Handsfree Line Interface Demoboard AN523/24

PRELIMINARY APPLICATION NOTE

Key Features

- Complete handsfree telephone with AS2523/24 Line Interface
- Jumper selectable AC impedance
- Easily configurable passive sidetone network on 8-pin socket

Applications

- Feature handsfree telephones
- AS2524 for handsfree telephones connected to a standard dialer
- AS2523 for handsfree telephones controlled via serial interface.

General description

This application note describes operation and features of the AS2523 and AS2524 Handsfree Line Interface IC including all external components necessary for the DB523 Demoboard, which is a handsfree telephone with a standard dialer interface on AS2524 and a serial interface on AS2523.

PTT spec conformity

The application notes hereafter should be understood as guidelines for other designs based on the AS252x circuit. No guarantee can be given for completeness or full conformity to PTT specification requirements. As requirements differ from country to country, each required parameter must be individually tested and adjusted, if necessary.
Further guidelines for adjustment is given in the documents, listed in other applicable documents and papers.

Table of Contents

Other applicable documents and papers

Data Sheet: AS2523/24 Handsfree Line Interface Circuit
Application Notes AN500-x: General analogue telephone IC descriptions

Further Applications

Applications based on the AS2523/24 are continuously updated. Visit our home-page:
http: //www.austriamicrosystems.com

Revision status

AS2523/24 Datasheet	Rev.: 1.9
AN523/24 Application note (this document):	Rev.: 1.01
DB523/24 Demoboard schematic:	Rev.: A01
DB523/24 Demoboard layout	Rev.: A01

Revision history

Demoboard and Application note are the first Revision

Demo kit contents

The available demo-kit DB523/24 contains the following parts:

- AS2523/24 Single Chip Handsfree Phone Demoboard DB523/24 “ready-to-go”
- handset
- handsfree microphone
- application note AN523/24
- AS2523/24 Datasheet

General description

Remark: all subsequent component numbering refers to the application schematics, shown in pt. Application Schematic.

Getting started

- connect the handset (included in demo kit) to J2
- select AC impedance (J23, J7)
- connect the telephone line connector to J1
- connect the handsfree microphone (included in demo kit) to “HF mic”(J4), observe polarity: capsule case is negative terminal
- for realistic performance check, you may connect an existing handsfree telephone with extended wires from the internal handsfree microphone and loudspeaker
- connect a 25...32Ω loudspeaker (not included in demo kit) to “Speaker” (J11)
- select line connector pins on J2,J5
- operation in handset mode: activate hookswitch S1 on left upper corner of PCB:
  depressed position: on-hook, released position: off-hook
- operation in handsfree mode: toggle “h/free”-switch SW2

Remark:
The hookswitch and handsfree functionality depends from the controller on the digital interface (J25)

Connector and Jumper locations

Listed below are the various connectors and jumpers. The default settings are indicated in bold letters:

