Austria Mikro Systeme International AG

Cordless telephone, answering machine line interface

Key Features

- Analogue line interface and speech circuit for a/b terminals on a 28-pin CMOS-IC
- 2 balanced transmit inputs
- 3 unbalanced transmit inputs
- 2 buffered single ended receive outputs (R_L>150Ω)
- 1 auxiliary single ended receive output (R_L>10kΩ)
- Low noise (max. -72dBmp)
- Soft clipping to avoid harsh distortion
- Operating range from 15mA to 100mA (down to 5mA with reduced performance)
- Line loss compensation selectable by pin option
- Real and complex impedance selectable by external components
- Side tone adaptation selectable by external components
- Digital controls input for mode selection
- Rx volume control

General Description

AS2504 is a CMOS integrated circuit that incorporates DC and AC line adaptation (DC-mask and synthesised AC-impedance of 1000Ω) as well as a speech circuit with softclipping, line loss compensation and Rx-volume control. It shall act as an a/b-line powered or auxiliarily powered device, which is controlled by a CPU.

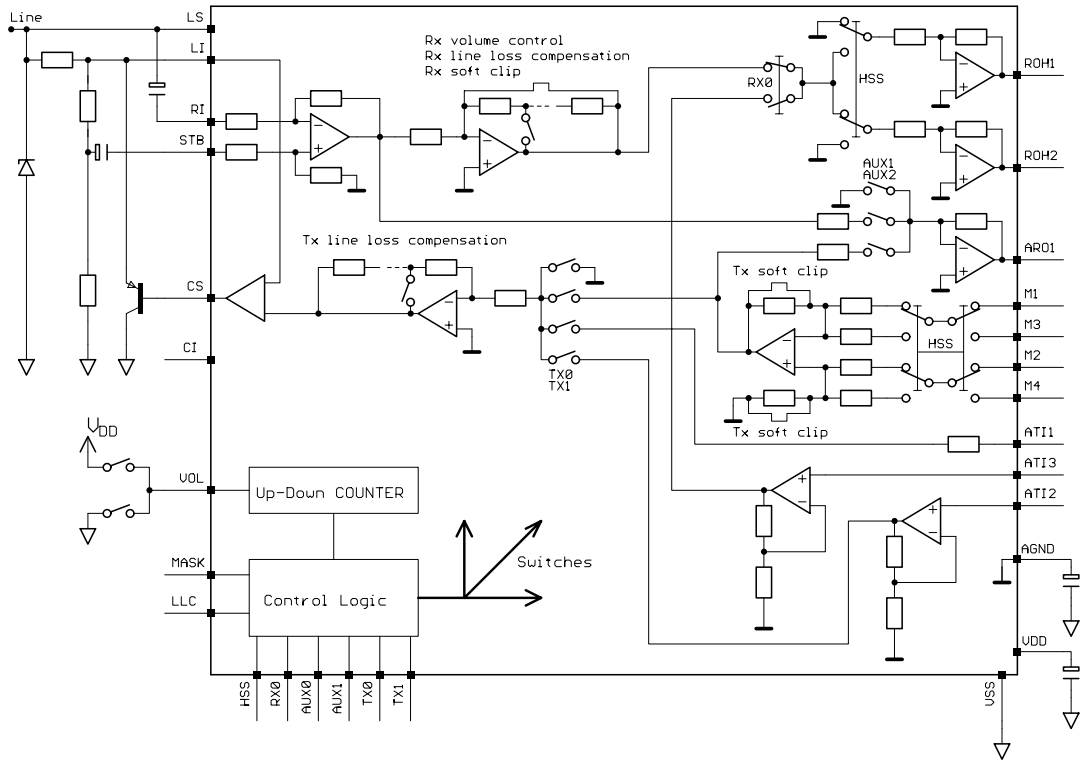
Application

Cordless base stations, answering machines, a/b-line or auxiliary powered telephone sets.

