THE BENDIX CORPORATION COMPUTER DIVISION
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APPLICATIONS SECTION

TITLE: Test Routine 1 and 2

TYPE: Service Routine

EQUIPMENT AFFECTED: G-15

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TEST ROUTINE NUMBER ONE AND TWO

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Part I

INTRODUCTION

Test Routine Number One and Number Two are combined in a one master magazine and a Block Selector Routine is incorporated for selection of the desired test. Test Number One is a cursory check of a computer resulting in a bell being rung at regular intervals. Basically re-circulation, arithmetic circuits, AR and PN registers are tested by this routine. In order to subject the computer to a more comprehensive test, Test Routine Number Two should be used.

It is assumed that the input circuits (including the pertinent memory lines, i. e. L. 23, L. MZ, and L. 19), L. 00, the command and the control circuits are in working condition. If one or more of these is making errors, the result will be erratic operation, usually evidenced by the computer getting lost in a loop of commands.

METHOD OF OPERATION

* 1. Read the Number Track in - p key.

* 2. Read in the Block Selector Routine by striking p key again.

3. Set "Compute" switch to "Go" - a type out will occur.

4. Type in 0000002 tab s for Test Number One. Test Number One will then begin.

5. If Test Number Two is desired, type in 0000005 tab s and perform steps 6 and 7.

* Steps 1 and 2 are automatically executed during start cycle. Steps 1 and 2 must be executed when machine is on.

TEST ROUTINE NUMBER TWO

METHOD OF OPERATION (Continued)

6. The computer will stop on a test ready at which time manual type-in will have been set. The operator must then type a sexadecimal number which is the number of times each type of test will be executed. For example, if 0000010 were typed, each line of the memory will be tested 16 times before the next type of test is accomplished. The normal method of seven digits, tab, and s key is the method used to type this number.

7. After the s key is hit, the computer will proceed to execute each type of test without further manual intervention (unless the computer gets lost). The first test to be made is a test to determine if the accumulator and its associated circuits work reliably. The test involves adding all the commands in Line 0 into the accumulator and subtracting them out again. If the AR is clear after this, the AR is considered reliable; however, if it is not clear, a number is typed out which is characteristic of this test. (See the list of indications.)

In accomplishing the above test, Line 23 is considered to be reliable and is used to store numbers for determination of the end of the test. A bell is rung at the end of the test.

8. The second test is the determination of the reliability of the two-word registers. Again, if an error is made, a characteristic number is typed. Certain four word registers and the AR are used in this test. A bell is rung upon completion of the test.

TEST ROUTINE NUMBER TWO

METHOD OF OPERATION (Continued)

9. The four word registers are then tested and characteristic numbers typed if an error is made. The two word registers and AR are used in this test. A bell is rung at the completion of this test also, the third and last bell in the first block of commands.

10. The next block of commands are then read in. This block tests all of the long lines from one to nineteen by putting the same information as is in line zero into all of them. It fills each line only once, at the beginning of this routine, unless a certain line makes an error, at which time the information in that line is renewed. As a result, the successful completion of this test is assurance that all lines have stored information for a considerable period of time, i.e. equal to the total length of time of the entire test.

The method of indication of errors results in a minimum of type-out. A type-out is not made each time a line makes an error. Instead, the number of errors made by each line is counted and this number typed at the completion of the entire test. At the completion of the test, then, a type-out is made; if no errors have been made, only a series of spaces are typed and nothing will appear on the printed page. However, let us suppose Line 9 has made fifteen errors (this could or could not be the total number of tests made on each line), a number will be typed out as follows:

690000z

TEST ROUTINE NUMBER TWO

METHOD OF OPERATION (Continued)

Notice that the second digit is the line number and the last digit is the number of errors (in sexadecimal). If the number is 7300012, the line would be Line 19 and it would have made 18 errors.

11. The next block of commands is then read in. This tests the inverting gates and the sign circuits of the two word registers. Two bells are rung, one after each of the above named tests.

