

# Objective

You are a digital systems engineer working on a critical mission for the space program on Mars. Your director, Dr. Extraterrestrial, has asked you to design a custom Digital Clock as a piece offering to the Martian inhabitants. The only catch is that the Martians only understand binary coded decimal.

Using your expert Digital Design Skills, design a 24 hour digital Clock that displays the time in Binary-Coded-Decimal.

## Digital Clock Design Requirements

To aid the design process, the power supply and clock divider subsystems design schematics are shown in Figures 1 & 2. You must finish the design by using counters, combined with the appropriate reset logic, to count the seconds, minutes, and hours of the day. Additionally, the final design at a minimum should include:

- A 24 Hour BCD display that shows
  - Hours
  - Minutes
  - Seconds
- A Set Time Button along with:
  - Set Hours Button
  - Set Minutes Button
  - Set Seconds Button
  - The operation should be such that when the "Set Time" button is depressed, the clock temporarily stops counting and you can manually push the Hours/Minutes/Seconds button to increment "set" those counts"
- A 9V source powered by a:
  - 9V Battery or
  - 9V Power Supply
- Soldered Prototype (Perf) Board
- A Project Box to enclose the final board. It could be
  - Clear or
  - Transparent Color

Additionally, extra credit will be awarded for adding the following to the basic design:

- 7-Segment displays to display Hours, Minutes, Seconds above the respective BCD column
  - Should have an external switch to enable/disable 7-segment display
- Creating a PCB (Printed Circuit Board) instead of using a Perf Board
- Eliminating any switch bouncing
- Additional points may be awarded for other modifications, alterations, or packaging that goes "above and beyond" as determined by Dr. Poe.

Grading Rubric	
Basic Functionality	7
Design Report	5
Packaging / Aesthetics	3
Extra Credit	
7-Segment Display	2
PCB Design	5
Switches Debounced	2

## Report Requirements

Please provide a full report describing your design, including Schematics and a full description of each subsystem, i.e. Power Supply, Clock Divider, Hours, Minutes, Seconds counters etc.

Please note that you may be requested by the department to donate your project at the end of the term.

