

**Circuit Cellar**  
4 Park St.      Vernon, CT 06066  
Tel: (203) 875-2751      Fax: (203) 872-2204

**HCS2-DX**  
**Assembly Instructions & Procurement List**

**Tools Required for Assembly:**

Low-Wattage or Temperature-Controlled Soldering Iron  
Rosin-Core Solder (DO NOT use Acid Core!)  
Lead Cutters  
Screwdriver

**Additional Tools to Ease Assembly:**

Needle-Nose Pliers  
Lead Bender  
Solvent for removing Rosin (Flux)

**Tools for Trouble-Shooting (and their use):**

Oscilloscope	Viewing AC/DC Signals
Logic Probe	Indicating Logic Levels (activity)
Continuity Checker	Determining Shorted or Open Traces
Volt/Ohm Meter	Checking Power Supply, Logic Levels, or Continuity

**1. ( ) PCB Inspection**

Before beginning assembly of the HCS2-DX board, you should inspect the PCB for shorted or open traces. This will increase your assembly time slightly but it is well worth the effort compared to the time it can take to track down a problem after the board has been assembled. The easiest way to do this is to hold the board up to a light. You should then be able to see all the traces clearly. Examine each trace for breaks or shorts to other traces. If you find what looks to be a short, use the schematic to verify that the traces should not be connected. A continuity checker or a VOM can then be used to determine if the short is truly there. The continuity checker or VOM can also be used to test for a break in a trace. You should also check for continuity between the Gnd and V+ pads of J12. These two points should NOT be shorted together.

## 2. ( ) Parts Inspection

The next step is to familiarize yourself with the parts to be installed in the kit. Parts kits may be purchased from Circuit Cellar or you may obtain the parts from the sources listed in the procurement list. All Circuit Cellar kits are thoroughly inspected so they should be complete and accurate. Regardless of how the parts were obtained, check to make sure you have the correct parts needed and the correct amount of each part.

**Note:** The side of the board with the silkscreen outline is the component side and the opposite side is the solder side. All components should be mounted on the component side and all soldering should be done on the solder side of the board.

## 3. ( ) Resistors

All resistor leads are spaced on 0.4" centers. Please note that R8 should only be installed if the board will be powered by a +5 VDC supply. Powering the board with a higher voltage while R8 is installed will damage the board! Insert the resistors into the circuit board, bending each lead over to prevent the resistor from falling out. Verify that each part is in its correct location. Check off each resistor on the list below after you have inserted and verified them.

( )	R1	470k $\Omega$	Yellow - Violet - Yellow
( )	R2	100 $\Omega$	Brown - Black - Brown
( )	R3	470 $\Omega$	Yellow - Violet - Brown
( )	R4, R7	10k $\Omega$	Brown - Black - Orange
( )	R5	1M $\Omega$	Brown - Black - Green
( )	R6	560 $\Omega$	Green - Blue - Brown
( )	R8	0 $\Omega$	Black (Note special instructions)

Solder the resistors to the board and clip the excess leads.

## 4. ( ) Diodes

All diode leads are spaced on 0.4" centers. Diodes are marked with a stripe on their cathode end. This stripe should match the stripe on the silkscreen when the diode is inserted into the board. Insert the diodes making sure they are oriented correctly. Bend each lead over to prevent the diodes from falling out. Verify that each part is in its proper location and that it is oriented correctly. Check off each diode on the list below after you have inserted and verified them.

( )	D1	1N4004
( )	D2, D3	1N914B

Solder the diodes to the board and clip the excess leads.

## 5. ( ) Crystals

Locate the two crystals and insert them in their appropriate locations. Bend each lead over to prevent the parts from falling out. Verify that the parts are in their proper location. Check off each crystal on the list below after you have inserted and verified them.

- ( ) XTL1            18.432 MHz, HC-49/US Case, Low Profile
- ( ) XTL2            32.768 kHz, Canister Style

Solder the crystals to the board and clip the excess leads.

## 6. ( ) IC Sockets

All the DIP sockets have a notch in one end to indicate pin 1 which must match the outline shown on the silkscreen. PLCC sockets have an arrow pointing toward pin 1 of the socket, and have one corner of the socket cut off. Note that the PLCC socket's shape must match the outline on the silkscreen and that pin 1 of SK1 and SK16 is closest to the J4 side of the board. Insert all of the sockets into the board making sure that they are oriented correctly and that all the pins protrude through the board. If the sockets you are using have straight solder tails rather than retention type, you may wish to tack down one pin and then the pin on the opposite corner to hold the socket in place. Once the socket is tacked in place, you can verify that socket is flush to the board and that all the pins are protruding through the holes. Check off each socket on the list below after they have been inserted and verified.

- ( ) SK1                            44 pin PLCC
- ( ) SK2, SK3                    20 pin DIP
- ( ) SK4, SK6                    8 pin DIP
- ( ) SK5, SK13, SK15            16 pin DIP

(no socket used for U7)

- ( ) SK8, SK12, SK14            14 pin DIP
- ( ) SK9, SK10, SK11, SK17    28 pin DIP
- ( ) SK16                        44 pin PLCC

Solder all the socket pins to the board. The spacing between the pins is tight, especially with the PLCC sockets, so care must be used when soldering so that no solder bridges are formed.

## 7. ( ) Capacitors

Capacitors C3-C7, C10, and C9 are polarized and must be installed with this in mind. These capacitors will have one lead marked with a stripe and a "+" or "-" symbol to denote whether it is positive or negative. The remaining capacitors are not polarized and may be installed either way. Insert the capacitors, noting polarity where appropriate, and bend the leads over to keep the parts from falling out. Verify that each part is in its correct location and that it is oriented correctly. Check off each capacitor on the list below after it has been installed and verified.

