Ian's ESS controller user's guide

By Ian Jin, Dec 30, 2018 Ver. 0.9 (draft)

A.　Introduction

Ian's ESS controller is the first smart universal ESS DAC driver board that can be installed into standard Raspberry Pi GPIO port. Equipped with powerful STM32 ARM Cortex processer, this tiny controller provides almost all kind of possible functions to run an ESS DAC, such as display, control, setting, monitoring, communicating and many more. It could be so far the best solution to integrate ESS DAC together with Raspberry Pi.

B.　Highlighted Features and Specifications

- Support ESS9018K2M, ES9028Q2M, and ES9038Q2M DAC in both stereo and dual mono configuration.

- Up to 768KHz 16/24/32 bit PCM and native DSD1024 support.

- Built-in OLED GUI for volume control and register settings.

- Can work in isolated mode to eliminate noise.

- Operate with knob encoder, Apple remote control or Web UI (for volume control).

- True SYNC mode of ESS DAC is supported.

- Real time music signal monitoring.

- Real time DPLL status monitoring.

- Analyzer mode designed for digital music signal measurement when no ESS DAC is attached.

- Mute I2C while music is playing.

- Fixable design, can be installed either into GPIO or at front panel through an adapter

- Possible to work with external ESS DAC.

- Small size PCB with GPIO connector very easy to use with Raspberry Pi audio applications.

C. Layout and Dimensions (in mm)
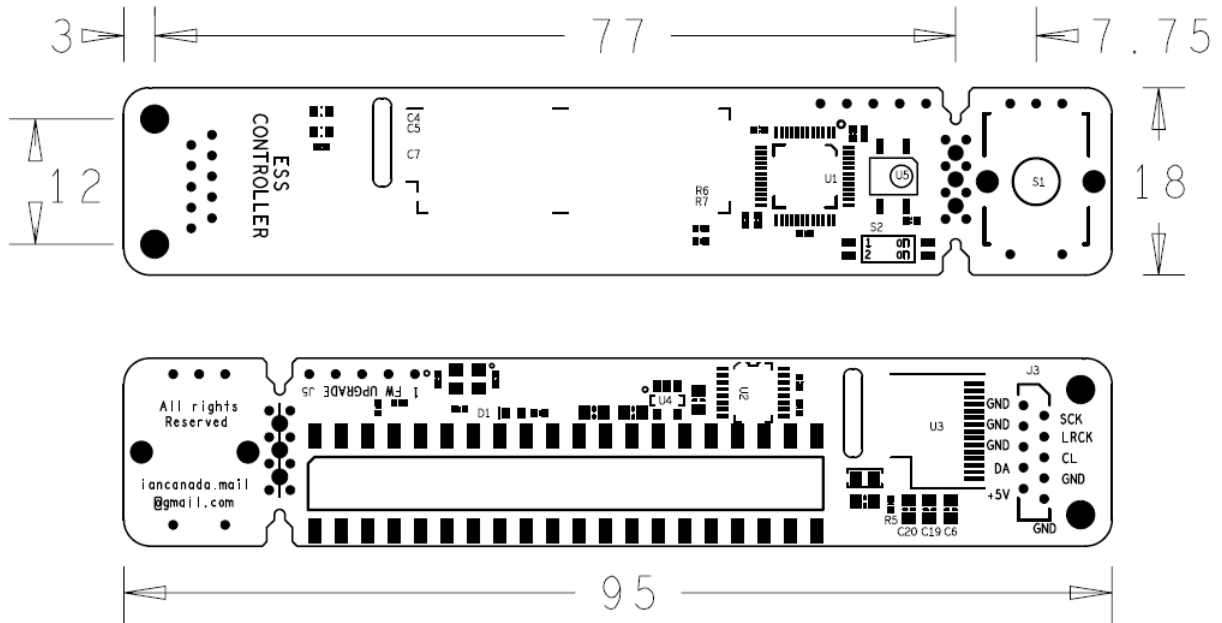
D. Getting start

1. Solder the knob encoder to the S1 position of ESS controller. Cut the pin leads by a side cutter if required. Please skip this step if only use Apple remote control;

2. Plug the ESS controller onto the GPIO of ESS DAC HAT (normal mode) or the non-isolated GPIO of FifoPi or IsolatorPi (Isolated mode);

3. Power Raspberry Pi and DAC system as usual; ESS DAC ID, address and working mode will be recognized and displayed on OLED screen. Adjust the volume to 0dB or other suitable level for the first time of operating if the ESS DAC default setting is too low.