## Parts List

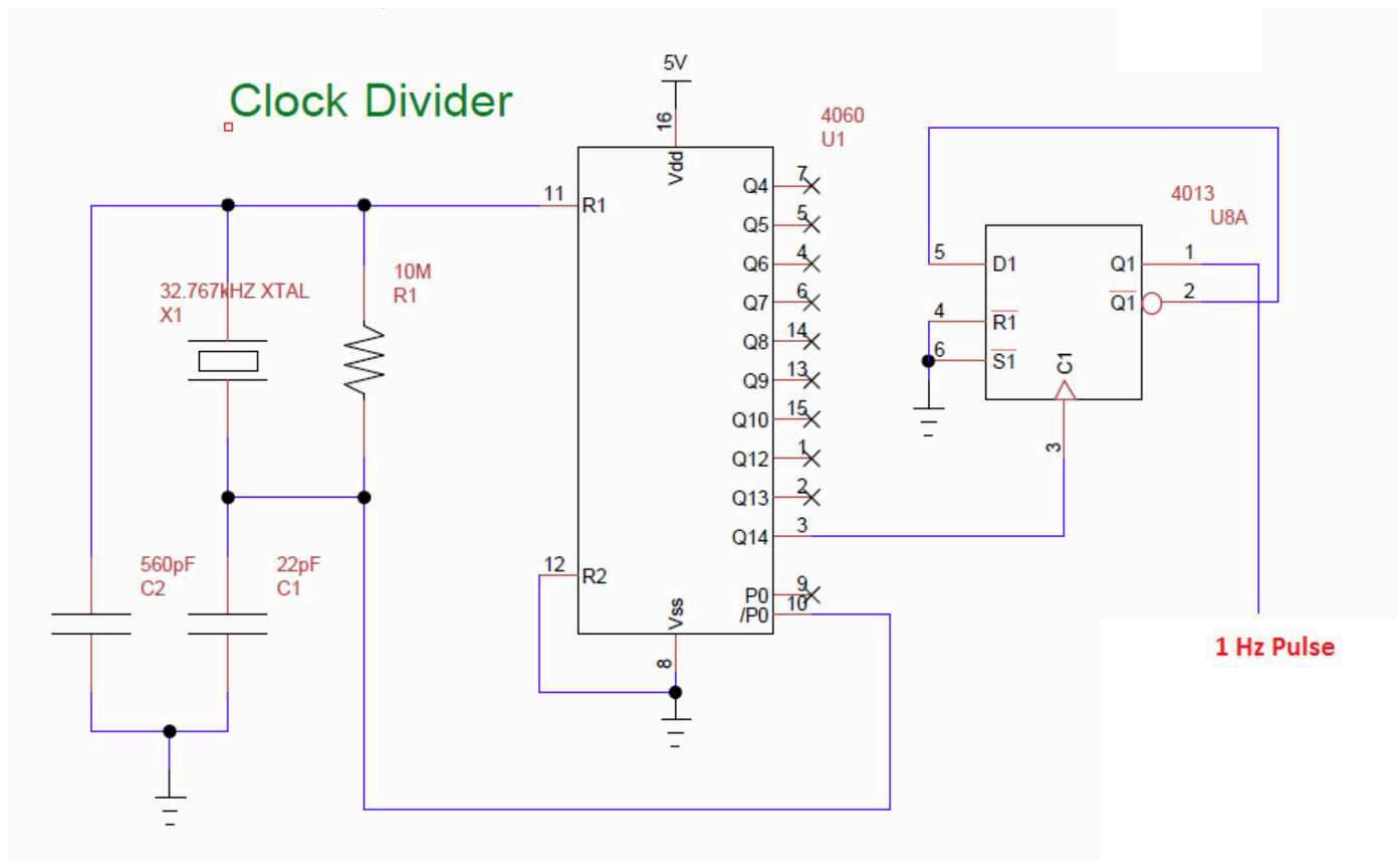
The following parts list should provide you with the minimum parts required to build the standard BCD clock. All ICs used are to be CMOS, not TTL. Be sure to order DIP parts. Please note that the following are NOT included in the parts list:

- The Perf-board or PCB material
- The parts for the extra credit 7-segment display subsystem
- The parts for switch debouncing
- The project housing and any packaging/casing material you may wish to use

<b>Name / Value</b>	<b>Description</b>	<b>Quantity</b>	<b>Reference</b>	<b>Subsystem</b>
<b>10M</b>	Resistor	1	R1	Clock Divider
<b>22pF</b>	Capacitor	1	C1	Clock Divider
<b>560pF</b>	Capacitor	1	C2	Clock Divider
<b>32.768 KHz XTAL</b>	Quartz Crystal	1	X1	Clock Divider
<b>4060</b>	14-Bit Ripple Counter /w Internal Oscillator	1	U1	Clock Divider
<b>4013</b>	D-Type Flip Flop	1	U8	Clock Divider
<b>9V</b>	9V Battery Connector	1	B1	Power
<b>On/Off Switch</b>	Toggle Switch	1	S5	Power
<b>7805</b>	5V DC Regulator	1	U2	Power
<b>SET (NO)</b>	SPST Normally Open Switch	4	S1,S2, S3, S4,	Set Time/H/M/S Switches

<b>14.7K</b>	Resistor	4	R22, R23, R24, R25	Set H/M/S Pull down Resistors
<b>4050</b>	Hex Buffer	4	U10, U11, U12, U13	LED Drivers
<b>330</b>	Resistor	20  Note: you can use discrete resistors or use a "resistor net" IC	R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R13, R14, R15, R16, R17, R18, R19, R20, R21	LED Output
<b>LED</b>	LEDs	20	L1, L2, L3, L4, L5, L6, L7, L8, L9, L10, L11, L12, L13, L14, L15, L16, L17, L18, L19, L20	LED Output
<b>4081</b>	Quad 2-Input AND Gate	2	U7, U8	Clock Logic
<b>4518</b>	Dual Decade Counter	3	U3, U4, U5	Clock Logic
<b>4071</b>	Quad 2-Input OR Gate	1	U14	Clock Logic

## Subsystem Designs



# Reference Websites

Jameco - <http://www.jameco.com>