TubeHobby Nixie Clocks Tubes & Accessories

NCV2.1 Nixie Clock

User's guide

Firmware version: v1.3

1 Safety instructions

Nixie clock is an electrical device and cautious handling must be assured. In spite of the relatively low voltage board power supply, a high voltage is present onboard. It can generate voltages exceeding 200V and can cause electrical shock if handled inappropriately. Keep in mind that nixie tubes may be disabled during night time but the clock can wake up at any time. Therefore do not touch any component or soldering point when power is on. Safe assembling, connecting and operation of this clock are the users' responsibility. Keep the clock away from children.

The NCV2.1 nixie clock's circuits and software (firmware) may not be reverse engineered, copied or used commercially without written permission.

2 Assembling

2.1 Logic board assembling

Start by fitting 0,25W resistors since they're the lowest. Then fit the diodes. Double check the polarity of any polarity sensitive device before soldering. Then assembly all other components height wise. If you want to experiment with your board or upgrade PICmicro with a newer firmware in the future, you may consider to use the sockets for the ICs (sockets are optional and are not provided along with kit. You may obtain them in your local store).
Do not use solder with acid, instead use colophony or any other not electrical conductive solder resin. Set the soldering iron at appropriate temperature to avoid "cold soldering". Do not heat any point for more than 3 seconds, otherwise you risk to damage the electronic components and printed circuit board.
After successful assembly set high voltage using R26 trimmer, measure the voltage across C6 capacitor. **Set the voltage to 160V for IN-14 nixie tubes and 170V for IN-18 nixie tubes.** Check power supply temperature after 10 minutes of operate, if switching transistor (M1 – IRF640) and/or inductor are very hot set lower voltage.

For IN-18 tube's board, 2.2K anode resistors (R15, R17, R18, R19, R20, R21) should be used.

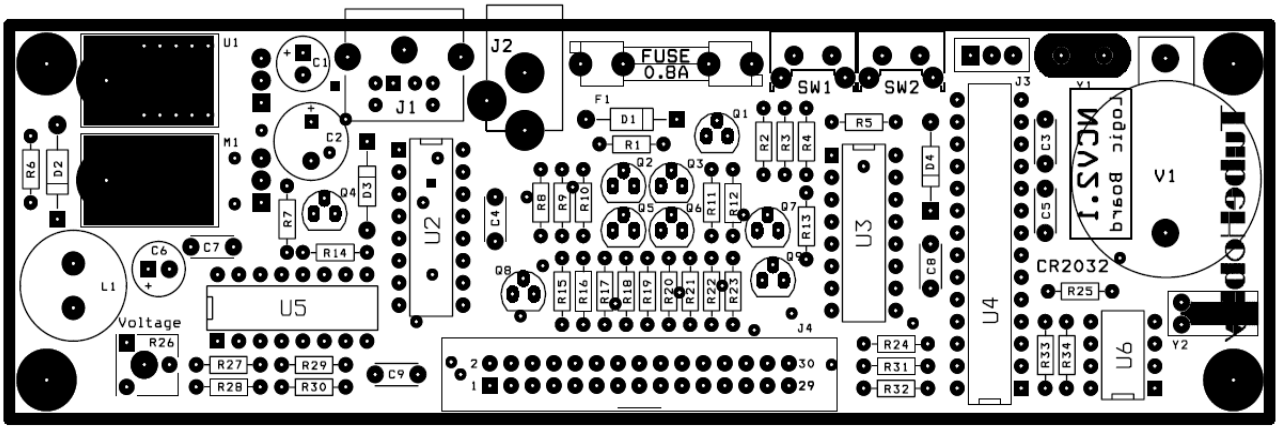


Fig. 1. The logic board's silk screen layer

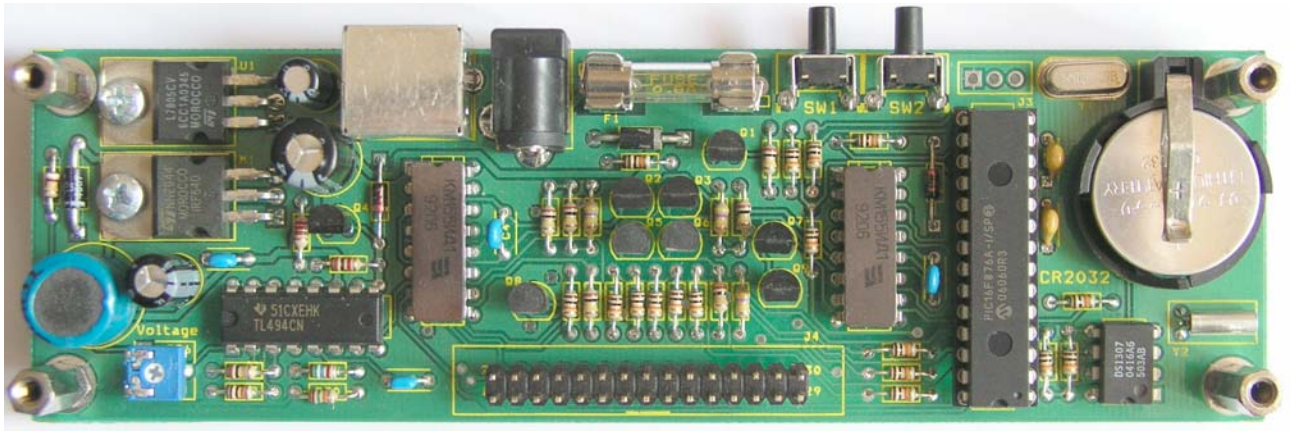


Fig. 2. Logic board

Table 1. Logic board's part's list.

Item	Quantity	Reference	Part
Capacitors			
1	1	C1	10U
2	1	C2	470U
3	2	C3, C5	22P
4	3	C4, C8, C9	10N
5	1	C6	1U 250V
6	1	C7	330N
Diodes			
7	1	D1	1N4007
8	1	D2	UF4007
9	2	D3, D4	1N4148
Transistors			
10	1	M1	IRF640
11	5	Q1, Q2, Q3, Q7, Q9	MPSA42
12	1	Q4	2SA1266
13	3	Q5, Q6, Q8	MPSA92
Resistors			
14*	6	R15, R17, R18, R19, R20, R21	2.2K
14*	18	R1, R3, R4, R5, R13, R15, R17, R18, R19, R20, R21, R24, R25, R28, R31, R32, R33, R34	10K
15	7	R2, R8, R9, R12, R16, R22, R27	100K
16	1	R6	910K
17	1	R7	220
18	3	R10, R11, R23	470K
19	1	R14	1K
20	1	R26	22K Trimmer
21	1	R29	5.6K
22	1	R30	15K

Integrated circuits			
23	1	U1	L7805CV
24	2	U2, U3	K155ID1
25	1	U4	PIC16F876A
26	1	U5	TL494
27	1	U6	DS1307
Other components			
28	1	V1	CR2032 3V Lithium Battery
29	1	Y1	Crystal 20MHZ
30	1	Y2	Crystal 32.768KHz
31	2	SW1, SW2	SW PUSHBUTTON
32	1	L1	270UH
33	1	F1	FUSE 0.8A
34	1	J1	PS/2 Connector
35	1	J2	PWR Connector
36	1	V1	Battery holder
37	1	J4	30Pin Connector
38	2	F1	Fuse holder
39	2	-	M3 Nut
40	10	-	M3 Screw
41	4	-	20mm spacer

*2.2K resistors are provided along with the kit for IN-18 tubes instead of appropriate amount of 10K resistors.

2.2 Tube's board assembling

2.2.1 IN-14 board

Move the plastic holder of the tube leaving approx 1-2mm of wire below the holder (see fig. 3) Be careful not to move it away.

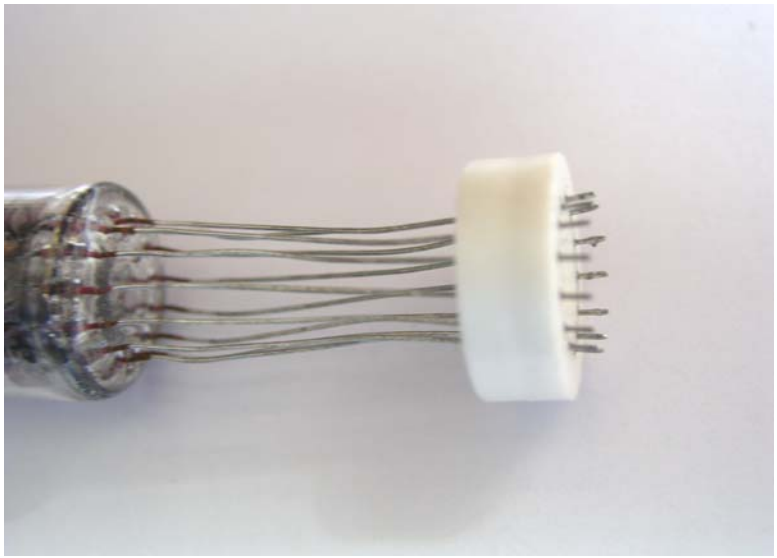


Fig. 3. Plastic holder

Find #1 pin of the tube. It is covered by the white substance inside the tube.

