Breakout Module For RC2014

User Guide

For module: SC115 version 1.0

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Edition 1.0.1

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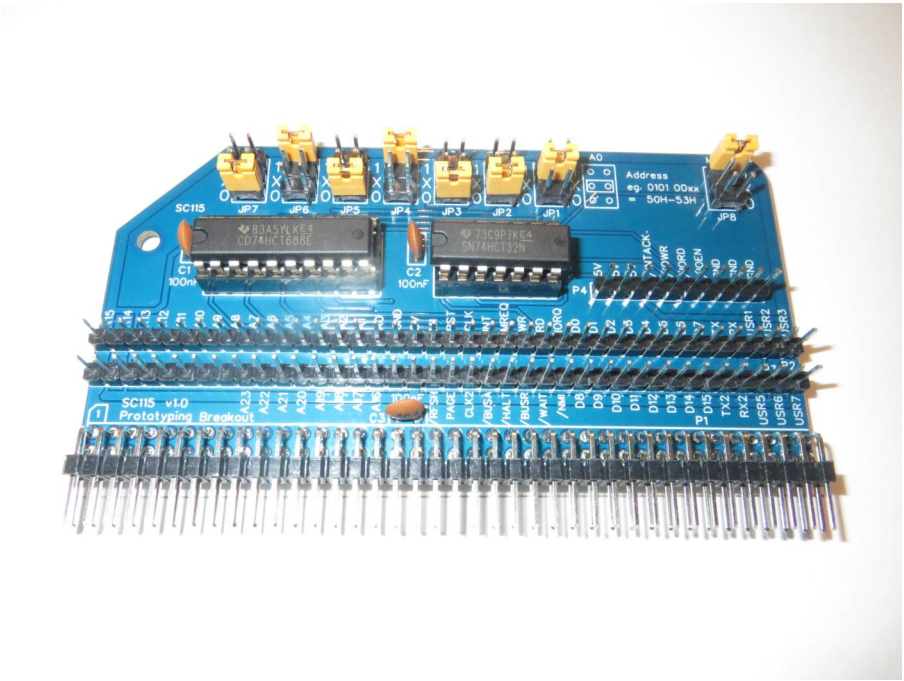
Overview

This prototyping module is designed to breakout signals to a solderless breadboard. All bus signals and some useful address decoding signals are available on header pins to be connected to a breadboard with Dupont, or similar, cables.

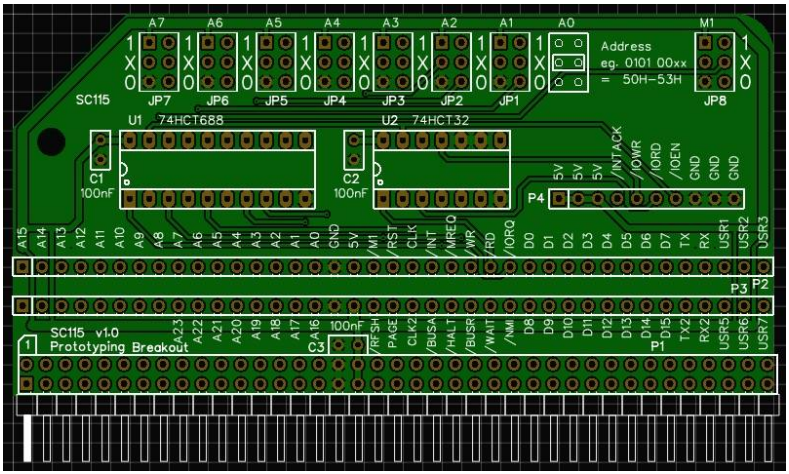


The module includes address decoding adequate for most I/O devices, thus saving the need to build a decoding circuit for every prototype. Address decoding is very flexible, allowing a configurable start address and a configurable range size.

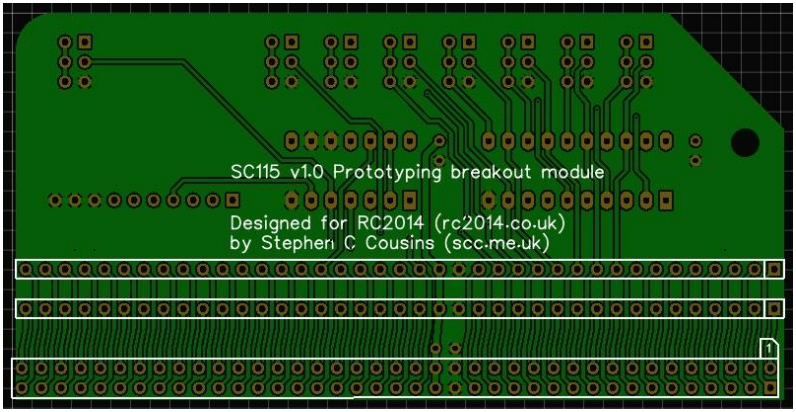
Printed Circuit Board

The printed circuit board is a standard footprint RC2014 board.

