OMRON

Expression Editor and Listen Node

TM ROBOT

Original Instruction

I848-E-01

Contents

Revision History Table

Revision	Date	Revised Content
01	July 2019	Original Release

1. Expression Editor

The Expression editor is a section of TMFlow where you can set variables, recast variable types, run math functions, access robot parameters, communicate with external devices, and control robot motion. The Listen node establishes a TCP/IP server to allow communications between TMFlow and external devices by using the Expression editor

This manual discusses the Expression Editor, Modbus, and Listen Node capabilities of the Omron TM robot.

In the first section, the document discusses data types, and basic Expression Editor variable setup and manipulation within TMFlow. The various operator symbols are highlighted and potential error messages are discussed here.

The second section discusses more advanced Expression Editor variable manipulation and the variety of functions that can be used within TMFlow. These functions are available in a variety of nodes within the software, some examples being the SET and IF nodes.

The third section addresses the Modbus capabilities of the robot and the use of these.

Finally, the fourth and fifth sections address the Listen Node and its capabilities. This is a TCP Socket Services connection method where the TM is the server in the connection. The TM can receive different script commands that are discussed in these sections to do a variety of tasks. Some of these tasks include robot motion as well as changing of base and payload. This is a potential method to control the robot using an external device.

This manual is written for Hardware version 3.0 and newer and TMFlow version 1.68 and newer.

1.1 Data Types

Different data types of variables can be declared in the Variable Manager

byte	8 bit integer	unsigned	0 to 255	significant digit 3
int	32 bit integer	signed	-2147483648 to 2147483647	significant digit 10
float	32 bit float number	signed	-3.40282e+038f to 3.40282e+038f	significant digit 7
double	64 bit float number	signed	-1.79769E+308 to 1.79769E+308	significant digit 15
bool	Boolean		true or false	
string	string			

For int type variable, both int16 and int32 are supported. The default type is int 32

int16	16 bit integer	signed	-32768 to 32767	significant digit 5
int32	32 bit integer	signed	-2147483648 to 2147483647	significant digit 10

1.2 Variables and Constants

1. Variables

In the naming rule of variables, only digits, the underline character, and upper case and lower case English characters are supported.

Digits	0123456789
Characters	a-z, A-Z, _

Example

```
int i = 0
string s = “ABC”
string s1 = “DEF”
string s2 = “123”
```

When using variables, double quotation marks are not used:

```
s = s1 + “ and “ + s2    // s = “DEF and 123”
                         // s, s1, s2 are variable, and “ and “ is a string.
```

When using constants, including digits, strings, and Boolean values, only strings use double quotation marks.

NOTE: Some variable names used in examples throughout this document do not have the var_ or g_ prefixes that are seen in the Variable Manager within TMflow. Please note that if a variable has a prefix, that prefix must be included when it is used in expressions.

2. Numbers

- Decimal integers, decimal float numbers, binary, hexadecimal integer and scientific notation are supported.

Decimal integer	123
	-123
	+456
Decimal float	34.567
	-8.9
Binary	0b0000111
	0B1110000
Hexadecimal integer	0x123abc
	0X00456DEF
Scientific notation	3.4e5

2.3E-4

- For binary and Hexadecimal notation, there is no float number.
- Characters in numbers are not case sensitive.

  For example:

  0b0011 equals 0B0011

  0xabcD equals 0XABCD, 0xABCd, 0Xabcd etc.

  3.4e5 equals 3.4E5
- Transforming between float numbers and byte arrays may cause discrepancy in values.

  For example:

  float 5.317302E+030 ➔ float to byte[] {0x72,0x86,0x3A,0x42}

  byte[] {0x72,0x86,0x3A,0x43} ➔ byte[] to float 5.317302E+030
- Byte can only present unsigned numbers from 0 to 255. As a result, if negative number is assigned to byte type variable directly or through calculation, only 8 bit unsigned value will be kept.

  For example:

  byte b = -100 // b = 156 // -100 is present as 0xFFFFFF9C by 16bit notation.

  // Because bytes can only keep 8 bit data, that is 0x9C (156), b will equals to 156

3. String

When inputting string constants, double quotation marks must be placed in pairs around the string to distinguish between variables and strings.

For example

“Hello World! “

“Hello TM""5” (If “ is one of the characters in the string, use two (“”) instead of one (”).

- Using control characters in double quotation marks is not supported.

  For example:

  “Hello World!\r\n” (the output would be **Hello World!\r\n**)

- Without double quotation marks, the compiling will follow the rules below:
  1. Numbers will be viewed as numbers.
  2. The combination of numbers and characters will be view as variables as long as the variable exists.
  3. If the variable does not exist, it will be compiled as a string with a warning message.

- The combination of string and variable:
  1. Inside double quotation marks, variables will not be compiled as variables.

     For example:

     s = “TM5” // s = ”TM5”

     s1 = “Hi, s Robot” // s1 = ”Hi, s Robot”
  2. To input the combination of variables and strings, double quotation marks needs to be placed around the string, and a plus sign (+) must be used to join variables and numbers

     Example:

     s1 = “Hi, “ + s + “ Robot” // s1 = ”Hi, TM5 Robot”
  3. To be compatible with the legacy software, single quotation marks can be placed around variables, but a warning message will be generated.

     For example:

     s1 = “Hi, ’s’ Robot” // s1 = ”Hi, TM5 Robot”

     s1 = “Hi, ’x’ Robot” // s1 = ”Hi, ‘x’ Robot” // Because variable x does not exist, ‘x’ is viewed as string
  4. Single quotation marks cannot be used to display a variable name. If users want to display a variable name, the standard format with double quotation marks should be used.

     For example

     s1 = “Hi, ‘s’ Robot” // s1 = ”Hi, TM5 Robot”

     s1 = “Hi, ‘” + “s” + “’ Robot” // s1 = “Hi, ‘s’ Robot”
- For control characters, e.g. new line, use the Ctrl() command.

  For example

  s1 = “Hi, “ + Ctrl(“\r\n”) + s + “ Robot” or “Hi, “ + NewLine + s + “ Robot”

  // s1 = Hi,

  // TM5 Robot
- Reserved characters are similar to variables. No double quotation marks are needed. (But single quotation marks ae not supported).
  1. empty empty string, equals “”
  2. newline or NewLine newline equals Ctrl(“\r\n”) or Ctrl(0x0D0A)

4. Boolean

Logical true or false.

Represent true value	true
	True
Represent false value	false
	False

Boolean values are case sensitive. If a format other than one of the four shown here is entered, it will be viewed as a variable or string.

1.3 Array

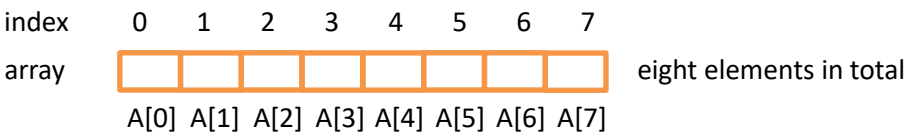
- Array is a set of data with the same data type. The initial value is assigned with {}, and every element has the characteristics of its data type.

  For example

  ```
  int[] i = {0,1,2,3}                    // elements in number data type
  string[] s = {“ABC”, “DEF”, “GHI”}     // elements in string data type
  bool[] bb = {true, false, true}        // elements in boolean data type
  ```

- By using an index, the value of a specific element can be retrieved. Index numbering starts at 0.

  For example

  Valid index values [0] .. [7], an error will occur with invalid index number.

- Only one-dimensional arrays are supported. The maximum index number is 2048.

- The array size is dynamic, and can change according to the return value of functions or assigned values. The maximum element number is 2048. This feature lets arrays meet the needs of different functions and applications in Network Node.

  For Example:

  ```
  string[] ss = {empty, empty, empty}          // The initial size of string array is 3 elements
  ss = String_Split(“A_B_C_D_F_G_H”, “_”)      // After splitting string, the string array has 7 elements
  len = Length(ss)                             // len = 7
  ss = String_Split(“A,B”, “,”)                // After splitting string, the string array has 2 elements
  len = Length(ss)                             // len = 2
  ```

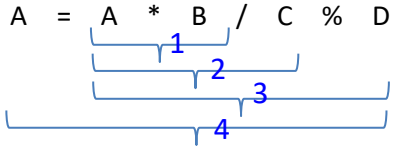
1.4 Operator Symbols

- The operator table is listed below.
- The calculation follows the precedence of operator first then the associativity.

  For example

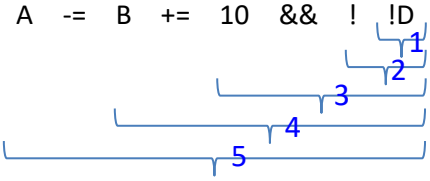
  left-to-right associativity

  A = A * B / C % D ➔ (A = (((A * B) / C) % D))

  right-to-left associativity

  A -= B += 10 && ! !D ➔ (A -= (B += (10 && (! (!D)))))

Precedence High to low	Operator	Name	Example	Requirement	Associativity
17	++	Postfix increment	i++	Integer variable	left-to-right
	--	Postfix decrement	i--		
	()	Function call	int x = f()		
	[]	Allocate storage	array[4] = 2	Array variable	
16	++	Prefix increment	++i	Integer variable	right-to-left
	--	Prefix decrement	--i		
	+	Unary plus	int i = +1	Numeric variable, Constant	
	-	Unary minus	int i = -1		
	!	Logical negation (NOT)	if (!done) …	Boolean	
	~	Bitwise NOT	flag1 = ~flag2	Integer	
14	*	Multiplication	int i = 2 * 4	Numeric variable, Constant	left-to-right
	/	Division	float f = 10.0 / 3.0		
	%	Modulo (integer remainder)	int rem = 4 % 3		
13	+	Addition	int i = 2 + 3	Numeric variable, Constant	
	-	Subtraction	int i = 5 - 1		
12	<<	Bitwise left shift	int flags = 33 << 1	Integer variable, Constant	
	>>	Bitwise right shift	int flags = 33 >> 1		
11	<	Less than	if (i < 42) …	Numeric variable, Constant	
	<=	Less than or equal to	if (i <= 42) ...		
	>	Greater than	if (i > 42) …		
	>=	Greater than or equal to	if (i >= 42) ...		
10	==	Equal to	if (i == 42) ...		
	!=	Not equal to	if (I != 42) …		
9	&	Bitwise AND	flag1 = flag2 & 42	Integer variable, Constant	
8	^	Bitwise XOR	flag1 = flag2 ^ 42		
7	|	Bitwise OR	flag1 = flag2 | 42		
6	&&	Logical AND	if (conditionA && conditionB)		
5	||	Logical OR	if (conditionA || conditionB)		
4	c ? t : f	Ternary conditional	int i = a > b ? a : b		right-to-left
3	=	Basic assignment	int a = b	Left side: Numeric	
	+=	Addition assignment	a += 3		
	-=	Subtraction assignment	b -= 4		

	*=	Multiplication assignment	a *= 5	variable Right side: Numeric variable, Constant	
	/=	Division assignment	a /= 2		
	%=	Modulo assignment	a %= 3		
	<<=	Bitwise left shift assignment	flags <<= 2	Left side: Integer variable Right side: Integer variable, Constant	
	>>=	Bitwise right shift assignment	flags >>= 2		
	&=	Bitwise AND assignment	flags &= new_flags		
	^=	Bitwise XOR assignment	flags ^= new_flags		
	|=	Bitwise OR assignment	flags |= new_flags		

1.5 Data Type Conversion

- Data types can be converted to each other and used in variables/constants or arrays.
- Conversions must be in the same format of the containers, such as variable/constant conversions or array conversions. It is not permitted to convert a variable to an array or an array to a variable.

Native type	Conversion type	Example	Result
byte	int	int i = (int)100	i = 100
	float	float f = (float)100	f = 100
	double	double d = (double)100	d = 100
	bool	bool flag = (bool)0	flag = true (not null)
	string	string s = (string)100	s = “100”
int	byte	byte b = (byte)1000	b = 232
	float	float f = (float)1000	f = 1000
	double	double d = (double)1000	d = 1000
	bool	bool flag = (bool)1000	flag = true (not null)
	string	string s = (string)1000	s = “1000”
float	byte	byte b = (byte)1.23	b = 1
	int	int i = (int)1.23	i = 1
	double	double d = (double)1.23	d = 1.23
	bool	bool flag = (bool)1.23	flag = true
	string	string s = (string)1.23	s = “1.23”
double	byte	byte b = (byte)1.23	b = 1
	int	int i = (int)1.23	i = 1
	float	float f = (float)1.23	f = 1.23

	bool	bool flag = (bool)1.23	flag = true
	string	string s = (string)1.23	s = “1.23”
bool	byte	byte b = (byte)True	Error
	int	int i = (int)False	Error
	float	float f = (float)true	Error
	double	double d = (double)false	Error
	string	string s = (string)True	s = “True”
string	byte	byte b1 = (byte)”1.23” byte b2 = (byte)”XYZ”	1 Error
	int	int i = (int)”1.23”	1
	float	float f1 = (float)”1.23” float f2 = (float)”XYZ”	1.23 Error
	double	double d = (double)”1.23”	1.23
	bool	bool flag1 = (bool)”1.23” bool flag2 = (bool)””	flag1 = true (not null) flag2 = false (null)

- The conversion method of arrays is in accordances with the table above. The conversion is performed for each element in the array.

```
string[] ss = {“1.23”, “4.56”, “0.789”}
int[] i_array = (int[])ss          // i_array = {1, 4, 0}
float[] f_array = (float[])ss      // f_array = {1.23, 4.56, 0.789}
```

- Error messages will be returned when the conversions below occur.
  - Fail to convert to numeric correctly such as Booleans (true/false) or non-numeric strings (“XYZ”).

```
int value = (int)true      // Error
int value = (int)”XYZ”     // Error
```

  - Invalid float numbers to convert to floats or doubles such as NaN or Infinity.

```
string dvalue = “1.79769e+308”
float f = (float)dvalue    // Error 1.79769e+308 is a valid double type and unable to convert to the float type.
```

1.6 Warning

A warning message will be display under the following conditions:

- Double quotation marks are not placed around a string constant.
- There are one or more single quotation marks inside the string constant.

- When assigning a float value to an integer constant, some digits may get dropped.

  For example

  ```
  int i = 1.234      // warning  i = 1
  float f = 1.234
  i = f              // warning  i = 1
  ```

- When assigning a value to variables with fewer digits, some digits may get dropped.

  For example

  ```
  byte b = 100
  int i = 1000
  float f = 1.234
  double d = 2.345
  b = i              // warning  b = 232      //    byte can contain values from 0 to 255
  f = d              // warning  f = 2.345
  ```

- When assigning a string value to a numeric variable, a conversion from string to number will be applied. If the conversion is executable, a warning message will prompt, or the project will be stopped by error.

  For example

  ```
  int i = “1234”             // warning  i = 1234
  int j = “0x89AB”           // warning  j = 35243
  int k = “0b1010”           // warning  k = 10
  string s1 = 123            // warning s1 = 123 // Number to string
  string s2 = “123”
  int x = s2                 // warning  // string to number
  // The following code can be compiled with warning, but will be stopped by error when executing.
  S2 = “XYZ”
  x = s2                     // warning // Stop executing by error// s = “XYZ” cannot be converted to
  number
  s2 = “”
  x = s2                     // warning // Stop executing by error// s = “” cannot be converted to number
  ```

- String parameters are used as numeric parameters in functions.

  For example

  ```
  Ctrl(0x0A0B0C0D0E)     // warning  // 0x0A0B0C0D0E is not int type (over 32bit)
                                      // Because there is another syntax, Ctrl(string), the parameter
                                      would be applied to Ctrl(string)
  ```

Although the project can still be executed with warning message, correcting all the errors in warning message is

highly recommended, which can eliminate unpredictable problems and prevent the project being stopped by errors.

2. Functions

2.1 Byte_ToInt16()

Transform the first two bytes of the assigned byte array to integer, and return as int type.

Syntax 1

```
int Byte_ToInt16(
    byte[],
    int,
    int
)
```

Parameters

`byte[]`	Byte array	
`int`	Byte array follows the Little Endian or Big Endian	
	`0`	Little Endian (Default)
	`1`	Big Endian
`int`	Transfer to signed int16 (Signed Number) or unsigned int16 (Unsigned Number)	
	`0`	signed int16 (Default)
	`1`	unsigned int16

Return

`int`	A signed or unsigned int16 formed by 2 bytes beginning at index [0]. Because only 2 bytes are needed, the index of the byte array will be [0][1]. If the data is not long enough, it would be filled to 2 bytes before transforming.

Note

byte[] bb1 = {0x90, 0x01, 0x05}

byte[] bb2 = {0x01} // Cause bb2[] does not fill 2 bytes. It would be filled to 2 bytes before transforming.

value = **Byte_ToInt16**(bb1, 0, 0) // 0x0190 value = 400
value = **Byte_ToInt16**(bb1, 0, 1) // 0x0190 value = 400
value = **Byte_ToInt16**(bb1, 1, 0) // 0x9001 value = -28671
value = **Byte_ToInt16**(bb1, 1, 1) // 0x9001 value = 36865
value = **Byte_ToInt16**(bb2, 0, 0) // 0x0001 value = 1
value = **Byte_ToInt16**(bb2, 0, 1) // 0x0001 value = 1
value = **Byte_ToInt16**(bb2, 1, 0) // 0x0100 value = 256
value = **Byte_ToInt16**(bb2, 1, 1) // 0x0100 value = 256

Syntax 2

```
int Byte_ToInt16(
    byte[],
    int
)
```

Note

Similar to Syntax 1 with return value as signed int16

Byte_ToInt16(bb1, 0) => **Byte_ToInt16**(bb1, 0, 0)

Syntax 3

```
int Byte_ToInt16(
    byte[]
)
```

Note

Similar to Syntax 1 with Little Endian input and return value as signed int16

Byte_ToInt16(bb1) => **Byte_ToInt16**(bb1, 0)

2.2 Byte_ToInt32()

Transform the first four bytes of byte array to integer, and return in int type.

Syntax 1

```
int Byte_ToInt32(
    byte[],
    int
)
```

Parameters

`byte[]`	The input byte array
`int`	The input byte array follows Little Endian or Big Endian
	`0` Little Endian (Default)
	`1` Big Endian

Return

`int`	An unsigned int32 formed by 4 bytes beginning at index [0]. Because only 4 bytes are needed, the index of byte array will be [0][1][2][3]. If the data is not long enough, it would be filled to 4 bytes before transforming.

Note

byte[] bb1 = {0x01, 0x02, 0x03, 0x4F, 1}

byte[] bb2 = {0x01, 0x02, 0x03} // Cause bb2[] does not fill 4 bytes. It would be filled to 4 bytes before transforming.

value = **Byte_ToInt32**(bb1, 0) // 0x4F030201 value = 1325597185

value = **Byte_ToInt32**(bb1, 1) // 0x0102034F value = 16909135

value = **Byte_ToInt32**(bb2, 0) // 0x00030201 value = 197121

value = **Byte_ToInt32**(bb2, 1) // 0x01020300 value = 16909056

Syntax 2

```
int Byte_ToInt32(
    byte[]
)
```

Note

Similar to Syntax 1 with Little Endian input

Byte_ToInt32(bb1) => **Byte_ToInt32**(bb1, 0)

2.3 Byte_ToFloat()

Transform the first four bytes of byte array to float number, and return in float type.

Syntax 1

```
float Byte_ToFloat(
    byte[],
    int
)
```

Parameters

byte[]	The input byte array
int	The input byte array follows Little Endian or Big Endian
	0 Little Endian (Default)
	1 Big Endian

Return

float	A floating-point number formed by 4 bytes beginning at index [0].
	Because only 4 bytes are needed, the index of the byte array will be [0][1][2][3]. If the data is

not long enough, it would be filled to 4 bytes before transforming.

Note

byte[] bb1 = {0x01, 0x02, 0x03, 0x4F, 1}

byte[] bb2 = {0x01, 0x02, 0x03} // Because bb2[] does not fill 4 bytes, it would be filled to 4 bytes before transforming.

value = **Byte_ToFloat**(bb1, 0) // 0x4F030201 value = 2.197947E+09

value = **Byte_ToFloat**(bb1, 1) // 0x0102034F value = 2.38796E-38

value = **Byte_ToFloat**(bb2, 0) // 0x00030201 value = 2.762254E-40

value = **Byte_ToFloat**(bb2, 1) // 0x01020300 value = 2.387938E-38

Syntax 2

```
float Byte_ToFloat(
    byte[]
)
```

Note

Similar to Syntax 1 with Little Endian input

Byte_ToFloat(bb1) => **Byte_ToFloat**(bb1, 0)

2.4 Byte_ToDouble()

Transform the first eight bytes of byte array to float number, and return in double type.

Syntax 1

```
double Byte_ToDouble(
    byte[],
    int
)
```

Parameters

`byte[]` The input byte array

`int` The input byte array follows Little Endian or Big Endian

`0` Little Endian (Default)

`1` Big Endian

Return

`double` A floating-point number formed by 8 bytes beginning at index [0].

Because only 8 bytes are needed, the index of the byte array will be [0][1][2][3][4][5][6][7]. If

the data is not long enough, it would be filled to 8 bytes before transforming.

Note

byte[] bb1 = {0x01, 0x02, 0x03, 0x4F, 1} // Cause bb1[] does not fill 8 bytes. It would be filled to 8 bytes before transforming.

byte[] bb2 = {0x01, 0x02, 0x03} // Cause bb1[] does not fill 8 bytes. It would be filled to 8 bytes before transforming.

value = **Byte_ToDouble**(bb1, 0) // 0x000000014F030201 value = 2.77692782029764E-314
value = **Byte_ToDouble**(bb1, 1) // 0x0102034F01000000 value = 8.20840179153173E-304
value = **Byte_ToDouble**(bb2, 0) // 0x0000000000030201 value = 9.73907141738724E-319
value = **Byte_ToDouble**(bb2, 1) // 0x0102030000000000 value = 8.20785244926136E-304

Syntax 2

```
double Byte_ToDouble(
    byte[]
)
```

Note

Similar to Syntax 1 with Little Endian input

Byte_ToDouble(bb1) => **Byte_ToDouble**(bb1, 0)

2.5 Byte_ToInt16Array()

Transform byte array to integer every 2 bytes, and return in int[] type.

Syntax 1

```
int[] Byte_ToInt16Array(
    byte[],
    int,
    int
)
```

Parameters

byte[]	The input byte array
int	The input byte array follows Little Endian or Big Endian
	0 Little Endian (Default)

	1	Big Endian
int	Transfer to signed int16 (Signed Number) or unsigned int16 (Unsigned Number)	
	0	signed int16 (Default)
	1	unsigned int16

Return

int[]	A integer array formed by every 2 bytes of byte array beginning at index [0]

Note

byte[] bb1 = {0x90, 0x01, 0x02, 0x03, 0x04} // When the remaining part does not fill 2 byte, it would be filled to 2 bytes before transforming.

byte[] bb2 = {1, 2, 3, 4}

value = **Byte_ToInt16Array**(bb1, 0, 0) // {0x0190, 0x0302, 0x0004} value = {400, 770, 4}
value = **Byte_ToInt16Array**(bb1, 0, 1) // {0x0190, 0x0302, 0x0004} value = {400, 770, 4}
value = **Byte_ToInt16Array**(bb1, 1, 0) // {0x9001, 0x0203, 0x0400} value = {-28671, 515, 1024}
value = **Byte_ToInt16Array**(bb1, 1, 1) // {0x9001, 0x0203, 0x0400} value = {36865, 515, 1024}

value = **Byte_ToInt16Array**(bb2, 0, 0) // {0x0201, 0x0403} value = {513, 1027}
value = **Byte_ToInt16Array**(bb2, 0, 1) // {0x0201, 0x0403} value = {513, 1027}
value = **Byte_ToInt16Array**(bb2, 1, 0) // {0x0102, 0x0304} value = {258, 772}
value = **Byte_ToInt16Array**(bb2, 1, 1) // {0x0102, 0x0304} value = {258, 772}

Syntax 2

```
int[] Byte_ToInt16Array(
    byte[],
    int
)
```

Note

Similar to Syntax 1 with return value as signed int16

Byte_ToInt16Array(bb1, 0) => **Byte_ToInt16Array**(bb1, 0, 0)

Syntax 3

```
int[] Byte_ToInt16Array(
    byte[]
)
```

Note

Similar to Syntax 1 with Little Endian input and return value as signed int16

Byte_ToInt16Array(bb1) => **Byte_ToInt16Array**(bb1, 0)

2.6 Byte_ToInt32Array()

Transform byte array to integer every 4 bytes, and return in int[] type

Syntax 1

```
int[] Byte_ToInt32Array(
    byte[],
    int
)
```

Parameters

`byte[]`	The input byte array
`int`	The input byte array follows Little Endian or Big Endian
`0`	Little Endian (Default)
`1`	Big Endian

Return

`int[]`	A integer array formed by every 4 bytes of byte array beginning at index [0]

Note

byte[] bb1 = {0x01, 0x02, 0x03, 0x04, 0x05} // When the remaining part does not fill 4 byte, it would be filled to 4 bytes before transforming.

byte[] bb2 = {1, 2, 3, 4}

value = **Byte_ToInt32Array**(bb1, 0) // {0x04030201, 0x00000005} value = {67305985, 5}

value = **Byte_ToInt32Array**(bb1, 1) // {0x01020304, 0x05000000} value = {16909060, 83886080}

value = **Byte_ToInt32Array**(bb2, 0) // {0x04030201} value = {67305985}

value = **Byte_ToInt32Array**(bb2, 1) // {0x01020304} value = {16909060}

Syntax 2

```
int[] Byte_ToInt32Array(
    byte[]
)
```

Note

Similar to Syntax 1 with Little Endian input.

Byte_ToInt32Array(bb1) => **Byte_ToInt32Array**(bb1, 0)

2.7 Byte_ToFloatArray()

Transform byte array to integer every 4 bytes, and return in float[] type.

Syntax 1

```
float[] Byte_ToFloatArray(
    byte[],
    int
)
```

Parameters

`byte[]`	The input byte array
`int`	The input byte array follows Little Endian or Big Endian
`0`	Little Endian (Default)
`1`	Big Endian

Return

`float[]`	A floating-point number array formed by every 4 bytes of byte array beginning at index [0]

Note

byte[] bb1 = {0x01, 0x02, 0x03, 0x04, 0x05} // When the remaining part does not fill 4 byte, it would be filled to 4 bytes before transforming.

byte[] bb2 = {1, 2, 3, 4}

value = **Byte_ToFloatArray**(bb1, 0) // {0x04030201, 0x00000005} value = {1.53999E-36, 7.006492E-45}

value = **Byte_ToFloatArray**(bb1, 1) // {0x01020304, 0x05000000} value = {2.387939E-38, 6.018531E-36}

value = **Byte_ToFloatArray**(bb2, 0) // {0x04030201} value = {1.53999E-36}

value = **Byte_ToFloatArray**(bb2, 1) // {0x01020304} value = {2.387939E-38}

Syntax 2

```
float[] Byte_ToFloatArray(
    byte[]
)
```

Note

Similar to Syntax 1 with Little Endian input

Byte_ToFloatArray(bb1) => **Byte_ToFloatArray**(bb1, 0)

2.8 Byte_ToDoubleArray()

Transform byte array to double every 8 bytes, and return in double[] type.

Syntax 1

```
double[] Byte_ToDoubleArray(
    byte[],
    int
)
```

Parameters

`byte[]`	The input byte array
`int`	The input byte array follows Little Endian or Big Endian
`0`	Little Endian (Default)
`1`	Big Endian

Return

`double[]`	A floating-point number array formed by every 8 bytes of byte array beginning at index [0]

Note

byte[] bb1 = {0x01, 0x02, 0x03, 0x04, 0x05} // When the remaining part does not fill 8 byte, it would be filled to 8 bytes before transforming.

byte[] bb2 = {1, 2, 3, 4} // When the remaining part does not fill 8 byte, it would be filled to 8 bytes before transforming.

value = **Byte_ToDoubleArray**(bb1, 0) // {0x0000000504030201} value = {1.06432325297744E-313}

value = **Byte_ToDoubleArray**(bb1, 1) // {0x0102030405000000} value = {8.20788039849233E-304}

value = **Byte_ToDoubleArray**(bb2, 0) // {0x0000000004030201} value = {3.32535749480063E-316}

value = **Byte_ToDoubleArray**(bb2, 1) // {0x0102030400000000} value = {8.2078802626846E-304}

Syntax 2

```
double[] Byte_ToDoubleArray(
    byte[]
)
```

Note

Similar to Syntax 1 with Little Endian input

Byte_ToDoubleArray(bb1) => **Byte_ToDoubleArray**(bb1, 0)

2.9 Byte_ToString()

Transform byte array to string

Syntax 1

```
string Byte_ToString(
    byte[],
    int
)
```

Parameters

`byte[]`	The input byte array
`int`	The character encoding rules applied to input byte array
`0`	UTF8 (Default) (0x00 END)
`1`	HEX BINARY
`2`	ASCII (0x00 END)

Return

`string`	String formed by byte array. The transformation begins from index [0].

Note

byte[] bb1 = {0x31, 0x32, 0x33, 0x00, 0x4F, 1}

byte[] bb2 = {0x01, 0x54, 0x4D, 0x35, 0xE6, 0xA9, 0x9F, 0xE5, 0x99, 0xA8, 0xE4, 0xBA, 0xBA}

value = **Byte_ToString**(bb1, 0) // value = “123” (UTF8 stop at 0x00)

value = **Byte_ToString**(bb1, 1) // value = “313233004F01”

value = **Byte_ToString**(bb1, 2) // value = “123” (ASCII stop at 0x00)

value = **Byte_ToString**(bb2, 0) // value = “\u01TM5機器人” (UTF8)

value = **Byte_ToString**(bb2, 1) // value = “01544D35E6A99FE599A8E4BABA”

value = **Byte_ToString**(bb2, 2) // value = “\u01TM5?????????” (ASCII)

* \u01 represents the SOH control character, not the string value.

Syntax 2

```
string Byte_ToString(
    byte[]
)
```

Note

Similar to Syntax 1 with UTF8 character encoding rules

Byte_ToString(bb1) => **Byte_ToString**(bb1, 0)

2.10 Byte_Concat()

Concatenate two byte arrays, or concatenate one array with a byte value.

Syntax 1

```
byte[] Byte_Concat(
    byte[],
    byte
)
```

Parameters

`byte[]` The input byte array

`byte` The byte value concatenated after the byte array

Return

`byte[]` The byte array formed by the input byte array and byte value

Note

byte[] bb1 = {0x31, 0x32, 0x33, 0x00, 0x4F, 1}

value = **Byte_Concat**(bb1, 12) // value = {0x31, 0x32, 0x33, 0x00, 0x4F, 0x01, 0x0C}

Syntax 2

```
byte[] Byte_Concat(
    byte[],
    byte[]
)
```

Parameters

`byte[]` The input byte array1

`byte[]` The input byte array2, would be concatenated to the end of array1

Return

`byte[]` Byte array formed from concatenating input arrays.

Note

byte[] bb1 = {0x31, 0x32, 0x33, 0x00, 0x4F, 1}

byte[] bb2 = {0x01, 0x02, 0x03}

value = **Byte_Concat**(bb1, bb2) // value = {0x31, 0x32, 0x33, 0x00, 0x4F, 0x01, 0x01, 0x02, 0x03}

Syntax 3

```
byte[] Byte_Concat(
    byte[],
    byte[],
    int
)
```

Parameters

byte[]	The input byte array1	
byte[]	The input byte array2, would be concatenated after the end of array1	
int	The number of element in array2 to be concatenated	
	0..the length of array2	Valid number
	<0	Invalid. Length of array2 will be applied instead.
	> the length of array2	Invalid. Length of array2 will be applied instead.

Return

byte[]	Byte array formed from concatenating input arrays.

Note

byte[] bb1 = {0x31, 0x32, 0x33, 0x00, 0x4F, 1}

byte[] bb2 = {0x01, 0x02, 0x03}

value = **Byte_Concat**(bb1, bb2, 2) // value = {0x31, 0x32, 0x33, 0x00, 0x4F, 0x01, 0x01, 0x02} // Concatenate only 2 elements from array2

value = **Byte_Concat**(bb1, bb2, -1) // value = {0x31, 0x32, 0x33, 0x00, 0x4F, 0x01, 0x01, 0x02, 0x03} // -1 is invalid value

value = **Byte_Concat**(bb1, bb2, 10) // value = {0x31, 0x32, 0x33, 0x00, 0x4F, 0x01, 0x01, 0x02, 0x03} // 10 exceeds the array size

// Length() can be utilized to acquire the array size

value = **Byte_Concat**(bb1, bb2, Length(bb2)) // value = {0x31, 0x32, 0x33, 0x00, 0x4F, 0x01, 0x01, 0x02, 0x03}

Syntax 4

```
byte[] Byte_Concat(
    byte[],
    int,
    int,
    byte[],
    int,
    int
)
```

Parameters

`byte[]` The input byte array1

`int` The starting index of array1

0..(length of array1)-1 Valid

<0 The starting index would be 0

>=(length of array1) The starting index would be the length of array2 (For index over the length of array2, an empty value would be captured)

`int` The number of element in array1 to be concatenated

0.. (length of array1) Valid

<0 Invalid，length of array1 will be applied instead

>(length of array1) Invalid，length of array1 will be applied instead

If the total number of starting index and assigning elements exceeds the length of array1, the surplus index will be suspended.

