

# CC Linux

## Programmer's Guide



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## Revision history

Revision	Date	Comments
1.4.0	2018-11-22	Released. Document compatible with devices running CC Linux 1.4.x.x

## 1. Introduction

This document contains reference information describing application development and APIs used when developing applications for the CCpilot products supported in the CC Linux platform (currently, this includes the CCpilot VS 12" and 2<sup>nd</sup> generation CCpilot VI). Additionally, this document contains information on how to build a custom Linux operating system for your device based on the CC Linux reference system.

Several functionalities are available using the operating system or standard APIs. These may be briefly mentioned but are not described in detail within this documentation.

A good prior understanding of Linux programming is needed to fully benefit from this documentation. It is also recommended to read the CC Linux - *Software Guide* prior to reading this document.

### 1.1. Convention and defines

This document covers all devices included in the CC Linux platform. For the sake of example, the CCpilot VS device is sometimes used throughout this document. Any significant device deviations will be stated. When the <xx> is used, it should be replaced with the proper device name (VS, for instance).



The observe symbol is used to highlight information in this document, such as differences between product models.



The exclamation symbol is used to highlight important information.

Text formats used in this document:

Format	Use
<i>Italics</i>	Paths, filenames, definitions.
<b>Bolded</b>	Command names and important information

### 1.2. References

For further information on the device software and the available APIs see the following references.

- [1] CC Linux – Software Guide
- [2] CCpilot VI - Technical Manual
- [3] CCpilot VS - Technical Manual
- [4] CCAux API documentation
- [5] Telematics API documentation
- [6] Yocto Project Development Tasks Manual:  
[www.yoctoproject.org/docs/2.4/dev-manual/dev-manual.html](http://www.yoctoproject.org/docs/2.4/dev-manual/dev-manual.html)
- [7] Yocto Project Application Development and the Extensible Software Development Kit (eSDK) manual:  
<https://www.yoctoproject.org/docs/2.4/sdk-manual/sdk-manual.html>

## 2. Interfaces

This section covers basic information on how to access the device hardware. Most of the hardware is accessed using the default Linux interfaces but some specific interfaces may require additional functions to be accessed.

Table 1 lists the API used to access each interface. These interfaces can be grouped into two categories; Standard operating system libraries (Std. API) and CCAux Library (CCAux API).

See also the operating system specific sections and additional documentation describing the software API.

*Table 1: APIs used for different interfaces in CCpilot devices*

Functionality	Std. API	CCAux API	Comment
CAN	√		SocketCAN available through Linux.
Ethernet	√		Standard Linux kernel drivers.
USB	√		Standard Linux kernel drivers.
RS232	√		Standard Linux kernel drivers.
RS485	√		Standard Linux kernel drivers.
Digital video	√		QtMultimedia, gstreamer <sup>1</sup>
Analog video in	√	√	Video4Linux2 API, gstreamer, and QtMultimedia can be used directly without CCAux API.
Digital output		√	
PWM output		√	
Configurable input		√	
Analog input		√	
Status indicator		√	
Backlight		√	
Ambient light sensor		√	
Buzzer		√	
Power management		√	

<sup>1</sup>On CCpilot VI the video stream needs to be rotated counter clockwise due to display orientation. This can be done by setting the *videoflip* method to *counterclockwise* in the gstreamer pipeline.



Your device might not support all interfaces stated here. See the *Product Leaflet* or *Technical Manual* of your device for a complete list of available interfaces.

## 2.1. Standard libraries

Most interfaces are accessed using standard libraries and access methods. Various access methods are possible to be used depending on the development environment and additional installed frameworks, such as Qt.

The standard libraries used for Linux are described in their respective documentation sources, such as MAN pages.


## 2.2. CCAux library


The CCAux API gives access to several hardware specific interfaces. The API functions of this library are documented in the *CCAux API documentation*.

Table 2 gives a brief introduction on the API's found therein and their functions. Most API functions can be used from the pre-installed *CCSettingsConsole* application as well.

