Editorial

THE FLOPPY-ROM™ EXPERIMENT

—Or the Joy of Developing a Simple Idea

by Robert S. Jones, Publisher

Seldom does one have the chance to participate in a new and exciting event which could initiate a programming revolution.

The Floppy-ROM™ has just such a potential.

With great pride INTERFACE AGE Magazine presents this pioneering special feature in this issue. We invite our colleagues in the publishing field to join with us in providing our combined readership with this important advantage of mass-distributed software.

Our plans for the future call for more Floppy-ROMs™ supporting the 8080, Z-80 and 6502 CPUs.

It would be a pleasure to say that it was our idea, but unfortunately we cannot take that credit. Neither was it developed nor debugged by us. And in that point lies the real story.

This event is the achievement of many manufacturers and retail computer stores who have worked together on this project.

The story began at the Personal Computing '76 Trade Fair at Atlantic City, NJ when Bob Marsh of Processor Technology Corp. proposed the idea of pressing software onto a vinyl record. (We are including a milestone chart in Figure 1 to outline the events leading up the present success.)

Processor Technology provided a test 8080 program which was recorded on a master disc. Unfortunately it did not work when tested. The designers at that time were unable to devote further development to the project.

Southwest Technical Products and Technical Design Labs were then contacted and positive commitments resulted.

Dan Meyer and Gary Kay of SWTPC co-ordinated the participation of Robert Uiterwyk, Software Consultant to much of the industry.

At this point activity split. The record manufacturer, EVA-TONE of Deerfield, IL, pursued an independent research to improve the recording technique. Ethan Lazar and Perry Farazi of Itty Bitty Machine Co. in Evanston, IL played a major role with EVA-TONE in producing four TV games on a record as a test which was later refined into a recording technique by the engineering personnel from Heath Co., Benton Harbor, MI. They brought their system into EVA-TONE's facility and worked directly with the recording engineers. The third record was cut with excellent results.

While this was taking place at EVA-TONE, Robert Uiterwyk, consultant Bill Turner and Bill Blomgren of MicroComputer Systems, Inc., Tampa, FL were preparing the final program and documentation which appear in this issue. These gentlemen worked many long hours in co-ordinating, developing and evaluating the pre-production test data.

Our thanks to Bruce Van Natta and Mike Stone, marketing manager of IMSAI; Dan Meyer and Gary Kay of SWTPC who co-ordinated Robert Uiterwyk's work; to Tom Durston and Ed Roberts, president of MITS, for all their valuable assistance and input in the pre-production testing stage of the Floppy-ROM™.

MITS plans to publish a loader in "Computer Notes" which will allow all 680 owners to use this Floppy-ROM™.

Our special thanks goes to Carl Evans of EVA-TONE whose patience and steadfast support made the Floppy-ROM™ a reality.

Our plans for the future call for more Floppy-ROMs™ supporting the 8080, Z-80 and 6502 CPUs.

In order to continue this program, we ask for your response to the questions listed below for you are the key to its success.

Please send your responses and any comments as soon as possible to: **Floppy-ROM™,** INTERFACE AGE Magazine, P.O. Box 1234, Cerritos, CA 90701.

SURVEY

QUESTIONS

1. Did your magazine with the Floppy-ROM™ arrive in good condition via the Post Office?
2. What kind of record player did you use? Approximate cost?
3. What type of cartridge is on your turntable, magnetic or ceramic? If you know, tell us the brand and model.
4. What model cassette interface did you use?
5. Whose 6800 system did you use? Tell us the manufacturer's name, not your friend's.
6. What is the memory size of the 6800 system and what peripheral do you have?
7. Did you have trouble loading the record?
8. How many times did you have to try loading before you were successful?
9. Did you have any difficulties that prevented it from operating at all? If so, what were they?
10. Did you load the computer directly from the record through the interface?
11. Did you record on cassette and from there to the computer? What happened?
12. What kind of tone control settings did you use and were they critical?
13. Was the playback level critical?
14. Did you play it back in monaural or stereo?
15. Do you like the Floppy-ROM™ concept?
16. What kinds of programs would you like to see in the future?

See page 83 for the Milestone Chart on the development of the Floppy-ROM™

PLATTER BASIC

The Search for a Good, Random Access, Record Cutting Juke Box

by William Blomgren

WHY "PLATTER BASIC" ON A FLOPPY-ROM™?

This is really a two-part question. First, why BASIC at all? The need for high level software is fairly self-evident, and BASIC will be explained in a second article later in this issue. For now, let's just settle with "Why a floppy-ROM™ or platter?"

Low cost software distribution is a recurring problem. It just appears that "low cost" and "high reliability" just don't seem to mix. Shipping programs in ROM, at several dollars per copy, is too expensive. All magnetic media cost too much, are fairly bulky, and are fragile. Machine readable print requires a fair amount of hardware. The bar code reader that we have located costs well over $100. Most people do not have a bar code reader, nor even access to one, but many do have some sort of record player. A conventional record costs a fair amount, and is relatively fragile. The "sound Sheet" or floppy-ROM contained in this issue is low in cost, and best of all, requires little more than a record player and your cassette interface.

WHAT'S ON THE RECORD?

There are two different sections on the record. First are the test patterns to align your cassette interface. The second section is the software you will want to load into your 6800 based microcomputer. This section of the record includes a binary loader program, and the binary dump of BASIC.

WHAT WILL I NEED TO USE THE RECORD?

A 6800 based microprocessor system is a must. A minimum amount of memory considered should be 6K. In addition, a Kansas City Cassette interface is also a must, and some sort of 300-baud terminal is desirable to check the alignment of your cassette interface. A cassette machine should be used to save BASIC once it gets loaded, because the record will have limited life. Don't rely on it for more than ten or twenty loads because it will wear out. Basic assumes that MIKBUG is resident in your system, with a scratchpad from A000 to A07F. Patching instructions are provided in an appendix to this article for those systems that do not have MIKBUG and the scratchpad. A separate loader program is also supplied for those without a MIKBUG loader. Several SWTPC 6800 systems have been used by various individuals in verifying the concept behind BASIC on a "floppy-ROM", so owners of those systems should not have any trouble at all. Last but certainly not least, a 33-1/3 RPM (*Roms Per Magazine* . . . or is it revolutions per minute???) turntable.

