COMM-LINK

8031/80C52 Microcontroller

CIRCUIT CELLAR INC.

4 Park Street ● Vernon, CT 06066

TECHNICAL MANUAL

VERSION 1.0

COMM-LINK

8031/80C52 MICROCONTROLLER

Technical Manual

Release 1.0
1/3/92

Circuit Cellar Inc.
4 Park St.
Vernon, CT 06066

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REV. 3/92

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MICROCONTROLLER REVOLUTION

'Expandable', the catch phrase of the 80's, is taking on new meaning in the 90's. The ability to add functions to a small microcontroller through an expansion bus has been a hot selling 'feature' for many companies. Today's cost-conscious product developer may not be willing to pay for that flexibility. Their product is well defined and must be minimal in cost. Expansion capabilities require additional parts, real estate, and power that is wasted in many cases where expansion will not be used.

What many need is an 8031/8052 controller in a plain brown wrapper, that is, optimized for these minimal-configuration applications.

The COMM-LINK board meets this criteria. Optimized both for single-use drop-in solutions as well as volume OEM applications, this new microcontroller is designed to be small and cost effective.

Measuring only 3.5 by 5.2 inches, the COMM-LINK board contains an 8031 (or 80C52) processor, EPROM and RAM memory, 12-bits of parallel I/O, and an RS/232-RS/485 serial port. A single 5 VDC regulated supply is necessary for operation or this can be obtained from a 9-12 VDC unregulated input by the on-board linear regulator.

8031 FAMILY PIN DESCRIPTION

Port 0	pins 39-32	8-bit open drain bidirectional I/O (multiplexed low-order data/address for external memory)
Port 1	pins 1-8	8-bit quasi-bidirectional I/O
Port 2	pins 21-28	8-bit quasi-bidirectional I/O (high-order address for ext. memory)
Port 3	pins 10-17	8-bit quasi-bidirectional I/O (secondary functions as follows: **RXD/data** Serial Channel's receiver **TXD/data** Serial Channel's transmitter ***INT0** Interrupt 0/counter gate 0 input ***INT1** Interrupt 1/counter gate 1 input **T0** Counter 0 input **T1** Counter 1 input ***WR** write for external data memory ***RD** read for external data memory
ALE	pin 30	Address latch enable
***PSEN**	pin 29	read for external program memory
***EA**	pin 31	tied to logic high for executing code masked within the 8x5x series processors with internal ROM or tied to logic low to disable internal ROM and fetches all instructions from external program memory

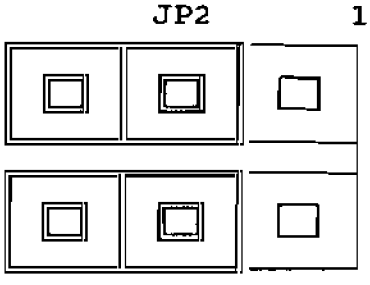
EXTERNAL ADDRESSING SPACE

The COMM-LINK microcontroller can directly address 64K of external memory. That is, overlapped DATA/CODE memory, for an "anything goes here" space.

Combinations of 8K and 32K RAMs and EPROMs are allowed on the COMM-LINK board. **When using the 8031, your EPROM code starts execution at 0000H. When using the 80C52 (masked with BASIC in the internal ROM), RAM must be at 0000H.**

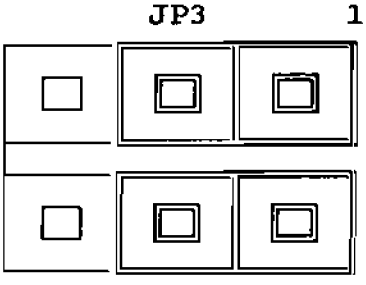
DEVICE TYPE SELECTION

Two memory sockets are provided on the COMM-LINK board (U2 & U3). Each memory socket has a jumper used in selecting the type of address space assigned to the socket. JP1 selects the device type for U2 and JP2 selects the device type for U3. The selection made determines where the control lines are connected on the memory socket. RAM and EPROM devices require slightly different configurations. The following is an example of memory configuration when using an 8031.



RAM in U3 at 8000H — EPROM in U3 at 8000H

JP2 shows RAM in U3 starting at address 8000H

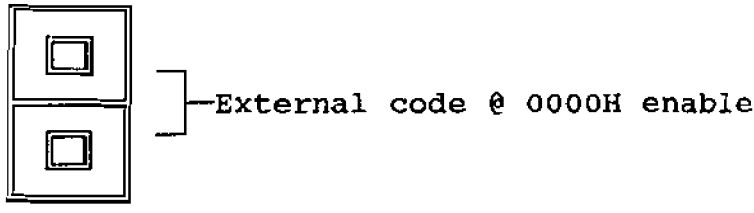


RAM in U2 at 0000H — EPROM in U2 at 0000H

JP1 shows EPROM in U2 starting at address 0000H

EXTERNAL CODE SELECTION

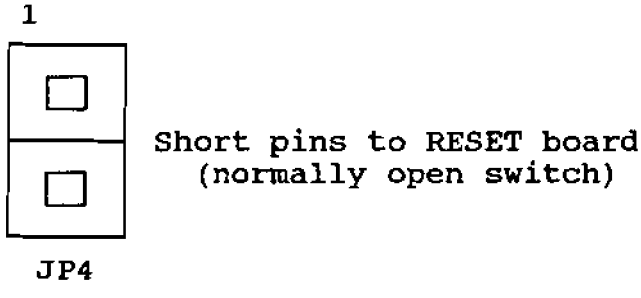
The 8031 microcontroller requires *EA (pin 31 on the microcontroller) to be pulled down to a logic low level. This instructs the processor to start executing machine language code starting at address 0000H. The 8052 is masked with BASIC and will run internal code (BASIC interpreter) if *EA is pulled up to a logic high. Pulling *EA low on an 8052 will disable BASIC and execute code starting at 0000H (similar to an 8032).



