GnuCOBOL Manual

for GnuCOBOL 3.2

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GnuCOBOL (formerly OpenCOBOL) is a free COBOL compiler and runtime. `cobc` translates COBOL source to executable using intermediate C together with a designated C compiler and linker. `cobcrun` is a module loader to run generated modules, `libcob` provides the necessary runtime.

This manual corresponds to GnuCOBOL 3.2.

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1 Getting started

1.1 Hello, world!

This is a sample program that displays "Hello, world!":

```
---- hello.cob -------------------------
      * Sample COBOL program
       IDENTIFICATION DIVISION.
       PROGRAM-ID. hello.
       PROCEDURE DIVISION.
           DISPLAY "Hello, world!".
           STOP RUN.
----------------------------------------
```

The compiler, `cobc`, is executed as follows:

```
$ cobc -x hello.cob
$ ./hello
Hello, world!
```

The executable file name (`hello` in this case) is determined by removing the extension from the source file name.

You can specify the executable file name by specifying the compiler option `-o` as follows:

```
$ cobc -x -o hello-world hello.cob
$ ./hello-world
Hello, world!
```

The program can be written in a more modern style, with free format code, inline comments, the `GOBACK` verb and an optional `END-DISPLAY` terminator:

```
---- hellonew.cob ----------------
*> Sample GnuCOBOL program
identification division.
program-id. hellonew.
procedure division.
display
   "Hello, new world!"
end-display
goback.
----------------------------------
```

To compile free-format code, you must use the compiler option `-free`.

```
$ cobc -x -free hellonew.cob
$ ./hellonew
Hello, new world!
```

2 Compile

This chapter describes how to compile COBOL programs using GnuCOBOL.

2.1 Compiler options

The compiler `cobc` accepts the options described in this section. The compiler arguments follow the general syntax `cobc` *`options file`* `[`*`file ...`*`]`. A complete list of options can be displayed by using the option `--help`.

2.1.1 Help options

The following switches display information about the compiler:

`--help, -h`
: Display help screen (see Appendix A [Appendix A], page 35). No further actions will be taken.

`--version, -V`
: Display compiler version, author package date and executable build date. No further actions will be taken.

`-dumpversion`
: Display internal compiler version (plain string of numbers). No further actions will be taken.

`--info`
: Display build information along with the default and current compiler configurations. No further actions will be taken except for further display options.

`--verbose, -v`
: Verbosely display the programs invoked during compilation and additional diagnostics. Use multiple times to increase the verbosity.

`--list-reserved`
: Display reserved words (see Appendix B [Appendix B], page 48). A Yes/No output shows if the word is supported[1], context sensitive and its aliases. The given options for reserved words specified for example by option `-std=`*`dialect`* will be taken into account. No further actions will be taken except for further display options.

`--list-intrinsics`
: Display intrinsic functions (see Appendix C [Appendix C], page 68). A Y/N field shows if the function is implemented. No further actions will be taken except for further display options.

`--list-system`
: Display system routines (see Appendix D [Appendix D], page 71). No further actions will be taken except for further display options.

`--list-mnemonics`
: Display mnemonic names (see Appendix E [Appendix E], page 73). No further actions will be taken except for further display options.

`--list-exceptions`
: Display exception names (see Appendix F [Appendix F], page 74). No further actions will be taken except for further display options.

[1] Support may be partial or complete.

2.1.2 Build target

The compiler `cobc` treats files like `*.cob`, `*.cbl` as COBOL source code, `*.c` as C source code, `*.o` as object code, `*.i` as preprocessed code and `*.so` as dynamic modules and knows how to handle such files in the generation, compilation, and linking steps.

The special input name `-` takes input from `stdin` which is assumed to be COBOL source, and uses a default output name of `a.out` (or `a.so/c/o/i`, selected as appropriate) for the build type.

You may also use `-` as output name for the listing file or the preprocessor result, for example with `cobc -t - prog.cob` / `cobc -P- prog.cob`.

By default, the compiler builds a dynamically loadable module.

The following options specify the target type produced by the compiler:

`-E` Preprocess only: compiler directives are executed, comment lines are removed and `COPY` statements are expanded. The output is sent to stdout, allowing you to directly use it as input for another process. You can manually set an output file using `-o`.

`-C` Translation only. COBOL source files are translated into C files. The output is saved in file `*.c`.

`--save-temps`
Normal compilation with additional storing the preprocessed files as `*.i` and the translated C files as file `*.c`.

`-S` Compile only. Translated C files are compiled by the C compiler to assembler code. The output is saved in file `*.s`.

`-c` Compile and assemble. This is equivalent to `cc -c`. The output is saved in file `*.o`.

`-m` Compile, assemble, and build a dynamically loadable module (i.e., a shared library). The output is saved in file `*.so`.[2] This is the default behaviour.

`-b` Compile, assemble, and combine all input files into a single dynamically loadable module. Unless `-o` is also used, the output is saved using the first filename as `*.so`.

`-x` Include the main function in the output, creating an executable image. The main entry point being the first program in the file.

This option takes effect at the translation stage. If you give this option with `-C`, you will see the main function at the end of the generated C file.

`-j, -job, -j=`*`args`*`, -job=`*`args`*
Run job after compilation. Either from executable with `-x`, or with `cobcrun` when compiling a module. Optional arguments *args*, if given, are passed to the program or module command line.

`-I` *`directory`*
Add *directory* to copy/include search path.

`-L` *`directory`*
Add *directory* to library search path.

`-l` *`lib`* Link the library *lib*.

`-D` *`define`* Pass *define* to the COBOL compiler.

`-o` *`file`* Place the output into *file*.

[2] The extension varies depending on your host.

2.1.3 Source format

GnuCOBOL supports fixed, free, Micro Focus' Variable, X/Open Free-form, ICOBOL xCard and Free-form, ACUCOBOL-GT Terminal, and COBOLX source formats. By default, the compiler tries to autodetect the format using the indicator on the first line, using the fixed format for correct indicators and the free format for incorrect ones. This can be overridden either by the `>>SOURCE [FORMAT] [IS] {FIXED|FREE|COBOL85|VARIABLE|XOPEN|XCARD|CRT|TERMINAL|COBOLX|AUTO}` directive, or by one of the following options:

`-free, -F, -fformat=free`
: Free format. The program-text area starts in column 1 and continues till the end of line (effectively 255 characters in GnuCOBOL).

`-fixed, -fformat=fixed`
: Fixed format. Source code is divided into: columns 1-6, the sequence number area; column 7, the indicator area; columns 8-72, the program-text area; and columns 72-80 as the reference area.[3]

`-fformat=cobol85`
: Fixed format with enforcements on the use of Area A.

`-fformat=variable`
: Micro Focus' Variable format. Identical to the fixed format above except for the program-text area which extends up to column 250 instead of 72.

`-fformat=xcard`
: ICOBOL xCard format. Variable format with right margin set at column 255 instead of 250.

`-fformat=xopen`
: X/Open Free-form format. The program-text area may start in column 1 unless an indicator is present, and lines may contain up to 255 characters. Indicator for debugging lines is '`D` ' (D followed by a space) instead of '`D`' or '`d`'.

`-fformat=crt`
: ICOBOL Free-form format (CRT). Similar to the X/Open format above, with lines containing up to 320 characters and single-character debugging line indicators ('`D`' or '`d`').

`-fformat=terminal`
: ACUCOBOL-GT Terminal format. Similar to the CRT format above, with indicator for debugging lines being '`\D`' instead of '`D`' or '`d`'. This format is mostly compatible with VAX COBOL terminal source format.

`-fformat=cobolx`
: COBOLX format. This format is similar to the CRT format above, except that the indicator area is always present in column 1; the program-text area starts in column 2 and extends up to the end of the record. Lines may contain up to 255 characters.

`-fformat=auto`
: Autodetection of format. The compiler will use the first line of the file to detect whether the file is in fixed format (with a correct indicator at position 7), or in free format.

Note that with source formats `XOPEN`, `CRT`, `TERMINAL`, and `COBOLX`, missing spaces are not inserted within continued alphanumeric literals that are truncated before the right margin.

[3] Historically, fixed format was based on 80-character punch cards.

Area A denotes the source code that spans between margin A and margin B, and Area B spans from the latter to the end of the record. *Area A enforcement* checks the contents of Area A, and reports any item that does not belong to the correct Area: this feature helps in developping COBOL programs that are portable to actual mainframe environments.

In general, division, section, and paragraph names must start in Area A. In the `DATA DIVISION`, level numbers '`01`' and '`77`', must also start in Area A. In the `PROCEDURE DIVISION`s, statements and separator periods must fit within Area B. Every source format listed above may be subject to Area A enforcement, except `FIXED`, `FREE`, and `XOPEN`.

Note that Area A enforcement enables recovery from missing periods between paragraphs and sections.

2.1.4 Warning options

Warnings are diagnostic messages that report constructions that are not inherently erroneous but that are risky or suggest there may have been an error.

The following options do not enable specific warnings but control the kinds of diagnostics produced by `cobc`.

`-fsyntax-only`
: Check Check the code for syntax errors, but don't do anything beyond that.

`-fmax-errors=`*n*
: Limits the maximum number of error messages to *n*, at which point `cobc` bails out rather than attempting to continue processing the source code. If *n* is 0, there is no limit on the number of error messages produced. If `-Wfatal-errors` is also specified, then `-Wfatal-errors` takes precedence over this option.

`-w`
: Inhibit all warning messages.

`-Werror`
: Make all warnings into errors.

`-Werror=`*warning*
: Make the specified *warning* into an error. The specifier for a warning is appended; for example `-Werror=obsolete` turns the warnings controlled by `-Wobsolete` into errors. This switch takes a negative form, to be used to negate `-Werror` for specific warnings; for example `-Wno-error=obsolete` makes `-Wobsolete` warnings not be errors, even when `-Werror` is in effect.

  The warning message for each controllable warning includes the option that controls the warning. That option can then be used with `-Werror=` and `-Wno-error=` as described above. (Printing of the option in the warning message can be disabled using the `-fno-diagnostics-show-option` flag.)

  Note that specifying `-Werror=foo` automatically implies `-Wfoo`. However, `-Wno-error=foo` does not imply anything.

`-Wfatal-errors`
: This option causes the compiler to abort compilation on the first error occurred rather than trying to keep going and printing further error messages.

You can request many specific warnings with options beginning with '`-W`', for example `-Wimplicit-define` to request warnings on implicit declarations. Each of these specific warning options also has a negative form beginning '`-Wno`' to turn off warnings; for example, `-Wno-implicit-define`. This manual lists only one of the two forms, whichever is not the default.

Some options, such as `-Wall` and `-Wextra`, turn on other options, such as `-Wtruncate`. The combined effect of positive and negative forms is that more specific options have priority over

less specific ones, independently of their position in the command-line. For options of the same specificity, the last one takes effect.

`-Wall` Enable all the warnings about constructions that some users consider questionable, and that are easy to avoid (or modify to prevent the warning).
The list of warning flags turned on by this option is shown in `--help`.

`-Wextra, -W`
Enable every possible warning that is not dialect specific. This includes more information than `-Wall` would normally provide.
(This option used to be called `-W`. The older name is still supported, but the newer name is more descriptive.)

`-W`*warning*
Enable single warning *warning*.

`-Wno-`*warning*
Disable single warning *warning*.

`-Warchaic`
Warn if archaic features are used, such as continuation lines or the `NEXT SENTENCE` statement.

`-Wcall-params`
Warn if non-01/77-level items are used as arguments in a `CALL` statement. This is *not* set with `-Wall`.

`-Wcolumn-overflow`
Warn if text after column 72 in FIXED format. This is *not* set with `-Wall`.

`-Wconstant`
Warn inconsistent constant

`-Wimplicit-define`
Warn if implicitly defined data items are used.

`-Wlinkage`
Warn dangling `LINKAGE` items. This is *not* set with `-Wall`.

`-Wobsolete`
Warn if obsolete features are used.

`-Wparentheses`
Warn about any lack of parentheses around `AND` within `OR`.

`-Wredefinition`
Warn about incompatible redefinitions of data items.

`-Wstrict-typing`
Warn about type mismatch strictly.

`-Wterminator`
Warn about the lack of scope terminator END-XXX. This is *not* set with `-Wall`.

`-Wtruncate`
Warn on possible field truncation. This is *not* set with `-Wall`.

`-Wconstant-expression`
`-Wconstant-numlit-expression`
Warn about expressions that always resolve to true/false and therefore lead to unreachable code.

`-Wunreachable`
: Warn if statements are likely unreachable. This is *not* set with `-Wall`.

`-Wadditional`
: Enable warnings that don't have an own warning flag.

2.1.5 Configuration options

The compiler uses many dialect specific options. These may be set via a defined dialect by `-std=`, a configuration file by `-conf=` or by using the single dialect flags directly.

See Appendix G [Compiler Configuration], page 78, and `config/*.conf`.

Note concerning the defined dialects: The GnuCOBOL compiler tries to limit both the feature-set and reserved words to the specified compiler when the "strict" dialects are used. COBOL sources compiled with these dialects are therefore *likely* to compile with the specified compiler and vice versa: sources that were compiled on the specified compiler should compile without any issues with GnuCOBOL.
With the "non-strict" dialects GnuCOBOL will activate the complete feature-set where it doesn't directly conflict with the specified dialect, including reserved words. COBOL sources compiled with these dialects therefore may work only with GnuCOBOL. COBOL sources may need a change because of reserved words in GnuCOBOL, otherwise offending words *word-1* and *word-2* may be removed by `-fno-reserved=`*`word-1`*`,`*`word-1`*.

The dialects COBOL-85, X/Open COBOL, COBOL 2002 and COBOL 2014 are always "strict".

`-std=`*`dialect`*
: Compiler uses the given *dialect* to determine certain compiler features and warnings.

`-std=default`
: GnuCOBOL dialect, supporting many of the COBOL 2002 and COBOL 2014 features, many extensions found in other dialects and its own feature-set

`-std=cobol85`
: COBOL-85 without any extensions other than the amendment Intrinsic Function Module (1989), source compiled with this dialect is likely to compile with most COBOL compilers

`-std=xopen`
: X/Open COBOL (based on COBOL-85) without any vendor extensions, source compiled with this dialect is likely to compile with most COBOL compilers; will warn items that "should not be used in a conforming X/Open COBOL source program"

`-std=cobol2002, -std=cobol2014`
: COBOL 2002 / COBOL 2014 without any vendor extensions, use `-Warchaic` and `-Wobsolete` if archaic/obsolete features should be flagged

`-std=ibm-strict, -std=ibm`
: IBM compatible

`-std=mvs-strict, -std=mvs`
: MVS compatible

`-std=mf-strict, -std=mf`
: Micro Focus compatible

`-std=bs2000-strict, -std=bs2000`
: BS2000 compatible

`-std=acu-strict, -std=acu`
: ACUCOBOL-GT compatible

`-std=rm-strict, -std=rm`
: RM/COBOL compatible

`-std=realia-strict, -std=realia`
: CA Realia II compatible

`-std=gcos-strict, -std=gcos`
: GCOS compatible

`-freserved-words=`*`dialect`*
: Compiler uses the given *dialect* to determine the reserved words.

`-conf=<file>`
: User-defined dialect configuration.

`-febcdic-table=`*`cconv-table/file`*
: EBCDIC/ASCII translation table to use; either read from *file*, or one of the existing *cconv-table* from the configuration directory (see `cobc --info`) which have a .ttbl extension, for example `-febcdic-table=alternate`.
See the `default.ttbl` file for detailed information about the format.

You can override each single configuration entry by using compiler configuration options on the command line.

Examples:

```
-frelax-syntax-checks
-frenames-uncommon-levels=warning
-fnot-reserved=CHAIN,SCREEN
-ftab-width=4
```

See Appendix A [Compiler `cobc` options], page 35.

2.1.6 Listing options

`-t=`*`file`* Generate and place the standard print listing into *`file`*.

`-T=`*`file`* Generate and place a wide print listing into *`*file`*.

`--tlines=`*`lines`*
: Specify lines per page in print listing, default = 55. Set to zero for no additional page breaks.

`-ftsymbols`
: Generate symbol table in listing.

`-fno-theader`
: Suppress all headers from listing while keeping page breaks.

`-fno-tmessages`
: Suppress warning and error summary from listing.

`-fno-tsource`
: Suppress actual source from listing (for example to only produce the cross-reference).

`-P, -P`*`directory`*`, -P=`*`file`*
: Generate and place a preprocessed listing (old format) into *`filename`*`.lst`, *`directory/filename`*`.lst`, *`file`*.

`-Xref`

`-X` Generate cross reference in the listing.

Here is an example program listing with the options `-t -ftsymbols`:

```
GnuCOBOL 3.0.0   test.cbl                  Mon May 14 10:23:45 2018  Page 0001

LINE    PG/LN  A...B.....................................................

000001         IDENTIFICATION   DIVISION.
000002         PROGRAM-ID.      prog.
000003         ENVIRONMENT DIVISION.
000004         CONFIGURATION SECTION.
000005         DATA             DIVISION.
000006         WORKING-STORAGE  SECTION.
000007         COPY 'values.cpy'.
000001C        78  I   VALUE 20.
000002C        78  J   VALUE 5000.
000003C        78  M   VALUE 5.
000008         01  SETUP-REC.
000009             05  FL1       PIC X(04).
000010             05  FL2       PIC ZZZZZ.
000011             05  FL3       PIC 9(04).
000012             05  FL4       PIC 9(08) COMP.
000013             05  FL5       PIC 9(04) COMP-4.
000014             05  FL6       PIC Z,ZZZ.99.
000015             05  FL7       PIC S9(05) SIGN LEADING SEPARATE.
000016             05  FL8       PIC X(04).
000017             05  FL9 REDEFINES FL8 PIC 9(04).
000018             05  FLA.
000019                 10  FLB OCCURS I TIMES.
000020                     15  FLC PIC X(02).
000021                 10  FLD   PIC X(20).
000022             05  FLD1      PIC X(100).
000023             05  FLD2 OCCURS M TO J TIMES DEPENDING ON FL5.
000024                 10  FILLER PIC X(01).
000025             05  FLD3      PIC X(3).
000026             05  FLD4      PIC X(4).
000027         PROCEDURE        DIVISION.
000028             STOP RUN.
```

The first part of the listing lists the program text. If the program text is a COPY the line number reflects the COPY line number and is appended with a '`C`'.

When the wide list option `-T` is specified, the `SEQUENCE` columns (for fixed-form reference-format) are included in the listing.

The second part of the listing file is the listing of the Symbol Table:

```
GnuCOBOL 3.0.0   test.cbl                  Mon May 14 10:23:45 2018  Page 0002

SIZE TYPE           LVL  NAME                          PICTURE

5204 GROUP          01   SETUP-REC
0004 ALPHANUMERIC   05     FL1                         X(04)
0005 ALPHANUMERIC   05     FL2                         ZZZZZ
0004 ALPHANUMERIC   05     FL3                         9(04)
0004 NUMERIC        05     FL4                         9(08) COMP
0002 NUMERIC        05     FL5                         9(04) COMP
0008 ALPHANUMERIC   05     FL6                         Z,ZZZ.99
0006 ALPHANUMERIC   05     FL7                         S9(05)
0004 ALPHANUMERIC   05     FL8                         X(04)
0004 ALPHANUMERIC-R 05     FL9                         9(04)
0060 ALPHANUMERIC   05     FLA
0040 ALPHANUMERIC   10       FLB                       OCCURS 20
0002 ALPHANUMERIC   15         FLC                     X(02)
0020 ALPHANUMERIC   10       FLD                       X(20)
0100 ALPHANUMERIC   05     FLD1                        X(100)
5000 ALPHANUMERIC   05     FLD2                        OCCURS 5 TO 5000
0001 ALPHANUMERIC   10       FILLER                    X(01)
```

```
0003 ALPHANUMERIC   05     FLD3                          X(3)
0004 ALPHANUMERIC   05     FLD4                          X(4)
```

If the symbol redefines another variable the `TYPE` is marked with '`R`'. If the symbol is an array the `OCCURS` phrase is in the `PICTURE` field.

The last part of the listing file is the summary of warnings an error in the compilation group:

```
0 warnings in compilation group
2 errors in compilation group
```

2.1.7 Debug switches

`-g` Produce C debugging information in the output.

`--debug, -d`
Enable all run-time error checks.

`-fmemory-check=scope`
Enable checking of internal storage during CALL (implied by `--debug`.

`-fec=exception-name, -fno=ec=exception-name`
Enable/disable specified exception checks, see Appendix F [Exception Names], page 74; `--debug` implies `-fec=ALL`.

`-fsource-location`
Generate source location code (implied by `--debug`, `-fdump` and `-fec`).

`-fstack-check`
Enable `PERFORM` stack checking (implied by `--debug` or `-g`).

`-ftrace` Generate trace code (log executed procedures, if tracing is enabled).

`-ftraceall`
Generate trace code (log executed procedures and statements, if tracing is enabled).

`-fdebugging-line`
Enable debugging lines ('`D`' in indicator column; '`>>D`' directive).

`-O` Enable optimization of code size and execution speed. See your C compiler documentation, for example `man gcc` for details.

`-O2` Optimize even more.