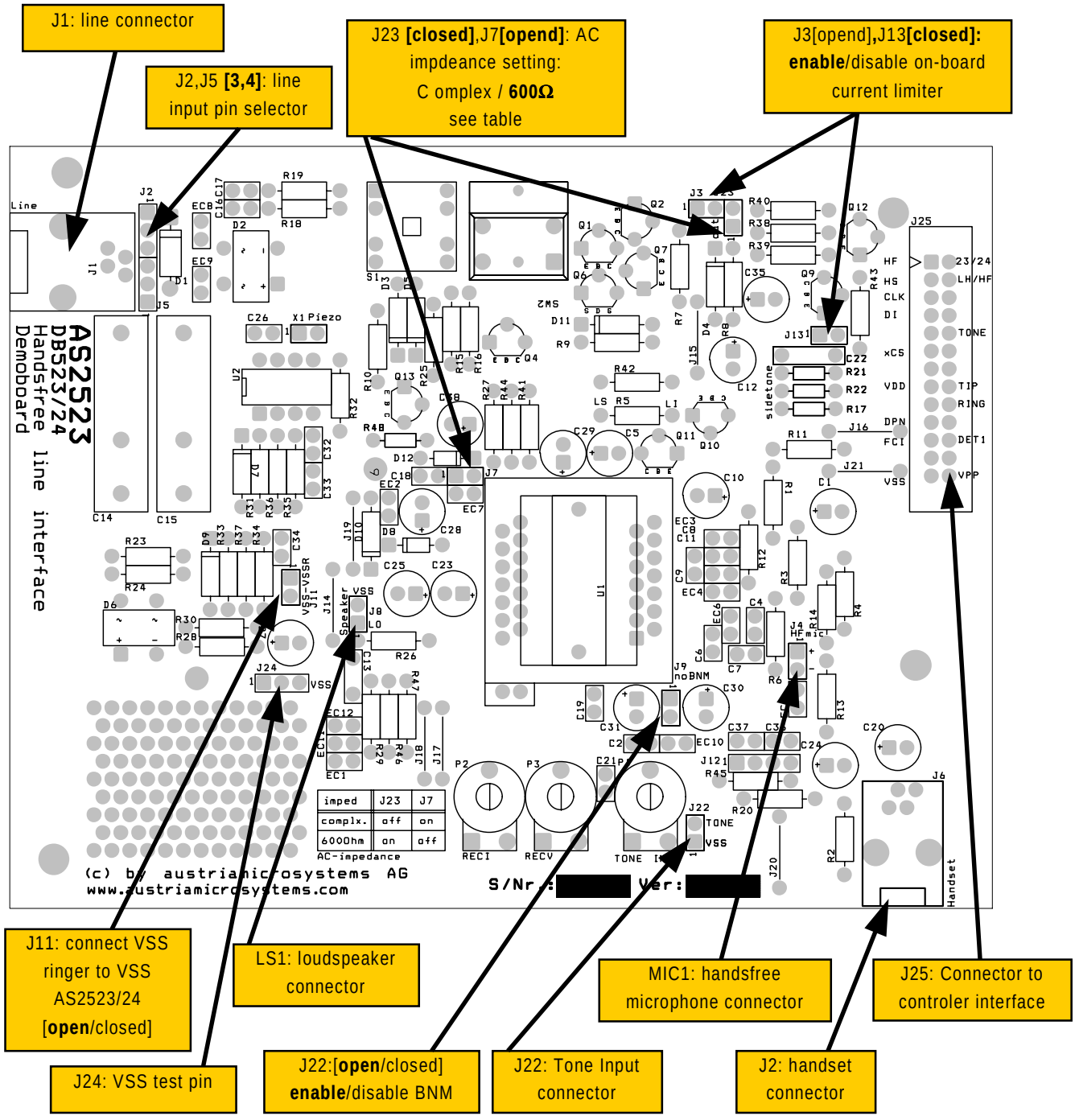


Figure 1: Connector and Jumper locations

Application Schematic, analog part

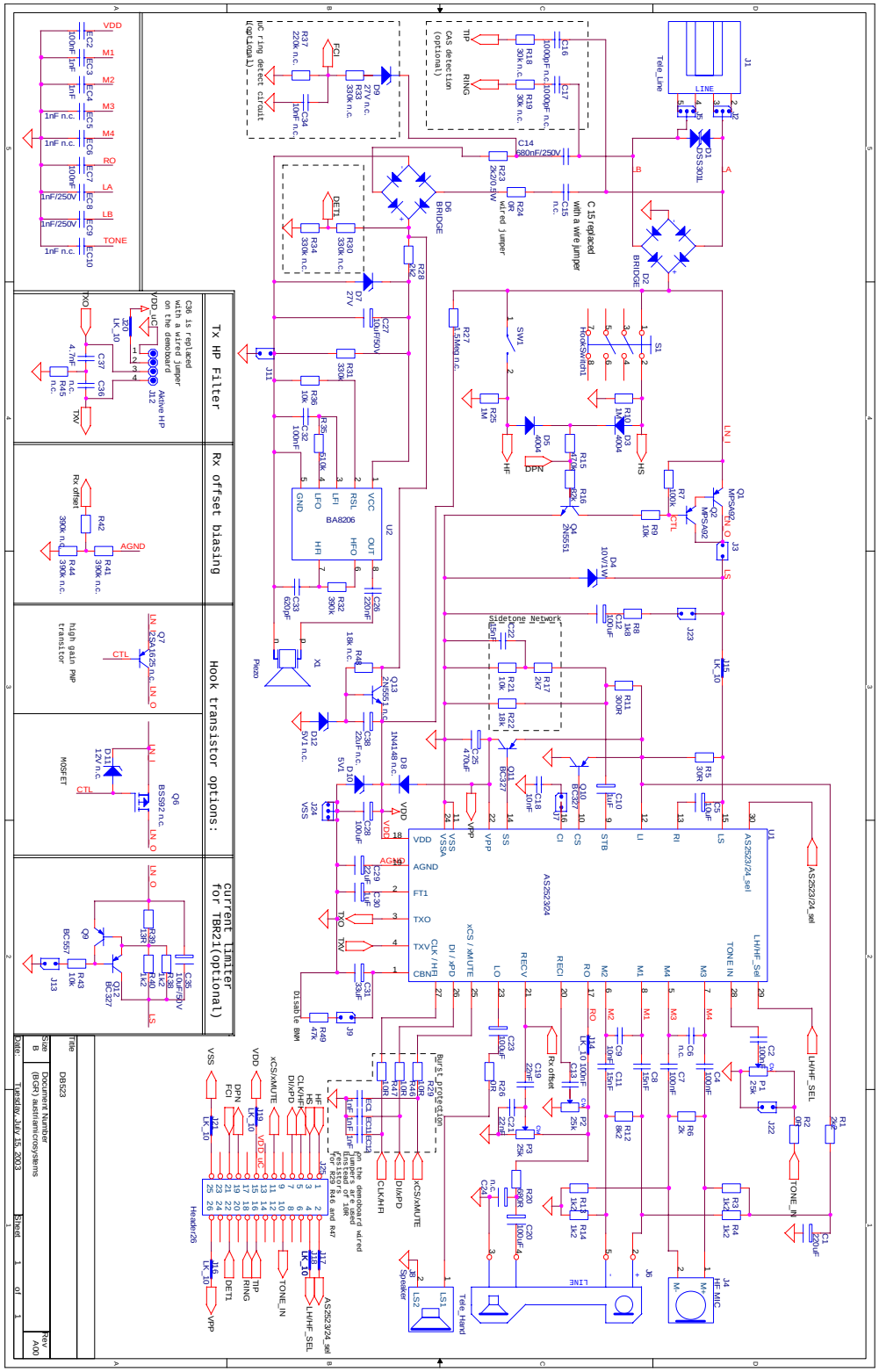


Figure 2: Application Schematic, analog part

DB523/24 demoboard: Layout (top view)

