



voice INTER connect

Documentation

"vicCOM 2"

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History

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02	Adaptation to software version 2.0.7.0.0	04/02/2014	Kinast
03	Review document	10/02/2014	Kinast
04	more extensive descriptions in B.4, added software features (section 5.3), added vicCOM-Manager (section 7), corrected transport layer of binary protocol	20/03/2014	Kinast
05	Adaptation to new hardware revision	26/11/2015	Kinast
06	Adaptation to software version v2.1.0.0.0	04/05/2016	Kinast
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List Of Abbreviations

Aec	Acoustic Echo Cancellation
Aes	Acoustic Echo Suppression
Attn	Attenuation
Comp	Compressor
Dcf	DC Filter
Eq	Equaliser
Fdb	Feedback
Lc	Loss Control
Lec	Line Echo Cancellation
Lim	Limiter
Mic	Microphone
Notch	Notch Filter
Ng	Noise Gate
Nr	Noise Reduction
Spk	Loudspeaker
Thr	Threshold
Vol	Volume

1 Key Features

- Acoustic echo cancellation up to 40 dB
- Acoustic echo suppression
- Line echo cancellation up to 40 dB
- Noise reduction
- Intelligent loss control
- Signal conditioning for microphone and loudspeaker (Compressor, Limiter, Noise Gate, Equaliser, Notch filter)
- Level adjustment to signal sources and sinks
- Management of different parameter sets
- ASCII and binary protocol for setting parameters at runtime
- Multimedia bandwidth with sampling frequency $f_s = 16$ kHz
- Playback and management of audio files (e.g. ring tones) up to a total playing time of approx. 230 s
- Easy integration into existing systems (analogue signal sources and sinks)
- Software can be updated
- Microphone input can be used as line input
- Edge contacts for direct soldering to your own circuit board, alternatively via ribbon connector
- 100% pin-compatible to vicCOM

2 Changelog

[2016-11-08] Software v2.1.2.0.0

- BUGFIX: Parameter SpkEq0n was not set properly

[2016-05-31] Software v2.1.1.0.0

- BUGFIX: Boot parameter was not set properly

[2016-05-04] Software v2.1.0.0.0

- Most recent version of AEC and AES with a lot of improvements
- Residual echo (RES) is renamed to acoustic echo suppression (AES)
- NrAttn is now a positive value
- LcLoopGain is renamed to LcRelAttn
- FdbAudio is renamed to LcFdbAudio
- FdbLine is renamed to LcFdbLine
- MinEchoAttn is renamed to LcAudioEchoAttn
- new parameter for echo cancellation (see section A.1):
AecTailLen, AesNearEchoSupp, AesFarEchoSupp, AesNonlinEchoSupp, AesReverbTime, LecTailLen, LcLineEchoAttn, LcDelayAudio, LcDelayLine, LcNoiseFade0n, LcNoiseFadeRate
- new parameter for loudspeaker (see appendix A.2):
SpkLimRel, SpkNgAttn, SpkNgFade, SpkCompRel, SpkEq0n, SpkEq[Low|High]Freq, SpkEq[Low|High]Gain, SpkNotch0n, SpkNotch[1|2|3]Freq, SpkNotch[1|2|3]Bw, SpkNotch[1|2|3]Gain
- new parameter for microphone (see appendix A.3):
MicLimRel, MicNgAttn, MicNgFade, MicCompRel, MicDcf0n, MicDcfCutoff, MicEq0n, MicEq[Low|High]Freq, MicEq[Low|High]Gain, MicNotch0n, MicNotchFreq, MicNotchBw, MicNotchGain
- new revision of parameter file (FileRev=6) and ini file (FileRev=2)
- Changed end of line for ASCII outputs from <\n> to <\r\n>
- Changed end of line for ASCII inputs from <\n> to <\r>
- Changed value of parameter Play0ut (0 and 1 swapped)

[2015-11-26] Hardware v2.3

- Correction for ribbon connector: swapped RX/TX for UART connection

[2014-09-02] Software v2.0.9.0.0

- first official release of vicCOM 2

3 System Integration

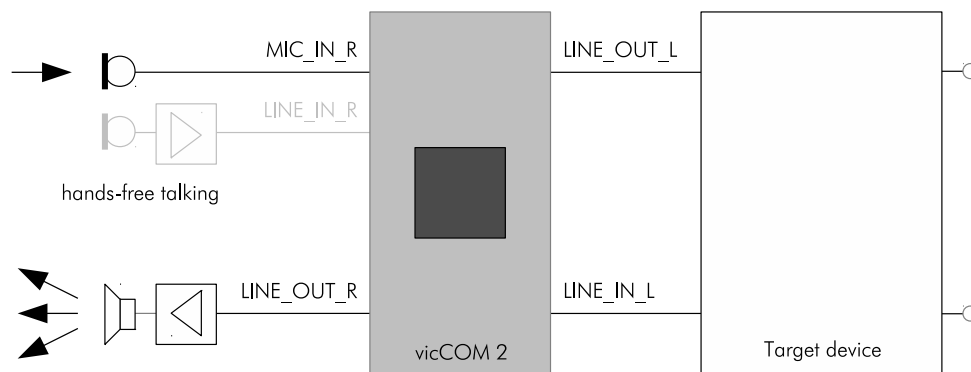


Figure 1: System integration for direct connection of an electret microphone or a microphone with external pre-amplifier (marked in lightgray)

Connector	Description
MIC_IN_R	Direct connection of an electret microphone. The bias voltage is provided by MIC_BIAS and should be connected with MIC_IN_R. The vicCOM 2 can be adjusted to the sensitivity of the electret microphone (see section 6.1). It is also possible to set the volume of the microphone.
LINE_IN_R	Alternative connector of a pre-amplified microphone signal (line level).
LINE_OUT_R	Loudspeaker signal with line level to connect an external audio amplifier. The vicCOM 2 can be adjusted to the input sensitivity of the audio amplifier (see section 6.1). Caution: For an optimal performance of the acoustic echo cancellation the volume of the loudspeaker must be set via the control interface of the vicCOM 2. Volume control outside of the vicCOM 2 is not recommend.
LINE_IN_L	Loudspeaker signal with line level of target device to vicCOM 2. The vicCOM 2 can be adjusted to the output level of the target device (see section 6.1).
LINE_OUT_L	Microphone signal of target device to vicCOM 2. The vicCOM 2 can be adjusted to the input level of the target device (see section 6.1).

4 Hardware

4.1 Version

Description	Board version	Placement variant
vicCORE-3	2.3	3

4.2 Connection and Environmental Conditions

4.2.1 Absolute Maximum Ratings

Symbol	Name	Value	Unit
T_{STORE}	Storage temperature range	−65 to 120	°C
T_{OP}	Operating temperature Range	−40 to 85	°C
FC	UL94 Flammability class	V-0	
V_{DD}	Operating voltage	2,7 bis 3,6	V

4.2.2 Operating Conditions

Symbol	Name	Min	Norm	Max	Unit
V_{DD}	Operating voltage	3,0	3,3	3,5	V
I_{DD}	Current consumption		90		mA
U_{MIC}	Voltage at microphone input MIC_IN_R (with GainMic = +20 dB)		30	100	mV(RMS)
U_{IN}	Voltage at LINE_IN_R and LINE_IN_L	0	1	1	V(RMS)
U_{OUT}	Voltage at LINE_OUT_R and LINE_OUT_L	0	1	1	V(RMS)
U_{RESET}	Voltage at reset input	0	3,3	V_{DD}	V

4.2.3 Audio Inputs

The impedance of the audio inputs is produced by the input circuitry of the vicCOM 2 (see figure 2). As can be seen the input resistance of the audio codec have an importance influence (gain adjustable with GainMic and GainLineIn). The relationship between the gain and the input resistance is given in the following table. The maximum DC offset is limited to 16 V.

