SIO/2 + CTC Module For RC2014

User Guide

For module: SC110 version 1.0 & 1.1

Design and Documentation by Stephen C Cousins

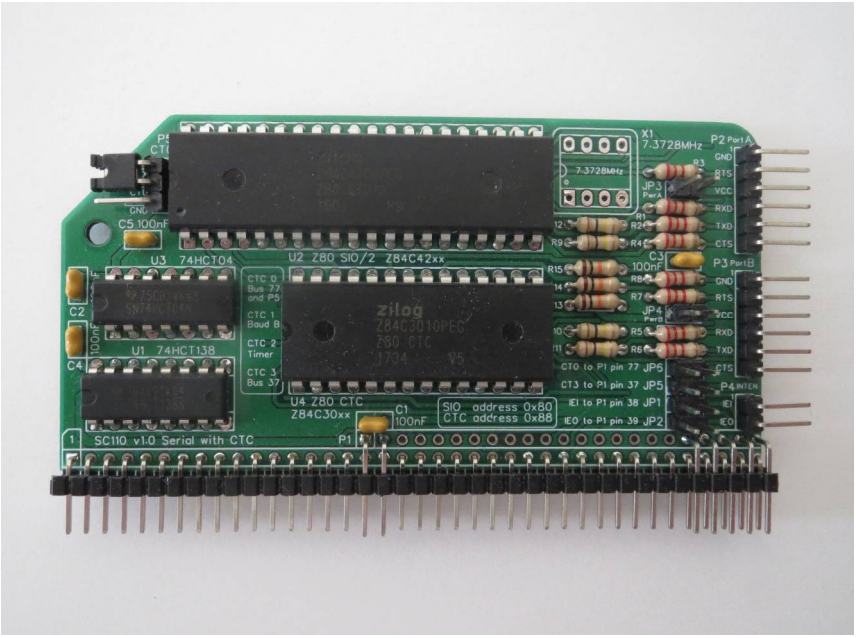
Edition 1.1.1

CONTENTS

Overview

This module is designed to provide serial port and timer functions. If more flexibility is required then modules SC104 SIO/2 and SC102 CTC should be used instead.

The Z80 SIO/2 plus Z80 CTC module (SC110) provides two TTL serial ports and a four channel counter timer. One serial port has software control of its baud rate via the CTC. The module includes support for Z80 mode 2 interrupt daisy chaining.



Each port has transmit, receive, request to send and clear to send signals brought out to connectors on the back edge of the module. The transmit and receive signals can be connected to the appropriate RC2014 bus pins.

The SIO/2 and CTC port addresses are fixed with the SIO/2 addressing matching the official SIO/2 module.

One of the CTC channels is used to generate a clock for serial port B, allowing software control of its baud rate. One channel is assigned as a system timer. This can be configured to give, say, a 200 Hz clock tick. Two channels are available for user functions and can be jumpered to USER pins on the RC2014.

The module can act as a interrupt manager for non-mode 2 interrupt devices. If the non-mode 2 interrupt sources are connected to the designated USER pins and the CTC appropriately configured, then the CTC can generate two separate mode 2 interrupts from these signals.

When using the CTC to generate serial port B's clock source, it is necessary to 'poke' two register values to set the divider value. At the time of writing this guide there is no known compatible software offering a more attractive solution than the two 'pokes'. The Small Computer Monitor v1.0.0 BAUD command is not implemented in the RC2014 builds as there is no official module with the necessary functionality.

To get the full range of possible baud rates also requires selecting the SIO's internal divider value. The CTC alone gives a reasonable range, but the combination of dividers in the CTC and SIO gives a more complete range.

The module uses the main bus clock (CLK) as its clock source. Currently available software assumes this clock is 7.3728MHz. There is space on the board for an oscillator which can be used to generate the main bus clock signal (CLK).

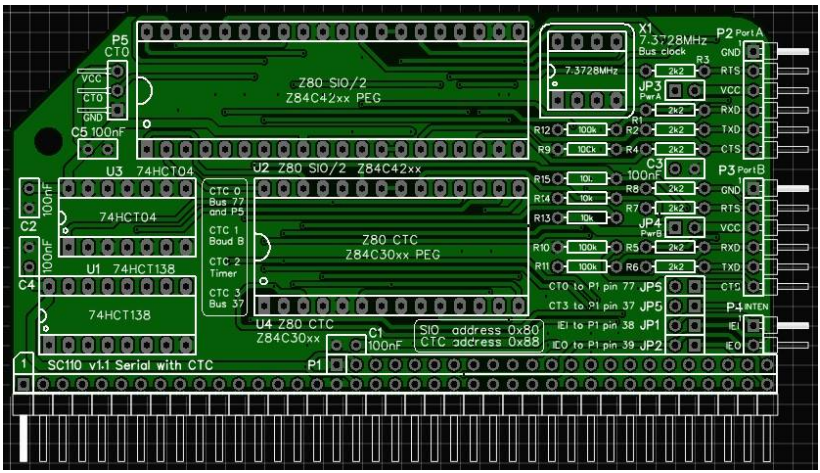
Version 1.0 of this module has the SIO and CTC clock source separate from the main bus clock. The on-board oscillator provides the clock source for this module, but not the rest of the system. Unfortunately, due to timing constraints between the CTC input clock and the bus clock, this proved very restrictive. Thus v1.1 uses the main bus clock as the CTC input, and also the SIO input. The on-board oscillator should only be fitted if it is to be the main bus clock (CLK) source.

For full details of the Z80 SIO and CTC see the Zilog data sheets.

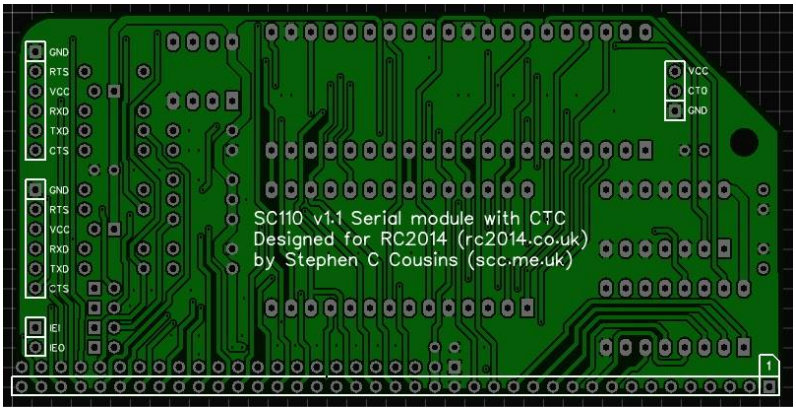
Printed Circuit Board v1.1

The printed circuit board is a standard footprint RC2014 board.