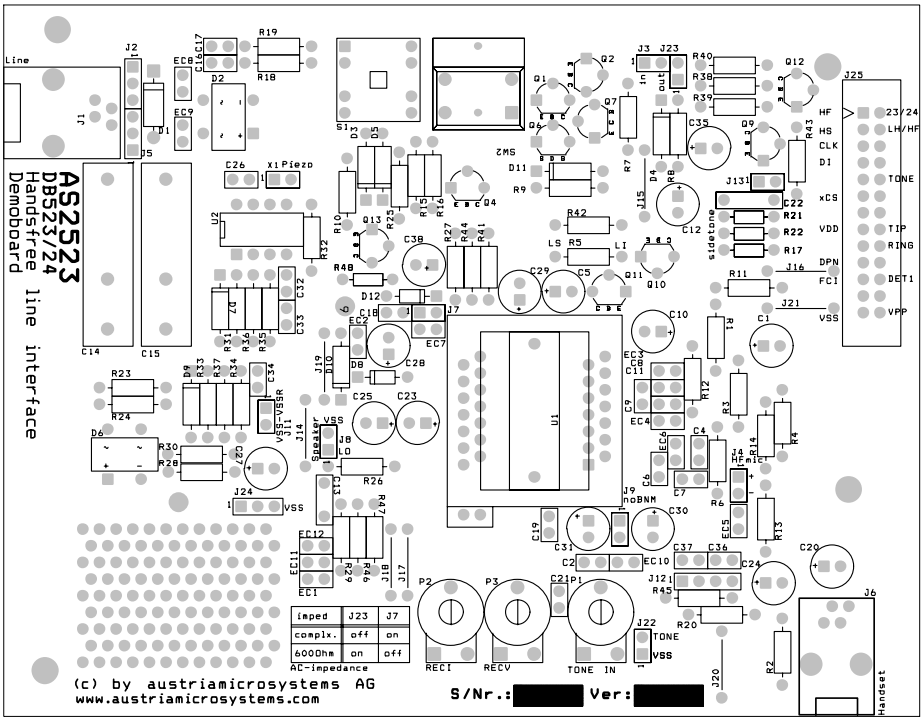


Figure 3: DB523/24 demoboard: Layout (top view)

DB523/24 Demoboard: Component Print

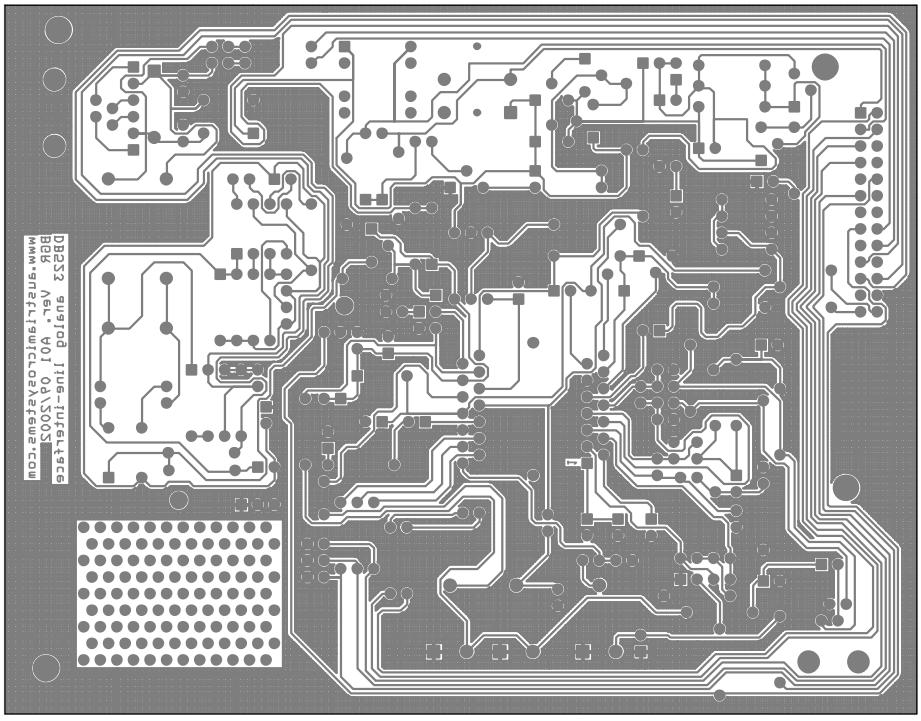


Figure 4: DB523/24 Demoboard: Component Print

External component selection

Passive components

All resistors can be ¼ Watt or less, except:
R5 (30Ω) P= $I_{Line,max}^2$ * 30Ω (e.g. 0.2W @ 80mA)
R38 and R40 (each 1k2 / 0.75W; TBR21 application only):