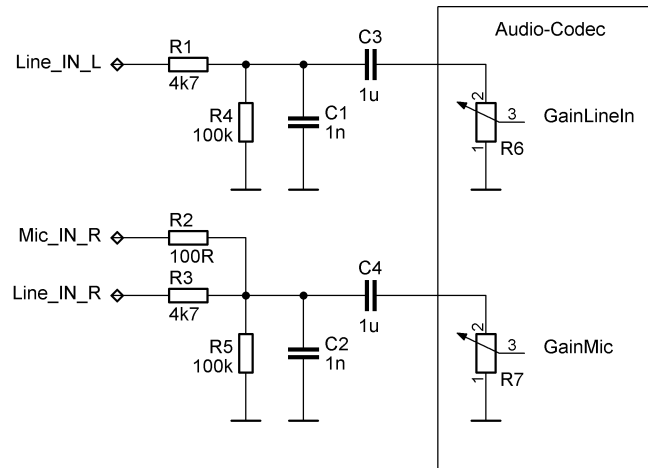


Figure 2: Audio inputs of vicCOM 2

Input resistors R6 / R7	
G in dB	R _{in} in kΩ
-12	85
0	53
25	5,6
35	2,0

4.2.4 Audio Outputs

The impedance of audio output is determined by the low impedance of the audio codec output which is not specified by the data sheet. The maximum DC offset is limited to 16 V.

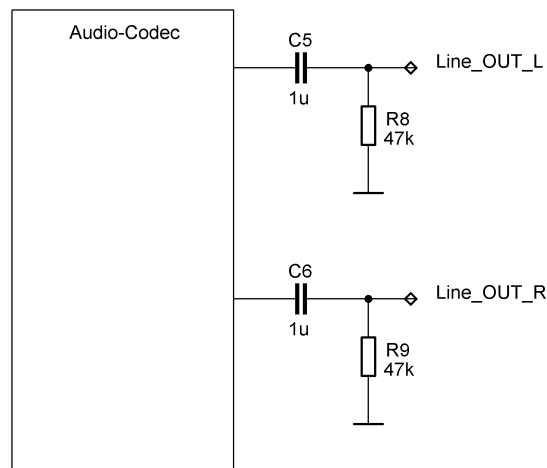


Figure 3: Audio outputs of vicCOM 2

4.3 Connections

4.3.1 Edge Contacts

All connections of the vicCOM 2 are implemented as edge contacts (see X101 – X146 in figure 4). It can be directly soldered onto a base board. Alternatively, a subset of the connections can be connected via the ribbon connector (see CON101 in figure 4), see section 4.3.2.

