

CATC Scripting Language Reference Manual for CATC USB Analyzers

A Scripting Language for CATC USBTracer, USBMobile, and
USBAdvisor USB Protocol Analyzers

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CHAPTER 1: INTRODUCTION

CATC Scripting Language (CSL) was developed to create scripts that would allow users to do file-based decoding with CATC USBTracer, USBMobile, and USBAdvisor analyzers. CSL is used to edit CATC Decode Scripting (CDS) files. CATC analyzers are equipped with built-in decoders in addition to script-based decoders that can be modified by the users or implemented as-is. Decoding scripts for analyzers are distributed in the `/scripts` directory. These scripts are tools to decode and display transactions. Users can also add entirely new, customized decoders.

Included with the CATC USBTracer Protocol Analyzer are USB decoder scripts for many of the USB classes, as described in the USB specification. They are located in the `USBTracer\Scripts` directory and are identifiable by the `.dec` and `.inc` extensions. These scripts are tools to decode and display transactions. Users can also add entirely new, customized decoders to fit their own, specific development needs. USBTracer looks in the `\Scripts` directory and automatically loads all of the `.dec` files that it finds. To prevent a particular decoder from being loaded, changed its extension to something other than `.dec` or move it out of the `\Scripts` directory.

CSL is based on C language syntax, so anyone with a C programming background will have no trouble learning CSL. The simple, yet powerful, structure of CSL also enables less experienced users to easily acquire the basic knowledge needed to start writing custom scripts.

Features of CATC Scripting Language

- Powerful -- provides a high-level API while simultaneously allowing implementation of complex algorithms.
- Easy to learn and use -- has a simple but effective syntax.
- Self-contained -- needs no external tools to run scripts.
- Wide range of value types -- provides efficient and easy processing of data.
- Used to create built-in script-based decoders for analyzers.
- May be used to write custom decoders.
- General purpose -- is integrated in a number of CATC products.

CHAPTER 2: VALUES

There are five value types that may be manipulated by a script: **integers**, **strings**, **lists**, **raw bytes**, and **null**. CSL is not a strongly typed language. Value types need not be pre-declared. Literals, variables and constants can take on any of the five value types, and the types can be reassigned dynamically.

Literals

Literals are data that remain unchanged when the program is compiled. Literals are a way of expressing hard-coded data in a script.

Integers

Integer literals represent numeric values with no fractions or decimal points. Hexadecimal, octal, decimal, and binary notation are supported:

Hexadecimal numbers must be preceded by 0x: 0x2A, 0x54, 0xFFFFFFFF01

Octal numbers must begin with 0: 0775, 017, 0400

Decimal numbers are written as usual: 24, 1256, 2

Binary numbers are denoted with 0b: 0b01101100, 0b01, 0b100000

Strings

String literals are used to represent text. A string consists of zero or more characters and can include numbers, letters, spaces, and punctuation. An *empty string* (" ") contains no characters and evaluates to false in an expression, whereas a non-empty string evaluates to true. Double quotes surround a string, and some standard backslash (\) escape sequences are supported.

String	Represented text
"Quote: \"This is a string literal.\""	Quote: "This is a string literal."
"256"	256 **Note that this does not represent the integer 256, but only the characters that make up the number.
"abcd!\$%&*"	abcd!\$%&*
"June 26, 2001"	June 26, 2001
"[1, 2, 3]"	[1, 2, 3]

Table 2.1: Examples of String Literals

Escape Sequences

These are the available escape sequences in CSL:

Character	Escape Sequence	Example	Output
backslash	\\	"This is a backslash: \\"	This is a backslash: \
double quote	\"	"\"Quotes!\""	"Quotes!"
horizontal tab	\t	"Before tab\tAfter tab"	Before tab After tab
newline	\n	"This is how\n to get a newline."	This is how to get a newline.
single quote	\'	"\'Single quote\'"	'Single quote'

Table 2.2: Escape Sequences

Lists

A list can hold zero or more pieces of data. A list that contains zero pieces of data is called an *empty list*. An empty list evaluates to false when used in an expression, whereas a non-empty list evaluates to true. List literals are expressed using the square bracket ([]) delimiters. List elements can be of any type, including lists.

```
[1, 2, 3, 4]
[]
["one", 2, "three", [4, [5, [6]]]]
```

Raw Bytes

Raw binary values are used primarily for efficient access to packet payloads. A literal notation is supported using single quotes:

```
'00112233445566778899AABBCCDDEEFF'
```

This represents an array of 16 bytes with values starting at 00 and ranging up to 0xFF. The values can only be hexadecimal digits. Each digit represents a nybble (four bits), and if there are not an even number of nybbles specified, an implicit zero is added to the first byte. For example:

```
'FFF'
```

is interpreted as

```
'0FFF'
```

Null

Null indicates an absence of valid data. The keyword `null` represents a literal null value and evaluates to false when used in expressions.

```
result = null;
```

Variables

Variables are used to store information, or data, that can be modified. A variable can be thought of as a container that holds a value.

All variables have names. Variable names must contain only alphanumeric characters and the underscore (`_`) character, and they cannot begin with a number. Some possible variable names are

```
x
_NewValue
name_2
```

A variable is created when it is assigned a value. Variables can be of any value type, and can change type with re-assignment. Values are assigned using the assignment operator (`=`). The name of the variable goes on the left side of the operator, and the value goes on the right:

```
x = [ 1, 2, 3 ]
New_value = x
name2 = "Smith"
```

If a variable is referenced before it is assigned a value, it evaluates to null.

There are two types of variables: *global* and *local*.

Global Variables

Global variables are defined outside of the scope of functions. Defining global variables requires the use of the keyword `set`. Global variables are visible throughout a file (and all files that it includes).

```
set Global = 10;
```

If an assignment in a function has a global as a left-hand value, a variable will not be created, but the global variable will be changed. For example

```
set Global = 10;

Function()
{
    Global = "cat";
    Local = 20;
}
```

will create a local variable called `Local`, which will only be visible within the function `Function`. Additionally, it will change the value of `Global` to `"cat"`, which will be visible to all functions. This will also change its value type from an integer to a string.

Local Variables

Local variables are not declared. Instead, they are created as needed. Local variables are created either by being in a function's parameter list, or simply by being assigned a value in a function body.

```
Function(Parameter)
{
    Local = 20;
}
```

This function will create a local variable `Parameter` and a local variable `Local`, which has an assigned value of 20.

Constants

A constant is similar to a variable, except that its value cannot be changed. Like variables, constant names must contain only alphanumeric characters and the underscore (`_`) character, and they cannot begin with a number.

Constants are declared similarly to global variables using the keyword `const`:

```
const CONSTANT = 20;
```

They can be assigned to any value type, but will generate an error if used in the left-hand side of an assignment statement later on. For instance,

```
const constant_2 = 3;

Function()
{
    constant_2 = 5;
}
```

will generate an error.

Declaring a constant with the same name as a global, or a global with the same name as a constant, will also generate an error. Like globals, constants can only be declared in the file scope.

CHAPTER 3: EXPRESSIONS

An expression is a statement that calculates a value. The simplest type of expression is assignment:

```
x = 2
```

The expression `x = 2` calculates 2 as the value of `x`.

All expressions contain operators, which are described in Chapter 4, *Operators*, on page 9. The operators indicate how an expression should be evaluated in order to arrive at its value. For example

```
x + 2
```

says to add 2 to `x` to find the value of the expression. Another example is

```
x > 2
```

which indicates that `x` is greater than 2. This is a Boolean expression, so it will evaluate to either true or false. Therefore, if `x = 3`, then `x > 2` will evaluate to true; if `x = 1`, it will return false.

True is denoted by a non-zero integer (any integer except 0), and false is a zero integer (0). True and false are also supported for lists (an empty list is false, while all others are true), and strings (an empty string is false, while all others are true), and `null` is considered false. However, all Boolean operators will result in integer values.

select expression

The `select` expression selects the value to which it evaluates based on Boolean expressions. This is the format for a `select` expression:

```
select {  
    <expression1> : <statement1>  
    <expression2> : <statement2>  
    ...  
};
```

The expressions are evaluated in order, and the statement that is associated with the first true expression is executed. That value is what the entire expression evaluates to.

```
x = 10
Value_of_x = select {
  x < 5 : "Less than 5";
  x >= 5 : "Greater than or equal to 5";
};
```

The above expression will evaluate to “Greater than or equal to 5” because the first true expression is `x >= 5`. Note that a semicolon is required at the end of a `select` expression because it is not a compound statement and can be used in an expression context.

There is also a keyword `default`, which in effect always evaluates to true. An example of its use is

```
Astring = select {
  A == 1 : "one";
  A == 2 : "two";
  A == 3 : "three";
  A > 3 : "overflow";
  default : null;
};
```

If none of the first four expressions evaluates to true, then `default` will be evaluated, returning a value of `null` for the entire expression.

`select` expressions can also be used to conditionally execute statements, similar to C `switch` statements:

```
select {
  A == 1 : DoSomething();
  A == 2 : DoSomethingElse();
  default: DoNothing();
};
```

In this case the appropriate function is called depending on the value of `A`, but the evaluated result of the `select` expression is ignored.

CHAPTER 4: OPERATORS

An operator is a symbol that represents an action, such as addition or subtraction, that can be performed on data. Operators are used to manipulate data. The data being manipulated are called *operands*. Literals, function calls, constants, and variables can all serve as operands. For example, in the operation

```
x + 2
```

the variable `x` and the integer `2` are both operands, and `+` is the operator.

Operations

Operations can be performed on any combination of value types, but will result in a null value if the operation is not defined. Defined operations are listed in the Operand Types column of Table 4.2 on page 12. Any binary operation on a null and a non-null value will result in the non-null value. For example, if

```
x = null
```

then

```
3 * x
```

will return a value of 3.

A binary operation is an operation that contains an operand on each side of the operator, as in the preceding examples. An operation with only one operand is called a unary operation, and requires the use of a unary operator. An example of a unary operation is

```
!1
```

which uses the logical negation operator. It returns a value of 0.

The unary operators are `sizeof()`, `head()`, `tail()`, `~` and `!`.

Operator Precedence and Associativity

Operator rules of precedence and associativity determine in what order operands are evaluated in expressions. Expressions with operators of higher precedence are evaluated first. In the expression

```
4 + 9 * 5
```

the `*` operator has the highest precedence, so the multiplication is performed before the addition. Therefore, the expression evaluates to 49.

The associative operator () is used to group parts of the expression, forcing those parts to be evaluated first. In this way, the rules of precedence can be overridden. For example,

$$(4 + 9) * 5$$

causes the addition to be performed before the multiplication, resulting in a value of 65.

When operators of equal precedence occur in an expression, the operands are evaluated according to the associativity of the operators. This means that if an operator's associativity is left to right, then the operations will be done starting from the left side of the expression. So, the expression

$$4 + 9 - 6 + 5$$

would evaluate to 12. However, if the associative operator is used to group a part or parts of the expression, those parts are evaluated first. Therefore,

$$(4 + 9) - (6 + 5)$$

has a value of 2.

