VoiceGP

Advanced Voice Recognition and Speech Synthesis Module

Data Sheet

Ver. 1.2

Go to www.VeeaR.eu for updated documents and examples!

Product Description

The VoiceGP module is a development platform for speech synthesis and voice recognition applications, based on Sensory RSC-4128 mixed signal processor.
Its small size of 42 x 72 mm and the two connectors at the edges with 2.54mm pin spacing, make it suitable for prototype boards and breadboard friendly.
Factory programmed with upgradeable Virtual Machine firmware, it enables easy and low-cost development for a wide variety of applications, with focus on speech and voice recognition.

VoiceGP hardware:

- RSC-4128 (with ROM Bootloader)
- 512KB Code/Const Flash
- 512KB Data Flash (Serial)
- 128KB External RAM
- Full access to RSC-4x I/O pins
- Expansion bus:
  - allows faster SPI interface to MMC cards
  - 5 dedicated chip select outputs (1 used for MMC on DevBoard)
  - 2 memory enable outputs (1 used for MMC on DevBoard)
  - 8-bit wide, read-write memory bus

VoiceGP DevBoard hardware:

- Wide range of power sources (USB, batteries, external power supply)
- On-board USB / Serial adapter and programmer (upgradeable)
- On-board Microphone (can be disabled for external audio input)
- Selectable audio output (mono[1], PWM or DAC with on-board amplifier)
- 4 push-button inputs and 4 LED outputs for demos and fast prototypes (can be disabled to connect external circuitry)
- SD/SDHC/MMC compatible socket for extended storage

VoiceGP firmware (Virtual Machine):

- VeeEm: Stack based, no Floating Point, 16-bit Virtual Machine
- Modified Harvard architecture:
  - 64KB Code / Near-Const memory
  - 64KB Data memory
  - 1MB Far-Const memory
- Native runtime support for:
  - most of Sensory's FluentChip™ library functions (T2SI, SD, SV, SX, RPMSG)
  - some C Runtime functions (integer math, strings)
  - serial Flash and EEprom memory access
  - fast SPI access to DevBoard memory-card socket (SD/SDHC/MMC)
  - generic I2C and SPI bus access (up to 5 SPI slaves)
  - generic and fast general purpose I/O access
  - asynchronous serial interface (9600 – 230400 baud)

1 Audio Out connector is a mono speaker output jack, with stereo speakers only one channel is active.

- Programmable in Standard C language (with extensions):
  - max 64KB program / 64KB volatile data memory
  - up to 320KB read-only data (QuickT2SI™, QuickSynthesis™ data)
  - up to 512KB read-write data (SD, SV, RPMSG)

VoiceGP software (Development Kit):

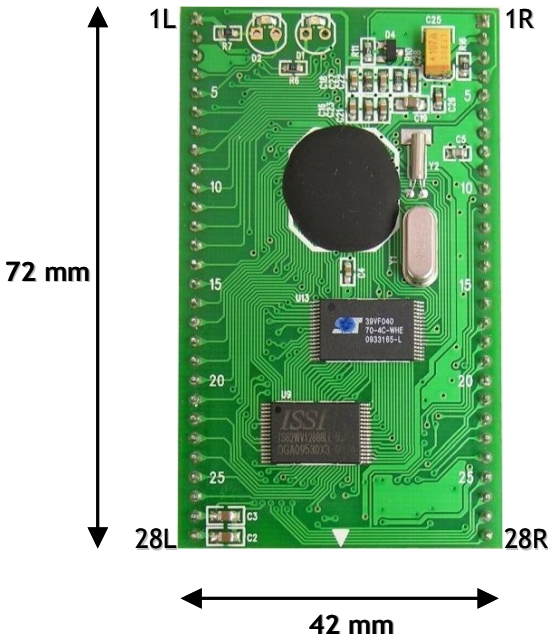
- VoiceGP Toolkit including:
  - VoiceGP IDE (Integrated Development Environment) with:
    - project management
    - syntax-coloring
    - auto-completion
    - project build and download
  - VoiceGP Toolchain:
    - VeeSee C language code translator (targeting the VeeEm VM)
    - VeeSee integrated C preprocessor, resource compiler and linker
    - VeeLoader code downloader / flash programmer
- VoiceGP DevBoard drivers:
  - USB / Serial port emulation
  - USB firmware upgrade
- Sensory development tools:
  - Sensory FluentChip™ Technology Library (build tools and documentation)
  - Sensory QuickSynthesis4™ software (speech and audio compression)
  - Sensory QuickT2SI™ Lite (creation of Speaker Independent vocabularies)