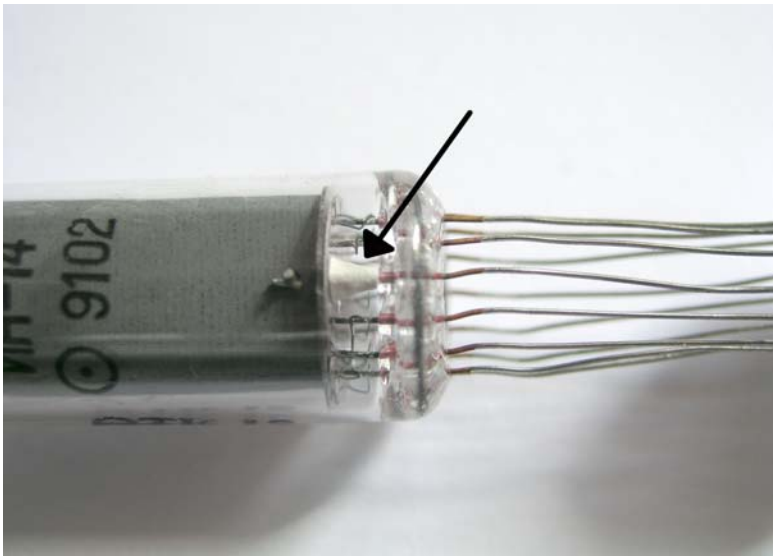


Fig. 4. Pin #1

Pin #1 on the PCB is the most upper pin.

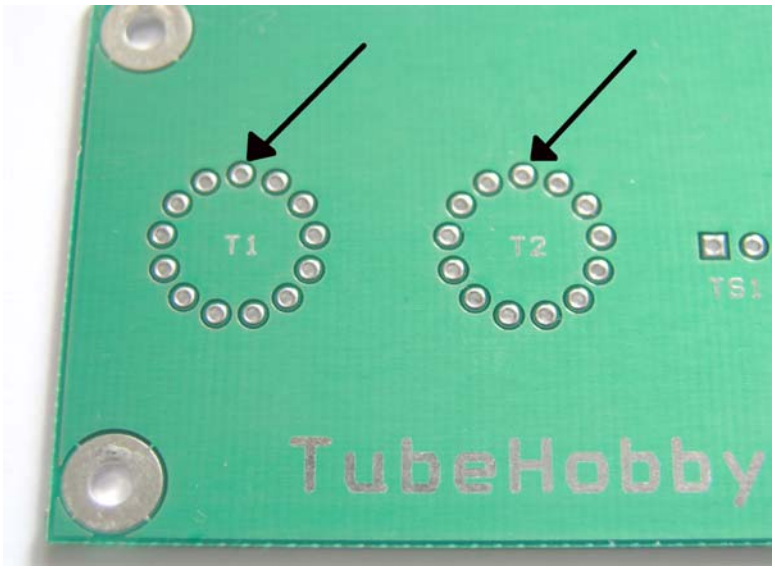


Fig. 5. Pin #1 on PCB

Insert the wires into the holes. Start from Pin #1. Be sure that the tubes are stacked on the right side of the PCB.

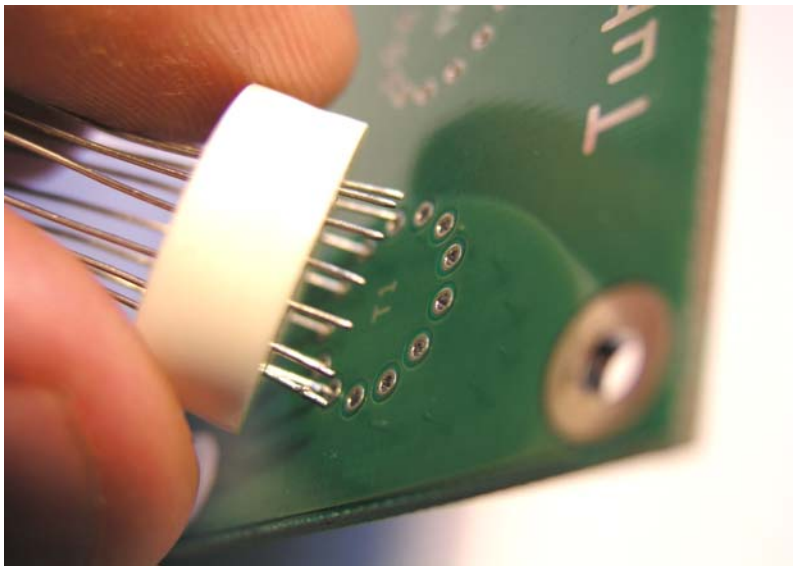


Fig. 6. Tube assembling

Stack and solder all the tubes in the same way. Then fit the female 30-pin connector on the opposite side of the PCB. Fit the column separator bulbs if you prefer to have them.

Fig. 7. IN-3 type column separator bulb

If IN-3 type column separator bulbs are used, be sure that they are stacked in the right polarity.

2.2.2 IN-18 board

Put all 72 receptacles into the tube's board holes.

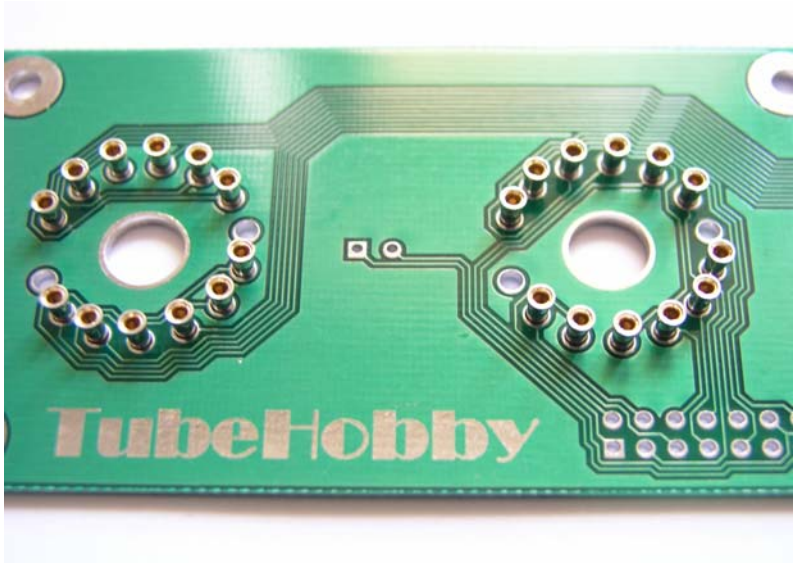


Fig. 8. Fitting receptacles

Note: pin #1 and pin #8 of each tube do not require receptacles since these pins are not connected. Make sure that receptacles are fitted on the right side of the PCB.

After all receptacles are placed correctly, cover the board with a piece of hard paper and turn everything upside-down.

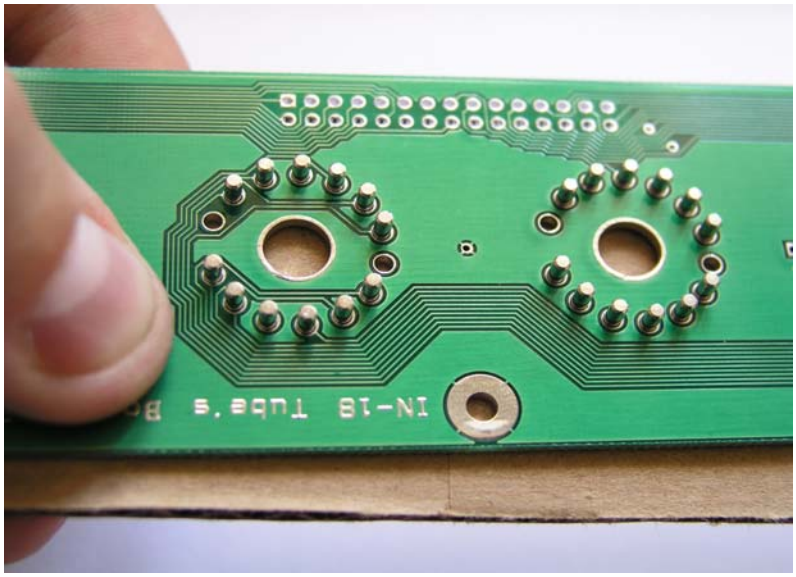


Fig. 9. Turning over

While soldering keep the PCB slightly pressed to ensure firm sitting of the receptacles. Do not use too much solder.