In Table 4.1, *Operator Precedence and Associativity*, the operators are listed in order of precedence, from highest to lowest. Operators on the same line have equal precedence, and their associativity is shown in the second column.

Operator Symbol	Associativity
++ --	Right to left
[] ()	Left to right
~ ! sizeof head tail	Right to left
* / %	Left to right
+ -	Left to right
<< >>	Left to right
< > <= >=	Left to right
== !=	Left to right
&	Left to right
^	Left to right
	Left to right
&&	Left to right
	Left to right

Table 4.1: Operator Precedence and Associativity

Operator Symbol									Associativity
=	+=	-=	*=	/=	%=	>>=	<<=	&=	Right to left
				^=	=				

Table 4.1: Operator Precedence and Associativity (Continued)

Operator Symbol	Description	Operand Types	Result Types	Examples
Index Operator				
[]	Index or subscript	Raw Bytes	Integer	Raw = '001122' Raw[1] = 0x11
		List	Any	List = [0, 1, 2, 3, [4, 5]] List[2] = 2 List[4] = [4, 5] List[4][1] = 5 *Note: if an indexed Raw value is assigned to any value that is not a byte (> 255 or not an integer), the variable will be promoted to a list before the assignment is performed.
Associative Operator				
()	Associative	Any	Any	(2 + 4) * 3 = 18 2 + (4 * 3) = 14
Arithmetic Operators				
*	Multiplication	Integer-integer	Integer	3 * 1 = 3
/	Division	Integer-integer	Integer	3 / 1 = 3
%	Modulus	Integer-integer	Integer	3 % 1 = 0
+	Addition	Integer-integer	Integer	2 + 2 = 4
		String-string	String	"one " + "two" = "one two"
		Raw byte-raw byte	Raw	'001122' + '334455' = '001122334455'
		List-list	List	[1, 2] + [3, 4] = [1, 2, 3, 4]
		Integer-list	List	1 + [2, 3] = [1, 2, 3]
		Integer-string	String	"number = " + 2 = "number = 2" *Note: integer-string concatenation uses decimal conversion.
-	Subtraction	Integer-integer	Integer	3 - 1 = 2
		String-list	List	"one" + ["two"] = ["one", "two"]
Increment and Decrement Operators				
++	Increment	Integer	Integer	a = 1 ++a = 2 b = 1 b++ = 1 *Note that the value of b after execution is 2.
--	Decrement	Integer	Integer	a = 2 --a = 1 b = 2 b-- = 2 *Note that the value of b after execution is 1.

Table 4.2: Operators

Operator Symbol	Description	Operand Types	Result Types	Examples
Equality Operators				
==	Equal	Integer-integer	Integer	2 == 2
		String-string	Integer	"three" == "three"
		Raw byte-raw byte	Integer	'001122' == '001122'
		List-list	Integer	[1, [2, 3]] == [1, [2, 3]] *Note: equality operations on values of different types will evaluate to false.
!=	Not equal	Integer-integer	Integer	2 != 3
		String-string	Integer	"three" != "four"
		Raw byte-raw byte	Integer	'001122' != '334455'
		List-list	Integer	[1, [2, 3]] != [1, [2, 4]] *Note: equality operations on values of different types will evaluate to false.
Relational Operators				
<	Less than	Integer-integer	Integer	1 < 2
		String-string	Integer	"abc" < "def"
>	Greater than	Integer-integer	Integer	2 > 1
		String-string	Integer	"xyz" > "abc"
<=	Less than or equal	Integer-integer	Integer	23 <= 27
		String-string	Integer	"cat" <= "dog"
>=	Greater than or equal	Integer-integer	Integer	2 >= 1
		String-string	Integer	"sun" >= "moon" *Note: relational operations on string values are evaluated according to character order in the ASCII table.
Logical Operators				
!	Negation	All combinations of types	Integer	!0 = 1 !"cat" = 0 !9 = 0 !" " = 1
&&	Logical AND	All combinations of types	Integer	1 && 1 = 1 1 && !" " = 1 1 && 0 = 0 1 && "cat" = 1
	Logical OR	All combinations of types	Integer	1 1 = 1 0 0 = 0 1 0 = 1 " " !"cat" = 0

Table 4.2: Operators (Continued)

Operator Symbol	Description	Operand Types	Result Types	Examples
Bitwise Logical Operators				
~	Bitwise complement	Integer-integer	Integer	~0b11111110 = 0b00000001
&	Bitwise AND	Integer-integer	Integer	0b11111110 & 0b01010101 = 0b01010100
^	Bitwise exclusive OR	Integer-integer	Integer	0b11111110 ^ 0b01010101 = 0b10101011
	Bitwise inclusive OR	Integer-integer	Integer	0b11111110 0b01010101 = 0b11111111
Shift Operators				
<<	Left shift	Integer-integer	Integer	0b11111110 << 3 = 0b11110000
>>	Right shift	Integer-integer	Integer	0b11111110 >> 1 = 0b01111111
Assignment Operators				
=	Assignment	Any	Any	A = 1 B = C = A
+=	Addition assignment	Integer-integer	Integer	x = 1 x += 1 = 2
		String-string	String	a = "one " a += "two" = "one two"
		Raw byte-raw byte	Raw	z = '001122' z += '334455' = '001122334455'
		List-list	List	x = [1, 2] x += [3, 4] = [1, 2, 3, 4]
		Integer-list	List	y = 1 y += [2, 3] = [1, 2, 3]
		Integer-string	String	a = "number = " a += 2 = "number = 2" *Note: integer-string concatenation uses decimal conversion.
+=	String-list	List	s = "one" s + ["two"] = ["one", "two"]	
		List	s = "one" s + ["two"] = ["one", "two"]	
-=	Subtraction assignment	Integer-integer	Integer	y = 3 y -= 1 = 2
*=	Multiplication assignment	Integer-integer	Integer	x = 3 x *= 1 = 3
/=	Division assignment	Integer-integer	Integer	s = 3 s /= 1 = 3
%=	Modulus assignment	Integer-integer	Integer	y = 3 y %= 1 = 0
>>=	Right shift assignment	Integer-integer	Integer	b = 0b11111110 b >>= 1 = 0b01111111
<<=	Left shift assignment	Integer-integer	Integer	a = 0b11111110 a <<= 3 = 0b11111110000

Table 4.2: Operators (Continued)

Operator Symbol	Description	Operand Types	Result Types	Examples
Assignment Operators (continued)				
<code>&=</code>	Bitwise AND assignment	Integer-integer	Integer	<code>a = 0b11111110</code> <code>a &= 0b01010101 = 0b01010100</code>
<code>^=</code>	Bitwise exclusive OR assignment	Integer-integer	Integer	<code>e = 0b11111110</code> <code>e ^= 0b01010101 = 0b10101011</code>
<code> =</code>	Bitwise inclusive OR assignment	Integer-integer	Integer	<code>i = 0b11111110</code> <code>i = 0b01010101 = 0b11111111</code>
List Operators				
<code>sizeof()</code>	Number of elements	Any	Integer	<code>sizeof([1, 2, 3]) = 3</code> <code>sizeof('0011223344') = 5</code> <code>sizeof("string") = 6</code> <code>sizeof(12) = 1</code> <code>sizeof([1, [2, 3]]) = 2</code> *Note: the last example demonstrates that the <code>sizeof()</code> operator returns the shallow count of a complex list.
<code>head()</code>	Head	List	Any	<code>head([1, 2, 3]) = 1</code> *Note: the Head of a list is the first item in the list.
<code>tail()</code>	Tail	List	List	<code>tail([1, 2, 3]) = [2, 3]</code> *Note: the Tail of a list includes everything except the Head.

Table 4.2: Operators (Continued)

CHAPTER 5: COMMENTS

Comments may be inserted into scripts as a way of documenting what the script does and how it does it. Comments are useful as a way to help others understand how a particular script works. Additionally, comments can be used as an aid in structuring the program.

Comments in CSL begin with a hash mark (#) and finish at the end of the line. The end of the line is indicated by pressing the Return or Enter key. Anything contained inside the comment delimiters is ignored by the compiler. Thus,

```
# x = 2;
```

is not considered part of the program. CSL supports only end-of-line comments, which means that comments can be used only at the end of a line or on their own line. It's not possible to place a comment in the middle of a line.

Writing a multi-line comment requires surrounding each line with the comment delimiters

```
# otherwise the compiler would try to interpret  
# anything outside of the delimiters  
# as part of the code.
```

The most common use of comments is to explain the purpose of the code immediately following the comment. For example:

```
# Add a profile if we got a server channel  
if(rfChannel != "Failure")  
{  
    result = SDPAddProfileServiceRecord(rfChannel,  
    "ObjectPush");  
    Trace("SDPAddProfileServiceRecord returned ",  
    result, "\n");  
}
```


CHAPTER 6: KEYWORDS

Keywords are reserved words that have special meanings within the language. They cannot be used as names for variables, constants or functions.

In addition to the operators, the following are keywords in CSL:

Keyword	Usage
select	select expression
set	define a global variable
const	define a constant
return	return statement
while	while statement
for	for statement
if	if statement
else	if-else statement
default	select expression
null	null value
in	input context
out	output context

Table 6.1: Keywords

CHAPTER 7: STATEMENTS

Statements are the building blocks of a program. A program is made up of list of statements.

Seven kinds of statements are used in CSL: expression statements, if statements, if-else statements, while statements, for statements, return statements, and compound statements.

Expression Statements

An expression statement describes a value, variable, or function.

```
<expression>
```

Here are some examples of the different kinds of expression statements:

```
Value: x + 3;  
Variable: x = 3;  
Function: Trace ( x + 3 );
```

The variable expression statement is also called an *assignment statement*, because it assigns a value to a variable.

if Statements

An if statement follows the form

```
if <expression> <statement>
```

For example,

```
if (3 && 3) Trace("True!");
```

will cause the program to evaluate whether the expression `3 && 3` is nonzero, or True. It is, so the expression evaluates to True and the Trace statement will be executed. On the other hand, the expression `3 && 0` is not nonzero, so it would evaluate to False, and the statement wouldn't be executed.

if-else Statements

The form for an if-else statement is

```
if <expression> <statement1>  
else <statement2>
```

The following code

```
if ( 3 - 3 || 2 - 2 ) Trace ( "Yes" );
else Trace ( "No" );
```

will cause “No” to be printed, because `3 - 3 || 2 - 2` will evaluate to False (neither `3 - 3` nor `2 - 2` is nonzero).

while Statements

A while statement is written as

```
while <expression> <statement>
```

An example of this is

```
x = 2;
while ( x < 5 )
{
    Trace ( x, ", " );
    x = x + 1;
}
```

The result of this would be

```
2, 3, 4,
```

for Statements

A for statement takes the form

```
for (<expression1>; <expression2>; <expression3>)
<statement>
```

The first expression initializes, or sets, the starting value for *x*. It is executed one time, before the loop begins. The second expression is a conditional expression. It determines whether the loop will continue -- if it evaluates true, the function keeps executing and proceeds to the statement; if it evaluates false, the loop ends. The third expression is executed after every iteration of the statement.