Printed circuit board, top/component side:



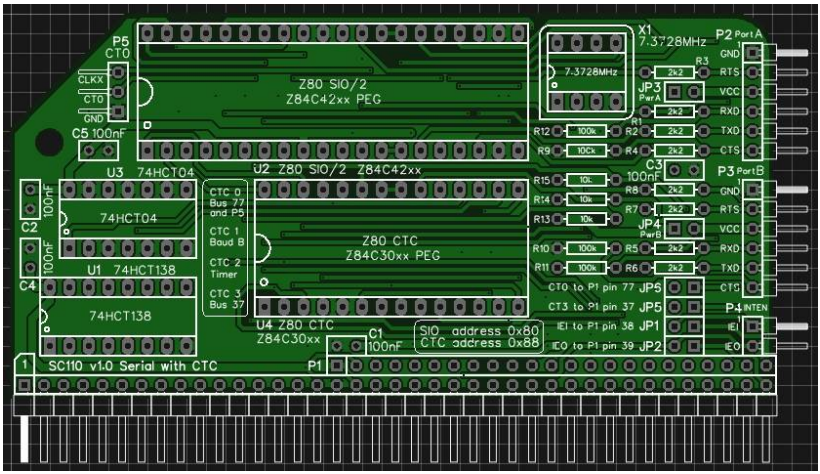
Printed circuit board, bottom/solder side:



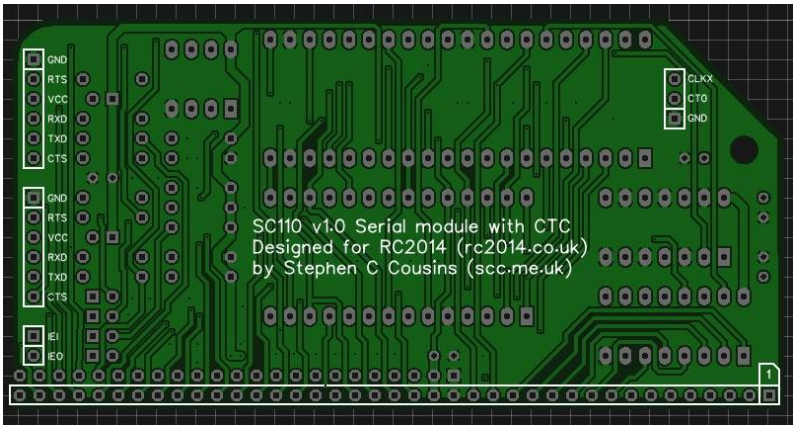
Printed Circuit Board v1.0

The printed circuit board is a standard footprint RC2014 board.

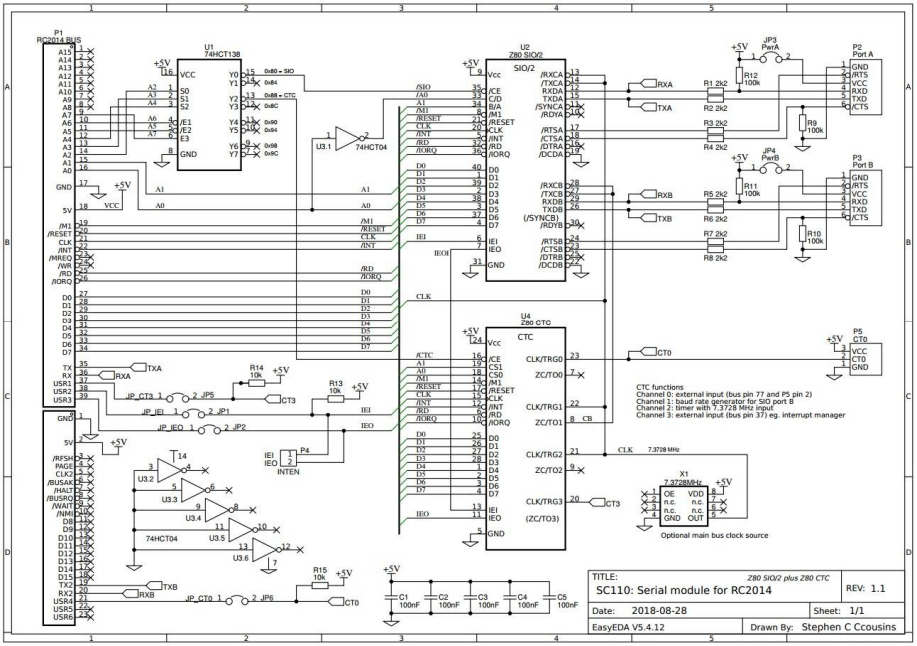
Printed circuit board, top/component side:



Printed circuit board, bottom/solder side:



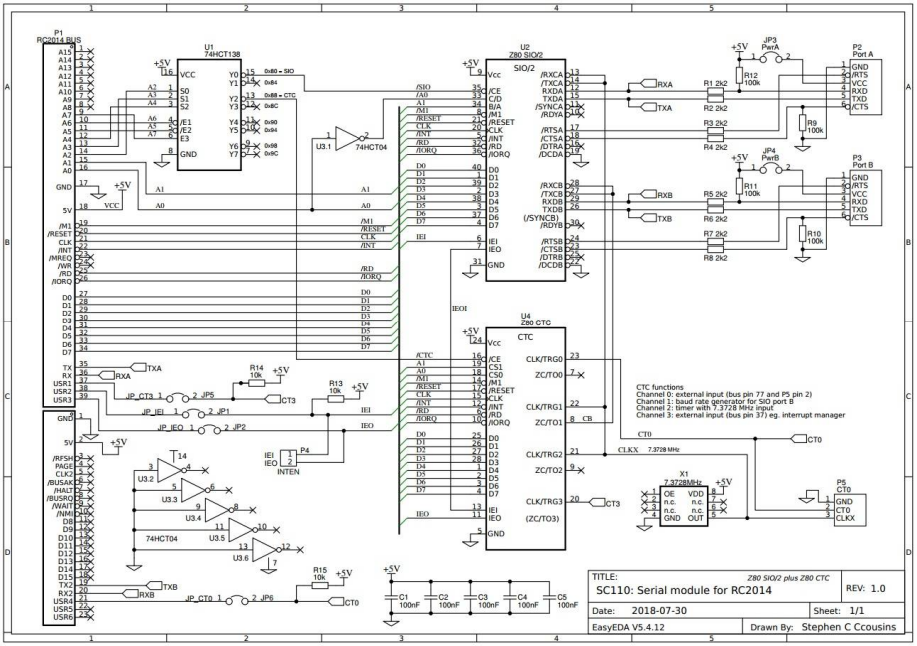
Schematic (PCB v1.1)



Errata

None yet.

