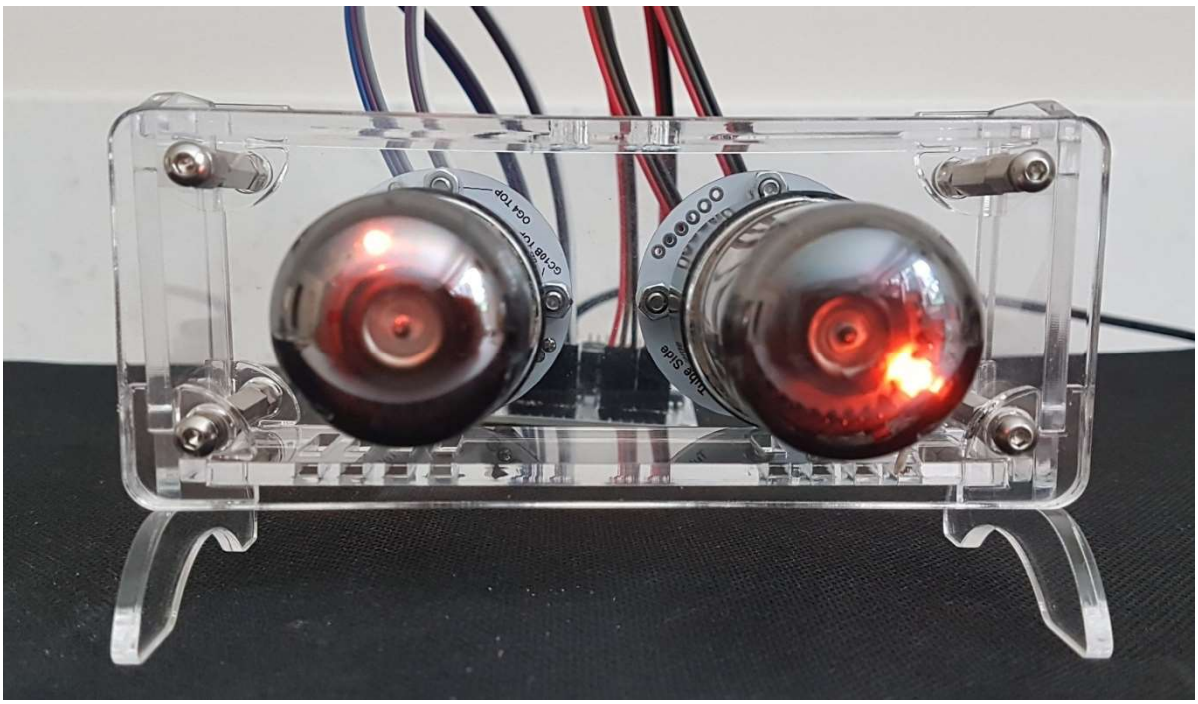
Assembly Instructions
And
User Guide

‘DekaDuo’



REVISION HISTORY

Issue Number	Date	Reason for Issue
Issue 1	01 June 2019	New document

1. INTRODUCTION

1.1 Here are the key features of the DekaDuo Kit:

- Drives two OG4 Dekatrons independently
- Each Dekatron can operate in one of 3 modes
- Can be powered direct from a compatible clock
- Compatible clocks will synchronise the Dekatrons
- When connected to a compatible clock, the Dekatrons can power down in clock night mode

1.2 SAFETY

DANGER: The clock pcb includes a switched-mode voltage booster circuit. This generates nominally 500 Volts DC. Assembly may only be undertaken by individuals who are suitably qualified and experienced in electronics assembly, and are familiar with safe procedures for working with high voltages. If in doubt, refer to a suitably qualified engineer before proceeding.

The voltages generated by this circuit can give a potentially LETHAL ELECTRIC SHOCK.

DISCLAIMER: This product is supplied as a kit of parts, intended only for suitably qualified electronic engineers, who are suitably qualified and experienced in electronics assembly, and are familiar with safe procedures for working with high voltages. The supplier, his agents or associates accept no liability for any damage, injury or death arising from the use of this kit of parts.

This is not a finished product, and the person assembling the kit is responsible for ensuring that the finished product complies with any applicable local regulations governing electrical equipment, eg. UL, CE, VDE.

2. TOOLS AND EQUIPMENT REQUIRED

2.1 Tools required to assemble the PCB.

The following tools will be required to assemble the PCB:

- Soldering iron with a small tip (1-2 mm).
- Wire cutters to trim the excess component leads after soldering. (TIP: A small pair of nail clippers works very well for this function).
- Wire strippers (TIP: A small pair of scissors is quite suitable).
- Multimeter for voltage tests and for identifying the resistors.

2.2 Materials you will need.

Solder – lead / tin solder is highly recommended.

USE LEAD/ TIN SOLDER!

Lead free solder, as now required to be used in commercial products in Europe, has a much higher melting point and can be very hard to work with.

Desoldering wick (braid) can be useful if you accidentally create solder bridges between adjacent solder joints.

2.3 Other items you will need.

The clock kit does not include a power adapter. It can either be powered by a 12V adapter as shown below.

Output 12V DC regulated, minimum power output capability of 500mA
Output plug: 2.1mm pin, centre positive.

Alternatively, it can be powered direct from a compatible clock via a 3 way cable which is provided. This gives the advantage that the Dekatrons will be perfectly synchronised to the top of the minute / second

3. LIST OF COMPONENTS

3.1 Table of Components – Driver Board

Circuit Designation	Part Description
Resistors	
R1	560 Ω, ¼ Watt
R2, R3	4.7 KΩ, ¼ Watt
R4	390 KΩ, ¼ Watt
R5 – R8	33 KΩ, ¼ Watt
R9	270 KΩ, ¼ Watt
R10	200 KΩ, ¼ Watt
R11	15 KΩ, ¼ Watt
R12	200 KΩ, ¼ Watt
R13	15 KΩ, ¼ Watt
R14	33 KΩ, ¼ Watt
R15	270 KΩ, ¼ Watt
R16	200 KΩ, ¼ Watt
R17	15 KΩ, ¼ Watt
R18	200 KΩ, ¼ Watt
R19	15 KΩ, ¼ Watt
R20	33 KΩ, ¼ Watt
R21	560 Ω, ¼ Watt
R22	1 KΩ, ¼ Watt
Capacitors	
C1	100 nF Ceramic
C2	220uF 16-25V Electrolytic
C3 – C7	1uF, 250V Electrolytic
C8	100 nF Ceramic
C9 – C11	22 pF Ceramic
Transistors	
Q1	IRFD220
Q2, Q3	MPSA42
Q4	EL817 Optocoupler
Q5, Q6	MPSA42
Q7	EL817 Optocoupler
Diodes	
D1	5.6V Zener diode
D2 – D6	UF4004
SYNC LED	3mm LED (various colours)
Integrated Circuits	
IC1	PIC16F1827
Miscellaneous	
L1	100uH Radial inductor
IC2 Socket	28 Way narrow IC socket for IC2
OUT1, OUT2	6 way X 0.1” Male header
DEK1, DEK2	4 way X 0.1” Male header with jumper
Sync Header	3 way X 0.1” Male header
X1	8.000 MHz Crystal
J1	2.1mm PCB power socket
Power Cable	3 way Power Cable to connect to clock