Package

Available in 28 pin SOIC

Block Diagram



Pin description

Pin #	Symbol	Function
7	LS	**L**ine Current **S**ense Input Input for sensing the line current
5	LI	**L**ine **I**nput Input used for power extraction and line current sensing
6	RI	**R**eceive **I**nput Input for ac-separated receive signal
13	STB	**S**ide **T**one **B**alance Input Input for side tone cancellation network
3	CS	**C**urrent **S**hunt Control Output N-channel open drain output to control the external high power shunt transistor for synthesising AC- and DC-impedance, modulation of line voltage and shorting the line during make periods of pulse dialling
14	CI	**C**omplex **I**mpedance Input Input pin for the capacitor to program a complex impedance
25	MASK	**MASK** Input pin to set circuit into power down mode during e.g. LD-dialling. During MASK=HIGH, CS-pin is internally shorted to ground.
26	LLC	**L**ine **L**oss **C**ompensation Select Pin 45mA-75mA —> VDD 20mA-50mA —> AGND None —> VSS
11	VDD	**V**oltage **D**rain **D**rain Positive Power Supply, for external circuitry t.m. 4.0mA@I_L=20mA and 4.0mA@I_L=20mA
4	VSS	**V**oltage **S**ource **S**ource Negative Power Supply
12	AGND	**A**nalogue **G**round Special ground for the internal amplifiers
2	M1	**M**icrophone Input **1** Differential input for the microphone (electret)
1	M2	**M**icrophone Input **2** Differential input for the microphone (electret)
28	M3	**M**icrophone Input **3** Differential input for the microphone (electret)
27	M4	**M**icrophone Input **4** Differential input for the microphone (electret)
24	ATI1	**A**uxiliary **T**ransmit **I**nput **1** R_I >= 25kΩ
23	ATI2	**A**uxiliary **T**ransmit **I**nput **2** R_I >= 100kΩ

Pin #	Symbol	Function
15	ATI3	**A**uxiliary **T**ransmit **I**nput **3** R_I >= 100kΩ
8	ROH1	**R**eceive **O**utput to **H**andset **1** Output for driving a dynamic earpiece with an impedance from 150Ω to 300Ω (max. 0.7Vp)
9	ROH2	**R**eceive **O**utput to **H**andset **2** Output for driving a dynamic earpiece with an impedance from 150Ω to 300Ω (max. 1.4Vp)
10	ARO1	**A**uxiliary **R**eceive **O**utput **1** R_L > 10kΩ (max. 1.4Vp)
16	VOL	**VOL**ume Input pin for increasing (= connect to V_{IN} >= V_{DD}-0.3V) or decreasing (= connect to V_{IN} <= VSS+0.3V) the Rx volume. The idle state is between V_{SS}+1.4V < V_{IN} < V_{DD}-1.4V. Max rise time 50ns, max fall time 50ns, min pulse width 1us
22	HSS	**H**and**S**et or Head**S**et / bit ① Digital input to select the ROH1 or ROH2 signal output path
21	RX0	**R**eceive **0** / bit ② Digital input to select a signal path
18	AUX0	**A**uxiliary **0** / bit ③ Digital input to select a signal path
17	AUX1	**A**uxiliary **1 /** bit ④ Digital input to select a signal path
20	TX0	**T**ransmit **0 /** bit ⑤ Digital input to select a signal path
19	TX1	**T**ransmit **1 /** bit ⑥ Digital input to select a signal path

Functional Description

Modes of operation

There are 3 possible modes:

Idle Mode: AS2504 is disconnected from the a/b-line (= no line current) and VDD is not supplied by auxiliary power. All internal circuits are powered down. Input of digital control signals is not possible.

Line Power Mode: AS2504 is connected to the a/b-line and VDD is generated by the internal power extraction. The speech circuit is powered up. The line interface circuit is functional (DC-mask and AC-impedance are synthesised). Input of digital control signals is possible.

Aux. Power Mode: AS2504 is disconnected from the a/b-line (= no line current) and VDD is supplied by auxiliary power. The speech circuit is powered up. The line interface circuit is not functional (DC-mask and AC-impedance). Input of digital control signals is possible.

Start-up in Line Power Mode

As soon as AS2504 is supplied with line current, the external V_{dd} capacitor will be charged up via the LI- and VDD-pin. After the V_{dd} voltage has reached the operating level of 2V, the line interface circuit and the selected signal path of the speech circuit is switched on. This off-hook status is signalled to the internal logic via the LS-pin (voltage level sensitive).

Start-up in Aux. Power Mode

As soon as AS2504 is supplied with auxiliary power at the VDD-pin, the selected signal path of the speech circuit is switched on. The line interface circuit (DC-mask and AC-impedance) is not functional. This on-hook status is signalled to the internal logic via the LS-pin (voltage level sensitive).

