9038Q2MPi Dual Mono Plus DAC HAT user's guide

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A. Introduction

9038Q2MPi Dual Mono Plus DAC HAT is an audiophile grade DAC core board for RaspberryPi. Based on the latest ES9038Q2M SABRE32 reference DAC technologies, it can provide the highest possible sound quality and performance for DIY audiophiles.

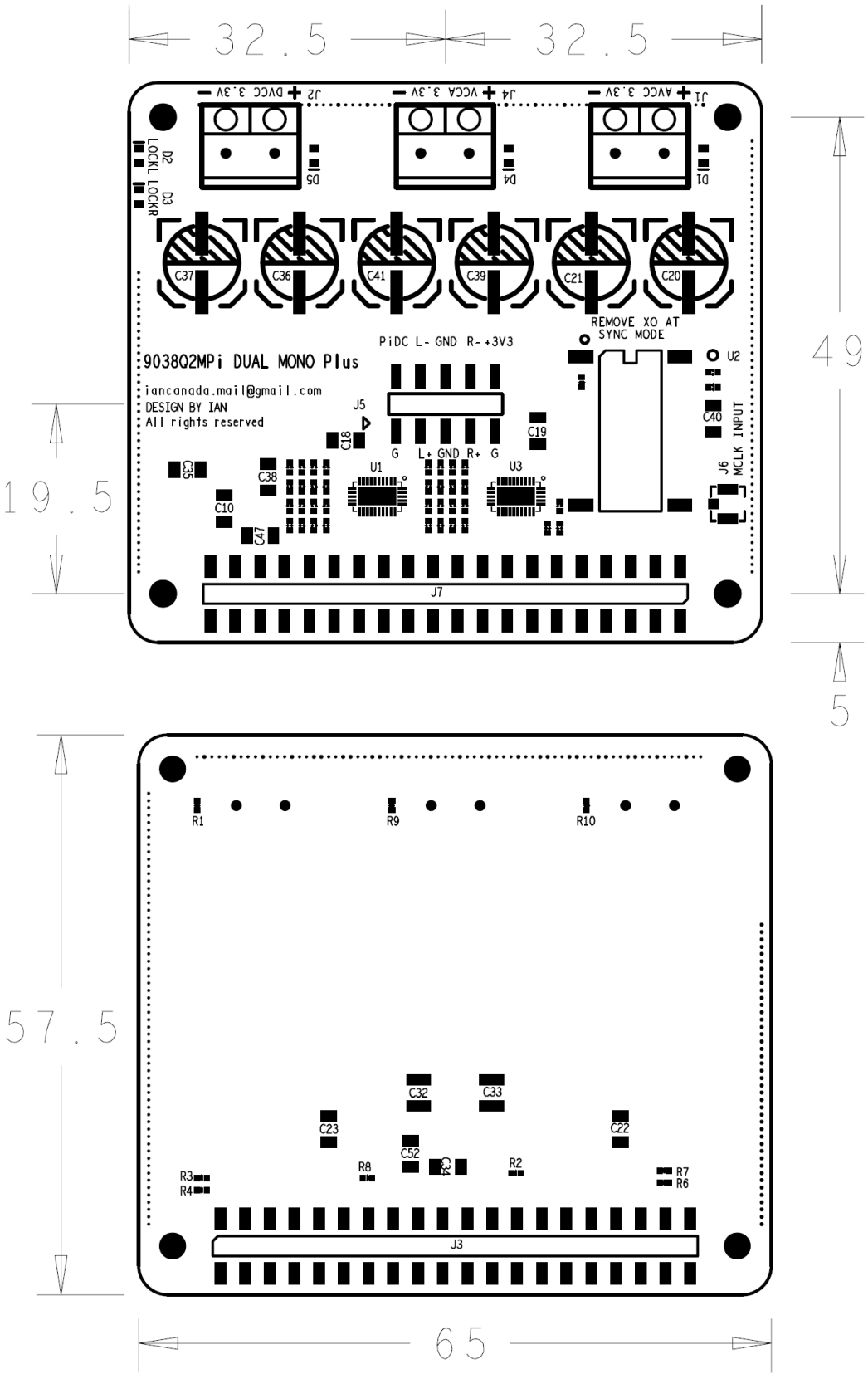
B. Highlighted Features and Specifications

- Dual mono ES9038Q2M 32bit RaspberryPi DAC HAT.
- Supports up to 768KHz 16/24/32 bit PCM, native DSD1024, and DSD256 via DoP.
- 100MHz internal Asynchronous clock or external Synchronous clock range from 22.5792MHz to 98.3040MHz.
- Settings controlled by either external ESS controller or possible Linux driver.
- To eliminate common mode ground noise and EMI noise, ESS controller or Linux driver operates in isolated mode when used FifoPi or IsolatorPi I/II is used
- Raw balanced current output enables use of a variety of external output stage solutions, both current-to-voltage conversion (I/V) or voltage direct modes. Plug-compatible external output board available. Third party I/V stage boards can be used via adapter PCB.
- 389 Ohm output impedance in dual mono configuration provides greater current output than the normal stereo architecture.
- Can automatically switch between PCM, DSD, DoP.
- DIY friendly with many modification and upgrading opportunities.

