

Single Decatron

Clock Rev1

Construction Manual

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What this document is about

This document is the construction manual for the Single Decatron Clock shown on the first page.

The User Manual for everyday use is in a different document, also available from the documentation site at

<https://www.nixieclock.biz/Manuals.html>

Contact Information

If you want to get in contact with us, please email to:

nixie@protonmail.ch

We'll usually get back to you right away. We can help you with kits or construction.

We also offer discounts for direct purchases, we save the Ebay fees, and share this with you.

<https://www.nixieclock.biz/Store.html>

Troubleshooting

If everything does not work as you expect, please carefully look at the tests in the construction steps, and the troubleshooting tips.

At the end of the manual, there is a troubleshooting section, which goes through some of the common problems. If you can't work it out, please get in contact with us. **We guarantee that you will get going.**

Safety

The voltages produced in the High Voltage circuit can reach peaks of 500V! Take precautions not to electrocute yourself! If you are not sure what this means, please do not use this clock and return it for a full refund.

We offer refunds with no questions asked, if you are concerned about any safety issues involved in building this kit.

A shock from the clock high voltage circuit is at least a nasty bite. At worst it can kill you.

Continuing past this point in the manual indicates your acceptance of any and all liability for yourself or others who can come into contact with the device before during or after construction, and furthermore you hereby certify that you believe to possess the competence and experience necessary to build and operate this device.

We decline any responsibility in the case of injury or death.

REPEAT: If you are not sure, please do not use the clock. We will refund you your payment, no questions asked.

Powering Up

When you power the unit up for the first time, it will go into the startup test routine, and the Decatron will “spin” indicating that it is looking for a WiFi network to connect to.

Full details of how to log in and set up the Decatron Clock are in the User Manual.

For the purposes of construction testing it is only necessary to wait for 60 seconds and the clock will move on, and start counting the time using the internal Real Time Clock.

Component Identification

Sometimes it is hard to tell one component from another. Please see the “Component Identification” manual to help you tell one component from another. You can get this document here:

<https://www.nixieclock.biz/Manuals.html>

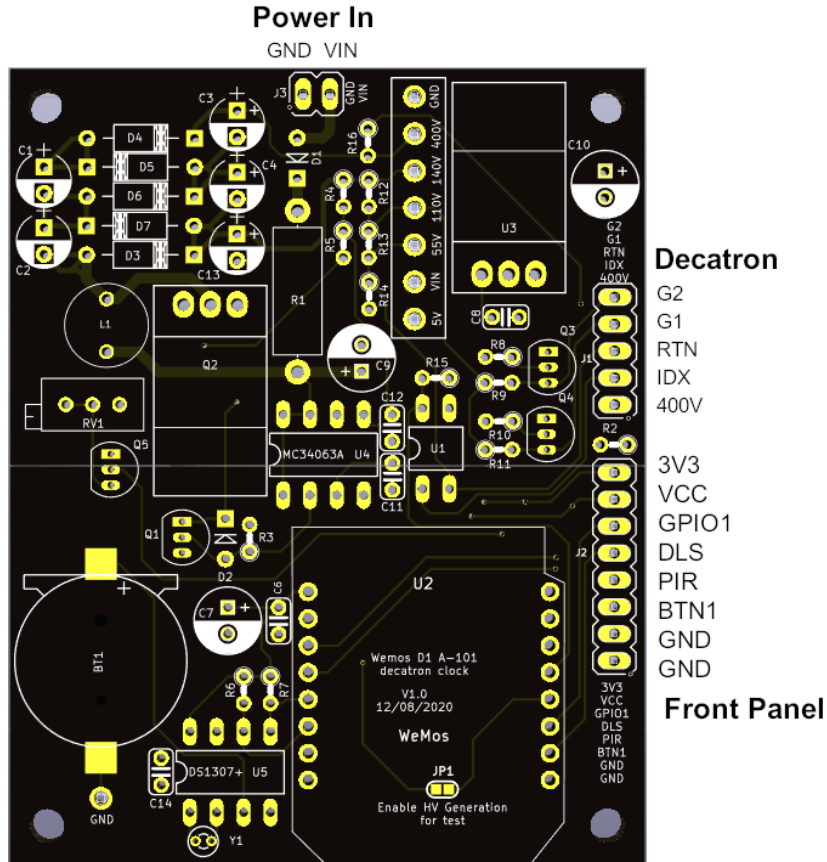
External power supply

The perfect voltage for the external power supply is between 7.5V and 12V DC. We recommend that you use a 9V DC supply. The connector should be “center positive”. An input protection diode is used, so you cannot damage the clock if you connect a “center negative” supply.

