DATA SHEET

TEA1064B

Low voltage versatile telephone transmission circuit with dialler interface and transmit level dynamic limiting

Product specification
File under Integrated Circuits, IC03A

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Philips
Semiconductors

PHILIPS

Low voltage versatile telephone transmission circuit with dialler interface and transmit level dynamic limiting

TEA1064B

FEATURES

- Low DC line voltage; operates down to 1.8 V (excluding polarity guard)
- Voltage regulator with low voltage drop and adjustable static resistance
- DC line voltage adjustment facility
- Provides a supply for external circuits
- Dynamic limiting (speech-controlled) in transmit direction prevents distortion of line signal and sidetone
- Symmetrical high-impedance inputs (64 kΩ) for dynamic, magnetic or piezo-electric microphones
- Asymmetrical high-impedance input (32 kΩ) for electret microphones
- DTMF signal input
- Confidence tone in the earpiece during DTMF dialling
- Mute input for disabling speech during pulse or DTMF dialling
- Power-down input for improved performance during pulse dial or register recall (flash)
- Receiving amplifier for dynamic, magnetic or piezo-electric earpieces
- Large amplification setting ranges on microphone and earpiece amplifiers
- Line loss compensation (line current dependent) for microphone and earpiece amplifiers (not used for DTMF amplifier)
- Gain control curve adaptable to exchange supply
- Automatic disabling of the DTMF amplifier in extremely-low voltage conditions
- Microphone MUTE function available with switch
- MUTE, POWER-DOWN and DTMF input reference (pin V_{EE2}) can be connected either to V_{EE1} or SLPE.

GENERAL DESCRIPTION

The TEA1064B is a bipolar integrated circuit that performs all the speech and line interface functions required in fully electronic telephone sets. It performs electronic switching between dialling and speech. The IC operates at line voltages down to 1.8 V DC (with reduced performance) to facilitate the use of more telephone sets connected in parallel. The transmit signal on the line is dynamically limited (speech-controlled) to prevent distortion at high transmit levels of both the sending signal and the sidetone.

ORDERING INFORMATION

EXTENDED TYPE NUMBER	PACKAGE			
	PINS	PIN POSITION	MATERIAL	CODE
TEA1064B	20	DIL	plastic	SOT146[1]
TEA1064BT	20	mini-pack	plastic	SO20; SOT163A[2]

Notes

1. SOT146-1; 1998 Jun 18.
2. SOT163-1; 1998 Jun 18.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{line}	line current operating range					
	normal operation	note 1	11	–	140	mA
	with reduced performance		2	–	11	mA
I_{CC}	internal supply current	V_{CC} = 2.8 V				
	power-down input LOW		–	1.3	1.6	mA
	power-down input HIGH		–	60	82	μA
G_v	voltage gain range					
	microphone amplifier		44	–	52	dB
	receiving amplifier		20	–	45	dB
	line loss compensation ranges					
G_v	gain control		5.7	6.1	6.5	dB
V_{exch}	exchange supply voltage		36	–	60	V
R_{exch}	exchange feeding bridge resistance		400	–	1000	Ω
$V_{LN(p-p)}$	maximum output voltage swing on LN (peak-to-peak value)	R16 = 392 Ω; I_{line} = 15 mA				
		I_p = 1.4 mA	3.55	3.80	4.05	V
		I_p = 2.7 mA	3.25	3.50	3.75	V
V_p	supply for peripherals	I_{line} = 15 mA				
		I_p = 1.4 mA	2.5	2.7	–	V
		I_p = 2.7 mA; $R_{REG-SLPE}$ = 20 kΩ	2.9	3.1	–	V
V_{LN}	DC line voltage	I_{line} = 15 mA				
		without $R_{REG-SLPE}$	3.25	3.5	3.75	V
		$R_{REG-SLPE}$ = 20 kΩ	4.05	4.4	4.75	V
T_{amb}	operating ambient temperature range		–25	–	+75	°C

Note

1. For the TEA1064BT the maximum line current depends on the heat dissipating qualities of the mounted device.

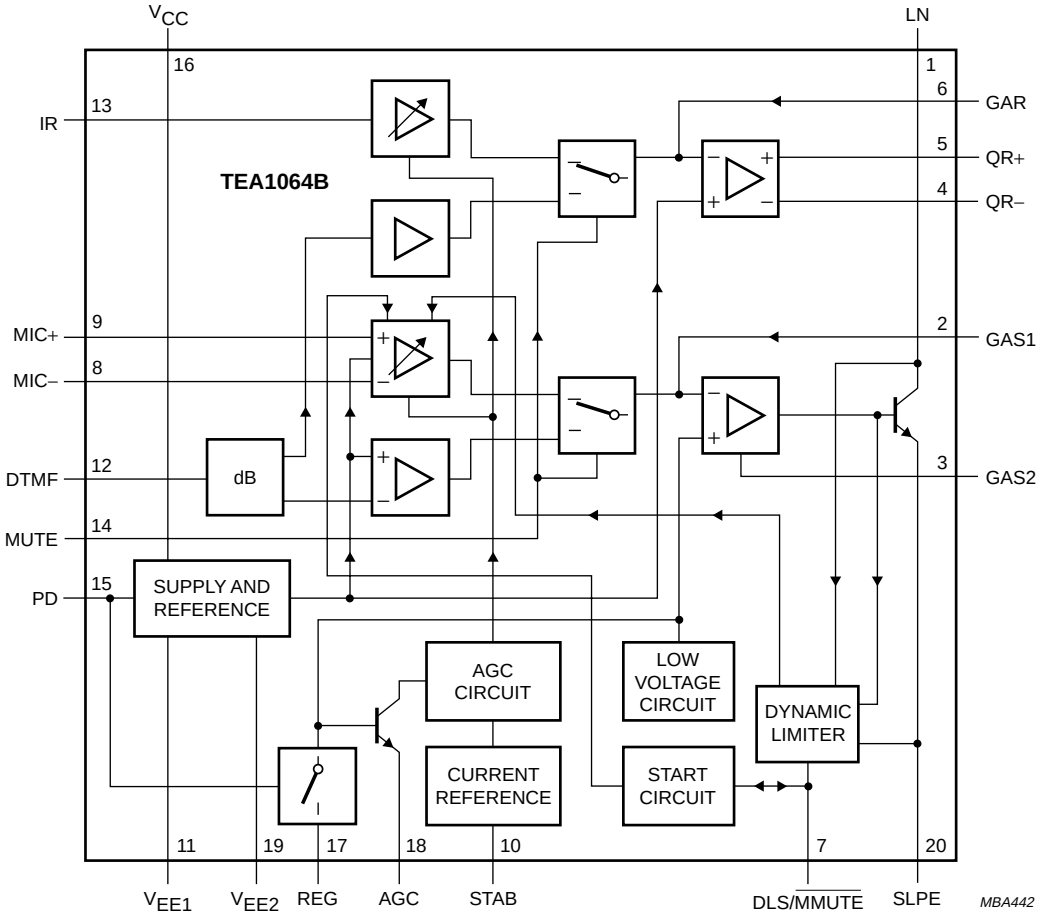


Fig.1 Block diagram.

PINNING

SYMBOL	PIN	DESCRIPTION
LN	1	positive line terminal
GAS1	2	gain adjustment; transmitting amplifier
GAS2	3	gain adjustment; transmitting amplifier
QR–	4	inverting output; receiving amplifier
QR+	5	non-inverting output; receiving amplifier
GAR	6	gain adjustment; receiving amplifier
DLS/$\overline{\text{MMUTE}}$	7	decoupling for transmit amplifier dynamic and microphone MUTE input
MIC–	8	inverting microphone input
MIC+	9	non-inverting microphone input
STAB	10	current stabilizer
V_{EE1}	11	negative line terminal
DTMF	12	dual-tone multi-frequency input
IR	13	receiving amplifier input
MUTE	14	mute input
PD	15	power-down input
V_{CC}	16	internal supply decoupling
REG	17	voltage regulator decoupling
AGC	18	automatic gain control input
V_{EE2}	19	reference for POWER-DOWN (PD), MUTE and DTMF
SLPE	20	slope adjustment for DC curve/reference for peripheral circuits

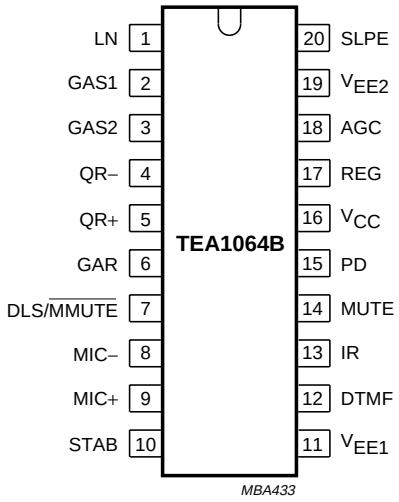


Fig.2 Pin configuration.

FUNCTIONAL DESCRIPTION

Supplies V_{CC}, V_{EE2}, LN, SLPE, REG and STAB (Figs 3 and 5)

Power for the TEA1064B and its peripheral circuits is usually obtained from the telephone line. The IC develops its own supply voltage at V_{CC} and regulates its voltage drop. The internal supply requires a decoupling capacitor between V_{CC} and V_{EE1}. The internal current stabilizer is set by a 3.6 kΩ resistor between STAB and V_{EE1}.

The DC current flowing into the set is determined by the exchange supply voltage V_{exch}, the feeding bridge resistance R_{exch}, the subscriber line DC resistance R_{line} and the DC voltage (including polarity guard) on the subscriber set (see Fig.3).

The internal voltage regulator generates a temperature-compensated reference voltage that is available between LN and SLPE ($V_{ref} = V_{LN-SLPE}$ = 3.23 V typ.). This internal voltage regulator requires decoupling by a capacitor between REG and V_{EE1} (C3).

