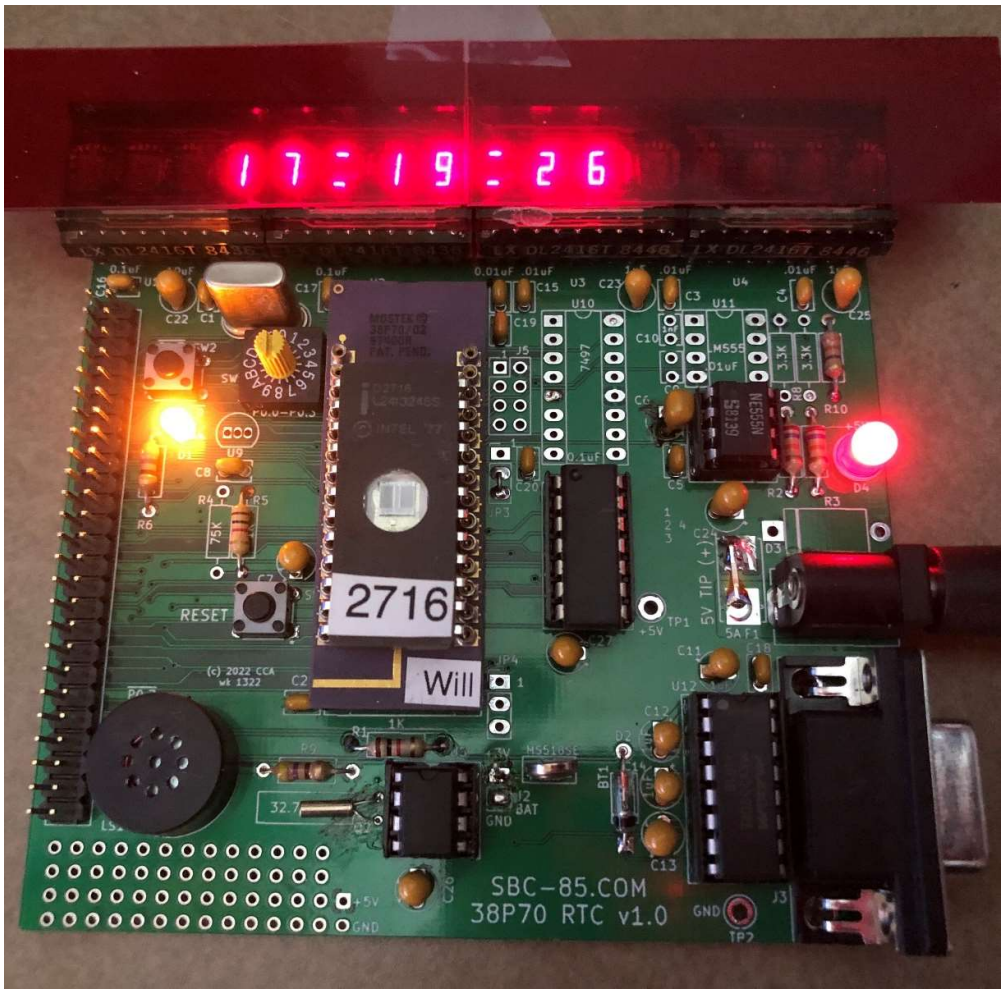
SBC-3870

38P70 F8 Based Single Board Computer

This user's guide describes the 38P70 F8 Single Board Computer.
Craig Andrews



Notation:

Pin numbers. Pin numbers are given as ***ID.pin***. for example, Pin 5 of connector X3 is given as ***X3.5***. IC7 pin 21 is given as ***IC7.21***.

Logic Levels. Lines having a signal that is active low is given with either an asterisk or a slash following the signal name. For example, **CS8/** and **CS11*** both refer to signals that is active when at 0V or logic low.

Terminology:

Most abbreviations will be spelled out when they are first used. However, the more commonly used terms are described in the ***Definitions of Terms and Notations*** at the end of the document.

