phyBOARD$^{®}$-Subra-i.MX 6

Application Guide

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Conventions, Abbreviations and Acronyms

This hardware manual describes the PB-00601-xxx Singe Board Computer (SBC) in the following referred to as phyBOARD-Subra-i.MX 6. The manual specifies the phyBOARD-Subra-i.MX 6's design and function. Precise specifications for the Freescale Semiconductor i.MX 6 microcontrollers can be found in the Freescale Semiconductor i.MX 6 Data Sheet and Technical Reference Manual.

Conventions

Technical conventions used in this manual are as follows:

- Signals that are preceded by an "n", "/", or “#”character (e.g.: nRD, /RD, or #RD), or that have a dash on top of the signal name (e.g.: $\overline{\text{RD}}$) are designated as active low signals. That is, their active state is when they are driven low, or are driving low.
- A "0" indicates a logic zero or low-level signal, while a "1" represents a logic one or high-level signal.
- The hex-numbers given for addresses of I^{2}C devices always represent the 7 MSB of the address byte. The correct value of the LSB which depends on the desired command (read (1), or write (0)) must be added to get the complete address byte. E.g. given address in this manual 0x41 => complete address byte = 0x83 to read from the device and 0x82 to write to the device.

Typographical conventions used in this manual are as follows:

- Tables which describe jumper settings show the default position in **bold, blue text.**
- Text in *blue italic* indicates a hyperlink within, or external to the document. Click these links to quickly jump to the applicable URL, part, chapter, table, or figure.
- Text in *italic* is used for file and directory names, program and command names, command-line options, menu items, URLs, and other terms that correspond the terms on your desktop.
- Text in **bold** is used in examples to show commands or other text that should be typed literally by the user.

Abbreviations and Acronyms

Many acronyms and abbreviations are used throughout this manual. Use the table below to navigate unfamiliar terms used in this document.

Abbreviation	**Definition**
A/V	Audio/Video
BSP	Board Support Package (Software delivered with the Development Kit including an operating system (Windows, or Linux) preinstalled on the module and Development Tools).
CB	Carrier Board; used in reference to the phyBOARD-Subra
DFF	D flip-flop.
DSC	Direct Solder Connect
EMB	External memory bus.
EMI	Electromagnetic Interference.
GPI	General purpose input.
GPIO	General purpose input and output.
GPO	General purpose output.
IRAM	Internal RAM; the internal static RAM on the Freescale i.MX 6 microcontroller.
J	Solder jumper; these types of jumpers require solder equipment to remove and place.
JP	Solderless jumper; these types of jumpers can be removed and placed by hand with no special tools.
NC	Not Connected
PCB	Printed circuit board.
PDI	PHYTEC Display Interface; defined to connect PHYTEC display adapter boards, or custom adapters
PEB	PHYTEC Extension Board
PMIC	Power management IC
PoE	Power over Ethernet
PoP	Package on Package
POR	Power-on reset
RTC	Real-time clock.
SBC	Single Board Computer; used in reference to the PB-00601-xxx /phyBOARD-Subra-i.MX 6 module
SMT	Surface mount technology.
SOM	System on Module; used in reference to the PFL-A-02 /phyFLEX®-i.MX 6 module
Sx	User button Sx (e.g. S1, S2) used in reference to the available user buttons, or DIP-Switches on the CB.
Sx_y	Switch y of DIP-Switch Sx; used in reference to the DIP-Switch on the carrier board.
VSTBY	SOM standby voltage input

Table 1: Abbreviations and Acronyms used in this Manual

🪧	At this icon you might leave the path of this Application Guide.
⚠️	This is a warning. It helps you to avoid annoying problems.
🦊	You can find useful supplementary information about the topic.
⏱️	At the beginning of each chapter you can find information about the time required to read the following chapter.
👍	You have successfully completed an important part of this Application Guide.
🧰	You can find information to solve problems.

Note: The BSP delivered with the phyBOARD-Subra-i.MX 6 usually includes drivers and/or software for controlling all components such as interfaces, memory, etc. Therefore programming close to hardware at register level is not necessary in most cases. For this reason, this manual contains no detailed description of the controller's registers. Please refer to the i.MX 6 Datasheet/Technical Reference Manual, if such information is needed to connect customer designed applications.

Preface

As a member of PHYTEC's new phyBOARD® product family the phyBOARD-Subra-i.MX 6 is one of a series of PHYTEC System on Modules (SBCs) that offers various functions and configurations. PHYTEC supports a variety of 8-/16- and 32-bit controllers in two ways:

(1) as the basis for Rapid Development Kits which serve as a reference and evaluation platform

(2) as insert-ready, fully functional phyBOARD® OEM modules, which can be embedded directly into the user's peripheral hardware design.

Implementation of an OEM-able SBC subassembly as the "core" of your embedded design allows you to focus on hardware peripherals and firmware without expending resources to "re-invent" microcontroller circuitry. Furthermore, much of the value of the phyBOARD® SBC lies in its layout and test.

PHYTEC's new phyBOARD® product family consists of a series of extremely compact embedded control engines featuring various processing performance classes.

Production-ready Board Support Packages (BSPs) and Design Services for our hardware will further reduce your development time and risk and allow you to focus on your product expertise. Take advantage of PHYTEC products to shorten time-to-market, reduce development costs, and avoid substantial design issues and risks. With this new innovative full system solution you will be able to bring your new ideas to market in the most timely and cost-efficient manner.

For more information go to:

http://www.phytec.de/de/leistungen/entwicklungsunterstuetzung.html or
www.phytec.eu/europe/oem-integration/evaluation-start-up.html

Ordering Information

Ordering numbers:

phyBOARD-Subra-i.MX 6 Development Kit:	**KPB-00601-xxx**
phyBOARD-Subra-i.MX 6 SBC:	**PB-00601-xxx**

In order to receive product specific information on changes and updates in the best way also in the future, we recommend to register at

http://www.phytec.de/de/support/registrierung.html or
http://www.phytec.eu/europe/support/registration.html

For technical support and additional information concerning your product, please visit the support section of our web site which provides product specific information, such as errata sheets, application notes, FAQs, etc.

http://www.phytec.de/de/support/faq/faq-phyBOARD-Subra-i.MX6.html or
http://www.phytec.eu/europe/support/faq/ faq-phyBOARD-Subra-i.MX6.html

Declaration of Electro Magnetic Conformity of the PHYTEC phyBOARD-Subra-i.MX 6

PHYTEC Single Board Computers (henceforth products) are designed for installation in electrical appliances or as dedicated Evaluation Boards (i.e.: for use as a test and prototype platform for hardware/software development) in laboratory environments.

Caution:
PHYTEC products lacking protective enclosures are subject to damage by ESD and, hence, may only be unpacked, handled or operated in environments in which sufficient precautionary measures have been taken in respect to ESD-dangers. It is also necessary that only appropriately trained personnel (such as electricians, technicians and engineers) handle and/or operate these products. Moreover, PHYTEC products should not be operated without protection circuitry if connections to the product's pin header rows are longer than 3 m.

PHYTEC products fulfill the norms of the European Union’s Directive for Electro Magnetic Conformity only in accordance to the descriptions and rules of usage indicated in this hardware manual (particularly in respect to the pin header row connectors, power connector and serial interface to a host-PC).

Implementation of PHYTEC products into target devices, as well as user modifications and extensions of PHYTEC products, is subject to renewed establishment of conformity to, and certification of, Electro Magnetic Directives. Users should ensure conformance following any modifications to the products as well as implementation of the products into target systems.

Product Change Management and information in this manual on parts populated on the SOM / SBC

When buying a PHYTEC SOM / SBC, you will, in addition to our HW and SW offerings, receive a free obsolescence maintenance service for the HW we provide.

Our PCM (Product Change Management) Team of developers, is continuously processing, all incoming PCN's (Product Change Notifications) from vendors and distributors concerning parts which are being used in our products.

Possible impacts to the functionality of our products, due to changes of functionality or obsolesce of a certain part, are being evaluated in order to take the right masseurs in purchasing or within our HW/SW design.

Our general philosophy here is: **We never discontinue a product as long as there is demand for it.**

Therefore we have established a set of methods to fulfill our philosophy:

Avoiding strategies

- Avoid changes by evaluating long-livety of parts during design in phase.
- Ensure availability of equivalent second source parts.
- Stay in close contact with part vendors to be aware of roadmap strategies.

Change management in case of functional changes

- Avoid impacts on product functionality by choosing equivalent replacement parts.
- Avoid impacts on product functionality by compensating changes through HW redesign or backward compatible SW maintenance.
- Provide early change notifications concerning functional relevant changes of our products.

Change management in rare event of an obsolete and non replaceable part

- Ensure long term availability by stocking parts through last time buy management according to product forecasts.
- Offer long term frame contract to customers.

Therefore we refrain from providing detailed part specific information within this manual, which can be subject to continuous changes, due to part maintenance for our products.

In order to receive reliable, up to date and detailed information concerning parts used for our product, please contact our support team through the contact information given within this manual.

1 Introduction

1.1 Hardware Overview

The phyBOARD-Subra for phyFLEX-i.MX 6 is a low-cost, feature-rich software development platform supporting the Freescale Semiconductor i.MX 6 microcontroller. Moreover, due to the numerous standard interfaces the phyBOARD-Subra-i.MX 6 can serve as bedrock for your application. At the core of the phyBOARD-Subra is the PFL-A-02 /phyFLEX®-i.MX 6 System On Module (SOM) containing the processor, DRAM, NAND Flash, power regulation, supervision, transceivers, and other core functions required to support the i.MX 6 processor. Surrounding the SOM is the PB-00601-xxx/phyBOARD-Subra carrier board, adding power input, buttons, connectors, signal breakout, and Ethernet connectivity amongst other things.

1.1.1 Features of the phyBOARD-Subra-i.MX 6

The phyBOARD-Subra-i.MX 6 supports the following features :

- PHYTEC's phyFLEX-i.MX 6 Solo SOM
- Dimensions 150 mm x 90 mm
- Boot from NAND Flash, optional from MMC
- Max. 1 GHz core clock frequency
- Combicon connector for 12 V – 24 V power supply
- RJ45 jack for 10/100/1000 Mbps Ethernet
- Two USB Host interfaces brought out to USB2.0 Standard-A connectors
- Micro-SD connector for Secure Digital / Multi Media Memory Card
- CAN interface at 2×4 MicroClasp
- Audiocodec with Stereo Line In, Line Out and Mic In at 2x5 MicroClasp plus mono speaker at 2-pole Molex Spox
- RS-232 transceiver supporting UART0 with data rates of up to 1 Mbps at 2x4 MicroClasp (same connector as for CAN)
- Buttons for Reset and Wakeup
- HDMI and display connectors
- Two camera interfaces at Hirose connectors
- Expansion connector for UART1, SD/MMC, SPI0 and I2C0.
- Four GPIOs available at 2x4 MicroClasp (default wiring: 2x input, 2x output)
- Backup battery supply for RTC with Goldcap (lasts approx. 7 days)Audiocodec with Stereo Line In and Line Out (3×2 pin header 2.54 mm) and mono speaker (2-pole Molex)

1.1.2 Block Diagram

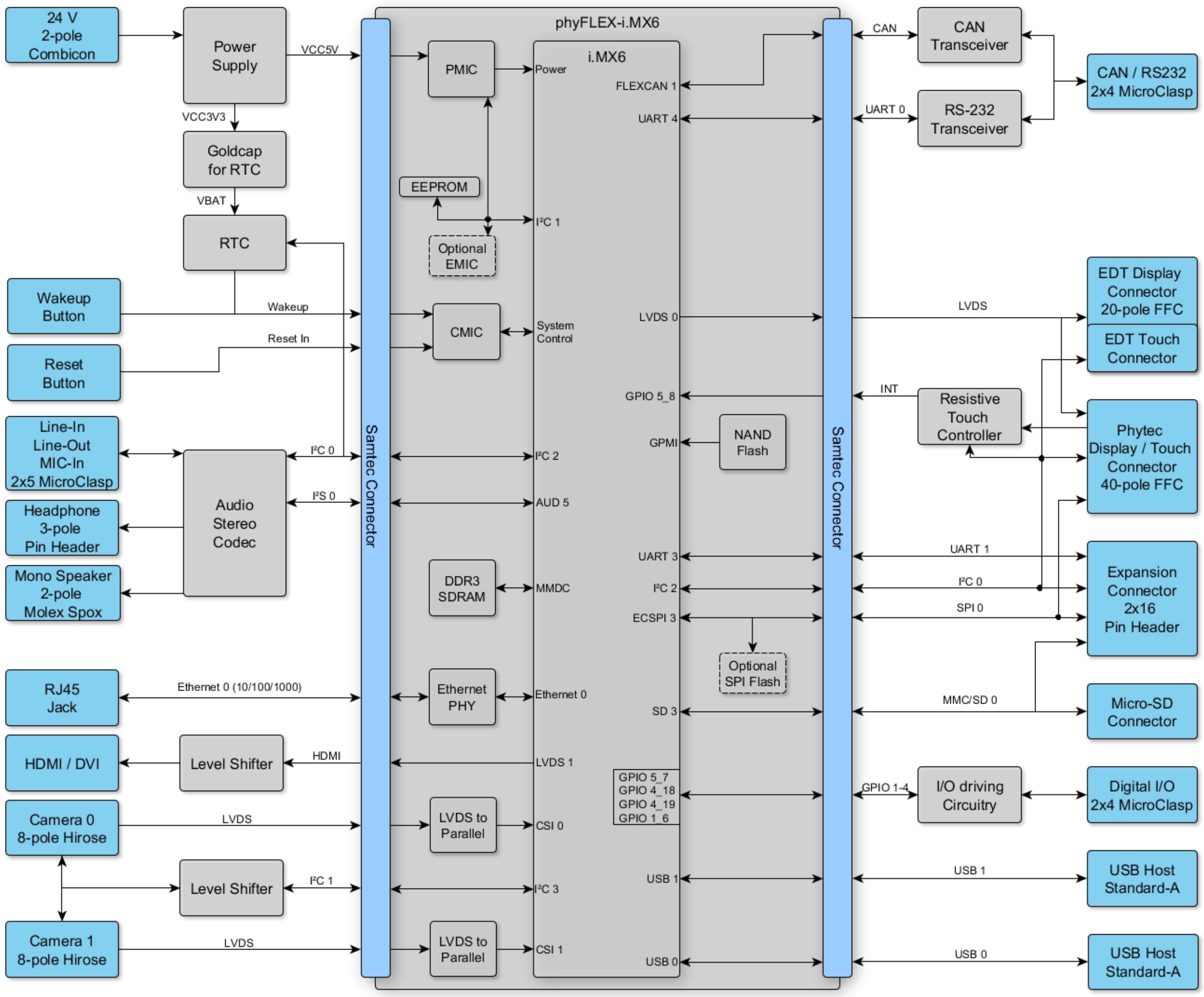


Figure 1: Block Diagram of the phyBOARD-Subra-i.MX 6

1.1.3 View of the phyBOARD-Subra-i.MX 6

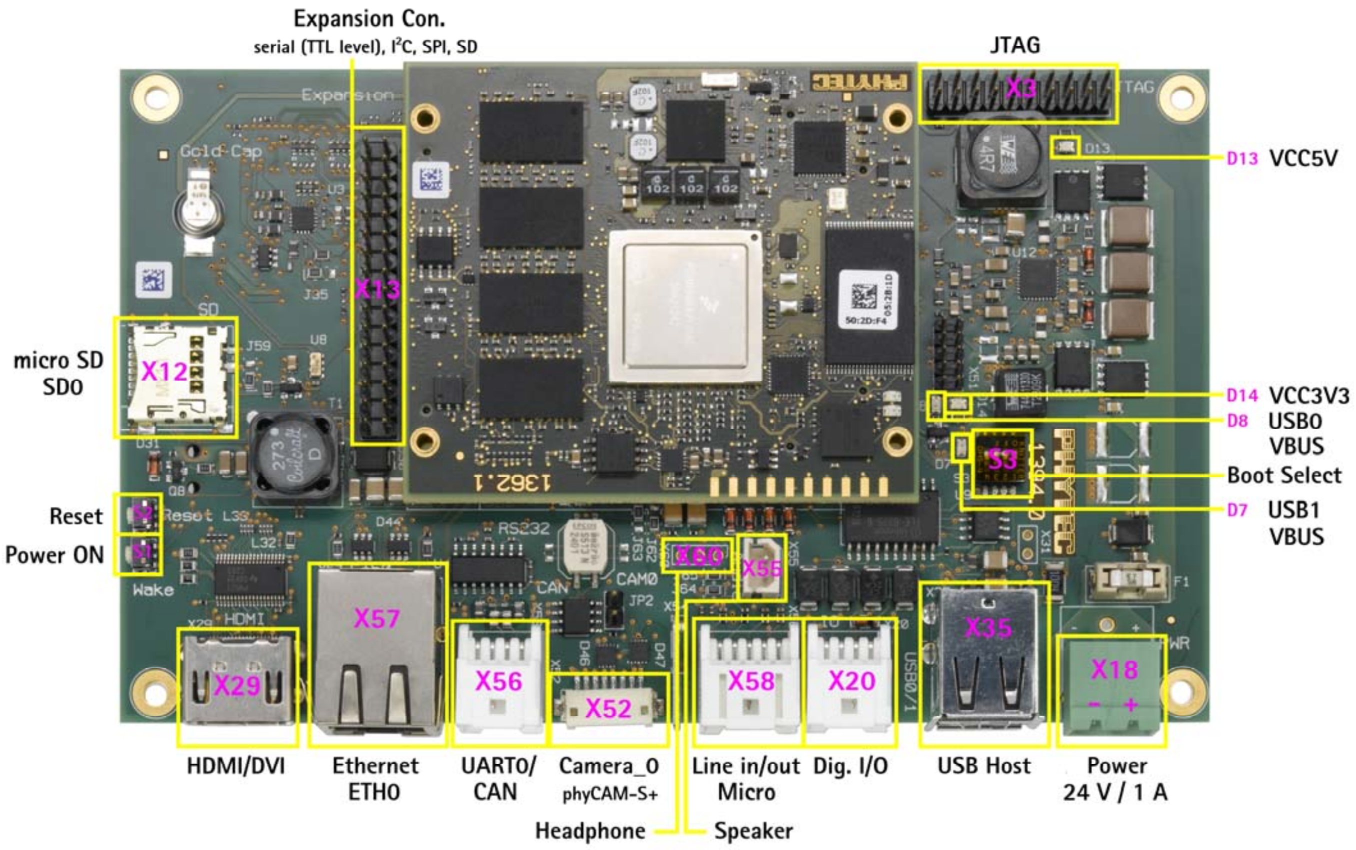


Figure 2: View of the phyBOARD-Subra-i.MX 6 (top view)

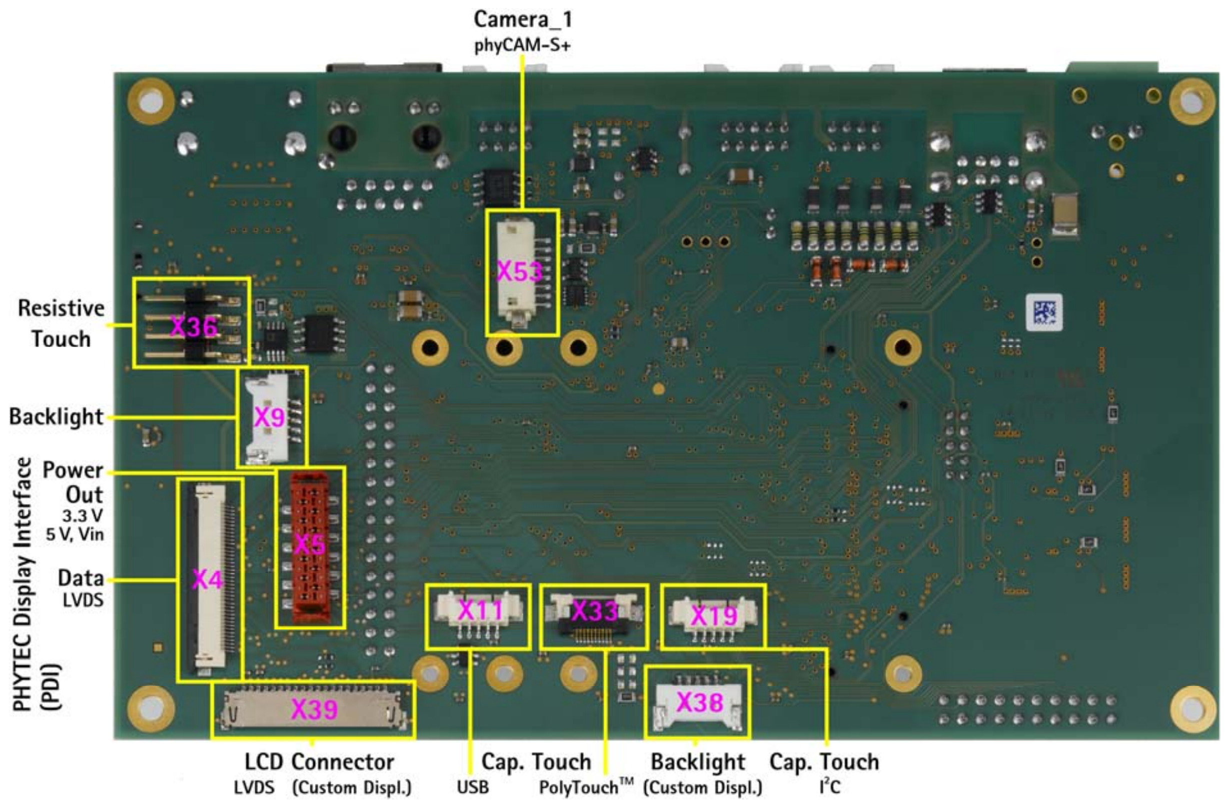


Figure 3: View of the phyBOARD-Subra-i.MX 6 (bottom view)

1.2 Software Overview

1.2.1 Ubuntu

Ubuntu - which you can find on the phyBOARD-Subra-i.MX 6 Kit-DVD - is a free and open source operating system based on *Debian Linux*. Basically it is designed for desktop use. Web statistics suggest that *Ubuntu* is one of the most popular operating systems in the Linux desktop environment.

The *Ubuntu* release which we deliver is *12.04.3* and was released on 15. February 2013. *Ubuntu* 12.04 code name "*Precise Pangolin*" is designated as a **Long Term Support (LTS)** release and the first stable release was on 26 April 2012. LTS means that it will be supported and updated for five years.

Our *Ubuntu* version comes with *Unity* as desktop environment, *dpkg* as package management system, the update method is based on *APT (Advanced Packaging Tool)* and the user space uses *GNU*.

1.2.2 Eclipse

The Eclipse platform is a powerful integrated development environment (IDE). Eclipse is only a framework for developer tools instead it uses external plug-ins. The pre-installed Eclipse version on our Ubuntu LiveDVD supports C/C++ and Qt directly. This Application Guide shows you how to make use of the *CDT,* a set of plug-ins for C/C++ development in conjunction with the GCC C/C++ tool chain.
The CDT (C/C++ Development Tooling) is an open source project (licensed under the Common Public License) implemented purely in Java as a set of plug-ins for the Eclipse SDK platform. These plug-ins add a C/C++ perspective to the Eclipse Workbench that can now support C/C++ development with a number of views and wizards, along with advanced editing and debugging support.
Due to its complexity, the CDT is broken down into several components, which take the form of separate plug-ins. Each component operates as an autonomous project, with its own set of committers, bug categories, and mailing lists. However, all plug-ins are required for the CDT to work properly. Here is a list of the plug-ins/components:

- **Primary CDT plug-in** is the “framework” for the CDT plug-ins.
- **CDT Feature Eclipse** is the CDT Feature Component.
- **CDT Core** provides Core Model, CDOM, and Core Components.
- **CDT UI** is the Core UI, views, editors, and wizards.
- **CDT Launch** provides the launch mechanism for external tools such as the compiler and debugger.

- **CDT Debug Core** provides debugging functions.
- **CDT Debug UI** provides the user interface for the CDT debugging editors, views, and wizards.
- **CDT Debug MI** is the application connector for MI-compatible debuggers.

1.2.3 The GNU Cross Development Tool Chain

Cross development in general refers to the overall software development process that produces a single application or a complete system running on a platform that is different from the development platform. This is an important concept when the target system doesn’t have a native set of compilation tools, or when the host system is faster and has greater resources.
The platform where the actual development takes place is called the *host platform.* The platform where the final application is tested and run is called the *target platform.* In this Quick Start we are using an x86-based Linux as the host platform. As the target platform we are using the ARM®Cortex™-A8 architecture on the phyBOARD-Subra-i.MX 6 SBC.
Building a program for a CPU architecture different from the one used on the machine where the compilation is done is accomplished using a cross compiler tool chain and cross-compiled libraries. In this Application Guide we are using the GNU C/C++ cross development tool chain.

2 Application Programming

During this chapter you will learn how to build your own C/C++ and Qt applications for the target with the help of Eclipse.

We establish that you have first played through our Quickstart Guide.

	As all changes on the example projects will be lost if you proceed using the live environment we recommend to install our modified Ubuntu LiveDVD. If you only want to make your own fast experience with our phyBOARD-Subra-i.MX 6-Kit you can go on with section *2.2 "Working with Eclipse*".

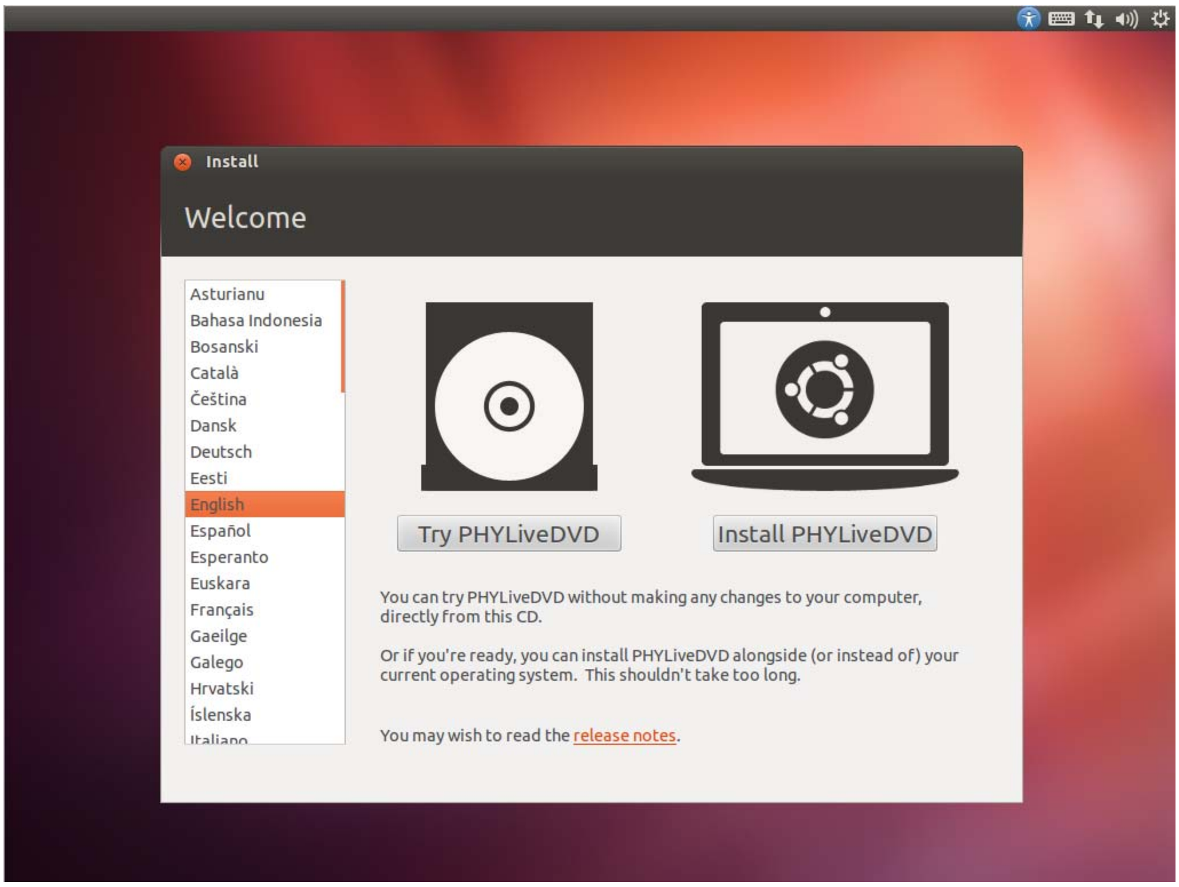
	To ensure successful introduction to the development with the phyBOARD-Subra-i.MX 6 we strongly recommend continuing with the modified Ubuntu, either in a live environment, or completely installed on your PC as described in the next section. Nontheless; if you want to use your already existing environment we explain how to modify your system to get the same experience like our LiveDVD in the System Guide in section "Setup your own host PC".

2.1 Installing our modified Ubuntu LiveDVD

As described above, this step is not needed to successfully finish this chapter but for more in-depth development it is better to install our LiveDVD on your computer or into a virtual machine.

If another operating system is installed on your computer, you should first make a backup of your important files. Before we can start, make sure that your computer is set to boot from DVD before it boots from a hard disk drive.

- Insert the Linux-phyBOARD-Subra-i.MX 6-Kit-DVD into your DVD drive.
- Start or restart your computer. Your system finds a bootable DVD and starts from it. After a while a language screen appears.



You can try PHYLiveDVD without making any changes to your computer, directly from this CD.

Or if you're ready, you can install PHYLiveDVD alongside (or instead of) your current operating system. This shouldn't take too long.

You may wish to read the release notes.

- Select your desired language and click **Install PHYLiveDVD**
- The **Preparing to install PHYLiveDVD** window appears. From Ubuntu it is adviced that you select "*Download updates while installing*" and "*Install this third-party software*" now. Click on **Continue**.
- The **Installation type** window appears. You now have different options how to install Ubuntu. Depending on your system you have a number of possibilities that are shown in the dialog. After you have selected one click on **Continue**.
- The **Install PHYLiveDVD...** window appears. After you have checked the settings you can click on **Install now**.
- While the installation is started Ubuntu asks for your location, keyboard layout and login and password details. Please insert this information and wait until the installation is finished.
- Finally you must restart your system after the installation is finished.
- After that the system boots up and you can log into Ubuntu. Please configure your network connection now. How to do that is shown in the Quickstart Guide.

2.2 Working with Eclipse

Now we start developing our own applications with the help of Eclipse. First we take a look on the C programming language before we go on with programming a QT project. At the end of this chapter we explain how to execute your written programs automatically when booting the target.

2.2.1 Programming in the C/C++ perspective

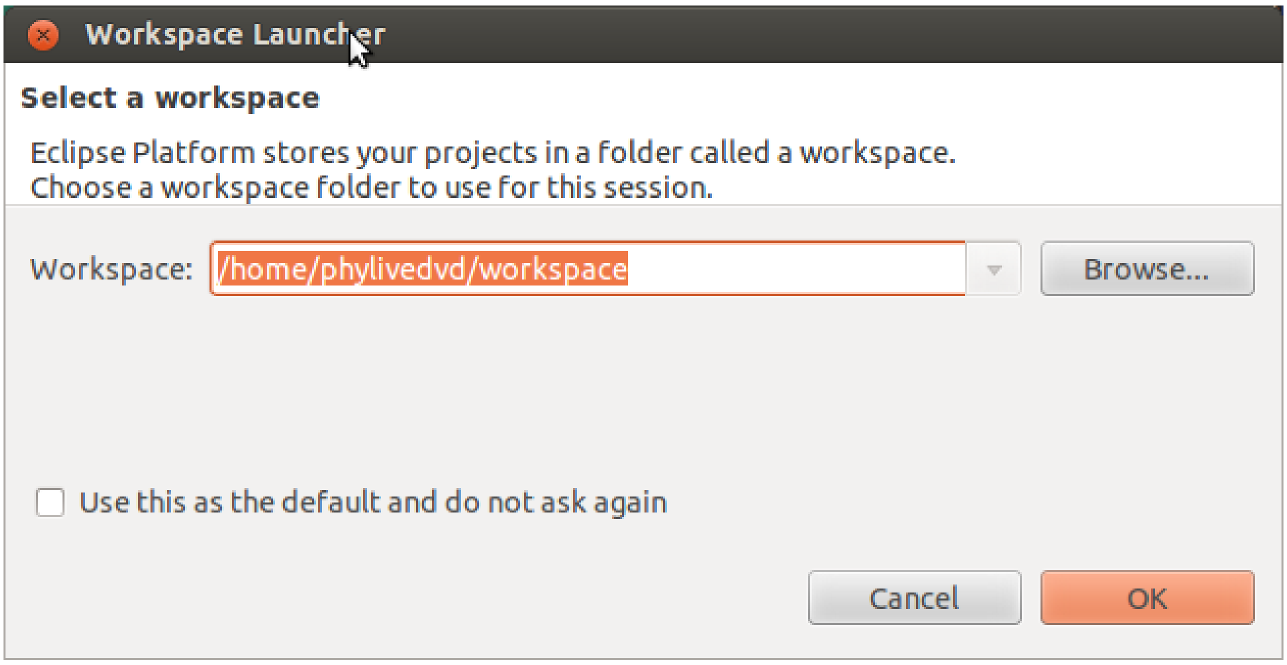
We are starting with the C/C++ workbench. Therefore you will import an existing Eclipse project into your workspace. The imported example project will be compiled with the cross compiler. After compiling the project, you will copy and execute the newly created program on the target.

2.2.1.1 Work with the demo project

- Click the *Eclipse* icon to start the application. You can find this icon on your desktop.

Eclipse

- Confirm the workspace directory with OK
  If you have installed our LiveDVD the workspace directory depends on your created username.



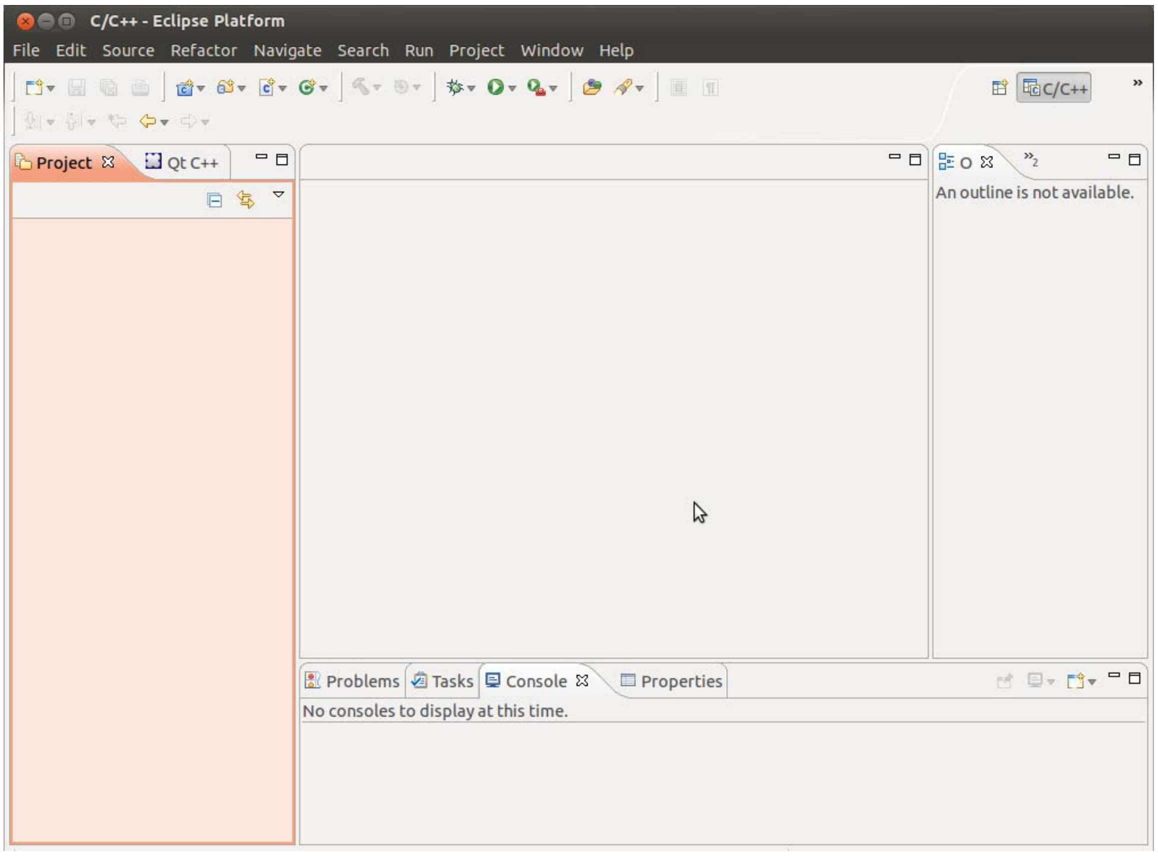
Workspace Launcher

Select a workspace

Eclipse Platform stores your projects in a folder called a workspace.
Choose a workspace folder to use for this session.