3.2 Packing Sheet

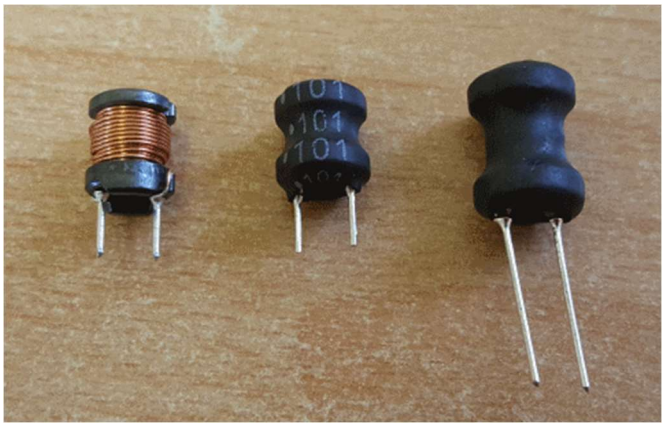
Part Description	Quantity
Resistors	
560 Ω, ¼ Watt	2
1 KΩ, ¼ Watt	1
4.7 KΩ, ¼ Watt	2
15 KΩ, ¼ Watt	4
33 KΩ, ¼ Watt	6
200 KΩ, ¼ Watt	4
270 KΩ, ¼ Watt	2
390 KΩ, ¼ Watt	1
Capacitors	
100nF, Ceramic	2
22pF, Ceramic disc	3
220uF, 16-25V, Electrolytic	1
1uF, 250V, Electrolytic	5
Transistors	
IRFD220	1
MPSA42	4
EL817 Optocoupler	2
Diodes	
5.6V Zener diode	1
UF4004	5
3mm LED	1
Integrated Circuits	
PIC16F1827 8-bit microcontroller	1
Miscellaneous	
100uH inductor	1
18 way narrow IC Socket for IC2	1
Male header strips (10+10+3)	23
0.1” pitch jumper	2
8.000 MHz Crystal	1
3 Way power cable 20cm	1
2.1mm PCB power socket	1

3.3 Parts Identification

We recommend to check against the list above, to ensure all parts are present before commencing assembly.

The resistors used in the kit are 1% tolerance metal film. They are marked with four coloured bands to identify the value. However it is sometimes unclear in which direction the bands should be read. Therefore, we recommend that the resistors be identified with a multimeter.

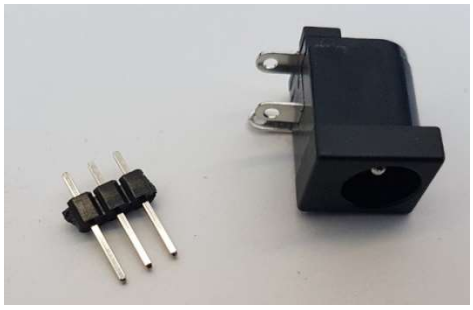
Inductor L1 may take different apperances:

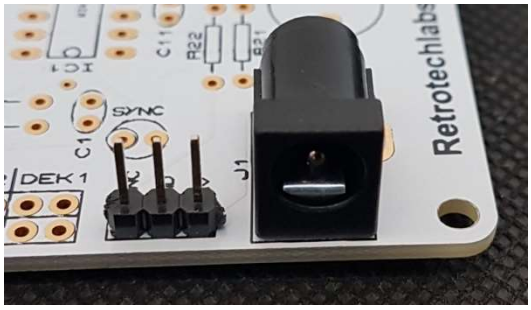


4. ASSEMBLY OF THE DRIVER PCB

4.1 Power Socket or 3 Way Power Header

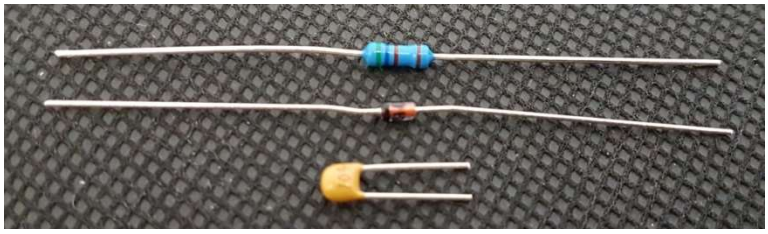
If you intend to power the DekaDuo from a compatible clock, there Is no need to solder the DC power socket. However it still may be a good idea to solder it as it will make things easier for testing voltages and other tests during construction, without having to have the clock to hand.



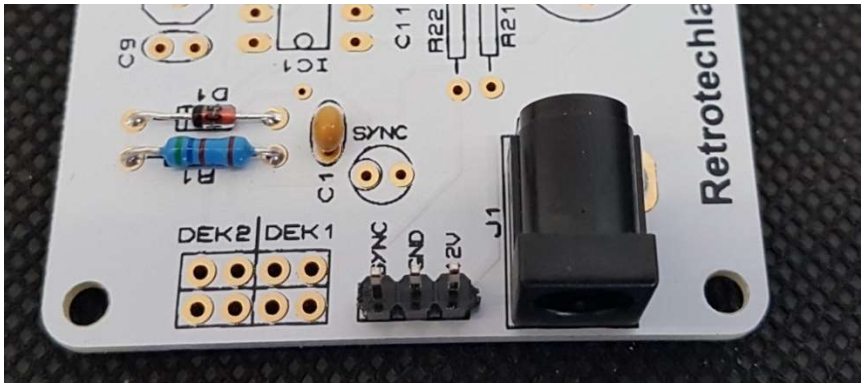


4.2 Low Voltage Components

R1 (560 Ω)
D1 (5.6V Zener Diode)
C1 (100nF)