HOW WAS THE PLATTER MADE?

This section was not designed to be a discussion of how to cut a record, rather is a bit of history describing the path that BASIC took finding its way into INTERFACE AGE. This is not the whole path either, but just the side trip it took through MicroComputer Systems, Inc. to generate the record.

In late February the disc project was mentioned to me, and I approved. This was later followed by the request "Dump a copy of version-2 4K BASIC on a reel-to-reel." I grabbed a machine, and recorded the dump in Motorola MIKBUG format. This hexidecimal checksum dump took seven-and-a-half minutes. I found out an hour later, that there was a 6½ minute time limit. *Back to the old drawing board* . . .

I gathered together a test pattern routine, and a binary dump and load routine, recorded them on tape, and sent them to EVA-TONE. Naturally, Murphy's First Law of Shipper-Smashing held true. The reel of tape arrived in seven pieces. The people at EVA-TONE managed to salvage the tape, however, and cut a sample disk. The test patterns looked great, but there was a drop out in the middle of the loader. It was a non-recoverable fault, so again I went through the entire procedure. The record worked well the second time. Level and tone settings however, were very critical. Carl Evans at EVA-TONE suggested a direct dump from the computer into their cutting equipment. *Back again to the old drawing board.*

I rewrote the machine code that generated the test patterns and dumped BASIC, so that they would need no operator assistance. I shipped a program tape off to Illinois. A computer store in that area provided the use of a Southwest Technical Products 6800 computer, and the dump was on. I received a telephone call asking how to use my dumping routine — I told them to just load it and type 'G'. Sure enough, Lady Luck was now on my side; it worked. Elimination of the intermediary tape stage was very important; they managed to do a direct dump into the cutting equipment with perfect results. A one-to-two DB variation was noted in the tapes I sent them, and this would present problems to many people. The direct dump eliminated this entirely.

The masters have traveled across the entire country several times, and final approval was finally made for production. The production pressings worked and the end result is here in INTERFACE AGE.

WHAT IS THE "KANSAS CITY STANDARD?"

The "Kansas City" recording standard was established to allow interchange of data and programs between microcomputer users. It allows great latitude in playback speed, and can be used with almost any cassette

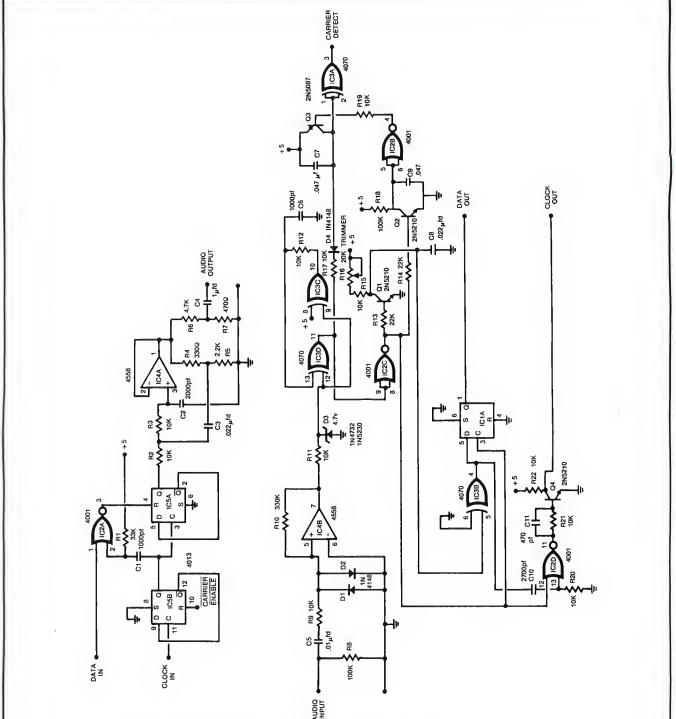

Figure 1. SWTPC AC-30 Cassette Tape Modulator/Demodulator Schematic

machine. "Marks", or logic ones, are represented by a frequency of 2400 Hz, and "spaces", or logic zeros, are represented by 1200 Hz. Data is transferred using the standard UART format, (1 start bit, 1 stop bit) at 300 baud. (Roughly thirty characters per second.) These frequencies were chosen because the 16X clock for the UART can be easily derived from the data being fed into the interface. Speed tolerances of 20- to 30% are acceptable. Figure 1 shows the circuit of the Southwest Technical Products AC-30. It is a fairly simple circuit, which will allow entry of the program into your system. With this circuit, or its equivalent, the program on the "floppy-ROM" may be read.

HOW DOES IT WORK?

Audio is fed through the highpass filter made up of R9 and C5. It is clipped by the pair of diodes, and fed into IC-4B, which acts as a comparator. IC-4 should be fed a well regulated 7.5V supply, to ensure stable operation at this point. Zener diode D3 limits the output of IC-4 to levels acceptable to the CMOS gate that follows. When the comparator changes state, IC-3C and IC-3D generate a short (5 microsecond) negative pulse. When data is being received, these pulses repeat. This train of negative pulses grounds C7 through D4. The output of C7 is inverted, buffered, and can be used to generate a carrier detect signal. These negative pulses are found at pin 11 of IC-3D. They're inverted by IC-2A, where they

Think about it!

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feed four circuits. The first circuit is a missing pulse detector, made up of Q2 and IC-2B. They pull the Carrier detect signal low if several cycles of audio are lost.

The second circuit is an adjustable missing pulse detector, which "times out" when 1200 Hz data are received. R16 trims this time period. The third circuit is flip-flop IC-1A, which outputs the data. Its output is high when 1200 Hz is received. The last circuit is the clock synthesizer, which is made up of IC-2D and IC-3B. These generate the 16X clock for your UART.

HOW DO I HOOK UP A TURNTABLE?

The AC-30 requires about 5 volts of signal to decode the data on the floppy record. Speaker output jacks will easily supply this level. Before you hook up Junior's phonograph, check to see if it has a transformer – isolated chassis. If it doesn't, *don't hook it up!* It would be all too easy to get 120V of your local power utility into your computer. This would tend to make a very expensive pile of write-only memory. If necessary, have a technician check out your stereo. Some component pre-amps are capable of driving 5 volts. A Dyna Pat-4 was used to test the records, and that worked nicely. However, it had to be turned up all the way. If your stereo set has a MONO-STEREO switch, set it on mono. A large percentage of noise on this type of disc is vertical. The vertical signal is essentially a "difference" signal for stereo, but is unwanted for this playback. It will cancel nicely, which will help load a very noisy disc.