Workspace: /home/phylivedvd/workspace

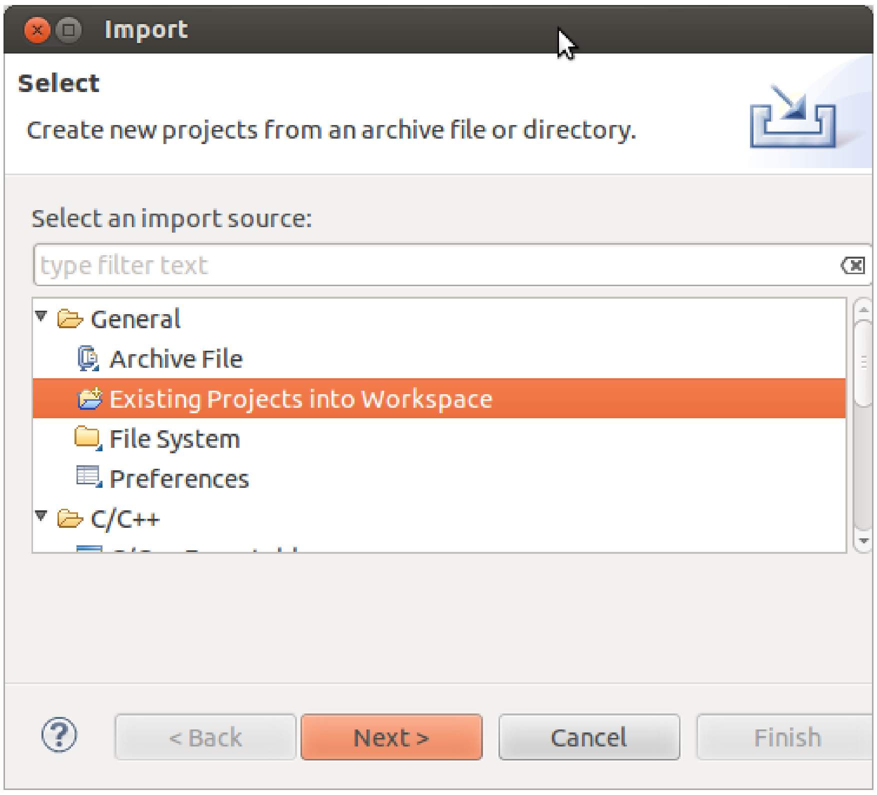
Now you can see the Eclipse workbench.


C/C++ - Eclipse Platform
File Edit Source Refactor Navigate Search Run Project Window Help
C/C++
Project
Qt C++
An outline is not available.
Problems
Tasks
Console
Properties

No consoles to display at this time.

First we will import an existing project.

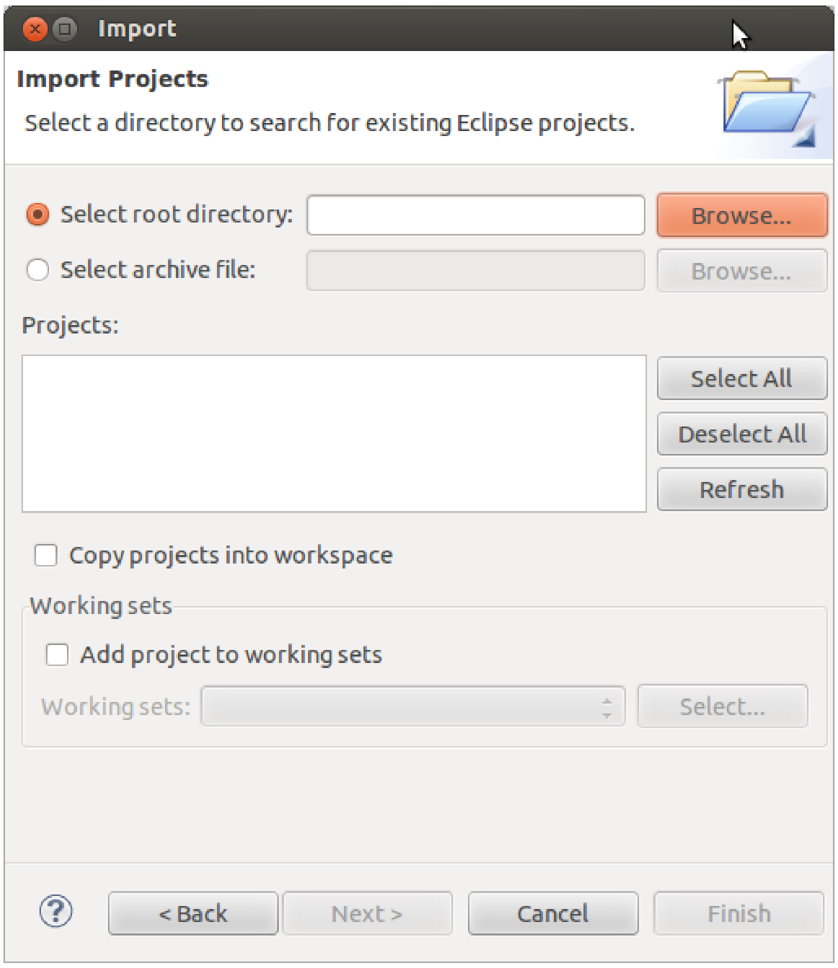
- Select *File* ▶ *Import* from the menu bar
- Select *Existing Projects into Workspace* and click *Next*



Create new projects from an archive file or directory.

Select an import source:

- Select *Browse*


Import

Import Projects

Select a directory to search for existing Eclipse projects.

(●) Select root directory: [   ] Browse...
( ) Select archive file: [   ] Browse...

Projects:

Select All / Deselect All / Refresh

[ ] Copy projects into workspace

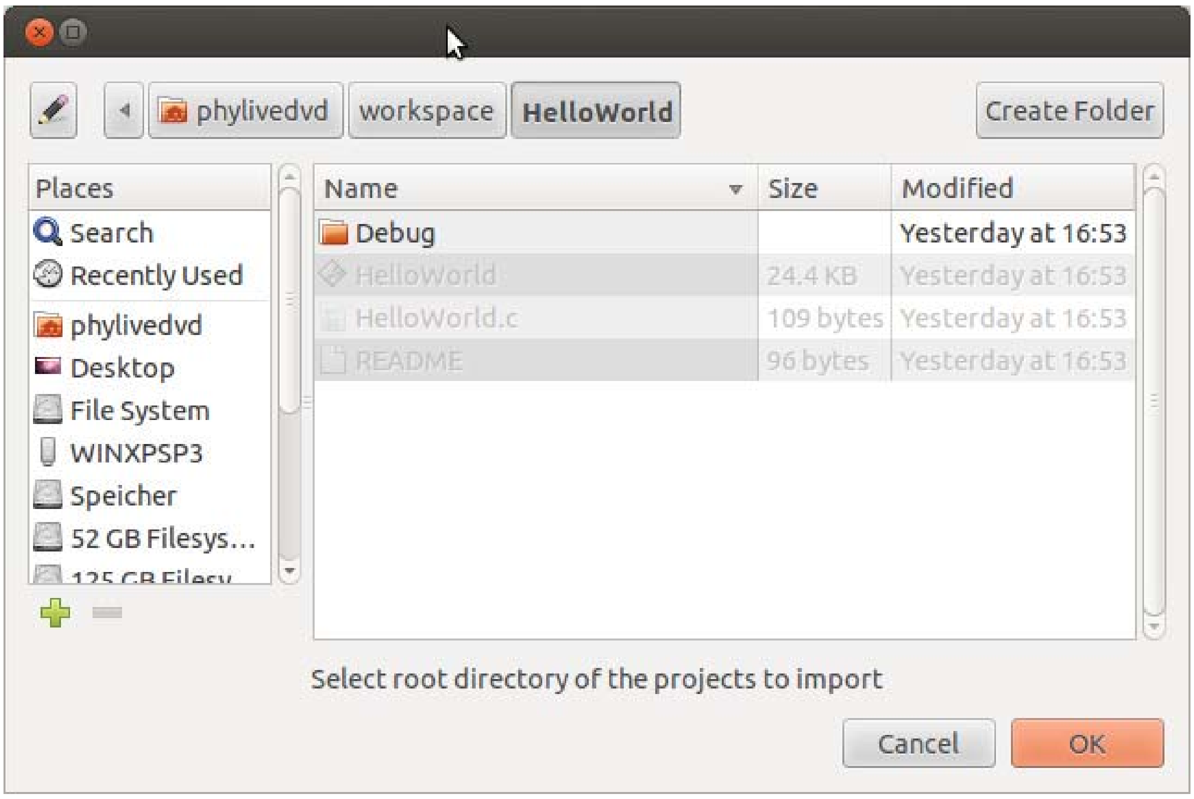
Working sets

[ ] Add project to working sets

Working sets: Select...

< Back / Next > / Cancel / Finish

- Double-click the *HelloWorld* directory under */home/phylivedvd/workspace/*
- Click *OK*


phylivedvd / workspace / **HelloWorld** — Create Folder

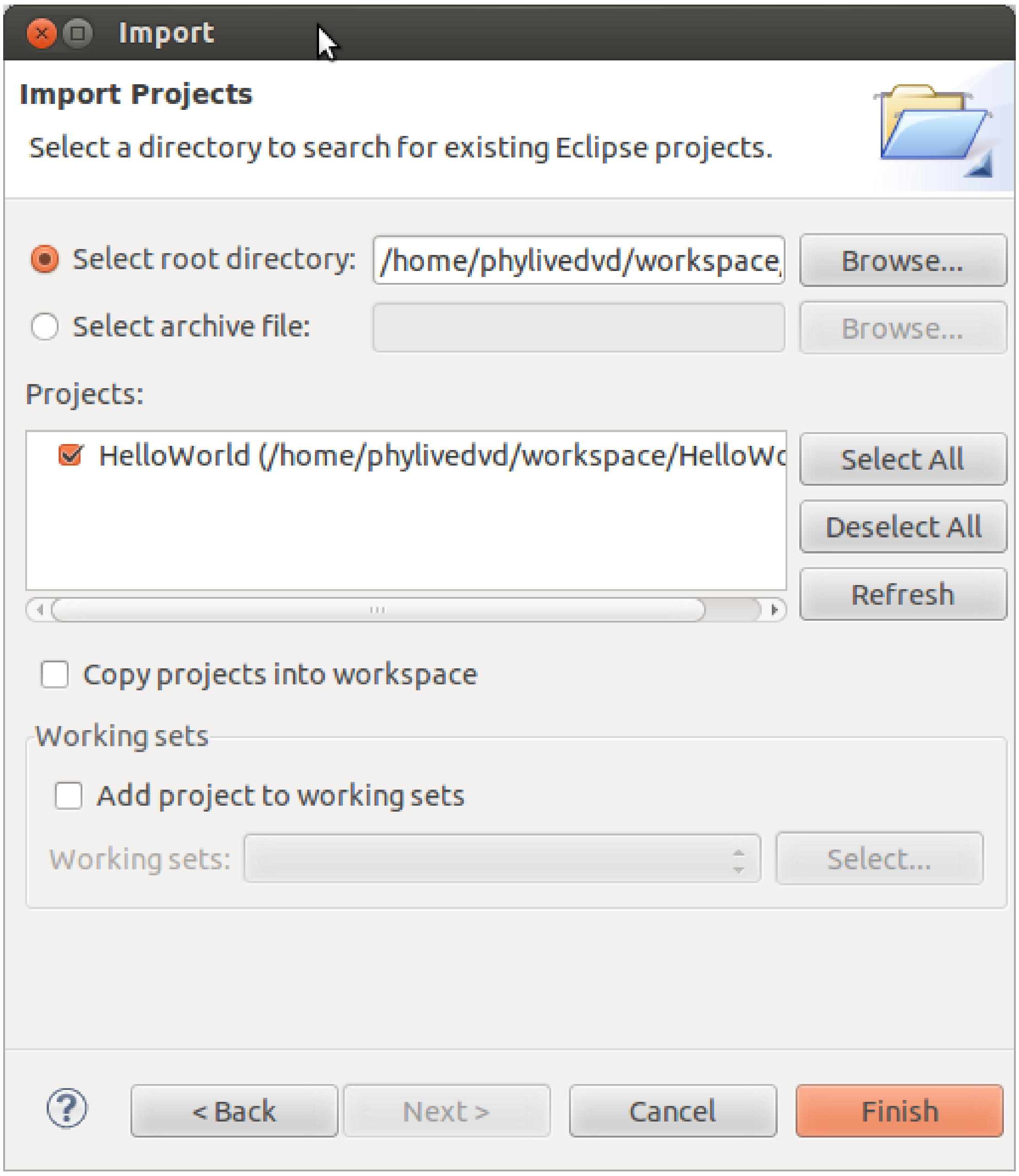
Places
Search
Recently Used
phylivedvd
Desktop
File System
WINXPSP3
Speicher
52 GB Filesys...
125 GB Filesy...

Name	Size	Modified
Debug		Yesterday at 16:53
HelloWorld	24.4 KB	Yesterday at 16:53
HelloWorld.c	109 bytes	Yesterday at 16:53
README	96 bytes	Yesterday at 16:53

Select root directory of the projects to import

Cancel / OK

- Select *Finish* to import the project


Import

Import Projects

Select a directory to search for existing Eclipse projects.

[✓ Select root directory:] /home/phylivedvd/workspace

Select archive file:

Projects:

[✓] HelloWorld (/home/phylivedvd/workspace/HelloWc

[ ] Copy projects into workspace

Working sets

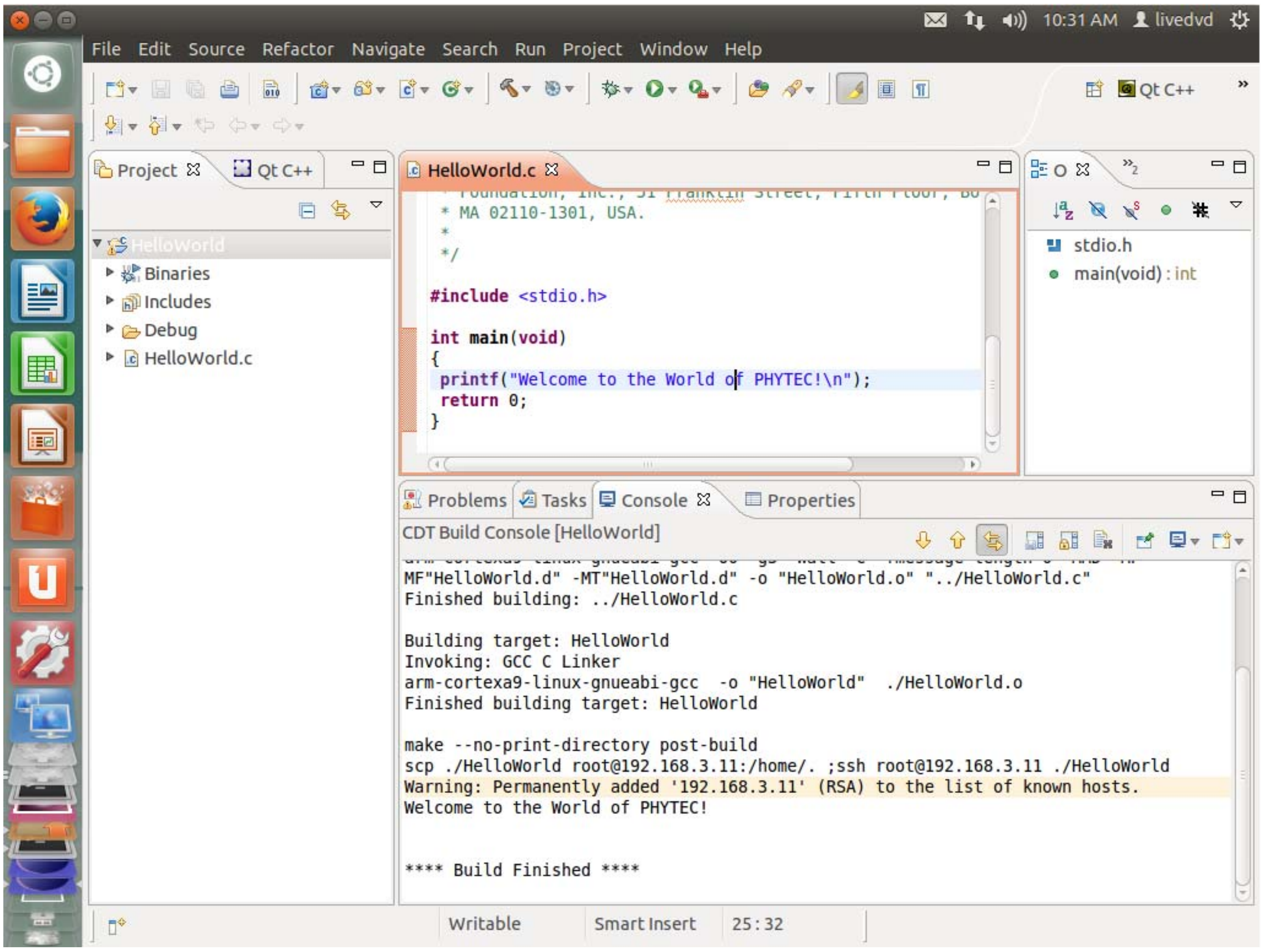
[ ] Add project to working sets

Working sets:

- Double-click the *HelloWorld.c* file on the left side in the project workspace to open it.
- Select *Project* ► *Build Project*

The *HelloWorld* program will be compiled and the *HelloWorld* executable is built for the target. Then the *HelloWorld* file is copied to the target using *secure copy*. After the file has been copied to the target, the program is executed on the target using *SSH*. Because this is our first SSH connection we must accept the fingerprint with yes.

You will see the following content in the *Console* window:



```
 * MA 02110-1301, USA.
 *
 */

#include <stdio.h>

int main(void)
{
 printf("Welcome to the World of PHYTEC!\n");
 return 0;
}
```

```
MF"HelloWorld.d" -MT"HelloWorld.d" -o "HelloWorld.o" "../HelloWorld.c"
Finished building: ../HelloWorld.c

Building target: HelloWorld
Invoking: GCC C Linker
arm-cortexa9-linux-gnueabi-gcc  -o "HelloWorld"  ./HelloWorld.o
Finished building target: HelloWorld

make --no-print-directory post-build
scp ./HelloWorld root@192.168.3.11:/home/. ;ssh root@192.168.3.11 ./HelloWorld
Warning: Permanently added '192.168.3.11' (RSA) to the list of known hosts.
Welcome to the World of PHYTEC!


**** Build Finished ****
```

	You have successfully passed the first steps with the Eclipse IDE. You are now able to import existing projects into the Eclipse workspace. You can compile an existing project and execute the program on the target.

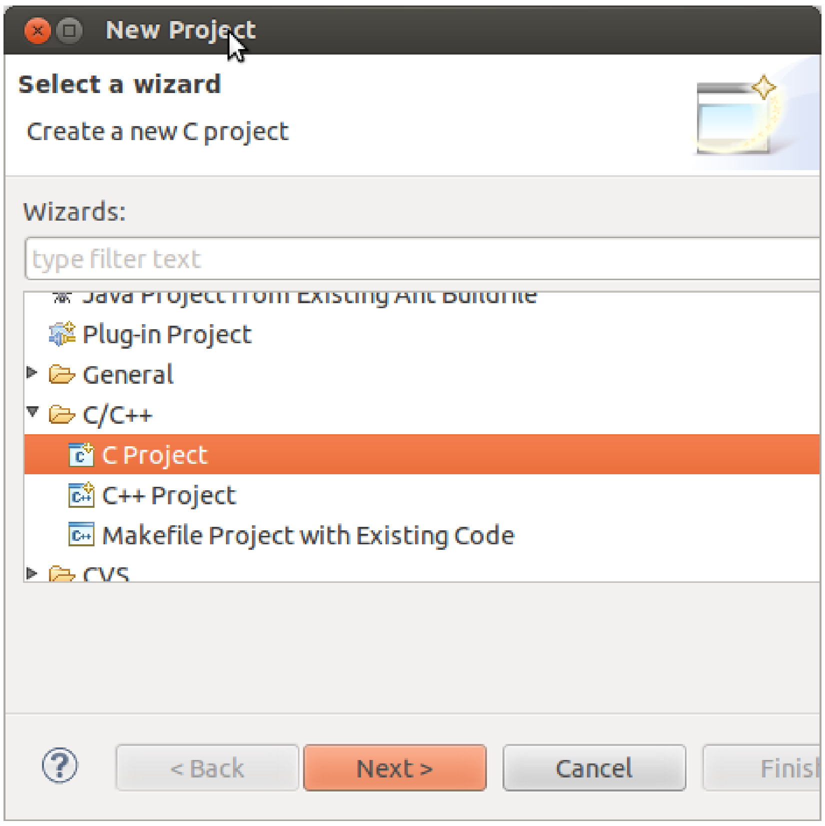
2.2.1.2 Creating a New Project

In this section you will learn how to create a new project with Eclipse and how to configure the project for use with the GNU C/C++ cross development toolchain.

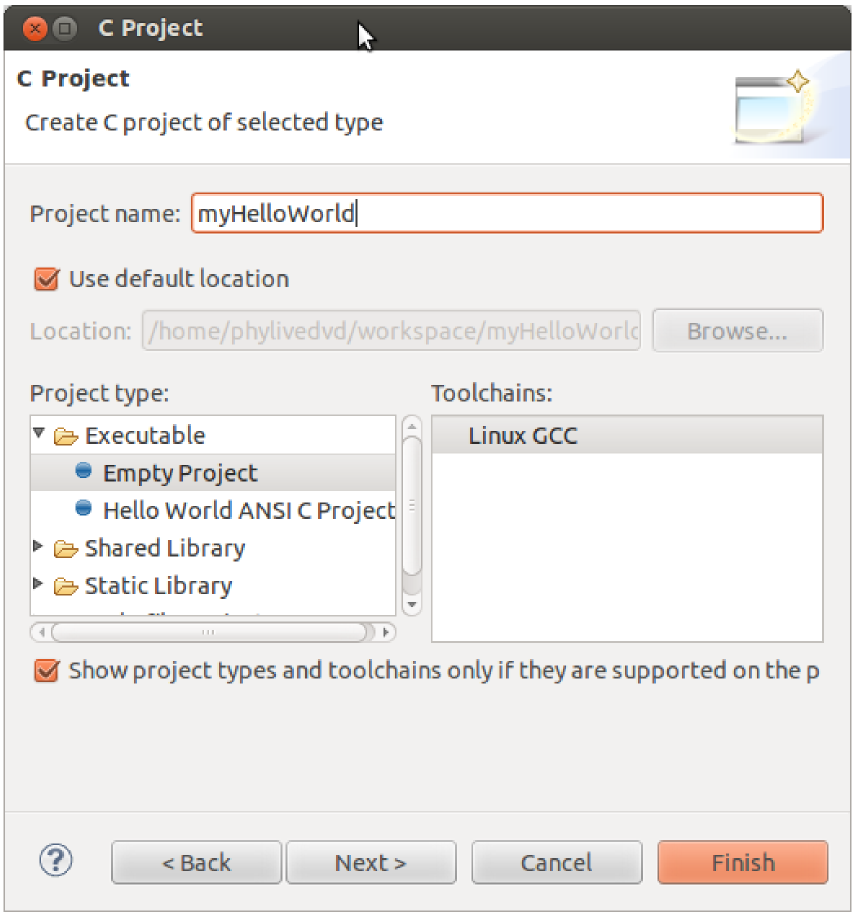
- Open Eclipse if it isn't already opened
- Select *File* ▶ *New* ▶ *Project* from the menu bar.

A new dialog opens

- Select *C Project* under *C/C++* and click *Next*



- Enter the project name *myHelloWorld* and click *Next*



C Project

C Project

Create C project of selected type

Project name: myHelloWorld

☑ Use default location

Location: /home/phylivedvd/workspace/myHelloWorlc

Project type:

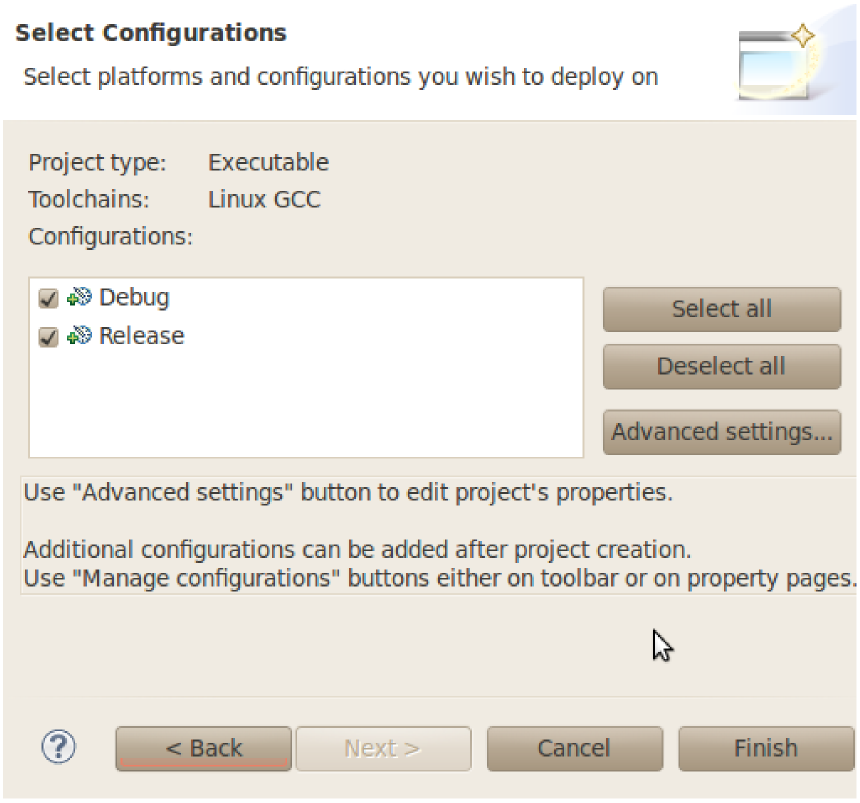
- Executable
  - Empty Project
  - Hello World ANSI C Project
- Shared Library
- Static Library

Toolchains:

- Linux GCC

☑ Show project types and toolchains only if they are supported on the p

- Click *Finish*



Select Configurations

Select platforms and configurations you wish to deploy on

Project type:	Executable
Toolchains:	Linux GCC
Configurations:	

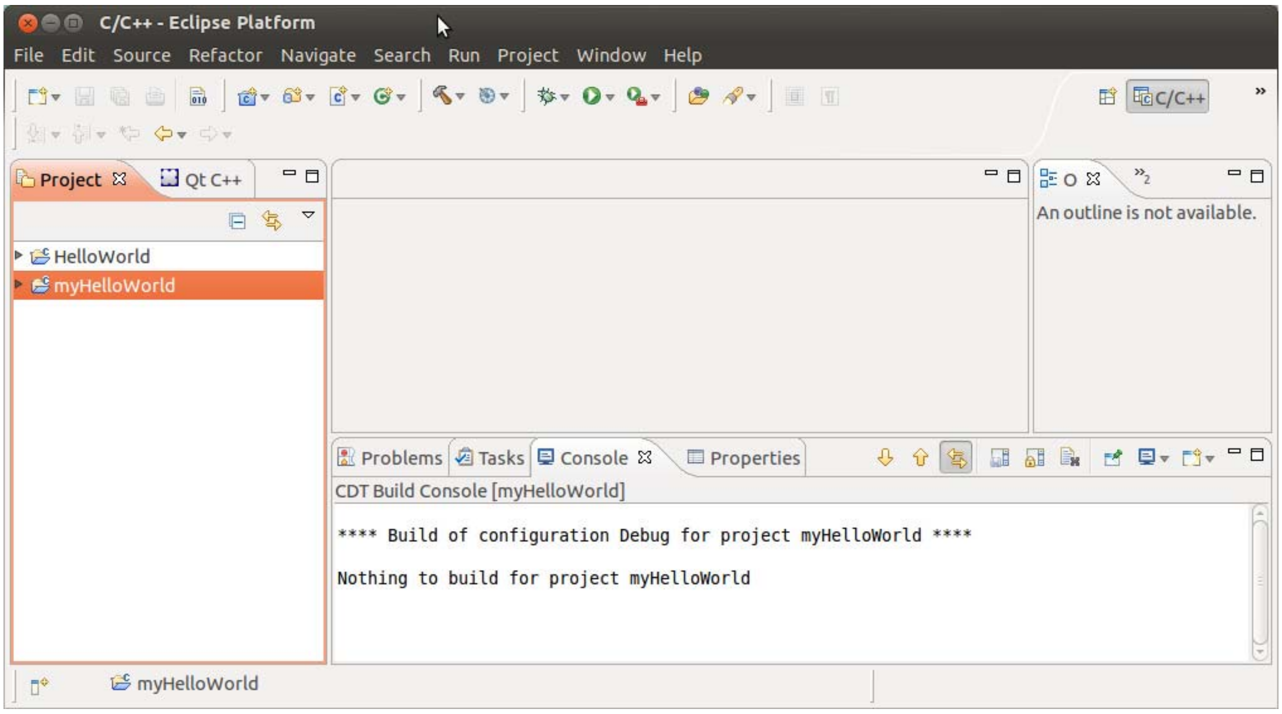
☑ Debug
☑ Release

Use "Advanced settings" button to edit project's properties.

Additional configurations can be added after project creation.
Use "Manage configurations" buttons either on toolbar or on property pages.

You will see the C/C++ IDE with the *myHelloWorld* project.

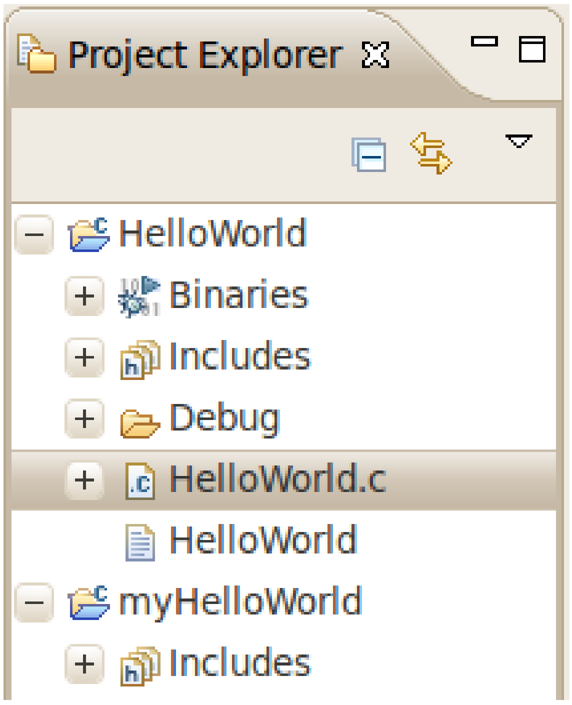
- Double-Click the *HelloWorld* project which we have worked with previously



CDT Build Console [myHelloWorld]

```
**** Build of configuration Debug for project myHelloWorld ****

Nothing to build for project myHelloWorld
```

- Right-click on *HelloWorld.c* in the *HelloWorld* project
- Select *Copy*



- Select the *myHelloWorld* project
- Right-click the *myHelloWorld* project
- Select *Paste*
- Double-click on *HelloWorld.c* in the *myHelloWorld* project

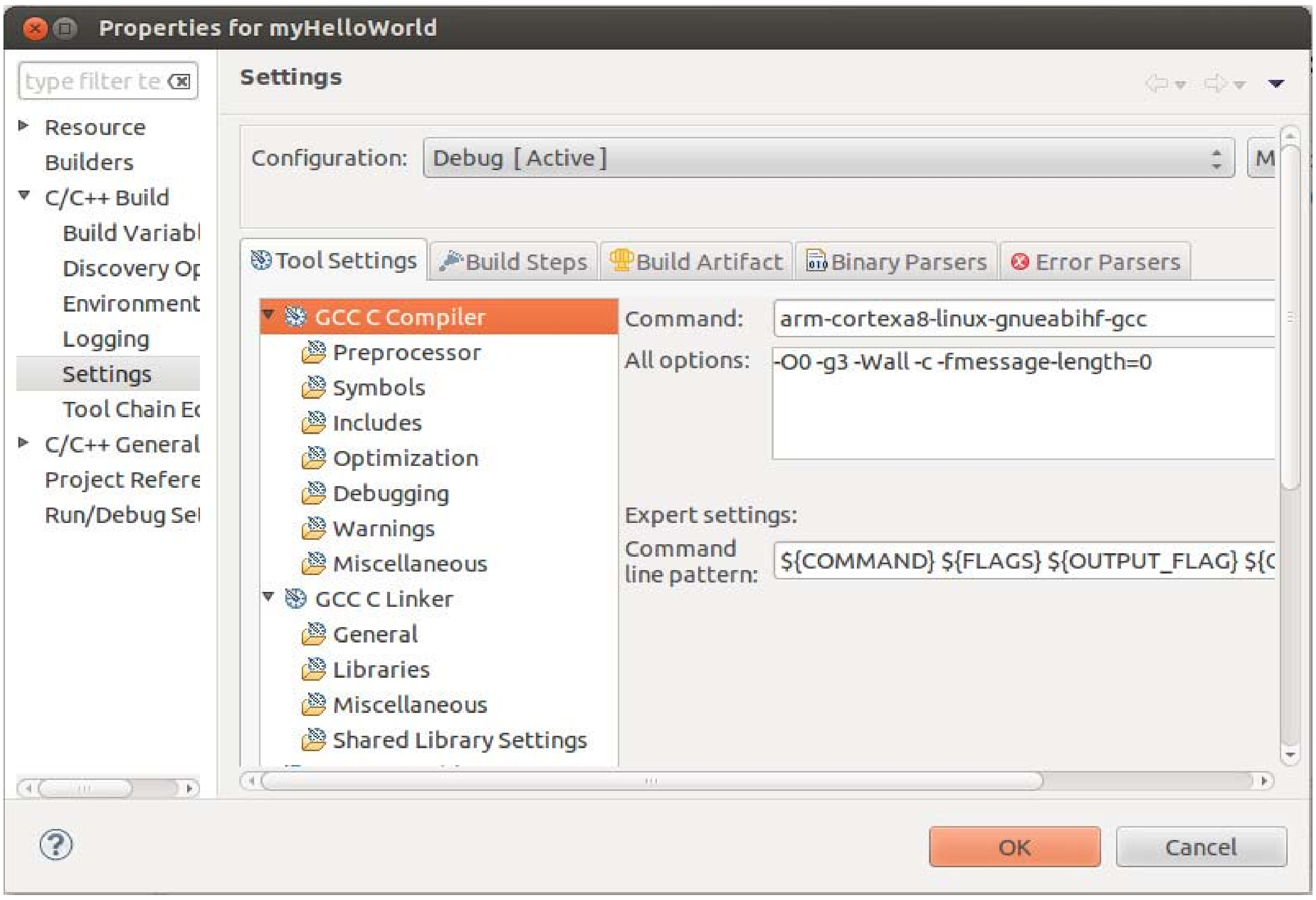
If *Build Automatically* from the *Project* menu is selected, the *HelloWorld* application will now be compiled and created with the standard GCC C/C++ compiler suitable for your host machine. You will find the executable file, which can only run on your host system, in the *workspace/myHelloWorld/Debug* directory.

To compile your project for the phyBOARD-Subra-i.MX6 instead, you will have to use the GNU C/C++ cross compiler.

- Right-click the *myHelloWorld* project and choose *Properties*

The *Properties* dialog appears.