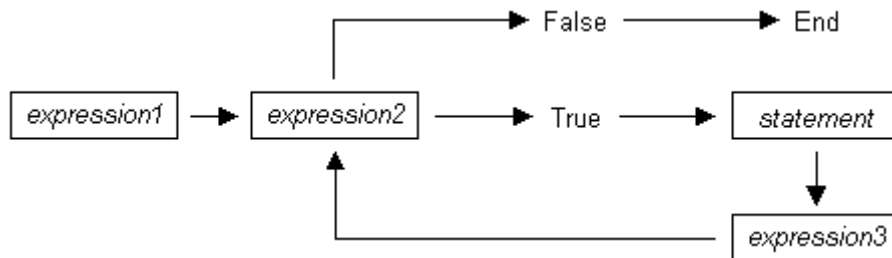


Figure 7-1: Execution of a for statement

The example

```
for ( x = 2; x < 5; x = x + 1 ) Trace ( x, "\n" );
```

would output

```
2
3
4
```

The example above works out like this: the expression `x = 2` is executed. The value of `x` is passed to `x < 5`, resulting in `2 < 5`. This evaluates to true, so the statement `Trace (x, "\n")` is performed, causing 2 and a new line to print. Next, the third expression is executed, and the value of `x` is increased to 3. Now, `x < 5` is executed again, and is again true, so the `Trace` statement is executed, causing 3 and a new line to print. The third expression increases the value of `x` to 4; `4 < 5` is true, so 4 and a new line are printed by the `Trace` statement. Next, the value of `x` increases to 5. `5 < 5` is *not* true, so the loop ends.

return Statements

Every function returns a value, which is usually designated in a `return` statement. A `return` statement returns the value of an expression to the calling environment. It uses the following form:

```
return <expression>;
```

An example of a `return` statement and its calling environment is

```
Trace ( HiThere() );
...
HiThere()
{
    return "Hi there";
}
```

The call to the primitive function `Trace` causes the function `HiThere()` to be executed. `HiThere()` returns the string “Hi there” as its value. This value is passed to the calling environment (`Trace`), resulting in this output:

```
Hi there
```

A `return` statement also causes a function to stop executing. Any statements that come after the `return` statement are ignored, because `return` transfers control of the program back to the calling environment. As a result,

```
Trace ( HiThere() );
...
HiThere()
{
    a = "Hi there";
    return a;
    b = "Goodbye";
    return b;
}
```

will output only

```
Hi there
```

because when `return a;` is encountered, execution of the function terminates, and the second return statement (`return b;`) is never processed. However,

```
Trace ( HiThere() );
...
HiThere()
{
    a = "Hi there";
    b = "Goodbye";
    if ( 3 != 3 ) return a;
    else return b;
}
```

will output

```
Goodbye
```

because the `if` statement evaluates to false. This causes the first `return` statement to be skipped. The function continues executing with the `else` statement, thereby returning the value of `b` to be used as an argument to `Trace`.

Compound Statements

A compound statement, or *statement block*, is a group of one or more statements that is treated as a single statement. A compound statement is always enclosed in curly braces (`{ }`). Each statement within the curly braces is followed by a semicolon; however, a semicolon is not used following the closing curly brace.

The syntax for a compound statement is

```
{
    <first_statement>;
    <second_statement>;
}
```

```
    ...  
    <last_statement>;  
}
```

An example of a compound statement is

```
{  
    x = 2;  
    x + 3;  
}
```

It's also possible to nest compound statements, like so:

```
{  
    x = 2;  
    {  
        y = 3;  
    }  
    x + 3;  
}
```

Compound statements can be used anywhere that any other kind of statement can be used.

```
if (3 && 3)  
{  
    result = "True!";  
    Trace(result);  
}
```

Compound statements are required for function declarations and are commonly used in `if`, `if-else`, `while`, and `for` statements.

CHAPTER 8: PREPROCESSING

The preprocessing command `%include` can be used to insert the contents of a file into a script. It has the effect of copying and pasting the file into the code. Using `%include` allows the user to create modular script files that can then be incorporated into a script. This way, commands can easily be located and reused.

The syntax for `%include` is this:

```
%include "includefile.inc"
```

The quotation marks around the filename are required, and by convention, the included file has a `.inc` extension.

The filenames given in the include directive are always treated as being relative to the current file being parsed. So, if a file is referenced via the preprocessing command in a `.dec` file, and no path information is provided (`%include "file.inc"`), the application will try to load the file from the current directory. Files that are in a directory one level up from the current file can be referenced using `..\file.inc`, and likewise, files one level down can be referenced using the relative pathname (`directory\file.inc`). Last but not least, files can also be referred to using a full pathname, such as `"C:\global_scripts\include\file.inc"`.

Additionally, the directory “shared” under “Scripts” is checked too. So if you want to reference a file in the “shared” directory, you can reference it by its name without any explicit pathname.

CHAPTER 9: CONTEXT

The context is the mechanism by which transaction data is passed in and out of the scripts. There is an output context that is modified by the script, and there are possibly multiple input contexts that the script will be invoked on separately.

A context serves two roles: firstly, it functions as a symbol table whose values are local to a particular transaction; secondly, it functions as an interface to the application. Two keywords are used to reference symbols in the context: `in` and `out`. Dot notation is used to specify a symbol within a context:

```
out.symbol = "abcd";  
out.type = in.type;
```

The output context can be read and written to, but the input context can only be read. Context symbols follow the same rules as local variables: they are created on demand, and uninitialized symbols always evaluate to null.

When a script is first invoked, it is given an input context that corresponds to a packet or transaction that is a candidate for being a part of a larger transaction. The output context is initially empty. It is the script's job to examine the input context and decide if it qualifies for membership in the type of transaction that the script was designed to decode. If it qualifies, the appropriate values will be decoded and put in the output context symbol table, and if the transaction is complete, it will be done. If the transaction is not complete, the script will indicate this to the application based on its return value, and will be invoked again with the same output context, but a new input context. The script then must decide if this new input context is a member of the transaction, and keep doing this until the transaction is complete.

In order to accomplish all this, state information should be placed in the output context. It should be possible to use the output context of one transaction as an input context to another transaction.

CHAPTER 10: FUNCTIONS

A function is a named statement or a group of statements that are executed as one unit. All functions have names. Function names must contain only alphanumeric characters and the underscore (`_`) character, and they cannot begin with a number.

A function can have zero or more *parameters*, which are values that are passed to the function statement(s). Parameters are also known as *arguments*. Value types are not specified for the arguments or return values. Named arguments are local to the function body, and functions can be called recursively.

The syntax for a function declaration is

```
name (<parameter1>, <parameter2>, ...)  
{  
    <statements>  
}
```

The syntax to call a function is

```
name (<parameter1>, <parameter2>, ...)
```

So, for example, a function named `add` can be declared like this:

```
add(x, y)  
{  
    return x + y;  
}
```

and called this way:

```
add(5, 6);
```

This would result in a return value of 11.

Every function returns a value. The return value is usually specified using a `return` statement, but if no `return` statement is specified, the return value will be the value of the last statement executed.

Arguments are not checked for appropriate value types or number of arguments when a function is called. If a function is called with fewer arguments than were defined, the specified arguments are assigned, and the remaining arguments are assigned to null. If a function is called with more arguments than were defined, the extra arguments are ignored. For example, if the function `add` is called with just one argument

```
add(1);
```

the parameter `x` will be assigned to 1, and the parameter `y` will be assigned to null, resulting in a return value of 1. But if `add` is called with more than two arguments

```
add(1, 2, 3);
```

`x` will be assigned to 1, `y` to 2, and 3 will be ignored, resulting in a return value of 3.

All parameters are passed by value, not by reference, and can be changed in the function body without affecting the values that were passed in. For instance, the function

```
add_1(x, y)
{
    x = 2;
    y = 3;
    return x + y;
}
```

reassigns parameter values within the statements. So,

```
a = 10;
b = 20;
add_1(a, b);
```

will have a return value of 5, but the values of `a` and `b` won't be changed.

The scope of a function is the file in which it is defined (as well as included files), with the exception of primitive functions, whose scopes are global.

Calls to undefined functions are legal, but will always evaluate to null and result in a compiler warning.

CHAPTER 11: PRIMITIVES

Primitive functions are called similarly to regular functions, but they are implemented outside of the language. Some primitives support multiple types for certain arguments, but in general, if an argument of the wrong type is supplied, the function will return null.

Call()

`Call(<function_name string>, <arg_list list>)`

Parameter	Meaning	Default Value	Comments
<code>function_name string</code>			
<code>arg_list list</code>			Used as the list of parameters in the function call.

Return value

Same as that of the function that is called.

Comments

Calls a function whose name matches the `function_name` parameter. All scope rules apply normally. Spaces in the `function_name` parameter are interpreted as the `'_'` (underscore) character since function names cannot contain spaces.

Example

```
Call("Format", ["the number is %d", 10]);
```

is equivalent to:

```
Format("the number is %d", 10);
```

Format()

`Format (<format string>, <value string or integer>)`

Parameter	Meaning	Default Value	Comments
<code>format string</code>			
<code>value string or integer</code>			

Return value

None.

Comments

`Format` is used to control the way that arguments will print out. The format string may contain conversion specifications that affect the way in which the arguments in the value string are returned. Format conversion characters, flag characters, and field width modifiers are used to define the conversion specifications.

Example

```
Format ("0x%02X", 20);
```

would yield the string `0x14`.

`Format` can only handle one value at a time, so

```
Format ("%d %d", 20, 30);
```

would not work properly. Furthermore, types that do not match what is specified in the format string will yield unpredictable results.

Format Conversion Characters

These are the format conversion characters used in CSL:

Code	Type	Output
<code>c</code>	Integer	Character
<code>d</code>	Integer	Signed decimal integer.
<code>i</code>	Integer	Signed decimal integer
<code>o</code>	Integer	Unsigned octal integer
<code>u</code>	Integer	Unsigned decimal integer
<code>x</code>	Integer	Unsigned hexadecimal integer, using "abcdef."
<code>X</code>	Integer	Unsigned hexadecimal integer, using "ABCDEF."
<code>s</code>	String	String

Table 11.1: Format Conversion Characters

A conversion specification begins with a percent sign (%) and ends with a conversion character. The following optional items can be included, in order, between the % and the conversion character to further control argument formatting:

- Flag characters are used to further specify the formatting. There are five flag characters:
 - A minus sign (-) will cause an argument to be left-aligned in its field. Without the minus sign, the default position of the argument is right-aligned.
 - A plus sign will insert a plus sign (+) before a positive signed integer. This only works with the conversion characters `d` and `i`.

