PHILIPS

ASHCAN

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ASHCAN

A Simple Helpful Conversational Assembler Nucleus

1. Introduction.

ASHCAN is a program that helps you when you begin to learn the P800 Assembler language. It is also very useful for engineers who want to make small test programs.
ASHCAN is available on, and can work with, papertape, magnetic tape cassette or floppy disc. Of course it can also be loaded from an X1215 disc, but it can't use this disc for program storage. Apart from ASHCAN, you only need a computer system. This may be a P851, P852, P856 or P857. It must have an operators typewriter with the standard address /10, a program loading device and minimum 8K of read-write memory. ASHCAN uses the lower 4K of memory: the rest of the memory, from /2000 to the top is available for your programs. (The User Area)
If you wish to store your programs on papertape, cassette or floppy, the system must have the appropriate devices. These devices must have standard addresses. (PP30-PR20, TK05, FL03)
The Power Failure/Automatic Restart interrupt must be wired to level 0; the other levels are determined by the system. Floppy and cassette may be operated by either the programmed channel or the input-output processor.

The nucleus contains the following programs:

- MONICA MONItoring program for the Conversational Assembler. Many of its input/output/conversion subroutines are also available to the user through the "LKM" instruction. The Real-Time-Clock is also serviced by MONICA
- TAPIO TAPe Input/Output handler, for papertape and cassette.
- MICA MIniature Conversational Assembler. It can translate the standard P800 mnemonics as described in the P800 Programmers Guide 1,2&3, Volume II: Instruction Set. Many syntax errors are detected by MICA: the error messages are self-explanatory. The results of MICA go directly into the computer memory, ready for execution.

- ACIM Adapt Computer Instructions to Mnemonics. Not only MICA in reverse: it also has the reverse function to list memory contents in the usual P800 mnemonics.
- USAREA This program initializes ASHCAN. It is overwritten later by user programs.
- USINST A description of ASHCAN which can be printed if the proper operator command is given.
- FLPSYS FLoPpy SYStem, only present if ASHCAN is available on floppy disc. It makes it possible to store various user programs on a floppy disc.

It must be noted that ASHCAN is not a standard Philips product. It is designed to work on any of the computers mentioned on page 1, under all circumstances. Because the program is frequently updated compatibility between different versions is not guaranteed. It is also not possible to test new versions on all possible machines. If you discover any errors, please tell me so. But always remember that you didn't pay for the program...

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2. Loading procedure.

If ASHCAN is available in papertape, put /1020 in the control panel switches. Put the tape in the reader and switch it on.
If ASHCAN is on a magnetic tape cassette, put /0785 in the switches, or /1785 if your system has no I.O.P. Put the cassette in the leftmost drive and wait for rewinding to be ready.
If you have ASHCAN on a floppy disc, put /4083 in the switches, or /5083 if your system has no I.O.P. Put the disc in drive 0 and shut the door.
Now push the IPL button. Depending on the device used, the operators typewriter will print an IDENT line, or it may skip this. The following should be printed always:

```
REV. 79-02-19
OPTION? (D, I, M OR CR) D
PUSH INT. BUTTON
 P851 WITH 8 K. RESTART ON  /0528
 I.O.P. AVAILABLE!
LEVEL & ADDRESS

LV  AD
04  20
05  30
06  10
0B  03
0B  13
0B  23
0B  33
TYPE IN FOR INSTRUCTIONS!
? IN
INSTRUCTIONS:      (A6) LKMS:

AS=ASSEMBLE, TY     0=(A1),ASCII-->TY
AT=ASSEMBLE, PR     1=TY,ASCII-->A1
BR=BREAKPNT, S/R    2=DIG. IN-->A1
CL=CLEAR US. AR.    3=(A1)-->DEC-->TY
FL=START FLOPPY     4=FLOPPY /03
DC=DUMP CLOCK       5=(A1)-->HEX-->TY
PR=LI ON LP07       6=CR/LF-->TY
DM=DUMP MEMORY      7=DUMP CLOCK
LD=LOAD FROM PR     8=CLOCK-->A1,2,3
LI=LIST ON TY       9=EXIT
PU=PUNCH ON PP30   10=(A1)-->PP30
SC=SET CLOCK       11=PR20-->A1 (8BITS)
SP=SEARCH PATTERN  12=FLOPPY /13
ST=START PROGRAM   IF (A6)>P: MESSAGE POINTER
MV=MOVE MEMORY
L*=LOAD, W*=WRITE, R*=REWIND, U*=UNLOCK
*=0, 1 OR 2,=CASSETTE 5, /15, /25
BRKPNT & CP-INT PRINT ??
COMMANDS: A*=, A*?, AB.
A*=A1--A15, AB=ABORT
```

