

TEST PROGRAM LIBRARY

for the

MCS 920 B COMPUTER

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MCS 920B COMPUTER
TEST PROGRAM LIBRARY

CONTENTS LIST

TEST PROGRAM X.1	INPUT/OUTPUT TEST
TEST PROGRAM X.2	STORE TEST 1: CHEQUERBOARD
TEST PROGRAM X.3	FUNCTION TEST
TEST PROGRAM X.4	STORE TEST 2: ON/OFF
TEST PROGRAM X.5	MANUAL LEVEL TEST
TEST PROGRAM X.6	INSTRUCTION TIMING
TEST PROGRAM X.7	CHANNEL 1 INPUT/OUTPUT TEST
TEST PROGRAM X.8	TEST TRACE FACILITY
TEST PROGRAM X.10	VARIABLE SPEED PAPER TAPE INPUT/ OUTPUT TEST
TEST PROGRAM X.202	STORE TEST 1: CHEQUERBOARD FOR INTERNAL AND EXTERNAL STORES
TEST PROGRAM X.402	STORE TEST 2: ON/OFF TEST FOR INTERNAL AND EXTERNAL STORES

MCS 920B COMPUTER

PROGRAM X.1 (ISSUE 3)

INPUT/OUTPUT TEST

1. FUNCTION

To test the tape reader and teletype punch.

2. TAPE

The tape is punched in sum-checked binary, for input under the initial instructions.

If, after reading, continuous output occurs then an error has arisen during reading.

3. METHOD OF USE

- (i) Set the 'MODE' switch to 'OPERATE' position.
- (ii) Select 8181 (111111110101) on the ADDRESS keys.
- (iii) Press 'JUMP' button (thus reading the tape in).
- (iv) Set up 8000 (111101000000) on the ADDRESS keys and depress the 'JUMP' button.

The program enters the Punching Routine and punches two blocks of information and reaches a dynamic stop.

Each block of information is made up as follows:-

150 pairs of the characters 10101.010

 01010.101 i.e. 300 characters

2 binary counts of 0 - 255 i.e. 512 characters

300 erase characters (11111.111)

100 blank characters

One block therefore comprises 1212 characters, being just over 10 feet in length (10 characters to the inch).

- (v) When the output of section (iv) has ceased, remove the program tape from the reader and replace it by the leading end of the tape just produced (do not tear off this tape from the punch).
- (vi) Set up 8031 (111101011111) on the ADDRESS keys and depress the JUMP button.

The program now enters a loop in which it successively inputs and checks one block of characters, followed by the punching of a further block.

This cycle continues until either

- (a) the punch runs out of tape
- or (b) the program is manually stopped
- or (c) an error is detected.

4. ERROR INDICATION

An error is only detected when a block of information is being passed through the reader, and when this occurs two characters are punched and the program reaches a dynamic stop.

The 2 characters represent:

- (a) the character as just read
- (b) the correct character

in this order.

The characters punched only represent the 7 bits input to the accumulator, thus track 5 of the input tape is ignored and tracks 6, 7

and 8 appear in positions 5, 6 and 7 respectively.

If a fault does occur, it is either because an incorrect character has been punched or the tape reader has misread a character. The tape should be removed from the reader and the portion of the tape at which reading stopped should be checked visually.

If this section of the tape has the correct sequence of characters, the tape reader is at fault.

Otherwise the punch is malfunctioning.

MCS 920B COMPUTER

PROGRAM X2B

STORE TEST 1 : CHEQUERBOARD

(8192 WORD STORE)

APPLICABLE TO MCS 920B COMPUTERS

1. FUNCTION

To test the 8192 word store with a complementary chequerboard pattern.

2. TAPES

The tape is punched in binary for input by initial instructions.

Alternative tapes using input modes 1 and 3 respectively on MCS 920B are available.

3. METHOD OF USE

Cause the computer to commence reading by the initial instructions (entry 8181 = 111111110101). The program will then be read into the computer and triggered automatically.

The computer writes the chequerboard pattern from location 2 to location 8030, tests this pattern and complements each location in turn. If this is correct the inverse pattern is written and tested. If no error has been found a character will be read from the tape.

When a blank character is read the program repeats the above process, but when a non-blank character is read the program causes the second part of the program tape to be read into the computer. This is self triggering and produces the legible tape.

920 STORE TEST 1 O K

X 2 B - 1

The clear store program is then automatically read into the computer and triggered.

4. PROCESS USED

The basic chequerboard pattern for the 8192 word store is as shown below:-

Location	0	1	2	3	4	5	6	7	60	61	62	63	
0	0	1	1	0	0	1	1	0	0	1	1	0	63
64	1	0	0	1	1	0	0	1	1	0	0	1	127
128	1	0	0	1	1	0	0	1	1	0	0	1	191
192	0	1	1	0	0	1	1	0	0	1	1	0	255
													et seq.

This pattern imposes the maximum strain on the store. If the store or its circuits are weak a zero bit might appear as 1 or a 1 bit as a zero.

By exchanging each zero location with a "full house" and each "full house" location with a zero and then restoring them to the original the test endeavours to induce errors.

5. ERROR INDICATION

If an error is detected the computer will punch seven characters as follows:-

- (i) The first is an erase character (1111111) which only serves to mark the start of the group.
- (ii) Characters 2, 3 and 4 are the address (in binary) of the store location which failed.
- (iii) Characters 5, 6 and 7 are the incorrect binary pattern read from that location.

Characters 4 and 7 are the least significant bits of each word; the most significant six bits of the most significant characters (2 and 5) are meaningless.

MCS 920B COMPUTER

PROGRAM X3 ISSUE 3

FUNCTION TEST

1. FUNCTION

To test that MCS 920A or 920B can perform functions 0 to 14 and that B-line modification is carried out correctly.

2. TAPES

The tape of 920 X.3 (3) is in sum-checked binary. This is for input via initial instructions and if, after reading, continuous output occurs, an error has occurred during reading.

The tape carries a clear store routine at the beginning and end of the tape.

Alternative tapes using input modes 1 and 3 respectively on MCS 920B are available.

3. METHOD OF USE

- (i) Set the 'MODE' switch to 'OPERATE' position.
- (ii) Select 8181 (111111110101) on the ADDRESS keys.
- (iii) Press 'JUMP' button (thus reading the tape in).