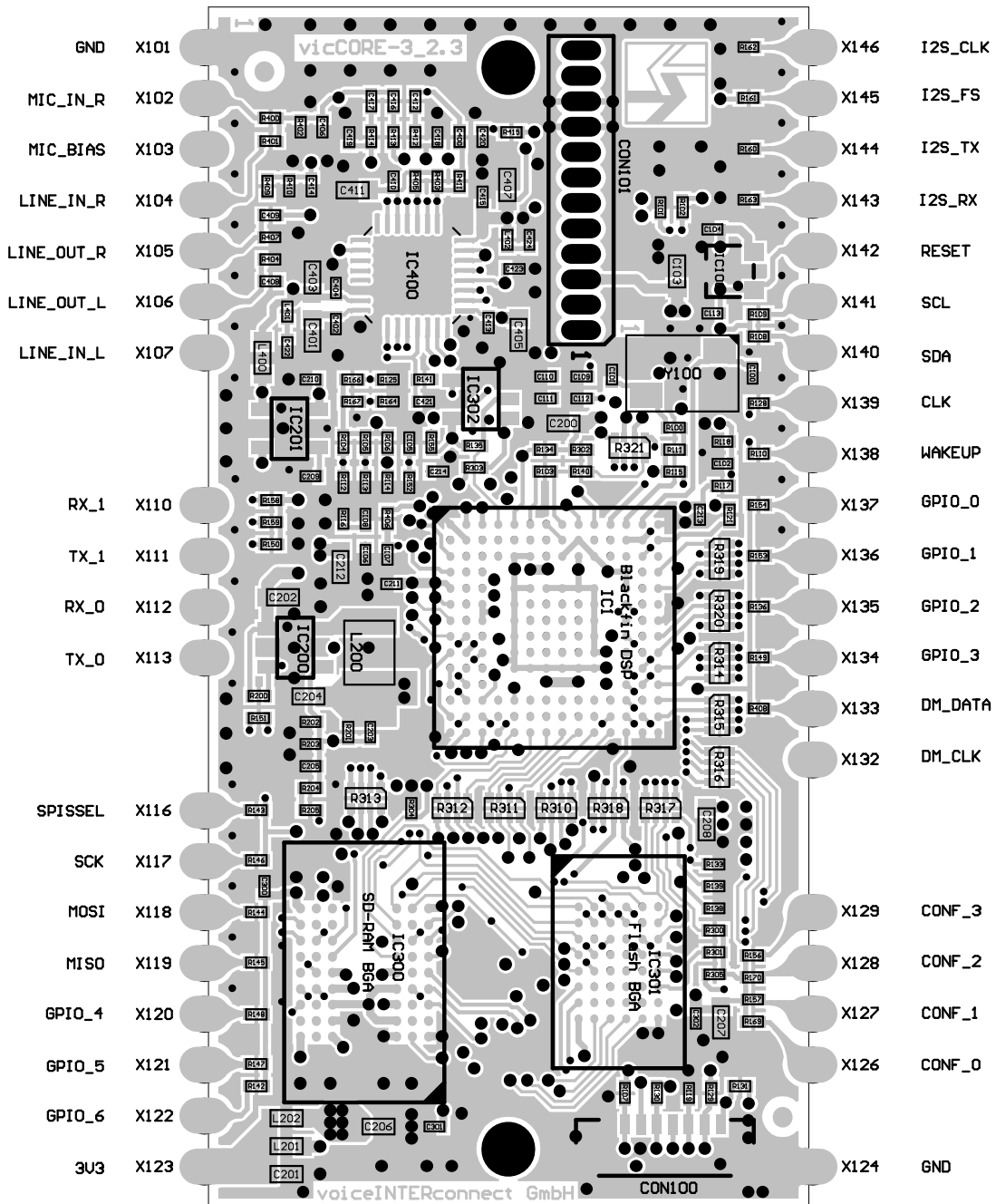


Figure 4: Edge contacts of vicCOM 2

Pin	Type	Name	Description
X101	Input	GND	Ground for audio connections X102 – X107
X102	Input	MIC_IN_R	Electret microphone
X103	Input	MIC_BIAS	Bias voltage for electret microphone (3,3 V; 2,2 kΩ)
X104	Input	LINE_IN_R	Optional microphone input (line level)
X105	Output	LINE_OUT_R	Audio signal for loudspeaker (line level)
X106	Output	LINE_OUT_L	Audio signal to target device (line level)
X107	Input	LINE_IN_L	Audio signal from target device (line level)
X110	Input	RX_1	UART-1-RX signal – as UART-0
X111	Output	TX_1	UART-1-TX signal – as UART-0
X112	Input	RX_0	UART-0-RX signal to control vicCOM 2
X113	Output	TX_0	UART-0-TX signal to output messages from vicCOM 2
X116	Output	SPISEL	internal use
X117	Output	SCK	internal use
X118	Output	MOSI	internal use
X119	Input	MISO	internal use
X120	In-/Output	GPIO_4	not used (high-impedance)
X121	In-/Output	GPIO_5	not used (high-impedance)
X122	In-/Output	GPIO_6	not used (high-impedance)
X123	Input	3V3	Supply voltage (+)
X124	Input	GND	Supply voltage (GND)
X126	Input	CONF_0	not used
X127	Input	CONF_1	not used
X128	Input	CONF_2	not used
X129	Input	CONF_3	not used
X132	Output	DM_CLK	internal use
X133	Input	DM_DATA	not used
X134	In-/Output	GPIO_3	not used (high-impedance)
X135	In-/Output	GPIO_2	not used (high-impedance)
X136	In-/Output	GPIO_1	not used (high-impedance)
X137	In-/Output	GPIO_0	not used (high-impedance)
X138	Input	WAKEUP	not used (high-impedance)
X139	Output	CLK	not used (high-impedance)

X140	In-/Output	SDA	not used (high-impedance)
X141	In-/Output	SCL	not used (high-impedance)
X142	Input	RESET	Hardware reset of vicCOM 2 Attention: low-active!
X143	Input	I2S_RX	not used
X144	Output	I2S_TX	not used (high-impedance)
X145	In-/Output	I2S_FS	not used (high-impedance)
X146	In-/Output	I2S_CLK	not used (high-impedance)

4.3.2 Ribbon Connector

The 12-pin ribbon connector is shown in figure 5. The numbering starts with pin 1 from the centre of the board. It uses a grid of 1,27 mm.

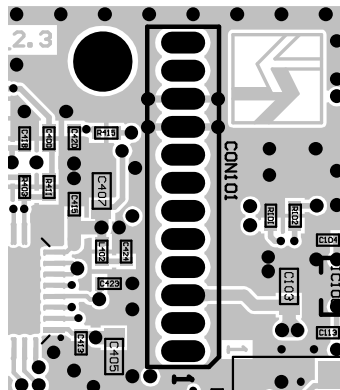


Figure 5: Ribbon connector of vicCOM 2

Pin	Type	Name	Description
Pin 1	In-/Output	SDA	not used (high-impedance)
Pin 2	In-/Output	SCL	not used (high-impedance)
Pin 3	Input	3V3	Supply voltage (+)
Pin 4	Input	LINE_IN_L	Audio signal from target device (line level)
Pin 5	Output	LINE_OUT_L	Audio signal to target device (line level)
Pin 6	Output	LINE_OUT_R	Audio signal for loudspeaker (line level)
Pin 7	Input	RX_1	UART-1-RX signal
Pin 8	Output	TX_1	UART-1-TX signal
Pin 9	Input	GND	Supply voltage (Ground)
Pin 10	Input	GND	Ground for audio signals
Pin 11	Output	MIC_BIAS	Bias voltage for electret microphone (3,3 V; 2,2 kΩ)
Pin 12	Input	MIC_IN_R	Electret microphone (+)