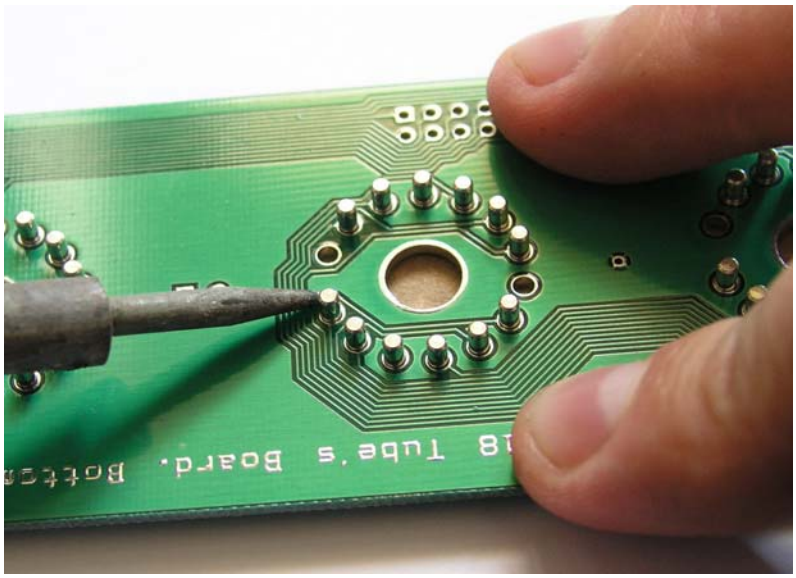


Fig. 10. Soldering

Fit the female 30 pin socket on the bottom side. Fit the column separator bulbs if you prefer to have them.

3 Software

The clock's firmware is driven by operating system and is able to work in multitasking mode. Several industrial protocols are involved and dozens of tasks and algorithms are coded. It is quite complex and contains many thousands of code lines.
It is programmed so that all settings and tube's lifetime counter values are stored in the battery back upped memory and are kept safely during the power outage. Moreover, time and date are still counted when the clock has no power.

3.1 Firmware updates

Current version of firmware: v1.3
Added selection of new DST rules for USA and Canada.

Obsolete version v1.2.
Description of fixed bug: While DST months are set (state 14 and 18) the month values are written to incorrect places in memory. Therefore both customized vernal and autumnal month values stay actual while clock has power supply but can not be read properly after power outage. Both of them will be set to default values (vernal = march; autumnal = october) after power outage.

Obsolete version v1.1.
Description of fixed bug: When power supply is connected DST offset is not calculated immediately but is calculated on the first change of minute.

Obsolete version v1.0
First version of firmware.

NOTE: In order to update the firmware of your clock please send the PICmicro chip or whole logic board back to us for re-flashing, or order preprogrammed chip. Please contact us by email: info@tubehobby.com

3.2 Clock’s menu

NCV2.1 nixie clock has 2 pushbuttons. There are 4 different behaviors pushing them: short and long push for each button. Long push event will be performed when the button is pressed for 3 or more seconds.

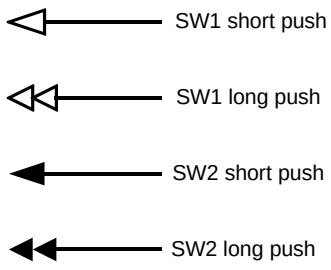


Fig. 11. Menu transitions

When the clock is powered it automatically enters the time state. A short push of SW1 pushbutton will change the time state into the date state. Next short push of any button will return to the time state again. A short push of SW2 pushbutton will change the time state to the tube's lifetime counter state. Next short push of any button will return to the time state again. If the clock is left in the date state or tube's lifetime counter state and none of the buttons is pressed within 30 seconds, timeout occurs and the clock automatically returns to the time state.

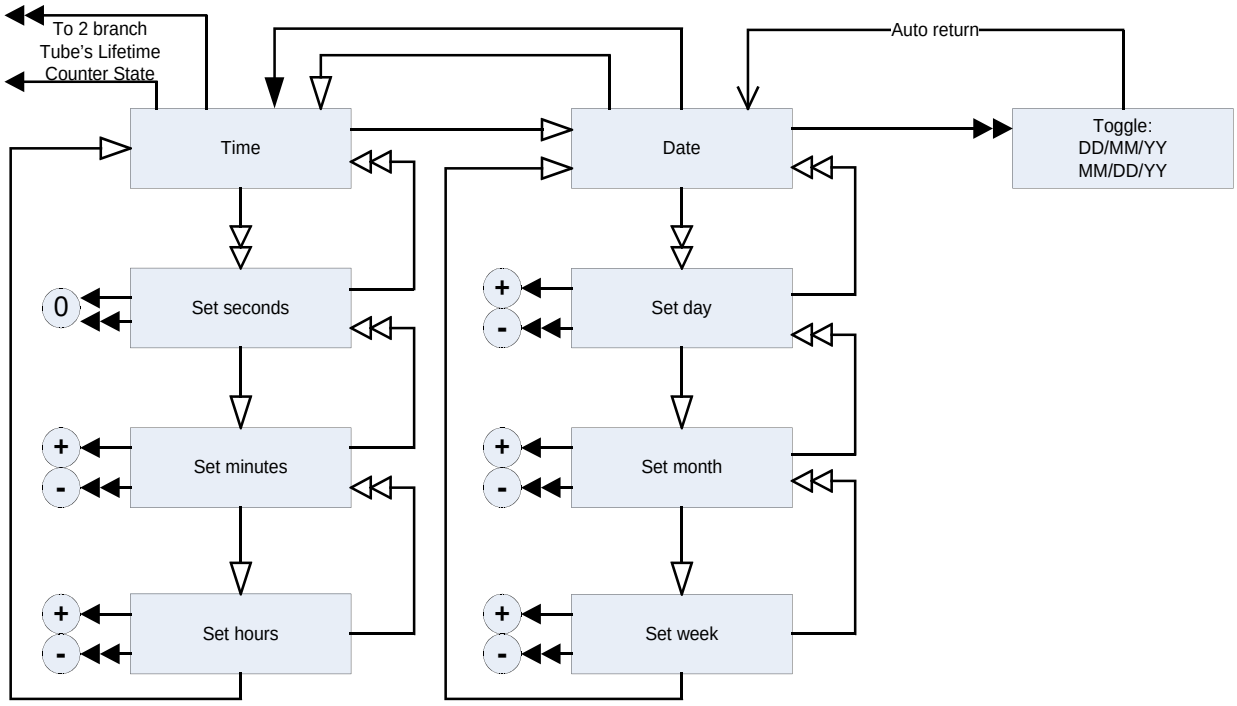


Fig. 12. Menu diagram. 1 branch

3.3 Setting time

When present time is shown, push and hold the SW1 pushbutton. After 3 seconds, the seconds will start blinking. A short push to SW2 will reset seconds to 00. A short push to SW1 will enter the minutes setting and minutes display will start blinking. A short push to SW2 will increase the minutes value by 1, a long push to SW2 will decrease the minutes by 1. Again, a short push to SW1 will enter the hour setting mode and hour display will start blinking. A short push to SW2 will increase the hour value by 1, a long push to SW2 will decrease the hour by 1. A short push to SW1 will lead to escape the time setting mode and the clock will return to the actual time display.
During the settings, time is not rounded (e.g. when the seconds are reset, the minutes value will remain the same). If 12-hour mode is selected, the clock will automatically convert time to the 24-hour format during settings and convert back on exit.
If a GPS receiver is connected time synchronization will be performed automatically and entering to the time setting menu will not be allowed. If a GPS receiver is connected and time does not represent your local time, check the time-zone and DST settings.

3.4 Setting date

Short push to SW1 to enter the date state. There are two date display modes: DD/MM/YY and MM/DD/YY. A long push to SW2 will toggle between these modes. To set date, push and hold SW1 while date is displayed. After 3 seconds day will start blinking. A short push to SW2 will increase the day by 1, a long push to SW2 will decrease by 1. Next pushes to the SW1 will enter month and year settings appropriately. Month and year settings should be performed in the same way as day setting. Next push to SW1 will exit date setting mode.
If a GPS receiver is connected date synchronization will be performed automatically and entering to the date setting menu will not be allowed. If a GPS receiver is connected and the date does not represent your local time, check the time-zone and DST settings.

