excellence in electronics

Texas Instruments,
Attn: Jim Arnold,
P.O. Box 10508, M/S 5873,
Lubbock, TX 79408

19th January 1982

Dear Jim Arnold

In review of the agreement between Texas Instruments and Exatron, to promote the Stringy Floppy as an Industry Standard mass-storage peripheral, there are many details which need to be resolved at an early date.

The following issues need to be considered:

1. How will "standard products" be determined?

2. How will standard product descriptions and specifications be developed?

3. When and how will the above information be officially released?

4. Under what conditions can the "second source" agreement be disclosed to prospective customers?

5. To what degree is it desireable to recommend standard data recording formats, file structures, and hardware and software interface standards.

Specifically Exatron has received a request for quotation for 500,000 Stringy Floppy drive mechanisms from Commodore International. Exatron would like to propose to supply both a "standard drive mechanism" and a standard "universal read/write interface", containing all the analog circuits needed to interface the Stringy Floppy to a "standard" digital interface connection. This would allow the production of a "pluggable subassembly" which could be used by a large number of OEM customers.

I believe that the Commodore opportunity creates a unique opportunity for Exatron and Texas Instruments to begin a joint marketing plan which will result in the rapid acceptance of the Stringy Floppy as an Industry Standard mass storage peripheral for use with small computers.

I also believe that Commodore is expecting a prompt response from Exatron. To what extent is Texas Instruments prepared to participate in preparing a response to Commodore International confirming the Industry Standard nature of the Stringy Floppy and TI's role as a second source?

Sincerely,

Robert L. Howell

RLH/jp-ep

exatron

181 Commercial Street • Sunnyvale, California 94086 • (408) 737-7111

1294 Lawrence Station Road / Sunnyvale, CA 94086 / (408)734-3133 / Telex 176337

April 11, 1983

entrepo

Mr. C. B. Wilson
Engineering Manager
Consumer Products Group
Texas Instruments Inc.
P. O. Box 10508 MS 5891
Lubbock, TX 79408

Dear Mr. Wilson:

Entrepo (formerly Exatron) wishes to officially inform you that we have recently discovered the existence of another licensee for the technology made available to you exclusively through June 30, 1983 and non-exclusively thereafter in our agreement dated December 16, 1981. This license was issued to California Technology, Inc. in 1979 by Microcommunications, Inc. prior to Exatron's acquiring the assets of that corporation. The license is non-exclusive and entitles California Technology, Inc. to the technology as it then existed but not subsequent improvements developed by Entrepo or our licensees.

We are currently in discussions with California Technology, Inc. regarding this matter. While these talks are not concluded, our current thinking would be to form no relationship with that company and to let them use the old technology and not provide them with subsequent improvements. We believe, that at worst, there could be some future confusion in the marketplace should they persist in marketing products based on the technology.

This license was apparently overlooked in our previous negotiations with TI, but I believe, not purposely. I shall attempt to contact you by phone to discuss this matter that is more a technicality than a matter of substance to TI. However, to make our records complete, we would like to ask you to return an endorsed copy of this letter to me via express shipment to confirm that Texas Instruments does not consider the above to be a breach of Entrepo's contract with you.

Sincerely,

Robert A. McDonald
President

TEXAS INSTRUMENTS INCORPORATED

BY:_____

_____

DATE:_____

cc: Darrell Whitten, Program Manager, T. I.

Introducing . . .

The Wafer Wheel™

- Protect your valuable collection of Stringy-Floppy Wafers.
- Holds 40 Wafers in ten compartments for easy organization.
- Rotates to eye level for easy access.
- Can be positioned on top of drive unit to conserve space.
- Made of high impact ABS plastic (like your telephone) in chocolate brown.

* DRIVE UNIT & WAFERS NOT INCLUDED.

(ALLOW 4 - 6 WEEKS DELIVERY)

INTRODUCTORY PRICE

$18.50 ea.

Reg. $24.95 Offer Expires May 30, 1982

Please send me ___ Wafer Wheels at the introductory price of $18.50 each. Add $2.00 for shipping & handling. (Calif. residents add applicable sales tax.) Enclosed is my: ☐ Check ☐ Master Charge ☐ Visa

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City, State and Zip Code

REVISIONS			
APPROVED	DATE	DCN NUMBER	REV
RY	8/18/83	1004	B

1.0 This specification describes the wafer tape utilized by the Entrepo's Model 100 Wafer Tape Drive. Since the tape is wound in a continuous loop form, the tape must be back-coated with a low-friction colloidal graphite to provide extended tape life.

2.0 Physical Characteristics:

Base Material:	Polyester (balanced)
Thickness	780 ± 20 Micro Inch
Yield Strength:	4.4 lbs/Tape width minimum
Oxide Thickness:	180 ± 20 Micro Inch

3.0 Magnetic Properties:

Oxide:	Longitudinally oriented chromium dioxide or cobalt modified ferric oxide.
Coercivity:	680 ± 50 Oersteds
Retentivity:	1200 Gauss minimum
Squareness:	0.80 minimum

4.0 Backcoating Properties:

Coating:	Colloidal graphite, or equivalent.
Thickness:	50 ± 10 Micro Inch

5.0 Operating Performance:

Tape speed - Normal	10 Inches/Second
- Fast Forward	15 Inches/Second
Recording Density:	4600 Flux Crossing/Inch minimum
Expected Life:	5000 Passes
Soft Error Rate:	1×10^{-9} errors/bits transferred
Hard Error Rate:	1×10^{-12} errors/bits transferred

6.0 Environmental:

Storage Temperature:	1°C to 50°C
Operating Temperature:	10°C to 45°C
Relative Humidity:	20% to 80%

7.0 The Tape may be accepted in any one of the following stages:

7.1 Stage I: Butt Roll - Oxide Coating only.
- 7.1.1 12 Inches to 13 Inches Wide
- 7.1.2 25 Inches to 26 Inches Wide

7.2 Stage II: Butt Roll - Oxide plus Backcoating.
- 7.2.1 12 Inches to 13 Inches Wide
- 7.2.2 25 Inches to 26 Inches Wide

7.3 Stage III: Slit to 0.0670 inch ± 0.0010 inch.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES
ANGLES ± 1° 3 PLC DEC ± 005
FRACTIONS ± 1/64 2 PLC DEC ± 01

INTERPRET THIS DWG PER USA STANDARDS

MAT'L:

P/L:

SIGNATURE AND DATE		
DRWN	FOR	8-18-83
DRFTG CHK	E MICCIO	8-18-83
DESIGN CHK		
PROJ MNGR	Ray Yokoyama	8/18/83
APVD		
FINISH		

entrepo 1294 Lawrence Station Road Sunnyvale, CA 94086

TITLE

WAFER TAPE SPECIFICATIONS

SIZE	DRAWING NO.	REV.
A	140007	B
SCALE	SHEET 1 OF 1	

FORM 030005 BISHOP GRAPHICS/ACCUPRESS REORDER NO. A23047

A. OBJECTIVE

The purpose of this document is to specify all electrical components inherent to the M101 Waferdrive electronics.

B. REFERENCE DOCUMENTS:

1. M101 Transport Motor - Dwg# 140006
2. M101 Transport Head - Dwg# 140008
3. M101 Schematic Diagram - Dwg# 240037
4. M101 Waferdrive Test Specification - Dwg# 030009
5. M101 Transport Switches:

   a. Assembly, Contact Stat., Write Protect - #200048
   b. Assembly, Contact Move., Write Protect - #200049
   c. Assembly, Contact Stat., Wafer Present - #200050
   d. Assembly, Contact Move., Wafer Present - #200051

C. M101 TRANSPORT MOTOR:

1. Performance Requirements...

a.	Nominal Voltage	6 VDC
b.	Voltage Range	3 VDC to 9 VDC
c.	Direction of Rotation	Clockwise, as viewed from shaft
d.	No Load Speed	2700 (+/-) 250 rpm
e.	No Load Current	30 mA maximum
f.	Current (load of 10g-cm)	85 mA maximum
g.	Reliability	1000 POH MTBF minimum at 6 VDC
h.	Capstan to Case resistance	100 ohms maximum

2. Shaft Requirements...

a.	Material	Stainless Steel Type 303
b.	End Play	0.010 inch maximum
c.	Run Out	0.0015 inch TIR
d.	Surface Finish	8 RMS

3. Operating Extremes...

a.	Temperature	-10 to 60C
b.	Humidity	30% to 90%
c.	Noise Output	0 dB to 40 dB

SEE Eng Spec 030014

D. M101 TRANSPORT HEAD: (Digital Magnetic Recording Head)

1. Electrical Static···

a.	Inductance	10 mH (+/-) 15%
b.	Turns	maximum with inductance
c.	DC Resistence	45 ohms maximum
d.	Resonant Frequency	100 KHz minimum
e.	Stray Capacitance	50 pf maximum
f.	Core to Case Resistence	10 ohms maximum

2. Electrical Dynamic...

a. Reference

(1) Media should be Entrepo's Microwafer, Dwg# 030006
(2) 1f = 10 KHz
(3) 2f = 20 KHz
(4) Write Current = 25 mAff

b. Signal Amplitudes

(1)	V2f	5 mVpp minimum
(2)	V1f	12 mVpp maximum

3. Mechanical...

a.	Gap Material	Titanium
b.	Core Contact Surface Finish	8 microinch RMS maximum
c.	Core Material	Permalloy, or equivalent
d.	Gap Width	100 microinch (=/-) 10%
e.	Core Potting and Lamination Material	Epoxy
f.	Casing Surface Roughness	125 microinch RMS maximum

E. M101 STATUS SWITCHES:

1. Write Protect
2. Wafer Present

F. PCB ELECTRONICS:

1. Write Channel...

a.	Write Current	25 mAff (+/-) 10%
b.	Write Data Asymmetry See Figure 1.	0.1% maximum

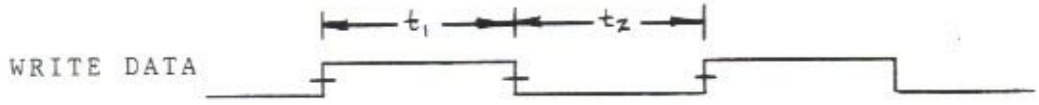


FIGURE 1. WRITE DATA ASSYMMETRY

2. Read Channel...

a. Voltage Gains at Z5-14 and Z5-15:

(1)	Av(1f)	97 (+/-) 20 V/V
(2)	Av(2f)	88 (+/-) 20 V/V

b. Droop Ignorer

(1)	O/S1 (Z5-7)	15.2 µs (+/-) 35%
(2)	O/S2 (Z5-9)	4.7 µs (+/-) 35%

c. Read Data at Z5-10 for an input voltage of 5 mVpp at frequency of 20 KHz. See Figure 1.

(1)	Pulse Width	4.7 µs (+/-) 35%
(2)	Assymmetry	0.5 µs maximum

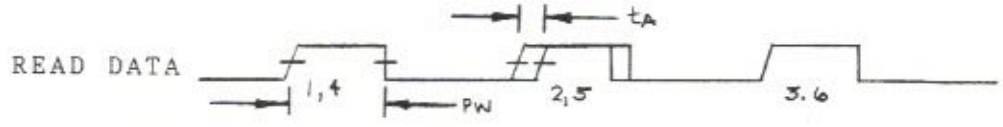


FIGURE 2. READ DATA PULSES

3. Status Switches...

a. Write Protect

(1)	Write Protected	2.5 VDC minimum
(2)	Not Write Protected	0.4 VDC maximum

b. Wafer Present

(1)	Wafer Present	0.4 VDC maximum
(2)	Not Wafer Present	2.5 VDC minimum

4. Motor Control Circuit

a.	Nominal Motor Voltage	6.0 VDC
b.	Voltage Range	3.5 VDC to 9.0 VDC
c.	Incremental Variation	1% maximum

5. Motor Speed Pulse Circuit...

a.	Voltage Gain (Z1-7 and f=15 KHz)	280 V/V (+/-) 25%
b.	Motor Speed Pulse Width	520 µs (+/-) 35%
c.	Motor Speed PRR (PRR = Pulse Recurrance Rate).	4.12 ms (+/-) 5% See Figure 2.

6. Index...

a.	Index Pulse Width	52 ms (+/-) 35%
b.	Index PRR	Dependent upon wafer tape length.

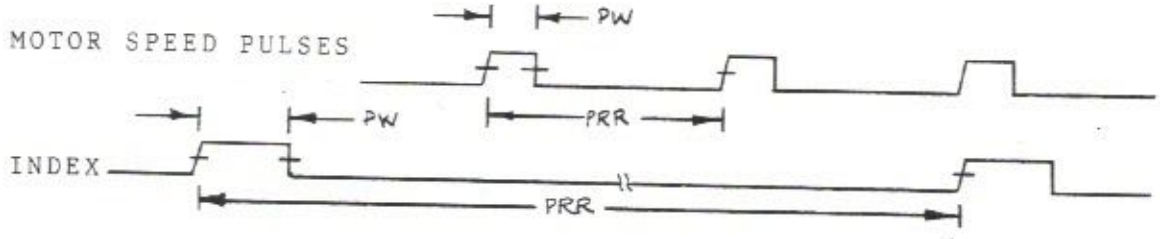


FIGURE 3. MOTOR SPEED PULSES & INDEX PULSE

A. GENERAL:

The Model 101 Waferdrive is a low cost wafertransport and read/write electronics capable of reading and writing on the Microwafer. The Microwafer is a continuous loop magnetic tape cartridge with capacity of 151 KBytes of FM encoded digital data in a 256 byte sector format and a data transfer of 20 Kbits/sec. The Waferdrive can sense the presense of the Microwafer to provide data security.

B. REQUIRED DOCUMENTS:

1. M101 WAFERDRIVE ELECTRICAL SPECIFICATIONS ~~#230007~~ 030015
2. M101 WAFERDRIVE MECHANICAL SPECIFICATIONS #140011
3. M101 MICROWAFER SPECIFICATION ~~#030006~~

C. SPECIFICATION SUMMARY:

1. PERFORMANCE SPECIFICATIONS:

a.	Capacity	151 KBytes max (50' tape)
b.	Transfer Rate	20 Kbits/sec
c.	Latency (Average)	30 sec max (50' tape)
d.	Start Time	200 msec
e.	Stop Time	100 msec

2. FUNCTIONAL SPECIFICATIONS:

a.	Tape Speed	
	(1) Read/Write	10 ips (+/-) 4%
	(2) Fast Forward	14 ips (+/-) 10%
b.	Encoding Method	FM (digital saturation recording)
c.	Recording Density	2048 bpi
d.	Flux Density	4096 fci
e.	Tracks	1
f.	Index	1

3. PHYSICAL SPECIFICATIONS:

a.	Environmental Limits:	Operating Shipping Storage
	(1) Ambient Temperature	10C to 45C
	(2) Relative Humidity	20% to 80%
	(3) Max Wet Bulb	30C (no condensation)
b.	Power Requirements:	
	(1) +12V DC (+/-) 5%	110 mA (typ): 500 mA (max)
	(2) +5V DC (+/-) 5%	100 mA (typ): 200 mA (max)
c.	Mechanical Dimensions:	
	(1) Height	2.70 inches
	(2) Width	3.25 inches
	(3) Depth	3.00 inches
	(4) Weight	4 ounces
d.	Operating Position:	Horizontal (+/-) 45 degrees
e.	Power Dissipation:	1.94W (typ): 7.24W (max)

4. RELIABILITY SPECIFICATIONS:

*a.	Mean Time Between Failures:	10,000 POH (typical)
b.	Preventive Maintenance:	clean head/capstan every 1000 POH.
c.	Components Design--Life:	5 years
d.	Error Rates:	
	(1) Soft Errors	1 per 1E8 bits read
	(2) Hard Errors	1 per 1E11 bits read
e.	Media Life:	5,000 passes

*MTFB assumes drive motor duty cycle of 10%.

D. ELECTRICAL INTERFACE:

1. PHYSICAL INTERFACE:
The physical interface between the Waferdrive and the host system is via a single connector, J1. This connector provides the signal interface, DC power, and ground.

2. The signal interface of connector J1 is listed on Table 1.

PIN	SIGNAL NAME
2	-WRITE DATA
4	-READ DATA
6	+WRITE PROTECT
8	-WRITE GATE
10	+INDEX
12	+CLK
14	-RESET
16	+SD
18	-WAFER PRESENT
20	+MOTOR SPEED
22	+5V DC
24	+12V DC (LOGIC)
26	+12V DC (MOTOR)

(All odd numbered pins are ground)

TABLE 1. CONNECTOR J1 SIGNAL INTERFACE

APPLICATION NOTE #1

MICRO WAFER RECORDING FORMAT

ENTREPO
1294 Lawrence Station Rd.
Sunnyvale, CA 94086
408-734-3133

November 1, 1983

1.0 RECORDING FORMAT

Data integrity specifications of the Entrepo Micro Drive are based upon extensive testing of the transport, electronics and Micro Wafer (TM) with data recorded in the following format. The specifications are valid only if the host system adheres to the following recommended format.

Data is recorded on the Micro Wafer (TM) using frequency modulation as the recording mode, i.e., each data bit recorded on the Micro Wafer (TM) has an associated clock bit recorded with it. Data written on and read back from the Micro Wafer (TM) takes the form as shown in figure 1. The binary data pattern shown represents a 101.

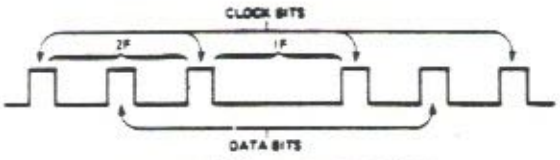


FIGURE 1 DATA PATTERN

1.1 BIT CELL

As shown in figure 2, the clock bits and data bits (if present) are interleaved. By definition, a Bit Cell is the period between the leading edge of one clock bit and the leading edge of the next clock bit.

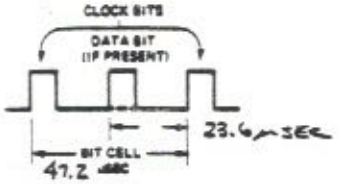


FIGURE 2 BIT CELL

1.2 BYTE

A Byte, when referring to serial data (being written onto or read from the Micro Wafer (TM)), is defined as eight (8) consecutive bit cells. The most significant bit cell is defined as bit cell 7. When reference is made to a specific data bit (i.e., data bit 3), it is with respect to the corresponding bit cell (bit cell 3).

During a write operation, bit cell 0 of each byte is transferred to the Micro Wafer (TM) first with bit cell 7 being transferred last. Correspondingly, the least significant byte of data is transferred to the wafer first and the most significant byte is transferred last.

When data is being read back from the drive, bit cell 0 of each byte will be transferred first with bit cell 7 last. As with reading, the most significant byte will be transferred first from the drive to the user.

Figure 3. illustrates the relationship of the bits within a byte and figure 4. illustrates the relationship of the bytes for read and write data.

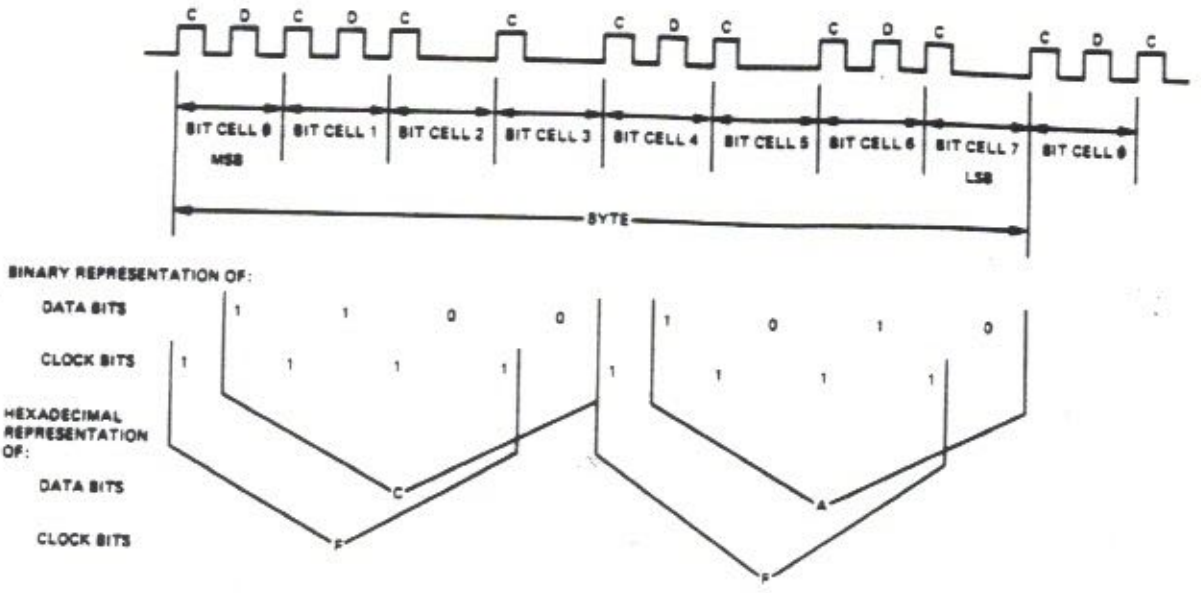


FIGURE 3 BYTE

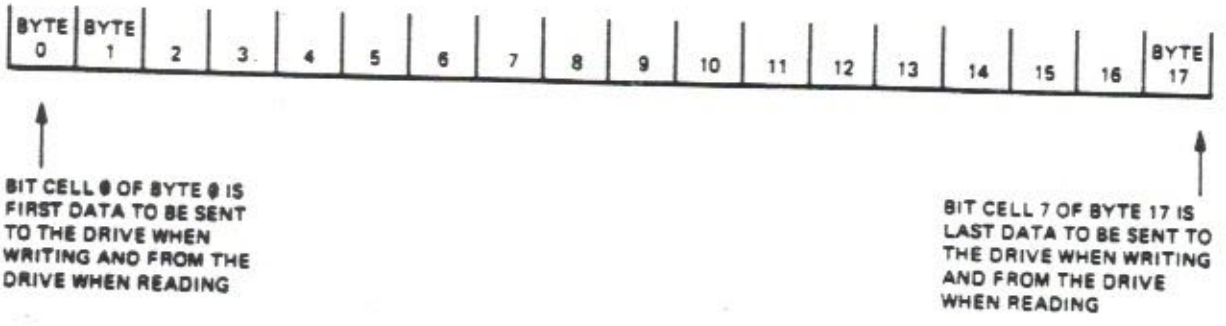


FIGURE 4 DATA BYTES

1.3 WAFER FORMAT

The Model 104 Wafer format is started by a physical index pulse and then each record is preceded by a unique recorded identifier. Figure 5. shows the format. The format described is similar to IBM disc formats with the interrecord gaps G1, G2, G3 and G4. The Entrepo Micro Wafer (TM) is the media to be used.