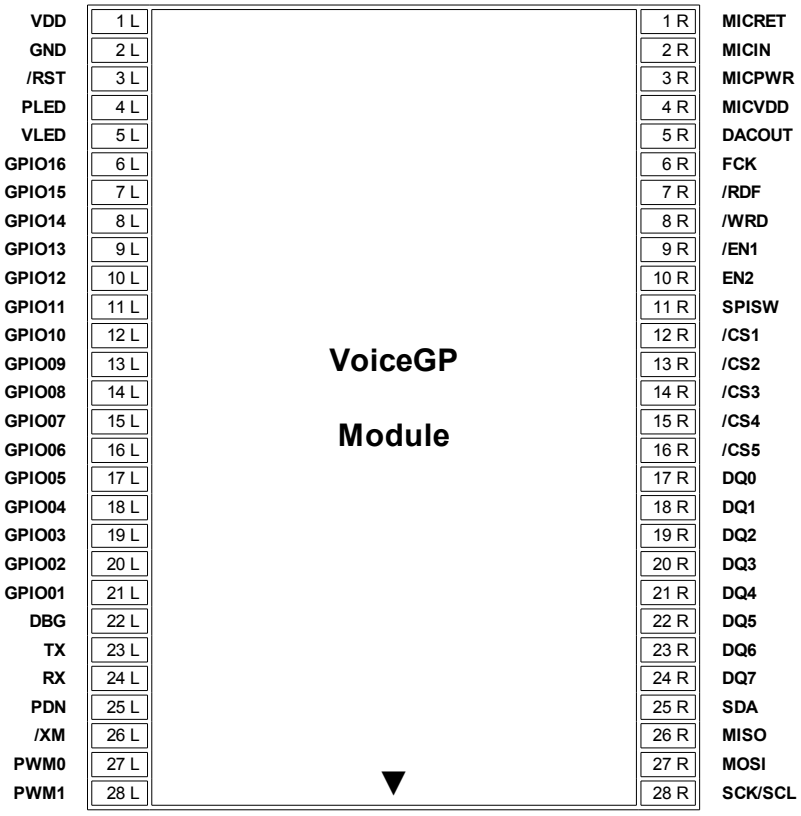
A QuickT2SI™ Lite license is included with the kit "VoiceGP DK-T2SI".

T2SI Demo sets or other pre-compiled vocabularies can still be used "as-is" without the QuickT2SI tool. All the other recognition technologies do not require external build tools.

Technical specifications

Physical dimensions and Pin configuration





Pin description

Pin No.	Pin name	Type	Description
1L	VDD	Power	DC Input Voltage
2L	GND	Ground	Ground
3L	/RST	Bi-Dir	Global Reset Input/Output
4L	PLED	Output	Power LED Indicator
5L	VLED	Output	Voice LED Indicator
6L	GPIO16	Input/Output	General Purpose Input/Output 16
7L	GPIO15	Input/Output	General Purpose Input/Output 15
8L	GPIO14	Input/Output	General Purpose Input/Output 14
9L	GPIO13	Input/Output	General Purpose Input/Output 13
10L	GPIO12	Input/Output	General Purpose Input/Output 12
11L	GPIO11	Input/Output	General Purpose Input/Output 11
12L	GPIO10	Input/Output	General Purpose Input/Output 10
13L	GPIO09	Input/Output	General Purpose Input/Output 09
14L	GPIO08	Input/Output	General Purpose Input/Output 08
15L	GPIO07	Input/Output	General Purpose Input/Output 07
16L	GPIO06	Input/Output	General Purpose Input/Output 06
17L	GPIO05	Input/Output	General Purpose Input/Output 05
18L	GPIO04	Input/Output	General Purpose Input/Output 04
19L	GPIO03	Input/Output	General Purpose Input/Output 03
20L	GPIO02	Input/Output	General Purpose Input/Output 02
21L	GPIO01	Input/Output	General Purpose Input/Output 01
22L	DBG	Input/Output	Debug/Diagnostic Output
23L	TX	Output	Serial Port Transmit Data (TTL level)
24L	RX	Input	Serial Port Receive Data (TTL level)
25L	PDN	Output	Power Down Indicator
26L	/XM	Input	Boot Mode Selector
27L	PWM0	Output	Speaker Output
28L	PWM1	Output	Speaker Output

