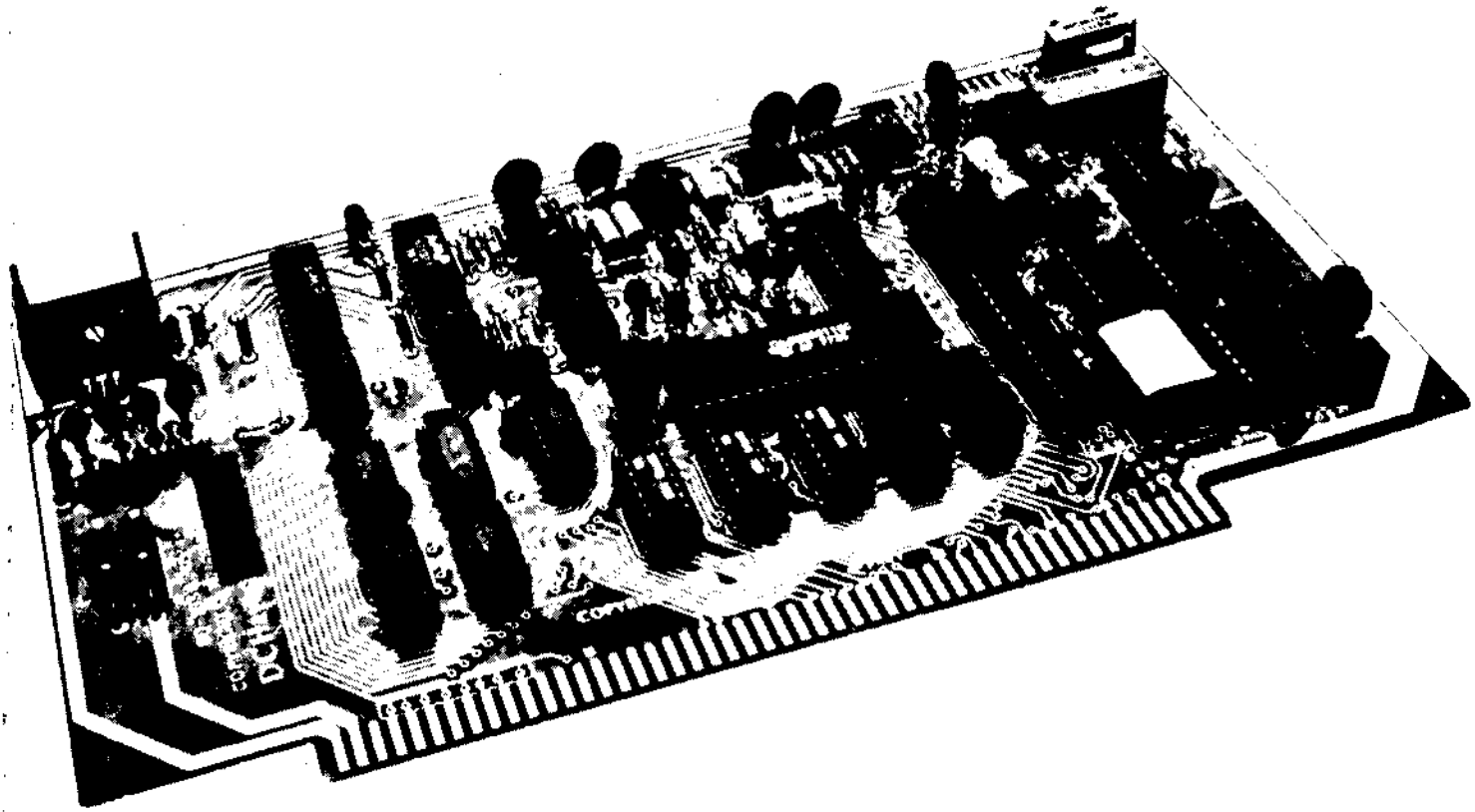
D.C. Hayes Associates, Inc.

MICROCOMPUTER PRODUCTS

80-103A
DATA COMMUNICATIONS ADAPTER

owner's manual



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FOURTH EDITION AUGUST 1978

1. INTRODUCTION

The time has come for microcomputer users to expand the power of their systems through the use of the existing telecommunication networks which are capable of connecting their computers to remote devices such as terminals, other small computers, or time sharing systems.

The instrument needed to implement these capabilities is a module which is compatible with the majority of small computer systems that will interface with common carrier transmission facilities.

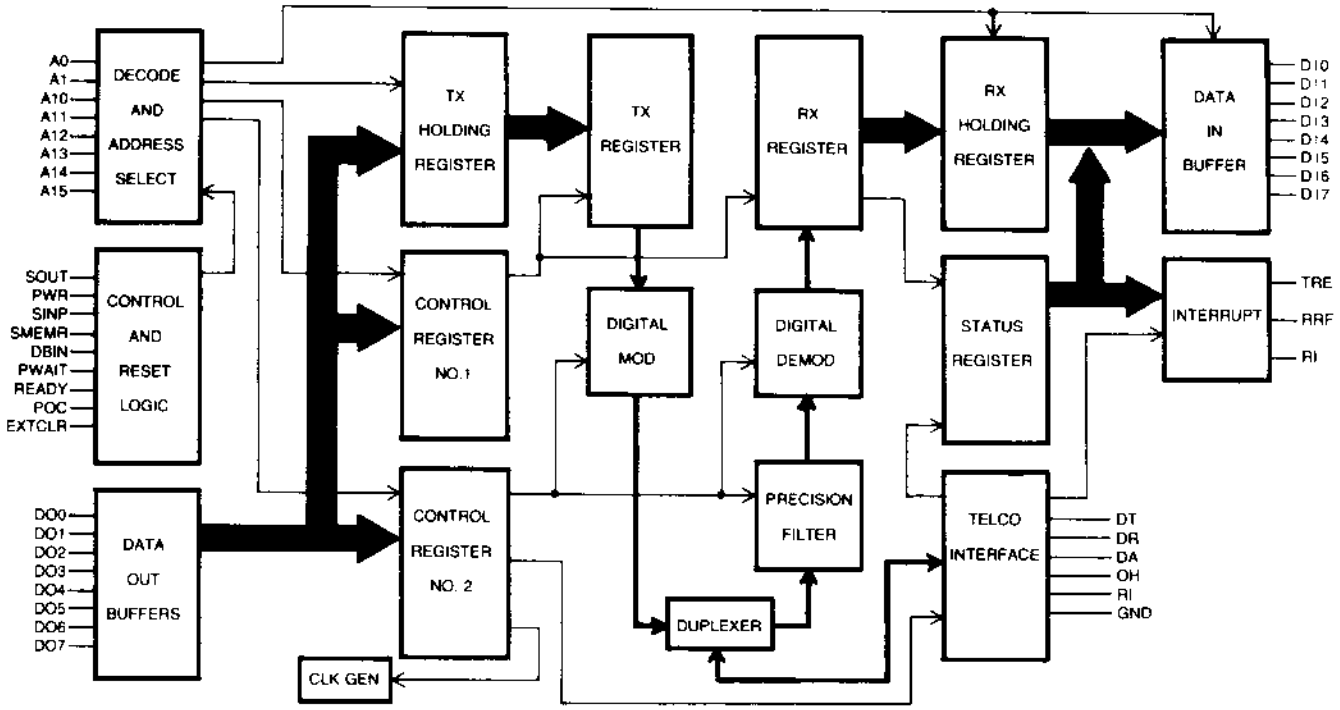
This manual describes the 80-103A Data Communications Adapter (DCA) which is a module that fills these needs for small computer systems which use the S-100 bus.

In addition to describing the operation, this manual describes the installation and programming of this module. A few applications are described in the hope that they may stimulate ideas for use in your system.

2. FUNCTIONAL DESCRIPTION

The 80-103A is an S-100 compatible printed circuit module which when properly installed performs the function of interfacing the S-100 computer bus to a telco (telephone company) supplied data access arrangement (DAA). The computer, using (vendor) supplied or user written software, controls the activity of the DCA by moving bytes into data and control registers and by sensing the status of the interface and accepting data from the receiving register. The address decode and control signals select the board and register and determine whether the processor is performing a write or read operation on the selected register. If it is determined that the current operation is a write, the Data Out Bus (DOO through DO7) is gated to the selected register and saved in that register. If the decoding logic determines that the operation is a read, the selected register is gated onto the Date In Bus (DIO through D17) with the proper timing so that the processor can accept the data.

Once the processor has caused the connection to be established and the DCA is ready to transfer data, the software should determine whether to transmit or receive characters on the line. If transmit is chosen, then the status register should be checked to see if the transmit holding register (TRE) is empty. The character to be sent is then written into the transmit holding register. After this operation is complete, the transmit register is checked automatically to see if it is empty. When it is found to be empty, the transmit holding register is loaded into the transmit register; the transmit holding register is marked empty allowing the next write. Following this transfer the transmit register and associated logic sends a start bit. When the start bit is finished, the least significant bit is transmitted followed by the succeeding bits of the character. If parity is set in the control register, the appropriate parity is generated followed by the indicated number of stop bits. Each of the transmitted bits passes through the modulator where the bit is converted into the appropriate



80-103A FUNCTIONAL BLOCK DIAGRAM

FIGURE 2.1

frequency using a digital sine wave generator. The originate and answer modes use different sets of frequencies allowing the ability to transmit full duplex (in both directions at the same time). Each set of frequencies consists of two frequencies with one frequency corresponding to each state of the line, i.e. "1" or "0". In all modes the signal is passed through to the telephone line at the DT and DR pins of the telco Interface. Normally (except for the self test, described later), the filter prevents the transmitter signal from feeding back into the receiver and prevents noise or unwanted signals from interfering with the data reception. The received signal comes through the telco interface, passes through the precision filter, and is demodulated by the digital demodulation circuit. Start and stop bits are checked for framing, then stripped off, and the character is assembled in the receive register, and if parity is called for, the

parity is checked creating a parity error if it is incorrect. When the character is completely assembled, the logic checks to see if the receive holding register is empty. If it is empty, the data is transferred from the receive register and the status is set to indicate that the receive holding register is full (RRF). If the logic is unable to transfer the received character to the receive holding register because the previous data has not been read by the processor, then the overflow error flag is set in the status register.

The self test mode is a variation where the filter is switched to the same set of frequencies as the transmitter so that the receiver gets each character sent by the transmitter thus checking the modulator and demodulator and all parts of the circuit except the transformer coupling the circuit to the line and the connection to the DAA.

3. INSTALLATION

Careful installation of the 80-103A Data Communication Adapter will prevent damage to the unit.

NOTE: BE SURE TO TURN THE COMPUTER POWER OFF WHEN INSERTING OR REMOVING THIS CIRCUIT MODULE.

3.1 LINE INTERFACE

The 80-103A is designed to interface to the dial telephone network via a Bell System 1001D CBT coupler or Data Access Arrangement (DAA). This coupler is primarily designed to protect the telephone network from improper signals which might be generated by foreign (i.e. not supplied by the phone company) equipment. Its use is required by law in most parts of the U.S. DAA's are usually installed by the phone company which adds a charge to your monthly phone bill that usually runs between $2.00 and $8.00 per month.

Couplers can also be purchased from independent suppliers at prices which range from about $100.00 to $200.00. D. C. Hayes Associates, Inc. will be happy to supply names of suppliers should you choose to purchase your DAA.

3.2 CONNECTION TO DAA

Currently manufactured Bell System DAA's measure 5" wide by 7" high by 1-3/4" thick and are designed to be mounted on a wall. They require a 24VDC power supply which is usually also supplied by the phone company. It also mounts on a wall, is 1.6" by 2.2" by 3.8", and will require an unswitched AC outlet. A telephone is an optional accessory.

At the bottom of the DAA is a flip-up plastic cover with 10 screw terminals under it (see fig. 3.1). The 24VDC power supply is connected to −V and +V. The 80-103A connects to DA, OH, DT, DR, RI, and −V (see fig. 3.4). The 80-103A does not use terminals SH, SH1, or CCT.

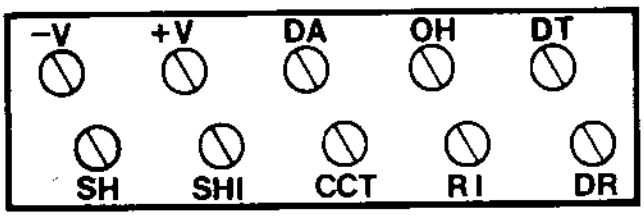


FIGURE 3.1 SCREW TERMINALS ON DAA

3.3 WHAT TO ORDER FROM THE PHONE COMPANY

A DAA can be installed on its own line or can be added to an existing line as an extension. It can be ordered with several options (see table 3.2). This table is not complete -- there are more options, but they are generally not relevant for the 80-103A, and may not even be available from your phone company.

Option A is the only one which is obvious -- you can get the DAA either with or without a phone. We recommend the phone because it is useful for testing among other things and, at least in Georgia, the phone company does not charge extra for it. The other two options are relevant only if you get the phone. The exclusion key is a switch which replaces one of the switchhook buttons (the ones the handset presses on when you hang it up). This switch transfers control of the telephone line between the phone and the modem. Option B-3 makes the modem the normal user of the line. To use the phone, you must lift the handset and pull up on the exclusion key. When the phone is hung up, control goes back to the modem. B-4 is just the opposite. To use the modem you must leave the phone off the hook and pull the exclusion key up. Option C determines whether the bell rings when the modem has control. With option C-6, the bell rings whether the modem has control or not.

The phone company uses a Uniform Service Order Code (USOCS) to specify equipment. To order the recommended DAA (options marked with * in fig. 3.2), you should ask your data marketing representative for USOCS CBT 05. Without the phone, it's USOCS CBT 02. In Georgia, Southern Bell charges $5.20 per month and $11.60 installation for the DAA (this in addition to the normal charge for the line).

PARTIAL DAA OPTION LIST

A. Telephone Option

*1. With Telephone

2. Without Telephone

B. Telephone Exclusion Key Wiring Option

*3. Coupler Controls Line

4. Telephone Controls Line

C. Telephone Ringer Wiring Option

5. Ringer Connected on Telephone Side of exclusion key

*6. Ringer Connected on Line Side of exclusion key

* Recommended Options

FIGURE 3.2

The DAA requires a power supply which is generally included with it, but your phone company may not include it. You will need to order option CBV.

For more information on DAA's, ask your phone company for a copy of Bell System Technical Reference "Data Couplers CBS and CBT for Automatic Terminals", PUB 41802.