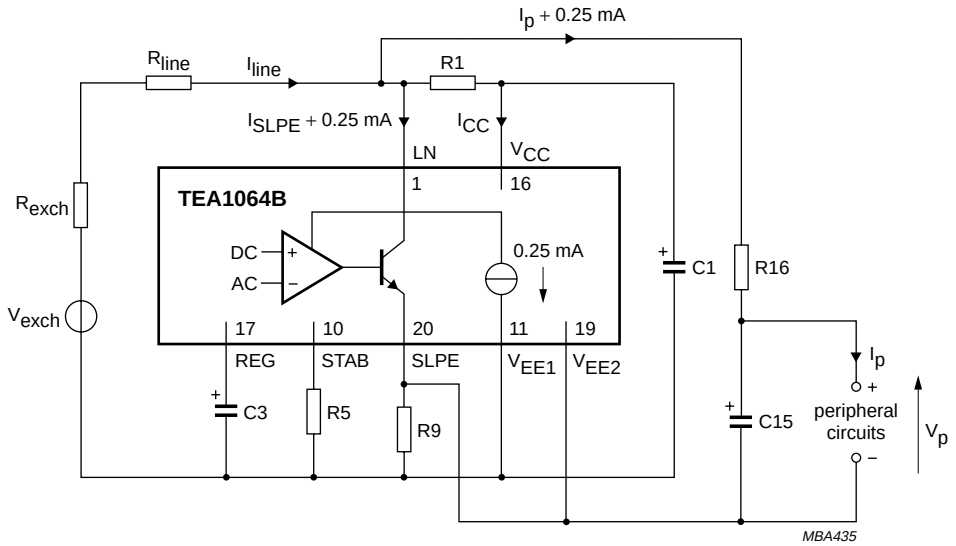
The configuration shown in Fig.3, gives a stabilized voltage across pins LN and SLPE which, applied via the low-pass filter R16, C15, provides a supply to the peripherals that is independant of the line current and depends only on the peripheral supply current.

The value of R16 and the level of the DC voltage $V_{LN-SLPE}$ determine the supply capabilities. In the basic application R16 = 392 Ω and C15 = 220 µF. The worst-case peripheral supply current as a function of supply voltage is shown in Fig.4.

To increase the supply capabilities, the value of R16 can be decreased or the DC voltage $V_{LN-SLPE}$ can be increased by using $R_{VA(REG-SLPE)}$.

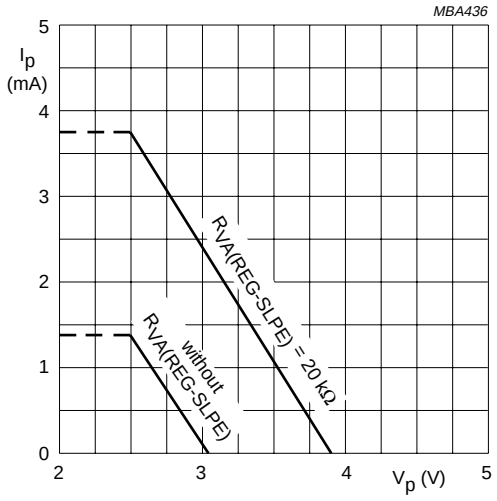
Note

The TEA1064B application is the same as is used for TEA1060/TEA1061, TEA1067 and TEA1068 integrated circuits.



The voltage $V_{LN-SLPE}$ is fixed to V_{ref} = 3.323 ±0.25 V.
Resistor R16 together with the line current determine the supply capabilities and the maximum output swing on the line (no loop damping is necessary).
The line voltage $V_{LN} = V_{ref} + (\{I_{line} - 1.55\ mA\} \times R9)$.

Fig.3 Supply arrangement with reference to SLPE.



I_{line} = 15 mA; R16 = 392 Ω; valid for MUTE = 0 and 1.
Line current has very little influence.

Fig.4 Maximum supply current with respect to Fig.3 for peripherals (I_p) as a function of the peripheral supply voltage (V_p).

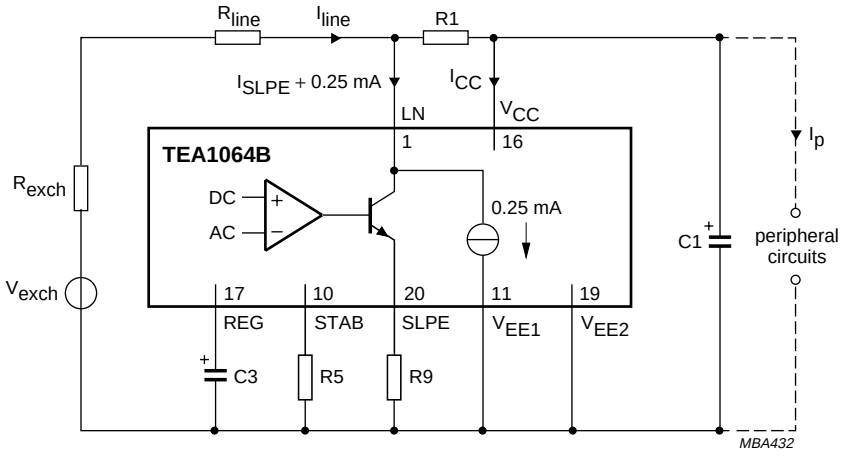
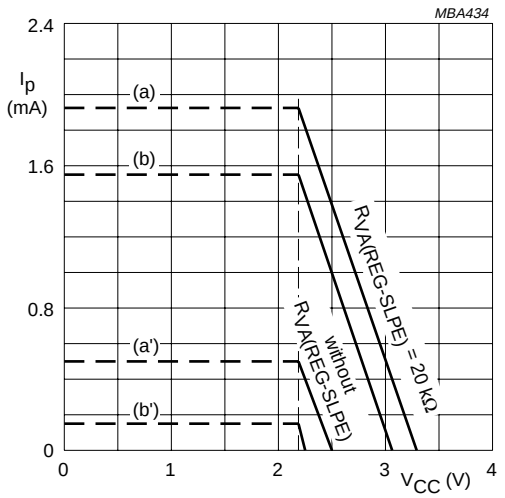


Fig.5 Supply arrangement with reference to V_{EE1}.



(a) I_p = 1.94 mA
(b) I_p = 1.54 mA
(a′) I_p = 0.54 mA
(b′) I_p = 0.16 mA
I_{line} = 15 mA
R1 = 620 Ω and R9 = 20 Ω
Curve (a) and (a′) are valid when the receiving amplifier is not driven or when MUTE = HIGH.
Curve (b) and (b′) are valid when the receiving amplifier is driven and when MUTE = LOW.
$V_{o(RMS)}$ = 150 mV, R_T = 150 Ω.

Fig.6 Maximum current I_p with respect to Fig.5 available from V_{cc} for peripheral circuitry with V_{CC} > 2.2 V.

The maximum AC output swing on the line at low currents is influenced by R16 (limited by current) and the maximum output swing on the line at high currents is influenced by DC voltage $V_{LN-SLPE}$ (limited by voltage). In both these situations, the internal dynamic limiter in the sending channel prevents distortion when the microphone is overdriven. The maximum AC output swing on LN is shown in Fig.7; practical values for R16 are from 200 Ω to 600 Ω and this influences both maximum output swing at low line currents and the supply capabilities.

When the SLPE pin is the reference for peripheral circuits, inputs MUTE, PD and DTMF must be referenced to SLPE. This is achieved by connecting pin V_{EE2} to pin SLPE; V_{EE2} being the reference of MUTE, PD and DTMF input stages.

Active microphones can be supplied between V_{CC} and V_{EE1} as shown in Fig.5. Low power circuits that provide MUTE, PD and DTMF inputs to the TEA1064B can also be powered from V_{CC} (see Fig.6 for the supply capability of V_{CC}). MUTE, PD and DTMF are then referenced to V_{EE1} and the pin V_{EE2} must therefore be connected to V_{EE1}.

If the line current I_{line} exceeds I_{CC} + 0.25 mA, the voltage converter shunts the excess current to SLPE via LN; where $I_{CC} \approx$ 1.3 mA, the value required by the IC for normal operation.

The DC line voltage on LN is:

- $V_{LN} = V_{LN-SLPE} + (I_{SLPE}$ x R9)
- $V_{LN} = V_{ref} + (\{I_{line} - I_{CC} - 0.25 \times 10^{-3}$ A} x R9)

in which:

- V_{ref} = 3.23 V ± 0.25 V is the internal reference voltage between LN and SLPE; its value can be adjusted by external resistor R_{VA}.
- R9 = external resistor between SLPE and V_{EE1} (20 Ω in basic operation).

With R9 = 20 Ω, this results in:

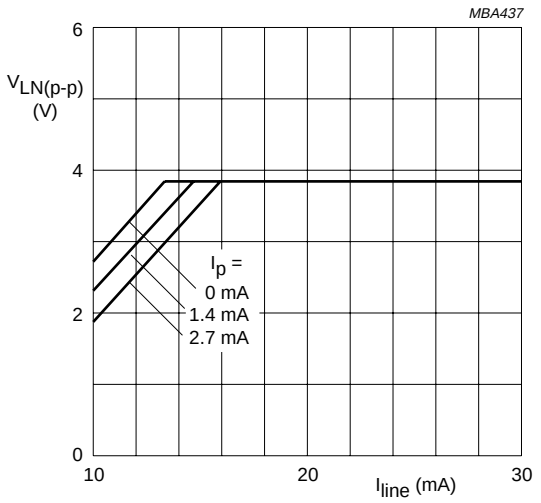
- V_{LN} = 3.3 ± 0.25 V at I_{line} = 15 mA
- V_{LN} = 4.1 ± 0.3 V at I_{line} = 15 mA, $R_{VA(REG-SLPE)}$ = 33 kΩ
- V_{LN} = 4.4 ± 0.35 V at I_{line} = 15mA, $R_{VA(REG-SLPE)}$ = 20 kΩ

The preferred value for R9 is 20 Ω. Changing R9 influences microphone gain, DTMF gain, the gain control characteristics, sidetone and the DC characteristics (especially the low voltage characteristics).