DC conditions

The normal operating mode is from 15mA to 100mA. An operating mode with reduced performance is from 5mA to 15mA. In the line hold range from 0mA to 5mA the device is in a power down mode and the voltage at LI is reduced to a maximum of 3.5V

The DC characteristic is determined by the voltage at LI-pin and a 30Ω resistor between LI- and LS-pin. It can be calculated by the following equation: $V_{LS} = V_{LI} + I_{Line} * 30\Omega$. The t.m. voltage at the LI-pin is 4.5V. The calculation leads to the following DC resistances: 330Ω to 75Ω at line currents from 15mA to 100mA.

With a HIGH at the MASK-pin, the speech circuit and other parts of the device, which are not needed for operation, are in power down mode in order to save current. The CS-pin is pulled to V_{ss} to turn the external shunt transistor fully on. This guarantees a low voltage drop (<1V) at the LI-pin during make periods of pulse dialling or flash.

2/4 wire conversion

AS2504 has a built-in dual Wheatstone bridge with one common ground. This provides a maximum of independence of AC-impedance and side tone from each other. One can adapt side tone without changing the AC-impedance.

AC-impedance

The AC-impedance of AS2504 is set to t.m. 1000Ω. With the external capacitor at CI-pin it can be programmed complex. With an external resistor of approx. 1.5kΩ connected to the LS-pin it can be programmed to 600Ω. $Z_{AC(syn)} = 33 * 30\Omega$.

Side Tone

A good sidetone cancellation can be achieved by using the following equation:

$Z_{BAL}/Z_{LINE} = 10$

Transmit path

The gain of the M1/M2 —> LS is set to 37dB. The input is differential with an impedance of 20kΩ. The soft clip circuit limits the output voltage at LS to $2V_p$. The attack time is 30µs/6dB and the decay time is 20ms/6dB.

The gain of the M3/M4 —> LS is set to 43dB. The input is differential with an impedance of 10kΩ. The soft clip circuit limits the output voltage at LS to $2V_p$. The attack time is 30µs/6dB and the decay time is 20ms/6dB.

The gain of the ATI1 —> LS is set to 6dB. The input is unbalanced with an impedance of 25kΩ. There is no softclipping.

The gain of the ATI2 —> LS is set to 20dB. The input is unbalanced with an impedance of 100kΩ. There is no softclipping.

Intercom path

The gain of the ATI3 —> ROH1 is set to 6dB. The input is unbalanced with an impedance of 100kΩ. There is no softclipping.

The gain of the ATI3 —> ROH2 is set to 12dB. The input is unbalanced with an impedance of 100kΩ. There is no softclipping.

The gain of the M1/M2 —> ARO1 is set to 23dB. The input is differential with an impedance of 20kΩ. The soft clip circuit limits the output voltage at ARO1 to $0.4V_{p.}$ The attack time is 30µs/6dB and the decay time is 20ms/6dB.

The gain of the M3/M4 —> ARO1 is set to 29dB. The input is differential with an impedance of 10kΩ. The soft clip circuit limits the output voltage at ARO1 to $0.4V_{p.}$ The attack time is 30µs/6dB and the decay time is 20ms/6dB.

Receive path

The gain of the LS —> ROH1 receive path is set to 3dB. The receive input is the differential signal of RI and STB. The soft clip circuit limits the output voltage at ROH1 to $0.7V_{p.}$ It prevents harsh distortion and acoustic shock. There is volume control and LLC for this path.

The gain of the LS —> ROH2 receive path is set to 9dB. The receive input is the differential signal of RI and STB. The soft clip circuit limits the output voltage at ROH2 to $1.4V_{p.}$ It prevents harsh distortion and acoustic shock. There is volume control and LLC for this path.

The gain of the LS —> ARO1 receive path is set to 3dB. The receive input is the differential signal of RI and STB. There is no softclipping, no LLC and no volume control for this path.

Rx volume control

The volume control is available for LS —> ROH1 and LS —> ROH2. It can be decreased by 6dB and increased by 8dB in 2dB steps from the default levels as described in the last paragraph. It remains in the pre-set position as long as VDD does not decrease less than 2.2V

Line Loss Compensation

The line loss compensation is a pin option. When it is activated, the transmit and receive gains for both I/O's are decreased by 6dB at line currents from 20mA to 50mA when the LLC-pin is connected to AGND and from 45mA to 75mA when the LLC-pin is connected to VDD. The line loss compensation is deactivated when LLC-pin is connected to VSS.

