

The GNU D Compiler

For GCC version 16.0.0 (pre-release)

(GCC)

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- `'c++23'` Sets `__traits(getTargetInfo, "cppStd")` to 202302.
- `-finclude-imports`
Include imported modules in the compilation, as if they were given on the command line. When this option is enabled, all imported modules are compiled except those that are part of libphobos.
- `-fno-invariants`
Turns off code generation for class `invariant` contracts.
- `-fmain` Generates a default `main()` function when compiling. This is useful when unittesting a library, as it enables running the unittests in a library without having to manually define an entry-point function. This option does nothing when `main` is already defined in user code.
- `-fno-moduleinfo`
Turns off generation of the `ModuleInfo` and related functions that would become unreferenced without it, which may allow linking to programs not written in D. Functions that are not be generated include module constructors and destructors (`static this` and `static ~this`), `unittest` code, and DSO registry functions for dynamically linked code.
- `-fonly=filename`
Tells the compiler to parse and run semantic analysis on all modules on the command line, but only generate code for the module specified by *filename*.
- `-fno-postconditions`
Turns off code generation for postcondition `out` contracts.
- `-fno-preconditions`
Turns off code generation for precondition `in` contracts.
- `-fpreview=id`
Turns on an upcoming D language change identified by *id*. The following values are supported:
- `'all'` Turns on all upcoming D language features.
 - `'bitfields'`
Implements bit-fields in D.
 - `'dip1000'` Implements <https://github.com/dlang/DIPs/blob/master/DIPs/other/DIP1000.md> (Scoped pointers).
 - `'dip1008'` Implements <https://github.com/dlang/DIPs/blob/master/DIPs/other/DIP1008.md> (Allow exceptions in `@nogc` code).
 - `'dip1021'` Implements <https://github.com/dlang/DIPs/blob/master/DIPs/accepted/DIP1021.md> (Mutable function arguments).
 - `'dip25'` Implements <https://github.com/dlang/DIPs/blob/master/DIPs/archive/DIP25.md> (Sealed references).
 - `'dtorfields'`
Turns on generation for destructing fields of partially constructed objects.

1.7 Developer Options

This section describes command-line options that are primarily of interest to developers or language tooling.

-fdump-d-original

Output the internal front-end AST after the **semantic3** stage. This option is only useful for debugging the GNU D compiler itself.

-v

Dump information about the compiler language processing stages as the source program is being compiled. This includes listing all modules that are processed through the **parse**, **semantic**, **semantic2**, and **semantic3** stages; all **import** modules and their file paths; and all **function** bodies that are being compiled.

2 Language Reference

The implementation of the D programming language used by the GNU D compiler is shared with parts of the front-end for the Digital Mars D compiler, hosted at <https://github.com/dlang/dmd/>. This common front-end covers lexical analysis, parsing, and semantic analysis of the D programming language defined in the documents at <https://dlang.org/>.

The implementation details described in this manual are GNU D extensions to the D programming language. If you want to write code that checks whether these features are available, you can test for the predefined version `GNU`, or you can check whether a specific feature is compilable using `__traits(compiles)`.

```
version (GNU)
{
    import gcc.builtins;
    return __builtin_atan2(x, y);
}

static if (__traits(compiles, { asm {"";} }))
{
    asm { "magic instruction"; }
}
```

2.1 Attributes

User-Defined Attributes (UDA) are compile-time expressions introduced by the `@` token that can be attached to a declaration. These attributes can then be queried, extracted, and manipulated at compile time.

GNU D provides a number of extra special attributes to control specific compiler behavior that may help the compiler optimize or check code more carefully for correctness. The attributes are defined in the `gcc.attributes` module.

There is some overlap between the purposes of attributes and pragmas. It has been found more convenient to use `@attribute` to achieve a natural attachment of attributes to their corresponding declarations, whereas `pragma` is of use for compatibility with other compilers or constructs that do not naturally form part of the grammar.

2.1.1 Attribute Syntax

`@(gcc.attributes.attribute)` is the generic entrypoint for applying GCC attributes to a function, variable, or type. There is no type checking done, as well as no deprecation path for attributes removed from the compiler. So the recommendation is to use any of the other UDAs available as described in Section 2.1.2 [Common Attributes], page 12, unless it is a target-specific attribute (See Section 2.1.4 [Target Attributes], page 17).