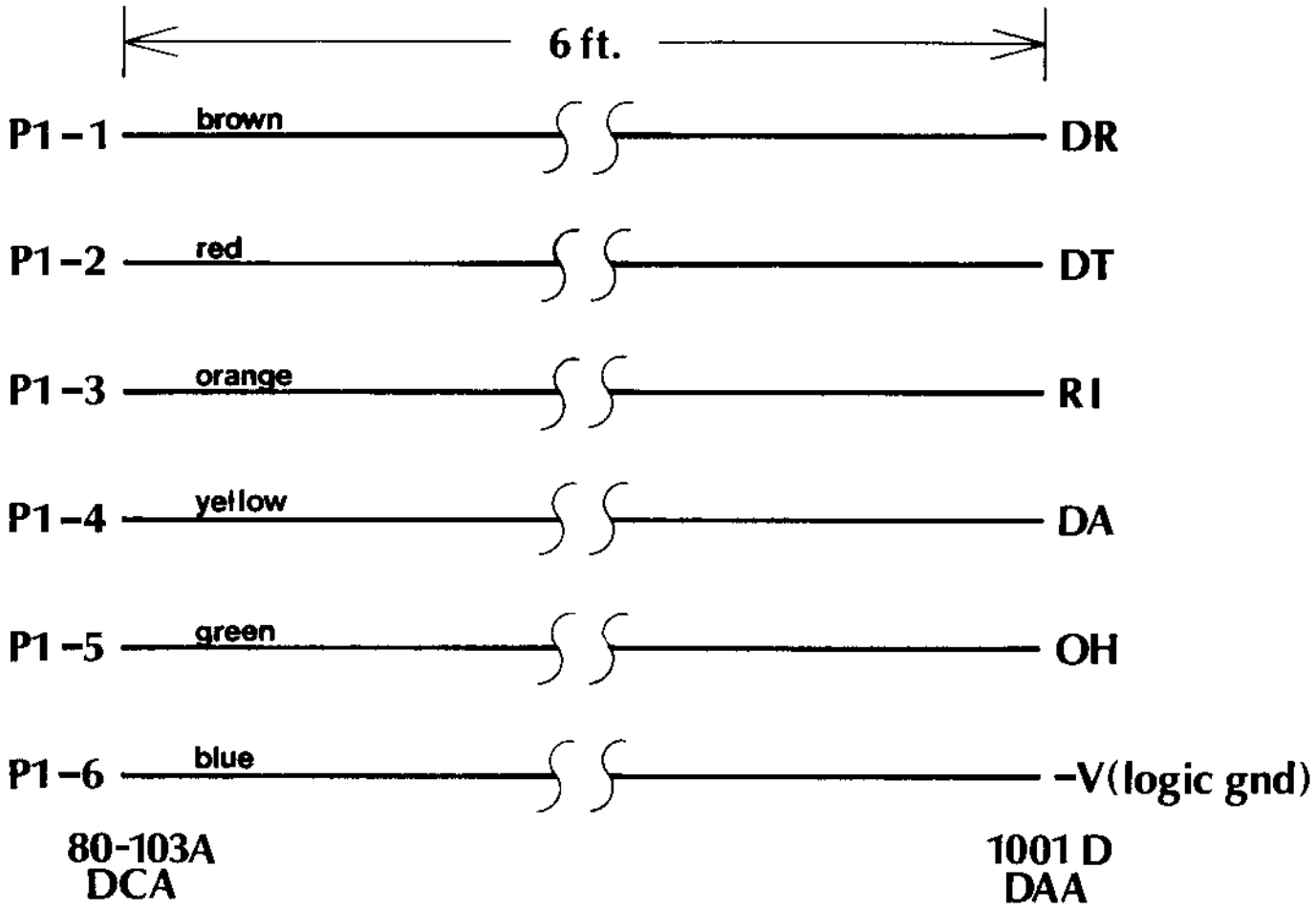


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FIGURE 3.4
DCA TO DAA CABLE

3.4 OUTPUT LEVEL

The output power level of the 80-103A is factory-set to –9dBm. This nominal value will normally give adequate service, but in some cases it may be desirable to adjust this value to compensate for losses in the wiring between the DAA and the central office. When the DAA is installed, the installer will measure this loss and mark the optimum output level on the DAA (on a tag beneath the flip-up cover). Should this value be significantly different from –9dBm, you may adjust the output of the 80-103A by changing R7. Figure 3.3 gives values of R7 for various output levels. There is no advantage to be gained from setting the level any higher than the value specified by the phone company because the DAA contains a protective circuit which will insert sufficient loss to limit the level on the phone line if the input level exceeds this level. Since this loss also affects the receiver, it is undesirable to activate this circuit.

OUTPUT LEVEL dBm	R7 VALUE Ohms
0	1000
– 1.1	1100
– 2.2	1300
– 3.3	1500
– 4.2	1700
– 5.4	2000
– 6.1	2200
– 7.0	2500
– 8.2	3000
– 9	3300
– 9.9	3900
– 11	4700
– 12	5600

FIGURE 3.5
VALUES OF R7 FOR VARIOUS OUTPUT LEVELS

3.5 DIRECT CONNECT

NOTE: Use this type of installation only after determining that it is in agreement with local and federal regulations in your area. We cannot be responsible for anyone who misuses this information.

For direct connect only two leads DT and DR pins 1 & 2 of the P1 connector are required to establish connection to the line. For use on dedicated circuits a jumper can be inserted across the relay contact to insure continuity at all times.

3.6 INSTALLATION IN THE COMPUTER

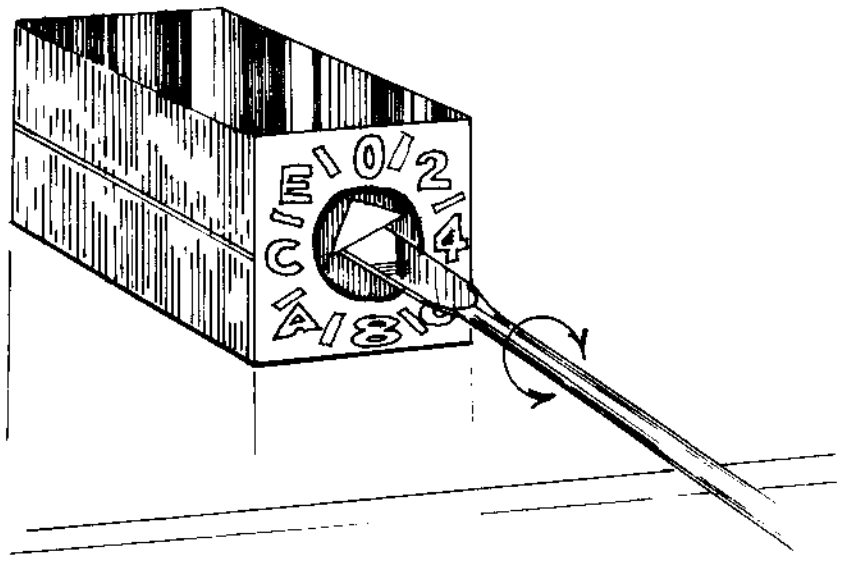
*****Power Off the computer before any removal or insertion of this circuit module.*****

Select the slot where the 80-103A is to be placed and insert it in the connector, checking to be sure that it is fully inserted and aligned in the connector. Next check the clearance between the line coupling transformer and any boards adjacent to the top of the transformer to be sure that there is no chance of shorting signals on the other card. If your system has the connectors too close to allow a safe margin of air gap, then leave a blank slot between the 80-103A and the adjacent module.

Now plug the 6 pin cable onto the connector on the top of the board so that the brown lead is on pin one, and attach the cable to the line according to the DCA TO DAA CABLE DIAGRAM (Fig. 3.4).

3.7 ADDRESS MAPPING

The 80-103A can be I/O or memory mapped by choosing the proper switch setting. Refer to Table 3.5 for I/O mapping and Table 3.6 for memory mapping. I/O mapping uses 4 I/O locations and the switch setting determines the base address. The memory mapped feature uses 1024 bytes of memory space because of incomplete decoding, so the user should make his own trade-offs between the space saving of I/O and the usually increased programming flexibility of memory mapping.



AMP SWITCH. FIGURE 3.6

PORT 00	SW1 F	SW2 C	PORT 80	SW1 F	SW2 8
04	B	C	84	B	8
08	7	C	88	7	8
0C	3	C	8C	3	8
10	E	C	90	E	8
14	A	C	94	A	8
18	6	C	98	6	8
1C	2	C	9C	2	8
20	D	C	A0	D	8
24	9	C	A4	9	8
28	5	C	A8	5	8
2C	1	C	AC	1	8
30	C	C	B0	C	8
34	8	C	B4	8	8
38	4	C	B8	4	8
3C	0	C	BC	0	8
40	F	4	C0	F	0
44	B	4	C4	B	0
48	7	4	C8	7	0
4C	3	4	CC	3	0
50	E	4	D0	E	0
54	A	4	D4	A	0
58	6	4	D8	6	0
5C	2	4	DC	2	0
60	D	4	E0	D	0
64	9	4	E4	9	0
68	5	4	E8	5	0
6C	1	4	EC	1	0
70	C	4	F0	C	0
74	8	4	F4	8	0
78	4	4	F8	4	0
7C	0	4	FC	0	0

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TABLE 3.7 1/0 MAPPED LOCATIONS

ADR 0000	SW1 F	SW2 F	ADR 8000	SW1 F	SW2 B
0400	B	F	8400	B	B
0800	7	F	8800	7	B
0C00	3	F	8C00	3	B
1000	E	F	9000	E	B
1400	A	F	9400	A	B
1800	6	F	9800	6	B
1C00	2	F	9C00	2	B
2000	D	F	A000	D	B
2400	9	F	A400	9	B
2800	5	F	A800	5	B
2C00	1	F	AC00	1	B
3000	C	F	B000	C	B
3400	8	F	B400	8	B
3800	4	F	B800	4	B
3C00	0	F	BC00	0	B
4000	F	7	C000	F	3
4400	B	7	C400	B	3
4800	7	7	C800	7	3
4C00	3	7	CC00	3	3
5000	E	7	D000	E	3
5400	A	7	D400	A	3
5800	6	7	D800	6	3
5C00	2	7	DC00	2	3
6000	D	7	E000	D	3
6400	9	7	E400	9	3
6800	5	7	E800	5	3
6C00	1	7	EC00	1	3
7000	C	7	F000	C	3
7400	8	7	F400	8	3
7800	4	7	F800	4	3
7C00	0	7	FC00	0	3

3.8 INTERRUPT OPTION

The 80 103A produces three signals which can be connected to generate interrupts. There are several ways that the interrupt options can be installed. The schematic diagram shows the primary method but this can be varied in any desired combination.

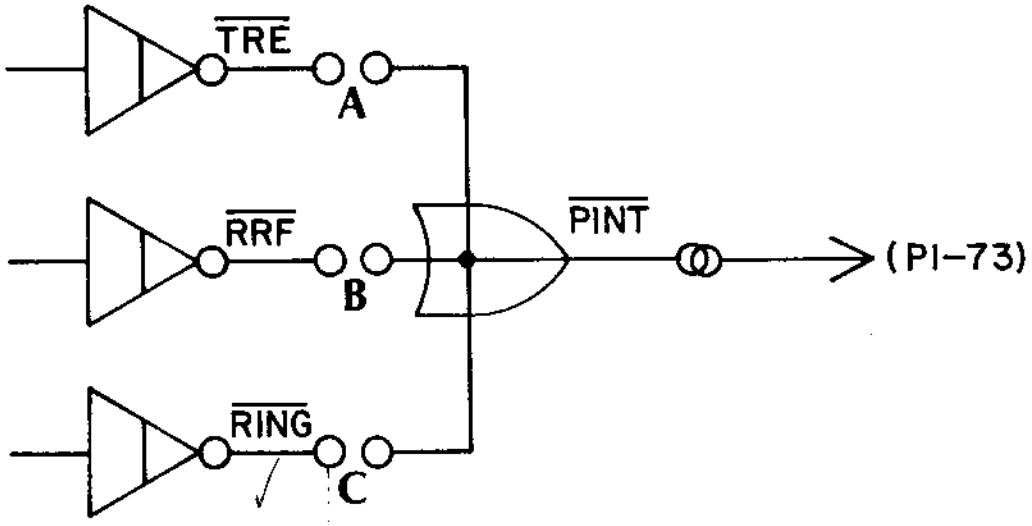

FIGURE 3.9

This symbol represents a feed thru hole which has not been plated thru. To install the option insert a wire and solder on both sides.

For some dedicated on-line applications, it may be desirable for a ring signal to reset the CPU. When it is reset, the processor should vector into a phone-answering program in ROM. This makes it possible to restart the processor from a remote location if it should hang or lose power momentarily. This can be arranged by connecting a wire from point C to pin 75 on the edge connector. A feed-thru has been provided for this. It is labeled PRST on the board.

3.9 WAIT STATE OPTION

For systems which require I/O accesses which respond in less than 500 ns, a single wait state can be generated by installing the wait state option. The 80-103A is supplied with this option disabled. To install the wait option, locate the circle with the letter W in it. Insert a wire in the hole in the circle and solder on both sides. Then trim any excess wire. Removing the wire at a later time will disable the option.

3.10 CLOCK OPTION (REV. 2)

For systems with a 2 MHZ clock on pin 49 of the S-100 bus the oscillator is not required and the clock can be derived from the bus. Install a jumper between E and F for this option.

For systems having other than a 2MHZ clock on pin 49 of the bus, install a jumper between D and E. Factory-assembled modems are normally shipped with this option.

3.11 WESTERN UNION - TWX INTERFACE

TWX stands for teletypewriter exchange and is a nationwide dial-up network operated by Western Union. It is designed around the model 33 Teletype, and is widely used for business correspondence, TWX messages having much the same legal standing as telegrams. The TWX network is also connected to the international Telex network by Western Union computers.

The 80-103A interfaces electrically to the Western Union TWX network in the same manner as it connects to the telephone network. The TWX coupler is called a TWX Access Arrangement (TAA) and is available with a monthly leased line. The front section of the TWX/telex directory gives full information on the logical interface for sending TWX, telex, mailgram, and international messages. The software in the back of this manual is usable as the basis for interfacing to the TWX arrangement when the proper answerback is included.

4. PROGRAMMING

4.1 OUTPUT (MEMORY WRITES)

The base address determined by SW1 and SW2 fixes the position of the 80-103A. The registers should be thought of as occupying the lowest addresses available to them, i.e., they are at the bottom of the mapping space.

4.1.1 TRANSMIT REGISTER

The transmit register is the base register. Data written to this register is converted and transmitted over the line. When 5, 6, or 7 bit characters are used, the most significant bits are not transmitted and their value has no effect on the transmitted character.

4.1.2 CONTROL REGISTER 1

Control register 1 sets up the format for the data characters and must be initialized to insure the desired operation. This register is located at the address (base + 1). Example: If the base address from Table 1 is 40 (Hex), then control register 1 is 41 (Hex).

BIT 0 EVEN PARITY ENABLE (EPE)

This bit determines whether odd or even parity is used when PI(Bit 4) = 0. When EPE = 0 odd parity is generated and checked. When EPE = 1 even parity is used.

BIT 1 AND BIT 2 LENGTH SELECT (LS1,LS2)

These two bits determine the length of the character transmitted and received by the 80-103A.

LS 2	LS 1	NUMBER OF BITS
0	0	5
0	1	6
1	0	7
1	1	8

BIT 3 STOP BIT SELECT (SBS)

This bit determines the number of stop bits transmitted or received. When SBS=0 one (1) stop bit is used, when SBS=1 two (2) stop bits are used, except for 5 bit data where 1.5 stop bits are used. Note: The 1.5 stop bit specification varies for some UARTS.

BIT 4 PARITY INHIBIT (PI)

This bit determines whether parity is generated for transmitted characters and checked for received characters.

PI = 0 => PARITY

PI = 1 => NO PARITY

4.1.3 CONTROL RESISTER 2

Control register 2 effects the operation of the modem and the telco interface. This register is located at the address expressed as (Base + 2).

BIT 0 BIT RATE SELECT (BRS)

This bit selects the bit rate (in this case the baud rate) at which data bits are transmitted over the line.

BRS = 0 => selects 110 bits per second (BPS).

BRS = 1 => selects 300 BPS

Note: This is related to character rate R_{char} by summing the number of bits in the character N_{bits} including the data bits, parity (if used), start and stop bits and dividing this number into the number of bits per second R_{bit}.

Example: For an 8 bit character with no parity, one start and one stop bit there are 10 bits. If a 300 bit rate is selected, then the character rate is 30 characters per second (CPS).

$$R_{char} = \frac{R_{bit}}{N_{bits}} = \frac{300\ BPS}{10\ BPC} = 30\ CPS$$

It is possible to modify the baud rate generator to produce other baud rates. To change the low baud rate from 110 to 75 or 134.5, first cut the traces at U31 pins 2, 3, 4, and 5 on the top of the board and at U32 pin 2 on the bottom of the board. Then install the following jumpers:

75 BAUD	
from	to
U31 - 2	U31 - 3
U31 - 3	U21 - 2
U31 - 4	U21 - 13
U31 - 5	U21 - 12
U32 - 2	U21 - 7

134.5 BAUD	
from	to
U31 - 2	U21 - 2
U31 - 3	U21 - 5
U31 - 4	U21 - 4
U31 - 5	U21 - 13
U31 - 2	U21 - 7

In general, the lower half of U31 decodes the one bits of a count in U21 which is equal to 1,000,000/((32*B)-2) where B is the desired baud rate.

