# 4.0" Blue LED DCF77 Clock documentation

## 1. LED Clock Main Board PCB mounting:

- Mount and solder the eight wire bridges.
- Mount and solder resistors R16, R18, R20, R22.
- Mount and solder capacitors C1…C3 (pitch 5.08mm).
- Mount and solder capacitors C8, C10 (pitch 2.54mm).
- Mount and solder all IC-sockets.
- Mount and solder headers JP1 to JP5.
- Mount and solder connectors K1, K2, K3, K4, K5, K6, K7, K8, K9.
- Mount and solder the 10K SIL resistor network.
- Mount and solder transistors T1 to T4.
- Mount and solder capacitors C1, C5, C6, C7, C9.
- Mount and solder VR1 (7805 regulator) + heat sink with M3 screw, washer and bolt.
- Mount and solder variable resistor P1.
- Mount and solder the 4.096MHz Xtal.

## 2. LED Display Board PCB mounting:

- Align the two display boards parts and solder the two middle rectangular pads temporarily together; mount the two middle displays and check if spacing between display board parts is OK.
- Solder all copper traces between the two display board parts.
- Align, mount and solder the two middle reinforcement brass parts.
- Align, mount and solder the four other brass parts.
- Mount the five wire bridges on the copper side.
- Optional: Brush-paint the component side of the display board with black matte paint.
- Optional: Brush-paint the four sides of all six displays.
- Optional: Brush-paint the decimal point of all six displays.
- File and sand the four 10mm colon LEDs with care to obtain a flat front.
- Optional: Brush-paint the sides of the four colon LEDs.
- Mount, align and solder the six 4.0" displays.
- Mount, align and solder the four 10mm colon LEDs (flush with the front of the displays).
- Mount and solder colon LED resistors R7 and R8 to the copper side of the display board.
- Mount and solder segment resistors R9…R15 to the copper side of the display board.
- Mount and solder status LED resistors R17, R19, R21, R23 to the copper side of the display board.
- Optional: Brush-paint the sides of the four status LEDs.
- Mount, align and solder the four status LEDs.

- Mount the four M3x10mm standoffs with the four M3 screws to the clock main board PCB.
- Align the standoffs to the four copper pads on the copper side of the display board.
- Solder or glue the standoffs to the display board.
- Solder the wires of K8 (20pin female connector) to the copper side of the display board (adjust length of wires if needed).
- Connect the 20pin female connector to the 20pin male connector on the clock main board PCB.

## 3. LED Clock main PCB cabling:

- Solder the two wires of K2 to the LDR. The LDR has to be mounted in a location where it can 'see' the ambient light conditions. A possible location is a 12mm diameter hole through the display board near the status LEDs.
- Solder the two wires of K4 to push button S1.
- Solder the two wires of K6 to SPST switch S2.
- Optional: Solder the three wires of K1 to the 3.5mm stereo jack socket (DCF77 input). Respect the same cabling order as used on the optional 3.5mm stereo plug on the DCF77 module.
- The DCF77 input K1 has to be connected to the inverted output of the DCF77 module.
- K3 (+5V output) and K5 (Gong output) are outputs to an optional Gong module (the gong output emits a 20msec pulse every hour).
- K9 has no function with the actual firmware (reserved for future use).

## 4. Settings:

- JP3 and JP4 must be mounted (pull-up resistors). They can be omitted if an optional RF433 transmitter/receiver requires it.
- JP5 allows for blinking or steady (always on) colons:
  1-2:     Blinking colons.
  2-3:     Steady colons.
- JP1 and JP2 are the Time Zone settings:
  CET:           No jumper mounted
  CET+1 :      Jumper JP1 mounted
  CET-1:        Jumper JP2 mounted

### 5. <u>Power up, adjustments and test:</u>

- Set potentiometer P1 half way.
- Connect K7 to an earthed +22VDC/minimum 250mA power supply (check polarity!).
- Measure the presence of the +5VDC on pin 3 of the regulator.
- Disconnect the +22VDC.
- Insert IC1 to IC5, respecting the notches (pin 1).
- Reconnect the +22VDC.
- The clock should start and count up beginning from 12:00:00 (date display = 01:01:00 for 01/01/2000).
- Adjust P1 to obtain a suitable display brightness in all possible ambient light conditions (the clock firmware checks the ambient light every 1.5 seconds).
- The four Status LEDs allow for precise DCF77 antenna setting:
    - <u>Yellow status LED lit:</u> No DCF signal detected.
    - Direct the DCF antenna towards Frankfurt in that way that the blue status LED is blinking in a <u>regular</u> 1second interval.
    - <u>Red status LED lit:</u> Missing or bad 20th DCF start bit or parity error in current DCF frame.
    - The yellow status LED will also light during the 59th missing DCF bit.
- On reception of a good DCF77 frame (normally after a few minutes) the clock will synchronize and display the correct DCF77 time. The green status LED will light, indicating that the last received DCF frame was correct.

