

NCR390 MACHINE LANGUAGE INSTRUCTIONS

IMPORTANT

Instructions Not Simulated

The following instructions are not simulated by SIM390, but will be compiled correctly by the PL390C compiler. They are processed by the simulator as "halting no-ops", causing the simulator to halt (except for ACL which is treated as a no-op only, without the halt). The halt can be resumed by depressing the ENTER key.

1. Read Magnetic Ledger (lacking info):
 - ACL - Accept Ledger (no-op only - no halt on SIM390)
 - REJ - Read and Eject Ledger
 - RLR - Read from Ledger Reader
 - RMG - Read Ledger with Magnetic Line Find
 - RMK - Read Ledger with Mechanical Line Find
2. Write Magnetic Ledger (lacking info, writes backwards):
 - WTL - Write Ledger with Line Find (see also WTN)
 - WTN - Write Ledger with No Line Find

NCR390 COMMAND INSTRUCTIONS (FROM NCR CORP MANUAL, 1963, 1-PAGE SUMMARY OF INSTRUCTIONS).

TERMINOLOGY NOTE: NCR CALLED THE FIRST 2 DIGITS OF THE INSTRUCTION THE "COMMAND". THE ENTIRE 12 DIGITS WERE CALLED THE "INSTRUCTION".

WE ARE CALLING THE COMMAND THE "OPERATION CODE" (OPCODE) TO DISTINGUISH IT FROM OPERATOR COMMANDS WHICH CAN BE ENTERED ON THE CONSOLE BY THE SIM390 OPERATOR, AND EMBEDDED IN A TAPE INPUT STREAM BY THE PROGRAMMER.

CELL SIZE: 12 DIGITS.
MEMORY SIZE: 200 CELLS NUMBERED 00 THRU 199.
TOTAL BYTES: 2,400 BYTES
ADDRESSABLE UNIT: 1 CELL (12 DIGITS).

CELL FORMAT (EXPANDED FOR LEGIBILITY):
OP YZ AA BB CC NI

...WHERE Y=MODIFIER,
Z=MEMORY PLANE

EXAMPLE:
05 10 01 99 00 02

(OP) = 2-DIGIT OPERATION CODE (OPCODE).

(MOD) = 1-DIGIT OPCODE MODIFIER. LETTERS E THRU U SPECIFY MOD.

(MEMORY PLANE) = 1-DIGIT MEMORY PLANE TYPE - R OR S.
L = LOWER MEMORY, IE, CELLS 00-99.

U = UPPER MEMORY, IE, CELLS 100-199.
 A "U" IN THE MEMORY PLANE POSITION FOR AN
 ADDRESS INTERNALLY ADDS 100 TO THE SPECIFIED
 ADDRESS TO PRODUCE AN EFFECTIVE ADDRESS 100
 CELLS HIGHER.

-- = IGNORED BY THE COMPUTER.

A = 2-DIGIT ADDRESS. MEMORY PLANE DETERMINES EFFECTIVE
 ADDRESS.

B = 2-DIGIT ADDRESS. MEMORY PLANE DETERMINES EFFECTIVE
 ADDRESS.

C = 2-DIGIT ADDRESS. MEMORY PLANE DETERMINES EFFECTIVE
 ADDRESS.
 SOME OPCODES HAVE ONLY AN OPCODE MODIFIER IN THE
 C POSITION. LETTERS E THRU U SPECIFY MOD.

D = 2-DIGIT ADDRESS. MEMORY PLANE DETERMINES EFFECTIVE
 ADDRESS.

NI = ADDRESS OF NEXT INSTRUCTION.

AI = ALTERNATE INSTRUCTION ADDRESS (DEPENDING ON RESULT)
 TO BE USED INSTEAD OF NEXT INSTRUCTION.
 USED FOR THE C ADDRESS IN SOME INSTRUCTIONS.

EW = END OF WORD PUNCHED SYMBOL.

ER = END OF RECORD PUNCHED SYMBOL.

EOT= END OF TAPE PUNCHED SYMBOL.
 EOT'S COULD ONLY BE PRODUCED BY PRESSING THE "EOT"
 BUTTON ON THE PAPER TAPE PUNCH. THE PAPER TAPE PUNCH
 WOULD PUNCH EOT'S UNTIL THE BUTTON WAS RELEASED.