Schematic (PCB v1.0)

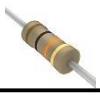


Errata

Due to time constraints between the CTC input clock and the main bus clock (CLK), using the CTC for baud rate generation proved very restrictive when using separate clock sources for input and bus. To get a reliable baud rate the CTC input clock frequency had to be reduced to less than half the bus clock. In practice this limited the maximum baud rate to an unacceptable degree. Thus version 1.1 of this module uses a common clock for both and provides a broad range of baud rate options. As a result this module is generally limited to systems with a 7.3728 MHz main bus clock. Any other frequency affects the specified baud rate, as it does with the official SIO/2 module.

What You Need

The following components are required to assemble the module with its full functionality and jumper options. Header pins JP1 to JP6, and P1 to P5 may need to be cut from longer strips.

Image	Qty	Reference	Description
	1	PCB	Printed circuit board SC110
	5	C1, 2, 3, 4, 5	Capacitor 100nF, ceramic, lead spacing = 2.54mm
	2	JP3, 4	Pin header, male, 1 row x 2 pins, straight
	1	JP1 and JP2 and JP5 and JP6	Pin header, male, 2 rows x 4 pins, straight
	7	JP1 - JP6 & P5 shunt	Jumper shunt for pin spacing = 2.54mm (unlikely to need all 7)
	1	P1	Pin header, male, 2 rows x 39 pins, angled (2nd row optional)
	2	P2, 3	Pin header, male, 1 row x 6 pins, angled
	1	P4	Pin header, male, 1 row x 2 pins, angled
	1	P5	Pin header, male, 1 row x 3-pins, angled
	8	R1 to R8	Resistor 2k2, axial, 5%, carbon film, 0.25W or 0.125W (see later for details of value options)
	4	R9 to R12	Resistor 100k, axial, 5%, carbon film, 0.25W or 0.125W
	3	R13 to R15	Resistor 10k, axial, 5%, carbon film, 0.25W or 0.125W

	1	U1	74HCT138, 3 to 8 line decoder, PDIP 16
	1	U1 socket	16 pin PDIP IC socket 0.3" wide
	1	U2	Z80 SIO/2, 8MHz, Z84C4208PEG (or Z80 SIO/2, 10MHz, Z84C4210PEG), PDIP 40
	1	U2 socket	40 pin PDIP IC socket 0.6" wide
	1	U3	74HCT04, hex inverter
	1	U3 socket	14 pin PDIP IC socket 0.3" wide
	1	U4	Z80 CTC, 8MHz, Z84C3008PEG (or Z80 CTC, 10MHz, Z84C3010PEG), PDIP 28
	1	U4 socket	28 pin PDIP IC socket 0.6" wide
	1	X1	Oscillator module 7.3728MHz, either 8 pin (Only required if used as main bus clock)
	1	X1 socket	8 pin PDIP IC socket 0.3" wide (socket not recommended for X1)

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 SC110
		Supplier	Part number
		EasyEDA	Search EasyEDA.com for SC110
		Tindie	Search Tindie.com for SC110

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

C1, 2, 3, 4, 5

Image	Qty	Reference	Description
	5	C1, 2, 3, 4, 5	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.

JP3, 4

Image	Qty	Reference	Description
	2	JP3, 4	Pin header, male, 1 row x 2 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)

JP3 and JP4 allow the serial port power pin to be connected to the module's 5 volt supply line. This can either be to power the RC2014 from the serial port, or power the serial port device from the RC2014.

Care needs to be taken when more than one device can be selected to power the RC2014. Only select one power source at a time.

JP1 and JP2 and JP5 and JP6

Image	Qty	Reference	Description
	1	JP1 and JP2 and JP5 and JP6	Pin header, male, 2 rows x 4 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 allow the interrupt daisy chain signals to be connected to the RC2014 bus signals USER 2 (pin 38) and USER 3 (pin 39), the input of CTC channel 3 to be connected to USER 1 (pin 37) and the input of CTC channel 0 to be connected to USER 5 (pin 77). To make use of the interrupt daisy chain feature you must use a backplane that is specifically designed to provide the necessary daisy chain, such as Backplane SC107, or SC113 with links fitted. The current official RC2014 backplanes do not support this feature.

Alternatively the signals IEI and IEO can be found on connector P4 on the back edge of the board. Dupont wires can be used to daisy chain these signals to other modules.

JP1 - JP6 and P5 shunts

Image	Qty	Reference	Description
	7	JP1 - JP6 & P5 shunts	Jumper shunt for pin spacing = 2.54mm (unlikely to need all 7)
		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 JP6 and P5.

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 enhanced RC2014 bus and thus a double row header.

Some pins need to be removed, using a pair of pliers, before fitting.

P2, 3

Image	Qty	Reference	Description
	2	P2, 3	Pin header, male, 1 row x 6-pin, angled
		Supplier	Part number
		eBay	200906546562 (1x40 pin to be cut to length)
		Farnell	2356192 (1x40 pin to be cut to length)
		Mouser	710-61304011021 (1x40 pin to be cut to length)
		RS	156-077 (1x40 pin to be cut to length)

These two connectors provide TTL serial ports A and B, suitable for connecting FTDI style serial cables. The pin-outs are:

1. GND Common ground / 0 volts
2. RTS Request to send output from SIO/2 module
3. VCC 5 volt in or out via jumper JP3 (port A) or JP4 (port B)
4. RXD Serial receive data input to SIO/2 module
5. TXD Serial transmit data output from SIO/2 module
6. CTS Clear to send input to SIO/2 module

P4

Image	Qty	Reference	Description
	1	P4	Pin header, male, angled, 1-row x 2-pin
		Supplier	Part number
		eBay	200906546562 (1x40 pin to be cut to length)
		Farnell	2356192 (1x40 pin to be cut to length)
		Mouser	710-61304011021 (1x40 pin to be cut to length)
		RS	156-077 (1x40 pin to be cut to length)

As the official RC2014 backplanes do not currently provide a Z80 mode 2 interrupt daisy chain (IEI and IEO signals), these have been brought to the back of the board where they can be easily linked to other modules with Dupont wires.

P5

Image	Qty	Reference	Description
	1	P5	Pin header, male, 1 row x 3-pins, angled
		Supplier	Part number
		eBay	200906546562 (1x40 pin to be cut to length)
		Farnell	2356192 (1x40 pin to be cut to length)
		Mouser	710-61304011021 (1x40 pin to be cut to length)
		RS	156-077 (1x40 pin to be cut to length)

This connector gives access to CTC channel zero's input (CT0).

