

7 Segment Clock

Instruction Manual & Functional Description



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1 Introduction

This card has been designed to generate a 24-hour clock using 7 Segment LED displays

Primary design goals:

- Simple to construct
- Parts are readily available
- No / minimal use of surface mount components
- Multiple power sources
- Full & detailed documentation

2 Components

Reference	Value	Qty	Notes
C1,C2	30pF	2	
C3,C4,C6	10nF	3	Electrolytic
C5	100uF	1	
D1,D2,D3,D4	1N4148	4	
D5,D6,D7,D8	LED	4	Pick a colour
J1	USB_C Receptacle Power Only 6 Pin	1	E.g. USB4125-GF-A – <i>Optional for USB-C</i>
J2	USB_A	1	E.g. KUSBX-AS1N
J5	Barrel Jack	1	E.g. WURTH ELEKTRONIK 694108301002
R1	10M	1	
R2	100K	1	
R3	2K2	1	
R4,R5	4K7	2	
R6,R7	5.1K	2	<i>Optional for USB-C</i>
RN1,RN2,RN3,RN4,RN5,RN6	1K	6	Resistor network, e.g. 4116R-1-102
SW1	SW_SPDT	1	
SW2,SW3	SW_Push	2	
U1,U2,U3,U4,U5,U6	4511	6	BCD to 7-Segment Display Driver
U7,U8,U9	4518	3	Dual BCD Up-Counter
U10	4060	1	14-Stage Binary Counter
U11	4013	1	Dual D-Type Flip-Flop
U12,U13,U14,U15,U16,U17	See Next Table	6	7 Segment Display
U18	4081	1	Quad 2 Input AND Gate
Y1	32768Hz	1	Crystal

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Note: This device uses COMMON CATHODE LED Displays

Part No.	Character height	Category	Common electrode	Luminous color	Current (mA)	Voltage (V)	Wavelength (nm)
ELS-5161AS	0.56" inch	Single digit led display	Common Cathode	Red	5-20	1.8-2.0	620-640
ELS-5161BS	0.56" inch	Single digit led display	Common Anode	Red	5-20	1.8-2.0	620-640
ELS-5161AO	0.56" inch	Single digit led display	Common Cathode	Orange	5-20	1.8-2.0	600-610
ELS-5161BO	0.56" inch	Single digit led display	Common Anode	Orange	5-20	1.8-2.0	600-610
ELS-5161AY	0.56" inch	Single digit led display	Common Cathode	Yellow	5-20	1.8-2.0	585-595
ELS-5161BY	0.56" inch	Single digit led display	Common Anode	Yellow	5-20	1.8-2.0	585-595
ELS-5161AG	0.56" inch	Single digit led display	Common Cathode	Olivine	5-20	1.8-2.0	565-575
ELS-5161BG	0.56" inch	Single digit led display	Common Anode	Olivine	5-20	1.8-2.0	565-575
ELS-5161AGG	0.56" inch	Single digit led display	Common Cathode	Emerald	10-20	2.6-2.8	515-525
ELS-5161BGG	0.56" inch	Single digit led display	Common Anode	Emerald	10-20	2.6-2.8	515-525
ELS-5161AB	0.56" inch	Single digit led display	Common Cathode	Blue	10-20	2.6-2.8	460-470
ELS-5161BB	0.56" inch	Single digit led display	Common Anode	Blue	10-20	2.6-2.8	460-470
ELS-5161AW	0.56" inch	Single digit led display	Common Cathode	White	10-20	2.6-2.8	/
ELS-5161BW	0.56" inch	Single digit led display	Common Anode	White	10-20	2.6-2.8	/
Forward current, IF=20mA							

3 Construction

Read everything here before starting

3.1 Before you start construction

Inspect the PCB for any visible signs of damage

Select your components:

- Turned pin sockets are recommended due to robustness and reliability if you are not soldering the IC's and displays directly to the board
- The IC's are static sensitive. Handling precautions need to be observed
- Resistor networks have been selected for convenience but may be replaced by discrete resistors if required. Due to space considerations, these would need to be mounted partially vertically

3.2 Order of construction

The recommended order of construction is:

- Sockets (Or IC's if not socketed)
- Disc capacitors / resistors / diodes
- Switches
- Power connectors
- 7 Segment Displays
- Insert IC's (IF using sockets)
- Other items, test pins, electrolytic capacitor etc.