4.4 Dimensions

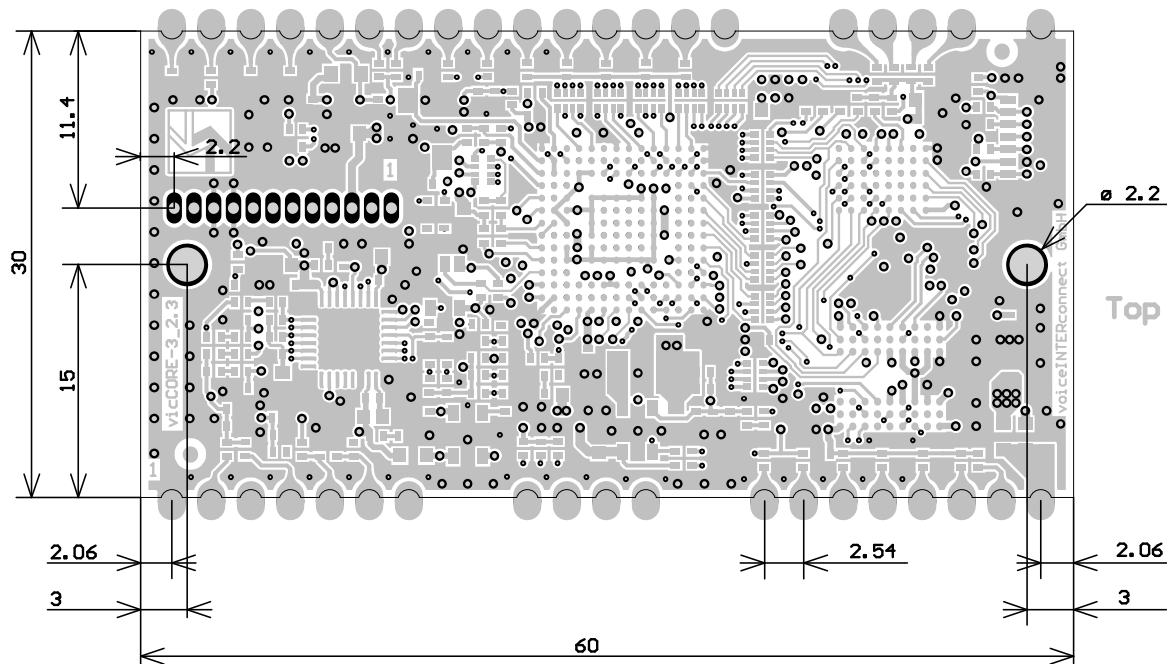


Figure 6: Dimensions of vicCOM 2 in mm

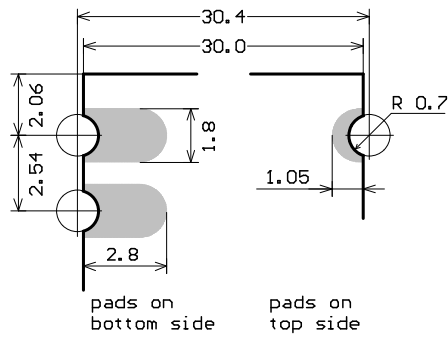


Figure 7: Dimensions of edge contacts in mm

4.5 Recommended Footprint

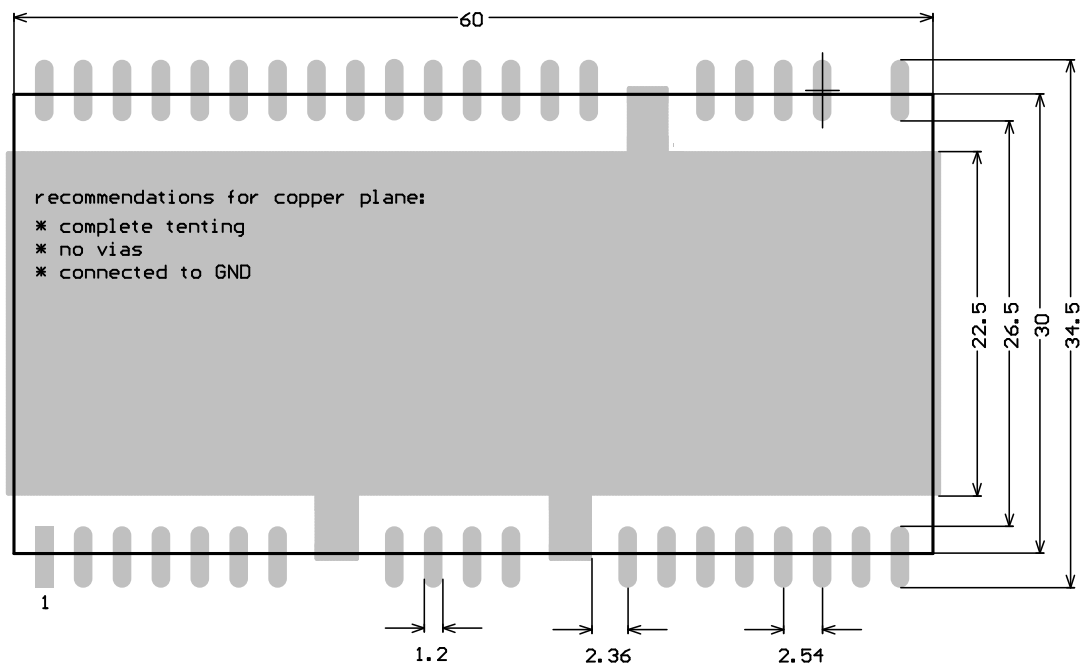


Figure 8: Recommended Footprint of vicCOM 2 in mm

5 Software

5.1 Version

Description
vicCOM2 v2.1.2.0.0

The software can be updated (see section 5.6). The version of the software could be readout via the control interface (see section 5.4).

5.2 Function

5.2.1 Signal Processing

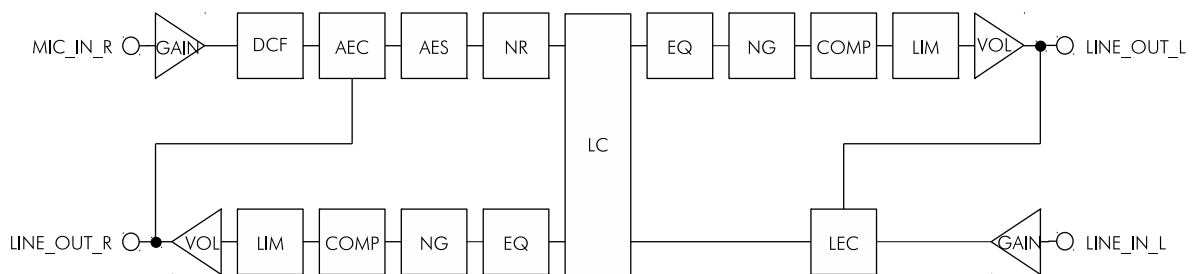


Figure 9: Block diagram of signal processing

The figure 9 shows all signal processing blocks that can be used and adjusted with the vicCOM 2. The abbreviations inside the blocks are explained in the list of the abbreviations at the beginning of the document.

The signal processing is designed to provide a full duplex hands-free speech operation. For that the microphone signal is equipped with the acoustic echo cancellation (AEC) and acoustic echo suppression (AES) and the line-in is equipped with the line echo cancellation (LEC). Furthermore the microphone signal and the loudspeaker signal can be influenced by noise suppression (NR, NG), sound equalising and filtering (EQ, DCF) and volume adjustments (COMP, LIM, VOL, GAIN) to fit the own needs.

For challenging acoustical environments the vicCOM 2 is able to switch to half duplex operation (LC) or to use full and half duplex operation side by side respectively.

5.2.2 Setting and Management of Parameter

The vicCOM 2 can be parametrised at runtime via the ASCII- or the binary interface respectively (see section 5.4). The values will be set immediately but will be not saved permanently. That means these settings will be lost during switch off or reboot. To keep them permanently the parameter file has to be saved on vicCOM 2.

The vicCOM 2 comes with two parameter files `default.param` and `user_1.param`. The parameter file `default.param` cannot be overwritten via ASCII-interface to protect it against accidentally saving of wrong settings. To save own settings use the parameter file `user_1.param`. To do so switch to this file **before** you start changing

parameters with command `ParamRead`. After setting the parameters successfully the command `ParamSave` saves the current settings in the current active parameter file. To use multiple different parameter settings download the parameter file `user_1.param` with the `vicCOM-Manager` (see section 7) to the PC, edit it and save it under a different name. The amount of parameter files depends only on the free space at the `vicCOM 2`.

The `vicCOM 2` boots by default with the parameters of the file `default.param`. The command `ParamBoot` changes the parameter file to boot from with the next boot cycle.

5.2.3 Playing Audio Files

During the normal hands-free operation at any time it is possible to play an audio file from the `vicCOM 2` with the command `Play`. At the end of playing the `vicCOM 2` switches back to hands-free operation automatically. By default the `vicCOM 2` provides two audio files: `ringtone.wav` and `gong.wav`. Furthermore it is possible to store your own audio files on the `vicCOM 2` using the `vicCOM-Manager` (see section 7). The amount or the length of the audio files depends only on the free space at the `vicCOM 2`.

Caution: At the moment only the following audio format is supported:

- "wav" with 16 Bit/16 kHz

5.3 Features

Besides the parameters that can be changed on runtime the software and the signal processing have some fixed characteristics listed in the following table:

Symbol	Name	Value	Unit
t_{ResetIC}	Turn-on delay by reset-chip	approx. 200	ms
t_{Boot}	Boot time of software	approx. 250	ms
t_{Total}	Time from turn-on to hands-free operation (= $t_{\text{ResetIC}} + t_{\text{Boot}}$)	approx. 450	ms
f_s	Sampling frequency of signal processing	16	kHz
$t_{\text{Mic-Line}}$	Time delay of microphone signal at line out	max. 78	ms
$t_{\text{Line-Spk}}$	Time delay of line in signal at loudspeaker output	47	ms
Lim_{Clip}	Clip mode of limiter (soft = soft-knee, hard = hard-knee)	soft	–

5.4 Control Interface

The `vicCOM 2` is equipped with a control interface supporting following actions:

- Readout, adjust and save parameters
- Management of parameter files
- Play and management of audio files
- Output of status messages

- Update of software

The control interface is accessible via both UART-connections of the vicCOM 2. Both UART-connections have the same functionality but only UART-1 is wired to the ribbon connector. For instance one UART can be used to connect the vicCOM 2 to a host processor meanwhile the second UART is used to be connected to a PC. The program "Terminal" is recommended to use on a PC and can be downloaded for free: <https://sites.google.com/site/terminalbpp/> (Windows only).