The pin-outs are:

1. GND Common ground / 0 volts
2. CT0 Input to CTC channel 0
3. Vcc 5 volts (CLKX on v1.0 PCB)

R1 to R8

Image	Qty	Reference	Description
	8	R1 to R8	Resistor 2k2, axial, 5%, carbon film, 0.25W or 0.125W
		Supplier	Part number
		Farnell	9339302
		Mouser	603-CFR-25JR-522K2
		RS	707-7690

These resistors are connected in series with all serial port input and output signals, to provide current limiting in the event that one side is powered when the other isn't.

There have been reports of some FTDI style serial adapter cables not working with resistors in the 2k range and requiring lower value resistors of 1k or less. The reason for this is not clear, but it might have something to do with the signal voltages used by the cable. When buying FTDI style serial adapter cables for use with the RC2014, make sure you select ones with 5 volt serial signals, not just 5 volt tolerant signals. If you want to reduce the risk of having to change resistors you could fit 1k resistors. The down side is more power leaks through when the cable is powered but the RC2014 is not, causing more chance of circuitry remaining active, such as memory not clearing during 'power down'.

R9 to R12

Image	Qty	Reference	Description
	4	R9 to R12	Resistor 100k, axial, 5%, carbon film, 0.25W or 0.125W
		Supplier	Part number
		Farnell	9339078
		Mouser	603-CFR-25JR-52100K
		RS	707-7824

These resistors pull up or down serial port inputs so that they are in a known state when no cable is connected.

R13 to R15

Image	Qty	Reference	Description
	3	R13 to R15	Resistor 10k, axial, 5%, carbon film, 0.25W or 0.125W
		Supplier	Part number
		Farnell	9339060
		Mouser	603-CFR-25JR-5210K
		RS	707-7745

These resistors pull up inputs CT0, CT3 and IEI.

U1

Image	Qty	Reference	Description
	1	U1	74HCT138, 3 to 8 line decoder, PDIP 16
		Supplier	Part number
		Farnell	1470803
		Mouser	595-SN74HCT138N
		RS	144-9994

This integrated circuit provides the address decoding. The SIO/2 is at address 0x80 to 0x83 and the CTC is at address 0x88 to 0x8B.

U1 socket

Image	Qty	Reference	Description
	1	U1 socket	16 pin PDIP IC socket 0.3" wide
		Supplier	Part number
		Farnell	2445622
		Mouser	571-1-2199298-4
		RS	674-2432

U2

Image	Qty	Reference	Description
	1	U2	Z80 SIO/2, 8MHz, Z84C4208PEG (or Z80 SIO/2, 10MHz, Z84C4210PEG), PDIP 40
		Supplier	Part number
		Farnell	6MHz version only
		Mouser	692-Z84C4208PEG (8 MHz version) 692-Z84C4210PEG (10 MHz version)
		RS	6MHz version only

The Z80 SIO/2 provides two TTL serial ports, suitable for use with FTDI style serial adapter cables.

Each port has transmit, receive, request to send and clear to send signals brought out to headers, see P2 and P3 above. The transmit and receive signals may also be connected to the appropriate RC2014 bus pins via jumpers.

Serial port A is fixed at 115200 baud when used with the recommended 7.3828 MHz oscillator and existing software.

Serial port B has its clock input connected to the output of CTC channel 1. This enables the baud rate to be selected by software. It should be noted that without the CTC being set up to generate the clock, serial port B does not work.

For further details see the Zilog SIO data sheet.

U2 socket

Image	Qty	Reference	Description
	1	U2 socket	40 pin PDIP IC socket 0.6"
		Supplier	Part number
		Farnell	4285669
		Mouser	571-1-2199299-5 or 649-DILB40P223TLF
		RS	674-2466

U3

Image	Qty	Reference	Description
	1	U3	74HCT04, hex inverter
		Supplier	Part number
		Farnell	9591770
		Mouser	595-SN74HCT04N
		RS	145-5808

This integrated circuit inverts one of the SIO/2's register select lines in order to provide software compatibility with the official SIO/2 module.

U3 socket

Image	Qty	Reference	Description
	1	U3 socket	14 pin PDIP IC socket 0.3" wide
		Supplier	Part number
		Farnell	2445621
		Mouser	571-1-2199298-3
		RS	674-2438

U4

Image	Qty	Reference	Description
	1	U4	Z80 CTC, 8MHz, Z84C3008PEG (or Z80 CTC, 10MHz, Z84C3010PEG), PDIP 28
		Supplier	Part number
		Farnell	6MHz version only
		Mouser	692-Z84C3008PEG (8 MHz version) 692-Z84C3010PEG (10 MHz version)
		RS	625-8996 (8 MHz version)

The Z80 CTC has four counter/timer channels.

Channel zero's input is available on P5 and can be jumpered to the RC2014 bus pin 77. This channel can be used as a general purpose counter/timer using the input on P5 or on the bus pin 77 (USER5), or it can be used to generate a Z80 mode 2 interrupt for devices that do not support Z80 mode 2.

Channel one is set up to provide a clock to serial port B of the SIO, thus allowing software control of the baud rate.

Channel 2 is reserved for use as a timer, typically to generate a periodic interrupt, say, at 200 Hz.

Channel 3's input is available on bus pin 37 (USER1), enabling it to be used as a general purpose counter/timer or to generate a Z80 mode 2 interrupt for devices that do not support Z80 mode 2.

For further details see the Zilog CTC data sheet.

U4 socket

Image	Qty	Reference	Description
	1	U4 socket	28 pin PDIP IC socket 0.6" wide
		Supplier	Part number
		Farnell	2453476
		Mouser	571-1-2199299-2
		RS	674-2454

X1

Image	Qty	Reference	Description
	1	X1	Oscillator module 7.3728MHz
		Supplier	Part number
		Farnell	2508742 (7.328MHz 8-pin QX8T50B)
		Mouser	774-MXO45HS-3C-7.3 (7.3728MHz 8-pin MXO45HS)
		RS	796-0574 (7.328MHz 8-pin QX8T50B)

Version 1.1 PCB: This oscillator should only be fitted if it is required as the main bus clock (CLK) source. If the system already has a clock source for CLK then do not fit this oscillator.

Version 1.0 PCB: This oscillator provides the clock source for serial port A, CTC channel 2, and optionally, CTC channel zero. As described earlier this proved to be very restrictive in terms of clock speeds and baud rates, thus the design was changed for v1.1 PCB.

The assumption is that a 7.3728 MHz oscillator is used. By using this value the board will match the frequency expected by software designed for this board.

X1 socket

Image	Qty	Reference	Description
	1	X1 socket	8 pin PDIP IC socket 0.3" wide (socket not recommended for X1)
		Supplier	Part number
		Farnell	2445620
		Mouser	571-1-2199298-2
		RS	674-2435

Oscillator module (X1) is quite large, so if you want to make a low profile board it is best to solder the oscillator directly onto the circuit board rather than fit this socket. The oscillator really needs to be 7.3728 MHz, so there is not much chance it will need to be changed.

