Modular Backplane for RC2014-Z80
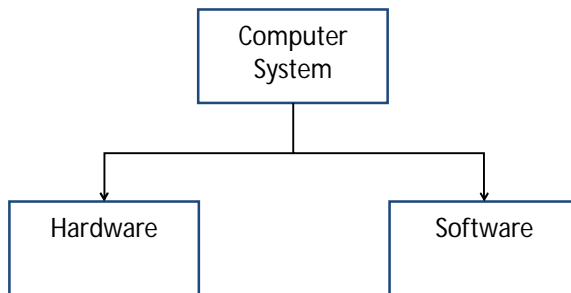
Specification

Draft discussion document

CONTENTS

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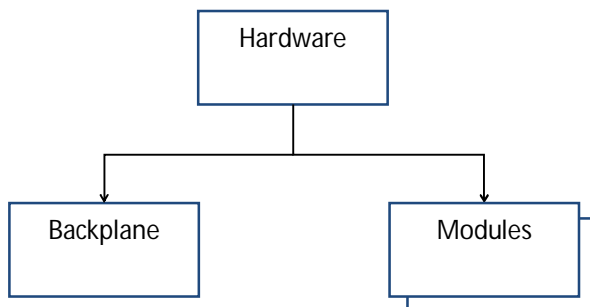
Overview

This document describes a modular backplane system designed for RC2014-Z80 systems.

In order to describe this system it is necessary to explain the context in which it is used.

An RC2014-Z80 computer system is a combination of hardware and software.

```
                    ┌──────────────┐
                    │   Computer   │
                    │   System     │
                    └──────┬───────┘
              ┌────────────┴────────────┐
              ▼                         ▼
        ┌──────────┐              ┌──────────┐
        │ Hardware │              │ Software │
        └──────────┘              └──────────┘
```

The hardware is divided into **modules** and a **backplane**. Peripheral hardware, such as disk drives, have not been included in this description.

```
                    ┌──────────────┐
                    │   Hardware   │
                    └──────┬───────┘
              ┌────────────┴────────────┐
              ▼                         ▼
        ┌───────────┐            ┌──────────┐
        │ Backplane │            │ Modules  │
        └───────────┘            └──────────┘
```

Modules are plugged into a backplane, which provides the required electrical connections between the modules.
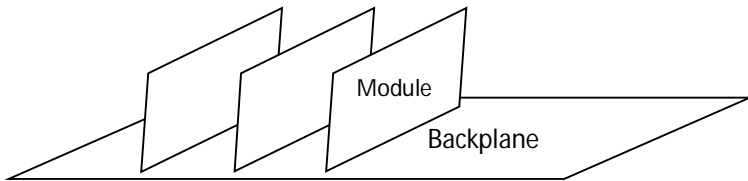
In the case of a modular backplane, the backplane can be formed from backplane **sections** joined together.
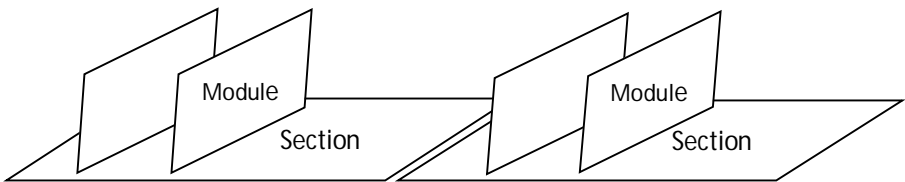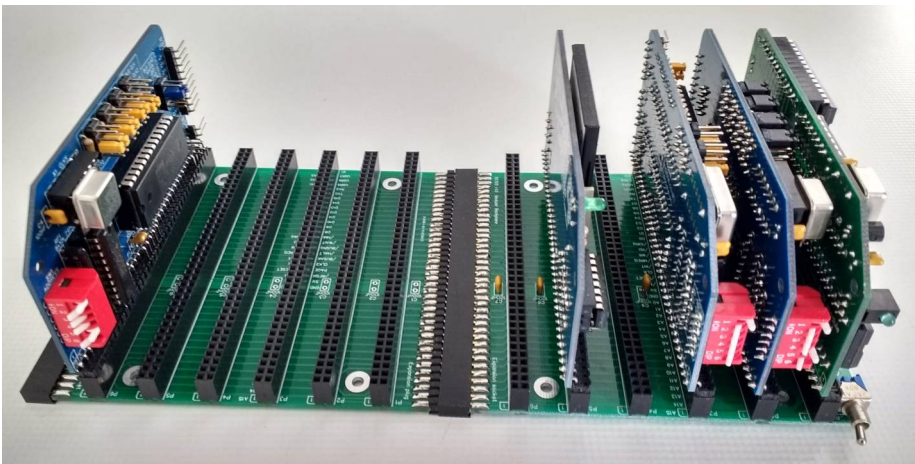

Making the backplane from sections allows flexibility in length and also enables a variety of section designs to be linked. Below are two linked sections.

Module

A typical module is illustrated below.
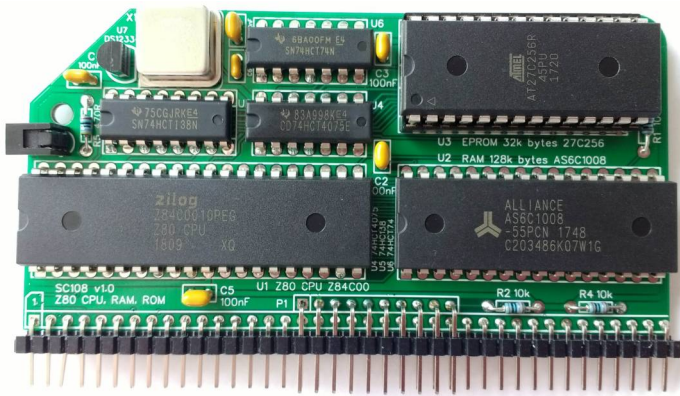
A module has a number of properties:
- Outline
- Bus

The **Outline** defines the size and shape of the circuit board, as illustrated below.

The **Bus** defines the physical connector, pin-out and the electrical characteristics of the signals.

Bus

A Bus defines the physical connector, the pin-out and the electrical characteristics of the signals.

There are two halves to a Bus; the male (plug) and the female (socket). The Module has the plug and the backplane has the mating socket. Similarly, backplane Sections usually have a male (plug) at the *input* end and a female (socket) at the *output* end.

The illustrations below show typical Bus connectors.

Male (plug)
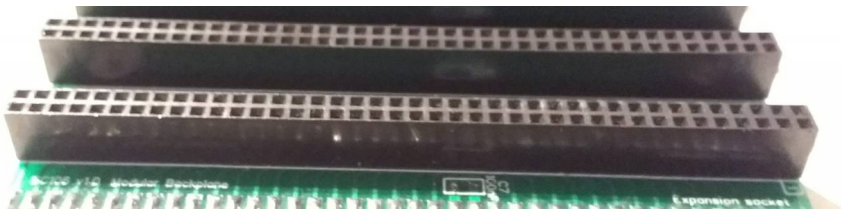
Female (socket)

USER pins

Any Bus pin labelled USER is free for any purpose. This is part of the existing RC2014-Z80 bus specification and is therefore included in the modular backplane specification.

Section

An example of a backplane section is shown below.
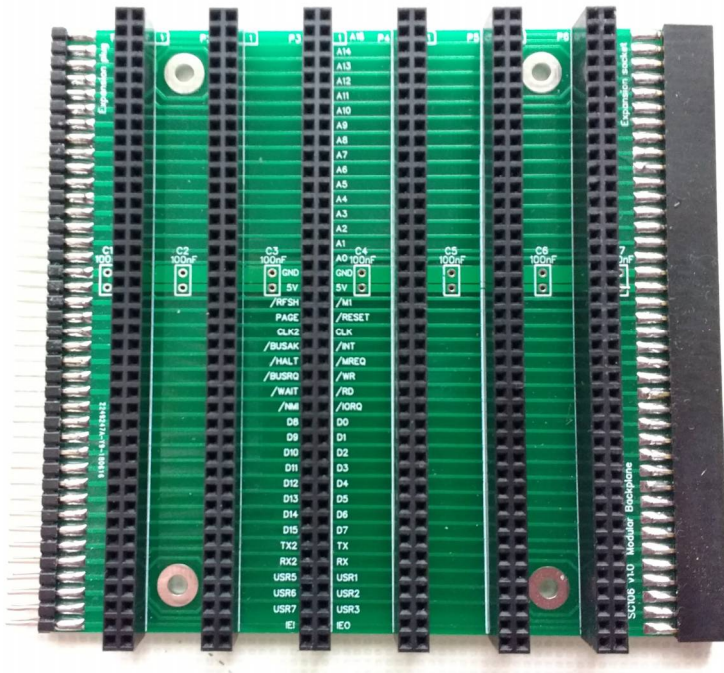
Sections can be joined together to form a larger backplane or to support special features.

A Section has the following properties:
- Outline
- Input bus
- Output bus
- Module bus
- Special features

The **Outline** defines the size, shape and fixing holes of the circuit board.

The **Input bus**, **Output bus** and **Module bus** define the connectors, pin-outs and electrical characteristics of the backplane section's *input* (shown on the left in the illustration above), *output* (right) and module slots.