*Table 2: Short description of CCAux API contents and the supported devices*

API	Description	Supported on device	
		VS	VI
About	Hardware information API related to the hardware configurations.	Yes	Yes
Adc	Read built in ADC voltage information.	Yes	Yes
AuxVersion	Read firmware version information.	Yes	Yes

Backlight	Control display backlight settings and configure automatic backlight functionality.	Yes	Yes
Battery	Control battery related settings, if a battery is connected.	No	No
Buzzer	Control the built-in buzzer.	Yes	Yes
CanSetting	Control CAN settings. <sup>1</sup>	Yes	Yes
CfgIn	Get/set current status of configurable input signals.	Yes	Yes
Config	Control internal and external power up and power down settings and time configurations, including power button and on/off signal configurations.	Yes	Yes
Diagnostic	Get run time information about the device.	Yes	Yes
DigIO	Get/set current status of Digital Output signals.	Yes	No
FirmwareUpdate	Update/verify System Supervisor (SS) and other firmware. <sup>2</sup> 	Yes	Yes
FrontLED	Override the default LED behaviour.	Yes <sup>3</sup>	Yes <sup>4</sup>
LightSensor	Read the light sensor values and get raw and/or calculated values.	Yes	No
Power	Read power status and control functions for advanced shut down behaviour.	Yes	Yes
PWMOut	Get/set current status and settings of PWM Output signals.	No	Yes
SoftKey	Get press status of buttons. Get/set button backlight settings.	No	Yes
Telematics	Control power to the telematics board, as well as basic initialization functions.	No <sup>5</sup>	No <sup>5</sup>
TouchScreen	Change the touch screen profile between mouse or touch profile and other touch screen related settings.	No	No
Video	Control the analog video streams in terms of channel, size, scaling etc.	Yes	No

 <sup>1</sup> Most settings for CAN usage are available over the SocketCAN interface instead.  
<sup>2</sup> **Consider careful usage for these functions, erroneous usage can result in a non-functional device.**

<sup>3</sup> CCPilot VS does not have a front LED, so this API controls the button backlight LED instead.

<sup>4</sup> CCPilot VI does not have a front LED, so this API controls the button backlight LEDs instead.

Additionally, the FrontLED class is deprecated on VI as it handles RGB LEDs which VI button backlight does not have. Calling this class on VI will result in a grey-scaled mapping in order to keep backwards compatibility. For new developments, the SoftKey class should be used instead.

<sup>5</sup> See the separate Telematics API instead.

### 2.3. CCAux API calling convention

The standard way to call CCAux API functions is shown below. Please adhere to this calling convention. Example code snippets for each function are available in the *CCAux API documentation*. Moreover, chapter 6.1 gives an example on how to call the CCAux API in order to set the front LED color.

```
/* Usage in CCAux API 2.x */
$ include "Module.h"

MODULEHANDLE pModule = CrossControl::GetModule();

eErr err = Module_function_1(pModule, arg, ...);

Module_release(pModule);
```

## 2.4. Telematics API

Some CCpilot devices support the external add-on telematics device CrossLink AI. The interfaces provided by this board are not accessed via the CCAux API, but through the separate Telematics API instead. This API is included in both the BSP and SDK and its functions are called in the same convention as in CCAux API. Please refer to the *Telematics API reference documentation* for more information about the functions available.

## 3. Board Support Package

In order to create custom Linux images for CCpilot devices, a board support package (BSP) has been created. The BSP is a Yocto-project build system that produces complete Linux images for the CCpilot devices. It also includes the necessary application and driver code, as well as example or template code that may serve as a basis for further application and driver development.

The open-source Yocto system has built-in package support with many thousands of maintained packages available, while also providing a set of standard tools and build guidelines. The BSP adds necessary drivers and applications required for the CCpilot board images. For more information regarding the Yocto project, please refer to the *Yocto Project Development Tasks Manual* [6].

### 3.1. Downloading and installing the BSP

The BSP package comes in the form of a gzipped tar archive which can be acquired from the CrossControl support site. The BSP was created on an x86-64 machine running Ubuntu 16.04.5 LTS and must be unpacked to a Linux host machine/build server. A large amount of disk space (at least several hundred gigabytes) and memory is required for the Yocto system, as the directory structure tends to grow quickly in size. Please refer to the *Yocto Project Development Tasks Manual* [6] for information about required dependencies.

### 3.2. BSP structure

This chapter will go through CrossControl specific parts of the BSP structure. For other third party components (Qt, OpenEmbedded, Yocto, etc.), please refer to their respective reference documentation.

Initially, the BSP base directory will only contain CrossControl directories. All other required third party tools are provided as hash-files which can be downloaded from remote repositories upon first build. The following subsections will describe these initial directories.