In normal conditions, I_{SLPE} >> (I_{CC} + 0.25 mA) and the static behaviour is equivalent to a voltage regulator diode with an internal resistance of R9. In the audio frequency range the dynamic impedance is determined mainly by R1. The equivalent impedance of the circuit in audio frequency range is shown in Fig.8.

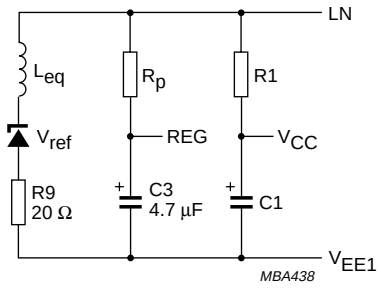
The internal reference voltage $V_{LN-SLPE}$ can be increased by external resistor $R_{VA(REG-SLPE)}$ connected between REG and SLPE. The voltage $V_{LN-SLPE}$ is shown as a function of $R_{VA(REG-SLPE)}$ in Fig.9. Changing the reference voltage influences the output swing of both sending and receiving amplifiers.

At line currents below 8 mA (typ.), the DC voltage dropped across the circuit is adjusted to a lower level automatically (approximately 1.8 V at 2 mA). This gives the possibility of operating more telephone sets in parallel with DC line voltages (excluding polarity guard) down to an absolute minimum of 1.8 V. At line currents below 8 mA (typ.), the circuit has limited sending and receiving levels.



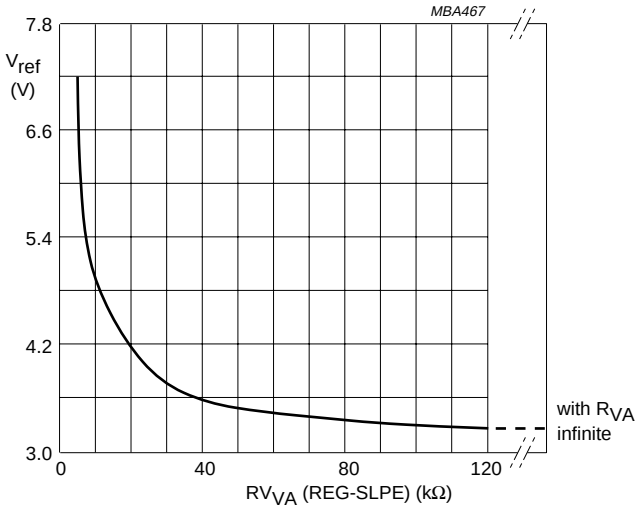
R16 = 392 Ω; I_p with respect to Fig.3.

Fig.7 Typical AC output swing at total harmonic distortion (THD) = 2% on the line as a function of line current with peripheral supply current as a parameter.



$L_{eq} = C3 \times R9 \times R_p$
R_p = 15 kΩ

Fig.8 Equivalent impedance between LN and V_{EE}.



$V_{LN} = V_{LN\text{-}SLPE} + (\{I_{line} - 1.55 \times 10^{-3}\ A\} \times R9)$.

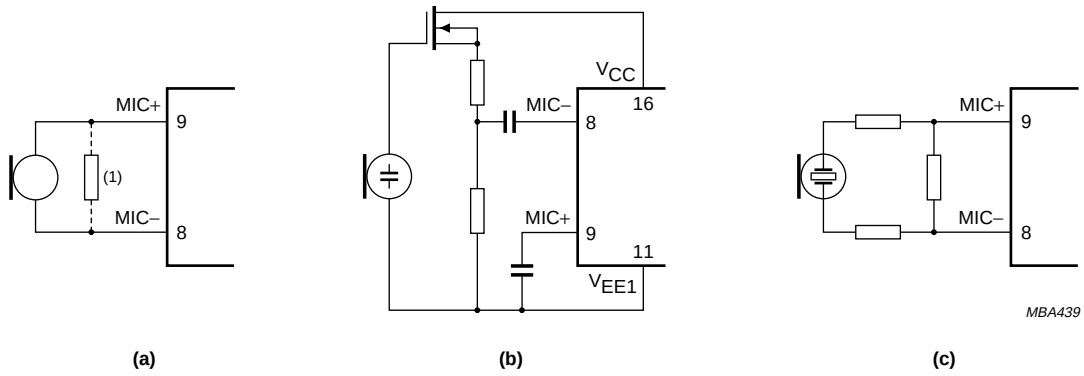
Fig.9 Internal reference voltage $V_{LN\text{-}SLPE}$ as a function of resistor $R_{VA(REG\text{-}SLPE)}$ for line currents between 11 mA and 140 mA.

Microphone inputs MIC+ and MIC− and gain pins GAS1 and GAS2

The TEA1064B has symmetrical microphone inputs, its input impedance is 64 kΩ (2 x 32 kΩ) and its voltage amplification is typically 52 dB with R7 = 68 kΩ. Either dynamic, magnetic or piezo-electric microphones can be used, or an electret microphone with a built-in FET buffer. Arrangements for the microphone types are shown in Fig.10.

The gain of the microphone amplifier is proportional to external resistor R7 connected between GAS1 and GAS2 and with this it can be adjusted between 44 dB and 52 dB to suit the sensitivity of the transducer.

An external 100 pF capacitor (C6) is required between GAS1 and SLPE to ensure stability. A larger value of C6 may be chosen to obtain a first-order low-pass filter with a cut-off frequency corresponding to the time constant R7 x C6.



Resistor (1) may be connected to reduce the terminating impedance, or for sensitive types a resistive attenuator can be used to prevent overloading the microphone inputs.

Fig.10 Microphone arrangements (a) magnetic or dynamic microphone (b) electret microphone (c) piezo-electric microphone currents.

Dynamic limiter (microphone) pin DLS/$\overline{\text{MMUTE}}$

A low level at the DLS/$\overline{\text{MMUTE}}$ pin inhibits the microphone inputs MIC+ and MIC– but has no influence on the receiving and DTMF amplifiers.

Removing the low level at the DLS/$\overline{\text{MMUTE}}$ pin provides the normal function of the microphone amplifier after a short time determined by the capacitor connected to DLS/$\overline{\text{MMUTE}}$ pin. The microphone mute function can be realised by a simple switch as shown in Fig.11.

To prevent distortion of the transmitted signal, the gain of the sending amplifier is reduced rapidly when peaks of the signal on the line exceed an internally-determined threshold. The time in which gain reduction is effected (attack time) is very short. The circuit stays in the gain-reduced condition until the peaks of the sending signal remain below the threshold level. The sending gain then returns to normal after a a time determined by the capacitor connected to DLS/$\overline{\text{MMUTE}}$ (release time).

The internal threshold adapts automatically to the DC voltage setting of the circuit ($V_{LN-SLPE}$). This means that the maximum output swing on the line will be higher if the DC voltage dropped across the circuit is increased. Fig.12 shows the maximum possible output swing on the line as a function of the DC voltage drop ($V_{LN-SLPE}$) with $I_{line} - I_p$ as a parameter.

The internal threshold level is lowered automatically if the DC current in the transmit output stage is insufficient. This prevents distortion of the sending signal in applications using parallel-connected telephones or telephones operating over long lines, for example.

Dynamic limiting also considerably improves sidetone performance in over-drive conditions (less distortion; limited sidetone level).

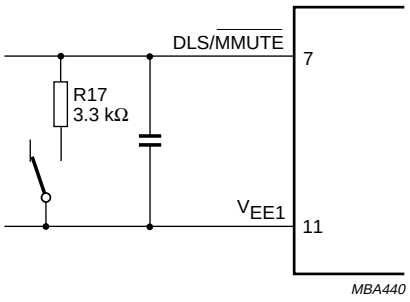
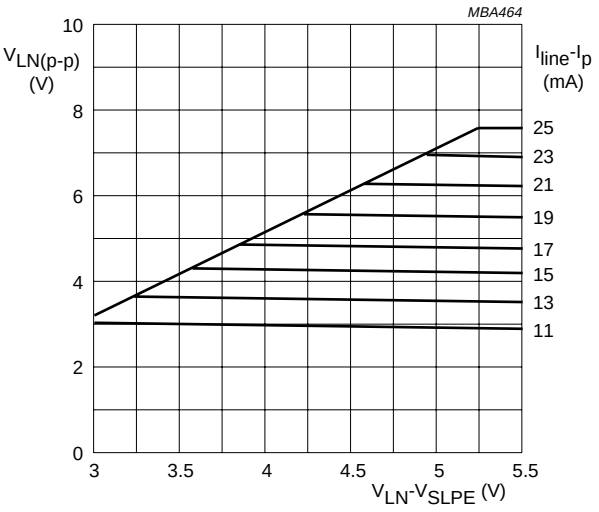


Fig.11 Microphone-mute function.

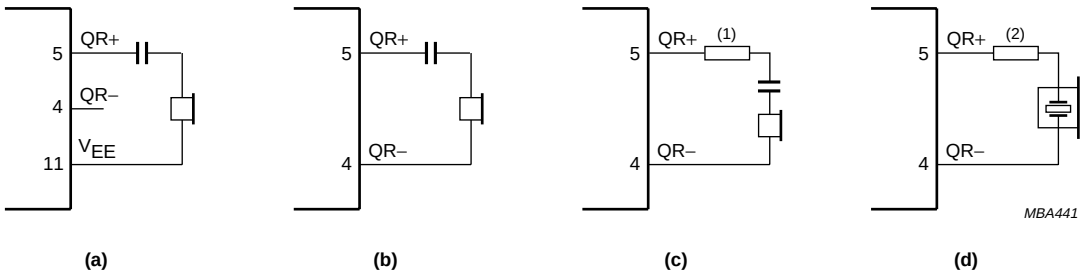


R16 = 392 Ω.