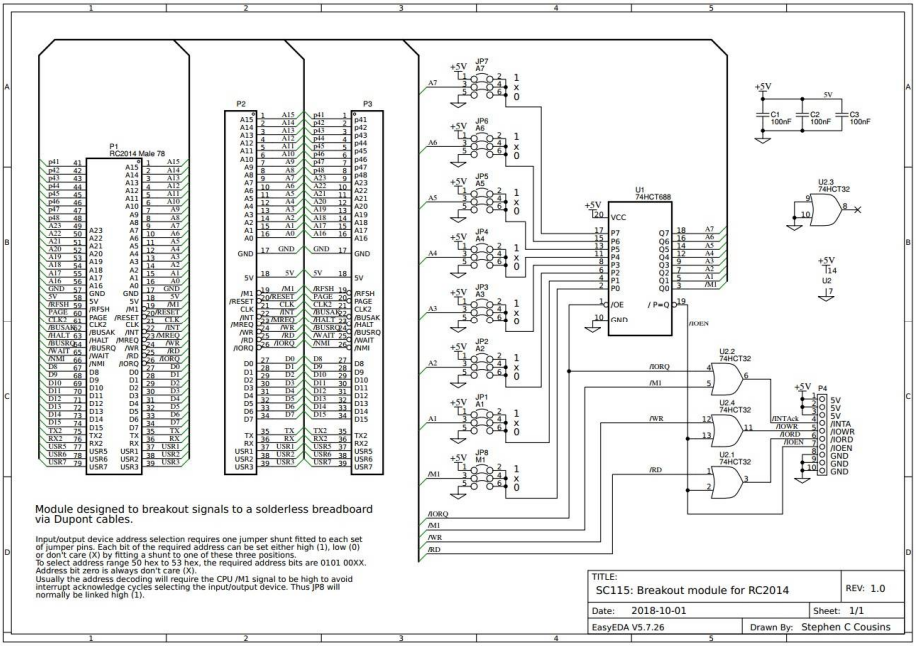
Printed circuit board, top/component side:



Printed circuit board, bottom/solder side:



Schematic



Errata

None yet.

What You Need

The following components are required to assemble the module with its full functionality and jumper options. Header pins JP1 to JP8, and P1 to P4 may need to be cut from longer strips.

Image	Qty	Reference	Description
	1	PCB	Printed circuit board SC115 Breakout
	3	C1, 2, 3	Capacitor 100nF, ceramic, lead spacing = 2.54mm
	8	JP1 to JP8	Pin header, male, 2 rows x 3 pins, straight
	8	JP1 - JP8	Jumper shunt for pin spacing = 2.54mm
	1	P1	Pin header, male, 2 rows x 39 pins, angled (2nd row optional)
	2	P2, 3	Pin header, male, 1 row x 39 pins, straight
	1	P4	Pin header, male, 1 row x 10 pins, straight
	1	U1	74HCT688, 8-bit identity comparator, PDIP 20
	1	U1 socket	20 pin PDIP IC socket 0.3" wide
	1	U2	74HCT32, quad 2-input OR gate
	1	U2 socket	14 pin PDIP IC socket 0.3" wide

Also required to assemble the module from the above components:

- Long nose pliers
- Side cutters
- Soldering iron
- Solder
- PCB cleaning materials

Components: What They Do & Where To Get Them

Each component is described below. I have listed multiple sources for most components, but have not actually tried all of them, so best treat the specified part numbers as guidance only. Where eBay is listed as a supplier, the part is likely to be cheaper there than the other sources, sometimes considerably cheaper. Further savings are usually possible by ordering parts direct from countries like China.

PCB

Image	Qty	Reference	Description
	1	PCB	Printed circuit board SC115 Breakout
		Supplier	Part number
		EasyEDA	Search EasyEDA.com for RC2014 Breakout
		Tindie	Search Tindie for SC115 or RC2014 Breakout

The PCB is currently only available to be ordered from Tindie or from EasyEDA.com, although you can download the Gerber and send it to your preferred manufacturer.

C1, 2, 3

Image	Qty	Reference	Description
	3	C1, 2, 3	Capacitor 100nF, ceramic, lead spacing = 2.54mm
		Supplier	Part number
		Farnell	1100533
		Mouser	75-1C10Z5U104M050R
		RS	699-5027

These capacitors provide power supply decoupling (or bypass). The fast switching in digital circuits creates spikes on the power supply lines which are suppressed with decoupling capacitors placed at key points on the circuit board.

