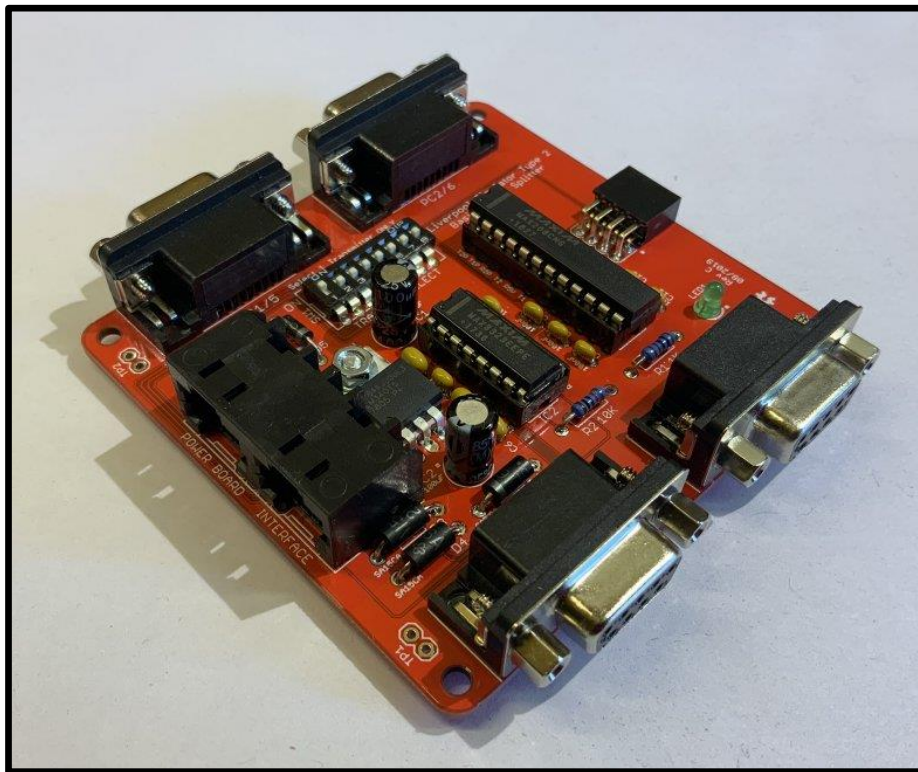# Type 2 Liverpool Ringing Simulator

07 – Multi-PC Guide

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Contents

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Document History

Version	Author	Date	Changes
1.0	A J Instone-Cowie	01/10/2019	First Release.
1.1	A J Instone-Cowie	18/08/2020	Minor update.

Cover photograph: A completed Type 2 Basic Serial Splitter PCB.

PC ports vector graphic design by https://www.vecteezy.com
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Licence

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[1] http://creativecommons.org/licenses/by-sa/4.0/

Documentation Map

Liverpool Ringing Simulator Documentation Map

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Configuring
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Guide

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Figure 1 – Documentation Map

About This Guide

This guide contains information on building modules which allow multiple PCs to be used concurrently with the Type 2 Liverpool Ringing Simulator:

- Second PC module
- Basic Serial Splitter module

If you are planning to use multiple PCs, it is strongly recommended that you complete and test the core Simulator modules first (Power, Interface, Sensors), as described in the **Build & Installation Guide**, before moving on to build the multiple PC modules.

In this guide you will find:

- Parts lists and schematics.
- Detailed construction and configuration information.

Notes on configuring the main Simulator Software Packages for use with multiple PCs can be found in the relevant software guides.

Please note that this is a Build-it-Yourself project. No pre-built hardware is available.

In view of the restrictions on ringing arising from COVID-19, there are currently no plans for further development of the Liverpool Simulator.

Using Multiple PCs

The Liverpool Ringing Simulator currently supports two alternative modules to use multiple Simulator PCs concurrently. For example, typically this allows more than one ringer with headphones to use the simulator with a simulated band at the same time.

- The **Second PC** module, as its name suggests, allows a second Simulator PC to be use concurrently with the PC connected to the Power module.
- The **Basic Serial Splitter** module supports up to four Simulator PCs, or up to eight PCs with an expansion board. Up to two Basic Serial Splitters can also be daisy-chained together, supporting a maximum of 16 PCs.

You can use either the Second PC module, or the Basic Serial Splitter module, depending on how many PCs you want to connect in total.

Second PC Module

A second Simulator PC can be connected via a Second PC module. This module utilises the second transmitter in the Simulator Interface MAX233 RS-232 serial line driver IC, and a spare core in the Power/Data cable, to provide a separate data feed to the Second PC.

The Second PC module is similar in size and shape to the Power module and is daisy-chained between the Power module and the Simulator Interface module on an RJ45 cable, in a similar manner to the chains of sensors. It also provides surge protection diodes on the power and serial lines.

A typical configuration with a Second PC module is illustrated in the following diagram (only eight sensors are shown to save space):
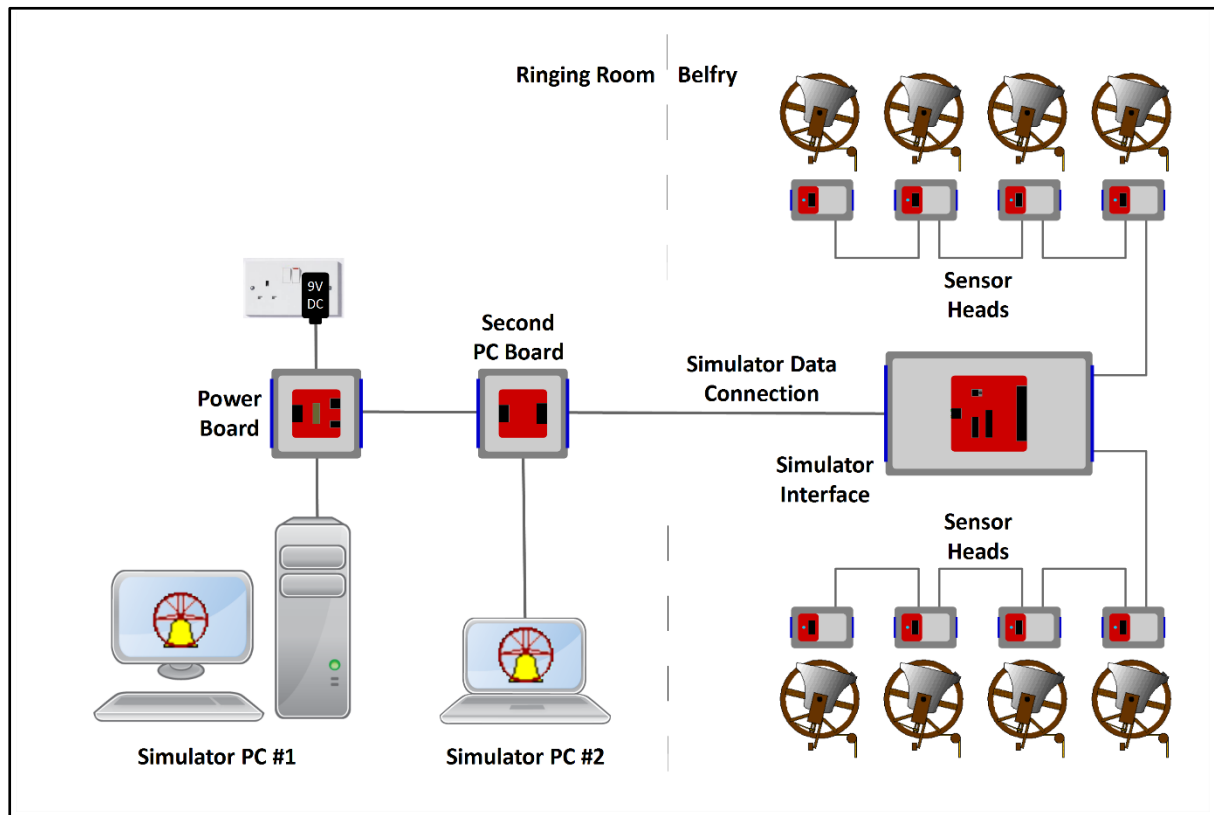
Figure 2 – Second PC Module General Arrangement

The Second PC receives a read-only copy of the same signals from the Simulator Interface module as the primary PC. Both PCs run their own copies of the Simulator Software Package (or even of different software packages), and the Simulator Software on each PC is configured to filter out unwanted signals.

Only the PC connected to the Power module can be used to configure the Simulator Interface.

The Second PC module requires Revision D or later of the Simulator Interface PCB. A modification is possible for older interface boards, and this is described in an Appendix below.

Basic Serial Splitter Module

The Basic Serial Splitter module uses additional RS-232 receiver and line driver ICs to copy the stream of signals from the Simulator Interface to multiple PCs. The minimum configuration of the Basic Serial Splitter (the "Master Board") supports up to four PCs, but this can be linked to a second "Expander Board" which supports four more PCs.

Up to two Basic Serial Splitters can be daisy-chained between the Power module and the Simulator Interface module on RJ45 cables, supporting a maximum of 16 Simulator PCs. The Basic Serial Splitter module also provides surge protection diodes on the power and serial lines.

