MG001 Seven Segment Display (Rev B)

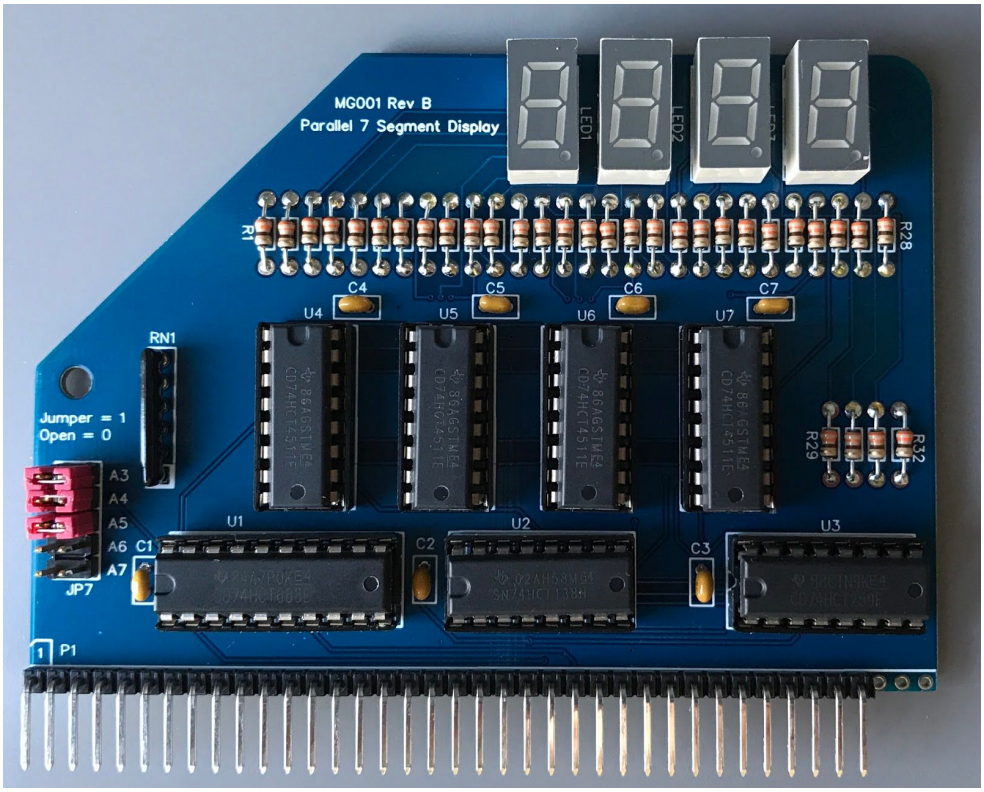
What is it?

MG001 is a four digit seven segment display designed for RC2014. It uses BCD to seven segment decoders, enabling the displays to be driven by an 8 bit data bus.

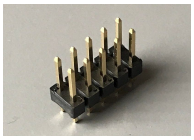
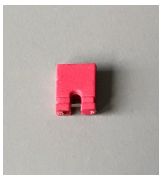
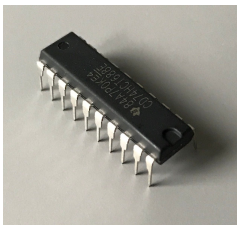
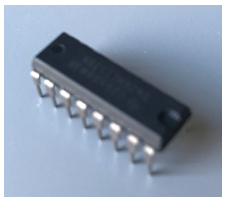
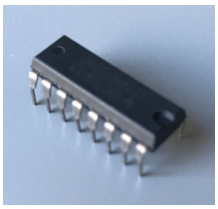
Its address can be set anywhere in the range 0 to 255, and occupies eight address locations (one for each digit, one for each decimal point).

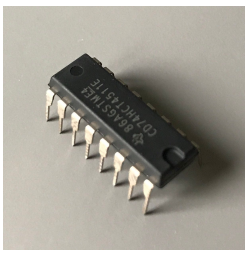
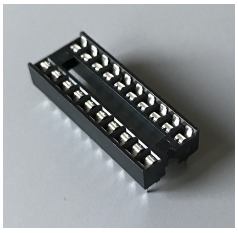
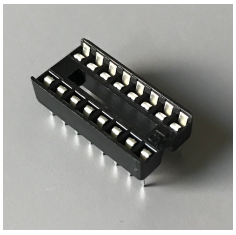
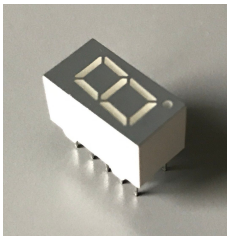
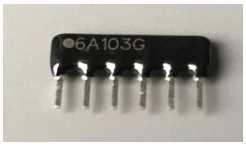
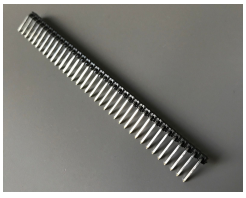
The MG001 can be used to display any four digit numerical value, such as time, date, temperature. When combined with a Real Time Clock (RTC) such as the MG002, and a host RC2014, it can be used to provide a fairly accurate clock and/or calendar.