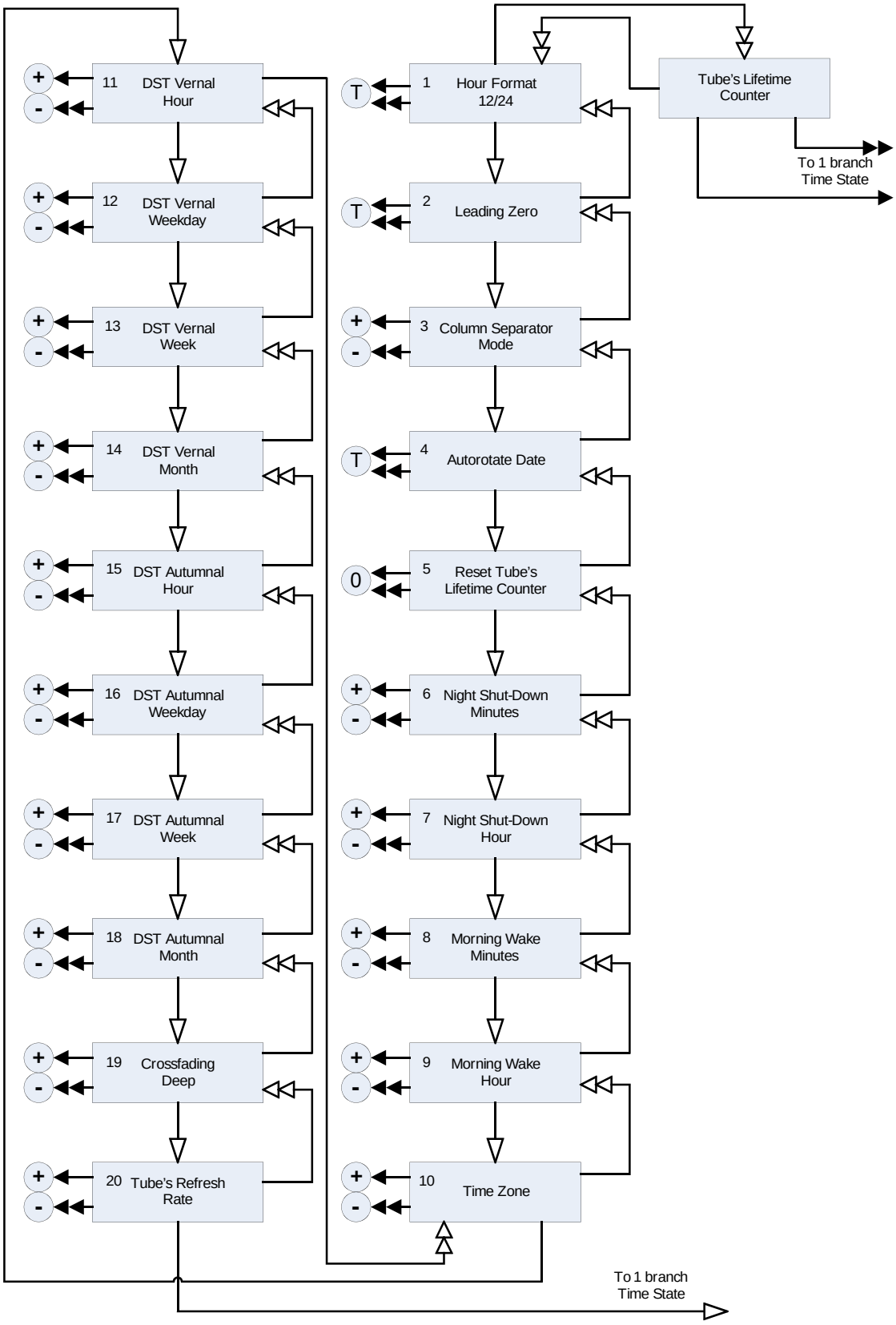


Fig. 13. Menu diagram. 2 branch

3.5 Tube's lifetime counter

The tube's lifetime counter counts hours when the tubes are lit. During the night shut-down (if enabled) hours are not taken into account. Counter counts until 65535 hours, then overflow occurs and counter will start again from zero.
To enter the tube's lifetime counter press SW2 when time is shown. The tube's lifetime counter can be reset via the settings menu. The data is stored in the battery back upped memory, so it will not be lost during power off.

3.6 Settings menu

To enter the settings menu push and hold SW1 for 3 or more seconds when the tube's lifetime counter state is present. When the settings mode is entered, on the most left tubes settings number is shown, which corresponds with the actual parameter (later this number will be enclosed in parenthesis). To set the next parameter push SW1 shortly. To return to the previous parameter push SW1 for 3 or more seconds. When the last parameter (20) is entered next short push to the SW1 will return the clock into the time state. *See fig.3.*

3.6.1 Hour format (1)

There are two modes available 12-hour and 24-hour. These modes can be toggled pushing SW2. The actual mode is shown on the most right tubes. *For AM/PM mode see chapter 3.4.3*
Default mode: 24-hour.

3.6.2 Leading zero (2)

The clock can display time with leading zero or it can be blanked (e.g. 01:23:45 or 1:23:45). These modes can be toggled pushing SW2. The actual mode is shown on the most right tubes.
Default mode: leading zero is shown.

3.6.3 Column separator mode (3)

Column separator bulbs can be set in one of the four modes. Select desired mode using SW2.

- Mode 0. Column separator bulbs are disabled
- Mode 1. Column separator bulbs are lit all the time
- Mode 2. Column separator bulbs blink by 1Hz
- Mode 3. Column separator bulbs shows AM/PM mode (lit when PM)

The actual mode is shown on the most right tubes.
Default mode: 2.

3.6.4 Auto rotate date (4)

The clock can automatically show date between 50 and 55 seconds every minute. Automatic change occurs in time state only. It is recommended to enable this option, since visual effects performed during display change prevents the unused cathodes of the nixie tubes from poisoning. Select desired the mode using SW2. The actual mode is shown on the most right tubes.

- Mode 00. Auto rotate is diabled

- Mode 01. Auto rotate is enabled

Default mode: enabled (in firmware v1.0 and v1.1 default mode - disabled).

3.6.5 Reset tube's lifetime counter (5)

To reset the tube's lifetime counter press SW2. When the counter is reset, 00 will appear on the most right tubes.

3.6.6 Night shut-down *minute* (6)

The clock can automatically disable the tubes during preset time (e.g. night time). This function involves 4 settings (night shut-down minute, night shut-down hour, morning wake-up minute, morning wake-up hour). During the time between shut-down and wake up the tubes will be disabled. If any button is pressed while the tubes are disabled, the clock will wake up for 10 seconds and then will shut down again. After 3 wake-ups tubes will remain enabled until the next shut down time. This function may be disabled by setting the same time (minutes and hours) for shut-down and wake-up. In this case the tubes will be lit all the time.

Set the night shut-down minutes using SW2.
Default minute: 00.

3.6.7 Night shut-down *hour* (7)

Set the night shut-down hour using SW2.
Default hour: 00. (12-AM)
Note: regardless of the setting of the clock hour mode (12 or 24 hour), hours during settings always will be displayed in 24-hour format.

3.6.8 Morning wake-up minute (8)

Set the morning wake-up minutes using SW2.
Default minute: 00.

3.6.9 Morning wake-up hour (9)

Set the morning wake-up hour using SW2.
Default hour: 06. (06-AM)

3.6.10 Time zone (10)

If a GPS receiver is connected, the clock must know your time zone to synchronize the time properly (in fact GPS service is a global service and provided time is GMT regardless of position). Select you time zone using SW2. The two middle tubes show offset hour, the two right ones show offset minutes. Blinking tubes means negative offset according to GMT, constantly lit tubes means positive offset.
Default time zone: 00:00.

3.6.11 DST vernal hour (11)

The clock can automatically adjust time according to your local daylight saving time (DST). Since the beginning of DST and reverting to the standard time varies across the world, you should set it accordingly to your local country rules. On the vernal change the clock is turned forward an hour and on the autumnal change reverted back. Each autumnal and vernal setting involves 4 settings (total 8). These settings are: hour, weekday, week of the month and month. Actual weekday is calculated automatically according to the actual date. If a GPS receiver is connected, DST correction applies as well. If you don not need DST correction, set the same values to all vernal and autumnal settings.

Set DST vernal hour using SW2. Hour is shown on the most right tubes.
Default hour: 01. (01-AM)
Note: *regardless of the setting of clock the hour mode (12 or 24 hour), hours during settings always will be displayed in 24-hour format.*

3.6.12 DST vernal weekday (12)

Set the DST vernal weekday using SW2. The weekday is shown on the most right tube. 1 means monday; 7- sunday.
Default weekday – 7 (sunday).

3.6.13 DST vernal week (13)

Set the DST vernal week of the month using SW2. The week is shown on the most right tube. 1 means first week of month; 5- last week of month (regardless how many weeks this month have).
Default week of month – 5 (last week).

3.6.14 DST vernal month (14)

Set the DST vernal month using SW2. The month is shown on the most right tubes.
Default month – 3 (march).

3.6.15 DST autumnal hour (15)

Set the DST autumnal hour using SW2. The hour is shown on the most right tubes.
Default hour: 01. (01-AM)

3.6.16 DST autumnal weekday (16)

Set the DST autumnal weekday using SW2. The weekday is shown on the most right tube. 1 means monday; 7- sunday.
Default weekday – 7 (sunday).

3.6.17 DST autumnal week (17)

Set the DST autumnal week of the month using SW2. The week is shown on the most right tube. 1 means first week of month; 5- last week of month (regardless how many weeks this month have).
Default week of month – 5 (last week).

3.6.18 DST autumnal month (18)

Set the DST autumnal month using SW2. The month is shown on the most right tubes.
Default month – 10 (october).

3.6.19 Crossfading deep (19)

The clock can fade one digit while simultaneously fading into a second digit creating smooth appearance of digit change. During crossfading digits are blinked up to several hundreds times with variable duration. Smoothness of crossfading may be set using SW2. Available range is 1-25.
Default value: 20.

3.6.20 Tube's refresh rate (20)

The clock uses multiplex mode of tubes driving, so the tubes flickers in pairs all the time. The flicking rate is very high and eyes can't distinguish it, therefore it creates an illusion of being constantly lit. Although in some cases flicking rate may correspond the tube's internal constructions resonance frequency and may lead to hearable buzzing. One of the three refresh rates can be chosen using SW2. 1 corresponds with the highest refresh rate, 3 – with the lowest one. If the lowest one (3) is chosen, deep crosfading (more than 15) may not look good because the tubes do not flick fast enough to show enough number of shapes with variable duration.
Default value: 2.