Fig.12 Typical output swing on line as a function of the DC voltage drop $V_{LN-SLPE}$ with $I_{line} - I_p$ as a parameter.

Receiving amplifier IR, QR+, QR− and GAR

The receiving amplifier has one input IR and two complimentary outputs, QR+ (non-inverting) and QR− (inverting). These outputs may be used for single-ended or differential drive, depending on the type and sensitivity of the earpiece used (see Fig.13). Gain from IR to QR+ is typically 31 dB with R4 = 100 kΩ, sufficient for low-impedance magnetic or dynamic earpieces which are suitable for single-ended drive. By using both outputs (differential drive) the gain is increased by 6 dB. Differential drive can be used when the earpiece impedance exceeds 450 Ω as with high-impedance dynamic, magnetic or piezo-electric earpieces.



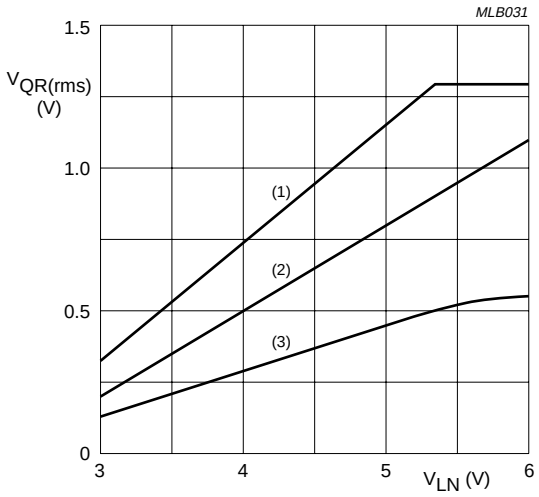
Resistor (1) may be connected to prevent distortion (inductive load).
Resistor (2) is required to increase the phase margin (stability with capacitive load).

Fig.13 Alternative receiver arrangements (a) dynamic earpiece with an impedance less than 450 Ω
(b) dynamic earpiece with an impedance more than 450 Ω
(c) magnetic earpiece with an impedance more than 450 Ω
(d) piezo-electric earpiece.

The output voltage of the receiving amplifier is specified for continuous-wave drive. Fig.14 shows the maximum output swing of the receiving amplifier as a function of the DC voltage drop (V_{LN}). The maximum output voltage will be higher under speech conditions, where the ratio of the peak to the RMS value is higher.

The gain of the receiving amplifier can be adjusted to suit the sensitivity of the transducer used. The adjustment range is between 20 dB and 39 dB with single-ended drive and between 26 dB and 45 dB with differential drive. The gain is proportional to the external resistor R4 connected between GAR and QR+. The overall gain between LN and QR+ can be found by subtracting the attenuation of the anti-sidetone network (32 dB) from the amplifier gain.

Two external capacitors (C4 = 100 pF and C7 = 10 x C4 = 1 nF) ensure stability. A larger value may be chosen to obtain a first-order low-pass filter. The cut-off frequency corresponds with time constant R4 x C4. The relationship C7 = 10 x C4 must be maintained.



Valid for both options; THD = 2%, I_{line} = 15 mA.
Curve (1) is for a differential load of 47 nf (series resistance = 100 Ω; f = 3400 Hz.
Curve (2) is for a differential load of 450 Ω; f = 1 kHz.
Curve (3) is for a single-ended load of 150 Ω; f = 1 kHz.

Fig.14 Typical output swing of the receiving amplifier as a function of DC voltage drop V_{LN} with the load at the receiver output as parameter.

Automatic gain control input AGC

Automatic compensation of line loss is obtained by connecting a resistor (R6) between AGC and V_{EE1}.

This automatic gain control varies the gain of the microphone amplifier and receiving amplifier in accordance with the DC line current. The control range is 6.1 dB; this corresponds to a 5 km line of 0.5 dB diameter copper twisted-pair cable (DC resistance = 176 Ω/km, average attenuation = 1.2 dB/km). The DTMF gain is not affected by this feature.

The value of R6 must be chosen with reference to the exchange supply voltage and its feeding bridge resistance (see Fig.15 and Table 1). Different values of R6 give the same line current ratios at the start and the end of the control range. If automatic line-loss compensation is not required the AGC pin can be left open-circuit, the amplifiers then provide their maximum gain.

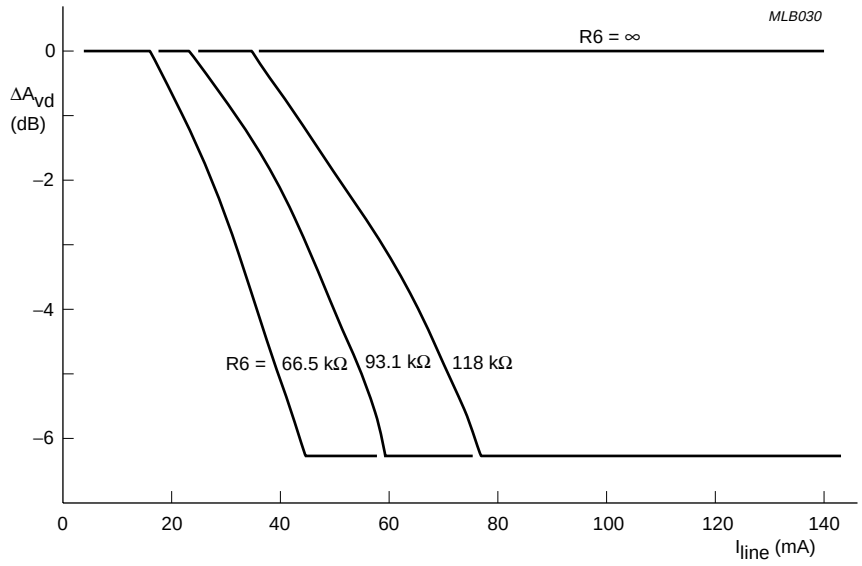


Fig.15 Variation of gain as a function of line current with R6 as a parameter; R9 = 20 Ω.

Table 1 Values of R6 giving optimum line-loss compensation at various values of exchange supply voltage (V_{exch}) and exchange feeding bridge resistance (R_{exch}); R9 = 20 Ω

		R_{exch} (Ω)			
		400	600	800	1000
		R6 (kΩ)			
V_{exch} (V)	35	84.5	66.5	x	x
	48	118	93.1	77.8	66.5
	60	x	x	97.6	84.5

V_{EE2} input

V_{EE2} is the reference for MUTE, POWER-DOWN and DTMF inputs. These signals are referenced to V_{EE1} when generated by peripherals powered between V_{CC} and V_{EE1}, but they can also be referenced to SLPE when peripherals are powered as shown in Fig.3. In the first instance (reference to V_{EE1}), V_{EE2} has to be connected to V_{EE1}. In the second instance (reference to SLPE), V_{EE2} has to be connected to SLPE.

MUTE input (see notes 1 and 2)

MUTE = HIGH enables the DTMF input and inhibits the microphone and receiving amplifier inputs.

MUTE = LOW or open-circuit disables the DTMF input and enables the microphone and receiving amplifier inputs.

Switching MUTE gives negligible clicks at the telephone outputs and on the line.

Dual-tone multi-frequency input DTMF (see note 1)

When the DTMF input is enabled, dialling tones may be sent on the line. The voltage gain between DTMF-V_{EE2} and LN-V_{EE1} is typically 26.5 dB less than the gain of the microphone amplifier and varies with R7 in the same way as the gain of the microphone amplifier. This means that the tone level at the DTMF input has to be adjusted after setting the gain of the microphone amplifier.

With R7 = 68 kΩ the gain is typically 25.5 dB.

The signalling tones can be heard in the earpiece at a low level (confidence tone).

Power-down input PD (see notes 1. and 2.)

During pulse dialling or register recall (timed loop break) the telephone line is interrupted; as a consequence it provides no supply for the transmission circuit connected to V_{CC} or for the peripherals between V_{LN} and SLPE.

These supply gaps are bridged by the charges in the capacitors C1 and C15. The requirements on these capacitors are eased by an applied HIGH level to the PD input during the time of the loop break. This reduces the internal supply current I_{CC1} from 1.3 mA (typ.) to 60 µA (typ.) and switches off the voltage regulator to prevent discharge via LN to V_{CC2}.

A HIGH level at PD also internally disconnects the capacitor at REG so that the voltage stabilizer has no switch-on delay after line interruptions. This minimizes the contribution of the IC to the current waveform during pulse dialling or register recall.

When the power-down facility is not required, the PD pin can be left open-circuit or connected to V_{EE2}.

Sidetone suppression

Suppression of the transmitted signal in the earpiece is obtained by the anti-sidetone network comprising R1//Z_{line}, R2, R3, R8, R9 and Z_{bal} (see Fig.16). Maximum compensation is obtained when the following conditions are fulfilled:

(a) $R9 \times R2 = R1 \times (R3 + \{R8//Z_{bal}\})$

(b) $(Z_{bal}/\{Z_{bal} + R8\}) = (Z_{line}/\{Z_{line} + R1\})$

If fixed values are chosen for R1, R2, R3 and R9, then condition (a) is always fulfilled provided $|R8//Z_{bal}| << R3$

To obtain optimum sidetone suppression, condition (b) has to be fulfilled, resulting in:

$$Z_{bal} = (R8/R1) \times Z_{line} = k \times Z_{line}$$

Where k is a scale factor; k = (R8/R1).

The scale factor k (value of R8) is chosen to meet the following criteria:

- compatibility with a standard capacitor from the E6 or E12 range for Z_{bal}
- $|Z_{bal}//R8| << R3$ to fulfil condition (a) and thus ensure correct anti-sidetone bridge operation
- $|Z_{bal} + R8| >> R9$ to avoid influencing the transmit gain

In practise Z_{line} varies considerably with the line length and line type. Therefore the value chosen for Z_{bal} should be for an average line length giving 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.

