Appendix G

Original 68701-Based Universal Serial Interface Card (USIC)

The original-design Universal Serial Interface Card (now called the Classic USIC) is discontinued and no longer available from JLC Enterprises. The MC68701 Microcontroller, used with the USIC, is no longer being manufactured by Motorola. In general this is good news because the Classic USIC has subsequently been replaced by the new and much improved SUSIC covered in Chapter 10. Not only has the performance been improved multi-fold but the cost has been basically cut in half. However, to provide support for the many-hundreds of Classic USIC cards still in service, I'll cover the card's highlights along with its schematic, parts layout and parts list.

The Classic USIC can use any one of three interface standards: 20mA current-loop, RS232, or RS422. The RS232 and RS422 (along with its nearly identical RS485) are covered in Chapter 4 with the SMINI. The 20mA current loop standard is rarely, if ever, used with today's computers so I've deleted its coverage in this manual. Nevertheless, its details are presented in the **Build Your Own Universal Computer Interface First- and Second-Edition** books.

The Classic USIC is limited to driving 24-bit I/O cards (CIN24, COUT24, DIN and DOUT). Including one or more Classic USIC-based nodes within a distributed serial system limits the maximum node count to 16 with node addresses 0 through 15. Although the Classic USIC is designed to operate with standard baud rates of 150, 300, 600, 1200, 2400, 4800, 9600, and 19200 bits per second when connected in a distributed system with SUSIC- and SMINI-based nodes, the useful baud values are limited to 9600 and 19200.

CLASSIC USIC SCHEMATIC

Although the Classic USIC uses different electronic parts than the SUSIC, the Classic USIC's schematic (see Fig. G-1) performs the same SUSIC functions detailed back in Figures 10-2 and 10-3. Thus, to conserve space, I'll just cover the highlights focusing on the circuitry differences.

The heart of the Classic USIC is part U1, a MC68701 MicroComputer Unit (MCU), making it a **smart interface**. The MC68701 is a single, 40-pin DIP containing a clock oscillator, a Micro-Processor Unit (MPU), 2048 bytes of ultraviolet-Erasable Programmable Read-Only Memory (EPROM), 128 bytes of Random Access Memory (RAM), a Serial Communications Interface (SCI), a programmable timer, and an abundance of I/O pins.

Just like with the SUSIC's Microcontroller, the MC68701 performs all the bookkeeping as to which particular bit the computer is sending and whether it's part of address or data. When the computer is to read data from input cards on the motherboard, it simply tells the MC68701, which gathers the data from the cards, sets it up in the prescribed format, and transmits it bit-by-bit back to the computer.

The serial connections between computer and Classic USIC are made with a 14-pin, right angle header at the top of the card. Which pins you use depend on whether you're using 20mA current-loop, RS232, or RS422. Unlike with the SUSIC, with the USIC using RS232 you must also supply ±12Vdc power through this same connector. How to build such a supply is covered in Chapter 19.