The maximum configuration of two daisy-chained Basic Serial Splitters is illustrated in the following diagram (all sensors are omitted to save space):
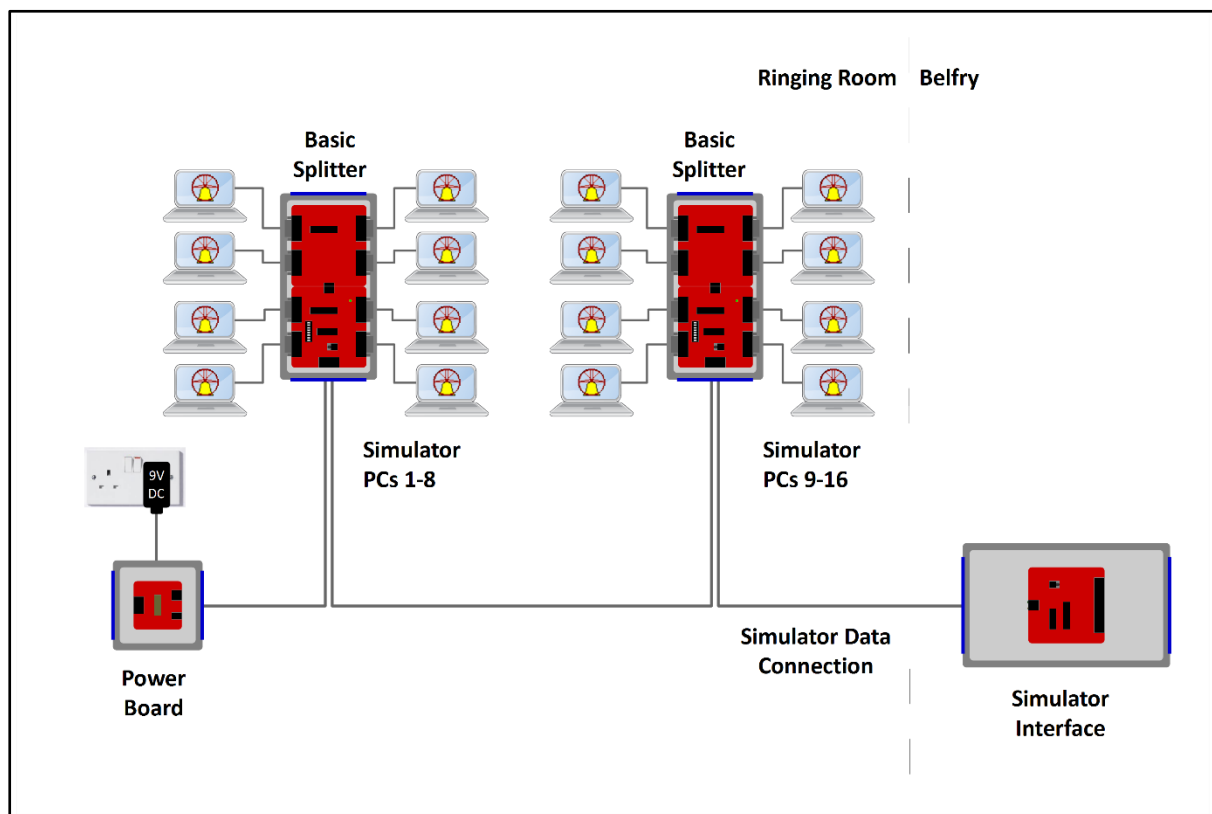
Figure 3 – Basic Serial Splitter Modules General Arrangement

All Simulator PCs receive a read-only copy of the same signals from the Simulator Interface. Each PC runs its own copy of the Simulator Software Package (or even of different software packages), and the Simulator Software on each PC is configured to filter out unwanted signals.

The PC connector on the Power module is not used with the Basic Serial Splitter.

Any one PC connected to the Basic Serial Splitter can be used to send configuration data to the Simulator Interface, selectable by a switch on the splitter. (If two Basic Serial Splitters are daisy-chained together, only PCs connected to the Splitter nearest to the Power module can be used to configure the Interface.)

Daisy-chaining two Basic Serial Splitters requires Revision D or later of the Simulator Interface PCB. A modification is possible for older interface boards, and this is described in an Appendix below.

What You Will Need

Skills

Like the rest of the Liverpool Ringing Simulator, the multi-PC modules are Build-it-Yourself projects. Please refer to the main *Build & Installation Guide* for details of the skills and tools you will require to build the Simulator.

The Basic Serial Splitter module is more complex to build than the core Simulator modules, so it is probably best to complete and test the core modules before moving on to the multi-PC modules.

Advice and guidance are available from the project via the contact form on the website.

Parts

Please refer to the main *Build & Installation Guide* for suggested sources of parts for the multi-PC modules. As with the core Simulator modules, where possible Farnell or CPC part numbers have been given.

PCBs

Surplus development PCBs may be available from the Liverpool Ringing Simulator Project, please enquire about availability via the contact form on the website.

The multi-PC modules use two basic types of PCB:

- Second PC Board.
- Basic Serial Splitter Board

Note that the Basic Serial Splitter has been designed so that the same type of PCB can be built either as the Master Board or the optional Expander Board.

Suggested sources of PCBs are listed in the main *Build & Installation Guide*, and PCB design files, known as "Gerber files", are available from the project GitHub repository:

- https://github.com/Simulators/simulator-type2

Hardware Assembly

This section describes the assembly of the multi-PC module options. It also covers the suggested enclosures.

Before you start construction of the multi-PC module hardware, check the log on the project GitHub repository for any open or late-breaking issues which may affect your build:

- https://github.com/Simulators/simulator-type2/issues

Polarised Components

A number of the components of the multi-PC modules are polarised and must be fitted the right way round for correct operation. Guidance is given in the main **Build & Installation Guide** on correct orientation of the polarised components, but if in any doubt consult the component supplier or the manufacturer's data sheets. Fitting a polarised component the wrong may round may result in damage to the component.

Second PC Board

Parts List
Table 1 – Second PC Module PCB Parts List

Reference	Component	Notes
PCB	Type 2 Second PC Board PCB	
PC Connector	Right Angle PCB D Sub Connector 9 Pin	Farnell 1848372
Connector	AMP TE Connectivity 5406526-1	Farnell 2452587
D1	SA12A	Farnell 2679618
D2, D3, D4	SA15CA	Farnell 2762809

Schematic

Simulator Type 2 Second PC
SimulatorT2SecondPCRevB
13/07/2019 18:18   A J Instone-Cowie
Sheet: 1/1   Rev:Rev B 07/2019
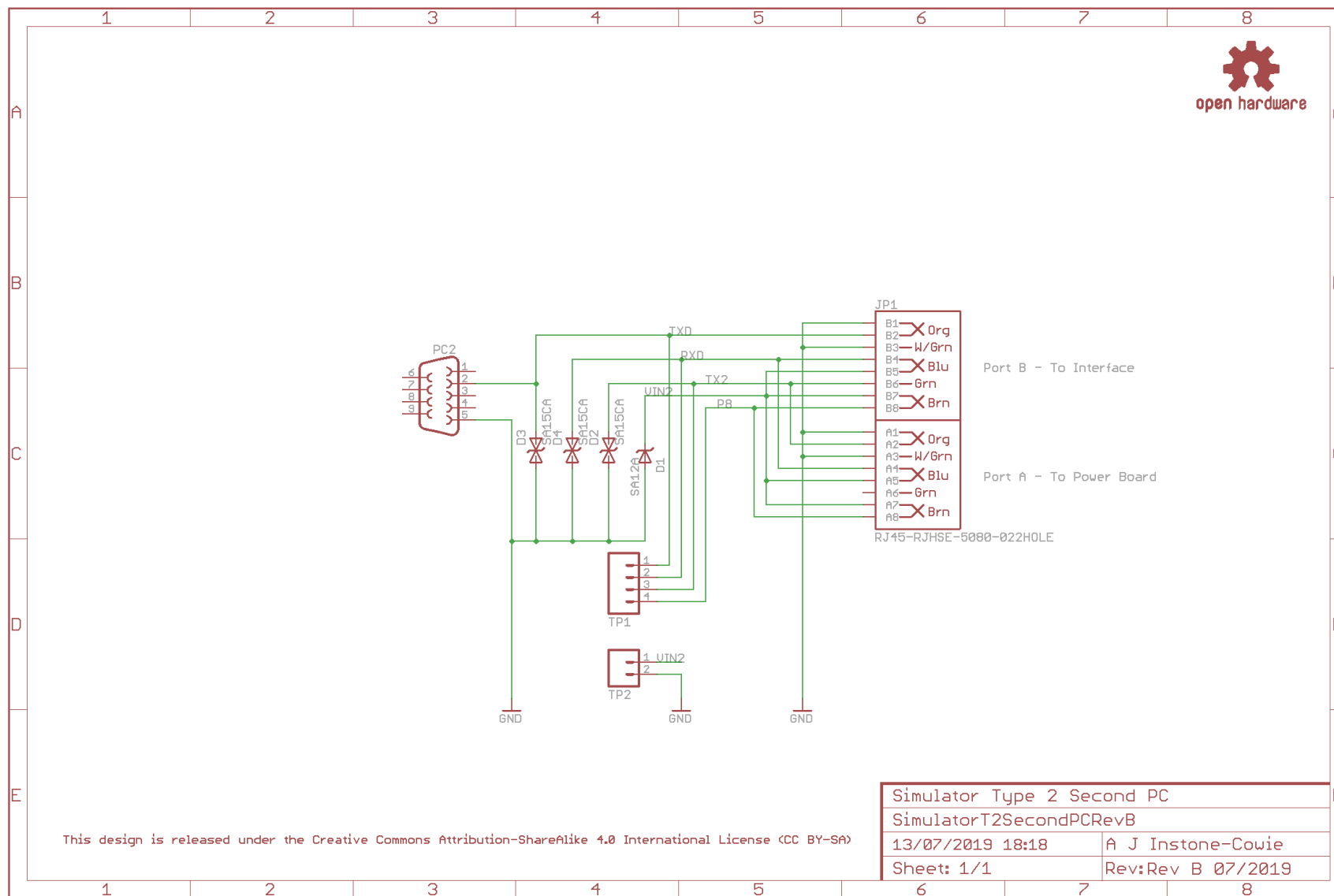
Parts