- A space will insert a space before a positive signed integer. This only works with the conversion characters `d` and `i`. If both a space and a plus sign are used, the space flag will be ignored.
- A hash mark (`#`) will prepend a 0 to an octal number when used with the conversion character `o`. If `#` is used with `x` or `X`, it will prepend `0x` or `0X` to a hexadecimal number.
- A zero (`0`) will pad the field with zeros instead of with spaces.
- Field width specification is a positive integer that defines the field width, in spaces, of the converted argument. If the number of characters in the argument is smaller than the field width, then the field is padded with spaces. If the argument has more characters than the field width has spaces, then the field will expand to accommodate the argument.

GetNBits ()

GetNBits (<bit_source *list* or *raw*>, <bit_offset *integer*>, <bit_count *integer*>)

Parameter	Meaning	Default Value	Comments
bit_source <i>list</i> , <i>raw</i> , or <i>integer</i>			Can be an integer value (4 bytes) or a list of integers that are interpreted as bytes.
bit_offset <i>integer</i>	Index of bit to start reading from		
bit_count <i>integer</i>	Number of bits to read		

Return value

None.

Comments

Reads `bit_count` bits from `bit_source` starting at `bit_offset`. Will return null if `bit_offset + bit_count` exceeds the number of bits in `bit_source`. If `bit_count` is 32 or less, the result will be returned as an integer. Otherwise, the result will be returned in a list format that is the same as the input format. `GetNBits` also sets up the bit data source and global bit offset used by `NextNBits` and `PeekNBits`. Note that bits are indexed starting at bit 0.

Example

```
raw = 'F0F0';      # 1111000011110000 binary
result = GetNBits ( raw, 2, 4 );
Trace ( "result = ", result );
```

The output would be

```

    result = C          # The result is given in
    hexadecimal. The result in binary is 1100.

```

In the call to `GetNBits`: starting at bit 2, reads 4 bits (1100), and returns the value 0xC.

NextNBits ()

```
NextNBits (<bit_count integer>)
```

Parameter	Meaning	Default Value	Comments
<code>bit_count integer</code>			

Return value

None.

Comments

Reads `bit_count` bits from the data source specified in the last call to `GetNBits`, starting after the last bit that the previous call to `GetNBits` or `NextNBits` returned. If called without a previous call to `GetNBits`, the result is undefined. Note that bits are indexed starting at bit 0.

Example

```

raw = 'F0F0';# 1111000011110000 binary
result1 = GetNBits ( raw, 2, 4 );
result2 = NextNBits(5);
result3 = NextNBits(2);
Trace ( "result1 = ", result1, " result2 = ", result2,
" result3 = ", result3 );

```

This will generate this trace output:

```
result1 = C result2 = 7 result3 = 2
```

In the call to `GetNBits`: starting at bit 2, reads 4 bits (1100), and returns the value 0xC.

In the first call to `NextNBits`: starting at bit 6, reads 5 bits (00111), and returns the value 0x7.

In the second call to `NextNBits`: starting at bit 11 (= 6 + 5), reads 2 bits (10), and returns the value 0x2.

Resolve ()

Resolve (<symbol_name string>)

Parameter	Meaning	Default Value	Comments
symbol_name string			

Return value

The value of the symbol. Returns null if the symbol is not found.

Comments

Attempts to resolve the value of a symbol. Can resolve global, constant and local symbols. Spaces in the symbol_name parameter are interpreted as the '_' (underscore) character since symbol names cannot contain spaces.

Example

```
a = Resolve( "symbol" );
```

is equivalent to:

```
a = symbol;
```

Trace ()

Trace (<arg1 any>, <arg2 any>, ...)

Parameter	Meaning	Default Value	Comments
arg any			The number of arguments is variable.

Return value

None.

Comments

The values given to this function are given to the debug console.

Example

```
list = ["cat", "dog", "cow"];
Trace("List = ", list, "\n");
```

would result in the output

```
List = [cat, dog, cow]
```


CHAPTER 12: DECODER PRIMITIVES

Abort ()

Abort ()

Parameter	Meaning	Default Value	Comments
N/A			

Return value

An integer that should be passed back to the application unchanged.

Comments

Called when an input context renders the currently pending transaction done, but is not itself a member of that transaction. An example would be an input transaction that represents some sort of reset condition that renders all pending transactions invalid. The input transaction is not consumed by this action and will go on to be considered for other pending transactions.

Example

```
if ( IsReset )
    return Abort ();
```

AddCell ()

AddCell(<name *string*>, <value *string*>, <description *string* or *null*>, <color *integer* or *list*>, <additional_info *any*>)

Parameter	Meaning	Default Value	Comments
name <i>string</i>			Displays in the name field of the cell.
value <i>string</i>			Displays in the value field of the cell.
description <i>string</i> or <i>null</i>			Displays in tool tip.
color <i>integer</i> or <i>list</i>		If not specified, a default color is used	Color can be specified as either a packed color value in an integer, or as an array of RGB values ranging from 0-255. Displays in the name field of the cell.

Parameter	Meaning	Default Value	Comments
<code>additional_info</code> <i>any</i>			Used to create special cells or to modify cell attributes. The values are predefined constants, and zero or more of them may be used at one time. Possible values are: _COLLAPSED _ERROR _EXPANDED [_FIXEDWIDTH, <i>w</i>] _HIDDEN _MONOCOLOR _MONOFIELD _SHOWN (default) _WARNING

Return value

None.

Comments

Adds a display cell to the current output context. Cells are displayed in the order that they are added. The name and value strings are displayed directly in the cell.

Example

```
# Create a regular cell named Normal with a value
"Cell" and tool tip "Normal cell":

AddCell( "Normal", "Value1", "Normal cell" );

# Use the _MONOCOLOR value in the additional_info
parameter to create a cell with a color value of
0x881122 in both the name and value fields:

AddCell( "MonoColor", "Value2", "MonoColor cell",
0x881122, _MONOCOLOR );

# Use the _MONOFIELD value to create a cell with only
a name field:

AddCell( "MonoField", "Value3", "MonoField cell",
[255, 200, 200], _MONOFIELD );

# Use the _ERROR value to create a cell with a red
value field:

AddCell( "Error", "Value4", "Error cell", 0xcc1155,
_ERROR );

# Use the _WARNING value to create a cell with a yellow
value field:
```

```
AddCell( "Warning", "Value5", "Warning cell",
0x00BB22, _WARNING );
```

Use the [_FIXEDWIDTH, w] value to create a cell with a fixed width of 20 in conjunction with the error value to create a fixed width cell with a red value field:

```
AddCell( "Fixed Width 20", "Value6", "Fixed Width and
Error cell", 0x001122, [_FIXEDWIDTH, 20], _ERROR );
```

The output of the example is:

Normal	MonoColor	MonoField	Error	Warning	Fixed Width 20
Value1	Value2		Value4	Value5	Value6

Figure 12-1: Example output for AddCell

AddDataCell()

```
AddDataCell(<data_value raw, list or integer>,
<additional_info any>, ...)
```

Parameter	Meaning	Default Value	Comments
<i>data_value raw, list, or integer</i>			Interpreted the same way as GetNBits interprets data_source
<i>additional_info any</i>			Used to create special cells or to modify cell attributes. Possible values are: _BYTES _COLLAPSED _DWORDS _EXPANDED _HIDDEN _SHOWN (default)

Return value

None.

Comments

Creates an expandable/collapsible cell for viewing raw data such as data payloads. Data can be raw bytes, an integer, or a list. If an integer is used, it will be interpreted as 4 bytes of data. Specifying _BYTES or _DWORDS in an additional_info field will force data to be interpreted as bytes or quadlets. _COLLAPSED, _EXPANDED, _HIDDEN and _SHOWN are all interpreted the same as in a regular AddCell call.

Example

```
# Creates a data cell with 2 dwords (32-bit integers)
of data.

AddDataCell( '0123456789ABCDEF', _DWORDS );

# Creates a data cell with 4 bytes. Integer data
values are always interpreted as 32 bits of data.

AddDataCell( 0x11223344, _BYTES );
```

The output of the example is:

Test Cells	Data	Data
0	01234567 89ABCDEF	11 22 33 44
Test Cells	Data	Data
1	2 quadlets	4 bytes

Figure 12-2: Example output for AddDataCell

AddEvent ()

```
AddEvent (<Group string>, <Value string> )
```

Parameter	Meaning	Default Value	Comments
Group <i>string</i>	The name of the group		Corresponds to the name of a field that might be encountered while decoding.
Value <i>string</i>	A value that will be associated with the group		Corresponds to a field value that might be encountered while parsing.

Return value

None.

Comments

Events are used for transaction searching and for transaction summary. This function is only effective when called during the `ProcessData ()` phase of decoding. Event groups and values are stored globally for transaction levels and new ones are created as they are encountered. Each transaction contains information as to which events were associated with it.

Example

```
AddEvent ( "DataLength", Format ( "%d",
out.DataLength ) );
```


AddSeparator()

AddSeparator(<additional_info any>, ...)

Parameter	Meaning	Default Value	Comments
additional_info any			Used to create special cells or to modify cell attributes. The values are predefined constants. Possible values are: _COLLAPSED _EXPANDED _HIDDEN _SHOWN (default)

Return value

None.

Comments

Creates a separator cell. _COLLAPSED, _EXPANDED, _HIDDEN, and _SHOWN are all interpreted the same as in a regular AddCell call.

Example

```
AddCell( "Stuff", "Things" );

# AddSeparator adds a space between the previous and
# subsequent cells.

AddSeparator();

AddCell( "More stuff", "More things" );
```

The output of the example is:

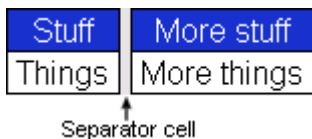


Figure 12-3: Separator cell example

BeginCellBlock()

BeginCellBlock(<name string>, <value string>, <description string or null>, <color integer or list>, <additional_info any>)

Parameter	Meaning	Default Value	Comments
name string			Displays in the name field of the cell.

Parameter	Meaning	Default Value	Comments
<i>value string</i>			Displays in the value field of the cell.
<i>description string or null</i>			Displays in tool tip.
<i>color integer or list</i>		If not specified, a default color is used	Color can be specified as either a packed color value in an integer, or as an array of RGB values ranging from 0-255. Displays in the name field of the cell.
<i>additional_info any</i>			Used to create special cells or to modify cell attributes. The values are predefined constants, and zero or more of them may be used at one time. Possible values are: [<code>_BLOCKNAME</code> , <code>x</code>] <code>_COLLAPSED</code> <code>_ERROR</code> <code>_EXPANDED</code> [<code>_FIXEDWIDTH</code> , <code>w</code>] <code>_HIDDEN</code> <code>_MONOCOLOR</code> <code>_MONOFIELD</code> <code>_SHOWN</code> (default) <code>_WARNING</code>

Return value

None.