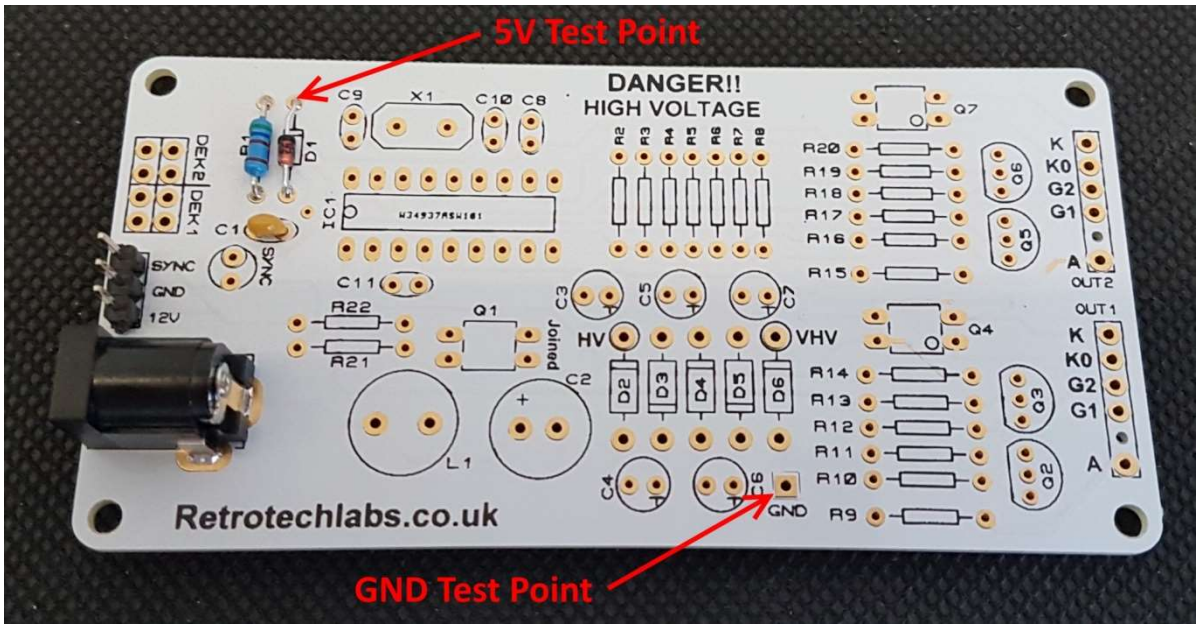


Note that D1 is polarized – match the black band on the body of the part with the corresponding band on the PCB.



4.3 Testing Low Voltage Power Supply.

Identify the test GND, and 5V test points as shown below.

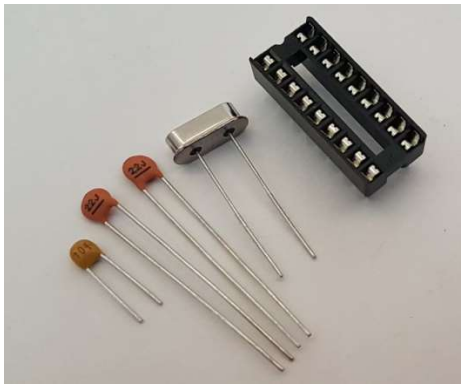


Plug in the 12V DC power supply, and then test using a DC voltmeter: Touch the black probe on the GND test point and the red probe on the 5V test point. The voltage should measure between 5.4 and 5.8 Volts. If not, disconnect power and check your work. Do not proceed with the assembly until the error is corrected. Once the test is completed, disconnect the power.

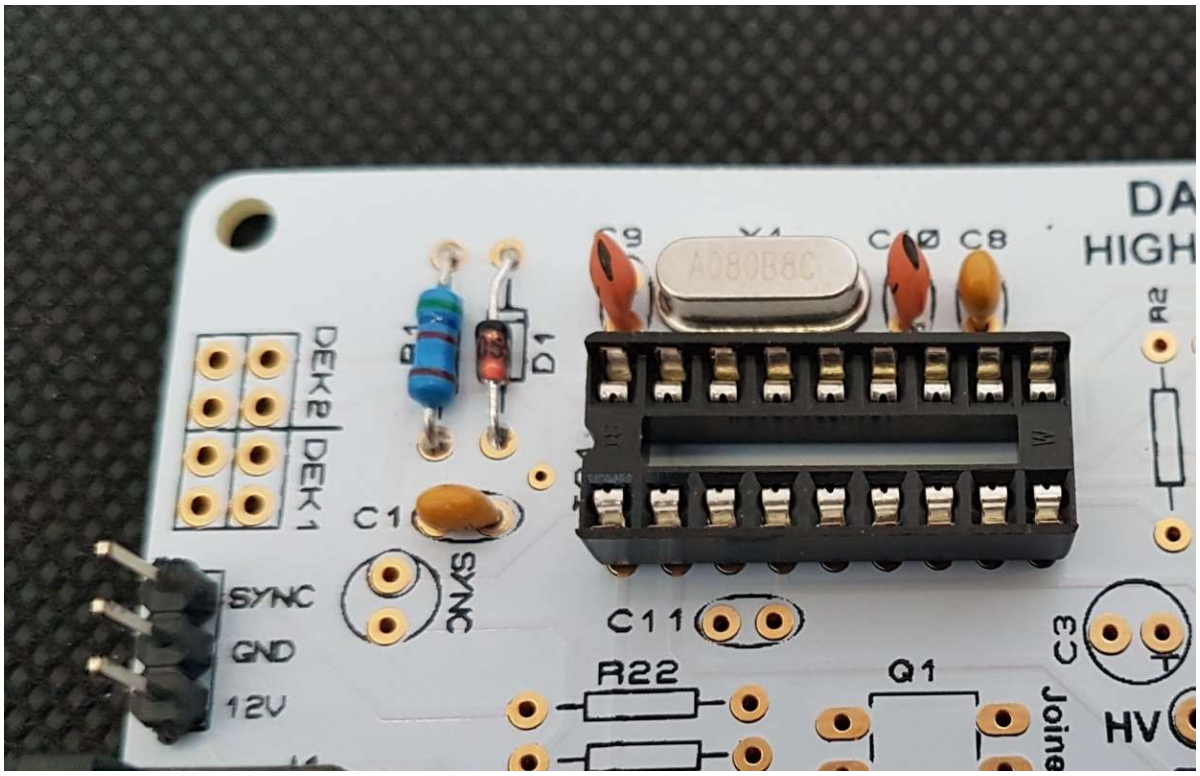
IF YOU CHOOSE TO PROCEED BEYOND THIS POINT WITHOUT GETTING THE CORRECT VOLTAGE, WE WILL NOT BE ABLE TO OFFER SUPPORT

4.4 Microcontroller and Ancillary Parts

Socket for IC1
X1 (8 MHz Crystal)
C8 (100 nF)
C9, C10 (22 pF)

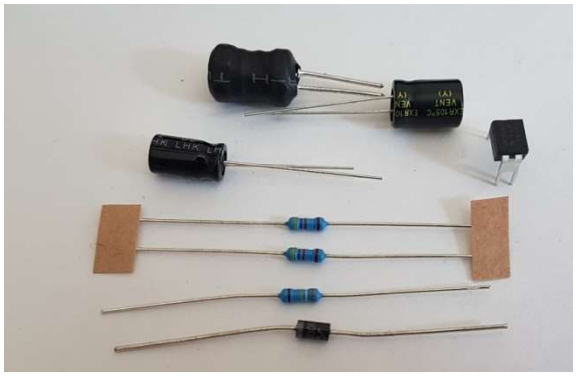


Take care that the notched end of the IC socket is at the end shown. However if after you solder the part you realise the notch is at the wrong end, DON'T try to desolder it! Actually, so long as the IC has the correct orientation, the socket does not really matter.



