

# Natural

## System Functions

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This document applies to Natural Version 9.2.1 and all subsequent releases.

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## Preface

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This documentation describes various Natural “built-in” functions for use in certain statements; see *System Functions* in the *Programming Guide*.

This documentation is organized under the following headings:

<b>System Functions for Use in Processing Loops</b>	Describes Natural system functions which can be used in a program loop context.
<b>Mathematical System Functions</b>	Describes the system functions which are supported in arithmetic processing statements and in logical condition criteria.
<b>Miscellaneous System Functions</b>	System functions to evaluate the minimum or maximum; system function for field identification; system function to receive the return code from a non-Natural program; system function to convert “incorrectly sorted” characters; system function for lower/upper case translation; system function to remove leading and/or trailing blanks.
<b>Functions Supplied as Natural Objects</b>	Describes functions which are supplied as Natural objects to support, for example, URL encoding and Base64 conversion.

See also *Example of System Variables and System Functions* in the *Programming Guide*.

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# 1 About this Documentation

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## Document Conventions

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Convention	Description
<b>Bold</b>	Identifies elements on a screen.
Monospace font	Identifies service names and locations in the format <i>folder.subfolder.service</i> , APIs, Java classes, methods, properties.
<i>Italic</i>	Identifies:  Variables for which you must supply values specific to your own situation or environment. New terms the first time they occur in the text. References to other documentation sources.
Monospace font	Identifies:  Text you must type in. Messages displayed by the system. Program code.
{ }	Indicates a set of choices from which you must choose one. Type only the information inside the curly braces. Do not type the { } symbols.
	Separates two mutually exclusive choices in a syntax line. Type one of these choices. Do not type the   symbol.
[ ]	Indicates one or more options. Type only the information inside the square brackets. Do not type the [ ] symbols.
...	Indicates that you can type multiple options of the same type. Type only the information. Do not type the ellipsis (...).

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## 2 Natural System Functions for Use in Processing Loops

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This chapter describes those Natural system functions which can be used in a program loop context.

## Using System Functions in Processing Loops

---

The following topics are covered:

- [Specification/Evaluation](#)
- [Format/Length Requirements for AVER, NAVER, SUM and TOTAL](#)
- [Use in SORT GIVE Statement](#)
- [Statement Referencing \(r\)](#)

### Specification/Evaluation

Natural system functions may be specified in

■ **assignment and arithmetic statements:**

- MOVE
- ASSIGN
- COMPUTE
- ADD
- SUBTRACT
- MULTIPLY
- DIVIDE

■ **input/output statements:**

- DISPLAY
- PRINT
- WRITE

that are used within any of the following statement blocks:

- AT BREAK
- AT END OF DATA
- AT END OF PAGE

that is, for all FIND, READ, HISTOGRAM, SORT or READ WORK FILE processing loops.

If a system function is used within an AT END OF PAGE statement, the corresponding DISPLAY statement must include the GIVE SYSTEM FUNCTIONS clause.

Records rejected by a WHERE clause are not evaluated by a system function.

If system functions are evaluated from database fields which originated from different levels of processing loops initiated with a `FIND`, `READ`, `HISTOGRAM` or `SORT` statement, the values are always processed according to their position in the loop hierarchy. For example, values for an outer loop will only be processed when new data values have been obtained for that loop.

If system functions are evaluated from user-defined variables, the processing is dependent on the position in the loop hierarchy where the user-defined variable was introduced in reporting mode. If the user-defined variable is defined before any processing loop is initiated, it will be evaluated for system functions in the loop where the `AT BREAK`, `AT END OF DATA` or `AT END OF PAGE` statement is defined. If a user-defined variable is introduced within a processing loop it will be processed the same as a database field from that processing.

For selective referencing of system function evaluation for user-defined variables it is recommended to specify a loop reference with the user-defined variable to indicate in which loop the value is to be processed. The loop reference may be specified as a statement label or source code line number.

### Format/Length Requirements for `AVER`, `NAVER`, `SUM` and `TOTAL`

In general, the format and length of the system functions `AVER`, `NAVER`, `SUM` and `TOTAL` are the same as the field to which they are applied. The output length of the field must be long enough (either by default or user-specified) to hold any overflow digits. If any arithmetic overflow occurs, an error message will be issued.

The following applies:

- If the field is not long enough, use the `NL` option of the `SORT GIVE` statement to increase the output length as follows:

```
SUM(field)(NL=nn)
```

This will not only increase the output length but also causes the field to be made longer internally.

- For a field of format `N`, the format of the system function will be of format `P` (with the same length as the field).
- When the system function is written to a work file (`WRITE WORK FILE` statement), the internal length of the field is increased by one digit for numeric fields (format `N` or `P`), for example, `SUM` of a field of format `P3` is increased to `P4`. This has to be taken into consideration when reading the work file.

### Use in SORT GIVE Statement

System functions may also be referenced when they have been evaluated in a GIVE clause of a SORT statement.

For a reference to a system function evaluated with a SORT GIVE statement, the name of the system function must be prefixed with an asterisk (\*).

### Statement Referencing (r)

Statement referencing is also available for system functions (see also *Referencing of Database Fields Using (r) Notation* in the section *User-Defined Variables* of the *Programming Guide*).

By using a statement label or the source-code line number (r) you can determine in which processing loop the system function is to be evaluated for the specified field.

## AVER(r)(field)

---

Format/length:	Same as field. Exception: See <i>Format/Length Requirements for AVER, NAVER, SUM and TOTAL</i> .
----------------	---

This system function contains the average of all values encountered for the field specified with AVER. AVER is updated when the condition under which AVER was requested is true.

## COUNT(r)(field)

---

Format/length:	P7
----------------	----

COUNT is incremented by 1 on each pass through the processing loop in which it is located. COUNT is incremented regardless of the value of the field specified with COUNT.



## MAX(r)(field)

---

Format/length:	Same as field.
----------------	----------------

This system function contains the maximum value encountered for the field specified with MAX. MAX is updated (if appropriate) each time the processing loop in which it is contained is executed.

## MIN(r)(field)

---

Format/length:	Same as field.
----------------	----------------

This system function contains the minimum value encountered for the field specified with MIN. MIN is updated (if appropriate) each time the processing loop in which it is located is executed.

## NAVER(r)(field)

---

Format/length:	Same as field. Exception: See <i>Format/Length Requirements for AVER, NAVER, SUM and TOTAL</i> .
----------------	---

This system function contains the average of all values - excluding null values - encountered for the field specified with NAVER. NAVER is updated when the condition under which NAVER was requested is true.

## NCOUNT(r)(field)

---

Format/length:	P7
----------------	----

NCOUNT is incremented by 1 on each pass through the processing loop in which it is located unless the value of the field specified with NCOUNT is a null value.

Whether the result of NCOUNT is an array or a scalar value depends on its argument (field). The number of the resulting occurrences is the same as of field.

## NMIN(r)(field)

---

Format/length:	Same as field.
----------------	----------------

This system function contains the minimum value encountered - excluding null values - for the field specified with `NMIN`. `NMIN` is updated (if appropriate) each time the processing loop in which it is located is executed.

## OLD(r)(field)

---

Format/length:	Same as field.
----------------	----------------

This system function contains the value which the field specified with `OLD` contained prior to a control break as specified in an `AT BREAK` condition, or prior to the end-of-page or end-of-data condition.

## SUM(r)(field)

---

Format/length:	Same as field.
	Exception: See <a href="#">Format/Length Requirements for AVER, NAVER, SUM and TOTAL</a> .

This system function contains the sum of all values encountered for the field specified with `SUM`. `SUM` is updated each time the loop in which it is located is executed. When `SUM` is used following an `AT BREAK` condition, it is reset after each value break. Only values that occur between breaks are added.

## TOTAL(r)(field)

---

Format/length:	Same as field.
	Exception: See <a href="#">Format/Length Requirements for AVER, NAVER, SUM and TOTAL</a> .

This system function contains the sum of all values encountered for the field specified with `TOTAL` in all open processing loops in which `TOTAL` is located.

## Examples

- Example 1 - AT BREAK Statement with Natural System Functions OLD, MIN, AVER, MAX, SUM, COUNT
- Example 2 - AT BREAK Statement with Natural System Function AVER
- Example 3 - AT END OF DATA Statement with System Functions MAX, MIN, AVER
- Example 4 - AT END OF PAGE Statement with System Function AVER

### Example 1 - AT BREAK Statement with Natural System Functions OLD, MIN, AVER, MAX, SUM, COUNT

```

** Example 'ATBEX3': AT BREAK (with Natural system functions)
*****
DEFINE DATA LOCAL
1 EMPLOY-VIEW VIEW OF EMPLOYEES
  2 NAME
  2 CITY
  2 SALARY (1)
  2 CURR-CODE (1)
END-DEFINE
*
LIMIT 3
READ EMPLOY-VIEW LOGICAL BY CITY = 'SALT LAKE CITY'
  DISPLAY NOTITLE CITY NAME 'SALARY' SALARY(1) 'CURRENCY' CURR-CODE(1)
  /*
  AT BREAK OF CITY
    WRITE / OLD(CITY) (EM=X^X^X^X^X^X^X^X^X^X^X^X^X^X^X^X^X^X^X^X^X^X^X)
      31T ' MINIMUM:' MIN(SALARY(1)) CURR-CODE(1) /
      31T ' AVERAGE:' AVER(SALARY(1)) CURR-CODE(1) /
      31T ' MAXIMUM:' MAX(SALARY(1)) CURR-CODE(1) /
      31T ' SUM:' SUM(SALARY(1)) CURR-CODE(1) /
      35T COUNT(SALARY(1)) 'RECORDS FOUND' /
  END-BREAK
  /*
  AT END OF DATA
    WRITE 22T 'TOTAL (ALL RECORDS):'
      T*SALARY TOTAL(SALARY(1)) CURR-CODE(1)
  END-ENDDATA
END-READ
*
END

```

Output of program ATBEX3:

CITY	NAME	SALARY	CURRENCY
SALT LAKE CITY	ANDERSON	50000	USD
SALT LAKE CITY	SAMUELSON	24000	USD
S A L T L A K E C I T Y		MINIMUM:	24000 USD
		AVERAGE:	37000 USD
		MAXIMUM:	50000 USD
		SUM:	74000 USD
		2 RECORDS FOUND	
SAN DIEGO	GEE	60000	USD
S A N D I E G O		MINIMUM:	60000 USD
		AVERAGE:	60000 USD
		MAXIMUM:	60000 USD
		SUM:	60000 USD
		1 RECORDS FOUND	
TOTAL (ALL RECORDS):		134000	USD ←