INPUT REGISTERS

RECEIVER REGISTER
ADDRESS = BASE

7	6	5	4	3	2	1	0
DATA	DATA	DATA	DATA	DATA	DATA	DATA	DATA

STATUS REGISTER
ADDRESS = BASE +1

7	6		4	3	2	1	0
RI	CD		OE	FE	PE	TRE	RRF

RRF	RECEIVER REG. FULL	1 = CHARACTER IN REG.
TRE	TRANSMITTER REG. EMPTY	1 = REGISTER EMPTY
PE	PARITY ERROR	1 = PARITY ERROR
FE	FRAMING ERROR	1 = FRAMING ERROR
OE	OVERFLOW ERROR	1 = OVERFLOW ERROR
CD	CARRIER DETECT	1 = CARRIER DETECTED
RI	NOT RING INDICATOR	0 = PHONE RINGING

OUTPUT REGISTERS

TRANSMIT REGISTER
ADDRESS = BASE

7	6	5	4	3	2	1	0
DATA	DATA	DATA	DATA	DATA	DATA	DATA	DATA

CONTROL REG. 1
ADDRESS = BASE +1

			4	3	2	1	0
			PI	SBS	LS2	LS1	EPE

EPE	EVEN PARITY ENABLE	1 = EVEN PARITY
LS1 · LS2	LENGTH SELECT BITS	00 = 5 BITS 01 = 6 BITS 10 = 7 BITS 11 = 8 BITS
SBS	STOP BIT SELECT	0 = 1 STOP BIT
PI	PARITY INHIBIT	1 = NO PARITY

CONTROL REG. 2
ADDRESS = BASE +2

7		5	4	3	2	1	0
OH		TIE	ST	BK	MS/RID	TXE	BRS

BRS	BIT RATE SELECT	1 = 300 BAUD 0 = 110 BAUD
TXE	TRANSMITTER ENABLE	1 = CARRIER ON
MS†	MODE SELECT	1 = ORIGINATE 0 = ANSWER
BK	BREAK	1 = EXCHANGE MARK & SPACE
ST	SELF TEST	1 = SELF TEST MODE
TIE	TRANSMIT INTERRUPT ENABLE	1 = ENABLE 0 = DISABLE
OH	OFF HOOK	1 = ANSWER 0 = HANG UP PHONE

† See text for full explanation

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FIGURE 4.1

BIT 1 TRANSMIT ENABLE (TXE)

This bit turns on the transmitter and causes carrier to be output to the line interfaces. This bit should remain on during entire connect time on most dialed systems. When the TX register is empty, the idle condition places a mark frequency on the line.

THIS BIT SHOULD BE TURNED OFF PRIOR TO LOADING THE CONTROL REGISTER WITH A NEW BYTE WHICH CAUSES THE MODE TO CHANGE.

BIT 2 MODE SELECT/RING INTERRUPT DISABLE (MS/RID)

This bit determines whether the modem will act as an originate or answer modem and changes the frequencies appropriately. Interrupts from the Ring detector will also be disabled when the originate mode is selected.

MS = 0 ⇒ Answer, ring interrupts enabled
MS = 1 ⇒ Originate, ring interrupts disabled

BIT 3 BREAK (BK)

When this bit is one, the serial data from the UART to the MODEM is inverted, thus exchanging the mark and the space frequencies. To generate a break (continuous space frequency), the program should wait 1 character time after TRE becomes true to allow the last character to be sent, then set the break bit for at least 3 character times. The bit should then be reset to return to normal operation.

Note: On boards serial #405 and earlier, this bit was wired to generate a CCITT echo suppress tone of 2100 Hz. This function is not needed for operation within the United States or Canada.

BIT 4 SELF TEST (ST)

This bit causes the receive side of the data communications adapter to switch so that it receives the information being sent by the transmitter. A character goes through all the circuits on the board leaving only the transformer and line connections for the user to trouble shoot. This feature gives a very high level of confidence when used with the appropriate software tests. For best results remove the connector from J1 when running a self test function.

BIT 5 TRANSMITTER INTERRUPT ENABLE (TIE)

This bit enables interrupts from the UART transmitter. When it is set to a 1, an interrupt will be sent to the CPU or interrupt controller each time the UART transmitter is empty.

TIE = 0	Transmitter interrupts disabled
TIE = 1	Transmitter interrupts enabled

BIT 6 - Unused

BIT 7 OFF HOOK (OH)

This bit causes the data communications adapter to take the line into the off hook condition. It is used to answer the phone and when pulsed at the appropriate rate by a software routine accomplishes the dialing function. This bit must be on during data transfers in all cases including self test. Bit off to hang up.

4.2 INPUT (MEMORY READ)

The base address determined by SW1 and SW2 is the same for input as for output. See section 2 for details.

4.2.1 RECEIVE REGISTER

The receive register is the base register on the input part of the 80-103A. When less than 8 bit data is transmitted, the programmer should mask out the most significant bits to insure that they are a known state.

4.2.2 STATUS REGISTER

The status register is an input register which is located at the (Base + 1) address.

BIT 0 RECEIVE REGISTER FILLED (RRF)

This bit ON indicates that the receive holding register contains a data character ready for input.

BIT 1 TRANSMIT REGISTER EMPTY (TRE)

This bit ON indicates that the transmitter holding register is empty and data can be output to the transmitter. Note that the transmitter is double-buffered, so when this bit goes true, the transmitter will still remain active for one more character time.

BIT 2 PARITY ERROR (PE)

This bit ON indicates that the receiving logic detected a parity error on a character. Parity must be enabled for this condition to occur.

BIT 3 FRAMING ERROR (FE)

This bit ON indicates that the receiving logic failed to detect a stop bit at the proper time indicating that the character in the receive register is probably invalid.

BIT 4 OVERFLOW ERROR (OE)

This bit ON indicates that the previous character was not removed from the receive holding register before the logic attempted to transfer the following received character.

BIT 5 Not Used

BIT 6 CARRIER DETECT (CD)

This bit ON indicates that a carrier signal in the proper frequency band is being received by the Data Communications Adapter.

BIT 7 NOT RING INDICATOR (RI)

This bit is inverted from normal. When RI = 0 it indicates that ringing is occurring, and when RI = 1 it indicates that ringing is not occurring. Ringing occurs as a 20 Hz signal, but the Data Communications Adapter integrates this so that each ring looks like a single level change on this bit, and the bit goes high between rings, allowing rings to be counted under software control.

5. APPLICATIONS

The 80-103A gives your computer a complete and very flexible communications capability. With it your computer can establish a connection to another computer in almost any part of the world and exchange data with it. It takes only a few seconds to make contact, and you can program it all to happen automatically. Below are a few of the many possible applications for this powerful tool:

5.1 INTELLIGENT TERMINAL

With the 80-103A, you can turn your computer into an intelligent terminal with which you can access timesharing systems, most of which use Bell 103 compatible modems (the kind the 80-103A can talk to). Most schools have computer systems with remote access ports. If you are a student, you can use your home computer to communicate with your school's computer for programming assignments etc.

5.2 CLUB DATA BASE

A computer with an 80-103A and a disk can be used to implement a powerful on-line data base. Such a system could contain a newsletter, hold messages (a digital bulletin board), and facilitate software exchange. Members could deposit programs into a library, and obtain copies of other people's programs. The system could even be programmed to sell the software, preparing bills for the recipients and checks for the authors.

5.3 LINE CONCENTRATOR

Several 80-103A's could be used to implement a low-cost line concentrator, multiplexing several low-speed lines together to share one high-speed modem and line. Such concentrators are widely used in time-sharing systems to share the cost of a leased line among several terminals.

5.4 INTERACTIVE GAMES

Computer games are usually played human vs. computer. With two computers equipped with 80-103A's, it is possible for a program running in your computer to play games against a program running in someone else's computer across town or across the country. Or you and your computer could play against another person with a computer . . .

Since the 80-103A has auto-dial and auto-answer capabilities, it is not necessary to have the phone line connected the whole time you are playing.

5.5 TELECOMMUTING

The energy situation being what it is, more and more people are seriously considering alternatives to commuting. If your job consists mostly of slaving over a hot computer terminal, the 80-103A may offer an economical way for your job to come to you instead of the other way around. Of course you would want to make an occasional trip to the office for meetings, but think how much pain and energy you could save. You might even be able to move to that beautiful valley 'way up there in the mountains . . .

5.6 ELECTRONIC MAIL

The late-night phone rates for a 30-second call are very low. For less than 50¢ you can get a line to anywhere in the continental U.S., and in that time an 80-103A can send over 700 bytes of anything you can put into your computer.

5.7 SOFTWARE EXCHANGE

Those bytes could easily be a program. With the auto-dial and auto-answer capabilities of the 80-103A, two computers can be programmed to wait until the phone rates are cheap (late at night) and then call up and exchange programs. A single three-minute call is long enough to send over 5000 bytes at 300 baud. And since the 80-103A operates full-duplex, that can be 5000 bytes in each direction, for a total of 10 K bytes.

5.8 AUTOMATIC DATA COLLECTION

A company with stores in several locations could use a network of S-100 bus computers linked together as needed by 80-103A's to keep the home office up to date. The outlying computers could work all day collecting orders, keeping books, etc. and at night wait for the cheap phone rates then call the home office computer. They could send the day's receipts, order more inventory, and inquire about yesterday's orders.

Managers at the home office and at the individual stores could have up-to-date reports waiting for them in the morning.

New applications will be found as more people use this tool and appreciate the power of electronic information exchange. We would enjoy hearing from you about any novel approach or new application area you are pioneering.

APPENDIX A

SCHEMATICS AND SIGNAL LISTS

S-100 Bus Signals Used By 80-103A

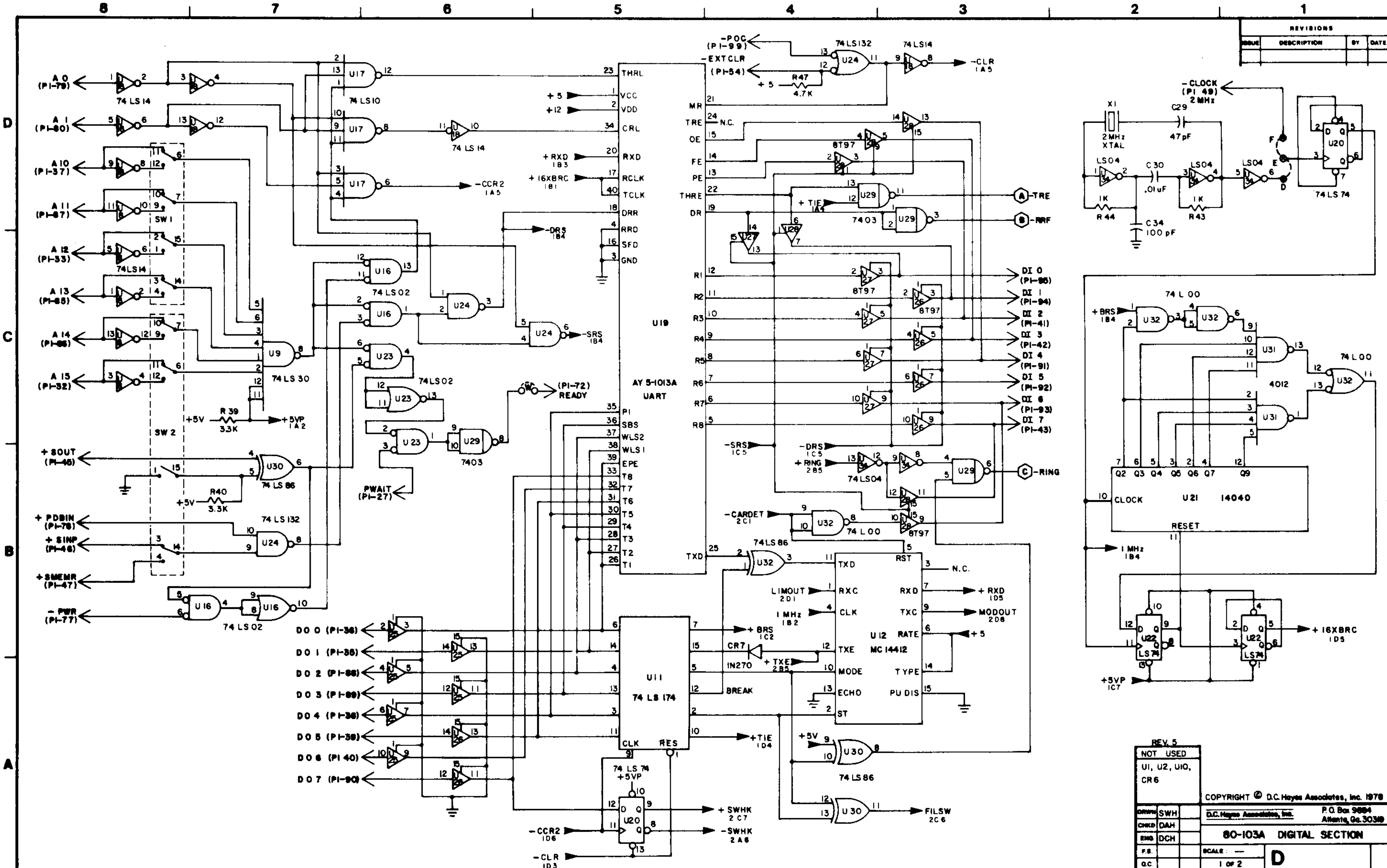
Pin	Signal	Pin	Signal
1	+8V	51	+8V
2	+16V	52	−16V
3		53	
4	INT 0	54	$\overline{\text{EXT CLR}}$
5	INT 1	55	
6	INT 2	56	
7	INT 3	57	
8	INT 4	58	
9	INT 5	59	
10	INT 6	60	
11	INT 7	61	
12		62	
13		63	
14		64	
15		65	
16		66	
17		67	
18		68	
19		69	
20		70	
21		71	
22		72	$\overline{\text{PRDY}}$
23		73	INT
24		74	
25		75	$\overline{\text{PRST}}$
26		76	
27	PWAIT	77	$\overline{\text{PWR}}$
28		78	PDBIN
29	A5	79	AØ
30	A4	80	A1
31	A3	81	A2
32	A15	82	A6
33	A12	83	A7
34	A9	84	A8
35	DO1	85	A13
36	DOØ	86	A14
37	A10	87	A11
38	DO4	88	DO2
39	DO5	89	DO3
40	DO6	90	DO7
41	DI2	91	DI4
42	DI3	92	DI5
43	DI7	93	DI6
44		94	DI1
45	SOUT	95	DIØ
46	SINP	96	
47	SMEMR	97	
48		98	−
49	$\overline{\text{CLOCK}}$ (2MHz)	99	POC
50	GND	100	GND

Signal Name List

Name	Source	Destination
A	–TRE	–
AØ	(P1-79)	1D8
A1	(P1-80)	1D8
A10	(P1-37)	1C8
A11	(P1-87)	1C8
A12	(P1-33)	1C8
A13	(P1-85)	1C8
A14	(P1-86)	1C8
A15	(P1-32)	1C8
B	–RRF	–
+BRS	1B4	1C2
C	–RING	–
CARDET	2C1	2B4
CARINH	2C5	2C1
–CCR2	1D6	1A5
–CLOCK(2MHz)	(P1-49)	1D1
–CLR	1D3	1A5
DA	2B4	J1–4
DIØ	1C3	(P1-95)
DI1	1C3	(P1-94)
DI2	1C3	(P1-41)
DI3	1C3	(P1-42)
DI4	1C3	(P1-91)
DI5	1C3	(P1-92)
DI6	1C3	(P1-93)
DI7	1C3	(P1-43)
DOØ	(P1-36)	1B7
DO1	(P1-35)	1B7
DO2	(P1-88)	1B7
DO3	(P1-89)	1A7
DO4	(P1-38)	1A7
DO5	(P1-39)	1A7
DO6	(P1-40)	1A7
DO7	(P1-90)	1A7
DR	J1–2	2C8
DT	J1–1	2C8

