P2000 M AND T MAINTENANCE PROGRAM REV. 2.0

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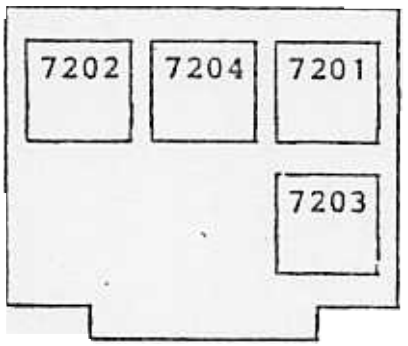
1. SCOPE

The program provides means to test the functional correctness of the P2000 Model M and T microcomputers.

2. GENERAL INFORMATION

The program has two levels: The first line level is 12 Kbyte long (3 pieces of 2732 EPROM pos. 7201, 7203, 7204), and the second line level can be realized simply with the addition of an extra EPROM (pos. 7202).



7202 contains the second line tests.

The first EPROM contains the texts and all tables for 6 different national versions (Austria/German, Spain, France,Italy, Holland/United Kingdom, Sweden). Another "first" EPROM contains the tables for Switzerland, Denmark/Norway and Greece (extendable).

After inserting the command module and depressing the RESET button the NATIONAL VERSION SELECTION MENU appears on the screen. The operator must type the number that corresponds to the national version of his machine. The selected national version is valid for the handling of keyboard, screen and printer, but THE MESSAGES ARE DISPLAYED IN ENGLISH IN ALL NATIONAL VERSIONS.

Next follows the MAIN SELECTION MENU, where the operator can select the test he wants to do. Each test is realized as a separate module. The test modules are: MEMORY, V24, KEYBOARD, SCREEN, TAPE, BEEPER and DISK. Auxiliary modules are the SUMMARY and the special second line routines.

Some testing modules are divided into sub-modules. They can be called through separate menu's. By typing ZERO the user can return to the main selection menu. Some testing procedures (tape, disk, printer, serial interface) can be disrupted also by typing a zero.

The test results are displayed as well as printed. If the printer is not connected, no message is sent (the only exception is the printer test).

At the T version normally only the left half of the pictures can be seen. However, the testing procedures are terminated generally by a TYPE A KEY message and now the full result can be observed at the T version by depressing the CURSOR RIGHT or CURSOR LEFT keys. Any other key leads back to the selection menu.

3. DESCRIPTION OF THE TESTING MODULES

3.1. Memory test

After selecting '1' in the main selection menu (or if the system RAM is defect after RESET) the memory is tested as follows. The first location (5000) is written by a random byte and in the following pattern the data on the next address is computed from the previous one by adding a constant (33H) and the high and low address of that byte. IF the memory remapping unit P2081 is implemented, the extra CPM range is also filled.

Then this pattern is 'disturbed' by:
1. Writing OOH to all port addresses.
Fast moving of the Video RAM range one line forward.

After restoring of the Video RAM range the actual testing procedure follows separately for each range. The ranges are:

1. 5000 57FF Video RAM.
2. 5800 5FFF Video RAM attribute range (only in Model-M).
3. 6000 9FFF System RAM.
4. A000 DFFF Extension RAM first range.
5. E000 FFFF Extension RAM second range (sw bit=0).
6. E000 FFFF Extension RAM second range (sw bit=1).
7. Extra CPM range (A000 DFFF) if implemented.

At first the 0 byte of the range is checked for correctness, than each bit is inverted twice. After each write operation a check follows. To each range corresponds one CPU register. In case of any erroneous bit the corresponding register bit is set. If all the 8 bits in this range have been set, the test of that range is terminated, thus saving testing time.

When this test is ready for all the bytes of the range each bit is inverted one by one (and tested of course), i.e. all bytes of the range are inverted.

