41 | R1 | Keyboard input |  |
| 42 | R2 | | |
| 43 | R3 | | |
| 44 | R4 | | |

## Keyboard Operation

| C1 | C2 | C3 | C4 | | |
|----|----|----|----|----|----|
| 1 | 2 | 3 | S | M1 | R1 |
| 4 | 5 | 6 | ⊠ | M2 | R2 |
| 7 | 8 | 9 | A | M3 | R3 |
| */T | 0 | # | R/P | N | R4 |
| F1 | F2 | F3 | E | ⊥ | |

⊥ ←

- S: Store function key
- A: Indirect repertory dialing function key (LN 0 to 9)
- R/P: Redial and pause function key
- N: Notice function
- */T: * function; pulse-to-tone function
- M1 to M3: One-touch memory
- F1, F2, F3: Flash keys

### Normal Dialing

OFF HOOK , D1 D2 , ..., Dn

1. D1, D2, ..., Dn will be dialed out.
2. Dialing length is unlimited, but redial is inhibited if length oversteps 32 digits.
3. If redialing length oversteps 32 digits, the redialing function will be inhibited.

### Redialing

OFF HOOK , D1 , D2 , ..., Dn BUSY, Come ON HOOK ,OFF HOOK , R/P

The R/P key can execute the redial function only as the first key-in after off-hook; otherwise, it executes the pause function (3.6 s).
Keys stored in redial memory: 0 to 9, #, R/P, A, M1, M2, M3, N, * (only tone mode)

Characters F1, F2, F3, Earth, (* in pulse mode) can only be stored in Mn, Ln and N memory.
Characters F1, F2, F3, Earth, (* in pulse mode) will not be dialled out from redial memory; dialling out was stopped, when recognizing one of the above characters.

Example:

OFF/ HOOK, D1, D2, F1, D4, D5, S, S, M1

a) ON/OFF-HOOK, R/P        only D1, D2 will be dialed out, then dialing out stops
b) ON/OFF-HOOK, M1        D1, D2, F1, D4, D5 will be dialed out

Content of redial memory can be copied to Mn, Ln, N; but copying memory Mn, Ln, N to itself or to another memory (except redial memory) will erase the destinated memory.

Example:

OFF/ HOOK, D1, D2, ... Dn

a) ON/OFF-HOOK, R/P, N.                          D1, ... Dn copied to N
b) ON/OFF-HOOK, R/P, S, S, Mn (or Ln)    D1, ... Dn copied to Mn (or Ln)

but

OFF/ HOOK, M1                                        content of M1 will be dialed out

a) ON/OFF-HOOK, R/P, S, S, M2              not possible, M2 will be erased
b) ON/OFF-HOOK, M1, S, S, M2               not possible, M2 will be erased

## Number Store

OFF HOOK  ,  D1  ,  D2  , ...,  Dn  ,  S  ,  S  ,  Mn  (or  Ln)

1.  D1, D2, ..., Dn will be stored in memory location only (not in redial memory) and dialed out.

OFF HOOK  S  ,  D1  ,  D2  , ...,  Dn  ,  S  ,  Mn  (or  Ln)

2.  D1, D2, ..., Dn will be stored in memory location but will not be dialed out.

3.  R/P and */T keys can be stored as a digit in memory, also F1, F2, F3, Earth. In store mode,  R/P is the pause function key;   */T is the pulse-to-tone function key.

4.  The store mode is released after the store function is executed or when the state of the hook switch is changed.

5.  Number store can be linked without going ON/OFF-Hook

Example:

OFF/HOOK          S, D1, D2, ... Dn, S, M1          storing D1, D2, ... Dn to M1

                            S, D1', D2', ... Dn', S, M2 ...      storing D1', D2', ... Dn' to M2

## Repertory Dialing

1.  OFF HOOK     ,     Mn
2.  OFF HOOK     ,     A     ,     Ln

## Notice (N)

OFF HOOK     D1     ,     D2     , ...,     Dn     ,     N

1.  If the dialing of D1 to Dn is finished, pressing the N key will cause D1 to Dn to be copied to the N memory.

2.  Pressing key N again, after D1, D2, ... Dn was copied to N, N will be dialed out again

OFF HOOK     ,     N

3.  D1 to Dn will be dialed out after the N key is pressed.

4.  Notice function is valid as first key only.

## Cascaded Dialing

1.  Normal dialing + Repertory dialing + Normal dialing
2.  Repertory dialing + Normal dialing + Normal dialing
3.  Redialing + Normal dialing + Repertory dialing
4.  Redialing is valid as first key-in only.
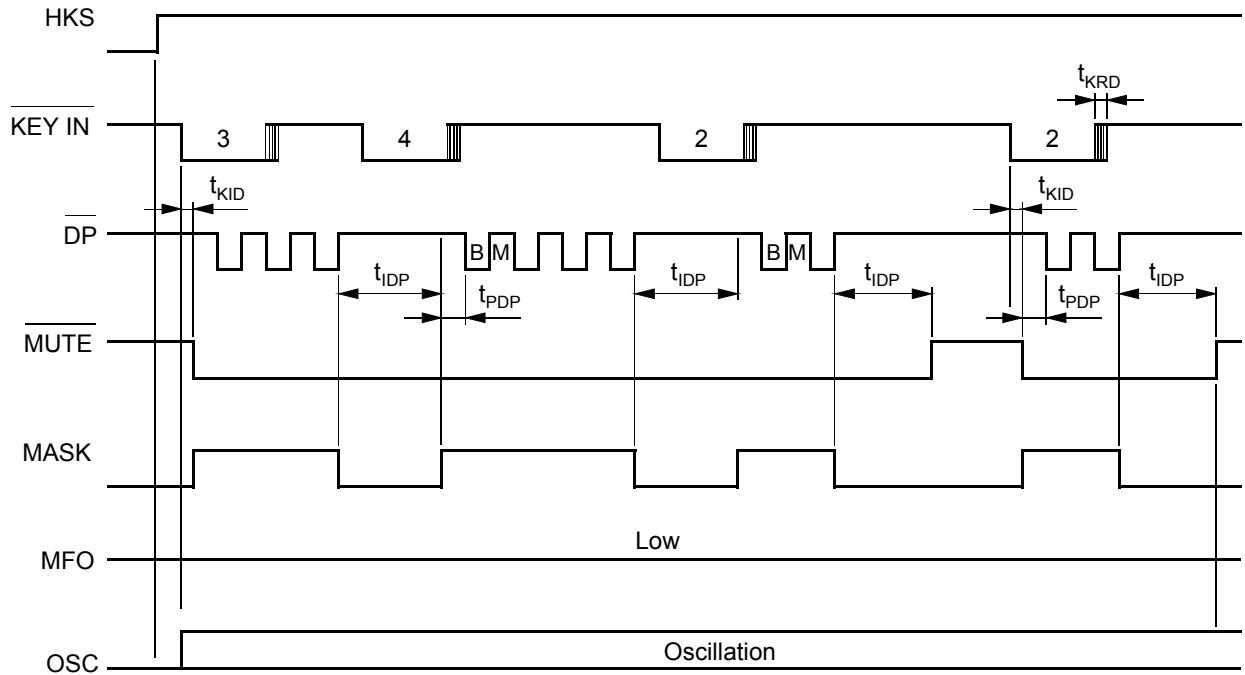
**Figure 3.** Pulse Mode Normal Dialing