BRIEF DESCRIPTIONS OF OPCODE MODIFIERS ARE GIVEN WITH
 EACH APPLICABLE OPCODE. SEE TEXT FOLLOWING THE
 OPCODES FOR FULL EXPLANATION.

DESCRIPTION	MEMORY				ADDRESSES			
	OP CODE	MOD	E	N	A	B	C	D
RDC - READ CONSOLE INTO A THRU B. OPERATOR INPUT. E = PAPER/CARRIAGE MODIFIER L = PUNCHING MODIFIER	00	E	S		AA	BB	-L	NI
PRT - PRINT FROM A THRU B.	01	E	S		AA	BB	PL	NI

E = PAPER/CARRIAGE MODIFIER
P = PRINTING MODIFIER
L = PUNCHING MODIFIER

CAC - CARRIAGE CONTROL
CARRIAGE MOVEMENT/PUNCHING 02 E R -- -- -L NI
E = PAPER/CARRIAGE MODIFIER
L = PUNCHING MODIFIER

CARRIAGE OPEN 02 8 R -- -- -4 NI

ADVANCE CONTINUOUS FORMS 02 9 R -- -- -4 NI
(TRACTOR FEED FOR PERFORATED
FORMS INSTEAD OF NORMAL
NARROW PAPER WITH PLATEN
FEED.
ACF = ADVANCE TO TOP OF
NEXT FORM.)

HLT - HALT [STOP PROCESSING] 03 - R -- -- -- NI
NI AFTER ENTER KEY
DEPRESSED

RPC - READ PUNCHED CARD 04 U S AA BB -- NI
INTO A THRU B.
U = CARD READING MODIFIER

RPT - READ PAPER TAPE (RR) 05 1 S AA BB AI NI
INTO A THRU B.
USE AI ADDRESS IF EOT'S
ENCOUNTERED. EG, LOOP TO
THIS INSTRUCTION UNTIL
DATA IS ENCOUNTERED, THEN
READ DATA INTO CELLS A
THRU B, 1 WORD (1 CELL)
AT A TIME. OR, IF EOT'S
ENCOUNTERED, GO TO EOF
ROUTINE.

RPT - READ PAPER TAPE (SR) 05 3 S AA BB AI NI
INTO A THRU B.
USE AI ADDRESS IF EOT'S
ENCOUNTERED. EG, LOOP TO
THIS INSTRUCTION UNTIL
DATA IS ENCOUNTERED, THEN
READ DATA INTO CELLS A
THRU B, 1 WORD (1 CELL)
AT A TIME. OR, IF EOT'S
ENCOUNTERED, GO TO EOF
ROUTINE.

RWP - RWD PAPER TAPE (RR) 05 4 R -- -- -- NI

RDL - READ MAG LEDGER 06 N S AA BB -- NI
INTO A THRU B.
N = READ MODIFIER

WTL - WRITE MAG LEDGER 07 M S AA BB -- NI
FROM A THRU B.
M = WRITE MODIFIER.
WRITE BACKWARDS A THRU B,
WHERE A GE B.
EXAMPLES:

READ: 06 XX 64 99 00 02
WRITE: 07 XX 99 64 00 03

SUM - SUMMARIZE A THRU B ==> C	08 0 S AA BB CC NI
CLR - CLEAR A THRU B. SET CELLS A THRU B TO ZERO.	09 0 S AA BB -- NI
MDD - MULTIPLY DOLLAR DECIMAL A X B ==> C. B MAX = 11 DIGITS. THE RESULT IS PLACED IN C, ROUNDED, AND SHIFTED RIGHT 2 PLACES.	10 0 R AA BB CC NI
MUS - MULTIPLY AND SHIFT A X B ==> B. B MAX = 11 DIGITS. F*= SHIFTING ATTRIBUTES. ONLY 0, 3, 7 ARE VALID FOR THIS OPCODE. SEE F MODIFIER, BELOW. G = NBR OF POS TO SHIFT	11 F* R AA BB GG NI
INS - INSERT DIGITS SELECTED DIGITS FROM A INTO B H = NBR OF DIGITS TO INSERT J = STARTING POS FOR INSERT	12 H R AA BB -J NI
SHF - SHIFT AND COPY A INTO B. F = SHIFTING ATTRIBUTES. G = NBR OF POS TO SHIFT. IF G GT 12, B ==> 0	13 F R AA BB GG NI
SUB - SUBTRACT A - B ==> C	14 0 R AA BB CC NI
CFE - COMPARE FOR EQUALITY A TO B: AI IF NOT EQUAL NI IF EQUAL	15 0 R AA BB AI NI
CFZ - COMPARE FOR ZERO A TO ZERO: AI IF NOT ZERO NI IF ZERO	15 1 R AA -- AI NI
CFM - COMPARE FOR MAGNITUDE A TO B: AI IF A IS LESS NI IF A IS GE	16 0 R AA BB AI NI
ADD - ADD A + B ==> C	17 0 R AA BB CC NI
CPY - COPY A INTO C	17 1 R AA -- CC NI
BLA - BLOCK ADD A TO B. K = NBR OF TIMES TO	18 0 R AA BB KK NI