1.3.1 Gaps

Each field on a wafer is separated from adjacent fields by a number of bytes. These areas are referred to as gaps and are provided to allow the updating of one field without affecting adjacent fields. At the end of each gap, except Gap 4, are three bytes of zeros which are used for synchronizing the data separator. As can be seen from figure 5., there are four different types of gaps on each wafer.

Gap 1 Index Gap

This gap is defined as the 1100 bytes between Pre Index Gap and the ID Address Mark for Record zero. This gap is always 1100 bytes in length and is not affected by any updating process.

Gap 2 ID Gap

The 6 bytes between the ID Field and the Data Field are defined as Gap 2 (ID Gap). This gap may vary in size slightly in length after the Data Field has been updated.

Gap 3 Data Gap

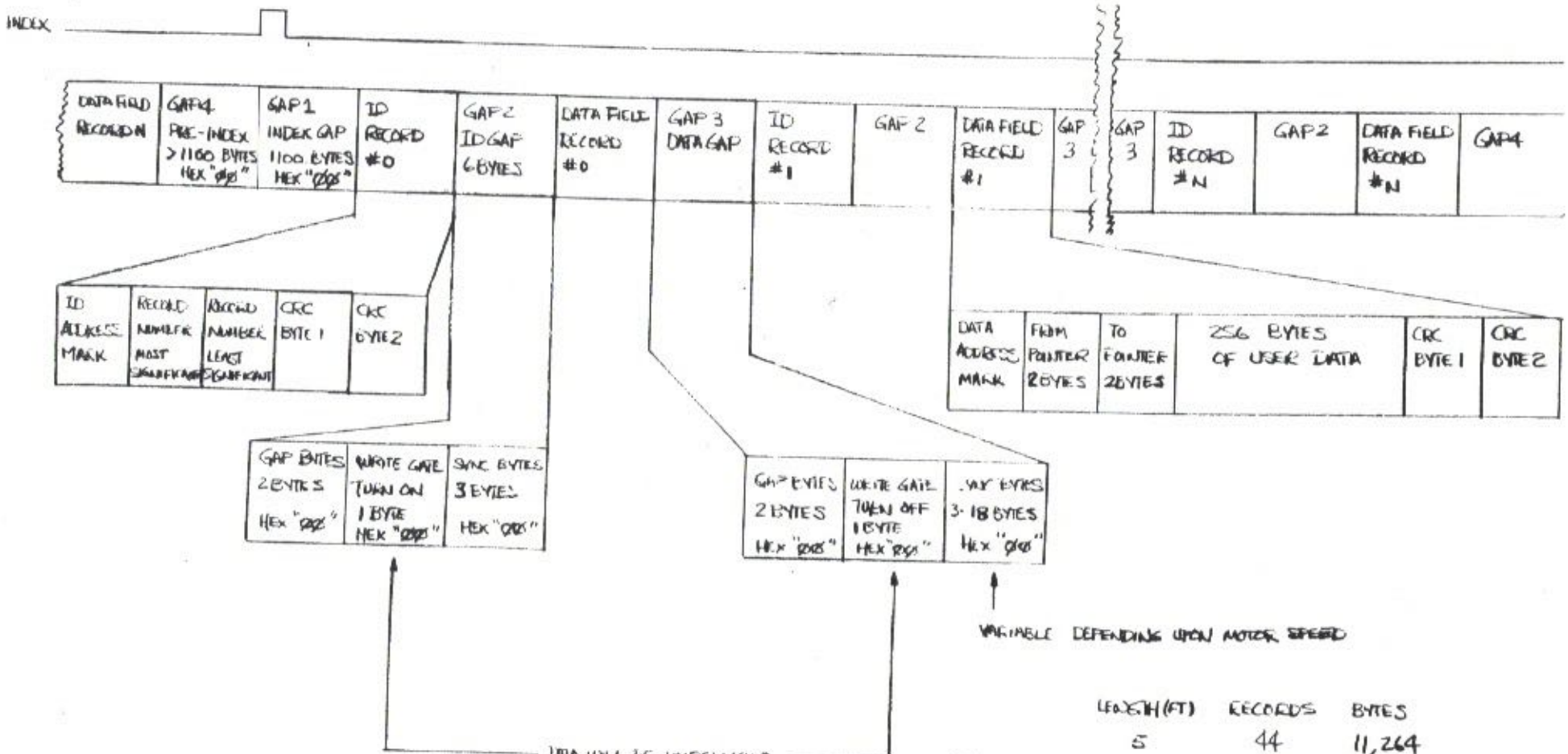
The 26 bytes between the Data Field and the next ID Field is defined as Gap 3 (Data Gap). As with the ID Gap, the Data Gap may vary slightly in length after the adjacent Data Field has been updated.

Gap 4 Pre-Index Gap

The 1100 bytes between the last Data Field on a wafer and the Index Gap is defined as Gap 4 (Pre Index Gap). This gap is normally 1100 bytes in length; however, due to variance in the physical length of tape and write frequency tolerances, this gap may vary slightly in length. Also, after the data field of the last record has been updated, this gap may again change slightly in length.

FIGURE 5.

WAFER FORMAT



LENGTH (FT)	RECORDS	BYTES
5	44	11,264
10	96	24,576
20	200	51,200
35	357	91,392
50	513	131,328

1.3.2 Address Marks (AM)

Address Marks are unique bit patterns one byte in length which are used in this recommended recording format to identigy the beginning of ID and Data Fields and to synchronize the deserializing software with the first byte of each field. Address Mark bytes are unique from all other data bytes in that certain bit cells do not contain a clock bit (all other data bytes have clock bits in every bit cell.) There are two different types of Address Marks used. Each of these is used to identify different types of fields.

ID Address Mark

The ID Address Mark byte is located at the beginning of each ID Field on the Micro Wafer (TM). The bit configuration for this Address Mark is shown in figure 6.

Data Address Mark

The Data Address Mark byte is located at the beginning of each normal Data Field on the Micro Wafer (TM). The bit configuration for this Address Mark is shown in figure 7.

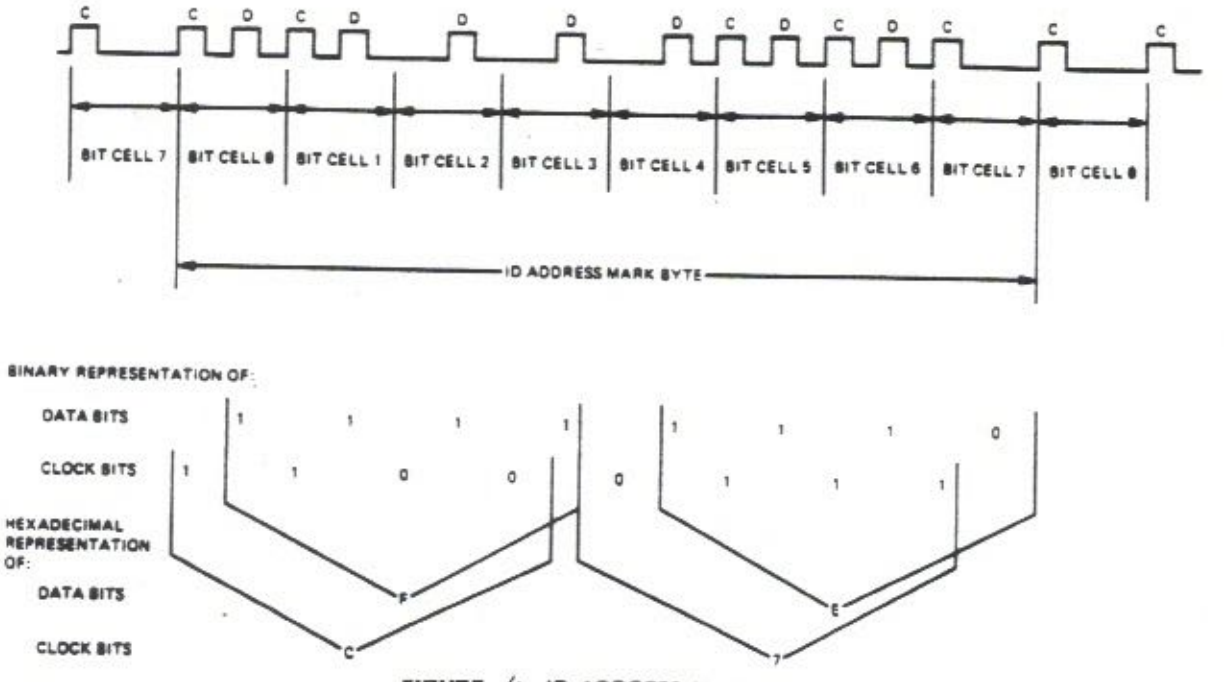


FIGURE 6 ID ADDRESS MARK

1.3.3 CRC

Each field written on the Micro Wafer (TM) is appended with two Cyclic Redundancy Check (CRC) bytes. These two CRC bytes are generated from a cyclic permutation of the data bits starting with bit zero of the first data byte and ending with bit seven of the last byte within a field (excluding the CRC bytes). When a field is read back from a Micro Wafer (TM), the data bits (from bit zero of the address mark to bit seven of the second CRC byte) are divided by the same generator polynomial. A non-zero remainder indicates an error within the data read back from the drive while a remainder of zero indicates the data has been read back correctly from the wafer.

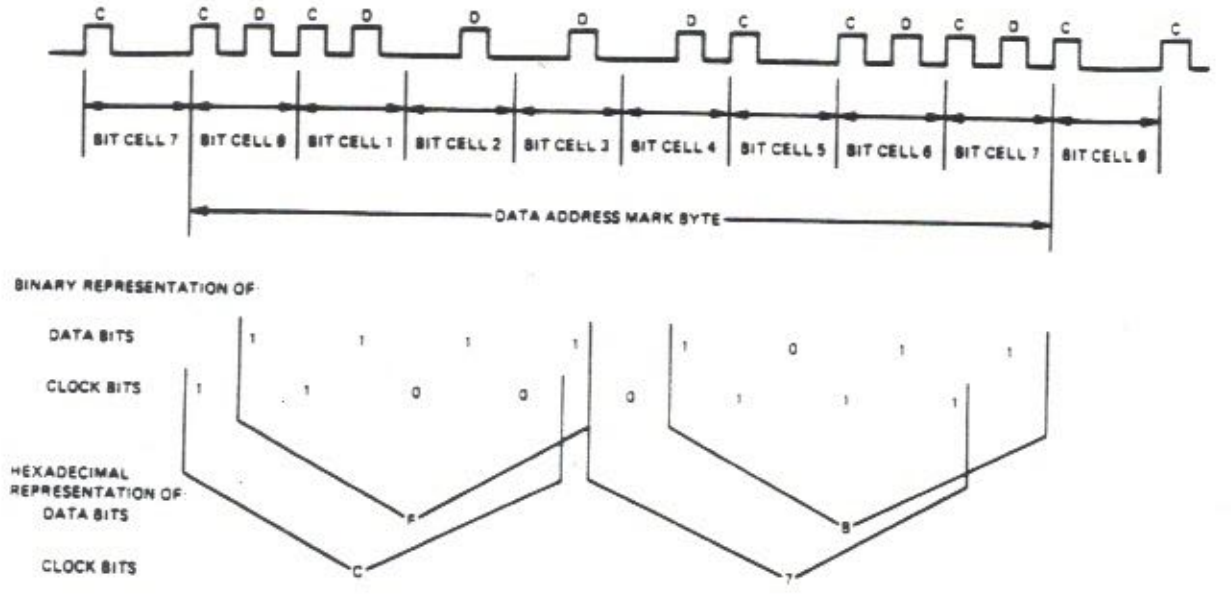


FIGURE 7 DATA ADDRESS MARK

ENTREPO WAFERDRIVE AND MICROWAFER

PRODUCT SELECTION GUIDE

MODEL	READ/WRITE	LOW PROFILE MOTOR	BATTERY OPERATION	MICROCOMPUTER	LOW LEVEL DRIVERS	FILE MANAGEMENT SYSTEM	POWER SUPPLY	CASE	RS232	TTL PARALLEL INTERFACE	DATA BUFFERING
101	X										
102	X	X	X								
103	X			X	X		X	X	X		
104	X			X	X	X	X	X	X		X
107	X	X	X	X	X					X	
108	X	X	X	X	X	X				X	X

Exatron Stringy Floppy Owners Association
181 Commercial, Sunnyvale, CA 94086

Annual Report

Dear ESFOA member,

The last year has been one of tremendous growth for both Exatron and the Owners Association. There are now several thousand Stringy Floppies in use, more than 250 local Workshop Chairmen, and the ESFOA library has broken the 200 program barrier.

Exatron has never been a "sell it, and forget it" type of company, and is working hard to provide user support. With the network of local Workshop Chairmen, @NEWS in 80–US Journal, @LOAD magazine, the ESFOA software library and toll-free hotline, the Stringy Floppy is one of the best supported peripherals available.

Looking forward, 1982 is certain to be an exciting year. A major goal is to improve communications among all ESFOA members. Jim Perry has joined Exatron on a full-time basis, and will be busy preparing new manuals, catalogs and newsletters. Several new products have been developed, some are described later in this report, and several more are nearing completion. The preparation of support documentation always seems to be the pacing factor in getting new products to market—we will sell no manual until it has been written!

A new product of interest to all Model I owners is a 64K memory board, the MM800. It installs inside the keyboard in a similar fashion to the 48K Holmes board, but has several advantages. It uses the latest 64K dynamic RAM chips, includes a 50- or 100-percent speedup circuit, and allows you to replace ROM with RAM. The possibilities are endless with the ROM/RAM feature, for example, you can copy Level II into RAM and then modify it. The MM800 is $199.50.

If you have an early Model I, with the ugly "up in the air" lowercase display, then the new Exatron character-generator kit may be of interest. The Radio Shack character-generator kit retails for $39.95, the Exatron kit is only $19.95. The Exatron kit has a couple of other advantages over the Shack's kit, besides being $20.00 cheaper; it displays control codes in reverse video and, because it is based on a 2716 EPROM, can be modified for special characters (if you have access to an EPROM programmer).

For those of you who have been waiting patiently for the Model III ESF—it's now available! The recording format used is the same as that used by the Model I ESF, making program transfer straightforward. The single-drive version is $349.50 and the twin-drive unit is $449.50, more details inside.

A lot of good quality commercial software is available from Exatron, and many other sources, at reasonable cost. The latest additions to the commercial software catalog are described later on. If your software catalog is dated earlier than August 1981 then let us know, and we'll send you a current edition.

@LOAD 2 ia now available. A big effort is being made to increase the number of @LOAD wafers in 1982. A major criteria in selecting programs for future @LOAD editions will be their educational value. If you haven't seen @LOAD 0 or @LOAD 1 then you're really missing out!

Speaking of education, a selection of public-domain educational programs have been put together for a school starter kit. This software package is available to schools purchasing starter kits in place of the normal starter kit software. The programs are also available through your local ESFOA library for the cost of wafers, and a nominal duplication charge.

A current list of library software, both public domain and magazine, is also included. These programs are only available through your local Workshop Librarian. Many local software libraries have been started in the last year, and hopefully many more will be founded this year.

Those of you who have accumulated a lot of wafers, and are looking for an efficient storage method, will be interested in the enclosed Wafer Wheel brochure. Developed by ESFOA Chapter 0 members, John Grass and Bill Stokes, the Wafer Wheel is a really useful addition to any work station.

Finally, if you haven't already, join and support your local Workshop—or start one yourself! 1982 is going to be a great year for both Exatron and the ESFOA.

Robert L. Howell,
Chairman of the Board.

MODEL III ESF NOW AVAILABLE

The Exatron Stringy Floppy for the TRS-80 Model III, operates just like, and is compatible with, its popular predecessor, the ESF for the TRS-80 Model I. This means that most BASIC programs written on the Model I and stored on an ESF wafer may be @LOADed and RUN on the ESF III.

The ESF III requires no special interface as it connects to the Model III through the 50-pin I/O bus on the rear of the computer. However, you must have at least 16K Level II BASIC and a cassette cable.

The ESF III will work together with a disk or cassette system—it does not eliminate any of the capabilities or functions that your present system now has.

The ESF III Operating System (ESF III O/S) with DATA I/O occupies about 4K bytes on non-relocatable memory (RAM) and is loaded through the cassette port (there are jacks on the ESF III to connect to your cassette cable). Once the ESF III O/S is loaded, the cassette cable may be removed. The ESF III O/S then relocates itself to high memory, and resets the top of memory to protect itself.

COMMANDS

The command set of the ESF III is summarized below. The suffix "n" is a number between 1 and 99 and designates a file number. The number of files which may be stored on a wafer is determined by the length of the wafer and the data (or programs) to be stored.

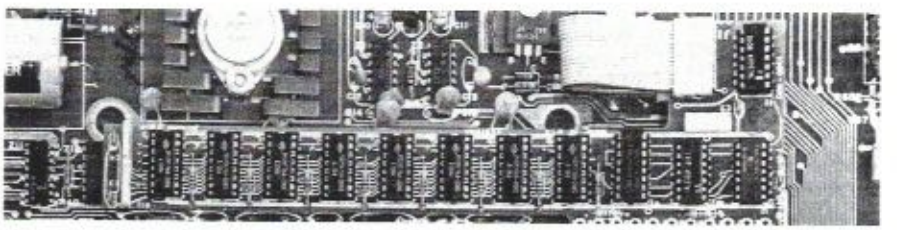
@LOADn	Equivalent to the commands CLOAD in cassette and LOAD in disk systems.
@SAVEn	Equivalent to the commands CSAVE in cassette and SAVE in disk systems.
@NEWn	Certifies wafers by writing data to the wafer and reading this pattern back. This checks the tape for any dropouts and determines how many unused bytes are available on the wafer.

DATA I/O

The ESF III Data I/O program provides the ESF III with data-file handling capabilities. The Data I/O program is included in the Starter Kit when you purchase an ESF III. The Data I/O command set is summarized below. These commands, with examples of how they are used, are covered in great detail in the ESF III Data I/O program documentation.

@OPEN	Initiates the link between the Data I/O program and the ESF III firmware in preparation for writing or reading a data file.
@PRINT	Writes a data file to the wafer.
@CLOSE	Closes the file.
@INPUT	Reads a data file from wafer.
@CLEAR	Similar to the @CLOSE command. Normally used in data handling and error trapping routines.

64K IN-KEYBOARD MODEL I MEMORY



The Exatron 64K In-Keyboard Memory Unit (MM800) modifies your TRS-80 Model I, and has the following features:

- Gives 64K bytes of RAM (61440 bytes user modifiable)
- Allows RAM to replace ROM.
- Easy return to normal TRS-80 mode (just press RESET key)
- Adds 50- or 100-percent speedup (software selectable).
- Easy installation
- Mounts in keyboard
- Uses 64K RAM chips—only 8 required.
- No expansion interface required.

In addition to having a full 48K of RAM available while in normal TRS-80 mode, you can replace ROM with RAM and make BASIC work your way. Add to, change, delete, or replace ROM routines. It becomes possible to replace BASIC with other operating systems, such as CPM, Forth, FORTRAN, COBOL, or your own.

NEW CHARACTER GENERATOR

The new character-generator board from Exatron is easy to install, and gives two switch-selectable character sets. The first set has reverse video for control codes, and the second set displays control codes with an underline.

Based on a 2716 EPROM, you can even design your own displays (if you have access to an EPROM programmer).

ELECTRIC PENCIL VERSION 2.0

Michael Shrayer's *Electric Pencil* is one of the most popular word processors in the world. This is a totally new version, with built-in Stringy Floppy commands, as well as cassette operation.

All known "bugs" have been eliminated, several new features have been added, and the price has been dropped to only $59.95, for the Model I or Model III version.

All existing Electric Pencil files can be used by this version, and it can also read Scripsit files. The 128-page manual was written by Harvard Pennington (of *Disk & Other Mysteries* fame), and anyone can learn to use the program in a few hours.

New features include saving of print parameters, separate print and control menus, three built-in print drivers, display of system status, and a multi-key type-ahead buffer.

Exatron Stringy Floppy Owners Association
181 Commercial, Sunnyvale, CA 94086

Annual Report

Dear ESFOA member,

The last year has been one of tremendous growth for both Exatron and the Owners Association. There are now several thousand Stringy Floppies in use, more than 250 local Workshop Chairmen, and the ESFOA library has broken the 200 program barrier.

Exatron has never been a "sell it, and forget it" type of company, and is working hard to provide user support. With the network of local Workshop Chairmen, @NEWS in 80-US Journal, @LOAD magazine, the ESFOA software library and toll-free hotline, the Stringy Floppy is one of the best supported peripherals available.

Looking forward, 1982 is certain to be an exciting year. A major goal is to improve communications among all ESFOA members. Jim Perry has joined Exatron on a full-time basis, and will be busy preparing new manuals, catalogs and newsletters. Several new products have been developed, some are described later in this report, and several more are nearing completion. The preparation of support documentation always seems to be the pacing factor in getting new products to market—we will sell no manual until it has been written!

A new product of interest to all Model I owners is a 64K memory board, the MM800. It installs inside the keyboard in a similar fashion to the 48K Holmes board, but has several advantages. It uses the latest 64K dynamic RAM chips, includes a 50- or 100-percent speedup circuit, and allows you to replace ROM with RAM. The possibilities are endless with the ROM/RAM feature, for example, you can copy Level II into RAM and then modify it. The MM800 is $199.50.

If you have an early Model I, with the ugly "up in the air" lowercase display, then the new Exatron character-generator kit may be of interest. The Radio Shack character-generator kit retails for $39.95, the Exatron kit is only $19.95. The Exatron kit has a couple of other advantages over the Shack's kit, besides being $20.00 cheaper; it displays control codes in reverse video and, because it is based on a 2716 EPROM, can be modified for special characters (if you have access to an EPROM programmer).

For those of you who have been waiting patiently for the Model III ESF—it's now available! The recording format used is the same as that used by the Model I ESF, making program transfer straightforward. The single-drive version is $349.50 and the twin-drive unit is $449.50, more details inside.

A lot of good quality commercial software is available from Exatron, and many other sources, at reasonable cost. The latest additions to the commercial software catalog are described later on. If your software catalog is dated earlier than August 1981 then let us know, and we'll send you a current edition.

@LOAD 2 ia now available. A big effort is being made to increase the number of @LOAD wafers in 1982. A major criteria in selecting programs for future @LOAD editions will be their educational value. If you haven't seen @LOAD 0 or @LOAD 1 then you're really missing out!

Speaking of education, a selection of public-domain educational programs have been put together for a school starter kit. This software package is available to schools purchasing starter kits in place of the normal starter kit software. The programs are also available through your local ESFOA library for the cost of wafers, and a nominal duplication charge.

