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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 (D10 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
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.

![Screw Terminals on DAA](image)

**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
   1. Coupler Controls Line
   2. Telephone Controls Line

C. Telephone Ringer Wiring Option
   1. Ringer Connected on Telephone Side of exclusion key
   2. 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.
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.

<table>
<thead>
<tr>
<th>OUTPUT LEVEL dBm</th>
<th>R7 VALUE Ohms</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1000</td>
</tr>
<tr>
<td>-1.1</td>
<td>1100</td>
</tr>
<tr>
<td>-2.2</td>
<td>1300</td>
</tr>
<tr>
<td>-3.3</td>
<td>1500</td>
</tr>
<tr>
<td>-4.2</td>
<td>1700</td>
</tr>
<tr>
<td>-5.4</td>
<td>2000</td>
</tr>
<tr>
<td>-6.1</td>
<td>2200</td>
</tr>
<tr>
<td>-7.0</td>
<td>2500</td>
</tr>
<tr>
<td>-8.2</td>
<td>3000</td>
</tr>
<tr>
<td>-9</td>
<td>3300</td>
</tr>
<tr>
<td>-9.9</td>
<td>3900</td>
</tr>
<tr>
<td>-11</td>
<td>4700</td>
</tr>
<tr>
<td>-12</td>
<td>5600</td>
</tr>
</tbody>
</table>

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 80103A 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 | SW1 | SW2 | | PORT | SW1 | SW2 |
|------|-----|-----| |------|-----|-----|
| 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   | P   | 4   | | C0   | P   | 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   | | FC   | C   | 0   |
| 74   | 8   | 4   | | F4   | 8   | 0   |
| 78   | 4   | 4   | | F8   | 4   | 0   |
| 7C   | 0   | 4   | | FC   | 0   | 0   |

**D.C. Hayes Associates, Inc.**

**TABLE 3.7 1/0 MAPPED LOCATIONS**
<table>
<thead>
<tr>
<th>ADR</th>
<th>SW1</th>
<th>SW2</th>
<th>ADR</th>
<th>SW1</th>
<th>SW2</th>
</tr>
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<td>0400</td>
<td>B</td>
<td>F</td>
</tr>
<tr>
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<td>7</td>
<td>F</td>
<td>0800</td>
<td>7</td>
<td>F</td>
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</tr>
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<td>2800</td>
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<td>F</td>
</tr>
<tr>
<td>2C00</td>
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<td>2C00</td>
<td>1</td>
<td>F</td>
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<td>3800</td>
<td>4</td>
<td>F</td>
</tr>
<tr>
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<td>3C00</td>
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<tr>
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<td>7</td>
<td>7</td>
</tr>
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<td>7</td>
</tr>
<tr>
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<td>E</td>
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<td>E</td>
<td>7</td>
</tr>
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<td>7</td>
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<td>A</td>
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<td>6C00</td>
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<td>1</td>
<td>7</td>
</tr>
<tr>
<td>7000</td>
<td>C</td>
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<td>7000</td>
<td>C</td>
<td>7</td>
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<tr>
<td>7C00</td>
<td>0</td>
<td>7</td>
<td>7C00</td>
<td>0</td>
<td>7</td>
</tr>
</tbody>
</table>

D.C. Hayes Associates, Inc.
3.8 INTERRUPT OPTION

The 80103A 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.

![Diagram showing the interrupt options]

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.

<table>
<thead>
<tr>
<th>LS 2</th>
<th>LS 1</th>
<th>NUMBER OF BITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>8</td>
</tr>
</tbody>
</table>

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.

\[
\begin{align*}
\text{PI} = 0 & \Rightarrow \text{PARITY} \\
\text{PI} = 1 & \Rightarrow \text{NO PARITY}
\end{align*}
\]

4.1.3 CONTROL REGISTER 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.

- \( BRS = 0 \rightarrow \) selects 110 bits per second (BPS).
- \( BRS = 1 \rightarrow \) selects 300 BPS

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

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).