SBC-3870 DESCRIPTION

The SBC-3870 is a 38P7x based Single Board Computer. As such, it contains all elements required for stand-alone operation including the processor, Random Access Memory (RAM) and Read Only Memory (ROM or EPROM). The SBC-3870 also includes an RS232 Serial port with a female DB9 connector for communication. Finally, the board includes a 50 pin offboard header for development and diagnostic.

The primary components on the SBC-85 are as follows:
U8 – 38P70 Microprocessor operating at 3.58 MHz
U3 – MAX232 TTL / RS232 Level Shifter

Additional 'glue logic' includes the following:

CIRCUIT DESCRIPTION

SERIAL INTERFACE

The utility of any single board computer is severely limited if it does not have a means of communication with a terminal or external device. In the case of the SBC-3870, this is RS-232 which is a bipolar serial stream consisting of a starting bit, data bits, stop bit, and parity bit. No other hardware handshaking is used on the SBC-85. To create the bipolar output, a MAX232 (U12) is used which contains an internal charge pump to create the +/- rails necessary to meet the RS232 standard (+/- 14V typical for the MAX232). With rails in the +/-12V range, the RS232 port on the SBC-85 will eat any TTL device connected to J3. If you want to use a TTL signal on J3, then remove U3 and jumper U12.10 to U12.8 and U12.9 to U12.7.

POWER INPUT

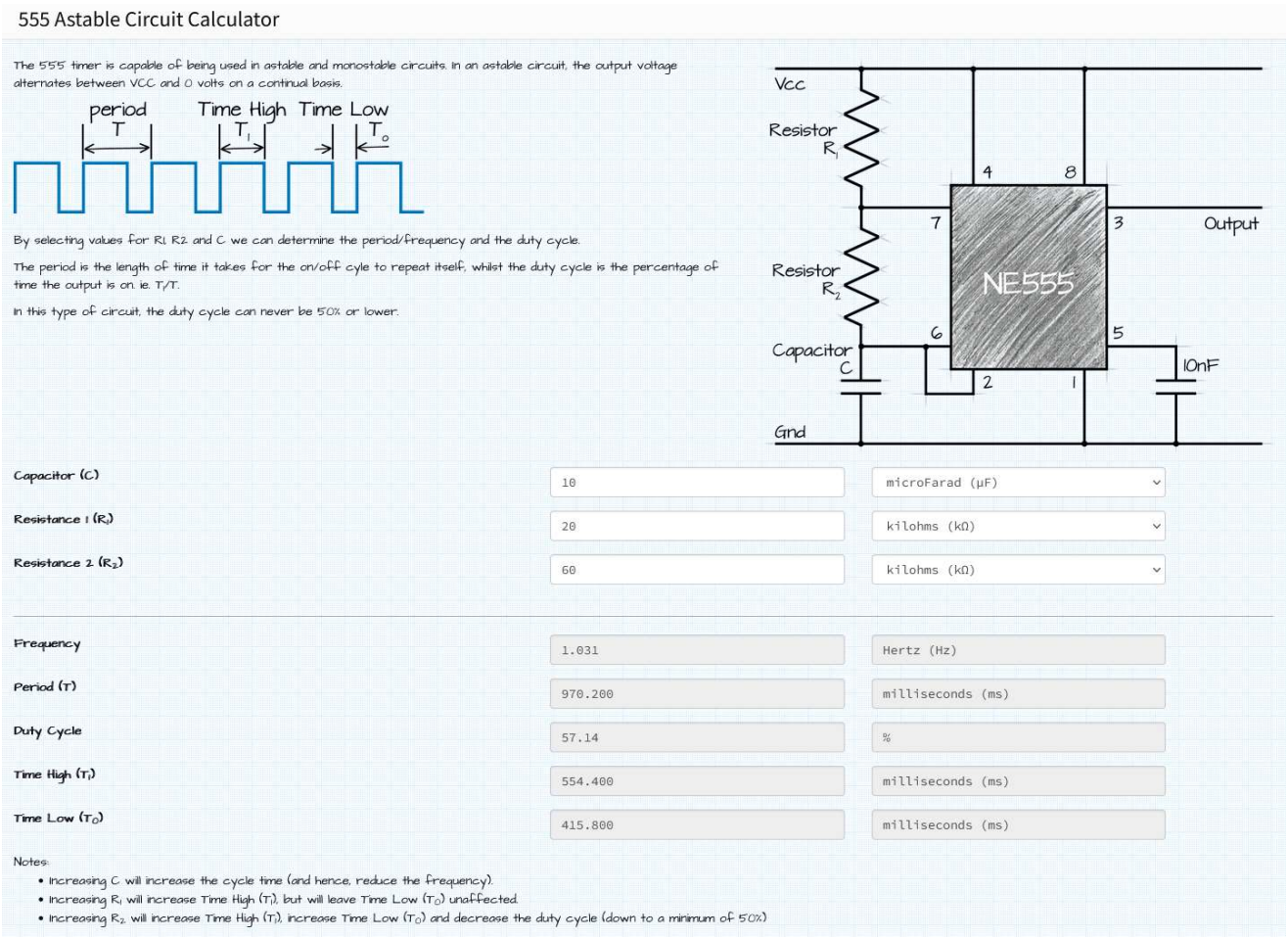
The SBC-3870 is fitted with a 2.1mm x 5.5mm barrel connector with the tip positive. A well regulated +5VDC power supply should be used to power the SBC-3870. Vcc specifications on the 38P70 are +5VDC +/- 10%.

