TEMIC
Semiconductors

**U3810BM**

# Multi-Standard Feature Phone IC

## Description

The U3810BM multi-standard feature phone circuit is designed to be used with a microcontroller using a 2-wire serial bus. It performs all speech and line interface functions required in an electronic telephone set: the ringing function with switching regulator and melody generator, the DTMF dialling, the loudhearing with antilarsen and antidistortion systems, a power supply, a clock and a reset for the microcontroller. Transmit,

receive and loudhearing gains control / AGC range / DTMF frequencies, preemphasis and level / melody generator, and mutes are programmable through the serial bus.

Electrostatic sensitive device.
Observe precautions for handling.

## Applications

- Feature phones
- Answering machines
- Fax machines

## Benefits

- Complete system integration of analog signal processing and digital control circuitry
- One IC for various PTT standards, e.g. programmable specification via µC
- Only three low-cost transducers needed (instead of four)

## Block Diagram



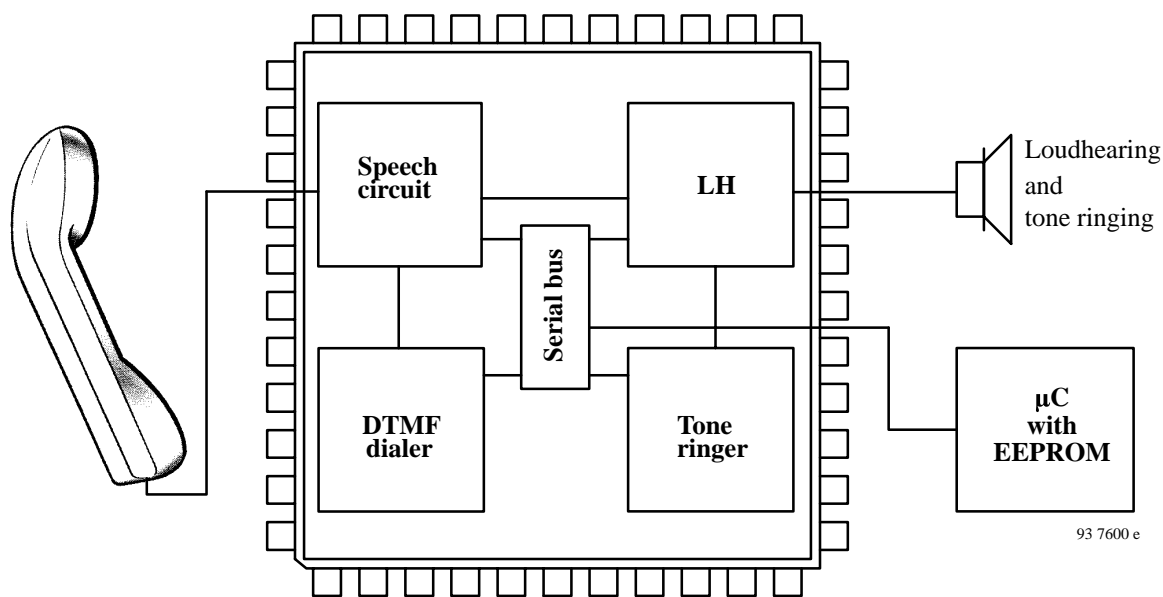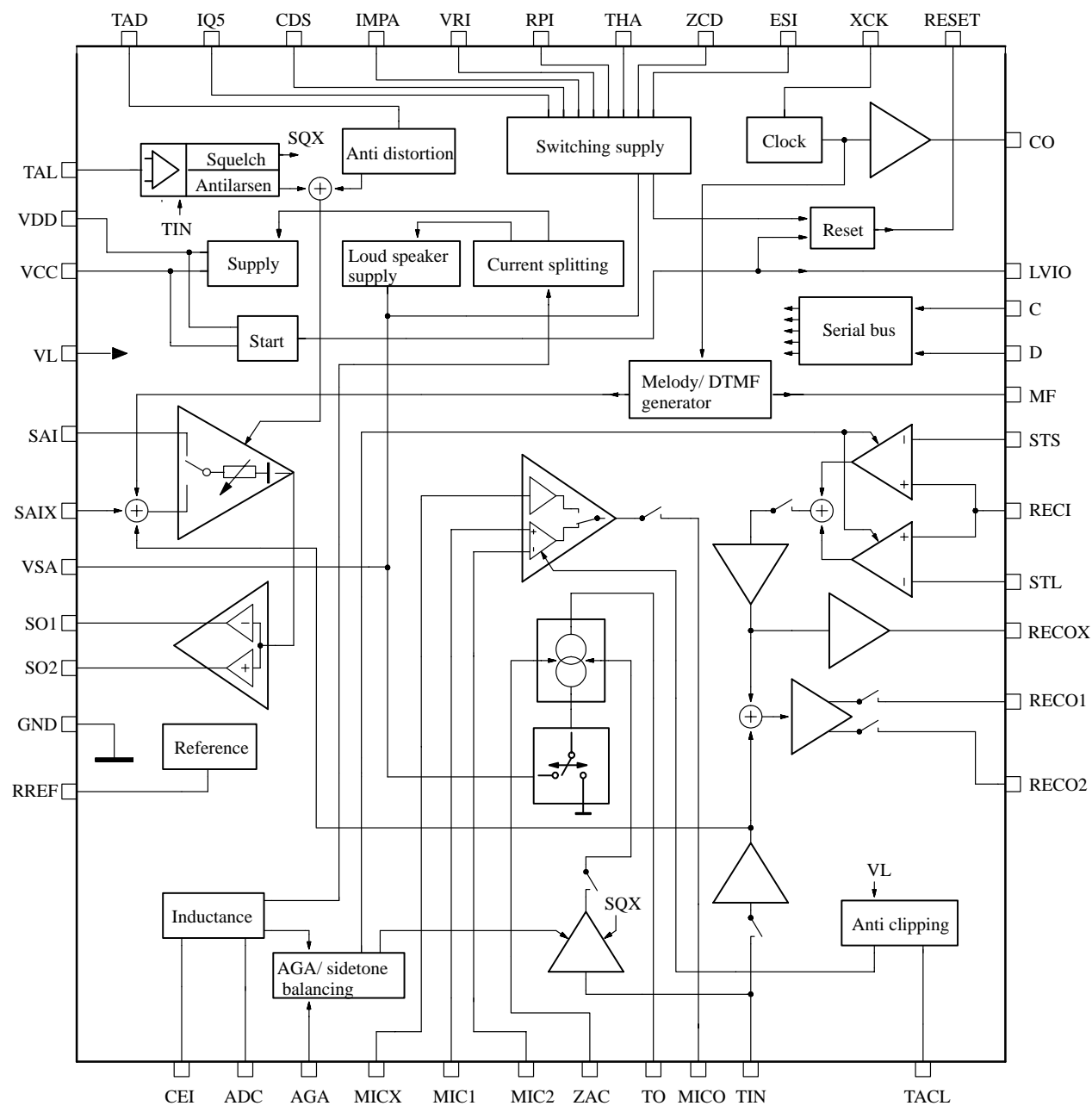Figure 1. Block diagram

## Ordering Information

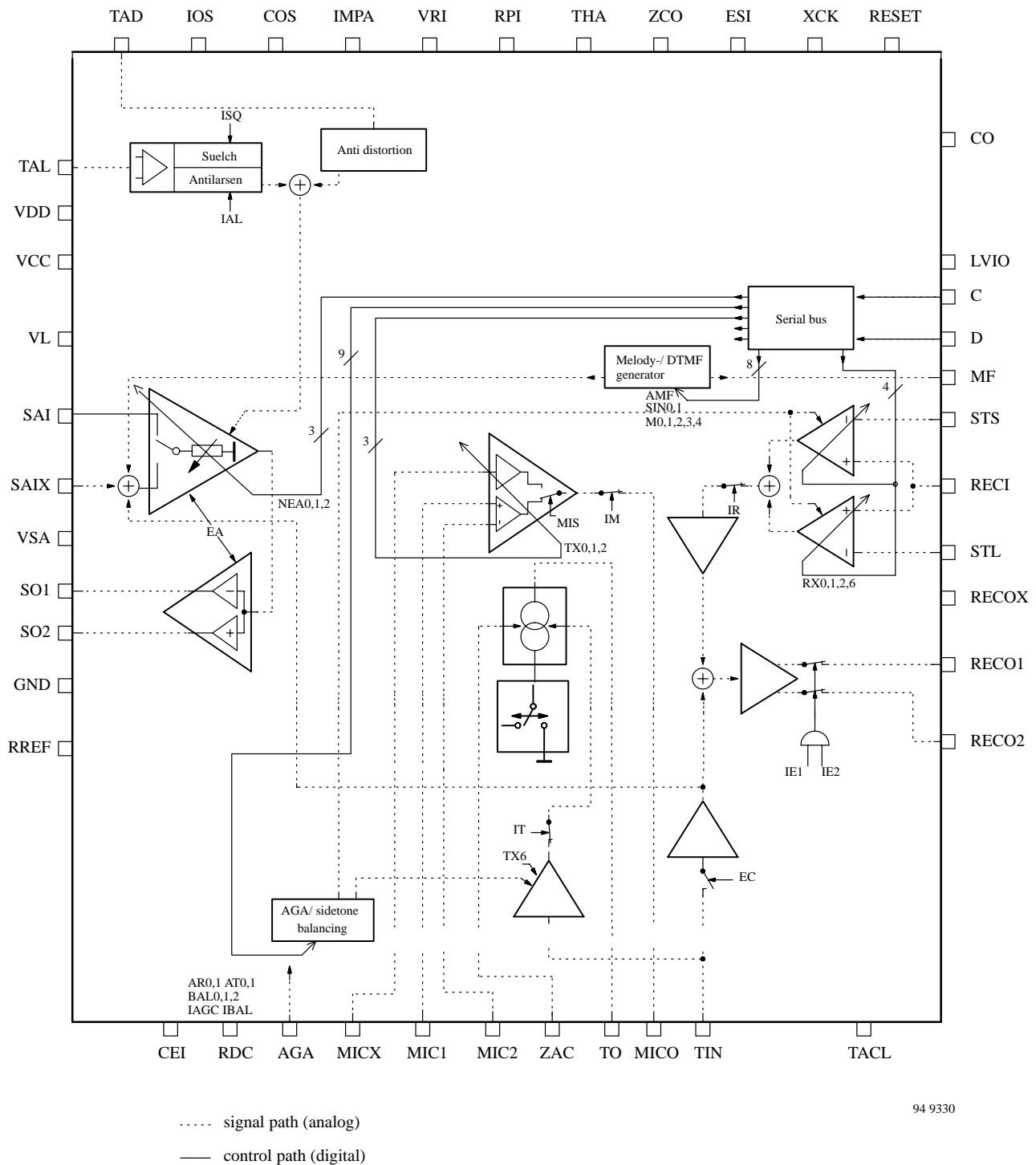| Extended Type Number | Package | Remarks |
|---|---|---|
| U3810BM-CP | PLCC44 | |
| U3810BM-FN | SSO44 | |

## Features

- Slope of DC characteristics adjustable by an external resistor

- Gain of transmit and receive amplifiers automatically adjusted by line-length control

- Regulation range adjustable by the serial bus

- Possibility of fixed gain (PABX)

- Sidetone balancing system adjustable with line length or by the serial bus

- Dynamic impedance adjustable by external components

- Stabilized power supply for peripherals

- Confidence level during dialing

- +6 dB possibility on second stage transmit gain

- Transmit and receive gains adjustable by serial bus

- Extra transmit input for hands-free and answering machine purpose

- +6 dB possibility on receive gain

- Receive amplifier for dynamic or piezo-electric earpieces

- Extra receive output for hands-free purpose

- High-impedance microphone inputs suitable for dynamic, magnetic, piezo-electric or electret microphone

- Distortion of line signal and sidetone prevented by dynamic range limitation in transmit direction (anticlipping)

- Squelch system in transmission mode prevents "room noise" being transmitted, and improves antilarsen efficiency (can be inhibited).

