# ST语言

## 关键字(Keyword)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| IF | THEN | ELSEIF | ELSE | END\_IF |  |
| CASE | OF | END\_CASE |  |  |  |
| FOR | TO | BY | DO | END\_FOR |  |
| WHILE | END\_WHILE | REPEAT | END\_REPEAT | UNTIL |  |
| RETURN | EXIT |  |  |  |  |
| XOR | AND | OR | MOD | NOT |  |
| BYTE | WORD | DWORD | BOOL | SINT | INT |
| DINT | USINT | UINT | UDINT | REAL | LREAL |
| TIME | TIME\_OF\_DAY | DATE | DATE\_AND\_TIME |  |  |
| ~~TYPE~~ | ~~END\_TYPE~~ |  |  |  |  |
| ~~VAR~~ | ~~END\_VAR~~ | ~~VAR\_INPUT~~ | ~~VAR\_OUTPUT~~ | ~~VAR\_IN\_OUT~~ | ~~VAR\_EXTERNAL~~ |
| ~~VAR\_TEMP~~ | ~~VAR\_ACCESS~~ | ~~VAR\_GLOBAL~~ | ~~VAR\_CONFIG~~ |  |  |
| ~~PERSISTENT~~ | ~~CONSTANT~~ | ~~RETAIN~~ |  |  |  |
| ~~AT~~ |  |  |  |  |  |
| ~~READ\_ONLY~~ | ~~READ\_WRITE~~ |  |  |  |  |
| ~~STRUCT~~ | ~~END\_STRUCT~~ |  |  |  |  |
| ~~FUNCTION~~ | ~~END\_FUNCTION~~ |  |  |  |  |
| ~~FUNCTION\_BLOCK~~ | ~~END\_FUNCTION\_BLOCK~~ |  |  |  |  |
| ~~PROGRAM~~ | ~~END\_PROGRAM~~ |  |  |  |  |

**备注：删除线部分表示M6不支持/支持不完整。**

## 内置类型(Elementary data types)

|  |  |  |  |
| --- | --- | --- | --- |
| **Keyword** | **Description** | **Default initial value** | **N** |
| BOOL | Boolean | 0, FALSE | 1 |
| SINT | Short integer | 0 | 8 |
| INT | Integer | 0 | 16 |
| DINT | Double integer | 0 | 32 |
| ~~LINT~~ | ~~Long integer~~ | ~~0~~ | ~~64~~ |
| USINT | Unsigned short integer | 0 | 8 |
| UINT | Unsigned integer | 0 | 16 |
| UDINT | Unsigned double integer | 0 | 32 |
| ~~ULINT~~ | ~~Unsigned long integer~~ | ~~0~~ | ~~64~~ |
| REAL | Real numbers | 0.0 | 32 |
| LREAL | Long reals | 0.0 | 64 |
| TIME | Duration | T#0s | - |
| ~~LTIME~~ | ~~Duration~~ | ~~LTIME#0s~~ | ~~64~~ |
| DATE | Date (only) | - | - |
| ~~LDATE~~ | ~~Long Date (only)~~ | ~~LDATE#1970-01-01~~ | ~~64~~ |
| TIME\_OF\_DAY or TOD | Time of day (only) | TOD#00:00:00 | - |
| ~~LTIME\_OF\_DAY or LTOD~~ | ~~Time of day (only)~~ | ~~LTOD#00:00:00~~ | ~~64~~ |
| DATE\_AND\_TIME or DT | Date and time of Day | - | - |
| ~~LDATE\_AND\_TIME or DT~~ | ~~Date and time of Day~~ | ~~LDT#1970-01-01-00:00:00~~ | ~~64~~ |
| ~~STRING~~ | ~~Variable-length single-byte character string~~ | ~~'' (empty)~~ | ~~8~~ |
| ~~WSTRING~~ | ~~Variable-length double-byte character string~~ | ~~"" (empty)~~ | ~~16~~ |
| ~~CHAR~~ | ~~Single-byte character~~ | ~~'$00'~~ | ~~8~~ |
| ~~WCHAR~~ | ~~Double-byte character~~ | ~~"$0000"~~ | ~~16~~ |
| ~~BYTE~~ | ~~Bit string of length 8~~ | ~~16#00~~ | ~~8~~ |
| ~~WORD~~ | ~~Bit string of length 16~~ | ~~16#0000~~ | ~~16~~ |
| ~~DWORD~~ | ~~Bit string of length 32~~ | ~~16#0000\_0000~~ | ~~32~~ |
| ~~LWORD~~ | ~~Bit string of length 64~~ | ~~16#0000\_0000\_0000\_0000~~ | ~~64~~ |