The concept of *input* and *output* is perhaps a bit strange for a bus, but is used here to indicate the plug side (input) and socket side (output).

Not all sections require both input and output connectors. For example, the section shown below has a power supply at the input end, and can thus only be extended at the output end.
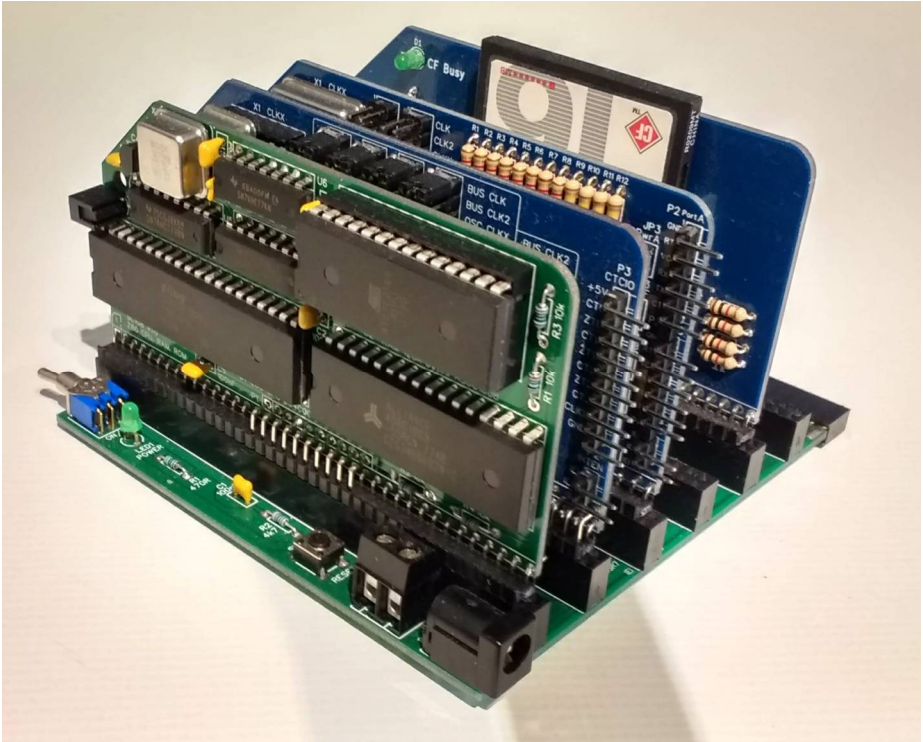
Backplane sections can have **Special features**. For example, the backplane shown above has a power supply. Others might have special bus signals, such as USER pins, connected for functions like the Z80 IEI/IEO daisy chain.

Sections

The following tables summarise the currently available Backplane Sections.

Section	Input bus	Module bus	Output bus	Feature
Stephen Cousins SC105	none	6 x RC2014/80	BP80 Edge mtg	Power input
Stephen Cousins SC106	BP80 Edge mtg	6 x RC2014/80	BP80 Edge mtg	None
Stephen Cousins SC107	BP80 Edge mtg	6 x RC2014/80	BP80 Edge mtg	IEI on pin 38 IEO on pin 39
Stephen Cousins SC112	none	6 x RC2014/80	BP80	Power input
Stephen Cousins SC113	BP80	6 x RC2014/80	BP80	None

The terms used in this table are described in detail in the following pages, but in summary they are as follows.

BP80   Backplane modules are joined with an 80-pin connector.
                The specification for this is called BP80.

Edge mtg   Indicates the connector is solder on the edge of the circuit board.
                The absence of the term "Edge mtg" means the connector uses through hole mounting.

IEI/IEO   These are the Z80 mode 2 interrupt daisy chain signals.

RC2014/80   This is an RC2014 bus using a full 80-pin connector.

All signals are connected straight through to each bus connector (wired in parallel) unless indicated in the table below.

Feature \ Section	SC105	SC106	SC107	SC112	SC113					
Detailed user guide available	•	•	•	•	•					
Edge mounted in/out bus connector(s)	•	•	•							
Through hole in/out bus connector(s)				•	•					
Power supply input instead of 'input' bus	•			•						
Interrupt daisy chain using pins 40 and 80	•	•	•	•	•					
Interrupt daisy chain using pins 38 and 39			•							
Linkable daisy chain using pins 38 and 39				•	•					
Signals linked to input bus connector via solder pads — USER1					•					
Signals linked to input bus connector via solder pads — USER2					•					
Signals linked to input bus connector via solder pads — USER3					•					
Signals linked to input bus connector via solder pads — TX2					•					
Signals linked to input bus connector via solder pads — RX2					•					
Signals linked between some or all module sockets via jumpers — USER1				•	•					
Signals linked between some or all module sockets via jumpers — USER2				•	•					
Signals linked between some or all module sockets via jumpers — USER3				•	•					
Signals linked between some or all module sockets via jumpers — TX2				•	•					
Signals linked between some or all module sockets via jumpers — RX2				•	•					
RC2018/80 module sockets	6	6	6	6	6					

A "linkable daisy chain" is one which can be created by fitting Dupont wires, or similar, between jumper pins. Alternatively, links can be soldered under the PCB for a tidier and more robust connection.

Section: Stephen C Cousins, SC105

| Section	Input bus	Module bus	Output bus	Feature
Stephen Cousins SC105	none	6 x RC2014/80	BP80 Edge mtg	Power input

This section, along with SC106 and SC107, use edge mounted 2 row by 40 pin header plugs and sockets, with 2.54mm pin spacing, for the input and output bus, as shown below.
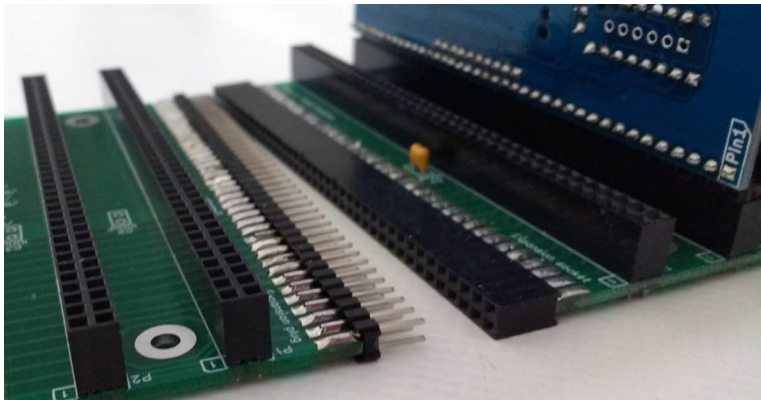
The input end has a simple power supply instead of an input connector.
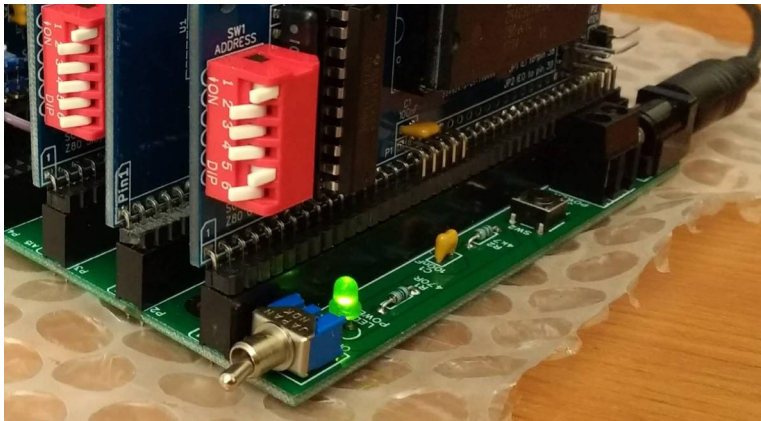
All signals run straight through, except pins 40 and 80 which are used for an interrupt daisy chain. These signals are labelled IEO and IEI.
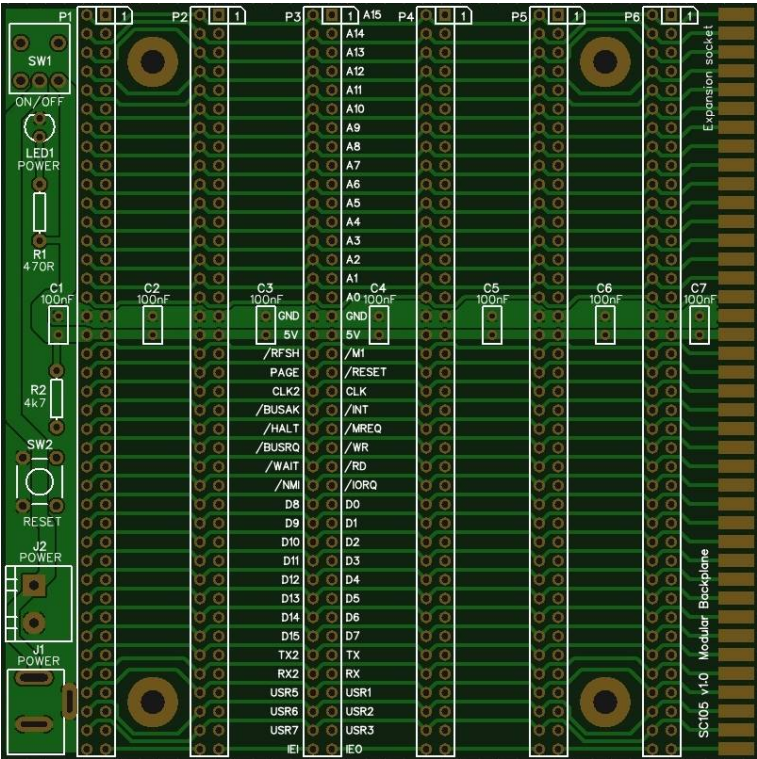
Power supply and reset circuit:
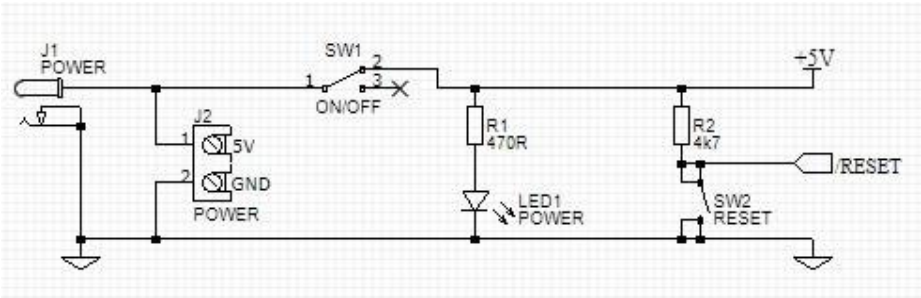
SC105 Layout