$$\begin{array}{lcl} A & + & B \implies B \\ A+1 & + & B+1 \implies B+1 \\ A+2 & + & B+2 \implies B+2 \dots \end{array}$$

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BLC - BLOCK COPY          18  1  R   AA  BB  KK  NI
  A INTO B.
  K = NBR OF TIMES TO
  INCREMENT A AND B ADDRS.
  A ==> B
  A+1 ==> B+1
  A+2 ==> B+2...

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DIV - DIVIDE                19  0  R   AA  BB  CC  NI
  A / B ==> C.
  QUOTIENT GIVEN TO
  4 DECIMAL PLACES.
  C = NNNNNNNN.NNNN
  EX: 10 / 2 = 5.0000
      EXPRESSED AS
      50000

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SIM390 OPCODE EXTENSIONS

```
EOJ - END-OF-JOB          20  -  R   --  --  --  CO
  END THE CURRENT JOB.
  OPTIONALLY SET CONDITION
  CODE (CO) VIA THE NI
  POSITION.
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CAN - CANCEL JOB                21  -  R  --  --  --  --
  CANCEL THE CURRENT JOB.

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OPCODE MODIFIERS

E

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... PAPER/CARRIAGE ATTRIBUTES
0 - PAPER FEED AND NON-TAB
1 - NO PAPER FEED AND NON-TAB
2 - TAB TO A NBR 1 BLOCK
3 - CARRIAGE RETURN TO NBR 1 INSERT
4 - SKIP TAB TO A NBR 2 BLOCK
5 - SKIP TAB TO A NBR 3 BLOCK

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F

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... SHIFTING ATTRIBUTES.
0 - SHIFT LEFT
1 - SHIFT RIGHT, ABSOLUTE
3 - SHIFT RIGHT, RETAIN SIGN
5 - SHIFT RIGHT, ABSOLUTE, AND ROUND
7 - SHIFT RIGHT, RETAIN SIGN, AND ROUND

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G

... SHIFTING POSITIONS.
2 DIGITS.
NUMBER OF POSITIONS TO BE SHIFTED.
NOT TO EXCEED 22 ON MULTIPLY AND SHIFT.

H

... INSERT LENGTH.
ONE LESS THAN NUMBER OF DIGITS
TO BE INSERTED.
INSERTION PROCEEDS RIGHT TO LEFT.
VALUES: 0 - 9.
MAX DIGITS = 10.

J

... INSERT START.
ONE LESS THAN LOW ORDER DIGIT TO BE
INSERTED. HIGHEST STARTING POSITION = 10
(3RD FROM LEFT) USING DIGIT POSITION
DIAGRAM.
IE, --X----- = HIGHEST STARTING POSITION (J=9).
 -----X = LOWEST STARTING POSITION (J=0).
VALUES: 0 - 9.

K

... BLOCK ADD, BLOCK COPY.
2 DIGITS.
ONE LESS THAN THE NUMBER OF PAIRS OF CELLS.
VALUES: 00 - 99.
MAX RANGE = 100 CELLS.

L

... PUNCHING ATTRIBUTES

MANUAL PUNCHING (OPERATOR DEPRESSES ENTER KEY)

0 - NO PUNCHING

1 - PUNCH DATA AND EW (END OF WORD)

2 - PUNCH DATA AND ER (END OF RECORD)

3 - PUNCH ER (END OF RECORD)

AUTOMATIC PUNCHING

4 - NO PUNCHING