4.5 High Voltage Generator components.

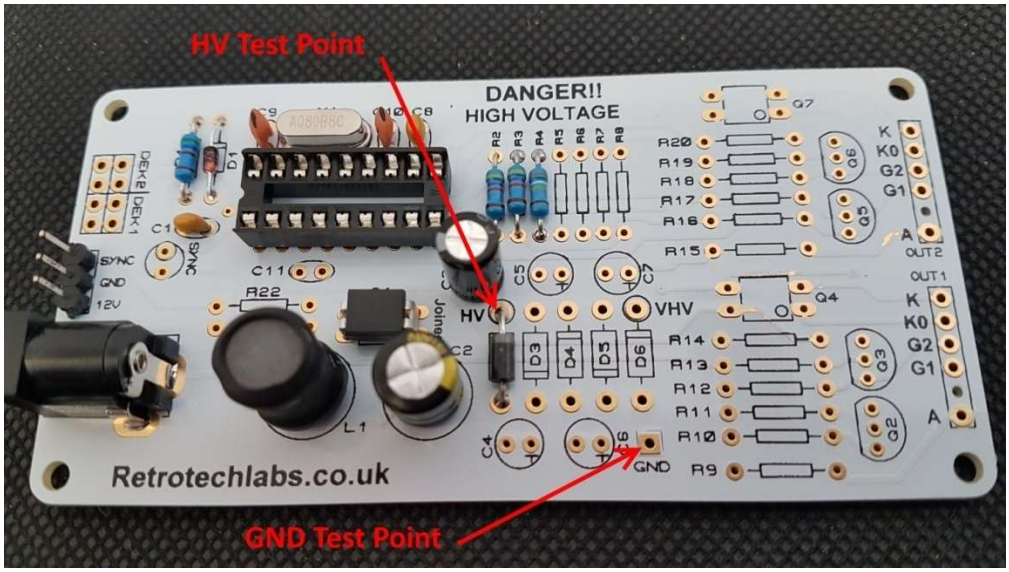
R2, R3 (4.7 KΩ)
R4 (390 KΩ)
C2 (220uF)
C3 (1uF)
D2 (UF4004)
Q1 (IRFD220)
L1 (100uH Inductor)



Take care that you have the correct part for Q1. It has 2 of its pins joined as they come out of its black resin body. Also the MOSFET needs to be placed with the two joined pins as marked on the PCB.

The 2 capacitors are polarised. The Longer lead goes into the hole with a + sign.

Finally, observe the polarity of D2 as per the image below.



4.6 High Voltage Generator Test.

- Refer to the warnings on page 3

- If you removed IC1, Insert IC1 back into its socket. Orient the notch on the IC with the notch on the IC socket and the PCB marking.
- Identify the GND and HV test points on the picture above.
- Power up the PCB, and using the GND and HV test points, measure the high voltage generated using a voltmeter on DC setting. It should be between 165 and 176 Volts. If this is in order, disconnect the power supply.

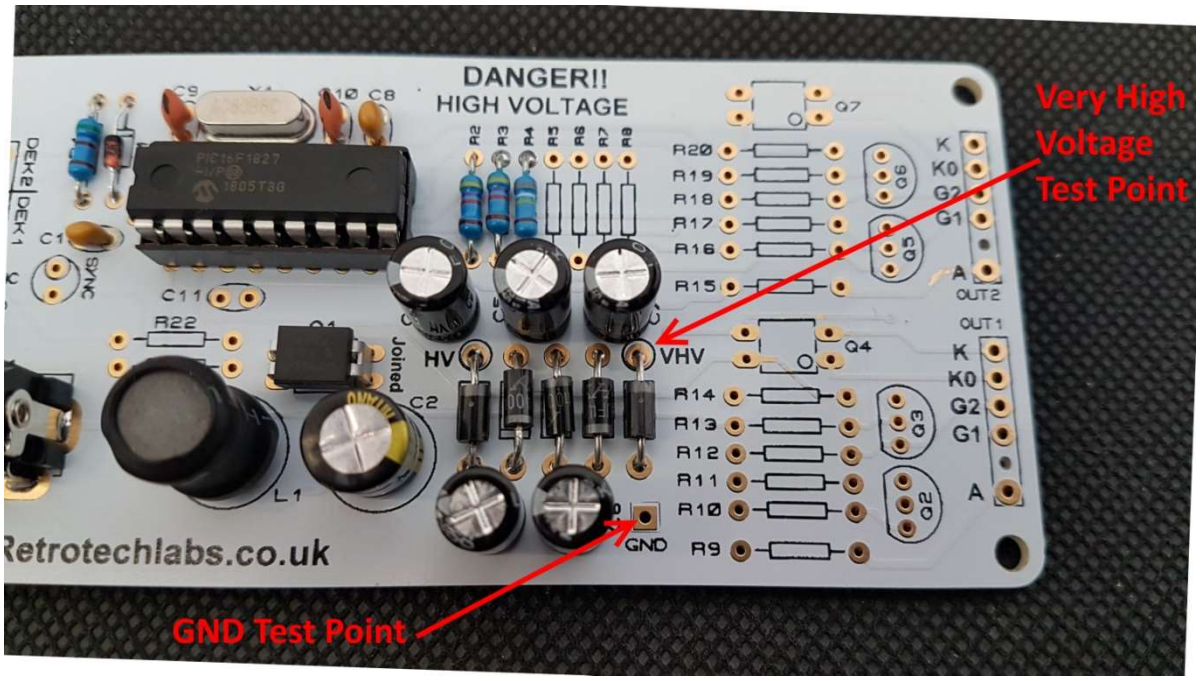
IF YOU CHOOSE TO PROCEED BEYOND THIS POINT WITHOUT GETTING THE CORRECT VOLTAGE, WE WILL NOT BE ABLE TO OFFER SUPPORT

4.7 Voltage Tripler Generator components

C4 – C7 (1uF)

D3 – D6 (UF4004)

Take care of polarities of these components. The long lead of the capacitor goes in the hole marked + and the white stripe on the diodes matches the stripe on the PCB. Look at the picture below:



4.8 Very High Voltage Generator Test (500V).

- Refer to the warnings on page 3

- Insert IC1 into its socket. Orient the notch on the IC with the notch on the IC socket and the PCB marking.

