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## Features

- **DC Characteristic Adjustable**
- **Receive Gain Adjustable**
- **Symmetrical Input of Microphone Amplifier**
- **Anti-clipping in Transmit Direction**
- **Automatic Line-loss Compensation**
- **Symmetrical Output of Earpiece Amplifier**
- **Built-in Ear Protection**
- **DTMF and MUTE Input**
- **Adjustable Sidetone Suppression Independent of Sending and Receiving Amplification**
- **Power Down**
- **Tone-ringer Interface**
- **2-bit D/A for Volume Control**
- **Supply Voltages for All Functional Blocks of a Subscriber Set**
- **Operation Possible from 8-mA Line Currents**

Pb Lead Free

## Applications

- **Telephone Sets**

## Benefits

- **Complete System Integration of Analog Signal Processing on One Chip**
- **Very Few External Components**

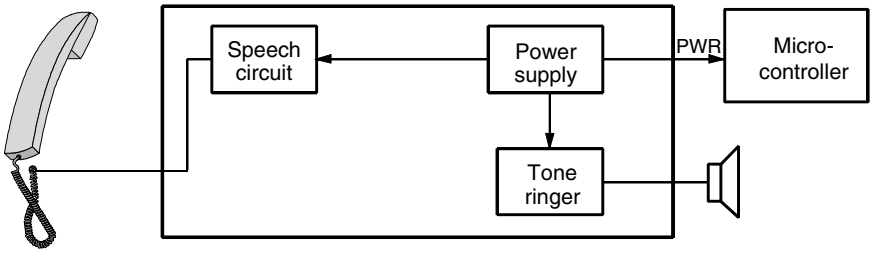
# Microcontroller-controlled Speech and Ringer Circuit

# U4037B-N

## 1. Description

The microcontroller-controlled telephone circuit U4037B-N is a linear integrated circuit for use in telephone sets. It contains the speech circuit, tone-ringer interface, sidetone equivalent and ear-protection rectifiers. The circuit is line powered and contains all components necessary for amplification of signals and adaptation to the line.