( )	C1, C2	10pF, 1/8"
( )	C3-C7, C10	10 $\mu$ F, Tantalum (polarized)
( )	C8, C11-C27	0.1 $\mu$ F, 0.10" (104)
( )	C9	47 $\mu$ F, Electrolytic, Radial (polarized)

Solder each capacitor to the board and clip the excess leads.

## 8. ( ) Three Terminal Devices and LED

Two different styles of cases are used for the three-terminal devices used on the HCS2-DX. Q1, U7, and Z1 are packaged in the TO-92 style case. When you look at the top of this style package, the device is shaped like a circle with a flat "side." This shape must match the outline on the silkscreen when the device is installed. Q2 is a TO-220 style case. This device is installed with a heat sink (HS1). When installing Q2, place the heat sink on the board, with the fins up, and lay Q2 on top of the heat sink. At this point you can judge how the leads need to be bent. Bend the leads, insert Q2 into the board and secure it to the board and heat sink with a screw and nut. Note that the nut should be installed on the component side of the board. The LED will have a flat side or notch on its base to identify its cathode. This flat side or notch should line up with the flat side of the outline on the silkscreen. Verify that each part is installed in the correct location and with the proper orientation. Check off each device on the list below after it has been installed and verified.

( )	Q1	2N2907 Transistor (TO-92)
( )	Q2	LM7805 Voltage Regulator (TO-220)
( )	HS1	Heat Sink, Screw, and Nut
( )	U7	MC33064 Reset Circuit (TO-92)
( )	Z1	LM336Z-5.0 Voltage Reference (TO-92)
( )	LED1	LED, Red, TIL220

Solder each device to the board and clip the excess leads.



## 12. ( ) Cleaning & Final Inspection

At this point all the components (except for the ICs and the battery) should be installed and soldered to the board. To facilitate the final inspection, we recommend that the board be cleaned with flux remover. Once the board is clean, verify once again that the components are in their proper location and oriented correctly. You should also inspect the solder side of the board to make sure that all the leads have been soldered and trimmed. Look also for any solder bridges and shorted leads.

## 13. ( ) Voltage Check

Before inserting any ICs or applying power to the board it is a good idea to check for shorts between the power supply input and ground. Use a VOM to check the resistance between the two pins of J12. If you obtain a very low resistance reading, there may be a short and the board should be inspected again to find the cause. If the board passes this test, connect a power supply with an output of between 9 and 12 VDC to terminal block J12. Remember that if R8 is installed, only a +5 VDC supply should be used. If you see smoke or hear popping sounds, disconnect the power supply immediately. Check the board for shorts and polarized capacitors that were inserted backwards. Correct any problems you find and try the test again. If everything appears normal when power is applied, use the power table (located on the last schematic page) to confirm that power is available to all the ICs.

## 14. ( ) Final Test

The next step is to install the ICs, jumpers, and battery. Make sure the power supply has been disconnected from the board before installing the ICs. Use the power table and the silkscreen as references for installing the ICs. Use the attached jumper diagram as a reference for installing the jumpers. Note that the ICs may be marked with a notch or a dot to show the location of pin 1. Remember that for the PLCC devices, U1 and U16, the dot must align with the arrow on the socket. Again, pin 1 of U1 and U16 should be on the side closest to connector J4. The battery should be installed with the positive (+) side up.

Inspect the board to be sure that all the ICs are firmly seated and correctly oriented. You should also watch for any pins that may have bent under the device or over the edge of the socket.

At this point you should connect your power supply to the board and apply power. If you don't see smoke and don't hear any strange noises coming from your board, the odds are in your favor that your HCS2-DX is in good health.

The next step is to calibrate the A/D converter reference. Connect your VOM's positive lead to pin 12 of U17 (ADC0808) and the negative lead to pin 16 of U17. Adjust POT1 until you obtain a reading of 5.00 volts.

For the final test, connect a serial cable from the board to your PC making sure that pin 1 of header connects to pin of the cable. Now run the HOST program. When HOST finishes opening its windows, press "T" to load the current time and date. If the time and date appear in the upper right-hand window and the seconds are incrementing you can feel confident that most of the board's functions are working.

### Troubleshooting

If, after several attempts, you cannot get the HCS2-DX to respond to the HOST program, try the following:

- Check your power supply and serial communications connections.
- Use a VOM to verify that U5 (MAX232) is producing around +9 V on pin 6 and around -9 V on pin 2.
- Run a terminal emulation or communications package on your PC so you can talk directly to the HCS2-DX. Use an oscilloscope to observe the receive pin (pin 9) of U5 (MAX232). You should see activity on the pin when characters are typed on the keyboard.
- Use an oscilloscope to verify that XTLL1 is operating.
- Check all the address and data lines with an oscilloscope. You should see signals that are steady or cycling between two voltages. Any line that stays at a solid ground or 5 volts may be shorted to the power lines. Any line that jumps between more than two voltage levels may be shorted to another line.
- Remove U16 (8255) and U17 (ADC0808) and try the board again. If a chip select line for one of these ICs is stuck active, they may be dragging down the bus. If removing the chips fixes the board, check their chip select lines for shorts.
- Inspect all of your solder joints again, checking for missed pins, solder bridges, and poor solder joints. A solder joint should be smooth and shiny. If a joint looks dull or somewhat crystalline, resolder the joint. A large number of inoperable boards can be fixed simply by correcting soldering mistakes.

