

# Keywords for Generics

## Generic Functions

```
[attributes] [modifiers]
return-type identifier <type-parameter identifier(s)> [type-parameter-constraints clauses]
([formal-parameters])
{
function-body
}
```

### Parameters

*attributes* (Optional)

Additional declarative information. For more information on attributes and attribute classes, see attributes.

*modifiers* (Optional)

A modifier for the function, such as static. virtual is not allowed since virtual methods may not be generic.

*return-type*

The type returned by the method. If the return type is void, no return value is required.

*identifier*

The function name.

*type-parameter identifier(s)*

Comma-separated identifiers list.

*formal-parameters* (Optional)

Parameter list.

*type-parameter-constraints-clauses*

This specifies restrictions on the types that may be used as type arguments, and takes the form specified in Constraints.

*function-body*

The body of the method, which may refer to the type parameter identifiers.

| Code                                                                                                                  | MD-UML                                                                                            |
|-----------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| generic <typename ItemType> void G(int i) {}                                                                          | ItemType with «C++TemplateParameter» applied and set tagged value <b>type keyword</b> = typename. |
| ref struct MyStruct { generic <typename Type1> void G(Type1 i) {} generic <typename Type2> static void H(int i) {} }; |                                                                                                   |

## Generic Classes

```
[attributes]
generic <class-key type-parameter-identifier(s)>
[constraint-clauses]
```

```
[accessibility-modifiers] ref class identifier [modifiers] [: base-list]
{
class-body
} [declarators] [;]
```

**Parameters**

- attributes* (optional)  
Additional declarative information. For more information on attributes and attribute classes, see Attributes.
- class-key*  
Either class or typename
- type-parameter-identifier(s)*  
Comma-separated list of identifiers specifying the names of the type parameters.
- constraint-clauses*  
A list (not comma-separated) of where clauses specifying the constraints for the type parameters. Takes the form:  
where type-parameter-identifier : constraint-list ...
- constraint-list*  
class-or-interface[, ...]
- accessibility-modifiers*  
Allowed accessibility modifiers include public and private. identifier  
The name of the generic class, any valid C++ identifier.
- modifiers* (optional)  
Allowed modifiers include sealed and abstract.
- base-list*  
A list that contains the one base class and any implemented interfaces, all separated by commas.
- class-body*  
The body of the class, containing fields, member functions, etc.
- declarators*  
Declarations of any variables of this type. For example: ^identifier[, ...]

| Code                                                                                                                                                                   | MD-UML |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| interface class MyInterface {};<br>ref class MyBase{};<br>generic <class T1, class T2><br>where T1 : MyInterface, MyBase<br>where T2 : MyBase<br>ref class MyClass {}; |        |

**Generic Interfaces**

```
[attributes] generic <class-key type-parameter-identifier[, ...]>
[type-parameter-constraints-clauses]
[accessibility-modifiers] interface class identifier [: base-list] { interface-body } [declarators] ;
```

Parameters

*attributes* (optional)

Additional declarative information. For more information on attributes and attribute classes, see Attributes.

*class-key*

class or typename

*type-parameter-identifier(s)*

Comma-separated identifiers list.

*type-parameter-constraints-clauses*

Takes the form specified in Constraints

*accessibility-modifiers* (optional)

Accessibility modifiers (e.g. public, private).

*identifier*

The interface name.

*base-list* (optional)

A list that contains one or more explicit base interfaces separated by commas.

*interface-body*

Declarations of the interface members.

*declarators* (optional)

Declarations of variables based on this type.

| Code                                                                                                                                                                                                  | MD-UML |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| <pre>generic &lt;typename Itype1, typename Itype2&gt; public interface class List {     Itype1 x; }; generic &lt;typename ItemType&gt; ref class List2 : public List&lt;ItemType, char&gt; { };</pre> |        |

Generic Delegates

[attributes]

generic < [class | typename] type-parameter-identifiers >

[type-parameter-constraints-clauses]

[accessibility-modifiers] delegate result-type identifier

([formal-parameters]);

Parameters

*attributes* (Optional)

Additional declarative information. For more information on attributes and attribute classes, see Attributes.

*type-parameter-identifier(s)*

Comma-separated list of identifiers for the type parameters.

*type-parameter-constraints-clauses*

Takes the form specified in Constraints

*accessibility-modifiers* (Optional)

Accessibility modifiers (e.g., public, private).

*result-type*

The return type of the delegate.