A current list of library software, both public domain and magazine, is also included. These programs are only available through your local Workshop Librarian. Many local software libraries have been started in the last year, and hopefully many more will be founded this year.

Those of you who have accumulated a lot of wafers, and are looking for an efficient storage method, will be interested in the enclosed Wafer Wheel brochure. Developed by ESFOA Chapter 0 members, John Grass and Bill Stokes, the Wafer Wheel is a really useful addition to any work station.

Finally, if you haven't already, join and support your local Workshop—or start one yourself! 1982 is going to be a great year for both Exatron and the ESFOA.

Robert L. Howell,
Chairman of the Board.

SOFTWARE UPDATE

Some of these programs are new or enhanced versions of existing programs. If you purchased an earlier version then you can "upgrade" by paying the difference in cost of the versions (if any), plus $3.95 for duplication costs.

To receive credit you must supply proof-of-purchase of the earlier version. This can be done by returning the original wafer (with its label still affixed), or a photocopy of your original invoice, with your order. To make life easier, the upgrade cost is shown where applicable.

BUSINESS

REAL ESTATE "SCRATCH PAD"

By Bob Sexton

Catalog #184 - $24.95

This program provides a five-year projection for any property from single family to large apartments. It is unique in that any factor in the analysis can be changed at any time. Even loan strategy can be changed in analysis midstream. The "What if?" game can be played with instant answers.

Provisions are made for entering local parameters where necessary, and full or partial reports can be printed with the touch of a key.

SMALL HOME-BUSINESS PROGRAMS

By Fred Blechman

Catalog #179 - $25.00

These programs are designed for the small entrepreneur with no employees, operating a home-based business such as Amway, Avon, Fuller Brush, Shaklee, Tupperware, Mail Order, Specialty Salesman, Insurance or Real Estate. The programs are designed for a 16K, Level II, Model I. No disk is required, but an 80-column printer is needed for three of the programs.

The 5 programs are:

- Speed-letter—a word processor.
- 12-Column Ledger—an accounting program.
- 3-Across Mailing Labels—a mailing list program.
- Telephone Auto-Dialer/Timer
- Toll-Charge—Real-time display of phone charges.

STRINGY MAILING SYSTEM

By Bob Sexton

Catalog #181 - $99.95

Written to take full advantage of your Exatron Stringy Floppy, this program can be used as a conventional mailing list or for direct-mail advertising lists. The program features machine level data creation and editing, automatic computer created addresses, fast single-keystroke data entry for general mailings and program control, and instructions for use with virtually any printer configuration.

Memory conservation features include the use of program overlays, tokens for certain data, and storage of a single address for multiple label printing in general mailings. (As many as 1300 different labels have been printed with a list of less than 80 address entries—this was done in a 16K machine with one data load.)

PATCHES

R. S. EDTASM

By David Purdue

Catalog #106 - $11.95 ($5.95 upgrade)

This is an enhanced version of the existing patch, to the cassette version of the Radio Shack Editor/Assembler (EDTASM). In this version both SOURCE and OBJECT codes may be saved and loaded with your ESF. The wafer contains patches for versions 1.1, 1.2 and Series 1 (version 1.0) of EDTASM.

CROWN MICROPRODUCTS ROM-116

By James Sladek

Catalog #186 - $7.95

This patch changes the general-purpose, and main-text, routines in RTTY version 1.3 to work with an ESF. With it you can also read/write line and callsign buffers, display the read/write mode, exit without ESF action and verify wafers. A limited display of ESF error messages is also implemented.

Tape operation is limited, due to the file number prompt needed to write files.

R. S. TINY PASCAL (32K)

By L. S. Preston

Catalog #183 - $9.95

A patch for the 32K version of Radio Shack's Tiny Pascal, which provides for ESF storage and/or retrieval of source and P-code files. Also available is a command to print source code on a line printer.

UTILITIES

SUPER LABEL MAKER (32/48K)

By Bill Burnham

Catalog #182 - $9.95

This program provides the capability of printing up to five lines of text on a standard 3½" by 15/16" mailing label. You can print special "Title Labels" that can be affixed to wafers for identifying program files, as well as printing mail and identifier labels for notebooks, file drawers, etc.

The number of characters printed per line is automatically set depending on which of four label formats is selected.

All text data can be saved as data files and loaded at a later date, for printing more titles or labels with the same text and format. These data files may be saved or read in the standard Data I/O format, or by a method that does not require the use of the Data I/O program. This method will also verify the saved data file.

EASY DOES IT (48K)

By Bill Burnham

Catalog #185 - $14.95

The ultimate in a screen display/formatter. Create mixed text and graphic displays, in either 32- or 64-character mode, with all or any portion of the screen automatically coded into packed strings—for fast, or animated, reproduction in your own program.

Choose your own packed string variable names and their resident line numbers. This program has screen editing functions similar to a word processor. Graphics can be generated utilizing the full graphics block (6 pixels at a time) or by utilizing just a single pixel.

Will automatically draw circles, rectangles, and diagonals of any size, anywhere on the screen. Just tell the program what you want and it will figure out how to do it for you.

ESOS 2.4

By Tom Wheeler

Catalog #169 - $35.00 ($13.95 upgrade)

ESOS 2.4 is an enhanced version of the original Extended BASIC (ESOS 1.4) and can operate with as little as 16K of memory, however, 32K or 48K is recommended.

The Extended BASIC part of ESOS 2.4 contains many useful new functions: Program Renumber, Hex to Decimal conversion (and vice-versa), flexible user-defined functions, screen (or directory) dump to line printer, and many others.

An "intelligent" upper-lowercase driver is also included (it works with the Radio Shack modification). BASIC programs can control this driver.

All of these features are in addition to the original ESOS features of wafer directory, named files, passwords, etc. A 40-page manual takes you step-by-step through all the features of the operating system.

ZAP & DUMP

By Brad Kidder

Catalog #109 - $9.95

These two machine-language utility programs may be used to display and modify memory in a 16, 32, or 48K Model I.

The display is in both hexadecimal and ASCII. The arrow keys are used to "scroll" the display through memory, and to position a cursor. Any byte in memory can be modified by simply typing over it on the display—just like using a word processor!

If you have ever wanted to know what is in memory, or needed to modify memory, then this wafer is the answer.

@LOAD 2 AVAILABLE

@LOAD 2 is now ready and orders are being taken. It contains five programs. Here is a brief description of each:

CHART OF ACCOUNTS: Data Input Module. First of a series of accounting programs that will be appearing in future issues.

SCREEN PRINT: Machine language utility. Will print any character (alphanumeric or graphic) that appears on the screen to a printer.

MISSOURI MULE: A game that is simple to play but not easy to win. Excellent graphics and the program code is written in a clean open style for easy study of programming techniques.

FRACTION BLOWOUT: An excellent educational game that first appeared in *Personal Computing* magazine. It has been reproduced with permission from *Personal Computing*.

PEEK AND POKE: A BASIC utility. Allows inspecting and changing memory contents directly.

We, as well as all ESF owners, appreciate the work being contributed to help make @LOAD a success. As a brief reminder of the @LOAD concept, the following is an excerpt from the @LOAD 0 covering letter.

The three main objectives of @LOAD are to provide our ESFOA members with good software at a reasonable price; to give recognition to the many capable authors out there in ESF land that have an unpublished quality program that they wish to share with others; and to point out and share examples of good programming techniques and useful routines that may be utilized in other programs of your own.

The per issue cost of @LOAD is $9.95. This charge does not represent any cost to you for the programs contained on the @LOAD wafer. These programs are free. The charge is made only to help defray the costs of shipping and, wafer/documentation reproduction.

SUPER-DISK FOR IBM

The Exatron Super Disk adds 192K of dynamic RAM to a 64K IBM Personal Computer, and it operates like a super-fast solid-state disk!

With the addition of a Stringy Floppy you can load and save the Super-Disk memory in seconds. Alternatively, if a disk drive is installed, the IBM DOS can be converted to SUPERDOS which will allow disk software to run in RAM.

```
Super Disk Version 8.00
(C)Copyright Lichen Wang 1982
Enter today's date (m-d-y): 3-13-82

The IBM Personal Computer DOS
Version 1.00 (C)Copyright IBM Corp 1981

A>_
```

The Super Disk was designed by Dr. Lichen Wang, the author of Palo Alto Tiny BASIC and the TRS-80 Stringy Floppy operating system. The 192K card is $995.00, and the ESF drive is $295.00.

ORDER FORM

Qty	Item	Unit cost	Total
	HARDWARE		
	MM800 64K RAM Board	200.00	
	ESF III (Starter Kit)	349.50	
	ESF III (Twin drive)	449.50	
	IBM Super Disk Card	995.00	
	IBM ESF	295.00	
	SOFTWARE		
	Character Generator	19.95	
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	Pascal Patch (183)	9.95	
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	Easy Does It (185)	14.95	
	ESOS 2.4 (169)	35.00	
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	Zap & Dump (109)	9.95	

HOTLINE 800-538-8559 or 408-737-7111

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	20' (SF220)	4.00	
	35' (SF235)	4.00	
	50' (SF250)	4.50	

Shipping & Handling: Software & Wafers **$3.00**. Hardware **$6.50**. All Canadian orders **$10.00**. C.O.D. an extra **$1.50**. USA shipping includes insurance.

UPS is used for USA shipments. Allow two weeks for clearance of personal checks and/or four weeks for shipping.

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BADEN Jim Lyon 412 266-8962
CORAOPOLIS Paul Sturpe 412 264-1492
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EAST STROUDBURG H. Kenneth Lee 717 421-4889
GLENSIDE Fred Donaldson 215 576-0962
KINGSTON Art Prutzman 717 675-2654
LEWISTON Robert C. Bender 717 248-0997
MOOSIC B. Platsky 717 823-4058
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UPPER DERBY Ron Cameron 215 352-4266
WILKES-BARRE David Hersker 717 822-1101
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RHODE ISLAND
PORTSMOUTH Keith Falt 401 841-2454

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SIOUX FALLS Gary Meade 605 336-9584

TENNESSEE
BRENTWOOD Edward F. Jaekle 615 373-0876
KNOXVILLE R. Gilbert Guay, Jr. 615 588-3804
KNOXVILLE Victor H. Klein 615 693-5267

TEXAS
AUSTIN James A. Isbell, Jr. 512 266-2115
BROWNWOOD Duane L. Schwab 915 643-3943
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DAYTON Steve Wright 713 258-7338
DECATUR W. Lowell Lonnon 817 627-3838
EDINBURG Robert L. Weathers 512 383-5706
FT. WORTH J.A. Van Velzer 817 451-6916
GARLAND Rich Casey 214 840-1818
HARLINGEN Sue Knetig 512 425-6655
HOUSTON Ron Pounds 713 495-7095
ODESA Les Blalock 915 367-0408
ROCKWELL Claude Sturgeon 214 722-3290

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SANDY R. Wayne Horscroft 801 566-7291

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ALEXANDRIA Aubrey Mitchell 703 768-2452
FARMVILLE John Fried 804 392-4111
GRAFTON H. Ross Wiant 808 898-8121
LORTON William Clugston 703 339-5973
RESTON Karl W. Berger 703 471-4007
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WASHINGTON
ENUMCLAW William P. Foley 206 825-5679
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OLYMPIA Timothy E. Linehan, MD 206 357-6300
PUYALLUP Ronald Hortloff 206 927-2175
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SEATTLE Ron Munson 206 228-5662
SPOKANE Tim Bowman 509 455-4174
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TACOMA Richard Frasier 206 759-4444

WEST VIRGINIA
ST. ALBANS Kay Howard 304 348-2411

WISCONSIN
HALES CORNER Leo L. Lamacchia 414 425-6381
HORICON Daniel E. Halfmann 414 485-4380
KEWAUNEE William R. Wagner 414 388-3215
MADISON Pat Stefonek 608 221-1917
MADISON Doug Swiggum 608 264-3440

WYOMING
CHEYENNE Vincent P. Foley 307 635-4157

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Contact your nearest Workshop Chariman for the name and address of your local librarian. If a library has not been established locally, and you are interested in setting one up, then contact Exatron.

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APPLICATIONS

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CAL81	038M	80MC 12/80
SHOPPING LIST	046M	80MC 3/81
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SCHEDULE G 1980	045M	C/COMP 3/81
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ENCRYPT/DECRYPT	064M	P/COMP 11/80
STOCK MKT RECORD PGM	072M	R/S
ORIENTEERING	074M	SOFTSIDE 5/81
COMPU-SKETCH	104M	SOFTSIDE 8/81
DATA BASE MANAGER	067M	SOFTSIDE 9/81

EDUCATION

DVORAK KEYBOARD	009M	80MC 12/80
VOCABULARY BUILDER	090M	80MC 2/81
PRE-SCHOOL MATH	034M	80MC 4/80
KID-STUFF PROGRAMMING	037M	80MC 9/80
ESTIMATOR	081M	80US 1/81
GEOGRAPHY	044M	C/COMP 9/79
COEFFICIENTS	056M	CCSF /81
SPELLING EXERCISE	051M	P/COMP 10/80
BASIC TYPIST	050M	P/COMP 4/80
DECIMAL TO ROMAN	085M	R/S 1/81
ON A SNOWY EVENING	032M	R/S MANUAL (L1)
VOLCANO	047M	SOFTSIDE 3/81

GAMES

23 MATCHES	059M	
BIORHYTHM	039M	
THE DUCK HUNTER	058M	
SKI RACER	011M	80MC
THIRTEEN WAYS	007M	80MC
ASTEROID ADVENTURE	063M	80MC 10/80
PETALS AROUND ROSE	065M	80MC 12/79
FIFTEEN PUZZLES	030M	80MC 2/81
MICRO-BASKETBALL	041M	80MC 3/81
SIMUL-80	055M	80MC 4/81
THIS AIN'T NO PARTY	096M	80MC 4/81
THE GAME OF LIFE	035M	80MC 6/80
SUPER MAZE	099M	80MC 6/81
TTT THIRD DIMENSION	062M	80MC 7/80
FRANKENSTEIN	100M	80MC 8/81
MAZE W/SOUND	052M	80US 11/80
SURVIVAL	026M	80US 3/80
YAHTZEE	019M	80US 3/80
SMART TIC-TAC-TOE	024M	80US 3/81
SPACE MARAUDER	084M	80US 5/81
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HANGMAN	016M	H&E COMP 12/80
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ROMULAN	093M	C/COMP /78

UTILITIES

BANNER BANTER	083M	80MC 2/81
ENDORSE/WRITE CHECK	087M	80MC 4/81
PILOT (LANGUAGE)	097M	80MC 7/81
FIXNEW	022M	80MC 1/80
CROSS REFERENCE	023M	80MC 1/81
CONVERT A NUMBER	042M	80MC 3/81
FIND GOTO/GOSUB	043M	80MC 3/81
TWOHAF	088M	80MC 7/81
SCREEN PRINT	020M	80MC 9/80
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ANDY CALENDAR MAKER	076M	80US 1/81
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GROCERY LIST	X065	Jack Martin
IRS FOR 1040	X008	R.D. Osborne
JAPANESE TRAINER	X033	Foe Fouke
LABELS/NAME TAGS	X060	Dana Huff
MOVING AVERAGES	X007D	Bob Wilson
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PERSONAL SECRETARY	X064	Jack Martin
PHONE LIST	X023	Brad Kidder
SLIDE TITLER	X001D	Lou Genco
SORT	X054	Bob Vollmer
TRAVEL EXPENSES	X012	Tom Warfield
UNIT PRICES	X016	R. Fasmore
WORM	X017	Brad Kidder

CONVERSIONS

ADVENTURE CONVERTER	X005D	Lue Genco
EDTASM PATCH	X013D	Tom Wheeler
ENHBAS	X009	Donald Howe

EDUCATION

LIFE EXPECTANCY PGM	X034	Foe Fouke
MATH TEST	X022	Brad Kidder
QUIZ MASTER	X039D	J. Tregeagle
SNOWFLAKES	X049D	V. Vann

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CHECKERS	X014D	Bob Wilson
CRAPS	X031	Brad Kidder
DREAD-NAUGHTS	X052	Lou Genco
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GUESS A NUMBER	X021	Brad Kidder
MASTERMIND	X015	Carl Kaminski
MAZE	X025	Brad Kidder
MISSOURI MULE	X058	Dan Shelby
OTHELLO	X057	Dan Shelby
RANDOM FOOD MENU	X040D	Jack Smock
REACTION	X019	Brad Kidder
SKETCH PAD	X002	Bob Wilson
SLOT MACHINE GAME	X003	Bob Vollmer
SLOT MACHINE W/SOUND	X029	Brad Kidder
THE GAME OF 'LIFE'	X030D	Brad Kidder
UNLIST	X028D	D. Dickerson
X-O-TRAN	X020	Brad Kidder

UTILITIES

2 CONVERSION PGMS	X038	Joe Fouke
ARTIST +	X062D	Bob Sexton
CENTERING AID	X048D	Benninghoff
DUMP & ZAP	X024D	Brad Kidder
EXATRON DISPLAY AD	X035	Wee Willy
LINK	X042D	George Weir
MATINV	X043	George Weir
MERGE	X041D	George Weir
QNEW	X027	Jim Preston
OUTLINE PROGRAM	X046D	Gerald Melin
PEAK & POKEN	X026D	Bill Burnham
PERSONAL DIRECTORY	X037D	Ridge Cotton
RECIPE CONVERTER	X047	B. Carlson
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SCREEN PRINT	X065	David Gavin
SINGLE VARIABLE ANALYSIS	X050	Dale Potter
SOUND DEMO	X045	Wee Willy
STRINGY INDEX	X036	Nolan Coker
STRING PACKER	X011	M. Van Pelt
SUPER GRAPHICS	X004D	Paul Kafoure
VARIABLE PRINT	X053D	David Gavin
Z-LANGUAGE	X067D	Spencer Hall

BSR Computer Components

SF1105 Series Stringy Floppy™ Microdrive

DESCRIPTION

The BSR SF1105 Series Stringy Floppy™ Microdrive is a high-performance memory storage system combining fast, convenient data/program access and reliability in a low-cost, compact device.

Featuring a data transfer rate of 17,066 bits per second, the Microdrive uses a removable, continuous-loop magnetic tape cartridge[1] for storage, distribution and mailing of data or programs.

The high-reliability drive mechanism, low power consumption, and rugged high-density cartridges make the Microdrive well suited as an economical replacement for floppy disc systems, as back-up storage, and for portable applications ranging from computers, remote data devices, typewriters and printers to cash registers, data loggers and telecommunications systems.

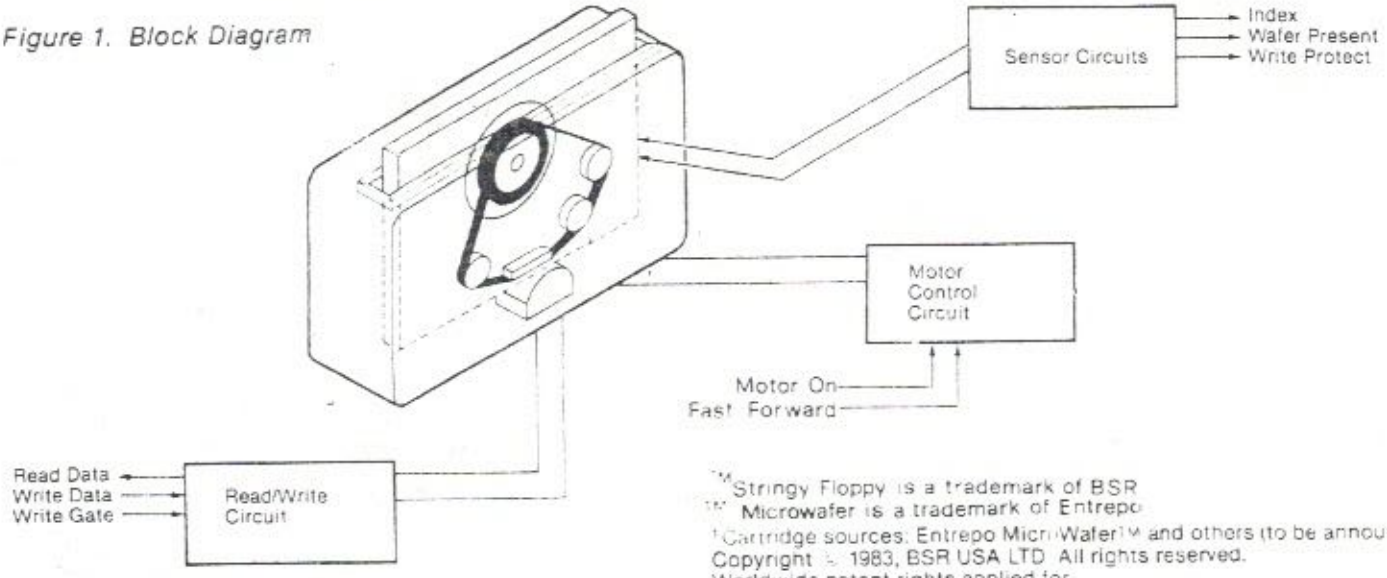
FEATURES

- Storage capacity up to 131 Kbytes (formatted), 151 Kbytes (unformatted)
- Minimal power consumption
- Mechanical write-protect for data security
- Media-detect sensor
- 17,066 bits-per-second transfer rate
- Easily interfaced
- Unique sliding cover for media protection
- Small size
- Special tape coating for low friction

APPLICATIONS

- Home/personal computers
- Smart telephones
- Small PBX systems
- Software distribution media
- Small data loggers
- Electronic typewriters
- Word processors
- Smart printers
- Portable computers
- Electronic cash registers

Figure 1. Block Diagram



™ Stringy Floppy is a trademark of BSR
™ Microwafer is a trademark of Entrepo
[1] Cartridge sources: Entrepo MicroWafer™ and others (to be announced)

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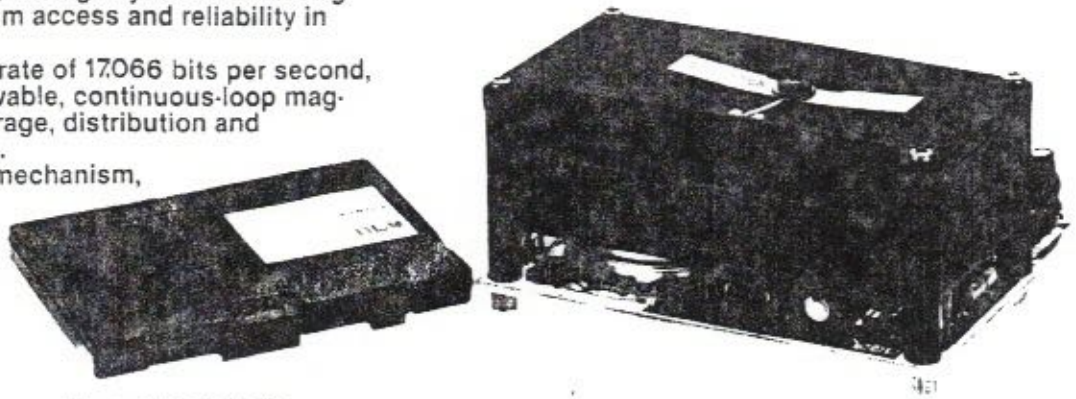