Comments

Begins a cell block and adds a block header cell. This is a special cell that can be collapsed and expanded. The collapsed/expanded state of this cell affects cells in the group according to their `_COLLAPSED`, `_EXPANDED` attributes. All calls to `AddCell` after a call to `BeginCellBlock()` will put the new cells into this group until a call to `EndCellBlock` is made.

Cell blocks can be nested.

Example

```
# Begin the 'red' group. For clarity these cells will
be red:

BeginCellBlock( "Red Group", null, null, 0x0000ff,
  _MONOFIELD );

# This cell will be displayed when the red group is in
the expanded state:

AddCell( "Red is", "Expanded", null, 0x0000ff,
  _EXPANDED );
```

```
# This cell will be displayed when the red group is
collapsed:

AddCell( "Red is", "Collapsed", null, 0x0000ff,
_COLLAPSED );

# This begins the nested blue group.  Nothing in the
blue group will be displayed unless the red group is
expanded:

BeginCellBlock( "Blue Group", null, null, 0xff0000,
_MONOFIELD, _EXPANDED, [_BLOCKNAME, "BlockName"] );

# This cell is only displayed when the blue group is
visible and expanded:

AddCell( "Blue is", "Expanded", null, 0xff0000,
_EXPANDED );

# This cell is also only displayed when the blue group
is visible and expanded:

AddCell( "Blue", "Too", null, 0xff0000, _EXPANDED );

# This cell is only displayed when the blue group is
visible and collapsed:

AddCell( "Blue is", "Collapsed", null, 0xff0000,
_COLLAPSED );

# This ends the blue group.

EndCellBlock();

# Cells with the _SHOWN attribute are always
displayed.  This is the default:

AddCell( "Always", "Shown", null, 0x0000ff, _SHOWN );

# This cell will never be displayed.  In a real script
this would be driven by a variable:

AddCell( "Never", "Shown", null, 0x0000ff, _HIDDEN );

# This ends the red group.

EndCellBlock();
```

The output of the example is:

Red Group	Red is	Always
	Collapsed	Shown

Figure 12-4: Example output for BeginCellBlock with red group collapsed

Red Group	Red is	Blue Group	Blue is	Always
	Expanded		Collapsed	Shown

Figure 12-5: Example output for BeginCellBlock with red group expanded and blue group collapsed

Red Group	Red is	Blue Group	Blue is	Blue	Always
	Expanded		Expanded	Too	Shown

Figure 12-6: Example output for BeginCellBlock with red group expanded and blue group expanded

Complete ()

Complete ()

Parameter	Meaning	Default Value	Comments
-----------	---------	---------------	----------

Return value

An integer that should be passed back to the application unchanged.

Comments

This should be called when it has been decided that an input context has been accepted into a transaction, and that the transaction is complete. The return value of this function should be passed back to the application from the ProcessData function. This function could be used to associate the input context with the output context.

Example

```
if ( done )
    return Complete();
```

EndCellBlock ()

EndCellBlock ()

Parameter	Meaning	Default Value	Comments

Return value

None.

Comments

Ends a cell block that was started with BeginCellBlock().

Example

See BeginCellBlock().

GetBitOffset ()

GetBitOffset ()

Parameter	Meaning	Default Value	Comments
N/A			

Return value

None.

Comments

Returns the current bit offset that is used in NextNBits or PeekNBits.

Example

```

raw = 'F0F0';# 1111000011110000 binary
result1 = GetNBits ( raw, 2, 4 );
result2 = PeekNBits(5);
result3 = NextNBits(2);
Trace ( "Offset = ", GetBitOffset() );

```

The example generates this Trace output:

Offset = D

PeekNBits ()

PeekNBits(<bit_count integer>)

Parameter	Meaning	Default Value	Comments
bit_count integer			

Return value

None.

Comments

Reads `bit_count` bits from the data source. The difference between `PeekNBits` and `NextNBits` is that `PeekNBits` does not advance the global bit offset. `PeekNBits` can be used to make decisions about how to parse the next fields without affecting subsequent calls to `NextNBits`. If `PeekNBits` is called without a prior call to `GetNBits`, the result is undefined. Note that bits are indexed starting at bit 0.

Example

```

raw = 'F0F0';# 1111000011110000 binary
result1 = GetNBits ( raw, 2, 4 );
result2 = PeekNBits(5);
result3 = NextNBits(2);
Trace ( "result1 = ", result1, " result2 = ", result2,
" result3 = ", result3 );

```

This will generate this Trace output:

```
result1 = C result2 = 7 result3 = 0
```

In the call to `GetNBits`: starting at bit 2, reads 4 bits (1100), and returns the value 0xC.

In the call to `PeekNBits`: starting at bit 6, reads 5 bits (00111), and returns the value 0x7.

In the call to `NextNBits`: starting at bit 6, reads 2 bits (00), and returns the value 0x0.

Pending ()

Pending()

Parameter	Meaning	Default Value	Comments
-----------	---------	---------------	----------

Return value

An integer that should be passed back to the application unchanged.

Comments

This should be called when it has been decided that an input context has been accepted into a transaction, but that the transaction still requires further input to be complete. This function could be used to associate input contexts with the output context. The return value of this function should be returned to the application in the `ProcessData` function.

Example

```
if ( done )
return Complete();
else return Pending();
```

Reject ()

Reject ()

Parameter	Meaning	Default Value	Comments

Return value

An integer that should be passed back to the application unchanged.

Comments

Called when it is decided that the input context does not meet the criteria for being a part of the current transaction. The output context should not be modified before this decision is made. The return value of this function should be returned by the `ProcessData` function.

Example

```
if ( UnknownValue )
return Reject();
```


CHAPTER 13: MODULES

Modules are a collection of functions and global data dedicated to decoding a certain type of transaction. Each module consists of one primary file (.dec), and possibly several included files (.inc).

Module Functions

Three functions are used as entry-points into a decoding module. They are called by the application and are used both in the initial transaction decoding phase, and each time that a transaction needs to be displayed.

ProcessData ()

Called repeatedly with input contexts representing transactions of the specified input types. Decides if input transaction is a member of this transaction, or if it begins a new transaction. This function will be called first using incomplete output transactions. If the input transaction is not accepted into any of the pending transactions, it will be called with an empty output transaction to see if it starts a new transaction.

CollectData ()

Called with each input transaction that was previously accepted by the function `ProcessData`. Generates all output context data that would be required for input into a higher level transaction.

BuildCellList ()

Called with the output context generated by the call to `CollectData`, and no input context. This function is responsible for adding display cells based on the data collected by `CollectData`.

Note that there is some flexibility in the use of these functions. For example, if it is easier for a particular protocol to build cells in `CollectData`, cells could be generated there, and `BuildCellList` could be left empty. Another approach would be to have `ProcessData` do everything (generate output data, and build cell lists) and then implement `CollectData` as a pass-thru to `ProcessData`. This will be less efficient in the decoding phase but may reduce some repetition of code. These decisions are dependent on the protocol to be decoded.

Module Data

There are several standard global variables that should be defined in a module which are queried by the application to figure out what the module is supposed to do.

ModuleType

Required. A string describing the role of the script. Currently, only `Transaction Decoder` and `DataBlock Decoder` are valid.

Example

```
set ModuleType = "Transaction Decoder";
```

`Transaction Decoder` uses `ProcessData()`. `DataBlock Decoder` does not.

OutputType

Required. A string label describing the output of the script. Example : `AVC Transaction`

Example

```
set OutputType = "AV/C Transaction";
```

InputType

Required. A string label describing the input to the script. Input and output types should be matched by the application in order to decide which modules to invoke on which contexts.

Example

```
set InputType = "1394 Transaction";
```

LevelName

Optional. A string that names this decoder.

Example

```
set LevelName = "AV/C Test Transactions";
```

DecoderDesc

Optional. A string that describes this decoder. Displays as a toolbar icon tool tip.

Example

```
set DecoderDesc = "View test transactions";
```

Icon

Optional. File name of an icon to display on the toolbar. Must be a 19x19 pixel bitmap file.

Example

```
set Icon = "bitmap.bmp";
```


CHAPTER 14: USB DECODERS

Decoding scripts for the CATC USB Analyzers can now be written in the new CATC Script Decoding Language. The document describing this decoding language is included with the CATC software on the CD, and also online.

USBTracer, USBMobile, and USB Advisor ship with decoder scripts for many of the classes and their attributes. These files are located in the USBTracer \Scripts directory (for example). Users may edit the decoder scripts or create new scripts to accommodate specific development needs, especially decoding of vendor- and application-specific classes and attributes.

This chapter discusses the purposes of the USBTracer decoder files, along with the common constants, global variables, and functions that make up the USBTracer Decoding API. The procedures for adding attribute decoders for existing management classes and for creating new management class decoders are provided as well.

Decoder Files

USBTracer decoders are used to decode packets with vendor-specific data or other custom information so that the custom content can be displayed as a CATC Trace in USBTracer. The view settings in the scripts may be edited to either reveal or hide particular fields when the header cells are expanded or collapsed. For instance, it may be desirable to have a field visible even when its header cell is collapsed; on the other hand, cells can also be defined so that they are revealed only when the header cell is expanded.

In addition to displaying decoded custom content as data as a trace, the decoder scripts create a special View window that presents the decoded data in a text format. The window is opened by left-clicking on any cell in the trace to access the pop-up View menu and then selecting the “View fields” option.

Script Decoding Mechanisms

The older script decoding mechanism is still supported, and the scripts are now stored in a directory called Legacy in the Scripts directory. The older mechanism is still used for many of the decoding types, such as the Standard descriptors. The scripts for it are the same as those used on USB Chief, the previous generation USB Analyzer. The newer decoding scripts are NOT compatible with USB Chief.

The new script language can be implemented using 2 different methods. These are distinguished in the scripts by the script variable **UsbScriptDecodeType**.

When **UsbScriptDecodeType=1**, the decoding for the colored fields of the trace display are handled separately from the decoding for the text-based decoding seen in the decoding dialogs. If this variable is not initialized in a .dec file, this is the default behavior. The Field Displays are handled through the normal **ProcessData()** script function, whereas the text is handled through either the **DataDecode()** or **RequestDecode()** functions (depending on which one you are trying to decode). You can

build up formatted output text in a manner which looks a lot like the older script mechanism this way. It does require some redundant code, however, since this creates a separate execution path in the script. When using this method for creating text, the user is essentially building up a text stream which will be retrieved for display in the Decode Dialog or as a tooltip. An example of this usage is found in the files in the HubClass directory under Scripts. For comparison with the old decoding method, you can look at the old hub decoding scripts in the Scripts/Legacy/Replaced directory. It contains the old version of the Hub and Bluetooth HCI decoders which have been replaced with new Script Decoder based files.