EXAMPLE

The line impedance for which optimum suppression is to be obtained can be represented by 210 Ω + (1265 Ω //140 nF). This represents a 5 km line of 0.5 mm diameter copper twisted-pair cable matched with 600 Ω (176 Ω/km; 38 nF/km).

With k = 0.64 this results in : R8 = 390 Ω; Z_{bal} = 130 Ω + (820 Ω//220 nF).

The anti-sidetone network for the TEA1060 family shown in Fig.16 attenuates the signal received from the line by 32 dB before it enters the receiving amplifier. The attenuation is almost constant over the whole audio-frequency range.

Alternatively a conventional Wheatstone bridge can be used as an anti-sidetone circuit (see Fig.17). Both bridge types can be used with either resistive or complex set impedances. (More information on the balancing of anti-sidetone bridges can be obtained in our publication *"Versatile speech transmission ICs for electronic telephone sets"*, order number 9398 341 10011).

Notes

1. The reference level used for the MUTE, DTMF and PD inputs is V_{EE2}.
2. A LOW level for any of these pins is defined by connection to V_{EE2}, a HIGH level is defined as a voltage greater than V_{EE2} + 1.5 V and smaller than V_{CC} + 0.4 V.

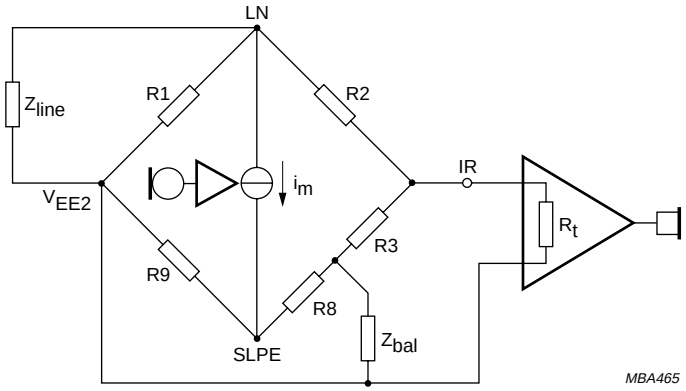


Fig.16 Equivalent circuit of TEA1060 family anti-sidetone bridge.

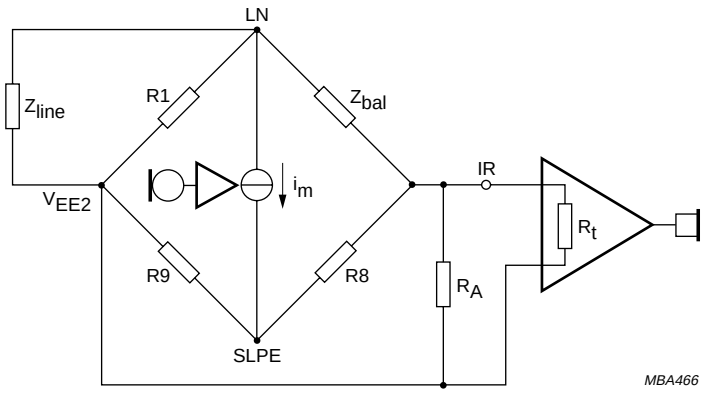


Fig.17 Equivalent circuit of an anti-sidetone network in the Wheatstone bridge configuration.

LIMITING VALUES

In accordance with the Absolute Maximum System (IEC134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{LN}	positive line voltage continuous		–	12	V
V_{LN}	repetitive line voltage during switch-on line interruption		–	13.2	V
V_{LN}	repetitive peak line voltage one 1 ms pulse per 5 s	R9 = 20 Ω; R10 = 13 Ω; see Fig.22	–	28	V
I_{LN}	line current	R9 = 20 Ω			
	TEA1064B	note 1	–	140	mA
	TEA1064BT	note 1	–	140	mA
V_i	input voltage on pins other than LN		V_{EE1}–0.7	V_{CC}+0.7	V
P_{tot}	total power dissipation	R9 = 20 Ω; note 2			
	TEA1064B		–	717	mW
	TEA1064BT		–	555	mW
T_{amb}	operating ambient temperature		–25	+75	°C
T_{stg}	storage temperature		–40	+125	°C
T_j	junction temperature		–	+125	°C

Notes

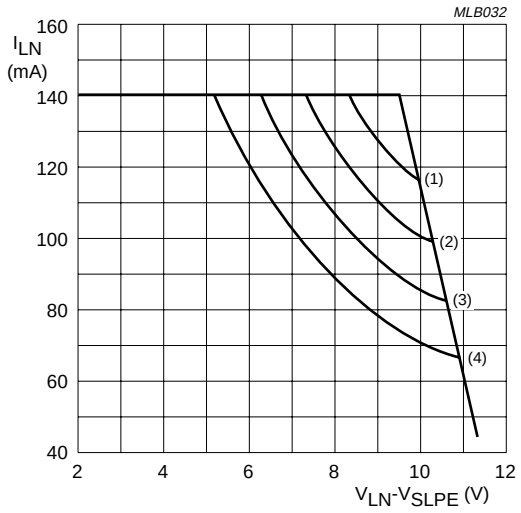
1. Mostly dependent on the maximum required T_{amb} and on the voltage between LN and SLPE. See Figs 18 and 19 to determine the current as a function of the required voltage and the temperature.
2. Calculated for the maximum ambient temperature specified T_{amb} = 75 °C and a maximum junction temperature of 125 °C.

THERMAL RESISTANCE

SYMBOL	PARAMETER	THERMAL RESISTANCE
$R_{th\ j\text{-}a}$	from junction to ambient in free air	
	SOT146	70 K/W
	SOT163A (note 1)	90 K/W

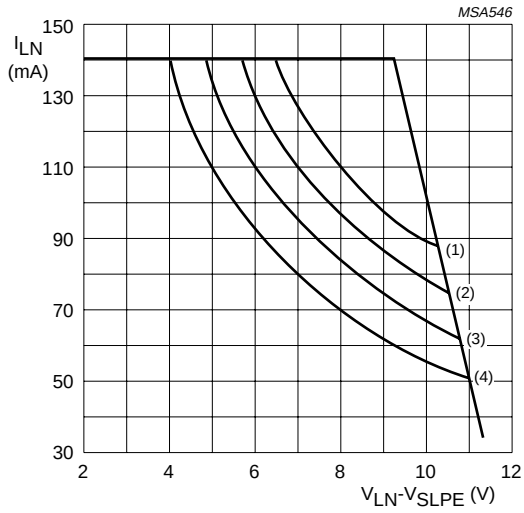
Note

1. Mounted on glass epoxy board 41 × 19 × 1.5 mm.



(1) T_{amb} = 45 °C; P_{tot} = 1143 mW.
(2) T_{amb} = 55 °C; P_{tot} = 1000 mW.
(3) T_{amb} = 65 °C; P_{tot} = 857 mW.
(4) T_{amb} = 75 °C; P_{tot} = 714 mW.

Fig.18 TEA1064B safe operating area.



(1) T_{amb} = 45 °C; P_{tot} = 888 mW.
(2) T_{amb} = 55 °C; P_{tot} = 777 mW.
(3) T_{amb} = 65 °C; P_{tot} = 666 mW.
(4) T_{amb} = 75 °C; P_{tot} = 555 mW.

Fig.19 TEA1064BT safe operating area.

