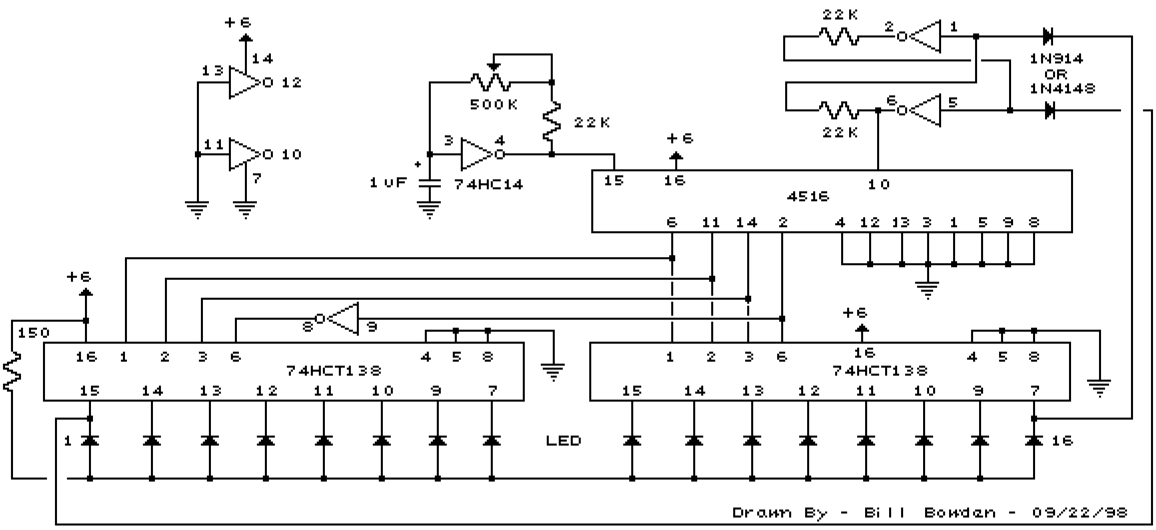
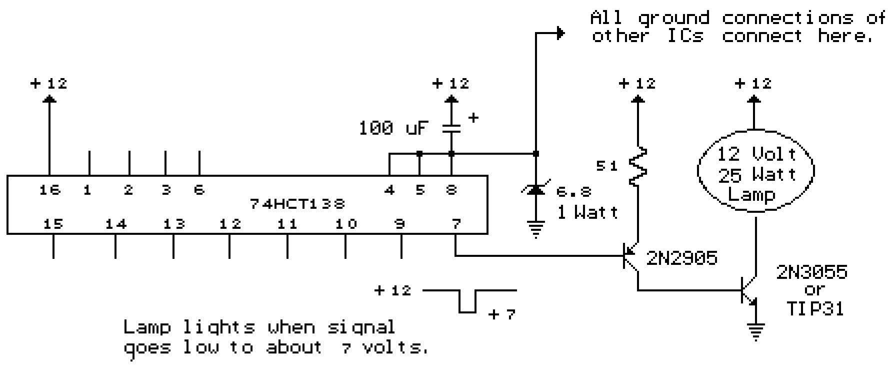
16 Stage Bi-Directional LED Sequencer

The bi-directional sequencer uses a 4 bit binary up/down counter (CD4516) and two "1 of 8 line decoders" (74HC138 or 74HCT138) to generate the popular "Night Rider" display. A Schmitt Trigger oscillator provides the clock signal for the counter and the rate can be adjusted with the 500K pot. Two additional Schmitt Trigger inverters are used as a SET/RESET latch to control the counting direction (up or down). Be sure to use the 74HC14 and not the 74HCT14, the 74HCT14 may not work due to the low TTL input trigger level. When the highest count is reached (1111) the low output at pin 7 sets the latch so that the UP/DOWN input to the counter goes low and causes the counter to begin decrementing. When the lowest count is reached (0000) the latch is reset (high) so that the counter will begin incrementing on the next rising clock edge. The three lowest counter bits (Q0, Q1, Q2) are connected to both decoders in parallel and the highest bit Q3 is used to select the appropriate decoder. The circuit can be used to drive 12 volt/25 watt lamps with the addition of two transistors per lamp as shown below in the section below titled "Interfacing 5 volt CMOS to 12 volt loads"