4 Functionality

The high-level design is broken into several relatively simple sections:

1. Clock & 1 second ticks
2. Counters and SS / MM / HH resets
3. Display drive
4. Power

4.1 Clock

The clock is derived from a 32768 Hz crystal. This is divided down through U10 to give a 2Hz signal. This is then further divided in U11 to give the required 1Hz signal. This is then used to drive U9 (A BCD counter) to represent seconds

4.2 Counters

The HH:MM:SS counts are held in U7:U8:U9 respectively. These are cascade together to give the required counts. However, these would could to 99 and not the required values. To get the required values, the AND gates in U18 are used to generate reset pulses at values 24:60:60 respectively and to clock the next counter in the sequence, this giving our 00:00:00 to 23:59:59 sequence.

4.3 Display Drive

The BCD counter outputs are fed through fixed resistors (in networks) to drive the 7 Segment LED's. These are common cathode devices.

4.4 Power

Power can be derived from either a USB-A, USB-C or Barrel Jack type connector. If the USB-C is not to be used, then the two resistors R6 & R7 can be omitted. These are used to indicate to an intelligent USB-C supply what is required

A capacitor (C5) is used to tidy up noisy supplies

5 Usage of the Clock

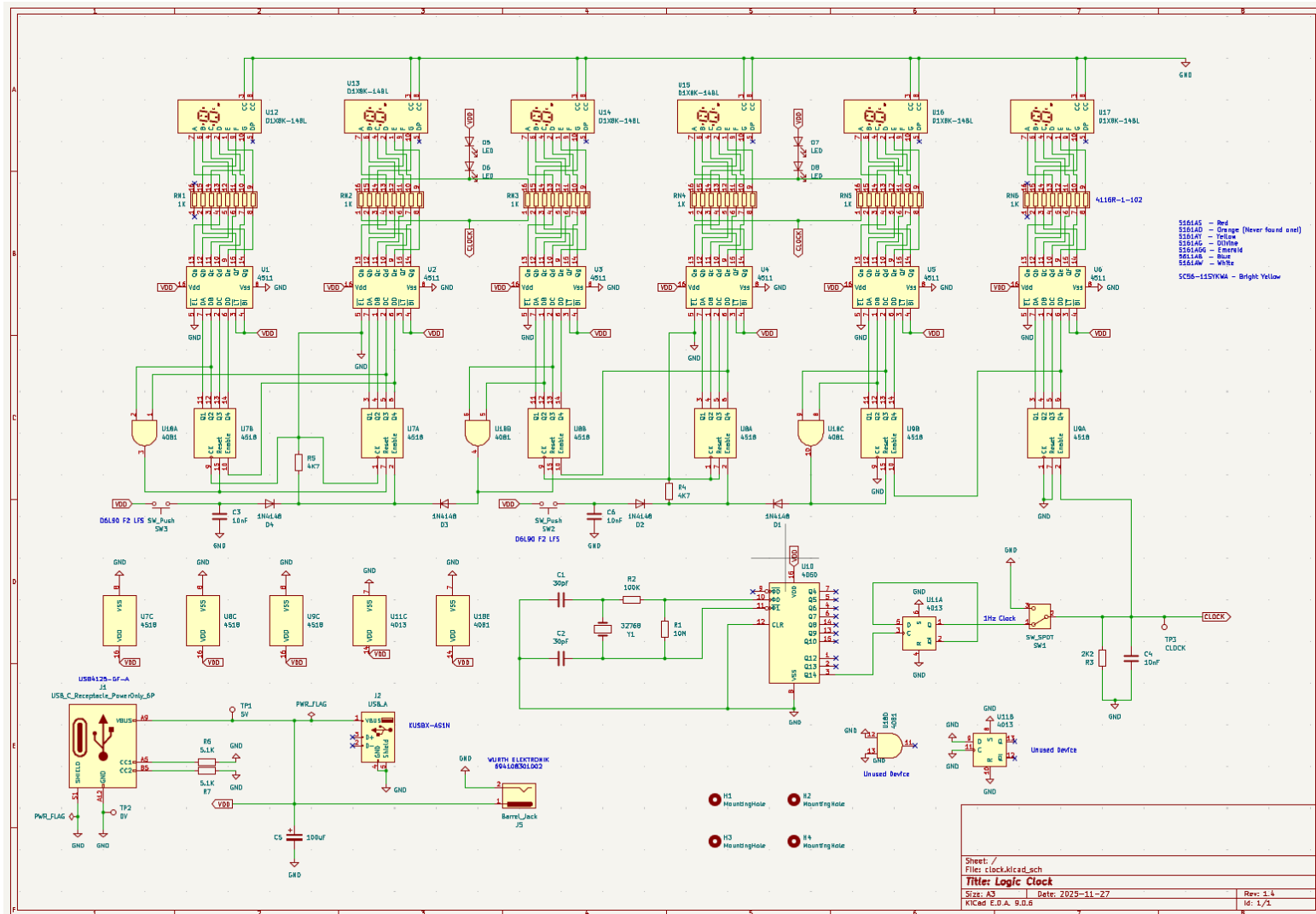
When initially powered up, the counters can potentially have any values. Set the switch SW1 to SET. This stops the counters incrementing. Use switches SW2 & SW3 to set Minutes and Hours respectively. Switch SW1 to RUN to start the clock.