**Internet connection is required to build a BSP.**



**While most components in the BSP are released under various open source licenses, others are of proprietary nature and protected under the CrossControl Software License. Be aware of which license applies and please comply with the license terms.**



VS is the internal CrossControl code name for the CCpilot VS architecture/platform; therefore the BSP contains references to the VS platform such as “PLATFORM\_VS”. The same applies for other CCpilot devices. Additionally, CrossControl specific components are named “cc”, such as “meta-cc” and “recipes-cc”.

### 3.2.1. apps

The *apps* directory contains the source code to CrossControl-developed libraries and applications such as *CCAux API library*, *CCAux daemon*, *CCLauncher*, *CCSettingsConsole*, *CCVideo*, *Telematic API*, etc.

### 3.2.2. drivers

The *drivers* directory contains the source code to the following CrossControl-developed drivers:

#### **ss**

Handles communications between the System Supervisor (SS) and the main processor (MP, i.e. the Linux system) over the MP-SS SPI bus. This driver is required for the *CCAux API* to work.

#### **<xx>-io**

Is used to set the direction of the internal UART, in order to support either bootloader output to the update board or to the serial port of the SS.

### 3.2.3. meta-cc

The *meta-cc* directory contains the Yocto layer with all CrossControl developed board-specific recipes. See Table 3 for more details of the subdirectories.

*Table 3: Content of the subdirectories in the meta-cc directory in the BSP.*

Directory	Content
<b>classes</b>	Class recipes which can be inherited by other recipes: <ul style="list-style-type: none"> <li>Class recipes to be inherited in recipes building applications and modules with locally stored source code</li> </ul>
<b>conf</b>	meta-cc layer configuration files for the <xx> machines. The machines are based on more general machines. For instance, the 'vs' machine is based on the 'mx6q' machine, which in turn is based on the 'mx6' machine in the meta-freescale layer.
<b>recipes-bsp</b>	Contains the u-boot specific patches which adapt the default iMX6 u-boot configuration.
<b>recipes-cc</b>	Contains recipes for CrossControl developed libraries and applications. These have the source code stored locally in the apps/ directory.
<b>recipes-connectivity</b>	Contains recipes for Ethernet configuration.
<b>recipes-core</b>	<ul style="list-style-type: none"> <li>Image recipes (both for the main and rescue system) for all supported devices; these are used to produce the reference CC Linux image. This is a good starting place to add or remove features from the image.</li> <li>Psplash recipe, used to create a boot splash image during the time in which the Linux system loads</li> <li>Init script recipes</li> </ul>
<b>recipes-devtools</b>	A recipe for input utilities, which are used to enable the touch panel driver for devices with a touch panel, such as CCPilot VS.
<b>recipes-extended</b>	A recipe to enable password free sudo privileges for users.
<b>recipes-graphics</b>	An init script for the Weston reference implementation of the Wayland graphics server.
<b>recipes-kernel</b>	<ul style="list-style-type: none"> <li>Kernel recipes; board-specific kernel patches, device tree, kernel configuration files</li> </ul>

	<ul style="list-style-type: none"> <li>• Recipes for the CrossControl developed drivers in the drivers directory</li> </ul>
<b>recipes-multimedia</b>	Contains recipes for adding mp4 video format support and Qt integration to gstreamer.
<b>recipes-navigation</b>	Recipe for gpsd which is used if connecting an external Crosslink AI telematics device.
<b>recipes-qt</b>	<ul style="list-style-type: none"> <li>• Recipe-append to build QtMultimedia with the gstreamer backend</li> <li>• Recipe-append to separate some default Qt applications (calculator for instance) from their examples-package, in order to enable individual installation</li> </ul>
<b>recipes-support</b>	A recipe for configuring the Network Time Protocol (NTP).

### 3.2.4. platform

The *platform* directory contains a directory for each of the CC Linux devices as well as one *common* directory. These directories contain environment-setup scripts, extra Makefile rules to build individual system components with bitbake, and the configuration files needed for configuring the build system. The file *local.conf* can be modified to change the default Yocto download directory etc. If you want to add a new layer to the Yocto build, it must be added to the *bblayers.conf* file.

When building, the working directory will be located in *platform/<xx>/build*.

### 3.2.5. tools

The *tools* directory contains scripts to be used for device OS update. See the *CC Linux – Software Guide* for instructions on how to use them.

### 3.2.6. binaries

All built images, update files, etc. are placed in the *binaries* directory which is created upon the first build.