It should be pointed out that if the inverting gates are not working, the chances are that the tests made in the preceeding blocks likely will not have worked and will have given false indications. The inverting gate test is merely to determine if the error indications have been caused, by chance, by the inverting gates.

12. The next block, after being read in will test the overflow circuits and all combinations of end around carry conditions in both the AR and PN registers. One bell is rung upon completion of both of these tests. Characteristic numbers are typed when errors are made.

13. The next block of commands has three types of tests in it. The first is a multiplication and division test. It involves the determination of the equality:

$$A = \frac{A \cdot B}{B}$$

TEST ROUTINE NUMBER TWO

METHOD OF OPERATION (Continued)

If this equality is not met, the computer then determines if the equality A·B = B·A is met. (A·B is the same multiplication made for testing the first equality.) If this equality is not met, the computer types out a number characteristic of a multiplication error, while if it is met, a division error indication is made. A bell is rung upon completion of the designated number of tests.

14. The second test is of the shifting and normalizing circuits. The test normalizes a number and then shifts it back where it was, hence, compares it with the starting number. A bell is rung upon completion.

15. The third test is of the logical commands. The third bell is rung here.

16. The next block of commands results in two types of tests. The first is a type-out of six test numbers in the following format:

-1122334 445566.7 778899

-uuvvwwx xxyyzz.0 2345

17. The second test in the last block is a series of computations using two standard subroutines. The blocks of commands for the subroutines are read in by the last test block before the type-out of the above test numbers.

The computations involve the calculation of the sine of an angle, θ, and the calculation of the arcsine of sine θ, to produce an angle ϕ. If the computations are correct, $\phi = \theta$;

TEST ROUTINE NUMBER TWO

METHOD OF OPERATION (Continued)

therefore, a check is made on this equality. If the angles are not equal a characteristic number is typed out. The angle, θ, is then varied by an incremental amount and the computation repeated the number of times specified by the operator.

The test type-out is proceeding during at least some of the computations.

18. At the end of these computations the tape automatically reverses to the beginning of the test routine and the operation started at the first test in number 4 above. If the operator wishes to change the number of times each test is accomplished he should stop computations when the first block is being read in and then do the operations starting with number 1.

Part II

ERROR INDICATIONS FOR TEST ROUTINE NUMBER ONE

TEST ROUTINE NUMBER ONE TITLE	Date: 5/27/57	Page 1 of 2 No. 2000

SUMMARY OF ERROR INDICATIONS

Typed Number	Likely Error	Possible, But Not Likely
159539v	Inverting gates (IG), LI	AR
21ul39v	LII	LI AR IG
33v339v	PN	AR IG
3xvx75v	ID MQ	PN* IG
-6466w9y	L4	PN* IG LII
-6466wvy	L5	PN* IG LII
-6466wxy	L6	PN* IG LII
-6466wzy	L7	PN* IG LII
-6466xly	L8	PN* IG LII
-6466x3y	L9	PN* IG LII
-6466x5y	L10	PN* IG LII
-6466x7y	L11	PN* IG LII
-6466x9y	L12	PN* IG LII
-6466xvy	L13	PN* IG LII
-6466xxy	L14	PN* IG LII
-6466xzy	L15	PN* IG LII
-6466yly	L16	PN* IG LII
-6466y3y	L17	PN* IG LII
-6466y5y	L18	PN* IG LII

* See Discussion of PN

TRI

Memory Test Indications

FORM BCD 108-7.0

TEST ROUTINE NUMBER ONE TITLE	Date: 5/27/57	Page 2 of 2 No. 2000

SUMMARY OF ERROR INDICATIONS (Continued)

Typed Number	Likely Error	Possible, But Not Likely
53000	Overflow flip-flop didn't sense OF. Test overflow didn't work.	Program or operator's error.*
56000	Overflow FF not turned off by test.	Test circuit not working properly.
6000	Source 30 or w1	LI LII
12000	Source 27, 29	LI LII
1x000	Multiplication Division LIII	PN* or IG
58000	Shift or Normalize	ID, MQ
32000	Input circuits Photo reader LV, LI9, LIV	

* See Discussion

TR2

Typed Indications of Errors

FORM BCD 108-7.0

Part III

ERROR INDICATIONS TO TEST ROUTINE NUMBER TWO

TEST ROUTINE NUMBER TWO TITLE	Date: 5/27/27	Page 1 of 13 No. 2000

ERROR INDICATIONS

Various characteristic numbers are typed out whenever the computer makes an error. The following is a list of these numbers, the type of error made, and some possibilities as to compute circuits which might have made the error.