`-Os` Optimize for size. Optimizer will favour code size over execution speed.

`-fnotrunc`
Do not truncate binary fields according to PICTURE.

2.1.8 Miscellaneous

`-ext <extension>`
Add default file extension.

`-fintrinsics=[ALL|intrinsic function name(,name,...)]`
Allow use of all or specific intrinsic functions without `FUNCTION` keyword.

Note: defining this within your source with `CONFIGURATION SECTION. REPOSITORY.` is preferred.

`-ffold-copy=LOWER`
Fold `COPY` subject to lower case (default no transformation).

`-ffold-copy=UPPER`
Fold `COPY` subject to upper case (default no transformation).

`-save-temps(=<dir>)`
: Save intermediate files (by default, in current directory).

`-fimplicit-init`
: Do automatic initialization of the COBOL runtime system.

2.2 Multiple sources

This section describes how to compile a program from multiple source files.

This section also describes how to build a shared library that can be used by any COBOL program and how to use external libraries in COBOL programs.

2.2.1 Static linking

The easiest way of combining multiple files is to compile them into a single executable.

One way is to compile all the files in one command:

```
$ cobc -x -o prog main.cob subr1.cob subr2.cob
```

Another way is to compile each file with the option `-c`, and link them at the end. The top-level program must be compiled with the option `-x`.

```
$ cobc -c subr1.cob
$ cobc -c subr2.cob
$ cobc -c -x main.cob
$ cobc -x -o prog main.o subr1.o subr2.o
```

You can link C routines as well using either method:

```
$ cobc -o prog main.cob subrs.c
```

or

```
$ cobc -c subrs.c
$ cobc -c -x main.cob
$ cobc -x -o prog main.o subrs.o
```

Any number of functions can be contained in a single C file.

The linked programs will be called dynamically; that is, the symbol will be resolved at run time. For example, the following COBOL statement

```
CALL "subr" USING X.
```

will be converted into equivalent C code like this:

```
int (*func)() = cob_resolve("subr");
if (func != NULL)
  func (X);
```

With the compiler option `-fstatic-call`, more efficient code will be generated:

```
subr(X);
```

Please notice that this option only takes effect when the called program name is in a literal (like `CALL "subr"`). With a data name (like `CALL SUBR`), the program is still called dynamically.

2.2.2 Dynamic linking

There are two methods to achieve this: a driver program, or compiling the main program and subprograms separately.

2.2.2.1 Driver program

Compile all programs with the option `-m`:

```
$ cobc -m main.cob subr.cob
```

This creates the shared object files `main.so` and `subr.so`.[4]

Before running the main program, install the module files in your library directory:

```
$ cp subr.so /your/cobol/lib
```

Set the runtime variable `COB_LIBRARY_PATH` to your library directory, and run the main program:

```
$ export COB_LIBRARY_PATH=/your/cobol/lib
```

(*Please notice:* You may set the variable via a runtime configuration file, see Appendix I [Runtime Configuration], page 86. You may also set the variable to directly point to the directory where you compiled the sources.)

Now execute your program:

```
$ cobcrun main
```

2.2.2.2 Compiling programs separately

The main program is compiled as usual:

```
$ cobc -x -o main main.cob
```

Subprograms are compiled with the option `-m`:

```
$ cobc -m subr.cob
```

This creates a module file `subr.so`[5].

Before running the main program, install the module files in your library directory:

```
$ cp subr.so /your/cobol/lib
```

Now, set the environment variable `COB_LIBRARY_PATH` to your library directory, and run the main program:

```
$ export COB_LIBRARY_PATH=/your/cobol/lib
$ ./main
```

2.2.3 Building library

You can build a shared library by combining multiple COBOL programs and even C routines:

```
$ cobc -c subr1.cob
$ cobc -c subr2.cob
$ cc -c subr3.c
$ cc -shared -o libsubrs.so subr1.o subr2.o subr3.o
```

2.2.4 Using library

You can use a shared library by linking it with your main program.

Before linking the library, install it in your system library directory:

```
$ cp libsubrs.so /usr/lib
```

or install it somewhere else and set `LD_LIBRARY_PATH`:

```
$ cp libsubrs.so /your/cobol/lib
$ export LD_LIBRARY_PATH=/your/cobol/lib
```

Then, compile the main program, linking the library as follows:

```
$ cobc -x main.cob -L/your/cobol/lib -lsubrs
```

[4] The extension used depends on your operating system.

[5] The extension used depends on your operating system.

2.3 C interface

This chapter describes how to combine C programs with COBOL programs.

2.3.1 Writing Main Program in C

Include `libcob.h` in your C program and call `cob_init` before using any COBOL module. Do a cleanup afterwards, either by calling `cob_stop_run` (if your program should terminate) or by calling `cob_tidy` (if your program should execute further on without any more COBOL calls). Calling `cob_init`, one or several GnuCOBOL modules and then `cob_tidy` in this sequence can be done multiple times).

```
#include <libcob.h>

int
main (int argc, char **argv)
{
  /* initialize your program */
  ...

  /* initialize the COBOL run-time library */
  cob_init (argc, argv);

  /* rest of your program */
  ...

  /* Clean up and terminate - This does not return */
  cob_stop_run (return_status);
}
```

You can write `cobc_init(0, NULL);` if you do not want to pass command line arguments to COBOL.

The easiest option to compile and/or link your C program is by passing the work to `cobc` as follows:

```
cobc -x main.c
```

possibly running in verbose mode to see what cobc does:

```
cobc -x --verbose main.c   # using -x -v or -xv would be also possible
```

or with several steps:

```
cobc -c main.c
cobc -x main.o
```

As an alternative you can use the `cob-config` tool to get the necessary options to be passed to the C compiler / linker.

```
cc -c `cob-config --cflags` main.c    # compile only
cc -o main main.o `cob-config --libs` # link only
```

2.3.2 Static linking with COBOL programs

Let's call the following COBOL module from a C program:

```
---- say.cob --------------------------
       IDENTIFICATION DIVISION.
       PROGRAM-ID. say.
       ENVIRONMENT DIVISION.
       DATA DIVISION.
```

```
        LINKAGE SECTION.
        01 hello PIC X(7).
        01 world PIC X(6).
        PROCEDURE DIVISION USING hello world.
            DISPLAY hello world.
            GOBACK.
----------------------------------------
```

This program accepts two arguments, displays them, and exits.

From the viewpoint of C, this is equivalent to a function having the following prototype:

```
extern int say(char *hello, char *world);
```

So, your main program will look like as follows:

```
---- hello.c --------------------------
#include <libcob.h>

extern int say(char *hello, char *world);

int
main()
{
  int ret;
  char hello[8] = "Hello, ";
  char world[7] = "world!";

  /* initialize the COBOL run-time library */
  cob_init(0, NULL);

  /* call the static module and store its return code */
  ret = say(hello, world);

  /* shutdown the COBOL run-time library, keep program running */
  (void)cob_tidy();

  return ret;
}
----------------------------------------
```

Compile and run these programs as follows:

```
$ cobc -x hello.c say.cob
$ ./hello
Hello, world!
```

or, more split and directly using the C compiler:

```
$ cc -c `cob-config --cflags` hello.c
$ cobc -c -static say.cob
$ cobc -x -o hello hello.o say.o
$ ./hello
Hello, world!
```

Note: The biggest benefits of static linking are that all programs are verified to be available in the resulting binary. Furthermore there is a slightly performance benefit in this type of CALL (not visible for "normal" programs).

2.3.3 Dynamic linking with COBOL programs

You can find a COBOL module having a specific name by using the C function `cob_resolve`, which takes the module name as a string and returns a pointer to the module function.

`cob_resolve` returns `NULL` if there is no module. In this case, the function `cob_resolve_error` returns the error message.

Let's see an example:

```
---- hello-dynamic.c -------------------
#include <libcob.h>

static int (*say)(char *hello, char *world);

int main()
{
  int ret;
  char hello[8] = "Hello, ";
  char world[7] = "world!";

  /* initialize the COBOL run-time library */
  cob_init(0, NULL);

  /* Find the module with PROGRAM-ID "say". */
  say = cob_resolve("say");

  /* If there is no such module, show error and exit. */
  if(say == NULL) {
    fprintf(stderr, "%s\n", cob_resolve_error());
    exit(1);
  }

  /* Call the module found ... */
  ret = say(hello, world);

  /* ...and exit with the return code. */
  cob_stop_run(ret);
}
----------------------------------------
```

Compile and run these programs as follows:

```
$ cobc -x -o hello hello-dynamic.c
$ cobc -m say.cob
$ export COB_LIBRARY_PATH=.
$ ./hello
Hello, world!
```

The check of the module load as written above can be directly done in libcob as follows:

```
---- hello-dynamic2.c ------------------
#include <libcob.h>

int main()
{
  int ret;
  char hello[8] = "Hello, ";
```

```
  char world[7] = "world!";

  void *cob_argv[2];
  cob_argv[0] = hello;
  cob_argv[1] = world;

  /* initialize the COBOL run-time library */
  cob_init(0, NULL);

  /* do a CALL, expecting the module to exist,
     otherwise exiting with an error. */
  ret = cob_call ("say", 2, cob_argv);

  /* ...and exit with the return code. */
  cob_stop_run(ret);
}
----------------------------------------
```

In any case be aware that all errors that happen within COBOL will exit your program, as same as a `STOP RUN` will do.

Depending on the application you possibly want to register C signal handlers; error and/or exit handlers in C and/or COBOL to do cleanups, logging or anything else.

There is one way to handle all these scenarios with a call, too, using `cob_call_with_exception_check` instead of `cob_call` as follows:

```
---- hello-dynamic3.c ------------------
#include <libcob.h>

int main()
{
  int ret;
  char hello[8] = "Hello, ";
  char world[7] = "world!";

  void *cob_argv[2];
  cob_argv[0] = hello;
  cob_argv[1] = world;

  /* initialize the COBOL run-time library */
  cob_init(0, NULL);

  /* do a CALL, catching all possible results, */
  ret = cob_call_with_exception_check ("say", 2, cob_argv);

  switch (ret) {
  case 0:  /* program coming back */

    /* Clean up and terminate runtime */
    cob_runtime_hint("program exited with return code %d",
       cob_last_exit_code ());
    cob_tidy ();
    break;
```

```
  case 1:  /* normal exit */
    cob_runtime_hint("STOP RUN with return code %d",
       cob_last_exit_code ());
    break;

  case -1:  /* error exit */
    cob_runtime_hint("error exit with return code %d and error \"%s\"",
       cob_last_exit_code (), cob_last_runtime_error ());
    break;

  case -2:  /* hard error exit */
    cob_runtime_hint("hard error exit with return code %d and error \"%s\"",
       cob_last_exit_code (), cob_last_runtime_error ());
    break;

  case -3:  /* signal handler  exit */
    cob_runtime_hint("signal handler exit with signal %d and error \"%s\"",
       cob_last_exit_code (), cob_last_runtime_error ());
    break;

  default:
    cob_runtime_hint("unexpected return from cob_call_with_exception_check,"
       " last exit code %d, last error \"%s\"",
       cob_last_exit_code (), cob_last_runtime_error ());
    break;
  }

  /* ...and exit with zero if no error happened */
  exit(ret != 0 && ret != 1);
}
----------------------------------------
```

2.3.4 Static linking with C programs

Let's call the following C function from COBOL:

```
---- say.c -----------------------------
int say(char *hello, char *world)
{
  int i;
  for(i = 0; i < 7; i++)
    putchar(hello[i]);
  for(i = 0; i < 6; i++)
    putchar(world[i]);
  putchar('\n');
  return 0;
}
----------------------------------------
```

This program is equivalent to the program in `say.cob` above.

Note that, unlike C, the arguments passed from COBOL programs are not terminated by the null character (i.e., '`\0`').

You can call this function in the same way you call COBOL programs:

```
---- hello.cob -----------------------
```

```
       IDENTIFICATION DIVISION.
       PROGRAM-ID. hello.
       ENVIRONMENT DIVISION.
       DATA DIVISION.
       WORKING-STORAGE SECTION.
       01 hello PIC X(7) VALUE "Hello, ".
       01 world PIC X(6) VALUE "world!".
       PROCEDURE DIVISION.
       CALL "say" USING hello world.
       STOP RUN.
----------------------------------------
```

Compile these programs as follows:

```
$ cobc -x -o hello -static hello.cob say.c
$ ./hello
Hello, world!
```

or separate:

```
$ cc -c say.c
$ cobc -c -static -x hello.cob
$ cobc -x -o hello hello.o say.o
$ ./hello
Hello, world!
```

2.3.5 Dynamic linking with C programs

You can create a dynamically-linked module from a C program by compiling it with cobc ...

```
$ cobc -m say.c
$ cobc -x hello.cob
$ export COB_LIBRARY_PATH=.
$ ./hello
Hello, world!
```

or with most C compilers by passing option `-shared` to the C compiler:

```
$ cc -shared -o say.so say.c
$ cobc -x hello.cob
$ export COB_LIBRARY_PATH=.
$ ./hello
Hello, world!
```

Mind that for COBOL to be able to load the module via CALL the name of the binary must either be identical to the CALL name or the binary containing the entry-point must have been loaded before (by a previous call or COB_PRE_LOAD).

2.3.6 Redirecting output to a (FILE *)

From a module written in C you can call `cob_set_runtime_option` to set the exact `(FILE *)` which is used to write trace data to. In `common.h` is the following:

```
enum cob_runtime_option_switch {
   COB_SET_RUNTIME_TRACE_FILE             /* 'p' is  FILE *  */
   COB_SET_RUNTIME_DISPLAY_PRINTER_FILE   /* 'p' is  FILE *  */
   COB_SET_RUNTIME_RESCAN_ENV             /* rescan environment variables */
   COB_SET_RUNTIME_DISPLAY_PUNCH_FILE     /* 'p' is  FILE *  */
};
COB_EXPIMP  void  cob_set_runtime_option   (enum cob_runtime_option_switch opt, void *p);
```

So from you C code you can tell the GnuCOBOL runtime to redirect TRACE output by:

```
cob_set_runtime_option (COB_SET_RUNTIME_TRACE_FILE,
```

```
                          (void*)((FILE*)myfd));
```

You could also redirect all `DISPLAY UPON PRINTER` output to a file by:

```
cob_set_runtime_option (COB_SET_RUNTIME_DISPLAY_PRINTER_FILE,
                        (void*)((FILE*)myfd));
```

You could also redirect all `DISPLAY UPON SYSPUNCH` output to a file by:

```
cob_set_runtime_option (COB_SET_RUNTIME_DISPLAY_PUNCH_FILE,
                         (void*)((FILE*)myfd));
```

Another routine can be used to return the current value of the option.

```
COB_EXPIMP  void *
cob_get_runtime_option (enum cob_runtime_option_switch opt);
```

2.3.7 Loading EBCDIC/ASCII translation tables (collating sequences)

When an EBCDIC/ASCII translation table is needed (for instance when calling sort functions), you can can call the `cob_load_collation` function to retrieve such tables:

```
COB_EXPIMP int
cob_load_collation (const char *col_name,
                    cob_u8_t *ebcdic_to_ascii,
                    cob_u8_t *ascii_to_ebcdic)
```

3 Customize

3.1 Customizing compiler

These settings are effective at compile-time.

Environment variables (default value in brackets):

`COB_CC` C compiler ("gcc")

`COB_CFLAGS`
: Flags passed to the C compiler ("-I$(PREFIX)/include")

`COB_LDFLAGS`
: Flags passed to the C compiler ("")

`COB_LIBS` Standard libraries linked with the program ("-L$(PREFIX)/lib -lcob")

`COB_LDADD`
: Additional libraries linked with the program ("")

3.2 Customizing library

These settings are effective at run-time. You can set them either via the environment or by a runtime configuration file.

To set the global runtime configuration file export `COB_RUNTIME_CONFIG` to point to your configuration file. To set an explicit runtime configuration file for a single run via `cobcrun` you can use its option `-c` *`file`*, `--config=`*`file`*.

For displaying the current runtime settings you can use the option `-r`, `--runtime-env` of `cobcrun`.

For a complete list of runtime variables, aliases, their default values and options to set them see Appendix I [Runtime Configuration], page 86.

4 Optimize

4.1 Optimize options

There are five compiler options for optimization: `-O0`, `-O`, `-Os`, `-O2`, `-O3`. These options enable optimization at both translation (from COBOL to C) and compilation (C to assembly) levels.

Currently, there is no difference between these optimization options at the translation level other than `-O0` disabling constant folding of expressions and disabling removement of unreachable code.

The option `-O`, `-Os` or `-O2` is passed to the C compiler as is and used for C level optimization.

Additional the options `-fremove-unreachable` and `-fconstant-folding` may be used to adjust handling of these parts; note that constant-folding is a dialect specific option and that both options have an effect on the detail of checks done to unreachable code.

4.2 Optimize call

When a `CALL` statement is executed, the called program is linked at run time. By specifying the compiler option `-fstatic-call`, you can statically link the program at compile time and call it efficiently. (see Section 2.2.1 [Static linking], page 11)

4.3 Optimize binary

By default, data items of usage binary or comp are stored in big-endian form. On those machines whose native byte order is little-endian, this is not quite efficient.

If you prefer, you can store binary items in the native form of your machine. Set the config option `binary-byteorder` to `native` in your config file (see Chapter 3 [Customize], page 20).

In addition, setting the option `binary-size` to `2-4-8` or `1-2-4-8` is more efficient than others.

5 Debug

5.1 Debug options

The compiler option `--debug` can be used, especially during the development of your programs. It enables all run-time error checking, such as subscript boundary checks and numeric data checks, and leads to display of run-time errors with source locations. Exceptions may also be enabled/disabled separately. See Section 2.1.7 [Debug switches], page 10.

5.2 Source Level Debugger

Compiling with `-g` enables several kinds of debug information, allowing you to run your programs with the system debugger. This allows you to step through the COBOL code and inspect the call stack, but direct access to the COBOL variables is not available. Different GDB frontends exist that provide access the COBOL variables directly.

Compiling with debug information also enables several tools to profile the code or test it, for example against memory violations.

5.3 Memory Dumps

Memory Dumps can be enabled/disabled at runtime and will by default be executed in case of runtime errors or handling of different signals.

They can also be requested via C interface.

Only modules that are explicit enabled for dump code will output their data.

5.4 Core Dumps

By default GnuCOBOL catches signals that normally may create core-dumps. To disable this or to even explicit raise SIGABRT on runtime errors or to directly generate core-dumps through libcob, see the runtime varialbes `COB_CORE_ON_ERROR` and `COB_CORE_FILENAME`. To inspecting the reason for the abort check the content of the variable `runtime_err_str` in the generated dump file.[1]

5.5 Tracing execution

Tracing program execution, either in general or in specific parts can be enabled.

[1] The usability of coredumps depends on your operating system.

6 Non-standard extensions

6.1 SELECT ASSIGN TO

A file may be assigned to a literal file, a file in a variable, or a file in an environment variable.

6.1.1 Literal file.

Assign to a literal file.

```
Select file assign to "/tmp/myfile.txt".
```

6.1.2 <variable>

Assign to a file which name is read from a variable.

```
Select file assign to my-file.

01  my-file            pic x(512).

Move "/tmp/myfile.txt" to my-file.
Open output <file>.
```

6.1.3 <environment variable>

Assign to a file in an environment variable.

```
export myfile=/tmp/myfile.txt

Select file assign to external myfile.
```

6.2 Indexed file packages

<This section is in progress.>

6.3 Extended ACCEPT statement

Extended `ACCEPT` statements allow for full control of items accepted from the screen. Items accept by line and column positioning.

All commands following `WITH` are optional.

```
ACCEPT variable-1
   LINE variable-2 | literal-1 COLUMN variable-3 | literal-2
   WITH
      AUTO-SKIP | AUTO
      BACKGROUND-COLOR variable-4 | literal-3
      BELL | BEEP
      BLINK
      FOREGROUND-COLOR variable-5 | literal-4
      LOWLIGHT | HIGHLIGHT
      PROMPT
      PROTECTED
      SIZE [IS] variable-6 | literal-5
      UPDATE
   ON EXCEPTION
      exception processing
   NOT ON EXCEPTION
      normal processing
END-ACCEPT.
```

6.3.1 LINE

The line number of *variable-2* or *literal-1* to accept the field.

6.3.2 COLUMN

The column number of *variable-3* or *literal-2* to accept the field.

6.3.3 AUTO-SKIP

The word `AUTO` may be used for `AUTO-SKIP`.

With this option the `ACCEPT` statement returns after the last character is typed at the end of the field. This is the same as if the Enter key were pressed.

Without this option the cursor remains at the end of the field and waits for the user to press Enter.

The Right-Arrow key returns from the end of the field. The Left-Arrow key returns from the beginning. See Section 6.4 [ACCEPT special], page 25.

The Alt-Right-Arrow and Alt-Left-Arrow keys never `AUTO-SKIP`.

6.3.4 BACKGROUND-COLOR

The background color is the color used behind the characters.

Variable-4 or *literal-3* must be numeric. See file `screenio.cpy` for the color assignments to *variable-4* or *literal-3*.

6.3.5 BELL

The word `BEEP` may be used for `BELL`.