JP1 to JP8

Image	Qty	Reference	Description
	8	JP1 to JP8	Pin header, male, 2 rows x 3 pins, straight
		Supplier	Part number
		eBay	200906546562 (2x40 pin to be cut to length)
		Farnell	2356151 (2x40 pin to be cut to length)
		Mouser	710-61308021121 (2x40 pin to be cut to length)
		RS	155-721 (2x40 pin to be cut to length)

This set of jumpers allows the I/O port address range to be configured.

Address decoding is achieved my matching the I/O address on the address bus to the address set with these jumpers. One jumper also allows the bus /M1 signal state to be selected.

Each jumper has three positions. These are high (1), low (0) or don't care (X). The "don't care" position means either high or low is considered to be a match. Using "don't care" for one or more signals allows a range of addresses to be considered a match.

Only address signals A1 to A7 are compared. A0 is considered to always be a match, thus the smallest selectable range is 2 addresses. The 8th jumper is used to select the required state of the /M1 signal.

JP1 to JP8 shunts

Image	Qty	Reference	Description
	8	JP1 to JP8	Jumper shunt for pin spacing = 2.54mm
		Supplier	Part number
		eBay	201261690156
		Farnell	2396303
		Mouser	649-68786-102LF
		RS	674-2397

These shunts (small sockets) connect the required pins on JP1 to JP8.

P1

Image	Qty	Reference	Description
	1	P1	Pin header, male, angled, 2-row x 39-pin, 2 row (1 row optional)
		Supplier	Part number
		eBay	200906546562 (2x40 pin to be cut to length)
		Farnell	2032912 (2x40 pin to be cut to length)
		Mouser	571-9-103795-0 (2x40 pin to be cut to length)
		RS	155-743 (2x40 pin to be cut to length)

This connector mates with the RC2014 bus backplane. You can fit a single or a double row header, but the full functionality of this module requires the all 78-pins.

P2, 3

Image	Qty	Reference	Description
	2	P2, 3	Pin header, male, 1 row x 39 pins, straight
		Supplier	Part number
		eBay	200906546562 (1x40 pin to be cut to length)
		Farnell	2356175 (1x40 pin to be cut to length)
		Mouser	855-M20-9774046 (1x40 pin to be cut to length)
		RS	156-049 (1x40 pin to be cut to length)

These two connectors provide access to all 78 bus signals. Dupont cables can be used to connect these to a solderless breadboard.

Alternatively, sockets can be fitted instead of the male header pins indicated.

P4

Image	Qty	Reference	Description
	1	P4	Pin header, male, 1 row x 10 pins, straight
		Supplier	Part number
		eBay	200906546562 (1x40 pin to be cut to length)
		Farnell	2356175 (1x40 pin to be cut to length)
		Mouser	855-M20-9774046 (1x40 pin to be cut to length)
		RS	156-049 (1x40 pin to be cut to length)

These connector provides access to chip select lines decoded by U1 and U2. The pin-outs are:

1. 5V Vcc (5 volts)
2. 5V Vcc (5 volts)
3. 5V Vcc (5 volts)
4. /INTACK Interrupt acknowledge (low if both IORQ and M1 are low)
5. /IOWR I/O device write (low if both IOEN and WR are low)
6. /IORD I/O device read (low if both IOEN and RD are low)
7. /IOEN I/O device enable (low if the current I/O address is a match)
8. GND Common ground (0 volts)
9. GND Common ground (0 volts)
10. GND Common ground (0 volts)

Dupont cables can be used to connect these to a solderless breadboard. The provided signals allow most I/O devices to be interfaced to the RC2014 bus without any further decoding.

Alternatively, a socket can be fitted instead of the male header pins indicated.

U1

Image	Qty	Reference	Description
	1	U1	74HCT688, 8-bit identity comparator, PDIP 20
		Supplier	Part number
		Farnell	2407104
		Mouser	595-CD74HCT688E
		RS	663-0650

This integrated circuit provides the address decoding, by comparing the current I/O address signals A1 to A7 and M1, from the CPU, with the states set with jumpers JP1 to JP8.

U1 socket

Image	Qty	Reference	Description
	1	U1 socket	20 pin PDIP IC socket 0.3"
		Supplier	Part number
		Farnell	4285608
		Mouser	571-1-2199298-6
		RS	674-2444

U2

Image	Qty	Reference	Description
	1	U2	74HCT32, quad 2-input OR gate
		Supplier	Part number
		Farnell	9591982
		Mouser	595-SN74HCT32N
		RS	333-4520

This integrated circuit further refines the decoded I/O address by providing separate /IOWR (I/O device write) and /IORD (I/O device read) signals, to complement /IOEN (I/O device enable). /IOWR and /IORD simplify interfacing of devices such as latches and buffers. It also provides /INTACK (interrupt acknowledge) when both IORQ and M1 are low.

