

# IsolatorPill User's Guide

By Ian Jin and Greg Stewart, Nov 18, 2018 Ver. 2.0b

## A. Description

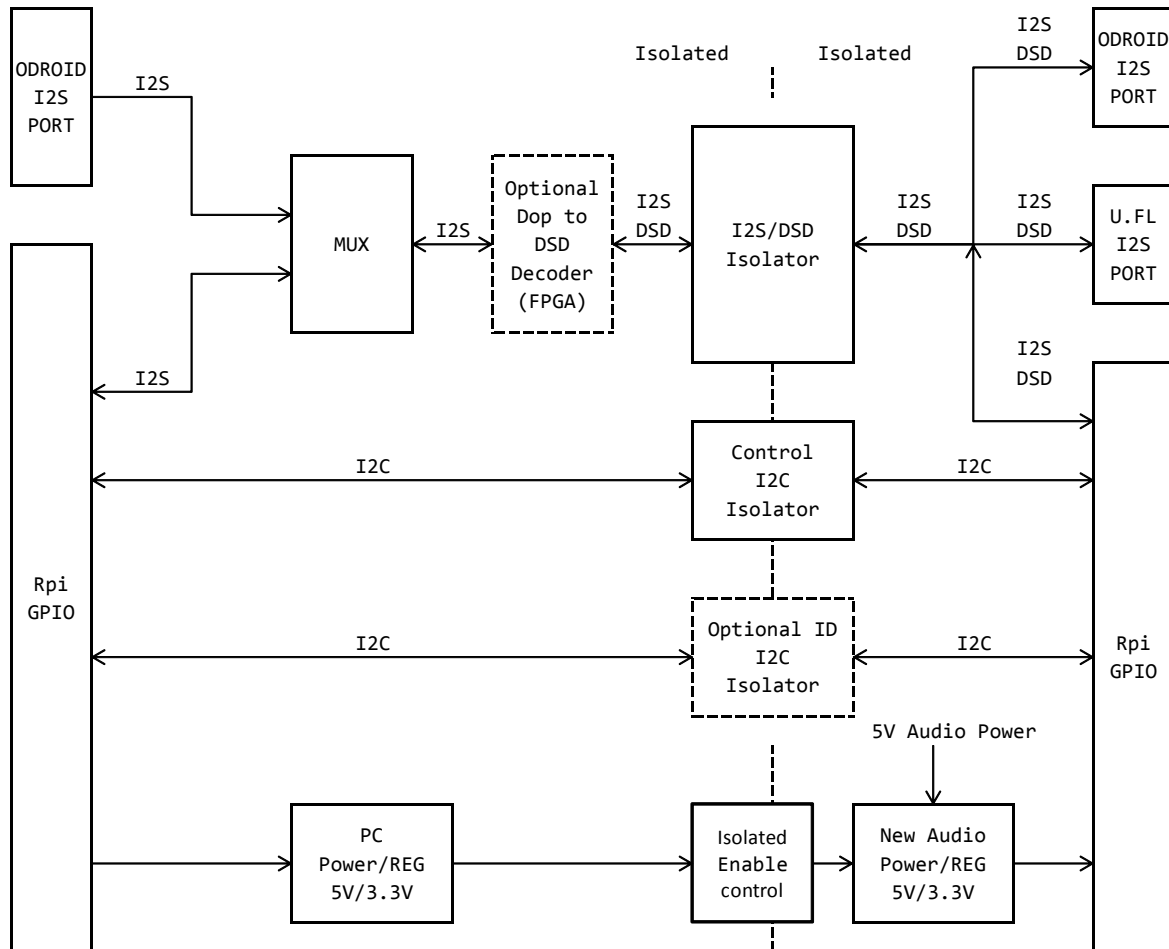
IsolatorPill is a Single Board Computer (SBC) HAT for RaspberryPi's or ODROID's that provides galvanic isolation for I2S, I2C, ID, some GPIO and power between the SBC and the digital audio card. It prevents transmission of SBC EMI noise via the ground and signal connection.

Preventing that noise from getting into your audio cards allows them to work better. AND with lower noise on the ground, when you introduce better power supplies and lower jitter clocks for your audio cards, the positive effects will be enhanced.