The following photograph shows the complete set of parts required for the Second PC module PCB.
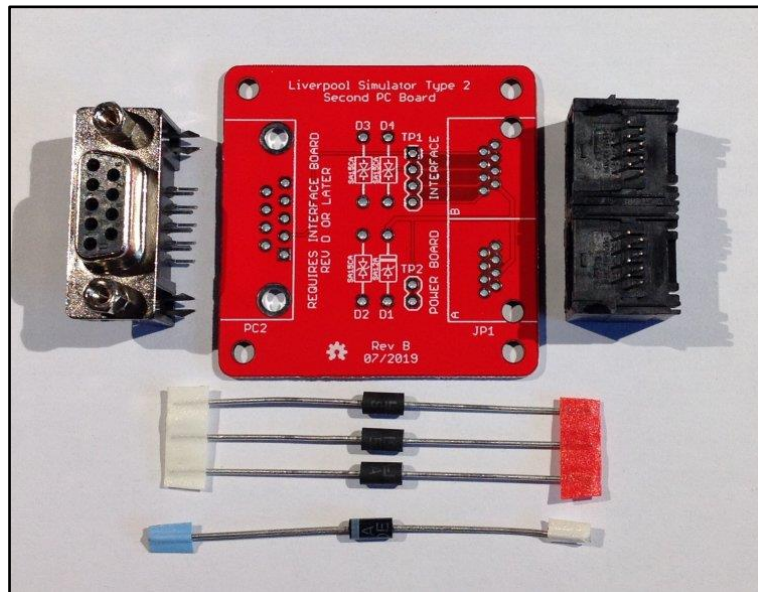
Figure 4 – Second PC Module Parts

PCB Layout

The following diagram shows the layout of the Second PC module PCB. All components are mounted on the top (silkscreen) side of the board.
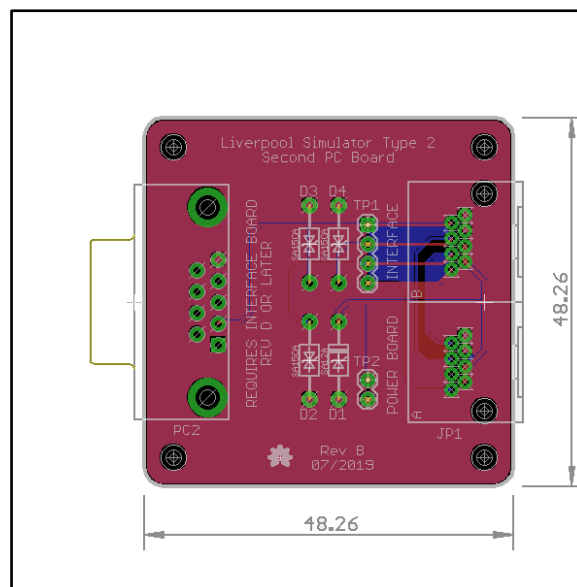
Figure 5 – Second PC Module PCB Layout

Construction

All the components on the Second PC module PCB are mounted on top, silkscreen, side of the board.

- If your Second PC PCB came from a panelized PCB, lightly file down any remaining nibs from the edges of the board.
- Pay close attention to the correct orientation of the polarised diode D1.
- D2, D3 & D4 are not polarised.
- There is no need to fit pins to the test point holes TP1 – TP2.

A completed Second PC module is shown in the following photograph.
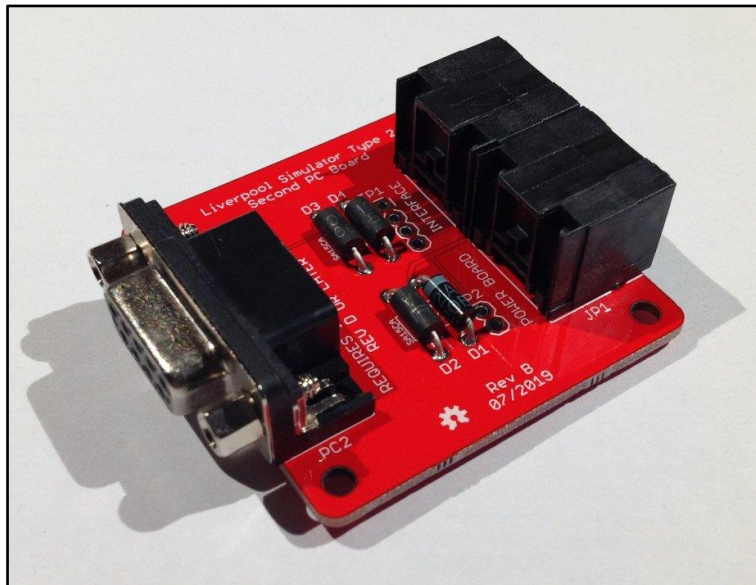
Figure 6 – Completed Second PC Module

Enclosure

The Second PC module may be housed in a 0.75 litre Really Useful Box, with space for a USB-Serial adapter if required, and with the same drilling as for the core Power module. The PCB may be mounted on standoffs, as described in the *Build & Installation Guide*.

Basic Serial Splitter Module – Master Board

Parts List

Table 2 – Basic Serial Splitter Module Master Board Parts List

Reference	Component	Notes
PCB	Type 2 Basic Serial Splitter PCB	
R1	1kΩ 0.25W Metal Film	Farnell 9341102
C1, C2	100µF 25V Electrolytic (6.3mm Radial)	Farnell 9451188
C3, C5, C6	330nF (0.33µF) 50V MLCC[2] (2.54mm Radial)	Farnell 2819679
C4	47nF (0.047µF) 50V MLCC (2.54mm Radial)	Farnell 2819680
C7, C8, C9, C10, C11, C12	100nF (0.1µF) 50V MLCC (2.54mm Radial)	Farnell 1457655
D1	SA12A	Farnell 2679618
D2, D3, D4	SA15CA	Farnell 2762809
D5	1N4001	Farnell 1458986
D6	SA5.0A	Farnell 1886342
IC1	LM340T-5.0 (replacement for LM7805)	Farnell 9490175
IC2	MAX3323EEPE+	Farnell 2511866
IC3	MAX208CNG+	Farnell 2511906
RJ45 Connector	AMP TE Connectivity 5406526-1	Farnell 2452587
PC1, PC2, PC3, PC4	Right Angle PCB D Sub Connector 9 Pin	Farnell 1848372
SW1	DIP Switch 8-Way SPST	Farnell 9472185
IC Socket	16-pin, 0.3" pitch	Farnell 1182587
IC Socket	24-pin, 0.3" pitch	Farnell 2445625
LED1	Green 3mm	Farnell 1581114
Hardware	6mm M3 PCB Standoffs, Nuts & Screws	eBay

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[2] Multi-Layer Ceramic Capacitor

