COMPUTER AID

Digital Data Recorders Model 3M1 and 3M3

Digital Data Recorders, models 3M1 and 3M3 were designed for educational, hobby, and small business applications where the storage of large blocks of data must be accomplished at low cost. They are a component of the Computer Aid Learning System and as such are exported under export tariff 861-9400 covering training equipment. The design has been made as simple as possible to provide easy maintenance and adjustment by the user.

SPECIFICATIONS

1. Tape Speed:	Adjustable, normally set at the factory at 5" (12.7 cm) per second for the 3M1 and 8" (20.32 cm) per second for the 3M3
2. Flux Density:	Maximum recommended is 1200 flux crossings kfm to the inch although higher densities are possible.
3. Recording Mode:	NRZ (Tape Saturation) Binary. A phase encoder board is provided for the 3M3. The 3M1 utilizes a 1/1 clock track on the tape.
4. Inputs:	Signal - RS232 or TTL, both are available at the connector. Motor Control - Two wire TTL levels. Record/Play and Rewind/Fast Forward are determined by the sequence of signals on the two wires.
5. Outputs:	TTL or RS232 data, both are available at the connector. End of tape Signal are Inter record gap signals are returned also.
6. Heads:	Four Track Parallel. The track in use is selected by a front panel switch.
7. Erase:	Erase is automatic while recording by saturating the tape over the previous recording.
8. Power Supply:	U.S. Canada - 110 Volts 60 Hertz Export - 220 Volts 50-60 Hertz Total power requirements 6 watts peak. Fused to blow at 12 watts.
9. Operation Monitor:	Light Emitting Diode on the front panel indicates the flow of the data.

10. Motor Speed: Tachometer generator-servo controlled to 1/3% of speed set. Normal operating speed 2200 RPM, rising to 7-8000 RPM in the fast mode.

11. Warrantee: 90 days unless abused or broken by careless use. No warrantee on PC boards which have been modified by the user unless such modifications appear in this manual or a subsequent service note.

Factory will repair any mechanical damage or faults when out of warrantee, or any PC board damage at any time for a flat $15 fee. Return shipping in the U.S. will be paid by the factory.

Based on prior experience with the motor used, the expected motor life is 2,000 to 3,000 hours. EOT/BOT incandescent lamp life is unknown at this time.

INSTALLATION

The recorder is connected to the computer or other controlling device by means of 12 pin edge card connector at the rear of the unit. This connector is furnished with the unit. Viewed from the top-rear, the fingers are:

1 - ground
2 - Clock in
3 - Record - TTL level signal from controller
4 - Play - TTL level signal from controller
5 - Inter record gap signal to computer
6 - End of tape signal to computer
7 - RS232 Output
8 - TTL Input
9 - TTL Output
10 - RS232 Input
11 - Clock Out
12 - Ground

OPERATION

Manual Operation

Five switches are provided at the top rear of the recorder for manual use. The & "Stop" switch is a "panic stop" switch which may be used at any time to stop the recorder.

The Power switch is of the Push-Push type. Push for on and push for off. It must be on to use the recorder.

The fast switch is a momentary switch. When pressed, (held in) the unit goes into fast forward and continues to run until released or it comes to the end of the tape. You can press fast, then play, while holding fast down and release fast. This will cause the tape to continue in the fast forward mode.

To rewind, you must press Fast, then the Record button while holding FAST in, then release FAST. When the FAST switch has been pressed, the recorder is in the play mode even if the record button is pressed. This enables the user to watch for inter record gaps during rewind.

CAUTION: You can ruin a program on tape by recording over it if you press RECORD when you wish to REWIND. You must press FAST first. Press FAST then press RECORD while holding FAST down. Release FAST and you are in REWIND. To release the STOP switch, press lightly on the PLAY and FAST switches together. Do not press RECORD.

These manual switches duplicate the software control program. Their use is not recommended for normal operation due to possible tape damage. Use software control if at all possible.

