

VECTOR

SAFSTOR
HARDWARE

Technical Information

SAFSTOR-HARDWARE

TECHNICAL INFORMATION

Revision A

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FOREWORD

Audience

This manual is intended for computer distributors, or others with at least a moderate technical knowledge of small computers.

Scope

It will describe how to add a Tape Drive unit to a 3005, 3105, 3032 and both MultiShare Vector Graphic computer systems. This manual will use the following terms to describe the various types of Vector Graphic Systems:

Description/New Name

Single user systems using a MZ Chassis/
Vector 2 Series

Single user systems using a Vector 3 Chassis/
Vector 3 Series

Multiuser systems using a MZ Chassis/
Vector 5 Series

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SECTION I - INTRODUCTION

1.1 WHAT COMPONENTS COME WITH YOUR TAPE ADD-ON KIT

Summary: The Tape Add-On Kit comes with an interface board (with associative cables), tape drive, and system disk. Installation and use of these components is described in this manual and other supporting documentation.

This manual describes how to install the Tape Add-On Kit. It also provides specific technical information on both the tape drive and Interface board.

The Interface Board has two separate subsystems. One subsystem supports the tape interface function. The other subsystem operates the clock/calendar function. Both of these subsystems require the use of special system software (included on your system floppy disk) which is fully described in the SAFSTOR-SOFTWARE REFERENCE MANUAL.

The clock/calendar subsystem also has a serial port which can be used for asynchronous or synchronous I/O operations. Both of these features are described in Section III of this manual.

1.2 HOW TO INSTALL THE TAPE INTERFACE BOARD AND CABLES

Summary: The Tape Interface Board and associated cables provide the hardware link between the CPU and Tape Drive. Installation of these components is accomplished by completing the following steps.

- Turn the power to your computer off and take out the AC plug. Remove the Vector 3 (or other computer) cover.
- Locate the Tape Interface Board and insert it into an available S-100 slot with the circuit side facing forward. This is accomplished by pushing the board into the slot until it locks with a clicking sound.
- Uncoil the 50-conductor cable that comes from the back panel of the Tape Drive unit.

Vector 3 Series

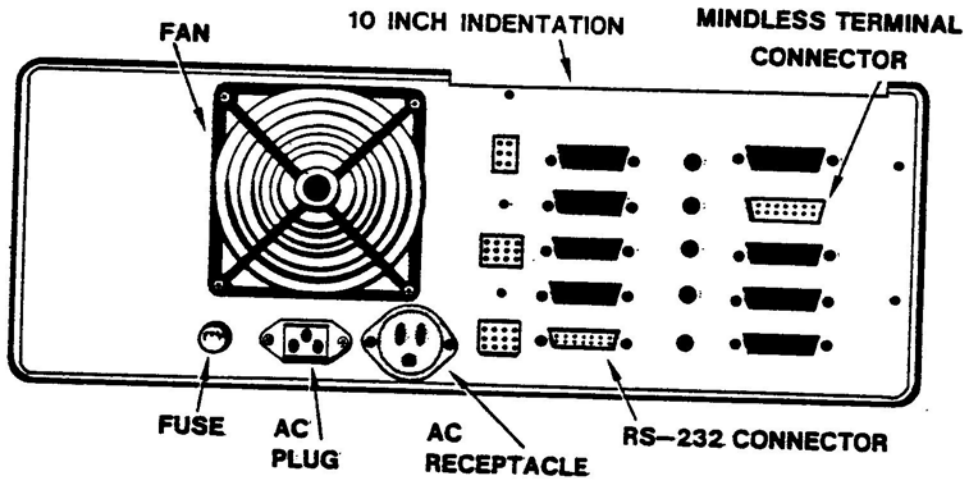
1. Loosen the strain relief clamp located above the 34-Pin connector (see Exhibit 1-1).
2. Guide the 50-conductor cable under the strain relief clamp to the Tape Controller board and insert the cable connector into the J2 connector. The J2 connector has a keyed region allowing you to attach the connector in only one orientation.
3. Check to make sure all the signal/data cables are under the strain relief clamp and tighten the clamp.
4. Check all connections for proper fitting and tightness. Place the Vector 3 cover back on the chassis.
5. Connect the Tape Drive power cord to an AC receptacle (see Section 2.3).

Vector 2.5 Series

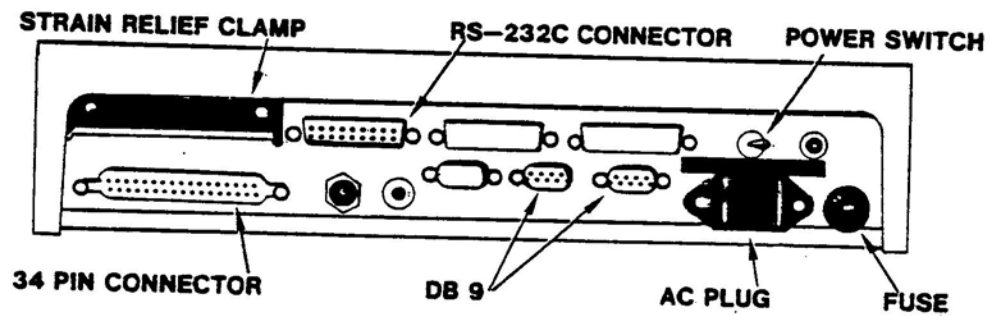
1. Guide the 50-conductor cable over the 10 inch long indentation in the top edge of the MZ Back Panel (located above the mindless terminal connectors). Insert the signal/data cable connector into the J2 connector on the Tape Controller board. The J2 connector has a keyed region allowing you to attach the connector in only one orientation.
2. Check all connections for proper fitting and tightness. Place the MZ (MZ5) cover back on the chassis.
3. Connect the Tape Drive power cord to an AC receptacle (see Section 2.3).