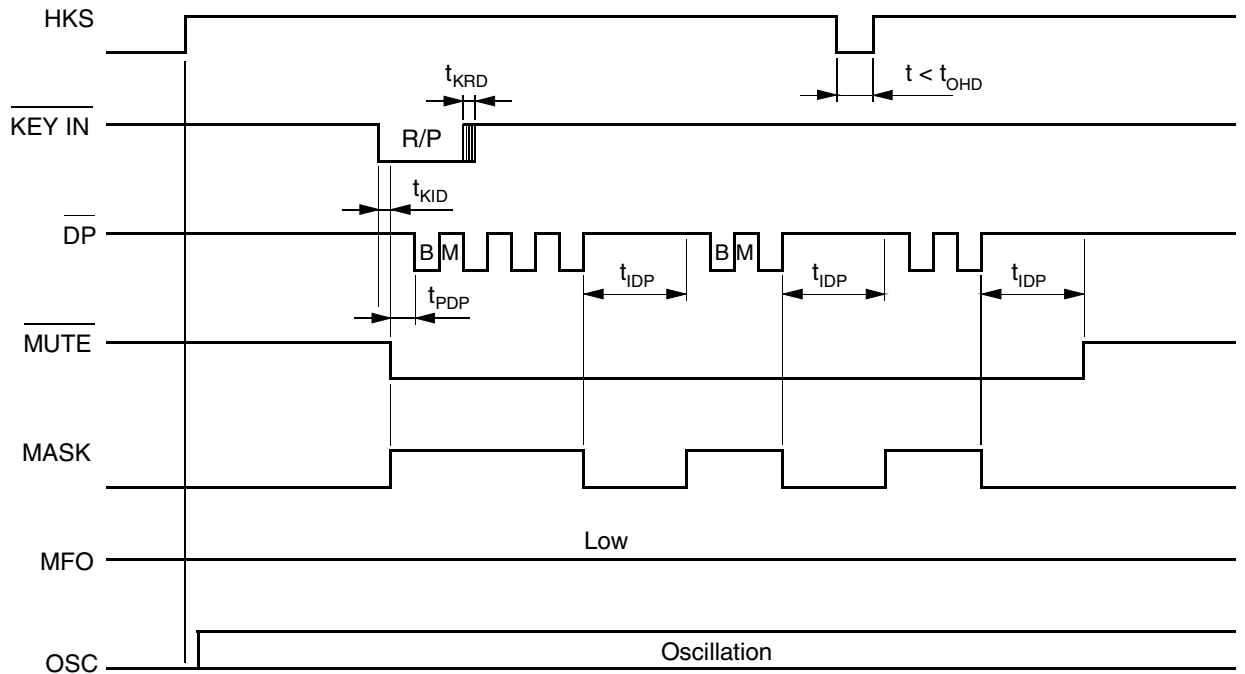**Figure 4.** Pulse Mode Auto Dialing, t < t$_{OHD}$

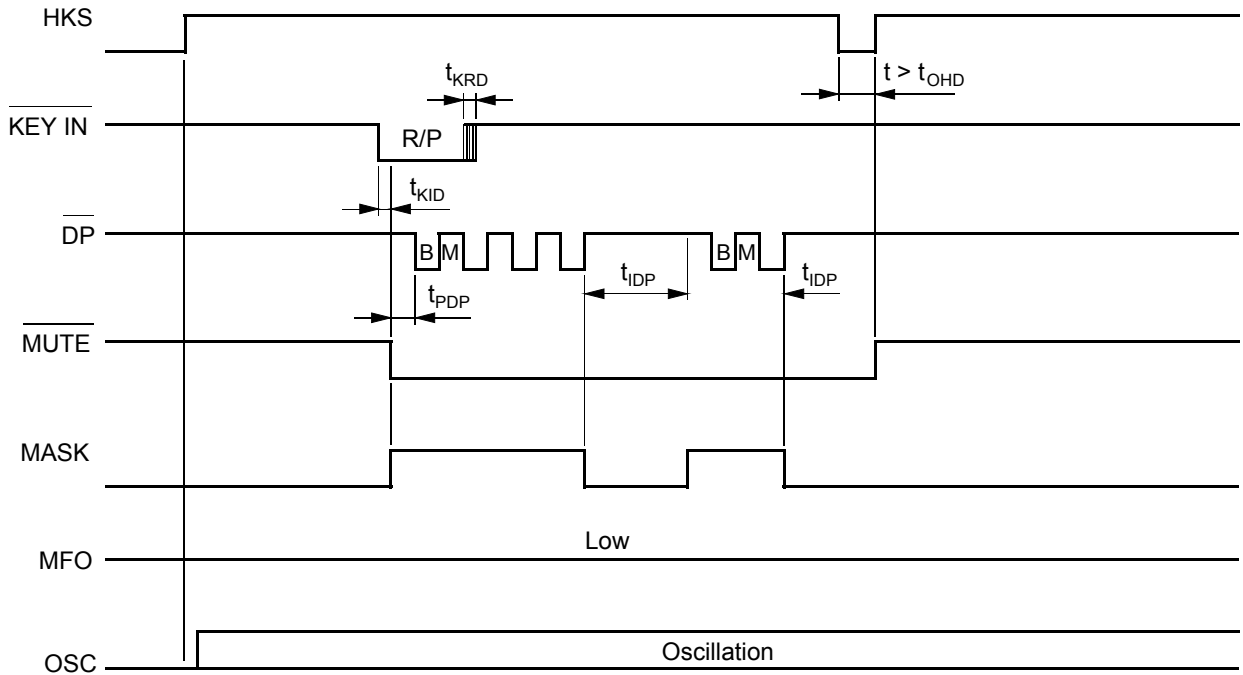**Figure 5.** Pulse Mode Auto Dialing, $t > t_{OHD}$



