ReceiverPi

Digital Audio Interface Receiver for RaspberryPi user's guide

By Ian Jin Dec 1, 2019 Ver. 1.0b

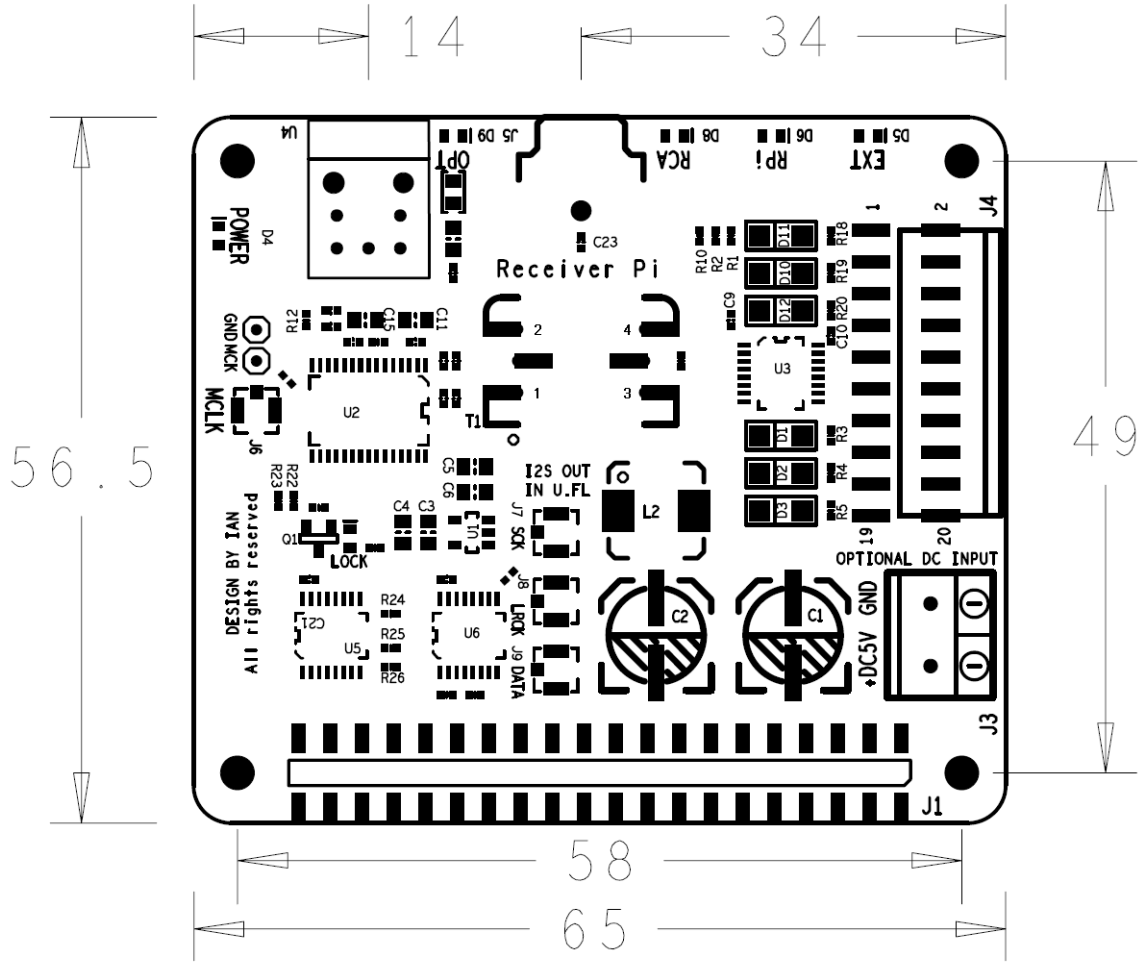
A. Introduction

ReceiverPi is designed for Raspberry Pi based DACs or streamers to extent the ability of playing digital music from multiple sources additional to RPi itself, such as CD/DVD player/transport, TV, TV box, Mac, PC, USB streamer and so on, through the S/PDIF inputs and external I2S/DSD input.