EXHIBIT 1-1 BACK PANELS OF VECTOR GRAPHIC COMPUTERS

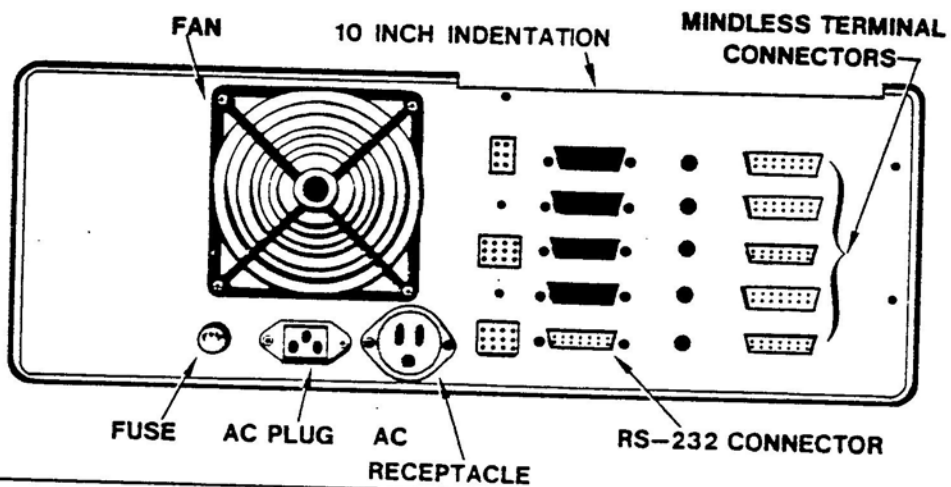
VECTOR 2 SERIES



VECTOR 3 SERIES



VECTOR 5 SERIES



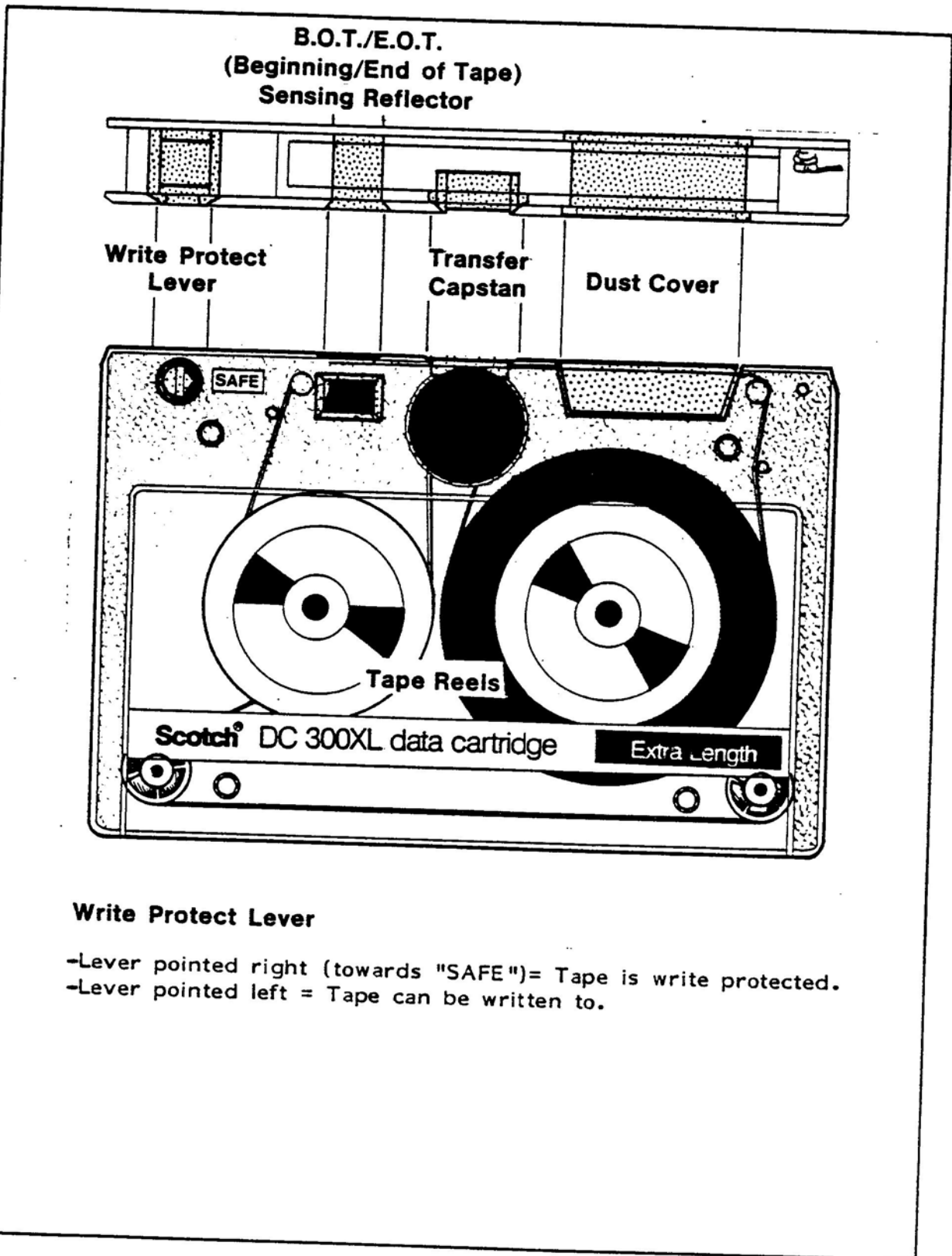
1.2 HOW TO LOAD THE TAPE

Summary: The SafStor System uses a 1/4 inch tape cartridge. This tape is inserted into the tape transport subassembly in a particular manner.

Loading the tape cartridge is accomplished by following the next group of steps.

1. Make sure your tape drive has power by checking the "power-on" light located on the front panel of the tape drive.
2. Locate the write protect lever on the cartridge and turn it to the appropriate position (see Exhibit 1-2).
3. Insert the cartridge, with the metal side down, into drive unit through the protective drive opening. Slide the cartridge along the grooves (located on edges of the drive opening) until it locks in causing a clicking sound.

EXHIBIT 1-2 TAPE TRANSPORT



Write Protect Lever

- Lever pointed right (towards "SAFE")= Tape is write protected.
- Lever pointed left = Tape can be written to.

SECTION II - TAPE BACK UP SUBSYSTEM

2.1 SUBSYSTEM SPECIFICATIONS

Summary: The Tape Drive Unit consists of a tape transport and an independent power supply housed in metal enclosure. This section gives the specifications of these subassemblies along with power requirements for the interface board.

TAPE TRANSPORT

Performance Specifications

Cartridge Type	See <u>Section 1.2.</u>
Recording Density	6400 BPI, MFM.
Transfer Rate	192,000 Bits/Sec @ 6400 BPI MFM and 30 IPS.
Recording Mode	4 Track serial.
Tape Cleaner	Integral
Drive	Single capstan motor drives roller inside the cartridge (no contact between tape and capstan).
Capstan Servo	Velocity feedback, generated from digital tachometer.
Tape Speed, Synchronous	30 ips (0.76 m/s) forward and reverse.
Tape Speed, Search	90 ips (2.3 m/s) +/- 5%, long term forward and reverse.
Rewind Speed	Same as reverse search speed.

Typical Data Specifications

Packing Density	252 bits per millimeter (6400 bpi).
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Recording Code	Modified frequency modulation, serial by bit.
Data Rate	192K bits per second (6400 BPI @ 30 IPS).
Interface	MFM into write electronics and out of read electronics.

POWER SUPPLY

Voltage option	115 VAC +/-10%	220 VAC +/-10%
Frequency	60 Hz +/-5%	50 Hz +/-5%
Current, Operating	.70 Amps	.35 Amps
Current, Surge	.50 Amps	.25 Amps
Power Dissipation	80.50 Watts	80.50 Watts
Fused at 1 amp		

DIMENSIONS AND WEIGHT *

Height	7.50 inches (19.05 cm)
Depth	14.50 inches (36.83 cm)
Width	8.30 inches (21.08 cm)
Weight	15.60 pounds (7.08 kg)

POWER REQUIREMENTS FOR INTERFACE BOARD

+5Vdc @ 760 mA (regulated voltage)
Minimum +8Vdc required by this regulator

+12Vdc @ 20 mA (regulated voltage)
Minimum +16Vdc required by this regulator

-12Vdc @ 8 mA (regulated voltage)
Minimum -16Vdc required by this regulator

* Includes signal and power cables.

**2.2 WHAT TYPE OF TAPE SHOULD BE USED WITH
YOUR TAPE DRIVE ?**

Summary: The Tape Drive requires a cartridge which meets specific standards. These standards are described in this section.

The magnetic tape cartridge type is given in ANSI X3.55 1977 specifications. These specifications can be obtained by writing to:

American National Standards Institute, Inc.
1430 Broadway
New York, New York 10018

The cartridge can have a 300 or 450 foot tape length. These lengths provide 12 and 17 Megabytes of unformatted storage area. The 450 foot tape can be used for the larger Vector Graphic Systems (Quantum Drive Units). The 300 foot tape is adequate for Vector Graphic Systems which use the 5 1/4 inch hard disk.

The SCOTCH Tape shown in Exhibit 1-2 is the recommended tape cartridge.

2.3 WHERE SHOULD THE TAPE DRIVE BE LOCATED ?

Summary: The Tape Drive Unit has an independent power supply which requires it to be located next to an AC receptacle. Other environmental factors must also be considered before the Tape Drive can be permanently positioned.

The Vector 2 and Vector 5 series systems have an AC receptacle on the back panel of the computer chassis. This can be used in lieu of a wall receptacle for these type of systems.

Other environmental factors are described in following chart:

Temperature, operating	+5 to +45 C, cartridge limited
Temperature, non-operating	-30 to +60 C, hardware +5 to 45 C, cartridge storage -40 to +45 C, cartridge transportation
Humidity	20% to 80% non condensing
Altitude, operating	300 m (10,000 feet) maximum
Altitude, non-operating	12000 m (40,000 feet) maximum
Vibration, operating	Tested with 0.5 G, 10 to 60 Hz
Shock, non-operating	Tested with 50G, 10 ms, half sinewave
Operating attitude	Any except with cartridge loaded directly upward; oxide residue from the tape cleaner and head may fall into the cartridge and reduce data reliability when mounted in this mode.

2.4 HOW THE TAPE DRIVE IS CLEANED

Summary: Your tape drive must be cleaned at specific intervals if it is to operate at maximum efficiency. The cleaning procedures require the use of alcohol and a lint free cloth.

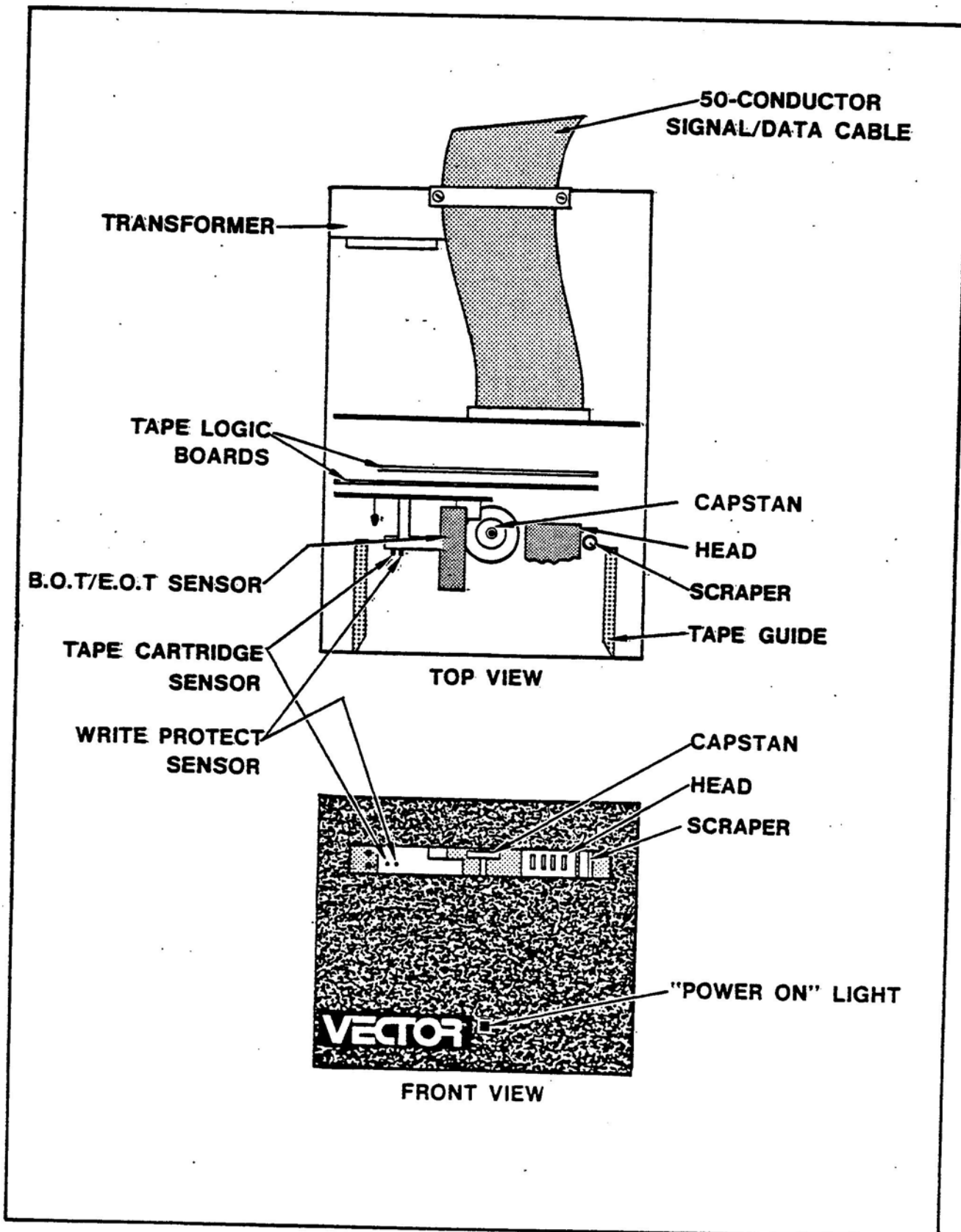
Cleaning Intervals

The Tape transport is cleaned after 8 hours of use or once a week- which ever comes first.