*identifier*

The name of the delegate.

*formal-parameters* (Optional)

The parameter list of the delegate.

| Code                                                                         | MD-UML |
|------------------------------------------------------------------------------|--------|
| <pre>generic &lt; class IT&gt; delegate IT GenDelegate(IT p1, IT% p2);</pre> |        |

**Clr Data Member option**

*initonly*

*initonly* indicates that variable assignment can only occur as part of the declaration or in a static constructor in the same class.

| Code                                                                                                                                                                                | MD-UML                                                                                                                                               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| <pre>ref struct MyStruct {     initonly     static int staticConst1;     initonly     static int staticConst2 = 2;     static MyStruct() {         staticConst1 = 1;     } };</pre> | MyStruct with «C++CLIStruct»<br>staticConst1 and staticConst2 have «C++CLIAttribute» applied with tagged value field = initonly and Is Static = true |

*literal*

A variable (data member) marked as *literal* in a /clr compilation is the native equivalent of a static const variable.

A data member marked as *literal* must be initialized when declared and the value must be a constant integral, enum, or string type. Conversion from the type of the initialization expression to the type of the static const data-member must not require a user-defined conversion.

| Code | MD-UML |
|------|--------|
|------|--------|

|                                                                     |                                                                                                                                                                       |
|---------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <pre>ref class MyClassWithLiteral {     literal int i = 1; };</pre> | MyClassWithLiteral with «C++CLIClass» Attribute i has «C++CLIAttribute» applied with tagged value field = literal and set to Is Static = true and Is Read Only = true |
|---------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### Inheritance Keywords

`__single_inheritance`, `__multiple_inheritance`, `__virtual_inheritance`

Grammar:

`class [__single_inheritance] class-name;`

`class [__multiple_inheritance] class-name;`

`class [__virtual_inheritance] class-name;`

**Parameter**

class-name

The name of the class being declared.

| Code                                       | MD-UML                 |
|--------------------------------------------|------------------------|
| <code>class __single_inheritance S;</code> | Class with «VC++Class» |

### Microsoft-Specific Native declaration keywords

`__interface`

Grammar:

`modifier __interface interface-name {interface-definition};`

A Visual C++ interface can be defined as follows:

- Can inherit from zero or more base interfaces.
- Cannot inherit from a base class.
- Can only contain public, pure virtual methods.
- Cannot contain constructors, destructors, or operators.
- Cannot contain static methods.
- Cannot contain data members; properties are allowed.

| Code                                     | MD-UML |
|------------------------------------------|--------|
| <code>__interface MyInterface {};</code> |        |

`__delegate`

Grammar:

`__delegate function-declarator`

A delegate is roughly equivalent to a C++ function pointer except for the following difference:

- A delegate can only be bound to one or more methods within a `__gc` class.

When the compiler encounters the `__delegate` keyword, a definition of a `__gc` class is generated. This `__gc` class has the following characteristics:

- It inherits from `System::MulticastDelegate`.
- It has a constructor that takes two arguments: a pointer to a `__gc` class or `NULL` (in the case of binding to a static method) and a fully qualified method of the specified type.
- It has a method called `Invoke`, whose signature matches the declared signature of the delegate.

| Code | MD-UML |
|------|--------|
|------|--------|

|                                           |  |
|-------------------------------------------|--|
| <code>__delegate int MyDelegate();</code> |  |
|-------------------------------------------|--|

`__event`

---

Grammar:

- `__event` method-declarator;
- `__event __interface` interface-specifier;
- `__event` member-declarator;

## Native Events

| Code                                                                  | MD-UML |
|-----------------------------------------------------------------------|--------|
| <pre>class Source { public:     __event void MyEvent(int i); };</pre> |        |

## Com Events

The `__interface` keyword is always required after `__event` for a COM event source.

| Code                                                                                            | MD-UML                                                                             |
|-------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| <pre>__interface IEvents { }; class CSource { public:     __event __interface IEvents; };</pre> | <pre>__event __interface IEvents;</pre> <p>is mapped to attribute without name</p> |

**NOTE** This mapping produces the exceptional case for syntax checker. The syntax checker has to allow attribute without name for this case.

## Managed Events

| Code                                                                                            | MD-UML                                                                             |
|-------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| <pre>__interface IEvents { }; class CSource { public:     __event __interface IEvents; };</pre> | <pre>__event __interface IEvents;</pre> <p>is mapped to attribute without name</p> |

`public __delegate void D();`

`public __gc class X { public:`

`__event D* E;`

`__event void noE(); };`

NOTE `__delegate` is in C++ Managed Profile whereas `__event` is in Microsoft Visual C++ Profile.