This procedure is repeated for all ranges and afterwards repeated once again for the whole memory range. The result has the following format.

```
5000 - 57FF
5800 - 5FFF
6000 - 9FFF
A000 - DFFF      BAD BITS: 1 3 6
E000 - FFFF (1)
E000 - FFFF (2) TOTAL ERROR
Extra CPM range
```

In the ranges without remark no error has been found. The 'BAD BITS' remark means that at least one error has been found on the bit positions mentioned. Ranges with 'TOTAL ERROR' are either missing completely or an error has been found on all the eight bit positions. To obtain a more detailed information about the behaviour of the memory the operator can enter the DEBUGGER in the second line program. When the result is displayed and printed, the beeper sounds and if no 'BAD BIT' has been found, a waiting loop of about 15 seconds is started and the test is repeated endlessly. If any 'BAD BIT' has been found and no printer is connected, the beeper is activated, the screen is inverted and the testing stops until a key is depressed. (It is not considered as an error if the second page of the video RAM is

3.2. V24 tests

Four sub modules can be selected by a menu:
1. Printer character test.
2. Serial interface P2174.
3. Viewdata interface P2171-1.
4. Socket static test.

3.2.1. Printer character test

The printer character test gives a general information about the computer-printer communication. It is very important that the COMPUTER SHOULD BE PREPARED FOR THE KIND OF PRINTER THAT IS USED (matrix or daisy wheel). In doubt choose SUMMARY in the main selection menu and type RETURN.
The CORRECT RESULT of the printer character test can be seen in Appendix A for daisy-wheel printer and in Appendix B for matrix printer.
The last four lines of the daisy-wheel diagram are:
- Print line once left to right.
- Print line twice left to right.
- Print line once left to right and once right to left.
- Print on the same position 20 times.

3.2.2. Serial interface P2174

The module must be inserted before switching the machine ON and the selected Baud rate should be noticed. The connector of the module should be plugged into the printer socket. If this connection is missing, the message 'NO START BIT' is displayed after the first transmission and the test is aborted.

After selecting this test for the first time a menu for the Baud rate appears. An incorrect answer results in 'WRONG DATA'.

At first all bytes 00 to FF are transferred from the module to the printer socket and then reverse. Each byte is checked and if no match is found 'WRONG DATA' is displayed. Afterwards the presence of the DTR bit is checked.

At a second calling no menu appears for the Baud rate. If a wrong baud rate has been entered or another transmission speed has to be tested, RESET the machine.

3.2.3. Viewdata interface P2171-1

To achieve a correct data reception an intermediate connector must be used between the cable connector and the printer socket. This connector SHORTS PIN 6 to 8.

As a first step bytes 00 to FF are sent from the module to the connector with 75 Baud, then with 1200 Baud. Afterwards the same data block is sent with 1200 Baud in the opposite direction. If no intermediate connector is used, WRONG DATA is received and the message 'CONNECT PINS 6-8' appears. Finally the DTR bit is checked.

3.2.4. V24 socket static test

If no printout is obtained at the printer character test and the printer cable is also perfect, use SOCKET STATIC TEST. It gives information about the static behaviour of the input and output ports. Follow the instructions appearing on the screen, i.e. at first REMOVE any connector from the socket and answer the 'READY? (Y/N)' question with 'Y'. Then CONNECT the required pins with a wire and type 'Y' if ready. The resulting table shows the errors. The correct result can be seen in Appendix-C. It should be noted that the input Pin-2 is not involved in the printing procedure, and an error here does not prevent the printing.

3.3. Keyboard test

The keyboard is displayed on the screen and first all positions are inverted (MODEL-M) or coloured with magenta (MODEL-T). The keys must be depressed ONE BY ONE beginning in the left upper corner and going to right. The expected key is flashing and underlined (MODEL-M) or inverted (MODEL-T). If a key is accepted, the corresponding position becomes non-inverted (MODEL-M) or green (MODEL-T) and the next position is requested. If a wrong key is depressed, the beeper sounds and the sensed key position is underlined without inversion (M) or white (T). A key may be tried up to 5 times, then it is left and remains inverted (M) or magenta (T). If no key is depressed WITHIN 5 SECONDS, a question appears: CONTINUE? (Y/N). If the answer is Y, the test can be continued.

