SYSTEM TIMINGS

Key to abbreviations used in formulas

- L_A = Length of the A-field
- L_B = Length of the B-field
- L_C = Length of Multiplicand field
- L_I = Length of Instruction
- L_M = Length of Multiplier field
- L_Q = Length of Quotient field
- L_R = Length of Divisor field
- L_S = Number of significant digits in Divisor (Excludes high-order 0's and blanks)
- L_W = Length of A- or B-field, whichever is shorter
- L_X = Number of characters to be cleared
- L_Y = Number of characters back to right-most "0" in control field
- L_Z = Number of 0's inserted in a field
- I/O = Timing for Input or Output cycle
- F_m = Forms movement times. Allow 20 ms for first space, plus 5 ms for each additional space
- T_m = Tape movement times
- Σ = Number of fields included in an operation

OPERATION	OP CODE	FORMULA
Add (no recomplement)	A	.0115 ($L_I + 3 + L_A + L_B$)
Add (recomplement)	A	.0115 ($L_I + 3 + L_A + 4\ L_B$)
Branch	B	.0115 ($L_I + 1$)
Branch if Bit Equal*	W	.0115 ($L_I + 2$)
Branch if Character Equal	B	.0115 ($L_I + 2$)
Branch if Indicator On	B	.0115 ($L_I + 1$)
Branch if Word Mark and/or Zone	V	.0115 ($L_I + 2$)
Clear Storage	/	.0115 ($L_I + 1 + L_X$)
Clear Word Mark	□	.0115 ($L_I + 3$)
Compare	C	.0115 ($L_I + 1 + L_A + L_B$)
Control Carriage	F	.0115 ($L_I + 1$) + F_m
Control Unit	U	.0115 ($L_I + 1$) + T_m
Divide (aver.)*	%	.0115 ($L_I + 2 + 7\ L_R\ L_Q + 8\ L_Q$)
Halt	•	.0115 ($L_I + 1$)
Load Characters to A Word Mark	L	.0115 ($L_I + 1 + 2\ L_A$)
Modify Address*	#	.0115 ($L_I + 9$)
Move Characters to A or B Word Mark	M	.0115 ($L_I + 1 + 2\ L_W$)
Move Characters and Edit	E	.0115 ($L_I + 1 + L_A + L_B + L_Y$)
Move Characters to Record or Word Mark*	P	.0115 ($L_I + 1 + 2\ L_A$)
Move Characters and Suppress Zeros	Z	.0115 ($L_I + 1 + 3\ L_A$)
Move and Insert Zeros*	X	.0115 ($L_I + 1 + 2\ \Sigma\ L_A + \Sigma\ L_Z$)
Move Numeric	D	.0115 ($L_I + 3$)
Move Zone	Y	.0115 ($L_I + 3$)
Multiply (aver.)*	@	.0115 ($L_I + 3 + 2\ L_C + 5 L_C L_M + 7\ L_M$)
No Operation	N	.0115 ($L_I + 1$)

SYSTEM TIMINGS

OPERATION	OP CODE	FORMULA
Punch a Card	4	.0115 ($L_I + 1$) + I/O
Read a Card	1	.0115 ($L_I + 1$) + I/O
Read and Punch	5	.0115 ($L_I + 1$) + I/O
Select Stacker	K	.0115 ($L_I + 1$)
Set Word Mark	,	.0115 ($L_I + 3$)
Start Punch Feed*	9	.0115 ($L_I + 1$)
Start Read Feed*	8	.0115 ($L_I + 1$)
Store A-address Register*	Q	.0115 ($L_I + 5$)
Store B-address Register*	H	.0115 ($L_I + 4$)
Subtract (no recomplement)	S	.0115 ($L_I + 3 + L_A + L_B$)
Subtract (recomplement)	S	.0115 ($L_I + 3 + L_A + 4\ L_B$)
Write a Line	2	.0115 ($L_I + 1$) + I/O
Write and Punch	6	.0115 ($L_I + 1$) + I/O
Write and Read	3	.0115 ($L_I + 1$) + I/O
Write, Read and Punch	7	.0115 ($L_I + 1$) + I/O
Zero and Add	+ 0	.0115 ($L_I + 1 + L_A + L_B$)
Zero and Subtract	− 0	.0115 ($L_I + 1 + L_A + L_B$)

TAPE OPERATIONS

T_m — Tape movement can be determined from the following:

N = Number of Characters

C = Character Rate

729 II at 200 cpi = .067 ms
at 556 cpi = .024 ms
729 IV at 200 cpi = .044 ms
at 556 cpi = .016 ms
7330 at 200 cpi = .139 ms
at 556 cpi = .050 ms