The system beeps when the cursor moves to accept from this field. On some systems, there is no sound. Some other method may indicate a beep, such a flashing screen or pop up window.

6.3.6 BLINK

The field blinks while the user enters the data. This can help small menu selection fields to stand out.

6.3.7 FOREGROUND-COLOR

The foreground color is the color used for the characters.

Variable-5 or *literal-4* must be numeric. See file `screenio.cpy` for the color assignments to *variable-5* or *literal-4*.

6.3.8 LOWLIGHT

The `LOWLIGHT` and `HIGHLIGHT` phrases vary the intensity of the field.

`LOWLIGHT` displays with lower intensity and `HIGHLIGHT` displays with higher intensity. Having neither `LOWLIGHT` nor `HIGHLIGHT` displays at normal intensity.

These may have different levels of intensity, if at all, depending on the make and model of the screens.

6.3.9 PROMPT

Display the field with prompt characters as the cursor moves to accept from this field.

6.3.10 PROTECTED

`PROTECTED` is ignored.

6.3.11 SIZE

The size of *variable-1* to accept from the screen.

Variable-6 or *literal-5* must be numeric.

`SIZE <greater than zero>`
: If *variable-6* or *literal-5* is less than the length of *variable-1* then only the `SIZE` number of characters accept into the field. *Variable-1* pads with spaces after `SIZE` to the end of the field.

  If *variable-6* or *literal-5* is greater than *variable-1*, then the screen pads with spaces after *variable-1* to the `SIZE` length.

`SIZE ZERO`
`<SIZE option not specified>`
: The *variable-1* accepts to its field length.

6.3.12 UPDATE

The contents of variable-1 displays on the screen as the `ACCEPT` begins. This allows the user to update the field without having to type it all again.

Without this option, the `ACCEPT` field is always blank.

6.3.13 ON EXCEPTION

Check the special register cob-crt-status for the special key that was pressed. This includes Escape, Tab, Back-Tab, F-keys, arrows, etc... See screenio.cpy for the values.

6.3.14 NOT ON EXCEPTION

Reset any F-key indicator because no special key was pressed.

6.4 ACCEPT special keys

Special keys are available for extended `ACCEPT` statements.

The `COB-CRT-STATUS` values are in the screenio.cpy copy file.

6.4.1 Arrow keys

The Left-Arrow key moves the cursor to the left. Without `AUTO-SKIP` the cursor stops at the beginning of the field. With `AUTO-SKIP` it returns with the `COB-SCR-KEY-LEFT` value of 2009. See Section 6.3 [Extended ACCEPT], page 23.

The Alt-Left-Arrow key is the same as Left-Arrow except that it never returns, even for `AUTO-SKIP`.

The Right-Arrow key moves the cursor to the right. Without `AUTO-SKIP` the cursor stops at the end of the field. With `AUTO-SKIP` it returns with the `COB-SCR-KEY-RIGHT` value of 2010. See Section 6.3 [Extended ACCEPT], page 23.

The Alt-Right-Arrow key is the same as Right-Arrow except that it never returns, even for `AUTO-SKIP`.

6.4.2 Backspace key

The Backspace key moves the cursor, and the remainder of the text, to the left.

6.4.3 Delete keys

The Delete key deletes the cursor's character and moves the remainder of the text to the left. The cursor does not move.

The Alt-Delete key deletes all text from the cursor to the end of the field.

6.4.4 End key

The End key moves the cursor after the last non-space character. Pressing the End key again moves the cursor to the end of the field. Repeated pressing moves the cursor back and forth.

6.4.5 Home key

The Home key moves the cursor to the first non-space character. Pressing the Home key again moves the cursor to the beginning of the field. Repeated pressing moves the cursor back and forth.

6.4.6 Insert key

The Insert key changes the insert mode.

The value of the insert mode is used in all following `ACCEPT` statements while the program is running.

When the insert mode is on, typed characters move the existing characters to the right until field is full. When it is off, typed characters type over existing characters.

Note: The insert mode is ignored for fields with a size of 1.

The insert mode can also be changed by the `COB_INSERT_MODE` setting at any time, see Appendix I [Runtime Configuration], page 86.

6.4.7 Tab keys

The Tab key returns from the `ACCEPT` with the `COB-SCR-TAB` value of 2007.

The Shift-Tab key returns with the `COB-SCR-BACK-TAB` value of 2008.

6.5 Extended DISPLAY statement

Extended `DISPLAY` statements allow for full control of items that display on the screen. Items display by line and column positioning.

```
DISPLAY variable-1 | literal-1 | figurative constant
   LINE line COLUMN column
   WITH BELL
        BLANK LINE | SCREEN
        ERASE EOL | EOS
        SIZE [IS] variable-2 | literal-2
END-DISPLAY.
```

6.5.1 BELL

Ring the bell. It is optional.

6.5.2 BLANK

Clear the whole line or screen. It is optional.

`BLANK LINE`
: Clear the line from the beginning of the line to the end of the line.

`BLANK SCREEN`
: Clear the whole screen.

6.5.3 ERASE

Clear the line or screen from LINE and COLUMN. It is optional.

`ERASE EOL`
: Clear the line from LINE and COLUMN to the end of the line.

`ERASE EOS`
: Clear the screen from LINE and COLUMN to the end of the screen.

6.5.4 SIZE

The size of *variable-1*, *literal-1*, or *figurative-constant* to display onto the screen. It is optional.

`SIZE` *`positive-integer`*
: If `SIZE` is less than the length of *variable-1* or *literal-1* then only the `SIZE` number of characters display.

  If `SIZE` is greater than the length of *variable-1* or *literal-1*, then the screen pads with spaces after the field to the `SIZE` length.

  Figurative constants display repeatedly the number of times in `SIZE`. Except that `LOW-VALUES` always positions the cursor (see `SIZE` ZERO below).

`SIZE ZERO`
`<SIZE option not specified>`
: *Variable-1* or *literal-1* displays with the field length.

6.5.5 Figurative Constants

Certain figurative constants and values have special functions. All other figurative constants display as a single character.

`SPACE` Display spaces from LINE and COLUMN to the end of the screen. This is the same as WITH ERASE EOS.

`LOW-VALUE`
: Position the cursor to LINE and COLUMN. The next `DISPLAY` statement does not need a LINE or COLUMN to display at that position.

`ALL X"01"`
: Display spaces from LINE and COLUMN to the end of the line. This is the same as `WITH ERASE EOL`.

`ALL X"02"`
: Clear the whole screen. This is the same as `WITH BLANK SCREEN`.

`ALL X"07"`
: Ring the bell. This is the same as `WITH BELL`.

6.6 CONTENT-LENGTH

`FUNCTION CONTENT-LENGTH` returns the length of NUL byte terminated data given a pointer:

```
       identification division.
       program-id. zlen.
       data division.
       working-storage section.
       01 ptr   usage pointer.
       01 str   pic x(4) value z"abc".

      *> Testing CONTENT-LENGTH
```

```
       procedure division.

       set ptr to address of str
       display content-length(ptr)

       goback.
       end program hosted.
```

6.7 CONTENT-OF

`FUNCTION CONTENT-OF` returns an alphanumeric field given a pointer and optional length:

Data from pointer is returned as a COBOL field either by scanning for a NUL byte or using the optional length. Reference modification of result allowed.

```
       identification division.
       program-id. contents.
       data division.
       working-storage section.
       01 ptr   usage pointer.
       01 str   pic x(4) value z"abc".

      *> Testing CONTENT-OF
       procedure division.

       set ptr to address of str
       display content-of(ptr)
       display content-of(ptr, 2)
       display content-of(ptr)(2:2)

       goback.
       end program hosted.
```

7 System Routines

For a complete list of supported system routines, see Appendix D [System routines], page 71.

7.1 CBL_GC_GETOPT

`CBL_GC_GETOPT` provides the quite well-known option parser, getopt, for GnuCOBOL. The usage of this system routine is described by the following example.

```
identification division.
program-id. prog.

data division.
working-storage section.
    78 shortoptions value "jkl".

    01 longoptions.
        05 optionrecord occurs 2 times.
            10 optionname   pic x(25).
            10 has-value    pic 9.
            10 valpoint     pointer value NULL.
            10 return-value pic x(4).

    01 longind     pic 99.
    01 long-only   pic 9 value 1.

    01 return-char pic x(4).
    01 opt-val     pic x(10).

    01 counter     pic 9 value 0.
```

We first need to define the necessary fields for getopt's shortoptions (so), longoptions (lo), longoption index (longind), long-only-option (long-only) and also the fields for return values return-char and opt-val (arbitrary size with trimming, see return codes).

The shortoptions are written down as an alphanumeric field (i.e., a string with arbitrary size) as follows:

```
"ab:c::d"
```

This means we want getopt to look for shortoptions named a, b, c or d and we demand an option value for b and we are accepting an optional one for c.

The longoptions are defined as a table of records with oname, has-value, valpoint and val.

- oname defines the name of a longoption.
- has-value defines if an option value is demanded (has-val = 1), optional (has-val = 2) or not required (has-val = 0).
- valpoint is a pointer used to specify an address to save getopt's return value to. The pointer is optional. If it is `NULL`, getopt returns a value as usual. If you use the pointer it has to point to a `PIC X(4)` field.
- The field val is a `PIC X(4)` character which is returned if the longoption was recognized.

The longoption structure is immutable! You can only vary the number of records.

Now we have the tools to run `CBL_GC_GETOPT` within the procedure division.

```
procedure division.
    move "version" to optionname   (1).
```

```
move 0         to has-value    (1).
move "v"       to return-value (1).

move "verbose" to optionname   (2).
move 0         to has-value    (2).
move "V"       to return-value (2).

perform with test after until return-code = -1
    call 'CBL_GC_GETOPT' using
       by reference shortoptions longoptions longind
       by value long-only
       by reference return-char opt-val
    end-call

    display return-char end-display
    display opt-val     end-display
end-perform
stop run.
```

The example shows how we initialize all parameters and call the routine until `CBL_GC_GETOPT` runs out of options and returns -1.

If the option is recognized, `return-char` contains the option character. Otherwise, `return-char` will contain one of the following:

`?` undefined or ambiguous option

`1` non-option (only if first byte of so is '`-`')

`0` `valpoint != NULL` and we are writing the return value to the specified address

`-1` no more options (or reached the first non-option if first byte of so is '`+`')

The return-code of `CBL_GC_GETOPT` is one of:

`1` a non-option (only if first byte of so is '`-`')

`0` `valpoint != NULL` and we are writing the return value to the specified address

`-1` no more options (or reach the first non-option if first byte of so is '`+`')

`2` truncated option value in opt-val (because opt-val was too small)

`3` regular answer from `getopt`

7.2 CBL_GC_HOSTED

`CBL_GC_HOSTED` provides access to the following C hosted variables:

- `argc` to binary-long by value
- `argv` to pointer to char **
- `stdin`, `stdout`, `stderr` to pointer
- `errno` giving address of errno in pointer to binary-long, use based for more direct access

and conditional access to the following variables:

- `tzname` pointer to pointer to array of two char pointers
- `timezone` C long, will be seconds west of UTC
- `daylight` C int, will be 1 during daylight savings

System will need to HAVE_TIMEZONE defined for these to return anything meaningful. Attempts made when they are not available return 1 from CBL_GC_HOSTED.

It returns 0 when match, 1 on failure, case matters as does length, arg won't match.

The usage of this system routine is described by the following example.

```
HOSTED identification division.
       program-id. hosted.
       data division.
       working-storage section.
       01 argc  usage binary-long.
       01 argv  usage pointer.

       01 stdin usage pointer.
       01 stdout usage pointer.
       01 stderr usage pointer.

       01 errno usage pointer.
       01 err   usage binary-long based.

       01 domain usage float-long value 3.0.

       01 tzname usage pointer.
       01 tznames usage pointer based.
          05 tzs usage pointer occurs 2 times.

       01 timezone   usage binary-long.
       01 daylight   usage binary-short.


      *> Testing CBL_GC_HOSTED
       procedure division.
       call "CBL_GC_HOSTED" using stdin "stdin"
       display "stdin                : " stdin
       call "feof" using by value stdin
       display "feof stdin           : " return-code

       call "CBL_GC_HOSTED" using stdout "stdout"
       display "stdout               : " stdout
       call "fprintf" using by value stdout by content "Hello" & x"0a"

       call "CBL_GC_HOSTED" using stderr "stderr"
       display "stderr               : " stderr
       call "fprintf" using by value stderr by content "on err" & x"0a"

       call "CBL_GC_HOSTED" using argc "argc"
       display "argc                 : " argc

       call "CBL_GC_HOSTED" using argv "argv"
       display "argv                 : " argv

       call "args" using by value argc argv
```

```
call "CBL_GC_HOSTED" using errno "errno"
display "&errno               : " errno
set address of err to errno
display "errno                : " err
call "acos" using by value domain
display "errno after acos(3.0): " err ", EDOM is 33"

call "CBL_GC_HOSTED" using argc "arg"
display "'arg' lookup         : " return-code
call "CBL_GC_HOSTED" using null "argc"
display "null with argc       : " return-code
display "argc is still        : " argc


*> the following only returns zero if the system has HAVE_TIMEZONE set

call "CBL_GC_HOSTED" using daylight "daylight "
display "'timezone' lookup    : " return-code

if return-code not = 0
   display "system doesn't has timezone"
else

   display "timezone is          : " timezone

   call "CBL_GC_HOSTED" using daylight "daylight "
   display "'daylight' lookup    : " return-code
   display "daylight is          : " daylight

   set environment "TZ" to "PST8PDT"
   call static "tzset" returning omitted on exception continue end-call

   call "CBL_GC_HOSTED" using tzname "tzname"
   display "'tzname' lookup      : " return-code

   *> tzs(1) will point to z"PST" and tzs(2) to z"PDT"
   if return-code equal 0 and tzname not equal null then
       set address of tznames to tzname
       if tzs(1) not equal null then
          display "tzs #1               : " tzs(1)
       end-if
       if tzs(2) not equal null then
          display "tzs #2               : " tzs(2)
       end-if
   end-if

end-if

goback.
end program hosted.
```

7.3 CBL_GC_NANOSLEEP

CBL_GC_NANOSLEEP allows you to pause the program for nanoseconds. The actual precision depends on the system.

```
*> Waiting a half second
 call "CBL_GC_NANOSLEEP" using "500000000" end-call

*> Waiting five seconds using compiler string catenation for readability
 call "CBL_GC_NANOSLEEP" using "500" & "0000000"  end-call
```

7.4 CBL_GC_FORK

CBL_GC_FORK allows you to fork the current COBOL process to a new one. The current content of the process' storage (including LOCAL-STORAGE) will be identical, any file handles get invalid in the new process, positions and file / record locks are only available to the original process.

This system routine is not available on Windows (exception: GCC on Cygwin).

Parameters

none

Returns PID (the child process gets '0' returned, the calling process gets the PID of the created children). Negative values are returned for system dependent error codes and -1 if the function is not available on the current system.

```
IDENTIFICATION DIVISION.
PROGRAM-ID. prog.
DATA DIVISION.
WORKING-STORAGE SECTION.
01 CHILD-PID   PIC S9(9) BINARY.
01 WAIT-STS    PIC S9(9) BINARY.
PROCEDURE DIVISION.

    CALL "CBL_GC_FORK" RETURNING CHILD-PID END-CALL
    EVALUATE TRUE
       WHEN CHILD-PID = ZERO
          PERFORM CHILD-CODE
       WHEN CHILD-PID > ZERO
          PERFORM PARENT-CODE
       WHEN CHILD-PID = -1
          DISPLAY 'CBL_GC_FORK is not available '
                  'on the current system!'
          END-DISPLAY
          PERFORM CHILD-CODE
          MOVE 0 TO CHILD-PID
          PERFORM PARENT-CODE
       WHEN OTHER
          MULTIPLY CHILD-PID BY -1 END-MULTIPLY
          DISPLAY 'CBL_GC_FORK returned system error: '
                  CHILD-PID
          END-DISPLAY
    END-EVALUATE

    STOP RUN.
```

```
CHILD-CODE.
    CALL "C$SLEEP" USING 1 END-CALL
    DISPLAY "Hello, I am the child"
    END-DISPLAY
    MOVE 2 TO RETURN-CODE

    CONTINUE.

PARENT-CODE.
    DISPLAY "Hello, I am the parent"
    END-DISPLAY
    CALL "CBL_GC_WAITPID" USING CHILD-PID RETURNING WAIT-STS
    END-CALL
    MOVE 0 TO RETURN-CODE
    EVALUATE TRUE
       WHEN WAIT-STS >= 0
          DISPLAY 'Child ended with status: '
                  WAIT-STS
          END-DISPLAY
       WHEN WAIT-STS = -1
          DISPLAY 'CBL_GC_WAITPID is not available '
                  'on the current system!'
          END-DISPLAY
       WHEN WAIT-STS < -1
          MULTIPLY -1 BY WAIT-STS END-MULTIPLY
          DISPLAY 'CBL_GC_WAITPID returned system error: ' WAIT-STS
          END-DISPLAY
    END-EVALUATE

    CONTINUE.
```

7.5 CBL_GC_WAITPID

CBL_GC_WAITPID allows you to wait until another system process ended. Additional you can check the process' return code.

Parameters: none Returns: function-status / child-status Negative values are returned for system dependent error codes and -1 if the function is not available on the current system.

```
CALL "CBL_GC_WAITPID" USING CHILD-PID RETURNING WAIT-STS
END-CALL
MOVE 0 TO RETURN-CODE
DISPLAY 'CBL_GC_WAITPID ended with status: ' WAIT-STS
END-DISPLAY
```

Appendix A Compiler `cobc` options

The following list of options was extracted from `cobc --help` and shows all available compiler options with a short description.

A.1 Common Options

`-h, --help`
: display this help and exit

`-V, --version`
: display compiler version information and exit

`-dumpversion`
: display compiler version and exit

`-i, --info`
: display compiler information (build/environment) and exit

`-v, --verbose`
: verbose mode, display additional information; multiple `-v` options increase the verbosity, the maximum is 3 as follows: (1) display compiler version and the commands invoked by the compiler, (2) pass verbose option to assembler/compiler (3) pass verbose option to linker

`-q, --brief`
: reduced displays, commands invoked not shown

`-###`
: like -v but commands not executed

`-x`
: build an executable program

`-m`
: build a dynamically loadable module (default)

`-j [`*args*`], --job[=`*args*`]`
: run program after build, passing *args*

`-std=`*dialect*
: warnings/features for a specific dialect *dialect* can be one of: default, cobol2014, cobol2002, cobol85, xopen, ibm-strict, ibm, mvs-strict, mvs, mf-strict, mf, bs2000-strict, bs2000, acu-strict, acu, rm-strict, rm, gcos-strict, gcos; see configuration files in directory config

`-F, --free`
: use free source format (alias for -fformat=free)

`--fixed`
: use fixed source format (default; alias for `-fformat=fixed`)

`-O, -O2, -O3, -Os`
: enable optimization

`-O0`
: disable optimization

`-g`
: enable C compiler debug and stack check

`-d, --debug`
: enable all run-time error checking, equal to `-fstack-check -fec=EC-ALL`

`-fec=`*exception-name*
: enable code generation for *exception-name*, see –list-exceptions for the possible values, sets `-fsource-location`

`-fno-ec=`*exception-name*
: disable code generation for *exception-name*

`-o` *file*
: place the output into *file*

`-b`
: combine all input files into a single dynamically loadable module

`-E`
: preprocess only; do not compile or link

`-C`
: translation only; convert COBOL to C

`-S`
: compile only; output assembly file

`-c`
: compile and assemble, but do not link

`-T` *file*
: generate and place a wide program listing into *file*

`-t` *file*
: generate and place a program listing into *file*

`--tlines=`*lines*
: specify lines per page in listing, default = 55

`-P[=`*dir or file*`]`
: generate preprocessed program listing (.lst)

`-X, --Xref`
: specify cross reference in listing

`-I` *directory*
: add *directory* to copy/include search path

`-L` *directory*
: add *directory* to library search path

`-l` *lib*
: link the library *lib*

`-K` *entry*
: generate `CALL` to *entry* as static

`-D` *define*
: define *define* for COBOL compilation

`-A` *options*
: add *options* to the C compile phase

`-Q` *options*
: add *options* to the C link phase

`--coverage`
: instrument generated binaries for coverage

`--conf=`*file*
: user-defined dialect configuration; see -std

`--list-reserved`
: display reserved words

`--list-intrinsics`
: display intrinsic functions

`--list-mnemonics`
: display mnemonic names

`--list-exceptions`
: display exception names

`--list-system`
: display system routines

`--save-temps[=`*dir*`]`
: save intermediate files; default: current directory

`-MT` *target*
: set/add target file used in dependency list

`-MF` *file*
: place dependency list into *file*

`-ext` *extension*
: add file extension for resolving `COPY`

A.2 Warning options

`-Wall`
: enable most warnings (all except as noted below)

`-Wextra`
: like -Wall but enable some extra warning flags

`-w`
: disable all warnings

`-Wno-`*warning*
: disable warning enabled by default, -Wall or -Wextra

`-Wadditional`
: additional warnings only raised with -Wall

`-Wno-unfinished`
: do not warn if unfinished features are used; *always* active

`-Wno-pending`
: do not warn if pending features are used; *always* active

`-Wno-repository-checks`
: do not warn/check for program/function/external signature mismatch; *always* active