- Loudhearing gain programmable in eight steps of 4 dB, using the serial bus, or linearly adjusted, using a potentiometer

- Antilarsen system efficiency is increased when inhibiting squelch

- Loudhearing antidistortion system by automatic gain control versus available current and voltage

- Switching regulator in ringing phase

- Input ringing detection, threshold and impedance adjustable with external resistors

- Ringing zero crossing information for external microprocessor

- Ringing programmable gain in eight steps of 4 dB using the serial bus

- Melody generator, with 30 frequencies in steps of semi tones, driven by serial bus

- Internal speed-up circuit permits a faster charge of VDD and VCC capacitor

- DTMF dialer driven by serial bus, in particular level and preemphasis adjustment

- Ability to transmit a confidence tone in speech mode using melody generator frequencies

- Four independent mutes driven by serial bus (two for transmission mute and two for reception mute)

- Standard low-cost 455-kHz ceramic / clock output for the microcontroller

- Extra loudhearing input for answering machines, hands-free and base station of cordless phones with loudhearing

## Detailed Block Diagram



Figure 2. Detailed block diagram

94 9329

TAD IOS COS IMPA VRI RPI THA ZCO ESI XCK RESET

CO

TAL

VDD

VCC

LVIO

C

VL

D

SAI

MF

SAIX

STS

VSA

RECI

SO1

STL

SO2

GND

RECOX

RREF

RECO1

RECO2

ISQ

Suelch
Antilarsen

Anti distortion

IAL

Serial bus

Melody-/ DTMF
generator

AMF
SIN0,1
M0,1,2,3,4

NEA0,1,2

EA

MIS

IM

IR

TX0,1,2

RX0,1,2,6

IE1  IE2

IT

TX6

EC

AGA/ sidetone
balancing

AR0,1 AT0,1
BAL0,1,2
IAGC IBAL

CEI RDC AGA MICX MIC1 MIC2 ZAC TO MICO TIN TACL

94 9330

..... signal path (analog)

——— control path (digital)

Figure 3. Digital adjustment of the analog parameters by the serial-bus microprocessor interface

Figure 4.  Application for feature phone

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## Typical Value of External Components

| Components | Min. | Typ. | Max. |
|---|---|---|---|
| RIN | 0.3 MΩ | 1.0 MΩ | 1.5 MΩ |
| CSC | | 0.1 μF | |
| TSC | | 2N5401A | |
| LSC | | 1 mH | |
| DSC | | SD103A | |
| RAD | | 100 kΩ | |
| CAD | | 470 nF | |
| CAL | | 470 nF | |
| RAL | | 68 kΩ | 82 kΩ |
| CVDD | | 470 μF | |
| RSAI | | 20 kΩ | |
| CSAI | | 0.1 μF | |
| CVSA | | 220 μF | |
| CSO | | 47 μF | |
| CVCC | | 100 μF | |
| RAGA1 | | 100 kΩ | |
| RAGA2 | | 51 kΩ | |
| CEI | | 0.47 μF | |
| RDC | | 20 kΩ | |
| RTO | | 62 Ω | |
| (CTO | | 0.33 μF) | |
| CZAC1 | | 0.47 μF | |
| RZAC | | 12 kΩ | |

| Components | Min. | Typ. | Max. |
|---|---|---|---|
| (CZAC2 | | 470 pF) | |
| RDTMF1 | | 240 kΩ | |
| RDMTF2 | | 330 kΩ | |
| CDTMF1 | | 4.7 nF | |
| CDTMF2 | | 220 pF | |
| CACL | | 0.47 μF | |
| RACL | | 6.8 MΩ | |
| CEAR | | 4.7 μF | |
| Earphone | | ~1 kΩ | |
| Loudspeaker | | ~100 Ω | |
| RSTL1 | | 6.2 kΩ | |
| (CSTL1 | | 330 pF) | |
| RSTS1 | | 6.2 kΩ | |
| (CSTS1 | | 330 pF) | |
| RSTL2 | | 43 kΩ | |
| RSTS2 | | 18 kΩ | |
| RSTL3 | | 100 kΩ | |
| RSTS3 | | 75 kΩ | |
| CSTL3 | | 10 nF | |
| CSTS3 | | 10 nF | |
| CSTS2 | | 470 pF | |
| CSTL2 | | 1.2 nF | |
| X1 | | CSB455E (Murata) | |

## Pin Description

| Pin | Symbol | Function |
|---|---|---|
| 1 | RPI | Ringing power information:<br>The RC combination smooths the drive current of the loudspeaker amplifier. |
| 2 | VRI | Tone-ringer supply voltage:<br>The rectified ringing voltage is delivered to VRI and then converted into the lower supply voltage, VSA, by the converter. |
| 3 | IMPA | External adjustment of input ringing impedance:<br>IMPA is adjusted with a resistance between Pins 2 and 3.        $ZIN = RIN/100$ |
| 4 | COS | Control output switching supply:<br>COS drives the base of the external switching transistor of the converter. |
| 5 | IOS | Current output of switching supply:<br>This output provides a constant current which supplies the external part of converter.<br>The magnitude of the current depends on the VRI voltage and the value of resistance RIN. |
| 6 | TAD | Adjustment of anti-distortion time constant in loudhearing with external RC combination |
| 7 | TAL | Adjustment of anti-larsen time constant in loudhearing with external RC combination |
| 8 | VDD | External logic supply |
| 9 | VCC | Power supply for peripherals:<br>VCC and VDD are stabilized supply voltages buffered with external capacitors. They are derived internally from the same voltage source, but are separated from each other by electronic switches. VDD also supplies the digital part of the circuit and is achieved in all three modes: speech mode, ringing mode and operation with external supply. According to the application, peripheral modules are connected to VDD which, in addition to speech mode, must be supplied at least in one of the two other modes. The digital part of circuit and microprocessor must continue operating during line breaks, as they occur during pulse dialing or during flash-signal transmission. Since VDD in this time intervals is fed only from the buffer capacity, the power consumption from VDD must not cause the total voltage dump. VCC supplies no internal parts of the circuit and is supplied exclusively in speech mode. External components, which must operate only in this mode, can be connected here. The power is drawn only from the relevant buffer capacitor in the supply intervals during pulse dialing or flash-signal transmission. |
| 10 | VL | Line voltage |
| 11 | SAI | Speaker amplifier input:<br>The signal coming from the receive part, e.g., from RECO1 or RECO2, is fed in here. |
| 12 | SAIX | Speaker amplifier input for special application, i.e., answering machine:<br>SAIX is selected via the serial bus. SAIX has to be selected for ringing, if ringing, anti-distortion and anti-larsen are disabled. |
| 13 | VSA | Supply voltage for the loudhearing amplifier:<br>Stabilized supply voltage buffered with an external capacitor for the loudhearing amplifier and zero crossing detector; additional connection point for an external supply. In speech mode, VSA is supplied by the analog part of the circuit. In this case, the stabilization point is adjusted to the DC line voltage $VSA = VL/1.5$. In ringing mode, VSA is supplied directly from the converter. The stabilization point is permanently set. The logic supply, VDD, is fed by a switch from VSA. $VSA = 5.2$ V. In the case of an external supply, VSA serves as a point for a current from a power supply. The stabilization point of VSA and supply for the logic correspond to the operation conditions in ringing mode. |

## Pin Description (continued)

| Pin | Symbol | Function |
|-----|--------|----------|
| 14 | SO1 | Loudspeaker output 1 |
| 15 | SO2 | Loudspeaker output 2 (differential output of loudhearing amplifier): The loudspeaker can also be connected asymmetrically to ground or to VSA via a capacitor at one of the two outputs. As a result of this connection, there is a bigger output power in reference to low line currents and loudspeakers with low impedance, while the differential connection method results in a higher power output and lower harmonic distortion with medium or high line currents and/or loudspeaker impedances. |
| 16 | GND | Ground |
| 17 | RREF | External reference resistor (connection for external reference resistor to generate the reference current): All basic currents of the circuit which must satisfy certain absolute accuracy requirements depend on this current. |
| 18 | CEI | Capacitor for electronic inductance (connection for capacitor of the electronic coil) The circuit contains a first-order RC active low-pass filter. The capacitor is connected externally between CEI and VL. |
| 19 | RDC | DC characteristic slope adjustment: A voltage across resistor RDC is proportional to the DC line voltage. This means the current flow through RDC is also proportional to the line voltage. This current drives the supply currents drawn from VL by the most important loads, and therefore defines the total current consumption of the circuit. Adjustment to the slope characteristic is realized by modification of RDC resistance. |
| 20 | AGA | Line-length adjustment (reference voltage level for AGA) The potential at this point defines the start threshold for the AGA and the automatic balancing in the receive part (both can be switched off by the serial bus). The potential is normally formed between VCC and ground using a voltage divider. When the line voltage exceeds the threshold level, the AGA or balancing becomes effective. |
| 21 | MICX | Asymmetrical microphone input for special applications: The input of the first stage of the transmit amplifier, selected by the serial bus. Anti-clipping is not effective at this input. |
| 22 | MIC1 | Inverting input of microphone amplifier |
| 23 | MIC2 | Non-inverting input of microphone amplifier |
| 24 | ZAC | AC impedance adjustment: Adjustment of the AC circuit impedance to the line by changing of RZAC. |
| 25 | TO | Transmit amplifier output: The transmit amplifier output modulates the current flowing into this output (typ. 4.8 mA). |
| 26 | MICO | Microphone amplifier output, output MICO; open-circuit potential = $2 \times V_{be}$ |
| 27 | TIN | Transmit and DTMF input, input of the second transmit stage. |
| 28 | TACL | Adjustment of anti-clipping time constant with external RC combination Anti-clipping controls the transmitter input level to prevent clipping with high signal levels. The dynamic range of the transmit peak limiter is controlled by an internal circuit. |
| 29 | RECO2 | Symmetrical output of receive amplifier |
| 30 | RECO1 | Symmetrical output of receive amplifier |
| 31 | RECOX | Receive amplifier output for hands-free and answering machine applications |
| 32 | STL | Long-line sidetone network |
| 33 | RECI | Receive amplifier input: It is driven by a signal from VL. |
| 34 | STS | Short-line sidetone network |

## Pin Description (continued)

| Pin | Symbol | Function |
|---|---|---|
| 35 | MF | Multifrequency output. Output DTMF signal and confidence tone in pulse-density-modulated form. DTMF signal and confidence tone are generated by special generators in the digital part of the circuit. The DTMF signal consists of two weighted and superimposed pulse-density-modulated signals, while in the case of confidence tone, a pulse-density-modulated signal is superimposed on a high-frequency rectangular-pulse signal with pulse duty factor 0.5. The superimposed signals are sent out to MF for further processing. |
| 36 | D | Data input of serial bus (Pin 37):<br>Serial data input from microprocessor for programming the circuit. |
| 37 | C | Clock line: 2-wire serial bus:<br>This pin is used together with the data input (Pin 36) to transfer data from the microprocessor to the circuit. The last 8 bits, consisting of 5 data bits and 3 address bits, are accepted by the circuit if, during the high phase at Pin 37, a positive edge on Pin 36 takes place. |
| 38 | LVIO | Line-voltage information output<br>State indicator of the line voltage, VL, and the supply voltage, VDD<br>Indicates to microprocessor whether line voltage VL is present across the circuit and the supply voltage VDD is sufficiently high. If both conditions are fulfilled, LVIO is on high level. |
| 39 | CO | Clock output:<br>Output 455-kHz clock pulse for the microprocessor. The 455-kHz clock signal generated in the circuit is amplified and sent to CO. This signal is delivered to the microprocessor as a clock signal. Various internal signals can be output to CO in test mode. |
| 40 | RESET | Reset signal for periphery:<br>A reset signal (active low) is generated to clear all registers of the circuit. This can be tapped by peripheral modules, particularly by the microprocessor. This pin enables synchronous resetting of the circuit and peripheral modules. |
| 41 | XCK | Clock signal generator, connector for ceramic resonator (455 kHz)<br>The clock for the digital part of the circuit is generated by a one-pin oscillator, the frequency of which is determined by the ceramic resonator. |
| 42 | ESI | Input for external supply information<br>Input to indicate the operating state external supply.<br>In the case of VSA supplied by a power supply unit, the supply source is connected directly to ESI. ESI is connected to VSA by an external diode in forward mode. The ESI voltage will be one forward voltage higher than the voltage on VSA. This voltage causes the circuit to be in external supply mode. |
| 43 | ZCO | Zero crossing output in ringing phase:<br>ZCO operates when the ringer voltage, VRI, and the supply voltage, VSA, are sufficiently high. The output voltage ZCO changes state each time the rectified AC signal of THA crosses the ringing detect turn–on and turn–off thresholds, thus providing information on the frequency of the ring signal. Further analysis of the ring frequency is be done by the microprocessor. Secondly, this pin is used as an input for switching on the test mode. Therefore, a negative voltage of approximately 1 V must be applied to Pin 43. |
| 44 | THA | Ringing detection threshold adjustment (input amplitude and frequency identification):<br>The rectified ringing voltage is present at this pin. The circuit evaluates the amplitude of the rectified voltage at THA and the supply voltage VSA (Pin 13). If both voltages exceed certain thresholds, the signal present at THA is converted to a rectangular-pulse signal and is sent via Pin 43 to the microprocessor. If the frequency is in the required range, the microprocessor initiates transmission of the ringing signal. The start threshold can be raised with a resistor connected in series to Pin 44. |

