**Beyond4P**

**Beyond former expectations of**

**Performance,   
 Productivity,   
 Predictability and   
 Professionalism**

**Turning Big Data to Smart Data**

**An unparalleled programming language for  
high performance data and table processing**

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**Release 7.04 07.04.2020  
A Release on Independence Day**

* **Another performance boost particularly on large and very large tables and data structures**
* **Extended locale support**
* **Supports text and background color on console outputs**
* **Smart tokenizer function provided to parse text for cleanup purposes**
* **Overhaul of 'literal' function and loading HTML tables**
* **Runs embedded B4P code in github markdown documents**
* **Increased support for scientific notation in tables**

**More than 780 functions, incl. 200 table manipulation functions**

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# Text, File Format and I/O Conventions

## Definitions

**White spaces:** One or more invisible space symbols including the space bar (ASCII 32) and tabulator (ASCII 9) as well as the non-ASCII control symbols like non-break space. New line symbols (ASCII 13 and 10) are not treated as white spaces. In source codes, literals cannot continue on a following line, e.g. with use of a hyphen.

**Blank:** A blank relates to an empty literal which contains zero characters. Literals containing one or more white spaces are not considered blank.

## HTML Entity References

Tables in supported HTML / MHTML, as well as softquoted literals (referenced in program code with single quotation marks) support entity references. Examples:

&euro; € Euro sign (case sensitive, i.e. &Euro; will not be converted)

&#8364; € ", represented with decimal UNICODE number

&#x20AC; € ", represented with hexadecimal UNICODE number

&#X20ac; € Same. The letters X and of hexadecimal digits are not case sensitive

All *non-break space* characters specified with the entity reference **&nbsp;** (code 160 / Hex A0), are converted to a regular space bar symbol ( code 32 / Hex 20 ). The reason is that various tables use this symbol to separate between words or specify multiple consecutive spaces where needed. The function **decode entities** ( … ) can also decode during entity references during run time.

## Formatting Attributes

**ATTENTION – Feature declared obsolete starting with Release 5.00: These features are still running, but will not be supported any further and are subject to be removed in due time. Please refer to section 11.1 instead where a novel and comprehensive library of style and formatting functions are provided. These functions are much more powerful and independent from the target file format.**

A novelty is saving Beyond4P tables into a HTML file:  
**table save ( table name, "file.html", HTML );**

This feature allows table contents to include formatting attributes which are supported in the HTML language. Below you see a selection of formatting features. Please refer to HTML handbooks to see a complete list of formatting options.

* Text color
* Field color
* Left / center / right alignment
* Excel numbering format
* Force Excel to recognize numeric, date and Boolean contents as text  
  ( 00012 is 00012 and not 12).
* Font, boldface, italic, underlining, font size
* and many more.

The formatting attributes are added to the end of the text contents like carry-on luggage. The formatting information begins with the **escape** symbol (ANSI / UNICODE 27) and further optional formatting entries are separated with **escape** symbols, too.

1. Data without formatting, as practiced all time in the past

|  |
| --- |
| **Table contents** |
| Hello |

2. Data with field formatting

|  |  |  |
| --- | --- | --- |
| **Table contents** | **escape** | **Data field formatting option** |
| Hello | escape | bgcolor = "yellow" |

In order to force Excel not to interpret data which looks like numbers, prices, dates and boolean values, use the formatting option **style="vnd.ms-excel.numberformat:@"**  
  
Example assignment:

force\_text\_format[ ] = escape + '**style="vnd.ms-excel.numberformat:@"**';

[ table : Phone No, 1] = '0800800800' + force\_text\_format[];

// Excel will treat phone number as text. Leading zero is preserved.

3. Data with field contents formatting. Example: Red text.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Table contents** | **escape** | **Data field formatting option** | **escape** | **Formatting before field contents** | **escape** | **Formatting after field contents** |
| Hello | escape | ( keep blank ) | escape | <font color = "red"> | escape | </font> |

Example assignment:

red\_text[] = escape + escape + '**<font color = "red">**' + escape + '**</font>**';

[ table : Status, 1] = Alarming + red\_text[];

4. Combination of field and field contents formatting

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **able contents** | **escape** | **Data field formatting option** | **escape** | **Formatting before field contents** | **escape** | **Formatting after field contents** |
| Hello | escape | bgcolor = "yellow" | escape | <font color = "red"> | escape | </font> |

red\_on\_yellow[] = escape + '**bgcolor = "yellow"**'

+escape + '**<font color = "red">**' + escape + '**</font>**';

[ table : Status, 1] = Alarming + red\_text[];

**Attention:**

Beyond4P will not check or process any attribute contents. They are recognizes as regular text contents where the escape character is treated similarly like any other visible character. The code will be inserted into the generated HTML files. Erroneous code may probably (but this is not guaranteed) be highlighted when viewing the resulting HTML file with a web browser or Excel.

You can easily remove all formatting attributes with the function call **left** (…), e.g.

a[] = **left**( a[], escape );

**Formatting attributes are discarded when saving files in the conventional way** using comma or other separation symbols.

**Formatting attributes or data with formatting attributes attached will not be discarded** with any other operations or function calls applied, e.g. a[ ] = b[ ] + c[ ]; .

# Formulas and Operators

### Ranges and Selections

The comparison operators = and <> (but not the remaining ones) support ranges and selections on the right hand side.

b[] = a[] = 2 | a[] = 5 | a[] = 9 | a[] = 13; // The conventional way

b[] = a[] = 2,5,9,13; // Using selections

b[] = !(a[] >= 4 & a[] <= 8); // The conventional way

b[] = a[]<> 4..8; // Using ranges

Combinations of selections and ranges

b[] = a[]= 4..8,14..18,20,23,None,Invalid; // Using a combination of ranges and  
 // selections, and different types

Hint: Use ranges and selections in functions like **if** (…), **while** (…), **case** (...) functions, etc.

## Deep Operators

Deep Operators are a very unique feature specifically introduced to this language. Deep operators applied on parameter sets will apply the operator on the elements inside rather on the actual parameter set. Adding an accent circumflex symbol ' ^ ' behind operators will declare them as deep operators. Deep operators provide very effective and powerful means to do vector and even matrix calculations on each of the parameter elements. In order to have deep operators work correctly, the corresponding operands, which are corresponding elements in the parameter sets, must be of matching type.

Case 1: One parameter set with unary operators:

All valid unary operators are supported.

Examples: Assuming a[ ] = { 1, 2, 3, 4 } and b[ ] = { true, false }:

c[ ] = –^a[ ]; // Calculates { -1, -2, -3, -4 }

c[ ] = !^ b[ ]; // Calculates { false, true }

Case 2: Two parameter sets of equal length applied with binary operators:

All binary operators (arithmetic, Boolean and comparison) are supported. Following restrictions apply to comparison operators: No modifiers '+' to ignore case, '~' to laxen comparison, ',' to compare with more than 1 value, and '..' to compare with a range.

Examples: Assuming a[ ] = { 1, 2, 3, 4 } and b[ ] = { 5, 6, 7, 8 }:

c[ ] = a[ ] + b [ ]; // Calculates { 1, 2, 3, 4, 5, 6, 7, 8 }

c[ ] = a[ ] +^ b[ ]; // Calculates { 6, 8, 10, 12 }

c[ ] = b[ ] –^ a[ ]; // Calculates { 4, 4, 4, 4 }

c[ ] = { 1, H, date(today) } +^ { 2, i, 7 }; // Calculates { 3, Hi, (date of next week) }

c[ ] = { 1, abc } +^ { def, 2 }; // Exception – Two type mismatches

c[ ] = { 1, 2, 3, 4 } >=^ { 2, 2, 4, 4 } // Calculates { false, true, false, true }

c[ ] = sum( a[ ] \*^ b[ ] ) // Calculates sum of products, totaling 70

d[ ] = { true, true, false, false } !=^ { true, false, true, false}; // Example of Exclusive OR.

// Calculates { false, true, true, false }

Case 3: One parameter set and one scalar applied with binary operators:

Examples: Assuming a[ ] = { 1, 2, 3, 4 } and b[ ] = { 5, 6, 7, 8 }:

c[ ] = a[ ] –^ 3; // Calculates { -2, -1, 0, 1 }

c[ ] = 3 \*^ b[ ]; // Calculates { 15, 18, 21, 24 }

c[ ] = "The " +^ { house, dog, tree }; // Calculates { The house, The dog, The tree }

c[ ] = true !=^ { true, false }; // Calculates { false, true }

Case 4: Two parameter sets of different lengths applied with binary operators:

Subcase 4.1: Stuffing shorter parameter set with neutral values according to rules listed in the table below:

|  |  |  |  |
| --- | --- | --- | --- |
| **Type** | **Binary Operator** | **Value** | **Remarks** |
| literal | Any allowed operator | Blank literal |  |
| numeral | +, -  \*, / | 0  1 |  |
| date | Any allowed operator | 0 | For binary operators on dates, the other operand must be a number: |
| boolean | and  All other operators | 1  0 |  |
| parameter set | Any allowed operator | Empty set { } |  |

Examples: Assuming a[ ] = { 2, 3 } and b[ ] = { 5, 6, 7, 8 }:

c[ ] = a[ ] +^ b[ ]; // Calculates { 7, 9, 7, 8 } ( a[ ] extends to {2,3,0,0} )

c[ ] = a[ ] \*^ b[ ]; // Calculates { 10, 18, 7, 8 } ( a[ ] extends to {2,3,1,1} )

c[ ] = a[ ] +^ { }; // Empty set = 0 for addition. c[ ] is same as a[ ]

c[ ] = { } -^ a[ ]; // Calculates { -2, -3 } ( {} extends to {0,0,0,0} )

Subcase 4.2: Repeating parameter values in shorter parameter set:

Alternative to subcase 4.1, the colon suffix ' : ' added to the (last) circumflex symbol applies a different rule for shorter parameter sets: The existing pattern will be repeated until the size of the opposite parameter set has been reached. This suffix applies to binary operators only. If the shorter parameter set is empty, then subcase 4.1 applies.

c[ ] = a[ ] +^: b[ ]; // Calculates { 7, 9, 9, 11 } ( a[ ] extends to {2,3,2,3} )

c[ ] = a[ ] \*^: b[ ]; // Calculates { 10, 18, 14, 24 }

c[ ] = { Jim, Sam, Jane, Tom, Lisa } +^: {' says ',' said ',' meant '} +^: { Hi, Ho }

// Calculates {Jim says Hi,Sam said Ho, Jane meant Hi,Tom says Ho,Lisa said Hi}

Case 5: Nested deep operators – Enabler for matrix arithmetics:

Use of 2 or more succeeding circumflex symbols (e.g. '^^') allows deeper use of operators in nested parameters. This feature becomes useful when doing matrix operations. All data types with their supported operators are supported. The example below shows the different results with additions on numeric parameter sets, i.e. matrices:

Illustrated example on scalar multiplication (left) and matrix multiplication (right)



Further examples, assuming a[ ] = { {1,2},{3,4} } and b[ ] = { {5,6},{7,8} }:

c[ ] = a[ ] + b[ ] ; // Calcula tes { {1,2},{3,4},{5,6},{7,8} }

c[ ] = a[ ] +^ b[ ] ; // Calculates { {1,2,5,6},{3,4,7,8} }

c[ ] = a[ ] +^^ b[ ] ; // Calculates { {6,8},{10,12} }

d[ ] = a[ ] +^^ 10; // Calculates { {11,12},{13,14} }

d[ ] = a[ ] +^^: {10}; // Same result

d[ ] = a[ ] +^^: {{10}}; // Same result

d[ ] = a[ ] +^^ {10}; // Calculates { {11,12},{3,4} }

d[ ] = a[ ] +^^ {{10}}; // Calculates { {11,2},{3,4} }

d[ ] = a[ ] +^^ {10, 20}; // Calculates { {11,12},{23,24} }

d[ ] = a[ ] +^^: {{10},{20}}; // Same result

d[ ] = a[ ] +^^ {{10,20}}; // Calculates { {11, 22},{3,4} }

d[ ] = a[ ] +^^ {{10,20},{10,20}}; // Calculates { {11,22},{13,24} }

d[ ] = a[ ] +^^: {{10,20}}; // Same result

d[ ] = a[ ] +^^ {{10},{20}}; // Calculates { {11, 2},{23,4} }

**Accessing Tables:**

Table values are handled like literals or numerals. Deep operators are only possible if the other operand is a parameter set.

**Deep Assignment Operators:**

Deep assignment operators are only allowed on destination variables, but not on tables.

Examples:

a[ ] = { 1, 2, 3, 4 };

a[ ] -^= 2; // Calculates { -1, 0, 1, 2}

a[ ] \*= { 2, 3, 4, 5 }; // Calculates { -2, 0, 4, 10 }, using result from previous line

a[ ] +^:= { 0, 10 }; // Calculates { -2, 10, 4, 20}.

**Deep Function Call:**

A dedicated function call named 'deep' will be introduced which allows function calls in deep operations.

a[ ] = deep( abs, {{ -1, 2, -3, 4 }} );

## Type Conversions

Implicit type conversions take place under following circumstances:

* Writing data back into tables: All data will be converted to literal.
* Reading data from tables (applicable to all forms: assignments, function calls, transactions):  
  Type conversion is ruled by Boolean settings of the system variable family   
  **table conversion** [ ]. Default setting: only **table conversion**[ **numeral** ] is true, the rest is false. This means that everything, which looks like number (regardless if with or without decimal point), will be converted into a numeral. You are allowed to change the settings, allowing for converting dates, Boolean values and forcing blank entries to zero. See section 16 for details.
* Specific function calls (parameter types may be checked strictly or be converted to required type, e.g. numeral to literal).
* Arithmetic operations with Boolean values: false converts to 0 and true to 1.  
  Examples: true + true returns a 2, 3 \* false returns a zero. Unary operators: +true returns 1,   
  -true returns -1, and +false / -false return 0.
* Arithmetic operations with dates:  
  Adding days: Date + Numeral results in a date (postponed by n days)  
   Date – Numeral results in a date, too (preponed by n days)  
   Date – Date results in a number (number of days between these dates)  
   Date + Date is invalid. Exception will be asserted.