The maximum voltage rating for all caps is ≥6V DC, except:

C5 (10µ, RI input)	25V
C12 (10µ, AC impedance setting)	25V
C23 (100µ, speaker decoupling)	16V
C6,C7 (0.9µ ringer caps)	160V
C35 (10µ, TBR 21 application only)	50V

Transistors

Most transistors can be general purpose types. Their function and minimum requirements are shown in the table below:

Part Nr.	Type on demoboard	pol.	function, minimum requirements	equivalent type(s)
Q7(optional)	2SA 1625K	PNP	hook transistor option: high voltage / high gain V_{CEO},V_{CBO}: ≥-200V; hFe ≥100; I_C <-100mA	KSA 1625K
Q1,Q2	MPSA 92	PNP	hook transistor option: high voltage darlington V_{CEO},V_{CBO}: ≥-200V; I_C <-100mA	MPSA 93, KSP 92/93
Q6 (optional)	BSS92	P-Ch	hook transistor option: VMOS, enhancement V_{DS} ≥-200V , I_D <-100mA	BSP 92 (SMD)
Q4	2N5551	NPN	driver transistor for Q1,Q2 V_{CEO},V_{CBO}: ≥200V IC ≈ 1mA	MPSA / KSP 42/43
Q10, Q11	BC327-25	PNP	line shunt regulation and Vpp supply generation general purpose.: V_{CE} <-10V , hFe ≥160 I_C <-100mA, PD ≤450mW	various
Q13(optional)	2N5551	NPN	Q13: ringer startup; generate V_{DD} from ringer signal; if not limited by ext. zener diode after bridge RB2, maximum voltage is the peak ringing voltage. High transient voltages may occur during pulse dialing (clamped by V1)	
Q9, Q12	BC557	PNP	opt. current limiter general purpose V_{CE} <-10V	various
	BC327-25	PNP	opt. current limiter general purpose V_{CE} <-40V , hFe ≥160 I_C <-100mA PD ≤450mW	various

Country specific Settings

Hardware and software settings

Most parameters (timings, gains, etc.) can be changed by software via the serial bus interface on AS2523. On AS2524 the gains are fix programmed and can be adjusted over external resistors in an easy way.

Some analogue parameters however, require modifications of external passive components. These are:

AC impedance

The internal AC impedance of the chip is 1000Ω./real. By adding a capacitor at pin CI (#16), the synthesized impedance becomes complex (close J7).

A parallel resistor (R8; DC-decoupled by C12) from pin LS (#15) to V_{SS} (#11,) lowers the total AC impedance in the form of a parallel connection between

a) the IC's impedance (1000Ω),
b) R9 (typ. 10kΩ) and
c) R8: R_{AC} = 1k //R9//R8

Example: To set an AC impedance of 600Ω, R8 must be 1,8kΩ (close J23 and open J7):

R_{AC} = 1000Ω // 10kΩ // 1k8 = 600Ω

Remark: When a MOSFET (optional) hook transistor is used, R9=10kΩ must be excluded from the calculation, because it is not in parallel to the line: gate-source resistance is high ohmic!)

On the demoboard, two jumpers, J23 and J7 are provided to quickly change the AC impedance between 600Ω and complex AC impedance. The table printed on the PCB describes the setting:

- For 600Ω, close J23 and open J7: R8 is connected to LS and CI is left open
- For complex impedance, open J23 and close J7: no parallel resistor at LS, C12 connected to CI

Sidetone cancellation

For sidetone cancellation, a passive complex network (R17,R21,C22) must be connected, which should be 10 times the value of the (complex) line termination for sidetone measurements:

- Sidetone network resistor values = 10 times of line termination resistor values
- Sidetone network capacitor value = 1/10 of line termination capacitor value

Example: for a line termination of 270Ω + 750Ω // 150nF, the equivalent sidetone network would be

(R17 + R21 // C22) = **2k7 + 7k5 // 15nF**

If R8 is installed (e.g. for 600Ω impedance setting), resistor R22 (= 10 times the value of R8) should be connected in parallel to the sidetone network to compensate for the additional load of R8
On the demoboard, an 8-pin DIP socket is provided for the sidetone network to allow easy replacement of the components.

Sending and receiving frequency response

Although transmit and receive gains can be set by software, additional frequency shaping may be required (depending on acoustic handset characteristics). This can be done by modifying

- C4, C5, C7, R6 for handsfree sending frequency shaping
- C8, C9, C11, R25 for handset sending frequency shaping
- R28, C26...27 for handset receiving frequency shaping

Adaption to pan-European regulations TBR21,EN301437,TBR38

The DB523/24 demoboard can be easily adapted to meet the TBR21/38/EN301437 regulations. The main change is, that a current limiter is required to meet the DC mask requirements for this specification.