## 3.3. Using the BSP

The purpose of this chapter is not to give the reader a full description of the Yocto build system and all its possibilities; but rather give useful tips on how to build Linux images and application binaries from within the BSP.

### 3.3.1. Building Linux images

Out of the box, the BSP produces a CC Linux image containing a reference implementation. The reference implementation is intended to be used as a basis for creating custom images.



**The first time building the image will take several hours, depending on your host machine. Subsequent builds will be quicker as Yocto reuses all unchanged components from previous builds.**

Depending on your host machine, you might need to edit the *platform/<xx>/local.conf* file. For instance, the default download directory can be changed; and if you have limited disk space, there is a setting for removing temporary files once builds are completed. However, removing temporary files will slow down your build process.



In the BSP root directory there is a Makefile containing rules to make main and rescue images for all CC Linux devices. For instance, to make the CCPilot VS rescue image, type

```
$ make vs-rescue
```

**make** will automatically source the environment scripts in the platform directory and invoke bitbake to bake the image recipe in the *meta-cc/recipes-core/images* directory.

The resulting image is located in *platform/<xx>*.

To build your own custom Linux image, either edit the image recipe right away, or make a new recipe and add a new rule for it to the Makefile. If choosing the latter, don't forget to add a rule to the *platform/<xx>/Makefile* as well.



See the *CC Linux - Software Guide* for instructions on how to program the images to the device.

### 3.3.2. Building applications

Provided there exists a recipe for the application, building with the BSP can be done in two ways. The first method is the most straightforward whereas the second can be more convenient during development as it is faster and more flexible.

#### First method:

1. Include the recipe for the application in the image recipe:

```
IMAGE_INSTALL += "applicationname"
```

2. Make the image as usual:

```
$ make <imagerule>
```

#### Second method:

1. Make sure you are in the *platform/<xx>* directory and source the environment script:

```
$ source oe-env
```

2. Use bitbake to build your application:

```
$ bitbake <applicationname>
```

Both methods will put the resulting application binaries in *platform/<xx>/build/tmp/work*.



In the second method, additional bitbake commands can be invoked. For instance, one can use the `-c` flag to recompile the application without re-fetching the source files.

## 4. Software Development Kit

This section is dedicated to useful tips and hints about how to use the Software Development Kit (SDK) on a Linux development host machine for application development and debugging purposes.

The SDK is based on the Yocto Project SDK. Refer to the *Yocto Project Application Development and the Extensible Software Development Kit (eSDK)* [7] manual for additional information and tips.

## 4.1. Downloading and installing the SDK

The toolchain included in the SDK is an ARM GNU/Linux cross compiler based on the standard GNU GCC compiler toolchain. Additionally, the SDK contains header and library files for CCAux API and other peripherals. In order to get the SDK, visit the CrossControl support site. For support on SDK issues, please contact CrossControl directly.

The SDK comes in the form of a self-extracting shell script. It contains precompiled binaries for Linux host systems. There are two versions of the SDK; one for 32-bit i686 hosts and one for 64-bit x86 hosts. To install the SDK, move the script to the host computer and run the following shell command:

```
$ sh scriptname.sh -d <sdk install dir>
```

Omitting the `-d` flag will install the SDK to the default directory, `/opt/cclinux/1.0.0`.

Example output from installing the CCPilot VS SDK to `/opt/sdk/`:

```
$ sh CCLinux-SDK-toolchain-x86_64-CCpilot-VS-v1.4.1.0.sh -d /opt/sdk/  
CCLinux Distribution SDK installer version 1.0.0  
=====
```

You are about to install the SDK to "/home/lisa/vs-sdk/sdkmapp". Proceed[Y/n]?  
Y  
Extracting SDK.....done  
Setting it up...done  
SDK has been successfully set up and is ready to be used.



The x86-64 SDK for CCPilot VS is named `CCLinux-SDK-toolchain-x86_64-CCpilot-VS-v1.4.1.0.sh`. On the same form, the i686 SDK for CCPilot VS is named `CCLinux-SDK-toolchain-i686-CCpilot-VS-v1.4.1.0.sh`. Both versions were created using an x86-64 machine running Ubuntu 16.04.5 LTS.