The first portion of the tape (clear store routine) is now read in. When the store has been cleared, the main program X.3 (3) is read in without further action from the operator. If continuous output does not occur, the program will wait.

Set up 8 (000000001000) on the ADDRESS keys and press the JUMP button. This action triggers the program and initiates the test cycle.

4. TEST CYCLE

Each function is tested in turn and unless an error is detected, this cycle is repeated 150 times, at which time one character is input via the tape reader.

If this character is a blank, the test cycle is repeated a further 150 times, another character is input, and so on.

If the character input is not a blank, the test cycle is ended and the computer punches the message "FUNCTION TEST OK" as legible tape, reads in the second clear store routine and stops when the store is clear.

The test cycle, once entered, may be stopped manually by depressing the STOP button. If this is done, however, the legible tape output is not produced. Having once been stopped the program may be continued by pressing RESTART or retriggered from the beginning by pressing JUMP.

5. ERROR INDICATIONS

If an error is detected during a test cycle, the program outputs one of 57 characters continuously.

The attached table indicates the function in error - together with the particular test causing that error - corresponding to each of these characters.

The table also includes the address of the location at which the particular test begins and ends - this facilitates look-up of the program sheets.

ERROR INDICATION TABLE

<u>Error Character</u>	<u>Function Failing</u>	<u>Locations of test</u>
00000.001	4	12 - 16
00000.010	5	17 - 20
00000.011	7 a	21 - 23
00000.100	7 b	24 - 26
00000.101	9 a	27 - 29
00000.110	9 b	30 - 33
00000.111	1 a	34 - 38
00001.000	1 b	39 - 43
00001.00	1 c	44 - 48
00001.010	1 d	49 - 56
00001.011	1 e	57 - 64
00001.100	1 f	65 - 73
00001.101	1 g	74 - 82
00001.110	2 a	83 - 87
00001.111	2 b	88 - 92
00010.000	2 c	93 - 100
00010.001	2 d	101 - 107
00010.010	6 a	108 - 112
00010.011	6 b	113 - 117
00010.100	6 c	118 - 125
00010.101	6 d	126 - 131
00010.110	10	132 - 140
00010.111	0	141 - 145
00011.000	11	146 - 152

<u>Error Character</u>	<u>Function Failing</u>	<u>Locations of test</u>
00011.001	3	153 - 159
00011.010	14 a	160 - 166
00011.011	14 b - Acc. wrong	167 - 174
00011.100	14 b - Q. wrong	175 - 179
00011.101	14 c	180 - 191
00011.110	14 c - Acc. wrong	192 - 199
00011.111	14 d - Q. wrong	200 - 204
00100.000	14 e - Acc. wrong	205 - 212
00100.001	14 e - Q. wrong	213 - 217
00100.010	14 f - Q. wrong	218 - 226
00100.011	14 g - Q. wrong	227 - 235
00100.100	14 h - Q. wrong	236 - 244
00100.101	14 i - Q. wrong	245 - 253
00100.110	14 j - Acc. wrong	254 - 260
00100.111	14 k - Q. wrong	261 - 269
00101.000	14 l - Q. wrong	270 - 278
00101.001	14 m - Q. wrong	279 - 287
00101.010	14 n - Q. wrong	288 - 296
00101.011	14 o - Q. wrong	297 - 305
00101.100	14 p - Acc. wrong	306 - 314
00101.101	14 q. Q. wrong	388 - 396
00101.110	14 q - Acc. wrong	397 - 400
00101.111	12 a - AR. wrong	315 - 322
00110.000	12 a - Acc. wrong	323 - 327
00110.001	12 b - AR. wrong	328 - 335
00110.010	12 b - Acc. wrong	336 - 340
00110.011	13 a - Q. wrong	341 - 349

<u>Error Character</u>	<u>Function Failing</u>	<u>Location of test</u>
00110.100	13 a - Acc. wrong	350 - 354
00110.101	13 b - Q. wrong	355 - 363
00110.110	13 b - Acc. wrong	364 - 368
00110.111	13 c - Acc. wrong	369 - 375
00111.000	13 d - Acc. wrong	376 - 381
00111.001	B - modification	382 - 387

6. TESTS CARRIED OUT

1. Function 4 - READ:

- place 0.0000000000000000 in Accumulator
- error if not zero.

2. Function 5 - WRITE:

- read back to Accumulator previously stored
0.0000000000000000
- error if not zero.

3. Function 7 - JUMP IF ZERO

- a) - place negative number 1.111111111111111 in Accumulator and test
- b) - place positive number 0.0000000000000010 in Accumulator and test

4. Function 9 - JUMP IF NEGATIVE

- a) - place 0.0000000000000000 in Accumulator and test
- b) - place negative number 1.111111111111111 in Accumulator and test

5. Function 1 - ADD

a) add the numbers 0.00000000000000000000

and 0.00000000000000000000

Correct answer 0.00000000000000000000

b) Add 1.111111111111111111

and 0.00000000000000000001

Correct answer 0.00000000000000000000

c) Add 0.00000000000000000001

and 1.111111111111111111

Correct answer 0.00000000000000000000

d) Add 1.0101010101010101010

and 0.1010101010101010101

Correct answer 1.111111111111111111

e) Add 0.1010101010101010101

and 1.0101010101010101010

Correct answer 1.111111111111111111

f) Add 1.0101010101010101010

and 1.0101010101010101010

and 1.0101010101010101010

Correct answer 1.111111111111111110

g) Add 0.1010101010101010101

and 0.1010101010101010101

and 0.1010101010101010101

Correct answer 1.111111111111111111

6.	Function 2 - NEGATE and ADD	
a)	Place in Accumulator	0.00000000000000000000
	Negate and add	<u>0.00000000000000000000</u>
	Correct answer	0.00000000000000000000
b)	Place in Accumulator	1.111111111111111111
	Negate and add	<u>1.111111111111111111</u>
	Correct answer	0.00000000000000000000
c)	Place in Accumulator	0.00000000000000000000
	Negate and add	<u>1.111111111111111111</u>
	Correct answer	1.111111111111111111
d)	Place in Accumulator	1.111111111111111111
	Negate and add	<u>0.00000000000000000000</u>
	Correct answer	0.00000000000000000001
7.	Function 6 - COLLATE	
a)	Place in Accumulator	0.00000000000000000000
	Collate with	<u>1.111111111111111111</u>
	Correct answer	0.00000000000000000000
b)	Place in Accumulator	1.111111111111111111
	Collate with	<u>0.00000000000000000000</u>
	Correct answer	0.00000000000000000000
c)	Place in Accumulator	1.111111111111111111
	Collate with	<u>1.111111111111111111</u>
	Correct answer	1.111111111111111111
d)	Place in Accumulator	0000000011111111
	Collate with	<u>00001111000011111</u>
	Correct answer	00000000000011111