Adjust your stereo set for 'flat' response. If your tone control is a 'High Cut' type, set the control for maximum. This is the starting point to align your system. If possible, transcribe the record the first time it is played. It should have reasonable life, 20 to 30 plays or more, but better safe than sorry.

WHAT ARE THE WEIRD SIGNALS AT THE START OF THE RECORD?

There are two test patterns that should be used to set up your AC-30. The first is a pattern of "5"s. Set your system up to echo the data from the tape to your terminal (local mode). Play back the tape. You should see a stream of "5"s. If you don't, adjust the tone and volume controls slowly and carefully. The "5"s should play back perfectly. There should be no other characters intermixed with the "5"s.

If you are not able to get the "5"s to play back properly, check your interface circuitry next. If you built the interface shown in Figure 1, adjust the R16 to trim the test pattern.

The second test pattern is a "U"' pattern, to check for jitter. If the "5"s worked properly, this should also. If you are not able to get the "5"s to read out, don't go further. Examine your connections, make sure you do not have any ground loops. Make sure you are getting a good clean signal out of the turntable. If you re-recorded the record on a cassette, make sure that you did not overload the cassette recorder when recording. Figure 2 shows a general view of how your system should be hooked up, with the turntable hooked into the AC-30 in place of a cassette machine. If you have arrived this far with flying colors, now is the time to load the program. First check your memory. Make sure all is well before going much further.

On March 26 we received the first sample run of floppy-ROMs. I had problems loading, until I found out someone had borrowed my low memory card. Memory from 0000 to 0FFF is a must! I set up my levels and the test pattern was good. A slightly high boost may be necessary in some systems. If your system has a rumble filter, switch it on. There will be no valid information below 100 Hz, and elimination of these noise components may be helpful.

I.

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If your record player has a good "scratch" filter, try it too. There is no information above 2400, but response at 2400 should be left as "Flat" as possible. If your scratch filter affects 5000 and above, it may be OK; 10000 and above would be better. Remember that most filters have a finite slope and frequencies 2 to 3 octaves away from the break frequency will be affected by level and phase changes. If you detect errors during program load, turn off the 'scratch' filter first.

WHAT IF MY TURNTABLE RUNS FAST OR SLOWLY?

Again, the beauty of the "Kansas City" standard comes to the rescue. Very few turntables have speed errors larger than 10%, so there is little reason for concern. If your error is very large, adjust your cassette interface card. I ran my turntable from 10% slow to 10% fast; 10% slow required a slight AC-30 'tweak', while 10% fast did not. Run as close to 33-1/3 as possible on an adjustable speed turntable.

HOW DO I LOAD THE PROGRAM?

After the test patterns, there is a 20-second space where the 'band' is cut. A string of 'L's follow, to start the loader function in MIKBUG. Place your tone arm down on the record near the end of the test patterns. There is a binary loader program in front of the data, which MIKBUG loads into memory at 1100 HEX. The computer then executes the binary load program, and loads BASIC. Very simple if you have MIKBUG. If you don't, I would recommend either patching the loader program, or reassembling it as necessary. Figure 4 is a listing of the loader program which was loaded at 1100 HEX. You will note several MIKBUG routines were used. Patch these to fit your operating system. If your turntable has a center depression, place a regular record on the turntable first to support the floppy-ROM.

2.

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WHICH MACHINES CAN USE 4K BASIC?

No 8080 based system will run this program. So IMSAI, Processor Tech, Altair 8080, DG 8080, 6502 and Z80 systems need not try.

The software will run only on a 6800 CPU, but this still becomes a fairly touchy question. I will tell you what I believe: the skill of the individual will tell what is really possible, and what is not. SWTPC 6800 owners should have no trouble at all if 6K of memory is present in the system. The MITS 680 will run the program with modifications. It will also require much more memory than is resident in the basic system. Several articles have been written on expanding the basic chassis. Expand and enjoy. You may need to supply a cassette interface as well. The schematic in Figure 1 should do well. You will need a block of memory from 0000 to at least 1200 HEX.

The Digital Group 6800 system will run the program, but you will need to completely re-do their cassette interface. In addition, you will have to supply several subroutines to operate BASIC. The memory that is standard with the DG should be adequate for 4K BASIC.

The Motorola evaluation module will run this program, but will need more memory. Their new evaluation module with the 'JBUG' monitor will require patching, but older MIKBUG equipped systems will run *as is*.

I don't have enough information on the Sphere 6800 system to predict success or failure. Operation in that


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MAGAZINE
Presents
THE FLOPPY ROM™
PROGRAM SHEET
33 1/3 RPM
MONAURAL
PLACE COIN HERE IF SOUNDSHEET SLIPS
6800 4K BASIC
Composed by
Robert Uiterwyk
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system has occurred, but will probably require extensive patching to BASIC.

This program will run in the OSI, but will require much patching. You will have to supply a loader program, and patch the I/O. Also, two routines in MIKBUG that are not in their ROM will have to be patched in. In addition, a cassette interface that is "Kansas City" standard may have to be supplied. Run and Enjoy!

This program should run in a Jupiter II, but I have insufficient data to predict success or failure. Much software may have to be written to drive their CRT interface. Good luck.

Owners of Motorola Exorcisors can run this program with relative ease. Some patches will be required.

The AMI EVK evaluation modules will run this BASIC, but will require patching. It will also need 6K of memory.

Other 6800 systems may be able to run this program. The memory map outlines memory usage. If you have RAM at the appropriate points, the system should go.

Memory Map for 4K Basic

0000-00FF	Input buffer and temporary variable storage
0100	Hard starting address of Basic (Cold start — clears program)
0103	Soft starting address of Basic (warm start — saves program)
0105-10FF	Basic Interpreter
1100-11FF	Arithmetic and For-Next stack
A000-A045	Machine stack
A04A-A07F	Index register stack

Note: Binary loader program starts at 1100. It will be cleared by the Basic interpreter when 0100 is executed.

4.

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5.