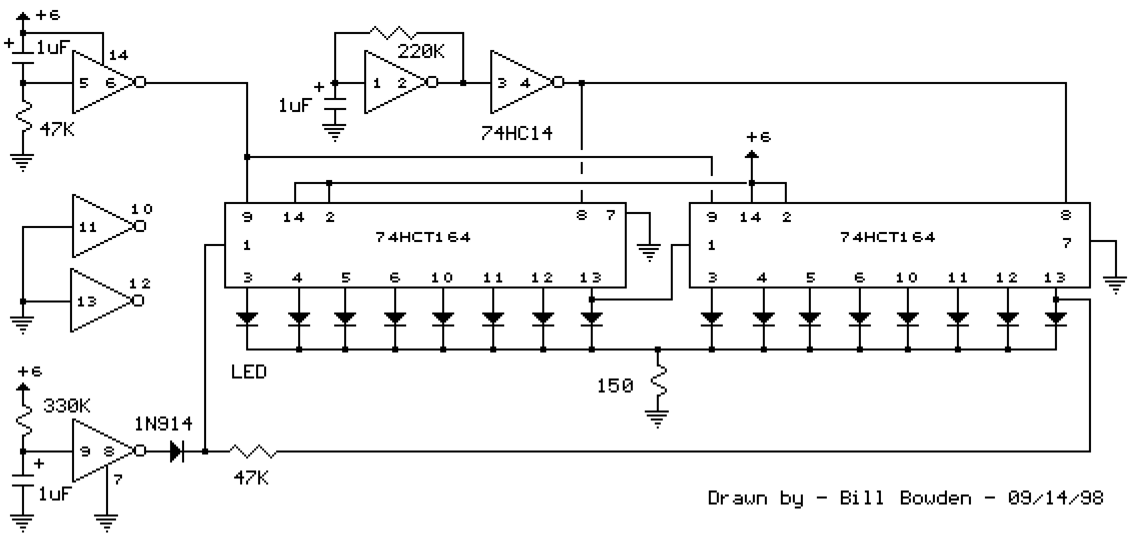
Interfacing 5 volt CMOS to 12 volt/ 25 Watt Loads

The circuit below is designed to be used with the bi-directional lamp sequencer shown above on this same page. Two additional transistors are used to increase the current from the 74HCT138 decoder to control 12 volt 25 watt lamps. A 6.8 volt/1 watt zener diode is used in series with the ground connection of all the CMOS ICs (74HC14, CD4516 and 74HC138s) so that the total voltage across the CMOS devices will be about 5.2 volts and the outputs will move from +12 to about +7 when selected. The 2N2905/PNP transistor stage is connected as an emitter follower which provides a high impedance to the decoder output and supplies about 80 mA of current to the base of the 2N3055 NPN power transistor which then supplies 2 or more amps to the 12 volt lamp. The voltage across the PNP transistor will be about 7 volts when it is turned on and the heat dissapation will be about 0.6 watts. That should't require a heat sink if several lamps are sequencing but it may get quite warm if the circuit is idle on a single output. The 2N3055 power transistor operates as a switch and drops very little voltage (less than 0.5) when conducting, and will not require a heat sink. Other transistors may be substituted such as the TIP29 or TIP31 for the 2N3055 and most any medium power (500mA) PNP for the 2N2905.