- e) Set Accumulator + Q-Register to
 101010101010101010 1010101010101010
 shift right one place
- f) Set Accumulator + Q-Register to
 00000000000000000000 00000000000000000000
 Shift left 2 places
- g) Set Accumulator to Q-Register to
 00000000000000000000 00000000000000000001
 Shift left 4 places
- h) Set Accumulator + Q-Register to
 00000000000000000000 00000000000000000001
 Shift left 8 places
- i) Set Accumulator + Q-Register to
 00000000000000000000 00000000000000000001
 shift left 16 places
- j) Set Accumulator + Q-Register to
 00000000000000000000 00000000000000000001
 Shift 32 places left
 New Contents of A + Q-Register should be
 00100000000000000000 00000000000000000000
- k) Set Accumulator + Q-Register to
 00000000000000000000 00000000000000001000
 Shift 2 places right
- l) Set Accumulator + Q-Register to
 00000000000000000000 000000000000100000
 shift 4 places right

- m) Set Accumulator + Q-Register to
 00000000000000000000 000000001000000000
 Shift 8 places right
- n) Set Accumulator + Q-Register to
 00000000000000000000 10000000000000000000
 Shift 16 places right
- o) Set Accumulator + Q-Register to
 00100000000000000000 00000000000000000000
 Shift 32 places right

NB. Correct answer after the shift for cases (k - o)

should be

00000000000000000000 00000000000000000010

- p) Set Accumulator + Q-Register to
 00000000000000000000 00000000000000000001
 Shift 35 places left
- Correct answer should be
 10000000000000000000 00000000000000000000
- q) Set Accumulator + Q-Register to
 10000000000000000000 00000000000000000000
 Shift 35 places right
- Correct answer should be
 11111111111111111111 11111111111111111111

13. Function 12 - MULTIPLY

- a) Multiply the number 101100110011001101
 by the number 101100110011001101
- The correct answer in Accumulator + Q should be
 001011100001010001 101011100001010011

b) Multiply the number 101100110011001101
by the number 000000000000000000000010
Correct answer in Accumulator + Q should be
11111111111111110 110011001100110101

14. Function 13 - DIVIDE

a) Form in Accumulator + Q the number
001011100001010001 101011100001010011
Divide by the number 101100110011001101
Correct answer in Accumulator + Q should be
101100110011001101 101100110011001100

b) Form in Accumulator + Q the number
001011100001010001 101011100001010011
Divide by the number 010011001100110011
Correct answer in Accumulator + Q should be
010011001100110011 010011001100110010

c) Form in Accumulator + Q the number
11111111111111110 110011001100110101
Divide by the number 000000000000000000000010
Correct answer in Accumulator should be
101100110011001101 101100110011001101

d) Form in Accumulator + Q the number
11111111111111110 110011001100110101
Divided by the number 101100110011001101
Correct answer in Accumulator should be
000000000000000000000011

15. B - modification

Set (level 1) B-Register = + 2
Do modified read.
Check Accumulator contents.

MCS 920B COMPUTER

PROGRAM X.4 (ISSUE 3)

STORE TEST 2: ON/OFF

1. FUNCTION

- (a) To test store address selection circuits.
- (b) To ensure that information is retained in the store when the power supply to the computer is switched off and then on.

2. TAPE

The tape is punched in sum-checked binary for input via the initial instructions. If, after having read in the tape, continuous output occurs, then an error has arisen during reading.

3. METHOD OF USE

- (a) Set the 'MODE' switch to 'OPERATE' position.
Select 8181 (111111110101) on the 'ADDRESS' keys.
Press 'JUMP' button (thus reading the tape in).

After reading, and providing continuous output does not occur, the program waits.

It may be triggered as follows:-

- (i) Place a previously prepared parameter tape in the tape reader (see section 5).
- (ii) Set up 8000 (111110100000) on the address keys and depress the JUMP button.

The program now writes a different number in each available location and then enters the Checking Routine, wherein each location is tested for correct content.

Having done one complete check and if no error has been detected, one character is input from the tape reader.

If this character is other than a blank, the program punches "STORE TEST 2 OK" as legible tape and reaches a dynamic stop. If the character input is a blank, the Checking Routine is repeated once more and the above process continued.

(b) After test (a) has been performed, it is possible to discover whether or not the store retains the information therein, when the computer is switched OFF and ON. This may be achieved as follows:-

- (i) Switch OFF.
- (ii) Set up 8009 (1111101001001) on address keys.
- (iii) Place a parameter tape in the tape reader.
- (iv) Switch ON.
- (v) Load the tape reader.

The program goes directly to the Checking Routine and proceeds as indicated in Section (a) above.

4. ERROR INDICATIONS

If an error is detected during the testing cycle, an output of two characters occurs. These characters indicate which location in the store is failing and are interpreted as follows:-

The first character represents the 8 least significant bits of the address of the location and the least significant five digits of the second character

represents the 5 most significant bits of the same address, the three most significant digits of this character always being ones.

e.g. output of the following two characters

01010.101

11111.011

indicates that the location failing has address.

1101101010101 = 6997

5. PARAMETER TAPE

The number of successive non-blank characters on the parameter tape controls the number of times the store is tested.

The rate of input of these characters is ten per 18 seconds and so a parameter tape consisting of 500 successive blank characters will allow the test to run for 15 minutes. The available store is tested once between input of two characters from the reader.

MCS 920 COMPUTER

PROGRAM X.5 ISSUE 3

MANUAL LEVEL TEST

1. FUNCTION

To test that MCS 920 models A and B will respond to external stimuli on levels 1, 2 and 3 and that it will terminate levels by program always using the correct S.C.R. and B-Register for the current level.