JP3 shows the microcontroller enabled for external code execution

RESETTING THE COMM-LINK

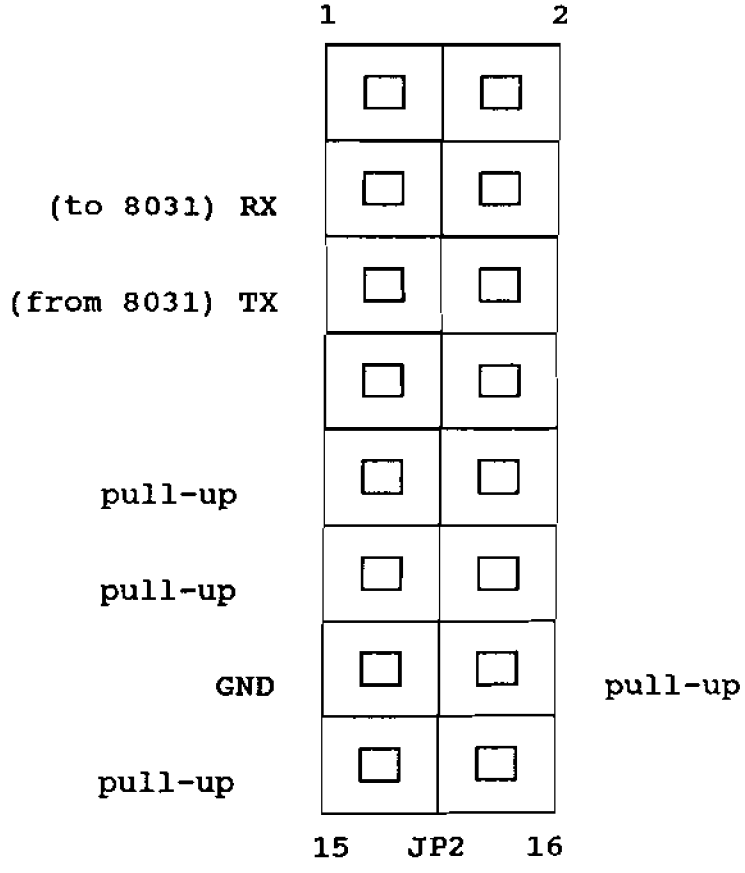
Reset of the COMM-LINK board occurs when a normally open push-button switch is attached to JP4 and momentarily pressed. A logic high is applied to the system RESET line and held momentarily high by an R/C circuit.

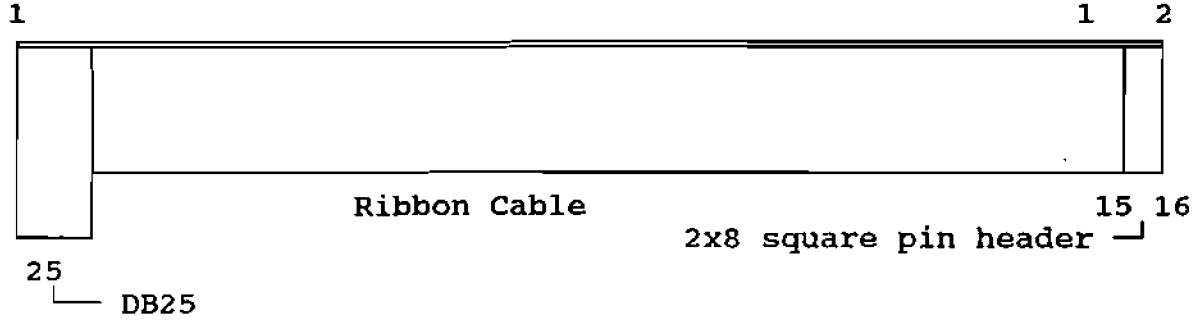


Use JP4 for connecting a normally open push-button switch as an external system RESET

RS-232 COMMUNICATIONS

The COMM-LINK contains a full-duplex serial channel. TTL-level serial signals are converted to ±10-volt RS-232-compatible signals by U7, the MAX232 device. A 16-lead flat ribbon cable made with a DB-25 at one end (for connection to DTE terminal device) and a 16-pin plug (for connection to JP2) will permit serial communication with a dumb terminal or computer.



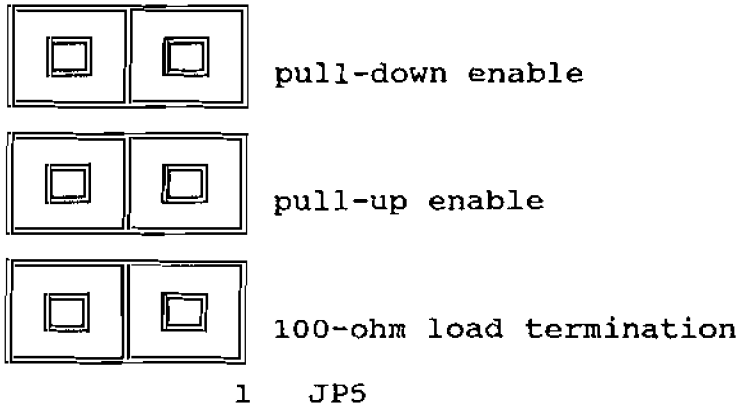


Cable required for RS-232 communications

To eliminate unwanted noise on the RX input to the processor, remove the unused line driver chip. (U7-MAX232 or U8-75176)

RS-485 COMMUNICATIONS

RS-485 communications over a single twisted pair can includ multiple (up to 32) devices. Since each device can transmit an receive, certain protocols must be adhered to to prevent messag collision. The simplest being "listen to the line and transmit onl if free". (The protocol you use will depend on the application and i beyond the scope of this manual.) JP5 enables termination resistor on the twisted pair and should be installed only on the microcontrol lers located at the extreme ends of the twisted pair (one at eac end). U8, the 75176 RS-485 device, draws as much current as the res of the COMM-LINK board. If you don't require RS485 communication removing U8 will reduce overall power requirements.



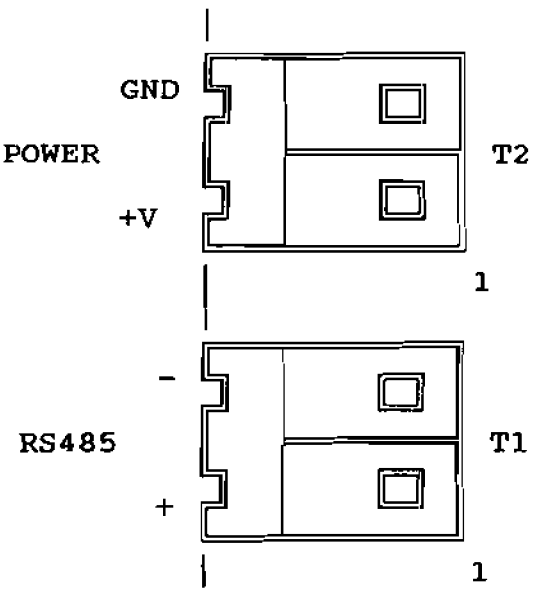
JP5 shows termination of the RS-485 lines enabled

The 100 ohm termination which is across the RS485 twisted pair may be needed on the node at the end of the twisted pair daisy chain. The pull-up and pull-down resistors may be required to assure that the twisted pair is coaxed to the idle state when no RS485 driver is active. It is suggested that any termination be done on the last node for less confusion.

RS485/POWER CONNECTIONS

Four screw-terminal connections are used for connecting power and the RS485 network to the COMM-LINK board. This allows the COMM-LINK board to operate remotely with only a four wire cable (i.e. telephone cable). Of course you could use the COMM-LINK board as a stand-alone controller with RS232 as the communications medium.