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If you have purchased the full kit from Circuit Cellar and are unable to get your board working, we do offer a repair service. For a flat fee of \$75.00 we will, at our discretion, repair or replace the board. Please note that we can only offer this service for kits which have been assembled with our parts. Therefore, this offer does not apply to boards assembled using our partial kit or parts procured from sources other than Circuit Cellar.

If you wish to take advantage of this service, please contact Circuit Cellar at (203) 875-2751 to obtain an RMA number. The board and a check or money order can then be sent postage-paid to us. Please note the RMA number on the outside of the package so that it will be directed to the correct department.

## Items Available from Circuit Cellar

### **HCS2-DX Technical Manual and XPRESS Software Manual**

The HCS2-DX technical and XPRESS software manuals are available for downloading from the Circuit Cellar BBS as HCSDXMAN.ZIP and XPRSMAN.ZIP in the Home Automation file area. Printed and bound versions are packaged with the partial and full kits. They are also available separately from CCI for \$10.00 each. Please request HCS2DX-MAN or XPRESS-MAN when ordering.

### **HCS2-DX Firmware**

The hex file for the version 2.0 HCS2-DX firmware is available for downloading from the Circuit Cellar BBS as HCS20.HEX in the Home Automation file area. A preprogrammed 27256 EPROM containing the code is included in the HCS2-DX-PART and HCS2-DX-FULL experimenters kits. The source code for this firmware is NOT available except under license.

### **Software Set**

A 5 $\frac{1}{4}$ " 360K diskette containing the COMPILE and HOST version 2.0 programs for DOS is packaged with the HCS2DX-1 and HCS2DX-2 kits. It is also available for downloading from the Circuit Cellar BBS as HCSPC20.ZIP in the Home Automation file area. If you are not buying a HCS2-DX-PART or HCS2-DX-FULL kit and don't care to call the BBC for the software and manuals, you can order printed manuals, an EPROM, and the utility diskette for \$39.00 plus shipping.

### **HCS2-DX Experimenters Kit (Partial)**

An experimenters kit containing a 64180 PLCC processor, processor crystal, MC33064 power fail indicator, PLCC 82C55 PPI, and a DS1215 clock chip is available from Circuit Cellar. The kit also contains the version 2.0 EPROM, diskette with COMPILE and HOST, and the HCS2-DX Technical and XPRESS software manuals. The partial kit is priced at \$89.00 plus shipping. Please request part number HCS2-DX-PART when ordering.

### **HCS2-DX Experimenters Kit (Full)**

A kit containing all the parts necessary to complete the HCS2-DX along with the version 2.0 firmware, a diskette containing COMPILE and HOST, and the HCS2-DX technical and XPRESS software manuals is available from Circuit Cellar for \$149.00 plus shipping. Please request part number HCS2-DX-FULL when ordering.

### **XPRESS 2.1**

XPRESS 2.1 allows the use of the new HCS-VOICE and HCS-DTMF boards with the HCS2-DX. You can upgrade the partial or full kits for \$25.00 when the upgrade is ordered with one of the kits. The XPRESS 2.1 upgrade is \$39.00 when ordered separately.

HCS2-DX PROCUREMENT LIST

Circuit Cellar

QTY	DESCRIPTION	LOCATION	CCI	DIGI-KEY	IDR	SOURCES
1	HCS2-DX PCB	PCB1	F			
1	RESISTOR, 0 OHM, 1/4W, 5% (****)	R8	F	0.00-ND		291-0
1	RESISTOR, 100 OHM, 1/4W, 5%	R2	F	100Q-ND	R100	29S1250-100
1	RESISTOR, 470 OHM, 1/4W, 5%	R3	F	470Q-ND	R470	29S1250-470
1	RESISTOR, 560 OHM, 1/4W, 5%	R6	F	560Q-ND	R560	29S1250-560
2	RESISTOR, 10K OHM, 1/4W, 5%	R4,R7	F	10KQ-ND	R10K	29S1250-10K
1	RESISTOR, 470K OHM, 1/4W, 5%	R1	F	470KQ-ND	R470K	29S1250-470K
1	RESISTOR, 1M OHM, 1/4W, 5%	R5	F	1.0MQ-ND	R1.0M	29S1250-1M
1	DIODE, 1N4004	D1	F	1N4004GI	1N4004	333-1N4004
2	DIODE, 1N914B	D2,D3	F	1N914BPH		392-1N914B
1	CRYSTAL, 18.432MHZ, HC-49/US CASE (LP)	XTL1	F	X436-ND		332-5184
1	CRYSTAL, 32.768KHZ, CANNISTER STYLE	XTL2	F, P	X803-ND		
1	44 PIN PLCC SOCKET, TL	SK 16	F	A2122-ND	PLCC44	151-1045
1	68 PIN PLCC SOCKET, AMP	SK1	F	A419-ND	PLCC68	151-1069
2	8 PIN DIP SOCKET	SK4, SK6	F	A95083-ND		506-208-AG29D
3	14 PIN DIP SOCKET	SK6, SK12, SK14	F	A95143-ND		506-214-AG19DC
3	16 PIN DIP SOCKET	SK5, SK13, SK15	F	A95163-ND		506-216-AG19DC
2	20 PIN DIP SOCKET	SK2, SK3	F	A95203-ND		506-220-AG19DC
4	28 PIN DIP SOCKET, .694"	SK9, SK10, SK11, SK17	F	A95286-ND		506-228-AG19DC
2	10 pF CAPACITOR, 1/8"	C1,C2	F	P4837	10PF	140-CD5056-010M
18	1.1 uF 50V .10" CAPACITOR	C8,C11 - C27	F	P4593	M.12	581-UDW104M1
6	10 uF, TANTALUM, CAPACITOR, 16V	C3-C7, C10	F	P2038	T10-25	540-10M16
1	47 uF, ELECTROLYTIC, RADIAL, CAPACITOR, 25V	C9	F	P5243	47R35	104-XRL25V47
1	PNP TRANSISTOR, 2N2907, TO-92	Q1	F	PN2907-ND	PN2907	333-KN2907
1	LM7805C - VOLTAGE REGULATOR, +5VDC, TO-220	Q2	F	LM78M05CT-ND	7805T	511-L7805CV
1	6106-13 HEAT SINK	HS1	F	HS106-ND	HS507302B	567-7-191-A-BA
1	SCREW, 4-40 x 5/16, PHILIPS, PAN HEAD		F	H343-ND		572-01881
1	NUT, 4-40 x 1/4		F	H216-ND		572-00484
1	MC33064 RESET CIRCUIT, TO-92	U7	F, P			no suggested small quantity source
1	LM336Z -5.0 VOLTAGE REFERENCE, TO-92	Z1	F	LM336Z-5.0-ND		
1	LIGHT EMITTING DIODE, T1L220	LED1	F	P300-ND	LED-JR	35BL501
1	SIP RESISTOR, 4.7K OHM, 9 ELEMENT, 10 PIN	RN1	F	Q9472	RP9472	592-108-472
1	POTENTIOMETER, 10 K, 10 mm	POT1	F	U262R103B-ND		322-5800-10K
1	3 V LITHIUM BATTERY, COIN, BR2325	B1	F	P135-ND	LITHIUM-3V	571-CR2032
1	COIN BATTERY HOLDER	BH1	F	105K-ND	3V-MHW	534-107
7	SCREW TERMINAL BLOCK, 2 POS, SIDE LOAD, 5mm		F	BD1623-ND		153-2102
6	SHORTING JUMPER, SHUNT		F	929955-06-ND	JUMPER	151-8000