## 4.2. Using the SDK

### 4.2.1. Starting a new session

Once installed, the SDK contains the `sysroots` directory with target and host system root file systems, and an environment setup file; `environment-setup-XXXX-linux-gnueabi`. The environment setup file exports the correct `$PATH` and other important build environment variables, such as `$CC` and `$CFLAGS`. (Read the file content to get an understanding of the default settings).

This file needs to be sourced before using the SDK each time a new shell session is started:

```
$ source environment-setup-XXXX-linux-gnueabi
```

Now the cross-compiler is ready to use.

### 4.2.2. Using correct development headers

The SDK is released containing binary images. This package contains libraries available at the unit and all header files for utilizing them. The header files are located in:

```
<sdk-install-dir>/sysroots/<targetsysroot>/usr/include/
```

and the libraries are found in these two directories:

```
<sdk-install-dir>/sysroots/<targetsysroot>/lib/
```

```
<sdk-install-dir>/sysroots/<targetsysroot>/usr/lib/
```

These directories are automatically added to the search path when sourcing the environment setup script and don't need any special consideration.

If additional development files placed outside of the SDK installation directory are to be used they can be added to the compiler search path by appending the `$CFLAGS/$CXXFLAGS` variable. This can be done either in the project settings or in the *Makefile* using:

```
CFLAGS+= -I<path-to-headerfile-dir> -L<path-to-library-dir>
```

### 4.2.3. Compiler optimizations

The environment setup script automatically sets the `-mcpu=<cpu>` compiler flag for optimizing the code for the instruction set generated for the specific processor. Additionally, floating point computations are automatically set to use the available hardware acceleration (`-mfpu=<fpu>`).

In order to optimize floating point additionally, append the `-funsafe-math-optimizations` flag to the `$CFLAGS/$CXXFLAGS` environment variables.

To see which optimizations are done by default, study the content of the environment setup script. All these settings can be overridden after the script has been sourced. See the compiler documentation for additional information about available optimizer flags.

### 4.2.4. Special considerations using CCAux API

In order to build applications using functions from the CCAux API library two steps need to be given special consideration in either the project file or the *Makefile*:

1. The `$LD` variable should be overridden to use the same content as the `$CXX` variable
2. The `$CFLAGS/$CXXFLAGS` must be appended with the `-DLINUX` flag

If either of these steps are omitted, the build will fail. See chapter 6.1 for examples of how to build CCAux API applications.

## 4.3. Debugging remotely

To use **GDB** to debug an application running on the device, the application must have been compiled with the `-g` flag. Start **gdbserver** on the device:

```
~$ gdbserver :10000 testApplication
```

Then start the host **GDB** and connect to the server:

```
$ arm-poky-linux-gnueabi-gdb testApplication
$ (gdb) target remote Y.Y.Y.Y:10000
```

Above Y.Y.Y.Y is the IP address of the device. Then issue the **set sysroot** command:

```
$ (gdb) set sysroot $SDKTARGETSYSROOT
```

You can now debug the application normally, except that instead of issuing the `run` command one should use `continue` since the application is already running on the remote side.

Note that it is possible to fully debug the application but not to make system calls made by the application. Such system calls include calls to the soft float library, like `divide`, `add` or `multiply` on

floating point variables. It is therefore recommended to use *next* rather than *step* when such system calls are being made.

## 5. Special considerations

This section is dedicated to device specific requirements that require extra attention and consideration when programming.

### 5.1. CAN

In Linux, CAN is interfaced using SocketCAN which is a standard used in the Linux kernel.

Usage of SocketCAN requires knowledge of some system specific settings and details described herein. For additional SocketCAN information see the official SocketCAN documentation.

#### 5.1.1. Configuration of the device interface

The device node files for the CAN interfaces are `cano ... canX` for a device with X CAN interfaces. The interfaces should be shown when listing all network interfaces with the `ifconfig` command.

The CAN bus itself is not initialized during start-up. Before any communications can be executed, the user must set correct bus speed (as an example 250kbps) by first writing the value into the `bitrate` parameter:

```
$ sudo ip link set can0 type can bitrate 250000
```

and then setting interface up with **ifconfig**:

```
$ sudo ifconfig can0 up
```

After this, **ifconfig** should show `cano` as a network interface:

```
$ ifconfig
can0    Link encap:UNSPEC  HWaddr 00-00-00-00-00-00
        UP RUNNING NOARP MTU:16 Metric:1
        RX packets:0 errors:0 dropped:0 overruns:0 frame:0
        TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
        collisions:0 txqueuelen:10
        RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)
        Interrupt:31
```



In CCpilot VS, the device drivers are implemented as loadable kernel modules. The modules are `can_dev.ko` and `flexcan.ko`. Startup scripts handle the loading of the kernel modules upon start-up. The loaded modules can be checked via terminal access using the **lsmod** command:

```
$ lsmod | grep can
flexcan    10092      0
can_dev    8641       1 flexcan,xilinx
```

Since the drivers are compiled as modules, unnecessary protocols may be removed or new modules inserted, according to user needs.

