Table of Contents

Jürgen’s Raspberry Pi Zero hat
- Overview
- The main connector J1
- Enocean connector J2
- I2C connectors J3, J4, J5, and J6
- LCD Display X1
- Backlight Power Selector J7
- Extension connector J8
- 220 Volt Connectors J9 and J10
- PWM Connectors J11 and J12

Jürgen’s Raspberry Pi Zero hat

Overview

Unlike other Raspberry hats, this hat is larger than the Raspberry Zero, so the raspberry is plugged onto the hat rather than the hat being pluggend onto the rapberry.

Although the hat was designed for the Raspberry Pi Zero form factor, it supposedly also works for other Raspberry Pi models.

The hat contains only a few active components; the rest is connectors for various purposes. Almost all components are optional and only needed if the interface that they belong to is needed. The hat provides the following connectors/interfaces:

- J1: The main interface between the hat and the Raspberry Pi Zero
- X1: an interface to a 3 Line LCD Display
- J2: an interface for enocean TCM310 hat (or alternatively a serial interface **at 3.3 Volt level (!)**)
- J3, J4, J5 and J6: I^2C interfaces (on the same I^2C bus)
- J11/J12 open-collector outputs connected to the Raspi’s hardware PWM units
- J9 and J10: two 220Volt Relays
- SW1: one pushbutton
- J8: 20 pin header with some more general purpose interface lines

All these interfaces are controlled via GPIO lines of the Raspberry; the I^2C and PWM interfaces can be realized either in software or in hardware.

The main connector J1

The only non-optional component is J1, which connects the hat with a Raspberry Pi Zero. The hat gets its power (3.3 and 5 Volts) via its J1 from the Raspberry, therefore the power from the power supply should go into the Raspberry’s normal power connector (J1/PWR IN), and not to the hat’s J1.

Most of the remaining lines on **J1** are GPIO lines. Unfortunately there exist exist 2 different naming/numbering conventions: the **Broadcom scheme** and the **WiringPi scheme**. If you control the GIPO pins by reading from and writing to files below **/sys/class/gpio** then the GPIO numbers used are those defined by the **Broadcom scheme**. If you instead use a library like wiringPi, then the pin numbers are completely differen and are defined by the **WiringPi scheme**. The following table

shows the mapping between the pin numbers of the hat's J1 connector, the **Broadcom scheme**, and the **WiringPi scheme**:

Alias	Wiring Pi Name	Broadcom Name	J1 Pin		Broadcom Name	Wiring Pi Name	Alias
Power 3.3 Volts			1	2	Power 5 Volts		
I^2C Data	GPIO-8	GPIO-2	3	4			
I^2C Clock	GPIO-9	GPIO-3	5	6	GND		
	GPIO-7	GPIO-4	7	8	GPIO-14	GPIO-15	
GND			9	10	GPIO-15	GPIO-16	
	GPIO-0	GPIO-17	11	12	GPIO-18	GPIO-1	
	GPIO-2	GPIO-27	13	14	GND		
	GPIO-3	GPIO-22	15	16	GPIO-23	GPIO-4	
Power			17	18	GPIO-24	GPIO-5	
	GPIO-12	GPIO-10	19	20	GND		
	GPIO-13	GPIO-9	21	22	GPIO-25	GPIO-6	
	GPIO-14	GPIO-11	23	24	GPIO-8	GPIO-10	
GND			25	26	GPIO-7	GPIO-11	
	GPIO-30		27	28	GPIO-1	GPIO-31	
	GPIO-21	GPIO-5	29	30	GND		
	GPIO-22	GPIO-6	31	32	GPIO-12	GPIO-26	PWM-0
PWM-1	GPIO-23	GPIO-13	33	34	GND		
	GPIO-24	GPIO-19	35	36	GPIO-16	GPIO-27	
	GPIO-25	GPIO-26	37	38	GPIO-20	GPIO-28	
GND			39	40	GPIO-21	GPIO-29	

Enocean connector J2

J2 connects the hat with an Enocean TCM310 based Raspi Transceiver Module. The enocean Module is plugged directly onto J2 of the hat. The connection uses the RxD and TxD lines of RasPi UART (aka. **/dev/ttyAMA0**). The Data format is 57600 Baud, 8N1. Instead of the TCM310 Module, you can use this connector for other purposes that need a serial connection.

The Enocean connector J2 has the following pinout:

Alias	J2 Pin	Broadcom Name	Wiring Pi Name	Alias

Alias	J2 Pin		Broadcom Name	Wiring Pi Name	Alias
Power 3.3 Volts	1	2	-		
-	3	4	-		
-	5	6	GND		
-	7	8	GPIO-14	GPIO-15	RxD
-	9	10	GPIO-15	GPIO-16	TxD
-	11	12	-		
-	13	14	-		
-	15	16	-		
-	17	18	-		
-	19	20	-		
-	21	22	-		
-	23	24	-		
-	25	26	-		

I²C connectors J3, J4, J5, and J6

These connectors are connected in parallel (so that they belong to the same I²C bus). They are typically used to connect sensors. It is normally better to put sensors that are located close to each other on one cable (bus connection) than using separate cables (star connection), because that way the signal reflections at the ends of (unterminated) cables are being reduced.

If the cable(s) are too long then the I²C becomes unreliable and buffering and/or proper termination of the cables might be needed. Another solution for long cables could be to run the I²C in software (using **/sys/class/gpio/gpio9/value** for the I²C clock and **/sys/class/gpio/gpio8/value** for the I²C data, instead of **/dev/i2c-1**.

