Sika Rev B Datasheet

With closed-Beta notes

(confidential)

Author
Alberto Gianelli
Contact
tech@mindmusiclabs.com
Revision
B

Warning

Please check the closed-beta notes on the bottom of each paragraph. They refer to the current status of the boards.
You will see hacks with red mod wires on your board, be aware that they can be sensitive to physical stress, **please do not touch the mod wires** since the could come off.
If a mod wire comes off (fully or partially), please send us a picture and we will give you instructions to solder it back (if you have a soldering iron, and average soldering skills). Otherwise we will tell you how to keep using the board without the wire.

Overview

Features

- Texas instrument PCM3168 audio codec, 24 Bit, 48 / 96 / 192 kHz
- 4 fixed analog audio inputs (2.54 mm pitch pin-header)
- 4 fixed analog audio outputs (2.54 mm pitch pin-header)
- Headphone stereo output (3.5 mm Stereo Jack) w/ adjustable volume
- Stereo Input jack (3.5 mm Stereo Jack)
- 2 fixed Control Voltage outputs (2.54 mm pitch pin-header)
- 2 Gate/Trigger inputs (2.54 mm pitch pin-header)
- 4 Gate/Trigger output (2.54 mm pitch pin-header)
- 2 configurable audio/CV inputs (2.54 mm pitch pin-header)
- 2 configurable audio/CV outputs (2.54 mm pitch pin-header)
- 16 analog sensor inputs (2.54 mm pitch pin-header)
- 32 digital inputs (2.54 mm pitch pin-header)
- 32 digital outputs (2.54 mm pitch pin-header)
- 5-poles DIN MIDI In/Out (2.54 mm pitch pin-header)
- 1 I2C interface (2.54 mm pitch pin-header)

Assembly content and accessories

Item	Q	Manufacturer, Part Number	Supplier
Raspberry Pi Model 3B+	1		Electrokit, Webhalllen
Power supply 5.1V 2.5A microUSB (RPi)	1		Many stores
microSD card 8/16/32 GB	1		
Heat Sink for Raspberry Pi CPU	1	Adafruit, 3038	Mouser
19 mm m-f spacer	4	M2114-2545-AL	Mouser
5 mm f-f spacers	4	M1252-2545-AL	Mouser
M2.5x4 steel screw	4	Keystone 29300	Mouser
Shunt connector 4 pos	5	Samtec, SAM10619-ND	Digikey
Jtag-USB cable	1	Digilent	Digilent store

Closed-beta note #1: you will have a pair of female-female jumper cables instead of the fifth 4-positions shunt connector. For further information refer to the closed-beta note #5.

Assembly Instructions

Figure 1:

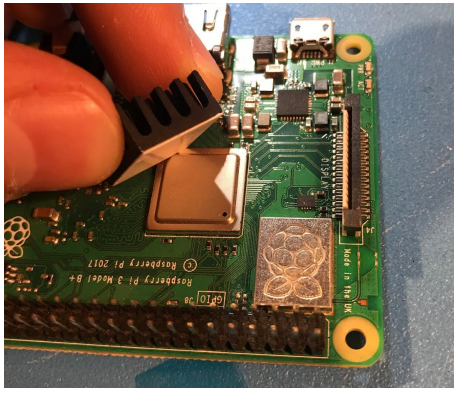


Figure 2:

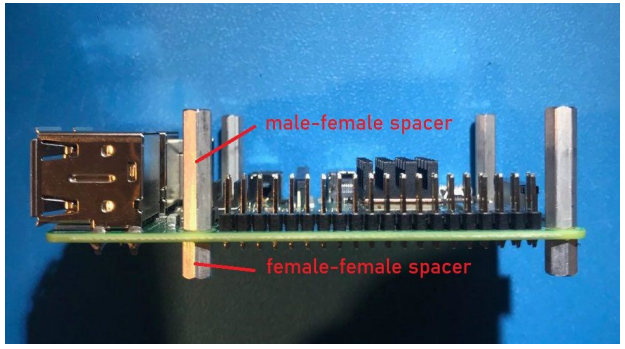


Figure 3:

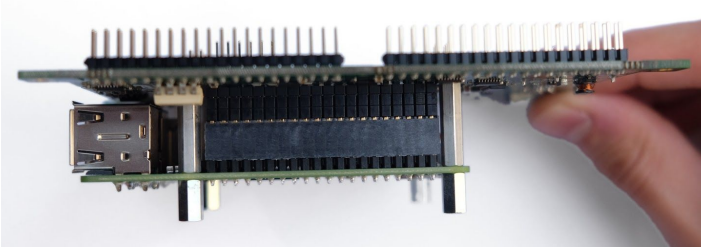
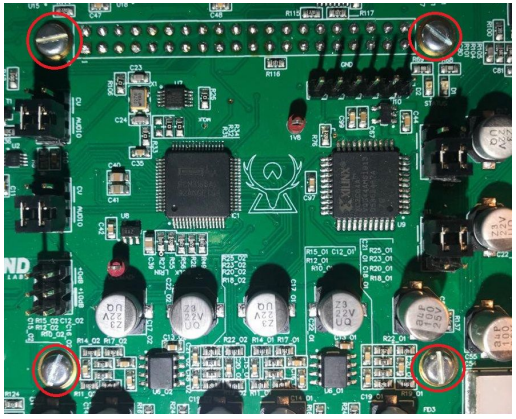


Figure 4:



1. Peal off the blue protective film from the bottom of the heat sink and apply it on top of the Raspberry Pi CPU (Figure 1).
2. Screw the four f-m spacers into the f-f spacers on the Raspberry Pi (Figure 2).
3. Plug the Sika on top of the Raspberry Pi (Figure 3).
4. Add the four screws if you want extra stability (Figure 4).

Connectors and pinout

Figure 4:

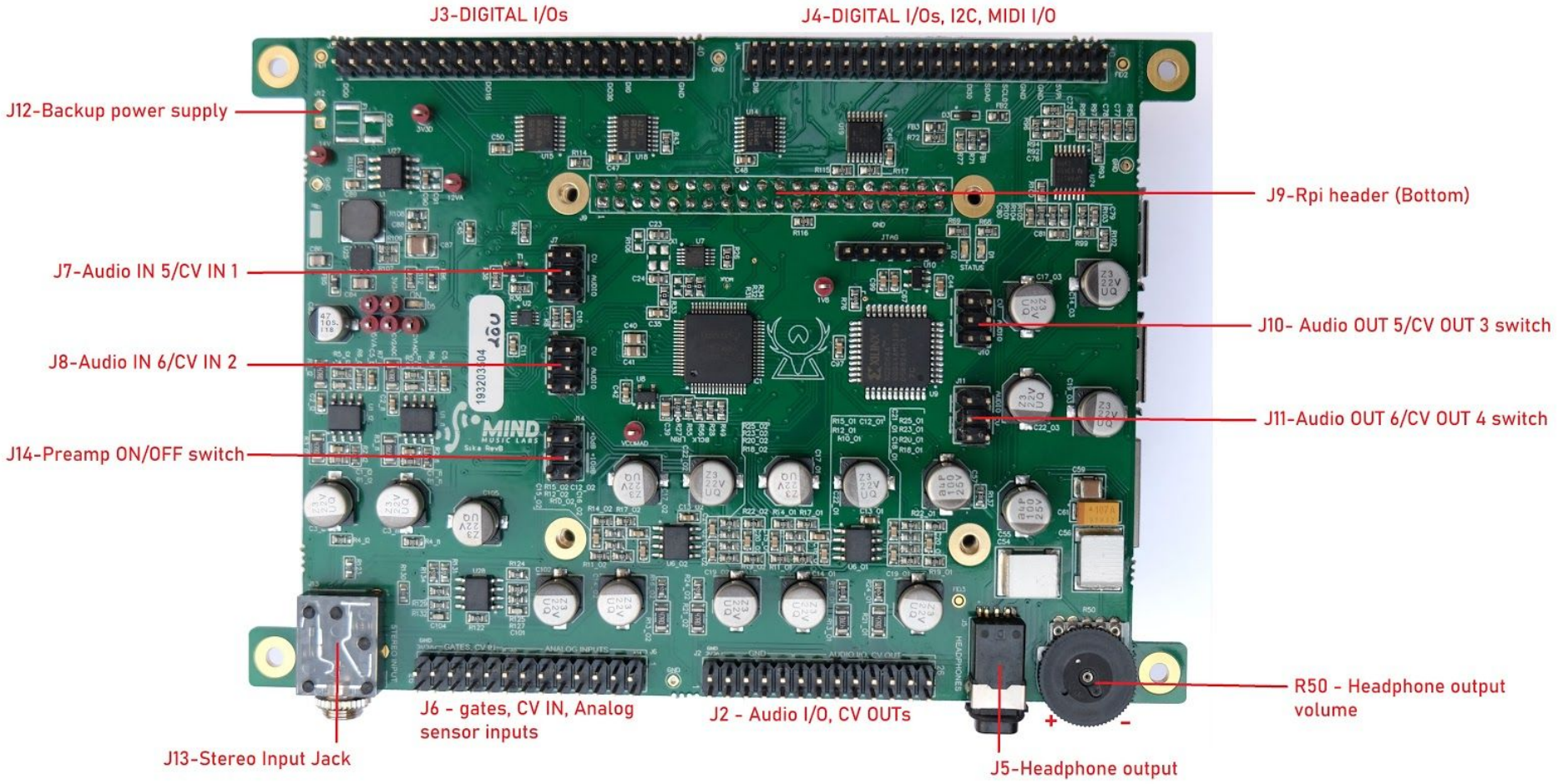
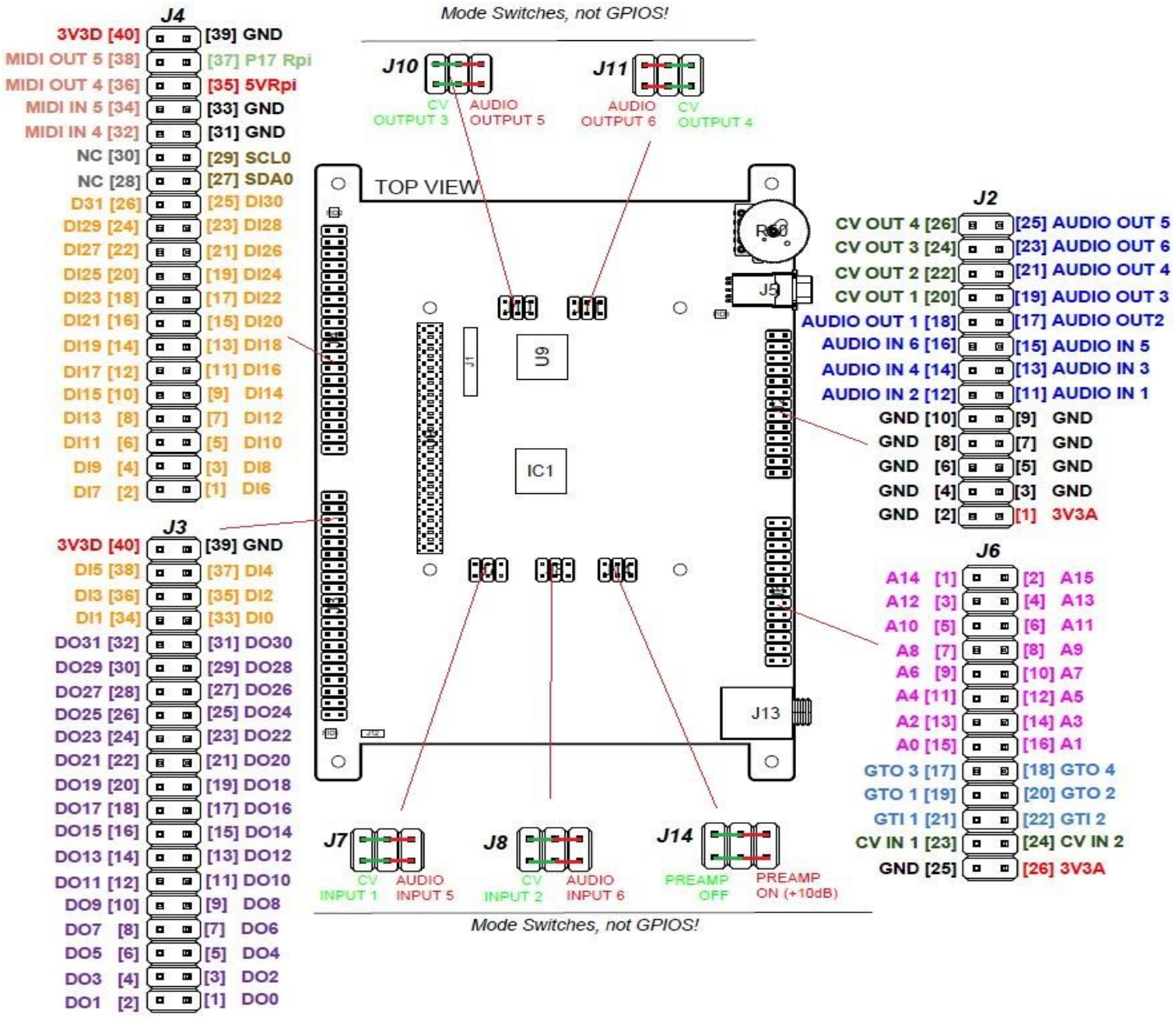


Figure 5:


J4
3V3D [40] [39] GND
MIDI OUT 5 [38] [37] P17 Rpi
MIDI OUT 4 [36] [35] 5VRpi
MIDI IN 5 [34] [33] GND
MIDI IN 4 [32] [31] GND
NC [30] [29] SCL0
NC [28] [27] SDA0
D31 [26] [25] DI30
DI29 [24] [23] DI28
DI27 [22] [21] DI26
DI25 [20] [19] DI24
DI23 [18] [17] DI22
DI21 [16] [15] DI20
DI19 [14] [13] DI18
DI17 [12] [11] DI16
DI15 [10] [9] DI14
DI13 [8] [7] DI12
DI11 [6] [5] DI10
DI9 [4] [3] DI8
DI7 [2] [1] DI6
J3
3V3D [40] [39] GND
DI5 [38] [37] DI4
DI3 [36] [35] DI2
DI1 [34] [33] DI0
DO31 [32] [31] DO30
DO29 [30] [29] DO28
DO27 [28] [27] DO26
DO25 [26] [25] DO24
DO23 [24] [23] DO22
DO21 [22] [21] DO20
DO19 [20] [19] DO18
DO17 [18] [17] DO16
DO15 [16] [15] DO14
DO13 [14] [13] DO12
DO11 [12] [11] DO10
DO9 [10] [9] DO8
DO7 [8] [7] DO6
DO5 [6] [5] DO4
DO3 [4] [3] DO2
DO1 [2] [1] DO0
Mode Switches, not GPIOS!
J10
CV OUTPUT 3
AUDIO OUTPUT 5
J11
AUDIO OUTPUT 6
CV OUTPUT 4
TOP VIEW
U9
IC1
J13
J7
CV INPUT 1
AUDIO INPUT 5
J8
CV INPUT 2
AUDIO INPUT 6
J14
PREAMP OFF
PREAMP ON (+10dB)
Mode Switches, not GPIOS!
J2
CV OUT 4 [26] [25] AUDIO OUT 5
CV OUT 3 [24] [23] AUDIO OUT 6
CV OUT 2 [22] [21] AUDIO OUT 4
CV OUT 1 [20] [19] AUDIO OUT 3
AUDIO OUT 1 [18] [17] AUDIO OUT2
AUDIO IN 6 [16] [15] AUDIO IN 5
AUDIO IN 4 [14] [13] AUDIO IN 3
AUDIO IN 2 [12] [11] AUDIO IN 1
GND [10] [9] GND
GND [8] [7] GND
GND [6] [5] GND
GND [4] [3] GND
GND [2] [1] 3V3A
J6
A14 [1] [2] A15
A12 [3] [4] A13
A10 [5] [6] A11
A8 [7] [8] A9
A6 [9] [10] A7
A4 [11] [12] A5
A2 [13] [14] A3
A0 [15] [16] A1
GTO 3 [17] [18] GTO 4
GTO 1 [19] [20] GTO 2
GTI 1 [21] [22] GTI 2
CV IN 1 [23] [24] CV IN 2
GND [25] [26] 3V3A

Power requirements

The Sika is fully powered from the 5V pin header exposed on the Raspberry Pi, so no additional power supply is needed other than the Raspberry Pi' one. Just plug the Sika on top of the Raspberry, power the Raspberry Pi, and the green "ON" LED (D5) will turn on. If this doesn't happen, you might be using an incorrect power supply. Otherwise, the board is likely malfunctioning. Note that you can power the Raspberry Pi before plugging the Sika onto it, there is no functional requirement related to this sequence, just make sure that the pins correctly line up to avoid possible short circuits.

Recommended Power Supply

The power supply that you will use to power the Rpi, has to have the following specifications:

- 5 VDC
- >=2.5 A
- Micro USB plug

Because of the voltage drop that the power cable usually causes, **we recommend using the official Raspberry Pi Power Supply available** here. Its 5.1V output and steady 2.5A guarantee proper power conditions for the Sika. For some power-efficient applications the Sika may work also if the Raspberry is powered from a less reliable power sources like phone chargers, USB ports or power-banks, but always try to **avoid using third-party power sources to minimize possible poor supply conditions**.

Power Consumption

The power consumption of Sika revB highly depends on the usage of the board or, in other words, what you connect to it.
Since the Sika and the raspberry Pi share the same 5V source, the current available for the Sika to use is:

$$I_{sika} = I_{PSU} - I_{Rpi}$$

It's reported from many sources (like this one) that the Raspberry Pi can draw at maximum around 1A of current with a 400% CPU stress test, so the sika will have at least 1.5 A to function, and this will be enough current in most use cases.

