

DATA SHEET

UBA2050(A); UBA2051(A;C) One-chip telephone ICs with speech, dialler and ringer functions

Product specification

2000 May 19

Supersedes data of 1998 Mar 24

File under Integrated Circuits, IC03

One-chip telephone ICs with speech, dialler and ringer functions

UBA2050(A); UBA2051(A;C)

FEATURES

Speech/transmission part

- Low DC line voltage; operates down to 1.45 V (excluding voltage drop over external polarity guard)
- Line voltage regulator with adjustable DC voltage
- Regulated 3.3 V supply (V_{DD}) for the dialler part and peripherals compatible with:
 - Speech mode
 - Ringer mode
 - Trickle mode.
- Unregulated supply (V_{CC}) for the transmission part and peripherals
- Transmit stage with:
 - Microphone amplifier with symmetrical high-impedance inputs
 - DTMF input with confidence tone on receive output.
- Receive stage with:
 - Receive amplifier with asymmetrical output
 - Earpiece amplifier with adjustable gain (and gain boost facility) for all types of earpieces.
- AGC: line loss compensation for microphone and receive amplifiers.

Dialler part

- Last Number Redial (LNR) (32 digits)
- Pulse dialling:
 - 10 PPS and 20 PPS (resistor option)
 - M/B 2 : 3 and 1 : 2 (resistor option).
- DTMF timing:
 - Manual dialling with minimum duration for bursts and pauses (85/85 ms)
 - Calibrated timing during redialling (85/85 ms).
- Pulse or tone mode select at start-up (resistor option)
- Flash function (600, 300, 98 and 80 ms) (resistor options)
- Access pause time 2.0 and 3.6 s (resistor option); access pauses in series are possible

- [*/T] key (for mixed mode dialling) or separate [P → T] key
- Repertory memory integrity check
- Keystroke generation (only UBA2050, UBA2050A and UBA2051C)
- Dial Mode Output (DMO) function during pulse dialling and flash function (only UBA2050 and UBA2051)
- LED output for DTMF dialling indication (only UBA2050A and UBA2051A)
- Function keys:
 - [LNR/P], [R] and [P → T]
 - [STORE], [MEM], [M1], [M2] and [M3] (only UBA2051, UBA2051A and UBA2051C).
- Resistor options:
 - [*/T] key definition (MMS)
 - Pulse or Tone mode Selection (PTS)
 - Flash Time Selection (FTSA and FTSB)
 - Make/Break ratio Selection (MBS)
 - Pulses Per Second (PPS)
 - Access Pause Time (APT).
- 13 repertory numbers (only UBA2051, UBA2051A and UBA2051C):
 - 3 direct memories (21 digits)
 - 10 indirect memories (21 digits).
- Supply and temperature independent tone output
- On-chip DTMF filtering for low output distortion ("CEPT CS 203" compatible)
- On-chip oscillator suitable for low-cost 3.579545 MHz quartz crystal or ceramic resonator
- Uses standard single-contact keyboard
- Keyboard entries fully debounced.

Ringer part

- Ringer input frequency discrimination
- 3-tone ringer with 4 programmable melodies (selectable via keyboard by keys [1] to [4])
- 4-level volume control (selectable via keyboard by keys [5] to [8]).

One-chip telephone ICs with speech, dialler and ringer functions

UBA2050(A); UBA2051(A;C)

GENERAL DESCRIPTION

The ICs UBA2050, UBA2050A, UBA2051, UBA2051A and UBA2051C contain all the functions needed to build a fully electronic telephone set.

In many places in the text, figures and tables, the description is not applicable for all the five types, but only for one or two or for a combination. These combinations will be referred to by means of short denotations as given in Table 1.

Table 1 Denotations of types

| DENOTATION | TYPES |
|------------|-----------------------------|
| UBA2050x | UBA2050; UBA2050A |
| UBA2051x | UBA2051; UBA2051A; UBA2051C |
| UBA205x | UBA2050; UBA2051 |
| UBA205xA | UBA2050A; UBA2051A |
| UBA205xx | all five types |

The devices incorporate a speech/transmission part, a dialler part and a ringer part. By offering a wide range of possible adaptations for each part, the UBA205xx applications can be easily adapted to meet different requirements.

Speech/transmission part

The speech/transmission part performs all transmission and line interface functions required in fully electronic telephone sets. It performs electronic switching between transmission and dialling. The IC operates at a DC voltage down to 1.45 V (with reduced performance) to facilitate the use of telephone sets connected in parallel.

ORDERING INFORMATION

| TYPE NUMBER | PACKAGE | | |
|-------------|---------|--|----------|
| | NAME | DESCRIPTION | VERSION |
| UBA2050T | SO28 | plastic small outline package; 28 leads; body width 7.5 mm | SOT136-1 |
| UBA2050AT | SO28 | plastic small outline package; 28 leads; body width 7.5 mm | SOT136-1 |
| UBA2051T | SO28 | plastic small outline package; 28 leads; body width 7.5 mm | SOT136-1 |
| UBA2051AT | SO28 | plastic small outline package; 28 leads; body width 7.5 mm | SOT136-1 |
| UBA2051CT | SO28 | plastic small outline package; 28 leads; body width 7.5 mm | SOT136-1 |

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QUICK REFERENCE DATA

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---------------------------------|--|--|------|------|------|------|
| Speech/transmission part | | | | | | |
| I_{line} | line current operating range | normal operation | 11 | – | 140 | mA |
| | | with reduced performance | 1 | – | 11 | mA |
| V_{LN} | DC line voltage | $I_{line} = 15 \text{ mA}$ | 4.05 | 4.35 | 4.65 | V |
| I_{CC} | internal current consumption | $V_{CC} = 3.6 \text{ V}$ | – | 1.25 | 1.5 | mA |
| V_{CC} | supply voltage for internal circuitry (unregulated) | $I_P = 0 \text{ mA}$ | – | 3.6 | – | V |
| V_{DD} | regulated supply voltage for peripherals | speech mode; $I_{DD} = -2.6 \text{ mA}$ | 3.0 | 3.3 | 3.6 | V |
| | | ringer mode; $I_{DD} = 75 \text{ mA}$ | 3.0 | 3.3 | 3.6 | V |
| I_{DD} | available supply current for peripherals | | – | – | -2.6 | mA |
| $G_{v(TX)}$ | typical voltage gain for microphone amplifier | $V_{MIC} = 4 \text{ mV (RMS)}$ | 43.2 | 44.2 | 45.2 | dB |
| $G_{v(RX)}$ | typical voltage gain for receiving amplifier | $V_{IR} = 4 \text{ mV (RMS)}$ | 32.4 | 33.4 | 34.4 | dB |
| $\Delta G_{v(QR)}$ | gain setting range for earpiece amplifier | $R_{E1} = 100 \text{ k}\Omega$ | -14 | – | +12 | dB |
| $\Delta G_{v(trx)}$ | gain control range for microphone and receive amplifiers | $I_{line} = 85 \text{ mA}; \text{referenced to } I_{line} = 15 \text{ mA}$ | – | 6.0 | – | dB |
| $\Delta G_{v(trx)(m)}$ | gain reduction for microphone and receive amplifiers | in DTMF mode | – | 80 | – | dB |
| Dialler part | | | | | | |
| $V_{HG(LN)(rms)}$ | high group frequency voltage (RMS value) on line | $R_{DTMF1} = 20 \text{ k}\Omega; R_{DTMF2} = 2.74 \text{ k}\Omega$ | 353 | 435 | 536 | mV |
| $V_{LG(LN)(rms)}$ | low group frequency voltage (RMS value) on line | $R_{DTMF1} = 20 \text{ k}\Omega; R_{DTMF2} = 2.74 \text{ k}\Omega$ | 277 | 341 | 420 | mV |
| G_V | pre-emphasis of group | | 1.5 | 2.0 | 2.5 | dB |
| THD | total harmonic distortion | | – | -25 | – | dB |
| Ringer part | | | | | | |
| f_{ring} | ringer detection frequency | | 13 | – | – | Hz |

One-chip telephone ICs with speech, dialler and ringer functions

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BLOCK DIAGRAM

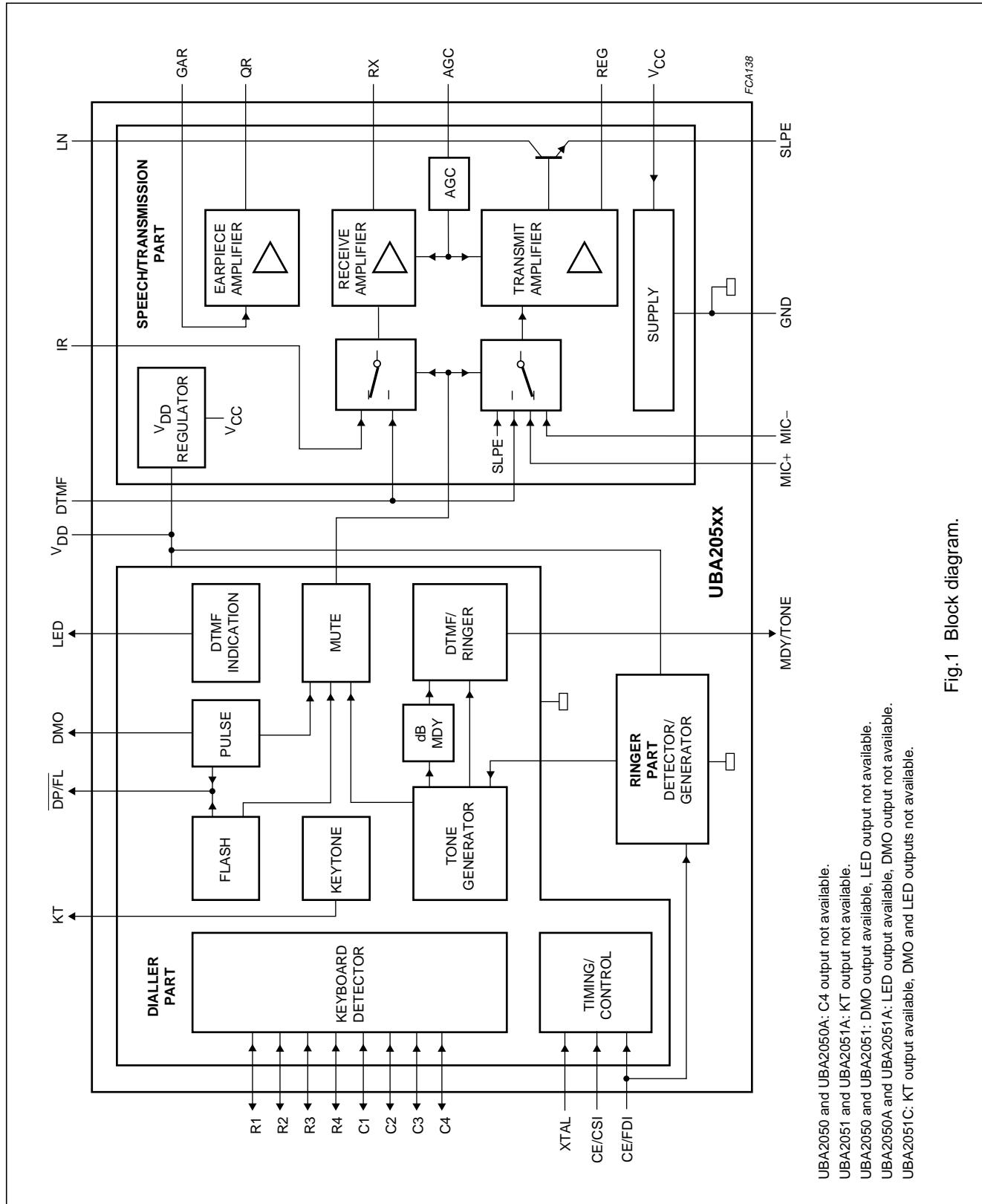


Fig.1 Block diagram.

One-chip telephone ICs with speech, dialler and ringer functions

UBA2050(A); UBA2051(A;C)

PINNING

| SYMBOL | PIN | | | | | DESCRIPTION |
|-----------------|---------|----------|---------|----------|----------|---|
| | UBA2050 | UBA2050A | UBA2051 | UBA2051A | UBA2051C | |
| LN | 1 | 1 | 1 | 1 | 1 | positive line terminal |
| SLPE | 2 | 2 | 2 | 2 | 2 | slope (DC resistance) adjustment |
| REG | 3 | 3 | 3 | 3 | 3 | line voltage regulator decoupling |
| IR | 4 | 4 | 4 | 4 | 4 | receive amplifier input |
| AGC | 5 | 5 | 5 | 5 | 5 | automatic gain control and line-loss compensation |
| DTMF | 6 | 6 | 6 | 6 | 6 | DTMF transmit input |
| V _{DD} | 7 | 7 | 7 | 7 | 7 | stabilized supply for dialler and ringer parts |
| XTAL | 8 | 8 | 8 | 8 | 8 | oscillator input |
| DP/FL | 9 | 9 | 9 | 9 | 9 | dial pulse/flash output (active LOW) |
| DMO | 10 | — | 10 | — | — | dial mode output |
| LED | — | 10 | — | 10 | — | DTMF mode indication output |
| CE/CSI | 11 | 11 | 11 | 11 | 11 | chip enable/cradle switch input; note 1 |
| CE/FDI | 12 | 12 | 12 | 12 | 12 | chip enable/frequency discrimination input |
| MDY/TONE | 13 | 13 | 13 | 13 | 13 | melody (ringer) output/DTMF generator output |
| KT | 14 | 14 | — | — | 10 | keytone output |
| C4 | — | — | 14 | 14 | 14 | keyboard input/output C4 |
| C3 | 15 | 15 | 15 | 15 | 15 | keyboard input/output C3 |
| C2 | 16 | 16 | 16 | 16 | 16 | keyboard input/output C2 |
| C1 | 17 | 17 | 17 | 17 | 17 | keyboard input/output C1 |
| R4 | 18 | 18 | 18 | 18 | 18 | keyboard input/output R4 |
| R3 | 19 | 19 | 19 | 19 | 19 | keyboard input/output R3 |
| R2 | 20 | 20 | 20 | 20 | 20 | keyboard input/output R2 |
| R1 | 21 | 21 | 21 | 21 | 21 | keyboard input/output R1 |
| GND | 22 | 22 | 22 | 22 | 22 | negative line terminal |
| QR | 23 | 23 | 23 | 23 | 23 | earpiece amplifier output |
| GAR | 24 | 24 | 24 | 24 | 24 | gain adjustment earpiece amplifier |
| RX | 25 | 25 | 25 | 25 | 25 | receive amplifier output |
| MIC+ | 26 | 26 | 26 | 26 | 26 | non-inverting microphone amplifier input |
| MIC- | 27 | 27 | 27 | 27 | 27 | inverting microphone amplifier input |
| V _{CC} | 28 | 28 | 28 | 28 | 28 | supply for speech/transmission part and peripherals |

Note

1. The cradle switch and the two positions 'handset on the cradle' and 'handset lifted' are further on in this document referred to as 'hook-switch', respectively 'on-hook' and 'off-hook' position.

One-chip telephone ICs with speech, dialler and ringer functions

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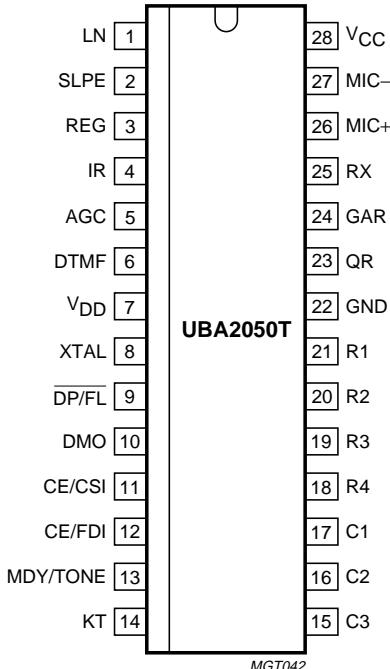


Fig.2 Pin configuration (UBA2050T).

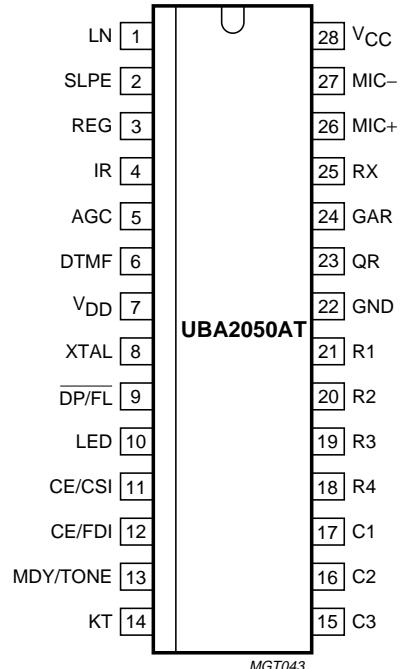


Fig.3 Pin configuration (UBA2050AT).

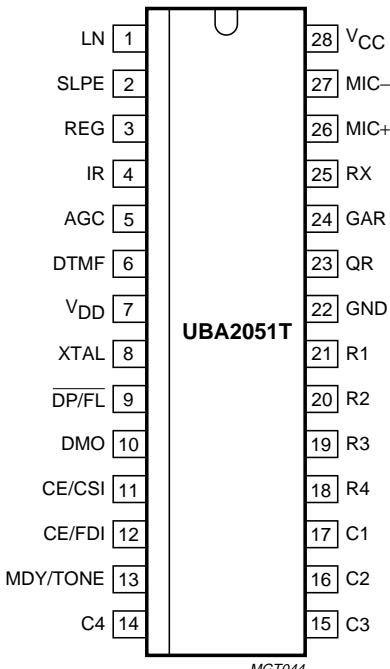


Fig.4 Pin configuration (UBA2051T).