B. Highlighted Features and Specifications

- RCA (75 ohm) S/PDIF input up to 192KHz, isolated
- Optical S/PDIF input up to 192KHz
- I2S/DSD input for external USB streamer and other PCM sources, up to 768KHz PCM or DSD1024
- I2S/DoP input from RPi GPIO up to 768KHz
- Can be automatically switched to selected S/PDIF source if valid signal is present
- Possible to switch to USB streamer automatically when it's power up
- Possible to have a control panel
- Reserved GPIO port for possible Linux/Web based software control
- Can be seamlessly integrated with FifoPi and ESS DAC HAT(sync mode) by installing it between RPi and FifoPi
- Run RPi DACs in either slave mode or sync mode with and without a FifoPi
- Can run RPi DACs or external DACs even without a RPi (RPi free mode)
- Can be easily configured as S/PDIF FIFO by integrating together with FifoPi and TransportPi
- Can be easily configured as HDMI transport by integrating with HDMIpi or TransportPi
- Upgradable/removable S/PDIF isolation transformer for the RCA input
- Possible to have independent DC power input
- DIY friendly and plug and play

C. Layout and Dimensions (in mm)



D. Getting start

1. Make sure your RPi DAC stack is working and playing music normally. Power off before going to next step.
2. Install the ReceiverPi into the GPIO port of RaspberryPi. And then install the rest of your system (FifoPi or DAC HAT and so on) on top of ReceiverPi through GPIO port. Make sure all other connections are connected as same as before. Power on your system as usual.

   Note: Please don't try any master mode DAC with ReceiverPi. By principle, no master mode DAC can work with S/PDIF music and external I2S/DSD streamer. They can only work with the music source that the control software is running at, which is one of the disadvantages of all this kind of DACs.
3. Play music from RPi as same as the time before you installed the ReceiverPi. Make sure the RPi LED on the ReceiverPi is lit and you DAC has music output normally.
4. Plug an optical cable from the output of a CD/DVD player or other S/PDIF source into the OPT port U4 on the ReceiverPi. Start playing music at that S/PDIF source. And now you will have both Lock LED and OPT LED lit

on the ReceiverPi. Music from the S/PDIF source should be playing already at the output of your DAC.

5. If you want to use RAC cable as the S/PDIF input, you just need to jump Pin17 and Pin18 of J4 with a shunt jumper to select RCA as your S/PDIF source. And then connect the coaxial cable to the RCA connector J5.

   Please Note: With FifoPi installed in the system, OPT and RCA will have no difference in sound quality. However, OPT has better isolation performance, while RCA is better at high Fs.

6. Enjoy the music.

E. Connectors

U4: Optical S/PDIF input

Have to leave the Pin17 of the multi-function connector J4 open (default) to select this optical input as the S/PDIF source. U4 is a standard TOSLINK optical connector.

J5: RCA coaxial S/PDIF input

Have to bridge the Pin17 and Pin19 (GND) with a shunt jumper on the multi-function connector J4 to select this RCA input as the S/PDIF source.

J6: MCLK output in u.fl coaxial cable socket

This MCLK is enabled only when valid S/PDIF is in receiving. Lock LED should be lit at same time. FifoPi doesn't need this MCLK signal to function.

J4: Multi-function connector, 20PIN, 2.54mm

PIN numbers	Descriptions	Notes
1	SCK input of external I2S/DSD source	To connect to external I2S/DSD source such as USB streamer, HDMI streamer and other PCM sources
2	GND, better to be paired with Pin1	
3	LRCK/DL input of external I2S/DSD source	
4	GND, better to be paired with Pin3	
5	DATA/DR input of external I2S/DSD source	
6	GND, better to be paired with Pin5	
7	LED- of External I2S/DSD indicator	If use external panel, connect these two pins to a LED directly to indicate that the external I2S/DSD source is currently switched to when lit
8	LED+ of External I2S/DSD indicator	
9	LED- of RPi GPIO indicator	If use external panel, connect these two pins to a LED directly to indicate that the RPi GPIO is currently switched to when lit
10	LED+ of RPi GPIO indicator	
11	LED- of RCA indicator	If use external panel, connect these two pins to a LED directly to indicate that the S/PDIF source in RCA is valid and currently switched to when lit
12	LED+ of RCA indicator	
13	LED- of OPT indicator	If use external panel, connect these two pins to a LED directly to indicate that the S/PDIF source in optical is valid and currently switched to when lit
14	LED+ of OPT indicator	