Cleaning Procedures

1. Toggle the power switch, on the back of the tape drive, to the OFF position.
2. Disconnect the tape drive power cord from the AC receptacle.
3. Locate the 4 screws holding the top cover to the tape drive chassis. They are positioned in pairs on each side of the cover (three inches in from the front and back ends). Remove these screws along with the cover and put them on a flat surface next to the drive.
4. Obtain a rectangular section of lint free cloth (approximately 12 X 16 inches) and fold it length-wise until its width is about 1 inch. Fold this long section in half causing the two extreme ends to touch. This cloth can now be used as a swab to clean the tape drive components.
5. Apply a small amount of isopropyl alcohol to one side (at folded end) of the swab.
6. Locate the tape transport subassembly (See Exhibit 2-1) and gently wipe the HEAD component with the alcohol side of the swab. Move the swab in one direction from right to left so that the dirt will be wiped from the HEAD to the cloth.
7. Apply a small amount of alcohol to the other side (at folded end) of the swab and wipe the HEAD again.

EXHIBIT 2-1 TAPE TRANSPORT SUBASSEMBLY



8. Invert swab at center fold so that the two inside clean edges are now outside. Apply alcohol to these surfaces and clean the tape scraper in a one stroke vertical motion.
9. The capstan is cleaned with any unused moistened surface. This can be accomplished by gently wiping the capstans edges clockwise and then counter clockwise.
10. While the alcohol is drying check the tape drives circuitry and make sure there are no loose connectors.
11. Secure the tape drive cover and reconnect the power cord.

Synchronous	
Rates	DC-615KHz
Synch detect	Can be wired for internal or external synch; 8251 SYNDET line is not connected
Parity	Even, odd, or none, programmable for each port
Data bits	5-8 programmable for each port
Sync character	Single or double synch character can be programmed for each port independently

3.2 WHAT ARE THE GENERAL FEATURES OF THE CLOCK/CALENDAR SUBSYSTEM

Summary: The Clock/Calendar Subsystem provides an accurate time keeping mechanism for the S-100 bus based computer system. In addition, an unused RS-232C serial port is also available for connection to a modem or printer.

A. Introduction

Complete programs and subroutines are provided in both assembly language and Basic to permit the user to interface with the Subsystem easily. One program included with the Subsystem allows the user to display the time and date on the CRT console. Another program allows the user to set the time and date.

The information available at the Clock/Calendar interface ports are easily accessible through either assembly language or higher level language subroutines. Representative examples of both are included in the SAFSTOR-SOFTWARE REFERENCE MANUAL. This permits the development of sophisticated time-dependent software such as appointment calendars and time organizers. In addition, processes can be monitored and changes in state can be recorded automatically.

B. Design Features

The Clock/Calendar Subsystem makes use of available LSI technology to reduce chip count. Major LSI devices used are an 8255 Parallel I/O chip, an 8251 USART and a 5832 clock IC.

The clock portion of the circuit is powered even when main computer power is off. A rechargeable battery backup system holds the clock up for up to 14 days. Board circuitry automatically recharges NICAD batteries when power is reapplied.

The Serial I/O port (on the Clock/Calendar Subsystem) can be used to connect the host to a modem if the available serial port on the ZCB is being used with the printer. It can be run at any speed from 110 to 9600 baud.

C. Determination of Use

With the included software, the Clock/Calendar Subsystem is immediately functional on any standard Vector Graphic system. If you are installing this Subsystem in a non-standard or a modified system first make sure that there will be no port addressing conflicts with existing interface boards and this Subsystem. If there are, you will most likely want to change the port addressing of the Clock/Calendar Subsystem because all your software is currently set up for your present equipment. This means that you will have to change the software included with this Subsystem as well as changing the port addresses of the Clock/Calendar Subsystem itself. To change the hardware, port addresses go to Section 3.4 of this manual. To change the port addresses of the software, go to the SAFSTOR-SOFTWARE TECHNICAL INFORMATION MANUAL.

3.3 HOW THE CLOCK/CALENDAR SUBSYSTEM WORKS

Summary: The theory of operation of the Clock/Calendar Subsystem is best understood when the circuit is considered as 6 segments as shown in Exhibit 3-1.

A. Data I/O Buffers

Data is received from S-100 bus lines DO0-DO7 and is buffered onto the internal data bus DB0-DB7 by U29 and U30 (8T28's). The tri-state buffers are gated by the IOWR signal generated by the address decoding section described below.

Data is output from the internal data bus onto the S-100 bus via tri-state buffers U29 and U30. The buffers are gated by the IORD/ signal (/ indicates active low) also supplied by the address decoding section.

The internal data bus is held up by 5V running through a 4.7K ohm resistor pack (Z2). POC is provided to the Subsystem by running POC/ from the S-100 bus (pin 99) through an inverter (U25-5,6).

B. Power Regulation

The on-board power regulation is straightforward using standard components.

5V @2A is provided by running the unregulated 9V from S-100 pins 1 and 51 through a pair (VR3, VR4) of 7805's. .1 mfd despiking capacitors are used as needed.

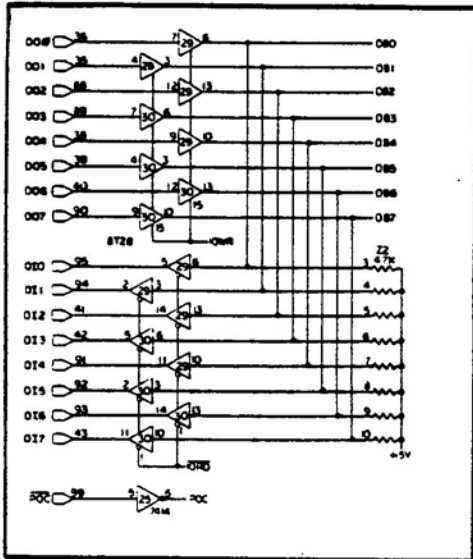
+12V @1A is derived from pin 2 (+18V) of the S-100 bus run through a 7812 (VR1). This voltage is used by the RS-232 line drivers.

-12V @1A results from the -18V of pin 52 of the S-100 bus being run through VR2 (a 7912). This voltage is used by the RS-232 line drivers.

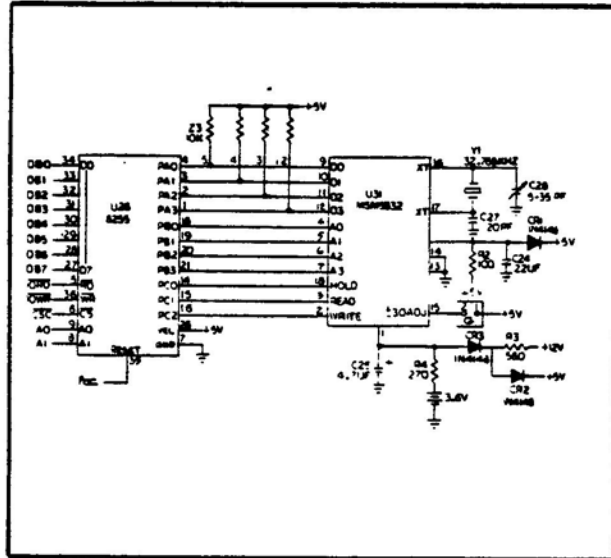
C. Clock and Interface

This is one of the most complex portions of the Clock/Calendar Subsystem. The 8255 is used as a dedicated multi-port parallel I/O device to provide a route for the bidirectional data transfer of clock information and to send the proper control signals to the MSM 5832 clock chip.

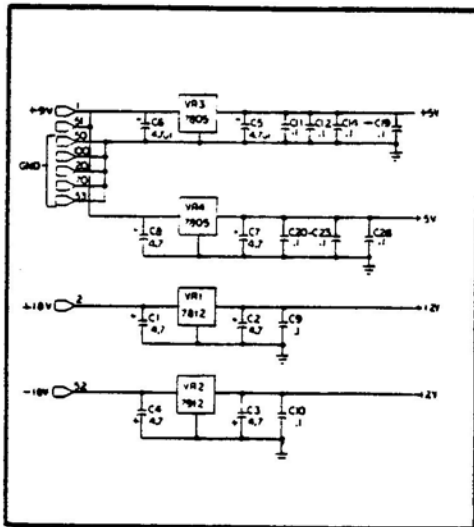
EXHIBIT 3-1 SCHEMATICS OF CLOCK/CALENDAR SUBSYSTEM



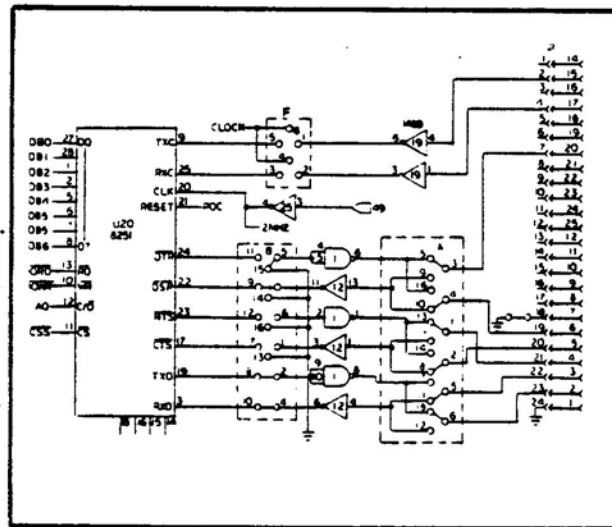
DATA I/O BUFFERS



CLOCK AND INTERFACE



POWER REGULATION



SERIAL PORT

EXHIBIT CONTINUED ON NEXT PAGE

The scheme is further complicated by the fact that the 8255 itself is a programmable device and must itself be configured by software before it can do its job of controlling the signals input to and output from the clock chip. It is suggested that the reader look up the specifications for the 8255 to gain an appreciation for this versatile device.