**Example 2 - AT BREAK Statement with Natural System Function AVER**

```

** Example 'ATBEX4': AT BREAK (with Natural system functions)
*****
DEFINE DATA LOCAL
1 EMPLOY-VIEW VIEW OF EMPLOYEES
  2 NAME
  2 CITY
  2 SALARY (2)
*
1 #INC-SALARY (P11)
END-DEFINE
*
LIMIT 4
EMPL. READ EMPLOY-VIEW BY CITY STARTING FROM 'ALBU'
  COMPUTE #INC-SALARY = SALARY (1) + SALARY (2)
  DISPLAY NAME CITY SALARY (1:2) 'CUMULATIVE' #INC-SALARY
  SKIP 1
/*
  AT BREAK CITY
    WRITE NOTITLE
      'AVERAGE:' T*SALARY (1) AVER(SALARY(1)) /
      'AVERAGE CUMULATIVE:' T*#INC-SALARY AVER(EMPL.) (#INC-SALARY)
  END-BREAK
END-READ
*
END

```

Output of program ATBEX4:

NAME	CITY	ANNUAL	CUMULATIVE SALARY
HAMMOND	ALBUQUERQUE	22000 20200	42200
ROLLING	ALBUQUERQUE	34000 31200	65200
FREEMAN	ALBUQUERQUE	34000 31200	65200
LINCOLN	ALBUQUERQUE	41000 37700	78700
AVERAGE:		32750	
AVERAGE CUMULATIVE:			62825

**Example 3 - AT END OF DATA Statement with System Functions MAX, MIN, AVER**

```

** Example 'AEDEXIS': AT END OF DATA
*****
DEFINE DATA LOCAL
1 EMPLOY-VIEW VIEW OF EMPLOYEES
  2 PERSONNEL-ID
  2 NAME
  2 FIRST-NAME
  2 SALARY (1)
  2 CURR-CODE (1)
END-DEFINE
*
LIMIT 5
EMP. FIND EMPLOY-VIEW WITH CITY = 'STUTTGART'
  IF NO RECORDS FOUND
    ENTER
  END-NOREC
  DISPLAY PERSONNEL-ID NAME FIRST-NAME
    SALARY (1) CURR-CODE (1)
  /*
  AT END OF DATA
    IF *COUNTER (EMP.) = 0
      WRITE 'NO RECORDS FOUND'
      ESCAPE BOTTOM
    END-IF
    WRITE NOTITLE / 'SALARY STATISTICS:'
      / 7X 'MAXIMUM:' MAX(SALARY(1)) CURR-CODE (1)
      / 7X 'MINIMUM:' MIN(SALARY(1)) CURR-CODE (1)
      / 7X 'AVERAGE:' AVER(SALARY(1)) CURR-CODE (1)
  END-ENDDATA
  /*

```

```
END-FIND
*
END
```

**Output of program AEDEX1S:**

PERSONNEL ID	NAME	FIRST-NAME	ANNUAL SALARY	CURRENCY CODE
11100328	BERGHAUS	ROSE	70800	DM
11100329	BARTHEL	PETER	42000	DM
11300313	AECKERLE	SUSANNE	55200	DM
11300316	KANTE	GABRIELE	61200	DM
11500304	KLUGE	ELKE	49200	DM
SALARY STATISTICS:				
	MAXIMUM:	70800	DM	
	MINIMUM:	42000	DM	
	AVERAGE:	55680	DM	

**Example 4 - AT END OF PAGE Statement with System Function AVER**

```
** Example 'AEPEX1S': AT END OF PAGE (structured mode)
*****
DEFINE DATA LOCAL
1 EMPLOY-VIEW VIEW OF EMPLOYEES
  2 PERSONNEL-ID
  2 NAME
  2 JOB-TITLE
  2 SALARY (1)
  2 CURR-CODE (1)
END-DEFINE
*
FORMAT PS=10
LIMIT 10
READ EMPLOY-VIEW BY PERSONNEL-ID FROM '20017000'
  DISPLAY NOTITLE GIVE SYSTEM FUNCTIONS
    NAME JOB-TITLE 'SALARY' SALARY(1) CURR-CODE (1)
  /*
  AT END OF PAGE
    WRITE / 28T 'AVERAGE SALARY: ...' AVER(SALARY(1)) CURR-CODE (1)
  END-ENDPAGE
END-READ
*
END
```

**Output of program AEPEX1S:**

---

NAME	CURRENT POSITION	SALARY	CURRENCY CODE
CREMER	ANALYST	34000	USD
MARKUSH	TRAINEE	22000	USD
GEE	MANAGER	39500	USD
KUNEY	DBA	40200	USD
NEEDHAM	PROGRAMMER	32500	USD
JACKSON	PROGRAMMER	33000	USD
	AVERAGE SALARY: ...	33533	USD





# 3 Mathematical System Functions

---

The following mathematical functions are supported in arithmetic processing statements (ADD, COMPUTE, DIVIDE, MULTIPLY, SUBTRACT) and in logical condition criteria:

Function	Format/Length	Explanation
ABS( <i>field</i> )	same as <i>field</i>	Absolute value of <i>field</i> .
ATN( <i>field</i> )	F8	Arc tangent of <i>field</i> .
COS( <i>field</i> )	F8	Cosine of <i>field</i> .  If the value of the <i>field</i> is equal to or greater than $10^{17}$ , COS( <i>field</i> ) will be "1".
EXP( <i>field</i> )	F8	Exponentiation of exponent <i>field</i> to base e, that is, $e^{\text{field}}$ , where e is Euler's number.
FRAC( <i>field</i> )	same as <i>field</i>	Fractional part of <i>field</i> .
INT( <i>field</i> )	same as <i>field</i>	Integer part of <i>field</i> .
LOG( <i>field</i> )	F8	Natural logarithm of <i>field</i> .  A negative value in the argument field will be treated as positive.
SGN( <i>field</i> )	same as <i>field</i>	Sign of <i>field</i> (-1, 0, +1).
SIN( <i>field</i> )	F8	Sine of <i>field</i> .  If the value of the <i>field</i> is equal to or greater than $10^{17}$ , SIN( <i>field</i> ) will be "0".
SQRT( <i>field</i> )	(*)	Square root of <i>field</i> .  A negative value in the argument field will be treated as positive.
TAN( <i>field</i> )	F8	Tangent of <i>field</i> .  If the value of the <i>field</i> is equal to or greater than $10^{17}$ , TAN( <i>field</i> ) will be "0".

Function	Format/Length	Explanation
VAL( <i>field</i> )	same as target field	<p>Extract numeric value from an alphanumeric <i>field</i>. The content of the <i>field</i> must be the alphanumeric (code page or Unicode) character representation of a numeric value. Leading or trailing blanks in the <i>field</i> will be ignored; decimal point and leading sign character will be processed.</p> <p>If the target field is not long enough, decimal digits will be truncated (see also <i>Field Truncation and Field Rounding</i> in the section <i>Rules for Arithmetic Assignment</i> of the <i>Programming Guide</i>).</p>

\* This function is evaluated as follows:

- If *field* has format/length F4, format/length of SQRT(*field*) will be F4.
- If *field* has format/length F8 or I, format/length of SQRT(*field*) will be F8.
- If *field* has format N or P, see *Precision of Results of Arithmetic Operations* for format/length of SQRT(*field*).

A *field* to be used with a mathematical function - except VAL - may be a constant or a scalar; its format must be numeric (N), packed numeric (P), integer (I), or floating point (F).

A *field* to be used with the VAL function may be a constant, a scalar, or an array; its format must be alphanumeric.

**Mathematical Functions Example:**

```

** Example 'MATHEX': Mathematical functions
*****
DEFINE DATA LOCAL
1 #A      (N2.1) INIT <10>
1 #B      (N2.1) INIT <-6.3>
1 #C      (N2.1) INIT <0>
1 #LOGA   (N2.6)
1 #SQRTA  (N2.6)
1 #TANA   (N2.6)
1 #ABS    (N2.1)
1 #FRAC   (N2.1)
1 #INT    (N2.1)
1 #SGN    (N1)
END-DEFINE
*
COMPUTE #LOGA = LOG(#A)
WRITE NOTITLE '=' #A 5X 'LOG'          40T #LOGA
*
COMPUTE #SQRTA = SQRT(#A)
WRITE          '=' #A 5X 'SQUARE ROOT' 40T #SQRTA
*
COMPUTE #TANA = TAN(#A)
WRITE          '=' #A 5X 'TANGENT'     40T #TANA

```

```

*
COMPUTE #ABS    = ABS(#B)
WRITE          // '=' #B 5X 'ABSOLUTE'    40T #ABS
*
COMPUTE #FRAC  = FRAC(#B)
WRITE          '=' #B 5X 'FRACTIONAL'    40T #FRAC
*
COMPUTE #INT   = INT(#B)
WRITE          '=' #B 5X 'INTEGER'       40T #INT
*
COMPUTE #SGN   = SGN(#A)
WRITE          // '=' #A 5X 'SIGN'        40T #SGN
*
COMPUTE #SGN   = SGN(#B)
WRITE          '=' #B 5X 'SIGN'          40T #SGN
*
COMPUTE #SGN   = SGN(#C)
WRITE          '=' #C 5X 'SIGN'          40T #SGN
*
END                                     ↵

```

### Output of program MATHEX:

```

#A:  10.0    LOG                2.302585
#A:  10.0    SQUARE ROOT        3.162277
#A:  10.0    TANGENT             0.648360

#B:  -6.3    ABSOLUTE           6.3
#B:  -6.3    FRACTIONAL        -0.3
#B:  -6.3    INTEGER           -6.0

#A:  10.0    SIGN                1
#B:  -6.3    SIGN               -1
#C:   0.0    SIGN                0      ↵

```



# II

## Miscellaneous System Functions

---

The following topics are covered:

**\*MINVAL/\*MAXVAL - Evaluate the Minimum/Maximum**

**\*TRANSLATE - Translate to Lower/Upper Case Characters**

**\*TRIM - Remove Leading and/or Trailing Blanks**

**POS - Field Identification Function**

**RET - Return Code Function**

**SORTKEY - Sort-Key Function**



# 4 \*MINVAL/\*MAXVAL - Evaluate the Minimum/Maximum

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```
{ *MINVAL } (([IR=result-format/length] operand,...)
  *MAXVAL }
```

Format/length: Format and length may be specified explicitly using the IR clause or evaluated automatically using the *Format/Length Conversion Rule Tables* below.

## Function

---

The Natural system function \*MINVAL/\*MAXVAL evaluates the minimum/maximum value of all given operand values. The result is always a scalar value. If an array is specified as operand, the minimum/maximum of all array fields is evaluated.

When using alphanumerical or binary data as an argument, if the data is the same (for example, \*MINVAL('AB', 'AB')), then the result is the argument with the smallest/largest length value.

## Restrictions

---

When using the system function \*MINVAL/\*MAXVAL, the following restrictions apply:

- \*MINVAL/\*MAXVAL must not be used where a target variable is expected.
- You may not nest \*MINVAL/\*MAXVAL in a system function.

## Syntax Description

---

Operand Definition Table:

Operand	Possible Structure	Possible Formats	Referencing Permitted	Dynamic Definition
<i>operand</i>	C S A G	A U N P I F B D T	yes	no

Syntax Element Description:



Syntax Element	Description
*MINVAL	Evaluates the minimum value of all given operand values.
*MAXVAL	Evaluates the maximum value of all given operand values.
<i>operand</i>	The operand(s) whose minimum/maximum values are to be evaluated by the *MINVAL/*MAXVAL system function.
<i>result-format-length</i>	Intermediate Result clause for <b>explicit specification</b> of the resulting format/length. See <i>IR Clause</i> below.

### IR Clause

The IR (Intermediate Result) clause may be used in order to specify explicitly the *result-format/length* of the whole \*MINVAL/\*MAXVAL system function.

IR=*result-format/length*

$$IR = \left\{ \begin{array}{l} \textit{format-length} \\ ( \left\{ \begin{array}{l} A \\ U \\ B \end{array} \right\} ) \text{ DYNAMIC} \end{array} \right\}$$

For an assortment of valid result-format/lengths, refer to the [Format/Length Conversion Rule Tables](#) below.

Syntax Element Description:

Syntax Element	Description
<i>format-length</i>	The compiler tries to determine the resulting format/length of the whole function. If the compiler cannot determine a format/length in a way that no loss of precision is guaranteed, the <i>format-length</i> must be set by the programmer using the IR operand extension.
A, U or B	Format: Alphanumeric, Unicode or Binary for dynamic variable.
DYNAMIC	Instead of specifying a fixed format/length, you may specify an alphanumeric, Unicode or binary format with dynamic length.

Example:

```
DEFINE DATA LOCAL
1 #RESULTI      (I4)
1 #RESULTA      (A20)
1 #RESULTADYN   (A) DYNAMIC
1 #A(I4)         CONST <1234>
1 #B(A20)        CONST <H'30313233'> /* '0123' stored
1 #C(I2/1:3)     CONST <2000, 2100, 2200>
END-DEFINE
*
#RESULTA      := *MAXVAL((IR=A20)      #A, #B)      /*no error, I4->A20 is allowed!
#RESULTADYN   := *MAXVAL((IR=(A)DYNAMIC) #A, #B)      /*result is (A) dynamic
/* #RESULTI   := *MAXVAL((IR=I4)      #A, #B)      /*compiler error, because conv. ←
A20->I4 is not allowed!
#RESULTI      := *MAXVAL((IR=I4)      #A, #C(*)) /*maximum of the array is ←
evaluated
DISPLAY #RESULTA #RESULTADYN (AL=10) #RESULTI
END
```

## Resulting Format/Length Conversion Rule Tables

---

There are different ways to define the resulting format/length of the whole \*MINVAL/\*MAXVAL system function.

- [Explicit Specification of the Resulting Format/Length](#)
- [Implicit Specification of the Resulting Format/Length](#)

### Explicit Specification of the Resulting Format/Length

The resulting format/length of the whole \*MINVAL/\*MAXVAL system function may be specified by the IR clause. All operands specified will be converted into this resulting format/length, if this is possible without any loss of precision. Afterwards the minimum/maximum of all the converted operands will be evaluated and one single scalar value with the evaluated format/length will be set as result of the whole system function.

### Implicit Specification of the Resulting Format/Length

If no IR clause is used inside the \*MINVAL/\*MAXVAL system function, the resulting format/length will be evaluated regarding the format/length of all operands specified as arguments inside the \*MINVAL/\*MAXVAL system function. The format/length of each operand is taken and combined with the format/length of the next following operand of the argument list. The resulting format/length of two single operands are then evaluated using the Format/Length Conversion Rule Tables below.

The Format/Length Conversion Rule Table is separated into two different subtables. All combinations not shown in the two tables below are invalid and must not be applied inside the argument list of the \*MINVAL/\*MAXVAL system function. The keyword FLF indicates that the IR clause must

be used in order to define the resulting format/length, because there otherwise may be a loss of precision.

**Table 1**

Covers all the numeric combinations of two different operands.

	Format- length	Second Operand				
		I1	I2	I4	$P_{a . b}, N_{a . b}$	F4, F8
First Operand	I1	I1	I2	I4	$P_{\max(3, a) . b}$	F8
	I2	I2	I2	I4	$P_{\max(5, a) . b}$	F8
	I4	I4	I4	I4	$P_{\max(10, a) . b}$	F8
	$P_{x . y}, N_{x . y}$	$P_{\max(3, x) . y}$	$P_{\max(5, x) . y}$	$P_{\max(10, x) . y}$	if $\max(x, a) + \max(y, b) \leq 29$ $P_{\max(x, a) . \max(y, b)}$ else FLF	if $y=0$ and $x \leq 15$ ; F8 else FLF
	F4, F8	F8	F8	F8	if $b=0$ and $a \leq 15$ F8 else FLF	F8

Legend:

<b>FLF</b>	Format-length declaration forced. The resulting format must be specified using the IR clause.
$I_x$	Format/length is Integer. $x$ specifies the number of bytes which are used to store the Integer value.
$F_x$	Format/length is Float. $x$ specifies the number of bytes which are used to store the Float value.
$P_{x . y}$ $P_{a , b}$	Packed format with corresponding number of digits before the decimal point ( $x, a$ ) and the precision ( $y, b$ ).
$N_{x . y}$ $N_{a , b}$	Numeric format with corresponding number of digits before the decimal point ( $x, a$ ) and the precision ( $y, b$ ).
$P_{\max(c, d) . e}$	The resulting format is packed. The length is evaluated by the information following. The number of digits before the decimal point is the maximum value of $c$ and $d$ . The precision value is $e$ .
$P_{\max(c, d) . \max(e, f)}$	The resulting format is packed. The length is evaluated by the information following. The number of digits before the decimal point is the maximum value of $c$ and $d$ . The precision value is the maximum value of $e$ and $f$ .

**Table 2**

Covers all other formats and lengths which may be used for \*MINVAL/\*MAXVAL system function operands.

	Second Operand					
	Format-length	D	T	A <sub>a</sub> , A dynamic	B <sub>a</sub> , B dynamic	U <sub>a</sub> , U dynamic
First Operand	D	D	T	NA	NA	NA
	T	T	T	NA	NA	NA
	A <sub>x</sub> , A dynamic	NA	NA	A dynamic	A dynamic	U dynamic
	B <sub>x</sub> , B dynamic	NA	NA	A dynamic	B dynamic	U dynamic
	U <sub>x</sub> , U dynamic	NA	NA	U dynamic	U dynamic	U dynamic

Legend:

<b>NA</b>	This combination is not allowed.
<b>D</b>	Date format.
<b>T</b>	Time format.
<b>B<sub>x</sub>, B<sub>a</sub></b>	Binary format with length <i>x</i> , <i>a</i> .
<b>A<sub>x</sub>, A<sub>a</sub></b>	Alphanumeric format with length <i>x</i> , <i>a</i> .
<b>U<sub>x</sub>, U<sub>a</sub></b>	Unicode format with length <i>x</i> , <i>a</i> .
<b>B dynamic</b>	Binary format with dynamic length.
<b>A dynamic</b>	Alphanumeric format with dynamic length.
<b>U dynamic</b>	Unicode format with dynamic length.

## Evaluating the result-format-length

Using the rules described above, the compiler is able to process the source operands by regarding pairs of operands and calculating an intermediate result for each pair. The first pair consists of the first and the second operand, the second pair of the intermediate result and the third operand, etc. After all operands have been processed, the last result shows the comparison of format and length which will be used to compare all operands in order to evaluate the minimum/maximum. When you use this method of format-length evaluation, the operand *format-lengths* can appear in any order.

Example:

```

DEFINE DATA LOCAL
1 A (I2)      INIT <34>
1 B (P4.2)    INIT <1234.56>
1 C (N4.4)    INIT <12.6789>
1 D (I1)      INIT <100>
1 E (I4/1:3)  INIT <32, 6745, 456>
1 #RES-MIN (P10.7)
1 #RES-MAX (P10.7)
END-DEFINE
*
MOVE *MINVAL(A, B, C, D, E(*)) TO #RES-MIN
MOVE *MAXVAL(A, B, C, D, E(*)) TO #RES-MAX
DISPLAY #RES-MIN #RES-MAX
END
    
```

Output:

```

#RES-MIN                                     #RES-MAX
-----
12.6789000                                6745.0000000
    
```

The following table shows the single steps evaluating the format/length of the example automatically. It shows the intermediate result (ir) of all steps and the comparison format/length (cf) which is used as *result-format/length*.

Evaluation Order	Name of First Operand	Format/Length of First Operand or Intermediate Result	Name of Second Operand	Format/Length of Second Operand or Intermediate Result	Format/Length of the Intermediate Result (ir)
1.	A	I2	B	P4.2	ir1 = P5.2
2.	ir1	P5.2	C	N4.4	ir2 = P5.4
3.	ir2	P5.4	D	I1	ir3 = P5.4
4.	ir3	P5.4	E	I4	<b>cf = P10.4</b>

During runtime, all operands are converted into the cf format/length; then all converted values are compared, and the corresponding minimum/maximum is evaluated.

Notes:

1. If only a single operand is specified, *result-format-length* will be the format/length of this operand.
2. If a binary operand with a length in the range 1- 4 is specified as an argument inside the \*MINVAL/\*MAXVAL system function along with an alphanumeric or Unicode operand, the intermediate result (*result-format-length*) is evaluated to alphanumeric or Unicode format with dynamic length.

In this case, the value of the binary operand is considered to be a numeric value, which is converted to the *result-format-length* according to the data transfer rules (the binary numeric value is converted to unpacked format) before the minimum/maximum is evaluated.

Example:

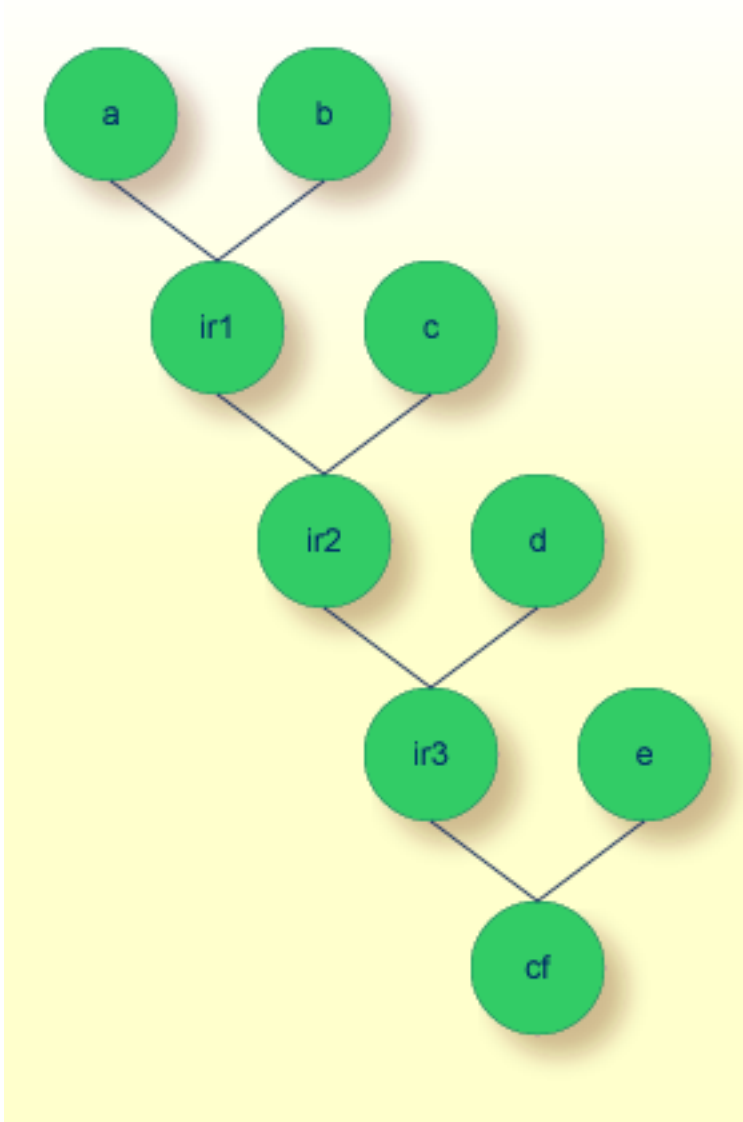
```
DEFINE DATA LOCAL
1 #B4 (B4) INIT <1>
1 #A10(A10) INIT <"2">
END-DEFINE
WRITE "=" *MAXVAL(#A10, #B4) (AL=60) /* RESULT FORMAT-LENGTH IS (A)DYNAMIC: "2"
WRITE "=" *MINVAL(#A10, #B4) (AL=60) /* RESULT FORMAT-LENGTH IS (A)DYNAMIC: "1"
END
```

Intermediate *result-format-length* (#A10, #B4) is **A dynamic**.

So first #A10 is converted into A dynamic as well as #B4 is converted into A dynamic (considering data transfer rules), before the intermediate result of both operands is evaluated.

### Format/Length Evaluation Order

The following graphic represents the order in which format and length are evaluated:



Legend:

ir1, ir2, ir3	Intermediate result 1, 2, 3.
cf	Resulting comparison format-length.





# 5

## \*TRANSLATE - Translate to Lower/Upper Case Characters

---

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```
*TRANSLATE ( operand , { LOWER } )
                    { UPPER }
```

Format/length: same as *operand*.

## Function

---

The Natural system function \*TRANSLATE converts the characters of an alphanumerical or binary operand to upper case or lower case. The content of the operand is not modified.

\*TRANSLATE may be specified as an operand in any position of a statement wherever an operand of format A, U or B is allowed.

## Restrictions

---

When using the system function \*TRANSLATE, the following restrictions apply:

- \*TRANSLATE must not be used where a target variable is expected.
- You may not nest \*TRANSLATE in a system function.

## Syntax Description

---

Operand Definition Table:

Operand	Possible Structure	Possible Formats	Referencing Permitted	Dynamic Definition
<i>operand</i>	C S A	A U B	yes	no

Syntax Element Description:

Syntax Element	Description
*TRANSLATE ( <i>operand</i> , LOWER)	<b>Lower Case Translation</b> When the keyword LOWER is used as a second argument, the character string in <i>operand</i> is translated to lower case.
*TRANSLATE ( <i>operand</i> , UPPER)	<b>Upper Case Translation</b> When the keyword UPPER is used as a second argument, the character string in <i>operand</i> is translated to upper case.

## Example

---

```
DEFINE DATA LOCAL
1 #SRC (A)DYNAMIC INIT <'aBcDeFg !$%&/()=?'>
1 #DEST (A)DYNAMIC
END-DEFINE
*
PRINT 'Source string to be translated.....:' #SRC
*
MOVE *TRANSLATE(#SRC, UPPER) TO #DEST
PRINT 'Source string translated into upper case:' #DEST
*
MOVE *TRANSLATE(#SRC, LOWER) TO #DEST
PRINT 'Source string translated into lower case:' #DEST
END
```

### Output:

```
Source string to be translated.....: aBcDeFg !$%&/()=?
Source string translated into upper case: ABCDEFG !$%&/()=?
Source string translated into lower case: abcdefg !$%&/()=?
```



# 6 \*TRIM - Remove Leading and/or Trailing Blanks

---

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```
*TRIM ( operand [ , { LEADING } ] )
```

Format/length: same as *operand* (A, U or B)/DYNAMIC.

## Function

---

The Natural system function \*TRIM removes all leading and/or trailing blanks from an alphanumeric or a binary string. The content of the operand is not modified. When using a dynamic variable as operand, the length of this variable is adapted according to the result.

The \*TRIM system function may be specified as an operand in any position of a statement wherever an operand of format A, U or B is allowed.

## Restrictions

---

When using the system function \*TRIM, the following restrictions apply:

- \*TRIM must not be used where a target variable is expected.
- You may not nest \*TRIM in a system function.
- If the operand is a static variable, it is not possible to remove trailing blanks using \*TRIM, because for static variables the remaining trailing positions of the variable memory are filled with space characters.

## Syntax Description

---

Operand Definition Table:

Operand	Possible Structure			Possible Formats								Referencing Permitted	Dynamic Definition				
<i>operand</i>	C	S	A			A	U	B								yes	no

Syntax Element Description:

Syntax Element	Description
*TRIM( <i>operand</i> , LEADING)	<b>Remove Leading Blanks</b>  When the keyword LEADING is used as a second argument, all leading blanks are removed from the string contained in <i>operand</i> .
*TRIM( <i>operand</i> , TRAILING)	<b>Remove Trailing Blanks</b>  When the keyword TRAILING is used as a second argument, all trailing blanks are removed from the string contained in <i>operand</i> .
*TRIM( <i>operand</i> )	<b>Remove Both Leading and Trailing Blanks</b>  When no keyword is used as a second argument, both the leading and the trailing blanks are removed from the string contained in <i>operand</i> .

## Examples

- [Example 1 - Using an Alphanumeric Argument](#)

### Example 1 - Using an Alphanumeric Argument

```

DEFINE DATA LOCAL
/*****
/* STATIC VARIABLE DEFINITIONS
/*****
1 #SRC (A15) INIT <' ab CD '>
1 #DEST (A15)

/* FOR PRINT OUT WITH DELIMITERS
1 #SRC-PRN (A20)
1 #DEST-PRN (A20)

/*****
/* DYNAMIC VARIABLE DEFINITIONS
/*****
1 #DYN-SRC (A)DYNAMIC INIT <' ab CD '>
1 #DYN-DEST (A)DYNAMIC

/* FOR PRINT OUT WITH DELIMITERS
1 #DYN-SRC-PRN (A)DYNAMIC
1 #DYN-DEST-PRN (A)DYNAMIC

END-DEFINE

PRINT 'static variable definition:'
PRINT '-----'
COMPRESS FULL ':' #SRC ':' TO #SRC-PRN LEAVING NO SPACE
PRINT ' '

```

## \*TRIM - Remove Leading and/or Trailing Blanks

```
PRINT ' 123456789012345      123456789012345'

MOVE *TRIM(#SRC, LEADING) TO #DEST
COMPRESS FULL ':' #DEST ':' TO #DEST-PRN LEAVING NO SPACE
DISPLAY #SRC-PRN #DEST-PRN '*TRIM(#SRC, LEADING)'
```

```
MOVE *TRIM(#SRC, TRAILING) TO #DEST
COMPRESS FULL ':' #DEST ':' TO #DEST-PRN LEAVING NO SPACE
DISPLAY #SRC-PRN #DEST-PRN '*TRIM(#SRC, TRAILING)'
```

```
MOVE *TRIM(#SRC) TO #DEST
COMPRESS FULL ':' #DEST ':' TO #DEST-PRN LEAVING NO SPACE
DISPLAY #SRC-PRN #DEST-PRN '*TRIM(#SRC)'
```

```
PRINT ' '
PRINT 'dynamic variable definition:'
PRINT '-----'
COMPRESS FULL ':' #DYN-SRC ':' TO #DYN-SRC-PRN LEAVING NO SPACE
PRINT ' '
PRINT ' 1234567890      12345678'
```

```
MOVE *TRIM(#DYN-SRC, LEADING) TO #DYN-DEST
COMPRESS FULL ':' #DYN-DEST ':' TO #DYN-DEST-PRN LEAVING NO SPACE
DISPLAY (AL=20) #DYN-SRC-PRN #DYN-DEST-PRN '*TRIM(#SRC, LEADING)'
```

```
MOVE *TRIM(#DYN-SRC, TRAILING) TO #DYN-DEST
COMPRESS FULL ':' #DYN-DEST ':' TO #DYN-DEST-PRN LEAVING NO SPACE
DISPLAY (AL=20) #DYN-SRC-PRN #DYN-DEST-PRN '*TRIM(#SRC, TRAILING)'
```

```
MOVE *TRIM(#DYN-SRC) TO #DYN-DEST
COMPRESS FULL ':' #DYN-DEST ':' TO #DYN-DEST-PRN LEAVING NO SPACE
DISPLAY (AL=20) #DYN-SRC-PRN #DYN-DEST-PRN '*TRIM(#SRC)'
```

```
PRINT ' '
PRINT '"":' := delimiter character to show the start and ending of a string!'
END
```

### Output of Example 1:

```
#SRC-PRN      #DEST-PRN
-----

static variable definition:
-----

 123456789012345      123456789012345
: ab CD      :      : ab CD      :      *TRIM(#SRC, LEADING)
: ab CD      :      : ab CD      :      *TRIM(#SRC, TRAILING)
: ab CD      :      : ab CD      :      *TRIM(#SRC)

dynamic variable definition:
-----
```



```
1234567890          12345678
: ab CD :          :ab CD :          *TRIM(#SRC, LEADING)
: ab CD :          : ab CD:         *TRIM(#SRC, TRAILING)
: ab CD :          :ab CD:         *TRIM(#SRC)

':' := delimiter character to show the start and ending of a string!
```



# 7 POS - Field Identification Function

---

Format/length: I4

The system function `POS(field-name)` returns an identification of the field whose name is specified with the system function. The value returned is an internal representation of the field address.

`POS(field-name)` may be used to identify a specific field, regardless of its position in a map. This means that the sequence and number of fields in a map may be changed, but `POS(field-name)` will still uniquely identify the same field. With this, for example, you need only a single `REINPUT` statement to make the field to be `MARKED` dependent on the program logic.

Example:

```
DECIDE ON FIRST VALUE OF ...
  VALUE ...
    COMPUTE #FIELDX = POS(FIELD1)
  VALUE ...
    COMPUTE #FIELDX = POS(FIELD2)
  ...
END-DECIDE
...
REINPUT ... MARK #FIELDX
```

If the field specified with `POS` is an array, a specific occurrence must be specified; for example, `POS(FIELDX(5))`. `POS` cannot be applied to an array range.



**Note:** `POS` cannot distinguish between two different variables that start at the same storage position (`REDEFINE` variables) since the internal field address returned by `POS` is the same for both.

## POS and \*CURS-FIELD

The system function `POS(field-name)` may be used in conjunction with the Natural system variable `*CURS-FIELD` to make the execution of certain functions dependent on which field the cursor is currently positioned in.

`*CURS-FIELD` contains the internal identification of the field in which the cursor is currently positioned; it cannot be used by itself, but only in conjunction with `POS(field-name)`. You may use them to check if the cursor is currently positioned in a specific field and have processing performed depending on that condition.

Example:

```
IF *CURS-FIELD = POS(FIELDX)
  MOVE *CURS-FIELD TO #FIELDY
END-IF
...
REINPUT ... MARK #FIELDY
```



### Notes:

1. The values of `*CURS-FIELD` and `POS(field-name)` serve only as internal identifications of the fields and cannot be used for arithmetic operations.
2. The value returned by `POS(field-name)` for an occurrence of an X-array (an array for which at least one bound in at least one dimension is specified as expandable) may change after the number of occurrences for a dimension of the array has been changed using the `EXPAND`, `RESIZE` or `REDUCE` statements.
3. Natural RPC: If `*CURS-FIELD` and `POS(field-name)` refer to a context variable, the resulting information can only be used within the same conversation.
4. In Natural for Ajax applications, `*CURS-FIELD` identifies the operand that represents the value of the control that has the input focus. You may use `*CURS-FIELD` in conjunction with the `POS` function to check for the control that has the input focus and perform processing depending on that condition.
5. `*CURS-FIELD` and `POS(field-name)` cannot distinguish between two different variables that start at the same storage position (`REDEFINE` variables) since the internal field addresses returned by `*CURS-FIELD` and `POS(field-name)` are the same for both variables.

See also

- *Dialog Design, Field Sensitive Processing and Simplifying Programming* in the *Programming Guide*.

## 8 RET - Return Code Function

---

Format/length: I4

The system function `RET(program-name)` may be used to receive the return code from a non-Natural program called via a `CALL` statement.

`RET(program-name)` can be used in an `IF` statement and within the arithmetic statements `ADD`, `COMPUTE`, `DIVIDE`, `MULTIPLY` and `SUBTRACT`.

Example:

```
DEFINE DATA LOCAL
1 #RETURN (I4)
...
END-DEFINE
...
...
CALL 'PROG1'
IF RET('PROG1') > #RETURN
    WRITE 'ERROR OCCURRED IN PROGRAM 1'
END-IF
...
```



## 9 SORTKEY - Sort-Key Function

---

SORTKEY (*character-string*)

This system function is used to convert “incorrectly sorted” characters (or combinations of characters) into other characters (or combinations of characters) that are “correctly sorted” alphabetically by the sort program or database system.

Format/length: A253

Several national languages contain characters (or combinations of characters) which are not sorted in the correct alphabetical order by a sort program or database system, because the sequence of the characters in the character set used by the computer does not always correspond to the alphabetical order of the characters.

For example, the Spanish letter "CH" would be treated by a sort program or database system as two separate letters and sorted between "CG" and "CI" - although in the Spanish alphabet it is in fact a letter in its own right and belongs between "C" and "D".

Or it may be that, contrary to your requirements, lower-case and upper-case letters are not treated equally in a sort sequence, that letters are sorted after numbers (although you may wish them to be sorted before numbers), or that special characters (for example, hyphens in double names) lead to an undesired sort sequence.

In such cases, you can use the system function `SORTKEY(character-string)`. The values computed by `SORTKEY` are only used as sort criterion, while the original values are used for the interaction with the end-user.

You can use the `SORTKEY` function as an arithmetic operand in a `COMPUTE` statement and in a logical condition.

As *character-string* you can specify an alphanumeric constant or variable, or a single occurrence of an alphanumeric array.

When you specify the `SORTKEY` function in a Natural program, the user exit `NATUSKnn` will be invoked - `nn` being the current language code (that is, the current value of the system variable `*LANGUAGE`).

You can write this user exit in any programming language that provides a standard `CALL` interface. The *character-string* specified with `SORTKEY` will be passed to the user exit. The user exit has to be programmed so that it converts any “incorrectly sorted” characters in this string into corresponding “correctly sorted” characters. The converted character string is then used in the Natural program for further processing.

The general calling conventions for external programs are explained in the description of the `CALL` statement.

See *User Exit for Computation of Sort Keys* for more details on the calling conventions for `SORTKEY` user exits.

### Example:

```

DEFINE DATA LOCAL
1 CUST VIEW OF CUSTOMERFILE
  2 NAME
  2 SORTNAME
END-DEFINE
...
*LANGUAGE := 4
...
REPEAT
  INPUT NAME
  SORTNAME := SORTKEY(NAME)
  STORE CUST
  END TRANSACTION
...
END-REPEAT
...
READ CUST BY SORTNAME
  DISPLAY NAME
END-READ
...

```

Assume that in the above example, at repeated executions of the `INPUT` statement, the following values are entered: "Sanchez", "Sandino" and "Sancinto".

At the assignment of `SORTKEY(NAME)` to `SORTNAME`, the user exit `NATUSK04` would be invoked. This user exit would have to be programmed so that it first converts all lower-case letters to upper-case, and then converts the character combination "CH" to "Cx" - where `x` would correspond to the last character in the character set used, i.e. hexadecimal `H'FF'` (assuming that this last character is a non-printable character).



The “original” names (NAME) as well as the converted names to be used for the desired sorting (SORTNAME) are stored. To read the file, SORTNAME is used. The DISPLAY statement would then output the names in the correct Spanish alphabetical order:

```
Sancinto  
Sanchez  
Sandino
```



# III

## Functions Supplied as Natural Objects

---



# 10 Functions Supplied as Natural Objects

---

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This document describes functions that are implemented by using Natural objects of the type function.

These function objects (and their prototype definitions) whose names start with `SAG` are supplied in the Natural system library `SYSTEM` on the system file `FNAT`. Example function calls are provided in the system library `SYSEXP`.

For detailed information on function calls, see the relevant section in the *Programming Guide*.

## URL Encoding

---

Interfacing Natural applications with HTTP requests often requires that the URI (Uniform Resource Identifiers) is URL-encoded. The `REQUEST DOCUMENT` statement needs such a URL to access a document.

URL-Encoding (or Percent-Encoding) is a mechanism to replace some special characters in parts of a URL. Only characters of the US-ASCII character set can be used to form a URL. Some characters of the US-ASCII character set have a special meaning when used in a URL - they are classified as “reserved” control characters, which structure the URL string into different semantic subcomponents. The quasi standard concerning the generic syntax of an URL is laid down in RFC3986, a document composed by the Internet community. It describes under which conditions the URL-Encoding is needed. This includes the representation of characters which are not inside the US-ASCII character set (for example, Euro sign), and it describes the use of reserved characters.

Reserved characters are:

?	=	&	#	!	\$	%	'	(	)	*	+	,	/	:	;	@	[	]
---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---	---	---	---

Non reserved characters are:

A-Z	a-z	0-9	-	_	.	~
-----	-----	-----	---	---	---	---

A URL may only consist of reserved and non-reserved characters, other characters are not permitted. If other byte values are needed (which do not correspond to any of the reserved and non-reserved characters) or if reserved characters are used as data (which should not have a special semantic meaning in the URL context), they need to be translated into the “%-encoding” form - a percent sign, immediately followed by the two-digit hexadecimal representation of the code point, due to the Windows-1252 encoding scheme. This causes a plus sign (+) to appear as `%2B`, a percent sign (%) to appear as `%25` and an at sign (@) to appear as `%40` in the string.

The following encoding functions are operating the complete input string. You should take care not to encode a complete URL or parts of it if they contain control characters (reserved characters) which must not be translated into the percent-form. These functions should only be applied to

characters not permitted for use in a URL, and to characters with a special meaning inside the URL context, which are supplied as a data item.

- [Simple Encoding](#)
- [SAGENC - Simple Encoding \(Format A to Format A\)](#)
- [SAGDEC - Simple Decoding \(Format A to Format A\)](#)
- [Extended Encoding](#)
- [SAGENCE - Extended Encoding \(Format U to Format A, Optional Parameters\)](#)
- [SAGDECE - Extended Decoding \(Format A to Format U, Optional Parameters\)](#)
- [Example Program](#)

## Simple Encoding

The single input parameter contains the character string to be encoded or decoded. All data inside is regarded as represented in code page EBCDIC 1140, regardless which session code page is really active at this time. The execution of the SAGENC/SAGDEC functions does not require Unicode support. The following characters are replaced with the corresponding US-ASCII hexadecimal equivalents.

Character	<	(	+		&	!	\$	*	)	;	/	,	%	>	?	`	:	#	@	'	=	"	^	[	]	{	}	\
which is at EBCDIC code point	4C	4D	4E	4F	50	5A	5B	5C	5D	5E	61	6B	6C	6E	6F	79	7A	7B	7C	7D	7E	7F	B0	BA	BB	C0	D0	E0
is encoded to %nn	3C	28	2B	7C	26	21	24	2A	29	3B	2F	2C	25	3E	3F	60	3A	23	40	27	3D	22	5E	5B	5D	7B	7D	5C

The following functions are available:

- [SAGENC](#) - Simple encoding (format A to format A)
- [SAGDEC](#) - Simple decoding (format A to format A)

### SAGENC - Simple Encoding (Format A to Format A)

The function SAGENC encodes a character string into its percent-encoded form. According to standard RFC3986, reserved characters and characters below US-ASCII x'7F' (*which are not allowed in a URL*) will be percent-encoded, a space character is replaced with a plus sign (+). Unreserved characters according to RCF3986 and characters above US-ASCII x'7F', such as German umlauts, are not encoded. If you want to encode such characters, use the extended encoding function [SAGENCE](#).

Object	Description
SAGENC	This is the simple encoding function call.
SAGENCP	The copycode containing the prototype definition is used at compilation time only in order to determine the type of the return variable for function call reference and to check the parameters, if this is desired.  SAGENCP is optional.
URLX01	<b>Example program</b> contained in library SYSEXP.G.  <pre>#URL-ENC := SAGENC(&lt;#URL-DEC&gt;)</pre>

### SAGDEC - Simple Decoding (Format A to Format A)

The function SAGDEC decodes the percent-encodings as provided by the function SAGENC. Besides the decoding string, no other input parameters are necessary.

Object	Description
SAGDEC	This is the simple decoding function call.
SAGDECP	The copycode containing the prototype definition is used at compilation time only in order to determine the type of the return variable for function call reference and to check the parameters, if this is desired.  SAGDECP is optional.
URLX01	<b>Example program</b> contained in library SYSEXP.G.  <pre>#URL-DEC := SAGDEC(&lt;#URL-ENC&gt;) ←</pre>

### Extended Encoding

The extended function considers all issues which are specified or recommended in RFC 3986. The following parameters may be considered (default settings shown in bold):

1. *<dynamic U-string>* to be encoded/decoded
2. Return code:  $\diamond 0$  (Natural error) if error in MOVE ENCODED statement.
3. Error character if return code  $\diamond 0$
4. Space character: %20/+/don't encode (default: **+**)
5. Unreserved characters: encode/**don't encode**
6. Reserved characters: **encode**/don't encode
7. Other special characters (neither unreserved nor reserved): **encode**/don't encode



8. Character Percent-Encoding: ISO-8859-1/UTF-8/any other code page/if = '' then \*CODEPAGE (default Natural code page, not default encoding code page!)
9. User-selected character in an X-array of format U, which shall not be percent-encoded according to the above parameters, for example, for the Euro sign character, which is not in the ISO-8859-1 code page, or to prevent a character from percent-encoding.
10. User defined percent-encoding in an X-array of format A, for a user-selected character in the same occurrence of the X-array.

The input parameter for a character string will be in Natural format U. This means the input string may contain all Unicode characters. The output string of the extended function is of format A in the Natural default code page (\*CODEPAGE). The code page of the percent-encoding can be selected. The UTF-8, ISO-8859-1, percent-encoding of the Euro sign will be done by the `MOVE ENCODED` statement. If an input character does not exist in the target code page used for percent-encoding, the character will not be encoded. This means the character will be returned unchanged in the default Natural code page. If the character does not exist in the default Natural code page either, it will be replaced by that substitution character which is returned by the `MOVE ENCODED` statement. The substitution character will be percent-encoded. This may happen only if the percent-encoding code page is not UTF-8. The last `MOVE ENCODED` error will be returned.

The parameters are optional parameters. If the user does not specify a parameter, the default value will be assumed. If the user specifies an own character translation table, the characters in the table will be percent-encoded according to this table and not according to the other parameters. If the percent-encoding of a character in the user-defined translation table is equal to the character or blank, this character will not be encoded. Thus, single characters from the reserved or unreserved character set can be excluded.

The following functions are available:

- `SAGENCE` - Extended encoding (format U to format A, optional parameters)
- `SAGDECE` - Extended decoding (format A to format U, optional parameters)

### **SAGENCE - Extended Encoding (Format U to Format A, Optional Parameters)**

The function `SAGENCE` percent-encodes a string, using the hexadecimal value of the selected code page (default UTF-8). According to standard RFC3986, reserved characters and characters below US-ASCII `x'7F'`, which are not allowed in a URL, will be percent-encoded. Also, the space and the percent sign (%) will be encoded.

In addition, unreserved characters according to RFC3986 and characters above US-ASCII `x'7F'`, such as German umlauts, will be encoded by this function.

`SAGENCE` needs Natural Unicode support.

Object	Description
SAGENCE	This is the extended encoding function call.
	Parameters:
	<pre> P-DEC-STR-E      (U) P-RET            (I4)      OPTIONAL /* 0:      ok                                    /* else: Natural error returned                                    /*          by the GIVING clause of                                    /*          MOVE ENCODED.                                    /*          This is the error which                                    /*          comes up when a character                                    /*          cannot be converted into                                    /*          the target code page.  /* Error strategy: /* Step 1: If a character shall be %-encoded and is not available /* in the code page for %-encoding, the character will not be /* %-encoded. It will be copied. /* Step 2: If a character will not be %-encoded but copied from the /* input format U-variable to a format A-variable (in *CODEPAGE) /* and the character is not available in *CODEPAGE, a substitution /* character will be used instead. The substitution character will /* be %-encoded. /* The last error will be returned in P-RET. P-ERR-CHAR      (U1)      OPTIONAL /* Character causing the error P-SPACE         (A1)      OPTIONAL /* '%' =&gt; %20                                    /* ' ' =&gt; ' '                                    /* else =&gt; '+' (default) P-UNRES         (A1)      OPTIONAL /* 'E' =&gt; encode                                    /* else =&gt; don't encode (default) P-RES           (A1)      OPTIONAL /* 'E' =&gt; encode (default)                                    /* else =&gt; don't encode P-OTHER         (A1)      OPTIONAL /* 'E' =&gt; encode (default)                                    /* else =&gt; don't encode P-CP            (A64)     OPTIONAL /* IANA name e.g. UTF-8 (default)                                    /* or ISO-8859-1  /* On mainframe only code page names defined with the macro NTCPAGE /* in the source module NATCONFIG can be used. Other code page names /* are rejected with a corresponding runtime error. /* P-CP-TABLE-CHAR(U1/1:*) OPTIONAL /* user selected char to be                                    /* %-encoded, e.g. 'ö' or '/' P-CP-TABLE-ENC (A12/1:*) OPTIONAL /* user %-encoding                                    /* e.g. character 'ö'                                    /*      '%F6'   -&gt; ISO-8859-1                                    /*      '%C3%B6' -&gt; UTF-8                                    /* e.g. character '/'                                    /*      '/'     -&gt; '/' not encoded                                    /*      although P-RES = 'E'  /* Characters in this table will be encoded according to the /* specified %-encoding. If the U12 encoding part is blank (space /* according to *CODEPAGE) or the P-CP-TABLE-ENC value is equal to </pre>

Object	Description
	<pre>/* the character, then the character will not be encoded at all. /*</pre>
SAGENCEP	<p>The copycode containing the prototype definition is used at compilation time only in order to determine the type of the return variable for function call reference and to check the parameters, if this is desired.</p> <p>SAGENCEP is optional.</p>
URLX01	<p><b>Example program</b> contained in library SYSEXP.</p> <p>Sample Calls</p> <p>Default values will be taken:</p> <pre>#URL-ENC := SAGENCE(&lt;&lt;#URL-DEC-U&gt;&gt;)</pre> <p>All possible parameters are specified:</p> <pre>#URL-ENC := SAGENCE(&lt;&lt;#URL-DEC-U, L-RET, L-ERR-CHAR, L-SPACE, L-UNRES, ← L-RES, L-OTHER, L-CP, L-CP-TAB-CHAR(*), L-CP-TAB-ENC(*) &gt;&gt;)</pre>

### SAGDECE - Extended Decoding (Format A to Format U, Optional Parameters)

The function SAGDECE decodes the percent-encodings as provided by the function SAGENCE. If a space character and/or a code page is specified, the values must be the same as specified for encoding.

SAGDECE needs Natural Unicode support.

Object	Description
SAGDECE	<p>This is the extended decoding function call.</p> <p>Parameters:</p> <pre>1 P-ENC-STR-E      (A) 1 P-RET            (I4)   OPTIONAL  /* 0:    ok                                      /* else: Natural error returned                                      /*      by the GIVING clause of                                      /*      MOVE ENCODED.                                      /*      This error comes up                                      /*      when a %-encoded                                      /*      character cannot be                                      /*      converted into the                                      /*      target code page.                                      /* The last error will be returned in P-RET. 1 P-ERR-CHAR       (A12)   OPTIONAL  /* Error character %-encoded 1 P-SPACE          (A1)   OPTIONAL  /* ' ' =&gt; ' '                                      /* else =&gt; '+' (default)</pre>

Object	Description
	<pre> 1 P-CP          (A64)  OPTIONAL /* IANA name e.g. UTF-8 (default)                                /* or ISO-8859-1 /* On mainframe only code page names defined with the macro NTCPAGE /* in the source module NATCONFG can be used. Other code page names /* are rejected with a corresponding runtime error. /* </pre>
SAGDECEP	<p>The copycode containing the prototype definition is used at compilation time only in order to determine the type of the return variable for function call reference and to check the parameters, if this is desired.</p> <p>SAGDECEP is optional.</p>
URLX01	<p><b>Example program</b> contained in library SYSEXP.</p> <p>Sample Calls</p> <p>Default values will be taken:</p> <pre> #URL-DEC-U := SAGDECE(&lt;#URL-ENC&gt;) </pre> <p>All possible parameters are specified:</p> <pre> #URL-DEC-U := SAGDECE(&lt;#URL-ENC,L-RET,L-ERR-CHAR-DEC,L-SPACE,L-CP&gt;) </pre>

## Example Program

Example program contained in library SYSEXP:

```

** Example 'URLX01': ENCODED-STR := SAGENC(<DECODED-STR>)
*****
DEFINE DATA
LOCAL
1 SAMPLE-STRING (A72)
/*
1 #URL-DEC      (A) DYNAMIC
1 #URL-ENC      (A) DYNAMIC
/*
1 #URL-DEC-U    (U) DYNAMIC
/*
1 L-RET         (I4) /* Return code
1 L-ERR-CHAR    (U1) /* Error character
1 L-ERR-CHAR-DEC(A12) /* Decoded error character
1 L-SPACE       (A1) /* '%' => %20, ' ' => ' ',
                    /* else => '+' (default)
1 L-UNRES       (A1) /* 'E' => encode, else => don't encode (default)
1 L-RES         (A1) /* 'E' => encode (default), else => don't encode
1 L-OTHER       (A1) /* 'E' => encode (default), else => don't encode
1 L-CP          (A64) /* default *CODEPAGE

```

```

1 L-CP-TAB-CHAR (U1/1:1)
1 L-CP-TAB-ENC  (A12/1:1)
1 L-MSG         (U72)
END-DEFINE
/*
/*
/*
WRITE 'Sample string to be processed:'
/* The string below shall be encoded and decoded again.
/* After decoding it should be unchanged.
SAMPLE-STRING := '"Decoded data!'"
WRITE SAMPLE-STRING (AL=72) /
/*
/* Assign the sample string to the input variable #URL-DEC of the
/* simple encoding function.
#URL-DEC      := SAMPLE-STRING
/*
/* Copycode SAGENCP containing the prototype definition is used at
/* compilation time only in order to determine the type of the return
/* variable for function call reference and to check the parameters,
/* if this is desired. SAGENCP is optional.
INCLUDE SAGENCP
/*
/* SAGENC(<#URL-DEC>) is the simple encoding function call.
/*
/* Function SAGENC %-encodes a string to code page ISO-8859-1.
/* According to standard RFC3986 reserved characters and characters
/* below US-ASCII x'7F' which are not allowed in a URL will be
/* %-encoded.
/* Also the space and the percent sign will be encoded.
/* Unreserved characters according to RFC3986 and characters above
/* US-ASCII x'7F' will not be encoded. If you want to encode such
/* characters, use the extended encoding function.
/*
/* ---- Space           ' ' -> '+'
/* ---- Percent sign    '%' -> '%25'
/*
/* Unreserved characters according to RFC3986 (will not be encoded!):
/* ---- Period (fullstop)  '.' -- '%2E'
/* ---- Tilde             '~' -- '%7E'
/* ---- Hyphen            '-' -- '%2D'
/* ---- Underscore character  '_' -- '%5F'
/* ---- digits, lower and upper case characters
/* ---- 0123456789abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ
/*
/* Reserved characters according to RFC3986:
/* ---- Exclamation mark  '!' -> '%21'
/* ---- Number sign       '#' -> '%23'
/* ---- Dollar sign       '$' -> '%24'
/* ---- Ampersand         '&' -> '%26'
/* ---- Apostrophe        ''' -> '%27'
/* ---- Left parenthesis  '(' -> '%28'

```