CHARACTERISTICS

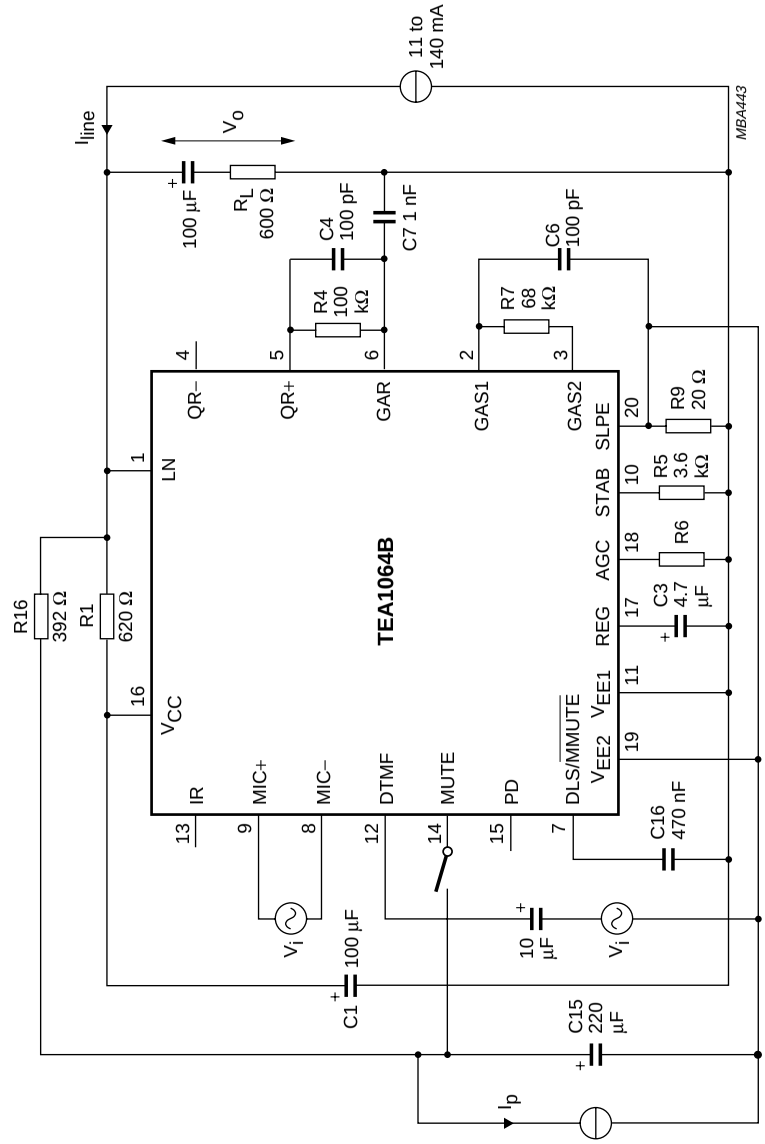
I_{line} = 11 to 140 mA; V_{EE1} = 0 V; f = 800 Hz; T_{amb} = 25 °C; R_L = 600 Ω; tested in the circuits of Fig.20 or Fig.21; V_{EE2} connected to SLPE; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supplies LN and V_{CC} (pins 1 and 16)						
V_{LN}	DC line voltage: voltage drop between LN and V_{EE1}	MIC–, MIC+ inputs open-circuit; without R_{VA}				
		I_{line} = 2 mA	–	1.8	–	V
		I_{line} = 4 mA	–	2.2	–	V
		I_{line} = 7 mA	–	3.2	–	V
		I_{line} = 11 mA	–	3.4	–	V
		I_{line} = 15 mA	3.25	3.5	3.75	V
		I_{line} = 100 mA	–	5.25	6.05	V
		I_{line} = 140 mA	–	6.1	7.0	V
$\Delta V_{LN}/\Delta T$	variation with temperature	I_{line} = 15 mA	–3	–1	+1	mV/K
V_{LN}	voltage drop over circuit with R_{VA} connected between REG and SLPE					
		R_{VA} = 33 kΩ	3.8	4.1	4.4	V
		R_{VA} = 20 kΩ	4.05	4.4	4.75	V
I_{CC}	internal supply current into pin 16	V_{CC} = 2.8 V				
		PD = LOW	–	1.3	1.6	mA
		PD = HIGH	–	60	82	µA
V_{CC}	supply voltage available for peripheral circuitry V_{EE2} connected to V_{EE1}	I_{line} = 15 mA; MUTE = HIGH; see Fig.5				
		I_p = 0.54 mA	2.2	2.4	–	V
		I_p = 0 mA	2.5	2.7	–	V
V_p	supply voltage available for peripheral circuitry	I_{line} = 15 mA				
		I_p = 1.4 mA	2.5	2.7	–	V
		I_p = 2.7 mA; $R_{REG-SLPE}$ = 20 kΩ	2.9	3.1	–	V
Microphone inputs MIC– and MIC+ (pins 8 and 9)						
Z_i	input impedance					
	differential		51	64	77	kΩ
	single-ended		25.5	32.0	38.5	kΩ
CMRR	common mode rejection ratio		–	82	–	dB
G_v	voltage gain (see Fig.20)	I_{line} = 15 mA; R7 = 68 kΩ	51	52	53	dB
$\Delta G_v f$	variation of G_v with frequency referred to 0.8 kHz	f = 300 and 3400 Hz	–0.5	±0.1	+0.5	dB

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
ΔG_vT	variation of G_v with temperature referred to 25 °C	without R6; I_{line} = 50 mA; T_{amb} = −25 to +75 °C	–	±0.2	–	dB
DTMF input (pin 12)						
Z_i	input impedance		16.8	20.7	24.6	kΩ
G_v	voltage gain (see Fig.20)	I_{line} = 15 mA; R7 = 68 kΩ	24.5	25.5	26.5	dB
ΔG_vf	variation of G_v with frequency referred to 0.8 kHz					
		f = 300 and 3400 Hz	−0.5	±0.01	+0.5	dB
		f = 697 and 1633 Hz	−0.2	±0.05	+0.2	dB
ΔG_vT	variation of G_v with temperature referred to 25 °C	I_{line} = 50 mA; T_{amb} = −25 to +75 °C	–	±0.2	0.5	dB
Gain adjustment inputs GAS1 and GAS2 (pins 2 and 3)						
ΔG_v	transmitting amplifier gain adjustment range		−8	–	+0	dB
Sending amplifier output LN (pin 1)						
DYNAMIC LIMITER						
$V_{LN(p-p)}$	output voltage swing (peak-to-peak value)	I_{line} = 15 mA; R7 = 68 kΩ; $V_{i(RMS)}$ = 3.6 mV	3.4	3.8	4.2	V
THD	total harmonic distortion					
		V_i = 3.6 mV +10 dB	–	1.5	–	%
		V_i = 3.6 mV +15 dB	–	2.8	–	%
$V_{LN(p-p)}$	output voltage swing (peak-to-peak value)	V_i = 3.6 mV +10 dB				
		I_p = 1.4 mA	3.55	3.8	4.05	V
		I_p = 2.7 mA	3.25	3.5	3.75	V
		I_p = 0 mA; I_{line} = 7 mA	–	1.8	–	V
		I_p = 0 mA; I_{line} = 4 mA	–	0.9	–	V
	dynamic behaviour of limiter	C16 = 470 nF				
t_{att}	attack time V_{mic} jumps from 2 mV to 40 mV		–	1.5	5.0	ms
t_{rel}	release time V_{mic} jumps from 40 mV to 2 mV		50	150	–	ms
$V_{no(RMS)}$	noise output voltage (RMS value)	I_{line} = 15 mA; R7 = 68 kΩ; 200 Ω between MIC− and MIC+; psophometrically weighted (P53 curve)	–	−72	–	dBmp

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Receiving amplifier input IR (pin 13)						
Z_i	input impedance		17	21	25	kΩ
Receiving amplifier outputs QR− and QR+ (pins 4 and 5)						
Z_o	output impedance	single-ended	–	4	–	Ω
G_v	voltage gain (see Fig.21)	I_{line} = 15 mA; R4 = 100 kΩ				
	single-ended	R_T = 300 Ω	30	31	32	dB
	differential	R_T = 600 Ω	36	37	38	dB
$\Delta G_v f$	variation of G_v with frequency referred to 0.8 kHz	f = 300 and 3400 Hz	–0.5	–0.2	0	dB
$\Delta G_v T$	variation of G_v with temperature referred to 25 °C	without R6; I_{line} = 50 mA; T_{amb} = −25 to +75 °C	–	±0.2	–	dB
$V_{o(RMS)}$	output voltage (RMS value)	TDA = 2%; sinewave drive; R4 = 100 kΩ; I_{line} = 15 mA				
	single-ended	R_T = 150 Ω	–	0.2	–	V
	differential	R_T = 450 Ω	–	0.37	–	V
	differential	C_T = 47 nF; R_s = 100 Ω; f = 3400 Hz	–	0.52	–	V
$V_{o(RMS)}$	output voltage (RMS value)	I_p = 0 mA; TDA = 10%; sinewave drive; R4 = 100 kΩ; R_T = 150 Ω				
		I_{line} = 4 mA	–	20	–	mV
		I_{line} = 7 mA	–	160	–	mV
$V_{no(RMS)}$	noise output voltage (RMS value)	I_{line} = 15 mA; R4 = 100 kΩ; psophometrically weighted (P53 curve); pin IR open-circuit				
	single-ended	R_T = 300 Ω	–	45	–	µV
	differential	R_T = 600 Ω	–	90	–	µV
$V_{no(RMS)}$	noise output voltage (RMS value)	see Fig.21; S1 in position 2; 200 Ω between MIC− and MIC+; single-ended; R_T = 300 Ω				
		R7 = 68 kΩ	–	100	–	µV
		R7 = 24.9 kΩ	–	65	–	µV

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Gain adjustment input GAR (pin 6)						
ΔG_v	receiving amplifier gain adjustment range		–11	–	+8	dB
MUTE input (pin 14)						
V_{IH}	HIGH level input voltage		1.5 + V_{EE2}	–	V_{CC} +0.4	V
V_{IL}	LOW level input voltage		0	–	0.3 + V_{EE2}	V
I_{mute}	input current		–	11	20	μA
ΔG_v	change of microphone amplifier gain at mute on	MUTE = HIGH	–	–100	–	dB
G_v	voltage gain from input DTMF-SLPE to QR+ output with mute on	MUTE = HIGH; single-ended load; R_L = 300 Ω	–	–18	–	dB
Power-down input PD (pin 15)						
V_{IH}	HIGH level input voltage		1.5 + V_{EE2}	–	V_{CC1} +0.4	V
V_{IL}	LOW level input voltage		0	–	0.3 + V_{EE2}	V
I_{PD}	input current		–	5	10	μA
Automatic gain control input AGC (pin 18)						
	controlling the gain from IR (pin 13) to QR+, QR– (pins 4, 5) and the gain from MIC+, MIC– (pins 8, 9) to LN (pin 1)	R6 = 93.1 kΩ (between pins 18 and 11)				
G_v	gain control range with respect to I_{line} = 15 mA	I_{line} = 75 mA	–5.7	–6.1	–6.5	dB
I_{line}	highest line current for maximum gain		–	24	–	mA
I_{line}	lowest line current for minimum gain		–	61	–	mA
ΔG_v	change of gain between I_{line} = 15 and 35 mA		–0.9	–1.4	–1.9	dB
Microphone mute input DLS/$\overline{\text{MMUTE}}$ (pin 7)						
V_{IL}	LOW level input voltage		V_{EE1}	–	V_{EE1} +0.3	V
I_{IL}	input current at LOW level input voltage		–85	–60	–35	μA
t_{rel}	release time after a LOW level on pin 7	C16 = 470 nF	–	30	–	ms
ΔG_v	change of microphone amplifier gain at LOW level input voltage on pin 7		–	–100	–	dB



For measuring gain from MIC+ and MIC− the MUTE input should be LOW or open-circuit.
For measuring the DTMF input, the MUTE input should be HIGH.
Inputs not being tested should be open-circuit.