The 8255 is selected when CSC/ (provided by address decoding logic) goes low. Whether a read or write operation will be performed is determined by IORD/ or IOWR/ which is also supplied by the address decoding section of the circuit. Address lines, wired straight through to the 8255, determine whether Port A, B, C or the control register are being addressed.

The 8255 has 24 I/O pins which may be grouped as three ports A, B and C. The device has 3 major modes of operation and there may be up to 16 different configurations within each mode which are all designated by software. On this board, the 8255 is used in Mode 0. This provides simple input/output functions in which outputs are latched and inputs are not latched. Configuration 8 of Mode 0 is used when performing a read operation: Port A is input, Port B is output and all 8 bits of Port C are output. This configuration is set during initialization by outputting the value of 90H to the control port, addressed at 87H on the Subsystem as shipped. Configuration 1 of Mode 0 is used when performing a write operation: all 3 8255 ports are set to output. This configuration is set by outputting a value of 80H to the control port.

The MSM 5832 clock chip keeps time with a 32.768 Khz oscillator. Current time and calendar information are stored in 13 internal 4-bit registers or counters. When these counters are addressed over a 4 bit address bus, they will present data on the 4 bit data bus if the READ and HOLD lines are high or will write data from the 4 bit data bus if the WRITE and HOLD lines are high. The control bus consists of 3 lines.

The following chart details the register addresses within the clock chip. To read data from the clock chip, the clock control lines must be set. These addresses must be output to port B (85H) before the appropriate data can be read from the data bus on port A (84H).

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<u>Description</u>	<u>Register</u>
SECONDS-UNITS	0
SECONDS-TENS	1
MINUTES-UNITS	2
MINUTES-TENS	3
HOURS-UNITS	4
HOURS-TENS	5
DAY OF THE WEEK	6
DATE-UNITS	7
DATE-TENS	8
MONTH-UNITS	9
MONTH-TENS	10
YEAR-UNITS	11
YEAR-TENS	12

The four bit data bus from the 8255 to the clock chip occupies the bottom 4 bits of Port A, the four bit address bus to the clock chip occupies the bottom 4 bits of Port B and the clock control lines use the lower 3 bits of Port C. The control port of the 8255 uses all 8 bits.

There are three control lines to the clock chip which are controlled by the bottom 3 bits of port C. These are READ, WRITE and HOLD. The HOLD line must be held high simultaneously with either the WRITE or READ line. At the conclusion of each read or write session, a 00H must be output to Port C in order to take the clock chip out of the hold mode.

Momentarily connecting pad 1 to pad 2 of Jumper Area G while the board is active will reset seconds to zero. If the seconds were 30 or more, the minute register will be incremented by one. If the seconds were 29 or less, the minutes will remain unchanged.

See SAFSTOR-SOFTWARE TECHNICAL INFORMATION MANUAL for more information.

D. Serial Port

See Appendix A for a complete discussion of Serial I/O operation.

The heart of the serial I/O ports is the 8251 USART consisting of independent receiver and transmitter (See Exhibit 3-6). The function of the transmitter is to accept eight bits of parallel data from the data bus, and convert this to serial data with a wide range of formats, parity and stop bits.

The speed at which data is output in asynchronous mode is controlled by the baud rate generator, discussed in Section F.

The 8251 USART is designed to interface easily to an 8080 bus structure, and the control signals RD/, C/D, CS/, and WR/ are derived easily from the Clock/ Calendar internal control bus. Since the device was intended to be

used with a bi-directional data bus, EIA RS-232C line drivers and receivers interface the RxD and TxD output of the 8251 to the outside world.

Two jumper areas, A and B, allow the user to modify the serial port to suit any commonly used RS-232C requirement (See Exhibit 3-2). Jumper area A allows the signals to be configured as either DCE or DTE. Jumper area B gives the user the option of using a signal or tying it to GND. Section 3.4-F discusses how these jumper areas are changed so that full handshaking (software and hardware) can be accommodated.

Jumper area F is used when the port is being used for synchronous communications. The TxC and RxC pins of the 8251 may be connected to the internal clock by jumpering pad 5 to 6 and 3 to 4. These pins may be connected to an external modem clock by jumpering pad 5 to 1 and 3 to 2.

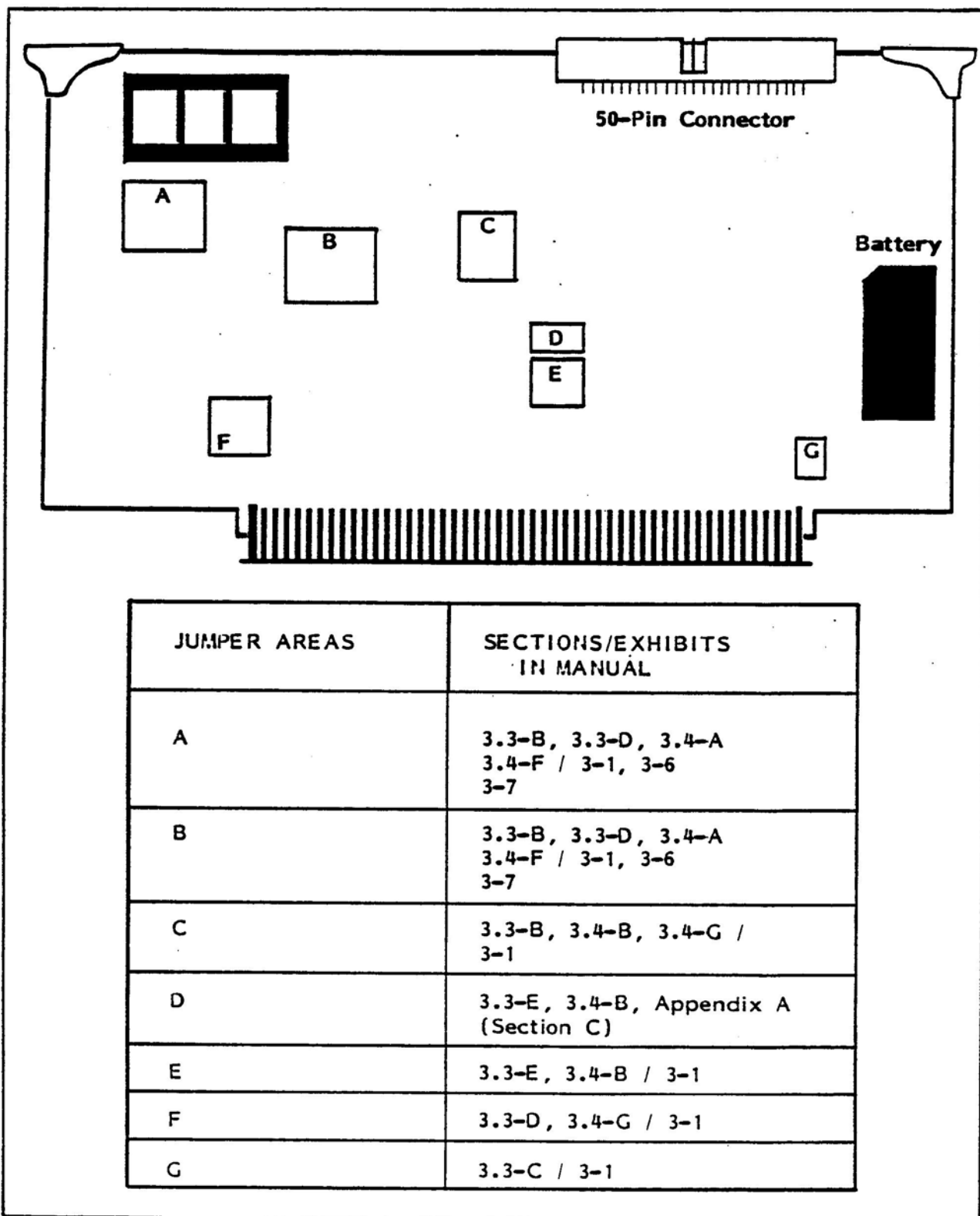
The serial port is selected under the following conditions. The CS/ pin, tied to the internal CSS/ (Chip Select-Serial) must be pulled low. That signal is provided by the address decoding section, described below. When CS/ has been pulled low, the state of 8251 pin C/D/ determines whether Control words will be read or Data will be written or read. This pin is connected to line A0.

E. Port Address Decoding Logic

The port address decoding logic takes signals from S-100 address lines A0 through A7 and uses them to produce chip select signals to enable various LSI devices on the Clock/Calendar Subsystem. The address signals are fed through various gates, decoders and jumper areas to select the proper combinations of signals.

Address lines A1, A2 and A4 connect directly to inputs of U6. Address lines A5, A6 and A7 connect via jumper area E and U24 to inputs of U6.

EXHIBIT 3-2 JUMPER AREA DESCRIPTIONS



As shipped, the serial port is selected via the CSS/ line when A7 and A1 are high and the other six lower address lines are low.

Clock interface Port A (84H as shipped) is selected when A7 and A2 are high and the other six lower address lines are low.

Clock interface Port B (85H as shipped) is selected when A7, A2 and A0 are high and the other five lower address lines are low. Lines A0 and A1 feed directly to the 8255.