`-Wno-ignored-error`
: do not warn about errors in code parts which are unreachable and so normally ignored; *always* active

`-Wobsolete`
: warn if obsolete features are used

`-Warchaic`
: warn if archaic features are used

`-Wredefinition`
: warn about non-referenced ambiguous data items

`-Wtruncate`
: warn about field truncation from constant assignments

`-Wpossible-truncate`
: warn about possible field truncation; *not* set with `-Wall`

`-Woverlap`
: warn about overlapping `MOVE` of items

`-Wpossible-overlap`
: warn about `MOVE` of items that may overlap depending on variables; *not* set with `-Wall`

`-Wparentheses`
: warn if parentheses are omitted around `AND` within `OR`

`-Wstrict-typing`
: warn strictly about type mismatch, even when same size; *not* set with `-Wall`

`-Wtyping` warn about type mismatch

`-Wimplicit-define`
: warn whenever data items are implicitly defined; *not* set with `-Wall`

`-Wno-corresponding`
: do not warn about `CORRESPONDING` with no matching items; *always* active

`-Winitial-value`
: warn if initial `VALUE` clause is ignored

`-Wprototypes`
: warn about missing `FUNCTION` prototypes/definitions

`-Warithmetic-osvs`
: warn if arithmetic expression precision has changed

`-Wcall-params`
: warn about non 01/77 items for `CALL` parameters; *not* set with `-Wall`

`-Wconstant-expression`
: warn about expressions that always resolve to true/false

`-Wconstant-numlit-expression`
: warn about numeric expressions that always resolve to true/false

`-Wlarger-01-redefines`
: warn about larger redefines allowed by COBOL standards

`-Wcolumn-overflow`
: warn about text after program-text area, `FIXED` format; *not* set with `-Wall`

`-Wterminator`
: warn about lack of scope terminator `END-XXX`; *not* set with `-Wall`

`-Wlinkage`
: warn about dangling `LINKAGE` items; *not* set with `-Wall`

`-Wunreachable`
: warn about likely unreachable statements; *not* set with `-Wall`

`-Wno-dialect`
: do not warn about dialect specific issues; *always* active

`-Wno-goto-section`
: do not warn about `GO TO` section-name; *always* active

`-Wgoto-different-section`
: warn about `GO TO` a praragraph defined in a different section

`-Wsuspicious-perform-thru`
: warn if `PERFORM THRU` references procedures not in ascending order or multiple sections; *always* active

`-Wdangling-text`
: warn about source text after program-area; *not* set with `-Wall`

`-Wno-missing-newline`
: do not warn about missing newlines; *always* active

`-Wno-others`
: do not warn about different issues; *always* active

`-Wno-unsupported`
: do not warn if runtime does not support a feature used

`-fdiagnostics-plain-output`
: make diagnostic output as plain as possible

`-Werror` : treat all warnings as errors

`-Wno-error`
: don't treat warnings as errors

`-Werror=`*warning*
: treat specified *warning* as error

`-Wno-error=`*warning*
: don't treat specified *warning* as error

A.3 Compiler options

`-fsign=[ASCII|EBCDIC]`
: define display sign representation; default: machine native

`-ffold-copy=[UPPER|LOWER]`
: fold `COPY` subject to value; default: no transformation

`-ffold-call=[UPPER|LOWER]`
: fold `PROGRAM-ID`, `CALL`, `CANCEL` subject to value; default: no transformation

`-fmax-errors=`*number*
: maximum number of errors to report before compilation is aborted; default: 128

`-fintrinsics=[ALL|intrinsic function name(,name,...)]`
: intrinsics to be used without `FUNCTION` keyword

`-fdump=`*scope*
: dump data fields on abort, *scope* may be a combination of: `ALL`, `WS`, `LS`, `RD`, `FD`, `SC`, `LO`

`-fcallfh=`*name*
: specifies *name* to be used for I/O as external provided EXTFH interface module

`-febcdic-table=`*cconv-table/file*
: `EBCDIC/ASCII` translation table; e.g. default, ebcdic500_latin1...

`-fdefault-colseq=[ASCII|EBCDIC|NATIVE]`
: define default collating sequence; default: `NATIVE`

`-fstack-extended`
: store origin of entrypoints and `PERFORM`; turned on by `--debug`/`-fdump`

`-fno-remove-unreachable`
: disable remove of unreachable code; turned off by `-g`

`-ftrace` : generate trace code; scope: executed `SECTION/PARAGRAPH`

`-ftraceall`
: generate trace code; scope: executed `SECTION/PARAGRAPH/STATEMENTS`

`-fsyntax-only`
: syntax error checking only; don't emit any output

`-fdebugging-line`
: enable debugging lines; '`D`' in indicator column or floating `>>D`

`-fsource-location`
: generate source location code; turned on by `--debug`/`-ftraceall`/`-fec`/`-fdump`

`-fimplicit-init`
: automatic initialization of the COBOL runtime system

`-fno-recursive-check`
: disable check of recursive program call; effectively compiling as `RECURSIVE` program

`-fstack-check`
: `PERFORM` stack checking; turned on by `--debug`/`-g`

`-fmemory-check=`*scope*
: checks for invalid writes to internal storage, *scope* may be one of: all, pointer, using, none; default: none, set to all by `--debug`

`-fsection-exit-check`
: check that code execution does not leave the scope of `SECTION`s

`-fimplicit-goback-check`
: check that code execution does not end implicit at end of `PROCEDURE DIVISION`

`-fwrite-after`
: use `AFTER 1` for `WRITE` of `LINE SEQUENTIAL`; default: `BEFORE 1`

`-fmfcomment`
: '`*`' in column 1 treated as comment with listing suppression; FIXED/COBOL85/VARIABLE format only

`-facucomment`
: '`$`' in indicator area treated as '`*`', '`|`' treated as floating comment

`-fno-trunc`
: allow numeric field overflow; non-ANSI behaviour

`-fsingle-quote`
: use a single quote (apostrophe) for `QUOTE`; default: double quote

`-foptional-file`
: treat all files as `OPTIONAL`; unless `NOT OPTIONAL` specified

`-fstatic-call`
: output static function calls for the `CALL` statement

`-fno-gen-c-decl-static-call`
: disable generation of C function declarations for subroutines with static `CALL`

`-fgen-c-line-directives`
: generate source location directives in C code;; turned on by `-g`/–coverage

`-fgen-c-labels`
: generate extra labels in C sources;; turned on by `-g`

`-fno-theaders`
: suppress all headers from listing while keeping page breaks

`-fno-tsource`
: suppress source from listing

`-fno-tmessages`
: suppress warning and error summary from listing

`-ftsymbols`
: specify symbols in listing

`-ftcmd` specify command line in listing

`-fno-ttimestamp`
: suppress timestamp in listing headers

`-fttitle=`*`title`*
: set listing title with '_' replaced by spaces; defaults to package name and version

`-fno-diagnostics-show-option`
: suppress output of option that directly controls the diagnostic

`-fno-diagnostics-show-caret`
: do not display source context on warning/error diagnostic

`-fno-diagnostics-show-line-numbers`
: suppress display of line numbers in diagnostics

A.4 Compiler dialect configuration options

`-freserved-words=`*`value`*
: use of complete/fixed reserved words

`-ftab-width=1..12`
: number of spaces that are assumed for tabs

`-ftext-column=72..255`
: right margin column number for fixed-form reference-format

`-fpic-length=`*`number`*
: maximum number of characters allowed in the `PICTURE` character-string

`-fword-length=1..63`
: maximum word-length for COBOL (= programmer defined) words

`-fliteral-length=`*`number`*
: maximum literal size in general

`-fnumeric-literal-length=1..38`
: maximum numeric literal size

`-fdefaultbyte=`*`value`*
: default initialization for fields without `VALUE`, may be one of; character in quotes; decimal 0..255 representing a character; `"init"` to initialize to `PICTURE/USAGE`; `"none"` to do no explicit initialization; default: `"init"`

`-fformat=`*`value`*
: default reference-format, may be one of: `FIXED`, `FREE`, COBOL85, `VARIABLE`, `XOPEN`, `XCARD`, `CRT`, `TERMINAL`, COBOLX

`-fbinary-size=`*`value`*
: binary byte size - defines the allocated bytes according to `PIC`, may be one of: 2-4-8, 1-2-4-8, 1–8

`-fbinary-byteorder=`*`value`*
: binary byte order, may be one of: native, big-endian

`-fassign-clause=`*`value`*
: how to interpret `ASSIGN` *`word`*`:` `as ASSIGN EXTERNAL` *`word`* `or ASSIGN DYNAMIC` *`word`*, may be one of: `dynamic`, `external`, `ibm` (= external), `mf` (= dynamic)

`-fscreen-section-rules=`*value*
: which compiler's rules to apply to `SCREEN SECTION` item clauses, may be one of: acu, gc, mf, rm, std, xopen

`-fdpc-in-data=`*value*
: whether `DECIMAL-POINT IS COMMA` has effect in `XML/JSON GENERATE`, may be one of: none, xml, json, all

`-fsubscript-check=`*value*
: checking for subscript (only done with `EC-BOUND-SUBSCRIPT` active), may be one of: full, max, record

`-ffilename-mapping`
: resolve file names at run time using environment variables

`-fpretty-display`
: alternate formatting of numeric fields

`-fbinary-truncate`
: numeric truncation according to ANSI

`-fcomplex-odo`
: allow non-standard `OCCURS DEPENDING ON` syntax

`-fodoslide`
: adjust items following `OCCURS DEPENDING` (implies complex-odo)

`-finit-justify`
: applies `JUSTIFY` with `VALUE` clause

`-findirect-redefines`
: allow `REDEFINES` to other than last equal level number

`-frelax-syntax-checks`
: allow certain syntax variations (e.g. `REDEFINES` position)

`-fref-mod-zero-length`
: allow zero length reference-modification (only changed with `EC-BOUND-REF-MOD` active)

`-frelax-level-hierarchy`
: allow non-matching level numbers

`-fselect-working`
: require `ASSIGN USING` items to be in `WORKING-STORAGE`

`-flocal-implies-recursive`
: `LOCAL-STORAGE SECTION` implies `RECURSIVE` attribute

`-fsticky-linkage`
: `LINKAGE SECTION` items remain allocated between invocations

`-fmove-ibm`
: `MOVE` operates as on IBM (left to right, byte by byte)

`-fperform-osvs`
: exit point of any currently executing perform is recognized if reached

`-farithmetic-osvs`
: limit precision in intermediate results to precision of final result (less accurate)

`-fconstant-folding`
: evaluate constant expressions at compile time

`-fhostsign`
: allow hexadecimal value 'F' for `NUMERIC` test of signed `PACKED DECIMAL` field

`-fprogram-name-redefinition`
: program names don't lead to a reserved identifier

`-faccept-update`
: set `WITH UPDATE` clause as default for `ACCEPT` dest-item, instead of `WITH NO UPDATE`

`-faccept-auto`
: set `WITH AUTO` clause as default for `ACCEPT` dest-item, instead of `WITH TAB`

`-fconsole-is-crt`
: assume `CONSOLE IS CRT` if not set otherwise

`-fno-echo-means-secure`
: `NO-ECHO` hides input with asterisks like `SECURE`

`-fline-col-zero-default`
: assume a field `DISPLAY` starts at `LINE 0 COL 0` (i.e. at the cursor), not `LINE 1 COL 1`

`-fdisplay-special-fig-consts`
: special behaviour of `DISPLAY SPACE/ALL X'01'/ALL X'02'/ALL X'07'`

`-fbinary-comp-1`
: `COMP-1` is a 16-bit signed integer

`-fnumeric-pointer`
: `POINTER` is a 64-bit unsigned integer

`-fmove-non-numeric-lit-to-numeric-is-zero`
: imply zero in move of non-numeric literal to numeric items

`-fimplicit-assign-dynamic-var`
: implicitly define a variable if an `ASSIGN DYNAMIC` does not match any data item

`-fdevice-mnemonics`
: specifying device by mnemonic

`-fxml-parse-xmlss`
: `XML PARSE XMLSS`

`-fareacheck`
: check contents of Area A (when reference format supports Area A enforcement), enabled checks include:; division, section, paragraph names, level indicators (`FD`, `SD`, `RD`, and `CD`), and toplevel numbers (01 and 77) must start in Area A;; statements must not start in Area A; and; separator periods must not be within Area A

`-fcomment-paragraphs=`*`support`*
: comment paragraphs in `IDENTIFICATION DIVISION` (`AUTHOR`, `DATE-WRITTEN`, ...)

`-fcontrol-division=`*`support`*
: `CONTROL DIVISION`

`-fpartial-replace-when-literal-src=`*`support`*
: apply partial replacing with literal source operand even when it replaces with spaces only;; "skip" prevents such replacements

`-fmemory-size-clause=`*`support`*
: `MEMORY-SIZE` clause

`-fmultiple-file-tape-clause=`*`support`*
: `MULTIPLE-FILE-TAPE` clause

`-flabel-records-clause=`*support*
: `LABEL-RECORDS` clause

`-fvalue-of-clause=`*support*
: `VALUE-OF` clause

`-fdata-records-clause=`*support*
: `DATA-RECORDS` clause

`-ftop-level-occurs-clause=`*support*
: `OCCURS` clause on top-level

`-fsame-as-clause=`*support*
: `SAME AS` clause

`-ftype-to-clause=`*support*
: `TYPE TO` clause

`-fusage-type=`*support*
: `USAGE` type-name

`-fsynchronized-clause=`*support*
: `SYNCHRONIZED` clause

`-fsync-left-right=`*support*
: `LEFT/RIGHT` phrases in `SYNCHRONIZED` clause

`-fspecial-names-clause=`*support*
: `SPECIAL-NAMES` clause

`-fgoto-statement-without-name=`*support*
: `GO TO` statement without name

`-fstop-literal-statement=`*support*
: `STOP`-literal statement

`-fstop-identifier-statement=`*support*
: `STOP`-identifier statement

`-fstop-error-statement=`*support*
: `STOP ERROR` statement

`-fdebugging-mode=`*support*
: `DEBUGGING MODE` and debugging indicator

`-fuse-for-debugging=`*support*
: `USE FOR DEBUGGING`

`-fpadding-character-clause=`*support*
: `PADDING CHARACTER` clause

`-fnext-sentence-phrase=`*support*
: `NEXT SENTENCE` phrase

`-flisting-statements=`*support*
: listing-directive statements `EJECT`, `SKIP1`, `SKIP2`, `SKIP3`

`-ftitle-statement=`*support*
: listing-directive statement `TITLE`

`-fentry-statement=`*support*
: `ENTRY` statement

`-fmove-noninteger-to-alphanumeric=`*support*
: move noninteger to alphanumeric

`-fmove-figurative-constant-to-numeric=`*support*
: move figurative constants to numeric

`-fmove-figurative-space-to-numeric=`*support*
: move figurative constant `SPACE` to numeric

`-fmove-figurative-quote-to-numeric=`*support*
: move figurative constant `QUOTE` to numeric

`-fodo-without-to=`*support*
: `OCCURS DEPENDING ON` without to

`-fsection-segments=`*support*
: section segments

`-falter-statement=`*support*
: `ALTER` statement

`-fcall-overflow=`*support*
: `OVERFLOW` clause for `CALL`

`-fnumeric-boolean=`*support*
: boolean literals (`B'1010'`)

`-fhexadecimal-boolean=`*support*
: hexadecimal-boolean literals (`BX‘A’`)

`-fnational-literals=`*support*
: national literals (`N'UTF-16` *`string`*`'`)

`-fhexadecimal-national-literals=`*support*
: hexadecimal-national literals (`NX'265E'`)

`-fnational-character-literals=`*support*
: non-standard national literals (`NC'UTF-16` *`string`*`'`)

`-fhp-octal-literals=`*support*
: `HP` COBOL octal literals (%377)

`-facu-literals=`*support*
: ACUCOBOL-GT literals (`#B` `#O` `#H` `#X`)

`-febcdic-symbolic-characters`
: `EBCDIC` symbolic characters in literals (`" "135,151,151"bar"195, 194"Z" for " foobarBAZ"`)

`-fword-continuation=`*support*
: continuation of COBOL words

`-fnot-exception-before-exception=`*support*
: `NOT ON EXCEPTION` before `ON EXCEPTION`

`-faccept-display-extensions=`*support*
: extensions to `ACCEPT` and `DISPLAY`

`-frenames-uncommon-levels=`*support*
: `RENAMES` of 01-, 66- and 77-level items

`-flarger-redefines=`*support*
: allow larger `REDEFINES` items

`-fsymbolic-constant=`*support*
: constants defined in `SPECIAL-NAMES`

`-fconstant-78=`*support*
: constant with level 78 item (note: has left to right precedence in expressions)

`-fconstant-01=`*support*
: constant with level 01 `CONSTANT AS/FROM` item

`-fperform-varying-without-by=`*support*
: `PERFORM VARYING` without `BY` phrase (implies `BY 1`)

`-freference-out-of-declaratives=`*support*
: references to sections not in `DECLARATIVES` from within `DECLARATIVES`

`-fprogram-prototypes=`*support*
: `CALL/CANCEL` with program-prototype-name

`-fcall-convention-mnemonic=`*support*
: specifying call-convention by mnemonic

`-fcall-convention-linkage=`*support*
: specifying call-convention by `WITH ... LINKAGE`

`-fusing-optional=`*support*
: support for `PROCEDURE DIVISION USING OPTIONAL`

`-fnumeric-value-for-edited-item=`*support*
: numeric literals in `VALUE` clause of numeric-edited items

`-fincorrect-conf-sec-order=`*support*
: incorrect order of `CONFIGURATION SECTION` paragraphs

`-fdefine-constant-directive=`*support*
: allow `>> DEFINE CONSTANT` var `AS` literal

`-ffree-redefines-position=`*support*
: `REDEFINES` clause not following entry-name in definition

`-frecords-mismatch-record-clause=`*support*
: record sizes does not match `RECORD` clause

`-frecord-delimiter=`*support*
: `RECORD DELIMITER` clause

`-fsequential-delimiters=`*support*
: `BINARY-SEQUENTIAL` and `LINE-SEQUENTIAL` phrases in `RECORD DELIMITER`

`-frecord-delim-with-fixed-recs=`*support*
: `RECORD DELIMITER` clause on file with fixed-length records

`-fmissing-statement=`*support*
: missing statement (e.g. empty `IF` / `PERFORM`)

`-fmissing-period=`*support*
: missing period in `PROCEDURE DIVISION` (when reference format supports Area A enforcement)

`-fzero-length-literals=`*support*
: zero-length literals, e.g. ” and `""`

`-fxml-generate-extra-phrases=`*support*
: `XML GENERATE`'s phrases other than `COUNT IN`

`-fcontinue-after=`*support*
: `AFTER` phrase in `CONTINUE` statement

`-fgoto-entry=`*support*
: `ENTRY FOR GO TO` and `GO TO ENTRY` statements

`-fassign-variable=`*support*
: `ASSIGN [TO]` variable in `SELECT`

`-fassign-using-variable=`*support*
: `ASSIGN USING/VARYING` variable in `SELECT`

`-fassign-ext-dyn=`*support*
: `ASSIGN EXTERNAL/DYNAMIC` in `SELECT`

`-fassign-disk-from=`*support*
: `ASSIGN DISK FROM` variable in `SELECT`

`-fvsam-status=`*support*
: `VSAM` status in `FILE STATUS`

`-fself-call-recursive=`*support*
: `CALL` to own `PROGRAM-ID` implies `RECURSIVE` attribute

`-frecord-contains-depending-clause=`*support*
: `DEPENDING` clause in `RECORD CONTAINS`

`-fpicture-l=`*support*
: `PICTURE` string with 'L' character where *support* is one of: `ok, warning, archaic, obsolete, skip, ignore, error, unconformable`

`-fnot-reserved=`*word*
: *word* to be taken out of the reserved words list

`-freserved=`*word*
: *word* to be added to reserved words list

`-freserved=`*word*`:`*alias*
: *word* to be added to reserved words list as *alias*

`-fnot-register=`*word*
: special register to disable

`-fregister=`*word* `or` *word*`:`*definition*`, where definition uses backslash esca`
: special register to enable

Appendix B Reserved Words

The following list of reserved words was extracted from `cobc --list-reserved` and shows the reserved words, an implementation

Please notice: This list is highly specific to the option `-std=`*`dialect`* and reserved word options (`-freserved=`*`word`*, `-fno-reserved=`*`word`*) in effect. You can get the list for a given *dialect* by calling `cobc -std=`*`dialect`* `--list-reserved`.