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- Minimal power consumption
- Mechanical write-protect for data security
- Media-detect sensor
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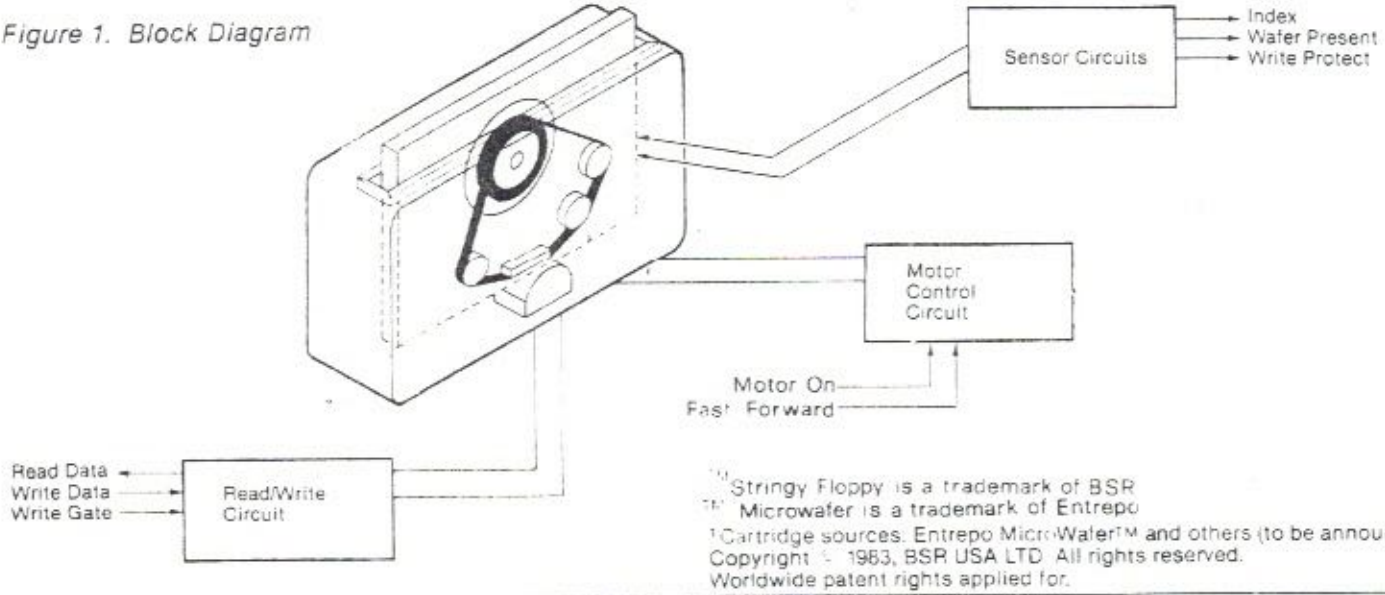
Figure 1. Block Diagram



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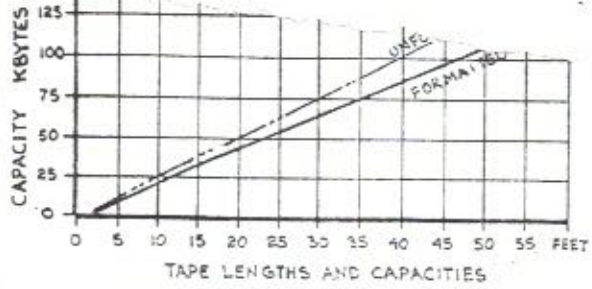


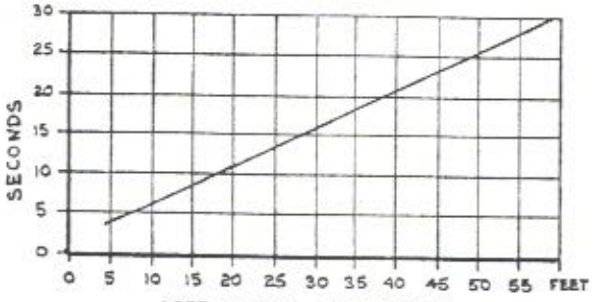
TAPE LENGTHS AND CAPACITIES

FUNCTIONAL SPECIFICATION

Tape speed tolerances:
- Read/Write 10 ips ±4%
- Fast forward up to 16 ips

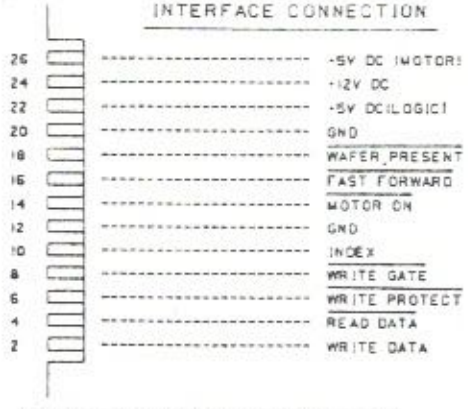
Tape positioning tolerances (nominal)
- Start time 250ms
- (0-1% of nominal velocity)
- Stop time 100ms
- Start distance 2 ins
- Stop distance 0.5 ins

Recording density 1706 bpi
Flux density 3413 fci
Media requirements Entrepo Microwafer



APPROXIMATE ACCESS TIME

INTERFACE CONNECTION



1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25 --- GND

Interface

All in[illegible] are [illegible]

Input			
Logic zero	4v	0.6ma	(max)
Logic one	-5.25v	20ma	(max)
Output			
Logic zero	0.4v	8ma	(max)
Logic one	5v	0.25ma	(max)

PHYSICAL SPECIFICATIONS
Enviromental limits

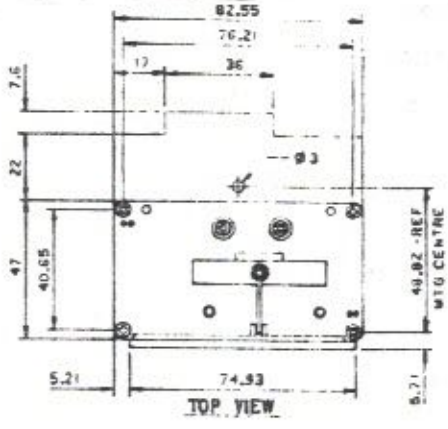
	Operating	Nonoperating
Ambient temp	10-45°C	-20-+60°C
Rel humidity	20%-80%	5%-95%
Max wet bulb	30°C	30°C

Operating positions
- Normal mounting 5 deg X,Y,Z axis
- Operation 45 deg X,Y,Z axis
- (Such as in portable equiptment)

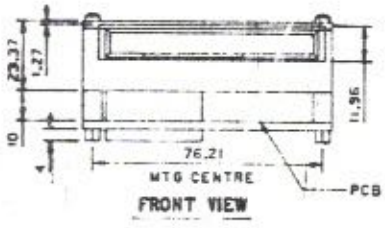
RELIABILITY SPECIFICATION

Product life 10,000 POH (5% duty cycle)
Component Life 5 years
Bit Error Rate (BER) 1 per 10^8 bits read
Media Life 5000 passes

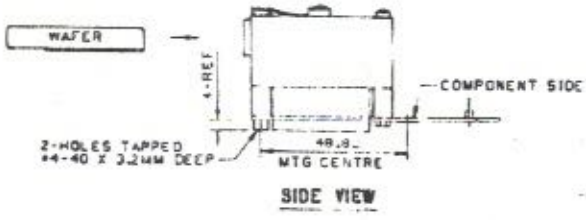
Preventative Maintenance
- Periodic cleaning of the head
- (approx every 10^6 bits read)



TOP VIEW



FRONT VIEW

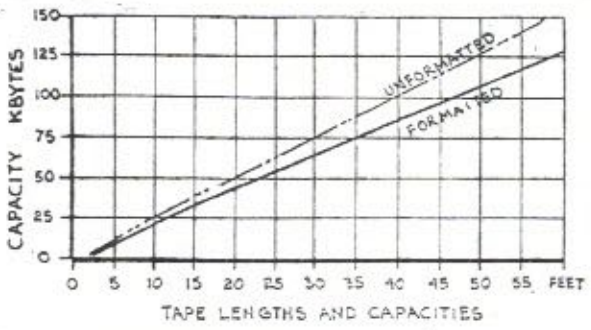


SIDE VIEW

BCC
A BSR Company

BSR USA LTD 2880 San Tomas Expressway,Suite 200 Santa Clara,California 95051 (408)748-1200
ASTEC EUROPE LTD 16 Albury Close, Reading, Berkshire, U.K. Tel (0734)53067

Capacity 151,000 bytes
Rate 17066 bits per second.



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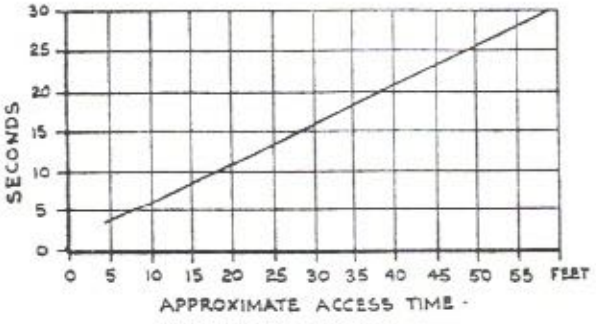
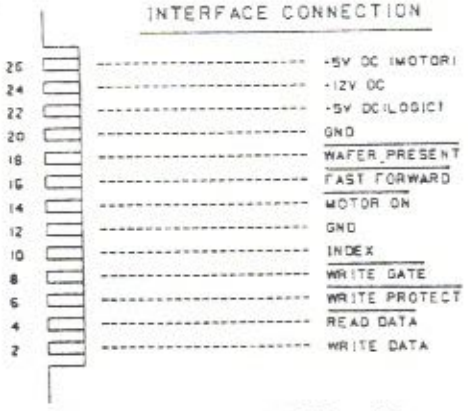


APPROXIMATE ACCESS TIME

INTERFACE CONNECTION



1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25 --- GND

Read/Write power requirements
+12 volts ±5% - 10ma typ
+5 volts ±5% - 70ma typ

Motor/Control power requirements

+5volts	500ma surge for 1s
-5volts	150ma typ. Read/Write state
+20%	200ma typ. Fast forward state

Interface Electrical requirements

All inputs & outputs are TTL compatable

Input			
Logic zero	0.0-0.4v	0.6ma	(max)
Logic one	2.5-5.25v	20ma	(max)
Output			
Logic zero	0.4v	8ma	(max)
Logic one	2.5v	0.25ma	(max)

PHYSICAL SPECIFICATIONS
Enviromental limits

	Operating	Nonoperating
Ambient temp	10-45°C	-20-+60°C
Rel humidity	20%-80%	5%-95%
Max wet bulb	30°C	30°C

Operating positions
- Normal mounting 5 deg X,Y,Z axis
- Operation 45 deg X,Y,Z axis
- (Such as in portable equiptment)

RELIABILITY SPECIFICATION

Product life 10,000 POH (5% duty cycle)
Component Life 5 years
Bit Error Rate (BER) 1 per 10^8 bits read
Media Life 5000 passes

Preventative Maintenance
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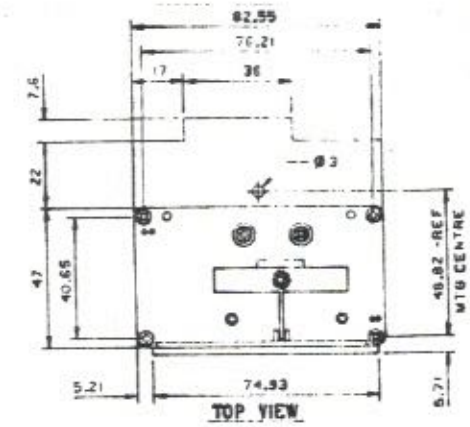
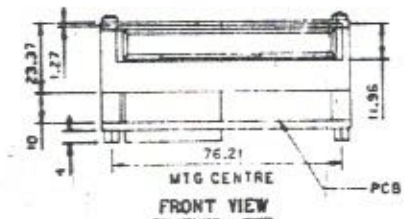
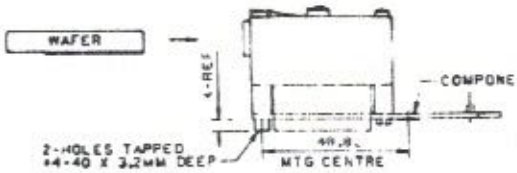


TOP VIEW



FRONT VIEW



SIDE VIEW

BCC
A BSR Company

BSR USA LTD 2880 San Tomas Expressway,Suite 200 Santa Clara,California 95051 (408)748-1200
ASTEC EUROPE LTD 16 Albury Close, Reading, Berkshire, U.K. Tel (0734)53067

MICRO COMMUNICATIONS CORPORATION

PRICE SCHEDULE

MODEL NUMBER	DESCRIPTION	1-9	10-49	50-99	100-499	500-999	1000 up
25-300	ELECTRONIC R/W TAPE SYSTEM, tape transport complete with sensors, motor control, TTL CMOS logic compatible, bit-serial, 3 ips R/W speed and 6 ips FF speed.	$110.00	$105.00	$99.00	$93.00	$80.00	$69.00
20-102	TAPE TRANSPORT, mechanical only complete with drive motor, R/W head, lead connections, 3 ips R/W speed and 6 ips FF speed. Motor control not included.	40.00	38.00	36.00	34.00	30.00	25.00
	OPTIONS						
103	MOTOR-CONTROL CHIP	4.00	4.00	4.00	3.25	3.25	2.25
105	SENSOR BOARD, complete with EOT (End of Tape) & WP (Write Permit) sensors attached to the Tape Transports.	25.00	24.00	23.00	22.00	20.00	19.00

TAPE WAFER CARTRIDGES (100% Certified, packaged 10 to a box).

Model No.	Length	Prices per box of: 1-99	100 up
91-003	5'	$24.00	$17.00
92-003	10'	24.00	17.00
93-003	15'	24.00	17.00
94-003	20'	24.00	17.00
95-003	25'	26.00	19.00
96-003	30'	26.00	19.00
97-003	35'	26.00	19.00
9X-003	Assorted (1 of each length)	26.00	19.00
98-003	40'	26.00	19.00
99-003	45'	30.00	21.00
90-003	50'	30.00	21.00

For additional OEM quantity discounts, consult your local representative or the factory.
All prices FOB Waltham, Massachusetts.
Prices effective 1 May 1978.
Prices and specifications subject to change without notice.

MICRO COMMUNICATIONS CORPORATION

Dear Engineering Manager:

As both a user of microprocessors and low cost digital tape transports, you are quite aware of the increasing need of a low cost peripheral loading device of RAM memory. Undoubtedly, devices such as floppy-disc drives and bubbles come to mind, but I'm sure the availability and their price/performance has to be your prime concern, especially if you are building systems for OEM distribution.

The Micro Digital Tape Transport is by far the lowest cost tape unit available today, with characteristics such as 3200 fci, a 4800 baud rate and along with its incredibly small size makes the Micro Tape Transport and System a better performer than any of its competitors.

Micro can provide transport systems based upon a user's application and electronic expertise. For example, we offer an Electronic Read/Write System or the "transport-only." We will soon make available for the Electronic Read/Write System a complete encoder/decoder microprocessor interfaced system consisting of an "option-board."

In addition, we also offer special systems consisting of dual transports with multi-tracks which run at tremendously high speeds and have an effective transfer rate of 64K bits-per-second.

For additional information concerning Micro products, please do not hesitate to contact me directly.

I look forward to hearing from you in the near future.

Sincerely,

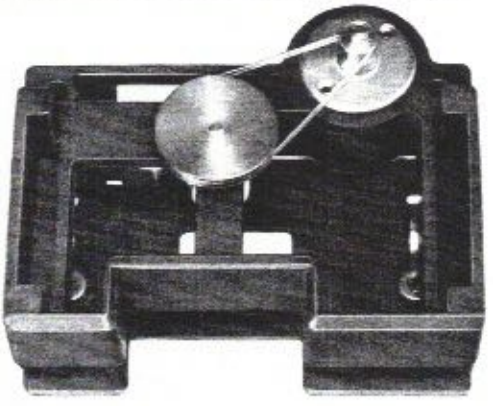
MICRO COMMUNICATIONS CORPORATION

Maurice W. Kirby
Director of Marketing

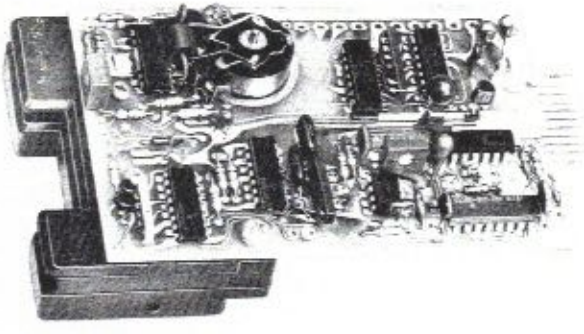
A BUCKEYE INTERNATIONAL COMPANY 80 Bacon Street, Waltham, Massachusetts 02154 617/899-8111

LOW COST DIGITAL TAPE TRANSPORT SYSTEMS FROM MICRO

MAGNETIC TAPE WAFER



TAPE TRANSPORT



ELECTRONIC R/W TAPE SYSTEM

MICRO

MAGNETIC TAPE WAFERS

Any tape transport system design is dependent upon the characteristics and constraints of the media it must manipulate. Tape systems that use cassettes and cartridges must compensate as well as regulate speed-sensitive motors which are required for reel-to-reel type transport systems.

The Micro Tape Wafer is both simple and inexpensive (a fraction of the cost of cassettes and cartridges) and can neatly fit into a first-class mailer.

A Micro Magnetic Wafer is a small, thin, continuous-loop cartridge containing a single reel of tape with the ends spliced together. In operation, the Micro single-point drive pulls the tape from the center of the wafer reel causing the entire reel to rotate. Thus, the tape automatically winds around the outside of the reel at the same rate at which it unwinds from the inside. There is only one reel and the diameter of that reel never changes.

THE TAPE

The recording tape used in wafers is different from ordinary recording tape in that the base is mylar, and its magnetic coating is a low friction dispersion of chromium dioxide and not ferric oxide like other digital tape. The back (non-recording) side of the wafer tape is coated with protrietary, low friction, high adhesive material that guarantees smooth tape motion. All digital wafers are certified for no errors at 3200 flux changes per inch. Micro Wafers are life tested to exceed the published figures of small cassette tapes.

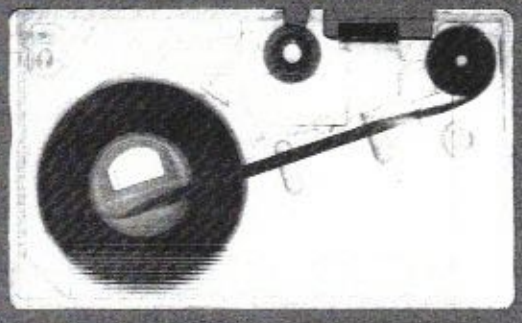
STORAGE CAPACITY

Wafers are available in 5-foot increments of tape length from a minimum of 5 feet to a maximum of 50 feet. In terms of storage capacity, 50 feet of magnetic tape stores 1.92 million flux changes at 3200 flux changes per inch (fci). If your encoding/decoding scheme utilizes a phase-encoding technique, you could store 120,000 bytes of information on a 50 foot wafer.

EOT/BOT AND FILE PROTECT

In a continuous-loop cartridge the end is, of course, the beginning and EOT = BOT. Thus, one EOT/BOT indicator is all that's required in a Wafer. That indicator is a piece of reflective tape that splices both ends together. An EOT/BOT sensor is included with all tape systems. The mechanical tape transport can be ordered with the EOT/BOT sensor by including Option # 105. The sensor board contains a photosensor/LED pair that generates an output signal each time the reflective splice passes it. File protection (WP) is generated by means of a conductive removable sticker on the wafer label. The presence of the sticker enables writing. You simply peel off the sticker from the label to protect the tape and when you want to write on the tape again, you simply paste on a new sticker (we sell them in sheets). Along with the EOT/BOT sensor, Write Protect (WP) is also included in the tape system and transports via Option # 105.

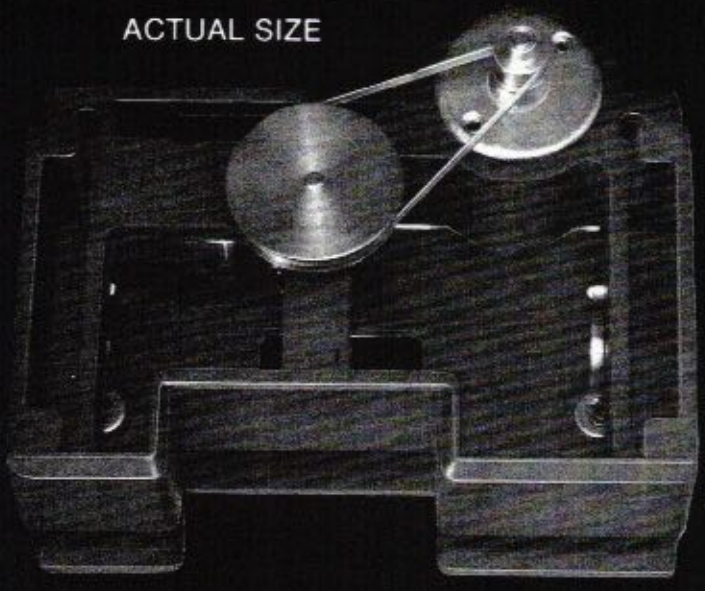
ACTUAL SIZE



SPECIFICATIONS

Configuration	Continuous loop cartridge.
Number of tracks	1
Capacity, maximum (50 feet recorded at 3200 fci)	1.92×10^{6} fc
Tape grade	Certified: Zero errors at 3200 fci
Loop time at 6 ips search speed:	
Maximum length (50 foot) wafer	1 minute, 40 seconds ±20%
Minimum length (5 foot) wafer	10 seconds ±20%
Dimensions:	
Wafer:	
Size	1.6 x 2.7 x 0.2 inches
Weight (50 foot)	1/3 ounce
Tape:	
Width	0.070 inches
Length:	
Maximum	50 feet
Minimum	5 feet
Thickness	0.001 inches
EOT/BOT marker: Length	0.55 inches
Write Permit marker: Diameter	0.25 inches
Tape Materials:	
Base	Mylar
Magnetic Coating	Chromium Dioxide
Back Coating	Proprietary, low friction high adhesive

ACTUAL SIZE



TAPE TRANSPORT

A Micro Transport is a very simple mechanism consisting of a precision die-cast aluminum block in which are mounted a magnetic tape head, drive motor and capstan. The Micro wafer cartridge edge-loads into a slot in the block, and the capstan drives the tape at a single point. Nominal tape read/write speed is 3 inches per second, likewise nominal fast forward speed is 6 inches per second. Optional sensors are available (option # 105) to detect the Write Permit (file protection) marker on the cartridge label and the end of the tape (EOT/BOT) reflector on the tape. A small unprotruding p.c. board mounted on the block provides easy access to head, sensor and motor leads in models ordered with sensors.