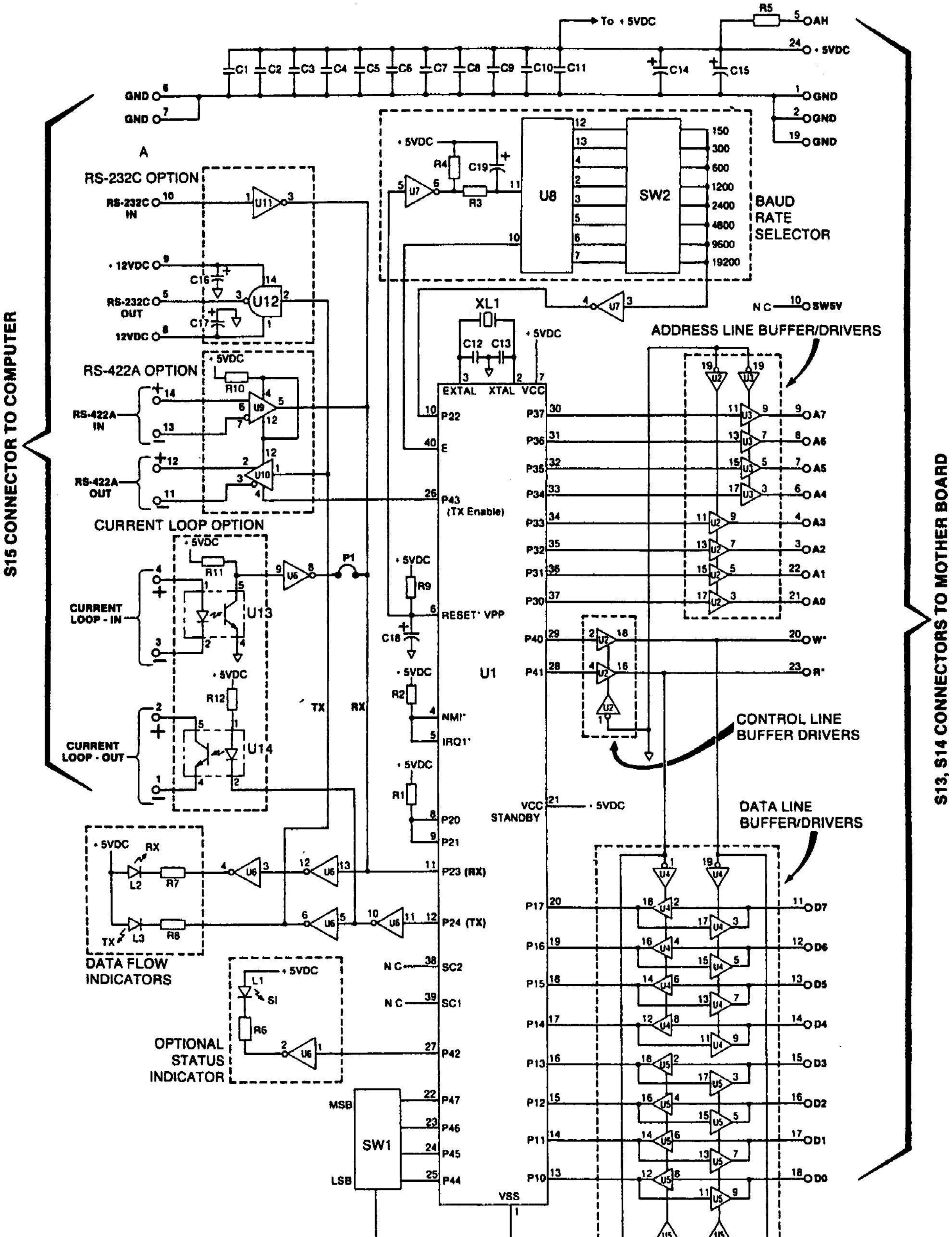

Fig. G-1. Classic USIC (using MC68701) schematic

An eight-segment DIP switch sets the baud rate generator to the desired serial transmission frequency, which in turn is fed into the MC68701. The MC68701 provides all the parallel-to-serial and serial-to-parallel conversions and determines the operational timings for both the serial and parallel lines. It also keeps track of which information is data and which is address and determines when to bring the R* and W* lines low for communication with the I/O cards.

Somewhat like the 8255 IC covered in Appendix F, the MC68701 can operate in different modes. The state of the U1 lines P20 through P22 during power-up sequence, defined by the rising edge of RESET*/VPP pin 6 input, sets the mode of operation. For the Classic USIC all three are high to define mode seven, setting U1 for its most basic single-chip mode. Once the reset period is over, the pin 10 P22 input takes on a second function as the external clock input to the MC68701 for determining the baud rate of the serial transmission.

The 2.4576 MHz crystal XL1 generates the clock frequency for U1's internal processing. U1 also divides the clock frequency by a factor of 4 and outputs the result on pin 40 as signal E to the pin 10 clock input of U8, a CD4040 12-stage binary ripple counter.

U1 requires that the frequency into its P22 be eight times the desired baud rate, which is taken care of in the U8 circuitry. Only one segment of SW2 should be ON at any time, and this setting must match the baud rate of the computer port connected to the USIC.

Each of the eight output lines used on U8 divides the clock input by a different factor of two, and passes through one of the eight segments of SW2. Turning on the segment for U8's pin 12 connects the input frequency to U1 pin 10, which provides a baud rate of 150. Likewise, turning on pin 13's segment gives 300 baud, and so on up to pin 7 for 19,200 baud.