Every I²C connector J3, J4, J5, or J6 has the same pinout:

Pin	Broadcom Name	WiringPi Name	Alias
1	Power 3.3 Volts		
2	GPIO-2	GPIO-8	I²C Data
3	GND		
4	GPIO-3	GPIO-9	I²C Clock

LCD Display X1

The hat may optionally be equipped with a 3-line LCD Dispay. The display is mounted on connector X1, which is a standard 40-pin, 600 mil socket with some pins not used. The pinout of X1 is:

Alias	Wiring Pi Name	Broadcom Name	J1 Pin		Broadcom Name	Wiring Pi Name	Alias
A1 +	J7 Pin 2 3.3/5 Volts		1	40	GPIO-11	GPIO-14	RESET
C1 -	R_{LED}		2	39	GPIO-21	GPIO-29	RS
-			-	38	GND		CSB
-			-	37	GPIO-20	GPIO-28	R/W
-			-	36	GPIO-16	GPIO-27	E
-			-	35		3.3 Volts	D0
-			-	34			D1
-			-	33			D2
-			-	32			D3
-			-	31	GPIO-7	GPIO-11	D4
-			-	30	GPIO-8	GPIO-10	D5
-			-	29	GPIO-25	GPIO-6	D6
-			-	28	GPIO-24	GPIO-5	D7
-			-	27	GND		V_{SS}
-			-	26	3.3 Volts		V_{DD}
-			-	25	3.3 Volts		V_{in}
-			-	24	(charge pump)		V_{out}
-			-	23	3.3 Volts		PSB
C2 -	GND		19	22	(charge pump)		CAP1P
A2 +	R_{LED}		20	21	(charge pump)		CAP1N

Backlight Power Selector J7

The optional LCD display X1 can by equipped with an optional LED backlight in order to improve its readability. The optional LED backlight can either be driven from 3.3 Volts or from 5 Volts. Driving it from 5 Volts is supposedly better since the current of the backlight (about 40 mA) does not flow through the RasPi's 5Volt → 3.3Volt converter.

Jumper J7

Jumper J7	
1-2	Run LED backlight from 3.3 Volts
2-3	Run LED backlight from 5 Volts

The LED backlight current **MUST** be limited, this is accomplished by resistor below the LCD display X1. The PCB shows a value of 10 (Ohms). This value is, however, dependant on two factors: the setting of J7 and the color of the LEDs. Typical values lie between about 0 and 30 Ohms, if unsure start with 30 Ohms and decrease as needed. For prototyping use a connector instead of soldering a (possibly incorrect) resistor.

Extension connector J8

Most of the GPIO lines that are not connected with specific interfaces are conncted to J8. That way additional components can be connected to the RasPi as needed. The Pinout of J8 is:

Wiring Pi Name	Broadcom Name	J8 Pins		Broadcom Name	Wiring Pi Name
GPIO-13	GPIO-9	1	2	GPIO-10	GPIO-12
GPIO-5	GPIO-21	3	4	GPIO-3	GPIO-22
GPIO-6	GPIO-22	5	6	GPIO-4	GPIO-23
GPIO-19	GPIO-24	7	8	Power 3.3V	
GND		9	10	GPIO-25	GPIO-26

220 Volt Connectors J9 and J10

The hat can be equipped with one or two relays that both can switch a 220 Volt power line. The Line (L) inputs of J9 and J10 are connected, it is therefore **NOT** possible to switch different phases, e.g. L1 and L2, of the same neutral (N) line.

The coils of each relays also operate at 220 Volt (or whatever voltage you choose for the relay components) and are galvanically isolated from the hat and the RasPi by means of optocoupler triacs (MOC 3041 or similar). The relay coild both use the primary AC input, therefore the secondary relay cannot be used without the primary.

For operation at 110 Volts you may need smaller values for the 470 Ohm resistors above the LCD display X1. Refer to the MOC 3063 data sheet for details. The coils of the relays should be protected with varistors R7 resp. R8 that suppress inductive spikes when a coil is being turned off. The values of the varistors need to match the voltage used for the relay, e.g. 270 Volts for 220 Volt relay coils and

> 140 Volts for 110 Volt relay coils.

> Unlike the coils of the relays, the relay contacts are **NOT** protected with varistors. For ohmic loads (e.g lamps) such protection is not needed, but for inductive loads (e.g. motors for blinds, door openers, etc.) additional protection for the relay contacts is recommended.

Connector J9, the primary 220 Volt connector, has one more pin than J10: this pin provides the neutral (N) line for both relay coils and contacts. The pinouts of J9 and J10 are:

J9 Pin	Purpose
1	Neutral (N)
2	Line out if Relay is OFF
3	Line in (L)
2	Line out if Relay is ON

J10 Pin	Purpose
1	Line out if Relay is OFF
2	Line in (L)
3	Line out if Relay is ON

The relays (ON/OFF) are controlled with the following GPIO pins:

Broadcom Name	Wiring Pi Name	Relay
GPIO-17	GPIO-0	Relay J9 ON/OFF
GPIO-27	GPIO-2	Relay J10 ON/OFF

PWM Connectors J11 and J12

J11 provides two PWM channels that are driven by the open collectors of the two transistors next to J1. These signals can be used, for example, to control the speed of fans. J11 has the following pinout:

J10 Pin	Broadcom Name	Wiring Pi Name	Alias
1	GPIO-12	GPIO-26	PWM-1
2	-		

J10 Pin	Broadcom Name	Wiring Pi Name	Alias
3	GPIO-23	GPIO-13	PWM-0
4	-		
5	GND		

J11 is intended for the case where both PWM channels are routed over the same cable. In contrast, J12 is intended for the case where differen cables are used for the two PWM channels. J12 has the following pinout:

J10 Pin	Broadcom Name	Wiring Pi Name	Alias
1	-		
2	-		
3	GPIO-12	GPIO-26	PWM-1
4	-		
5	GND		

If J12 is used, then typically pin 1 of J11 is not.