Schematic
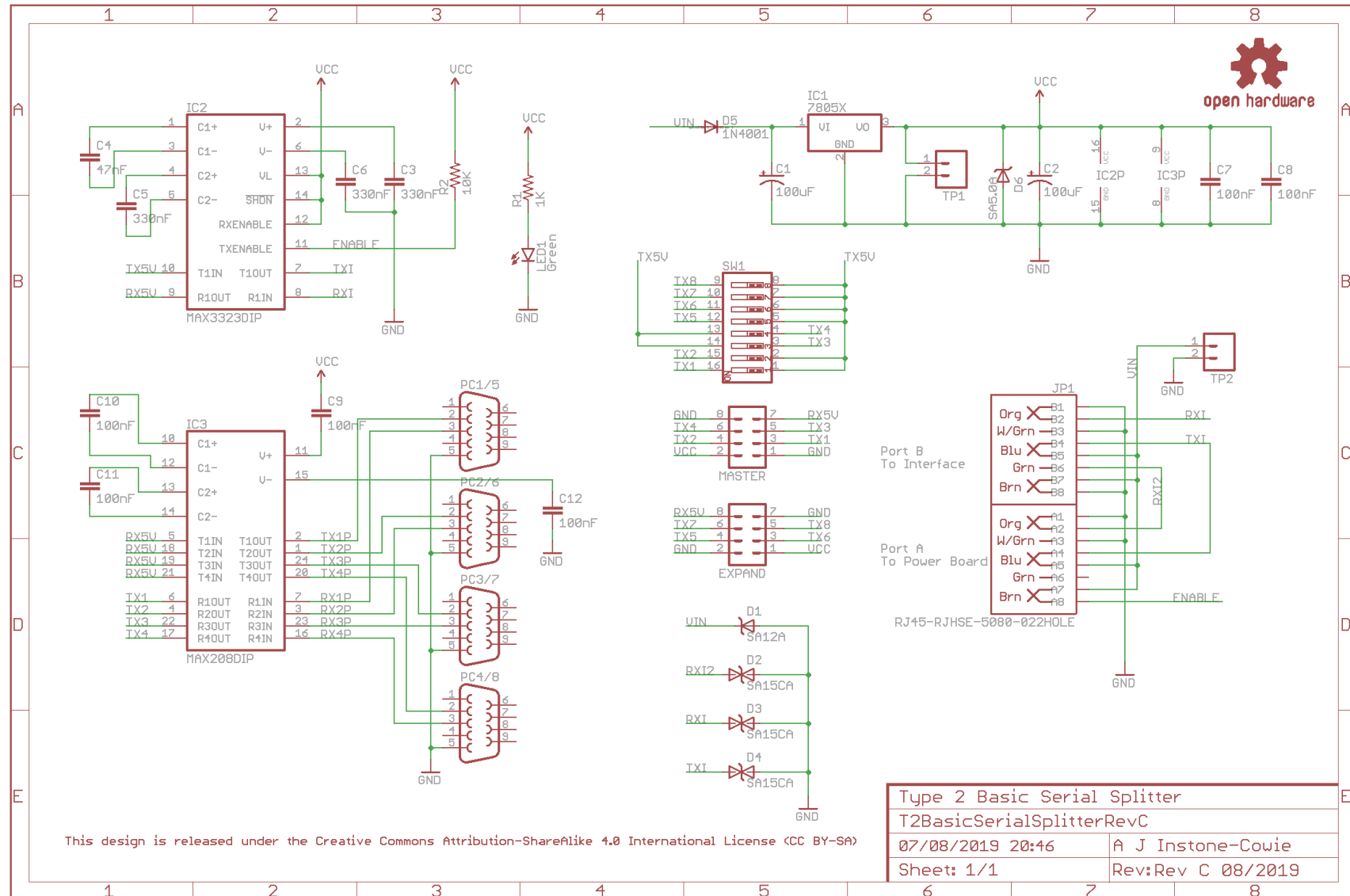
Parts

The following photograph shows the complete set of parts required for the Basic Serial Splitter Module Master Board.

Figure 7 – Basic Serial Splitter Module Master Board Parts

PCB Layout

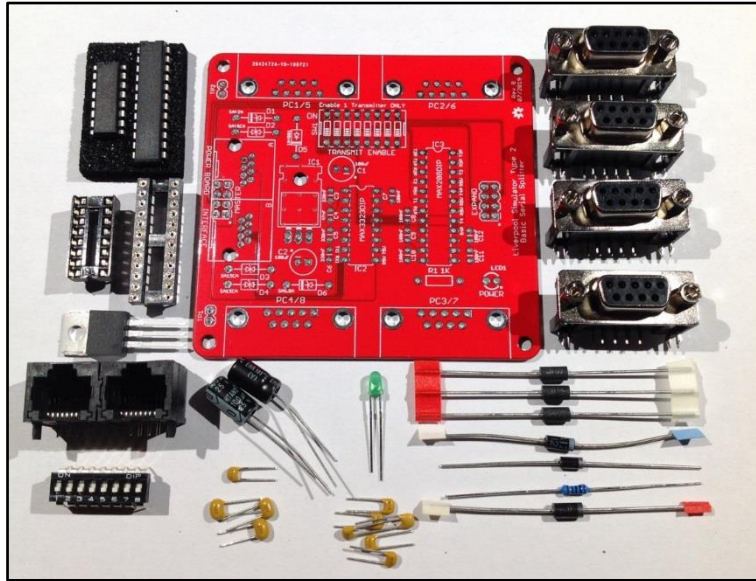The following diagram shows the layout of the Basic Serial Splitter Master PCB. All components are mounted on the top (silkscreen) side of the board. Note that the Expander uses an identical PCB.
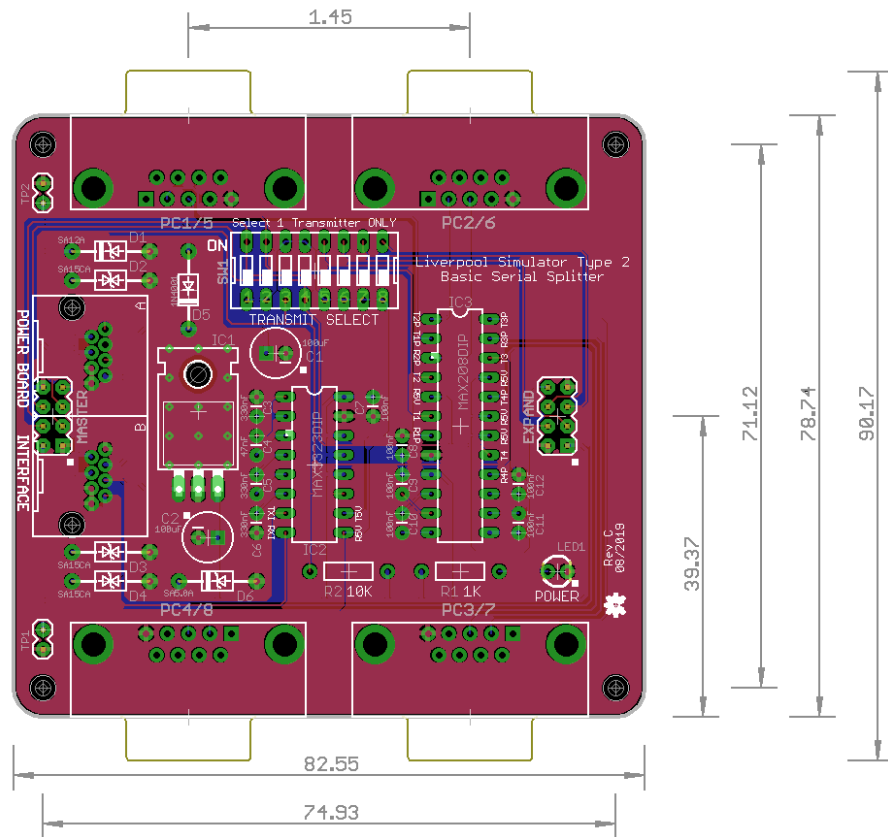
Figure 8 – Basic Serial Splitter Module Master Board Layout

Construction

All the components on the Basic Serial Splitter Module Master Board are mounted on top, silkscreen, side of the board.

- Start by soldering the components with the lowest profile (resistors, ceramic capacitors), then the remainder of the components in order of increasing height, ending with the RJ45 and 9-Pin Serial connectors.
- The use of IC sockets for IC2 & IC3 is strongly recommended.
- When fitting the voltage regulator, carefully bend the pins through 90 degrees so that the mounting hole in the tab lines up with the mounting hole in the PCB. Secure the regulator to the board with an M3 nut, bolt and washer underline before soldering the pins. A tiny smear of heatsink compound between the tab and board will improve heatsinking. No additional heatsink is required.

- Before fitting the socketed ICs, connect the board to a power supply (using the Power module and a short RJ45 cable) and check using a multimeter that the supply voltage appears on the pins of TP2, and that +5V and 0V appear on the pins of TP1 and the correct pins of the IC sockets. The pins are identified in the diagram below. The green power LED should also light. Disconnect the power supply and fit the ICs.
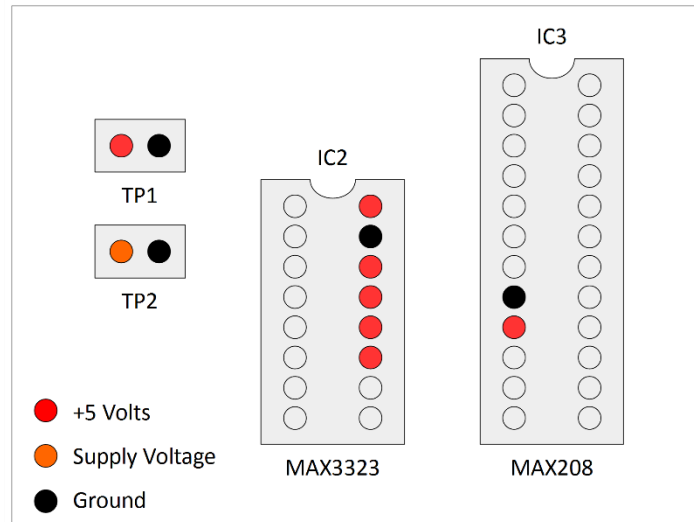
Figure 9 – Voltage Check Pin Locations

- Pay close attention to the correct orientation of the polarised components D1, D5, D6, C1, C2, IC1, IC2, IC3 & LED1.
- Diodes D2, D3 & D4 are not polarised.
- The mounting lugs of the RJ45 and 9-Way D-Sub connectors clip into the holes in the PCB. Make sure the connector pins are correctly aligned with the holes before clipping the connector into the board, and then soldering the pins.