## Absolute Maximum Ratings

| Parameters | Symbol | Value | Unit |
|---|---|---|---|
| DC calling voltage (Pin 2) | VRI | 35 | V |
| DC calling current (Pin 2) | IR | 30 | mA |
| Conversation line voltage (Pin 10)<br>        Voltage pulse for $t \le 20$ ms | $V_L$ | 15<br>17 | V<br>V |
| Conversation line current | $I_L$ | 150 | mA |
| Total power dissipation (assembly on PC board $\ge 24$ cm$^2$) | $P_{tot}$ | 1 | W |
| Operating temperature range | $T_{amb}$ | $-25$ to $+55$ | °C |
| Storage temperature range | $T_{stg}$ | $-55$ to $+150$ | °C |
| Junction temperature | $T_j$ | 125 | °C |

## Thermal Resistance

| Parameters | Symbol | Value | Unit |
|---|---|---|---|
| Junction ambient (for assembly on PC board $\ge 24$ cm$^2$) | $R_{thJA}$ | 70 | K/W |

## Electrical Characteristics

$I_L = 28$ mA, $T_{amb} = 25$°C, $f = 1$ kHz, $R_{DC} = 20$ k$\Omega$, all internal registers cleared, unless otherwise specified



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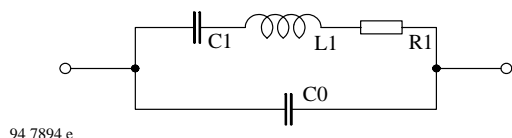
- 455-kHz ceramic resonator: MURATA or equivalent
- Refer to the test circuits

Figure 5.  Resonator equivalent circuit

Resonance factor $Q_m = 3100$, $L1 = 6.1$ mH, $C1 = 21$ pF, $CO = 268.5$ pF, $R1 = 5.5$ $\Omega$ (Schematic above)

All resistances are specified at 1%, all capacitances at 2%.

| Parameters | Test Conditions | Min. | Typ. | Max. | Unit | Fig. |
|---|---|---|---|---|---|---|
| Line voltage | $I_L = 15$ mA<br>$I_L = 28$ mA<br>$I_L = 60$ mA | 4.2<br>6.7<br>12.8 | 4.75<br>7.2<br>13.45 | 5.2<br>7.5<br>14.1 | <br>V<br> | 6 |
| VDD, VCC stabilized power supply | $I_L = 8$ mA, $-Idd$ (ICC) $= 0.6$ mA<br>$I_L = 28$ mA, $-Idd$ (ICC) $= 2.3$ mA | 2.5<br>3.2 | 2.65<br>3.45 | <br>3.6 | V | 6 |
| IDD at VDD $= 3.5$ V Internal operating supply current | S4 on 3 | | 180 | 210 | μA | 9 |
| Leakage current | | | | 100 | nA | |
| Speed-up off threshold VSOFF | See figure 11  $I_{Lmax} = 80$ mA<br>$V_L = 4$ V | 2.45 | 2.65 | 2.8 | V | 7 |
| Speed-up on line-current ISON | See figure 14  $I_L$ decreasing<br>$V_{DD} = 2.8$ V | 5.0 | 5.9 | 7.5 | mA | |
| Speed-up current | $V_L = 4$ V | 40 | 70 | | mA | 7 |

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## Electrical Characteristics – Transmission

| Parameters | Test Conditions | | | | | Min. | Typ. | Max. | Unit | Fig. |
|---|---|---|---|---|---|---|---|---|---|---|
| Transmit gain (note 1) | $V_{MIC} = 3$ mV$_{rms}$ | | | | | | | | | |
| | | MIS | TX2 | TX1 | TX0 | | | | | |
| on MIC1 / MIC2 | max. gain | 0 | 1 | 1 | 1 | 47.0 | 48.0 | 49.0 | dB | |
| | min. gain | 0 | 0 | 0 | 0 | 39.8 | 41.0 | 42.2 | dB | |
| | $V_{MICX} = 5$ mV$_{rms}$ | | | | | | | | | 6 |
| | | MIS | TX2 | TX1 | TX0 | | | | | |
| | max. gain | 1 | 1 | 1 | 1 | 43.0 | 44.0 | 45.0 | dB | |
| on MICX | min. gain | 1 | 0 | 0 | 0 | 35.8 | 37.0 | 38.2 | dB | |
| Gain adjustment of microphone amplifier | Gain change between two steps (both on MIC1/MIC2 and on MICX) | | | | | 0.8 | 1.0 | 1.2 | dB | 6 |
| Transmit gain without AGC $G_T$ at 28 mA | $V_{MIC} = 3$ mV$_{rms}$, Bit AGC=1 | | | | | | | | | |
| | | | TX2 | TX1 | TX0 | | | | | |
| $\Delta G_T$ at $I_L = 20$ to 28 mA | | | 0 | 1 | 1 | 42.6 | 44.0 | 45.5 | | |
| $\Delta G_T$ at $I_L = 28$ to 60 mA | | | 0 | 1 | 1 | –0.5 | 0.0 | 0.5 | dB | 6 |
| | | | 0 | 1 | 1 | –0.5 | 0.0 | 0.5 | | |
| Gain change between 28 and 60 mA | $V_{MIC} = 3$mV$_{rms}$: | | | AT1 | AT0 | | | | | |
| | (MIS = 0) | | | 0 | 0 | 3.6 | 4.1 | 4.6 | | |
| on MIC1 / MIC2 | | | | 0 | 1 | 4.9 | 5.35 | 5.9 | | |
| on MICX | or $V_{MICX} = 5$ mV$_{rms}$ | | | 1 | 0 | 6.3 | 6.9 | 7.4 | dB | 6 |
| | (MIS = 1) | | | 1 | 1 | 7.7 | 8.2 | 8.7 | | |
| +6 dB delta transmit gain | $I_L = 28$ mA and 60 mA $V_{MIC} = 1.5$ mV$_{rms}$, Bit TX6 = 1 | | | | | 5.4 | 6.0 | 6.6 | dB | 6 |
| Noise at line psophometrically weighted | GT = max. gain | | | | | | | | | |
| | $V_{MIC} = 0$ (MIS = 0) ISQ = 0 | | | | | | –79 | –75 | | |
| | $V_{MIC} = 0$ (MIS = 0) ISQ = 1 | | | | | | –73 | –70 | dBmp | 6 |
| | $V_{MICX} = 0$ (MIS = 1) ISQ = 1 | | | | | | | –64 | | |
| Muted gain | $V_{MIC} = 3$ mV$_{rms}$ (MIS = 0) or $V_{MIC} = 5$ mV$_{rms}$ (MIS = 1) (at max. and min. gain) *) | | | | | | | | | |
| on MIC1 / MIC2 | | | | Bit IM = 1 | | 65 | | | dB | 6 |
| | | | | Bit IT = 1 | | 65 | | | dB | |
| on MICX | $V_{MIC} = 3$ mV$_{rms}$ (MIS = 1) or | | | | | 60 | | | dB | |
| | $V_{MIC} = 5$ mV$_{rms}$ (MIS = 0) | | | | | 60 | | | dB | |
| Microphone input impedance | | | | | | | | | | |
| on MIC1/MIC 2 | $V_{MIC} = 3$ mV$_{rms}$ (MIS = 0) | | | | | 70 | 110 | | kΩ | 6 |
| on MICX | $V_{MICX} = 5$ mV$_{rms}$ (MIS = 1) | | | | | 35 | 55 | | kΩ | |
| CMRR common mode rejection ratio | $G_T$ = at maximum gain *) | | | | | | 65 | | dB | 6 |
| Voltage step on Pin 26 when going from transmission to mute mode Bit IM from 0 to 1 | $I_L = 28$ mA and 60 mA $V_{MIC} = 0$ (MIS = 0) or $V_{MICX} = 0$ (MIS = 1) At maximum gain *) | | | | | –75 | | +75 | mV | 6 |

## Transmission (continued)

| Parameters | Test Conditions | Min. | Typ. | Max. | Unit | Fig. |
|---|---|---|---|---|---|---|
| **Dynamic limiter (anti-clipping) CACL = 470 nF, RACL = 6.8 MΩ, operational only on MIC1/MIC2** | | | | | | |
| Output voltage swing (peak-to-peak value) | $V_{MIC}$ = 4 mV$_{rms}$ + 10 dB<br>　　TX2　TX1　TX0<br>　　1　　1　　1 | 3.3 | | 4.4 | V$_{pp}$ | 6 |
| Delta output voltage swing | $V_{MIC}$ = 9 mV$_{rms}$ +10 dB<br>　　TX2　TX1　TX0<br>　　0　　0　　0 | –200 | 0 | 200 | mV$_{pp}$ | 6 |
| | IL = 60 mA, AT1 = AT0 = 1<br>$V_{MIC}$ = 22 mV$_{rms}$ + 10 dB<br>　　TX2　TX1　TX0<br>　　0　　0　　0 | –200 | 0 | 200 | mV$_{pp}$ | 6 |
| Line distortion (on 600 Ω) | $V_{MIC}$ = 9 mV$_{rms}$<br>$V_{MIC}$=9 mV$_{rms}$+26 dB<br>　　TX6　TX2　TX1　TX0<br>　　0　　0　　0　　0 | | | 2<br>3 | %<br>% | 6 |
| | $V_{MIC}$ = 2 mV$_{rms}$<br>$V_{MIC}$=2 mV$_{rms}$+26 dB<br>$I_L$ = 60 mA, AT0 = AT1 = 1<br>　　TX6　TX2　TX1　TX0<br>　　1　　1　　1　　1 | | | 2<br>3.5 | %<br>% | 6 |
| | $V_{MIC}$ = 22 mV$_{rms}$<br>$V_{MIC}$=22mV$_{rms}$+24dB<br>　　TX6　TX2　TX1　TX0<br>　　0　　0　　0　　0 | | | 3<br>3 | %<br>% | 6 |
| **Squelch function** | **CAL = 470 nF, RAL = 68 kΩ** | | | | | |
| Dynamic range attenuation | $I_L$ = 28 mA and 60 mA (note 2) | 8.3 | 9.3 | 10.3 | dB | 6 |
| Squelch inhibition (tested on GT) | $\Delta G_T = G_{T1}(ISQ = 1) - G_{T2}(ISQ = 0)$<br>$G_{T1}$ ($V_{MIC}$ = 160 μV$_{rms}$),<br>$G_{T2}$ ($V_{MIC}$ = 3 mV$_{rms}$)<br>at maximum gain　*) | –0.3 | 0 | 0.3 | dB | 6 |

**\*)　Max. gain is without +6 dB function which is especially devoted for DTMF**

**Notes**

GT

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IL

12　　30　　50 mA
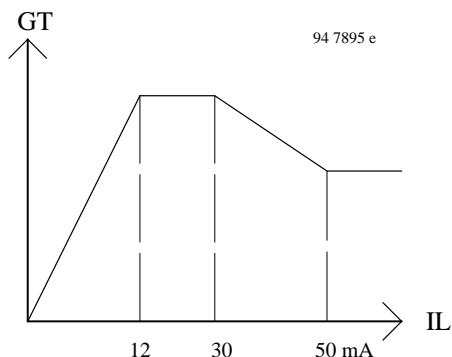
- Note 1: transmit gain: $G_T = V_L/V_{MIC}$ on MIC1/MIC2
  $G_T = V_L/V_{MIC}$ on MICX with the above values of RAG1 and RAG2

