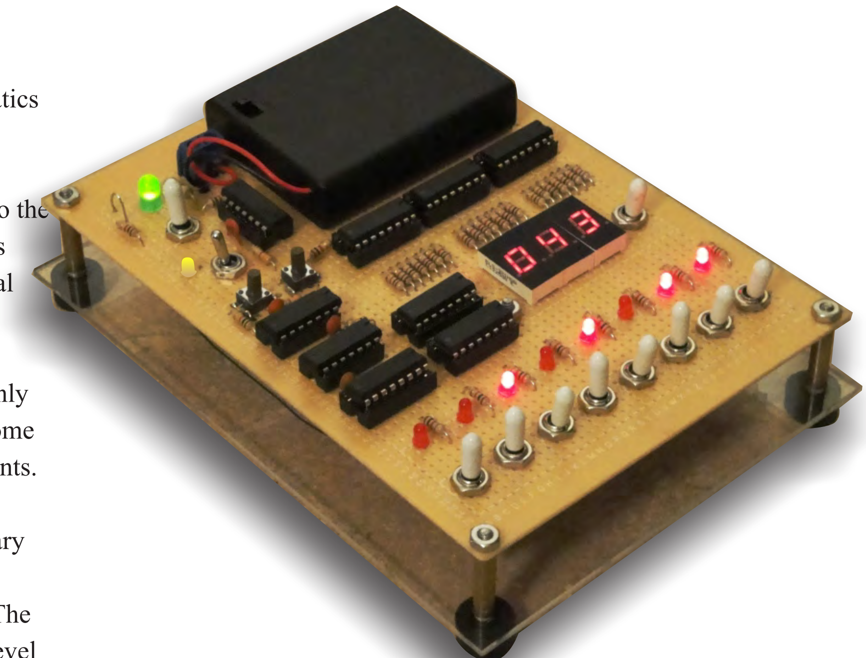
BINARY DECIMAL CONVERTER

By Bernie Mesa



This instrument has been designed as a teaching tool for both students of mathematics and electronics. In mathematics, it demonstrates the principles of the binary numerical system and its correspondence to the decimal system. In electronics, it illustrates aspects of design and construction of digital electronic circuits.

The binary numerical system consists of only two digits, zero and one. Page 6 shows some binary numbers and their decimal equivalents. Just as the decimal system is a place value system based on the powers of 10, the binary system is based on the powers of 2. The powers of 2 from 0 to 10 are highlighted. The binary system is used at the fundamental level of digital circuits and computers whose basic components are electronic switches. Switches have only two positions on or off, which are interpreted as one or zero. All the billions of instructions and numbers handled by a computer executing a program are streams of zeros and ones. Binary "bits" control everything digital, from the letter pressed on the keyboard to the colors of the screen to worldwide internet transmissions.

This converter has a row of 8 switches with 8 LED's (Light Emitting Diode) as the binary input. A three digit display shows the decimal equivalent. On the automatic mode the display continually shows the correct decimal output. On the manual mode, after pushing the reset button, the decimal display shows the count of pulses from the input button. When the count matches the binary input, the yellow LED lights on.