The power input is fused at 5 Amps and has a basic reverse polarity protection. Rather than face the continuous voltage drop across an input diode, the SBC-3870 uses a reverse biased diode and fuse as a simple crowbar circuit. If a reverse voltage is applied to the input, ideally the diode will create a short circuit and blow the fuse well before the system voltage gets high enough (reversed) to damage any of the components. Therefore, if you are confident in your power supply and expect that you are immune from these mistakes, D3 can be eliminated and F1 can be shorted. However, if D3 is not installed fill the via with solder since it is used to pass the bulk of the current from the fuse outlet (on the top of the board) to the +5V rail on the solder side of the board.

EXTERNAL INTERRUPT

The LM555 is operating as an astable oscillator with frequency and duty cycle set by the charge & discharge resistors and charge capacitor. The 3870 external interrupt input is edge triggered, so for most reasonable frequeincies, the 555 duty cycle is not important. Handy frequency calculators are available online to choose the R2, R3 and C7 values. When using these calculators, R2 on the board is connected to the +5 so R2+R3 are the charge resistors while R3 on the SBC-3820 is the discharge resistor, for example, with a 10uF capacitor, R2 as 20K, and R3 as 60K the interrupt will be about 1 Hz with a pretty non-offensive duty cycle of 57%:

(from https://ohmslawcalculator.com/555-astable-calculator)



COMPONENTS

FUSE

F1 Five (5)-amp Socketed Surface Mount Fuse along with D3 is part of the reverse voltage crowbar protection

JUMPERS AND CONNECTORS

J1 signal header
J2 External RTC battery
J3 D-SUB 9R Female for RS232
JP3 DL2416 display WR* strobe. Select from Port 4 STROBE* or Port 5.5 (for manual control)
JP4 3870 TEST pin, normally tied to ground

LEDs

D1 General uController output
D4 Board +5V power indicator

CAPACITORS

C6 External Interrupt 555 charge capacitor
C7 Reset in RC charge capacitor

RESISTORS

R2, R3 External Interrupt 555 charge / discharge resistors
R4 Reset in charge capacitor. Not required if U9 supervisory is installed with pullup
R5 reset in to gently discharge C7

SWITCHES

SW1 Hexadecimal or BCD rotary switch for general uController input
SW2 Momentary Pushbutton switch for general uController input
SW3 Resets the CPU by taking the RESET IN*