1. Accumulator Register Test

393939v This test does additions and subtractions of the commands in LO in the accumulator. If an error is made, it is usually an indication that the accumulator is not holding information reliably, but other circuits such as the inverting gates may also be operating erroneously.

Look for:

1. Accumulator read head out of tangential adjustment.
2. Bad AR read amplifier.
3. Weak tube in AR preamplifier.
4. Bad AR record amplifier.
5. Bad component in accumulator adder.
6. Bad component in inverting gates. (Try replacing IS flip-flop)
7. Read or write head open or shorted.
8. Bad taper pin connection between logic panel and memory.
9. Source or destination selector gates bad.

ERROR INDICATIONS (Continued)

2. PN Register Test

555539v This test stores data in the PN register and compares it against data stored in Line 23. Therefore, Line 23 may be making the error, but since Line 23 was used for read-in, one suspects PN. The AR is used for this test so it may also be making the error although it should be okay if it passes its test.

Look for:

1. PN register read head out of tangential adjustment.
2. Weak read amplifier.
3. Weak preamplifier tube.
4. Bad record amplifier.
5. Bad component in PN adder and associated circuitry.
6. Read or write head open or shorted.
7. Bad taper pin connection to or from memory.
8. Source or destination selector gates bad.

3. ID and MQ Register Tests

656839v ID
y0y39v MQ

See discussion of PN test.

Look for:

1. Read head out of tangential adjustment.
2. Bad read amplifier.
3. Bad preamplifier tube.

ERROR INDICATIONS (Continued)

4. Bad record amplifier.
5. Recirculation, source or destination gates bad.
6. Read or write head open or shorted.
7. Bad taper pin connection.

4. Lines 20, 21, 22, 23

616139v - L20

x1x39v - L21

454639v - L22

595w39v - L23 The AR and two-word registers are used in this test. They could be making the error even though they passed their test but this is unlikely. If L23 indication is made careful scrutiny is in order because it worked properly to read the data from tape.

Look for:

Same things as are listed for ID and MQ Registers.

ERROR INDICATIONS (Continued)

5. Long Line Tests

730000n - Line 19

720000n - Line 18

710000n - Line 17

700000n - Line 16

6z0000n - Line 15

6y0000n - Line 14

6x0000n - Line 13

6w0000n - Line 12

6v0000n - Line 11

6u0000n - Line 10

690000n - Line 9

680000n - Line 8

6 - - - - - - - -

- - - - - - - - -

610000n - Line 1

The number N is the number of times the particular line makes an error. Short lines are used in the test so it should be remembered that they can make errors even though they have passed their own tests. This is unlikely, however.

Look for:

Same things as listed for ID and MQ Registers.

ERROR INDICATIONS (Continued)

6.. Miscellaneous Test

Continuous Bell Ringing

The Long Lines test requires the storage of test data in Line 23. If this data becomes in error, the computer continuously rings a bell. To stop the bell ringing one can hit the s key at which time the computer will try again. However, since Line 23 or some other circuit not connected with a long line failed, the best thing to do is to start the whole routine over to test the other circuits again.

Look for:

1. Line 23 not reliable
2. PN register not reliable

7. Inverting Gates

222439v Additions and subtractions of very simple numbers into the AR are not working properly. The numbers are stored in lines 21 and 22 so that these lines could have failed.