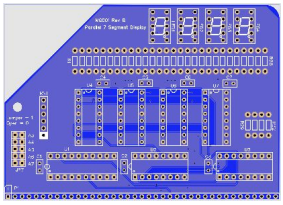
Reasonably authentic 1980's technology is used throughout, without modern capabilities such as serial I2C busses (nothing wrong with them, it's just not what I'm trying to do here).



What's in the kit?

Name	Quantity	Description	Picture	Present?
C1 to 7	7	Capacitor, ceramic, 100 nF		☐
JP1 to 5	1	Header, male, 2 x 5 pin, straight		☐
JP1 to 5 shunts	5	Jumper shunt		☐
U1	1	74HCT688		☐
U2	1	74HCT138		☐
U3	1	74HCT259		☐

U4-7	4	74HCT4511		☐
U1 socket	1	20-pin DIP socket		☐
U2-7 socket	6	16-pin DIP socket		☐
D1-4	4	HDSP-C3A3		☐
RN1	1	Fixed Network Resistor, 10 kohm, 5 Elements, bussed, SIP, 6 Pins		☐
R1-32	32	Through Hole Resistor, 330 ohm, MCRE Series, 125 mW		☐
P1	1	Pin Header, Right Angle		☐

PCB	1	MG001 PCB		☐

How do I build it?

There's a good chance you will have some soldering experience, as you're likely to have built an RC2014 or equivalent to plug your MG001 into. If you haven't, I recommend searching for an online tutorial, there are some good ones on YouTube.

Recommended tools include:

- Soldering iron (ideally temperature controlled)
- Multicore solder
- Small snips to cut off leads
- Small pliers
- Desoldering pump and/or braid
- Anti-static wrist strap (or steer clear of materials that cause static and touch a grounded object every now and then).

The normal rule of thumb is to solder the lowest height components first, working up:

- R1-32. Orientation doesn't matter, but they look a bit neater if they are soldered in the same way round
- P1. P1 is 39 pins, but in the real world these are normally only manufactured with 36 or 40. I normally supply 40 pins, in which case one pin needs cutting off with a sharp knife. If only 36 pins are supplied, they need to be soldered all the way down the "pin 1" end of the PCB. In either case, solder one joint only, check the alignment, melt solder and correct alignment if required before soldering remaining joints
- C1-7. Orientation doesn't matter
- Sockets for U1-7 (do not fit ICs yet). Similarly to P1, solder two opposite corners, check the socket is flat on the board before continuing. Make sure the notches at the end of the sockets match

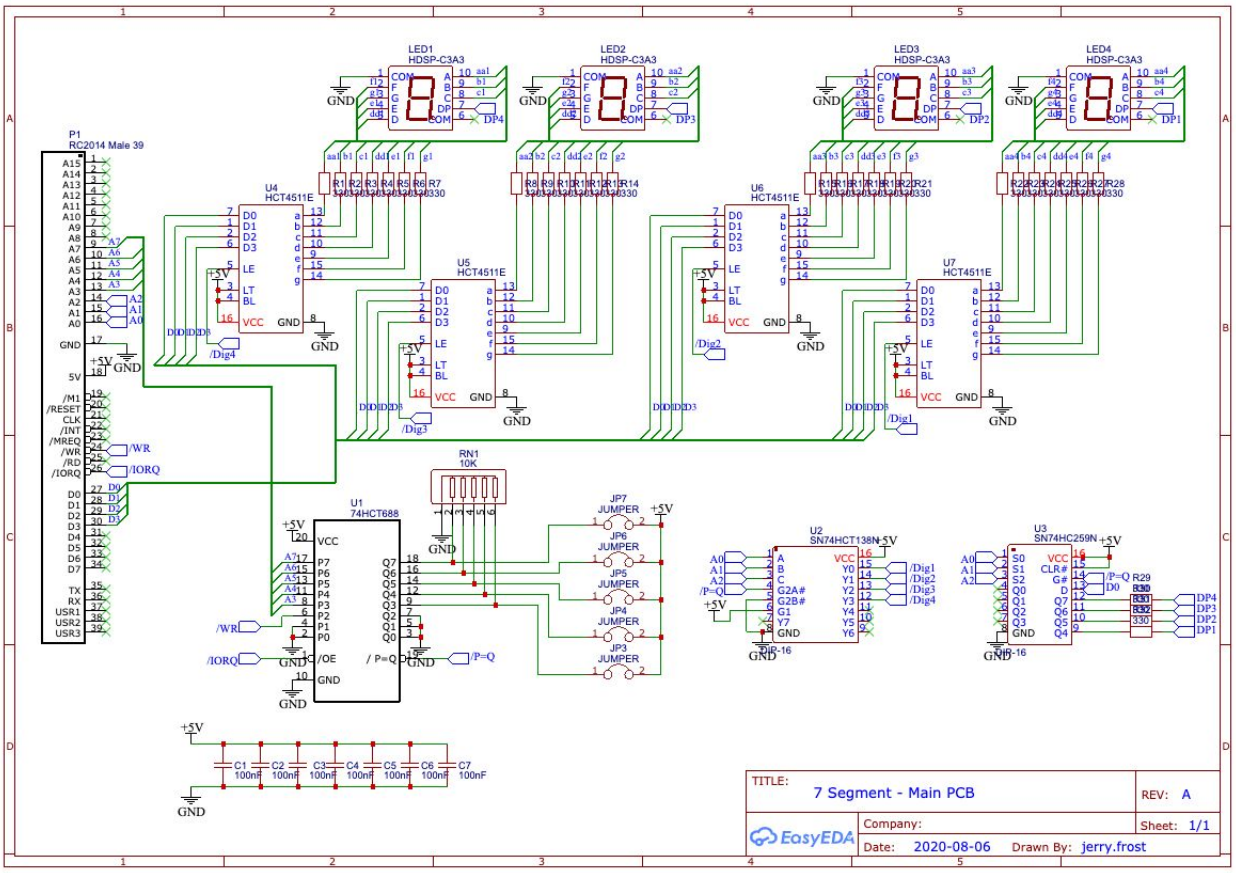
with the PCB graphics, to reduce the risk of installing the ICs the wrong way round