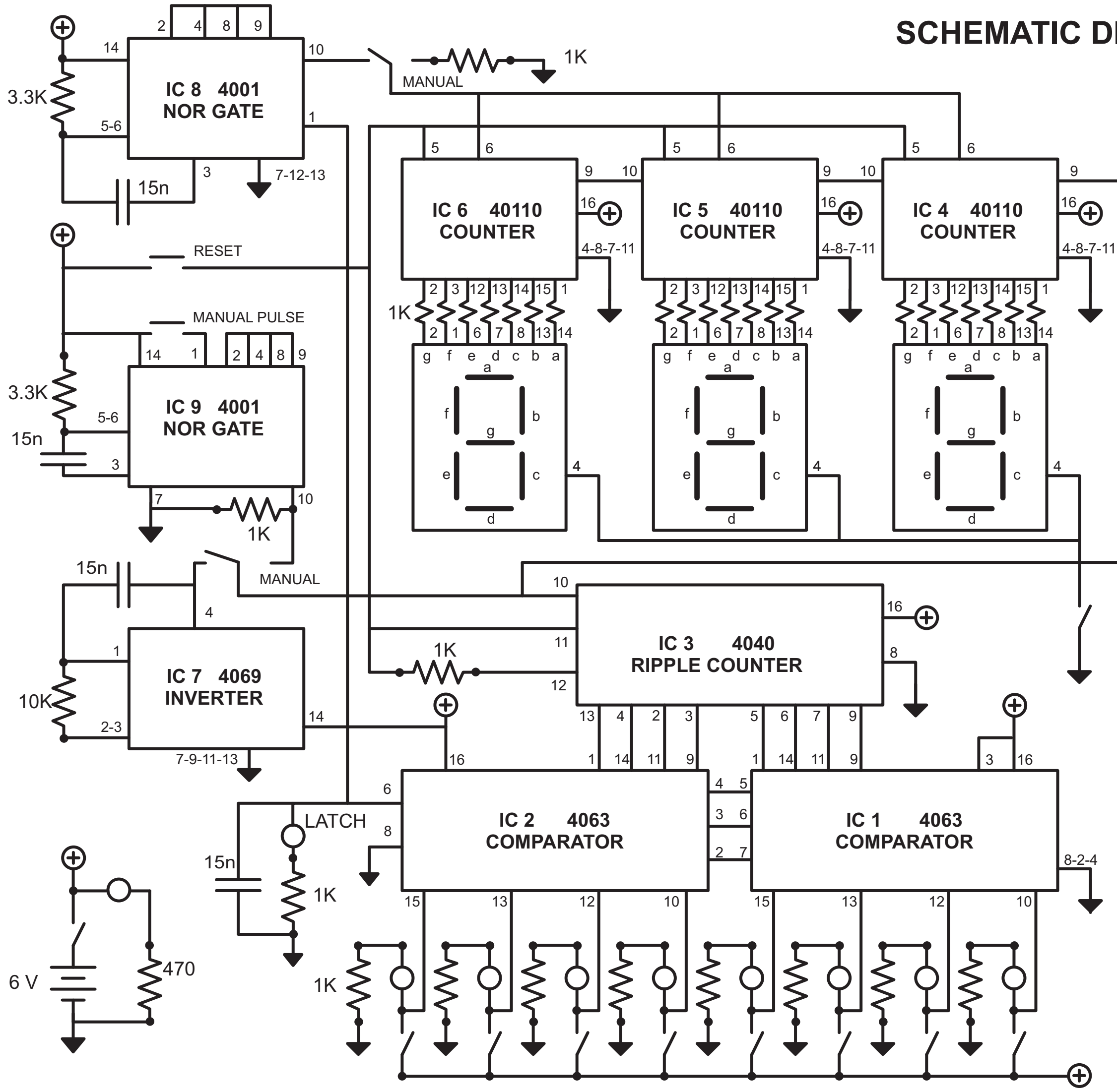
Page 3 shows the complete electronic schematic. The circuit consists of two simultaneous pulse counters. The first counter (IC3) feeds the binary count through 8 lines to two comparators (IC1 and IC2). The second counter is composed of three IC's (4, 5, and 6) which drive the 3 decimal displays but only with the count latched by a signal from the comparators. The latching signal is activated when the comparators detect a match between the binary input and the feed from the first counter.

Automatic pulses originate at an oscillator (IC7). The oscillator frequency is about 4.5 kHz (4,500 pulses per second). The system resets the count to zero every 256 pulses. This happens 17 times per second shown by the blinking yellow LED. On manual mode the reset and pulse are done by pushing the respective buttons.

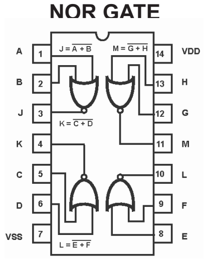
Pages 4 and 5 show the schematic for a very simple converter limited to four binary bits and one decimal. There are no simple IC's to convert more than four bits because most digital electronic circuits operate sequentially, the bigger converter is an example of a sequential circuit.