- Select *Settings* under *C/C++ Build*
- Enter **arm-cortexa9-linux-gnueabi-gcc** into the *Command* input field
-



Configuration: Debug [Active]

Command: arm-cortexa8-linux-gnueabihf-gcc

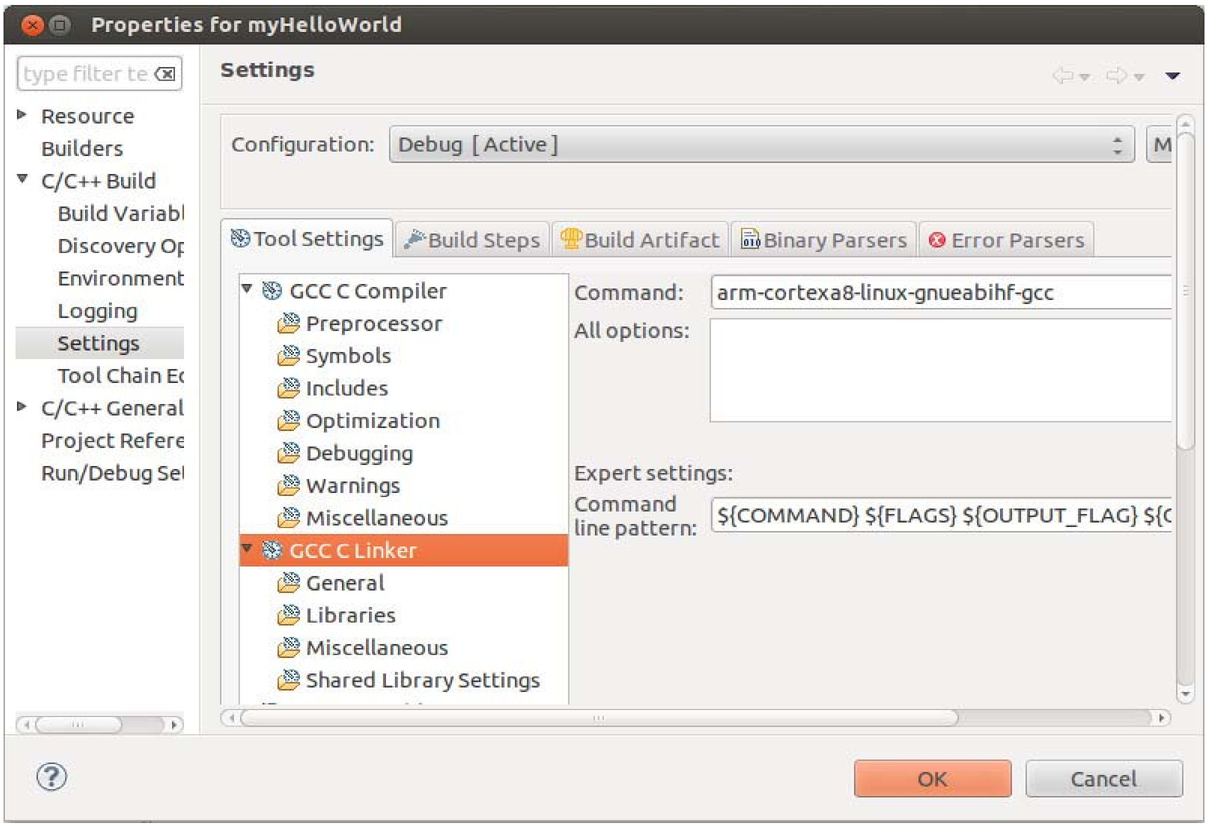
All options: -O0 -g3 -Wall -c -fmessage-length=0

Expert settings:

Command line pattern: ${COMMAND} ${FLAGS} ${OUTPUT_FLAG} ${C

Select *GCC C Linker*

- Enter **arm-cortexa9-linux-gnueabi-gcc** into the *Command* input field



Configuration: Debug [Active]

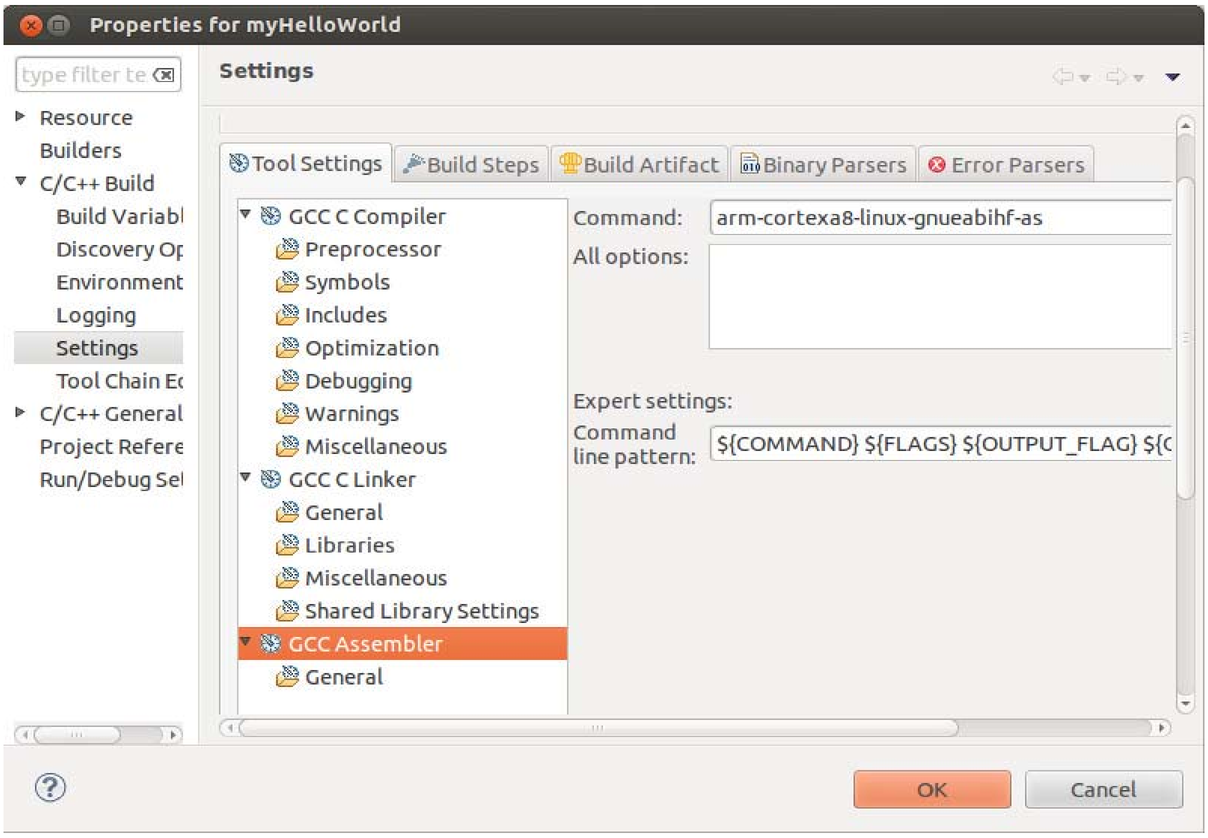
Command: arm-cortexa8-linux-gnueabihf-gcc

All options:

Expert settings:

Command line pattern: ${COMMAND} ${FLAGS} ${OUTPUT_FLAG} ${(

- Select *GCC Assembler*
- In the *Command* input field, change the default **..as** to **arm-cortexa9-linux-gnueabi-as**



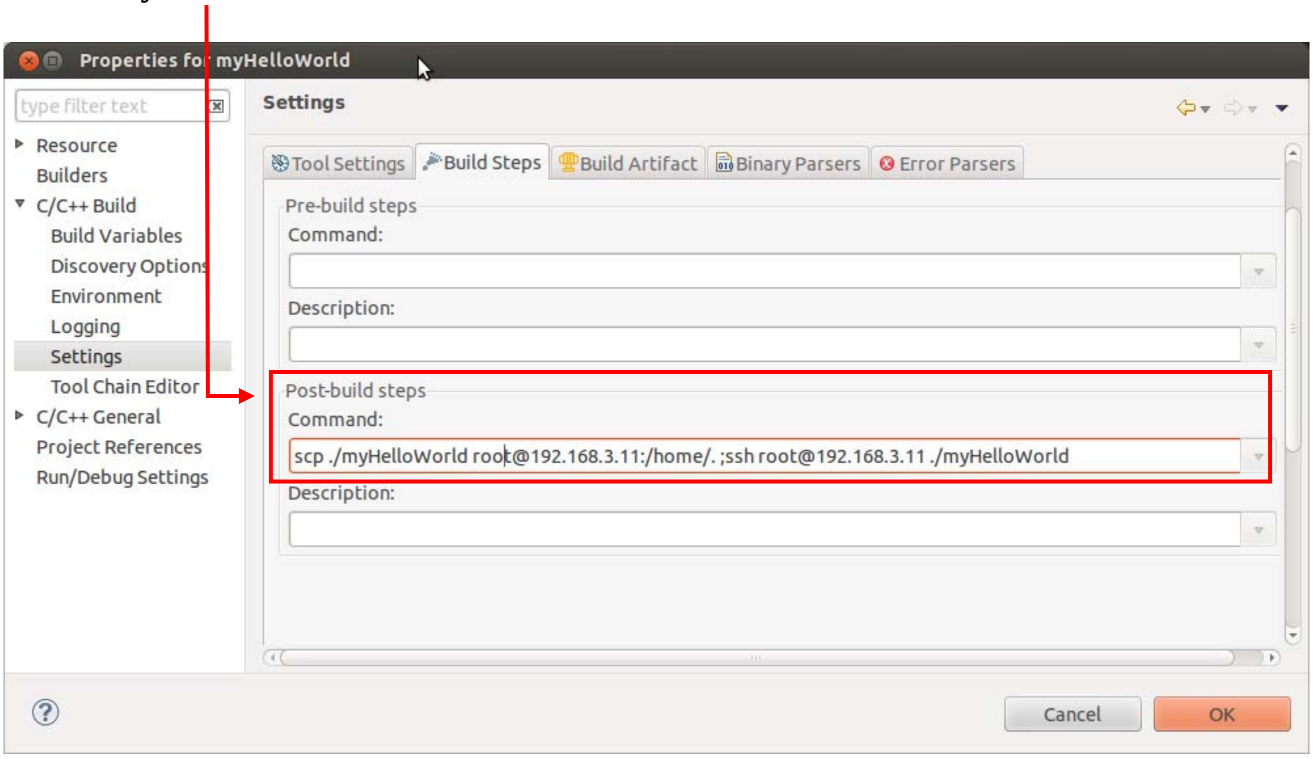
Command: arm-cortexa8-linux-gnueabihf-as

All options:

Expert settings:

Command line pattern: ${COMMAND} ${FLAGS} ${OUTPUT_FLAG} ${(

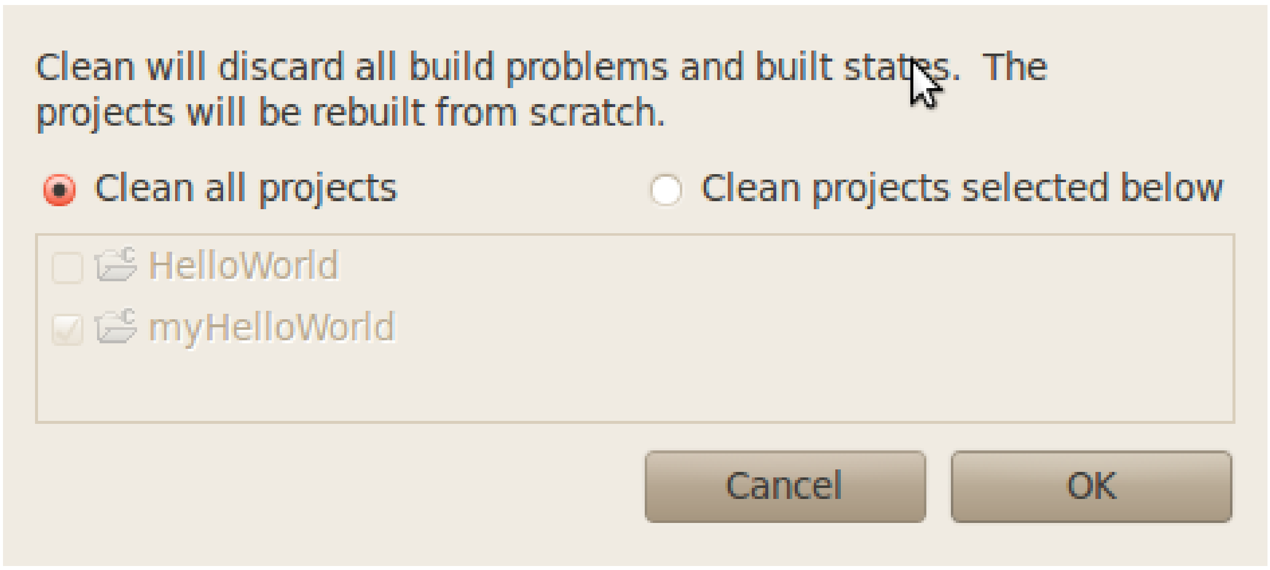
- Click *Apply*
- Select the *Build Steps* tab
- Enter the following command in the Post-build steps *Command* input field:
  scp ./myHelloWorld root@192.168.3.11:/home/. ;ssh root@192.168.3.11 ./ myHelloWorld



Pre-build steps
Command:
Description:
Post-build steps
Command: scp ./myHelloWorld root@192.168.3.11:/home/. ;ssh root@192.168.3.11 ./myHelloWorld
Description:

	Be sure to enter the **semicolon** before the ssh command. Ensure that the file *myHelloWorld* on the target will have execution rights, because otherwise *ssh* will fail.

- Click *Apply*
- Click *OK*
- Select *Project* ► *Clean* from the menu bar



Clean will discard all build problems and built states. The projects will be rebuilt from scratch.

[● Clean all projects] ○ Clean projects selected below

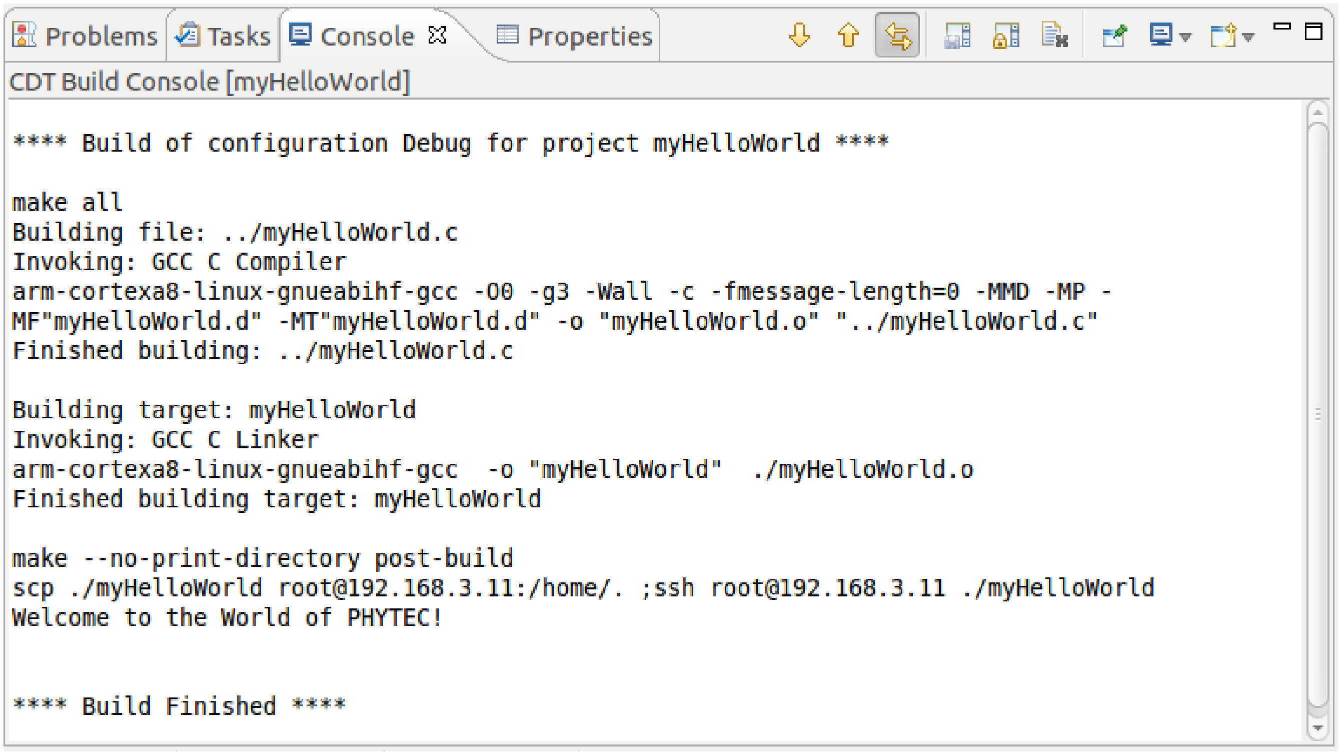
☐ HelloWorld
☑ myHelloWorld

- Confirm with *OK*

The project will be rebuilt.

- Select the *Console* tab

If no errors occur while building the project, you will see the following output:



```
**** Build of configuration Debug for project myHelloWorld ****

make all
Building file: ../myHelloWorld.c
Invoking: GCC C Compiler
arm-cortexa8-linux-gnueabihf-gcc -O0 -g3 -Wall -c -fmessage-length=0 -MMD -MP -
MF"myHelloWorld.d" -MT"myHelloWorld.d" -o "myHelloWorld.o" "../myHelloWorld.c"
Finished building: ../myHelloWorld.c

Building target: myHelloWorld
Invoking: GCC C Linker
arm-cortexa8-linux-gnueabihf-gcc  -o "myHelloWorld"  ./myHelloWorld.o
Finished building target: myHelloWorld

make --no-print-directory post-build
scp ./myHelloWorld root@192.168.3.11:/home/. ;ssh root@192.168.3.11 ./myHelloWorld
Welcome to the World of PHYTEC!


**** Build Finished ****
```

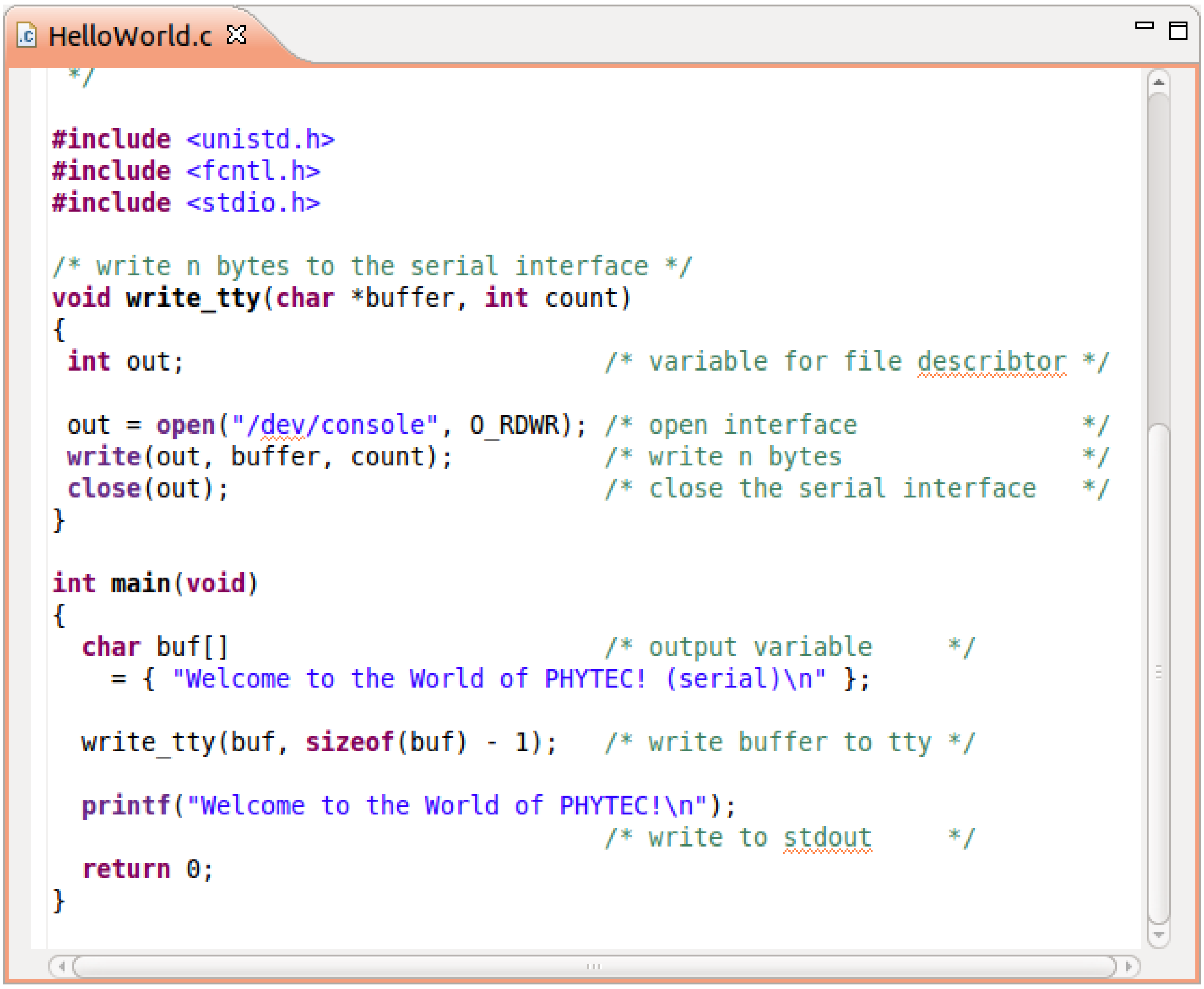
	You have successfully created your first own project with the Eclipse IDE. You have configured the project to create an application for your target platform.

2.2.1.3 Modifying the Demo Application

Now we will extend the *myHelloWorld* application. The extended *myHelloWorld* application will write an output to the first serial interface as well as to the standard output.

- Open Eclipse if it is not opened yet
- Double-click *HelloWorld.c* in the *myHelloWorld* project
- First include the following two additional header files:
  #include <unistd.h>
  #include <fcntl.h>
- Then add the function *write_tty()*, which writes *n* bytes to the first serial interface (which, on the phyBOARD-Subra-i.MX 6, is connected to the system console */dev/console*):
  ```
  void write_tty (char *buffer, int count) {
  int out
  out = open ("/dev/console", O_RDWR)
  write(out, buffer, count)
  close(out)
  }
  ```
- Enter the following two lines in the *main()* function to declare the buffer and call the *write_tty()* function:
  ```
  char buf [] = { "Welcome to the World of PHYTEC! (serial)\n" }
  write_tty(buf, sizeof (buf) - 1);
  ```

In the next screenshot you can see the complete program



```c
 */

#include <unistd.h>
#include <fcntl.h>
#include <stdio.h>

/* write n bytes to the serial interface */
void write_tty(char *buffer, int count)
{
 int out;                              /* variable for file describtor */

 out = open("/dev/console", O_RDWR); /* open interface              */
 write(out, buffer, count);          /* write n bytes               */
 close(out);                         /* close the serial interface  */
}

int main(void)
{
  char buf[]                           /* output variable     */
    = { "Welcome to the World of PHYTEC! (serial)\n" };

  write_tty(buf, sizeof(buf) - 1);     /* write buffer to tty */

  printf("Welcome to the World of PHYTEC!\n");
                                       /* write to stdout     */
  return 0;
}
```

- Save your program after changing the code

The application will be compiled, built, copied to the target and executed.

- Click the *Microcom* icon on the desktop

- If you are not logged in, enter **root** and press *Enter*
- Type *./myHelloWorld* to start the application
- You will see the following output:
  Welcome to the World of PHYTEC! (serial)
  Welcome to the World of PHYTEC!
- Close Microcom

When you start the application via an SSH session, you only see one output line. When you execute the program with Microcom, you see **both** output lines.

The first line is a direct output on the serial interface. You can not see this line in a SSH session, because you are connected over a TCP/IP connection to the target. With Microcom, however, you have direct access to the serial interface, so you can also see the line that is written to the serial console.

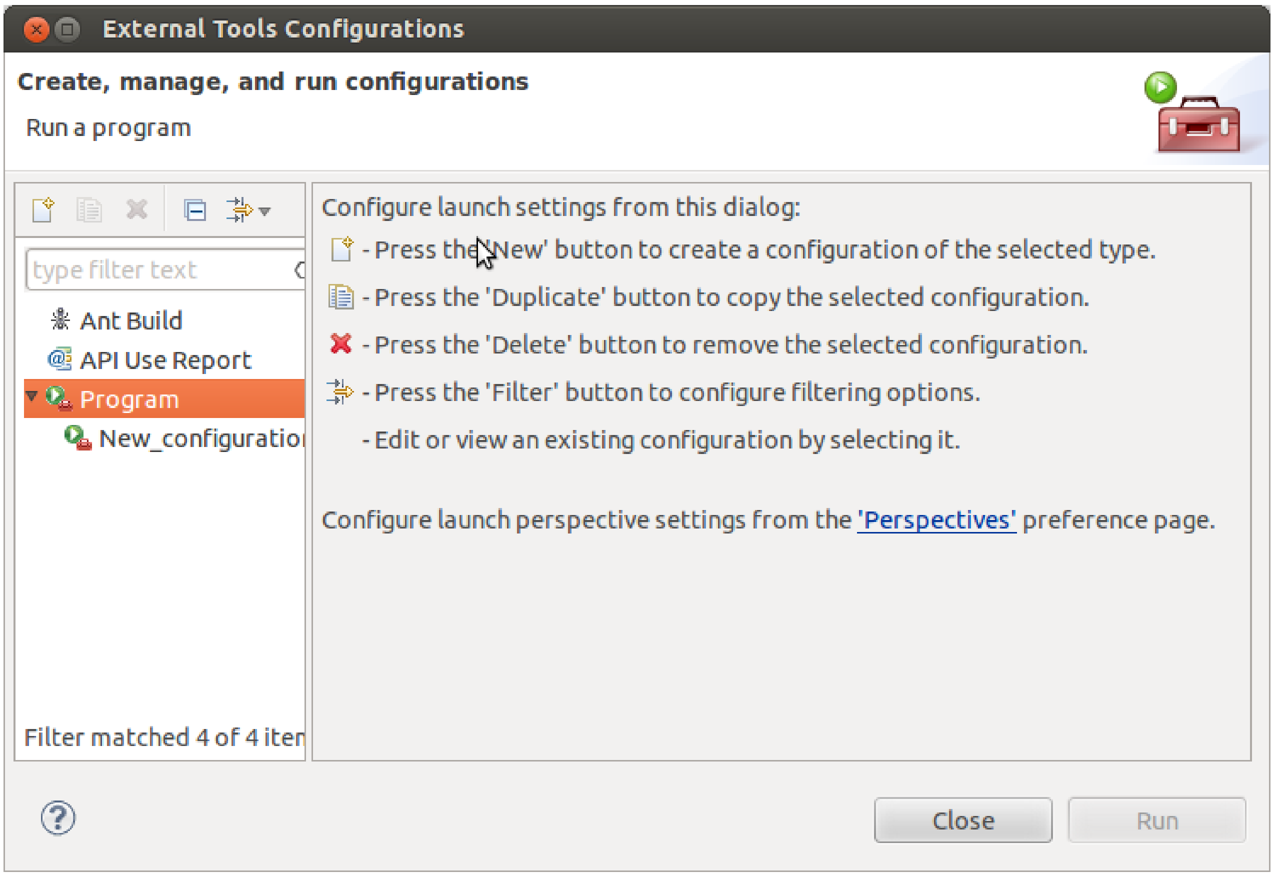
In this section you have changed an existing application. You also learned how to access the serial interface. First you called the function *open()* on the device */dev/console*. The return value of this function was a file descriptor. With the file descriptor you called the function *write()* to send *n* bytes to the device */dev/console*. After that, the file descriptor was closed with the function *close()*.

This procedure is in principle quite typical for Linux, because Linux treats everything like a file.

2.2.1.4 Starting a Program out of Eclipse on the Target

After compiling a project in Eclipse, the program is copied to the target and directly executed. A program can also be executed on the target without compiling a project. In the following section you will learn how to start a program on the target as an external tool.

- Select *Run* ► *External Tools* ► *External Tools Configurations* from the menu bar



External Tools Configurations

Create, manage, and run configurations

Run a program

type filter text

Ant Build
API Use Report
Program
New_configuratio

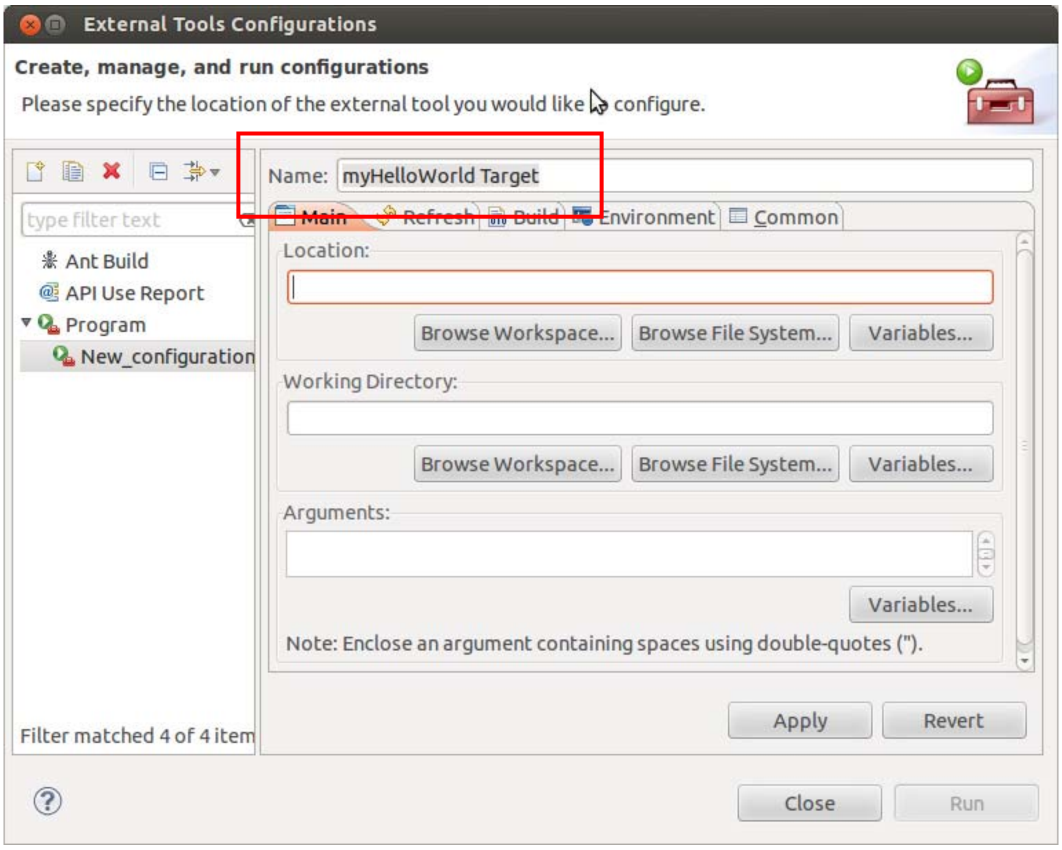
Filter matched 4 of 4 iter

Configure launch settings from this dialog:
- Press the 'New' button to create a configuration of the selected type.
- Press the 'Duplicate' button to copy the selected configuration.
- Press the 'Delete' button to remove the selected configuration.
- Press the 'Filter' button to configure filtering options.
- Edit or view an existing configuration by selecting it.

Configure launch perspective settings from the 'Perspectives' preference page.

- Under *Program* select *New_configuration (1)*

- In the *Name* input field, enter: **myHelloWorld Target**



External Tools Configurations

Create, manage, and run configurations

Please specify the location of the external tool you would like to configure.

Name: myHelloWorld Target

Location:

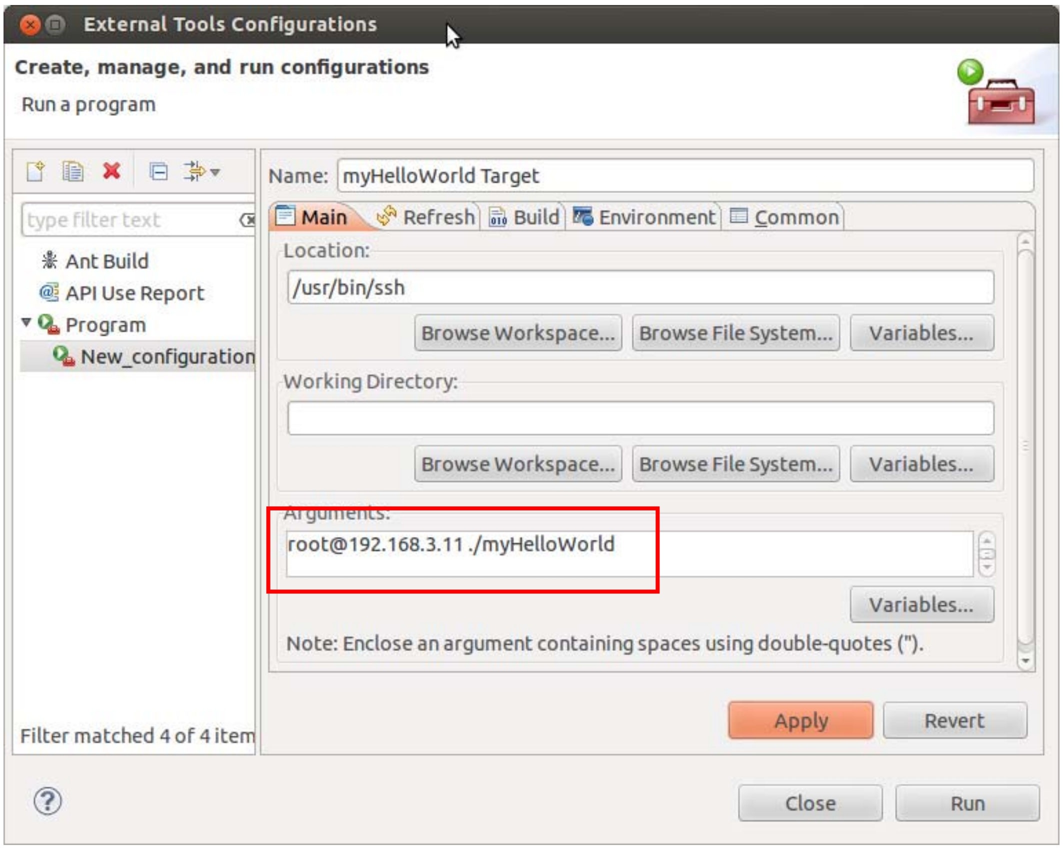
Working Directory:

Arguments:

Note: Enclose an argument containing spaces using double-quotes (").

Filter matched 4 of 4 item

- Enter **/usr/bin/ssh** in the *Location* input field
- Enter **root@192.168.3.11 ./myHelloWorld** into the *Arguments* field



External Tools Configurations

Create, manage, and run configurations

Run a program

Name: myHelloWorld Target

Location: /usr/bin/ssh

Working Directory:

Arguments: root@192.168.3.11 ./myHelloWorld

Note: Enclose an argument containing spaces using double-quotes (").

Filter matched 4 of 4 item

- Select *Apply*

- Select *Run*

If you want to execute the program the next time, you can use the *Run External Programs* button from the menu bar.

You have successfully created your own Eclipse project and you learned how to execute a program on the target.

2.2.2 Debugging an Example Project

In this chapter you will learn using the GNU debugger GDB on the host for remote debugging in conjunction with the GDB server on the target. GDB is the symbolic debugger of the GNU project and is arguably the most important debugging tool for any Linux system.

First you will start the GDB server on the target. Then you will configure the Eclipse platform and start the GNU debugger out of Eclipse using the Debug view.

The CDT extends the standard Eclipse Debug view with functions for debugging C/C++ code. The Debug view allows you to manage the debugging and running of a program in the workbench. Using the Debug view you will be able to set breakpoints/watchpoints in the code and trace variables and registers. The Debug view displays the stack frame for the threads of each target you are debugging. Each thread in your program appears as a node in the tree, and the Debug view displays the process for each target you are running.

The GDB client is running on the host and is used to control the GDB server on the target, which in turn controls the application running on the target. GDB client and GDB server can communicate over a TCP/IP network connection as well as via a serial interface. In this Application Guide we will only describe debugging via TCP/IP.

2.2.2.1 Starting the GDB server on the target

In this passage you will learn how to start the GDB server on the target. The GDB server will be used to start and control the *myHelloWorld* program.

To debug a program with GDB, the program needs extended debugging symbols. These have been already added while building the program.

- Open Microcom
- Type **root** and press **Enter**
- Start the GDB server:
  gdbserver 192.168.3.11:10000 myHelloWorld

You have started the GDB server on the target. The GDB server is now waiting for connections on TCP port 10000.

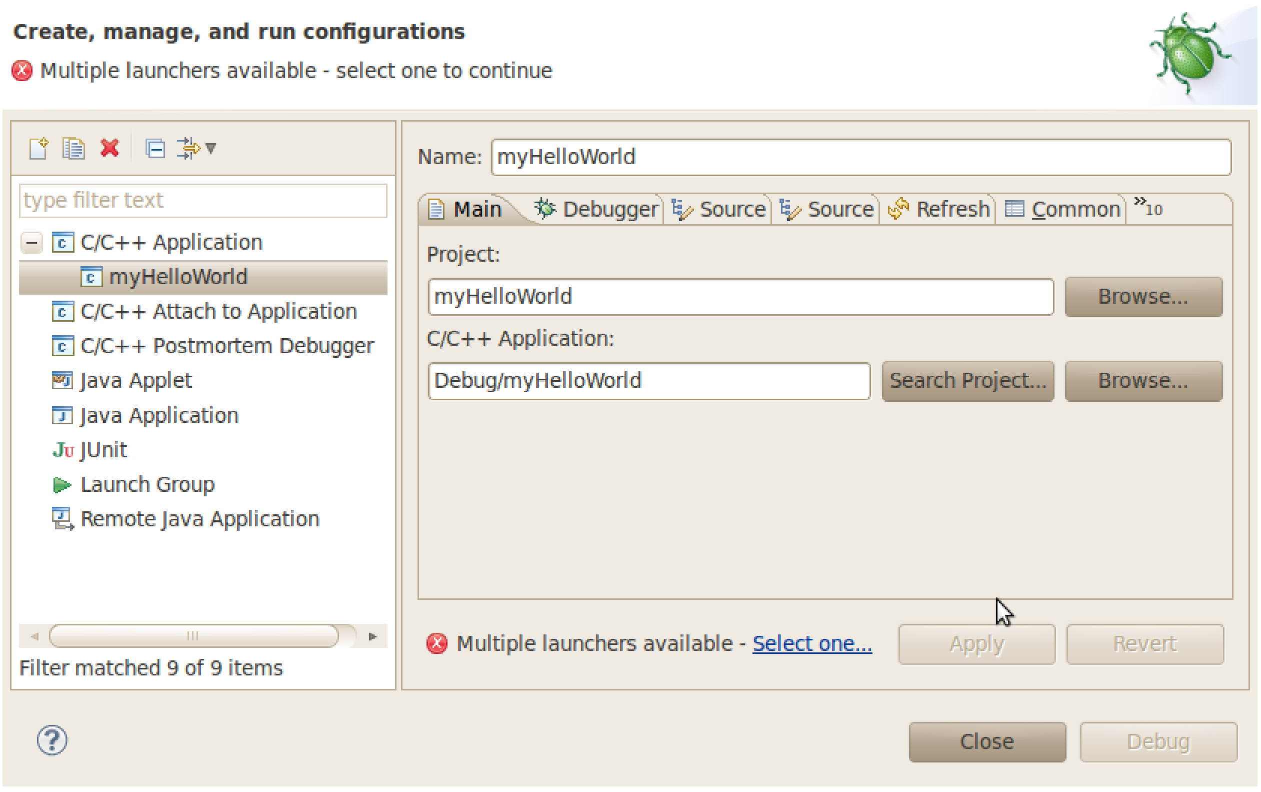
2.2.2.2 Configuring and starting the debugger in Eclipse

In this passage you will learn how to configure your project settings to use Eclipse with the GNU debugger. After the configuration of your project settings, the GNU debugger will start and connect to the GDB server on the target.