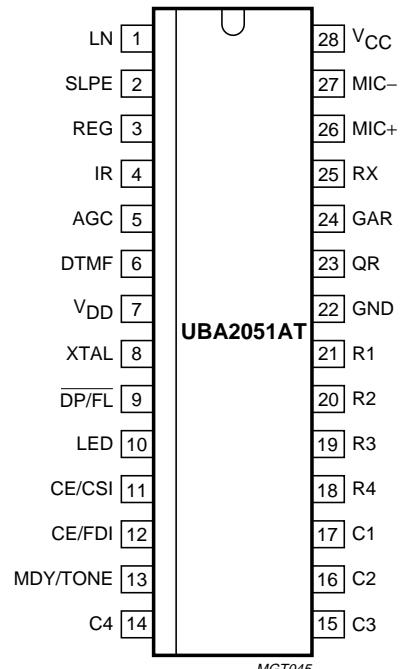


Fig.5 Pin configuration (UBA2051AT).

One-chip telephone ICs with speech, dialler and ringer functions

UBA2050(A); UBA2051(A;C)

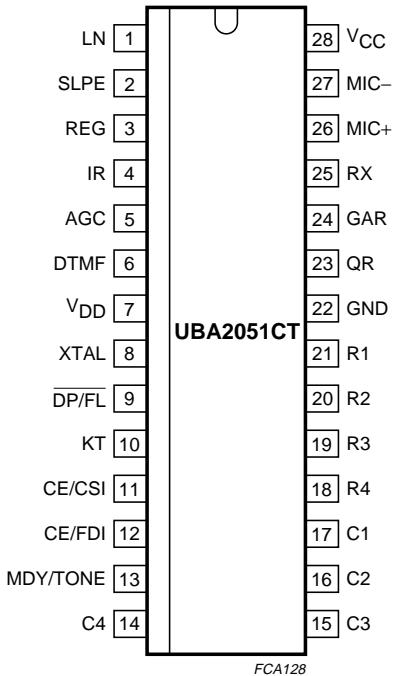


Fig.6 Pin configuration (UBA2051CT).

FUNCTIONAL DESCRIPTION

The values given in the functional description are typical values unless otherwise specified.

For numbering of components, refer to Figs 7, 37 and 38. Voltage levels are referenced to the negative line terminal GND, except when otherwise specified.

Speech/transmission part

SUPPLY

The supply for the IC and its peripheral circuits is obtained from the telephone line (see Fig.7).

Line interface (pins LN, SLPE and REG)

The IC generates a stabilized reference voltage V_{ref} between pins LN and SLPE. This reference voltage is 4.15 V, is temperature compensated and can be adjusted by means of an external resistor R_{VA} .

The reference voltage can be increased by connecting the resistor R_{VA} between pins REG and SLPE or decreased by connecting the resistor R_{VA} between pins REG and LN. The voltage at pin REG is used by the internal regulator to generate V_{ref} and is decoupled by capacitor C_{REG} connected between pins REG and GND. This capacitor, converted into an equivalent inductance (see Section "Set impedance"), realizes the set impedance conversion from its DC value (R_{SLPE}) to its AC value (R_{CC} in the audio frequency range).

The voltage at pin SLPE is proportional to the line current, and the voltage V_{LN} at pin LN can be calculated as follows:

$$V_{LN} = V_{ref} + R_{SLPE} \times I_{SLPE}$$

$$I_{SLPE} = I_{line} - I_{CC} - I_P - I_{SUP}$$

where:

I_{line} = line current

I_{CC} = internal current consumption

I_P = supply current for peripheral circuits

I_{SUP} = current consumed by the V_{DD} regulator from pin LN.

Resistor R_{SLPE} is an external resistor connected between pins SLPE and GND. The preferred value for R_{SLPE} is 20 Ω . Changing the value of R_{SLPE} will affect more than the DC characteristics: it also influences the microphone and DTMF gains, the gain control characteristics, the sidetone level and the maximum output swing on the line.

The DC current flowing into the set is determined by the exchange supply voltage (V_{exch}), the feeding bridge resistance (R_{exch}), the DC resistance of the telephone line (R_{line}) and the reference voltage (V_{ref}). The excess current is shunted via pin LN to pin SLPE when the line current (I_{line}) is greater than the sum of the supply current of the speech/transmission part (I_{CC}), the current drawn by the peripheral circuitry connected to V_{CC} (I_P) and the input current of the V_{DD} regulator (I_{SUP}). With line currents below I_{low} (9 mA), the internal reference voltage (generating V_{ref}) is automatically adjusted to a lower value.

This means that more sets can operate in parallel with DC line voltages (excluding the polarity guard) down to an absolute minimum voltage of 1.45 V. At line currents below I_{low} , the circuit has limited sending and receiving levels. This is called the low voltage area.

One-chip telephone ICs with speech, dialler and ringer functions

UBA2050(A); UBA2051(A;C)

Internal supply (pin V_{CC})

The internal transmission part circuitry is supplied from V_{CC} . This supply voltage is derived from the voltage on pin LN by means of resistor R_{CC} and must be decoupled by capacitor C_{VCC} connected between pins V_{CC} and GND. This supply point may also be used to supply peripheral circuits e.g. an electret microphone taking into account the supply possibilities according to Fig.8.

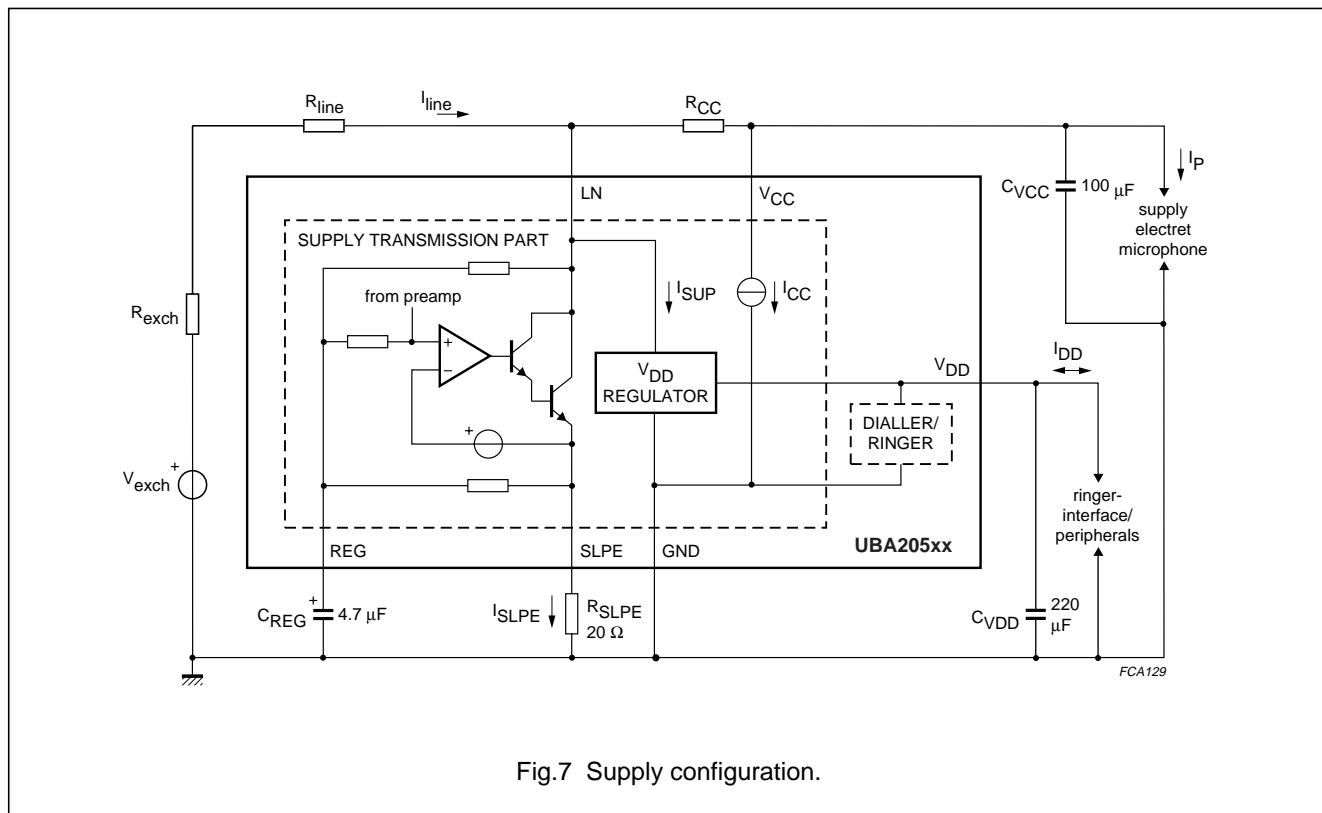
The voltage V_{CC} (see Fig.9) depends on the current consumed by the transmission part and the peripheral circuits:

$$V_{CC} = V_{CC0} - R_{CC} \times (I_P + I_{REC})$$

where:

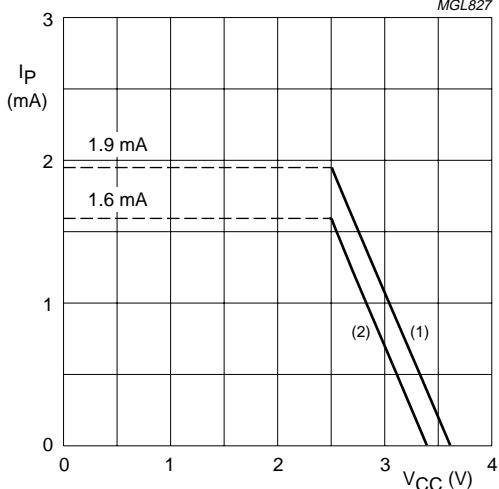
$$V_{CC0} = V_{LN} - I_{CC} \times R_{CC}$$

I_{REC} = the current consumed by the output stage of the earpiece amplifier.



One-chip telephone ICs with speech, dialler and ringer functions

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$V_{CC} \geq 2.5$ V; $V_{LN} = 4.35$ V at $I_{line} = 15$ mA; $R_{CC} = 619 \Omega$;
 $R_{SLPE} = 20 \Omega$.

- (1) This curve is valid when the receiving amplifier is not loaded.
- (2) This curve is valid when the receiving amplifier is loaded;
 $V_{o(rms)} = 150$ mV; $R_L = 150 \Omega$.

Fig.8 Typical current I_P available from V_{CC} for peripheral circuitry.

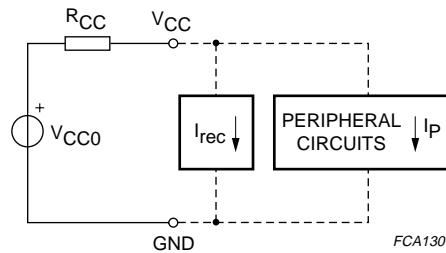


Fig.9 V_{CC} used as supply voltage for peripheral circuits.

Regulated supply point (pin V_{DD})

The V_{DD} regulator delivers a stabilized voltage to supply the internal dialler and ringer parts and peripheral circuits in transmission mode (nominal V_{LN}) and in ringer mode ($V_{LN} = 0$ V). The maximum supply current for peripherals is 1.9 mA in dialling mode (DTMF generator on) and 2.6 mA in speech mode (DTMF generator off). The supply conditions in ringer and trickle (on-hook condition) modes must not be disturbed by the peripheral supply currents.

The regulator (see Fig.7) consists of a sense input circuitry (pin LN), a current switch and a V_{DD} output stabilizer (pin V_{DD}). V_{DD} is decoupled by capacitor C_{VDD} .

The regulator function depends on the transmission, ringer and trickle modes as follows:

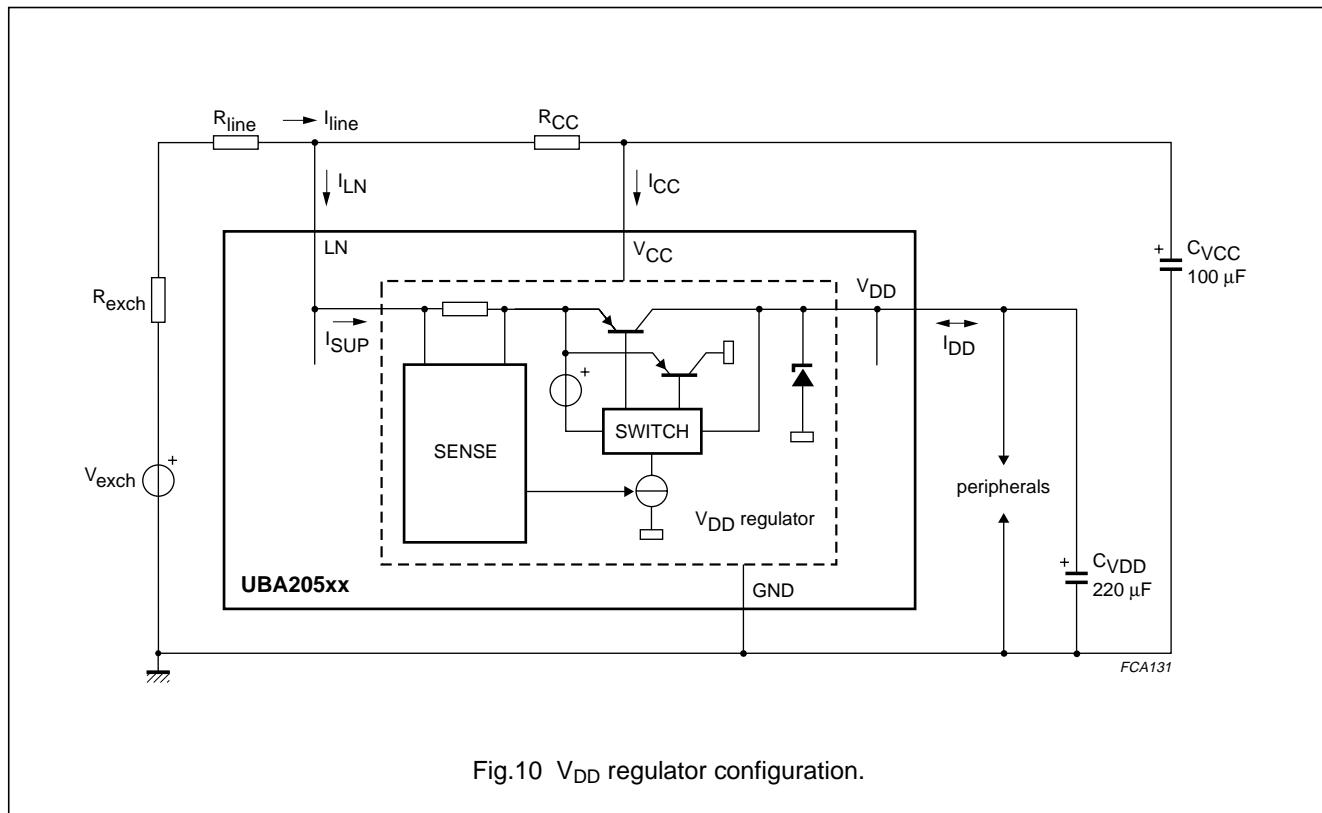
- Transmission mode: The regulator operates as a current source at the LN input; it takes a constant current of $I_{SUP} = 4.5$ mA (at nominal conditions) from pin LN. The current switch reduces the distortion on the line at large signal swings.

Output V_{DD} follows the DC voltage at pin LN (with typically 0.35 V difference) up to $V_{DD} = 3.3$ V. The input current of the regulator is constant while the output (source) current is determined by the consumption of the peripherals. The difference between input and output current is shunted by the internal V_{DD} stabilizer.

- Ringer mode: The regulator operates as a shunt stabilizer to keep V_{DD} at 3.3 V. The input voltage V_{LN} equals 0 V while the input current into pin V_{DD} is delivered by the ringing signal.
- Trickle mode: When V_{DD} is below typically 2 V, the regulator is inhibited. The current consumption of the V_{DD} regulator in trickle mode is very low to save most of the trickle current for memory retention of the dialler and ringer parts.

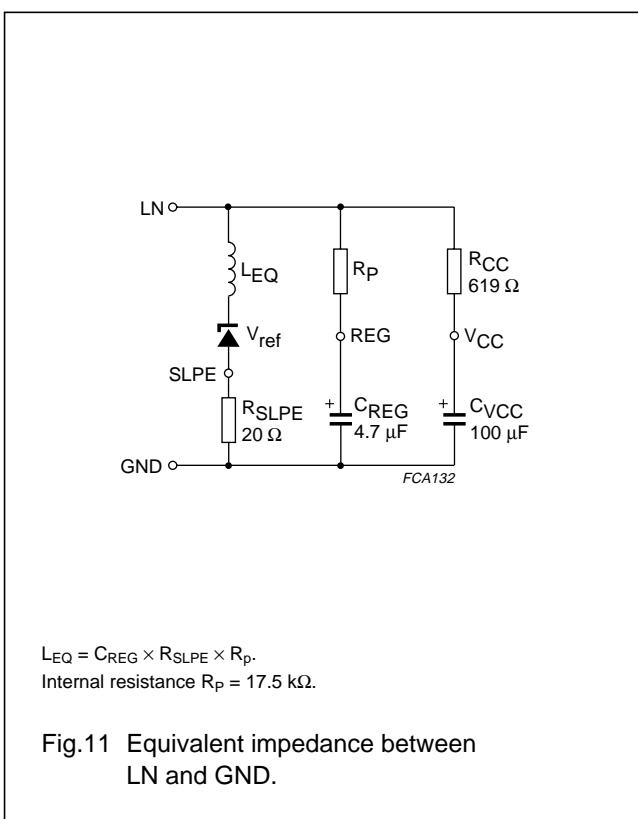
One-chip telephone ICs with speech, dialler and ringer functions

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SET IMPEDANCE

In the audio frequency range, the dynamic impedance is mainly determined by resistor R_{CC}. The equivalent impedance of the circuit is illustrated in Fig.11.