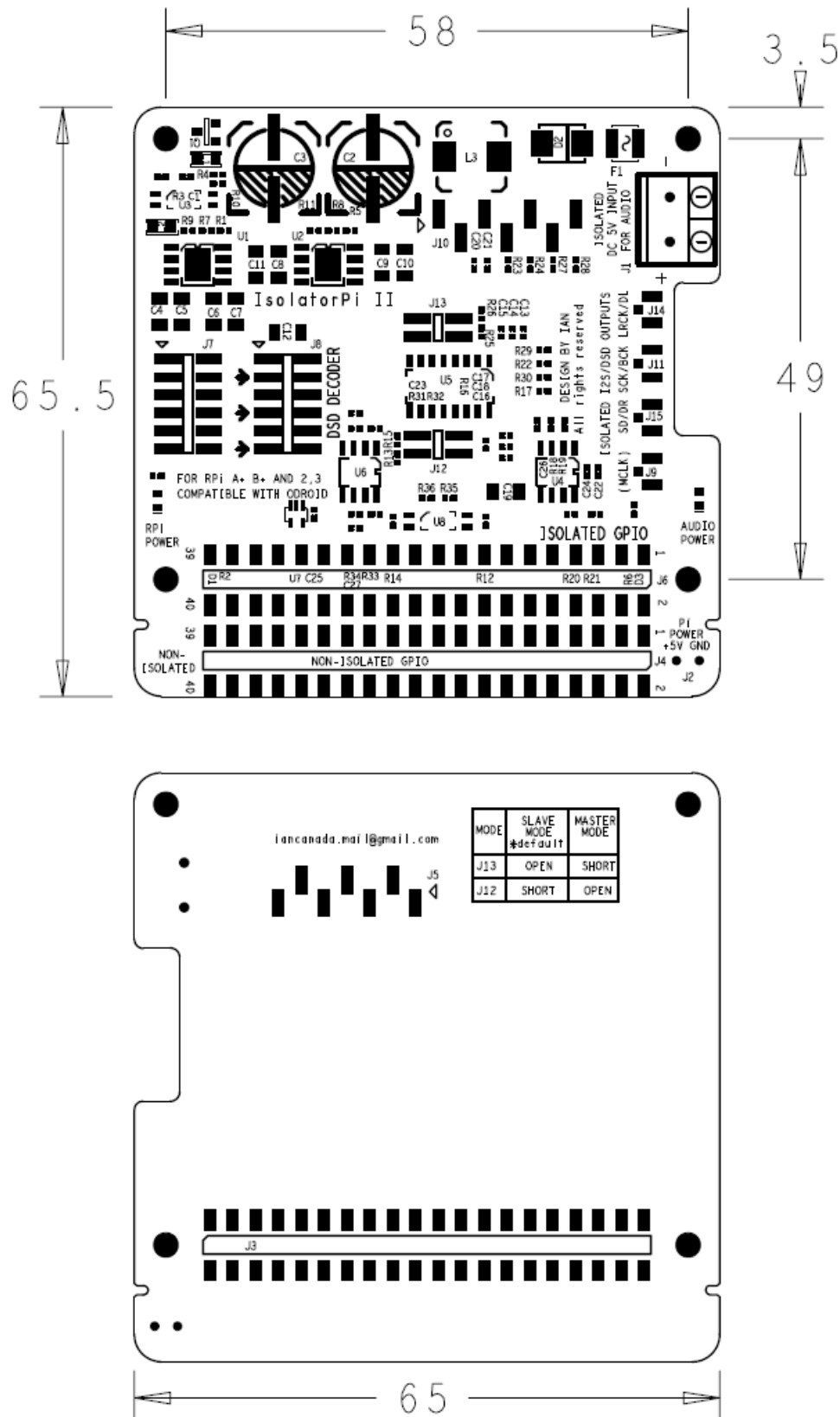
## B. Features and Specifications

- 150MHz 2.5KV digital isolator, 768KHz I2S and DSD512 capable.
- Bi-directional architecture works with audio cards in both slave clock and master clock modes.
- Ready for native DSD output using companion DoP decoder in on-board socket.
- 5v-6v audio power input with RPi-controlled automatic and isolated enable/disable. Un-isolated side powered by RPi/ODROID.
- Isolated I2C for audio card configuration and control.
- ID EEPROM isolator provided for RaspberryPi HAT DACs
- Also works with ODROID. Adapts RPi audio cards to ODROID.
- IsolatorPi II now supports 502DAC Pro, Hifiberry Digi Pro +, and all other WM8804 based applications in master clock mode;
- IsolatorPi II has an additional 40Pin non-isolated GPIO connector. With which, we can connect the possible ESS DAC controller, IR receiver, the rotary encoder and all other non-audio devices to RPi. The good thing is that all of those devices will become 100% isolated from DAC under this configuration. DSD signals will also be applied to this non-isolated GPIO if the DoP decoder daughter board is installed.
- IsolatorPill reserves an optional power Pi connector. With it, we can now power RPi from GPIO (reported better than USB power) through this connector's +5V and GND Pins. Powering Pi from GPIO can be done through the no-isolated GPIO too.
- Needs no device driver and/or overlay. Works in transparent mode.
- Suitable for most Raspberry Pi audio cards such as DAC HATs, S/PDIF Adapter HATs, I2S Reclocker HATs and many other RPi HiFi applications.

## C. Block diagram



## D. Layout and Dimensions (in mm)



## E. Connectors

### J1: 5V-6V DC power input

A 5V-6V DC power supply must be connected to this terminal for the IsolatorPill to operate. This is regulated to 3.3v to run the IsolatorPill and is also passed to the connected audio board via the R-Pi GPIO 5v & 3.3v pins. When used with the optional DoP decoder daughter board, IsolatorPill consumes around 100mA current. You **MUST** add this to the current required by the audio board to determine the minimum current output for your power supply. Generally use a supply that provides 300mA as a minimum.