- Power up the PCB, and using the GND and VHV test points as shown above, measure the high voltage generated using a voltmeter on DC setting. It should be approximately 500 Volts. If this is in order, disconnect the power supply.

Note that the capacitors can hold this voltage for some minutes after power off, so do not handle the PCB for 5 minutes after this test.

IF YOU CHOOSE TO PROCEED BEYOND THIS POINT WITHOUT GETTING THE CORRECT VOLTAGE, WE WILL NOT BE ABLE TO OFFER SUPPORT

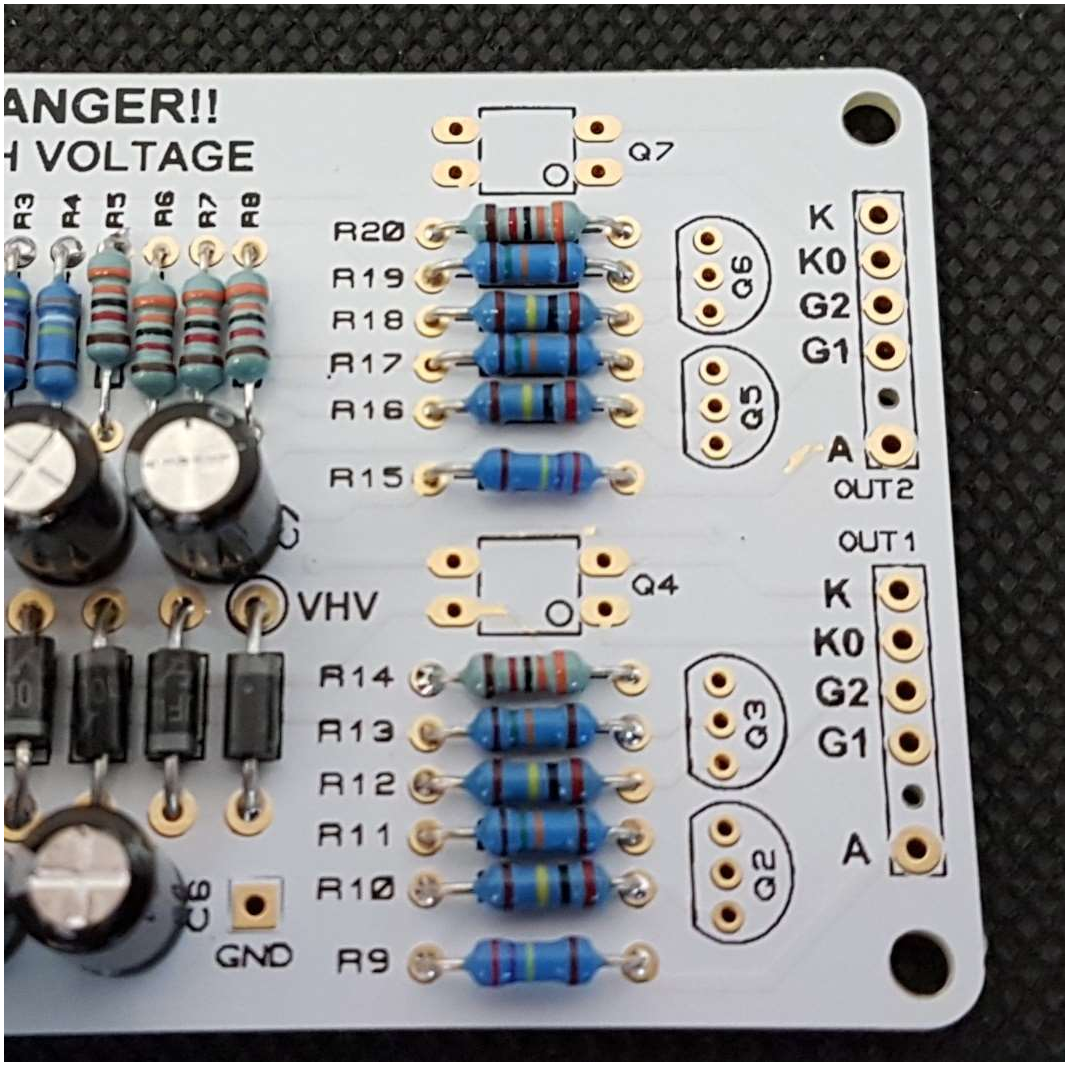
4.9 Voltage Divider Resistors
R5 – R8 (33 KΩ)

4.10 Anode Driver Resistors
R9, R15 (270 KΩ)

4.11 R11, R13, R17, R19 (15 KΩ)

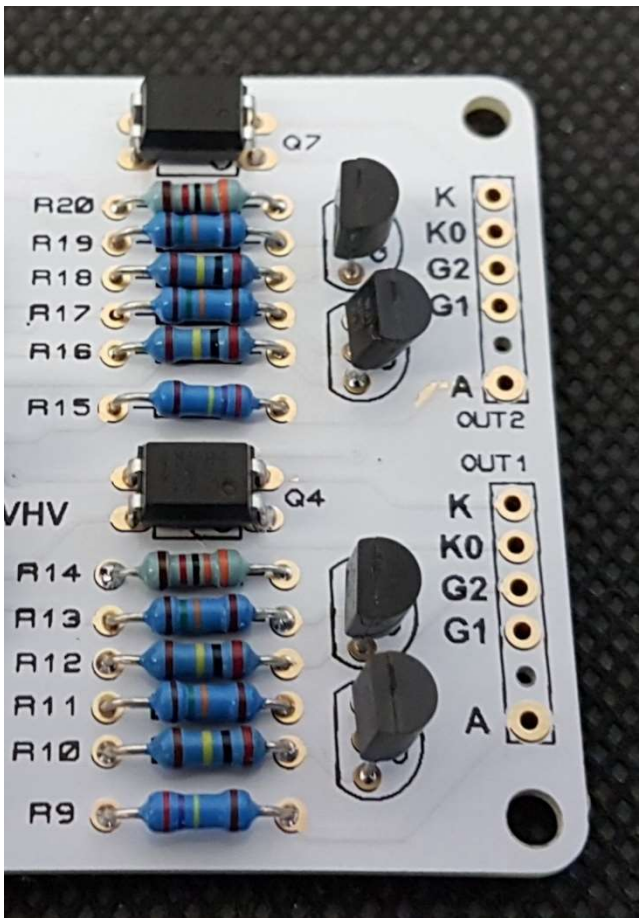
4.12 R10, R12, R16, R18 (200 KΩ)

