



ND-100 INSTANT INSTRUCTION CODES

ND-99.005.02 12/84

Instruction formats and explanation found in ND-100 Reference Manual, ND-06.014.

MEMORY REFERENCE INSTRUCTIONS

Effective Address:

,X	000000	Address relative to P;	$EL = P + \Delta$
	002000	Address relative to X;	$EL = X + \Delta$
l	001000	Indirect address;	$EL = (P + \Delta)$
,B	000400	Address relative to B;	$EL = B + \Delta$

Store Instructions:

STZ	000000	Store zero;	$(EL) := 0$
STA	004000	Store A;	$(EL) := A$
STT	010000	Store T;	$(EL) := T$
STX	014000	Store X;	$(EL) := X$
MIN	040000	Mem.incr, skip if zero	$(EL) := (EL) + 1$

Load Instructions:

LDA	044000	Load A;	$A := (EL)$
LDT	050000	Load T;	$T := (EL)$
LDX	054000	Load X;	$X := (EL)$

Arithmetical and Logical Instructions:

ADD	060000	Add to A (C, O and Q may also be affected);	$A := A + (EL)$
SUB	064000	Subtract from A (C, O and Q may also be affected);	$A := A - (EL)$
AND	070000	Logical AND to A;	$A := A \wedge (EL)$
ORA	074000	Logical inclusive OR to A;	$A := A \vee (EL)$
MPY	120000	Multiply integer (O and Q may also be affected);	$A := A * (EL)$

Double Word Instructions:

STD	020000	Store double word;	$(DW) := AD$
LDD	024000	Load double word;	$AD := (DW)$

MEMORY REFERENCE INSTRUCTIONS **Cont.**

Floating Instructions:

STF	030000	Store floating accum.;	(FW) = TAD
LDF	034000	Load floating accum.;	TAD = (FW)
FAD	100000	Add to floating accum. (C may also be affected);	TAD = TAD + (FW)
FSB	104000	Subtract from floating accum. (C may also be affected);	TAD = TAD - (FW)
FMU	110000	Multiply floating accum. (C may also be affected);	TAD = TAD * (FW)
FDV	114000	Divide floating accum. (Z and C may also be affected);	TAD = TAD / (FW)

Byte Instructions:

Addressing:	EL = (T) + (X) / 2
	X = 1: Right byte
	X = 0: Left byte
BFILL	140130 Byte fill
MOVB	140131 Move bytes
MOVBF	140132 Move bytes forward
SBYT	142600 Store byte
LBYT	142200 Load byte

EXECUTE INSTRUCTION

EXR 140600 Execute instruction found in specified register.

BIT INSTRUCTIONS

BSPK	175000	Skip next location if specified condition is true;	P = P + 1
BSET	174000	Set specified bit equal to specified condition;	
BSTA	176200	Store and clear K;	(B) = K; K = 0
BSTC	176000	Store complement and set K;	(B) = K ₀ ; K = 1
BLDA	176600	Load K;	K = (B)
BLDC	176400	Load bit complement to K;	K = (B)
BANC	177000	Logical AND with bit compl.;	K = K \wedge (B) ₀
BORC	177400	Logical OR with bit compl.;	K = K \vee (B) ₀
BAND	177200	Logical AND to K;	K = K \wedge (B)
BORA	177600	Logical OR to K;	K = K \vee (B)

SHIFT INSTRUCTIONS

SHT	154000	Shift T register
SHD	154200	Shift D register
SHA	154400	Shift A register
SAD	154600	Shift A and D registers connected
	000000	Arithmetic shift. During right shift, bit 15 is extended. During left shift, zeros are shifted in from right.
ROT	001000	Rotational shift. Most and least significant bits are connected.
ZIN	002000	Zero end input
LIN	003000	Link end input. The last vacated bit is fed to M after every shift instruction.
SHR	000200	Shift right; gives negative shift counter.