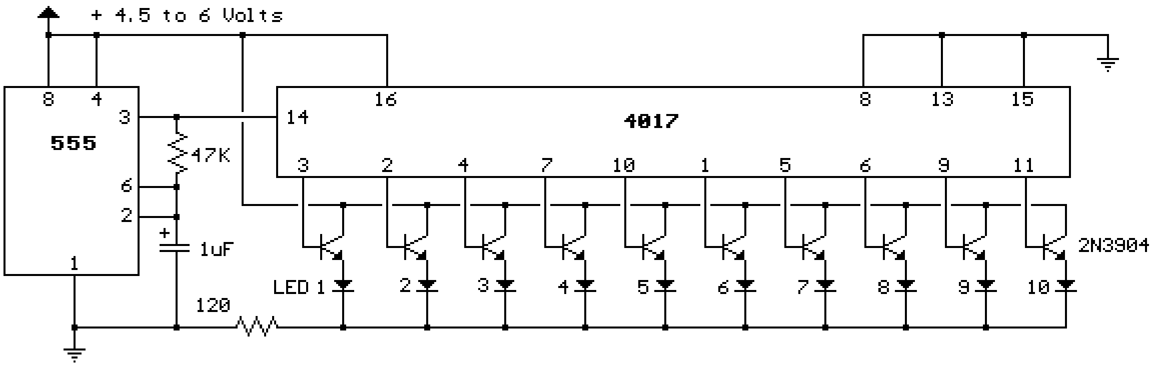


Expandable 16 Stage LED Sequencer

The circuit below uses a hex Schmitt Trigger inverter (74HC14) and two 8 bit Serial-In/Parallel-Out shift registers (74HCT164 or 74HC164) to sequence 16 LEDs. The circuit can be expanded to greater lengths by cascading additional shift registers and connecting the 8th output (pin 13) to the data input (pin 1) of the succeeding stage. A Schmitt trigger oscillator (74HC14 pin 1 and 2) produces the clock signal for the shift registers, the rate being approximately 1/RC. Two additional Schmitt Trigger stages are used to reset and load the registers when power is turned on. Timing is not critical, however the output at pin 8 of the Schmitt Trigger must remain high during the first LOW to HIGH clock transition at pin 8 of the registers, and must return low before the second rising edge to load a single bit. If the clock rate is increased, the length of the signal at pin 9 of the Schmitt Trigger should be reduced proportionally to avoid loading more than one bit. The HCT devices will normally provide about 4 mA (source or sink) from each output but can supply greater currents (possibly 25 mA) if only one output is loaded. The common 150 ohm resistor restricts the current below 25 mA using a 6 volt power source. If the circuit is operated with two or more LEDs on at the same time, resistors may be needed in series with each LED to avoid exceeding the maximum total output current for each IC of 25 mA. For greater brightness, individual buffer transistors can be used as shown in the 10 stage LED sequencer on this same page.

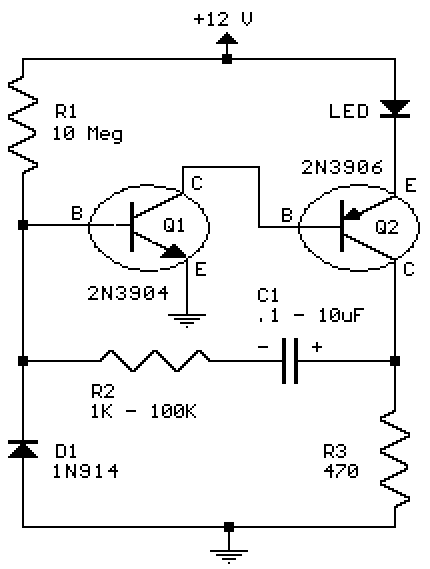


10 Channel LED Sequencer



The 4017 is a CMOS decade counter with 10 decoded outputs. Inputs include a CLOCK (pin 14), a RESET (pin 15), and a CLOCK INHIBIT (pin 13). The clock input drives an internal schmitt trigger circuit for pulse shaping and allows for unlimited clock rise and fall times. The counter is advanced one count at the rising edge of the clock signal if the CLOCK INHIBIT line is low. A high RESET signal resets the counter to the zero count. The circuit may be configured for counts less than 10 by connecting RESET to an output pin one above the desired count. Thus, a five channel sequencer could be made by connecting pin 15 to pin 1. A CARRY-OUT signal (pin 12) may be used to clock subsequent stages in a multi-device counting chain (ones, tens, hundreds, etc.) Small signal NPN transistors are used to increase the output current for the LEDs to about 20 ma which is set by the common 120 ohm resistor. Other NPN transistors may be substituted for the 3904. The 555 timer generates the clock signal, the frequency being determined by the 1uF capacitor and 47K resistor which is approximately = 1.44 / 2RC = 15 Hz.

Two Transistor LED Flasher



This circuit will flash a bright red LED (5000 mcd) as an attention getting device or fake car alarm. Component values are not critical and other transistors may be used. Flash duration is determined by R2 and C1 and is approximately 3 time constants (3*R2*C1). Brightness is controlled by R3 which limits the LED current to about 20 milliamps for values listed. R1 provides bias for the transistors which should be low enough not to saturate Q2 with the capacitor disconnected. If the circuit does not oscillate, R1 may be too low or R2 may be too high. D1 allows for higher duty cycle operation and limits the reverse voltage at the base of Q1 to -0.7 volts. D1 may be omitted for low voltage (3-9) and low duty cycle operation. Most parts available at Radio Shack. Cat. No. (276-086) for the LED.