Pin No.	Pin name	Type	Description
1R	MICRET	Analog Ground	Microphone signal reference
2R	MICIN	Analog Input	Microphone input signal
3R	MICPWR	Analog Power	Microphone power (for on-board gain resistor)
4R	MICVDD	Analog Power	Microphone power (for custom gain resistor)
5R	DACOUT	Analog Output	DAC Output (line level)
6R	FCK	Output	External SPI Fast Clock
7R	/RDF	Output	Memory Bus Read Strobe
8R	/WRD	Output	Memory Bus Write Strobe
9R	/EN1	Output	Memory Device Enable
10R	EN2	Output	Memory Device Enable
11R	SPISW	Output	External SPI Clock Switch
12R	/CS1	Output	SPI Bus Chip Select 1
13R	/CS2	Output	SPI Bus Chip Select 2
14R	/CS3	Output	SPI Bus Chip Select 3
15R	/CS4	Output	SPI Bus Chip Select 4
16R	/CS5	Output	SPI Bus Chip Select 5
17R	DQ0	Bi-Dir	Memory Bus Data Line
18R	DQ1	Bi-Dir	Memory Bus Data Line
19R	DQ2	Bi-Dir	Memory Bus Data Line
20R	DQ3	Bi-Dir	Memory Bus Data Line
21R	DQ4	Bi-Dir	Memory Bus Data Line
22R	DQ5	Bi-Dir	Memory Bus Data Line
23R	DQ6	Bi-Dir	Memory Bus Data Line
24R	DQ7	Bi-Dir	Memory Bus Data Line
25R	SDA	Bi-Dir	I2C Bus Data Line
26R	MISO	Input	SPI Bus Data Line
27R	MOSI	Output	SPI Bus Data Line
28R	SCK/SCL	Output	SPI Bus Clock / I2C Bus Clock

VDD, GND – Power supply

It supports external regulated or battery power in the range 2.7V – 3.6V

RX, TX – Serial port

Main serial connection for application protocol or flash programming with the bootloader. It supports standard UART signaling with programmable rate in the range 2400bps – 115200bps

DBG – Debug / Diagnostic port

At power-up it is sampled for Diag-Enable function (active low) and can be activated as a normal TxDiag pin. In bootloader mode, it is held low internally and cannot be used.

/RESET – Reset input

Active-low asynchronous reset signal, with internal pull-up.

PDN – Power Down output

Low power mode indicator. It can be used to shutdown additional external circuitry.

/XM – Boot mode

It selects between normal operating mode and flash programming mode. Internally pulled-down, it must be held high at reset to enter the boot-loader, or left unconnected to start the user code.

GPIO01-GPIO16 – General purpose digital I/O pins

Digital input/output pins available for connections to external hardware.
After reset all pins are inputs with light internal pullup (~200K). In bootloader mode they are programmed as Hi-Z inputs (within around 10µs).
Various configuration options are available for pin direction, internal pull-up, wake-up capability.

SDA, SCL – I^2C Bus

Two-wire synchronous serial bus for simple I^2C master operation over external devices.

SCK, MOSI, MISO – SPI Bus

Synchronous serial bus supporting Serial Peripheral Interface Mode 3 or 0.

/CS1, /CS2, /CS3, /CS4, /CS5 – Chip Select lines

Additional lines to select slave devices on the SPI bus.

MICIN, MICRET – Microphone Input

This is the single-ended audio input port for connecting an external microphone (see paragraph *Connecting an external microphone*).

MICPWR – Microphone Power

Analog power supply for the microphone, with a default gain resistor of 1.2K. It can be tied directly to MICIN, when used with the default microphone sensitivity.