**Figure 6.** DTMF Mode Normal Dialing
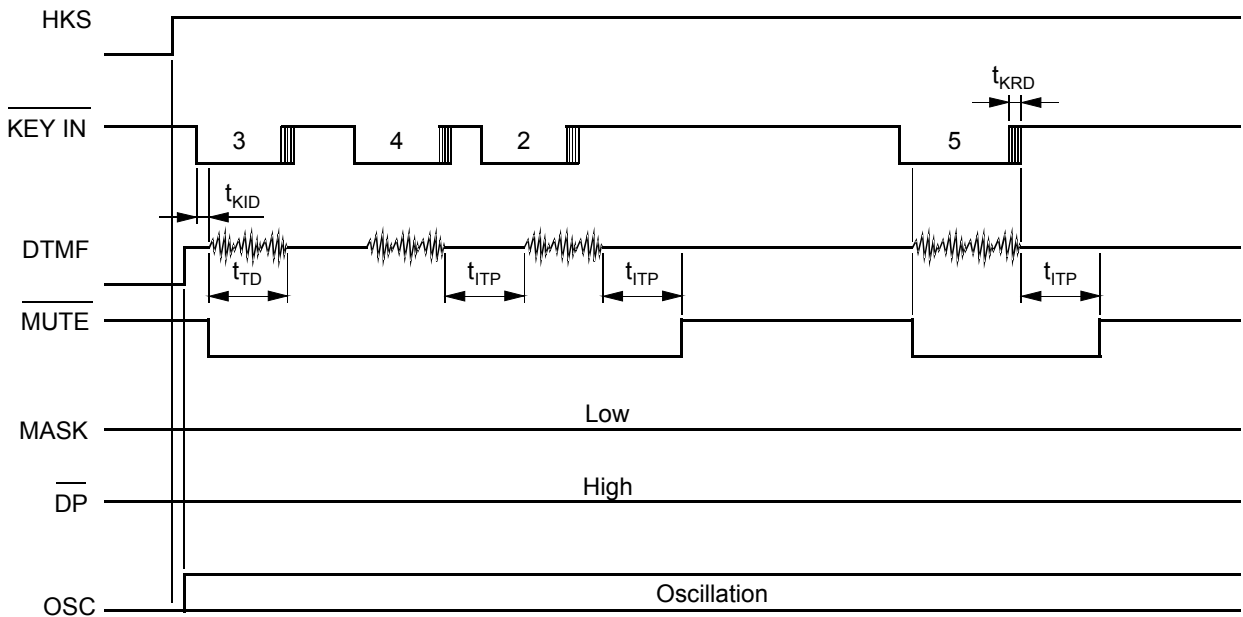
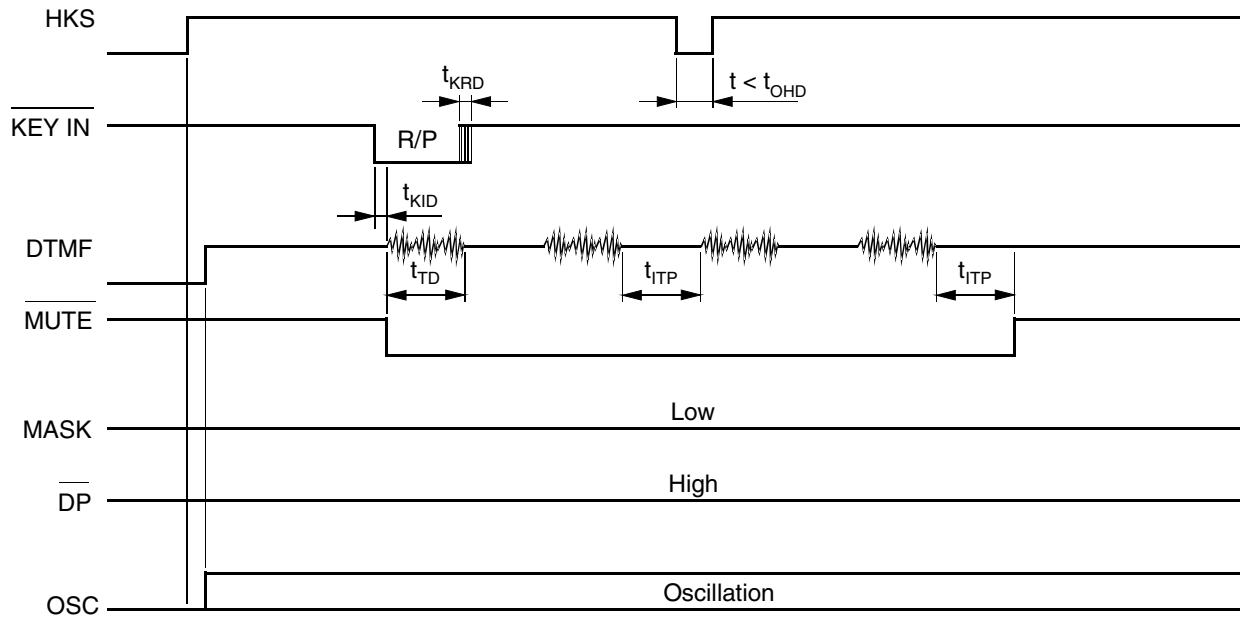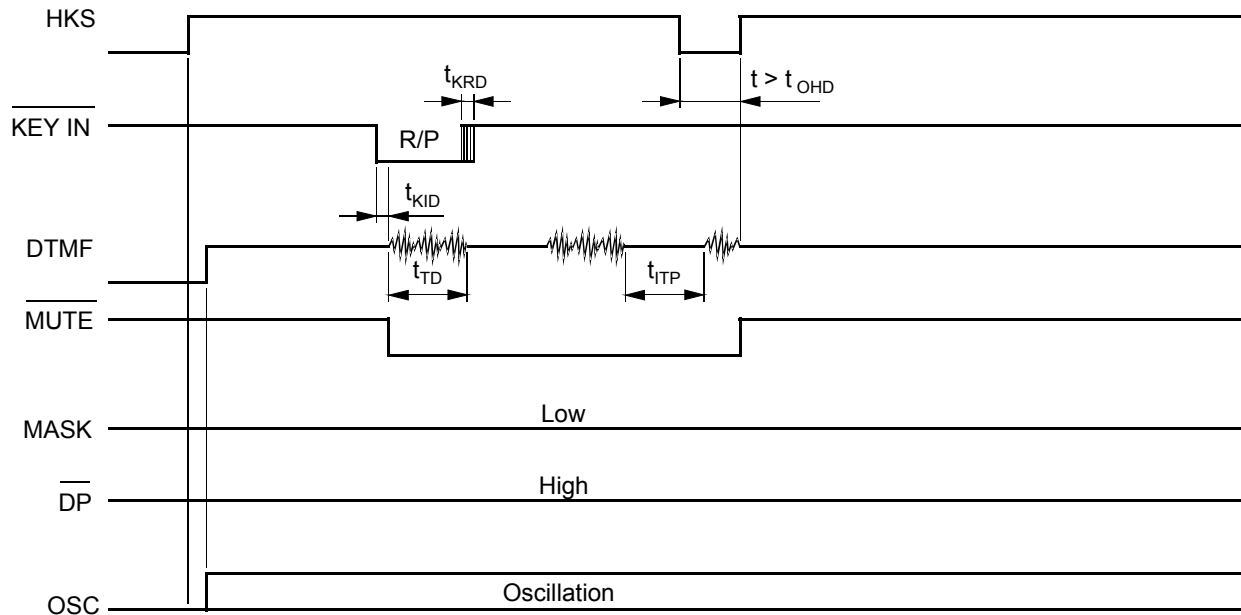**Figure 7.** DTMF Mode Auto Dialing (t < t$_{OHD}$)



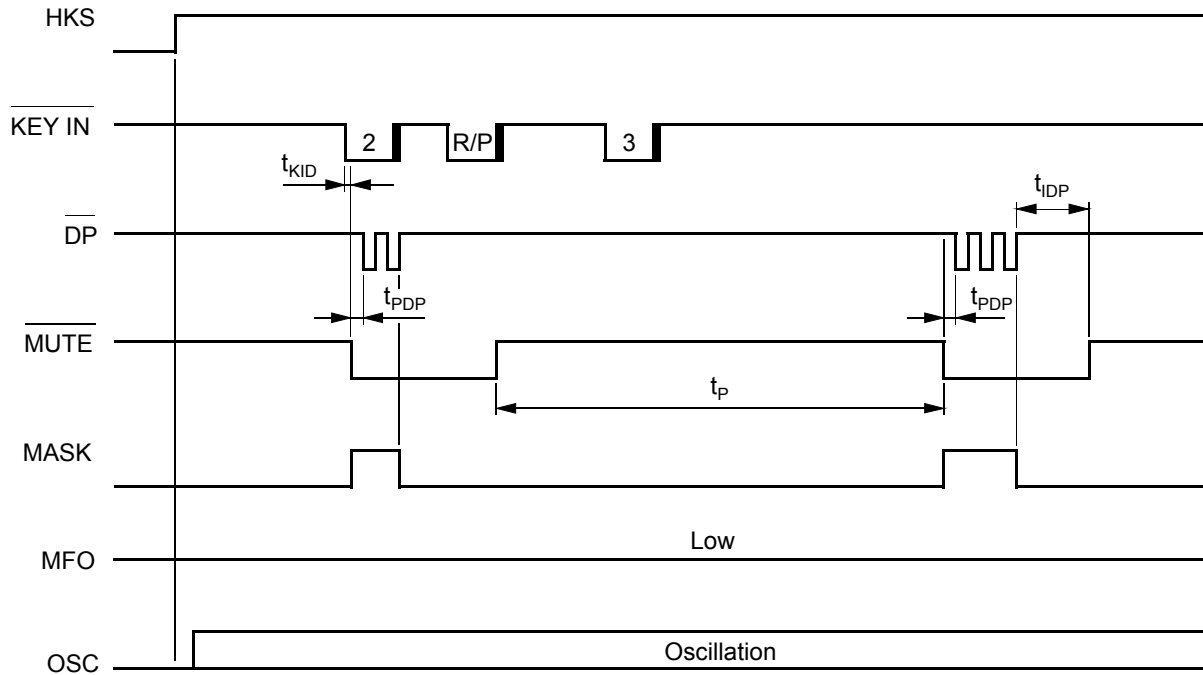**Figure 8.** DTMF Mode Auto Dialing (t > t$_{OHD}$)