Look for:

1. Bad IS flip-flop.
2. Bad IC flip-flop.
3. Other bad component in the inverting gates.

ERROR INDICATIONS (Continued)

4. Bad AR (See AR test).

5. Bad Line 21 or Line 22 (See test number 4).

8. Sign Circuits of Product Registers

1y1y2xz	Sign did not properly set up to be negative when a negative number entered the ID and a positive entered the MQ.
2x2x29w	Sign was negative when two positive numbers were entered into ID and MQ.
3w3w2xz	Sign was positive when a positive number was entered into the ID and a negative number into the MQ.
484w2xz	Sign was negative when two negative numbers were entered into ID and MQ.

9. Reader Test

nnnnnnn

5w5w39v	When reading in the next block of commands, the computer checks the read in for errors. It types out the block sum that was obtained, which should have been zero, and the indication number.

Look for:

1. Photo reader out of adjustment.
2. Bad Line 23, 19 or 23.
3. Bad AR register (See AR test).
4. Other bad component in input circuitry.

ERROR INDICATIONS (Continued)

10. Overflow Test

Two quantities, A and B, are used in this test. A is equal to $\frac{1}{2}$, B is slightly greater than $\frac{1}{2}$.

12323vz — Overflow did not set when A+B was added in the AR.

ju3u3vz — Overflow did not set when -A -B was calculated in AR.

4444 3vz — Overflow did not set when -A -A was calculated in AR.

4y4x3vz — Overflow set up when the difference of two positive numbers was taken in AR.

5u593vz — Overflow set up when the difference of two positive numbers was taken in PN.

66663vz — Overflow did not set up when A+B was added in PN.

uOu3vz — Overflow did not set up when -A -B was calculated in PN.

191u3vz — Overflow did not set up when -A -A was calculated in PN.

11. End Around Carry Test

This subtracts zero from AR and PN to see if the end around carry is propagated to correct the sign.

25262xz — The sign of (-A -0) was positive indicating no end around carry when calculated in AR.

363v2xz — The sign of (B - 0) was negative when calculated in PN.

12. Multiplication - Division Test

Two numbers, A and B, are used in this test. The identity A·B = C is assumed in the discussion.

ERROR INDICATIONS (Continued)

z5v294 The equality A = $\frac{C}{B}$ does not check but A·B = B·A does check. This indicates division failed.

Look for:

1. Bad IS flip-flop.
2. Bad IC flip-flop.
3. Sloppy wave forms on input to IS flip-flop or elsewhere in inverting gates.
4. Bad buffer-inverter driving "division" signal.
5. Bad component in PN adder.
6. A bad two word register.

105v2v5 The equality A = $\frac{C}{B}$ does not check nor does the equality A·B = B·A. Lines 20 and 23 are used to store intermediate data on this test.

Look for:

1. Bad PN flip-flop or gate driving this flip-flop.
2. Bad PN adder.
3. Slow rising or falling signals in adder inputs or output.
4. Bad two word register.
5. Bad Line 20 or Line 23.

13. Shift and Normalize

A number is put in the even half of MQ and normalized. After normalization it is put in ID and shifted right, with the number of shifts determined by the number accumulated in the AR when normalization was done.

ERROR INDICATIONS (Continued)

The number should end up in the same position of ID that it started in MQ.

65662xw The number left in ID at the end of the shifting operation does not agree with the original number which started in the MQ.

Look for:

1. Bad ID or MQ register.
2. Bad AR register.
3. Circuits used to turn on AR carry for incrementing not working properly.
4. Bad PN flip-flop or associated circuits.
5. Gates controlling control circuits on normalize or on shifting not working properly.

14632zz This is a miscellaneous test. Upon shifting the ID right, the MQ should also be shifted left. Further, the number of shifts should be sufficient to shift all the contents of MQ off the left hand end, clearing MQ. This number will be typed out if MQ is not clear.

Look for:

1. Bad MQ register.
2. Same things as are listed on test above.

14. Logical Commands

x0513vw One or both of the logical commands 20•21 and $\overline{20}$•21 (Sources 31 and 30) did not work properly.

ERROR INDICATIONS (Continued)

Look for:

1. Bad Line 20 or 21.
2. Bad gates for logical commands.

u4292xw The command 20·21 + $\overline{20}$·AR (Source 27) did not work properly.

Look for:

Same as above.