Current limiter

The current limiter must be connected between hook transistor and pin LS (see schematic: optional current limiter). This device is already installed on the demoboard, but can be bypassed with jumper J3 (J13 = open).
To activate it, open J3 and close J13.

See also for pt. Related Standards links to the European Telecommunications Standards Institute.

AC impedance, Echo Return Loss

Requirement: The AC impedance must be set to 1000Ω / complex. Echo Return Loss must be ≥14dB @ Z_{REF} (270Ω + 750Ω // 150nF)

⇒ remove R8 and C12 (or open J23) and remove R22
⇒ short J7 (make sure C18 is 10nF)
⇒

Sending and receiving Loudness ratings

Requirement: SLR = +3 ±4dB, RLR = -8 ±4dB
With the included handset, the loudness ratings requirements can be met by using the resistor and capacitor values shown in the application schematic.

Remark: if necessary, handset Tx and Rx gains can be adjusted by programming on AS2523. On AS2524 gains must be adjusted with resistors. See pt. Signal truth table AS2523.

Sidetone cancellation

Requirement: Sidetone cancellation is measured with 3 different terminations:

a) Zref = 82Ω + 600Ω // 68nF STMR ≥ 5dB
b) Zref = 270Ω + 750Ω // 150nF STMR ≥ 10dB
c) Zref = 220Ω + 1800Ω // 15nF STMR ≥ 7dB

⇒ Good sidetone cancellation is achieved with the installed sidetone network: R17 = 2k7, R21 = 10kΩ, C22 = 15nF, R22=21kΩ
some fine tuning may be necessary. Generally, the sidetone network should be 10 X the line termination. R22 is to compensate resistors R9 (10kΩ).

Startup in speech mode

As soon as either the hookswitch is closed or the handsfree button is pressed, The line transistor is turned on via R15,R16 and Q4.
LS is clamped to 10V by the external zener diode D2 and V_{DD} is quickly charged via LI (and an internal path from LI to V_{DD}). The rising supply voltage generates an internal power-on-reset (POR) on AS2523/24.
The POR sets the AS2523/24 into default state (see pt. Signal truth table AS2523 default settings).
The first job for the controller is to detect the hook event and hold the hook transistor in off-hook state by turning pin 19 (DPN on controller interface jumper J25) on. This is necessary because in case the handsfree button was pressed, it would only turn Q4 ON, while it is closed. Therefore DPN must go HIGH, before the handsfree button is released again.
The hookswitch (SW1) on the other hand, would always keep Q4 ON, as long as it is offhook (=closed).
Next, depending on hook event, the AS2523 must be set to the corresponding speech mode (handset mode, handsfree mode) by sending the proper command (“D4“ for handset mode, “D6” for handsfree mode) to the serial bus.
Remark: Per default the AS2523 is set into handset mode after a POR.
The AS2523 serial interface will accept commands, as soon as V_{DD} is powered up.

Connecting a Microcontroller

One of the major benefits, when using AS2523 is, that it can be interfaced with almost any microcontroller.
For the serial interface only 3 signals are necessary to control the AS2523: Chip Select, Clock and Data In.
The digital interface on the Demoboard DB523/24 provides the most common signals, which are required for an analog telephone design.

Figure 5 and Table XXXX shows the pin description for the DB523/24 digital interface.

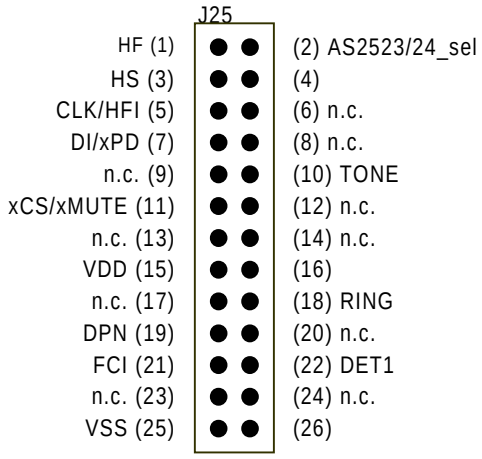


Figure 5: Controller interface on DB523/24

Pin Nr.	Pin Name	description
1	HF	Handsfree hook signal
2	AS2523/24_sel	Selector for AS2523/24 (only for COB)
3	HS	Handset hook signal
4	LH/HF_Sel	Selector for Loudhearing or Handsfree (only for COB)
5	CLK/HFI	CLK clock signal on AS2523 HFI Handsfree pin on AS2524
6	n.c.	not connected
7	DI/xPD	DI Data input on AS2523 xPD Power down pin on AS2524
8	n.c.	not connected
9	n.c.	not connected
10	TONE IN	Analog tone input forDTMF, FSK .. Signals
11	xCS/xMUTE	xCS Chip select on AS2523 xMute pin on AS2524
12	n.c.	not connected
13	n.c.	not connected
14	n.c.	not connected
15	VDD	Supply voltage analog
16	TIP	for CID (optional)
17	n.c.	not connected
18	RING	for CID (optional)
19	DPN	
20	n.c.	not connected
21	FCI	Ring frequency detetcion (optional)
22	DET1	for CID (optional)
23	n.c.	not connected
24	n.c.	not connected
25	VSS	Common ground
26	VPP	Supply voltage