Note: *refresh rate selection does not influent brightness much. To select brightness, use R26 potentiometer onboard. Do not exceed voltage limit (170V).*

3.7 Reset settings values to default

First time when the clock is connected to the power supply, all settings are set to default automatically. If you want to reset all values to default manually, do the following sequence: disconnect the power supply, hold both pushbuttons (SW1 and SW2) pressed and connect the power supply, release the pushbuttons.

4 GPS synchronization

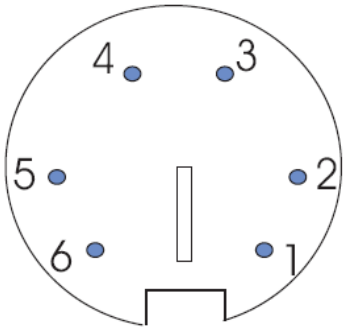
To keep time and date accurate all the time a GPS receiver can be connected. It is optional since clock has internal RTC (Real Time Clock) as a time base and is fully functional without a GPS receiver. If a GPS receiver is connected, the clock's firmware automatically detects it and periodically updates internal RTC time and date according to the time provided by the GPS satellite.

Fig. 14. GPS receiver

A GPS receiver should be NMEA-0183 standard compatible and should be able to provide GPRMC sentences via RS232 interface at 4800 baud. A required PS/2 type connector usually is used with the receivers for PDAs. Compatible receivers are: “NAVILOCK NL-208P”, “HAICOM HI-204III” and many others.

GPS female connector pinout:

1. Not connected
2. Not Connected
3. +5V Power supply
4. Ground
5. Not connected
6. RS232 TX



4.1.1 Technical data

4.2 Software

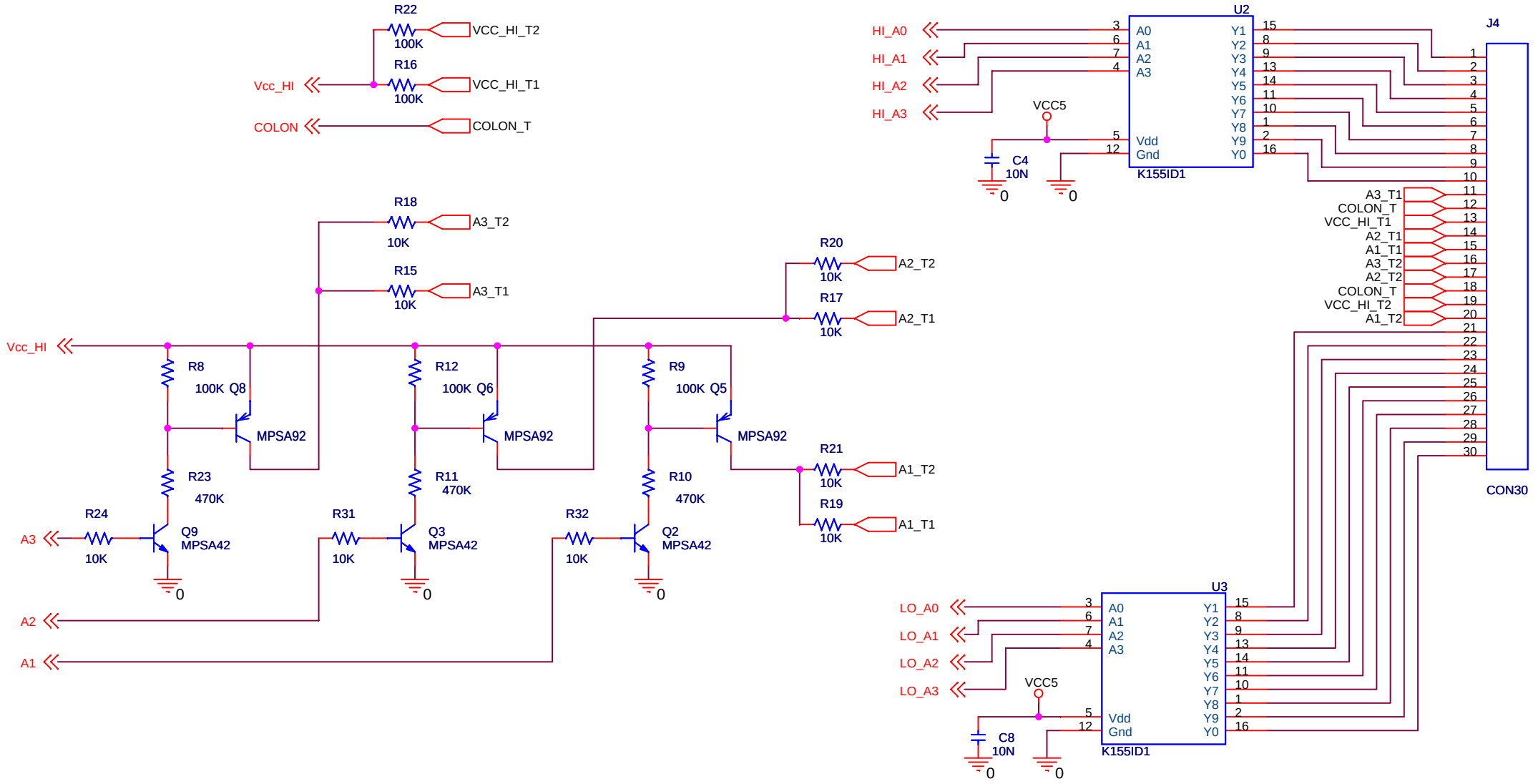
- Time display
  - 12-hour mode
  - 24-hour mode
  - AM/PM indication
  - Programmable leading zero suppression
  - Programmable DST correction

- Date display
  - DD/MM/YY mode
  - MM/DD/YY mode
  - Leap year correction

- Programmable column separators
- Programmable tubes shut-down during night time
- Crossfading with selectable deep
- Three visual effects
- Selectable refresh rate of tubes
- Tube's lifetime counter (16-bit, up to 65535 hours)
- GPS time and date synchronization (GPS receiver is optional)
- Selectable time-zone
- Cathode poisoning prevention
- Tube testing routine

4.3 Hardware

- Microchip PIC16F876A main controller
- Real Time Clock with battery back-up (CR2032 Lithium battery)
- Tube's drive mode: 3x2 multiplex
- High voltage power supply with PWM control and software shut-down
- RS232 levels serial input
- 2 pushbuttons
- Power supply: 9-12V @ 500-1000mA DC; 5.5/2.5mm jack with positive inner (recommended 12V 1A DC PSU. It does not matter stabilized or not)
- Incorrect polarity protection
- High precision (10ppm) timebase XTAL



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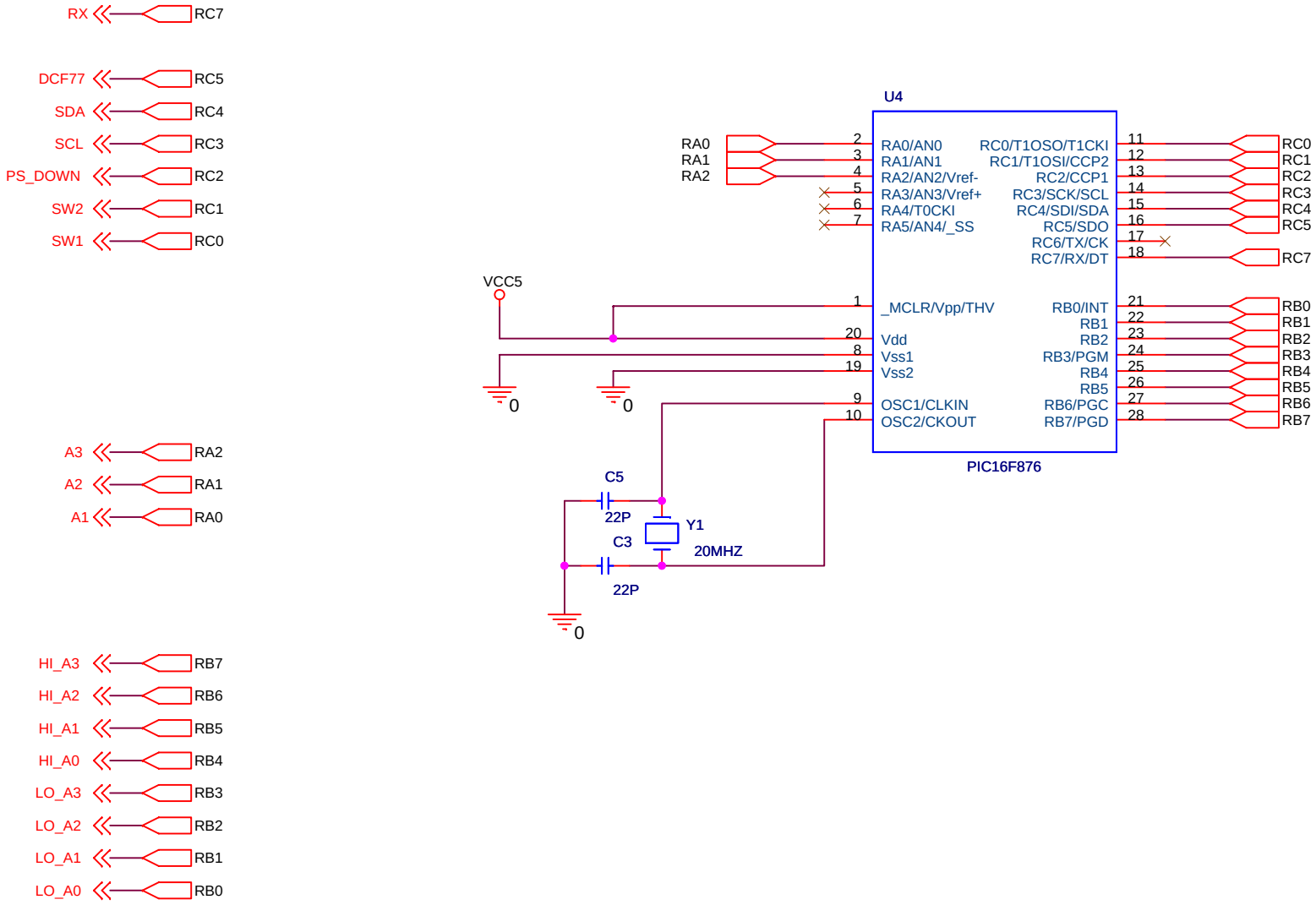
Size A4	Document Number NCV2, Copyright 2006, TubeHobby	Rev 2.1
Date: Saturday, April 22, 2006	Sheet 1 of 4	



