

Lesson 6: Toolchain (Assignment 6)

SourceCode - hello_c

```
GNU nano 5.4                                         hello.c
#include <stdio.h>

int main()
{
    printf("Hello World");
    return 0;
}

[ Read 7 lines ]
^G Help          ^O Write Out      ^W Where Is      ^K Cut           ^T Execute      ^C Location      M-U Undo
^X Exit          ^R Read File      ^\ Replace       ^U Paste         ^J Justify      ^_ Go To Line   M-E Redo
                                         M-A Set Mark
                                         M-6 Copy
```

Output - file hello (rpi -64 bit)

```
cxr1020@raspberrypi:~/Documents/EmbeddedLinuxRepo/CSR-EmbeddedLinux/Assignment06-Code $ nano hello.c
cxr1020@raspberrypi:~/Documents/EmbeddedLinuxRepo/CSR-EmbeddedLinux/Assignment06-Code $ gcc -Wall -o hello hello.c
cxr1020@raspberrypi:~/Documents/EmbeddedLinuxRepo/CSR-EmbeddedLinux/Assignment06-Code $ file hello
hello: ELF 64-bit LSB pie executable, ARM aarch64, version 1 (SYSV), dynamically linked, interpreter /lib/ld-linux-aarch64.so.1, BuildID[sha1]=df61e7146da723bc5c6908727d7dedd087208f29, for GNU/Linux 3.7.0, not stripped
cxr1020@raspberrypi:~/Documents/EmbeddedLinuxRepo/CSR-EmbeddedLinux/Assignment06-Code $
```

Command - wget <https://buildroot.org/downloads/buildroot-2023.02.7.tar.gz>

```
cxr1020@raspberrypi:~/Documents $ mkdir buildroot
cxr1020@raspberrypi:~/Documents $ cd buildroot/
cxr1020@raspberrypi:~/Documents/buildroot $ wget https://buildroot.org/downloads/buildroot-2023.02.7.tar.gz
--2023-11-24 18:15:31-- https://buildroot.org/downloads/buildroot-2023.02.7.tar.gz
Resolving buildroot.org (buildroot.org)... 140.211.167.122
Connecting to buildroot.org (buildroot.org)|140.211.167.122|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 7269977 (6.9M) [application/x-gzip]
Saving to: 'buildroot-2023.02.7.tar.gz'

buildroot-2023.02.7.tar.gz      100%[=====] 6.93M 4.31MB/s   in 1.6s

2023-11-24 18:15:38 (4.31 MB/s) - 'buildroot-2023.02.7.tar.gz' saved [7269977/7269977]

cxr1020@raspberrypi:~/Documents/buildroot $
```

Command - tar tf buildroot-2023.02.7.tar.gz | head

```
cxr1020@raspberrypi:~/Documents $ mkdir buildroot
cxr1020@raspberrypi:~/Documents $ cd buildroot/
cxr1020@raspberrypi:~/Documents/buildroot $ wget https://buildroot.org/downloads/buildroot-2023.02.7.tar.gz
--2023-11-24 18:15:31-- https://buildroot.org/downloads/buildroot-2023.02.7.tar.gz
Resolving buildroot.org (buildroot.org)... 140.211.167.122
Connecting to buildroot.org (buildroot.org)|140.211.167.122|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 7269977 (6.9M) [application/x-gzip]
Saving to: 'buildroot-2023.02.7.tar.gz'

buildroot-2023.02.7.tar.gz      100%[=====] 6.93M 4.31MB/s   in 1.6s

2023-11-24 18:15:38 (4.31 MB/s) - 'buildroot-2023.02.7.tar.gz' saved [7269977/7269977]

cxr1020@raspberrypi:~/Documents/buildroot $ tar tf buildroot-2023.02.7.tar.gz | head
buildroot-2023.02.7/
buildroot-2023.02.7/.checkpackageignore
buildroot-2023.02.7/.clang-format
buildroot-2023.02.7/.defconfig
buildroot-2023.02.7/.flake8
buildroot-2023.02.7/.gitignore
buildroot-2023.02.7/.gitlab-ci.yml
buildroot-2023.02.7/.shellcheckrc
buildroot-2023.02.7/CHANGES
buildroot-2023.02.7/COPYING
cxr1020@raspberrypi:~/Documents/buildroot $
```

