

GNU Fortran Internals

For GCC version 4.3.2

(GCC)

The gfortran team

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1 Introduction

This manual documents the internals of **gfortran**, the GNU Fortran compiler.

At present, this manual is very much a work in progress, containing miscellaneous notes about the internals of the compiler. It is hoped that at some point in the future it will become a reasonably complete guide; in the interim, GNU Fortran developers are strongly encouraged to contribute to it as a way of keeping notes while working on the compiler.

2 Code that Interacts with the User

2.1 Command-Line Options

Command-line options for `gfortran` involve four interrelated pieces within the Fortran compiler code.

The relevant command-line flag is defined in `'lang.opt'`, according to the documentation in [Section “Options” in *GNU Compiler Collection Internals*](#). This is then processed by the overall GCC machinery to create the code that enables `gfortran` and `gcc` to recognize the option in the command-line arguments and call the relevant handler function.

This generated code calls the `gfc_handle_option` code in `'options.c'` with an enumerator variable indicating which option is to be processed, and the relevant integer or string values associated with that option flag. Typically, `gfc_handle_option` uses these arguments to set global flags which record the option states.

The global flags that record the option states are stored in the `gfc_option_t` struct, which is defined in `'gfortran.h'`. Before the options are processed, initial values for these flags are set in `gfc_init_option` in `'options.c'`; these become the default values for the options.

2.2 Error Handling

The GNU Fortran compiler’s parser operates by testing each piece of source code against a variety of matchers. In some cases, if these matchers do not match the source code, they will store an error message in a buffer. If the parser later finds a matcher that does correctly match the source code, then the buffered error is discarded. However, if the parser cannot find a match, then the buffered error message is reported to the user. This enables the compiler to provide more meaningful error messages even in the many cases where (erroneous) Fortran syntax is ambiguous due to things like the absence of reserved keywords.

As an example of how this works, consider the following line:

```
IF = 3
```

Hypothetically, this may get passed to the matcher for an IF statement. Since this could plausibly be an erroneous IF statement, the matcher will buffer an error message reporting the absence of an expected `'('` following an IF. Since no matchers reported an error-free match, however, the parser will also try matching this against a variable assignment. When IF is a valid variable, this will be parsed as an assignment statement, and the error discarded. However, when IF is not a valid variable, this buffered error message will be reported to the user.

The error handling code is implemented in `'error.c'`. Errors are normally entered into the buffer with the `gfc_error` function. Warnings go through a similar buffering process, and are entered into the buffer with `gfc_warning`. There is also a special-purpose function, `gfc_notify_std`, for things which have an error/warning status that depends on the currently-selected language standard.

The `gfc_error_check` function checks the buffer for errors, reports the error message to the user if one exists, clears the buffer, and returns a flag to the user indicating whether or

not an error existed. To check the state of the buffer without changing its state or reporting the errors, the `gfc_error_flag_test` function can be used. The `gfc_clear_error` function will clear out any errors in the buffer, without reporting them. The `gfc_warning_check` and `gfc_clear_warning` functions provide equivalent functionality for the warning buffer.

Only one error and one warning can be in the buffers at a time, and buffering another will overwrite the existing one. In cases where one may wish to work on a smaller piece of source code without disturbing an existing error state, the `gfc_push_error`, `gfc_pop_error`, and `gfc_free_error` mechanism exists to implement a stack for the error buffer.

For cases where an error or warning should be reported immediately rather than buffered, the `gfc_error_now` and `gfc_warning_now` functions can be used. Normally, the compiler will continue attempting to parse the program after an error has occurred, but if this is not appropriate, the `gfc_fatal_error` function should be used instead. For errors that are always the result of a bug somewhere in the compiler, the `gfc_internal_error` function should be used.

The syntax for the strings used to produce the error/warning message in the various error and warning functions is similar to the `printf` syntax, with `'%'`-escapes to insert variable values. The details, and the allowable codes, are documented in the `error_print` function in `'error.c'`.

3 Frontend Data Structures

This chapter should describe the details necessary to understand how the various `gfc_*` data are used and interact. In general it is advisable to read the code in `'dump-parse-tree.c'` as its routines should exhaust all possible valid combinations of content for these structures.

3.1 `gfc_code`

The executable statements in a program unit are represented by a nested chain of `gfc_code` structures. The type of statement is identified by the `op` member of the structure, the different possible values are enumerated in `gfc_exec_op`. A special member of this `enum` is `EXEC_NOP` which is used to represent the various `END` statements if they carry a label. Depending on the type of statement some of the other fields will be filled in. Fields that are generally applicable are the `next` and `here` fields. The former points to the next statement in the current block or is `NULL` if the current statement is the last in a block, `here` points to the statement label of the current statement.

If the current statement is one of `IF`, `DO`, `SELECT` it starts a block, i.e. a nested level in the program. In order to represent this, the `block` member is set to point to a `gfc_code` structure whose `block` member points to the block in question. The `SELECT` and `IF` statements may contain various blocks (the chain of `ELSE IF` and `ELSE` blocks or the various `CASEs`, respectively).

4 The LibGFortran Runtime Library

4.1 Symbol Versioning

In general, this capability exists only on a few platforms, thus there is a need for configure magic so that it is used only on those targets where it is supported.

The central concept in symbol versioning is the so-called map file, which specifies the version node(s) exported symbols are labeled with. Also, the map file is used to hide local symbols.

Some relevant references:

- [GNU ld manual](#)
- [ELF Symbol Versioning - Ulrich Depper](#)
- [How to Write Shared Libraries - Ulrich Depper \(see Chapter 3\)](#)

If one adds a new symbol to a library that should be exported, the new symbol should be mentioned in the map file and a new version node defined, e.g. if one adds a new symbols `foo` and `bar` to libgfortran for the next GCC release, the following should be added to the map file:

```
GFORTTRAN_1.1 {
    global:
        foo;
        bar;
} GFORTTRAN_1.0;
```

where `GFORTTRAN_1.0` is the version node of the current release, and `GFORTTRAN_1.1` is the version node of the next release where `foo` and `bar` are made available.

If one wants to change an existing interface, it is possible by using some asm trickery (from the `ld` manual referenced above):

```
__asm__(".symver original_foo,foo@");
__asm__(".symver old_foo,foo@VERS_1.1");
__asm__(".symver old_foo1,foo@VERS_1.2");
__asm__(".symver new_foo,foo@VERS_2.0");
```

In this example, `foo@` represents the symbol `foo` bound to the unspecified base version of the symbol. The source file that contains this example would define 4 C functions: `original_foo`, `old_foo`, `old_foo1`, and `new_foo`.

In this case the map file must contain `foo` in `VERS_1.1` and `VERS_1.2` as well as in `VERS_2.0`.

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Version 1.2, November 2002

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