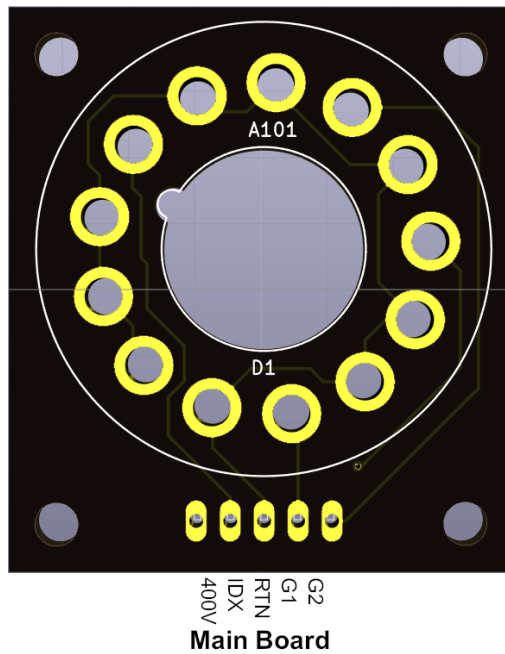
It is not advised to use more than 12V. The absolute maximum permissible is 16V DC. Higher voltages than this will surely damage the clock.

Board layout

For reference, the main board layout is:



The A-101 Decatron board layout is:

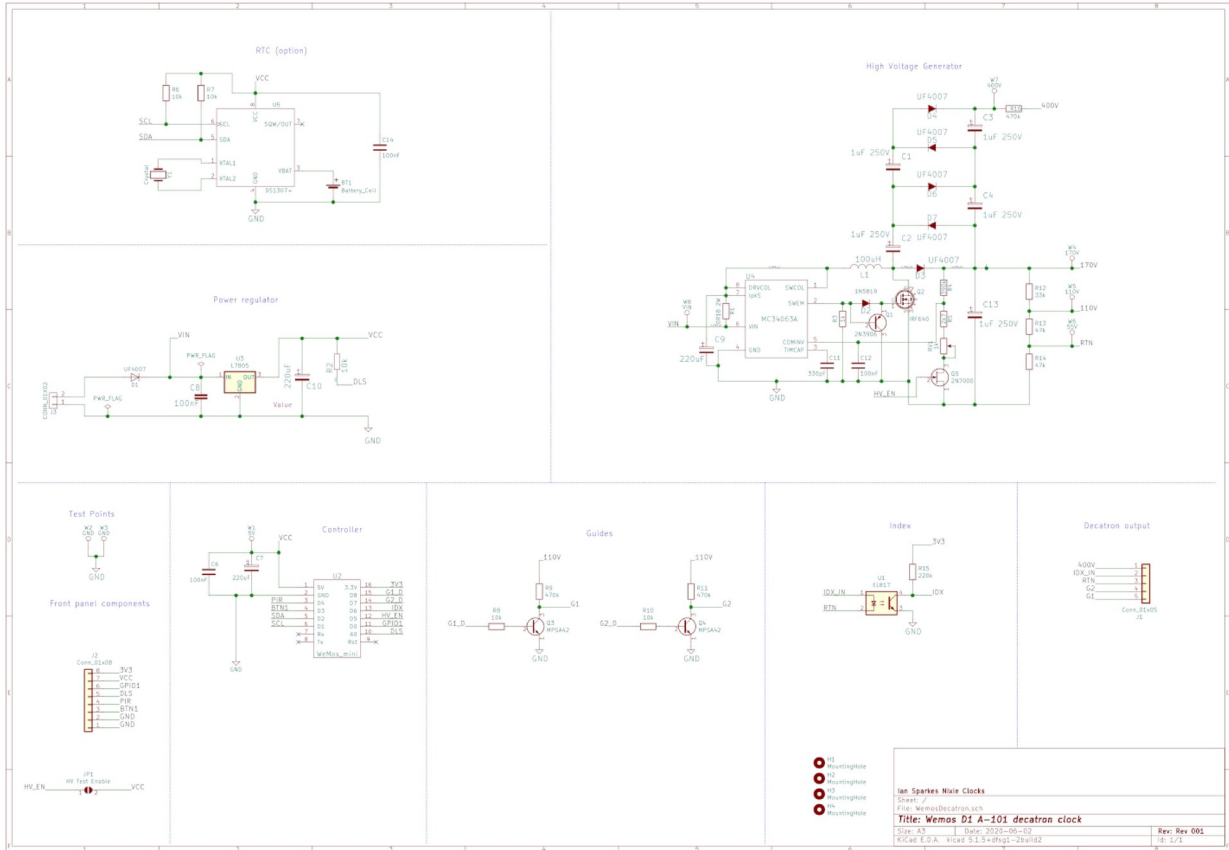


The connections are:

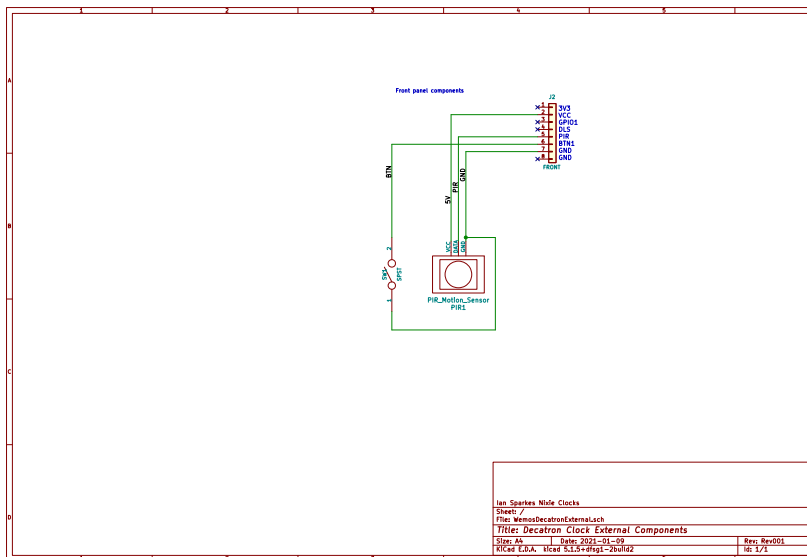
Connector	Description
Decatron and Main Board	<p>This is the connector which connects the Decatron Clock Main board to the Decatron mounting board.</p> <p>This connector has high voltage on it, so be careful!</p> <p>400V: The high voltage supply for driving the Decatron IDX: The index signal that lets the controller know when the index pin is illuminated RTN: The other side of the input supply G1: Guide signal for moving the currently illuminated pin G2: Guide signal for moving the currently illuminated pin</p>
FRONT PANEL	<p>These are the signals that you can use for the components on the case of the clock.</p> <p>GND: The "ground". One lead of the button and one lead of the motion detector are connected to this VCC: Regulated 5V output to power the motion detector. 3V3: Regulated 3.3V output. Not currently used. DLS: "Dimming LDR Sense": Not currently used. BTN1: The other lead of the button is connected to this input PIR: The motion detector sense lead input. GPIO1: A spare GPIO for your own ideas.</p>
Power IN	<p>External power can be applied to the board with this connector. Any DC input source is possible, from 7.5V - 12V.</p> <p>The absolute maximum input voltage is 16V. Any higher voltage than this will damage the board within a few seconds!</p> <p>GND: The negative side of the input supply VIN: The positive side of the input supply</p>

Schematic

Below is the schematic for the clock.



And for the Front Panel components:



Construction

Preparation

You should have a small tipped soldering iron, some thin ($\leq 1\text{mm}$) solder, and electronic side cutters.

Components

You should find the following contents as listed in the BOM (Bill of Materials) at the end of the document. It is best to check the contents before you start.

Please see the separate “Component Identification” manual to help you identify individual components if you need any help.

Low Voltage Circuit

Parts List:

D1	UF4007
C8	100nF
C10	220uF 10V
U3	7805
J3	CONN_POWER

The Low Voltage circuit is bog standard linear regulator. Its job is to reduce the external voltage from the power adapter down to a known and stable 5V to drive the micro-controller.

Put the parts on the board in the marked locations in the order they appear on the list.

Notes:

- See the section on “Component Identification” for help with identifying the components.
- D1 should be placed so that the lead from the end with the white stripe on the body goes into the square pad on the board.
- C10 must go the right way round. The negative side is marked with a stripe. (See hint)
- Put U3 so that the metal tab lays flat on the board. The space is quite tight so you have to bend the leads quite close to the body. Test fit the part to check that it fits in the space provided before soldering it.



Test Step

Once all the components are on the board, hook up the power, and check that the voltage is 5V between the “GND” test point and the “5V” test point and at the power connector.