SPECIFICATIONS

Material ..... Precision die-cast aluminum

Finish ..... Black Anodized

Weight:
- Without Sensor Board Option ..... 3.8 ounces
- With Sensor Board Option ..... 4 ounces

Tape path length from EOT sensory location to head gap ..... 2 inches

Operating environment:
- Temperature ..... 5°C to 45°C
- Relative Humidity, non-condensing ..... 20% to 80%

Motor:
- Type ..... Dc permanent magnet, 5 pole
- Voltage, nominal ..... 5 volts
- Load current, typical ..... 100 ma
- Back emf constant ..... 1 volt/ips
- Dc resistance ..... 14.2 ohms

Head:
- Track Width (full) ..... 0.074 inches
- Inductance, maximum ..... 50 mh
- Resistance, maximum ..... 100 ohms
- Gap Length ..... 0.0001 inches

Write current, p-p:
- 145% of Saturation ..... 2.8 ma

Output, p-p minimum at 3 ips and 3200 fci
- 145% of Saturation ..... 2 mV

Sensor Board Option:

Power requirements:
- Voltage ..... 5 vdc
- Current, typical ..... 35 ma

Output voltage:
- Sensor marker absent, minimum ..... 2.4 vdc
- Sensor marker present, maximum ..... 0.4 vdc

Any transport can be operated at a lower tape speed, depending upon the requirements of the motor control circuit being used, but the motor should not be operated continuously at greater than approximately 6 ips.

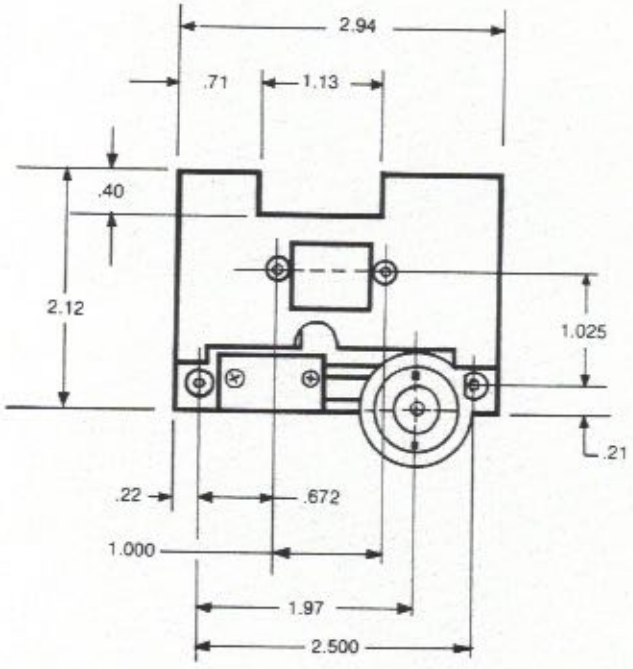
Certified Micro wafers are delivered with the certification program intact. The program consists of a continuous string of flux changes at a density of 3200 fci. Since the head signal frequency is Hz divided by 1600 is equal to the tape speed in ips, that pattern can be used to adjust tape speed.

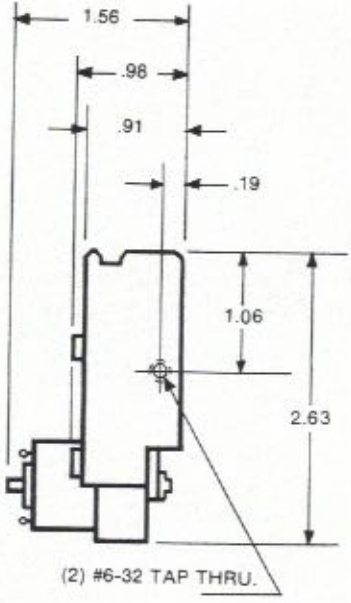
P2 MOTOR CONTROL CHIP

The Micro P2 Motor Control Chip (option #103) is recommended for use with Micro transports. The P2 is a monolithic, integrated-circuit chip that provides precise speed regulation at tape speeds of 1 to 5.5 ips sufficient to generate 1 volt of motor back emf.

Its ratings (at 25°C) are as follows:

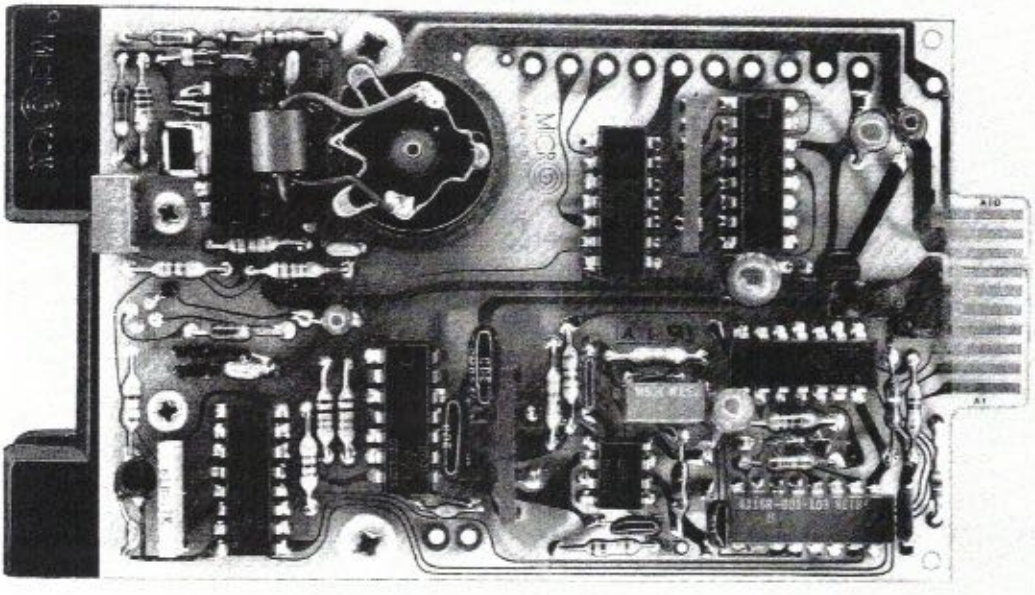
- Supply Voltage ..... 4 vdc to 18 vdc
- Output Current ..... 1 amp
- Dissipation, maximum ..... 1.4 watts
- Speed regulation vs load, typical 1%
- Speed regulation vs supply voltage, typical ..... 0.6%/±35%





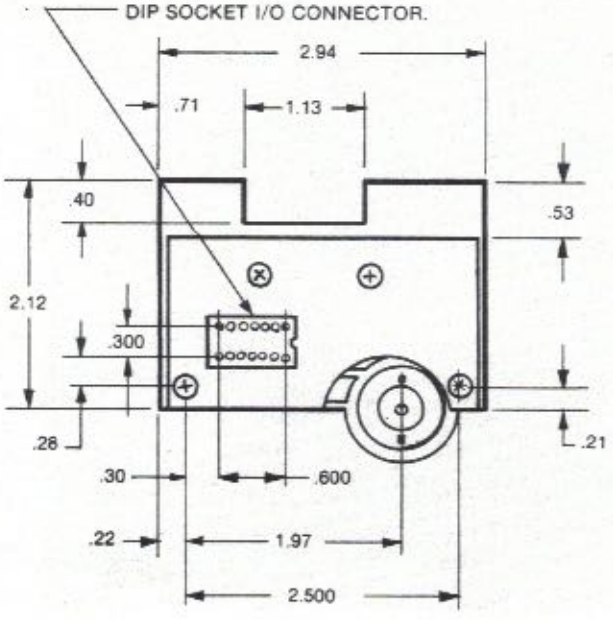
Outline Dimensions of Tape Transport

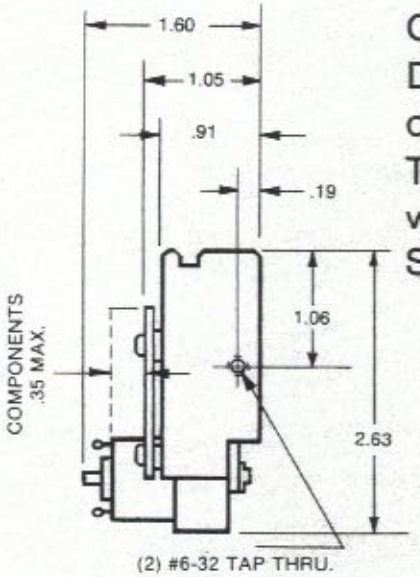
ACTUAL SIZE



Electronic Read/Write Tape System

The Micro Read/Write Digital Data Storage System is a complete digital input/output system designed for use in storing and retrieving digital information that is encoded and decoded by the user. In addition to complete electronics, the Electronic Read/Write System contains sensors for both EOT/BOT and Write Permit. When coupled with a microprocessor or other CPU (or the appropriate hardware logic) an Electronic Read/Write System becomes a complete serial data storage and retrieval system at a fraction of the usual cost. Because they leave the encoding and decoding to the user, Electronic Read/Write Systems permit the use of any bit-serial, self-clocking code.

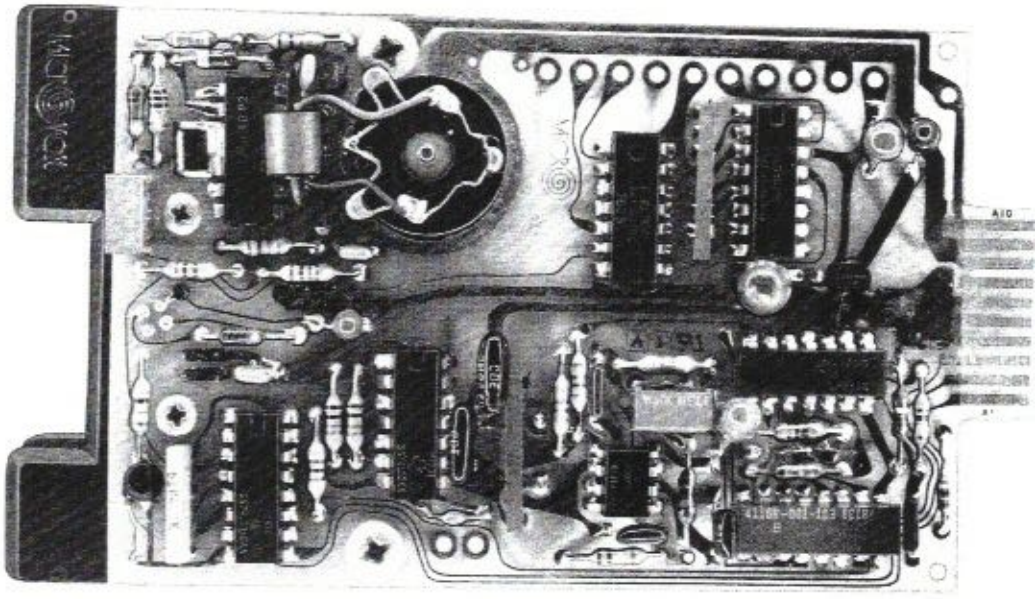




Outline Dimensions of Tape Transport with Sensors

Electronic Read/Write Tape System

ACTUAL SIZE



PERFORMANCE

The Electronic Read/Write System has distinct advantages over other competitive bit serial systems. The input/output signals are TTL and 5-volt CMOS compatible. All input/output signals are true digital logic levels. The analog circuit functions are completely transparent to the user.

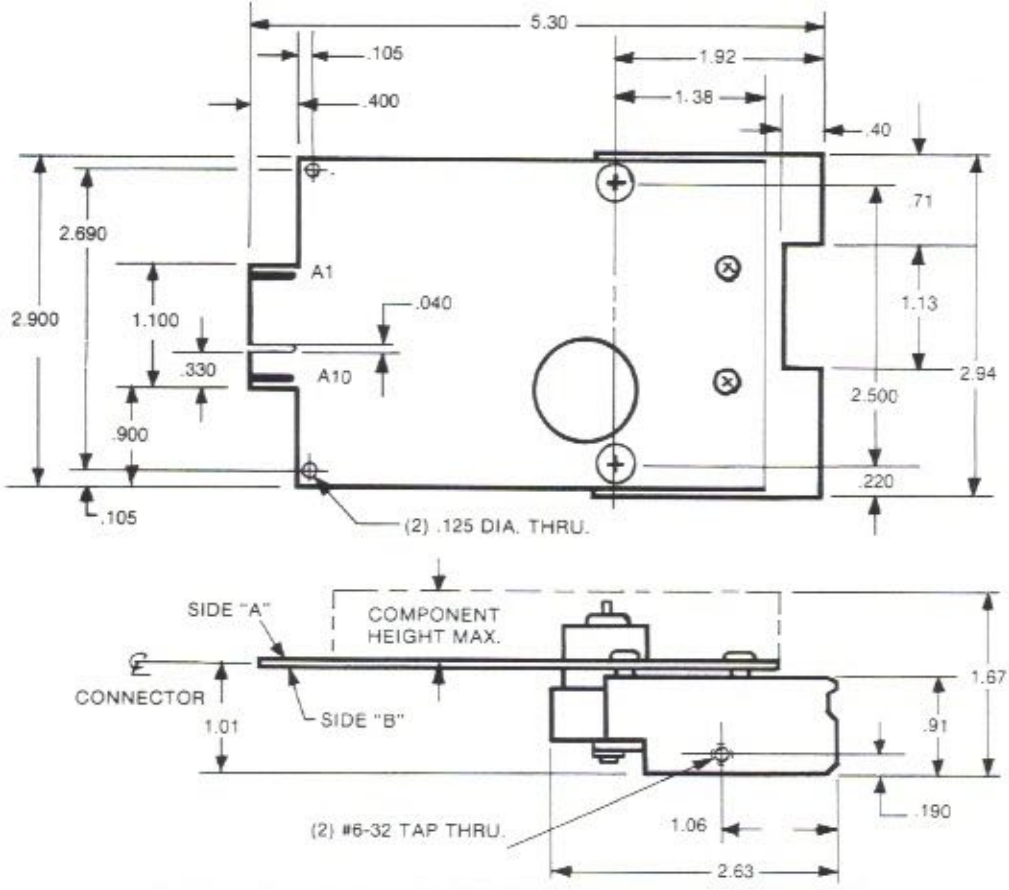
The operating characteristics of the Electronic Read/Write System are quite impressive and certainly are more than one would expect from a low-cost digital tape system. Because of the high packing densities, a transfer rate (using normal read/write speed of 3 inches per second) of 9600 fcs is possible. The system can affect a 4800 baud transfer rate when reading and writing, start time is at 30 ms while stop time is at 40 ms.

SELF-CLOCKING CODES

Because tape systems are basically mechanical assemblies, they cannot be relied upon to maintain perfectly constant speed. To overcome this obstacle a digital tape system must transmit a recorded clock signal along with the binary information. This information must be recorded together. Choosing a self-clocking code generally boils down to a compromise between tape storage and speed control. In a Micro wafer cartridge, which is certified for 3200 fci, the maximum bit density and storage capacity for the two most commonly used codes are shown on the following page.

SPECIFICATIONS

Dimensions		5.30 x 2.94 x 1.67 inches
Weight		6 ounces
Operating Environment:		
Temperature		5°C to 45°C
Relative Humidity (non-condensing)		20% to 80%
Power Requirements:		
Voltage (nominal)		+12 & +5 vdc
Current:		
Operation (typical)	+12V	+5V
Standby	35 ma	47 ma
Normal Speed	100 ma	48 ma
Fast Forward	110 ma	48 ma
Starting	160 ma	48 ma
Consumption:		
Standby		0.7 watts
Operating		1.5 watts
Peak		2.2 watts
Tape Speed:		
Read/Write:		
Speed		3 ips (±3%)
Start Time		30 ms
Start Distance		0.05 inches
Stop Time		40 ms
Stop Distance		0.06 inches
Fast Forward:		
Speed		6 ips (±10%)
Start Time		40 ms
Start Distance		0.12 inches
Stop Time		50 ms
Stop Distance		0.15 inches
Control & Status Signals:		
Level		LSTTL Compatible
Input Loading		1 LSTTL load
Drive Capability		15 TTL or 60 LSTTL
Jitter		5% or less
Data Density		300 to 3200 fci
Data Transfer Rate, maximum		9600 fcs or 4800 baud
Data Capacity		960K bits/120K bytes



Outline Dimensions of Electronic Read/Write Tape System

Code	Flux Changes per bit	Density on Tape (BPI)	Maximum Storage Capacity per 50' Wafer	
			Bits	Bytes
Ratio	3	1,067	640,000	80,000
Biphase	2	1,600	960,000	120,000

Prices and specifications subject to change without notice.

INTERFACE FOR ELECTRONIC READ/WRITE SYSTEM

Board Conn.	#Abbrev.	Signal
A1	$\overline{\text{EOT}}$	END OF TAPE status output
A2	$\overline{\text{WP}}$	WRITE PERMIT status output
A3	$\overline{\text{CIP}}$	Not used.
A4	LGND	LOGIC GROUND
A5	LGND	LOGIC GROUND
A6	LGND	LOGIC GROUND
A7		Not used.
A8	MGND	MOTOR GROUND
A9	MGND	MOTOR GROUND
A10	$\overline{\text{CGND}}$	CHASSIS GROUND
B1	$\overline{\text{WEN}}$	WRITE ENABLE input
B2	$\overline{\text{RMOD}}$	READ MODULATION output
B3	$\overline{\text{MEN}}$	MOTOR ENABLE input
B4	$\overline{\text{FAST}}$	FAST speed input
B5	$\overline{\text{WMOD}}$	WRITE MODULATION input
B6	$\overline{\text{SEL}}$	Drive SELect input
B7		Not used.
B8	+5V	+5V logic supply
B9	+12V	+12V motor supply
B10		Not used.

MICRO
Micro Communications Corporation
A BUCKEYE INTERNATIONAL COMPANY
80 Bacon Street, Waltham, Massachusetts 02154 617/899-8111

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Digital Recording In Low Cost Transports

by Clark E. Johnson, Jr.

Reprinted from *Digital Design* June, 1977

Digital Recording In Low Cost Transports

by **Clark E. Johnson, Jr.**

Clark E. Johnson, Jr. *is President of Micro Communications Corporation in Waltham, Massachusetts.*

Historically, most digital engineers have looked upon magnetic tape peripherals as black boxes which were fairly easily connected to the computer without much concern for the magnetic recording process and its requirements. The advent of microprocessors and microprocessor-based systems has greatly increased the need for low cost tape storage, requiring the software to do more and more of the data manipulation, encoding and decoding. This article reviews the system constraints imposed by the magnetic recording and playback process and shows you how to overcome them. This article is restricted to direct digital recording; it does not include such analog and quasi-analog techniques as frequency selective keying (FSK) or other tone-burst approaches.

introduction

A magnetic recording system may be thought of as a bandwidth limited communications channel. We must, of course, ignore the time delay between the writing and reading of a given unit of information. Fig 1 shows the usual model of a communications system. It consists of five components: an, encoder, a modulator, the communications channel itself, a detector and a decoder. Some of these elements may be combined in whole or in part and each of them will be briefly explored as to its relevance in a magnetic recording system.

Since we are concerned only with recording digitally, we first must review how a pattern of ones and zeros is laid down on the tape. Clearly, only two unique states of magnetization are necessary for the storage of binary data. These states are normally positive and negative saturation of the magnetic tape surface to give maximum differentiation between the two states. Saturation recording takes maximum advantage of the non-linear saturation characteristic of the magnetic recording medium. It is to be clearly distinguished from a normal analog recording in which only about 25% of the magnetic moment of the media is put to use. Thus, the output from a saturated recording is approximately 12 db higher than that of an audio recording. The magnetic material in saturation recording provides inherent limiting action which greatly reduces the effects of variations in write current, tape-to-head spacing and media parameters. Because of the use of saturation techniques, you cannot use a direct correspondence between the input and output of a magnetic tape channel and a conventional signal transmission system.

the encoder

The function of the encoder is to take raw data at the input to the system (a bit stream of zeros and ones) and transform it into another data stream that has been specifically conditioned for transmission through the channel. This conditioning serves a number of purposes: for example, the addition of parity bits, error propagation limitation, spectral shaping and speed tolerance. Note that with a microprocessor-controlled system, software easily accomplishes this encoding and subsequent decoding. A later section will go into detail on various encoding techniques.

the modulator

The purpose of the modulator is to take the digital sequence produced by the encoder and convert it into an analog waveform that can then be transmitted through the channel. In a communications system with linear but bandwidth-limited channels, the modulator normally serves the purpose of producing a waveform whose spectrum is matched to the bandpass of the channel. In magnetic recording systems where the channel exhibits both saturation and hysteresis effects, as well as a frequency limitation, the modulator must serve the additional function of setting the proper write current amplitude and switching characteristic. The modulator in a tape system therefore consists of the magnetic recording head and the head driver. Recording takes place at the trailing edge of the record gap by the fringing flux, since this is the area of the highest flux gradient. Excessive current in the record head simply moves the magnetizing zone downstream from the gap.

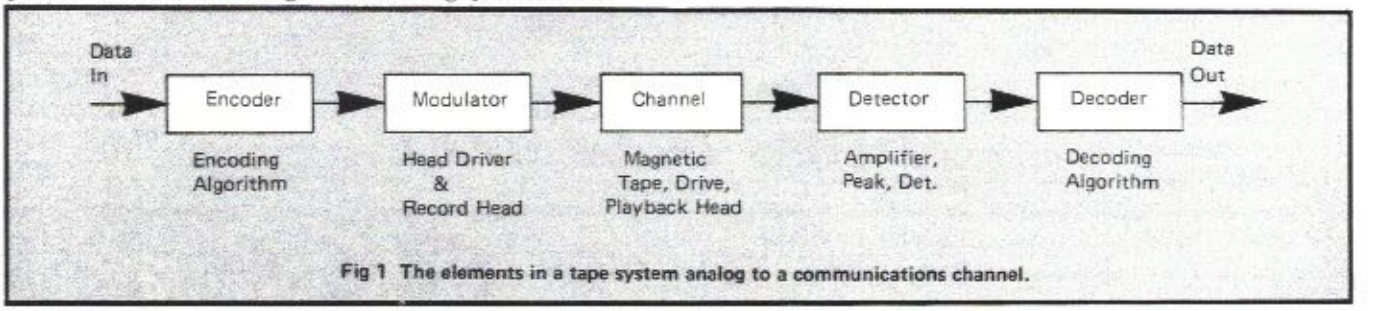

Fig 1 The elements in a tape system analog to a communications channel.

the channel

In the usual communications channel, there is normally very little control over the channel characteristics, and the rest of the system is designed around it. Things are not so fixed in the magnetic recording channel. The transmission (storage) medium can be controlled in several ways. These include the magnetic and mechanical characteristics of the media itself such as surface finish, coating thickness, coercive force and saturation magnetization. The most accessible parameter to the user is tape speed which is directly proportional to the frequency response of the channel. Since the fundamental limiting feature of the magnetic recording channel is the tape/read-head interface, the read head is considered a part of the channel.