`byte[]` The input byte array2，would be concatenated after the end of array1

`int` The starting index of array2

0.. (length of array2)-1 Valid

<0 The starting index would be 0

>=(length of array2) The starting index would be the length of array2 (For index over the length of array2, an empty value would be captured)

`int` The number of element in array2 to be concatenated

0.. (length of array2) Valid

<0 Invalid. Length of array2 will be applied instead.

>(length of array2) Invalid. Length of array2 will be applied instead.

If the total number of starting index and assigning elements exceeds the length of array2, the surplus index will be suspended.

Return

`byte[]` Byte array formed from concatenating input arrays.

Note

byte[] bb1 = {0x31, 0x32, 0x33, 0x00, 0x4F, 1}

byte[] bb2 = {0x01, 0x02, 0x03}

value = **Byte_Concat**(bb1, 1, 3, bb2, 1, 2) // value = {0x32, 0x33, 0x00, 0x02, 0x03}

value = **Byte_Concat**(bb1, -1, 3, bb2, 3, -1) // value = {0x31, 0x32, 0x33}

2.11 String_ToInteger()

Transform string to integer (int type)

Syntax 1

```
int String_ToInteger(
    string,
    int
)
```

Parameters

`string`	The input string.	
`int`	The input string's notation is decimal, hexadecimal or binary	
	`10`	decimal or auto format detecting (Default)
	`16`	hexadecimal
	`2`	binary
	String's notation	
	123	decimal
	0x7F	hexadecimal
	0b101	binary

Return

`int`	The integer value formed from input string. If notation is invalid, returns 0.

Note

```
value = String_ToInteger("1234", 10)      // value = 1234
value = String_ToInteger("1234", 16)      // value = 4660
value = String_ToInteger("1234", 2)       // value = 0      // Invalid binary format
value = String_ToInteger("1100", 2)       // value = 12
value = String_ToInteger("0x1234", 10)    // value = 4660   // Hexadecimal format by auto detecting
value = String_ToInteger("0x1234", 16)    // value = 4660
value = String_ToInteger("0x1234", 2)     // value = 0      // Invalid binary format
value = String_ToInteger("0b1100", 10)    // value = 12     // Binary format by auto detecting
value = String_ToInteger("0b1100", 16)    // value = 725248// Valid Hexadecimal number
value = String_ToInteger("0b1100", 2)     // value = 12
value = String_ToInteger("+1234", 10)     // value = 1234
value = String_ToInteger("-1234", 10)     // value = -1234
value = String_ToInteger("-0x1234", 16)   // value = 0      // Invalid
value = String_ToInteger("-0b1100", 2)    // value = 0      // Invalid
```

Syntax 2

```
int String_ToInteger(
    string
)
```

Note

Similar to syntax1 with decimal format or auto format detection

String_ToInteger(str) => **String_ToInteger**(str, 10)

Syntax 3

```
int[] String_ToInteger(
    string[],
    int
)
```

Parameters

`string[]`	Input string array	
`int`	The notation of element in input string array is decimal, hexadecimal or binary	
	`10`	decimal or auto format detecting (Default)
	`16`	hexadecimal
	`2`	binary
	String's notation	
	123	decimal
	0x7F	hexadecimal
	0b101	binary
	* The data type of all the elements in a single array has to be identical.	

Return

`int[]`	The integer array formed from input string array. If notation is invalid, returns 0.

Note

ss = {"12", "ab", "cc", "dd", "10"}

value = **String_ToInteger**(ss) // value = {12, 0, 0, 0, 10} // "ab","cc","dd" are invalid decimal numbers

value = **String_ToInteger**(ss, 2) // value = {0, 0, 0, 0, 2} // "12","ab","cc","dd" are invalid binary numbers

value = **String_ToInteger**(ss, 16) // value = {18, 171, 204, 221, 16}

value = **String_ToInteger**(ss, 10) // value = {12, 0, 0, 0, 10} // "ab","cc","dd" are invalid decimal numbers

2.12 String_ToFloat()

Transform string to float number (float type)

Syntax 1

```
float String_ToFloat(
    string,
    int
)
```

Parameters

`string` Input string

`int` Input string's notation is decimal, hexadecimal or binary format

`10`	decimal or auto format detecting (Default)
`16`	hexadecimal
`2`	binary

String's notation

123	decimal
0x7F	hexadecimal
0b101	binary

Return

`float` The floating-point number formed from input string. If the format is invalid, returns 0.

Note

```
value = String_ToFloat("12.34", 10)          // value = 12.34
value = String_ToFloat("12.34", 16)          // value = 0       // Invalid hexadecimal format
value = String_ToFloat("12.34", 2)           // value = 0       // Invalid binary format
value = String_ToFloat("11.00", 2)           // value = 0       // Invalid binary format
value = String_ToFloat("0x1234", 10)         // value = 6.530051E-42      // Hexadecimal format by auto detecting
value = String_ToFloat("0x1234", 16)         // value = 6.530051E-42
value = String_ToFloat("0x1234", 2)          // value = 0       // Invalid binary format
value = String_ToFloat("0b1100", 10)         // value = 1.681558E-44      // Binary format by auto detecting
value = String_ToFloat("0b1100", 16)         // value = 1.016289E-39      // Valid hexadecimal format
value = String_ToFloat("0b1100", 2)          // value = 1.681558E-44
value = String_ToFloat("+12.34", 10)         // value = 12.34
value = String_ToFloat("-12.34", 10)         // value = -12.34
value = String_ToFloat("-0x1234", 16)        // value = 0       // Invalid format
value = String_ToFloat("-0b1100", 2)         // value = 0       // Invalid format
```

Syntax 2

```
float String_ToFloat(
    string
)
```

Note

Similar to syntax1 with decimal format or auto format detection

String_ToFloat(str) => **String_ToFloat**(str, 10)

Syntax 3

```
float[] String_ToFloat(
    string[],
    int
)
```

Parameters

string[]	Input string array	
int	The data type of elements in the input string array is decimal, hexadecimal, or binary.	
	10	decimal or auto format detecting (Default)
	16	hexadecimal
	2	binary
	String's notation	
	123	decimal
	0x7F	hexadecimal
	0b101	binary
	* The data type of all the elements in a single array has to be identical.	

Return

float[] The floating-point number array formed from input string array. If notation is invalid, returns 0.

Note

ss = {"12.345", "ab", "cc", "dd", "10.111"}

value = **String_ToFloat**(ss) // value = {12.345, 0, 0, 0, 10.111}

value = **String_ToFloat**(ss, 2) // value = {0, 0, 0, 0, 0}

value = **String_ToFloat**(ss, 16) // value = {0, 2.39622E-43, 2.858649E-43, 3.09687E-43, 0}

value = **String_ToFloat**(ss, 10) // value = {12.345, 0, 0, 0, 10.111}

2.13 String_ToDouble()

Transform string to float number (double type)

Syntax 1

```
double String_ToDouble(
    string,
    int
)
```

Parameters

`string` Input string

`int` Input string's notation is decimal, hexadecimal or binary format

`10` decimal or auto format detecting (Default)

`16` hexadecimal

`2` binary

String's notation

123 decimal

0x7F hexadecimal

0b101 binary

Return

`double` The floating-point number formed from input string. If notation is invalid, returns 0.

Note

value = **String_ToDouble**("12.34", 10) // value = 12.34

value = **String_ToDouble**("12.34", 16) // value = 0 // Invalid hexadecimal format

value = **String_ToDouble**("12.34", 2) // value = 0 // Invalid binary format

value = **String_ToDouble**("11.00", 2) // value = 0 // Invalid binary format

value = **String_ToDouble**("0x1234", 10) // value = 2.30234590962021E-320 // Hexadecimal format by auto detecting

value = **String_ToDouble**("0x1234", 16) // value = 2.30234590962021E-320

value = **String_ToDouble**("0x1234", 2) // value = 0 // Invalid binary format

value = **String_ToDouble**("0b1100", 10) // value = 5.92878775009496E-323 // Binary format by auto detecting

value = **String_ToDouble**("0b1100", 16) // value = 3.58320121515072E-318 // Valid hexadecimal format

value = **String_ToDouble**("0b1100", 2) // value = 5.92878775009496E-323

value = **String_ToDouble**("+12.34", 10) // value = 12.34

value = **String_ToDouble**("-12.34", 10) // value = -12.34

value = **String_ToDouble**("-0x1234", 16) // value = 0 // Invalid format

value = **String_ToDouble**("-0b1100", 2) // value = 0 // Invalid format

Syntax 2

```
double String_ToDouble(
    string
)
```

Note

Similar to syntax1 with decimal format or auto format detection

String_ToDouble(str) => **String_ToDouble**(str, 10)

Syntax 3

```
double[] String_ToDouble(
    string[],
    int
)
```

Parameters

string[]	Input string array	
int	The notation of elements in input string array is decimal, hexadecimal or binary	
	10	decimal or auto format detecting (Default)
	16	hexadecimal
	2	binary
	String's notation	
	123	decimal
	0x7F	hexadecimal
	0b101	binary
	* The notaion of all the elements in a single array has to be identical	

Return

double[]	The floating-point number array formed from input string array. If notation is invalid, returns 0.

Note

ss = {"12.345", "ab", "cc", "dd", "10.111"}

value = **String_ToDouble**(ss) // value = {12.345, 0, 0, 0, 10.111}

value = **String_ToDouble**(ss, 2) // value = {0, 0, 0, 0, 0}

value = **String_ToDouble**(ss, 16) // value = {0, 8.44852254388532E-322, 1.00789391751614E-321, 1.09188507730915E-321, 0}

value = **String_ToDouble**(ss, 10) // value = {12.345, 0, 0, 0, 10.111}

2.14 String_ToByte()

Transform string to byte array

Syntax 1

```
byte[] String_ToByte(
    string,
    int
)
```

Parameters

`string` Input string

`int` The character encoding rules applied to input string

- `0` UTF8 (Default)
- `1` HEX BINARY // Stop at invalid Hex value
- `2` ASCII

Return

`byte[]` The byte array formed from input string

Note

value = **String_ToByte**(“12345”, 0) // value = {0x31, 0x32, 0x33, 0x34, 0x35}

value = **String_ToByte**(“12345”, 1) // value = {0x12, 0x34, 0x50} // the insufficient part will be filled with 0

value = **String_ToByte**(“12345”, 2) // value = {0x31, 0x32, 0x33, 0x34, 0x35}

value = **String_ToByte**(“0x12345”, 0) // value = {0x30, 0x78, 0x31, 0x32, 0x33, 0x34, 0x35}

value = **String_ToByte**(“0x12345”, 1) // value = {0x00} // Only 0 be transformed, cause x is an invalid Hex value

value = **String_ToByte**(“0x12345”, 2) // value = {0x30, 0x78, 0x31, 0x32, 0x33, 0x34, 0x35}

value = **String_ToByte**(“TM5機器人”, 0) // value = {0x54, 0x4D, 0x35, 0xE6, 0xA9, 0x9F, 0xE5, 0x99, 0xA8, 0xE4, 0xBA, 0xBA}

value = **String_ToByte**(“TM5機器人”, 1) // value = {0x00} // T is an invalid Hex value

value = **String_ToByte**(“TM5機器人”, 2) // value = {0x54, 0x4D, 0x35, 0x3F, 0x3F, 0x3F}

value = **String_ToByte**(“0123456”, 1) // value = {0x01, 0x23, 0x45, 0x60}

value = **String_ToByte**(“01234G5”, 1) // value = {0x01, 0x23, 0x40} // G is an invalid Hex value

Syntax 2

```
byte[] String_ToByte(
    string
)
```

Note

Similar to syntax1 with UTF8 format

String_ToByte(str) => **String_ToByte**(str, 0)

2.15 String_IndexOf()

Report the zero-based index of the first occurrence of a specified string

Syntax 1

```
int String_IndexOf(
    string,
    string
)
```

Parameters

`string`	Input string
`string`	The specified string to be searched. The zero-based index of the first occurrence is to be found.

Return

`int`	`0..(Length of string)-1`	If the specified string is found, returns the index number
	`-1`	Not found
	`0`	The specified string is “” or empty

Note

```
value = String_IndexOf(“012314”, “1”)      // value = 1
value = String_IndexOf(“012314”, “”)       // value = 0
value = String_IndexOf(“012314”, empty)    // value = 0
value = String_IndexOf(“012314”, “d”)      // value = -1
value = String_IndexOf(“”, “d”)            // value = -1
```

2.16 String_LastIndexOf()

Report the zero-based index position of the last occurrence of a specified string

Syntax 1

```
int String_LastIndexOf(
    string,
    string
)
```

Parameters

`string`	Input string

`string` The specified string to be searched. The zero-based index of the last occurrence is to be found.

Return

`int`	`0..(Length of string)-1`	If the specified string is found, returns the index number
	`-1`	Not found
	`0`	The specified string is “” or empty

Note

value = **String_LastIndexOf**(“012314”, “1”) // value = 4

value = **String_LastIndexOf**(“012314”, “”) // value = 5

value = **String_LastIndexOf**(“012314”, empty) // value = 5

value = **String_LastIndexOf**(“012314”, “d”) // value = -1

value = **String_LastIndexOf**(“”, “d”) // value = -1

2.17 String_Substring()

Retrieve a substring from input string

Syntax 1

```
string String_Substring(
    string,
    int,
    int
)
```

Parameters

`string` Input string

`int` The starting character position of sub string (0 .. (length of input string)-1)

`int` The length of substring

Return

`string` Substring

If starting character position <0, returns empty string

If starting character position >= length of input string, returns empty string

If length of substring <0, the substring ends at the last charactor of the input string

If the sum of starting character position and length of substring exceeds the length of input string, the substring ends at the last character of the input string

Note

value = **String_Substring**(“0x12345”, 2, 4) // value = “1234”

value = **String_Substring**(“0x12345”, -1, 4) // value = “”

value = **String_Substring**(“0x12345”, 7, 4) // value = “”

value = **String_Substring**(“0x12345”, 2, -1) // value = “12345”

value = **String_Substring**(“0x12345”, 2, 100) // value = “12345”

Syntax 2

```
string String_Substring(
    string,
    int
)
```

Note

Similar to syntax1 with the substring ends at the last character of the input string

String_Substring(str, 2) => **String_Substring**(str, 2, maxlen)

Syntax 3

```
string String_Substring(
    string,
    string,
    int
)
```

Parameters

`string` Input string

`string` The target string to be searched. The substring will start at its position, if it is found.

`int` The length of substring

Return

`string` Substring

If the target string is empty, the substring starts at index zero

If the target string is not found, returns empty string

If length of substring <0, the substring ends at the last character of the input string

If the sum of starting character position and length of substring exceeds the length of input string, the substring ends at the last character of the input string

Note

This syntax is the same as **String_Substring**(str, **String_IndexOf**(str1), int)

value = **String_Substring**(“0x12345”, “1”, 4) // value = “1234”

value = **String_Substring**(“0x12345”, “”, 4) // value = “0x12”

value = **String_Substring**(“0x12345”, “7”, 4) // value = “”

value = **String_Substring**(“0x12345”, “1”, -1) // value = “12345”

value = **String_Substring**(“0x12345”, “1”, 100) // value = “12345”

Syntax 4

```
string String_Substring(
    string,
    string
)
```

Note

Similar to Syntax 3 with the substring ends at the last character of the input string

String_Substring(str, “1”) => **String_Substring**(str, “1”, maxlen)

Syntax 5

```
string String_Substring(
    string,
    string,
    string,
    int
)
```

Parameters

string	Input string
string	Prefix. The leading element of the substring
string	Suffix. The trailing element of the substring
int	The number of occurrence

Return

string	Substring
	If prefix and suffix are empty string, returns input string
	If the number of occurrence<=0, returns empty string

Note

value = **String_Substring**(“0x12345”, “”, “”, 0) // value = “0x12345”

value = **String_Substring**(“0x12345”, “1”, “4”, 1) // value = “1234”

value = **String_Substring**(“0x12345”, “1”, “4”, 2) // value = “”

value = **String_Substring**(“0x12345”, “1”, “4”, 0) // value = “”

value = **String_Substring**(“0x123450x12-345”, “1”, “4”, 1) // value = “1234”

value = **String_Substring**(“0x123450x12-345”, “1”, “4”, 2) // value = “12-34”

value = **String_Substring**(“0x123450x12-345”, “1”, “4”, 3) // value = “”

value = **String_Substring**(“0x12345122”, “1”, “”, 1) // value = “12345122” // All the character after prefix

value = **String_Substring**(“0x12345122”, “1”, “”, 2) // value = “122”

value = **String_Substring**(“0x12345122”, “1”, “”, 4) // value = “”

value = **String_Substring**(“0x12345433”, “”, “4”, 1) // value = “0x123454” // All the character before

suffix

value = **String_Substring**(“0x12345433”, “”, “4”, 2) // value = “0x1234”

Syntax 6

```
string String_Substring(
    string,
    string,
    string
)
```

Note

Similar to Syntax 5 with the substring starting at the first occurrence

String_Substring(str, prefix, suffix) => **String_Substring**(str, prefix, suffix, 1)

2.18 String_Split()

Split the string using specified separator.

Syntax 1

```
string[] String_Split(
    string,
    string,
    int
)
```

Parameters

`string`	Input string
`string`	Separator (String)
`int`	Format
0	Split and keep the empty strings
1	Split and eliminate the empty strings
2	Split with the elements inside double quotation mark skipped, and keep the empty strings
3	Split with the elements inside double quotation mark skipped, and eliminate the empty strings

Return

`string[]`	Split substring If input string is empty, return substring have only one element. [0] = empty If separator is empty, return substring have only one element. [0] = Input string

Note

value = **String_Split**(“0x112345”, “1”, 0) // value = {“0x”, “”, “2345”}

value = **String_Split**(“0x112345”, “”, 0) // value = {“0x112345”}

value = **String_Split**(“0x112345”, “1”, 1) // value = {“0x”, “2345”}

s1 = “123, ""456,67"",89”

value = **String_Split**(s1, “,”, 0) // value = {“123”, “””456”, “67”””, “89”} // length = 4

value = **String_Split**(s1, “,”, 2) // value = {“123”, “””456,67”””, “89”} // length = 3

Syntax 2

```
string[] String_Split(
    string,
    string
)
```

Note

Similar to Syntax1 with splitting and keeping the empty strings

String_Split(str, separator) => **String_Split**(str, separator, 0)

2.19 String_Replace()

Return a new string in which all occurrences of a specified string in the input string are replaced with another specified string

Syntax 1

```
string String_Replace(
    string,
    string,
    string
)
```

Parameters

`string` Input string

`string` Old value, the string to be replaced

`string` New value, the string to replace all occurrences of old value

Return

`string` The string formed by replacing the old value with new value in input value. If the old value is empty, returns the input string

Note

value = **String_Replace**(“0x112345”, “1”, “2”) // value = “0x222345”

value = **String_Replace**(“0x112345”, “”, “2”) // value = “0x112345”

value = **String_Replace**(“0x112345”, “1”, “”) // value = ”0x2345”

2.20 String_Trim()

Return a new string in which all leading and trailing occurrences of specified characters or white-space characters from the input string are removed

Syntax 1

```
string String_Trim(
    string
)
```

Parameters

`string` Input string

Return

`string` String formed by removing all leading and trailing occurrences of white-space characters

Note

value = **String_Trim**(“0x112345 ”) // value = “0x112345”

value = **String_Trim**(“ 0x112345”) // value = “0x112345”

value = **String_Trim**(“ 0x112345 ”) // value = ”0x112345”

White-space characters

\u0020 \u1680 \u2000 \u2001 \u2002 \u2003 \u2004

\u2005 \u2006 \u2007 \u2008 \u2009 \u200A \u202F

\u205F \u3000

\u2028

\u2029

\u0009 \u000A \u000B \u000C \u000D \u0085 \u00A0

\u200B \uFEFF

Syntax 2

```
string String_Trim(
    string,
    string
)
```

Parameters

`string` Input string

`string` Specified characters to be removed from leading occurrences

Return

`string` String formed by removing all leading occurrences of specified characters

Syntax 3

```
string String_Trim(
    string,
    string,
    string
)
```

Parameters

`string` Input string

`string` Specified characters to be removed from leading occurrences

`string` Specified characters to be removed from trailing occurrences

Return

`string` String formed by removing all leading and trailing occurrences of the specified characters

Note

string s1 = “Hello Hello World Hello World”
string s2 = “HelloHelloWorldHelloWorld”
value = **String_Trim**(s1, “Hello”) // value = “ Hello World Hello World”
value = **String_Trim**(s1, “World”) // value = “Hello Hello World Hello World”
value = **String_Trim**(s1, “”, “Hello”) // value = ”Hello Hello World Hello World”
value = **String_Trim**(s1, “”, “World”) // value = ”Hello Hello World Hello ”
value = **String_Trim**(s1, “Hello”, “World”) // value = ” Hello World Hello ”
value = **String_Trim**(s2, “Hello”) // value = ”WorldHelloWorld”
value = **String_Trim**(s2, “World”) // value = ”HelloHelloWorldHelloWorld”
value = **String_Trim**(s2, “”, “Hello”) // value = ”HelloHelloWorldHelloWorld”
value = **String_Trim**(s2, “”, “World”) // value = ”HelloHelloWorldHello”
value = **String_Trim**(s2, “Hello”, “World”) // value = ”WorldHello”

2.21 String_ToLower()

Change all the characters in string to lower case

Syntax 1

```
string String_ToLower(
    string
```

)

Parameters

`string` Input string

Return

`string` The string formed by converting all the English characters into lower case. Non-English characters will remain the same.

Note

value = **String_ToLower**(“0x11Acz34”) // value = “0x11acz34”

2.22 String_ToUpper()

Change all the characters in string to upper case

Syntax 1

```
string String_ToUpper(
    string
)
```

Parameters

`string` Input string

Return

`string` The string formed by converting all the English characters into upper case. Non-English characters will remain the same.

Note

value = **String_ToUpper**(“0x11Acz34”) // value = “0X11ACZ34”

2.23 Array_Equals()

Determine whether the two specified arrays are identical

Syntax 1

```
bool Array_Equals(
    ?[],
    ?[]
)
```

Parameters

`?[]` Input array1 (Data type can be byte, int, float, double, bool, string)

`?[]` Input array2 (Data type can be byte, int, float, double, bool, string)

* The data type of array1 and array2 must be the same.

Return

`bool` Two arrays are identical or not?

`true` two arrays are identical

`false` two arrays are not identical

Syntax 2

```
bool Array_Equals(
    ?[],
    int,
    ?[],
    int,
    int
)
```

Parameters

`?[]` Input array1 (Data type can be byte, int, float, double, bool, string)

`int` The starting index of array1 (0 .. (length of array1)-1)

`?[]` Input array2 (Data type can be byte, int, float, double, bool, string)

`int` The starting index of array2 (0 .. (length of array2)-1)

`int` The number of elements to be compared (0: return true)

* The data type of array1 and array2 must be identical.

Return

`bool` The assigned elements in two arrays are identical or not?

`true` identical

`false` not identical (or parameters are not valid)

Note

`?` `byte[]` n1 = {100, 200, 30}

`byte[]` n2 = {100, 200, 30}

Array_Equals(n1, n2) // true

Array_Equals(n1, 0, n2, 0, 3) // true

Array_Equals(n1, 0, n2, 0, Length(n2)) // true

`?` `int[]` n1 = {1000, 2000, 3000}

`int[]` n2 = {1000, 2000, 3000, 4000}

Array_Equals(n1, n2) // false

```
Array_Equals(n1, 0, n2, 0, Length(n2))      // false     // compare 4 elements
Array_Equals(n1, 0, n2, 0, 3)               // true
? float[] n1 = {1.1, 2.2, 3.3}
float[] n2 = {1.1, 2.2}
Array_Equals(n1, n2)                        // false
Array_Equals(n1, 0, n2, 0, Length(n2))      // true      // compare 2 elements
Array_Equals(n1, 0, n2, 0, Length(n1))      // false
? double[] n1 = {100, 200, 300, 3.3, 2.2, 1.1}
double[] n2 = {100, 200, 400, 3.3, 2.2, 4.4}
Array_Equals(n1, n2)                        // false
Array_Equals(n1, 0, n2, 0, Length(n2))      // false
Array_Equals(n1, 0, n2, 0, 2)               // true
Array_Equals(n1, 3, n2, 3, 2)               // true
? bool[] n1 = {true, false, true, true, true}
bool[] n2 = {true, false, true, false, true}
Array_Equals(n1, n2)                        // false
Array_Equals(n1, 0, n2, 0, -1)              // false
Array_Equals(n1, 0, n2, 0, 0)               // true      // compare 0 element
? string[] n1 = {"123", "ABC", "456", "DEF"}
string[] n2 = {"123", "ABC", "456", "DEF"}
Array_Equals(n1, n2)                        // true
Array_Equals(n1, -1, n2, 0, 4)              // false     // Invalid starting index
```

2.24 Array_IndexOf()

Search for the specified element and return the index of its first occurrence in the input array

Syntax 1

```
int Array_IndexOf(
    ?[],
    ?
)
```

Parameters

`?[]`	Input array (data type can be byte, int, float, double, bool, string)
`?`	The target element to search (The data type needs to be the same as the input array `?[]`, but not an array.)

Return

int	0..(length of input array)-1	If the element is found , returns the index value
	-1	No element found

Note

? byte[] n = {100, 200, 30}

value = **Array_IndexOf**(n, 200) // 1

value = **Array_IndexOf**(n, 2000) // error // 2000 is not byte data

? int[] n = {1000, 2000, 3000}

value = **Array_IndexOf**(n, 200) // -1

? float[] n = {1.1, 2.2, 3.3}

value = **Array_IndexOf**(n, 1.1) // 0

? double[] n = {100, 200, 300, 3.3, 2.2, 1.1}

value = **Array_IndexOf**(n, 1.1) // 5

? bool[] n = {true, false, true, true, true}

value = **Array_IndexOf**(n, true) // 0

? string[] n = {“123”, “ABC”, “456”, “DEF”}

value = **Array_IndexOf**(n, “456”) // 2

2.25 Array_LastIndexOf()

Search for the specified element and return the index of the last occurrence within the entire array.

Syntax 1

```
int Array_LastIndexOf(
    ?[],
    ?
)
```

Parameters

?[]	Input array (data type can be byte, int, float, double, bool, string)
?	The target element to search (The data type needs to be the same as the input array ?[], but not an array.

Return

int	0..(length of input array)-1	If the element is found , returns the index value
	-1	No element found

Note

? byte[] n = {100, 200, 30}

```
    value = Array_LastIndexOf(n, 200)          // 1
    value = Array_LastIndexOf(n, 2000)         // error // 2000 is not byte data
? int[] n = {1000, 2000, 3000}
    value = Array_LastIndexOf(n, 200)          // -1
? float[] n = {1.1, 2.2, 3.3}
    value = Array_LastIndexOf(n, 1.1)          // 0
? double[] n = {100, 200, 300, 3.3, 2.2, 1.1}
    value = Array_LastIndexOf(n, 1.1)          // 5
? bool[] n = {true, false, true, true, true}
    value = Array_LastIndexOf(n, true)         // 4
? string[] n = {“123”, “ABC”, “456”, “DEF”}
    value = Array_LastIndexOf(n, “456”)        // 2
```

2.26 Array_Reverse()

Reverse the order of the elements in the array

Syntax 1

```
? [ ] Array_Reverse(
    ? [ ]
)
```

Parameters

? [ ]	Input array (data type can be byte, int, float, double, bool, string)

Return

? [ ]	The reversed array

Note

```
? byte[] n = {100, 200, 30}
    n = Array_Reverse(n)       // n = {30, 200, 100}
? int[] n = {1000, 2000, 3000}
    n = Array_Reverse(n)       // n = {3000, 2000, 1000}
? float[] n = {1.1, 2.2, 3.3}
    n = Array_Reverse(n)       // n = {3.3, 2.2, 1.1}
? double[] n = {100, 200, 300, 3.3, 2.2, 1.1}
    n = Array_Reverse(n)       // n = {1.1, 2.2, 3.3, 300, 200, 100}
? bool[] n = {true, false, true, true, true}
    n = Array_Reverse(n)       // n = {true, true, true, false, true}
```

```
?    string[] n = {“123”, “ABC”, “456”, “DEF”}
     n = Array_Reverse(n)        // n = {“DEF”, “456”, “ABC”, “123”}
```

Syntax 2

```
?[] Array_Reverse(
    ?[],
    int
)
```

Parameters

?[]	Input array (data type can be byte, int, float, double, bool, string)
int	The number of elements to be viewed as a section to be reversed
2	2 elements as a section
4	4 elements as a section
8	8 elements as a section

* The sequence of the elements in the same section will be reversed, but the sequence of the sections will remain the same.