A completed Basic Serial Splitter module Master Board is shown in the following photograph.

Figure 10 – Completed Basic Serial Splitter Module Master Board

Basic Serial Splitter Module – Expander Board

The Expander Board links to the Master Board and provides four additional serial ports for Simulator PCs. Only one Expander can be linked to a Master Board.
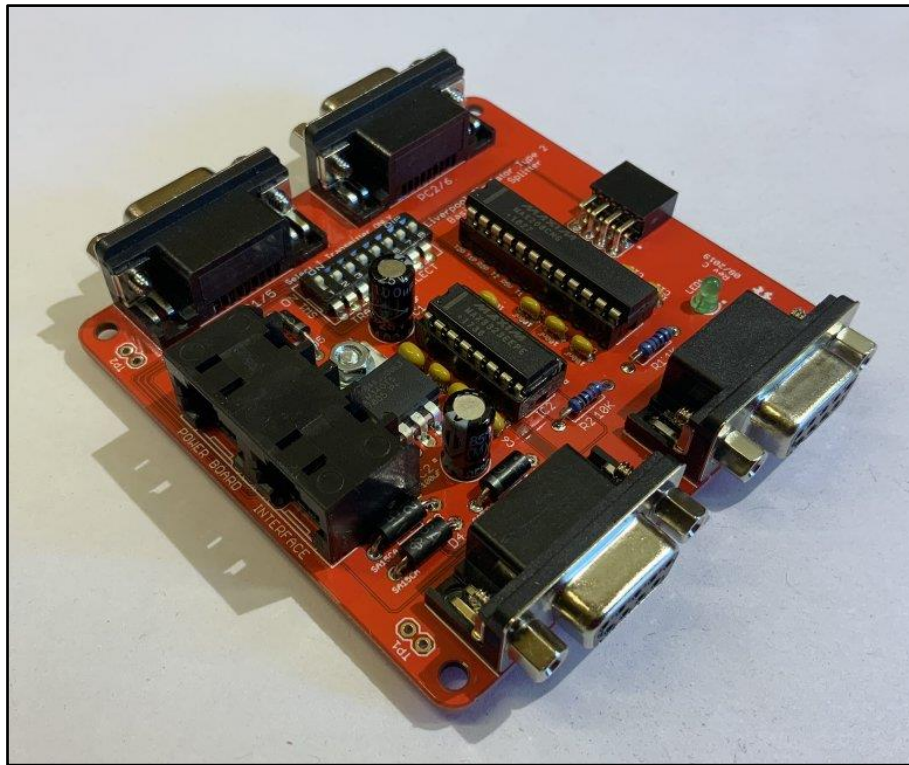
Parts List

Table 3 – Basic Serial Splitter Module Expander Board Parts List

Reference	Component	Notes
PCB	Type 2 Basic Serial Splitter PCB	
C8, C9, C10, C11, C12	100nF (0.1µF) 50V MLCC (2.54mm Radial)	Farnell 1457655
IC3	MAX208CNG+	Farnell 2511906
PC5, PC6, PC7, PC8	Right Angle PCB D Sub Connector 9 Pin	Farnell 1848372
IC Socket	24-pin, 0.3" pitch	Farnell 2445625
Master Connector	8-Way Right Angle Header	Farnell 2356196
Expand Connector[3]	8-Way Right Angle Socket	Farnell 1668343
Hardware	6mm M3 PCB Standoffs, Nuts & Screws	eBay

---

[3] Note that this component is installed on the MASTER board.

Parts

The following photograph shows the complete set of parts required for the Basic Serial Splitter Expander PCB.
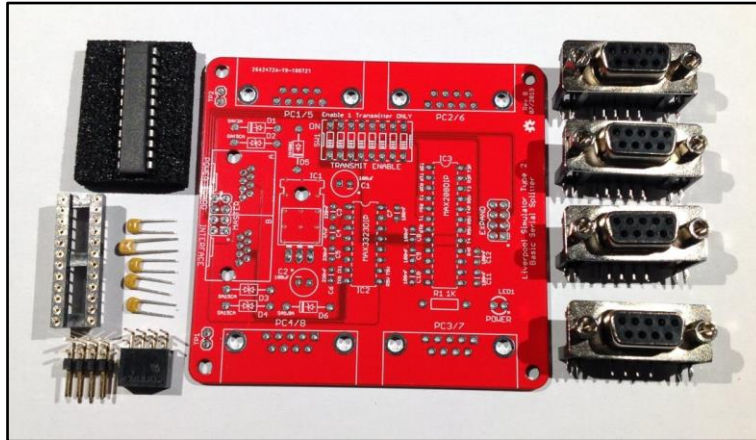

Figure 11 – Basic Serial Splitter Module Expander Board Parts

Construction

The Basic Serial Splitter module Expander uses the same PCB as the Master board, shown in the diagram in the previous section. All the components are mounted on top, silkscreen, side of the board.

- Fit only the parts listed in the Expander parts list above. All remaining positions on the Expander PCB can be left empty.
- Note that the 8-Way Right Angle Socket is fitted to the Expand position on the <u>MASTER</u> board, not the Expander. It mates with the 8-Way Right Angle Header fitted to the Master position on the Expander board, as shown in the photographs below.
- The use of an IC socket for IC3 is strongly recommended.
- Before fitting the socketed IC, connect the board to a power supply (via the Master board and a Power Board and a short RJ45 cable) and check using a multimeter that +5V and 0V appear on TP1 and the correct pins of the IC3 socket. The pins are the same as identified in the diagram above. Disconnect the power supply and fit the ICs.
- Pay close attention to the correct orientation of the polarised component IC3.
- The mounting lugs of the 9-Way D-Sub connectors clip into the holes in the PCB. Make sure the connector pins are correctly aligned with the holes before clipping the connector into the board, and then soldering the pins.

A completed Basic Serial Splitter module with Master and Expander Boards is shown in the following photograph.
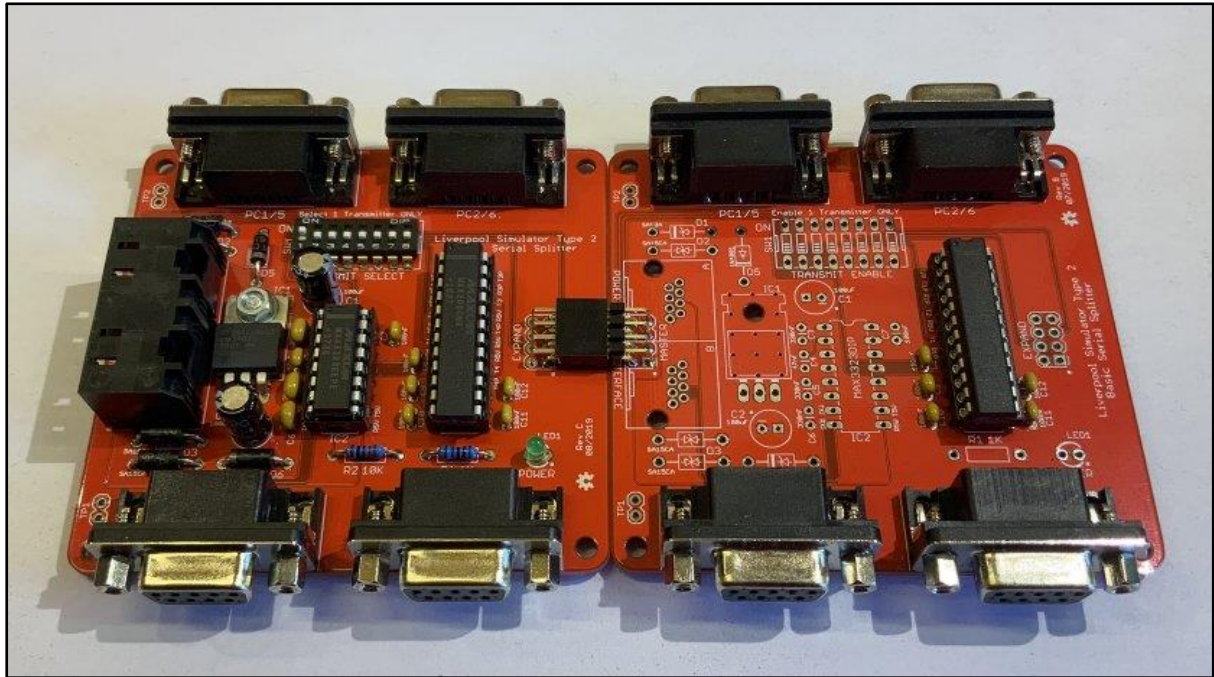

Figure 12 – Basic Serial Splitter Master & Expander PCBs

Enclosures

The suggested enclosures for the Second PC module and the Basic Serial Splitter module are from the "Really Useful" series of plastic boxes, widely available from hobby and stationery shops, or direct from the manufacturer[4].