Idle Power consumption on 5V pin (Sika only) = 200 - 300 mA
Idle Power consumption on 5V pin (Sika+Rpi) = 800 - 950 mA

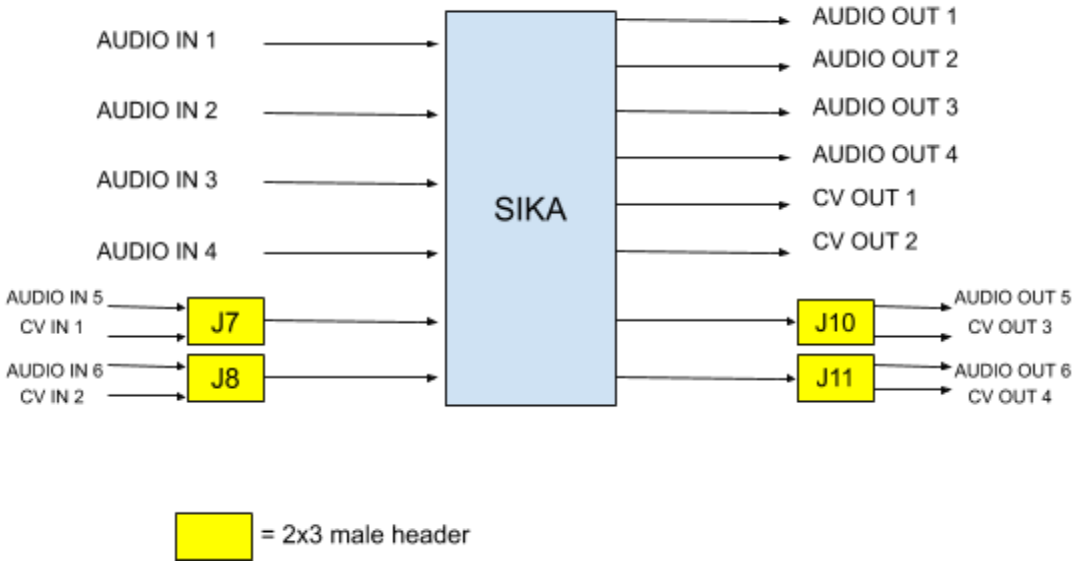
Backup Power Supply

Not available for closed-beta version

Audio/CV configurations

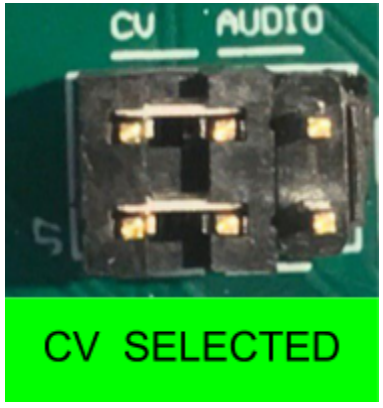
One of the Sika main features is its audio/cv configurability. The board has a total of 6 inputs and 8 output channels. A total of 4 channels, two for the Inputs and two for the outputs, are individually configurable to work for either CV or Audio signals. *Figure 6* below illustrates the possible configurations:

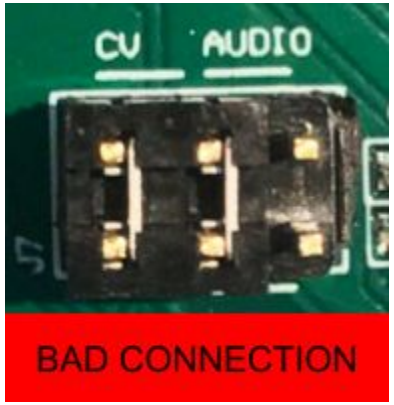
Figure 6:



As you can see from *Figure 6*, there are two mode-switches for the input and two for the output. The switches are implemented using standard 2x3 pin headers in combination with a dual jumper connector, as shown in Figure 7 below.

Figure 7:





Audio I/O

The board presents a maximum of 6 audio inputs (if J7 and J8 are on “audio” configuration) and 6 audio outputs (if J10 and J11 are on “audio” configuration). The first two input channels are high impedance and fed into a +10 dB preamp for guitar/bass inputs. (check the chapter “Stereo preamp” for further information)

Input Impedance Ch 1,2	1 MΩ
Input Impedance Ch 3,4,5,6	122 kΩ
Max Input signal amplitude (all channels, preamp OFF)	5 Vpp
Max Input signal amplitude (Ch1, 2 , preamp ON)	1.5 Vpp
Line output Impedance (all channels)	47 Ω
Max output voltage (all channels)	4 Vpp

The Codec *Texas Instruments PCM3168*, supports 6 input channels and 8 output channels at 24 bit, at 48kHz. Since the Raspberry Pi SOC natively supports only 2 channels, a CPLD is introduced between the Codec and the Raspberry Pi to achieve multi-channel support.