You can locate your program on the tape by means of the turn counter (3M3 models only) and by means of the inter record gaps. The LED on the front will light when data is present and remain dark during silent periods. Keep a log of the data and locate the desired data by counting gaps. For example, record 5136 is Track 1-~~3xx~~ 5th record in.

You can use software to find your records and format your data. A ROM program for this purpose is given in the 2SIO(R) Manual, (8080 users.) 6800 users refer to Interface Age, Dec.76, PP. 85.

NOTE: Allow 1-2 seconds for the recorder to get up to speed. Stop it during inter record gaps if possible. A 4 second gap is recommended as standard since this is about 1 second when viewed in fast forward or rewind.

SOFTWARE CONTROL

To use the recorder under software control only the power switch is used (on/off.) The motor is then started and stopped by means of two TTL level signals obtained from latches in the computer. These same latches also determine record and play functions according to the following table:

For normal forward RECORD or PLAY

	Bit 1(P)	Bit 2(R)
Start from	1	1
Record	1	0
Play	0	1
Stop	1	1

For FAST FORWARD and REWIND

	Bit 1	Bit 2
Start from	1	1
Set Fast	0	0
Fast Forward	0	1
Rewind	1	0
Stop	1	1

0011 0 0/0 1 WRITE
0001 0110 READ

Bit 1 and 2 in the table may be obtained in various ways.

1. From the Intel 8251 - Use RTS and DTR latches on the chip. Control them by output control signals to the 8251. DTR is bit 1 , RTS is bit 2.

2. Any PIA or PIO Board. These boards generally have 8 bit latches. Use two of the bits for each recorder and control them by output signals to set the Parallel latch. See Figure 2. Up to four recorders can be controlled from one 8 bit parallel latch.

* 3. Any of the IO boards used with 8080 microprocessors having control latches (88SIO A, B, or C, 2SIO (Imsai) 3 P+S PT company or 2SIO(R) from National Multiplex.) The 2SIO Board from MITS cannot be used since it has only one control output (RTS). A parallel board must be added or interrupt latches used

The software program should be written along the following lines. (Bits 1, 2, are assumed as Record, Play control bits.)

To Playback: (a) Out to control Port a signal to make bit 1 low, bit 2, high. This will start the recorder.
(b) Read the data from the data port.
(c) Out to control Port a signal to make bit 1 and 2 high to stop the recorder.

To Record: (a) Control Out bit 1 high, bit 2 low.
(b) Output data to data port.
(c) Control Out bits 1 and 2 high to stop.

Fast Forward: (a) Control Out bits 1 and 2 low to [illegible]
(b) Control Out bits 1 and 2 high to stop.

Rewind: (a) Control out bits 1 and 2 low to [illegible]
(b) Control out bit 1 high, bit 2 low [illegible] then, control out bits 1 and 2 high to [illegible]

Bit 1=0 Bit 2=0

Note that there is no acceleration and brake deceleration time involved. For this reason, [illegible] delay before reading or writing data must be provided. On the 2SIO(R) board [illegible] is done by formatting the tape with a 4 second leader [illegible] A software time delay loop is used to hold off any data [illegible] to the tape for 4 seconds, thus allowing the motor speed [illegible] At the end of a [illegible] the motor stops automatically [illegible] play [illegible] 1 second [illegible] up to the [illegible] speed before any data [illegible] on the tape.

This time delay can also be provided by means of a 74121 one shot which holds off data by the hand shake method. RTS from the computer is used to start the recorder and fire the one shot. The one shot then removes a "no go" signal via the CTS line until the motor is up to speed.

These techniques are covered in the pamphlet "Cassette Interface Manual." Bit 1 and 2 here are the RTS/CTS and they were shown starting the recorders in the pamphlet.

The instruction manual for the 2SIO(R) board is included with this manual so that you may have a software example. This ROM program controls the terminal and cartridge player. It enables the user to keyboard control the tape in fast forward and rewind. It also enables the user to search for records by name or encoded strings within the record.