U2 socket

Image	Qty	Reference	Description
	1	U2 socket	14 pin PDIP IC socket 0.3" wide
		Supplier	Part number
		Farnell	2445621
		Mouser	571-1-2199298-3
		RS	674-2438

Assembly Guide

This guide assumes you are familiar with assembling circuit boards, soldering and cleaning. If not, it is recommended you read some of the guides on the internet before continuing.

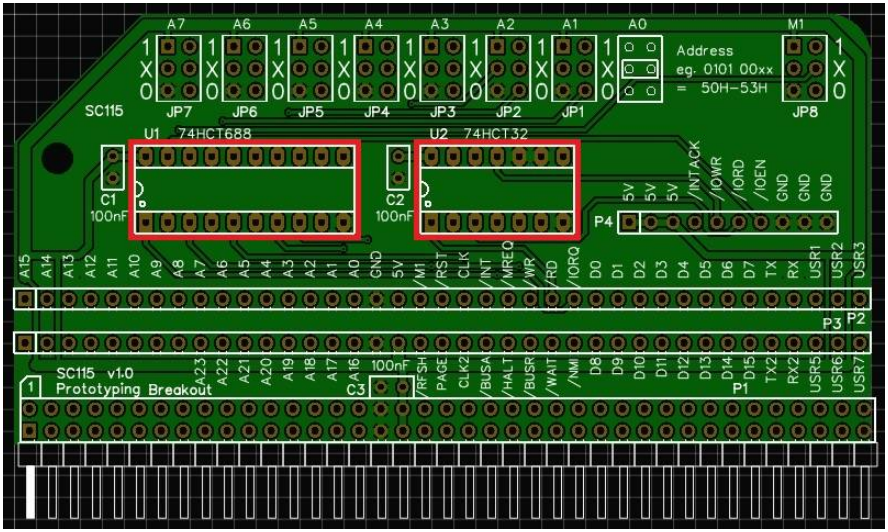
First check you have all the required components, as listed in the section "What You Need". Header pins JP1 to JP8, and P1 to P4 may need to be cut from longer strips.

Step 1

Fit and solder IC sockets for U1 and U2.

Be sure to fit them with the notch matching the legend on the circuit board, so you do not end up fitting the IC the wrong way round too.

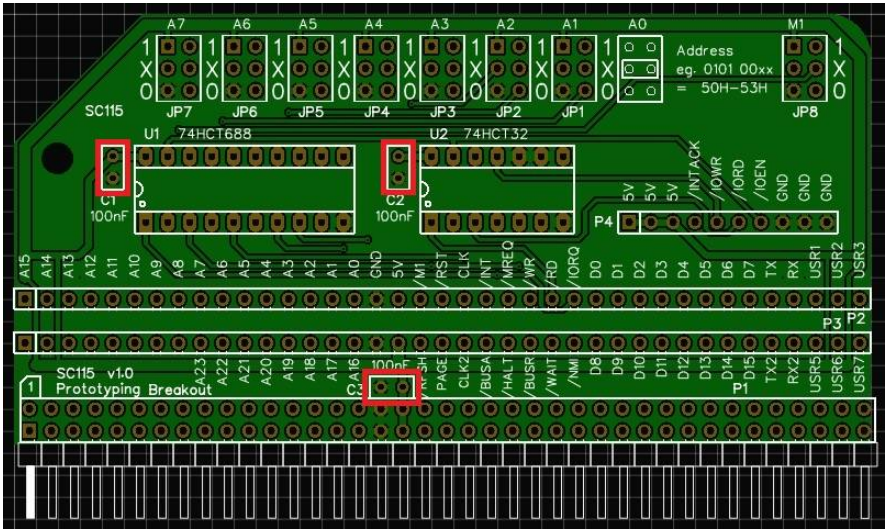
The sockets should be fitted in the positions shown below.



Step 2

Fit and solder capacitors C1, C2 and C3.

These can be fitted either way round, as they are not polarity dependent.

