Final Presentation

Design of a high-speed, multi-channel LVTTL Level shifter board working with Swabian 8/2 Pulse Streamer and Acousto-optic modulators

Hongyi Lin

QD Team Research Intern

Trinity College, Cambridge

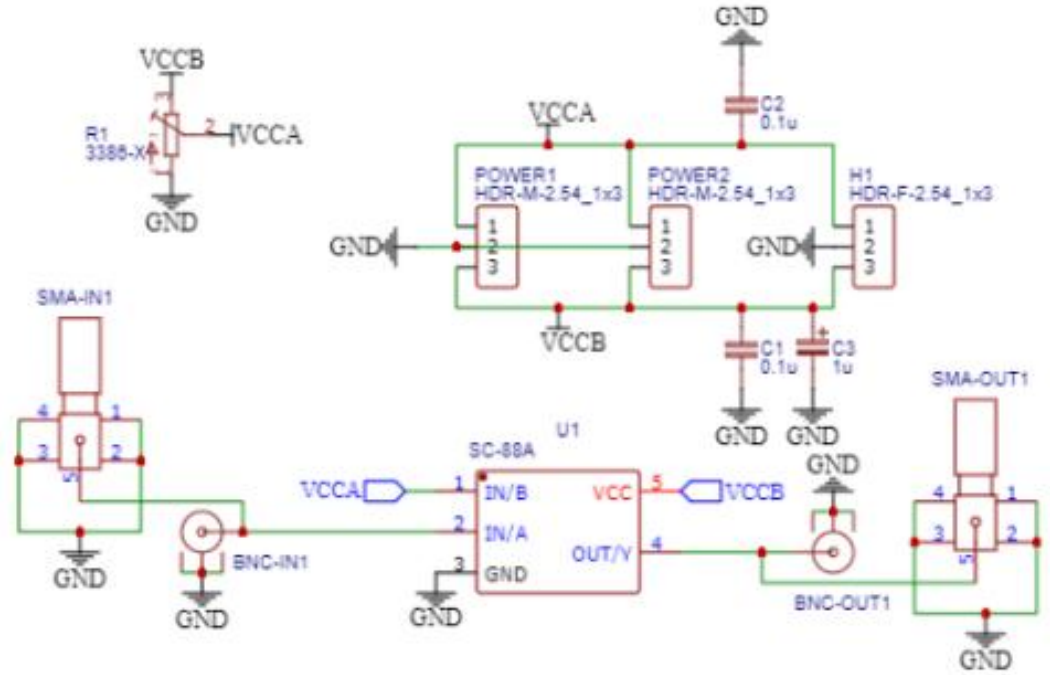
UNIVERSITY OF CAMBRIDGE

Content

1. Definition of Requirements
2. Prototyping Design
3. Manufacture and Assembly
4. Validation and Deployment
5. Conclusion

Definition of Requirements

To improve from the previous design:



- Lack of circuit protection
- Needs manual tuning of potentiometer for translating different voltages
- Insufficient mechanisms to reduce crosstalks
- Single channel - messy power line connections for a typical setup

UNIVERSITY OF CAMBRIDGE

Definition of Requirements

Hence, the design requirements:

- Level shifting with LVTTL signals with rise/fall time 2-5ns and floating voltage levels from 2V to 3.3V
- Multi-channel board with common input and isolated outputs and a single power supply
- Circuit protection and cross-talk reduction

2.7V TTL → LF board → 5V Digital

UNIVERSITY OF CAMBRIDGE

Prototype Design - Components Selection

- NXU0101GM - 1 bit dual-supply translator with Schmitt-trigger
  - wide input range from 0.9V to 5V,
  - rise time & fall time ~ 1ns

- LP3982 - LDO Voltage Regulator with adjustable Vout
  - R1= 162kΩ,R2 = 100kΩ
    -> Vout 3.3V

Use Equation 6 for adjusting the output to a particular voltage:

$$R_1 = R_2\left[\frac{V_O}{1.25V} - 1\right] \quad (6)$$

Choose R_2 = 100 kΩ to optimize accuracy, power supply rejection, noise, and power consumption.