One-chip telephone ICs with speech, dialler and ringer functions

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TRANSMIT STAGES

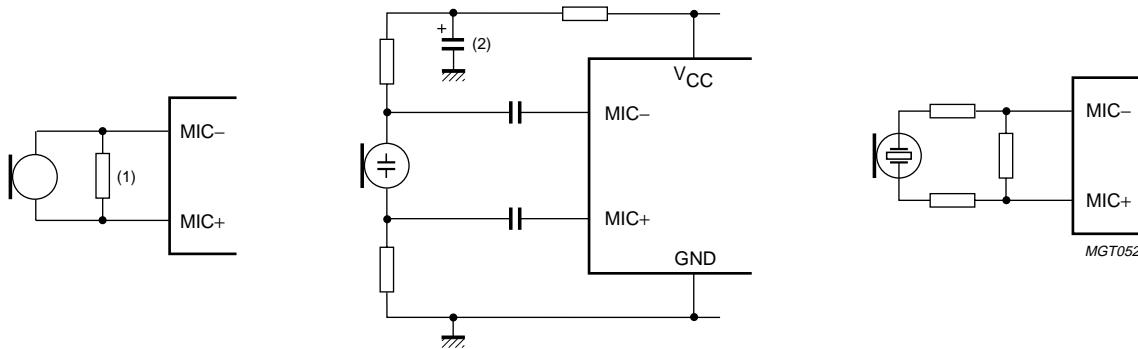
Microphone signal amplification (pins MIC+ and MIC-)

The UBA205xx has symmetrical microphone inputs. The input impedance between pins MIC+ and MIC- is $64\text{ k}\Omega$ ($2 \times 32\text{ k}\Omega$).

In speech mode, the voltage gain from pins MIC+ and MIC- to pin LN is set at 44.2 dB at $600\text{ }\Omega$ line load.

Microphone arrangements are illustrated in Fig.12.

Automatic gain control is provided on this amplifier for line loss compensation.



a. Magnetic or dynamic microphone.

b. Electret microphone.

c. Piezoelectric microphone.

(1) This resistor may be connected to reduce the terminating impedance.

(2) Extra decoupling capacitor for the microphone supply.

Fig.12 Microphone arrangements.

DTMF amplification (pin DTMF)

When the DTMF amplifier is enabled, dialling tones may be sent on the line. These tones are generated at pin MDY/TONE and their amplitude can be adjusted by means of an attenuator and filter network (see Fig.35) before being applied to the DTMF amplifier at pin DTMF. These tones are also sent to the receive output RX at a low level (confidence tone).

The UBA205xx has an asymmetrical DTMF input. The input impedance between pins DTMF and GND is $20\text{ k}\Omega$. The voltage gain from pin DTMF to pin LN is set at 26 dB at $600\text{ }\Omega$ line load. The DC voltage between pins DTMF and GND is 0 V. So, when an external attenuator/filter network is used, there is no need for a second decoupling capacitor.

The automatic gain control has no effect on the DTMF amplifier.

RECEIVE STAGES

The receive part consists of a receive amplifier and an earpiece amplifier.

Receive amplifier (pins IR and RX)

The receive amplifier transfers the received signal from input IR to output RX. The input impedance between pins IR and GND is $20\text{ k}\Omega$.

The voltage gain from pin IR to pin RX is fixed at 33.4 dB. The RX output is intended to drive high ohmic (real) loads.

Automatic gain control is provided on the receive amplifier.

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Earpiece amplifier (pins GAR and QR)

The earpiece amplifier is an operational amplifier having its output QR and inverting input GAR available. It can be used in conjunction with two resistors to get some extra gain or attenuation.

Arrangements of the receive and earpiece amplifier are illustrated in Fig.13. Earpiece connections are shown in Fig.14.

In the basic configuration (see Fig.13), output RX drives the earpiece amplifier by means of R_{E1} connected between pins RX and the inverting input GAR. Feedback resistor R_{GAR} of the earpiece amplifier is connected between pins QR and GAR. Output QR drives the earpiece via a series capacitor C_{ear} .

The gain of the earpiece amplifier (from RX to QR) can be set between +12 and -14 dB by means of resistor R_{GAR} . The preferred value of R_{E1} is 100 k Ω .

The earpiece amplifier offers a gain boost facility relative to the initial gain. Resistor R_{GAR} has to be replaced by the network of R_{GAR1} , R_{GAR2} and R_{gb} and a series capacitor C_{gb} as shown in Fig.13.

The initial gain is defined by: $\frac{V_{QR}}{V_{RX}} = -\left(\frac{R_{GAR1} + R_{GAR2}}{R_{E1}}\right)$

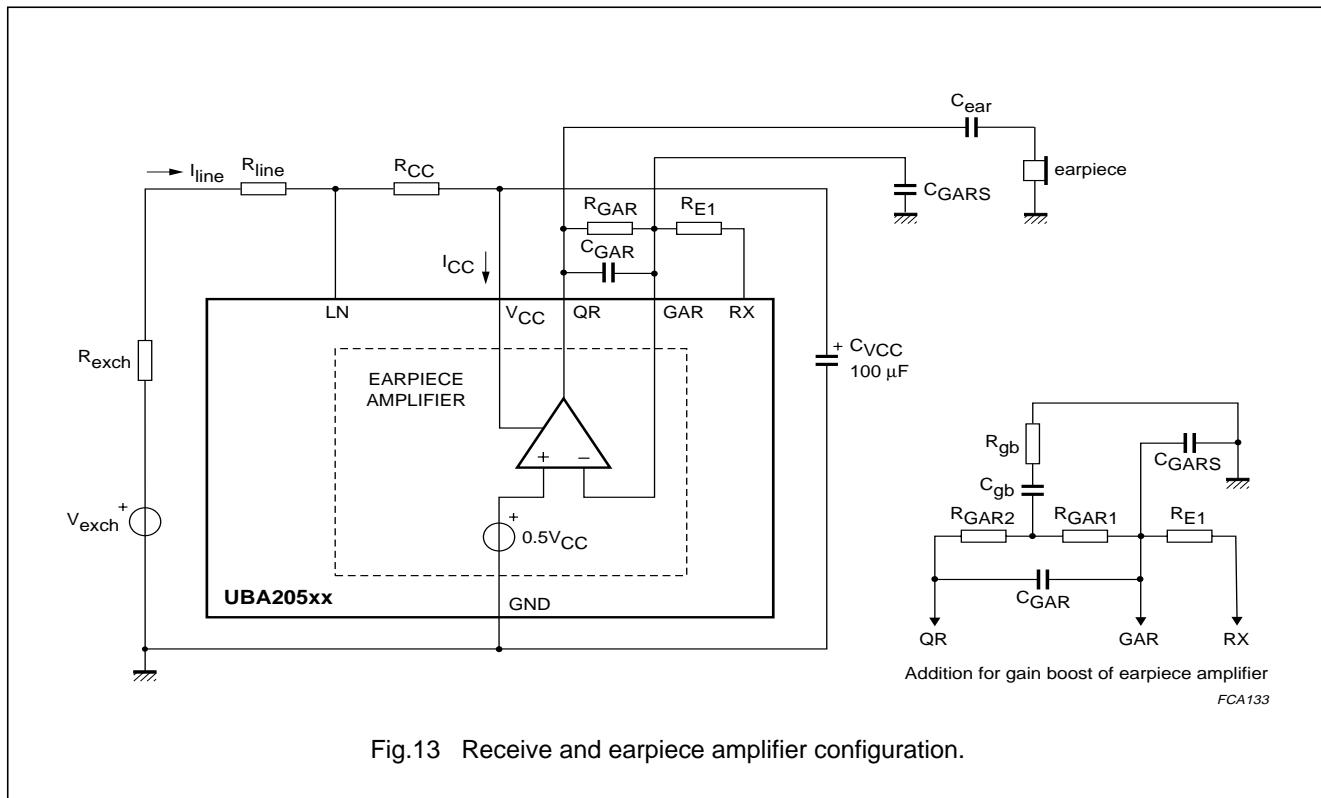
which corresponds to $R_{gb} = \infty$.

The gain boost is realised by a defined value of R_{gb} and is defined by:

$$\frac{V_{QR}}{V_{RX}} = -\left(\frac{R_{GAR1} + R_{GAR2}}{R_{E1}}\right) \times \left(1 + \frac{\frac{R_{GAR1} \times R_{GAR2}}{R_{GAR1} + R_{GAR2}}}{R_{gb}}\right)$$

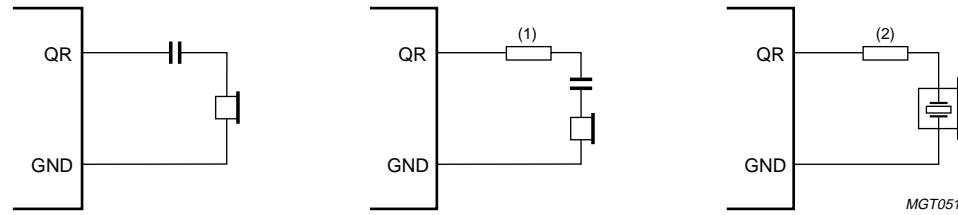
External capacitors C_{GAR} (connected between pins QR and GAR) and C_{GARS} (connected between pins GAR and GND) ensure stability. The capacitor C_{GAR} provides a first-order low-pass filter. The cut-off frequency corresponds to the time constant $C_{GAR} \times R_{GAR}$. The value of C_{GARS} must be 10 times the value of C_{GAR} to ensure stability.

The output voltages of the earpiece amplifier and the DTMF amplifier are specified for continuous wave drive. The maximum output voltage swing depends on the DC line voltage V_{LN} , the DC resistance R_{CC} of the set-impedance network between pins LN and V_{CC} , the current consumption I_{CC} and I_P from pin V_{CC} and the load impedance at pin QR.



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a. Dynamic earpiece.

b. Magnetic earpiece.

c. Piezoelectric earpiece.

(1) This resistor may be connected to prevent distortion due to the inductive load.
(2) This resistor is required to increase the phase margin due to the capacitive load.

Fig.14 Earpiece connections.

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AUTOMATIC GAIN CONTROL (PIN AGC)

The UBA205xx performs automatic line loss compensation. The automatic gain control varies the gain of the microphone amplifier and the gain of the receive amplifier in accordance with the DC line current.

The control range is 6.0 dB. This corresponds approximately to the loss for a cable length of 5 km with an 0.5 mm diameter twisted copper-pair, a DC resistance of $176 \Omega/\text{km}$ and an average attenuation of 1.2 dB/km).

The IC can be used with different configurations of exchange supply voltage and feeding bridge resistance by connecting an external resistor R_{AGC} between pins AGC and GND (see Fig.15). This resistor enables the I_{start} and I_{stop} line currents to be increased (the ratio between I_{start} and I_{stop} is not affected by the resistor).

The AGC function is disabled when pin AGC is left open-circuit.

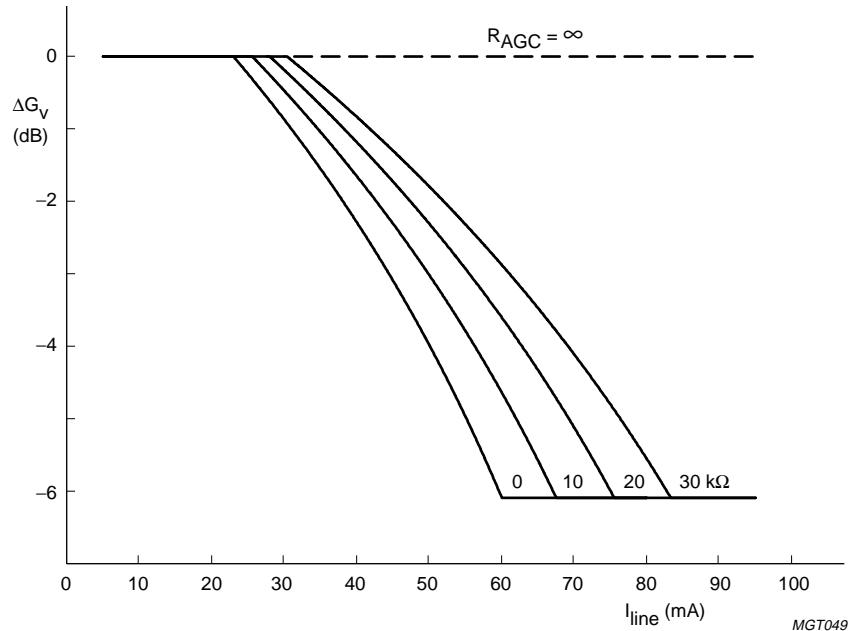


Fig.15 Variation of gain as a function of line current with R_{AGC} as parameter.

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SIDETONE SUPPRESSION

The anti-sidetone network for the UBA205xx, comprising R_{CC} in parallel with Z_{line} , R_{ast1} , R_{ast2} , R_{ast3} , R_{SLPE} and Z_{bal} (see Fig.16), suppresses the transmitted signal in the earpiece. Maximum compensation is obtained when the following conditions are fulfilled:

$$R_{SLPE} \times R_{ast1} = R_{CC} \times (R_{ast2} + R_{ast3})$$

$$k = \frac{R_{ast2} \times (R_{ast3} + R_{SLPE})}{R_{ast1} \times R_{SIPF}}$$

$$Z_{bal} = k \times Z_{line}$$

The scale factor k is chosen to meet the compatibility with a standard capacitor from the E6 or E12 range for Z_{bal} .

In practice, Z_{line} varies considerably with the line type and the line length. Therefore, the value of Z_{bal} should be chosen for an average line length, which gives satisfactory sidetone suppression with short and long lines.

The suppression also depends on the accuracy of the match between Z_{bal} and the impedance of the average line.

The anti-sidetone network for the UBA205xx attenuates the received signal from the line by 32 dB before it enters the receive stage. The attenuation is almost constant over the whole audio frequency range.

A Wheatstone bridge configuration (see Fig.17) may also be used.

More information on the balancing of an anti-sidetone bridge can be obtained in our publication *“Application Handbook for Wired Telecom Systems, IC03b”*.

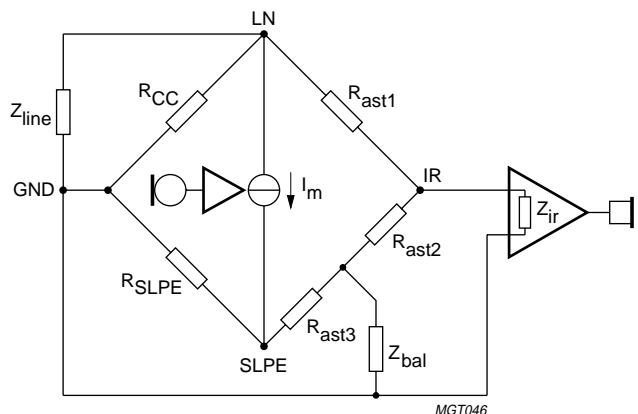


Fig.16 Equivalent circuit of UBA205xx anti-sidetone bridge.

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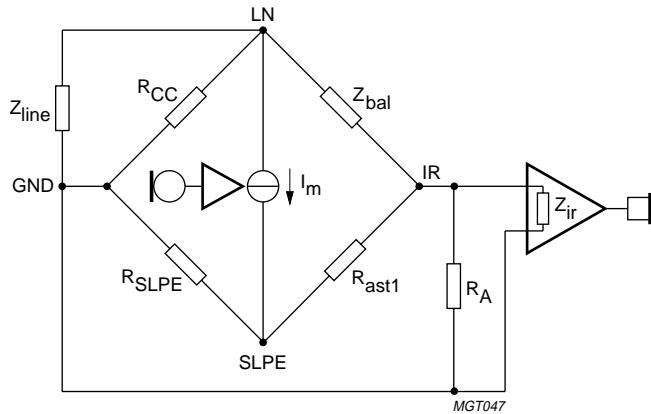


Fig.17 Equivalent circuit of an anti-sidetone network in a Wheatstone bridge configuration.

Dialler and ringer parts

SUPPLY VOLTAGE (PIN V_{DD})

The power supply must be maintained for repertory memory retention (standby supply voltage) and may drop down to 1.0 V, being the minimum value of the memory retention voltage V_{MR}. Applying a large capacitor across the supply terminals can retain the memory when power connections are broken.

The minimum operating voltage is 2.0 V (the Power-on reset voltage V_{POR} has its maximum value). Below this value, the internal Power-on reset disables the IC. A memory integrity check is performed at each start-up. In the event of a failing check, the memory is cleared.

OSCILLATOR (PIN XTAL)

The UBA205xx uses an on-chip oscillator as the master timing source. It needs to be completed by an external 3.579545 MHz quartz crystal or ceramic resonator connected between pins XTAL and GND. When using an external ceramic resonator, additional components may be required depending upon the ceramic resonator specifications (refer to the product type specification).

By connecting a capacitor with a value of a few pico-farad in parallel with the resonator, the oscillator frequency can be decreased. By connecting a capacitor with a value of a few ten pico-farad in series with the resonator, the oscillator frequency can be increased. The oscillator starts when V_{DD} reaches the operating voltage level V_{POR} and pin CE/FDI or pin CE/CSI goes HIGH.

Recommended resonator types: Murata CSA 3.58MG300FGA or CSAC 3.58MGC300FGA.

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INTERNAL RESET CIRCUIT (PINS CE/FDI AND CE/CSI)

A reset signal is internally generated to initialize the UBA205xx as follows (see Fig.18):

- By the on-chip Power-On Reset (POR) circuit as long as V_{DD} is lower than V_{POR}
- When the voltage on pin CE/CSI and on pin CE/FDI are both LOW for a time greater than the reset delay time t_{RD} .

When reset conditions are fulfilled, pins MDY/TONE and DP/FL are set to high-impedance; pins DMO, KT, LED, R1 to R4 and C1 to C4 are set to LOW.