CRYSTALS

Q1 38P70 primary oscillator 2-4 MHz
Q2 1302+ Real Time Clock crystal 32.768 kHz

ICs

U1-U4 DL2416 LED Intelligent Display
U5 1302+ Real Time Clock
U6 LM555 astable oscillator for external interrupt signal generation
U7 74LS86 quad exclusive OR
U8 38P70 microcontroller
U12 MAX232 RS232 driver/receiver

REVISIONS

v1.0 First produced board week 1022

MODIFICATIONS to UPDATE REVISIONS

N/A

CHANGE REQUESTS

v1.0

- Silkscreen for charge capacitor C6 in interrupt 555 U6 should not be polarized
- J2 for battery too close to BT1 and U5
- Place coin cell holder on solder side?
- Place all LEDs and switches (except reset) along bottom edge
- Add Zener (e.g., 3.3V) to protect lithium cell from over-voltage during trickle charge
- Remove display diming circuit
- Add numbers / signal names to header J1
- Add mounting holes
- Invert speaker drive
- Add 1416 display option? Would require external decoder
- Possibly change the orders of the displays?
- Remove JP3 (strobe latch)
- Bring /CE1 and /CE2 to header if room
- Jumper SI to EXT_INT?
- DB9 can be closer to edge
- Replace XOR with inverter
- Maybe bring BL*, uncommitted I/O, unused gates together to short option/reconfiguration header

ASSEMBLY NOTES AND PROCEDURES – Most of these are important

- The silkscreen on C6 is incorrect. You do not need to use a polarized capacitor here and if you do the silkscreen is reversed. It is best to just scrape the + off of the silkscreen.

DIAGNOSTIC NOTES

Hot or Dead MAX232-

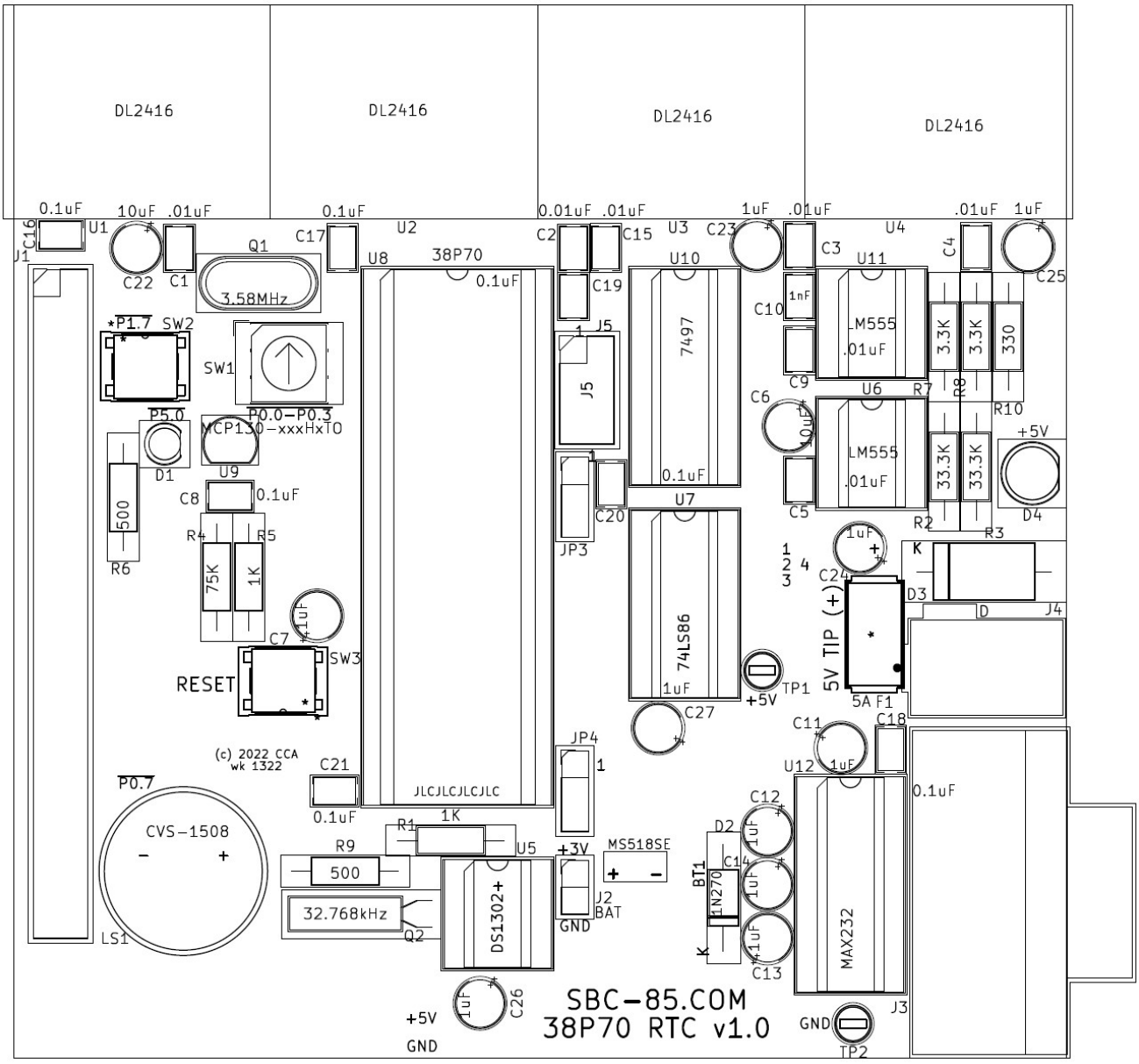
- Check the charge pump capacitors are correctly installed (polarized)
- Board versions prior to v1.3 required a Texas Instruments MAX232 part