Write, Read Tape
729 Model II = 10.8 + CN ms
729 Model IV = 7.3 + CN ms
7330 Read 7.6 + C(N+7) = ms if processing exceeds 13.2 ms
20.8 + C(N+7) = ms if processing is less than 13.2 ms
Write 13.3 + C(N+4) = ms if processing exceeds 7.5 ms
20.8 + C(N+4) = ms if processing is less than 7.5 ms

Rewind
729 Model II =1.2 minutes/reel
729 Model IV = .9 minutes/reel
7330 (High Speed) = 2.2 minutes/reel

Skip and Blank Tape
(add to subsequent write time)
729 Model II = 108 ms
729 Model IV = 72 ms
7330 = 108 ms

Backspace (after Read)
729 Model II = 46 + CN ms
729 Model IV = 33 + CN ms
7330 = 436.1 + CN ms

Backspace (after Write)
729 Model II = 52 + CN ms
729 Model IV = 37 + CN ms
7330 = 452.1 + CN ms

IBM® 1401 Data Processing System Reference Card

INSTRUCTION FORMAT

The IBM 1401 Data Processing System uses a variable word-length concept; the length of an instruction can vary from one to eight characters.

OP CODE	A- or I-ADDRESS	B-ADDRESS	d-CHARACTER
X	XXX	XXX	X

Op Code: This is always a single character which defines the basic operation being performed. A word mark is always associated with the operation code position of an instruction.

A-Address: This always consists of three characters. It can identify the units position of the A-field, or it can be used to select a special unit or feature (tape unit, 1412 magnetic character reader, column binary feature, disk storage, inquiry, etc.).

I-Address: Instructions that can cause program branches use the I-address to specify the location of the next instruction to be executed if a branch occurs.

B-Address: This is a three-character storage address associated with the B-field. It usually addresses the units position of the B-field, but in some operations, such as tape or disk record read and write, it specifies the high-order position of a record storage area.

d-Character: The d-character is used to modify an operation code. It is a single alphabetic, numerical, or special character, positioned as the last character of an instruction. It can be used with instructions of any length.

RAMAC 1401

INSTRUCTION FORMAT

OP CODE	A- or I-ADDRESS	B-ADDRESS	d-CHARACTER
X	%FX	XXX	X

d modifier
R = Read
W = Write

Specifies core storage location of disk address and record area

Operation
0 — Seek, 1 — Single record
2 — Full track, 3 — Write check

Operation Code
M — Read or Write
L — Read or Write with Word Marks

DISK ADDRESS FORMAT

ACCESS ARM	DISK UNIT	DISK FACE	TRACK	SECTOR	CONSTANT
X	X	XX	XX	X	X
0-1	0	00-99	00-99	0-9	0

TIMINGS (Model 2)	MAX.	AVG.	MIN.
Disk to Disk	800 ms	600 ms	450 ms
Track to Track	250 ms	175 ms	100 ms
Record to Record, same Track	50 ms	25 ms	

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INPUT-OUTPUT CODES

1	Read a Card	R	1	1
2	Write a Line	W	2	2
2 □	Write Word Marks	□ is modifier		
3	Write-Read	WR	C21	3
4	Punch a Card	P	4	4
4R	Read-Punch Feed*	R is modifier		
4(I)R	Read-Punch Feed and Branch*	R is modifier		
5	Read-Punch	RP	C41	5
6	Write-Punch	WP	C42	6
6R	Write-Read Punch Feed*	R is modifier		
6(I)R	Write-Read Punch Feed and Branch*	R is modifier		
7	Write-Read-Punch	WRP	421	7
8	Start Read Feed*	SRF	8	8
9	Start Punch Feed*	SPF	C81	9

ARITHMETIC CODES

A	Add	A	BA1	12-1
S	Subtract	S	CA2	0-2
+ 0	Zero and Add	ZA	CBA82	12-0
− 0	Zero and Subtract	ZS	B82	11-0
@	Multiply*	M	C84	4-8
%	Divide*	D	A84	0-4-8

LOGIC OPERATION CODES

B(I)	Branch	B	BA2	12-2
B(I)d	Branch if Indicator ON	d is modifier		
B(I)(B)d	Branch if Character is Equal	Contents of B compared to d		
V(I)(B)d	Branch if WM and/or Zone	BWZ	A41	0-5

MOVE AND LOAD CODES

D	Move Numerical	MN	BA4	12-4
L	Load Character to A Word Mark	LCA	B21	11-3
M	Move Characters to A or B Word Mark	MCW	CB4	11-4
Y	Move Zone	MZ	CA8	0-8
Z	Move Characters and Suppress Zeros	MCS	A81	0-9
'	Set Word Mark	SW	CA821	0-3-8
□	Clear Word Mark	CW	CBA84	12-4-8