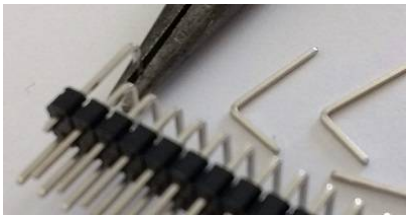


Step 3

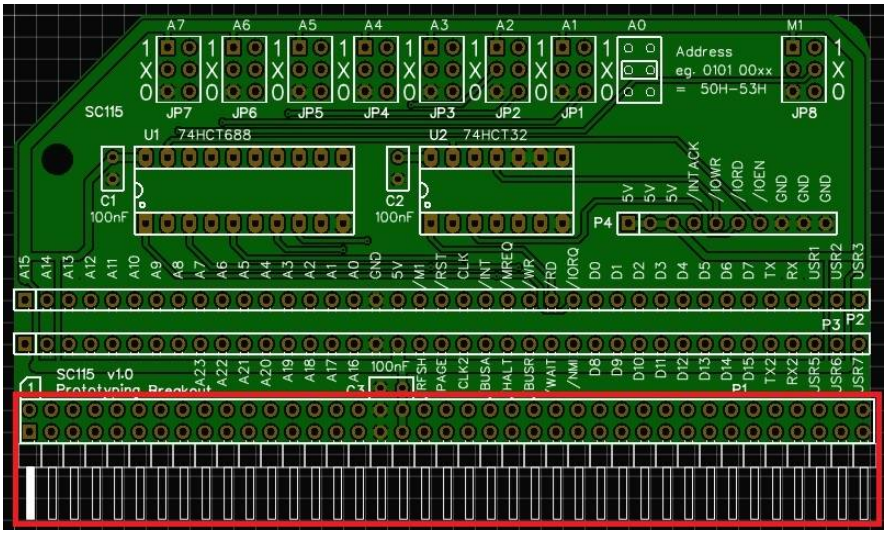
Fit and solder connector P1.

You can fit just a single row header as used by the RC2014 standard bus, but doing so means not all the features of this module can be used. It is best to fit a double row even if the module is initially only used with a standard bus backplane.

To prepare the header, it should first be cut to length (if starting with a strip more than 39 pins long) and then unwanted pins must be removed. If you want to make the board as easy to insert and remove as possible, you can remove any unwanted pins in the second row (the upper row in the illustration below).



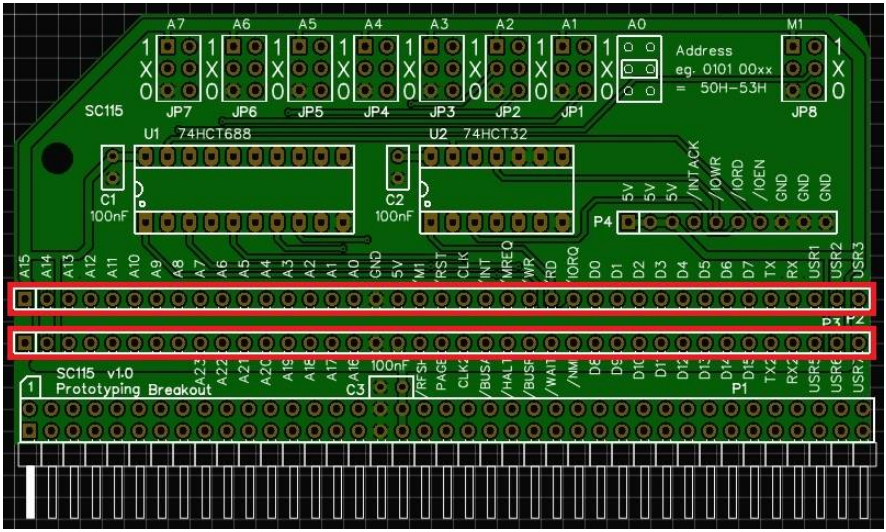
Take care to ensure the pins are parallel to the circuit board so that the board will be vertical when plugged into a backplane.



Step 4

Fit and solder connector P2 and P3.

Take care to ensure the pins are perpendicular to the circuit board.

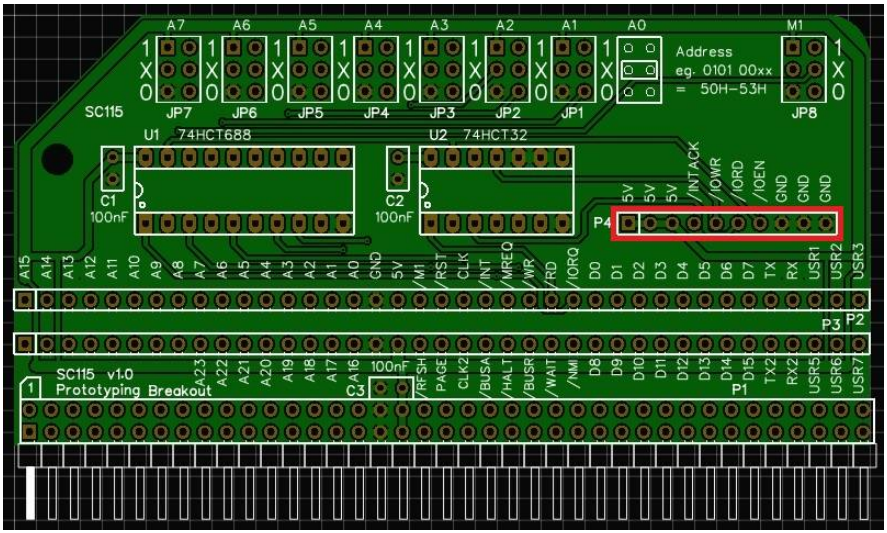


P3 is only required for signals on the enhanced bus (the second row), so it may not be necessary to fit this connector.