Trouble shooting

If you don't get 5V, turn off immediately to avoid damage to the components. Check your soldering and the polarity of the components.

If the components are in the right way, connect the power again, and check that the voltage regulator does not get hot. If it does not, measure the voltages in the low voltage circuit.

Measure the voltage at the VIN test point and at the cathode side of D1 (nearest the centre of the board). This should measure 0.7V less than the input voltage.

If all is well, proceed to the next step. If not, check carefully the orientation of the components and the power leads. Diode D1 protects the board from having the power connected inverted.

Hint: The electrolytic capacitors

Each electrolytic capacitor has a stripe on it to denote the **negative** side of the capacitor. The positive side of the capacitor (which goes into the “+” on the board) is the other one!



220uF capacitor “stripe”

At the end of the low voltage circuit build, your board should look like this:

Low Voltage Circuit

High Voltage Circuit Part1

Parts List:

C9	220uF 35V
R1	0R18, 1W
C11	330pF
C12	100nF
R3	1k
Q1	2N3906
D2	1N5819
Q2	IRF640
L1	100uH
R4	390k
R5	2k7
RV1	1k
Q5	2N7000
U4	MC34063
D3	UF4007
C13	1uF 250V

The high voltage circuit uses a traditional MC34063 boost circuit to take the input voltage up to around 140V-170V. The exact voltage produced is not critical.

Later we will use a voltage multiplier to take this up to the required 400V+ for the Decatron.

Notes:

- See the section on “Component Identification” for help with identifying the components.
- C9 and C13 must go the right way round. The negative side is marked with a stripe (see hint).
- Put Q2 so that the metal tab lays flat on towards the PCB. The leads must be bent into shape close to the body of the device so that the component fits in the space on the board. Test how it fits before soldering it.
- D2 should be placed so that the lead from the end with the white stripe on the body goes into the square pad on the board.
- D3 should be placed so that the white stripe on the body lines up with the white stripe on the board.
- Put the socket for the MC34063 in place and take care that the “notch” lines up with the silk screen on the PCB. The IC should also go in the same orientation.
- If you have a lab power supply, use this with the current limited to 12V at 200mA for the first test.



Double check the orientation/location of the components!

Especially check that C13 and D2 are the right way round.

Temporarily jump the solder jumper JP1 on the board to enable the power supply.

Once all the components are on the board, hook up the power. Give your work a careful check to make sure that the orientation of the components is right.



Be careful, we are dealing with high voltages now!

The voltage may be significantly higher than 170V at the moment, because the high voltage generator is powerful and the output is not loaded.



Apply power to the board again. Listen for any stressed sounding buzzing or humming, and check that neither the voltage regulator nor the MOSFET get excessively hot.

Check that no components get hot.

Test the voltage at the 140V test point and check that it is around 140V. You can adjust RV1 to make the voltage about 140V.



If you hear any angry sounding buzzing turn the power off immediately and check the orientation of C1!

The circuit should run almost silently, with only a very faint “crackling” sound.



No HV is produced and you see only the input voltage at the 140V test point

Did you remember to close jumper JP1?



Q1 can get warm, **but should not get too hot to touch**. If it gets hot, you need to check the orientation of the components and that there are no solder bridges.

If you don't get the expected voltage reading:

- See the “Troubleshooting” section later in the document! There are lots of tips and tricks there.

At the end of the high voltage circuit build, your board should look like this:

High Voltage Circuit

High Voltage Circuit Part2

Parts List:

C1, C2, C3, C4	1uF 250V
D4, D5, D6, D7	UF4007
R16	470K
R12	33k
R13, R14	47K

The high voltage we produced in the last step is boosted up to three times the original voltage using a voltage multiplier.

We then also derive some intermediate voltages using a potential divider.

Notes:

- C1 - C4 must go the right way round. The negative side is marked with a stripe (see hint).
- D4 - D7 should be placed so that the white stripe on the body lines up with the white stripe on the board.



Warning!

Double check the orientation/location of the components!

Especially check that C1 - C4 and D4 - D7 are the right way round.



Warning!

Be careful, we are dealing with VERY high voltages now!

The voltage may be significantly higher than 500V at the moment, because the high voltage generator is powerful and the output is not loaded.



Test Step

Apply power to the board again. Listen for any stressed sounding buzzing or humming, and check that neither the voltage regulator nor the MOSFET get excessively hot.

Check that no components get hot.