The R9/C18 circuit ensures that the U1 RESET*/VPP line is held low during the power-up sequence. Likewise, the U7 inverter—along with R3, R4, and C19—holds the pin 11 reset line to U8 high for a period longer than U1's reset period. This initialization forces all the counter's outputs low, and these are inverted by U7 to set the P22 input high initially for mode 7 initialization of U1.

Returning to the interface-unique circuitry, like with the SUSIC, you install parts for only one of the three possible serial interface systems. For example, U11 is an RS232 receiver IC that converts the incoming ±12Vdc signals to +5Vdc and 0V logic levels for U1. U12 is an RS232 driver IC that converts the +5Vdc and 0V logic levels from U1 line TX to ±12Vdc outgoing signals. U12 needs an external ±12Vdc power supply, with + and - connected to pins 9 and 8, respectively, and the common ground to pin 7, of the right angle header S15.

Receiver-driver pairs U9 and U10 are for RS422. Resistor R10 keeps the U9 receiver chip always enabled, while the pin 4 enable line for the U10 driver chip is software controlled by the P43 line out of U1. That way with multiple USICs the only one with an active transmitter driver on the line is the one from which input data is requested.

Optoisolators U13 and U14 are for the 20mA current-loop, and with them the inverters in U6 provide the proper signal polarity and prevent the optoisolator’s circuitry from overloading U1. Because U6 is always installed, **it’s very important to omit jumper P1 when using either the RS232 or RS422** to keep the pin 12 output of U6 from interfering with the U9 or U11 outputs.

The three LEDs, L1-L3, indicate the operational status of the USIC. L1 (green) blinks to show that U1's internal program is operating correctly and also provides error codes when not operating correctly. See

Fig. 6-4 in Chapter 6 for details covering the green LED. L2 (amber) blinks when the USIC is receiving data and L3 (red) blinks when USIC is sending data.

CLASSIC USIC PARTS LAYOUT AND PARTS LIST

Because new unassembled Classic USIC cards are no longer available, I'll skip the how to build text. However, to help with card usage, debug and repair, a parts layout is provided as Fig. G-2 and the parts list as Table G-1.