QTY	DESCRIPTION	LOCATION	CCI	SOURCES		
				DIGI-KEY	JDR	MOUSER
2	1X2 SQUARE PIN HEADER, .1" SPACING, .318" PIN HEIGHT	J3,JP1	F	2440-6212TG-ND		571-41029760
3	1X3 SQUARE PIN HEADER, .1" SPACING, .318" PIN HEIGHT	JP2,JP4,JP5	F	2440-6212TG-ND		571-41029760
1	1X4 SQUARE PIN HEADER, .1" SPACING, .318" PIN HEIGHT	JP3	F	2440-6212TG-ND		571-41029760
1	1X5 SQUARE PIN HEADER, .1" SPACING, .318" PIN HEIGHT	JP6	F	2440-6212TG-ND		571-41029760
1	2X8 SQUARE PIN HEADER, .1" SPACING, .318" PIN HEIGHT	J2	F	2480-6222TG-ND		571-41029770
3	2X13 SQUARE PIN HEADER, .1" SPACING, .5" OR .318" HGT	J4,J5,J6	F	2480-6222TG-ND		571-41029770
1	74LS14 - LS TTL HEX INVERTER WITH SCHMITT TRIGGER	U8	F	DM74LS14N-ND	742574LS14	511-74LS14
1	74LS32 - LS TTL QUAD 2 INPUT OR GATE	U12	F	DM74LS32N-ND	47LS32	511-74LS32
1	74LS139 - LS TTL DUAL 2 TO 4 DECODER	U13	F	DM74LS139N-ND	74LS139	511-74LS139
2	74LS245 - LS TTL OCTAL BUS TRANSCEIVER	U2,U3	F	DM74LS245N-ND	74LS245	511-74LS245
1	MAX232 5V RS232 DUAL RECEIVER/TRANSMITTER	U5	F	MAX232CPE-ND	MAX232CPE	
1	HD64180 MICROPROCESSOR (68 PIN PLCC)	U1	F, P	no suggested small quantity source		
1	SN75176B - RS-485 TRANSCEIVER	U4	F	DS75176BN-ND	75176	
1	62256 SRAM 32K X 8	U11, (U10 - optional)	F	SRM2A256SLC85-ND	HM62256LP-12	551-43256AC-10L
1	8255 - PROGRAMMABLE PERIPHERAL INTERFACE (PLCC)	U16	F, P	no suggested small quantity source		
1	ADC0808 8-CHANNEL, 8-BIT A/D CONVERTER	U17	F	ADC0808CCN-ND	ADC-0808	
1	NMC9346 1024-BIT EEPROM (OPTIONAL)	U6	F	NM93C46N-ND	9346	
1	7425 - TTL DUAL 4-INPUT NOR GATE WITH STROBE	U14	F		7425	526-NTE7425
1	DS1215 PHANTOM TIME CHIP	U15	F, P		DS1215	
1	EPROM 27256, HCS2-DX FIRMWARE	U9	F, P, E	NM27C256Q150-ND	27C256-150	511-M27C256B-15

\*\*\*\*\* - R8 should only be installed if the board is to be run off +5 VDC ONLY!!!

F - An experimenter's full kit containing these parts is available from CCI. Please call for pricing.

P - An experimenter's partial kit containing these parts is available from CCI. Please call for pricing.

E - The 27C256 included with the experimenter's kits comes preprogrammed with V2.0 of the DX firmware. The parts available from the other three sources come unprogrammed. A hex file containing the DX firmware is available for downloading from the CCI BBS at (203) 871-1988.