Of course, the revision date may be later than 79-02-15. If it is earlier, try to get hold of a newer edition of ASHCAN, because the older versions do not contain all features as described in this book.
The question OPTION? should be answered by typing D, M, I or carriage return (CR). If D is selected (as in the example on page 3) information about the devices is printed. If M is selected, the User Area is not erased. This means that any program that was in the memory, higher than /2500, will be accessible by ASHCAN. This may be useful to transfer programs made by "standard" methods to the ASHCAN system. If I is used, the Control Panel Interrupt is assumed to go to level 7. If you don't type I, then the system asks you to push the Interrupt button on the control panel. After this it will continue by printing the machine type, the memory size etc. as shown in the example.
Interrupt level and address of all devices are only printed if option D was chosen. If a level 00 is shown, it only means that the device did not generate "interrupt" when tested by ASHCAN methods.
The start-up procedure is always terminated by the message:
TYPE IN FOR INSTRUCTIONS!
?

When the ? appears you may type any ASHCAN command. If you type IN, as shown, you get a list of all possible commands. Always do this at least once when you get a new version of ASHCAN. It is not practical to print a new book for each version, but all new commands will always be shown in this list.

3. MONICA commands.

Always when the ? is printed, MONICA waits for a two character command, maybe followed by a space and other data, always terminated by Carriage Return. If this other data is an address it must be a valid address in the user area. If the address is omitted, MONICA assumes it to be /2000. If the command is not correct, MONICA will print !? and you may try again.
Many commands return automatically to MONICA when they are ready with doing their function. At any moment it is possible to interrupt the execution of a command by pushing INT. (On many typewriters the "BREAK" key is wired to have the same function as INT). MONICA will print BRK and wait. If the A is typed, it is considered as Abort command. Any other code will cause continuation.

After a return to MONICA the ? will be printed again. In some cases MONICA waits for a CR to be typed. If you do this and the ? still does not show up, ASHCAN itself got disturbed. You can try to re-start on the address mentioned in the initial start message.
If this does not work either, you will have to re-load the ASHCAN program.

Here is an overview of the commands:

AS Assemble a program (Run MICA)
AT AS with papertape input
BR Set a Breakpoint
CL Clear the User Area of the memory
DC Dump clock on operators typewriter
DM Dump memory on operators typewriter
FL Start the floppy system
LD Load a user program from papertape
LI List a user program (Run ACIM)
MV Move memory data
PR List on LP07
PU Punch a user program on PP30, machine code
SC Set clock
SP Search pattern
ST Start a user program

The following commands are only used with cassette systems:

Ln Load a user program from cassette
Wn Write a user program on cassette
Rn Rewind a cassette
Un Unlock a cassette drive

n=0, 1, 2: for drive /05, /15 or /25. This are the standard addresses for cassette drives.

The special commands for the floppy system are described at the entry FL in the following part.

3.1. Details of MONICA commands

AS (address)

If you type this, MONICA goes to MICA. This program prints:
MICA REV.4
and a line feed. Now you can type any instruction from the P800 repertoire, using the standard syntax rules.

Exceptions on the syntax rules:
-the leading space may be omitted
-labels are not allowed
-ASCII constants are only allowed in the DATA pseudo-operation
-no line shall be longer than 70 characters
-some exotic branches are not translated.
-DAK and DSK must be followed by two DATA words on the next line

Following an instruction you may type comment, but this is not stored in the memory. If MICA finds no error during the translation it stores the machine code in the memory. The address where the code is stored, and the code itself is then printed (in hexa-decimal) in the space that was left open earlier. If an error is detected, this space will be used for a short error message. In any case a linefeed is done, and you may type the next instruction.
The first address is either the address following the letters AS, or /2000 if there is no address specified. Any operation code may be preceded by an address. MICA will then start storing its results on that address. If no address is given, the next higher address will be used automatically.
The possiblity to type in addresses is very useful to correct errors.
The pseudo-operation DATA may have the length of one line.
It may contain decimal, hexadecimal and ASCII data, as in the standard software.
The pseudo-operation RES can be used to reserve a number of words. If the number specified with RES is greater than the current instruction address, RES reserves memory up to that number. This is similar to AORG in the standard software.
The last pseudo-operation that may be used is END. this is used to indicate the end of the assembly. MICA will return to MONICA.