**Access Pause**

OFF HOOK , D1 , D2 , R/P , D3 , ..., Dn'

1. The pause function can be stored in the memory.
2. The pause function is executed in normal dialing and redialing.

**Figure 9.** Pause Function



## Pulse-to-tone (*/T)

OFF HOOK , D1 , D2 , ..., Dn , */T , D1' , D2' , ..., Dn'

1.  If the mode switch is set to pulse mode, then the output signal will be:

    D1, D2, ..., Dn, Pause (3.6 s), D1', D2' ,..., Dn'

    (Pulse)                         (Tone)

2.  If the mode switch is set to tone mode, then the output signal will be:

    D1, D2, ..., Dn,      *    , D1', D2', ..., Dn'

    (Tone)            (Tone)         (Tone)

3.  The dialer remains in tone mode when the digits have been dialed out and can be reset to pulse mode by going on-hook only.

4.  ON/OFF-HOOK, R/P    D1, D2, Dn dialed out, then further dialing out stops and remains in pulse mode, when dialling from redial memory.

5.  If characters are stored in Mn, Ln or N, dialing out will be the same in pulse mode as point 1.

**Figure 10.** Pulse-to-tone Operation
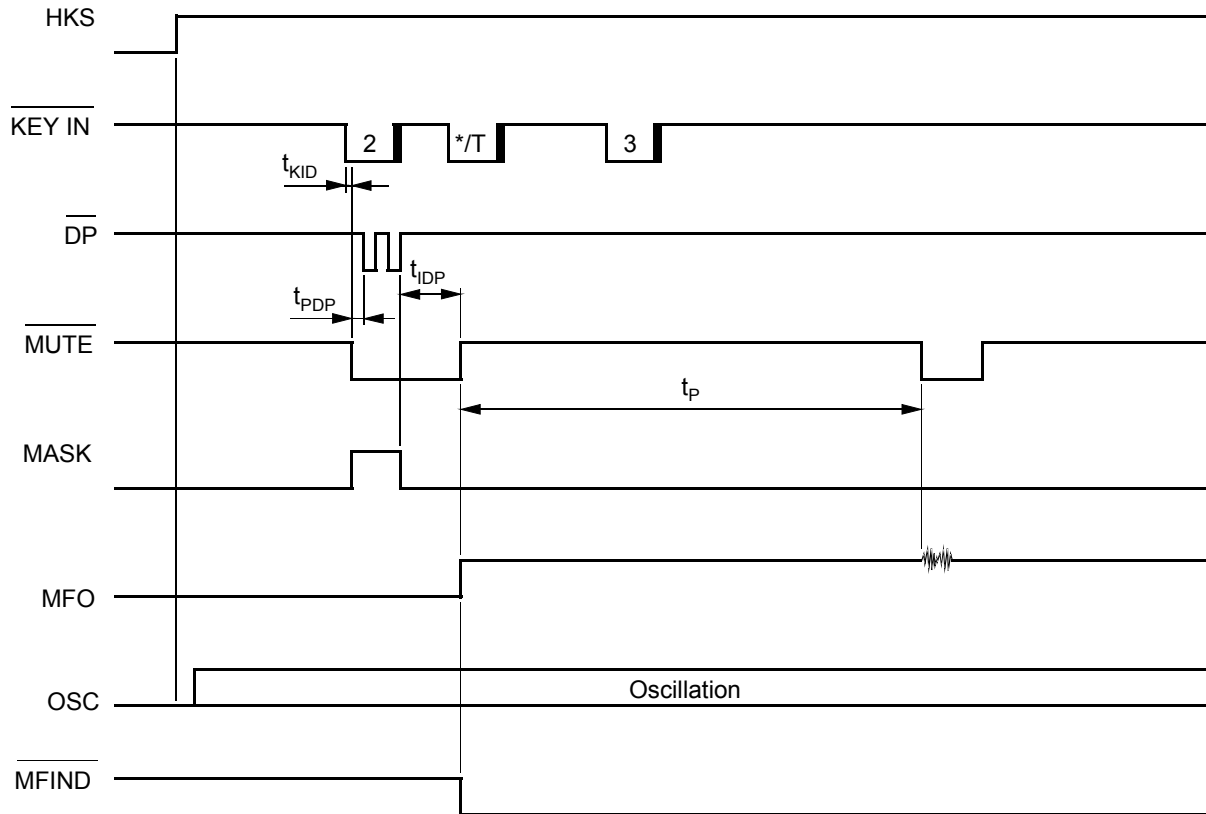


## Flash
## (F1 or F2 or F3)

OFF HOOK    ,    Fn

1. The dialer will execute a flash break and the entire flash pause time will elapse before the next digits are dialed out.