- Start Eclipse if the application is not started yet
- Right-click on the *myHelloWorld* project in the *Navigator* window
- Select *Debug As* ► *Debug Configurations*

A dialog to create, manage and run applications appears.

- Select *myHelloWorld Debug* under *C/C++ Application* (to expand it *double click* on it)



Create, manage, and run configurations

Multiple launchers available - select one to continue

type filter text

- C/C++ Application
  - myHelloWorld
- C/C++ Attach to Application
- C/C++ Postmortem Debugger
- Java Applet
- Java Application
- JUnit
- Launch Group
- Remote Java Application

Filter matched 9 of 9 items

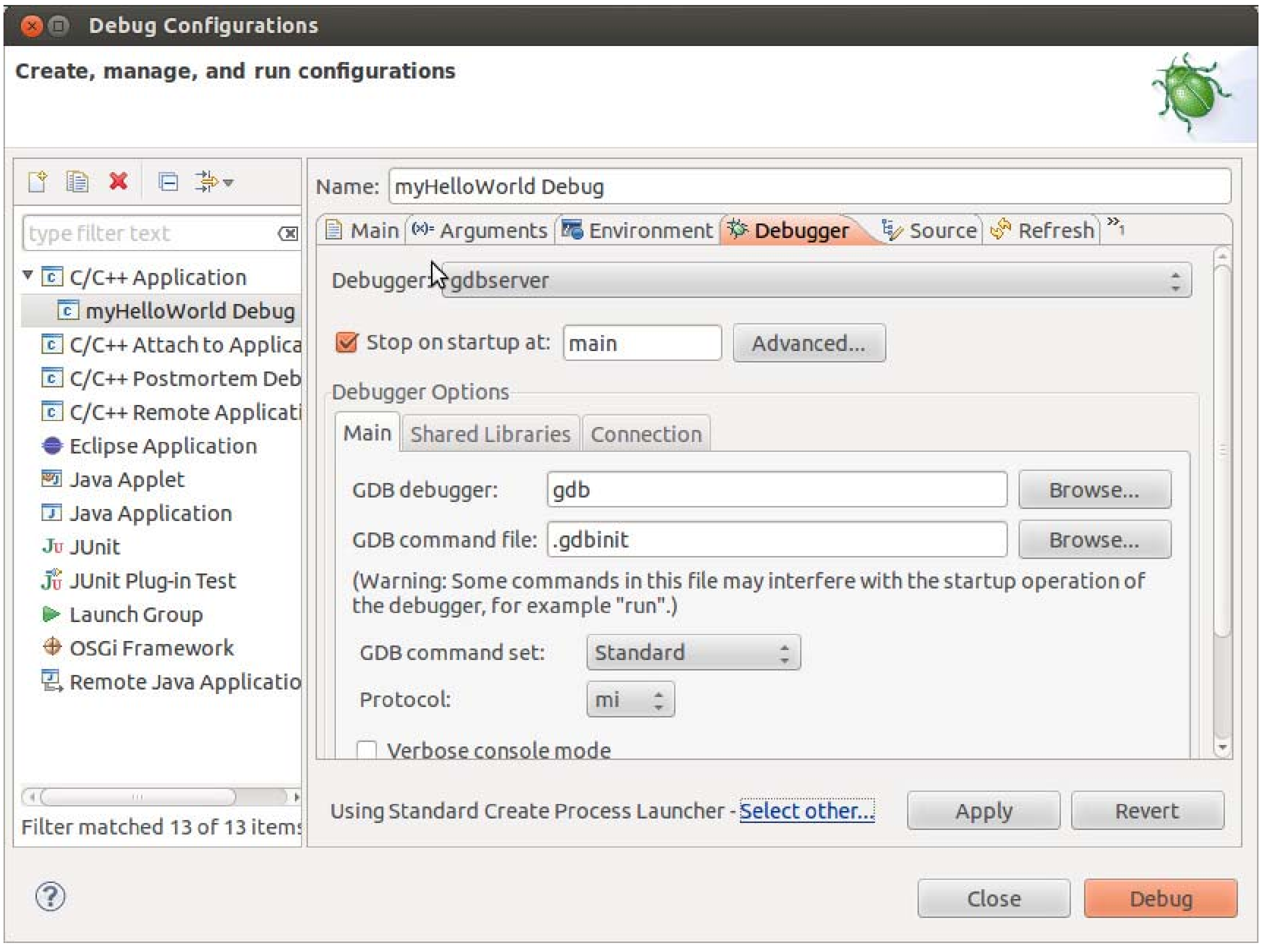
Name: myHelloWorld

Project: myHelloWorld

C/C++ Application: Debug/myHelloWorld

Multiple launchers available - Select one...

- Select the *Debugger* tab



Debug Configurations

Create, manage, and run configurations

type filter text

- C/C++ Application
  - myHelloWorld Debug
- C/C++ Attach to Applica
- C/C++ Postmortem Deb
- C/C++ Remote Applicati
- Eclipse Application
- Java Applet
- Java Application
- JUnit
- JUnit Plug-in Test
- Launch Group
- OSGi Framework
- Remote Java Applicatio

Filter matched 13 of 13 items

Name: myHelloWorld Debug

Debugger: gdbserver

☑ Stop on startup at: main

Debugger Options

GDB debugger: gdb

GDB command file: .gdbinit

(Warning: Some commands in this file may interfere with the startup operation of the debugger, for example "run".)

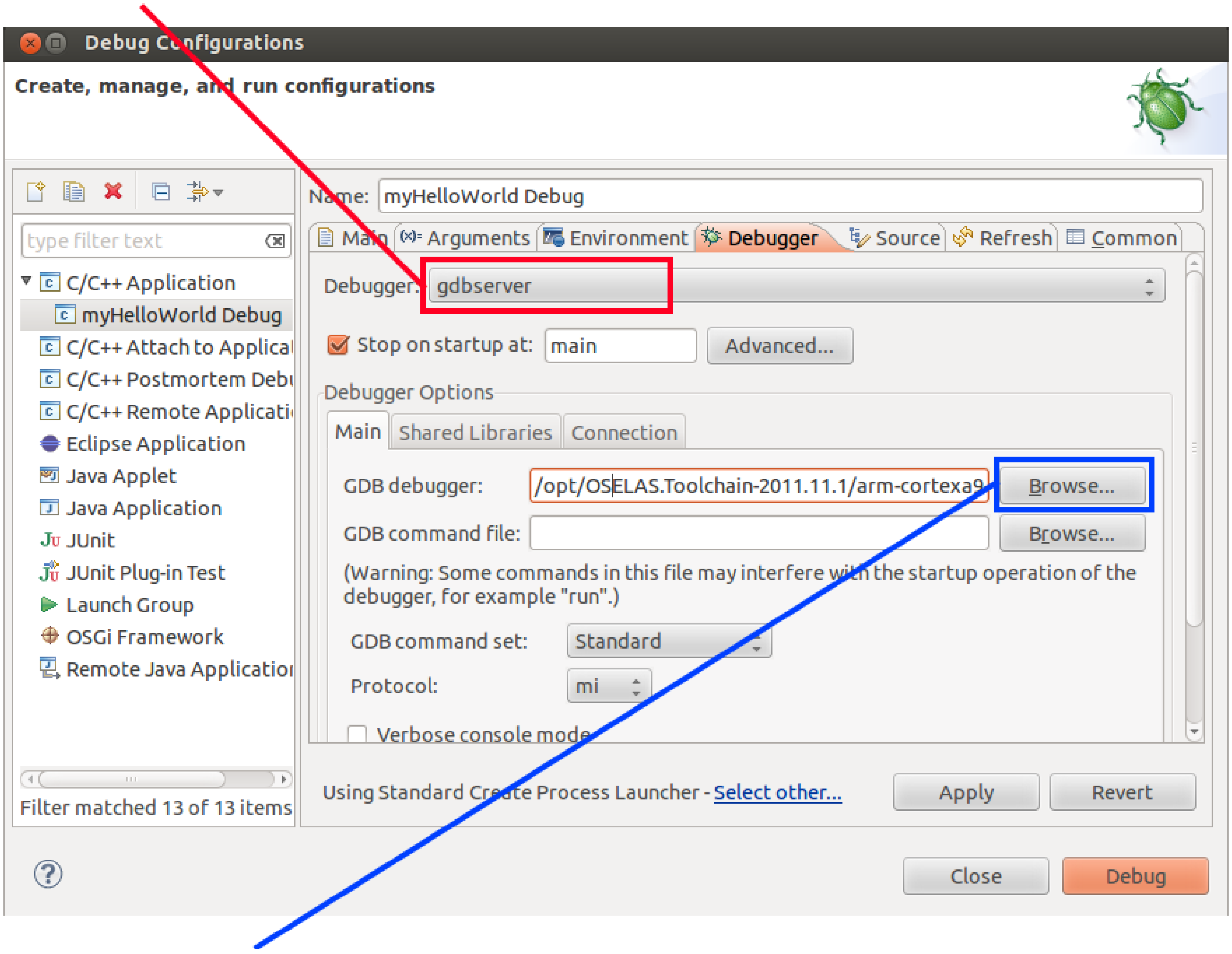
GDB command set: Standard

Protocol: mi

☐ Verbose console mode

Using Standard Create Process Launcher - Select other...

- Select *gdbserver Debugger* from the *Debugger* drop-down box


Debug Configurations

Create, manage, and run configurations

type filter text

- C/C++ Application
  - myHelloWorld Debug
- C/C++ Attach to Applica
- C/C++ Postmortem Debu
- C/C++ Remote Applicati
- Eclipse Application
- Java Applet
- Java Application
- JUnit
- JUnit Plug-in Test
- Launch Group
- OSGi Framework
- Remote Java Applicatio

Filter matched 13 of 13 items

Name: myHelloWorld Debug

Main | Arguments | Environment | Debugger | Source | Refresh | Common

Debugger: gdbserver

Stop on startup at: main

Debugger Options

Main | Shared Libraries | Connection

GDB debugger: /opt/OSELAS.Toolchain-2011.11.1/arm-cortexa9

GDB command file:

(Warning: Some commands in this file may interfere with the startup operation of the debugger, for example "run".)

GDB command set: Standard

Protocol: mi

Verbose console mode

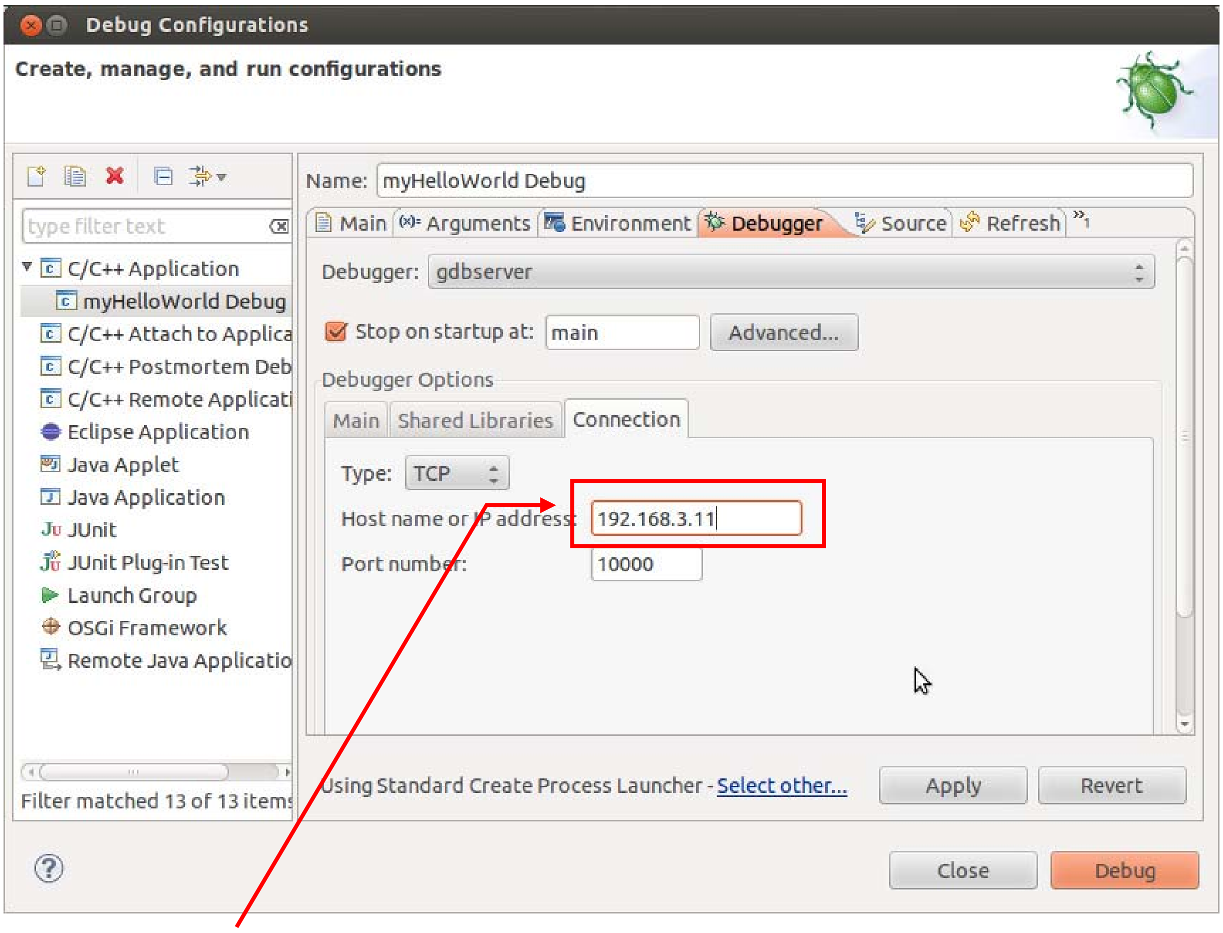
Using Standard Create Process Launcher - Select other...

- Click the *Browse* button right beside the *GDB debugger* input field

A new dialog opens to choose the GDB executable.

- Click on *File System*
- Navigate to the directory */opt/OSELAS.Toolchain*/arm-cortexa9-linux-gnueabi/ gcc-4.6.2-glibc-2.14.1-binutils-2.21.1a-kernel-2.6.39-sanitized/bin*.
- Select the file *arm-cortexa9-linux-gnueabi-gdb*.
- Click *OK*
- Keep the *GDB command file* field empty

- Select the *Connection* tab and select *TCP* in the drop-down box



Name: myHelloWorld Debug
Debugger: gdbserver
Stop on startup at: main
Type: TCP
Host name or IP address: 192.168.3.11
Port number: 10000

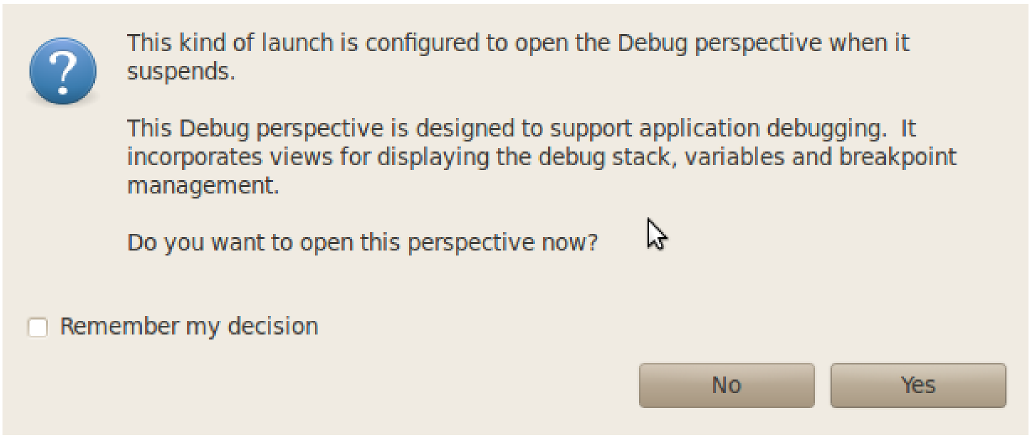
- Enter **192.168.3.11** (the target's IP address) in the *Host name* input field

The host's GDB will connect to this IP address to communicate with the target's GDB server.

- Click *Apply*
- Click *Debug*

A new dialog appears

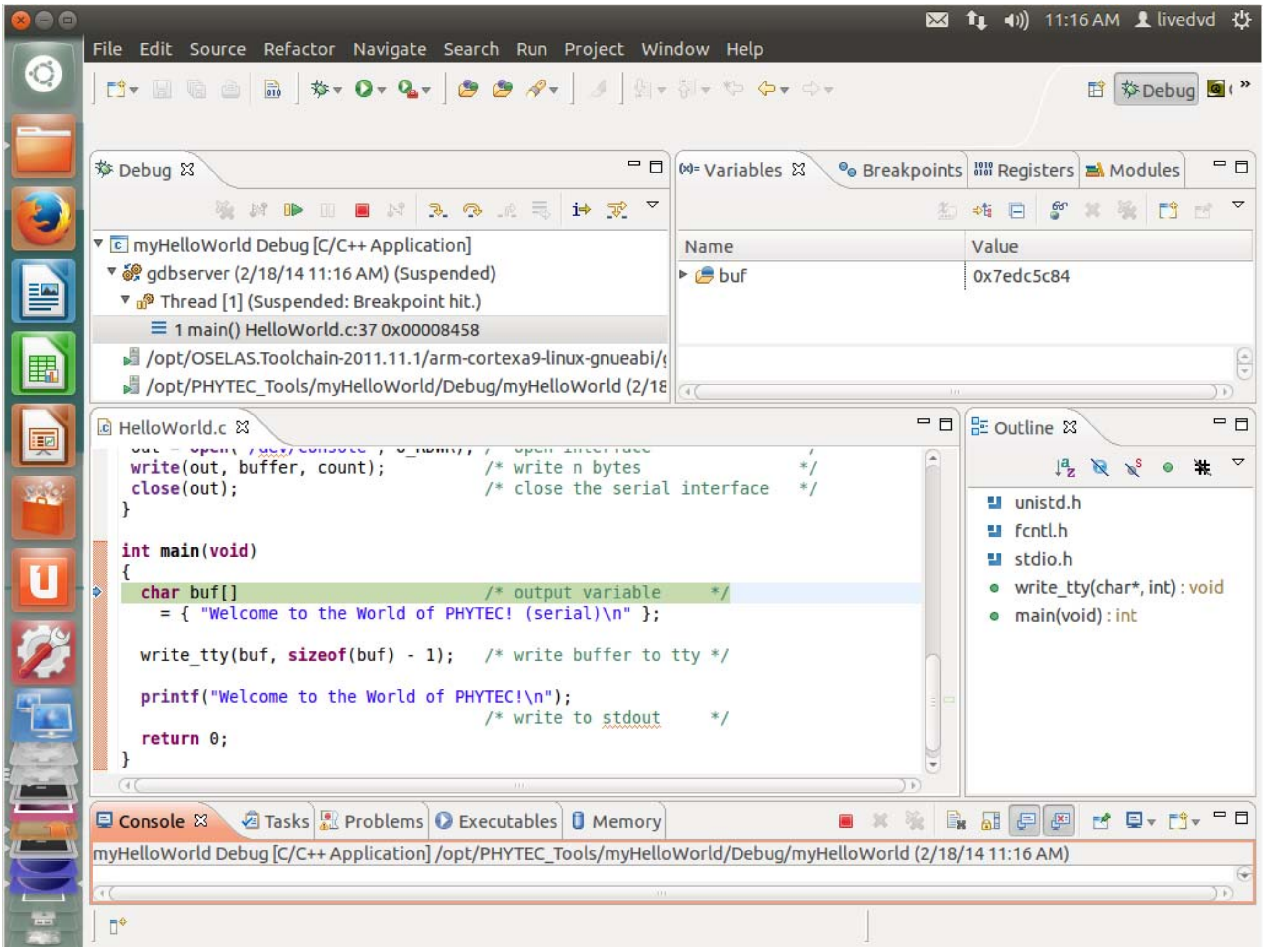
- •Select Yes to switch to the Debug perspective


This kind of launch is configured to open the Debug perspective when it suspends.

This Debug perspective is designed to support application debugging. It incorporates views for displaying the debug stack, variables and breakpoint management.

Do you want to open this perspective now?

The debug perspective opens and the debugger stops automatically at the first line. The host's GDB is now connected to the GDB server on the target.



```
myHelloWorld Debug [C/C++ Application]
  gdbserver (2/18/14 11:16 AM) (Suspended)
    Thread [1] (Suspended: Breakpoint hit.)
      1 main() HelloWorld.c:37 0x00008458
  /opt/OSELAS.Toolchain-2011.11.1/arm-cortexa9-linux-gnueabi/(
  /opt/PHYTEC_Tools/myHelloWorld/Debug/myHelloWorld (2/18
```

Name	Value
buf	0x7edc5c84

```
  write(out, buffer, count);          /* write n bytes              */
  close(out);                         /* close the serial interface */
}

int main(void)
{
  char buf[]                          /* output variable     */
    = { "Welcome to the World of PHYTEC! (serial)\n" };

  write_tty(buf, sizeof(buf) - 1);    /* write buffer to tty */

  printf("Welcome to the World of PHYTEC!\n");
                                      /* write to stdout     */
  return 0;
}
```

```
unistd.h
fcntl.h
stdio.h
write_tty(char*, int) : void
main(void) : int
```

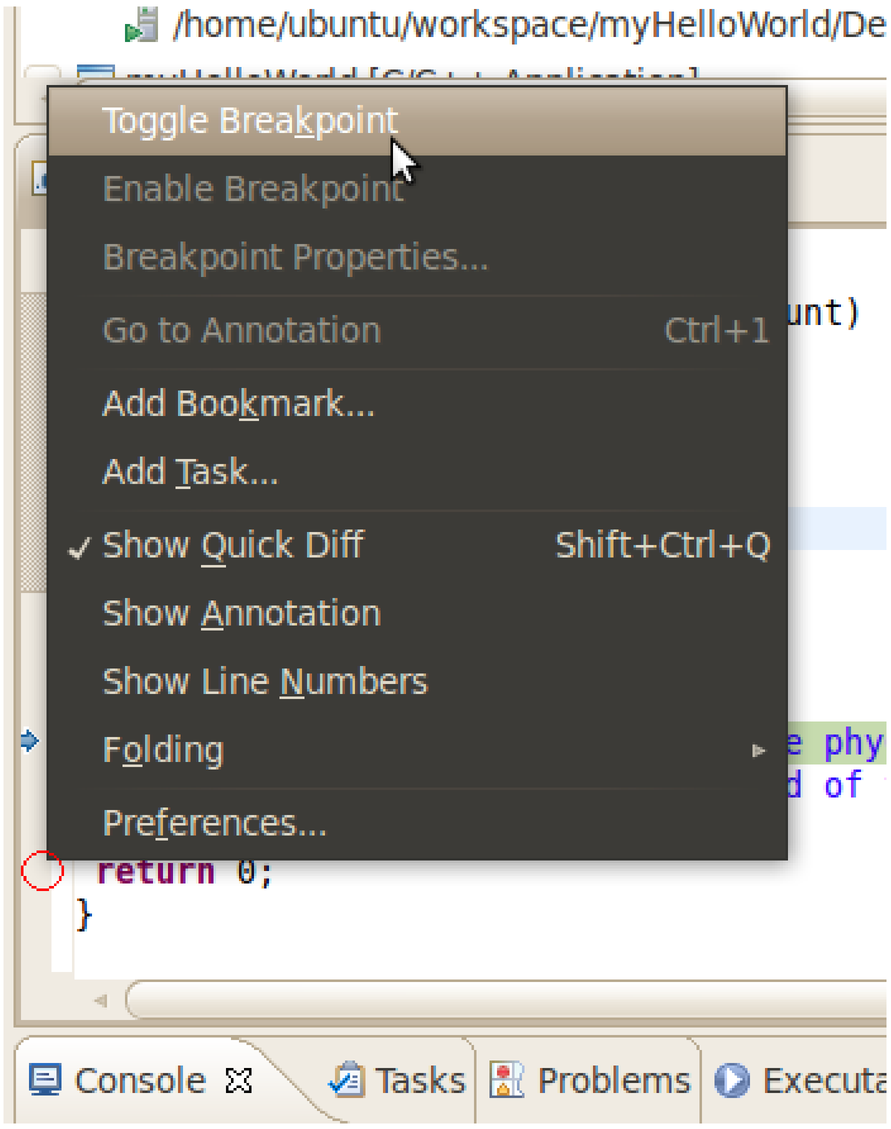
```
myHelloWorld Debug [C/C++ Application] /opt/PHYTEC_Tools/myHelloWorld/Debug/myHelloWorld (2/18/14 11:16 AM)
```

You have configured your project for remote debugging. You have started the GNU debugger in Eclipse and connected the host's GDB with the target's GDB server. You can now start to debug the project.

2.2.2.3 Setting a Breakpoint

Now you will set a breakpoint in your program. The breakpoint will be set on the last line of the function *main()*. If you resume the application, the debugger will stop on this line.

- Select the last line in *main()*
- Right-click into the small grey border on the left-hand side and select *Toggle Breakpoint* to set a new breakpoint

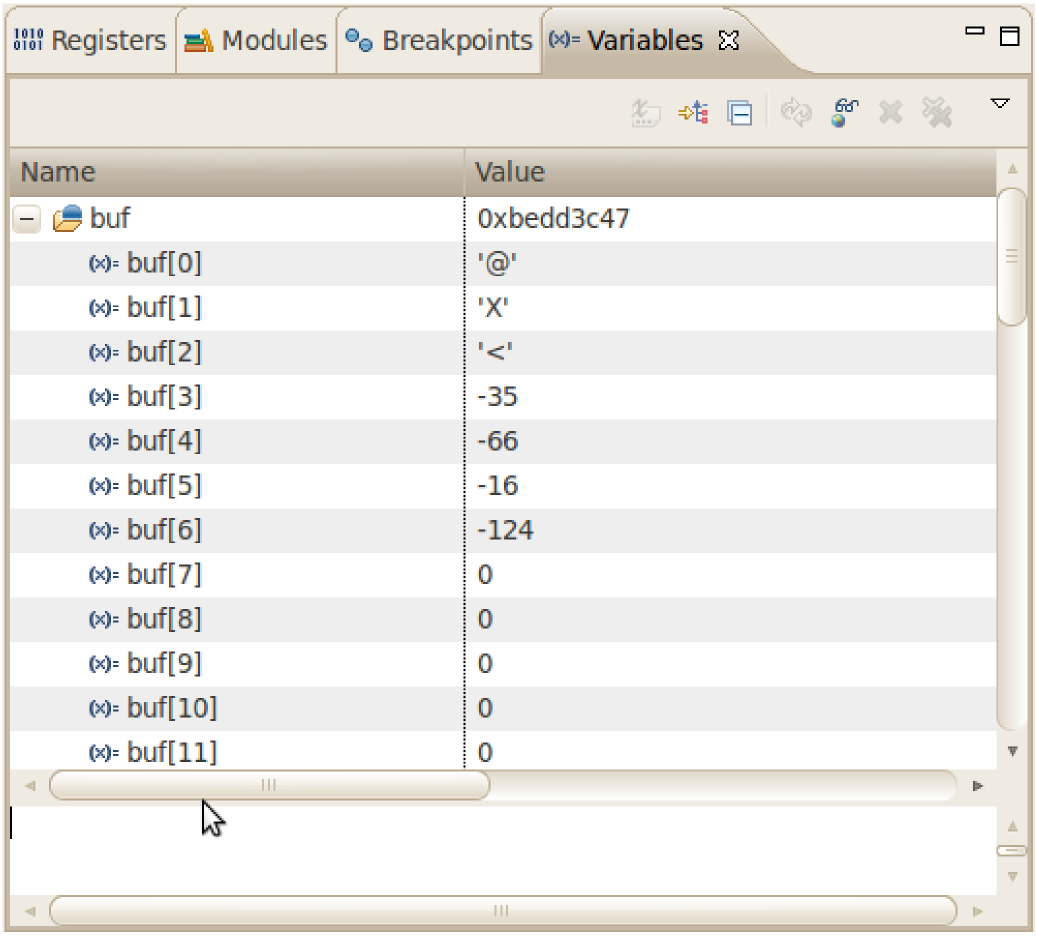


```
return 0;
}
```

2.2.2.4 Stepping through and Watching Variable Contents

In this part you will step through the example project with the debugger. You will also learn how to check the content of a variable.

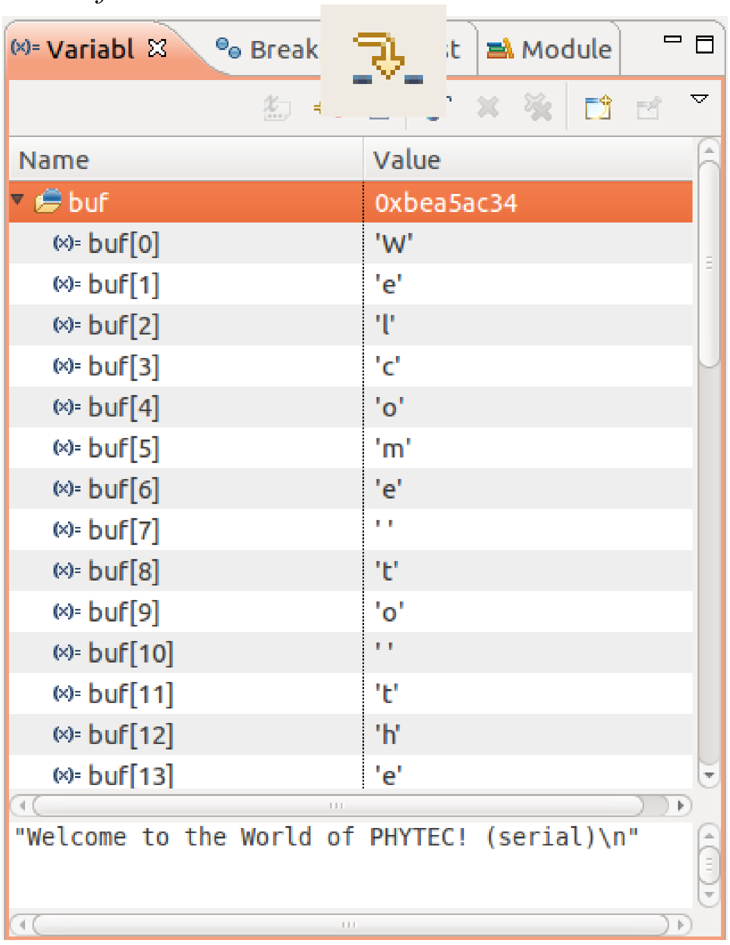
- Expand *buf* in the *Variables* window



Name	Value
buf	0xbedd3c47
buf[0]	'@'
buf[1]	'X'
buf[2]	'<'
buf[3]	-35
buf[4]	-66
buf[5]	-16
buf[6]	-124
buf[7]	0
buf[8]	0
buf[9]	0
buf[10]	0
buf[11]	0

- Click the *Step Over* button in the *Debug* window to step to the next line. You will see the content of the *buf* variable in the *Variables* window

- Click on the variable *buf*

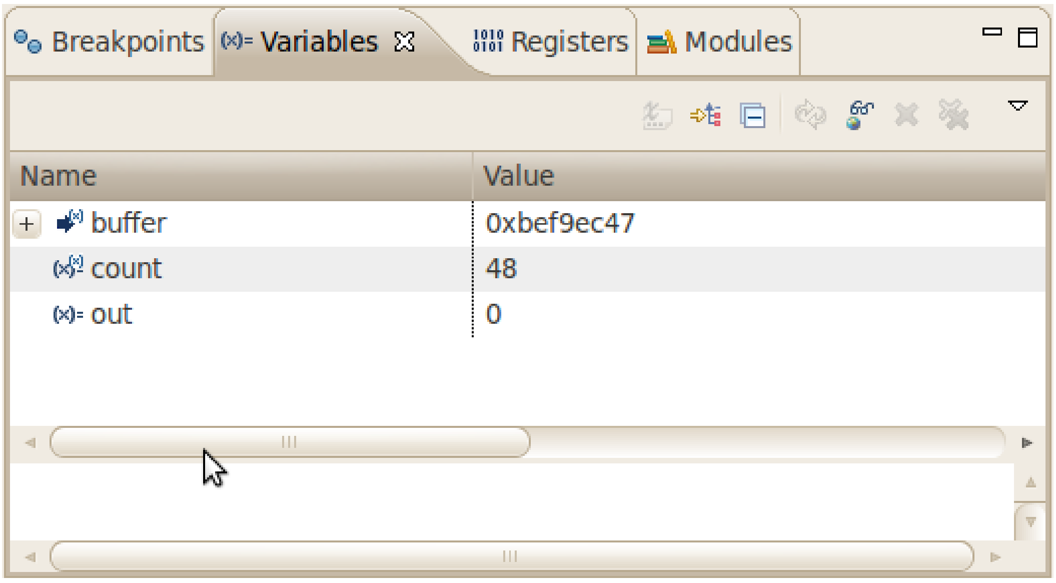


Name	Value
buf	0xbea5ac34
buf[0]	'W'
buf[1]	'e'
buf[2]	'l'
buf[3]	'c'
buf[4]	'o'
buf[5]	'm'
buf[6]	'e'
buf[7]	' '
buf[8]	't'
buf[9]	'o'
buf[10]	' '
buf[11]	't'
buf[12]	'h'
buf[13]	'e'

```
"Welcome to the World of PHYTEC! (serial)\n"
```

- The debugger stops in *write_tty()*
- Then click the button *Step into* to enter the function *write_tty()*

You will see the following variable window:



Name	Value
buffer	0xbef9ec47
count	48
out	0

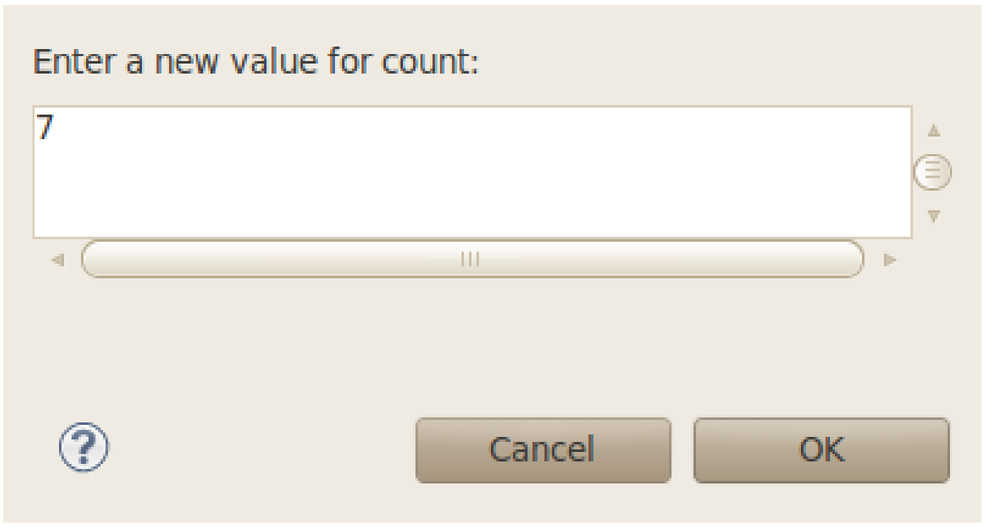
- Click on the variable *buffer*

You will probably see a different address on the buffer pointer. Remember what address is shown in your case; you will need this address later.

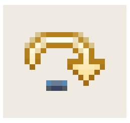
2.2.2.5 Stepping through and Changing Variable Contents

In this section you will change the value of a variable. At the end of this part you will see the effect of this change.