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Size A4	Document Number NCV2, Copyright 2006, TubeHobby	Rev 2.1
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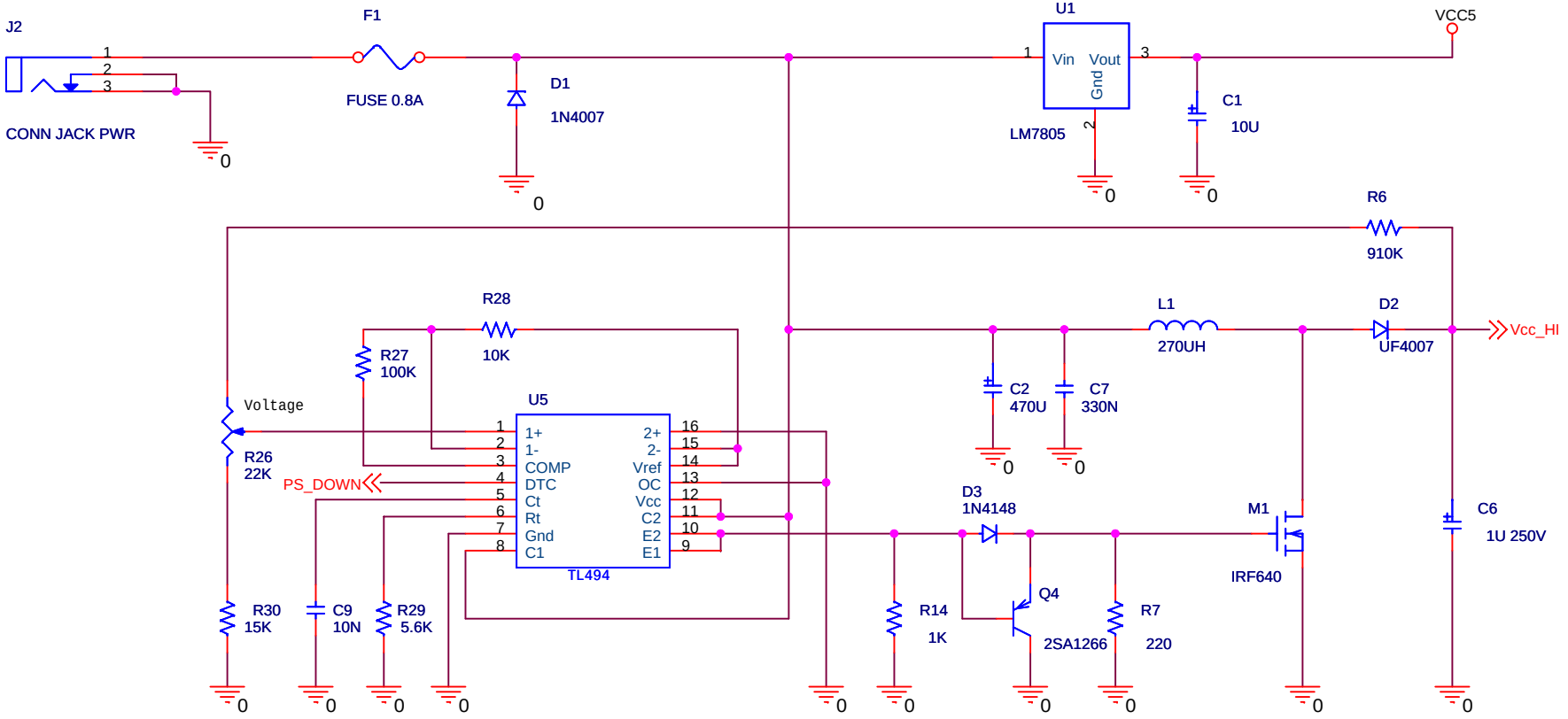

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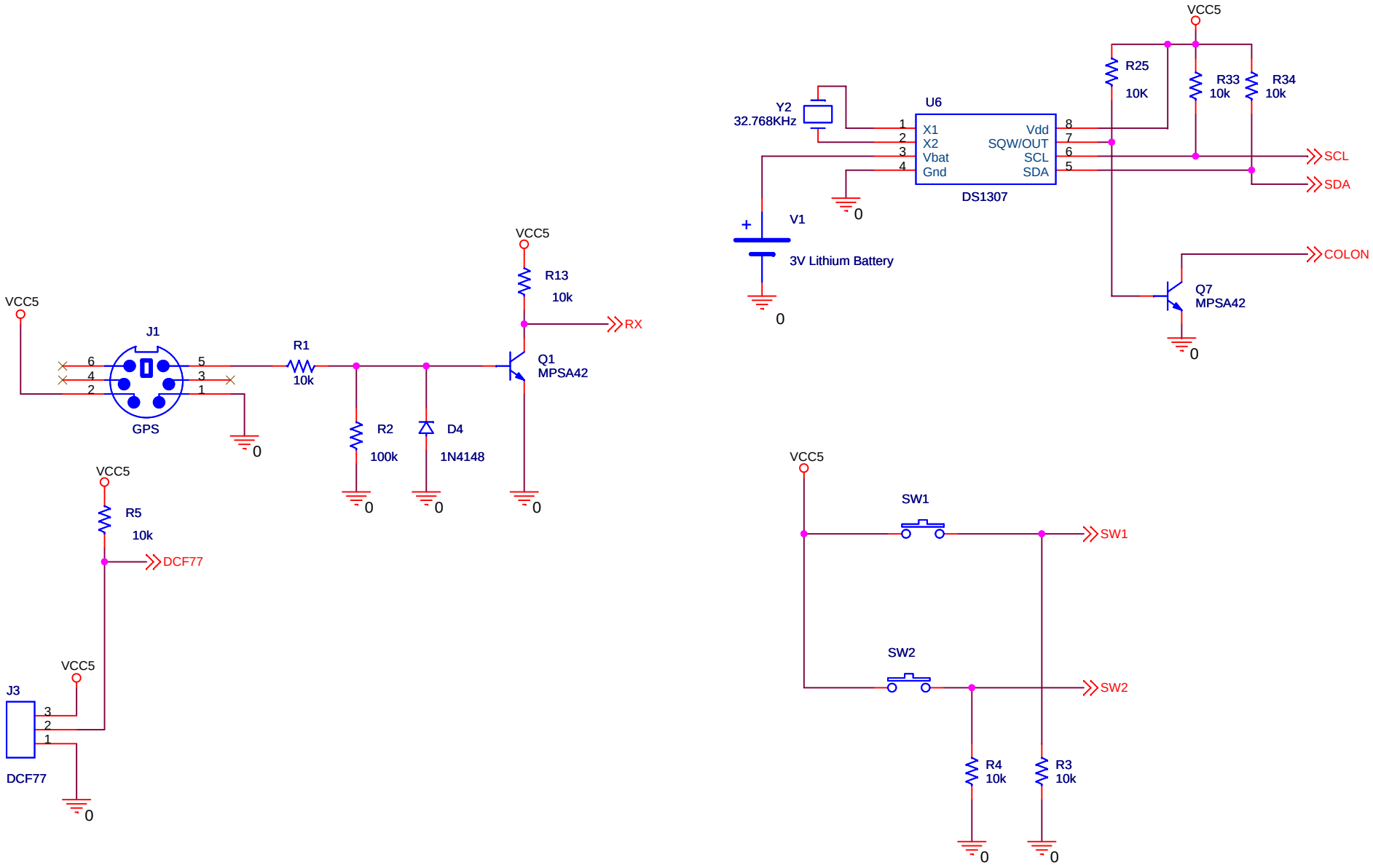