2. STORE USED

389 consecutive locations.

3. TAPES

The library tape is punched in sum-checked binary form for input via initial instructions. If, after reading in, continuous output occurs, an error has occurred during reading.

Alternative tapes using input modes 1 and 3 respectively on MCS 920B are available.

4. ENTRY POINT AND METHOD OF USE

Entry is at location 8.

When entered the routine will set up the S.C.R.'s for levels 2, 3 and 4 whilst obeying program on level 1. It will then terminate level 1 leaving level 1 S.C.R. set for entry to the test program.

The following action depends on the current stimuli.

If any of levels 1, 2 or 3 have been demanded then the highest priority level will be selected and "nS" will be punched legibly on paper tape. Whenever any of these levels are terminated (after 5 seconds running) then "nT" will be punched. "n" denotes the level number. If none of these

levels are stimulated then level 4 will be entered and repeated every 5 seconds. This is denoted by "4R".

In order to fully test the interrupt logic a sequence of demands as shown in annexure 1 is suggested. The correct legibly punched response is also given.

5. ERROR INDICATION

If a program level is selected and the wrong S. C. R. or B-Register is used the program will stop after punching.

"nAE" to denote S. C. R. (i.e. Address Error)

"nBE" to denote B Register (i.e. Modified Error)

again "n" denotes the level number.

ANNEXURE 1

SEQUENCE OF DEMANDS X5

Operators Action	Correct output response
Release all level demands	-
Trigger program location 0,	"4R"
Press level 3 within 5 seconds	"3S"
" " 2 " " "	"2S"
" " 1 " " "	"1S"
NIL	"IT"
NIL	"2T"
NIL	"3T"
NIL	"4R"
NIL	"4R"
The operator may now stop the program or continue with level selections at will.	

MCS 920 COMPUTER

PROGRAM X. 6

INSTRUCTION TIMING

1. FUNCTION

To enable an operator using a stop watch to time any of the sixteen instructions of the MCS 920 instruction code. Where the timing of an instruction depends on the accumulator contents or the particular address within the instruction word then these variations are also possible.

2. STORE USED

Locations 8 - 69 inclusive (Set up program)

Locations 999 - 3499 " (W/S + 2500 instructions)

Locations 3500 - 3510 " (print count Program)

3. TAPES

The library tape is punched complete with its own directory for input by 920 T2.

The parameter tape is punched complete with its own directories for input by 920 T2.

The Address tapes must be prepared as required by the operator.

Alternative tapes using input modes 1 and 3 respectively on MCS 920B are available.

4. ENTRY POINT AND METHOD OF USE

Read in the library tape by 920 T2 then select the required parameter tape and again read in by 920 T2. If instructions 14 or 15 have been selected then an Address tape must be prepared and placed in the Tape Reader prior to triggering the program, otherwise trigger to location 8.

The program will then write 2500 identical instructions in locations 1000 to 3499. These instructions will be obeyed consecutively and repeated, every 20th cycle the program will output "1101100" on paper tape. The repetition rate of this output can now be judged and 20 such outputs timed with a stop watch, the measured time in seconds will then be the time in microseconds for one of the selected instructions.

The maximum error will be in the order of .06 microseconds, due to the control instructions in the timing loop.

5. PREPARATION OF TAPES

The parameter tapes are provided but they can be punched as follows:-

&
+52
*
a
b
c
)

where if $a = +0$. The program will expect to read an address tape. This is only used for instructions 14 or 15.

if $a = +1$. The program will write the address of the next location in all those locations containing the jump instruction being timed. This is only used for instructions 7, 8 and 9.

if $a = -1$. The program will write address 999 into all those locations containing the instructions being timed. This is used for all the remaining instructions.

where b will denote the accumulator contents during the test cycle. This enables the timing of instruction 7 and 9 to be varied according to the

state of the Accumulator.

Where c will denote the selected instruction the address bits always being zero. The modifier digit may be included if required.

The Address tape for use with instructions 14 and 15 must be punched as follows:-

" " run out " " x x x x " " run out " "

where x x x x denotes the digits of the address.

NOTE

There is no error detection during input of the address tape so no other characters may be punched (i.e. no signs no spaces nor any erases).

MCS. 920B COMPUTER

PROGRAM X. 7 (ISSUE 3)

CHANNEL 1. INPUT/OUTPUT TEST

1. FUNCTION

To test channel 1 input/output facilities of the MCS. 920B computer. This test requires the use of a Channel 1 test set.

2. TAPE

The library tape is in sum-checked binary form and is read in by initial instructions. Alternative tapes using input modes 1 and 3 respectively are available.

3. DESCRIPTION

The test set provides facilities for input/output and block transfer testing.

There are 5 separate tests, blocks 1 to 4 and block 5. The tests are performed as follows:

Blocks 1 to 4 A single word (data or address) is output from the computer, stored in the test set and then input to the computer. Where the received and transmitted words are identical, the computer outputs the next word. If the words are different, a dynamic stop occurs; the received word is placed in Q and the transmitted word in A.

Block 5 This tests block size (verifying the process counter) and address increment (verifying: (a) that the computer outputs the first word from the correct area of the store and (b) that subsequent words are output from consecutive store locations). The last word signal is also checked.

The test is commenced by storing a binary pattern of 4095 words and then performing a block output of these 4095 words. The first word is binary 1, the second binary 2, et seq.

A binary counter within the test set is stepped each time a new word is output and only when the counter and store contents are identical does the test set give a reply signal. When the last word signal occurs, the test set checks that the counter has been stopped 4095 times.

A block transfer input of one word occurs next and the test set checks that the counter remains at 4095 (i.e. that no further input words were received after the last word signal).

Finally, a block transfer output of 1 word which contains data bit 13 is generated. This steps the counter to 0 in readiness for the next block output of 4095 words.

4. METHOD OF USE

- (i) Connect PL.2 of Channel 1 test set to computer SKT. 4
" PL. 3 " " " " " " SKT. 13
" PL. 1 " " " " " "+6V and -6V supplies
- (ii) Switch the equipment ON
- (iii) Load X. 7 (issue 3) into the tape reader
- (iv) Press READ button on the paper tape controller
(extinguishing the READ lamp).
- (v) Switch the computer control unit to the OPERATE mode.
Set the starting address of the initial instructions
8181 (111111110101) on the ADDRESS keys and depress
the JUMP button. The tape will be read in under intial
instructions.