AT (address)

Same as AS, but with program data input from the papertape reader If an error is detected, the program switches to typewriter input until you have typed a correct instruction. Then it goes back to the papertape redder. This is useful for off-line preparation of your programs.

BR (address)

BR with a valid address sets a breakpoint in a user program.
BR, without address, will reset the breakpoint.
If you run a program and it encounters a breakpoint it will go to MONICA and print:
BRK address
??
The two ?? indicate that we are not in the normal part of MONICA. Only some special commands, as explained below, may be used now.
If, during the running of a program, the INT button is pressed, the same effect is obtained as by setting a breakpoint. Only now the address is not predefined.
The breakpoint should not be set on an address containing DATA, a double word instruction, or an instruction that changes the program counter.
The special commands following the ?? are:
An?(CR)
If n=1-15 the contents of the register specified by n will be dumped on the operators typewriter. (hexa-decimal)
An=m(CR)
If n=1-13 the contents of register n will be replaced by the number m.
AB
Abort the program: return to MONICA

Only CR
Continue the operation.

CL (address)

This command clears the user area of the memory, starting at the given address. If the answer to the OPTION question was not M, the CL will be done automatically when starting the system.

DC

Dump Clock, on operators typewriter. 8 15 7 means it is seven seconds later than quarter past eight. The time is only valid if the RTC is switched on, and SC was done earlier.(See there)

DM (address)

Dump memory contents on the operators typewriter. On each line the first address of a group of eight memory words is printed, followed by the contents of these words, all in hexa-decimal. This is followed by a translation into ASCII, if possible. Dumping stops after a full line of zeros is printed.

FL

This command starts the floppy system. It loads the supporting program from the floppy, into memory locations /3C00--/3FFE This means that it disturbs the higher part of an 8K memory. After typing FL, the following may be shown on the typewriter:

```
 FLOPPY SYSTEM
IN
AS   -->ASHCAN
CF N CLEAR FLOPPY, N>299
CO   COPY /03-->/13
DA   DIRECT ACCESS
DF M DELETE FILE M
RF M READ FILE M
WF M WRITE FILE M
LF   LIST ALL FILE NAMES
```

The IN command now causes the floppy commands to be listed. With CF the floppy may be cleared, starting at sector N. N must be 300 or greater, on sectors 0--299 the system software is written.

CO is a command that causes a complete copy of the disc in drive 0 to the disc in drive 1. "Premark" of the second disc is not necessary. All userfiles on the first disc will also be copied.

The following example shows the use of DA

```
 FL

 FLOPPY SYSTEM
DA
RECORD:    305
MEMORY:    /2200
READ Y/N: Y? DM /2200
2200 4349 4F20 2020 8000 2000 47E5 543C 8120  CIO        G TK
2210 5555 4125 5454 47A5 49E5 546E 0609 2804  UUA%TIG I T    (
2220 0000 2040 8620 2100 2804 5F36 0000 2060     @  ! (  6
2230 8620 2200 5F22 0000 2080 8620 2200 5F42    '  "        #  B
2240 0000 2100 4349 4F20 5354 4152 5420 0D0A    ! CIO START
2250 0000 2200 4F54 5220 000A 0000 2300 5353    " OTR      # SS
2260 5420 0D0A 0000 0000 0000 0000 0000 0000  T
2270 0000 0000 0000 0000 0000 0000 0000 0000 ?
```

The system asks which record and which memory area you want to access. Then it asks which way the data should go. Be careful: the file structure of the floppy may be disturbed in this way! Also note that this is an example of the DM command.

In the following three commands M is a filename of maximum six characters. These characters may be anything except spaces. First use of this name is with WF. All code in the memory between /2000 and /3BFE is written on the floppy under the name M. Now this code may be read again, using RF and the same name M. If different programs are stored on disc with the same name, only the first one will be found by RF. Also, only the first will be found by DF, delete file. That means that a next RF will find the second file, because the first one is now deleted.
To see which programs are written on the disc, use LF:

```
 FLOPPY SYSTEM
LF
BEGINN 300
PCMIO  301
FL2    303
FL3    304
CIO    305
THOUT  306
THEO   307
THFO   308
OUPP   309
SQUARE 310
QUIT   311
WORTEL 312
ABC    313
LIJN   314
LYN1   316
LYN2   318
WORTEL 320
?
```

The program on sector 302 was probably deleted, or the length of PCMIO is more than one sector.
Some names appear twice, as explained before this is not practical.
All sectors from 320 up to 2000 are still empty, ready for use.
If sectors are written by DA they may not be found by the LF command!