Table 1: Pin description controller interface

AS2523/24 Block Diagram

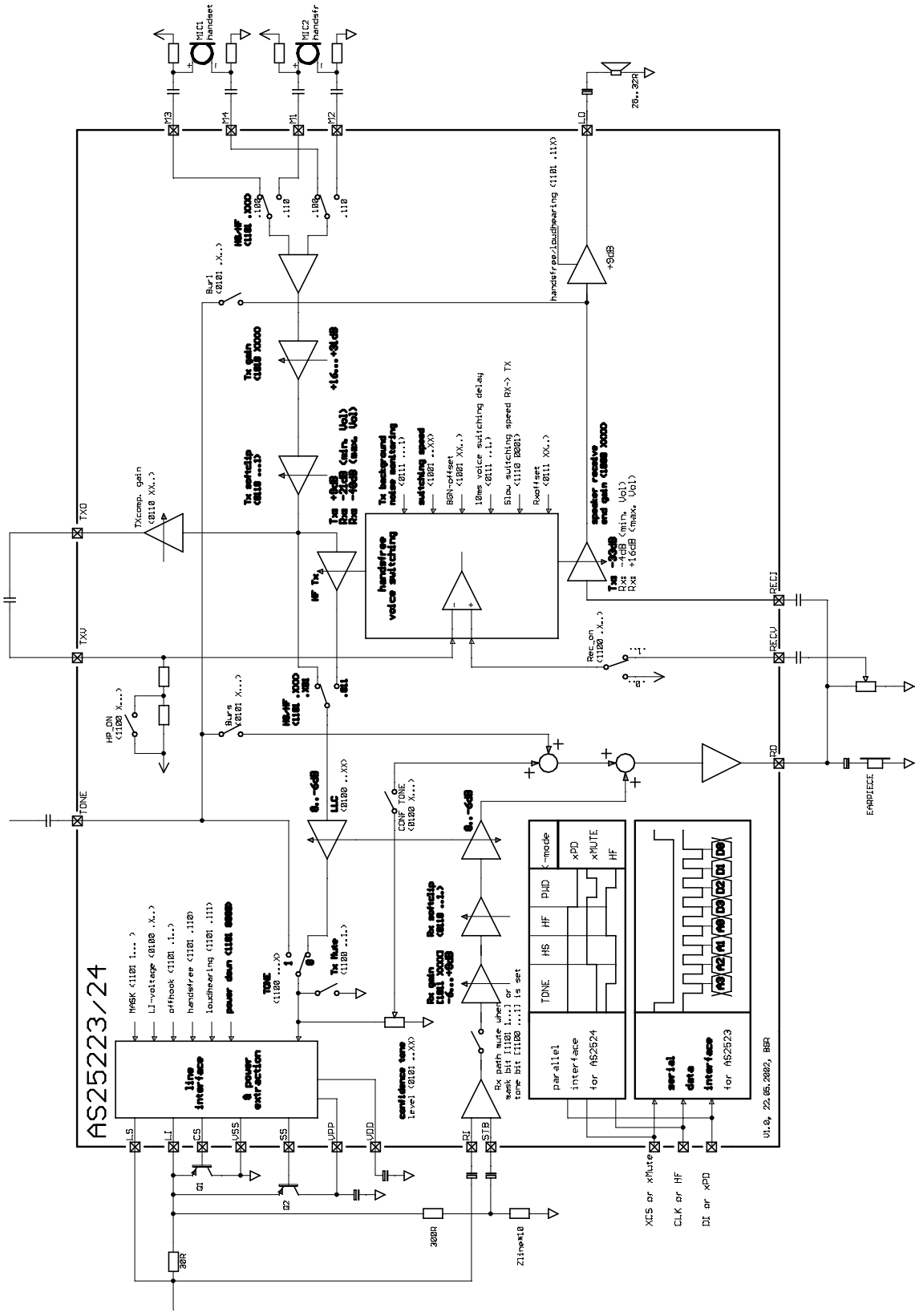
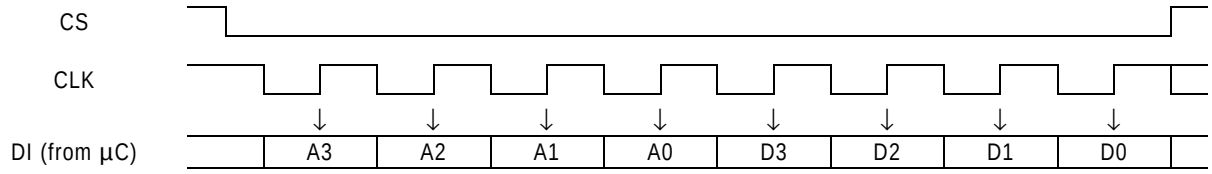


Figure 5: AS2523/24 Block Diagram

Signal truth table AS2523



For programming the AS2523, three signals are required: Chip Select (XCS), Clock (CLK), and Data In (DI).