2. The flash key can be stored as a digit in the memory. Only one flash, however, will be released to the users.

3. The system will return to the initial state after the flash pause time has elapsed.

**Figure 11.** Flash Operation
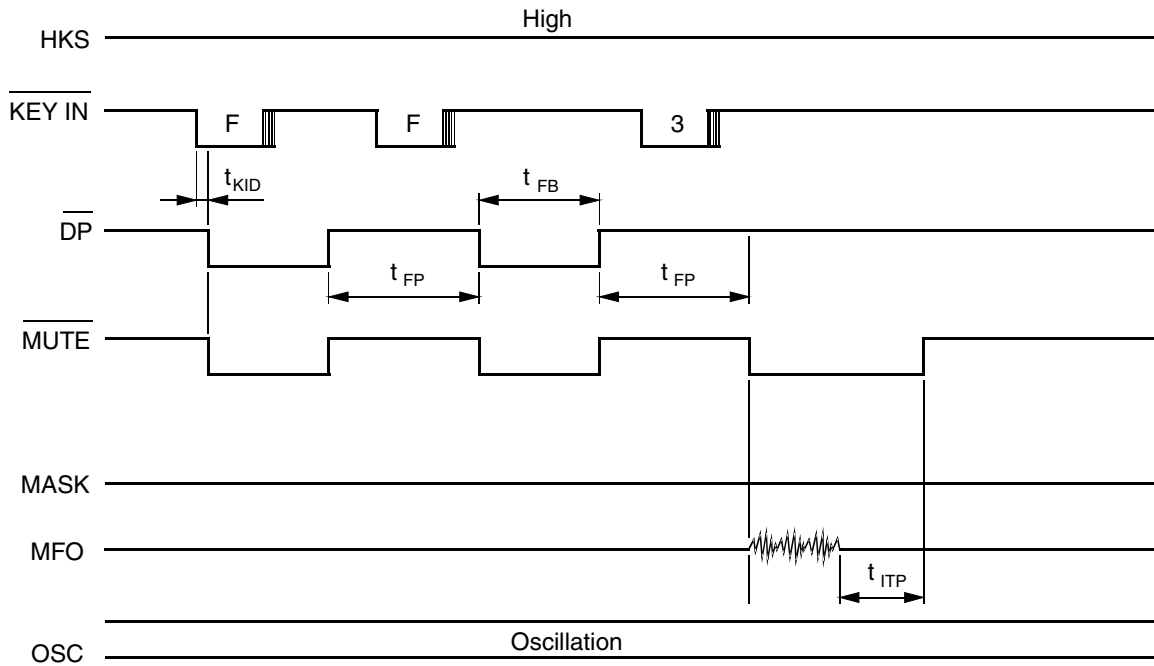


$t_{KID}$ = key active in debounce

$t_{KRD}$ = key release debounce

$t_{PDP}$ = pre-digit pause

$t_{IDP}$ = inter-digit pause

$t_{TD}$ = DTMF output duration

$t_{ITP}$ = intertone pause

$t_{FB}$ = flash break time

$t_{FP}$ = flash pause time

$t_{P}$ = pause time

**Figure 12.** Symbolic Timing Diagram: Earth Function
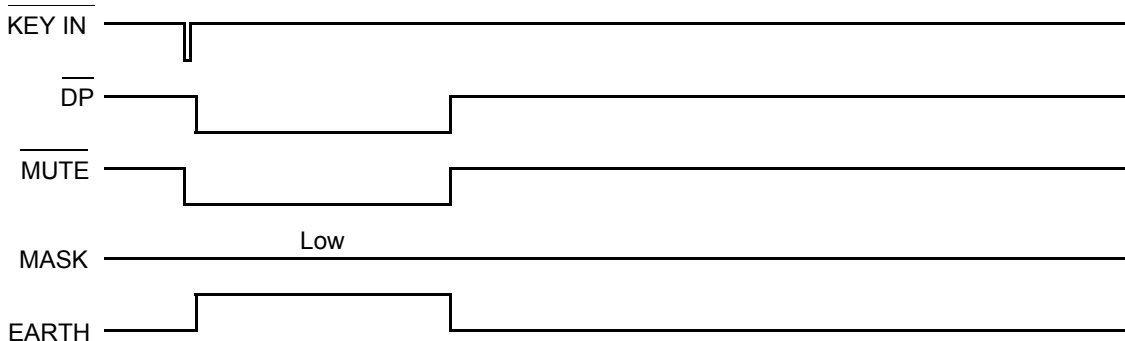
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**Figure 13.** Symbolic Timing Diagram: HFI, HFO Function
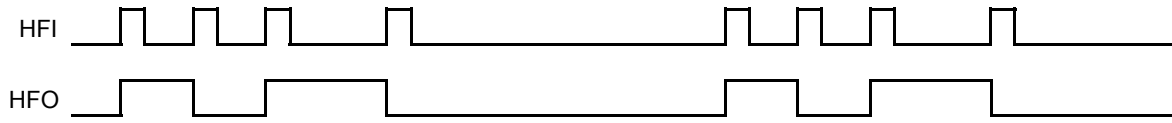


**Figure 14.** Symbolic Timing Diagram: On Hook Debounce Time
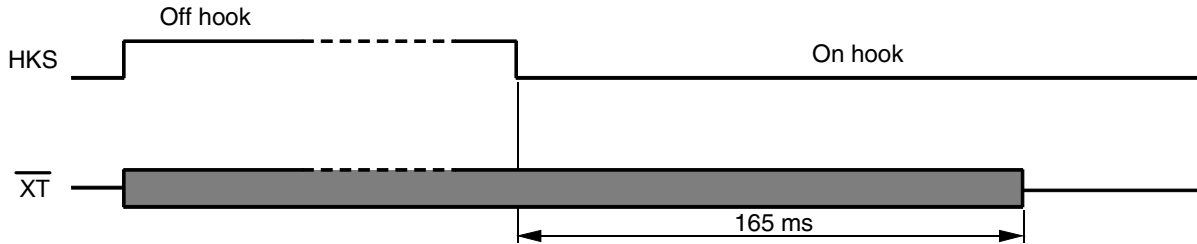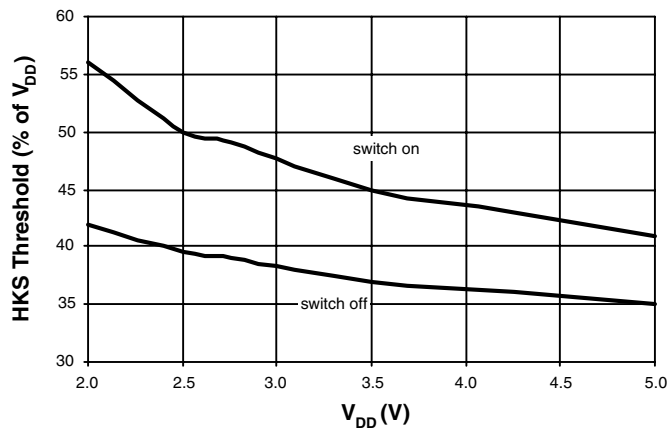


**Figure 15.** HKS Threshold Voltage

# Absolute Maximum Ratings

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

| Parameters | Symbol | Value | Unit |
|---|---|---|---|
| Line current | $I_L$ | 140 | mA |
| DC line voltage | $V_L$ | 14 | V |
| DC voltage at pins 1 to 11 and 33 to 44 | $V_{DC}$ | 5.5 | V |
| Junction temperature | $T_j$ | 125 | °C |
| Ambient temperature | $T_{amb}$ | -25 to +75 | °C |
| Storage temperature | $T_{stg}$ | -55 to +150 | °C |
| Total power dissipation, $T_{amb}$ = 60°C, SSO44 | $P_{tot}$ | 0.9 | W |
| Junction ambient, SSO44 | $R_{thJA}$ | 70 | K/W |

Note:     ESD withstand voltage 1 kV according to ESD standard S5.1 (HBM)

# Electrical Characteristics: Speech Circuit

Reference point pin GND, f = 1000 Hz, 0 dBm = 775 mV$_{rms}$, $R_{DC}$ = 39 Ω/1 W, $T_{amb}$ = 25°C, unless otherwise specified, refer to "Basic Test Circuit". CLIM = GND

| Parameters | Test Conditions | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Line voltage | $I_L$ = 8 mA<br>$I_L$ = 20 mA<br>$I_L$ = 73 mA<br>$I_L$ = 100 mA | $V_L$ | <br>3.6<br>5.9<br>6.9 | 1.4<br>3.85<br>6.55<br> | <br>4.1<br>7.2<br>8.2 | V<br>V<br>V<br>V |
| **Transmit and Sidetone** | | | | | | |
| Input resistance | $R_i$ | $R_i$ | 45 | 80 | 120 | kΩ |
| Gain | $I_L$ = 20 mA, S5 = open | $G_s$ | 46.8 | 47.8 | 48.8 | dB |
| Gain change with current | $I_L$ = 20 to 60 mA, $R_{AGC}$ = infinite | $\Delta G_S$ | -0.5 | | 0.5 | dB |
| Gain deviation | $T_{amb}$ = -10 to +60°C, $I_L$ = 20 mA | $\Delta G_S$ | -0.5 | | 0.5 | dB |
| Line-loss compensation | $R_{AGC}$ = 12 kΩ, $I_L$ = 73 mA | $\Delta G_s$ | -7 | -6 | -4.8 | dB |
| Distortion at line $V_L$ = 0.775 $V_{rms}$ | $I_L$ = 20 mA, S5 = open | $d_t$ | | | 2 | % |
| Maximum output voltage at line d ≤ 5% | $I_L$ = 20 mA, $V_{mic}$ = 10 mV, CLIM = 2.2 µF, $S_1$ = open | $V_{Lmax}$ | | 1.2 | | dBm |
| Attack time transmit anticlipping | CLIM = 2.2 µF | $t_{att}$ | | 3.5 | | ms |
| Noise at line weighted psophometrically | $I_L$ > 20 mA, $G_S$ = 48 dB | $n_o$ | | | -72 | dBmp |
| Sidetone reduction | $I_L$ ≥ 20 mA | $G_{STA}$ | 10 | 15 | 20 | dB |
| **DTMF Amplifier** | | | | | | |
| Volume range d < 5% | Single tone, $I_L$ ≥ 20 mA | $V_L$ | 1.3 | | | dBm |
| DTMF output level low frequency group | $I_L$ = 20 mA, S5 = closed<br>$T_{amb}$ = -5°C to +60°C | $V_L$ | -7.6 | | -4.6 | dBm |
| Pre-emphasis between high- and low-level frequency group | $P_{PRE}$ = $P_{HLG}$ - $P_{LLG}$, S5 = closed,<br>$T_{amb}$ = -5°C to +60°C | $P_{PRE}$ | 1.9 | 2.5 | 3.1 | dB |
| Total harmonic distortion relative to sum level of low and high frequency group signal | IL ≥ 20 mA, measured at pin MFO | THD | | -33 | -25 | dBr |