B.1 Common reserved words

Reserved word	Implemented	Aliases
3-D	Yes (C/S)	
ABSENT	Yes	
ACCEPT	Yes	
ACCESS	Yes	
ACTION	Yes (C/S)	
ACTIVATING	No (C/S)	
ACTIVE-CLASS	Yes	
ACTIVE-X	Yes (C/S)	
ACTUAL	Yes (C/S)	
ADD	Yes	
ADDRESS	Yes	
ADJUSTABLE-COLUMNS	Yes (C/S)	
ADVANCING	Yes	
AFTER	Yes	
ALIGNED	Yes	
ALIGNMENT	Yes (C/S)	
ALL	Yes	
ALLOCATE	Yes	
ALLOWING	Yes (C/S)	
ALPHABET	Yes	
ALPHABETIC	Yes	
ALPHABETIC-LOWER	Yes	
ALPHABETIC-UPPER	Yes	
ALPHANUMERIC	Yes	
ALPHANUMERIC-EDITED	Yes	
ALSO	Yes	
ALTER	Yes	
ALTERNATE	Yes	
AND	Yes	
ANUM	No (C/S)	
ANY	Yes	
ANYCASE	No	
APPLY	Yes (C/S)	
ARE	Yes	
AREA	Yes	AREAS
AREAS	Yes	AREA
ARGUMENT-NUMBER	Yes	
ARGUMENT-VALUE	Yes	
ARITHMETIC	Yes (C/S)	
AS	Yes	
ASCENDING	Yes	

ASCII	Yes (C/S)	
ASSIGN	Yes	
AT	Yes	
ATTRIBUTE	Yes (C/S)	
ATTRIBUTES	Yes (C/S)	
AUTHOR	Yes (C/S)	
AUTO	Yes (C/S)	AUTO-SKIP, AUTOTERMINATE
AUTO-DECIMAL	Yes (C/S)	
AUTO-SKIP	Yes	AUTO, AUTOTERMINATE
AUTO-SPIN	Yes (C/S)	
AUTOMATIC	Yes	
AUTOTERMINATE	Yes	AUTO, AUTO-SKIP
AWAY-FROM-ZERO	Yes (C/S)	
B-AND	Yes	
B-NOT	Yes	
B-OR	Yes	
B-SHIFT-L	Yes	
B-SHIFT-LC	Yes	
B-SHIFT-R	Yes	
B-SHIFT-RC	Yes	
B-XOR	Yes	
BACKGROUND-COLOR	Yes (C/S)	BACKGROUND-COLOUR
BACKGROUND-COLOUR	Yes	BACKGROUND-COLOR
BACKGROUND-HIGH	Yes	
BACKGROUND-LOW	Yes	
BACKGROUND-STANDARD	Yes	
BACKWARD	Yes (C/S)	
BAR	Yes (C/S)	
BASED	Yes	
BEEP	Yes	BELL
BEFORE	Yes	
BELL	Yes (C/S)	BEEP
BINARY	Yes	
BINARY-C-LONG	Yes	
BINARY-CHAR	Yes	
BINARY-DOUBLE	Yes	BINARY-LONG-LONG
BINARY-INT	Yes	BINARY-LONG
BINARY-LONG	Yes	BINARY-INT
BINARY-LONG-LONG	Yes	BINARY-DOUBLE
BINARY-SEQUENTIAL	Yes (C/S)	
BINARY-SHORT	Yes	
BIT	Yes	
BITMAP	Yes (C/S)	
BITMAP-END	Yes (C/S)	
BITMAP-HANDLE	Yes (C/S)	
BITMAP-NUMBER	Yes (C/S)	
BITMAP-START	Yes (C/S)	
BITMAP-TIMER	Yes (C/S)	
BITMAP-TRAILING	Yes (C/S)	
BITMAP-TRANSPARENT-COLOR	Yes (C/S)	
BITMAP-WIDTH	Yes (C/S)	
BLANK	Yes	

BLINK	Yes (C/S)	
BLOCK	Yes	
BOOLEAN	Yes	
BOTTOM	Yes	
BOX	Yes (C/S)	
BOXED	Yes (C/S)	
BULK-ADDITION	Yes (C/S)	
BUSY	Yes (C/S)	
BUTTONS	Yes (C/S)	
BY	Yes	
BYTE	No (C/S)	
BYTE-LENGTH	Yes (C/S)	
BYTES	No	
C	Yes (C/S)	
CALENDAR-FONT	Yes (C/S)	
CALL	Yes	
CANCEL	Yes	
CANCEL-BUTTON	Yes (C/S)	
CAPACITY	Yes (C/S)	
CARD-PUNCH	Yes (C/S)	
CARD-READER	Yes (C/S)	
CASSETTE	Yes (C/S)	
CCOL	Yes (C/S)	
CD	Yes	
CELL	Yes (C/S)	CELLS
CELL-COLOR	Yes (C/S)	
CELL-DATA	Yes (C/S)	
CELL-FONT	Yes (C/S)	
CELL-PROTECTION	Yes (C/S)	
CELLS	Yes	CELL
CENTER	Yes (C/S)	
CENTERED	Yes (C/S)	
CENTERED-HEADINGS	Yes (C/S)	
CENTURY-DATE	Yes (C/S)	
CF	Yes	
CH	Yes	
CHAIN	No	
CHAINING	Yes	
CHANGED	Yes (C/S)	
CHARACTER	Yes	
CHARACTERS	Yes	
CHECK-BOX	Yes (C/S)	
CLASS	Yes	
CLASS-ID	No	
CLASSIFICATION	Yes (C/S)	
CLEAR-SELECTION	Yes (C/S)	
CLINE	Yes (C/S)	
CLINES	Yes (C/S)	
CLOSE	Yes	
COBOL	Yes (C/S)	
CODE	Yes	
CODE-SET	Yes	

COL	Yes	
COLLATING	Yes	
COLOR	Yes	
COLORS	Yes (C/S)	COLOURS
COLOURS	Yes	COLORS
COLS	Yes	
COLUMN	Yes	
COLUMN-COLOR	Yes (C/S)	
COLUMN-DIVIDERS	Yes (C/S)	
COLUMN-FONT	Yes (C/S)	
COLUMN-HEADINGS	Yes (C/S)	
COLUMN-PROTECTION	Yes (C/S)	
COLUMNS	Yes	
COMBO-BOX	Yes (C/S)	
COMMA	Yes	
COMMAND-LINE	Yes	
COMMIT	Yes	
COMMON	Yes	
COMMUNICATION	Yes	
COMP	Yes	COMPUTATIONAL
COMP-0	Yes	COMPUTATIONAL-0
COMP-1	Yes	COMPUTATIONAL-1
COMP-10	Yes	COMP-15, DOUBLE, FLOAT-LONG
COMP-15	Yes	COMP-10, DOUBLE, FLOAT-LONG
COMP-2	Yes	COMPUTATIONAL-2
COMP-3	Yes	COMPUTATIONAL-3
COMP-4	Yes	COMPUTATIONAL-4
COMP-5	Yes	COMPUTATIONAL-5
COMP-6	Yes	COMPUTATIONAL-6
COMP-9	Yes	FLOAT, FLOAT-SHORT
COMP-N	Yes	COMPUTATIONAL-N
COMP-X	Yes	COMPUTATIONAL-X
COMPUTATIONAL	Yes	COMP
COMPUTATIONAL-0	Yes	COMP-0
COMPUTATIONAL-1	Yes	COMP-1
COMPUTATIONAL-2	Yes	COMP-2
COMPUTATIONAL-3	Yes	COMP-3
COMPUTATIONAL-4	Yes	COMP-4
COMPUTATIONAL-5	Yes	COMP-5
COMPUTATIONAL-6	Yes	COMP-6
COMPUTATIONAL-N	Yes	COMP-N
COMPUTATIONAL-X	Yes	COMP-X
COMPUTE	Yes	
CONDITION	Yes	
CONFIGURATION	Yes	
CONSTANT	Yes	
CONTAINS	Yes	
CONTENT	Yes	
CONTINUE	Yes	
CONTROL	Yes	
CONTROLS	Yes	
CONVERSION	Yes (C/S)	

CONVERTING	Yes	
COPY	Yes	
COPY-SELECTION	Yes (C/S)	
CORE-INDEX	Yes (C/S)	
CORR	Yes	CORRESPONDING
CORRESPONDING	Yes	CORR
COUNT	Yes	
CRT	Yes	
CRT-UNDER	Yes	
CSIZE	Yes (C/S)	
CURRENCY	Yes	
CURRENT	No (C/S)	
CURSOR	Yes	
CURSOR-COL	Yes (C/S)	
CURSOR-COLOR	Yes (C/S)	
CURSOR-FRAME-WIDTH	Yes (C/S)	
CURSOR-ROW	Yes (C/S)	
CURSOR-X	Yes (C/S)	
CURSOR-Y	Yes (C/S)	
CUSTOM-PRINT-TEMPLATE	Yes (C/S)	
CYCLE	Yes (C/S)	
CYL-INDEX	Yes (C/S)	
CYL-OVERFLOW	Yes (C/S)	
DASHED	Yes (C/S)	
DATA	Yes	
DATA-COLUMNS	Yes (C/S)	
DATA-POINTER	Yes	
DATA-TYPES	Yes (C/S)	
DATE	Yes	
DATE-COMPILED	Yes (C/S)	
DATE-ENTRY	Yes (C/S)	
DATE-MODIFIED	Yes (C/S)	
DATE-WRITTEN	Yes (C/S)	
DAY	Yes	
DAY-OF-WEEK	Yes	
DE	Yes	
DEBUGGING	Yes	
DECIMAL-POINT	Yes	
DECLARATIVES	Yes	
DEFAULT	Yes	
DEFAULT-BUTTON	Yes (C/S)	
DEFAULT-FONT	Yes	
DELETE	Yes	
DELIMITED	Yes	
DELIMITER	Yes	
DEPENDING	Yes	
DESCENDING	Yes	
DESTINATION	Yes	
DESTROY	Yes	
DETAIL	Yes	
DISABLE	Yes	
DISC	Yes (C/S)	

DISK	Yes (C/S)	
DISP	Yes (C/S)	
DISPLAY	Yes	
DISPLAY-1	Yes	
DISPLAY-COLUMNS	Yes (C/S)	
DISPLAY-FORMAT	Yes (C/S)	
DIVIDE	Yes	
DIVIDER-COLOR	Yes (C/S)	
DIVIDERS	Yes (C/S)	
DIVISION	Yes	
DOTDASH	Yes (C/S)	
DOTTED	Yes (C/S)	
DOUBLE	Yes	COMP-10, COMP-15, FLOAT-LONG
DOWN	Yes	
DRAG-COLOR	Yes (C/S)	
DROP-DOWN	Yes (C/S)	
DROP-LIST	Yes (C/S)	
DUPLICATES	Yes	
DYNAMIC	Yes	
EBCDIC	Yes (C/S)	
EC	Yes	
ECHO	Yes	
EDITING	No	
EGI	Yes	
ELEMENT	Yes (C/S)	
ELSE	Yes	
EMI	Yes	
EMPTY-CHECK	Yes	REQUIRED
ENABLE	Yes	
ENCODING	Yes (C/S)	
ENCRYPTION	Yes (C/S)	
END	Yes	
END-ACCEPT	Yes	
END-ADD	Yes	
END-CALL	Yes	
END-CHAIN	No	
END-COLOR	Yes (C/S)	
END-COMPUTE	Yes	
END-DELETE	Yes	
END-DISPLAY	Yes	
END-DIVIDE	Yes	
END-EVALUATE	Yes	
END-IF	Yes	
END-JSON	Yes	
END-MODIFY	Yes (C/S)	
END-MULTIPLY	Yes	
END-OF-PAGE	Yes	EOP
END-PERFORM	Yes	
END-READ	Yes	
END-RECEIVE	Yes	
END-RETURN	Yes	
END-REWRITE	Yes	

END-SEARCH	Yes	
END-SEND	Yes	
END-START	Yes	
END-STRING	Yes	
END-SUBTRACT	Yes	
END-UNSTRING	Yes	
END-WRITE	Yes	
END-XML	Yes	
ENGRAVED	Yes (C/S)	
ENSURE-VISIBLE	Yes (C/S)	
ENTRY	Yes	
ENTRY-CONVENTION	Yes (C/S)	
ENTRY-FIELD	Yes (C/S)	
ENTRY-REASON	Yes (C/S)	
ENVIRONMENT	Yes	
ENVIRONMENT-NAME	Yes	
ENVIRONMENT-VALUE	Yes	
EO	No	
EOL	Yes (C/S)	
EOP	Yes	END-OF-PAGE
EOS	Yes (C/S)	
EQUAL	Yes	EQUALS
EQUALS	Yes	EQUAL
ERASE	Yes (C/S)	
ERROR	Yes	
ESCAPE	Yes	
ESCAPE-BUTTON	Yes (C/S)	
ESI	Yes	
EVALUATE	Yes	
EVENT	Yes	
EVENT-LIST	Yes (C/S)	
EVERY	Yes (C/S)	
EXCEPTION	Yes	
EXCEPTION-OBJECT	No	
EXCEPTION-VALUE	Yes (C/S)	
EXCLUSIVE	Yes	
EXCLUSIVE-OR	No	
EXHIBIT	Yes	
EXIT	Yes	
EXPAND	Yes (C/S)	
EXPANDS	No (C/S)	
EXTEND	Yes	
EXTENDED-SEARCH	Yes (C/S)	
EXTERN	Yes (C/S)	
EXTERNAL	Yes	
EXTERNAL-FORM	Yes	
F	Yes (C/S)	
FACTORY	Yes	
FALSE	Yes	
FD	Yes	
FH--FCD	Yes (C/S)	
FH--KEYDEF	Yes (C/S)	

FILE	Yes	
FILE-CONTROL	Yes	
FILE-ID	Yes	
FILE-LIMIT	Yes (C/S)	
FILE-LIMITS	Yes (C/S)	
FILE-NAME	Yes (C/S)	
FILE-POS	Yes (C/S)	
FILL-COLOR	Yes (C/S)	
FILL-COLOR2	Yes (C/S)	
FILL-PERCENT	Yes (C/S)	
FILLER	Yes	
FINAL	Yes	
FINALLY	No	
FINISH-REASON	Yes (C/S)	
FIRST	Yes	
FIXED	Yes	
FIXED-FONT	Yes	
FIXED-WIDTH	Yes (C/S)	
FLAT	Yes (C/S)	
FLAT-BUTTONS	Yes (C/S)	
FLOAT	Yes	COMP-9, FLOAT-SHORT
FLOAT-BINARY-128	No	
FLOAT-BINARY-32	No	
FLOAT-BINARY-64	No	
FLOAT-DECIMAL-16	Yes	
FLOAT-DECIMAL-34	Yes	
FLOAT-EXTENDED	Yes	
FLOAT-INFINITY	No	
FLOAT-LONG	Yes	COMP-10, COMP-15, DOUBLE
FLOAT-NOT-A-NUMBER	No (C/S)	
FLOAT-SHORT	Yes	COMP-9, FLOAT
FLOATING	Yes	
FONT	Yes	
FOOTING	Yes	
FOR	Yes	
FOREGROUND-COLOR	Yes (C/S)	FOREGROUND-COLOUR
FOREGROUND-COLOUR	Yes	FOREGROUND-COLOR
FOREVER	Yes (C/S)	
FORMAT	Yes	
FRAME	Yes (C/S)	
FRAMED	Yes (C/S)	
FREE	Yes	
FROM	Yes	
FULL	Yes (C/S)	LENGTH-CHECK
FULL-HEIGHT	Yes (C/S)	
FUNCTION	Yes	
FUNCTION-ID	Yes	
FUNCTION-POINTER	Yes	
GENERATE	Yes	
GET	No	
GIVING	Yes	
GLOBAL	Yes	

GO	Yes	
GO-BACK	Yes (C/S)	
GO-FORWARD	Yes (C/S)	
GO-HOME	Yes (C/S)	
GO-SEARCH	Yes (C/S)	
GOBACK	Yes	
GRAPHICAL	Yes (C/S)	
GREATER	Yes	
GRID	Yes (C/S)	
GROUP	Yes	
GROUP-USAGE	No	
GROUP-VALUE	Yes (C/S)	
HANDLE	Yes	
HAS-CHILDREN	Yes (C/S)	
HEADING	Yes	
HEADING-COLOR	Yes (C/S)	
HEADING-DIVIDER-COLOR	Yes (C/S)	
HEADING-FONT	Yes (C/S)	
HEAVY	Yes (C/S)	
HEIGHT-IN-CELLS	Yes (C/S)	
HEX	No (C/S)	
HIDDEN-DATA	Yes (C/S)	
HIGH-COLOR	Yes (C/S)	
HIGH-VALUE	Yes	HIGH-VALUES
HIGH-VALUES	Yes	HIGH-VALUE
HIGHLIGHT	Yes (C/S)	
HOT-TRACK	Yes (C/S)	
HSCROLL	Yes (C/S)	
HSCROLL-POS	Yes (C/S)	
I-O	Yes	
I-O-CONTROL	Yes	
ICON	Yes (C/S)	
ID	Yes	
IDENTIFICATION	Yes	
IDENTIFIED	Yes	
IF	Yes	
IGNORE	Yes	
IGNORING	Yes (C/S)	
IMPLEMENTS	No (C/S)	
IN	Yes	
INDEPENDENT	Yes (C/S)	
INDEX	Yes	
INDEXED	Yes	
INDICATE	Yes	
INHERITS	No	
INITIAL	Yes	
INITIALISE	Yes	INITIALIZE
INITIALISED	Yes	INITIALIZED
INITIALIZE	Yes	INITIALISE
INITIALIZED	Yes (C/S)	INITIALISED
INITIATE	Yes	
INPUT	Yes	

INPUT-OUTPUT	Yes	
INQUIRE	Yes	
INSERT-ROWS	Yes (C/S)	
INSERTION-INDEX	Yes (C/S)	
INSPECT	Yes	
INSTALLATION	Yes (C/S)	
INTERFACE	No	
INTERFACE-ID	No	
INTERMEDIATE	Yes (C/S)	
INTO	Yes	
INTRINSIC	Yes (C/S)	
INVALID	Yes	
INVOKE	No	
IS	Yes	
ITEM	Yes (C/S)	
ITEM-TEXT	Yes (C/S)	
ITEM-TO-ADD	Yes (C/S)	
ITEM-TO-DELETE	Yes (C/S)	
ITEM-TO-EMPTY	Yes (C/S)	
ITEM-VALUE	Yes (C/S)	
JSON	Yes	
JUST	Yes	JUSTIFIED
JUSTIFIED	Yes	JUST
KEPT	Yes	
KEY	Yes	
KEYBOARD	Yes (C/S)	
LABEL	Yes	
LABEL-OFFSET	Yes (C/S)	
LARGE-FONT	Yes	
LARGE-OFFSET	Yes (C/S)	
LAST	Yes	
LAST-ROW	Yes (C/S)	
LAYOUT-DATA	Yes (C/S)	
LAYOUT-MANAGER	Yes	
LC_ALL	No (C/S)	
LC_COLLATE	No (C/S)	
LC_CTYPE	No (C/S)	
LC_MESSAGES	No (C/S)	
LC_MONETARY	No (C/S)	
LC_NUMERIC	No (C/S)	
LC_TIME	No (C/S)	
LEADING	Yes	
LEADING-SHIFT	Yes (C/S)	
LEAVE	Yes (C/S)	
LEFT	Yes	
LEFT-JUSTIFY	No	
LEFT-TEXT	Yes (C/S)	
LEFTLINE	Yes	
LENGTH	Yes	
LENGTH-CHECK	Yes	FULL
LESS	Yes	
LIKE	Yes	

LIMIT	Yes	
LIMITS	Yes	
LINAGE	Yes	
LINAGE-COUNTER	Yes	
LINE	Yes	
LINE-COUNTER	Yes	
LINE-SEQUENTIAL	Yes (C/S)	
LINES	Yes	
LINES-AT-ROOT	Yes (C/S)	
LINKAGE	Yes	
LIST-BOX	Yes (C/S)	
LM-RESIZE	Yes	
LOC	Yes (C/S)	
LOCAL-STORAGE	Yes	
LOCALE	Yes	
LOCATION	No (C/S)	
LOCK	Yes	
LOCK-HOLDING	Yes (C/S)	
LONG-DATE	Yes (C/S)	
LOW-COLOR	Yes (C/S)	
LOW-VALUE	Yes	LOW-VALUES
LOW-VALUES	Yes	LOW-VALUE
LOWER	Yes (C/S)	
LOWERED	Yes (C/S)	
LOWLIGHT	Yes (C/S)	
MAGNETIC-TAPE	Yes (C/S)	
MANUAL	Yes	
MASS-UPDATE	Yes (C/S)	
MASTER-INDEX	Yes (C/S)	
MAX-LINES	Yes (C/S)	
MAX-PROGRESS	Yes (C/S)	
MAX-TEXT	Yes (C/S)	
MAX-VAL	Yes (C/S)	
MEDIUM-FONT	Yes	
MEMORY	Yes (C/S)	
MENU	Yes	
MERGE	Yes	
MESSAGE	Yes	
MESSAGE-TAG	No	
METHOD	No	
METHOD-ID	No	
MICROSECOND-TIME	Yes (C/S)	
MIN-VAL	Yes (C/S)	
MINUS	Yes	
MODE	Yes	
MODIFY	Yes	
MODULES	Yes (C/S)	
MOVE	Yes	
MULTILINE	Yes (C/S)	
MULTIPLE	Yes	
MULTIPLY	Yes	
NAME	Yes (C/S)	