Explicit type conversions with available functions:

* numeral ( ) Converts boolean and literals to numerals.
* literal ( ) (will also convert void values into literal with explanatory message text inside)
* date ( ) Converts numeral and literal into date.
* boolean ( ) Converts 0, 1, No, Yes, True, False (not case sensitive) into Boolean
* clean numeral ( ) Converts literal with commercial style number representations,  
   e.g. "EUR (1'000.50)" to correct number, which is -1000.5 in this case.

# Transactions

## Transactions Basics

Transactions are elegantly structured assignment and manipulation features for exchanging information between variables (with their structure and array members) and tables. Transactions make use of dedicated assignment symbols called *transaction operators* which include copying, moving and swapping contents

|  |  |  |  |
| --- | --- | --- | --- |
| **Left hand destination** | **Transaction prefix** | **Transaction operator** | **Right hand destination** |
| Variables like a[ ], b[ c ], etc.  Tables like [ table1, 0, 1 ] | Simple replacement: No operator  And combination: **&**  Or combination: **|**  Add entry: **+** | Copy: **<== <==^**  Move: **<<= <<=^**  Swap: **<=> <=>^** | Variables like a[ ];, b[ c ];, etc.  Tables like [ table1, 0, 1 ]; |

**Suffix ^: Members only:** Applicable to variable-variable transactions

If this suffix '^' is appended to the transaction operator, then the transaction will only affect the member variables and array members, but the base variable contents remain unaffected on both sides of the operator. This operator applies only for transaction between variables (and no tables).

a[Hi] = He;

d1[] <== a[]; // Transaction

d2[] <== b[]; // Exception

d3[] <== a[Ho]; // Exception

d4[] <== a[Hi]; // Transaction initiated, but no members found.

## Transactions between Variables

Transactions are possible with simple variables (base variables without members), structures and arrays. Note that on both left and right hand side, variables need to be referenced directly. No arithmetic or logic operations, function calls and parentheses are allowed.

|  |  |  |  |
| --- | --- | --- | --- |
| **Correct Specifications** | **Explanation** | **Incorrect Specifications** | **Explanation** |
| a[ ]  a[1], a[b]  a[1,2], a[b,c], a[b,2], a[1,c] | Base variable  Chosen Member, will be treated as given base variable for the transaction  Chosen sub-member, same approach as above | a[ ] + 1  a[ ] + b[ ]  abs( a[ ] )  - a[ ]  ( a[ ] ) | Arithmetic  Arithmetic  Function call  Arithmetic  Parentheses  All these features use the value in the base value only and actual variable specification is lost. |

It does not matter if the variables on both sides are arrays, structures of a combination of both.

|  |  |  |  |
| --- | --- | --- | --- |
| **Transactions from variable to variable** | | | |
| **Transaction** | **Symbol** | **Example** | **Description of transaction sequence** |
| **Copy** | **<==** | a[ ] <== b[ ]; | Step 1a: If a[ ] does not yet exist, then it will be created  Step 1b: If a[ ] does already exist, then the variable will be initialized, including discarding all members and sub-members.  Step 2: Copies the value of the base value from b[ ] to a[ ] like in a regular assignment: a[ ] = b[ ];  Step 3: Copies all members and sub-members from b[ ] to a[ ] |
| **Copy Members** | **<==^** | a[ ] <==^ b[ ] | Step 1a: Like above  Step 1b: If a[ ] does already exist, then the members and sub-members will be discarded. The base variable will be preserved.  Step 2: Skipped because base variables shall not be touched  Step 3: Like above |
| **Move** | **<<=** | a[ ] <<= b[ ] | Steps 1-3: Same as for symbol <==  Step 4: Deletes variable b[ ] entirely |
| **Move Members** | **<<=^** | a[ ] <<=^ b[ ] | Steps 1-3: Same as for symbol <==^  Step 4: Deletes all members and sub-members of variable b[ ], but the base variable remains unaffected. |
| **Swap** | **<=>** | a[ ] <=> b[ ] | Step 1: All contents (base variable, members, sub-members) will be exchanged between a[ ] and b[ ] |
| **Swap Members** | **<=>^** | a[ ] <=>^ b[ ] | Step 1: All contents in members, sub-members will be exchanged between a[ ] and b[ ], but the base variables remain unchanged.  As an example, if a[ ] is a structure and b[ ] an array, then a[ ] will be an array and b[ ] a structure. |

Code example 1:

{

structure( animals1[], { mammal, bird, fish }, { dog, duck, trout } );

animals1[] = Mikes collection;

a[] <== animals1[];

b[] <==^ animals1[];

echo( a[], ", member names: ", set names( a[] ), " contents: ", set ( b[] ));

echo( b[], ", member names: ", set names( b[] ), " contents: ", set ( b[] ));

}

Output:

Mikes collection,member names: {bird,fish,mammal} contents: {duck,trout,dog}

# void value #,member names: {bird,fish,mammal} contents: {duck,trout,dog}

Code example 2:

{

structure( a[], { mammal, bird, fish }, { dog, duck, trout } );

a[] = Mike;

structure( b[], { bird, reptile, fish }, { swallow, crocodile, shark } );

b[] = Jane;

a[] <=> b[]; // The two owners just change position, but keep their pets.

echo( a[], " member names: ", set names( a[] ), " contents: ", set ( a[] ));

echo( b[], " member names: ", set names( b[] ), " contents: ", set ( b[] ));

echo(new line, "Exchange the pets ...");

a[] <=>^ b[];

echo(new line, "Jane gives the animals to Nick");

c[] = "Nick";

c[] <<=^ a[]; // But Jane inside base variable stays inside

echo( a[], ", member names: ", set names( a[] ), " contents: ", set ( a[] ));

echo( c[], ", member names: ", set names( c[] ), " contents: ", set ( c[] ));

echo(new line, "Nick gives all his animals to Mike's crocodile");

b[reptile] <<=^ c[]; // Use ^ symbol because Nick should not be eaten

echo( b[], ", member names: ", set names( b[] ), " contents: ", set ( b[] ));

echo(new line, "Lynn gets the same animals as Mike.");

d[] = Lynn;

d[] <==^ b[]; // Duplicate all members

echo( d[], ", member names: ", set names( d[] ), " contents: ", set ( d[] ));

}

Output:

Jane, member names: {bird,fish,reptile} contents: {swallow,shark,crocodile}

Mike, member names: {bird,fish,mammal} contents: {duck,trout,dog}

Exchange the pets ...

Jane, member names: {bird,fish,mammal} contents: {duck,trout,dog}

Mike, member names: {bird,fish,reptile} contents: {swallow,shark,crocodile}

Jane gives the animals to Nick

Jane, member names: {} contents: {}

Nick, member names: {bird,fish,mammal} contents: {duck,trout,dog}

Nick gives all his animals to Mike's crocodile

Mike, member names: {bird,fish,reptile,{bird,fish,mammal}} contents: {swallow, shark,crocodile,{duck,trout,dog}}

Lynn gets the same animals as Mike.

Lynn, member names: {bird,fish,reptile,{bird,fish,mammal}} contents: {swallow, shark,crocodile,{duck,trout,dog}}

## Transactions from Tables to Variables

Transactions provide a powerful way to read one row or specified part of the row and store the contents into a structure. For every item read from the table, a new member will be created, given the name of the corresponding column header name and the contents placed into the variable. Similar Implicit type conversions apply to reading the contents into the members, e.g. what looks like numbers will be converted into numerals unless configured otherwise.

Rules:

* Only simple and horizontal accesses on tables are allowed. Vertical and matrix accesses will be rejected and cause exceptions.
* Partial table specifications are allowed, provided the context information for the table and row number is available (e.g. inside the **table process**(…) call)
* Transactions from tables to variables can generate members, but no submembers
* Empty accesses create no members
* Void value is assigned to the base variable unless the **^** suffix is used behind the transction operator.
* Make sure every table header you want to work with is unique. Otherwise, the same member variable will be overwritten since the same name is used repeatedly.
* Blank table header names translate into a [""] (blank member name).

In the table below, the example table with the cities is used.

|  |  |  |  |
| --- | --- | --- | --- |
| **Correct Specifications** | **Explanation** | **Incorrect Specifications** | **Explanation** |
| Any simple and horizontal accesses are allowed:  [ table: , 1 ]  [ table: .., 1 ]  [ table: City, 1]  [ table: 1..3, 1]  [ table: ..2, 1 ]  [ table: -2.., 1]  [ table: {City, Country}, 1]  [ table: :'C\*' only)  [ table, .., {1} ] | Entire row 1, all items  "  Row 1, column "City" only  Columns selected by range  "  "  Columns chosen by a set  Columns chosen by a filter  Designates 1 row, also OK | Vertical and matrix accesses  [ table: City, 2..3 ]  [ table: .., .. ] | Vertical access  Matrix access |
| Partial table specifications:  [ ], [..]  [1..3], [..6], [5..]  [ {City,Country} ] | Entire row  Columns selected by range  Columns | Vertical and matrix accesses  [ City, 2..3 ]  [ .., .. ] | Vertical access  Matrix access |
| Lookups  { table: City, Boston, .. } | Entire row with Boston inside |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| **Transactions from table to variable** | | | |
| **Transaction** | **Symbol** | **Example** | **Description of transaction sequence** |
| **Copy** | **<==** | a[ ] <== [t: .., 1]; | Step 1a: If a[ ] does not yet exist, then it will be created  Step 1b: If a[ ] does already exist, then the variable will be initialized, including discarding all members and sub-members.  Step 2: Initializes the base variable a[ ] to a void value  Step 3: For every field retrieved from the table, a dedicated member will be created, named by corresponding table header name. Members are overwritten in case a header name is encountered for which a member has already been created. |
| **Copy Members** | **<==^** | a[ ] <==^ [t: ..,1] | Step 1a: Like above  Step 1b: If a[ ] does already exist, then the members and sub-members will be discarded. The base variable will be preserved.  Step 2: Skipped because base variables shall not be touched  Step 3: Like above |
| **Move** | **<<=** | a[ ] <<= [t: ..,1] | Steps 1-3: Same as for symbol <==  Step 4: Deletes the table row entirely. The rows below shift upwards. |
| **Move Members** | **<<=^** | a[ ] <<=^ [t: ..,1] | Steps 1-3: Same as for symbol <==^  Step 4: Deletes the table row entirely. The rows below shift upwards. |
| **Swap** | **<=>** | a[ ] <=> [t: ..,1] | Step 1: All contents (base variable, members, sub-members) will be exchanged between a[ ] and the table. |
| **Swap Members** | **<=>^** | a[ ] <=>^ [t: ..,1] | Step 1: All contents in members, sub-members will be exchanged between a[ ] and b[ ], but the base variables remain unchanged. |

If you want to use the transaction to create an array instead of a structure, then consider following two steps:

1. Delete the variable if already existing
2. Use the operator + in front of the transaction, e.g. a[ ] +<== [t:..1];  
   The size of the array will be adjusted automatically.
3. Attention: Further operations with this transaction will add further elements to the variable.

## Transactions from Variables to Tables

This is the opposite direction where member contents of structures as well as arrays are transferred into tables. As long the transaction operator has no assignment operator (discussed in later sections), then the destination row will be cleared entirely before writing.

Structures to tables: The member names will be matched with the existing column header names, provided they are part of the table specification (where whole row, a set of columns, a range or just one column is defined). If a member name cannot be matched with any column header, then an additional header with that name will be introduced and the data will be written into the designated row.