APPLICABLE DATA SHEETS

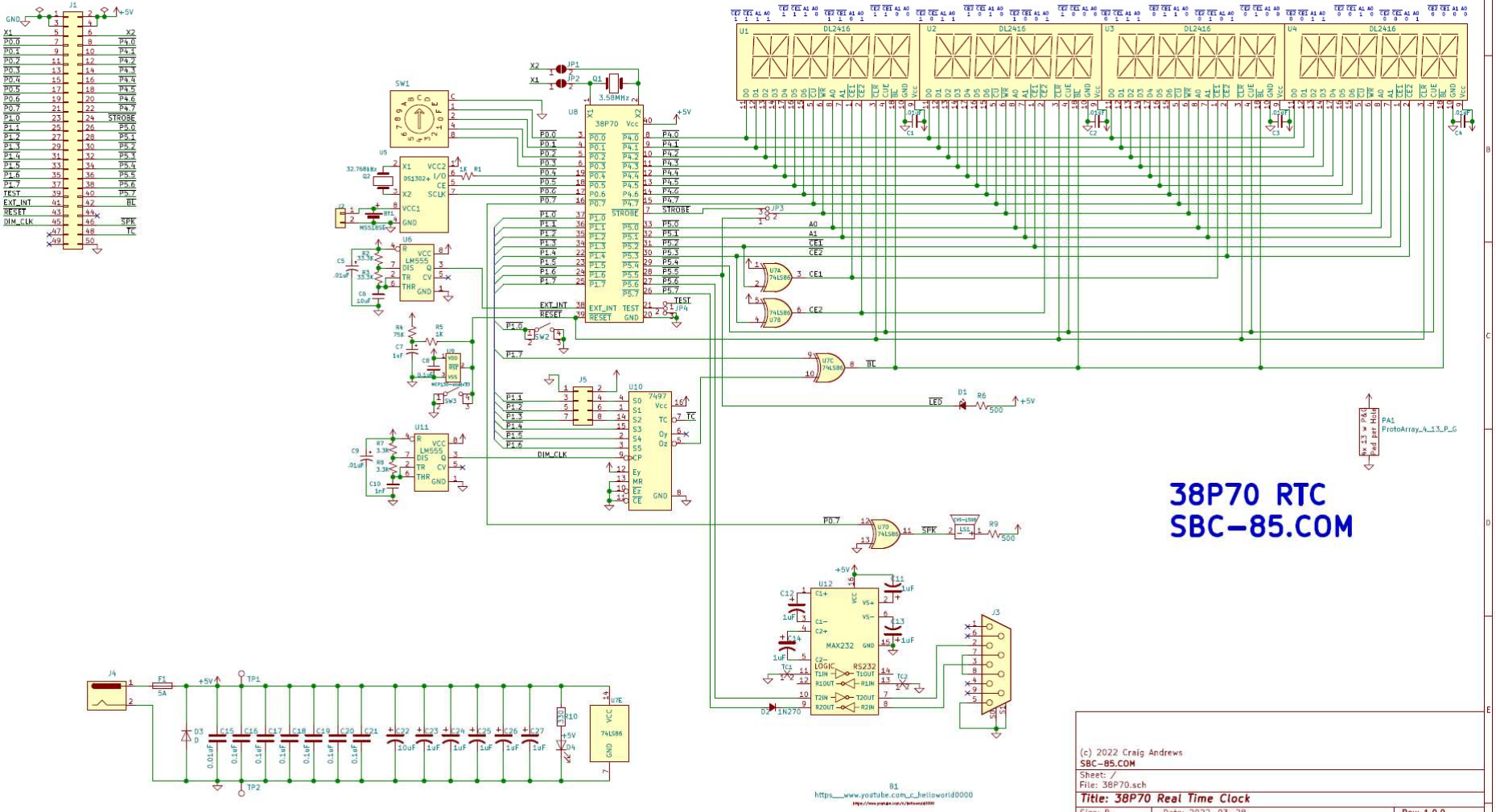
- MK38P70 Microcontroller
- DL2416 4-digit LED Smart Display
- DS1302+ Real Time Clock
- MAX232