4. On the player's setup page, select general I2S DAC. Or PCM5122 compatible DAC such Hifiberry DAC+ if need additional volume control from Web UI. Restart player if it is required.

5. Enjoy the music.

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E. OLED working screen

OLED display has four sections on the main working screen:

1. Right side of the screen: Volume numbers in unit of dB.

2. Top left of the screen: Music format and sampling rate or Music signal status.

3. Top middle of the screen: Real time measured data length of PCM music, can be 16,24 or 32bit.

4. Bottom left of the screen: Real time measured bit clock (SCK or BCK) frequency in unit of Mhz.

F. Volume control

There are three ways to control the volume of ESS DAC :

1. Turn the knob.

2. Press arrow keys on the Apple remote control.

3. Change the volume at the Web UI of Linux player if the PCM5122 compatible DAC is selected.

Please note that the volume display is in unit of dB corresponding to the ESS DAC internal register settings. 0dB is the maximal, while the -99dB is the minimal. To keep the best sound quality, please always set the volume to 0dB if you have an analog volume control in your system (such as the one in pre-amplifier or power amplifier). Linux player will also internally convert volume in unit of percentage into unit of dB.

G. GUI manual of register settings

To open the GUI manual, you need to press the knob or the play key on the Apple remote. Then turn the knob or press the arrow keys of the remote control to go through all register setting pages. Current settings will be highlighted.

To change a setting, you just need to press the knob or the play key of the remote control at the highlighted setting that you want to change. It will go into edit mode with current editing setting in flashing. Turn the knob or press the arrow keys of the remote control to go through all the options. Press the knob or the play key of the remote control at the option that you want to change to, it will be set and saved. GUI manual will exit to the main

working screen. If cancel is selected, it will exit setting manual without making any change.

Or, you can wait for ten seconds or press the manual key of the remote control at any time; it will automatically go back the main screen.

Register setting pages	Setting options	Descriptions and notes
DPLL Bandwidth PCM	NO Bandwidth 0	Set the PCM DPLL bandwidth
	Lowest Bandwidth 1	
	Lower Bandwidth 2	Smaller numbers can only apply to better XO or external MCLK of ESS DAC.
	Low default 5	
	Low-medium 8	
	Medium 10	
	High-medium 12	NO bandwidth will only apply to DAC in true SYNC mode with DPLL stopped.
	High Bandwidth 14	
	Highest Bandwidth 15	
DPLL Bandwidth DSD	NO Bandwidth 0	Set the DSD DPLL bandwidth
	Lowest Bandwidth 1	
	Lower Bandwidth 2	Smaller numbers can only apply to better XO or external MCLK of ESS DAC.
	Low Bandwidth 5	
	Low-medium 8	
	Medium default 10	NO bandwidth will only apply to DAC in true SYNC mode with DPLL stopped, but not a guarantee to work well with all DAC
	High-medium 12	
	High Bandwidth 14	
	Highest Bandwidth 15	
IIR filter Bandwidth	1.0757fs default	Set IIR filter Bandwidth
	1.1338fs	
	1.3605fs	For supported ESS DACs except ESS9038Q2M
	1.5873fs	

FIR filter shape	Fast rolloff default Slow rolloff	Set IIR filter Bandwidth For all supported ESS DACs except ESS9038Q2M
ES9038Q2M filters	Brick Wall Filter	Select digital filters For ES9038Q2M DAC only
	Cor MIN Fast Roll-Off	
	Apodiz Fast Roll-Off (default)	
	Minimum Slow Roll-Off	
	Minimum Fast Roll-Off	
	Linear Slow Roll-Off	
	Linear Fast Roll-Off	
MCLK true SYNC Mode	ASRC mode default	Default ASYNC mode
	SYNC mode stop DPLL	True SYNC mode Only works for DACs in true SYNC mode with external MCLK fed from FifoPi. Needs jumper switch being set to SYNC mode on ESS DAC HAT.
OSF Bypass	OSF enabled (default)	OSF enabled
	OSF bypass	OSF bypass
IIR Bypass	IIR enabled default	IIR enabled
	IIR bypass	IIR bypass
Watch DPLL Ratio	Yes or Cancel	Monitoring internal DPLL ratio status numbers in real time. This powerful function is useful for evaluating the quality of XO clock or status of SYNC mode.