Function attributes introduced by the `@attribute` UDA are used in the declaration of a function, followed by an attribute name string and any arguments separated by commas enclosed in parentheses.

```
import gcc.attributes;
@attribute("regparm", 1) int func(int size);
```

Multiple attributes can be applied to a single declaration either with multiple `@attribute` attributes, or passing all attributes as a comma-separated list enclosed by parentheses.

```
// Both func1 and func2 have the same attributes applied.
```


2.2.1 Built-in Types

In addition to built-in functions, the following types are defined in the `gcc.builtins` module.

```

__builtin_clong
    The D equivalent of the target's C long type.

__builtin_clonglong
    The D equivalent of the target's C long long type.

__builtin_culong
    The D equivalent of the target's C unsigned long type.

__builtin_culonglong
    The D equivalent of the target's C unsigned long long type.

__builtin_machine_byte
    Signed unit-sized integer type.

__builtin_machine_int
    Signed word-sized integer type.

__builtin_machine_ubyte
    Unsigned unit-sized integer type.

__builtin_machine_uint
    Unsigned word-sized integer type.

__builtin_pointer_int
    Signed pointer-sized integer type.

__builtin_pointer_uint
    Unsigned pointer-sized integer type.

__builtin_unwind_int
    The D equivalent of the target's C _Unwind_Sword type.

__builtin_unwind_uint
    The D equivalent of the target's C _Unwind_Word type.

__builtin_va_list
    The target's va_list type.

```

2.2.2 Querying Available Built-ins

Not all of the functions are supported, and some target-specific functions may only be available when compiling for a particular ISA. One way of finding out what is exposed by the built-ins module is by generating a D interface file. Assuming you have no file `builtins.d`, the command

```
echo "module gcc.builtins;" > builtins.d; gdc -H -fsyntax-only builtins.d
```

will save all built-in declarations to the file `builtins.di`.

Another way to determine whether a specific built-in is available is by using compile-time reflection.

```
enum X86_HAVE_SSE3 = __traits(compiles, __builtin_ia32_haddps);
```


2.5.4 Variadic Intrinsics

The following functions are a collection of variadic intrinsics, available by importing the `core.stdc.stdarg` module.

```
void core.stdc.stdarg.va_arg (T)(ref va_list ap, ref T      [Template]
    parmn)
```

Retrieve and store in *parmn* the next value from the *va_list ap* that is of type *T*.

This intrinsic is equivalent to writing the following:

```
parmn = __builtin_va_arg (ap, T);
```

```
T core.stdc.stdarg.va_arg (T)(ref va_list ap)                [Template]
```

Retrieve and return the next value from the *va_list ap* that is of type *T*.

This intrinsic is equivalent to writing the following:

```
result = __builtin_va_arg (ap, T);
```

```
void core.stdc.stdarg.va_copy (out va_list dest, va_list    [Function]
    src)
```

Make a copy of *src* in its current state and store to *dest*.

This intrinsic is the same as the GCC built-in function `__builtin_va_copy`.

```
void core.stdc.stdarg.va_end (va_list ap)                    [Function]
```

Destroy *ap* so that it is no longer useable.

This intrinsic is the same as the GCC built-in function `__builtin_va_end`.

```
void core.stdc.stdarg.va_start (T)(out va_list ap, ref T    [Template]
    parmn)
```

Initialize *ap* so that it can be used to access the variable arguments that follow the named argument *parmn*.

This intrinsic is the same as the GCC built-in function `__builtin_va_start`.

2.5.5 Volatile Intrinsics

The following functions are a collection of intrinsics for volatile operations, available by importing the `core.volatile` module.

Calls to them are guaranteed to not be removed (as dead assignment elimination or presumed to have no effect) or reordered in the same thread.

These reordering guarantees are only made with regards to other operations done through these functions; the compiler is free to reorder regular loads/stores with regards to loads/stores done through these functions.

This is useful when dealing with memory-mapped I/O (MMIO) where a store can have an effect other than just writing a value, or where sequential loads with no intervening stores can retrieve different values from the same location due to external stores to the location.