Signal Name List

Name	Source	Destination
–EXTCLR	(P1-54)	1D4
FILSW	1A3	2C7
FOUT	2D3	2C4
LIMOUT	2D2	1B4
MODOUT	1B3	2D7
OH	2C6	J1–5
PDBIN	(P1-78)	1B8
–POC	(P1-99)	1D4
PRDY	1C5	(PI-72)
PWAIT	(P1-27)	1C6
–PWR	(P1-77)	1B8
RING	2B5	1B4
–RING	1B3	C
–RRF	1D3	B
+RXD	1B3	1D5
+SINP	(P1-46)	1B8
+SMEMR	(P1-47)	1B8
+SOUT	(P1-45)	1B8
–SRS	1C5	1B4
+SWHK	1A4	2C7
–TRE	1D3	A
+TXE	2B5	1B4
W	1C5	(P1-72)
1MHz	1B2	1B4
+5V	2B2	Many
+8V	(P1-1),(P1-51)	2B4
+12V	2B4	Many
–12V	2A3	Many
+16V	(P1-2)	2A5
–16V	(P1-52)	2A5
+16XBRC	1B1	1D5
TIE	1A4	1D4
–SWHK	1A4	2A6
–DRS	1C5	1A5


REVISIONS
ISSUE DESCRIPTION BY DATE
REV. 5
NOT USED
U1, U2, U10, CR6
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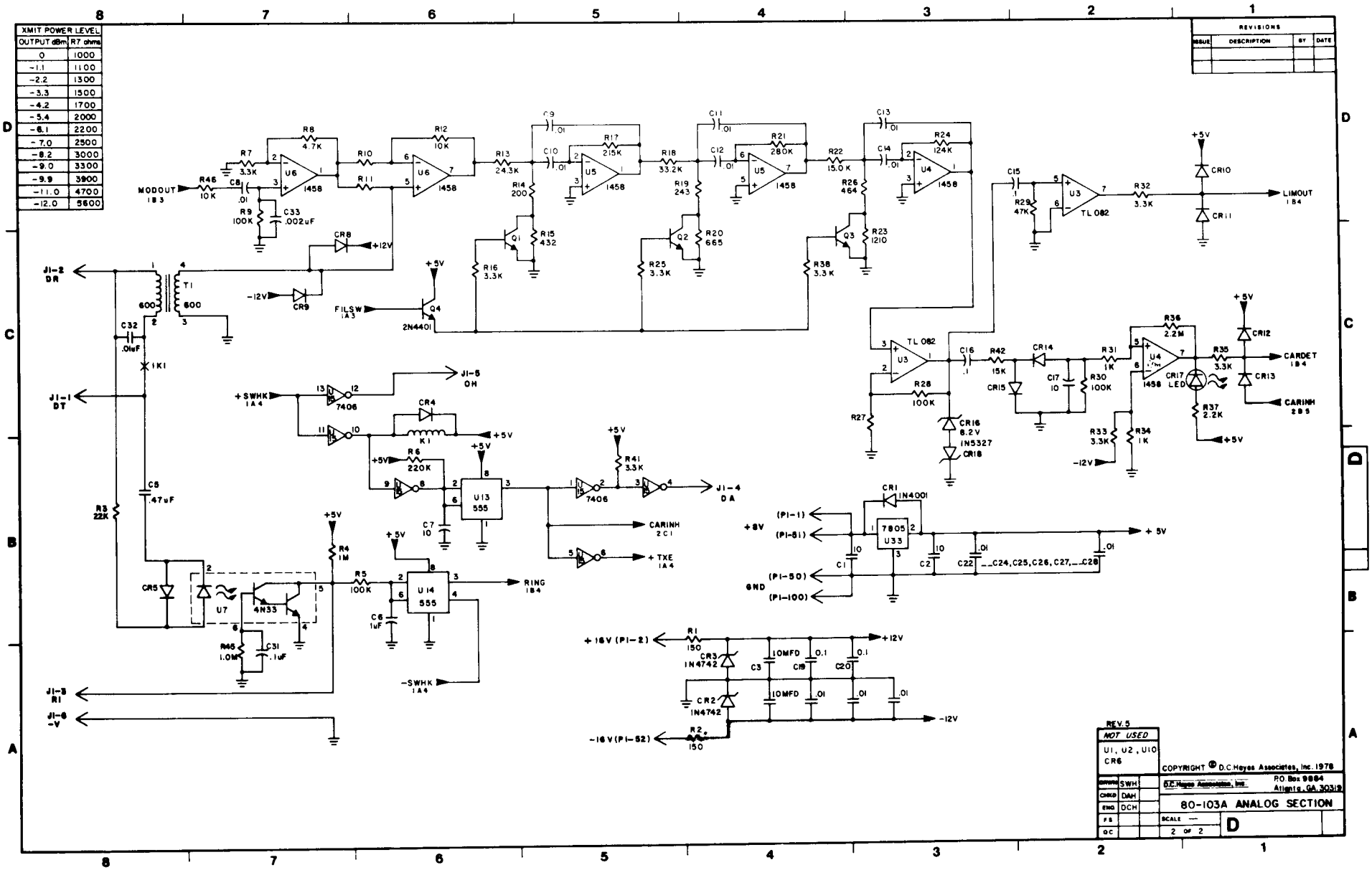
DRWN SWH
CHKD DAH
ENG DCH
F.S.
Q.C.
80-103A DIGITAL SECTION
SCALE: —
1 OF 2
D
U19
AY 5-1013A
UART
U11
74 LS 174
U12
MC 14412
U21
14040
74 LS 14
74 LS10
74 LS 30
74 LS 02
74 LS 132
74 LS 86
7403
74 L 00
74 LS 74
8T97
74LS04
4012
SW 1
SW 2
X1
2 MHz
XTAL
-CLOCK
(P1 49)
2 MHz


XMIT POWER LEVEL
OUTPUT dBm | R7 ohms
0 | 1000
-1.1 | 1100
-2.2 | 1300
-3.3 | 1500
-4.2 | 1700
-5.4 | 2000
-6.1 | 2200
-7.0 | 2500
-8.2 | 3000
-9.0 | 3300
-9.9 | 3900
-11.0 | 4700
-12.0 | 5600
REVISIONS
ISSUE | DESCRIPTION | BY | DATE
MODOUT 183
R46 10K
C8 .01
R9 100K
C33 .002uF
R7 3.3K
R8 4.7K
R10
R11
R12 10K
U6 1458
R13 24.3K
R14 200
R15 432
R16 3.3K
C9 .01
C10 .01
R17 215K
U5 1458
R18 33.2K
R19 243
R20 665
R25 3.3K
C11 .01
C12 .01
R21 280K
U4 1458
R22 15.0K
R26 464
R23 1210
R38 3.3K
C13 .01
C14 .01
R24 124K
C15 .1
R29 47K
U3 TL 082
R32 3.3K
+5V
CR10
CR11
LIMOUT 184
CR8
+12V
-12V
CR9
J1-2 DR
T1
600
600
C32 .01uF
J1-1 DT
1K1
FILSW 1A3
Q4 2N4401
+5V
Q1
Q2
Q3
C16 .1
R42 15K
CR14
CR15
C17 10
R31 1K
R30 100K
R28 100K
R27
CR16 8.2V IN5327
CR18
R36 2.2M
U4 1458
CR17 LED
R35 3.3K
R37 2.2K
CR12
CR13
CARDET 184
CARINH 285
+5V
-12V
R33 3.3K
R34 1K
+SWHK 1A4
7406
J1-5 OH
CR4
K1
R6 220K
U13 555
C7 10
R41 3.3K
7406
J1-4 OA
CARINH 2C1
+ TXE 1A4
C5 .47uF
R3 22K
CR5
U7
4N33
R45 1.0M
C31 .1uF
R4 1M
R5 100K
U14 555
C6 1uF
RING 1B4
-SWHK 1A4
J1-3 RI
J1-6 -V
CR1 IN4001
7805 U33
C1 10
C2 10
C22 .01
C24,C25,C26,C27,C28 .01
+8V
(PI-1)
(PI-81)
(PI-50)
(PI-100)
GND
+5V
R1 150
CR3 IN4742
CR2 IN4742
C3 10MFD
C19 10MFD
C20 0.1
0.1
.01
.01
.01
+16V (PI-2)
-16V (PI-52)
R2 150
+12V
-12V
REV. 5
NOT USED
U1, U2, U10
CR6
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CHKD DAH
ENG DCH
PS
QC
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Atlanta, GA. 30319
80-103A ANALOG SECTION
SCALE —
2 OF 2
D

APPENDIX B

PART LIST

DES.	PART NO.	DESCRIPTION	MANUF.
C1	TA06G1 06MC	CAP. 10 MFD. 25V DIP TANT.	G.E.
C2	TA06G1 06MC	CAP. 10 MFD. 25V DIP TANT.	G.E.
C3	TA06G1 06MC	CAP. 10 MFD. 25V DIP TANT.	G.E.
C4	TA06G1 06MC	CAP. 10 MFD. 25V DIP TANT.	G.E.
C5	BA1 3B474A	CAP. 0.47 MFD 200V	G.E.
C6	TA01G1 05MC	CAP. 1.0 MFD. 25V DIP TANT.	G.E.
C7	TA06G1 06MC	CAP. 10 MFD. 25V DIP TANT.	G.E.
C8	HY-420	CAP. 0.01 MFD. 16V CER. DISC.	SPRAGUE
C9	MD5B1 03H	CAP. 0.01 MFD. 1%	ELPAC
C10	MD5B1 03H	CAP. 0.01 MFD. 1%	ELPAC
C11	MD5B1 03H	CAP. 0.01 MFD. 1%	ELPAC
C12	MD5B1 03H	CAP. 0.01 MFD. 1%	ELPAC
C13	MD5B1 03H	CAP. 0.01 MFD. 1%	ELPAC
C14	MD5B1 03H	CAP. 0.01 MFD. 1%	ELPAC
C15	HY-450	CAP 0.1 MFD 16V CER. DISC.	SPRAGUE
C16	HY-450	CAP. 0.1 MFD. 16V CER. DISC.	SPRAGUE
C17	TA06G1 06MC	CAP. 10 MFD. 25V DIP TANT.	G.E.
C18	HY-450	CAP. 0.1 MFD. 16V CER. DISC.	SPRAGUE
C19	HY-450	CAP. 0.1 MFD. 16V CER. DISC.	SPRAGUE
C20	HY-450	CAP. 0.1 MFD. 16V CER. DISC.	SPRAGUE
C21	HY-450	CAP. 0.1 MFD. 16V CER. DISC.	SPRAGUE
C22	HY-450	CAP. 0.1 MFD. 16V CER. DISC.	SPRAGUE
C23	HY-450	CAP. 0.1 MFD. 16V CER. DISC.	SPRAGUE
C24	HY-450	CAP. 0.1 MFD. 16V CER. DISC.	SPRAGUE
C25	HY-450	CAP. 0.1 MFD. 16V CER. DISC.	SPRAGUE
C26	HY-450	CAP. 0.1 MFD. 16V CER. DISC.	SPRAGUE
C27	HY-450	CAP. 0.1 MFD. 16V CER. DISC.	SPRAGUE
C28	HY-450	CAP. 0.1 MFD. 16V CER. DISC.	SPRAGUE
C29	DD-470	CAP. 47 pF 1KV CER. DISC.	CENTRALAB
C30	HY-420	CAP. .01 MFD. 16V CER. DISC.	SPRAGUE

DES.	PART NO.	DESCRIPTION	MANUF.
C31	HY-450	CAP .1 MFD 16V CER. DISC.	ARCO
C32	HY-420	CAP .01 uf CER DISC	ARCO
C33	5GA-D20	CAP .002 uf CER. DISC.	ARCO
C34	5GA-T10	CAP 100 pf CER. DISC.	ARCO
CR1	IN4001	DIODE	ITT
CR2	IN4742	DIODE	ITT
CR3	IN4742	DIODE	ITT
CR4	IN4148	DIODE	ITT
CR5	IN4148	DIODE	ITT
CR7	IN270	DIODE	ITT
CR8	IN4148	DIODE	ITT
CR9	IN4148	DIODE	ITT
CR10	IN4148	DIODE	ITT
CR11	IN4148	DIODE	ITT
CR12	IN4148	DIODE	ITT
CR13	IN4148	DIODE	ITT
CR14	IN4148	DIODE	ITT
CR15	IN4148	DIODE	ITT
CR16	IN5237	8.2V, ZENER DIODE	
CR17	FLV117	LED	FAIRCHILD
CR18	IN5237	8.2V, ZENER DIODE	
HS1	6106B-14	HEATSINK	THERMALLOY
J2	929835-01	CONNECTOR, 6 PIN	AP PRODUCTS
X1		2 MHz XTAL .01% GP 32 pF	CRYSTEK
K1	205-100-5/6	RELAY	TRI-RIDGE
PWB	80-103A	PRINTED WIRING BOARD	H&L
CA1	UBC-1106-01-072	CABLE, 6' W/CONNECTOR	SPECTRA-STRIP

DATE 9-1-78	REV 5	DRW	APR
D.C. Hayes Associates, Inc.	ASSY NO 80-103A	PAGE 2 OF 6	

DES.	PART NO.	DESCRIPTION	MANUF.
Q1	2N4401	TRANSISTOR	NATIONAL
Q2	2N4401	TRANSISTOR	NATIONAL
Q3	2N4401	TRANSISTOR	NATIONAL
Q4	2N4401	TRANSISTOR	NATIONAL
R1		150 OHM 5% 1 W	
R2		150 OHM 5% 1 W	
R3		22K OHM 5% 1/4W	
R4		1M OHM 5% 1/4W	
R5		100K OHM 5% 1/4W	
R6		220 K OHM 5% 1/4W	
R7		3.3K OHM 5% 1/4W	
R8		6.8K OHM 5% 1/4W	
R9		100K OHM 5% 1/4W	
R10		8.2K OHM 5% 1/4W	
R11		620 OHM 5% 1/4W	
R12		10K OHM 5% 1/4W	
R13	RN55D2432F	24.3K OHM 1%	DALE
R14	RN55D2000F	200 OHM 1%	DALE
R15	RN55D4320F	432 OHM 1%	DALE
R16		3.3K OHM 5% 1/4W	
R17	RN55D2153F	215K OHM 1%	DALE
R18	RN55D3322F	33.2K OHM 1%	DALE
R19	RN55D2430F	243 OHM 1%	DALE
R20	RN55D6650F	665 OHM 1%	DALE
R21	RN55D2803F	280K OHM 1%	DALE
R22	RN55D1502F	15K OHM 1%	DALE
R23	RN55D1211F	1210 OHM 1%	DALE
R24	RN55D1243F	124K OHM 1%	DALE
R25		3.3K OHM 5% 1/4W	

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DES.	PART NO.	DESCRIPTION	MANUF.
R26	RN55D4640F	464 OHM 1%	DALE
R27		2.7K OHM 5% 1/4W	
R28		100K OHM 5% 1/4W	
R29		47K OHM 5% 1/4W	
R30		100K OHM 5% 1/4W	
R31		1K OHM 5% 1/4W	
R32		3.3K OHM 5% 1/4W	
R33		3.3K OHM 5% 1/4W	
R34		1K OHM 5% 1/4W	
R35		3.3K OHM 5% 1/4W	
R36		2.2M OHM 5% 1/4W	
R37		2.2K OHM 5% 1/4W	
R38		3.3K OHM 5% 1/4W	
R39		3.3K OHM 5% 1/4W	
R40		3.3K OHM 5% 1/4W	
R41		3.3K OHM 5% 1/4W	
R42		15K OHM 5% 1/4W	
R43		1K OHM 5% 1/4W	
R44		1K OHM 5% 1/4W	
R45		2.2M OHM 5% 1/4W	
R46		10K OHM 5% 1/4W	
R47		4.7K OHM 5% 1/4W	
SW1	531 37-1	SWITCH - HEX CODED	AMP
SW2	531 37-1	SWITCH - HEX CODED	AMP
T1	T1104	TRANSFORMER	MICROTRAN
U1	----------	NOT USED	----------
U2	----------	NOT USED	----------