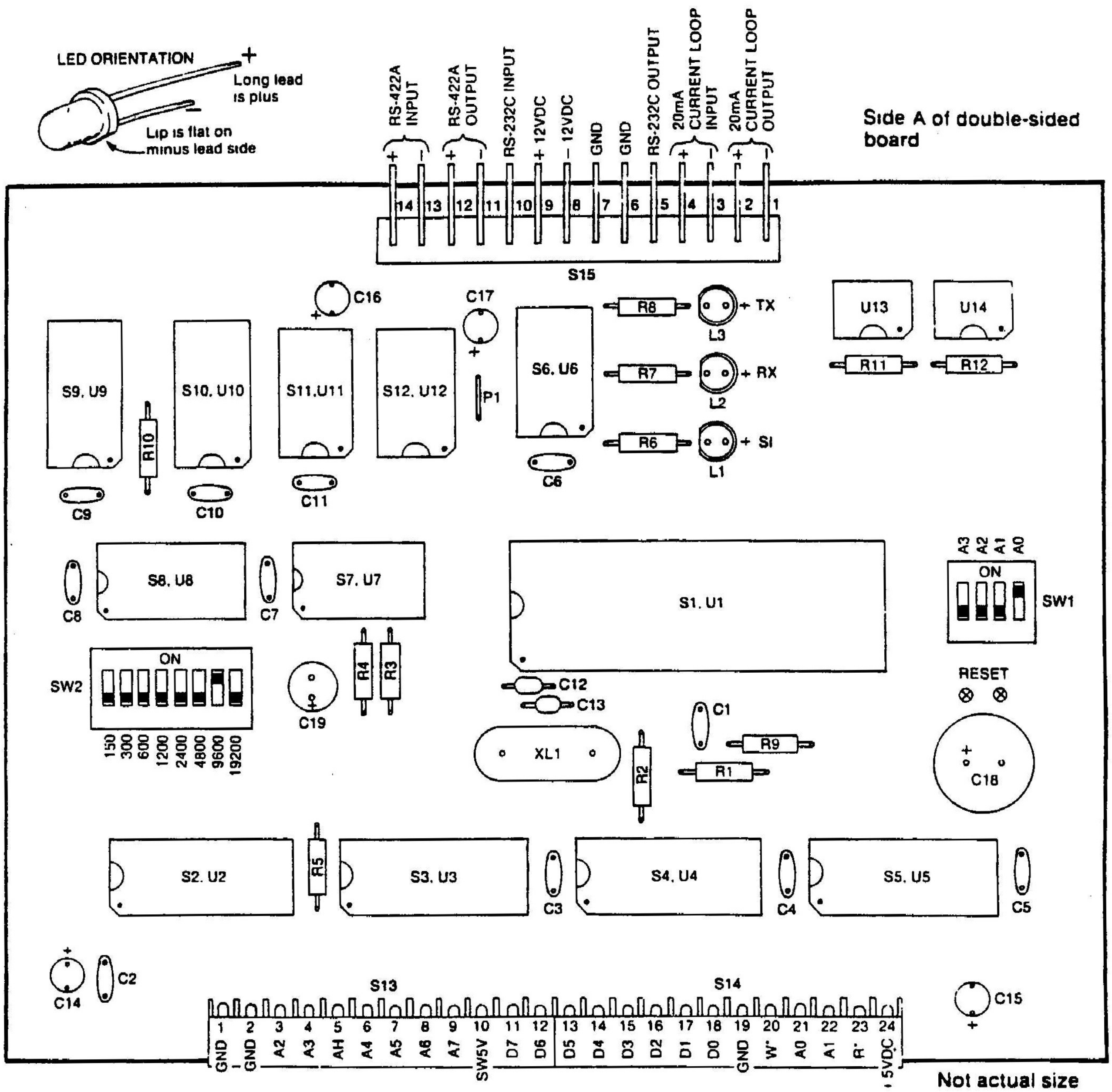

Fig. G-2. Classic USIC (using MC68701) parts layout

Table G-1. Classic USIC (using MC68701) parts list

Qnty.	Symbol	Description
2	R1, R2	4.7KΩ resistors [yellow-violet-red]
1	R3	470Ω resistor [yellow-violet-brown]
1	R4	2.2KΩ resistor [red-red-red]
1	R5	1.0KΩ resistor [brown-black-red]
3	R6-R8	330Ω resistors [orange-orange-brown]
1	R9	51Ω resistor [green-brown-black]
1	S1	40-pin DIP socket (Jameco 112310)
4	S2-S5	20-pin DIP sockets (Jameco 112248)
2	S6, S7	14-pin DIP sockets (Jameco 112213)
1	S8	16-pin DIP socket (Jameco 112221)
2	S13, S14	12-pin Waldom side entry connectors (Mouser 538-09-52-3121)
1	S15	4- or 6-pin right angle header (see text to cut from Mouser 538-26-48-1242)
1	SW1	4-segment DIP switch (Digi-Key CT2064)
1	SW2	8-segment DIP switch (Digi-Key CT2068)
8	C1-C8	.1μF, 50V ceramic disk capacitors (JDR .1UF)
2	C12, C13	22pF, 50V ceramic disk capacitors (Digi-Key P4016)
2	C14, C15	2.2μF, 35V tantalum capacitors (Jameco 33734)
1	C18	1000μF, 10V radial lead electrolytic capacitor (Digi-Key P5127 or equivalent with .197” lead spacing)
1	C19	100μF, 25V radial lead electrolytic capacitor (Digi-Key P5152 or equivalent with .098” lead spacing)
1	XL1	2.4576mHz crystal (JLC CTX047 or equivalent with .486” lead spacing)
1	L1	Diffused green T1¾ size LED (Digi-Key P303)
1	L2	Diffused amber T1¾ size LED (Digi-Key P306)
1	L3	Diffused red T1¾ size LED (Digi-Key P300)
1	U1	MC68701 Mirocomputer unit with USIC programmed EPROM (New programmed parts no longer available – try second hand purchase from another C/MRI user via the C/MRI User’s Group)
4	U2-U5	74LS244 octal buffer/drivers, non-inverting (Jameco 47183)
2	U6, U7	74LS04 hex inverters (Jameco 46316)
1	U8	CD4040 12-state binary/ripple counter (Jameco 12950)
Used only for RS232		
2	S11, S12	14-pin DIP sockets (Jameco 112213)
1	C11	.1μF, 50V ceramic disk capacitors (JDR .1UF)
2	C16, C17	2.2μF, 35V tantalum capacitors (Jameco 33734)
1	U11	LM1489N quad line receiver, RS232 (Jameco 23181)
1	U12	LM1488N quad line driver, RS232 (Jameco 23157)
Used only for RS422		
1	R10	1.0KΩ resistor [brown-black-red]
2	S9, S10	16-pin DIP sockets (Jameco 112221)
2	C9, C10	.1μF, 50V ceramic disk capacitors (JDR .1UF)
1	U9	MC3486 quad differential line receiver, RS422 (Jameco 25232) or may substitute LM3486, 26LS32 or SN75175
1	U10	MC3487 quad differential line driver, RS422 (Jameco 25259) or may substitute LM3487, 26LS31 or SN75174
Used only for 20-mA current loop		
1	P1	Program jumper, use no. 24 insulated wire
2	R11, R12	330Ω resistors [orange-orange-brown)
2	U13, U14	4N33 optoisolators (Digi-Key 4N33QT)
Mating connectors for USIC cable to computer		
1	--	4- or 6-pin terminal housing (see text to cut from Mouser 538-09-50-3121)
4 or 6	--	Crimp terminals (Mouser 538-09-50-3121 for wire sizes 18-24 or 538-08-50-0108 for wire sizes 22-26)