Volts	R1	R2	R3	C1	Approx. Flash Rate
12	10 Meg	22 K	470	0.47 uf	140 per minute
12	10 Meg	10 K	470	1.0 uF	60 per minute
9	6.8 Meg	1 K	390	6.8 uF	15 per minute
6	3.3 Meg	10 K	220	1.0 uF	80 per minute
3	1.5 Meg	10 K	51	1.0 uF	120 per minute
3	3.3 Meg	47 K	51	0.47 uF	140 per minute

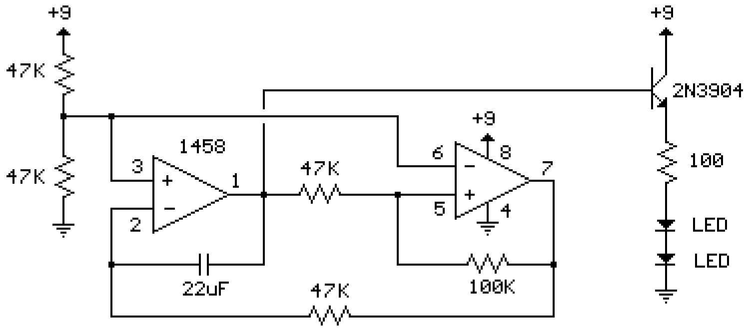
Fading Red Eyes

This circuit can be used to slowly illuminate and fade a pair of LEDs, or with the addition of a second transistor (PNP) the circuit will fade two pairs of LEDs out of phase so that one pair gets brighter while the other grows dimmer. The dual transistor version is shown below the single transistor circuit. Most any op-amp should work, I used the 1458 dual op-amp in the single transistor circuit and the LM324 quad op-amp in the dual transistor version. The two spare op-amps in the LM324 package could be used for a second circuit running at a different rate which would allow using four pairs of LEDs.

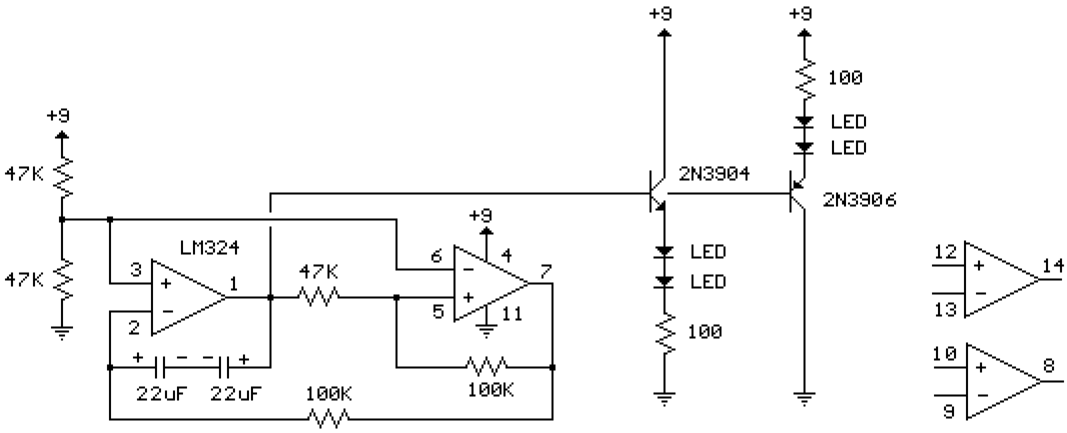
In operation, a linear 3 volt p-p ramping wavform is generated at pin 1 of the IC and buffered with an emitter follower transistor stage. The 22uF capacitor and 47K resistor connected to pin 2 establish the frequency which is about 0.5 Hz. You can make the rate adjustable by using a 100K potentiometer in place of the 47K resistor at pin 2.

The circuit consists of two operational amplifiers (op-amps), one producing a slow rising and falling voltage from about 3 volts to 6 volts, and the other (on the right) is used as a voltage comparator, the output of which supplies a alternating voltage between 2 and 7 volts to charge and discharge the capacitor with a constant current.