Arrays to tables: The array members will be written into the table as defined in the table specification (whole row, set of columns, a range or just one column). Normally, the members are written to the table from left to right except if a set of columns is specified. In this case, the sequence inside the set will apply. If the array contains more elements than the number of columns provided, then the remaining elements will not be written into the table. Only exception: Open-ended ranges, for example: **[t:5..,1]**, **[t:..,1]**, **[t:, 1]**.

|  |  |  |  |
| --- | --- | --- | --- |
| **Transactions from table to variable** | | | |
| **Transaction** | **Symbol** | **Example** | **Description of transaction sequence** |
| **Copy** | **<==** | [t: .., 1] <== a[ ]; | Step 1: Checks that exactly one table row and one or more or all columns are specified.  Step 2: Clears the contents in the specified table row  Step 3a: if a[ ] is a structure, then all members are checked for existing header names and, if found, the contents are written to the table. This applies to those columns explicitly specified in the table specification.  If the column header does not exist and the table specification does not restrict column selection, then additional columns are created.  Step 3b: If a[ ] is an array, then member 0 through the last ones are copied into the corresponding table columns as specified in the table specification.  Additional columns are created if the table specification denotes to an open end range, e.g. [t: 5.., 1], [t: .., 1], [t:, 1]. |
| **Copy Members** | **<==^** | [t: .., 1] <==^ a[ ]; | Same as above since base variable contents are not copied. |
| **Move** | **<<=** | [t: .., 1] <<= a[ ]; | Steps 1-3: Same as for symbol <==  Step 4: Deletes the table row entirely. The rows below shift upwards. |
| **Move Members** | **<<=^** | [t: .., 1] <<=^ a[ ]; | Same as above since base variable contents are not copied. |
| **Swap** | **<=>** | [t: .., 1] <=> a[ ]; | Step 1: All contents (base variable, members, sub-members) will be exchanged between a[ ] and the table. |
| **Swap Members** | **<=>^** | [t: .., 1] <=>^ a[ ]; | Step 1: All contents in members, sub-members will be exchanged between a[ ] and the table, but the base variable remains unchanged. |

Code example on transactions from and to tables:

{

table load( table, "Cities.csv" );

a[] <== [table:..Country,1];

echo( "member names: ", set names( a[] ), " contents: ", set ( a[] ));

c[City] = Köln;

c["State / Province"] = NRW;

c[Famous attraction] = Dome;

c[Famous cultural place] = Walraff Richards Museum;

c[Country] = GER;

echo(new line, Exchange Cologne with NYC);

c[] <=> [table:,1]; // Cologne replaces New York City

echo("Whereabouts of orig. variable for cologne: ", c[City]);

echo([table:,0], new line, [table:,1], new line, [table:,2]);

echo(new line,Remove Cologne);

c[] <<= [table:,1];

echo([table:,0], new line, [table:,1], new line, [table:,2]);

echo("Whereabouts of orig. variable for cologne: ", c[City]);

echo(new line,Put Düsseldorf into table);

d[City] = Düsseldorf;

d["State / Province"] = NRW;

c[Famous attraction] = Altstadt;

d[Inhabitants] = 604000;

d[Famous cultural place] = Tonhalle;

d[Country] = GER;

d[Famous Person] = Robert Schumann;

d[Drink] = Altbier;

[table:..3,2] <== d[];

echo([table:,0], new line, [table:,2]);

echo(new line,Add Montreux where data is stored in an array);

array( m[], { Jazz Festival, SWI, Montreux, 390, sunshine } );

[table:{Famous attraction,Country,City,"Alt. (m)"},3] <<= m[];

echo([table:,3], " and the array is ", identify(m[]));

}

Output:

member names: {City,Country,State / Province} contents: {New York City,USA,New York}

Exchange Cologne with NYC

Whereabouts of orig. variable for cologne: New York City

{City,State / Province,Country,Inhabitants,Famous attraction,Alt. (m),Famous cultural place,  
Moving along}

{Köln,NRW,GER,,Dome,,Walraff Richards Museum}

{Washington,D.C.,USA,650000,Lincoln Statue,7,Smithsonian Institute,Delivery drone}

Exchange Cologne with NYC

Whereabouts of orig. variable for cologne: Köln

{Washington,D.C.,USA,650000,Lincoln Statue,7,Smithsonian Institute,Delivery drone}

{Philadelphia,Pennsylvania,USA,1500000,Independence hll,12,,PPC streetcar}

{City,State / Province,Country,Inhabitants,Famous attraction,Alt. (m),Famous cultural place,  
Moving along,Drink,Famous Person}

{Düsseldorf,,GER,,,,,,Altbier,Robert Schumann}

Add Montreux where data is stored in an array

{Montreux,,SWI,,Jazz Festival,390} and the array is not found.

Düsseldorf: The table specification describes a horizontal access covering the first four columns. For this reason, the *Inhabitants*, *Famous attraction* and *Famous cultural place* are not updated. However the two new columns have (*Drink*, *Famous Person*) have been added.

Montreux: A set specifies the right columns and sequence in order to update the table correctly. The weather condition (sunshine) was not added because the column specification is not open ended. The original array **m[ ]** is no longer found because the **<<=** operator deleted the source afterwards.

## Transactions between Tables

Transactions are possible between two table rows inside the same table or between two different tables. The **^** suffix has no impact into these operations since no variables are involved.

|  |  |  |  |
| --- | --- | --- | --- |
| **Transactions from table to table** | | | |
| **Transaction** | **Symbol** | **Example** | **Description of transaction sequence** |
| **Copy** | **<==** | [t: .., 1] <== [u: .., 1]  [t: .., 1] <== [t: .., 2] | Step 1: Checks that exactly one table row and one or more or all columns are specified in both source and destination tables  Step 2: Clears the contents in the specified table row in the destination table.  Step 3: Copies all selected items from the source table to the destination table as long they are also selected in the destination table. It's like an intersection of the column headers selected in the source and the destination table. If no overlap exists, then nothing will be copied, for example: [t: {City, Country}, 3] <== [t: {State, Street}, 4]; |
| **Copy Members** | **<==^** | [t: .., 1] <==^ a[ ]; | Same functionality because variables are not involved. |
| **Move** | **<<=** | [t: .., 1] <<= a[ ]; | Steps 1-3: Same as for symbol <==  Step 4: Deletes the row in the source table entirely. The rows below shift upwards. |
| **Move Members** | **<<=^** | [t: .., 1] <<=^ a[ ]; | Same functionality because variables are not involved. |
| **Swap** | **<=>** | [t: .., 1] <=> a[ ]; | Step 1: All contents (base variable, members, sub-members) will be exchanged between the two table rows. |
| **Swap Members** | **<=>^** | [t: .., 1] <=>^ a[ ]; | Same functionality because variables are not involved. |

Code example:

{

table load( t1, "Cities.csv" );

table initialize( t2,

{ { Country, Moving along, City, Famous attraction, Drink },

{ GER , Hoverboard, Düsseldorf, Tonhalle, Altbier },

{ GER , By foot, Köln, Dome, Kölsch },

{ SWI , Mountain bike, Montreux, Châtelard castle }

} );

[t2:,4] <== [t1:{Country,Moving along,City,Famous attraction,"State / Province"},1];

[t2:,5] <<= [t1:{Country,Moving along,City,Famous attraction,"State / Province"},2];

echo([t2:,0]);

table process( t2, echo([]) );

[t1:,1] <== [t2:,1]; // Note: It creates a new column named "Drink".

echo(new line,"Row 1 should contain Düsseldorf, Row 2 should be Phily.");

echo([t1:,1], new line, [t1:,2]);

}

Output:

{Country,Moving along,City,Famous attraction,Drink,State / Province}

{GER,Hoverboard,Düsseldorf,Tonhalle,Altbier}

{GER,By foot,Köln,Dome,Kölsch},

{SWI,Mountain bike,Montreux,Châtelard castle}

[USA,Taxi,New York City,St. of Liberty,,New York}

{USA,Delivery drone,Washington,Lincoln Statue,,D.C.}

Row 1 should contain Düsseldorf, Row 2 should be Phily.

{Düsseldorf,,GER,,Tonhalle,,,Hoverboard,Altbier}

{Philadelphia,Pennsylvania,USA,1500000,Independence hall,12,,PCC streetcar}

## Transaction Assignment Operators

Transaction assignment operators provide additional powerful features which allow existing contents in the destination tables and variables to be preserved and only selectively overwritten where intended to do so

### No Assignment Operator

This is a repetition of the basic table access functionality

|  |  |  |
| --- | --- | --- |
| **Assignment Operator:** | | **None Combinations: <== <<= <=>** |
| **Destination** | **Source** | **Description** |
| Nonexistent Simple Structure Array  *Changes to:* Structure | Structure | Step 1: The destination is initialized as specified, i.e. old members will be deleted entirely.  Step 2: The base variable is copied if the assignment operator has no ^ suffix.  Step 3: The members are transferred from source to destination. Missing members will be created. |
| Nonexistent Simple Structure Array  *Changes to:* Array | Array | Step 1: The destination is initialized as specified, i.e. old members will be deleted entirely.  Step 2: The base variable is copied if the assignment operator has no ^ suffix.  Step 3: The members are transferred in alphabetical order from source to destination. The destination contains no header names. |
| Nonexistent Simple Structure Array  *Changes to:* Structure | Table | Step 1: The destination is initialized as specified, i.e. old members will be deleted entirely.  Step 2: The base variable is initialized if the assignment operator has no ^ suffix.  Step 3: The selected table rows are read and added as named elements to the destination structure. Missing members will be created. |
| Table | Simple | Step 1: The specified table row contents will be cleared.  No further actions because the source variable contains no members. |
| Table | Structure | Step 1: The specified table row contents will be cleared.  Step 2: For each member, the member name will be matched with the corresponding table header, provided the header is part of the table specification. - If a matching table header exists, use that column. - If no match found, then add a new table header at the end of the table  and use that new column  Step 3: Write the contents in the member variable into the corresponding field in the date. |
| Table | Array | Step 1: The specified table row contents will be cleared.  Step 2: Each member will be copied into the columns as given in the table specification. - If the table specifies fewer number of columns the number of elements, then the remaining elements will not be transferred.   Example: [t:1..2,1] = a[ ]; // a[ ] contains 3 members. - If the table specifies open end range (e.g. [t:3..,1], t[..,1], [t:,1]), then the  contents will be written into further columns to the right, even if these  columns have no column header names. - If the table specifies more columns, then the excessive columns will not  be updated. |
| Table | Table | Step 1: The specified table row contents will be cleared.  Step 2: Each column as specified in both table specifications and provided if existing will be copied from one table row to the other. |

### The & (And) Assignment Operator

The & (and) operator considers following simple rules to carry out modified transactions:

* Contents in the destination will not be cleared
* Type of destination (array or structure) will be preserved. If destination is not yet existing, then a structure will be built up.
* Contents may be overwritten
* No new members, or if destination is a table, new table columns will be created.

|  |  |  |
| --- | --- | --- |
| **Assignment Operator:** | | **& Combinations: &<== &<<= &<=>** |
| **Destination** | **Source** | **Description** |
| Nonexistent Simple  *Changes to:* Structure | Structure Array | Step 1: The destination is initialized as specified.  Step 2: The base variable is copied if the assignment operator has no ^ suffix.  No further actions because destination has no prior members to match. |
| Structure | Structure | Step 1: The base variable is copied if the assignment operator has no ^ suffix.  Step 2: Members with matching member names will be copied. All other members in the source will not be copied. All other members in the destination remain unaffected. |
| Array | Structure | Step 1: The base variable is copied if the assignment operator has no ^ suffix.  Step 2: The existing array members will be replaced by members from the source variable, sorted in alphabetic order by member name. - Excess destination members remain unaffected. - If the destination has fewer members than the source, then not all  members will be copied. |
| Structure | Array | Step 1: The base variable is copied if the assignment operator has no ^ suffix.  No further actions because no member names are available to match. |
| Array | Array | Step 1: The base variable is copied if the assignment operator has no ^ suffix.  Step 2: The existing array members will be replaced from the members in the source variable in unchanged sequential order. - Excess destination members remain unaffected. - If the array is too small, then the remaining members will not be copied. |
| Structure | Table | Step 1: The base variable is initialized if the assignment operator has no ^ suffix.  Step 2: Data will be copied from the specified table columns into the structure as long as existing member names match with the corresponding column header names. - No further members are created - All other members in the destination remain unaffected. |
| Array | Table | Step 1: The base variable is initialized if the assignment operator has no ^ suffix.  Step 2: Data will be copied from the specified table columns into the existing array members starting with the first one and in the sequential order as specified in the table specification. - Excess destination members remain unaffected. - If the array is too small, then the remaining members will not be copied. |
| Table | Simple | No actions because the source variable contains no members. |
| Table | Structure | Step 1: Only the members which names match with the table header names will be copied into the corresponding columns. - No additional table columns will be created. - All other contents in the table row remain unaffected. |
| Table | Array | Step 1: The columns specified in the table specification will be overwritten in sequential order. - No additional table columns will be created if the array is bigger - If the array is smaller, then remaining table columns remain unchanged. |
| Table | Table | Step 1: The columns with matching header names in both tables, provided they are specified in the table specification, will be copied. - No additional table columns will be created. |

### The | (Or) Assignment Operator

The | (or) operator considers following simple rules to carry out modified transactions:

* Contents in the destination will not be cleared
* Type of destination (array or structure) will be preserved. If destination is not yet existing, then a structure will be built up.
* Contents may be overwritten
* New members, or if destination is a table, new table columns will be created if needed.

|  |  |  |
| --- | --- | --- |
| **Assignment Operator:** | | **| Combinations: |<== |<<= |<=>** |
| **Destination** | **Source** | **Description** |
| Nonexistent Simple Structure  *Changes to:* Structure | Structure | Step 1: The base variable is copied if the assignment operator has no ^ suffix.  Step 2: All members will be copied. Existing destination members will be overwritten. New members are added if the member names do not yet exist. |
| Array | Structure | Step 1: The base variable is copied if the assignment operator has no ^ suffix.  Step 2: The existing array members will be replaced by members from the source variable, sorted in alphabetic order by member name. - Excess destination members remain unaffected. - The array will be extended if needed. |
| Structure | Array | Step 1: The base variable is copied if the assignment operator has no ^ suffix.  Step 2: Member names will be created for each array member: Literal representation of index numbers with 8 digits ("00000000", "00000001", "00000002"), etc. The leading zeros will preserve the sorting order in order to avoid the "1", "10", "11", … "2" sequence.  Step 3: Continue with Step 2 described for structures in the section above. |
| Array | Array | Step 1: The base variable is copied if the assignment operator has no ^ suffix.  Step 2: The existing array members will be replaced from the members in the source variable in unchanged sequential order. - Excess destination members remain unaffected. - The array will be extended if needed. |
| Structure | Table | Step 1: The base variable is initialized if the assignment operator has no ^ suffix.  Step 2: Data will be copied from the specified table columns into the structure in the sequence specified as long as existing member names match with the corresponding column header names. - Missing members will be created. |
| Array | Table | Step 1: The base variable is initialized if the assignment operator has no ^ suffix.  Step 2: Data will be copied from the specified table columns into the array in the sequence specified. - Excess destination members remain unaffected. - The array will be extended if needed. |
| Table | Simple | No actions because the source variable contains no members. |
| Table | Structure | Step 1: Only the members which names match with the table header names will be copied into the corresponding columns. - If header names are missing, then they will be added. - All other contents in the table row remain unaffected. |
| Table | Array | Step 1: The columns specified in the table specification will be overwritten in sequential order. - Additional table columns will be created if the array is bigger, but  without header names! - If the array is smaller, then remaining table columns remain unchanged. |
| Table | Table | Step 1: The columns with matching header names in both tables, provided they are specified in the table specification, will be copied. - Additional table columns will be created. |