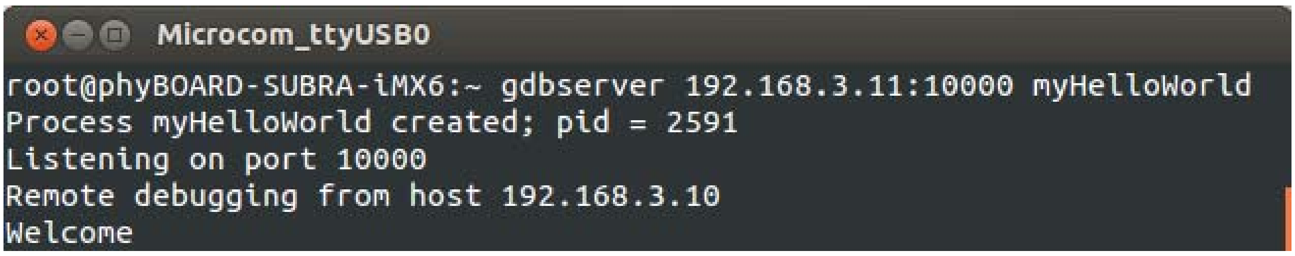
- Select the *count* variable in the *Variables* window
- Right-click on *count* and select *Change Value*
- Change the value of count to **7** and click *OK*



- Open *Microcom* if the application is not already opened
- Go back to *Eclipse*
- Click the *Step Over*button **two times**



- Switch to *Microcom*



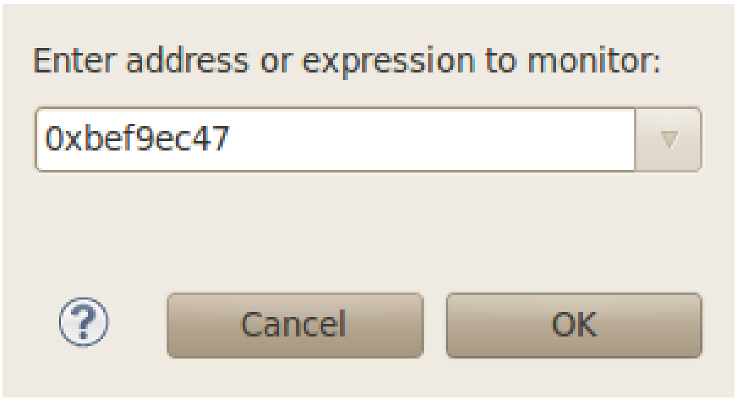
```
root@phyBOARD-SUBRA-iMX6:~ gdbserver 192.168.3.11:10000 myHelloWorld
Process myHelloWorld created; pid = 2591
Listening on port 10000
Remote debugging from host 192.168.3.10
Welcome
```

You will see the output *Welcome* in the Microcom window. This shows when changing the *counter* variable's value to 7 only the first seven characters of the buffer are displayed, instead of the whole sentence.

2.2.2.6 Using the Memory Monitor

In the last section of this chapter you will use the memory monitor to control the content at a memory address.

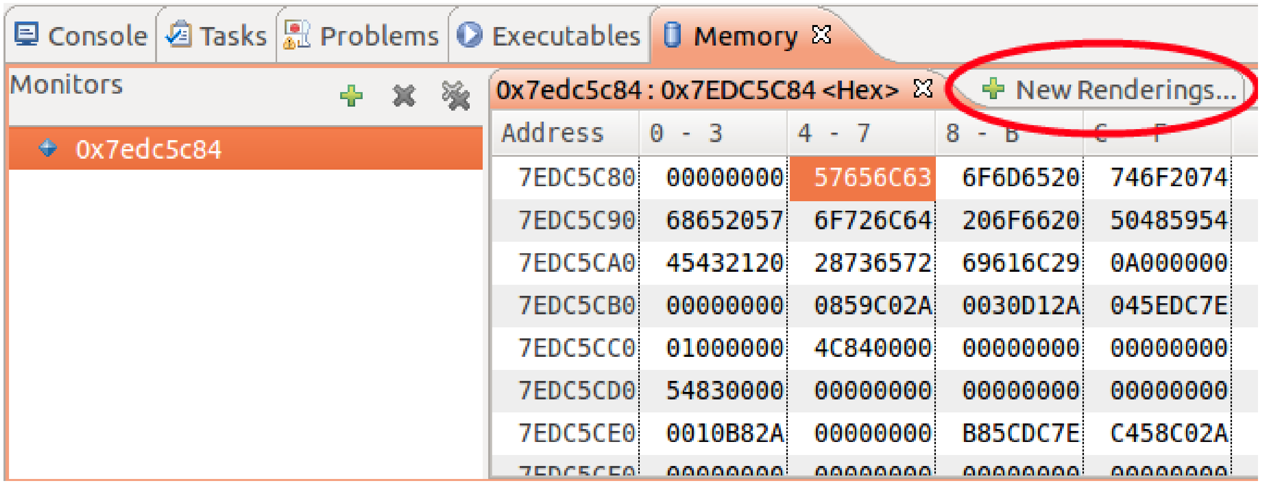
- Select the *Memory* tab on the bottom of Eclipse window
- Click *Add Memory Monitor (+)*
- Enter the address of buffer and click OK. Remember that the variable's address might be different on your system



Enter address or expression to monitor:

0xbef9ec47

- Click on the Tab *New Renderings*

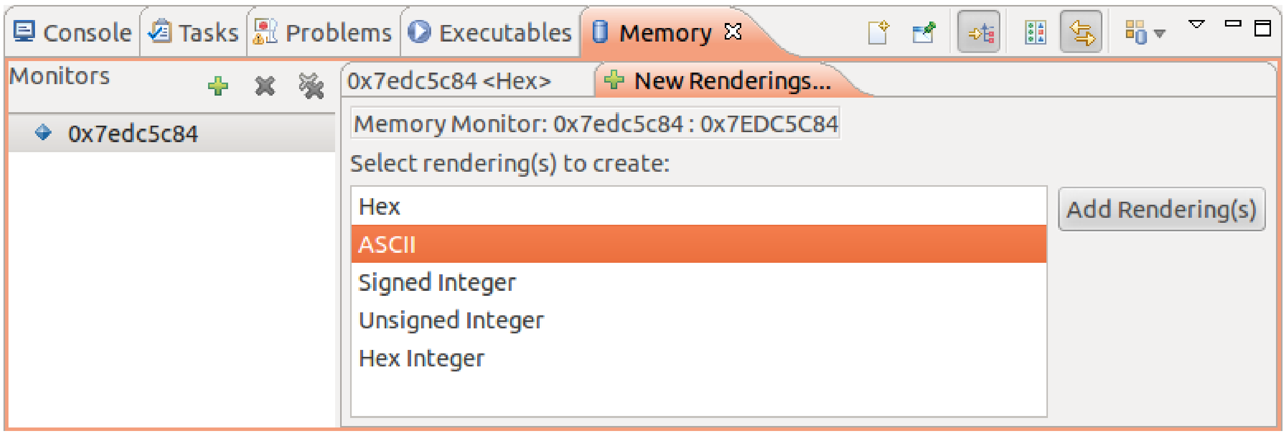


0x7edc5c84

0x7edc5c84 : 0x7EDC5C84 <Hex>

```
Address    0 - 3     4 - 7     8 - B     C - F
7EDC5C80   00000000  57656C63  6F6D6520  746F2074
7EDC5C90   68652057  6F726C64  206F6620  50485954
7EDC5CA0   45432120  28736572  69616C29  0A000000
7EDC5CB0   00000000  0859C02A  0030D12A  045EDC7E
7EDC5CC0   01000000  4C840000  00000000  00000000
7EDC5CD0   54830000  00000000  00000000  00000000
7EDC5CE0   0010B82A  00000000  B85CDC7E  C458C02A
7EDC5CF0   00000000  00000000  00000000  00000000
```

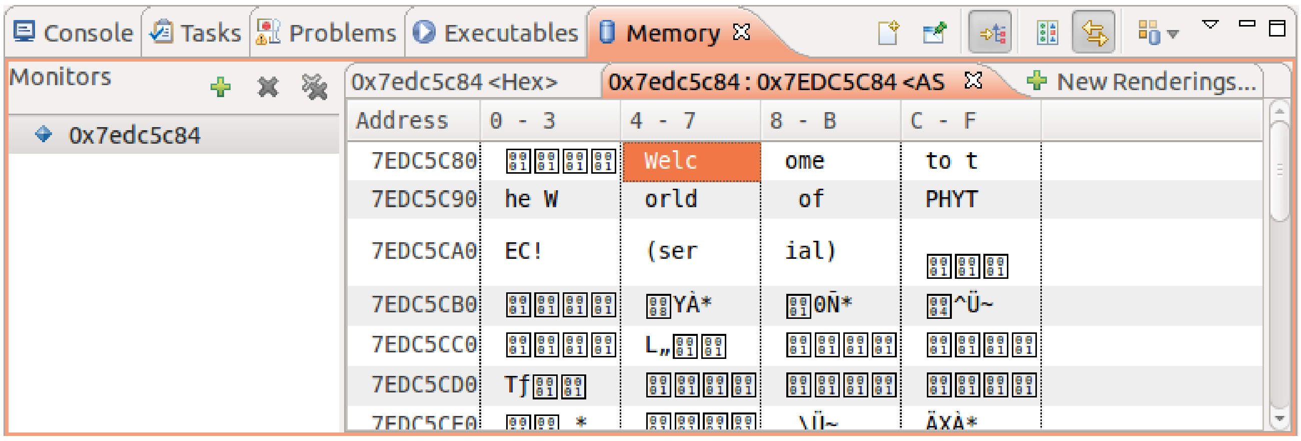
- Select *ASCII* and click *Add Rendering(s)*



Memory Monitor: 0x7edc5c84 : 0x7EDC5C84
Select rendering(s) to create:

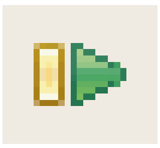
Hex
ASCII
Signed Integer
Unsigned Integer
Hex Integer

You can see the contents of the variable *buffer* at the address *0xbef9ec47* (or whatever address is used on your system).

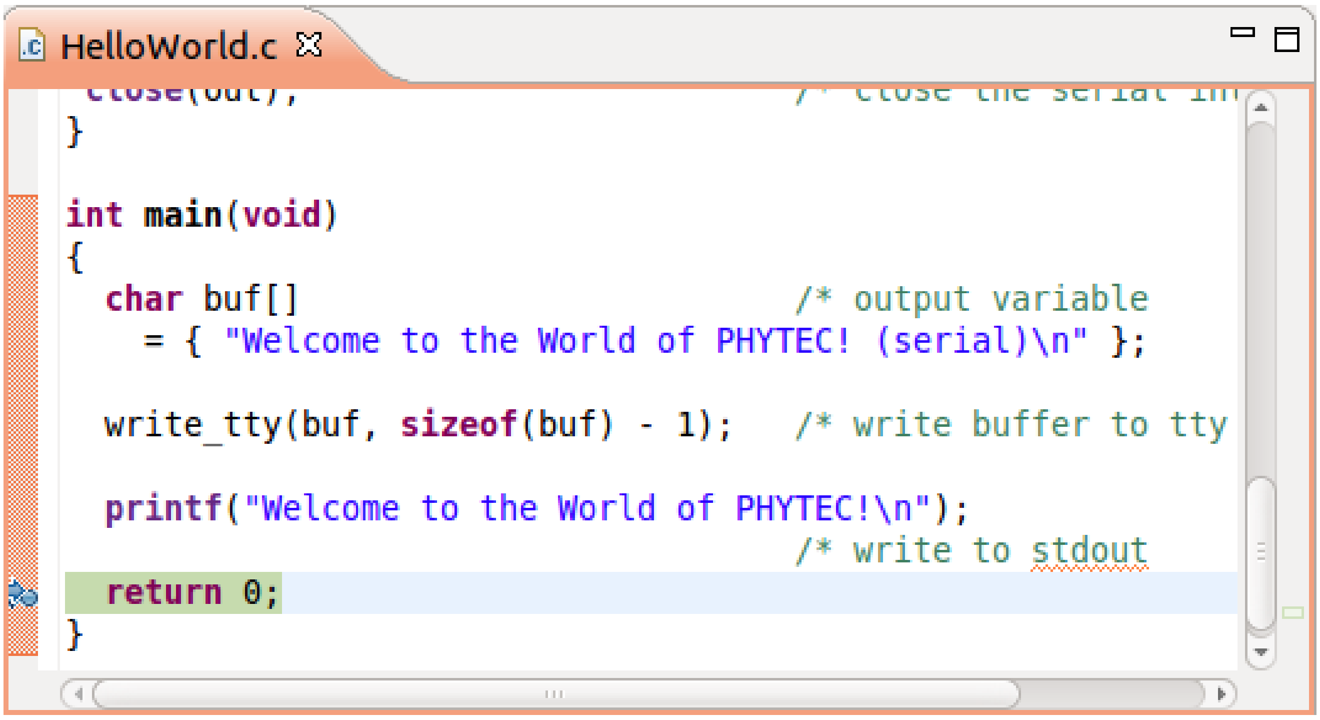


Address	0 - 3	4 - 7	8 - B	C - F
7EDC5C80		Welc	ome	to t
7EDC5C90	he W	orld	of	PHYT
7EDC5CA0	EC!	(ser	ial)	
7EDC5CB0		YÀ*	0Ñ*	^Ü~
7EDC5CC0		L„		
7EDC5CD0	Tƒ			
7EDC5CE0	*		\Ü~	ÄXÀ*

- Now click the *Resume* button from the menu bar

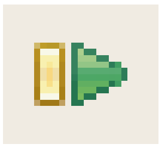


The debugger stops at the breakpoint in the last line of *main()*.



```
  close(out);                             /* close the serial int
}

int main(void)
{
  char buf[]                              /* output variable
    = { "Welcome to the World of PHYTEC! (serial)\n" };

  write_tty(buf, sizeof(buf) - 1);        /* write buffer to tty

  printf("Welcome to the World of PHYTEC!\n");
                                          /* write to stdout

  return 0;
}
```

- Click the *Resume* button to end the application



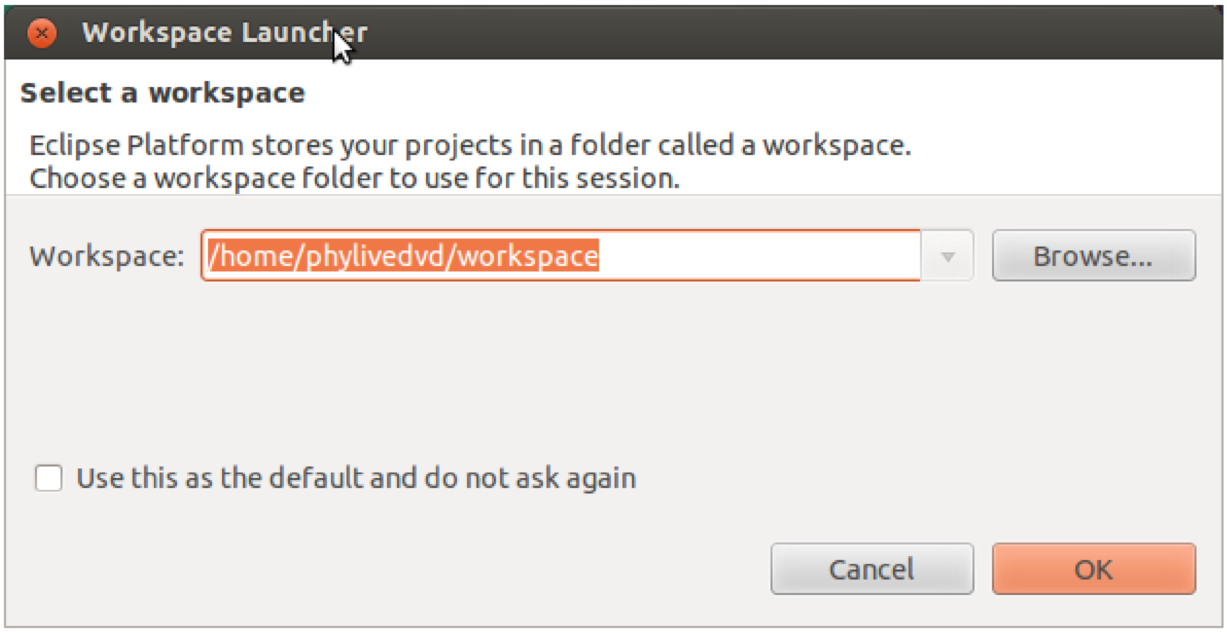
	You have successfully passed the debugging chapter. You are now able to configure and use Eclipse for remote debugging. You can step through a project, watch and change the content of variables, and you can use the memory monitor to view the content at a memory address.

2.2.3 Programming in the Qt C++ perspective

In this section our attention goes to the Qt framework, which gives us tools to develop graphical user interfaces. With the help of an example project we will give you a short introduction of how to work with Qt.

2.2.3.1 Importing the demo application

- Click the Eclipse icon to start the application, if it is not already open. You can find this icon on your desktop.



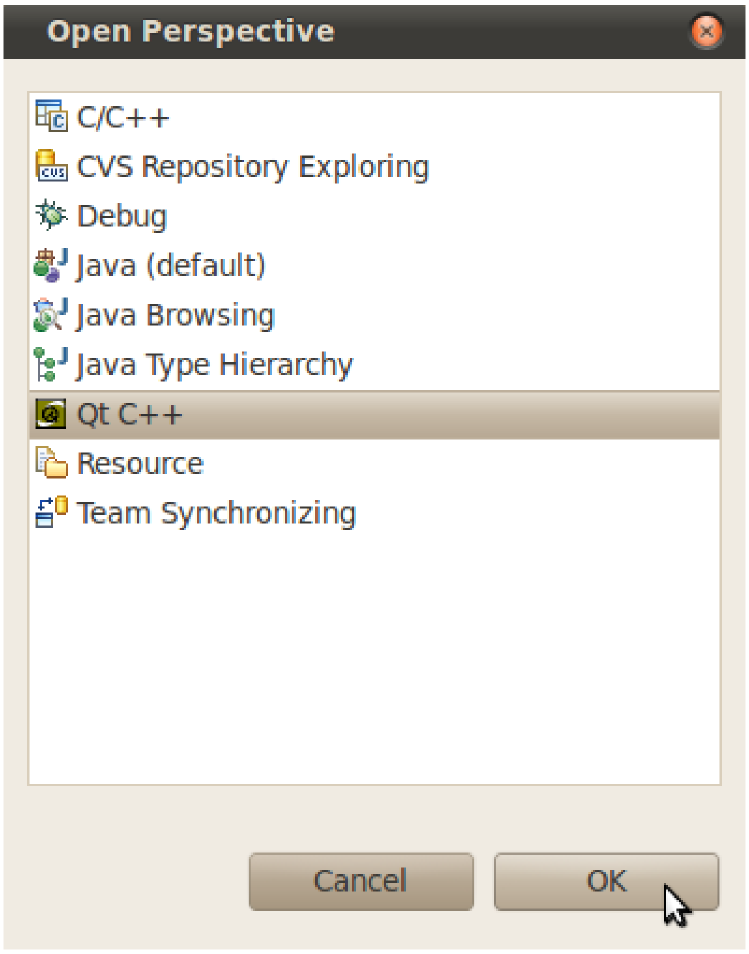
Select a workspace

Eclipse Platform stores your projects in a folder called a workspace.
Choose a workspace folder to use for this session.

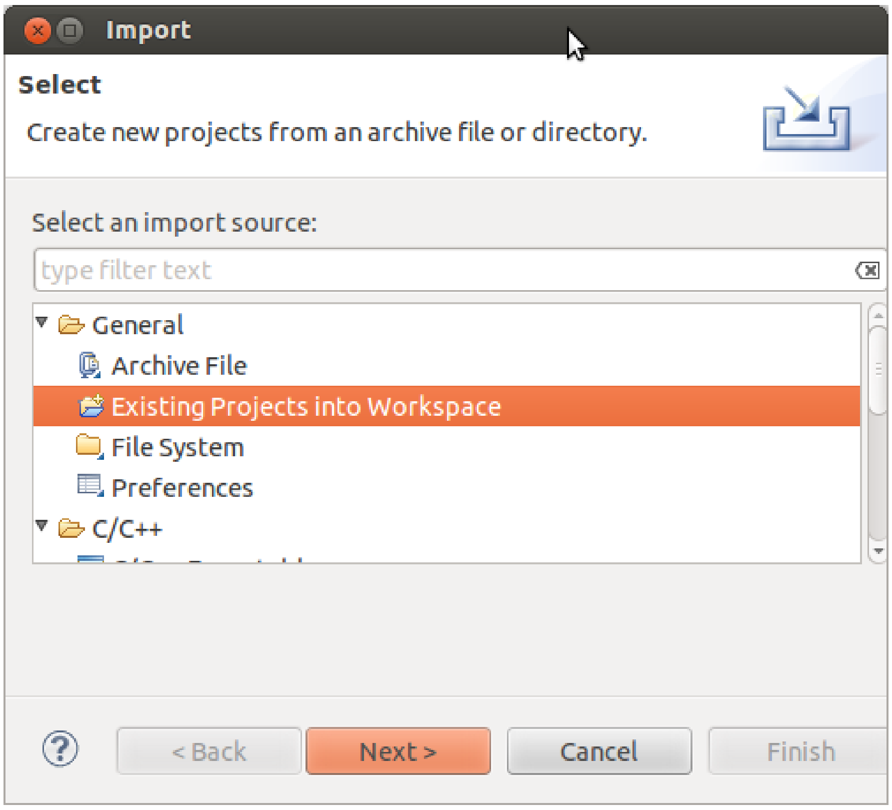
Workspace: /home/phylivedvd/workspace

☐ Use this as the default and do not ask again

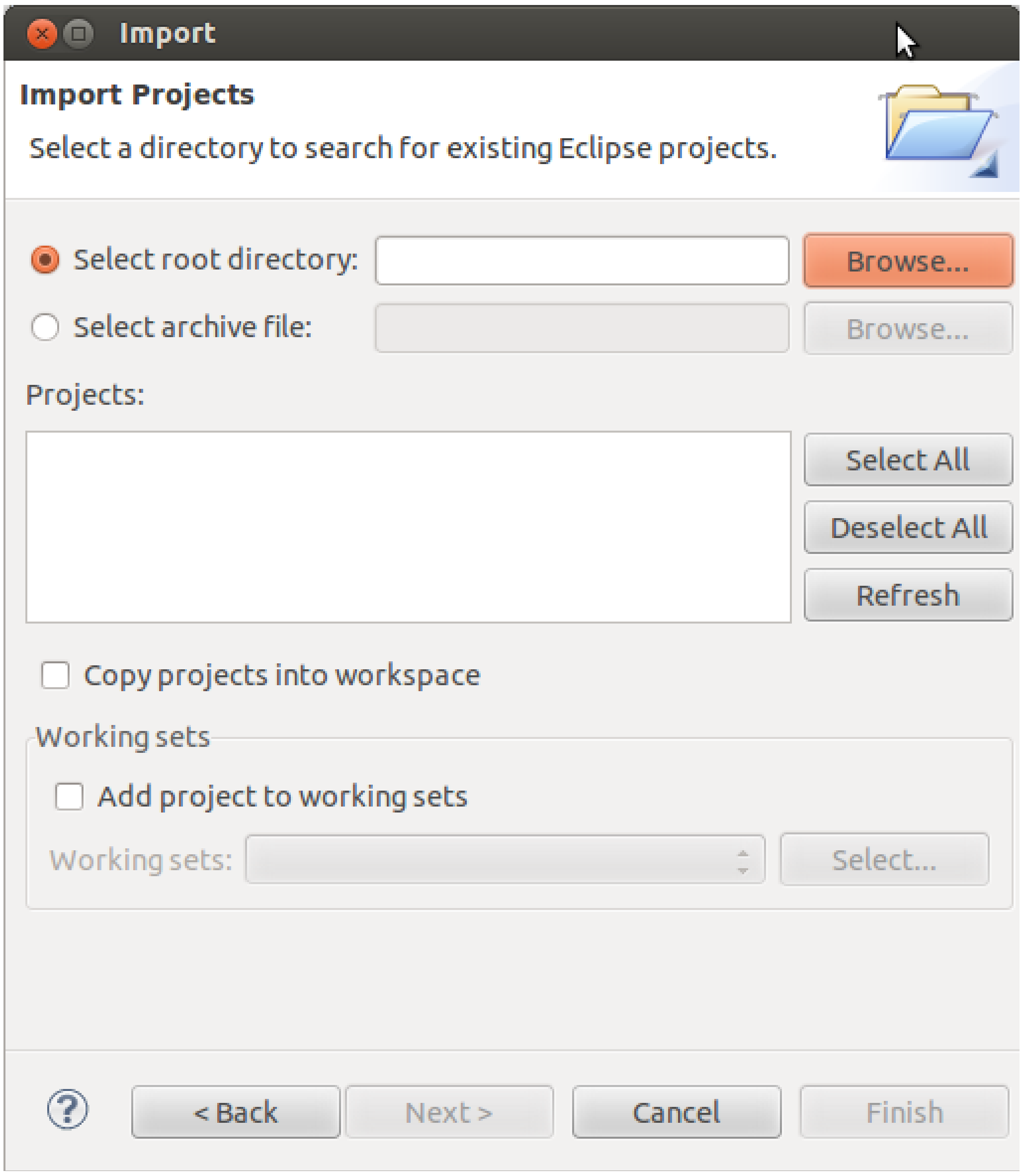
- After confirming the workspace we switch to the Qt C++ perspective. Click Window ►Open Perspective ► Other



- A dialog opens. Choose *Qt C++* and click **OK**
- Now you can import the example project. Select *File* ► *Import* from the menu bar



- Select *Existing Projects into Workspace*
- Click *Next*


Import

Import Projects

Select a directory to search for existing Eclipse projects.

(●) Select root directory: [ ] Browse...

( ) Select archive file: [ ] Browse...

Projects:

Select All | Deselect All | Refresh

☐ Copy projects into workspace

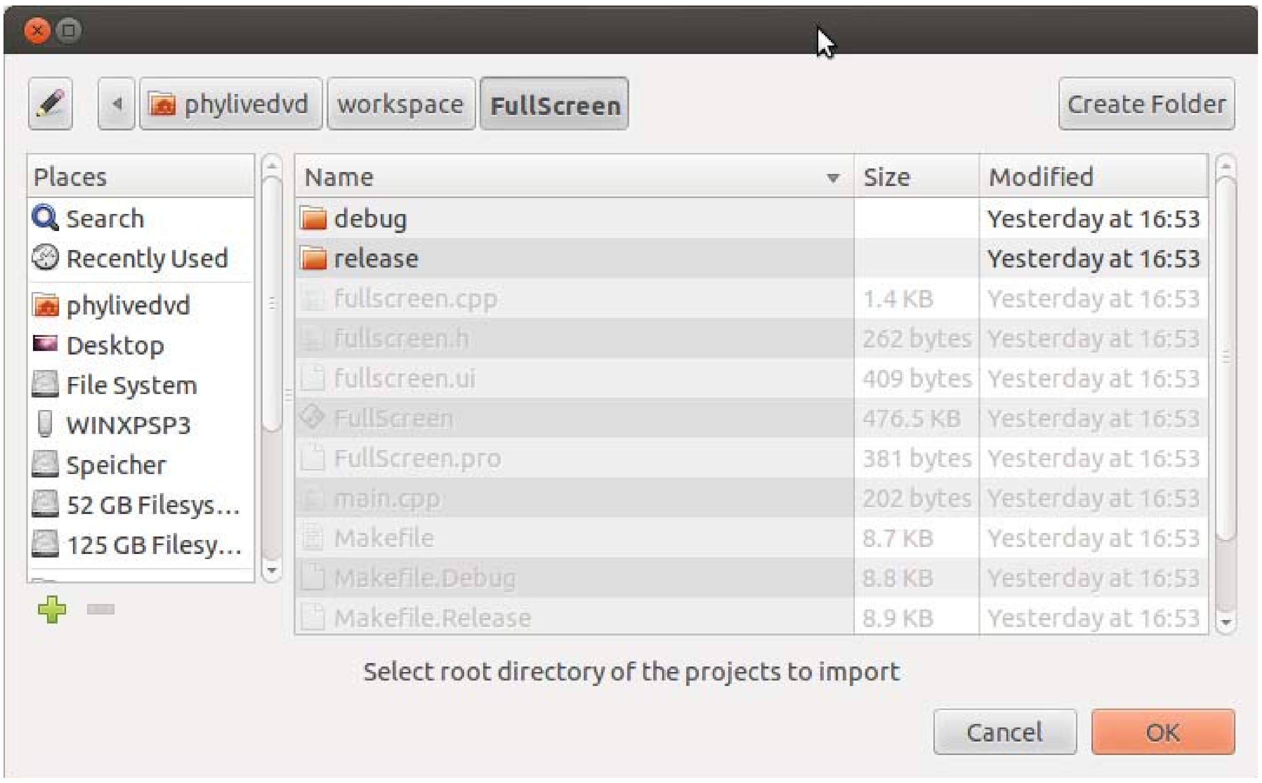
Working sets

☐ Add project to working sets

Working sets: [ ] Select...

< Back | Next > | Cancel | Finish

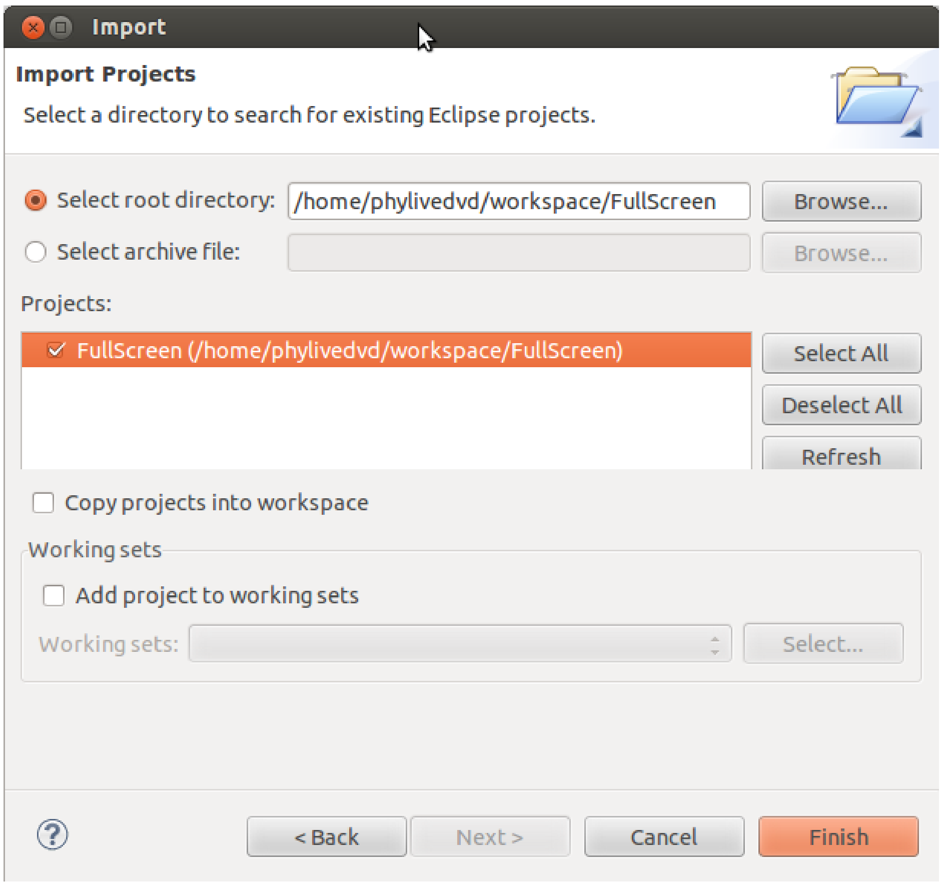
- Select *Browse*
- Double-click the *FullScreen* directory under */home/phylivedvd/workspace/*



Name	Size	Modified
debug		Yesterday at 16:53
release		Yesterday at 16:53
fullscreen.cpp	1.4 KB	Yesterday at 16:53
fullscreen.h	262 bytes	Yesterday at 16:53
fullscreen.ui	409 bytes	Yesterday at 16:53
FullScreen	476.5 KB	Yesterday at 16:53
FullScreen.pro	381 bytes	Yesterday at 16:53
main.cpp	202 bytes	Yesterday at 16:53
Makefile	8.7 KB	Yesterday at 16:53
Makefile.Debug	8.8 KB	Yesterday at 16:53
Makefile.Release	8.9 KB	Yesterday at 16:53

Select root directory of the projects to import

- Click *OK*



Import Projects

Select a directory to search for existing Eclipse projects.

[✓] Select root directory: /home/phylivedvd/workspace/FullScreen

Select archive file:

Projects:

[✓] FullScreen (/home/phylivedvd/workspace/FullScreen)

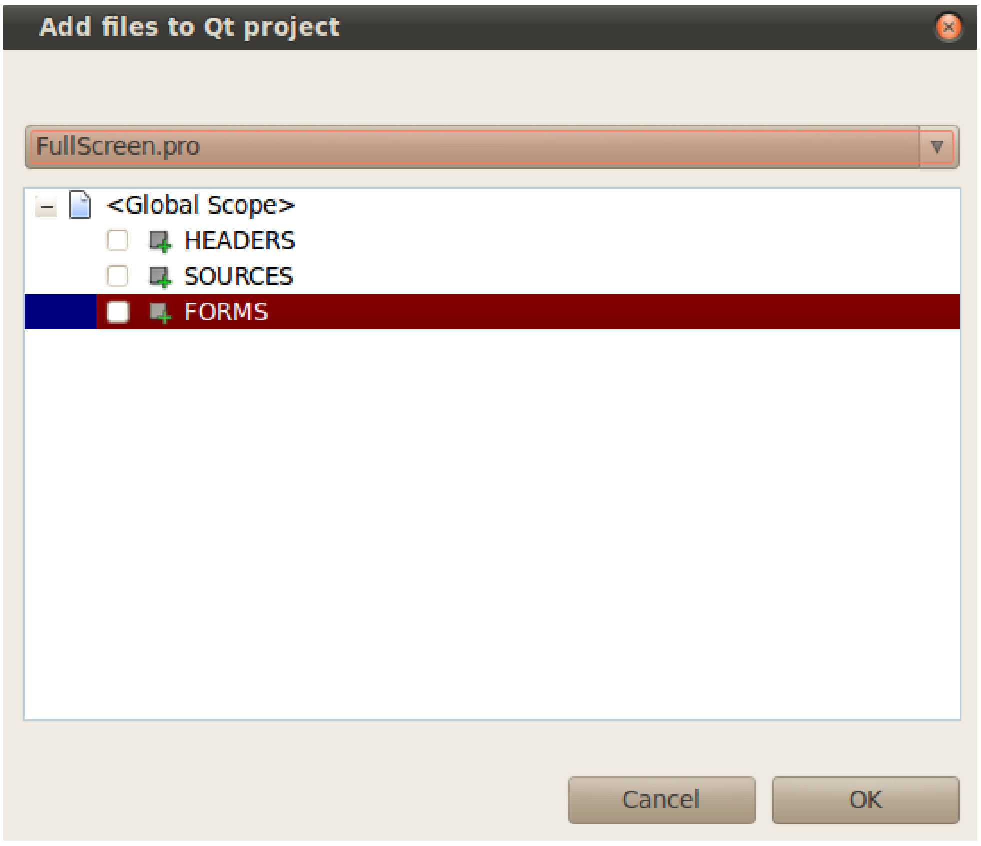
[ ] Copy projects into workspace

Working sets

[ ] Add project to working sets

Working sets:

- Select *Finish* to import the project
- On the next window **deselect** *HEADERS* and *FORMS* and click *OK*



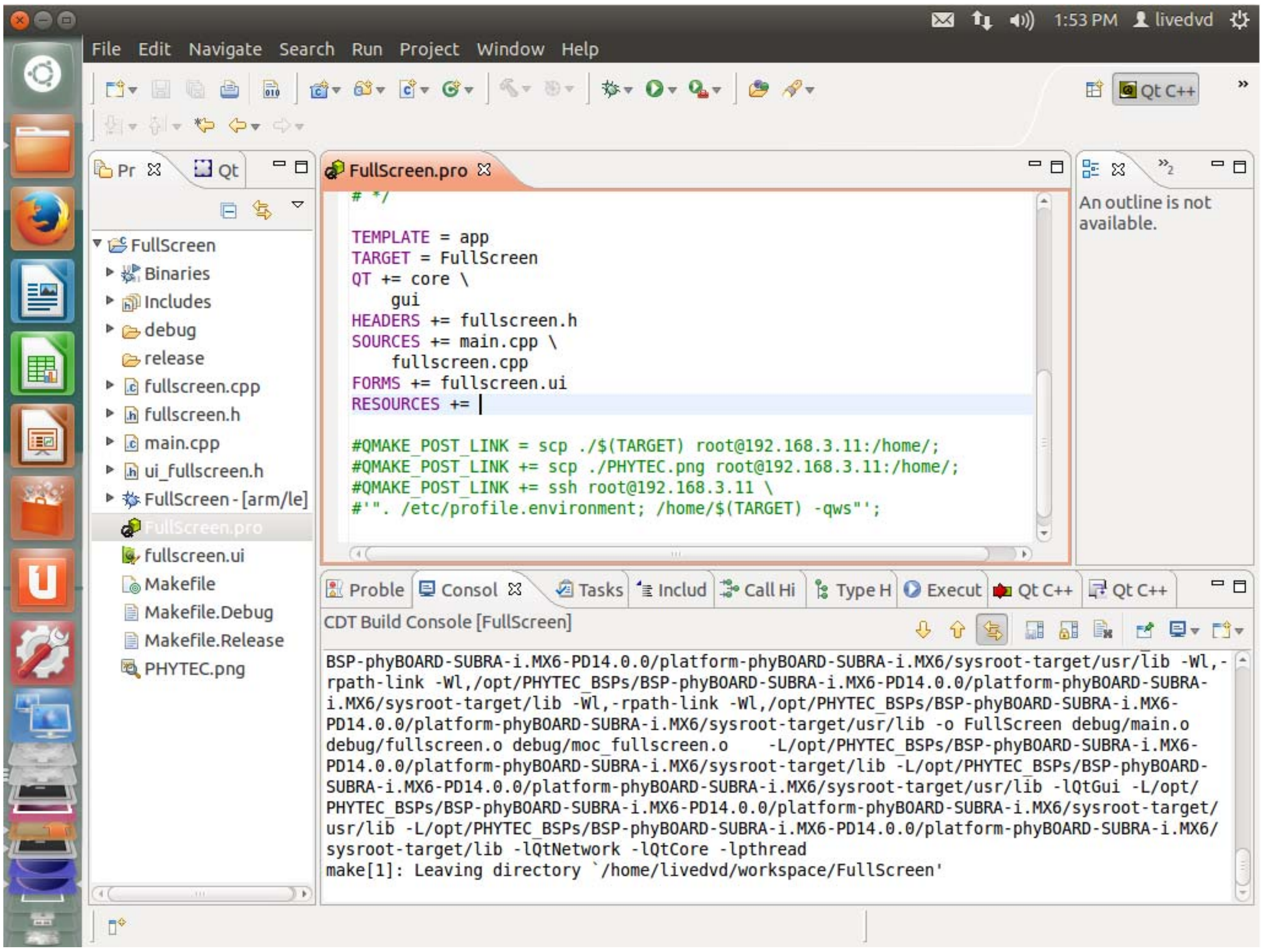
- Select *Project* ► *Build Project*

The FullScreen program will be compiled and you can find the outputs on the console. After the compilation is finished successfully the FullScreen executable for the target is built and can be found under */home/phylivedvd/workspace/FullScreen*.