Return

?[]	The reversed array

Note

```
?    byte[] n = {100, 200, 30}
     n = Array_Reverse(n, 2)     // n = {200, 100, 30}     // 2 elements as a section, that is {100,200}{30}
     n = Array_Reverse(n, 4)     // n = {30, 200, 100}     // 4 elements as a section, that is {100,200,30}
     n = Array_Reverse(n, 8)     // n = {30, 200, 100}
?    int[] n = {100, 200, 300, 400}
     n = Array_Reverse(n, 2)     // n = {200, 100, 400, 300}     // 2 elements as a section, that is {100,200}{300,400}
     n = Array_Reverse(n, 4)     // n = {400, 300, 200, 100}     // 4 elements as a section, that is {100,200,300,400}
     n = Array_Reverse(n, 8)     // n = {400, 300, 200, 100}
?    float[] n = {1.1, 2.2, 3.3, 4.4, 5.5}
     n = Array_Reverse(n, 2)     // n = {2.2, 1.1, 4.4, 3.3, 5.5}  // 2 elements as a section, that is {1.1,2.2}{3.3,4.4}{5.5}
     n = Array_Reverse(n, 4)     // n = {4.4, 3.3, 2.2, 1.1, 5.5}  // 4 elements as a section, that is {1.1,2.2,3.3,4.4}{5.5}
     n = Array_Reverse(n, 8)     // n = {5.5, 4.4, 3.3, 2.2, 1.1}
?    double[] n = {100, 200, 300, 400, 4.4, 3.3, 2.2, 1.1, 50, 60, 70, 80}
     n = Array_Reverse(n, 2)     // n = {200, 100, 400, 300, 3.3, 4.4, 1.1, 2.2, 60, 50, 80, 70}
     n = Array_Reverse(n, 4)     // n = {400, 300, 200, 100, 1.1, 2.2, 3.3, 4.4, 80, 70, 60, 50}
     n = Array_Reverse(n, 8)     // n = {1.1, 2.2, 3.3, 4.4, 400, 300, 200, 100, 80, 70, 60, 50}
?    bool[] n = {true, false, true, true, true, false, true, false}
```

```
n = Array_Reverse(n, 2)    // n = {false, true, true, true, false, true, false, true }
n = Array_Reverse(n, 4)    // n = {true, true, false, true, false, true, false, true}
n = Array_Reverse(n, 8)    // n = {false, true, false, true, true, true, false, true}
? string[] n = {“123”, “ABC”, “456”, “DEF”, “000”, “111”}
n = Array_Reverse(n, 2)    // n = {“ABC”, “123”, “DEF”, “456”, “111”, “000”}
n = Array_Reverse(n, 4)    // n = {“DEF”, “456”, “ABC”, “123”, “111”, “000”}
n = Array_Reverse(n, 8)    // n = {“111”, “000”, “DEF”, “456”, “ABC”, “123”}
```

2.27 Array_Sort()

Sort the elements in an array

Syntax 1

```
?[] Array_Sort(
    ?[],
    int
)
```

Parameters

?[]	Input array (data type can be byte, int, float, double, bool, string)
int	Sorting direction
0	Ascending Order (Default)
1	Descending Order

Return

?[]	The array after sorting

Syntax 2

```
?[] Array_Sort(
    ?[]
)
```

Note

Similar to Syntax1 with sorting direction as ascending order

Array_Sort(array[]) => **Array_Sort**(array[], 0)

```
? int[] n = {1000, 2000, 3000}
n = Array_Sort(n)          // n = {1000, 2000, 3000}
? double[] n = {100, 200, 300, 3.3, 2.2, 1.1}
n = Array_Sort(n, 1)       // n = {300, 200, 100, 3.3, 2.2, 1.1}
```

```
?   bool[] n = {true, false, true, true,true}
    n = Array_Sort(n, 1)          // n = {true, true, true, true, false}
?   string[] n = {"123", "ABC", "456", "DEF"}
    n = Array_Sort(n)             // n = {"123", "456", "ABC", "DEF"}
```

2.28 Array_SubElements()

Retrieve sub-elements from the input array

Syntax 1

```
?[] Array_SubElements(
    ?[],
    int,
    int
)
```

Parameters

?[]	Input array (data type can be byte, int, float, double, bool, string)
int	The starting index of sub-elements. (0 .. (length of array)-1)
int	The number of elements in sub-elements

Return

?[]	The sub-elements from input arrays If starting index <0, sub-elements is an empty array If starting index >= length of input array, sub-elements is an empty array If sub-element number <0, sub-elements starts at starting index of the last element of input array If the sum of starting index and the number of element exceeds the length of the input array, sub-elements starts at starting index through the last element of input array

Syntax 2

```
?[] Array_SubElements(
    ?[],
    int
)
```

Note

Similar to Syntax1, but the sub-elements starts at starting index to the last element of input array

Array_SubElements(array[], 2) => **Array_SubElements**(array[], 2, maxlen)

```
?   byte[] n = {100, 200, 30}
```

n1 = **Array_SubElements**(n, 0) // n1 = {100, 200, 30}

n1 = **Array_SubElements**(n, -1) // n1 = {}

n1 = **Array_SubElements**(n, 0, 3) // n1 = {100, 200, 30}

n1 = **Array_SubElements**(n, 1, 3) // n1 = {200, 30}

n1 = **Array_SubElements**(n, 2) // n1 = {30}

n1 = **Array_SubElements**(n, 3, 3) // n1 = {}

? int[] n = {1000, 2000, 3000}

n1 = **Array_SubElements**(n, 0) // n1 = {1000, 2000, 3000}

n1 = **Array_SubElements**(n, -1) // n1 = {}

n1 = **Array_SubElements**(n, 1, 3) // n1 = {2000, 3000}

n1 = **Array_SubElements**(n, 2) // n1 = {3000}

? float[] n = {1.1, 2.2, 3.3}

n1 = **Array_SubElements**(n, 0) // n1 = {1.1, 2.2, 3.3}

n1 = **Array_SubElements**(n, -1) // n1 = {}

n1 = **Array_SubElements**(n, 1, 3) // n1 = {2.2, 3.3}

n1 = **Array_SubElements**(n, 2) // n1 = {3.3}

? double[] n = {100, 200, 3.3, 2.2, 1.1}

n1 = **Array_SubElements**(n, 0) // n1 = {100, 200, 3.3, 2.2, 1.1}

n1 = **Array_SubElements**(n, -1) // n1 = {}

n1 = **Array_SubElements**(n, 1, 3) // n1 = {200, 3.3, 2.2}

n1 = **Array_SubElements**(n, 2) // n1 = {3.3, 2.2, 1.1}

? bool[] n = {true, false, true, true, true}

n1 = **Array_SubElements**(n, 0) // n1 = {true, false, true, true, true}

n1 = **Array_SubElements**(n, -1) // n1 = {}

n1 = **Array_SubElements**(n, 1, 3) // n1 = {false, true, true}

n1 = **Array_SubElements**(n, 2) // n1 = {true, true, true}

? string[] n = {“123”, “ABC”, “456”, “DEF”}

n1 = **Array_SubElements**(n, 0) // n1 = {“123”, “ABC”, “456”, “DEF”}

n1 = **Array_SubElements**(n, -1) // n1 = {}

n1 = **Array_SubElements**(n, 1, 3) // n1 = {“ABC”, “456”, “DEF”}

n1 = **Array_SubElements**(n, 2) // n1 = {“456”, “DEF”}

2.29 ValueReverse()

Reverse the sequence of bytes inside input data (int 2 bytes or 4 bytes, float 4 bytes, double 8 bytes); or reverse the sequence of characters of a string.

Syntax 1

```
int ValueReverse(
    int,
    int
)
```

Parameters

`int` Input value

`int` The input value follows int32 or int16 format

`0` int32 (Default)

`1` int16. If the data does not meets int16 format, int32 will be applied instead.

`2` int16. Forced to apply int16 format. For int32 data input, there could be some bytes missing

Return

`int` The value formed from reversing the sequence of bytes inside the input value. For Int32 data, reverse with 4 bytes. For int16 data, reverse with 2 bytes.

Note

int i = 10000

value = **ValueReverse**(i, 0) // 10000=0x00002710 → 0x10270000 // value = 270991360

value = **ValueReverse**(i, 1) // 10000=0x2710 → 0x1027 // value = 4135

i = 100000 // int32 數值

value = **ValueReverse**(i, 0) // 100000=0x000186A0 → 0xA0860100 // value = -1601830656

value = **ValueReverse**(i, 1) // 100000=0x000186A0 → 0xA0860100 // value = -1601830656

value = **ValueReverse**(i, 2) // 100000=0x000086A0 → 0xA0860000 // value = -24442

Syntax 2

```
int ValueReverse(
    int
)
```

Parameters

`int` Input value

Note

Similar to Syntax1 with int32 input format

ValueReverse(int) => **ValueReverse**(int, 0)

Syntax 3

```
float ValueReverse(
    float
)
```

Parameters

`float` Input value

Return

`float` The value formed from reversing the sequence of bytes inside the input value. For float data, reverse 4 bytes.

Note

float i = 40000

value = **ValueReverse**(i) // 40000=0x471C4000 → 0x00401C47 // value = 5.887616E-39

Syntax 4

```
double ValueReverse(
    double
)
```

Parameters

`double` Input value

Return

`double` The value formed from reversing the sequence of bytes inside the input value. For double data, reverse 8 bytes.

Note

double i = 80000

value = **ValueReverse**(i) // 80000=0x40F3880000000000 → 0x000000000088F340 // value = 4.43432217445369E-317

Syntax 5

```
string ValueReverse(
    string
)
```

Parameters

`string` Input string

Return

`string` The value formed from reversing the sequence of characters of the input string.

Note

string i = “ABCDEF”

value = **ValueReverse**(i) // value = “FEDCBA”

Syntax 6

```
int[] ValueReverse(
```

```
    int[],
    int
)
```

Parameters

`int[]` Input array value

`int` The input value follows int32 or int16 format

`0` int32 (Default)

`1` int16. If the data does not meets int16 format, int32 will be applied instead.

`2` int16. Forced to apply int16 format. For int32 data input, there could be some bytes missing

Return

`int[]` The array formed from reversing the sequence of bytes inside every element of the input array.

Note

int[] i = {10000, 20000, 60000, 80000}

value = **ValueReverse**(i, 0) // value = {270991360, 541982720, 1625948160, -2143813376}

value = **ValueReverse**(i, 1) // value = {4135, 8270, 1625948160, -2143813376}

value = **ValueReverse**(i, 2) // value = {4135, 8270, 24810, -32712}

Syntax 7

```
int[] ValueReverse(
    int[]
)
```

Parameters

`int[]` Input array value

Note

Similar to Syntax6 with input integer as int32

ValueReverse(int[]) => **ValueReverse**(int[], 0)

Syntax 8

```
float[] ValueReverse(
    float[]
)
```

Parameters

`float[]` Input array value

Return

`float[]` The array formed from reversing the sequence of bytes inside every element of the input array.

Note

float[] i = {10000, 20000}

value = **ValueReverse**(i) // value = {5.887614E-39, 5.933532E-39}

Syntax 9

```
double[] ValueReverse(
    double[]
)
```

Parameters

`double[]` Input array value

Return

`double[]` The array formed from reversing the sequence of bytes inside every element of the input array.

Note

double[] i = {10000, 20000}

value = **ValueReverse**(i) // value = {4.42825109579759E-317, 4.43027478868296E-317}

Syntax 10

```
string[] ValueReverse(
    string[]
)
```

Parameters

`string[]` Input string array

Return

`string[]` The string array formed from reversing the string inside every element of the input string array.

Note

string[] i = {“ABCDEFG”, “12345678”}

value = **ValueReverse**(i) // value = {“GFEDCBA”, “87654321”}

2.30 GetBytes()

Convert arbitrary data type to byte array.

Syntax 1

```
byte[] GetBytes(
    ?,
    int
)
```

Parameters

?	The input data. Data type can be int, float, double, bool, string or array.
int	The input data follows Little Endian or Big Endian
0	Little Endian (Default)
1	Big Endian

Return

byte[]	The byte array formed by input data

Syntax 2

```
byte[] GetBytes(
    ?
)
```

Note

Similar to Syntax1 with Little Endian

GetBytes(?) => **GetBytes**(?, 0)

```
?   byte n = 100
    value = GetBytes(n)          // value = {0x64}
    value = GetBytes(n, 0)       // value = {0x64}
    value = GetBytes(n, 1)       // value = {0x64}
?   byte[] n = {100, 200}        // Convert every element of the array to byte, 1 byte as a single unit.
    value = GetBytes(n)          // value = {0x64, 0xC8}
    value = GetBytes(n, 0)       // value = {0x64, 0xC8}
    value = GetBytes(n, 1)       // value = {0x64, 0xC8}
?   int
    value = GetBytes(123456)     // value = {0x40, 0xE2, 0x01, 0x00}
    value = GetBytes(123456, 0)  // value = {0x40, 0xE2, 0x01, 0x00}
    value = GetBytes(0x123456, 0) // value = {0x56, 0x34, 0x12, 0x00}
    value = GetBytes(0x1234561, 1) // value = {0x01, 0x23, 0x45, 0x61}
```

? int[] n = {10000, 20000, 80000} // Convert every single element of the array to byte. For int32 data, works on 4 bytes sequentially.

value = **GetBytes**(n) // value = {0x10, 0x27, 0x00, 0x00, 0x20, 0x4E, 0x00, 0x00, 0x80, 0x38, 0x01, 0x00}

value = **GetBytes**(n, 0) // value = {0x10, 0x27, 0x00, 0x00, 0x20, 0x4E, 0x00, 0x00, 0x80, 0x38, 0x01, 0x00}

value = **GetBytes**(n, 1) // value = {0x00, 0x00, 0x27, 0x10, 0x00, 0x00, 0x4E, 0x20, 0x00, 0x01, 0x38, 0x80}

? float

value = **GetBytes**(123.456, 0) // value = {0x79, 0xE9, 0xF6, 0x42}

float n = -1.2345

value = **GetBytes**(n, 0) // value = {0x19, 0x04, 0x9E, 0xBF}

value = **GetBytes**(n, 1) // value = {0xBF, 0x9E, 0x04, 0x19}

? float[] n = {1.23, 4.56, -7.89} // Convert every single element of the array to byte. For float data, works on 4 bytes sequentially.

value = **GetBytes**(n) // value = {0xA4, 0x70, 0x9D, 0x3F, 0x85, 0xEB, 0x91, 0x40, 0xE1, 0x7A, 0xFC, 0xC0}

value = **GetBytes**(n, 0) // value = {0xA4, 0x70, 0x9D, 0x3F, 0x85, 0xEB, 0x91, 0x40, 0xE1, 0x7A, 0xFC, 0xC0}

value = **GetBytes**(n, 1) // value = {0x3F, 0x9D, 0x70, 0xA4, 0x40, 0x91, 0xEB, 0x85, 0xC0, 0xFC, 0x7A, 0xE1}

? double n = -1.2345

value = **GetBytes**(n, 0) // value = {0x8D, 0x97, 0x6E, 0x12, 0x83, 0xC0, 0xF3, 0xBF}

value = **GetBytes**(n, 1) // value = {0xBF, 0xF3, 0xC0, 0x83, 0x12, 0x6E, 0x97, 0x8D}

? double[] n = {1.23, -7.89} // Convert every single element of the array to byte. For double data, works on 8 bytes sequentially.

value = **GetBytes**(n) // value = {0xAE,0x47,0xE1,0x7A,0x14,0xAE,0xF3,0x3F,0x8F,0xC2,0xF5,0x28,0x5C,0x8F,0x1F,0xC0}

value = **GetBytes**(n, 0) // value = {0xAE,0x47,0xE1,0x7A,0x14,0xAE,0xF3,0x3F,0x8F,0xC2,0xF5,0x28,0x5C,0x8F,0x1F,0xC0}

value = **GetBytes**(n, 1) // value = {0x3F,0xF3,0xAE,0x14,0x7A,0xE1,0x47,0xAE,0xC0,0x1F,0x8F,0x5C,0x28,0xF5,0xC2,0x8F}

? bool flag = true // true is converted to 1；false is converted to 0

value = **GetBytes**(flag) // value = {1}

value = **GetBytes**(flag, 0) // value = {1} // Because bool is 1 byte, Endian Parameters are not sufficient.

value = **GetBytes**(flag, 1) // value = {1}

? bool[] flag = {true, false, true, false, false, true, true}

value = **GetBytes**(flag) // value = {1, 0, 1, 0, 0, 1, 1}

value = **GetBytes**(flag, 0) // value = {1, 0, 1, 0, 0, 1, 1}

value = **GetBytes**(flag, 1) // value = {1, 0, 1, 0, 0, 1, 1}

? string n = “ABCDEFG” // string 使用 UTF8 轉換

value = **GetBytes**(n) // value = {0x41, 0x42, 0x43, 0x44, 0x45, 0x46, 0x47}

value = **GetBytes**(n, 0) // value = {0x41, 0x42, 0x43, 0x44, 0x45, 0x46, 0x47} // Endian Parameters not sufficient

value = **GetBytes**(n, 1) // value = {0x41, 0x42, 0x43, 0x44, 0x45, 0x46, 0x47}

? string[] n = {“ABC”, “DEF”, “達明機器人” }

value = **GetBytes**(n) // value = {0x41, 0x42, 0x43, 0x44, 0x45, 0x46,
0xE9,0x81,0x94,0xE6,0x98,0x8E,0xE6,0xA9,0x9F,0xE5,0x99,0xA8,0xE4,0xBA,0xBA}

Syntax 3

Convert integer (int type) to byte array.

```
byte[] GetBytes(
    int,
    int,
    int
)
```

Parameters

`int` The input integer (int type)

`int` The input value follows Little Endian or Big Endian

`0` Little Endian (Default)

`1` Big Endian

`int` The input integer value's data type is int32 or int16

`0` int32 (Default)

`1` int16. If the data does not meets int16 format, int32 will be applied instead.

`2` int16. Forced to apply int16 format. For int32 data input, there could be some bytes missing.

Return

`byte[]` The byte array formed by input integer. For int32 data, convert with 4 bytes. For int16 data, convert with 2 bytes.

Note

value = **GetBytes**(12345, 0, 0) // value = {0x39, 0x30, 0x00, 0x00}
value = **GetBytes**(12345, 0, 1) // value = {0x39, 0x30}
value = **GetBytes**(12345, 0, 2) // value = {0x39, 0x30}
value = **GetBytes**(0x123456, 0, 0) // value = {0x56, 0x34, 0x12, 0x00}
value = **GetBytes**(0x123456, 0, 1) // value = {0x56, 0x34, 0x12, 0x00}
value = **GetBytes**(0x123456, 0, 2) // value = {0x56, 0x34} // bytes missing
value = **GetBytes**(0x1234561, 1, 0) // value = {0x01, 0x23, 0x45, 0x61}
value = **GetBytes**(0x1234561, 1, 1) // value = {0x01, 0x23, 0x45, 0x61}
value = **GetBytes**(0x1234561, 1, 2) // value = {0x45, 0x61} // bytes missing

Syntax 4

Convert the integer array (int[] type) to byte array

```
byte[] GetBytes(
    int[],
    int,
    int
)
```

Parameters

`int[]` The input integer array (int[] type)

`int` The input integer array follows Little Endian or Big Endian

- `0` Little Endian (Default)
- `1` Big Endian

`int` The input integer array's data type is int32 or int16

- `0` int32 (Default)
- `1` int16. If the data does not meets int16 format, int32 will be applied instead
- `2` int16. Forced to apply int16 format. For int32 data input, there could be some bytes missing.

Return

`byte[]` The byte array formed by input integer array. Every element is converted independently and forms an array. For int32 data, convert with 4 bytes. For int16 data, convert with 2 bytes.

Note

```
i = {10000, 20000, 80000}
value = GetBytes(i, 0, 0)    // value = {0x10, 0x27, 0x00, 0x00, 0x20, 0x4E, 0x00, 0x00, 0x80, 0x38, 0x01, 0x00}
value = GetBytes(i, 0, 1)    // value = {0x10, 0x27, 0x20, 0x4E, 0x80, 0x38, 0x01, 0x00}
value = GetBytes(i, 0, 2)    // value = {0x10, 0x27, 0x20, 0x4E, 0x80, 0x38}    // bytes missing
value = GetBytes(i, 1, 0)    // value = {0x00, 0x00, 0x27, 0x10, 0x00, 0x00, 0x4E, 0x20, 0x00, 0x01, 0x38, 0x80}
value = GetBytes(i, 1, 1)    // value = {0x27, 0x10, 0x4E, 0x20, 0x00, 0x01, 0x38, 0x80}
value = GetBytes(i, 1, 2)    // value = {0x27, 0x10, 0x4E, 0x20, 0x38, 0x80}    // bytes missing
```

2.31 GetString()

Convert arbitrary data type to string

Syntax 1

```
string GetString(
    ?,
    int,
    int
```

)

Parameters

`?` The input data. Data type can be int, float, double, bool, string or array.

`int` The output string's notation is decimal, hexadecimal or binary (Can be only applied to hexadecimal or binary number)

`10` decimal

`16` hexadecimal

`2` binary

String's notation

123 decimal

0x7F hexadecimal

0b101 binary

`int` The output string format (Can be only applied to hexadecimal or binary number)

`0` Fill up digits. Add prefix 0x or 0b, e.g. 0x0C or 0b00001100

`1` Fill up digits. No prefix 0x or 0b, e.g. 0C or 00001100

`2` Don't fill up digits. Add prefix 0x or 0b, e.g. 0xC or 0b1100

`3` Don't fill up digits. No prefix 0x or 0b, e.g. C or 1100

Return

`string` String converted from input data. If the input data cannot be converted, returns empty string. If the input data is an array, every element is converted respectively, and returned in "{ , , }" format.

Syntax 2

```
string GetString(
    ?,
    int
)
```

Note

Similar to Syntax1 with filling up digits and adding prefix 0x or 0b.

GetString(?, 16) => **GetString**(?, 16, 0)

Syntax 3

```
string GetString(
    ?
)
```

Note

Similar to Syntax1 with decimal output, filling up digits and adding prefix.

GetString(?) => **GetString**(?, 10, 0)

```
?   byte n = 123
    value = GetString(n)        // value = "123"
    value = GetString(n, 10)    // value = "123"
    value = GetString(n, 16)    // value = "0x7B"
    value = GetString(n, 2)     // value = "0b01111011"
    value = GetString(n, 16, 3) // value = "7B"
    value = GetString(n, 2, 2)  // value = "0b1111011"
?   byte[] n = {12, 34, 56}
    value = GetString(n)        // value = "{12,34,56}"
    value = GetString(n, 10)    // value = "{12,34,56}"
    value = GetString(n, 16)    // value = "{0x0C,0x22,0x38}"
    value = GetString(n, 2)     // value = "{0b00001100,0b00100010,0b00111000}"
    value = GetString(n, 16, 3) // value = "{C,22,38}"
    value = GetString(n, 2, 2)  // value = "{0b1100,0b100010,0b111000}"
?   int n = 1234
    value = GetString(n)        // value = "1234"
    value = GetString(n, 10)    // value = "1234"
    value = GetString(n, 16)    // value = "0x000004D2"
    value = GetString(n, 2)     // value = "0b00000000000000000000010011010010"
    value = GetString(n, 16, 3) // value = "4D2"
    value = GetString(n, 2, 2)  // value = "0b10011010010"
?   int[] n = {123, 345, -123, -456}
    value = GetString(n)        // value = "{123,345,-123,-456}"
    value = GetString(n, 10)    // value = "{123,345,-123,-456}"
    value = GetString(n, 16)    // value = "{0x0000007B,0x00000159,0xFFFFFF85,0xFFFFFE38}"
    value = GetString(n, 2)     // value = "{0b00000000000000000000000001111011,
                                          0b00000000000000000000000101011001,
                                          0b11111111111111111111111110000101,
                                          0b11111111111111111111111000111000}"
    value = GetString(n, 16, 3) // value = "{7B,159,FFFFFF85,FFFFFE38}"
    value = GetString(n, 2, 2)  // value = "{0b1111011,
                                          0b101011001,
                                          0b11111111111111111111111110000101,
                                          0b11111111111111111111111000111000}"
?   float n = 12.34
    value = GetString(n)        // value = "12.34"
    value = GetString(n, 10)    // value = "12.34"
```

```
value = GetString(n, 16)     // value = "0x414570A4"
value = GetString(n, 2)      // value = "0b01000001010001010111000010100100"
value = GetString(n, 16, 3) // value = "414570A4"
value = GetString(n, 2, 2)   // value = "0b10000010100010101110000101001 00"
? float[] n = {123.4, 345.6, -123.4, -456.7}
value = GetString(n)         // value = "{123.4,345.6,-123.4,-456.7}"
value = GetString(n, 10)     // value = "{123.4,345.6,-123.4,-456.7}"
value = GetString(n, 16)     // value = "{0x42F6CCCD,0x43ACCCCD,0xC2F6CCCD,0xC3E4599A}"
value = GetString(n, 16, 3) // value = "{42F6CCCD,43ACCCCD,C2F6CCCD,C3E4599A}"
? double n = 12.34
value = GetString(n)         // value = "12.34"
value = GetString(n, 10)     // value = "12.34"
value = GetString(n, 16)     // value = "0x4028AE147AE147AE"
value = GetString(n, 16, 3) // value = "4028AE147AE147AE"
? double[] n = {123.45, 345.67, -123.48, -456.79}
value = GetString(n)         // value = "{123.45,345.67,-123.48,-456.79}"
value = GetString(n, 10)     // value = "{123.45,345.67,-123.48,-456.79}"
value = GetString(n, 16)     // value = "{0x405EDCCCCCCCCCCD,0x40759AB851EB851F,
                                        0xC05EDEB851EB851F,0xC07C8CA3D70A3D71}"
value = GetString(n, 16, 3) // value = "{405EDCCCCCCCCCCD,40759AB851EB851F,
                                        C05EDEB851EB851F,C07C8CA3D70A3D71}"
? bool n = true
value = GetString(n)         // value = "true"
value = GetString(n, 16)     // value = "true"
value = GetString(n, 2)      // value = "true"
value = GetString(n, 16, 3) // value = "true"
? bool[] n = {true, false, true, false, false, true}
value = GetString(n)         // value = "{true,false,true,false,false,true}"
value = GetString(n, 16)     // value = "{true,false,true,false,false,true}"
value = GetString(n, 2)      // value = "{true,false,true,false,false,true}"
value = GetString(n, 16, 3) // value = "{true,false,true,false,false,true}"
? string n = "1234567890"
value = GetString(n)         // value = "1234567890"
value = GetString(n, 16)     // value = "1234567890"
value = GetString(n, 2)      // value = "1234567890"
value = GetString(n, 16, 3) // value = "1234567890"
? string[] n = {"123.45", "345.67", "-12""3.48", "-45A6.79"}
value = GetString(n)         // value = "{123.45,345.67,-12""3.48,-45A6.79}" // -12""3.48 displayed as -12"3.48
```

```
value = GetString(n, 16)     // value = “{123.45,345.67,-12""3.48,-45A6.79}”
value = GetString(n, 2)      // value = “{123.45,345.67,-12""3.48,-45A6.79}”
value = GetString(n, 16, 3) // value = “{123.45,345.67,-12""3.48,-45A6.79}”
```

Syntax 4

```
string GetString(
    ?,
    string,
    int,
    int
)
```

Parameters

`?`	The input data. Data type can be int, float, double, bool, string or array.
`string`	Separator for output string (Only effective for array input)
`int`	The output string’s notation is decimal, hexadecimal or binary (Can be only applied to hexadecimal or binary number)
	`10` decimal
	`16` hexadecimal
	`2` binary
	String’s notation
	123 decimal
	0x7F hexadecimal
	0b101 binary
`int`	The output string format (Can be only applied to hexadecimal or binary number)
	`0` Fill up digits. Add prefix 0x or 0b, e.g. 0x0C or 0b00001100
	`1` Fill up digits. No prefix 0x or 0b, e.g. 0C or 00001100
	`2` Don’t fill up digits. Add prefix 0x or 0b, e.g. 0xC or 0b1100
	`3` Don’t fill up digits. No prefix 0x or 0b, e.g. C or 1100

Return

`string`	String converted from input data. If the input data cannot be converted, returns empty string. If the input data is array, every element is converted respectively, and returned as a string with the assigned separator

Syntax 5

```
string GetString(
    ?,
    string,
    int
)
```

Note

Similar to Syntax4 with filling up digits and adding prefix 0x or 0b

GetString(?, str, 16) => **GetString**(?, str, 16, 0)

Syntax 6

```
string GetString(
    ?,
    string
)
```

Note

Similar to Syntax4 with decimal output, filling up digits and adding prefix

GetString(?, str) => **GetString**(?, str, 10, 0)

```
?   byte n = 123
    value = GetString(n)              // value = "123"
    value = GetString(n, ";", 10)     // value = "123"
    value = GetString(n, "-", 16)     // value = "0x7B"
    value = GetString(n, "#", 2)      // value = "0b01111011"
    value = GetString(n, ",", 16, 3)  // value = "7B"
    value = GetString(n, ",", 2, 2)   // value = "0b1111011"
```

* Separator is only effective to array input

```
?   byte[] n = {12, 34, 56}
    value = GetString(n, "-")                 // value = "12-34-56"
    value = GetString(n, Ctrl("\r\n"), 10)    // value = "12\u0D0A34\u0D0A56"
    value = GetString(n, newline, 16)         // value = "0x0C\u0D0A0x22\u0D0A0x38"
    value = GetString(n, NewLine, 2)          // value = "0b00001100\u0D0A0b00100010\u0D0A0b00111000"
    value = GetString(n, "-", 16, 3)          // value = "C-22-38"
    value = GetString(n, "-", 2, 2)           // value = "0b1100-0b100010-0b111000"
```

* \u0D0A is Newline control character, not string value.

Syntax 7

```
string GetString(
    ?,
    string,
    string,
    int,
    int
)
```

Parameters

`?` The input data. Data type can be int, float, double, bool, string or array.

`string` The index of the output string for array input. (Only effective to ? as array type data)

* Support numeric format strings

`string` Separator for output string (Only effective to array input)

`int` The output string's notation is decimal, hexadecimal or binary (Can be only applied to hexadecimal or binary number)

`10` decimal

`16` hexadecimal

`2` binary

String's notation

123 decimal

0x7F hexadecimal

0b101 binary

`int` The output string format (Can be only applied to hexadecimal or binary number)

`0` Fill up digits. Add prefix 0x or 0b, e.g. 0x0C or 0b00001100

`1` Fill up digits. No prefix 0x or 0b, e.g. 0C or 00001100

`2` Don't fill up digits. Add prefix 0x or 0b, e.g. 0xC or 0b1100

`3` Don't fill up digits. No prefix 0x or 0b, e.g. C or 1100

Return

`string` The string value formed by input data. For input data not convertible, an empty string will be returned. For array type input, every element is converted to a string with index prefix and separator.

Syntax 8

```
string GetString(
    ?,
    string,
    string,
    int
)
```

Note

Similar to Syntax7 with filling up digits and adding prefix.

GetString(?, str, str, 16) => **GetString**(?, str, str, 16, 0)

Syntax 9

```
string GetString(
```

```
    ?,
    string,
    string
)
```

Note

Similar to Syntax7 with decimal output, with filling up digits and adding prefix.

GetString(?, str, str) => **GetString**(?, str, str, 10, 0)

```
? byte n = 123
    value = GetString(n)                    // value = "123"
    value = GetString(n, "[0]=", ";", 10)   // value = "123"
    value = GetString(n, "[0]=", "-", 16)   // value = "0x7B"
    value = GetString(n, "[0]=", "#", 2)    // value = "0b01111011"
```

* Index and sepapator are only effective to array input.

```
? byte[] n = {12, 34, 56}
    value = GetString(n, "[0]=", "-")               // value = "[0]=12-[1]=34-[2]=56"
    value = GetString(n, "[0]=", Ctrl("\r\n"), 10)// value = "[0]=12\u0D0A[1]=34\u0D0A[2]=56"
    value = GetString(n, "[0]=", newline, 16)   // value = "[0]=0x0C\u0D0A[1]=0x22\u0D0A[2]=0x38"
    value = GetString(n, "[0]=", "-", 16, 3)    // value = "[0]=C-[1]=22-[2]=38"
    value = GetString(n, "[0]=", "-", 2, 2)     // value = "[0]=0b1100-[1]=0b100010-[2]=0b111000"
```

* "[0]=" Support numeric format strings

* \u0D0A is Newline control character, not string value.

2.32 GetToken()

Retrieve a substring from input string, or the sub-array from the input byte[] array

Syntax 1

```
string GetToken(
    string,
    string,
    string,
    int,
    int
)
```

Parameters

`string` Input string

`string` Prefix. The leading element of the substring

`string` Suffix. The trailing element of the substring

`int` The number of occurrence

`int` Remove the prefix and suffix or not

`0` Preserve prefix and suffix (Default)

`1` Remove prefix and suffix

Return

`string` String formed by part of the input string

If the prefix and suffix are empty, returns the input string

If the number of occurrence <=0, returns empty string

Syntax 2

```
string GetToken(
    string,
    string,
    string,
    int
)
```

Note

Similar to Syntax1, preserving prefix and suffix.

GetToken(str,str,str,1) => **GetToken**(str,str,str,1,0)

Syntax 3

```
string GetToken(
    string,
    string,
    string
)
```

Note

Similar to Syntax1 with returning the first occurrence, and preserving prefix and suffix.

GetToken(str,str,str) => **GetToken**(str,str,str,1,0)

```
string n = "$abcd$1234$ABCD$"
value = GetToken(n, "", "", 0)          // value = "$abcd$1234$ABCD$"
value = GetToken(n, "$", "$")           // value = "$abcd$"
value = GetToken(n, "$", "$", 0)        // value = ""
value = GetToken(n, "$", "$", 1)        // value = "$abcd$"
value = GetToken(n, "$", "$", 2)        // value = "$ABCD$"
value = GetToken(n, "$", "$", 3)        // value = ""
value = GetToken(n, "$", "$", 1, 1)     // value = "abcd"
```

value = **GetToken**(n, “$”, “$”, 2, 1) // value = “ABCD”

value = **GetToken**(n, “$”, “”, 1) // value = “$abcd”

value = **GetToken**(n, “$”, “”, 2) // value = “$1234”

value = **GetToken**(n, “$”, “”, 3) // value = “$ABCD”

value = **GetToken**(n, “$”, “”, 4) // value = “$”

value = **GetToken**(n, “”, “$”, 1) // value = “$”

value = **GetToken**(n, “”, “$”, 2) // value = “abcd$”

value = **GetToken**(n, “”, “$”, 3) // value = “1234$”

value = **GetToken**(n, “”, “$”, 4) // value = “ABCD$”

string n = “$abcd$1234$ABCD$” + Ctrl(“\r\n”) + “56\r\n78$”

value = **GetToken**(n, “$”, Ctrl(“\r\n”), 1) // value = “$abcd$1234$ABCD$\u0D0A”

value = **GetToken**(n, “$”, newline, 2) // value = “”

value = **GetToken**(n, “$”, NewLine, 1, 1) // value = “abcd1234ABCD$” // Remove prefix and suffix

value = **GetToken**(n, Ctrl(“\r\n”), “$”, 1) // value = “\u0D0A56\r\n78$”

value = **GetToken**(n, newline, “$”, 2) // value = “”

value = **GetToken**(n, NewLine, “$”, 1, 1) // value = “56\r\n78”

* \u0D0A is Newline control character, not string value.