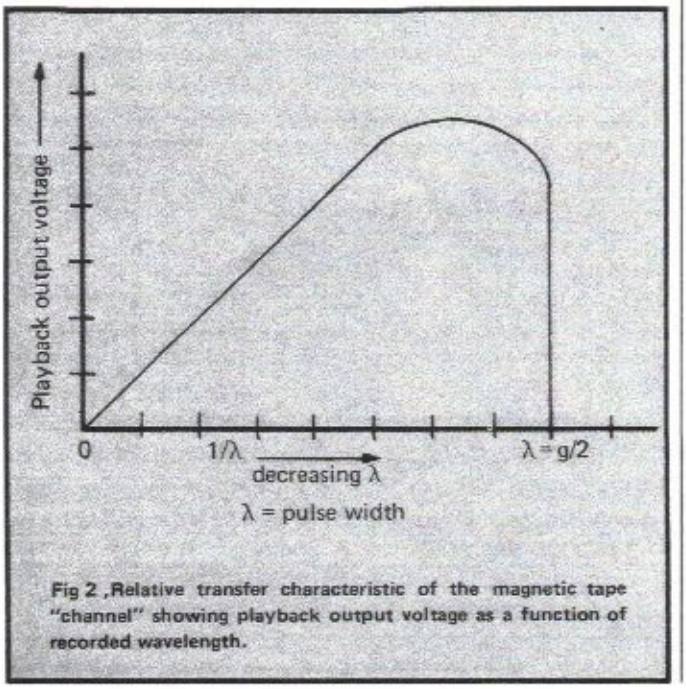

Fig 2 ,Relative transfer characteristic of the magnetic tape "channel" showing playback output voltage as a function of recorded wavelength.

Fig 2 shows the magnetic tape channel frequency response. Notice that a low frequencies the output rises at 6 db per octave in accordance with Faraday's Law. The output goes exactly to zero at the point where the recorded wavelength is equal to one-half of the playback head gap length. The peak of the response curve depends upon the magnetic parameters of the tape and can be pushed to higher frequencies by increasing the coercive force and decreasing the coating thickness. A main contributor to the roll-off of response with decreasing recorded wavelength on the tape is self-demagnetization. That is, as the recorded wavelength decreases, a decreasing amount of flux finds its way through the read head, and more of it is short-circuited through the tape itself. Clearly, significant advances in performance can be expected as tape materials and manufacturing techniques improve.

detector

The detector is the device that takes the incoming analog signal from the channel and converts it into a digital signal identical to that of the input to the modulator. Since, in the magnetic tape system, the read head is part of the channel, the detector is merely the amplifier and bit-by-bit detector, normally a peak detector. Note that the information content of the signal, located at the zero crossings of the record current, becomes translated to peaks of the detected voltage. The detector also recovers the timing information necessary to reconstruct the digital data stream.

decoder

The function of the decoder is exactly opposite that of the encoder: it takes the output of the detector and converts it back into the input data bit stream. Depending upon the type of encoding used, the decoder may correct errors in addition to performing the inverse algorithm of the encoder.

recording density limits

Since the recording process itself takes place at the trailing edge of the write-head gap, bit density on the tape does not

COMPARISON OF VARIOUS ENCODING SCHEMES

Encoding Scheme	Bandwidth (Fundamental) DC 0.5f 1.0f 1.5f	DC Present?	Transitions / Bit Density	F_{max}/F_{min}	Preamble?	Speed Tolerance: Bit-to-Bit*	Speed Tolerance: Long Term	Notes
NRZ	⊢—⊣	Yes	1	–	–	–	–	Listed for comparative purposes.
RZ	⊢——⊣	Yes	2	4	No	High	High Virtually Asynchronous	Requires demagnetized tape.
S-NRZ	⊢—⊣	Yes	1.125	9	Yes	Low	None	
Biphase	⊢—⊣	No	2	2	No**	±33%	±33%	Includes Manchester, Phase, FM.
Double Density	⊢⊣	Yes	1	2	Yes	Low	None	Includes MFM, DM, Miller, etc.
Ratio	⊢——⊣	No	3	2	No	High	High	
3M VCW	⊢—⊣	Yes	2	2	No	±20%	±20%	Record length on tape depends upon ratio of 0's to 1's.

*Tolerance shown is total of both write and read.
**Some configurations require preambles.

Fig 3 Characteristics of various self-clocking data encoding schemes showing bandwidth (in terms of the fundamental frequency component of the data rate), the presence of dc in the recorded signal, the ratio of the transition density to bit length, the bandspread ratio, whether the scheme requires a lengthy (≥1 bit) preamble and speed tolerance both a short-term (bit-to-bit) and long-term basis.

depend, at least to the first order, on the write-head-gap length. The cutoff wavelength (Fig 2) is directly proportional to the playback-gap length. There are, however, several other factors involved. One of these is head-to-tape spacing which greatly affects the playback output voltage and waveform. Reduction in output voltage causes errors in the detected signal because of insufficient amplifier gain to drive the detector. This reduction is dependent upon the ratio of band-to-tape spacing divided by read head gap length. Wave-shape broadening increases the effect of pulse crowding. Any non-uniformity of the head-tape interface such as debris on the tape or non-uniform surface, can cause an increase in head-to-tape spacing. As an example of how serious this is, a system which may exhibit one error in 10^7 bits at 800 bits-per-inch could easily exhibit one error in 10^3 bits at 1200 bits-per-inch using the same encoding scheme.

Pulse crowding is another effect that needs to be considered. In essence, the playback system (i.e., the detector) is linear and subject to the superposition theorem. The record process is very non-linear and depends upon the state of magnetization of the previous pulse, assuming that the magnetization did not reach zero before the next pulse came along. As a result, there is a phase shift of higher density pulses with respect to lower density pulses. Consequently, the detection window and amplitude of each pulse is dependent not only upon its own characteristics but those of its predecessor. Most manufacturers give specifications as to the acceptable maximum flux changes per unit length of tape for their system for low error rates.

signal processing techniques

There are basically two types of digital magnetic recording schemes: those providing a separate clock track independently recorded, and those which are self-clocking – that is, in which the data stream and the clock are encoded together into a single bit stream. Since this discussion is related to single-track recording, we are restricting ourselves to the latter case. One might legitimately ask why it is necessary to provide timing information at all. Why can't the data be recorded on tape and then played back using an independent timing oscillator identical to that used during recording? The problem is, of course, that tape systems, being mechanical, cannot provide the precise tape speed control necessary to make this feasible. In fact, it is even difficult to take the serial output from a UART, record it on tape, and then play it back on a different machine into a UART and recover error-free data. The reason for this is that the data timing between input and output can only change by 4% over one byte to faithfully recover the data. As a consequence, it is essential to provide independent clocking on the channel itself.

There are a number of self-clocking codes that can be used with digital recording. One author reports over a hundred of them, but most of them can be reduced to half a dozen or so basically different schemes. If we now refer to Fig 2, we note that dc cannot be transmitted through the magnetic tape channel. In fact, to reduce equalization, it is desirable to reduce the bandwidth spread as much as possible. Fig 3 shows the characteristics of various types of self-clocking codes (with NRZ included for the sake of comparison).

The abscissa of Fig 3 is the fundamental frequency bandwidth component required in terms of the data rate. The columns at the right indicate various characteristics of these codes. "DC Present" is whether or not the encoded waveform is asymmetric; that is, does it include a dc component. The second column is the "Ratio of the Transition Density to the Bit Density," which is a measure of the efficiency of

the recording scheme. Note that NRZ recording has a ratio of one. The third column gives the bandwidth requirements of the channel in terms of the "Ratio of the Maximum Frequency to the Minimum Frequency." The fourth column is whether a "Preamble" is required to provide read clock synchrony. A preamble is a known bit length and pattern appended to the front of each record. Generally, a preamble is required for all systems, but it may be only one bit long, as in biphase or ratio recording. Methods which do not provide a clock pulse for every bit require long, formalized preambles. Only long preambles have a "yes" in this column. The next two columns give the relative "Speed Tolerance" on both a bit-to-bit basis and on a long-term basis. Finally, the last column gives some additional comments.

Now let's look at each of these encoding schemes by itself and try to draw some conclusions about them. Fig 4 shows the encoded data stream for some of the encoding schemes of Fig 3 for an arbitrary 16 bits of data.

RZ recording starts out with unmagnetized tape (not such an easy requirement if one wants to reuse an already recorded tape) and simply goes positive for a one and negative for a zero, always returning to the demagnetized state between bits. The densities are relatively low, due to need to get back to zero between bits. The bandwidth requirements run roughly from 0.25 times the data rate to the data rate. RZ recording is particularly attractive for low density recording because it is virtually asynchronous, making minimal constraints on the density of the recorded data. RZ recording does not require a preamble.

S-NRZ recording is simply NRZ recording with an extra bit at every eight bits to provide a lower bound to the bandwidth requirements. Rather tricky electronics and buffering are required to squeeze an extra bit in for every eight in encoding and then clip it out again in decoding.

Bi-phase recording is a class of double frequency self-clocking schemes, many of which require no preamble and have a bandwidth requirement of only two to one. Bi-phase goes under many names, such as Manchester Code, Phase Encoding and Frequency Modulation. These are

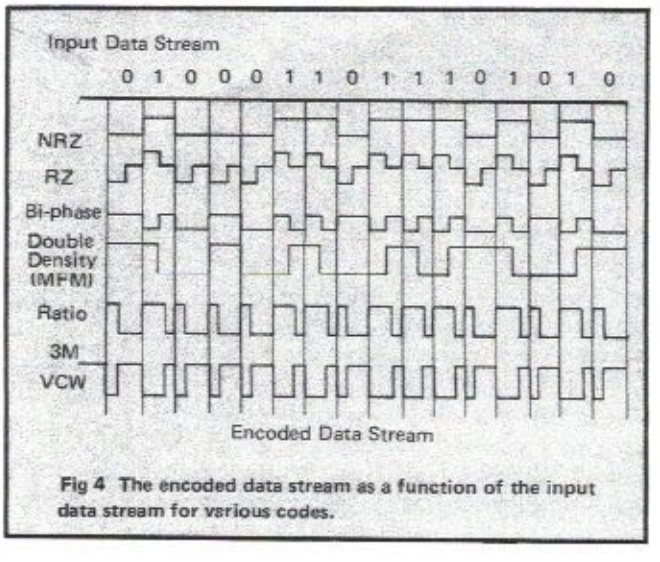

Fig 4 The encoded data stream as a function of the input data stream for various codes.

all essentially the same scheme in which a one bit is represented by two flux changes and a zero bit by one flux change. All the other schemes in this category are simply variations on this with inversions and phase shifts brought into play. All have essentially the same mathematical characteristics as far as the channel is concerned. Bi-phase (which I have elected to use as the generic name) generally has no dc component present and is relatively insensitive to small speed changes both on a bit-to-bit or over a long-term basis. Fancy electronics can take into account long term speed changes by simply altering the sampling clock rate to agree with the average bit cell.

Double density recording, used in various disk files, do not provide a clock bit for every data bit and thus requires a preamble to provide read clock synchronization. With the exception of ZM recording, discussed below, all double density schemes have dc present and are very sensitive to speed changes. Their bandwidth requirements, however, are equal to one-half the data rate.

Ratio recording is a relatively inefficient scheme, but one which has significant virtues for low cost systems. In ratio recording, a positive-going flux change at the leading bit cell edge always corresponds to a clock pulse while the position of the negative-going change (whether it is in the first half or the second half of the bit cell) determines the data. Since each bit cell stands alone, no preamble is required; a lost bit has no effect on adjacent bits as happens with double density and some bi-phase schemes. In addition, the speed tolerance is theoretically ±50% on a bit-to-bit basis and very high on a long term basis, limited only by the ability of the amplifier to provide sufficient gain for slow-moving tape or to handle the bandwidth requirements of rapidly-moving tape. You pay a price for this capability, however, in that there are essentially three flux changes per bit cell, thereby limiting the maximum recorded density. Detection is done by charging a capacitor (or turning on an up-counter) during the first portion of the cycle and then discharging the capacitor (or causing the counter to count downward) during the second part of the cycle Since the capacitor is discharged at the end of each bit cell to start over again (or the counter reset to zero), the presence of dc in the detector is of no consequence.

Zero modulation or ZM recording was developed by IBM for their 3850 Honeycomb Mass Storage System. This is simply an algorithm of other double density schemes, but one which has zero dc component, thereby eliminating the accumulated unbalance between positive and negative pulse durations which cause baseline shift. This scheme is very sophisticated in terms of generating the encoded bit stream, since it requires an algorithm which looks both forward and backward in the data pattern, thereby requiring external memory. It is too sophisticated for simple cassette and cartridge tape systems.

Variable Cell Width, developed by 3M for use with their DC-100 transport, uses a combination of bi-phase and ratio recording. In this scheme, the bit cell length for a one is 50% longer than that for a zero. A zero is two pulses of opposite polarity for half the time, whereas for a one, the leading or

negative pulse is equal to the leading or negative pulse for the zero, but the positive pulse is twice as long.

what encoding scheme to use?

This is not an easy question to answer since it depends upon the following factors:

- Mechanical stability
- The nature of the data being recorded, and
- Whether one can use error-correcting codes.

The mechanical stability of the system includes such things as the need for interchangeability of tapes recorded on one machine to play on another, the accuracy and uniformity of tape speed and the mechancial rigidity of the tape-handling system to minimize structurally caused azimuth problems, etc. Apropos of the latter, the alignment between the gap in the playback head and the recorded data on the tape is very critical at high flux-change densities and requires the tape to pass over the head at a constant angle no matter what machine the tape is played on and no matter when and under what conditions. At high data densities, a slight azimuth misalignment of the tape with the head will cause a serious decrease in output and increased errors. Nonuniform tape speed requires the use of a speed-tolerant recording system such as ratio recording.

A second factor is the nature of the recorded data. Some of the encoding techniques require a preamble which must be appended to each record – expensive in terms of tape utilization if the records are short. Clearly, it is not any problem for a long, unformatted record since the preamble will represent only a minuscule fraction of the total record length. However, for short records, the requirement to append a preamble will cause an appreciable increase in the record length, thereby negating the gains made by going to a higher density recording scheme. In addition, the use of double density schemes on tape is particularly tricky, since they are virtually intolerant of any long term speed changes because their detection window is extremely narrow and difficult to change in concert with a change in data rate.

Finally, the use of error-correcting codes, either cyclic codes added on to fixed-length records or other more exotic codes, can provide automatic error correction in the decoding process itself. Again, the addition of error-correcting codes may or may not be required, depending upon what is to be done with the data. Most users find it sufficient to add a checksum at the end of a record in order to tell if the record has been received correctly by the decoder.

using a microprocessor to replace the encoder and decoder

Clearly, a microprocessor can be used to generate the encoded waveforms from the data stream, based on which encoding algorithm is required. The microprocessor can be run in interrupt mode during encoding, since the timing for writing the data is not critical. In playback, however, since the timing comes off the tape, the microprocessor must be dedicated to the reading of tape. If the system already has a microprocessor in it, then it may be easy to dedicate a small amount of the program to writing and reading tape, thereby saving the considerable expense of hardware implementation of encoding and decoding.

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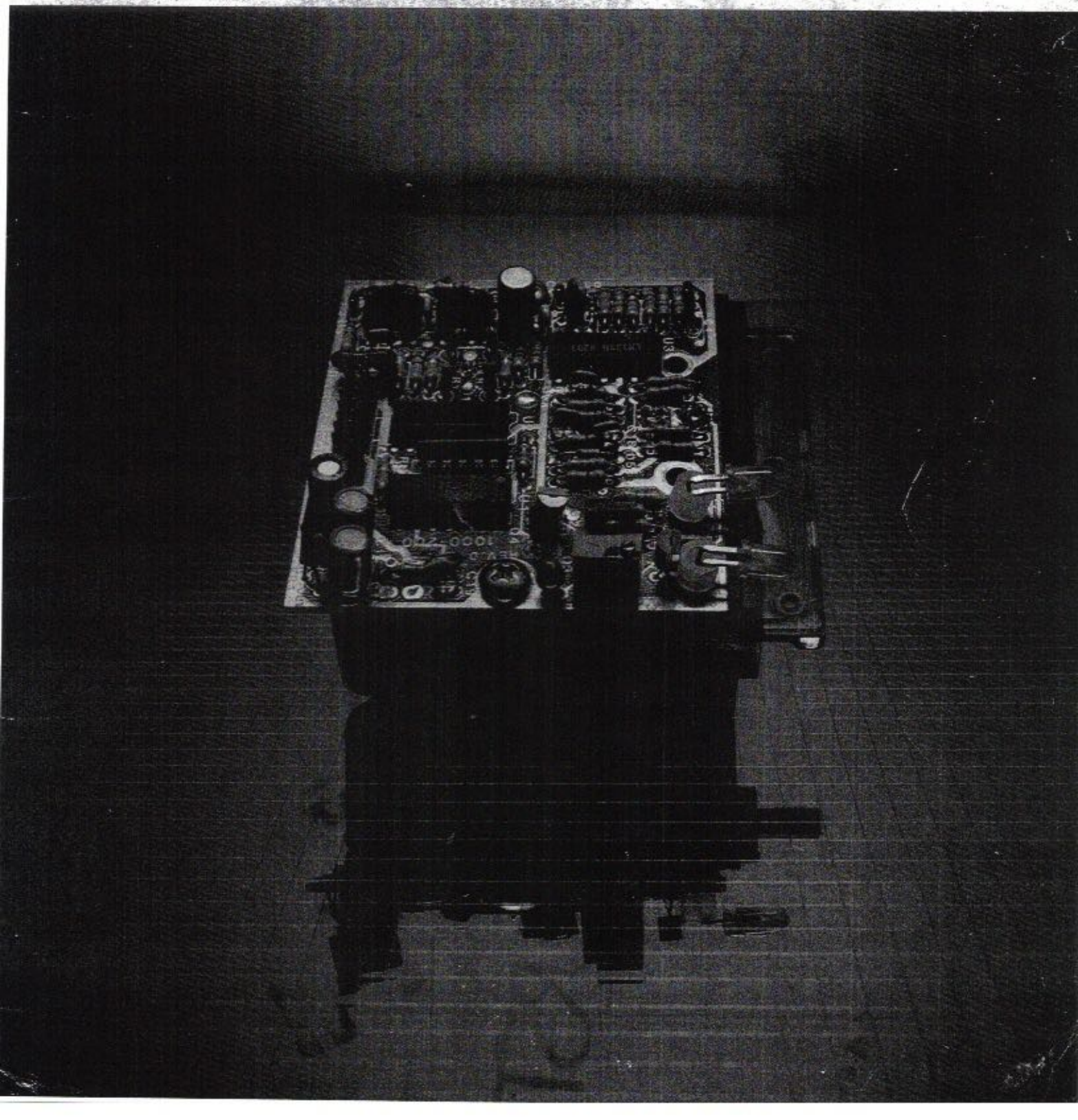

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Robert A. McDonald, President

ENTREPO, A NEW COMPANY WITH A NEW DATA STORAGE MEDIUM.

Entrepo has introduced a major new data storage technology and product line that promise to have significant impact on home computers, video games, portable computers, electronic typewriters and other products. Entrepo's Wafer Drive technology offers performance approaching flexible disk drives at one third of the price. The low power consumption and small size make the Wafer Drive ideal for portable applications.

Entrepo's Micro Wafer is a continuous loop of magnetic tape in a cartridge. Each wafer is the size of a business card, stores up to 100K bytes of data and demonstrates the data integrity of a flexible disk. The Entrepo Wafer Drive is a wafer transport with read write electronics to interface with microcomputers. The Micro Wafer and Wafer Drive offer OEM's a new, cost effective magnetic storage medium to expand the markets for their products.

Systems designers at major electronics companies have recognized the advantages of Entrepo's Wafer Drive system and technology. New products recently introduced by Entrepo customers offer consumers the sophistication of disk operating systems including automated file maintenance.

The real power of a microprocessor is never realized unless the owner has a magnetic storage device for loading and saving programs written on the system or loading powerful financial analyses, word processing programs and video games developed by software manufacturers. While advances in semiconductor technology have resulted in dramatic decreases in the price of home computers and made them available to consumers, the cost of flexible disk systems has remained high. Frequently purchasers of home computers must pay two to three times as much for a disk drive as for the computer itself—or settle for the reduced capability of audio cassette program recorders. Entrepo's Wafer Drive technology provides a less expensive alternative which means expanded markets for OEM's.

Entrepo President Bob McDonald has drawn on his marketing experience in the consumer electronics and semiconductor industries to recognize the Wafer Drive technology as the solution to many customer problems. His experience in high volume manufacturing gave him the insight that the product could be produced at reasonable costs. This would enable Entrepo's customers to sell their products at retail price points that fit consumer expectations.

Entrepo's manufacturing capabilities will stress quality techniques that will insure a high degree of control over the large volumes of products required by consumer markets. The manufacturing strategy will depend heavily on automation of production and testing processes.

Entrepo is headquartered in Sunnyvale, California.