- RN1. Note that the dot on one end should align with the marking on the PCB RN1 graphic (the dot should go closest to P1)
- D1-4. The decimal points should be closest to P1. As with U1-7 sockets, do two opposite corners and check before soldering the rest
- JP1 to JP5. This is actually a single assembly

If you have flux cleaner, clean all joints. Now inspect them carefully for issues (a magnifying glass of some sort can be very helpful, the camera on some phones works quite well).

The final step prior to plugging into the host system and testing is to fit the ICs into their sockets. The IC legs will probably need a bit of gentle bending on a table or similar surface, to bring the two rows a little closer to each other. Pay attention to orientation (even after all this hard work, it's easy to get wrong). U2 upwards will physically fit in each other's sockets (but the circuit will then not work), so please be careful to get them the right way round.

How does it work?



JP1-5 are used to set the address of the upper 5 address bits (A1 to A5). When the address bus matches this, and the "/WR" write signal is also low, U1 sends a "/P=Q" signal to U2 and U3.

U2 is a 3 to 8 line demultiplexer. It selects U4-7, with U7 being selected by the lowest address selected by JP1-5, and so forth (for 4 addresses).

U3 is an 8 bit addressable latch. For the next 4 addresses up from those used by U2, it allows a "1" (on) or "0" to be written to the decimal point, starting with the rightmost one. R29 to 32 limit the current through the decimal points and set the brightness.

U4-7 are BCD to seven segment latch/decoder/drivers. Each expects a number between 0 and 9 in binary form on the data lines, which they latch (so the displayed number remains until replaced by a new number) and then

output to the seven segment displays D1-4. R1-28 limit the current through D1-4 and set the brightness.

How do I use it?

The first step is to set the address. If you are using the standard RC2014 serial I/O board, then setting A7 to zero (jumper removed) ensures the MG001 will not clash with it. If you have other I/O boards fitted, then you will need to take them into account also.
To use an example:

Jumper	A7	A6	A5	A4	A3
Status	Open	Open	Jumper	Jumper	Jumper
Value	0	0	32	16	8

Summing the values gives a decimal address of 56 if A0, A1 and A2 =0. The address range goes up to 63 as follows:

Address (dec)	A2	A1	A0	Usage
56	0	0	0	Right hand digit
57	0	0	1	Next to right digit
58	0	1	0	Next to left digit
59	0	1	1	Left hand digit
60	1	0	0	Right hand decimal point
61	1	0	1	Next to right decimal point
62	1	1	0	Next to left decimal point
63	1	1	1	Left hand decimal point

For the digits, it is a case of just sending the number to be displayed (0-9) to the correct digit. To blank the digit, send "10". So to make the right hand digit "8", use "OUT 56,8"

For the decimal points, send a "1" to light them, and "0" to extinguish them. To illuminate the right hand decimal point, use "OUT 60,1".

Notes

The differences between this and the prior versions of MG001 relate to U2 and U3. Basically, I was able to tidy up and simplify the circuitry to select U4 to U7, and add a capability to drive the decimal points.

LED1-4 were chosen on the basis of being decent quality, not too expensive seven segment displays. However, the circuit will handle most common cathode seven segment displays. There are a few out there of the same or similar size and different colours that have the same pinouts and will fit straight in. Others (especially larger LEDs) will probably have dramatically different pinouts. They can be adapted by running wires from MG001 to another PCB with the displays fitted, but it will be fiddly and time consuming.

Acknowledgements/Legal

MG001 has been designed for RC2014 with reference to the RC2014 Module Template. All pinouts used are in compliance with the RC2014 Module Template. The physical outline of MG001 also complies with the template, with the obvious exception that it has been extended upwards to: a) provide enough space for the components, and b) to allow the displays to be visible over the top of other RC2014 cards.

RC2014 is a trademark of RFC2795 Ltd.

The design and prototyping of MG001 was helped enormously by using Steve Cousin's SC-115 Breakout Card. So much so, the design around U1 is inspired by SC-115.

MG001 has been designed for hobbyist use only and is not to be used for safety or business critical applications.