Dimdim's Blog

DIY Audio, Arduino, Computers, Music

# Universal Signal Isolator shield for the Arduino DUE

Why bother?

If you are reading these lines, you are probably into DIY audio. A big part of DIY audio is building DACs. Since these last few years DACs have become fairly complex, sometimes they can benefit from being controlled by microcontrollers. I myself own two such DACs, a Buffalo III and a Soekris dam1021. I have written code to control them with the help of Arduinos, but early on I realized that I also needed to have electrical isolation between the Arduino and the DAC, in order to eliminate the possibility of interference and/or noise. To accomplish that I had designed a little Arduino shield.

The years passed and my needs changed with the introduction of the dam1021 DAC and its serial interface. Even though this interface is electrically isolated from the dam board, it is not isolated from the USB to I2S interface. This means that my Arduino would have to share a common ground with my XMOS-based USB interface. I did not want that to happen.

My first thought was to design a new shield specific to the dam but then I thought "why not design a universal isolator shield?". It would provide electrical isolation for both I2C as well as serial signalling.

Thus was born the Universal Signal Isolator shield for the Arduino DUE:
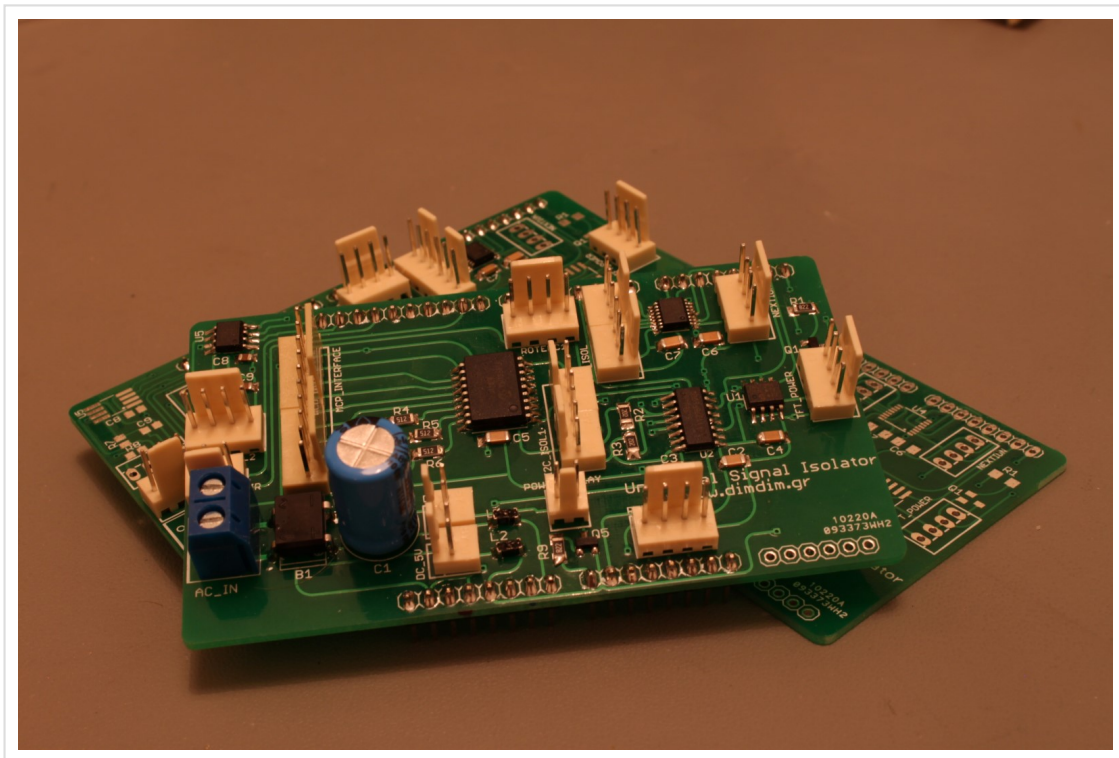
It may look a lot more complicated than my first shield but remember, you only need to solder in the parts that your DAC & your build actually needs.

Specs

So, what does this thing do?

1. Electrical isolation of I2C signals, complete with support of 8 isolated inputs or outputs (via an MCP23008 IC). Three of the MCP's pins are high current outputs (up to 100mA).
2. Electrical isolation of up to 2 serial ports (implemented with an Si8642).
3. Electrical isolation of the second I2C interface of the DUE (implemented with an ADUM1250).
4. Powered either by 5VDC, 8-15VDC (non-regulated) or 7-12VAC (includes support for on-board rectification and filtering).
5. Support of a 5VDC power-on relay (up to 100mA).
6. Header for connecting a Nextion display.
7. On-board EEPROM memory (24LC256).
8. And of course full compatibility with the previous shield (same pinouts for the encoders, IR, TFT, etc.).