### The + (Plus) Assignment Operator

The + (plus) operator considers following simple rules to carry out modified transactions:

* Contents in the destination will not be cleared
* If the destination is an array, then it will be extended to fit the additional data. Existing members are not overwritten.
* If the destination is a structure, then it behaves similar the "or" assignment operator, but values in already existing target members will not be overwritten.
* If the destination is a simple variable or nonexistent, then it will be initialized as an array.
* If the destination is a table row, then a new blank row will be inserted and the remaining rows below will shift down accordingly before the transaction starts.

|  |  |  |
| --- | --- | --- |
| **Assignment Operator:** | | **+ Combinations: +<== +<<= +<=>** |
| **Destination** | **Source** | **Description** |
| Nonexistent Simple  *Changes to:* Array | Structure  Array | Step 1: The base variable is copied if the assignment operator has no ^ suffix.  Step 2: An array will be created and data copied from the source, sorted in alphabetic order by member name if the source is a structure, or by the given order of the source array. |
| Structure Array  *Changes to:* Array | Structure  Array | Step 1: The base variable is copied if the assignment operator has no ^ suffix.  Step 2: If the destination is a structure, then it will be converted to an array. The ordering corresponds with the previous alphabetic order of the member names.  Step 3: The array will be extended with the data copied from the source. |
| Structure Array  *Changes to:* Array | Table | Step 1: The base variable is initialized if the assignment operator has no ^ suffix.  Step 2: See Step 2 in the previous section.  Step 3: The array will be extended with the data copied from the specified table row and selected table columns. |
| Table | Simple | Step 1: A new empty row will be inserted, the rows below move downwards.  No further actions because the source variable contains no members. |
| Table | Structure | Step 1: A new empty row will be inserted, the rows below move downwards.  Step 2: For each member, the member name will be matched with the corresponding table header, provided the header is part of the table specification. - If a matching table header exists, use that column. - If no match found, then add a new table header at the end of the table  and use that new column  Step 3: Write the contents in the member variable into the corresponding field in the date. |
| Table | Array | Step 1: A new empty row will be inserted, the rows below move downwards.  Step 2: Each member will be copied into the columns as given in the table specification. - If the table specifies fewer number of columns the number of elements, then the remaining elements will not be transferred.   Example: [t:1..2,1] = a[ ]; // a[ ] contains 3 members. - If the table specifies open end range (e.g. [t:3..,1], t[..,1], [t:,1]), then the  contents will be written into further columns to the right, even if these  columns have no column header names. - If the table specifies more columns, then the excessive columns will not  be updated. |
| Table | Table | Step 1: A new empty row will be inserted, the rows below move downwards.  Step 2: Each column as specified in both table specifications and provided if existing will be copied from one table row to the other. |

### Transaction Assignment Operators: Examples

Code examples targeting structures:

{

structure( a[], { Name, Street, Town }, { Jane, Main St., Naples } );

structure( b[], { Town, Name, State }, { Florence, Linda, Tuscany } );

echo(set(a[])); // Outputs {Jane,Main St.,Naples}

echo(set(b[])); // Outputs {Linda,Tuscany,Florence} Name is first in alphabetic order

c[] <== a[]; // Make a copy

c[] &<== b[]; // Overwrites Name and Town.

c[] |<== b[]; // Overwrites Name and Town, and adds State

c[] <== a[];

c[] +<== b[]; // Adds State, but leaves existing items unchanged.

echo(set(c[])); // Outputs {Jane,Tuscany,Main St.,Naples}

}

Code examples targeting arrays:

{

array( a[], { Ha, He, Hi, Ho, Hu } );

array( b[], { Hi, Hello, Ahoi } );

c[] <== b[]; // Make a copy

c[] &<== a[]; // Hi, Hello and Ahoi are replaced by Ha, He, Hi

echo( set(c[])); // Outputs {Ha,He,Hi}

c[] <== a[];

c[] |<== b[];

echo( set(c[])); // Outputs {Hi,Hello,Ahoi,Ho,Hu}

c[] <== a[];

c[] +<== b[]; // Plus operator will always convert to array

echo( identify(c[]),":", set(c[])); // Output: array {Ha,He,Hi,Ho,Hu,Hi,Hello,Ahoi}

}

Code examples targeting tables:

{

table load( t1, "Cities.csv" );

ny[City] = "Big Apple";

ny[Country] = "U.S.";

ny[Famous person] = Frank Sinatra;

// This assignment replaces city and country, but preserves remaining contents

[t:,1] &<== ny[];

// And this operator also adds the missing column

[t:,1] |<== ny[];

dus[City] = Düsseldorf;

dus[Famous Person] = Robert Schumann;

// Moves NYC and other rows down by 1 row, row 1 becomes vacant.

// Adds Düssledorf (City and new column Famous Person) to row 1.

[t:,1] +<== dus[];

}

Again, all these transaction operators with assignment operator prefixes may also carry the ^ suffix to avoid manipulating the base variable. This happens independently from whether a and which operator is chosen.

## Parameter Sets, Arrays, Structures, Tables: Summary

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Data conversions and transactions** | | | | |
| from below | to Parameter set | to Array | to Structure | to Table |
| Parameter set | Assignment  a[ ] = b[ ]; | **array (…)** function  array( a[ ]. {…} ) | **structure (…)** function  structure( a[ ], {…}, {…} ) | horizontal, vertical and matrix write access to table  Alternatively with functions like: **table write row(…)** |
| Array | **set (…)** function  s[ ] = set( a[ ] ); | Transaction  a[ ] <== b[ ]; | Function **array to structure(…)**  array to structure( a[ ] );  Transactions with assignment operators & or | (or).  a[ ] |<== b[ ]; | Transaction  [t: .., 1] <== a[ ]; |
| Structure | **set (…)** function For member names: **set names (…)**  s[ ] = set( a[ ] ); n[ ] = set names( a[ ] ); | Function **structure to array** (…)  structure to array( a[ ] );  Transaction with assignment operator plus:  a[ ] +<== b[ ]; | Transaction  a[ ] <== b[ ]; | Transaction  [t: .., 1] <== a[ ]; |
| Table | horizontal, vertical and matrix read access to table  Alternatively with functions like: **table read row(…)** | Transaction with assignment operator plus  delete( a[ ] ); // if existing a[ ] +<== [t: .., 1]; | Transaction  a[ ] <== [t: .., 1]; | Transaction  [t: .., 1] <== [u: .., 1]; |
| **Further actions:** | | | | |
| Initialization | Assignment  a[ ] = { … }; | Functions including:  **dim(…), redim(…), array(…),** etc. | Assignments:  a[a1] = Hi; a[a2] =Ho;  Function **structure**(…) | Functions including:  table create (…) table initialize (…) table load (…) |
| Elimination | delete( a[ ] ); | delete members( a[ ] ); | members( a[ ] ); | table delete (…); |

# Special Features

## Exceptions

The language interpreter has an exception handling model which handles start and termination of application programs as well as exceptions resulting from errors. Following exceptions are distinguished:

|  |  |  |
| --- | --- | --- |
| **Exception** | **Invoked by** | **Description** |
| start | Program start  **start**() function called | A program will be loaded, compiled and started. Calling programs can also start other programs. When they have ended, the calling program continues with the next instructions following the **start**() function.  The start exception passes through interactive mode without stopping there. |
| stop | **stop**() function called  Most error exception (e.g. file not found) | The program will be stopped and returns to interactive mode, allowing users to debug and restart the program.  When typing 'return', control resumes to calling program or ends if the main program was left before. |
| interactive | **interactive**() function called | The interactive mode is called. Returning from interactive mode will resume program execution with the next instructions falling the **interactive**() function. |
| return | **return** command in interactive mode  Program execution: Leaving function | Return to calling program. |
| end | **end**() function called.  End of program reached | The current program (or interactive mode) will be ended and control resumes to calling program or ends if the main program was ended.. |
| abort | **abort**() function called  Some error exceptions (e.g. memory overflow) | Immediate program stop. |
| continue | Some error exceptions (not severe ones, are more a kind of warnings) | Issues exception to document an error or warning message, then continues program execution immediately. |
| pause | **pause**() function called | Does "Press ENTER to continue". |
| exit | **exit()** function called | Normal program termination. Execution will end entirely, even if program is called by a superior program. |
| throw | **throw**() function called | User defined exception. Execution stops at this place. Further code is "flown over" without entering nested program blocks or conditional statements until **catch**() is encountered or end of program has been reached. In the latter case, **throw**() behaves like **exit**(). |
| catch | **catch**() function called | Catches throw exceptions encountered earlier in the program and continues following the **catch**() function. |



## JavaScript Open Notation (JSON) Data Format

Beyond4P supports the JavaScript Open Notation format to load and save both table and variables. The JSON format is based on the standard described in [www.json.org](http://www.json.org). The JSON standard has no special ruling for comments. However, Beyond4P accepts comments specified in C/C++ format as comments: // for line comments and /\* … \*/ for commented sections. Others use comments as part of data in objects, e.g. { "" : "a comment?" , "\_comment" : "another comment?" } . In these cases, both will be fully read into Beyond4P variables and you need to ignore them afterwards: a[''] = "a comment?", and a['\_comment'] = "another comment?".

Beyond4P translates all JSON escape sequences as ruled, including. \\, \" ,\n, \u20ac. The last one is the Euro sign.

When saving variables into JSON text, or loading JSON text into variables, Beyond4P is smart enough to detect dates and parameter sets.

Dates must be in a strict format (no extra spaces tolerated) in order to be translated into dates automatically. Format must be "YYYY-MM-DD", "YYYY-MM-DD hh:mm:ss", "hh:mm:ss", or "0000-00-00" for blank dates. All values must be numeric.

Parameter sets are also properly handled. They are parsed and the parameter set structure is built up accordingly. Example: "{a,b,{1,2}}" will automatically build up the parameter set. Prerequisite: Must begin and end with braces.

Following functions support JSON:

* **table load** (…, JSON …)
* **table save** (…, JSON …)
* **variable load** (…)
* **variable save** (…)
* **variable to json** (…)
* **json to variable** (…)
* **attribute …** (…) function

Restriction specific to Beyond4P: JSON numbers with scientific notations are not yet supported, e.g. 3.14E+03. Will be enabled in the near future.

# Standard Function and Procedure Library

### Registry Functions (Windows only)

**WARNING!**

**Beyond4P's registry functions are considered depreciated and will no longer be supported for user programming. To store user settings and other data or variables you want to make resident, consider attribute functions or JSON data format instead.**

The following functions accesses the **Microsoft Windows Registry**. Please note that the reliable operation of your computer, the operating system and applications relies on valid contents in the registry. Any form of manipulations without knowledge of the impacts may severely affect the system. **For this reason, functions doing manipulations on the registry** (creating folders, writing, deleting data and folders) **are restricted to the following isolated location:**

**HKEY\_CURRENT\_USER: Software\Beyond4P\My Space**

Inside this dedicated location, you can freely add and remove further subkeys (folders), write and read data without causing harm elsewhere. This space is specific to your personal computer and your user name. Other users sharing your machine will not see your data. However, read accesses are possible in any registry location as long user access privileges are given.

The path is also available in the system variable (read-only) called **runtime settings [ registry my space ]**

Applications which require extended write access must use an **activation code** (20 bytes in hexadecimal format) or with a license providing higher privileges (e.g. **supervisor** privileges) which can be provided upon legitimate request. Such a code is provided in the installation script. The code will only be valid with the given script. Any manipulations in the script will void the activation and a new activation code is required.

**$$** **activation code** = 11 12 13 14 21 22 23 24 31 32 33 34 41 42 43 44 51 52 53 54; // Example

**Referencing the registry: Not case-sensitive:**

In contrast to variables, function names, header names, etc., which are case sensitive, the registry keys (folders) as well as the entry names are not case sensitive.