LD

Load a program from papertape. The tape should be the result of the PU command.

LI (address)

LI calls ACIM to list machine code instructions in mnemonic form.

```
? AS
MICA REV.4
2000 0102 LDK A1,2
2002 81-0 LDKL A2,???
2004 03E7
2006 8127 STP A1,A2
2008 5F0A RB /2000
? LI      EN
PUNCH SOURCE?(TY,PP,NO) NO

2000 0102 LDK     A1,/02
2002 8100 LDKL    A2,/03E7
2004 03E7
2006 8127 STP     A1,A2
2008 5F0A RB      /2000
END
```

Shown here is the result of AS and LI
If T or P is answered on the question PUNCH SOURCE? a source tape will be punched simultaneously. If T is used, the typewriter must be an ASR with the punch control option. (as usual for the ASR 33 used with the P800)
If P is used, PP30 must be available.
LI scans the memory from the first address to the top, but it does not print fields of consecutive zeros.

MV a,n

Move memory data, starting at address a, n words. The moved data goes to higher locations, until a field of zero words, greater than n is found. Then moving stops. The places no longer occupied by the program are filled with /5000. This is the code for RF(0) #+2, it acts as no-operation. This may be overwritten by AS: in this way instructions can be inserted into a program.

PU (address)

Punch any non-zero data words in two frames of the papertape. The papertape punch with the address /30 is used.
Each group of words is preceded by an indication of the starting address and the length of the group. It is followed by a software checksum, to make sure that no data is disturbed during the process of punching and reading. If, after punching, you clear the memory (by CL) and then load the tape (by LD) all memory contents will be fully restored.

PR (address)

This command works similar to LI, but it uses the Lineprinter. The lineprinter must have the address 7, it must be connected via the I.O.P. During printing interrupt is blocked, so the RTC may be disturbed slightly.

SC H M

SC H M or SC H M S may be used to set the clock. H M S = Hours, Minutes,Seconds. This command is only meaningful if the RTC is not turned off, and the INH instruction is not used.

SP data string

SP=Search Pattern. The pattern is in the data string. It contains ones, zeros and periods. On any address in the user area a compare for the ones and zeros is done. The bits that are compared with a . are ignored. If equality is found the address and the complete word are dumped on the typewriter. Trailing . do not have to be typed. Example:
SP .101
Any word that begins with /5... or /D... will be printed.

ST (address)

Start the program at the given address, or at /2000.

3.2. Cassette commands.

At least one cassette drive must be available to execute the following commands. The control unit must have the address 5. The letter n in the following commands is 0, 1 or 2. The program then selects drive /05, /15 or /25.

Ln Similar to LD, but now from cassette.

Wn Similar to PU, but now on cassette.

As the controlunit circuitry does already a check on the validity of the data, the software check from PU and LD is omitted. Otherwise the methods are identical.

Rn Rewind cassette

Un Unlock cassette

When the cassette is inserted in the drive, it does an automatic rewind. If you try to do a command while the drive is rewinding you will get an error message from TAPIO. Try again later!
The error message contains a hexa-decimal number. This is the hardware status word as explained in the little blue book. (P800M programmers reference data)
When the cassette is put in the drive, there is an electro-mechanical lock that makes it impossible to take it out again. On some drives an "Unlock" switch is mounted. If you don't have this switch, you can use the Un command. If you want to use the cassette again after "Unlock", you have to take the cassette out of the drive, and insert it again.

4. Link-to-Monitor.

MONICA needs several subroutines to operate the system. Many of these subroutines may be called by user programs through the use of the LKM instruction. The use of LKM's by ASHCAN is completely different from the use of this instruction by the standard P800 software! The function that is wanted is selected by putting the proper constant in A6. If this load instruction is followed by a LKM, MONICA will perform the desired function. Of course, the program may not be in the "inhibit" mode!
In general, MONICA will return to the user program on the instruction following the LKM. None of the registers will be disturbed, unless it is the function of the LKM to put something in a register.
If a user program containing LKM's is interrupted, by the INT button, one of two messages may be printed. That is, either BRK, when the interrupt occurred while the program was executing the LKM, or BRK followed by an address, when the interrupt occurred in a part of the program on an address above /2000.