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## Electrical Characteristics: Speech Circuit  (Continued)

Reference point pin GND, f = 1000 Hz, 0 dBm = 775 mV$_{rms}$, R$_{DC}$ = 39 $\Omega$/1 W, T$_{amb}$ = 25°C, unless otherwise specified, refer to "Basic Test Circuit". CLIM = GND

| Parameters | Test Conditions | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Receiving Amplifier** | | | | | | |
| Gain | I$_L$ $\geq$ 20 mA | G$_R$ | 3 | | 5 | dB |
| Gain change with current | I$_L$ = 20 to 60 mA<br>R$_{AGC}$ = infinite | $\Delta$G$_R$ | -0.5 | | 0.5 | dB |
| Gain deviation | T$_{amb}$ = -10 to +60°C<br>I$_L$ = 20 mA | $\Delta$G$_R$ | -0.3 | | 0.7 | dB |
| Line-loss compensation | I$_L$ = 73 mA | DG$_R$ | -7 | -6 | -4.7 | dB |
| Receiving noise at earphone weighted psophometrially | I$_L$ = 73 mA | n$_i$ | | -77.5 | -71 | dBm |
| Gain change when muted | I$_L$ $\geq$ 20 mA | G$_{RM}$ | 24 | 29 | 34 | dB |
| Output voltage push-pull | I$_L$ $\geq$ 20 mA, Z$_{ear}$ = 68 nF, 100 $\Omega$ in series, d $\leq$ 2% | V$_{RECO}$ | 0.8 | 0.9 | | V$_{rms}$ |
| Ear protection differential | I$_L$ = 40 mA, V$_{gen}$ = 4 V$_{rms}$, Z$_{ear}$ = 68 nF + 100 $\Omega$ | V$_{ear}$ | 1.3 | 1.6 | 2.5 | V$_{rms}$ |
| **Supply Voltage (For Internal Use Only)** | | | | | | |
| Output voltage<br>Note: Output must be limited externally to 5.5 V maximum | I$_L$ $\geq$ 20 mA dialing mode | V$_{DD}$ | 2.0 | | 6.3 | V |
| Available current for peripherals | I$_L$ $\geq$ 20 mA dialing mode | I$_{DD}$ | 150 | | | µA |
| Transmit | | | | | | |
| Maximum output voltage swing at line | I$_L$ = 20 mA, V$_{MIC}$ = 50 mV$_{rms}$ | V$_{L\ max}$ | | 3.4 | 4 | Vpp |
| Mute suppression transmit with privacy function | I$_L$ = 20 mA | G$_{SPRIV}$ | 60 | | | dB |

## DC Characteristics Dialer

V$_{DD}$ = 2.7 V, f$_{OSC}$ = 3.58 MHz, all outputs unloaded, S9 closed; HKS = 1

| Parameters | Test Conditions | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Memory retention current | HKS = 0, V$_{DD}$ = 1.0 V | I$_{MR}$ | | | 0.1 | µA |
| Data retention voltage | | | | 0.5 | | V |
| DTMF distortion | R$_L$ = 5 k$\Omega$ | d | | -30 | -23 | dB |
| DP output sink current | V$_{PO}$ = 0.5 V | I$_{PL}$ | 0.5 | | | mA |
| Keyboard input drive current | V$_I$ = 0 V | I$_{KD}$ | | 20 | | µA |
| Keyboard input sink current | V$_I$ = 2.7 V | I$_{KS}$ | | 500 | | µA |
| Key on resistance | | R$_{KON}$ | | | 5 | k$\Omega$ |
| Key off resistance | | R$_{KOFF}$ | 100 | | | k$\Omega$ |
| Mask sink/drive current | | I$_M$ H/L | 0.5 | | | mA |
| Earth sink/drive current | | I$_e$ H/L | 0.5 | | | mA |

## DC Characteristics Dialer  (Continued)

$V_{DD}$ = 2.7 V, $f_{OSC}$ = 3.58 MHz, all outputs unloaded, S9 closed; HKS = 1

| Parameters | Test Conditions | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Isolation resistance XT/XT | | $R_{iso}$ | 4.7 | | | M$\Omega$ |
| Maximum voltage at HKS | | | | | 5.5 | V |
| Maximum input current at HKS | | | | | 0.5 | mA |

## AC Characteristics Dialer

$V_{DD}$ = 2.7 V, $f_{OSC}$ = 3.58 MHz, all outputs unloaded, S9 closed; HKS = 1

| Parameters | Test Conditions | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Keypad active in debounce mode | | $t_{KID}$ | 15 | 20 | 25 | ms |
| Key release debounce | | $t_{KRD}$ | 15 | 20 | 25 | ms |
| Pre-digit pause | MODE pin = R3 (10 pps)<br>MODE pin = C1, C4 (10 pps) | $t_{PDP}$<br>$t_{PDP}$ | 37<br>31 | 40<br>33.3 | 41<br>33.5 | ms<br>ms |
| | MODE pin = R1 (20 pps)<br>MODE pin = R2 | $t_{PDP}$<br>$t_{PDP}$ | | 20<br>16.65 | | ms<br>ms |
| Inter-digit pause (auto dialing) | 10 pps, $t_{IP}$ = $t_{IDP}$ + $t_{PDP}$<br>20 pps | $t_{IP}$<br>$t_{IP}$ | 810 | 836<br>512 | 860 | ms<br>ms |
| Make/break ratio | MODE pin = R1 (20 pps), R3 10 pps)<br>MODE pin = C1, R4 (10 pps) R2<br>(20 pps) | M/B | 40.8:60.2<br><br>35.6:64.4 | 40:60<br><br>33:67 | 39.2:60.8<br><br>31.2:68.8 | %<br><br>% |
| DTMF output duration | Auto dialing, MODE = C4<br>MODE = C3 | $t_{TD}$ | 84<br>84 | 87<br>87 | 90<br>90 | ms |
| Inter-tone pause | Auto dialing, MODE = C4<br>MODE = C3 | $t_{ITP}$ | 84<br>135 | 87<br>140 | 90<br>147 | ms |
| Flash break time<br>F1<br>F2<br>F3 | $C_1$ connected to GND<br>$C_2$ connected to GND<br>$C_3$ connected to GND | $t_{FB}$ | 95<br>245<br>590 | 98<br>250<br>604 | 101<br>255<br>610 | ms<br>ms<br>ms |
| Rise time of leading edge at HKS | 20 to 70% of VDD | $t_{rHKS}$ | | | 10 | ms |
| Flash pause time | F1, F2, F3 | $t_{FP}$ | 0.9 | 1 | 1.1 | s |
| Pause time | | $t_P$ | 3.5 | 3.6 | 3.7 | s |
| On-hook debounce time | | $t_{ohd}$ | 145 | 165 | 185 | ms |
| Earth time | $C_4$ connected to GND | $t_{et}$ | | 604 | | ms |
| Earth pause time | | $t_{pt}$ | 0.9 | 1 | 1.1 | s |
| Break duration | MODE pin = R3<br>MODE pin = C1, R4 | $t_B$ | 57.6<br>63 | 60<br>66.7 | 62.4<br>69 | ms<br>ms |
| | MODE pin = R1 (20 pps)<br>MODE pin = R2 | $t_B$ | | 30<br>33.35 | | ms<br>ms |
| Make duration | MODE pin = R3<br>MODE pin = C1, R4 | $t_M$ | 38<br>31 | 40<br>33.3 | 41<br>35 | ms<br>ms |
| | MODE pin = R1 (20 pps)<br>MODE pin = R2 | $t_M$ | | 20<br>16.65 | | ms<br>ms |
| Break + make duration | MODE pin = C1, R3, R4 | $t_P$ | 95 | 100 | 105 | ms |
| | MODE pin = R1, R2 (20 pps) | $t_P$ | | 50 | | ms |