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 JP6, and P1 to P5 may need to be cut from longer strips.

WARNING: There have been reports of some FTDI style serial adapter cables not working with resistors in the 2k range and requiring lower value resistors of 1k or less. The reason for this is not clear, but it might have something to do with the signal voltages used by the cable. When buying FTDI style serial adapter cables for use with the RC2014, make sure you select ones with 5 volt serial signals, not just 5 volt tolerant signals. If you want to reduce the risk of having to change resistors you could fit 1k resistors. The down side is more power leaks through when the cable is powered but the RC2014 is not, causing more chance of circuitry remaining active, such as memory not clearing during 'power down'.

Step 1

Fit and solder the eight 2k2* resistors R1 to R8 (shown in red below).

Colour code for 2k2 resistor: Red, Red, Red

* Note warning about resistor values on previous page.

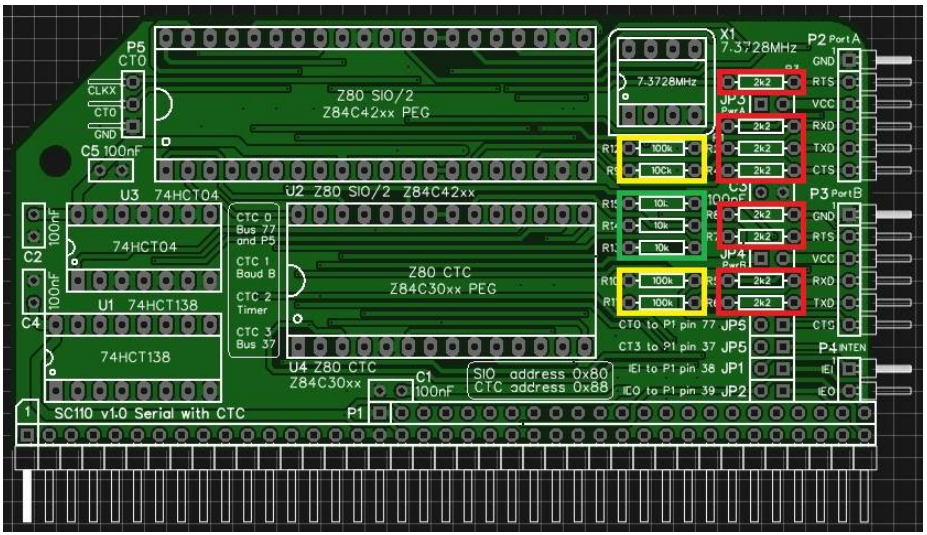
Fit and solder the four 100k resistors R9 to R12 (shown in yellow below).

Colour code for 100k resistor: Brown, Black, Yellow

Fit and solder the three 10k resistors R13 to R15 (shown in green below).

Colour code for 10k resistor: Brown, Black, Orange

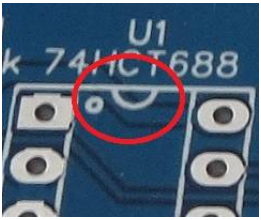
Resistors can be fitted either way round, as they are not polarity dependent.



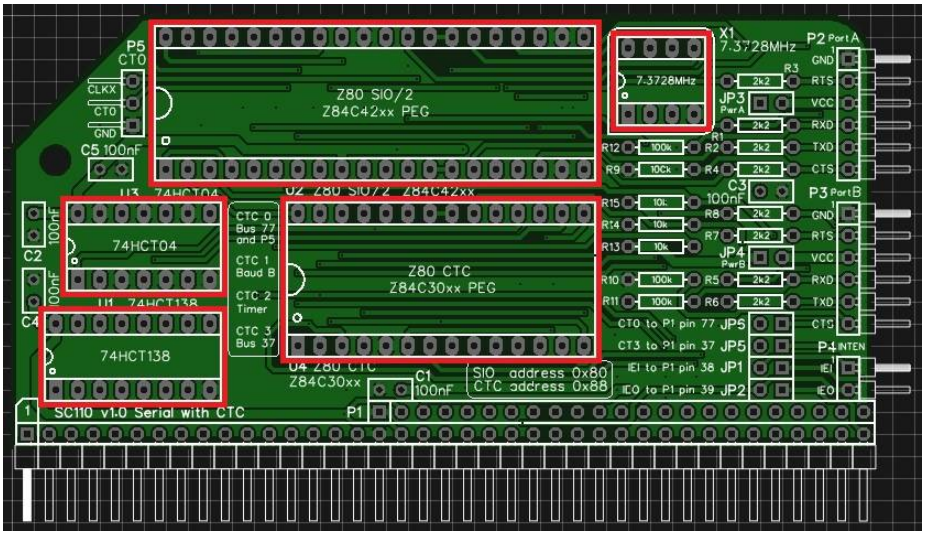
Step 2

Fit and solder IC sockets for U1, U2, U3, U4 and optionally X1.

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.



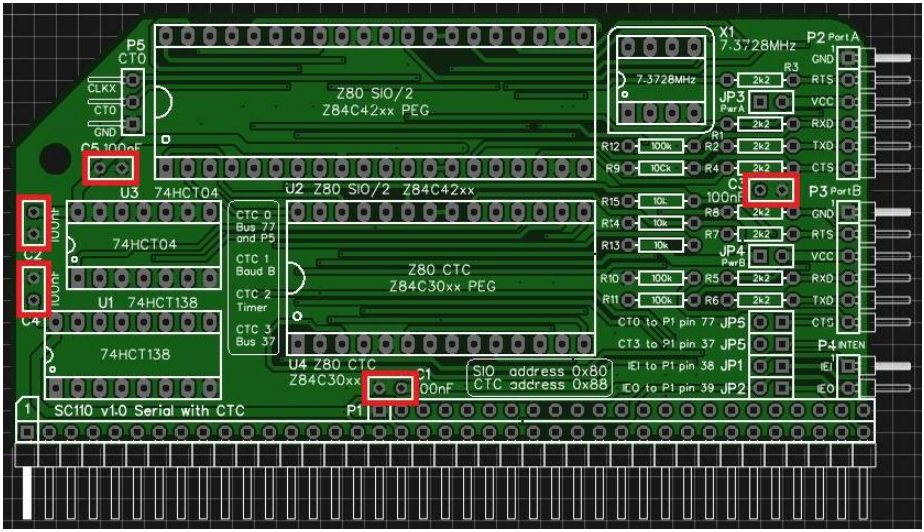
You may wish to solder the oscillator X1 directly to the board, in which case fit the oscillator now instead of the socket. Only fit this oscillator if it is to be the main bus clock (CLK) source.