**备注：以上内容来自IEC 61131-3第三版，红色部分是第三版新增部分，删除线表示M6目前不支持。**

## 内置复杂类型

|  |  |  |  |
| --- | --- | --- | --- |
| **Keyword** | **Description** | **Default initial value** | **N** |
| **ARRAY** |  |  |  |
| **POINTER** |  |  |  |

B:=ADR(A);

C:=VAL(B);

## 运算符(Operators)

|  |  |  |  |
| --- | --- | --- | --- |
| **Description** | **Symbol** | **Example** | **Precedence** |
| Parentheses | (expression) | (A+B/C), (A+B)/C, A/(B+C) | 11 (Highest) |
| Evaluation of result of  function and method  – if a result is declared | Identifier(parameter list) | LN(A), MAX(X,Y) | 10 |
| ~~Dereference~~ | ~~^~~ | ~~R^~~ | ~~9~~ |
| Negation | - | -A, - A | 8 |
| Unary Plus | + | +B, + B | 8 |
| Complement | NOT | NOT C | 8 |
| ~~Exponentiation~~ | ~~\*\*~~ | ~~A\*\*B, B \*\* B~~ | ~~7~~ |
| Multiply | \* | A\*B, A \* B | 6 |
| Divide | / | A/B, A / B / D | 6 |
| Modulo | MOD | A MOD B | 6 |
| Add | + | A+B, A + B + C | 5 |
| Subtract | - | A-B, A – B - C | 5 |
| Comparison | < , > , <= , >= | A<B ~~A < B < C~~ | 4 |
| Equality | = | A=B, A=B & B=C | 4 |
| Inequality | <> | A<>B, A <> B | 4 |
| Boolean AND | & | A&B, A & B, A & B & C | 3 |
| Boolean AND | AND | A AND B | 3 |
| Boolean Exclusive OR | XOR | A XOR B | 2 |
| Boolean OR | OR | A OR B | 1 (Lowest) |

## 声明(Statements)

| No. | Description | Examples |
| --- | --- | --- |
| 1 | **Assignment** Variable:= expression; |  |
| 1a | Variable and expression of elementary data type | A:= B; CV:= CV+1; C:= SIN(X); |
| 1b | Variables and expression of different elementary data types with implicit type conversion according | A\_Real:= B\_Int; |
| 1c | Variable and expression of user-defined type | A\_Struct1:= B\_Struct1;  C\_Array1 := D\_Array1; |
| 1d | Instances of function block type | A\_Instance1:= B\_Instance1; |
| 2 | **Call**  Function call  Function block call and FB output  usage | FCT(17);  CMD\_TMR(IN:= bIn1, PT:= T#300ms);  A:= CMD\_TMR.Q; |
| 3 | **RETURN** | RETURN ; |
|  | **Selection** |  |
| 4 | IF ...  THEN ...  ELSIF ...  THEN ...  ELSE ...END\_IF | D := B\*B - 4\*A\*C ; IF D < 0.0 THEN NROOTS := 0 ; ELSIF D = 0.0 THEN  NROOTS := 1 ;  X1 := - B/(2.0\*A) ; ELSE  NROOTS := 2 ;  X1 := (- B + SQRT(D))/(2.0\*A) ;  X2 := (- B - SQRT(D))/(2.0\*A) ; END\_IF ; |
| 5 | CASE ... OF  ...  ELSE ...  END\_CASE | TW := BCD\_TO\_INT(THUMBWHEEL);  TW\_ERROR := 0;  CASE TW OF  1,5: DISPLAY := OVEN\_TEMP;  2: DISPLAY := MOTOR\_SPEED;  3: DISPLAY := GROSS - TARE;  4,6..10: DISPLAY := STATUS(TW - 4); ELSE DISPLAY := 0 ;  TW\_ERROR := 1;  END\_CASE; QW100 := INT\_TO\_BCD(DISPLAY); |
|  | Iteration |  |
| 6 | FOR ... TO ... BY ... DO  ...  END\_FOR | J := 101 ; FOR I := 1 TO 100 BY 2 DO  IF WORDS[I] = 'KEY' THEN  J := I ;  EXIT ;  END\_IF ;  END\_FOR ; |
| 7 | WHILE ... DO  ...  END\_WHILE | J := 1; WHILE J <= 100 & WORDS[J] <> 'KEY' DO  J := J+2 ; END\_WHILE ; |
| 8 | REPEAT ...  UNTIL ...  END\_REPEAT | J := -1 ; REPEAT  J := J+2 ; UNTIL J = 101 OR WORDS[J] = 'KEY' END\_REPEAT ; |
| 9 | **CONTINUE** | J:= 1;  WHILE (J <= 100 AND WORDS[J] <> 'KEY') DO  IF (J MOD 3 = 0) THEN  CONTINUE;  END\_IF;  (\* if j=1,2,4,5,7,8, ... then this statement\*);  ;  END\_WHILE; |
| 10 | **EXIT** an iteration | EXIT ; |
| 11 | Empty Statement | ; |