## Electrical Characteristics Tone Ringer

$f_{RCK}$ = 4 kHz, $V_{RING}$ = 20 V, $T_{amb}$ = 25°C, reference point GND, unless otherwise specified

| Parameters | Test Conditions | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Supply current, outputs open | $V_{RIAC}$ = 20 V | $I_{RING}$ | 2.1 | | 3.8 | mA |
| Switch-on threshold | $V_{RIAC}$, THA = open | $V_{RON}$ | 8 | 9 | 10 | V |
| Switch-off threshold | $V_{RIAC}$ | $V_{ROFF}$ | 5.0 | 5.6 | 6.5 | V |
| Ringing frequency | R = 150 k$\Omega$, C = 1 nF<br>$V_{RIAC}$ > $V_{RON}$ | $f_{1H}$<br>$f_{1L}$ | 937<br>752 | 1010<br>808 | 1083<br>868 | Hz<br>Hz |
| Range of external components for R/C oscillator | | C | 1000 | | 2200 | pF |
| | | R | 50 | | 330 | k$\Omega$ |
| Audio sequence frequency | | $f_2$ | 11.5 | 12.5 | 14.0 | Hz |
| Output voltage swing | $V_{Ring}$ = 25 V, $C_{out}$ = 68 nF | $V_{out}$ | 21 | 23 | | $V_{pp}$ |
| Turn-off delay | See Figure 15 | $t_{off}$ | | 65 | 100 | ms |

Note:     Max. current into internal zener diode at pin VRING = 20 mA

**Figure 16.**  Turn-off Delay Time
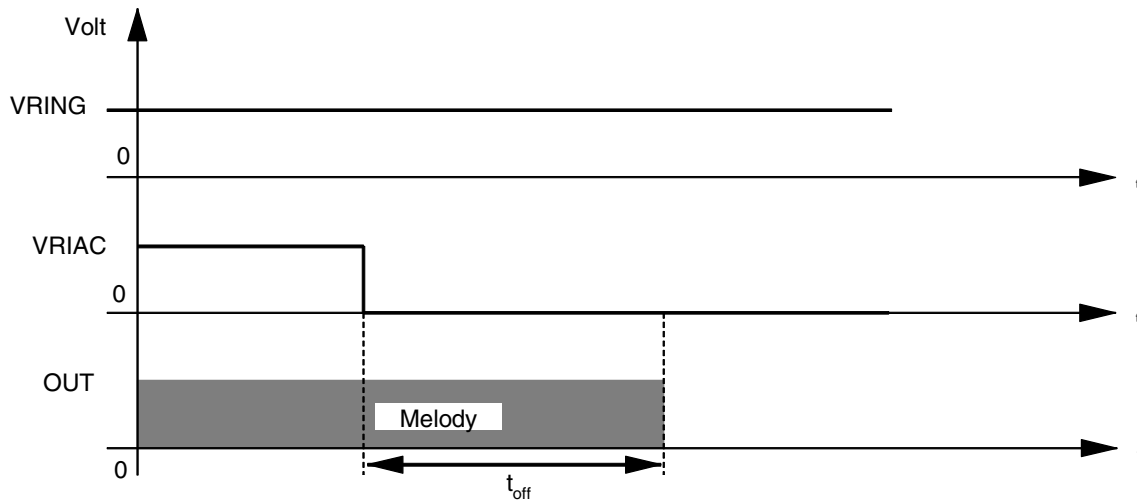


**Note**

The oscillator frequency is defined by R and C at pin RCK.
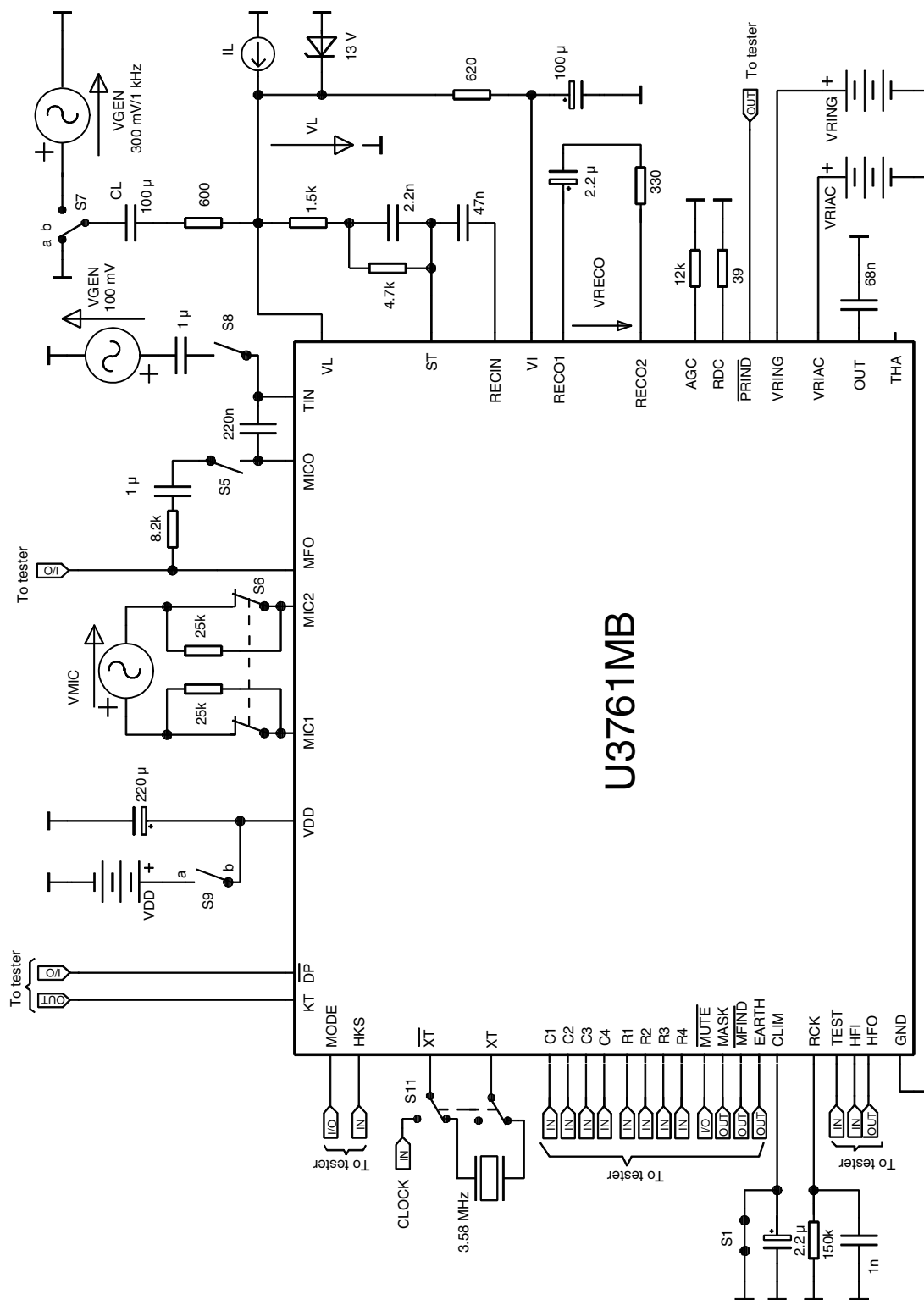
$$f_{Osc} \approx \frac{1}{1.594 \times C \times [R + 3809 \; \Omega]}$$