Step 3

Fit and solder capacitors C1, C2, C3, C4 and C5.

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

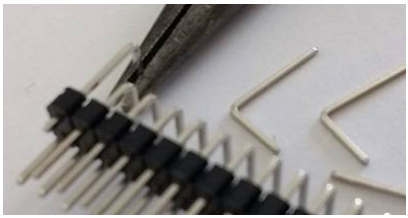


Step 4

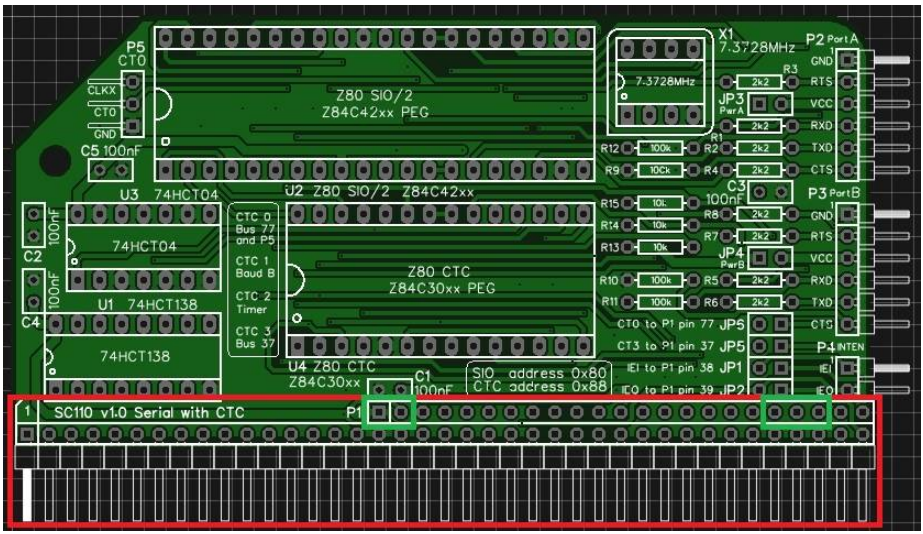
Fit and solder connector P1.

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 all the pins in the second row except those shown on the schematic as used and indicated below in green.



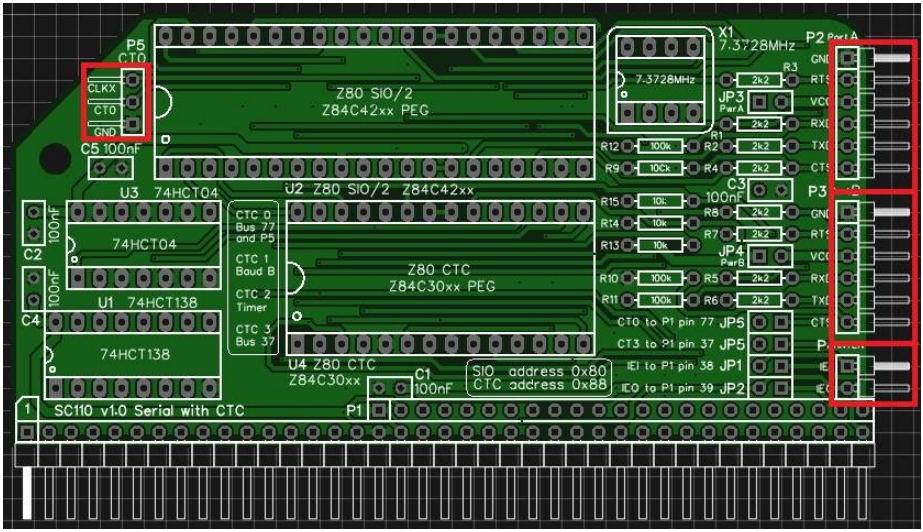
Take care to ensure the pins are parallel to the circuit board so that the board will be vertical when plugged into a backplane.



Step 5

Fit and solder connector P2, P3 P4 and P5.

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



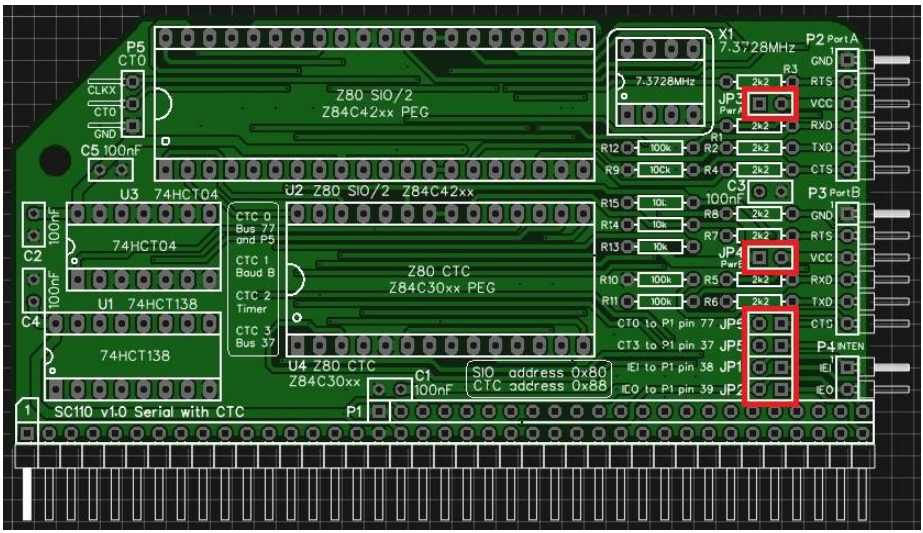
P2, P3 and P4 can be fitted as a single strip but with two pins pulled out at the gaps between P2/P3 and P3/P4.

Step 6

Fit and solder header pins JP1 to JP6.

JP3 and JP4 are individual headers 1 pin by 2 pins as illustrated right.

JP1 and JP2 and JP5 and JP6 are made up of a single header 2 pins by 4 pins as illustrated right.



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 8 and U1 pin 16. This should be 4.5 to 5.5 volts, preferably 4.75 to 5.25 volts.
- Check RXD on connector P2 and RXD on connector P3 are being pulled up to at least 4.5 volts.
- Check CTS on connector P2 and CTS on connector P3 are being pulled down to least than 0.4 volts.
- Check the interrupt enable input (IEI) on connector P4 is being pulled up to at least 4.5 volts.

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.

There is no need to fit any other jumper shunts yet, unless they are specifically needed in your system's configuration.