2.2.3.2 Handle with the demo application

If you want the project to be automatically copied to the target and executed you must make some changes in the *FullScreen.pro* file.

- Double-click the *FullScreen.pro* to open it



```
# */

TEMPLATE = app
TARGET = FullScreen
QT += core \
    gui
HEADERS += fullscreen.h
SOURCES += main.cpp \
    fullscreen.cpp
FORMS += fullscreen.ui
RESOURCES += 

#QMAKE_POST_LINK = scp ./$(TARGET) root@192.168.3.11:/home/;
#QMAKE_POST_LINK += scp ./PHYTEC.png root@192.168.3.11:/home/;
#QMAKE_POST_LINK += ssh root@192.168.3.11 \
#'". /etc/profile.environment; /home/$(TARGET) -qws"';
```

```
BSP-phyBOARD-SUBRA-i.MX6-PD14.0.0/platform-phyBOARD-SUBRA-i.MX6/sysroot-target/usr/lib -Wl,-
rpath-link -Wl,/opt/PHYTEC_BSPs/BSP-phyBOARD-SUBRA-i.MX6-PD14.0.0/platform-phyBOARD-SUBRA-
i.MX6/sysroot-target/lib -Wl,-rpath-link -Wl,/opt/PHYTEC_BSPs/BSP-phyBOARD-SUBRA-i.MX6-
PD14.0.0/platform-phyBOARD-SUBRA-i.MX6/sysroot-target/usr/lib -o FullScreen debug/main.o
debug/fullscreen.o debug/moc_fullscreen.o    -L/opt/PHYTEC_BSPs/BSP-phyBOARD-SUBRA-i.MX6-
PD14.0.0/platform-phyBOARD-SUBRA-i.MX6/sysroot-target/lib -L/opt/PHYTEC_BSPs/BSP-phyBOARD-
SUBRA-i.MX6-PD14.0.0/platform-phyBOARD-SUBRA-i.MX6/sysroot-target/usr/lib -lQtGui -L/opt/
PHYTEC_BSPs/BSP-phyBOARD-SUBRA-i.MX6-PD14.0.0/platform-phyBOARD-SUBRA-i.MX6/sysroot-target/
usr/lib -L/opt/PHYTEC_BSPs/BSP-phyBOARD-SUBRA-i.MX6-PD14.0.0/platform-phyBOARD-SUBRA-i.MX6/
sysroot-target/lib -lQtNetwork -lQtCore -lpthread
make[1]: Leaving directory `/home/livedvd/workspace/FullScreen'
```

In this file you will find four uncommented rows.

- Remove the commentar signs (#) to enable the three *QMAKE_POST_LINK* tags. With these tags you can add post-build commands. In our case we copy the compiled project and the picture to the target and connect via *ssh*, set the environment and execute the application

Before you clean and build the project, be sure that no other QT application is started on the target (for example the *Fluidlauncher* from the autostart).

- Select *Project* ► *Clean....*
- Confirm the Clean dialog with *OK*

After the FullScreen program is compiled the *QMAKE_POST_LINK* is called.

The *FullScreen* file is copied to the target using secure copy and executed using *SSH*.

At the connected display on the target the project is started and you can change between windowed and fullscreen mode by clicking the button. By touching/pressing the **X** you can close the program.

	You have successfully imported and built a Qt project in Eclipse. You havve also learned to run your application on the target.

	Knowing how to work with Eclipse and how to develop and execute an application on the phyBOARD-Subra-i.MX 6, you are now ready prepared to start your project. The following section will give you detailed information on the different features and interfaces of the phyBOARD-Subra and how to use them within your application. *If your project is more complex, or if you crave more information about working with the BSP, continue with chapter* **Fehler! Verweisquelle konnte nicht gefunden werden.**. *Chapter* **Fehler! Verweisquelle konnte nicht gefunden werden.***ff inlcude step by step instructions on how to modify and download the BSP using PTXdist. They also include system level information on the phyBOARD-Subra-i.MX 6.*

3 Accessing the phyBOARD-Subra Features

PHYTEC phyBOARD-Subra is fully equipped with all mechanical and electrical components necessary for the speedy and secure start-up and subsequent communication to and programming of applicable PHYTEC System on Module (SOM) modules. phyBOARD-Subra Boards are designed for evaluation, testing and prototyping of PHYTEC System on Module in laboratory environments prior to their use in customer designed applications.

3.1 Concept of the phyBOARD-Subra

The phyBOARD-Subra provides a flexible development platform enabling quick and easy start-up and subsequent programming of its soldered phyFLEX-i.MX 6 System on Module. The carrier board design allows easy connection of additional extension boards featuring various functions that support fast and convenient prototyping and software evaluation. The carrier board is compatible with phyFLEX-i.MX 6 only.

This modular development platform concept includes the following components:

- the **phyFLEX-i.MX 6 module** populated by default with the i.MX 6 processor and all applicable SOM circuitry such as DDR SDRAM, Flash, PHYs, and transceivers to name a few.

- the **phyBOARD-Subra** which offers all essential components and connectors for start-up including: A power socket which enables connection to an **external power adapter**, interface connectors such as **USB, Ethernet** and **microSDHC card slot** allowing for use of the SOM's interfaces with standard cable.

The following sections contain specific information relevant to the operation of the phyFLEX-i.MX 6 mounted on the phyBOARD-Subra Carrier Board.

3.2 Overview of the phyBOARD-Subra Peripherals

The phyBOARD-Subra is depicted in *Figure 2*. It features many different interfaces and is equipped with the components as listed in ***Fehler! Verweisquelle konnte nicht gefunden werden.***, *Table 3*, and *Table 4*. For a more detailed description of each peripheral refer to the appropriate chapter listed in the applicable table. *Figure 2* highlights the location of each peripheral for easy identification.

3.2.1 Connectors and Pin Header

Table 2 lists all available connectors on the phyBOARD-Subra. *Figure 2* highlights the location of each connector for easy identification.

Reference Designator	Description	See Section
X1	phyFLEX-fix connector for mounting the phyFLEX-i.MX 6	
X2	phyFLEX-optional connector for mounting the phyFLEX-i.MX 6	
X3	JTAG pin header connector	*3.3.11*
X4	PDI (PHYTEC Display Interface) data connector, LVDS (40 pin FFC connector, 0.5 mm pitch)	*3.3.8*
X5	PDI (PHYTEC Display Interface) power out connector (AMP microMatch 8-338069-2)	
X9	Backlight power supply connector (5 circuits 1.25 mm pitch Molex PanelMate^{TM} header)	
X11	USB interface to connect a capacitive touch panel (5 circuits 1.25 mm pitch Molex PicoBlade^{TM} header)	*3.3.10*
X19	I^2C interface to connect a capacitive touch panel (5 circuits 1.25 mm pitch Molex PicoBlade^{TM} header)	
X33	EDT PolyTouch^{TM} interface connector (10 circuits 0.5 mm pitch FPC connector)	
X36	Resistive touch connector (4 circuits 2.54 mm pin header)	
X38	12 V Backlight power supply and control to connect a custom display (5 circuits 1.25 mm pitch Molex PanelMate^{TM} header)	*3.3.9*
X39	LCD Display interface connector to connect a custom display, LVDS (20 pin 1 mm pitch board to cable connector)	
X12	SecureDigital / Multi Media Card (Micro-slot)	*3.3.12*

Table 2: phyBOARD-Subra Connectors and Pin Headers

X13	Expansion connector (2×16 socket connector, 2.54 mm pitch)	*4.6.4*
X18	Power supply 12 V - 24 V / 24 W only (via 2-pole PHOENIX base strip; 5.08 mm pitch)	*3.3.1.1*
X20	Digital In/Out (4×2 Molex MicroClasp™ Wire-to-Board header; 2 mm pitch)	
X29	HDMI/DVI connector (0.50 mm pitch HDMI receptacle)	*3.3.7*
X35	USB Host connector (Double USB 2.0 Standard-A socket)	*0*
X52	Camera_0, phyCAM-S+ Connector (8 pin miniature crimping connector, 1.25 mm pitch)	
X53	Camera_1, phyCAM-S+ Connector (8 pin miniature crimping connector, 1.25 mm pitch)	
X54	GND connector dedicated to the camera interfaces (blade terminal)	
X55	Mono Speaker output (2-pole Molex SPOX™ Wire-to-Board Header; 2.50 mm pitch)	*3.3.6*
X58	Stereo Line In/Out and Microphone connector (5×2 Molex MicroClasp™ Wire-to-Board header; 2 mm pitch)	
X60	Headset out connector (soldering holes)	
X56	UART0 / CAN connector (4×2 Molex MicroClasp™ Wire-to-Board header; 2 mm pitch)	*3.3.3*
X57	Ethernet 0 connector (RJ45 with speed and link LED)	*0*
C438	Battery Buffer for RTC	

Table 2: phyBOARD-Subra Connectors and Pin Headers (continued)

Note:
Ensure that all module connections are not to exceed their expressed maximum voltage or current. Maximum signal input values are indicated in the corresponding controller User's Manual/Data Sheets. As damage from improper connections varies according to use and application, it is the user‘s responsibility to take appropriate safety measures to ensure that the module connections are protected from overloading through connected peripherals.

3.2.2 LEDs

The phyBOARD-Subra is populated with four LEDs to indicate the status of the USB VBUS voltages, as well as of the power supply voltages.

Figure 2 shows the location of the LEDs. Their function is listed in the table below:

LED	Color	Description	See Section
D7	green	Indicates presence of VBUS at the USB1 Host interface	*0*
D8	green	Indicates presence of VBUS at the USB0 Host interface	
D13	green	5 V voltage generation of the phyBOARD-Subra	*3.3.1.2*
D14	green	3.3 V voltage generation of the phyBOARD-Subra	

Table 3: phyBOARD-Subra LEDs Descriptions

3.2.3 Switches

The phyBOARD-Subra is populated with some switches which are essential for the operation of the phyFLEX-i.MX 6 module. *Table 5* shows the location of the switches and push buttons.

Button	Description	See Section
S1	System Reset Button – system reset signal generation	
S2	Power Button – powering on and off main supply voltages of the carrier board	
S3	DIP-switch – boot mode selection	

Table 4: phyBOARD-Subra Push Buttons Descriptions

S1 Issues a **system reset** signal. Pressing this button will toggle the nRESET_IN pin (X1A72) of the phyFLEX microcontroller LOW, causing the controller to reset.

S2 Issues a **power on/off/wake** event. Pressing this button will turn on the system, if it is powered off. Pressing this button more than 5 seconds will turn off the system without proper shut down of the operating system.

S3 This DIP-switch allows to change the booting device order of the phyFLEX-i.MX 6

Note:
Detailed descriptions of the assembled connectors, jumpers and switches can be found in the following chapters.

3.2.4 Jumpers

The phyBOARD-Subra comes pre-configured with removable jumpers (JP) and solder jumpers (J). The jumpers allow the user flexibility of configuring a limited number of features for development constraint purposes. *Table 5* below lists the jumpers, their default positions, and their functions in each position. *Figure 4* depicts the jumper pad numbering scheme for reference when altering jumper settings on the development board.

Figure 2 provides a detailed view of the phyBOARD-Subra jumpers and their default settings. In these diagrams a beveled edge indicates the location of pin 1.

Before making connections to peripheral connectors it is advisable to consult the applicable section in this manual for setting the associated jumpers.

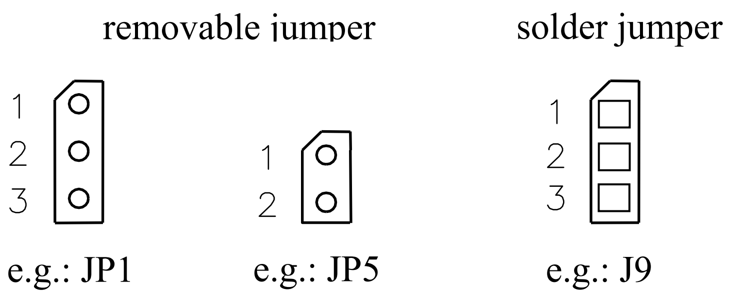


Figure 4: Typical Jumper Numbering Scheme

Table 5 provides a comprehensive list of all carrier board jumpers. The table only provides a concise summary of jumper descriptions. For a detailed description of each jumper see the applicable chapter listing in the right hand column of the table.

If manual modification of the solder jumpers is required please ensure that the board as well as surrounding components and sockets remain undamaged while de-soldering. Overheating the board can cause the solder pads to loosen, rendering the board inoperable. Carefully heat neighboring connections in pairs. After a few alternations, components can be removed with the solder-iron tip. Alternatively, a hot air gun can be used to heat and loosen the bonds.

The following conventions were used in the Jumper column of the jumper table (*Table* 5)

- J = solder jumper
- JP = removable jumper

Jumper/ Setting	Description	See Section
JP2	Jumper JP2 allows to connect an terminating resistor of 120 Ohm to the CAN interface	
open	Terminating resistor not connected	
closed	**Terminating resistor connected**	
J47	Jumper J47 connects the RTC Interrupt to the Power_ON/Wake/Off Signal or to the GPIO5 Signal of the phyFLEX-i.MX 6.	
1+2	RTC Interrupt connect to GPIO5	
2+3	**RTC Interrupt connect to Power_ON/Wake/Off**	
J1-5, J38-J40, J48, J49	Jumpers J1-5, J38-J40, J48, J49 allow to change the distribution of the USB Host interfaces USB0 and USB2. USB0 can be connected to the double USB 2.0 Standard-A connector X35, to the PDI data connector X4, or to the touch panel interface connector X11. USB2 can be connected either the PDI data connector X4, or to the touch panel interface connector X11	
J4, J5 2+3 all others open	**USB0 connected to the USB Host connector X35 USB2 not brought out**	
other configurations	Please contact our sales team if you need another configuration	
J7-J10	Jumpers J7-J10 allow to configure the use of GPIOs GPIO1-GPIO4[1] of the phyFLEX-i.MX 6. Each GPIO can be routed as output via an opto-coupler, or as input via a Low-Side switch.	
J7, J8 1+2 J9, J10 2+3	GPIO1 and GPIO2 configured as output GPIO3 and GPIO4 configured as input	
other configurations	Please contact our sales team if you need another configuration	

Table 5: phyBOARD-Subra Jumper Descriptions

[1]: GPIO1 connects to GPIO5_07 (pin R20) of the i.MX 6 on the phyFLEX-i.MX 6
GPIO2 to GPIO4_18 (pin N25), GPIO3 to GPIO4_19 (pin N20), and GPIO4 to GPIO1_06 (pin T3)

J62	Jumper J62 connects the shield contact of audio jack X60 (headphone out) to either GND, or the HPCOM output driver of the stereo audio codec at U35. Connecting the shield contact to HPCOM allows using the jack detection function of the stereo audio codec.	
1+2	Shield contact connected to GND, jack detection disabled	
2+3	**Shield contact connected to the HPCOM output driver of the stereo audio codec, jack detection enabled**	
J35	Jumper J35configures the I²C address of the touch screen controller at U3.	
1+2	**Touch Controller (U3) Address: 0x41**	
2+3	Touch Controller (U3) Address: 0x44	
J36, J37	Jumpers J36 and J37 select the serial interface available at the EDT PolyTouch^{TM} interface connector X33. Either I2C0, or SPI0 of the phyFLEX-i.MX 6 can be brought out at X33.	
1+2	SPI0 routed to X33[1]	
2+3	**I2C0 available at X33**	
J42, J43, J50, J51	Jumpers J42, J43, J50 and J51 connect the LVDS display signals either to the PDI data connector X4, or to the custom display connector X36.	
1+2	**The phyFLEX-i.MX 6 display interface is available at X4**	
2+3	The phyFLEX-i.MX 6 display interface is connected to X36	
J59	Jumper J59 connects either VIN, or VCC12V to the additional power output for the backlight at X9.	
1+2	**VIN available at X9**	
2+3	VCC12V attached at X9	
J61	Jumper J61 allows to use the same clock signal for both camera interfaces and thus operate them synchronized. This might be useful e.g. for stereo applications	
1+2	Camera_1 interface operates with a dedicated CLK signal	
2+3	Camera_1 uses the same clock signal as Camera_0	

Table 5: phyBOARD-Subra Jumper Descriptions (continued)

[1]: **Note:** in order to use the SPI0 interface SPI0_CLK and SPI0_MISO must also be connected to X33 by mounting 0 Ohm resistors at R18 and R19

3.3 Functional Components on the phyBOARD-Subra Board

This section describes the functional components of the phyBOARD-Subra. Each subsection details a particular connector/interface and associated jumpers for configuring that interface.

3.3.1 Power Supply

Caution:
Do not change modules or jumper settings while the phyBOARD-Subra is supplied with power!

3.3.1.1 Power Connectors (X18)

Connector X18 is the primary input power supply connector of the phyBOARD-Subra. X18 is a 2-pole PHOENIX base strip 5.08 mm connector suitable for a single supply voltage of up to 24 V / 1 A.

The required current load capacity for all power supply solutions depends on the specific configuration of the phyFLEX mounted on the phyBOARD-Subra the particular interfaces enabled while executing software as well as whether an optional expansion board is connected to the carrier board. A 24 V adapter with a minimum supply of 1 A is recommended.

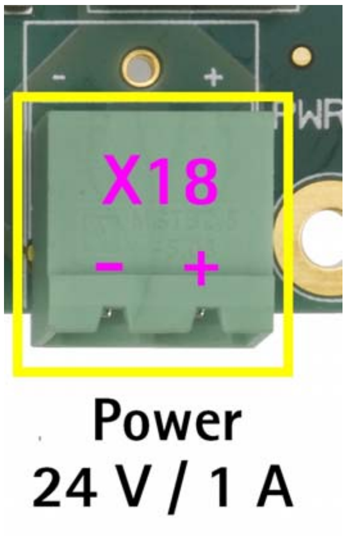


Figure 5: Power Supply Connectors

3.3.1.2 Power LEDs D13 and D14

The green LEDs D13 and D14 (see *Figure 2*) indicate the presence of the 3.3 V (D14) and 5 V (D13) supply voltage generated from input voltage.

3.3.2 RS-232 Connectivity (X56)

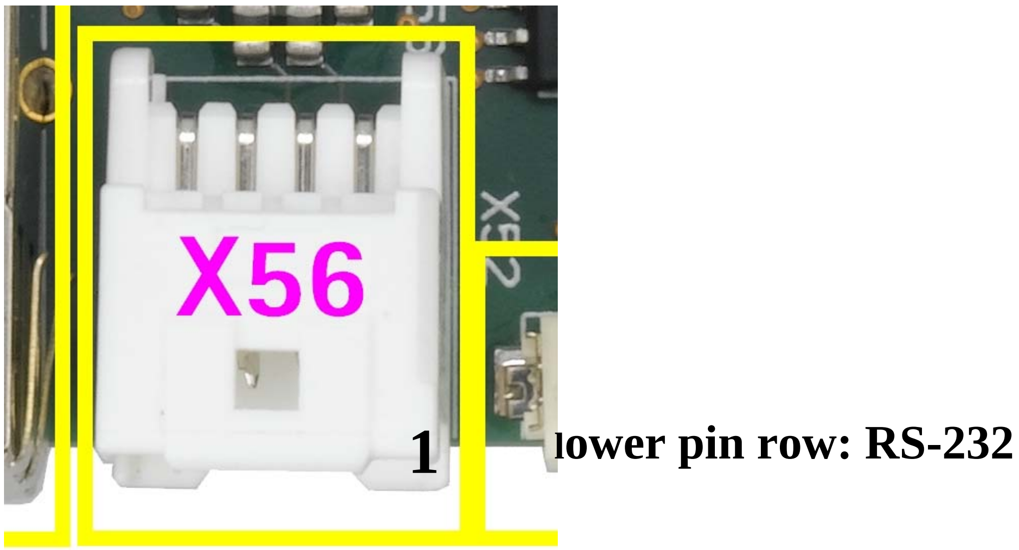


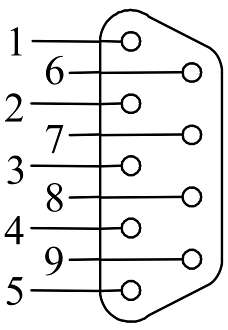
Figure 6: RS-232 Interface Connector X56

The lower pin row of connector X56 located next to the Ethernet connector (see *Figure* 2*)* provides the UART0 signals of the i.MX 6 at RS-232 level. The pins count from right to left. *Table 6* below shows the signal mapping of the RS-232 level signals at connector X56.

Pin	Signal
1	**NC**
3	**UART0_RXD_RS232**
5	**UART0_TXD_RS232**
7	**GND**

Table 6: Pin Assignment of RS-232 Connector X56

An adapter cable is included in the phyBOARD-Subra-i.MX 6 Kit to facilitate the use of the UART0 interface. The following figure shows the signal mapping of the adapter.



Pin 2:	RxD-RS232
Pin 7:	RTS-RS232
Pin 3:	TxD-RS232
Pin 8:	CTS-RS232
Pin 5:	GND

Figure 7: RS-232 Connector Signal Mapping

The signals of the phyFLEX-i.MX 6 second serial interface UART1 are available at expansion connector X13 (TTL level). Please refer to *section 4.6.4* for more informtaion.

3.3.2.1 Software Implementation

In order to use UART0 at connector 56 */dev/ttymxc3* has been implemented within the BSP. It acts as the standard console. It's mainly used for debugging and control of software updates.

3.3.3 CAN Connectivity (X56)

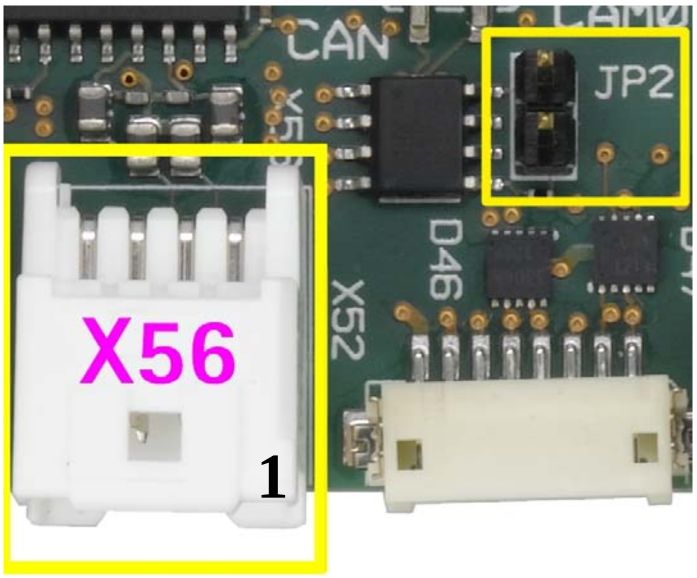


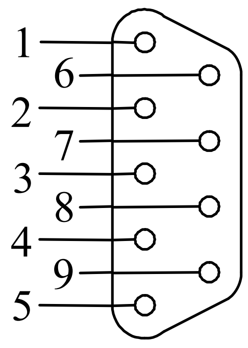
Figure 8: Components supporting the CAN Interface

The upper pin row of connector X56 located next to the Ethernet connector (see *Figure* 2*)* provides the CAN signals of the i.MX 6. The pins count from right to left. *Table 6* below shows the signal mapping of the CAN signals at connector X56.

Pin	Signal
2	**NC**
4	**X_CANH**
6	**X_CANL**
8	**GND**

Table 7: Pin Assignment of the CAN Interface at Connector X56

An adapter cable is included in the phyBOARD-Subra-i.MX 6 Kit to facilitate the use of the CAN interface. The following figure shows the signal mapping of the adapter.



Pin 6:	GND
Pin 2:	X_CANL
Pin 7:	X_CANH
Pin 3:	GND
Pin 5:	Shield

Figure 9: CAN Connector Signal Mapping

3.3.3.1 Software Implementation

The i.MX 6 SOM provides a CAN feature, which is supported by drivers using the proposed Linux standard CAN framework ”Socket-CAN”. Using this framework, CAN interfaces can be programmed with the BSD socket API.

The CAN (Controller Area Network) bus offers a low-bandwidth, prioritized message fieldbus for communication between microcontrollers. Unfortunately, CAN was not designed with the ISO/OSI layer model in mind, so most CAN APIs available throughout the industry don’t support a clean separation between the different logical protocol layers, like for example known from Ethernet.

The Socket-CAN framework for Linux extends the BSD socket API concept towards CAN bus. The Socket-CAN interface behaves like an ordinary Linux network device, with some additional features special to CAN. Thus for example you can use

ifconfig –a

in order to see if the interface is up or down, but the given MAC and IP addresses are arbitrary and obsolete.

Configuration happens within the script */etc/network/can-pre-up* which will be called by script */etc/network/interfaces*. This script will be executed by service *ifupdown.service* (located in */lib/systemd/system*) during system boot. To change default used bitrates on the target change the variable *BITRATE* in */etc/network/can-pre-up*.

For a persistent change of the default bitrates change the local *projectroot/etc/network/can-pre-up* instead and rebuild the BSP.

The information for *can0* (which is used for i.MX 6's CAN0 routed to X56) looks like

```
root@phyCORE-I.MX 6:~ ifconfig can0
can0      Link encap:UNSPEC  HWaddr 00-00-00-00-00-00-00-00-00-
00-00-00-00-00-00
          inet addr:127.42.23.180  Mask:255.255.255.0
          UP RUNNING NOARP  MTU:16  Metric:1
          RX packets:1284643 errors:0 dropped:0 overruns:0 frame:0
          TX packets:67450 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:10
          RX bytes:5138560 (4.9 MiB)  TX bytes:269767 (263.4 KiB)
          Interrupt:211
```

The output contains a standard set of parameters also shown for Ethernet interfaces, so not all of these are necessarily relevant for CAN (for example the MAC address). The following output parameters contain useful information:

Field	Description
can0	Interface Name
NOARP	CAN cannot use ARP protocol
MTU	Maximum Transfer Unit
RX packets	Number of Received Packets
TX packets	Number of Transmitted Packets
RX bytes	Number of Received Bytes
TX bytes	Number of Transmitted Bytes
errors...	Bus Error Statistics

You can send messages with *cansend* or receive messages with *candump*:

```
cansend can0 0x03 0x12 0x06
candump can0
```

See *cansend --help* and *candump --help* help messages for further information about using and options.

3.3.4 Ethernet Connectivity (X57)

The Ethernet interface ETH0 of the phyFLEX-i.MX 6 is accessible at RJ45 connector X57 of the phyBOARD-Subra.

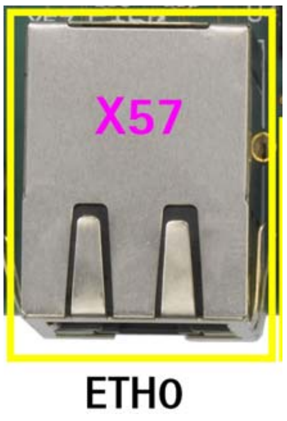


Figure 10: Ethernet Interfaces at Connectors X57

The Ethernet interfaces is configured as 10/100Base-T networks. The LEDs for LINK (green) and SPEED (yellow) indication are integrated in the connector. The interface supports HP Auto-MDIX technology, eliminating the need for the consideration of a direct connect LAN cable, or a cross-over path cable. They detect the TX and RX pins of the connected device and automatically configure the PHY TX and RX pins accordingly.

3.3.4.1 Software Implementation

The i.MX6 SOM features ethernet, which is being used to provide the network interface *eth0* with static IP 192.168.3.11 by default. The interface offers a standard Linux network port at RJ45 connector X57 which can be programmed using the BSD socket interface.

3.3.5 USB Host Connectivity (X35, X4 an X11)

The phyBOARD-Subra features two USB Host interfaces at the double USB 2.0 Standard-A socket.

USB0 is accessible at the bottom connector of X35, whereas USB1 is brought out at the top connector of X35. These interfaces are compliant with USB revision 2.0.

Jumpers J2 - J5, J39, J40, J48 and J49 allow to alternatively route USB0 to the PHYTEC Display Interface at X4, or the touch screen connector X11. Please refer to the tables on the schematic for more details.

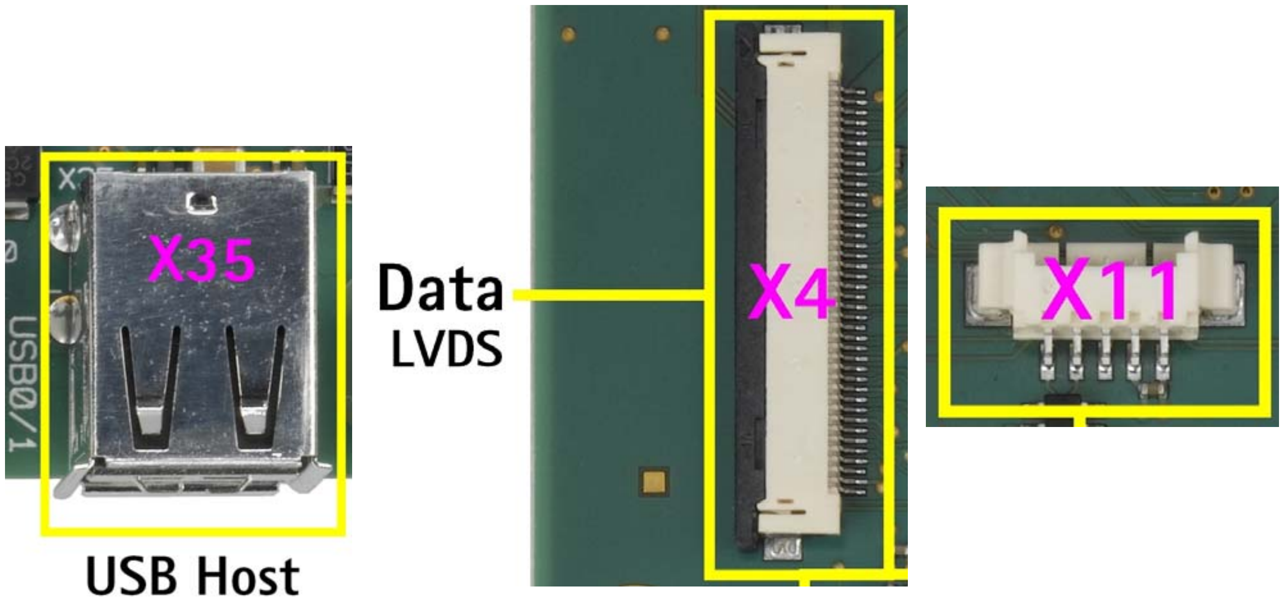


Figure 11: Components supporting the USB Interfaces

LED D8 displays the status of USB0_VBUS and LED D7 the status of USB1_VBUS (see *Figure* 2).

3.3.5.1 Software Implementation

The i.MX 6 CPU embeds one USB 2.0 EHCI controller that is also able to handle low and full speed devices (USB 1.1). It also embeds one USB 2.0 OTG controller which is hard configured as second USB Host.

The BSP includes support for mass storage devices, keyboards and mouse. Other USB related device drivers must be enabled in the kernel configuration on demand.

Due to *udev*, connecting various mass storage devices get unique IDs and can be found in */dev/disk/by-id*. These IDs can be used in */etc/fstab* to mount different USB memory devices in a different way.

3.3.6 Audio Interface (X55, X58 and X60)

The phyBOARDSubra is populated with a low-power stereo audio codec with integrated mono class-d amplifier at U35. It provides a High Performance Audio DAC and ADC with sample rates from 8 kHz to 96 kHz. It supports a stereo line input, stereo microphone input, stereo line output, stereo headphone output and direct speaker output.

The audio codec is interfaced to the phyFLEX-i.MX 6 via I²S interface for audio data and the I²C0 interface for codec configuration (I²C address 0x18).

A detailed list of applicable connectors is presented below. The pin header connector at X55 allows for direct connection of a Mono Class-D 1W BTL 8 Ohm Speaker.

X58 –	Line In, Line Output, Microphone In (pin counting from left to right starting in the lower right corner with pin 1)
X60 –	Headset Output
X55 –	Seaker Output

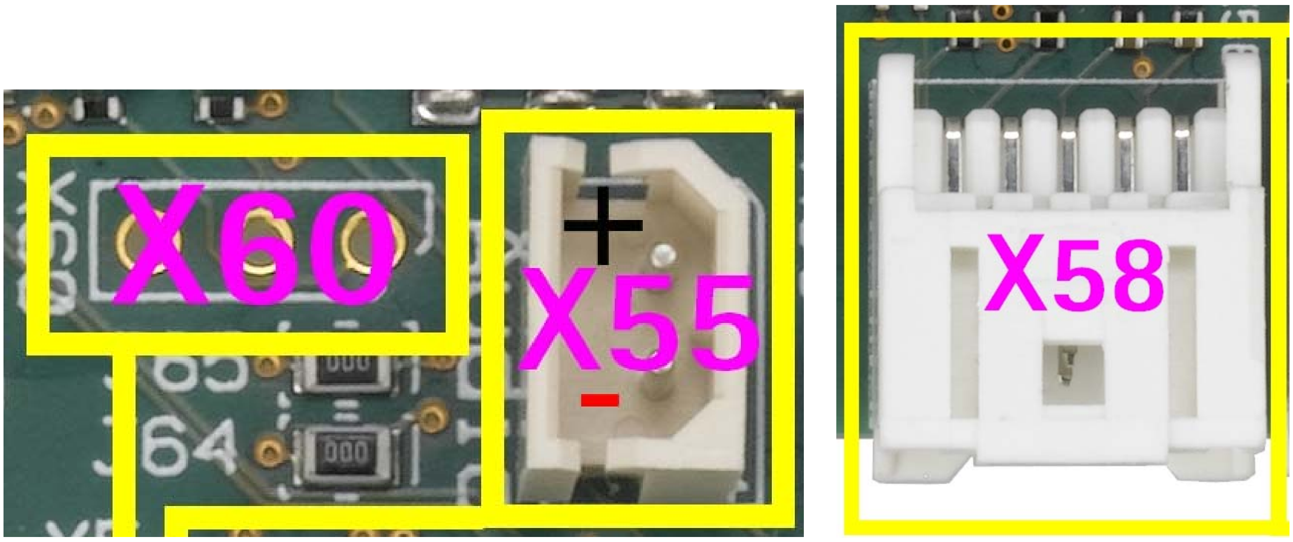


Figure 12: Audio Interfaces at Connectors X55, X58 and X60

Pin assignment at X55

Pin	Signal	Description
1	**SPOM**	**Class-D negative differential output**
2	**SPOP**	**Class-D positive differential output**

Pin assignment at X58

Pin	Signal	Pin	Signal
1	**Shield**	2	**AGND**
3	**LINE_IN_R**	4	**LINE_IN_L**
5	**LINE_OUT_R**	6	**LINE_OUT_L**
	AGND	8	**AGND**
9	**MIC_IN_R**	10	**MIC_IN_L**

Pin assignment at X60

Pin	Signal
1	**HEAD_PHONE_L**
2	**HEAD_PHONE_R**
3	**HEAD_PHONE_COM**

Please refer to the audio codec’s reference manual for additional information regarding the special interface specification.