C. 9038Q2MPi Dual Mono Plus new improvements

- Three separated power rails for AVCC, DVCC and VCCA.
- Optimized PCB layout with 2oz double thickness copper layers for lowest possible ground noise level.
- To make it focus only on the sound quality, all unrelated circuits were removed.
- Enhanced ultra low ESR decoupling networks for better voltage rails quality.
- New XO socket design makes it possible to swap/upgrade to better local clock.
- Very easy to switch to SYNC modem by just removing local XO from the socket and plugging an U.FL MCLK cable. Thus the SYNC mode will have less noise and no longer need the jumper switches.
- Ready to work with high quality 3.3V ultra capacitor power supplies.

D. Layout and Dimensions (in mm)



E. Quick-Start Guide

1. Connect the 9038Q2MPi Dual Mono Plus DAC HAT on top of RaspberryPi.
2. Connect an I/V output board on top of it.
3. Connect the ESS Controller into GPIO connector J7 (unless you have a Linux driver for ES9038Q2M loaded on your RaspberryPi).
4. Install a micro SD card loaded with your preferred distro and player combination into your RaspberryPi.
5. Connect three 3.3V / 100mA (minimum) low noise DC power supplies to J1, J4 and J2 (ultra capacitor or LifePO4 battery direct recommended). Or one 3.3V / 100mA DC power supply if the three power connectors are bridged together.
6. If needed, connect the appropriate power to the output board.
7. Power the Raspberry Pi (with your preferred distro and player micro SD card installed) as usual. 9038Q2MPi and output stage can be powered at same time or before.
8. Connect to the RaspberryPi as usual. In the player's configuration dialog, select generic I2S DAC of Audiophonics I-Sabre (for hardware based volume control from ESS controller), or PCM5122-compatible DAC (such as Hifiberry DAC+ pro) if you desire additional hardware volume control from player UI. Restart the player if required.
9. Adjust volume to 0dB or other suitable level at first time before turning on the rest of your audio system.
10. Enjoy the music.

F. Connectors

J1: 3.3V DC power input for AVCC
J4: 3.3V DC power input for VCCA
J2: 3.3V DC power input for DVCC
Connect three 3.3V DC / 100mA (minimum) power supplies to those 2-pin 5.0mm terminals, MAINTAINING CORRECT POLARITY!!! Any low noise linear 3.3V power supply will work. We prefer a direct-connected 3.3V ultra capacitor / LifePO4 battery power supply for best possible sound quality.
J1, J4 and J2 can be bridged together if you want to use only one DC power. The 9038Q2MPi consumes around 50mA average in total with 50MHz MCLK in asynchronous mode (default).

J6: External MCLK input (u.fl coaxial cable socket)
When operating the 9038Q2MPi in Synchronous mode, connect the external MCLK signal from a FifoPi or similar synchronous MCLK source using a u.fl coaxial cable. Local XO U2 has to be removed from the socket in this mode.
*Note: DO NOT connect J6 when operating in Asynchronous mode (default).

J5: Fully balanced ES9038Q2M raw current output

Connect an output stage board as below:

pin number	Descriptions
1	NC
2	RaspberryPi 5V, internally connected to RaspberryPi GPIO pins 2 and 4
3	L+, Left positive current output
4	L-, Left negative current output
5	GND
6	GND
7	R+, Right positive current output
8	R-, Right negative current output
9	NC
10	AVCC (ES9038Q2M AVCC 3.3V voltage rail)

40 pin GPIO connectors

pin number	**J3** 40 PIN GPIO socket connector to board below (RaspberryPi, IsolatorPi I/II, FiFoPi, or similar)	**J7** 40 PIN GPIO connector to HAT on top of 9038Q2MPi
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
3	I2C DA	I2C DA
4	I2C CL	I2C CL
27	ID DA	ID DA
28	ID CL	ID CL
12	SCK input	SCK from preceding board
35	LRCK/D1 input	LRCK/D1PIN from preceding board
40	SD/D2 input	SD/D2 PIN from preceding board
All other pins	same pin from preceding board	same pin from preceding board

40PIN GPIO connector note: All input/output signals are LVTTL (3.3V) logic level except power and ground.