Clock interface Port C (86H as shipped) is selected when A7, A2 and A1 are high and the other five lower address lines are low.

Clock interface Control Port (87H as shipped) is selected when A7, A2, A1 and A0 are high and the other four lower address lines are low.

Jumper Areas D and C and the gate from U15 disable the top 16 addresses of the 32 address block that A5 and A6 select. Never disturb these jumper areas.

SINP and SOUT from the S-100 bus are combined with decoded address select lines to produce IORD, IOWR and their inverses. Several other signals, notably CSTS/ and CSHD are not used by this implementation of the board.

F. Baud Rate Generator

The Baud Rate Generator consists of two 74LS393s, one 74LS10 and one 74LS04.

The 2MHz clock frequency is divided by 13 by half of U21 and one gate of U14. This provides a frequency of 153.846 KHz which is 16 times the highest baud rate, 9600 baud. The 8251 serial port chip can divide the incoming baud rate frequency by factors of 1X, 16X or 64X. You must, therefore, set the 8251 to chose the divide by 16X mode when choosing the command instruction unless you want to make the baud rate software selectable. The 153.846 KHz base frequency is sent through a network of divide by two counters (LS393's) to provide all subsequent frequencies with the exception of 110 baud which is generated by dividing the frequency for 1200 baud by 11. The appropriate baud rate is set by SW1.

3.4 HOW THE SERIAL PORTS FUNCTION ON THE CLOCK/CALENDAR SUBSYSTEM

Summary:The CPU sends and receives data to and from the serial and parallel ports (used by the lock portion of the board) by means of I/O addresses. The I/O addresses used by the Clock/Calendar section can be changed as a group.

A. How to Enable the Serial Ports

There are many options available to the user of the serial port available on this board. For the current standard options see the Specifications section (Section 3.1) of this manual. The board is configured as DTE (Data Terminal Equipment) so connecting this serial port to a modem is relatively easy. Connecting a serial printer to this port is more involved. It is suggested that the user connect a serial printer to his system via the serial port on the ZCB board or the Bitstreamer I/O board.

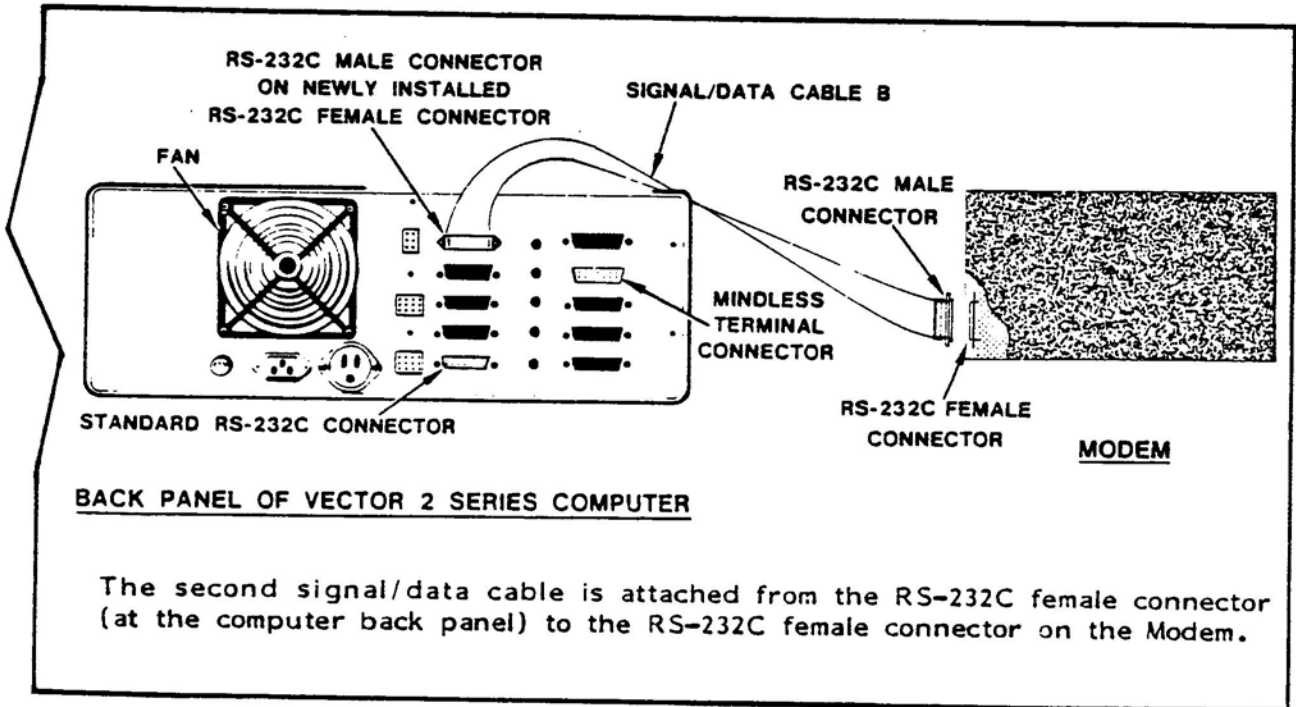
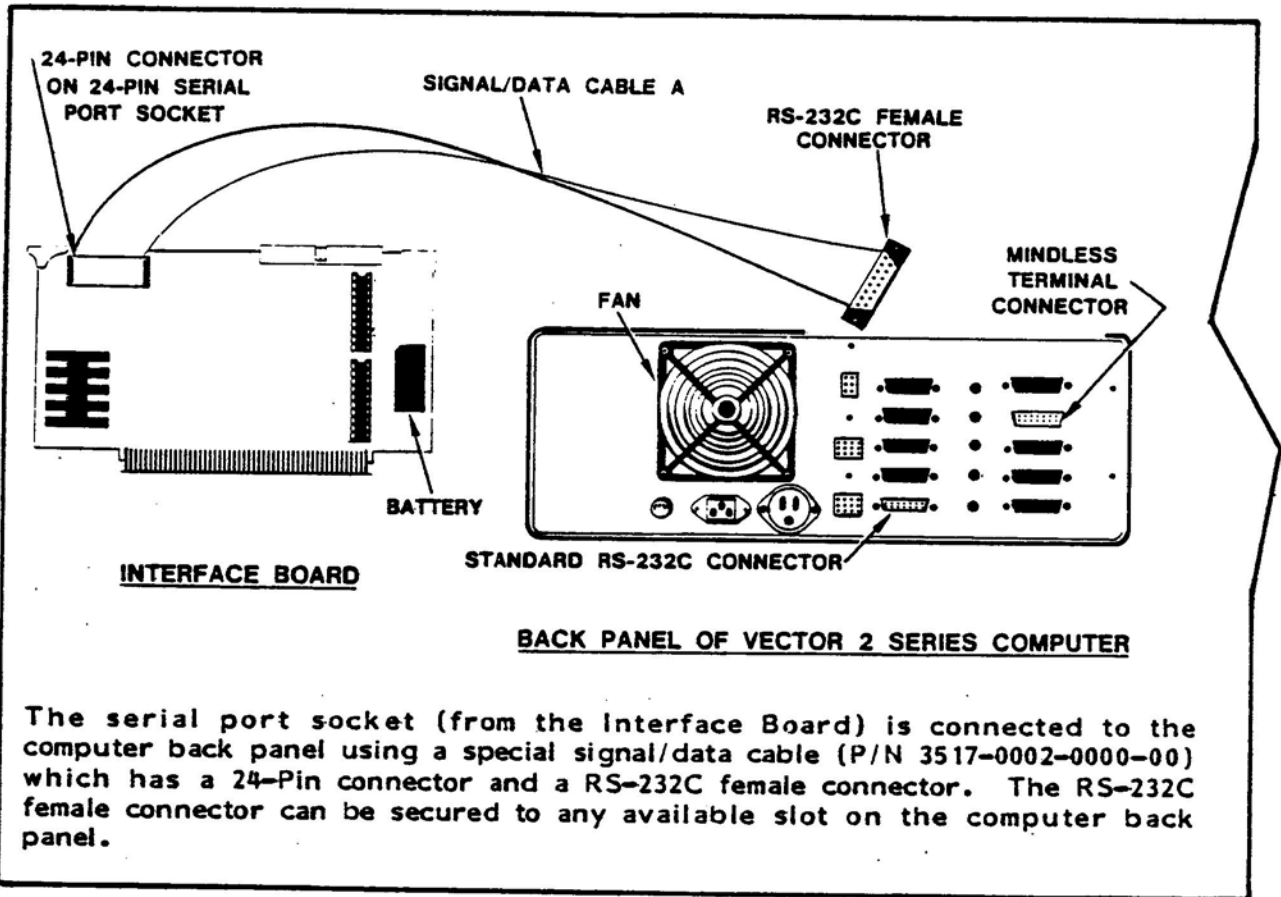
To enable the serial port to communicate over an RS-232C line, you will connect one end of the serial I/O cable to the serial port socket on the Clock/Calendar Subsystem, and the other end, having an RS-232C standard DB-25 female connector, to the back panel of the computer. The cable is designed so that appropriate signals from the board are directed to the RS-232C lines at the DB-25 connector as if it were Data Terminal Equipment. Thus, the resulting DB-25 socket at the rear of the computer is a DTE RS-232C port (See Exhibit 3-3).

Drivers are provided for the serial port to enable the 8251 Transmit Data and Receive Data lines to input or output at RS-232C voltage levels. These receivers and drivers are already connected on the board, requiring no jumpering. When a serial I/O cable is installed these signals are connected to RS-232C lines 2 and 3 respectively.

There is one RS-232C handshaking line connected as the board is shipped: DSR/. DTR/ is connected to ground. RTS/ and CTS/ are unconnected as shipped but may be connected as desired in jumper areas A and B. See Exhibit 3-5 for the pin assignments. There are four other signals available from the 8251 which can be accessed: TxRDY, TxEMPTY, SYNDET and RxRDY. You can install jumpers and RS-232C line drivers to enable the 8251 to control any two of them via software.