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entrepo

David D. Osborne *Vice President Marketing and Sales*

MODEL 101 WAFERDRIVE

PRELIMINARY

entrepo

FEATURES

UP TO 151 KBYTES PER WAFER

20 KBITS/SEC DATA TRANSFER

FAST FORWARD SEEK

LOW POWER DISSIPATION

COMPACT DESIGN

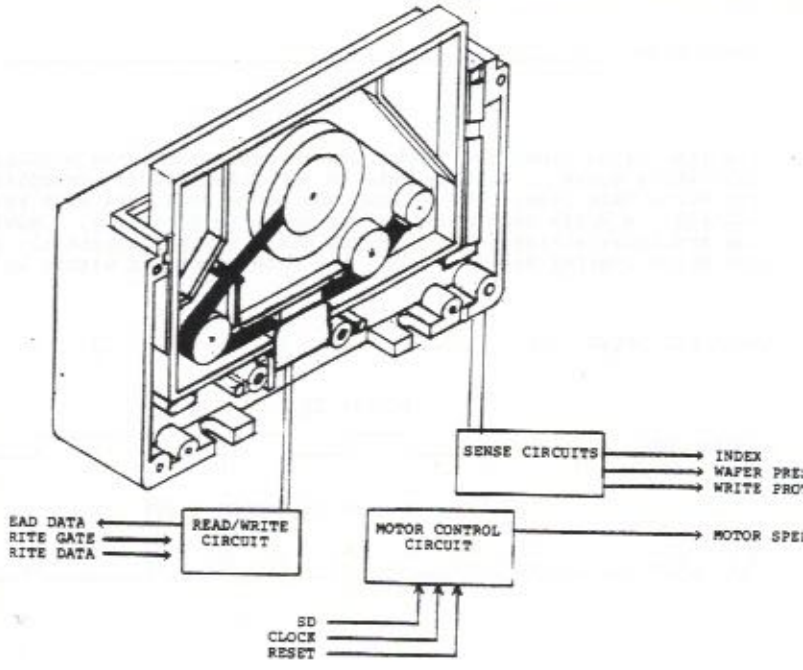
5, 10, 20, 35 AND 50 FOOT TAPES

READ/ WRITE ELECTRONICS

DIGITAL MOTOR CONTROL CIRCUIT

TTL INTERFACE

The Entrepo Model 101 Waferdrive is a compact low cost, fast access mass storage device optimized for program and load and save applications. The drive consists of a Wafertransport with read/write and motor control electronics capable of reading and writing on the Entrepo Microwafer with a data transfer rate of 20 Kbits per second. The Microwafer is a continuous loop of magnetic tape in a cartridge with maximum unformatted capacity of 151 Kbytes or 131 Kbytes formatted in 256 byte sectors. The Waferdrive can sense the presence of a Microwafer and the write protect feature on the Microwafer to provide data security.



SPECIFICATIONS SUMMARY

Transfer Rate	20 Kbits/sec
Recording Density	2048 bpi
Flux Density	4096 fci
Recording Method	FM

Tape Speed

Read/Write	10 ± 4% ips
Fast Forward	16 ± 10% ips
Start Time	200 msec
Stop Time	100 msec
Start Distance	1.5 in
Stop Distance	0.5 in

Tape Length/Capacity	Formatted	Unformatted
5 feet +10%-0 feet	11 Kbytes	13 Kbytes
10 feet +10%-0 feet	24 Kbytes	28 Kbytes
20 feet +10%-0 feet	51 Kbytes	59 Kbytes
35 feet +10%-0 feet	91 Kbytes	105 Kbytes
50 feet +10%-0 feet	131 Kbytes	151 Kbytes

Media Requirements: Entrepo Microwafer

READ/WRITE CIRCUIT

- WRITE GATE When Write Gate is low, Write Data will be written on the Microwafer if the Microwafer has not been write protected. Refer to figures 1 and 2 for timing.

WRITE DATA Provides the data to be written on the Micro Wafer. Each transition from a logical one level to a logical zero level or vice versa, will cause current through the R/W head to be reversed thereby writing a data bit. This line in enabled by Write Gate being active. Refer to figures 1 and 2 for timing.

- READ DATA Provides the clock and data pulses as detected by the read/write electronics. Reference figures 1 and 2 for timing and bit shift tolerance within normal media variations.

MOTOR CONTROL CIRCUIT

SERIAL DATA Data input to least significant bit of Motor Control Register. When a binary number is shifted into the Motor Control Register the value is converted to an analog voltage and applied to the motor.

CLOCK Clock input of the Motor Control Register. Data that is present on the Serial Data input will be clocked into the least significant bit of the Motor Control Register and each bit that is in the register will be shifted to the next most significant bit position on the low to high transition of the Clock input.

- RESET Reset input of the Motor Control Register. All bits of the Motor Control Register will be set to zero when the Reset input is held low for a minimum of 40 nanoseconds.

MOTOR SPEED The signal is a pulse with duration of 520 microseconds that occurs six times per revolution of the shaft. The tape speed can be calculated in inches per second by dividing 0.0412 by the time between pulses on the motor speed line.

SENSORS

INDEX Active for a period of 50 milliseconds once each revolution of the tape to indicate the beginning of tape.

- WRITE PROTECT To write protect a Microwafer, the user must remove the write protect knock out area on the wafer. A sense switch will detect the missing tab and inhibit writing. The Write Protect signal will be low when there is no wafer present and when a write protected wafer is in the drive.

- WAFER PRESENT This signal is low whenever a wafer is inserted into the Drive.

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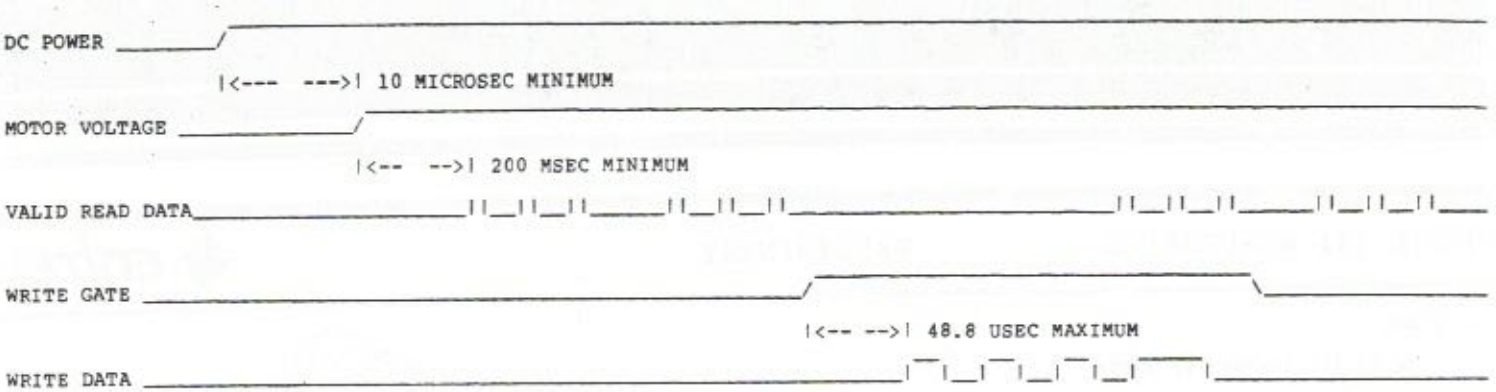


Figure 1. INTERFACE TIMING

Reading data from the Model 101 is accomplished by holding Write Gate being inactive and moving the tape at the read/write speed. Writing data to the Model 101 is accomplished by moving the tape at the read/write speed, activating the Write Gate line, and pulsing the Write Data line with the data to be written. The timing relationships required to initiate a write data sequence are shown in figures 1. Moving the tape at read/write speed is accomplished by storing the appropriate binary value in the Motor Control Register, monitoring the motor speed line and adjusting the value in the Motor Control Register until the motor speed is within an acceptable tolerance.

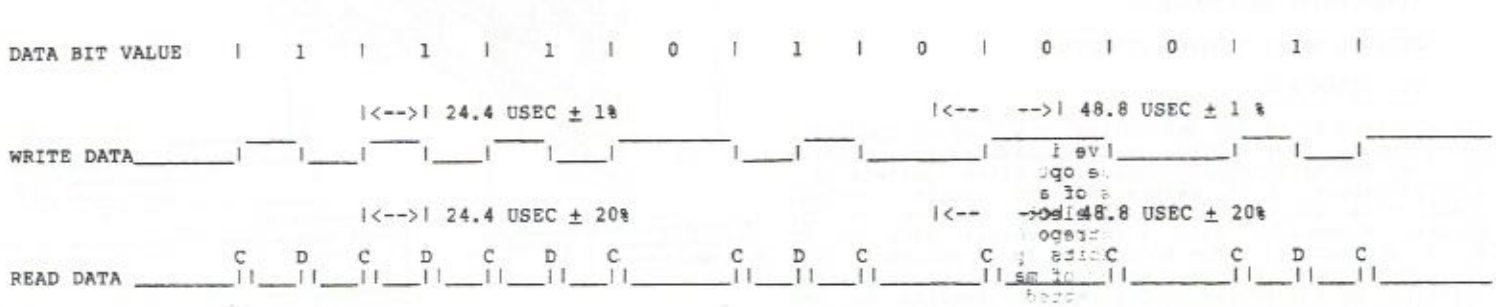
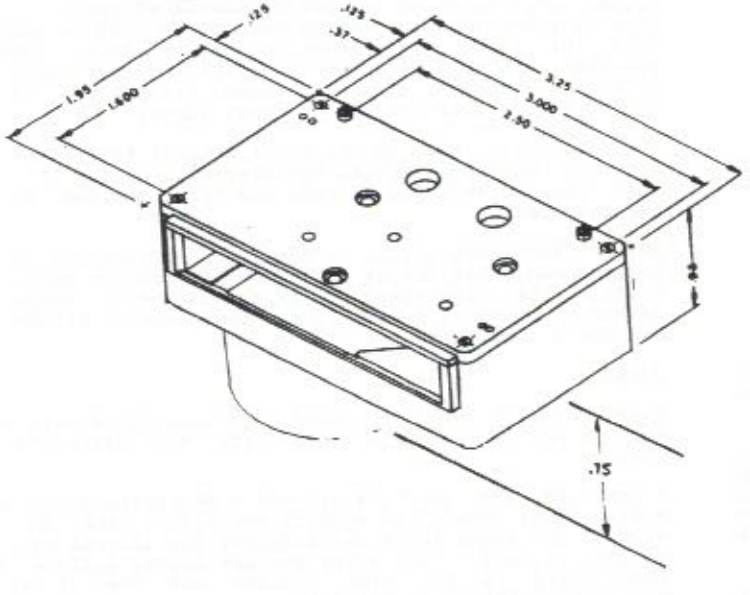


Figure 2. READ/WRITE TIMING

The read/write circuits have been optimized for FM encoding and the data integrity specifications are based upon testing done with FM encoding. Other encoding schemes may have a detrimental effect upon data integrity. The timing of write data is shown in Figure 2. The fundemental write oscillator frequency can be determined within a range of +20% - 0%, however once the value is selected, the actual oscillator should be crystal controlled. Read data bit shift tolerances are also shown in figure 2.



PHYSICAL SPECIFICATIONS

	OPERATING	NON OPERATING
Environment Limits		
Ambient Temp	10 to 45 C	-20 to +60 C
Rel Humidity	20% to 80%	5% to 95%
Max Wet Bulb	30 C (No Condensation)	30 C

Power Requirements

Read/Write Electronics

+12 Volts ±5%	110 mA typ	500 mA max
+5 Volts ±5%	100 mA typ	200 mA max

Motor Control Electronics

+12 Volts	500 mA surge for 100 msec
read/write	40 mA typ steady state
fast forward	80 mA typ steady state

Weight 4 ounces

RELIABILITY SPECIFICATIONS

MTBF	10,000 POH *
Component Life	5 Years
Media Life	5000 passes

Error Rates

Soft Read Errors	1 per 10 exp 8 bits read
Hard Read Errors	1 per 10 exp 11 bits read
Preventive Maintenance	Clean head and capstan every 1000 POH. *

* Assumes 10% duty cycle

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MODEL 102 WAFERDRIVE

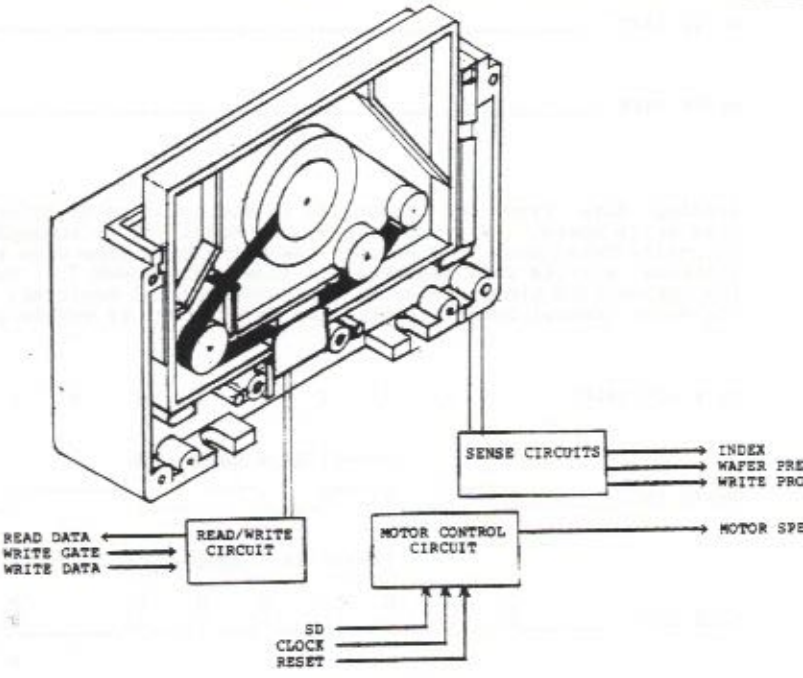
PRELIMINARY

entrepo

FEATURES

- UP TO 151 KBYTES PER WAFER
- 20 KBITS/SEC DATA TRANSFER
- SINGLE POWER SUPPLY (+5 VOLTS)
- OPTIMIZED FOR BATTERY OPERATION
- LOW POWER DISSIPATION
- COMPACT DESIGN
- 5, 10, 20, 35 AND 50 FOOT TAPES
- READ/ WRITE ELECTRONICS
- DIGITAL MOTOR CONTROL CIRCUIT
- TTL INTERFACE

The Entrepo Model 102 Waferdrive is a compact low cost, fast access mass storage device optimized for battery operation. The drive consists of a Wafertransport with read/write and motor control electronics capable of reading and writing on the Entrepo Microwafer with a data transfer rate of 20 Kbits per second. The Microwafer is a continuous loop of magnetic tape in a cartridge with maximum unformatted capacity of 151 Kbytes or 131 Kbytes formatted in 256 byte sectors. The Waferdrive can sense the presence of a Microwafer and the write protect feature on the Microwafer to provide data security.



SPECIFICATIONS SUMMARY

Transfer Rate	20 Kbits/sec
Recording Density	2048 bpi
Flux Density	4096 fci
Recording Method	FM

Tape Speed

Read/Write	10 ± 4% ips
Start Time	200 msec
Stop Time	100 msec
Start Distance	1.5 in
Stop Distance	0.5 in

Tape Length/Capacity	Formatted	Unformatted
5 feet +10%-0 feet	11 Kbytes	13 Kbytes
10 feet +10%-0 feet	24 Kbytes	28 Kbytes
20 feet +10%-0 feet	51 Kbytes	59 Kbytes
35 feet +10%-0 feet	91 Kbytes	105 Kbytes
50 feet +10%-0 feet	131 Kbytes	151 Kbytes

Media Requirements: Entrepo Microwafer

READ/WRITE CIRCUIT

- WRITE GATE When Write Gate is low, Write Data will be written on the Microwafer if the Microwafer has not been write protected. Refer to figures 1 and 2 for timing.

WRITE DATA Provides the data to be written on the Micro Wafer. Each transition from a logical one level to a logical zero level or vice versa, will cause current through the R/W head to be reversed thereby writing a data bit. This line in enabled by Write Gate being active. Refer to figures 1 and 2 for timing.

- READ DATA Provides the clock and data pulses as detected by the read/write electronics. Reference figures 1 and 2 for timing and bit shift tolerance within normal media variations.

MOTOR CONTROL CIRCUIT

SERIAL DATA Data input to least significant bit of Motor Control Register. When a binary number is shifted into the Motor Control Register the value is converted to an analog voltage and applied to the motor.

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- RESET Reset input of the Motor Control Register. All bits of the Motor Control Register will be set to zero when the Reset input is held low for a minimum of 40 nanoseconds.

MOTOR SPEED The signal is a pulse with duration of 520 microseconds that occurs six times per revolution of the shaft. The tape speed can be calculated in inches per second by dividing 0.0412 by the time between pulses on the motor speed line.

SENSORS

INDEX Active for a period of 50 milliseconds once each revolution of the tape to indicate the beginning of tape.

- WRITE PROTECT To write protect a Microwafer, the user must remove the write protect knock out area on the wafer. A sense switch will detect the missing tab and inhibit writing. The Write Protect signal will be low when there is no wafer present and when a write protected wafer is in the drive.

- WAFER PRESENT This signal is low whenever a wafer is inserted into the Drive.

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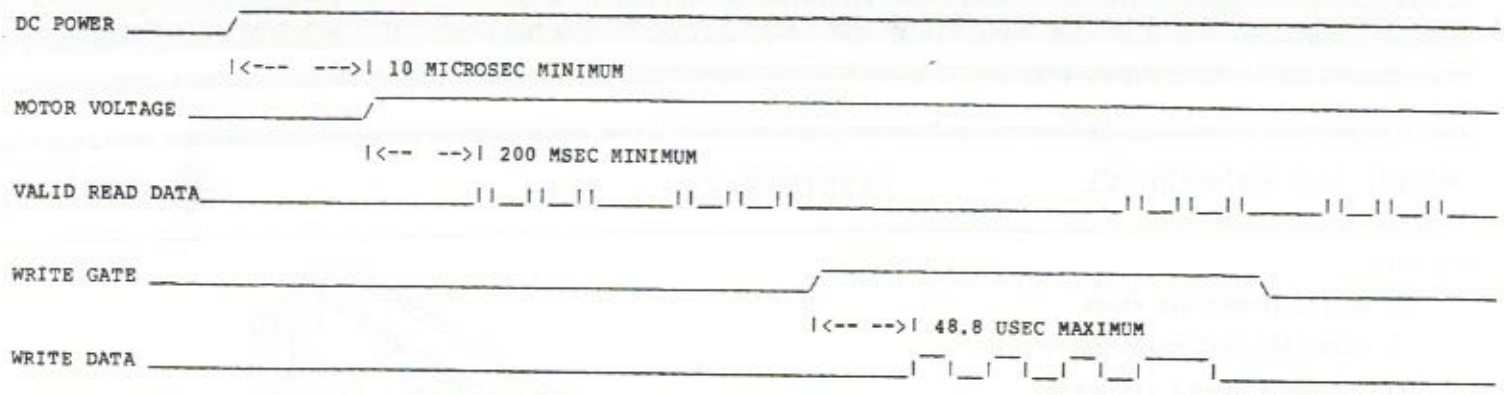


Figure 1. INTERFACE TIMING

Reading data from the Model 102 is accomplished by holding Write Gate being inactive and moving the tape at the read/write speed. Writing data to the Model 102 is accomplished by moving the tape at the read/write speed, activating the Write Gate line, and pulsing the Write Data line with the data to be written. The timing relationships required to initiate a write data sequence are shown in figures 1. Moving the tape at read/write speed is accomplished by storing the appropriate binary value in the Motor Control Register, monitoring the motor speed line and adjusting the value in the Motor Control Register until the motor speed is within an acceptable tolerance.

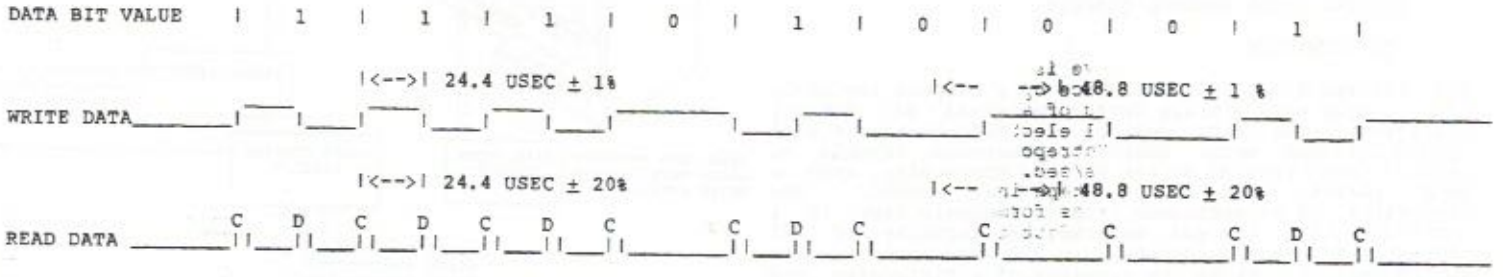
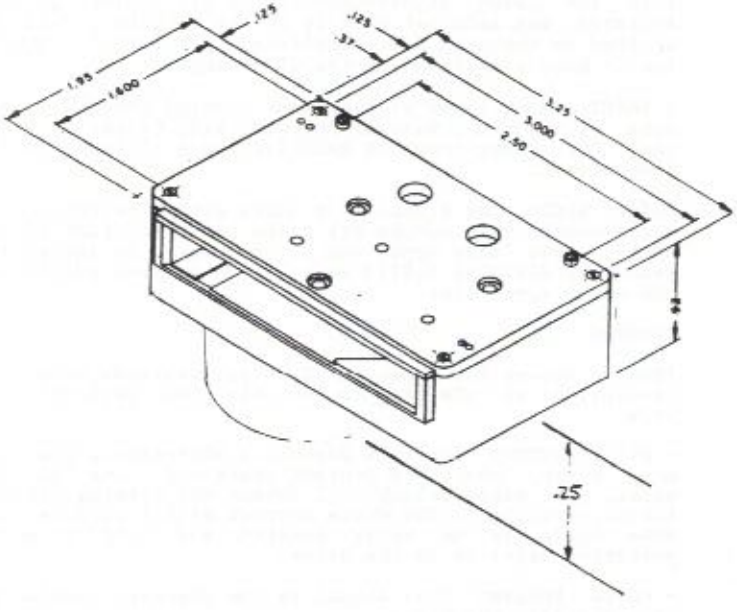


Figure 2. READ/WRITE TIMING

The read/write circuits have been optimized for FM encoding and the data integrity specifications are based upon testing done with FM encoding. Other encoding schemes may have a detrimental effect upon data integrity. The timing of write data is shown in Figure 2. The fundemental write oscillator frequency can be determined within a range of +20% - 0%, however once the value is selected, the actual oscillator should be crystal controlled. Read data bit shift tolerances are also shown in figure 2.