An alternative method (and the one used for all the MassStorage decoders) is when **UsbScriptDecodeType=2**. In these files, there is one main execution path through **ProcessData()** which outputs either colored field cells or formatted text, depending on a context variable named **PrepareFldsForDlg**. This is passed in as a 0 by the software when the decoding is occurring in the normal Trace View, and is set to 1 when being called in situations where text decoding is desired by the software. This is described in detail in earlier chapters. The advantage of this mechanism is that it is easier to program and there is less redundancy of code. The disadvantage is that the format of the output is fixed and not flexible. It is currently implemented to output the decoding fields in simple columns, and the comments/tooltip strings are provided in the last column whenever the trace view for the transfer is shown in Expanded mode. In other words, it is not as pretty, but at least you can select the text and copy it to an editor, etc.

Reserved Variable and Constant Names

The following names are reserved for use in the Script Decoding Files. (These are in addition to the ones described in earlier chapters). These are case-sensitive, so pay attention to the capitalization.

UsbDecodeType

Values: “Endpoint” or “Request”. Used to distinguish whether the .dec file is to be used for endpoint decoding or for decoding control transfers (The ones that start with a Setup packet).

UsbReqType

Values: “Class” or “Vendor”. Used to distinguish the request types for decoding.

UsbEndpType

Values: “Bulk” or “Interrupt”. Used to distinguish transfer types of the endpoints.

UsbEndpDir

Values: “In” or “Out”. Used to distinguish the endpoint direction. Any endpoint can provide 2 pipes: one in each direction.

UsbMaxPktSize

Value: The maximum packet size allowed for this endpoint/direction combination. This will be used to help decode the file.

UsbMaxXferSize

Value: The maximum transfer size allowed for this endpoint/direction combination. This will be used to help decode the file.

UsbMaxXferDecodeSize

Value: The maximum portion of the transfer size that will be examined for possible decoding. If, for example, each transfer had a 25 byte header at the beginning, this value could be used to improve the speed at which the decoding occurs, since the software would only pass the first N bytes to the decoding logic. In cases where there might be a trailer, the value would have to be equal to the maximum transfer length to insure that the last bytes would be examined.

UsbClassCode

Value: The value assigned by the USB IF for this particular Class. For example, Mass Storage is 8 and the Hub Class is 9.

UsbSubClass

Value: If defined, it is specified by the Class Specification. For example, the Mass Storage Class provides for SubClass 4 for UFI (USB Floppy Interface) and SubClass 6 for Transparent SCSI.

UsbProtocol

Value: If defined, it is specified by the Class Specification. For example,

the Mass Storage Class provides for Protocol 0x50 for Bulk-Only Transport, and Protocol 0 for CBI (Control/Bulk/Interrupt) Transport.

UsbVendorId

Value: If defined, it is provided for by the Vendor as registered with the USB IF. This is used in the case where you have vendor-specific decoding. For example, if CATC created a file to decode it's communication for it's analyzer's USB connection, we would use our USB-IF identification number of 1059.

UsbProductId

Value: If defined, it is provided for by the Vendor. Used to distinguish decoding based on product-specific differences.

UsbEndpointId

Value: You must assign a unique value between 1 and 127 to differentiate endpoint decoders used for the same Class/Vendor group. This value has nothing to do with the actual Endpoint value the device will use for this particular decoder, it is merely a mechanism used by the software to avoid confusion over the mapping of an endpoint decoder to a particular instance of an endpoint.

UsbIgnoreSetupData

Value: 0(Default) means that the data being passed to this request decoder should include the 8 bytes of the Setup Packet. If the value is 1, the data passed to this decoder starts with that found in the first DATA packet. This is used to provide compatibility with decoders such as the Bluetooth HCI decoder, which is built to be compatible with other non-USB CATC products which don't have an 8 byte 'header'. If this variable is not declared, the default behavior is applied by Software: the 8 byte header is included.

UsbLsbToMsb

Value: 0(Default) means the data passed to this decoder should have its most significant bit in bit position 7 and it's least significant bit in bit position 0. If 1, the opposite is true: the data is expected to be LsbToMsb. If this variable is not declared, the default (0) behavior is applied by Software: the bytes are passed as MsbToLsb, otherwise known as "normal".

UsbReqStr

Value: This will contain the string you build up for the Request portion of the Request text decoding when you have selected “**UsbDecodeType =1**”. This string will be displayed in the left-hand pane of the text decode dialog.

UsbDescTooltipStr

Value: This will contain the string you build up for the Descriptor portion of the Request text decoding when you have selected “**UsbDecodeType =1**”. This string should only contain an amount appropriate for displaying as a ToolTip.

UsbDataDecodeStr

Value: This will contain the string you build up for the Data portion of the Endpoint text decoding, or the Descriptor portion of a Request decoding when you have selected “**UsbDecodeType =1**”. This string will be displayed in the text decoding dialog. If this is an endpoint decode, it will be displayed in the only pane of the dialog. If this is a request decode, it will display in the right-hand side pane of the dialog.

UsbDecHdrType

Value: Used to pass explicit information to the decoder to help decoding where the normal data byte stream does not contain enough information or context to allow it to be decoded all by itself. Currently, only the value 2 is used in the case of Mass Storage Decoding. This tells the software that this decoder needs the SCSI or UFI Opcode of the previous transfer to help determine if this is supposed to be a response to a SCSI/UFI Command that was just sent. Without this, it would be impractical to distinguish a normal READ data stream from a SCSI/UFI control request response. This item requires explicit support in the software, so you cannot use it arbitrarily.

UsbDecHdrLen

Value: This specifies the length (up to 8 bytes) of additional context information that will be passed in conjunction with the use of “**UsbDecHdrLen**”. This item requires explicit support in the software, so you cannot use it arbitrarily. It is currently only used for Mass Storage decode, and in that case has a value of 1.

UsbDecExtraInfoBytePos

Value: The byte offset in this transfer where the information byte potentially used for decoding the next transfer exists. For example, in CBI-UFI decoding, the byte at offset 8 contains the UFI Opcode. For Bulk-Only SCSI, the opcode is at offset 15. In both cases, this byte can be used to identify that a subsequent Transfer contains the response data to an issued command. This item requires explicit support in the software, so you cannot use it arbitrarily.

UsbScriptDecodeType

Value: 1(default) for explicit text decoding, 2 for combined text/field decoding as described in earlier chapters.

Reserved Parameter Strings (Used as values in the above string declarations):

Request
Endpoint
Class
Vendor
Bulk
Interrupt
In
Out

Constants

Constants defined in DecoderTools2.inc

```
const COLLAPSED = 0
const EXPANDED = 1

const WarningColor = RGB(255, 255, 0) #Yellow
const ERROR_COLOR = RGB(255, 0,0) #Red
```

The next constant, `WARNING_SIGN`, is used in cell tooltips as a delimiter of the “normal” part of the tooltip and the part containing a message about USB specification errors in the subfield.

```
const WARNING_SIGN = "\n\n!!! WARNING !!!\n";
```

This is an example of its use:

```
...
tooltip = normal_tooltip + WARNING_SIGN +
error_tooltip;
Add...Cell( caption, value, tooltip, _ERROR );
...
```

Global Variables

Globals set in DecoderTools2.inc

```
val = 0 # global buffer for keeping temporary values
of any type.
```

```
str = "" # global buffer for keeping temporary values
of presumed string type.
```

```
base_tooltip = "" # global buffer for keeping
temporary values of presumed parts of tooltips.
```

```
ViewAll = 0 # global variable that keeps View All
fields parameter of currently decoded attribute --
this variable is the set attribute decoder responsible
for decoding of the current attribute.
```

```
HideAll = 0 # global variable that keeps Hide All
fields parameter of currently decoded attribute --
this variable is the set attribute decoder responsible
for decoding of the current attribute.
```

```
Prefix = "" # global variable that keeps the prefix,
which is a kind of identifier for the decoder
responsible for decoding of the current attribute.
```

```
VS = [] # global variable that stores the View setting
of the cell currently being shown. It can be used only
as a list of two values: [ show_in collapsed, show in
expanded ]. When show_in collapsed > 0, it means that
the current cell will be shown in collapsed state;
otherwise, it will be hidden. show in expanded means
the same, but for expanded state only.
```

```
# The following variables are specific to dialog view:
```

```
set Global_BitField_offset = 0; # global variable
that contains the offset, in bits, from the beginning
of packet for beginning of current attribute. Roughly
speaking, it is the entry point from which an
attribute decoder starts decoding.
```

```
set BitCurrentFieldOffset = 0; # global variable that
contains the offset, in bits, from the starting point
of decoding for the current field inside of the
decoder.
```

```
set BitCurrentFieldLength = 0; # the length, in bits,
of the currently decoded field.
```

Common Functions

Functions found in DecoderTools2.inc

These are the most commonly-used functions from DecoderTools2.inc.

RGB ()

RGB(*r*, *g*, *b*)

Parameter	Meaning	Default Value	Comments
<i>r integer</i>	red value		
<i>g integer</i>	green value		
<i>b integer</i>	blue value		

Comments

Used to define a color based on red, green, and blue values.

Example

```
RGB(255, 255, 255); #white
```

SaveFieldSettings ()

SaveFieldSettings ()

Parameter	Meaning	Default Value	Comments
N/A			

Comments

Saves the global field settings. Can be used in conjunction with `RestoreFieldSettings()` to show one attribute inside another.

Example

```

...
... # pre-decoding of container attribute
SaveFieldSettings();

Global_BitField_offset = MAD_HEADER_LEN_BITS +
amount_of_bits_before_attribute;

ShowSomeAttribute();

RestoreFieldSettings( );

... # post-decoding of container attribute
...

```

RestoreFieldSettings()

`RestoreFieldSettings()`

Parameter	Meaning	Default Value	Comments
N/A			

Comments

Restores the global field settings. Can be used in conjunction with `SaveFieldSettings()` to show one attribute inside another.

Example

See “`SaveFieldSettings()`” on page 62.

Find()

`Find(table, table_key)`

Parameter	Meaning	Default Value	Comments
table			
table_key string			

Comments

Finds a string in the table by a key value. If the key is not found, the first string is returned.

Example

```
val = Find(AttrIDValue_Table, PacketType);
```

ShowDataBlock()

```
ShowDataBlock(len, no_cells)
```

Parameter	Meaning	Default Value	Comments
len	Length of DataBlock		
no_cells	No cells will be drawn		If this parameter is set, then data cells are not shown.

Comments

Used to display a DataBlock.

Example

```
ShowDataBlock(40, !VEX_MyDataBlock[in.Expanded]);
```

AddDecSeparator()

```
AddDecSeparator()
```

Parameter	Meaning	Default Value	Comments
N/A			

Comments

Used to create a separator cell.

Example

```
AddDecSeparator();
```

Warning()

```
Warning(text, tooltip)
```

Parameter	Meaning	Default Value	Comments
text <i>string</i>			This text is displayed in the warning cell.
tooltip <i>string</i>			This text is displayed in the tooltip.

Comments

Creates a warning cell.

Example

```
if(in.Expanded) Warning("Bad value", "This is example
of Warning-cell.");
```

WarningForDlg()

```
WarningForDlg(text, tooltip)
```

Parameter	Meaning	Default Value	Comments
text <i>string</i>			Warning text.
tooltip <i>string</i>			Tooltip text.