T1 is a two position screw terminal block used for RS-485 twisted-pair communications. T2 is used as the power supply input, requiring either 9-12 volts of unregulated DC from a remote supply on a second pair of wires or a local 5 VDC regulated supply (with the zero ohm jumper at R15 installed).



Screw terminal blocks for Power and RS485 Communication

POWER for the COMM-LINK

Use T2 for attaching the power supply connections to the COMM-LINK board. The input can be any unregulated DC voltage from 9-12 volts. A series diode protects the COMM-LINK board from accidental voltage reversals. The unregulated DC powers a linear voltage regulator on the COMM-LINK board which provides the nominal 5.0 volts.

Alternately, a regulated 5.0 volts can be used as input. When the input is a regulated 5.0 volts, the user must install a zero ohm jumper at R15. This bypasses the linear regulator and series diode. Caution: Voltage reversal protection is eliminated when a jumper is placed at location R15.

PROTOTYPING AREA

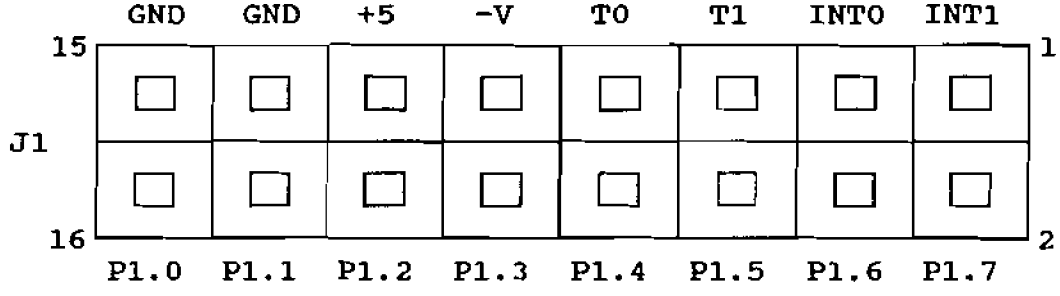
Since the COMM-LINK board does not have expansion addressing circuitry, adding memory-mapped I/O is not possible. The 12 bits of TTL I/O are the only means of expansion. 8 bits (of the 12) are bidirectional bits from PORT1 of the microcomputer. Four TTL open collector drivers are provided to directly drive LEDs (i.e. LED5). These can be removed if the lines are to be used as inputs.

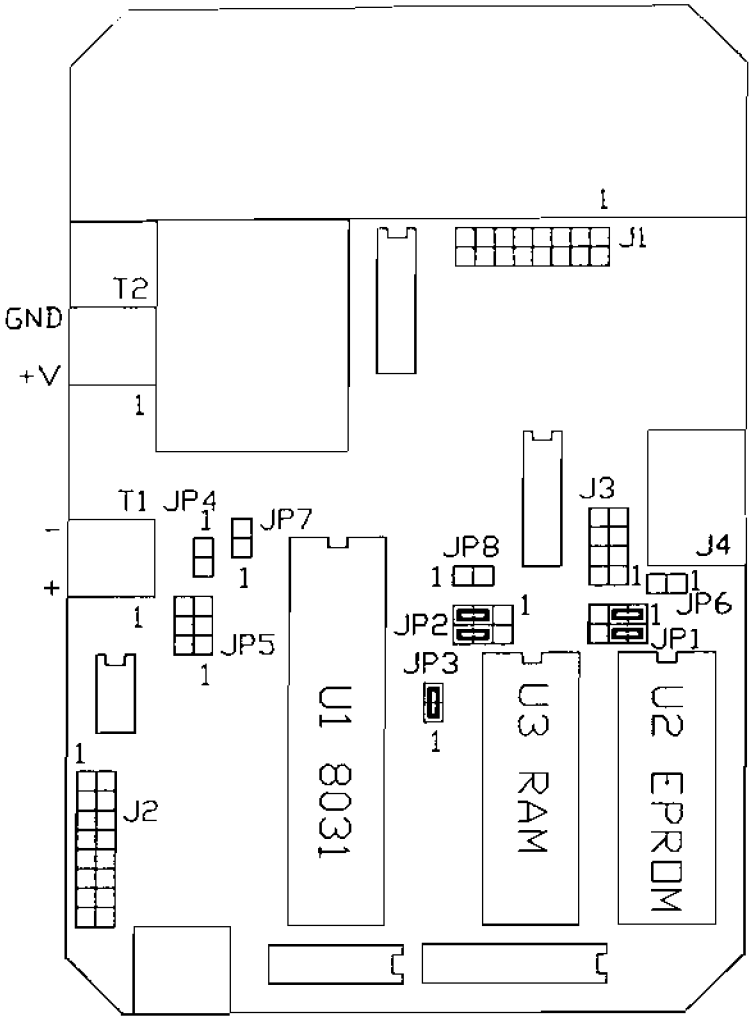
These are easily used as a parallel bus with the other 4 bits used as control lines for connection to most any parallel device. 3-wire serial chips are also easily implemented such as ADC083x or MAX170 A/Ds and MAX500 D/As.

3.5 square inches of 0.1 by 0.1 inch prototyping grid will accommodate up to a 40 pin 0.6 inch device with room left over for discretes.