## Microsoft-Specific Modifiers

Based addressing with \_\_based

The **\_\_based** keyword allows you to declare pointers based on pointers (pointers that are offsets from existing pointers).

type **\_\_based**( base ) declarator

Example

```
// based_pointers1.cpp
// compile with: /c
void *vpBuffer;

struct llist_t {
    void __based( vpBuffer ) *vpData;
    struct llist_t __based( vpBuffer ) *llNext;
};
```

| Code                                               | MD-UML |
|----------------------------------------------------|--------|
| void *vpBuffer;<br>void __based(vpBuffer) *vpData; |        |

Function calling conventions

The Visual C/C++ compiler provides several different conventions for calling internal and external functions.

**\_\_cdecl**

return-type **\_\_cdecl** function-name[(argument-list)]

This is the default calling convention for C and C++ programs. Because the stack is cleaned up by the caller, it can do **vararg** functions. The **\_\_cdecl** calling convention creates larger executables than **\_\_stdcall**, because it requires each function call to include stack cleanup code. The following list shows the implementation of this calling convention.

| Code                                               | MD-UML                                                              |
|----------------------------------------------------|---------------------------------------------------------------------|
| class CMyClass {<br>void __cdecl myMethod();<br>}; | __event __interface IEvents;<br>is mapped to attribute without name |

**\_\_clrcall**

return-type **\_\_clrcall** function-name[(argument-list)]

Specifies that a function can only be called from managed code. Use **\_\_clrcall** for all virtual functions that will only be called from managed code. However, this calling convention cannot be used for functions that will be called from native code.

Example

```
// compile with: /clr:oldSyntax /LD
void __clrcall Test1() {}

void (__clrcall *fpTest1)() = &Test1;
```

| Code | MD-UML |
|------|--------|
|      |        |

|                                                                                                     |                                                                             |
|-----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| <pre>__interface IEvents {     }; class CSource { public:     __event __interface IEvents; };</pre> | <pre>__event __interface IEvents; is mapped to attribute without name</pre> |
|-----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|

Code

```
void __cdecl Test1( ) {} void (__cdecl *fpTest1)( ) = &Test1;
```

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217

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\_\_stdcall

```
return-type __stdcall function-name[(argument-list)]
```

The \_\_stdcall calling convention is used to call Win32 API functions. The callee cleans the stack, so the compiler makes vararg functions \_\_cdecl. Functions that use this calling convention require a function prototype.

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| Code                                                                                                | MD-UML                                                                      |
|-----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| <pre>__interface IEvents {     }; class CSource { public:     __event __interface IEvents; };</pre> | <pre>__event __interface IEvents; is mapped to attribute without name</pre> |

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```
class CmyClass2 {
void __stdcall mymethod();

};
```

```
__fastcall
return-type __fastcall function-name[(argument-list)]
```

The \_\_fastcall calling convention specifies that arguments to functions are to be passed in registers, when possible. The following list shows the implementation of this calling convention.

Example

```
class CmyClass3 {
void __fastcall mymethod();

};
```

| Code                                                                                                                    | MD-UML                                                                               |
|-------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <pre>__interface IEvents {<br/>    };<br/>class CSource {<br/>public:<br/>    __event __interface IEvents;<br/>};</pre> | <pre>__event __interface IEvents;<br/><br/>is mapped to attribute without name</pre> |

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```
class CmyClass3 {  
void __fastcall mymethod();  
  
};
```

```
__thiscall  
return-type __thiscall function-name[(argument-list)]
```

The `__thiscall` calling convention is used on member functions and is the default calling convention used by C++ member functions that do not use variable arguments. Under `__thiscall`, the callee cleans the stack, which is impossible for `vararg` functions. Arguments are pushed on the stack from right to left, with the `this` pointer being passed via register `ECX`, and not on the stack, on the x86 architecture.