		This function is useful to reset all register settings back to the factory default if not happy with current settings or getting confused.
Reset factory default	Yes or Cancel	

H. Connectors

J1: 40PIN GPIO socket to connect to DAC

This right angle GPIO socket can be connected right on top to the 40PIN GPIO connector of the ESS DAC HAT (normal mode) or to the 40PIN non-isolated GPIO connector of FifoPi or IsolatorPi (isolated mode).

It will hold the ESS controller in the position. Please make sure both of the rows are fitted well into the connector.

PIN numbers	Signal description
2,4	Pi 5V
6,9,14,20, 25,30,34, 39	GND
3	I2C DA
4	I2C CL
8	Txd
10	Rxd
12	SCK input
35	LRCK/D1 input

J3: Optional FFC/FPC cable connector to connected to DAC

This optional FFC/FPC connector will be alternative to J1 to connect to an ESS DAC externally with 10 PIN FFC/FPC cable. This connector is not assembled by default.

PIN	Signal	PIN	Signal
1	GND	2	SCK input
3	GND	4	LRCK/D1 input
5	GND	6	I2C CL
7	I2C DA	8	GND
9	Pi5V	10	GND

J5: FW upgrade connector

Reserved for firmware upgrade adapter.

Note1: All input/output signals are in LVTTL (3.3V) logic level.

I. Jumper settings

Jumper switch S2 is located beside the IR receiver at the front side of PCB.

Jumper Switch S2	OFF (default)	ON
1	Auto mute enabled	Auto mute disabled
2	WebUI volume control enabled	WebUI volume control disabled

For normal applications, please keep all jumper switchs at default position.

J. Tips and application notes

DPLL ratio monitoring
To perform DPLL ratio real time monitoring function, you will need:
1. At the GUI manual "Watch DPLL Ratio" page, select "Yes".
2. The 32bit hex DPLL ratio number will be displayed on the screen if there is music signal.

$F_{SR} = (DPLL\_NUM \times F_{MCLK}) / 2^{32}$

This number will keep at 0x00000000 with no change in true SYNC mode because DPLL is stopped.
DPLL ratio number can also be used to evaluate the DPLL lock status or the quality of music signal.

DPLL ratio number display will be terminated automatically in ten seconds.

Music signal analyzer mode
ESS controller can also be used as stand along digital music signal analyzer if no DAC is connected.
To enable this feature, you just need to press and hold the knob for more than 2 second while "Check ESS DAC" message is showing on the OLED screen.
After enter this mode, the real monitoring music signal status will be displayed on the screen, including music format, real frequencies and data length.
This feature is useful for hardware debugging by capturing real music signal information without/before DAC connected.
To get back to normal DAC controller mode, you will need turn off the power and then include an ESS DAC into system.

Reset register settings back to the factory default
It is very helpful to reset all register settings back to factory default at any time when the setting gets confused or there is something wrong. To do so, you will need:
At the GUI manual "Reset factory default" page, select "Yes".

The factory default reset is also required when DAC is replaced.

After factory default reset is performed, you may need to change the volume to 0 or other suitable level if the default volume number is too low.

Enable S/PDIF receiving

To enable S/PDIF receiving, PIN1 of jumper switch S2 needs to be switched to "ON".

Move ESS controller to the front panel

To move the ESS controller to the front panel rather than plug onto GPIO connector, you will need the Ess controller extension KIT (sold separately).

1. Plug the ESS extension adapter into the same GPIO connector that the ESS controller was connected to.
2. Solder the 10PIN FFC/FPC connector to J3 position at back side of the ESS controller PCB.
3. Connect the ESS controller to the extension adapter with the 10PIN FPC/FFC cable. Make sure the cable orientation is correct.
4. Fix the ESS controller at the front panel.

Works with external ESS DAC

It's also possible to make this ESS controller working as a dedicated controller of an external ESS DAC even without a Raspberry Pi. To do so, you will need:

1. Solder the 10 wires of the cable to the footprint of J3.
2. Connect the wires of the cable to the corresponding signal pins of the DAC.
3. Remove any possible local controller that connected to the I2C bus of the ESS DAC. Also make sure I2S bus has pull-up resistors for both signals.