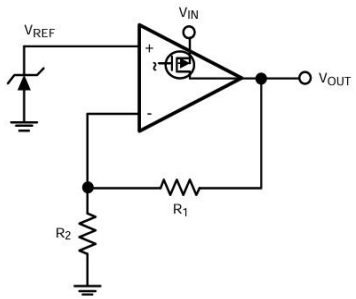
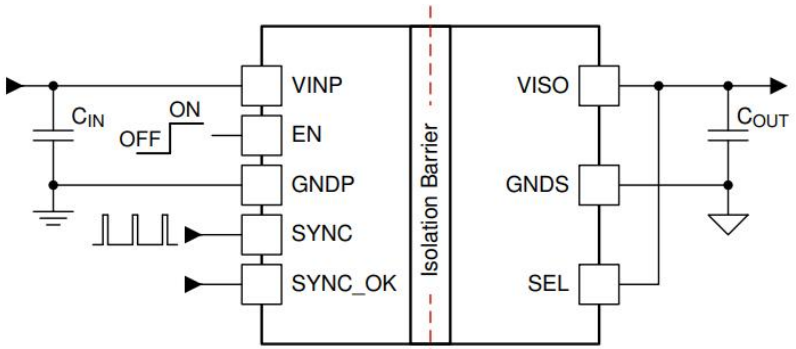


Figure 15. Regulator Topology Simplified

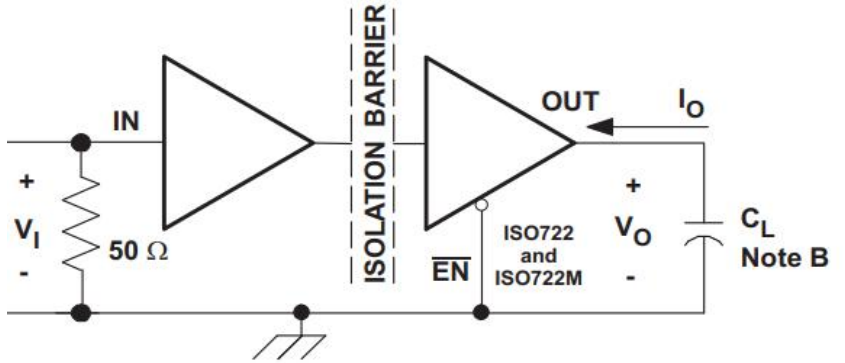
UNIVERSITY OF CAMBRIDGE

Prototype Design - Components Selection

- For supplying isolated output signals to multiple AOMs,
  - UCC12051-Q1: High-efficiency Isolation DC/DC converter (Left)
  - ISO721M-EP: 5V High-speed digital Isolators (Right)
    - rise time & fall time ~1ns, max 150 Mbps signaling rate