* Special Feature

MISCELLANEOUS OPERATION CODES

C	Compare	C	CBA21	12-3
E	Move Characters and Edit	MCE	CBA41	12-5
F	Control Carriage	CC	CBA42	12-6
H	Store B-Address Register*	SBR	BA8	12-8
K	Select Stacker	SS	CB2	11-2
N	No Operation	NOP	B41	11-5
Q	Store A-Address Register*	SAR	CB8	11-8
/	Clear Storage	CS	CA1	0-1
.	Halt	H	BA821	12-3-8
#	Modify Address*	MA	821	3-8

CHARACTER AT d FOR B I d BRANCH

d	BRANCH ON	d	BRANCH ON
b1	Unconditional	R	Carriage Busy*
9	Carr. Chan. #9	T	Low Compare B < A*
A	"Last Card" Switch	U	High Compare B > A*
B	Sense Switch B*	Z	Overflow
C	Sense Switch C*	+ 0	Reader Error if I/O Check Stop Switch OFF
D	Sense Switch D*		
E	Sense Switch E*	− 0	Punch Error if I/O Check Stop Switch OFF
F	Sense Switch F*		
G	Sense Switch G*	+	Printer Error if I/O Check Stop Switch OFF
K	End of Reel*	@	Carr. Chan. #12
L	Tape Error*	%	Processing Check with Process Check Switch OFF
S	Equal Compare B = A*		
P	Printer Busy*	/	Unequal Compare B ≠ A
Q	Inquiry Request (1407)	*	Inquiry Clear (1407)

COLUMN BINARY

1C	Read Column Binary	C is Modifier
4C	Punch Column Binary	C is Modifier
M(A)(B)A	Move and Binary Decode	A is Modifier
M(A)(B)B	Move Binary Code	B is Modifier
M(%BX)(A)R	Read Binary Tape	%BX is Address of tape unit
M(%BX)(A)W	Write Binary Tape	
W(I)(B)d	Branch if Bit Equal	BBE is mnemonic

1407 INQUIRY %TO ADDRESS

M(%TO)(B)R	Read Console Printer	Data from 1407 transferred to B-address
M(%TO)(B)W	Write Console Printer	Data at B-address transferred to 1407
L(%TO)(B)R	Read Console Printer with Word Marks	Data from 1407 transferred to B-address with Word Marks
L(%TO)(B)W	Write Console Printer with Word Marks	Data at B-address transferred to 1407 with Word Marks

MAGNETIC TAPE %UX TAPE UNIT ADDRESS

L(%UX)(B)d	Read/Write Tape with Word Marks	d-modifier, R-Read Tape W-Write Tape		
M(%UX)(B)d	Read/Write Tape			
M(%CX)(B)R	Read Compressed Tape*	(%CX) is address of tape unit		
P(A)(B)	Move Characters to Record or Group Mark*	MCM	CB421	11-7
U(%UX)d	Control Unit	CU	CA4	0-4
X(A)(B)	Move and Insert Zeros*	MIZ	CA421	0-7

DISK STORAGE %FX DISK OPERATION

M(%F0)(B)	Seek Disk	B is Disk Address
M(%FX)(B)R	Read Disk	X can be 1, 2, or 3 1 Specifies Single Record 2 Specifies Full Track 3 Specifies a Write Disk Check operation M(%F3)(B)W
M(%FX)(B)W	Write Disk	
L(%FX)(B)R	Read Disk with Word Marks	
L(%FX)(B)W	Write Disk with Word Marks	

1412 MAGNETIC CHARACTER READER %S1 MAG CHAR READER ADDRESS

Kd	Select Stacker Char Reader	d is Modifier
L(%S1)(B)R	Read from Character Reader	R-Reader
U(%S1)d	Control Unit	d, E-Engage, D-Disengage

CHARACTER AT d FOR MAGNETIC TAPE

d	OPERATION
B	Backspace Tape Record
E	Skip and Blank Tape
M	Write Tape Mark
R	Rewind Tape
U	Rewind Tape and Unload

CHARACTER AT d FOR 1412 MAG CHAR READER

d	BRANCH ON
1	Control-Check Indicator ON
2	Reader-not-Ready Signal ON
3	Read-Check Indicator ON
4	Amount-Field Indicator ON
5	Process-Control Indicator ON
6	Account-Number Indicator ON
7	Transit-Number Indicator ON
8	Document-Spacing-Check Indicator ON

CHARACTER AT d FOR DISK STORAGE

d	BRANCH ON	d	BRANCH ON
V	Read/Write Parity Check or Read Back Check Error	X	Unequal Address Compare
W	Wrong-Length Record	Y	Any Disk Storage Error Condition

* Special Feature