These functions will, when possible, do the load/store as a single operation. In general, this is possible when the size of the operation is less than or equal to `(void*).sizeof`, although some targets may support larger operations. If the load/store cannot be done as a single operation, multiple smaller operations will be used.

`float std.math.rounding.floor (float x)` [Function]
`double std.math.rounding.floor (double x)` [Function]
`real std.math.rounding.floor (real x)` [Function]
 Returns the value of *x* rounded downward to the next integer (toward negative infinity).
 This function is evaluated during CTFE as the GCC built-in function `__builtin_floor`.

`real std.math.rounding.round (real x)` [Function]
 Return the value of *x* rounded to the nearest integer. If the fractional part of *x* is exactly 0.5, the return value is rounded away from zero.
 This function is evaluated during CTFE as the GCC built-in function `__builtin_round`.

`real std.math.rounding.trunc (real x)` [Function]
 Returns the integer portion of *x*, dropping the fractional portion.
 This function is evaluated during CTFE as the GCC built-in function `__builtin_trunc`.

`R std.math.traits.copysign (R, X)(R to, X from)` [Template]
 Returns a value composed of *to* with *from*'s sign bit.
 This function is evaluated during CTFE as the GCC built-in function `__builtin_copysign`.

`bool std.math.traits.isFinite (X)(X x)` [Template]
 Returns true if *x* is finite.
 This function is evaluated during CTFE as the GCC built-in function `__builtin_isfinite`.

`bool std.math.traits.isInfinity (X)(X x)` [Template]
 Returns true if *x* is infinite.
 This function is evaluated during CTFE as the GCC built-in function `__builtin_isinf`.

`bool std.math.traits.isNaN (X)(X x)` [Template]
 Returns true if *x* is NaN.
 This function is evaluated during CTFE as the GCC built-in function `__builtin_isnan`.

`float std.math.trigoometry.tan (float x)` [Function]
`double std.math.trigoometry.tan (double x)` [Function]
`real std.math.trigonometry.tan (real x)` [Function]
 Returns tangent of *x*, where *x* is in radians.
 This intrinsic is the same as the GCC built-in function `__builtin_tan`.

MIPS32	
MIPS64	
MIPS_EABI	
MIPS_HardFloat	
MIPS_N32	
MIPS_N64	
MIPS_O32	
MIPS_O64	
MIPS_SoftFloat	
	Versions relating to the MIPS family of processors.
NetBSD	Version relating to NetBSD systems.
OpenBSD	Version relating to OpenBSD systems.
OSX	Version relating to OSX systems.
Posix	Version relating to POSIX systems (includes Linux, FreeBSD, OSX, Solaris, etc).
PPC	
PPC64	
PPC_HardFloat	
PPC_SoftFloat	
	Versions relating to the PowerPC family of processors.
RISCV32	
RISCV64	Versions relating to the RISC-V family of processors.
S390	
SystemZ	Versions relating to the S/390 and System Z family of processors.
S390X	Deprecated; use <code>SystemZ</code> instead.
Solaris	Versions relating to Solaris systems.
SPARC	
SPARC64	
SPARC_HardFloat	
SPARC_SoftFloat	
SPARC_V8Plus	
	Versions relating to the SPARC family of processors.
Thumb	Deprecated; use <code>ARM_Thumb</code> instead.
D_X32	
X86	
X86_64	Versions relating to the x86-32 and x86-64 family of processors.
Windows	
Win32	
Win64	Versions relating to Microsoft Windows systems.

On x86 targets, all intrinsics are available as functions in the `gcc.builtins` module, and have predictable equivalents.

```
version (DigitalMars)
{
    __simd(XMM.PSLLW, op1, op2);
    __simd_ib(XMM.PSLLW, op1, imm8);
}
version (GNU)
{
    __builtin_ia32_psllw(op1, op2);
    __builtin_ia32_psllwi(op1, imm8);
}
```

TypeInfo-based `va_arg`

The Digital Mars D compiler implements a version of `core.vararg.va_arg` that accepts a run-time `TypeInfo` argument for use when the static type is not known. This function is not implemented by GNU D. It is more portable to use variadic template functions instead.

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