SYSTEM CONTROL INSTRUCTIONS

IOF	150401	Turn off interrupt system
ION	150402	Turn on interrupt system
LWCS	143500	Load writable control store
MON	153000	Monitor call instruction
PIOF	150405	Turn off paging and interrupt
PION	150412	Turn on paging and interrupt
POF	150404	Turn off paging system
PON	150410	Turn on paging system
REX	150407	Reset extended address mode
SEX	150406	Set extended address mode
WAIT	151000	Halt the program/ Give up priority
OPCOM	150400	Start MOPC

TRANSFER INSTRUCTIONS

Load Independent Instructions:

TRA	150000	Transfer specified internal register to A
TRR	150100	Transfer A to specified internal register
MCL	150200	Masked clear
MST	150300	Masked set

Inter-level Instructions:

IRR	153600	Inter-register Read A: = Specified register on specified level
IRW	153400	Inter-register Write Specified register on specified level: = A
MON	153000	Monitor call instruction

REGISTER OPERATIONS

Arithmetic Operations, RAD = 1:

C, O and Q may be affected by the following instructions:

RADD	146000	Add source to destination;	$(dr) := (dr) + (sr)$
RSUB	146600	Subtract source from destination;	$(dr) := (dr) - (sr)$
COPY	146100	Register transfer;	$(dr) := (sr)$
AD1	000400	Also add one to destination;	$(dr) := (dr) + 1$
ADC	001000	Also add old carry to destination;	$(dr) := (dr) + C$

Logical Operations, RAD = 0:

SWAP	144000	Register exchange;	$(sr) := (dr); (dr) := (sr)$
RAND	144400	Logical AND to destination;	$(dr) := (dr) \wedge (sr)$
REXO	145000	Logical exclusive OR;	$(dr) := (dr) \vee (sr)$
RORA	145400	Logical inclusive OR;	$(dr) := (dr) \vee (sr)$
CLD	000100	Clear destination before op.;	$(dr) = 0$
CM1	000200	Use one's complement of source;	$(sr) = (sr)_o$

Combined Instructions:

EXIT	146142	= COPY SL DP, Return from subroutine
RCLR	146100	= COPY, Register clear
RINC	146400	= RADD AD1, Register increment
RDCR	146200	= RADD CM1, Register decrement

Extended Arithmetic Operations:

RMPY	141200	Multiply source with destination. Result in double accumulator	$AD := (sr) * (dr)$
RDIV	141600	Divide double accumulator with source register. Quotient in A, remainder in D. ($AD = A * (sr) + D$)	$A := AD // (sr)$
MIX3	143200	$(X) := [(A) - 1] * 3$	

FLOATING CONVERSION

NLZ	151400	Convert the number in A to a floating number in FA.
DNZ	152000	Convert the floating number in FA to a fixed point number in A.
NLZ+20	151420	Integer to floating conversion.
DNZ-20	152360	Floating to integer conversion.

MEMORY EXAMINE/DEPOSIT INSTRUCTIONS

EXAM	150416	Memory examine T = memory location pointed to by AD register.
DEPO	150417	Memory deposit Mové T to memory location pointed to by AD register.

SEQUENCING INSTRUCTIONS

Unconditional Jump:

JMP	124000	Jump;	P=EL
JPL	134000	Jump to subroutine;	L=P; P=EL

Conditional Jump:

JAP	130000	Jump if A is positive; $P = \pm \Delta$ if:	$A \geq 0$
JAN	130400	Jump if A is negative;	$A < 0$
JAZ	131000	Jump if A is zero;	$A = 0$
JAF	131400	Jump if A is nonzero;	$A \neq 0$
JXN	133400	Jump if X is negative;	$X < 0$
JXZ	133000	Jump if X is zero;	$X = 0$
JPC	132000	Increment X and jump if positive; $X = X + 1$; $P = P + \Delta$ if:	$X \geq 0$
JNC	132400	Increment X and jump if negative; $X = X + 1$; $P = P + \Delta$ if:	$X < 0$

Skip Instructions:

SKP	140000	Skip next location if specified condition is true;	$P = P + 1$
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Specified Condition:

EQL	000000	Equal to
UEQ	002000	Unequal to
GRE	001000	Signed greater than or equal to, overflow OK
LST	003000	Signed less than, overflow OK
MLST	003400	Magnitude less than
MGRE	001400	Magnitude greater than or equal to
IF	000000	May be used freely to obtain easy readability
0	000000	
GEQ	000400	Signed greater than or equal to, overflow not OK
LSS	002400	Signed less than, overflow not OK

PRIVILEGED INSTRUCTIONS

The instructions available only to programs running in system mode (ring 2 or 3) are termed privileged instructions, which are:

IOF	150401	Turn off interrupt system
ION	150402	Turn on interrupt system
PIOF	150405	Turn off paging and interrupt
PION	150412	Turn on paging and interrupt
POF	150404	Turn off memory management system
PON	150410	Turn on memory management system
LWCS	143500	Load writable control store
WAIT	151000	Give up priority, reset current PID bit
IDENT	143600	Identify interrupt
IOX	164000	Input/Output
IOXT	150415	Input/Output
TRA	150000	Transfer internal register to A
TRR	150100	Transfer internal register from A
MCL	150200	Masked clear of register
MST	150300	Masked set of register
LRB	152600	Load register block
SRB	152402	Store register block
IRW	153400	Inter-register write
IRR	153600	Inter-register read
REX	150407	Reset extended address mode
SEX	150406	Set extended address mode
EXAM	150416	Memory examine T = memory location pointed to by AD register
DEPO	150417	Memory deposit Memory location pointed to by AD register
OPCOM	150400	Set in OPCOM mode

INPUT/OUTPUT CONTROL

IOX	164000	Transfer data to/from specified device
IOXT	150415	Transfer data to/from specified device
IDENT	1436PL	Transfer IDENT code of interrupting device to A register with highest priority on the specified level.
PL10	000004	Level 10
PL11	000011	Level 11
PL12	000022	Level 12
PL13	000043	Level 13

REGISTER BLOCK INSTRUCTIONS

Addressing: (EL) + 1 + 2 + 3 + 4 + 5 + 6 + 7
P X T A D L STS B

LRB 152600 Load register block
SRB 152402 Store register block

ARGUMENT INSTRUCTIONS

SAA	170400	Set argument to A;	A: = ARG
AAA	172400	Add argument to A;	A: = A + ARG
SAX	171400	Set argument to X;	X: = ARG
AAX	173400	Add argument to X;	X: = X + ARG
SAT	171000	Set argument to T;	T: = ARG
AAT	173000	Add argument to T;	T: = T + ARG
SAB	170000	Set argument to B;	B: = ARG
AAB	172000	Add argument to B;	B: = B + ARG

PHYSICAL MEMORY READ/WRITE INSTRUCTIONS

Read Instructions:

LDATX 143300 A: = (EL)
LDXTX 143301 X: = (EL)
LDDTX 143302 A: = (EL), D: = (EL + 1)
LDBTX 143303 B: = 177000 V((EL) + (EL))

Write Instructions:

STATX 143304 (EL): = A
STZTX 143305 (EL): = 0
STDTX 143306 (EL): = A, (EL + 1): = D

INSTRUCTIONS IN THE CX-OPTION (By expanding the microprogram PROM)

Decimal Instructions:

ADDD	140120	Add decimal
SUBD	140121	Subtract decimal
COMD	140122	Compare decimal
PACK	140124	Convert to packed decimal
UPACK	140125	Convert to unpacked decimal
SHDE	140126	Decimal shift

Stack Instructions:

INIT	140134	Initialize stack
ENR	140135	Enter stack
LEAVE	140136	Leave stack
ELEAV	140137	Error leave stack

SINTRAN III Segment-change Instructions:

SETPT	140300	Set page tables
CLEPT	140301	Clear page tables
CLNREENT	140302	Clear non reentrant
CHREENTPAGES	140303	Change non reentrant pages
CLEPU	140304	Clear page tables, collect PGU information