Author’s recommendations for suppliers given in parentheses above with part numbers where applicable. Equivalent parts may be substituted. Resistors are ¼W, 5 percent and color codes are given in brackets.

Note that U1, the MC68701, is static-sensitive and should be handled accordingly. The two DIP switches (SW1 and SW2) should be installed so their contacts are closed when the switches are thrown toward the ON label as printed on the USIC card, i.e. without any regard to ON and OFF labeling that may be on the DIP switch itself.

When using RS232, the RS422 ICs (U9 and U10) should not be installed. When using RS422 the RS232 ICs (U11 and U12) should not be installed. For RS232 and RS422, program jumper P1 should not be installed. In case you have difficulty with the Classic USIC the IC power tests are defined in Table G-2.

Table G-2. Classic USIC (using MC68701) IC power tests

√	IC	+ METER LEAD ON PIN No.	– METER LEAD ON PIN No.	VOLTAGE READING
	U1	6	1	+5Vdc*
	U1	7	1	+5Vdc
	U1	8	1	+5Vdc*
	U1	21	1	+5Vdc
	U2	20	10	+5Vdc
	U3	20	10	+5Vdc
	U4	20	10	+5Vdc
	U5	20	10	+5Vdc
	U6	14	7	+5Vdc
	U7	14	7	+5Vdc
	U8	16	8	+5Vdc
	U9	16	8	+5Vdc
	U10	16	8	+5Vdc
	U11	14	7	+5Vdc
	U12	14	7	+12Vdc
	U12	7	1	+12Vdc

No application uses all ICs
You should read indicated voltage on all that are installed
*Reading may be slightly less than other +5Vdc readings

If you find an IC not getting power, work back along the circuit path to locate and correct the open circuit. A low voltage, less than 4.8Vdc, most likely means a short circuit on your card caused by a solder bridge or a reversed or failed part. Turn off the power and re-examine the card to find and correct the problem. If necessary, remove ICs one at a time to isolate the problem. If you do trace a problem to an IC, replace it with a new part. It's handy to keep at least one spare of each IC type used in your C/MRI for debugging and possible replacement.

For RS232 you'll need a ±12Vdc supply connected to S15 to check the U12 voltage. See Chapter 19 for obtaining one.