MICVDD – Microphone Voltage Reference

Analog power supply for the microphone, with external gain. A custom gain resistor must be connected between this pin and MICIN, with a suitable value for the selected microphone.

PWM0, PWM1 – Speaker Out

It can be used as a differential audio output line, with direct speaker driving capability, or as two PWM output pins for application specific purposes (e.g. motor control).

DACOUT – Line Out

It can be used as an externally amplified high quality audio output or optionally as a general purpose analog output.

/RDF, /WRD, DQ0-DQ7 – Memory Bus

Data and control lines for “data” memory address space. It can be used to map external devices in memory.

/EN1, EN2 – Memory device Enable lines

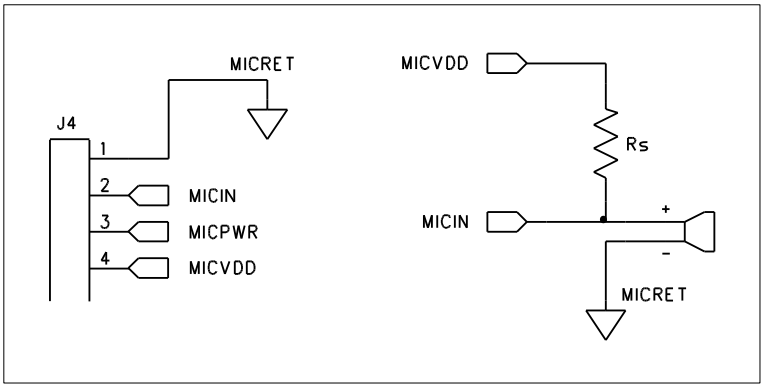
Address decoded lines to enable/disable access to external memory-mapped devices.
/EN1 goes low when A19, A18 and A17 are all high. It is used for the external “Fast SPI” circuit.
EN2 goes high when A19 and A18 are both high. It may be used in AND with /EN1 for an additional external memory-mapped device.

SPISW, FCK – “Fast SPI” control lines

A fast serial clock line (~2.4MHz) and a control line to switch between slow/fast clock.
These signals are used together with SCK, MISO, MOSI to control external circuitry implementing a “Fast SPI” bus.

Connecting an external microphone

An external microphone must be connected with proper source resistor (Rs), as follows:



MICPWR is the analog power supply for the microphone, with a default gain resistor of 1.2K. It can be tied directly to MICIN, when used with the default microphone sensitivity. If another sensitivity is needed, use MICVDD instead, as in the above picture.

Calculating source resistor Rs

Selecting a proper microphone and its source resistor are essential for achieving good recognition results. This paragraph describes the procedures for calculating the optimal resistor value, and provides a recommended microphone (used in VeeaR products: VRbot and VoiceGP Development Board).

You can calculate the microphone source resistor using the formula below:

$$Rs = I \times 10^{\frac{G - Sensitivity}{20}}$$

where:

1. ***G*** is the desired overall system gain, defined as follows:
   a) If the program source code is configured for “headset” microphone distance (typically a few centimeters from the user’s mouth), then the overall system gain should be -49 dB (0dB=1v/Pa@1KHz);
   b) If the program source code is configured for "arms_length" microphone distance (typically 60-90 cm from the user's mouth – this is the default setting in VoiceGP firmware), then the overall system gain should be -44 dB;
   c) If the program source code is configured for "far_mic" microphone distance (up to about 3 meters from the user's mouth), then the overall system gain should be -43 dB.
2. ***Sensitivity*** is the sensitivity rating of the microphone you want to use, and it is specified in –dB in the microphone’s specification[2];
3. ***I*** is the impedance rating of the microphone;
4. ***Rs*** is the optimal microphone source resistor.

2 Converting uBars to Pascal: microphone manufacturers specify the sensitivity referencing to uBars or Pascal. If the microphone sensitivity is referenced to uBars, simply add 20 dB to the rating. For example, -58 dB/uBars + 20dB = -38 dBV/Pa.