### 5.1.2. Configuring the CAN socket transmission buffer

By default, the CAN driver is configured with a transmission buffer that can hold up to 10 CAN frames. As each frame is sent over the bus, the buffer is cleared. However, it is possible to write frames to the socket faster than the frames are sent, especially if your messages are low-priority frames on a high-traffic bus. If your application needs to send more than 10 CAN frames in bursts, it might be a good idea to increase the size of the transmission buffer:

```
$ ifconfig can0 txqueuelen 100
```

### 5.1.3. Bus recovery options

It is possible to implement automatic bus recovery after bus off has occurred. State changes are automatically detected and controller is re-initialized after the specified time period.

Automatic bus recovery from bus off state is by default turned off. It can be turned on using the **ip** command, where the wanted restart period in milliseconds is set. For example, a 100 ms restart period for can0 is set from command line like this:

```
$ ifconfig can0 down  
$ ip link set can0 type can restart-ms 100  
$ ifconfig can0 up
```

Same commands apply for all available CAN interfaces by replacing can0 appropriately. The restart period interval is possible to set as needed by the application. Value zero turns automatic bus recovery off.



**Warning:** Enabling automatic bus recovery may disturb other nodes on the bus, if CAN interface is incorrectly initialized.

## 5.2. Analog video

For QML applications with analog video, CrossControl recommends using the *QtMultimedia* framework rather than CCAux API since the video performance is higher and development process quicker. For non-QML applications, CCAux API is recommended.

### 5.2.1. Analog Video using QtMultimedia

CC Linux includes an example QML application *CCVideo* for displaying analog video using a *QtCamera* instance. This application is for test purposes only, CrossControl recommends implementing the video functionality into your application for correct behavior. The source code for *CCVideo* is provided in both the BSP and SDK.

*QtMultimedia* uses the *gstreamer* backend and the application must export the correct video source:

```
setenv("QT_GSTREAMER_CAMERABIN_VIDEOSRC", "imxv4l2videosrc", 1);
```

### 5.2.2. Analog Video using CCAux API

There are some design constraints on the usage of analog video and CCAux API that it is important to highlight, to create a better understanding of what can be done and what is necessary to do within the applications. Below is a brief description of the video API for developers to consider when building their application.

The most important CCAuxVideo API functions are as follows:

Initialize (will open file handles, setup basic settings and request frame buffers), select deviceNr=1 for input channel 1:

```
Video_init(VIDEOHANDLE pObj, unsigned char deviceNr)
```

Select the active channel 1-4, corresponds to the physical port number:

```
Video_setActiveChannel(VIDEOHANDLE pObj, VideoChannel channel)
```



Note that CCPilot VS has one video channel only. CCPilot VI does not support analog video at all.

Set the area of the display where the video will be shown:

```
Video_setVideoArea(VIDEOHANDLE pObj, unsigned short topLeftX, unsigned short topLeftY, unsigned short bottomRightX, unsigned short bottomRightY)
```

Enable or disable (horizontal) mirroring of the video image:

```
Video_setMirroring(VIDEOHANDLE pObj, CCStatus mode)
```

Show (or hide) video image:

```
Video_showVideo(VIDEOHANDLE pObj, bool show)
```

Further and more detailed API information can be found in the *CCAux API documentation*.

### 5.3. Graphics

The graphics framework uses the Wayland protocol reference implementation Weston for graphic operations. Wayland is fast and efficient, and is used by all modern advanced Linux systems, giving it vast standard support in the Linux user space.

For example, Qt has a plugin that enables the Qt libraries to be built for Weston. For Qt applications the impact for that means that it simply needs to be started with a specific flag, *-platform wayland-egl*, and built with the correct development libraries. In CC Linux, this flag has been set to the default graphics framework, hence there's no need to pass the flag.

Weston includes a windowing system, enabling several applications to overlap while in operation.