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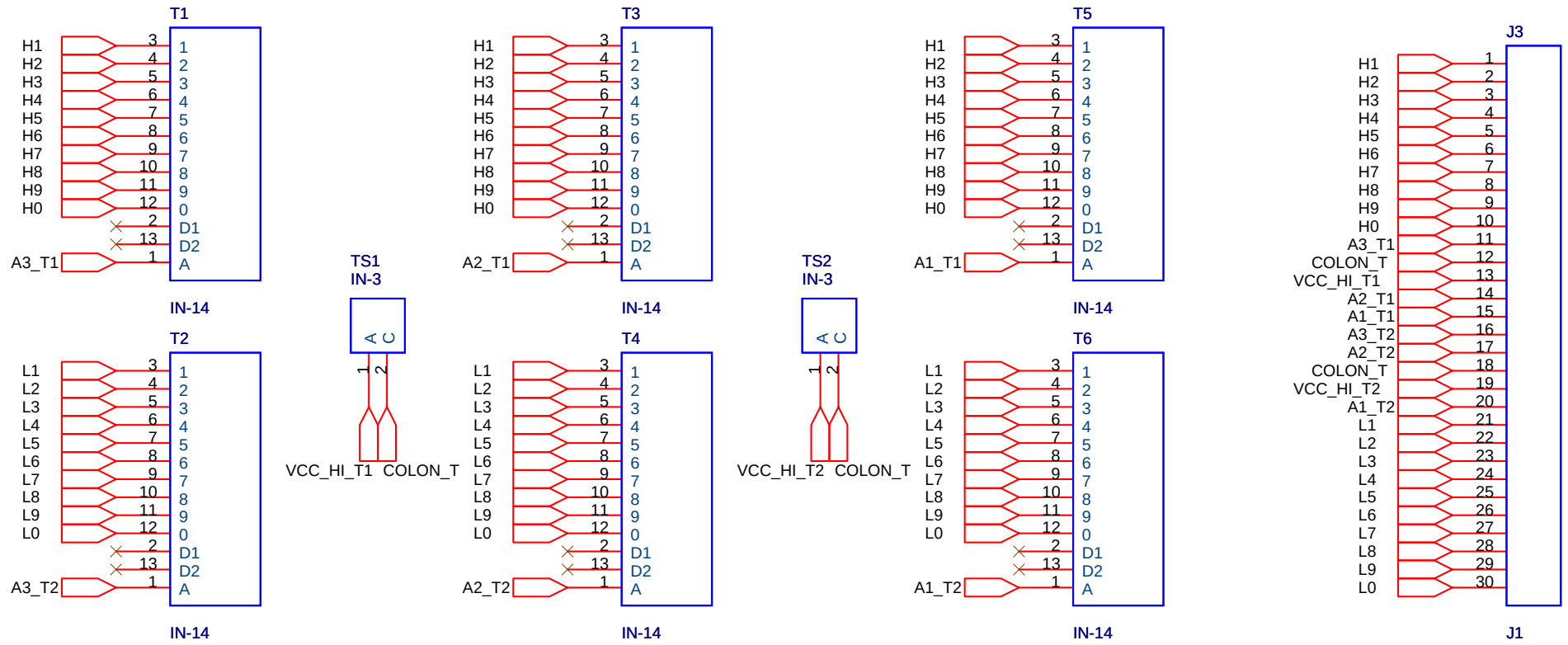

T1 T2 TS1 T3 T4 TS2 T5 T6

Hours

Minutes

Seconds

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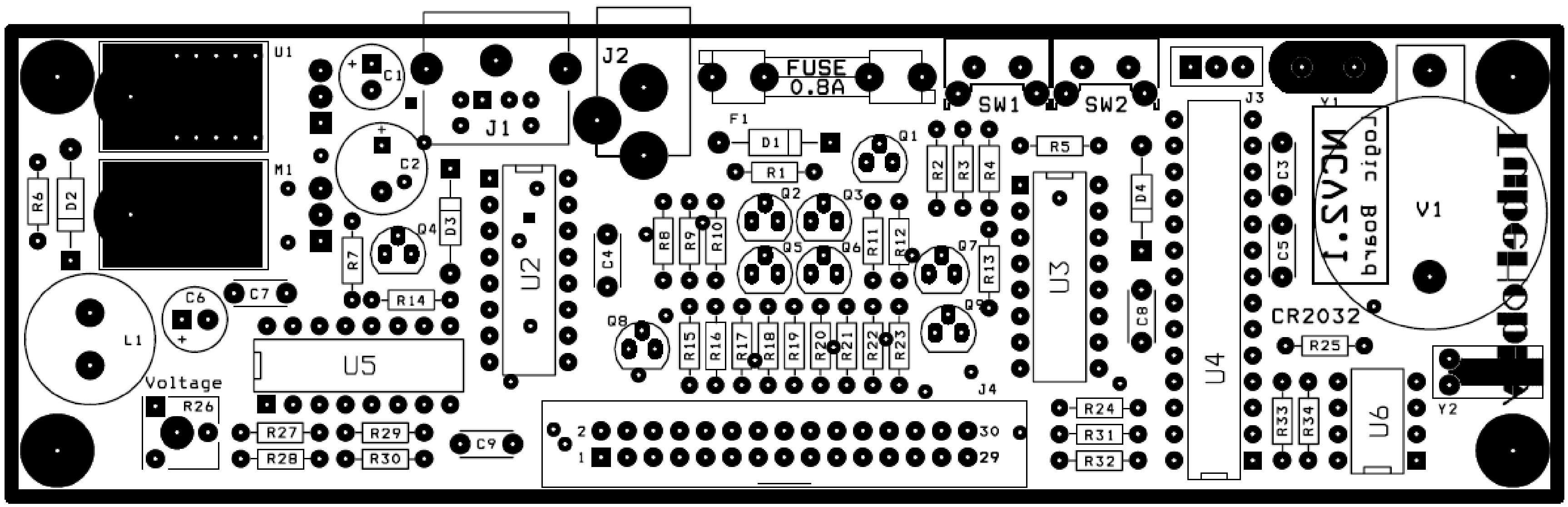
Size: A	Document Number: NCV2, Copyright 2006, TubeHobby	Rev: 1.0
Date: Monday, December 13, 2010	Sheet 1 of 1	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M1
C1
C2
J1
J2
FUSE
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F1
D1
R1
Q1
SW1
SW2
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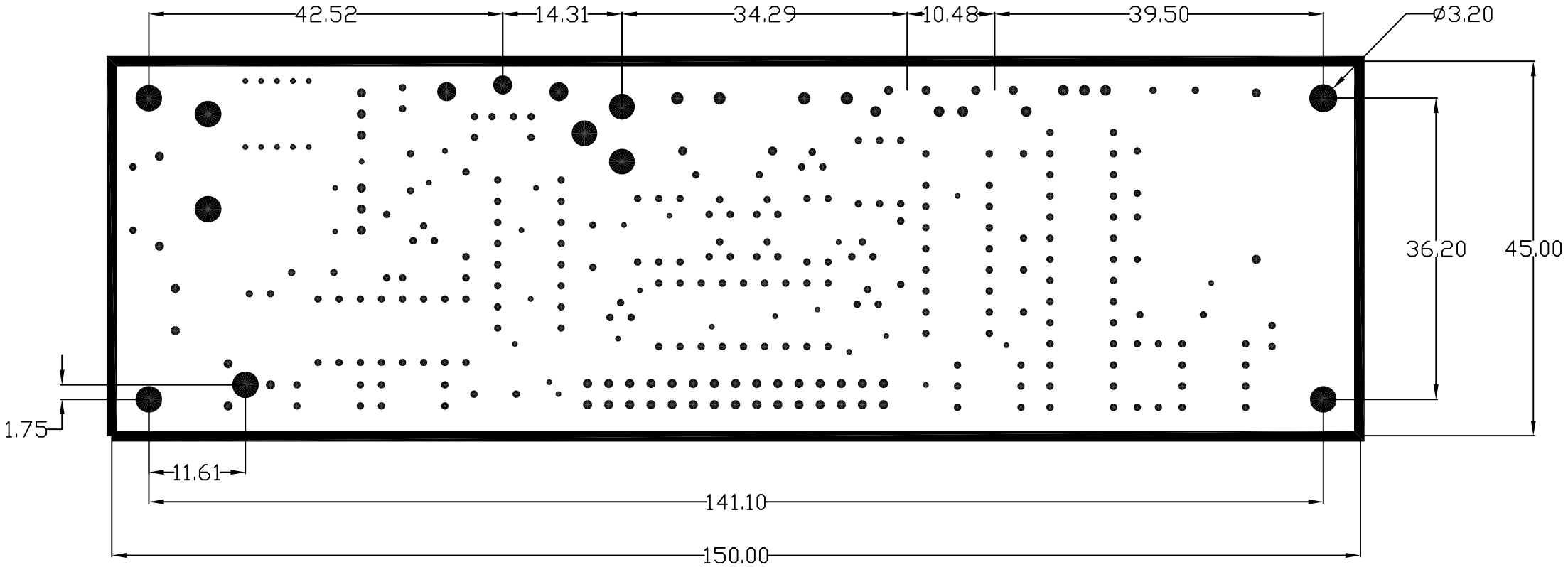
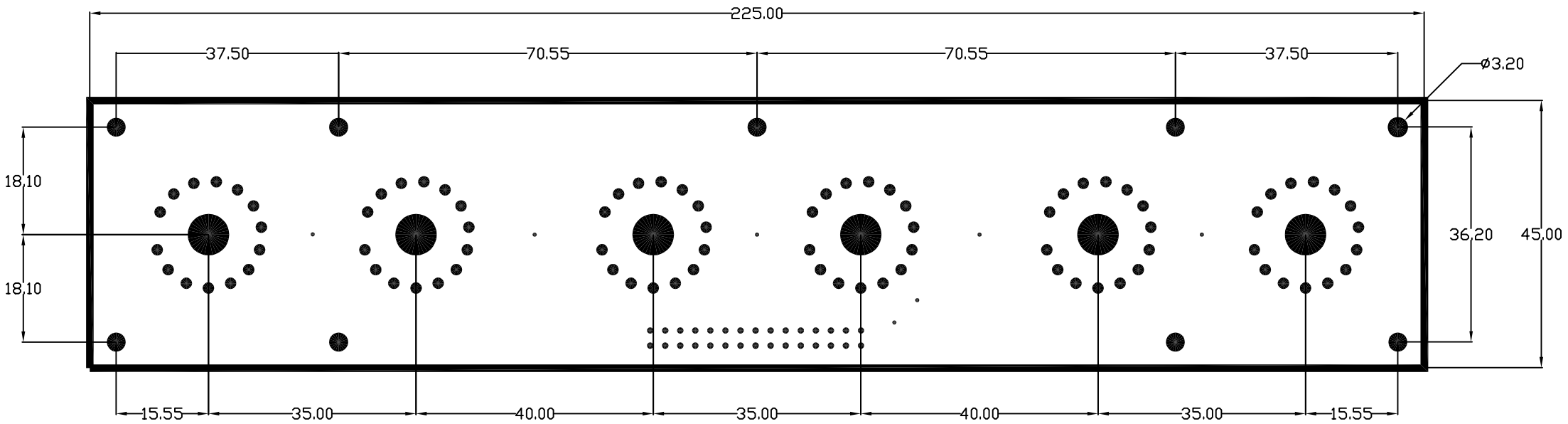
NCV2.1
Logic Board
V1
CR2032
R25
Y2
U6
R33
R34
U4
R24
R31
R32
U3
R5
D4
C8
C3
C5
R2
R3
R4
R13
Q7
Q9
J4
Q2
Q3
Q5
Q6
R8
R9
R10
R11
R12
R15
R16
R17
R18
R19
R20
R21
R22
R23
Q8
C4
U2
D3
Q4
R7
R14
R6
D2
L1
C6
C7
U5
Voltage
R26
R27
R28
R29
R30
C9
2
1
30
29