Schematic & PCB

This is the schematic & PCB of the board in Eagle format (v0.97): USI Schematic & PCB (130 downloads)
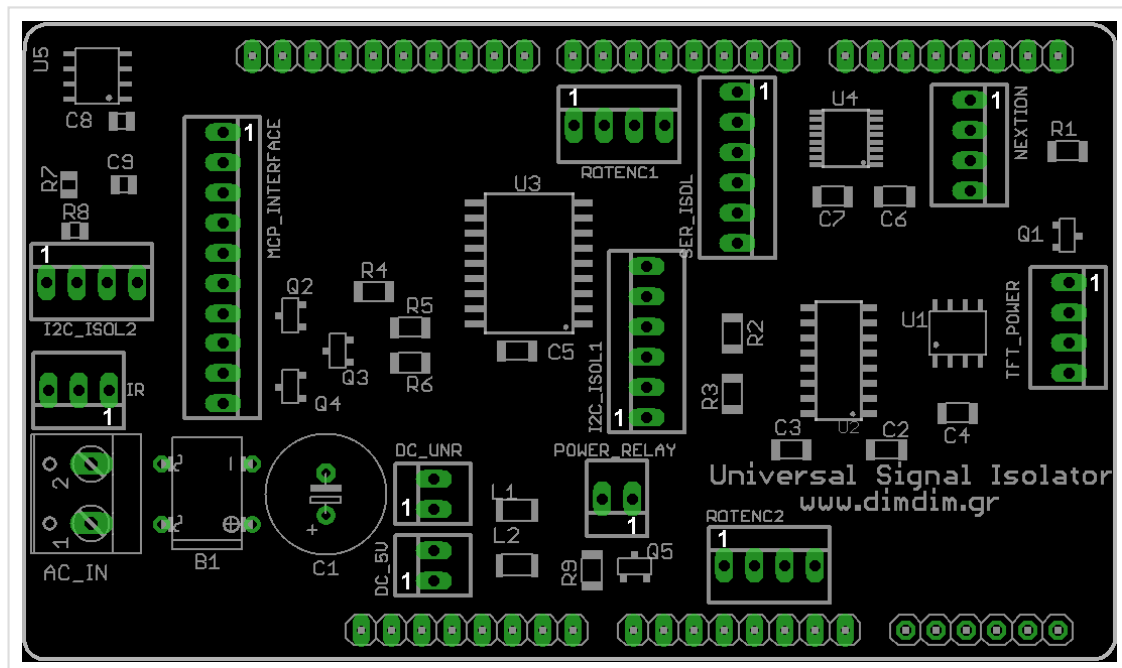
USI Bill of Materials

PCB PART	VALUE	NOTES
U1	24LC256 SO-08	EEPROM chip
U2	Si8605 SOIC-16	I2C Isolator
U3	MCP23008 SO-18W	8 input/output port expan
U4	Si8642 QSOP-16	Serial port isolator
U5	ADUM1250 SOIC-8	I2C Isolator
Q1	BC856, BC808 or other equivalent PNP SOT-23	TFT backlight control
Q2	BC856, BC808 or other equivalent PNP SOT-23	port expander transistor
Q3	BC856, BC808 or other equivalent PNP SOT-23	port expander transistor
Q4	BC856, BC808 or other equivalent PNP SOT-23	port expander transistor
Q5	BC856, BC808 or other equivalent PNP SOT-23	power relay transistor
B1	Bridge rectifier 1A DB107 DIP-4	
C1	1000uF 16V	
C2	100n 1206	
C3	100n 1206	
C4	100n 1206	

C5	100n 1206	
C6	100n 1206	
C7	100n 1206	
C8	100n 0805	
C9	100n 0805	
R1	8.2K 1206	
R2	2K 1206	pull-up resistor (optional)
R3	2K 1206	pull-up resistor (optional)
R4	5.1K 1206	
R5	5.1K 1206	
R6	5.1K 1206	
R7	2K 0805	pull-up resistor (optional)
R8	2K 0805	pull-up resistor (optional)
R9	8.2K 1206	
L1	Ferrite Bead, low DC resistance, 3216	
L2	Ferrite Bead, low DC resistance, 3216	

How do I make it work?