K. ESS controller pictures

a. ESS controller
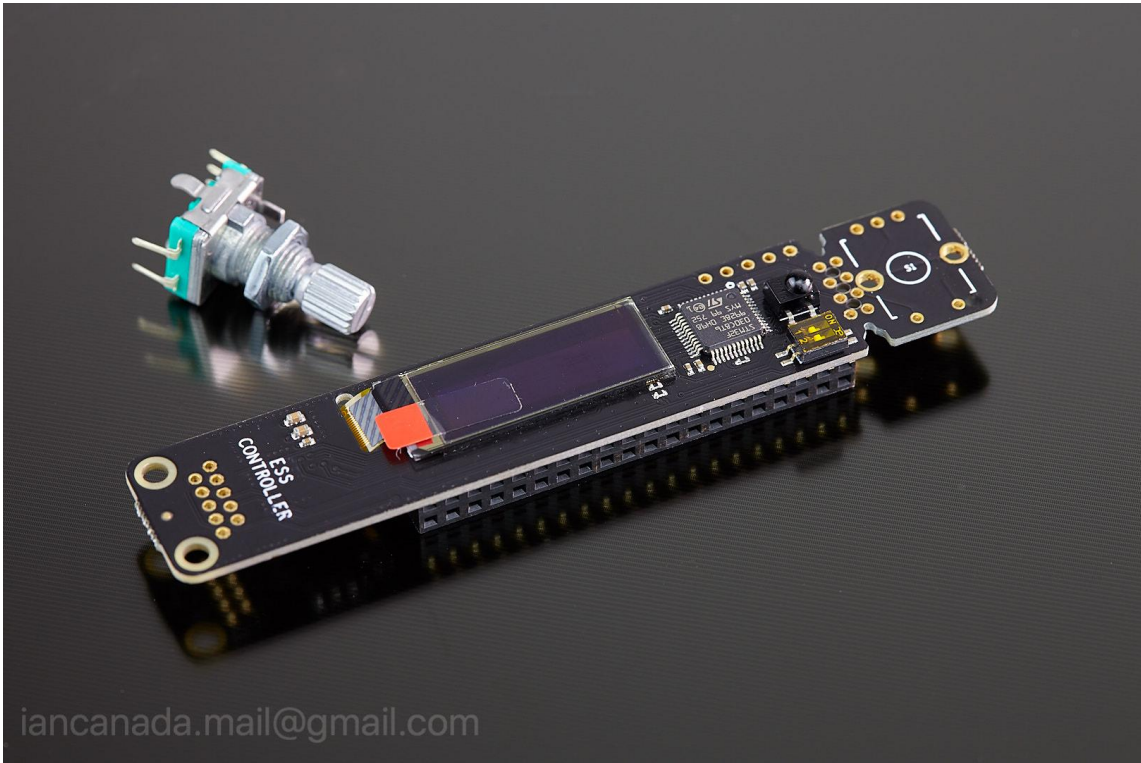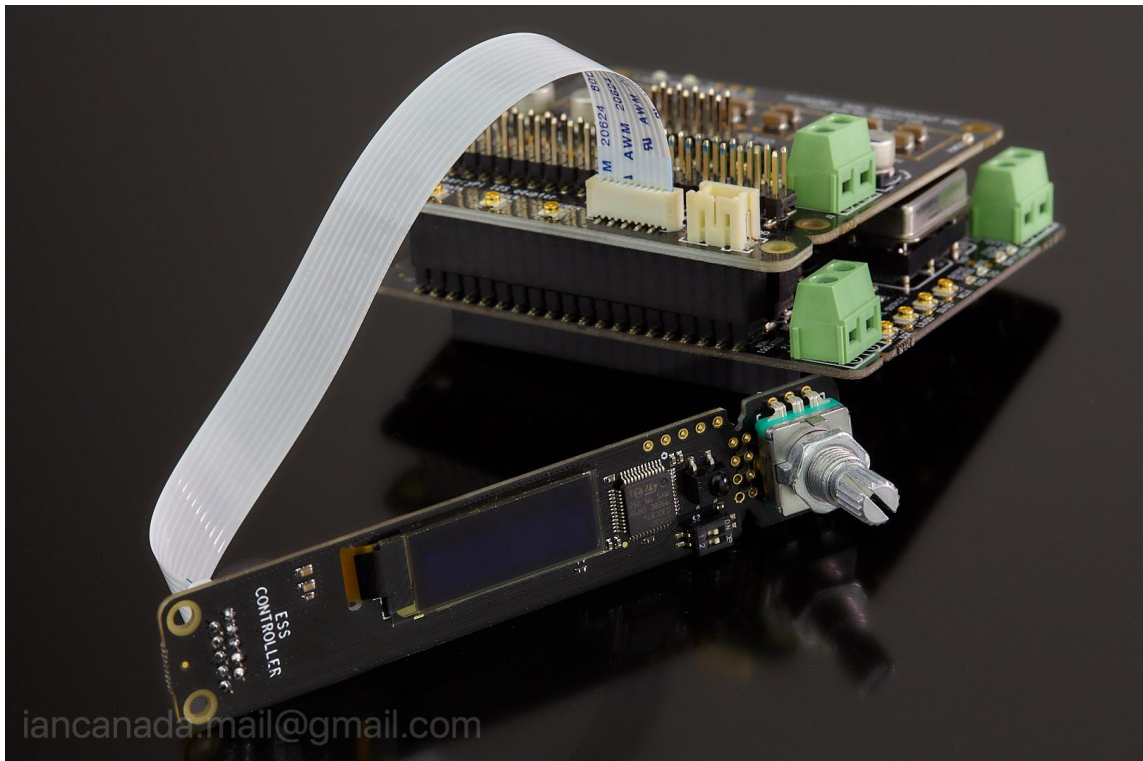