- (vi) Select the type of test to be performed on the switches of the Channel 1 test set, in accordance with the table below, and place the AUTO/MANUAL switch in the AUTO position.

B L O C K	Function	Test	Test Set Switching Setting			
			Test Mode	Count Type	Test Type	reset button
1	I/P-O/P	Data	Data	Single Shifting '1'	I/P-O/P	-
2	"	Address	Address	" " "	"	-
3	Block Transfer	Data	Data	Binary	BT	-
4	"	Address	Address	"	"	-
5	"	Block Size and Address Increment	Block Size		"	Press

- (vii) Set the ADDRESS keys of the computer control unit to the start address of the required test as given below and depress JUMP button.

Block	Function	Test	Start Address
1	I/P-O/P	Data	32
2	"	Address	64
3	BT	Data	96
4	"	Address	128
5	"	Block Size	160

(viii) To change to another test, depress STOP button on computer control unit and repeat the above procedure from step (vi).

5. ERROR DISPLAYS

When an error occurs in tests 1 to 4, the computer reaches a dynamic stop. The received word (data or address) will be displayed on the Q-register neons and the transmitted word on the A-register neons.

Block 1 error, program stops in location 54.

Block 2 error, program stops in location 85.

Block 3 error, program stops in location 120.

Block 4 error, program stops in location 154.

An error in Block 5 will give no reply signal to the computer after each SOP or SIP.

The computer is caused to wait:

- (i) If the BT lamp is lit during blocks 1 and 2
- and (ii) If the BT lamp remains unlit during blocks 3, 4 and 5.

6. FURTHER FACILITIES

An error word (displayed on the test set lamps) may be repeated by setting the ADDRESS keys of the computer control unit to the appropriate address quoted in the Repeat and Check column of the table overleaf and pressing the JUMP button. To repeat the word without check, the ADDRESS keys should be set to the Repeat address quoted and the JUMP button pressed. It is also possible to cycle through the set of words (without check) by setting the ADDRESS keys to the cycle column address quoted and pressing the JUMP button.

B L O C K	Function	Test	Start Address				Restart Address
			Cycle & Check	Cycle	Repeat & check	Repeat	
1	I/P-O/P	Data	32	35	38	41	55
2	"	Address	64	67	70	73	86
3	BT	Data	96	99	102	105	121
4	"	Address	128	131	134	137	155
5	"	Block Size	For continuous checking, Jump to 160. To stop after each block transfer, Jump to 167.				187, 191, 183

To proceed to the next word after an error has occurred, set the ADDRESS keys to the appropriate Restart address given above and press the JUMP button.

To repeat a particular word (which has not caused an error stop) the AUTO/MANUAL switch of the test set should be placed in MANUAL* and the control unit ADDRESS keys set to the quoted Cycle column address. Depress the JUMP button then step the REPLY button until the required word appears on the test set store display lamps. The ADDRESS keys should now be set to the appropriate Repeat and Check or Repeat address in the above table and the JUMP button depressed.

* NOTE: When the MANUAL position is selected, it is necessary to press the REPLY pushbutton when the test set SOP or SIP lamps are lit.

MCS 920 COMPUTER

PROGRAM X. 8 (ISSUE 3)

TEST TRACE FACILITY

1. FUNCTION

To test for the correct operation of the "program trace" facility.

3. TAPE

The tape of 920 X8 is punched in sum-checked binary form for input by the initial instructions. If after having read in the tape continuous output occurs, then an error has arisen during reading.

Alternative tapes using input modes 1 and 3 respectively on MCS 920B are available.

3. METHOD OF USE

Cause MCS 920 to read in the tape by setting up 8181 (111111110101) on the address keys and pressing the JUMP button.

After reading, and providing continuous output does not occur, the program waits.

The following action is then required:-

- (i) Place a long length (or a loop) of blank tape in the reader.
- (ii) Set up 8 (000000001000) on the address keys and depress the JUMP button. The tape will then be read in at about 20 characters per second.
- (iii) Depress PROGRAM TRACE key (920A) or raise the LEVEL ONE control switch to the TRACE position (920B).

The rate of reading will then slow down to approximately 1 character per second.

4. ERROR INDICATIONS

If an error occurs a character will be punched. The binary value of the character indicates the function digits of the last instruction obeyed of the "traced" program (level 4).

MCS 920B COMPUTER
PROGRAM X.10

VARIABLE SPEED PAPER TAPE
INPUT/OUTPUT TEST

APPLICABLE WHEN CONTROLLERS MCB.61 OR MCB.64 FITTED

1. FUNCTION

To test the tape reader and tape punch at randomly varying speeds of operation.

2. TAPE

The tape is punched in sum-checked binary form, for input under the initial instructions.

If, after reading, continuous punching occurs then a reading error has been detected.

3. METHOD OF USE

- (i) Set the Tape Reader MODE switch to "MODE 3"
- (ii) Set the control unit MODE switch to "OPERATE"
- (iii) Select 8181 (111111110101) on the address keys.
- (iv) Press "JUMP" button (thus causing the tape to be read in).
- (v) Set up 8 (000000001000) on the address keys and press "JUMP".
The specimen tape which forms the final section of the program tape, will be read in and two copies of this will then be punched out, the punch operates at varying speeds. The program then reaches a dynamic stop.

(vi) Place the leading end of the tape punched out in (v) in the tape reader (do not tear off this tape from the punch). Press the tape reader LOAD button.

(vii) Set up 32 (0000000100000) on the address keys and press "JUMP".

The program now enters a loop in which it successively inputs and checks one block of tape and punches a further block. On alternate cycles reading and punching take place at randomly varying speeds.

This cycle continues until either

(a) the punch runs out of tape

or (b) the program is manually stopped

or (c) an error is detected

4. ERROR INDICATION

If an error is detected the program reaches a dynamic stop with the incorrect character in the A register and the correct value of the character in the Q register.

An error may be due to either an incorrect character having been punched or because a character has been misread. The portion of the tape at which reading stopped should be compared visually with the specimen tape to determine which error occurred.

MCS 920 COMPUTER

PROGRAM X.51 (ISSUE 1)

PAPER TAPE STATION TEST PROGRAM (MCS 66).