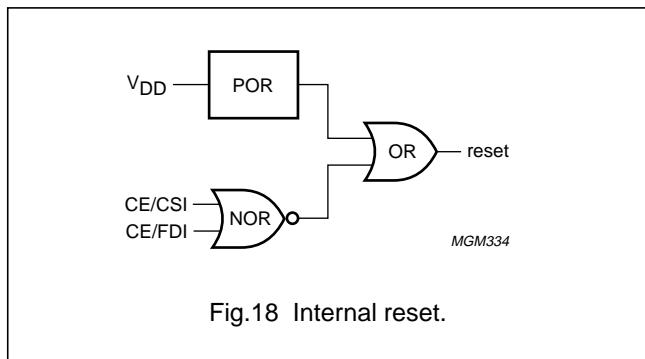


Fig.18 Internal reset.

CHIP ENABLE AND FREQUENCY DISCRIMINATOR INPUT (PIN CE/FDI)

This input is used to activate and initialize part of the system. This pin together with the pin CE/CSI determines which mode to enter (see Table 2) and detects line power breaks during on-line states. To prevent the dialler from reacting on voltage disturbances on the telephone line, a time-out is active. The dialler returns to the standby state if the voltage on both pins CE/CSI and CE/FDI is LOW for a time greater than t_{RD} .

In the exchange, several AC signals can be superimposed on the DC signal, e.g. dialling tone, busy tone, disturbances (such as line power breaks) and ringer signal. The ringer signal is evaluated and checked if its frequency is above a specified ringer frequency f_{ring} . It is assumed that the frequency at pin CE/FDI is the same as the ringer frequency present on the telephone line.

The signal at this pin is half-wave rectified so that the dialler can easily detect zero-crossing, especially at high frequency.

During switching (on-hook/off-hook and pulse dialling) this pin is protected by its ESD diodes. The maximum input current on these diodes should be below 1 mA.

CHIP ENABLE/CRADLE SWITCH INPUT (PIN CE/CSI)

To distinguish between different operating states an extra CE/CSI input is used. Comparable to the CE/FDI input, the CE/CSI activates the dialler part. From that moment the dialler part polls this input and the CE/FDI input regularly for line power breaks during on-line states. When pins CE/CSI and CE/FDI are set LOW for a time greater than t_{RD} , the standby state is entered. Pin CE/CSI is set HIGH during the off-hook situation (basic application). The basic states are shown in Table 2.

Table 2 UBA205xx basic states

| INPUT CE/CSI | INPUT CE/FDI | STATE |
|--------------|--------------|----------------|
| LOW | LOW | standby |
| HIGH | X; note 1 | handset |
| LOW | HIGH | ringer; note 2 |

Notes

1. Don't care.
2. AC signal at pin CE/FDI.

During switching (on-hook/off-hook and pulse dialling) this pin is protected by its ESD diodes. The maximum input current on these diodes should be below 1 mA.

RINGER MELODY (PIN MDY/TONE)

When an incoming ringer signal at pin CE/FDI is valid, the UBA205xx starts generating a melody via the MDY/TONE output ringer hardware (see Fig.35). The signal at pin MDY/TONE is a square wave signal (see Fig.19).

This melody follows the cadence of the ringer signal. Both the melody and the volume can be selected via the keyboard.

The melody frequencies and the duration are given in Table 3. Table 8 shows how a melody can be selected by pressing a key during ringing. The melody setting will be stored in the memory.

The volume of the ringer circuit can be controlled by changing the amplitude of the square wave. The voltage level at pin MDY/TONE can be changed as shown in Table 9. The volume setting will be stored in the memory.

MDY/TONE is a push-pull output. MDY/TONE is high-impedance when $V_{DD} < V_{POR}$.

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Table 3 Ringer melodies

| NAME | FREQUENCIES (Hz) | DURATION (ms) |
|------------------|--------------------|---------------|
| Bell 1 (default) | 770 + 943 + 1341 | 28 + 28 + 28 |
| Bell 2 | 852 + 943 + 1206 | 28 + 28 + 28 |
| Bell 3 | 943 + 1206 + 1341 | 28 + 28 + 28 |
| Bell 4 | 1206 + 1341 + 1482 | 28 + 28 + 28 |

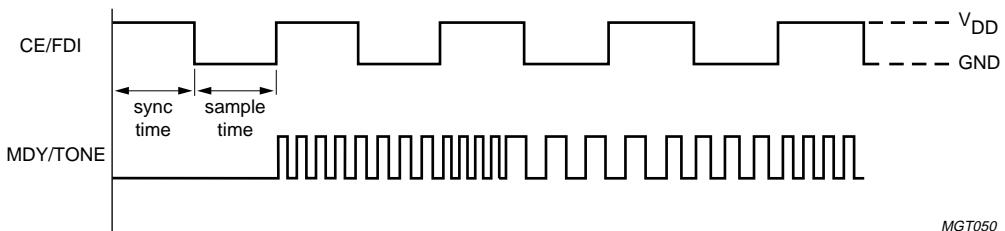


Fig.19 Ringer frequency detection.

PULSE DIALLER (PINS DP/FL, DMO AND LED)

The pulse dialling system uses line current interruptions to signal the digits dialled to the exchange. The number of line current interruptions corresponds to the digit dialled except for the digit [0] which is characterized by 10 interruptions. After each digit there is an inter-digit pause time (t_{idp}).

When dialling, the transmission part is muted.

The $[\ast/T]$ key definition, the dialling mode, the make/break ratio, repetition rate (pulse dialling), the flash time and the access pause time depend on the resistor options: MMS, PTS, MBS, PPS, FTSA, FTSB and APT (see Fig.25 and Table 7).

Valid keys are the digits [0] to [9], [R], [LNR/P], [P \rightarrow T] and $[\ast/T]$ (when MMS resistor option is off).

To allow start-up from C_{VDD} discharged, no ESD diode is implemented between pin DP/FL and pin V_{DD} .

Pin DP/FL is an open-drain output and is set HIGH (via an external pull-up resistor) when $V_{DD} < V_{POR}$.

Pin DMO of the UBA205x is used to enable external hardware (see Fig.37) which decreases the DC voltage over the A and B network exchange terminals during pulse dialling. Several countries require this feature. Pin DMO is a push-pull output and is LOW when $V_{DD} < V_{POR}$.

Figure 20 shows the timing diagram in pulse dialling mode for the UBA205x when keys [3], [3], [LNR/P] and [4] are pressed.

Figure 20 is also valid for the UBA2051C, with the exception of the DMO signal.

In pulse dialling mode, pin LED of the UBA205xA is set LOW after off-hook and becomes HIGH when the first DTMF code is sent after switching over to DTMF dialling. Pin LED is a push-pull output and is LOW when $V_{DD} < V_{POR}$.

Figure 21 shows the timing diagram in pulse dialling mode for the UBA205xA when keys [3], [3], [P \rightarrow T] and [4] are pressed.

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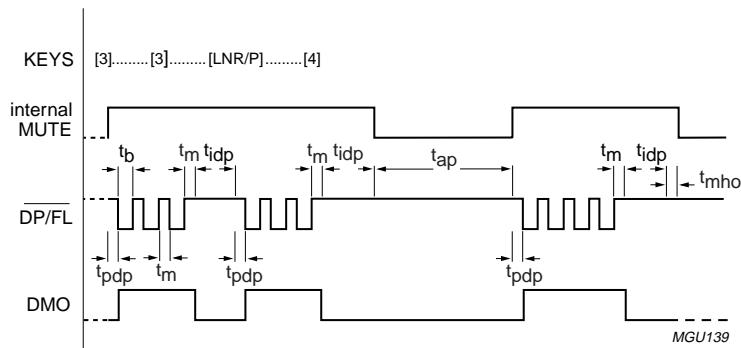
 t_b = break time. t_m = make time. t_{idp} = interdigit pause time. t_{ap} = access pause time. t_{mho} = mute holdover time. t_{pdp} = pre-digit pause.

Fig.20 Timing diagram in pulse dialling mode for the UBA205x.

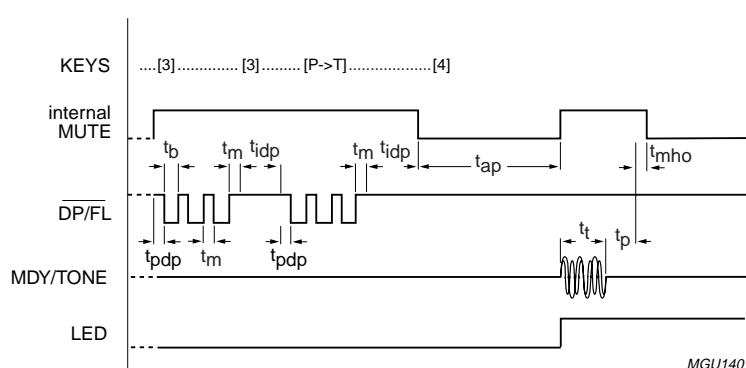
 t_b = break time. t_m = make time. t_{idp} = interdigit pause time. t_{ap} = access pause time. t_{mho} = mute holdover time. t_{pdp} = pre-digit pause. t_t = burst time. t_p = pause time.

Fig.21 Timing diagram in pulse dialling mode for the UBA205xA.

One-chip telephone ICs with speech, dialler and ringer functions

UBA2050(A); UBA2051(A;C)

TONE DIALLER (PINS MDY/TONE AND LED)

The digits are transmitted as two simultaneously generated tones: the Dual-Tone Multi-Frequency (DTMF) system. These dual tones which are provided at the MDY/TONE output are internally generated with two digital sine wave synthesizers together with digital-to-analog converters. Their amplitudes are precisely scaled according to a band gap voltage reference. This ensures tone output levels independent of the supply voltage and temperature. The two sine waves are summed and then filtered by an on-chip switched capacitor filter, followed by an active RC low-pass filter. These guarantee that all DTMF tones generated fulfil the CEPT CS203 recommendations with respect to amplitude, frequency deviation, total harmonic distortion and suppression of unwanted frequency components. Tone digits are separated by a pause time (t_p).

At dialling, the DTMF input of the transmission part is enabled while the microphone and receive amplifier inputs are disabled. The signal at the DTMF input is sent to the receive output at a low level [see Section "DTMF amplification (pin DTMF)".

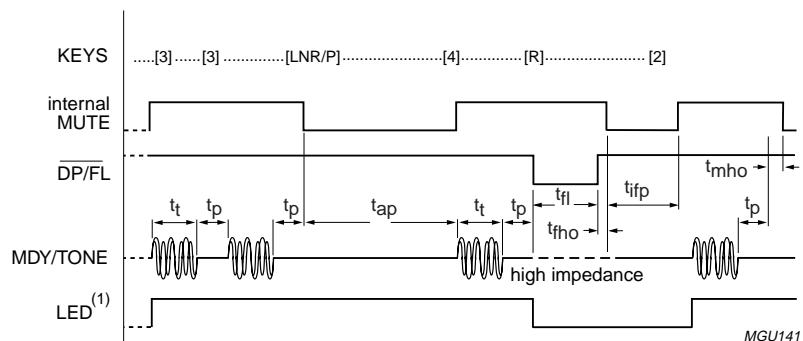
Valid keys are the digits [0] to [9], [*T], [#], [R], [LNR/P] and [P → T].

The dialling mode, the flash time and the access pause time depend on the resistor options: PTS, FTSA, FTSB and APT (see Fig.25 and Table 7).

Figure 22 shows the timing diagram in tone dialling mode when keys [3], [3], [LNR/P], [4], [R] and [2] are pressed.

In DTMF dialling mode, pin LED of the UBA205xA is set LOW after the hook-switch changes to off-hook and becomes HIGH as soon as a key is pressed and the first DTMF code is sent. Pin LED is a push-pull output and is LOW when $V_{DD} < V_{POR}$.

The DTMF standard frequencies are implemented as shown in Table 4.



t_t = burst time.

t_p = pause time.

t_{ap} = access pause time.

t_{fl} = flash time.

t_{ifp} = interflash pause time.

t_{mho} = mute holdover time.

t_{fho} = flash holdover time.

Note: the maximum tone burst and pause times are equal to the real key press/release time.

(1) pin LED only available in UBA205xA.

Fig.22 Timing diagram in tone dialling mode.

One-chip telephone ICs with speech, dialler and ringer functions

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Table 4 DTMF standard frequencies and their implementation

| DTMF FREQUENCY (Hz) | FREQUENCY AT MDY/TONE (Hz) ⁽¹⁾ | DEVIATION (%) | DEVIATION (Hz) |
|---------------------|---|---------------|----------------|
| 697 | 697.90 | 0.13 | 0.90 |
| 770 | 770.46 | 0.06 | 0.46 |
| 852 | 850.45 | -0.18 | -1.55 |
| 941 | 943.23 | 0.24 | 2.23 |
| 1209 | 1206.45 | -0.21 | -2.55 |
| 1336 | 1341.66 | 0.42 | 5.66 |
| 1477 | 1482.21 | 0.35 | 5.21 |

Note

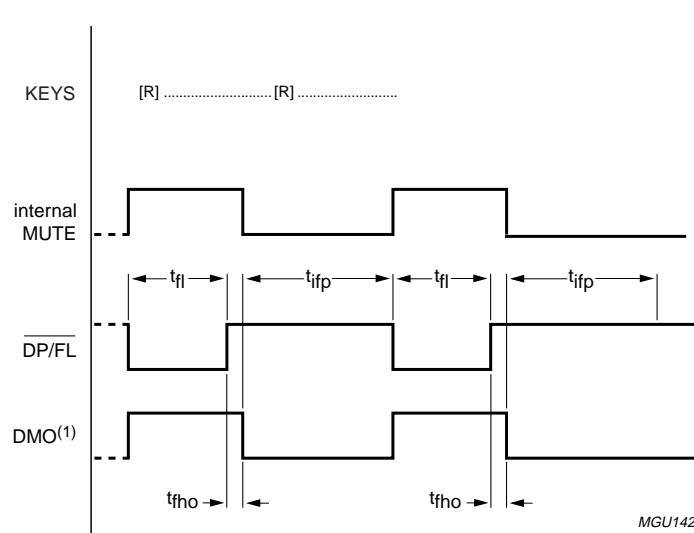
- Assuming $f_{\text{xtal}} = 3.579545 \text{ MHz}$.

FLASH FUNCTION (PINS $\overline{\text{DP/FL}}$ AND DMO)

Pressing the flash function key [R] results in a calibrated pulse which drives the electronic line current interrupter via pin $\overline{\text{DP/FL}}$. The DMO output is also activated during pulse production (see Fig.23). After a flash pulse, an interflash pause time t_{ifp} of 800 ms is inserted to recover the power supply for the dialler part.

The duration of the flash time depends on the resistor options FTSA and FTSB (see Fig.25 and Table 7).

During $t_{\text{fl}} + t_{\text{fho}}$, the reset delay time is inhibited.



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(1) pin DMO available only on UBA205x.

t_{fl} = flash time.

t_{fho} = flash holdover time.

t_{ifp} = interflash pause time.

Fig.23 Flash timing diagram.

One-chip telephone ICs with speech, dialler and ringer functions

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KEYBOARD DETECTOR (PINS C1 TO C4 AND R1 TO R4)

The pins are directly connected to a traditional single contact keyboard. The keyboard is normally static with outputs R1 to R4 at LOW level and inputs C1 to C4 with internal pull-up resistors. When any key is pressed, scanning is done to detect which key has been pressed. A second key entry will be valid after having released the first key entry. Simultaneously pressing several keys will result in no action.

A key entry becomes valid when the depress debounce time t_{dd} has elapsed (see Fig.24). After the release of a valid key, the scanning is frozen when the release debounce time t_{rd} has elapsed.

The pins R1 to R4 are LOW and pull-down resistors replace pull-up resistors at pins C1 to C4 when $V_{DD} < V_{POR}$.

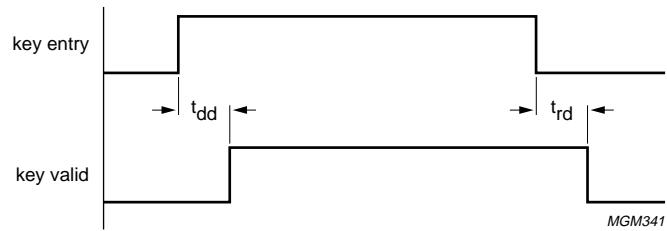


Fig.24 Timing diagram debouncing.

One-chip telephone ICs with speech, dialler and ringer functions

UBA2050(A); UBA2051(A;C)

Keyboard structure

The UBA205xx supports the keyboard structure given in Fig.25. Pin C4 is not available in the UBA2050x.

For key definitions, see Table 5.

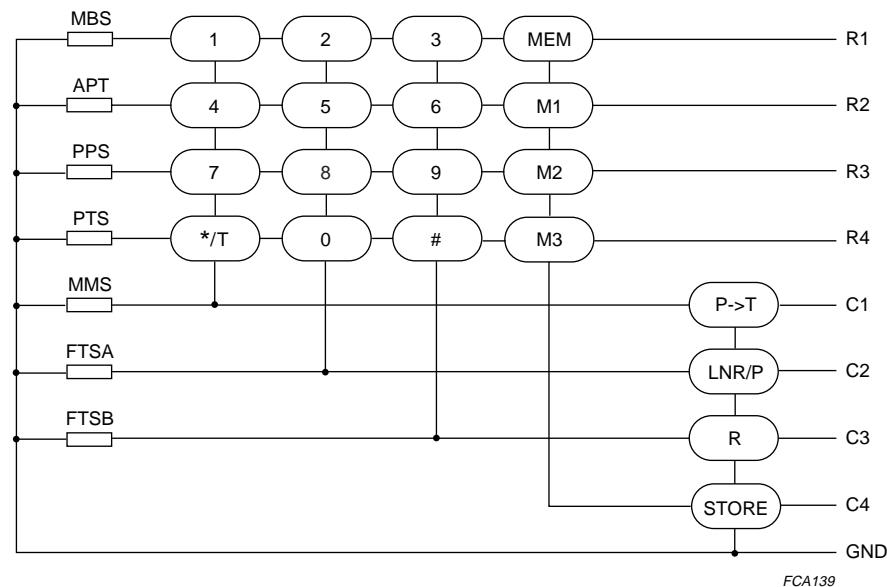


Fig.25 Keyboard structure.