Digital interface

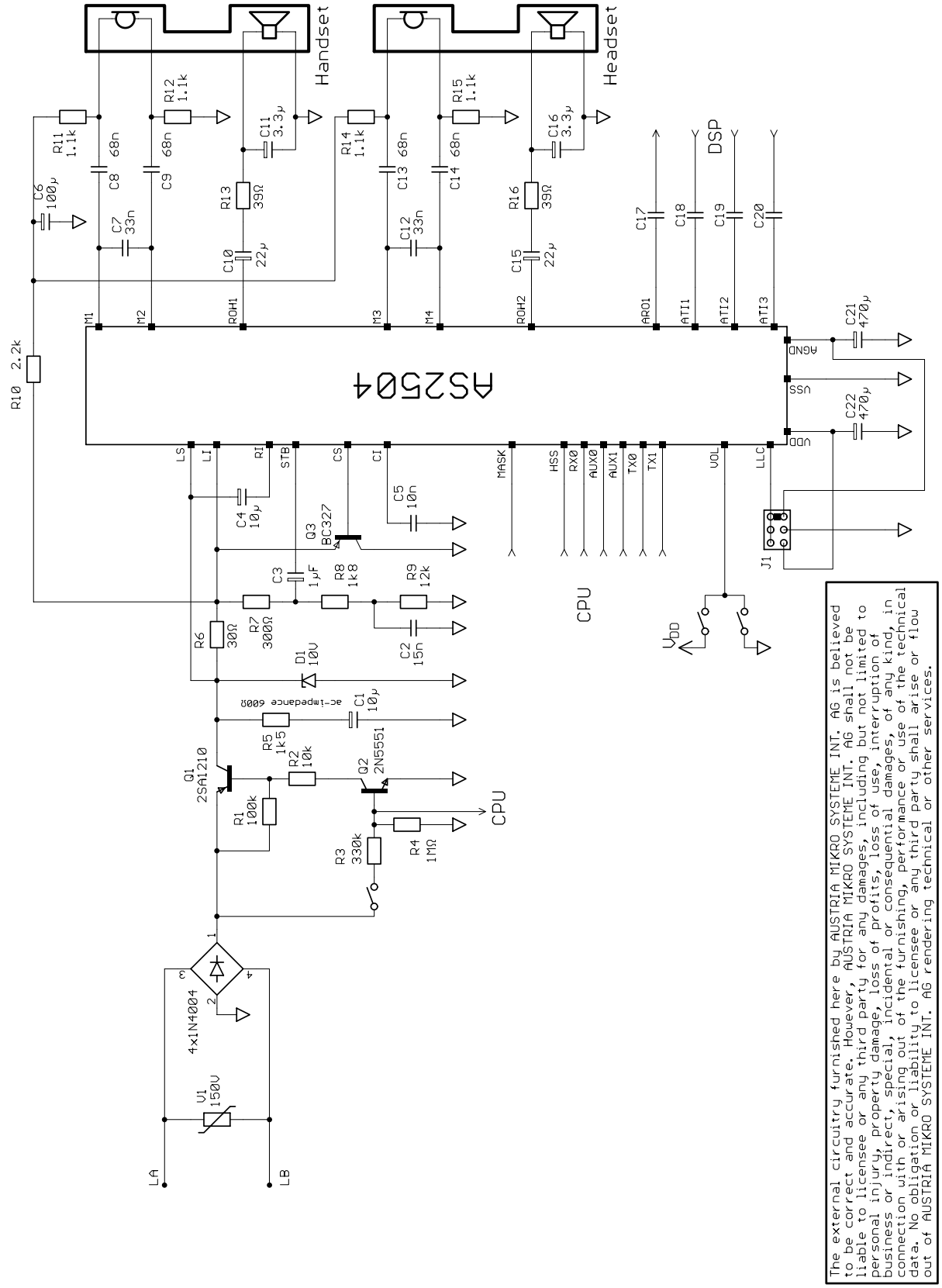
The selection of the available signal paths must be set via the digital control pins. The following modes are possible:

HSS: bit ①	RX0: bit ②	
0	0	LS —> ROH1
1	0	LS —> ROH2
0	1	ATI3 —> ROH1
1	1	ATI3 —> ROH2

AUX0: bit ③	AUX1: bit ④	HSS: bit ①	
1	1	X	MUTE
0	1	0	M1/M2 —> ARO1
0	1	1	M3/M4 —> ARO1
1	0	X	LS —> ARO1
0	0	X	MUTE

TX0: bit ⑤	TX1: bit ⑥	HSS: bit ①	
0	0	0	M1/M2 —> LS
0	0	1	M3/M4 —> LS
0	1	X	ATI1 —> LS
1	0	X	ATI2 —> LS
1	1	X	MUTE

Typical Application



Electrical characteristics

Electrical charateristics are measured with the Test Circuit application. Typical mean values will not be tested.

Absolute maximum ratings

Positive Supply Voltage	-0.3V <= V_{DD} <= 7V
Input Current	± 25mA
Input Voltage (LS)	-0.3V <= V_{in} <= 12V
Input Voltage (LI, CS)	-0.3V <= V_{in} <= 8V
Input Voltage (STB, RI)	-2V <= V_{in} <= V_{DD}+0.3V
Digital Input Voltage	-0.3V <= V_{in} <= V_{DD}+0.3V
Electrostatic Discharge (HBM 1.5kΩ-100pF)	± 1000V
Storage Temperature	-65°C to +125°C

Recommended operating conditions

Supply Voltage (generated internally)	4V <= V_{DD} <= 5V
Operating Temperature	-25°C to +70°C

DC characteristics

I_{Line}=15mA w/o operation of any additional external circuitry, unless other specified

Symbol	Parameter	Conditions	Min	Typ	Max	Units
I_{DD}	Operating Current	Speech Mode MASK=H, V_{DD}=2.5V		3 300	5	mA µA
V_{LI}	Line Voltage	15mA<=I_{LINE}<=100mA	4.2	4.5	4.8	V
I_{OL}	Output Current, Sink CS	V_{OL}=0.4V		1		mA
V_{IL}	Digital Input Voltage LOW	Pins HSS,RX0,TX0, TX1,AUX0,AUX1	V_{SS}		0.2 V_{DD}	V
V_{IH}	Digital Input Voltage HIGH	Pins HSS,RX0,TX0, TX1,AUX0,AUX1	0.8 V_{DD}		V_{DD}	V

Transmit characteristics

V I_{Line}=15mA f=800Hz, unless other specified

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$A_{M1/2TX}$	Transmit Gain M1/M2 —> LS	$Z_{AC(syn)}$=1000Ω	+36.0	+37.5	+39.0	dB
$A_{M3/4TX}$	Transmit Gain M3/M4 —> LS	$Z_{AC(syn)}$=1000Ω	+42.0	+43.5	+45.0	dB
A_{AT1X}	Transmit Gain ATI1 —> LS	$Z_{AC(syn)}$=1000Ω	+5.0	+6.5	+8.0	dB
A_{AT2X}	Transmit Gain ATI2 —> LS	$Z_{AC(syn)}$=1000Ω	+19.0	+20.5	+22.0	dB
ΔA_{TX}	Variation with frequency	f = 500Hz … 3.4kHz		±0.8		dB
THD	Distortion	V_{LS}=0.25V_{RMS}			2	%
V_{UFC}	Unwanted Freq. Comp.	f = 200Hz … 20kHz			-60	dBm
V_{AGC1}	Soft Clip Level M1/M2 —> LS at LS			2.0		V_P
V_{AGC2}	Soft Clip Level M3/M4 —> LS at LS			2.0		V_P
A_{SCO}	Soft Clip Overdrive M1/M2 - M3/M4			20		dB
t_{attack} t_{decay}	Attack time Decay time			30 20		µs/6dB ms/6dB
$Z_{IN-M1/2}$	Input Impedance M1/M2			20		kΩ
$Z_{IN-M3/4}$	Input Impedance M3/M4			10		kΩ
$Z_{IN-ATI1}$	Input Impedance ATI1			25		kΩ
$Z_{IN-ATI2}$	Input Impedance ATI2			100		kΩ
A_{MUTE}	Mute Attenuation M1/2 - M3/4		60			dB
V_{INmax}	Input Voltage Range M1/2 - M3/4	differential		±1		Vp
V_{NO}	Noise Output Voltage LS	T_{AMP}=25°C			-71	dBmp
RL $\Delta Z_{AC/°C}$	Return Loss Temp. Variation	$Z_{AC(syn)}$=1000Ω	18	 0.5		dB Ω/°C