Example with recommended microphone:

The recommended microphone used in VRbot and VoiceGP Development Board is the *Horn Elec. EM9745P-382*:

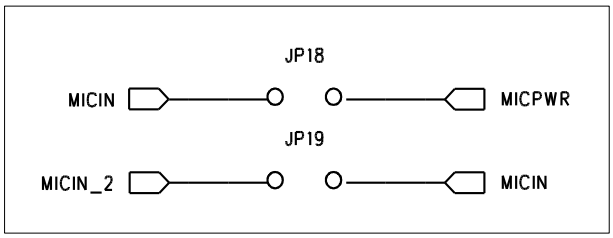
- Sensitivity –38dB (0dB=1V/Pa@1KHz);
- Impedance 2.2K.

Therefore the optimal microphone source resistor for "arms_length" microphone distance is:

$$Rs = 2200 \times 10^{\frac{-44-(-38)}{20}} = 1102$$

Use the closest standard 5% resistor to Rs. In this example, it would be 1.1-1.2 K ohms.

Connecting an external microphone to the Development Board



In order to use an external microphone when the VoiceGP is installed on the Development Board, first remove jumpers JP18-JP19 (see also *DevBoard Schematics* as reference) and then connect the external microphone as described above.

Recommended Operating Conditions

Symbol	Parameter	Min	Typ	Max	Unit
V_{DD}	DC Input Voltage	2.7	3.3	3.6	V
T_A	Ambient Operating Temperature Range	0	25	70	°C

Power Supply Requirements

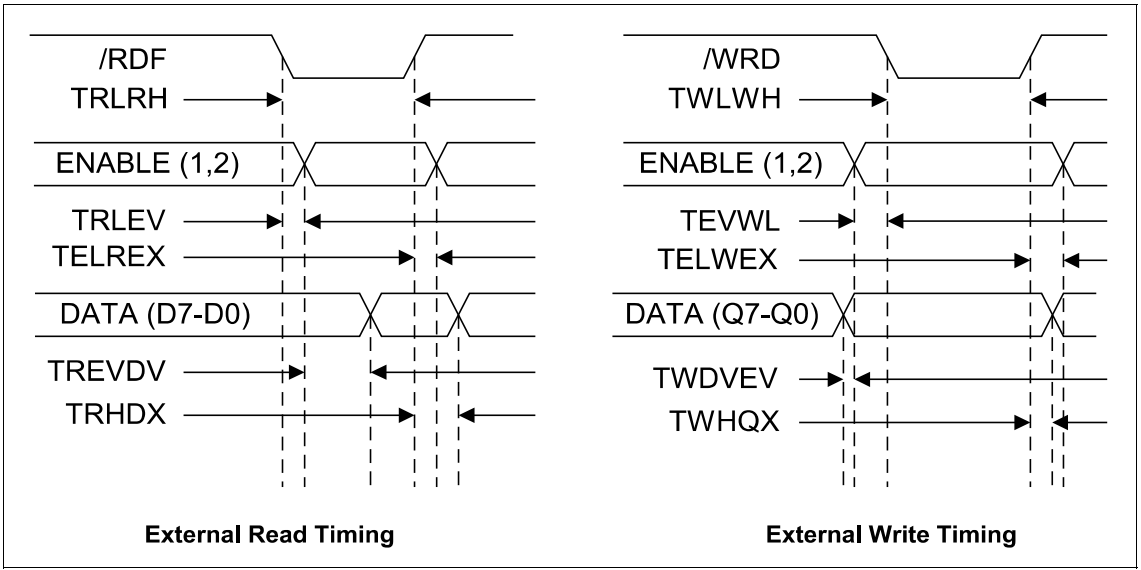
Symbol	Parameter	Min	Typ	Max	Unit
I_{IDLE}	Sleep current		< 1		mA
I_{DD}	Operating current[3]		11		mA

Electrical DC Characteristics

Symbol	Parameter	Min	Typ	Max	Unit
V_{IL}	GPIO Input Low Voltage	-0.1		0.75	V
V_{IH}	GPIO Input High Voltage	0.8 × V_{DD}		V_{DD} + 0.3	V
V_{OL}	GPIO Output Low Voltage (I_{OL} = 8 mA)			0.5	V
V_{OH}	GPIO Output High Voltage (I_{OH} = -8 mA)	V_{DD} - 0.7			V
R_{PU}	Pull-up resistance GPIO01-GPIO16 DQ0-DQ7, /RDF, /WRD /RESET PWM0, PWM1	10, 200, Hi-Z 100 50 10			kΩ
R_{PD}	Pull-down resistance /XM	1			kΩ