b. Run ESS DAC at normal mode by connecting to the GPIO of DAC HAT

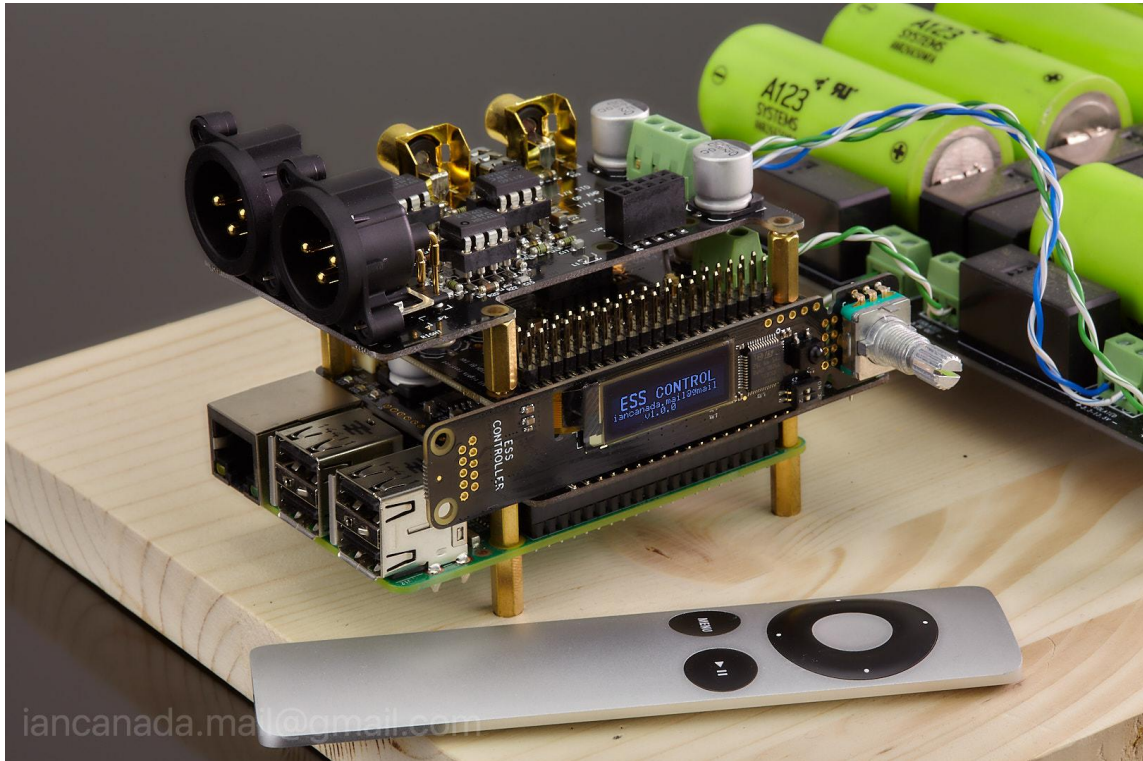c. Run ESS DAC HAT at isolated mode by connecting to non-isolated GPIO of the FifoPi or IsolatorPi

d. Move ESS controller to front panel by an adapter through a FFC/FPC cable

e. ESS controller with complete ESS DAC system

Raspberry Pi + FifoPi + ES9038Q2M dual mono + I/V std + ESS controller