Sockets could be fitted in positions P2 and P3, if you prefer.

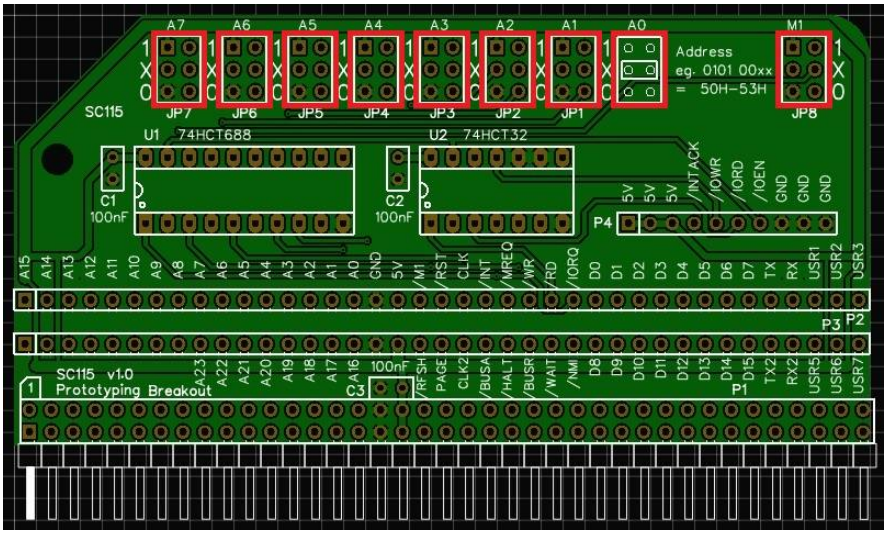
Step 5

Fit and solder header pins P4.



Step 6

Fit and solder header pins JP1 to JP8.



Step 7

Remove any solder ‘splats’ with a brush, such as an old toothbrush.

Visually inspect the soldering for dry joints and shorts.

Clean the flux off with suitable cleaning materials.

Visually inspect again.

Before fitting the ICs or jumper shunts, plug the board into an RC2014 backplane with no other boards fitted. Power the backplane and perform the following checks with a volt meter:

- Check the supply voltage on this module, between, say, U1 pin 10 and U1 pin 20. This should be 4.5 to 5.5 volts, preferably 4.75 to 5.25 volts.
- Check the supply voltage between P4 pins 1 and 10.
- Check the supply voltage between JP1 pins 1 and 5. Similarly check JP2 to JP8.

If all is well, power down and remove the module.

Step 8

Insert the ICs into their sockets, taking care to insert them the right way round, as illustrated below. Be careful not to bend any legs over.

Fit one jumper shunt to each set of jumper pins JP1 to JP8. These shunts are fitted in the positions needed to select the required I/O address range. This is explained in the next section.

Now plug the module into the RC2014 backplane together with your normal working set of modules. Power up and check the system is working as usual.

Configuring the Module

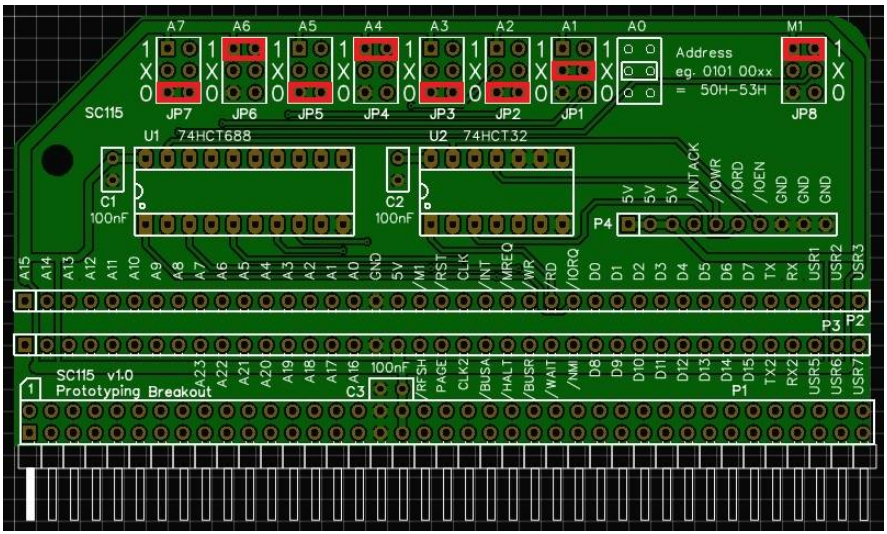
The only configuration required is the setting of the I/O address decoding jumpers JP1 to JP8. This sets the I/O port address range which activates signals /IOEN, /IORD and /IOWR on connector P4.