Since these programs are written for the 8080, they will not apply to other computers. Eventually, it is hoped to have programs of this nature available for other systems. Those skilled in software should be able to translate this source listing and assemble programs to fit their own needs.

References: Byte Magazine March 76, PP. 10 (6800 Software)
Interface Age Dec. 76, PP. 35 (8080 Software)

THIS IS A TEMPORARY INSTRUCTION MANUAL

If you ordered an assembled kit, the kit was tested at 300 and 2400 baud using a Hitachi portable recorder. It is set as shipped for 2400 baud (PE 2400.)

To improve high baud rate reliability a -5 jumper has been added to the 1458 op amp. There may be other changes on your board not shown. These will be caught and corrected on the drawing in the printed manual.

AUDIO CASSETTE INTERFACE (ACI)

PHASE ENCODER BOARD (3M3)

This printed circuit board was designed originally for audio cassette interfacing. Due to a design specification change, it was adapted to the 3M3 recorders to provide phase encoding at high baud rates.

As a phase encoder board for Audio or 3M3 use, it is recommended that TTL levels be used for the clock. There is no provision for RS232 clock levels, but RS232 data levels are available to and from the 3M3 recorder. TTL levels are also available.

Several minor changes have been made in circuitry since the layout was made and these have been made or wired on the board for you if you ordered the ACI kit.

The board will operate at baud rates of 9600 or below, utilizing a 1/1 or 16/1 clock. A 1/1 clock is preferred, but 16/1 may be utilized with additional complexity. For 1/1 clock use, 2 IC's are omitted.

Encode Circuit

One half of the 1458 op. amp. is used to gate the clock signal on and offwith data. The clock is obtained from the I/O board or from the 565/7493 combination on the ACI board and must be a 1/1 clock. During data 1's, the clock is passed by the op. amp. During data zeros, the clock is blocked or gated out.

The clock also goes directly to an RC differentiator which converts the normally square wave to a series of differentiated spikes. The output of the op. amp. is also differentiated and the resulting spike series are amplified to drive a D flip flop wired to do a divide by 2.

Because of the mixing and differentiating of spikes, spikes occur at 2 times the baud rate during 1's and at the baud rate during zeros. These spikes are then used in the D flip flop to create (after dividing by 2) - the restored clock during 1's and a square wave at 1/2 the clock rate during zeros.

Those familiar with the Kansas City or Byte standard will recognize the pattern, i.e., 2400 Hz during 1's and 1200 Hz during zeros.

The encode circuit is automatic and requires no adjustment regardless of baud rate. For use with audio recorders, an RC network is provided to reduce levels and round off the high frequencies.

One half of a 74221 dual monostable is connected to the D flip flop to inhibit output during motor start up. This insures that the data on the cassette will start on a string of 1's (mark) during playback.

Decode Circuit

One half of the 1458 op.amp. is used for a voltage crossing detector. Data from the recorder is passed through this detector and converted to square waves. These square waves drive a 74123 1 shot connected as a bi-directional flip flop i.e., it xxxxxx creates a spike about 15 microseconds wide on each positive and negative excursion of the encoded data coming in.

This spike 1 shot is followed by a 74221 1 shot which is adjusted in time so that its on period starts with 1 spike and overlaps the next spike, but is not on so long that it reaches the third spike. The output of this 1 shot is the restored clock with about a 75% duty cycle. This period allows about a 10-15% speed variation between tape units.

NOTE: This one-shot must be reset or retimed if you shift baud rates. It is set at the factory for requested baud rates, but is difficult to adjust without an oscilloscope. If you cannot adjust this board yourself, return it to the factory for setting to the desired baud rate.

The spiking one-shot is used to fire the other half of the retriggerable one-shot and the output passed to the D flip flop. This retriggerable one-shot is reset by the clock which also clocks the D flip flop output. The output of a D flip flop is the same as that on the D input at the time of clocking so that when spikes are present a 1 is clocked out and when spikes are missing a zero is clocked out. The output of the D flip flop is therefore the reconstructed Data/

The board is wired so that the clock and data phase out are the same as the input phase. If necessary, the board can be altered to invert the phase.