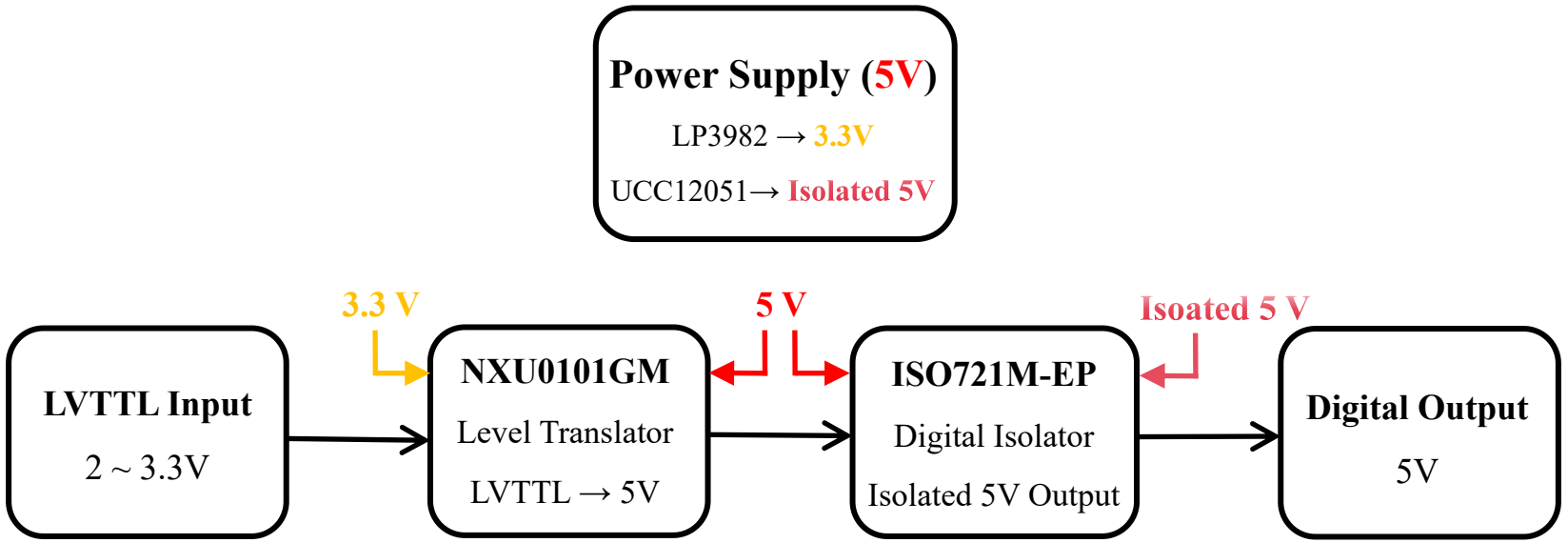


Simplified Application



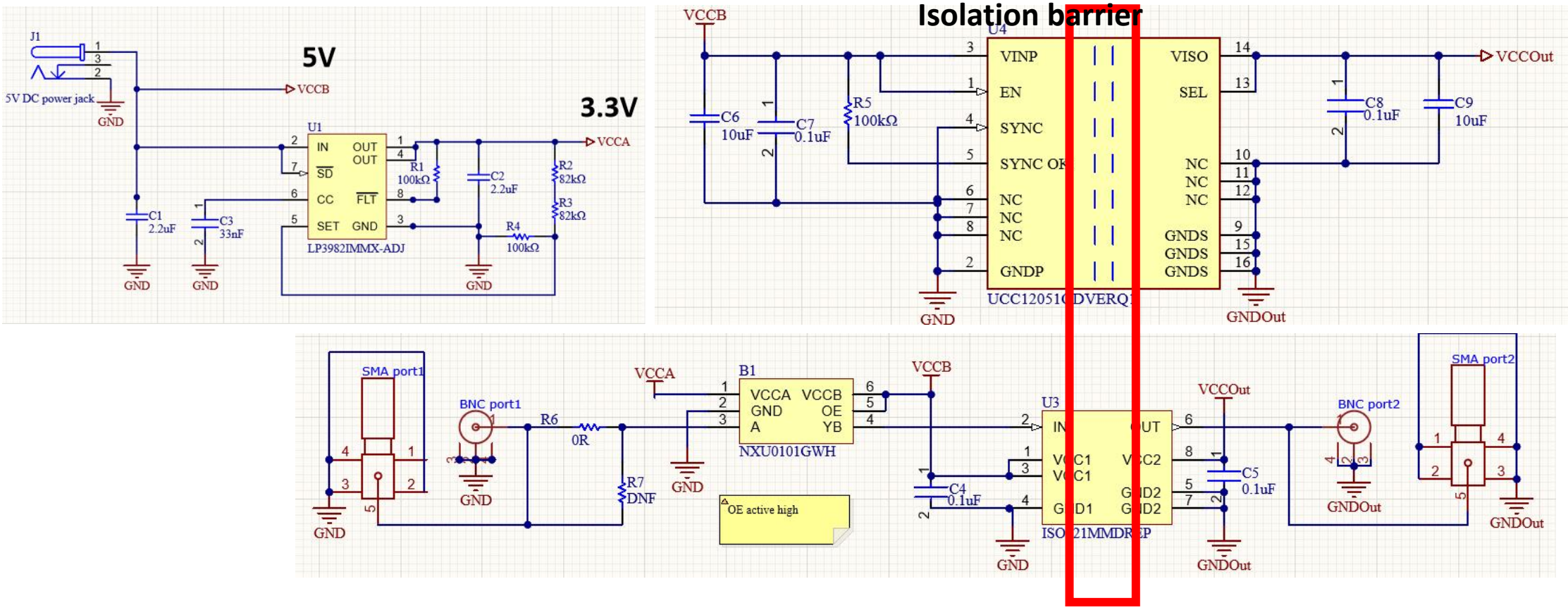
UNIVERSITY OF CAMBRIDGE

Prototype Design - Block Diagram



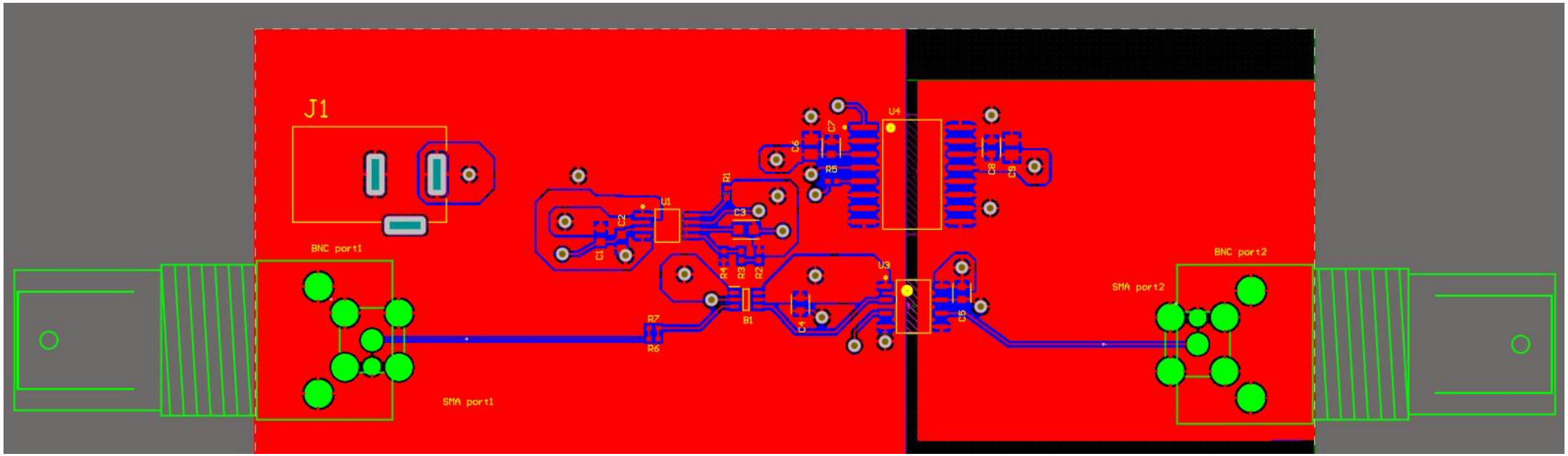
UNIVERSITY OF CAMBRIDGE

Prototype Design - Schematics Design



UNIVERSITY OF CAMBRIDGE

Prototype Design - PCB Layout



UNIVERSITY OF CAMBRIDGE

Manufacture and Assembly - Cost

Part Number	Description	Manufacture	Supplier	Supplier Part Number	lier Unit	Quantity
NXU0101GWH	1 bit dual supply translator, Wide supply voltage range from 1.65 V to 5.5 V				$0.22	4
CMP-2006-02273-1	2.2uF Ceramic capacitors	KEMET	Newark	07X0789	$0.09	2
CMP-2006-04516-2	General Purpose Ceramic Capacitor, 0603, 33nF, 10%, X7R, 15%, 16V	Kyocera AVX	Arrow Electronics	0603YC333KAT2A	$0.06	1

Pricing

Printed circuits

Basket nr.	Delivery term	PCB quantity	Unit price	Transport price	Transport mode	Total price	VAT	Gross
B4917171	3 Working days	5	22.14 GBP	8.08 GBP	Express	118.78 GBP	20.0 %	142.54 GBP