### 6. <u>Features (Firmware version 2.8):</u>

- Push button S1 allows for manual Date display. Every action toggles the display between Time or Date.
- Switch S2 allows for automatic Time/Date display every minute from second 50 to 55.
- Scrolling effect between Time/Date transitions.
- When CET+1 or CET-1 time zones are selected the clock will switch to standalone (free-running) mode between 22:59:00 and 03:01:00 and the yellow status LED will light. This allows for easier +/-1hour correction of the DCF time/date parameters during day/month/year/leap-year and Winter/Summer transitions.
- In absence of a valid DCF77 signal the clock runs in standalone mode (30ppm time precision) with correct 24H, day/month/year/leap-year transitions.

## 7. Part list:

| Part number | Value/Description | Quantity |
|---|---|---|
| | | |
| Passive: | | |
| R1...R6 | 10Kx8 SIL Network Resistor | 1 |
| R7, R8 | 220R | 2 |
| R9...R15 | 100R | 7 |
| R16, R18, R20, R22 | 10K | 4 |
| R17, R19, R21 | 270R | 3 |
| R23 | 820R | 1 |
| P1 | 2k5 variable resistor, 10mm, vertical | 1 |
| LDR1 | Light Dependent Resistor, diameter 12mm | 1 |
| | | |
| C1...C3 | 100nF - 5.08mm | 3 |
| C8, C10 | 100nF - 2.54mm | 2 |
| C4 | 10µF/50V, electrolytic | 1 |
| C5, C6 | 27pF, ceramic | 2 |
| C7 | 47µF/50V, electrolytic | 1 |
| C9 | 10µF/35V, tantalium | 1 |
| | | |
| Semiconductors: | | |
| IC1 | 16F870(A), 16F873(A), 16F876(A) | 1 |
| IC2 | 74HC(T)238 | 1 |
| IC3 | CD4543, HEF4543 | 1 |
| IC4 | ULN2803A | 1 |
| IC5 | UDN2981A, TD62783AP | 1 |
| VR1 | 7805 voltage regulator | 1 |
| T1...T4 | BC547B | 4 |
| D1 | LED 2.5x5mmm, Green, diffused | 1 |
| D2 | LED 2.5x5mmm, Yellow, diffused | 1 |
| D3 | LED 2.5x5mmm, Red, diffused | 1 |
| D4 | LED 2.5x5mmm, Blue, diffused | 1 |
| D5...D8 | LED 10mm, blue, diffused | 4 |
| Disp1...Disp6 | LC-Led LCD-40012TB11 4.0" blue 7-segment display | 6 |
| | (Not included in kit) | |
| Miscellaneous: | | |
| XTAL1 | Crystal 4.096MHz | 1 |
| S1 | Push button switch, (ON)/OFF | 1 |
| S2 | SPST switch, ON/OFF | 1 |
| JP1, JP2 | 4-pin header + jumpers | 1 |
| JP3, JP4 | 2-pin header + jumpers | 2 |
| K1 | 3-pin header Male PCB, 90° + Female with wires | 1+1 |
| K2, K4, K6, K7 | 2-pin header Male PCB, 90° + Female with wires | 4+4 |
| K8 | 20-pin header Male PCB, 90° + Female with wires | 1+1 |
| K9 | 1-pin header Male PCB | 1 |
| | | |
| | DC socket 5.5x2.1mm chassis mount | 1 |
| | 3.5mm stereo socket chassis mount | 1 |
| | IC socket, 28-pin, narrow | 1 |
| | | |

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|  | IC socket, 16-pin | 2 |
|---|---|---|
|  | IC socket, 18-pin | 2 |
|  | Heat sink TO220 | 1 |
|  | Standoff M3x10mm | 4 |
|  | M3x5mm screw | 4 |
|  | M3x10mm screw + bolt + washer | 1 |
|  | Brass reinforcements 40x10x10mm | 6 |
|  |  |  |