## 变量(Variable)

## 用户自定义类型(User-defined type)

## 函数(Function)

# 语言转换(ST->C)

## 原则

1. 以正确性为第一原则
2. 适度考虑生成代码的风格和可读性，建议不作为硬性指标，作为持续优化指标

## 内置类型

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **ST语言** | **C语言** | **备注** | **ST举例** | **C举例** |
| BOOL | bool | ST规范定义为1bit，C语言定义为8bit |  |  |
| SINT | int8\_t |  |  |  |
| INT | int16\_t |  |  |  |
| DINT | int32\_t |  |  |  |
| ~~LINT~~ | int64\_t |  |  |  |
| USINT | uint8\_t |  |  |  |
| UINT | uint16\_t |  |  |  |
| UDINT | uint32\_t |  |  |  |
| ~~ULINT~~ | uint64\_t |  |  |  |
| REAL | float | **需要确定浮点数所使用的规范是否一致** |  |  |
| LREAL | double |  |  |
| TIME | uint32\_t | **待确认** |  |  |
| ~~LTIME~~ |  |  |  |  |
| DATE | time\_t |  |  |  |
| ~~LDATE~~ |  |  |  |  |
| TIME\_OF\_DAY or TOD | uint32\_t | **待确认** |  |  |
| ~~LTIME\_OF\_DAY or LTOD~~ |  |  |  |  |
| DATE\_AND\_TIME or DT | time\_t | **待确认** |  |  |
| ~~LDATE\_AND\_TIME or DT~~ |  |  |  |  |
| ~~STRING~~ |  |  |  |  |
| ~~WSTRING~~ |  |  |  |  |
| ~~CHAR~~ |  |  |  |  |
| ~~WCHAR~~ |  |  |  |  |
| ~~BYTE~~ |  |  |  |  |
| ~~WORD~~ |  |  |  |  |
| ~~DWORD~~ |  |  |  |  |
| ~~LWORD~~ |  |  |  |  |

## 运算符

|  |  |  |  |
| --- | --- | --- | --- |
| **描述** | **ST语言** | **C语言** | **备注** |
| Parentheses | (expression) | (expression) |  |
| Evaluation of result of  function and method  – if a result is declared | Identifier(parameter list) | Identifier(parameter list) |  |
| ~~Dereference~~ | ~~^~~ |  |  |
| Negation | - | - |  |
| Unary Plus | + | + |  |
| Complement | NOT | ~ |  |
| ~~Exponentiation~~ | ~~\*\*~~ | \*\* |  |
| Multiply | \* | \* |  |
| Divide | / | / |  |
| Modulo | MOD | % |  |
| Add | + | + |  |
| Subtract | - | - |  |
| Comparison | < , > , <= , >= | <,>,<=,>= |  |
| Equality | = | == |  |
| Inequality | <> | != |  |
| Boolean AND | & | & |  |
| Boolean AND | AND | & |  |
| Boolean Exclusive OR | XOR | ^ |  |
| Boolean OR | OR | || |  |

## 声明

## 风险点

1. 时间相关类型的处理，ST语言和C语言差别比较大，而且和编译器处理相关，需要与编译器设计人员讨论 – 采用自定义数据类型，通过运行库的方式解决
2. ST语言输出变量的处理

其它事项记录

1. IEC运行库的设计，采用C语言编写