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BILOAD PROGRAM

```
02775 1100                      ORG     $1100
02780 1100 BE A047 BILOAD LDS   $$A047
02790 1103 8D 49                BSR     LOAD

02800 1105 8D 3C    OVER        BSR     INPUT
02810 1107 81 58                CMP A   #'X
02820 1109 26 FA                BNE     OVER
02830 110B 8D 36                BSR     INPUT
02840 110D 81 31                CMP A   #'1
02850 110F 27 07                BEQ     READ
02860 1111 81 39                CMP A   #'9
02870 1113 26 F0                BNE     OVER
02880 1115 7E E0E3              JMP     CONTRL

02900 1118 7F A016  READ        CLR     CKSM
02910 111B 8D 26                BSR     INPUT
02920 111D 16                   TAB
02930 111E 5C                   INC B
02940 111F 8D 22                BSR     INPUT
02950 1121 B7 A019              STA A   TW
02960 1124 8D 1D                BSR     INPUT
02970 1126 B7 A01A              STA A   TW+1
02980 1129 FE A019              LDX     TW

03000 112C 8D 15    STORE       BSR     INPUT
03010 112E A7 00                STA A   X
03020 1130 01                   NOP
03040 1131 A1 00                CMP A   X
03050 1133 26 0B                BNE     OUT
03060 1135 08                   INX
03080 1136 5A                   DEC B
03090 1137 26 F3                BNE     STORE
03100 1139 8D 08                BSR     INPUT
03110 113B 7C A016              INC     CKSM
03120 113E 27 C5                BEQ     OVER

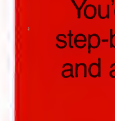
03130 1140 7E E040  OUT         JMP     LOAD19

03140 1143 8D 14    INPUT       BSR     INCHP
03150 1145 36                   PSH A
03160 1146 B8 A016              ADD A   CKSM
03170 1149 B7 A016              STA A   CKSM
03180 114C 32                   PUL A
03190 114D 39                   RTS
```

6.

Assembly Manuals

that are by far the best and most complete in the world. You'd want illustrated, step-by-step instructions and a "we won't let you fail" pledge.



CIRCLE INQUIRY NO. 21


```
03210 114E B6 11    LOAD    LDA A   $11
03220 1150 BD E1D1          JSR     OUTEEE
03230 1153 B6 3C            LDA A   $3C
03240 1155 B7 8007          STA A   $8007
03250 1158 39               RTS
03270 1159 37       INCHP   PSH B
03280 115A BD E1A5          JSR     SAV

03290 115D A6 00    IN1     LDA A   X
03300 115F 2B FC            BMI     IN1
03320 1161 6F 02            CLR     2,X
03330 1163 BD E1F3          JSR     DE
03340 1166 BD E1EF          JSR     DEL
03350 1169 C6 04            LDA B   #4
03360 116B E7 02            STA B   2,X
03370 116D 58               ASL B

03390 116E BD E1EF  IN3     JSR     DEL
03400 1171 0D               SEC
03410 1172 69 00            ROL     X
03420 1174 46               ROR A
03430 1175 5A               DEC B
03440 1176 26 F6            BNE     IN3

03450 1178 BD E1EF          JSR     DEL
03460 117B 7E E1E3          JMP     IOUT2
```