Each of the op-amps has one of the inputs (pins 3 and 6) tied to a fixed voltage established by two 47K resistors so that the reference is half the supply voltage or 4.5 volts. The left op-amp is connected as an inverting amplifier with a capacitor placed between the output (pin 1) and the inverting input (pin 2). The right op-amp is connected as a voltage comparator so that the output on pin 7 will be low when the input is below the reference and high when the input is higher than the reference. A 100K resistor is connected between the comparator output and input which provides positive feedback and pulls the input above or below the switching point when the threshold is reached. When the comparator output changes at pin 7, the direction of the current changes through the capacitor which in turn causes the inverting op-amp to move in the opposite direction. This yields a linear ramping waveform or triangle waveform at pin 1 of the inverting op-amp. It is always moving so that the voltage on the non-inverting input stays constant at 4.5 volts. Note that the capacitor will charge in both directions since one side is held at a constant 4.5 volts while the other side moves between 3 and 6 volts so you may want to use a couple 22uF caps connected with oposite polarity (as shown in the lower circuit). However, the reverse charge is only around 1.5 volts so a single electrolytic should work with little effect on linearity.



Drawn by - Bill Bowden - 8/7/96



Drawn by - Bill Bowden - 9/30/01

28 LED Clock Timer

This is a programmable clock timer circuit that uses individual LEDs to indicate hours and minutes. 12 LEDs can be arranged in a circle to represent the 12 hours of a clock face and an additional 12 LEDs can be arranged in an outer circle to indicate 5 minute intervals within the hour. 4 additional LEDs are used to indicate 1 to 4 minutes of time within each 5 minute interval.

The circuit is powered from a small 12.6 volt center tapped line transformer and the 60 cycle line frequency is used for the time base. The transformer is connected in a full wave, center tapped configuration which produces about 8.5 volts unregulated DC. A 47 ohm resistor and 5.1 volt, 1 watt zener regulate the supply for the 74HCT circuits.

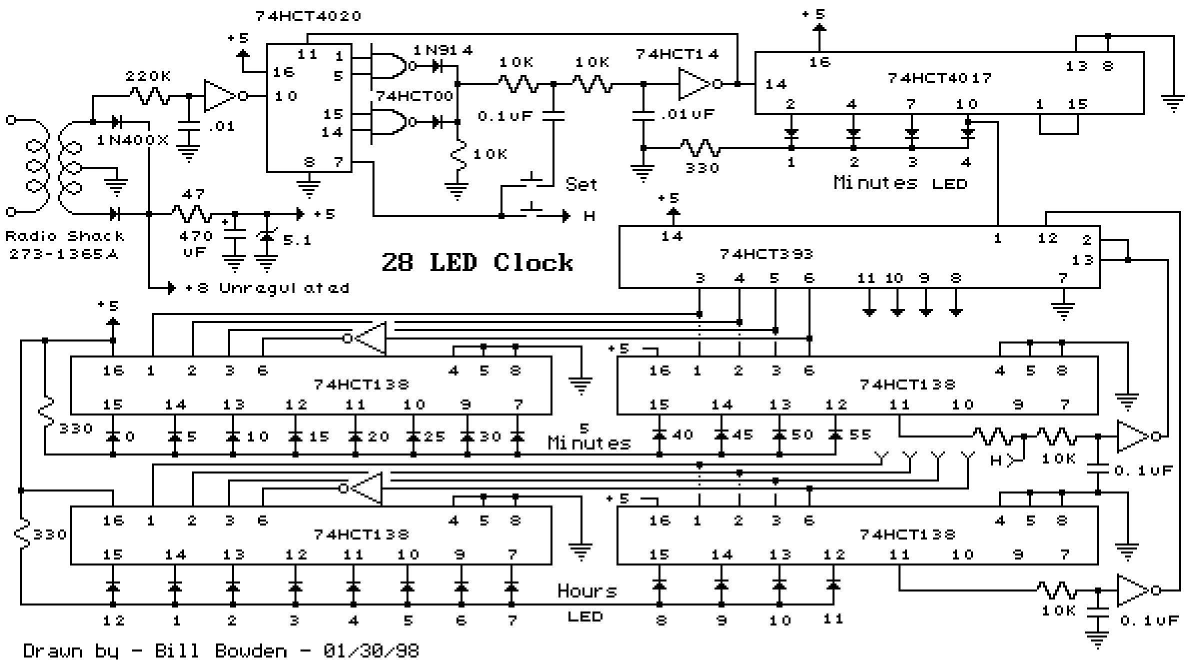
A 14 stage 74HCT4020 binary counter and two NAND gates are used to divide the line frequency by 3600 producing a one minute pulse which is used to reset the counter and advance the 4017 decade counter. The decade counter counts the minutes from 0 to 4 and resets on the fifth count or every 5 minutes which advances one section of a dual 4 bit binary counter (74HCT393). The 4 bits of this counter are then decoded into one of 12 outputs by two 74HCT138 (3 line to 8 line) decoder circuits. The most significant bit is used in conjunction with an inverter to select the appropriate decoder. During the first eight counts, the low state of the MSB is inverted to supply a high level to enable the decoder that drives the first 8 LEDs. During counts 9 to 12, the MSB will be high and will select the decoder that drives the remaining 4 LEDs while disabling the other decoder. The decoded outputs are low when selected and the 12 LEDs are connected common anode with a 330 ohm current limiting resistor to the +5 volt supply. The 5th output of the second decoder (pin 11) is used to reset the binary counter so that it counts to 11 and then resets to zero on the 12th count. A high reset level is required for the 393 counters, so the low output from the last decoder stage (pin 11) is inverted with one section of a 74HCT14 hex Schmitt trigger inverter circuit. A 10K resistor and 0.1uF cap are used to extend the reset time, ensuring the counter receives a reset signal which is much longer than the minimum time required. The reset signal is also connected to the clock input (pin 13) of the second 4 bit counter (1/2 74HCT393) which advances the hour LEDs and resets on the 12th hour in a similar manner.