- Drilling large diameter holes with twist drills can result in bit grabbing and damage to the enclosure. Use a 20mm hole saw[5] for cable holes, this makes the process of drilling the enclosure much easier and safer.
- Support the inside surface of the enclosure with a block of scrap wood when cutting the holes and cut at a low speed.
- Clean up any rough edges or swarf with a sharp knife.
- Cables are run into the enclosures via PVC grommets, which provide some protection against dust and moisture.
- A set of suitable paper templates is available from the GitHub repository as a PDF and should be printed out full size with no scaling.

Parts List

Table 4 – Enclosures Parts List

Reference	Component	Notes
Second PC Module	Really Useful Box® 0.75 Litre	195 x 135 x 55mm
Basic Serial Splitter	Really Useful Box® 0.55 Litre	220 x 100 x 40mm
Grommets	20mm Closed Grommets	Screwfix 18603

---

[4] http://www.reallyusefulproducts.co.uk/
[5] Frequently used by electricians.

Second PC Module Enclosure

The following diagram shows the holes required in a 0.75 litre Really Useful Box for the Second PC module.
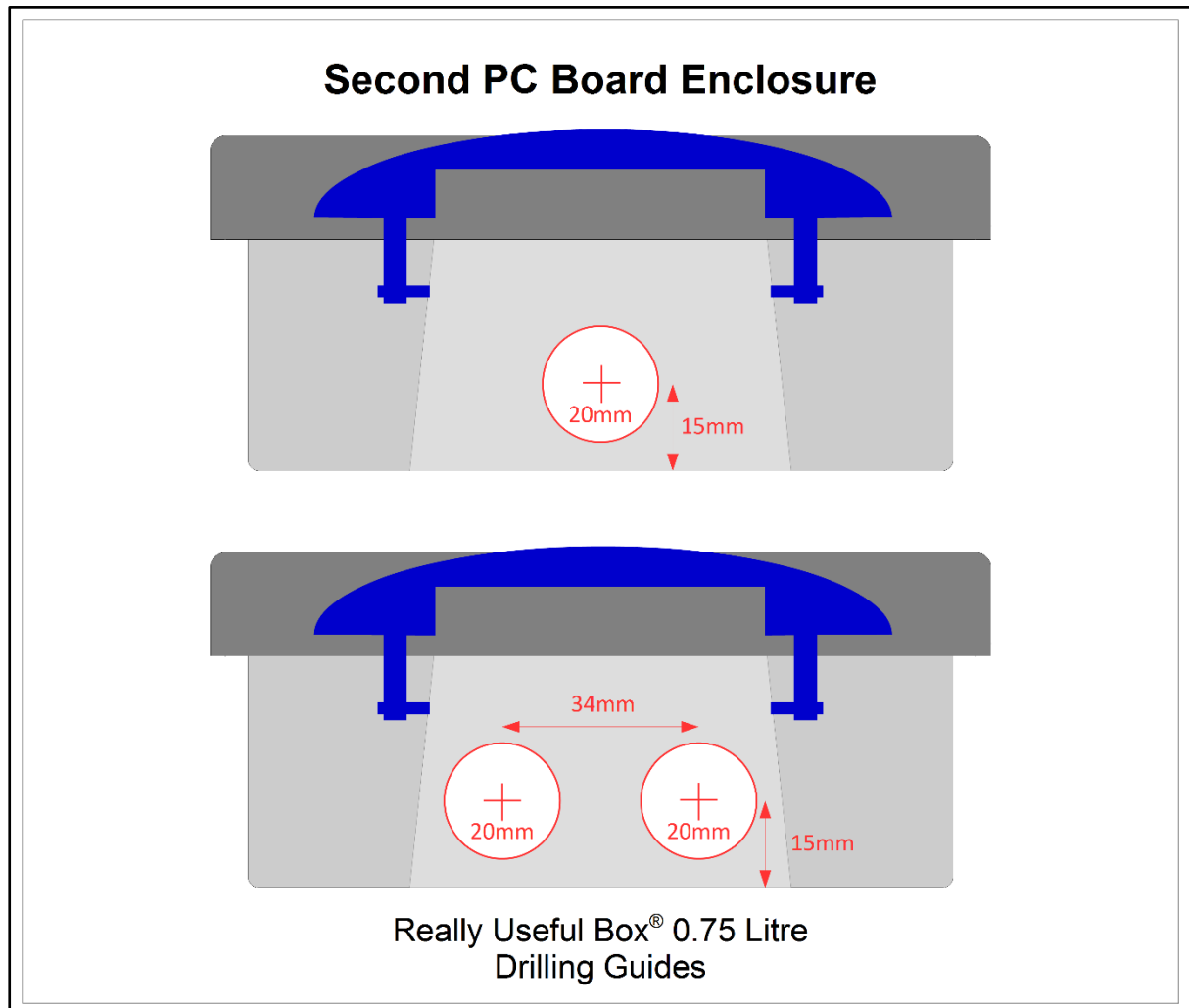

Figure 13 – Second PC Module Enclosure Drilling Guide

Basic Serial Splitter Enclosure

The following diagram shows the holes required in a 0.55 litre Really Useful Box for the Basic Serial Splitter. A single enclosure is big enough for a linked Master Board and Expander Board.
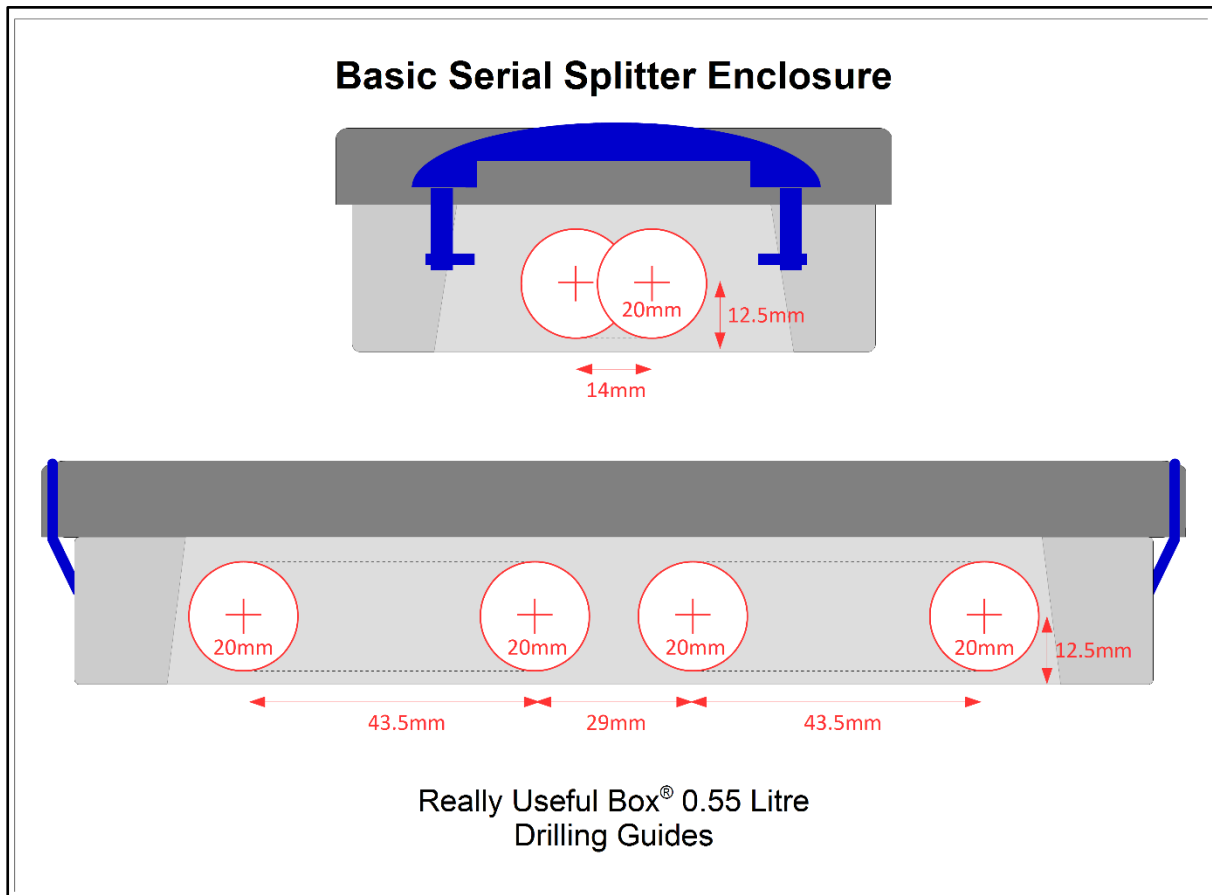

Basic Serial Splitter Enclosure

20mm
12.5mm
14mm

20mm
20mm
20mm
20mm
12.5mm
43.5mm
29mm
43.5mm

Really Useful Box® 0.55 Litre
Drilling Guides

Figure 14 – Basic Serial Splitter Module Enclosure Drilling Guide

The two 20mm holes in the end of the enclosure overlap. The material between each pair of 20mm holes in each side of the enclosure should be cut out, leaving two slots. This can be seen in the completed assembly module photograph below.