RU4K BASIC OBJECTIVE LISTING

```
END OF DUMP? 10FF
0100 - 7E 08 0E 7E 08 15 54 4F 1E 99 99 53 54 45 50 1E
0110 - 88 BB 52 55 4E 1E 08 76 4C 49 53 54 1E 08 9D 4E
0120 - 45 57 1E 08 0E 50 41 54 1E 08 EE 4C 4F 41 1E 09
0130 - 2B 53 41 56 1E 09 00 47 4F 53 55 42 1E 0A 6A 47
0140 - 4F 54 4F 1E 0A BC 4F 4E 1E 0A 4B 54 4B 45 4E 1E
0150 - 0A 39 50 52 49 4E 54 1E 0C B2 4C 45 54 1E 0D D5
0160 - 49 4E 50 55 54 1E 0A 27 49 46 1E 0F E0 52 45 41
0170 - 44 1E 0C 2B 44 41 54 41 1E 0D F9 52 45 53 54 4F
0180 - 52 45 1E 0C 79 45 4E 44 1E 08 15 52 45 54 55 52
0190 - 4E 1E 0A B2 44 49 4D 1E 0E 21 46 4F 52 1E 0E A2
01A0 - 4E 45 5B 54 1E 0F 53 52 45 4D 1E 0B F9 41 50 50
01B0 - 1E 09 2B 53 54 4F 50 1E 0A C6 1E 0D D5 52 4E 44
01C0 - 28 1E 10 BE 54 41 42 28 1E 0C F7 49 4E 54 28 1E
01D0 - 10 7C 43 4B 52 24 28 1E 0C BA 43 4B 52 28 1E 0C
01E0 - BA 41 42 53 28 1E 10 B5 53 47 4E 28 1E 10 9A 55
01F0 - 53 45 52 28 1E 10 6E 13 14 0D 0A 15 52 45 41 44
0200 - 59 1E 20 44 45 4C 1E 10 16 1E 52 45 2B 45 4E 54
0210 - 45 52 1E 45 52 52 4F 52 23 20 1E 20 49 4E 20 4C
0220 - 49 4E 45 20 1E CE 02 02 BD 6A 20 07 86 3F BD 4B
```



```
0230 - BD 03 59 CE 00 B0 BD 45 81 1B 27 E9 81 0D 27 25
0240 - 81 0F 26 0C 86 5F BD 30 BC 00 B0 27 E9 09 20 E6
0250 - 8C 00 FB 26 05 C6 21 7E 7E 47 A7 00 08 20 F7 86
0260 - 23 BD 15 20 CE 86 1E A7 00 DF AE 96 B5 26 02 BD
0270 - 31 39 7E E0 BF 7E E0 CB BD 09 7E E1 D1 BD E1 AC
0280 - 36 20 08 36 86 80 04 2B 09 BD F2 81 03 26 03 7E
0290 - 08 15 32 39 BD 05 20 0A BD DE 0B A6 00 81 1E 26
02A0 - F7 39 BD 10 CE 02 AC BD F2 BD 1E 39 0D 0A 15 FF
02B0 - FF FF FF 1E DF 3B DE 3A 09 09 DF 3A 3A 9A 3B A7
02C0 - 00 96 39 A7 01 32 DE 3B 39 DE 3A EE 00 7C 00 3B
02D0 - 7C 00 3B 39 BD DE BD 04 4E 9F 2B 35 DE 3A EE 00
02E0 - 20 11 BD D0 BD 04 4E 9F 2B 35 09 09 09 09 09 09
02F0 - 09 EE 00 C4 05 32 A7 00 08 3A 26 F9 32 32 A7 00
0300 - 9E 2B BD C5 39 BD AD 9F 2B 35 20 0A BD A6 BD 04
0310 - 4E 9F 2B AE 00 34 C6 05 DE 5D 32 A7 00 08 5A 26
0320 - F9 32 A7 01 6F 00 7F 2B DE 04 A7 02 BD 39 BD 02
0330 - 75 A6 00 08 BD 02 B4 CE 01 12 DF 48 97 49 DE 4B
0340 - 09 09 A6 00 81 1E 26 F9 9B 08 BD 02 9B BD 09
0350 - 7F 00 40 BD 02 C9 7E 02 34 A6 00 BD 02 9B 08 32
0360 - 39 BD 07 60 BD 04 33 25 26 16 A6 01 BD 04 33 25
0370 - 26 BD 07 A5 BD 02 B4 DE 34 BD 04 BA DF 34 BD 02
0380 - C9 EE 00 A0 00 BD 04 47 DE 34 31 31 31 31 39 0B
0390 - 39 BD 04 3B 24 07 81 2B 27 03 09 B6 20 08 08 BD
03A0 - 02 B4 DE 2A 9C 46 0D 27 09 E1 00 26 0C A1 01 26
03B0 - 08 0C DF 63 BD 02 C9 0A 39 3A A6 01 81 2B 32 27
03C0 - 05 BD 04 5D 20 DE EE 00 DA BD 02 83 BD 92 2B
03D0 - 01 39 36 25 31 DF 34 DE 63 81 2B 27 15 08 08 DF
03E0 - 63 DE 5D 96 63 A7 00 96 64 A7 01 BD 5A 32 DE 34
03F0 - 0C 39 BD 0D FF 24 04 BD 74 26 01 5F 37 BD 6E 17
0400 - 33 BD 0E 75 20 D9 DF 34 DE 63 E7 00 A7 01 81 2B
0410 - 26 19 C6 0A E7 02 E7 03 BD 0D FF 25 03 5F E7 03
0420 - A6 02 BD 0E 5D 4D 03 27 1D 20 CC BD 0D FF 46 DE
0430 - 63 20 AA B1 41 2B 0C B1 5A 2F 0A B1 30 2B 04 B1
0440 - 39 2F 02 0D 39 0C 39 DE 5D BD 13 DF 5D 39 DE 5D
0450 - BD 03 20 F7 09 09 09 09 09 09 09 09 09 08 08 08
0460 - 08 08 08 08 08 9C 44 2B 03 7E 0A 0B 39 BD 02 B4
0470 - BD DC A6 06 81 04 2F 05 C6 01 7E 0B 47 4F 5F 6D
0480 - 06 23 19 5B 49 D7 52 97 51 5B 49 5B 49 DB 52 99
0490 - 51 E8 00 B9 00 BD 05 5C 6A 06 20 E3 4B 24 D9 BD
04A0 - 02 C9 39 BD 07 60 BD 03 CA 25 04 BD 03 0C 39 BD
04B0 - 0B 3B 25 01 39 B1 2B 26 11 0B BD 33 BD 07 60 26
04C0 - 02 26 02 0B 39 26 13 7E 0B 47 C6 06 20 F9 BD D3
04D0 - BD 07 60 B1 2A 26 0B 0B BD 07 60 BD C6 BD 06 E6