Comments

Creates a warning for dialog view.

Example

```
WarningForDlg(Format("Not correct AttrM(0x%X)",
AttModifier), "Valid values for Attribute Modifier as
a pointer to a block of 8 GUIDs\n" + "are from 0 to
31." );
```

AddWarningTooltip()

```
AddWarningTooltip(error_tooltip)
```

Parameter	Meaning	Default Value	Comments
error_tooltip			

Comments

Adds a special warning or error description part to a tooltip string.

Example

```
...
LID_number = 2345;
tooltip = "LID block number.";

error = null;
error_tooltip = "";
if( LID_number > UPPER_BOUND ) { error = _ERROR;
error_tooltip = "LID number is out of range"; }
```

```
AddSimplePLCell("LID", Format("%d", LID_number ),
tooltip + AddWarningTooltip(error_tooltip), error);
...
```

If there is an error for the cell, the tooltip will display this text:

```
LID block number.
!!! WARNING !!!
LID number is out of range
```

The warning message will be displayed in dark red in dialog view.

Another way to add a warning message to a tooltip is to use the `WARNING_SIGN` constant like this:

```
...
if( error_tooltip != "" )
error_tooltip = WARNING_SIGN + error_tooltip;
```

ReservedCheck()

ReservedCheck(bits_reserved)

Parameter	Meaning	Default Value	Comments
bits_reserved			

Comments

Makes a check for next `bits_reserved` bits that are reserved and should be set to zero. If the bits are not zero, a corresponding warning cell will be shown in expanded state.

Example

```
ReservedCheck( reserved_bits );
```

IncFieldOffset()

IncFieldOffset(len)

Parameter	Meaning	Default Value	Comments
len			

Comments

Increments the field offset by designated length (`len`) and sets the field length variable equal to `len`. This is useful when it's not possible to obtain a field value using only one `GetNBits_` or `NextNBits_` command.

Example

```
IncFieldOffset( 64 );
```

PrepareFieldForDlg()

```
PrepareFieldForDlg(field_name, str_value, tooltip,
addparam)
```

Parameter	Meaning	Default Value	Comments
field_name			
str_value			
tooltip			
addparam			Used to create special cells or to modify cell attributes. The values are predefined constants, and zero or more of them may be used at one time. Possible values are: _ERROR: creates a cell with a red value field to indicate an error.

Comments

Prepares the field for dialog view. Writes passed data to `out.FieldList`, using current values of field offset and field length.

Example

```
PrepareFieldForDlg(caption , text, tooltip );
```

PrepareZeroFieldForDlg()

```
PrepareZeroFieldForDlg(field_name, str_value, tooltip,
addparam)
```

Parameter	Meaning	Default Value	Comments
field_name			
str_value			
tooltip			
addparam			Used to create special cells or to modify cell attributes. The values are predefined constants, and zero or more of them may be used at one time. Possible values are: _ERROR: creates a cell with a red value field to indicate an error.

Comments

ZeroField means that the field to be added to `out.FieldsList` is not a data field. Rather, it is an additional field such as a caption or a separator.

Example

```
PrepareZeroFieldForDlg(caption , text, tooltip);
```

PrepareFieldForDlgExt()

```
PrepareFieldForDlgExt(field_name, len, offset,
str_value, tooltip, addparam)
```

Parameter	Meaning	Default Value	Comments
field_name			
len			
offset			
str_value			
tooltip			
addparam			Used to create special cells or to modify cell attributes. The values are predefined constants, and zero or more of them may be used at one time. Possible values are: _ERROR: creates a cell with a red value field to indicate an error.

Comments

Writes passed data to `out.FieldList`, using passed values of field offset and field length.

Example

```
PrepareFieldForDlgExt("FIELD_INIT", 0,
Global_BitField_offset);
```

AddCaptionToDlg()

```
AddCaptionToDlg(caption, text, tooltip, addparam)
```

Parameter	Meaning	Default Value	Comments
caption			
text			
tooltip			

Parameter	Meaning	Default Value	Comments
addparam			Used to create special cells or to modify cell attributes. The values are predefined constants, and zero or more of them may be used at one time. Possible values are: _ERROR: creates a cell with a red value field to indicate an error.

Comments

Writes passed data to `out.FieldList` as a special field called 'CAPTION'.

Example

```
AddCaptionToDlg("Common USB Header", caption + " " +
text, tooltip);
```

AddStringToDlg()

AddStringToDlg(caption, text, tooltip, addparam)

Parameter	Meaning	Default Value	Comments
caption			
text			
tooltip			
addparam			Used to create special cells or to modify cell attributes. The values are predefined constants, and zero or more of them may be used at one time. Possible values are: _ERROR: creates a cell with a red value field to indicate an error.

Comments

Writes passed data to `out.FieldList` as a special field called 'STRING'.

Example

```
AddStringToDlg(caption , text, tooltip);
```

AddDataBlockToDlg()

AddDataBlockToDlg(len)

Parameter	Meaning	Default Value	Comments
len			

Comments

Makes a special record about DataBlock with length equal to `len` for dialog view.

Example

```
AddDataBlockToDlg(72);
```

CheckBadDataLength()

```
CheckBadDataLength()
```

Parameter	Meaning	Default Value	Comments
N/A			

Comments

Checks offset from beginning of data payload for packet with bad data length and sets the current field color to the error color when the offset exceeds the length of the data payload.

Example

```
CheckBadDataLength();
```

NextNBits_()

```
NextNBits_(next_n_bits)
```

Parameter	Meaning	Default Value	Comments
next_n_bits			

Comments

This is a redefinition of the `NextNBits` primitive which increments field offset and field length.

Example

```
NextNBits_(8);
```

PeekNBits_()

```
PeekNBits_(next_n_bits)
```

Parameter	Meaning	Default Value	Comments
next_n_bits			

Comments

This is a redefinition of the `PeekNBits` primitive which increments field offset and field length.

Example

```
PeekNBits_(16);
```

GetNBits_()

```
GetNBits_(offset, len)
```

Parameter	Meaning	Default Value	Comments
offset			
length			

Comments

This is a redefinition of the `GetNBits` primitive which increments field offset and field length.

Example

```
GetNBits_(640, 4);
```

GetRangeBits()

```
GetRangeBits(start_bit, end_bit, source)
```

Parameter	Meaning	Default Value	Comments
start_bit			
end_bit			
source <i>integer</i>			

Comments

Extracts a range of bits from `source` starting from `start_bit` and ending at `end_bit`. Most Significant Bit → Least Significant Bit order is used here.

Example

```
GetRangeBits(10, 15, peek_value);
```

GetBit()

```
GetBit(bit_needed, source)
```

Parameter	Meaning	Default Value	Comments
bit_needed			
source <i>integer</i>			

Comments

Extracts a bit (`bit_needed`) from source.

Example

```
GetBit(3, peek_value);
```

AddCaptionCell()

```
AddCaptionCell(caption, text, tooltip, addparam)
```

Parameter	Meaning	Default Value	Comments
caption			Displays in the name field of the cell.
text			Displays in the value field of the cell.
tooltip			Displays in tooltip.
addparam			Used to create special cells or to modify cell attributes. The values are predefined constants, and zero or more of them may be used at one time. Possible values are: _ERROR: creates a cell with a red value field to indicate an error. _WARNING: creates a cell with a yellow value field to indicate a warning. _MONOFIELD: cell consists of only a name field. _MONOCOLOR: creates a cell with the same color in both fields. _FIXEDWIDTH: creates a cell with a fixed, specified width.

Comments

Used to draw a special caption cell. Note: all `Add...Cell` functions use colors as defined in the global variable `FieldColor`.

Example

```
AddCaptionCell(VNDR_DATA_CAP, "VendorExample",
"Example of vendor-attribute decoder.\n\n" + "This
attribute is completely fictive and\n" + "was
contemplated for example ONLY.\n\n" + "We use
AddCaptionCell() for depiction of attribute
captions." + "\r" + "Use '\\r' - as delimiter to add
extended part of your\n" + "tooltip");
```

AddPayloadCell()

AddPayloadCell(caption, text, tooltip, addparam)

Parameter	Meaning	Default Value	Comments
caption			Displays in the name field of the cell.
text			Displays in the value field of the cell.
tooltip			Displays in tooltip.
addparam			Used to create special cells or to modify cell attributes. The values are predefined constants, and zero or more of them may be used at one time. Possible values are: _ERROR: creates a cell with a red value field to indicate an error. _WARNING: creates a cell with a yellow value field to indicate a warning. _MONOFIELD: cell consists of only a name field. _MONOCOLOR: creates a cell with the same color in both fields. _FIXEDWIDTH: creates a cell with a fixed, specified width.

Comments

Draws a payload cell. Note: all Add...Cell functions use colors as defined in the global variable FieldColor.

Example

```
AddPayloadCell("Field_1", "Value : " +
Format("0x%04X", NextNBits_(16)), "Field 1\n" + "View
setting for this field is set to show field\n" + "both
in collapsed and expanded states.\n\n" + "We use
AddPayloadCell() to depict this cell.");
```

AddPayloadCellMono()

AddPayloadCellMono(caption, text, tooltip, addparam)

Parameter	Meaning	Default Value	Comments
caption			Displays in the name field of the cell.
text			Displays in the value field of the cell.
tooltip			Displays in tooltip.

Parameter	Meaning	Default Value	Comments
addparam			Used to create special cells or to modify cell attributes. The values are predefined constants, and zero or more of them may be used at one time. Possible values are: _ERROR: creates a cell with a red value field to indicate an error. _WARNING: creates a cell with a yellow value field to indicate a warning. _MONOFIELD: cell consists of only a name field. _MONOCOLOR: creates a cell with the same color in both fields. _FIXEDWIDTH: creates a cell with a fixed, specified width.

Comments

Draws a monocolored cell that is similar to the usual payload cell except that both the upper and lower parts of the cell are the same color. Note: all `Add...Cell` functions use colors as defined in the global variable `FieldColor`.

Example

```
AddPayloadCellMono("MonoColorField", text, tooltip +
"\n\nWe use AddPayloadCellMono() to depict this
cell.\n" + "This monocolored cell is similar to usual
payload cell but both upper and\n" + "lower parts of
Cell are depicted by the same color defined for this
attribute\n" + "in file MAD_colors.inc");
```

AddPLCellMonoStr()

```
AddPLCellMonoStr(caption, text, tooltip, addparam)
```

Parameter	Meaning	Default Value	Comments
caption			Displays in the name field of the cell.
text			Displays in the value field of the cell.
tooltip			Displays in tooltip.

Parameter	Meaning	Default Value	Comments
addparam			Used to create special cells or to modify cell attributes. The values are predefined constants, and zero or more of them may be used at one time. Possible values are: _ERROR: creates a cell with a red value field to indicate an error. _WARNING: creates a cell with a yellow value field to indicate a warning. _MONOFIELD: cell consists of only a name field. _MONOCOLOR: creates a cell with the same color in both fields. _FIXEDWIDTH: creates a cell with a fixed, specified width.