The section layout and dimensions are shown below.

There are four fixing holes, symmetrically placed.

There are six RC2014/80 module sockets, 0.6" apart, and centred on the circuit board.
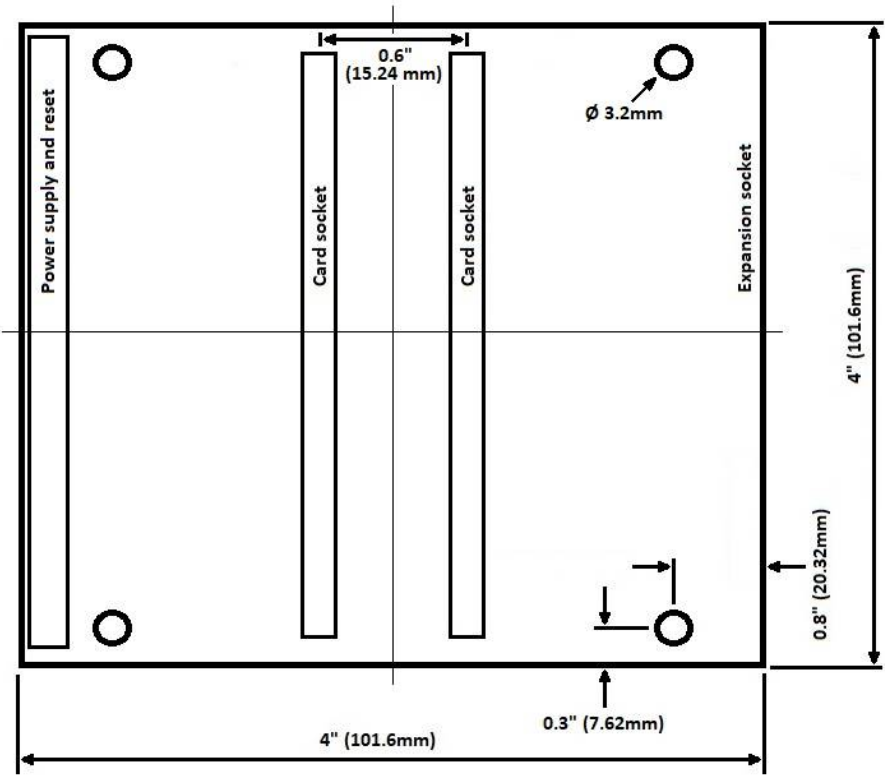
SC105 Schematic
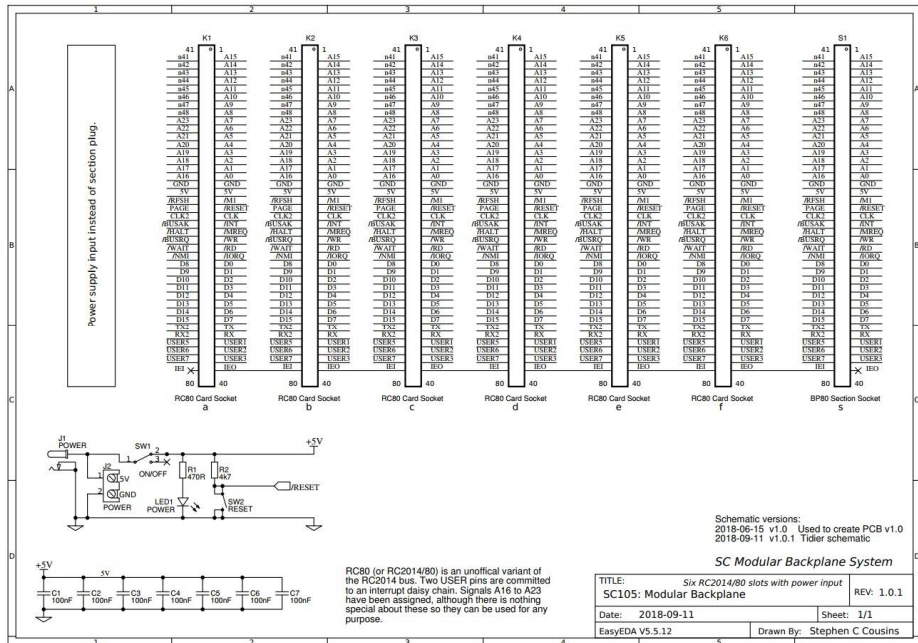
Additional information: www.scc.me.uk
Circuit board supplier: www.EasyEDA.com

Section: Stephen C Cousins, SC106

Section	Input bus	Module bus	Output bus	Feature
Stephen Cousins SC106	BP80 Edge mtg	6 x RC2014/80	BP80 Edge mtg	None

This section uses the same edge mounted 2 row by 40 pin header plugs and sockets as SC105 and SC107.

All signals run straight through, except pins 40 and 80 which are used for an interrupt daisy chain. These signals are labelled IEO and IEI.

SC106 Layout

The section layout and dimensions are shown below.

There are four fixing holes, symmetrically placed.