## 8.  **Main PCB Rev C component layout:**
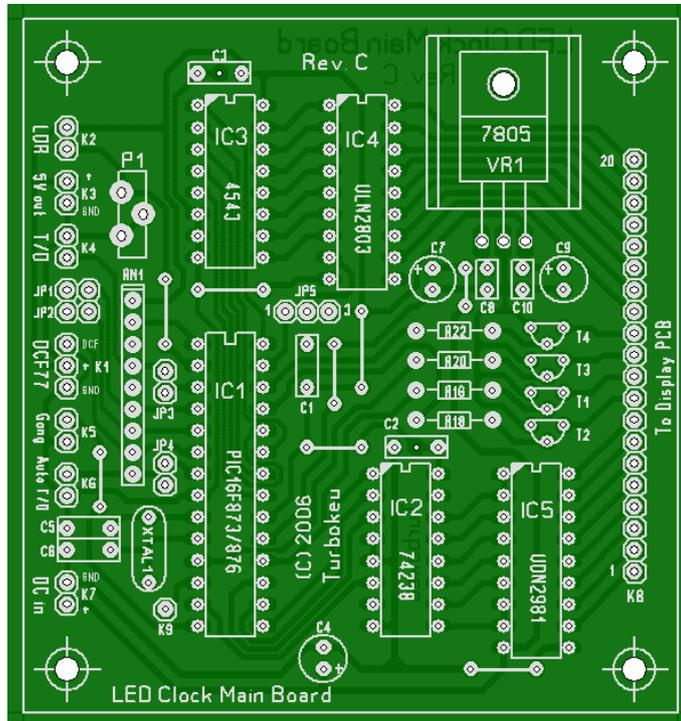
## 9.  Main PCB Rev E component layout:
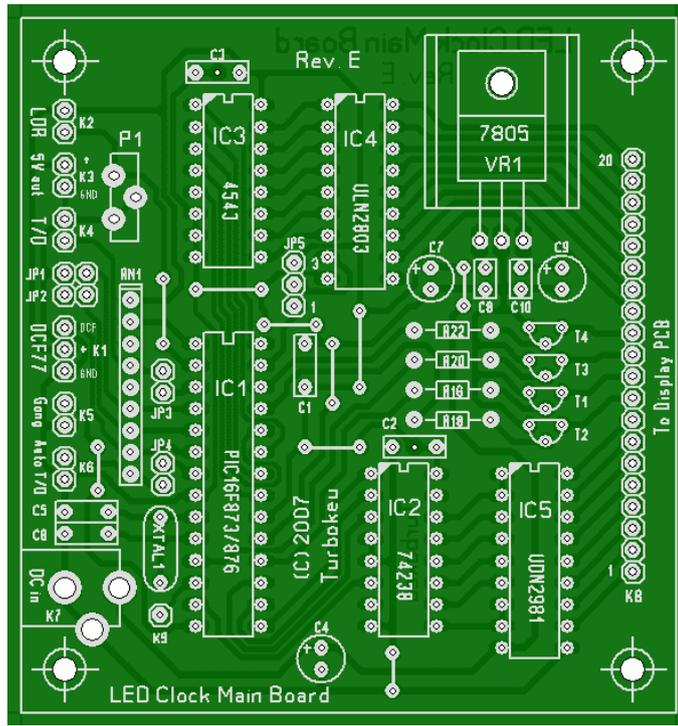