Closed-beta note #2: in this version of the board, to be able to use the first two channels from the header pins, a STEREO minijack has to be plugged in the on-board input minijack (J13). If the jack is left empty, channel 1 and 2 will be grounded, and no signal will flow. Once the stereo mini-jack is plugged, the ground connection is broken and the two channels can be used. Note that the function of connecting the cable, is just to break the ground connections, the jack can be left floating on the other side.

Mini-jack input

A 3.5 mm stereo jack input (J13) is present on the board. This is directly connected to input channels 1 and 2. The same two inputs are also reported on the pin headers like the rest of the channels. The function of the jack is to be able to get some signals into the board without having to design a hat for the sika, which is required to access most of all the I/O on the board. Since channel 1 and 2 of the board goes through the preamp, it is also possible to connect an instrument-level signal into it, using a mini-jack to mono jack splitter (*Figure 8*):

Figure 8:

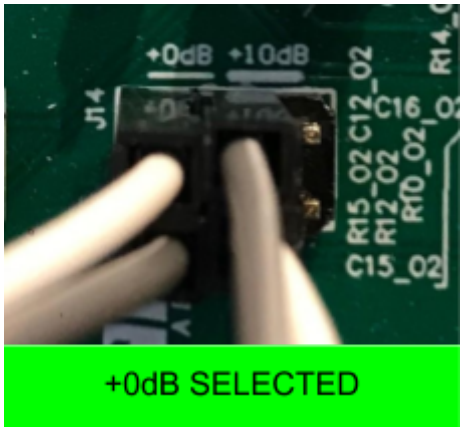
Closed-beta note #3: in this version of the board, only the TIP (left channel, channel 1 of the Sika) of the mini-jack input will work.

Reminder: if you want to use the first two channels from the pin headers, you need to connect a floating stereo minijack to the jack input. (refer to Closed-beta note #2)

Stereo Preamp

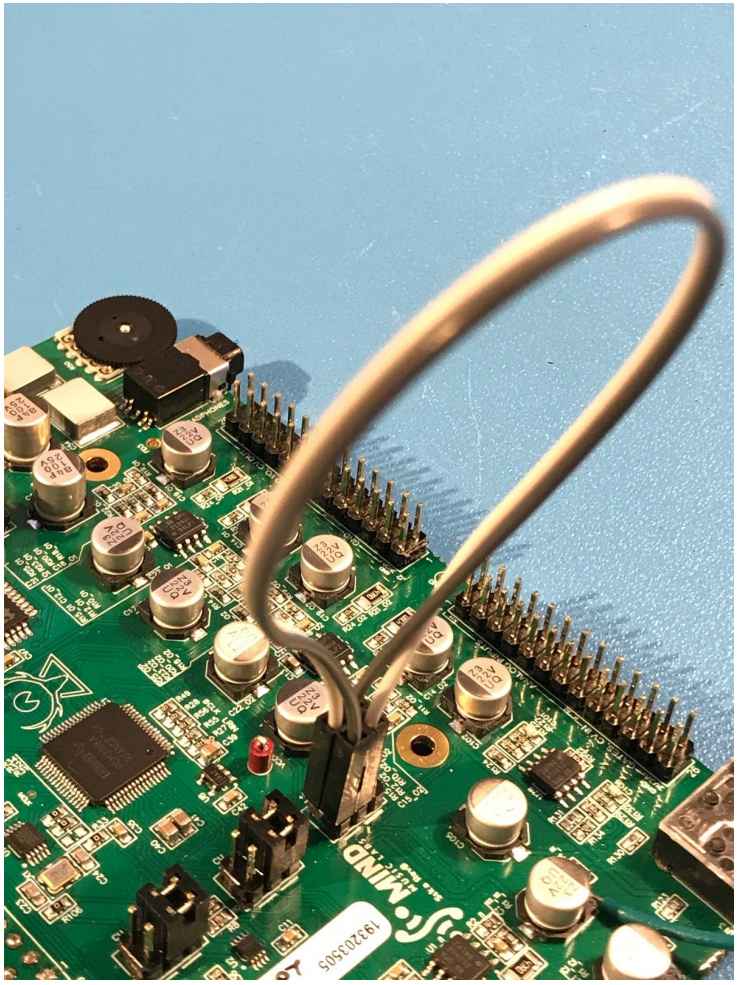
The board has a two-channel preamp with a fixed gain of +10dB (3.16 times). The preamp is only available on channels 1 and 2 and it can be disabled with the mode switch J14.
Leave J14 open to select +10dB mode, use jumpers to select +0db mode (Figure 9).

Figure 9:



For normal line-level input signals, the preamp amplification is not needed, so make sure to configure J14 on 0dB mode if you are feeding a line-level signal, otherwise, clipping will occur. When J14 is on 0dB mode, the preamp works as a buffer and no amplification will occur. If you are feeding an instrument-level signal (coming from a guitar or bass for example) you might want to switch J14 on +10dB mode, to boost the input to the ADC range.

