PROGRAMMING COMPATIBILITY OF 920 SERIES COMPUTERS

Differences between the computers of the 920 range occur in the following areas.

1. Secondary effects of instructions on the auxiliary register.
2. The high order digit positions of the S.C.R.
3. The effects of certain addresses in functions 14 and 15.

Tables 1, 2 and 3 list the complete effect of all operations on 920A, B and M; the effects being divided where appropriate into primary, which constitute the basic 920 series instruction code, and secondary which vary between the different models.

It will be noted that the effects of functions 0, 2 and 13 on the auxiliary register are regarded as primary.

The following rules should be observed whenever there is any possibility of compatibility problems arising. Future 920 series machines should accept programs written in accordance with either set of rules.

1. Universal Programs

These are programs which can be run on any 920 series machine.

(a) Functions 6, 7, 8, 9 and 11 also B-modification must be assumed to alter the Q register in an undefined manner.

(b) Bits 14-18 of the S.C.R. must be regarded as undefined.

(c) 14 instructions must not have addresses in the range $36 < N < 8156$.

(d) Tape reader input must use instruction 15 2048.

(e) 503 paper tape format must be used.

(f) Tape punch output must use 15 6144.

(g) Priority terminate instruction must be 15 7168.

(h) Locations 8183 and 8186 of the initial instructions must not be addressed.

(i) A program must not address its own S.C.R. location (0, 2, 4 or 6); it may however, address the S.C.R. locations of other priority levels.

(j) B-modification (i.e. the addition of B register contents to the instruction) must not alter the B or function digit positions, except for functions 14 and 15.

2. 920B Forward Compatible Programs

These are programs which use facilities not available on 920A (e.g. block transfer, extra store) or which for other reasons will never be used with 920A, but which would possibly be required to be used on 920M or any future designs.

(a) Functions 7, 9 and 11, also B-modification must be assumed to alter the Q register in an undefined manner.

(b) Bits 17-18 of the S.C.R. must be regarded as undefined.

(c) 14 instructions must not have addresses in the ranges $36 < N \leqslant 2047$ and $6144 \leqslant N < 8156$.

(d) 15 instructions with addresses in the ranges $2049 \leqslant N \leqslant 4095$, $6145 \leqslant N \leqslant 7167$ and $7169 \leqslant N \leqslant 8191$ must not be used.

(e) A program must not address its own S.C.R. location.

(f) B-modification (i.e. the result of adding B (18 digits) to N (16 digits)) must not generate an address exceeding 65,535 ($= 2^{16-1}$).

(g) The effect of a block transfer instruction on A and Q must be regarded as undefined.

Restrictions 1(i), 2(b), 2(d) (part), 2(e) and 2(f) are imposed to allow for possible future developments of the series.

Paper Tape Codes

No requirements as to paper tape codes or format have been included in 2. above; the 920B has three modes of tape input.

1. Ignoring track 5 (i.e. the 503 code format used on 920A, ignoring parity check).

2. Ignoring track 8 (i.e. 4100 code format ignoring parity check).

3. 8 track input.

Whereas all current 920 programs use mode 1, it is expected that the 503 code will fall out of use eventually with the anticipated international standardization of tape codes. It having been decided that the 903 (i.e. the commercial version of the 920B) will use the 4100 tape code (which is compatible with the proposed international standard) in conjunction with mode 3, it is recommended that any programs written to use 4100 or A.S.I.I. codes should use mode 3.

When mode 3 is used tapes for input by initial instructions must be punched with no holes in track 8, i.e. without the parity check bit, as the input instruction always shifts 7 places and the eighth track is "ORed" into digit position 8 of the accumulator. Such tapes can be copied, but not prepared on a model 33 teleprinter.

Notation

In the tables that follow:

A	refer to the contents of the	Accumulator
Q		Q register
B		Modifier register
S		Sequence control register

(A, Q) means the double length number held in A and Q_{2-18}.

N means the address bits of the instruction (modified when appropriate); N consists of 13 bits for 920A and 16 bits for 920B (other bit positioning are undefined).

n means the contents of store location N.

I* (920A only) means all 18 bits of the instruction. If the instruction is modified I* is the result of adding the B register contents to the instruction (18 bits).

Individual digit positions and groups of digits are indicated by suffixes.

B-modification

This has the following effects:

On 920A the complete unmodified instruction is placed in Q.

On 920B ~~and 920M~~ the unmodified address (16 digits) is placed in Q.

On 920M Q is affected.

The number thus placed in Q will be over-written if the instruction itself has any effect on Q.