The registry stores data in following types:

|  |  |  |  |
| --- | --- | --- | --- |
| **Registry Data Type** | **Beyond4P Data Type** | **Representation when reading the value** | **Example** |
| REG\_BINARY | Literal | Hexadecimal contents. Bytes (2 Hex values) separated with spaces. Every line contains 16 values.  For write access: Use valid hexadecimal symbols (0-9,A-F or a-f; blanks, tabs and new lines are allowed). Separation allowed between even number of hex digits. | 10 5A 92 3E 15 14 E4 FF 91 A2 B3 CE D6 76 F1 00 03 12 |
| REG\_DWORD | Plain Numeral | 32 bit integer is converted into numeral format and vice versa | 10002000 |
| REG\_DWORD\_ BIG\_ENDIAN | Plain Numeral | Same as above, but byte ordering is reverse: Lowest byte address begins with most significant 8 bits. | 10002000 |
| REG\_EXAND\_SZ | Literal | Literal contents, contains references to environment variables, e.g. %PATH% or %USERPROFILE%  Write access: Must always be literal. | %USERPROFILE%\Own Documents |
| REG\_LINK | Literal | Registry links, stored as literals. | Contains cross references to other registry entries |
| REG\_MULTI\_SZ | Parameter set containing literals | Multiple strings.  Contents will be converted into literal if they are not literals. | { Hello, Hi, He, Ho } |
| REG\_NONE | Boolean | No data in this entry.  *False* will be returned all time.  Write access: Value of type Boolean expected (e.g. *true* or *false*), actual value will be ignored.  Write access: Must always be literal. |  |
| REG\_QWORD | Numeral  Write access: Numeral (double precision value); Literal (hex code) | Quadruple word (64 bits) will be provided as literal containing hexadecimal representation and a numeral which is a 64-bit double precision floating point number (size is same as size of Qword).  Note that the value read contains both numeric and literal representation.  Use **literal**(…) to isolate the literal contents in hexadecimal format. First symbol is most significant.  Use **numeral** (…) to isolate the numeric contents.  Write access: You can either provide a literal containing a hexadecimal value (max. 16 hex digits) or a numeral (equivalent to double precision floating point value). | Numeric representation: 2.5  Literal representation: 4004000000000000 (hex code) |
| REG\_SZ | Literal  Write access: Any type | Literal contents.  Write access: The value provided will be converted into literal format if not already being of literal format. This is particularly useful when writing dates. | Hello World |

All registry functions can be either used with the suffix "**silently**" or without. If "**silently**" is not specified (e.g. **registry read value** (…), then any error results in an exception and program execution will stop. If "**silently**" is added to the name (e.g. registry read value **silently** (…)), then short text error messages of *literal* type are returned.

Registry functions: Return values and error messages

|  |  |
| --- | --- |
| **Short message (Literal)** | **Full error message and description** |
| OK | No error has occurred. |
| Registry bad HKEY | The HKEY to access the registry is invalid or does not exist.  Check the spelling. The following HKEYs are supported: HEKY\_CLASSES\_ROOT, HKEY\_LOCAL\_MACHINE, HKEY\_CURENT\_USER, HKEY\_USERS, HKEY\_CURRENT\_CONFIG |
| Registry can't open | The registry cannot be opened with the HKEY provided.  You may probably have insufficient access privileges. |
| Registry entry not found | Access to registry entry failed (not existing).  The entry is probably not existing in the folder (key) specified. Check the spelling. |
| Registry can't read | Read access to registry not possible or allowed.  Check path and entry name as well as access rights. |
| Registry can't write | Write access to registry not possible or allowed.  Check path and entry name as well as access rights. |
| Registry unsupported format | The value read from the registry has a data format not supported by Beyond4P.  This error should normally not happen since all existing data formats in the present and past Windows versions are supported. |
| Registry invalid data type | The registry specific data type of the value to write to the registry is invalid.  Following data types are valid:  REG\_BINARY, REG\_DWORD, REG\_DWORD\_BIG\_ENDIAN, REG\_EXPAND\_SZ, REG\_LINK, REG\_MULTI\_SZ, REG\_NONE, REG\_QWORD, REG\_SZ |
| Registry incompatible types | The type of the value to write is incompatible with the registry data type specified.  E.g. writing a literal value to a registry entry of type REG\_DWORD would cause this error. |
| Registry improper hex code | The data provided in hexadecimal format is improper.  When providing hex code to data of type REG\_BINARY: 1) Total number of hex digits must be even 2) Blanks may be put between even number of hex digits (e.g. CA FE AF FE, or CAFE AFFE. Invalid: CAF E A FFE) 3) Invalid characters (Only **0**-**9** **A**-**F** and **a**-**f** as well as space ' ', new line and tabs are allowed)  When providing hex code to data of type REG\_QWORD: 1) Total number of hex digits must be 16 or less. Odd number of digits are allowed. 2) Invalid characters (see above) |
| Registry key already exists | Attempted to create a registry key (folder) which is already existing. |
| Registry other error | An undocumented error has occurred while accessing the registry  This error message should normally not occur. |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Function** | | **registry read value registry read value silently** | | | | |
| Description | | Reads a dedicated Windows registry entry  The ending "silently" will not issue an exception if the read access fails. | | | | |
| Call as | | **X** | Procedure call | | **X** | Function call, providing a return value |
| Parameter count | | 4 - 5 | | | | |
| Parameters | 1, … | Literal | | HKEY  Takes one of the following values: HKEY\_CLASSES\_ROOT, HKEY\_LOCAL\_MACHINE, HKEY\_CURENT\_USER, HKEY\_USERS, HKEY\_CURRENT\_CONFIG | | |
|  | 2. | Literal | | Registry Folder Path (keys) | | |
|  | 3. | Literal | | Registry Entry Name | | |
|  | 4. Out | Depends on data type | | Value  See next table below on the data type used. It depends on the data type of the value stored in the registry. | | |
|  | 5. Out, Opt. | Literal | | Registry Data Type  See next table. Example: REG\_BINARY, REG\_DWORD, etc. | | |
| Return value | | Literal | | Short error messages as described in the introductory part of this section | | |
| Exception | | Unsuccessful access (if function name does not end with 'silently') | | | | |
| Example | | registry read value ( HKEY\_CURRENT\_USER, Control Panel\International, sCountry, country name[ ] ) | | | | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Function** | | **registry write value registry write value silently** | | | | |
| Description | | Writes a dedicated Windows registry entry  The ending "silently" will not issue an exception if the write access fails. | | | | |
| Call as | | **X** | Procedure call | | **X** | Function call, providing a return value |
| Parameter count | | 5 | | | | |
| Parameters | 1, … | Literal | | HKEY  Takes one of the following values: HKEY\_CLASSES\_ROOT, HKEY\_LOCAL\_MACHINE, HKEY\_CURENT\_USER, HKEY\_USERS, HKEY\_CURRENT\_CONFIG | | |
|  | 2. | Literal | | Registry Folder Path (keys) | | |
|  | 3. | Literal | | Registry Entry Name | | |
|  | 4. | Depends on data type | | Value  See next table below on the data type used. It depends on the data type of the value stored in the registry. | | |
|  | 5. | Literal | | Registry Data Type  See next table. Example: REG\_BINARY, REG\_DWORD, etc. | | |
| Return value | | Literal | | Short error messages as described in the introductory part of this section | | |
| Exception | | Unsuccessful access (if function name does not end with 'silently') | | | | |
| Example | | registry write value ( HKEY\_CURRENT\_USER, Control Panel\International, sCountry, country name[ ], REG\_SZ ) | | | | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Function** | | **registry delete value registry delete value silently** | | | | |
| Description | | Deletes a dedicated Windows registry entry  The ending "silently" will not issue an exception if the delete access fails. | | | | |
| Call as | | **X** | Procedure call | | **X** | Function call, providing a return value |
| Parameter count | | 3 | | | | |
| Parameters | 1 | Literal | | HKEY  Takes one of the following values: HKEY\_CLASSES\_ROOT, HKEY\_LOCAL\_MACHINE, HKEY\_CURENT\_USER, HKEY\_USERS, HKEY\_CURRENT\_CONFIG | | |
|  | 2. | Literal | | Registry Folder Path (keys) | | |
|  | 3. | Literal | | Registry Entry Name | | |
| Return value | | Literal | | Short error messages as described in the introductory part of this section | | |
| Exception | | Unsuccessful access (if function name does not end with 'silently') | | | | |
| Example | | registry delete value ( HKEY\_CURRENT\_USER, Beyond4P Demo, My Entry) | | | | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Function** | | **registry list names registry list keys registry list names silently registry list keys silently** | | | | |
| Description | | Lists the names of all entries resp. keys (subfolders) in a specific registry location | | | | |
| Call as | | **X** | Procedure call | | **X** | Function call, providing a return value |
| Parameter count | | 3 | | | | |
| Parameters | 1 | Literal | | HKEY  Takes one of the following values: HKEY\_CLASSES\_ROOT, HKEY\_LOCAL\_MACHINE, HKEY\_CURENT\_USER, HKEY\_USERS, HKEY\_CURRENT\_CONFIG | | |
|  | 2. | Literal | | Registry Folder Path | | |
|  | 3. Out | Parameter set containing literals | | **registry list names** … (…): List of all entry names **registry list keys** … (…): List of all keys (subfolders) | | |
| Return value | | Literal | | Short error messages as described in the introductory part of this section | | |
| Exception | | Unsuccessful access (if function name does not end with 'silently') | | | | |
| Example | | **registry list names** ( HKEY\_CURRENT\_USER, Control Panel\International, entry Names[ ] )  **registry list keys** ( HKEY\_CURRENT\_USER, Control Panel, folder names[] ); | | | | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Function** | | **registry value existing registry key existing** | | | | |
| Description | | Checks if the specified data entry name or registry key (folder name) is existing | | | | |
| Call as | | **X** | Procedure call | | **X** | Function call, providing a return value |
| Parameter count | | 2, 3 | | | | |
| Parameters | 1. | Literal | | HKEY  Takes one of the following values: HKEY\_CLASSES\_ROOT, HKEY\_LOCAL\_MACHINE, HKEY\_CURENT\_USER, HKEY\_USERS, HKEY\_CURRENT\_CONFIG | | |
|  | 2. | Literal | | Registry Folder Path (keys)  Specify the registry folder path name but excluding the final key to delete | | |
|  | 3. Opt. | Literal | | Key or entry name  required for **registry value existing**. | | |
| Return value | | Literal | | true if existing, otherwise false | | |
| Exception | | Only if wrong HKEY is specified.  If access privileges are not sufficient, Boolean false will be returned | | | | |
| Example | | Following three function calls return **true**:  **registry value existing**( HKEY\_CURRENT\_USER, control panel\international, sCountry)  **registry key existing**( HKEY\_CURRENT\_USER, control panel\international ) | | | | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Function** | | **registry read accessible registry write accessible** | | | | |
| Description | | Checks if access rights are given for the specified registry folder path (key). | | | | |
| Call as | | **X** | Procedure call | | **X** | Function call, providing a return value |
| Parameter count | | 2 | | | | |
| Parameters | 1. | Literal | | HKEY  Takes one of the following values: HKEY\_CLASSES\_ROOT, HKEY\_LOCAL\_MACHINE, HKEY\_CURENT\_USER, HKEY\_USERS, HKEY\_CURRENT\_CONFIG | | |
|  | 2. | Literal | | Registry Folder Path (keys)  Specify the registry folder path name but excluding the final key to delete | | |
| Return value | | Literal | | true if accessible, otherwise false | | |
| Exception | | Only if wrong HKEY or a non-existing registry key is specified.  If access privileges are not sufficient, Boolean false will be returned | | | | |
| Example | | Following three function calls return **true**:  **registry name existing**( HKEY\_CURRENT\_USER, control panel\international, sCountry)  **registry key existing**( HKEY\_CURRENT\_USER, control panel, international )  **registry key existing**( HKEY\_CURRENT\_USER, control panel\international ) | | | | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Function** | | **registry create key registry create key silently** | | | | |
| Description | | Creates a key (registry folder).  Multiple nested keys (folders) can be created with one function call. | | | | |
| Call as | | **X** | Procedure call | | **X** | Function call, providing a return value |
| Parameter count | | 2 | | | | |
| Parameters | 1. | Literal | | HKEY  Takes one of the following values: HKEY\_CLASSES\_ROOT, HKEY\_LOCAL\_MACHINE, HKEY\_CURENT\_USER, HKEY\_USERS, HKEY\_CURRENT\_CONFIG | | |
|  | 2. | Literal | | Registry Folder Path (keys)  It must be the complete path, e.g. "Software\Beyond4P\Demo" where only the missing keys (folders) are created. | | |
| Return value | | Literal | | Short error messages as described in the introductory part of this section | | |
| Exception | | Unsuccessful access (if function name does not end with 'silently') | | | | |
| Example | | registry delete value ( HKEY\_CURRENT\_USER, Beyond4P Demo, My Entry) | | | | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Function** | | **registry delete key registry delete tree registry delete key silently registry delete tree silently** | | | | |
| Description | | Deletes a registry key (folder).  With **registry delete key** … (…), the key must not contain any further sub-keys. If they do, then they need to be deleted first.  The **registry delete tree** … (…) is more aggressive: It will eliminate all values and subkeys recursively before concluding with deleting the specified key. | | | | |
| Call as | | **X** | Procedure call | | **X** | Function call, providing a return value |
| Parameter count | | 3 | | | | |
| Parameters | 1. | Literal | | HKEY  Takes one of the following values: HKEY\_CLASSES\_ROOT, HKEY\_LOCAL\_MACHINE, HKEY\_CURENT\_USER, HKEY\_USERS, HKEY\_CURRENT\_CONFIG | | |
|  | 2. | Literal | | Registry Folder Path (keys)  Specify the registry folder path name but excluding the final key to delete | | |
|  | 3. | Literal | | Key to delete | | |
| Return value | | Literal | | Short error messages as described in the introductory part of this section | | |
| Exception | | Unsuccessful access (if function name does not end with 'silently') | | | | |
| Example | | registry delete value ( HKEY\_CURRENT\_USER, Beyond4P Demo, My Entry) | | | | |

# Supplementary Function and Procedure Libraries

Beyond4P now offers additional functions which provide powerful features in table processing and formatting. These functions are not implemented in the Beyond4P machine but are actually written in the language Beyond4P and need to be included using the **include** (…) function.

## Style and Formatting Functions

### Introduction

Tables in Beyond4P may be saved in CSV, HTML or EXCEL (actually XML) data formats. All three formats are readable by Microsoft Excel. The HTML format is also suitable for web browsers. The EXCEL data format is in fact an XML format specifically designed for database systems creating formatted output which can be viewed in Excel.