Comments

Used to begin new group of cells and a table in dialog view that allows the tooltip to be shown below a table caption. Note: all `Add...Cell` functions use colors as defined in the global variable `FieldColor`.

Example

```
AddPLCellMonoStr("CellMonoStr", Format("%d",
NextNBits_(8)), "CellMonoStr.\n\n" + "The
AddPLCellMonoStr function is used to begin new group
of cells\n" + "and table in dialog view allowing
tooltip to be shown below\n" + "a caption of the
table.");
```

AddPLCellMonoCap()

```
AddPLCellMonoCap(caption, text, tooltip, addparam)
```

Parameter	Meaning	Default Value	Comments
caption			Displays in the name field of the cell.
text			Displays in the value field of the cell.
tooltip			Displays in tooltip.

Parameter	Meaning	Default Value	Comments
addparam			Used to create special cells or to modify cell attributes. The values are predefined constants, and zero or more of them may be used at one time. Possible values are: _ERROR: creates a cell with a red value field to indicate an error. _WARNING: creates a cell with a yellow value field to indicate a warning. _MONOFIELD: cell consists of only a name field. _MONOCOLOR: creates a cell with the same color in both fields. _FIXEDWIDTH: creates a cell with a fixed, specified width.

Comments

Creates a monocolored cell. It is intended to be used to start a new group of cells and table in dialog view. Note: all Add . . . Cell functions use colors as defined in the global variable `FieldColor`.

Example

```
AddPLCellMonoCap("DiagData", "->", "Vendor specific diagnostic information.\n" + "Format is not defined by USB specification.");
```

AddPLCellMonoNoDlg()

AddPLCellMonoNoDlg(caption, text, tooltip, addparam)

Parameter	Meaning	Default Value	Comments
caption			Displays in the name field of the cell.
text			Displays in the value field of the cell.
tooltip			Displays in tooltip.
addparam			Used to create special cells or to modify cell attributes. The values are predefined constants, and zero or more of them may be used at one time. Possible values are: _ERROR: creates a cell with a red value field to indicate an error. _WARNING: creates a cell with a yellow value field to indicate a warning. _MONOFIELD: cell consists of only a name field. _MONOCOLOR: creates a cell with the same color in both fields. _FIXEDWIDTH: creates a cell with a fixed, specified width.

Comments

Creates a monocolored cell. It is intended to be used to start a new group of cells but doesn't create a table in dialog view. Note: all `Add...Cell` functions use colors as defined in the global variable `FieldColor`.

Example

```
AddPLCellMonoNoDlg("LIDS : ", "Valid Ports : ", "");
```

AddSimplePLCell()

```
AddSimplePLCell(caption, text, tooltip, addparam)
```

Parameter	Meaning	Default Value	Comments
caption			Displays in the name field of the cell.
text			Displays in the value field of the cell.
tooltip			Displays in tooltip.
addparam			Used to create special cells or to modify cell attributes. The values are predefined constants, and zero or more of them may be used at one time. Possible values are: _ERROR: creates a cell with a red value field to indicate an error. _WARNING: creates a cell with a yellow value field to indicate a warning. _MONOFIELD: cell consists of only a name field. _MONOCOLOR: creates a cell with the same color in both fields. _FIXEDWIDTH: creates a cell with a fixed, specified width.

Comments

A 'simple' payload cell does not respond to view settings. It is always hidden when collapsed and always shown when expanded. Note: all `Add...Cell` functions use colors as defined in the global variable `FieldColor`.

Example

```
AddSimplePLCell("Field 6", "Value : " +
Format("0x%01X", NextNBits_(8)), "Field 6\n\n" +
"Here we use AddSimplePLCell for showing field.\n" +
"The ...SimpleCell-functions don't care about view
settings for the field.\n" + "They DON'T show cell in
collapsed state but DO show in expanded state.");
```

AddSimpleCellMonoCap()

AddSimpleCellMonoCap(caption, text, tooltip, addparam)

Parameter	Meaning	Default Value	Comments
caption			Displays in the name field of the cell.
text			Displays in the value field of the cell.
tooltip			Displays in tooltip.
addparam			Used to create special cells or to modify cell attributes. The values are predefined constants, and zero or more of them may be used at one time. Possible values are: _ERROR: creates a cell with a red value field to indicate an error. _WARNING: creates a cell with a yellow value field to indicate a warning. _MONOFIELD: cell consists of only a name field. _MONOCOLOR: creates a cell with the same color in both fields. _FIXEDWIDTH: creates a cell with a fixed, specified width.

Comments

A ‘simple’ payload cell does not respond to view settings. It is always hidden when collapsed and always shown when expanded. Note: all Add . . . Cell functions use colors as defined in the global variable FieldColor.

Example

```
AddSimpleCellMonoCap("Private", "Data", "This block
contains private data.\n\n" + "This is an example of
datablock.");
```

AddBlockPLCell()

AddBlockPLCell(caption, text, tooltip, addparam)

Parameter	Meaning	Default Value	Comments
caption			Displays in the name field of the cell.
text			Displays in the value field of the cell.
tooltip			Displays in tooltip.

Parameter	Meaning	Default Value	Comments
addparam			Used to create special cells or to modify cell attributes. The values are predefined constants, and zero or more of them may be used at one time. Possible values are: _ERROR: creates a cell with a red value field to indicate an error. _WARNING: creates a cell with a yellow value field to indicate a warning. _MONOFIELD: cell consists of only a name field. _MONOCOLOR: creates a cell with the same color in both fields. _FIXEDWIDTH: creates a cell with a fixed, specified width.

Comments

Used instead of `AddPayloadCell()` for cells in group. 'Block' payload cells use view settings contained in global view setting variable `VS`. This way, one view setting can be applied to a block of cells. Note: all `Add...Cell` functions use colors as defined in the global variable `FieldColor`.

Example

```
AddBlockPLCell("Group Field_1", "Value : " +
Format("0x%04X", NextNBits_(16)), "Block Group Field
1" + "\n\nWe use AddBlockPLCell() to depict this
cell.");
```

AddBlockPLCellMonoStr()

`AddBlockPLCellMonoStr(caption, text, tooltip, addparam)`

Parameter	Meaning	Default Value	Comments
caption			Displays in the name field of the cell.
text			Displays in the value field of the cell.
tooltip			Displays in tooltip.

Parameter	Meaning	Default Value	Comments
addparam			Used to create special cells or to modify cell attributes. The values are predefined constants, and zero or more of them may be used at one time. Possible values are: _ERROR: creates a cell with a red value field to indicate an error. _WARNING: creates a cell with a yellow value field to indicate a warning. _MONOFIELD: cell consists of only a name field. _MONOCOLOR: creates a cell with the same color in both fields. _FIXEDWIDTH: creates a cell with a fixed, specified width.

Comments

'Block' payload cells use view settings contained in global view setting variable VS. This way, one view setting can be applied to a block of cells. Note: all Add...Cell functions use colors as defined in the global variable FieldColor.

Example

```
AddBlockPLCellMonoStr("BM class Notice", str,
  "This block describes a BaseBoard Management class-
  specific part of Notice.\n\n" +
  GetBASE_NTtooltip());
```

AddBlockPLCellMonoCap()

AddBlockPLCellMonoCap(caption, text, tooltip, addparam)

Parameter	Meaning	Default Value	Comments
caption			Displays in the name field of the cell.
text			Displays in the value field of the cell.
tooltip			Displays in tooltip.

Parameter	Meaning	Default Value	Comments
addparam			Used to create special cells or to modify cell attributes. The values are predefined constants, and zero or more of them may be used at one time. Possible values are: _ERROR: creates a cell with a red value field to indicate an error. _WARNING: creates a cell with a yellow value field to indicate a warning. _MONOFIELD: cell consists of only a name field. _MONOCOLOR: creates a cell with the same color in both fields. _FIXEDWIDTH: creates a cell with a fixed, specified width.

Comments

Used to start a new group of cells and table in dialog view, similarly to `AddPLCellMonoCap()`, except that 'Block' payload cells use view settings contained in a global view setting variable `VS`. This way, one view setting can be applied to a block of cells. Note: all `Add...Cell` functions use colors as defined in the global variable `FieldColor`.

Example

```
AddBlockPLCellMonoCap("NewGroupOfCells",
"MonoColorFieldCap", "MonoColorFieldCap\n" +
    "This cell and two next follow one common for this
group\n" +
    "view setting : VEX_NewGroupOfCells\n\n" +
    "We start new group using AddBlockPLCellMonoCap
function.\n" +
    "The same as AddPLCellMonoCap it is intended to
start new group of cells -\n" +
    "(both part of this cell is painted by the same
color) -\n" +
    "and table in dialog view but it could share the
same view setting\n" +
    "(assigned to global variable VS) for all cells in
group.");
```

ShowItem()

ShowItem(view_setting)

Parameter	Meaning	Default Value	Comments
view_setting			

Comments

Used to determine whether an item defined with `view_setting` is shown.

Example

```
ShowDataBlock(bytes, !ShowItem(CME_ReadWriteData));
```

PLReservedCheck()

```
PLReservedCheck(reserved_bits)
```

Parameter	Meaning	Default Value	Comments
reserved_bits			

Comments

Used to make a common check of reserved bits while taking into account the view settings. If these bits are not zero, a corresponding warning cell will be shown in the expanded state. Note: only up to 32 bits should be passed to this function.

Example

```
PLReservedCheck(32);
PLReservedCheck(8);
```

UnsignedCompare()

```
UnsignedCompare(op1, op2)
```

Parameter	Meaning	Default Value	Comments
op1	Operand		
op2	Operand		

Comments

This function returns difference between integer values and considers them to be unsigned values. So, the value `0xFFFFFFFF` is -1 and less than 0 in logical conditions, but as an unsigned integer it is so much bigger than 0. Use this function in places where you want integer values to be thought of as unsigned.

Example

```
select {
  (low_limit == high_limit) :
  {
    ...
  }
  # (AttModifier < low_limit) || (AttModifier >
  high_limit) :
```



```

    (UnsignedCompare(AttModifier, low_limit) < 0) ||
    (UnsignedCompare(AttModifier, high_limit) > 0) :
    {
    ...
    }
    default : {attrm_chk_error = null; chk_attrmod_tlp
= null;}
};

```

CurrentFldInit()

CurrentFldInit()

Parameter	Meaning	Default Value	Comments
N/A			

Comments

This function performs necessary initialization routine for a field to be decoded. It must be called before starting field decoding.

Example

```
CurrentFldInit();
```

SetFieldOffsetLen()

SetFieldOffsetLen(offset, len)

Parameter	Meaning	Default Value	Comments
offset			
len			

Comments

This function sets values for field (or subfield) length and offset from beginning of field structure.

Example

```
SetFieldOffsetLen(24, 8);
```