Other CX Instructions:

MOVEW	143100	Move block of words
TSET	140123	Test and set
RDUS	140127	Read does not use cache

ASCII CHARACTER SET (ANSI X3.4-1968)

Octal	000	010	020	030	040	050	060	070	100	110	120	130	140	150	160	170
Decimal	000	008	016	024	032	040	048	056	064	072	080	088	096	104	112	120
	0	NUL	BS	DLE	CAN	(	0	8	@	H	P	X	.	h	p	x
A	1	SOH	HT	DC1	EM	)	1	9	A	I	Q	Y	a	i	q	y
d	2	STX	LF	DC2	SUB	"	2	:	B	J	R	Z	b	j	r	z
d	3	ETX	VT	DC3	ESC	#	3	;	C	K	S	[	c	k	s	{
e	4	EOT	FF	DC4	FS	\$	4	<	D	L	T	\	d	l	t	|
r	5	ENQ	CR	NAK	GS	%	5	=	E	M	U	]	e	m	u	}
s	6	ACK	SO	SYN	RS	&	6	>	F	N	V	^	f	n	v	~
	7	BEL	SI	ETB	US	'	7	?	G	O	W	_	g	o	w	DEL

Example: Finding ASCII value for A

A (Octal) = $100 + 1 = 101_8$

A (Decimal) = $64 + 1 = 65_{10}$

↑
adder

Generating control characters:

The character CTRL+x (control-x) is produced by holding down the CTRL key and at the same time pressing the x character key.

NUL	Null	DC2 (CTRL+R)	Device Control 2
SOH (CTRL+A)	Start Of Heading	DC3 (CTRL+S)	Device Control 3
STX (CTRL+B)	Start Of Text	DC4 (CTRL+T)	Device Control 4
ETX (CTRL+C)	End Of Text	NAK (CTRL+U)	Negative
EOT (CTRL+D)	End Of Transmission		Acknowledge
ENQ (CTRL+E)	Enquiry	SYN (CTRL+V)	Synchronous Idle
ACK (CTRL+F)	Acknowledge	ETB (CTRL+W)	End Of Transmission
BEL (CTRL+G)	Bell		Block
BS (CTRL+H)	Backspace	CAN (CTRL+X)	Cancel
HT (CTRL+I)	Horizontal Tabulation	EM (CTRL+Y)	End Of Medium
LF (CTRL+J)	Line Feed	SUB (CTRL+Z)	Substitute
VT (CTRL+K)	Vertical Tabulation	ESC (CTRL+[)	Escape
FF (CTRL+L)	Form Feed	FS (CTRL+\)	File Separator
CR (CTRL+M)	Carriage Return	GS (CTRL+])	Group Separator
SO (CTRL+N)	Shift Out	RS (CTRL+^)	Record Separator
SI (CTRL+O)	Shift In	US (CTRL+_)	Unit Separator
DLE (CTRL+P)	Data Link Escape	DEL	Delete (Rubout)
DC1 (CTRL+Q)	Device Control 1		