Version 1.0

COMPONENT PLACEMENT



SCHEMATIC v1.0



BOM

SBC-3870 CPU v1.0 BOM

QTY	ID	Value Package/description	Manufacturer	Manufacturer PN	DIGI KEY PN
5	C1, C2, C3, C4, C5	0.01uF decoupling Capacitor			
7	C8, C16, C17, C18, C19, C20, C21	100nF CAP CER 0.1UF 50V Z5U RADIALKEMET	kemet	C315C104M5U5TA	399-4151-ND
10	C7, C11, C12, C13, C14, C23, C24, C25, C26, C27	1µF Conformal Coated Tantalum Capacitors 35V Radial 8Ohm	avx	TAP105M035SCS	478-5812-ND
1	C6	User Picks Value --- 10 uF Capacitor			
2	D1, D4	LED pick a color DIFF T/H		SSL-LX2573AD	67-1045-ND
1	D2	1N270 germanium diode			
1	D3	4A GENERAL PURPOSE DIODE crowbar	ON semiconductor	MUR460RLG	MUR460RLGOSCT-ND
1	F1	5A FUSE BRD MNT 125VAC/VDC 2SMD	Littelfuse	0154005.DRT	F1310CT-ND
2	JP3, JP4	CONN HEADER VERT 3POS 2.54MM	Sullins connector	PREC003SAAN-RC	S1012EC-03-ND
1	J1	CONN HEADER 50POS 2.54MM	Sullins connector		
1	J2	2 position header with shield			
1	J4	Power Barrel Connector Jack 2.10mm ID (0.083"), 5.50mm OD (0.217") Through Hole, Right Angle	CUI	PJ-050AH	CP-050AH-ND
1	J3	9 Position D-Sub Receptacle, Female Sockets Connector	Amphenol ICC	D09S13A4GX00LF	609-1484-ND
1	TP1	PC TEST POINT .065 COMPACT RED	keystone electronics	5005	36-5005-ND
1	TP2	PC TEST POINT .065 HOLE COMPACT BLACK	keystone electronics	5006	36-5006-ND
1	BT1	Lithium rechargeable battery	Seiko	MS518SE	
1	PCB1	SBC-3870 v1.0 PCB			
1	Q1	3.58 MHz			
1	Q2	32.768 kHz			
2	R1, R10	330 OHM 1/4W 5% AXIAL	stackpole	CF14JT330R	CF14JT330RCT-ND
1	R2	56K OHM 1/4W 5% AXIAL	stackpole	CF14JT56K0	CF14JT56K0CT-ND
2	R1, R5	1K OHM 1/4W 5% AXIAL	stackpole	CF14JT1K00	CF14JT1K00CT-ND
1	R2	User Picks Value 20KOhm for 1Hz. Knock yourself out if you want higher specifications than standard 5%			
1	R3	User Picks Value 60KOhm gives about 1Hz			
1	R4	75K Ohm 1/4W 5% AXIAL			
2	R6, R9	500 OHM 1/4W 5% AXIAL			
1	LS1	Miniature speaker	CVS	CVS-1508	
1	SW1	Hexadecimal or BCD rotary encoded switch			