Only in the latter case display and changing of registers is possible.
If IN is typed a review of the LKM's is printed too, as shown on page 3. Here are some more details:

(A6)=0 The right half of (A1) is considered as ASCII. It is printed by the operators typewriter.

(A6)=1 Code from the operators keyboard, 7 bits, goes into A1

(A6)=2 Digital input on the operators keyboard to A1. The number may be + or -, decimal or hexa-decimal

(A6)=3 (A1) is printed as a positive or negative decimal number.

(A6)=4 Operate floppy /03. Use the following program:

```
LDKL  A1,/8040 (for input, use: /C040 for output)
LDKL  A2,Buffer address
LDK(L) A3,CIO start pattern
LDK   A6,4
LKM
```

This works in machines with or without I.O.P.
Details about the control words may be found in the Hardware Guide (790117), page 30 and 31

(A6)=5 (A1) is printed as a hexa-decimal number

(A6)=6 The CR/LF (Carriage return/Linefeed) code is sent to the operators typewriter.

(A6)=7 Dump Clock, same as DC command. The time is printed as hours, minutes and seconds.

(A6)=8 Get Clock. The clock values H, M and S are loaded as binary numbers into the registers A1, A2 and A3 for use by the program.

(A6)=9 Exit of the user program: return to MONICA

(A6)=10 Punch right half of (A1) on PP30.

(A6)=11 Read 8 bits from PR20 into A1.

(A6)=12 Operate floppy /13. See (A6)=4.

If (A6) is greater than the begin address of the user area (/2000) it is considered as a message pointer. It should be pointing to the begin of an ASCII string of any length. The string should be terminated by 8 binary zeros. An example of such a string is the data printed by the IN command.
Incorrect values in A6 are only recognized by MONICA if they are greater than 12 and less than /2000.

5. Typing errors.

Any typing error may be erased by typing one or more ← as in the standard software. Also, ↑ may be used to erase a line up to the next carriage return.
On some keyboards ← and ↑ are replaced by _ and ^.

6. Examples.

```
REV. 79-02-19
OPTION? (D, I, M OR CR)
PUSH INT. BUTTON
 P851 WITH 8 K. RESTART ON  /0528
 I.O.P. AVAILABLE!
TYPE IN FOR INSTRUCTIONS!
? SC 11 35
? DC
11 35 3
? AS
MICA REV.4
2000 0101 LDK A1,1
NUMBER?   LDK A2,-2            No negative short constants.
2002 8220 LDKL A2,-2
2004 FFFE
REGISTER? LDK A9,9             No A8--A15 in short const. instr.
2006 0709 LDK A7,9
CONDITION?RB(9) *-4
CONDITION?RB(PP) *-4           Non existing conditions
2008 5906 RB(P) *-4
200A 5F0C RB /2000             Condition 7 may be omitted.
DISPLACE? RB /1000             Displacement too large
200C 8F20 ABL /1000
200E 1000
? LI      END
PUNCH SOURCE?(TY,PP,NO) NO

2000 0101 LDK     A1,/01
2002 8220 LDKL    A2,/FFFE
2004 FFFE
2006 0709 LDK     A7,/09
2008 5906 RB(1)   /2004
200A 5F0C RB      /2000
200C 8F20 ABL     /1000
200E 1000
END
  ? CL                         Clear the user area
? LI
PUNCH SOURCE?(TY,PP,NO) NO
                               There is no program left...
END
```

```
  ? AS
MICA REV.4
2000 0101 DATA /101,/202,/303,/404,/505,/606,/707
2002 0202
2004 0303
2006 0404
2008 0505
200A 0606
200C 0707
200E 5F10 RB /2000
? LI       END
PUNCH SOURCE?(TY,PP,NO) NO

2000 0101 LDK      A1,/01
2002 0202 LDK      A2,/02
2004 0303 LDK      A3,/03
2006 0404 LDK      A4,/04
2008 0505 LDK      A5,/05
200A 0606 LDK      A6,/06
200C 0707 LDK      A7,/07
200E 5F10 RB       /2000
END
  ? BR /2006
? ST

BRK 2006 ?? A1?
0001
?? A2?
0002
?? A5?
004F
??

BRK 2006 ?? A5?
0005
?? AB
? BR
? ST

BRK 200A ?? AB
? BR /200E

PLEASE NOT THERE?
```

This data will be considered as instructions.

