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DEI Motion Control

1/24/77 wg

Latest information:

Read to Write gaps : .300" ± .005"

Write gap to Erase gap : .300" ± .010"

Start to within ±5% of final long term speed: 20.0 ms

30ips Start distance (20.0 ms) 0.214" min , 0.225" max

30ips Stop distance 0.326" min , 0.458" max

Minimum Gap:

min gap = max stop + max read gap to write gap

+ max write gap to erase gap

= 0.458" + .305" + .310 = 1.073

To position ~~read~~ erase head on Read Rev,

the read head must go ≥ .305 + .310 = .615"

min stop is ~~[illegible]~~ 0.326" ⇒ Rev delay must guarantee

.615 − .~~[illegible]~~ 326 = ~~[illegible]~~ .289"

Perex START/STOP

[when moving tape forward only]

STOP DISTANCE

technique: write a very long sync zone. Come up to speed in that sync zone and assert stop & erase simultaneously. The distance on the tape that gets erased will be the stop distance plus the erase-spread of the erase head. Well, the erase spread was unmeasurable by asserting erase momentarily while the tape was stopped in a sync zone, so what we measured was the stop distance. In all cases in this discussion, when I quote the ramp time, it is the average of the start and stop ramps, which differed by about 2 msec.

DEI stop distance at 18 ms RAMP = .384"
Perex " " " " " .684 −.3 = .384
25 .792 −.3 = .492
30 .858 −.3 = .558

examination showed that DEI's write head does not diminish the signal below the read threshold, while Perex's does. So if we subtract .300 inches from the above measurements, we get a much more reasonable number.

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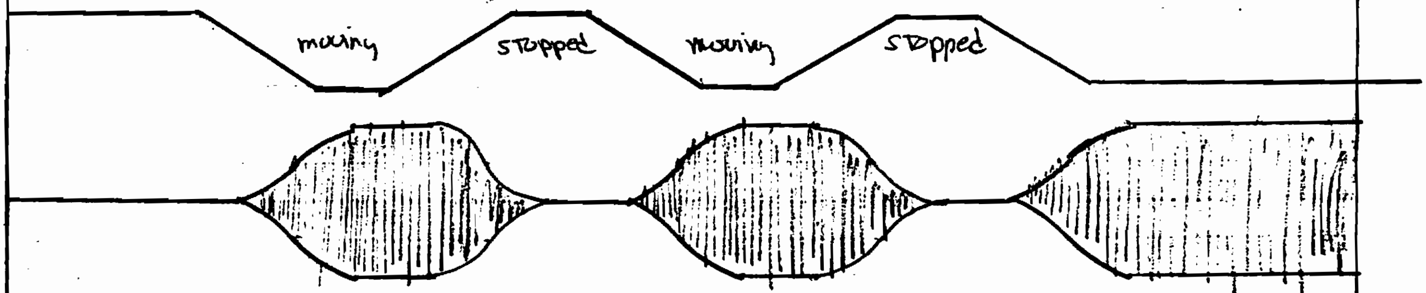
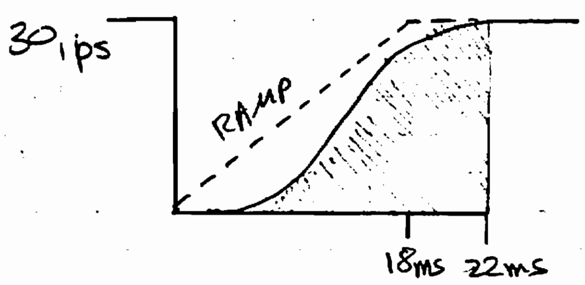
technique. The tape was started and stopped at 35 ms intervals while reading the long sync zone. The read data was monitored, on an oscilloscope. Here's what it looked like



over

Perex START/STOP cont.



The shaded are represents the distance the tape moves in the first 22 ms

using this technique, here's what I found

	18/22	25/28	← RAMP SPEED ACTUAL TIME
START DISTANCE	.24"	.34"	
STOP DISTANCE	.37"	.50"	

the above distances are how far the tape moved:

START: FROM ASSERT OF START TILL 22 or 28 ms later.

STOP: FROM ASSERT OF STOP TILL 22 or 28 ms later

With the RAMP at 18 ms, this drive stops + starts just like DEI. It's ability to write and recover data and interchange with DEI's tapes is as good as DEI's ability to do the same.

The only differences I could find are slightly different data detected thresholds. I don't believe this will be any problem, provided the drives have the same thresholds as the evaluation unit (whose thresholds have been changed by Perex's engineer while he was visiting BTI).