3 Module running VM firmware, no outputs loaded, no audio processing

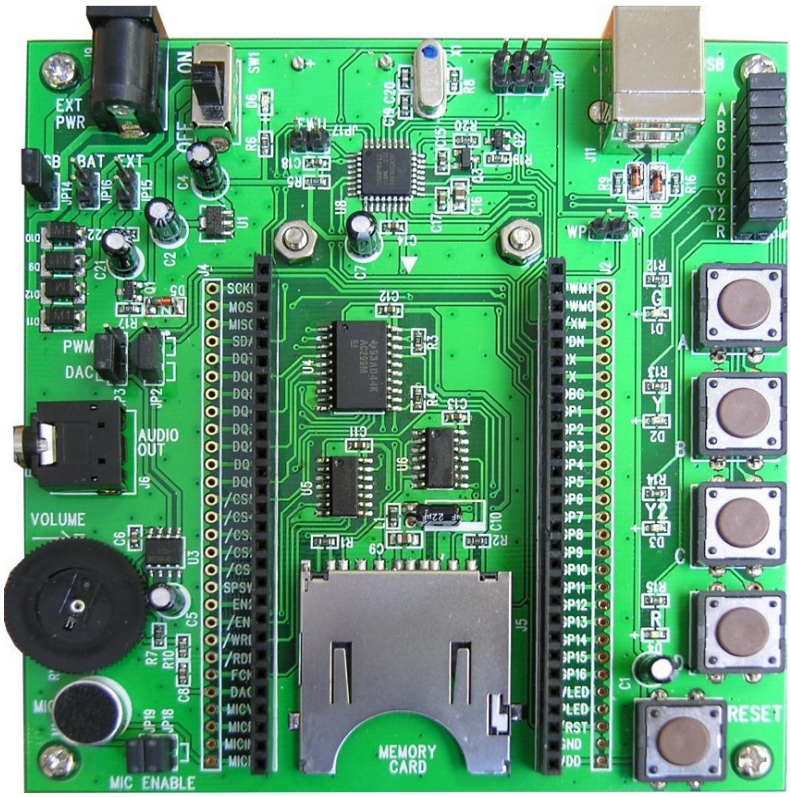
Electrical AC Characteristics

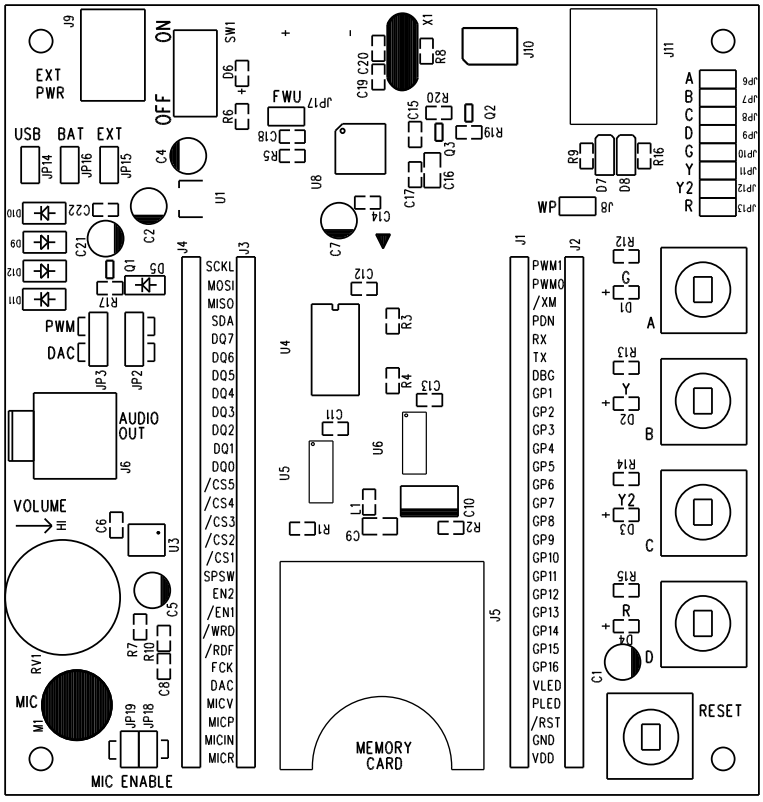


Symbol	Parameter	Min	Max	Unit
T_{RLRH}	/RDF Pulse Width		140	ns
T_{RLAV1}	/RDF Low to /EN1 valid		22	ns
T_{RLAV2}	/RDF Low to EN2 valid		11	ns
T_{ALRAX1}	/EN1 hold after /RDF		17	ns
T_{ALRAX2}	EN2 hold after /RDF		6	ns
T_{RAVDV1}	/EN1 valid to Valid Data In		93	ns
T_{RAVDV2}	EN2 valid to Valid Data In		104	ns
T_{RHDX}	Data Hold after /RDF	0	0	ns