16

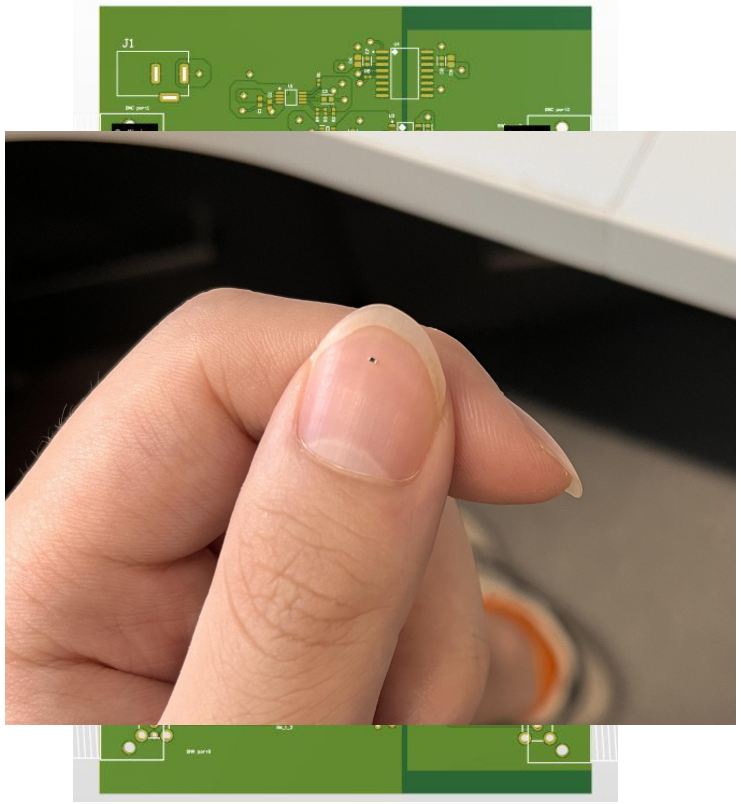
8

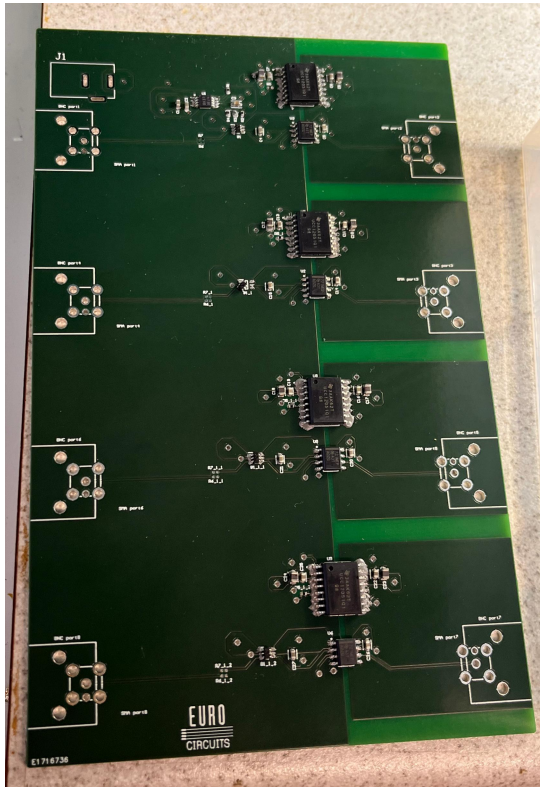
1

CMP-2002-07341-1	100kΩ resistor	Yageo	Newark	49AK1178	$0.00	14
CMP-2002-05757-1	82k resistor	TE Connectivity	Farnell	2331569	$0.01	2
CMP-0062-02330-3	LP3982, Micropower, Ultra Low-Dropout, Low-Noise, 300mA CMOS Regulator, 8-pin Mini SOIC	TI National Semiconductor			$0.64	1
CMP-0328-00073-4	150 Mbps Enhanced Product Single Digital Isolator, 3.3 V / 5 V, -55 to +125 degC, 8-pin SOIC (D), Green (RoHS & no Sb/Br)	Texas Instruments	Arrow Electronics	ISO721MMDREP	$7.86	4
CMP-04918-000737-	AUTOMOTIVE, 500-MW, 5-KVRMS ISOL	Texas Instruments	Mouser	595-UCC12051QDVERQ1	$4.62	4
Total					$53.54	