The typical approach to format a table is:

1. **Finalize the table with all necessary contents**. You may want to have some helper columns on the right hand side which you can delete after adding formatting features, but the formatted table must not move in any direction.
2. If needed: **Define special colors** so you can reference them conveniently by color name.  
   Available functions:  
    **add color** (…) Add user-defined colors  
    **lighten colors** (…) Lighten colors  
    **darken colors** (…) Darken colors  
    **weaken colors** (…) Lower color intensities of selected colors
3. **Add style and formatting** with the functions listed below:  
    **table style table** (…) to format the entire sheet, table or table body  
    **table style rows** (…) to format table rows  
    **table style columns** (…) to format table columns  
    **table style cells** (…) to format individual cells or areas  
   The actual table contents remain unaffected. No special markup symbols
4. **If needed, remove redundant contents** in rows at the bottom and columns at the right.  
   Attention: The table you want to keep must not shift. The formats you have defined keep their positions where they are. For example, If you delete (or insert) a row, the formats in the row below will not shift up (or down) accordingly. Same applies to columns, sorting, rearranging, etc.
5. **Generate the final formatting automatically** for the intended type (HTML or EXCEL) by calling  
   one of the two functions below:  
    **translate style attributes for excel** (…)  
    **translate style attributes for html** (…)
6. **And finally, save your work** using one of the functions below:  
    **table save** (…),  
    **table save multiple** (…),  
   with the formats **EXCEL** or **HTML**. Other formats, such as the default CSV, will ignore the formatting. These two functions will actually spot the formatting data structures generated in a global variable and use the contents while writing contents to the files.
7. **To reset all format and styles in your table,** call the following function  
    **table style reset** (…)  
   so all formatting have been removed and you can start from scratch again.

The following function library provides generic functions which allows you to apply specific styles and formatting on tables, rows, columns and individual cells. During the formatting process, a global variable with underlying structures will be built up which needs to be converted and is then spotted by the functions table save (…) and table save multiple (…).

Important to watch out for:

* You must call the file "Style Library.txt" as follows  
  **include** ("Style Library.txt"). If not located in the same directory, then include the path in front of the file name.
* The library generates and works with the following global variables listed below. UNDER ANY CIRCUMSTANES, DO NOT USE OR MANIPULATE THE CONTENTS OF THESE VARIABLES INCLUDING THEIR MEMBERS. DOING SO WILL RESULT TO UNSTABLE AND MALFUNCTIONING BEHAVIOR.  
   **table style descriptions** [ ] Contains all formatting relevant information for all tables formatted  
   **hex** [ ] Conversion to hexadecimal values  
   **table style rules** [ ] Defines rules to properly interpret formatting codes  
   **table style html comments**[ ] Template to put comments into HTML file format
* The table **global color table** is created. WE STRONGLY ADVISE NOT TO MODIFY THE CONTENTS IN THIS FILE DIRECTLY, BUT FEEL FREE READING THE TABLE. Use the documented functions to add or modify colors. Feel free to add further columns to create your own categorizations.  
    
  The table contains following columns:  
   **Color Name** Obvious, like 'green', 'turquoise', etc.  
   **Cat 1**  First category (standard, lightened, darkened, weakened, user defined)  
   **Cat 2** 2nd category (primary, saturated, gray scales, excel color, red tones,   
   yellow tones, green tones, blue tones, purple tones, pink tones, brown tones)  
   **Red** Red color channel intensity, 0 … 255  
   **Green** Green color channel intensity, 0 … 255  
   **Blue** Blue color channel intensity, 0 … 255  
   **HTML Color** HTML RGB color coding, e.g. #FFC000 for orange

### Defining User specific Colors

Colors can either be specified by color name, the RGB value in a parameter set (e.g. { 255, 192, 0 } for orange), or the RGB value in HTML format (#FFC000 for orange).

Beyond4P provides more than 150 different standard colors, including the six primary colors (red, yellow, green, cyan, blue, magenta), gray scales (from black to white), fully saturated colors along the color circle (a total of 32 including the six primary colors), excel 2000+ colors (excel light green, excel green, excel light blue, excel blue, excel dark blue, excel violet; the other ones are primary colors) and a nice fashion and interior designer's collection of different shades of red, yellow, green, blue, purple, pink and brown colors.

Functions are available to extend the named colors by applying functions to derive lightened, darkened and weakened (reduction of color saturation) varieties. The function **add color**(…) allows you to add colors.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Function** | | **add color** | | | | |
| Library File | | Style Library.b4p Use **include** ( Style Library ) to include the library | | | | |
| Description | | Adds a further color to the color table | | | | |
| Call as | | **X** | Procedure call | |  | Function call, returning a return value |
| Parameter count | | 5 | | | | |
| Parameters | 1. | Literal | | Color name | | |
|  | 2. | Literal | | Category 2 (written to column Cat 2) Note: Category 1 will be set to "user defined" | | |
|  | 3. | Numeral | | Red color intensity, 0..255 (values beyond will be corrected) | | |
|  | 4 | Numeral | | Green color intensity, see above | | |
|  | 5. | Numeral | | Blue color intensity, see above | | |
| Return value | | n/a | | Procedure call | | |
| Example | | **add color**( corporate red, logo, 213, 0, 50 );  **add color**( taxi beige, surface color, 229, 219, 182 ); | | | | |

Next page: Overview of standard color names

 

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Function** | | **lighten colors** | | | | |
| Library File | | Style Library.b4p Use **include** ( Style Library ) to include the library | | | | |
| Description | | Derives lightened shades of selected colors | | | | |
| Call as | | **X** | Procedure call | |  | Function call, returning a return value |
| Parameter count | | 5 | | | | |
| Parameters | 1. | Numerals (Parameter set of numerals) | | Row numbers  The row numbers must correspond to the rows in the **global color table**. | | |
|  | 2. | Literal or numeral | | Suffix (can be a number or literal, will always be converted to literal) | | |
|  | 3. | Numeral | | Lightening up factor. e.g. factor 2 is the color precisely between white and specified color E.g. mandarin (255,128,0) translates to (255,192,128)  Use lower factors (e.g. 1.5) for less lighter shades, and bigger factors (e.g. 4) for significantly lighter shades. | | |
| Return value | | n/a | | Procedure call | | |
| Example | | **lighten colors**( **table selected rows**( global color table, [Cat 2]=primary), 1, 2 ); Generates lighter color variants of the six primary colors: red 🡪 light red 1 yellow 🡪 light yellow 1 etc. | | | | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Function** | | **darken colors** | | | | |
| Library File | | Style Library.b4p Use **include** ( Style Library ) to include the library | | | | |
| Description | | Derives darkened shades of selected colors | | | | |
| Call as | | **X** | Procedure call | |  | Function call, returning a return value |
| Parameter count | | 5 | | | | |
| Parameters | 1. | Numerals (Parameter set of numerals) | | Row numbers  The row numbers must correspond to the rows in the **global color table**. | | |
|  | 2. | Literal or numeral | | Suffix (can be a number or literal, will always be converted to literal) | | |
|  | 3. | Numeral | | Darkening down factor. e.g. factor 2 is the color precisely between black and specified color E.g. mandarin (255,128,0) translates to (128,65,0)  Use lower factors (e.g. 1.5) for lesser darkening, and bigger factors (e.g. 4) for significantly darker shades. | | |
| Return value | | n/a | | Procedure call | | |
| Example | | **darken colors**( **table selected rows**( global color table, [Cat 2]=primary), 1, 2 ); Generates darker color variants of the six primary colors: red 🡪 dark red 1 yellow 🡪 dark yellow 1, etc. | | | | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Function** | | **weaken colors** | | | | |
| Library File | | Style Library.b4p Use **include** ( Style Library ) to include the library | | | | |
| Description | | Derives color shades of weakened intensity | | | | |
| Call as | | **X** | Procedure call | |  | Function call, returning a return value |
| Parameter count | | 5 | | | | |
| Parameters | 1. | Numerals (Parameter set of numerals) | | Row numbers  The row numbers must correspond to the rows in the **global color table**. | | |
|  | 2. | Literal or numeral | | Suffix (can be a number or literal, will always be converted to literal) | | |
|  | 3. | Numeral | | Weakening factor. e.g. factor 2 is the color precisely between gray (gray level depends on color tone, e.g. light gray when weakening yellow). The corresponding luminance of gray is (0.299\*Red+0.587\*Green+0.114\*Blue) as applied in color television.  Use lower factors (e.g. 1.5) little weakening, and bigger factors (e.g. 4) for significantly weaker intensities. | | |
| Return value | | n/a | | Procedure call | | |
| Example | | **weaken colors**( **table selected rows**( global color table, [Cat 2]=primary), 1, 2 ); Generates weaker color variants of the six primary colors: red 🡪 weak red 1 yellow 🡪 weak yellow 1, etc. | | | | |

### Add Style and Formatting

After you have defined the colors you need, start with style and formatting work. The following four functions are available:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Function** | | **table style table** | | | | |
| Library File | | Style Library.b4p Use **include** ( Style Library ) to include the library | | | | |
| Description | | Applies styles and formatting on the whole table | | | | |
| Call as | | **X** | Procedure call | |  | Function call, returning a return value |
| Parameter count | | 4, 6, 8, etc. | | | | |
| Parameters | 1. | Literal | | Table name | | |
|  | 2. | Literal | | Coverage, takes one of following:  sheet Applies formatting to entire sheet, even beyond the table.  (When saving as HTML, rows below the table remains  unaffected)  table Applies formatting to entire table, but not beyond last row  and last column  body Like 'table', but except the top row. | | |
|  | 3, 5, … | Literal | | Generic Attribute Name (described later) | | |
|  | 4, 6, … | Valid parameter | | Generic Attribute Value (described later) | | |
| Return value | | n/a | | Procedure call | | |
| Example | | table style table( cities, sheet, fill color, yellow):    If saved in HTML, then vacant rows below end of table will not be colored yellow.  table style table( cities, table, fill color, lemon):    table style table( cities, body, fill color, green): | | | | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Function** | | **table style rows** | | | | |
| Library File | | Style Library.b4p Use **include** ( Style Library ) to include the library | | | | |
| Description | | Applies styles and formatting on selected rows | | | | |
| Call as | | **X** | Procedure call | |  | Function call, returning a return value |
| Parameter count | | 5, 7, 9, etc. | | | | |
| Parameters | 1. | Literal | | Table name | | |
|  | 2. | Numerals (parameter set of numerals) | | Row numbers | | |
|  | 3. | Literal | | Coverage, takes one of following:  sheet Applies formatting to entire sheet, even beyond the table.  table Applies formatting to entire table. Width determined by  width of header row  body Like 'table', width in actual table row (which may deviate  from number of columns in the header row | | |
|  | 4, 6, … | Literal | | Generic Attribute Name (described later) | | |
|  | 5, 7, … | Valid parameter | | Generic Attribute Value (described later) | | |
| Return value | | n/a | | Procedure call | | |
| Example | | table style rows( cities, 2, sheet, fill color, yellow ); // Entire Excel row is yellow  table style rows( cities, 3, table, fill color, lemon );  table style rows( cities, 4, body, fill color, green ); // Given: row 4 has fewer columns inside | | | | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Function** | | **table style columns** | | | | |
| Library File | | Style Library.b4p Use **include** ( Style Library ) to include the library | | | | |
| Description | | Applies styles and formatting on selected rows | | | | |
| Call as | | **X** | Procedure call | |  | Function call, returning a return value |
| Parameter count | | 5, 7, 9, etc. | | | | |
| Parameters | 1. | Literal | | Table name | | |
|  | 2. | *Table columns specification*  (See section 9.3) | | Select one or multiple columns by column numbers or column header names. | | |
|  | 3. | Literal | | Coverage, takes one of following:  sheet Applies formatting to entire sheet, even beyond the table.  (When saving as HTML, rows below the table remains  unaffected)  table Applies formatting to entire table. Width determed by  width of header row  body Like 'table', but except header row | | |
|  | 4, 6, … | Literal | | Generic Attribute Name (described later) | | |
|  | 5, 7, … | Valid parameter | | Generic Attribute Value (described later) | | |
| Return value | | n/a | | Procedure call | | |
| Example | | table style columns( cities, 1, sheet, fill color, yellow );  table style columns( cities, 2, table, fill color, lemon );  table style columns( cities, Dining, body, fill color, green );    If saved in HTML, then vacant rows below end of table will not be colored yellow. | | | | |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Function** | | **table style cells** | | | | |
| Library File | | Style Library.b4p Use **include** ( Style Library ) to include the library | | | | |
| Description | | Applies styles and formatting on selected cells | | | | |
| Call as | | **X** | Procedure call | |  | Function call, returning a return value |
| Parameter count | | 6, 8, 10, etc. | | | | |
| Parameters | 1. | Literal | | Table name | | |
|  | 2. | *Table columns specification*  (See section 9.3) | | Select one or multiple columns by column numbers or column header names. | | |
|  | 3. | Numerals (parameter set of numerals) | | Row numbers | | |
|  | 4. | Literal | | Coverage, takes one of following:  single Single cell addressed. If parameter set provided, then both  parameter set must contain same number of elements. Each  element pair corresponds to coordinates for one cell matrix Intersections of all specified rows and columns will be  formatted field Pairs of 2 parameter set elements represent a field  to format. | | |
|  | 5, 7, … | Literal | | Generic Attribute Name (described later) | | |
|  | 6, 8, … | Valid parameter | | Generic Attribute Value (described later) | | |
| Return value | | n/a | | Procedure call | | |
| Example | | table style cells( cities, Daytime 1, 1, single, fill color, yellow ); table style cells( cities, {0,1}, {3,5}, single, fill color, lemon ); table style cells( cities, {3,5}, {3,5}, matrix, fill color, green ); table style cells( cities, {3,5}, {0,1}, field, fill color, cyan ); | | | | |