A breakpoint is set on /2006

(A1) is dumped, when the program stops at the breakpoint.

A5 is not yet changed by the user program

Here only CR was typed, to continue.

Now, at the next cycle, (A5)=5.

This resets the breakpoint

This break was caused by CP interrupt.

The system does not allow setting a breakpoint on a RB

```
? CL
? AS
MICA REV.4
2000 8620 LDKL A6,/3000          Print the message on /3000
2002 3000
2004 2804 LKM
2006 0607 LDK A6,7 DUMP CLOCK    This comment is not stored in the
2008 2804 LKM                    memory
200A 0609 LDK A6,9
200C 2804 LKM
          /2000^                 This was a typing error
3000 5448  /3000 DATA 'THE TIME IS NOW:',0
3002 4520
3004 5449
3006 4D45
3008 2049
300A 5320
300C 4E4F
300E 573A
3010 0000
? LI      END
PUNCH SOURCE?(TY,PP,NO) NO

2000 8620 LDKL    A6,/3000
2002 3000
2004 2804 LKM
2006 0607 LDK     A6,/07
2008 2804 LKM
200A 0609 LDK     A6,/09
200C 2804 LKM
          RES /07F9
3000 5448 RF(4)   /304A          ASCII data is translated as instruction
3002 4520 OTR     A5,0,/20
3004 5449 RF(4)   /304F
3006 4D45 INR     A5,1,/05
3008 2049 DATA    /2049
300A 5320 RF(3)   /302C
300C 4E4F INR     A6,1,/0F
300E 573A RF      /304A
END                              Text looks better with DM:
  ? DM /3000
3000 5448 4520 5449 4D45 2049 5320 4E4F 573A  THE TIME IS NOW:
3010 0000 0000 0000 0000 0000 0000 0000 0000 ? SC 11 45
? ST
THE TIME IS NOW:11 45 3          The program works!
? ST
THE TIME IS NOW:11 45 7
```

```
? CL
? AS
MICA REV.4
2000 0001 DATA 1,2,3,4,5,6,7,8
2002 0002
2004 0003
2006 0004
2008 0005
200A 0006
200C 0007
200E 0008
3000 0009 /3000 DATA 9,8,7,6,5,4,3,2,1
3002 0008
3004 0007
3006 0006
3008 0005
300A 0004
300C 0003
300E 0002
3010 0001
          RES /3098
NUMBER?   DATA 400000
3098 0FA0 DATA 4000
309A FFFF DATA -1
309C 0001 DATA -/FFFF
INSTR?    DTA 'ABC'
309E 4142 DATA 'ABCDEFGHIJKLM'
30A0 4344
30A2 4546
30A4 4748
30A6 494A
30A8 4B4C
30AA 4D20
3200 000B /3200 DATA 11,22,33,44,55,66,77
3202 0016
3204 0021
3206 002C
3208 0037
320A 0042
320C 004D
?         END
 !? SP .............110

200A 0006
3006 0006
30A2 4546
3202 0016 ? DC
11 48 14
? SP 1.1

309A FFFF ? DM
2000 0001 0002 0003 0004 0005 0006 0007 0008
2010 0000 0000 0000 0000 0000 0000 0000 0000 ? DM/3000
3000 0009 0008 0007 0006 0005 0004 0003 0002
3010 0001 0000 0000 0000 0000 0000 0000 0000
3020 0000 0000 0000 0000 0000 0000 0000 0000 ? DM /3098
3090 0000 0000 0000 0000 0FA0 FFFF 0001 4142
30A0 4344 4546 4748 494A 4B4C 4D20 0000 0000
30B0 0000 0000 0000 0000 0000 0000 0000 0000 ? DM /3200
3200 000B 0016 0021 002C 0037 0042 004D 0000
3210 0000 0000 0000 0000 0000 0000 0000 0000
```

By preceding the word DATA with /3000 assembly continues on address /3000.

By using RES /3098 assembly continues on/3098

Search Pattern finds any word ending on 6 or /E.

Only one word begins with this pattern

AB

CDEFGHIJKLM

! , 7 B M

DM stops at any line containing all zeros.