Table 5 Key definitions

| KEYS | DEFINITION |
|--|--|
| [0] to [9] and [#] ⁽¹⁾ ; [*/*] ⁽¹⁾ | digits; see Table 6 |
| [*/*] ⁽²⁾ ; [P → T] | switch over to DTMF dialling (mixed mode dialling) |
| [LNR/P] | last number redial if this key is the first key pressed after going off-hook; access pause if this key is not the first key pressed after going off-hook |
| [M1] to [M3] | direct memories |
| [MEM] | indirect memory recall |
| [R] | recall (flash function) |
| [STORE] | memory programming |

Notes

1. In tone dialling mode.
2. In pulse dialling mode, when MMS resistor option is off (see Table 7).

One-chip telephone ICs with speech, dialler and ringer functions

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Table 6 Digits keypad activation and corresponding DTMF frequency pairs

| DIGIT KEYS | GENERATED DTMF FREQUENCIES | | NUMBER OF PULSES |
|------------|----------------------------|------------|------------------|
| | f_L (Hz) | f_H (Hz) | |
| [0] | 941 | 1336 | 10 |
| [1] | 697 | 1209 | 1 |
| [2] | 697 | 1336 | 2 |
| [3] | 697 | 1477 | 3 |
| [4] | 770 | 1209 | 4 |
| [5] | 770 | 1336 | 5 |
| [6] | 770 | 1477 | 6 |
| [7] | 852 | 1209 | 7 |
| [8] | 852 | 1336 | 8 |
| [9] | 852 | 1477 | 9 |
| [#] | 941 | 1477 | — |
| [*/T] | 941 | 1209 | — |

Resistor options

The resistors are connected between the pins of the keyboard (C1 to C3 and R1 to R4) and pin GND. One resistor connection is shown in Fig.26. The resistor options are read after each reset of the dialler.

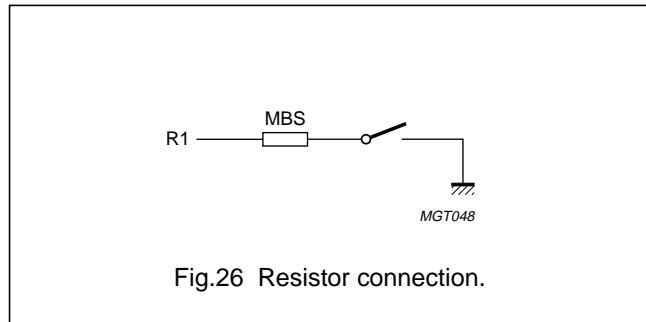


Table 7 Resistor functions

| RESISTOR | TO PIN | FUNCTION | CONDITIONS | ON ⁽¹⁾ | OFF ⁽¹⁾ |
|----------|--------|--------------------------|-----------------------|-------------------|-----------------------|
| FTSA | C2 | flash time select | FTSB = off; note 2 | 300 ms | 98 ms |
| | | | FTSB = on; note 2 | 80 ms | 600 ms |
| MMS | C1 | [*/T] key definition | | [*/T] becomes [*] | [*/T] becomes [P → T] |
| MBS | R1 | make/break ratio select | | 33/66 | 40/60 |
| APT | R2 | access pause time select | | 3.6 s | 2.0 s |
| PPS | R3 | pulses per second | | 20 pps | 10 pps |
| PTS | R4 | pulse/tone select | | pulse mode | DTMF mode |

Notes

1. On = option resistor present; off = option resistor not present.
2. Pin C3 belongs to resistor option FTSB.

One-chip telephone ICs with speech, dialler and ringer functions

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KEY TONE (PIN KT)

A keytone with a frequency $f_{kt} = 597$ Hz and a duration $t_{kt} = 30$ ms (see Fig.27) is generated each time a valid key is pressed resulting in the expected action, digit keys in tone dialling mode excepted.

Pin KT is a push-pull output and is set LOW when $V_{DD} < V_{POR}$.

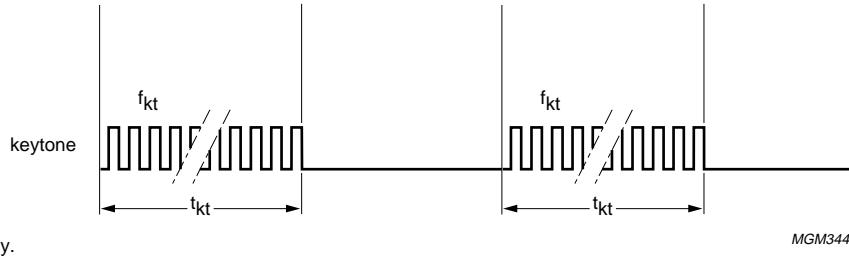


Fig.27 Keytones via KT output.

Key sequences

The behaviour of the UBA205xx can be represented as a State Transition Diagram (STD).

The STD contains the states (rectangles in Fig.28) and state transitions (arrows) of the set. The upper arrow in the figure pointing to the standby state means that the set is initially in the standby state. When, for instance, an incoming call is detected, the set enters the ringer state, waiting for end of a ringer signal or off-hook. If the set goes off-hook, the UBA205xx enters the on-line state.

The UBA205xx has 3 basic states:

- Standby state
- Ringer state
- On-line state.

Each state with its own functional requirements is described in the following sections.

STANDBY STATE

In the standby state the UBA205xx is inactive. The current drawn is for memory retention; the loads on the inputs/outputs of the dialler have influence on the retention current.

The UBA205xx leaves the standby state if:

- The set goes off-hook (lift handset)
- A ringer signal is available on the line.

The UBA205xx returns to the standby state if:

- The set goes on-hook (handset on-hook)
- A line-break occurs with a duration greater than t_{RD}
- The ringer signal becomes invalid.

RINGER STATE

If the set is in standby state, a ringer signal can be received from the line. After evaluating the incoming ringer signal (and the ringer signal is valid), the UBA205xx starts a melody via the MDY/TONE output and ringer hardware; this melody is stopped when the ringer signal is no longer valid. After going off-hook, the ringer signal stops and the set is in the conversation (on-line) state.

While ringing, the melody can be changed according to Table 8 and the volume according to Table 9.

As long as memory retention conditions are fulfilled, melody and volume are stored.

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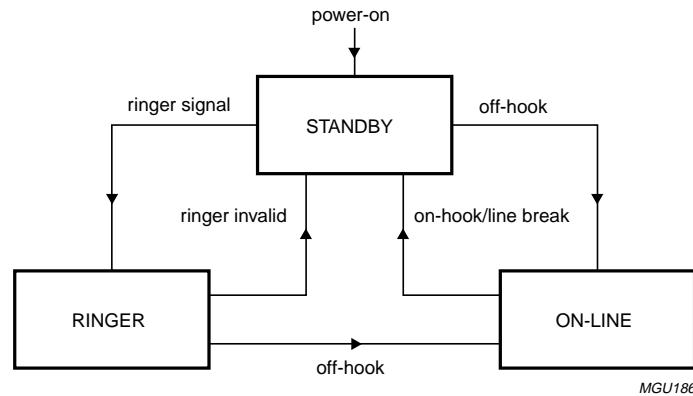


Fig.28 UBA205xx standby, ringer and on-line states.

Table 8 Melody selection during ringer state

| MELODY | KEY |
|--------|---------------|
| Bell 1 | [1] (default) |
| Bell 2 | [2] |
| Bell 3 | [3] |
| Bell 4 | [4] |

Table 9 Ringer volume setting during ringing

| KEY | VOLUME | ATTENUATION | AMPLITUDE OF MDY/TONE |
|---------------|---------|-------------|--------------------------------|
| [8] (default) | highest | 0 dB | V_{DD} |
| [7] | high | -6 dB | $\frac{V_{DD} - 0.7}{2} + 0.7$ |
| [6] | low | -12 dB | $\frac{V_{DD} - 0.7}{4} + 0.7$ |
| [5] | lowest | -18 dB | $\frac{V_{DD} - 0.7}{8} + 0.7$ |

One-chip telephone ICs with speech, dialler and ringer functions

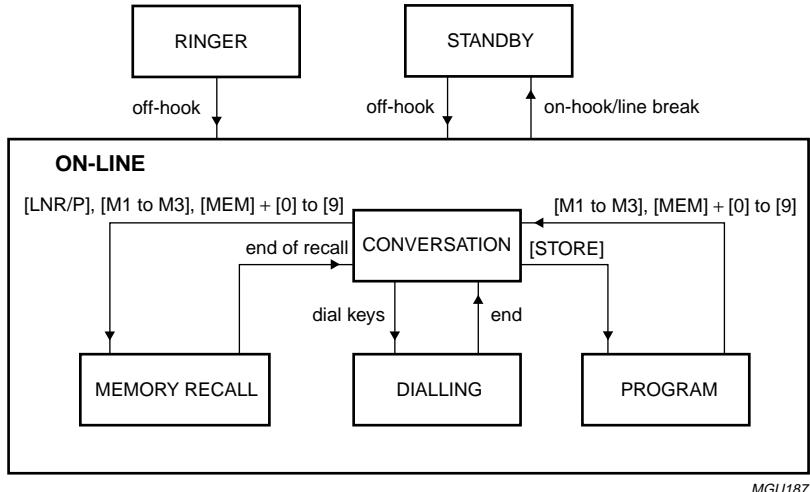
UBA2050(A); UBA2051(A;C)

ON-LINE STATE

This section describes all the actions of the UBA205xx during the on-line state. This state starts with making output DP/FL HIGH (external pull-up resistor), which makes line current flow possible.

The on-line state contains a number of sub-states (see Fig.29):

- Conversation state
- Dialling state
- Memory recall state
- Program state.



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Conversation state

In this state, conversation is possible.

Dialling state

During the dial-key entries the UBA205xx starts immediately with transmission of the digit(s); the minimum transmission time is unaffected by the speed of the entry. Transmission continues as long as further dial-key entries have to be processed.

However when more than 32 digits are dialled the LNR memory will overflow and the last number redial function will be inhibited.

There are two dial modes: pulse dialling and tone dialling. The initial dialling mode is determined by resistor option PTS.

The state machine which controls the dialling mode is illustrated in Fig.30.

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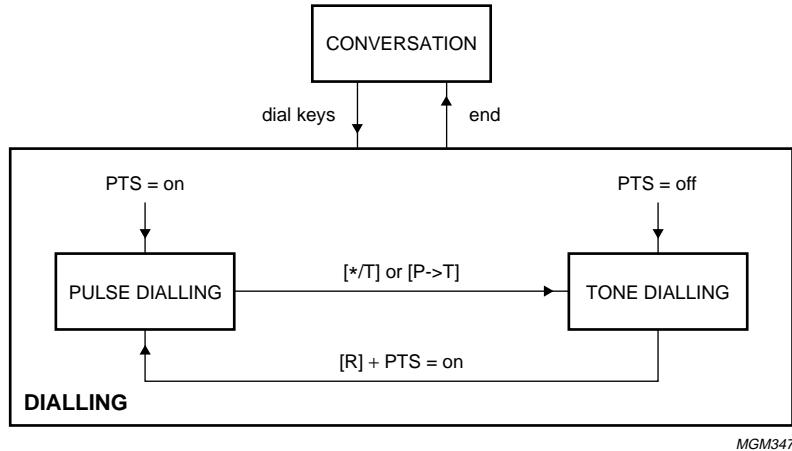


Fig.30 Dialling mode state machine.

- Pulse dialling

In this mode all valid keys are dialled by the pulse dialler. When, during pulse dialling, either $[\ast/T]$ when MMS is off or $[P \rightarrow T]$ is pressed, the UBA205xx switches over to tone dialling (mixed mode dialling). After the switch over, valid keys are dialled by the tone dialler. The temporary tone mode is terminated by going on-hook or flash (Recall).

- Tone dialling

The UBA205xx converts valid key entries into data for the on-chip DTMF generator. Tones are transmitted via output MDY/TONE with a minimum tone burst/pause duration. The maximum tone burst duration is equal to the key pressing time.

- Flash function

The $[R]$ key will result in pin $\overline{DP/FL}$ being set to LOW to generate a flash (line current interruption) with a selected time (FTSA and FTSB resistor options). Pressing one digit after $[R]$ key is pressed clears the LNR memory. When going on-hook after the $[R]$ key is pressed, then digits previously dialled in the LNR memory are kept.

- Access pause

When the $[LNR/P]$ button is not the first key pressed, an access pause is entered for repertory or redialling procedures.

- Last number redial

If the first key pressed is $[LNR/P]$, the number stored in the LNR memory is dialled and sent. A maximum number of 32 digits can be stored in the LNR memory. If this maximum is exceeded the redial function is inhibited. Pauses, which are stored in the LNR memory, are also dialled.

The tone switch keys $[\ast/T]$ (when MMS is off) and $[P \rightarrow T]$ are also stored in the LNR memory. When a $[\ast/T]$ key (when MMS is on) or $[#]$ key occurs during pulse dialling, its code is not stored in the LNR memory.

The LNR memory is always cleared when the $[STORE]$ key is pressed. Its content may also be programmed (see Section "Program state (only UBA2051x)").

One-chip telephone ICs with speech, dialler and ringer functions

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Memory recall state (only UBA2051x)

Repertory numbers can be dialled out after or before entering manual dialling, last number redial and by entering the memory locations in successive order.

Repertory recall is not possible as long as a dial out is pending. The three direct memory locations are numbered [M1] to [M3] and the ten indirect memory locations [MEM] [1] to [MEM] [0].

The stored numbers can be dialled by using one of the following procedures:

Press one of the direct memory keys [M1] to [M3]

or

Press [MEM], followed by one of the numeric keys [1] to [0], corresponding to the memory locations 1 to 10.

In case [R] is included in one memory location, when the LNR capacity is exceeded by using it, the LNR function is inhibited.

Program state (only UBA2051x)

The program state can be entered from the conversation mode (on-line) when no dial out is pending. Pressing the [STORE] key in this state puts the UBA2051x in the program state and also clears the LNR memory. Pressing the [STORE] key again in the program state will restart the program sequence.

- Leaving the program state

The program state can be left in one of the following ways:

- By going on-hook; the entered digits are stored in the LNR memory
- By ending the store procedures properly (see below), resulting in a proper store of the programmed item.

- Programming repertory numbers

A maximum number of 32 digits can be stored in the memory of repertory numbers (including access pauses, tone switch and flash) and can be achieved by using the following procedure:

- Press [STORE]; the LNR memory is cleared
- Press the sequence of digits that must be stored; the keys [0] to [9], [#], [LNR/P], [*T], [P → T] or [R] may be used
- Store the number in the memory.

- Memory overflow

If more than 21 digits are entered the old memory contents is kept and the LNR memory is cleared. All the following digits are ignored, except the [STORE] key. The memory overflow state can be left:

- By going on-hook
- By pressing the [STORE] key again to restart the program sequence.

- Clear repertory numbers

Clearing a memory location is possible by using the same procedure as for storing a number, except that no telephone number is entered:

- Press [STORE]; the LNR memory will be cleared
- Press one of the memory keys.

- Notepad function

In the conversation state it is possible to store a 21 digit number into the LNR memory, which may be dialled after an on-hook/off-hook action. The procedure is as follows:

- Press [STORE], the LNR memory will be cleared
- Press the sequence of digits that must be stored; the keys [0] to [9], [#], [LNR/P], [*T], [P → T] or [R] may be used
- Go on-hook/off-hook.

One-chip telephone ICs with speech, dialler and ringer functions

UBA2050(A); UBA2051(A;C)

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 60134).

| SYMBOL | PARAMETER | CONDITIONS | MIN. | MAX. | UNIT |
|-----------|-------------------------|---------------------------------|------|------|------|
| P_{tot} | total power dissipation | $R_{SLPE} = 20 \Omega$; note 1 | – | 625 | mW |
| T_{amb} | ambient temperature | | –25 | +75 | °C |
| T_{stg} | storage temperature | | –40 | +125 | °C |
| T_j | junction temperature | | – | 125 | °C |

Speech/transmission part

| | | | | | |
|-------------|--|---------------------------------|-----------|----------------|----|
| V_{LN} | positive continuous voltage on pin LN | | GND – 0.4 | 12 | V |
| $V_{LN(R)}$ | repetitive voltage on pin LN during switch-on or line interruption | | GND – 0.4 | 13.2 | V |
| I_{LN} | line current | $R_{SLPE} = 20 \Omega$; note 2 | – | 140 | mA |
| V_{CC} | supply voltage for the speech/transmission part and peripherals | | GND – 0.4 | 12 | V |
| V_{DD} | stabilized supply voltage for the dialler and ringer parts | $I_{DD} \leq 75 \text{ mA}$ | GND – 0.4 | 3.6 | V |
| I_{DD} | input current at pin V_{DD} for the dialler and ringer parts | $I_{line} = 0 \text{ mA}$ | – | 75 | mA |
| V_n | voltage on pins SLPE, IR, REG, AGC, DTMF, RX, QR, GAR, MIC+ and MIC– | | GND – 0.4 | $V_{CC} + 0.4$ | V |

Dialler and ringer parts

| | | | | | |
|-------|---|--|-----------|----------------|----|
| V_n | voltage on pins 8 to 21 | | GND – 0.4 | $V_{DD} + 0.4$ | V |
| I_n | DC sink/source current for pins 8 to 21 | | –10 | +10 | mA |

Notes

- Calculated for $T_{amb} = 75 \text{ }^{\circ}\text{C}$ and $T_j = 125 \text{ }^{\circ}\text{C}$.
- Mostly dependent on the maximum required ambient temperature and on the voltage between pins LN and SLPE (see Fig.31).

THERMAL CHARACTERISTICS

| SYMBOL | PARAMETER | CONDITIONS | VALUE | UNIT |
|---------------|---|---------------------|-------|------|
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | in free air; note 1 | 70 | K/W |

Note

- Mounted on glass epoxy board $28.5 \times 19.1 \times 1.5 \text{ mm}$.