Setting the correct time is accomplished with two manual push buttons which feed the Q4 stage (pin 7) of the 4020 counter to the minute and hour reset circuits which advance the counters at 3.75 counts per second. A slower rate can be obtained by using the Q5 or Q6 stages. For test purposes, you can use Q1 (pin 9) which will advance the minutes at 30 per second.

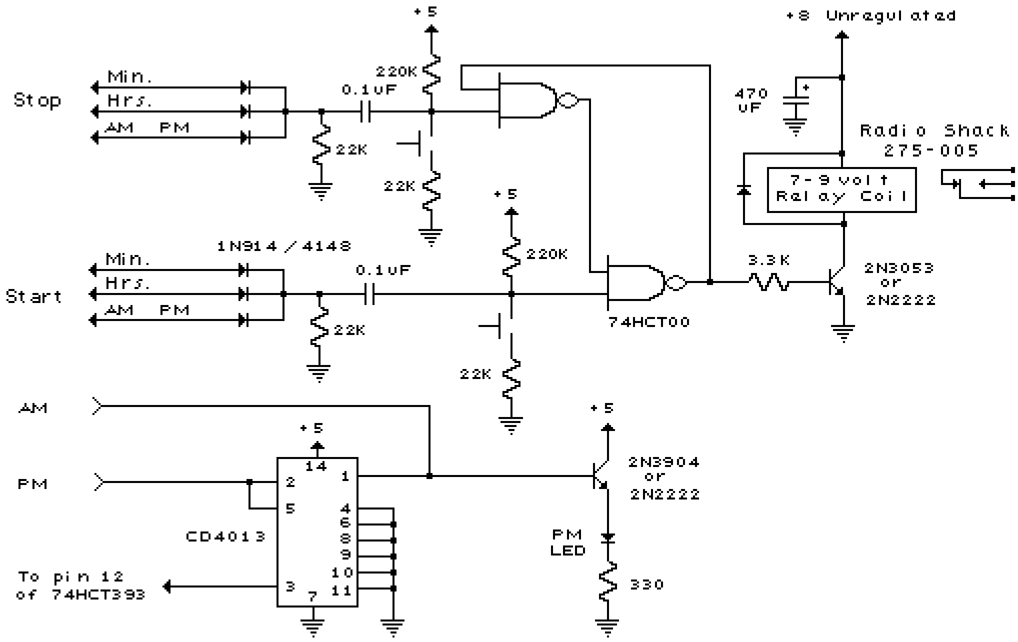
The time interval circuit (shown below the clock) consists of a SET/RESET flipflop made from the two remaining NAND gates (74HCT00). The desired time interval is programmed by connecting the anodes of the six diodes labeled start, stop and AM/PM to the appropriate decoder outputs.