This program adds two numbers and prints the result. Various versions are shown.

```
  ? CL
? LDK A6,2
 !? AS
MICA REV.4
2000 0602 LDK A6,2
2002 2804 LKM
2004 8204 LDR A2,A1
2006 2804 LKM
2008 9108 ADR A1,A2
200A 0603 LDK A6,3
200C 2804 LKM
200E 0606 LDK A6,6
2010 2804 LKM
2012 5F14 RB /2000
? ST      END

123
321
444
```

not a command
digits input
save first number
add first number
print result
CRLF

blank obtained by typing LF

```
123
-321
-198
      5
     -6
-1
/A    = 10
/B    = 11
21
```

Spaces are ignored

Second version produces 2 extra blank lines

```
BRK 2004 ?? AB
? AS
MICA REV.4
INSTR?     /2012
2012 2804 /2012 LKM
2014 2804 LKM
2016 5F18 RB /2000
? LI      EN
PUNCH SOURCE?(TY,PP,NO) NO

2000 0602 LDK      A6,/02
2002 2804 LKM
2004 8204 LDR      A2,A1
2006 2804 LKM
2008 9108 ADR      A1,A2
200A 0603 LDK      A6,/03
200C 2804 LKM
200E 0606 LDK      A6,/06
2010 2804 LKM
2012 2804 LKM
2014 2804 LKM
2016 5F18 RB       /2000
END
  ? ST
 12
 34
 46
```

2 blank lines

```
8888888

 INP. ERR.
8888
9999
18887
```

"MOVE" is used here

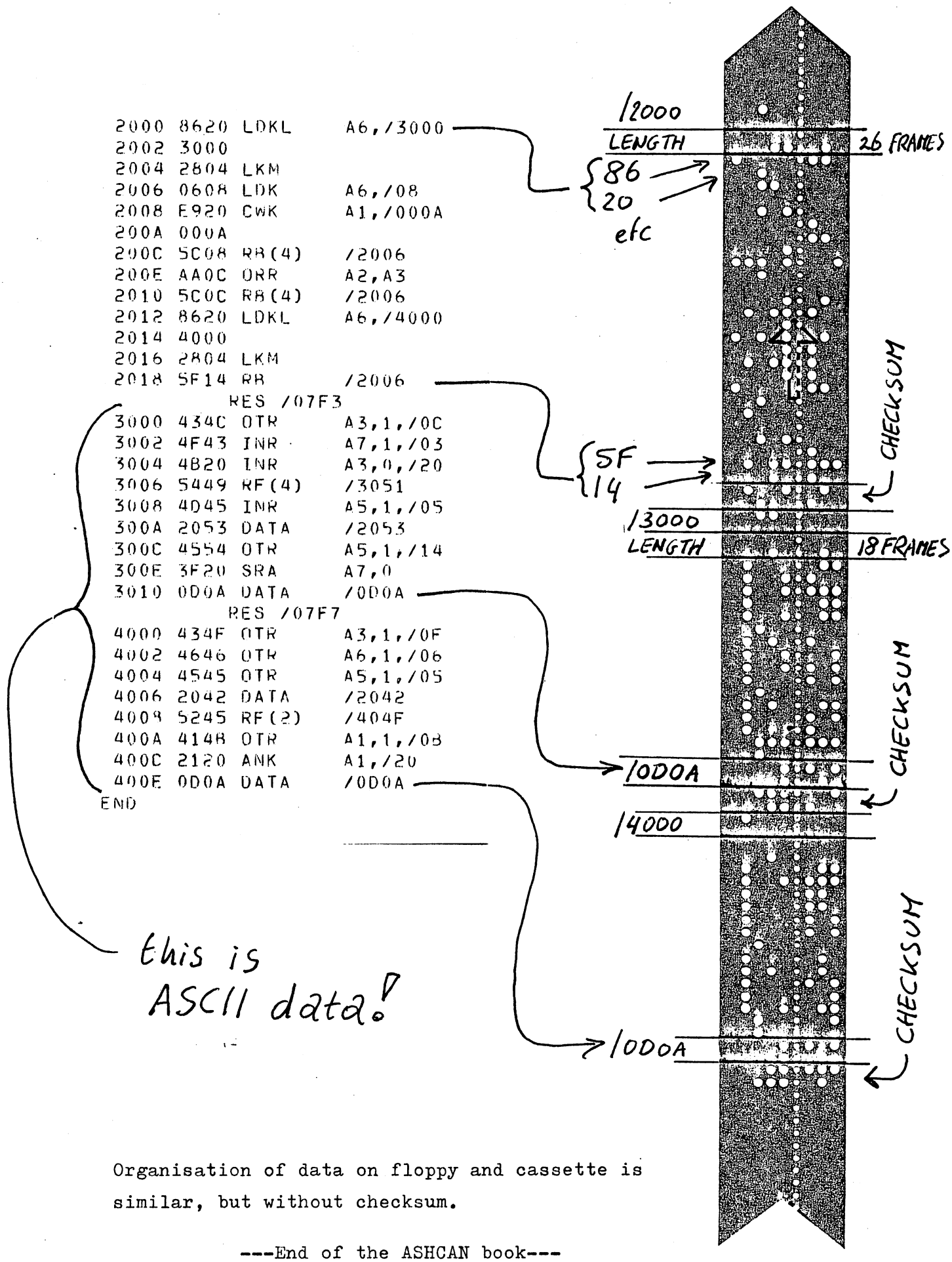
```
BRK 2004 ?? AB
? MV /2000,3
? AS
MICA REV.4
2000 8620 LDKL A6,2 /2020
2002 2020
2004 2804 LKM
2020 4144 /2020 DATA 'ADDER PROGRAM',/D0A,0
2022 4445
2024 5220
2026 5052
2028 4F47
202A 5241
202C 4D20
202E 0D0A
2[illegible]0 0000
          EN
```