NAMED	Yes (C/S)	
NAMESPACE	Yes (C/S)	
NAMESPACE-PREFIX	Yes (C/S)	
NAT	No (C/S)	
NATIONAL	Yes	
NATIONAL-EDITED	Yes	
NATIVE	Yes	
NAVIGATE-URL	Yes (C/S)	
NEAREST-AWAY-FROM-ZERO	Yes (C/S)	
NEAREST-EVEN	Yes (C/S)	
NEAREST-TOWARD-ZERO	Yes (C/S)	
NEGATIVE	Yes	
NESTED	Yes	
NEW	Yes	
NEXT	Yes	
NEXT-ITEM	Yes (C/S)	
NO	Yes	
NO-AUTO-DEFAULT	Yes (C/S)	
NO-AUTOSEL	Yes (C/S)	
NO-BOX	Yes (C/S)	
NO-DIVIDERS	Yes (C/S)	
NO-ECHO	Yes	
NO-F4	Yes (C/S)	
NO-FOCUS	Yes (C/S)	
NO-GROUP-TAB	Yes (C/S)	
NO-KEY-LETTER	Yes (C/S)	
NO-SEARCH	Yes (C/S)	
NO-UPDOWN	Yes (C/S)	
NOMINAL	Yes (C/S)	
NONE	Yes (C/S)	
NONNUMERIC	Yes (C/S)	
NORMAL	Yes (C/S)	
NOT	Yes	
NOTAB	Yes (C/S)	
NOTHING	Yes	
NOTIFY	Yes (C/S)	
NOTIFY-CHANGE	Yes (C/S)	
NOTIFY-DBLCLICK	Yes (C/S)	
NOTIFY-SELCHANGE	Yes (C/S)	
NULL	Yes	NULLS
NULLS	Yes	NULL
NUM-COL-HEADINGS	Yes (C/S)	
NUM-ROWS	Yes (C/S)	
NUMBER	Yes	
NUMBERS	Yes	
NUMERIC	Yes	
NUMERIC-EDITED	Yes	
OBJECT	Yes	
OBJECT-COMPUTER	Yes	
OBJECT-REFERENCE	No	
OCCURS	Yes	
OF	Yes	

OFF	Yes	
OK-BUTTON	Yes (C/S)	
OMITTED	Yes	
ON	Yes	
ONLY	Yes	
OPEN	Yes	
OPTIONAL	Yes	
OPTIONS	Yes	
OR	Yes	
ORDER	Yes	
ORGANISATION	Yes	ORGANIZATION
ORGANIZATION	Yes	ORGANISATION
OTHER	Yes	
OTHERS	Yes (C/S)	
OUTPUT	Yes	
OVERFLOW	Yes	
OVERLAP-LEFT	Yes (C/S)	OVERLAP-TOP
OVERLAP-TOP	Yes (C/S)	OVERLAP-LEFT
OVERLINE	Yes	
OVERRIDE	No	
PACKED-DECIMAL	Yes	
PADDING	Yes	
PAGE	Yes	
PAGE-COUNTER	Yes	
PAGE-SETUP	Yes (C/S)	
PAGED	Yes (C/S)	
PARAGRAPH	Yes (C/S)	
PARENT	Yes (C/S)	
PARSE	Yes (C/S)	
PASCAL	Yes (C/S)	
PASSWORD	Yes (C/S)	
PERFORM	Yes	
PERMANENT	Yes (C/S)	
PF	Yes	
PH	Yes	
PHYSICAL	Yes	
PIC	Yes	PICTURE
PICTURE	Yes	PIC
PIXEL	Yes (C/S)	PIXELS
PIXELS	Yes	PIXEL
PLACEMENT	Yes (C/S)	
PLUS	Yes	
POINTER	Yes	
POP-UP	Yes (C/S)	
POS	Yes (C/S)	
POSITION	Yes	
POSITION-SHIFT	Yes (C/S)	
POSITIVE	Yes	
PREFIXED	No (C/S)	
PRESENT	Yes	
PREVIOUS	Yes (C/S)	
PRINT	Yes (C/S)	

PRINT-NO-PROMPT	Yes (C/S)	
PRINT-PREVIEW	Yes (C/S)	
PRINTER	Yes (C/S)	
PRINTER-1	Yes (C/S)	
PRINTING	Yes	
PRIORITY	Yes	
PROCEDURE	Yes	
PROCEDURE-POINTER	Yes	PROGRAM-POINTER
PROCEDURES	Yes	
PROCEED	Yes	
PROCESSING	Yes (C/S)	
PROGRAM	Yes	
PROGRAM-ID	Yes	
PROGRAM-POINTER	Yes	PROCEDURE-POINTER
PROGRESS	Yes (C/S)	
PROHIBITED	Yes (C/S)	
PROMPT	Yes	
PROPERTIES	Yes (C/S)	
PROPERTY	Yes	
PROTECTED	Yes (C/S)	
PROTOTYPE	Yes	
PURGE	Yes	
PUSH-BUTTON	Yes (C/S)	
QUERY-INDEX	Yes (C/S)	
QUEUE	Yes	
QUOTE	Yes	QUOTES
QUOTES	Yes	QUOTE
RADIO-BUTTON	Yes (C/S)	
RAISE	Yes	
RAISED	Yes (C/S)	
RAISING	Yes	
RANDOM	Yes	
RD	Yes	
READ	Yes	
READ-ONLY	Yes (C/S)	
READERS	Yes (C/S)	
RECEIVE	Yes	
RECEIVED	Yes	
RECORD	Yes	
RECORD-DATA	Yes (C/S)	
RECORD-OVERFLOW	Yes (C/S)	
RECORD-TO-ADD	Yes (C/S)	
RECORD-TO-DELETE	Yes (C/S)	
RECORDING	Yes	
RECORDS	Yes	
RECURSIVE	Yes (C/S)	
REDEFINES	Yes	
REEL	Yes	
REFERENCE	Yes	
REFERENCES	Yes	
REFRESH	Yes (C/S)	
REGION-COLOR	Yes (C/S)	

RELATION	Yes (C/S)	
RELATIVE	Yes	
RELEASE	Yes	
REMAINDER	Yes	
REMARKS	Yes (C/S)	
REMOVAL	Yes	
RENAMES	Yes	
REORG-CRITERIA	Yes (C/S)	
REPEATED	Yes	
REPLACE	Yes	
REPLACING	Yes	
REPORT	Yes	
REPORTING	Yes	
REPORTS	Yes	
REPOSITORY	Yes	
REQUIRED	Yes (C/S)	EMPTY-CHECK
REREAD	Yes (C/S)	
RERUN	Yes (C/S)	
RESERVE	Yes	
RESET	Yes	
RESET-GRID	Yes (C/S)	
RESET-LIST	Yes (C/S)	
RESET-TABS	Yes (C/S)	
RESUME	No	
RETRY	Yes	
RETURN	Yes	
RETURNING	Yes	
REVERSE	Yes	
REVERSE-VIDEO	Yes (C/S)	
REVERSED	Yes	
REWIND	Yes	
REWRITE	Yes	
RF	Yes	
RH	Yes	
RIGHT	Yes	
RIGHT-ALIGN	Yes (C/S)	
RIGHT-JUSTIFY	No	
RIGHTLINE	Yes	
RIMMED	Yes (C/S)	
ROLLBACK	Yes	
ROUNDED	Yes	
ROUNDING	Yes (C/S)	
ROW-COLOR	Yes (C/S)	
ROW-COLOR-PATTERN	Yes (C/S)	
ROW-DIVIDERS	Yes (C/S)	
ROW-FONT	Yes (C/S)	
ROW-HEADINGS	Yes (C/S)	
ROW-PROTECTION	Yes (C/S)	
RUN	Yes	
S	Yes (C/S)	
SAME	Yes	
SAVE-AS	Yes (C/S)	

SAVE-AS-NO-PROMPT	Yes (C/S)	
SCREEN	Yes	
SCROLL	Yes (C/S)	
SCROLL-BAR	Yes (C/S)	
SD	Yes	
SEARCH	Yes	
SEARCH-OPTIONS	Yes (C/S)	
SEARCH-TEXT	Yes (C/S)	
SECONDS	Yes (C/S)	
SECTION	Yes	
SECURE	Yes (C/S)	
SECURITY	Yes (C/S)	
SEGMENT	Yes	
SEGMENT-LIMIT	Yes	
SELECT	Yes	
SELECT-ALL	Yes (C/S)	
SELECTION-INDEX	Yes (C/S)	
SELECTION-TEXT	Yes (C/S)	
SELF	No	
SELF-ACT	Yes (C/S)	
SEND	Yes	
SENTENCE	Yes	
SEPARATE	Yes	
SEPARATION	Yes (C/S)	
SEQUENCE	Yes	
SEQUENTIAL	Yes	
SET	Yes	
SHADING	Yes (C/S)	
SHADOW	Yes (C/S)	
SHARING	Yes	
SHORT-DATE	Yes (C/S)	
SHOW-LINES	Yes (C/S)	
SHOW-NONE	Yes (C/S)	
SHOW-SEL-ALWAYS	Yes (C/S)	
SIGN	Yes	
SIGNED	Yes	
SIGNED-INT	Yes	
SIGNED-LONG	Yes	
SIGNED-SHORT	Yes	
SIZE	Yes	
SMALL-FONT	Yes	
SORT	Yes	
SORT-MERGE	Yes	
SORT-ORDER	Yes (C/S)	
SOURCE	Yes	
SOURCE-COMPUTER	Yes	
SOURCES	No	
SPACE	Yes	SPACES
SPACE-FILL	No	
SPACES	Yes	SPACE
SPECIAL-NAMES	Yes	
SPINNER	Yes (C/S)	

SQUARE	Yes (C/S)	
STACK	No (C/S)	
STANDARD	Yes	
STANDARD-1	Yes	
STANDARD-2	Yes	
STANDARD-BINARY	Yes (C/S)	
STANDARD-DECIMAL	Yes (C/S)	
START	Yes	
START-X	Yes (C/S)	
START-Y	Yes (C/S)	
STATEMENT	No (C/S)	
STATIC	Yes (C/S)	
STATIC-LIST	Yes (C/S)	
STATUS	Yes	
STATUS-BAR	Yes (C/S)	
STATUS-TEXT	Yes (C/S)	
STDCALL	Yes (C/S)	
STEP	Yes (C/S)	
STOP	Yes	
STRING	Yes	
STRONG	Yes (C/S)	
STYLE	Yes (C/S)	
SUB-QUEUE-1	Yes	
SUB-QUEUE-2	Yes	
SUB-QUEUE-3	Yes	
SUBTRACT	Yes	
SUBWINDOW	Yes	
SUM	Yes	
SUPER	No	
SUPPRESS	Yes	
SYMBOL	No (C/S)	
SYMBOLIC	Yes	
SYNC	Yes	SYNCHRONISED, SYNCHRONIZED
SYNCHRONISED	Yes	SYNC, SYNCHRONIZED
SYNCHRONIZED	Yes	SYNC, SYNCHRONISED
SYSTEM-DEFAULT	Yes	
SYSTEM-INFO	Yes (C/S)	
SYSTEM-OFFSET	Yes	
TAB	Yes (C/S)	
TAB-TO-ADD	Yes (C/S)	
TAB-TO-DELETE	Yes (C/S)	
TABLE	Yes	
TALLYING	Yes	
TAPE	Yes (C/S)	
TEMPORARY	Yes (C/S)	
TERMINAL-INFO	Yes (C/S)	
TERMINATE	Yes	
TERMINATION-VALUE	Yes (C/S)	
TEST	Yes	
TEXT	Yes	
THAN	Yes	
THEN	Yes	

THREAD	Yes	
THREADS	Yes	
THROUGH	Yes	THRU
THRU	Yes	THROUGH
THUMB-POSITION	Yes (C/S)	
TILED-HEADINGS	Yes (C/S)	
TIME	Yes	
TIME-OUT	Yes (C/S)	TIMEOUT
TIMEOUT	Yes	TIME-OUT
TIMES	Yes	
TITLE	Yes (C/S)	
TITLE-POSITION	Yes (C/S)	
TO	Yes	
TOP	Yes	
TOP-LEVEL	No (C/S)	
TOWARD-GREATER	Yes (C/S)	
TOWARD-LESSER	Yes (C/S)	
TRACK	Yes (C/S)	
TRACK-AREA	Yes (C/S)	
TRACK-LIMIT	Yes (C/S)	
TRACKS	Yes (C/S)	
TRADITIONAL-FONT	Yes	
TRAILING	Yes	
TRAILING-SHIFT	Yes (C/S)	
TRAILING-SIGN	No	
TRANSFORM	Yes	
TRANSPARENT	Yes (C/S)	
TREE-VIEW	Yes (C/S)	
TRUE	Yes	
TRUNCATION	Yes (C/S)	
TYPE	Yes	
TYPEDEF	Yes	
U	Yes (C/S)	
UCS-4	Yes (C/S)	
UNBOUNDED	Yes (C/S)	
UNDERLINE	Yes (C/S)	
UNFRAMED	Yes (C/S)	
UNIT	Yes	
UNIVERSAL	No	
UNLOCK	Yes	
UNSIGNED	Yes	
UNSIGNED-INT	Yes	
UNSIGNED-LONG	Yes	
UNSIGNED-SHORT	Yes	
UNSORTED	Yes (C/S)	
UNSTRING	Yes	
UNTIL	Yes	
UP	Yes	
UPDATE	Yes	
UPDATERS	Yes (C/S)	
UPON	Yes	
UPPER	Yes (C/S)	

USAGE	Yes	
USE	Yes	
USE-ALT	Yes (C/S)	
USE-RETURN	Yes (C/S)	
USE-TAB	Yes (C/S)	
USER	Yes (C/S)	
USER-DEFAULT	Yes	
USING	Yes	
UTF-16	Yes (C/S)	
UTF-8	Yes (C/S)	
V	Yes (C/S)	
VAL-STATUS	Yes	VALIDATE-STATUS
VALID	Yes	
VALIDATE	Yes	
VALIDATE-STATUS	Yes	VAL-STATUS
VALIDATING	Yes (C/S)	
VALUE	Yes	
VALUE-FORMAT	Yes (C/S)	
VALUES	Yes	
VARIABLE	Yes (C/S)	
VARIANT	Yes	
VARYING	Yes	
VERTICAL	Yes (C/S)	
VERY-HEAVY	Yes (C/S)	
VIRTUAL-WIDTH	Yes (C/S)	
VOLATILE	Yes	
VPADDING	Yes (C/S)	
VSCROLL	Yes (C/S)	
VSCROLL-BAR	Yes (C/S)	
VSCROLL-POS	Yes (C/S)	
VTOP	Yes (C/S)	
WAIT	Yes	
WEB-BROWSER	Yes (C/S)	
WHEN	Yes	
WIDTH	Yes (C/S)	
WIDTH-IN-CELLS	Yes (C/S)	
WINDOW	Yes	
WITH	Yes	
WORDS	Yes	
WORKING-STORAGE	Yes	
WRAP	Yes (C/S)	
WRITE	Yes	
WRITE-ONLY	Yes (C/S)	
WRITE-VERIFY	Yes (C/S)	
WRITERS	Yes (C/S)	
X	Yes (C/S)	
XML	Yes	
XML-DECLARATION	Yes (C/S)	
XML-SCHEMA	Yes (C/S)	
XOR	No	
Y	Yes (C/S)	
YYYYDDD	Yes (C/S)	

YYYYMMDD	Yes (C/S)	
ZERO	Yes	ZEROES, ZEROS
ZERO-FILL	No (C/S)	
ZEROES	Yes	ZERO, ZEROS
ZEROS	Yes	ZERO, ZEROES

B.2 Internal registers

Register	Implemented	Definition
'ADDRESS OF' phrase	Yes	USAGE POINTER
COB-CRT-STATUS	Yes	PICTURE 9(4) USAGE DISPLAY VALUE ZERO
DEBUG-ITEM	Yes	PICTURE X(n) USAGE DISPLAY
'LENGTH OF' phrase	Yes	CONSTANT USAGE BINARY-LONG
NUMBER-OF-CALL-PARAMETERS	Yes	USAGE BINARY-LONG
RETURN-CODE	Yes	GLOBAL USAGE BINARY-LONG VALUE ZERO
SORT-RETURN	Yes	GLOBAL USAGE BINARY-LONG VALUE ZERO
TALLY	Yes	GLOBAL PICTURE 9(5) USAGE BINARY VALUE ZERO
WHEN-COMPILED	Yes	CONSTANT PICTURE X(16) USAGE DISPLAY
XML-CODE	Yes	GLOBAL PICTURE S9(9) USAGE BINARY VALUE 0
XML-EVENT	Yes	GLOBAL USAGE DISPLAY PICTURE X(30) VALUE SPACE
XML-INFORMATION	Yes	GLOBAL PICTURE S9(9) USAGE BINARY VALUE 0
XML-NAMESPACE	Yes	GLOBAL PIC X ANY LENGTH
XML-NAMESPACE-PREFIX	Yes	GLOBAL PIC X ANY LENGTH
XML-NNAMESPACE	Yes	GLOBAL PIC N ANY LENGTH
XML-NNAMESPACE-PREFIX	Yes	GLOBAL PIC N ANY LENGTH
XML-NTEXT	Yes	GLOBAL PIC N ANY LENGTH
XML-TEXT	Yes	GLOBAL PIC X ANY LENGTH
JSON-CODE	Yes	GLOBAL PICTURE S9(9) USAGE BINARY VALUE 0
JSON-STATUS	Yes	GLOBAL PICTURE S9(9) USAGE BINARY VALUE 0

Appendix C Intrinsic Functions

The following list of intrinsic functions was extracted from `cobc --list-intrinsics` and shows the names of the available functions, an implementation note and the number of parameters.

Intrinsic	Function	Implemented
ABS	Yes	1
ACOS	Yes	1
ANNUITY	Yes	2
ASIN	Yes	1
ATAN	Yes	1
BASECONVERT	No	3
BIT-OF	Yes	1
BIT-TO-CHAR	Yes	1
BOOLEAN-OF-INTEGER	No	2
BYTE-LENGTH	Yes	1
CHAR	Yes	1
CHAR-NATIONAL	No	1
COMBINED-DATETIME	Yes	2
CONCAT	Yes	Unlimited
CONCATENATE	Yes	Unlimited
CONTENT-LENGTH	Yes	1
CONTENT-OF	Yes	1
CONVERT	No	3
COS	Yes	1
CURRENCY-SYMBOL	Yes	0
CURRENT-DATE	Yes	0
DATE-OF-INTEGER	Yes	1
DATE-TO-YYYYMMDD	Yes	1
DAY-OF-INTEGER	Yes	1
DAY-TO-YYYYDDD	Yes	1
DISPLAY-OF	No	1
E	Yes	0
EXCEPTION-FILE	Yes	0
EXCEPTION-FILE-N	No	0
EXCEPTION-LOCATION	Yes	0
EXCEPTION-LOCATION-N	No	0
EXCEPTION-STATEMENT	Yes	0
EXCEPTION-STATUS	Yes	0
EXP	Yes	1
EXP10	Yes	1
FACTORIAL	Yes	1
FIND-STRING	No	7
FORMATTED-CURRENT-DATE	Yes	1
FORMATTED-DATE	Yes	2
FORMATTED-DATETIME	Yes	4
FORMATTED-TIME	Yes	3
FRACTION-PART	Yes	1
HEX-OF	Yes	1
HEX-TO-CHAR	Yes	1
HIGHEST-ALGEBRAIC	Yes	1
INTEGER	Yes	1
INTEGER-OF-BOOLEAN	No	1

INTEGER-OF-DATE	Yes	1
INTEGER-OF-DAY	Yes	1
INTEGER-OF-FORMATTED-DATE	Yes	2
INTEGER-PART	Yes	1
LENGTH	Yes	1
LENGTH-AN	Yes	1
LOCALE-COMPARE	Yes	2
LOCALE-DATE	Yes	1
LOCALE-TIME	Yes	1
LOCALE-TIME-FROM-SECONDS	Yes	1
LOG	Yes	1
LOG10	Yes	1
LOWER-CASE	Yes	1
LOWEST-ALGEBRAIC	Yes	1
MAX	Yes	Unlimited
MEAN	Yes	Unlimited
MEDIAN	Yes	Unlimited
MIDRANGE	Yes	Unlimited
MIN	Yes	Unlimited
MOD	Yes	2
MODULE-CALLER-ID	Yes	0
MODULE-DATE	Yes	0
MODULE-FORMATTED-DATE	Yes	0
MODULE-ID	Yes	0
MODULE-NAME	No	1
MODULE-PATH	Yes	0
MODULE-SOURCE	Yes	0
MODULE-TIME	Yes	0
MONETARY-DECIMAL-POINT	Yes	0
MONETARY-THOUSANDS-SEPARATOR	Yes	0
NATIONAL-OF	No	1
NUMERIC-DECIMAL-POINT	Yes	0
NUMERIC-THOUSANDS-SEPARATOR	Yes	0
NUMVAL	Yes	1
NUMVAL-C	Yes	2
NUMVAL-F	Yes	1
ORD	Yes	1
ORD-MAX	Yes	Unlimited
ORD-MIN	Yes	Unlimited
PI	Yes	0
PRESENT-VALUE	Yes	Unlimited
RANDOM	Yes	0
RANGE	Yes	Unlimited
REM	Yes	2
REVERSE	Yes	1
SECONDS-FROM-FORMATTED-TIME	Yes	2
SECONDS-PAST-MIDNIGHT	Yes	0
SIGN	Yes	1
SIN	Yes	1
SQRT	Yes	1
STANDARD-COMPARE	No	2
STANDARD-DEVIATION	Yes	Unlimited

STORED-CHAR-LENGTH	Yes	1
SUBSTITUTE	Yes	Unlimited
SUBSTITUTE-CASE	Yes	Unlimited
SUM	Yes	Unlimited
TAN	Yes	1
TEST-DATE-YYYYMMDD	Yes	1
TEST-DAY-YYYYDDD	Yes	1
TEST-FORMATTED-DATETIME	Yes	2
TEST-NUMVAL	Yes	1
TEST-NUMVAL-C	Yes	2
TEST-NUMVAL-F	Yes	1
TRIM	Yes	1
UPPER-CASE	Yes	1
VARIANCE	Yes	Unlimited
WHEN-COMPILED	Yes	0
YEAR-TO-YYYY	Yes	1

Appendix D System routines

The following list of system routines was extracted from `cobc --list-system` and shows the names of the available system routines along with the number of parameters.