Use with 1/1 Clock

Do not plug in or use the 565 and 7493. These are for use at other clock rates. Simply connect clock in and clock out.

Kansas City Standard

Use the 565 and 7493. The 565 is set for 4800 Hz and divided by 2 in one section of the 7493 to obtain a 2400 Hz clock. The 4800 Hz from the 565 is used by the UART or USART in the 16X clock mode instead of the normal 4800 Hz (300 baud) clock.

On the foil side of the board, above pin 11 of the 7493, note that there are two unused solder pads. Cut the foil between these solder pads with a sharp knife and jump the pad away from the IC to pin 12 where there is also an unused pad. This passes the divide by two count to the 565 so that the 565 can lock to a 2400 Hz clock.

Do not install Q3, instead put a jumper across from collector to emitter. This enables the 7493 to count.

To set the 4800 Hz of the 565, unsolder the end of the 4.7K resistor going to pin 2 of the 565 at the end away from the 565 and clip lead the 4800 Hz TTL clock from your I/O board to pin 2 via the 4.7K resistor. Put a voltmeter across pins 6 and 7. Then adjust R1 until the meter goes to zero or the lowest voltage. Once this null is obtained, note the extent to which you can shift the pot side to side and leave it at the center.

If you have a frequency counter or scope, use them. To use the scope, lock it to the 60 Hz power line and look at the D output of the 7493 (Pin 11.) Adjust the frequency to get 5 square waves on the trace. This will be 300 Hz. Do this without clipping the 4.7K resistor to the I/O board clock so that the 565 will be free running.

Replace the 4.7K resistor.

With no data coming from the cassette, the 565 should xxx now put out a steady 4800 Hz, which will be available to you on connection point P on your I/O board. Remove the clock signal to the UART or USART and obtain the clock from the ACI.

Jump connection point B to pins 11 and 12 on the 7493 xxxx so that you are now giving the Phase encoder board a 2400 Hz clock to work with. 300 Baud data can now be entered via pin C (TTL) or A (RS232).

Note that there are several levels of audio available to the recorder. (Connections H, I, and J). Select a level which will not overload the recorder.

Playing back the KC standard tape, the P.E. board will recover the 2400 baud clock, compare it with the count down from the 565 Phase Locked Loop and the 7493, readjust the frequency of the 4800 Hz (16X clock) and clock in the 300 baud data.

If you do not use time delays and software control, start the recorder to get a long lead in of constant clock tone (6-10 seconds) and then dump the program to the cassette.

On play back, set up the computer bootstrap to accept the data and leave the computer on Stop. Start the cassette and when the tone is steady switch to run.

P.E. 2400

Since you are recording audio at 2400 Hz phase encoded and using 8 cycles at 2400 Hz 4 cycles at 1200 Hz x to get 1's and zero's in the K.C. Standard, why not up the baud rate and go 1 for 1. This is what Tarbell does in the Tarbell board. If your recorder won't take 2400 baud, try 1200 baud data and 2400 Hz clock.

If your computer I/O board can accept a 1/1 clock, leave the 565 and 7493 off the board and go directly. Obtain 2400 Hz for the

the encoding from the I/O board clock generator. Separate the Receive clock pin on the USART or ACIA and use the recovered clock for receive only. Since this is self-clocking you can accept quite a wide variety of tape speeds (± 10%.)

For standardization, use 8 bits, 1 stop bit, even parity.

For use with UART's, a 16/1 clock is required. The 565 must be set at 16X 2400 or 38,400 Hz.

To lock the 565 to 38,400 Hz, lift the 4.7K resistor going to pin 2 of the 565 at the end away from the 565. Clip this to the 2400 baud clock on your I/O board and adjust the value of R1 until the voltage between pins 6 and 7 of the 565 goes to zero or nulls. Note that this requires that you use the appropriate value of C given in the timing frequency chart.