Address decoding is achieved my matching the I/O address on the address bus to the address set with these jumpers. One jumper also allows the bus /M1 signal state to be selected.

Each jumper has three positions. These are high (1), low (0) or don't care (X). The "don't care" position means either high or low is considered to be a match. Using "don't care" for one or more signals allows a range of addresses to be considered a match.

Only address signals A1 to A7 are compared. A0 is considered to always be a match, thus the smallest selectable range is 2 addresses. The 8th jumper is used to select the required state of the /M1 signal.

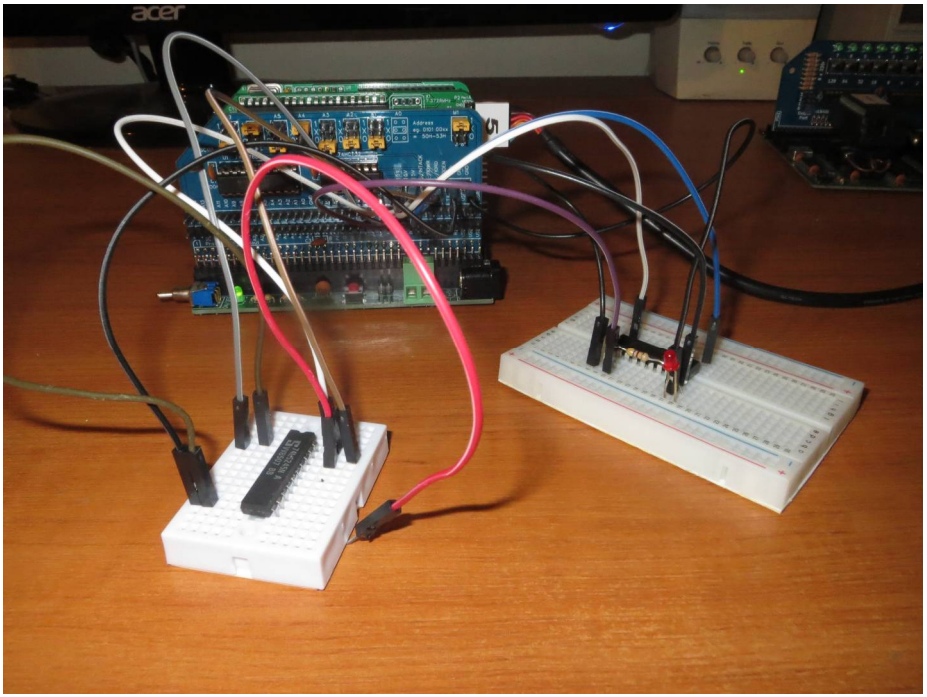
To select the address range 50 hexadecimal to 53 hexadecimal, and include the usual requirement of /M1 being high, the jumper settings are as shown below.



This works as 50 hexadecimal to 53 hexadecimal is 0101 0000 binary to 0101 0011 binary. When the "don't care" bits are substituted, it is 0101 00XX.

Example Application

This example shows how to build a simple digital input port and a simple digital output port on solderless breadboards.