#### Sources

CCI, 4 Park St., Vernon, CT 06066, Tel: (203) 875-2751 Fax: (203) 872-2204

Pure Unobtainium, 13109 Old Creedmoor Rd., Raleigh, NC 27613-7412, Tel: (919) 676-4525 [Offers many of the hard to find parts, send \$1 for catalog]

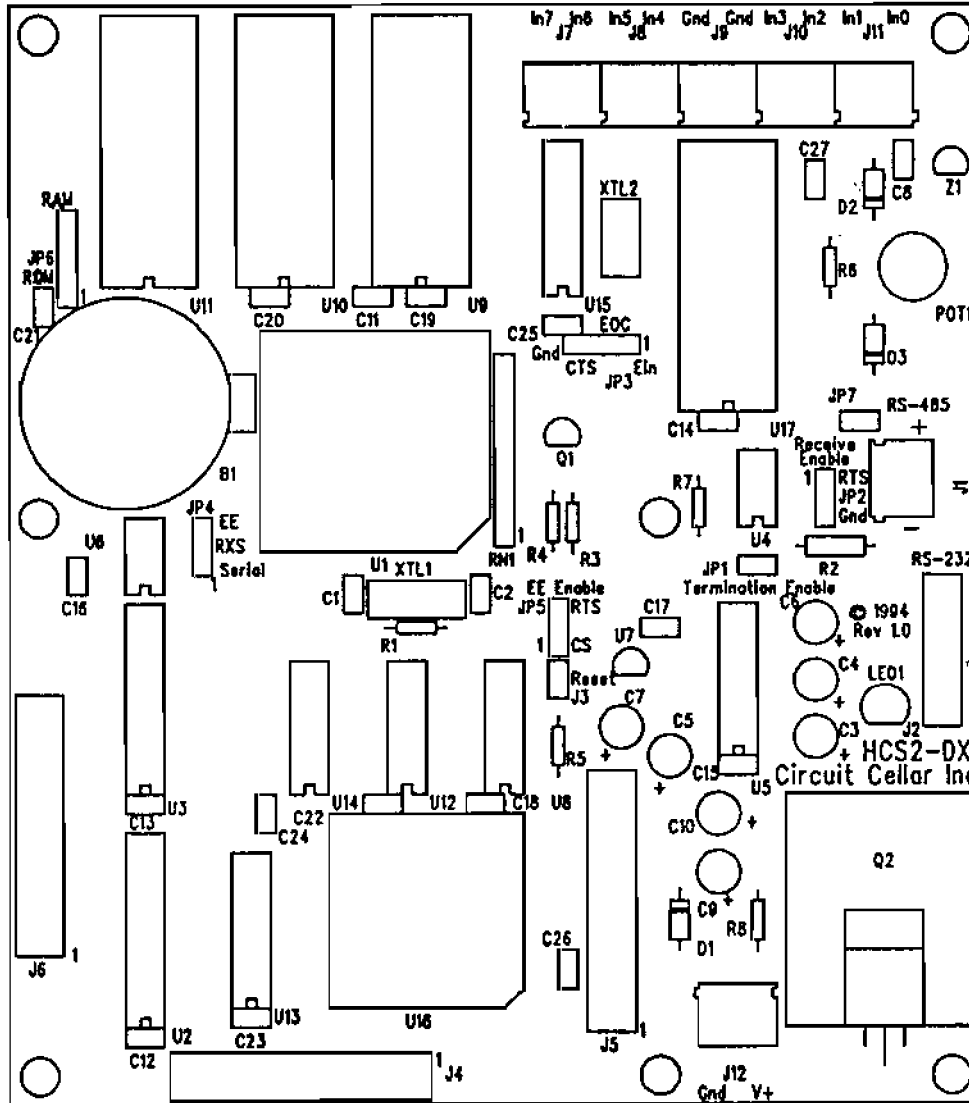
Digi-Key, 701 Brooks Ave. South, Thief River Falls, MN 56701, Tel: (800) 344-4539