T_{WLWH}	/WRD Pulse Width		140	ns
T_{AVWL1}	/EN1 Valid to /WRD	18		ns
T_{AVWL2}	EN2 Valid to /WRD	29		ns
T_{ALWAX1}	/EN1 Hold after /WRD	52		ns
T_{ALWAX2}	EN2 Hold after /WRD	41		ns
T_{WDVAV1}	Write Data Valid to /EN1 Valid		22	ns
T_{WDVAV2}	Write Data Valid to EN2 Valid		11	ns
T_{WHQX}	Data Hold after /WRD	35		ns

Voice GP Development Board

Physical dimensions and layout





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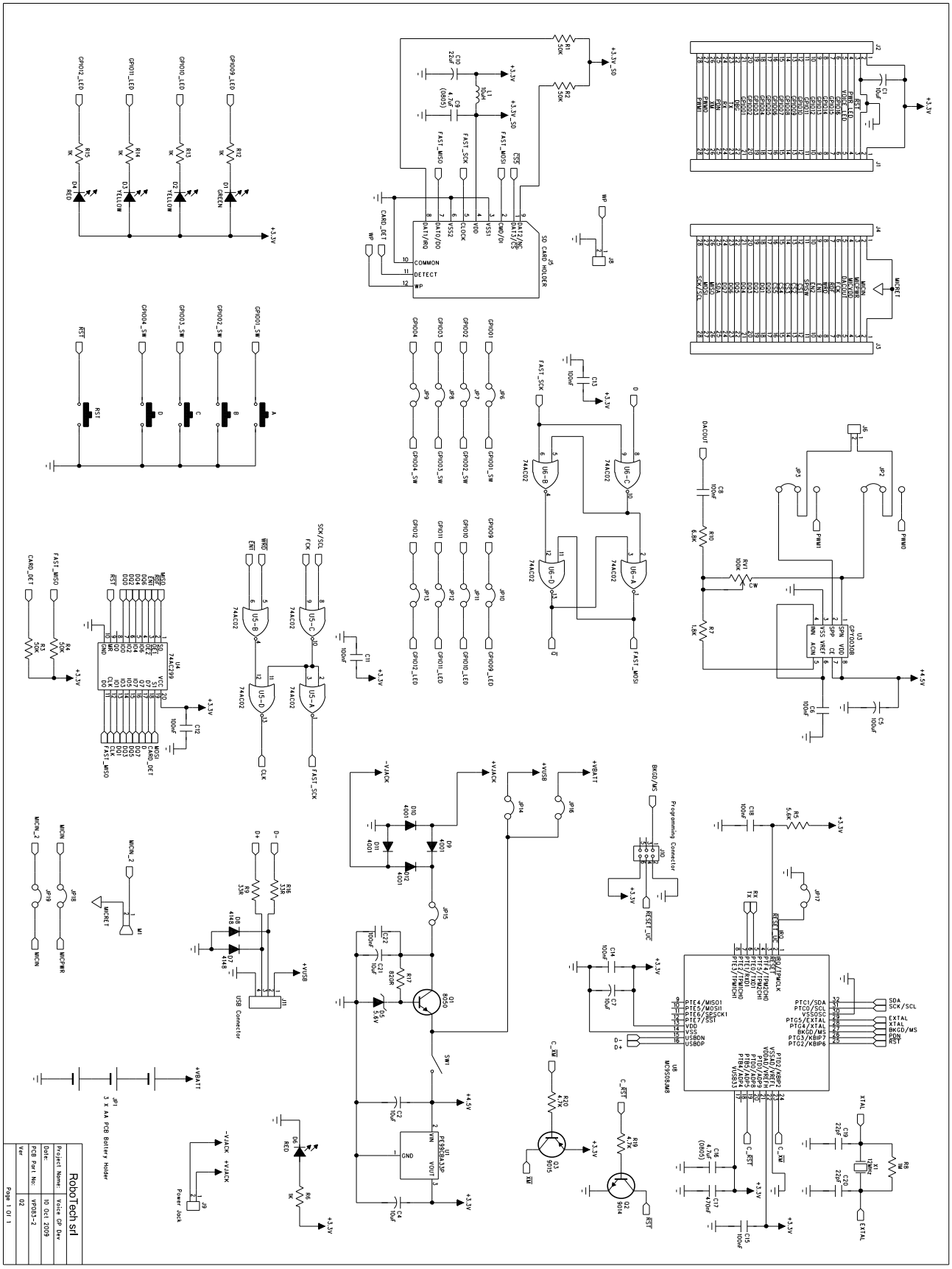
DevBoard Schematics