U2: Local XO socket

A 100MHz XO was installed in this socket for default asynchronous mode. Local XO can be upgraded by swapping to a higher quality low jitter XO.

Local XO must be removed from the socket with connecting a U.FL MCLK cable to J6 from FifoPi when run this DAC in synchronous mode (better sound quality).

G. LED indicators

LED	Description	On Indicates...
D2	LOCKL	Left ES9038Q2M DAC U2 is locked to input music signals (green or red)
D3	LOCKR	Right ES9038Q2M DAC U6 is locked to input music signals (green or red)
D1	AVCC POWER	AVCC power applied
D4	VCCA POWER	VCCA power applied
D5	DVCC POWER	DVCC power applied

H. How to produce the best sound quality from your 9038Q2MPi

Run your 9038Q2MPi in Synchronous mode

We prefer running this DAC with a synchronous MCK than the default Asynchronous mode. To do that, switch to Synchronous clock mode by:

1. Installing a FifoPi between the RaspberryPi and the 9038Q2MPi DAC (see FifoPi user's manual for installation and configuration details).
2. Installing a pair of really nice clocks into the FifoPi according to your personal preference. The quality of these clocks is very important to the sound quality and sonic signature.
3. Remove local XO from socket U2.
4. Connecting the MCLK signal from the FifoPi to J6 on the 9038Q2MPi using a u.fl coaxial cable. Cable length should be as short as possible.
5. Setting DPLL bandwidth to lowest level 1 for both PCM and DSD in the ESS Controller, at the "DPLL Bandwidth' setting panel (see ESS Controller manual for configuration details).
6. Power up and enjoy the music.

After performing the above steps, your 9038Q2MPi now is using an MCLK that is synchronous to the music signal and is largely bypassing the DPLL.

Further gains can be made by stopping the DPLL and enabling True Sync mode. BUT there are limitations to True Sync mode with the ES9038Q2M:

- It supports PCM format only. DSD and DoP are not supported.
- MCLK has to be 128FSR

If you do not follow these limitations, True Sync mode does not work properly. Also, once you have enabled True Sync mode on the 9038Q2MPi, the lock LEDs stay on continuously.

Enable True Sync mode on your 9038Q2M by:

1. Selecting “True SYNC with DPLL stopped” in the ESS Controller at the “Normal/True SYNC mode” setting panel.
2. Setting both PCM bandwidths to “No band width 0”.

See ESS Controller manual for configuration details.

Isolate your 9038Q2MPi from the ESS Controller

ESS Controller contains a micro-processor. It generates EMI noise that can impact sound quality. Connecting the ESS Controller through an isolator eliminates any direct electronic connections between ESS controller and 9038Q2MPi and prevents this noise from reaching the DAC. The 9038Q2MPi grounds will be cleaner when configured this way.

To run the ESS Controller in isolated mode, you need to use a FiFoPi or IsolatorPi I/II between your RaspberryPI and 9038Q2MPi and connect the ESS Controller to the non-isolated GPIO connector of the FifoPi or IsolatorPi I/II.

Power your 9038Q2MPi directly from 3.3V ultra capacitor or LiFePO4 battery power supplies

We have found using a directly-connected (no LDO on the output) 3.3V ultra capacitor or LiFePO4 battery power supply to be a significant improvement over most traditional power supplies. To do this, connect the supply directly to J1, J4 and J2. OBSERVING CORRECT POLARITY!!!

Select an output board(s) that matches your preferred listening style

Which output board is used makes a significant contribution to both the sound quality and sonic signature produced from your ES9038QMPi. The standard op-amplifier I/V board (and what opamps you use in the board), OPA861 I/V board, OPA1632 I/V board, a discrete I/V board, Transformer Output board, and so on, will all sound different. Also whether you use them in single-ended or balanced mode will also impact the sound quality and sonic signature. Please choose the output board best suited to your system and your personal preferences. Also use the balanced XLR outputs if you can in your system. In most cases, we have found the balanced XLR output produces better overall sound quality than the single ended output.

Experiment with the settings of your ES9038Q2MPi using the ESS Controller

Many of ES9038Q2MPi settings can be programmed using the ESS Controller. Some that make a difference sonically include DPLL bandwidth for both PCM and DSD format, the seven preset FIR filters, OSF bypassing, IIR bypassing. Using the guidelines in the ESS Controller manual to safely set these settings, feel free to experiment and find the best settings for your ES9038Q2MPi setup and your system based on listening.