BINARY TO DECIMAL CONVERTER

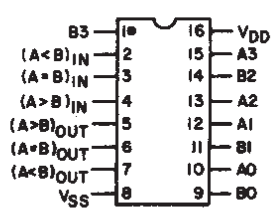
SCHEMATIC DIAGRAM



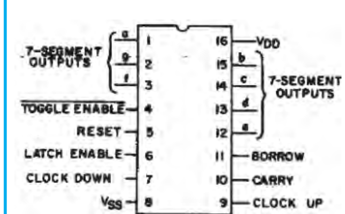
CD4001
NOR GATE



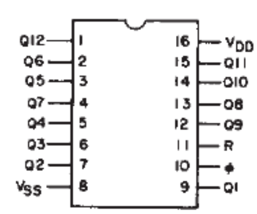
CD4063
COMPARATOR



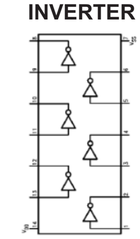
CD40110
COUNTER



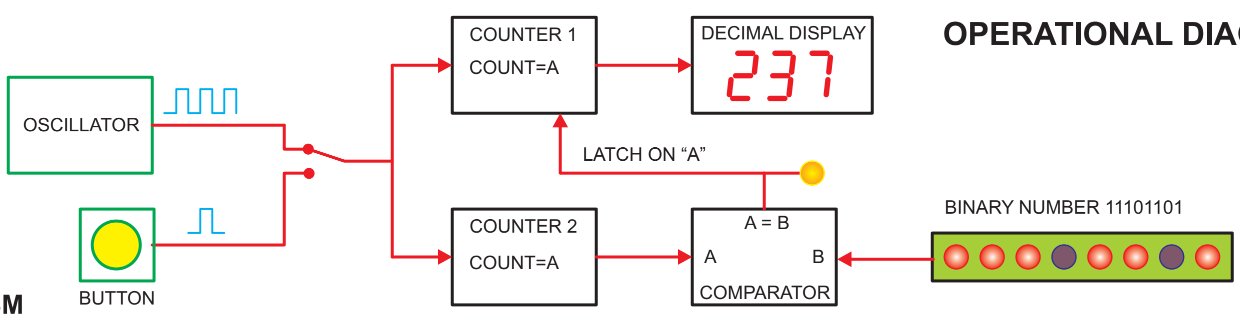
CD4040
RIPPLE COUNTER



CD4069
INVERTER



OPERATIONAL DIAGRAM



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