The falling edge of CS enables the internal shift register. Data at DI is read with every rising edge of CLK, A3 must be clocked in first, D0 is last. After 8 clock pulses, CS should be pulled high. With the rising edge of CS, the shift register data is sent to the internal registers.

Programming options

Each command consists of a 4-bit address and 4 bit data. The following commands are possible:

Command [Hex]	A_3	A_2	A_1	A_0	D_3	D_2	D_1	D_0	Default settings are shown in D_3...D_0 and in bold letters:
0x	0	0	0	0	X	x	X	x	Not used
1x	0	0	0	1	X	X	X	X	Not used
2x	0	0	1	0	X	X	X	X	Not used
3x	0	0	1	1	x	X	x	X	Not used
40...4F	0	1	0	0	Co 0	Liv 0	A_1 0	A_0 0	**Confidence Tone, DC-mask, Line Loss Compensation** Co = Confidence tone: [0]= off, [1]= on L = LI-Voltage: [0]= 3,5V, [1]= 4,5V A_1,A_0: **11**= 01 = noLLC, 00= LO (20-50mA), 10= HI (45-75mA)
50...5F	0	1	0	1	A B_R 0	A B_S 0	C_1 0	C_0 1	**Analog Tone confidence tone level:** AB_R: Tone is sent to receiver (RO) : on[1] / off[**0**] AB_S: Tone is sent to Speaker (LO) : on[1] / off[**0**] C_1/C_0: confidence tone level @RO /LO1,2 rel. to LS: 00 = -36dB -15dB **01** = -30dB -9dB 10 = -24dB -3dB 11 = -18dB +3dB
60...6F	0	1	1	0	T_1 1	T_0 0	S_R 0	S_T 0	**Transmit comperator gain and soft clipping:** T_1/T_0: Tx comperator gain settings for Handsfree adjustment 00 = +8dB 01 = +11dB **10** = +14dB 11 = +17dB S_R: Soft clipping at RO: on[1] / off[**0**] S_T: Soft clipping at LS: on[1] / off[**0**]

Command [Hex]	A_3	A_2	A_1	A_0	D_3	D_2	D_1	D_0	Default settings areshown in D_3...D_0 and in bold letters:
70...7F	0	1	1	1	R_1 0	R_0 0	D 1	B 1	**Rx- DC offset, Switching delay and Noise monitoring:** R_1/R_0: Rx DC offset: **00** = 0mV 01 = 12mV 10 = 40mV 11 = 120mV D: 10ms switching delay: on[**1**] / off[0] B: Handsfree Background noise monitoring: on[**1**] / off[0]
80...8F	1	0	0	0	X 1	X 0	x 1	x 1	Handsfree receive end gain; speaker volume [1011] 16 steps, total attenuation range = -20dB: 0000=min Vol; Rx gain = -20dB; Tx gain = -30dB 1111=max Vol; Rx gain = 0dB; Tx gain = -50dB
90...93	1	0	0	1	O_1 1	O_0 0	S_1 0	S_0 0	**Handsfree voice switching speed 1/2/4/8x:** S_1,S_0: **00** ≈ 1ms / 6dB (maximum speed) 01 ≈ 2ms / 6dB 10 ≈ 4ms / 6dB 11 ≈ 8ms / 6dB (minimum speed) with BNM on, switching from Tx->idle, Rx->idle is ≈30/60/120/240 ms/6dB respectively O_0,O_1 Background Noise Monitor Offset **O_1 O_0** BGN-offset 0 0 120mV 0 1 180mV **1 0 240mV** 1 1 300mV
A0...AF	1	0	1	0	T_3 0 0 0 0 0 0 **0** 1 1 1 1 1 1 1 1	T_2 0 0 0 0 1 1 **1** 0 0 0 0 1 1 1 1	T_1 0 0 1 1 0 0 1 **1** 0 0 1 0 1 0 1	T_0 0 1 0 1 0 1 0 **1** 0 1 0 1 0 1 0 1	Transmit gain [0111] Data[Hex] / Handset mode / Handsfree mode 0 / 30dB / 39dB 1 / 31dB / 40dB 2 / 32dB / 41dB 3 / 33dB / 42dB 4 / 34dB / 43dB 5 / 35dB / 44dB 6 / 36dB / 45dB **7 / 37dB / 46dB** 8 / 38dB / 47dB 9 / 39dB / 48dB A / 40dB / 49dB B / 41dB / 50dB C / 42dB / 51dB D / 43dB / 52dB E / 44dB / 53dB F / 45dB / 54dB