The audio sequence frequency $f_2$ and the ratio of low frequency $f_{1L}$ and high frequency $f_{1H}$ are derived from the oscillator by internal deviders. So $f_2$, $f_{1H}$ and $f_{1L}$ are given by:

$$f_2 = \frac{f_{Osc}}{320} \; ; \; f_{1H} = \frac{f_{Osc}}{4} \; ; \; f_{1L} = \frac{f_{Osc}}{5}$$

For more information on adjusting ringer melody refer to the document "Application and Adjustment Hints".

**Figure 17.** Basic Test Circuit

## Equations for Electrical Characteristic Parameters of the Speech Circuit

The equations refer to the basic test circuit. If not otherwise specified, the switches in the basic test circuit are inactive.

**Transmit Gain**

$$GS = 20 \times \log\left(\frac{V_L}{V_{MIC}}\right)$$

$V_{MIC} = 3$ mV/1 kHz, S5 = open

**Line-loss Compensation Transmit**

$\Delta GS = GS$ (at $I_L = 73$ mA) - GS (at $I_L = 20$ mA)

TX-mode: $V_{MIC} = 3$ mV/1 kHz, S5 = open

**Line-loss Compensation Receive**

$\Delta GR = GR$ (at $I_L = 73$ mA) - GR (at $I_L = 20$ mA)

RX-mode: $V_{gen} = 300$ mV/1 kHz, S7b

**Receiving Gain**

$$GR = 20 \times \log\left(\frac{V_{RECO}}{V_L}\right)$$

RX-mode: $V_{gen} = 300$ mV/1 kHz, S7b

**Sidetone Reduction**

$$GSTA = 20 \times \log\left(\frac{V_L}{V_{RECO}}\right) \text{ (in TX-mode)} + GR$$

TX-mode: $V_{MIC} = 3$ mV/1 kHz, S5 = open

**Input Impedance of Microphone Amplifier**

$$Ri = \frac{50 \text{ k}}{\left(\frac{V_{L(S6 = closed)}}{V_{L(S6 = open)}} - 1\right)}$$

TX-mode: VMIC = 3 mV/1 kHz, S5 = open

**Gain Change when Muted**

$$GRM = 20 \times \log\left(\frac{V_{RECO}}{V_L}\right) \text{ (Mute = inactive)} - 20 \times \log\left(\frac{V_{RECO}}{V_L}\right) \text{ (Mute = active)}$$

$V_{gen} = 100$ mV/1 kHz, S5 = open, S8 = open

**Total Harmonic Distortion (THD)**

$$THD = 20 \times \log\left(\frac{\sqrt{n_1 \times U_{LG}{}^2 + n_1 \times U_{HG}{}^2 + n_2 \times U_{LG}{}^2 + n_2 \times U_{HG}{}^2 + ...n_n \times U_{LG}{}^2 + n_n \times U_{HG}{}^2}}{\sqrt{U_{LG}{}^2 + U_{HG}{}^2}}\right)$$
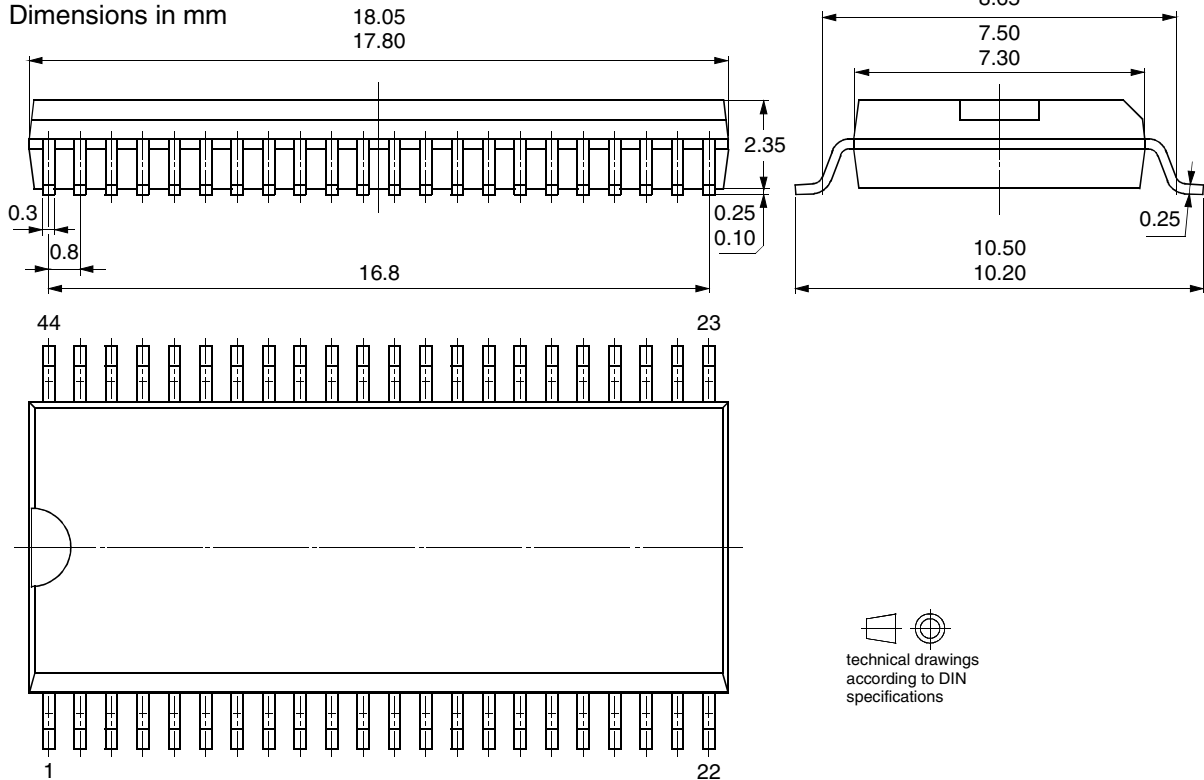
$n_1, ... n_n$ = harmonics of high and low frequency group

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## Ordering Information

| Extended Type Number | Package | Remarks |
|---|---|---|
| U3761MB-TFN | SSO44 | Tube |
| U3761MB-TFNG3 | SSO44 | Taped and reeled |

## Package Information

Package SSO44
Dimensions in mm



technical drawings
according to DIN
specifications

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