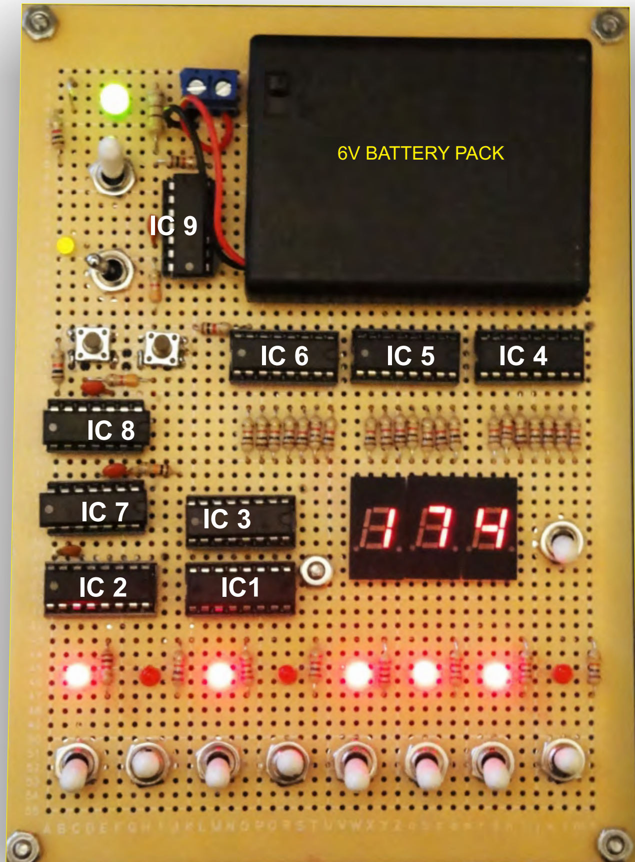
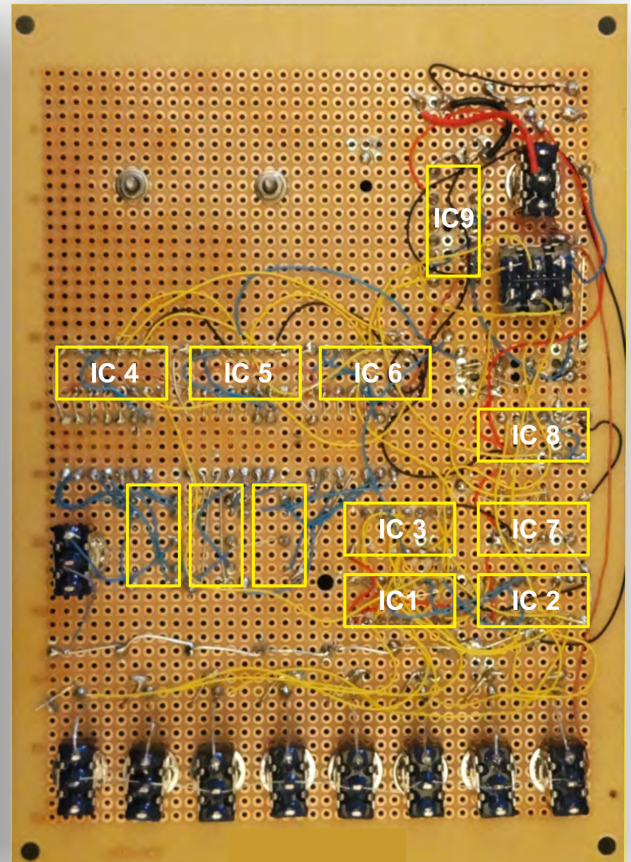
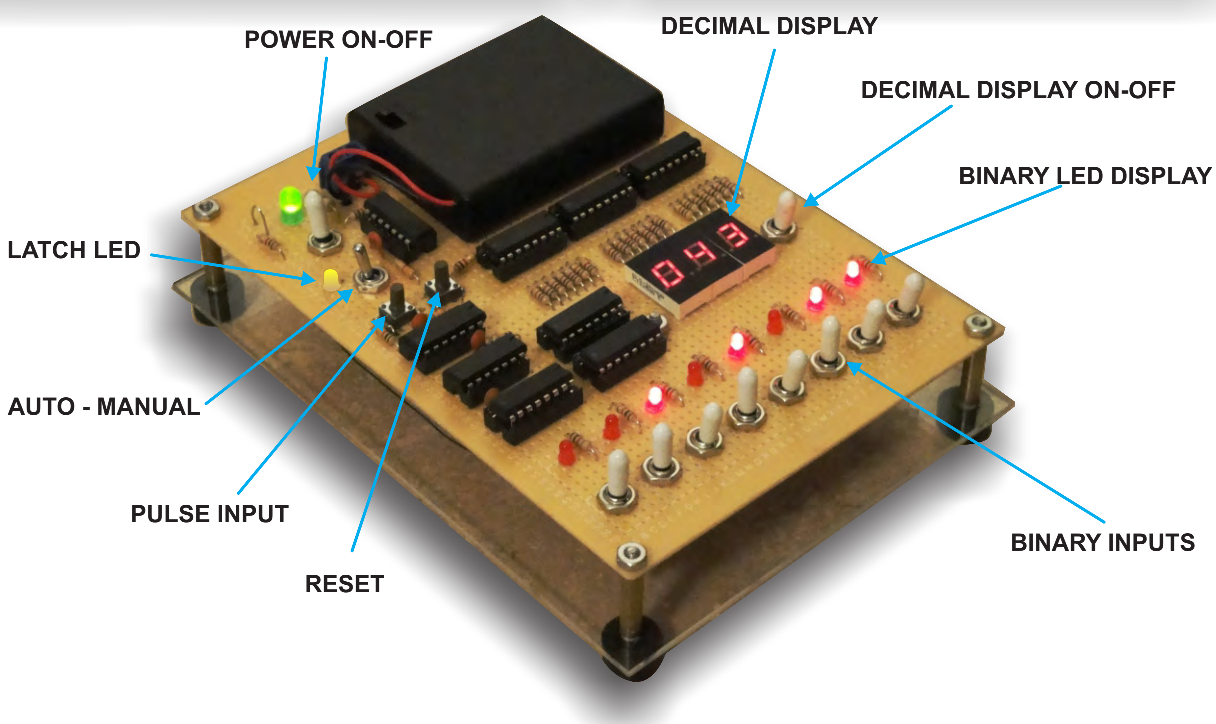
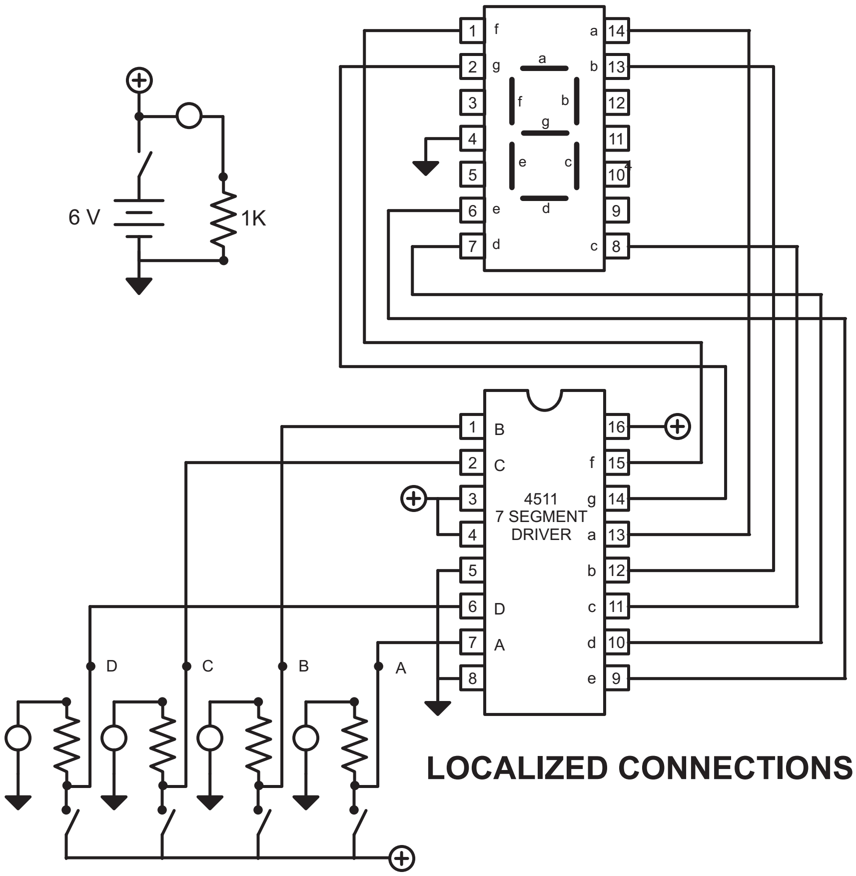
INTRUMENT CONSTRUCTION