Example

```
// compile with: /c /clr:oldSyntax class CmyClass4 {  
  
void __thiscall mymethod();  
  
void __clrcall mymethod2(); };
```

| Code                                                                                                                    | MD-UML                                                                               |
|-------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <pre>__interface IEvents {<br/>    };<br/>class CSource {<br/>public:<br/>    __event __interface IEvents;<br/>};</pre> | <pre>__event __interface IEvents;<br/><br/>is mapped to attribute without name</pre> |

Code

```
class CmyClass4 {  
void __thiscall mymethod();  
  
};
```

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\_\_unaligned  
type \_\_unaligned pointer\_identifier

When a pointer is declared as \_\_unaligned, the compiler assumes that the type or data pointed to is not aligned. \_\_unaligned is only valid in compilers for x64 and the Itanium Processor Family (IPF).

Example

```
// compile with: /c // processor: x64 IPF #include <stdio.h> int main() {  
  
char buff[100];  
int __unaligned *p1 = (int*)&buff[37]; int *p2 = (int *)p1;  
*p1=0; //ok  
__try {  
  
*p2 = 0; // throws an exception }  
}
```

| Code                                                                                                                    | MD-UML                                                                               |
|-------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <pre>__interface IEvents {<br/>    };<br/>class CSource {<br/>public:<br/>    __event __interface IEvents;<br/>};</pre> | <pre>__event __interface IEvents;<br/><br/>is mapped to attribute without name</pre> |

Code

```
__except(1) { puts("exception");  
}  
  
int __unaligned *p1;
```

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\_\_w64

type \_\_w64 identifier

Parameters

type

One of the three types that might cause problems in code being ported from a 32-bit to a 64-bit compiler: int, long, or a pointer.

identifier

The identifier for the variable you are creating.

\_\_w64 lets you mark variables, such that when you compile with /Wp64 the compiler will report any warnings that would be reported if you were compiling with a 64-bit compiler.

Example

```
// compile with: /W3 /Wp64 typedef int Int_32;  
#ifdef _WIN64  
typedef __int64 Int_Native; #else  
  
typedef int __w64 Int_Native; #endif  
int main() {
```

```
Int_32 i0 = 5;
Int_Native i1 = 10;
i0 = i1; // C4244 64-bit int assigned to 32-bit int

// char __w64 c; error, cannot use __w64 on char }
```

| Code                                                                                                | MD-UML                                                                      |
|-----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| <pre>__interface IEvents {     }; class CSource { public:     __event __interface IEvents; };</pre> | <pre>__event __interface IEvents; is mapped to attribute without name</pre> |

Code

```
int __w64 i;

Extended storage-class attributes with __declspec
```

The extended attribute syntax for specifying storage-class information uses the `__declspec` keyword, which specifies that an instance of a given type is to be stored with a Microsoft-specific storage-class attribute listed below. Examples of other storage-class modifiers include the `static` and `extern` keywords. However, these key- words are part of the ANSI specification of the C and C++ languages, and as such are not covered by extended attribute syntax. The extended attribute syntax simplifies and standardizes Microsoft-specific extensions to the C and C++ languages.

```
decl-specifier:
__declspec ( extended-decl-modifier-seq ) extended-decl-modifier-seq: extended-decl-modifieropt
extended-decl-modifier extended-decl-modifier-seq extended-decl-modifier:
align(#)
allocate("segname")
appdomain
deprecated
dllimport
dllexport
jitintrinsic
naked
```

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```
noalias
noinline
noreturn
nothrow
novtable
process property({get=get_func_name|,put=put_func_name}) restrict

selectany
thread uuid("ComObjectGUID")
```

White space separates the declaration modifier sequence.

Extended attribute grammar supports these Microsoft-specific storage-class attributes: `align`, `allocate`, `appdo- main`, `deprecated`, `dllexport`, `dllimport`, `jitintrin- sic`, `naked`, `noalias`, `noinline`, `noreturn`, `nothrow`, `novtable`, `process`, `restrict`, `selectany`, and `thread`. It also supports these COM-object attributes: `property` an `d uuid`.

The `dllexport`, `dllimport`, `naked`, `noalias`, `nothrow`, `property`, `restrict`, `selectany`, `thread`, and `uuid` storage- class attributes are properties only of the declaration of the object or function to which they are applied. The `thread` attribute affects data and objects only. The `naked` attribute affects functions only. The `dllimport` and `dll- export` attributes affect functions, data, and objects. The `property`, `selectany`, and `uuid` attributes affect COM objects.

The `__declspec` keywords should be placed at the beginning of a simple declaration. The compiler ignores, without warning, any `__declspec` keywords placed after `*` or `&` and in front of the variable identifier in a declara- tion.

Note:

- A `__declspec` attribute specified in the beginning of a user-defined type declaration applies to the variable of that type.
- A `__declspec` attribute placed after the `class` or `struct` keyword applies to the user-defined type.

| Code                                                                                                                    | MD-UML                                                                               |
|-------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <pre>__interface IEvents {<br/>    };<br/>class CSource {<br/>public:<br/>    __event __interface IEvents;<br/>};</pre> | <pre>__event __interface IEvents;<br/><br/>is mapped to attribute without name</pre> |

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```
class __declspec(dllimport) X {};
```