Further, a number of other RS-232C lines are available on the board using the standard serial I/O cable mentioned above. These are both input and output lines, but they are not connected to anything other than pads on the board, nor are drivers and receivers connected to them.

EXHIBIT 3-3 CONNECTING A MODEM



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The table "RS-232C Connections on the Clock/Calendar Subsystem" in Exhibit 3-5 lists the functions of each of these lines.

Any RS-232C line can be connected to +12 VDC on the board. In addition, the 8251 can be used to monitor in software most any one RS-232C handshaking line, and the 8251 can be used to control from software the output of any two RS-232C handshaking lines, and lastly, the 8251's transmitter can be disabled or enabled by any one RS-232C incoming handshaking line. There is one spare RS-232C receiver and one spare RS-232C driver available on the board which can be used to connect one input and one output handshaking line. Driver U1 (1488): pins 12, 13 are in, pin 11 is out. Receiver (1489) U12 pin 10 is in, pin 12 is out.

For the large majority of applications, no additional RS-232C lines will be required other than those already connected to active components on the Clock/Calendar Subsystem. Thus the serial ports can very often be used as DCE RS-232C input/output ports without modification. Most modems can be connected with little or no difficulty.

To connect to a modem, acoustic coupler, or other kind of Data Communications Equipment, this serial port may be used. However, if RS-232C handshaking is required, other than the lines already connected, then additional modifications to the board will be necessary as explained in Section 3.4-E,F.

If you wish to interface a serial printer to this port, you will have to change the appropriate jumpers to convert the board from DTE to DCE. See the Vector PRINTER INTERFACE MANUAL for further details.

Of course, software is necessary in order to operate specific devices connected to the serial port. Section 3.4-B gives the standard I/O port addresses and instructs you how to change them as necessary. Other documents from Vector Graphic describe the particular I/O addresses and peripheral devices which each Vector Graphic software product controls.

B. How to Change the Serial Port Addresses

The Clock/Calendar Subsystem occupies sixteen consecutive I/O port addresses. Factory standard are ports 80H through 8FH. (In this manual, hexadecimal numbers will be designated by an "H" following the number.) The base address of the boards port address may be changed from 80H through E0H in increments of 20H. Even though the base port address can only be changed in increments of 20H (32 decimal), only sixteen (FH) port addresses are occupied.

This is due to the circuitry included between jumper areas C and D on the schematic. Under the current configuration of this board, do not disturb these jumper areas. This will allow other boards the use the second group of 16 ports, if desired.

The port addresses for the one free serial port and three parallel ports used by the clock circuit must be selected in such a manner as to coordinate with software that is being used. For this reason, the preconfigured port addresses,

that is, those addresses already set at the Vector Graphic plant, match the port addresses called for in our standard software.

The serial port addresses are preset for data 82H and control 83H. Four port addresses are dedicated for the three parallel ports used by the clock circuit. They are designated Ports A (84H), B (85H) and C (86H) while the fourth port address designates the control port or Control Status Register (87H.) The parallel ports and hence the 8255 which controls them are dedicated to interfacing to the on board clock chip and must be configured by software as specified in the software section of this manual.

The four possible port address groups are:

<u>Base Port Address</u>	<u>Area E Pads Jumpered</u>
80H	1-2 and 4-5
A0H	2-3 and 4-5
C0H	1-2 and 5-6
E0H	2-3 and 5-6

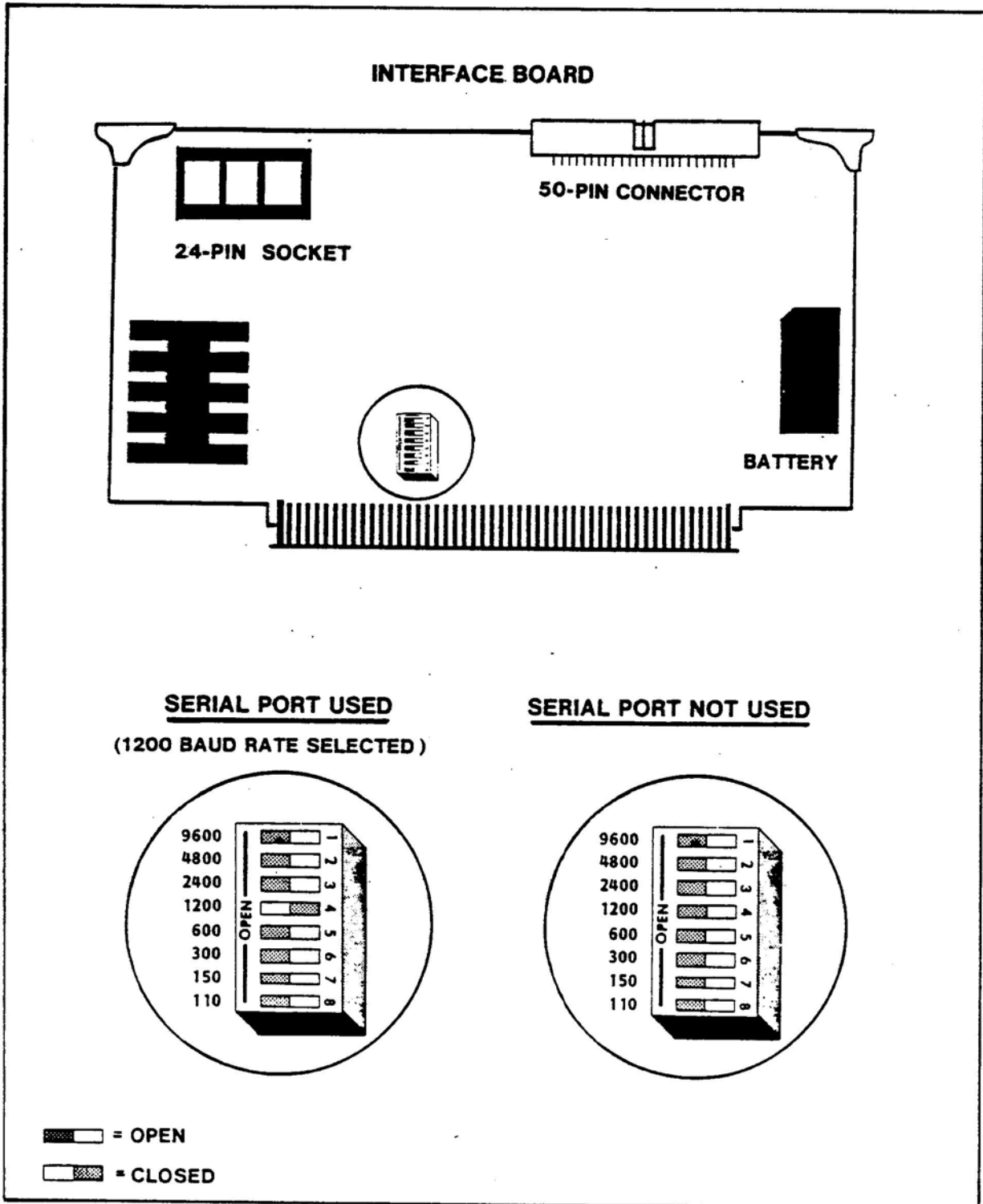
C. Asynchronous Serial Operation

You select the desired baud rate through a combination of hardware switches and software. If you are using the standard operating systems and Extended Systems Monitors for Vector Graphic Systems, however, you need only be concerned with the hardware switches.

The hardware switch is located in the bottom center area of the board. It is labeled "Baud Rate Select". The switch contains eight rockers labeled "1" to "8" and also labeled "9600," "4800," "2400," "1200," "600," "300," "150," and "110." The switch is, in addition, labeled "OPEN" on the left side.

To select one of the labeled baud rates, press the desired rocker down on the right side, i.e. on the side opposite the "OPEN" designation. Then press all other rockers down on the left side, i.e. toward the "OPEN" designation. The result must be that one rocker is down toward the right, and all others are down toward the left. Otherwise the serial channel will not work at all. If you are not using the serial channel, switch all the rockers to the "OPEN" position (See Exhibit 3-4).

EXHIBIT 3-4 BAUD RATE SELECTION



The labeled baud rates assume that the corresponding 8251 will be initialized for a clock factor of 16. (It creates the baud rate by dividing the clock input by 16.) This initialization is handled in software, as described in the 8251 references given in Exhibit 3-7. All standard Vector Graphic software, unless otherwise documented, use a clock factor of 16, and therefore the labeled baud rates are correct.

However, custom software can use a clock factor of 64. If this is the case, the actual baud rate will be 1/4 of the baud rate selected on the switch. (The only two asynchronous clock factors allowed by the 8251's are 16 and 64.) Further, it may be desired to create software which allows the operator to choose between two baud rates that differ by a factor of 4.

For example, the software may be designed in conjunction with a modem that can accept signals at either 300 or 1200 baud. In this case, you would create the software so that the operator's input determines whether the 8251 is initialized with a clock rate factor of 64 or 16, respectively.

Remember, if you are using standard Vector Graphic software, do not worry about this software option. You simply set the baud rate for a desired serial channel by setting the baud rate select switch on the Clock/Calendar Subsystem.

D. How to connect many low speed asynchronous acoustic couplers and modems

This section is applicable to many acoustic couplers and modems which carry out asynchronous communications at rates of 1200 baud or less. It is almost always applicable for asynchronous couplers and modems operating at 300 baud or less. Specifically, it is applicable to modems and couplers which require only three RS-232C lines coming from the computer: Transmit Data (line 2), Receive Data (line 3), and Signal Ground (line 7).