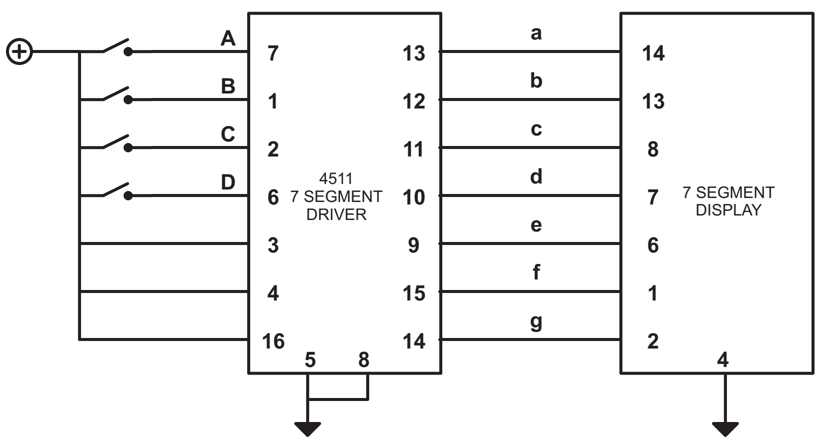




SINGLE DECIMAL DIGIT CIRCUIT (1)

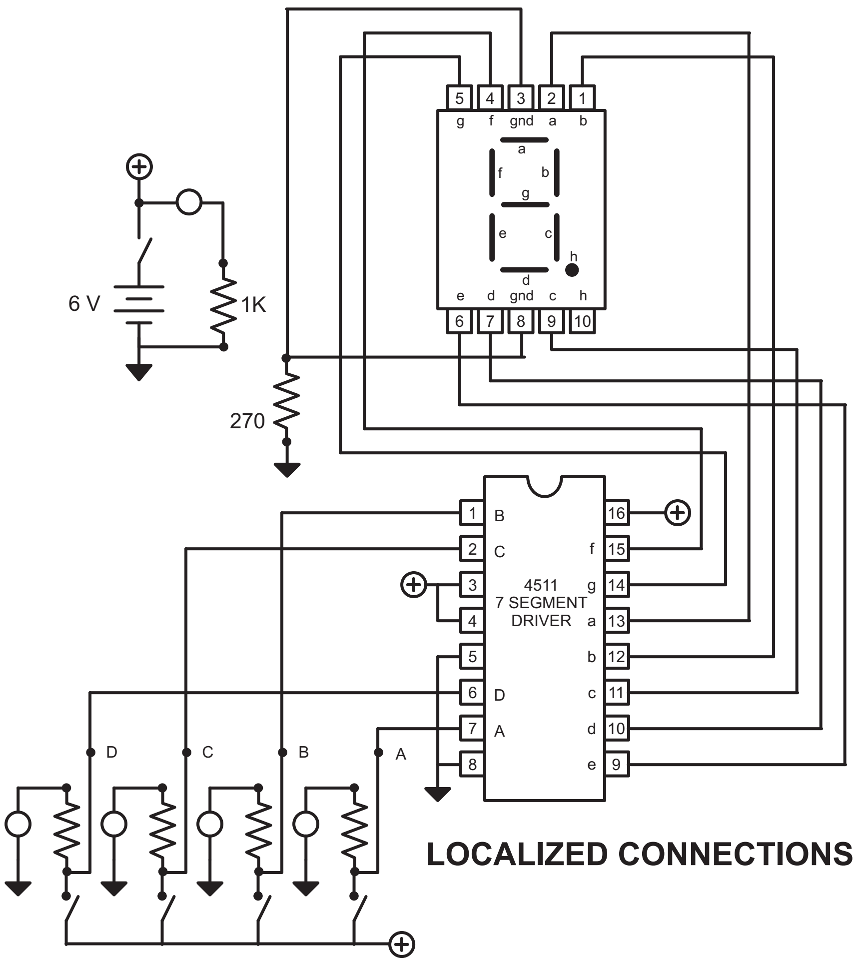


LOCALIZED CONNECTIONS

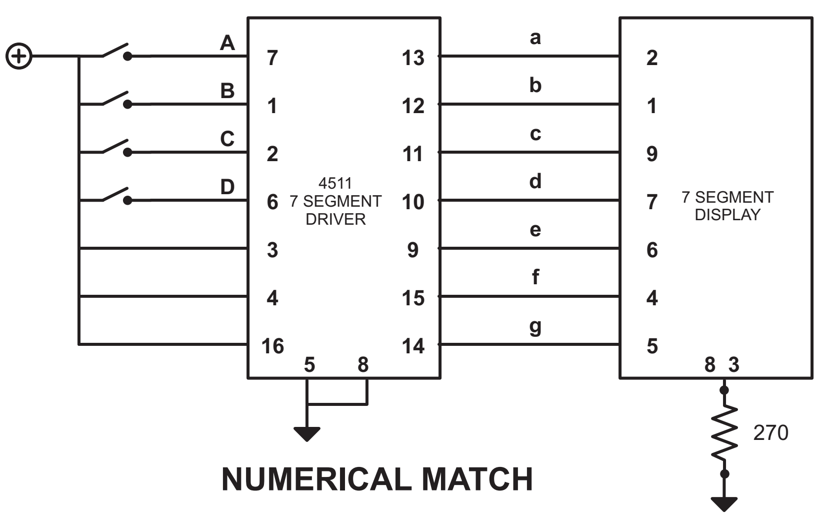


NUMERICAL MATCH

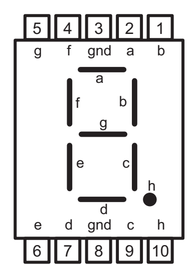
SINGLE DECIMAL DIGIT CIRCUIT (2)