Command [Hex]	A_3	A_2	A_1	A_0	D_3	D_2	D_1	D_0	Default settings areshown in D_3...D_0 and in bold letters:		
B0...BF	1	0	1	1	R_3	R_2	R_1	R_0	Receive gain [0111]		
									Data[Hex]	handset mode: LS->RO	handsfree mode: LS->LO1/2@max vol.
					0	0	0	0	0	-6dB	22dB
					0	0	0	1	1	-5dB	23dB
					0	0	1	0	2	-4dB	24dB
					0	0	1	1	3	-3dB	25dB
					0	1	0	0	4	-2dB	26dB
					0	1	0	1	5	-1dB	27dB
					0	1	1	0	6	0dB	28dB
					0	**1**	**1**	**1**	**7**	**1dB**	**29dB**
					1	0	0	0	8	2dB	30dB
					1	0	0	1	9	3dB	31dB
					1	0	1	0	A	4dB	32dB
					1	0	1	1	B	5dB	33dB
					1	1	0	0	C	6dB	34dB
					1	1	0	1	D	7dB	35dB
					1	1	1	0	E	8dB	36dB
					1	1	1	1	F	9dB	37dB
C0...C7	1	1	0	0	H 0	R 1	M 0	T 0	**High pass for loudhearing , Receive comperator, Mute, Tone:** H: High pass cut off frequency: 200Hz [1] / 2000Hz[**0**] R: Signal to Rx comperator : on[**1**] / off[0] M: Mute: on[1] / off[**0**] T: Tx signal path: Tone in signal path[1] / Tx signal path on[**0**]		
D0...DF	1	1	0	1	M 0	S_2 1	S_1 0	S_0 0	**Mask Bit, Speech modes: S_2,S_1,S_0:** M: Maske:[**0**]: normal [1]: power save; LI Forced to 0.7V(for LD dialing) S_2,S_1,S_0,Speech modes: 0xx = power down, no line regulation 100 = Handset mode 101 = not allowed 110 = Handsfree mode 111 = Loudhearing mode		
E0...EF	1	1	1	0	K_5	K_3	K_2	S	**S Only for the loudhearing mode!** **S:** [**0**]:Normal voice switching speed [1]:fast change to TX, slow change to Rx, no IDLE **S_2,S_1,S_0 for factory testing only [0000]**		
Fx	1	1	1	1	X	x	x	x	Reset to default settings		

Programming examples

The following examples give some guidelines on how to perform specific functions when using the AS2523 in a system design. All commands, addresses and data are in Hex-numbers, component numbers refer to the DB523/24 schematic in pt.Application Schematic, analog part:

Going off-hook

After power up (close hookswitch & apply line current), the AS2523 line regulation is active (see defaults Addr. D).
The first command must therefore set the AS2523 in the detected speech mode:

command = D4 for handset mode,
D6 for handsfree mode
D7 for loudhearing mode

Afterwards, if necessary, the other parameters, like DC-mask, Line loss compensation, Tx-Rx gains and soft clipping can be sent.
For handsfree operation, voice switching speed, speaker volume and background noise monitoring can be selected.

Generating a flash

A flash is a timed interruption of the line, consequently it must be performed by turning off the hook transistor during the flash (Q1, via Q4). However, as soon ad the hook transistor is turned off, there is no more line current available to support the ICs. Therefore, V_{DD} must be supplied from the buffer capacitor (C10). To avoid fast discharge of the V_{DD} buffer cap by high supply current during the flash, the AS2523 shall be switched to a power-save mode:
command = DC (MASK-bit = 1).

Generating a dial pulse

The break-period of a dial pulse is generated in the same way as a flash (see pt. Generating a flash), the make-period is generated by turning the hook transistor on while leaving the AS2523 in the power-save mode (MASK-bit = 1). In power-save, LI is pulled down to 1.2V, resulting in a low DC-resistance at the tip/ring terminals during the make-period.

Muting the transmit and receive path

The receive path can be muted by setting bit M of addr. C.:
There is no dedicated mute-bit for the transmit path, but you may mute the transmit path by switching to Tone In mode while there is no tone applied at the tone pin:
command = C1 (Tone path = on).

Related Standards

The product, AS25xx, is designed to be in compliance with ETSI standards for connection to the analogue PSTN of terminal equipment including voice telephony services or other voice band communication when installed into a properly designed system. The specification of the product is based on following standards and requirements:

NET 4	ETS 300 001, PSTN basic access; analogue terminal equipment general requirements, March 1996.
EN55022	EMC (Electro Magnetic Compatibility)
IEC 1000-4-3	Electromagnetic Irradiation (CE approval)
TBR 21	pan-European approval for connection to the analogue Public Switched Telephone Network (line interface part)
TBR 38	pan-European approval for connection to the analogue Public Switched Telephone Network (acoustics). See http://www.etsi.org for further information

Note: Some national PTT authorities may have additional requirements exceeding the above standards and requirements. Such additional requirements have only been respected to the extent that they were known to austriamicrosystems prior to designing the product. However, austriamicrosystems shall not be liable to recipient or any third party in connection with the approval procedures of applications in which the AS25xx is used.

Approvals

Since the AS25xx is a component and not a complete system, it can not be approved as a stand alone part by the standards bodies. Hence, full conformance to above standards is depending on the application in which the AS25xx is being used, and therefore, approvals by the standards bodies are the responsibility of the customer and austriamicrosystems will not have tested the product to meet the above standards.

Ordering information

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