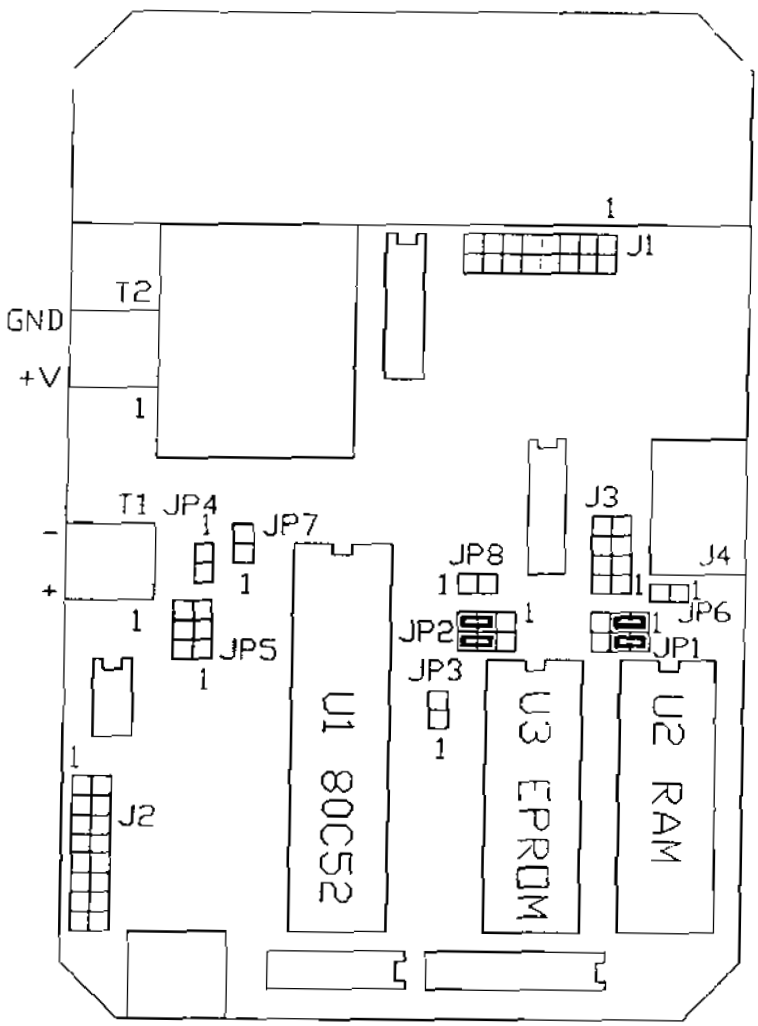
I/O SIGNALS

In addition to 12 bits of I/O brought out to J1; +5 volts, Ground, and -9 volts (about 7mA) are also available. These signals are located next to the protyping area for easy access. NOTE: P1.4-P1.7 have open collector drivers. To use these as input lines remove U9 and jumper pin1 to pin2, pin3 to pin4, pin5 to pin6, and pin8 to pin9.





Suggested jumper configurations for 8031 system using an EPROM @)00H and a RAM @ 8000H on the COMM-LINK board.



Suggested jumper configurations for an 80C52 system using a RAM @ 0000H and an EPROM @ 8000H on the COMM-LINK board

To eliminate unwanted noise on the RX input to the processor, remove the unused line driver chip. (U7 or U8)

GETTING STARTED

80C52

The 80C52 processor, with internal BASIC, can communicate with the user on power-up if correct connection to a dumb terminal or computer (running communication software) is made. **After pressing the space bar** the 80C52 will inspect the serial transmission and select the correct baud rate (transmission must be 8 bits, no parity, and 1 stop bit). The 80C52 will respond with a sign-on message and command prompt ">".

Type in the short program below to verify BASIC is operating correctly. This should toggle the P1.7 line (and LED5) on the microcontroller about once per second.

```
10 PORT1 = PORT1 .AND. 07FH
20 GOSUB 60
30 PORT1 = PORT1 .OR. 80H
40 GOSUB 60
50 GOTO 10
60 FOR X = 1 TO 100
70 NEXT X
80 RETURN
```

NOTE: When using a COMM-LINK with a terminal or computer, press the space bar to start the system's auto-baud rate sequence. A sign-on message will be displayed after it is correctly received.

8031

The COMM-LINK does not have any internal program, so the user must program an EPROM with machine language code which will start execution at 0000H. The following code can be programmed into a blank EPROM and will turn LED5 on and off about once per second, verifying the ability to execute code. Refer to Intel's EMBEDDED CONTROLLER HANDBOOK for additional information on the 8031/8052 microcontroller functions.

```
0000H  15H  F0H          ;DEC  B
0002H  D5H  F0H  FBH     ;DJNZ B,0000H
0005H  14H               ;DEC  A
0006H  70H  F8H          ;JNZ  0000H
0008H  B2H  B4H          ;CPL  T0
000AH  01H  00H          ;AJMP 0000H
```

GETTING YOUR CODE INTO AN EPROM

The COMM-LINK does not have a built in EPROM programmer. Development and EPROM programming can be most easily done on the MICROMINT BCC52C (2764/27128) or the BCC52CX (27256). Alternately, you can use any Eprom Programmer along with a program, such as HOST-52, to extract an INTEL.HEX file from your ASCII program.

Generic Instructions for Kit Assembly

Tools Required for Assembly:

Low Wattage or Temperature Controlled Soldering Iron
Rosin Core Solder
Lead Cutters

Additional Tools to Ease the Assembly:

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

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

Familiarize yourself with all of the parts included in the kit. Pay particular attention to proper orientation of parts. Markings might include a bump, hole, number, arrow, or notch indicating pin1 (or the pin1 end) of ICs and sockets. A stripe may indicate a plus or minus potential lead of a capacitor or the cathode of a diode. An LED might indicate the cathode by a notch or flat side on the girth of the component.

Inspect the PC Board prior to installing any parts. If held up to a lamp, you can usually see the signal traces fairly clearly. Eye each trace for defects, a copper short between adjacent traces or pads, or a break in the copper trace. Verify any traces that look shorted by first looking at the schematic to verify they should not be connected and then checking the traces for continuity. You should check traces which seem to be broken for continuity as well. Circuit Cellar Inc. inspects each and every board for manufacturing defects; we feel confident that the components packaged for you are free from defects. However, inspecting your PCB is much easier before any parts are inserted which would obscure a defect from view.

This is a generic overview of the construction process. At this time, please read the Kit Specific Instructions packaged with each kit. These explain any special requirements or mounting procedures necessary for individual components. Place these parts aside until the rest of the kit is completed.

The best approach to use in building a kit is to choose the smallest (or shortest) parts to install first. Start with any small signal diodes. Use the FOIBSAT method on each part or group of parts. Find, Orient, Insert, Bend, Solder, And Trim each part. Find the part, verify it using the parts list and silkcreen layout. Orient the part correctly using markings on the part and the silkscreen layout. Insert the part into its designated location, forming the component leads if necessary. Bend over the component leads to prevent the part from falling out, preferably in the direction of the connecting circuit board trace. Solder each lead filling in the area between the lead and its plated through hole. And finally, Trim the leads to prevent shorting between traces, components, or holes.

Continue with the 1/4 watt resistors, IC sockets, and smaller monolithic capacitors. Next, insert all the square pin headers and jumpers. These can't be easily bent and will simply fall out if not handled one at a time. Start by soldering only one or two pins, flipping over the board to check that the header isn't tilted, then fix by reheating the soldered pin and/or complete by soldering the rest of the header's pins. Follow up with the larger components, resistors, capacitors, and axial semiconductors.