ND-100 MNEMONICS AND THEIR OCTAL VALUES - ALPHABETICAL ORDER

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
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AAA	: 172400	EXAM	: 150416	MCL	: 150200	SAD	: 154600
AAB	: 172000	EXIT	: 146142	MGRE	: 001400	SAT	: 171000
AAT	: 173000	EXR	: 140600	MIN	: 040000	SAX	: 171400
AAX	: 173400	FAD	: 100000	MIX3	: 143200	SB	: 000030
ADC	: 001000	FDV	: 114000	MLST	: 003400	SBYT	: 142600
ADD	: 060000	FMU	: 110000	MON	: 153000	SD	: 000010
ADDD	: 140120	FSB	: 104000	MOVB	: 140131	SETPT	: 140300
AD1	: 000400	GEQ	: 000400	MOVBF	: 140132	SEX	: 150406
ALD	: 000012	GRE	: 001000	MOVEV	: 143100	SHA	: 154400
AND	: 070000	I	: 001000	MPY	: 120000	SHD	: 154200
.B	: 000400	IDENT	: 143600	MST	: 150300	SHDE	: 140126
BAC	: 000600	IF	: 000000	NLZ	: 151400	SHR	: 000200
BANC	: 177000	IIC	: 000005	ONE	: 000200	SHT	: 154000
BAND	: 177200	IIE	: 000005	OPCOM	: 150400	SKP	: 140000
BCM	: 000400	INIT	: 140134	OPR	: 000002	SL	: 000040
BFILL	: 140130	IOF	: 150401	ORA	: 074000	SP	: 000020
BLDA	: 176600	ION	: 150402	PACK	: 140124	SRB	: 152402
BLDC	: 176400	IOX	: 164000	PCR	: 000003	SSC	: 000060
BORA	: 177600	IOXT	: 150415	PEA	: 000015	SSK	: 000020
BORC	: 177400	IRR	: 153600	PES	: 000013	SSM	: 000070
BSET	: 174000	IRW	: 153400	PGC	: 000014	SSO	: 000050
BSKP	: 175000	JAF	: 131400	PGS	: 000003	SSQ	: 000040
BSTA	: 176200	JAN	: 130400	PID	: 000006	SSTG	: 000010
BSTC	: 176000	JAP	: 130000	PIE	: 000007	SSZ	: 000030
CCLR	: 000010	JAZ	: 131000	PIOF	: 150405	ST	: 000060
CHREENT-		JMP	: 124000	PION	: 150412	STA	: 004000
PAGES	: 140303	JNC	: 132400	PL10	: 000004	STATX	: 143304
CLD	: 000100	JPC	: 132000	PL11	: 000011	STD	: 020000
CLEPT	: 140301	JPL	: 134000	PL12	: 000022	STDTX	: 143306
CLEPU	: 140304	JXN	: 133400	PL13	: 000043	STF	: 030000
CLNREENT	: 140302	JXZ	: 133000	POF	: 150404	STS	: 000001
CM1	: 000200	LBYT	: 142200	PON	: 150410	STT	: 010000
CM2	: 000600	LCILR	: 000011	PVL	: 000004	STX	: 014000
COMD	: 140122	LDA	: 044000	RADD	: 146000	STZ	: 000000
COPY	: 146100	LDATX	: 143300	RAND	: 144400	STZTX	: 143305
CSR	: 000010	LDBTX	: 143303	RCLR	: 146100	SUB	: 064000
DA	: 000005	LDD	: 024000	RDCR	: 146200	SUBD	: 140121
DB	: 000003	LDDTX	: 143302	RDIV	: 141600	SWAP	: 144000
DD	: 000001	LDF	: 034000	RDUS	: 140127	SX	: 000070
DEPO	: 150417	LDT	: 050000	REX	: 150407	TRA	: 150000
DL	: 000004	LDX	: 054000	REXO	: 145000	TRR	: 150100
DNZ	: 152000	LDXTX	: 143301	RINC	: 146400	TSET	: 140123
DP	: 000002	LEAVE	: 140136	RMPY	: 141200	UCILR	: 000012
DT	: 000006	LIN	: 003000	RORA	: 145400	UEQ	: 002000
DX	: 000007	LMP	: 000002	ROT	: 001000	UPACK	: 140125
ECCR	: 000015	LRB	: 152600	RSUB	: 146600	WAIT	: 151000
ELEAV	: 140137	LSS	: 002400	SA	: 000050	.X	: 002000
ENTR	: 140135	LST	: 003000	SAA	: 170400	ZIN	: 002000
EQL	: 000000	LWCS	: 143500	SAB	: 170000	ZRO	: 000000