Intercom characteristics

I_{Line}=15mA f=800Hz, unless other specified

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$A_{M1/2IX}$	Intercom Gain M1/M2 —> ARO1		+21.5	+23.0	+24.5	dB
$A_{M3/4IX}$	Intercom Gain M3/M4 —> ARO1		+27.2	+28.7	+30.2	dB
A_{AT3IX}	Intercom Gain ATI3 —> ROH1		+4.5	+6.0	+7.5	dB
A_{AT4IX}	Intercom Gain ATI3 —> ROH2		+10.5	+12.0	+13.5	dB
$Z_{IN-ATI3}$	Input Impedance ATI3			100		kΩ

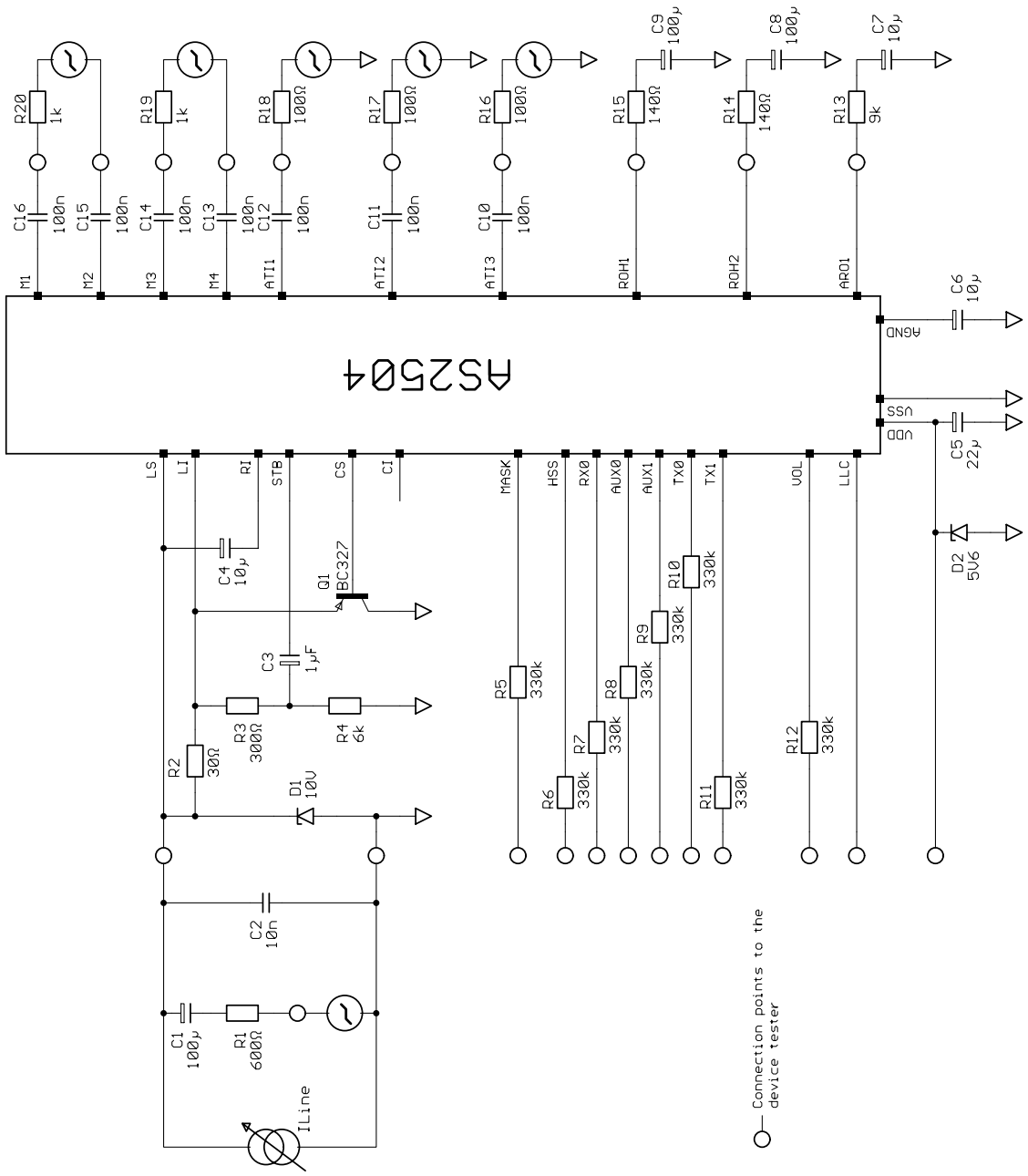
Receive characteristics

I_{Line}=15mA f=800Hz, unless other specified

Symbol	Parameter	Conditions	Min	Typ	Max	Units
A_{HRX}	Receive Gain LS —> ROH1	$Z_{AC(syn)}$=1000Ω	+1.0	+2.5	+4.0	dB
A_{AR1X}	Receive Gain LS —> ROH2	$Z_{AC(syn)}$=1000Ω	+7.0	+8.5	+10.0	dB
A_{AR1X}	Receive Gain LS —> ARO1	$Z_{AC(syn)}$=1000Ω	+0.7	+2.2	+3.7	dB
ΔA_{RX}	Variation with frequency	f=500Hz to 3.4kHz		±0.8		dB
A_{VOL}	Volume control range			-6/+8		dBr
THD	Distortion ROH1-ROH2	V_{LS}=0.25V_{RMS}			2	%
THD	Distortion ARO1	V_{LS}=0.25V_{RMS}			3	%
V_{UFC}	Unwanted Freq. Comp.	f = 200 … 20kHz			-60	dBm
V_{AGC}	Soft Clip Level ROH1			0.7		V_P
V_{AGC}	Soft Clip Level ROH2			1.4		V_P
A_{SCO}	Soft Clip Overdrive ROH1/2			10		dB
t_{attack} t_{decay}	Attack time Decay time			30 20		µs/6dB ms/6dB