The Wayland protocol does not allow its clients (Qt applications etc.) to have any information about where the client is positioned on the screen. Therefore, some Qt functions, like **QWidget::pos()**, will always give a zero return.

### 5.4. Serial Number Broadcast interface

The device has a Serial Number Broadcast service (SNB). The SNB does not have a programming interface at the device end, but the broadcasted data output can be handled elsewhere; including in another device if required.

The message sent is a multicast UDP datagram to address 224.0.0.27. The message contains a char array with three values separated by tabs; Serial number, Firmware version and device type. The sender's IP address is available in datagram headers.

Example data contents (without quotes):

```
"PR01<tab>10.0.0<tab>0"
```

An example implementation of the data listener is available in the BSP: *apps/snb/snb\_reader.c*.

## 5.5. Polarity of PWM outputs

The PWM outputs can be either high or low sided, which will affect the duty cycle behavior. For high sided outputs, a duty cycle of 90 % will result in the output signal being 90% high and 10% low. For low sided outputs, the opposite is true - the output signal will be 10% high and 90% low.

Refer to the *Technical Manual* of your device in order to know if it has PWM outputs and if they are high or low sided if so.

## 6. Build Examples

Source code for the example applications included in the CC Linux reference image (*CCSettingsConsole*, *CCSettings*, *CCVideo*, *CCLauncher*, *CCMultitouchDemo*, etc.) are provided in both the SDK and BSP. These can be used as templates or starting points for your applications.

Example code on how to call the functions provided by CCAux API are found in the *CCAux API documentation* and in the *examples* directory of the CCAux API source code. Additionally, this chapter provides examples on the build process.

### 6.1. Building applications with the SDK

This chapter gives two examples on how to build a small example application which uses CCAux API functions to set the color of the status LED. The first example shows how to build a C++ application using a Makefile. The second example shows how to build a Qt application with **qmake** to auto generate the Makefile.

#### 6.1.1. C++ Makefile example

This example shows how to build a C++ application *example* using a Makefile. The source file *example.cpp* is listed below. The file consists of a simple main function calling the status LED functions.

```
/**
 * example.cpp
 **/

#include <stdio.h>
#include <FrontLED.h>
#include <CCAuxErrors.h>

using namespace CrossControl;

int main(void)
{
    printf("Setting FrontLED to blue!\r\n");

    FRONTLEDHANDLE pLed = GetFrontLED();
```

```
    eErr err;
    err = FrontLED_setStandardColor(pLed, BLUE);

    if(err != ERR_SUCCESS)
        printf("An error occurred!\r\n");

    FrontLED_release(pLed);
    return 0;
}
```

Following is an example *Makefile* that is used to build *example*. The additional *-Wall* flag enables all warnings and is recommended. This file can easily be expanded to build more complex applications.

```
#
# Makefile for example using FrontLed
#
# NOTE: before running make, the SDK environment must be set up by
# sourcing the environment file
#

TARGET=example
LD = $(CXX)

CC_OBJS = $(TARGET).o
C_OBJS =

OBJS = $(CC_OBJS) $(C_OBJS)

CXXFLAGS+= -DLINUX -Wall
CFLAGS+= -DLINUX -Wall
LDFLAGS+= -lcc-aux2 -lpthread

CCCMD = $(CC) -c $(CFLAGS)
CXXCMD = $(CXX) -c $(CXXFLAGS)

all:      clean
          $(TARGET)

$(TARGET): $(OBJS)
           $(LD) -o $@ $(OBJS) $(LDFLAGS)

# pattern rules for object files
%.o: %.c
      $(CCCMD) $< -o $@

%.o: %.cpp
      $(CXXCMD) $< -o $@

clean:
      rm -rf *.o *.elf *.gdb *~ $(TARGET)
```



To build example, make sure the environment setup script has been sourced, and then issue the following command:

```
$ make example
```

**make** will expand the content of the *Makefile* and the previously sourced environment setup script to the following output (in this instance for CCpilot VS):

```
arm-poky-linux-gnueabi-g++ -march=armv7-a -marm -mfpu=neon -mfloat-abi=hard -mcpu=cortex-a9 --sysroot=/opt/vs-sdk/sysroots/cortexa9hf-neon-poky-linux-gnueabi -c -O2 -pipe -g -feliminate-unused-debug-types -DLINUX -Wall example.cpp -o example.o
arm-poky-linux-gnueabi-g++ -march=armv7-a -marm -mfpu=neon -mfloat-abi=hard -mcpu=cortex-a9 --sysroot=/opt/vs-sdk/sysroots/cortexa9hf-neon-poky-linux-gnueabi -o example example.o -Wl,-O1 -Wl,--hash-style=gnu -Wl,--as-needed -lcc-aux2 -lpthread
```