04E0 - 20 EE B1 2F 26 08 0B BD B4 BD 06 4E 20 E2 39 BD
04F0 - 07 60 B1 2D 26 07 0B BD D5 BD 2D 20 07 B1 2B 26
0500 - 01 0B BD CA BD 07 60 B1 2B 26 0B 0B BD C0 BD 06
0510 - 07 20 F1 B1 2D 26 08 0B BD B4 BD 06 04 20 E5 39
0520 - BD 02 B4 BD 04 5E 20 DC BD 02 B4 DE 5D 09 09 20
0530 - 06 BD 02 B4 BD 04 40 36 37 C6 06 B6 99 A0 00 A7
0540 - 00 09 5A 26 F6 BD 04 5F 0D C6 06 B6 00 A9 00 19
0550 - A7 00 09 5A 26 F5 BD 02 C9 33 32 39 36 BD 0B A6
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...but you don't need to design your own because our systems* are coming this Fall:

They're the ones you've been waiting for.

The Health Co. Benton Harbor MI

CIRCLE INQUIRY NO. 22

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0560 - 00 84 0F A7 00 32 39 36 37 DF 57 C6 04 DE 57 BD
0570 - 04 60 68 00 86 05 09 69 00 4A 26 FA 5A 26 EE 33
0580 - 32 39 36 37 DF 57 A6 00 84 F0 97 53 C6 04 DE 57
0590 - 64 00 86 05 08 66 00 4A 26 FA 5A 26 F1 DE 57 A6
05A0 - 00 9B 53 A7 00 33 32 39 BD 02 B4 BD 04 4E 7F 00
05B0 - 56 BD 0D BC 24 19 A6 00 2A 0B 97 56 BD 05 31 86
05C0 - 0F A4 00 A7 00 A6 00 26 08 8D 91 6A 06 20 F6 6F
05D0 - 06 6F 05 A6 06 81 65 2D 15 37 C6 05 86 99 A7 00
05E0 - 08 5A 26 FA 86 64 A7 01 BD 04 57 33 20 D1 81 9D
05F0 - 2E 03 BD 0B F0 7D 00 56 27 03 BD 05 31 BD 04 47
0600 - BD 02 C9 39 BD 05 28 BD 02 B4 BD 04 4E BD 0D BC
0610 - 24 28 BD 05 82 6C 06 BD 04 4E BD 0D BC 24 11 BD
0620 - 05 82 6C 06 A6 06 A1 0D 27 08 2D F3 8D 10 20 EF
0630 - 8D 0C 8D 23 BD 04 47 BD 05 A8 BD 02 C9 39 DE 5D
0640 - 37 36 C6 07 A6 00 36 A6 07 A7 00 32 A7 07 08 5A
0650 - 26 F2 DE 5D 32 33 39 36 37 DE 5D C6 06 0C A6 05
0660 - A9 0C 19 A7 05 09 5A 26 F5 DE 5D 33 32 39 BD 02
0670 - B4 BD 0B F0 BD 04 4E BD 0D BC 25 05 C6 08 7E 08
0680 - 47 60 06 8D 38 BD 05 82 BD 05 20 86 0B 5F 5C 8D
0690 - C6 6D 00 2A F9 5A BD 05 20 8D BC BD 05 20 BD 04
06A0 - 5E BD 04 5E BD 05 67 EB 05 E7 05 DE 5D BD 05 67
06B0 - 4A 26 DA BD 04 47 8D 86 7C 00 50 20 59 BD 05 82
06C0 - 4F 6D 00 2A 05 BD 05 31 86 80 BD 04 4E 6D 00 2A
06D0 - 05 BD 05 31 8B 80 97 4A A6 06 AB 0D 28 05 86 78
06E0 - 24 01 40 97 50 39 BD 02 B4 BD 04 4E BD CF DF 59
06F0 - BD 04 47 BD 06 3E BD 0B F0 86 09 DE 59 E6 00 BD
0700 - 05 5C 5D 27 06 BD 06 57 5A 20 F7 DE 5D BD 04 5E
0710 - BD 05 82 4A 26 E5 BD 04 4E BD 06 3E 96 50 A7 06
0720 - BD 04 47 BD 05 A8 7D 00 4A 2A 03 BD 05 28 BD 02
0730 - C9 39 96 32 D6 33 D0 31 92 30 25 1E DE 2E 96 30
0740 - D6 31 E0 01 A2 00 25 14 26 03 5D 27 10 08 08 A6
0750 - 00 81 1E 26 F9 08 9C 2A 26 E4 DE 2A 0D DF 2C 39
0760 - A6 00 81 20 26 03 08 20 F7 39 BD 0B 3B 24 05 C6
0770 - 07 7E 08 47 DF AC BD 04 4E E6 06 23 F2 C1 04 2E
0780 - EE 86 05 10 4D 27 06 BD 05 82 4A 20 F7 A6 01 97
0790 - 30 A6 02 97 31 DE AC 0C 39 DE 34 A6 00 08 81 1E
07A0 - 26 F9 DF 36 39 DF AC 9F 28 CE 01 BC 20 12 DF AC
07B0 - 9F 28 CE 01 05 20 09 8D A7 DF AC 9F 28 CE 01 11
07C0 - 9E AC 34 08 32 81 20 27 FB E6 00 C1 1E 27 18 11
07D0 - 27 F1 08 8C 01 BA 27 17 8C 01 F4 27 18 E6 00 C1
07E0 - 1E 26 EF 08 08 20 D9 08 9F AC 9F 34 9E 28 39 9E
07F0 - 28 CE 01 BB 39 7E 0B 2B CE 12 00 DF 2E DF 2A DF
0800 - 46 4F 97 32 97 33 97 40 CE 10 7B DF 67 39 8E A0
0810 - 45 8D E5 20 61 8E A0 45 CE A0 7F DF 3A 7F 00 85
0820 - CE 01 F7 BD 02 94 7F 00 40 BD 02 5F CE 00 B0 BD
0830 - 07 60 BD 04 3B 25 05 BD 09 59 20 EA 81 1E 27 E6
0840 - BD 07 B7 EE 00 6E 00 8E A0 45 BD 02 A2 CE 02 13
0850 - BD 02 9B D7 20 CE 00 20 BD 02 72 CE 02 1B BD 02
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0880 - 65 CE 11 80 DF 5F DE 2A DF 46 4F 09 08 A7 00 9C
0890 - 44 27 07 A6 00 27 F5 09 DF 44 7E 0A 10 CE 02 07