This is the result of the final version:

```
? ST
ADDER PROGRAM
1234
-1235
-1


9999
1
10000



BRK 200A ?? AB
? LI
PUNCH SOURCE?(TY,PP,NO) NO

2000 8620 LDKL    A6,/2020
2002 2020
2004 2804 LKM
2006 0602 LDK     A6,/02
2008 2804 LKM
200A 8204 LDR     A2,A1
200C 2804 LKM
200E 9108 ADR     A1,A2
2010 0603 LDK     A6,/03
2012 2804 LKM
2014 0606 LDK     A6,/06
2016 2804 LKM
2018 2804 LKM
201A 2804 LKM
201C 5F18 RB      /2006
          RES /0001
2020 4144 OTR     A1,1,/04
2022 4445 OTR     A4,1,/05
2024 5220 RF(2)   /2046
2026 5052 RF(0)   /207A
2028 4F47 INR     A7,1,/07
202A 5241 RF(2)   /206D
202C 4D20 INR     A5,0,/20
202E 0D0A DATA    /0D0A
END
  ? DM /2000
2000 8620 2020 2804 0602 2804 8204 2804 9108      (   (   (
2010 0603 2804 0606 2804 2804 2804 5F18 0000    (   ( ( (
2020 4144 4445 5220 5052 4F47 5241 4D20 0D0A  ADDER PROGRAM
2030 0000 0000 0000 0000 0000 0000 0000 0000 ?
```

The list was produced on the line printer, using the PR command.
The tape was produced by the papertape punch, using the PU command.

```
2000 8620 LDKL     A6,/3000
2002 3000
2004 2804 LKM
2006 0608 LDK      A6,/08
2008 E920 CWK      A1,/000A
200A 000A
200C 5C08 RB(4)    /2006
200E AA0C ORR      A2,A3
2010 5C0C RB(4)    /2006
2012 8620 LDKL     A6,/4000
2014 4000
2016 2804 LKM
2018 5F14 RB       /2006
          RES /07F3
3000 434C OTR      A3,1,/0C
3002 4F43 INR      A7,1,/03
3004 4B20 INR      A3,0,/20
3006 5449 RF(4)    /3051
3008 4D45 INR      A5,1,/05
300A 2053 DATA     /2053
300C 4554 OTR      A5,1,/14
300E 3F20 SRA      A7,0
3010 0D0A DATA     /0D0A
          RES /07F7
4000 434F OTR      A3,1,/0F
4002 4646 OTR      A6,1,/06
4004 4545 OTR      A5,1,/05
4006 2042 DATA     /2042
4008 5245 RF(2)    /404F
400A 414B OTR      A1,1,/0B
400C 2120 ANK      A1,/20
400E 0D0A DATA     /0D0A
END
```



Organisation of data on floppy and cassette is similar, but without checksum.

---End of the ASHCAN book---