One-chip telephone ICs with speech,
dialler and ringer functions

UBA2050(A); UBA2051(A;C)

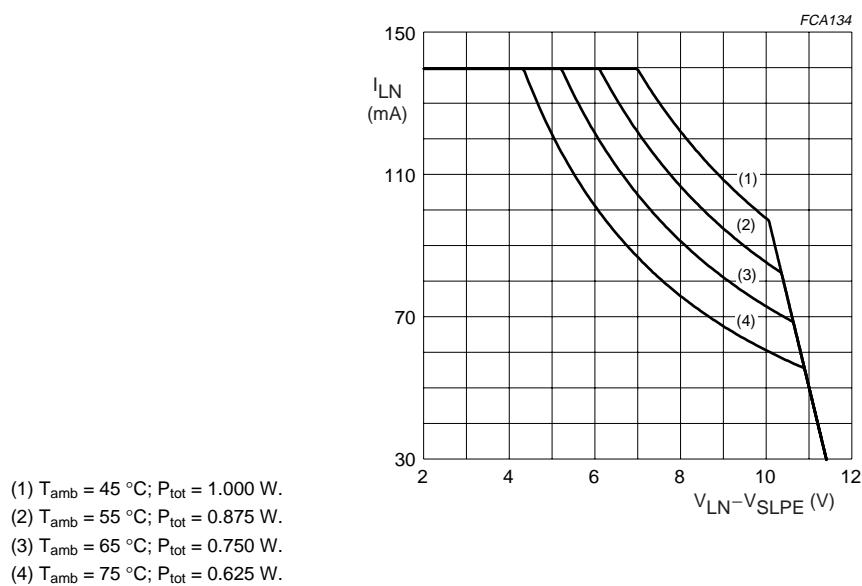


Fig.31 Safe operating area.

One-chip telephone ICs with speech, dialler and ringer functions

UBA2050(A); UBA2051(A;C)

CHARACTERISTICS

$I_{line} = 15 \text{ mA}$; $GND = 0 \text{ V}$; $R_{SLPE} = 20 \Omega$; pin AGC connected to GND; $Z_{line} = 600 \Omega$; $f = 1 \text{ kHz}$; $f_{xtal} = 3.579545 \text{ MHz}$; $T_{amb} = 25 \text{ }^\circ\text{C}$; measured according to the test circuits of Figs 32, 33 and 34; see also Figs 37 and 38; unless otherwise specified.

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|--|---|---|------|-----------------|------|------|
| Supplies | | | | | | |
| LINE INTERFACE (PIN LN) | | | | | | |
| I_{line} | line current operating range | normal operation | 11 | — | 140 | mA |
| | | reduced performance | 1 | — | 11 | mA |
| V_{ref} | stabilized reference voltage between pins LN and SLPE | | 3.9 | 4.15 | 4.4 | V |
| V_{LN} | DC line voltage | $I_{line} = 1 \text{ mA}$ | — | 1.45 | — | V |
| | | $I_{line} = 4 \text{ mA}$ | — | 2.0 | — | V |
| | | $I_{line} = 15 \text{ mA}$ | 4.05 | 4.35 | 4.65 | V |
| | | $I_{line} = 140 \text{ mA}$ | — | 7.1 | 7.55 | V |
| $V_{LN(Rext)}$ | DC line voltage with external resistor | external resistor $R_{VA} = 44.2 \text{ k}\Omega$ (between pins LN and REG) | — | 3.6 | — | V |
| $\Delta V_{LN(T)}$ | DC line voltage variation with temperature | $T_{amb} = -25 \text{ to } +75 \text{ }^\circ\text{C}$; referenced to $T_{amb} = 25 \text{ }^\circ\text{C}$ | — | ± 40 | — | mV |
| INTERNAL SUPPLY VOLTAGE (PIN V_{CC}) | | | | | | |
| I_{CC} | internal current consumption | $V_{CC} = 3.6 \text{ V}$ | — | 1.25 | 1.5 | mA |
| V_{CC} | supply voltage for speech/transmission part and peripherals | $I_P = 0 \text{ mA}$ | — | 3.6 | — | V |
| REGULATED SUPPLY VOLTAGE (PIN V_{DD}) | | | | | | |
| I_{SUP} | input current of the V_{DD} regulator | current from pin LN not flowing through pin SLPE | — | 0 | — | mA |
| | | $I_{line} = 1 \text{ mA}$ | — | 0 | — | mA |
| | | $I_{line} = 4 \text{ mA}$ | — | 2.15 | — | mA |
| V_{DD} | regulated supply voltage | $I_{line} \geq 11 \text{ mA}$ | — | 4.5 | — | mA |
| | | speech mode; $I_{DD} = -2.6 \text{ mA}$; $V_{LN} > 3.6 \text{ V} + 0.25 \text{ V}$ (typ.); $I_{line} \geq 11 \text{ mA}$ | 3.0 | 3.3 | 3.6 | V |
| | | speech mode at reduced performance; $I_{line} = 4 \text{ mA}$ | — | $V_{LN} - 0.35$ | — | V |
| | | ringer mode; $I_{line} = 0 \text{ mA}$; $I_{DD} = 75 \text{ mA}$ | 3.0 | 3.3 | 3.6 | V |

One-chip telephone ICs with speech, dialler and ringer functions

UBA2050(A); UBA2051(A;C)

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---------------|--|--|------|------|------|------|
| I_{DD} | available supply current for peripherals in on-line mode | $I_{line} \geq 11 \text{ mA}$; DTMF generator on; no AC signal on the line | — | — | -1.9 | mA |
| | | $I_{line} \geq 11 \text{ mA}$; DTMF generator off; no AC signal on the line | — | — | -2.6 | mA |
| $I_{DD(MR)}$ | memory retention current (internal consumption on V_{DD}) | $I_{line} = 0 \text{ mA}$; V_{CC} discharging; $V_{DD} = 1.2 \text{ V}$ | — | — | 300 | nA |
| $V_{DD(MR)}$ | memory retention voltage | | 1.0 | — | 3.6 | V |
| $V_{DD(POR)}$ | Power-on reset trip level | note 1 | 1.3 | 1.65 | 2.0 | V |

Transmit stages

MICROPHONE AMPLIFIER (PINS MIC+ AND MIC- AND LN)

| | | | | | | |
|-----------------------|--|---|------|-----------|------|------------|
| $ Z_i $ | input impedance | differential between pins MIC+ and MIC- | — | 68 | — | k Ω |
| | | single-ended between pin MIC+ or MIC- and GND | — | 34 | — | k Ω |
| $G_{v(TX)}$ | voltage gain from pins MIC+ or MIC- to LN | $V_{MIC} = 4 \text{ mV}$ (RMS) | 43.2 | 44.2 | 45.2 | dB |
| $\Delta G_{v(TX)}$ | voltage gain reduction of microphone amplifier | internal MUTE active | — | 80 | — | dB |
| $\Delta G_{v(TX)(f)}$ | voltage gain variation with frequency | $f = 300 \text{ to } 3400 \text{ Hz}$; referenced to $f = 1 \text{ kHz}$ | — | ± 0.2 | — | dB |
| $\Delta G_{v(TX)(T)}$ | voltage gain variation with temperature | $T_{amb} = -25 \text{ to } +75 \text{ }^{\circ}\text{C}$; referenced to $T_{amb} = 25 \text{ }^{\circ}\text{C}$ | — | ± 0.3 | — | dB |
| CMRR | common mode rejection ratio | | — | 80 | — | dB |
| $V_{LN(max)(rms)}$ | maximum sending signal voltage level (RMS value) | $I_{line} = 15 \text{ mA}$; THD = 2% | 1.8 | 2.15 | — | V |
| | | $I_{line} = 4 \text{ mA}$; THD = 10% | — | 0.35 | — | V |
| $V_{n(LN)}$ | noise output voltage at pin LN | psophometrically weighted (P53 curve); pins MIC+ and MIC- shorted through 200Ω | — | -78 | — | dB μ p |

DTMF AMPLIFIER (PIN DTMF)

| | | | | | | |
|-------------------------|--|--|---|-----------|---|------------|
| $ Z_i $ | input impedance | | — | 21 | — | k Ω |
| $G_{v(DTMF)}$ | voltage gain from pin DTMF to pin LN | in tone dialling mode; $V_{DTMF} = 20 \text{ mV}$ (RMS) | — | 26 | — | dB |
| $\Delta G_{v(DTMF)}$ | voltage gain reduction of DTMF amplifier | internal MUTE inactive | — | 80 | — | dB |
| $\Delta G_{v(DTMF)(f)}$ | voltage gain variation with frequency | $f = 300 \text{ to } 3400 \text{ Hz}$; referenced to $f = 1 \text{ kHz}$ | — | ± 0.2 | — | dB |

One-chip telephone ICs with speech, dialler and ringer functions

UBA2050(A); UBA2051(A;C)

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|-------------------------|--|--|------|-----------|------|------|
| $\Delta G_{v(DTMF)(T)}$ | voltage gain variation with temperature | $T_{amb} = -25$ to $+75$ °C; referenced to $T_{amb} = 25$ °C | – | ± 0.4 | – | dB |
| $G_{v(ct)}$ | voltage gain from pin DTMF to pin RX (confidence tone) | in tone dialling mode; $V_{DTMF} = 20$ mV (RMS); $R_{L2} = 10$ kΩ; | – | –9.2 | – | dB |

Receive stages

RECEIVE AMPLIFIER (PINS IR AND RX)

| | | | | | | |
|-----------------------|--|--|------|-----------|------|------|
| $ Z_i $ | input impedance | | – | 21.5 | – | kΩ |
| $G_{v(RX)}$ | voltage gain from pin IR to pin RX | $V_{IR} = 4$ mV (RMS) | 32.4 | 33.4 | 34.4 | dB |
| $\Delta G_{v(RX)}$ | voltage gain reduction of receive amplifier | internal MUTE active | – | 80 | – | dB |
| $\Delta G_{v(RX)(f)}$ | voltage gain variation with frequency | $f = 300$ to 3400 Hz; referenced to $f = 1$ kHz | – | ± 0.2 | – | dB |
| $\Delta G_{v(RX)(T)}$ | voltage gain variation with temperature | $T_{amb} = -25$ to $+75$ °C; referenced to $T_{amb} = 25$ °C | – | ± 0.3 | – | dB |
| $I_{o(RX)(max)}$ | maximum source and sink current on pin RX (peak value) | $I_P = 0$ mA; sine wave drive | 50 | – | – | μA |
| $V_{RX(max)(rms)}$ | maximum receiving signal on pin RX (RMS value) | $I_P = 0$ mA; sine wave drive; without R_{L2} ; THD = 2% | 0.4 | – | – | V |
| $V_{n(RX)(rms)}$ | noise output voltage at pin RX (RMS value) | pin IR open-circuit; $R_{L2} = 10$ kΩ; psophometrically weighted (P53 curve) | – | –86 | – | dBVp |

EARPIECE AMPLIFIER (PINS GAR AND QR)

| | | | | | | |
|--------------------|--|--|------|------|-----|------|
| $G_{v(QR)}$ | voltage gain from pin RX to pin QR | $V_{IR} = 4$ mV (RMS); $R_{E1} = R_{GAR} = 100$ kΩ | – | 0 | – | dB |
| $\Delta G_{v(QR)}$ | voltage gain setting range | $R_{E1} = 100$ kΩ | –14 | – | +12 | dB |
| $V_{QR(max)(rms)}$ | maximum receiving signal on pin QR (RMS value) | $I_P = 0$ mA; sine wave drive; $R_{L1} = 150$ Ω; THD = 2% | 0.3 | 0.38 | – | V |
| | | $I_P = 0$ mA; sine wave drive; $R_{L1} = 450$ Ω; THD = 2% | 0.46 | 0.56 | – | V |
| $V_{n(QR)(rms)}$ | noise output voltage at pin QR (RMS value) | IR open-circuit; $R_{L1} = 150$ Ω; $R_{E1} = R_{GAR} = 100$ kΩ; psophometrically weighted (P53 curve) | – | –86 | – | dBVp |
| | | $R_{E1} = 100$ kΩ; $R_{GAR} = 25$ kΩ | – | –98 | – | dBVp |

One-chip telephone ICs with speech, dialler and ringer functions

UBA2050(A); UBA2051(A;C)

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|--|--|---|--------------------|--------------------|-----------------------|------------------|
| Automatic gain control (pin AGC) | | | | | | |
| $\Delta G_{V(\text{trx})}$ | voltage gain control range for microphone and receive amplifiers | $I_{\text{line}} = 85 \text{ mA}$; referenced to $I_{\text{line}} = 15 \text{ mA}$ | – | 6.0 | – | dB |
| I_{start} | highest line current for maximum gain | | – | 23 | – | mA |
| I_{stop} | lowest line current for minimum gain | | – | 59 | – | mA |
| Oscillator (pin XTAL) | | | | | | |
| V_{XTAL} | DC voltage level | | – | $0.5V_{\text{DD}}$ | – | V |
| $R_{e(Z_i)}$ | real part of input impedance of pin XTAL | $V_{\text{XTAL}} = 100 \text{ mV (RMS)}$; $f_{\text{xtal}} = 3.57 \text{ MHz}$ | – | –6 | – | $\text{k}\Omega$ |
| Control inputs (pins CE/CSI and CE/FDI) | | | | | | |
| V_{IL} | LOW-level input voltage | | GND – 0.4 | – | $0.2V_{\text{DD}}$ | V |
| V_{IH} | HIGH-level input voltage | | $0.8V_{\text{DD}}$ | – | $V_{\text{DD}} + 0.4$ | V |
| I_{LI} | input leakage current | $\text{GND} < V_i < V_{\text{DD}}$ | –500 | – | +500 | nA |
| Keyboard inputs/outputs (pins C1 to C4, R1 to R4); note 2 | | | | | | |
| V_{IL} | LOW-level input voltage | | 0 | – | $0.2V_{\text{DD}}$ | V |
| V_{IH} | HIGH-level input voltage | | $0.8V_{\text{DD}}$ | – | V_{DD} | V |
| I_{OL} | port sink current LOW | $V_{\text{OL}} = 0.15 \text{ V}$ | 0.7 | 1.6 | – | mA |
| I_{OH1} | port pull-up source 1 current HIGH | $V_{\text{OH}} = V_{\text{IH(min)}}$ | 15 | 35 | – | μA |
| | | $V_{\text{OL}} = V_{\text{IL(max)}}$ | – | 70 | 140 | μA |
| I_{OH2} | port pull-up source 2 current HIGH | $V_{\text{OH}} = V_{\text{IH(min)}}$ | 30 | 80 | – | nA |
| | | $V_{\text{OL}} = V_{\text{IL(max)}}$ | – | 150 | 300 | nA |
| Control output (pin DP/FL) | | | | | | |
| I_{LI} | input leakage current | $\text{GND} < V_i < V_{\text{DD}}$ | –500 | – | +500 | nA |
| I_{OL} | port sink current LOW | $V_o = 0.15 \text{ V}$ | 1 | 2.5 | – | mA |
| Control outputs (pins DMO, KT and LED) | | | | | | |
| I_{OL} | port sink current LOW | $V_o = 0.4 \text{ V}$ | 1.5 | 4 | – | mA |
| I_{OH} | port source current HIGH | $V_o = V_{\text{DD}} - 0.15 \text{ V}$ | –1 | –2 | – | mA |
| DTMF/ringer output | | | | | | |
| TONE GENERATOR (PIN MDY/TONE); note 3 | | | | | | |
| $ I_o $ | maximum output current | | 70 | 100 | – | μA |
| $V_{\text{HG(rms)}}$ | high group frequency voltage (RMS value) | DTMF mode | – | 181 | – | mV |
| $V_{\text{LG(rms)}}$ | low group frequency voltage (RMS value) | DTMF mode | – | 142 | – | mV |
| G_V | pre-emphasis of group | | 1.5 | 2.0 | 2.5 | dB |
| V_{DC} | DC voltage level | | – | $0.5V_{\text{DD}}$ | – | V |

One-chip telephone ICs with speech, dialler and ringer functions

UBA2050(A); UBA2051(A;C)

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---------------------------|---|---|------------------|--------------------------|------------------|------------------|
| $ Z_o $ | output impedance | | — | 100 | 500 | Ω |
| THD | total harmonic distortion | note 4 | — | —25 | — | dB |
| TRANSMIT CHANNEL (PIN LN) | | | | | | |
| $V_{HG(LN)(rms)}$ | high group frequency voltage (RMS value) | $R_{DTMF1} = 20 \text{ k}\Omega$; $R_{DTMF2} = 2.74 \text{ k}\Omega$ | 353 | 435 | 536 | mV |
| $V_{LG(LN)(rms)}$ | low group frequency voltage (RMS value) | $R_{DTMF1} = 20 \text{ k}\Omega$; $R_{DTMF2} = 2.74 \text{ k}\Omega$ | 277 | 341 | 420 | mV |
| MDY output (pin MDY/TONE) | | | | | | |
| $V_{o(p-p)}$ | ringer volume output voltage (peak-to-peak value) | $V_{DD} = 3.3 \text{ V}$; note 5 Key [8] Key [7] Key [6] Key [5] | — — — — | 3.2 2.0 1.4 1.1 | — — — — | V V V V |

Notes

1. When this level is reached at rising V_{DD} , the internal reset signal is deactivated. There is no hysteresis in the switching level, only hysteresis in the time domain.
2. At start-up the output has a pull-up source I_{OH2} for detection of the resistor options. After initializing the output pull-up source will be I_{OH1} .
3. MDY/TONE has three modes:
 - a) In speech mode or DTMF mode: $0.5V_{DD}$ output.
 - b) In ringer mode: push-pull output stage.
 - c) In standby mode: high-impedance output.
4. Related to the low group frequency component (CEPT CS203 compatible).
5. In the event of a valid ringer signal present at pin CE/FDI.