08A0 - DD 02 94 DE 34 BD 07 60 81 1E 27 2B BD 07 6A DF
08B0 - 34 BD 07 3C DF 24 DE 34 BD 07 60 81 1F 27 04 08
08C0 - BD 07 6A 4F C6 01 DB 31 19 D7 31 99 30 19 97 30
08D0 - BD 07 3C DE 24 20 06 DE 2A DF 2C DE 2E 9C 2C 27
08E0 - 0A 9C 2A 27 06 BD 03 2E 08 20 F2 7E 0D F9 BD 07
08F0 - 99 CE 0A 10 FF A0 46 8E A0 40 BF A0 08 7E E0 E3
0900 - DE 2E 86 12 BD 02 78 8D 3A BD 38 8D 41 9C 2A 27
0910 - 0D 86 02 BD 02 78 BD 03 2E 08 8D 29 20 EF 86 03
0920 - BD 02 78 8D 29 7E 08 15 BD 07 F8 86 11 97 85 BD
0930 - 02 78 BD 02 7D 81 02 26 F9 BD 02 33 CE 00 B0 8D
0940 - 18 20 EF 8D 00 5F 4F 4A 26 FD 5A 26 F9 39 C6 32
0950 - 86 FF BD 02 78 5A 26 F8 39 BD 07 6A BD 07 32 24
0960 - 13 DE AC BD 07 60 81 1F 27 21 DE 2C 9C 2A 27 1C
0970 - 8D 48 20 17 DE AC BD 07 60 81 1E 26 0A DE 2A 9C
0980 - 2E 27 08 8D 0F 20 04 8D 0B 8D 2F 39 8D 2C DE 30
0990 - DF 32 20 F7 9F 28 DE 2C 9E 2A 08 08 34 34 A6 00
09A0 - 34 08 81 1E 26 F8 9F 2A 9F 46 35 DE 2C 9C 2A 27
09B0 - 06 32 A7 00 08 20 F6 9E 28 39 DE AC BD 07 B7 9F
09C0 - 28 DF 48 DE 2A DF 20 D6 AF D0 AD CB 04 DB 2B 86
09D0 - 00 99 2A 91 44 22 34 D7 2B 97 2A DE 2A DF 46 35
09E0 - DE 20 9C 2C 27 06 09 A6 00 36 20 F6 DE 2C 96 30
09F0 - A7 00 08 96 31 A7 00 08 96 49 A7 00 08 9E AC 34
0A00 - 32 A7 00 08 81 1E 26 F8 9E 28 39 C6 14 7E 08 47
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0A20 - 26 03 7E 08 15 7D 00 36 27 F8 08 A6 00 08 DF
0A30 - 34 97 49 DE 48 EE 00 6E 00 DE 34 BD 07 60 BD 04
0A40 - 3B 24 49 7E 0F F5 C6 20 7E 08 47 DE 34 BD 04 EF
0A50 - BD 04 6D 5D 27 F0 5A D7 55 BD 07 B7 EE 00 8C 0A
0A60 - 8C 27 2C 8C 0A 6A 27 05 20 DC 7F 00 55 DE 36 BD
0A70 - 07 99 DE 65 8C 00 85 26 05 C6 09 7E 08 47 96 36
0A80 - A7 00 08 96 37 A7 00 08 DF 65 20 03 7F 00 55 DE
0A90 - 34 BD 07 6A 7A 00 55 2B 0A BD 07 60 81 2C 26 A6
0AA0 - 08 20 EE BD 07 32 24 05 C6 07 7E 08 47 DF 36 7E
0AB0 - 0A 10 DE 65 8C 00 75 26 05 C6 10 7E 08 47 09 09
0AC0 - DF 65 EE 00 20 E7 CE 01 B3 BD 02 9B BD 03 59 DE
0AD0 - 36 BD 02 75 7E 08 15 96 34 26 05 C6 02 7E 08 47
0AE0 - BD 02 2C CE 00 B0 DF AC DE 34 BD 03 CA 25 31 DF
0AF0 - 34 DE AC 8D 3B 24 12 81 1E 27 06 CE 02 0A BD 02
0B00 - 94 BD 02 2C CE 00 B0 20 EA BD 02 E2 BD 07 60 81
0B10 - 2C 26 01 08 DF AC DE 34 BD 07 60 08 81 2C 27 CA
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0B70 - 26 0F 7D 00 4C 26 0C 7D 00 4D 27 EA 7A 00 4B 20
0B80 - E5 97 4C BD 02 B4 DE 26 5D 27 16 7D 00 4E 26 08
0B90 - AB 00 A7 00 08 5A 20 06 48 48 48 48 A7 00 73 00
0BA0 - 4E DF 26 7D 00 4D 26 03 7C 00 4B BD 02 C9 20 B6
0BB0 - 7D 00 4D 26 08 81 2E 26 04 97 4D 20 A9 5F 81 45
0BC0 - 26 14 08 A6 00 81 2D 27 09 81 2B 26 01 08 8D 36
0BD0 - 20 04 08 8D 31 50 96 4B 1B BD 02 B4 DE 5D A7 06
0BE0 - BD 04 47 BD 02 C9 7D 00 4A 27 03 BD 05 28 0C 39
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0C50 - 00 08 81 1E 26 F5 A6 02 81 79 26 EF 08 08 08 20
0C60 - D9 BD 02 E2 08 DF 3C DE 34 BD 07 60 08 81 2C 27
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0C90 - 22 27 4A 81 1E 26 04 C6 04 20 1C 8D 6E 20 ED 81
0CA0 - 1E 26 35 09 A6 00 08 81 3B 27 06 BD 02 A2 7F 00
0CB0 - 40 08 DF 36 7E 0A 10 7E 08 47 DE 34 BD 04 6D 17
0CC0 - 8D 49 8E A0 45 20 16 DE 34 BD 04 6D D0 40 23 F2
0CD0 - BD 03 59 5A 26 FA 20 EA BD 04 EF 8D 4B BD 07 60
0CE0 - 81 2C 26 0E 08 96 40 16 C4 F0 10 27 0A BD 03 59
0CF0 - 20 F3 81 3B 26 04 08 7E 0C 84 81 1E 27 A1 C6 06
0D00 - 20 B5 86 2E 20 05 4F 84 0F 8B 30 36 BD 02 78 32
0D10 - 37 D6 40 5C C1 30 23 0C C1 3F 27 04 81 20 26 04
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0D30 - 4D 6D 00 26 08 8D CF BD 02 C9 7E 03 59 6D 00 2A