There are six RC2014/80 module sockets, 0.6" apart, and centred on the circuit board.
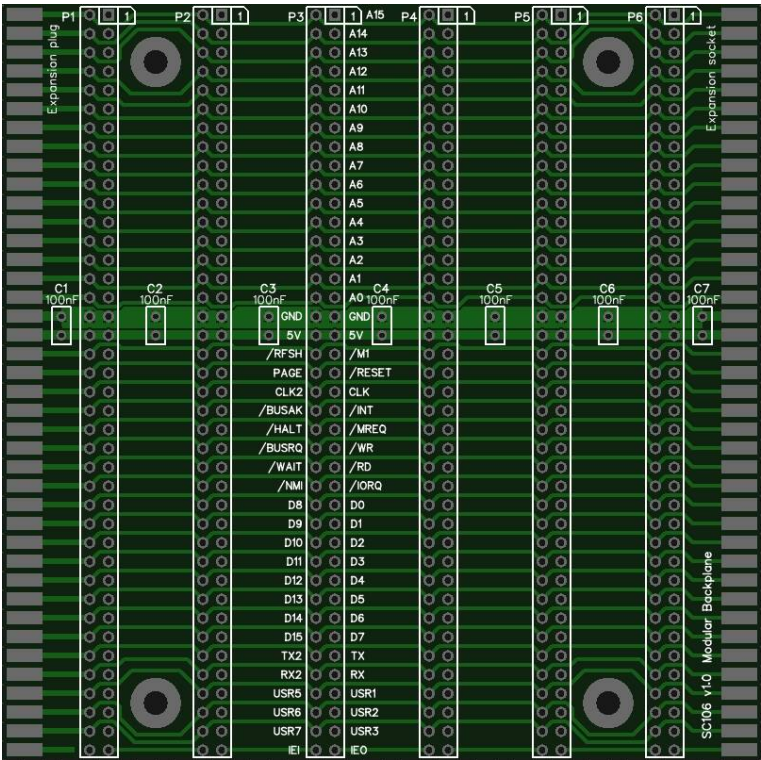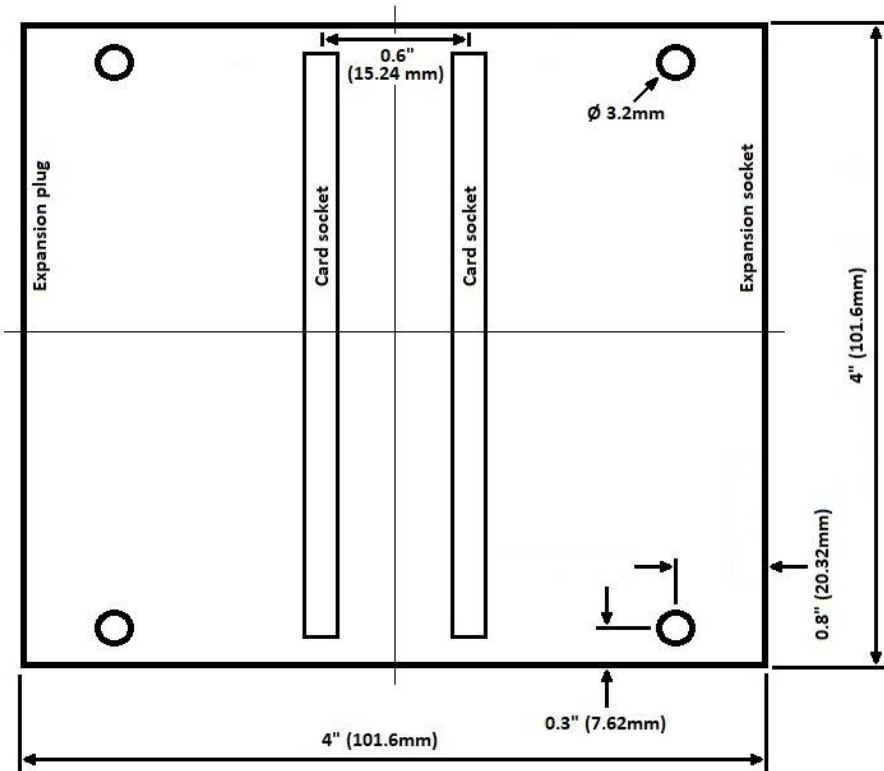
SC106 Schematic
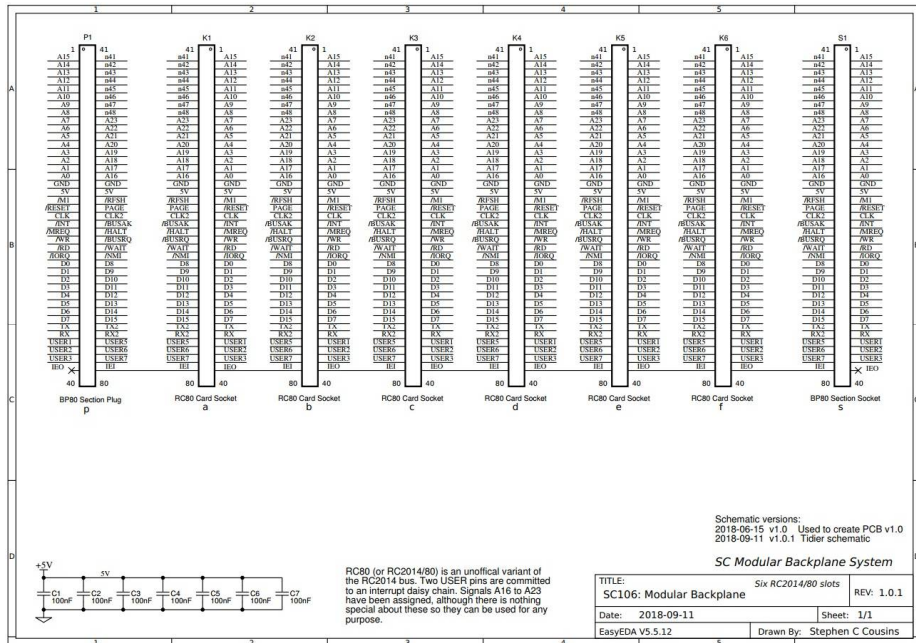
Additional information: www.scc.me.uk
Circuit board supplier: www.EasyEDA.com

Section: Stephen C Cousins, SC107

Section	Input bus	Module bus	Output bus	Feature
Stephen Cousins SC107	BP80 Edge mtg	6 x RC2014/80	BP80 Edge mtg	IEI on pin 38 IEO on pin 39

This section uses the same edge mounted 2 row by 40 pin header plugs and sockets as SC105 and SC106.

All signals run straight through, except pins 40 and 80, and also 38 and 39, which are all used for an interrupt daisy chain. The daisy chain signals are duplicated on pins 38 and 39 so they can be used by modules that are only 39 pins long. These signals are labelled IEO and IEI.

SC107 Layout

The section layout and dimensions are shown below.

There are four fixing holes, symmetrically placed.

There are six RC2014/80 module sockets, 0.6″ apart, and centred on the circuit board.
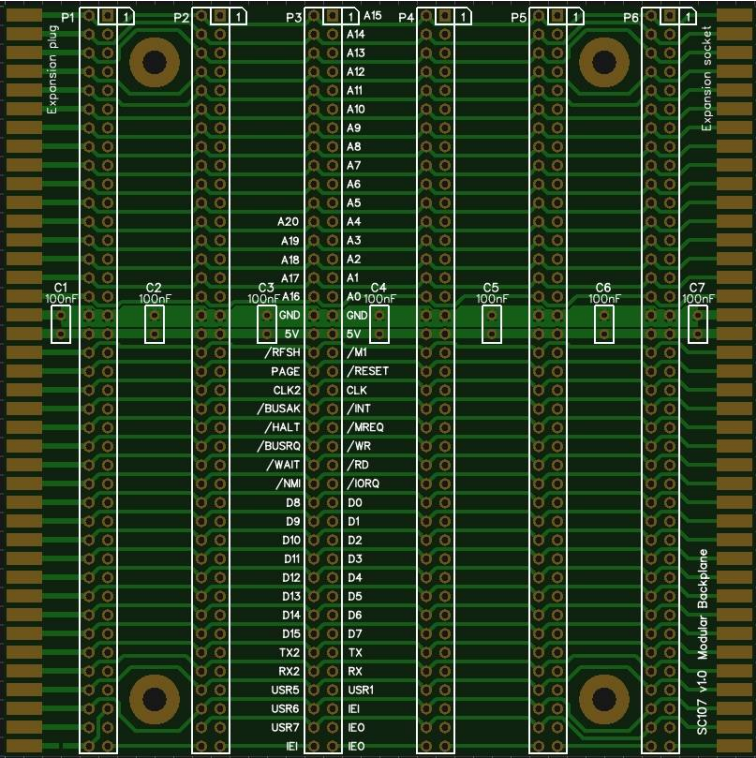
SC107 Schematic

SC Modular Backplane System

TITLE: Six RC2014/80 slots with IEI (38) & IEO (39)
SC107: Modular Backplane

REV: 1.0.1

Date: 2018-09-11

Sheet: 1/1

EasyEDA V5.5.12

Drawn By: Stephen C Cousins

Schematic versions:
2018-06-17 v1.0 Used to create PCB v1.0
2018-09-11 v1.0.1 Tidier schematic

RC80 (or RC2014/80) is an unofficial variant of the RC2014 bus. Four USER pins are committed to an interrupt daisy chain. Signals A16 to A23 have been assigned, although there is nothing special about these so they can be used for any purpose.

BP80 Section Plug — p
RC80 Card Socket — a
RC80 Card Socket — b
RC80 Card Socket — c
RC80 Card Socket — d
RC80 Card Socket — e
RC80 Card Socket — f
BP80 Section Socket — s

Additional information: www.scc.me.uk
Circuit board supplier: www.EasyEDA.com

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Section: Stephen C Cousins, SC112

Section	Input bus	Module bus	Output bus	Feature
Stephen Cousins SC112	none	6 x RC2014/80	BP80	Power input

This section, along with SC113, use through hole 2 row by 40 pin header plugs and sockets, with 2.54mm pin spacing, for the input and output bus, as shown below.