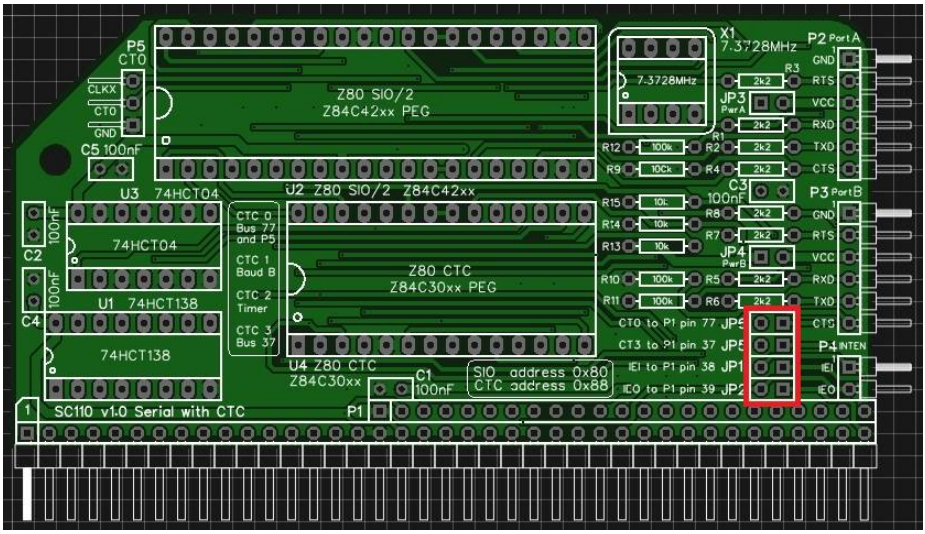
Now plug the module into the RC2014 backplane together with your normal working set of modules (except any previous serial port module you were using). Power up and check the system is working as usual.

Configuring the Module

The following are just a few examples of how you can configure and use this module. To realise its full potential it is necessary to study the Zilog Z80 SIO and CTC data sheets, which can be found on the internet by searching for “zilog UM0081”.

Bus Signals

The RC2014 bus has provision for a number of user functions. This module takes advantage of this by allowing CTC input zero, CTC input three, and the interrupt daisy chain signals, IEI and IEO, to be optionally connected to bus pins reserved for user functions. Jumpers JP1, JP2, JP5 and JP6 are provided to connect these signals, as illustrated below.



The jumpers highlighted in red have the following functions:

- JP6 Connect CTC channel zero’s input to pin 77 (USER5)
- JP5 Connect CTC channel three’s input to pin 37 (USER1)
- JP1 Connect interrupt daisy chain signal IEI to pin 38 (USER2)
- JP2 Connect interrupt daisy chain signal IEO to pin 39 (USER3)

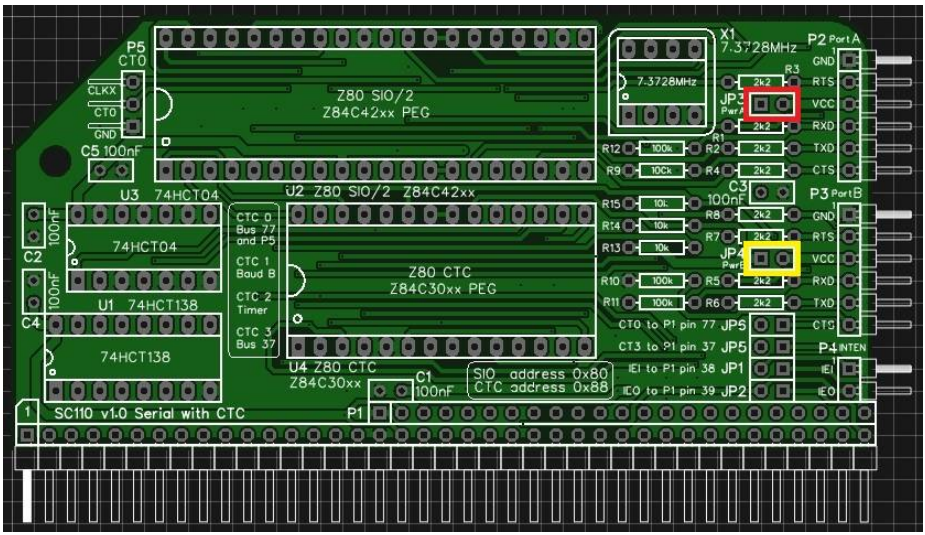
Power Sources

The module provides a means of sourcing power from, or supplying power to, either or both serial ports.

The jumpers JP3 and JP4 connect pin 3 of the serial port connectors to the module's 5 volt supply.

With one of these jumper shunts fitted the RC2014 can be powered from an FTDI style serial adapter. Alternatively, with the shunt fitted, the RC2014 can supply power to the serial device.

The illustration below shows the jumper position for port A power in red and port B power in yellow.



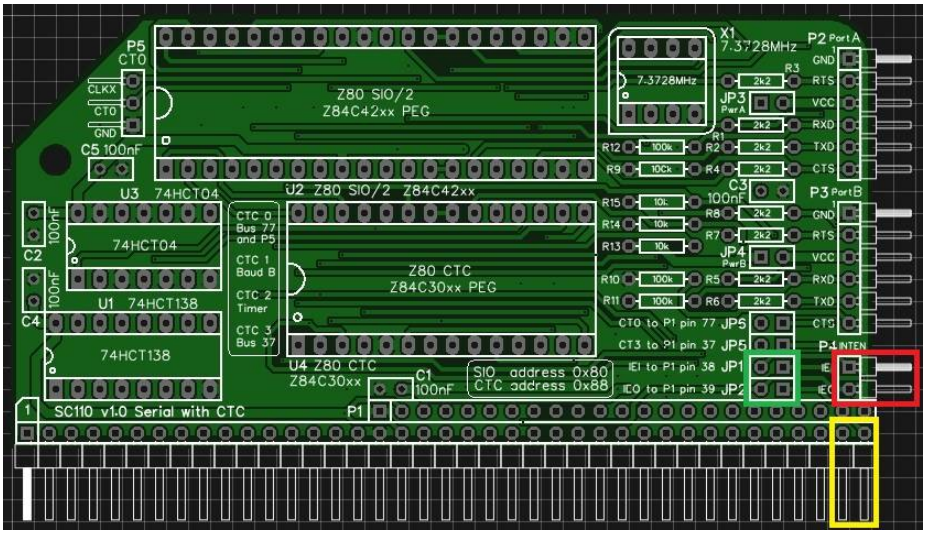
Warning: Do not connect two power sources at the same time.

Interrupt Daisy Chain

If your system has more than one device using interrupt mode 2, it will be necessary to set up an interrupt daisy chain.