SBC-3870 CPU v1.0 BOM

QTY	ID	Value Package/description		Manufacturer	Manufacturer PN	DIGI KEY PN
2	SW2,SW3	Tactile Switch SPST-NO Top Actuated Through Hole	SWITCH PUSH SPST-NO 0.1A 32V	TE Connectivity ALCOSWITCH	1825910-7	450-1804-ND
4	U1, U2, U3, U4	DL2416 four-character LED Smart Display		Litronix	DL2416	
1	U5	DS1302+ Real Time clock				
1	U6	LM555				
1	U9	MCP130-485HTO Supervisory Circuit				
1	U12	MAX232				
2	JP3, JP4	CONN JUMPER SHORTING .100"			QPC02SXGN-RC	S9337-ND
2	U5, U6	8 pin DIP socket				
1	U7	14 pin DIP socket				
1	U12	16 pin DIP socket				
1	U8	40 pin DIP socket				
1		AC/DC DESKTOP ADAPTER 5V 20W Power Supply 2.1mm x 5.5mm 5V TIP Positive		phihong USA	PSAC30U-050L6	993-1343-ND

Definitions of Terms and Notation

0xF
Hex Interpretation of 4 binary bits (nibble), in this example HEX F which is 1111 in binary

0xFF
Hex Interpretation of 8 binary bits (byte), in this example HEX FF which is 1111 1111 in binary

0xFFFF
Hex Interpretation of 16 binary bits or Word (two bytes). In this example HEX FFFF is the interpretation of the binary value 1111 1111 1111 1111

A*n*
Individual Address Line where n is 0-15

AD*n*
Individual Multiplexed Address / Data line where n is 0-8

Byte
8-bits

Component Side
The 'top' of the PC board where the components are mounted. On the SBC-85 this is the side with the bulk of the silkscreen and the component numbers and footprints.

CS/ or CS*
Chip Select (reverse, a.k.a., negative logic) where a logic LOW (0v) is active

U*n*
Integrated Circuit ID n

LSB
Least Significant Byte

LSBit
Least Significant Bit

MSB
Most Significant Byte

MSBit
Most Significant Bit

Nibble
4-bits

On
Logic TRUE or active. May be HIGH (+5V) or LOW (0V)

Off
Logic FALSE or inactive. May be HIGH (+5V) or LOW (0V)

RTC
Real Time Clock

SWn
Switch were n is the switch identifier

Solder Side

The 'bottom' of the PC board

UART

Universal Asynchronous Receiver Transmitter. A serial port controller that autonomously handles asynchronous serial communication e.g., RS232

USART

Universal Synchronous Asynchronous Receiver Transmitter. A serial port controller that autonomously handles either synchronous or asynchronous serial communication e.g., RS232