For example, to turn the relay on at 7:05AM and turn it off at 8:05AM, you would connect one of the diodes from the start section to the cathode of the LED that represents 7 hours, the second diode to the LED cathode that represents 5 minutes and the third diode to the AM line of the CD4013. The stop time is programmed in the same manner. Two additional push buttons are used to manually open and close the relay. The low start and stop signals at the common cathode connections are capacitively coupled to the NAND gates so that the manual push buttons can override the 5 minute time duration. That way, you can immediately reset the relay without waiting 5 minutes for the start signal to go away.

The two power supply rectifier diodes are 1N400X variety and the switching diodes are 1N914 or 4148s but any general purpose diodes can be used. 0.1 uF caps (not shown on schematic) may be needed near the power pins of each IC. All parts should be available from Radio Shack with the exception of the 74HCT4017 decade counter which I didn't see listed. You can use either 74HC or 74HCT parts, the only difference between the two is that the input switching levels of the HCT devices are compatible with worst case TTL logic outputs. The HC device inputs are set at 50% of Vcc, so they may not work when driven from marginal TTL logic outputs. You can use a regular 4017 in place of the 74HCT4017 but the output current will much lower (less than 1 mA) and 4 additional transistors will be required to drive the LEDs. Without the buffer transistors, you can use a 10K resistor in place of the 330 and the LEDs will be visible, but very dim. Using the 4017 to drive LEDs with transistor buffers is shown in the "10 Channel LED Sequencer" at the top of this page.