6 Notes on Components

All the components used have been selected at time of design to be readily available via commercial component suppliers and eBay, with the exception of the Orange LED (ELS-5161AO) which appears to be impossible to source!

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7 Circuit Diagram



8 Errata – Changed and Fixed Items

8.1 Version 1.2

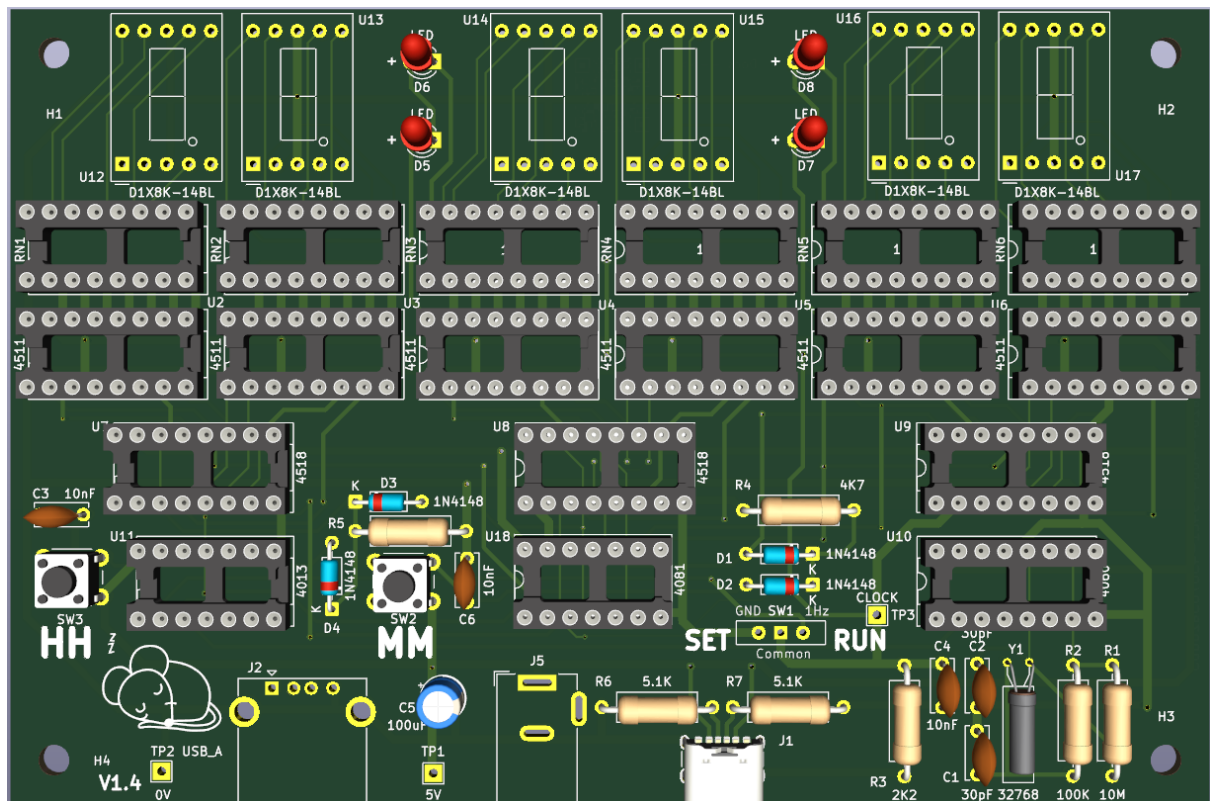
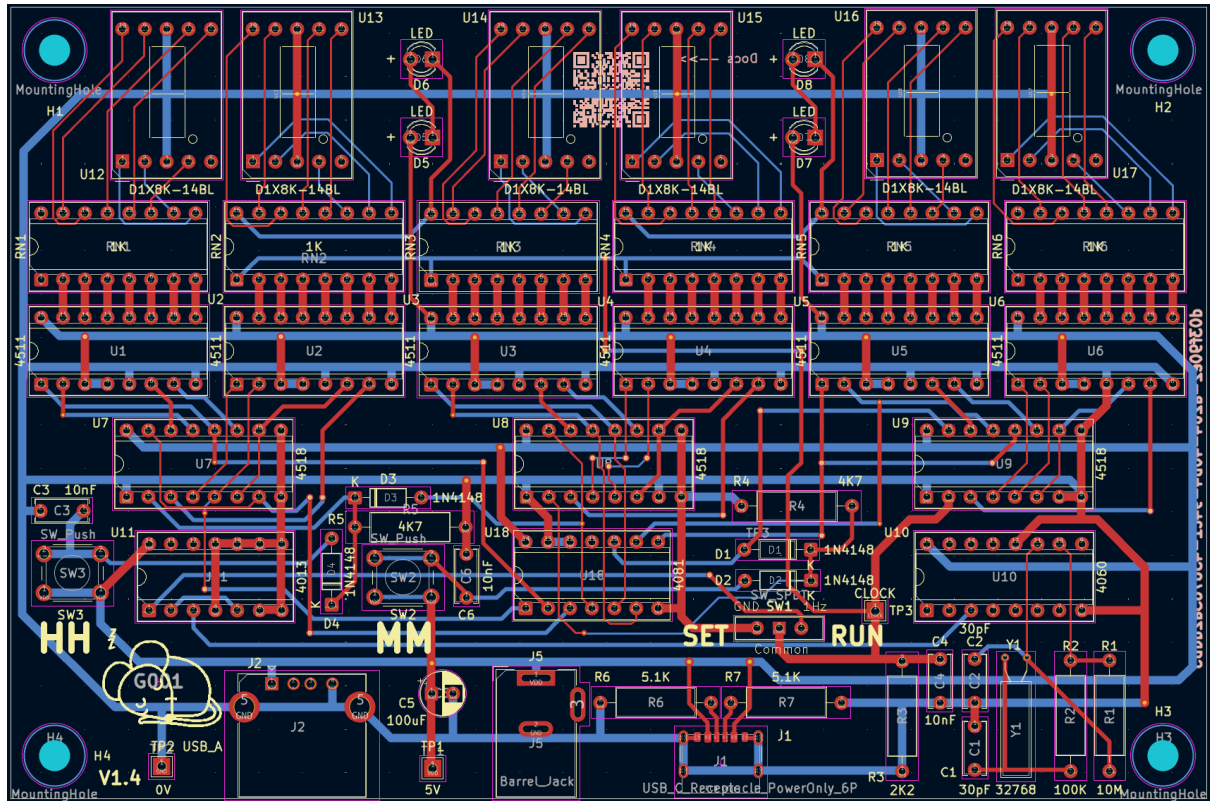
- First complete and bug free design