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DES.	PART NO.	DESCRIPTION	MANUF.
U3	TLO82CP	I.C. DUAL OP-AMP	TI
U4	MC1458CP1	I.C. DUAL OP-AMP	MOTOROLA
U5	MC1458CP1	I.C. DUAL OP-AMP	MOTOROLA
U6	MC1458CP1	I.C. DUAL OP-AMP	MOTOROLA
U7	4N33	I.C. OPTO-ISOLATOR	G.E.
U8	74LS14	I.C. HEX INVERTER	NATIONAL
U9	74LS30	I.C. 8-INPUT NAND	NATIONAL
U10	———	NOT USED ———	———
U11	74174	I.C. 6-BIT LATCH	NATIONAL
U12	MC14412P	I.C. MODEM	MOTOROLA
U13	MC1455P1	I.C. (NE555 EQUIV)	MOTOROLA
U14	MC1455P1	I.C. (NE555 EQUIV)	MOTOROLA
U15	7406	I.C. HEX INVERTER O.C.	NATIONAL
U16	74LS02	I.C. QUAD NOR	NATIONAL
U17	74LS10	I.C. 3-3 INPUT NAND	NATIONAL
U18	74LS14	I.C. HEX INVERTER	NATIONAL
U19	TR1 602	I.C. UART	WESTERN DIGITAL
	OR TMS 6011	UART	TI
	OR AY5-1013	UART	GEN. INST.
	OR S1883	UART	AMI
U20	7474	I.C. 2-D TYPE FLOP	NATIONAL
U21	MC14040CP	I.C. BINARY COUNTER	MOTOROLA
U22	74LS74	I.C. 2-D TYPE FLOP	NATIONAL
U23	74LS02	I.C. QUAD NOR	NATIONAL
U24	74LS132	I.C. 4-2 INPUT NAND	NATIONAL
U25	8T97	I.C. HEX TRI-STATE BUF.	NATIONAL
U26	8T97	I.C. HEX TRI-STATE BUF.	NATIONAL
U27	8T97	I.C. HEX TRI-STATE BUF.	NATIONAL
U28	8T97	I.C. HEX TRI-STATE BUF.	NATIONAL
U29	7403	I.C. 4-2 INPUT NAND	NATIONAL

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DES.	PART NO.	DESCRIPTION	MANUF.
U30	74LS86	I.C. QUAD-EXCLUSIVE OR	NATIONAL
U31	MC14012CP	I.C. 2-4 INPUT NAND	MOTOROLA
U32	74L00	I.C. 4-2 INPUT NAND	NATIONAL
U33	7805UC	I.C. REGULATOR +5V	FAIRCHILD
U34	74LS04	I.C. HEX INVERTER	NATIONAL
1@	ICN-063-S3-T	SOCKET 6 PIN	ROBINSON-NUG
6@	308AG39D	SOCKET 8 PIN	AUGAT
14@	314AG39D	SOCKET 14 PIN	AUGAT
7@	316AG39D	SOCKET 16 PIN	AUGAT
1@	340AG39D	SOCKET 40 PIN	AUGAT
1@		#6-32 SCREW 1/4"	ATL FASTNER
1@		#6-32 NUT	ATL FASTNER
1@		#6 SPLIT WASHER	ATL FASTNER

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APPENDIX C

SAMPLE PROGRAM

SAMPLE PROGRAM OPERATION

This sample program provides a working example of software which controls the 80-103A Data Communications Adapter. The subroutines in this program may be called by user-supplied routines to provide the basic functions used by more sophisticated programs. It allows an 8080 or Z80 mirocomputer equipped with a terminal and an 80-103A to originate or answer calls and transfer data with a 103 compatible communication facility.

The program assumes that the 80-103A is I/O mapped at HEX "80" which requires SW1 be set to F and SW2 be set to 8 (see table 3.5 and table 3.6).

Upon initialization at the label START (HEX"0100") the program is ready to answer on ring and go into answer mode or if control shift B (HEX"02") is entered from the terminal it will initiate a call. A message asking for the number will be output to the terminal and the number can then be input. A * character in the input number string will cause a delay in dialing to accommodate systems with a second dialtone. The software will output the numbers to the terminal as it dials then test for carrier from the line. Once carrier is received the data transfer can begin. The call is terminated by a loss of carrier from the line or a control D (HEX"04") from the terminal or the line. The program then returns to the state where it is waiting for a new call to begin.

See the user I/O routine area on page 11 for the terminal interface.

This program is written so that it can be loaded into ROM. All the variable storage is located in the data storage area at the end of the program, and the program does not modify itself. By relocating the program to the location of the ROM and the data area to a suitable RAM location and reassembling, the program can be run from a ROM.

```
CP/M MACRO ASSEM 2.0     #001     MODEM 2.0

                         TITLE    'MODEM 2.0'

                  ;      MODEM CONTROL PROGRAM BY DALE HEATHERINGTON
                  ;      REV      2.0      AUG. 9, 1978
                  ;      COPYRIGHT 1978, D.C. HAYES ASSOCIATES, INC.

                  ;CONTROL CHARACTERS USED

                  ;      CONTROL B , WHEN TYPED DURING COMMUNICATIONS
                  ;      WILL CAUSE A BREAK TO BE TRANSMITTED.
                  ;      OTHERWISE IT GETS YOU INTO THE DIALING MODE.

                  ;      CONTROL R CAUSES THE LAST NUMBER DIALED TO
                  ;      BE RE-DIALED.

                  ;      CONTROL D IS THE ABORT CHARACTER. USE IT
                  ;      TO GET BACK TO THE BEGINNING OF THIS PROGRAM.

                  ;      CONTROL X SENDS CONTROL TO YOUR MONITOR OR
                  ;      OPERATING SYSTEM. IT IS SET TO F000 HEX IN
                  ;      THIS VERSION AND SHOULD BE CHANGED TO SUIT
                  ;      YOUR SYSTEM.
                  ;      THE PROGRAM MAY BE RE-ENTERED IN THE
                  ;      COMMUNICATIONS LOOP BY JUMPING TO THE LOCATION
                  ;      "RENTER".
                  ;      3 OF THE LOCATIONS IN THE JUMP TABLE AT THE BEGINNING
                  ;      OF THE PROGRAM (XMSTAT, XREC, AND XSEND) CAN BE CALLED
                  ;      BY EXTERNAL PROGRAMS FOR I/O. THIS ALLOWS THE MODEM TO
                  ;      ACT AS A REMOTE CONSOLE.


                  ;      QUESTIONS MUST BE ANSWERED WITH A Y FOR YES
                  ;      OR ANY OTHER CHARACTER FOR NO.



                  ;MODEM CONTROL BYTES

0002 =            TXE      EQU      2        ;TRANSMITTER ON MASK
001F =            WORD     EQU      1FH      ;8 BITS, NO PARITY,2 STOP BITS

                  ;PORT ASSIGNMENTS

0080 =            DATA     EQU      80H      ;DATA I/O PORT
0081 =            STAT     EQU      DATA+1   ;STATUS PORT
0082 =            MODE     EQU      DATA+2   ;MODE CONTROL PORT


F000 =            MONIT    EQU      0F000H   ;ADDRESS OF THE SYSTEMS MONITOR PGM.
0018 =            XIT      EQU      18H      ;CONTROL X

0100                       ORG      100H     ;PROGRAM STARTS A 100 HEX
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0100 C31201    START:  JMP     SIGNON
0103 C3E501    RENTER: JMP     TTY     ;COME HERE TO RE-ENTER

               ;USE THESE JUMP VECTORS TO LINK WITH EXTERNAL PROGRAMS.

0106 C39603    XMSTAT: JMP     MSTAT   ;RETURNS WITH FF IN A IF BYTE IS READY
0109 C39F03    XREC:   JMP     MREC    ;CHARACTER FROM MODEM RETURNS IN A.
010C C37A03    XSEND:  JMP     MSEND   ;CHARACTER IN C IS SENT TO MODEM
010F C38503    XBREAK: JMP     BREAK   ;SEND A BREAK



0112 97        SIGNON: SUB     A
0113 D381              OUT     STAT    ;TURN OFF SERIAL INTF
0115 D382              OUT     MODE    ;MAKE SURE MODEM'S ALL TURNED OFF.
0117 32B905            STA     MDBYTE
011A 31FA05            LXI     SP,STKTOP
011D CD2D05            CALL    INIT    ;INITIALIZE I/O BOARDS
0120 215A04            LXI     H,SIGN
0123 CD5802            CALL    PRINTM  ;PRINT SIGNON MESSAGE AT CONSOLE

               ;       TIMING LOOP CALIBRATION ROUTINE
               ;       THIS ROUTINE USES THE MODEM CLOCK TO
               ;       CALIBRATE THE TIMING LOOP DELAY

0126 3E01              MVI     A,1
0128 D382              OUT     MODE    ;SET BAUD RATE TO 300
012A 3E06              MVI     A,6
012C D381              OUT     STAT    ;THIS WILL GET TRE EVERY 33.33 MS.
012E D380              OUT     DATA    ;FILL THE TRANSMITTER REG
0130 3E80              MVI     A,80H   ;GIVE THE UART TIME TO DIGEST IT
0132 E3        LAB0:   XTHL
0133 E3                XTHL
0134 3D                DCR     A
0135 C23201            JNZ     LAB0    ;FOOL AROUND LONG ENUFF FOR UART
0138 D380              OUT     DATA    ;FILL UP THE TRANSMITTER
013A 210000            LXI     H,0     ;CLEAR COUNTER IN H

013D DB81      LAB:    IN      STAT
013F 1F                RAR
0140 1F                RAR             ;MOVE TRE INTO CARRY
0141 2B                DCX     H       ;COUNT PASSES   NOP
0142 00                NOP
0143 D23D01            JNC     LAB     ;LOOP
0146 22B605            SHLD    TIME    ;THAT'S THE CALIBRATION CONSTANT!



               ;GET SPEED AND DUPLEX MODE FROM THE USER NOW.

0149 217F04    SELECT: LXI     H,MSPEED        ;POINT TO SPEED MESSAGE
014C CD5802            CALL    PRINTM          ;PRINT IT
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014F CDA903            CALL    XINPUT
0152 FE59              CPI     'Y'             ;YES TO 110 BAUD QUESTION
0154 C25D01            JNZ     A1
0157 CDA602            CALL    S110            ;SET TO 110 BAUD
015A C36001            JMP     A2
015D CDAE02    A1:     CALL    S300            ;SET TO 300 BAUD
0160 CD4902    A2:     CALL    CRLF            ;DO CARRAGE RETURN
0163 219704            LXI     H,MDPLX
0166 CD5802            CALL    PRINTM          ;ASK DUPLEX MODE QUESTION
0169 CDA903            CALL    XINPUT
016C FE59              CPI     'Y'             ;HALF DUPLEX?
016E CA7601            JZ      A3
0171 3EFF              MVI     A,255
0173 C37801            JMP     A4
0176 3E00      A3:     MVI     A,0
0178 32B805    A4:     STA     FDPLX
017B 3E1F              MVI     A,WORD          ;SET DATA WORD FORMAT
017D D381              OUT     STAT
017F CD4902            CALL    CRLF            ;DO CARRAGE RETURN

0182 21B104            LXI     H,MREADY
0185 CD5802            CALL    PRINTM          ;TELL 'EM WE ARE READY



0188 CD3605    RINGCK: CALL    INSTAT  ;GET CONSOLE STATUS
018B C43305            CNZ     INPUT   ;GET BYTE IF READY
018E FE02              CPI     2       ;CHECK FOR "STX" OR CONTROL B
0190 CAA601            JZ      MAKCALL ;GOTO ORIGINATE ROUTINE
0193 DB81              IN      STAT    ;GET MODEM STATUS
0195 E680              ANI     80H     ;ISOLATE RING DET. BIT
0197 C28801            JNZ     RINGCK  ;LOOP UNTIL IT GOES LOW
019A CD9602    ANCALL: CALL    ANSW    ;SET TO ANSWER MODE
019D CD6602            CALL    TXON    ;TURN   ON TRANSMITTER
01A0 CD7602            CALL    OFFHK   ;PICK   UP PHONE
01A3 C3B801            JMP     ONLINE  ;JUMP TO DATA HANDLING ROUTINE

01A6 31FA05    MAKCALL: LXI    SP,STKTOP
01A9 CD9E02            CALL    ORIG    ;SET FOR ORIGINATE MODE
01AC 21CE03            LXI     H,MNUM  ;POINT TO STRING "NUMBER"
01AF CD5802            CALL    PRINTM  ;PRINT THE STRING
01B2 CDB902            CALL    DIAL    ;GET AND DIAL A PHONE NUMBER
01B5 CD4902            CALL    CRLF    ;DO CARRAGE RET.
01B8 115802    ONLINE: LXI     D,600   ;SETUP FOR A 30 SECOND DELAY
01BB DB81      CARR:   IN      STAT    ;LOOK FOR A CARRIER
01BD E640              ANI     40H     ;ISOLATE CARRIER BIT
01BF C2D401            JNZ     CONNECT ;JUMP IF TRUE
01C2 CD1103            CALL    DELAY   ;WAIT 50 MS
01C5 1B                DCX     D       ;COUNT IT
01C6 7A                MOV     A,D     ;TEST FOR D&E =0
01C7 B3                ORA     E
01C8 C2BB01            JNZ     CARR    ;LOOP IF NOT TIMED OUT
01CB 21F903            LXI     H,NOASW ;POINT TO STRING "NO ANSWER"
01CE CD5802            CALL    PRINTM  ;PRINT THE STRING
01D1 C32602            JMP     EOT     ;DISCONNECT
               CONNECT:
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01D4 CD6602             CALL    TXON    ;TURN ON TRANSMITTER
01D7 21FA04             LXI     H,MCONN ;PRINT "CONNECTION ESTABLISHED"
01DA CD5802             CALL    PRINTM
01DD 3AB905             LDA     MDBYTE  ;GET CURRENT MODE
01E0 E604               ANI     4       ;ISOLATE ORIG/ANSW BIT
01E2 CC4D03             CZ      SAB     ;SEND ANSWER-BACK


                ;       THIS IS THE MAIN PROGRAM LOOP WHICH IS ENTERED
                ;        AFTER COMMUNICATIONS ARE ESTABLISHED.

01E5 DB81       TTY:    IN      STAT    ;GET MODEM STATUS
01E7 E640               ANI     40H     ;ISOLATE CARRIER DETECT BIT
01E9 C2F501             JNZ     OK
01EC 211F04             LXI     H,LOSTC ;POINT TO STRING "LOST CARRIER
01EF CD5802             CALL    PRINTM  ;PRINT THE STRING
01F2 C32602             JMP     EOT     ;DISCONNECT
01F5 CD9603     OK:     CALL    MSTAT   ;SEE IF WE GOT A BYTE FROM MODEM
01F8 A7                 ANA     A
01F9 C43502             CNZ     GETC    ;GET THE BYTE
01FC CD3605             CALL    INSTAT  ;CHECK THE CONSOLE STATUS
01FF A7                 ANA     A       ;SET THE FLAGS
0200 CAE501             JZ      TTY     ;LOOP IF STATUS NOT TRUE
0203 CD3305             CALL    INPUT   ;GET THE CONSOLE CHARACTER
0206 4F                 MOV     C,A     ;SAVE IT
0207 CD6303     TTY1:   CALL    TRANS   ;SEND AND ECHO THE CHAR.
020A C3E501             JMP     TTY     ;LOOP AGAIN


                ;PRINTS CHARACTER ON CONSOLE, CHECKS FOR EOT CHARACTER
                ;AND TERMINATES CALL IF TRUE.


020D 79         PRINT:  MOV     A,C     ;GET A BYTE
020E FE04               CPI     4       ;CHECK FOR EOT
0210 C23005             JNZ     OUTPUT  ;OUTPUT THE BYTE
0213 213604     EOT1:   LXI     H,MEOT  ;POINT TO STRING "EOT"
0216 CD5802             CALL    PRINTM  ;PRINT IT
0219 0602               MVI     B,2     ;SET FOR 100 MS DELAY
021B CD0903             CALL    VARDLY  ;WAIT 2 SECONDS
021E CD8602             CALL    BRKON   ;SEND CONSTANT SPACE (BREAK)
0221 0628               MVI     B,40
0223 CD0903             CALL    VARDLY  ;DO IT FOR 2 SECONDS
0226 CD7E02     EOT:    CALL    ONHK    ;HANG UP PHONE
0229 CD6E02             CALL    TXOFF   ;TURN OFF TRANSMITTER
022C 210304             LXI     H,TERM  ;POINT TO STRING "TERMINATED"
022F CD5802             CALL    PRINTM  ;PRINT THE STRING
0232 C31201             JMP     SIGNON  ;BACK TO THE START

                ;GETS A BYTE FROM THE MODEM

0235 CD9F03     GETC:   CALL    MREC    ;GET THE MODEMS BYTE
0238 E67F               ANI     7FH     ;KILL PARITY
```