POWER

You have five ways of powering your Arduino & Shield:

- Through one of the Arduino's USB ports. I use this way only for testing – it's not very practical once you have your Arduino inside a chassis. Still, it will work just fine and you do not need to install any of the power-related parts of the shield.
- Through the DUE's DC in jack.
- Through the DC_5V header. Here you need to supply 5VDC. No more, no less. Your power supply needs to be regulated and be capable of supplying between 250-350mA of power, depending on whether you will be driving a power relay or not. You need to solder on L2 and the relevant header.

DC_5V	
PIN NO.	FUNCTION
1	5VDC

2	GND

- Through the DC_UNR header. Here you need to supply between 8 and 15 VDC, but it may be non-regulated. The Arduino's reg will do the regulation.You need to solder on L1 and the relevant header.

DC_UNR

PIN NO.	FUNCTION
1	8-15VDC
2	GND

- Through the AC_IN header. Here you may connect a transformer with a secondary winding of 7-12VAC, rated at at least 5VA. If you choose to go this way, you need to install B1, C1 and L1 besides the relevant header. The shield takes care of the rectification and the filtering but the Arduino does the regulation.

BASIC CONNECTIVITY

You really should install U1 and C4. Both TFT HiFiDuino and ArDAM1021 now make use of this memory to store DAC settings.

If you will be using the shield with a 3.2″ TFT, you will need to install R1, Q1 and TFT_POWER. This is the pinout of TFT_POWER:

TFT_POWER

PIN NO.	FUNCTION
1	TFT backlight (+)
2	TFT RD
3	TFT Vcc
4	GND

The current versions of TFT HiFiDuino and ArDAM1021 still make use of only one of the two supported rotary encoders, so you can get away with installing only ROTENC1.

ROTENC1

PIN NO.	FUNCTION
1	D7
2	D6

| 3 | D5 |
| 4 | GND |

If you will be using an IR control (what are the chances of you not using one, right?), you will need to install the IR header.

IR	
PIN NO.	FUNCTION
1	D9
2	GND
3	Vcc

If you will be controlling a power on/off relay, you will need to install R9, Q5 and the POWER_RELAY header. Note: The board has a bug here, preventing it from being able to turn off the relay. If you would like to fix it, you will need to do this:
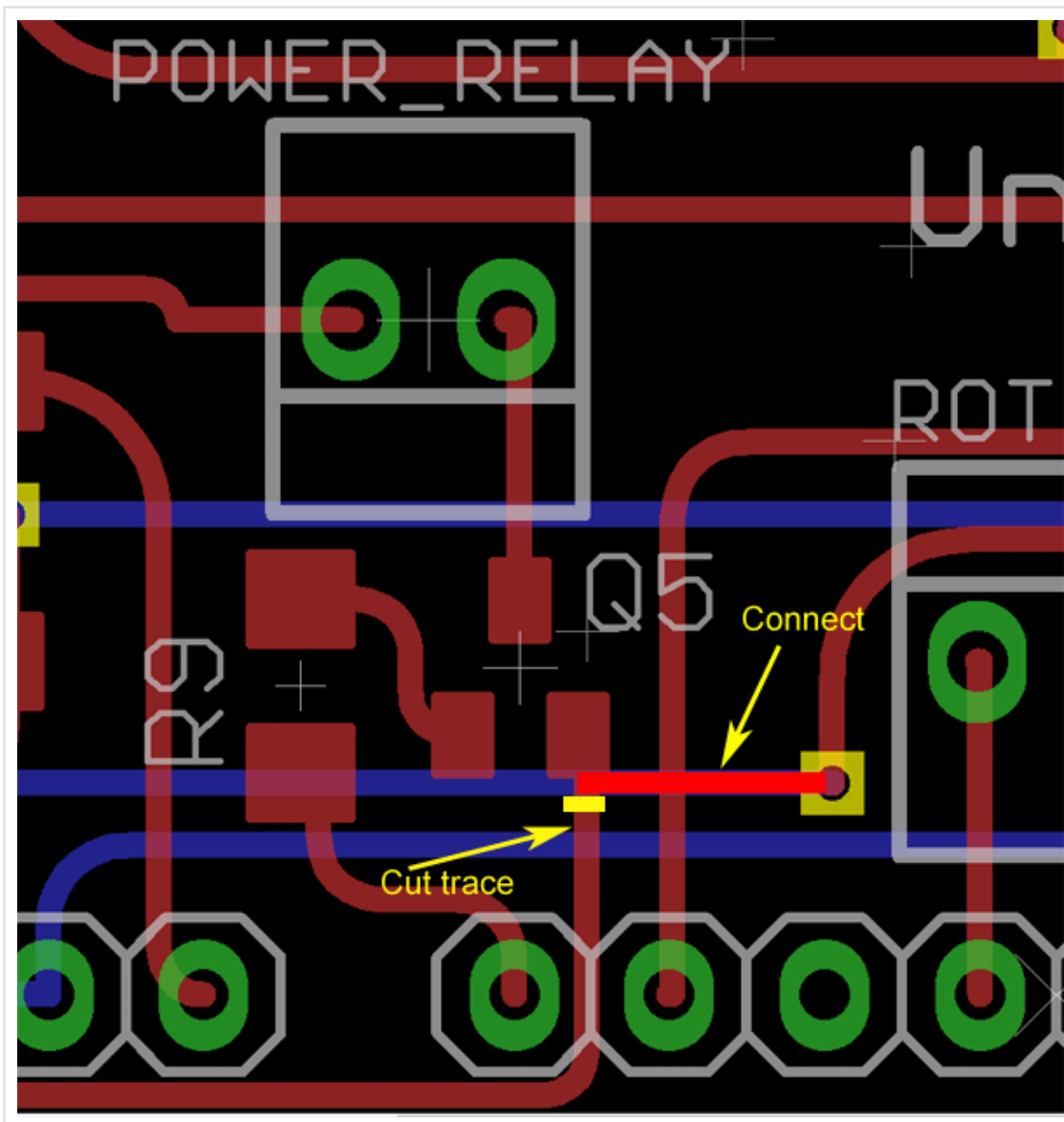
This way you will be able to power a 3.3V relay or signal a larger relay.