Command - tar xf buildroot-2023.02.7.tar.gz

```
cxr1020@raspberrypi:~/Documents $ mkdir buildroot
cxr1020@raspberrypi:~/Documents $ cd buildroot/
cxr1020@raspberrypi:~/Documents/buildroot $ wget https://buildroot.org/downloads/buildroot-2023.02.7.tar.gz
--2023-11-24 18:15:31-- https://buildroot.org/downloads/buildroot-2023.02.7.tar.gz
Resolving buildroot.org (buildroot.org)... 140.211.167.122
Connecting to buildroot.org (buildroot.org)|140.211.167.122|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 7269977 (6.9M) [application/x-gzip]
Saving to: 'buildroot-2023.02.7.tar.gz'

buildroot-2023.02.7.tar.gz      100%[=====] 6.93M 4.31MB/s   in 1.6s

2023-11-24 18:15:38 (4.31 MB/s) - 'buildroot-2023.02.7.tar.gz' saved [7269977/7269977]

[cxr1020@raspberrypi:~/Documents/buildroot $ tar tf buildroot-2023.02.7 | head
buildroot-2023.02.7/
buildroot-2023.02.7/.checkpackageignore
buildroot-2023.02.7/.clang-format
buildroot-2023.02.7/.defconfig
buildroot-2023.02.7/.flake8
buildroot-2023.02.7/.gitignore
buildroot-2023.02.7/.gitlab-ci.yml
buildroot-2023.02.7/.shellcheckrc
buildroot-2023.02.7/CHANGES
buildroot-2023.02.7/COPYING
[cxr1020@raspberrypi:~/Documents/buildroot $ tar xf buildroot-2023.02.7.tar.gz
[cxr1020@raspberrypi:~/Documents/buildroot $ ls buildroot-2023.02.7
arch  boot  Config.in      configs  DEVELOPERS  fs      Makefile      package  support  toolchain
board CHANGES  Config.in.legacy  COPYING  docs       linux  Makefile.legacy  README  system  utils
[cxr1020@raspberrypi:~/Documents/buildroot $ ]
```

Command - ls buildroot-2023.02.7

```
cxr1020@raspberrypi:~/Documents $ mkdir buildroot
cxr1020@raspberrypi:~/Documents $ cd buildroot/
cxr1020@raspberrypi:~/Documents/buildroot $ wget https://buildroot.org/downloads/buildroot-2023.02.7.tar.gz
--2023-11-24 18:15:31-- https://buildroot.org/downloads/buildroot-2023.02.7.tar.gz
Resolving buildroot.org (buildroot.org)... 140.211.167.122
Connecting to buildroot.org (buildroot.org)|140.211.167.122|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 7269977 (6.9M) [application/x-gzip]
Saving to: 'buildroot-2023.02.7.tar.gz'

buildroot-2023.02.7.tar.gz      100%[=====] 6.93M 4.31MB/s   in 1.6s

2023-11-24 18:15:38 (4.31 MB/s) - 'buildroot-2023.02.7.tar.gz' saved [7269977/7269977]

[cxr1020@raspberrypi:~/Documents/buildroot $ tar tf buildroot-2023.02.7 | head
buildroot-2023.02.7/
buildroot-2023.02.7/.checkpackageignore
buildroot-2023.02.7/.clang-format
buildroot-2023.02.7/.defconfig
buildroot-2023.02.7/.flake8
buildroot-2023.02.7/.gitignore
buildroot-2023.02.7/.gitlab-ci.yml
buildroot-2023.02.7/.shellcheckrc
buildroot-2023.02.7/CHANGES
buildroot-2023.02.7/COPYING
[cxr1020@raspberrypi:~/Documents/buildroot $ tar xf buildroot-2023.02.7.tar.gz
[cxr1020@raspberrypi:~/Documents/buildroot $ ls buildroot-2023.02.7
arch  boot  Config.in      configs  DEVELOPERS  fs      Makefile      package  support  toolchain
board CHANGES  Config.in.legacy  COPYING  docs       linux  Makefile.legacy  README  system  utils
[cxr1020@raspberrypi:~/Documents/buildroot $ ]
```