Figure 10:



Closed-beta note #4: In the current revision of the board two of J14 are flipped, and the two pins that have to be shunted are not horizontally placed (Figure 10).

Headphones output

The same stereo output signal that goes to the line out jack (J5) is also fed into a headphone amplifier TPA6111A2.

Max output power to each channel:

150 mW	@ 16 Ω
90 mW	@ 32 Ω
50 mW	@ 64 Ω

Since the headphone and line-out share the same output filter from the codec, the input signal into the headphone amplifier might be affected by the heavy loads connected to the line-out jack. Be aware that by short-circuiting the right channel (by using mono 6.3 mm to RCA plug for example) the right channel will be muted on the headphones!

Closed-beta note #5: if you have board #10-14 you will have problems connecting TRRS jacks on the headphones output, the signal will not be grounded properly. Please avoid them at this time. The board # is written on a sticker on the back of the board.

Analog and Digital GPIOs

Digital IO

Digital IO is based on shift registers. Namely 74HC165 for input and 74HC595 for output. Logic level for both is 3.3V and exceeding it will damage the whole GPIO subsystem permanently since the shift registers are daisy chained. The inputs do not have any pullup- or pulldown resistors! All inputs are captured simultaneously by toggling the parallel load input of all input shift registers. Similarly all outputs are written concurrently on the rising edge of the storage register clock input.

Input type	3.3V CMOS (without pull-up or pull-down resistors)
Input logic high level	>1.5 V
Input logic low level	<0.5 V
Quantization frequency	1 kHz
Output type	3.3V CMOS (push & pull)
Max sink & source current per output	4 mA
Writing frequency	1 kHz

32 Digital inputs (DIx) and 32 Digital outputs (DOx) are available on the 40-pins male connectors J3 and J4 (refer to pinout). They shall be used to connect buttons, switches, rotary encoders, rotary switches, LEDs, LED rings, etc..

Analog Inputs

The analog inputs are based on one single channel 10-bit analog to digital converter ADS70411 and an analog multiplexer 74HC4067. The multiplexer is controlled by a single shift register that shares the same SPI bus as digital GPIO but has dedicated storage register input from the MCU. Only one channel can be read simultaneously by enabling certain multiplexer and selecting desired channel.

Input voltage range relative to GND	0V - 3.3V
Input impedance	600 kΩ
Quantization frequency	1 kHz / 16 channels = 62.5 Hz

16 Analog inputs are (Ax) are available on the 26-pins male connector J6 (refer to pinout). They shall be used to connect potentiometers, sliders and sensors.

Connection guidelines for GPIO peripherals

1. Inputs and outputs of multi-pin peripheral device must be sequential for the ease of software development. A perfect example would be individual bits of an LED-ring situated around a rotary encoder. The LEDs in this case should be connected to DO0...DOn in a way that DO0 connects the first and DOn the last LED in the ring. While it is not mandatory to start from DO0, it is very important to keep outputs sequential. If multiple LED rings are multiplexed, the common control signal of individual rings should be also kept sequential and placed at the start or to the end of the LED control pins.
2. Current sink and source from digital outputs should be kept lower than 4 mA per pin.

CV & GATE I/O

CV I/O

Up to two CV inputs and four CV outputs are available on the board (refer to *Figure 4* to understand the possible configurations). The CV signals are processed using the same codec used for the audio. Note that the Input HPF of the last two input channels of the codec are deactivated by default to make the CV processing possible. The CV inputs signals are sampled at the same frequency of the audio (48kHz), but they are downsampled in software, so the effective sampling rate depends on the buffer size. CV inputs that exceed the input range are clipped.

CV input range:	-5 : +5 V
CV input impedance	122 kΩ
CV output range:	0 : 10 V
CV output impedance	47 Ω
CV Sampling frequency :	48 kHz/buffer size (depends on SW)