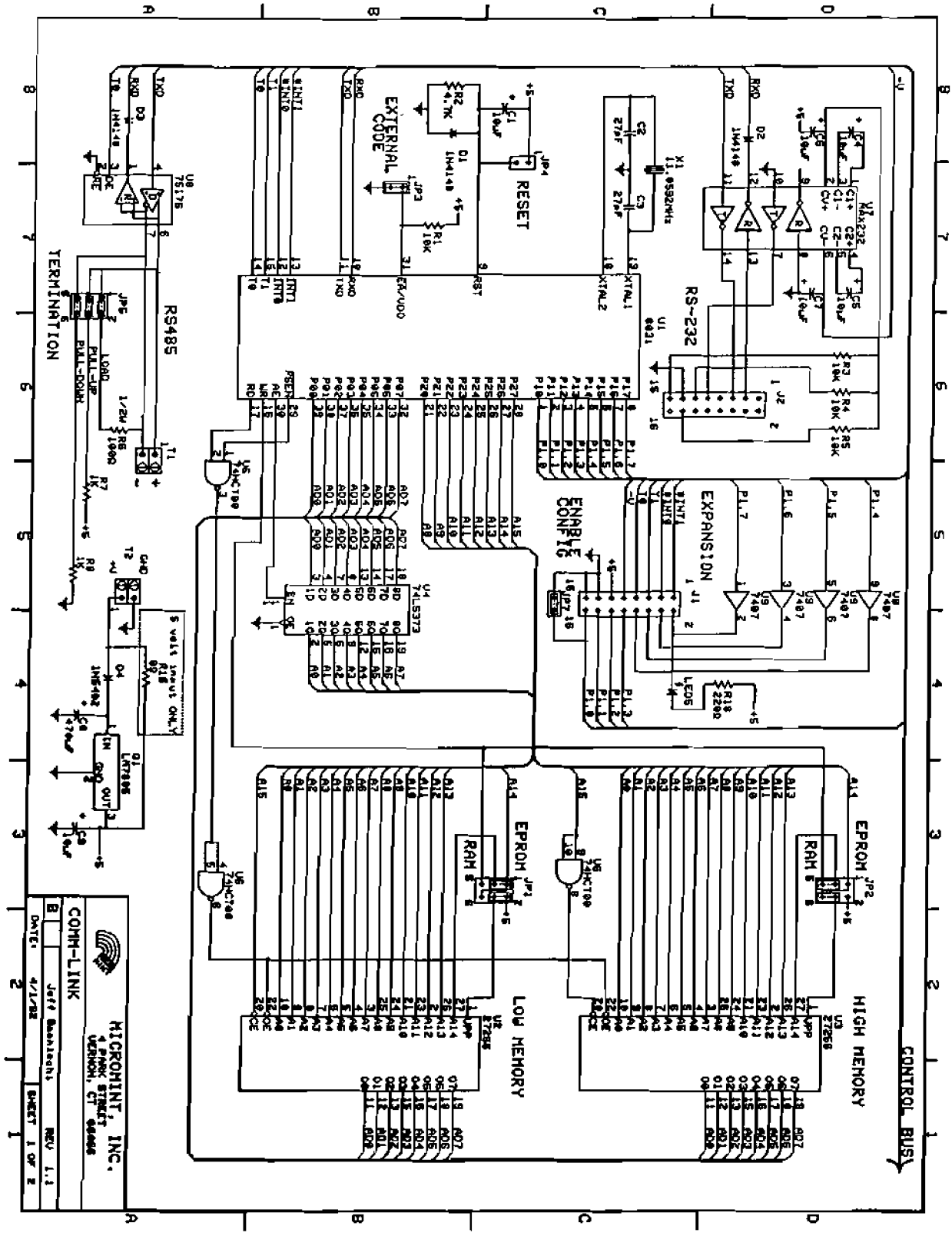
Finally, the taller, odd-shaped components are added, transistors, LEDs, crystals, potentiometers, connectors, heatsinks, etc.

Now it's time to add those items listed in the Kit Specific Instructions. This is where you may be given special instructions on placement or a choice on how components are oriented according to your application.

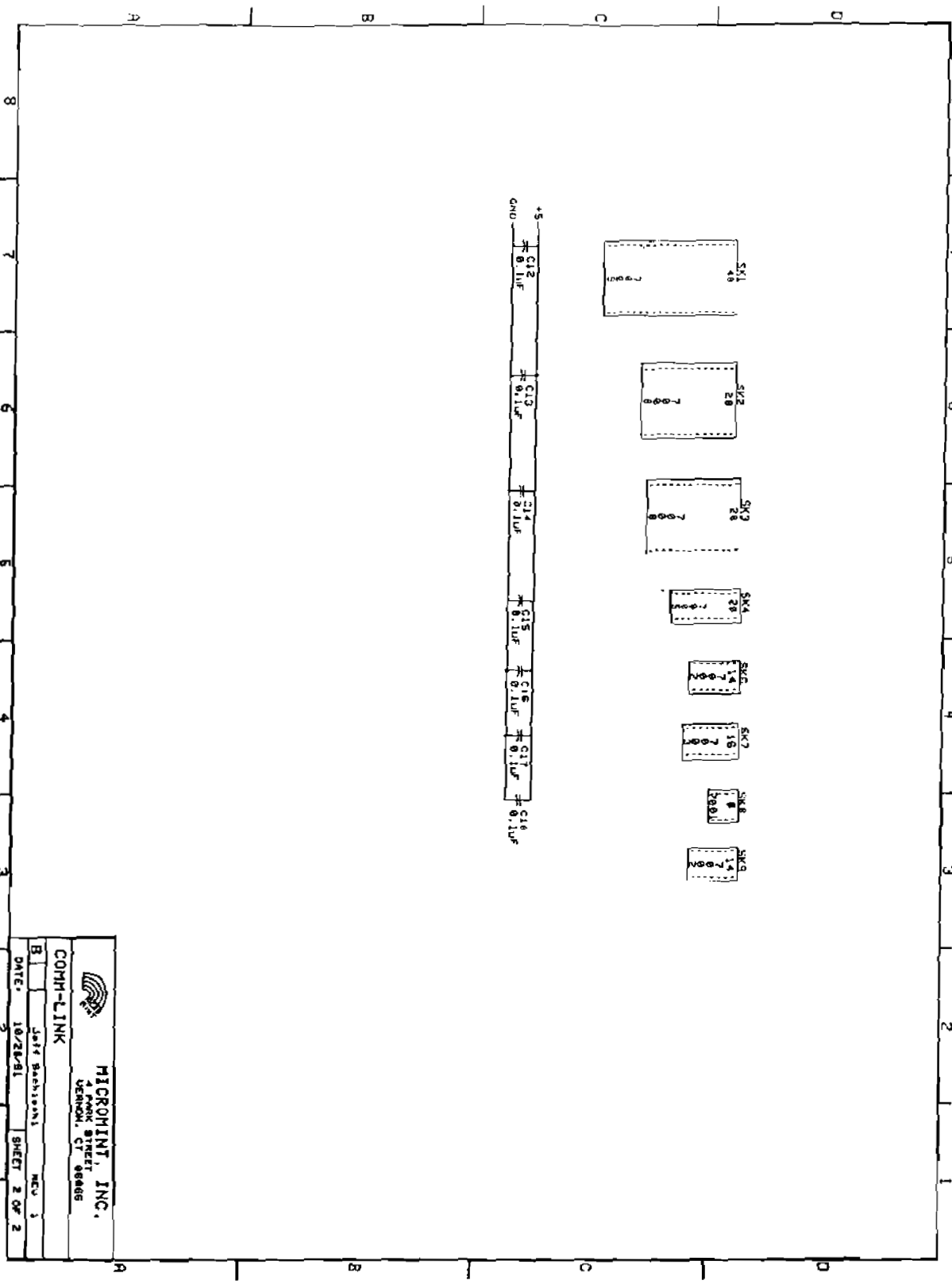
Prior to installing the ICs, it is a good idea to give the PCB another inspection. Look for unsoldered or untrimmed leads. Cleaning the solder side of the PCB with a flux remover will make inspection easier, not to mention less sticky.