4.13 R14, R20 (33 KΩ)



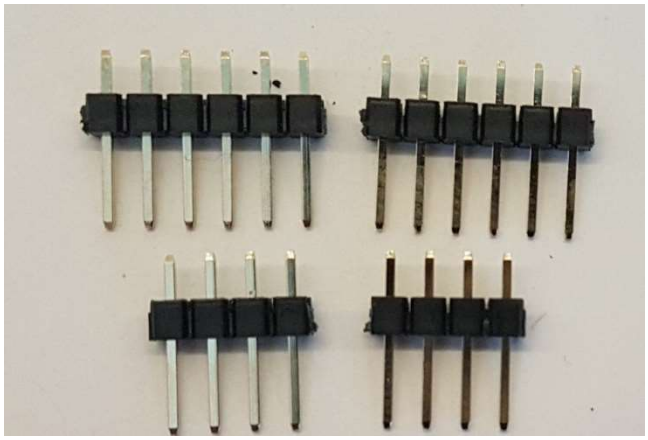
4.14 Transistors Q2, Q3, Q5, Q6 (MPSA42) Q4, Q7 (EL817)

The PCB marking shows clearly the orientation of the EL817's by reference to the dots on the parts matching the dots on the PCB

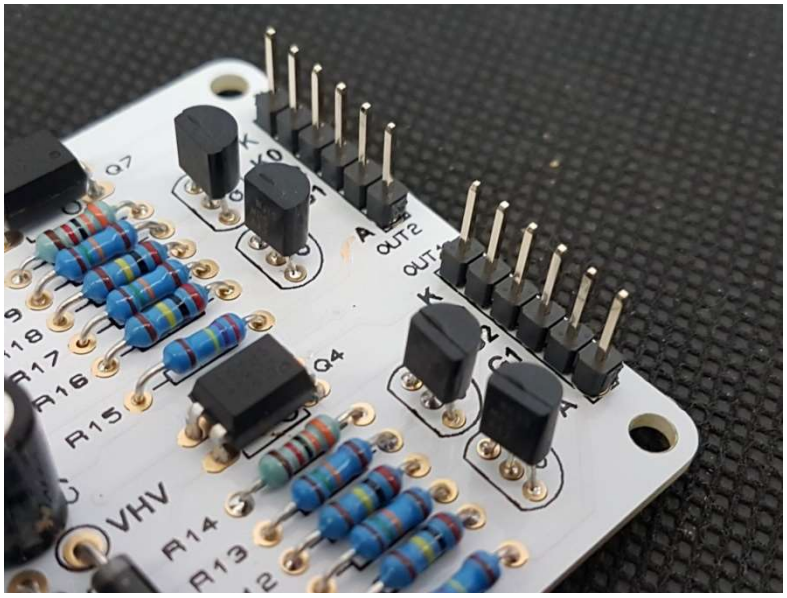


4.15 Dekatron Output Headers

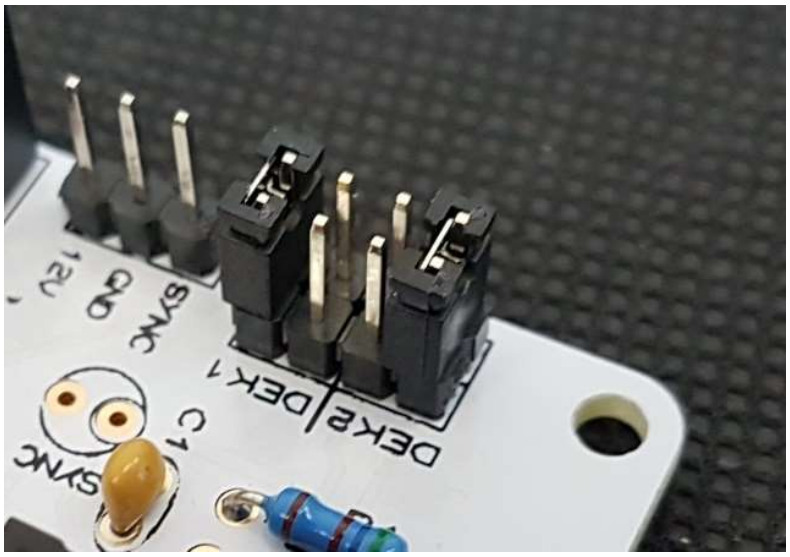
Break the two 10-way headers into a 6 and a 4:



Now solder the 6 way headers at the Dekatron output pads



Also solder the 4 way headers at the DEK1 DEK2 positions where you will use jumpers to select which of three modes each Dekatron operates in. It helps to put the jumpers onto the pins before soldering, so the pins are in exactly the right place.



4.16 C11 (22pF)
R21 (560 Ω)
Sync LED
R22 (1 KΩ)

The LED is polarised – the longer lead goes in the hole with the black circle around it.

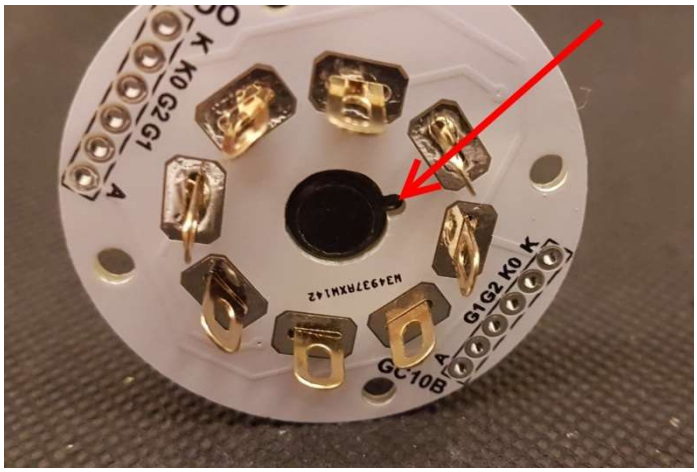
The Driver PCB is now fully assembled.

5. ASSEMBLY OF THE TUBE PCB

5.1 Gold Sockets

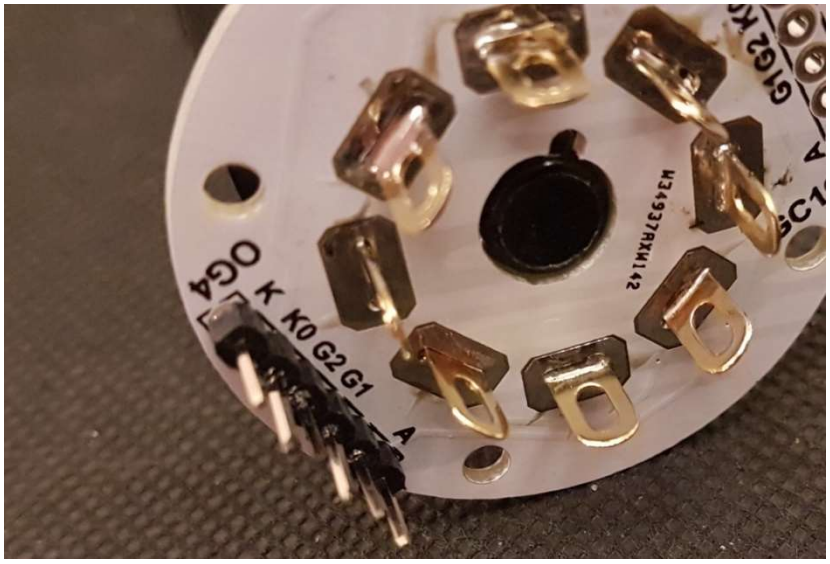
Push the 8 gold sockets onto the pins of the OG-4 tube fully, until they touch the main resin body. Note the alignment of each socket – the flat is on the outside rather than on the inside.