- Note 2: Squelch dynamic range: $\Delta G_T = G_{T0} - G_{T1}$
  $G_{T0}$ measured at $V_{MIC}$ = 1 mV$_{rms}$
  $G_{T1}$ measured at $V_{MIC}$ = 160 μV$_{rms}$

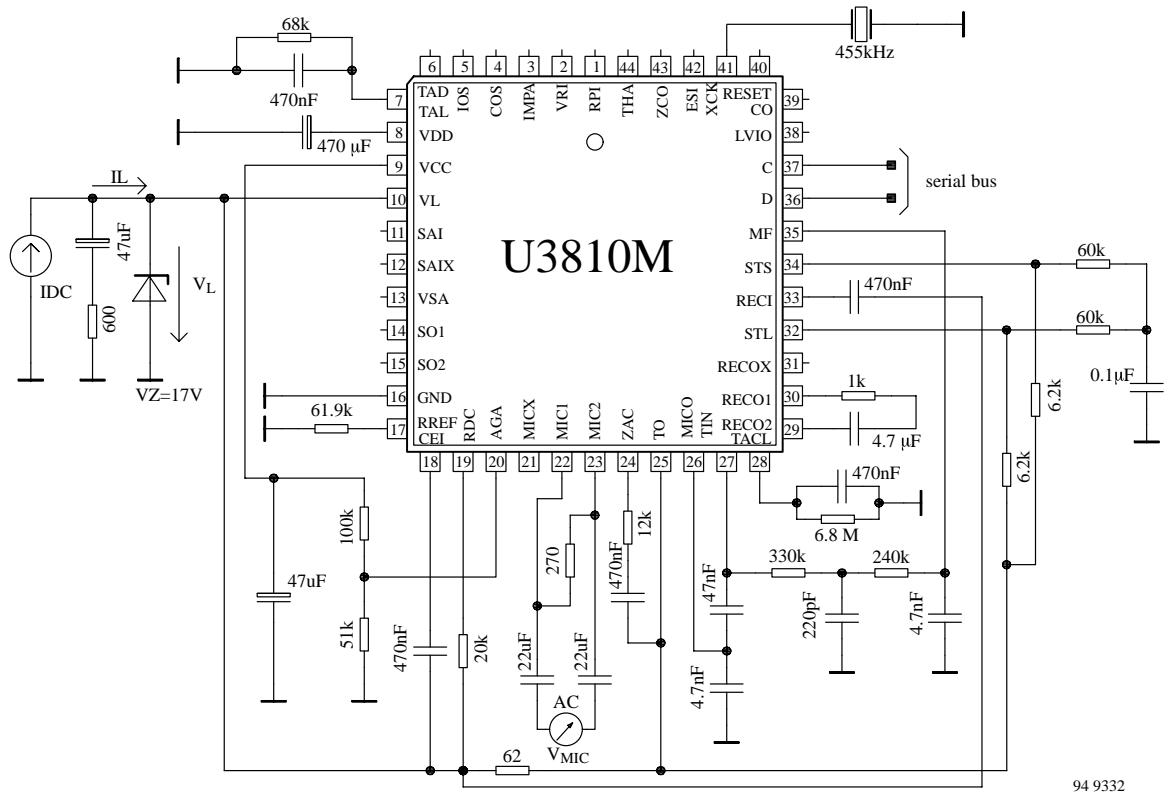Figure 6. Test circuit for transmission

## Electrical Characteristics – Receive

| Parameters | Test Conditions | | | | Min. | Typ. | Max. | Unit | Fig. |
|---|---|---|---|---|---|---|---|---|---|
| $G_R$ receiving gain | $V_{GEN} = 0.3 V_{rm}$ | RX2 | RX1 | RX0 | | | | | |
| $G_R = V_R{}^*/V_L$ | maximum gain | 1 | 1 | 1 | 3.5 | 4.5 | 5.5 | dB | |
| (for normal output) | minimum gain | 0 | 0 | 0 | −3.7 | −2.5 | −1.3 | dB | 7 |
| $\Delta G_R = V_R/V_{RECOX}$ | $V_{GEN} = 0.3 V_{rms}$ | | | | 14.0 | 15.0 | 16.0 | dB | 7 |
| Gain adjustment at earphone | $I_L = 28$ mA and 60 mA Attenuation between two steps (both on RECO1/RECO2 and on RECOX) | | | | 0.8 | 1.0 | 1.3 | dB | 7 |
| Receiving gain without AGC | $V_{GEN} = 0.3 V_{rms}$ Bit: AGC =1, IBAL = 1 | | | | | | | | |
| $G_R = V_R/V_L$ | | RX2 | RX1 | RX0 | | | | | |
| $G_R$ at 28 mA | | 1 | 1 | 1 | −3 | −1.5 | 0 | dB | 7 |
| $\Delta G_R$ at 20 mA $< I_L <$ 28 mA | | 1 | 1 | 1 | −0.5 | 0 | 0.5 | dB | |
| $\Delta G_R$ at 28 mA $< I_L <$ 60 mA | | 1 | 1 | 1 | −0.5 | 0 | 0.5 | dB | |
| $\Delta G_R$ receiving gain | $V_{GEN} = 0.3 V_{rms}$ | | AR1 | AR0 | | | | | |
| between 28 and 60 mA | | | 0 | 0 | 3.6 | 4.1 | 4.6 | dB | |
| on RECO1/RECO2 | | | 0 | 1 | 4.9 | 5.5 | 5.9 | dB | 7 |
| and on RECOX | | | 1 | 0 | 6.3 | 6.9 | 7.4 | dB | |
| | | | 1 | 1 | 7.5 | 8.3 | 8.7 | dB | |

* VR = VRECO1 – VRECO2

## Receive (continued)

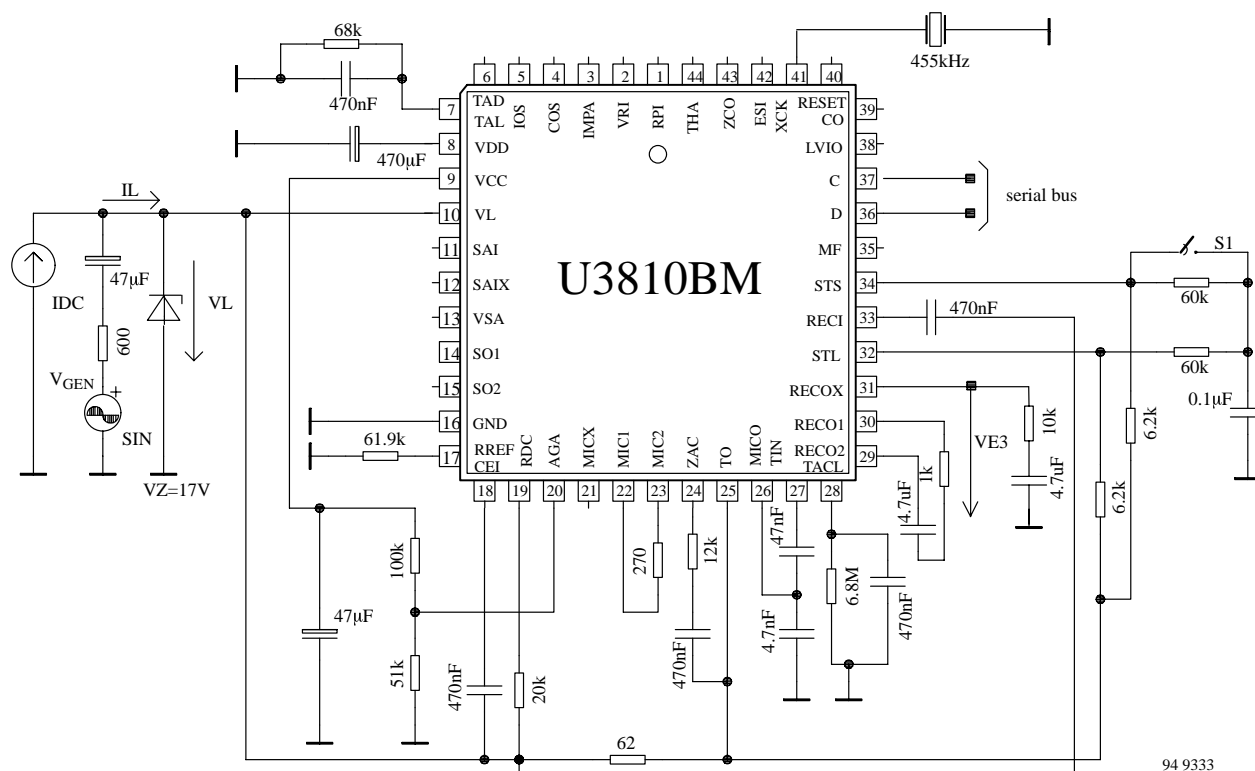| Parameters | Test Conditions | Min. | Typ. | Max. | Unit | Fig. |
|---|---|---|---|---|---|---|
| +6 dB delta receiving gain on RECO1/RECO2 and on RECOX | $V_{GEN}$=0.3 $V_{rms}$, $I_L$ = 28 mA and 60 mA (at maximum and minimum gain)          Bit RX6 = 1 | 5.6 | 6.1 | 6.7 | dB | 7 |
| Muted gain | $V_{GEN}$ = 0.3 $V_{rms}$ Mute on RECO1/RECO2                              Bit      IR=1                              Bit IE1 = IE2 = 1 RECOX            Bit      IR=1 | 65 60 36 | | | dB dB dB | 7 |
| Noise at earpiece psophometric weighted | At maximum gain $V_{GEN}$ = 0 V | | 150 | 220 | μVp | 7 |
| Receiving distortion | $I_L$ = 28 mA and 60 mA max gain, RX6 = 1   VR = 5 $V_{pp}$ min. gain, RX6 = 0   VR = 2 $V_{pp}$ | | 1 | 3 | % | 7 |
| Receiver output impedance on RECO1/RECO2 (Pins 29 – 30) | $V_R$ = 50 m$V_{rms}$ | 40 | 65 | 85 | Ω | 7 |
| Receiver output impedance on RECOX (Pin 31) | $V_{RECOX}$ = 50 m$V_{rms}$ | 800 | 950 | 1100 | Ω | 7 |
| Receiver output impedance on RECOX (Pin 31) | $V_{RECOX}$ = 50 m$V_{rms}$ | 800 | 950 | 1100 | Ω | 7 |
| Receiver output offset (Pins 29 – 30) | $I_L$ = 28 mA and 60 mA Maximum gain          RX6 = 1 | −800 | | +600 | mV | 7 |
| Automatic sidetone balancing ($V_R^*/V_{MIC}$) | At maximum gain $V_{MIC}$ = 4 m$V_{rms}$       $I_L$ = 28 mA                                   $I_L$ = 60 mA | | 24 16 | | dB dB | 6 |
| Digitally balanced sidetone tested on receiving gain $V_R/V_L$ | $V_{GEN}$ = 0.3 $V_{rms}$    maximum gain close switch  S1    IBAL = 1     BAL2      BAL1      BAL0      0          0          0      0          0          1      0          1          0      0          1          1      1          0          1      1          1          0      1          1          1 | 18.0 16.9 15.5 4.2 | 19.0 17.9 16.5 14.5 12.3 9.2 5.7 | 20.0 18.9 17.5 7.2 | dB dB dB dB dB dB dB | 7 |
| Confidence level attenuation | $V_{MIC}$ = 2 m$V_{rms}$          $I_R$ = 1 | 60 | | | dB | 6 |
| Confidence level gain $V_R/V_{MIC}$ | $V_{MIC}$ = 2 m$V_{rms}$          $I_R$ = 1 EC = 1 | 19.5 | 22.0 | 23.5 | dB | 6 |
| Z line match. impedance | $V_{GEN}$ = 0.3 $V_{rms}$     $I_L$ = 28 and 60 mA | 520 | 570 | 620 | Ω | 7 |