On the I/O board, disconnect the clock to the UART and use the 16/1 clock from connection P on the ACI as the UART clock. Jump pin 11 on the 7493 to connection B so that you have the divided by 16X clock available for recording phase encoded. Since we must now lock our 1/1 clock after count down, to the data, connection; D must be connected to the UART data strobe (pin 23.) When a character is loaded, the 1/1 clock is reset to match the data string from the UART. Otherwise your data and clock will not coincide.

Because there is a possibility of bad timing on the first character, it is advisable to start dumps and loads 1 character ahead of the desired data batch. Otherwise, you may have to alter or correct the first character of your data.

TARBELL TAPES

The 565 can be set to 6,000 Hz and the 1/1 clock taken from pin 9 of the 7493 (jumped to connection point B.) Alternately, set it for 3,000 Hz and take the 1/1 clock from pin 12.

You can only use Tarbell tapes with an Intel 8251 and Tarbell software. Alter the Tarbell software to output 8251 control data for the IBM Bisync system. This is described in the Intel 8251 instruction sheet sent out with Imsai Computers and the National Multiplex 2SIO(R) Board.

PHASE ENCODING 3M3

When it is known that the 3M3 will be used with a 2SIO(R) Board, Imsai 2SIO, MITS 88-2SIO or 6800 system, the board is wired for 1/1 clock. The 565 and 7493 are omitted since they are not required and only complicate adjustment.

Only one adjustment, R2, is required. This is set for a 75% duty cycle on the recovered clock. All units are shipped for x&x 4800 baud unless the user asks for a lower baud rate. To go to 9600 baud, remove the base and unsolder the condenser on the foil side of the Phase Encoder board. This doubles the clock rate. The factory makes every effort to set it as requested. Should your unit not be set as requested and you cannot alter it yourself, return it with your specific request. It is almost impossible to set the clock without a scope or externally clocked terminal.