Output – README

```
UW PICO 5.09                                         File: README

Buildroot is a simple, efficient and easy-to-use tool to generate embedded
Linux systems through cross-compilation.

The documentation can be found in docs/manual. You can generate a text
document with 'make manual-text' and read output/docs/manual/manual.text.
Online documentation can be found at http://buildroot.org/docs.html

To build and use the buildroot stuff, do the following:

1) run 'make menuconfig'
2) select the target architecture and the packages you wish to compile
3) run 'make'
4) wait while it compiles
5) find the kernel, bootloader, root filesystem, etc. in output/images

You do not need to be root to build or run buildroot. Have fun!

Buildroot comes with a basic configuration for a number of boards. Run
'make list-defconfigs' to view the list of provided configurations.

Please feed suggestions, bug reports, insults, and bribes back to the
buildroot mailing list: buildroot@buildroot.org
You can also find us on #buildroot on OFTC IRC.

If you would like to contribute patches, please read
https://buildroot.org/manual.html#submitting-patches

^G Get Help      ^O WriteOut     ^R Read File     ^Y Prev Pg      ^K Cut Text      ^C Cur Pos
^X Exit         ^J Justify       ^W Where is      ^V Next Pg      ^U UnCut Text    ^T To Spell
```

Command - make menuconfig (failed due to missing ncurses)

```
cxr1020@raspberrypi:~/Documents/buildroot $ cd buildroot-2023.02.7/
cxr1020@raspberrypi:~/Documents/buildroot-buildroot-2023.02.7 $ make menuconfig
mkdir -p /home/cxr1020/Documents/buildroot/buildroot-2023.02.7/output/build/buildroot-config/lxdialog
PKG_CONFIG_PATH="" make CC="/usr/bin/gcc" HOSTCC="/usr/bin/gcc" \
    obj=/home/cxr1020/Documents/buildroot/buildroot-2023.02.7/output/build/buildroot-config -C support/kconfig -f Makefile.br mconf
make[1]: Entering directory '/home/cxr1020/Documents/buildroot/buildroot-2023.02.7/support/kconfig'
/usr/bin/gcc -DCURSES_LOC=<curses.h> -DLOCALE -I/home/cxr1020/Documents/buildroot/buildroot-2023.02.7/output/build/buildroot-config -DCONFIG_=\"\" -MM *.c > /home/cxr1020/Documents/buildroot/buildroot-2023.02.7/output/build/buildroot-config/.depend 2>/dev/null || :
/usr/bin/gcc -DCURSES_LOC=<curses.h> -DLOCALE -I/home/cxr1020/Documents/buildroot/buildroot-2023.02.7/output/build/buildroot-config -DCONFIG_=\"\" -c conf.c -o /home/cxr1020/Documents/buildroot/buildroot-2023.02.7/output/build/buildroot-config/conf.o
*** Unable to find the ncurses libraries or the
*** required header files.
*** 'make menuconfig' requires the ncurses libraries.
***
*** Install ncurses (ncurses-devel or libncurses-dev
*** depending on your distribution) and try again.
***
make[1]: *** [Makefile:253: /home/cxr1020/Documents/buildroot/buildroot-2023.02.7/output/build/buildroot-config/dochecklxdialog] Error 1
make[1]: Leaving directory '/home/cxr1020/Documents/buildroot/buildroot-2023.02.7/support/kconfig'
make: *** [Makefile:960: /home/cxr1020/Documents/buildroot/buildroot-2023.02.7/output/build/buildroot-config/mconf] Error 2
cxr1020@raspberrypi:~/Documents/buildroot-buildroot-2023.02.7 $
```