Another suggestion is to use a volt-ohm meter and measure the resistance between ground and any power supply input. A short circuit here could ruin your power supply and won't allow your board to operate properly. Power-up the board before inserting the ICs and check for voltage according to POWER TABLE listed in the schematics.

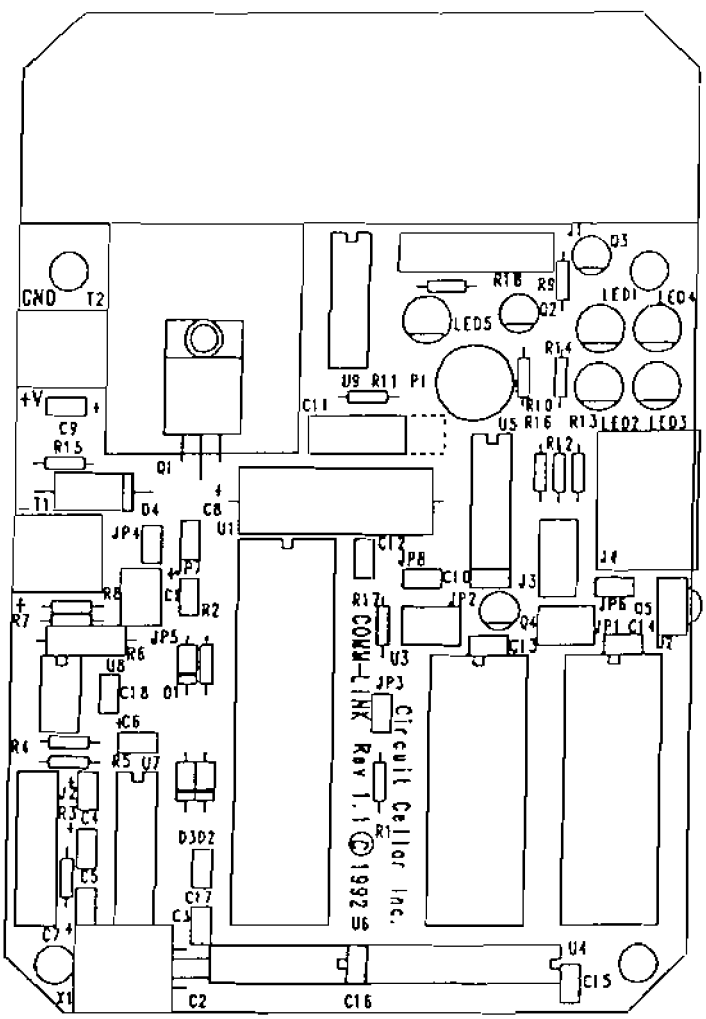
Refer to the parts list and silkscreen for proper IC orientation and insertion. This concludes the assembly instructions. Refer to the SOFTWARE - GETTING STARTED section of the manual for operation of the board.



COMM-LINK SCHEMATICS (1 of 2)



COMM-LINK SCHEMATICS (2 of 2)



Silkscreen for the COMM-LINK

PARTS LIST for the COMM-LINK

DESIGNATION	PART#	DESCRIPTION
Printed Circuit Board		
PCB1		COMM-LINK PC Board
Integrated Circuits		
U1	8031	Microcontroller
U2, U3	62256/27256	RAM/EPROM
U4	74LS373	Octal Latch
U6	74LS00	Quad 2-Input NAND
U7	MAX232	Dual Transmitter/Receiver
U8	75176	Differential Transmitter/Receiver
U9	7407	Hex Buffer w/OC Outputs
Resistors		
R1, R3, R4, R5	10K	1/4W, 5% (brn-blk-org)
R2	4.7K	1/4W, 5% (yel-vio-red)
R6	100Ω	1/2W, 5% (brn-blk-brn)
R7 & R8	1K	1/4W, 5% (brn-blk-red)
R18	240Ω	1/4W, 5% (red-yel-brn)
R15	0Ω	1/4W, 5% (blk) or bus wire
Capacitors		
C1, C4, C5, C6, C7 & C9	10μF	Tantalum
C2 & C3	27pF	Monolithic
C8	470μF	Electrolytic
C12-C18	0.1μF	Monolithic

PARTS LIST for the COMM-LINK (continued)

DESIGNATION	PART#	DESCRIPTION
Semiconductors		
D1-D3	1N4148	Small Signal Diode
D4	1N5402	Diode
Q1	LM7805	5.0 Volt Linear Regulator
LED5	TIL220	Visible LED
Connectors		
J2	2x8	Square-Pin Header
JP1, JP2, JP5	2x3	Square-Pin Header
JP3, JP4, JP7	1x2	Square-Pin Header
Sockets		
SK1	40-Pin	0.6 inch IC-Socket
SK2 & SK3	28-Pin	0.6 inch IC-Socket
SK4	20-Pin	0.3 inch IC-Socket
SK6 & SK9	14-Pin	0.3 inch IC-Socket
SK7	16-Pin	0.3 inch IC-Socket
SK8	8-Pin	0.3 inch IC-Socket
Miscellaneous		
HS1		Heat Sink w/4-40 screw and nut
SJ1-SJ9		Shorting Jumper
T1, T2	1x2	Screw Terminal Block
X1	11.059MHz	Crystal

COMM-LINK, THE BASIC NETWORK NODE FOR THE HCS II

The HCS II is an expandable network-based intelligent-node industrial-oriented supervisory control system which, in its minimal configuration, performs quite suitably as a home control system. HCS II incorporates direct digital inputs and outputs, direct analog inputs and outputs, real time or boolean decision event triggering, X-10 transmission or reception, infrared remote control transmission and reception, remote displays as well as a master console, and it has the capability to perform as a complete badge monitoring and personnel tracking system.

The HCS II system architecture consists of a central supervisory controller connected to up to 31 other functional modules (called links) via an RS-485 serial network. The system controller and the links can operate independently and do not need the system controller or other links to function. This allows easy testing or incorporation as intelligent subsystems in other control equipment. The subsystem links all share a common 8031 controller board (generically called a COMM-LINK) with the I/O customized for each application.