Available formatting options:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Generic Attribute Name** | **Generic Attribute Value** | **Scope** | **Description** | **Restrictions, compatibility** |
| **text color** | color specification  (see separate table below) | table, row, column, cell | Text color | - |
| **fill color** | color specification | " | Background color of the cell | - |
| **top border bottom border left border right border** | border specification | " | Applies colored border lines above / below / left to / right to the cell | HTML: Thickness 'hairline' is same as 'thin' |
| **underscore boldface italic** | Boolean true / false | " | Applies text formatting | - |
| **wrap text** | Boolean true / false | " | Wrap text forces text to continue on the next line inside the same cell if the entire line does not fit inside. | - |
| **comment** | Literal | cell | Adds comments to specified cells. In Excel, cells with comments are tagged with red triangles at the top right corner. Hold the mouse above to see the comments. | Excel: Will only function properly in 1st table in case multiple tables are saved in one HTML file. |
| **font name** | Literal | table, row, column, cell | Sets the font name |  |
| **font size** | Numeral | " | Sets font size in units of typographical points |  |
| **number format** | Excel number format | " | Applies a number format according to Excel specification.  E.g. #,###0.00, DD-MMM-YYY, etc. | Not compatible to Beyond4P's number format as used by the function **literal** (…) |
| **type** | default, literal, numeral, boolean | " | default No special rules  literal All contents are literal, including numbers  numeral Shown as numerals  boolean Shows 0 and 1 as TRUE and  FALSE in Excel  Attention: Forcing boolean and numerals while literals are inside may be rejected by Excel. Loading the file would fail. | Functionality depends on output format EXCEL or HTML. |
| **horizontal align** | automatic left middle right | " | Alignment of contents to desired horizontal direction |  |
| **vertical align** | automatic top center bottom | " | Alignment of contents to desired vertical direction |  |
| **column width** | 1 … 255  (Numeral) | column | Sets the column width. Values are compatible with Excel column width units |  |
| **row height** | 1 … 255  (Numeral) | row | Sets the row height. Values are compatible with Excel row height units. | Not 100% accurate with HTML exports (+/- 1% deviation) |
| **autofilter** | Row number  (Numeral) | table | Applies the Excel autofilter feature on a specific row. Only 1 row can be specified.  The header row is row 0.  Attention: No autofilter settings are applied in order to prefilter selected rows. |  |
| **freeze rows** | Row number | table  Use coverage: 'sheet' | Freeze pane at row number (0 = No freeze)  E.g. specify 1 to freeze header row | Works with EXCEL only. HTML format ignores this. |
| **freeze columns** | Column number | table  Use coverage: 'sheet' | Freeze pane at column number (0 = No freeze)  E.g. specify 2 to freeze first two columns | Works with EXCEL only. HTML format ignores this. |
| **hidden**  Also allowed: **hidden row hidden column** | Boolean true / false | row, column  row column | Hides selected rows and columns  Attention: Combination with some other styles may prevent this function. | In HTML, column width is set to 0 |

Color Specification

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Method** | **Type** | **Example** | **Description** | **Restrictions, compatibility** |
| By color name | Literal | red | Existing name found in the table called '**global color table**', column 'Color Name'  Any standard, customized or custom added color name added to that table is valid. | - |
| HTML color code | Literal | #FF0000  (for red) | Color values for red, green and blue are coded with 2 hexadecimal digits each. Range: 00 … FF |  |
| RGB color values | parameter set containing 3 numerals | { 255, 0, 0 }  (for red) | Color values for red, green and blue are coded from 0 to 255. |  |

Border Specification

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Method** | **Type** | **Example** | **Description** | **Restrictions, compatibility** |
| Direct (Thickness name and color specification) | Parameter set containing 1 literal and 1 color specification | { thin, red }  (for thin line in red color) | Thickness names may be one of:  hairline, thin, medium, thick | - |

Note that HTML as well as XML for Excel have different characteristics and functional scopes and limitations which are listed below:

|  |  |  |
| --- | --- | --- |
| **Category** | **Excel** | **HTML** |
| Default character set | Arial, 10 pt  Font name may change when modifying text color. To prevent this, I suggest to assign a default font name for the entire table. | Calibri, 11 pt. |
| Spreadsheet grid visible | Yes  To make invisible, apply following function: **table style table** ( table name, sheet, fill color, white ); | No  If required, imitate them with drawing borders. |
| Column width | Standard 10.71 | Automatic (to fit contents) |
| Dates | No automatic date recognition.  You need to put numbers into the fields (e.g. with function **abs** ( *date value* ) and then apply a number format with values like "DD.MM.YYYY". | Excel recognizes dates in an intelligent manner. Dates in local format or specified as YYYY-MM-DD are detected automatically and loaded as dates. |
| Horizontal align | Default: left | Default: left, except header row: middle |
| Vertical align | Default: bottom | Default: center |
| Header row: | Standard text | Boldface text |
| Wrap text | Default: false | Default: true |
| Text colors | Some text colors appear slightly modified, e.g. crimson is displayed as plain red. | All colors appear to be shown as specified |
| Formulas | Not supported | Supported, but language specific. Formulate as you work in Excel. All formulas must begin with an equal sign.  Function names must be specified in the local language set. E.g. if Excel is configured for German, use a function name like "Summewenn" instead of "Sumif". |
| Outputting Booleans properly | Not supported | Boolean values in local language (which is not necessarily English), e.g. Wahr and Falsch (not case sensitive). Other languages (e.g. English if German is chosen as Excel language) are shown as text. |
| Forcing data to literal format, including numbers | use attribute name 'type' and value 'text'. e.g. table style table( test, sheet, type, literal); | Same. |

Code example with number formatting:

echo("Test various date, numeric and boolean representations");

format[] = input quick ignore case("Choose H for HTML, X for EXCEL: ", HX );

table initialize( test,

{ { Dates Lit 1,Dates Lit 2,Dates Num,Boolean EN,Boolean DE,Boolean Num,Numbers,Formulas },

{ "2017-01-30","30.01.2017",abs(date("2017-01-30")),TRUE,WAHR,1,123.45,"=Wurzel(4)" },

{ "2017-01-30","30.01.2017",abs(date("2017-01-30")),TRUE,WAHR,1,123.45,"=G2\*2" },

{ "2017-01-30","30.01.2017",abs(date("2017-01-30")),TRUE,WAHR,1,123.45,"=G2\*2" },

{ "2017-01-30","30.01.2017",abs(date("2017-01-30")),TRUE,WAHR,1,123.45,"=Root(4)" } } ) ;

table style columns( test, {0..7}, table, column width, 14 );

table style cells( test, Dates Num, 2, single, number format, "DD.MMM.YYYY" );

table style cells( test, Dates Lit 1, 2, single, number format, "DD.MMM.YYYY" );

table style cells( test, Dates Lit 2, 2, single, number format, "DD.MMM.YYYY" );

table style rows( test, 3, sheet, type, literal );

table style cells( test, Boolean Num, 4, single, type, boolean );

if (format[] == H)

{

translate style attributes for html( test );

table save( test , working directory[] + "Numbers out in html.xls", HTML );

}

else

{

translate style attributes for excel( test );

table save( test, working directory[] + "Numbers out in excel.xls", EXCEL );

}

Following HTML output is generated:



Note: It recognizes Boolean values as well as formula names (Wurzel instead of Root) in current Excel language and not necessarily in English. Note the last row in "Boolean Num" is blank.

Following EXCEL output is generated:



Formulas are not recognized in this format. Implementation is being considered in a future release. Note the last row under "Boolean Num" is the only field containing an authentic Boolean value. Formulas are ignored and treated as plain text instead.

### Translate Generic Type to Specific File Format

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Function** | | **translate style attributes for excel**  **translate style attributes for html** | | | | |
| Library File | | Style Library.b4p Use **include** ( Style Library ) to include the library | | | | |
| Description | | All generic style descriptions will be translated to a desired target format which is then used by the **table save** / **table save multiple** (…) function. | | | | |
| Call as | | **X** | Procedure call | |  | Function call, returning a return value |
| Parameter count | | 1 | | | | |
| Parameters | 1. | Literal | | Table name | | |
| Return value | | n/a | | Procedure call | | |
| Example | | **translate style attributes for html** ( customer list ); | | | | |

### Reset Style and Formatting

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Function** | | **table style reset** | | | | |
| Library File | | Style Library.b4p Use **include** ( Style Library ) to include the library | | | | |
| Description | | Removes any style and formatting on the specified tables.  If no formatting exists, then there will be no error.. | | | | |
| Call as | | **X** | Procedure call | |  | Function call, returning a return value |
| Parameter count | | min 0 | | | | |
| Parameters | 1. | Literal | | Table name | | |
| Return value | | n/a | | Procedure call | | |
| Example | | **table style reset**( customers, orders, products ); | | | | |

# Compile-Time Directives

Compile-Time Directives are special-purpose instructions recognized during initial code loading subsequent compilation into internal data structures. These directives become invisible during run-time before code execution begins. Directives only apply for the program file where specified, but not in other files referenced, e.g. with the **start**(…) function. The intention of these directives is to influence the code compilation process, but not to influence run-time behavior.

Compile-Time Directives consist of the following sequence:

1. **$$** Two subsequent dollar signs, without a space in-between

2. **literal** Name of directive: One literal (without quotation marks)

3. **=** One equal sign

4. **value** Value to assign: Choice of literal (with or without quotation marks),   
 numeral or Boolean, depending on the name of directive

5. **;** Semicolon to delimit the Compile-Time Directive.

Arithmtics, function calls and other algorithmic features, even calculations with constants only (for example $$ abc = 3+5 ; ), are not allowed and will give out error messagees.

Compile-Time Directives inside comments are ignored, e.g. // $$ abc = 123; has no impact.

Compile-Time Directives may be used in any place of the program code, as long they are outside quoted literals and comments. This means that they do also work if inserted somewhere inside code blocks and evens statements.

Presently, following directives are supported:

|  |  |  |
| --- | --- | --- |
| **Directive** | **conventional coding style** | |
| Description | Enables conventional coding style where literals without quotation marks are automatically treated as variables unless they are used as function and procedure names.  Benefit: Code sections using lots of variables, e.g. while doing calculations, will look leaner and cleaner.  Attention: If enabled, make sure you use single or double quotation marks to declare literal values. This also applies to parameters passed into functions as well as table names and table header names.  E.g. a = a + b[ ] + c['a'] + 'd' + e[a]  is automatically converted into a[ ] = a[ ] + b[ ] + c['a'] + 'd' + e[ a[ ] ]  Attention: To avoid confusions with procedure calls (without own parameters) submitted into function calls such as **table process**…(), delimit these statements with semicolon. Otherwise they are interpreted as simple variables. e.g. **table process**( 'table1', **echo;** );  Note the table name has been put inside quotation marks. | |
| Values | false (default) | Not enabled |
| true | Enabled |
| Example | **$$ conventional coding style = true;**  for (a = 1, a < 10, a+=1) { echo; echo( "a is ", a ); echo( "a is ", a[ ] ); }  **$$ conventional coding style = false;** // Reset directive.  This example shows that *a* is treated as a variable and *echo* remains a procedure call. | |

|  |  |  |
| --- | --- | --- |
| **Directive** | **allow entity references** | |
| Description | Allows conversion of HTML like character entity references in **softquoted literals** into their effective characters. Example:  If enabled: a[ ] = '**&euro;** 20.00'; // is "€ 20.00"  a[ ] = "&euro; 20.00"; // is "&euro; 20.00"  a[ ] = '&' + 'euro; 20.00'; // is "&euro; 20.00"  In the 3rd entry, the entity reference is not recognized in a single  string. Use function call **decode entities** (…) when needed during  run time.  If not enabled: No conversion. Entity references remain unaffected.  Result is always "&euro; 20.00". | |
| Values | false | Not enabled |
| true (default) | Enabled |
| Example | echo('10 &euro; ');  **$$ allow entity references = false;**  echo('10 &euro; ');  **$$ conventional coding style = true;** // Reset directive.  echo('10 &euro; ');  Resulting output:  10 € 10 &euro; 10 € | |
| See also | Function **decode entities** | |