Test the voltage at the 55V, 110V and 400V test points and check that they are approximately correct.

Guides and Index

Parts List:

R8, R10	10k
R9, R11	470k
Q3, Q4	MPSA42
U1	EL817

Place the components on the board in the order above.

Notes:

- Be careful soldering U1 - make sure that it goes in the right way round.

There is no test for this step.

Controller

Parts List:

C6	100nF
C7	220uF 10V
U3	Wemos D1 R2

Solder the header strips for the Wemos onto the PCB, and the header pins onto the Wemos. Place the two decoupling capacitors.

Notes:

- Take care of the orientation of C7 and the Wemos. When you place the Wemos into the headers, the “antenna” on the Wemos PCB is on the outside of the board.
- The Wemos is mounted so that the silver metal case is upwards, and the rest of the components are on the side closest to the main PCB. (See picture).

Remove the solder from the solder jumper JP1 on the board to let the Wemos control the HV generator!



Test Step

Apply power to the board again.

Check that no components get hot.

Test the voltage at the 55V, 110V and 400V test points and check that they are approximately correct.

Mount and attach the Decatron

Parts List:

Decatron	A-101 Decatron
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Put the Decatron on the holder board and wire up the two boards 1:1.

Notes:

- Take care of the orientation of interconnect between the main PCB and the Decatron PCB.



Test Step

Apply power to the board again.

The Decatron should show a slowly rotating point on the display.

Real Time Clock

Parts List:

R6, R7	10k
U5	DS1307
C10	100nF
Y1	32.768kHz crystal
B1	CR1220 holder

Put the components onto the PCB, being careful of getting the DS1307 and the socket the right way round.

After you have done this, the construction is completed, and the PCB should look like this:

Completed Construction

Front Panel components

Most of the front panel components are not needed. Only the optional motion detector (PIR or microwave module) is really useful.

Possibilities for a switch and an LDR are included if you wish to expand the software yourself. By default they are not used and are not supplied.

Parts list:

SV2	8 pin connector
LDR	LDR (not used)
S1	SWITCH (not used)
R2	10k
PIR	PIR detector (optional)

The switch is de-bounced in software, so practically any switch you want to use is suitable. A simple switch is provided in the kit, but you might want to substitute this switch with one that suits your case.

The motion detector is supported by default in the software. Link it up as in the “External Components” wiring diagram.

Troubleshooting

If not everything goes as you expect, please refer to the test steps during the construction and the associated troubleshooting tips. If that does not cover the problem you have, please see below. If you still can't find the answer, contact us!



Trouble
shooting

Q2 can get warm, **but should not get too hot to touch**. If it gets hot, you need to check the orientation of the components and that there are no solder bridges.

If you don't get the expected voltage reading:

- Check your soldering that there are no bridges or dry joints.
- Check that the external power supply is able to supply the power needed to achieve the high voltage: check that the VIN voltage is stable and not fluctuating.

Other items will be added here as time goes on.

Programming the micro-controller

The micro-controller comes preprogrammed. You don't **need** to program it, but you might want to.

You can update the micro-controller with a newer version of the software, or even create your own software, and load it onto the chip. We have gone to a lot of trouble to make this as easy as possible.

The easiest way is to use the OTA (“Over The Air”) update possibility. This lets you load new firmware just using a browser. See the User Manual for more information.

The other way is to connect to the Wemos using a USB cable. The software has been developed in the Arduino IDE, and this makes it easy to change and upload.

Parts list / BOM

#	Qty	Value
R16,R9,R11	3	470k
Q5	1	2N7000
C8,C6,C12,C14	4	100nF
Q2	1	IRF640
U3	1	L7805
D1	1	UF4007
D2	1	1N5819
C13,C2,C1,C4,C3	5	1uF 250V
D3,D4,D5,D6,D7	5	UF4007
U1	1	EL817
L1	1	100uH
Y1	1	Crystal
C11	1	330pF
R2,R6,R7,R8,R10	5	10k
R3	1	1k
R4	1	390k
R5	1	2k7
Q1	1	2N3906
R1	1	0R18 2W
U5	1	DS1307+
U4	1	MC34063A
U2	1	WeMos mini D1 R2
BT1	1	Battery Holder CR1220
C10,C7	3	220uF 10V
C9		220uF 35V
RV1	1	1k
Q3,Q4	2	MPSA42
R12	1	33k
R13,R14	2	47k
R15	1	220k

Revisions:

V0001: 9Jan20201: First version