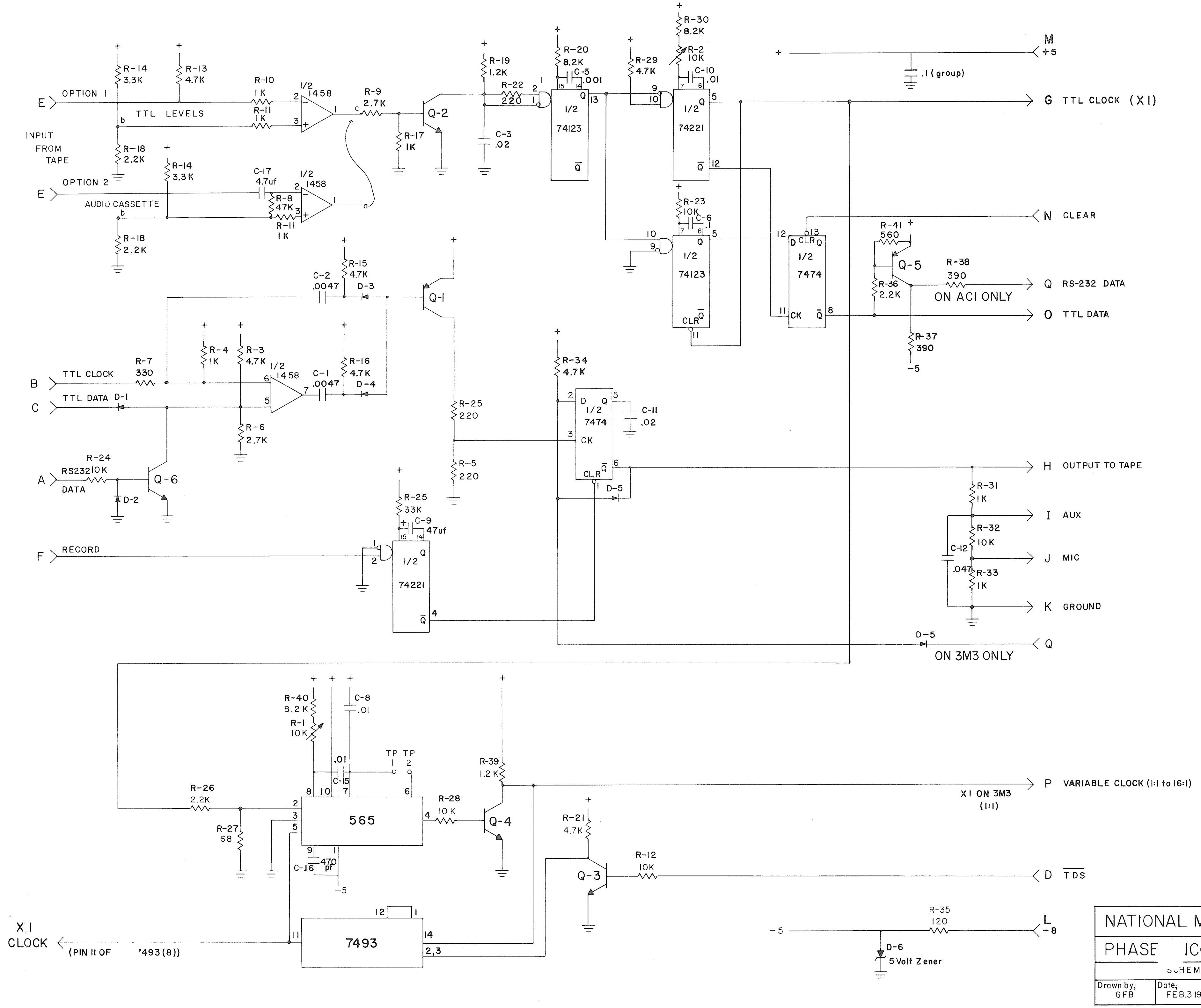
If you are using a UART or 16/1 clock, we must add the 565 and 7493. You must alter your I/O board to use the clock from the recorder and provide the data strobe signal, (see PE 2400 when used with 16/1 clock.) We recommend that you use XX TTL levels for the clock and RS232 levels for data. TTL data levels can be used however.

ADJUSTING with an Externally Clocked ~~Tekxm~~ Terminal

Set the terminal for even parity, 1 stop bit and obtain a clock from your I/O board. Locate a clock rate 1/2 the desired clock rate and use it for data. This will print out a continuous string of "U"s on the terminal.

Taking these signals into the P.E. board, encode and decode them. If the value of R1 is not correct, the terminal will print gibberish. As you adjust R1, this will change to a steady string of "U"s.

Utilizing the 565 and 7493 you can do this with a 16/1 clocked terminal (Lear Siegler). Pick 9600 Hz for clock, 4800 Hz for data, set the 565 to 153,600 Hz and use 153,600 for the clock to the terminal UART. (You will have to remove the normal clock source.)



NATIONAL MULTIPLEX

PHASE ENCODING BOARD

SCHEMATIC

Drawn by;	Date;	Approved by;
GFB	FEB.3 1977	

REVISED ROM PROGRAMS
(Gold Dot for 3M3 Recorders)

The software in the ROMs previously provided is faulty when used with the 3M3 in the - hase encoding mode. If you wish to check where, note the FORM D routine in ROM II. This calls TENIT, which sets the USART for 1/1 clock and then jumps to ROM I. In ROM I this routine is then re-initialized by RDINIT for 16/1 clock

The Software has been altered tox correct this clocking change and to provide lead in characters in the formatted modes. Control D was a problem with many systems since it triggers other actions in Teletypes and VDM units. It has been eliminated. Since the new ROM's are for the 3M3 only, the Asynchronous commands have been removed.

NEW COMMANDS

(Gold Dot ROM"s)

Control L has been deleted.

Control D changed to E.

N has been deleted.

Control E has been deleted

E now replaces Control D.