GATE I/O

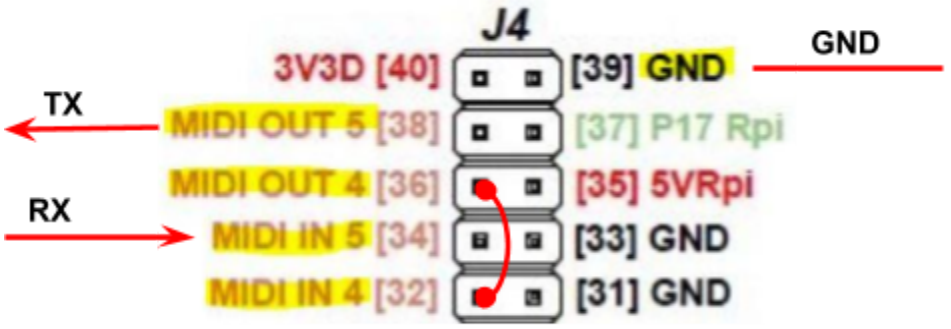
Two gate inputs and four gate outputs are available on the board. The input stage is inverting and is based on a transistor high-side switch linked directly to a Raspberry Pi GPIO. The outputs are not inverting and generated from four different Raspberry Pi GPIO and a series CMOS buffer. Note that the gate IO pins can be also used as a trigger or clock IOs, depending on the software configuration.

Input High voltage range	>= 0.7 V
Input Low voltage range	< 0.7 V
Input Sampling frequency	Depends on buffer size
Output “High” voltage	5V
Output “Low” voltage	0V
Max output source current	6 mA

UART interface

The UART interface can be accessed using the pins 32, 34, 36, 38, 39 of J4 (Figure 11), that are labeled as “MIDI” since they are the same pins that can be used to connect the MIDI 5 Poles DIN connectors. For this reason the UART cannot be used if the dedicated pins are connected to the MIDI DIN connectors.

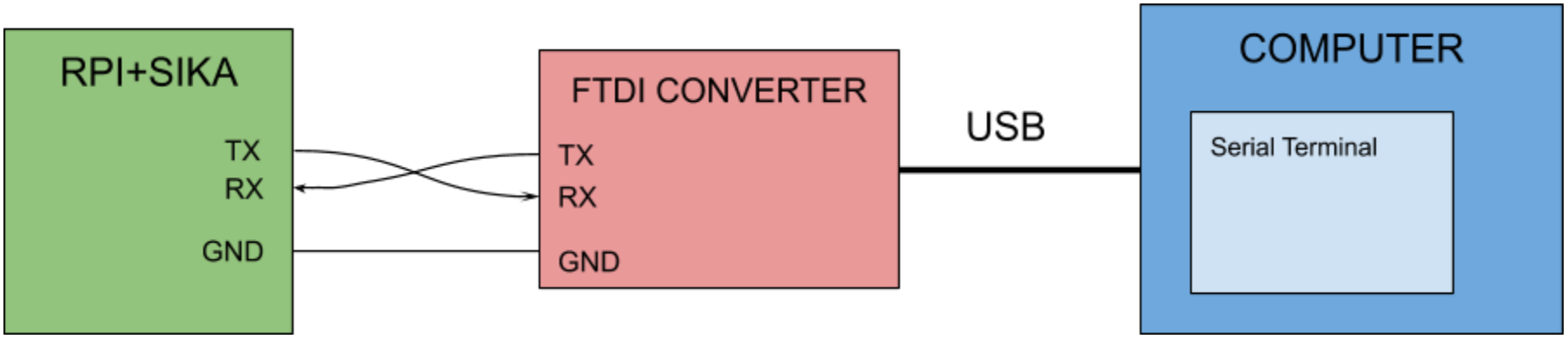
Figure 11:



UART configuration

As you can see from Figure 11, to use the UART you must short (with a female to female jumper) pin [36] and pin [32]. Pin [38] will be UART TX and pin [34] will be UART RX. Figure 12 illustrates how to connect the Sika to your computer with a TTL to USB connector (FTDI).

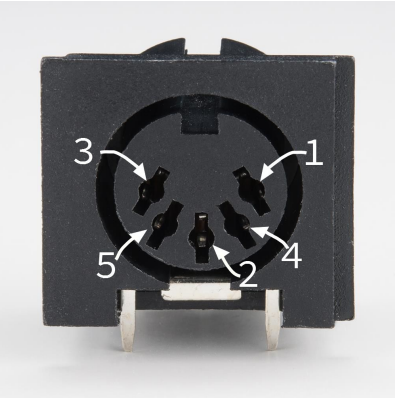
Figure 12:



MIDI DIN I/O

Sika has Optocoupled MIDI IN and MIDI OUT built in, so it is possible to interface it with 5 pins DIN connectors. You might want to do this when you will build your own User interface to plug on top of the Sika. The MIDI signal can be found on the connector J9 (refer to Figure 11 and Figure 5). On the following table you can see some guidelines on how to make the connections:

	Pin on J4	Pin Label	Correspondent Pin on MIDI DIN socket
MIDI IN	32	MIDI IN 4	4
	34	MIDI IN 5	5
	31/33/39...	GND	2
MIDI OUT	36	MIDI OUT 4	4
	38	MIDI OUT 5	5
	31/33/39...	GND	2



Board dimensions