The supervisory controller is quite literally the brains of the system. While every Link has its own processor, they each rely upon the supervisory controller for timing, control commands, and overall system coordination.

The supervisory controller is a 9.218 MHz 64180-based single board computer. It has two serial ports, up to 96K bytes of memory (32K bytes are battery-backed), an eight channel 8-bit or 10-bit A/D, a real time clock-calendar, and 24-bits of parallel I/O (an additional 48-bits of parallel I/O can be added if required). These parallel I/O bits can be further conditioned by externally connecting them to optoisolators, relays, or drivers. Depending upon your application you may find that the supervisory controller is all you need.

One of the serial ports performs as a dedicated 9600 bps serial RS-485 connection to the various network links. The wire from this port can be up to 4000 feet long (as opposed to 50 feet for RS-232). The second port connects (RS-232) to a PC/AT which functions as the master console. Programs running on the master console allow the user to enter and store control sequences which will be subsequently compiled and downloaded to the supervisory controller's non-volatile memory. The master console also acts as an on-line real time display of all control activity in the system. When these downloading or display functions are not required, the master console can be turned off to reduce system power consumption.

Besides the Supervisory Controller, the HCS II system consists of a multitude (none to 31) of specialized-function network nodes which facilitate remote data acquisition, closed-loop control, and display. With the exception of the ADIO-LINK, all COMM-LINKs consist of the same generic 8031 computer with only the external parallel I/O circuitry and operating software being different.

The generic COMM-LINK board is configured with minimal components. It accommodates up to 64K bytes of either RAM and/or EPROM memory. The single serial port is configured to operate both RS-232 and RS-485. When connected to the Supervisory Controller in normal operation, the connection is via a twisted pair to the RS-485. Additional line balancing and termination resistors are included. According to the driver chip manufacturers, this line can be 4000 feet long.

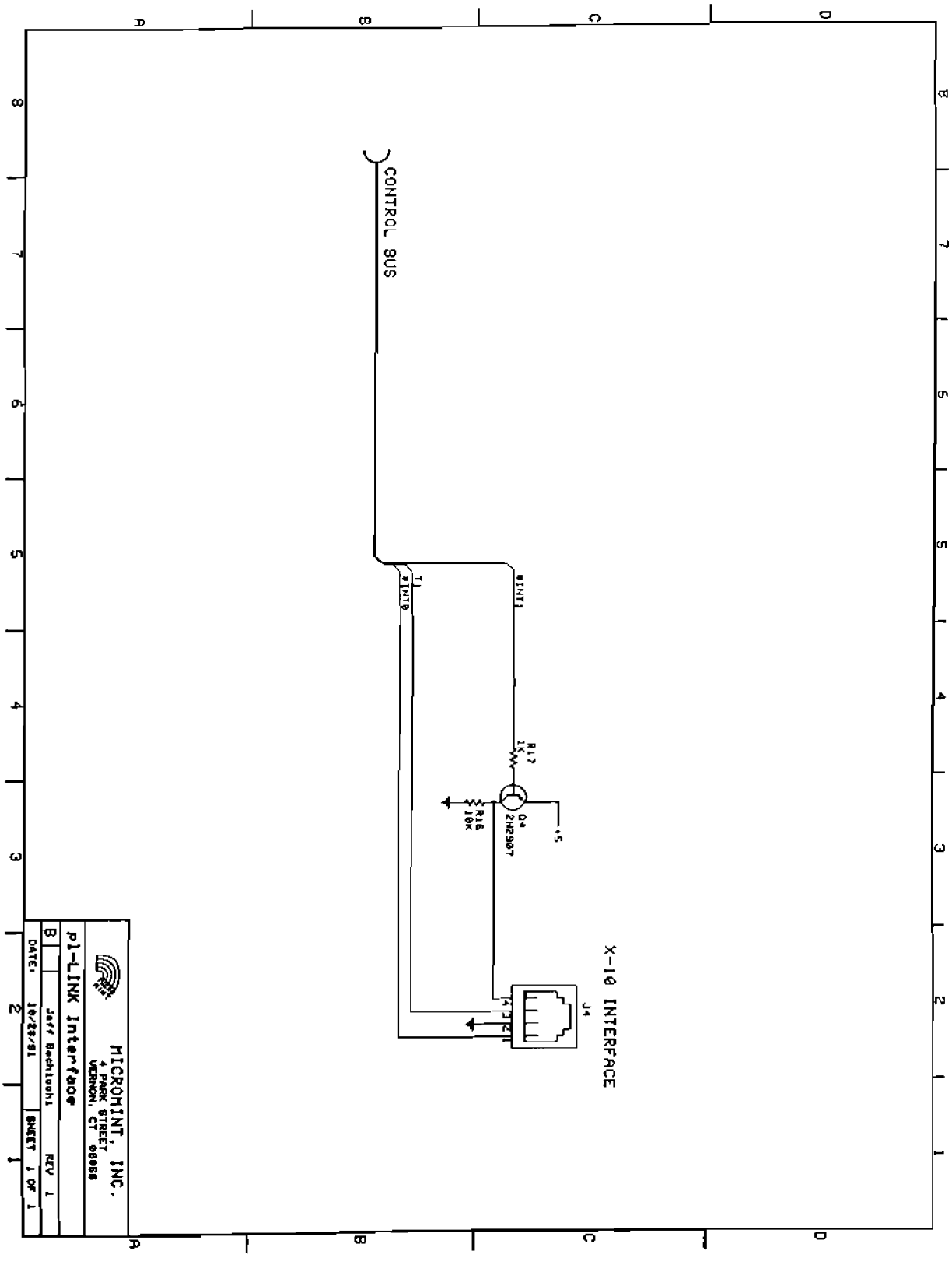
The available I/O on the comm-link circuit is limited to the PORT1 bits of the processor, interrupt lines, and T0 and T1. When used as a powerline interface, these lines connect to the TW-523 X-10 module; when used as an infrared gateway, these lines connect to infrared LED driver logic and an IR receiver; when used as an LCD display, these lines supply character data to the LCD. In addition, to facilitate additional link designs or modifications to the existing circuits, the comm-link PC boards contain a prototyping area.

The RS-232 is reserved for local non-system direct testing or use (of course, you could also operate it stand-alone with RS-485). Each link has a unique command set and, for multiple units of the same type, a unique address. By connecting the link to the serial port of a terminal or any PC running a terminal emulation program, you can directly command the comm-link to do any activity which it would normally do for the Supervisory Controller.