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023A FE04               CPI     4       ;CHECK FOR EOT
023C CA1302             JZ      EOT1
023F FE05               CPI     5       ;CHECK FOR ENQ
0241 CC4D03             CZ      SAB     ;SEND ANSWER BACK IF TRUE
0244 4F                 MOV     C,A
0245 CD3005             CALL    OUTPUT  ;PRINT THE CHARACTER
0248 C9                 RET

                ;SEND CARRAGE RETURN- LINE FEED TO CONSOLE


0249 0E0D       CRLF:   MVI     C,0DH
024B CD3005             CALL    OUTPUT
024E 0E0A               MVI     C,0AH
0250 CD3005             CALL    OUTPUT
0253 0E00               MVI     C,00
0255 C33005             JMP     OUTPUT


                ;PRINT ASCII STRING ON THE CONSOLE
                ;ENTRY CONDITIONS:  HL POINT TO STRING,
                ;           STRING ENDS WITH FF HEX.

0258 3EFF       PRINTM: MVI     A,255
025A 4E                 MOV     C,M     ;GET A BYTE
025B B9                 CMP     C       ;TEST FOR FF (END OF STRING)
025C CA4902             JZ      CRLF    ;FINISHED
025F CD3005             CALL    OUTPUT  ;PRINT IT
0262 23                 INX     H       ;POINT TO NEXT BYTE
0263 C35802             JMP     PRINTM  ;LOOP AGAIN



                ;       FUNCTION SETTING ROUTINES


0266 3AB905     TXON:   LDA     MDBYTE
0269 F602               ORI     2       ;TURN ON TRANSMITTER
026B C3B302             JMP     SETT

026E 3AB905     TXOFF:  LDA     MDBYTE
0271 E6FD               ANI     0FDH    ;TURN OFF TRANSMITTER
0273 C3B302             JMP     SETT

0276 3AB905     OFFHK:  LDA     MDBYTE
0279 F680               ORI     80H     ;PICK UP PHONE
027B C3B302             JMP     SETT

027E 3AB905     ONHK:   LDA     MDBYTE
0281 E67F               ANI     7FH     ;HANGUP PHONE
0283 C3B302             JMP     SETT

0286 3AB905     BRKON:  LDA     MDBYTE
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0289 F608              ORI     08H     ;SET BREAK BIT
028B C3B302            JMP     SETT

028E 3AB905    BRKOFF: LDA     MDBYTE
0291 E6F7              ANI     0F7H    ;RESET BREAK BIT
0293 C3B302            JMP     SETT

0296 3AB905    ANSW:   LDA     MDBYTE  ;GET CURRENT MODE BYTE
0299 E6FB              ANI     0FBH    ;SET MODE BIT TO ZERO (ANSWER MODE)
029B C3B302            JMP     SETT

029E 3AB905    ORIG:   LDA     MDBYTE  ;GET CURRENT MODE BYTE
02A1 F604              ORI     4       ;SET MODE BIT (ORIGINATE MODE)
02A3 C3B302            JMP     SETT

02A6 3AB905    S110:   LDA     MDBYTE
02A9 E6FE              ANI     0FEH    ;RESET SPEED BIT (110 BAUD)
02AB C3B302            JMP     SETT

02AE 3AB905    S300:   LDA     MDBYTE
02B1 F601              ORI     1       ;SET SPEED BIT (300 BAUD)
02B3 32B905    SETT:   STA     MDBYTE
02B6 D382              OUT     MODE    ;SET MODEM
02B8 C9                RET


               ;THIS ROUTINE GETS DIGITS FROM THE CONSOLE
               ;AND STORES THEM IN MEMORY. IT THEN TAKES THE LINE
               ;OFF HOOK AND DIALS THE DIGITS STORED IN MEMORY.
               ;IF A '*' APPEARS IN THE DIGIT STRING THE PROGRAM
               ;PAUSES FOR 2 SECONDS. THIS IS TO WAIT FOR SECOND DIAL
               ;TONE IN SOME EXCHANGES.

02B9 CD3003    DIAL:   CALL    GETNUM  ;GET PHONE NUMBER FROM KBD.
02BC CD4902            CALL    CRLF    ;CARRAGE RETURN, LINE FEED
02BF CD7602            CALL    OFFHK   ;GO OFFHOOK
02C2 211604            LXI     H,MDIAL ;POINT TO STRING "DIALING-"
02C5 CD5802            CALL    PRINTM  ;PRINT IT
02C8 0628              MVI     B,40    ;SETUP FOR 2 SECOND DELAY
02CA CD0903            CALL    VARDLY  ;WAIT 2 SECONDS
02CD 21BA05    DIAL2:  LXI     H,NMBR  ;POINT TO PHONE NUMBER
02D0 7E        DL:     MOV     A,M     ;GET A DIGIT
02D1 FE0D              CPI     0DH     ;CHECK FOR THE END
02D3 C8                RZ
02D4 4F                MOV     C,A
02D5 CD3005            CALL    OUTPUT  ;PRINT THE DIGIT TO BE DIALED
02D8 FE2A              CPI     '*'     ;DELAY?
02DA 0628              MVI     B,40    ;SET    FOR 2 SECOND DELAY
02DC CC0903            CZ      VARDLY  ;WAIT ONLY IF WE SAW A *
02DF 23                INX     H       ;POINT TO NEXT DIGIT
02E0 D630              SUI     30H     ;REMOVE ASCII BIAS
02E2 C2E702            JNZ     NOTZERO ;CHECK FOR A DIGIT '0'
02E5 3E0A              MVI     A,10    ;MAKE THE ZERO A TEN
02E7 DAD002    NOTZERO:JC      DL      ;IF < 0 GET NEXT DIGIT
02EA FE0B              CPI     11      ;CHECK FOR MORE THAN 10
02EC D2D002            JNC     DL      ;IF MORE GET NEXT DIGIT
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02EF CDF502             CALL    PULSE   ;MAKE DIAL PULSES
02F2 C3D002             JMP     DL


                ;THIS SUBROUTINE PULSES THE LINE.
                ;THE VALUE IN ACC EQUALS THE NUMBER OF
                ;PULSES OUTPUT.


02F5 F5         PULSE:  PUSH    PSW
02F6 CD7E02             CALL    ONHK    ;GO ONHOOK
02F9 CD1103             CALL    DELAY   ;WAIT 50 MS
02FC CD7602             CALL    OFFHK   ;GO OFF HOOK
02FF CD1103             CALL    DELAY   ;WAIT 50 MS
0302 F1                 POP     PSW     ;GET DIGIT
0303 3D                 DCR     A       ;SUBTRACT 1 FROM DIGIT
0304 C2F502             JNZ     PULSE   ;ANOTHER PULSE IF NOT ZERO
0307 060A               MVI     B,10    ;SET UP FOR 500 MS DELAY

                ;       VARIABLE DELAY ROUTINE.
                ;       REGISTER B HAS NUMBER OF 50 MS DELAYS
                ;       DELAY TIME= B*50 MS

0309 CD1103     VARDLY: CALL    DELAY
030C 05                 DCR     B
030D C20903             JNZ     VARDLY
0310 C9                 RET


                ;THIS ROUTINE WAITS 50 MILLISECONDS BEFORE RETURNING
                ;
0311 E5         DELAY:  PUSH    H
0312 D5                 PUSH    D
0313 F5                 PUSH    PSW
0314 CD3605             CALL    INSTAT
0317 B7                 ORA     A       ;SET FLAGS
0318 C43305             CNZ     INPUT   ;GET A CONSOLE BYTE
031B FE04               CPI     4       ;CONTROL D ?
031D CA1302             JZ      EOT1    ;ABORT
0320 F1                 POP     PSW
0321 110100             LXI     D,1
0324 2AB605             LHLD    TIME    ;GET    CALIBRATION VALUE
0327 E3         DLYLP:  XTHL            ;WASTE  TIME FOR DELAY
0328 E3                 XTHL
0329 19                 DAD     D       ;ADD D&E TO H&L
032A D22703             JNC     DLYLP   ;LOOP UNTIL CARRY
032D D1                 POP     D
032E E1                 POP     H
032F C9                 RET


                ;GETS BYTES FROM THE CONSOLE AND STORES THEM IN RAM.
                ; CARRAGE RETURN TERMINATES THE STRING.
                ; IF CONTROL R IS THE FIRST CHARACTER IN THE STRING
```

```
                ; THE BUFFER IS LEFT AS IT WAS. THIS ALLOWS THE USER
                ; TO RE-DIAL THE SAME NUMBER SEVERAL TIMES BY
                ; TYPING CONTROL R.



0330 21BA05     GETNUM: LXI     H,NMBR  ;POINT TO BUFFER
0333 CDA903     G1:     CALL    XINPUT  ;GET AND ECHO CONSOLE INPUT
0336 FE12               CPI     12H     ;CONTROL R (RE-DIAL LAST NUMBER)
0338 C8                 RZ              ;YES, DON'T FILL BUFFER, JUST RETURN
0339 77                 MOV     M,A     ;PUT CHARACTER IN MEMORY BUFFER
033A FE0D               CPI     0DH     ;CHECK FOR ASCII "CR"
033C C8                 RZ              ;DONE IF TRUE
033D 23                 INX     H       ;POINT TO NEXT BUFF. LOC.
033E FE7F               CPI     7FH     ;RUBOUT?
0340 C23303             JNZ     G1      ;IF NOT GET NEXT DIGIT
0343 0E5F               MVI     C,5FH   ;ECHO A BACK ARROW (5F HEX)
0345 CD3005             CALL    OUTPUT
0348 2B                 DCX     H       ;BACK   UP POINTER
0349 2B                 DCX     H
034A C33303             JMP     G1      ;GET NEXT DIGIT


                ;THIS   SUBROUTINE SENDS THE ANSWER BACK MESSAGE

034D E5         SAB:    PUSH    H
034E C5                 PUSH    B
034F 211205             LXI     H,ANSBK ;POINT TO ANSWER BACK MESSAGE
0352 7E         GAB:    MOV     A,M     ;GET A BYTE
0353 FEFF               CPI     255     ;END?
0355 CA6003             JZ      EXIT
0358 4F                 MOV     C,A
0359 CD6303             CALL    TRANS   ;SEND THE BYTE
035C 23                 INX     H
035D C35203             JMP     GAB     ;LOOP AGAIN
0360 C1         EXIT:   POP     B
0361 E1                 POP     H
0362 C9                 RET

                ;THIS SUBROUTINE SENDS A BYTE TO THE MODEM
                ;AND TO THE CONSOLE DISPLAY DEVICE.

0363 CD7A03     TRANS:  CALL    MSEND   ;SEND THE BYTE
0366 79                 MOV     A,C
0367 FE02               CPI     2
0369 CA8503             JZ      BREAK
036C FE04               CPI     4       ;CONTROL D (ABORT)
036E CA1302             JZ      EOT1
0371 3AB805             LDA     FDPLX   ;CHECK FOR HALF DUPLEX
0374 B7                 ORA     A
0375 C0                 RNZ             ;RETURN NOW IF FULL DUPLEX (NO LOCAL ECHO)
0376 CD0D02             CALL    PRINT   ;PRINT IT ON THE CONSOLE
0379 C9                 RET
```

```
                ;SENDS A BYTE OUT THRU THE MODEM

037A DB81       MSEND:  IN      STAT    ;SEE IF READY FOR BYTE
037C E602               ANI     2
037E CA7A03             JZ      MSEND   ;LOOP UNTIL READY
0381 79                 MOV     A,C     ;GET THE BYTE
0382 D380               OUT     DATA
0384 C9                 RET


                ;       THIS ROUTINE SENDS A BREAK

0385 0602       BREAK:  MVI     B,2     ;SET FOR 100 MS DELAY
0387 CD0903             CALL    VARDLY  ;WAIT 100 MS
038A CD8602             CALL    BRKON   ;SEND A BREAK
038D 0604               MVI     B,4     ;SET FOR 200 MS DELAY
038F CD0903             CALL    VARDLY
0392 CD8E02             CALL    BRKOFF  ;RELEASE BREAK
0395 C9                 RET

                ;THIS ROUTINE CHECKS TO SEE IF A BYTE HAS BEEN RECEIVED
                ;BY THE MODEM. IT RETURNS WITH REGISTER A SET TO 00 IF
                ;NO CHARACTER WAS RECEIVED OR FF IF ONE WAS RECEIVED.

0396 DB81       MSTAT:  IN      STAT
0398 E601               ANI     1
039A 3E00               MVI     A,0
039C C8                 RZ                      ;RETURN ZERO IF NONE RECEIVED
039D 2F                 CMA
039E C9                 RET                     ;RETURN FF IF BYTE WAS RECEIVED


                ;THIS ROUTINE GET A BYTE FROM THE MODEM

039F DB81       MREC:   IN      STAT
03A1 E601               ANI     1
03A3 CA9F03             JZ      MREC
03A6 DB80               IN      DATA
03A8 C9                 RET


                ; THIS ROUTINE GETS CHARACTERS FROM THE CONSOLE, CHECKS 'EM FOR
                ; CONTROL D, AND ECHOS THEM TO THE CONSOLE.