Syntax 4

```
string GetToken(
    string,
    byte[],
    byte[],
    int,
    int
)
```

Parameters

`string`	Input string
`byte[]`	Prefix. The leading element of the substring, byte[] type
`byte[]`	Suffix. The trailing element of the substring, byte[] type
`int`	The number of occurrence
`int`	Remove prefix and suffix or not
	`0` Preserve prefix and suffix (Default)
	`1` Remove prefix and suffix

Return

`string`	String formed by part of the input string
	If the prefix and suffix are empty, returns the input string
	If the number of occurrence<=0, returns empty string

Syntax 5

```
string GetToken(
    string,
    byte[],
    byte[],
    int
)
```

Note

Similar to Syntax4, preserving prefix and suffix

GetToken(str,byte[],byte[],1) => **GetToken**(str,byte[],byte[],1,0)

Syntax 6

```
string GetToken(
    string,
    byte[],
    byte[]
)
```

Note

Similar to Syntax 4 with the first occurrence and preserving prefix and suffix

GetToken(str,byte[],byte[]) => **GetToken**(str,byte[],byte[],1,0)

```
string n = "$abcd$1234$ABCD$"
byte[] bb0 = {}, bb1 = {0x24}      // 0x24 is $
value = GetToken(n, bb0, bb0, 0)      // value = "$abcd$1234$ABCD$"
value = GetToken(n, bb1, bb1)         // value = "$abcd$"
value = GetToken(n, bb1, bb1, 0)      // value = ""
value = GetToken(n, bb1, bb1, 1)      // value = "$abcd$"
value = GetToken(n, bb1, bb1, 2)      // value = "$ABCD$"
value = GetToken(n, bb1, bb1, 3)      // value = ""
value = GetToken(n, bb1, bb1, 1, 1)   // value = "abcd"
value = GetToken(n, bb1, bb1, 2, 1)   // value = "ABCD"
value = GetToken(n, bb1, bb0, 1)      // value = "$abcd"
value = GetToken(n, bb1, bb0, 2)      // value = "$1234"
value = GetToken(n, bb1, bb0, 3)      // value = "$ABCD"
value = GetToken(n, bb1, bb0, 4)      // value = "$"
value = GetToken(n, bb0, bb1, 1)      // value = "$"
value = GetToken(n, bb0, bb1, 2)      // value = "abcd$"
value = GetToken(n, bb0, bb1, 3)      // value = "1234$"
value = GetToken(n, bb0, bb1, 4)      // value = "ABCD$"
```

```
string n = "$abcd$1234$ABCD$" + Ctrl("\r\n") + "56\r\n78$"
byte[] bb0 = {0x0D,0x0A}, bb1 = {0x24}      // 0x24 is $ // 0x0D,0x0A is \u0D0A
value = GetToken(n, bb1, bb0, 1)      // value = "$abcd$1234$ABCD$\u0D0A"
value = GetToken(n, bb1, bb0, 2)      // value = ""
value = GetToken(n, bb1, bb0, 1, 1)   // value = "abcd$1234$ABCD$"     // 去除前置與後置
value = GetToken(n, bb0, bb1, 1)      // value = "\u0D0A56\r\n78$"
value = GetToken(n, bb0, bb1, 2)      // value = ""
value = GetToken(n, bb0, bb1, 1, 1)   // value = "56\r\n78"
```

* \u0D0A is Newline control character, not string value.

Syntax 7

```
byte[] GetToken(
    byte[],
    string,
    string,
    int,
    int
)
```

Parameters

`byte[]`	The input byte[]
`string`	Prefix. The leading element of the output byte[], byte[] type
`string`	Suffix. The trailing element of the output byte[], byte[] type
`int`	The number of occurrence
`int`	Remove prefix and suffix or not
	`0` Preserve prefix and suffix (Default)
	`1` Remove prefix and suffix

Return

`byte[]`	The byte[] formed from part of the input byte[]
	If the prefix and suffix are empty, returns the input array
	If the number of occurrence<=0, returns empty array

Syntax 8

```
byte[] GetToken(
    byte[],
    string,
    string,
    int
)
```

Note

Similar to Syntax7 with preserving prefix and suffix

GetToken(byte[],str,str,1) => **GetToken**(byte[],str,str,1,0)

Syntax 9

```
byte[] GetToken(
    byte[],
    string,
    string
)
```

Note

Similar to Syntax7 with returning the first occurrence, and preserving prefix and suffix.

GetToken(byte[],str,str) => **GetToken**(byte[],str,str,1,0)

```
string s = "$abcd$1234$ABCD$"
byte[] n = GetBytes(s)
value = GetToken(n, "", "", 0)    // value = {0x24,0x61,0x62,0x63,0x64,0x24,0x31,0x32,0x33,0x34,0x24,0x41,0x42,0x43,0x44,0x24}
value = GetToken(n, "$", "$")          // value = {0x24,0x61,0x62,0x63,0x64,0x24}
value = GetToken(n, "$", "$", 0)       // value = {}
value = GetToken(n, "$", "$", 1)       // value = {0x24,0x61,0x62,0x63,0x64,0x24}
value = GetToken(n, "$", "$", 2)       // value = {0x24,0x41,0x42,0x43,0x44,0x24}
value = GetToken(n, "$", "$", 1, 1)    // value = {0x61,0x62,0x63,0x64}
value = GetToken(n, "$", "$", 2, 1)    // value = {0x41,0x42,0x43,0x44}
value = GetToken(n, "$", "", 1)        // value = {0x24,0x61,0x62,0x63,0x64}
value = GetToken(n, "$", "", 2)        // value = {0x24,0x31,0x32,0x33,0x34}
value = GetToken(n, "$", "", 3)        // value = {0x24,0x41,0x42,0x43,0x44}
value = GetToken(n, "$", "", 4)        // value = {0x24}
value = GetToken(n, "", "$", 1)        // value = {0x24}
value = GetToken(n, "", "$", 2)        // value = {0x61,0x62,0x63,0x64,0x24}
value = GetToken(n, "", "$", 3)        // value = {0x31,0x32,0x33,0x34,0x24}
value = GetToken(n, "", "$", 4)        // value = {0x41,0x42,0x43,0x44,0x24}
string s = "$abcd$1234$ABCD$" + Ctrl("\r\n") + "56\r\n78$"
byte[] n = GetBytes(s)
value = GetToken(n, "$", Ctrl("\r\n"), 1)
    // value = {0x24,0x61,0x62,0x63,0x64,0x24,0x31,0x32,0x33,0x34,0x24,0x41,0x42,0x43,0x44,0x24,0x0D,0x0A}
value = GetToken(n, "$", Ctrl("\r\n"), 1, 1)
    // value = {0x61,0x62,0x63,0x64,0x24,0x31,0x32,0x33,0x34,0x24,0x41,0x42,0x43,0x44,0x24}    // Removing prefix and
suffix
```

value = **GetToken**(n, Ctrl("\r\n"), "$", 1)

// value = {0x0D,0x0A,0x35,0x36,0x5C,0x72,0x5C,0x6E,0x37,0x38,0x24}

value = **GetToken**(n, Ctrl("\r\n"), "$", 1, 1)

// value = {0x35,0x36,0x5C,0x72,0x5C,0x6E,0x37,0x38}

Syntax 10

```
byte[] GetToken(
    byte[],
    byte[],
    byte[],
    int,
    int
)
```

Parameters

`byte[]`	The input byte[] array
`byte[]`	Prefix. The leading element of the output byte[]
`byte[]`	Suffix. The trailing element of the output byte[]
`int`	The number of occurrence
`int`	Remove prefix and suffix or not
	`0` Preserve prefix and suffix (Default)
	`1` Remove prefix and suffix

Return

`byte[]`	The byte[] formed from part of the input byte[]
	If the prefix and suffix are empty, returns the input array
	If the number of occurrence<=0, returns empty array

Syntax 11

```
byte[] GetToken(
    byte[],
    byte[],
    byte[],
    int
)
```

Note

Similar to Syntax10 with preserving the prefix and suffix

GetToken(byte[],byte[],byte[],1) => **GetToken**(byte[],byte[],byte[],1,0)

Syntax 12

```
byte[] GetToken(
    byte[],
    byte[],
    byte[]
)
```

Note

Similar to Syntax10 with returning the first occurrence, and preserving prefix and suffix.

GetToken(byte[],byte[],byte[]) => **GetToken**(byte[],byte[],byte[],1,0)

string s = “$abcd$1234$ABCD$”

byte[] n = GetBytes(s)

byte[] bb0 = {}, bb1 = {0x24} // 0x24 is $

value = **GetToken**(n, bb0, bb0, 0)// value = {0x24,0x61,0x62,0x63,0x64,0x24,0x31,0x32,0x33,0x34,0x24,0x41,0x42,0x43,0x44,0x24}

value = **GetToken**(n, bb1, bb1) // value = {0x24,0x61,0x62,0x63,0x64,0x24}

value = **GetToken**(n, bb1, bb1, 0) // value = {}

value = **GetToken**(n, bb1, bb1, 1) // value = {0x24,0x61,0x62,0x63,0x64,0x24}

value = **GetToken**(n, bb1, bb1, 2) // value = {0x24,0x41,0x42,0x43,0x44,0x24}

value = **GetToken**(n, bb1, bb1, 1, 1) // value = {0x61,0x62,0x63,0x64}

value = **GetToken**(n, bb1, bb1, 2, 1) // value = {0x41,0x42,0x43,0x44}

value = **GetToken**(n, bb1, bb0, 1) // value = {0x24,0x61,0x62,0x63,0x64}

value = **GetToken**(n, bb1, bb0, 2) // value = {0x24,0x31,0x32,0x33,0x34}

value = **GetToken**(n, bb1, bb0, 3) // value = {0x24,0x41,0x42,0x43,0x44}

value = **GetToken**(n, bb0, bb1, 1) // value = {0x24}

value = **GetToken**(n, bb0, bb1, 2) // value = {0x61,0x62,0x63,0x64,0x24}

value = **GetToken**(n, bb0, bb1, 3) // value = {0x31,0x32,0x33,0x34,0x24}

string s = “$abcd$1234$ABCD$” + Ctrl(“\r\n”) + “56\r\n78$”

byte[] n = GetBytes(s)

byte[] bb0 = {0x0D,0x0A}, bb1 = {0x24}

value = **GetToken**(n, bb1, bb0, 1)

// value = {0x24,0x61,0x62,0x63,0x64,0x24,0x31,0x32,0x33,0x34,0x24,0x41,0x42,0x43,0x44,0x24,0x0D,0x0A}

value = **GetToken**(n, bb1, bb0, 1, 1)

// value = {0x61,0x62,0x63,0x64,0x24,0x31,0x32,0x33,0x34,0x24,0x41,0x42,0x43,0x44,0x24} // Remove prefix and suffix

value = **GetToken**(n, bb0, bb1, 1)

// value = {0x0D,0x0A,0x35,0x36,0x5C,0x72,0x5C,0x6E,0x37,0x38,0x24}

value = **GetToken**(n, bb0, bb1, 1, 1)

// value = {0x35,0x36,0x5C,0x72,0x5C,0x6E,0x37,0x38}

2.33 GetAllTokens()

Retrieve all the substrings from input string, which meet the given condition

Syntax 1

```
string[] GetAllTokens(
    string,
    string,
    string,
    int
)
```

Parameters

`string`	Input string
`string`	Prefix. The leading element of the substring
`string`	Suffix. The trailing element of the substring
`int`	Remove prefix and suffix or not
`0`	Preserve prefix and suffix (Default)
`1`	Remove prefix and suffix

Return

`string[]`	String array formed from retrieving all the substrings from input string If the prefix and suffix are empty, returns the input array

Syntax 2

```
string[] GetAllTokens(
    string,
    string,
    string
)
```

Note

Similar to Syntax1 with preserving prefix and suffix

GetAllTokens(str,str,str) => **GetAllTokens**(str,str,str,0)

```
string n = "$abcd$1234$ABCD$"
value = GetAllTokens(n, "", "")        // value = {"$abcd$1234$ABCD$"}
value = GetAllTokens(n, "$", "$")      // value = {"$abcd$", "$ABCD$"}
value = GetAllTokens(n, "$", "$", 1)   // value = {"abcd", "ABCD"}
value = GetAllTokens(n, "$", "")       // value = {"$abcd", "$1234", "$ABCD", "$"}
value = GetAllTokens(n, "", "$", 1)    // value = {"", "abcd", "1234", "ABCD"}
```

2.34 GetNow()

Get the current system time

Syntax 1

```
string GetNow(
    string
)
```

Parameters

`string` The date and time format strings defining the text representation of a date and time value. The definition of each specifier is listed below. The strings not included will remains the same.

`d`	One-digit day of the month for days below 10, from 1 to 31
`dd`	Two-digit day of the month, from 01 to 31
`ddd`	Three-letter abbreviation for day of the week, e.g. Mon
`dddd`	Day of the week spelled out in full, e.g. Monday
`f`	Second to 0.1 second
`ff`	Second to 0.01 Second
`fff`	Second to 0.001 Second
`ffff`	Second to 0.0001 Second
`h`	One-digit hour for hours below 10 in 12-hour format, from 1 to 12
`hh`	Two-digit hour in 12-hour format, from 01 to 12
`H`	One-digit hour for hours below 10 in 12-hour format, from 0 to 23
`HH`	Two-digit hour in 24-hour format, from 00 to 23
`m`	One-digit minute for minutes below 10, from 0 to 59
`mm`	Two-digit minute, from 00 to 59
`M`	One-digit month for months below 10, from 1 to 12
`MM`	Two-digit month, from 01 to 12
`MMM`	Three-letter abbreviation for month, Jun
`MMMM`	Month spelled out in full, June
`s`	One-digit second for seconds below 10, from 0 to 59
`ss`	Two-digit second, from 00 to 59
`t`	The frist digit of AM/PM
`tt`	AM/PM
`y`	One-digit year for years below 10, from 0 to 99
`yy`	Two-digit year, from 00 to 99
`yyyy`	four-digit year
`/`	Separator for date. / or – or . (Based on different languages)

Return

`string` Current date and time. If there is errors in format setting, the default format will be applied.

Note

value = **GetNow**("MM/dd/yyyy HH:mm:ss") // value = 08/15/2017 13:40:30

value = **GetNow**("yyyy/MM/dd HH:mm:ss.ffff") // value = 2017/08/15 13:40:30.123

value = **GetNow**("yyyy-MM-dd hh:mm:ss tt") // value = 2017-08-15 01:40:30 PM

Syntax 2

```
string GetNow(
)
```

Parameters

`void` No format defined. Default format "MM/dd/yyyy HH:mm:ss" will be applied

Return

`string` Current date and time.

Note

value = **GetNow**() // value = 08/15/2017 13:40:30

2.35 GetNowStamp()

Get the total run time or difference in total run time

Syntax 1

```
int GetNowStamp(
)
```

Parameters

`void` No parameter

Return

`int` The total run time of the current project in ms. The upper limit is 2147483647 ms

`< 0` Overflow, invalid total run time

Note

value = **GetNowStamp**() // value = 2147483647

... others ...

value = **GetNowStamp**() // value = -1 // Over flow

Syntax 2

```
double GetNowStamp(
    bool
)
```

Parameters

`bool` Use double format to record project's total run time or not?

`true` Use double type, the upper limit is 9223372036854775807 ms

`false` Use int32 type, the upper limit is 2147483647 ms

Return

`double` The total run time of the current project

`< 0` Overflow. Invalid total run time.

Note

```
value = GetNowStamp(false)          // value = 2147483647
... others ...
value = GetNowStamp(false)          // value = -1          // Over flow
value = GetNowStamp(true)           // value = 3147483647
```

Syntax 3

```
int GetNowStamp(
    int
)
```

Parameters

`int` Previous recorded run time in ms

Return

`int` The difference between the current run time and the input run time in ms.

Run time difference = current run time – input run time

`< 0` Invalid run time difference, caused by input run time larger than current run time, or overflow.

Note

```
value = GetNowStamp()          // value = 2147483546
... others ... (After 100ms)
diff = GetNowStamp(value)      // diff = 100
... others ... (After 200ms)
diff = GetNowStamp(value)      // diff = -1          // Value is over 2147483647
```

Syntax 4

```
double GetNowStamp(
    double
)
```

Parameters

`double` Previous recorded run time in ms

Return

`double` The difference between the current run time and the input run time in ms.

Run time difference = current run time – input run time

`< 0` Invalid run time difference, caused by input run time larger than current run time, or overflow.

Note

```
value = GetNowStamp()          // value = 2147483546
... others ... (After 100ms)
diff = GetNowStamp(value)      // diff = 100
... others ... (After 200ms)
diff = GetNowStamp(value)      // diff = 200
```

Syntax 5

```
bool GetNowStamp(
    int,
    int
)
```

Parameters

`int` Previous recorded run time in ms

`int` The expected run time difference

Return

`bool` The time difference between current run time and input run time is lager than the expected run time difference or not.

`true` (Current run time – input run time) >= expected run time

Or Time difference smaller than zero or overflow

`false` (Current run time – input run time) < expected run time

Note

```
value = GetNowStamp()              // value = 41730494
... others ... (After 60ms)
flag = GetNowStamp(value, 100)     // diff = 60     // flag = false
... others ... (After 60ms)
flag = GetNowStamp(value, 100)     // diff = 120    // flag = true
```

Syntax 6

```
bool GetNowStamp(
    double,
    double
)
```

Parameters

`double` Previous recorded run time in ms

`double` The expected run time difference

Return

`bool` The time difference between current run time and input run time is larger than the expected run time difference or not.

`true` (Current run time – input run time) >= expected run time

Or Time difference smaller than zero or overflow

`false` (Current run time – input run time) < expected run time

Note

```
value = GetNowStamp()              // value = 41730494
... others ... (After 60ms)
flag = GetNowStamp(value, 100)     // diff = 60      // flag = false
... others ... (After 60ms)
flag = GetNowStamp(value, 100)     // diff = 120     // flag = true
```

2.36 Length()

Acquire the number of byte of input data, length of string or length of array (number of elements in array)

Syntax 1

```
int Length(
    ?
)
```

Parameters

`?` The input data. The data type could be integer, floating number, Boolean, string or array

Return

`int` Length of data

For input of integer, floating number and Boolean, returns the number of bytes.

For input of string, returns the length of string.

For input of array, returns the number of element in array

Note

`?` byte n = 100

```
value = Length(n)          // value = 1
value = Length(100)        // value = 1
```

`?` int n = 400

```
    value = Length(n)          // value = 4
    value = Length(400)        // value = 4
?   float n = 1.234
    value = Length(n)          // value = 4
    value = Length(1.234)      // value = 4
?   double n = 1.234
    value = Length(n)          // value = 8
    value = Length(1.234)      // value = 4       // float // Numbers would be stored as the smaller data type first.
?   bool n = true
    value = Length(n)          // value = 1
    value = Length(false)      // value = 1
?   string n = "A""BC"
    value = Length(n)          // value = 4       // The string is A"BC. Two double quotation marks represent " in
                               string
    value = Length("")         // value = 0
    value = Length("123")      // value = 3
    value = Length(empty)      // value = 0
?   byte[] n = {100, 200, 30}
    value = Length(n)          // value = 3
?   int[] n = {}
    value = Length(n)          // value = 0
    n = {400, 500, 600}
    value = Length(n)          // value = 3
?   float[] n = {1.234}
    value = Length(n)          // value = 1
?   double[] n = {1.234, 200, -100, +300}
    value = Length(n)          // value = 4
?   bool[] n = {true, false, true, true, true, true, false}
    value = Length(n)          // value = 7
?   string[] n = {"A""BC", "123", "456", "ABC"}
    value = Length(n)          // value = 4
```

2.37 Ctrl()

Change the integer or string to control characters

Syntax 1

```
string Ctrl(
    int
)
```

Parameters

`int` The input integer, which follows the Big Endian format. 4 characters could be transformed at most. 0x00 will not be transformed.

Return

`string` The string formed by input integer (contains the control character)

Note

```
b = 0x0D0A
value = Ctrl(b)             // value = \r\n
value = Ctrl(0x0D0A)        // value = \r\n
value = Ctrl(0x0D000A09)    // value = \r\n\t      // 0x00 will not be tranformed
value = Ctrl(0x0D300A09)    // value = \r0\n\t     // 0x30 is transformed to 0
value = Ctrl(0x00)          // value = ""          // empty string does not equal to NULL. For NULL, the code is
                            Ctrl("\0")
```

Syntax 2

```
string Ctrl(
    string
)
```

Parameters

`string` Input string. The following rules will be applied. For string not on the list, it will remain the same.

`\0`	0x00 null
`\a`	0x07 bell
`\b`	0x08 backspace
`\t`	0x09 horizontal tab
`\r`	0x0D carriage return
`\v`	0x0B vertical tab
`\f`	0x0C form feed
`\n`	0x0A line feed

Return

`string` The string formed by input integer (contains the control character)

Note

```
b = "\r\n"
value = Ctrl(b)             // value = \r\n
```

value = **Ctrl**(“\r\n”) // value = \r\n

value = **Ctrl**(“\r\n\t”) // value = \r\n\t

value = **Ctrl**(“\r0\n\t”) // value = \r0\n\t

value = **Ctrl**(“\0”) // value = \0 // NULL

Syntax 3

```
string Ctrl(
    byte[]
)
```

Parameters

`byte[]` The input byte array, the transfer will start from index [0] to the end of the array. (0x00 will be transferred also)

Return

`string` The string formed by input integer (contains the control character)

Note

byte[] bb1 = {0xFF,0x55,0x31,0x32,0x33,0x00,0x35,0x36,0x0D,0x0A}

value = **Ctrl**(bb1) // value = U123 56\r\n

byte[] bb2 = {}

value = **Ctrl**(bb2) // value = “”

2.38 XOR8()

Utilize XOR 8 bits algorithm to compute the checksum

Syntax 1

```
byte XOR8(
    byte[],
    int,
    int
)
```

Parameters

`byte[]` The input byte array

`int` The starting index

0..(array size-1) Valid

<0 Invalid. Returns the initial value 0

>=array size Invalid. Returns the initial value 0

`int` The number of elements to be computed.

If the number of elements <0, the calculation ends at the last element of the array

If the sum of strating index and number of element exceeds the array size, the calculation ends at the last element of the array.

Return

`byte` Checksum.

Note

byte[] bb1 = {0x10, 0x20, 0x50, 0xF0, 0xFF, 0xFF, 0xFF}

value = **XOR8**(bb1,0,Length(bb1)) // value = 0x6F

value = **XOR8**(bb1,0,-1) // value = 0x6F

value = **XOR8**(bb1,1,-1) // value = 0x7F

value = **XOR8**(bb1,-1,-1) // value = 0

Syntax 2

```
byte XOR8(
    byte[],
    int
)
```

Note

Similar to Syntax1 with computing to the last element of the array

XOR8(byte[], int) => **XOR8**(byte[], int, Length(byte[]))

Syntax 3

```
byte XOR8(
    byte[]
)
```

Note

Similar to Syntax1 with computing all the elements of the array

XOR8(byte[]) => **XOR8**(byte[], 0, Length(byte[]))

byte[] bb1 = {0x10, 0x20, 0x50, 0xF0, 0xFF, 0xFF, 0xFF}

value = **XOR8**(bb1,0,Length(bb1)) // value = 0x6F

value = **XOR8**(bb1,0) // value = 0x6F

value = **XOR8**(bb1) // value = 0x6F

bb1 = **Byte_Concat**(bb1, **XOR**(bb1)) // bb1 = {0x10, 0x20, 0x50, 0xF0, 0xFF, 0xFF, 0xFF, 0x6F}

2.39 SUM8()

Utilize SUM 8 bits algorithm to compute the checksum

Syntax 1

```
byte SUM8(
    byte[],
    int,
    int
)
```

Parameters

byte[]	The input byte array	
int	The starting index	
	0..array size-1	Valid
	<0	Invalid. Returns the initial value 0
	>=array size	Invalid. Returns the initial value 0
int	The number of elements to be computed.	
	If the number of elements <0, the calculation ends at the last element of the array	
	If the sum of strating index and number of element exceeds the array size, the calculation ends at the last element of the array.	

Return

byte	Checksum.

Note

byte[] bb1 = {0x10, 0x20, 0x50, 0xF0, 0xFF, 0xFF, 0xFF}

value = **SUM8**(bb1,0,Length(bb1)) // value = 0x6D

value = **SUM8**(bb1,0,-1) // value = 0x6D

value = **SUM8**(bb1,1,-1) // value = 0x5D

value = **SUM8**(bb1,-1,-1) // value = 0

Syntax 2

```
byte SUM8(
    byte[],
    int
)
```

Note

Similar to Syntax1 with computing to the last element of the array

SUM8(byte[], int) => **SUM8**(byte[], int, Length(byte[]))

Syntax 3

```
byte SUM8(
    byte[]
```

)

Note

Similar to Syntax1 with computing all the elements of the array

SUM8(byte[]) => **SUM8**(byte[], 0, Length(byte[]))

byte[] bb1 = {0x10, 0x20, 0x50, 0xF0, 0xFF, 0xFF, 0xFF}

value = **SUM8**(bb1,0,Length(bb1)) // value = 0x6D

value = **SUM8**(bb1,0) // value = 0x6D

value = **SUM8**(bb1) // value = 0x6D

bb1 = **Byte_Concat**(bb1, **SUM8**(bb1)) // bb1 = {0x10, 0x20, 0x50, 0xF0, 0xFF, 0xFF, 0xFF, 0x6D}

2.40 SUM16()

Utilize SUM 16 bits algorithm to compute the checksum

Syntax 1

```
byte[] SUM16(
    byte[],
    int,
    int
)
```

Parameters

`byte[]` The input byte array

`int` The starting index

0..array size-1 Valid

<0 Invalid. Returns the initial value 0

>=array size Invalid. Returns the initial value 0

`int` The number of elements to be computed.

If the number of elements <0, the calculation ends at the last element of the array

If the sum of strating index and number of element exceeds the array size, the calculation ends at the last element of the array.

Return

`byte[]` Checksum. The length is 16bits 2 bytes (The Checksum follows Big Endian)

Note

byte[] bb1 = {0x10, 0x20, 0x50, 0xF0, 0xFF, 0xFF, 0xFF}

value = **SUM16**(bb1,0,Length(bb1)) // value = {0x04, 0x6D}

value = **SUM16**(bb1,0,-1) // value = {0x04, 0x6D}

value = **SUM16**(bb1,1,-1) // value = {0x04, 0x5D}

value = **SUM16**(bb1,-1,-1) // value = {0x00, 0x00}

Syntax 2

```
byte[] SUM16(
    byte[],
    int
)
```

Note

Similar to Syntax1 with computing to the last element of the array

SUM16(byte[], int) => **SUM16**(byte[], int, Length(byte[]))

Syntax 3

```
byte[] SUM16(
    byte[]
)
```

Note

Similar to Syntax1 with computing all the elements of the array

SUM16(byte[]) => **SUM16**(byte[], 0, Length(byte[]))

byte[] bb1 = {0x10, 0x20, 0x50, 0xF0, 0xFF, 0xFF, 0xFF}

value = **SUM16**(bb1,0,Length(bb1)) // value = {0x04, 0x6D}

value = **SUM16**(bb1,0) // value = {0x04, 0x6D}

value = **SUM16**(bb1) // value = {0x04, 0x6D}

bb1 = **Byte_Concat**(bb1, **SUM16**(bb1)) // bb1 = {0x10, 0x20, 0x50, 0xF0, 0xFF, 0xFF, 0xFF, 0x04, 0x6D}

2.41 SUM32()

Utilize SUM 32 bits algorithm to compute the checksum

Syntax 1

```
byte[] SUM32(
    byte[],
    int,
    int
)
```

Parameters

`byte[]` The input byte array

`int` The starting index

0..array size-1	Valid
<0	Invalid. Returns the initial value 0
>=array size	Invalid. Returns the initial value 0

`int` The number of elements to be computed.

If the number of elements <0, the calculation ends at the last element of the array

If the sum of strating index and number of element exceeds the array size, the calculation ends at the last element of the array.

Return

`byte[]` Checksum. The length is 32bits 4 bytes (The Checksum follows Big Endian)

Note

byte[] bb1 = {0x10, 0x20, 0x50, 0xF0, 0xFF, 0xFF, 0xFF}

value = **SUM32**(bb1,0,Length(bb1)) // value = {0x00, 0x00, 0x04, 0x6D}

value = **SUM32**(bb1,0,-1) // value = {0x00, 0x00, 0x04, 0x6D}

value = **SUM32**(bb1,1,-1) // value = {0x00, 0x00, 0x04, 0x5D}

value = **SUM32**(bb1,-1,-1) // value = {0x00, 0x00, 0x00, 0x00}

Syntax 2

```
byte[] SUM32(
    byte[],
    int
)
```

Note

Similar to Syntax1 with computing to the last element of the array

SUM32(byte[], int) => **SUM32**(byte[], int, Length(byte[]))

Syntax 3

```
byte[] SUM32(
    byte[]
)
```

Note

Similar to Syntax1 with computing all the elements of the array

SUM32(byte[]) => **SUM32**(byte[], 0, Length(byte[]))

byte[] bb1 = {0x10, 0x20, 0x50, 0xF0, 0xFF, 0xFF, 0xFF}

value = **SUM32**(bb1,0,Length(bb1)) // value = {0x00, 0x00, 0x04, 0x6D}

value = **SUM32**(bb1,0) // value = {0x00, 0x00, 0x04, 0x6D}

value = **SUM32**(bb1) // value = {0x00, 0x00, 0x04, 0x6D}

```
bb1 = Byte_Concat(bb1, SUM32(bb1))      // bb1 = {0x10, 0x20, 0x50, 0xF0, 0xFF, 0xFF, 0xFF, 0x00, 0x00, 0x04, 0x6D}
```

2.42 CRC16()

Utilize CRC 16 bits algorithm to compute the checksum

Syntax 1

```
byte[] CRC16(
    int,
    byte[],
    int,
    int
)
```

Parameters

`int` CRC16 algorithm (Reference https://www.lammertbies.nl/comm/info/crc-calculation.html)

0	CRC16	// initial value 0x0000 // Polynomial 0xA001
1	CRC16 (Modbus)	// initial value 0xFFFF // Polynomial 0xA001
2	CRC16 (Sick)	// initial value 0x0000 // Polynomial 0x8005
3	CRC16-CCITT (0x1D0F)	// initial value 0x1D0F // Polynomial 0x1021
4	CRC16-CCITT (0xFFFF)	// initial value 0xFFFF // Polynomial 0x1021
5	CRC16-CCITT (XModem)	// initial value 0x0000 // Polynomial 0x1021
6	CRC16-CCITT (Kermit)	// initial value 0x0000 // Polynomial 0x8408
7	CRC16 Schunk Gripper	// initial value 0xFFFF // Polynomial 0x1021

`byte[]` The input byte array

`int` The starting index

0..array size-1	Valid
<0	Invalid. Returns the initial value
>=array size	Invalid. Returns the initial value

`int` The number of elements to be computed.

If the number of elements <0, the calculation ends at the last element of the array

If the sum of strating index and number of element exceeds the array size, the calculation ends at the last element of the array.

Return

`byte[]` Checksum. The length is 16bits 2 bytes (The checksum follows Big Endian)

Note

```
byte[] bb1 = {0x10, 0x20, 0x50, 0xF0, 0xFF, 0xFF, 0xFF}
value = CRC16(0, bb1,0,Length(bb1))      // value = {0x2D, 0xD4}
value = CRC16(0, bb1,0,-1)               // value = {0x2D, 0xD4}
value = CRC16(0, bb1,1,-1)               // value = {0xEC, 0xC5}
value = CRC16(0, bb1,-1,-1)              // value = {0x00, 0x00}
```

value = **CRC16**(3, bb1,0,Length(bb1)) // value = {0x42, 0x12}

value = **CRC16**(4, bb1,0,Length(bb1)) // value = {0xAB, 0xAE}

Syntax 2

```
byte[] CRC16(
    int,
    byte[],
    int
)
```

Note

Similar to Syntax1 with computing to the last element of the array

CRC16(int, byte[], int) => **CRC16**(int, byte[], int, Length(byte[]))

Syntax 3

```
byte[] CRC16(
    int,
    byte[]
)
```

Note

Similar to Syntax1 with computing all the elements of the array

CRC16(int, byte[]) => **CRC16**(int, byte[], 0, Length(byte[]))

byte[] bb1 = {0x10, 0x20, 0x50, 0xF0, 0xFF, 0xFF, 0xFF}

value = **CRC16**(0, bb1,0,Length(bb1)) // value = {0x2D, 0xD4}

value = **CRC16**(0, bb1,0) // value = {0x2D, 0xD4}

value = **CRC16**(0, bb1) // value = {0x2D, 0xD4}

bb1 = **Byte_Concat**(bb1, **CRC16**(0, bb1)) // bb1 = {0x10, 0x20, 0x50, 0xF0, 0xFF, 0xFF, 0xFF, 0x2D, 0xD4}

Syntax 4

```
byte[] CRC16(
    byte[],
    int,
    int
)
```

Note

Similar to Syntax1 with CRC16 algorithm as 0 CRC16

CRC16(byte[], int, int) => **CRC16**(0, byte[], int, int)

Syntax 5

```
byte[] CRC16(
    byte[],
    int
)
```

Note

Similar to Syntax1 with CRC16 algorithm as 0 CRC16 and computing to the last element of the array

CRC16(byte[], int) => **CRC16**(0, byte[], int, Length(byte[]))

Syntax 6

```
byte[] CRC16(
    byte[]
)
```

Note

Similar to Syntax1 with CRC16 algorithm as 0 CRC16 and computing all the elements of the array

CRC16(byte[]) => **CRC16**(0, byte[], 0, Length(byte[]))

2.43 CRC32()

Utilize CRC 32 bits algorithm to compute the checksum

Syntax 1

```
byte[] CRC32(
    byte[],
    int,
    int
)
```

Parameters

byte[]	The input byte array	
int	The starting index	
	0..array size-1	Valid
	<0	Invalid. Returns the initial value 0
	>=array size	Invalid. Returns the initial value 0
int	The number of elements to be computed.	
	If the number of elements <0, the calculation ends at the last element of the array	
	If the sum of strating index and number of element exceeds the array size, the calculation ends at the last element of the array.	