The input end has a simple power supply instead of an input connector.
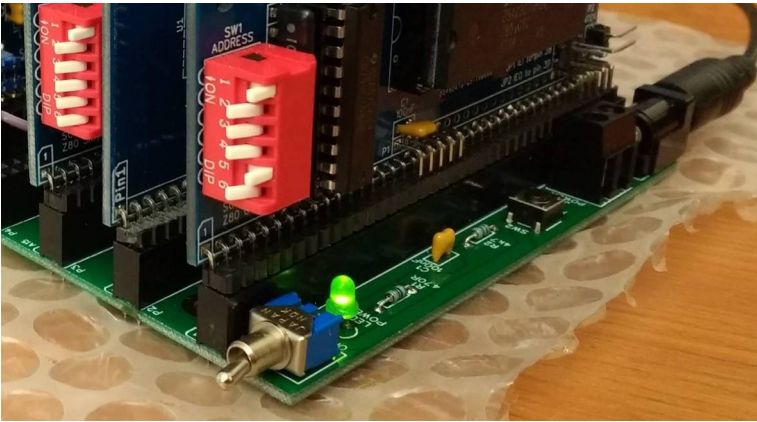
All signals run straight through, except pins 40 and 80 which are used for an interrupt daisy chain. These signals are labelled IEO and IEI.
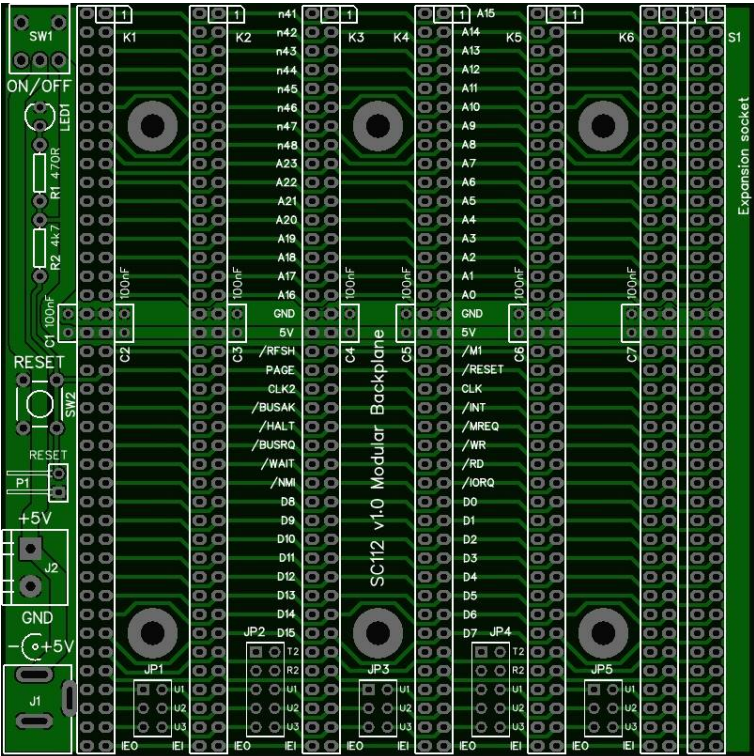
Power supply and reset circuit:

SC112 Layout

Jumpers are provided to enable some bus signals to be isolated or connected to adjacent module sockets.
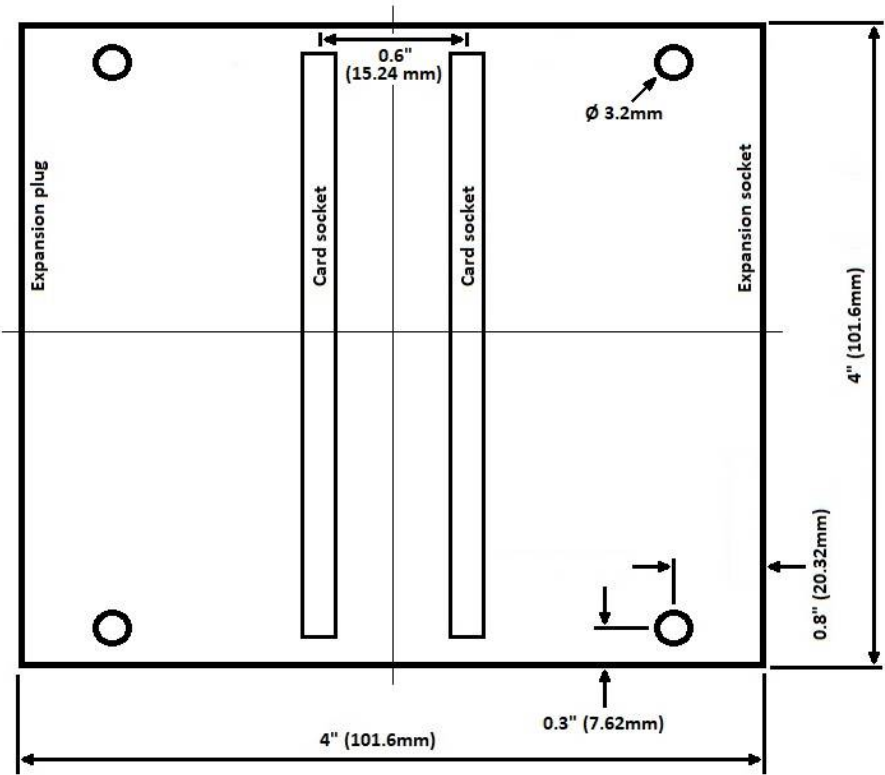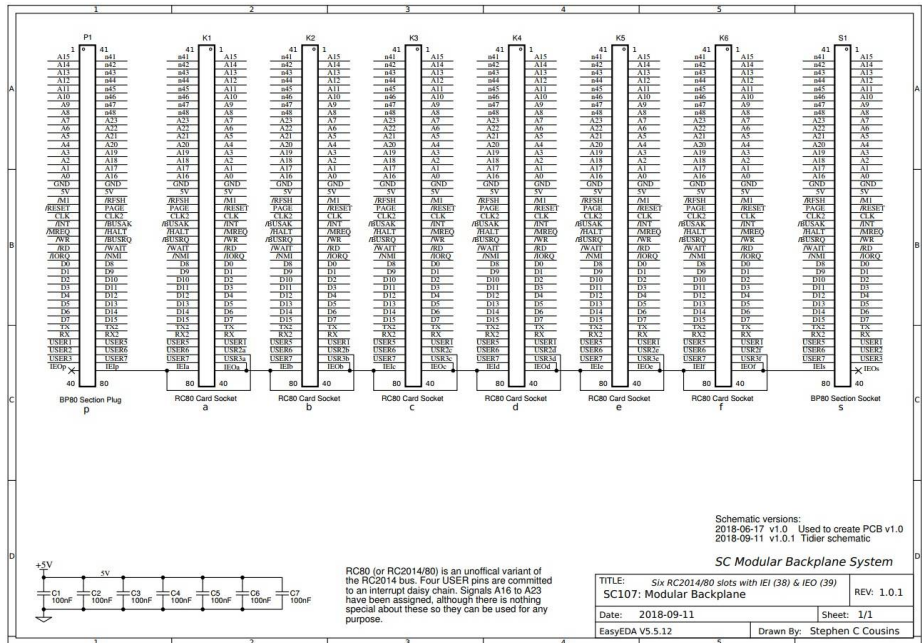
The section layout and dimensions are shown below.

There are six fixing holes, symmetrically placed.

There are six RC2014/80 module sockets, 0.6" apart, and centred on the circuit board.

The spacing between two joined sections is shown below.

0.6" (15.24 mm)   **1.2"** (30.48 mm)   **0.6"** (15.24 mm)

Module socket   Module socket   Section plug   Section socket   Module socket   Module socket

1.8" (45.72 mm)
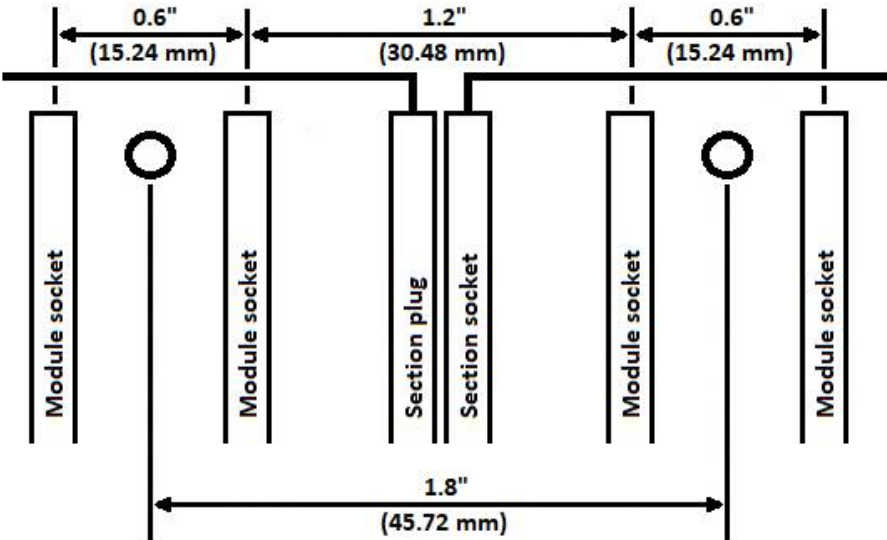
This spacing is for modular backplane sections that are connected with through hole connectors, such as SC113, not the alternative design using edge mounted connectors.

SC112 Schematic

Power supply input instead of section plug.

K1 K2 K3 K4 K5 K6 S1

RC80 Card Socket a RC80 Card Socket b RC80 Card Socket c RC80 Card Socket d RC80 Card Socket e RC80 Card Socket f BP80 Section Socket s

Jumpers allow some signals TX2, RX2, USER1, USER2 and USER 3 to be isolated from adjacent sockets. These signals are normally also isolated from adjacent backplane sections, but can be linked via solder pads.

RC80 (or RC2014/80) is an unofficial variant of the RC2014 bus. Two USER pins are committed to an interrupt daisy chain, while others can be optionally isolated. Signals A16 to A23 have been assigned, although there is nothing special about these so they can be used for any purpose.

+5V

C1 C2 C3 C4 C5 C6 C7
100nF 100nF 100nF 100nF 100nF 100nF 100nF

J1 POWER
SW1 ON/OFF
+5V
J2 5V
GND
POWER
LED1 POWER
R1 470R
R2 4k7
SW2 RESET
/RESET
P1 /RESET

SC Modular Backplane System

TITLE: SC112: Modular Backplane		REV: 1.0.1
Date: 2018-08-16		Sheet: 1/1
EasyEDA V5.5.12	Drawn By: Stephen C Cousins	

Six RC2014/80 slots with power input

Additional information: www.scc.me.uk
Circuit board supplier: www.EasyEDA.com

Section: Stephen C Cousins, SC113

Section	Input bus	Module bus	Output bus	Feature
Stephen Cousins SC113	BP80	6 x RC2014/80	BP80	none

This section uses through hole mounted 2 row by 40 pin header plugs and sockets as input and output connectors.