PCB Mounting Hardware

The Basic Serial Splitter PCBs should be secured to the base of the enclosure using M3 x 6mm Nylon PCB standoffs, nuts, screws and washers.

Figure 15 – PCB Mounting Hardware

The following photograph shows how the bare PCBs can be used to mark out the base of the Basic Serial Splitter enclosure prior to drilling.
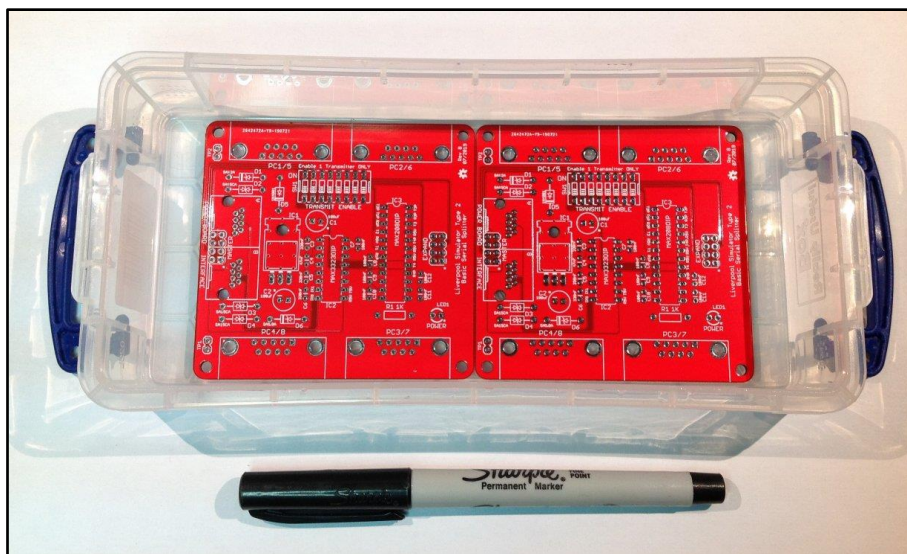

Figure 16 – Enclosure Marking Out

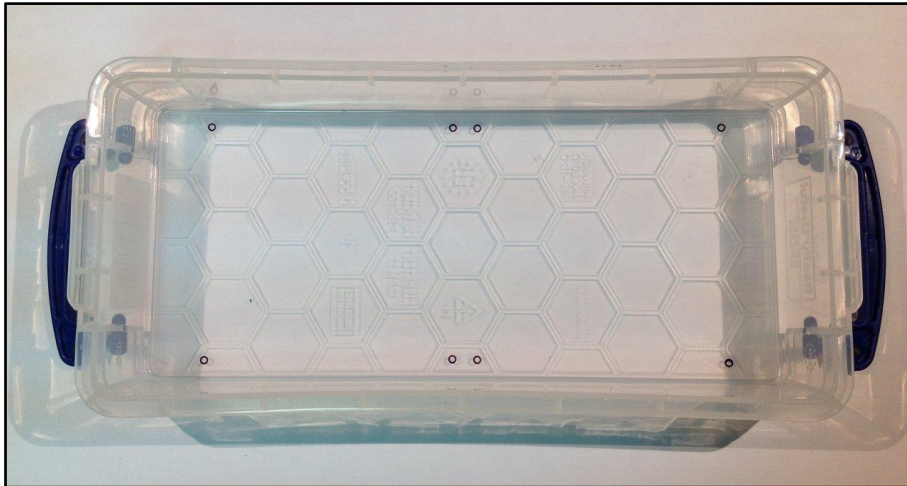The Basic Serial Splitter enclosure marked out for drilling is shown in the following photograph.

Figure 17 – Enclosure Marked for Drilling

Completed Assemblies

Second PC Module

The following photograph shows a completed Second PC Board, with a USB-Serial adapter also inside the enclosure.

Figure 18 – Completed Second PC Module in Enclosure

Basic Serial Splitter Module

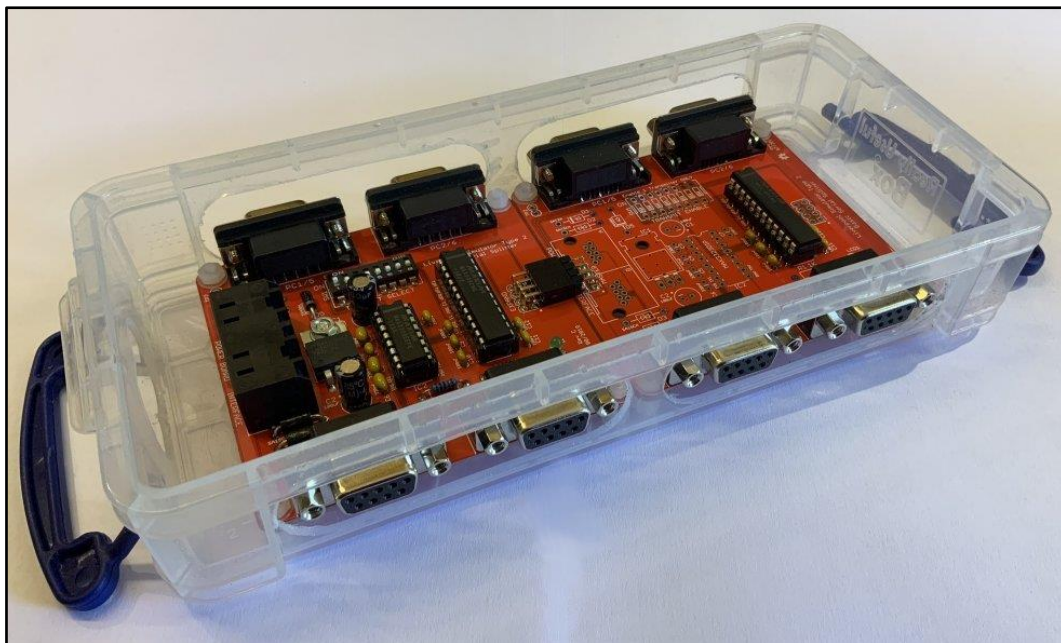The following photographs show completed Basic Serial Splitter modules, with Master & Expander Boards.

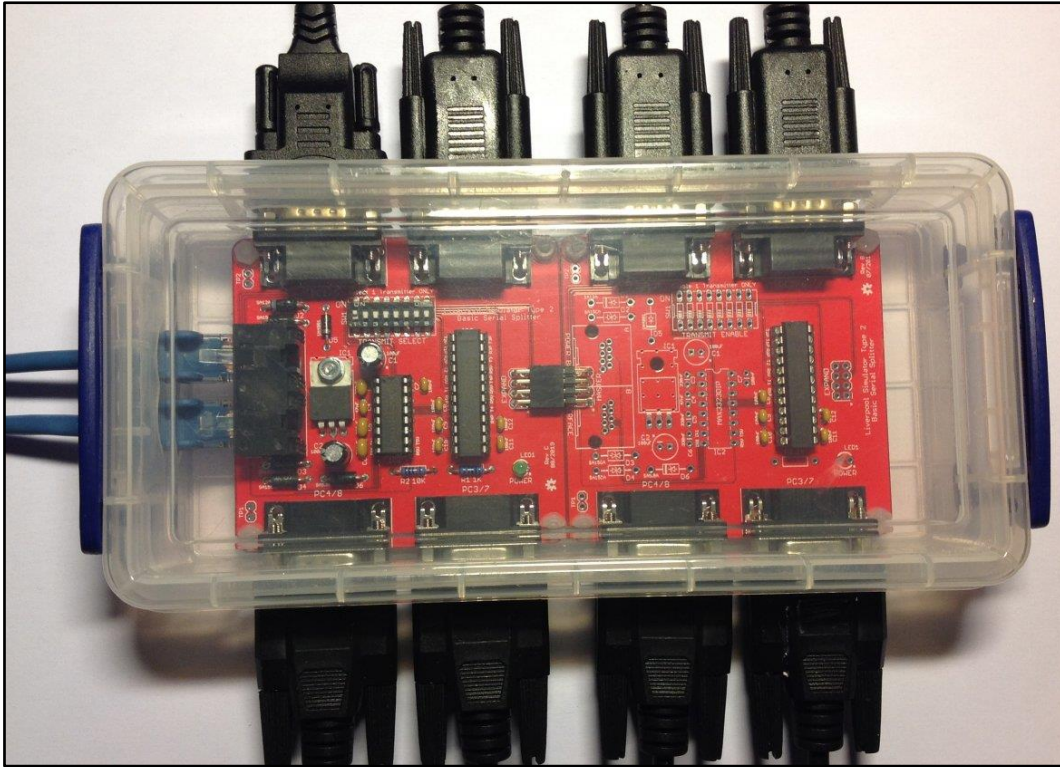Figure 19 – Completed Basic Serial Splitter Module in Enclosure

Figure 20 – Completed Basic Serial Splitter Module

Cabling

Second PC Module

The Second PC module is daisy-chained between the Simulator Interface module and the Power module, as shown in the following diagram.