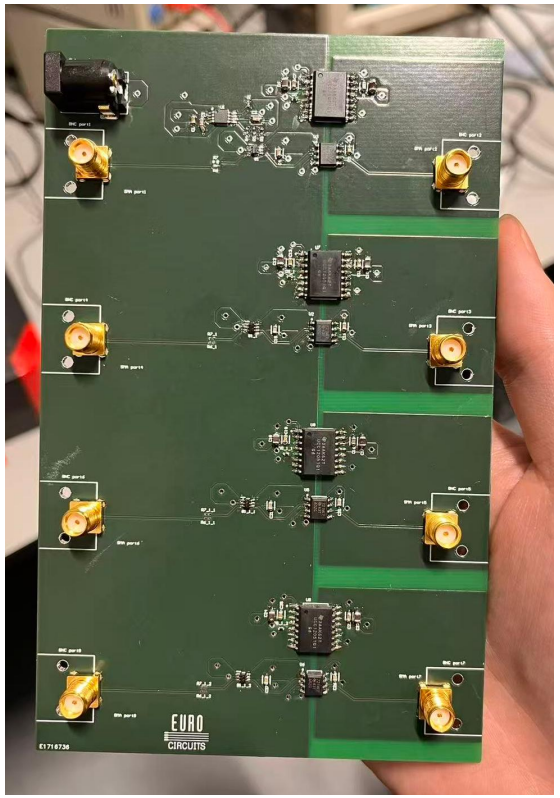
UNIVERSITY OF CAMBRIDGE

Manufacture and Assembly - Soldering





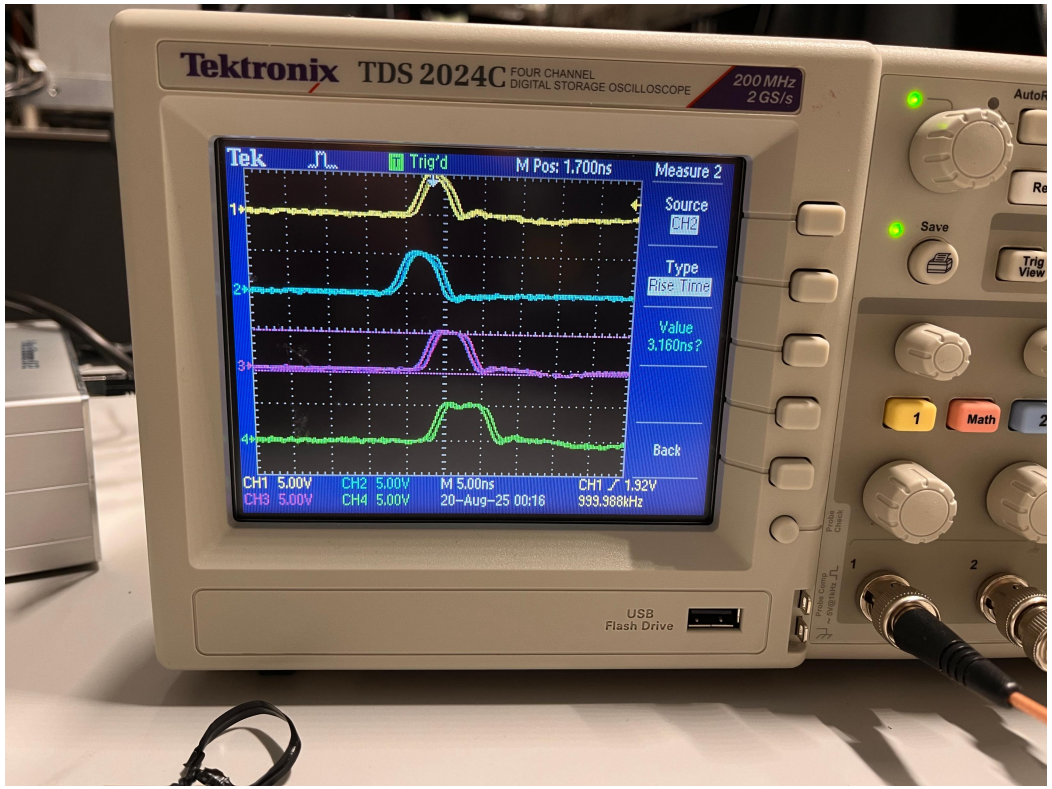
Surface-mount soldering



Through-hole soldering

UNIVERSITY OF CAMBRIDGE

Validation and Deployment



Validation with Swabian 8/2 Pulse Streamer

- **sending in 3ns, 4ns, 5ns and 7ns width pulse**
- **consistent 5V output with 2.7V TTL input**
- **approximately equal rise and fall time ~ 2-4 ns**
- **no cross-talk between any output signals**

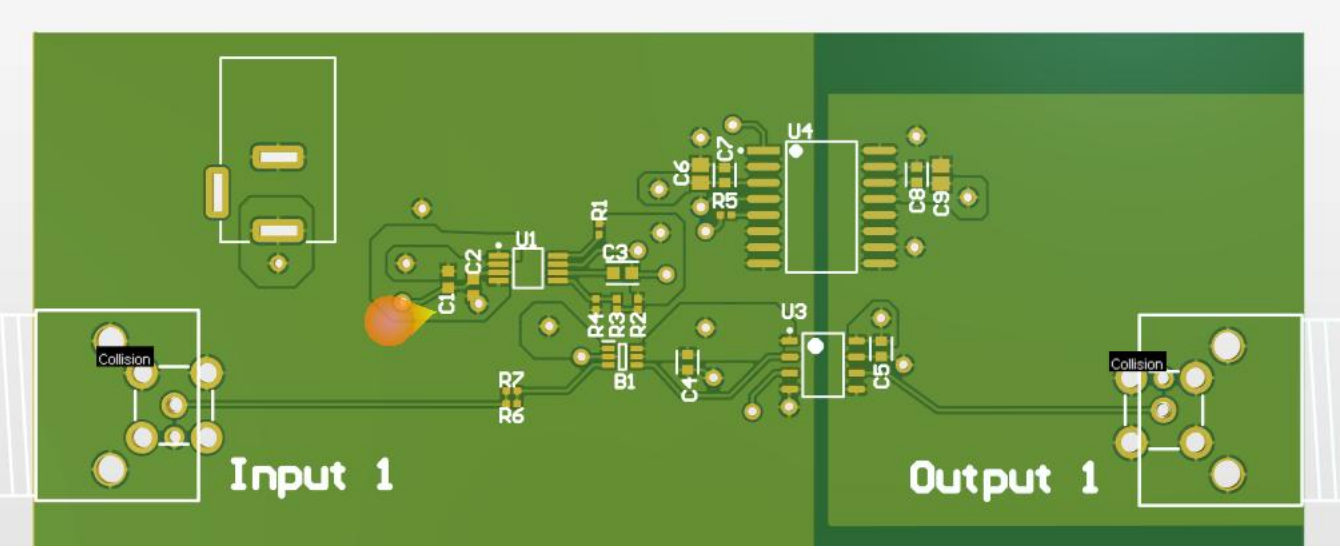
UNIVERSITY OF CAMBRIDGE

Validation and Deployment

Four boards with SMA ports successfully deployed, the last one left for flexiblity (BNC connection)

UNIVERSITY OF CAMBRIDGE

Validation and Deployment - Further improvement



Upload of the full project file to the teams eletronics channel by the end of this week.

UNIVERSITY OF CAMBRIDGE

Conclusion

- Successfully designed and deployed 4 functional level shifter boards satisfying all the requirements defined:
  - protected, high-speed, 4-channel board with clean isolated outputs and a single power supply
- Learned about PCB design and manufacturing, surface-mount soldering, assembly and validation