All signals run straight through, except pins 40 and 80, which are used for an interrupt daisy chain.
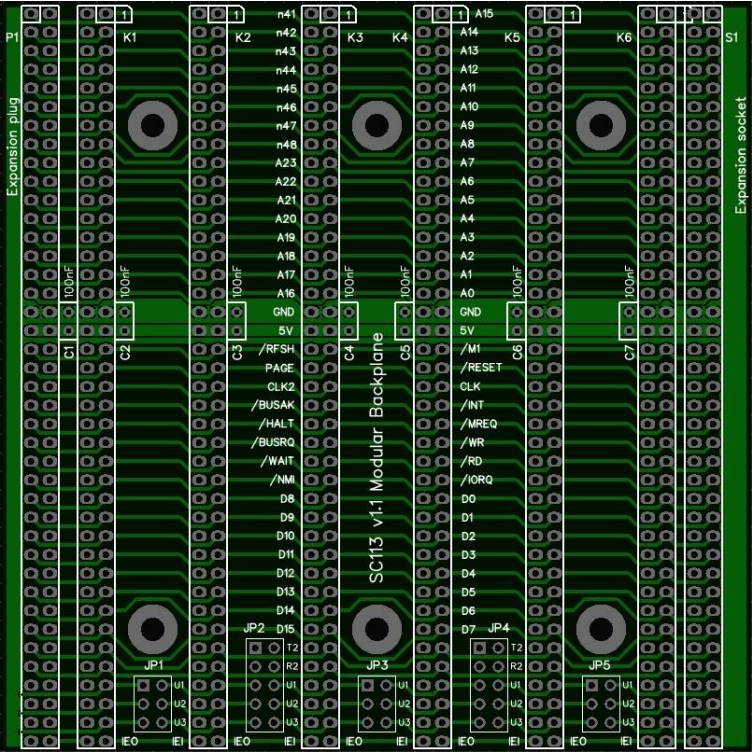
SC113 Layout

Jumpers are provided to enable some bus signals to be isolated or connected to adjacent module sockets.

The section layout and dimensions are shown below.

There are six fixing holes, symmetrically placed.

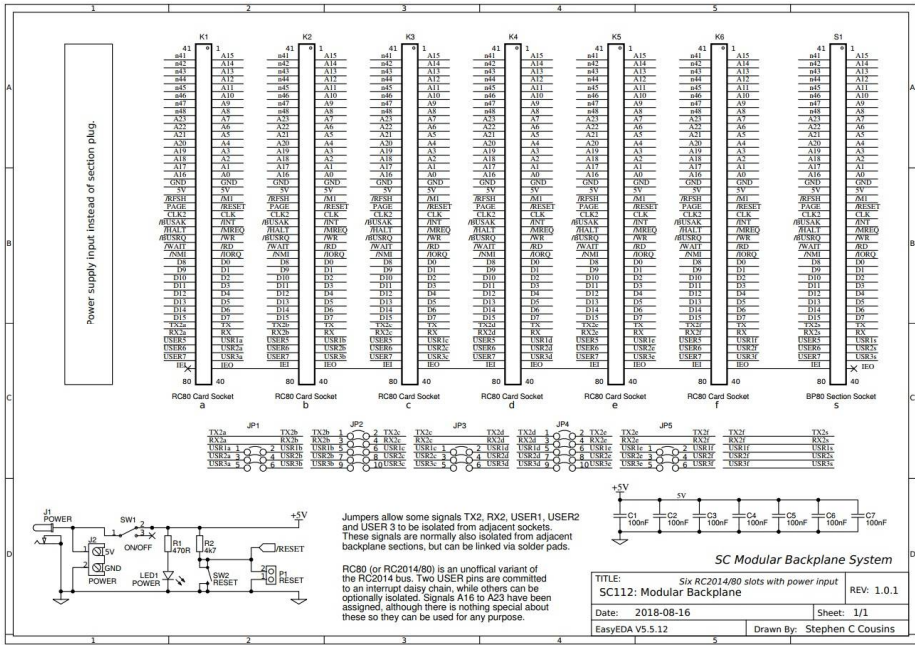There are six RC2014/80 module sockets, 0.6" apart, and centred on the circuit board.
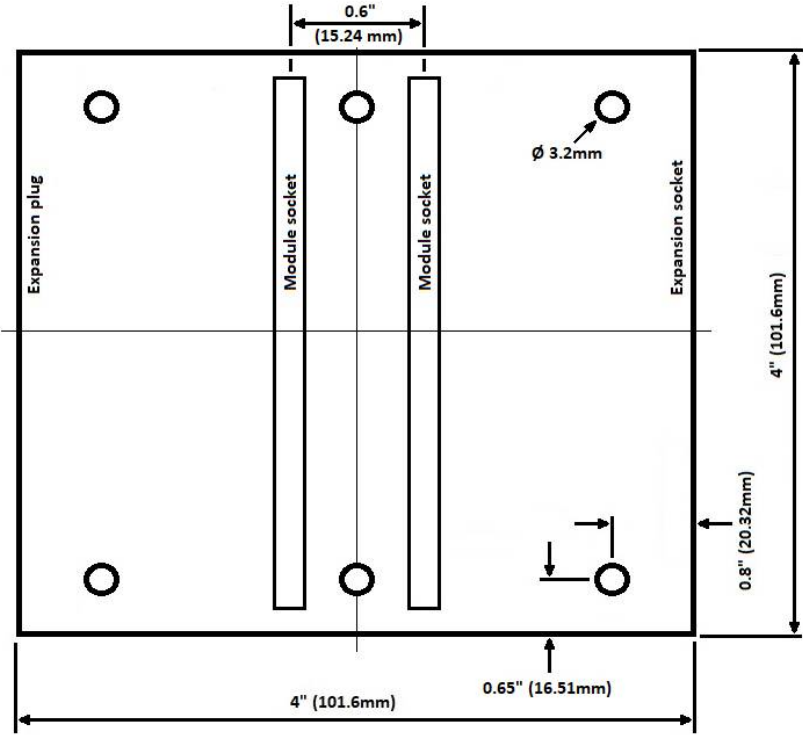
The spacing between two joined sections is shown below.
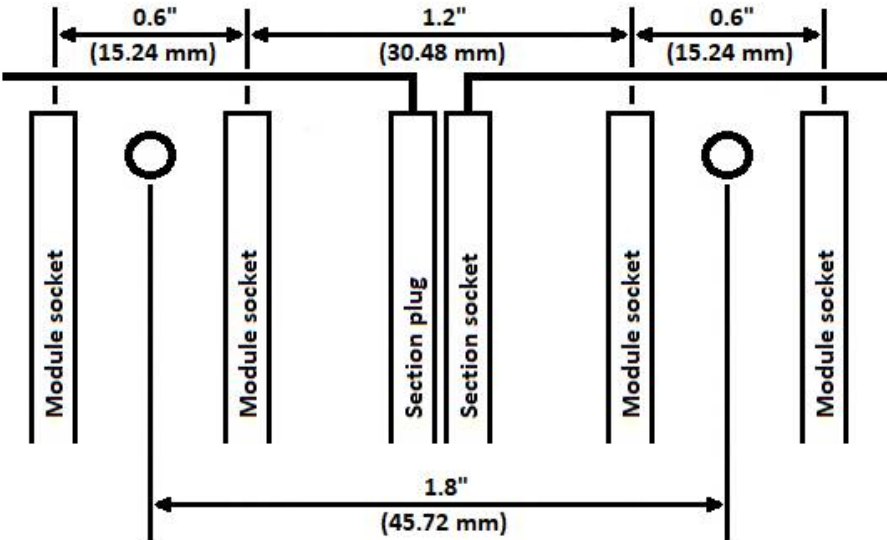
This spacing is for modular backplane sections that are connected with through hole connectors, such as SC112, not the alternative design using edge mounted connectors.