- As with the core Simulator cabling, the cable is a standard straight-through (not crossover) Cat5e or Cat6 Ethernet network cable, with RJ45 connectors.
- The maximum total length of cable tested is 30m (25m between Interface and Second PC module, and a further 5m to the Power module), although longer cables may be feasible.
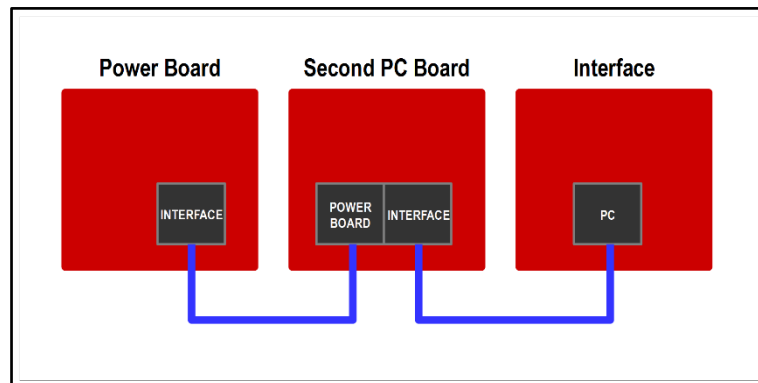

Figure 21 – Second PC Module Cabling

Basic Serial Splitter Module

The Basic Serial Splitter module is daisy-chained between the Simulator Interface module and the Power module, as shown in the following diagram.

- One or two Basic Serial Splitter modules may be connected as shown, providing ports for up to 8 or up to 16 Simulator PCs.
- As with the core Simulator cabling, the cable is a standard straight-through (not crossover) Cat5e or Cat6 Ethernet network cable, with RJ45 connectors.
- The maximum total length of cable tested is 30.5m (25m between Interface and Basic Serial Splitter module, a further 5m to the second Splitter module, and a short cable to the Power module), although longer cables may be feasible.
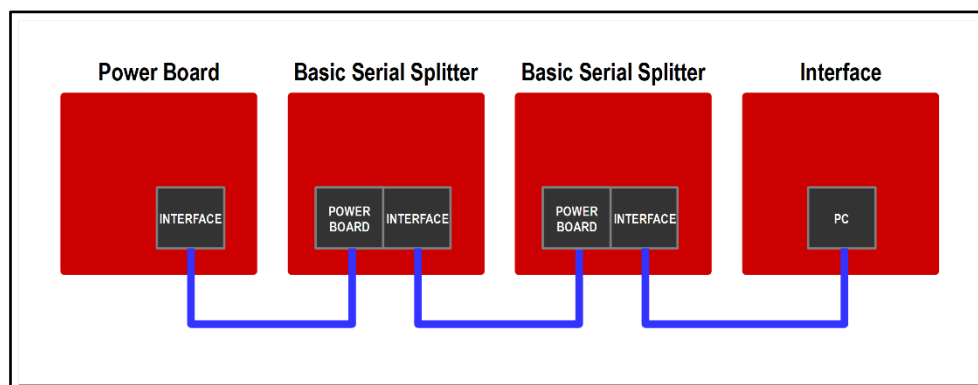

Figure 22 – Basic Serial Splitter Module Cabling

Appendix: Older Interface Boards

The Second PC module works with Simulator Interface PCBs from PCB Revision D onwards – no modification of these interface boards is necessary.

Daisy-chaining two Basic Serial Splitter modules together works with Simulator Interface PCBs from PCB Revision D onwards – no modification of these interface boards is necessary.

A single Basic Serial Splitter module will work with any version of the Simulator Interface PCB.

Older Simulator Interface PCBs may be modified for use with the Second PC module, or to allow daisy-chaining of two Basic Serial Splitter modules, with the addition of two wire links. On the solder side of the Simulator Interface PCB, fit two small wire links:

- Between pins 1 and pin 2 of IC2.
- Between pin 18 of IC2 and pin 2 of TP5 (pin 1 of TP5 is marked with a square pad).

Remember that when working on the solder side of the PCB the IC pin numbers will be reversed. The locations of the links are shown in the diagram below:
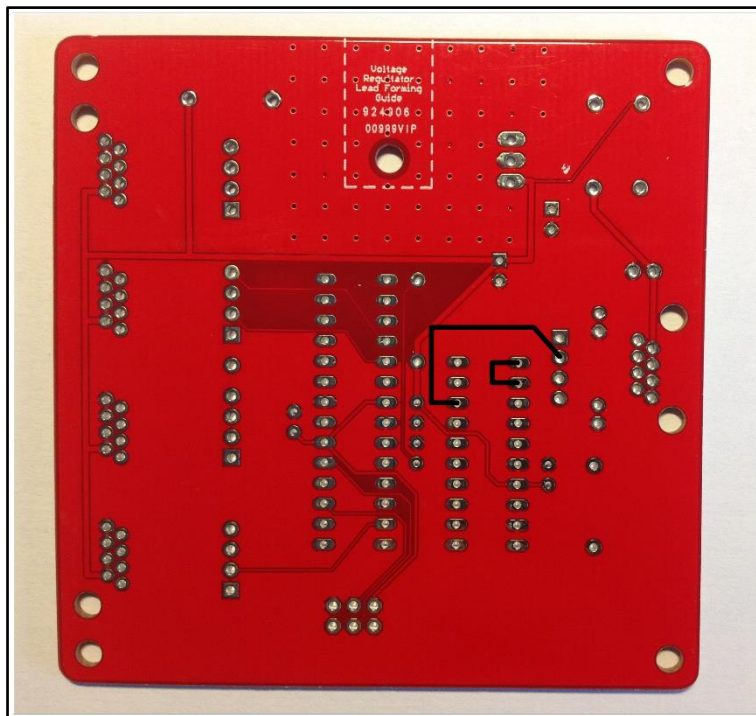

Figure 23 – Modification for Older Interface PCBs

An example of a modified Simulator Interface PCB is shown in the following photograph.
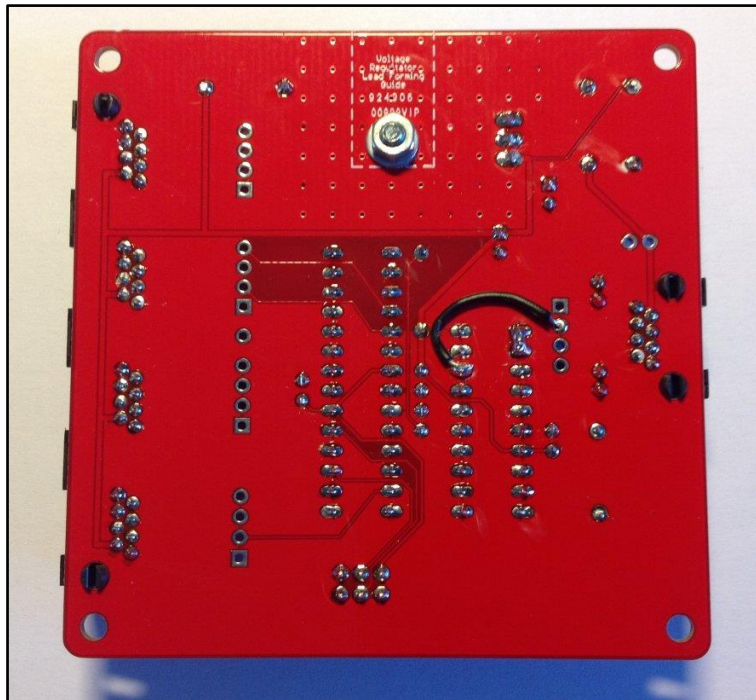

Figure 24 – Modified Interface Board

Appendix: Configuring the Interface

When multiple PCs are connected, only one PC can be used to configure the Simulator Interface using a terminal emulator (as described in the **Build & Installation Guide**).

- When using the Second PC module, only the PC connected to the Power module can be used to configure the Interface.
- The PC connected to the Second PC module is not able to send data to the Interface and cannot be used for configuration.
- When using a single Basic Serial Splitter module, any one PC (selected by the 8-way DIP switch on the PCB) can be used to configure the Interface. Only one PC should be enabled at any time.
- When two Basic Serial Splitter modules are connected, any one PC (selected by the 8-way switch) connected to the Splitter closest to the Power module can be used to configure the Interface. The PCs connected to the Splitter closer to the Interface module are automatically disabled for configuration use.
- The PC connector on the Power module is not used at all when the Basic Serial Splitter(s) is used and must not have a PC connected to it.

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All original manuals and other documentation (including PCB layout CAD files and schematics) released as part of the Liverpool Ringing Simulator project[6] are released under the Creative Commons Attribution-ShareAlike 4.0 International License (CC BY-SA),[7] which includes the following disclaimers:

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[6] http://www.simulators.org.uk
[7] http://creativecommons.org/licenses/by-sa/4.0/
[8] http://www.gnu.org/licenses/gpl-3.0.en.html

Acknowledgements

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