RS232/422 CONVERSION CARD (RS422)

This card has been superceded by the new RS485 conversion card covered in Chapter 4. However, to provide support for the many-hundreds of original-design RS422 Conversion Cards still in service, I'll cover its schematic, parts layout and parts list. C/MRI users already making use of the RS422 card can continue to use it with SMINI- and SUSIC-based nodes as well as with their Classic USIC-based nodes. The RS422 card is compatible with RS485 except that the corresponding distributed system is limited to 16 nodes rather than 128 nodes when using the new and improved RS485 conversion card.

The schematic for the original-design RS422 card is shown as Fig. G-4, the parts list in Table G-3 and the parts layout in Fig. G-5.

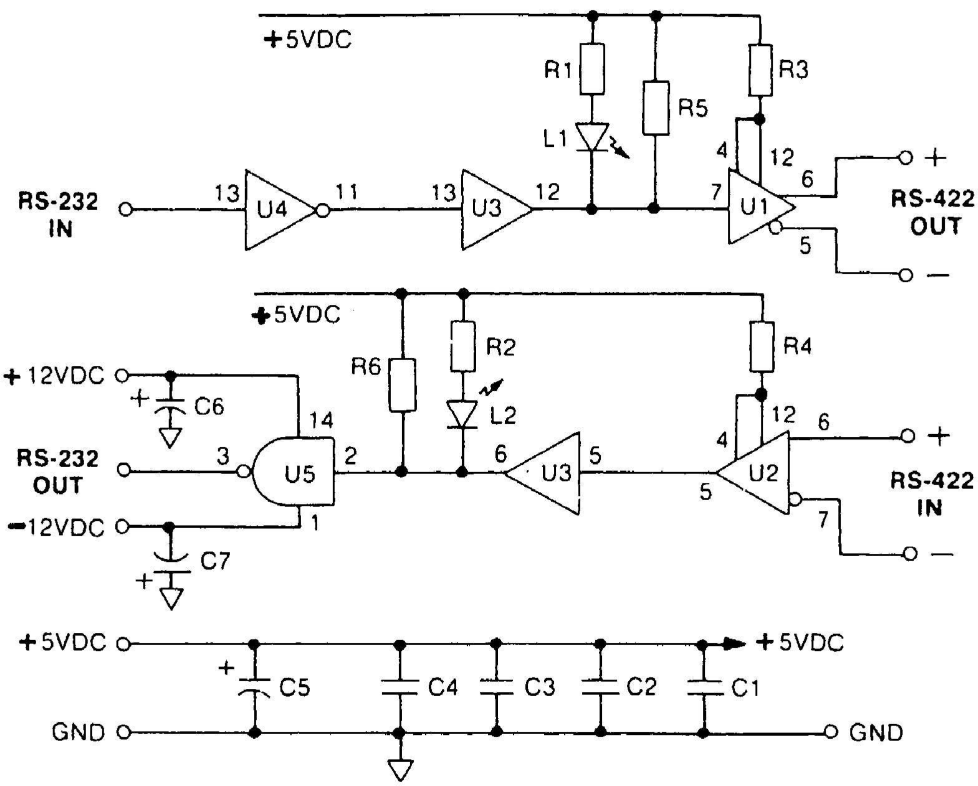

Fig. G-4. RS232/422 conversion card schematic

Table G-3. RS232/422 Conversion Card parts list

Qnty.	Symbol	Description
11	-	4-40 x ¼" pan-head machine screws (Digi-Key H142)
11	-	4-40 hex nuts (Digi-Key H216)
2	R1, R2	330Ω resistors [orange-orange-brown]
4	R3-R6	2.2KΩ resistors [red-red-red]
2	S1, S2	16-pin DIP sockets (Jameco 112221)
3	S3-S5	14-pin DIP sockets (Jameco 112213)
4	C1-C4	.1µF, 50V ceramic disk capacitors (JDR .1UF)
3	C5-C7	2.2µF, 35V tantalum capacitors (Jameco 33734)
1	L1	Diffused amber LED (Digi-Key P306)
1	L2	Diffused red LED (Digi-Key P300)
1	U1	MC3487 quad differential line driver, RS422 (Jameco 25259) or may substitute LM3487, 26LS31 or SN75174
1	U2	MC3486 quad differential line receiver, RS422 (Jameco 25232) or may substitute LM3486, 26LS32 or SN75175
1	U3	7407 hex buffer/driver, noninverting (Jameco 49120)
1	U4	LM1489N quad line receiver, RS232 (Jameco 23181)
1	U5	LM1488N quad line driver, RS232 (Jameco 23157)

Author's recommendations for suppliers given in parentheses above with part Numbers where applicable. Equivalent parts may be substituted. Resistors are ¼W, 5 percent and color codes are given in brackets.