PHYSICAL SPECIFICATIONS

	OPERATING	NON OPERATING
Environment Limits		
Ambient Temp	10 to 45 C	-20 to +60 C
Rel Humidity	20% to 80%	5% to 95%
Max Wet Bulb	30 C (No Condensation)	30 C
Power Requirements		
Read/Write Electronics		
+5 Volts ±5%	120 mA max	
Weight	4 ounces	

RELIABILITY SPECIFICATIONS

MTBF	10,000 POH *
Component Life	5 Years
Media Life	5000 passes
Error Rates	
Soft Read Errors	1 per 10 exp 8 bits read
Hard Read Errors	1 per 10 exp 11 bits read
Preventive Maintenance	Clean head and capstan every 1000 POH. *

* Assumes 10% duty cycle

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MODEL 107 WAFERDRIVE — PRELIMINARY

entrepo

FEATURES

UP TO 131K BYTES PER TAPE

ON BOARD MICROCOMPUTER CONTROLLER

IBM SOFT SECTORED FORMAT CAPABILITY

MULTIPLE OR SINGLE SECTOR READS AND WRITES

BYTE PARALLEL TTL INTERFACE

FAST FORWARD SEEK

5, 10, 20, 35, AND 50 FOOT TAPES

WRITE PRECOMPENSATION

COPY PROTECTION FEATURE

ERROR DETECTION

The Entrepo Model 107 is a compact, low cost, fast access, mass storage system optimized for ease of interface in program load and save applications. The system consists of a Wafertransport, read/write, motor control, sensor electronics, and microcomputer on a circuit board which provides a reliable, inexpensive mass storage subsystem.

The Model 107 is capable of reading and writing on the Entrepo Microwafer. The Microwafer is a continuous loop of magnetic tape in a cartridge with maximum capacity of 151 Kbytes unformatted or 131 Kbytes formatted in 256 byte sectors.

Simple to use, the controller has just seven commands:

FORMAT - formats the tape

READ - reads a sector from the wafer

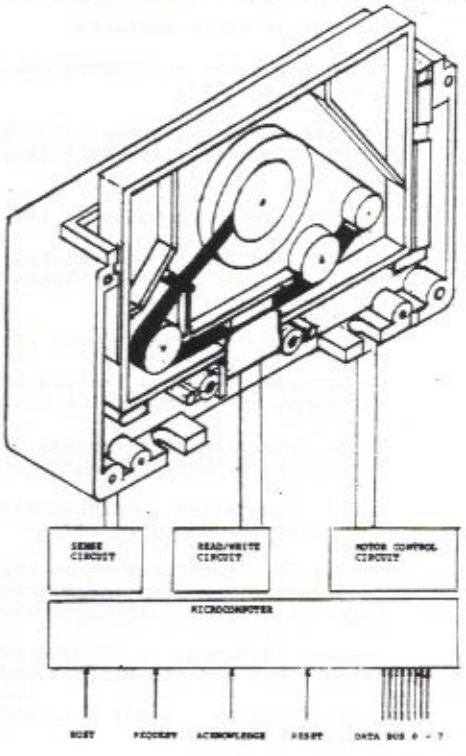
WRITE - writes sector onto the wafer

READ MULTIPLE - reads multiple sectors from the wafer

WRITE MULTIPLE - writes multiple sectors onto the wafer

STATUS - returns the tape controller status

REWIND - positions the tape at the index



PERFORMANCE SPECIFICATIONS

Maximum Storage Capacity (Unformatted)	151 Kbytes
Host Communications Transfer Rate	2,560 Bytes/sec
Media Data Transfer Rate	20,480 Bits/sec
Tape Speed	
Read/Write	10 ± 4% ips
Fast Forward	16 ± 10% ips
Start Time	200 msec
Stop Time	100 msec
Start Distance	1.5 inches
Stop Distance	0.5 inches

Tape Length	Capacity Formatted	Capacity Unformatted
5 feet +10% - 0 feet	11 Kbytes	13 Kbytes
10 feet +10% - 0 feet	24 Kbytes	28 Kbytes
20 feet +10% - 0 feet	51 Kbytes	59 Kbytes
35 feet +10% - 0 feet	91 Kbytes	105 Kbytes
50 feet +10% - 0 feet	131 Kbytes	151 Kbytes

Recording Density	2048 bpi
Flux density	4096 fci
Index	1
Encoding Method	FM

PHYSICAL SPECIFICATIONS

	OPERATING	NON OPERATING
Environment Limits		
Ambient Temp	10 to 45 C	-20 to +60 C
Rel Humidity	20% to 80%	5% to 95%
Max Wet Bulb	30 C (No Condensation)	30 C

Power Requirements

To be determined

Weight 5 ounces

RELIABILITY SPECIFICATIONS

MTBF	10,000 POH *
Component Life	5 Years
Media Life	5,000 passes

Error Rates

Soft Read Errors	1 per 10 exp 8 bits read
Hard Read Errors	1 per 10 exp 11 bits read
Preventive Maintenance	Clean head and capstan every 1000 POH. *

* Assumes 10% duty cycle

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FIRMWARE DESCRIPTION

The Model 1[illegible] contains these main components:

Write Circuitry - energizes the read/write head to put flux transitions on the tape.

Read Circuitry - reads the signal off the tape, amplifies it, filters the signal, detects flux transitions, additionally filters it, and supplies the controller with the flux change data.

Motor Control - adjusts the speed of the motor via a closed loop servo technique when reading and writing, and operates the motor at full speed during searches.

Controller which contains:

Data Separator - converts the FM signal from the tape into 1's and 0's.

Address mark detector - finds special data encodings which identify the beginning of ID blocks and DATA blocks.

Deserializer - accumulates 1's and 0's into bytes.

Error Detector - accumulates check bytes and compares these against the check bytes written with the data on the tape.

Serializer - converts bytes to 1's and 0's.

FM Modulator - takes 1's and 0's and converts them to an FM signal to be written on the tape.

Check Byte Gnrtr - generates check bytes from the sector data to be written on the tape along with the data.

Motor Controller - participates in the servo loop for the motor speed controller.

Formatter - generates an beginning-of-tape gap, a string of sectors, and an end-of-tape gap; then verifies the tape for dropouts, improper length, missing index.

Command Intrprtr - decodes commands from the host and which activates the various sections of the controller.

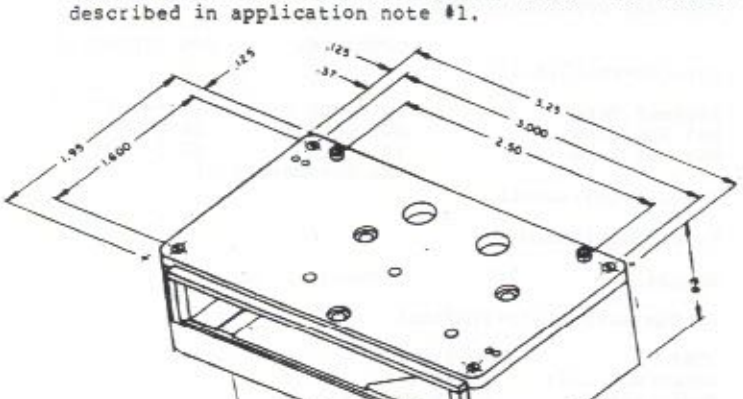
Sector Locater - finds a specified sector by repeatedly reading ID blocks.

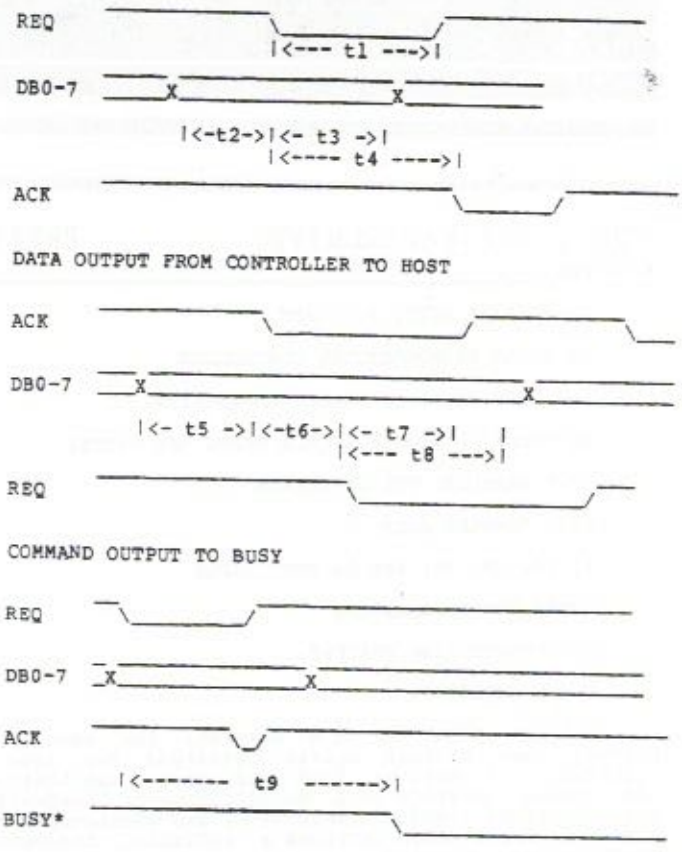
Read Sector Cntrl - activates the sector locator and which transfers data from the data deserializer to the host.

Write Sectr Cntrl - actives the sector locator and transfers data from the deserializer to the host.

RECORDING FORMAT

Data is recorded on the Micro Wafer (TM) using frequency modulation as the recording mode. The format is similar to the IBM soft sector for flexible disk. The format is described in application note #1.





t1 = REQ = 250 ns minimum
t2 = data valid set up time to REQ low = 30 ns.
t3 = data hold time to REQ low = 60 ns.
t4 = REQ low to ACK low (depends on command executio time)
t5 = output data valid to ACK delay = 50 ns
t6 = ACK low to REQ low = 150 us maximum whe transferring data bytes. (i.e. the host must kee up with the byte data rate off of the tape = 256 bytes per second with FM encoding).
t7 = REQ low to ACK high delay = 100 ns max.
t8 = REQ low to data not valid = 1 us minimum
t9 = REQ low to ACK when controller not busy = 100 usec

PARALLEL INTERFACE TRANSFERS

To write a command, parameter, or data byte to th controller, the HOST puts the byte on the data bus, DB0 7, and pulses the REQ line. This will latch the byt into the controller. Subsequently, the controlle processes the byte and returns a pulse on the ACK lin indicating that the byte has been input to th controller and another byte can be put on the data bus

For bytes to be transfered from the controller to th HOST, the controller places the byte on the data bus DB0-7, and pulses the ACK line. The host reads the data bus, then pulses the REQ line to indicate that the byte has been taken and another can be placed on the data bus.

COMMAND

FORMAT Writes beginning of tape gap. Writes ID marks, ID field, data marks, data fields initilized to 0's, gaps and end-tape gap. Verifies the tape to find bad sectors.

READ SECTOR Searches for the specified sector, reads the sector, computes and checks the checkbytes.

WRITE SECTOR Searches for the specified sector, writes the sector and checkbytes.

REWIND Spaces to the tape INDEX mark at fast forward speed.

STATUS Returns the status from the previous command.

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MODEL 301 WAFERDRIVE

PRELIMINARY

entrepo

FEATURES:

UP TO 1.593 MEGABYTES PER MICROWAFER

125 KBITS PER SECOND DATA TRANSFER

IBM PC COMPATIBLE 369 KBYTE WITH 3.7 SEC AVG ACCESS

SINGLE POWER SUPPLY (+5 VOLTS)

LOW POWER DISSIPATION (0.75 WATT)

OPTIMIZED FOR BATTERY OPERATION

COMPACT DESIGN (1" X 2" X 3.25")

READ/WRITE ELECTONICS

MOTOR CONTROL CIRCUIT

TTL INTERFACE

The Entrepo Model 301 Waferdrive is a compact, low cost, fast access, mass storage device optimized for battery operation. The drive consists of a Wafertransport with read/write and motor control electronics capable of reading and writing on the Entrepo Microwafer with a data transfer rate of 125 Kbits/sec. The Microwafer is a continuous loop of magnetic tape in a cartridge with maximum capacity of 1.593 Mbytes formatted in 512 byte sectors. A Microwafer with 12 foot tape length can be formatted into an IBM PC compatible 369 Kbyte format with an average access time of 3.7 seconds. The Waferdrive can sense the presence of a Microwafer and the write protect feature on the Microwafer to provide data security.

SPECIFICATIONS SUMMARY

Transfer Rate	125 Kbits/sec
Recording Density	6250 bpi
Flux Density	6250 fci
Recording Method	MFM
Tape Speed	
Read/Write	20 ± 4% ips
Start Time	200 msec
Stop Time	100 msec
Start Distance	1.5 in
Stop Distance	0.5 in

Tape Lengths (feet)	12	24	36	48
Access Time Avg (sec)	3.7	7.4	11.1	14.8
Access Time Max (sec)	7.4	14.8	22.2	29.6
Capacity (Kbytes)	369	784	1,190	1,593

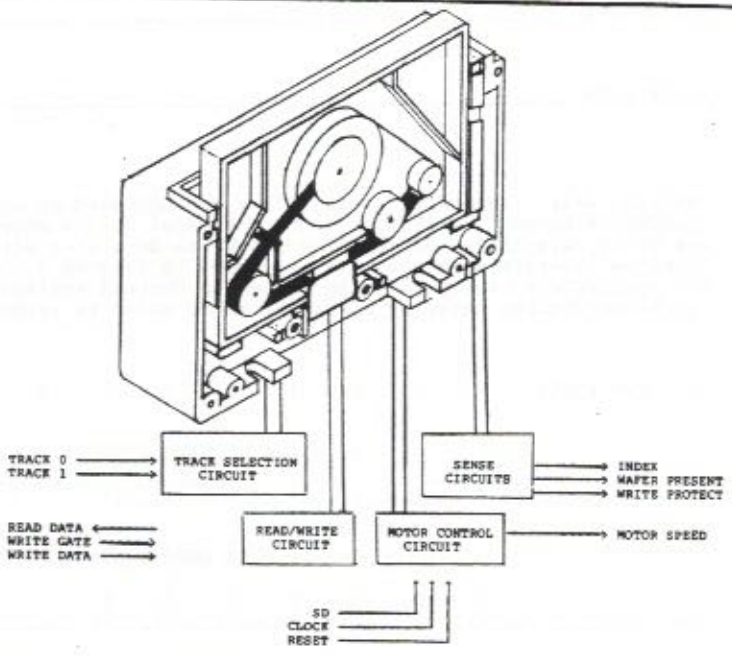
Media Requirements: Entrepo Micro Wafer

READ/WRITE CIRCUIT

- WRITE GATE When Write Gate is low, Write Data will be written on the Micro Wafer if the Micro Wafer has not been write protected. Refer to figures 1 and 2 for timing.

WRITE DATA Provides the data to be written on the Micro Wafer. Each transition from a logical one level to a logical zero level or vice versa, will cause current through the R/W head to be reversed thereby writing a data bit. This line in enabled by Write Gate being active. Refer to figures 1 and 2 for timing.

- READ DATA Provides the clock and data pulses as detected by the read/write electronics. Reference figures 1 and 2 for timing and bit shift tolerance within normal media variations.



MOTOR CONTROL CIRCUIT

SERIAL DATA Data input to least significant bit of Motor Control Register. When a binary number is shifted into the Motor Control Register the value is converted to an analog voltage and applied to the motor.

CLOCK Clock input of the Motor Control Register. Data that is present on the Serial Data input will be clocked into the least significant bit of the Motor Control Register and each bit that is in the register will be shifted to the next most significant bit position on the low to high transition of the Clock input.

- RESET Reset input of the Motor Control Register. All bits of the Motor Control Register will be set to zero when the Reset input is held low for a minimum of 40 nanoseconds.

MOTOR SPEED The signal is a pulse with duration of 520 microseconds that occurs six times per revolution of the shaft. The tape speed can be calculated in inches per second by dividing 0.0412 by the time between pulses on the motor speed line.

TRACK SELECTION

TRACK 0,1 The binary equivalent of the two lines determines which of four tracks is selected. For example both lines low selects track 0. Both lines high selects track 3.

SENSORS

INDEX Active for a period of 50 milliseconds once each revolution of the tape (6 seconds for a 5 foot wafer, 60 seconds for a 50 foot wafer) to indicate the beginning of tape.

- WRITE PROTECT To write protect a Microwafer, the user must remove the write protect knock out area on the wafer. A sense switch will detect the missing tab and inhibit writing. The Write Protect signal will be low when there is no wafer present and when a write protected wafer is in the drive.

- WAFER PRESENT This signal is low whenever a wafer is inserted into the Drive.

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PRELIMINARY

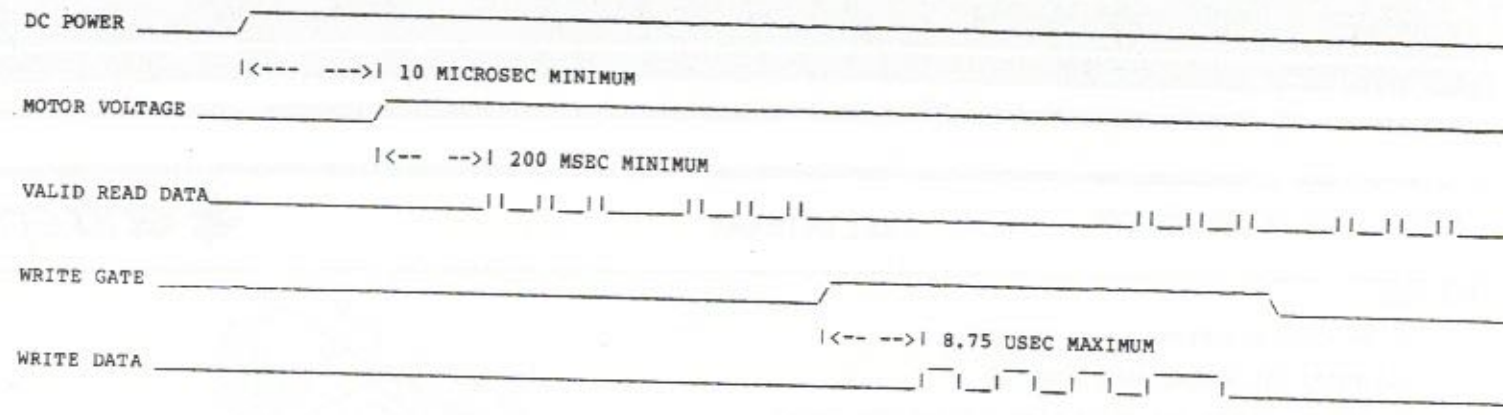


Figure 1. INTERFACE TIMING

Reading data from the Model 301 is accomplished by holding Write Gate being inactive and moving the tape at th read/write speed. Writing data to the Model 301 is accomplished by moving the tape at the read/write speed, activatin the Write Gate line, and pulsing the Write Data line with the data to be written. The timing relationships required t initiate a write data sequence are shown in figures 1. Moving the tape at read/write speed is accomplished by storin the appropriate binary value in the Motor Control Register, monitoring the motor speed line and adjusting the value i the Motor Control Register until the motor speed is within an acceptable tolerance.

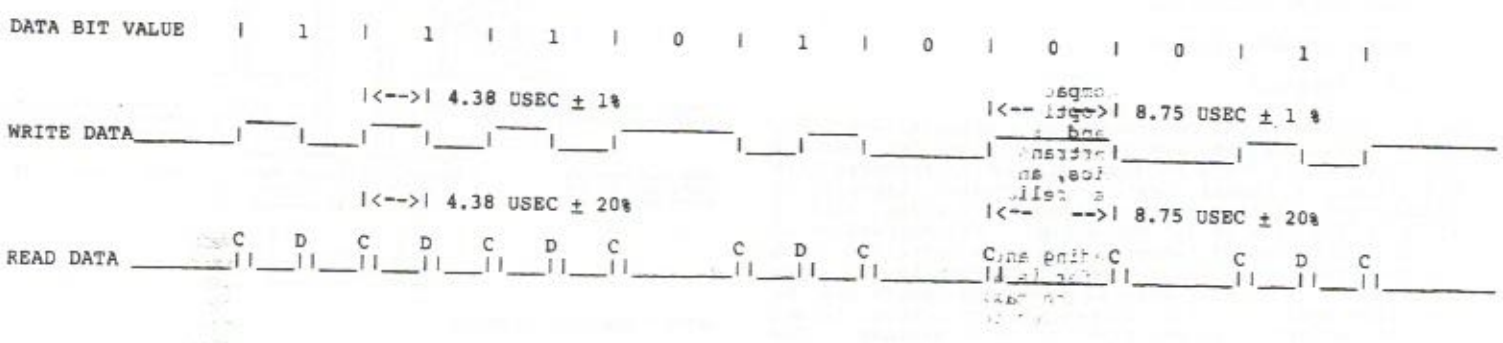
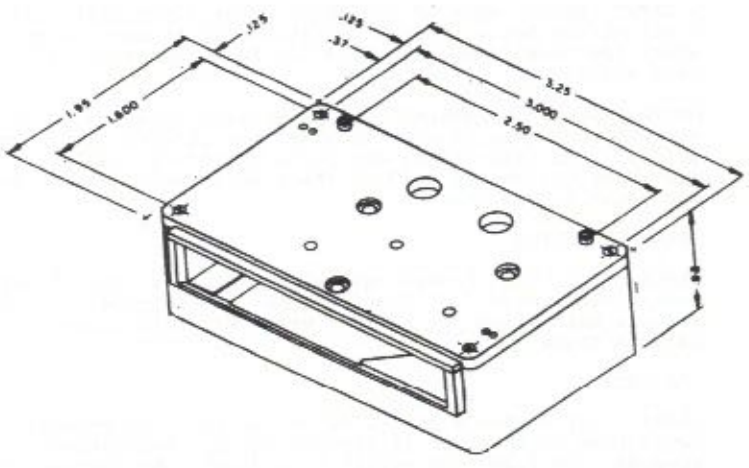


Figure 2. READ/WRITE TIMING

The read/write circuits have been optimized for MFM encoding and the data integrity specifications are based upon testing done with FM encoding. Other encoding schemes may have a detrimental effect upon data integrity. The timing of write data is shown in Figure 2. The fundemental write oscillator frequency can be determined within a range of +20% - 0%, however once the value is selected, the actual oscillator should be crystal controlled. Read data bit shift tolerances are also shown in figure 2.



PHYSICAL SPECIFICATIONS

Environment Limits	OPERATING	NON OPERATING
Ambient Temp	10 to 45 C	-20 to +60 C
Rel Humidity	20% to 80%	5% to 95%
Max Wet Bulb	30 C (No Condensation)	30 C

Power Requirements

Voltage	+5 Volts ±5%		
Current	Standby	Read	Write
	5 ma	125 ma	150 ma

Weight 4 ounces

RELIABILITY SPECIFICATIONS

MTBF	10,000 POH *
Component Life	5 Years
Media Life	5000 passes

Error Rates

Soft Read Errors	1 per 10 exp 8 bits read
Hard Read Errors	1 per 10 exp 11 bits read
Preventive Maintenance	Clean head and capstan every 1000 POH. *

* Assumes 10% duty cycle

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