Both UART-connections are configured as:

Data rate: 115200 Baud
 Data bits: 8 Bit
 Parity: none
 Stop bit: 1 Bit
 Handshaking: none

5.5 Control Protocol

The control protocol of the control interface provides two different formats:

1. *ASCII* – for human-readable protocol to use with a terminal program
2. *Binary* – for machine-based control, e.g. by a host controller

Both formats can be used at the same time, it is not necessary to switch between them.

5.5.1 ASCII

The ASCII-protocol is characterised by its easy and intuitive syntax. It is especially designed to set-up or evaluating the vicCOM 2. The control commands are divided in parameter (control commands with values) and function calls (control commands without values). All ASCII-control commands are listed in appendix A.

The ASCII-in- and outputs are configured as:

Direction	Name	ASCII-symbols	Hexadecimal
Output	End of line	CR+LF	0x0D 0x0A
Output	Prompt	>	0x3E
Input	End of line	CR	0x0D

Inputs and Outputs

On start-up the first strings displayed by the vicCOM 2 are the start-up message:

```

INF: -----
INF: hands-free speech application
INF: by voice INTER connect GmbH
INF: vicCOM2 2.1.2.0.0 (Nov 8 2016)
INF: -----

INF: starting ...
INF: File system initialized.
INF: Boot parameter file: default.param
INF: done.
INF: >

```

The angle bracket at the end is the prompt and signals that the vicCOM 2 is ready for input:

```
<CR> <CR>
```

... outputs all control commands and parameters including their current values

```
Parameter<CR>
```

... outputs the current value of the given *Parameter*

```
Parameter=Value<CR>
```

... assigns the given *Parameter* a new *Value* (without white-spaces!)

```
Function call<CR>
```

... carries out the given *Function call* and returns the following output:

```
[<optional, function-specific output>]
Ok.
>
```

... i.e. function calls will be always acknowledged at the end by Ok. and a >

Error messages

```
Variable or command not found.
>
```

... the given control command was not found (e.g. misspelled)

```
Value out of range.
>
```

... the given value of parameter is out of range

```
Input too long.
>
```

... the input string is too long (e.g. multiple parameters on one line)

5.5.2 Binary

The binary format of the control protocol was developed mainly for machine based interaction between the vicCOM 2 and a host controller. The vicCOM 2 reacts to incoming messages (Request) with outgoing messages (Respond) and send its own messages (Status) without any request. The binary commands are specified in appendix B.

The binary format of the control protocol is subdivided into a transport layer and a command layer.

Transport Layer

<Start><Type><Length1> [<CS>] [<S-Port>] [<T-Port>] [ACK] [<Data>]

Name	Length in Byte	Description
<Start>	1	Start byte 0x8F
<Type>	1	specifies the following parameters: Bit [7]: 0 (reserved) Bit [6]: <S-Port> available (1), not available (0) Bit [5]: <T-Port> available (1), not available (0) Bit [4]: Request for acknowledge (1), no request (0) Bit [3]: flag for acknowledge (1), no acknowledge (0) Bit [2:0]: <CS> specification (see next section)
<Length1>	1	Length of <Data>
<CS>	1–4	Checksum Caution: Signature for <Type> byte and all following bytes! Hint: Length and algorithm will be determined by the <Type> byte!
<S-Port>	1	(optional) Source port (is used as target port in the opposite direction)
<T-Port>	1	Target port 0x0F: Application
<ACK>	1	Acknowledge of transport layer with ok (0), otherwise not ok
<Data>	<i>Length 1</i>	Data for command layer

Checksum specification

The <Type> byte specifies the algorithm of the checksum. The following algorithms are implemented:

Bit [2:0]	Name	Specification
000	no CS	–
001	BYTESUM8	Length: 1 Byte BYTESUM8_INITIAL: 0x00

010	XOR8	Length: 1 Byte XOR8_INITIAL: 0x00
011	CRC8	Length: 1 Byte CRC8_POLYNOMIAL: 0x07 CRC8_MODE: <i>crc_eModeForward</i> CRC8_INITIAL: 0xFF
100	BYTESUM16	Length: 2 Byte BYTESUM16_INITIAL: 0x0000
101	CRC16	Length: 2 Byte CRC16_POLYNOMIAL: 0x1021 CRC16_MODE: <i>crc_eModeForward</i> CRC16_INITIAL: 0xFFFF
110	CRC32	Length: 4 Byte CRC32_POLYNOMIAL: 0x04C11DB7 CRC32_MODE: <i>crc_eModeForward</i> CRC32_INITIAL: 0xFFFFFFFF
111	reserved	Length: 4 Byte for integration of particular CS

Command Layer

<Command1><Command2>[<Payload>]

Name	Length in Byte	Description
<Command1>	1	Bit [7]: ACK of command layer (1), no ACK (0) Bit [6]: Request for ACK (1), no request (0) Bit [5]: 0x00 Bit [4]: 0x00 Bit [3:0]: Command group
<Command2>	1	Bit [7:0]: Command Caution: Bit [0]: REQ (0), RES (1)
<Payload>	<i>flexible</i>	Payload of command

Status codes

The majority of the responses send within the payload a status byte located directly behind <Command2>. It can be used to control if the request was processed successfully. The following errors will be reported:

Status code	Description
-------------	-------------

0x00	Ok, no error
0x01	General error
0x04	Feature not available
0x05	Parameter out of range
0x06	File not found
0x07	vicCOM 2 is busy
0x08	Wrong revision of parameter file

5.6 Update

The software update is provided by *voice INTER connect GmbH* as the file `application_release.ldr`. This file should be uploaded to the *vicCOM 2* by using the *vicCOM-Manager* (see section 7).

The new software will be used after resetting the *vicCOM 2*.

6 Parametrisation

6.1 Adjusting Audio Levels

For an optimal performance of the signal processing it is essential to adjust the audio levels properly to the connected devices. For this purpose the commands `GainSpk`, `GainMic`, `GainLineIn` and `GainLineOut` (see section A.6 or B.5) should be used. All values are in dB. The reference value is calculated with the maximum voltage level of in- and output that is given in the table in section 4.2:

$$0 \text{ dB} = 1 \text{ V(RMS)} \quad (1)$$

Example:

Electret microphone according to data sheet:

$$\text{Sensitivity} = -40 \text{ dB} \quad (0 \text{ dB} = 1 \text{ V/Pa}) \quad (2)$$

Maximum output voltage of microphone at an assumed sound pressure level of 114 dB(SPL) und 1 Pa = 94 dB(SPL):

$$U_{\text{Mic,max}} = 10^{\frac{(-40+(114-94))\text{dB}}{20\text{dB}}} = 100 \text{ mV(RMS)} \quad (3)$$

`GainMic` has to be adjusted to:

$$\text{GainMic} = 20 \log \frac{1 \text{ V(RMS)}}{100 \text{ mV(RMS)}} = 20 \text{ dB} \quad (4)$$

That means that the input gain has to be increased by 20 dB in order to use the full voltage range of the `vicCOM 2`. Before setting up the values ultimately consider the following hint:

Caution:

In any circumstances avoid clipping of the audio signal by a gain that is too high! Otherwise the function of the signal processing could be impaired!