TABLE 1

FUNCTIONS 0 - 13

Function Number	Name	Prime Effects 920A	Prime Effects 920B	Prime Effects 920M	Secondary Effects 920A	Secondary Effects 920B	Secondary Effects 920M
0	Set B	B: = n Q: = n			-	-	-
1	Add	A: = A + n			-	-	-
2	Negate and add	A: = n - A Q: = n			-	-	-
3	Store A.R.	n_{18}: = 0 n_{1-17}: = Q_{2-18}			-	-	-
4	Read	A: = n			-	-	-
5	Write	n: = A			-	-	-
6	Collate	A: = A & n			Q: = A + n	-	-
7	Jump if zero	S: = I* if A = 0	S: = N if A = 0	S: = N if A = 0	Q: = I*	Q: = N	Q: = N
8	Jump	S: = I*	S: = N	S: = N	Q: = I*	-	-
9	Jump if negative	S: = I* if A < 0	S: = N if A < 0	S: = N if A < 0	Q: = I*	Q: = N	-
10	Count in store	n: = n + 2^{-17}			-	-	-

Table 1 (Continued)

Function Number	Name	Prime Effects 920A 920B 920M	Secondary Effects 920A	920B	920M
I1	Store S.C.R.	n: = S	Q: = S	Q: = N	Q: = N
I2	Multiply	A, Q: = A x n	Q_1: = 1 if A < 0 otherwise Q_1: = 0		
I3	Divide	$A: = \frac{(A, Q)}{n} \pm 2^{-17}$	-	-	-
		$Q: = \frac{(A, Q)}{n} + 0, -2^{-16}$	-	-	-
		$(A_1: = 1, Q_1: = 0)$			

TABLE 2

FUNCTION 14

Address range (inclusive)	Effect 920A	920B	920M
0 to 48	Shift (A, R) N_{1-12} places left		
49 to 2047	Shift (A, R) N_{1-12} places left		If $N_{1-6} \leqslant 48$ shift N_{1-6} places left If $N_{1-6} > 48$ shift $N_{1-6}-16$ places left
2048 to 4095	Shift (A, R) N_{1-12} places left	Block transfer input from device selected by N_{1-11} into locations A to A + Q_{1-12} - 1 A and Q not changed	Block transfer input from device selected by N_{1-11} into locations A to A + Q_{1-12} - 1 A: = last word input Q: = -(A + Q_{1-12})
4096 to 6143	Shift (A, R) right (4096-N_{1-12}) places arithmetically.	Block transfer output to device selected by N_{1-12} from locations A to A + Q_{1-12} - 1 A: = last word output Q not affected	Block transfer output to device selected by N_{1-12} from locations A to A + Q_{1-12} - 1 A: = last word output Q: = -(A + Q_{1-12})
6144 to 8143	Shift (A, Q) right (4096-N_{1-12}) places arithmetically.	Shift (A, Q) right (4096-N_{1-12}) places arithmetically.	If (64-N_{1-6}) $\leqslant$ 48 shift (64-N_{1-6}) places right. If (64-N_{1-6}) > 48 shift (48-N_{1-6}) places right.
8144 to 8191	Shift (A, Q) right (4096-N_{1-12}) places arithmetically		

Note that N* is interpreted modulo 8192 for all function 14 instructions

TABLE 3

FUNCTION 15

Address range (inclusive)	Effect 920A	920B	920M
0 to 2047	Input from device selected by N_{1-11}		
2048	Tape Reader input		
2049 to 2063	Tape reader input	Other input instructions via tape channel (selected by N_{1-4}) Acc. shifted left 7 places	Other input instructions via tape channel (selected by N_1 and N_2) Acc. shifted left 7 places
2064 to 4095	Tape reader input	Computer stops	
4096 to 6143	Output to device selected by N_{1-11}		
6144	Tape punch output		
6145 to 6159	Tape punch output	Other output instructions via paper tape channel (selected by N_{1-4})	Other output instructions via paper tape channel (selected by N_1 and N_2)
6160 to 7167	Tape punch output	Computer stops	
7168	Program terminate		
7169 to 7183	Program terminate	Program terminate	Program terminate
7184 to 8191	Program terminate	Computer stops	Program terminate

TABLE 4

INITIAL INSTRUCTIONS

Address	Contents	
	920A	920B and 920M
8180	/15 8189	/15 8189
8181	0 8180	0 8180
8182	4 8189	4 8189
8183	15 4084	15 2048
8184	9 8186	9 8186
8185	8 8183	8 8183
8186	15 4094	15 2048
8187	/5 8180	/5 8180
8188	10 1	10 1
8189	4 1	4 1
8190	9 8182	9 8182
8191	8 8177	8 8177

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322/PJL/JGG
12th November, 1965