Command. - sudo apt-cache search libncurses

```
cxr1020@raspberrypi:~/Documents/buildroot/buildroot-2023.02.7 $ sudo apt-cache search libncurses
libncurses-gst - Ncurses bindings for GNU Smalltalk
libncursesada-doc - Ada binding to the ncurses text interface library: documentation
libncursesada6.2.3 - Ada binding to the ncurses text interface library: shared library
libncursesada9-dev - Ada binding to the ncurses text interface library: development
libncurses-dev - developer's libraries for ncurses
libncurses5 - shared libraries for terminal handling (legacy version)
libncurses5-dev - transitional package for libncurses-dev
libncurses6 - shared libraries for terminal handling
libncursesw5 - shared libraries for terminal handling (wide character legacy version)
libncursesw5-dev - transitional package for libncurses-dev
libtinfo-dev - transitional package for libncurses-dev
cxr1020@raspberrypi:~/Documents/buildroot/buildroot-2023.02.7 $
```

Command - sudo apt install libncurses-dev

```
cxr1020@raspberrypi:~/Documents/buildroot/buildroot-2023.02.7 $ sudo apt install libncurses-dev
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following packages were automatically installed and are no longer required:
  libfuse2 raspiinfo
Use 'sudo apt autoremove' to remove them.
Suggested packages:
  ncurses-doc
The following NEW packages will be installed:
  libncurses-dev
0 upgraded, 1 newly installed, 0 to remove and 0 not upgraded.
Need to get 336 kB of archives.
After this operation, 2,472 kB of additional disk space will be used.
Get:1 http://deb.debian.org/debian bullseye/main arm64 libncurses-dev arm64 6.2+20201114-2+deb11u2 [336 kB]
Fetched 336 kB in 0s (776 kB/s)
Selecting previously unselected package libncurses-dev:arm64.
(Reading database ... 111214 files and directories currently installed.)
Preparing to unpack .../libncurses-dev_6.2+20201114-2+deb11u2_arm64.deb ...
Unpacking libncurses-dev:arm64 (6.2+20201114-2+deb11u2) ...
Setting up libncurses-dev:arm64 (6.2+20201114-2+deb11u2) ...
Processing triggers for man-db (2.9.4-2) ...
cxr1020@raspberrypi:~/Documents/buildroot/buildroot-2023.02.7 $
```

Command - make menuconfig (success)

```
Buildroot 2023.02.7 Configuration
Arrow keys navigate the menu. <Enter> selects submenus ---> (or empty submenus ----). Highlighted letters are hotkeys.
Pressing <Y> selects a feature, while <N> excludes a feature. Press <Esc><Esc> to exit, <?> for Help, </> for Search.
Legend: [*] feature is selected [ ] feature is excluded

[ Target options --->
  Toolchain --->
  Build options --->
  System configuration --->
  Kernel --->
  Target packages --->
  Filesystem images --->
  Bootloaders --->
  Host utilities --->
  Legacy config options --->

<Select>  < Exit >  < Help >  < Save >  < Load >
```