0D40 - 07 86 2D 8D C6 BD 05 31 A6 06 81 09 2E 31 81 FF
0D50 - 2D 2D 4D 2E 10 8D AF 8D A9 97 4D 6D 06 2A 1C 8D
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0D70 - 5C 6A 06 26 F5 8D 45 24 BE 8D 87 8D 30 20 B8 A6
0D80 - 00 8D 84 BD 05 5C BD 0D 02 8D 22 86 45 BD 0D 0B
0D90 - E6 06 5A 2A 06 86 2D BD 0D 0B 50 4F 4C C0 0A 2A
0DA0 - FB 4A CB 0A BD 0D 07 17 BD 0D 07 20 8A 8D 0D 24
0DB0 - 0A A6 00 BD 0D 07 BD 05 5C 20 F2 39 BD 02 B4 DE
0DC0 - 5D 37 C6 06 6D 00 26 07 08 5A 26 F8 0C 20 01 0D
0DD0 - BD 02 C9 33 39 DE 34 BD 03 CA 24 05 C6 12 7E 08
0DE0 - 47 BD 07 60 08 81 3D 27 04 C6 06 20 F1 BD 04 EF
0DF0 - 81 1E 26 F5 BD 02 E2 20 00 BD 07 99 7E 0A 10 BD
0E00 - 02 B4 DE 34 BD 04 EF 08 81 2C 27 0B 81 29 26 1A
0E10 - DF 34 BD 02 C9 0C 39 BD 04 BA DF 34 BD 02 C9 0D
0E20 - 39 DE 34 BD 03 61 29 02 25 05 C6 05 7E 08 47 81
0E30 - 28 26 F7 DF 34 DE 63 E7 00 A7 01 8D C2 24 05 BD
0E40 - 04 6D 20 01 5F E7 03 BD 04 6D 17 A7 02 8D 0E DE
0E50 - 34 BD 07 60 08 81 2C 27 CA 09 7E 0D F9 BD 02 B4
0E60 - E6 03 8D 11 BD 04 5F DF 46 BD 02 C9 96 46 A7 04
0E70 - 96 47 A7 05 39 4D 26 05 C6 15 7E 08 47 A1 02 22
0E80 - F7 E1 03 22 F3 36 A6 02 97 51 5D 27 0D 5A 27 0A
0E90 - 96 51 BD 04 5F 4A 26 FA 20 F3 32 BD 04 5F 4A 26
0EA0 - FA 39 DE 34 BD 03 CA 24 03 7E 0D DC DF 34 DE 5D
0EB0 - BD 04 55 A6 00 E6 01 CE 11 80 9C 5F 27 0F A1 00
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0ED0 - 26 05 C6 10 7E 08 47 A7 00 08 E7 00 08 DF 5F DE
0EE0 - 34 BD 07 60 08 81 3D 27 03 7E 0D E9 BD 04 EF BD
0EF0 - 02 E2 BD 07 AE 8C 01 09 26 EF DE 34 BD 04 EF DF
0F00 - 34 DE 5F BD 02 D4 BD 04 5F DF 5F DE 34 BD 07 AE
0F10 - 8C 01 10 26 09 DE 34 BD 04 EF DF 34 20 0E DE 5D
0F20 - BD 0B F0 86 01 A7 00 A7 06 BD 04 47 DE 5F BD 02
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0F40 - DF 36 DE 5F D6 36 E7 00 08 D6 37 E7 00 08 DF 5F
0F50 - 7E 0A 10 DE 34 BD 03 CA 24 03 7E 0D DC BD 07 60
0F60 - 81 1E 26 D9 08 DF 36 BD 04 4E A6 00 E6 01 DE 5F
0F70 - 8C 11 80 27 66 DF 5F 8C 11 80 27 5B BD 04 54 BD
0F80 - 04 54 A1 00 26 EF F1 01 26 EB DF 61 EE 00 BD 03
0F90 - 05 DE 61 BD 04 5D 86 02 6D 00 2A 02 8B 03 97 4F
0FA0 - BD 03 05 BD 06 07 CE 00 6F BD 02 D4 BD 04 47 DE
0FB0 - 61 08 08 BD 03 05 BD 10 3A 24 07 DE 61 DF 5F 7E
0FC0 - 0A 10 CE 00 6F BD 03 05 DE 61 EE 00 BD 02 D4 DE
0FD0 - 61 EE 0E DF 36 20 E8 C6 18 20 02 C6 17 7E 08 47
0FE0 - DE 34 BD 04 EF 8D 17 97 4F BD 04 EF DF 34 8D 4A
0FF0 - 24 03 7E 0D F9 DE 34 BD 07 B7 EE 00 6E 00 BD 07
1000 - 60 08 81 3D 26 03 86 00 39 E6 00 81 3C 26 13 C1
1010 - 3D 26 04 08 86 02 39 C1 3E 26 04 08 86 03 39 86
1020 - 01 39 81 3E 27 05 C6 06 7E 08 47 C1 3D 26 04 08
1030 - 86 05 39 C1 3C 27 E4 86 04 39 96 4F 48 48 CE 10
1040 - 54 DF 20 9B 21 97 21 BD 06 04 BD 04 4E A6 00 DE
1050 - 20 4D 6E 00 27 16 20 12 2B 12 20 0E 2B 0E 20 F4
1060 - 26 0A 20 06 27 04 2B 02 2A 02 0D 39 0C 39 BD 04
1070 - 4E BD 02 B4 DE 67 AD 00 BD 02 C9 39 BD 04 4E C6
1080 - 09 E0 06 5D 2F 08 BD 05 82 6C 06 5A 20 F5 6F 05
1090 - BD 04 47 BD 05 A8 BD 04 4E 39 BD 04 4E A6 00 27
10A0 - 13 97 4A BD 0B F0 86 01 A7 00 A7 06 7D 00 4A 2A
10B0 - 03 BD 05 31 39 BD 04 4E 6D 00 2A F8 20 F3 BD 04
10C0 - 4E BD 0D BC 24 05 BD 04 47 20 06 CE 00 69 BD 03
10D0 - 05 CE 10 F9 BD 03 05 BD 06 E6 BD 04 4E BD 05 5C
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10F0 - 05 A8 CE 00 69 BD 02 D4 39 08 37 25 41 69 00
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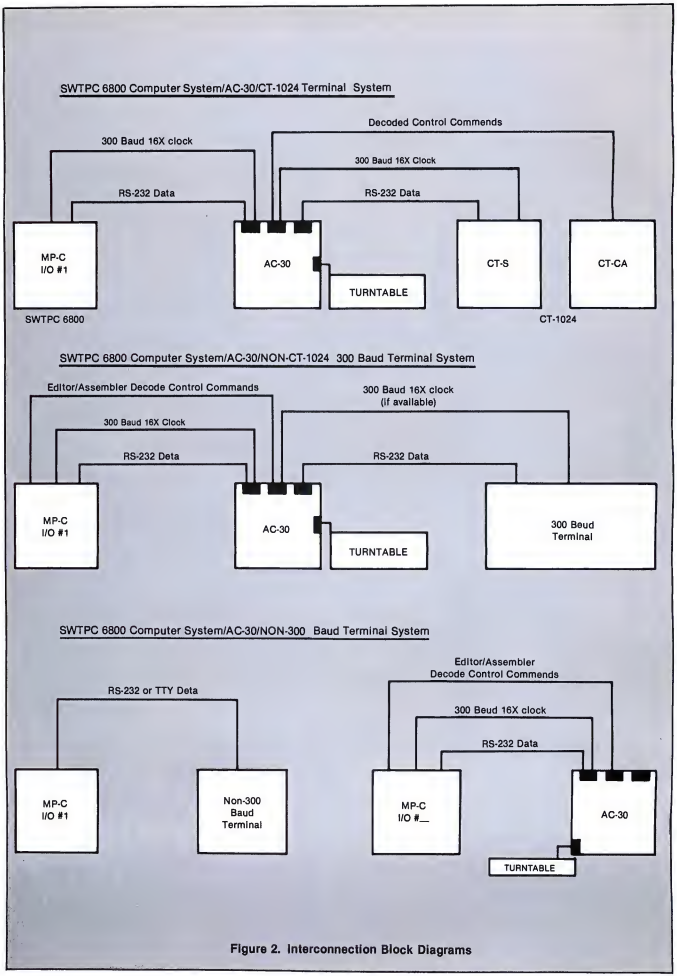

Figure 2. Interconnection Block Diagrams

Vectored from page 28