JDR Microdevices, 2233 Samaritan Dr., San Jose, CA 95124, Tel: (800) 538-5000

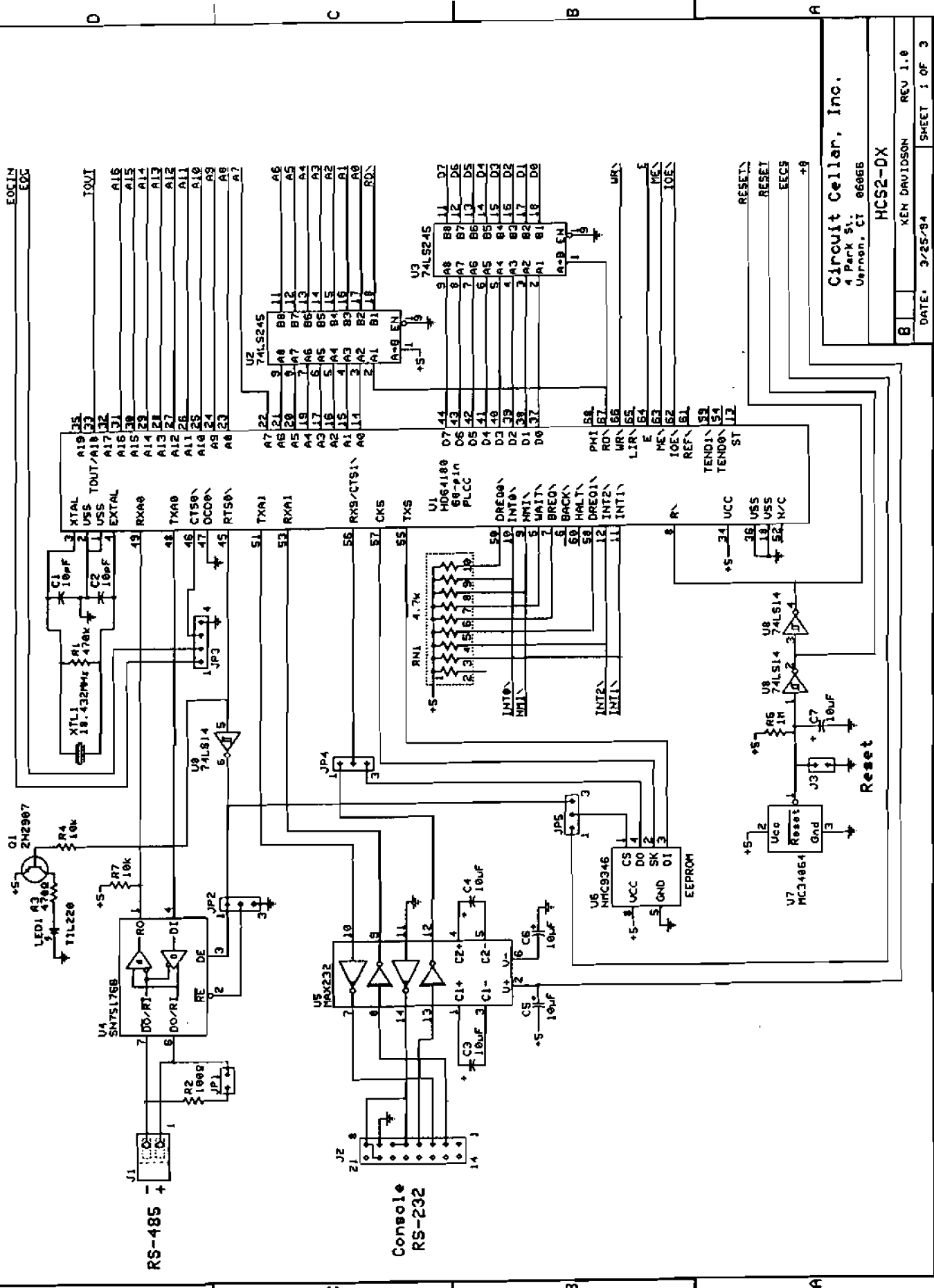
Mouser, 2401 Highway 287 North, Mansfield, TX 76063-4827, Tel: (800) 346-6873

This procurement list was developed as an aid for kit builders in locating parts for the HCS2-DX. The listings are taken from the latest available catalogs of a few companies that cater to low volume buyers. We have tried to make sure that there are no errors but catalog listings often change. To be sure of ordering the correct components, we suggest you contact the sources and obtain their latest catalogs. We take no responsibility for changes in catalog listings or availability since it is beyond our control. This procurement list is offered as an aid and is not an endorsement of any company or product.