This powers the fully isolated side of the IsolatorPill and is completely separate from the Raspberry Pi's power and ground. The isolated side automatically turns on and off using an optically-isolated enable/disable controlled by the Raspberry Pi's power. You **MUST** power the IsolatorPill before powering the Raspberry Pi. It draws very little current in 'off' mode, so you can leave it powered all the time if you desire.

See Note 8 for use with audio cards that are designed to power the Raspberry Pi.

### J6: 40PIN isolated GPIO connector

Pin	Signal	Description
2, 4	5V	5V-6V DC output for attached audio cards such as DACs. This is a filtered pass-through of the power supply connected at J1 and the available voltage and current are set by that supply. It is entirely isolated from the RPi 5V.
1, 17	3.3V	Isolated and regulated 3.3V 200mA DC output.
3	I2CDA	Isolated I2C bus to configure and control audio cards
5	I2CCL	
27	IDDA	Isolated I2C to access ID EEPROM of audio cards
28	IDCL	
12	SCK/BCK	Isolated I2S or DSD output
35	LRCK/DL	
40	DATA/DR	
6,9,14,20,25,30,34,39	GND	Isolated ground
15,22,31	PULL UP	Pull up to 3.3Vcc with 4.7K resistor, reserved for some audio cards
All other pins	NC	Not connected

**J10: Isolated I2S output connector for ODROID (Not used for RPi)**

Pin	Signal	Description
1	GND	Isolated ground
2	NC	Not connected
3	3.3V	Isolated and regulated 3.3V 200mA DC output
4	MCLK	Isolated MCLK output, only available when source SBC is an ODROID
5	LRCK/DL	Isolated I2S or DSD output
6	SCK/BCK	
7	DATA/DR	

**J11, J14, J15: Isolated I2S/DSD outputs U.FL sockets for coaxial cable**

	I2S output	DSD output
J11	SCK	BCK
J14	LRCK	DL
J15	DATA	DR

**J9: Isolated ODROID MCLK output U.FL sockets for coaxial cable (Not used for RPi)**

Only active when source SBC is an ODROID.

**J3: RPi GPIO socket**

Connect to the source SBC's (RaspberryPi or ODROID) 40PIN GPIO connector.