```

/* ---- Right parenthesis      ')' -> '%29'
/* ---- Asterisk               '*' -> '%2A'
/* ---- Plus sign              '+' -> '%2B'
/* ---- Comma                  ',' -> '%2C'
/* ---- Reverse solidus (backslash) '/' -> '%2F'
/* ---- Colon                  ':' -> '%3A'
/* ---- Semi-colon             ';' -> '%3B'
/* ---- Equals sign            '=' -> '%3D'
/* ---- Question mark          '?' -> '%3F'
/* ---- Commercial at         '@' -> '%40'
/* ---- Square bracket open    '[' -> '%5B'
/* ---- Square bracket close   ']' -> '%5D'
/*
/* Other characters below x'7F' (US-ASCII) but not allowed in URL
/* ---- Quotation mark         '"' -> '%22'
/* ---- Less than              '<' -> '%3C'
/* ---- Greater than           '>' -> '%3E'
/* ---- Reverse solidus (backslash) '\' -> '%5C'
/* ---- Accent, Circumflex     '^' -> '%5E'
/* ---- Accent, Grave          '`' -> '%60'
/* ---- Opening brace          '{' -> '%7B'
/* ---- Vertical bar           '|' -> '%7C'
/* ---- Closing brace          '}' -> '%7D'
/*
#URL-ENC := SAGENC(<#URL-DEC>)
/*
/*
WRITE 'Simple function, encoded:'
WRITE #URL-ENC (AL=72)
/*
/* Copycode SAGDECP containing the prototype definition is used at
/* compilation time only in order to determine the type of the return
/* variable for function call reference and to check the parameters,
/* if this is desired. SAGDECP is optional.
INCLUDE SAGDECP
/*
/* SAGDEC(<#URL-ENC>) is the simple decoding function call.
/* It decodes the above described %-encodings.
/*
#URL-DEC := SAGDEC(<#URL-ENC>)
/*
/*
/* The result after encoding and decoding must be equal to the original
/* SAMPLE-STRING.
WRITE 'Simple function, decoded:'
WRITE #URL-DEC (AL=72)
/*
/*
/*
WRITE /
/*
/*

```

```

/*
/* Assign the sample string to the input variable #URL-DEC-U of the
/* enhanced encoding function.
#URL-DEC-U := SAMPLE-STRING
/*
/* Copycode SAGENCEP containing the prototype definition is used at
/* compilation time only in order to determine the type of the return
/* variable for function call reference and to check the parameters,
/* if this is desired. SAGENCEP is optional.
INCLUDE SAGENCEP
/*
/* This is the enhanced encoding function call.
/* The way, characters will be %-encoded depends on the input
/* parameter of the function.
/* The parameters of the encoding and decoding function are preset
/* with the default values.
/* L-CP-TAB-CHAR(*) and L-CP-TAB-ENC(*) don't have default values.
/* L-CP-TAB-CHAR(1) = 'ä' and L-CP-TAB-ENC(1) = '%C3%A4' will not be
/* used for the sample string '"Decoded data! "'. The string does not
/* contain an 'ä'.
L-SPACE      := '+'          /* encoding and decoding
L-UNRES      := 'D'          /* encoding only
L-RES        := 'E'          /* encoding only
L-OTHER      := 'E'          /* encoding only
L-CP         := 'UTF-8'      /* encoding and decoding
                                   /* e.g. ISO-8859-1, UTF-16BE, UTF-32BE
L-CP-TAB-CHAR(1) := 'ä'      /* encoding only
L-CP-TAB-ENC (1) := '%C3%A4' /* encoding only
/*
/* Note that all possible parameters are specified for this sample
/* call.
/* If the default values shall be used and no return code is wanted,
/* all parameters can be omitted, besides the string #URL-DEC-U.
/*
#URL-ENC := SAGENCE(<#URL-DEC-U,L-RET,L-ERR-CHAR,L-SPACE,L-UNRES,
  L-RES,L-OTHER,L-CP,L-CP-TAB-CHAR(*),L-CP-TAB-ENC(*) >)
WRITE 'Extended function, encoded:'
WRITE #URL-ENC (AL=72)
IF L-RET NE 0 THEN
  /* If L-RET = 0, the function worked ok. Else L-RET contains the
  /* Natural error returned by the GIVING clause of MOVE ENCODED.
  /* The error comes up when a character cannot be converted into
  /* the target codepage, e.g. because a character does not exist
  /* in the target codepage.
  COMPRESS 'Error' L-RET 'with MOVE ENCODED of' L-ERR-CHAR INTO L-MSG
  WRITE L-MSG
END-IF
/*
/* Copycode SAGDECEP containing the prototype definition is used at
/* compilation time only in order to determine the type of the return
/* variable for function call reference and to check the parameters,
/* if this is desired. SAGDECEP is optional.

```

```
INCLUDE SAGDECEP
/*
/* This is the 1st enhanced decoding function call with 5 parameters.
/* Note that all possible parameters are specified for this sample
/* call.
/* Since the parameters have the default values, the subsequent
/* function calls return the same result although parameters
/* have been omitted.
#URL-DEC-U := SAGDECE(<#URL-ENC,L-RET,L-ERR-CHAR-DEC,L-SPACE,L-CP>)
WRITE 'Extended function, decoded:'
WRITE #URL-DEC-U (AL=72)
IF L-RET NE 0 THEN
  /* If L-RET = 0, the function worked ok. Else L-RET contains the
  /* Natural error returned by the GIVING clause of MOVE ENCODED.
  /* The error comes up when a %-encoded character cannot be converted
  /* into the target codepage, e.g. because a character does not exist
  /* in the target codepage.
  COMPRESS 'Error' L-RET 'with MOVE ENCODED of' L-ERR-CHAR INTO L-MSG
  WRITE L-MSG
  RESET L-RET
END-IF
/*
/* This is the 2nd enhanced decoding function call with one parameter.
#URL-DEC-U := SAGDECE(<#URL-ENC>)
WRITE #URL-DEC-U (AL=72)
/* L-RET will not be returned
/*
/* This is the 3rd enhanced decoding function call with 3 parameters.
#URL-DEC-U := SAGDECE(<#URL-ENC,L-RET,2X,L-CP>)
WRITE #URL-DEC-U (AL=72)
IF L-RET NE 0 THEN
  COMPRESS 'Error' L-RET 'with MOVE ENCODED of' L-ERR-CHAR INTO L-MSG
  WRITE L-MSG
  RESET L-RET
END-IF
/*
END
```

## Base64 Encoding

---

This section describes Natural functions which can be used to convert binary data into printable, network-compatible data or vice versa, using Base64 conversion.

Base64 conversion means conversion from format B to format A and back to format B, where 6 (binary) bits will be converted into 8 (alphanumeric) bits; for example, a B3 value will be converted into an A4 value.





**Note:** Every binary value will be converted into a non-ambiguous alphanumerical value. Re-converting this alphanumerical value again will result in the original binary value. However, this is not the case for most of the format A to format B and back to format A conversions.

The conversion may be used to transfer a .bmp file via TCP/IP, or to transfer Natural binary or integer values via the utility protocol.

**On Open Systems only:** There are 3 modes available: RFC3548, RFC2045 and NATRPC (default). NATRPC means the conversion is done according the NATRPC logic. This is 100% mainframe compatible. RFC2045 is the default of the CMBASE64 call. RFC3548 is like NATRPC, but alphanumerical bytes which are not needed are filled with an equals sign character (=).

The following functions are available:

- SAG64BA - Binary to Alphanumerical Conversion
- SAG64AB - Alphanumerical to Binary Conversion

These two functions together provide the same functionality as the Natural application programming interface USR4210N, which is delivered in library SYSEXT.

### SAG64BA - Binary to Alphanumerical Conversion

The function SAG64BA converts binary data into printable, network-compatible data, using Base64 encoding.

Object	Description
SAG64BA	This is the binary to alphanumerical format conversion function.
	Parameters:
1 PARM-B	(B) DYNAMIC BY VALUE /* Binary source input/target output
1 PARM-RC	(I4) OPTIONAL /* 0: ok /* Mainframe /* 1 Source is not numeric /* 2 Source is not packed /* 3 Source is not floating point /* 4 Overflow, source doesn't fit into target /* 5 Integer overflow /* 6 Source is not a valid date or time /* 7 Length error (hex input not even) /* 8 Target precision is less than source precision /* 9 Float underflow (result->0) /* 10 Alpha source contains non-hex characters /* 20 Invalid function code /* Open Systems /* 1 Invalid value for RFC parameter

Object	Description
	<pre> /* 2 Invalid function code /* 3 CMBASE64: Overflow, source doesn't fit into /*      target /* 4 CMBASE64: Non-base64 character found in encoded /*      data /* 5 CMBASE64: Out of memory /* 6 CMBASE64: Invalid number of parameters /* 7 CMBASE64: Invalid parameter type /* 8 CMBASE64: Invalid parameter length /* 9 CMBASE64: Invalid function code /* 10 CMBASE64: Unkown return code 1 PARM-ERRTXT (A72) OPTIONAL /* blank, if ok no error /* else error text 1 PARM-RFC (B1) OPTIONAL /* OS only, not used for MF /* 0 - RFC3548; 3 - RFC2045; 4 - NATRPC; </pre>
SAG64BAP	<p>The copycode containing the prototype definition is used at compilation time only in order to determine the type of the return variable for function call reference and to check the parameters, if this is desired.</p> <p>SAG64BAP is optional.</p>
B64X01	<p><b>Example program</b> contained in library SYSEXP.G.</p> <p>Default values will be taken:</p> <pre> PARM-A := SAG64BA(&lt;PARM-B&gt;) </pre> <p>All possible parameters are specified (PARM-RFC does not apply to mainframe):</p> <pre> PARM-A := SAG64BA(&lt;PARM-B, PARM-RC, PARM-ERRTXT, PARM-RFC&gt;) </pre>

### SAG64AB - Alphanumerical to Binary Conversion

The function SAG64AB converts printable, network-compatible data into binary data, using Base64 encoding.

Object	Description
SAG64AB	<p>This is the alphanumerical to binary format conversion function.</p> <p>Parameters:</p>

Object	Description
<p>1 PARM-A</p> <p>1 PARM-RC</p> <p>1 PARM-ERRTXT</p> <p>1 PARM-RFC</p>	<pre> (A) /* Alpha source input/target output (I4)  OPTIONAL /* 0:   ok /* Mainframe /* 1 Source is not numeric /* 2 Source is not packed /* 3 Source is not floating point /* 4 Overflow, source doesn't fit into target /* 5 Integer overflow /* 6 Source is not a valid date or time /* 7 Length error (hex input not even) /* 8 Target precision is less than source precision /* 9 Float underflow (result-&gt;0) /* 10 Alpha source contains non-hex characters /* 20 Invalid function code /* Open Systems /* 1 Invalid value for RFC parameter /* 2 Invalid function code /* 3 CMBASE64: Overflow, source doesn't fit into /*      target /* 4 CMBASE64: Non-base64 character found in encoded /*      data /* 5 CMBASE64: Out of memory /* 6 CMBASE64: Invalid number of parameters /* 7 CMBASE64: Invalid parameter type /* 8 CMBASE64: Invalid parameter length /* 9 CMBASE64: Invalid function code /* 10 CMBASE64: Unkown return code (A72)  OPTIONAL /* blank, if ok no error /* else error text (B1)  OPTIONAL /* OS only, not used for MF /* 0 - RFC3548; 3 - RFC2045; 4 - NATRPC; </pre>
<p>SAG64ABP</p>	<p>The copycode containing the prototype definition is used at compilation time only in order to determine the type of the return variable for function call reference and to check the parameters, if this is desired.</p> <p>SAG64ABP is optional.</p>
<p>B64X01</p>	<p><b>Example program</b> contained in library SYSEXP.</p> <p>Default values will be taken:</p>

Object	Description
	<p>PARM-B := SAG64AB(&lt;PARM-A&gt;)</p> <p>All possible parameters are specified (PARM-RFC does not apply to mainframe):</p> <p>PARM-B := SAG64AB(&lt;PARM-A, PARM-RC, PARM-ERRTXT, PARM-RFC&gt;)</p>

### Example Program

Example program B64X01 contained in library SYSEXP:

```

** Example 'B64X01': BASE64-A-STR := SAG64BA(<BASE64-B-STR>)
*****
* Function ..... Convert binary data into printable,
*                   network-compatible data or vice versa using
*                   Base64 encoding.
*
*                   Base64 encoding means (B) -> (A) -> (B),
*                   where 6 (binary) bits will be encoded into 8
*                   (alpha) bits, e.g a (B3) value will be encoded
*                   into a (A4) value.
*
*                   Note: Every binary value will be encoded into
*                   a non-ambiguous alpha value. Re-encoding this
*                   alpha value again will result in the original
*                   binary value. However, this is not the case with
*                   most of the (A) -> (B) -> (A) encodings.
*
*                   The encoding may be used to transfer a .bmp
*                   file via TCP/IP, or to transfer Natural binary or
*                   integer values via the utility protocol.
*
*                   Open Systems only:
*                   On Open Systems, there are 3 modes:
*                   RFC3548, RFC2045 and NATRPC (default).
*                   NATRPC means the encoding follows
*                   the NATRPC logic. This is 100% MF compatible.
*                   RFC2045 is the default of the CMBASE64 call.
*                   RFC3548 is like NATRPC, but alpha bytes not
*                   needed are filled with '='.
*
DEFINE DATA
LOCAL
1 FUNCTION          (A2)
/* 'AB' Alpha to binary encoding
/* 'BA' Binary to alpha encoding
1 PARM-RC          (I4)
/* 0:      ok
/* Mainframe

```

```

/* 1 Source is not numeric
/* 2 Source is not packed
/* 3 Source is not floating point
/* 4 Overflow, source doesn't fit into target
/* 5 Integer overflow
/* 6 Source is not a valid date or time
/* 7 Length error (hex input not even)
/* 8 Target precision is less than source precision
/* 9 Float underflow (result->0)
/* 10 Alpha source contains non-hex characters
/* 20 Invalid function code
/* Open Systems
/* 1 Invalid value for RFC parameter
/* 2 Invalid function code
/* 3 CMBASE64: Overflow, source doesn't fit into
/*      target
/* 4 CMBASE64: Non-base64 character found in encoded
/*      data
/* 5 CMBASE64: Out of memory
/* 6 CMBASE64: Inalid number of parameters
/* 7 CMBASE64: Invalid parameter type
/* 8 CMBASE64: Invalid parameter length
/* 9 CMBASE64: Invalid function code
/* 10 CMBASE64: Unkown return code
1 PARM-ERRTXT      (A72)
/* blank, if ok no error
/* else error text
1 PARM-A          (A)  DYNAMIC
/* Alpha source input/target output
1 PARM-B          (B)  DYNAMIC
*                /* Binary source input/target output
1 PARM-RFC        (B1)
/* OS only, not used for MF
/* 0 - RFC3548; 3 - RFC2045; 4 - NATRPC;
/*
1 #BACKUP-A      (A) DYNAMIC
1 #BACKUP-B      (B) DYNAMIC
END-DEFINE
/*
/*
SET KEY ALL
/*
/* Copycode SAG64BAP and SAG64ABP containing the prototype definition
/* is used at compilation time only in order to determine the type of
/* the return variable for function call reference and to check the
/* parameters, if this is desired. SAG64BAP and SAG64ABP are optional.
INCLUDE SAG64BAP
INCLUDE SAG64ABP
/*
REPEAT
  RESET PARM-A PARM-B
  REDUCE DYNAMIC PARM-A TO 0

```

```

REDUCE DYNAMIC PARM-B TO 0
FUNCTION := 'BA'
PARM-B := H'0123456789ABCDEF'
INPUT (AD=MIL IP=OFF CD=NE) WITH TEXT PARM-ERRTXT
  // 10T 'Base64 Encoding:' (YEI)
  / 10T '-' (19) (YEI) /
  / 10T 'Function (BA,AB) ..' (TU) FUNCTION (AD=T)
  / 10T 'Alpha In/Output ...' (TU) PARM-A (AL=30)
  / 10T 'Binary In/Output ..' (TU) PARM-B (EM=HHHHHHHH)
  / 10T 'Response .....' (TU) PARM-RC (AD=OD CD=TU)
  / PARM-ERRTXT (AD=OD CD=TU)
RESET PARM-ERRTXT
IF *PF-KEY NE 'ENTR'
  ESCAPE BOTTOM
END-IF
/*
RESET #BACKUP-A #BACKUP-B
REDUCE DYNAMIC #BACKUP-A TO 0
REDUCE DYNAMIC #BACKUP-B TO 0
#BACKUP-A := PARM-A
#BACKUP-B := PARM-B
/*
IF FUNCTION = 'BA'
  /* Parameter PARM-RC, PARM-ERRTXT and PARM-RFC are optional
  /* Parameter PARM-RFC does not apply to mainframe
  /* PARM-A := SAG64BA(<PARM-B,PARM-RC,PARM-ERRTXT,PARM-RFC>)
  PARM-A := SAG64BA(<PARM-B,PARM-RC,PARM-ERRTXT>)
  /* PARM-A := SAG64BA(<PARM-B,PARM-RC>)
  /* PARM-A := SAG64BA(<PARM-B>)
ELSE
  /* Parameter PARM-RC, PARM-ERRTXT and PARM-RFC are optional
  /* Parameter PARM-RFC does not apply to mainframe
  /* PARM-B := SAG64AB(<PARM-A,PARM-RC,PARM-ERRTXT,PARM-RFC>)
  PARM-B := SAG64AB(<PARM-A,PARM-RC,PARM-ERRTXT>)
  /* PARM-B := SAG64AB(<PARM-A,PARM-RC>)
  /* PARM-B := SAG64AB(<PARM-A>)
END-IF
/*
IF PARM-RC NE 0 THEN
  WRITE 'Encoding' FUNCTION
  WRITE NOTITLE PARM-ERRTXT
ELSE
  IF FUNCTION = 'BA' THEN
    WRITE 'Binary -> Alpha'
    WRITE '=' PARM-B (EM=HHHHHHHHHHHHHHHHHHHHHHHHHHHHHH)
    / '=' PARM-A (AL=50)
    RESET PARM-B
    REDUCE DYNAMIC PARM-B TO 0
    FUNCTION := 'AB'
  ELSE
    WRITE 'Alpha -> Binary'
    WRITE '=' PARM-A (AL=50) /

```

```

      '=' PARM-B (EM=HHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHH)
    RESET PARM-A
    REDUCE DYNAMIC PARM-A TO 0
    FUNCTION := 'BA'
  END-IF
/*
  IF FUNCTION = 'BA'
    /* Parameter PARM-RC, PARM-ERRTXT and PARM-RFC are optional
    /* Parameter PARM-RFC does not apply to mainframe
    /* PARM-A := SAG64BA(<PARM-B,PARM-RC,PARM-ERRTXT,PARM-RFC>)
    PARM-A := SAG64BA(<PARM-B,PARM-RC,PARM-ERRTXT>)
    /* PARM-A := SAG64BA(<PARM-B,PARM-RC>)
    /* PARM-A := SAG64BA(<PARM-B>)
  ELSE
    /* Parameter PARM-RC, PARM-ERRTXT and PARM-RFC are optional
    /* Parameter PARM-RFC does not apply to mainframe
    /* PARM-B := SAG64AB(<PARM-A,PARM-RC,PARM-ERRTXT,PARM-RFC>)
    PARM-B := SAG64AB(<PARM-A,PARM-RC,PARM-ERRTXT>)
    /* PARM-B := SAG64AB(<PARM-A,PARM-RC>)
    /* PARM-B := SAG64AB(<PARM-A>)
  END-IF
  IF PARM-RC NE 0 THEN
    WRITE 'Encoding' FUNCTION
    WRITE NOTITLE PARM-ERRTXT
  ELSE
    IF FUNCTION = 'BA' THEN
      WRITE 'Binary -> Alpha'
      WRITE '=' PARM-B (EM=HHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHH)
      / '=' PARM-A (AL=50)
      IF PARM-A = #BACKUP-A THEN
        WRITE '***** Encoding successful *****'
      ELSE
        WRITE '***** Value changed by encoding *****'
      END-IF
    ELSE
      WRITE 'Alpha -> Binary'
      WRITE '=' PARM-A (AL=50) /
      '=' PARM-B (EM=HHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHH)
      IF PARM-B = #BACKUP-B THEN
        WRITE '***** Encoding successful *****'
      ELSE
        WRITE '***** Value changed by encoding *****'
      END-IF
    END-IF
  END-IF
END-IF
END-REPEAT
END

```