Now gently feed the sockets into the matching slots on the tube PCB. Get the alignment of the tube correct with regard to the slot on the PCB. Be really careful to push the tube in from the correct side of the PCB, marked 'Tube Side'. Then solder the sockets. Don't flood with too much solder that the solder passes through the PCB and solders the actual tube pin!



5.2 Connections Header

Solder the 6 way header on the PCB as shown below. Solder at the OG-4 position. Ignore the GC10 position.



Use two 3-Way cables to connect up the tube to the driver PCB. Use the different colours of the cables to ensure the connections match!

6. HOW TO OPERATE THE UNIT

6.1 Power Source

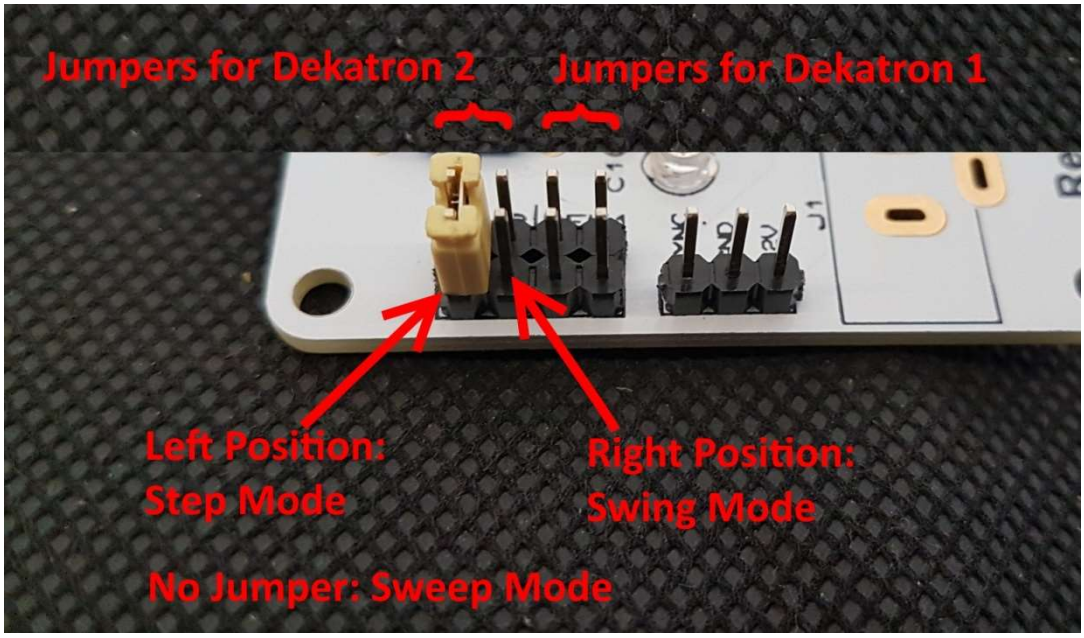
You can either power using the DC socket with 12V, or using the 3 way header from a 12V power source. In either case, you can still use the SYNC pin of the header to synchronise the Dekatrons with a clock.

6.2 Configuring the Jumpers

The jumpers configure how each Dekatron will cycle. There are three possible modes:

Sweep: The Dekatron completes a full rotation in 1 second.
Step: The Dekatron advances 1 step per second, so completes a full rotation in 30 seconds
Swing: The Dekatron swings fully anticlockwise, then fully clockwise each second.

The default mode for each Dekatron is with NO JUMPER installed, and the Dekatron will be in Sweep mode. Refer to the diagram below to show how to configure each of the 2 Dekatrons



6.3 Providing a Sync Signal

Many of our compatible clocks are being upgraded to provide the necessary sync pulse, but if you are driving from your own clock or Arduino type project, here are the requirements:
High Signal Level: 3.3V to 5.5V
Sync pulse length: 20uS (min 18uS, max 22uS)
Polarity: The pulse should be negative going, in other words the Sync line should be held high, and when appropriate, pulled to GND for 20uS

6.4 Function of SYNC LED

The LED is provided as a very simple indication whether the module has received a valid 20uS sync signal. Note: It flashes for longer than 20uS otherwise you would not actually see it!

It can be very helpful when connecting up your clock to know that the critical sync signal is being transmitted correctly.

6.5 Notes about Sync Signal

If the clock does not receive a valid sync signal within 3 minutes of power up, it will assume it is to run independently, and no longer seek a sync signal. Similarly, if the module IS running under Sync control, then discontinuing of the Sync signal will make the module sleep. It waits 3 consecutive minutes of discontinued Sync signal before entering sleep mode.

6.6 Reversing the Direction

The direction of rotation of the Dekatron can be achieved by swapping the connectors at the G1 / G2 positions – either at the PCB end or the tube end of the cable. The default direction in step and sweep modes is clockwise.

6. CONNECTION TO COMPATIBLE CLOCKS

6.1 Compatible Clocks

The Dekatron input pulse can be connected and synchronised to the following clocks. Check your clock firmware revision by pressing and holding SET.

RemoteSystem Kit:
Compatible with all PCBs, all firmware versions

QTC Plus Kit:
Compatible with all PCB dates, but firmware 2.0 or above is required. We have an upgraded PIC processor for sale on the website at nominal cost.

ELITE Kits:
Compatible with all PCB dates, but firmware 2.0 or above is required. We have an upgraded PIC processor for sale on the website at nominal cost.

Spectrum 1040 Kit:
Compatible with all PCB dates, but firmware 4.4 or above is required. We have an upgraded PIC processor for sale on the website at nominal cost.