**J5: Isolated I2S input connector for ODROID (Not used for RPi)**

Connects to an ODROID I2S connector.

**J4: Non-isolated 40PIN RPi GPIO**

This connection parallels all power and signal connections from the input 40PIN GPIO connector (pin to pin connected). This provides access to GPIOs for applications such as IR receivers, rotary encoders and other non-analog devices while preserving isolation with the audio cards. You can power the RPi through this connector by connecting 5v to pin 5 (and/or pin 2) and ground to pins 6 (and/or pins 9,14,20,25,30,34,39).

**J2: Reserved Power Pi connector**

To power RaspberryPi from GPIO through +5V and GND (No longer needs the USB power if RPi is powered from GPIO).

## F. Jumper settings

### J7: RaspberryPi/ODROID selection

	RaspberryPi (default)	ODROID
J7	<p>Diagram showing jumper settings for RaspberryPi (default) on J7. The board has two columns of 6 pins each (1-6 on the left, 2-7 on the right). Jumper 1 is on pins 1 and 2. Jumper 2 is on pins 3 and 4. Jumper 3 is on pins 5 and 6. Jumper 4 is on pins 7 and 8. Jumper 5 is on pins 9 and 10. Jumper 6 is on pins 11 and 12.</p>	<p>Diagram showing jumper settings for ODROID on J7. The board has two columns of 6 pins each (1-6 on the left, 2-7 on the right). Jumper 1 is on pins 1 and 2. Jumper 2 is on pins 3 and 4. Jumper 3 is on pins 5 and 6. Jumper 4 is on pins 7 and 8. Jumper 5 is on pins 9 and 10. Jumper 6 is on pins 11 and 12.</p>

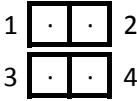

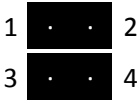
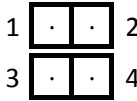
### J12 and J13: Slave/Master mode selection

In slave mode, the RPi generates the three I2S (SCK, LRCK and DATA) signals using its internal clock. These I2S signals are fed into the audio card through the IsolatorPill. Most RPi audio cards such as DAC HATs operate in slave mode.

In master mode, the audio card (typically a DAC) contains two dedicated audio clock oscillators (XO) that are used to generate the SCK and LRCK of I2S signals. These two I2S clock signals are fed back into the RPi through the IsolatorPill. The RPi uses these two I2S clock signals to generate the DATA signal instead of using its internal clock.

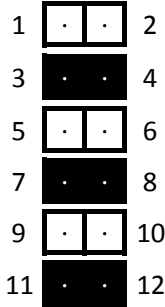
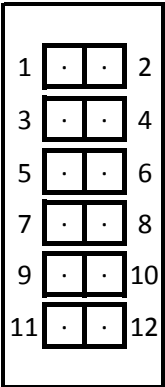
Because the RPi internal clock is not dedicate audio clock AND must be converted to the audio clock frequencies by internal PLL and CTC, it is a very high jitter clock. Audio cards that operate in master mode can produce better quality results when they use high quality / low jitter clocks and feed high quality / low jitter SCK and LRCL I2S signals to the RPi. Using the IsolatorPill with an audio board operating in master mode can further improve the sound quality by preventing transmission of EMI noise via the RPi ground AND by powering the audio card (and isolated side of the IsolatorPill) using a separate power supply.

Audio cards operating in master mode typically require dedicated device drivers. Please see the audio card's user manual for details.

	Slave clock mode (default)	Master clock mode
J13		
J12		

## G. DoP to native DSD decoding

Conversion of DoP to native DSD can be enabled using the DoP decoder daughter board into J8. With this card installed, the IsolatorPill will output native DSD signals when playing a DSD music file. Most of current software for RPi can support DoP. For this to work, the music player on the RPi must be set to enable the DoP output function.