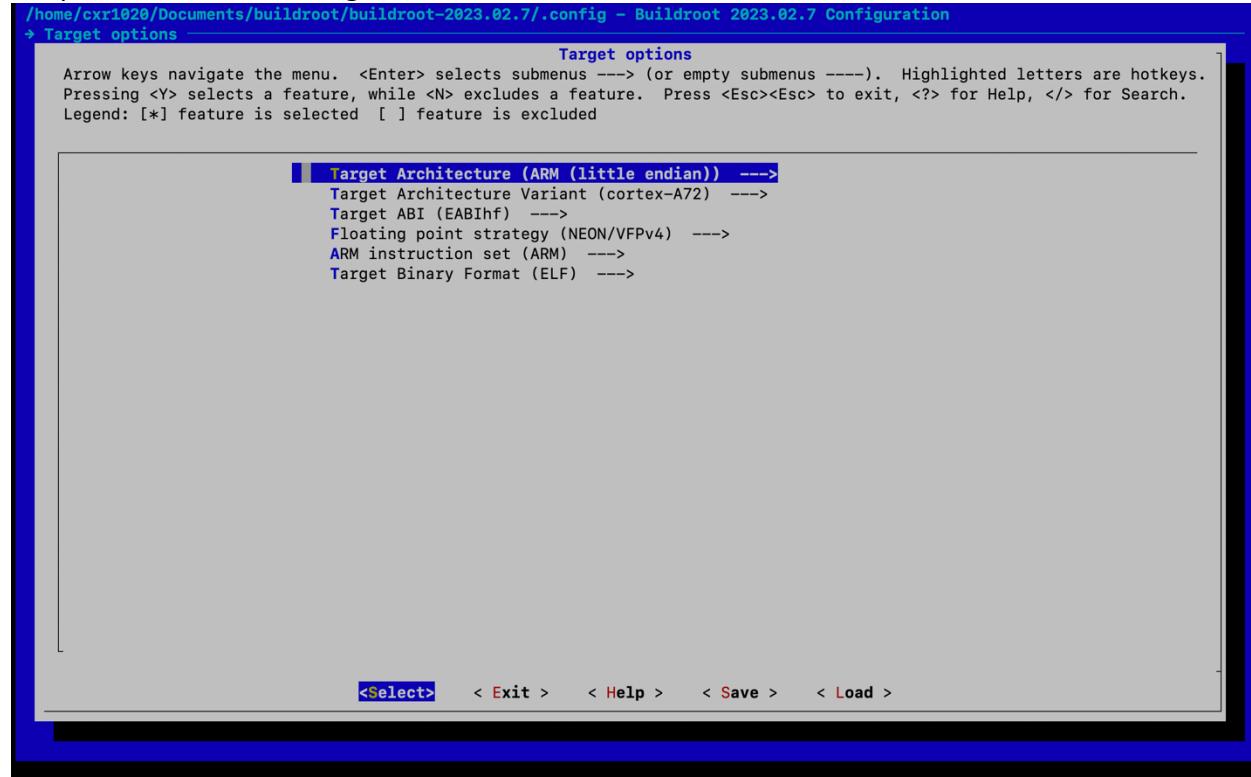
Command - ls configs/

```
cxr1020@raspberrypi:~/Documents/buildroot/buildroot-2023.02.7 $ ls
arch  boot  Config.in      configs  DEVELOPERS  fs      Makefile      output  README  system  utils
board CHANGES  Config.in.legacy  COPYING  docs      linux  Makefile.legacy  package  support  toolchain
[cxr1020@raspberrypi:~/Documents/buildroot/buildroot-2023.02.7 $ ls configs/
aarch64_efi_defconfig          imx6ulpico_defconfig           qemu_mips64r6el_malta_defconfig
acmesystems_acqua_a5_256mb_defconfig  imx7dpico_defconfig           qemu_mips64r6_malta_defconfig
acmesystems_acqua_a5_512mb_defconfig  imx7d-sdb_defconfig           qemu_nios2_10m50_defconfig
acmesystems_aria_g25_128mb_defconfig  imx8mmppico_defconfig         qemu_or1k_defconfig
acmesystems_aria_g25_256mb_defconfig  imx8mn_bsh_smm_s2_defconfig  qemu_ppc64_e5500_defconfig
acmesystems_arieitta_g25_128mb_defconfig  imx8mn_bsh_smm_s2_pro_defconfig  qemu_ppc64le_powernv8_defconfig
acmesystems_arieitta_g25_256mb_defconfig  imx8mpico_defconfig         qemu_ppc64le_pseries_defconfig
amarula_vyasa_rk3288_defconfig     imx8mqevk_defconfig           qemu_ppc64_pseries_defconfig
andes_ae350_45_defconfig         kontron_b1_imx8mm_defconfig   qemu_ppc_bamboo_defconfig
arcturus_ucl1012a_defconfig       kontron_pitx_imx8m_defconfig   qemu_ppc_e500mc_defconfig
arcturus_ucp1020_defconfig        kontron_smarc_sal28_defconfig  qemu_ppc_g3beige_defconfig
armadeus_apf27_defconfig         lafrite_defconfig             qemu_ppc_mac99_defconfig
armadeus_apf28_defconfig         lego_ev3_defconfig           qemu_ppc_mpc8544ds_defconfig
armadeus_apf51_defconfig         licheepi_zero_defconfig      qemu_riscv32_virt_defconfig
arm_foundationv8_defconfig       linksprite_pcduino_defconfig  qemu_riscv64_nommu_virt_defconfig
aspeed_ast2500evb_defconfig      ls1028ardb_defconfig          qemu_riscv64_virt_defconfig
aspeed_ast2600evb_defconfig      mender_x86_64_efi_defconfig  qemu_s390x_defconfig
asus_tinker_rk3288_defconfig     microchip_sam9x0ek_mmc_defconfig  qemu_sh4eb_r2d_defconfig
at91sam9260ekn_defconfig        microchip_sam9x0ek_mmc_dev_defconfig  qemu_sh4_r2d_defconfig
at91sam9g20dfc_defconfig        microchip_sama5d27_wlsm01_ek_mmc_defconfig  qemu_sparc64_sun4u_defconfig
at91sam9g45m10ek_defconfig      microchip_sama5d27_wlsm01_ek_mmc_dev_defconfig  qemu_sparc_ss10_defconfig
at91sam9rlek_defconfig          microchip_sama5d2_icp_mmc_defconfig  qemu_x86_64_defconfig
at91sam9x5ek_defconfig          microchip_sama5d2_icp_mmc_dev_defconfig  qemu_x86_defconfig
at91sam9x5ek_dev_defconfig      microchip_sama7g5ek_mmc_defconfig  qemu_xtensa_lx60_defconfig
at91sam9x5ek_mmc_defconfig      microchip_sama7g5ek_mmc_dev_defconfig  qemu_xtensa_lx60_nommu_defconfig
at91sam9x5ek_mmc_dev_defconfig  minnowboard_max_defconfig      raspberrypi0_defconfig
atmel_sama5d27_som1_ek_mmc_dev_defconfig  mx25pdk_defconfig           raspberrypi0w_defconfig
atmel_sama5d2_xplained_mmc_defconfig  mx5levk_defconfig           raspberrypi2_defconfig
atmel_sama5d2_xplained_mmc_dev_defconfig  mx53loco_defconfig         raspberrypi3_64_defconfig
atmel_sama5d3xek_defconfig       mx6cubox_defconfig           raspberrypi3_defconfig
atmel_sama5d3_xplained_defconfig  mx6sx_udoo_neo_defconfig     raspberrypi3_gt5we_defconfig
atmel_sama5d3_xplained_dev_defconfig  mx6udoo_defconfig           raspberrypi4_64_defconfig
atmel_sama5d3_xplained_mmc_defconfig  nexbox_a95x_defconfig      raspberrypi4_defconfig
```