POWER_RELAY

PIN NO.	FUNCTION
1	3.3VDC
2	GND

ISOLATED I2C PORTS

You may enable either the first I2C port (I2C) or the second one (I2C1) or both.

- To enable the basic functionality of the first port, you need to install U2, C2 and C3. The resistors R2 & R3 are pullup resistors and you may need to install them depending on your DAC's I2C lines. If they already have pullup resistors (like in the case of the TPA Buffalo III) you do not need them. Power to the isolated side is provided by I2C_ISOL1, pins 1 (+) and 6 (-).

I2C_ISOL1

PIN NO.	FUNCTION
1	Vcc (isolated)
2	SDA
3	OUT
4	IN
5	SCL
6	GND (isolated)

- To enable the 8 isolated inputs/outputs, you need to also install U3, C5, R4, R5, R6, Q2, Q3, Q4 and of course the MCP_INTERFACE header. In this case, power to the isolated side my be provided either through the I2C_ISOL1 header or through the MCP_INTERFACE header (pin 1 (+), pin 10 (-)).

MCP_INTERFACE

PIN NO.	FUNCTION
1	Vcc (isolated)
2	GP0
3	GP1
4	GP2
5	GP3
6	GP4
7	GP5 (only output, 100mA max)
8	GP6 (only output, 100mA max)
9	GP7 (only output, 100mA max)
10	GND (isolated)

- To enable the second port, you need to install U5, C8 and C9. The resistors R7 & R8 are optional pullup resistors (see first case above). Power to the isolated side is provided by I2C_ISOL2, pins 1 (+) and 4 (-).

I2C_ISOL2

PIN NO.	FUNCTION
1	Vcc (isolated)
2	SDA1

| 3 | SCL1 |
| 4 | GND (isolated) |

ISOLATED SERIAL PORTS

The shield supports two (2) isolated serial ports, SERIAL2 and SERIAL3. They share one power supply and have a common ground, since they are both supplied from the same one isolator IC, U4. You will also need to install C6, C7 and the SER_ISOL header. Power to the isolated side is provided by pins 6 (+) and 5 (-).

SER_ISOL

PIN NO.	FUNCTION
1	TX2
2	RX2
3	TX3
4	RX3
5	GND (isolated)
6	Vcc (isolated)

Do you have one for me?

I might have left over boards, since I usually have to order more than I can use. Contact me.

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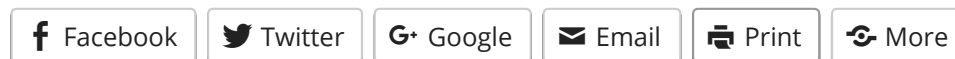
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