System routine	Parameters
SYSTEM	1
CBL_AND	3
CBL_ALARM_SOUND	0
CBL_BELL_SOUND	0
CBL_CHANGE_DIR	1
CBL_CHECK_FILE_EXIST	2
CBL_CLOSE_FILE	1
CBL_COPY_FILE	2
CBL_CREATE_DIR	1
CBL_CREATE_FILE	5
CBL_DELETE_DIR	1
CBL_DELETE_FILE	1
CBL_EQ	3
CBL_ERROR_PROC	2
CBL_EXIT_PROC	2
CBL_RUNTIME_ERROR	2
CBL_FLUSH_FILE	1
CBL_GET_CSR_POS	1
CBL_GET_CURRENT_DIR	3
CBL_GET_SCR_SIZE	2
CBL_IMP	3
CBL_NIMP	3
CBL_NOR	3
CBL_NOT	2
CBL_OPEN_FILE	5
CBL_OR	3
CBL_READ_FILE	5
CBL_READ_KBD_CHAR	1
CBL_RENAME_FILE	2
CBL_SET_CSR_POS	1
CBL_TOLOWER	2
CBL_TOUPPER	2
CBL_WRITE_FILE	5
CBL_XOR	3
CBL_GC_FORK	0
CBL_GC_GETOPT	6
CBL_GC_HOSTED	2
CBL_GC_NANOSLEEP	1
CBL_GC_PRINTABLE	1 - 2
CBL_GC_SET_SCR_SIZE	2
CBL_GC_WAITPID	1
CBL_OC_GETOPT	6
CBL_OC_HOSTED	2
CBL_OC_NANOSLEEP	1
C$CALLEDBY	1
C$CHDIR	2
C$COPY	3

C$DELETE	2
C$FILEINFO	2
C$GETPID	0
C$JUSTIFY	1 - 2
C$MAKEDIR	1
C$NARG	1
C$PARAMSIZE	1
C$PRINTABLE	1 - 2
C$SLEEP	1
C$TOLOWER	2
C$TOUPPER	2
EXTFH	2
X"91"	3
X"E4"	0
X"E5"	0
X"F4"	2
X"F5"	2

Appendix E System names

The following list of system names was extracted from `cobc --list-mnemonics` and shows the system names categorized by their type.

E.1 System names: device

SYSIN, SYSIPT, STDIN, SYSOUT, SYSLIST, SYSLST, SYSPCH, SYSPUNCH, STDOUT, PRINT, PRINTER, PRINTER-1, SYSERR, STDERR, CONSOLE, ALTERNATE-CONSOLE, ALTERNATE

E.2 System names: feature

C01, C02, C03, C04, C05, C06, C07, C08, C09, C10, C11, C12, S01, S02, S03, S04, S05, CSP, FORMFEED, TOP, CALL-CONVENTION

E.3 System names: switch

SWITCH-0, SWITCH-1, SWITCH-2, SWITCH-3, SWITCH-4, SWITCH-5, SWITCH-6, SWITCH-7, SWITCH-8, SWITCH-9, SWITCH-10, SWITCH-11, SWITCH-12, SWITCH-13, SWITCH-14, SWITCH-15, SWITCH-16, SWITCH-17, SWITCH-18, SWITCH-19, SWITCH-20, SWITCH-21, SWITCH-22, SWITCH-23, SWITCH-24, SWITCH-25, SWITCH-26, SWITCH-27, SWITCH-28, SWITCH-29, SWITCH-30, SWITCH-31, SWITCH-32, SWITCH-33, SWITCH-34, SWITCH-35, SWITCH-36

Appendix F Exception names

The following list of exception names was extracted from `cobc --list-exceptions` and shows the exception names and if those are fatal (lead to a program abort).

All of those can be activated and deactivated, both directly and at group level, using `-fec`.

```
Exception Name
EC-ALL
  EC-ARGUMENT
    EC-ARGUMENT-FUNCTION (f)
    EC-ARGUMENT-IMP
  EC-BOUND
    EC-BOUND-FUNC-RET-VALUE
    EC-BOUND-IMP
    EC-BOUND-ODO (f)
    EC-BOUND-OVERFLOW (f)
    EC-BOUND-PTR (f)
    EC-BOUND-REF-MOD (f)
    EC-BOUND-SET (f)
    EC-BOUND-SUBSCRIPT (f)
    EC-BOUND-TABLE-LIMIT (f)
  EC-CONTINUE
    EC-CONTINUE-IMP
    EC-CONTINUE-LESS-THAN-ZERO
  EC-DATA
    EC-DATA-CONVERSION
    EC-DATA-IMP
    EC-DATA-INCOMPATIBLE (f)
    EC-DATA-NOT-FINITE (f)
    EC-DATA-OVERFLOW (f)
    EC-DATA-PTR-NULL (f)
  EC-EXTERNAL
    EC-EXTERNAL-DATA-MISMATCH (f)
    EC-EXTERNAL-FILE-MISMATCH (f)
    EC-EXTERNAL-FORMAT-CONFLICT (f)
    EC-EXTERNAL-IMP
  EC-FLOW
    EC-FLOW-APPLY-COMMIT (f)
    EC-FLOW-COMMIT (f)
    EC-FLOW-GLOBAL-EXIT (f)
    EC-FLOW-GLOBAL-GOBACK (f)
    EC-FLOW-IMP
    EC-FLOW-RELEASE (f)
    EC-FLOW-REPORT (f)
    EC-FLOW-RETURN (f)
    EC-FLOW-ROLLBACK (f)
    EC-FLOW-SEARCH (f)
    EC-FLOW-USE (f)
  EC-FUNCTION
    EC-FUNCTION-ARG-OMITTED (f)
    EC-FUNCTION-IMP
```

```
    EC-FUNCTION-NOT-FOUND (f)
    EC-FUNCTION-PTR-INVALID (f)
    EC-FUNCTION-PTR-NULL (f)
  EC-I-O
    EC-I-O-AT-END
    EC-I-O-EOP
    EC-I-O-EOP-OVERFLOW
    EC-I-O-FILE-SHARING
    EC-I-O-IMP
    EC-I-O-INVALID-KEY
    EC-I-O-LINAGE (f)
    EC-I-O-LOGIC-ERROR (f)
    EC-I-O-PERMANENT-ERROR (f)
    EC-I-O-RECORD-CONTENT (f)
    EC-I-O-RECORD-OPERATION
    EC-I-O-RECORD-WARNING
  EC-IMP
    EC-IMP-ACCEPT
    EC-IMP-DISPLAY
    EC-IMP-UTC-UNKNOWN (f)
    EC-IMP-FEATURE-DISABLED
    EC-IMP-FEATURE-MISSING
  EC-LOCALE
    EC-LOCALE-IMP
    EC-LOCALE-INCOMPATIBLE
    EC-LOCALE-INVALID (f)
    EC-LOCALE-INVALID-PTR (f)
    EC-LOCALE-MISSING (f)
    EC-LOCALE-SIZE (f)
  EC-MCS
    EC-MCS-ABNORMAL-TERMINATION
    EC-MCS-IMP
    EC-MCS-INVALID-TAG
    EC-MCS-MESSAGE-LENGTH
    EC-MCS-NO-REQUESTER
    EC-MCS-NO-SERVER
    EC-MCS-NORMAL-TERMINATION
    EC-MCS-REQUESTOR-FAILED
  EC-OO
    EC-OO-ARG-OMITTED (f)
    EC-OO-CONFORMANCE (f)
    EC-OO-EXCEPTION (f)
    EC-OO-IMP
    EC-OO-METHOD (f)
    EC-OO-NULL (f)
    EC-OO-RESOURCE (f)
    EC-OO-UNIVERSAL (f)
  EC-ORDER
    EC-ORDER-IMP
    EC-ORDER-NOT-SUPPORTED (f)
  EC-OVERFLOW
    EC-OVERFLOW-IMP
```

```
    EC-OVERFLOW-STRING
    EC-OVERFLOW-UNSTRING
  EC-PROGRAM
    EC-PROGRAM-ARG-MISMATCH (f)
    EC-PROGRAM-ARG-OMITTED (f)
    EC-PROGRAM-CANCEL-ACTIVE (f)
    EC-PROGRAM-IMP
    EC-PROGRAM-NOT-FOUND (f)
    EC-PROGRAM-PTR-NULL (f)
    EC-PROGRAM-RECURSIVE-CALL (f)
    EC-PROGRAM-RESOURCES (f)
  EC-RAISING
    EC-RAISING-IMP
    EC-RAISING-NOT-SPECIFIED (f)
  EC-RANGE
    EC-RANGE-IMP
    EC-RANGE-INDEX (f)
    EC-RANGE-INSPECT-SIZE (f)
    EC-RANGE-INVALID
    EC-RANGE-PERFORM-VARYING (f)
    EC-RANGE-PTR (f)
    EC-RANGE-SEARCH-INDEX
    EC-RANGE-SEARCH-NO-MATCH
  EC-REPORT
    EC-REPORT-ACTIVE (f)
    EC-REPORT-COLUMN-OVERLAP (f)
    EC-REPORT-FILE-MODE (f)
    EC-REPORT-IMP
    EC-REPORT-INACTIVE (f)
    EC-REPORT-LINE-OVERLAP
    EC-REPORT-NOT-TERMINATED
    EC-REPORT-PAGE-LIMIT
    EC-REPORT-PAGE-WIDTH
    EC-REPORT-SUM-SIZE (f)
    EC-REPORT-VARYING (f)
  EC-SCREEN
    EC-SCREEN-FIELD-OVERLAP
    EC-SCREEN-IMP
    EC-SCREEN-ITEM-TRUNCATED
    EC-SCREEN-LINE-NUMBER
    EC-SCREEN-STARTING-COLUMN
  EC-SIZE
    EC-SIZE-ADDRESS (f)
    EC-SIZE-EXPONENTIATION (f)
    EC-SIZE-IMP
    EC-SIZE-OVERFLOW (f)
    EC-SIZE-TRUNCATION (f)
    EC-SIZE-UNDERFLOW (f)
    EC-SIZE-ZERO-DIVIDE (f)
  EC-SORT-MERGE
    EC-SORT-MERGE-ACTIVE (f)
    EC-SORT-MERGE-FILE-OPEN (f)
```

```
    EC-SORT-MERGE-IMP
    EC-SORT-MERGE-RELEASE (f)
    EC-SORT-MERGE-RETURN (f)
    EC-SORT-MERGE-SEQUENCE (f)
  EC-STORAGE
    EC-STORAGE-IMP
    EC-STORAGE-NOT-ALLOC
    EC-STORAGE-NOT-AVAIL
  EC-USER
  EC-VALIDATE
    EC-VALIDATE-CONTENT
    EC-VALIDATE-FORMAT
    EC-VALIDATE-IMP
    EC-VALIDATE-RELATION
    EC-VALIDATE-VARYING (f)
  EC-XML
    EC-XML-CODESET (f)
    EC-XML-CODESET-CONVERSION (f)
    EC-XML-COUNT (f)
    EC-XML-DOCUMENT-TYPE (f)
    EC-XML-IMPLICIT-CLOSE (f)
    EC-XML-INVALID (f)
    EC-XML-NAMESPACE (f)
    EC-XML-STACKED-OPEN (f)
    EC-XML-RANGE (f)
    EC-XML-IMP (f)
  EC-JSON
    EC-JSON-IMP (f)
```

Appendix G Compiler Configuration

The following list was extracted from `config/default.conf`.

```
# Value: any string
name: "GnuCOBOL"

# Value: enum
standard-define                 0
# NOTE: see enum cb_std_def, defined in cobc/cobc.h.
#        CB_STD_GC = 0,
#        CB_STD_MF,
#        CB_STD_IBM,
#        CB_STD_MVS,
#        CB_STD_BS2000,
#        CB_STD_ACU,
#        CB_STD_RM,
#        CB_STD_85,
#        CB_STD_2002,
#        CB_STD_2014

# Default source reference-format; values: FIXED, FREE, COBOL85,
# VARIABLE, XOPEN, XCARD, CRT, TERMINAL, COBOLX
format:                         auto

# Value: int
tab-width:                      8
text-column:                    72
# Maximum word-length for COBOL words / Programmer defined words
# Be aware that GC checks the word length against COB_MAX_WORDLEN
# first (currently 63)
word-length:                    63

# Maximum literal size in general
literal-length:                 8191

# Maximum numeric literal size (absolute maximum: 38)
numeric-literal-length:         38

# Maximum number of characters allowed in the character-string (max. 255)
pic-length:                     255

# Enable AREACHECK by default, for reference formats other than {fixed,free}
areacheck:                      no

# Default assign type
# Value: 'dynamic', 'external'
assign-clause:                  dynamic

# If yes, file names are resolved at run time using
# environment variables.
```

```
# For example, given ASSIGN TO "DATAFILE", the file name will be
#  1. the value of environment variable 'DD_DATAFILE' or
#  2. the value of environment variable 'dd_DATAFILE' or
#  3. the value of environment variable 'DATAFILE' or
#  4. the literal "DATAFILE"
# If no, the value of the assign clause is the file name.
#
filename-mapping:               yes

# Alternate formatting of numeric fields
pretty-display:                 yes

# Allow complex OCCURS DEPENDING ON
complex-odo:                    no

# Adjust position of items following OCCURS DEPENDING
odoslide:                       no

# Allow REDEFINES to other than last equal level number
indirect-redefines:             no

# Binary byte size - defines the allocated bytes according to PIC
# Value:         signed  unsigned  bytes
#                ------  --------  -----
# '2-4-8'         1 -  4    same        2
#                 5 -  9    same        4
#                10 - 18    same        8
#
# '1-2-4-8'       1 -  2    same        1
#                 3 -  4    same        2
#                 5 -  9    same        4
#                10 - 18    same        8
#
# '1--8'          1 -  2    1 -  2      1
#                 3 -  4    3 -  4      2
#                 5 -  6    5 -  7      3
#                 7 -  9    8 -  9      4
#                10 - 11   10 - 12      5
#                12 - 14   13 - 14      6
#                15 - 16   15 - 16      7
#                17 - 18   17 - 18      8
#
binary-size:                    1-2-4-8

# Numeric truncation according to ANSI
binary-truncate:                yes

# Binary byte order
# Value: 'native', 'big-endian'
binary-byteorder:               big-endian

# Allow larger REDEFINES items other than 01 non-external
```

```
larger-redefines:               error

# Allow certain syntax variations (eg. REDEFINES position)
relax-syntax-checks:            no

# Allow zero length reference-modification
# (only checked with active EC-BOUND-REF-MOD)
ref-mod-zero-length:            yes

# Perform type OSVS - If yes, the exit point of any currently
# executing perform is recognized if reached.
perform-osvs:                   no

# Compute intermediate decimal results like IBM OSVS
arithmetic-osvs:                no

# MOVE like IBM (mvc); left to right, byte by byte
move-ibm:                       no

# SELECT RELATIVE KEY and ASSIGN fields must be in WORKING-STORAGE
select-working:         no

# LOCAL-STORAGE SECTION implies RECURSIVE attribute
local-implies-recursive:                no

# If yes, LINKAGE SECTION items remain allocated
# between invocations.
sticky-linkage:                 no

# If yes, allow non-matching level numbers
relax-level-hierarchy:          no

# If yes, evaluate constant expressions at compile time
constant-folding:               yes

# Allow Hex 'F' for NUMERIC test of signed PACKED DECIMAL field
hostsign:                       no

# If yes, set WITH UPDATE clause as default for ACCEPT dest-item,
# except if WITH NO UPDATE clause is used
accept-update:                  no

# If yes, set WITH AUTO clause as default for ACCEPT dest-item,
# except if WITH TAB clause is used
accept-auto:                    no

# If yes, DISPLAYs and ACCEPTs are, by default, done on the CRT (i.e., using
# curses).
console-is-crt:                 no

# If yes, allow redefinition of the current program's name. This prevents its
# use in a prototype-format CALL/CANCEL statement.
```

```
program-name-redefinition:      yes

# If yes, NO ECHO/NO-ECHO/OFF is the same as SECURE (hiding input with
# asterisks, not spaces).
no-echo-means-secure:           no

# If yes, the first item in a field screen ACCEPT/DISPLAY (e.g. DISPLAY x UPON
# CRT) is located after the previous ACCEPT/DISPLAY (as though LINE 0 COL 0 had
# been specified).
line-col-zero-default:          yes

# If yes, DISPLAY SPACES acts as ERASE EOS, DISPLAY X"01" acts as ERASE EOL,
# DISPLAY X"02" acts as BLANK SCREEEN and DISPLAY X"07" acts as BELL. Note
# DISPLAY LOW-VALUE is excluded from this; it will always just position the
# cursor.
display-special-fig-consts:     no

# If yes, COMP-1 is a signed 16-bit integer and any PICTURE clause is ignored.
binary-comp-1:                  no

# If yes, POINTER is handled as BINARY-DOUBLE UNSIGNED instead of its own class
numeric-pointer:                no

# auto-adjust to zero like MicroFocus does
move-non-numeric-lit-to-numeric-is-zero: no

# If yes, implicitly define a variable for an ASSIGN DYNAMIC which does not
# match an existing data item.
implicit-assign-dynamic-var:    yes

# If yes, ACCEPT and DISPLAY statements accept device names using mnemonics
device-mnemonics:                       no

# full clauses in XML PARSE - and adjusted XML-EVENTs
xml-parse-xmlss:                yes

# What rules to apply to SCREEN SECTION items clauses
screen-section-rules:           gc

# Whether DECIMAL-POINT IS COMMA has effect in XML/JSON GENERATE
dpc-in-data:                    xml

# Bounds against which to check subscripts (full, max, record)
subscript-check:                full

# Functionality of JUSTIFY for INITIALIZE verb and initialization of storage
init-justify:           no

# Dialect features
# Value: 'ok', 'warning', 'archaic', 'obsolete', 'skip', 'ignore', 'error',
#        'unconformable'
```

```
alter-statement:                        obsolete
comment-paragraphs:                     obsolete
control-division:                       unconformable
partial-replace-when-literal-src:       obsolete
call-overflow:                          archaic
data-records-clause:                    obsolete
debugging-mode:                         ok
use-for-debugging:                      ok
listing-statements:                     skip    # may be a user-defined word
title-statement:                        skip    # may be a user-defined word
entry-statement:                        ok
goto-statement-without-name:            obsolete
label-records-clause:                   obsolete
memory-size-clause:                     obsolete
move-noninteger-to-alphanumeric:        error
move-figurative-constant-to-numeric:    archaic
move-figurative-space-to-numeric:       error
move-figurative-quote-to-numeric:       obsolete
multiple-file-tape-clause:              obsolete
next-sentence-phrase:                   archaic
odo-without-to:                         warning
padding-character-clause:               obsolete
section-segments:                       ignore
stop-literal-statement:                 obsolete
stop-identifier-statement:              obsolete
stop-error-statement:                   unconformable
same-as-clause:                         ok
type-to-clause:                         ok
usage-type:                                     ok
synchronized-clause:                    ok
sync-left-right:                        ok
special-names-clause:                   ok
top-level-occurs-clause:                ok
value-of-clause:                        obsolete
numeric-boolean:                        ok
hexadecimal-boolean:                    ok
national-literals:                      ok
hexadecimal-national-literals:          ok
national-character-literals:            warning

acu-literals:                           unconformable
hp-octal-literals:                      unconformable
ebcdic-symbolic-characters:             no
word-continuation:                      warning
not-exception-before-exception:         ok
accept-display-extensions:              ok
renames-uncommon-levels:                ok
symbolic-constant:                      ok
constant-78:                            ok
constant-01:                            ok
perform-varying-without-by:             ok
reference-out-of-declaratives:          warning
```

```
program-prototypes:                     ok
call-convention-mnemonic:               ok
call-convention-linkage:                ok
using-optional:         ok
numeric-value-for-edited-item:          ok
incorrect-conf-sec-order:               ok
define-constant-directive:              archaic
free-redefines-position:                warning
records-mismatch-record-clause  warning
record-delimiter:                       ok
sequential-delimiters:                  ok
record-delim-with-fixed-recs:           ok
missing-statement:                      warning
missing-period:                         warning #when format not in {fixed,free}
zero-length-literals:                   ok
xml-generate-extra-phrases:             ok
continue-after:                         ok
goto-entry:                             warning
assign-variable:                        ok
assign-using-variable:                  ok
assign-ext-dyn:                         ok
assign-disk-from:                       ok
vsam-status:                            ignore
self-call-recursive:            warning
record-contains-depending-clause:       unconformable
defaultbyte:            init    # GC inits as INITIALIZE ALL TO VALUE THEN TO DEFAULT,
                                # with INDEXED BY variables initialized to 1
picture-l:                              ok

# use complete word list; synonyms and exceptions are specified below
reserved-words:         default

# not-reserved:
# Value: Word to be taken out of the reserved words list
not-reserved:   TERMINAL
not-reserved:   EXAMINE
# reserved:
#   Entries of the form word-1=word-2 define word-1 as an alias for default
# reserved word word-2. No spaces are allowed around the equal sign.
reserved:       AUTO-SKIP=AUTO
reserved:       AUTOTERMINATE=AUTO
reserved:       BACKGROUND-COLOUR=BACKGROUND-COLOR
reserved:       BEEP=BELL
reserved:       BINARY-INT=BINARY-LONG
reserved:       BINARY-LONG-LONG=BINARY-DOUBLE
reserved:       CELLS=CELL
reserved:       COLOURS=COLORS
reserved:       EMPTY-CHECK=REQUIRED
reserved:       EQUALS=EQUAL
reserved:       FOREGROUND-COLOUR=FOREGROUND-COLOR
reserved:       HIGH-VALUES=HIGH-VALUE
reserved:       INITIALISE=INITIALIZE
```

```
reserved:       INITIALISED=INITIALIZED
reserved:       LENGTH-CHECK=FULL
reserved:       LOW-VALUES=LOW-VALUE
reserved:       ORGANISATION=ORGANIZATION
reserved:       PIXELS=PIXEL
reserved:       SYNCHRONISED=SYNCHRONIZED
reserved:       TIMEOUT=TIME-OUT
reserved:       ZEROES=ZERO
reserved:       ZEROS=ZERO
```

Appendix H Module loader `cobcrun` options

The following list of options was extracted from `cobcrun --help` and shows all available options for the module loader with a short description.