It is recommended to use an audio signal headroom of at least 6 dB and to use always the commands `SpkVol` and/or `MicVol` to adjust the volume.

6.2 Adjusting Volume

The volume of microphone and loudspeaker should be always adjusted by the commands `SpkVol` and `MicVol` since the signal processing needs the current values for working optimal. External volume changes could lead to malfunctions in signal processing!

Once again, if the volume setting is to high and the audio signal is clipped the signal processing is not working properly any more.

7 vicCOM-Manager

7.1 Version

- Version: 1.3 (Windows XP, 7, 8.1)

7.2 Function

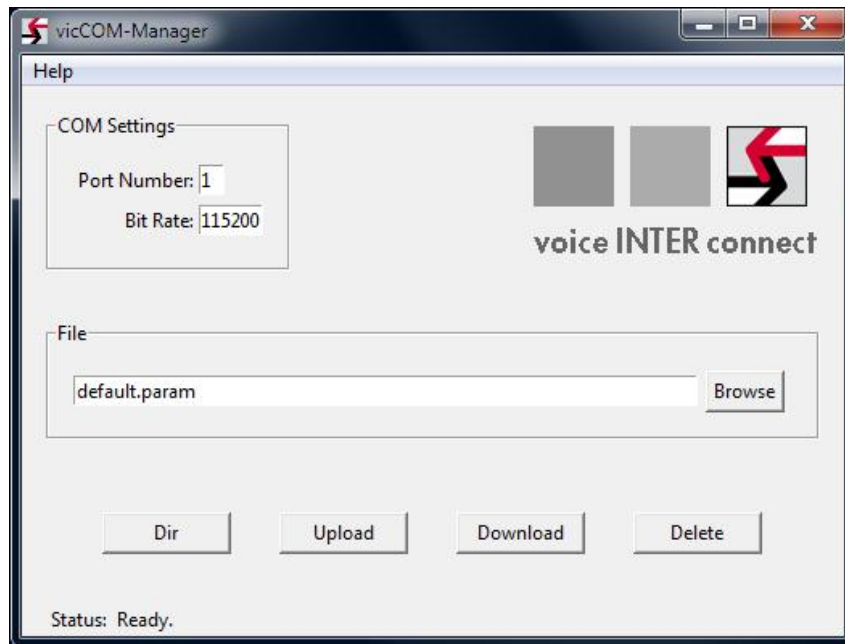


Figure 10: Screenshot vicCOM-Manager

The vicCOM-Manager is a PC-based tool to manage the vicCOM 2. It is used mainly for software updates, uploading audio files and exchanging parameter files between the PC and the vicCOM 2.

Caution:

There is no notification before existing files will be overwritten on PC or on the vicCOM 2!

Upload: (PC → vicCOM 2)

- enter number of COM-port where the vicCOM 2 is connected
- choose the right file on PC with "Browse"
- **alternatively:** enter file name including relative path directly
- click "Upload" and wait until the status display shows "Ok."

Download: (vicCOM 2 → PC)

- enter number of COM-port where the vicCOM 2 is connected

- navigate to a folder with "Browse" and enter the file name that should be downloaded
- **alternatively:** enter file name including relative path directly
- click "Download" and wait until the status display shows "Ok."

7.3 Remarks

1. The COM-port should not be occupied by any other application.
2. The data exchange during up- and downloading is secured by checksum algorithm CRC32.
3. The data exchange is carried out using data rate of about 5,6 kB/s.

APPENDIX

A ASCII Control Commands

A.1 Echo Suppression

Parameter/ Function	Value Default	Value Range	Description
AecOn	1	0/1	Switch off (=0) and switch on (=1) of acoustic echo cancellation (AEC)
AecTailLen	60	20 ...100	Filter length of AEC in ms Attention: Only multiplier of 10 possible!
AesOn	1	0/1	Switch off (=0) and switch on (=1) of acoustic echo suppression (AES) of AEC
AesNearEchoSupp	72	0 ...100	Suppression of near, direct residual echos
AesFarEchoSupp	65	0 ...100	Suppression of far, spatial residual echos
AesNonlinEchoSupp	10	0 ...100	Suppression of nonlinear residual echos
AesReverbTime	400	0 ...1000	Reverberation time of far, spatial echos in ms
NrOn	1	0/1	Switch off (=0) and switch on (=1) of noise reduction (NR) in microphone signal
NrAttn	6	0 ...20	Strength of noise reduction in microphone signal in dB
LecOn	0	0/1	Switch off (=0) and switch on (=1) of line echo cancellation (LEC)
LecTailLen	10	10	Filter length of LEC in ms ATTENTION: only fixed time possible at the moment!
LcOn	0	0/1	Switch off (=0) and switch on (=1) of loss control (LC)
LcRelAttn	0	-96 ...0	relative attenuation of loss control in dB
LcFdbAudio	0	-96 ...96	measured feedback between loudspeaker and microphone in dB
LcFdbLine	0	-96 ...96	measured feedback between Line-Out and Line-In in dB
LcAudioEchoAttn	0	-96 ...0	estimated minimum echo attenuation of AEC in dB
LcLineEchoAttn	0	-96 ...0	estimated minimum echo attenuation of LEC in dB
LcDelayAudio	0	0 ...1000	maximum delay between loudspeaker and microphone signal in ms
LcDelayLine	0	0 ...1000	maximum delay between Line-Out and Line-In signal in ms
LcNoiseFadeOn	1	0/1	Switch off (=0) and switch on (=1) of fade out in voice inactivities
LcNoiseFadeRate	60	1 ...96	Velocity of fade out in voice inactivities in dB/s