Return

`byte[]` Checksum. The checksum length is 32bits 4 bytes (The checksum follows Big Endian)

Note

byte[] bb1 = {0x10, 0x20, 0x50, 0xF0, 0xFF, 0xFF, 0xFF}

value = **CRC32**(bb1,0,Length(bb1)) // value = {0x43, 0xD5, 0xB9, 0xF8}
value = **CRC32**(bb1,0,-1) // value = {0x43, 0xD5, 0xB9, 0xF8}
value = **CRC32**(bb1,1,-1) // value = {0x08, 0xA5, 0x5B, 0xEB}
value = **CRC32**(bb1,-1,-1) // value = {0x00, 0x00, 0x00, 0x00}

Syntax 2

```
byte[] CRC32(
    byte[],
    int
)
```

Note

Similar to Syntax1 with computing to the last element of the array

CRC32(byte[], int) => **CRC32**(byte[], int, Length(byte[]))

Syntax 3

```
byte[] CRC32(
    byte[]
)
```

Note

Similar to Syntax1 with computing all the elements of the array

CRC32(byte[]) => **CRC32**(byte[], 0, Length(byte[]))

byte[] bb1 = {0x10, 0x20, 0x50, 0xF0, 0xFF, 0xFF, 0xFF}

value = **CRC32**(bb1,0,Length(bb1)) // value = {0x43, 0xD5, 0xB9, 0xF8}
value = **CRC32**(bb1,0) // value = {0x43, 0xD5, 0xB9, 0xF8}
value = **CRC32**(bb1) // value = {0x43, 0xD5, 0xB9, 0xF8}
bb1 = **Byte_Concat**(bb1, **CRC32**(bb1)) // bb1 = {0x10, 0x20, 0x50, 0xF0, 0xFF, 0xFF, 0xFF, 0x43, 0xD5, 0xB9, 0xF8}

2.44 ListenPacket()

Pack the string into Listen Node compatible format

Syntax 1

```
string ListenPacket(
    string,
    string
)
```

Parameters

`string` User defined Header. For empty string, default string “TMSCT” will be applied

`string` The data section in Listen Node communication format

Return

`string` Packeted data (Including header, data length and check sum)

Note

string var_data1 = “ABC”

string var_data2 = “Hello World”

value = **ListenPacket**(“TMSCT”,var_data1) // $TMSCT,3,ABC,*02\r\n

value = **ListenPacket**(“CPERR”, var_data2) // $CPERR,11,Hello World,*5A\r\n

value = **ListenPacket**(“”, var_data2) // $TMSCT,11,Hello World,*51\r\n

value = **ListenPacket**(“”, “Techman Robot”) // $TMSCT,13,Techman Robot,*4F\r\n

Syntax 2

```
string ListenPacket(
    string
)
```

Parameters

`string` The data section in Listen Node communication format (With TMSCT header)

Return

`string` Packeted data (Including header, data length and check sum)

Note

string var_data1 = “Techman Robot”

value = **ListenPacket**(var_data1) // $TMSCT,13,Techman Robot,*4F\r\n

2.45 VarSync()

Send the Variable object to TM Manager (Robot Management System)

* When performing this function, the flow will not go forward until the object is sent out successfully or the maximum retry times is reached.

Syntax 1

```
int VarSync(
    int,
    int,
    ?
)
```

Parameters

int	The maximum retry times	
	<= 0	Keep retrying as error occurred.
int	The time duration between two retries (millisecond)	
	< 0	Invalid time duration. The default value, 1000ms, will be applied
?	The string or string array. The name of variables to be sent.	
	Various items can be listed. The undefined variables will not be sent out, but the residual items will still be sent.	
	* The item is the name of the variable, not variable itself, e.g. “var_i” instead of var_i.	
	* If the variable is listed, the value of the variable will be use as the parameter to send the corresponding object	

Return

int	Sending times	
	> 0	Send success. The return value represents the sending times
	0	Send failed
	-1	TM Manager function is not enabled
	-9	Invalid Parameters

Note

string var_s = “ABC”

string var_s1 = “var_s”

string[] var_ss = {“ABC”, “var_s”, “var_s1”}

value = **VarSync**(1, 1000, “var_s”) // Send var_s variable object

value = **VarSync**(2, 2000, var_s) // Send ABC variable object (Because the value of var_s is “ABC”)

value = **VarSync**(3, 2000, var_ss) // Send ABC, var_s, var_s1 variable object (From the value of var_ss string array)

value = **VarSync**(3, 2000, “var_ss”) // Send var_ss variable object

value = **VarSync**(4, 2000, “var_ss”, “var_s1”, “ABC”) // Send var_ss, var_s1, ABC variable object

Syntax 2

```
int VarSync(
    int,
```

```
    ?
)
```

Note

Similar to Syntax1 with 1000 ms retry time duration

VarSync(int, ?) => **VarSync**(int, 1000, ?)

Syntax 3

```
int VarSync(
    ?
)
```

Note

Similar to Syntax1 with 1000 ms retry time duration and no retry times limit

VarSync(?) => **VarSync**(0, 1000, ?)

3. Math Functions

3.1 abs()

Return the absolute value of the designate number

Syntax1

```
int abs(
    int
)
```

Parameter

`int` Input number as integer

Return

`int` Return the absolute value of the input number as integer

Note

```
int i = 10
value = abs(i)    // 10
i = -10
value = abs(i)    // 10
```

Syntax2

```
float abs(
    float
)
```

Parameter

`float` Input number as float

Return

`float` Return the absolute value of the input number as float

Note

```
float f = 10.1
value = abs(f)    // 10.1
f = -10.1
value = abs(f)    // 10.1
```

Syntax3

```
double abs(
    double
```

)

Parameter

`double` Input number as double

Return

`double` Return the absolute value of the input number as double

Note

```
double d = 10.8
value = abs(d)   // 10.8
d = -10.8
value = abs(d)   // 10.8
```

3.2 pow()

Return the power of the designate base and exponent

Syntax1

```
int pow(
    int,
    double
)
```

Parameter

`int` Input base as integer

`double` Exponent

Return

`int` Return the power as integer

Syntax2

```
float pow(
    float,
    double
)
```

Parameter

`float` Input base as float

`double` Exponent

Return

`float` Return the power as float

Syntax3

```
double pow(
    double,
    double
)
```

Parameter

`double` Input base as double

`double` Exponent

Return

`double` Return the power as double

Note

? `int` b = 100

value = **pow**(b, 2) // 10000

value = **pow**(b, -2) // 0 // 0.0001, but int type

value = **pow**(b, 0.1) // 1 // 1.5848931924611136, but int type

value = **pow**(b, 2.1) // 15848 // 15848.931924611141, but int type

value = **pow**(b, -2.1) // 0 // 0.000063095734448019293, but int type

? `float` b = -100

value = **pow**(b, 2) // 10000

value = **pow**(b, -2) // 0.0001

value = **pow**(b, 0.2) // Error // NaN

value = **pow**(b, 2.2) // Error // NaN

value = **pow**(b, -2.2) // Error // NaN

? `double` b = 100

value = **pow**(b, 2) // 10000

value = **pow**(b, -2) // 0.0001

value = **pow**(b, 0.31) // 4.16869383470335

value = **pow**(b, 2.31) // 41686.9383470336

value = **pow**(b, -2.31) // 0.0000239883291901949

3.3 sqrt()

Return the square root of the designate number

Syntax1

```
float sqrt(
    float
)
```

Parameter

`float` Input number as float

Return

`float` Return the square root as float

Syntax2

```
double sqrt(
    double
)
```

Parameter

`double` Input number as double

Return

`double` Return the square root as double

Note

```
value = sqrt(100)          // 10
value = sqrt(100.1234)     // 10.005
value = sqrt(0.1234)       // 0.3162278
value = sqrt(-100)         // Error // NaN
value = sqrt(-100.1234)    // Error // NaN
value = sqrt(-0.1234)      // Error // NaN
```

3.4 ceil()

Return a number rounded upward to its nearest integer.

Syntax1

```
float ceil(
    float
)
```

Parameter

`float` input number as float

Return

`float` Return a number in float rounded upward to its nearest integer

Syntax2

```
double ceil(
    double
)
```

Parameter

`double` input number as double

Return

`double` Return a number in double rounded upward to its nearest integer

Note

```
value = ceil(100)          // 100
value = ceil(100.1234)     // 101
value = ceil(0.1234)       // 1
value = ceil(-100)         // -100
value = ceil(-100.1234)    // -100
value = ceil(-0.1234)      // 0
```

3.5 floor()

Return a number rounded downward to its nearest integer.

Syntax1

```
float floor(
    float
)
```

Parameter

`float` input number as float

Return

`float` Return a number as float rounded downward to its nearest integer

Syntax2

```
double floor(
    double
)
```

Parameter

`double` input number as double

Return

`double` Return a number as double rounded downward to its nearest integer

Note

```
value = floor(100)          // 100
value = floor(100.1234)     // 100
value = floor(0.1234)       // 0
value = floor(-100)         // -100
value = floor(-100.1234)    // -101
value = floor(-0.1234)      // -1
```

3.6 round()

Return a number rounded to its nearest integer.

Syntax1

```
float round(
    float,
    int
)
```

Parameter

float	input number as float
int	digits after the returned decimal point (0 by default meaning the number is rounded to integer)
0 .. 15	valid values
< 0	value invalid, will use 0 by default
> 15	value invalid, will use 0 by default

Return

float	Return a number as float rounded to its nearest integer.

Syntax2

```
float round(
    float
)
```

Note

Same as syntax 1. Obtain 0 digit after the decimal point by default.

round(float) => **round**(float, 0)

Syntax3

```
double round(
    double,
    int
)
```

Parameter

`double` input number as double

`int` digits after the returned decimal point (0 is default, meaning the number is rounded to integer)

0 .. 15	valid values
< 0	value invalid, will use 0 as default
> 15	value invalid, will use 0 as default

Return

`double` Return a number in double rounded to its nearest integer.

Syntax4

```
double round(
    double
)
```

Note

Same as syntax 3. Obtain 0 digit after the decimal point by default.

round(double) => **round**(double, 0)

```
value = round(100)              // 100
value = round(100.456)          // 100
value = round(0.567)            // 1
value = round(-100)             // -100
value = round(-100.456)         // -100
value = round(-0.567)           // -1
value = round(100.345, 1)       // 100.3
value = round(100.345, 2)       // 100.35
value = round(-100.345, 1)      // -100.3
value = round(-100.345, 2)      // -100.35
value = round(-100.345, 16)     // -100
```

3.7 random()

Return a random number in float between 0 and 1 or in integer between the lowerbound and the upperbound.

Syntax1

```
float random(
)
```

Parameter

`void` No input value required.

Return

`float` Return a random number in float between 0 and 1.

Note

```
value = random()        // 0.9473762
value = random()        // 0.7764986
value = random()        // 0.9911129
```

Syntax2

```
int random(
    int
)
```

Parameter

`int` The upperbound of the random number

Return

`int` Return a random number in integer between 0 and the upperbound

Note

```
value = random(10)      // 8
value = random(10)      // 1
value = random(10)      // 5
value = random(-10)     // 0   // The value of the upperbound must be larger than 0.
```

Syntax3

```
int random(
    int,
    int
)
```

Parameter

`int` The lowerbound of the random number

`int` The upperbound of the random number must be larger than the lowerbound, or it will return the value of the lowerbound in integer.

Return

`int` Return a random number in integer between the lowerbound and the upperbound.

Note

```
value = random(5, 10)   // 8
value = random(5, 10)   // 8
value = random(5, 10)   // 6
value = random(5, -1)   // 5   // The upperbound is smaller than the lowerbound. Returned the value of the
                                lowerbound in integer.
```

3.8 d2r()

Convert the value of degrees to radian

Syntax1

```
float d2r(
    float
)
```

Parameter

`float` Input the value of degrees as float

Return

`float` Return the value of radian as float

Syntax2

```
double d2r(
    double
)
```

Parameter

`double` Input the value of degrees as double

Return

`double` Return the value of radian as double

Note

value = **d2r**(1) // 0.01745329

3.9 r2d()

Convert the value of degree to radian to degrees

Syntax1

```
float r2d(
    float
)
```

Parameter

`float` Input the value of radian as float

Return

`float` Return the value of degrees as float

Syntax2

```
double r2d(
    double
)
```

Parameter

`double` Input the value of radian as double

Return

`double` Return the value of degrees as double

Note

value = **r2d**(1) // 57.29578

3.10 sin()

Return the sine of the input value of degrees

Syntax1

```
float sin(
    float
)
```

Parameter

`float` Input the value of degrees as float

Return

`float` Return the sine of the input value of degrees as float

Syntax2

```
double sin(
    double
)
```

Parameter

`double` Input the value of degrees as double

Return

`double` Return the sine of the input value of degrees as double

Note

value = **sin**(0) // 0

value = **sin**(15) // 0.258819

value = **sin**(30) // 0.5

value = **sin**(60) // 0.8660254

value = **sin**(90) // 1

3.11 cos()

Return the cosine of the input value of degrees

Syntax1

```
float cos(
    float
)
```

Parameter

`float` Input the value of degrees as float

Return

`float` Return the cosine of the input value of degrees as float

Syntax2

```
double cos(
    double
)
```

Parameter

`double` Input the value of degrees as double

Return

`double` Return the cosine of the input value of degrees as double

Note

value = **cos**(0) // 1
value = **cos**(15) // 0.9659258
value = **cos**(30) // 0.8660254
value = **cos**(45) // 0.7071068
value = **cos**(60) // 0.5

3.12 tan()

Return the tangent of the input value of degrees

Syntax1

```
float tan(
    float
)
```

Parameter

`float` Input the value of degrees as float

Return

`float` Return the tangent of the input value of degrees as float

Syntax2

```
double tan(
    double
)
```

Parameter

`double` Input the value of degrees as double

Return

`double` Return the tangent of the input value of degrees as double

Note

```
value = tan(0)      // 0
value = tan(15)     // 0.2679492
value = tan(30)     // 0.5773503
value = tan(45)     // 1
value = tan(60)     // 1.732051
```

3.13 asin()

Return the arcsine of the input value as degrees

Syntax1

```
float asin(
    float
)
```

Parameter

`float` Input the sine value as float between -1 and 1

Return

`float` Return the arcsine of the input value of degrees as float

Syntax2

```
double asin(
    double
)
```

Parameter

`double` Input the sine value in double between -1 and 1

Return

`double` Return the arcsine of the input value of degrees as double

Note

```
value = asin(0)          // 0
value = asin(0.258819)   // 15
value = asin(0.5)        // 30
value = asin(0.8660254)  // 60
value = asin(1)          // 90
```

3.14 acos()

Return the arccosine of the input value in degrees

Syntax1

```
float acos(
    float
)
```

Parameter

`float` Input the cosine value in float between -1 and 1

Return

`float` Return the degree value as float

Syntax2

```
double acos(
    double
)
```

Parameter

`double` Input the cosine value in double between -1 and 1

Return

`double` Return the degree value as double

Note

```
value = acos(1)          // 0
value = acos(0.9659258)  // 15
value = acos(0.8660254)  // 30
value = acos(0.7071068)  // 45
value = acos(0.5)        // 60
```

3.15 atan()

Return the arctangent of the input value in degrees

Syntax1

```
float atan(
    float
)
```

Parameter

`float` Input the arctangent value as float

Return

`float` Return the degree value as float

Syntax2

```
double atan(
    double
)
```

Parameter

`double` Input the arctangent value as double

Return

`double` Return the degree value as double

Note

```
value = atan(0)             // 0
value = atan(0.2679492)     // 15
value = atan(0.5773503)     // 30
value = atan(1)             // 45
value = atan(1.732051)      // 60
```

3.16 atan2()

Return the arctangent of the quotient of it arguments

Syntax1

```
float atan2(
    float,
    float
)
```

Parameter

`float` Input a number in float representing the Y coordinate

`float` Input a number in float representing the X coordinate

Return

`float` Return the degree value as float

Syntax2

```
double atan2(
    double,
    double
)
```

Parameter

`double` Input a number in double representing the Y coordinate

`double` Input a number in double representing the X coordinate

Return

`double` Return the degree value as double

Note

```
value = atan2(2, 1)        // 63.43495
value = atan2(1, 1)        // 45
value = atan2(-1, -1)      // -135
value = atan2(4, -3)       // 126.8699
```

3.17 log()

Return the natural logarithm of the input value

Syntax1

```
float log(
    float,
    double
)
```

Parameter

`float` Input value as float

`double` The base of the logarithm

Return

`float` Return the logarithm of the input value and the base as float

Syntax2

```
double log(
    double,
    double
)
```

Parameter

`double` Input value as double

`double` The base of the logarithm

Return

`double` Return the logarithm of the input value and the base as double

Note

```
value = log(16, 2)          // 4
value = log(16, 8)          // 1.333333
value = log(16, 10)         // 1.20412
value = log(16, 16)         // 1
```

Syntax3

```
float log(
    float
)
```

Parameter

`float` Input value as float

Return

`float` Return the natural logarithm of the input value and the base as float

Syntax4

```
double log(
    double
)
```

Parameter

`double` Input value as double

Return

`double` Return the natural logarithm of the input value and the base as double

Note

```
value = log(16, 2)          // 4
value = log(16)             // 2.772589
value = log(2)              // 0.6931472
value = log(16)/log(2)      // 2.772589/ 0.6931472 = 4.000000288539
```

3.18 log10()

Return the logarithm of the input value with the base 10

Syntax1

```
float log10(
```

```
    float
)
```

Parameter

`float` Input value as float

Return

`float` Return the logarithm of the input value with the base 10 as float

Syntax2

```
double log10(
    double
)
```

Parameter

`double` Input value as double

Return

`double` Return the logarithm of the input value with the base 10 as double

Note

```
value = log(16, 10)        // 1.20412
value = log10(16)          // 1.20412
value = log(500, 10)       // 2.69897
value = log10(500)         // 2.69897
```

3.19 norm2()

Return the second norm of a specified vector.

Syntax 1

```
float norm2(
    float[]
)
```

Parameter

`float[]` A vector whose second norm (also called Euclidean norm, vector magnitude) is to be found.

Return

`float` the second norm (also called Euclidean norm, vector magnitude) of a specified vector

Note

$$\|v\| = \sqrt{\sum_{i=1}^{i=N} |v_i|^2}$$

```
float[] vector1 = {3,4}
float[] vector2 = {3,4,5}
float[] vector3 = {3,4,5,6,8}
value = norm2(vector1)          // 5
value = norm2(vector2)          // 7.071068
value = norm2(vector3)          // 12.24745
```

3.20 dist()

Return the distance between the two coordinates.

Syntax 1

```
float dist(
    float[],
    float[]
)
```

Parameter

float[]	The first coordinate $\{X_1 \quad Y_1 \quad Z_1 \quad RX_1 \quad RY_1 \quad RZ_1\}$
float[]	The second coordinate $\{X_2 \quad Y_2 \quad Z_2 \quad RX_2 \quad RY_2 \quad RZ_2\}$

Return

float	The distance between the two coordinates

Note

```
float[] c1 = {100,200,100,30,50,20}
float[] c2 = {100,100,100,50,50,10}
value = dist(c1, c2)          // 100
```

3.21 trans()

Return the displacement and rotation angle from one specified point to another point.

Syntax 1

```
float[] trans(
    float[],
    float[]
)
```

Parameter

float[]	First Point	$\{X_1 \quad Y_1 \quad Z_1 \quad RX_1 \quad RY_1 \quad RZ_1\}$
float[]	Second Point	$\{X_2 \quad Y_2 \quad Z_2 \quad RX_2 \quad RY_2 \quad RZ_2\}$

Return

`float[]` The displacement and rotation angle from first point to second point

$$\{X_{trans} \quad Y_{trans} \quad Z_{trans} \quad RX_{trans} \quad RY_{trans} \quad RZ_{trans}\}$$

Note

Transformation Matrix of first point w.r.t. origin = $\begin{bmatrix} & R_1 & & \begin{matrix} X_1 \\ Y_1 \\ Z_1 \end{matrix} \\ 0 & 0 & 0 & 1 \end{bmatrix}$

$$R_1 = \begin{bmatrix} cos(RZ_1)\,cos(RY_1) & -sin(RZ_1)cos(RX_1) + cos(RZ_1)sin(RY_1)sin(RX_1) & sin(RZ_1)sin(RX_1) + cos(RZ_1)sin(RY_1)cos(RX_1) \\ sin(RZ_1)cos(RY_1) & cos(RZ_1)cos(RX_1) + sin(RZ_1)sin(RY_1)sin(RX_1) & -cos(RZ_1)sin(RX_1) + sin(RZ_1)sin(RY_1)cos(RX_1) \\ -sin(RY_1) & cos(RY_1)sin(RX_1) & cos(RY_1)cos(RX_1) \end{bmatrix}$$

Transformation Matrix of second point w.r.t. origin = $\begin{bmatrix} & R_2 & & \begin{matrix} X_2 \\ Y_2 \\ Z_2 \end{matrix} \\ 0 & 0 & 0 & 1 \end{bmatrix}$

$$R_2 = \begin{bmatrix} cos(RZ_2)\,cos(RY_2) & -sin(RZ_2)cos(RX_2) + cos(RZ_2)sin(RY_2)sin(RX_2) & sin(RZ_2)sin(RX_2) + cos(RZ_2)sin(RY_2)cos(RX_2) \\ sin(RZ_2)cos(RY_2) & cos(RZ_2)cos(RX_2) + sin(RZ_2)sin(RY_2)sin(RX_2) & -cos(RZ_2)sin(RX_2) + sin(RZ_2)sin(RY_2)cos(RX_2) \\ -sin(RY_2) & cos(RY_2)sin(RX_2) & cos(RY_2)cos(RX_2) \end{bmatrix}$$

Calculate X_{trans} Y_{trans} Z_{trans}

Transformation Matrix of second point w.r.t. first point = $\begin{bmatrix} & R_{trans} & & \begin{matrix} X_{trans} \\ Y_{trans} \\ Z_{trans} \end{matrix} \\ 0 & 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} & R_1 & & \begin{matrix} X_1 \\ Y_1 \\ Z_1 \end{matrix} \\ 0 & 0 & 0 & 1 \end{bmatrix}^{-1} \times \begin{bmatrix} & R_2 & & \begin{matrix} X_2 \\ Y_2 \\ Z_2 \end{matrix} \\ 0 & 0 & 0 & 1 \end{bmatrix}$

R_{trans}

$$= \begin{bmatrix} cos(RZ_{trans})\,cos(RY_{trans}) & -sin(RZ_{trans})cos(RX_{trans}) + cos(RZ_{trans})sin(RY_{trans})sin(RX_{trans}) & sin(RZ_{trans})sin(RX_{trans}) + cos(RZ_{trans})sin(RY_{trans})cos(RX_{trans}) \\ sin(RZ_{trans})cos(RY_{trans}) & cos(RZ_{trans})cos(RX_{trans}) + sin(RZ_{trans})sin(RY_{trans})sin(RX_{trans}) & -cos(RZ_{trans})sin(RX_{trans}) + sin(RZ_{trans})sin(RY_{trans})cos(RX_{trans}) \\ -sin(RY_{trans}) & cos(RY_{trans})sin(RX_{trans}) & cos(RY_{trans})cos(RX_{trans}) \end{bmatrix}$$

Calculate RX_{trans} RY_{trans} RZ_{trans}

$$RY_{trans} = atan2\left(-\mathrm{R}_{trans}(2,\ 0)\ ,\ \sqrt{\mathrm{R}_{trans}(0,\ 0)\mathrm{R}_{trans}(0,\ 0) + \mathrm{R}_{trans}(1,\ 0)\mathrm{R}_{trans}(1,\ 0)}\right)$$

$If\ cos(RY_{trans}) \neq 0$

$$RZ_{trans} = atan2((\mathrm{R}_{trans}(1,\ 0)/cos(RY_{trans}))\ ,\ (\mathrm{R}_{trans}(0,\ 0)/cos(RY_{trans})))$$

$$RX_{trans} = atan2((\mathrm{R}_{trans}(2,\ 1)/cos(RY_{trans}))\ ,\ (\mathrm{R}_{trans}(2,\ 2)/cos(RY_{trans})))$$

$If\ cos(RY_{trans}) = 0$

$$RZ_{trans} = 0$$

$$RX_{trans} = sign(RY_{trans}) \cdot atan2(\mathrm{R}_{trans}(0,\ 1)\ ,\ \mathrm{R}_{trans}(1,\ 1))$$

3.22 inversetrans()

Return the displacement and rotation angle {x, y, z, rx, ry, rz} opposite to the specified displacement and rotation angle {x, y, z, rx, ry, rz}.

Syntax 1

```
float[] inversetrans(
    float[]
)
```

Parameter

`float[]` The original displacement and rotation angle $\{X_o \quad Y_o \quad Z_o \quad RX_o \quad RY_o \quad RZ_o\}$

Return

`float[]` The displacement and rotation angle $\{\mathrm{X_{inv}} \quad \mathrm{Y_{inv}} \quad \mathrm{Z_{inv}} \quad \mathrm{RX_{inv}} \quad \mathrm{RY_{inv}} \quad \mathrm{RZ_{inv}}\}$ opposite to the specified displacement and rotation angle $\{\mathrm{X_o} \quad \mathrm{Y_o} \quad \mathrm{Z_o} \quad \mathrm{RX_o} \quad \mathrm{RY_o} \quad \mathrm{RZ_o}\}$

Note

Original Transformation Matrix = $\begin{bmatrix} & R_o & & \begin{matrix} X_o \\ Y_o \\ Z_o \end{matrix} \\ 0 & 0 & 0 & 1 \end{bmatrix}$

$$R_o = \begin{bmatrix} cos(RZ_o)\,cos(RY_o) & -sin(RZ_o)cos(RX_o) + cos(RZ_o)sin(RY_o)sin(RX_o) & sin(RZ_o)sin(RX_o) + cos(RZ_o)sin(RY_o)cos(RX_o) \\ sin(RZ_o)cos(RY_o) & cos(RZ_o)cos(RX_o) + sin(RZ_o)sin(RY_o)sin(RX_o) & -cos(RZ_o)sin(RX_o) + sin(RZ_o)sin(RY_o)cos(RX_o) \\ -sin(RY_o) & cos(RY_o)sin(RX_o) & cos(RY_o)cos(RX_o) \end{bmatrix}$$

Calculate X_{inv} Y_{inv} Z_{inv}

Inverse Transformation Matrix = T_{inv} = $\begin{bmatrix} & R_{inv} & & \begin{matrix} X_{inv} \\ Y_{inv} \\ Z_{inv} \end{matrix} \\ 0 & 0 & 0 & 1 \end{bmatrix}$ = $\begin{bmatrix} & R_o & & \begin{matrix} X_o \\ Y_o \\ Z_o \end{matrix} \\ 0 & 0 & 0 & 1 \end{bmatrix}^{-1}$

Calculate RX_{inv} RY_{inv} RZ_{inv}

$$RY_{inv} = atan2\left(-\mathrm{R}_{inv}(2,\ 0)\ ,\ \sqrt{\mathrm{R}_{inv}(0,\ 0)\mathrm{R}_{inv}(0,\ 0) + \mathrm{R}_{inv}(1,\ 0)\mathrm{R}_{inv}(1,\ 0)}\right)$$

If $cos(RY_{inv}) \neq 0$

$$RZ_{inv} = atan2((\mathrm{R}_{inv}(1,\ 0)/cos(RY_{inv}))\ ,\ (\mathrm{R}_{inv}(0,\ 0)/cos(RY_{inv})))$$

$$RX_{inv} = atan2((\mathrm{R}_{inv}(2,\ 1)/cos(RY_{inv}))\ ,\ (\mathrm{R}_{inv}(2,\ 2)/cos(RY_{inv})))$$

If $cos(RY_{inv}) = 0$

$$RZ_{inv} = 0$$

$$RX_{inv} = sign(RY_{inv}) \cdot atan2(\mathrm{R}_{inv}(0,\ 1)\ ,\ \mathrm{R}_{inv}(1,\ 1))$$

3.23 applytrans()

Return the terminal point computed by applying the displacement and rotation angle to the specified point.

Syntax 1

```
float[] applytrans(
    float[],
    float[]
```

)

Parameter

`float[]` Initial point $\{X_i \quad Y_i \quad Z_i \quad RX_i \quad RY_i \quad RZ_i\}$

`float[]` the displacement and rotation angle $\{X_o \quad Y_o \quad Z_o \quad RX_o \quad RY_o \quad RZ_o\}$

Return

`float[]` the terminal point $\{X_t \quad Y_t \quad Z_t \quad RX_t \quad RY_t \quad RZ_t\}$ computed by applying the displacement and rotation angle to the initial point

Note

Original Transformation Matrix = $\begin{bmatrix} & R_o & & \begin{matrix} X_o \\ Y_o \\ Z_o \end{matrix} \\ 0 & 0 & 0 & 1 \end{bmatrix}$

$$R_o = \begin{bmatrix} cos(RZ_o)\,cos(RY_o) & -sin(RZ_o)cos(RX_o) + cos(RZ_o)sin(RY_o)sin(RX_o) & sin(RZ_o)sin(RX_o) + cos(RZ_o)sin(RY_o)cos(RX_o) \\ sin(RZ_o)cos(RY_o) & cos(RZ_o)cos(RX_o) + sin(RZ_o)sin(RY_o)sin(RX_o) & -cos(RZ_o)sin(RX_o) + sin(RZ_o)sin(RY_o)cos(RX_o) \\ -sin(RY_o) & cos(RY_o)sin(RX_o) & cos(RY_o)cos(RX_o) \end{bmatrix}$$

Transformation Matrix of initial point related to origin = $\begin{bmatrix} & R_i & & \begin{matrix} X_i \\ Y_i \\ Z_i \end{matrix} \\ 0 & 0 & 0 & 1 \end{bmatrix}$

$$R_i = \begin{bmatrix} cos(RZ_i)\,cos(RY_i) & -sin(RZ_i)cos(RX_i) + cos(RZ_i)sin(RY_i)sin(RX_i) & sin(RZ_i)sin(RX_i) + cos(RZ_i)sin(RY_i)cos(RX_i) \\ sin(RZ_i)cos(RY_i) & cos(RZ_i)cos(RX_i) + sin(RZ_i)sin(RY_i)sin(RX_i) & -cos(RZ_i)sin(RX_i) + sin(RZ_i)sin(RY_i)cos(RX_i) \\ -sin(RY_i) & cos(RY_i)sin(RX_i) & cos(RY_i)cos(RX_i) \end{bmatrix}$$

Calculate $X_t \;\; Y_t \;\; Z_t$

Transformation Matrix of terminal point related to origin = $\begin{bmatrix} & R_t & & \begin{matrix} X_t \\ Y_t \\ Z_t \end{matrix} \\ 0 & 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} & R_i & & \begin{matrix} X_i \\ Y_i \\ Z_i \end{matrix} \\ 0 & 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} & R_o & & \begin{matrix} X_o \\ Y_o \\ Z_o \end{matrix} \\ 0 & 0 & 0 & 1 \end{bmatrix}$

$$R_t = \begin{bmatrix} cos(RZ_t)\,cos(RY_t) & -sin(RZ_t)cos(RX_t) + cos(RZ_t)sin(RY_t)sin(RX_t) & sin(RZ_t)sin(RX_t) + cos(RZ_t)sin(RY_t)cos(RX_t) \\ sin(RZ_t)cos(RY_t) & cos(RZ_t)cos(RX_t) + sin(RZ_t)sin(RY_t)sin(RX_t) & -cos(RZ_t)sin(RX_t) + sin(RZ_t)sin(RY_t)cos(RX_t) \\ -sin(RY_t) & cos(RY_t)sin(RX_t) & cos(RY_t)cos(RX_t) \end{bmatrix}$$

Calculate $RX_t \;\; RY_t \;\; RZ_t$

$$RY_t = atan2\left(-\mathrm{R}_t(2,\,0)\;,\;\; \sqrt{\mathrm{R}_t(0,\,0)\mathrm{R}_t(0,\,0) + \mathrm{R}_t(1,\,0)\mathrm{R}_t(1,\,0)}\right)$$

If $cos(RY_t) \neq 0$

$$RZ_t = atan2((\mathrm{R}_t(1,\,0)/cos(RY_t))\;,\;\; (\mathrm{R}_t(0,\,0)/cos(RY_t)))$$

$$RX_t = atan2((\mathrm{R}_t(2,\,1)/cos(RY_t))\;,\;\; (\mathrm{R}_t(2,\,2)/cos(RY_t)))$$

If $cos(RY_t) = 0$

$$RZ_t = 0$$

$$RX_t = sign(RY_t) \cdot atan2(\mathrm{R}_t(0,\,1)\;,\;\; \mathrm{R}_t(1,\,1))$$

3.24 interpoint()

Return the interpolate point between two points according to the specified points and ratio

Syntax 1

```
float[] interpoint(
    float[],
    float[],
    float
)
```

Parameter

`float[]`	First Point $\{X_1 \quad Y_1 \quad Z_1 \quad RX_1 \quad RY_1 \quad RZ_1\}$
`float[]`	Second Point $\{X_2 \quad Y_2 \quad Z_2 \quad RX_2 \quad RY_2 \quad RZ_2\}$
`float`	Ratio

Return

`float[]`	the linear interpolate point $\{X_i \quad Y_i \quad Z_i \quad RX_i \quad RY_i \quad RZ_i\}$ between initial point and endpoint according to the ratio

Note

$$\{X_i \quad Y_i \quad Z_i \quad RX_i \quad RY_i \quad RZ_i\}$$
$$= (\{X_2 \quad Y_2 \quad Z_2 \quad RX_2 \quad RY_2 \quad RZ_2\} - \{X_1 \quad Y_1 \quad Z_1 \quad RX_1 \quad RY_1 \quad RZ_1\}) \times Ratio$$
$$+ \{X_1 \quad Y_1 \quad Z_1 \quad RX_1 \quad RY_1 \quad RZ_1\}$$

3.25 changeref()

Return the new coordinate value described with the new coordinate system converted from the original coordinate value through the coordinate system conversion. In the process of the conversion, the physical position of the original point in the world of the coordinates will remain the same. The change takes effects on its descriptions of the reference coordinates and the corresponding coordinate values.