If the mechanical package can be made to conform to BTI's needs, I see no reason why we should not ship the Perex drive with our systems

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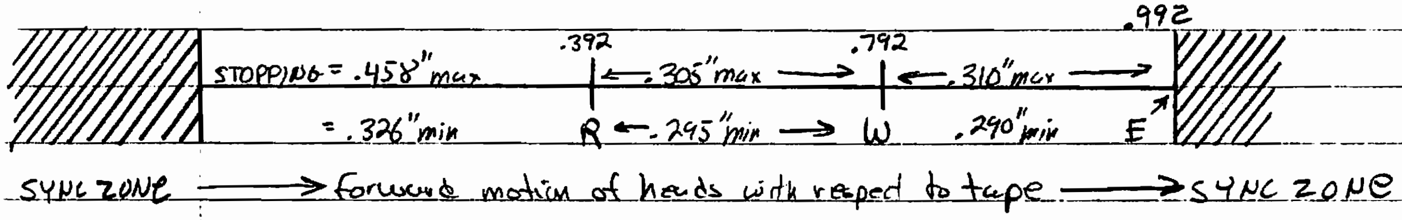
8-21-81

Dimensions of the Inter Record Gap [IRG]



Shown above is a first pass at the positions of the Read (R), Write (W) and Erase (E) heads when they come to a stop following a forward read or read after write. After the Read head exits the sync zone it takes from .326" to .458" to stop. the ranges on the ranges on the mechanical spacing of the 3 heads is also given.

An IRG must be defined such that all 3 heads may come to a stop within the gap. Thus the minimum gap size must be .458" + .305" + .310" = 1.073". The soonest the write head may stop is .326" + .295" = .621". Thus, if the next operation is to be a write, we must guarantee the write head travels (before writing) 1.073 - .621 = .452". The minimum starting distance is .214" (after a 20.0 ms start-up time). So after timing out the start delay [20.0ms × 192,000 bits/sec = 3840 bit times] we must further time-out .452" - .214" = .238". To guarantee this distance with 10% speed variations, we must nominally time out .238/90% = .264" which is .264" × 6400 bits/inch = 1692 bit times

so as a first approximation, we have

start up delay = 3840 bit-times
delay before write = 1692 bit times

Next, we must consider the case of entering the IRG from a reverse direction. Since the Read head is the first to enter the IRG, it should be easy to guarantee all 3 heads stop within the gap. But if we are to do a write next, we must be able to guarantee that the gap length remains ≥ 1.073" which means we must guarantee the write head does not start

We have guaranteed our IRG size is ≥ 1.109". A glance back over these figures shows that any time the Read head stops, it is at least .296" from either sync zone (that .246 is how close it is to the sync zone behind it when it gets in the gap with a reverse stop) so we are guaranteed to be at speed when we start the tape before the read head enters a sync zone. Notice also that the read head will be at least .615" from the sync zone in front of it, which will give us up to .615 − .225 = .390" any time we start a forward read to check + make sure we begin in an IRG. If due to an error we didn't stop the heads in an IRG, a read instruction will thus have time to look for an IRG before attempting to attain snyc in the sync zone.

summary of delays

bit times

	decimal	hex	inches (nominally)
start up delay =	3840	#F00	.220
reverse stop delay =	2055	#807	.327
delay before write =	2162	#872	.338

minimum IRG size = 1.109"
(that this device will write)

minimum IRG size = 1.073"
(that this device will read + edit)

timer are designed to hit this distance "dead nuts"

Actual timers in the SIO (DEI) Micro-code

Start-up delay

Any time the tape is started to read or read after write, in either direction, I will timeout the 20msec start up time by counting #F00$_{16}$ bit-times.

Reverse delay before read

When tape motion is started in the reverse direction, it is to do a search for file mark backwards or skip backwards. For the case of beginning in an IRG, I am guaranteed .071" before I hit a sync zone after coming to speed. I shall wait .070" = 448 bit times = #1C0$_{16}$ bit times. While this is convenient to ignore data glitches in the IRG, this wait is really there to help the skip back on an error recovery. In this case, you have halted the tape because an error has been detected. You would like to skip back + not begin examining the data until you are at the point where you decided to halt. Considering min + max starting + stopping distances, when you have started the tape for a backwards skip and have come up to speed, you may have this range of distance to go yet before you are where you were when you decided to stop the tape:

min stop	.326"	max stop	.458"
- max start	-.225	- min start	-.214"
	.105"		.224"

so the best compromise would be to use the .103" reverse wait before read, but the IRG reverse start limits me to .071

so I'll use .070" = #1C0$_{16}$ bit-times

Stopped Wait

After you tell the tape to stop, it will take approximately 25 msec for the tape motion to have actually stopped. So after each read, I'll wait that long before doing anything to guarantee that I won't attempt to start the tape again until its stopped. That 25msec = 4800_{10} = # $12C0_{16}$ bit-times

Write turn-off delay

After doing a write, after stopping the tape, after waiting the stopped wait for the tape to actually stand still, then you have to turn off the current to the write and erase heads. It takes about 5 ms for these heads to actually wind-down, so I have to wait 5 ms before starting the tape again. this timer will be

$5 msec = 960_{10} = 3C0_{16}$ bit times

IRG wait

when searching for a FM, I will detect the next IRG by waiting for 1" of IRG = 6400_{10} bit-times = # 1900_{16}