SC113 Schematic
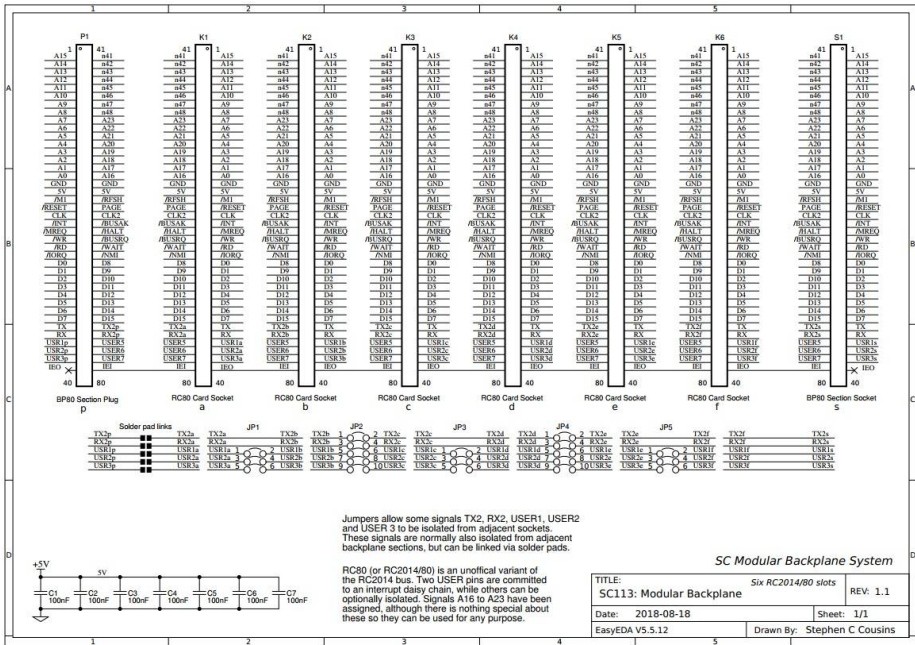
Additional information: www.scc.me.uk
Circuit board supplier: www.EasyEDA.com

Buses

A Bus defines the physical connector, the pin-out and the electrical characteristics of the signals.

The following pages detail all the bus systems used by the modular backplane system.

This specification relates to the RC2014 bus when used with Z80 family processors. Being a very simple bus, many of the bus signals are directly connected to the processor. The specification for most bus signals is therefore defined in the Z80 data sheets.

Other bus signals, specific to the RC2014 bus, are defined by the RC2014 specification. Details can be found at www.rc2014.co.uk

Bus: BP80

This bus uses a 2 row by 40 pin header and socket, with 2.54mm pin spacing, and is based on the RC2014 enhanced bus. It is used only for connecting together backplane Sections.

The pin out below is shown looking from above the socket (from the plug side, not the solder side)

Pin	Signal name		Pin
41	Not yet assigned	A15	1
42	Not yet assigned	A14	2
43	Not yet assigned	A13	3
44	Not yet assigned	A12	4
45	Not yet assigned	A11	5
46	Not yet assigned	A10	6
47	Not yet assigned	A9	7
48	Not yet assigned	A8	8
49	A23	A7	9
50	A22	A6	10
51	A21	A5	11
52	A20	A4	12
53	A19	A3	13
54	A18	A2	14
55	A17	A1	15
56	A16	A0	16
57	GND	GND	17
58	5V	5V	18
59	/RFSH	/M1	19
60	PAGE or /RESET2	/RESET	20
61	CLOCK2	CLOCK	21
62	/BUSACK	/INT	22
63	/HALT	/MREQ	23
64	/BUSRQ	/WR	24
65	/WAIT	/RD	25
66	/NMI	/IORQ	26
67	D8	D0	27
68	D9	D1	28
69	D10	D2	29
70	D11	D3	30
71	D12	D4	31

72	D13	D5	32
73	D14	D6	33
74	D15	D7	34
75	TX2	TX	35
76	RX2	RX	36
77	USER5	USER1	37
78	USER6	USER2	38
79	USER7	USER3	39
80	USER8 (IEI)	USER4 (IEO)	40

All signals conform to the RC2014 bus specification unless otherwise stated.

Backplane sections supporting the Z80 interrupt daisy chain should input and output the IEI and IEO signals on USER8 and USER4 respectively. These signals are defined in the Z80 data sheet. The input (IEI) has a pull up resistor on the module using it. Signals A16 to A23 are additional address lines.

The position of through hole style input (plug) and output (socket) connectors, relative to the edge of the section boards, is shown below.
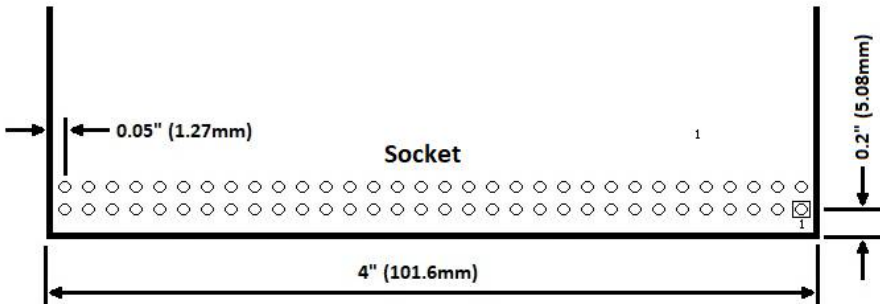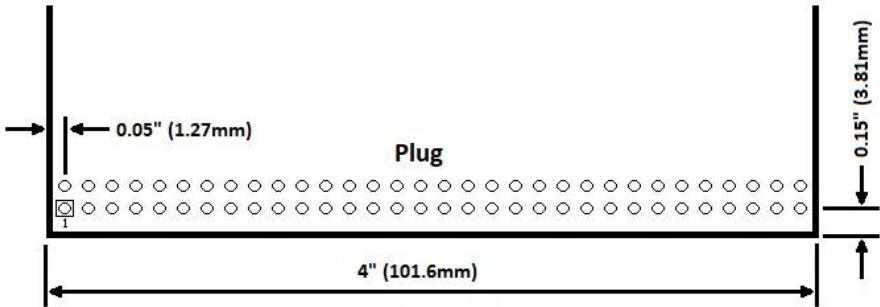
The position of the input and output connectors is set such that the spacing between module sockets on joined sections remains consistent across joins, as illustrated below.
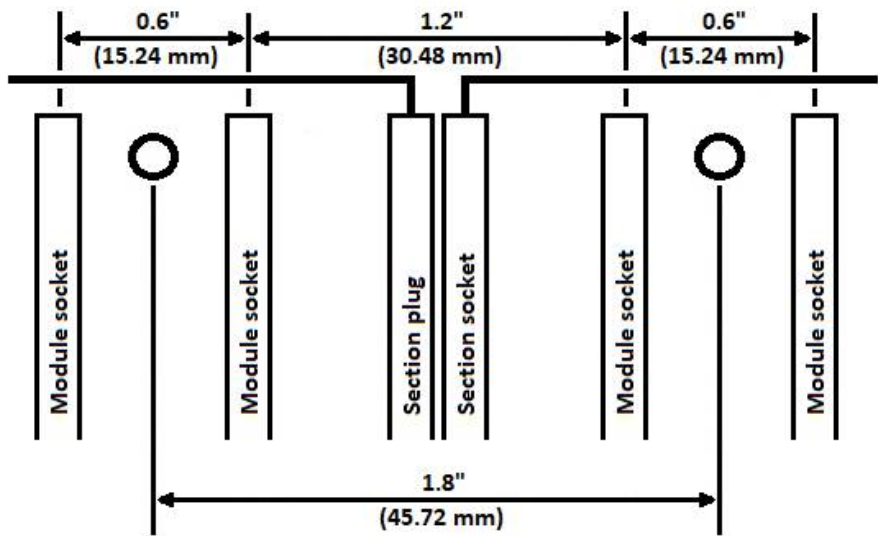
The illustration below shows the pin numbering of the BP80 connector:
- Socket - seen from the plug side (not the solder side), and
- Plug - seen from the solder side
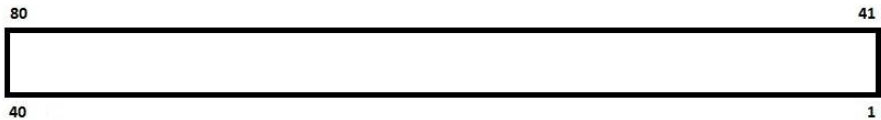
This bus can also be implemented using edge mounted connectors. This variant is called BP80 Edge mtg.

Bus: RC2014/standard

This is the original RC2014 bus. It uses a 1 row by 40 pin header and socket. In some cases pin 40 is not present, such as when the conventional module outline is used which is too short for all 40 pins.

The pin out below is shown looking from above the socket (from the plug side, not the solder side)

		Signal name	Pin
		A15	1
		A14	2
		A13	3
		A12	4
		A11	5
		A10	6
		A9	7
		A8	8
		A7	9
		A6	10
		A5	11
		A4	12
		A3	13
		A2	14
		A1	15
		A0	16
		GND	17
		5V	18
		/M1	19
		/RESET	20
		CLOCK	21
		/INT	22
		/MREQ	23
		/WR	24
		/RD	25
		/IORQ	26
		D0	27
		D1	28
		D2	29
		D3	30
		D4	31

		D5	32
		D6	33
		D7	34
		TX	35
		RX	36
		USER1	37
		USER2	38
		USER3	39
		USER4	40

Additional information: www.rc2014.co.uk

Bus: RC2014/enhanced

The original RC2014 bus connector is only a single row, while the enhanced bus, introduced for the Pro backplane, adds a partial second row. It uses a 2 row by 40 pin header and socket, but with some positions not present. Those labelled below as "Not used" do not have holes or tracks on the Pro backplane. In some cases pins 40 and 80 are not present, such as when the conventional module outline is used which is too short for all 40 or 80 pins. In most cases enhanced bus modules do not have pins in many of the enhanced bus positions.