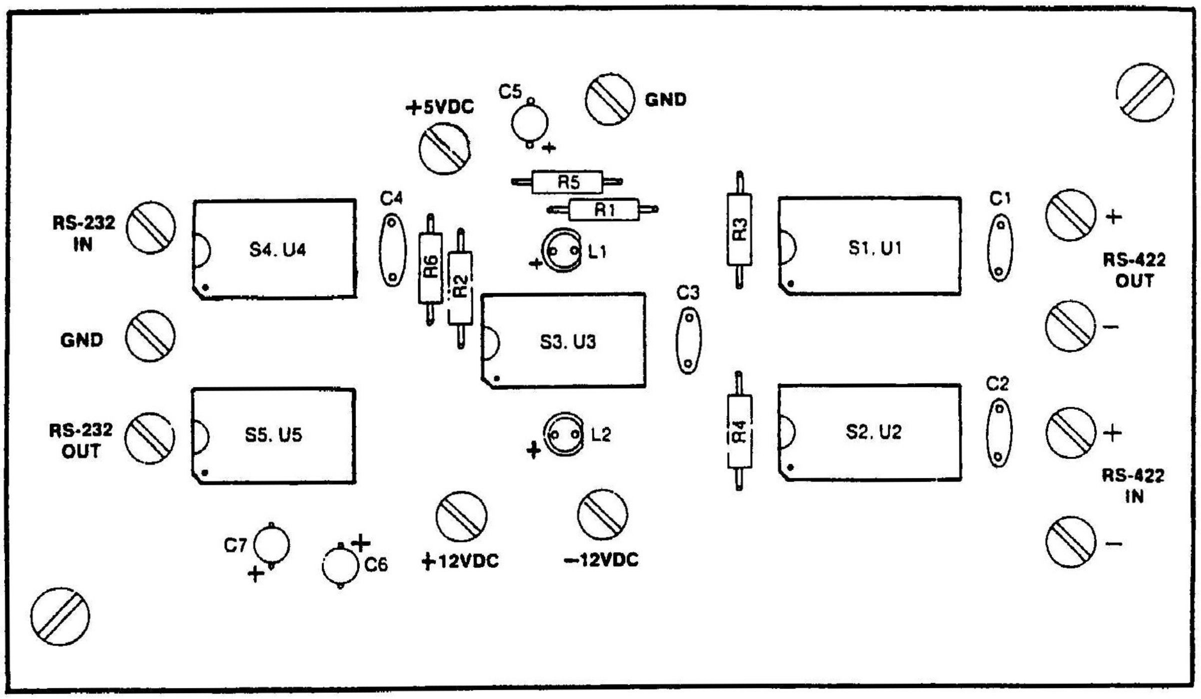

Fig. G-5. RS232/422 conversion card parts layout

IC power test. Connect +5Vdc and ±12Vdc power, using the same ground screw for both. Use your VOM to make the power tests listed in Table G-3. If you don't find correct voltage follow the circuit traces back to find the fault.

Table G-3. RS232/422 Conversion Card IC power tests

√	IC	+ METER LEAD ON PIN No.	– METER LEAD ON PIN No.	VOLTAGE READING
	U1	16	8	+5Vdc
	U2	16	8	+5Vdc
	U3	14	7	+5Vdc
	U4	14	7	+5Vdc
	U5	14	7	+12Vdc
	U5	7	1	+12Vdc

LED test. Attach one end of a clip lead to the ground screw, and clip a bit of bare, solid wire in the other end as a test probe. Carefully touch the probe to pin 12 of U3: L1 should light. Touch pin 6 of U3: L2 should light. If not, check for poor soldering, or reversed or faulty LEDs.