## 10. Main PCB Rev E component layout:
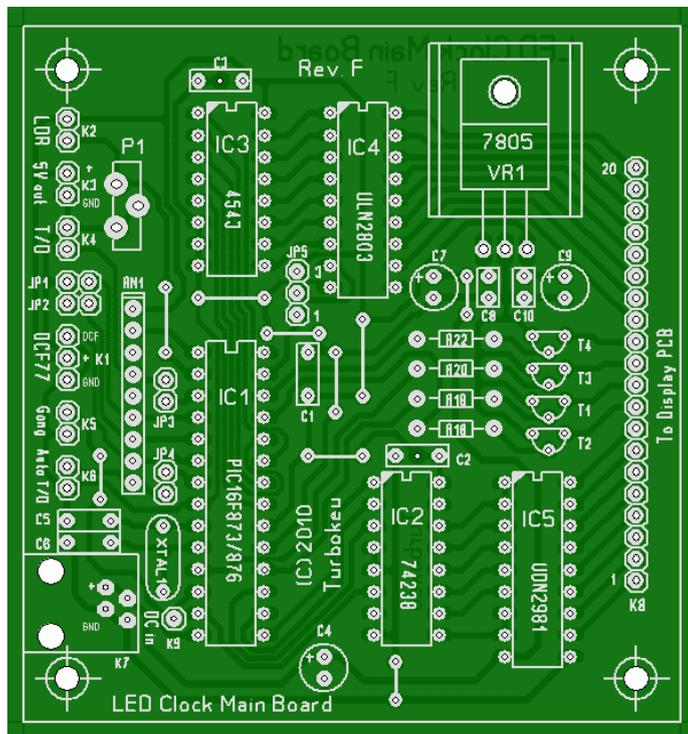
## 11. Main PCB connection layout:

LDR

+5VDC Output

Time/Date Switch S1

DCF77 module

Gong Output

Auto T/D Switch S2

DC Power Input

Display Segments

f
g
e
d
c
b
a
Colon Cathode
DCF BEAT LED
DCF ERROR LED
DCF OK LED
Standalone LED
Status LEDs Anode
1
2
3
4
5
6
Colon Anode

Display Anodes
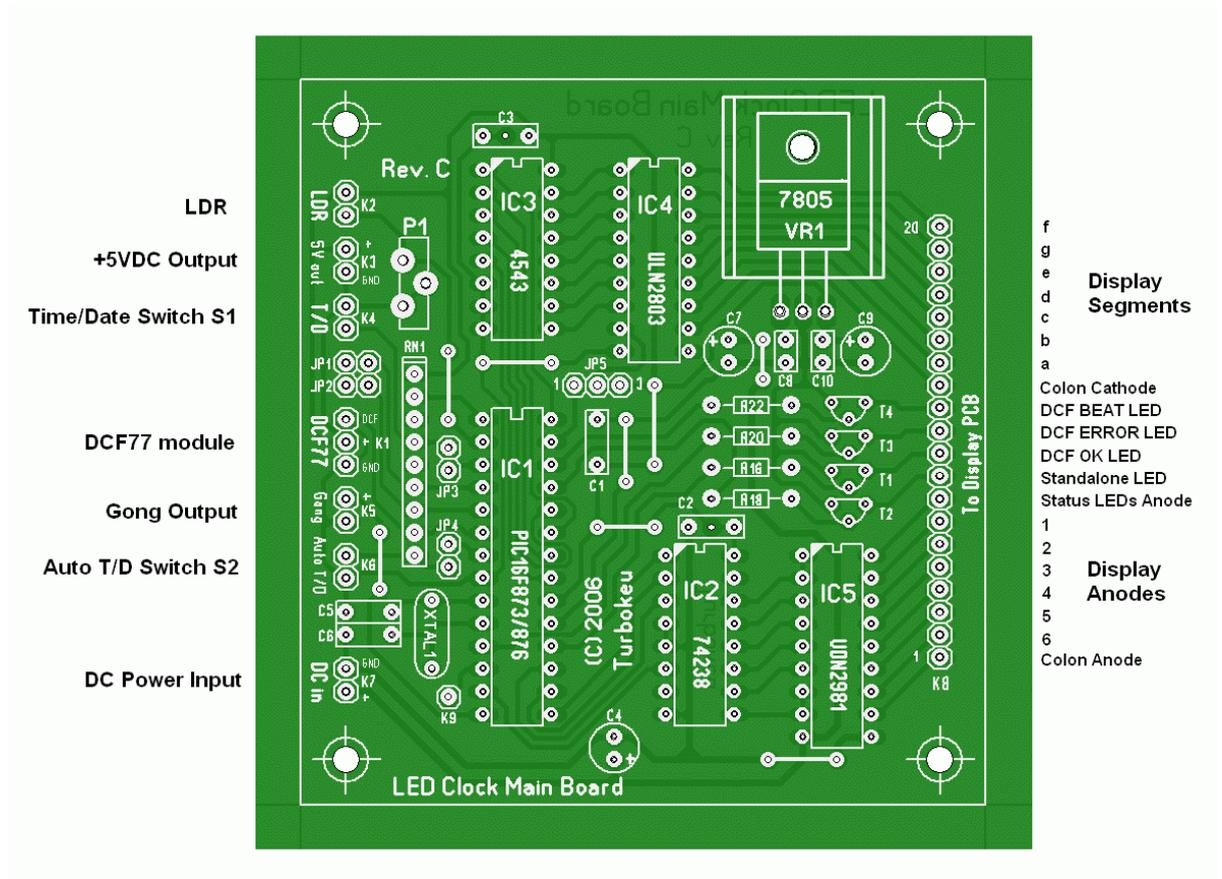
## 12. Display board copper layout (reduced size)