I to load Intel checksum paper tape has been added.

Unformatted material must be loaded via the KC Load (K) command.

EXAMPLES

To dump to the 3M3
E 5600 59FF/NEW ROM

To search for and Recover
S NEWROM ØØØØ space

Control S and R are used as before.

The error message has been changed to a single X per error. There should be no errors between the time the alarm for "found" sounds and the completion of loading. Errors at other times - such as between files - are permissable.

ROM II COMMANDS

[ ] is indication for space.
Line Feed is preferable to C/R on some terminals.

I N - Puts 11 seconds of leader on the tape. Use with CC-7 and CC-7A units to put 11 seconds of erased leader at the start of a cassette.

II F Fast Forward - Used with 3M1 and 3M3 Cartridge units to advance the tape at approximately 25" per second. Stop the cassette or cartridge drive by hitting the space bar.

III R Rewind - Used to rewind the 3M1 and 3M3 cartridge units at approximately 25" per second. Stop by hitting the space bar.

I 0 Overshoot, Used to relocate an interrecord gap after a rewind overshoot. Causes the tape to advance at normal speed to locate the interrecord gap by means of sound or LED indicator.

* NOTE - When using F, R or 0, the cartridge units are in the play mode and inter record gaps may be seen on the LED indicator. This signal is also returned to the USART via the DSR lead and may be polled in software.

For F, R, N and O do not use C/R. F, R and O are stopped by any new character coming in. N will time itself out.

V W [ ] Start Address C/R
Enables you to enter ASCII characters into memory from the keyboard. Backspace and type over are recognized. This is a Word Processing command, or word storage system.

V_I Control W [ ] Start Address [ ] Stop Address C/R.

This command prints out the memory in ASCII. Form letters or mailing labels can be printed from the computer utilizing magnetic tape storage.

VII H [ ] 5 letter String [ ] Loading Address C/R

A formatted file with five letters or numbers embedded will be loaded. For example, a mailing label can be picked out by means of the first five letters of the Addressee's last name or by means of the five numbers in the zip code. The entire file is loaded, even though the string occurs at the center or end. This differs from the S or Control S where the string must be at the start

XV E [ ] Start Address C/R

This command loads unformatted tape in the PE2400 mode. It is similar to the Control L handler used in the NRZ program.

SVI GC3F7 Clear All of Memory to Zeroes.

This is an endless loop which writes zeroes to all of memory. The computer must be stopped from the front panel and the monitor reinitialized by examining location C000 and running from this point.

* Note PE2400 is the name given to the new "Phase Encoded 2400 Baud, 1 stop bit, even parity" system. It can be used with audio cassettes and a suitable audio or Phase Encoded interface such as the National Multiplex AC1 or the PerCom interface. However, the method is not limited to 2400 baud. The USART can operate in the 40-50 kilobaud region.

EXTERNAL CLOCK OPERATION

When using the 2SIO(R) with self-clocking systems such as the Tarbell, K.C. Standard, PE2400, Bi-Sync, or other encoded systems, follow the instructions below:

Just below the USART are two pads marked "T" and "R". On the opposite side of the board is a short foil jumper which connects these two points. Cut this foil. The R pad now goes directly to Connector I, pin j. A clock from the recorder or reconstructed clock is brought in via pin j. Remove any baud rate jumper to R above IC "F" and jump the baud rate to "T" on the USART. The USART now receives its transmit clock from the baud generator and its receive clock from an external source.

You may use any external clock source such as a K.C. standard board, the clock track on the CC-7 or the National Multiplex Audio cassette board.

To use the CC-7 with a 1/1 clock, remove the white wire in the cable from its normal RS232 Output point and connect it to pins 3,4 ($\overline{Q}$) of the 7401 on the P.C. board. Record the clock via the blue lead, recover it from the white lead. Clock gain is best left full on. The CC-7 will record a 2400 baud clock, but not a 4800 baud clock. At 4800 baud you will have to run asynchronous or use a 2/1 divided clock.