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

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:

<table>
<thead>
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<th>75 BAUD</th>
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In general, the lower half of U31 decodes the one bits of a count in U21 which is equal to \( 1,000,000/(32 \times B - 2) \) where \( B \) is the desired baud rate.
INPUT REGISTERS

RECEIVER REGISTER ADDRESS = BASE

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STATUS REGISTER ADDRESS = BASE +1

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<tbody>
<tr>
<td>RI</td>
<td>CD</td>
<td>OE</td>
<td>FE</td>
<td>PE</td>
<td>TRE</td>
<td>RRF</td>
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</tbody>
</table>

RRF  READER 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

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<th>2</th>
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CONTROL REG. 1 ADDRESS = BASE +1

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<tbody>
<tr>
<td>PI</td>
<td>SBS</td>
<td>LS2</td>
<td>LS1</td>
<td>EPE</td>
</tr>
</tbody>
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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
 1 = NO PARITY
PI  PARITY INHIBIT
 1 = NO PARITY

CONTROL REG. 2 ADDRESS = BASE +2

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</tr>
</thead>
<tbody>
<tr>
<td>OH</td>
<td>TIE</td>
<td>ST</td>
<td>BK</td>
<td>MS</td>
<td>TXE</td>
<td>BRS</td>
</tr>
</tbody>
</table>

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

D.C. Hayes Associates, Inc.

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.

\[
\begin{align*}
MS = 0 & \Rightarrow \quad \text{Answer, ring interrupts enabled} \\
MS = 1 & \Rightarrow \quad \text{Originate, ring interrupts disabled}
\end{align*}
\]

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.

\[ \text{TIE} = 0 \quad \text{Transmitter interrupts disabled} \]
\[ \text{TIE} = 1 \quad \text{Transmitter interrupts enabled} \]

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
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APPENDIX B

PART LIST
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**DATE** 9-1-78  **REV** 5  **DRW**  **APR**

D.C. Hayes
Associates, Inc.

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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 microcomputer 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
CP/M MACRO ASSEM 2.0   #002   MODEM 2.0

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   MSSEND   ;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 28   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
CP/M MACRO ASSEM 2.0  #003  MODEM 2.0

014F  CDA903  CALL  XINPUT  ;YES TO 110 BAUD QUESTION
0152  FE59   CPI  'Y'  ;SET TO 110 BAUD
0154  C25D01  JNZ  A1
0157  CDA602  CALL  S110
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  ;ASK DUPLEX MODE QUESTION
0166  CD5802  CALL  PRINTM  ;HALF DUPLEX?
0169  CDA903  CALL  XINPUT
016C  FE59   CPI  'Y'
016E  CA7601  JZ  A3
0171  3EFF   MVI  A,255
0173  C37801  JMP  A4
0176  3E00   A3:  MVI  A,0
0178  328805  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  ;TELL 'EM WE ARE READY
0185  CD5802  CALL  PRINTM

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  J2  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:
CALL TXON ;TURN ON TRANSMITTER
LXI H,MCONN ;PRINT "CONNECTION ESTABLISHED"
CALL PRINTM
LDA MDBYTE ;GET CURRENT MODE
ANI 4 ;ISOLATE ORIG/ANSW BIT
CZ SAB ;SEND ANSWER-BACK

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

TTY: IN STAT ;GET MODEM STATUS
ANI 40H ;ISOLATE CARRIER DETECT BIT
JNZ OK
LXI H,LOSTC ;POINT TO STRING "LOST CARRIER"
CALL PRINTM ;PRINT THE STRING
JMP EOT ;DISCONNECT
CALL MSTAT ;SEE IF WE GOT A BYTE FROM MODEM
ANA A
CNZ GETC ;GET THE BYTE
CALL INSTAT ;CHECK THE CONSOLE STATUS
ANA A ;SET THE FLAGS
JZ TTY ;LOOP IF STATUS NOT TRUE
CALL INPUT ;GET THE CONSOLE CHARACTER
MOV C,A ;SAVE IT
CALL TRANS ;SEND AND ECHO THE CHAR.
JMP TTY ;LOOP AGAIN