Because the Clock/Calendar Subsystem is wired as DTE you can connect the Clock Calendar serial I/O cable to a modem. To connect the RS-232C output connector to the modem you can create a three line cable with male DB-25 connectors at both ends. Wire lines 2, 3 and 7 straight across. Such a cable will work with any modem or coupler requiring only three lines. Connect one end of the cable to the DB-25 of the Clock Calendar Serial I/O cable and the other end to the modem or coupler (See Exhibit 3-3).

We suggest that you do not modify the Clock Calendar board itself or the Clock Calendar Serial I/O cable if possible. By modifying or adapting the external cabling instead, the computer itself remains standard, and the serial ports can easily be used for connecting to a terminal or other kind of peripheral if ever required.

E. How to Connect Additional RS-232C Handshaking Lines

If you are using a modem or coupler which requires any handshaking at all, that is, requires more than a three line connection (lines 2, 3 and 7), then

continue reading this section.

The following chart (Exhibit 3-5) lists all 25 RS-232C lines by name, number, and source, and indicates what subset of these are connected to the Clock/Calendar Subsystem via the Clock/Calendar Serial I/O Cable. For this subset, the table specifies each line's pin number on the 24-pin socket connected to the end of the Clock/Calendar Serial I/O Cable. The table also lists those lines which are connected to components or jumper pads, in the factory configuration of the board, and what they are connected to. "U16-13" means it is connected to pin "13" of U16. "GND" indicates the line is connected to Ground in the factory configuration.

E. How to Change the Serial Port From DTE to DCE

It is important to note here that in the RS-232C protocol, any given line has one name, regardless of your point of view. For example, although a modem, which is a kind of Data Communications Equipment ("DCE"), receives its data on line 2, line 2 is still called Transmitted Data. Notice that the names of the lines are more meaningful if you look at them from the point of view of a terminal at the other end of the line, that is from the point of view of the Data Terminal Equipment ("DTE"). According to RS-232C, Data Terminal Equipment transmits on the Transmitted Data line and receives on the Received Data line.

The Clock/Calendar Subsystem is wired to behave as if it were Data Terminal Equipment. This is reasonable because the board is most commonly connected to modems.

NOTE: A serial port is available on the System's ZCB board. That serial port is configured as Data Communications Equipment. If you desire to connect a serial printer to your system, it will be easier to connect it to the ZCB. See the ZCB MANUAL for details.

EXHIBIT 3-5 RS-232C CONNECTIONS

<u>Source RS-232C name</u>		<u>RS-232C pin</u>	<u>CLK/CAL</u>	<u>8251 pin</u>
(g=Ground, x=not connected)			<u>board pin</u>	
Both	Protective Ground	1	24	x
DTE	Transmitted Data	2	23	19
DCE	Received Data	3	22	3
DTE	Request to Send	4	21	g
DCE	Clear to Send	5	20	x
DCE	Data Set Ready	6	19	22
Both	Signal Ground	7	18	g
DCE	Received Line Signal Detector	8	17	x
---	Reserved	9	16	x
---	Reserved	10	15	x
---	Unassigned	11	14	x
DCE	Secondary Received Line Signal Det.	12	13	x
DCE	Secondary Clear to Send	13	x	x
DTE	Secondary Transmitted Data	14	1	x
DTE	Transmitter Signal	15	2	x
DCE	Secondary Received Data	16	3	x
DCE	Receiver Signal Element Timing	17	4	x
---	Unassigned	18	5	x
DTE	Secondary Request to Send	19	6	x
DTE	Data Terminal Ready	20	7	g
DCE	Signal Quality Detector	21	8	x
DCE	Ring Indicator	22	9	x
Either	Data Signal Rate Detector	23	10	x
DCE	Transmitter Signal Element Timing	24	11	x
---	Unassigned	25	12	x

* See Section D of Appendix A for more information on RS-232C protocol.

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The boards name (source) can be changed by completing ONE of the following procedures:

1. Use a Null Modem Cable: A Null Modem Cable can be constructed from ribbon or round computer quality signal/data cable. The number of conductors depends on how many handshaking lines are going to be used. If no handshaking is required the cable can consist of 3 wires (RS-232C lines 2,3 and ground).

RS-232C lines 2 and 3 are crossed allowing the Clock/Calendar Subsystem to viewed as a DCE device. i.e. The Clock/Calendar 8251 will be transmitting on RS-232C line 3 and receiving on RS-232C line 2. Other lines (handshaking) can be crossed if they are going to be used. NOTE: The Clock/Calendar Subsystem comes with only one handshaking line directly jumpered (8251 DSR). Therefore, if you plan on using the handshaking lines (through software control) it is necessary to re jumper those pads in Area B which connect the 8251 handshaking signals. Exhibit 3-6 shows the jumpering used when full software handshaking is used. Exhibit 3-7 shows how the 8251 is used to accomodate full software handshaking.

Refer to Exhibit 3-5 and the schematics in Exhibits 3-1 for specific jumpering used in the standard Clock/Calendar configuration.

NOTE: Handshaking signals can also be handled through hardwiring. For instance Data Terminal Equipment connected to the board may require +12 VDC on some line other than 5 or 6, though this is rare. You can supply +12 VDC as a constant enabling signal, by connecting the desired RS-232C line(s) to +12 VDC through a pull-up resistor.

2. Rejumper Areas A and B on the Clock/Calendar Subsystem: This rejumping is shown in the bottom portion of Exhibit 3-5.

3. Connect a Breakout Box to the Signal/Data cable going from the DTE device to the Clock/Calendar Subsystem: A Breakout Box can be used in place of a Null Modem Cable. Refer to the description given in number 1 for an explanation of the specific line switching.

G. Synchronous Operation

RS-232C lines 15 and 17 are not connected to the 8251 since the clock signal comes from the on-board baud rate generator. If you want to use your own clock signal, pad pairs 6/5 and 4/3 (jumper area F) must be disconnected. Your clock signals can then be attached either through jumper area C or by lines 15 and 17.

In addition, you will have to connect the SYNDET (pin 16) line on the 8251 to the appropriate pin on J1. See Section C of Appendix A for further information.

EXHIBIT 3-6 CONNECTING A DTE DEVICE

I. Connecting a Null Modem Cable

DCE Clock/Calendar Subsystem				NULL MODEM CABLE		DTE
8251	Jumper* Area B	Jumper Area A	RS-232C Female Connector	RS-232C Male Connector	RS-232C Male Connector	RS-232C Female Connector
<u>DTR</u>	11-5	N/C	20	20	6	6
<u>DSR</u>	N/C	N/C	6	6	20	20
<u>CTS</u>	7-1	N/C	5	5	4	4
<u>RTS</u>	12-6	N/C	4	4	5	5
<u>RXD</u>	N/C	N/C	3	3	2	2
<u>TXD</u>	N/C	N/C	2	2	3	3

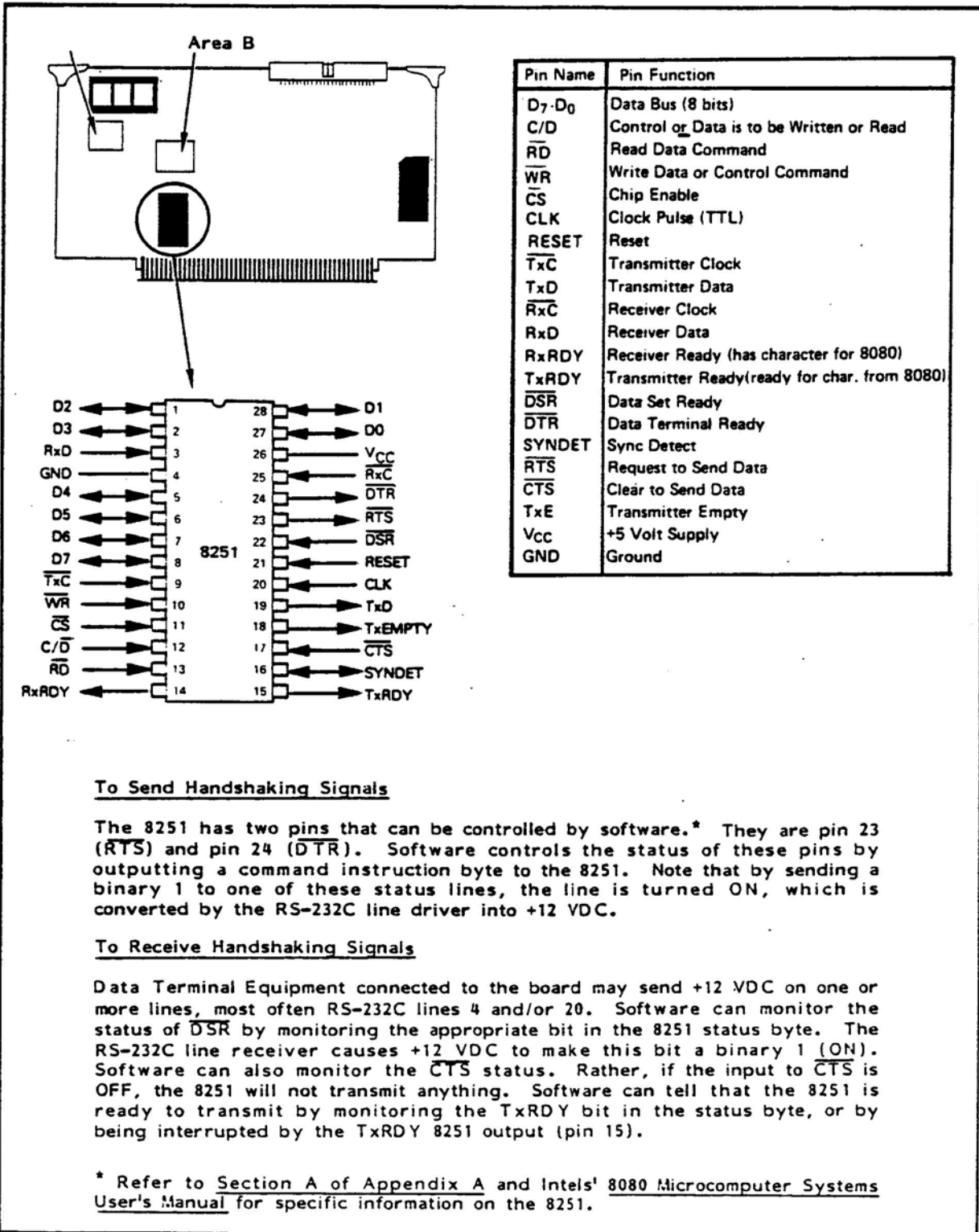
II. Rejumpering Areas A and B

DCE Clock/Calendar Subsystem				STANDARD CABLE		DTE
8251	Jumper* Area B	Jumper* Area A	RS-232C Female Connector	RS-232C Male Connector	RS-232C Male Connector	RS-232C Female Connector
<u>DTR</u>	11-5	9-3	20	20	20	20
<u>DSR</u>	N/C	16-4	6	6	6	6
<u>CTS</u>	7-1	7-1	5	5	5	5
<u>RTS</u>	12-6	14-2	4	4	4	4
<u>TXD</u>	N/C	17-5	3	3	3	3
<u>RXD</u>	N/C	12-6	2	2	2	2

* Other jumpers are cut.