Command - make raspberrypi4_defconfig

```
cxr1020@raspberrypi:~/Documents/buildroot/buildroot-2023.02.7 $ make raspberrypi4_defconfig
mkdir -p /home/cxr1020/Documents/buildroot/buildroot-2023.02.7/output/build/buildroot-config/lxdialog
PKG_CONFIG_PATH="" make CC="/usr/bin/gcc" HOSTCC="/usr/bin/gcc" \
    obj=/home/cxr1020/Documents/buildroot/buildroot-2023.02.7/output/build/buildroot-config -C support/kconfig -f Makefile.br config
make[1]: Entering directory '/home/cxr1020/Documents/buildroot/buildroot-2023.02.7/support/kconfig'
/usr/bin/gcc -D_DEFAULT_SOURCE -D_XOPEN_SOURCE=600 -DCURSES_LOC=<ncurses.h> -DCURSES_WIDECHAR=1 -DLOCALE -l/home/cxr1020/Documents/buildroot/buildroot-2023.02.7/output/build/buildroot-config -DCONFIG_=\" \" /home/cxr1020/Documents/buildroot/buildroot-2023.02.7/output/build/buildroot-config/conf.o /home/cxr1020/Documents/buildroot/buildroot-2023.02.7/output/build/buildroot-config/conf_nt.tab.o -o /home/cxr1020/Documents/buildroot/buildroot-2023.02.7/output/build/buildroot-config/conf
make[1]: Leaving directory '/home/cxr1020/Documents/buildroot/buildroot-2023.02.7/support/kconfig'
#
# configuration written to /home/cxr1020/Documents/buildroot/buildroot-2023.02.7/.config
#
cxr1020@raspberrypi:~/Documents/buildroot/buildroot-2023.02.7 $
```