One-chip telephone ICs with speech, dialler and ringer functions

UBA2050(A); UBA2051(A;C)

TIMING CHARACTERISTICS

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|--|--------------------------------|-----------------------------|------|------|------|------|
| Timing | | | | | | |
| KEYBOARD INPUTS/OUTPUTS (PINS C1 TO C4 AND R1 TO R4) | | | | | | |
| t_{dd} | keyboard depress debounce time | | — | 20 | — | ms |
| t_{rd} | keyboard release debounce time | | — | 20 | — | ms |
| KEY TONE OUTPUT (PIN KT) | | | | | | |
| t_{kt} | keytone time | | — | 30 | — | ms |
| f_{kt} | keytone frequency | | — | 597 | — | Hz |
| DIAL PULSE/FLASH OUTPUT (PIN DP/FL) | | | | | | |
| t_{idp} | interdigit pause time | dialling rate 10 pps | — | 800 | — | ms |
| | | dialling rate 20 pps | — | 500 | — | ms |
| t_{fho} | flash holdover time | | — | 40 | — | ms |
| t_{mho} | mute holdover time | | — | 15 | — | ms |
| t_{ap} | access pause time | resistor APT is not present | — | 2.0 | — | s |
| | | resistor APT is present | — | 3.6 | — | s |
| t_{ifp} | interflash pause time | | — | 800 | — | ms |
| t_{pdp} | pre-digit pause | | — | 40 | — | ms |
| t_m | make time | dialling rate 10 pps | — | 40 | — | ms |
| | | resistor MBS is not present | — | 33 | — | ms |
| | | resistor MBS is present | — | 20 | — | ms |
| | | dialling rate 20 pps | — | 16 | — | ms |

One-chip telephone ICs with speech,
dialler and ringer functions

UBA2050(A); UBA2051(A;C)

| SYMBOL | PARAMETER | CONDITIONS | MIN. | TYP. | MAX. | UNIT |
|---|----------------------------|--|------|-----------|------|----------|
| t_b | brake time | dialling rate 10 pps resistor MBS is not present resistor MBS is present | – | 60 66 | – | ms ms |
| | | dialling rate 20 pps resistor MBS is not present resistor MBS is present | – | 30 33 | – | ms ms |
| t_f | flash time | resistor FTSB is not present resistor FTSA is not present resistor FTSA is present | – | 98 300 | – | ms ms |
| | | resistor FTSB is present resistor FTSA is not present resistor FTSA is present | – | 600 80 | – | ms ms |
| DIAL TONE OUTPUT (PIN MDY/TONE) | | | | | | |
| t_t | burst time | | – | 85 | – | ms |
| t_p | pause time | | – | 85 | – | ms |
| CHIP ENABLE INPUTS (PINS CE/CSI AND CE/FDI) | | | | | | |
| t_{RD} | reset delay time | | – | 280 | – | ms |
| Timing | | | | | | |
| f_{ring} | ringer detection frequency | | 13 | – | – | Hz |
| $t_{d(res)(ring)}$ | ringer response delay | <1.5 frequency cycle; $V_{DD} > V_{POR}$ | – | – | 150 | ms |

One-chip telephone ICs with speech, dialler and ringer functions

UBA2050(A); UBA2051(A;C)

TEST AND APPLICATION INFORMATION

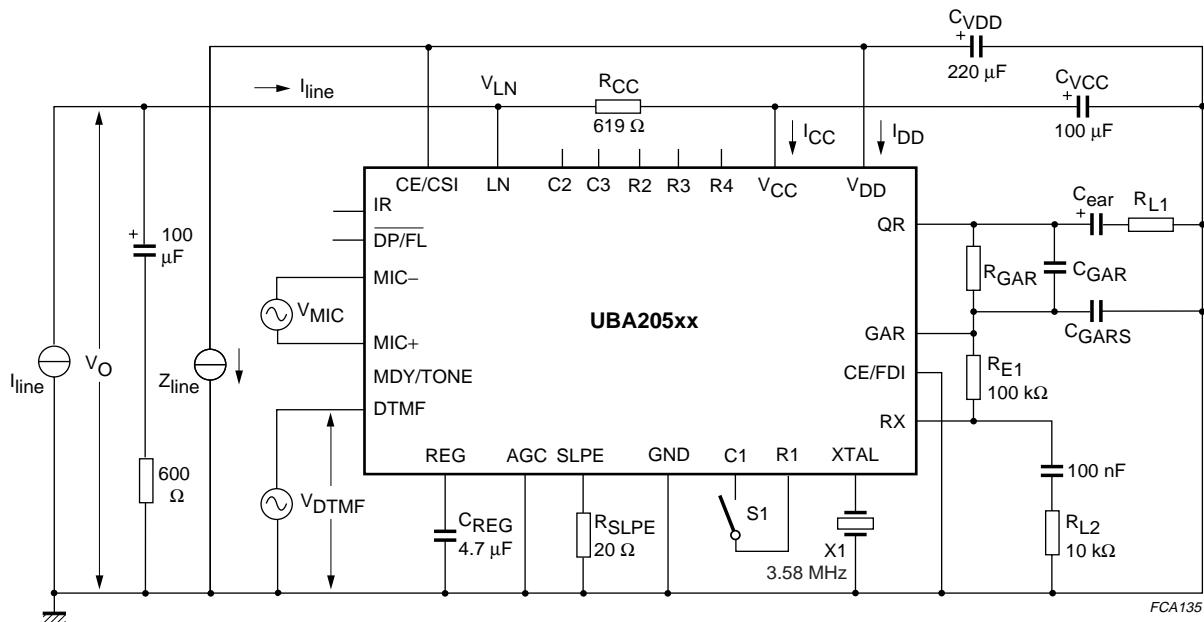
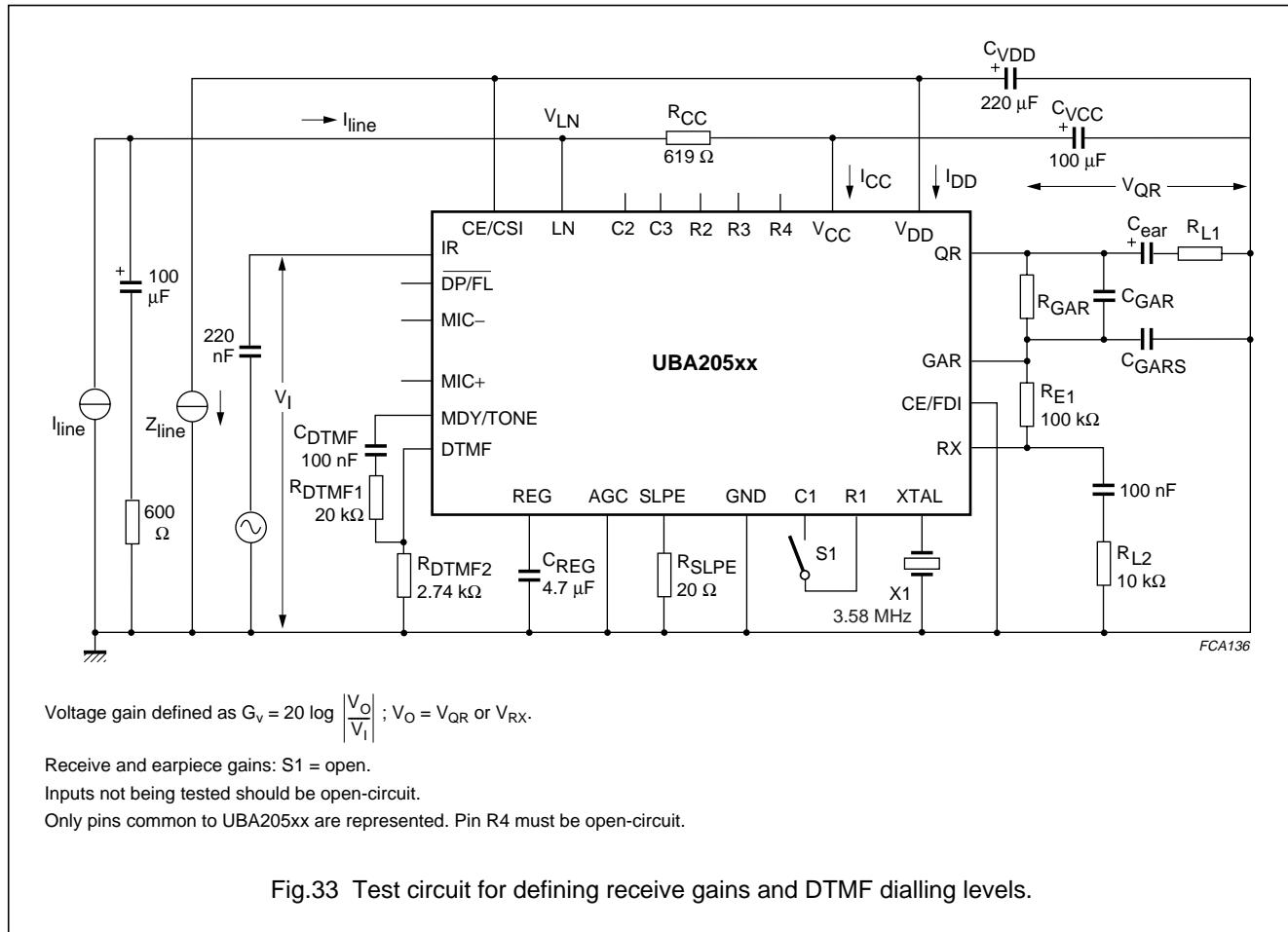


Fig.32 Test circuit for defining transmit gains.

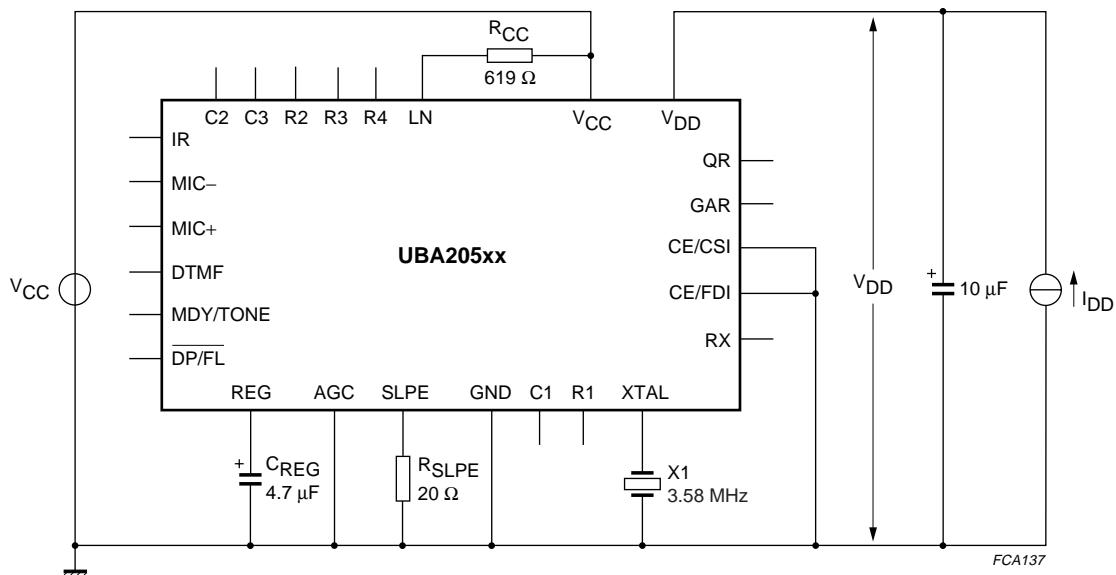
One-chip telephone ICs with speech, dialler and ringer functions

UBA2050(A); UBA2051(A;C)



One-chip telephone ICs with speech, dialler and ringer functions

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Inputs not being tested should be open-circuit.

Only pins common to UBA205xx are represented. Pin R4 must be open-circuit.

Fig.34 Test circuit for defining regulated supply (V_{DD}) performance in ringer and trickle mode.

One-chip telephone ICs with speech, dialler and ringer functions

UBA2050(A); UBA2051(A;C)

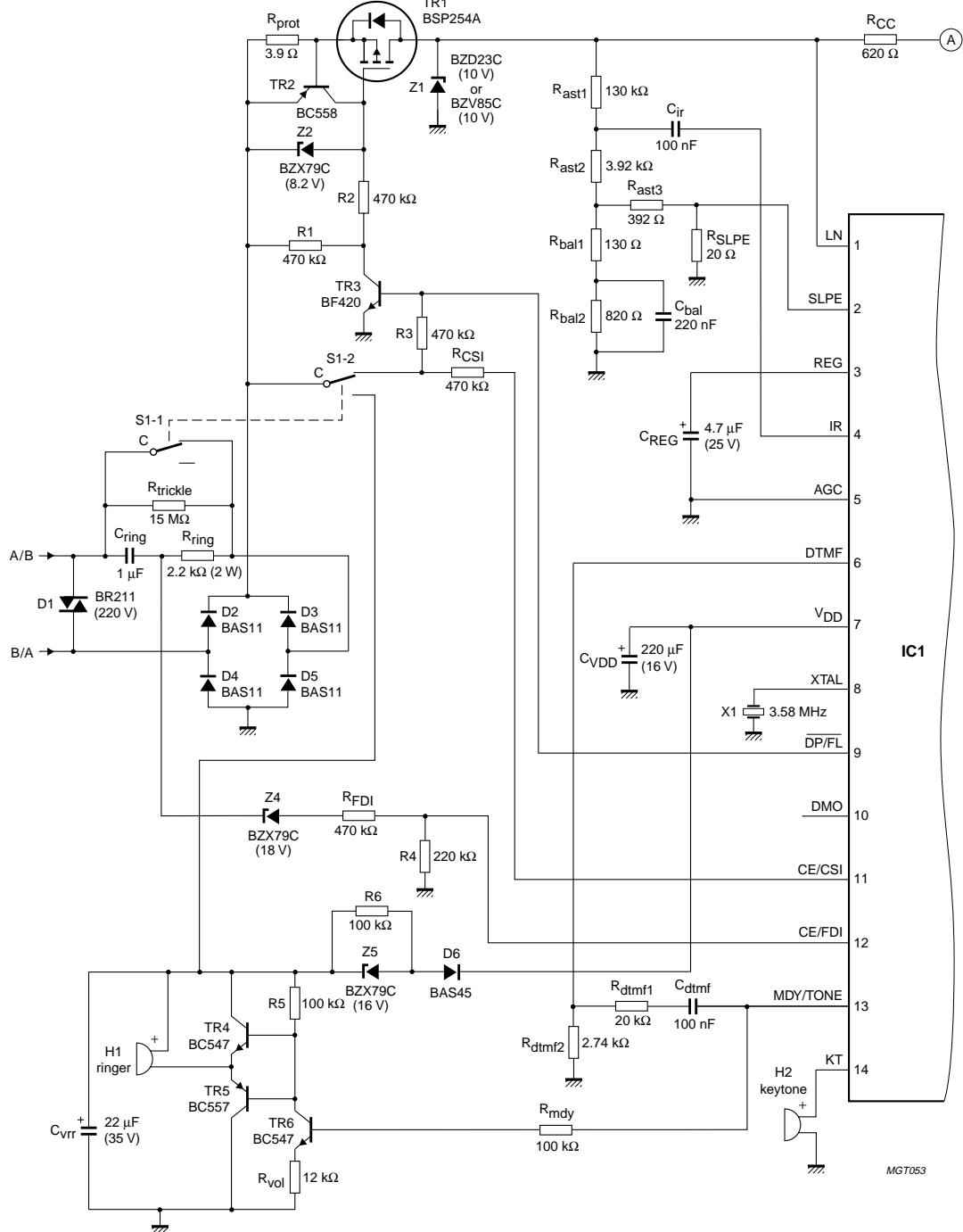


Fig.35 Application of the UBA2050 (continued in Fig.36).

One-chip telephone ICs with speech, dialler and ringer functions

UBA2050(A); UBA2051(A;C)

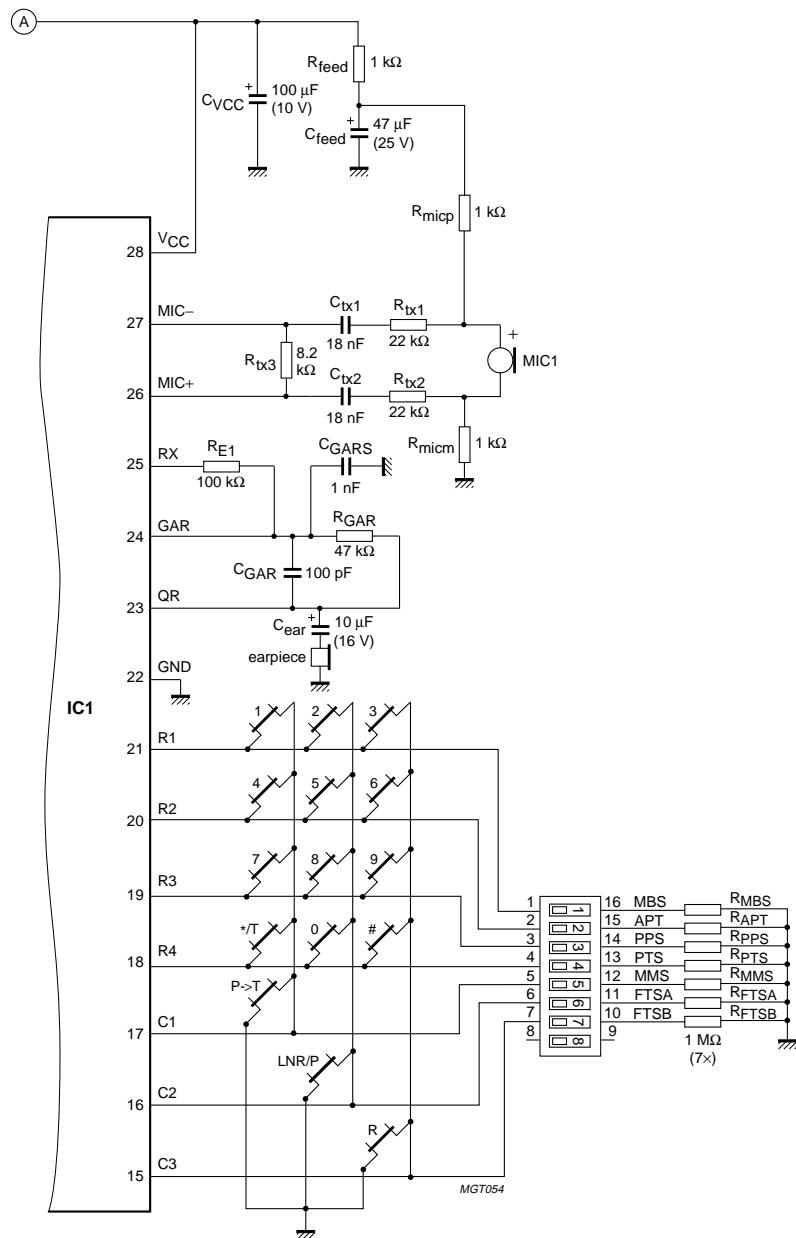


Fig.36 Application of the UBA2050 (continued from Fig.35).