Deadtape timer

The maximum length of the tape from one frayed end to the other is
(18+3)" + (18+3)" + (18+3)" + (48+3)" + 12(300'+10')" + (36+3)" + (18+3)" + (18+3)" + (8+3)"
which is 3936". At a slowest speed of 27ips, it will take
$\frac{3936}{27}$ = 146 seconds to pass thru the tape.
IN Real-time-clock times (once every 5 useconds approximately, 5.12 exactly)
thats 28515625_{10} clock-ticks ≈ $1B0\,0000_{16}$ clock ticks ≈ $2\frac{1}{2}$ minutes
which is the number I will use for my dead tape timers

41927083_{10} ≈ $28\,00000_{16}$ clock ticks ≈ 4 minutes
for 450+15 ft cardtridge

1/3" of IRG to be found timer

the reverse stop delay is .321" = #807 bit times
the same number is used to detect 1/3" of IRG

SYNC ZONE LATE DURING READ-AFTER WRITE

the latest the read head may encounter the sync zone the write head has written is:

.305" + #872 bit times
↳ delay before write.

both read & write will already have waited the same start up delay

.305" @ 27ips = .0112963sec = 2206 bit times = #89E
#872 + #89E = #1110 + #12 bits before we will be in sync zone to stay (cuz if sync zone lasts less than #A bits, I consider it noise in the IRG)
1110 + 12 = #1122 = how long I'll wait till middle of sync zone is late during read after write

Rev 2 CTC μcode timers

RTC comes up once each byte time
thats: 200 instructions for GCR
256 instruction for MFM
$41\frac{2}{3}$ micro-seconds for MFM
$32\frac{1}{2}$ micro seconds for GCR

I will need a 20 ms start up timer in both modes

20ms in GCR = $\frac{.020}{.0000325} = 615_{10} = 267_{16}$
20ms in MFM = $\frac{.020}{.00004166} = 480_{10} = 1E0_{16}$

START DELAY →

LOAD POINT LATE If at first BOT, LOAD POINT is MAX $(18+3)+(18+3)+(48+3) =$ 93 inches + 10% = 102.3. Lets say the LOAD POINT is LATE in 110 inches. Cuz I'm lazy, I'm not gonna time this for both GCR & MFM, but rather time GCR for 110 inches, MFM for 141 inches. That's the same timer:
thats $(110 \text{ inches}/30\text{ips})/32\frac{1}{2}\mu\text{sec} = 112821_{10} = 1B8B5_{16}$
lets be simple and use $\#\,1B9XX_{16}$

Delay before write As discussed in first rev of this code, it should be .338 inches. However, if we have just passed the load point, we will make it 1".

Delay, MFM $= (.338''/30\text{ips})/41\frac{2}{3}\mu\text{sec} = 270_{10} = 10E_{16} \rightarrow 10D_{16}$
Delay, GCR $= (.338''/30\text{ips})/32.5\mu\text{sec} = 346_{10} = 15A_{16} \rightarrow 159_{16}$
Delay, MFM, near load point $= (1''/30\text{ips})/41\frac{2}{3}\mu\text{sec} = 800_{10} = 320_{16} \rightarrow 31F_{16}$
Delay, GCR, near load point $= (1''/30\text{ips})/32.5\mu\text{sec} = 1025_{10} = 401_{16} \rightarrow 400_{10}$

the code really waits 2 more ticks before beginning the write, so I rounded all the numbers down and then subtracted one.

1/3" Dropout detector

as discussed in Rev 1, the IRG size which is recognized as a dropout is .321 inches (nominally)

MFM: $\frac{.321}{30} / 41.6\,\mu sec = 257_{10} = \#101$

GCR: $\frac{.321}{30} / 32.5\,\mu sec = 330_{10} = \#14A$

ERASE TIMERS

The wait 1 inch routine is always called in MFM MODE

$$\text{timer} = \frac{1\,\text{inch}}{30\,\text{ips}} \Big/ 41.6\,\mu\text{sec} = 800 \text{ byte times}$$

If erasing a given number of inches, the start time is timed in the read routines. The stop distance must be considered IN THE distance timers. So, if we start past load point,

$$1\text{inch} - \underbrace{\underset{\text{START}}{.2195} - \underset{\text{STOP}}{.392}}_{\text{DISTANCES}} = .3885 \text{ inches to time}$$

$$.3885/30/41.6\,\mu\text{sec} = 3108 \text{ byte times} = \boxed{\#0136}$$

all except one of the inches may be timed by the 1 inch timer

If we start before load point, we must erase 1 inch past load and then the next inch must be less the stopping distance less the distance between the erase + write heads.

When you write, you begin writing 1" past LoPo. If you say erase 1", you mean move the erase head 1" into the written record which begins 1" past where the write head is positioned when Load point is detected.

$$2 - \underset{\substack{\text{STOP}\\ \text{distance}}}{.392} - \underset{\substack{\text{distance}\\ \text{between write + erase}}}{.3} = 1.308 \text{ inches}$$

$$\frac{1.308}{30} \Big/ 41.6 = 1046.4 = \boxed{\#0416}$$