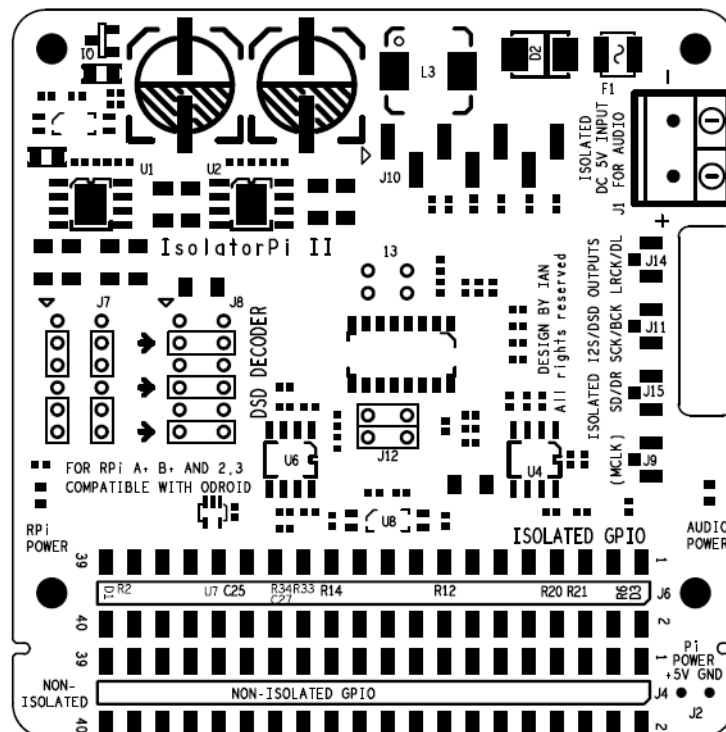
	I2S only mode,default (No DoP function 3-4,7-8,11-12 need to be shorted by jumpers)	I2S/DSD mode (Remove all jumpers, plug the DoP Decoder daughter board into J7)
J8		

## H. LED indicators

LED	Descriptions	Notes
D1	RPi power LED	On when power is provided to the connected SBC (RPi or ODROID)
D3	Audio power LED	On when both the IsolatorPill power supply is present (via J1) and the SBC (RPi or ODROID) is powered. Both the RPi power LED and Audio power LED should glow about the same brightness. If the voltage is different between the SBC and IsolatorPill, one will be darker than the other. Please check the power supply in this case.