Real board size is 68x14cm
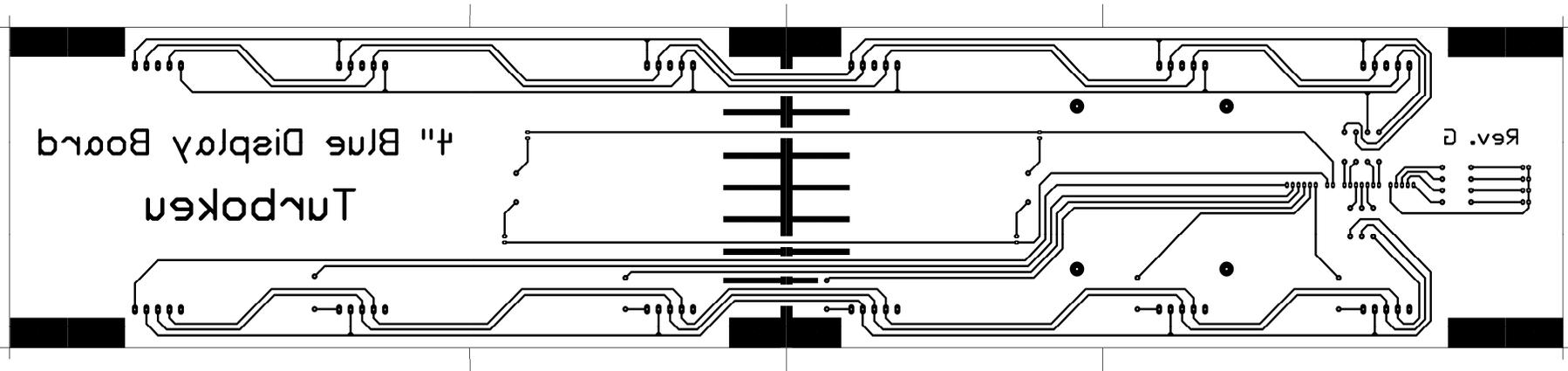
## 13. Display board component layout (left part):
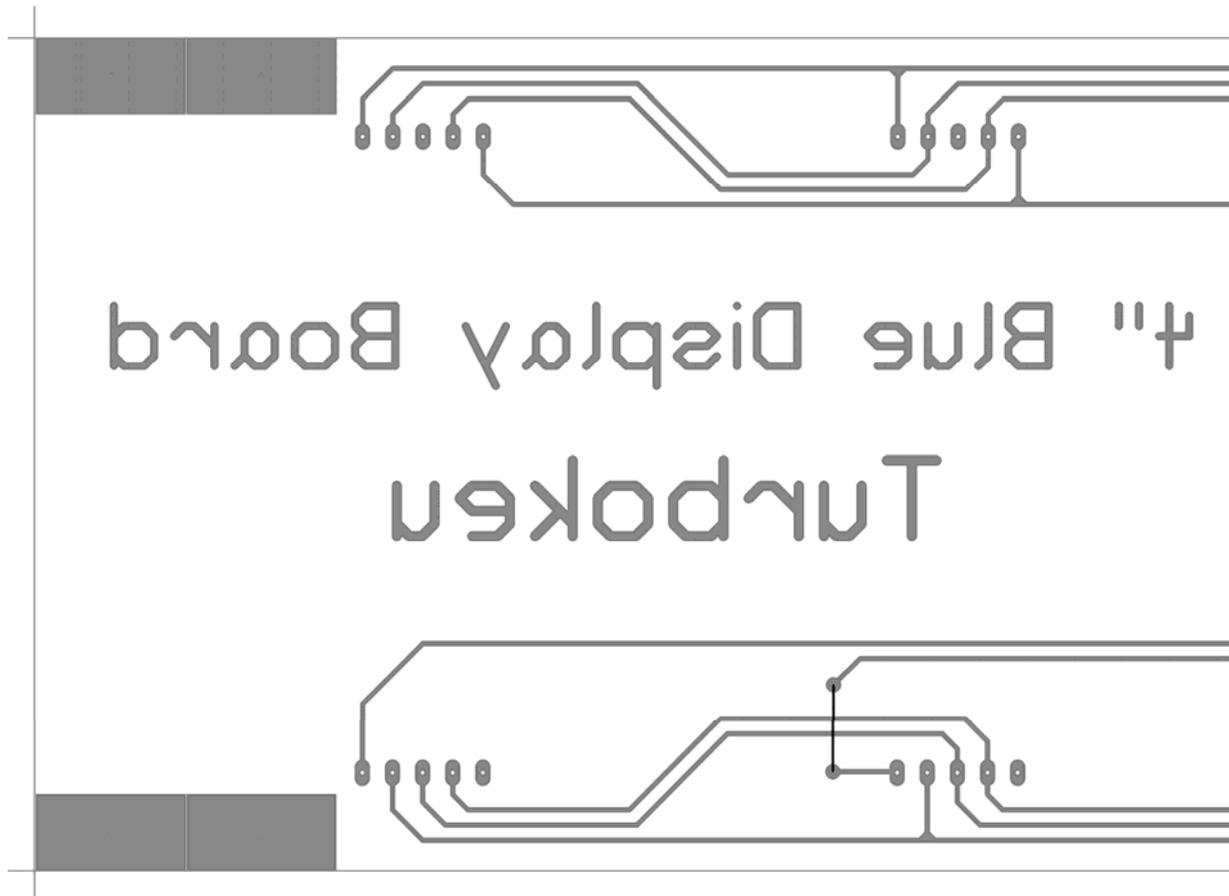