PIN numbers	Descriptions	Notes
15	PCM sources selector RPi or EXT I2S/DSD	Keep Pin15 open (low, default): To select RPi GPIO as PCM source Short Pin15 and Pin16 by a shunt jumper(high): To select external I2S/DSD as PCM source
16	VCC 5V power output	
17	S/PDIF sources selector OPT or RCA	Keep Pin17 open (high, default): To select OPT as S/PDIF source Short Pin17 and Pin18 by a shunt jumper(low): To select external RCA as S/PDIF source
18	GND	
19	Auto S/PDIF selector	Keep Pin19 open (high, default): To automatically switch to S/PDIF sources when valid S/PDIF signal is applied (S/PDIF priority) Short Pin19 and Pin20 by a shunt jumper(low): Force to switch to PCM sources
20	GND	

40 pin GPIO connectors

pin numbers	**J2** 40 PIN GPIO connector to board below (Normally Raspberry Pi)	**J1** 40 PIN GPIO connector to HAT on top (FifoPi or DAC or other audio board)
1,17	3.3V from preceding board	3.3V from preceding board
2,4	5V from preceding board	5V from preceding board
6,9,14,20, 25,30,34, 39	GND	GND
12	SCK input	SCK output
35	LRCK/DL input	LRCK/DL output
40	SD/DR input	SD/DR output
3	I2C DA	I2C DA
5	I2C CL	I2C CL
8	TXD0	TXD0
10	RXD0	RXD0
All other pins	same pin from preceding board	same pin from preceding board

Note: All input/output signals on the GPIO connectors are in LVTTL (3.3V) logic level except power and ground.

I2S/DSD outputs in u.fl

J7: SCK
J8: LRCK/DL
J9: DATA/DR

Note: I2S/DSD outputs in u.fl have better signal quality. So u.fl coaxial cables are highly recommended to connect to external digital audio devices.

J3: Optional independent DC power input

If don't want picking up power from GPIO, you can connect a 5V DC / 100mA (minimum) power supply to this 2-pin 5.0mm terminal J3. MAINTAINING CORRECT POLARITY!!! Low noise linear 5V power supply will be good for ReceiverPi. Direct-connected 3.3V ultra capacitor / LifePO4 battery power supply can also be used.
J3 was not installed by default. L1 (at bottom side of the PCB) needs to be removed if you don't want new DC power being connected to GPIO. No need to remove L1 if ReceiverPi works independently without plugged into GPIO.

F. LED indicators

D4: Power indicator, indicating that ReceiverPi is powered
D7: Lock indicator, indicating that valid S/PDIF is received and locked. Either OPT or RCA
D9: OPT indicator, indicating that valid S/PDIF signal in OPT is received and switched to
D8: RCA indicator, indicating that valid S/PDIF signal in RCA is received and switched to
D6: RPi indicator, indicating that ReceiverPi outputs are currently switched to RPi GPIO input
D5: External I2S indicator, indicating that ReceiverPi outputs are currently switched to external I2S/DSD input

Note: LED output signals on J4 have the same function as D5, D6, D8 and D9.

G. Application notes

1. How to make an external control panel?

External control panel would be very easy to make by connecting three switches to Pin15-16, Pin17-18, Pin19-20 and 4 LEDs to Pin7-8, Pin9-10, Pin11-12, and Pin12-14 of the multi-function connector J4.
Note: If you are happy with the automatic switch function maybe you don't really need an external control panel.

2. How does the auto S/PDIF selecting function work?

By default, the ReceiverPi works in auto S/PDIF selection mode. In this case, when external S/PDIF source, such as a CD player is turned on and playing music, the ReceiverPi's outputs will be automatically switched to that S/PDIF source. Which S/PDIF input (RCA or OPT) is in use will be decided by the jumper setting of Pin17 and Pin18 on J4.

3. Is it possible to switch to external USB streamer automatically?

Yes, it's possible. You can use the Vcc (3.3V to 5V) of the USB streamer as the control signal. Connect this control signal to the Pin15 of J4. When the USB cable is plugged in, the ReceiverPi's outputs will be automatically switched to the USB streamer. Don't forget connecting I2S/DSD signals from the USB streamer to the Pin1 to Pin6 of J4.

4. How to upgrade or remove the S/PDIF isolation transformer?

The S/PDIF transform T1 is installed by default for additional safety and ground isolation. As a DIY friendly product, T1 was designed to be upgradeable and removable.

S/PDIF signal quality can be improved if better transformer is used. To upgrade T1 you just need to un-plug it from the socket and then plug the new one back to the socket. Make sure the orientation is correct.