* VR = VRECO1 – VRECO2

Figure 7.  Test circuit for receive

## Electrical Characteristics – Speaker Amplifier

| Parameters | Test Conditions | Min. | Typ. | Max. | Unit | Fig. |
|---|---|---|---|---|---|---|
| VSA shunt regulator power supply (Pin 13) in transmission mode | Speaker amplifier without signal<br>EA = 1<br>IL = 28 mA<br>IL = 60 mA | <br><br>4.0<br>7.85 | <br><br>4.3<br>8.3 | <br><br>4.6<br>8.7 | <br><br>V<br>V | 8 |
| Loudhearing gain (note 3) from SAI/SAIX to SO1, SO2 | $GSA1 = \dfrac{VSO1 - VSO2}{VSAI}$   EA = 1 <br><br>$GSA2 = \dfrac{VSO1 - VSO2}{VSAIX}$ <br><br>NEA2 NEA1 NEA0 VSAI=VSAIX<br>  1    1      1   $VSAI = 3.5\,mV_{rms}$<br>  0    0      0   $VSAI = 88\,mV_{rms}$ | <br><br><br><br><br><br>33<br>5 | <br><br><br><br><br><br>34<br>6 | <br><br><br><br><br><br>35<br>7 | <br><br><br><br><br><br>dB<br>dB | 8 |
| Loudhearing gain between 28 and 60 mA GSA1 and GSA2 (note 3) | EA = 1 | −0.5 | 0 | 0.5 | dB | 8 |
| Gain adjustment of speaker amplifier | EA = 1<br>gain change between two steps | 3.8 | 4.0 | 4.2 | dB | 8 |

## Speaker Amplifier (continued)

| Parameters | Test Conditions | Min. | Typ. | Max. | Unit | Fig. |
|---|---|---|---|---|---|---|
| Distortion (measured on 100-Ω load) | EA = 1<br>NEA2  NEA1  NEA0      VSAI<br>  1      1      1    VSAI=12mV$_{rms}$<br>                      VSAI=30mV$_{rms}$<br>  0      0      0    VSAI=250mV$_{rms}$<br><br>EA = 1, I$_L$ = 60 mA<br>NEA2  NEA1  NEA0<br>  1      1      1    VSAI=80mV$_{rms}$<br>  0      0      0    VSAI=250mV$_{rms}$ | | | 2.0<br>4.0<br>1.5<br><br><br><br>2.0<br>2.0 | %<br>%<br>%<br><br><br>%<br>%<br> | 8 |
| Input impedance        SAI<br>                          SAIX | EA = 1 | 4<br>4 | 7<br>7 | 10<br>10 | <br>kΩ | 8 |
| Confidence gain in loudhearing | V$_{MIC}$ = 4 mV VSO   EA = 1<br>              V$_{MIC}$   EC = 1, ITAL = 1 | 36 | | 40 | dB | 8 |
| Loudhearing input cross talk attenuation | NEA = 7              EA = 1<br>VSAI =12 mV$_{rms}$   LIS = 1<br>VSAIX = 12 mV$_{rms}$  LIS = 0 | <br>60<br>60 | | | <br>dB<br>dB | 8 |
| Output power (note 4, 5) | EA = 1  I$_L$ = 20 mA     50 Ω load asym.<br>                            100 Ω load sym.<br>          I$_L$ = 28 mA     50 Ω load asym.<br>                            100 Ω load sym.<br>          I$_L$ = 60 mA     50 Ω load asym.<br>                            100 Ω load sym. | <br>9.0<br><br>19.0<br><br>140 | 12.5<br>11.5<br>24<br>30<br>120<br>170 | | mW<br>mW<br>mW<br>mW<br>mW<br>mW | 8 |
| Output offset (Pins 14 – 15) | LIS = 0, 1, EA = 1, max. and min. gain | −200 | | +200 | mV | 8 |
| Leakage current (Pin 6) | EA = 1 | | | 140 | nA | 8 |
| Offset (Pin 7) | RAL = 68 kΩ, I$_L$ = 28 mA and 60 mA<br>EA = 1 | | | 140 | mV | 6 |
| **Anti-larsen system**        **CAL = 470 nF, RAL = 68 kΩ** | | | | | | |
| Dynamic range attenuation | IL = 28 mA and 60 mA<br>EA = 1 VSAI = 6 mV$_{rms}$<br>          Bit ISQ = 0<br>          BIT ISQ = 1   (note 5) | <br><br>11<br>23 | <br><br>12<br>26 | <br><br>13<br>29 | <br><br>dB<br>dB | 8 |

- Note 3:  GSA1 measured with S2 on 11
  GSA2 measured with S2 on 12 and Bit LIS = 1

- Note 4:  Anti-larsen dynamic range:,
  ΔGLS = GLSA – GLSB
  GLSA measured at V$_{MIC}$ = 160 μV$_{rms}$
  GLSB measured at V$_{MIC}$ = 1 mV$_{rms}$

- Note 5:  The available output current of the speaker amplifier can be increased by reduction of the quiescent current of the receiver output stage (bits IE1, IE2, see "contents of internal registers").

Figure 8. Test circuit for speaker amplifier

## DTMF Dialing

The output pin MF provides the multi-frequency signal to be transmitted on line. This signal is the result of the sum of two frequency pulse modulations and requires an external filter to compose a dual sine wave. The frequencies are chosen in a low group and a high group.

The circuit conforms to the T/CS 46–02 CEPT recommendation concerning DTMF option 1 (–9/–11 dBm) and option 2 (–6/–8 dBm) transmit level 5 (example: in figure 6, option 2 can be fulfilled with 3.5 dB preemphasis and 1.5 Vpp low frequency level Pin 35).

Two different low levels (with 3 dB difference) and two different preemphases (2.5 and 3.5 dB) can be chosen through the serial bus.

## Melody – Confidence Tone

Melody/confidence tone frequencies are given in table 2.

In the state SIN1 = 1, SIN0 = 0, the IC delivers a single pulse-density-modulated frequency at pin MF (the same behavior as DTMF), denoted as a confidence tone. The confidence tone is sent either to the line or on the earpiece. In the state SIN1 = 0, SIN0 = 1, a square wave is sent to the loudhearing input for ringing melodies.

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Table 1. Frequency tolerance of the output tones for DTMF signalling tone output frequency when using 455 kHz

| Standard Frequency Hz | Tone Output Frequency Hz | Frequency Deviation | |
|---|---|---|---|
| | | % | Hz |
| Low Group | | | |
| 697 | 697.85 | 0.12 | +0.85 |
| 770 | 771.18 | 0.15 | +1.18 |
| 852 | 852.06 | 0.01 | +0.06 |
| 941 | 940.08 | −0.10 | −0.92 |
| | | | |
| High Group | | | |
| 1209 | 1210.1 | 0.09 | +1.1 |
| 1336 | 1338.2 | 0.17 | +2.2 |
| 1477 | 1477.3 | 0.02 | +0.3 |
| 1633 | 1636.7 | 0.22 | +3.7 |

Note: Frequency can be directly measured on CO when S3 is closed (figure 9)

Table 2. Melody generator mode

| AMF | SIN0 | SIN1 | CO |
|---|---|---|---|
| 1 | 1 | 1 | DTMF : HF |
| 0 | 1 | 1 | DTMF : LF |
| 0 | 1 | 0 | MELODY |
| 0 | 0 | 1 | CONFIDENCE TONE |

Table 3. DTMF two tone matrix

| Upper frequency/ Hz | 1209 | 1336 | 1477 | 1633 |
|---|---|---|---|---|
| Lower frequency/ Hz | Corresponding telephone buttons | | | |
| 697 | 1 | 2 | 3 | A |
| 770 | 4 | 5 | 6 | B |
| 852 | 7 | 8 | 9 | C |
| 941 | * | 0 | # | D |

Table 4. Frequency tolerance of the output tone – tone output frequency when using 455 kHz

| Standard Frequency Hz | Tone Output Frequency Hz | Frequency Deviation $^0/_{00}$ |
|---|---|---|
| 440.00 | 440.04 | 0.09 |
| 466.16 | 466.19 | 0.06 |
| 493.88 | 493.49 | −0.78 |
| 523.25 | 522.99 | −0.50 |
| 554.36 | 554.88 | 0.92 |
| 587.33 | 587.86 | 0.89 |
| 622.25 | 621.58 | −1.07 |
| 659.25 | 659.42 | 0.26 |
| 698.46 | 697.85 | −0.87 |
| 740.00 | 741.04 | 1.41 |
| 784.00 | 784.48 | 0.62 |
| 830.00 | 830.29 | −0.37 |
| 880.00 | 878.38 | −1.84 |
| 932.30 | 932.38 | 0.08 |
| 987.77 | 989.13 | 1.38 |
| 1046.50 | 1048.39 | 1.80 |
| 1108.73 | 1109.76 | 0.93 |
| 1174.66 | 1172.68 | −1.69 |
| 1244.50 | 1243.17 | −1.07 |
| 1318.50 | 1315.03 | −2.63 |
| 1396.90 | 1395.71 | −0.86 |
| 1480.00 | 1477.27 | −1.84 |
| 1568.00 | 1568.97 | 0.62 |
| 1661.20 | 1660.58 | −0.37 |
| 1760.00 | 1763.57 | 2.03 |
| 1864.65 | 1864.75 | 0.06 |
| 1975.50 | 1978.26 | 1.40 |
| 2093.00 | 2087.16 | −2.79 |
| 2217.46 | 2208.74 | −3.93 |
| 2349.30 | 2345.36 | −1.68 |

## Electrical Characteristics – DTMF Generation (Pin MF)

| Parameters | Test Conditions | | Min. | Typ. | Max. | Unit | Fig. |
|---|---|---|---|---|---|---|---|
| Tone frequency accuracy | See table 1 | | | | | | |
| Low-group tone level without attenuation | Note 7 S3 closed | BFOA (preemphasis A) BFOB (preemphasis B) | 1.35 1.25 | 1.50 1.40 | 1.65 1.55 | V V | 9 |
| High-group tone level without attenuation | Note 7 closed | HFOA (preemphasis A)    S3 HFOB (preemphasis B) | 1.80 1.90 | 2.00 2.10 | 2.20 2.35 | V V | 9 |
| Preemphasis A without attenuation | Note 7 S3 closed | PROA | 2.04 | 2.54 | 3.04 | dB | 9 |
| Preemphasis B without attenuation | Note 7 S3 closed | PROB | 3.02 | 3.52 | 4.02 | dB | 9 |
| Low-group tone level with attenuation | Note 7 S3 closed | BF1A (preemphasis A) BF1B (preemphasis B) | 0.95 0.90 | 1.05 1.00 | 1.15 1.10 | V V | 9 |
| High-group tone level with attenuation | Note 7 S3 closed | HF1A (preemphasis A) HF1B (preemphasis B) | 1.25 1.35 | 1.40 1.50 | 1.55 1.65 | V V | 9 |