3.4. Screen tests

3.4.1. Screen character test

The aim of this test is to check if the character generator displays all screen codes correctly.
The testing figures contain 23 lines. The first line contains only '!' (code 21H), the second line only "s" (22H) etc. The correct sequence is shown in Appendix D. The cursor is set to the beginning of the first line. The operator should observe the characters and decide if they are correct. If the page is OK, the answer is TAB or RETURN. Otherwise the cursor should be positioned to the line with the rejected character by using the CURSOR UP or CURSOR DOWN keys and the DEFINE key should be depressed (shift and zero on the numeric pad). If all errors have been marked, TAB or RETURN brings the next picture. This procedure is repeated until the message 'NO MORE CHARACTERS' appears. Above this line no empty line may appear, it is an error too.

If any error has been marked, the hexadecimal codes of these characters are printed.

3.4.2. Graphics test

Two pictures are generated where all graphics characters are displayed twice. Both pictures are symmetric and the second picture is the inverse of the first one. (See Appendix E). They must be perfect and must not vibrate. The operator should qualify them.

3.4.3. National version test

The aim of this test is to make sure that the national version of both the KEYBOARD and the SCREEN character generator match with the version entered in the NATIONAL VERSION SELECTION MENU.
At first a character is displayed on the screen and the operator must type the corresponding key. If a wrong key is depressed, the beeper sounds and the operator can try it again. If the second and the third attempts are also wrong, the test is aborted.
If the proper key is depressed, two further characters must be found on the keyboard.

3.4.4. Screen adjustment test

```
00000000000000000000000
0+++++++++++++++++++++++0
0+++++++++++++++++++++++0
0+++++++++++++++++++++++0
0+++++++++++++++++++++++0
00000000000000000000000
```

A picture is displayed as shown above to check if the screen LIMITS have been properly adjusted. It is also important that the letters at the edges have the same WIDTH. The FOCUSING can be checked too. The operator should qualify the picture.

3.4.5. Special screen test

In Model-M three lines are displayed to check the UNDERLINE, FLASH and INVERT features of the screen. Each second character must show the required feature. The operator should qualify the picture.

In Model-T at first a picture is shown with the required TV-screen features (ALPHANUMERIC and GRAPHICS in all different COLOURS, FLASH, DOUBLE HEIGHT, CONCEAL DISPLAY, NEW BACKGROUND, SEPARATE AND CONTINUOUS GRAPHICS). When the operator has qualified the picture, a scroll test is performed, where the picture is moved right to left and then back again until a key is depressed. If it is Y or N, the picture is qualified and the test is ready. On any other key the scrolling stops and on the next key it starts again. Afterwards the 7 color beams are displayed in the following order: Black, blue, red, magenta, green, cyan, yellow and white. The user must qualify the picture.

3.5. Tape drive test

There are 1 static and 2 dynamic tests selectable. Before entering a dynamic test the tape must be in position, otherwise the program returns to the menu immediately.

3.5.1. Read master tape

To make sure that your tape unit reads properly use a known good tape containing the TESTING PATTERN. This pattern can be produced by making a full pass of WRITE-SKIPBACK-READ test on a good machine.

At first the tape is rewound, the write protection is checked and the first record is read. The tape name is displayed in the first line., If it is not a TEST tape, the message WRONG TAPE is displayed and the test is aborted. One record is 256 bytes long and has the following structure. The first two bytes contain the pass number from the WRITE-SKIPBACK-READ test where the pattern has been produced. The third byte is the record number+3, and the next byte is always by 3 higher than the previous one. The 'increment by 3' algorythm is continued till the end of the record.

If an error is found, it is displayed and printed. In case of serious error (no mark, etc.) the test is aborted. If TAPE END is reached, the tape is rewound and the next pass is started. The test can be stopped either by removing the tape or holding on the '0' key.

Note: If you read a test tape created with the 1.0 version of the maintenance program, a WRONG DATA error is found at the first record. This message should be ignored.