Fig.20 Test circuit for defining voltage gain of MIC−, MIC+ and DTMF inputs; voltage gain (G_v) is defined as 20log $|V_o/V_i|$.

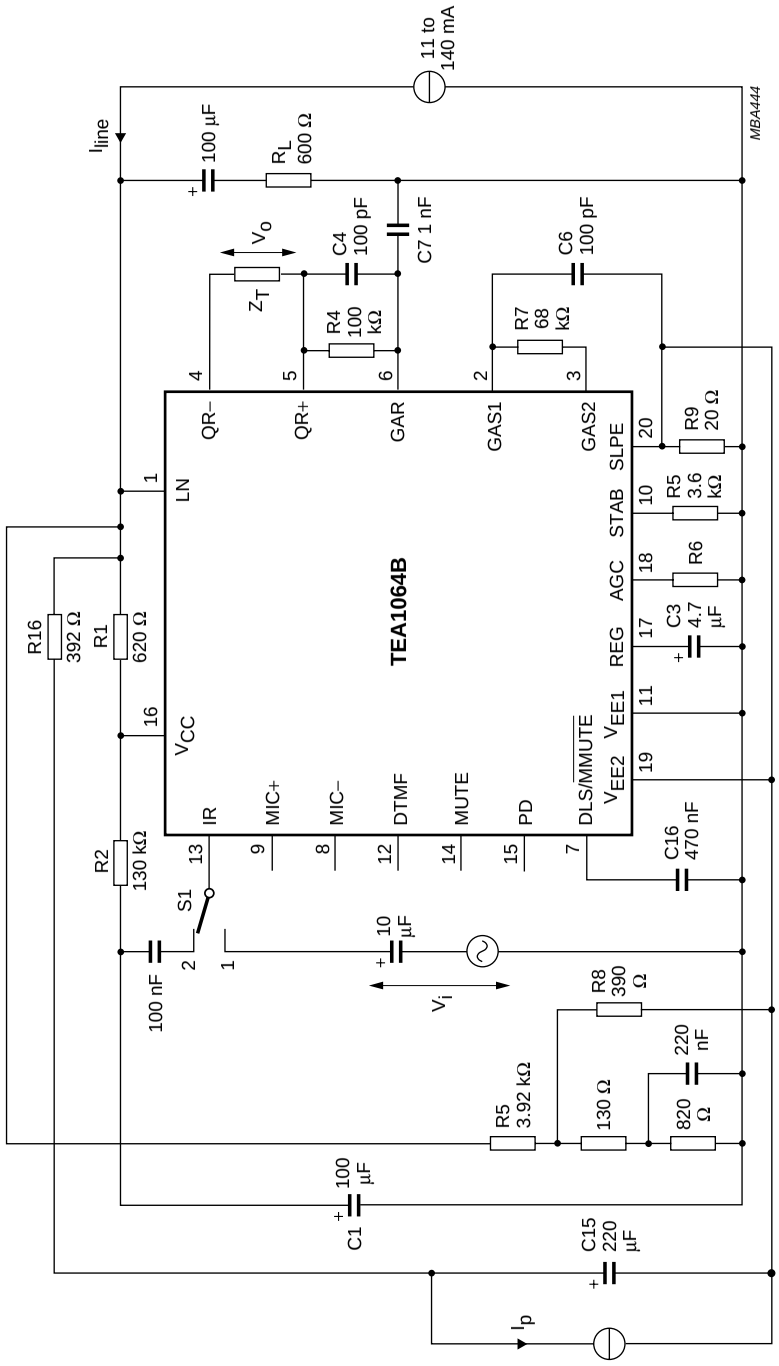
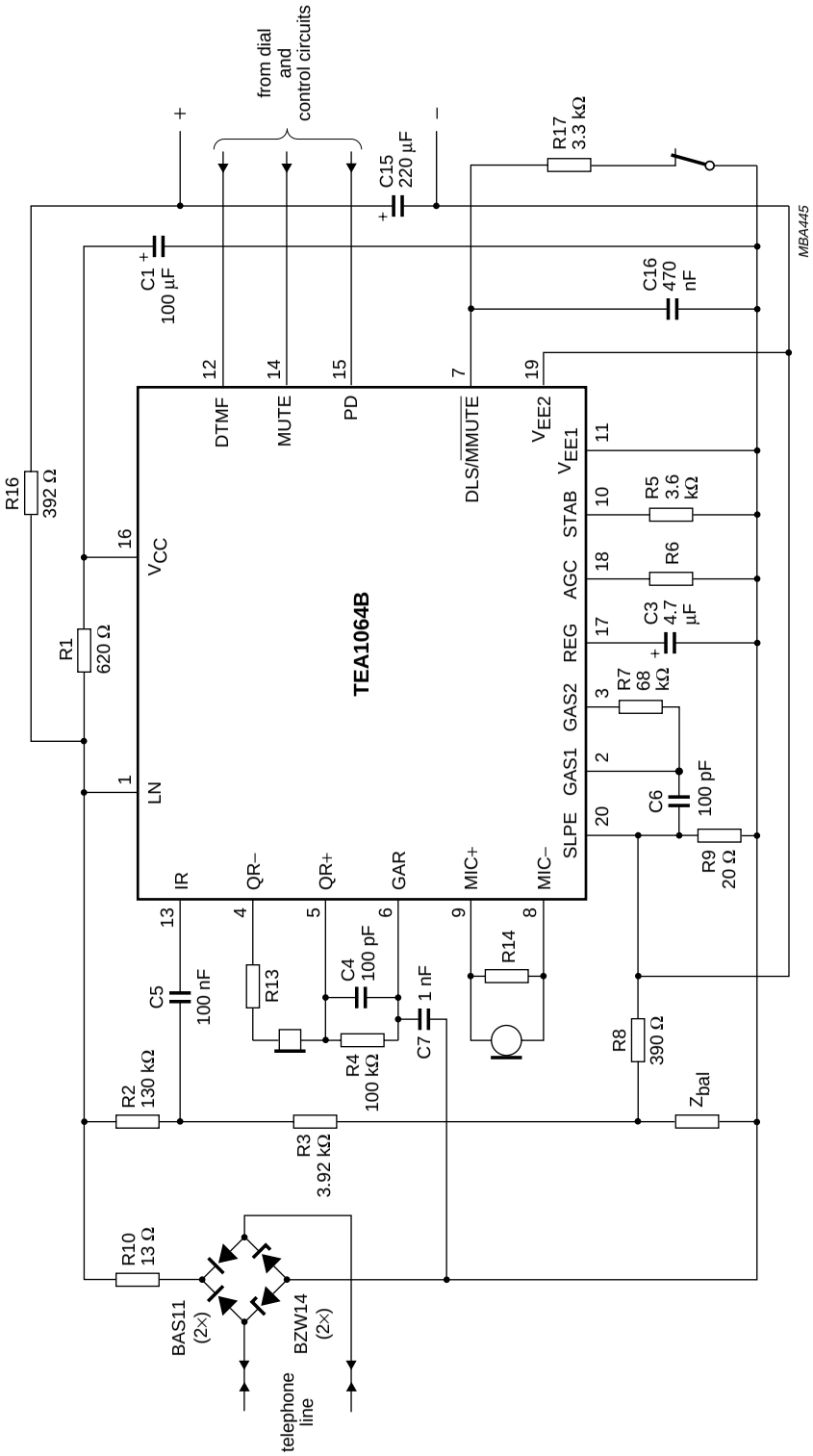


Fig.21 Test circuit for defining voltage gain of the receiving amplifier; voltage gain (G_v) is defined as 20log $|V_o/V_i|$ (with S1 in position 1).

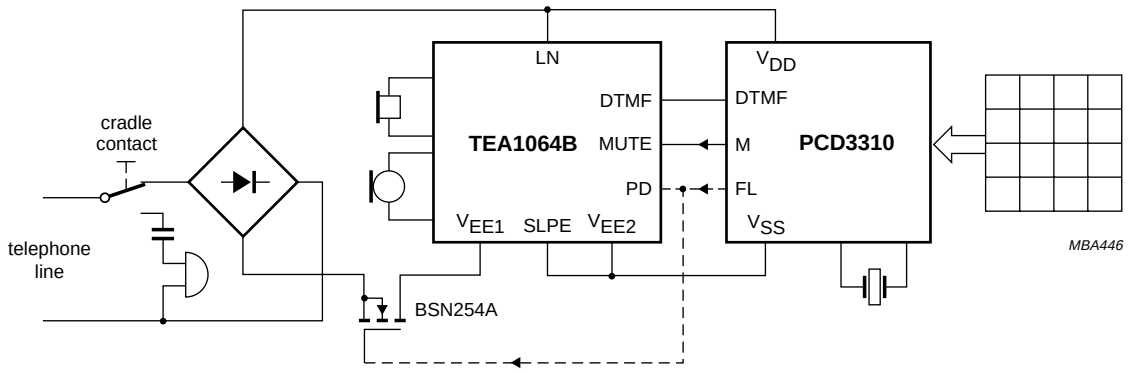
APPLICATION INFORMATION

The basic application circuit is shown in Fig.22 and a typical application is shown in Fig.23.



The diode bridge and R10 limit the current into, and the voltage across, the circuit during line transients.
A different protection arrangement is required for pulse dialling or register recall.

Fig.22 Basic application of TEA1064B with SLPE as supply reference for peripherals, shown here with piezo-electric earpiece and DTMF dialling.

