**Digital Clock Project**

**Introduction**

This project is based on the commonly available 74xx series logic ICs. I wanted to build a clock from basic logic gates instead of using a dedicated clock IC. This way wanted to understand digital logic design.

**Design**

1 Hz clock pulse is generated by a combination of 32Khz crystal, CD4060 (U1) and CD4013 (U2) CMOS ICs. The clock oscillator is built around the CD4060 and 32khz standard clock crystal. 32768 is divided by 14 by the divider built into CD4060. This is further divided by 2 by CD4013 D type flip flop and a 1 Hz pulse is got.

This pulse is fed to the clock input of first decade counter U3 and the output Q3 is fed to the clock input of the second decade counter U5. These two ICs constitute the seconds counter of the clock. The output is fed to two 7447 U4, U6 7 segment decoders which in turn drive the common anode 7 segment displays AFF1, AFF2.

AND Gate U15A is used to detect 60 seconds count and then reset U5 counter and also drive the minutes counter built with U7. The pulse is gated through a OR gate U16A which also has a minutes advance pulse input.

The minutes advance is built with pushbutton SW1 and switch debounce circuit using U17A 74LS14 schmitt trigger inverter.

This minute pulse is fed to the clock input of third decade counter U7 and the output Q3 is fed to the clock input of the fourth decade counter U9. These two ICs constitute the minutes counter of the clock. The output is fed to two 7447 U8, U10 7 segment decoders which in turn drive the common anode 7 segment displays AFF3, AFF4.

AND Gate U15B is used to detect 60 minutes count and then reset U9 counter and also drive the hour counter built with U11. The pulse is gated through a OR gate U16B which also has a hour advance pulse input.

The hour advance is built with pushbutton SW2 and switch debounce circuit using U17B 74LS14 schmitt trigger inverter.

This hour pulse is fed to the clock input of fifth decade counter U11 and the output Q3 is fed to the clock input of the sixth decade counter U13. These two ICs constitute the hour counter of the clock. The output is fed to two 7447 U12, U14 7 segment decoders which in turn drive the common anode 7 segment displays AFF5, AFF6.

AND Gate U15C is used to detect 24 hour count and then reset U13 counter

Seconds blinker is built with transistor T1 which drives two LEDs D3,D4. The input is taken from the 1 Hz clock generator.

The circuit is powered by 5 volts through a Barrel jack connector.

C6 to C22 are power bypass capacitors used to reduce switching noise at logic gates.

The schematics and PCB was designed using opensource Kicad application.

**Parts List**

|  |  |  |
| --- | --- | --- |
| **Part ID** | **Description** | **Quantity** |
| Semiconductors | | |
| U1 | CD4060 CMOS 14 stage ripple carry binary counter/divider and oscillator | 1 |
| U2 | CD4013 CMOS Dual D-Type Flip-Flop | 2 |
| U3, U5, U7, U9, U11, U13 | 74LS90 Decade counter | 6 |
| U4, U6, U8, U10, U12, U14 | 74LS47 BCD to 7 segment decoder | 6 |
| U15 | 74LS08 Quad 2-input AND Gate | 1 |
| U16 | 74LS32 Quad 2-input OR Gate | 1 |
| U17 | 74LS14 Hex Schmitt-Trigger Inverters | 1 |
| T1 | 2N2222 NPN transistor | 1 |
| D1, D2 | 1N4148 small signal diode | 2 |
| D3, D4 | Red LED 3mm | 2 |
| Resistors (All ¼ watt) | | |
| R1 | 220K ohm resistor | 1 |
| R2 | 10M ohm resistor | 1 |
| R3, R5 | 5.1K ohm resistor | 2 |
| R4, R6 | 2.2K ohm resistor | 2 |
| R7 | 10K ohm resistor | 1 |
| R8, R9, R10, R11, R12, R13, R14, R15, R16, R17, R18, R19, R20, R21, R22, R23, R24, R25, R26, R27, R28, R29, R30, R31, R32, R33, R34, R35, R36, R37, R38, R39, R40, R41, R42, R43, R44, R45, R46, R47, R48, R49 | 220 ohm resistor | 42 |
| Capacitors | | |
| C1, C2 | 33pf ceramic capacitor | 2 |
| C3, C4 | 4.7uf electrolytic capacitor | 2 |
| C5 | 10uf electrolytic capacitor | 1 |
| C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16, C17, C18, C19, C20, C21, C22 | 0.1uf ceramic capacitor | 17 |
| Miscellaneous | |  |
| AFF1, AFF2, AFF3, AFF4, AFF5, AFF6 | 7 segment common anode display 0.56 inch | 6 |
| J1 | Barrel Jack 2.1x5.5mm | 1 |
| SW1, SW2 | Tactile switches 6mm | 2 |
| X1 | 32Khz Crystal | 1 |