## DTMF Generation (Pin MF) (continued)

| Parameters | Test Conditions | Min. | Typ. | Max. | Unit | Fig. |
|---|---|---|---|---|---|---|
| Preemphasis A with attenuation | Note 7　　　　PR1A<br>S3 closed | 2.04 | 2.54 | 3.04 | dB | 9 |
| Preemphasis B with attenuation | Note 7　　　　PR1B<br>S3 closed | 3.02 | 3.52 | 4.02 | dB | 9 |
| Leakage | S4 = 2　　　Bits　SIN1　SIN0<br>S3 closed　　　　0　　0 | −100 | | 100 | nA | 9 |
| Distortion at line | IL = 28 mA<br>M = 8　Key = «3»<br>TX6 = 1　　　　IM = 1 | | 1 | 3 | % | 6 |
| Low-group tone level at line | IL = 28 mA and 60 mA<br>M = 8　Key = «3»<br>TX6 = 1　　　　IM = 1 | −10 | −8 | −6 | dBm | 6 |
| **Melody generation** | | | | | | |
| Tone frequency accuracy | See table 4 | | | | | |
| Confidence tone level | Note: 7　　　　CTL | 2.10 | 2.33 | 2.60 | V | 9 |
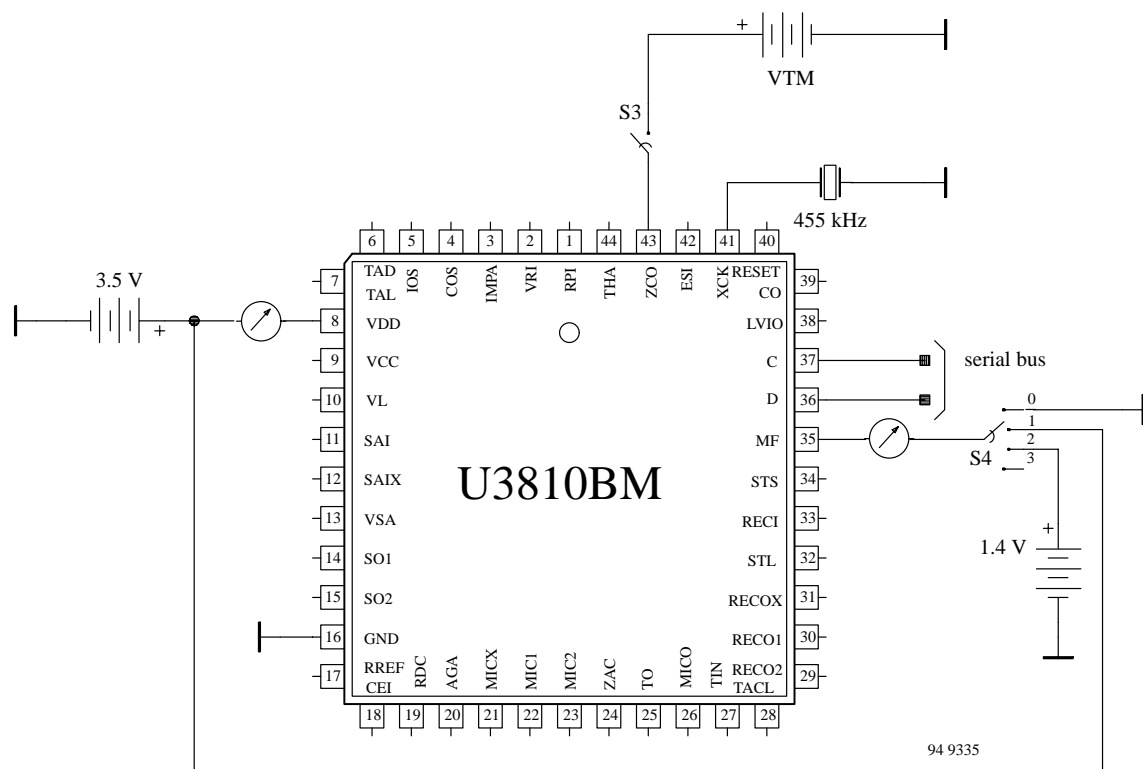


Figure 9.  Test circuit for DTMF generation

Table 5.  DTMF setup for indirect (by current) level measurement

| S4 (Figure 9) | Internal Registers Set by Serial Bus | | | | Internal Signal Set by Clock Count | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | AMF | SIN1 | SIN0 | M4 | FB | FH | F227 | I measured |
| 0 | 0 | 1 | 1 | 0 | 1 | 0 | X | I1 |
| 0 | 0 | 1 | 1 | 0 | 0 | 1 | X | I2 |
| 0 | 0 | 1 | 1 | 1 | 0 | 1 | X | I3 |
| 0 | 0 | 1 | 0 | 0 | 0 | X | 1 | I4 |
| 0 | 1 | 1 | 1 | X | 0 | 0 | 1 | I5 |
| 1 | 0 | 1 | 1 | 1 | 0 | 1 | X | I6 |
| 1 | 0 | 1 | 1 | 0 | 1 | 0 | X | I7 |
| 1 | 0 | 1 | 1 | 1 | 1 | 0 | X | I8 |
| 1 | 0 | 1 | 0 | X | 1 | X | 0 | I9 |
| 1 | 1 | 1 | 1 | X | 1 | 1 | 0 | I10 |

X: either 1 or 0

**Note 7: DTMF calculations**

BF level without attenuation with pre-emphasis A:
$$BFOA = \left(\frac{I1}{I1 + I7} + \frac{I6}{I6 + I2}\right)\frac{VDD}{2}$$

BF level without attenuation with pre-emphasis B:
$$BFOB = \left(\frac{I1}{I1 + I8} + \frac{I6}{I6 + I3}\right)\frac{VDD}{2}$$

HF level without attenuation with pre-emphasis A:
$$HFOA = \left(\frac{I2}{I2 + I6} + \frac{I7}{I7 + I1}\right)\frac{VDD}{2}$$

HF level without attenuation with pre-emphasis B:
$$HFOB = \left(\frac{I3}{I3 + I6} + \frac{I8}{I8 + I1}\right)\frac{VDD}{2}$$

Pre-emphasis A without attenuation:
$$PROA = 20 \log\left(\frac{HFOA}{BFOA}\right)$$

Pre-emphasis B without attenuation:
$$PROB = 20 \log\left(\frac{HFOB}{BFOB}\right)$$

BF level with attenuation with pre-emphasis A:
$$BF1A = \left(\frac{I1}{I1 + I7 + I10} + \frac{I6}{I6 + I2 + I5}\right)\frac{VDD}{2}$$

BF level with attenuation with pre-emphasis B:
$$BF1B = \left(\frac{I1}{I1 + I8 + I10} + \frac{I6}{I6 + I3 + I5}\right)\frac{VDD}{2}$$

HF level with attenuation with pre-emphasis A:
$$HF1A = \left(\frac{I2}{I2 + I6 + I10} + \frac{I7}{I7 + I1 + I5}\right)\frac{VDD}{2}$$

HF level with attenuation with pre-emphasis B:
$$HF1B = \left(\frac{I3}{I3 + I6 + I10} + \frac{I8}{I8 + I1 + I5}\right)\frac{VDD}{2}$$

Pre-emphasis A without attenuation:
$$PR1A = 20 \log\left(\frac{HF1A}{BF1A}\right)$$

Pre-emphasis B without attenuation:
$$PR1B = 20 \log\left(\frac{HF1B}{BF1B}\right)$$

Confidence tone level:
$$CTL = \left(\frac{I1}{I1 + I9} + \frac{I6}{I6 + I4}\right)\frac{VDD}{2}$$

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## Electrical Characteristics – Ringer

| Parameters | Test Conditions | Min. | Typ. | Max. | Unit | Fig. |
|---|---|---|---|---|---|---|
| THA threshold voltage THTV | $V_S = 5$ V      S5 on 1 | 8.30 | 8.75 | 9.20 | V | 10 |
| THA hysteresis ΔTH | $V_S = 5$ V      S5 on 1 | 435 | 465 | 495 | mV | 10 |
| VSA threshold voltage VSAON (ring detector enabled) | VTHA = 12 V          S5 on 1 | 3.0 | 3.2 | 3.4 | V | 10 |
| VSA threshold voltage VSAOFF (ring detector disabled) | VTHA = 12 V          S5 on 1 | 2.45 | 2.5 | 2.65 | V | 10 |
| Switching supply output current | VS = 5 V      VIN = 30 V<br>S7 on 1      S5 on 1    RIN = 300 kΩ | 33 | 37 | | mA | 10 |
| Input impedance VIN/IIN | S5 on 1      VS = 5 V      S7 on 1<br>Off state VIN = 5 V  RIN = 300 kΩ<br>On state VIN = 30 V RIN = 300 kΩ<br>On state VIN = 30 V RIN = 1500 kΩ | 50.0<br>2.78<br>13.4 | 2.90<br>14.1 | 3.05<br>15.0 | kΩ<br>kΩ<br>kΩ | 10 |
| RPI ringing power information | RIN = 300 kΩ          S7 on 2<br>S5 on 2      VIN = 30 V      VESI = 0 V<br>S5 on 1      VIN =  0 V      VESI = 5 V | 1.48<br>1.57 | 1.55<br>1.61 | 1.64<br>1.64 | V<br>V | 10 |
| VSA/VDD switch off VSA-OFF1 (measured on VSA) | S8 closed<br>S5 on 1          IVDD = – 1 mA | 5.55 | 5.8 | 6.0 | V | 10 |
| VSA shunt regulator<br>     VSAL<br>     VSAH | S5 on 3      ISA =  2 mA<br>                 ISA = 45 mA | 4.75<br>5.0 | 5.0<br>5.3 | 5.15<br>5.7 | V<br>V | 10 |
| Difference between max. VSA voltage and cut off voltage | VSADIFF = VSAOFF1 – VSAH | 250 | 500 | | mV | 10 |
| ZCO Zero crossing information | VS = 5 V      S5 on 1          S6 closed<br>IZCO = 100 µA      VTHA =  7.5 V<br>IZCO = –100 µA      VTHA = 12.0 V | <br><br>4.4 | | 0.5 | V<br>V | 10 |
| Ringer output power (on 100-Ω load) | VIN = 30 V          RIN = 300 kΩ<br>S7 on 2      S5 on 2<br>SIN1  SIN0  LIS    EA<br>0      1      1      1<br>NEA – maximum gain | 70 | 105 | 130 | mW | 10 |
| Extra ringing attenuation | VIN = 30 V          RIN = 300 kΩ<br>S7 on 2      S5 on 2<br>SIN1  SIN0  LIS    AMF  EA<br>0      1      1      1      1<br>NEA – maximum gain | –12.8 | –12.2 | –11.6 | dB | 10 |

Figure 10. Test circuit for ringer

$$ZC = ZC1 \times ZC2$$

Figure 11.

# U3810BM

## Electrical Characteristics of Logical Part

$f_{xck} = 455$ kHz                                        VDD = 3.5 V

| Parameter | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|
| INPUTS : C, D | | | | |
| Low-voltage input $V_{il}$ | | | 0.7 | V |
| High-voltage input $V_{ih}$ | 2.8 | | | V |
| Input leakage current $I_i$ | $-1$ | | 1 | μA |
| $(0 < VI < VDD)$ | | | | |
| Output: RESET, CO, LVIO | | | | |
| Low-voltage output (Iol = 100 μA) $V_{ol}$ | | | 0.35 | V |
| High-voltage output (Ioh = $-100$ μA) $V_{oh}$ | 3.1 | | | V |
| CLOCK: CO (figure 16) | | | | |
| Using reference ceramic resonator | | | | |
| period:                          $t_{cyc}$ | 2.19 | 2.20 | 2.21 | μs |
| High pulse width:           $t_{wch}$ | 1.10 | | 1.45 | μs |
| SERIAL BUS (figure 20) | | | | |
| Data setup time                $t_{sud}$ | 0.1 | | | μs |
| Data hold time                  $t_{hd}$ | 0 | | | μs |
| Clock low time                  $t_{cl}$ | 2 | | | μs |
| Clock high time               $t_{ch}$ | 2 | | | μs |
| Hold time before transfer condition   $t_{eon}$ | 0.1 | | | μs |
| Data low pulse on transfer condition   $t_{eh}$ | 0.2 | | | μs |
| Data high pulse on transfer condition   $t_{eoff}$ | 0.2 | | | μs |
| RESET TIMING (figures 12, 13 and 14) | | | | |
| Clock start-up time           $t_{on}$ | | 3 | 5 | ms |
| Clock inhibition time        $t_{off}$ | 70 | | 150 | μs |
| Reset time (without $t_{on}$)   $t_r$ | 30 | 31.6 | 32 | ms |

## Power-on Reset and Reset Pin

The system (U3810BM + microcontroller) is woken up by an initial condition:
- line voltage (VL)
- ringer (THA)
- external supply (ESI)

To avoid undefined states of the system when it is powered on, an internal reset clears the internal registers, and maintains pin RESET low during trt.