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Recommended Operating Conditions

Symbol	Parameter	Min	Typ	Max	Unit
V_{JACK}	External DC Input Voltage	9	-	12	V
V_{BATT}	Batteries DC Input Voltage	3.3	-	6.8	V
V_{DD}	DC Output Voltage		3.3		V

Power Supply Requirements

Symbol	Parameter	Min	Typ	Max	Unit
I_{DD}	Operating current (DevBoard only)		26		mA
I_{PWM}	Overall current, PWM Audio Playback[4]		125	140	mA
I_{DAC}	Overall current, DAC Audio Playback[4]		150	180	mA
I_{LED}	LED current (depends on color)	0.6	1.3	1.5	mA

Jumper settings and connections

JP6-JP13 – Demo I/O Enable

Close each jumper to enable Demo I/O included on board: 4 push buttons and 4 colored LEDs. Leave any jumper open to disconnect Demo I/O from the corresponding VoiceGP GPIO pin.

Jumper	GPIO Pin	Description
JP6	GPIO01	Push Button A enable/disable
JP7	GPIO02	Push Button B enable/disable
JP8	GPIO03	Push Button C enable/disable
JP9	GPIO04	Push Button D enable/disable
JP10	GPIO09	Green LED enable/disable
JP11	GPIO10	Yellow LED enable/disable
JP12	GPIO11	Yellow2 LED enable/disable
JP13	GPIO12	Red LED enable/disable

4 Playback of 1KHz square or sine wave at max volume on an 8 Ohm loud-speaker

JP14-JP16 – Power Source Selection

Close one of the jumpers to choose input power source: USB, batteries or external power connector.

JP14	JP15	JP16	Power Source
ON	OFF	OFF	USB cable (max 300mA)
OFF	ON	OFF	EXT PWR external power jack
OFF	OFF	ON	Battery holder (bottom side)

Important: Only one jumper must be closed!

JP2-JP3 – Audio Output Selection

Move both jumpers to choose which audio output is routed to the Audio Out output jack.

JP2	JP3	Audio Output
1-2	1-2	Audio connected to PWM output (Volume knob has no effect)
2-3	2-3	Audio driven by amplified DAC output (Volume is adjustable)

Important: Jumpers must be both in the same position!

JP18-JP19 – Microphone Enable

Close both jumpers to enable on-board microphone, or leave both open to connect an external microphone or another audio source.

JP18	JP19	Effect
ON	ON	Enable on-board microphone
OFF	OFF	Disable on-board microphone

Important: Jumpers must be both open or both closed!

JP17 (FWU) – Firmware Upgrade

Leave open for normal operation.

J8 (WP) – Write Protect

Connector for the WP signal from the memory card socket. It can be connected to a GPIO input pin to implement write-protection in application software.

All VeeaR branded boards and software are designed and manufactured by RoboTech srl

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