**Figure 1-1.** Block Diagram




Rev. 4742B–CORD–11/05

## 2. Pin Configuration

**Figure 2-1.** Pinning SO24

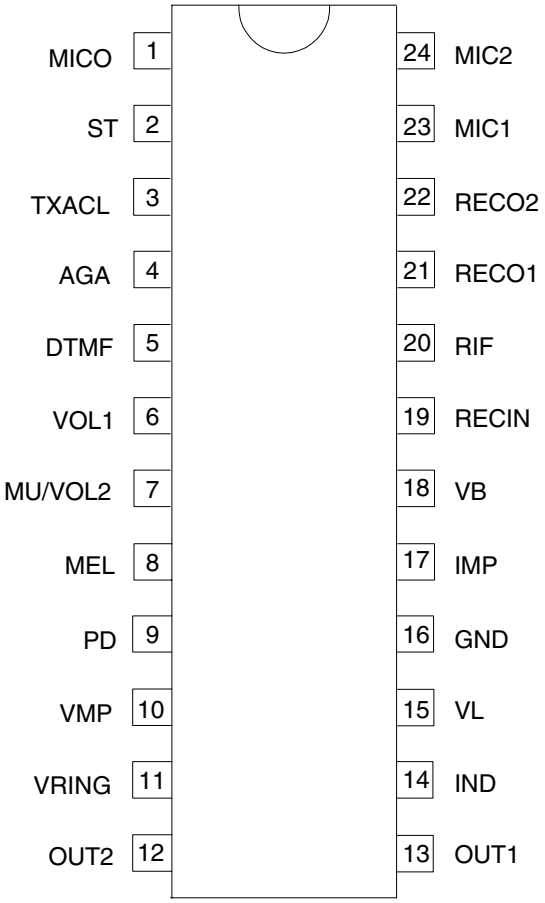
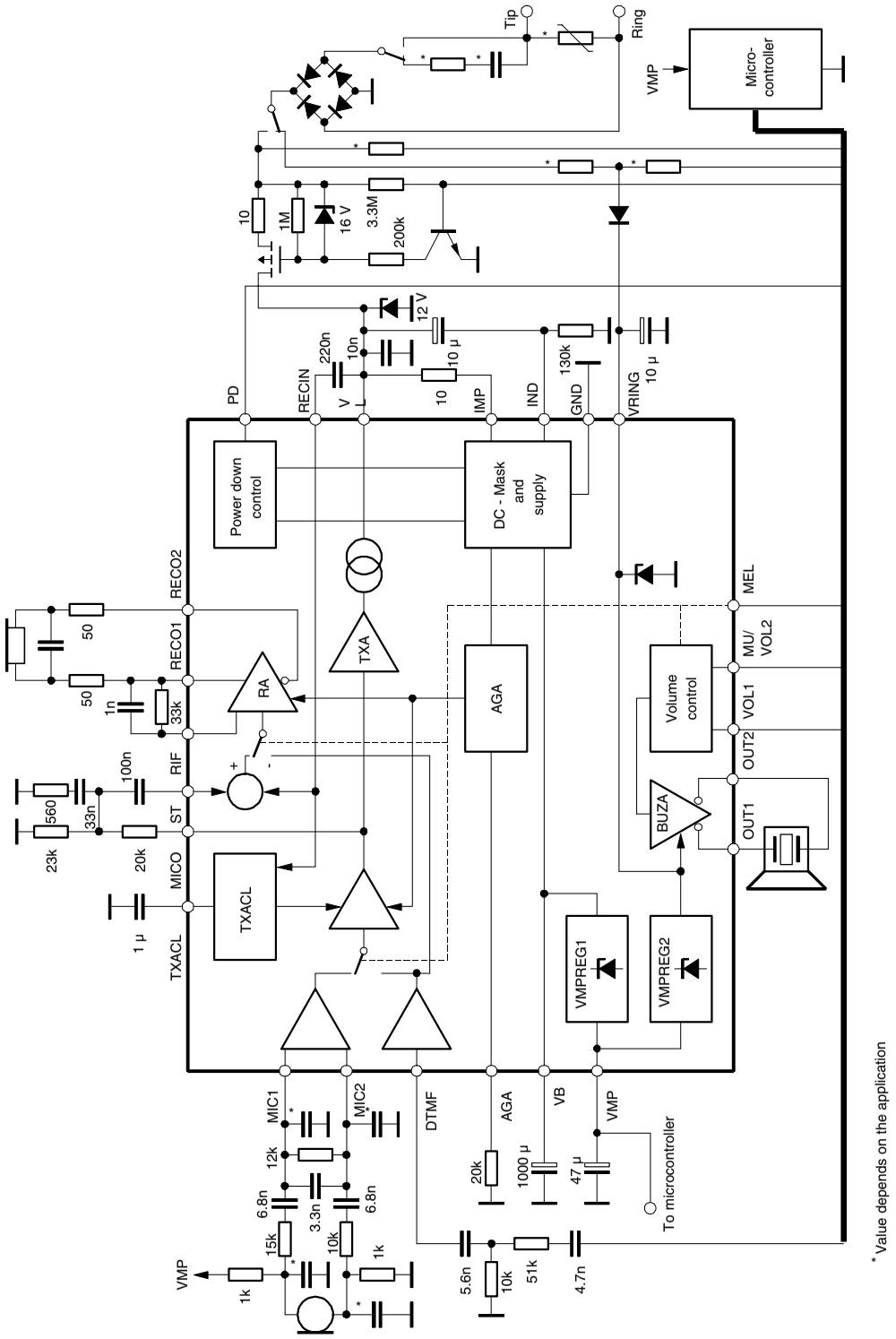


**Table 2-1.** Pin Description

| Pin | Symbol | Function |
|---|---|---|
| 1 | MICO | Output of microphone preamplifier |
| 2 | ST | Sidetone reduction input, input resistance is approximately 25 kΩ |
| 3 | TXACL | Time constant of anti-clipping in transmit path |
| 4 | AGA | Automatic gain adjustment with line current, a resistor connected from this pin to GND sets the starting point maximum gain change: 6 dB |
| 5 | DTMF | Input for DTMF signals |
| 6 | VOL1 | 2-bit volume adjustment for tone ringer |
| 7 | MU/VOL2 | 1) 2-bit volume adjustment for tone ringer<br>2) Mute of microphone amplifier:<br>- Speech condition, input MU/VOL2 low<br>- DTMF condition input MU/VOL2 high DTMF signal at pin 5 is fed to the line. A part of the DTMF signal is passed to the receiving amplifier as a confidence signal during dialing |
| 8 | MEL | Input for melody |
| 9 | PD | Active high input for reducing the current consumption of the circuit, $V_L$ simultaneously is shorted by an internal switch |
| 10 | VMP | 3.4V regulated supply voltage for peripheral circuits (especially microprocessors), minimum output current: 2 mA (ringing), 4 mA (speech mode) |
| 11 | VRING | Input for ringer supply voltage |
| 12 | OUT2 | Differential output for tone ringer |
| 13 | OUT1 | |
| 14 | IND | The internal equivalent inductance of the circuit is proportional to the value of the capacitor at this pin, a resistor connected to ground may be used to reduce the DC line voltage |
| 15 | VL | Line voltage |
| 16 | GND | Reference point for DC- and AC-output signals |
| 17 | IMP | Impedance adjustment |
| 18 | VB | Unregulated supply voltage for peripheral circuits (voice switch), limited to typically 7V |
| 19 | RECIN | Receiver input |
| 20 | RIF | Pin for adjustment of frequency response and gain of receiver |
| 21 | RECO1 | Output of receiving amplifier |
| 22 | RECO2 | Inverting output of receiving amplifier |
| 23 | MIC1 | Inverting input of microphone amplifier |
| 24 | MIC2 | Non-inverting input of microphone amplifier |