5 - PUNCH DATA AND EW (END OF WORD)

6 - PUNCH DATA AND ER (END OF RECORD)

7 - PUNCH ER (END OF RECORD)

M

0 - DO NOT WRITE LINE-FIND ON MAG LEDGER

1 - WRITE LINE-FIND ON MAG LEDGER

N

0 - READ LEDGER WITH MECHANICAL LINE-FIND
1 - READ LEDGER WITH MAGNETIC LINE-FIND
2 - READ LEDGER AND EJECT
3 - READ LEDGER FROM LEDGER READER
4 - POSITION LEDGER WITH MECHANICAL LINE-FIND
(DO NOT READ). IGNORE A AND B ADDRESSES.
"ACCEPT LEDGER" (ACL).

P

0 - PRINT POSITIVE IN BLACK, NEGATIVE IN RED
2 - PRINT ABSOLUTE (ALL BLACK)

MEMORY PLANE SELECTION (R MODIFIER)

PLANE A B C D

R

0	L	L	L	L
1	L	L	L	U
2	L	U	U	L
3	L	U	U	U
4	U	L	L	L
5	U	L	L	U
6	U	U	U	L
7	U	U	U	U

MEMORY PLANE SELECTION (S MODIFIER)

PLANE A B C D

S

0	L	L	L	L
1	L	L	L	U
2	L	L	U	L
3	L	L	U	U
4	U	U	L	L
5	U	U	L	U
6	U	U	U	L
7	U	U	U	U

U

... 80-COLUMN PUNCHED CARD
0 - READ NUMERICS INTO MEMORY
1 - READ ALPHA DATA AND TYPE FROM THE CARD USING
THE TYPEWRITER SECTION OF THE 390 CONSOLE.
ALPHA DATA IS NOT READ INTO MEMORY.
2 - RELEASE CARD

TAPE SYMBOLS

SPECIAL SYMBOLS WERE PUNCHED INTO THE PAPER TAPE AND USED BY THE 390 FOR END-OF-WORD, END-OF-RECORD, AND END-OF-TAPE.

THESE SYMBOLS ARE REPLACED BY LETTERS FOR SIM390 USE (IN THE CASE OF "ER" AND "EOT"), AND NOT USED AT ALL IN THE CASE OF "EW".

IN DOCUMENTATION, THEY ARE REFERRED TO AS "EW, ER, AND EOT".

EW (END-OF-WORD) - NOT USED BY SIM390.
 THIS SYMBOL MEANT THE SAME THING AS
 "END OF CELL". IE, 1 CELL = 1 WORD.
 IN SIM390 FORMAT, 2 BLANKS
 FOLLOWING THE INPUT DATA SIGNIFIES
 END-OF-WORD.

ER (END-OF-RECORD) - COLUMNS 1 AND 2
 MUST CONTAIN THE LETTERS "ER".
 EXAMPLE - PROGFM: ER [COMMENTS...]
 EXAMPLE - DATAFM: ER [COMMENTS...]

EOT (END-OF-TAPE) - LOGICAL END-OF-FILE IS DENOTED BY
 END-OF-TAPE SYMBOLS.
 EOT'S MAY ALSO BE PRESENT AT THE
 BEGINNING OF A FILE.
 COLUMNS 1-3: THE LETTERS "EOT".
 EXAMPLE - PROGFM: EOT [COMMENTS...]
 EXAMPLE - DATAFM: EOT [COMMENTS...]

Opcode Cross Reference

NCR390 To PL390

Opcode to PL390 Language Symbolics Cross Reference

NCR390 Opcode	PL390 Symbolics
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00	RDC
01	PRT, PRN, PER, PTB, PTN
02	CAR, FRM
03	HLT, LOK
04	RCA, RCN, RLS
05-1	RPT
05-3	RPS
05-4	RWD, ULD
06	RMG, RMK, RLR, REJ, ACL
07	WTL, WTN
08	SUM
09	CLR
10	MDD
11	MUL/MUS, SQR
12	INS
13	SHF
14	SUB
15-0	IFF EQ/NE (CFE), NOP
15-1	IFF ZERO (CFZ)
16	IFF GE/LT (CFM)
17-0	ADD
17-1	CPY
18-0	ADD A THRU B (BLA)
18-1	CPY A THRU B (BLC), REP
19	DIV

--- Extensions ---

20	EOJ
21	CAN