N/C =Not Connected

EXHIBIT 3-7 USING THE 8251 WITH A DTE DEVICE



To Send Handshaking Signals

The 8251 has two pins that can be controlled by software.* They are pin 23 (\overline{RTS}) and pin 24 (\overline{DTR}). Software controls the status of these pins by outputting a command instruction byte to the 8251. Note that by sending a binary 1 to one of these status lines, the line is turned ON, which is converted by the RS-232C line driver into +12 VDC.

To Receive Handshaking Signals

Data Terminal Equipment connected to the board may send +12 VDC on one or more lines, most often RS-232C lines 4 and/or 20. Software can monitor the status of \overline{DSR} by monitoring the appropriate bit in the 8251 status byte. The RS-232C line receiver causes +12 VDC to make this bit a binary 1 (ON). Software can also monitor the \overline{CTS} status. Rather, if the input to \overline{CTS} is OFF, the 8251 will not transmit anything. Software can tell that the 8251 is ready to transmit by monitoring the $TxRDY$ bit in the status byte, or by being interrupted by the $TxRDY$ 8251 output (pin 15).

* Refer to Section A of Appendix A and Intel's 8080 Microcomputer Systems User's Manual for specific information on the 8251.

3.5 HOW TO CALIBRATE THE BOARD

Summary: The Clock/Calendar subassembly has been calibrated at the factory. Should it ever require future recalibration, follow this procedure:

1. Place the Tape Interface Board on an extender card in an S-100 based computer.
2. A frequency counter will be required. Attach the ground lead of the probe to board ground. Switch the counter to 1 ms. time base (period average).
3. Measure the frequency at pin 17 of U31 (MSM5832). The reading should be 30.517578 microseconds. (This is the inverse of the clock crystal frequency which is 32.768 KHz.) If your reading differs from this, adjust trimming capacitor C28 until the reading averages to the proper amount.
4. This procedure is now complete.

SECTION IV - UPDATES

APPENDIX A - HOW SERIAL PORTS FUNCTION

Summary: Discussion of the serial port centers around the industry standard 8251 USART (Universal Synchronous/Asynchronous Receiver/Transmitter) chip. You, through software, can control the rate of serial transmission, and the format of the transmitted data.

A. Introduction

Data can be transmitted having between 5 and 8 bits per character, with an optional added-on parity bit (choice of even or odd), and with one start bit and a choice of one, one and a half, or two stop bits per character. Further, using the 8251 can handle either asynchronous or synchronous communication. Baud rates, format, handshaking, and whether communication is asynchronous or synchronous, is specified through software and, in some cases, hardware modifications.

It is not within the scope of this manual to detail the functioning of the 8251 USART chip, nor to teach the theory of serial communication. In order to write your own communications software or to modify the Clock/Calendar serial port, you will need to be thoroughly familiar with this chip. You can refer to Intel's Application Note #16, entitled "Using The 8251 Universal Synchronous/Asynchronous Receiver/Transmitter," which Intel will provide. This Note is also an excellent reference on basic communications theory. More readily available references on the 8251, but ones that have less to say about communication theory, are the "INTEL 8080 Microcomputer Systems User's Manual," available either from Intel or most computer retail stores, and Adam Osborne's "An Introduction to Microcomputers, Volume II - Some Real Products," also available in many computer stores (See Exhibit 3-7).

B. Serial asynchronous communication

You can select the rate of transmission and reception from a choice of 110, 150, 300, 600, 1200, 2400, 4800, or 9600 bits/second. You choose the rate using a small DIP-switch (See Section 3.4-C and Exhibit 3-4).

If you are writing custom software, there is also a simple way to divide the chosen rate of a port by 4, allowing some software control of the rate without physically opening up the computer. For example, if you have a modem that is switch selectable for either 1200 bits/second or 300 bits/second, you can write a program that enables the operator using the keyboard to change the computer's rate of communication to match that of the modem at any given time.

You can select via software the number of data bits in each ASCII character, selecting either 5, 6, 7, or 8. You can also select the number of stop bits in each character, selecting either 1, 1-1/2, or 2. Finally, you can select whether or not a parity bit is included for each character, and if chosen, whether or not it is even or odd parity. For how to do this in software, see the references given earlier for the 8251 USART.

C. Serial synchronous communication

You can enable the serial port to communicate in the synchronous mode. Modifications to the board will be required to accomplish this. In brief, the 8251 SYNDET (pin 16) and the TxC and RxC clock pins must be connected to the outside world, which is not the case in the standard configuration of the Clock/Calendar Subsystem (The TxC and RxC clock pins can be connected using jumper area D).

Once set up for synchronous communication, you can select the rate of communication, by using an external clock between 0 and 56K bits/second. As with asynchronous communication, you can select via software the character length, selecting either 5, 6, 7, or 8 bits. You can also select via software whether or not a parity bit is included for each character, and if chosen, whether or not it is even or odd parity. Also via software, you can select separately for each port whether you are using internal or external synchronization, and whether one or two synch characters are used.

D. RS-232C theory

This manual cannot describe the RS-232C protocol in detail. For a full description, obtain a copy of the RS-232C EIA STANDARD document, published by Electronic Industries Association, Engineering Department, 2001 Eye Street, N.W., Washington, D.C. 20006. Alternately, if you have access to Datapro or Auerbach reports on communications, they contain thorough articles describing the protocol and its implications. The following information, however, will be of immediate relevance in this manual:

An RS-232C signal can either be POSITIVE (+12 Vdc) or NEGATIVE (-12 Vdc). Positive is ON or SPACING, Negative is OFF or MARKING. (These terms are industry wide conventions that date back to the days of key telegraphy.) RS-232C line drivers typically invert these signals when they are converted to and from TTL signals. Hence, RS-232C POSITIVE corresponds to TTL low (about 0 Vdc) and RS-232C NEGATIVE corresponds to TTL high (about 5 Vdc).

An RS-232C cable consists of 25 lines (See Exhibit 3-5). An RS-232C transmit or receive data line carries a serial sequence of POSITIVE and NEGATIVE pulses that correspond with the characters you want to transmit or receive. There is also associated formatting and parity information attached to the information by the communication device such as an 8251. In addition to the transmit and receive data lines, there are ground lines, (lines 1 and 7), and there are handshaking lines that are used by communication, terminal, and computer equipment to inform each other of their status (lines 4, 5, 6, 8, 20, 22, and a few others that are rarely used). The full RS-232C protocol also specifies a set of rarely used "secondary" lines which have the same definitions as some of the primary lines, but carry an independent set of signals. Altogether there are 25 RS-232C lines defined, but most applications use only a few of them.

In the real world, very few devices require "full RS-232C" protocol. In fact, very few devices even require all of the handshaking lines mentioned above. Many require one or even none. Further, many devices use handshaking lines differently than defined by RS-232C, violating the protocol. In short, it is confusing at this time to say that a given device requires "full RS-232C." You must specify exactly what signals it sends and expects to receive on each line.

It is important to understand that most of the RS-232C lines are directional, that is, the protocol specifies which direction the signal travels on each line, relative to the ends of the cable. Therefore, the protocol specifies that at one end of an RS-232C cable there must be a device of the type called "Data Communications Equipment", or "DCE" for short, and at the other end there must be a device of the type "Data Terminal Equipment, or "DTE" for short. The direction of the signal on a given line can be determined once you decide which end of your cable has which kind of device.

The terms Data Communication Equipment and Data Terminal Equipment derive from the original purpose for RS-232C - to connect a terminal with a communication device such as a modem. A computer does not have to be involved at all. Since a computer can either play the part of a terminal, when connected to a modem, or it can play the part of communication equipment, when connected to a terminal, a computer serial port can be used either as DCE or DTE. However, a given serial port can only be wired up as one or the other at any one time. If the port happens to be wired up to look like DCE, and you want to connect it to another DCE such as a modem, then the RS-232C connection will not work. Both ends would be transmitting on the same lines and receiving on the same lines. Before the RS-232C connection can be made, in this case, you must rewire the computer's serial port so that it receives and transmits on the lines specified for DTE.

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If a serial I/O board uses an 8251 USART, you can determine if the board is set up as DCE or DTE fairly easily. Find pin 2 of the DB-25 (RS-232C) connector on the schematic. Now trace this line to the 8251. It will probably go through an assortment of jumper areas and buffers. If this line connects to pin 19 of the 8251 (TxD), then the board is configured as DTE. If pin 2 of the DB-25 connector is connected to pin 3 of the 8251 (RxD), then the board is configured as DCE. This board is configured as DTE.