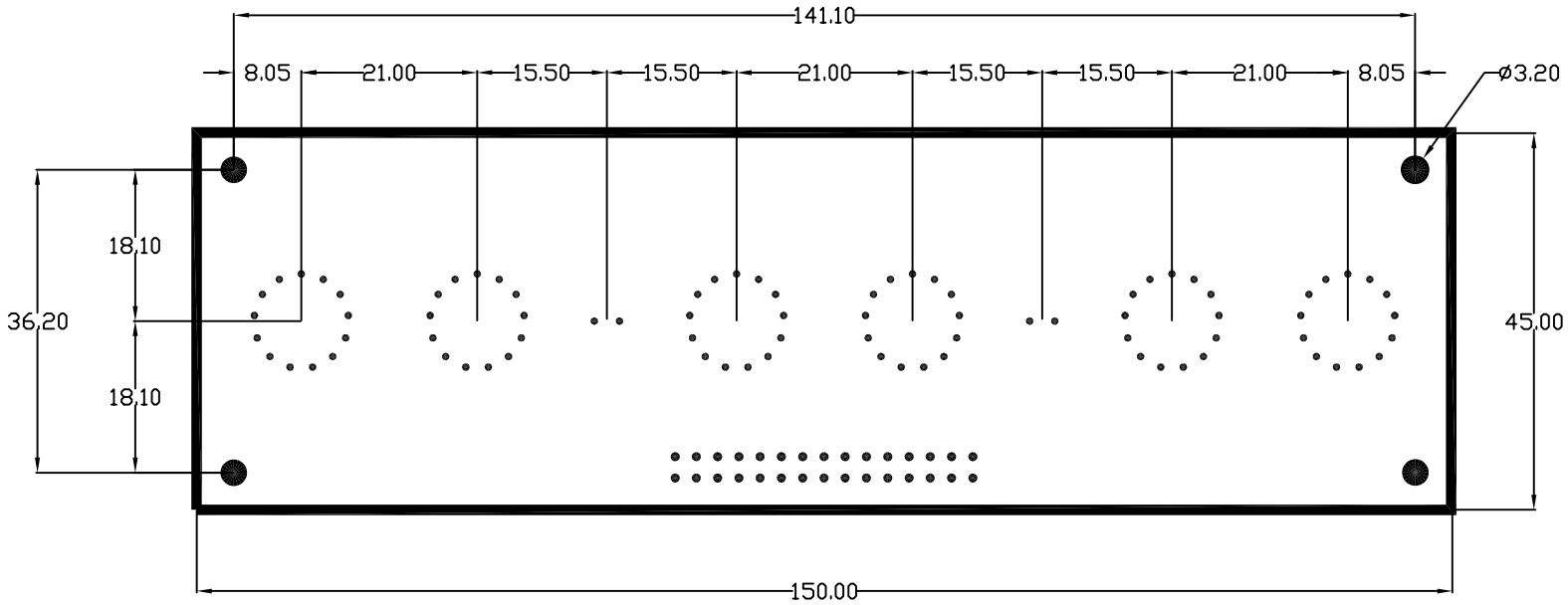
Main PCB. Dimensions are in millimeters



IN-18 tube's Board. Dimensions are in millimeters



IN-14 Tube's board. Dimensions are in millimeters



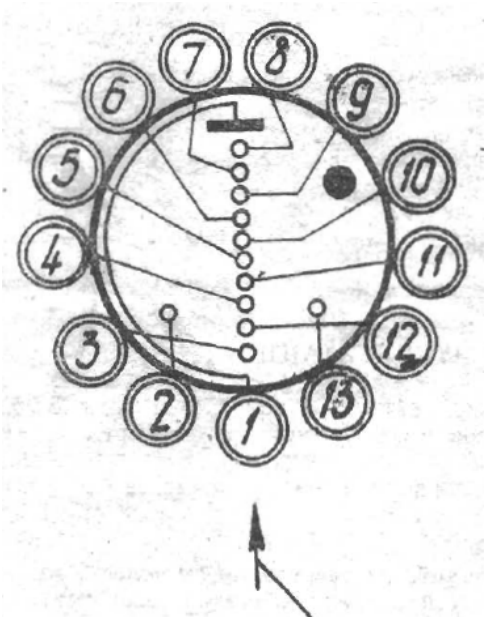
Gas discharge indicator type IN-14 (ИН-14)

Datasheet translated by TubeHobby
www.tubehobby.com

Description

Gas discharge indicator is intended for visual indication of electrical signals in digital form in broad kind of equipment.

Connection diagram



Arrow on glass

Pin number	Description
1	Anode
2	Cathode comma
3	Cathode “1”
4	Cathode “2”
5	Cathode “3”
6	Cathode “4”
7	Cathode “5”
8	Cathode “6”
9	Cathode “7”
10	Cathode “8”
11	Cathode “9”
12	Cathode “0”
13	Cathode comma

Pins are counted clockwise from pin #1 which is shown by arrow on glass body underneath the plastic spacer. Pins are counted looking to the tube from the pin’s side (bottom).

Basic electrical and lighting parameters

Firing voltage (no more than)	170V
Current for digits (no more than)	2.5mA
Current for commas (no more than)	0.3mA
Brightness (no less than)	100 cd/m²
Viewing angle (no less than)	+/- 30º

Allowable limits

Power supply voltage	200V
Current for digits	2.0 - 3.5mA
Current for commas	0.3 – 0.7mA

Average current (supplying from mains 50Hz via single-period rectifier)

Current for digits (no more than)	2.0mA
Current for commas (no more than)	0.2mA

Multiplex mode

Power supply voltage	190V
Average current for digits	0.7 - 1.5mA
Average current for commas	0.15 – 0.6mA
Pulse current for digits	7 – 13mA
Pulse current for commas	1.5 – 5mA
Pulse width (no less than)	70µS
Period	1 – 1.8 kHz

Tube does not contain precious metals.

Notes

Pin soldering and bending should be performed at least 5mm away from the glass body. Avoid multiple soldering – desoldering.

After long period of non-use it is recommended to train cathodes applying working current for 1 minute for each cathode.