15. Test Type-Out

A test type-out occurs which operates all possible characters of the typewriter.

-1122334 445566.7 778899

-uuvvwwx xxyyzz.0 2345

If this does not type correctly

Look for:

1. Sticking keys on typewriter.
2. Broken or sticking relays in typewriter base.
3. Bad OB flip-flop.
4. Bad Line 23, Line 19 or Line 2.
5. Any other Input/Output circuit.

16. Computation Test

w7483xv This test involves the calculation of the sine of an angle, θ, and the calculation of the arcsine of this result. If the arcsine agrees with θ, the test is passed. This is the last test of the routine, and

ERROR INDICATIONS (Continued)

since practically all circuits are tested before this, this should work.

Look for:

1. Bad CD flip-flop (this is not tested before) or circuit driving CD.
2. Something wrong with computation registers (all short tracks).
3. Since type-out occurs during computation look for arcing contacts in typewriter relays.
4. Any other portion of machine bad.

TEST ROUTINE NUMBER TWO TITLE	Date: 5/27/57	Page 12 of 13 No. 2000

SUMMARY OF ERROR INDICATIONS

1.	393939v	Accumulator Register
2.	555539v	PN Register
3.	656839v	IO Register
4.	y0y39v	MQ Register
5.	616139v	Line 20
6.	x1x39v	Line 21
7.	454639v	Line 22
8.	595w39v	Line 23
9.	6?0000N	Line ?
10.	7?0000N	Line 16 + ?
11.	Continuous Bells	Line 23, or PN
12.	222439v	Inverting Gates
13.	1y1y2xz	Sign Circuits
14.	2x2x29w	Sign Circuits
15.	3w3w2xz	Sign Circuits
16.	484w2xz	Sign Circuits
17.	5w5w39v	Input Error
18.	32323vz	Overflow Circuits
19.	3u3u3vz	Overflow Circuits
20.	4444 3vz	Overflow Circuits
21.	4y4x3vz	Overflow Circuits
22.	54593vz	Overflow Circuits
23.	u0u3vz	Overflow Circuits

TEST ROUTINE NUMBER TWO TITLE	Date: 5/27/57	Page 13 of 13 No. 2000

SUMMARY OF ERROR INDICATIONS (Continued)

24.	191u3vz		Overflow Circuits	
25.	25262xz		End Around Carry - AR	
26.	363v2xz		End Around Carry - PN	
27.	z5v294		Division	
28.	105v2v5		Multiplication	
29.	65662xw		Shift or Normalize	
30.	14632zz		Shift or Normalize	
31.	x0513vw		Source 30 or 31	
32.	u4292xw		Source 27	
33.	-112234	445566.7	778899	Test Type Out
	-uuvvwwx	xxyyzz.0	2345	
34.	w7483zv		Computational Error	

March 15, 1960
James F. Jecker

TEST ROUTINE OPERATION & INFORMATION

I. GENERAL INFORMATION ABOUT DATA BLOCKS ON THE PAPER TAPE

Block #	Information
0	Number track
1	Block Selection Routine a) contains standard format. b) allows selection of block which begins the test routine to be chosen. c) gates the computer for type-in.
2	Test #1
3	Test #1
4	Test #1
5 thru 12	Test #2

II. OPERATION PROCEDURE

a) Blocks "0" and "1" are read automatically when D.C. is turned on.

b) Set compute to <GO> after the green ready light on the front panel comes on.

c) A "1" should type out.

d) Select the test routine desired by typing in <GO> 000000 followed by the block number in which the desired test routine begins e.g.,

(1) 000000 2 TAB S (TEST #1)

(2) 000000 5 TAB S (TEST #2)

e) If (1) above is selected Test #1 will be initiated and repeat, ringing the bell twice during each compute cycle of testing.

f) To select Test #2 after Test #1 has been cycled Block #5 must be read in by <SA> <P>. NOTE: Up until this point only four blocks have been read in.

g) After reading in Block #5 the operator must select the number of times he desires the test to be cycled before each type-out. (This type-out is simply an impression test of all the typewriter keys available to the G-15.)