224

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| Code                                                                                                                    | MD-UML                                                                               |
|-------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <pre>__interface IEvents {<br/>    };<br/>class CSource {<br/>public:<br/>    __event __interface IEvents;<br/>};</pre> | <pre>__event __interface IEvents;<br/><br/>is mapped to attribute without name</pre> |

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```
__declspec(dllimport) class X {} varX;
```

```
__restrict
```

The `__restrict` keyword is valid only on variables, and `__declspec(restrict)` is only valid on function declara- tions and definitions.

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When `__restrict` is used, the compiler will not propagate the `no-alias` property of a variable. That is, if you assign a `__restrict` variable to a non-`__restrict` vari- able, the compiler will not imply that the non-`__restrict` variable is not aliased.

Generally, if you affect the behavior of an entire function, it is better to use the `__declspec` than the keyword. `__restrict` is similar to `restrict` from the C99 spec, but `__restrict` can be used in C++ or C programs.

Example

```
// __restrict_keyword.c
// compile with: /LD
// In the following function, declare a and b as disjoint arrays // but do not have same assurance for c and d.
void sum2(int n, int * __restrict a, int * __restrict b,
int * c, int * d) { int i;

for (i = 0; i < n; i++) { a[i] = b[i] + c[i]; c[i] = b[i] + d[i];

}}

    • // By marking union members as __restrict, tells the compiler that
    • // only z.x or z.y will be accessed in any given scope. union z {
```

```
int * __restrict x;
double * __restrict y; };
```

| Code                                                                                            | MD-UML                                                                      |
|-------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| <pre>__interface IEvents { }; class CSource { public:     __event __interface IEvents; };</pre> | <pre>__event __interface IEvents; is mapped to attribute without name</pre> |

Code

MD-UML

```
int * __restrict x;
```

`__forceinline`, `__inline`

The insertion (called inline expansion or inlining) occurs only if the compiler's cost/benefit analysis show it to be profitable. Inline expansion alleviates the function-call overhead at the potential cost of larger code size.

The `__forceinline` keyword overrides the cost/benefit analysis and relies on the judgment of the programmer instead. Exercise caution when using `__forceinline`. Indiscriminate use of `__forceinline` can result in larger code with only marginal performance gains or, in some cases, even performance losses (due to increased paging of a larger executable, for example).

Using inline functions can make your program faster because they eliminate the overhead associated with function calls. Functions expanded inline are subject to code optimizations not available to normal functions.

The compiler treats the inline expansion options and keywords as suggestions. There is no guarantee that functions will be inlined. You cannot force the compiler to inline a particular function, even with the `__forceinline` keyword. When compiling with `/clr`, the compiler will not inline a function if there are security attributes applied to the function.

The `inline` keyword is available only in C++. The `__inline` and `__forceinline` keywords are available in both C and C++. For compatibility with previous versions, `_inline` is a synonym for `__inline`.

Grammar:

`__inline function_declarator; __forceinline function_declarator;`

| Code                                                                                                                    | MD-UML                                                                               |
|-------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <pre>__interface IEvents {<br/>    };<br/>class CSource {<br/>public:<br/>    __event __interface IEvents;<br/>};</pre> | <pre>__event __interface IEvents;<br/><br/>is mapped to attribute without name</pre> |

Code

```
__inline int max( int a , int b ) { if( a > b )  
    return a; return b;  
}
```

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## C++ Attributes

Attributes are designed to simplify COM programming and .NET Framework common language runtime development. When you include attributes in your source files, the compiler works with provider DLLs to insert code or modify the code in the generated object files.

| Code                                                                                                                               | MD-UML                                                                               |
|------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <pre>[ coclass,<br/>aggregatable(allowed),<br/>    uuid("1a8369cc-1c91-<br/>42c4-befa-5a5d8c9d2529")]<br/>class CMyClass {};</pre> | <pre>__event __interface IEvents;<br/><br/>is mapped to attribute without name</pre> |