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

PRINT: MOV A,C ;GET A BYTE
CPI 4 ;CHECK FOR EOT
JNZ OUTPUT ;OUTPUT THE BYTE
LXI H,MEOT ;POINT TO STRING "EOT"
CALL PRINTM ;PRINT IT
MVI B,2 ;SET FOR 100 MS DELAY
CALL VARDLY ;WAIT 2 SECONDS
CALL BRKON ;SEND CONSTANT SPACE (BREAK)
MVI B,40
CALL VARDLY ;DO IT FOR 2 SECONDS
CALL ONHK ;HANG UP PHONE
CALL TXOFF ;TURN OFF TRANSMITTER
LXI H,TERM ;POINT TO STRING "TERMINATED"
CALL PRINTM ;PRINT THE STRING
JMP SIGNON ;BACK TO THE START

GETC: CALL MREC ;GET THE MODEMS BYTE
ANI 7FH ;KILL PARITY
CP/M MACRO ASSEM 2.0 #005 MODEM 2.0

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,ODH
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 89 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 MBYTE
0269 F602 ORI 2 ;TURN ON TRANSMITTER
026B C3B302 JMP SETT

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

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

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

0286 3AB905 BRKON: LDA MBYTE
CP/M MACRO ASSEM 2.0  806  MODEM 2.0

0289 F608  ORI  08H  ;SET BREAK BIT
028B C3B302  JMP  SETT

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

0296 3AB905  ANSW: LDA  MBYTE  ;GET CURRENT MODE BYTE
0299 E6FB  ANI  0F8H  ;SET MODE BIT TO ZERO (ANSWER MODE)
029B C3B302  JMP  SETT

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

02A6 3AB905  S110: LDA  MBYTE
02A9 E6FE  ANI  0F8H  ;RESET SPEED BIT (110 BAUD)
02AB C3B302  JMP  SETT

02AE 3AB905  S300: LDA  MBYTE
02B1 F601  ORI  1  ;SET SPEED BIT (300 BAUD)
02B3 32B905  SETT: STA  MBYTE
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  CR LF  ;CARRAGE RETURN, LINE FEED
02BF CD7602  CALL  OFFHK  ;GO OFFHOOK
02C2 211604  LXI  H,M DIAL  ;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 D530  SUL  30H  ;REMOVE ASCII BLAS
02E2 C2702  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 FB0B  CPI  11  ;CHECK FOR MORE THAN 10
02EC D2D002  JNC  DL  ;IF MORE GET NEXT DIGIT
CP/M MACRO ASSEM 2.0  #007  MODEM 2.0

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
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
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
039D 2F  CMA
039E C9  RET

; 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 CA903  JZ  XINPUT  ; LOOP UNTIL READY
03B0 CD305  CALL  INPUT
03B3 FE04  CPI  4  ; CONTROL D?
03B5 CA1201  JZ  SGNON
03B8 4F  MOV  C,A
03B9 FE7B  CPI  7BH
CP/M MACRO ASSEM 2.0 #010 MODEM 2.0

03BB D2C503 JNC RL
03BE F660 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 ;DON'T ECHO RUBOUTS
03C8 C8 RZ CALL OUTPUT
03C9 CD3005 MOV A,C
03CC 79 RET
03CD C9

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 2A2A2A2A DB '***** LOST CARRIER'
0434 07FF DB 7,255

0436 0D0A00 MEOT: DB 0DH,0AH,0
0439 2A2A2A2A 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 434F4E4E45MCNONN: 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 REGISTER 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
CP/M MACRO ASSEM 2.0  #012  MODEM 2.0

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 CB IOS
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 CB IOS
POP B
POP D
POP H
RET

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

; THIS ROUTINE STEALS THE CB IOS 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
; 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 DUPELX MODE
05B9  MBYTE: 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>
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 67 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 6C ontrol B to dial
04F0 20 61 20 66 75 6E 6D 65 72 4F 43 4F 4E 45 43 a number. CONNECT
0500 5A 49 4F 4E 64 65 73 69 67 6E 73 74 65 73 69 6E 73 TION ESTABLISHED
0510 0D FF 00 0D 0A 00 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 00 FF C3 5A 05 A MODEM...... 2.
0530 C3 4D 05 C3 39 05 C3 43 05 DB 35 E6 7F FE 18 CA .M...9..C...5.....
0540 00 FO 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

0.2 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
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.

All comments become the property of DCHayes Associates, Inc.

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