3.3.6.1 Software Implementation

Audio support on the module is done via the I2S interface and controlled via I2C.

On the phyBOARD-Subra the audio codec's registers can be accessed via the I2C0 interface at address 0x18 (7-bit MSB addressing).

As of the printing of this manual the BSP delivered with the phyBOARD-Subra-i.MX 6 does not support the audio interfaces. Please visit the PHYTEC website for a road map of the BSP.

3.3.7 High-Definition Multimedia Interface (HDMI) (X29)

The High-Definition Multimedia Interface (HDMI) of the phyFLEX-i.MX 6 Module is compliant to HDMI 1.4, HDCP 1.4 and DVI 1.0. It supports a maximum pixel clock of 340 Mhz at a resolution of up to 1080p @ 60 Mhz and 720p/1080i @ 120 Mhz. Please refer to the *i.MX 6 Reference* Manual for more information. The HDMI interface brought out at a 0.50 mm pitch HDMI receptacle X29 on phyBOARD-Subra comprises the following signal groups: three pairs of data signals, one pair of clock signals, an I²C bus which is exclusively for the HDMI interface, and the hot plug detect (HPD) signal. Level shifters shift the I²C interface signals and the hot plug detect signal from IO voltage (VCC3V3) to 5 V, while the data and clock signals extend directly from the phyFLEX-Connector to the HDMI receptacle.

Pin #	Signal name	ST	SL	Description
1	HDMI_TMDS_DATA2+	O	HDMI	HDMI data channel 2 positive output
2	Shield		GND	
3	HDMI_TMDS_DATA2-	O	HDMI	HDMI data channel 2 negative output
4	HDMI_TMDS_DATA1+	O	HDMI	HDMI data channel 1 positive output
5	Shield		GND	
6	HDMI_TMDS_DATA1-	O	HDMI	HDMI data channel 1 negative output
7	HDMI_TMDS_DATA0+	O	HDMI	HDMI data channel 0 positive output
8	Shield		GND	Shield
9	HDMI_TMDS_DATA0-	O	HDMI	HDMI data channel 0 negative output
10	HDMI_TMDS_CLOCK+	O	HDMI	HDMI clock positive output
11	Shield		GND	Shield
12	HDMI_TMDS_CLOCK-	O	HDMI	HDMI clock positive output
13	CE_REMOTE	-	-	
14	NC	-	-	Not connected
15	X_HDMI_SCL	I/O	5 V	HDMI I²C clock signal
16	X_HDMI_SDA	I/O	5 V	HDMI I²C data signal
17	GND	-	-	Ground
18	V5_HDMI	O	5 V	5 V power supply
19	X_nHDMI_HPD	I	5 V	HDMI hot plug detection

Table 8: HDMI/DVI Connector X40 Pinout

3.3.7.1 Software Implementation

This driver gains access to the display via device node */dev/fb0* for HDMI which is default.

A simple test of the framebuffer feature can then be run with:

fbtest

This will show various pictures on the display.

You can check your framebuffer resolution with the command

fbset

⚠	*fbset* cannot be used to change display resolution or colour depth. Depending on the framebuffer device different kernel command line are mostly needed to do this.

Setting the resolution will be done within Barebox's environment. Therefore within script */env/video/display* you will find the lines

#HDMI Resolution
hdmi_res=1280x1024M@60

You'll also find the lines

# Set prim out put (hdmi/ldb)
prim_out=hdmi

In case that you want to select the display connector instead of the HDMI connector as /dev/fb0, just modify to

prim_out=ldb

⚠	Because the i.MX6 on the module is a SOLO (i.e. single core version), it cannot access HDMI and display connector at the same time.

3.3.7.2 Using Qt

Nokia's Qtopia is very commonly used for embedded systems and it's supported by this BSP. Please visit http://qt.nokia.com in order to get all the documentation that are available about this powerful cross-platform GUI toolkit.

Within the BSP come some demos that show what is possible with Qt version 4.7.4. They're located in */usr/bin/qt4-demos*. In order to try them you need to connect an USB mouse or USB keyboard to the board.

Start demos with commands like:

```
cd /usr/bin/qt4-demos
spreadsheet/spreadsheet -qws
```

Each of the Qt applications shows a standardized little green Qt-icon at its upper left side that offers standard window functions like minimize, maximize and close.

Demo *fluidlauncher* will be started automatically after booting.

3.3.8 PHYTEC Display Interface (X4, X5)

The various performance classes of the phyFLEX family allow to attach a large number of different displays varying in resolution, signal level, type of the backlight, pinout, etc. In order not to limit the range of displays connectable to the , the phyBOARD-Subra has no special display connector suitable only for a small number of displays. The new concept intends the use of an adapter board (e.g. PHYTEC's LCD display adapters LCD-014, LCD-017 and LCD-018) to attach a special display, or display family to the phyBOARD-Subra. A new PHYTEC Display-Interface (PDI) was defined to connect the adapter board to the phyBOARD-Subra. It consists of two universal connectors which provide the connectivity for the display adapter. They allow easy adaption also to any customer display. One connector (40 pin FFC connector 0.5 mm pitch) at X4 is intend for connecting all data signals to the display adapter. It combines various interface signals like LVDS, USB, I2C, etc. required to hook up a display. The second connector of the PDI (AMP microMatch 8-338069-2) at X5 provides all supply voltages needed to supply the display and a backlight, and the brightness control.

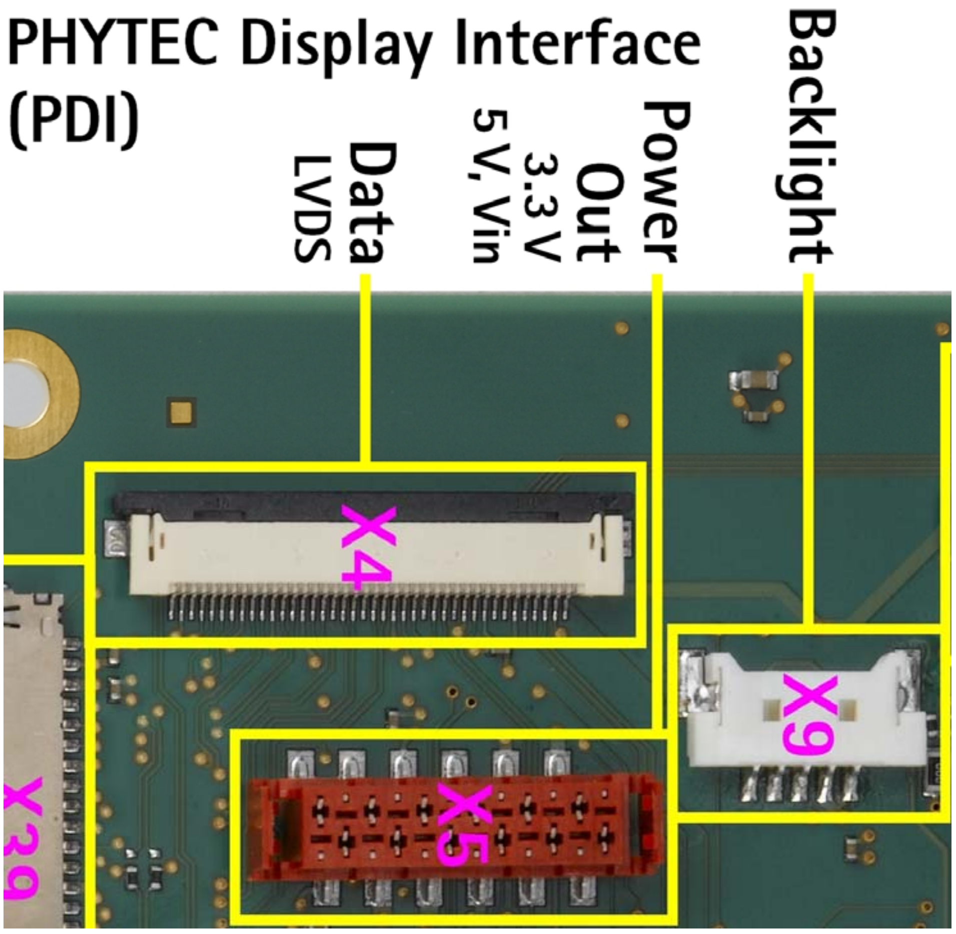


Figure 13: PHYTEC Display Interface Connectors X4, X5 and X9

The following sections contain specific information on each connector.

3.3.8.1 Display Data Connector (X4)

PDI data connector X4 provides display data from the serial LVDS display interface of the phyFLEX- i.MX 6.

In addition other useful interfaces such as USB, I^{2}C, etc. are available at PDI data connector X4. *Table 10* lists all miscellaneous signals and gives detailed explanations. The following table shows the pin-out of the PDI's display data connectors at X4.

The display data connector at X4 is 40 pin FFC connector with 0.5 mm pitch.

Pin #	Signal name	ST	SL	Description
1	SPI0_SCLK	O	3.3 V	SPI 0 clock
2	SPI0_MISO	I/O	3.3 V	SPI 0 master data in; slave data out
3	SPI0_MOSI	O/I	3.3 V	SPI 0 master data out; slave data in
4	SP10_CS0	O	3.3 V	SPI 0 chip select display
5	GPIO6	I	3.3 V	Display interrupt input[1]
6	VCC3V3	O	3.3 V	Power supply display[2]
7	I2C0_SCL	I/O	3.3 V	I^{2}C clock signal
8	I2C0_SDA	I/O	3.3 V	I^{2}C data signal
9	GND	-	-	Ground
10	LVDS_DISP_BACKLIGHT_PWM	O	3.3 V	PWM brightness output
11	VCC3V3	O	3.3 V	Logic supply voltage[1]
12	nPower_ON/Wake/OFF	I	3.3 V	Power on/off Button
13	nLVDS-DISP_EN	O	3.3 V	Display enable signal
14	HW-Introspection	I/O	3.3 V	Hardware Introspection Interface **for internal use only**
15	GND	-	-	Ground
16	USB_DP_DISP	I/O	3.3 V	USB data +
17	USB_DM_DISP	I/O	3.3 V	USB data -
18	GND	-	-	Ground
19	LVDS_L0-_LCD_Adapter	O	3.3 V	LVDS data channel 0 negative output
20	LVDS_L0+_LCD_Adapter	O	3.3 V	LVDS data channel 0 positive output
21	GND	-	-	Ground
22	LVDS_L1-_LCD_Adapter	O	3.3 V	LVDS data channel 1 negative output
23	LVDS_L1+_LCD_Adapter	O	3.3 V	LVDS data channel 1 positive output

Table 9: Display Data Connector Signal Description

[1]: Connects to GPIO.....
[2]: Provided to supply any logic on the display adapter. Max. draw 100 mA

24	GND	-	-	Ground
25	LVDS_L2-_LCD_Adapter	O	3.3 V	LVDS data channel 2 negative output
26	LVDS_L2+_LCD_Adapter	O	3.3 V	LVDS data channel 2 positive output
27	GND	-	-	Ground
28	LVDS_L3-_LCD_Adapter	O	3.3 V	LVDS data channel 3 negative output
29	LVDS_L3+_LCD_Adapter	O	3.3 V	LVDS data channel 3 positive output
30	GND	-	-	Ground
31	LVDS_CLK-_LCD_Adapter	O	3.3 V	LVDS clock channel negative output
32	LVDS_CLK+_LCD_Adapter	O	3.3 V	LVDS clock channel positive output
33	GND	-	-	Ground
34	TS_X+	I/O	3.3 V	Touch
35	TS_X-	I/O	3.3 V	Touch
36	TS_Y+	I/O	3.3 V	Touch
37	TS_Y-	I/O	3.3 V	Touch
38	NC	-	-	Not connected
39	GND	-	-	Ground
40	LS_ANA	I	3.3 V	Light sensor analog input (not supported)

Table 9: Display Data Connector Signal Description (continued)

The table below shows the auxiliary interfaces at display data connector X4.

Signal	Description
USB	USB host interface derived USB0 (jumper configuration required). Suitable for optional features e.g. front USB.
I2C0	I^{c}C interface for optional EEPROM, or other I^{2}C devices
SPI0	SPI interface to connect optional SPI slave
1-WIRE	Hardware Introspection Interface **For internal use only**
/Power_ON/Wake/OFF	Power on/off signal to allow for an ON/OFF switch on a front panel. It connects to the PWRON input of the CMIC on the phyFLEX-i.MX 6
nLVDS-DISP_EN	Can be used to enable, or disable the display, or to shutdown the backlight.
LVDS_DISP_BACKLIGHT_PWM	PWM output to control the brightness of a display´s backlight (0%=dark, 100%=bright).
LS_ANA	Analog light sensor input. The phyBOARD-Subra does not support an analog light sensor

Table 10: Auxiliary Interfaces at PDI Data Connector X4

3.3.8.2 Display Power Connector (X5)

The display power connector X5 (AMP microMatch 8-188275-2) provides all supply voltages needed to supply the display and a backlight.

Pin #	**Signal name**	**ST**	**SL**	**Description**
1	GND	-		Ground
2	VCC3V3	O	3.3 V	3.3 V power supply display
3	GND	-		Ground
4	VCC5	O	5 V	5V power supply display
5	GND	-		Ground
6	VCC5	O	5 V	5 V power supply display
7	GND	-		Ground
8	VCC5	O	5 V	5 V power supply display
9	GND	-		Ground
10	LVDS_DISP_BACKLIGHT_PWM	O	3.3 V	PWM brightness output
11	VIN	O	+12 V	Backlight power supply
12	VIN	O	+12 V	Backlight power supply

Table 11: PDI Power Connector X5 Signal Description

3.3.8.3 Display Power Connector (X9)

The phyBOARD-Subra features a second display power connector at X9. This one is intend to be used in case of space constraints.

The following table shows the pinout of the 1.25 mm pitch Molex PanelMate^{TM} header.

Pin #	**Signal name**	**ST**	**SL**	**Description**
1	VIN/VCC12V	O	VIN or 12 V	Supply voltage output. Configurable with jumper J59
2	VCC5	O	5 V	5V power supply display
3	VCC3V3	O	3.3 V	3.3 V power supply display
4	GND	-		Ground
5	GND	-		Ground

Table 12: Display Power Connector X9 Signal Description

Jumper J59 selects the output voltage at pin 1. The default position 1+2 connects the input voltage VIN to pin 1 of connector X9. Alternatively the specially generated 12 V backlight supply voltage can be connected by changing jumper J59 to 2+3.

3.3.8.4 Software Implementation

Because default setting for this BSP is to use the HDMI connector, using the display connector affords a modification within Barebox's environment. Therefore within script */env/video/display* you'll find the lines:

# Set prim out put (hdmi/ldb)
prim_out=hdmi

Please modify to:

prim_out=ldb

Within this script you'll also find the possibility to select which display is attached. The BSP is already prepared for use with the PrimeView displays PD050VL1 (640x480), PD035VL1 (640x480), PD104SLF (800x600), PM070WL4 (800x480) and for the ETM0700G0DH6 (800x480). Simply modify comments of these lines:

#Displays
#display=Primeview-PD050VL1
#display=Primeview-PD035VL1
#display=Primeview-PD104SLF
#display=Primeview-PM070WL4
display=ETM0700G0DH6

For further information about using a display see chapters 3.3.5.1 and 3.3.5.2.

3.3.9 Custom Display Interface (X39)

Meanwhile there are a few displays with kind of standardized interfaces on the market. The custom display connector X39 is intend to connect these displays

The custom display connector at X39 is a 20 pin FFC connector with 0.5 mm pitch.

Pin #	Signal name	ST	SL	Description
1	VCC3V3	O	3.3 V	Power supply display[1]
2	VCC3V3	O	3.3 V	Power supply display
3	LVDS_CONFIG1	O	3.3 V	Display configuration pin 1
4	LVDS_CONFIG2	O	3.3 V	Display configuration pin 2
5	LVDS_L0-_EDT_Display	O	3.3 V	LVDS data channel 0 negative output
6	LVDS_L0+_EDT_Display	O	3.3 V	LVDS data channel 0 positive output
7	GND	-	-	Ground
8	LVDS_L1-_EDT_Display	O	3.3 V	LVDS data channel 1 negative output
9	LVDS_L1+_EDT_Display	O	3.3 V	LVDS data channel 1 positive output
10	GND	-	-	Ground
11	LVDS_L2-_EDT_Display	O	3.3 V	LVDS data channel 2 negative output
12	LVDS_L2+_EDT_Display	O	3.3 V	LVDS data channel 2 positive output
13	GND	-	-	Ground
14	LVDS_CLK-_EDT_Display	O	3.3 V	LVDS clock channel negative output
15	LVDS_CLK+_EDT_Display	O	3.3 V	LVDS clock channel positive output
16	GND	-	-	Ground
17	LVDS_L3-_ EDT_Display	O	3.3 V	LVDS data channel 3 negative output
18	LVDS_L3+_ EDT_Display	O	3.3 V	LVDS data channel 3 positive output
19	LVDS_CONFIG3	O	3.3 V	Display configuration pin 3
20	LVDS_CONFIG4	O	3.3 V	Display configuration pin 4

Table 13: Custom Display Connector Signal Description X39

3.3.9.1 Custom Display Backlight Connector (X38)

In order to support a backlight for the custom display X38 provides the supply voltages and control signals necessary.

[1]: Provided to supply any logic on the display adapter. Max. draw 100 mA

The following table shows the pinout of the 1.25 mm pitch Molex PanelMate™ header.

Pin #	**Signal name**	**ST**	**SL**	**Description**
1	NC			Not connected
2	LVDS_DISP_BACKLIGHT_PWM	O	3.3 V	PWM brightness output
3	LVDS_DSP_EN	O	5 V	3.3 V power supply display
4	GND	-		Ground
5	VCC12V	O	12 V	Supply voltage output (max. 2 A)
6				

Table 14: Custom Display Power Connector X38 Signal Description

3.3.9.2 Software Implementation

Please refer to *section 3.3.8.4*

3.3.10 Touch Screen Connectivity

As many smaller applications need a touch screen as user interface, different provisions are made to connect as well 4- wire resistive touch screens as various capacitive touch screens.

The following table summarizes the different connectors available to connect a touch screen.

Connector	**Touch Screen**
X36	4-wire resistive touch
X4 (pins 34 – 37)	
X33	Capacitive EDT PolyTouch™
X11	Capacitive touch screen with USB interface
X19	Capacitive touch screen with I^{2}C interface

Table 15: Touch Screen Connectivity

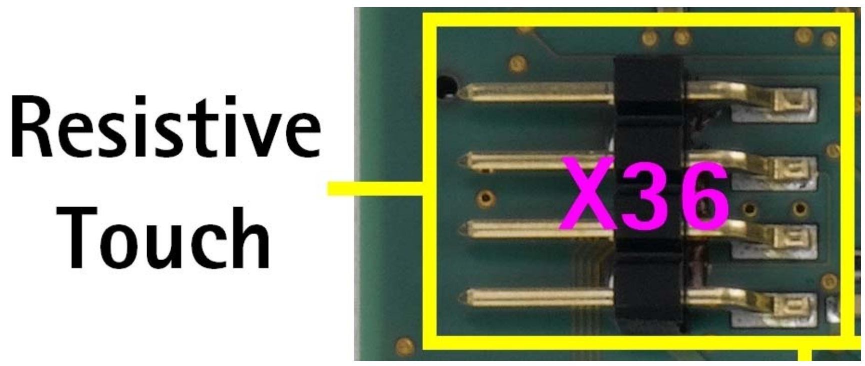


Figure 14: Touch Screen Connectors X36

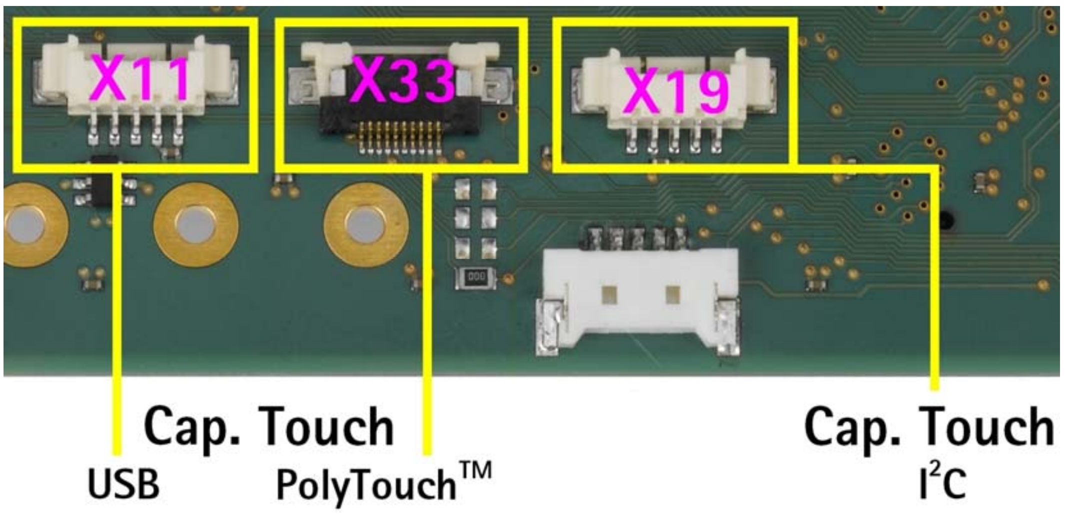


Figure 15: Touch Screen Connectors X11, X19, X33

3.3.10.1 Software Implementation

The BSP of the phyBOARD-Subra supports touch screens connected via I^{2}C. Hence capacitive touch screens provided with a touch controller and connected to X33, or X19 and resistive touch screens using the touch controller at U3 on the phyBOARD-Subra (connection via X36, or X4).

A simple test of this feature can be run with

ts_calibrate

to calibrate the touch and with

ts_test

to execute a simple application using this feature.

3.3.11 JTAG Interface (X3)

The JTAG interface of the phyFLEX-i.MX 6 is accessible at connector X3 on the phyBOARD-Subra This interface is compliant with JTAG specification IEEE 1149.1 or IEEE 1149.7. No jumper settings are necessary for using the JTAG port.

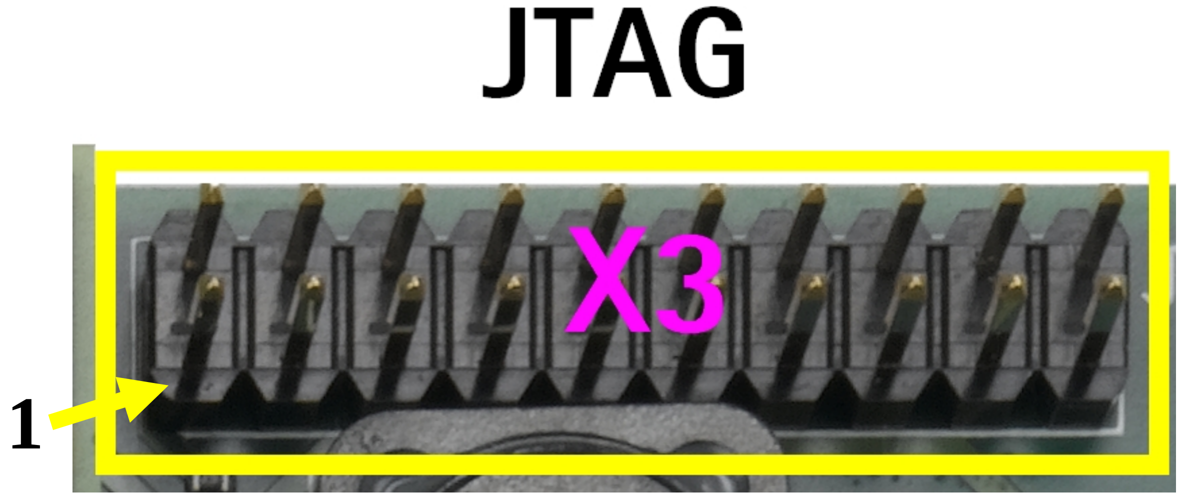


Figure 16: PHYTEC Display Interface Connectors X4, X5 and X9

The following table describes the signal configuration at X3. When referencing contact numbers note that pin 1 is located at the angled corner. Pins towards the edge of the phyBOARD-Subra are even numbered.

Pin #	Signal Name	ST	SL	Description
1	VCC3V3	O	3.3 V	JTAG reference voltage
2	VCC3V3	O	3.3 V	JTAG supply voltage
3	nJTAG_TRST	I	3.3 V	JTAG Test Reset
4,6,8,10, 12,14,18 ,20	GND	-		Ground
5	JTAG_TDI	I	3.3 V	JTAG Test Data Input
7	JTAG_TMS	I/O	3.3 V	JTAG Test Mode Select Signal
9	JTAG_TCK	I	3.3 V	JTAG Test Clock Signal
11	JTAG_RTCLK	O	3.3 V	JTAG Return Test Clock Signal
13	JTAG_TDO	O	3.3 V	JTAG Test Data Output
15	nRESET_IN	I	3.3 V	System Reset
17	n.c.	-	-	-
19	n.c.	-	-	-

Table 16: JTAG Connector X3

3.3.12 Secure Digital Memory Card/ MultiMedia Card (X12)

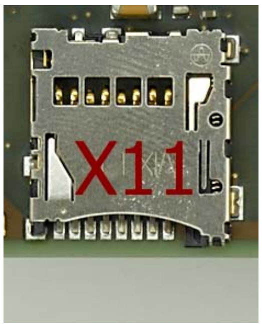


Figure 17: SD / MM Card interface at connector X11

The phyBOARD-Subra provides a standard microSDHC card slot at X12 for connection to SD/MMC interface cards. It allows easy and convenient connection to peripheral devices like SD- and MMC cards. Power to the SD interface is supplied by inserting the appropriate card into the SD/MMC connector, who features a card detection, a lock mechanism and a smooth extraction function by Push-in /-out of card.

3.3.12.1 Software Implementation

The phyBOARD-Subra supports a slot for Micro Secure Digital Cards and Micro Multi Media Cards to be used as general purpose blockdevices. These devices can be used in the same way as any other blockdevice.

⚠	These kind of devices are hot pluggable, so you must pay attention not to unplug the device while it's still mounted. This may result in data loss.

After inserting an MMC/SD card, the kernel will generate new device nodes in */dev*. The full device can be reached via its */dev/mmcblk0* device node, MMC/SD card partitions will occur in the following way:

```
/dev/mmcblk0p<Y>
```

<Y> counts as the partition number starting from 1 to the max count of partitions on this device.

⚠	These partition device nodes will only occur if the card contains a valid partition table ("hard disk" like handling). If it does not contain one, the whole device can be used for a filesystem ("floppy" like handling). In this case */dev/mmcblk0* must be used for formatting and mounting.

The partitions can be formatted with any kind of filesystem and also handled in a standard manner, e.g. the *mount* and *umount* command work as expected.

⚠	The cards are always mounted as being writable. Setting of write-protection of MMC/SD cards is not recognized.

In general the i.MX 6 processor on the phyFLEX-i.MX 6 can boot from an SD card. Please refer to *section 4.4.*

⚠	The phyBOARD-Subra-i.MX6 is configured for booting from NAND only! In order to be able to boot from SD card, you need to close solder jumpers R4 and R5!

3.3.13 RTC U8

The phyBOARD-Subra is equipped with an RTC RV-4162-C7 at U8. The RTC interrupt can be connected to either ...

A Gold Cap

3.3.13.1 Software Implementation

The RTC on the phyBOARD-Subra can be accessed as */dev/rtc1*. It also has the entry */sys/class/rtc/rtc1* in the sysfs file system, where you can read for example the *name*.

Date and time can be manipulated with the *hwclock* tool, using the *-w* (systohc) and *-s* (hctosys) options. For more information about this tool refer to the manpage of *hwclock*.

To set the date first use *date* (see *man date* on the PC) and then run *hwclock -w -u* to store the new date into the RTC.

The internal RTC of the i.MX6 can be accessed as /dev/rtc2, but please note that it is not very precisely.

/dev/rtc0 would be the internal RTC of the PMIC, but it is non-functional.

3.3.14 Boot Mode

The pyhBOARD-Subra has a defined boot sequence:

1. NAND
2. SD/MMC

The exact choosen boot mode in the processor is SYSBOOT[4:0] = 10011b : NAND, NANDI2C, MMC0, UART0

3.3.15 CPU core frequency Scaling

The phyCORE-i.MX 6 supports dvfs (dynamic voltage and frequency scaling). Four different frequencies are supported. Type:

```
cat /sys/devices/system/cpu/cpu0/cpufreq/scaling_available_frequencies
```

and you'll get them all listed. In case you have an AM3354 or AM3359 with a maximum of 800MHz these are:

```
300000 600000 720000 800000
```

The voltages are scaled according to the setup of the frequencies.

You can decrease the maximum frequency (e.g. to 720000)

```
echo 720000 > /sys/devices/system/cpu/cpu0/cpufreq/scaling_max_freq
```

or increase the minium frequency (e.g. to 600000)

```
echo 600000 > /sys/devices/system/cpu/cpu0/cpufreq/scaling_min_freq
```

Asking for the current frequency will be done with:

```
cat /sys/devices/system/cpu/cpu0/cpufreq/scaling_cur_freq
```

So called governors are selecting one of this frequencies in accordance to their goals, automatically. Available governors are:

performance Always selects the highest possible CPU core frequency.

powersave Always selects the lowest possible CPU core frequency.

ondemand Switches between possible CPU core frequencies in reference to the current system load. When the system load increases above a specific limit it increases the CPU core frequency immediately. This is the default governor when the system starts up.

userspace Allows the user or userspace program running as root to set a specific frequency (e.g. to 600000):

```
echo 600000 > /sys/devices/system/cpu/cpu0/cpufreq/scaling_setspeed
```

So when you type

```
cat /sys/devices/system/cpu/cpu0/cpufreq/scaling_available_governors
```

you'll get the result:

```
userspace powersave ondemand performance
```

In order to ask for the current governor, type

```
cat /sys/devices/system/cpu/cpu0/cpufreq/scaling_governor
```

and you'll normally get:

```
ondemand
```

Switching over to another governor (e.g. *userspace*) will be done with:

```
echo userspace > /sys/devices/system/cpu/cpu0/cpufreq/scaling_governor
```

For more detailed information about the govenors refer to the linux kernel documentation in:

Documentation/cpu-freq/governors.txt.

3.3.16 System Reset Button (S2)

The phyBOARD-Subra is equipped with a system reset button at S2. Pressing this button will toggle the X_nRESET_IN pin (X64A11) of the phyCORE SOM low, causing the module to reset. Additionally, a reset is generated on nRESET_OUT to reset peripherals.

3.3.16.1 Software Implementation

See chapter 3.3.9.1.

4 System Level Customizing

4.1 About this Section

This Section addresses advanced developers who want to configure, build and install a new kernel and file system, design custom expansion boards, or display adapters. It includes the following information:

- Step by step instructions on how to configure, build and install a new kernel and file system using the LiveDVD
- An explanation on how to set up PTXdist and the BSP on your Linux Host PC
- A description how to update the Bootloader and how to write the Kernel and Root File System into the Flash from within your own Linux system
- Detailed information on the different interfaces and features of the phyBOARD-Subra at a system level

4.2 Software Overview

In chapter 2 you have learned how to work with Eclipse. The following section shows you how to work with PTXdist.

PTXdist is a GPL licensed tool for userlands, started by Pengutronix a close partner of PHYTEC. It is mainly a development environment to build your own embedded linux system. PTXdist creates a complete runable operating system with the root filesystem and all it’s applications. After building the BSP on your host PC you can download it to and execute it on the target.

4.3 Getting Started with the BSP

In this chapter you will go through some software topics. First you will configure and compile your own kernel and root file system. With the help of PTXdist you can add additional features, or disable them if they are not needed. After compiling the new images, you will learn how to write the newly created kernel and root file system into target’s flash memory and how to start from.

4.3.1 Working with the Kernel

In this part you will learn how to configure and build a new Linux kernel and a root file system. Then you will configure the kernel and the root file system with the help of PTXdist, a tool to build the Board Support Package and to create your own image. After the configuration you will create your own image.

To configure your images the following files are already pre-installed:

- ptxdist-2012.03.0.tar.bz2 (Tool from our partner Pengutronix, that configures and compiles BSPs)
- arm-cortexa9-linux-gnueabi (Toolchain)
- BSP-phyBOARD-SUBRA-i.MX 6-PDX14.0.0 (BSP for the phyBOARD)

4.3.2 Working with the filesystem

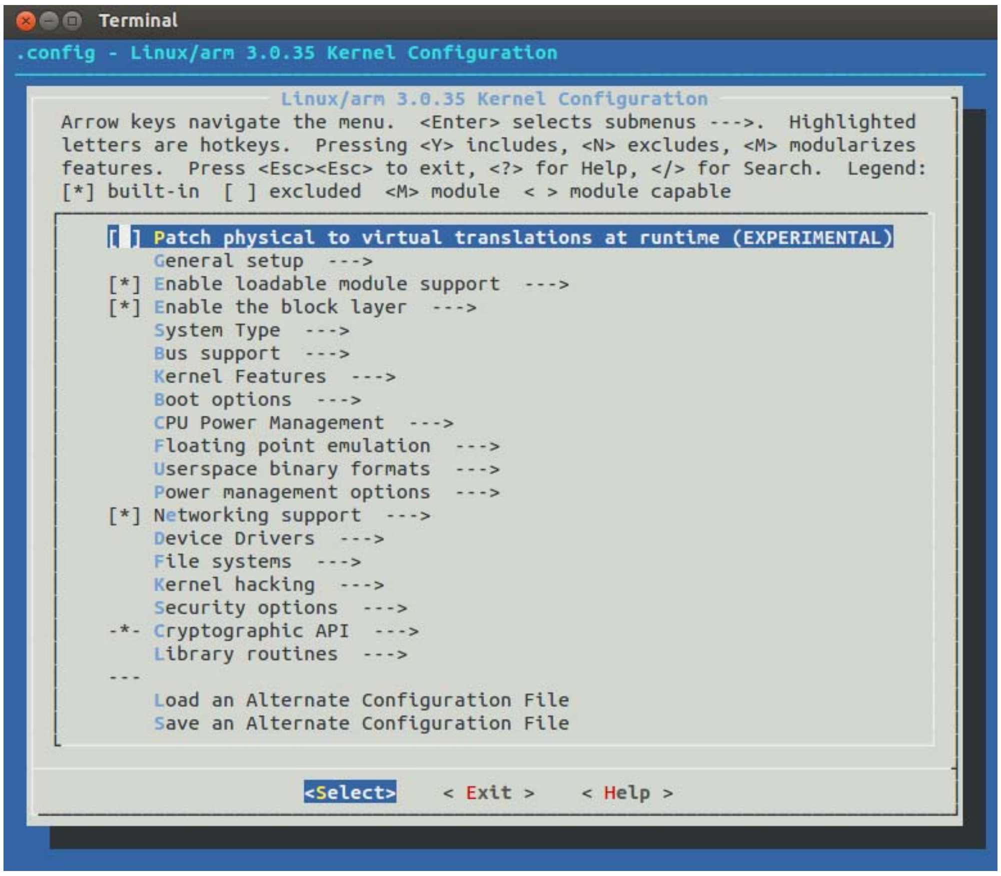
Let's start by opening a new terminal if you haven't already opened it and switch to the directory of the pre-installed BSP:

- Click the terminal icon on your desktop

Terminal

- Type the following command to change to the BSP-directory: **cd /opt/PHYTEC_BSPs/BSP-phyBOARD-SUBRA-i.MX 6-PD14.0.0**
- Type the following to show the deselected/selected kernel features: **ptxdist kernelconfig**

You should see the following output on the terminal:



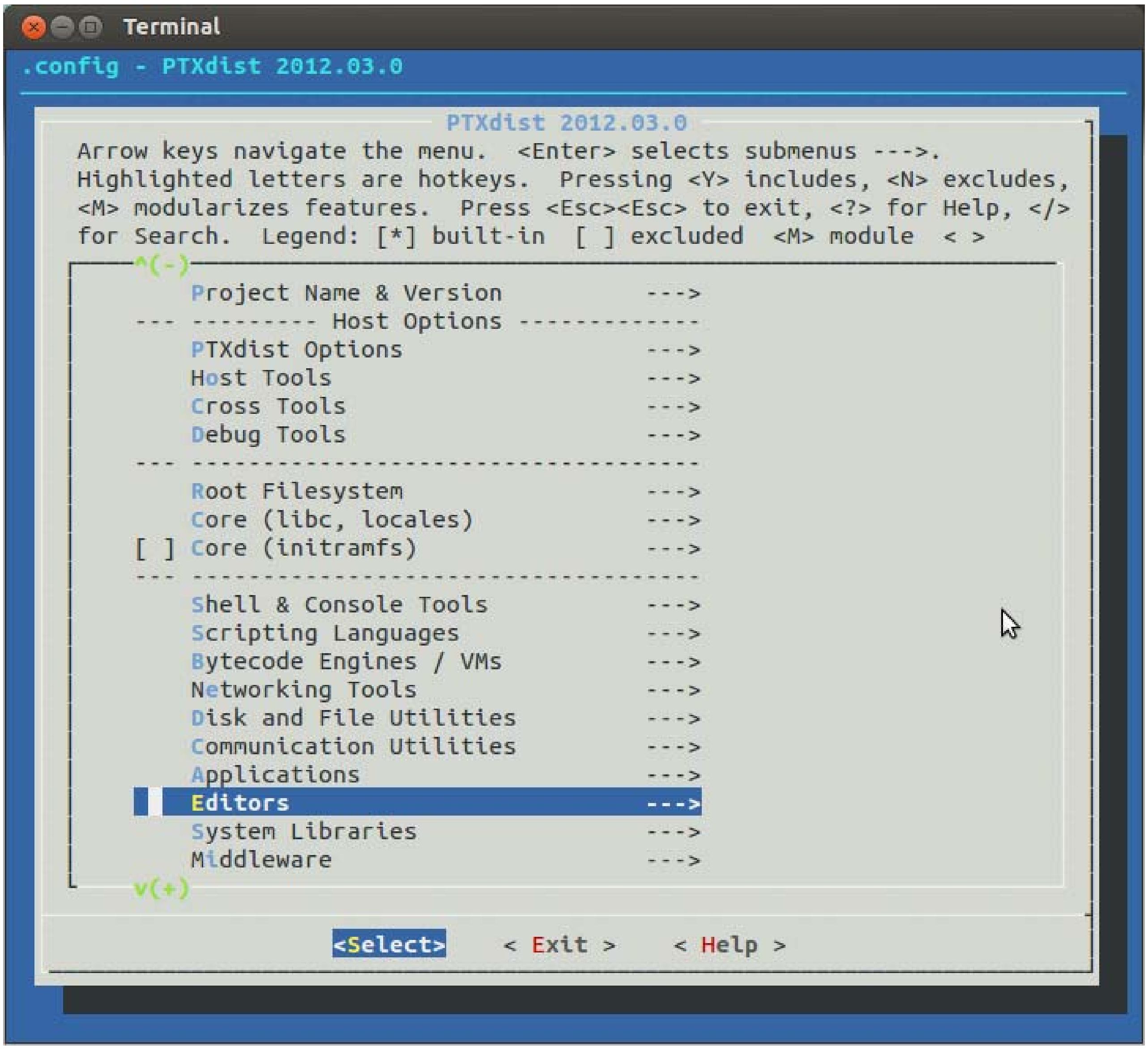
```
Terminal
.config - Linux/arm 3.0.35 Kernel Configuration
                    Linux/arm 3.0.35 Kernel Configuration
  Arrow keys navigate the menu.  <Enter> selects submenus --->.  Highlighted
  letters are hotkeys.  Pressing <Y> includes, <N> excludes, <M> modularizes
  features.  Press <Esc><Esc> to exit, <?> for Help, </> for Search.  Legend:
  [*] built-in  [ ] excluded  <M> module  < > module capable

      [ ] Patch physical to virtual translations at runtime (EXPERIMENTAL)
          General setup  --->
      [*] Enable loadable module support  --->
      [*] Enable the block layer  --->
          System Type  --->
          Bus support  --->
          Kernel Features  --->
          Boot options  --->
          CPU Power Management  --->
          Floating point emulation  --->
          Userspace binary formats  --->
          Power management options  --->
      [*] Networking support  --->
          Device Drivers  --->
          File systems  --->
          Kernel hacking  --->
          Security options  --->
      -*- Cryptographic API  --->
          Library routines  --->
      ---
          Load an Alternate Configuration File
          Save an Alternate Configuration File

                  <Select>    < Exit >    < Help >
```

- Leave the menu by selecting < *Exit* > at the bottom with the arrow right key and press **Enter**

Now we take a look into the user space and add a new program in the root file system.