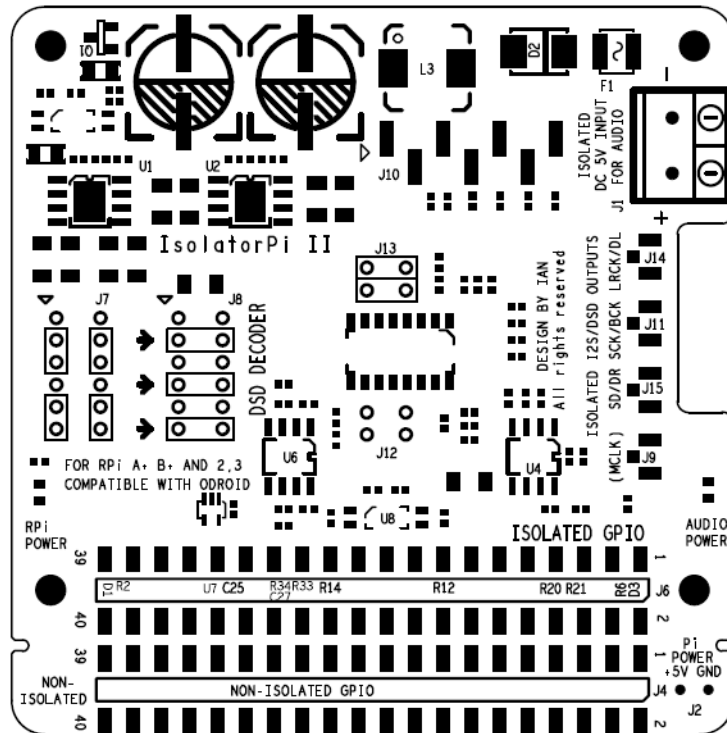
## I. Typical applications

**A: Works with slave mode RPi DAC HATs and other audio cards (default as supplied)**

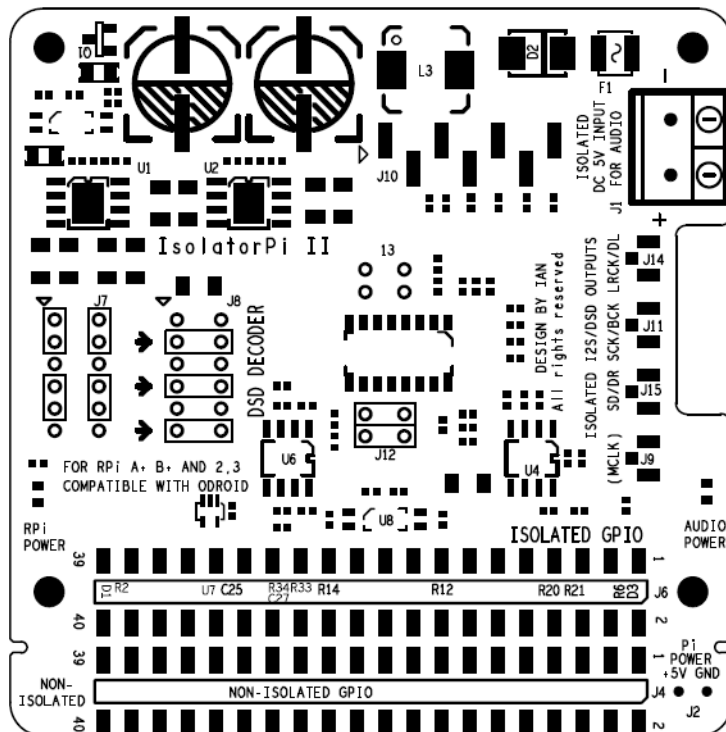




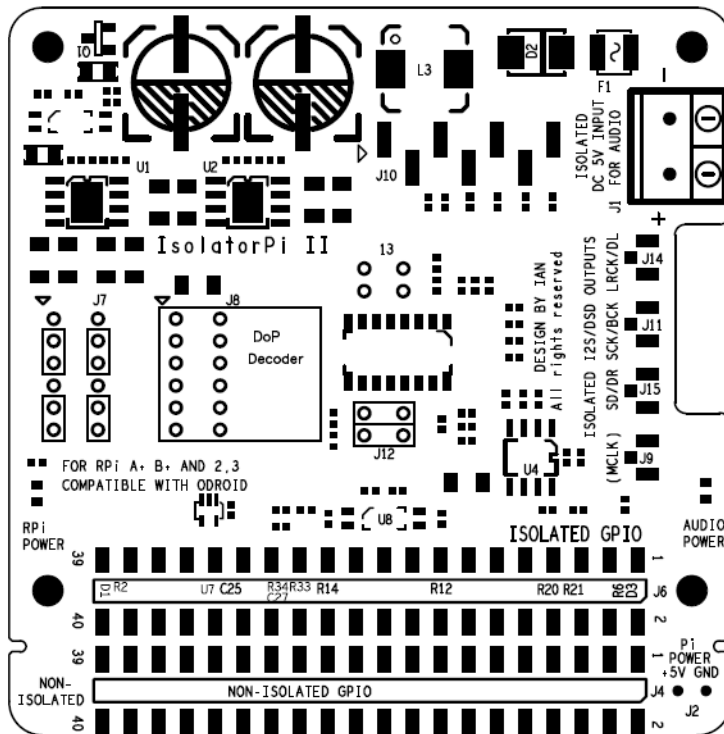
**B: Works with master mode RPi DAC HATs and other audio cards**