A.2 Loudspeaker

Parameter/ Function	Value		Description
	Default	Range	
SpkVol	0	-96 ...96	Loudspeaker volume in dB
SpkLimOn	0	0/1	Switch off (=0) and switch on (=1) of limiter (LIM)
SpkLimThr	0	-96 ...0	Voltage threshold for limiter in dB (0 dB = 1 V(RMS))
SpkLimRel	60	1 ...96	Release rate of limiter in dB/s
SpkNgOn	0	0/1	Switch off (= 0) and switch on (= 1) of noise gate (NG)
SpkNgThr	-96	-96 ...0	Voltage threshold of noise gate in dB (0 dB = 1 V(RMS))
SpkNgAttn	20	0 ...96	Attenuation of noise gate in dB
SpkNgFade	60	0 ...96	Velocity of fade of noise gate in dB/s
SpkCompOn	0	0/1	Switch off (=0) and switch on (=1) of compressor (COMP)
SpkCompThr	-96	-96 ...0	Voltage threshold of compressor in dB (0 dB = 1 V(RMS))
SpkCompRatio	1	1 ...10	Ratio of compressor
SpkCompRel	60	1 ...96	Release rate of compressor in dB/s
SpkEqOn	0	0/1	Switch off (=0) and switch on (=1) of equaliser (EQ)
SpkEqLowFreq	300	1 ...4000	Cut off frequency of lower frequency band of EQ in Hz
SpkEqLowGain	0	-96 ...96	Gain of lower frequency band of EQ in dB
SpkEqHighFreq	4000	1k ...8k	Cut off frequency of upper frequency band of EQ in Hz
SpkEqHighGain	0	-96 ...96	Gain of upper frequency band of EQ in dB
SpkNotchOn	0	0/1	Switch off (=0) and switch on (=1) of notch filter (NOTCH)
SpkNotch1Freq	300	1 ...8000	Centre frequency of notch filter 1 in Hz
SpkNotch1Bw	100	1 ...2000	Band width of notch filter 1 in Hz
SpkNotch1Gain	0	-96 ...96	Gain of notch filter 1 in dB
SpkNotch2Freq	1000	1 ...8000	Centre frequency of notch filter 2 in Hz
SpkNotch2Bw	200	1 ...2000	Band width of notch filter 2 in Hz
SpkNotch2Gain	0	-96 ...96	Gain of notch filter 2 in dB
SpkNotch3Freq	4000	1 ...8000	Centre frequency of notch filter 3 in Hz
SpkNotch3Bw	300	1 ...2000	Band width of notch filter 3 in Hz
SpkNotch3Gain	0	-96 ...96	Gain of notch filter 3 in dB

A.3 Microphone

Parameter/ Function	Value		Description
	Default	Range	
MicVol	0	-96 ...96	Microphone volume in dB
MicLimOn	0	0/1	Switch off (=0) and switch on (=1) of limiter (LIM)
MicLimThr	0	-96 ...0	Voltage threshold of limiter in dB (0 dB = 1 V(RMS))
MicLimRel	60	1 ...96	Release rate of limiter in dB/s
MicNgOn	0	0/1	Switch off (=0) and switch on (=1) of noise gate (NG)
MicNgThr	-96	-96 ...0	Voltage threshold of noise gate in dB (0 dB = 1 V(RMS))
MicNgAttn	20	0 ...96	Attenuation of noise gate in dB
MicNgFade	60	0 ...96	Velocity of fade of noise gate in dB/s
MicCompOn	0	0/1	Switch off (=0) and switch on (=1) of compressor (COMP)
MicCompThr	-96	-96 ...0	Voltage threshold of compressor in dB (0 dB = 1 V(RMS))
MicCompRatio	1	1 ...10	Ratio of compressor
MicCompRel	60	1 ...96	Release rate of compressor in dB/s
MicDcfOn	1	0/1	Switch off (=0) and switch on (=1) of DC filter (DCF)
MicDcfCutoff	100	1 ...1000	Cut off frequency of DC filter in Hz
MicEqOn	0	0/1	Switch off (=0) and switch on (=1) of equaliser (EQ)
MicEqLowFreq	300	1 ...4000	Cut off frequency of lower frequency band of EQ in Hz
MicEqLowGain	0	-96 ...96	Gain of lower frequency band of EQ in dB
MicEqHighFreq	4000	1k ...8k	Cut off frequency of upper frequency band of EQ in Hz
MicEqHighGain	0	-96 ...96	Gain of upper frequency band of EQ in dB
MicNotchOn	0	0/1	Switch off (=0) and switch on (=1) of notch filter (NOTCH)
MicNotchFreq	1000	1 ...8000	Centre frequency of notch filter in Hz
MicNotchBw	100	1 ...2000	Band width of notch filter in Hz
MicNotchGain	0	-96 ...96	Gain of notch filter in dB

A.4 Playing Audio Files

Parameter/ Function	Value		Description
	Default	Range	
PlayerVol	-6	-96 ...96	Volume of audio file
PlayerOutput	0	0 ...1	Output channel of audio file (0 = Line-Out output; 1 = Loudspeaker output)
Play	<i>File name</i>	-	Playing of given audio file

A.5 Management of Parameter

Parameter/ Function	Value		Description
	Default	Range	
ParamName	–	–	Display name of active parameter file
ParamRev	–	–	Display revision of active parameter file
ParamSave	–	–	Store of current parameters in active parameter file Hint: The default parameter file cannot be overwritten.
ParamRead	<i>File name</i>	–	Load and apply settings of given parameter file
ParamDefault	–	–	Load and apply settings of default parameter file
ParamBoot	<i>File name</i>	–	Set parameter file which will be loaded after next boot sequence

A.6 Common

Parameter/ Function	Value		Description
	Default	Range	
Ping	–	–	Check accessibility of platform
Version	–	–	Display of software version
GainSpk	0	-57 ...6	Gain of loudspeaker output at audio codec in dB
GainMic	20	-12 ...35	Gain of microphone input at audio codec in dB
GainLineIn	0	-12 ...35	Gain of Line-In at audio codec in dB
GainLineOut	0	-57 ...6	Gain of Line-Out at audio codec in dB

B Binary Control Commands

All the commands below are using the simplest way of the binary protocol without source port, checksum and acknowledgement.

B.1 Echo Suppression

Name	Command-ID	Name	Command-ID
AecOn	0x02	LcOn	0x0C
AecTailLen	0x20	LcRelAttn	0x0E
AesOn	0x04	LcFdbAudio	0x10
AesNearEchoSupp	0x2A	LcFdbLine	0x12
AesFarEchoSupp	0x2C	LcAudioEchoAttn	0x14
AesNonlinEchoSupp	0x2E	LcLineEchoAttn	0x16
AesReverbTime	0xB0	LcDelayAudio	0x18
NrOn	0x06	LcDelayLine	0x1A
NrAttn	0x08	LcNoiseFadeOn	0x1C
LecOn	0x0A	LcNoiseFadeRate	0x1E
LecTailLen	0xB2		

REQUEST								
	Start	Type	Length	T-Port	Command1	Command2	Command-ID	Value
SET:	0x8F	0x20	0x04	0x0F	0x02	0x02	see above	see section A.1
GET:	0x8F	0x20	0x03	0x0F	0x02	0x04	see above	–

RESPONSE			
Byte	Value	Description	
SET			
1	0x8F	Start	
2	0x40	Type	
3	0x04	Length	
4	0x0F	S-Port	
5	0x02	Command1	
6	0x03	Command2	
7		Status (0x00 = ok, else error)	
8		Command-ID	
GET			
1	0x8F	Start	
2	0x40	Type	
3	0x05	Length, if length of Value = 1 Byte	
	0x06	Length, if length of Value = 2 Byte	
4	0x0F	S-Port	
5	0x02	Command1	
6	0x05	Command2	
7		Status (0x00 = ok, else error)	
8		Command-ID	
9		Value (if Length = 2 Byte: low-order Byte)	
10		Value, only if range > 1 Byte (with Length = 2 Byte: high-order Byte)	