If your S/PDIF source already has the isolation transformer at the transmitter end, then you will not need an additional isolation transformer on the ReceiverPi. In this case, removing T1 can improve the S/PDIF signal quality even more. To do so, you just need to un-plug the transformer from the T1socket and then short Pin1-Pin3 and short Pin2-Pin4 of the T1 socket to bypass the transformer. Solder those jumper wires at back to the PCB would be a good way to go.

Note: With FifoPi installed in your system, finial sound quality could have no business with the transformer.

5. How to use independent DC power supply?

The ReceiverPi was designed to pick up power from GPIO. With FifoPi installed in the system, ReceiverPi's power supply may not affect the finial jitter performance. However real listening test shows that better power supply before FifoPi can still make slightly improvement to the finial sound quality. Because of the overall EMI noise can still have chance to be reduced when good power supply is used.

To use independent DC power, you will need:

a. Solder the supplied DC connector to the position of J3.
b. Remove FB L1 at bottom side of PCB if you don't want this power supply to be connected to GPIO.
c. Feed a good 5V linear/ultra capacitor voltage rail or a 3.3V LifePO4/ultra capacitor rail to J3.
d. If 3.3V pure LifePO4 or ultra capacitor voltage is used, it's highly recommended to short the L7 by soldering jumper wires at bottom side of PCB to bypass the on-board LDO. Though it's just optional.
   Please note that after L7 was shorted, you can no longer use 5V or any other voltage higher than 3.8V.

6. About the possible software control

ReceiverPi can use three reserved GPIO pins for possible Linux/Web based software control.

To do so, you will need short R34, R35 and R36 with 0 to 50 ohm 0805 resistors or just jumper wires.

The GPIO pin numbers and control logic are listed as below:

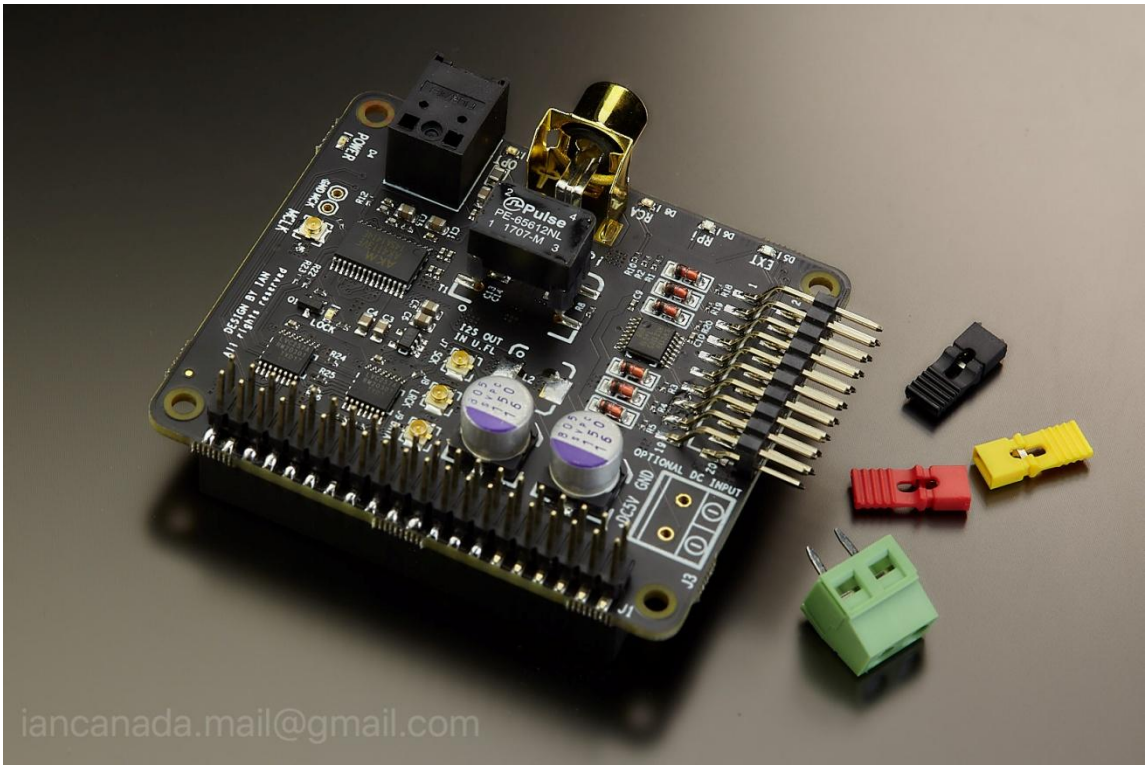
GPIO pin number	Signal name	Resistor	Control logic
GPIO27	Auto S/PDIF	R36	High: Auto S/PDIF mode Low: Force to receive from PCM
GPIO17	S/PDIF selection	R35	High: OPT is selected as S/PDIF input Low: RCA is selected as S/PDIF input
GPIO4	PCM selection	R34	High: RPi GPIO is selected as PCM input Low: External I2S/DSD is selected as PCM input