V_{NO}	Noise Output Voltage ROH1/2 - ARO1	T_{AMP}=25°C			-71	dBmp
Z_{IN-RI} V_{INmax}	Input Imp. RI Input Voltage Range RI			8 ±2		kΩ Vp

Symbol	Parameter	Conditions	Min	Typ	Max	Units
Z_{IN-STB} V_{INmax}	Input Imp. STB Input Volt. Range STB			80 ±2		kΩ Vp
ST	Sidetone	V_{RI}<=0.25V_{RMS}	24			dB
RL $\Delta Z_{AC/°C}$	Return Loss Temp. Variation	$Z_{AC(syn)}$=1000Ω	18	 0.5		dB Ω/°C

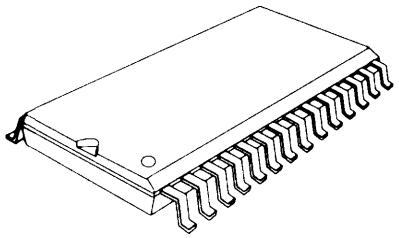
Test circuit



Packaging

The device is available in the packages outlined below (not to scale). For exact mechanical package dimensions please see AMSAG packaging information.

28-pin plastic SOIC (suffix T)

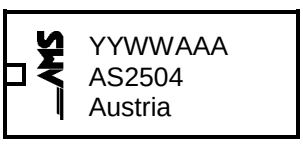


Max. Body Length	18.1mm / 713mil
Max. Body Width	7.6mm / 300mil
Pitch	1.27mm / 50mil

Pin-out

1	–	M2	M3	–	28
2	–	M1	M4	–	27
3	–	CS	LLC	–	26
4	–	VSS	MASK	–	25
5	–	LI	ATI1	–	24
6	–	RI	ATI2	–	23
7	–	LS	HSS	–	22
8	–	ROH1	RX0	–	21
9	–	ROH2	TX0	–	20
10	–	ARO1	TX1	–	19
11	–	VDD	AUX0	–	18
12	–	AGND	AUX1	–	17
13	–	STB	VOL	–	16
14	–	CI	ATI3	–	15

Marking



YY	year of production
WW	calendar week of production
AAA	AMSAG assembly ID

Ordering information

Number	Package	Description
AS2504 T	SO28	plastic small outline package - 28 leads (suffix T)

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