3.5.2. Write, Skip-back, read test tape

This test checks the quality of the tape and the tape driver as well. The test tape must be write enabled (insert a plug into the left-side hole). At first the tape is rewound, an END OF FILE record is written, rewound again. Then the first data record is written, rewound again. Then the first data record is written (pattern is described at READ MASTER TAPE), a skipback is performed and the record is read. The pass number, record number and the description of the operation is always displayed. If a non-serious error is found, it is displayed, scrolled up and printed. Then follows the next record and the previous OK message is overwritten.

At TAPE END the tape is rewound and the test started again with an incremented pass number.

The user can cancel the testing by opening the door of the tape driver, or holding on the '0' key.

Error messages

Message	Interpretation
CRC ERROR	Read error, the recorded check information and the read data do not match.
END OF FILE	End-of-file record is found (instead of data).
IDNT CRC ERROR	Read error in the record identifier.
NO MARK	Record identifier is missing.
NO RECORD FOUND	Record is not found.
NOT READY	Tape is not in position.
REWIND TIMEOUT	Tape begin is not found within 103 seconds, tape is likely teared.
SHORT RECORD	Wrong format on the tape.
TAPE BEGIN	At skip backward the begin of tape is found, i.e. record marking is bad.
WR PROTECT	Attempt to write on a protected tape (left-side hole is empty).
WRONG DATA!	Data other than the test data is read.

3.5.3. Continuous status test

This is an auxiliary procedure for the adjusting of the TAPE IN DRIVE and the WRITE PROTECT switches. If you insert a tape, you can see continuously the status of these bits and adjust exactly the switching points.

3.6. Beeper test

The beeper is activated until a key is depressed.

3.7. Disk drive test

The disk testing procedures test the disk and the drive at the same time, therefore if an error is found, either the disk or the disk drive may be faulty.

3.7.1. Read master disk

To make sure that your disk drives read properly use a known good disk with test pattern. Such a disk can be created by the WRITE-READ TEST DISK procedure on a known good drive.

At first a message ENTER DRIVES 1-4: appears. The user can enter in any sequence the drive numbers that he wants to test.

The master disk must be WRITE PROTECTED (the write protection hole must be covered by a label). This is checked by the RECALIBRATE operation and if it fails, the messsage 'NO WRITE PROTECTION' is displayed.

The steps:

1. Recalibrate and check Track-0 and Write Protection.
2. Step to Track-34 (highest track).
3. Step to Track-0.

4. Read tracks 0 to 34 and evaluate result. In case of error a sector by sector read is started up to 10 times for each sector. After each stepping the identifier is read too. The error messages are displayed on the screen and printed.
5. After reading of track 34 the next drive is tested. If all drives have been tested, the PASS counter is incremented and the first drive is tested again from Point-3.

The testing pattern and the error messages are described under write-read test.

3.7.2. Write_read_test_disk

The tested drives are entered the same way as for read master disk.
The testing steps are:

1. Recalibrate.
2. Step to the track-0 and write the test pattern. Repeat it for all tracks 1-34.
3. Read tracks 34 to 0.
4. Test next drive form Point-2 (or from Point-1 in the first pass).

Testing pattern:
Slightly different for each sector of the disk. (One sector has 256 bytes, one track has 16 sectors and one disk has 35 tracks. The disks are written single sided, single track and double density).

Byte-0 and 1 : A random word different for each writing pass but the same for all sectors if the write procedure has not been disrupted.

Byte-2 : Drive descriptor byte: Drive-1: 31H.
Drive-2: 32H.
Drive-3: 33H.
Drive-4: 30H.
It is the same for all sectors.

Byte-3 : Track number.
Byte-4 : Sector number+67H (varies 70-7F).
Bytes 5 to 255: DB 6D B6 6D B6.....

Error messages:
The message line is build up as follows.

PASS (pass #) ST TR-(Tr #) n*(error text) (7 Hex Bytes) E(n1/n2)
RD
WR

Whereas
Pass # shows which pass is executed.
ST means step (followed by 'read identifier').
RD means READ.
WR means WRITE.
Track # is track number; at sector read the track number is extended by 'S' + sector number (1 to 16).
n is the error repetition number.