1.) Power-on in speed-up condition ($V_{DD} < V_{SON}$)



$$t_{rt} = t(V_{DD} \text{ to } V_{SOFF}) + t_r + t_{on}$$

937609
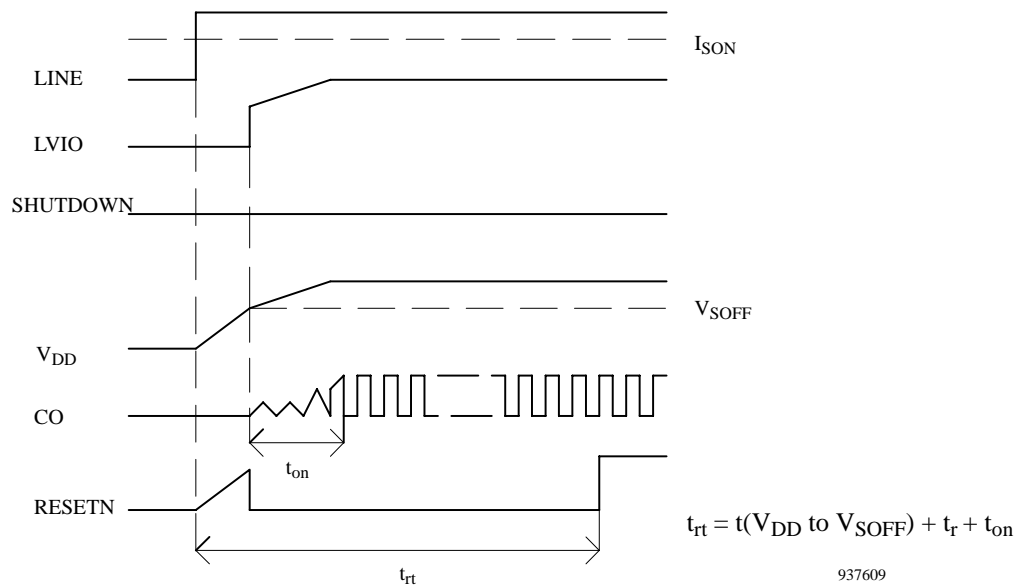
Figure 12. Power on in speed-up condition ($V_{DD} < V_{SON}$)

2.) Power-on without speed-up ($V_{DD} > V_{SON}$)



$$t_{rt} = t_r + t_{on}$$

937610
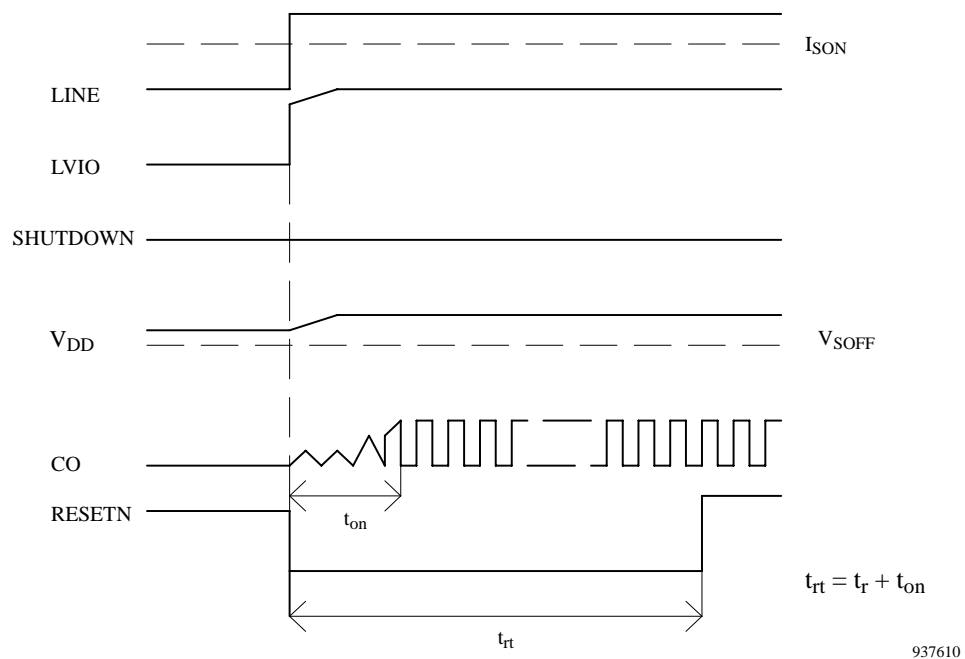
Figure 13. Power on without speed-up ($V_{DD} > V_{SON}$)

3.) Line break
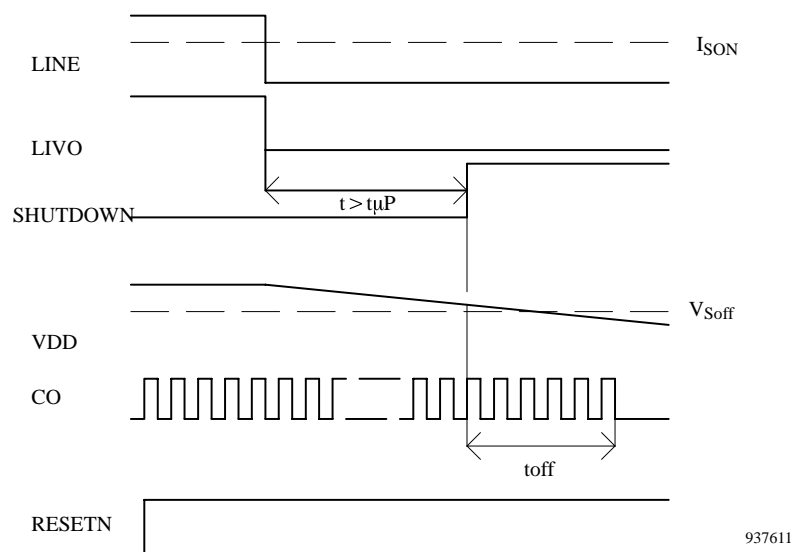


Figure 14.  Line break

When the microprocessor detects LIVO low during t > tμC (internal microprocessor timing special for line breaks), it forces high the shutdown bit through the serial bus, thus leading the IC, after $t_{off}$, to go into standby mode (oscillator stop). Pin RESET remains high.

When the line break is shorter than tμC, nothing appears.

4.) Line current fall
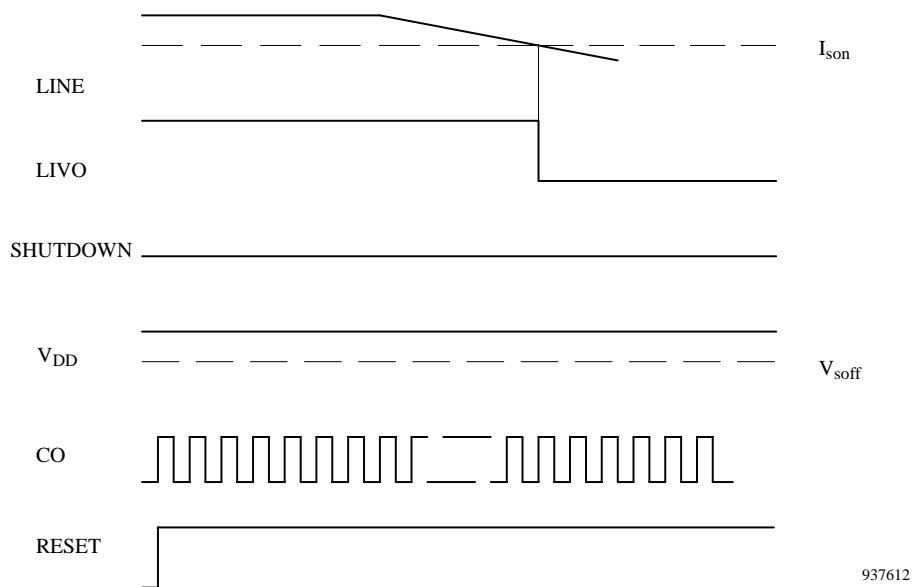


Figure 15.  Line current fall
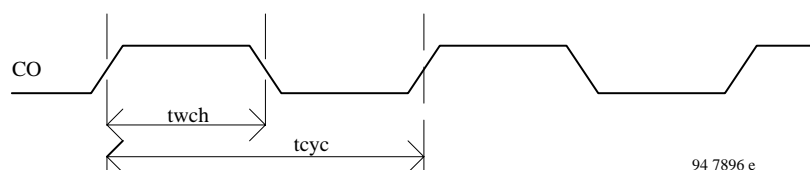
Figure 16.  Clock output (CO)

## Serial Bus

The circuit is remoted by an external microcontroller through the serial bus:

The data is an 8-bit word:
B7 – B6 – B5: address of the destination register (0 to 7)
B4 – B0: contents of register

The data line must be stable when the clock is high and data must be serially shifted.

After 8 clock periods, the transfer to the destination register is (internally) generated by a low-to-high transition of the data line when the clock is high.
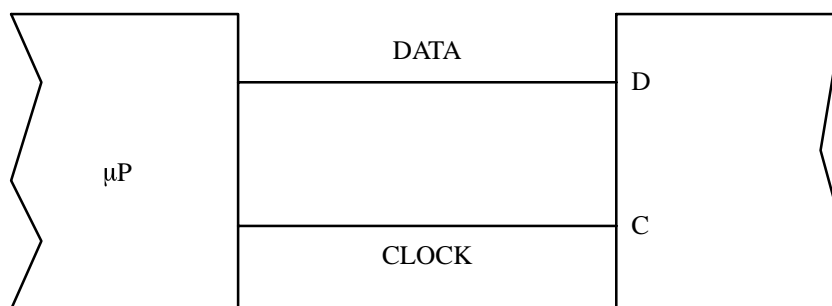


Figure 17.  Principle of the serial bus



Figure 18.

8-bit register
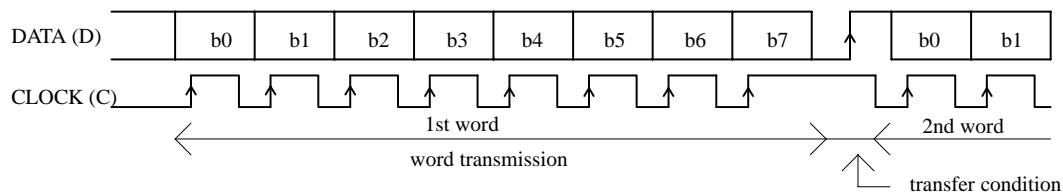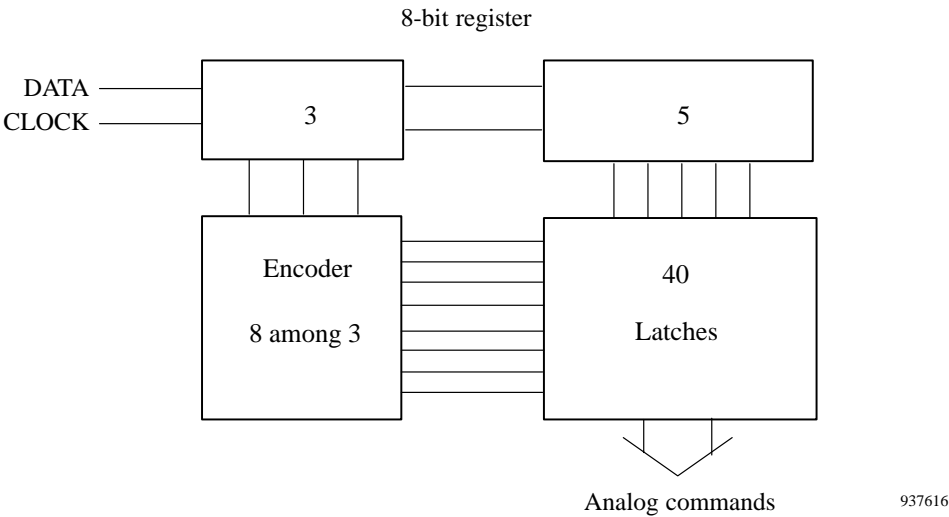