One-chip telephone ICs with speech, dialler and ringer functions

UBA2050(A); UBA2051(A;C)

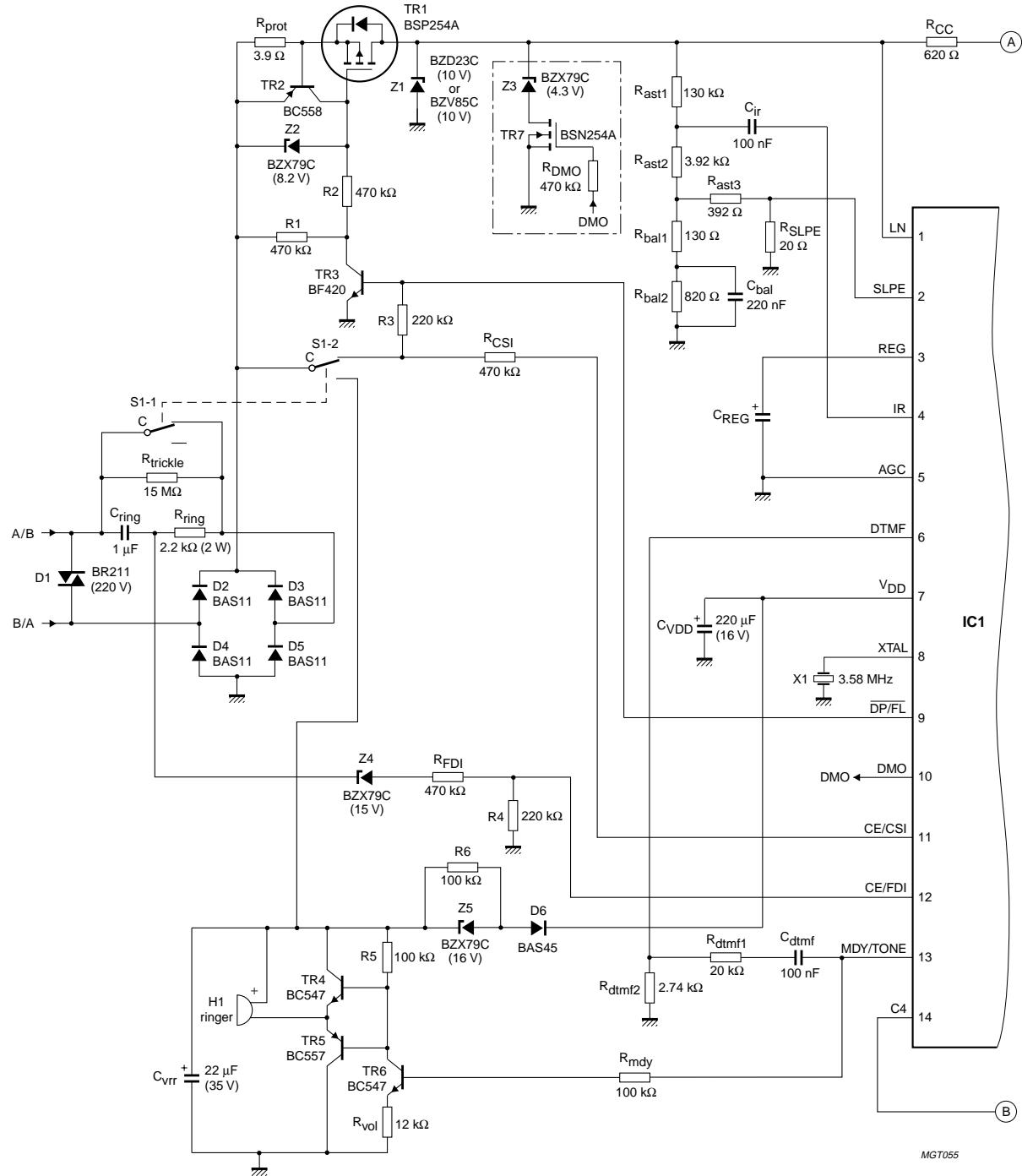


Fig.37 Application of the UBA2051 (continued in Fig.38).

One-chip telephone ICs with speech, dialler and ringer functions

UBA2050(A); UBA2051(A;C)

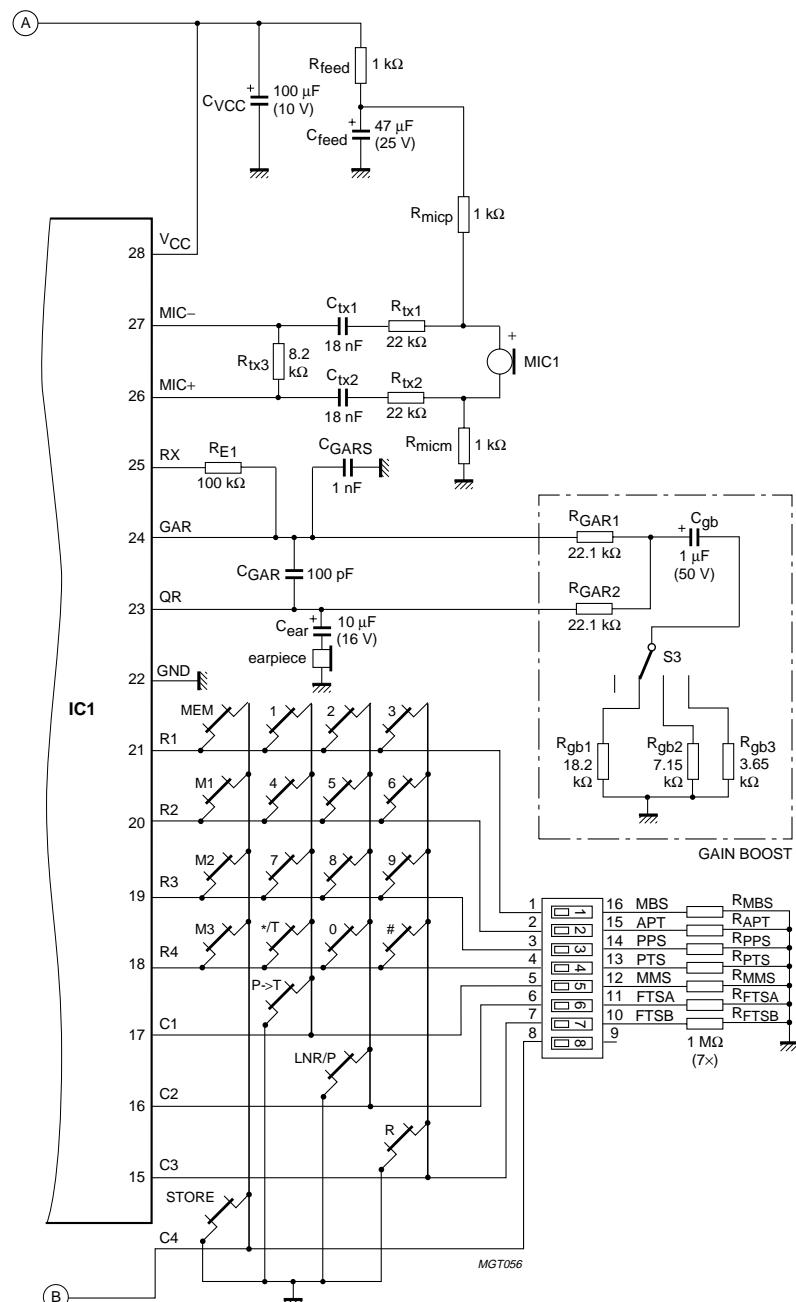


Fig.38 Application of the UBA2051 (continued from Fig.37).

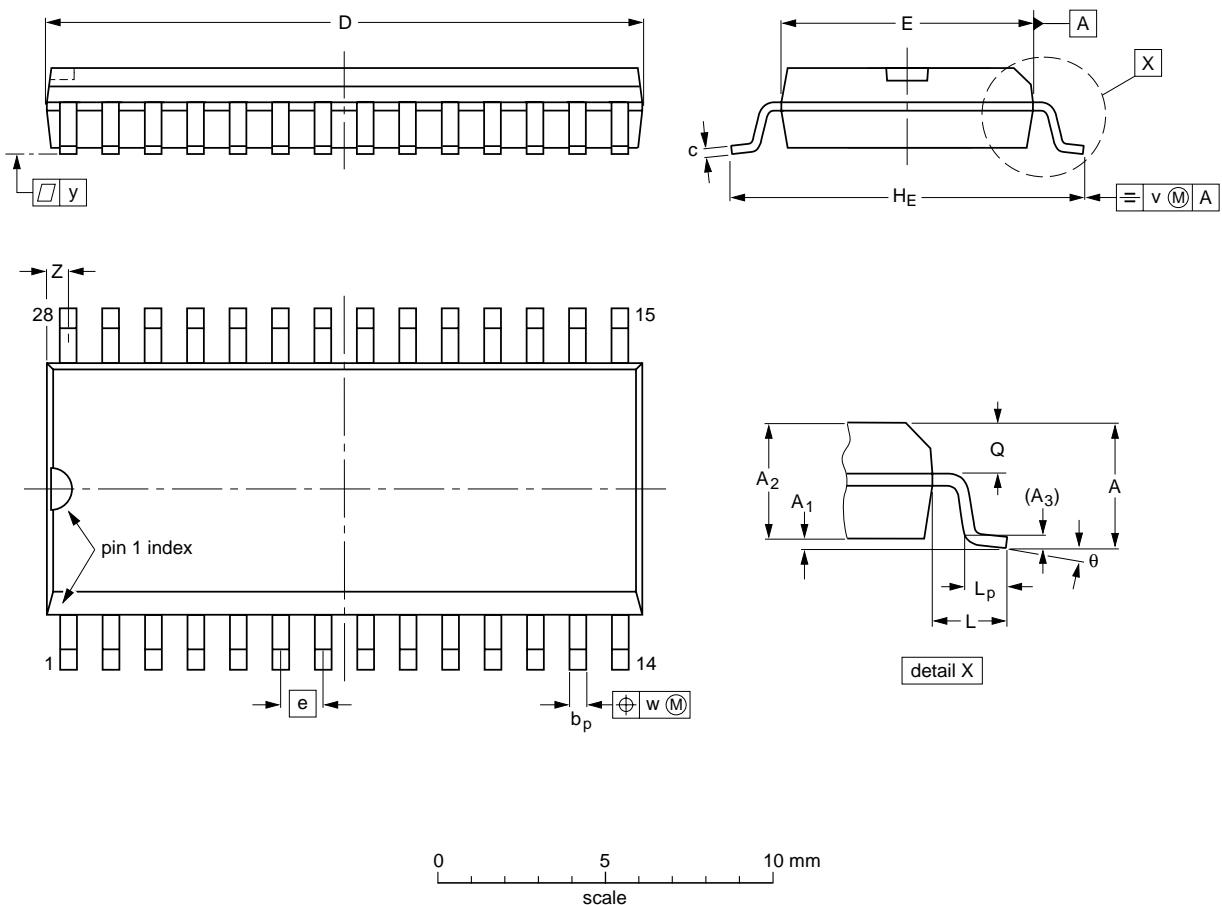
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PACKAGE OUTLINE

SO28: plastic small outline package; 28 leads; body width 7.5 mm

SOT136-1



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

| UNIT | A max. | A ₁ | A ₂ | A ₃ | b _p | c | D ⁽¹⁾ | E ⁽¹⁾ | e | H _E | L | L _p | Q | v | w | y | z ⁽¹⁾ | θ |
|--------|---------------|----------------|----------------|----------------|----------------|----------------|------------------|------------------|-------|----------------|-------|----------------|----------------|------|------|-------|------------------|----------|
| mm | 2.65 0.10 | 0.30 2.25 | 2.45 | 0.25 | 0.49 0.36 | 0.32 | 18.1 17.7 | 7.6 7.4 | 1.27 | 10.65 10.00 | 1.4 | 1.1 0.4 | 1.1 1.0 | 0.25 | 0.25 | 0.1 | 0.9 0.4 | 8° 0° |
| inches | 0.10 0.004 | 0.012 0.089 | 0.096 | 0.01 | 0.019 0.014 | 0.013 0.009 | 0.71 0.69 | 0.30 0.29 | 0.050 | 0.419 0.394 | 0.055 | 0.043 0.016 | 0.043 0.039 | 0.01 | 0.01 | 0.004 | 0.035 0.016 | |

Note

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|--------------------|------------|--------|------|--|------------------------|-----------------------|
| | IEC | JEDEC | EIAJ | | | |
| SOT136-1 | 075E06 | MS-013 | | | | -97-05-22 99-12-27 |

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SOLDERING

Introduction to soldering surface mount packages

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our *"Data Handbook IC26; Integrated Circuit Packages"* (document order number 9398 652 90011).

There is no soldering method that is ideal for all surface mount IC packages. Wave soldering is not always suitable for surface mount ICs, or for printed-circuit boards with high population densities. In these situations reflow soldering is often used.

Reflow soldering

Reflow soldering requires solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the printed-circuit board by screen printing, stencilling or pressure-syringe dispensing before package placement.

Several methods exist for reflowing; for example, infrared/convection heating in a conveyor type oven. Throughput times (preheating, soldering and cooling) vary between 100 and 200 seconds depending on heating method.

Typical reflow peak temperatures range from 215 to 250 °C. The top-surface temperature of the packages should preferably be kept below 230 °C.

Wave soldering

Conventional single wave soldering is not recommended for surface mount devices (SMDs) or printed-circuit boards with a high component density, as solder bridging and non-wetting can present major problems.

To overcome these problems the double-wave soldering method was specifically developed.

If wave soldering is used the following conditions must be observed for optimal results:

- Use a double-wave soldering method comprising a turbulent wave with high upward pressure followed by a smooth laminar wave.
- For packages with leads on two sides and a pitch (e):
 - larger than or equal to 1.27 mm, the footprint longitudinal axis is **preferred** to be parallel to the transport direction of the printed-circuit board;
 - smaller than 1.27 mm, the footprint longitudinal axis **must** be parallel to the transport direction of the printed-circuit board.

The footprint must incorporate solder thieves at the downstream end.

- For packages with leads on four sides, the footprint must be placed at a 45° angle to the transport direction of the printed-circuit board. The footprint must incorporate solder thieves downstream and at the side corners.

During placement and before soldering, the package must be fixed with a droplet of adhesive. The adhesive can be applied by screen printing, pin transfer or syringe dispensing. The package can be soldered after the adhesive is cured.

Typical dwell time is 4 seconds at 250 °C.

A mildly-activated flux will eliminate the need for removal of corrosive residues in most applications.

Manual soldering

Fix the component by first soldering two diagonally-opposite end leads. Use a low voltage (24 V or less) soldering iron applied to the flat part of the lead. Contact time must be limited to 10 seconds at up to 300 °C.

When using a dedicated tool, all other leads can be soldered in one operation within 2 to 5 seconds between 270 and 320 °C.

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Suitability of surface mount IC packages for wave and reflow soldering methods

| PACKAGE | SOLDERING METHOD | |
|--|-----------------------------------|-----------------------|
| | WAVE | REFLOW ⁽¹⁾ |
| BGA, LFBGA, SQFP, TFBGA | not suitable | suitable |
| HBCC, HLQFP, HSQFP, HSOP, HTQFP, HTSSOP, SMS | not suitable ⁽²⁾ | suitable |
| PLCC ⁽³⁾ , SO, SOJ | suitable | suitable |
| LQFP, QFP, TQFP | not recommended ⁽³⁾⁽⁴⁾ | suitable |
| SSOP, TSSOP, VSO | not recommended ⁽⁵⁾ | suitable |

Notes

1. All surface mount (SMD) packages are moisture sensitive. Depending upon the moisture content, the maximum temperature (with respect to time) and body size of the package, there is a risk that internal or external package cracks may occur due to vaporization of the moisture in them (the so called popcorn effect). For details, refer to the Drypack information in the *"Data Handbook IC26; Integrated Circuit Packages; Section: Packing Methods"*.
2. These packages are not suitable for wave soldering as a solder joint between the printed-circuit board and heatsink (at bottom version) can not be achieved, and as solder may stick to the heatsink (on top version).
3. If wave soldering is considered, then the package must be placed at a 45° angle to the solder wave direction. The package footprint must incorporate solder thieves downstream and at the side corners.
4. Wave soldering is only suitable for LQFP, TQFP and QFP packages with a pitch (e) equal to or larger than 0.8 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.65 mm.
5. Wave soldering is only suitable for SSOP and TSSOP packages with a pitch (e) equal to or larger than 0.65 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.5 mm.

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DATA SHEET STATUS

| DATA SHEET STATUS | PRODUCT STATUS | DEFINITIONS ⁽¹⁾ |
|---------------------------|----------------|--|
| Objective specification | Development | This data sheet contains the design target or goal specifications for product development. Specification may change in any manner without notice. |
| Preliminary specification | Qualification | This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product. |
| Product specification | Production | This data sheet contains final specifications. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product. |

Note

1. Please consult the most recently issued data sheet before initiating or completing a design.

DEFINITIONS

Short-form specification — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

Limiting values definition — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

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