Error text is a short description of the error.
IMPORTANT! If a message with '!' appears, it means wrong data without any error message from the disk controller.
7 Hex Sytes show the 'Result' bytes from the disk controller.
E means error summary.
n1 is the total number of aborted track operation.
n2 is the total number of detected errors.

Error texts for the messages from the Floppy Disk Controller

ABNORM TERM : Command was started but was not successfully completed.
BAD TRACK : The track number stored on the diskette is FF.
CRC ERROR : The Floppy Disk Controller (FDC) detected a checksum error in data field.
DELETED DATA: A sector with Deleted Data Address Mark.
END OF TRACK: FDC tries to access a sector beyond the final sector cylinder.
FAULT : The Fault signal is received from FDD.
IDNT CRC ERR: Checksum error in the sector identifier.
NO DATA : FDC cannot find the specified sector.
NO MARK : FDC cannot find either Identifier Address Mark or Data Address Mark.
NO TRACK-0 : The Track-0 signal fails to appear after 77 steps during the RECALIBRATE command.
NO WRITE PROTECTION: The master diskette at "READ MASTER DISK" has no write protection label.
NOT READY : FDC is in the "NOT READY" state and a read or write command is issued.
UNIT SELECT ERR: Response from another unit as selected.
WR PROTECT : During write FDC detected a write protect signal.
WRONG SIDE : The Side Select Signal of the drive is incorrect.
WRONG TRACK : The track number stored on the diskette differs from the expected value.

Other error texts

RANDOM DATA ERROR!: The random data of the sector (byte 0 and 1) is incorrect.
DRIVE DATA ERROR!: The drive inf. in a sector (byte 2) is wrong.
TRACK DATA ERROR!: The track inf. in a sector (byte 3) is wrong.
SECT DATA ERROR!: The sector inf. in a sector (byte 4) is wrong.
WRONG DATA! : The DB, 6D, B6, DB... pattern (bytes 5-FF) wrong.
SYSTEM DISK!: A system disk is found.

3.7.3. Continuously read one track

The user can define the drive and the track. Then the drive is recalibrated and the specified track is read continuously regardless of data or error until the '0' key is deptressed. Now the drive and the track can be entered again, and if it is the same drive as previously, the head is stepped direct to the required track (without recalibration).

3 8. Summary

This auxiliary module gives a summary of the machine configuration.
It has the following format:

```
SERIAL NUMBER: 1234567890:234567890
NATIONAL VERS: UK
TYPE         : MODEL-M 48K USER RAM
               Extra CRM range yes
PREPARED FOR : DAISY-WHEEL PRINTER
DATE         : 11-05-1982
INSPECTED BY : Abcdefghijk Lmnopqrstuvwx
```

The serial number must be typed by the user (up to 20 characters) or omitted simply by typing RETURN. The NATIONAL VERSION is taken from the national version selection menu. The TYPE can be MODEL-M (if the auxiliary video range 5800-5FFF is present) machine can be prepared either for daisy-wheel or for matrix printer. The date and the name of the inspector is typed by the user (or omitted by RETURN).

3.9. Special items for second line

3.9.1. Debugger

This auxiliary module has the following features.
- Display and modify memory.
- Read and write ports.
- Read, modify and write tape data.
- Read, modify and write disk data.
- Print from memory.
- Send and receive communication (through P2174)

This module is very useful to study the memory behaviour in case of error and to check and repair data on tape or disk.
The debugger has the 20 commands. The numbers used in these commands are always HEXADECIMAL, the only EXCEPTION is the track number at disk read. The command lines must be terminated by RETURN. To correct a wrong entry the BACKSPACE and DELETE LINE keys can be used.

The user can stop any procedure by typing any key. The program now waits until a second key is depressed. If it is '0', the procedure is aborted, otherwise continued.

By using the PS (printer switch) command, all results can be PRINTED as well.

In MODEL-T the right half of the screen can be made visible any time by using the CURSOR RIGHT key (or the left half by CURSOR LEFT).

The debugger uses the user RAM range 6100-61FF. Writing in this range may lead to irregular results. The following commands are implemented.