Syntax 1

```
float[] changeref(
    float[],
    float[],
    float[]
)
```

Parameter

`float[]` The coordinate value of the original point $\{X_o \quad Y_o \quad Z_o \quad RX_o \quad RY_o \quad RZ_o\}_A$

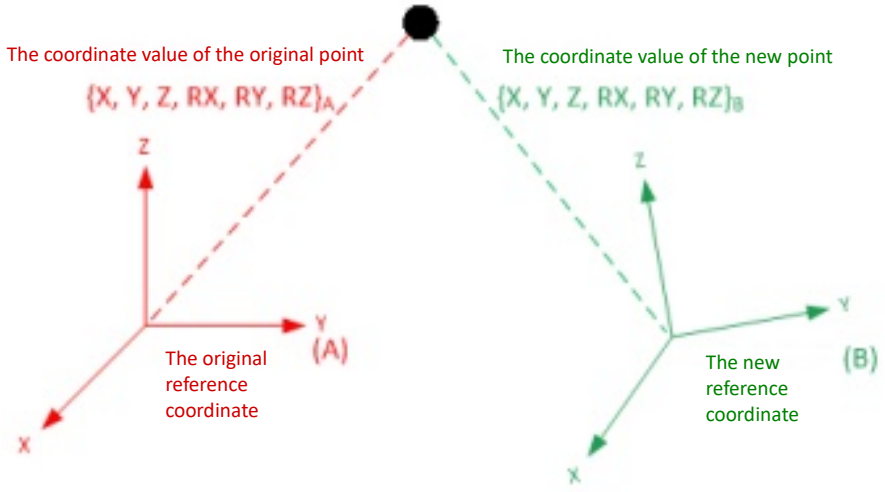
`float[]` The orignial reference coordinate system $\{X_{oa} \quad Y_{oa} \quad Z_{oa} \quad RX_{oa} \quad RY_{oa} \quad RZ_{oa}\}_A$

`float[]` The new reference coordinate system $\{X_n \quad Y_n \quad Z_n \quad RX_n \quad RY_n \quad RZ_n\}_B$

Return

`float[]` The coordinate value of the new point $\{X_{nb} \quad Y_{nb} \quad Z_{nb} \quad RX_{nb} \quad RY_{nb} \quad RZ_{nb}\}_B$

Note



P1 = {-431.927, -140.6103, 368.7306, -179.288, -0.6893783, -105.8449}

RobotBase = {0, 0, 0, 0, 0, 0}

base1 = {-431.93, -140.61, 368.73, -57.70, -44.98, 33.62}

float[] f0 = changeref(Point["P1"].Value, Base["RobotBase"].Value, Base["base1"].Value)

// f0 = {0.002052, 0.000020, -0.002272, 113.9423, 14.9346, -123.1989}

// Convert the value of "P1" in the coordinate system "RobotBase" to the value of a point in the coordinate system "base1"

Syntax 2

```
float[] changeref(
    float[],
    float[]
)
```

Parameter

`float[]` The coordinate value of the original point $\{X_o \quad Y_o \quad Z_o \quad RX_o \quad RY_o \quad RZ_o\}_A$

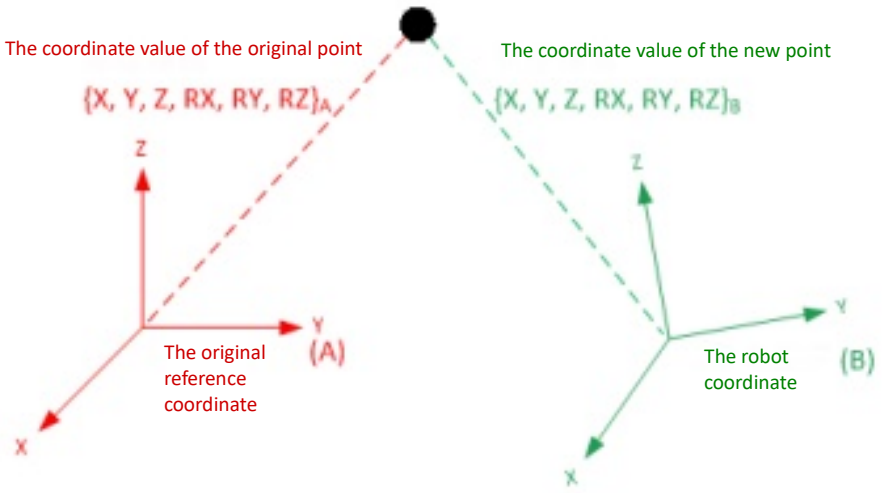
`float[]` The original reference coordinate system $\{X_{oa} \quad Y_{oa} \quad Z_{oa} \quad RX_{oa} \quad RY_{oa} \quad RZ_{oa}\}_A$

Return

`float[]` The coordinate value of the new point $\{X_{nr} \quad Y_{nr} \quad Z_{nr} \quad RX_{nr} \quad RY_{nr} \quad RZ_{nr}\}_R$

Note

The usage is the same as Syntax1's except assuming the robot coordinate system $\{0 \quad 0 \quad 0 \quad 0 \quad 0 \quad 0\}_R$ as the default new reference coordinate system.



base1 = {-431.93, -140.61, 368.73, -57.70, -44.98, 33.62}

f0 = {0.002052, 0.000020, -0.002272, 113.9423, 14.9346, -123.1989}

float[] f1 = changeref(f, Base["base1"].Value)

// f1 = {-431.927, -140.6103, 368.7306, -179.288, -0.6893424, -105.8449}

4. Modbus Functions

4.1 modbus_read()

Modbus TCP/RTU read function

Syntax 1 (TCP/RTU)

```
? modbus_read(
    string,
    string
)
```

Parameters

`string` TCP/RTU device name (Set in Modbus Device setting)

`string` The predefined parameters belong to TCP/RTU device (Set in Modbus Device setting)

Return

`?` The return data type is decided by the predefined parameters

Signal Type	Function Code	Type	Num Of Addr	Return data type
Digital Output	01	byte	1	byte (H: 1)(L: 0)
		bool	1	bool (H: true)(L: false)
Digital Input	02	byte	1	byte (H: 1)(L: 0)
		bool	1	bool (H: true)(L: false)
Register Output	03	byte	1	byte
		int16	1	int
		int32	2	int
		float	2	float
		double	4	double
		string	?	string
		bool	1	bool
Register Input	04	byte	1	byte
		int16	1	int
		int32	2	int
		float	2	float
		double	4	double
		string	?	string
		bool	1	bool

* According to the Little Endian (CD AB) or Big Endian (AB CD) setting, the int32, float, double data

will transformed automatically.

* string will follow the UTF8 data format transformation (Stop at 0x00)

Note

Modbus Address data size

Digital	1 address = 1 bit size
Register	1 address = 2 bytes size

If the default values are applied in Preset Setting

preset_800	DO	800	byte	
preset_7202	DI	7202	bool	
preset_9000	RO	9000	string	4
preset_7001	RI	7001	float	Big-Endian (AB CD)

```
value = modbus_read("TCP_1", "preset_800")   // value = 1              // DO 1 address = 1 bit
value = modbus_read("TCP_1", "preset_7202")  // value = true           // DI 1 address = 1 bit
value = modbus_read("TCP_1", "preset_9000")  // value = ab1234cd       // RO 4 address = 8 bytes size
value = modbus_read("TCP_1", "preset_7001")  // value = -314.1593      // RI 2 address = 4 bytes size (float)
```

Syntax 2 (TCP/RTU)

```
byte[] modbus_read(
    string,
    byte,
    string,
    int,
    int
)
```

Parameters

string	TCP/RTU Device Name (Set in Modbus Device setting)		
byte	Slave ID		
string	Read type		
	DO	Digital Output	(Function Code : 01)
	DI	Digital Input	(Function Code : 02)
	RO	Register Output	(Function Code : 03)
	RI	Register Input	(Function Code : 04)
int	Starting address		

`int` Data length

Return

`byte[]` The returned byte array from modbus server

*User defined modbus_read only follows Big-Endian (AB CD) format to read byte[]

Note

Modbus Address data size

Digital	1 address = 1 bit size
Register	1 address = 2 bytes size

If the user defined values are applied to User Setting as

TCP device	0	DO	800	4
TCP device	0	DI	7202	3
TCP device	0	RO	9000	6
TCP device	0	RI	7001	12
TCP device	0	RI	7301	6

value = **modbus_read**("TCP_1", 0, "DO", 800, 4)

// value = {0,0,0,0} // DO 4 address = 4 bit to byte array

value = **modbus_read**("TCP_1", 0, "DI", 7202, 3)

// value = {1,0,0} // DI 3 address = 3 bit to byte array

value = **modbus_read**("TCP_1", 0, "RO", 9000, 6)

// value = {0x54,0x65,0x63,0x68,0x6D,0x61,0x6E,0xE9,0x81,0x94,0xE6,0x98} // RO 6 address = 12 bytes size

value = **modbus_read**("TCP_1", 0, "RI", 7001, 12)

// value = {0x29,0x30,0x9F,0x4C,0xC3,0x7C,0x99,0x9A,0x44,0x5E,0xEC,0xCD,0x42,0xB4,0x00,0x00,
0x80,0x00,0x00,0x00,0x00,0x00,0x00,0x00} // RI 12 address = 24 bytes size

value = **modbus_read**("TCP_1", 0, "RI", 7301, 6)

// value = {0x07,0xE2,0x00,0x05,0x00,0x12,0x00,0x0F,0x00,0x0A,0x00,0x39} // RI 6 address = 12 bytes size

4.2 modbus_read_int16()

Modbus TCP/RTU read function, and transform modbus address data array to int16 array

Syntax 1 (TCP/RTU)

```
int[] modbus_read_int16(
    string,
    byte,
    string,
    int,
    int,
    int
)
```

Parameters

`string`	TCP/RTU Device Name (Set in Modbus Device setting)		
`byte`	Slave ID		
`string`	Read type		
	`DO`	Digital Output	(Function Code : 01)
	`DI`	Digital Input	(Function Code : 02)
	`RO`	Register Output	(Function Code : 03)
	`RI`	Register Input	(Function Code : 04)
`int`	Starting address		
`int`	Data length		
`int`	Follows Little Endian (CD AB) or Big Endian (AB CD) to transform the address data to int16 array.		
	*Invalid Parameter. Only support int32, float, double		
	`0`	Little Endian	
	`1`	Big Endian (Default)	

Return

`int[]`	The returned int array from modbus server

Syntax 2 (TCP/RTU)

```
int[] modbus_read_int16(
    string,
    byte,
    string,
    int,
    int
)
```

Note

Similar to Syntax1 with Big Endian (AB CD) setting

modbus_read_int16(“TCP_1”, 0, “DI”, 7200, 2) => **modbus_read_int16**(“TCP_1”, 0, “DI”, 7200, 2, 1)

Modbus Address data size

Digital	1 address = 1 bit size
Register	1 address = 2 bytes size

If the user defined values are applied to User Setting as

TCP device	0	DO	800	4
TCP device	0	DI	7202	3
TCP device	0	RO	9000	6
TCP device	0	RI	7001	12
TCP device	0	RI	7301	6

value = **modbus_read_int16**(“TCP_1”, 0, “DO”, 800, 4)

// byte[] = {0,0,0,0} to int16[] value = {0,0} // byte[0][1] , byte[2][3]

value = **modbus_read_int16**(“TCP_1”, 0, “DI”, 7202, 3)

// byte[] = {1,0,0} to int16[] value = {256,0} // byte[0][1] , byte[2][3] // Fill up to [3] automatically

value = **modbus_read_int16**(“TCP_1”, 0, “RO”, 9000, 6)

// byte[] = {0x54,0x65,0x63,0x68,0x6D,0x61,0x6E,0xE9,0x81,0x94,0xE6,0x98}

// to int16[] value = {21605,25448,28001,28393,-32364,-6504}

value = **modbus_read_int16**(“TCP_1”, 0, “RI”, 7001, 12)

// byte[] = {0x29,0x30,0x9F,0x4C,0xC3,0x7C,0x99,0x9A,0x44,0x5E,0xEC,0xCD,0x42,0xB4,0x00,0x00,

0x80,0x00,0x00,0x00,0x00,0x00,0x00,0x00}

// to int16[] value = {10544,-24756,-15492,-26214,17502,-4915,17076,0,-32768,0,0,0}

value = **modbus_read_int16**(“TCP_1”, 0, “RI”, 7301, 6)

// byte[] = {0x07,0xE2,0x00,0x05,0x00,0x12,0x00,0x0F,0x00,0x31,0x00,0x23}

// to int16[] value = {2018,5,18,15,49,35}

value = **modbus_read_int16**(“TCP_1”, 0, “RI”, 7301, 6, 0)

// byte[] = {0x07,0xE2,0x00,0x05,0x00,0x12,0x00,0x0F,0x00,0x31,0x00,0x23}

// to int16[] value = {2018,5,18,15,49,35}

4.3 modbus_read_int32()

Modbus TCP/RTU read function, and transform modbus address data array to int32 array

Syntax 1 (TCP/RTU)

```
int[] modbus_read_int32(
    string,
    byte,
    string,
    int,
    int,
    int
)
```

Parameters

`string`	TCP/RTU DEVICE NAME (Set in Modbus Device setting)		
`byte`	Slave ID		
`string`	Read type		
	`DO`	Digital Output	(Function Code : 01)
	`DI`	Digital Input	(Function Code : 02)
	`RO`	Register Output	(Function Code : 03)
	`RI`	Register Input	(Function Code : 04)
`int`	Starting address		
`int`	Data length		
`int`	Follows Little Endian (CD AB) or Big Endian (AB CD) to transform the address data to int32 array.		
	`0`	Little Endian	
	`1`	Big Endian (Default)	

Return

`int[]`	The returned int array from modbus server

Syntax 2 (TCP/RTU)

```
int[] modbus_read_int32(
    string,
    byte,
    string,
    int,
    int
)
```

Note

Similar to Syntax1 with Big Endian (AB CD) setting.

modbus_read_int32(“TCP_1”, 0, “DI”, 7200, 2) => **modbus_read_int32**(“TCP_1”, 0, “DI”, 7200, 2, 1)

Modbus Address data size

Digital	1 address = 1 bit size
Register	1 address = 2 bytes size

If the user defined values are applied to User Setting as

TCP device	0	DO	800	4
TCP device	0	DI	7202	3
TCP device	0	RO	9000	6
TCP device	0	RI	7001	12
TCP device	0	RI	7301	6

value = **modbus_read_int32**(“TCP_1”, 0, “DO”, 800, 4)

// byte[] = {0,0,0,0} to int32[] value = {0} // byte[0][1][2][3]

value = **modbus_read_int32**(“TCP_1”, 0, “DI”, 7202, 3)

// byte[] = {1,0,0} to int32[] value = {16777216} // byte[0][1][2][3] // Fill up to [3] automatically.

value = **modbus_read_int32**(“TCP_1”, 0, “RO”, 9000, 6)

// byte[] = {0x54,0x65,0x63,0x68,0x6D,0x61,0x6E,0xE9,0x81,0x94,0xE6,0x98}

// to int32[] value = {1415930728,1835101929,-2120948072}

value = **modbus_read_int32**(“TCP_1”, 0, “RI”, 7001, 12)

// byte[] = {0x29,0x30,0x9F,0x4C,0xC3,0x7C,0x99,0x9A,0x44,0x5E,0xEC,0xCD,0x42,0xB4,0x00,0x00,
0x80,0x00,0x00,0x00,0x00,0x00,0x00,0x00}

// to int32[] value = {691052364,-1015244390,1147071693,1119092736,-2147483648,0}

value = **modbus_read_int32**(“TCP_1”, 0, “RI”, 7301, 6)

// byte[] = {0x07,0xE2,0x00,0x05,0x00,0x12,0x00,0x0F,0x00,0x31,0x00,0x23}

// to int32[] value = {132251653,1179663,3211299}

value = **modbus_read_int32**(“TCP_1”, 0, “RI”, 7301, 6, 0) // byte[2][3][0][1]

// byte[] = {0x07,0xE2,0x00,0x05,0x00,0x12,0x00,0x0F,0x00,0x31,0x00,0x23}

// to int32[] value ={0x000507E2,0x000F0012,0x00230031} = {329698,983058,2293809}

4.4 modbus_read_float()

Modbus TCP/RTU read function, and transform modbus address data array to float array

Syntax 1 (TCP/RTU)

```
float[] modbus_read_float(
    string,
    byte,
    string,
    int,
    int,
    int
)
```

Parameters

`string`	TCP/RTU DEVICE NAME (Set in Modbus Device setting)		
`byte`	Slave ID		
`string`	Read type		
	`DO`	Digital Output	(Function Code : 01)
	`DI`	Digital Input	(Function Code : 02)
	`RO`	Register Output	(Function Code : 03)
	`RI`	Register Input	(Function Code : 04)
`int`	Starting address		
`int`	Data length		
`int`	Follows Little Endian (CD AB) or Big Endian (AB CD) to transform the address data to float array.		
	`0`	Little Endian	
	`1`	Big Endian (Default)	

Return

`float[]`	The returned float array from modbus server

Syntax 2 (TCP/RTU)

```
float[] modbus_read_float(
    string,
    byte,
    string,
    int,
    int
)
```

Note

Similar to Syntax1 with Big Endian (AB CD) setting.

modbus_read_float(“TCP_1”, 0, “DI”, 7200, 2) => **modbus_read_float**(“TCP_1”, 0, “DI”, 7200, 2, 1)

Modbus Address data size

Digital	1 address = 1 bit size
Register	1 address = 2 bytes size

If the user defined values are applied to User Setting as

TCP device	0	DO	800	4
TCP device	0	DI	7202	3
TCP device	0	RO	9000	6
TCP device	0	RI	7001	12
TCP device	0	RI	7301	6

value = **modbus_read_float**("TCP_1", 0, "DO", 800, 4)

// byte[] = {0,0,0,0} to float[] value = {0} // byte[0][1][2][3]

value = **modbus_read_float**("TCP_1", 0, "DI", 7202, 3)

// byte[] = {1,0,0} to float[] value = {2.350989E-38} // byte[0][1][2][3] // Fill up to [3] automatically.

value = **modbus_read_float**("TCP_1", 0, "RO", 9000, 6)

// byte[] = {0x54,0x65,0x63,0x68,0x6D,0x61,0x6E,0xE9,0x81,0x94,0xE6,0x98}

// to float[] value = {3.940861E+12,4.360513E+27,-5.46975E-38}

value = **modbus_read_float**("TCP_1", 0, "RI", 7001, 12)

// byte[] = {0x29,0x30,0x9F,0x4C,0xC3,0x7C,0x99,0x9A,0x44,0x5E,0xEC,0xCD,0x42,0xB4,0x00,0x00,
0x80,0x00,0x00,0x00,0x00,0x00,0x00,0x00}

// to float[] value = {3.921802E-14,-252.6,891.7,90,0,0}

value = **modbus_read_float**("TCP_1", 0, "RI", 7001, 12, 0) // byte[2][3][0][1]

// to float[] value = {0x9F4C2930,0x999AC37C,0xECCD445E,0x000042B4,0x00008000,0x00000000}
= {-4.323275E-20,-1.600218E-23,-1.985221E+27,2.392857E-41,4.591775E-41,0}

value = **modbus_read_float**("TCP_1", 0, "RI", 7301, 6)

// byte[] = {0x07,0xE2,0x00,0x05,0x00,0x12,0x00,0x0F,0x00,0x3A,0x00,0x26}

// to float[] value = {3.400471E-34,1.65306E-39,5.326512E-39}

4.5 modbus_read_double()

Modbus TCP/RTU read function, and transform modbus address data array to double array

Syntax 1 (TCP/RTU)

```
double[] modbus_read_double(
    string,
    byte,
    string,
    int,
    int,
    int
)
```

Parameters

`string`	TCP/RTU DEVICE NAME (Set in Modbus Device setting)		
`byte`	Slave ID		
`string`	Read type		
	`DO`	Digital Output	(Function Code : 01)
	`DI`	Digital Input	(Function Code : 02)
	`RO`	Register Output	(Function Code : 03)
	`RI`	Register Input	(Function Code : 04)
`int`	Starting address		
`int`	Data length		
`int`	Follows Little Endian (CD AB) or Big Endian (AB CD) to transform the address data to double array.		
	`0`	Little Endian	
	`1`	Big Endian (Default)	

Return

`double[]`	The returned double array from modbus server

Syntax 2 (TCP/RTU)

```
double[] modbus_read_double(
    string,
    byte,
    string,
    int,
    int
)
```

Note

Similar to Syntax1 with Big Endian (AB CD) setting.

modbus_read_double(“TCP_1”, 0, “DI”, 7200, 2) => **modbus_read_double**(“TCP_1”, 0, “DI”, 7200, 2,

1)

Modbus Address data size

Digital	1 address = 1 bit size
Register	1 address = 2 bytes size

If the user defined values are applied to User Setting as

TCP device	0	DO	800	4
TCP device	0	DI	7202	3
TCP device	0	RO	9000	6
TCP device	0	RI	7001	12
TCP device	0	RI	7301	6

value = **modbus_read_double**("TCP_1", 0, "DO", 800, 4)

// byte[] = {0,0,0,0} to double[] value = {0} // byte[0][1][2][3][4][5][6][7]

value = **modbus_read_double**("TCP_1", 0, "DI", 7202, 3)

// byte[] = {1,0,0} to double[] value = {7.2911220195564E-304} // byte[0][1][2][3][4][5][6][7]

value = **modbus_read_double**("TCP_1", 0, "RO", 9000, 6)

// byte[] = {0x54,0x65,0x63,0x68,0x6D,0x61,0x6E,0xE9,0x81,0x94,0xE6,0x98}

// to double[] value = {3.65481260356117E+98,-4.87647898854073E-301}

value = **modbus_read_double**("TCP_1", 0, "RI", 7001, 12)

// byte[] = {0x29,0x30,0x9F,0x4C,0xC3,0x7C,0x99,0x9A,0x44,0x5E,0xEC,0xCD,0x42,0xB4,0x00,0x00,

0x80,0x00,0x00,0x00,0x00,0x00,0x00,0x00}

// to double[] value = {2.76472410615396E-110,2.2818627604613E+21,0}

value = **modbus_read_double**("TCP_1", 0, "RI", 7001, 12, 0) // byte[6][7][4][5][2][3][0][1]

// to double[] value = {0x999AC37C9F4C2930,0x000042B4ECCD445E,0x0000000000008000}

= {-2.4604103205376E-185,3.62371629877526E-310,1.6189543082926E-319}

value = **modbus_read_double**("TCP_1", 0, "RI", 7301, 6)

// byte[] = {0x07,0xE2,0x00,0x05,0x00,0x12,0x00,0x10,0x00,0x0B,0x00,0x29}

// to double[] value = {1.06475148078395E-270,1.52982527955113E-308}

4.6 modbus_read_string()

Modbus TCP/RTU read function, and transform modbus address data array to string text by UTF8

Syntax 1 (TCP/RTU)

```
string modbus_read_string(
    string,
    byte,
    string,
    int,
    int,
    int
)
```

Parameters

`string`	TCP/RTU DEVICE NAME (Set in Modbus Device setting)		
`byte`	Slave ID		
`string`	Read type		
	`DO`	Digital Output	(Function Code : 01)
	`DI`	Digital Input	(Function Code : 02)
	`RO`	Register Output	(Function Code : 03)
	`RI`	Register Input	(Function Code : 04)
`int`	Starting address		
`int`	Data length		
`int`	Follows Little Endian (CD AB) or Big Endian (AB CD) to transform the address data to string. *Invalid Parameter. Only support int32, float, double. String follows UTF8 and is sequentially transferred according to address.		
	`0`	Little Endian	
	`1`	Big Endian (Default)	

Return

`string`	The returned UTF8 string from modbus server (Stop at 0x00)

Syntax 2 (TCP/RTU)

```
string modbus_read_string(
    string,
    byte,
    string,
    int,
    int
```

)

Note

Similar to Syntax1 with Big Endian (AB CD) setting.

modbus_read_string(“TCP_1”, 0, “RO”, 9000, 2) => **modbus_read_string**(“TCP_1”, 0, “RO”, 9000, 2, 1)

Modbus Address data size

Digital	1 address = 1 bit size
Register	1 address = 2 bytes size

If the user defined values are applied to User Setting as

TCP device	0	RO	9000	12

modbus_write(“TCP_1”, 0, “RO”, 9000) = “1234 達明机器手臂”

```
// Undefined number of address to write, the default value 0 means write the whole data
// Write byte[] = {0x31,0x32,0x33,0x34,0xE9,0x81,0x94,0xE6,0x98,0x8E,
                   0xE6,0x9C,0xBA,0xE5,0x99,0xA8,0xE6,0x89,0x8B,0xE8,0x87,0x82}
```

value = **modbus_read_string**(“TCP_1”, 0, “RO”, 9000, 3)

```
// byte[] = {0x31,0x32,0x33,0x34,0xE9,0x81}    // RO 3 address = 6 bytes size
// to string = 1234
```

value = **modbus_read_string**(“TCP_1”, 0, “RO”, 9000, 6)

```
// byte[] = {0x31,0x32,0x33,0x34,0xE9,0x81,0x94,0xE6,0x98,0x8E,0xE6,0x9C}
// to string = 1234 達明
```

value = **modbus_read_string**(“TCP_1”, 0, “RO”, 9000, 12)

```
// byte[] = {0x31,0x32,0x33,0x34,0xE9,0x81,0x94,0xE6,0x98,0x8E,
             0xE6,0x9C,0xBA,0xE5,0x99,0xA8,0xE6,0x89,0x8B,0xE8,0x87,0x82, 0x41,0x42}
// to string = 1234 達明机器手臂 AB    // UTF8 format transformation
// The ending, 0x00, will not be included when writing data. When reading 12 addresses, the data out
of the range set in first step will be captured
```

modbus_write(“TCP_1”, 0, “RO”, 9000) = “1234”+Ctrl(“\0”)

```
// Write byte[] = {0x31,0x32,0x33,0x34,0x00}    // Needs to write 3 Register address
```

value = **modbus_read_string**(“TCP_1”, 0, “RO”, 9000, 5)

```
// byte[] = {0x31,0x32,0x33,0x34,0x00,0x00, 0x94,0xE6,0x98,0x8E}      // The last 4 values are the orginal
```

```
data at those addresses
// to string = 1234        // UTF8 format transformation stops at 0x00
```

4.7 modbus_write()

Modbus TCP/RTU write function

Syntax 1 (TCP/RTU)

```
bool modbus_write(
    string,
    string,
    ?,
    int
)
```

Parameters

`string` TCP/RTU Device Name (Set in Modbus Device setting)

`string` TCP/RTU The predefined parameters belong to TCP/RTU device (Set in Modbus Device setting)

`?` The input data. The predefined parameters will be applied according to the table below.

Signal Type	Function Code	Type	Input ? type	Input value
Digital Output	05	byte	byte	(H: 1)(L: 0)
		bool	bool	(H: true)(L: false)
Register Output	06	byte	byte	
		bool	bool	
		int16	int	
Register Output	16	int32	int	
		float	float	
		double	double	
		string	string	

* int32, float, double will be transferred with Little Endian (CD AB) or Big Endian (AB CD) according to user's setting.

* string will be transferred with UTF8 format

* Writing array value is not supported with predefined parameters. To write with the array value, user defined method should be applied (Syntax 3/4)

`int` The maximum number of addresses to be write, only effective to string type data

`> 0` Valid address length. Write with defined address length

`<= 0` Invalid address length. Write all the data

When this parameter is skipped (As shown in Syntax2), the predefined address length will be applied.

Return

bool	True	Write success	
	False	Write failed	1. If the input data ? is empty string or array 2. If an error occurred in Modbus communication

Syntax 2 (TCP/RTU)

```
bool modbus_write(
    string,
    string,
    ?,
)
```

Note

Similar to Syntax1 with predefined address length to write. If the predefined address length <= 0, it will write all the data.

Modbus Address data size

Digital	1 address = 1 bit size
Register	1 address = 2 bytes size

If the user defined values are applied to User Setting as as

preset_800	DO	800	bool	
preset_9000	RO	9000	string	4

modbus_write(“TCP_1”, “preset_800”, 1) // write 1 (true)

modbus_write(“TCP_1”, “preset_800”, 0) // write 0 (false)

bool flag = true

modbus_write(“TCP_1”, “preset_800”, flag) // write 1 (true)

modbus_write(“TCP_1”, “preset_800”, false) // write 0 (false)

string ss = “ABCDEFGHIJKLMNOPQRST” // With no number of address, the predefined address length, 4, is applied. That is 4 RO = 8 bytes size can be wrote.

modbus_write(“TCP_1”, “preset_9000”, ss) // write ABCDEFGH // The exceeding part will be skipped

// With no number of address, the predefined address length,

4, is applied. That is 4 RO = 8 bytes size can be wrote.

```
modbus_write("TCP_1", "preset_9000", "1234567")      // write 1234567\0    // Use 0x00 to fill up 4 address
                                                     // With address length = 0, write all the data. "09AB123" nees 4 addresses.
modbus_write("TCP_1", "preset_9000", "09AB123", 0)   // write 09AB123\0    // Use 0x00 to fill up 4 address
                                                     // With address length = 5, write data in 5 addresses. That is 5 RO = 10 bytes size can be wrote.
modbus_write("TCP_1", "preset_9000", "09AB1234", 5)  // write 09AB1234     // The input data needs only 4 addresses.
```

Syntax 3 (TCP/RTU)

```
bool modbus_write(
    string,
    byte,
    string,
    int,
    ?,
    int
)
```

Parameters

`string` TCP/RTU DEVICE NAME (Set in Modbus Device setting)

`byte` Slave ID

`string` Write type

DO	Digital Output	(Function Code : 05/15)
RO	Register Output	(Function Code : 06/16)

`int` Starting address

`?` Input data

Signal Type	Function Code	Input ? type	Input value
Digital Output	05	byte	(H: 1)(L: 0)
		bool	(H: true)(L: false)
Digital Output	15	byte[]	(H: 1)(L: 0)
		bool[]	(H: true)(L: false)
Register Output	06	byte	

		bool	
Register Output	16	int	
		float	
		double	
		string	
		byte[]	
		int[]	
		float[]	
		double[]	
		string[]	
		bool[]	

*User defined modbus_write will follows Big-Endian (AB CD) format to write

* Here int means int32. For int16 type data, GetBytes() needs to be applied first to change int16 to byte[]

`int` The maximum number of addresses to be write, only effective to string type data

> 0 Valid address length. Write with defined address length

<= 0 Invalid address length. Write all the data

Return

`bool` `True` Write success

`False` Write failed 1. If the input data ? is empty string or array

2. If an error occurred in Modbus communication

Syntax 4 (TCP/RTU)

```
bool modbus_write(
    string,
    byte,
    string,
    int,
    ?
)
```

Note

Similar to Syntax3 with address length <= 0, it will write all the data.

modbus_write(“TCP_1”, 0, “RO”, 9000, bb) => **modbus_write**(“TCP_1”, 0, “RO”, 9000, bb, 0)

Modbus Address data size

Digital 1 address = 1 bit size

Register 1 address = 2 bytes size

If the user defined values are applied to User Setting as as

TCP device	0	DO	800	4
TCP device	0	RO	9000	12

```
byte[] bb = {10, 20, 30}
modbus_write("TCP_1", 0, "DO", 800, bb)        // write 1,1,1
                                               // Zero value, write 0. Non-zero value, write 1.
modbus_write("TCP_1", 0, "DO", 800, bb, 2)     // write 1,1
                                               // Address number = 2, only write 2 addresses.
modbus_write("TCP_1", 0, "DO", 800, true)      // write 1
int i = 10000
modbus_write("TCP_1", 0, "RO", 9000, i)        // write 0x00,0x00,0x27,0x10
                                               // with int32 BigEndian (AB CD) default
bb = GetBytes(i, 0, 1)                         // bb = {0x10,0x27}
                                               // transfer to int16 LittleEndian (CD AB)
modbus_write("TCP_1", 0, "RO", 9000, bb)           // write 0x10,0x27
string[] n = {"ABC", "12", "34"}
modbus_write("TCP_1", 0, "RO", 9000, n, 2)     // write ABC1
                                               // Only 2 addresses available, the exceeding values cannot be
                                               applied.
modbus_write("TCP_1", 0, "RO", 9000, n, 5)     // write ABC1234\0
                                               // The data needs only 4 addresses
```

5. *Parameterized objects*

Using parameterized objects is the same as using user-defined variables. Parameterized objects can be used without declarations to get or modify point data through the syntaxes in the project operations and make the robot go with more flexibility. The expression comes with 3 parts, item, index, and attribute, and the syntax is shown as below.

```
parameterized item[index].attribute
```

The supported parameterized items include:

1. Point
2. Base
3. TCP
4. VPoint
5. IO
6. Robot
7. FT

Definitions of the index and attribute values vary from parameterized items.