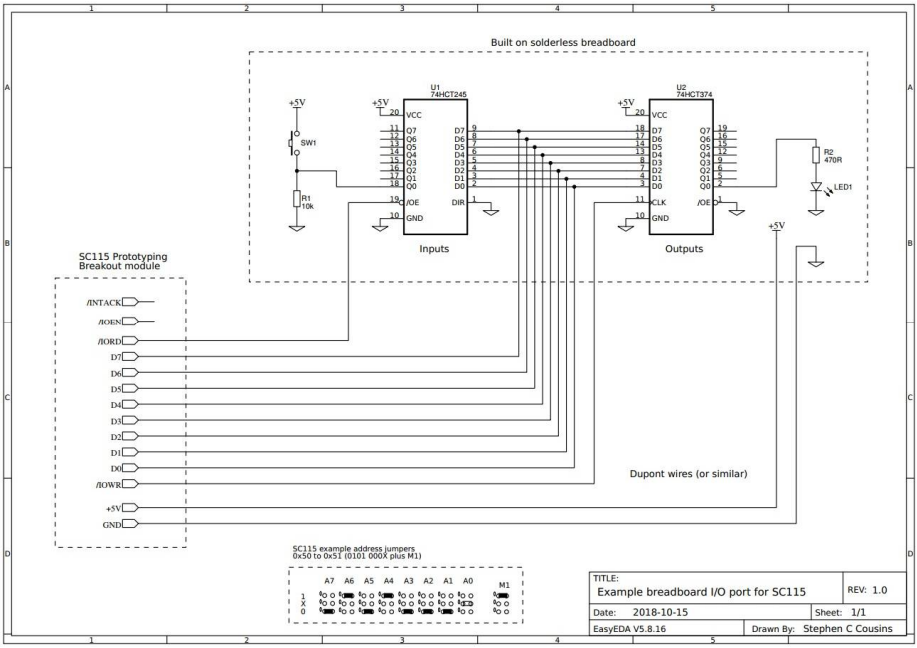


The breakout module provides access to all the necessary signals which are connected to solderless breadboards with Dupont cables.

The breadboard on the left provides an input to the data bus, while the breadboard on the right provides an output from the data bus to drive an LED. In this simple example only one input and one output are in use, but the circuits actually have 8 inputs and 8 outputs.

Address decoding is provided by the Breakout module. In this case the signal /IOWR is used to control latching of data from the data bus to the Octal D-type flip flop (74xx374), and the signal /IORD controls the tri-state outputs of an Octal bus transceiver (74xx245) which then puts data on the data bus.

The schematic for the breadboard circuits is shown below.



Address decoding is set to write to the output port when the processor writes to I/O address 0x50 or 0x51, and read from the input port when the processor reads from I/O address 0x50 or 0x51.

Purchasing the Printed Circuit Board

Currently the circuit board is available from Tindie and from EasyEDA (in China), or more accurately from their production partner JLCPCB.

You can download Gerber files from EasyEDA and send them to your preferred manufacturer, but the following describes the ordering process through EasyEDA.

Browse to EasyEDA.com

Select the main menu item "Explore"

In the search box, enter "RC2014 Breakout" or "sccousins"

Select, from the list shown, the project "SC115 v1.x Breakout Board for RC2014"

The project's details should now be displayed.

Select "Open in Editor" (the button next to the circuit board illustration, not the one next to the schematic).

Select "Generate Fabrication File (Gerber)" to get a summary of the board details.

Select "Generate Gerber" to download the Gerber files or "Order at JLCPCB" to order the boards direct from JLCPCB. Selecting "Order at JLCPCB" requires you to log in (or create an account and log in).

Wait for the progress bar to complete.

You should now be presented with the image of each side of the board and the following options:

Layers	2	
Dimensions	50 x 99 mm	
PCB Qty	10	There is no saving selecting less than 10
PCB Thickness	1.6	
PCB Colour	Green	You may want to change this to Blue
Surface Finish	HASL	
Copper Weight	1 oz	
Gold Fingers	No	
Material Details	FR4-Standard Tg 140C	
Panel By JLCPCB	No	
Different Design	1	

Note, the price increases significantly if you select a colour other than green.

Select “Save to Cart”

Select “Checkout securely”

Enter your details and select your shipping options.

And finally complete the order.

Warning

You may get a warning about design rule violations. There are 2 legitimate warnings that may be reported due to the position of the last pair of holes on the RC2014 bus connector being too close to the edge of the board when using the standard RC2014 board outline. These warnings can be safely ignored, but any others may be a cause for concern.

Fault Finding

Check all links and jumpers, check no chips have bent legs and thus not making contact with their socket, carefully inspect all soldering, check all the chips are inserted the right way round, check all the components are in the right place.

With the module plugged in to the RC2014 backplane with no other boards fitted. Power the backplane and perform the following checks with a volt meter:

- Check the supply voltage on this module, between, say, U1 pin 10 and U1 pin 20. This should be 4.5 to 5.5 volts, preferably 4.75 to 5.25 volts.
- Check voltage on U1 pins P0 to P7 match the states set with jumpers JP1 to JP8. You can only easily check these voltages when the jumpers are set to either high (1) or low (0).
- Jumpers JP1 to JP8's "don't care" (X) position can be tested with the RC2014 powered down and the continuity tested between U1 pins P0 to P7 and their counterparts Q0 to Q7.

With an oscilloscope or logic analyser you can test if U1 and U2 are working properly, but there is not much more you can do with just a meter.

History

2018-10-15	v1.0	First circuit boards
2018-10-15	e1.0.0	First release of this user guide
2019-03-06	e1.0.1	Revised this user guide General improvements plus corrected some component part numbers

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

Stephen C Cousins, Chelmsford, Essex, United Kingdom.

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/