# Appendix: Programming Language Symbols

|  |  |  |  |
| --- | --- | --- | --- |
| **Character** | **Usage** | **Context** | **Description** |
| Constants | | |  |
| **"** | " … " | Quoted literals | Contents as enclosed in double quotation marks are (hard-) quoted literals. |
| **'** | ' … ' | Softquoted literals | Contents as enclosed in double quotation marks are softquoted literals. Comma used as separator in some parameters to functions, ? and \* inside used as wildcard symbols for comparisons. |
| **.** | . | Decimal point | Only applicable if correctly used in a numeral, e.g. 1.234 |
| Comments | | |  |
| **//** | // | Line comment | Ignores rest of line. |
| **/\* \*/** | /\* … \*/ | Code comment | Ignores contents between these two symbols. |
| Assignment operator | | |  |
| **=** | *dest* = *expr* | Assignment |  |
| Arithmetic operators and Boolean binary operators | | |  |
| **+** | *expr* + … *expr* | Addition |  |
| **−** | *expr* − *expr* | Subtraction |  |
| **\*** | *expr* \* *expr* | Multiplication |  |
| **/** | *expr* / *expr* | Division |  |
| **&** | *expr* & *expr* | Boolean AND |  |
| **|** | *expr* | *expr* | Boolean OR |  |
| **==** | *expr* == *expr* | Boolean Equivalent | See also comparison operator (if expressions are not Boolean) |
| **!=** | *expr* ! = *expr* | Boolean XOR | See also comparison operator (if expressions are not Boolean) |
| Arithmetic assignment operators | | | Symbols may be written with or without space in-between. |
| **+=** | *dest* + = *expr* | Addition |  |
| **-=** | *dest* − = *expr* | Subtraction |  |
| **\*=** | *dest* \*= *expr* | Multiplication |  |
| **/=** | *expr* / = *expr* | Division |  |
| **&=** | *dest* & = *expr* | Boolean AND |  |
| **|=** | *dest* | = *expr* | Boolean OR |  |
| **== =** | *dest* == = *expr* | Boolean Equivalent |  |
| **!= =** | *dest* != = *expr* | Boolean XOR |  |
| Parentheses in formulas | | |  |
| **(, )** | ( *expr* ) | Expression | Contents inside parentheses are calculated first |
| Unary operators | | |  |
| **+** | + *expr* | Upper case |  |
| **-** | − *expr* | Negation |  |
| **!** | ! *expr* | Boolean NOT |  |
| Comparison operators | | |  |
| < | *expr* < *expr* | Less than |  |
| <= | *expr* <= *expr* | Less than or equal |  |
| > | *expr* > *expr* | Greater than |  |
| >= | *expr* >= *expr* | Greater than or equal |  |
| = | *expr* = *expr* | Equal | Supports selection (a,b,c,…) and ranges on right hand side |
| == | *expr* == *expr* | Equal to | Supports no selection (a,b,c…) and ranges (a..c) |
| <> | *expr* <> *expr* | Not equal to | Supports selection (a,b,c,…) and ranges on right hand side |
| != | *expr* == *expr* | Not equal to | Supports no selection (a,b,c…) and ranges (a..c) |

|  |  |  |  |
| --- | --- | --- | --- |
| **Character** | **Usage** | **Context** | **Description** |
| Comparison suffix operators | | | To be used after = and <> |
| **+** | + *expr* | Ignore case |  |
| **~** | ~ *expr* | Ignore blanks / epsilon tolerance | Comparing texts: Ignore blank characters  Comparing numbers: Tolerate residual error epsilon. |
| Ad hoc operators | | |  |
| **++** | ++ expr, expr++ | Increment | On variables & tables. A delta value in parenthesis is optional |
| **--** | -- expr, expr - | Decrement | On variables & tables. A delta value in parenthesis is optional |
| **\*\*** | \*\*(expr) expr expr \*\*(expr) | Apply scaling factor | On variables & tables. A scaling factor inside parenthesis is required |
| **(, )** | ++/--/\*\* (*expr*) | Value to apply | Value to applied in ad hoc operation, e.g. ++(3) adds 3. |
| Transactions | | |  |
| **<==** | *dest* <== *dest* | Copy transaction |  |
| **<<=** | *dest* <<= *dest* | Move transaction |  |
| **<=>** | *dest* <=> *dest* | Swap transaction |  |
| Transaction prefix | | | Applicable to all 3 transacation operators |
| **&** | *dest* &<== *dest* | Overwrite existing element only |  |
| **|** | *dest* |<== *dest* | Overwrite + new elements |  |
| **+** | *dest* +<== *dest* | Add new elements | Add / append items (no overwriting) |
| Operator suffix | | |  |
| **^** | *operator* ^ | Deep operator suffix | Added behind selected operators to apply the operator not on the parameter set but on their elements (1 level down) |
| **^** | ^ *transaction* | Base variable unchanged | Do the 'deep' part of the transaction |
| **^** | = ^ | Create reference to variable |  |
| **^^** | = ^ ^ | Create reference to referece |  |
| Wildcard symbols | | | Inside literals and softquoted literals, used in comparisons and selecting table rows and columns |
| **\*** | \* | Characters of choice | Stands for 0, 1, or more characters of choice between |
| **?** | ? | 1 character | Stands for exactly 1 character of choice |
| **,** | , | OR Separator | Choice of multiple texts to compare. OK if one is matching |
| Selections in comparisons | | | Combined use of commas and .. is allowed |
| **,** | *= expr , expr <> expr, expr* | Comma separator | Multiple Selections |
| **..** | *= expr* .. *expr <> expr .. expr* | From .. to range | Alphabetic and numeric range |
| Selections in picking details | | | Combined use of commas and .. is allowed |
| , | *= expr , expr* | Comma separator | Multiple Selections |
| .. | *= expr* .. *expr* | From .. to range | Numeric range |
| Selections in table specifications | | | Combined use of commas and .. is *not* allowed |
| **..** | *expr* .. *expr* | From A to B |  |
| **..** | *expr ..* | From A to end |  |
| **..** | *.. expr* | From begin to A |  |
| **..** | *..* | From begin to end |  |
| **:** | : *expr* | Match all | Following expression may use wildcard symbols |
| Parameter sets | | |  |
| **{ , }** | { *expr* , *expr* } { } | Parameter sets | Can contain 0 or 1 or multiple elements, comma separated |
| Parameters in function and procedure calls | | |  |
| **( , )** | *expr* ( *expr, expr* ) | Expression | Contains 1 or multiple parameters, comma separated |

|  |  |  |  |
| --- | --- | --- | --- |
| Code blocks | | |  |
| **{ ; }** | { *stmt* ; *stmt* } { } | Code block | Contains 0 or 1 or multiple code statements |
| **;** | *statement* ; … | Statement separator | All statements shall end with semicolon (Exception: Last statement when passed as parameter to function or procedure) |
| Picking details | | |  |
| **{ , }** | *expr* { *expr*, *expr* } *expr* { } | Pick details | Contains 0 or 1 or multiple expression providing numeric index to select parameter set elements or characters from literals |
| Accessing variables | | |  |
| **[ , ]** | *expr* [ ] expr [ expr, expr ] | Access base variable Access var. member | Contains 0 or 1 or multiple expressions describing a variable access. Expressions inside selected intended member. |
| Accessing tables | | |  |
| **[ : , ]** | [ *expr* : *expr,expr* ] | Full table specification | Must contain table name before colon |
| **[ , ]** | [ *expr* ] [ *expr*, *expr* ] | Partial table specification | Table name not required |
| **[ ^ , }** | [ ^ *expr* ] etc. | Partial table specification "Next level up" | Use 1 or more accent circumflex symbols to select the next outer table context information in order access their table contents easily. |
| Miscellany | | |  |
| **:** | else : *statement* | Literal separator | If single statement follows the 'else', then a colon is required to separate. |
| **$$** | $$ literal = value ; | Compile-Time directive | Processed during compile time. Directives will be invisible during run time. |

# Language Syntax Summary

Style: Only the symbols in bold typestyle are actual programming language symbols.

| **Building Block** | **Summary** | **Description** |
| --- | --- | --- |
| Program | *Choice or combination of 1 or more:*  block  statement **;** … | The entire program may consist of one or more blocks and/or one or more statements. |
| Block | *Choice or combination of 1 or more:* **{**  statement **;**  block …  **}** | The program starts with an open brace symbol **{**, contains at least one statement or nested block and is finalized with an close brace symbol **}**.  The initial brackets are not required |
| Statement | *choice of:*  assignment  procedure call  transaction | Statements are the key instructions interpreted and carried out during run time. Statements consist of assignments and procedure calls. |
| Assignment | *Sequence of:*  destination expression  assignment operator  expression; | In assignments, values obtained / calculated in the expression are assigned to LH (left-hand) expressions. |
| Transaction | *Sequence of:*  destination expression  transaction operator  destination expression | Transactions allow for smart data movement inside and among table rows and structured variables. |
| Transaction operator | *Sequence of:*  *optional* transaction prefix  transaction operator |  |
| Transaction prefix | *Choice of:*  **+**, **&**, **|** |  |
| Transaction operator | *Choice of:*  **<==**, **<<=**, **<=>** |  |
| Destination expression | *Choice of:*  variable reference  table reference | Destination expressions do either reference variables (main variables or one of its members) or tables. |
| Variable reference | *Choice of:*  variable name **[** **]**  variable name **[** member spec  ( … **,** member spec) **]** | Variable name must be an expression providing a literal.  1 or more member specs separated with commas can be used to specify members, sub-members, etc.  member spec is either a literal expression (refer member variable by name) or numeric expression (members are automatically kept in alphabetic sequence, 0 points to first member in alphabetic order) |
| Table reference | *Choice of:*  full table specification*,*  partial table specification | Full table specification always includes table name and a reference to a row number. For partial table specifier, implicit knowledge of table name and current row (typically an iterator) must be known. Applicable in combination with specific functions, e.g. **with table** (…), **for all table rows** (…), **table process** (…). |
| Full table specification | *Choice of:*  **[** table name **:** column spec **,**  row spec **]**,  **[** table name **:** column spec **,**  row spec **,**  column spec **]** | Table name: Expression returning a literal  Column spec: Expression returning a literal (column name) or numeral (column number).  Row spec: Expression returning a literal (matching row content) or numeral (row number). |
| Partial table specification | *Choice of:*  **[** column spec **]**,  **[** column spec, row spec **]**  **[** column spec **,** row spec **,**  column spec **]** | Table name and row spec are not mandatory.  Column spec and Row spec: See above. |
| Assignment Operator | *Choice of:*  **=**  binary operator **=** | Simple assignment: Use equal sign. Also allowed in combination with certain allowed arithmetic and Boolean operators, e.g. **+=**. as well as deep operators, e.g. **+^=** |
| Binary operator | *Choice of:*  **+**, **−**, **\***, **/**, **&**, **|**, **==**, **!=**,  **=**, **<>**, **>**, **>=**, **<**, **<=**  *Optional: Operator suffix 1 or more occurrence of*  **^** | Arithmetic operators Boolean operators Simple comparative operators Comparative operators (Not as part of assignment operator) Relational operators (Not as part of assignment operator)  Circumflex symbol is a suffix which indicates deep operator usage, applicable on calculations with parameter sets. |
| Expression | *Combination of:*  constants  variable references  table references  formulas  function calls  parameter sets  *Optionally followed by 1 or more:*  parameter elements | Expression can be any constant value (e.g. 123, Hello, "Price [EUR]"), variables (e.g. variable name[ ]), tables (e.g.[table1:…]), formulae (combination of values and references with unary and/or binary operators) and function calls.  Parameter elements may be specified if the expression represents or returns a parameter set. Otherwise, error will be issued. |
| Function calls | *Sequence of:*  function name  **(** parameter**,**  parameter**,** … **)**  **or**  function name **(** **)** | Function name is a literal. Not allowed: Any other form of expression, softquoted and quoted literals.  A function with provided parameters is called and returns a value. Selected functions may be called as functions and procedure calls (return value ignored in this case). |
| Procedure calls | *Sequence of:*  procedure name  **(** parameter**,**  parameter**,** … **)**  *or:* procedure name **;** | Function name is a literal. Not allowed: Any other form of expression, softquoted and quoted literals.  Same syntax as function calls, but in procedure calls possible return values will be discarded.  No parentheses required here if no parameters are passed.  Some procedures provide additional control flow structures which are described in the function library. Examples: **if**(…), **while**(…). |
| Parameter (in function and procedure calls) | *Choice of:*  expression  destination expression  code piece | 🡪 Applicable for most parameters (= input parameters)  🡪 Where data is written back to variable during function call  e.g. in **exchange**(…)  🡪 Code piece, e.g. in **for** (…), **table delete selected rows** (…)  Not to confuse with 'parameter set'. |
| Code piece | *Choice of:*  expression  comparison expression  destination expression  statement ( **;** statement )  **:** literal expression ) | Hint: If the expression contains a comparison with **=** or **<>** (but not any of the other comparison operators), then apply parentheses around them if the expression passed as parameter into a procedure or function call and is not the last parameter. Otherwise, the succeeding comma may be interpreted as a selection separator symbol (🡪 see 'Selection').  Instead of code pieces, expressions returning literals can be supplied, but must precede with a colon symbol. |
| Constants | *Choice of:* numerals  literals  softquoted literals  quoted literals  **true**, **false**, **tab**, **new line** | Numerals are positive and negative numbers which must start with a minus sign, then a digit and may contain a decimal point with digits behind. Spaces, thousand-separators and scientific notations are not supported.  Softquoted literals: 'literal' Quoted literals: **"**literal**"**  **true, false**: Boolean values **tab**, **new line**; Literal values |
| Formulas | Combination of expressions with unary operators and binary operators as well as parentheses.  Expressions combined with preceding symbols **=**, **<>**, **<**, **<=**, **=>** and **<** are comparison expressions (including the symbol), but not applicable to **==** and **!=**. | Pay attention to precedence rules.  Parentheses |
| Comparison expression | *Choice of:*  expression  comparison spec, expression  comparison spec, range  comparison spec, selection … | Ranges and selections are only applicable in combination with = and <> or = assumed implicitly in the absence of an equal sign. |
| Comparison spec(ification) | Sequence of:  comparison operator  comparison modifier |  |
| Comparison operator | *Choice of:* **<**, **<=**, **=**, **=>**, **>**, **<>** |  |
| Comparison modifier | *Choice or combination of:* **~**, **+** | **~** = Literal: Ignore case, Numeric: epsilon error tolerance **+** = Literal: Ignore blanks |
| Range | expression **..** expression |  |
| Selection | expression ( **,** expression … ) |  |
| Parameter set | Sequence of: **{**  expression,  expression,  …  expression **}** | Contains zero or more expressions (so called elements) inside braces.  (Not to confuse with 'parameter') |
| Parameter element | Sequence of: **{**  numeric expression, **}**  *or* **{ }** | Parameter elements may succeed expressions which represent or return  parameter sets.  Empty set will return the number of elements. |