8.2 Version 1.4

- Minor circuit diagram documentation changes

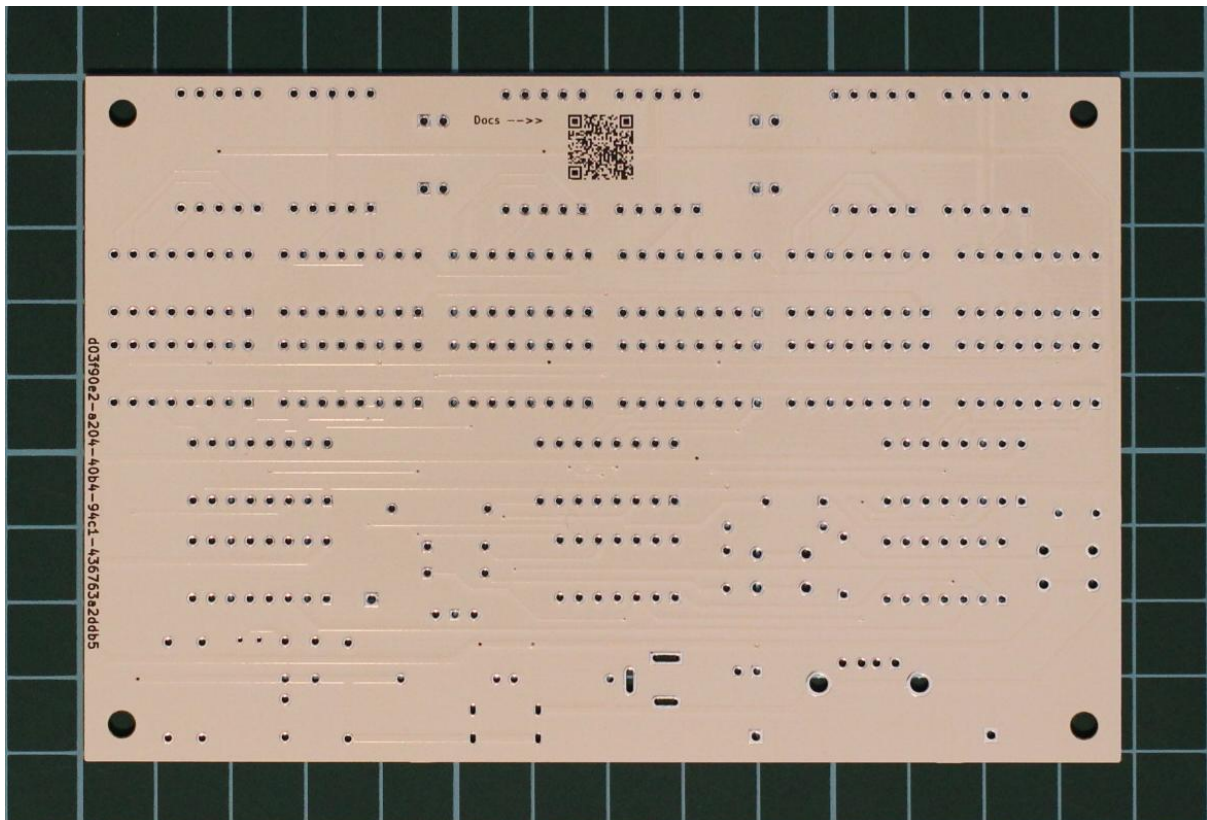
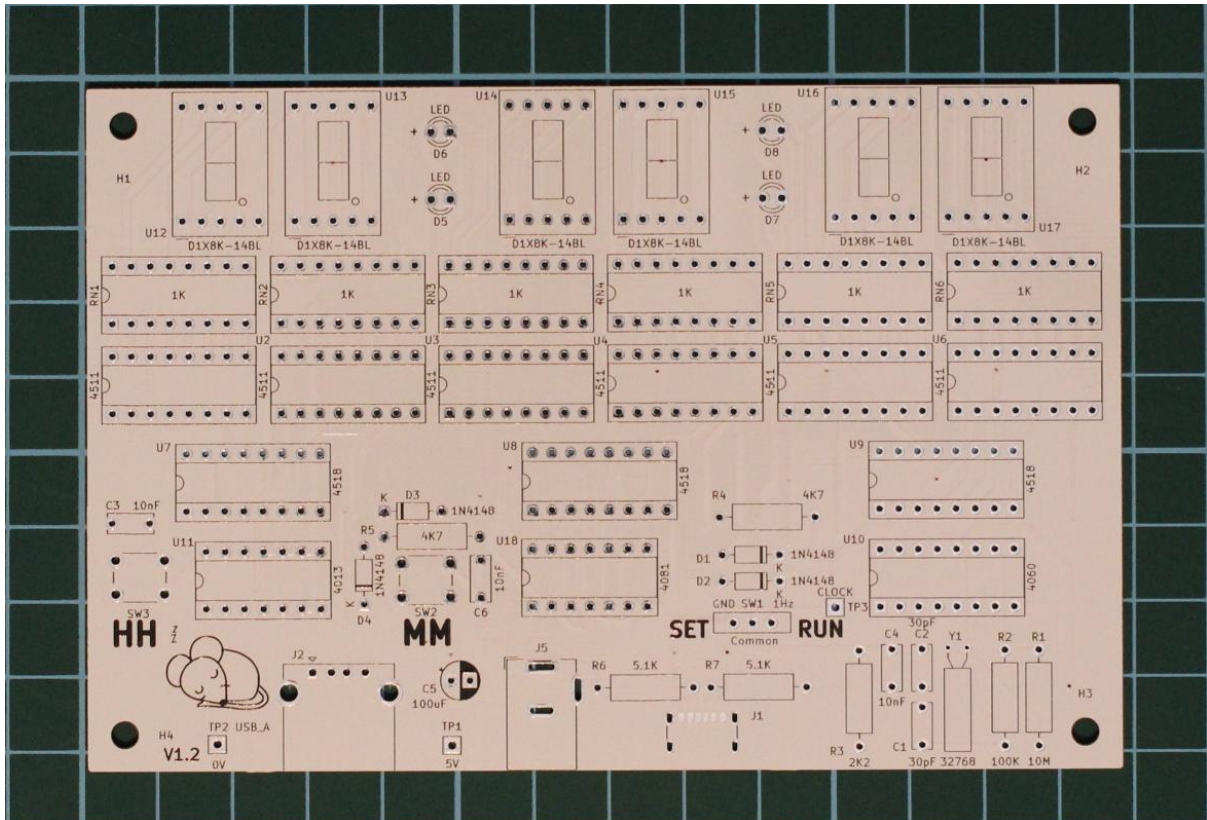
9 Reference Images

9.1 PCB (v1.4)



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9.2 Built (v1.2)



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