Output - make menuconfig



Output - make menuconfig (toolchain)

```
/home/cxr1020/Documents/buildroot/buildroot-2023.02.7/.config - Buildroot 2023.02.7 Configuration
+ Toolchain
    Toolchain
Arrow keys navigate the menu. <Enter> selects submenus ---> (or empty submenus ----). Highlighted letters are hotkeys.
Pressing <Y> selects a feature, while <N> excludes a feature. Press <Esc><Esc> to exit, <?> for Help, </> for Search.
Legend: [*] feature is selected [ ] feature is excluded

[ ] Toolchain type (Buildroot toolchain) --->
    *** Toolchain Buildroot Options ***
    (buildroot) custom toolchain vendor name
    C library (glibc) --->
        *** Kernel Header Options ***
        Kernel Headers (Same as kernel being built) --->
        Custom kernel headers series (5.10.x) --->
            *** Glibc Options ***
            [ ] Enable compatibility shims to run on older kernels
            [ ] Install glibc utilities
                *** Binutils Options ***
                Binutils Version (binutils 2.38) --->
                () Additional binutils options
                    *** GCC Options ***
                    () Additional gcc options
                    [*] Enable C++ support
                    [ ] Enable Fortran support
                    [ ] Enable D language support
                    [ ] Enable compiler OpenMP support
                    [ ] Enable graphite support
                    *** Host GDB Options ***
                    [ ] Build cross gdb for the host
                    *** Toolchain Generic Options ***
↓(+)

<Select>  < Exit >  < Help >  < Save >  < Load >
```

Output - make menuconfig (C library)

```
/home/cxr1020/Documents/buildroot/buildroot-2023.02.7/.config - Buildroot 2023.02.7 Configuration
+ Toolchain
    C library
    Use the arrow keys to navigate this window or press the
    hotkey of the item you wish to select followed by the <SPACE
    BAR>. Press <?> for additional information about this
    ( ) uClibc-ng
    (X) glibc
    ( ) musl

    <Select>  < Help >
```

Output - make menuconfig (System Configuration) (notice that init system would be busybox instead of systemd)

```
/home/cxri020/Documents/buildroot/buildroot-2023.02.7/.config - Buildroot 2023.02.7 Configuration
+ System configuration
    System configuration

Arrow keys navigate the menu. <Enter> selects submenus ---> (or empty submenus ----). Highlighted letters are hotkeys.
Pressing <Y> selects a feature, while <N> excludes a feature. Press <Esc><Esc> to exit, <?> for Help, </> for Search.
Legend: [*] feature is selected [ ] feature is excluded

Root FS skeleton (default target skeleton) --->
  (buildroot) System hostname
  (Welcome to Buildroot) System banner
    Passwords encoding (sha-256) --->
      [*] Init system (BusyBox) --->
        /dev management (Dynamic using devtmpfs only) --->
          (system/device_table.txt) Path to the permission tables
          [ ] support extended attributes in device tables
          [ ] Use symlinks to /usr for /bin, /sbin and /lib
          [*] Enable root login with password
          () Root password
            /bin/sh (busybox' default shell) --->
            [*] Run a getty (login prompt) after boot --->
            [*] remount root filesystem read-write during boot
            (eth0) Network interface to configure through DHCP
            (/bin:/sbin:/usr/bin:/usr/sbin) Set the system's default PATH
            [*] Purge unwanted locales
            (C en_US) Locales to keep
            () Generate locale data
            [ ] Enable Native Language Support (NLS)
            [ ] Install timezone info
            () Path to the users tables
            () Root filesystem overlay directories
            () Custom scripts to run before commencing the build
↓(+)

<Select>  < Exit >  < Help >  < Save >  < Load >
```