LOCALIZED CONNECTIONS



NUMERICAL MATCH



DISPLAY CHIP 2

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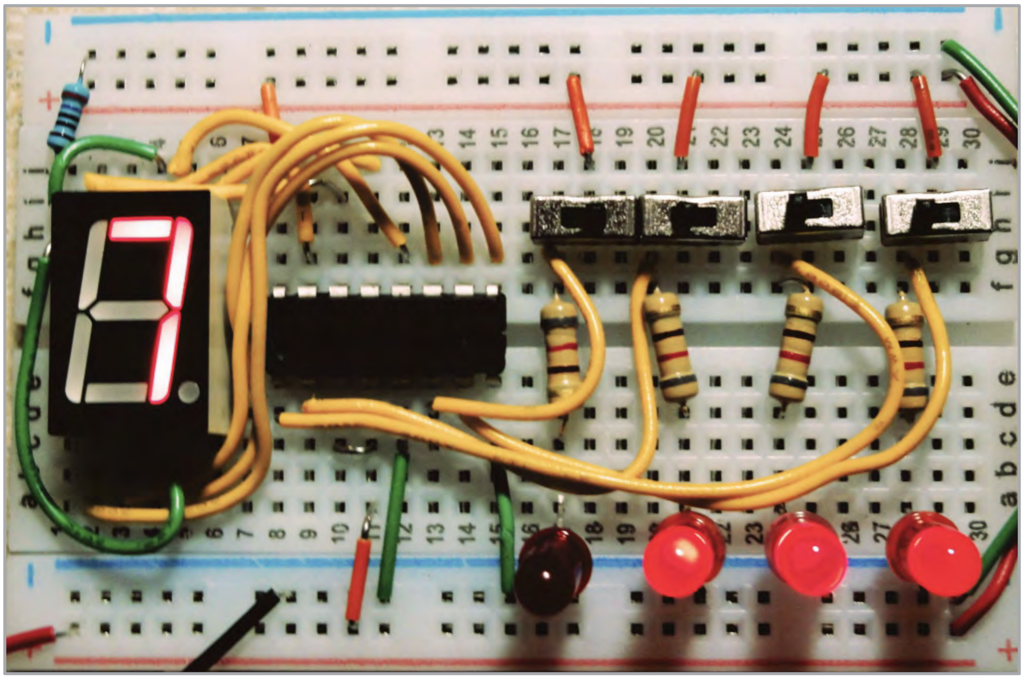
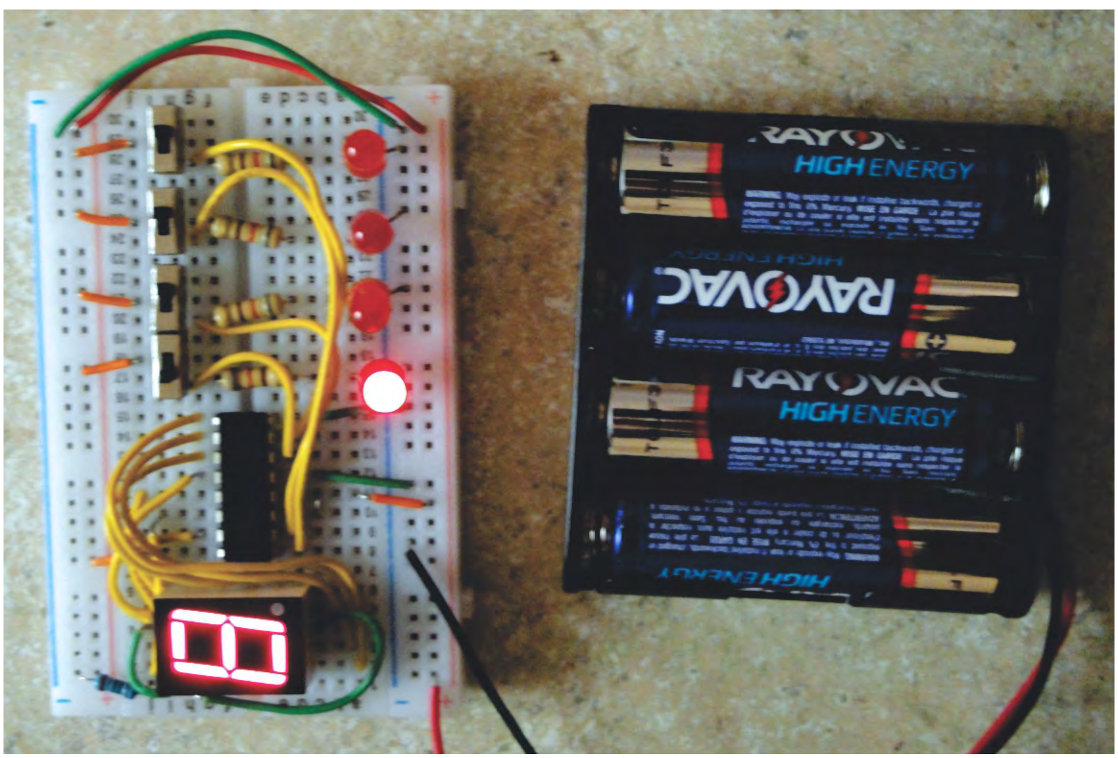
SINGLE DECIMAL DIGIT CIRCUIT (2) BUILT ON A BREAD BOARD





BINARY NUMBER SYSTEM

POWERS OF 2	BINARY DIGITAL DISPLAY	BINARY NUMBERS	DECIMAL NUMBERS
		0	0
2^0		1	1
2^1		10	2
		11	3
2^2		100	4
		101	5
		110	6
		111	7
2^3		1000	8
		1001	9
		1010	10
		1011	11
		1100	12
		1101	13
		1110	14
		1111	15
2^4		10000	16
		10001	17
		11111	31
2^5		100000	32
		111111	63
2^6		1000000	64
2^7		10000000	128
2^8		100000000	256
2^9		1000000000	512
2^{10}		10000000000	1024
BM		11111111111	2047

BINARY - DECIMAL CONVERSION EXERCISES

POWERS OF 2	BINARY DIGITAL DISPLAY	BINARY NUMBERS	DECIMAL NUMBERS	
		10	2	EXAMPLES
		11010	26	
		0	0	
		10100111001	1337	
2^5		100000	32	
			425	CONVERT TO BINARY
			11	
			999	
			15	
			34	
			7	
2^7			128	
			2000	
			255	
2^8			256	
		11		CONVERT TO DECIMAL
		11001110		
		11111011100		
		1001110001		
		100001		
		1101111		
		110001		
		10010000		
				YOUR EXAMPLES
BM				