Time Interval Relay Circuit for the clock circuit above

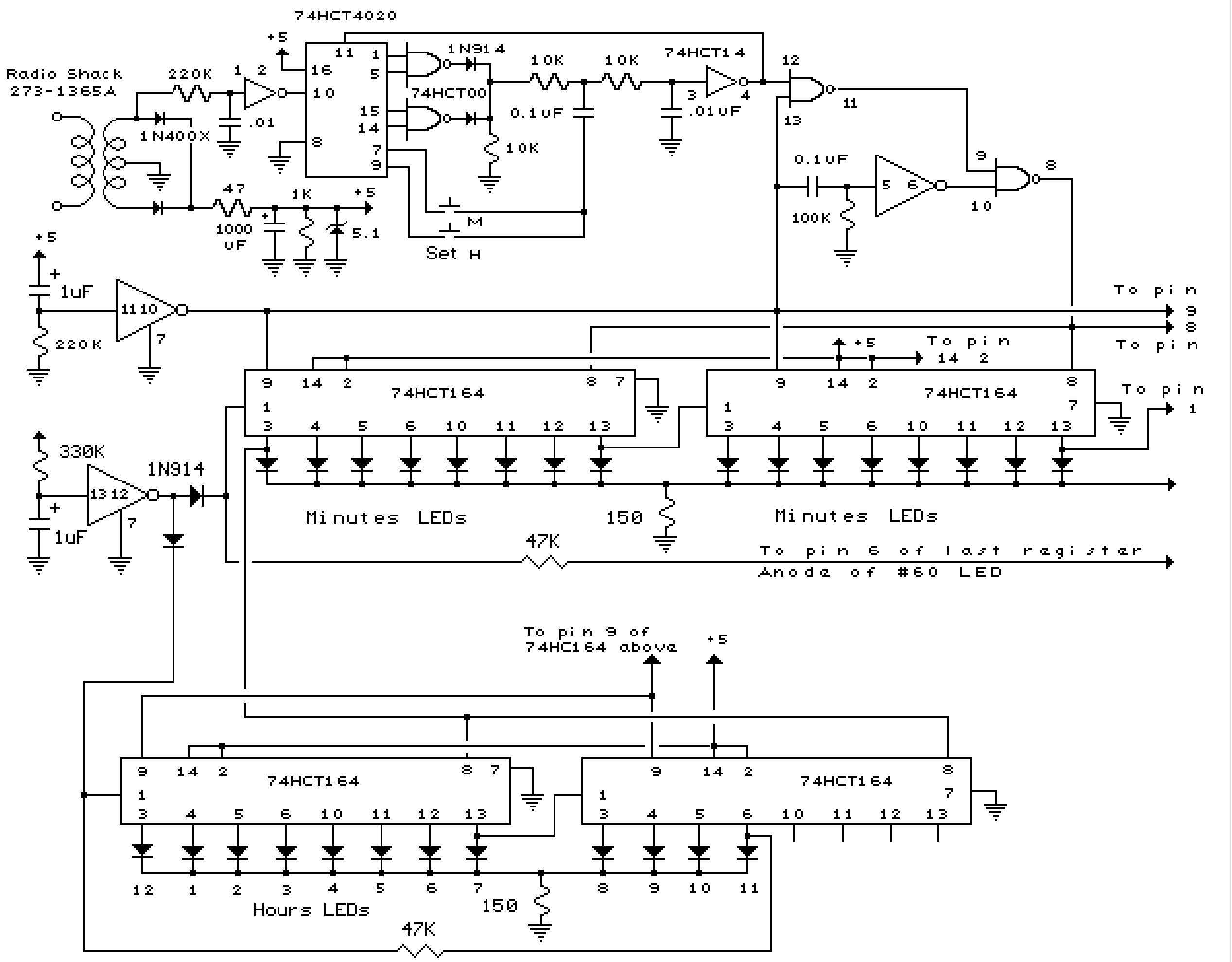


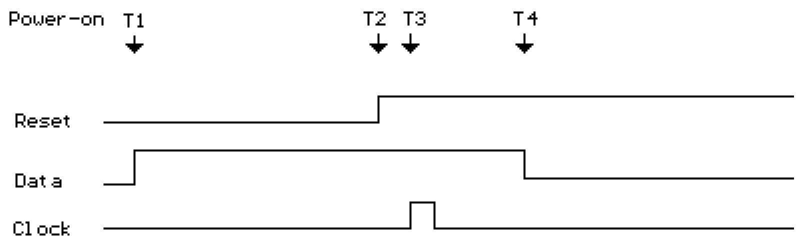
72 LED Clock

In the circuit below, 60 individual LEDs are used to indicate the minutes of a clock and 12 LEDs indicate hours. The power supply and time base circuitry is the same as described in the 28 LED clock circuit above. The minutes section of the clock is comprised of eight 74HCT164 shift registers cascaded so that a single bit can be recirculated through the 60 stages indicating the appropriate minute of the hour. Only two of the minutes shift registers are shown connected to 16 LEDs. Pin 13 of each register connects to pin 1 of the next for 7 registers. Pin 6 of the 8th register should connect back to pin 1 of the first register using the 47K resistor. Pins 2,9,8, 14 and 7 of all 8 minutes registers (74HC164) should be connected in parallel (pin 8 to pin 8, pin 9 to pin 9, etc.). The hours section contains two 8 bit shift registers and works the same way as the minutes to display 1 of 12 hours. Pin 9 of all 74HCT164s (hours and minutes) should be connected together. For 50 Hertz operation, the time base section of the circuit can be modified as shown in the lower drawing labeled "50 Hertz LED Clock Time Base". You will need an extra IC (74HC30) to do this since it requires decoding 7 bits of the counter instead of 4. The two dual input NAND gates (1/2 74HC00) that are not used in the 50 Hertz modification should have their inputs connected to ground.

When power is applied, a single "1" bit is loaded into the first stage of both the minutes and hours registers. To accomplish this, a momentary low reset signal is sent to all the registers (at pin 9) and also a NAND gate to lock out any clock transitions at pin 8 of the minutes registers. At the same time, a high level is applied to the data input lines of both minutes and hours registers at pin 1. A single positive going clock pulse (at pin 8) is generated at the end of the reset signal which loads a high level into the first stage of the minutes register. The rising edge of first stage output at pin 3 advances the hours (at pin 8) and a single bit is also loaded into the hours register. Power should remain off for about 3 seconds or more before being re-applied to allow the filter and timing capacitors to discharge. A 1K bleeder resistor is used across the 1000uF filter capacitor to discharge it in about 3 seconds. The timing diagram illustrates the power-on sequence where T1 is the time power is applied and beginning of the reset signal, T2 is the end of the reset signal, T3 is the clock signal to move a high level at pin 1 into the first register, T4 is the end of the data signal. The time delay from T2 to T3 is exaggerated in the drawing and is actually a very short time of just the propagation delay through the inverter and gate.

Two momentary push buttons can be used to set the correct time. The button labeled "M" will increment the minutes slowly and the one labled "H" much faster so that the hours increment slowly. The hours should be set first, followed by minutes.





50 Hertz LED Clock Timebase