I. Other upgrade options

Upgrade the on-board 100MHz clock

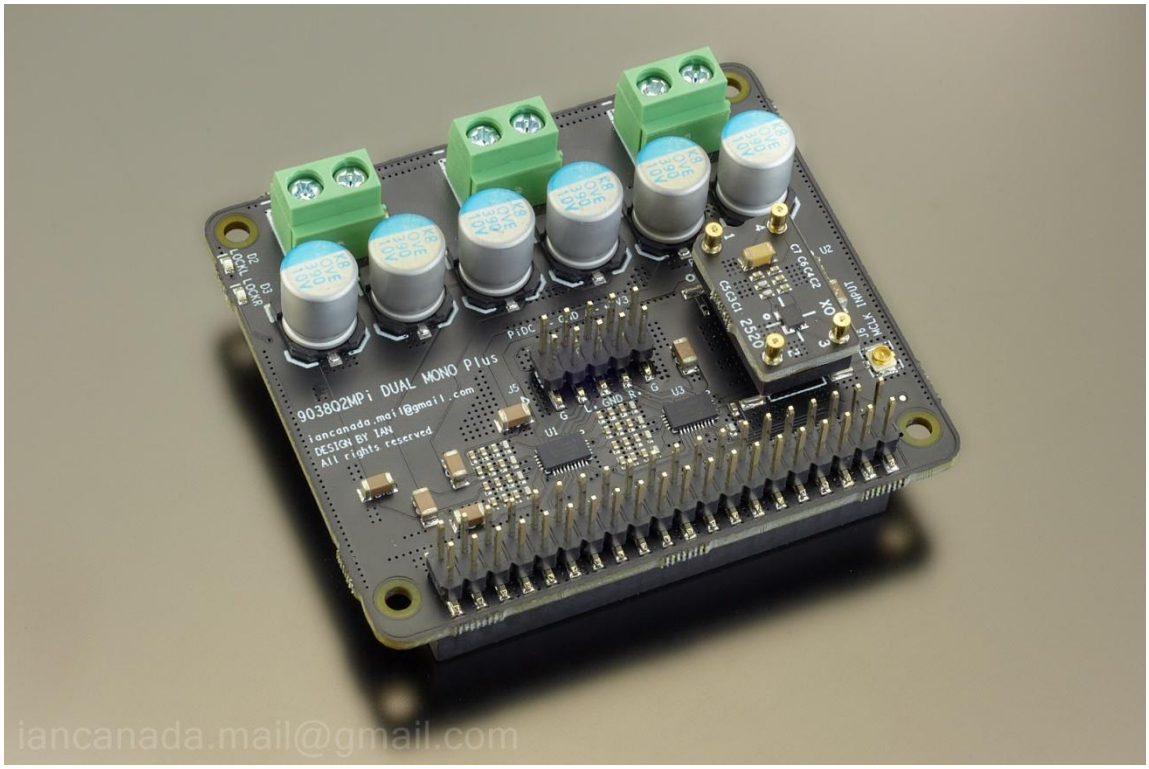
If you are running your ES9038Q2MPi in Asynchronous mode, you can upgrade on-board XO clock to a higher grade lower jitter one such as a 100MHz CCHD950 or equivalent. You do this by removing the originally-installed XO from socket U2 and then installing a new XO. IF you are operating your ES9038Q2MPi in Synchronous mode with a FiFoPi or equivalent, local XO must be removed from socket U2.

J. Note of new 9038Q2M Dual Mono Plus

The new plus version DAC uses some high performance components on PCB. Those components could be taller than before. So have to be very careful not to touch the I/V output board on top of it. If it is necessary, use tapes or higher standoffs to avoid any short circuit. Or, if it is possible, cut the pins shorter under the I/V board.

K. ES9038Q2Mpi Dual Mono Plus DAC HAT pictures

1. ES9038Q2MPi dual mono plus DAC HAT as shipped



2. Getting start with Asynchronous mode (default)

Raspberry Pi + ES9038Q2MPi dual mono DAC HAT + ESS controller + I/V board

3. Running in isolated Asynchronous mode

Raspberry Pi + IsolatorPi I/II + ESS controller + ES9038Q2MPi dual mono DAC HAT + I/V board

4. Running in Synchronous mode (highly recommended)

   Raspberry Pi + FifoPi + ESS controller + ES9038Q2MPi dual mono DAC HAT + I/V board