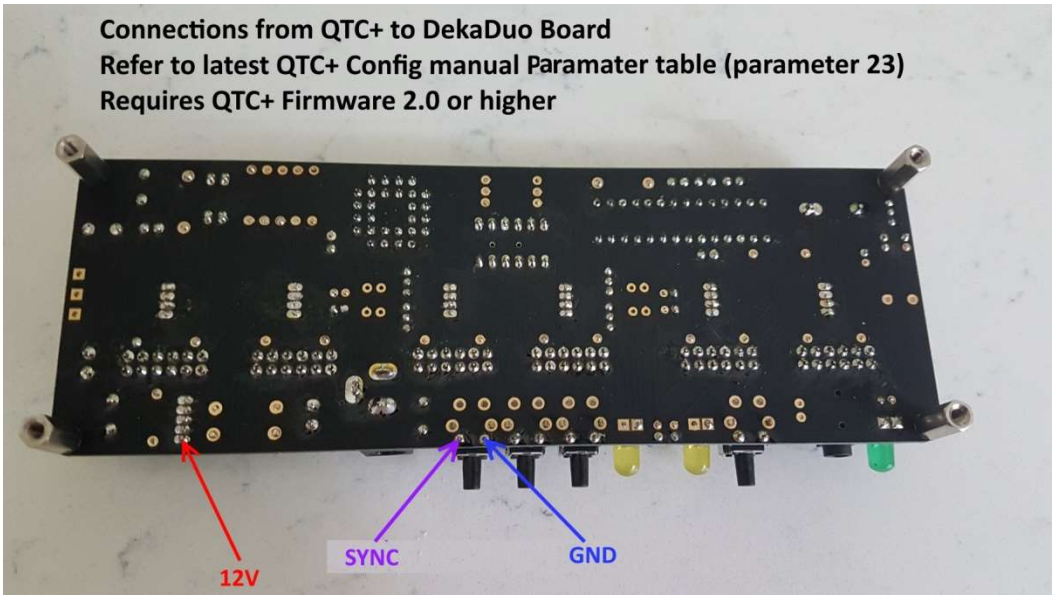
Spectrum 18 Kits:
PCB Date: January 2015: Not Compatible
PCB Date: 1 June 2015: Not Compatible
PCB Date: 1 October 2015: Compatible, but firmware 4.4 or above is required. We have an upgraded PIC processor for sale on the website at nominal cost.

Spectrum R|568 Kit:
Compatible with PCB date 10 August 16, but firmware 4.4 or above is required. We have an upgraded PIC processor for sale on the website at nominal cost.

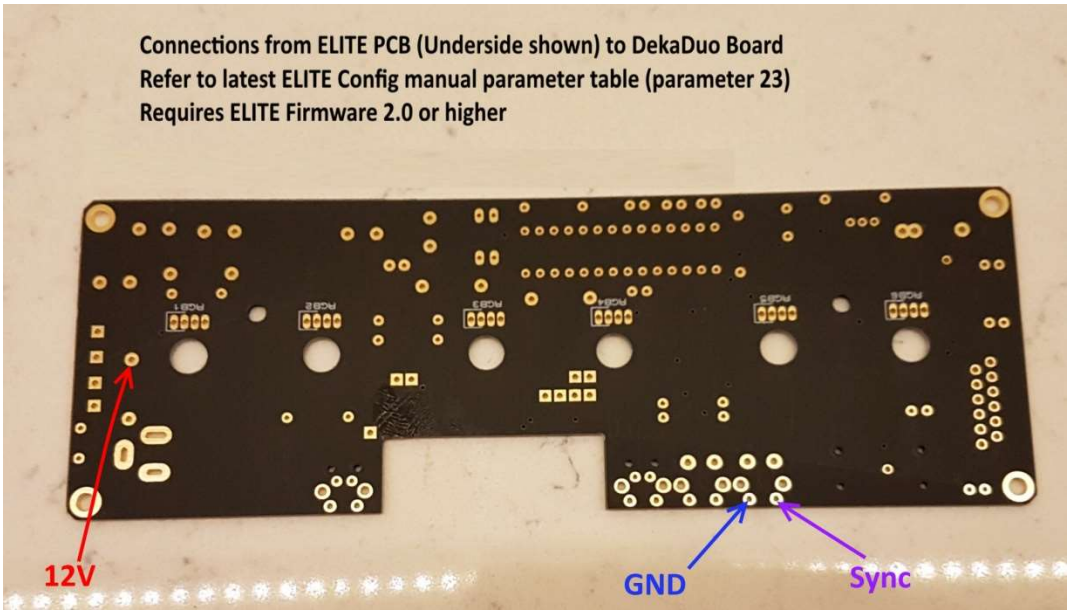
6.2 Making the connections

Connecting to the RemoteSystem Board is via a dedicated header, so no further explanation should be required. All other kits require wiring into the clock's 12V line, GND and the Sync pin on the clock. Please see below for specific details for your clock:

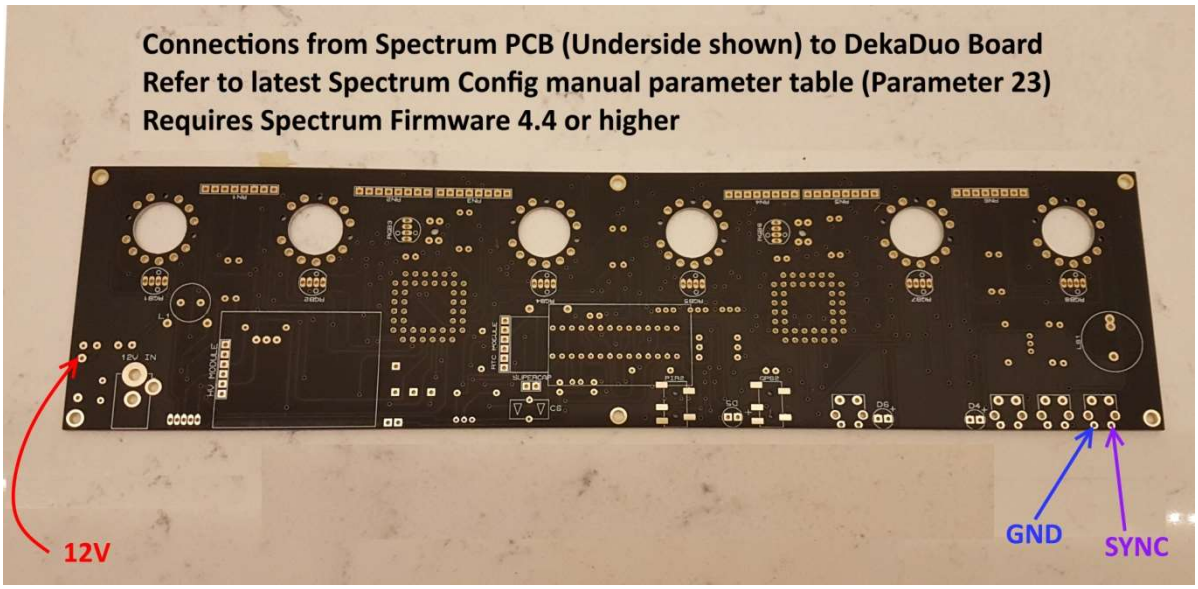
QTC Plus:



ELITE:



Spectrum 18 / Spectrum 1040:



8. CIRCUIT DIAGRAM