**Figure 2-2.** Detailed Block Diagram with External Components



## 3. 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 | $V_L$ | 12 | V |
| Maximum input current | $I_{RING}$ | 15 | mA |
| 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 | $P_{tot}$ | 520 | W |

## 4. Thermal Resistance

| Parameters | Symbol | Value | Unit |
|---|---|---|---|
| Junction ambient | $R_{thJA}$ | 75 | K/W |

## 5. Electrical Characteristics

f = 1 kHz, 0 dBm = 775 $mV_{rms}$, $I_{MP}$ = 2 mA, $T_{amb}$ = 25°C, $Z_{ear}$ = 68 nF + 100Ω, $Z_M$ = 68 nF, unless otherwise specified

| Parameters | Test Conditions | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC Characteristics** | | | | | | |
| DC voltage drop over circuit | $I_L$ = 2 mA<br>$I_L$ = 14 mA<br>$I_L$ = 60 mA<br>$I_L$ = 100 mA | $V_L$ | <br>4.6<br><br>8.8 | 2.4<br>5.0<br>7.5<br>9.4 | <br>5.4<br><br>10.0 | V |
| **Transmission Amplifier, $I_L$ = 14 mA, $V_{MIC}$ = 2 mV, Unless Otherwise Specified** | | | | | | |
| Transmitting amplification | | $G_T$ | 47 | 48 | 49 | dB |
| Frequency response | $I_L \geq$ 14 mA<br>f = 300 to 3400 Hz | $\Delta G_T$ | | | ±0.5 | dB |
| Gain change with current | $I_L$ = 14 to 100 mA | $\Delta G_T$ | | | ±0.5 | dB |
| Gain deviation | $T_{amb}$ = –10 to +60°C | $\Delta G_T$ | | | ±0.5 | dB |
| CMRR of microphone amplifier | | CMRR | 60 | 80 | | dB |
| Input resistance of MIC amplifier | | $R_i$ | | 50 | | kW |
| Distortion at line | $I_L$ > 14 mA<br>$V_L$ = 700 $mV_{rms}$ | $d_t$ | | | 2 | % |
| Maximum output voltage | $I_L$ > 19 mA, d < 5%<br>$V_{MIC}$ = 10 mV<br>CTXA = 1 µF | $V_{Lmax}$ | 1.8 | 3 | 4.2 | dBm |
| Noise at line psophometrically weighted | $I_L$ > 14 mA<br>$G_T$ = 48 dB | no | | –80 | –72 | dBmp |
| Anti-clipping attack time<br>release time | CTXA = 1 µF<br>each 3 dB overdrive | | | 0.5<br>9 | | ms |
| Line-loss compensation | $I_L$ = 100 mA, RAGA = 20 kΩ | $\Delta G_{TI}$ | –6.4 | –5.8 | –5.2 | dB |
| Mute suppression | $I_L \geq$ 14 mA | $G_{TM}$ | 60 | 80 | | dB |

