CMake Build system generator

START HERE

`cmake -S . -B build`
Configure into build/

`cmake --install build --prefix <dir>`
Install

`cmake --build build`
Compile

`cmake -B build -DCMAKE_BUILD_TYPE=Release`
Set a cache variable

`cmake --build build -j`
Compile in parallel

`cmake -B build -G Ninja`
Pick a generator

`ctest --test-dir build`
Run the tests

`cmake --preset <name>`
Configure from a preset

CMakeLists.txt project description → `configure` → **Build tree** cache + generated files → `--build` → **Binaries** via Make/Ninja → `ctest / --install` → **Tests, install** results, prefix

Configure once, then build, test and install from the same tree

CONCEPTS

CMake does not build anything itself: it generates files for a native tool (Make, Ninja, Visual Studio), which then compiles. Keep the build tree out of the source tree.

Cache variables (-D) persist in build/CMakeCache.txt, so later runs reuse them. Use --fresh or delete the build dir to reset.

CONFIGURE

`cmake -S <src> -B <build>`
Configure source into build dir

`cmake -B build -G "<generator>"`
Choose generator (Ninja, Unix Makefiles)

`cmake -B build -D<VAR>=<value>`
Set a cache entry

`cmake -B build -DCMAKE_BUILD_TYPE=<type>`
Debug, Release, RelWithDebInfo

`cmake -B build --fresh`
Drop the cache and reconfigure

`cmake -B build --toolchain <file>`
Use a toolchain file (cross-compile)

`-DCMAKE_EXPORT_COMPILE_COMMANDS=ON`
Write compile_commands.json

BUILD

`cmake --build <dir>`
Build everything

`cmake --build <dir> -j <N>`
Build with N parallel jobs

`cmake --build <dir> -t <target>`
Build one target

`cmake --build <dir> --clean-first`
Clean, then build

`cmake --build <dir> --config <cfg>`
Choose config (multi-config generators)

BUILD (cont.)

`cmake --build <dir> -v`
Show full compiler commands

INSTALL AND TEST

`cmake --install <dir>`
Install the project

`cmake --install <dir> --prefix <dir>`
Override the install prefix

`ctest --test-dir <dir>`
Run all tests

`ctest --test-dir <dir> --output-on-failure`
Show output of failing tests

`ctest -R <regex>`
Run tests whose name matches

`ctest -E <regex>`
Exclude matching tests

`ctest -j <N>`
Run tests in parallel

`ctest --rerun-failed`
Run only tests that failed last time

PRESETS

`cmake --list-presets`
List configure presets

`cmake --preset <name>`
Configure with a preset

`cmake --workflow --preset <name>`
Run configure, build, test in sequence

Presets live in CMakePresets.json (shared, committed) and CMakeUserPresets.json (personal, usually git-ignored).

INSPECT AND DEBUG

`cmake -L -N <dir>`
List cache variables, no reconfigure

`cmake --trace-expand`
Trace every command run

`cmake --debug-find`
Show how find_package searches

INSPECT AND DEBUG (cont.)

`cmake --help-command <cmd>`
Docs for one command

`cmake --version`
Print the version

SCRIPT AND TOOLS

`cmake -P <script.cmake>`
Run a CMake script

`cmake -E copy <src> <dst>`
Copy a file

`cmake -E rm -rf <path>`
Remove files or directories

CMAKELISTS.TXT

`cmake_minimum_required(VERSION <x.y>)`
Declare the minimum CMake version

`project(<name> VERSION <x.y> LANGUAGES CXX)`
Name the project

`add_executable(<tgt> <sources>)`
Define an executable target

`add_library(<tgt> STATIC|SHARED <sources>)`
Define a library target

`target_link_libraries(<tgt> PRIVATE <lib>)`
Link a dependency

`target_include_directories(<tgt> PUBLIC <dir>)`
Add include paths

`target_compile_features(<tgt> PUBLIC cxx_std_17)`
Require a language standard

`target_compile_definitions(<tgt> PRIVATE <NAME>=1)`
Add preprocessor defines

`find_package(<Pkg> REQUIRED)`
Locate an installed package

`add_subdirectory(<dir>)`
Include a nested CMakeLists.txt

`option(<VAR> "<doc>" ON)`
Declare a boolean switch

CMAKELISTS.TXT (cont.)

`set(<VAR> <value>)`
Set a normal variable

`enable_testing()`
Turn on ctest support

`add_test(NAME <t> COMMAND <exe>)`
Register a test

`install(TARGETS <tgt> DESTINATION bin)`
Install a target

Prefer target_* commands over global ones (include_directories, add_definitions). Use ${VAR} to read a variable and $<...> for generator expressions evaluated at build time.

RECIPES

Minimal project with a test

```
cmake_minimum_required(VERSION 3.20)
project(app LANGUAGES CXX)
add_executable(app main.cpp)
target_compile_features(app PRIVATE cxx_std_17)
enable_testing()
add_test(NAME smoke COMMAND app)
```

Out-of-source build and test

```
cmake -S . -B build -G Ninja -DCMAKE_BUILD_TYPE=Release
cmake --build build -j
ctest --test-dir build --output-on-failure
cmake --install build --prefix ~/.local
```

Library plus app with a dependency

```
find_package(fmt REQUIRED)
add_library(core src/core.cpp)
target_include_directories(core PUBLIC include)
target_link_libraries(core PUBLIC fmt::fmt)
add_executable(app src/main.cpp)
target_link_libraries(app PRIVATE core)
```

Minimal CMakePresets.json

```
{
  "version": 6,
  "configurePresets": [{
    "name": "dev", "generator": "Ninja",
    "binaryDir": "${sourceDir}/build",
    "cacheVariables": {"CMAKE_BUILD_TYPE": "Debug"}
  }]
}
```