Take the reading and writing of the coordinate (attribute) of the Point (item) "P1" (index) as a example. The index is defined as the name of the point, and the attribute, as the data type of float (the same usage as the array's) with modes of reading and writing.

Value	float[]	R/W	point coordinate{X,Y,Z,RX,RY,RZ}

Read values

```
float[] f = Point["P1"].Value          // In the item Point, the index is defined as the name of the point and the data type of string.
float f1 = Point["P1"].Value[0]        // Just the x value of "P1" can be obtained
```

Write values

```
Point["P1"].Value = {0, 0, 90, 0, 90, 0}   // Replace to the coordinate of "P1" with {0,0,90,0,90,0}
Point["P1"].Value[2] = 120                 // or replace just the z value of "P1" with 120
```

5.1 Point

Syntax

```
Point[string].attribute
```

Item

`Point`

Index

`string` The name of the point in the point manager

Attribute

Name	Type	Mode	Description	Format
`Value`	float[]	R/W	The coordinate of the point	{X, Y, Z, RX, RY, RZ}, Size = 6
`Pose`	int[]	R/W	The pose of the robot	{Config1, Config2, Config3}, Size = 3
`Flange`	float[]	R	The coordinate of the flange's center	{X, Y, Z, RX, RY, RZ}, Size = 6
`BaseName`	string	R	The name of the base	"Base Name"
`TCPName`	string	R	The name of the TCP	"TCP Name"
`TeachValue`	float[]	R	The original coordinate of the teaching point	{X, Y, Z, RX, RY, RZ}, Size = 6
`TeachPose`	int[]	R	The original pose of the robot on the teaching point	{Config1, Config2, Config3}, Size = 3

Note

```
// Read values
float[] f = Point["P1"].Value          // Obatin the coordinate {X, Y, Z, RX, RY, RZ} of "P1"
float f1 = Point["P1"].Value[0]        // or retrieve the x value of "P1" solely
float f1 = Point["P1"].Value[6]        // Return error, exceeding the array's access range
string s = Point["P1"].BaseName        // s = "RobotBase"
// Write values
Point["P1"].Value = {0, 0, 90, 0, 90, 0}    // Replace the coordinate of "P1" with {0,0,90,0,90,0}
Point["P1"].Value[2] = 120                  // or replace the z value of "P1" with 120 solely
Point["P1"].Flange = {0, 0, 90, 0, 90, 0}   // Read only, invalid operation
Point["P1"].Value = {0, 0, 90, 0, 90}       // Return error, not 6 writing elements to the array
                                            (writing 5 elements)
Point["P1"].Pose = {1, 2, 4, 0}             // Return error, writing elements to the array do not match to 3
                                            (writing 4 elements)
```

5.2 Base

Syntax

`Base[string].attribute`

`Base[string, int].attribute`

Item

Base

Index

string	The name of the base in the base manager *The name of the base comes with the attribute of the mode in reading without writing only. "RobotBase"
int	The index of the base, available to assign with multiple bases built by vision one shot get all, ranging from 0 as the default to N.

Attribute

Name	Type	Mode	Description	Format
Value	float[]	R/W	The value of the base	{X, Y, Z, RX, RY, RZ}, Size = 6
Type	string	R	The type of the base	"R": Robot Base "V": Vision Base "C": Custom Base
TeachValue	float[]	R	The original teaching value of the base	{X, Y, Z, RX, RY, RZ}, Size = 6

Note

```
// Read values
float[] f = Base[“RobotBase”].Value          // Obtain the base value {0,0,0,0,0,0} of the base “RobotBase”
float f1 = Base[“base1”].Value[0]            // or retrieve just the x value of “base1”
string s = Base[“base1”].Type                // s = “C”
s = Base[Point[“P1”].BaseName].Type          // s = “R”          // Given the type of “P1” is “RobotBase”
float[] f = Base[“vision_osga”,1].Value      // Obtain the 2nd value of the “vision_osga”
// Write values
Base[“RobotBase”].Value = {0, 0, 90, 0, 90, 0}   // Read only, invalid operation, because "RobotBase" is the system coordinate system
Base[“base1”].Value = {0, 90, 0, 0, 90, 0}       // Replace the value of “base1” with {0,90,0,0,90,0}
Base[“base1”].Value[4] = 120                     // or replace the RY value of “base1” with 120 solely
Base[“base1”].Value[6] = 120                     // Return error, exceeding the array’s access range
Base[“base1”].Type = “C”                         // Read only, invalid operation
Base[“base1”].Value = {0, 0, 90, 0, 90}          // Return error, not 6 writing elements to the array (writing 5 elements)
Base[“base1”].Value = {0, 0, 90, 0, 90, 0, 100}  // Return error, not 6 writing elements to the array (writing 7 elements)
```

5.3 TCP

Syntax

```
TCP[string].attribute
```

Item

```
TCP
```

Index

`string` The name of the TCP in the TCP list

*The name of the TCP comes with the attribute of the mode in reading without writing only.

"NOTOOL"

"HandCamera"

Attribute

Name	Type	Mode	Description	Format
Value	float[]	R/W	The value of the TCP	{X, Y, Z, RX, RY, RZ}, Size = 6
Mass	float	R/W	The value of mass	Mass in kg
MOI	float[]	R/W	The value of the Principal Moments of Inertia	{Ixx, Iyy, Izz}, Size = 3
MCF	float[]	R/W	The value of Mass center frame with principle axes w.r.t tool frame	{X, Y, Z, RX, RY, RZ}, Size = 6
TeachValue	float[]	R	The original value of the TCP	{X, Y, Z, RX, RY, RZ}, Size = 6
TeachMass	float	R	The original value of mass	Mass in kg
TeachMOI	float[]	R	The original value of the Principal Moments of Inertia	{Ixx, Iyy, Izz}, Size = 3
TeachMCF	float[]	R	The original value of Mass center frame with principle axes w.r.t tool frame	{X, Y, Z, RX, RY, RZ}, Size = 6

Note

```
// Read values
float[] f = TCP[“NOTOOL”].Value          // Obtain the value {0,0,0,0,0,0} of the TCP “NOTOOL”
float f1 = TCP[“NOTOOL”].Value[0]        // or retrieve the x value of “NOTOOL” solely
float mass = TCP[“T1”].Mass              // mass = 2.0
float[] moi = TCP[“T1”].MOI              // moi = {0,0,0}
float[] mcf = TCP[“T1”].MCF              // mcf = {0,0,0,0,0,0}
// Write values
TCP[“NOTOOL”].Value = {0, -10, 0, 0, 0, 0}   // Read only, invalid operation, because ”NOTOOL” is the system TCP
TCP[“T1”].Value = {0, -10, 0, 0, 0, 0}       // Replace the value of “T1”with {0,-10,0,0,0,0}
```

```
TCP["T1"].Value[0] = 10                  // or replace the X value of "T1" with 10 solely
TCP["T1"].Mass = 2.4                     // Replace the mass value of "T1" with 2.4 kg
TCP["T1"].MOI = {0, 0, 0, 1, 2}          // Return error, writing elements to the array do not match to
                                         3 (writing 5 elements)
TCP["T1"].MCF = {0, -20, 0, 0, 0, 0, 0}  // Return error, writing elements to the array do not match to
                                         6 (writing 7 elements)
```

5.4 VPoint

A VPoint is the initial point of a vision job with the Hand Camera set as the TCP.

Syntax

```
VPoint[string].attribute
```

Item

```
VPoint
```

Index

`string`	The name of the VPoint

Attribute

Name	Type	Mode	Description	Format
`Value`	float[]	R/W	The initial coordinate of VPoint	{X, Y, Z, RX, RY, RZ}, Size = 6
`BaseName`	string	R	The name of the VPoint	"Base Name"
`TeachValue`	float[]	R	The original job initial coordinate of VPoint	{X, Y, Z, RX, RY, RZ}, Size = 6

Note

```
// Read values
float[] f = VPoint["Job1"].Value        // Obtain the initial coordinate   {X, Y, Z, RX, RY, RZ} of VPoint "Job1"
float f1 = VPoint["Job1"].Value[0]      // or retrieve the x valueof "Job1"
float f1 = VPoint["Job1"].Value[6]      // Return error, exceeding the array's access range
string s = VPoint["Job1"].BaseName      // s = "RobotBase"
// Write values
VPoint["Job1"].Value = {0, 0, 90, 0, 90, 0}   // Replacethe initial coordinate of VPoint "Job1" with
                                              {0,0,90,0,90,0}
VPoint["Job1"].Value[2] = 120           // or replace the Z value of "Job1" with 120 solely
VPoint["Job1"].BaseName = "base1"       // Read only, invalid operation
VPoint["Job1"].Value = {0, 0, 90, 0, 90}      // Return error, writing elements to the array do not match to
                                              6 (writing 5 elements)
VPoint["Job1"].Value = {0, 0, 90, 0, 90, 0, 100}  // Return error, writing elements to the array do not match to
                                                  6 (writing 7 elements)
```

5.5 IO

Syntax

```
IO[string].attribute
```

Item

```
IO
```

Index

string	The name of the control module
	ControlBox
	EndModule
	ExtModuleN (N = 0 .. n)

Attribute

Name	Type	Mode	Description	Format
DI	byte[]	R	Digital input	[0] = DI0 0: Low, 1: High [1] = DI1 [n] = DIn
DO	byte[]	R/W	Digital output	[0] = DO0 0: Low, 1: High [1] = DO1 [n] = DOn
AI	float[]	R	Analog input	-10.24V .. +10.24V (Voltage)
AO	float[]	R/W	Analog output	-10.00V .. + 10.00V (Voltage)

Note

```
// Read values
byte[] di = IO[“ControlBox”].DI          // Obtain the digital input status of “ControlBox”
int dilen = Length(di)                   // Obtain the amount of digital PINs with the size of the array
byte di0 = IO[“ControlBox”].DI[0]        // Obtain the status of “ControlBox” DI[0]
byte di32 = IO[“ControlBox”].DI[32]      // Return error, exceeding the array’s access range (given DI is an array
                                         with the length of 16 where the indexes start with 0 and end with 15.
float[] ai = IO[“ControlBox”].AI         // Obtain the analog input status of “ControlBox”
float[] ao = IO[“ControlBox”].AO         // Obtain the analog output status of “ControlBox”
// Write values
IO[“ControlBox”].DI = {1,1,0,0}          // Read only, invalid operation
IO[“ControlBox”].DI[0] = 0               // Read only, invalid operation
IO[“ControlBox”].DO[2] = 1               // Set DO 2 to High
IO[“ControlBox”].AO[1] = 3.3             // Set AO1 to 3.3V
IO[“ControlBox”].DO = {1,1,0,0}          // Return error, elements to write mismatch to array’s size (given DI is an
                                         array with the length of 16 which covers 16 elements)
```

5.6 Robot

Syntax

```
Robot[int].attribute
```

Item

```
Robot
```

Index

```
int
```
The index of the robot fixed at 0

Attribute

Name	Type	Mode	Description	Format
CoordRobot	float[]	R	The TCP coordinate of the robot end point opposite to the RobotBaseof the robot	{X, Y, Z, RX, RY, RZ}, Size = 6
CoordBase	float[]	R	The TCP coordinate of the robot end point opposite to the current base fo the robot.	{X, Y, Z, RX, RY, RZ}, Size = 6
Joint	float[]	R	The current robot joint angle	{J1, J2, J3, J4, J5, J6}, Size = 6
BaseName	string	R	The name of the current base	"Base Name"
TCPName	string	R	The name of the current TCP	"TCP Name"
CameraLight	byte	R/W	The lighting of the robot's camera	0: Low (Off), 1: High (On)

Note

```
// Read values
float[] rtool = Robot[0].CoordRobot          // Obtain the current TCP coordinate of the robot end point opposite to the RobotBaseof the robot
float[] ftool = Robot[0].CoordBase           // Obtain the current TCP coordinate of the robot end point opposite to the current base fo the robot.
float f = Robot[0]. CoordBase[0]             // or retrieve the X value of the current TCP coordinate of the robot end point opposite to the current base fo the robot solely.
f = Robot[0]. CoordBase[6]                   // Return error, exceeding the array's access range
float[] joint = Robot[0].Joint               // Obtain the current robot joint angle
float j = Robot[0].Joint[0]                  // or retrieve the current angle of the robot's 1st joint solely
string b = Robot[0].BaseName                 // b = "RobotBase"
string t = Robot[0].TCPName                  // t = "NOTOOL"
byte light = Robot[0].CameraLight            // light = 0 (OFF)
// Write values
Robot[0].CoordRobot = {0, 90, 0, 0, 0, 0}    // Read only, invalid operation
Robot[0].CoordBase = {0, 0, 90, 0, 90, 0}    // Read only, invalid operation
```

```
Robot[0].BaseName = “Base1”          // Read only, invalid operation
Robot[0].TCPName = “Tool1”           // Read only, invalid operation
Robot[0].CameraLight = 1             // Turn on the lighting of the robot’s camera
Robot[0].CameraLight = 0             // Turn off the lighting of the robot’s camera
```

5.7 FT

Syntax

```
FT[string].attribute
```

Item

```
FT
```

Index

`string` The name of F/T sensor in the F/T sensor list

Attribute

Name	Type	Mode	Description	Format
X	float	R	The strength value of the X axis	
Y	float	R	The strength value of the y axis	
Z	float	R	The strength value of the z axis	
TX	float	R	The torque value of the X axis	
TY	float	R	The torque value of the y axis	
TZ	float	R	The torque value of the z axis	
F3D	float	R	The XYZ force strength value	
T3D	float	R	The XYZ force torque value	
ForceValue	float[]	R	The XYZ force strength value array	{X, Y, Z}, Size = 3
TorqueValue	float[]	R	The XYZ force torque value array	{TX, TY, TZ}, Size = 3
Model	string	R	The Model name of the F/T sensor	
Zero	byte	R/W	Turn on or off F/T sensor offset	0: Zero OFF, 1: Zero ON

Note

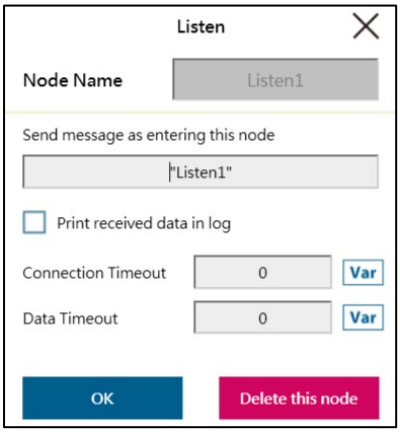
```
// Read values
float x = FT[“fts1”].X                  // Obtain the current X-axis strength value of F/T sensor “fts1”
float tx = FT[“fts1”].TX                // Obtain the current X-axis torque value of F/T sensor “fts1”
float f3d = FT[“fts1”].F3D              // Obtain the current XYZ force value of F/T sensor “fts1”
float[] force = FT[“fts1”].ForceValue   // Obtain the current XYZ force strength value array of F/T sensor
                                        “fts1”
string mode = FT[“fts1”].Model          // Obtain the model name of F/T sensor “fts1”
                                        // Write values
FT[“fts1”].Y = 3.14                     // Read only, invalid operation
```

```
FT[“fts1”].TY = 1.34                    // Read only, invalid operation
FT[“fts1”].T3D = 4.13                   // Read only, invalid operation
FT[“fts1”].TorqueValue = {1.1, 2.2, 3.3}  // Read only, invalid operation
FT[“fts1”].Zero = 1                     // Book the current offset of F/T sensor
```

6. External Script

6.1 Listen Node

In the Listen Node, a TCP/IP server (Socket Server) can be established and be connected by an external device to communicate according to the defined format. All the functions available in "Expression Editor" can also be executed in Listen Node.



- **Send Message:** When entering this node, it will initiate a message
- **Print Log:** Enable Communication Log (shown on the right)
- **Connection Timeout:** When entering this node, if more than the time (milliseconds) is not connected, it will be overtime.
  If <= 0, no timeout
- **Data Timeout:** When connected, the timeout will be exceeded when there is no communication packet
  If <= 0, no timeout

Socket TCPListener is started up after the project being executed, and closed as the project stopped. The IP and listen port will be shown on the Notice Log window on the right, after the Socket TCPListener is started up.

IP HMI → System → Network → IP Address

Port 5890

When entering the Listen Node, the flow will keep at Listen Node until either of the the two exit conditions is fulfilled.

Pass: *ScriptExit()* is executed or the project is stopped

Fail: 1. Connection Timeout

2. Data Timeout

3. Before the TCP Listener is started up, the flow has entered this Listen Node

The command received by listen node will be executed in order. If the command is not valid, an error message will be returned carrying the line number with errors. If the command is valid, it will be executed.

The command can be divided into two categories. The fist category is commands which can be accomplished in instance, like assigning variable value. The second category is commands needs to be executed in sequence, like motion command and IO value assigning. The second category command will be placed in queue and executed in order.

6.2 ScriptExit()

Exit external control mode.

Syntax 1

```
bool ScriptExit(
)
```

Parameters

`void` No parameter

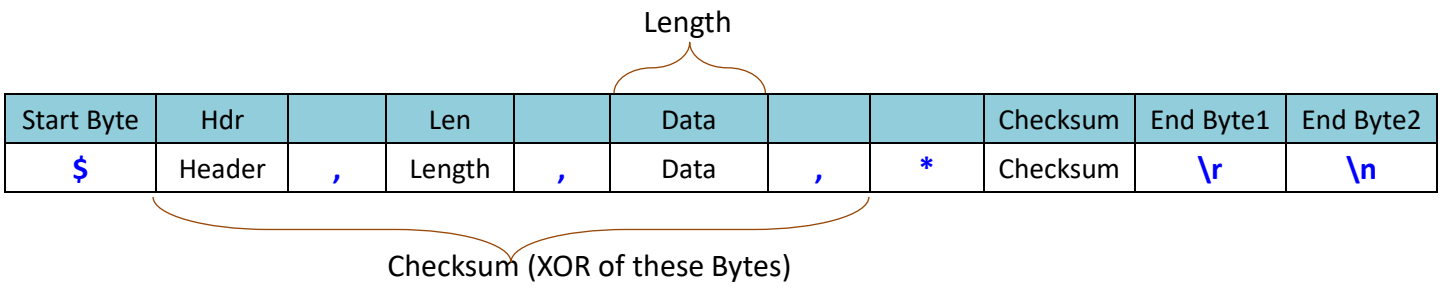
Return

`bool` `True` Command accepted; `False` Command rejected (format error)

Note

Exit the Listen Node through pass terminal

6.3 Communication Protocol



Name	Size	ASCII	HEX	Description
Start Byte	1	$	0x24	Start Byte for Communication
Header	*X*			Header for Communication
Separator	1	,	0x2C	Separator between Header and Length
Length	*Y*			Length of Data
Separator	1	,	0x2C	Separator between Length and Data
Data	*Z*			Communication Data
Separator	1	,	0x2C	Separator between Data and Checksum
Sign	1	*	0x2A	Begin Sign of Checksum
Checksum	*2*			Checksum of Communication
End Byte 1	1	\r	0x0D	
End Byte 2	1	\n	0x0A	End Byte of Communication

1. Header

Defines the purpose of the communication package. The data definition could be different with different Header.

- *TMSCT* External Script

- *TMSTA* Acquiring status or properties
- *CPERR* Communication data error (E.g. Packet error, checksum error, header error, etc.)

2. *Length*

Length defines the length in UTF8 byte. It can be represented in decimal, hexadecimal or binary, the upper limit is int 32bits

Example:

```
$TMSCT,100,Data,*CS\r\n      // Decimal 100, that is the data length is 100 bytes
$TMSCT,0x100,Data,*CS\r\n    // Hexadecimal 0x100, that is the data length is 256 bytes
$TMSCT,0b100,Data,*CS\r\n    // Binary 0b100, that is the data length is 4 bytes
```

3. *Data*

The content of the communication package. Arbitrary characters are supported (including 0x00 .. 0xFF in UTF8).

The data length is defined in Length and the purpose is defined in Header

4. *Checksum*

The checksum of the communication package. The checksum is calculated with XOR(exclusive OR), and the range for checksum computation starts from $ to * ($ and * are excluded) as shown below:

$TMSCT,100,Data,*CS\r\n

Checksum = Byte[1] ^ Byte[2] … ^ Byte[N-6]

The representation of checksum is fixed to 2 bytes in hexadecimal format (without 0x).

For example:

$TMSCT,5,10,OK,*6D

CS = 0x54 ^ 0x4D ^ 0x53 ^ 0x43 ^ 0x54 ^ 0x2C ^ 0x35 ^ 0x2C ^ 0x31 ^ 0x30 ^ 0x2C ^ 0x4F ^ 0x4B ^ 0x2C = 0x6D

CS = 6D (0x36 0x44)

6.4 TMSCT

Start Byte	Hdr		Len		Data			Checksum	End Byte1	End Byte2
$	*TMSCT*	**,**	Length	**,**	Data	**,**	*****	Checksum	**\r**	**\n**

ID		SCRIPT
Script ID	**,**	Script Language

TMSCT defines the communication package as External Script Language. In External Script Language, the data contains two parts and is separated by comma. One is ID and the other is SCRIPT

ID	Script ID, can be arbitrary English character or number (the invalid byte will be ignored). The ID is used as specifying the target SCRIPT of return message.
,	Separator
SCRIPT	The content defined in Script Language. In a communication package, multi-line scripts can fit into the SCRIPT section with separator (0x0D 0x0A)

Note

TMSCT is functional only when flow enters the Listen Node

Return (Robot→External Device)

1. When flow enters Listen Node, robot will send a message to all the connected device. The ID is set to 0.

   $***TMSCT***,9,0,Listen1,*4C\r\n

9	The length of *0,Listen1* is 9 bytes
0	The Script ID is 0
,	Separator
Listen1	The message to send

2. The OK or ERROR returning message according to the Script's content. For message with ;N, ;N represents the number of line with error or warning. After the message is received, robot will execute the message, then send back the return message, if the Script is valid. For invalid Script, the return message will be sent back immediately without execution.

   $***TMSCT***,4,1,OK,*5C\r\n // Response to ID 1
   // OK means valid Script.

   $***TMSCT***,8,2,OK;2;3,*52\r\n // Response to ID 2
   // OK;2;3 means valid Script with warnings in line 2 and 3.

   $***TMSCT***,13,3,ERROR;1;2;3,*3F\r\n // Response to ID 3
   // ERROR;1;2;3 means invalid Script with errors in line 1, 2 and 3.

Receive (Robot←External Device)

1. When flow enters Listen Node, the robot will start to receive, check and execute the Script. The Script received before entering Listen Node will be disposed without response.
2. The message from external device should contain the Script ID as a ID used in return message by robot.

   < $***TMSCT***,25,1,ChangeBase("RobotBase"),*08\r\n // Defined as ID 1

> $***TMSCT***,4,1,OK,*5C\r\n // Response to ID 1

3. In a communication package, multi-line scripts can fit into the SCRIPT section with separator \r\n

< $***TMSCT***,64,2,ChangeBase("RobotBase")\r\n
ChangeTCP("NOTOOL")\r\n
ChangeLoad(10.1),*68\r\n // Three lines Script in a communication package (Lines are separated by \r\n)

> $***TMSCT***,4,2,OK,*5F\r\n

4. In Listen Node, Local variables are supported. The local variable in Listen Node will vanish after exiting the Listen Node.

< $***TMSCT***,40,3,int *var_i* = 100\r\n
var_i = 1000\r\n
var_i++,*5A\r\n

> $***TMSCT***,4,3,OK,*5E\r\n

< $***TMSCT***,42,4,int *var_i* = 100\r\n
var_i = 1000\r\n
var_i++\r\n
,*58\r\n

> $***TMSCT***,9,4,ERROR;1,*02\r\n // Because int var_i has been declared, an error occurred.

5. In Listen Node, it is possible to access or modify the project's variables, but no new variable can be declared. The variables created in the Listen Node are local variables.

6.5 TMSTA

Start Byte	Hdr		Len		Data			Checksum	End Byte1	End Byte2
$	*TMSTA*	**,**	Length	**,**	Data	**,**	*	Checksum	**\r**	**\n**

SubCmd		
SubCmd	…	…

(Based on SubCmd)

TMSTA defines the communication package as acquiring status or properties. The data section of the package contains different sub command (SubCMD). The package format could be different according to different SubCMD. The definitions are listed below.

SubCmd

00 Whether the flow enters Listen Node.

Note

TMSTA could be executed without entering the Listen Node

SubCmd 00 Whether the flow enters Listen Node

Format

Response (Robot→External Device)

SubCmd		Entry		Message
00	,	false	,	
00	,	true	,	message

Receive (Robot←External Device)

SubCmd
00

Response (Robot→External Device)

1. If the flow have not entered Listen Node

   $***TMSTA***,9,00,false,,*37\r\n

   9 Indicates the length of 00,false, is 9 bytes

   00 Indicates SubCmd as 00

   , Separator

   false The flow has not entered Listen Node

   , Separator

   Empty string (Have not entered Listen Node)

2. If the flow have entered the Listen Node

   $***TMSTA***,15,00,true,Listen1,*79\r\n

   15 Indicates the length of 00,true,Listen1 is 15 bytes

   00 Indicates SubCmd as 00

   , Separator

   true The flow has entered the Listen Node

   , Separator

   Listen1 The message to be sent as entering Listen Node (It indicates the flow is in Listen1)

Receive (Robot←External Device)

1. Send to robot from external device

   $***TMSTA***,2,00,*41\r\n

   2 Indicates the length of 00 is 2 bytes.

   00 Indicates the SubCmd is 00, whether entering the Listen Node mode.

6.6 CPERR

Start Byte	Hdr		Len		Data			Checksum	End Byte1	End Byte2
$	*CPERR*	**,**	Length	**,**	Data	**,**	*	Checksum	**\r**	**\n**

Error Code
Code (00 .. FF)

CPERR defines the communication package as sending the Communication Protocol Error. The data section is defined as Error Code.

`Error Code` Error code, presented in 2 bytes hexadecimal format (without 0x)

`00` Packet correct. No error. (The return message usually reply to the content of packet instead of returning no error)

`01` Packet Error.

`02` Checksum Error.

`03` Header Error.

`04` Packet Data Error.

`F1` Have not entered Listen Node

Note

Used by robot to response to external device

Response (Robot→External Device)

01 Packet Error

< $***TMSCT***,**-100**,1,ChangeBase("RobotBase"),*13\r\n // Length cannot be negative

> $***CPERR***,2,01,*49\r\n // CPERR Error Code 01

02 Checksum Error

< $***TMSCT***,25,1,ChangeBase("RobotBase"),*09\r\n // 09 is not a correct Checksum

> $***CPERR***,2,02,*4A\r\n // CPERR Error Code 02

03 Header Error

< $***TMsct***,25,1,ChangeBase("RobotBase"),*28\r\n // TMsct is not a correct Header

> $***CPERR***,2,03,*4B\r\n // CPERR Error Code 03

04 Packet Data Error

< $***TMSTA***,4,XXXX,*47\r\n // There is no XXXX SubCmd under TMSTA

> $***CPERR***,2,04,*4C\r\n // CPERR Error Code 04

F1 No Listen

< $***TMSCT***,25,1,ChangeBase("RobotBase"),*0D\r\n // Have not entered Listen Node

> $***CPERR***,2,F1,*3F\r\n // CPERR Error Code F1

7. Robot Motion Functions

Robot Motion Functions can only be performed with external scripts meaning the project flow must be in listen node to use Robot Motion Functions. All the motion functions will be queued in the buffer and performed in sequence

7.1 StopAndClearBuffer()

Stop the motion of the robot and clear existing commands of the robot in the buffer.

Syntax

```
bool StopAndClearBuffer(
)
```

Parameter

void	No input values required

Return

bool	True Command accepted； False Command rejected

Note

StopAndClearBuffer()

7.2 Pause()

Pause the project and the motion of the robot other than non-paused threads and external script in listen node. Use Resume() or press the Play button on the stick to resume.

Syntax1

```
bool Pause(
)
```

Parameter

void	No input values required

Return

bool	True Command accepted； False Command rejected

Note

Pause()

7.3 Resume()

Resume the project and the motion of the robot.

Syntax1

```
bool Resume(
)
```

Parameter

`void` No input values required

Return

`bool` `True` Command accepted； `False` Command rejected

Note

Resume()

7.4 PTP()

Define and send PTP motion command into buffer for execution.

Syntax 1

```
bool PTP(
    string,
    float[],
    int,
    int,
    int,
    bool
)
```

Parameters

`string` Definition of data format, combines three letters

#1: Motion target format:

`"J"` expressed in joint angles

`"C"` expressed in Cartesian coordinate

#2: Speed format:

`"P"` expressed as a percentage

#3: Blending format

`"P"` expressed as a percentage

`float[]` Motion target。If defined with joint angle, it includes the angles of six joints: Joint1(°), Joint 2(°), Joint 3(°), Joint 4(°), Joint 5(°), Joint 6(°)；If defined with Cartesian coordinate, it includes the Cartesian coordinate of tool center point: X (mm), Y (mm), Z (mm), RX (mm), RY (mm), RZ (mm)

`int` The speed setting, expressed as a percentage (%)

`int` The time interval to accelerate to top speed (ms)

`int` Blending value, expressed as a percentage (%)

`bool` Disable precise positioning

`true` Disable precise positioning

`false` Enable precise positioning

Return

`bool` `True` Command accepted； `False` Command rejected (format error)

Note

Data format parameter includes: (1) `"JPP"`, (2) `"CPP"`

```
float[] targetP1= {0,0,90,0,90,0}          // Declare a float array to store the target coordinate
PTP("JPP",targetP1,10,200,0,false)         // Move to targetP1 with PTP, speed = 10%, time to top speed = 200ms.
```

Syntax 2

```
bool PTP(
    string,
    float[],
    int,
    int,
    int,
    bool,
    int[]
)
```

Parameters

`string` Definition of data format, combines three letters

#1: Motion target format:

`"C"` expressed in Cartesian coordinate

#2: Speed format:

`"P"` expressed as a percentage

#3: Blending format

`"P"` expressed as a percentage

`float[]` Motion target. If defined with Cartesian coordinate, it includes the Cartesian coordinate of tool center point: X (mm), Y (mm), Z (mm), RX (mm), RY (mm), RZ (mm)

`int` The speed setting, expressed as a percentage (%)

`int` The time interval to accelerate to top speed (ms)

`int` Blending value, expressed as a percentage (%)

`bool` Disable precise positioning

- `true` Disable precise positioning
- `false` Enable precise positioning

`int[]` The pose of robot : [Config1, Config2, Config3], please find more information in appendix

Return

`bool` True Command accepted； False Command rejected (format error)

Note

Data format parameter includes: (1) `"CPP"`

```
float[] targetP1 = {417.50,-122.30,343.90,180.00,0.00,90.00}    // Declare a float array to store the target coordinate.
float[] pose = {0,2,4}                                          // Declare a float array to store pose.
PTP("CPP",targetP1,50,200,0,false,pose)                         // Move to targetP1 with PTP, speed = 50%, time to top speed = 200ms.
```

Syntax 3

```
bool PTP(
    string,
    float, float, float, float, float, float,
    int,
    int,
    int,
    bool
)
```

Parameters

`string` Definition of data format, combines three letters

#1: Motion target format:

- `"J"` expressed in joint angles
- `"C"` expressed in Cartesian coordinate

#2: Speed format:

- `"P"` expressed as a percentage

#3: Blending format:

- `"P"` expressed as a percentage

`float, float, float, float, float, float`

Motion target. If expressed in joint angles, it includes the angles of six joints: Joint1(°), Joint 2(°), Joint 3(°), Joint 4(°), Joint 5(°), Joint 6(°)；If expressed in Cartesian coordinate, it includes the Cartesian coordinate of tool center point: X (mm), Y (mm), Z (mm), RX (mm), RY (mm), RZ (mm)

`int` The speed setting, expressed as a percentage (%)

`int` The time interval to accelerate to top speed (ms)

`int` Blending value, expressed as a percentage (%)

`bool` Disable precise positioning

`true` Disable precise positioning

`false` Enable precise positioning

Return

`bool` True Command accepted； False Command rejected (format error)

Note

Data format parameter includes: (1) `"JPP"` and (2) `"CPP"`

PTP("JPP",0,0,90,0,90,0,35,200,0,false) // Move to joint angle 0,0,90,0,90,0 with PTP, speed = 35%, time to top speed = 200ms.

