

ND 073 BCD Arithmetic for ND-500

A special Hardware Module for Use in Commercial Data Processing on the ND-500/CE Series of Computers.

In order to increase the speed of COBOL programs on the ND-500, a special BCD-processor is provided as an extension of the ND-500 CPU.

The processor performs arithmetic on Binary Coded Decimal (BCD) numbers, and converts data fields between BCD-format and ASCII-format, and between BCD – and binary (integer) format.

This new processor can handle automatic scaling on all operands and multiplication.

The following instructions are implemented:

BCD instructions:

- PADD : Add packed decimal numbers with automatic scaling.
- PADDR : Same as PADD, rounding the result.
- PSUB : Subtract Packed decimal numbers with automatic scaling.
- PSUBR : Same as PSUB, rounding the result.
- PCOMP : Compare packed decimal numbers.
- PMPY : Multiply packed decimal numbers with automatic scaling.
- PMPYR : Same as PMPY, rounding the result.
- PSHIFT : Shift packed decimal number with automatic scaling.
- PSHIFTR : Same as PSHIFT with rounding.
- PPACK : Convert from ASCII coded decimal number to packed decimal number with automatic scaling.
- PPACKR : Same as PPACK, rounding the result.
- PUPACK : Convert from packed decimal number to ASCII coded decimal number with automatic scaling.

PUPACKR : Same as PUPACK, rounding the result.

W_n WPCONV : Convert from ordinary binary to packed decimal numbers.

W_n PWCONV : Convert from packed decimal numbers to ordinary binary.

The instructions operate on packed decimal numbers with from 1 to 31 decimal digits. The decimal point ranges from –32 to 31 counted from the least significant digit.

What is a Packed Decimal Number (BCD-number)

Each decimal digit is represented by four bits. Therefore two digits can be placed adjacent in a byte. In the rightmost byte of the the string of bytes representing your number, the last four bits are used to keep the sign. Each decimal digit is encoded as follows:

Digit	Bit pattern	Hexa-decimal
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
+	1010	A
–	1011	B
+	1100	C
–	1101	D
+	1110	E
unsigned	1111	F

Every number will fill an integral number of bytes right justified. If the leftmost 4 bits are not needed, they will always contain a zero.

What is an ASCII coded Decimal Number

In the ASCII format each decimal digit occupies one byte (8 bits). The four high-order bits of a byte are called the zone. The four low-order bits are encoded in the same way for the packed decimal digits.

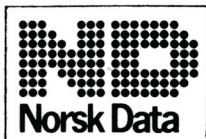
A decimal number in this format may have four different sign representations:

- 1) Embedded trailing sign.
The right-most byte occupies both the least significant digit and the sign.
- 2) Separate trailing sign.
The right-most byte occupies the ASCII-coded sign only.

- 3) Embedded leading sign.
The left-most byte contains both the most significant digit and the sign.
- 4) Separate leading sign.
The left-most byte occupies the ASCII-coded sign only.

When a sign is embedded the following codes are used:

positive : 0 = 173B
 : 1-9 = 101B-111B
negative : 0 = 175B
 : 1-9 = 112B-122B



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NOTE: NORSK DATA reserves the right to change specifications without notice