The pin out below is shown looking from above the socket (from the plug side, not the solder side)

Pin	Signal name		Pin
41	Not used	A15	1
42	Not used	A14	2
43	Not used	A13	3
44	Not used	A12	4
45	Not used	A11	5
46	Not used	A10	6
47	Not used	A9	7
48	Not used	A8	8
49	Not used	A7	9
50	Not used	A6	10
51	Not used	A5	11
52	Not used	A4	12
53	Not used	A3	13
54	Not used	A2	14
55	Not used	A1	15
56	Not used	A0	16
57	GND	GND	17
58	5V	5V	18
59	/RFSH	/M1	19
60	PAGE or /RESET2	/RESET	20
61	CLOCK2	CLOCK	21
62	/BUSACK	/INT	22
63	/HALT	/MREQ	23
64	/BUSRQ	/WR	24
65	/WAIT	/RD	25
66	/NMI	/IORQ	26
67	D8	D0	27

68	D9	D1	28
69	D10	D2	29
70	D11	D3	30
71	D12	D4	31
72	D13	D5	32
73	D14	D6	33
74	D15	D7	34
75	TX2	TX	35
76	RX2	RX	36
77	USER5	USER1	37
78	USER6	USER2	38
79	USER7	USER3	39
80	USER8	USER4	40

Additional information: www.rc2014.co.uk

Bus: RC2014/80

This is an unofficial extension of the RC2014 bus. It uses a 2 row by 40 pin header and socket. Backplanes have all 80 positions fitted, with 40 and 80 being used as an interrupt daisy chain. Modules are long enough for all 80 pins, but may have some pins missing in the second row.

The pin out below is shown looking from above the socket (from the plug side, not the solder side)

Pin	Signal name		Pin
41	Not assigned	A15	1
42	Not assigned	A14	2
43	Not assigned	A13	3
44	Not assigned	A12	4
45	Not assigned	A11	5
46	Not assigned	A10	6
47	Not assigned	A9	7
48	Not assigned	A8	8
49	A23	A7	9
50	A22	A6	10
51	A21	A5	11
52	A20	A4	12
53	A19	A3	13
54	A18	A2	14
55	A17	A1	15
56	A16	A0	16
57	GND	GND	17
58	5V	5V	18
59	/RFSH	/M1	19
60	PAGE or /RESET2	/RESET	20
61	CLOCK2	CLOCK	21
62	/BUSACK	/INT	22
63	/HALT	/MREQ	23
64	/BUSRQ	/WR	24
65	/WAIT	/RD	25
66	/NMI	/IORQ	26
67	D8	D0	27
68	D9	D1	28
69	D10	D2	29
70	D11	D3	30

71	D12	D4	31
72	D13	D5	32
73	D14	D6	33
74	D16	D7	34
75	TX2	TX	35
76	RX2	RX	36
77	USER5	USER1	37
78	USER6	USER2	38
79	USER7	USER3	39
80	IEI	IEO	40

All signals conform to the RC2014 bus specification unless otherwise stated.

Signals IEI and IEO form an interrupt daisy chain. These signals are defined in the Z80 data sheet. The input (IEI) has a pull up resistor on the module using it. Signals A16 to A23 are additional address lines.

Additional information: www.scc.me.co.uk

Modules

A Module is a circuit board which plugs in to a backplane.

The following pages describe the various Module designs supported by the modular backplane system.

Module: RC2014/Standard

These modules are designed for the RC2014 standard bus and thus use a single row bus connector.

In the early days of the RC2014 bus, module sizes were not standardised. More recently however, the module outline is nearly always that illustrated below and documented here: http://rc2014.co.uk/1377/module-template/

Modules designed for the RC2014 standard bus do not have to conform to the recommended outline shown here.
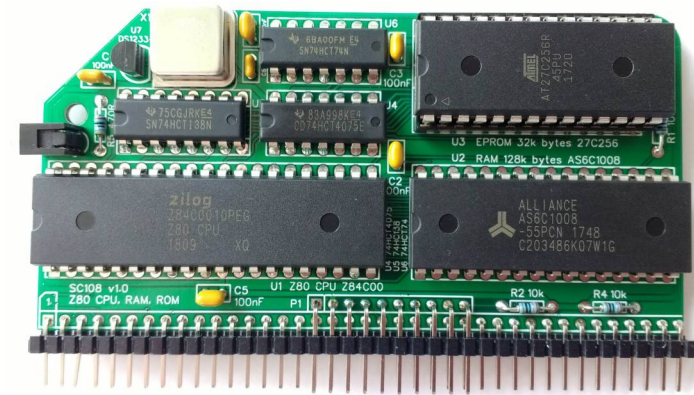
Modules built for the RC2014 standard bus also work with RC2014 enhanced bus backplanes, such as the Backplane Pro, and the unofficial RC2014/80 bus.

Module: RC2014/Enhanced

These modules are designed to take advantage of the RC2014 enhanced bus and thus use at least some of the second row of pins in the enhanced bus specification.

The module outline is nearly always that illustrated below and documented here: http://rc2014.co.uk/1377/module-template/

Modules designed for the RC2014 enhanced bus do not have to conform to the recommended outline shown here.
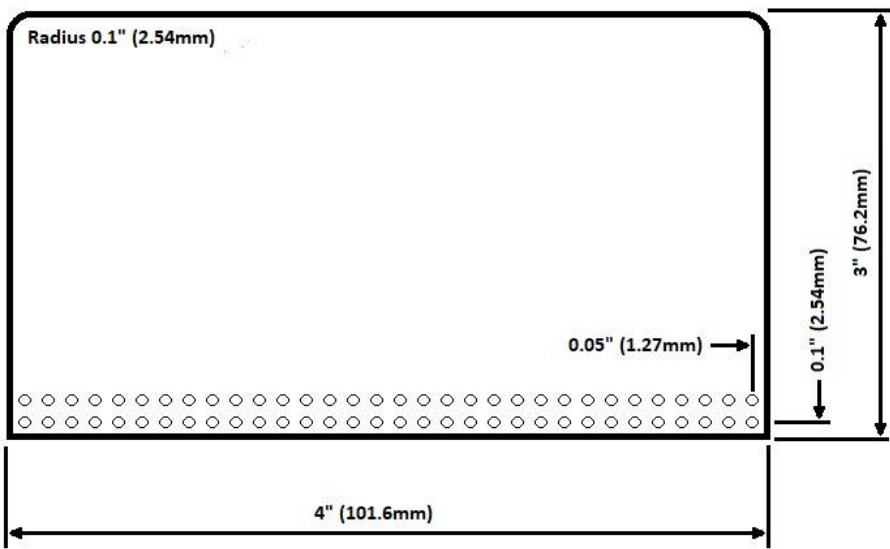
Modules built for the RC2014 enhanced bus may also work with RC2014 standard bus backplanes, such as the Backplane 5. However, when connected to an RC2014 standard backplane some of the module's features may not be available.

Module: RC2014/80

These modules are designed for the RC2014/80 bus (which is not an official RC2014 variant).

The main distinguishing feature of these modules is that they are large enough to fit a full 40 or 80 pin header. Pin 40 and 80 are used for an interrupt daisy chain.

The suggested outline for these modules is illustrated below.

Radius 0.1" (2.54mm)

0.05" (1.27mm)

0.1" (2.54mm)

3" (76.2mm)

4" (101.6mm)

Modules designed for the RC2014/80 bus do not have to conform to the recommended outline shown here.

Modules built for the RC2014/80 bus may also work with RC2014 standard or enhanced bus backplanes. However, when connected to these backplanes some of the module's features may not be available.

History

2018-07-21	v0.0	Began first draft
2018-07-29	v0.1	Shared only with Tom Szolyga
2018-08-22	v0.2	Shared on the RC2014 google group for discussion
2018-09-09	v0.3	Modified to take into account feedback from group
		The document is now more focused on RC2014-Z80
2018-09-19	v0.4	Added schematics and other minor changes

Contact Information

If you wish to contact me regarding this document, or the hardware and software it relates to, use the contact page at www.scc.me.uk

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RC2014 information

Information about the RC2014 system can be found at www.rc2014.co.uk

RC2014 support

Issues related to the RC2014 can be posted on the google group "RC2014-Z80".

RC2014 supplies

Parts can be purchased through Tindie at www.tindie.com (search "RC2014")

Official RC2014 parts are at:
https://www.tindie.com/stores/Semachthemonkey/

More information and updates

Visit www.scc.me.uk for additional information and updates to this document.

Credits

The design of my first modular backplanes (SC105, SC106 and SC107) was inspired by Jon Langseth's Z50Bus 5 slot backplane, which is available to extend the LiNC80 SBC1. Thanks Jon.

The design of the second generation modular backplanes (SC112 and SC113) is the result of improvements made from the earlier designs. In addition the earlier backplanes have provided feedback from other RC2014 users. So thanks to those who have provided valuable feedback and comments.

A further influence has been Tom Szolyga. I've recently been discussing many aspects of retro computers with Tom and we have been actively working towards some common designs, including modular backplanes. The second generation designs (SC112 and SC113) are the first products to benefit from these discussions. Thanks Tom.