`-h, --help`
: display this help and exit

`-V, --version`
: display version information for cobcrun + runtime and exit

`-dumpversion`
: display runtime version and exit

`-i, --info`
: display runtime information (build/environment)

`-v, --verbose`
: display extended output with –info

`-c` *file*`, --config=`*file*
: set runtime configuration from *file*

`-r, --runtime-config`
: display current runtime configuration (value and origin for all settings)

`-M` *module*`, --module=`*module*
: set entry point module name and/or load path where `-M` module prepends any directory to the dynamic link loader library search path and any basename to the module preload list (`COB_LIBRARY_PATH` and/or `COB_PRELOAD`)

Appendix I Runtime configuration

The following list was extracted from `config/runtime.cfg`.

I.1 General instructions

The initial `runtime.cfg` file is found in the `$COB_CONFIG_DIR` , which defaults to installdir/gnucobol/config (see `cobcrun --info` for the local path that is configured). The environment variable `COB_RUNTIME_CONFIG` may define a different runtime configuration file to read.

If settings are included in the runtime environment file multiple times then the last setting value is used, no warning occurs.

Settings via environment variables always take precedence over settings that are given in runtime configuration files. And the environment is checked after completing processing of the runtime configuration file(s)

All values set to string variables or environment variables are checked for ${envvar} and replacement is done at the time of the setting. You can also specify a default value for the case that envvar is not set: `${envvar:default}` (the format `${envvar:-default}` is supported, too).

Any environment variable may be set with the directive `setenv` .

Example `setenv COB_LIBARAY_PATH ${LD_LIBRARY_PATH}`

Any environment variable may be unset with the directive `unsetenv` (one var per line).

Example `unsetenv COB_LIBRARY_PATH`

Runtime configuration files can `include` other files with the directive `include` .

Example `include my-runtime-configuration-file`

To `include` another configuration file only if it is present use the directive `includeif` . You can also use ${envvar} inside this.

Example `includeif ${HOME}/mygc.cfg`

If you want to reset a parameter to its default value use `reset parametername` .

Most runtime variables have boolean values, some are switches, some have string values, integer values (if not explicit noted: unsigned) and some are size values. The boolean values will be evaluated as following: to true: `1`, `Y`, `ON`, `YES`, `TRUE` (no matter of case) to false: `0`, `N`, `OFF`.

A `size` value is an unsigned integer optionally followed by '`K`', '`M`', or '`G`' for '`kilo`', '`mega`' or '`giga`'.

For convenience a parameter in the `runtime.cfg` file may be defined by using either the environment variable name or the parameter name. In most cases the environment variable name is the parameter name (in upper case) with the prefix `COB_` .

For a complete list of the settings in use see `cobcrun --runtime-config` .

Note: If you want to *slightly* speed up a program's startup time, remove all of the comments from the actual real configuration file that is processed.

I.2 General environment

```
Environment name:  COB_DISABLE_WARNINGS
  Parameter name:  disable_warnings
         Purpose:  turn off runtime warning messages
            Type:  boolean
         Default:  false
         Example:  DISABLE_WARNINGS  TRUE

Environment name:  COB_ENV_MANGLE
  Parameter name:  env_mangle
         Purpose:  names checked in the environment would get non alphanumeric
                   change to '_'
            Type:  boolean
         Default:  false
         Example:  ENV_MANGLE  TRUE

Environment name:  COB_SET_DEBUG
  Parameter name:  debugging_mode
         Purpose:  to enable USE ON DEBUGGING procedures that were active
                   during compile-time because of WITH DEBUGGING MODE,
                   otherwise the code generated will be skipped
            Type:  boolean
         Default:  false
         Example:  COB_SET_DEBUG  1

Environment name:  COB_SET_TRACE
  Parameter name:  set_trace
         Purpose:  to enable COBOL trace feature
            Type:  boolean
         Default:  false
         Example:  SET_TRACE  TRUE

Environment name:  COB_TRACE_FILE
  Parameter name:  trace_file
         Purpose:  to define where COBOL trace output should go
            Type:  string       : $$ is replaced by process id
            Note:  file is opened for append if name starts with "+"
         Default:  stderr
         Example:  TRACE_FILE  ${HOME}/mytrace.$$

Environment name:  COB_TRACE_FORMAT
  Parameter name:  trace_format
         Purpose:  to define format of COBOL trace output
            Type:  string
         Default:  "%P %S Line: %L"
                   %P is replaced by Program-Id/Function-Id minimal length 29
                      with prefix
                   %I is replaced by Program-Id/Function-Id variable length,
```

```
                   without prefix
                %L is replaced by Line number, right justified, length 6
                %S is replaced by statement type and name
                %F is replaced by source file name
        Example: TRACE_FORMAT  "Line: %L %S"
           Note: format of GC2.2 and older:
                 "PROGRAM-ID: %I      Line: %L        %S"

Environment name: COB_CORE_ON_ERROR
  Parameter name: core_on_error
         Purpose: to enable operating system handling of signals and to
                  raise an ABORT signal on runtime error instead of the
                  default error handling, which will commonly kill the
                  process after creating a coredump
            Type: 0   means catching all default signals and do full
                      internal error handling as done in versions pre 3.2
                      along with full internal handling of COBOL runtime
                      errors
                  1   means to forward any signals; whatever happens
                      by means of system signal handers will happen,
                      which may include creating coredumps and killing
                      the process before libcob does any cleanup; preserve
                      full internal handling of COBOL runtime errors
                  2   is identical to 1, but on runtime errors explicit
                      raises SIGABRT after displaying it along with the
                      stacktrace and after doing minimal cleanup
                  3   similar to 2, but instead of raising SIGABRT execute
                      "gcore -a -o NAME $$" (where $$ is the process id and
                      NAME is specified by COB_CORE_FILENAME) as early as
                      possible before doing the normal internal error
                      handling; if the command does not work or if a signal
                      handler was executed before a SIGABRT is raised
         Default: 0
         Example: core_on_error 3
            Note: If the operating system kills the process as part of the
                  signal handling no COBOL centric dump will be created and
                  no cleanup will be done either.
                  When catching a signal (for example 11) it will be
                  returned as exit code of the process, the generated
                  coredumps store the reason for the error in the variable
                  "runtime_err_str".

Environment name: COB_CORE_FILENAME
  Parameter name: core_filename
         Purpose: to adjust the default name or specify a folder for a
                  COB_CORE_ON_ERROR=3 generated coredump
            Type: string
         Default: ./core.libcob
         Example: core_filename /home/me/SomeApp.core

Environment name: COB_STACKTRACE
  Parameter name: stracktrace
```

```
         Purpose:  to disable stracktrace creation on abort
            Type:  boolean
         Default:  true
         Example:  STRACKTRACE  no

Environment name:  COB_DUMP_FILE
  Parameter name:  dump_file
         Purpose:  to define where COBOL dump output should go
            Note:  the -fdump=all compile option prepares for dump;
                   file is opened for append if name starts with "+";
                   may be disabled by setting it to "NONE"
            Type:  string       : $$ is replaced by process id
         Default:  stderr
         Example:  DUMP_FILE  ${HOME}/mytrace.log

Environment name:  COB_DUMP_WIDTH
  Parameter name:  dump_width
         Purpose:  to define COBOL dump line length
            Type:  integer
         Default:  100
         Example:  dump_width 120

Environment name:  COB_CURRENT_DATE
  Parameter name:  current_date
         Purpose:  specify an alternate Date/Time to be returned to ACCEPT
                   statement; this is used for testing purposes or to tweak
                   a missing offset, partial setting is allowed
            Type:  numeric string in format YYYYDDMMHHMISS or date string
                   or seconds since the epoch as @SSSSSSSS
         Default:  the operating system date is used
         Example:  COB_CURRENT_DATE "2026/03/16 16:40:52"
                   current_date YYYYMMDDHHMMSS+01:00


@section Call environment
@verbatim


Environment name:  COB_LIBRARY_PATH
  Parameter name:  library_path
         Purpose:  paths for dynamically-loadable modules
            Type:  string
            Note:  the default paths .:/installpath/extras are always
                   added to the given paths
         Example:  LIBRARY_PATH    /opt/myapp/test:/opt/myapp/production

Environment name:  COB_PRE_LOAD
  Parameter name:  pre_load
         Purpose:  modules that are loaded during startup, can be used
                   to CALL COBOL programs or C functions that are part
                   of a module library
            Type:  string
```

```
            Note:  the modules listed should NOT include extensions, the
                   runtime will use the right ones on the various platforms,
                   COB_LIBRARY_PATH is used to locate the modules
         Example:  PRE_LOAD      COBOL_function_library:external_c_library

Environment name:  COB_LOAD_CASE
  Parameter name:  load_case
         Purpose:  resolve ALL called program names to UPPER or LOWER case
            Type:  Only use  UPPER  or  LOWER
         Default:  if not set program names in CALL are case sensitive
         Example:  LOAD_CASE  UPPER

Environment name:  COB_PHYSICAL_CANCEL
  Parameter name:  physical_cancel
         Purpose:  physically unload a dynamically-loadable module on CANCEL,
                   this frees some RAM and allows the change of modules during
                   run-time but needs more time to resolve CALLs (both to
                   active and not-active programs)
           Alias:  default_cancel_mode, LOGICAL_CANCELS (0 = yes)
            Type:  TRUE/YES/1  unload module on CANCEL
                   FALSE/NO/0  unload module on STOP RUN only
                   NEVER       never unload module, only useful for profilers
                               and tracing tools that do a post-mortem lookup
                               of function address
         Default:  false
         Example:  PHYSICAL_CANCEL  TRUE
```

I.3 File I/O

```
Environment name:  COB_VARSEQ_FORMAT
  Parameter name:  varseq_format
         Purpose:  declare format used for variable length sequential files
                   - different types and lengths precede each record
                   - 'length' is the data length, does not include the prefix
            Type:  0   means 2 byte record length (big-endian) + 2 NULs
                   1   means 4 byte record length (big-endian)
                   2   means 4 byte record length (local machine int)
                   3   means 2 byte record length (big-endian)
         Default:  0
         Example:  VARSEQ_FORMAT 1

Environment name:  COB_FILE_PATH
  Parameter name:  file_path
         Purpose:  define default location where data files are stored
            Type:  file path directory
         Default:  .  (current directory)
         Example:  FILE_PATH ${HOME}/mydata
```

```
Environment name:  COB_LS_FIXED
  Parameter name:  ls_fixed
         Purpose:  Defines if LINE SEQUENTIAL files should be fixed length
                   (or variable, by removing trailing spaces)
           Alias:  STRIP_TRAILING_SPACES  (0 = yes)
            Type:  boolean
         Default:  false
            Note:  This setting is most useful if you want to REWRITE those
                   files.
         Example:  LS_FIXED TRUE

Environment name:  COB_LS_VALIDATE
  Parameter name:  ls_validate
         Purpose:  Defines for LINE SEQUENTIAL files that the data should be
                   validated as it is read (status 09) / written (status 71).
            Type:  boolean
         Default:  true (per COBOL 2022)
            Note:  If active effectively disables COB_LS_NULLS.
         Example:  LS_VALIDATE FALSE

Environment name:  COB_LS_NULLS
  Parameter name:  ls_nulls
         Purpose:  Defines for LINE SEQUENTIAL files what to do with data
                   which is not DISPLAY type.  This could happen if a LINE
                   SEQUENTIAL record has BINARY/COMP data fields in it.
            Type:  boolean
         Default:  false
            Note:  The TRUE setting will insert a null character x"00" before
                   those values to escape them, and redo on read-in plus
                   validating that they only occur after a null character.
                   Decreases LINE SEQUENTIAL performance and prevents writing
                   escape sequences or formatting within the data.
                   Only checked if COB_LS_VALIDATE is disabled.
         Example:  LS_NULL = TRUE

Environment name:  COB_LS_SPLIT
  Parameter name:  ls_split
         Purpose:  Defines for LINE SEQUENTIAL files what to do when a record
                   is longer than the program handles. If 'ls_split=true' then
                   the data is returned as multiple records with io status 06,
                   otherwise the record is truncated, io status set to 04 and
                   the file skips to the next LF.
            Type:  boolean
         Default:  true (per COBOL 2022)
         Example:  LS_SPLIT = FALSE

Environment name:  COB_SYNC
  Parameter name:  sync
         Purpose:  Should the file be synced to disk after each write/update
            Type:  boolean
         Default:  false
         Example:  SYNC: TRUE
```

```
Environment name:  COB_SORT_MEMORY
  Parameter name:  sort_memory
         Purpose:  Defines how much RAM to assign for sorting data
                   if this size is exceeded the  SORT  will be done
                   on disk instead of memory
            Type:  size  but must be more than 1M
         Default:  128M
         Example:  SORT_MEMORY 64M

Environment name:  COB_SORT_CHUNK
  Parameter name:  sort_chunk
         Purpose:  Defines how much RAM to assign for sorting data in chunks
            Type:  size  but must be within 128K and 16M
         Default:  256K
         Example:  SORT_CHUNK 1M

Environment name:  COB_SEQ_CONCAT_NAME
  Parameter name:  seq_concat_name
         Purpose:  Does DD_asgname hold multiple input file names
            Type:  boolean
         Default:  false
         Example:  seq_concat_name = true

Environment name:  COB_SEQ_CONCAT_SEP
  Parameter name:  seq_concat_sep
         Purpose:  Character separating file names
            Type:  char
         Default:  +
         Example:  seq_concat_name = '&'
```

I.4 Screen I/O

```
Environment name:  COB_BELL
  Parameter name:  bell
         Purpose:  Defines how a request for the screen to beep is handled
            Type:  FLASH, SPEAKER, FALSE, BEEP
         Default:  BEEP
         Example:  BELL SPEAKER

Environment name:  COB_REDIRECT_DISPLAY
  Parameter name:  redirect_display
         Purpose:  Defines if DISPLAY output should be sent to 'stderr'
            Type:  boolean
         Default:  false
         Example:  redirect_display Yes

Environment name:  COB_SCREEN_ESC
```

```
  Parameter name:  screen_esc
         Purpose:  Enable handling of ESC key during ACCEPT
            Type:  boolean
         Default:  false
            Note:  is only evaluated if COB_SCREEN_EXCEPTIONS is active
         Example:  screen_esc Yes

Environment name:  COB_SCREEN_EXCEPTIONS
  Parameter name:  screen_exceptions
         Purpose:  enable exceptions for function keys during ACCEPT
            Type:  boolean
         Default:  false
         Example:  screen_exceptions Yes

Environment name:  COB_TIMEOUT_SCALE
  Parameter name:  timeout_scale
         Purpose:  specify translation in milliseconds for ACCEPT clauses
                   BEFORE TIME value / AFTER TIMEOUT
            Type:  integer
                   0 means 1000 (Micro Focus COBOL compatible), 1 means 100
                   (ACUCOBOL compatible), 2 means 10, 3 means 1
         Default:  0
            Note:  the minimum and possible maximum value depend on the
                   screenio library used
         Example:  timeout_scale 3

Environment name:  COB_INSERT_MODE
  Parameter name:  insert_mode
         Purpose:  specify default insert mode for ACCEPT; 0=off, 1=on
            Type:  boolean
         Default:  false
            Note:  also sets the cursor type (if available)
         Example:  insert_mode Y

Environment name:  COB_MOUSE_FLAGS
  Parameter name:  mouse_flags
         Purpose:  specify which mouse events will be sent as function key
                   to the application during ACCEPT and how they will be
                   handled
            Type:  int (by bits)
         Default:  1
            Note:  0 disables the mouse cursor, any other value enables it,
                   any value containing 1 will enable internal handling (click
                   to position, double-click to enter).
                   See copy/screenio.cpy for list of events and their values.
           Alias:  MOUSE_FLAGS
         Example:  11 (enable internal handling => 1, left press => 2,
                       double-click => 8; 1+2+8=11)

Environment name:  COB_MOUSE_INTERVAL
  Parameter name:  mouse_interval
         Purpose:  specifies the maximum time (in thousands of a second)
```

```
                that can elapse between press and release events for them
                to be recognized as a click.
           Type: int (0 - 166)
        Default: 100
           Note: 0 disables the click resolution (instead press + release
                are recognized), also disables positioning by mouse click

Environment name: COB_DISPLAY_PRINT_PIPE
  Parameter name: display_print_pipe
         Purpose: Defines command line used for sending output of
                DISPLAY UPON PRINTER to (via pipe)
                This is very similar to Micro Focus COBPRINTER
           Note: Each executed DISPLAY UPON PRINTER statement causes a
                new invocation of command-line (= new process start).
                Each invocation receives the data referenced in
                the DISPLAY statement and is followed by an
                end-of-file condition.
                COB_DISPLAY_PRINT_FILE, if set, takes precedence
                over COB_DISPLAY_PRINT_PIPE.
          Alias: COBPRINTER
           Type: string
        Default: not set
        Example: print 'cat >>/tmp/myprt.log'

Environment name: COB_DISPLAY_PRINT_FILE
  Parameter name: display_print_file
         Purpose: Defines file to be appended to by DISPLAY UPON PRINTER
           Note: Each DISPLAY UPON PRINTER opens, appends and closes the file.
           Type: string       : $$ is replaced by process id
        Default: not set
        Example: display_printer '/tmp/myprt.log'

Environment name: COB_DISPLAY_PUNCH_FILE
  Parameter name: display_punch_file
         Purpose: Defines file to be created on first
                DISPLAY UPON SYSPUNCH/SYSPCH
           Note: The file will be only be closed on runtime exit.
           Type: string       : $$ is replaced by process id
        Default: not set
        Example: display_punch './punch_$$.out'

Environment name: COB_LEGACY
  Parameter name: legacy
         Purpose: keep behavior of former runtime versions, currently only
                for setting screen attributes for non input fields and
                disabling blinking on some systems
           Type: boolean
        Default: not set
        Example: legacy true

Environment name: COB_EXIT_WAIT
  Parameter name: exit_wait
```

```
         Purpose:  to wait on main program exit if an extended screenio
                   DISPLAY was issued without an ACCEPT following
            Type:  boolean
         Default:  true
         Example:  COB_EXIT_WAIT off

Environment name:  COB_EXIT_MSG
  Parameter name:  exit_msg
         Purpose:  string to display if COB_EXIT_WAIT is processed, set to ''
                   if no actual display but an ACCEPT should be done
            Type:  string
         Default:  'end of program, please press a key to exit' (localized)
         Example:  COB_EXIT_MSG ''
```

I.5 Report I/O

```
Environment name:  COB_COL_JUST_LRC
  Parameter name:  col_just_lrc
         Purpose:  If true, then COLUMN defined as LEFT, RIGHT or CENTER
                   will have the data justified within the field limits
                   If false, then the data is just copied into the column as is
            Type:  boolean
         Default:  TRUE
         Example:  col_just_lrc True
```

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