ND-100 MNEMONICS AND THEIR OCTAL VALUES - NUMERICAL ORDER

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
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000000 : EQL	000200 : CM1	133400 : JXN	146400 : RINC
000000 : IF	000200 : ONE	134000 : JPL	146600 : RSUB
000000 : STZ	000200 : SHR	140000 : SKP	150000 : TRA
000000 : ZRO	000400 : AD1	140120 : ADDD	150100 : TRR
000001 : DD	000400 : B	140121 : SUBD	150200 : MCL
000001 : STS	000400 : BCM	140122 : COMD	150300 : MST
000002 : DP	000400 : GEQ	140123 : TSET	150400 : OPCOM
000002 : LMP	000600 : BAC	140124 : PACK	150401 : IOF
000002 : OPR	000600 : CM2	140125 : UPACK	150402 : ION
000003 : DB	001000 : ADC	140126 : SHDE	150404 : POF
000003 : PCR	001000 : GRE	140127 : RDUS	150405 : PEOF
000003 : PGS	001000 : I	140130 : BFILL	150406 : SEX
000004 : DL	001000 : ROT	140131 : MOVB	150407 : REX
000004 : PL 10	001400 : MGRE	140132 : MOVBF	150410 : PON
000004 : PVL	002000 : UEQ	140134 : INIT	150412 : PION
000005 : DA	002000 : X	140135 : ENTR	150415 : IOXT
000005 : IIC	002000 : ZIN	140136 : LEAVE	150416 : EXAM
000005 : IIE	002400 : LSS	140137 : ELEAV	150417 : DEPO
000006 : DT	003000 : LIN	140300 : SETPT	151000 : WAIT
000006 : PID	003000 : LST	140301 : CLEPT	151400 : NLZ
000007 : DX	003400 : MLST	140302 : CLNREENT	152000 : DNZ
000007 : PIE	004000 : STA	140303 : CHREENT-	152402 : SRB
000010 : CCLR	010000 : STT	PAGES	152600 : LRB
000010 : CSR	014000 : STX	140304 : CLEPU	153000 : MON
000010 : SD	020000 : STD	140600 : EXR	153400 : IRW
000010 : SSTG	024000 : LDD	141200 : RMPY	153600 : IRR
000011 : LCILR	030000 : STF	141600 : RDIV	154000 : SHT
000011 : PL 11	034000 : LDF	142200 : LBYT	154200 : SHD
000012 : ALD	040000 : MIN	142600 : SBYT	154400 : SHA
000012 : UCILR	044000 : LDA	143100 : MOVEW	154600 : SAD
000013 : PES	050000 : LDT	143200 : MIX3	164000 : IOX
000014 : PGC	054000 : LDX	143300 : LDATX	170000 : SAB
000015 : ECCR	060000 : ADD	143301 : LDXTX	170400 : SAA
000015 : PEA	064000 : SUB	143302 : LDDTX	171000 : SAT
000020 : SP	070000 : AND	143303 : LDBTX	171400 : SAX
000020 : SSK	074000 : ORA	143304 : STATX	172000 : AAB
000022 : PL12	100000 : FAD	143305 : STZTX	172400 : AAA
000030 : SB	104000 : FSB	143306 : STDTX	173000 : AAT
000030 : SSZ	110000 : FMU	143500 : LWCS	173400 : AAX
000040 : SL	114000 : FDV	143600 : IDENT	174000 : BSET
000040 : SSQ	120000 : MPY	144000 : SWAP	175000 : BSKP
000043 : PL13	124000 : JMP	144400 : RAND	176000 : BSTC
000050 : SA	130000 : JAP	145000 : REXO	176200 : BSTA
000050 : SSO	130400 : JAN	145400 : RORA	176400 : BLDC
000060 : SSC	131000 : JAZ	146000 : RADD	176600 : BLDA
000060 : ST	131400 : JAF	146100 : COPY	177000 : BANC
000070 : SSM	132000 : JPC	146100 : RCLR	177200 : BAND
000070 : SX	132400 : JNC	146142 : EXIT	177400 : BORC
000100 : CLD	133000 : JXZ	146200 : RDCR	177600 : BORA



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