1. FUNCTION

The program tests the logical and mechanical aspects of the paper tape reader and punch at randomly varying speeds of operation.

2. TAPES

The program is issued as a sumchecked binary tape.

3. DESCRIPTION

In the normal mode of operation, the program reads, checks and punches continuously a particular pattern with a variable delay in each alternate cycle of reading and punching. The program can also read and check tape without punching and punch tape without reading. The pattern output consists of a 'JU' pattern - 256 characters comprising 85 (01010101) and 170 (10101010) alternately - and a binary count of 0-255.

4. METHOD OF USE

4.1 The operator reads in the program tape under initial instructions (111111110101 on address keys) with the tape reader MODE switch (where fitted) set to MODE 3 and the control unit MODE switch set to OPERATE/MANUAL. If, after reading, continuous output occurs from the punch, an error has arisen during reading.

4.2 The operator enters the program at location 21 (0000000010101). The program punches at full speed 6" of blanks followed by 1024 characters of the pattern (about 8' of tape) and comes to a dynamic stop.

4.3 Without tearing off the tape from the punch, the operator loads the leading blanks of the tape just punched into the tape reader.

4.4 For normal operation, the entry point is at 22 (0000000010110); on triggering to this location, the program successively reads in

and checks one block of 256 characters and punches a further block. The first 8192 characters are read and punched at full speed, the next 8192 characters are read and punched with a varying delay between each character i.e. on alternate 8192 character cycles, reading and punching take place at varying speeds. The program continues to run until either it detects an error, or the punch runs out of tape, or the operator stops it manually prior to re-entry at another point.

4.5 The entry points for the 'read only' and 'punch only' modes of operation are 23 (0000000010111) and 24 (0000000011000) respectively; the program reads or punches tape at varying speeds in alternate cycles as before.

4.6 The delay is varied within the program using pseudo-random numbers within the range 120-1023; these values give delays between read or punch instructions within the range 9-70 ms.

5. ERRORS

The program detects an error only while tape is being read in and checked against the store. The error output occurs on the punch and the program then reaches a dynamic stop.

The error output consists of 6" of blanks followed by the correct character, 4 blanks followed by the character actually read and then a further 6" of blanks.

An error may be due to either an incorrect character having been punched, or to the paper tape reader having misread a character. The operator should examine the portion of tape at which reading stopped, comparing it visually with a specimen tape to determine which error occurred.

MCS. 920B COMPUTER

PROGRAM X.202 (ISSUE 1)

STORE TEST 1: CHEQUERBOARD FOR INTERNAL
AND EXTERNAL STORES

1. FUNCTION

To test any block of internal or external stores with a complementary chequerboard pattern.

2. TAPE

The tape is punched in binary for input under initial instructions. The tape includes a clear store routine at the end. Alternative tapes using input modes 1 and 3 respectively are available.

3. METHOD OF USE

- (i) Load X.202 (Issue 1) into the tape reader.
- (ii) Select the appropriate tape MODE on the paper tape controller and press the READ button (extinguishing the READ lamp).
- (iii) Set the MODE switch on the computer control unit to the OPERATE position. Select 8181 (111111110101) on the address keys and press the JUMP button. The tape will be read in under initial instructions and triggered automatically.
- (iv) To trigger the program, place a previously prepared parameter tape if necessary (see Section 6) into the tape reader and depress the READ button on the paper tape controller.

- (v) Set 7884 (1111011001100) on the address keys of the computer control unit and press the JUMP button.

The parameter tape will be read in up to the first non-blank character and the store block specified by that character will be tested. For each successive blank character, the test will be repeated.

The program writes the chequerboard pattern into the store, tests this pattern and complements each location in turn. If this is correct the inverse pattern is written and tested. If no error is found, a character will be read from the parameter tape, on receipt of the second non-blank character the computer will punch "STORE TEST 1 O.K. UNIT N" in legible tape (where N is the block just tested).

The test will continue on the block next specified. The process being repeated until a stop code is received.

At the conclusion of the test, the clear store routine should be entered. This is self-triggering and should be read in by intial instructions. The clear store routine runs until all the store units which are connected and switched on are cleared. The RESET button should now be pressed.

4. PROCESS USED

The basic chequerboard pattern for the store blocks is as shown below:

Location	0	1	2	3	4	5	6
0	1	0	0	1	1	0	0
64	0	1	1	0	0	1	1
128	0	1	1	0	0	1	1
192	1	0	0	1	1	0	0
256	1	0	0	1	1	0	0
320	0	1	1	0	0	1	1
								.	.	.	et seq.

This pattern imposes the maximum strain on the store and will expose any weakness in the store or its circuits.

The Boolean expression for the pattern is:

$$C = (J1 \cdot \overline{J2} + \overline{J1} \cdot J2) \cdot (J7 \cdot \overline{J8} + \overline{J7} \cdot J8)$$

5. ERROR INDICATIONS

If an error is detected the computer will punch nine characters as follows:

- (i) 2 blanks and an erase character (as a marker for the beginning of an error punchout).
- (ii) 3 characters (the address in binary of the failed location, least significant bits first).
- (iii) 3 characters (the contents of the failed location).

NOTE: The 6 most significant bits of (ii) and (iii) are meaningless.

After error punchout, the program continues the test from the address subsequent to the failed location.

6. PARAMETER TAPE

The parameter tape must specify the store block to be tested and may be punched in binary, 920 or 903 telecode. The blocks are defined as:

UNIT 0: locations 8 - 7878 (internal store). Punch 0 on flexowriter or teleprinter.

UNIT 1: locations 8192-16383 (external store).
Punch 1 on flexowriter or teleprinter.

et seq.

The number of successive blank characters on the parameter tape controls the number of times the particular store block is tested.

The rate of input of these characters is 5 per minute.

The library tape tests units 0 and 1.

7. FURTHER FACILITIES

A soak test may be run on a single block of extra store by loading a blank loop of tape into the reader after reading-in X.202.

- (i) Place MODE switch of computer control unit to TEST position.
- (ii) Enter the binary representation of the block to be tested into the accumulator (i.e. 01 for UNIT 1, 10 for UNIT 2, etc.) via the address keys.
- (iii) Place the ENTER key in the UP position and press RESTART button.
- (iv) Place MODE switch to OPERATE position, set 7887 (1111011001111) on the address keys and press JUMP button.