## 5. Electrical Characteristics (Continued)

f = 1 kHz, 0 dBm = 775 $mV_{rms}$, $I_{MP}$ = 2 mA, $T_{amb}$ = 25°C, $Z_{ear}$ = 68 nF + 100Ω, $Z_M$ = 68 nF, unless otherwise specified

| Parameters | Test Conditions | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Receiving Amplifier, $I_L$ = 14 mA, Unless Otherwise Specified, $V_{GEN}$ = 300 mV** | | | | | | |
| Receiving amplification | | $G_R$ | | | 12 | dB |
| Adjustment range | | $G_R$ | –8 | | 12 | dB |
| Amplification of DTMF signal from DTMF IN to RECO 1, 2 | $I_L \geq 14$ mA<br>$V_{DTMF}$ = 8 mV | $G_{RM}$ | 14 | | 20 | dB |
| Frequency response | $I_L$ > 14 mA<br>f = 300 to 3400 Hz | $\Delta G_{RF}$ | | | ±0.5 | dB |
| Gain change with current | $I_L$ = 14 to 100 mA | $\Delta G_R$ | | | ±0.5 | dB |
| Gain deviation | $T_{amb}$ = –10 to + 60°C | $\Delta G_R$ | | | ±0.5 | dB |
| Ear protection differential | $I_L \geq 14$ mA<br>$V_{GEN}$ = 11 $V_{rms}$ | EP | | | 2.2 | $V_{rms}$ |
| MUTE suppression | $I_L \geq 14$ mA | $\Delta G_R$ | 60 | | | dB |
| Output voltage d ≤ 2% differential | $I_L$ = 14 mA, $Z_{ear}$ = 68 nF + 100Ω | | 0.775 | | | $V_{rms}$ |
| Output voltage d ≤ 5% differential | $I_L$ = 14 mA<br>$Z_{ear}$ = 68 nF + 100Ω<br>RDC = infinite | | 1.2 | | | $V_{rms}$ |
| Receiving noise psophometrically weighted | $Z_{ear}$ = 68 nF + 100Ω<br>$I_L \geq 14$ mA | ni | | | –64 | dBmp |
| Output resistance | Each output against GND | Ro | | | 40 | Ω |
| Line-loss compensation | RAGA = 20 kΩ<br>$I_L$ = 100 mA | $\Delta G_{RI}$ | –7.0 | –6.0 | –5.0 | dB |
| Gain at low operating current | $I_L$ = 8 mA, $I_{MP}$ = 1 mA<br>$I_M$ = 300 µA<br>$V_{GEN}$ = 100 mV<br>RDC = 68 kΩ | $G_R$ | 10.5 | 12 | 13.5 | dB |
| **DTMF-amplifier Test Conditions: IMP = 2 mA** | | | | | | |
| DTMF amplification | $I_L$ = 15 mA<br>$V_{DTMF}$ = 8 mV<br>Mute active | $G_D$ | 40.7 | 41.7 | 42.7 | dB |
| Gain deviaton | $I_L$ = 15 mA<br>$T_{amb}$ = –10 to +60°C | $G_D$ | | | ±0.5 | dB |
| Input resistance | RGT = 15 kΩ | $R_i$ | 15 | 20 | 25 | kΩ |
| Distortion of DTMF signal | $I_L \geq 15$ mA<br>$V_L$ = 0 dBm | $d_D$ | | | 2 | % |
| Gain deviation with current | $I_L$ = 15 to 100 mA | ΔGD | | | ±0.5 | dB |
| **Supply Voltages, $V_{MIC}$ = 10 mV, $T_{amb}$ = –10 to +60°C** | | | | | | |
| $V_{MP}$ | $I_L$ = 8 mA<br>RDC = 130 kΩ<br>$I_{MP}$ = 1 mA | $V_{MP}$ | 3.1 | 3.4 | 3.6 | V |
| **Ringing Part, $I_{VMP}$ = 1 mA** | | | | | | |
| Maximum output voltage | $V_{RING}$ = 20V | $V_{out}$ | | 25 | | $V_{pp}$ |
| Input impedance in speech mode | f = 300 Hz to 3400 Hz<br>$I_L$ > 15 mA<br>$V_{TIP/RING}$ = 1.5 $V_{rms}$ | $R_i$ | 50 | | | kΩ |

## 5. Electrical Characteristics (Continued)

f = 1 kHz, 0 dBm = 775 $mV_{rms}$, $I_{MP}$ = 2 mA, $T_{amb}$ = 25°C, $Z_{ear}$ = 68 nF + 100Ω, $Z_M$ = 68 nF, unless otherwise specified