# HCS2-DX Silkscreen



# HC82-DX Schematic

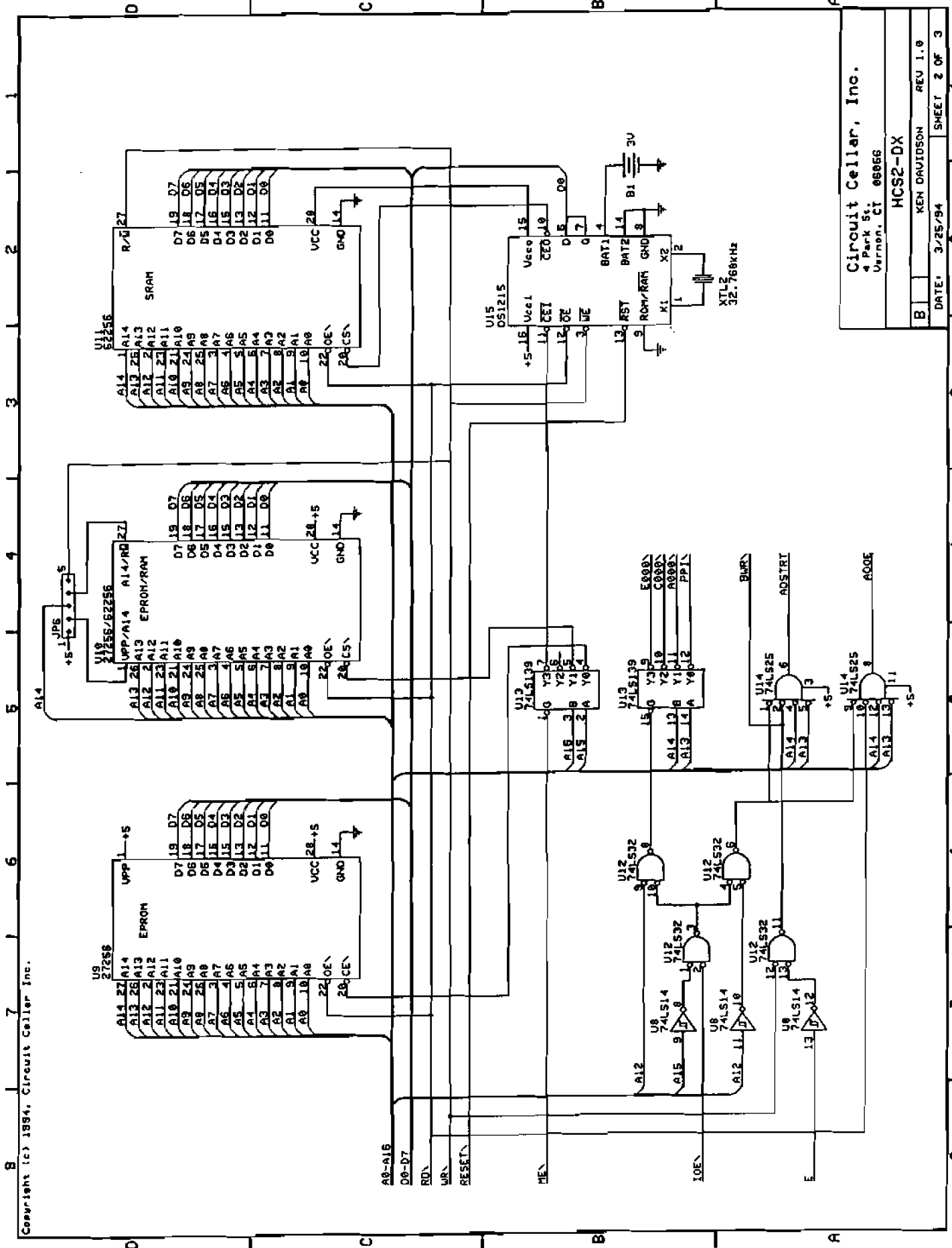


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HC82-DX

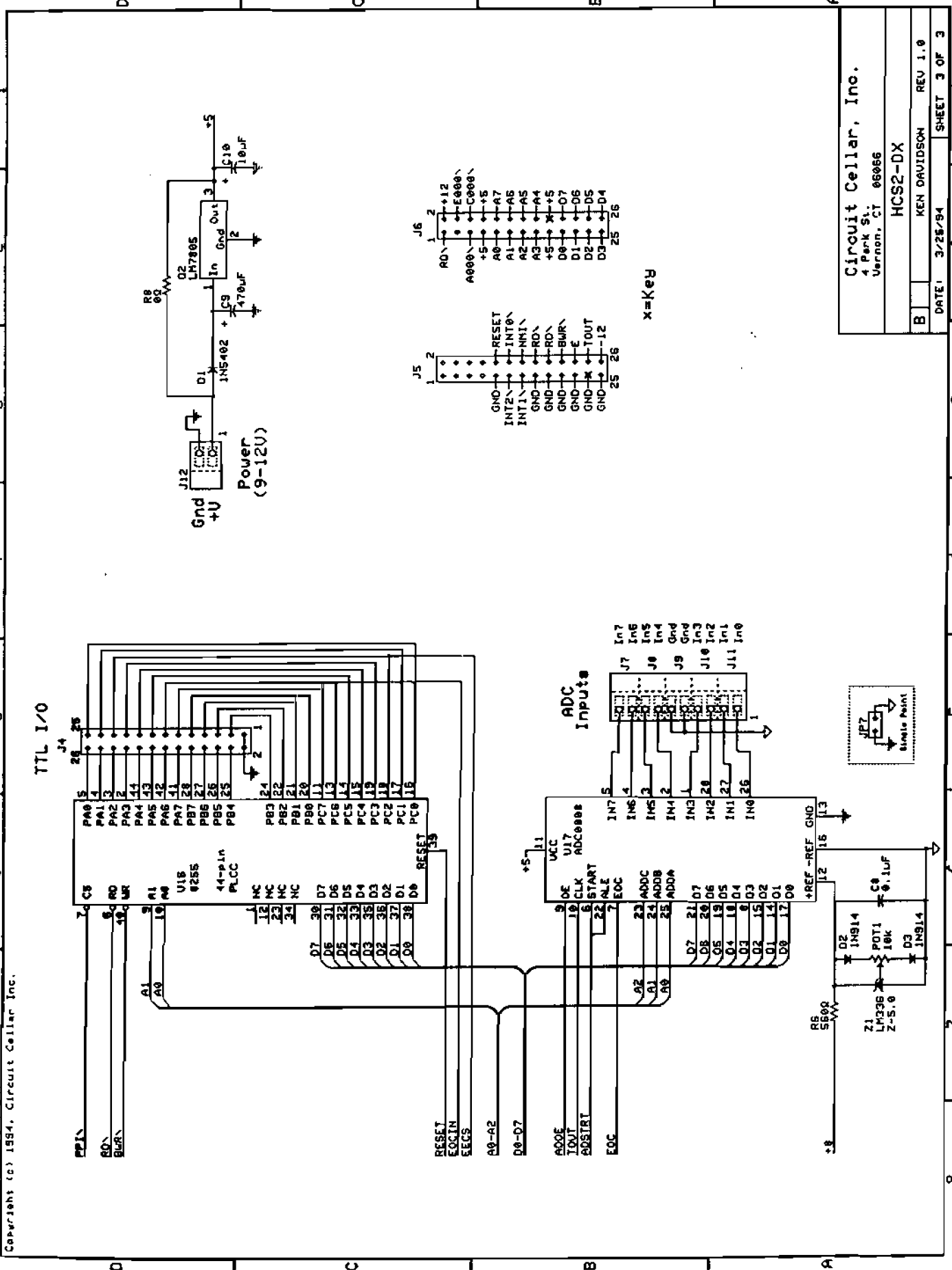
8 | KEN DAVIDSON | REV 1.0  
DATE: 3/25/94 | SHEET 1 OF 3

# HCS2-DX Schematic



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 KEN DAVIDSON REV 1.0  
 DATE: 3/25/94 SHEET 2 OF 3