### 6.1.2. Qt qmake example

This example shows how to build a Qt application *example-qt*. The source file *example-qt.cpp* is listed below. The file consists of a simple main function calling the status LED functions and opening a MessageBox widget.

```
/**
 * example-qt.cpp
 **/

#include <FrontLED.h>
#include <CCAuxErrors.h>
#include <QMessageBox>
#include <QtWidgets/QApplication>

using namespace CrossControl;

int main(int argc, char *argv[])
{
    QApplication a(argc, argv);
    QMessageBox msg;

    msg.setText("Setting FrontLED to red!\r\n");
    msg.show();

    FRONTLEDHANDLE pLed = GetFrontLED();

    eErr err;
    err = FrontLED_setStandardColor(pLed, RED);

    if(err != ERR_SUCCESS)
        printf("An error occurred!\r\n");

    FrontLED_release(pLed);
}
```

```
        a.exec();

        return 0;
}
```

Following is an example Qt project file that is used to build *example-qt*. It can easily be expanded for more complex applications.

```
#
# Example-qt.pro
#

QT += core gui widgets

TARGET = example-qt
TEMPLATE = app
SOURCES += example-qt.cpp

unix:{
    linux-oe-g++ {
        message(Compiling for Yocto Linux)
        DEFINES+=LINUX
        LIBS += -lcc-aux2
    }
}
```

To autogenerate the *Makefile* from the project file, make sure the environment setup script has been sourced, and then run **qmake**:

```
$ qmake
Project MESSAGE: Compiling for Yocto Linux
```

Then, run **make** in order to build the application:

```
$ make example-qt
```

**make** will expand the content of the *Makefile* and the previously sourced environment setup script to the following output (for CCpilot VS):

```
arm-poky-linux-gnueabi-g++ -march=armv7-a -marm -mfpu=neon -mfloat-abi=hard -mcpu=cortex-a9 --sysroot=/opt/vs-sdk/sysroots/cortexa9hf-neon-poky-linux-gnueabi -c -pipe -O2 -pipe -g -feliminate-unused-debug-types -O2 -Wall -W -D_REENTRANT -fPIC -DLINUX -DQT_NO_DEBUG -DQT_WIDGETS_LIB -DQT_GUI_LIB -DQT_CORE_LIB -I. -I../vs-sdk/sysroots/cortexa9hf-neon-poky-linux-gnueabi/usr/include/qt5 -I../vs-sdk/sysroots/cortexa9hf-neon-poky-linux-gnueabi/usr/include/qt5/QtWidgets -I../vs-sdk/sysroots/cortexa9hf-neon-poky-linux-gnueabi/usr/include/qt5/QtGui -I../vs-sdk/sysroots/cortexa9hf-neon-poky-linux-gnueabi/usr/include/qt5/QtCore -I. -I../vs-sdk/sysroots/cortexa9hf-neon-poky-linux-gnueabi/usr/lib/qt5/mkspecs/linux-oe-g++ -o example-qt.o example-qt.cpp
arm-poky-linux-gnueabi-g++ -march=armv7-a -marm -mfpu=neon -mfloat-abi=hard -mcpu=cortex-a9 --sysroot=/opt/vs-sdk/sysroots/cortexa9hf-neon-
```

```
poky-linux-gnueabi -Wl,-O1 -Wl,--hash-style=gnu -Wl,--as-needed -Wl,-O1 -o  
example-qt example-qt.o -lcc-aux2 -lQt5Widgets -lQt5Gui -lQt5Core -IEGL -  
IGLESv2 -lpthread
```

## Technical support

Contact your reseller or supplier for help with possible problems with your device. In order to get the best help, you should have access to your device and be prepared with the following information before you contact support.

- The part number and serial number of the device, which you can find on the brand label.
- Date of purchase, which can be found on the invoice.
- The conditions and circumstances under which the problem arises.
- Status indicator patterns (i.e. LED blink pattern).
- Prepare a system report on the device, using CCSettingsConsole (if possible).
- Detailed description of all external equipment connected to the unit (when relevant to the problem).

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