| Parameters | Test Conditions | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Ringing part: Ringer output voltage | f = 25 Hz, $C_{BUZ}$ = 50 nF<br>$V_{TIP/RING}$ = 63 $V_{rms}$ | $V_{out}$ | 28 | | | $V_{pp}$ |
| | $V_{TIP/RING}$ = 45 $V_{rms}$ | $V_{out}$ | | 18 | | $V_{pp}$ |
| | $V_{TIP/RING}$ = 25 $V_{rms}$ | $V_{out}$ | 7 | | | $V_{pp}$ |
| Volume adjustment steps | | 11<br>10<br>01<br>00 | | 0<br>–6<br>–12<br>–24 | | dB |
| Zener diode voltage | $I_{RING}$ = 25 mA | $V_{RINGmax}$ | | 28.5 | | V |
| **PD Input** | | | | | | |
| PD input current | PD active, $I_L$ > 14 mA, $V_{PD}$ = $V_{MP}$ | $I_{pd}$ | | 9 | | µA |
| Input voltage | PD = active<br>PD = inactive | $V_{pd}$<br>$V_{pd}$ | 2 | | 0.3 | V |
| Voltage drop at $V_L$ | PD = active<br>$I_L$ = 14 mA<br>$I_L$ = 100 mA | <br>$V_L$<br>$V_L$ | | <br>1.5<br>1.9 | | V |
| Internal current comsumption at $V_B$ | $V_B$ = 3.5V<br>PD = active, $I_L$ = 0 mA | $I_B$ | | 300 | | µA |

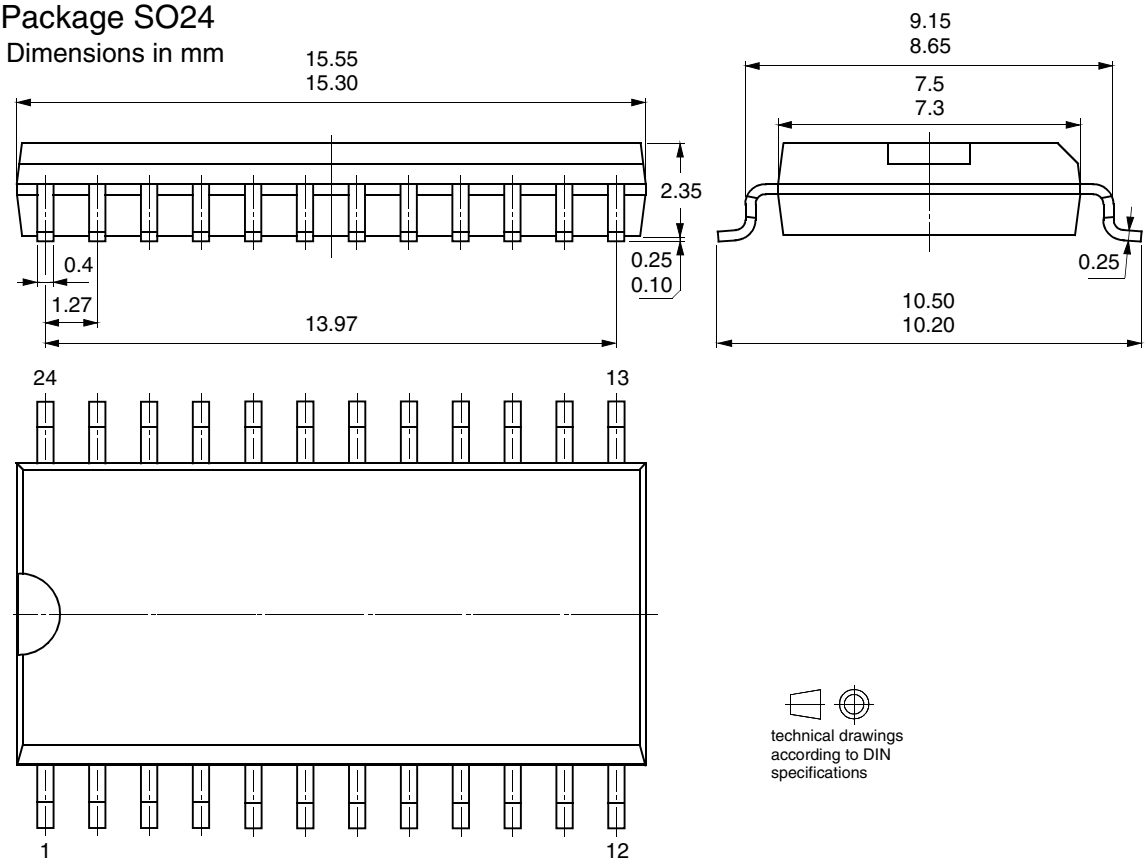
# 6. Ordering Information

| Extended Type Number | Package | Remarks |
|---|---|---|
| U4037B-NFLY | SO24 | Pb-free |
| U4037B-NFLG3Y | SO24 | Taped and reeled, Pb-free |

# 7. Package Information

Package SO24

Dimensions in mm



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