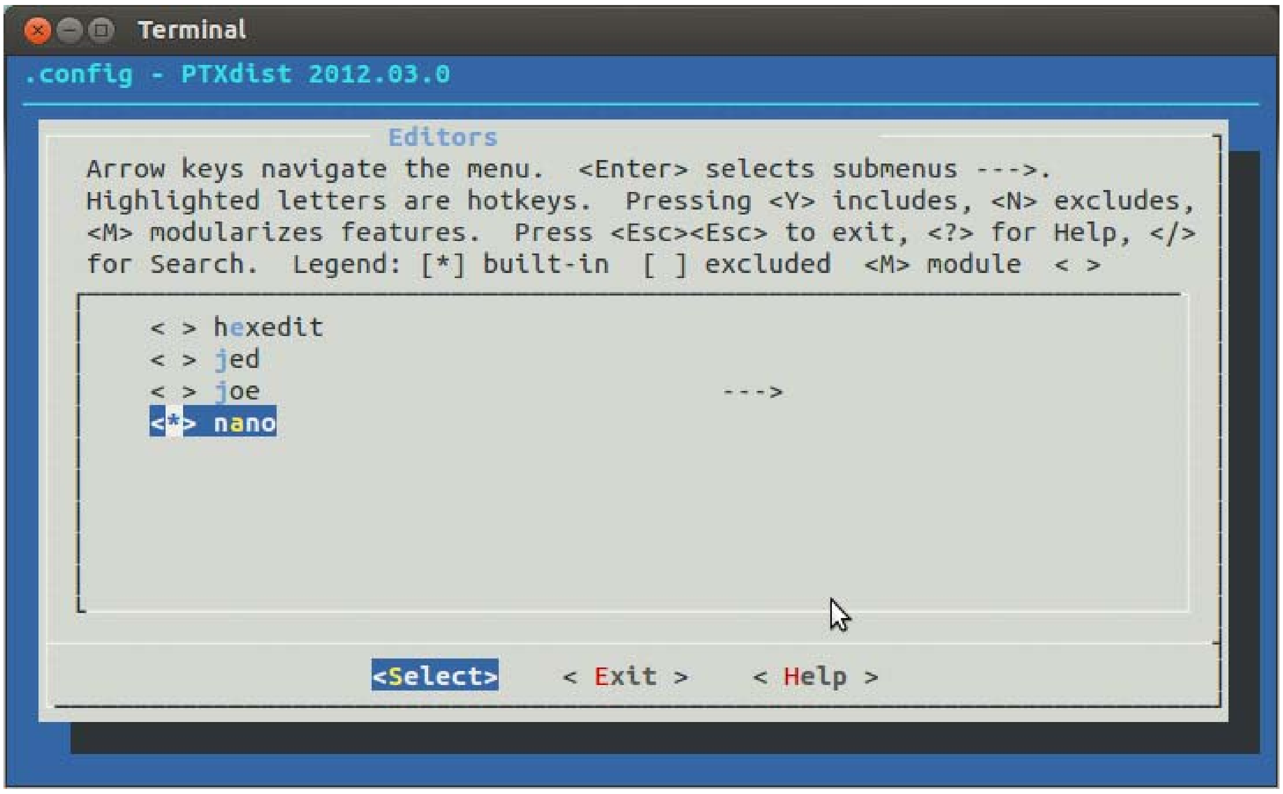
- Type the following:
  ptxdist menuconfig

You should see the following output:



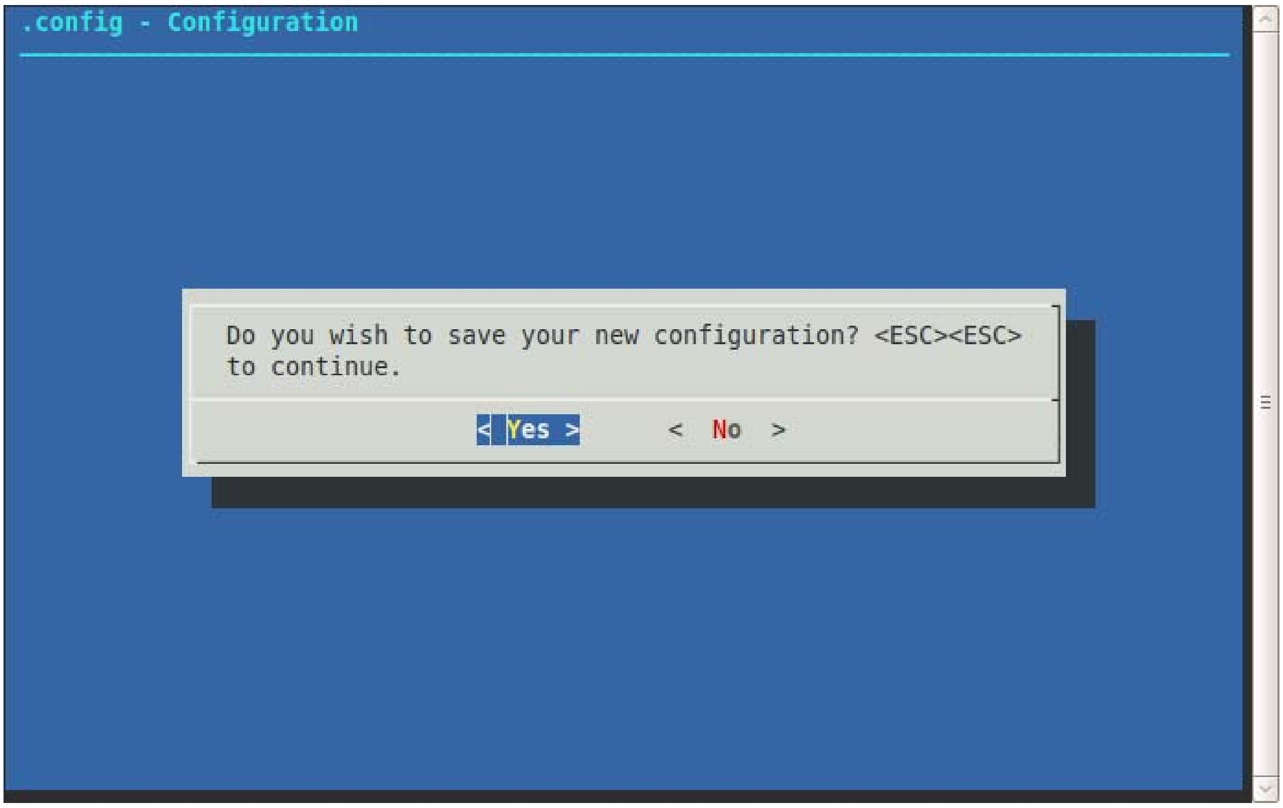
```
Terminal
.config - PTXdist 2012.03.0
                              PTXdist 2012.03.0
  Arrow keys navigate the menu.  <Enter> selects submenus --->.
  Highlighted letters are hotkeys.  Pressing <Y> includes, <N> excludes,
  <M> modularizes features.  Press <Esc><Esc> to exit, <?> for Help, </>
  for Search.  Legend: [*] built-in  [ ] excluded  <M> module  < >
      ^(-)
          Project Name & Version          --->
      --- --------- Host Options -------------
          PTXdist Options                 --->
          Host Tools                      --->
          Cross Tools                     --->
          Debug Tools                     --->
      --- ------------------------------------
          Root Filesystem                 --->
          Core (libc, locales)            --->
      [ ] Core (initramfs)                --->
      --- ------------------------------------
          Shell & Console Tools           --->
          Scripting Languages             --->
          Bytecode Engines / VMs          --->
          Networking Tools                --->
          Disk and File Utilities         --->
          Communication Utilities         --->
          Applications                    --->
          Editors                         --->
          System Libraries                --->
          Middleware                      --->
      v(+)

                 <Select>    < Exit >    < Help >
```

- For example we add *nano* to the user space which is another editor. With the help of the up and down arrow key we select *Editors* and press **Enter**.
- After that, we navigate to *nano* in the list of editors. By pressing **Y** we select *nano* as "*built-in*".



```
Terminal
.config - PTXdist 2012.03.0
                              Editors
  Arrow keys navigate the menu.  <Enter> selects submenus --->.
  Highlighted letters are hotkeys.  Pressing <Y> includes, <N> excludes,
  <M> modularizes features.  Press <Esc><Esc> to exit, <?> for Help, </>
  for Search.  Legend: [*] built-in  [ ] excluded  <M> module  < >

        < > hexedit
        < > jed
        < > joe                                 --->
        <*> nano

                    <Select>    < Exit >    < Help >
```

- Leave the menu by selecting < *Exit* > at the bottom with the arrow right key and press **Enter**. Repeat this until a question appears to save the new configuration.
- Select < *Yes* > and press **Enter** to save the configuration.



```
.config - Configuration

     Do you wish to save your new configuration? <ESC><ESC>
     to continue.

                    < Yes >      <  No  >
```

- Now we can start building the configured BSP. Type :**ptxdist go** in the terminal window
- After it is finished you can finally create the root file system by calling:
  ptxdist images

You will find the kernel named *linuximage* and the root file system named *root.ubifs* in the directory *platform- phyBOARD-SUBRA-i.MX 6 /images/*.

4.3.3 Writing the Images into the Target's Flash

In this section you will find a description on how to write the newly created images into the phyBOARD-Subra-i.MX 6's flash memory. Before the images can be written into the flash, the target will have to download them from a TFTP server which is already pre-installed in our LiveDVD. This will be done from the command line of the boot loader. The images will be copied into the target's RAM. Then you will have to erase the part of the flash to which you want to copy the images. Finally the images are written from the RAM to the flash.

In the default configuration you will find four partitions on the target: The first partition contains the boot loader, the second is used to store the boot loader settings, the third partition stores the Linux kernel, and the fourth contains the root file system.

⚠	You should never erase the Barebox partition. If this partition is erased, you won't be able to start your target anymore. In such a case refer to chapter *4.4* "*Updating the software*".

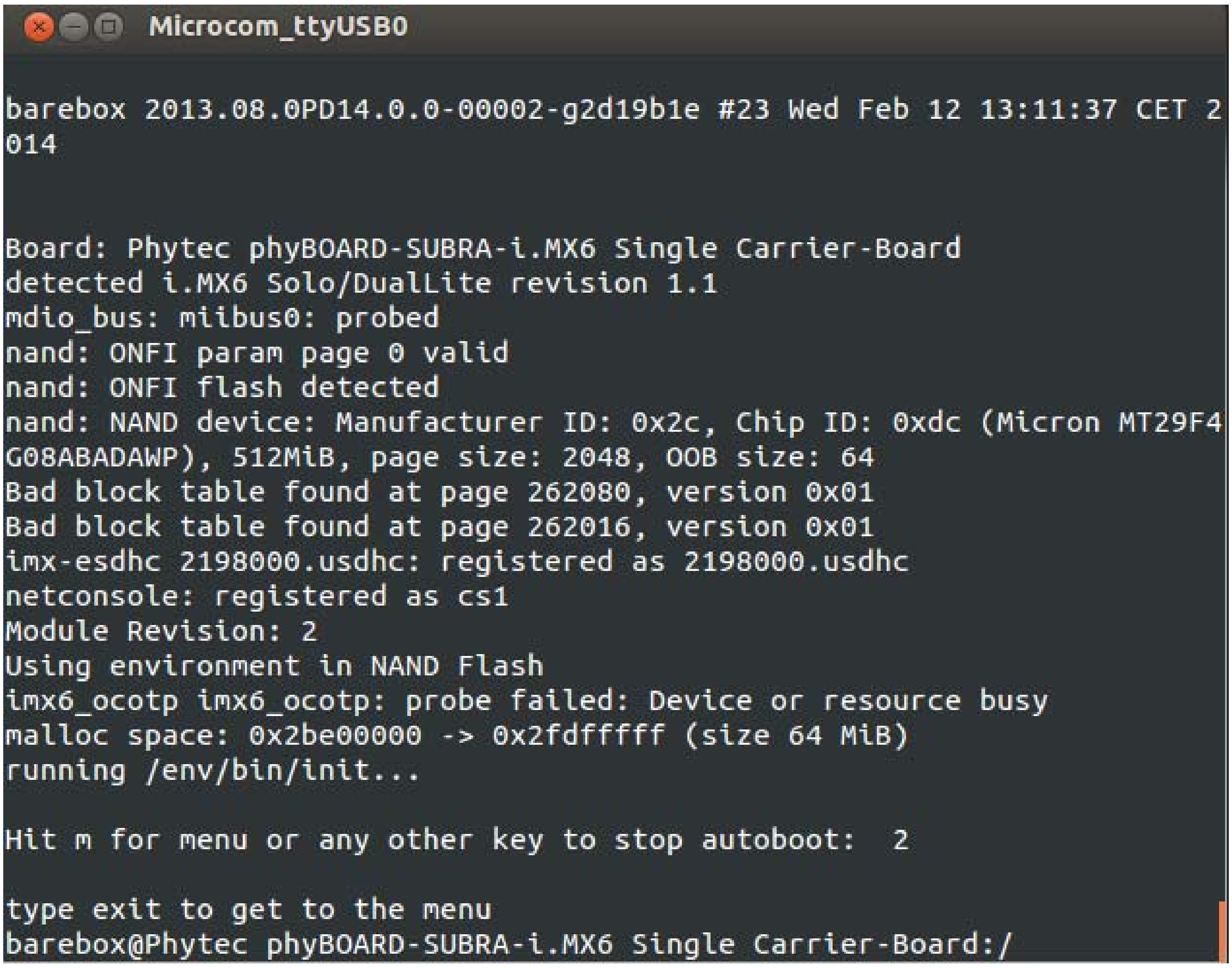
⚠	Versions of Barebox and Linux kernel must match. Therefore the following steps should only be done using the hardware that was shipped together with the DVD and thus already contains the same version of the BSP.

- First open a new terminal window if it is not opened yet. Then change to the directory */opt/PHYTEC_BSPs/BSP-phyBOARD-SUBRA-i.MX6-PD**

Terminal

- Copy the new images to the */tftpboot* directory and exit:
  cd platform-phyBOARD-Subra-i.MX 6/images
  sudo cp linuximage /tftpboot
  sudo cp root.ubifs /tftpboot
  exit
- Open *Microcom* and press the RESET button on the target.
  You will see the output "*Hit any key to stop autoboot*".

- Press any key to stop autoboot.



```
barebox 2013.08.0PD14.0.0-00002-g2d19b1e #23 Wed Feb 12 13:11:37 CET 2
014


Board: Phytec phyBOARD-SUBRA-i.MX6 Single Carrier-Board
detected i.MX6 Solo/DualLite revision 1.1
mdio_bus: miibus0: probed
nand: ONFI param page 0 valid
nand: ONFI flash detected
nand: NAND device: Manufacturer ID: 0x2c, Chip ID: 0xdc (Micron MT29F4
G08ABADAWP), 512MiB, page size: 2048, OOB size: 64
Bad block table found at page 262080, version 0x01
Bad block table found at page 262016, version 0x01
imx-esdhc 2198000.usdhc: registered as 2198000.usdhc
netconsole: registered as cs1
Module Revision: 2
Using environment in NAND Flash
imx6_ocotp imx6_ocotp: probe failed: Device or resource busy
malloc space: 0x2be00000 -> 0x2fdfffff (size 64 MiB)
running /env/bin/init...

Hit m for menu or any other key to stop autoboot:  2

type exit to get to the menu
barebox@Phytec phyBOARD-SUBRA-i.MX6 Single Carrier-Board:/
```

- Check the network settings with following command:
  ifup eth0
  devinfo eth0
  The target should present the this lines:
  ipaddr=192.168.3.11
  netmask=255.255.255.0
  gateway=255.255.255.0
  serverip=192.168.3.10
  If you need to change something, type:
  edit /env/network/eth0
  edit the settings, save them by leaving the editor with Strg-D, then type *saveenv* and reboot the board.

Now we download the images from the TFTP server to the target's RAM, then we erase the required flash and write the images from the RAM into the flash.

- Type **erase /dev/nand0.kernel.bb** to erase the kernel partition

- Type **cp /mnt/tftp/linuximage /dev/nand0.kernel.bb** to download the kernel using TFTP and write it into the target's flash. The copy process can take up to several minutes
- Now we flash the root filesystem type:
  ubiformat -y /dev/nand0.root
  ubiattach /dev/nand0.root
  ubimkvol /dev/ubi0 root 0
  cp /mnt/tftp/root.ubifs /dev/ubi0.root
- Type **boot** to boot the phyBOARD-Subra-i.MX 6 with the new kernel and root file system
- After the target has successfully finished booting, type **root** to log in
- Now we can test our new editor *nano* by trying to open a file with it
- **nano /etc/profile.environment**
- Close *nano* by pressing **CTRL+X**
- Close *Microcom* when *nano* is closed

In this section you learned how to download images from a tftp server into the RAM of the target. The images have been written from RAM to flash and finally the target was started with the new images.

All files are also downloadable from our ftp server or you can find them on our Linux-phyBOARD-Subra-i.MX 6-Kit-DVD under */PHYTEC/BSP/*. If you want other versions check our ftp server too:
ftp://ftp.phytec.de/pub/Products/

Troubleshooting:
If any problem occurs after writing the kernel or the root file system into the flash memory, you can restore the original kernel (*linuximage*) and root file system (*root.ubifs*) from the */tftpboot* directory.

4.4 Updating the software

If you found a newer BSP on our ftp server ftp://ftp.phytec.de/pub/Products and want to flash it, this chapter shows how to do. Also in case that your phyBOARD-Subra-i.MX 6 doesn’t start anymore because you damaged its software during the previous chapter, you’re right here, too. In the latter case you’ll find all needed original images on the DVD under */PHYTEC/BSP*.

⚠	The phyBOARD-Subra-i.MX 6 is configured to boot only from NAND! In order to be able to boot from SD card, switches S3_1 and S3_2 of the Boot Selection Switch S3 must be ON. If S3 is not available on your board you need to close solder jumpers R4 and R5!

4.4.1 Creating a bootable SD card

In case that your phyBOARD-Subra-i.MX 6 doesn’t start anymore due to a damaged bootloader, you need to boot from an SD card. This SD card must be formatted in a special way, because the i.MX 6 doesn’t know anything about file systems. Instead the expected location of the bootloader within a reserved 8 MB space at the beginning of the SD card is hard coded.

- Type **ls /dev** on your Ubuntu PC
- Insert an SD card into the card reader slot of your Ubuntu PC.
- Type **ls /dev** again. You should now see one more */dev/sd<x>* device and at least one additional */dev/sd<x><n>* device.
- For each newly appeared */dev/sd<x><n>* device type **umount /dev/sd<x><n>**
- Type **sudo fdisk /dev/sd<x>**. Be very careful that you type the right letter for *<x>*! You are able to destroy the content of your whole hard disk or of any other attached mass storage device in case that you typed the wrong letter at this point!
- Type **u** and ENTER in order to use sectors as scale unit of all further specifications
- Type **p** and ENTER for getting SD card’s parameter
- Look for the sector size. It should be 512 bytes. Then calculate the amount of sectors needed for 8 MB space: 8192 * (1024 / sectorsize). Also calculate the amount of sectors needed for 256 MB space: 262144 * (1024 / sectorsize)
- Type **d** and ENTER for deleting the first partition of the SD card. If there are more partitions, please delete them also
- Use the first 256 MB of the SD card for creating a new first partition. Reserve 8 MB space at its' beginning. Thus type **n** ENTER **p** ENTER **1** ENTER. You will now get a default value presented for the first sector. Add the calculated amount of sectors necessary for 8 MB space to it and type in the result followed by ENTER. Finally subtract 1 from the amount of sectors necessary for 256 MB space and type in the result followed by ENTER

- Use the remaining space of the SD card for creating a new second partition. Type **n** ENTER **p** ENTER **2** ENTER. Now type in the amount of sectors needed for 256 MB space followed by ENTER. Finally accept the default value for the last sector by just typing ENTER again
- Declare the first partition as FAT by typing **t** ENTER **1** ENTER **c** ENTER
- Save your work and leave *fdisk* by typing **w** and ENTER
- Type **sudo mkfs.vfat /dev/sd<x>1**
- Type **sudo mkfs.ext3 /dev/sd<x>2**
- Type **sync**

The card is now ready for writing a Barebox image to the reserved 8 MB space.

- Type **sudo dd if=./barebox-phytec-pbab05s-512mb.img of=/dev/sd<x> bs=512 skip=2 seek=2**
- Type **sync**

Copy the images of Barebox, Linux kernel (*linuximage*) and rootfs (*root.ubifs*) to the first partition of the SD card.

Extract the archive of the rootfs to the second partition:

- Type **sudo tar -xvzf ./root.tgz -C /media/<path_of_SD_card>**
- Type **sync**

The SD card should now allow you to boot up to the Linux prompt again.

4.4.2 Flashing the Bootloader

Use bootable SD card in order to boot into Barebox.

⚠	The phyBOARD-Subra-i.MX 6 is configured to boot only from NAND! In order to be able to boot from SD card, switches S3_1 and S3_2 of the Boot Selection Switch S3 must be ON. If S3 is not available on your board you need to close solder jumpers R4 and R5!

- Type **barebox_update -t nand /mnt/mmc/barebox-phytec-pbab05s-512mb.img**

	Alternatively you could use bootable SD card in order to boot into Linux. Then copy Barebox's image from your PC into the rootfs of your module for example by using an ftp-connection. After that flash the image into the NAND by typing: **kobs-ng init --chip_0_device_path=/dev/mtd0 -v -w barebox-image** In case you use a module with an SPI NOR (not included by default), you need to write to **/dev/mtd4** instead to **/dev/mtd0**.

4.4.3 Writing the Kernel and Root File System into Flash

Use a bootable SD card in order to boot into Barebox.

- Flash the Linux kernel by typing
  erase /dev/nand0.kernel.bb
  cp /mnt/mmc/linuximage /dev/nand0.kernel.bb

- Write root file system into flash by typing
  ubiformat /dev/nand0.root
  ubiattach /dev/nand0.root
  ubimkvol /dev/ubi0 root 0
  cp /mnt/mmc/root.ubifs /dev/ubi0.root

	Troubleshooting: In some rare cases it might be that using these UBI commands will not lead to a working root file system. Then it should help to replace *root.ubifs* by *root.ubi* on your SD card and use the following commands: **erase /dev/nand0.root.bb** **cp /mnt/mmc/root.ubi /dev/nand0.root.bb** But note that normally you should not flash Linux's root file system into NAND by this way! Ubifs keeps erase counters within the NAND in order to be able to balance write cycles equally over all NAND sectors. So if there is already an ubifs on your module and you want to replace it by a new one, using erase and cp will also erase these erase counters, and this "brute way" should be avoided.

4.5 Setup your own Linux-Host-PC

This chapter is for developers who want to use their own existing environment and not our modified Ubuntu version. It is not needed if you have already installed our modified Ubuntu version as explained in the Application Guide.

We give an overview in this chapter of the modifications which we made to the Ubuntu version on the phyBOARD-Subra-i.MX 6 LiveDVD in comparison to the original Ubuntu. In the following we distinguish between optional and essential modifications. So you can see faster which changes are important to execute this Application Guide in case you don't want to use our modified Ubuntu version. You can find a step-by-step instruction of the essential changes in order to modify your own distribution.

⚠	We can't guarantee that the presented changes are compatible to other distributions or versions. If you want to use another distribution, it might take a lot of individual initiative. We do not support other distributions. You should be sure about what you do.

4.5.1 Essential settings

In the following you see a short instruction of the important settings which are essential to guarantee the execution of the examples in this Application Guide.

4.5.1.1 Installation of software packages

At first various software packages required must be installed using the package manager APT.

To gain a better understanding of the packages required they are installed separately according to their function:

1. Packages which are needed for compiling and building the Board Support Package:
   ```
   sudo apt-get -y install libncurses-dev gawk flex bison texinfo gettext
   ```
2. Packages for developoment
   ```
   sudo apt-get -y install vim eclipse
   ```
3. Packeges to set up the TFTP server:
   ```
   sudo apt-get -y install tftpd-hpa
   ```

During installation it can happen that some programs ask for a license agreement. Just go through the steps.

The first preparations are completed. In the next sections you will proceed with the installation of Eclipse and the set up of the TFTP server.

4.5.1.2 Setting up Eclipse and integrate plug ins

The instructions in this chapter show how to setup *Eclipse* and integrate the plug ins for *QT* and *C/C++*. Thereby you can assign own programs, written in *Eclipse,* to the target.

- First you must create a *workspace* folder, in which you can save your *Eclipse* projects. In the example this is done in your */home/* folder:
  mkdir /home/$USER/workspace
- Thereafter you can open *Eclipse* and insert the path to the created workspace in the pop-up window:
  eclipse
- Eclipse is started and now we click at *Help* in the menu bar *Install new Software*.
- Thereupon a window was opened and in the text field "*Work with*" we enter the following address: **http://download.eclipse.org/tools/cdt/releases/indigo** and click on *Add*.
- After a while the software which we can integrate appears in the area with a scrollbar. We check **"CDT Main Features"** and click on *Next*.
- Now the system shows us an overview of the installation details, which we skip with a click on *Next*.
- At last the system shows us the licensing agreement, which we accept and after we have clicked on *Finish* it begins to install the required software.

The *CDT* plug in is installed. We close *Eclipse* and go on with the *QT* integration.

- For the *QT* integration you must use an external package from the *Nokia* website. This package is already available on our DVD under */PHYTEC/Applications*. Unpack the compressed archive in the */usr/lib* folder:
  cd /usr/lib
  tar xzf ...PHYTEC/Applications/qt-eclipse-integration-linux.x86-1.6.1.tar.gz
- After that start *Eclipse* with the option *clean*, which cleans any cached data:
  eclipse --clean
- *Eclipse* is started and now you must include two path variables:
  In the menu bar click on *Window* ► *Preferences* ► *QT* and enter the following QT specific information *Name:* **QT** ► *Bin Path:* **/opt/PHYTEC_BSPs/BSP-phyBOARD-SUBRA-i.MX6-PD14.0.0/platform-phyBOARD-SUBRA-i.MX6/sysroot-cross/bin** ► *Include Path:* **/opt/PHYTEC_BSPs/BSP-phyBOARD-SUBRA-i.MX6-PD14.0.0/platform-phyBOARD-SUBRA-i.MX6/sysroot-target/usr/include**
- Finally close *Eclipse* and start it again with the *clean* option.

Congratulations! You have successfully integrated two new plugins in Eclipse and now you can start programming in C/C++ and QT in an Eclipse environment. In the next sub-section you will find a short introduction on how to setup a TFTP server.

4.5.1.3 Setting up a TFTP server

In the chapter *"Installation of software packages"* you have installed the required packages to set up a TFTP server. Now we must change some short settings.

- First change the file */etc/default/tftp-hpa* as follows:
  ```
  TFTP_USERNAME="tftp"
  TFTP_DIRECTORY="/tftpboot"
  TFTP_ADDRESS="0.0.0.0:69"
  TFTP_OPTIONS="--secure"
  ```
- Then create a folder called */tftpboot*. The TFTP server will access this folder later.
  ```
  mkdir /tftpboot
  ```
- At last we must set the right permissions:
  ```
  chmod 777 /tftpboot
  ```

You have successfully set up the TFT server. In the future the phyBOARD-Subra-i.MX 6 can access to the /tftpboot/ folder to load the images.

4.5.2 Optional settings

In the following we show the optional settings. These settings are not needed for a successful operation of this Application Guide. They only simplify the handling and the look of the system. For this reason we show the modifications without big explanation.

- Installation of *vim*, the improved *vi* editor.
- Creation of desktop-icons for faster and easier start of required programs.
- **History-search-backward** and **history-search-forward** in */etc/inputrc* is activated. This allows you to search through your history with the entered string.
- Also there are some scripts that will be executed at the first start after the installation. These scripts ensure that the right permissions are set for the created user.

Congratulations! You have successfully configured your Ubuntu to work with.

4.6 System Level Hardware Information

4.6.1 Software Implementation

4.6.2 Audio I^{2}S

Audio support on the module is done via the I2S interface and controlled via I2C.

On the phyBOARD-Subra the audio codec's registers can be accessed via the I2C0 interface at address 0x18 (7-bit MSB addressing).

As of the printing of this manual the BSP delivered with the phyCARD-Subra-i.MX 6 does not support the audio interfaces. Please visit the PHYTEC website for a road map of the BSP.

4.6.3 I^{2}C Connectivity

The I^{2}C interface of the i.MX 6 is available at different connectors on the phyBOARD-Subra. The following table provides a list of the connectors and pins with I^{2}C connectivity.

Connector	Location
Expansion connector X69	pin 11 (I^{2}C_SDA); pin 13 (I^{2}C_SCL)
A/V connector X71	pin 16 (I^{2}C_SDA); pin 15 (I^{2}C_SCL)

Table 17: I^{2}C Connectivity

To avoid any conflicts when connecting external I^{2}C devices to the phyBOARD-Subra the addresses of the on-board I^{2}C devices must be considered. *Table 18* lists the addresses already in use. The table shows only the default address.

Board	Prod. No.	Device	Address used (7 MSB)
phyCORE-i.MX 6	PCL-051	EEPROM	0x52
		RTC	0x68
		PMIC	0x2D, 0x12
phyBOARD-Subra	PBA-CD-02	Audio	0x18
AV-Adapter HDMI	PEB-AV-01	HDMI Core	0x70
		CEC Core	0x34
AV-Adapter Display	PEB-AV-02	GPIO Expander	0x41
Evaluation Board	PEB-EVAL-01	EEPROM	0x56
M2M Board	PEB-C-01	GPIO Expander	0x20
		GPIO Expander	0x21
		GPIO Expander	0x22

Table 18: I^2C Addresses in Use

4.6.4 Expansion connector (X13)

The expansion connector X13 provides an easy way to add other functions and features to the phyBOARD-Subra. Standard interfaces such as UART, SPI and I^2C as well as the SD card interface are available at the expansion pin header connector. The pinout of the expansion connector is shown in the following table.

Pin #	Signal Name	Description
1	SPI0_CS1	SPI 0 chip select 1
2	GND	Ground
3	SPI0_MOSI	SPI 0 master output/slave input
4	I2C0_SDA	I²C 0 Data
5	SPI0_CLK	SPI 0 clock output
6	I2C0_SCL	I²C 0 Clock
7	GND	Ground
8	GND	Ground
9	UART1_TXD	UART 1 transmit data
10	VCC5V	5 V supply voltage output
11	UART1_RTS	UART 1 request to send
12		5 V supply voltage output
13	SD0_D5	SD0 data 5
14	VCC3V3	3.3 V supply voltage output

15	GND	Ground
16	VCC3V3	3.3 V supply voltage output
17	SD0_D4	SD0 data 4
18	GND	Ground
19	SD0_D6	SD0 data 6
20	SPI0_MISO	SPI 0 master input/slave output
21	SD0_D3	SD0 data 3
22	UART1_RXD	UART 1 receive data
23	GND	Ground
24	UART1_CTS	UART 1 clear to send
25	SD0_D2	SD0 data 2
26	GND	Ground
27	SD0_D1	SD0 data 1
28	SD0_D7	SD0 data 7
29	SD0_D0	SD0 data 0
30	SD0_CMD	SD0 command
31	GND	Ground
32	SD0_CLK	SD0 clock

Table 19: PHYTEC Expansion Connector X69

4.6.4.1 Software Implementation SPI and I^{2}C Connectivity

The drivers for SPI and I^{2}C can be accessed by their API within the kernel. If you connect a chip to SPI or I^{2}C, you should implement its driver into the kernel, as well. The SPI and I^{2}C drivers offer no /dev/spi or */dev/i2c* entry in userspace, because using them would mean to place the driver for your chip in userspace, too, what most probably would n**o**t be useful. Please note that the BSP already includes a couple of deactivated drivers for various chips. These drivers might be helpful for you even though they are usually not tested.

To avoid any conflicts when connecting external I^{2}C devices to the phyBOARD-Subra the addresses of the on-board I^{2}C devices must be considered. On thephyBOARD-Subra only I2C0 is used for the different devices. I2C1 is reserved for camera interfaces. Some of the addresses can be configured by jumper. *Table 20* lists the addresses already in use. The table shows only the default address. Please refer to *section* ***Fehler! Verweisquelle konnte nicht gefunden werden.*** for alternative address settings.

Device	Address used I2C0 (7 MSB)	Jumper
RTC (U28)	0x51	
A/D converter (U7)	0x64	
Touch screen controller (U6)	0x41 (Switchable to 0x44)	J12
Audio Controller (U25)	0x18	
LED dimmer (U52)	0x62	

Table 20: I^2C0 Addresses in Use

4.6.4.2 Software Implementation UART Connectivity

Use of */dev/ttymxc4* for UART1 at the expansion connector is not implemented yet.

4.6.4.3 Software Implementation SD card Connectivity

5 Revision History

Date	Version #	Changes in this manual
21.02.2014	Manual L-794e_0	First edition. Describes the phyFLEX-i.MX 6 SOM (PCB 1362.2) with phyBOARD-Subra- Carrier Board (PCB 1394.1).

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Document number:	**L-794e_0, February 2013**

How would you improve this manual?

Did you find any mistakes in this manual? **page**

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