B.2 Loudspeaker and Microphone

Name	Command-ID	Name	Command-ID
SpkVol	0x30	MicVol	0x50
SpkLimOn	0x32	MicLimOn	0x52
SpkLimThr	0x34	MicLimThr	0x54
SpkLimRel	0x40	MicLimRel	0x60
SpkNgOn	0x36	MicNgOn	0x56
SpkNgThr	0x38	MicNgThr	0x58
SpkNgAttn	0x42	MicNgAttn	0x62
SpkNgFade	0x44	MicNgFade	0x64
SpkCompOn	0x3A	MicCompOn	0x5A
SpkCompThr	0x3C	MicCompThr	0x5C
SpkCompRatio	0x3E	MicCompRatio	0x5E
SpkCompRel	0x46	MicCompRel	0x66
SpkEqOn	0x70	MicDcfOn	0x68
SpkEqLowFreq	0x72	MicDcfCutoff	0x6A
SpkEqLowGain	0x74	MicEqOn	0x90
SpkEqHighFreq	0x76	MicEqLowFreq	0x92
SpkEqHighGain	0x78	MicEqLowGain	0x94
SpkNotchOn	0x7A	MicEqHighFreq	0x96
SpkNotch1Freq	0x7C	MicEqHighGain	0x98
SpkNotch1Bw	0x7E	MicNotchOn	0x9A
SpkNotch1Gain	0x80	MicNotchFreq	0x9C
SpkNotch2Freq	0x82	MicNotchBw	0x9E
SpkNotch2Bw	0x84	MicNotchGain	0xA0
SpkNotch2Gain	0x86		
SpkNotch3Freq	0x88		
SpkNotch3Bw	0x8A		
SpkNotch3Gain	0x8C		

REQUEST								
	Start	Type	Length	T-Port	Command1	Command2	Command-ID	Value
SET:	0x8F	0x20	0x04	0x0F	0x02	0x02	see above	see A.2 and A.3
GET:	0x8F	0x20	0x03	0x0F	0x02	0x04	see above	–

RESPONSE			
	Byte	Value	Description
SET			
	1	0x8F	Start
	2	0x40	Type
	3	0x04	Length
	4	0x0F	S-Port
	5	0x02	Command1
	6	0x03	Command2
	7		Status (0x00 = ok, else error)
	8		Command-ID
GET			
	1	0x8F	Start
	2	0x40	Type
	3	0x05	Length, if length of Value = 1 Byte
		0x06	Length, if length of Value = 2 Byte
	4	0x0F	S-Port
	5	0x02	Command1
	6	0x05	Command2
	7		Status (0x00 = ok, else error)
	8		Command-ID
	9		Value (if Length = 2 Byte: low-order Byte)
	10		Value, only if range > 1 Byte (with Length = 2 Byte: high-order Byte)

B.3 Playing Audio Files

PlayerVol / PlayerOutput

Name	Command-ID
PlayerVol	0x02
PlayerOutput	0x04

REQUEST								
	Start	Type	Length	T-Port	Command1	Command2	Command-ID	Value
SET:	0x8F	0x20	0x04	0x0F	0x03	0x02	see above	see section A.4
GET:	0x8F	0x20	0x03	0x0F	0x03	0x04	see above	–

RESPONSE			
	Byte	Value	Description
SET			
	1	0x8F	Start
	2	0x40	Type
	3	0x04	Length
	4	0x0F	S-Port
	5	0x03	Command1
	6	0x03	Command2
	7		Status (0x00 = ok, else error)
	8		Command-ID
GET			
	1	0x8F	Start
	2	0x40	Type
	3	0x05	Length
	4	0x0F	S-Port
	5	0x03	Command1
	6	0x05	Command2
	7		Status (0x00 = ok, else error)
	8		Command-ID
	9		Value

Play

REQUEST							
Start	Type	Length	T-Port	Command1	Command2	StrLength	Audio file
0x8F	0x20	0x03 + StrLength	0x0F	0x03	0x06	Length	String + '0x00'

RESPONSE		
Byte	Value	Description
1	0x8F	Start
2	0x40	Type
3	0x03	Length
4	0x0F	S-Port
5	0x03	Command1
6	0x07	Command2
7		Status (0x00 = ok, else error)

The response of play command will be generated immediately in case of error (e.g. file not found) or after end of playing.

B.4 Management of Parameter

Name	Command-ID
ParamName	0x02
ParamRev	0x04
ParamSave	0x06
ParamDefault	0x0A

REQUEST					
Start	Type	Length	T-Port	Command1	Command2
0x8F	0x20	0x02	0x0F	0x04	see above

RESPONSE		
Byte	Value	Description
1	0x8F	Start
2	0x40	Type
3	0x03 [+ x Bytes]	Length (depends on command)
4	0x0F	S-Port
5	0x04	Command1
6	see above + 0x01	Command2
7		Status (0x00 = ok, else error)
[8 - x]		on ParamName: String with length of parameter file (incl. termination) on ParamRev: revision number with length 1 Byte on ParamSave: without Byte 8 on ParamDefault: without Byte 8

Name	Command-ID
ParamRead	0x08
ParamBoot	0x0C

REQUEST							
Start	Type	Length	T-Port	Command1	Command2	StrLength	File name
0x8F	0x20	0x03 + StrLength	0x0F	0x04	see above	Length	String + '0x00'

RESPONSE		
Byte	Value	Description
1	0x8F	Start
2	0x40	Type
3	0x03	Length
4	0x0F	S-Port
5	0x04	Command1
6	see above + 0x01	Command2
7		Status (0x00 = ok, else error)

B.5 Common

Ping

REQUEST					
Start	Type	Length	T-Port	Command1	Command2
0x8F	0x20	0x02	0x0F	0x01	0x02

RESPONSE		
Byte	Value	Description
1	0x8F	Start
2	0x40	Type
3	0x03	Length
4	0x0F	S-Port
5	0x01	Command1
6	0x03	Command2
7		Status (0x00 = ok, else error)

Version

REQUEST					
Start	Type	Length	T-Port	Command1	Command2
0x8F	0x20	0x02	0x0F	0x01	0x04

RESPONSE		
Byte	Value	Description
1	0x8F	Start
2	0x40	Type
3	0x3E	Length
4	0x0F	S-Port
5	0x01	Command1
6	0x05	Command2
7		Status (0x00 = ok, else error)
8	0x82	Application-ID
9	0x00	Instance-ID
10		Major number
11		Minor number
12		Revision number
13	0x00	reserved
14	0x00	reserved
15	0x33	Length of following string incl. termination '0x00'
16–61		Version string (padded with '0x00')

GainSpk / GainMic / GainLineIn / GainLineOut

Name	Command-ID
GainSpk	0x02
GainMic	0x04
GainLineIn	0x06
GainLineOut	0x08

REQUEST								
	Start	Type	Length	T-Port	Command1	Command2	Command-ID	Value
SET:	0x8F	0x20	0x04	0x0F	0x05	0x02	see above	see section A.6
GET:	0x8F	0x20	0x03	0x0F	0x05	0x04	see above	–

RESPONSE			
	Byte	Value	Description
SET			
	1	0x8F	Start
	2	0x40	Type
	3	0x03	Length
	4	0x0F	S-Port
	5	0x05	Command1
	6	0x03	Command2
	7		Status (0x00 = ok, else error)
GET			
	1	0x8F	Start
	2	0x40	Type
	3	0x05	Length
	4	0x0F	S-Port
	5	0x05	Command1
	6	0x05	Command2
	7		Status (0x00 = ok, else error)
	8		Command-ID
	9		Value in dB