C : Compares the contents of two memory blocks. Example: C 7000 8000 280 (C addr-1 addr-2 length).
The memory blocks 7000-727F and 8000-827F are compared and the bytes that are not equal are displayed.

Communication input from P2174 or P2171-1.
Example: CI 9000 100 (CI address length) fills 9000 to 90FF with the communication input data.

CO: Communication output to P2174 or P2171-1.
Example: CO 9000 100 (CO address length) sends the data from 9000-90FF to the interface. At the beginning the DSR bit is checked: If set, no character is sent until this bit is active, otherwise it is ignored.

D : Display or change memory. Example 1: D 9210 140 (D address length).
The contents of the range 9210-934F is displayed.

Example-2:
D 8840 (D address)
8840 28
At first the Debugger displays the contents on the given location.
The answers can be:
1. Another hexadecimal byte to change the byte.
2. RETURN to ask for the next byte.
3. Q to leave the change mode.

Disk read track (not for system disk!). DR 126 8000 reads track-26 (DECIMAL NUMBER!) from drive-1 into 8000 to 87FF. If no range is given, 7000 to 7FFF is assumed.

Disk write track (not for system disk! . DW 29 9000 writes track 9 of drive-2 from 9000-97FF.

E : Disk CRC error correction. There is a very limited possibility to correct a disk CRC error in a sector with ASCII data. The bad disk must be copied, the error messages show which sectors are bad. The corresponding track is read by a DR command and the error can be located by a memory display, because from this position up to the sector limit the characters are no more ASCII. After entering e.g. E 7547 the whole range 7547 tp 75FF is shifted left one BIT, displayed, and a question appears: ESCAPE? (Y/CR). After typing of RETURN the block is shifted again, Y and RETURN stops it. If none of the 7 possible shifts give an acceptable ASCII code, the message is sent: WARNING-RESULT IS VERY UNCERTAIN, ESCAPE? (Y/CR). If no escape is required, a transformation is made that considers a slip in the MFM recording. This transformation can give NO EXACT DATA, only an overview, what the data might have been!.

F : Fill memory with data. Example: F 7100 2B0 3F (F start-addr length). The range 7100-73AF is filled with 3F.

G : Go to a given address: G 8000 transfers the control to the program on 8000. If this program ends with RET (C9), a return is made to the debugger.

M : Move memory block. Example:
M 6400 7C00 2BC (M destination source length).
The range 7C00-7EAF is copied into the range 6400 66AF

Reads and/or writes ports. Example-1:
P and RETURN reads all ports 0 to FF.

Example-2:
P 3F.
3F 9C
Reads and displays the data from Port-3F.
The answer can be:
1. Another hexadecimal byte to write on the port.
2. RETURN to ask for the next port address.
3. Q to leave change mode.

Print data from memory: PR A000 4F 3 (PR address length repetition) prints the data from A000 to A04E 3 times. If no repetition number is given, 1 is assumed.

Printer switch: After entering the PS command all debugger actions are printed too. The next PS command stops the printing.

S : Search string. Example:
S 21 00 50 ... (up to 5 bytes) searches this string in the whole memory and displays the addresses where it occurs.

TB: Tape backwards. The tape is positioned one record backwards.

Tape end. Writes an END OF FILE RECORD on the current tape position.

TF: Tape forward 1 block 1 block = 1K = 400 Hexadecimal).

Tape initialize rewind).

Tape read. Example:
TR 8000 800 (TR address length) reads 2 blocks from the tape and stores the data in the 8000-87FF range.

TW: Tape write. Example.
TW 9000 C00 (TW address length) writes 3 blocks onto the tape from the 9000 9BFF range.

The DEBUGGER can be left by typing Q or 0 and RETURN.

3.9.1. Copy_disk_1_to_2

The disk in drive-1 is copied to drive-2 regardless of data unless it is a protected system disk. The data are read by a READ TRACK command, but in case of an error each sector of the track is re-read up to 9 times in an attempt at error recovery. After copy the disks are verified automatically.

3.9.2. Verify_disks

The disks in drive-1 and drive-2 are compared on track by track basis. The number of deviations (if any) is printed for each track.