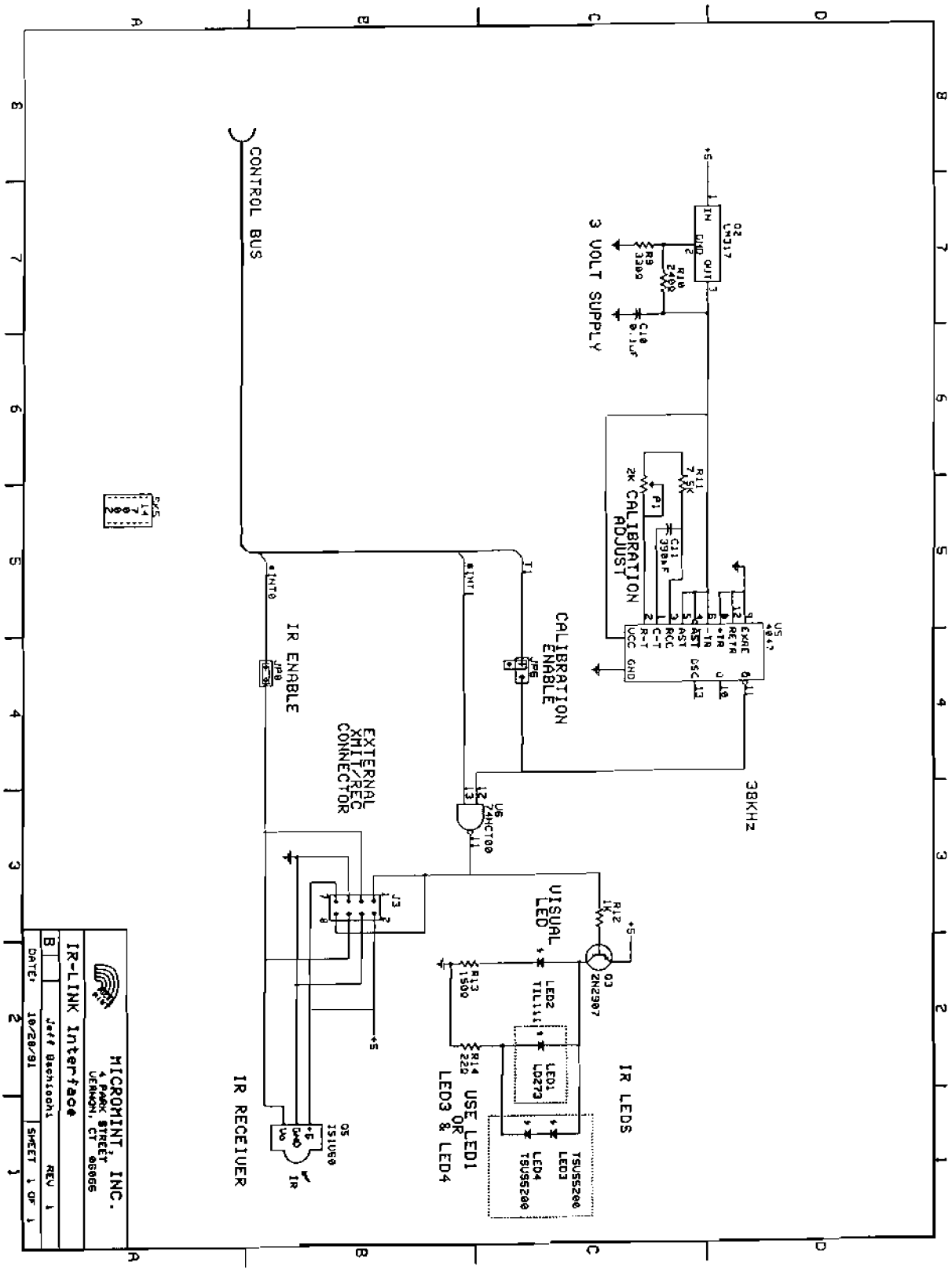
With the PL-LINK alone, for example, you could directly control all X-10 on/off, dim/bright functions from a PC. In addition, because the PL-LINK is "smart" it offers the user the added capability to "listen" to the power line and record whether any other X-10 codes have been transmitted (either manually or automatically, from this or any other transmitter), and it will automatically "refresh" desired X-10 modules at a prescribed refresh rate. Intelligent links simplify testing and problem diagnosis. More often than not, the location where sensors are placed have no convenient AC power outlet and 5 volts is no longer 5 volts if run over any length of a twisted pair. To remedy this, the individual network links will operate on a 9-12 VDC input.

While the comm-link circuitry runs on 5 volts, the design incorporates a linear regulator so that the 5V can be derived from a wide-ranging DC input. The intention is to promote connecting the individual links via a 4-wire cable, rather than just a 2-wire twisted pair, when local power is unavailable. Two wires supply RS-485 while the other pair supplies +12V and ground (actually 9-12V is fine. Higher voltages require a larger heatsink on the regulator). Of course, using the regulator is optional, and the board can be operated (jumper selectable) on +5V.

The following information is strictly informational. It is not supported and only meant to explain the additional component holes which are not discussed in this manual. The additional components are not available separately as upgrades to the COMM-LINK kit. However, by collecting the appropriate parts yourself, you can begin to experiment with those devices. By ordering the FIRMWARE discussed in Circuit Cellar INK, "The Computer Applications Journal", beginning with issue #25, upgrading the COMM-LINK to an 'HCS II NODE' is possible.



PL-LINK SCHEMATICS (1 of 1)



IR-LINK SCHEMATICS (1 of 1)

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IN THE EVENT THAT YOU NEED TO RETURN AN ITEM TO US, PLEASE TAKE THE FOLLOWING STEPS:

1. Call CCI and obtain an RMA number.

2. Complete the form below and return it with the merchandise. Include a copy of your original invoice.

3. Should you need a replacement item shipped immediately, contact a CCI customer service rep. at **(203) 875-2751.**

4. Ship the merchandise (pre-paid) to the address below. Using the original packaging, safely repack with all original accessories included.

PLEASE COMPLETE THIS FORM AND RETURN WITH THE MERCHANDISE AND A COPY OF THE ORIGINAL INVOICE:

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Date_____ Invoice #_____ P.O.#_____ Daytime Phone_____

Customer #_____ Account Name_____

Contact Name _____

METHOD OF PAYMENT:

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Signature of Cardholder _____ Purchase Order #_____

ITEM(S) RETURNED	**REASON(S)**

(Use additional paper to be as explicit as possible on your reason(s) for return)

What action would you like us to take? (Repair or Replace item, Refund or Credit your account):

Is Shipping Data on Invoice correct? Yes_____ No_____

If not, please provide correct information: _____

To help us serve you better, use this space for your comments regarding Circuit Cellar Inc.'s service, support, product quality, etc. Thank you.

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2. A minimum inspection fee must be prepaid for the repair of units that are no longer under warranty. Call Circuit Cellar Inc. for a current list of fees.

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