This is fully described in the Z80 peripherals data sheet, but essentially it requires linking the output (IEO) of one interrupt generating device to the input (IEI) of the next, and so on. The position in the chain determines the device's interrupt priority.

The illustration below shows the connections required when using external Dupont wires on P4 (shown in red) and the RC2014 bus USER pins (shown in yellow). To connect the IEI and IEO signals to the RC2014 bus fit shunts to jumpers J1 and J2 (shown in green).



This feature requires software support.

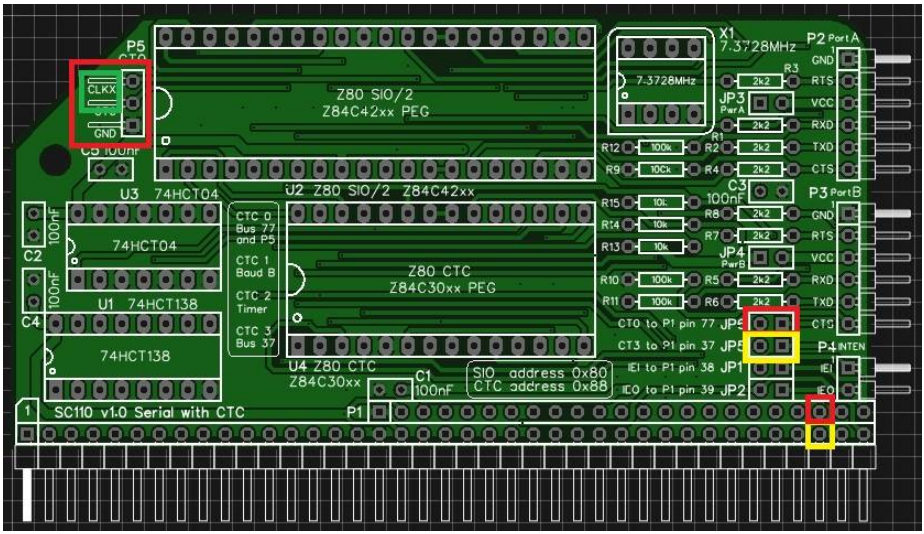
Setting up a mode 2 interrupt system is not trivial so requires study of the data sheets rather than following any simple example I could write here.

Counter/Timer Inputs

CTC channel zero and three's inputs are available for external connection.

Channel three's input (shown in yellow below) is available at jumper JP5. With the jumper shunt fitted at JP5 the input is connected to the RC2014 bus pin 37 (USER1). This input can then be used to generate Z80 mode 2 interrupts for devices that can not do that for themselves, or be used as a general purpose counter/timer input.

Channel zero's input (shown in red below) is available at P5 and also jumper JP6. With the jumper shunt fitted at JP6 the input is connected to the RC2014 bus pin 77 (USER5). This input can then be used to generate Z80 mode 2 interrupts for devices that can not do so themselves, or be used as a general purpose counter/ timer input. Channel zero's input is also available on P5 (shown in red below). In the case of PCB v1.0, but not PCB v1.1, the on-board oscillator's signal is also available on P5 (shown in green below).



These features require software support.

Setting up a mode 2 interrupt system is not trivial so requires study of the data sheets rather than following any simple example I could write here.

Baud Rates

Serial port A has its baud rate set by the main bus clock (CLK) frequency divided by the SIO's internal divider value. Standard RC2014 software sets the SIO's divider to 64. With the recommended 7.3728 MHz oscillator the baud rate is 7.3728 MHz / 64, which is 115200 baud.

Serial port B has its baud rate set as port A, but with the addition of CTC channel 1 further dividing the clock frequency. By just setting the CTC channel 1 divider *constant*, a range of baud rates is possible, as indicated in the left hand table below. By also changing the SIO's divider constant, an alternative range of baud rates can be set, as indicated in the right hand table below.

SIO divider = 64 (default)	
Constant	**Baud rate**
1	57600
2	28800
3	19200
4	14400
6	9600
12	4800
24	2400
48	1200
96	600
192	300

SIO divider = 16	
Constant	**Baud rate**
1	230400
2	115200
4	57600
6	38400
12	19200
16	14400
24	9600
48	4800
96	2400
192	1200

To set serial port B's baud rate to 9600, CTC channel 1's time constant register must be set to 6, assuming the SIO is in its default divide by 64 state. This can be achieved by issuing the following two Small Computer Monitor commands:

```
O 89 55
O 89 6
```

Or the BASIC commands:

```
OUT &H89, &H55
OUT &H89, 6
```

Where:

- &H89 is the address of CTC channel 1's control register (&H88+1)
- &H55 selects:
  - No interrupt
  - Counter mode
  - Count on rising edge
  - Time constant follows
- 6 is the time constant

The time constant value 6 selects divide by 12. The doubling of the divider, or halving of the frequency, is caused by the CTC only counting the second edge.

Timers

All four CTC channels can be used as timers, but this module is configured to use channel 2 as the primary timer.

To set CTC channel 2 to a 200 Hz time period, the following two Small Computer Monitor commands should be entered:

```
O 8A 35
O 8A 90
```

Or the BASIC commands:

```
OUT &H8A, &H35
OUT &H8A, 144
```

The first output statement selects timer mode with a prescaler of 256. The second output statement sets the time constant to 144 (0x90). With the recommended 7.3728 MHz oscillator, the timer period is clock input (7.3728 MHz) divided by the prescaler (256), then further divided by the time constant value (144). Which gives 200 Hz.

When set as a periodic timer, the CTC channel counts down until it reaches zero, then it reloads the counter/timer with the preset time constant value and counts down again. By regularly reading this timer it is possible to keep track of time or to initiate some event at regular time intervals.

A more sophisticate use of this timer would be to generate a periodic clock *tick* interrupt. Such applications are beyond the scope of this guide.

Purchasing the Printed Circuit Board

Currently the circuit board is available Tindie and also 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 “SC110” or “RC2014 SIO” or “sccousins”

Select, from the list shown, the project “SC110 v1.x Z80 SIO/2+CTC 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 8 and U1 pin 16. This should be 4.5 to 5.5 volts, preferably 4.75 to 5.25 volts.
- Check RXD on connector P2 and RXD on connector P3 are being pulled up to at least 4.5 volts.
- Check CTS on connector P2 and CTS on connector P3 are being pulled down to least than 0.4 volts.
- Check the interrupt enable input (IEI) on connector P4 is being pulled up to at least 4.5 volts.

History

2018-08-06	v1.0	First circuit boards
2018-09-12	v1.1	Version 1.1 PCB uses the bus clock as the baud rate source Version 1.0 PCB uses the on-board oscillator as the source Pin out of P5 changed to include Vcc rather than CLKX
2019-03-06	e1.1.1	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/