## 14. Display board component layout (middle part):
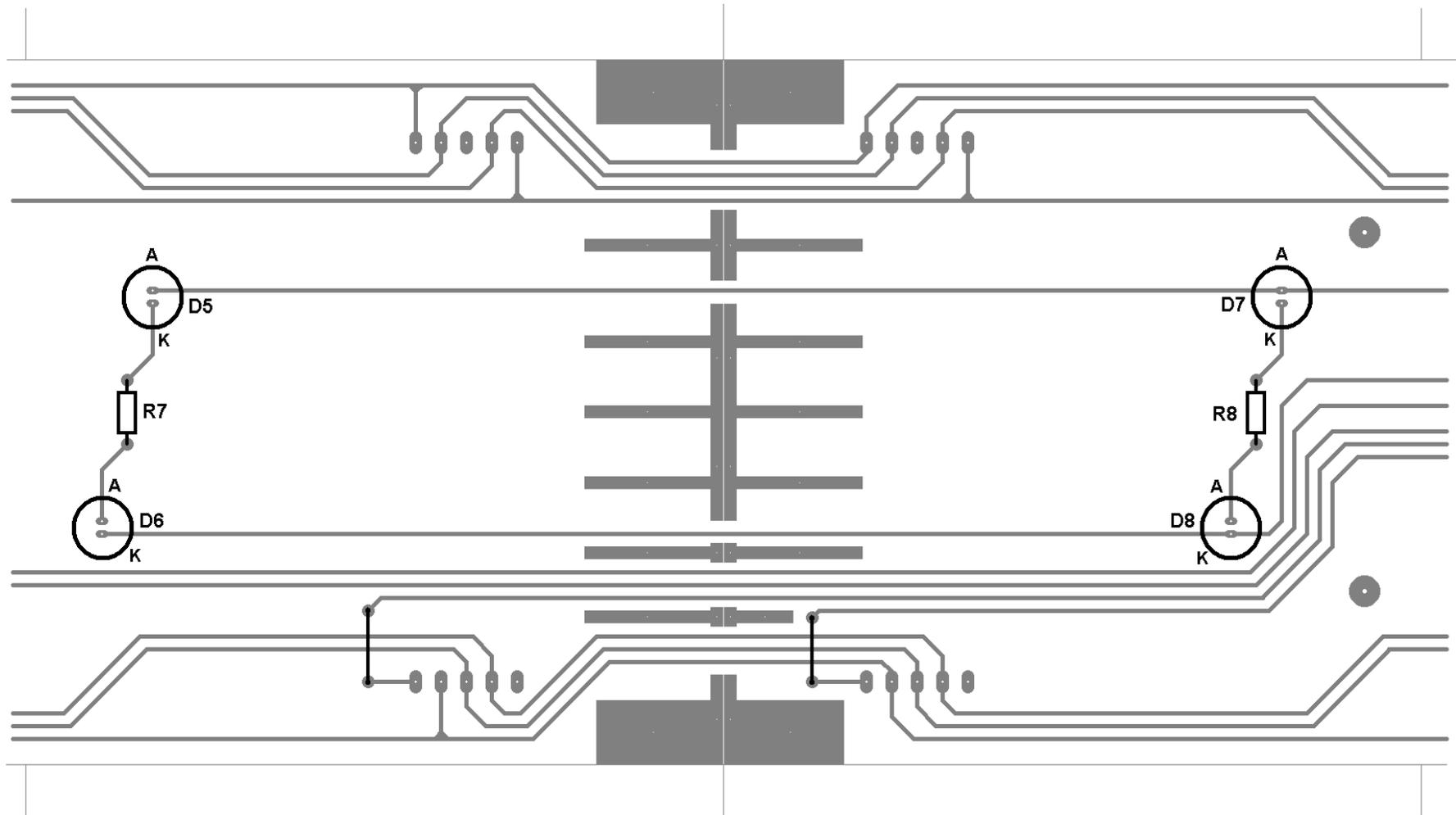
## 15. Display board component layout (right part):