Please note:

a. No any official control software is provided so far. Users need to write code by themselves or use the possible third party software.
b. Pin15, Pin17 and Pin19 on the connector J4 have to leave open after R34, R35 and R36 are installed.

H. Pictures ReceiverPi

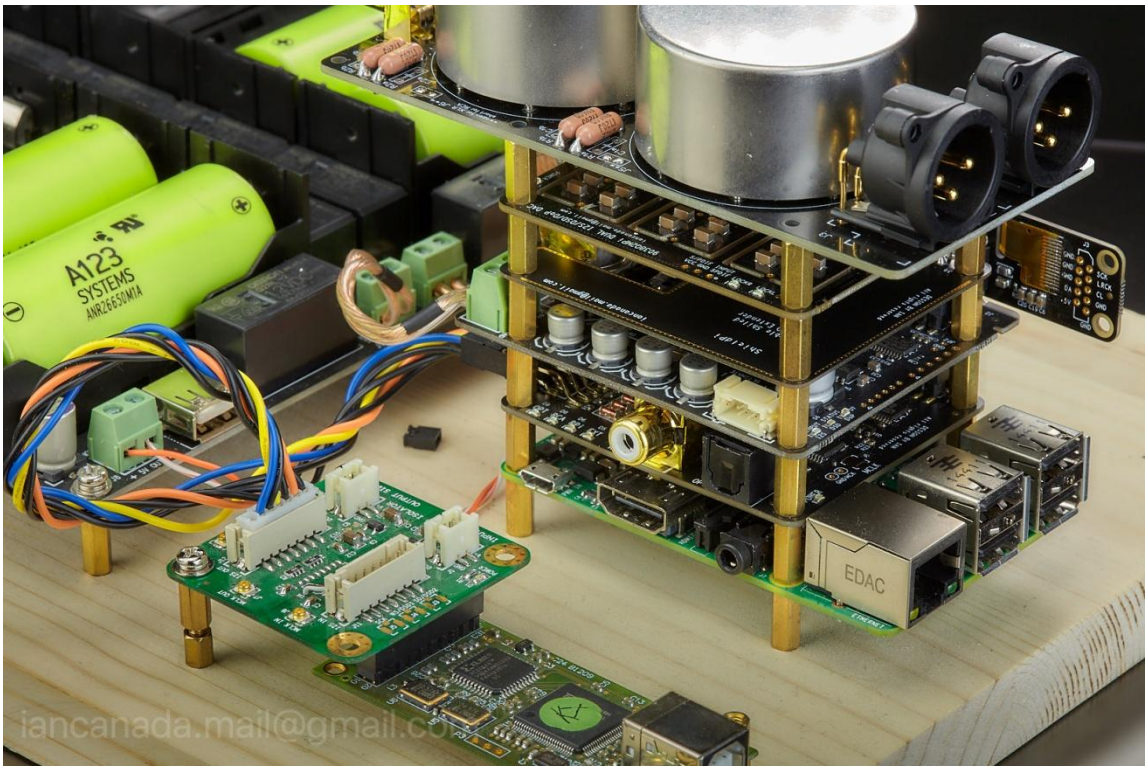
1. ReceiverPi as shipped



2. Works as S/PDIF FIFO with FifoPi and TransportPi

3. A full system configured of a high quality audiophile DAC
    a. RaspberryPi
    b. ReceiverPi
    c. FifoPi
    d. ShieldPi
    e. ESS9038Q2M dual mono DAC
    f. Transformer I/V stage

    Note: LifePO4 power supply with ultra capacitor conditioner upgraded is highly recommended for best possible sound quality



I. History of revising

Dec 1, 2019 V1.0b released