# HCS2-DX Schematic



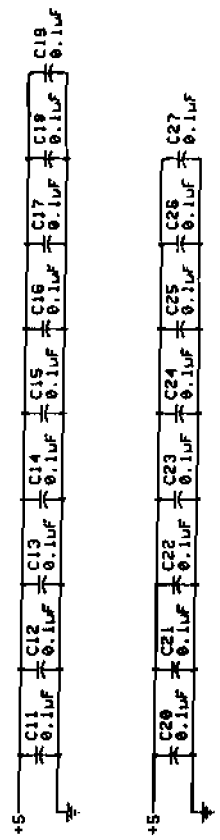
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 REV 1.0

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 SHEET 3 OF 3

# HC82-DX Schematic

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### HC82-DX Power Table

Socket	I.C.	+5 V	Grid
SK1	HD64190	34	18.36
SK2, SK3	74LS245	20	10
SK4	SN75176B	0	5
SK5	MAX232	16	15
SK6	NMCR346	0	5
SK8	74LS14	14	7
SK9-SK11	62256/27258	20 *	14
SK12	74LS32	14	7
SK13	74LS139	16	8
SK14	7425	16	8
SK15	951215	16	8
SK16	8255	20	8
SK17	ADC0808	11	13

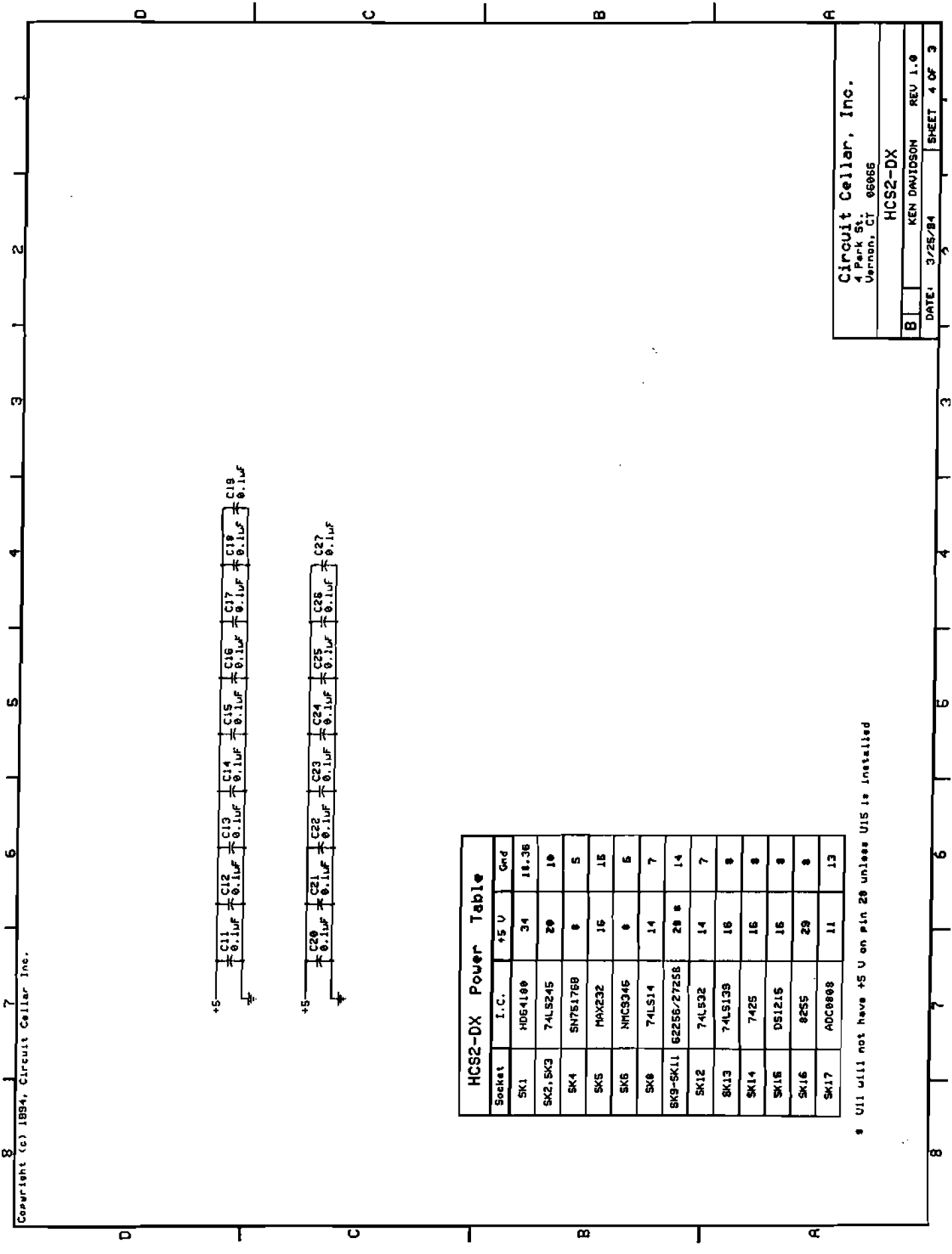
\* U11 will not have +5 V on pin 20 unless U15 is installed

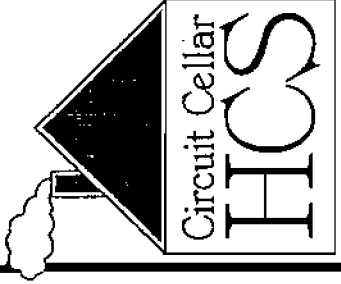
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DATE: 3/25/84 SHEET 4 OF 3





HCS2-DX

Assembly Guide &  
Procurement List