Error indications are as given in Section 5.

MCS. 920 COMPUTER

PROGRAM X.212 (ISSUE 2)

STORE TEST 1: CHEQUERBOARD FOR INTERNAL
AND EXTERNAL STORES

1. FUNCTION

5 us store.

To test any block of internal or external stores with a complementary chequerboard pattern.

2. TAPE

The tape is punched in binary for input under initial instructions. The tape includes a clear store routine at the end. Alternative tapes using input modes 1 and 3 respectively are available.

3. METHOD OF USE

- (i) Load X.212 (Issue 2) into the tape reader.
- (ii) Select the appropriate tape MODE on the paper tape controller and press the READ button (extinguishing the READ lamp).
- (iii) Set the MODE switch on the computer control unit to the OPERATE position. Select 8181 (111111110101) on the address keys and press the JUMP button. The tape will be read in under initial instructions and triggered automatically.
- (iv) To trigger the program, place a previously prepared parameter tape if necessary (see Section 6) into the tape reader and depress the READ button on the paper tape controller.
- (v) Set 8 on the address keys of the computer control unit and press the JUMP button.

The parameter tape will be read in up to the first non-blank character and the store block specified by that character will be tested. For each successive blank character, the test will be repeated.

The program writes the chequerboard pattern into the store, tests this pattern and complements each location in turn. If this is correct the inverse pattern is written and tested. If no error is found, a character will be read from the parameter tape, on receipt of the second non-blank character the computer will punch "STORE TEST 1 O.K. UNIT N" in legible tape (where N is the block just tested).

The test will continue on the block next specified. The process being repeated until a stop code is received.

4. PROCESS USED

The basic chequerboard pattern for the store blocks is as shown below:

LOCATION	0	1	2	3	4	5					
0	1	0	0	1	0	1
64	1	1	1	1	0	0
128	0	0	0	0	1	1
192	0	1	1	0	1	0
256	0	1	1	0	1	0
320	0	0	0	0	1	1	et seq.

At location 4096 the pattern is inverted.

This pattern imposes the maximum strain on the store and will expose any weakness in the store or its circuits.

5. ERROR INDICATIONS

If an error is detected the computer will punch ten characters as follows:

- (i) the character 101010 (as a marker for the beginning of an error punchout)
- (ii) 3 characters (the address in binary of the failed location, most significant bits first)
- (iii) 3 characters (the contents of the failed location)
- (iv) 3 characters (the word written into the failed location).

NOTE: The 6 most significant bits of (ii), (iii) and (iv) are meaningless.

After error punchout, the program continues the test from the address subsequent to the failed location.

6. PARAMETER TAPE

The parameter tape must specify the store block to be tested and may be punched in binary, 920 or 903 telecode. The blocks are defined as:

UNIT 0: locations 320 - 8180 (internal store). Punch 0 on flexowriter or teleprinter.

UNIT 1: locations 8192-16282 (external store)
punch 1 on flexowriter or teleprinter.

et seq.

The number of successive blank characters on the parameter tape controls the number of times the particular store block is tested.

The library tape tests units 0 and 1.

7. FURTHER FACILITIES

A soak test may be run on a single block of extra store by loading a blank loop of tape into the reader after reading-in X.212.

- (i) Place MODE switch of computer control unit to TEST position.

- (ii) Enter the binary representation of the block to be tested into the accumulator (i.e. 01 for UNIT 1, 10 for UNIT 2, etc.,) via the address keys.
- (iii) Place the ENTER key in the UP position and press RESTART button.
- (iv) Place MODE switch to OPERATE position, set 10 (0000000001010) on the address keys and press JUMP button.

Error indications are as given in Section 5.

MCS 920 COMPUTER
PROGRAM X.217 (ISSUE 1)

STORE TEST 1: CHEQUERBOARD FOR INTERNAL
AND EXTERNAL 2 μ sec STORES

1. FUNCTION

To test any block of internal or external stores with a complementary chequerboard pattern.

2. TAPE

The tape is punched in binary for input under initial instructions. The tape includes a clear store routine at the end. Alternative tapes using input modes 1 and 3 respectively are available.

3. METHOD OF USE

- (i) Load X.217 into the tape reader.
- (ii) Select the appropriate tape MODE on the paper tape controller and press the READ button (extinguishing the READ lamp).
- (iii) Set the MODE switch on the computer control unit to the OPERATE position. Select 8181 (111111110101) on the address keys and press the JUMP button. The tape will be read in under initial instructions and triggered automatically.
- (iv) To trigger the program, place a previously prepared parameter tape if necessary (see Section 6) into the tape reader and depress the READ button on the paper tape controller.
- (v) Set 8 on the address keys of the computer control unit and press the JUMP button.

The parameter tape will be read in up to the first non-blank character and the store block specified by that character will be tested. For each successive blank character, the test will be repeated.

The program writes the chequerboard pattern into the store, tests this pattern and complements each location in turn. If this is correct the inverse pattern is written and tested. If no error is found, a character will be read from the parameter tape, on receipt of the second non-blank character the computer will punch "STORE TEST 1 O.K. UNIT N" in legible tape (where N is the block just tested).

The test will continue on the block next specified. The process being repeated until a stop code is received.

4. PROCESS USED

The basic chequerboard pattern for the store blocks is as shown below:

LOCATION	0	1	2	3	4	5	6	7	60	61	62	63
0	1	1	1	1	0	0	0	0						0	0	0	0
64	1	0	0	1	0	1	1	0						0	1	1	0
128	1	0	0	1	0	1	1	0						0	1	1	0
192	1	1	1	1	0	0	0	0						0	1	1	0
										et seq.			

This pattern imposes the maximum strain on the store and will expose any weakness in the store or its circuits.

5. ERROR INDICATIONS

If an error is detected the computer will punch ten characters as follows:

- (i) the character 101010 (as a marker for the beginning of an error punchout)
- (ii) 3 characters (the address in binary of the failed location, most significant bits first)
- (iii) 3 characters (the contents of the failed location)
- (iv) 3 characters (the word written into the failed location).

NOTE: The 6 most significant bits of (ii), (iii) and (iv) are meaningless.