03A9 CD3605     XINPUT: CALL    INSTAT  ;CHECK STATUS
03AC B7                 ORA     A
03AD CAA903             JZ      XINPUT  ;LOOP UNTIL READY
03B0 CD3305             CALL    INPUT
03B3 FE04               CPI     4       ;CONTROL D?
03B5 CA1201             JZ      SIGNON
03B8 4F                 MOV     C,A
03B9 FE7B               CPI     7BH
```

```
03BB D2C503             JNC     R1
03BE FE60               CPI     60H     ;TEST FOR LOWER CASE
03C0 DAC503             JC      R1
03C3 DE20               SBI     20H     ;MAKE IT UPPER CASE
03C5 4F         R1:     MOV     C,A
03C6 FE7F               CPI     7FH
03C8 C8                 RZ              ;DON'T ECHO RUBOUTS
03C9 CD3005             CALL    OUTPUT
03CC 79                 MOV     A,C
03CD C9                 RET


03CE 4E554D4245MNUM:    DB      'NUMBER ?  (control R re-dials last number)'
03F8 FF                 DB      255


03F9 4E4F20414ENOASW:   DB       'NO ANSWER'
0402 FF                 DB       255

0403 0D0A00     TERM:   DB       0DH,0AH,0
0406 43414C4C20         DB       'CALL TERMINATED'
0415 FF                 DB       255

0416 4449414C49MDIAL:   DB       'DIALING-'
041E FF                 DB       255

041F 0D0A00     LOSTC:  DB      0DH,0AH,0
0422 2A2A2A2A2A         DB      '***** LOST CARRIER'
0434 07FF               DB      7,255

0436 0D0A00     MEOT:   DB      0DH,0AH,0
0439 2A2A2A2A2A         DB      '***** CONTROL D RECEIVED  (EOT)'
0458 07FF               DB      7,255
045A 4443486179SIGN:    DB      'DCHayes 80-103 Modem control program'
047E FF                 DB      255

047F 57414E5420MSPEED:  DB      'WANT 110 BAUD (Y OR N)?'
0496 FF                 DB      255

0497 57414E5420MDPLX:   DB      'WANT LOCAL ECHO (Y OR N)?'
04B0 FF                 DB      255

04B1 5761697469MREADY:  DB      'Waiting for the phone to ring or......'
04D7 0D0A00             DB      0DH,0AH,00
04DA 5479706520         DB      'Type control B to dial a number'
04F9 FF                 DB      255

04FA 434F4E4E45MCONN:   DB      'CONNECTION ESTABLISHED'
0510 07FF               DB      7,255


                ;  ***  THIS IS THE ANSWER BACK MESSAGE  ***

0512 000D0A0000ANSBK:   DB      0,0DH,0AH,0,0,0,0,0
051A 38302D3130         DB      '80-103A MODEM'
0527 0D0A000000         DB      0DH,0AH,0,0,0,255
```

```
                ;USER I/O ROUTINE AREA

052D C35A05     INIT:   JMP     XINIT   ;I/O INITIALIZER
0530 C34D05     OUTPUT: JMP     USEROT  ;JUMP TO USER OUTPUT ROUTINE
0533 C33905     INPUT:  JMP     USERIN  ;JUMP TO USER INPUT ROUTINE
0536 C34305     INSTAT: JMP     USERST  ;JUMP TO USER CONSOLE STATUS
                                        ;CHECK ROUTINE. RETURNS 'FF'
                                        ;IF A BYTE IS WAITING OR
                                        ; '00' IF NOT.

0000 =                  CPM     EQU     0       ;DON'T DO CPM
                        IF      NOT CPM

                ; ASSEMBLE THE FOLLOWING CODE FOR NON-CPM SYSTEMS

0035 =          DATAIN  EQU     35H     ;SYSTEM INPUT DATA INPUT PORT
0034 =          DISTAT  EQU     34H     ;SYSTEM STATUS PORT

0005 =          DATAOUT EQU     5       ;SYSTEM DATA OUT PORT
0004 =          DOSTAT  EQU     4       ;DATA OUT STATUS PORT


                ; USER CONSOLE INPUT ROUTINE
                ; RETURNS WITH THE CHARACTER IN RESISTER A.


0539 DB35       USERIN: IN      DATAIN  ;GET CONSOLE DATA BYTE
053B E67F               ANI     7FH     ;KILL PARITY
053D FE18               CPI     XIT     ;EXIT TO MONITOR?
053F CA00F0             JZ      MONIT   ;YES, GO
0542 C9                 RET


                ;USERS CONSOLE STATUS CHECK ROUTINE
                ;RETURNS WITH WITH  FF IN REGISTER A  IF A KEY IS PRESSED
                ;OR 00 IF NOT.


0543 DB34       USERST: IN      DISTAT  ;GET CONSOLE STATUS
0545 E601               ANI     1       ;MASK IN CONSOLE READY BIT
0547 3E00               MVI     A,0     ;SET A TO ZERO
0549 C8                 RZ              ;RETURN IF NOT TRUE
054A 3EFF               MVI     A,0FFH  ; FF TO A
054C C9                 RET             ;RETURN WITH WITH FF IF TRUE


                ;USERS CONSOLE OUTPUT ROUTINE
                ;THE ASCII CHARACTER TO BE OUTPUT IS IN REGISTER C.


054D DB04       USEROT: IN      DOSTAT  ;GET THE STATUS BYTE
054F E602               ANI     2
```

```
0551 CA4D05             JZ      USEROT  ;LOOP 'TIL READY
0554 79                 MOV     A,C     ;GET THE DATA BYTE
0555 D305               OUT     DATAOUT ;SEND IT OUT
0557 C9                 RET
0558 00                 NOP
0559 00                 NOP

                ;YOU MAY PUT ANY I/O BOARD INITIALIZATION ROUTINES HERE

055A 3E01       XINIT:  MVI     A,1
055C D384               OUT     84H
055E C9                 RET

055F                    DS      20H             ;EXTRA SPACE FOR USER ROUTINES

                        ENDIF

                        PAGE
```

```
            IF      CPM

        ; ASSEMBLE THIS CODE FOR CPM SYSTEMS


        USERIN: PUSH    H
                PUSH    D
                PUSH    B
                CALL    CONIN   ;GET CHARACTER FROM CBIOS
                POP     B
                POP     D
                POP     H
                CPI     XIT     ;CONTROL X (EXIT COMMAND)  ?
                JZ      0       ;WARM BOOT CP/M
                RET

        USERST: PUSH    H
                PUSH    D
                PUSH    B
                CALL    CONST   ;GET CONSOLE STATUS FROM CBIOS
                POP     B
                POP     D
                POP     H
                RET

        USEROT: PUSH    H
                PUSH    D
                PUSH    B
                CALL    CONOUT  ;SEND CHARACTER TO CBIOS
                POP     B
                POP     D
                POP     H
                RET

        ;       THIS ROUTINE STEALS THE CBIOS JUMP TABLE AND PUTS IT IN RAM
        ;       AT "JTAB"

        XINIT:  LHLD    1       ;GET ADDRESS OF FIRST TABLE ENTRY
                LXI     D,JTAB  ;DESTINATION ADDRESS
                MVI     B,5*3   ;NUMBER OF BYTES TO MOVE
        MOVE:   MOV     A,M     ;GET A BYTE
                STAX    D       ;MOVE IT
                INX     H
                INX     D       ;ADVANCE POINTERS
                DCR     B       ;COUNT 'EM
                JNZ     MOVE    ;LOOP
                RET

                ENDIF



                PAGE
```

```
                ;       DATA STORAGE AREA
                ;       THIS AREA MUST BE LOCATED IN RAM.
 05B6                   ORG     INSTAT+128      ;ALLOW 128 BYTES FOR I/O ROUTINES

 05B6           TIME:   DS      2               ;TIMER CALIBRATION VALUE
 05B8           FDPLX:  DS      1               ; 255 = FULL DUPLEX MODE
 05B9           MDBYTE: DS      1               ;MODE BYTE STORAGE LOC.
 05BA           NMBR:   DS      32              ;32 BYTES FOR PHONE NUMBER
 05DA                   DS      32              ;32 BYTES FOR STACK
 05FA           STKTOP  DS      1               ;TOP OF STACK

 05FB           JTAB:   DS      3               ;CBIOS JUMP TABLE IS MOVED HERE
                                                ; (FOR CP/M VERSION ONLY)
 05FE           CONST:  DS      3               ;CONSOLE STATUS VECTOR
 0601           CONIN:  DS      3               ;CONSOLE INPUT VECTOR
 0604           CONOUT: DS      3               ;CONSOLE OUTPUT VECTOR


 0607                   END START

A>
```

```
015D A1          0160 A2          0176 A3          0178 A4          019A ANCALL
0512 ANSBK       0296 ANSW        0385 BREAK       028E BRKOFF      0286 BRKON
01BB CARR        0601 CONIN       01D4 CONNECT     0604 CONOUT      05FE CONST
0000 CPM         0249 CRLF        0080 DATA        0035 DATAIN      0005 DATAOUT
0311 DELAY       02B9 DIAL        02CD DIAL2       0034 DISTAT      02D0 DL
0327 DLYLP       0004 DOSTAT      0226 EOT         0213 EOT1        0360 EXIT
05B8 FDPLX       0333 G1          0352 GAB         0235 GETC        0330 GETNUM
052D INIT        0533 INPUT       0536 INSTAT      05FB JTAB        0132 LAB0
013D LAB         041F LOSTC       01A6 MAKCALL     04FA MCONN       05B9 MDBYTE
0416 MDIAL       0497 MDPLX       0436 MEOT        03CE MNUM        0082 MODE
F000 MONIT       04B1 MREADY      039F MREC        037A MSEND       047F MSPEED
0396 MSTAT       05BA NMBR        03F9 NOASW       02E7 NOTZERO     0276 OFFHK
01F5 OK          027E ONHK        01B8 ONLINE      029E ORIG        0530 OUTPUT
020D PRINT       0258 PRINTM      02F5 PULSE       03C5 R1          0103 RENTER
0188 RINGCK      02A6 S110        02AE S300        034D SAB         0149 SELECT
02B3 SETT        0112 SIGNON      045A SIGN        0100 START       0081 STAT
05FA STKTOP      0403 TERM        05B6 TIME        0363 TRANS       01E5 TTY
0207 TTY1        0002 TXE         026E TXOFF       0266 TXON        0539 USERIN
054D USEROT      0543 USERST      0309 VARDLY      001F WORD        010F XBREAK
055A XINIT       03A9 XINPUT      0018 XIT         0106 XMSTAT      0109 XREC
010C XSEND

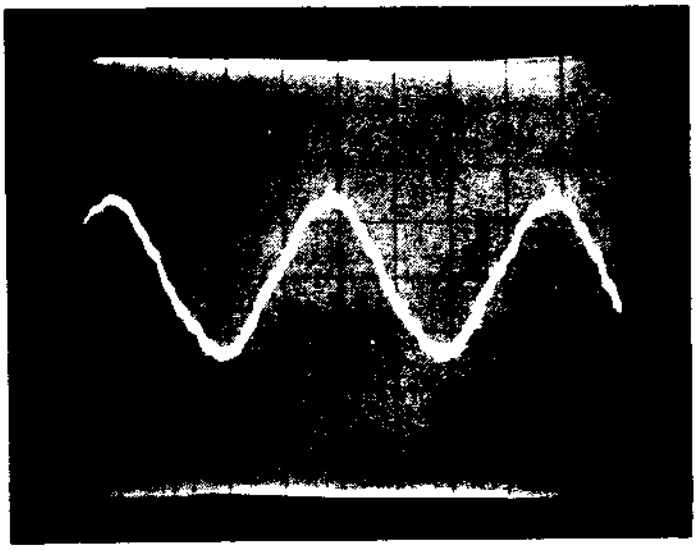
A>
```

```
0100 C3 12 01 C3 E5 01 C3 96 03 C3 9F 03 C3 7A 03 C3 .............z..
0110 85 03 97 D3 81 D3 82 32 B9 05 31 FA 05 CD 2D 05 .......2..1...-.
0120 21 5A 04 CD 58 02 3E 01 D3 82 3E 06 D3 81 D3 80 !Z..X.>...>.....
0130 3E 80 E3 E3 3D C2 32 01 D3 80 21 00 00 DB 81 1F >...=.2...!.....
0140 1F 2B 00 D2 3D 01 22 B6 05 21 7F 04 CD 58 02 CD .+..=."..!...X..
0150 A9 03 FE 59 C2 5D 01 CD A6 02 C3 60 01 CD AE 02 ...Y.]......`....
0160 CD 49 02 21 97 04 CD 58 02 CD A9 03 FE 59 CA 76 .I.!...X.....Y.v
0170 01 3E FF C3 78 01 3E 00 32 B8 05 3E 1F D3 81 CD .>..x.>.2..>....
0180 49 02 21 B1 04 CD 58 02 CD 36 05 C4 33 05 FE 02 I.!...X..6..3...
0190 CA A6 01 DB 81 E6 80 C2 88 01 CD 96 02 CD 66 02 ..............f.
01A0 CD 76 02 C3 B8 01 31 FA 05 CD 9E 02 21 CE 03 CD .v....1.....!...
01B0 58 02 CD B9 02 CD 49 02 11 58 02 DB 81 E6 40 C2 X.....I..X....@.
01C0 D4 01 CD 11 03 1B 7A B3 C2 BB 01 21 F9 03 CD 58 ......z....!...X
01D0 02 C3 26 02 CD 66 02 21 FA 04 CD 58 02 3A B9 05 ..&..f.!...X.:..
01E0 E6 04 CC 4D 03 DB 81 E6 40 C2 F5 01 21 1F 04 CD ...M....@...!...
01F0 58 02 C3 26 02 CD 96 03 A7 C4 35 02 CD 36 05 A7 X..&......5..6..
0200 CA E5 01 CD 33 05 4F CD 63 03 C3 E5 01 79 FE 04 ....3.O.c....y..
0210 C2 30 05 21 36 04 CD 58 02 06 02 CD 09 03 CD 86 .0.!6..X........
0220 02 06 28 CD 09 03 CD 7E 02 CD 6E 02 21 03 04 CD ..(....~..n.!...
0230 58 02 C3 12 01 CD 9F 03 E6 7F FE 04 CA 13 02 FE X...............
0240 05 CC 4D 03 4F CD 30 05 C9 0E 0D CD 30 05 0E 0A ..M.O.0.....0...
0250 CD 30 05 0E 00 C3 30 05 3E FF 4E B9 CA 49 02 CD .0....0.>.N..I..
0260 30 05 23 C3 58 02 3A B9 05 F6 02 C3 B3 02 3A B9 0.#.X.:.......:.
0270 05 E6 FD C3 B3 02 3A B9 05 F6 80 C3 B3 02 3A B9 ......:.......:.
0280 05 E6 7F C3 B3 02 3A B9 05 F6 08 C3 B3 02 3A B9 ......:.......:.
0290 05 E6 F7 C3 B3 02 3A B9 05 E6 FB C3 B3 02 3A B9 ......:.......:.
02A0 05 F6 04 C3 B3 02 3A B9 05 E6 FE C3 B3 02 3A B9 ......:.......:.
02B0 05 F6 01 32 B9 05 D3 82 C9 CD 30 03 CD 49 02 CD ...2......0..I..
02C0 76 02 21 16 04 CD 58 02 06 28 CD 09 03 21 BA 05 v.!...X..(...!..
02D0 7E FE 0D C8 4F CD 30 05 FE 2A 06 28 CC 09 03 23 ~...O.0..*.(...#
02E0 D6 30 C2 E7 02 3E 0A DA D0 02 FE 0B D2 D0 02 CD .0...>..........
02F0 F5 02 C3 D0 02 F5 CD 7E 02 CD 11 03 CD 76 02 CD .......~.....v..
0300 11 03 F1 3D C2 F5 02 06 0A CD 11 03 05 C2 09 03 ...=............
0310 C9 E5 D5 F5 CD 36 05 B7 C4 33 05 FE 04 CA 13 02 .....6...3......
0320 F1 11 01 00 2A B6 05 E3 E3 19 D2 27 03 D1 E1 C9 ....*......'....
0330 21 BA 05 CD A9 03 FE 12 C8 77 FE 0D C8 23 FE 7F !.........w...#..
0340 C2 33 03 0E 5F CD 30 05 2B 2B C3 33 03 E5 C5 21 .3.._.0.++.3...!
0350 12 05 7E FE FF CA 60 03 4F CD 63 03 23 C3 52 03 ..~...`.O.c.#.R.
0360 C1 E1 C9 CD 7A 03 79 FE 02 CA 85 03 FE 04 CA 13 ....z.y.........
0370 02 3A B8 05 B7 C0 CD 0D 02 C9 DB 81 E6 02 CA 7A .:.............z
0380 03 79 D3 80 C9 06 02 CD 09 03 CD 86 02 06 04 CD .y..............
0390 09 03 CD 8E 02 C9 DB 81 E6 01 3E 00 C8 2F C9 DB ..........>../..
03A0 81 E6 01 CA 9F 03 DB 80 C9 CD 36 05 B7 CA A9 03 ..........6.....
03B0 CD 33 05 FE 04 CA 12 01 4F FE 7B D2 C5 03 FE 60 .3......O.{....`
03C0 DA C5 03 DE 20 4F FE 7F C8 CD 30 05 79 C9 4E 55 .... O....0.y.NU
03D0 4D 42 45 52 20 3F 20 20 28 63 6F 6E 74 72 6F 6C MBER ?  (control
03E0 20 52 20 72 65 2D 64 69 61 6C 73 20 6C 61 73 74  R re-dials last
03F0 20 6E 75 6D 62 65 72 29 FF 4E 4F 20 41 4E 53 57  number).NO ANSW
0400 45 52 FF 0D 0A 00 43 41 4C 4C 20 54 45 52 4D 49 ER....CALL TERMI
0410 4E 41 54 45 44 FF 44 49 41 4C 49 4E 47 2D FF 0D NATED.DIALING-..
0420 0A 00 2A 2A 2A 2A 2A 20 4C 4F 53 54 20 43 41 52 ..***** LOST CAR
0430 52 49 45 52 07 FF 0D 0A 00 2A 2A 2A 2A 2A 20 43 RIER.....***** C
0440 4F 4E 54 52 4F 4C 20 44 20 52 45 43 45 49 56 45 ONTROL D RECEIVE
0450 44 20 20 28 45 4F 54 29 07 FF 44 43 48 61 79 65 D  (EOT)..DCHaye
0460 73 20 38 30 2D 31 30 33 20 4D 6F 64 65 6D 20 63 s 80-103 Modem c
0470 6F 6E 74 72 6F 6C 20 70 72 6F 67 72 61 6D FF 57 ontrol program.W
0480 41 4E 54 20 31 31 30 20 42 41 55 44 20 28 59 20 ANT 110 BAUD (Y
0490 4F 52 20 4E 29 3F FF 57 41 4E 54 20 4C 4F 43 41 OR N)?.WANT LOCA
04A0 4C 20 45 43 48 4F 20 28 59 20 4F 52 20 4E 29 3F L ECHO (Y OR N)?
```