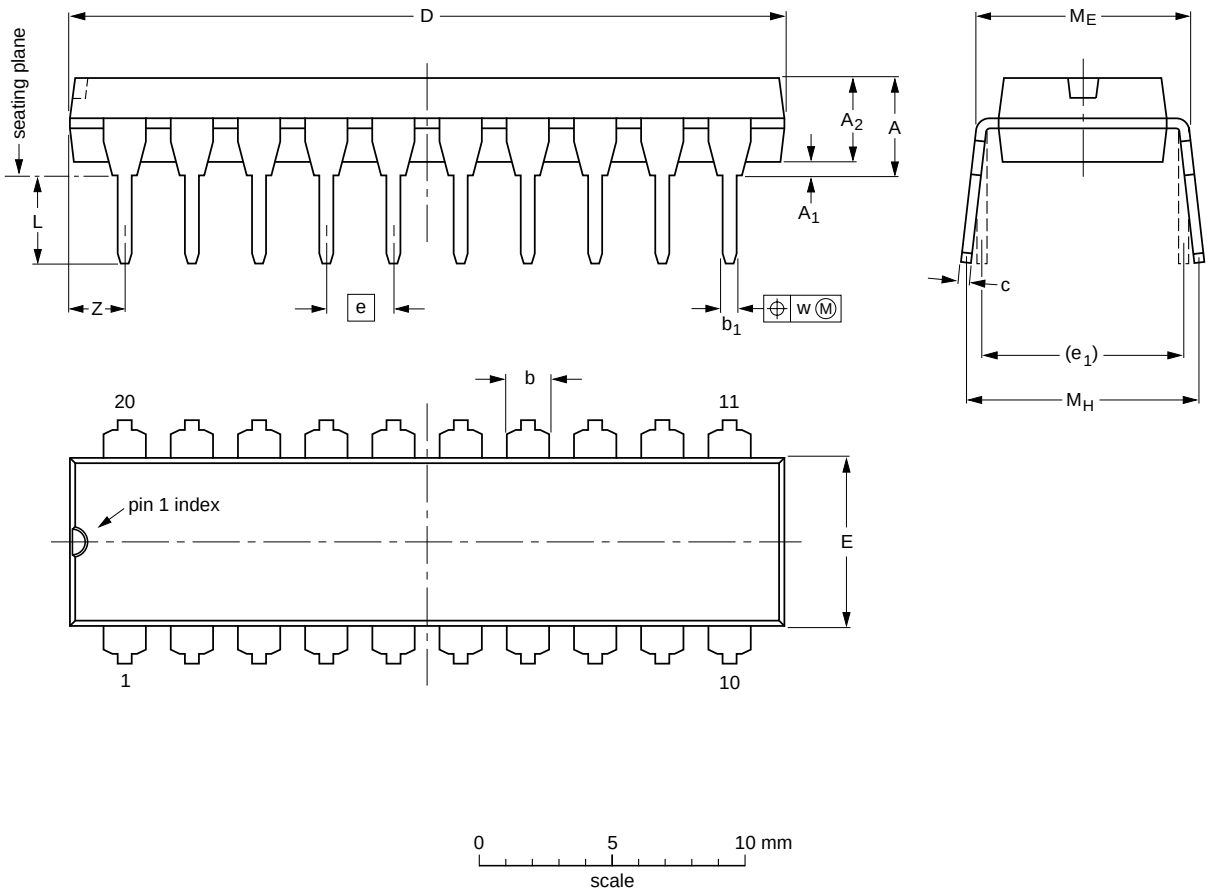


The broken line indicates optional flash (register recall by timed loop break).

Fig.23 Typical DTMF-pulse set application circuit (simplified) showing the TEA1064B with the CMOS bilingual dialling circuit PCD3310.

PACKAGE OUTLINES

DIP20: plastic dual in-line package; 20 leads (300 mil) **SOT146-1**



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

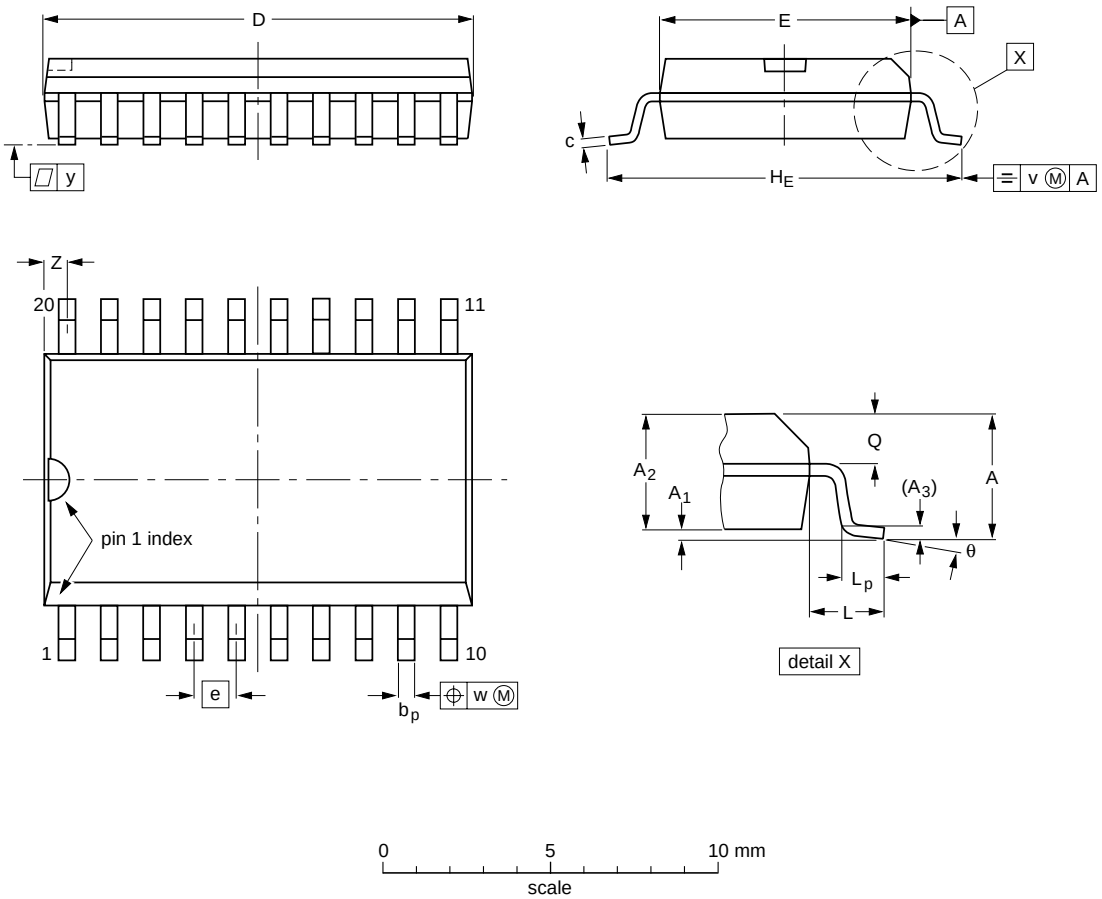
UNIT	A max.	A_1 min.	A_2 max.	b	b_1	c	D (1)	E (1)	e	e_1	L	M_E	M_H	w	Z (1) max.
mm	4.2	0.51	3.2	1.73 1.30	0.53 0.38	0.36 0.23	26.92 26.54	6.40 6.22	2.54	7.62	3.60 3.05	8.25 7.80	10.0 8.3	0.254	2.0
inches	0.17	0.020	0.13	0.068 0.051	0.021 0.015	0.014 0.009	1.060 1.045	0.25 0.24	0.10	0.30	0.14 0.12	0.32 0.31	0.39 0.33	0.01	0.078

Note

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT146-1			SC603			~~92-11-17~~ 95-05-24

SO20: plastic small outline package; 20 leads; body width 7.5 mm **SOT163-1**



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	0.30 0.10	2.45 2.25	0.25	0.49 0.36	0.32 0.23	13.0 12.6	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^o 0^o
inches	0.10	0.012 0.004	0.096 0.089	0.01	0.019 0.014	0.013 0.009	0.51 0.49	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			
SOT163-1	075E04	MS-013AC				~~95-01-24~~ 97-05-22

SOLDERING

Introduction

There is no soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and surface mounted components are mixed on one printed-circuit board. However, wave soldering is not always suitable for surface mounted ICs, or for printed-circuits with high population densities. In these situations reflow soldering is often used.

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"* (order code 9398 652 90011).

DIP

Soldering by dipping or by wave

The maximum permissible temperature of the solder is 260 °C; solder at this temperature must not be in contact with the joint for more than 5 seconds. The total contact time of successive solder waves must not exceed 5 seconds.

The device may be mounted up to the seating plane, but the temperature of the plastic body must not exceed the specified maximum storage temperature ($T_{stg\ max}$). If the printed-circuit board has been pre-heated, forced cooling may be necessary immediately after soldering to keep the temperature within the permissible limit.

Repairing soldered joints

Apply a low voltage soldering iron (less than 24 V) to the lead(s) of the package, below the seating plane or not more than 2 mm above it. If the temperature of the soldering iron bit is less than 300 °C it may remain in contact for up to 10 seconds. If the bit temperature is between 300 and 400 °C, contact may be up to 5 seconds.

SO

Reflow soldering

Reflow soldering techniques are suitable for all SO packages.

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 techniques exist for reflowing; for example, thermal conduction by heated belt. Dwell times vary between 50 and 300 seconds depending on heating method. Typical reflow temperatures range from 215 to 250 °C.

Preheating is necessary to dry the paste and evaporate the binding agent. Preheating duration: 45 minutes at 45 °C.

Wave soldering

Wave soldering techniques can be used for all SO packages if the following conditions are observed:

- A double-wave (a turbulent wave with high upward pressure followed by a smooth laminar wave) soldering technique should be used.
- The longitudinal axis of the package footprint must be parallel to the solder flow.
- The package footprint must incorporate solder thieves at the downstream end.

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.

Maximum permissible solder temperature is 260 °C, and maximum duration of package immersion in solder is 10 seconds, if cooled to less than 150 °C within 6 seconds. 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.

Repairing soldered joints

Fix the component by first soldering two diagonally-opposite end leads. Use only a low voltage soldering iron (less than 24 V) 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.

DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). 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.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

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