After error punchout, the program continues the test from the address subsequent to the failed location.

6. PARAMETER TAPE

The parameter tape must specify the store block to be tested and may be punched in binary, 920 or 903 telecode. The blocks are defined as:

UNIT 0: locations 320 - 8180 (internal store). Punch 0 on flexowriter or teleprinter.

UNIT 1: locations 8192 - 16383 (external store)
punch 1 on flexowriter or teleprinter.

et seq.

The number of successive blank characters on the parameter tape controls the number of times the particular store block is tested.

The library tape tests units 0 and 1.

7. FURTHER FACILITIES

A soak test may be run on a single block of extra store by loading a blank loop of tape into the reader after reading-in X.217.

- (i) Place MODE switch of computer control unit to TEST position.
- (ii) Enter the binary representation of the block to be tested into the accumulator (i.e. 01 for UNIT 1, 10 for UNIT 2, etc.,) via the address keys.
- (iii) Place the ENTER key in the UP position and press RESTART button.
- (iv) Place MODE switch to OPERATE position, set 10 (000000001010) on the address keys and press JUMP button.

Error indications are as given in Section 5.

MCS 920M COMPUTER

PROGRAM X400 (ISSUE 1)

COMBINED FUNCTION AND STORE TESTS.

1. FUNCTION

This is a combination of X3 (Function test) and X4 (Store test).

It performs functions 0-14, B-line modifications and tests store address selection circuits.

2. TAPES

The tape is in sum-checked binary for input via initial instructions. If, after having read in tape, continuous output occurs, an error has occurred during reading.

The tape carries a clear store routine at the beginning and end of the tape.

Alternative tapes using input modes 1 and 3 respectively are available.

3. METHOD OF USE

- (i) Set the 'MODE' switch to 'OPERATE' position
- (ii) Select 8181 (111111110101) on the ADDRESS keys.
- (iii) Press 'JUMP' button.

The first portion of the tape (clear store routine) is now read in. When the store has been cleared, the main program X400 is read in. Providing continuous output does not occur, the program will wait.

Set up 16 or 18 on the ADDRESS keys and press the JUMP button. This triggers the program and initiates the test cycle. Address 16 should be used for normal running with a tape reader; Address 18 allows running without reading - i.e. excludes need for peripherals on a protracted test.

4. TEST CYCLE

The function test is started and unless an error is detected, is repeated 150 times. Upon completion one character is input via the

tape reader.

If this character is a blank, the store test is initiated and on completion, a character is input via the tape reader. If this is also a blank, the function test is re-commenced. Hence the program will alternate function test with store test.

If the character input is not a blank, the test is ended and the computer punches the message "X400 TEST OK" as legible tape, reads in the second clear store routine and stops when the store is clear.

Function Test

Each function is tested in turn, and the cycle repeated 150 times.

Store Test

The program writes the address of a location into that location, from location 636 to location 8179. It then enters a checking routine, wherein each location is tested for correct content.

5. ERROR INDICATIONS

Function Test

If an error is detected, the program outputs one of 65 characters continuously.

The attached table indicates the function in error - together with the particular test causing that error - corresponding to each of these characters. Included in the table are the absolute addresses of the locations in the program, of the test causing malfunction.

Store Test

If an error is detected, the program outputs 3 characters on the paper tape. The first character represents the 8 least significant bits of the address (Bits 1-8); the second character represents the 5 most significant bits of the address (bits 9-13); the third character is a blank. After this output the program reads the next location.

MCS. 920B COMPUTER

PROGRAM X.402 (ISSUE 1)

STORE TEST 2: ON/OFF FOR INTERNAL AND
EXTERNAL STORES

1. FUNCTION

- (a) To test address selection circuits of any storage block in the MCS 920B system including internal store (locations 8-7945) and external stores (locations 8192 to a maximum of 65,536).
- (b) To test that information is retained in the stores when their power supplies are disconnected and then reconnected.

2. TAPE

The tape is punched in binary for input under initial instructions. The tape carries a clear store routine at the beginning and is prepared for mode 1 operation. An alternative tape using input mode 3 is available.

3. METHOD OF USE

- (a) (i) Load the X.402 into the tape reader.
(ii) Select the appropriate tape MODE on the paper tape controller, and depress the READ button.
(iii) Set the MODE switch to the OPERATE position. Select 8181 (111111110101) on the address keys of the computer control unit and press the JUMP button.
(iv) Place a previously prepared parameter tape into the tape reader if necessary, (see Section 5) and depress the READ button on the paper tape controller.

- (v) Set 7947 (1111100001011) on the address keys of the computer control unit and press the JUMP button.

The computer will read in the parameter tape up to the first non-blank character and apply the address selection test to the store block specified by that character. The program writes a different number in each available location and enters a checking routine where each location is tested for the correct content. This test is repeated (provided that no error is detected) until a second non-blank character is read, when a legible output of "STORE TEST 2 O.K. UNIT N" is given. (Where N is the block just tested.) The test will continue on the block specified by the second non-blank character. The process is repeated until a stop code is reached.

- (b) After test (a) has been performed, the data retention test may be carried out as follows:

- (i) Switch off the power supplies.
- (ii) Set 8028 (1111101011100) on the address keys.
- (iii) Switch on the power supplies.
- (iv) Press the JUMP button.

The program will enter the checking routine.

Error indications, which are identical to those of test (a) are given in Section 4.

4. ERROR DISPLAYS

An error detected during test (a) or (b) causes nine characters to be punched. These are:

- (i) 2 blanks and an erase character (marking the beginning of a block).

(ii) 3 characters (the contents of the failed location)

(iii) 3 characters (the correct content of the location)

NOTE: Clauses (ii) and (iii) output the least significant bits of the word first. The most significant six bits of the third character in each error indication are meaningless.

5. PARAMETER TAPE

The parameter tape must specify the store block to be tested and may be punched in binary, 920 or 903 telecode. The blocks are defined as:

UNIT 0: locations 8-7945 (internal store). Punch 0 on flexowriter or teleprinter.

UNIT 1: locations 8192-16,383 (external store). Punch 1 on flexowriter or teleprinter.

et seq.

The number of successive blank characters on the parameter tape controls the number of times the particular store block is tested.

The rate of input of these characters is 16 per minute.

The library tape tests units 0 and 1.