```
04B0 FF 57 61 69 74 69 6E 67 20 66 6F 72 20 74 68 65 .Waiting for the
04C0 20 70 68 6F 6E 65 20 74 6F 20 72 69 6E 67 20 6F  phone to ring o
04D0 72 2E 2E 2E 2E 2E 2E 0D 0A 00 54 79 70 65 20 63 r.........Type c
04E0 6F 6E 74 72 6F 6C 20 42 20 74 6F 20 64 69 61 6C ontrol B to dial
04F0 20 61 20 6E 75 6D 62 65 72 FF 43 4F 4E 4E 45 43  a number.CONNEC
0500 54 49 4F 4E 20 45 53 54 41 42 4C 49 53 48 45 44 TION ESTABLISHED
0510 07 FF 00 0D 0A 00 00 00 00 00 38 30 2D 31 30 33 ..........80-103
0520 41 20 4D 4F 44 45 4D 0D 0A 00 00 00 FF C3 5A 05 A MODEM.......Z.
0530 C3 4D 05 C3 39 05 C3 43 05 DB 35 E6 7F FE 18 CA .M..9..C..5.....
0540 00 F0 C9 DB 34 E6 01 3E 00 C8 3E FF C9 DB 04 E6 ....4..>..>.....
0550 02 CA 4D 05 79 D3 05 C9 00 00 3E 01 D3 84 C9 F1 ..M.y.....>.....
-
```

APPENDIX D

TYPICAL WAVEFORMS



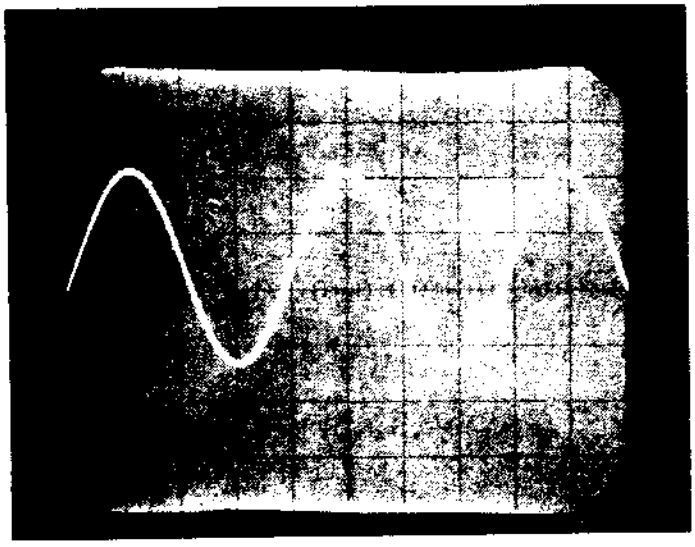
MODULATOR OUTPUT

INTO 600 OHM LOAD

.2 MS / CM HORIZ.

.5 V / CM VERT.

PIN 5, U6



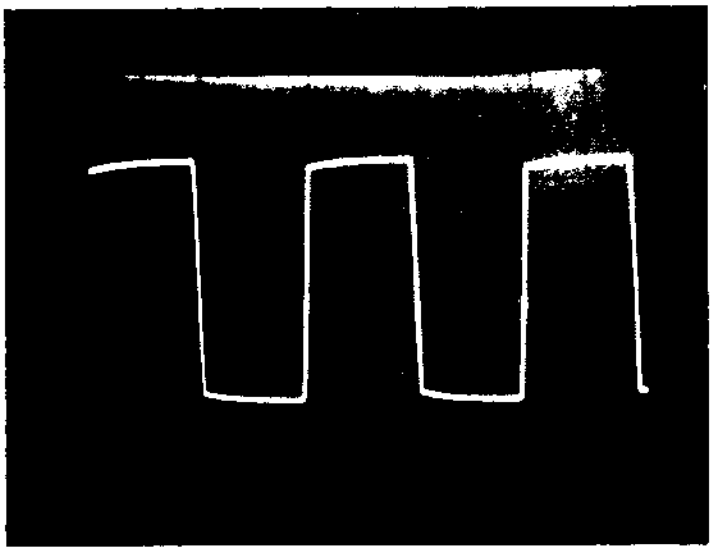
FILTER OUTPUT

IN SELF TEST

.2 MS / CM HORIZ.

1V / CM

PIN 5, U3

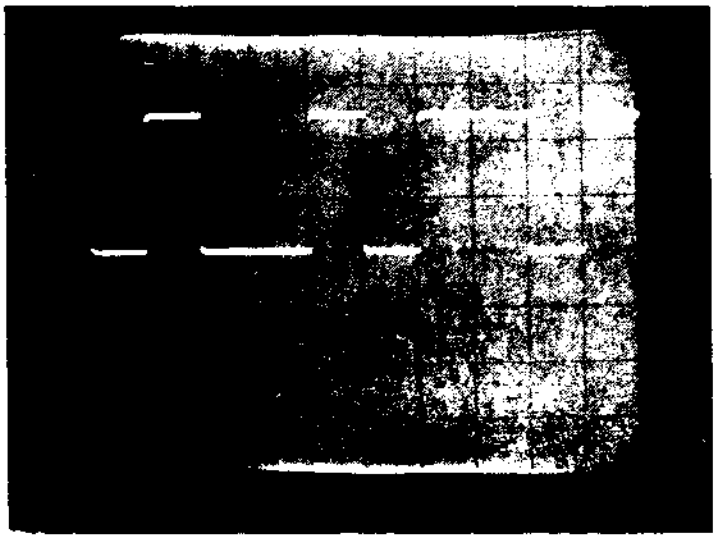


LIMITER OUTPUT

.2 MS / CM HORIZ.

5 V / CM VERT.

PIN 7, U3



CHARACTER FRAME

START BIT

HEX (69) LSB FIRST

STOP BIT

1 BIT / CM HORIZ.

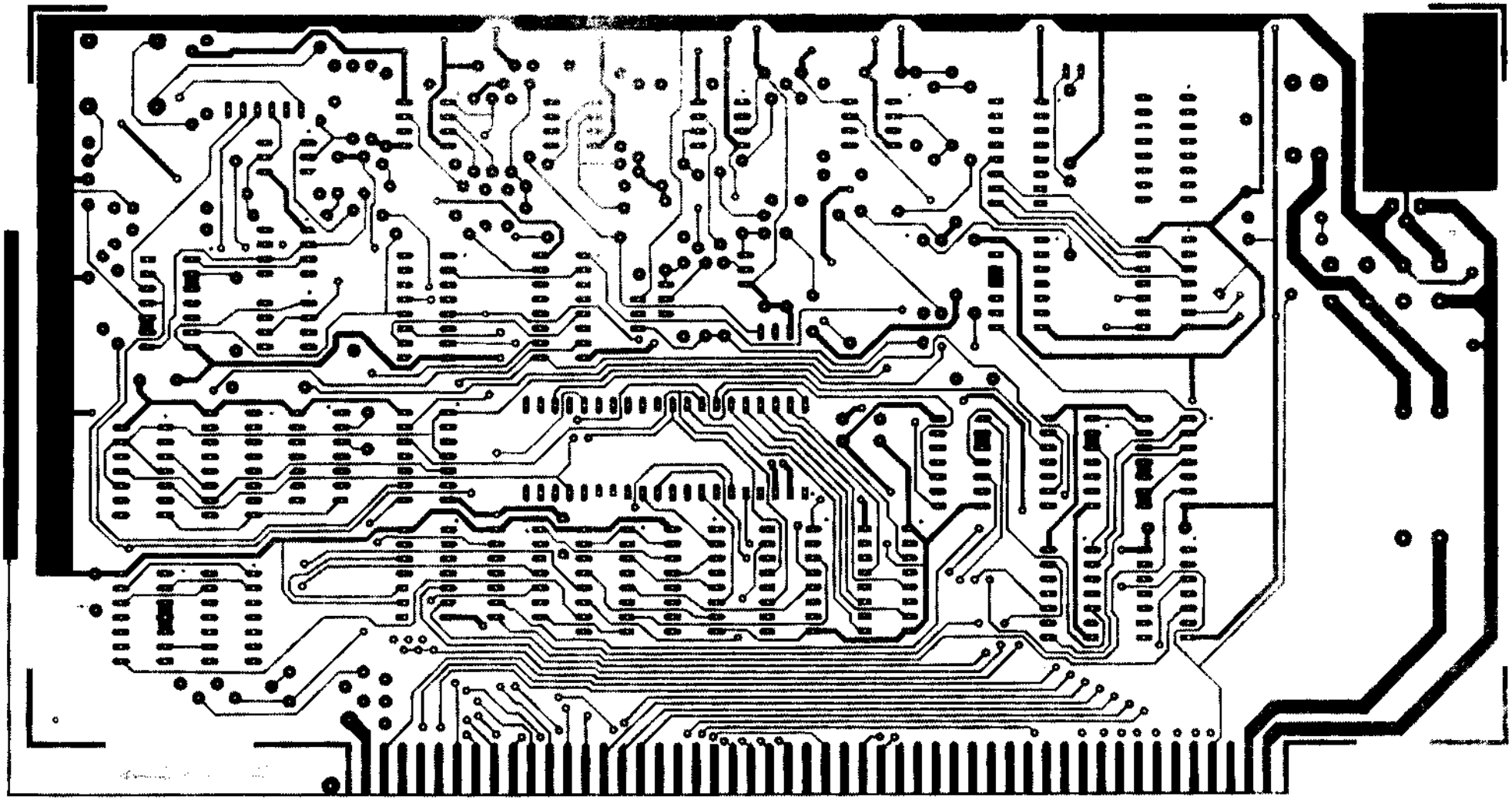
2 V / CM VERT.

PIN 25, U19

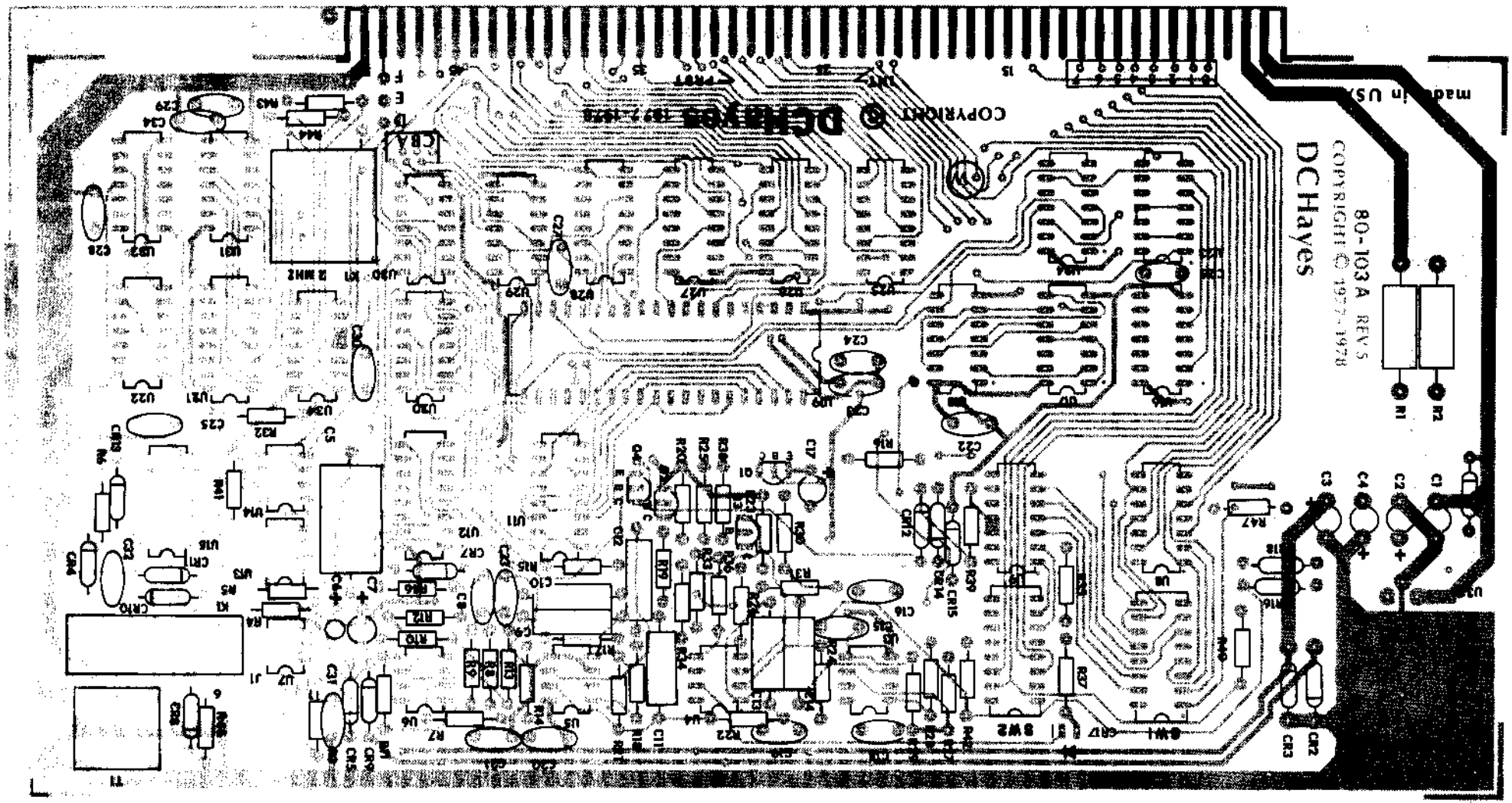
APPENDIX E

BOARD LAYOUT

WIRING SIDE



COMPONENT SIDE



80-103A DATA COMMUNICATIONS ADAPTER

SN_____

We believe the information in this manual is accurate. However, should you find errors or want to comment about our product, you can fold this sheet and mail it to us.

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