Syntax 4

```
bool PTP(
    string,
    float, float, float, float, float, float,
    int,
    int,
    int,
    bool,
    int, int, int
)
```

Parameters

`string` Definition of data format, combines three letters

#1: Motion target format:

`"C"` expressed in Cartesian coordinate

#2: Speed format:

`"P"` expressed as a percentage

#3: Blending format:

"P" expressed as a percentage

`float, float, float, float, float, float`

Motion target. It includes the Cartesian coordinate of tool center point: X (mm), Y (mm), Z (mm), RX (mm), RY (mm), RZ (mm)

`int` The speed setting, expressed as a percentage (%)

`int` The time interval to accelerate to top speed (ms)

`int` Blending value, expressed as a percentage (%)

`bool` Disable precise positioning

`true` Disable precise positioning

`false` Enable precise positioning

`int, int, int`

The pose of robot : Config1, Config2, Config3, please find more information in appendix

Return

`bool` True Command accepted； False Command rejected (format error)

Note

Data format parameter includes: (1) "CPP"

```
PTP("CPP",417.50,-122.30,343.90,180.00,0.00,90.00,10,200,0,false,0,2,4)  // Move to coordinate 417.50,-122.30,343.90,180.00,0.00,90.00, with PTP, speed = 10%, time to top speed = 200ms, pose = 024.
```

7.5 Line()

Define and send Line motion command into buffer for execution.

Syntax 1

```
bool Line(
    string,
    float[],
    int,
    int,
    int,
    bool
)
```

Parameters

`string` Definition of data format, combines three letters

#1: Motion target format:

"C" expressed in Cartesian coordinate

#2: Speed format:

"P" expressed as a percentage

"A" expressed in velocity (mm/s)

#3: Blending format:

"P" expressed as a percentage

"R" expressed in radius

`float[]` Motion target. It includes the Cartesian coordinate of tool center point: X (mm), Y (mm), Z (mm), RX (mm), RY (mm), RZ (mm)

`int` The speed setting, expressed as a percentage (%) or in velocity (mm/s)

`int` The time interval to accelerate to top speed (ms)

`int` Blending value, expressed as a percentage (%) or in radius (mm)

`bool` Disable precise positioning

`true` Disable precise positioning

`false` Enable precise positioning

Return

`bool` `True` Command accepted; `False` Command rejected (format error)

Note

Data format parameter includes: (1) "CPP", (2) "CPR", (3) "CAP"與(4) "CAR"

```
float[] Point1 = {417.50,-122.30,343.90,180.00,0.00,90.00} // Declare a float array to store the target coordinate
Line("CAR",Point1,100,200,50,false)                        // Move to Point1 with Line, speed = 100 mm/s, time to top speed = 200 ms, blending radius = 50mm
```

Syntax 2

```
bool Line(
    string,
    float, float, float, float, float, float,
    int,
    int,
    int,
    bool
)
```

Parameters

`string` Definition of data format, combines three letters

#1: Motion target format:

"C" expressed in Cartesian coordinate

#2: Speed format:

"P" expressed as a percentage

"A" expressed in velocity (mm/s)

#3: Blending format:

"P" expressed as a percentage

"R" expressed in radius

`float, float, float, float, float, float`

Motion target. It includes the Cartesian coordinate of tool center point: X (mm), Y (mm), Z (mm), RX (mm), RY (mm), RZ (mm)

`int` The speed setting, expressed as a percentage (%) or in velocity (mm/s)

`int` The time interval to accelerate to top speed (ms)

`int` Blending value, expressed as a percentage (%) or in radius (mm)

`bool` Disable precise positioning

`true` Disable precise positioning

`false` Enable precise positioning

Return

`bool` `True` Command accepted; `False` Command rejected (format error)

Note

Data format parameter includes: (1) "CPP", (2) "CPR", (3) "CAP"與(4) "CAR"

```
Line("CAR", 417.50,-122.30,343.90,180.00,0.00,90.00,100,200,50,false)    // Move to 417.50,-122.30,343.90,180.00,0.00,90.00 with Line, velocity = 100mm/s, time to top speed = 200ms, blending radius = 50mm
```

7.6 Circle()

Define and send Circle motion command into buffer for execution.

Syntax 1

```
bool Circle(
    string,
    float[],
    float[],
    int,
    int,
    int,
```

int,
bool
)

Parameters

string Definition of data format, combines three letters
#1: Motion target format:
"C" expressed in Cartesian coordinate
#2: Speed format:
"P" expressed as a percentage
"A" expressed in velocity (mm/s)
#3: Blending format:
"P" expressed as a percentage

float[] A point on arc. It includes the Cartesian coordinate of tool center point: X (mm), Y (mm), Z (mm), RX (mm), RY (mm), RZ (mm)

float[] The end point of arc, it includes the Cartesian coordinate of tool center point: X (mm), Y (mm), Z (mm), RX (mm), RY (mm), RZ (mm)

int The speed setting, expressed as a percentage (%) or in velocity (mm/s)

int The time interval to accelerate to top speed (ms)

int Blending value, expressed as a percentage (%)

int Arc angle(°), If non-zero value is given, the TCP will keep the same pose and move from current point to the assigned arc angle via the given point and end point on arc; If zero is given, the TCP will move from current point and pose to end point and pose via the point on arc with linear interpolation on pose.

bool Disable precise positioning
true Disable precise positioning
false Enable precise positioning

Return

bool True Command accepted; False Command rejected (format error)

Note

Data format parameter includes: (1) "CPP" and (2) "CAP"

```
float[] PassP = {417.50,-122.30,343.90,180.00,0.00,90.00}   // Declare a float array to store the via point value
float[] EndP = {381.70,208.74,343.90,180.00,0.00,135.00}    // Declare a float array to store the end point value
Circle("CAP",PassP,EndP,100,200,50,270,false)               // Move on 270° arc, velocity = 100mm/s, time to top speed = 200ms, blending value =
```

50%

Syntax 2

```
bool Circle(
    string,
    float, float, float, float, float, float,
    float, float, float, float, float, float,
    int,
    int,
    int,
    int,
    bool
)
```

Parameters

`string` Definition of data format, combines three letters

#1: Motion target format:

`"C"` expressed in Cartesian coordinate

#2: Speed format:

`"P"` expressed as a percentage

`"A"` expressed in velocity (mm/s)

#3: Blending format:

`"P"` expressed as a percentage

`float, float, float, float, float, float`

A point on arc. It includes the Cartesian coordinate of tool center point: X (mm), Y (mm), Z (mm), RX (mm), RY (mm), RZ (mm)

`float, float, float, float, float, float`

The end point of arc. It includes the Cartesian coordinate of tool center point: X (mm), Y (mm), Z (mm), RX (mm), RY (mm), RZ (mm)

`int` The speed setting, expressed as a percentage (%) or in velocity (mm/s)

`int` The time interval to accelerate to top speed (ms)

`int` Blending value, expressed as a percentage (%)

`int` Arc angle(°), If non-zero value is given, the TCP will keep the same pose and move from current point to the assigned arc angle via the given point and end point on arc; If zero is given, the TCP will move from current point and pose to end point and pose via the point on arc with linear interpolation on pose.

`bool` Disable precise positioning

`true` Disable precise positioning

`false` Enable precise positioning

Return

`bool` `True` Command accepted; `False` Command rejected (format error)

Note

Data format parameter includes: (1) `”CPP”` and (2) `”CAP”`

Circle(”CAP”, 417.50,-122.30,343.90,180.00,0.00,90.00,
381.70,208.74,343.90,180.00,0.00,135.00,100,200,50,270,false)
// Move on 270° arc, velocity = 100mm/s, time to top speed = 200ms, blending value = 50%, via point = 417.50,-122.30,343.90,180.00,0.00,90.00, end point = 381.70,208.74,343.90,180.00,0.00,135.00

7.7 PLine()

Define and send PLine motion command into buffer for execution.

Syntax 1

```
bool PLine(
    string,
    float[],
    int,
    int,
    int
)
```

Parameters

`string` Definition of data format, combines three letters

#1: Motion target format:

"J" expressed in joint angles

"C" expressed in Cartesian coordinate

#2: Speed format:

"A" expressed in velocity (mm/s)

#3: Blending format:

"P" expressed as a percentage

`float[]` Motion target. If expressed in joint angles, it includes the angles of six joints: Joint1(°), Joint 2(°), Joint 3(°), Joint 4(°), Joint 5(°), Joint 6(°)；If expressed in Cartesian coordinate, it includes the Cartesian coordinate of tool center point: X (mm), Y (mm), Z (mm), RX (mm), RY (mm), RZ (mm)

`int` The speed setting, expressed in velocity (mm/s)

`int` The time interval to accelerate to top speed (ms)

`int` Blending value, expressed as a percentage (%)

Return

`bool` True Command accepted； False Command rejected (format error)

Note

Data format parameter includes: (1) "JAP" and (2) "CAP"

```
float[] targetP1 = {417.50,-122.30,343.90,180.00,0.00,90.00}    // Declare a float array to store the target coordinate
PLine("CAP",targetP1,100,200,50)                                // Move to targetP1 with PLine,
```

velocity = 100mm/s, time to top speed
= 200ms, blending value = 50%

Syntax 2

```
bool PLine(
    string,
    float, float, float, float, float, float,
    int,
    int,
    int
)
```

Parameters

`string` Definition of data format, combines three letters

#1: Motion target format:

"J" expressed in joint angles

"C" expressed in Cartesian coordinate

#2: Speed format:

"A" expressed in velocity (mm/s)

#3: Blending format:

"P" expressed as a percentage

`float, float, float, float, float, float,`

Motion target. If expressed in joint angles, it includes the angles of six joints: Joint1(°), Joint 2(°), Joint 3(°), Joint 4(°), Joint 5(°), Joint 6(°)；If expressed in Cartesian coordinate, it includes the Cartesian coordinate of tool center point: X (mm), Y (mm), Z (mm), RX (mm), RY (mm), RZ (mm)

`int` The speed setting, expressed in velocity (mm/s)

`int` The time interval to accelerate to top speed (ms)

`int` Blending value, expressed as a percentage (%)

Return

`bool` `True` Command accepted; `False` Command rejected (format error)

Note

Data format parameter includes: (1) "JAP" and (2) "CAP"

PLine("CAP", 417.50,-122.30,343.90,180.00,0.00,90.00,100,200,50)

// Move to 417.50,-122.30,343.90,180.00,0.00,90.00 with PLine, velocity = 100mm/s, time to top speed = 200ms, Blending value = 50%

7.8 Move_PTP()

Define and send PTP relative motion command into buffer for execution.

Syntax 1

```
bool Move_PTP(
    string,
    float[],
    int,
    int,
    int,
    bool
)
```

Parameters

`string` Definition of data format, combines three letters

#1: Relative motion target format:

`"C"` expressed w.r.t. current base

`"T"` expressed w.r.t. tool coordinate

`"J"` expressed in joint angles

#2: Speed format:

`"P"` expressed as a percentage

#3: Blending format:

`"P"` expressed as a percentage

`float[]` relative motion parameters. If expressed in Cartesian coordinate (w.r.t. current base or tool coordinate), it includes the relative motion value with respect to the specified coordinate: X (mm), Y (mm), Z (mm), RX (mm), RY (mm), RZ (mm); If defined with joint angle, it includes the angles of six joints: Joint1(°), Joint 2(°), Joint 3(°), Joint 4(°), Joint 5(°), Joint 6(°)

`int` The speed setting, expressed as a percentage (%)

`int` The time interval to accelerate to top speed (ms)

`int` Blending value, expressed as a percentage (%)

`bool` Disable precise positioning

`true` Disable precise positioning

`false` Enable

Return

`bool` `True` Command accepted; `False` Command rejected (format error)

Note

Data format parameter includes: (1) `"CPP"`, (2) `"TPP"` or (3) `"JPP"`

```
float[] relmove = {0,0,10,45,0,0}                    // Declare a float array to store the relative motion target
```

Move_PTP(”TPP”,relmove,10,200,0,false) // Move to relative motion target with PTP, velocity = 10%, time to top speed = 200ms

Syntax 2

```
bool Move_PTP(
    string,
    float, float, float, float, float, float,
    int,
    int,
    int,
    bool
)
```

Parameters

`string` Definition of data format, combines three letters

#1: Relative motion target format:

`”C”` expressed w.r.t. current base

`”T”` expressed w.r.t. tool coordinate

`”J”` expressed in joint angles

#2: Speed format:

`”P”` expressed as a percentage

#3: Blending format:

`”P”` expressed as a percentage

`float, float, float, float, float, float`

Relative motion parameters. If expressed in Cartesian coordinate (w.r.t. current base or tool coordinate), it includes the relative motion value with respect to the specified coordinate: X (mm), Y (mm), Z (mm), RX (mm), RY (mm), RZ (mm); If defined with joint angle, it includes the angles of six joints: Joint1(°), Joint 2(°), Joint 3(°), Joint 4(°), Joint 5(°), Joint 6(°)

`int` The speed setting, expressed as a percentage (%)

`int` The time interval to accelerate to top speed (ms)

`int` Blending value, expressed as a percentage (%)

`bool` Disable precise positioning

`true` Disable precise positioning

`false` Enable

Return

`bool` `True` Command accepted; `False` Command rejected (format error)

Note

Data format parameter includes: (1) `”CPP”`, (2) `”TPP”` and (3) `”JPP”`

Move_PTP(”TPP”,0,0,10,45,0,0,10,200,0,false) // Move 0,0,10,45,0,0, with respect to tool coordinate, with PTP, velocity = 10%, time to top speed = 200 ms

7.9 Move_Line()

Define and send Line relative motion command into buffer for execution.

Syntax 1

```
bool Move_Line(
    string,
    float[],
    int,
    int,
    int,
    bool
)
```

Parameters

`string` Definition of data format, combines three letters

#1: Relative motion target format:

`"C"` expressed w.r.t. current base

`"T"` expressed w.r.t. tool coordinate

#2: Speed format:

`"P"` expressed as a percentage

`"A"` expressed in velocity (mm/s)

#3: Blending format:

`"P"` expressed as a percentage

`"R"` expressed in radius

`float[]` Relative motion parameter. It includes the relative motion value with respect to the specified coordinate (current base or tool coordinate): X (mm), Y (mm), Z (mm), RX (mm), RY (mm), RZ (mm).

`int` The speed setting, expressed as a percentage (%) or in velocity (mm/s)

`int` The time interval to accelerate to top speed (ms)

`int` Blending value, expressed as a percentage (%) or in radius (mm)

`bool` Disable precise positioning

`true` Disable precise positioning

`false` Enable

Return

`bool` `True` Command accepted; `False` Command rejected (format error)

Note

Data format parameter includes: (1) `"CPP"`, (2) `"CPR"`, (3) `"CAP"`, (4) `"CAR"`, (5) `"TPP"`, (6) `"TPR"`, (7) `"TAP"` and (8) `"TAR"`

```
float[] relmove = {0,0,10,45,0,0}          //Declare a float array to store the relative motion target

Move_Line("TAP",relmove,125,200,0,false)   // Move to relative motion target, with Line, velocity = 125mm/s, time to top speed = 200 ms
```

Syntax 2

```
bool Move_Line(
    string,
    float, float, float, float, float, float,
    int,
    int,
    int,
    bool
)
```

Parameters

`string` Definition of data format, combines three letters

#1: Relative motion target format:

"C" expressed w.r.t. current base

"T" expressed w.r.t. tool coordinate

#2: Speed format:

"P" expressed as a percentage

"A" expressed in velocity (mm/s)

#3: Blending format:

"P" expressed as a percentage

"R" expressed in radius

`float, float, float, float, float, float`

Relative motion parameter. It includes the relative motion value with respect to the specified coordinate (current base or tool coordinate): X (mm), Y (mm), Z (mm), RX (mm), RY (mm), RZ (mm).

`int` The speed setting, expressed as a percentage (%) or in velocity (mm/s)

`int` The time interval to accelerate to top speed (ms)

`int` Blending value, expressed as a percentage (%) or in radius (mm)

`bool` Disable precise positioning

`true` Disable precise positioning

`false` Enable

Return

`bool` True Command accepted； False Command rejected (format error)

Note

Data format parameter includes: (1) "CPP", (2) "CPR", (3) "CAP", (4) "CAR", (5) "TPP", (6) "TPR", (7) "TAP" and (8) "TAR"

Move_Line(”TAP”, 0,0,10,45,0,0,125,200,0,false) // Move to relative motion target 0,0,10,45,0,0 with Line, velocity = 125mm/s, time to top speed = 200ms.

7.10 Move_PLine()

Define and send PLine relative motion command into buffer for execution.

Syntax 1

```
bool Move_PLine(
    string,
    float[],
    int,
    int,
    int
)
```

Parameters

`string` Definition of data format, combines three letters

#1: Relative motion target format:

`”C”` expressed relative to current base

`”T”` expressed relative to tool coordinate

`”J”` expressed in joint angles

#2: Speed format:

`”A”` expressed in velocity (mm/s)

#3: Blending format:

`”P”` expressed as a percentage

`float[]` Relative motion parameters. If expressed in Cartesian coordinate (w.r.t. current base or tool coordinate), it includes the relative motion value with respect to the specified coordinate: X (mm), Y (mm), Z (mm), RX (mm), RY (mm), RZ (mm); If defined with joint angle, it includes the angles of six joints: Joint1(°), Joint 2(°), Joint 3(°), Joint 4(°), Joint 5(°), Joint 6(°)

`int` The speed setting, expressed in velocity (mm/s)

`int` The time interval to accelerate to top speed (ms)

`int` Blending value, expressed as a percentage (%)

Return

`bool` `True` Command accepted; `False` Command rejected (format error)

Note

Data format parameter includes: (1) `”CAP”`, (2) `”TAP”` and (3) `”JAP”`

```
float[] target = {0,0,10,45,0,0}                    // Declare a float array to store the relative motion
```

target

Move_PLine(”CAP”,target,125,200,0) //Move to relative motion target, with PLine, velocity = 125 mm/s, time to top speed = 200 ms.

Syntax 2

```
bool Move_PLine(
    string,
    float, float, float, float, float, float,
    int,
    int,
    int,
)
```

Parameters

`string` Definition of data format, combines three letters

#1: Relative motion target format:

”C” expressed w.r.t. current base

”T” expressed w.r.t. tool coordinate

”J” expressed in joint angles

#2: Speed format:

”A” expressed in velocity (mm/s)

#3: Blending format:

”P” expressed as a percentage

`float, float, float, float, float, float`

Relative motion parameters. If expressed in Cartesian coordinate (w.r.t. current base or tool coordinate), it includes the relative motion value with respect to the specified coordinate: X (mm), Y (mm), Z (mm), RX (mm), RY (mm), RZ (mm); If defined with joint angle, it includes the angles of six joints: Joint1(°), Joint 2(°), Joint 3(°), Joint 4(°), Joint 5(°), Joint 6(°)

`int` The speed setting, expressed in velocity (mm/s)

`int` The time interval to accelerate to top speed (ms)

`int` Blending value, expressed as a percentage (%)

Return

`bool` True Command accepted； False Command rejected (format error)

Note

Data format parameter includes: (1) ”CAP”, (2) ”TAP” and (3) ”JAP”

Move_PLine(”CAP”,0,0,10,45,0,0,125,200,0) // Move 0,0,10,45,0,0, with PLine, velocity = 125mm/s, time to top speed = 200ms

7.11 ChangeBase()

Send the command of changing the base of the follow-up motions into buffer for execution.

Syntax 1

```
bool ChangeBase(
    string
)
```

Parameters

`string` Base Name

Return

`bool` `True` Command accepted; `False` Command rejected (format error)

Note

```
ChangeBase("RobotBase")          // Change the base to "RobotBase", a base listed on the base
                                 // list in TMflow.
```

Syntax 2

```
bool ChangeBase(
    float[]
)
```

Parameters

`float[]` Base parameters, combines X, Y, Z, RX, RY, RZ

Return

`True` Command accepted; `False` Command rejected (format error)

Note

```
float[] Base1 = {20,30,10,0,0,90}    // Declare a float array to store the base value
ChangeBase(Base1)                    // Change the base value to Base1
```

Syntax 3

```
bool ChangeBase(
    float, float, float, float, float, float
)
```

Parameters

`float, float, float, float, float, float`

Base parameters, combines X, Y, Z, RX, RY, RZ

Return

`bool` `True` Command accepted; `False` Command rejected (format error)

Note

ChangeBase(20,30,10,0,0,90) // Change the base value to {20,30,10,0,0,90}

7.12 ChangeTCP()

Send the command of changing the TCP of the follow-up motions into buffer for execution.

Syntax 1

```
bool ChangeTCP(
    string
)
```

Parameters

`string` TCP name

Return

`bool` `True` Command accepted; `False` Command rejected (format error)

Note

ChangeTCP(”NOTOOL”) // Change the TCP to ”NOTOOL”, a TCP listed on the base list in TMflow.

Syntax 2

```
bool ChangeTCP(
    float[]
)
```

Parameters

`float[]` TCP Parameter, combines X, Y, Z, RX, RY, RZ

Return

`bool` `True` Command accepted; `False` Command rejected (format error)

Note

float[] Tool1 = {0,0,150,0,0,90} // Declare a float array to store the TCP value

ChangeTCP(Tool1) // Change the TCP value to Tool1

Syntax 3

```
bool ChangeTCP(
    float[],
    float
)
```

Parameters

`float[]` TCP Parameter, combines X, Y, Z, RX, RY, RZ

`float` Tool's weight

Return

`bool` `True` Command accepted; `False` Command rejected (format error)

Note

```
float[] Tool1 = {0,0,150,0,0,90}          // Declare a float array to store the TCP value
ChangeTCP(Tool1,2)                        // Change the TCP value to Tool1 with weight = 2kg
```

Syntax 4

```
bool ChangeTCP(
    float[],
    float,
    float[]
)
```

Parameters

`float[]` TCP Parameter, combines X, Y, Z, RX, RY, RZ

`float` Tool's weight

`float[]` Tool's moment of inertia: (1)Ixx, (2)Iyy, (3)Izz and its frame of reference: (4)X, (5)Y, (6)Z, (7)RX, (8)RY, (9)RZ

Return

`bool` `True` Command accepted; `False` Command rejected (format error)

Note

```
float[] Tool1 = {0,0,150,0,0,90}          // Declare a float array to store the TCP value
float[] COM1 = {2,0.5,0.5,0,0,-80,0,0,0}  // Declare a float array to store the moment of inertia
                                          and its frame of reference
ChangeTCP(Tool1,2,COM1)                   // Change the TCP value to Tool1 with weight = 2kg and
                                          moment of inertia to COM1
```

Syntax 5

```
bool ChangeTCP(
    float, float, float, float, float, float
)
```

Parameters

`float, float, float, float, float, float`

TCP Parameter, combines X, Y, Z, RX, RY, RZ

Return

`bool` `True` Command accepted; `False` Command rejected (format error)

Note

ChangeTCP(0,0,150,0,0,90) // Change the TCP value to {0,0,150,0,0,90}

Syntax 6

```
bool ChangeTCP(
    float, float, float, float, float, float,
    float
)
```

Parameters

`float, float, float, float, float, float`
TCP Parameter, combines X, Y, Z, RX, RY, RZ

`float` TCP weight

Return

`bool` `True` Command accepted; `False` Command rejected (format error)

Note

ChangeTCP(0,0,150,0,0,90,2) // Change the TCP value to {0,0,150,0,0,90}, weight = 2kg

Syntax 7

```
bool ChangeTCP(
    float, float, float, float, float, float,
    float,
    float, float, float, float, float, float, float, float, float
)
```

Parameters

`float, float, float, float, float, float`
TCP Parameter, combines X, Y, Z, RX, RY, RZ

`float` Tool's weight

`float, float, float, float, float, float, float, float, float`
Tool's moment of inertia: (1)Ixx, (2)Iyy, (3)Izz and its frame of reference: (4)X, (5)Y, (6)Z, (7)RX, (8)RY, (9)RZ

Return

`bool` `True` Command accepted; `False` Command rejected (format error)

Note

ChangeTCP(0,0,150,0,0,90,2, 2,0.5,0.5,0,0,-80,0,0,0) // Change the TCP value to {0,0,150,0,0,90}, weight = 2kg, moment of inertia = {2,0.5,0.5} and frame of reference = {0,0,-80,0,0,0}

7.13 ChangeLoad()

Send the command of changing the payload value of the follow-up motions into buffer for execution.

Syntax 1

```
bool ChangeLoad(
    float
)
```

Parameters

`float` Payload(kg)

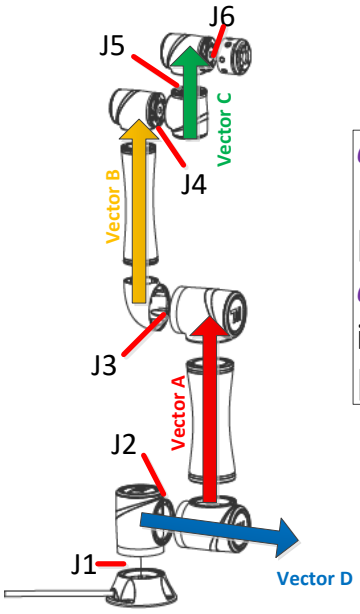
Return

`bool` `True` Command accepted; `False` Command rejected (format error)

Note

ChangeLoad(5.3) //Set payload to 5.3kg

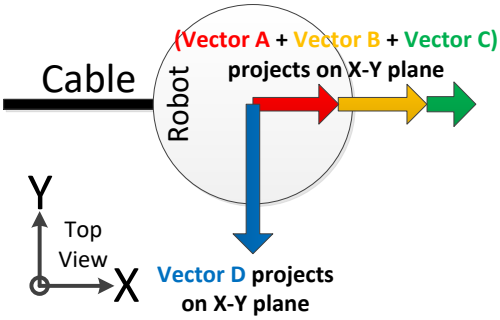
Appendix: Pose Configuration Parameters: [Config1, Config2, Config3]



Config: config1, config2, config3

config1=0:
if [(Vector A + Vector B + Vector C) projects on X-Y plane] cross [Vector D projects on X-Y plane] is on negative-Z
config1=1:
if [(Vector A + Vector B + Vector C) projects on X-Y plane] cross [Vector D projects on X-Y plane] is on positive-Z

config2=2:
if (M=0 and J3 is positive) or (M=1 and J3 is negative)
config2=3:
if (M=0 and J3 is negative) or (M=1 and J3 is positive)



config3=4:
if (M=0 and J5 is positive) or (M=1 and J5 is negative)
config3=5:
if (M=0 and J5 is negative) or (M=1 and J5 is positive)

7.14 PVTEnter()

Set PVT mode to start with Joint/Cartesian command

Syntax1

```
bool PVTEnter(
    int
)
```

Parameter

`int` PVT Mode

`0` Joint

`1` Cartesian

Return

`bool` `True` Command accepted; `False` Command rejected

Note

Syntax2

```
bool PVTEnter(
)
```

Parameter

`void` No input values required. Use PVT mode with Joint Command by default.

Return

`bool` `True` Command accepted; `False` Command rejected

Note

PVTEnter(1)

7.15 PVTExit()

Set PVT mode motion to exit

Syntax1

```
bool PVTExit(
)
```

Parameter

`void` No input values required

Return

`bool` `True` Command accepted; `False` Command rejected

Note

PVTExit()

7.16 PVTPoint()

Set the PVT mode parameters of motion in position, velocity, and duration.

Syntax1

```
bool PVTPoint(
    float[],
    float[],
    float
)
```

Parameter

`float[]`	Target position {J1, J2, J3, J4, J5, J6} in PVT mode with Joint {X, Y, Z, RX, RY, RZ} in PVT mode with Cartesian
`float[]`	Target velocity {J1, J2, J3, J4, J5, J6}' in PVT mode with Joint {X, Y, Z, RX, RY, RZ}' in PVT mode with Cartesian
`float`	Duration (ms)

Return

`bool`	`True` Command accepted; `False` Command rejected

Note

Syntax2

```
bool PVTPoint(
    float, float, float, float, float, float,
    float, float, float, float, float, float,
    float
)
```

Parameter

`float, float, float, float, float, float,`	Target Position. {J1, J2, J3, J4, J5, J6} in PVT mode with Joint {X, Y, Z, RX, RY, RZ} in PVT mode with Cartesian
`float, float, float, float, float, float,`	Target Velocity. {J1, J2, J3, J4, J5, J6}' in PVT mode with Joint {X, Y, Z, RX, RY, RZ}' in PVT mode with Cartesian
`float`	Duration (ms)

Return

`bool` `True` Command accepted; `False` Command rejected

Note

PVTEnter(1)

PVTPoint(467.5,-122.2,359.7,180,0,90,50,50,0,0,0,0,0.5)

PVTPoint(467.5,-72.2,359.7,180,0,90,-50,50,0,0,0,0,0.5)

PVTPoint(417.5,-72.2,359.7,180,0,90,0,0,0,0,0,0,0.5)

PVTPoint(417.5,-122.2,359.7,180,0,90,50,50,0,0,0,0,0.5)

PVTPoint(417.5,-122.2,359.7,180,0,60,50,50,0,0,0,0,3)

PVTPoint(417.5,-122.2,359.7,180,0,90,50,50,0,0,0,0,3)

PVTExit()

7.17 PVTPause()

Set PVT mode motion to pause

Syntax1

`bool` **`PVTPause`**`(`

`)`

Parameter

`void` No input values required

Return

`bool` `True` Command accepted; `False` Command rejected

Note

PVTPause()

7.18 PVTResume()

Set PVT mode motion to resume

Syntax1

`bool` **`PVTResume`**`(`

`)`

Parameter

`void` No input values required

Return

`bool` `True` Command accepted; `False` Command rejected

Note

PVTResume()

OMRON Corporation **Industrial Automation Company**
Kyoto, JAPAN
Contact: www.ia.omron.com

Regional Headquarters

OMRON EUROPE B.V.
Wegalaan 67-69, 2132 JD Hoofddorp
The Netherlands
Tel: (31)2356-81-300/Fax: (31)2356-81-388

OMRON ASIA PACIFIC PTE. LTD.
No. 438A Alexandra Road # 05-05/08 (Lobby 2),
Alexandra Technopark,
Singapore 119967
Tel: (65) 6835-3011/Fax: (65) 6835-2711

OMRON ELECTRONICS LLC
2895 Greenspoint Parkway, Suite 200 Hoffman Estates,
IL 60169 U.S.A.
Tel: (1) 847-843-7900/Fax: (1) 847-843-7787

OMRON ROBOTICS AND SAFETY TECHNOLOGIES, INC.
4550 Norris Canyon Road, Suite 150, San Ramon, CA 94583 U.S.A.
Tel: (1) 925-245-3400/Fax: (1) 925-960-0590

OMRON (CHINA) CO., LTD.
Room 2211, Bank of China Tower, 200 Yin Cheng Zhong Road,
PuDong New Area, Shanghai, 200120, China
Tel: (86) 21-5037-2222/Fax: (86) 21-5037-2200

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