LDR1

R1 10k

P1 2k5

C2 100nF  IC2  IC3  C3 100nF

16  16
8  8

+22V

C4 10uF 35V-TA

R7 220R  R8 220R

D5  D7
D6  D8

Colon Beat
10mm Blue

+22V  VR1 7805  +5V
IN  OUT
COM

C7 47uF 35V  C8 100nF  C9 10uF 35V-TA  C10 100nF

+5V

C1 100nF

R2 10k  R3 10k  R4 10k  R5 10k  R6 10k

JP3  JP4

IC2 74238
1 A0  Q0 15
2 A1  Q1 14
3 A2  Q2 13
      Q3 12
      Q4 11
      Q5 10
4 E1  Q6 9
5 E2  Q7 7
6 E3

IC5 TD62783AP
1 I1  O1 18
2 I2  O2 17
3 I3  O3 16
4 I4  O4 15
5 I5  O5 14
6 I6  O6 13
7 I7  O7 12
8 I8  O8 11
9 VCC  GND 10

K1
DCF77
Vcc
Gnd

DCF77
Module

RF433
decoder
inputs

1 MCLR  Vdd20  RB0 21
2 RA0  RB1 22
3 RA1  RB2 23
4 RA2  RB3 24
5 RA3  RB4 25
6 RA4  RB5 26
7 RA5  RB6/PGC 27
        RB7/PGD 28
IC1
PIC16F876
RC0 11
RC1/CCP2 12
RC2/CCP1 13
RC3/SCL 14  K9
RC4/SDA 15
RC5 16
RC6 17
RC7 18
Vss8  Vss19

C5 27pF  XTAL1
C6 27pF
4.096MHZ
OSC1 9
OSC2 10

IC3 4543
4 D3  1B
2 D2  a 2B
3 D1  b 3B
5 D0  c 4B
1 LD  d 5B
7 BI  e 6B
6 PH  f 7B
      g

IC4 ULN2803A
1C 18
2C 17
3C 16
4C 15
5C 14
6C 13
7C 12
8C 11
COM 10
GND

R9-R15
100R

a  CA  a  CA  a  CA  a  CA  a  CA  a  CA
b      b      b      b      b      b
c      c      c      c      c      c
d      d      d      d      d      d
e      e      e      e      e      e
f      f      f      f      f      f
g      g      g      g      g      g
dp     dp     dp     dp     dp     dp

Disp6  Disp5   Disp4  Disp3   Disp2  Disp1
Hours          Minutes        Seconds
Days           Months         Years

6x LC-Led LCS-40012TB11 4.0" Display

JP5  +5V
1 2 3
Gong output

PIC DCF77 4.0" Blue LED Clock
Turbokeu

D1 Green DCF77 OK
D2 Yellow Standalone
D3 Red DCF Error
D4 Blue DCF Beat

R16 10k  R17 270R
R18 10k  R19 270R
R20 10k  R21 270R
R22 10k  R23 820R

Time/
Date  S1

TZ0 JP1 CET-1
TZ1 JP2 CET+1

S2 AutoT/D

T1 BC547B  T2 BC547B  T3 BC547B  T4 BC547B

GND