**C: Works with ODROID**



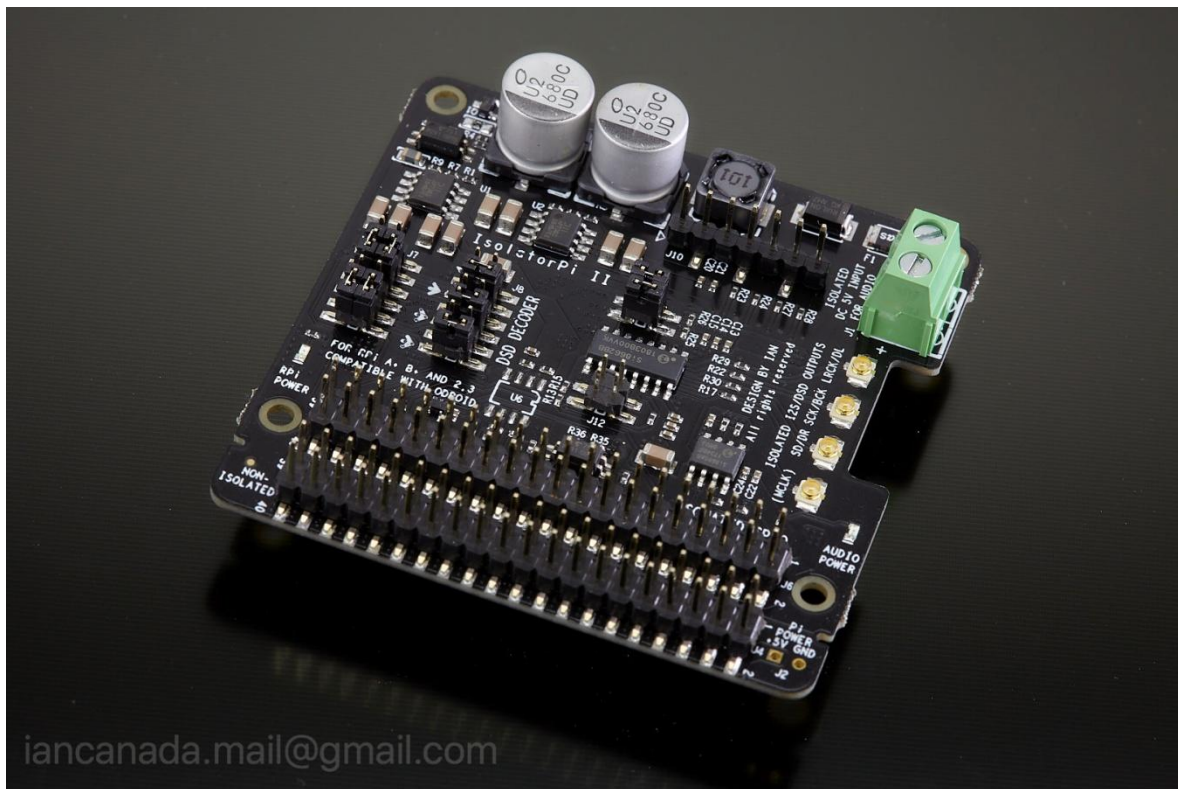
## D: Works with DoP decoder daughter board



## J. Application Notes and Tips

1. Validate that both your hardware and software functions as expected AND produces audio output BEFORE you install the IsolatorPi between the SBC (RPi or ODDROID) and the audio card(s). If you do not do this, debugging any problems will be much more difficult.
2. ALWAYS apply power to the Isolator Pi via J1 BEFORE or at same time applying power to the SBC (RPi or ODDROID). The IsolatorPi will power connected audio cards if they are configured to accept power on their input.
3. IsolatorPi by itself MAY NOT improve sound quality. BUT the ground isolation will enhance the effects of a good audio-quality power supply connected to the Isolator Pi and audio card and use of good clocks.
4. DO NOT make any link or connection between the input side of the IsolatorPi (non-isolated GPIO) and output side (isolated GPIO). If you do the ground isolation is defeated and no benefit is produced.
5. BE VERY CAREFUL on the orientation of jumpers. Double and triple check before applying power. Incorrectly oriented jumpers can damage the IsolatorPi.
6. ONLY change the jumpers on J7 when the IsolatorPi will be used with an ODDROID.
7. ONLY change the jumpers on J8 when the IsolatorPi will be used with a DoP decoder daughter board.
8. Some audio cards use on-board power supplies that also power the RaspberryPi via the 5v pins on the GPIO connector. Examples of these audio cards include the original Mamboberry DAC and the IQ Audio Pi-DigiAMP+. To use these cards on the IsolatorPi, connect them to their power supply as normal and do not connect a 5v power supply to J1. Because the IsolatorPi power is still controlled by the RPi power, you still must apply power to these audio cards before powering the RPi.

## K. IsolatorPill picture



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