Figure 19.  Serial bus interface
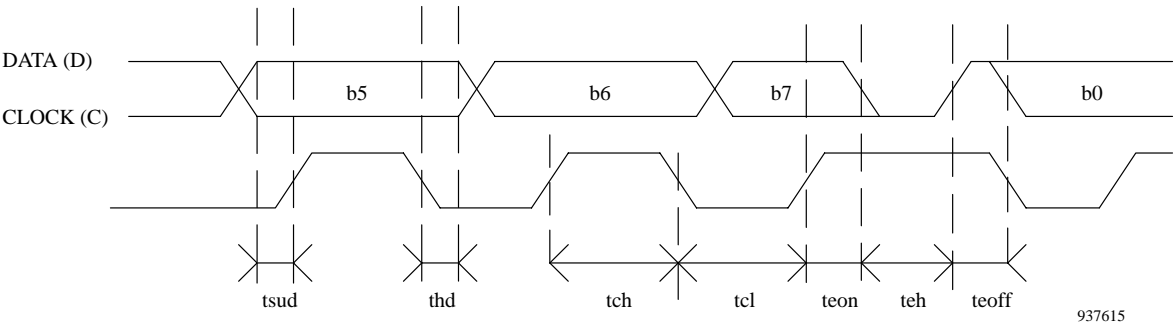


Figure 20.  Serial bus timing

# Content of Internal Registers

0: Transmission mode

| MIS | TX6 | TX2 | TX1 | TX0 | MIS: Microphone input switching<br>TX6: +6dB<br>TX: Transmission gain adjustment |
|-----|-----|-----|-----|-----|---|

1: Reception mode

| LIS | RX6 | RX2 | RX1 | RX0 | LIS: Loudhearing input switching<br>RX6: +6dB<br>RX: Reception gain adjustment |
|-----|-----|-----|-----|-----|---|

2: Loudhearing mode

| IAL | EA | NEA2 | NEA1 | NEA0 | IAL: Anti-larsen inhibition<br>EA: Loudhearing enable<br>NEA: Loudhearing gain adjustment |
|-----|-----|------|------|------|---|

3: AGC mode

| IAGC | AR1 | AR0 | AT1 | AT0 | IAGC: AGC inhibition<br>AT: Transmission AGC adjustment<br>AR: Reception AGC adjustment |
|------|-----|-----|-----|-----|---|

4: Sidetone mode

| IE2 | IBAL | BAL2 | BAL1 | BAL0 | IE2: Reception output amplifier current adjustment<br>IBAL: Inhibition of automatic sidetone balance |
|-----|------|------|------|------|---|

5: Sidetone balancing

| BAL | Z |
|-----|---|
| 0 | 1 STS |
| 1 | 5/6 STS + 1/6 STL |
| 2 | 2/3 STS + 1/3 STL |
| 3 | 1/2 STS + 1/2 STL |
| 4 | 1/2 STS + 1/2 STL |
| 5 | 1/3 STS + 2/3 STL |
| 6 | 1/6 STS + 5/6 STL |
| 7 | 1 STL |

6: Internal inhibitions

| IR | EC | IT | IM | IE1 | IR: Reception inhibition<br>EC: Confidence enable<br>IT: Transmit inhibition<br>IM: Microphone inhibition<br>IE1: Reception output amplifier current adjustment |
|-----|-----|-----|-----|-----|---|

7: Earpiece current

| IE1 | IE2 | IREC | |
|-----|-----|------|---|
| 0 | 0 | 3 mA | |
| 0 | 1 | 2 mA | |
| 1 | 0 | 1 mA | |
| 1 | 1 | 0 mA | Earpiece inhibition |

8: Melody / DTMF choice

| M4 | M3 | M2 | M1 | M0 | |
|-----|-----|-----|-----|-----|---|

9: Melody / DTMF selection

| M | Melody or Confidence Tone Output | | DTMF mode | |
|---|---|---|---|---|
| | | | Key | HF/LF |
| 00 | A3 | 440.0 | «1» | 2.5 dB |
| 01 | A#3 | 466.2 | «4» | ” |
| 02 | B3 | 493.5 | «7» | ” |
| 03 | C4 | 523.0 | «*» | ” |
| 04 | C#4 | 554.9 | «2» | ” |
| 05 | D4 | 587.8 | «5» | ” |
| 06 | D#4 | 621.6 | «8» | ” |
| 07 | E4 | 659.4 | «0» | ” |
| 08 | F4 | 697.8 | «3» | ” |
| 09 | F#4 | 741.0 | «6» | ” |
| 0A | G4 | 784.5 | «9» | ” |
| 0B | G#4 | 830.3 | «#» | ” |
| 0C | A4 | 878.4 | «A» | ” |
| 0D | A#4 | 932.4 | «B» | ” |
| 0E | B4 | 989.1 | «C» | ” |
| 0F | C5 | 1048.4 | «D» | ” |
| 10 | C# | 1109.7 | «1» | 3.5 dB |
| 11 | D5 | 1172.7 | «4» | ” |
| 12 | D#5 | 1243.2 | «7» | ” |
| 13 | E5 | 1315.0 | «*» | ” |
| 14 | F5 | 1395.7 | «2» | ” |
| 15 | F#5 | 1477.3 | «5» | ” |
| 16 | G5 | 1569.0 | «8» | ” |
| 17 | G#5 | 1660.6 | «0» | ” |
| 18 | A5 | 1763.6 | «3» | ” |
| 19 | A#5 | 1864.7 | «6» | ” |
| 1A | B5 | 1978.3 | «9» | ” |
| 1B | C6 | 2087.2 | «#» | ” |
| 1C | C#6 | 2208.7 | «A» | ” |
| 1D | D6 | 2345.4 | «B» | ” |
| 1E | | | «C» | ” |
| 1F | | | «D» | ” |

10: Control register

| AMF | ISQ | SD | SIN1 | SIN0 | AMF: MF output attenuation –3 dB<br>extra ringing attenuation (12 dB)<br>ISQ: Squelch inhibition<br>SD: Shutdown<br>SIN: Generator mode<br>    0: OFF<br>    1: Melody (Ringer)<br>    2: Confidence tone<br>    3: DTMF |
|---|---|---|---|---|---|

TEMIC
Semiconductors

# U3810BM

## Package Information

Package PLCC44
Dimensions in mm



13009
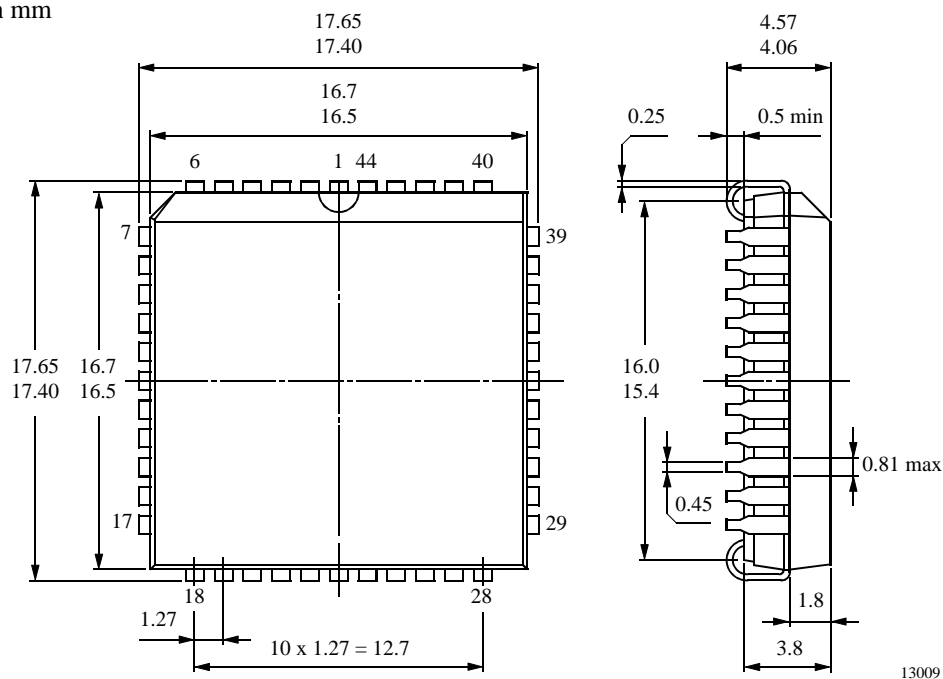
Package SSO44
Dimensions in mm



technical drawings
according to DIN
specifications

13040
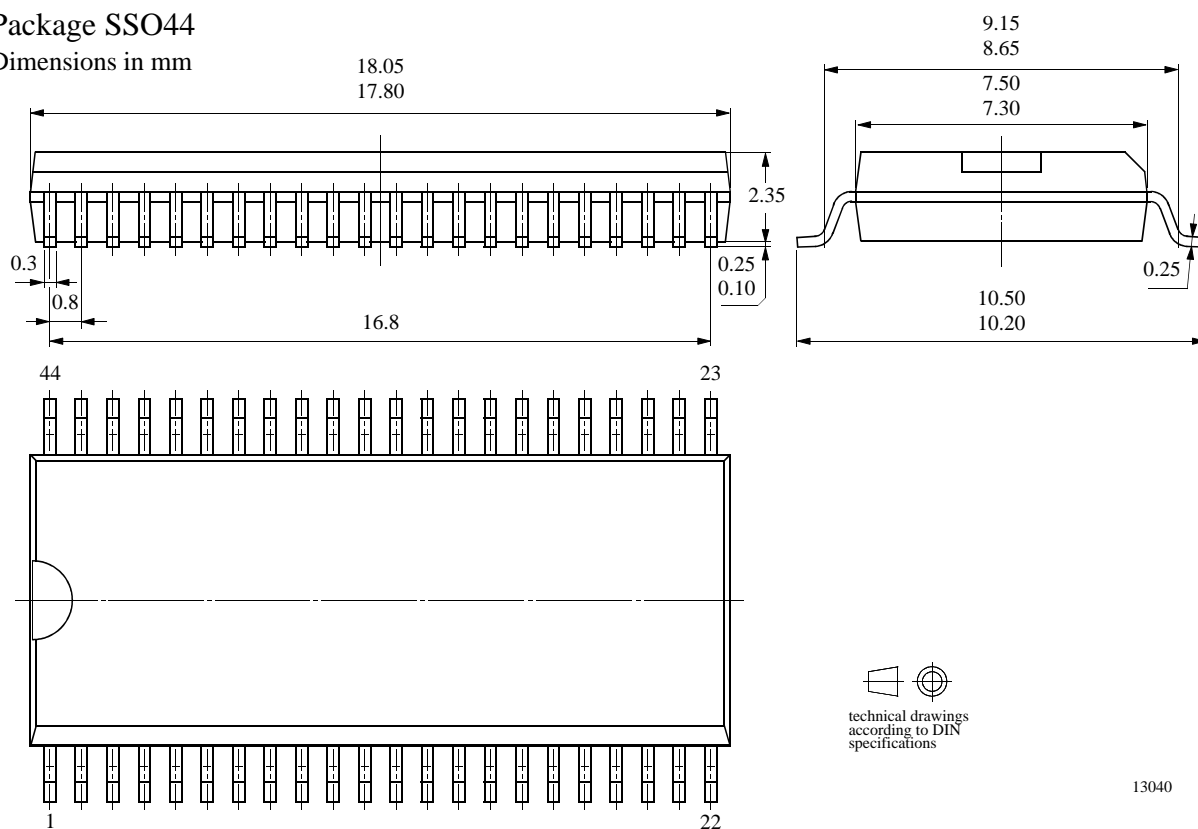
## Ozone Depleting Substances Policy Statement

It is the policy of **TEMIC Semiconductor GmbH** to

1. Meet all present and future national and international statutory requirements.

2. Regularly and continuously improve the performance of our products, processes, distribution and operating systems with respect to their impact on the health and safety of our employees and the public, as well as their impact on the environment.

It is particular concern to control or eliminate releases of those substances into the atmosphere which are known as ozone depleting substances (ODSs).

The Montreal Protocol (1987) and its London Amendments (1990) intend to severely restrict the use of ODSs and forbid their use within the next ten years. Various national and international initiatives are pressing for an earlier ban on these substances.

**TEMIC Semiconductor GmbH** has been able to use its policy of continuous improvements to eliminate the use of ODSs listed in the following documents.

1. Annex A, B and list of transitional substances of the Montreal Protocol and the London Amendments respectively

2. Class I and II ozone depleting substances in the Clean Air Act Amendments of 1990 by the Environmental Protection Agency (EPA) in the USA

3. Council Decision 88/540/EEC and 91/690/EEC Annex A, B and C (transitional substances) respectively.

**TEMIC Semiconductor GmbH** can certify that our semiconductors are not manufactured with ozone depleting substances and do not contain such substances.