QUICK START GUIDE

DVK-2

Version 2.0

Table of Contents

1. DVK-2 Introduction

1.1.   DVK-2 base-kit

The **DVK-2** is designed as quick start solution for the development of applications with **AXSEM** micro-controllers and **AXSEM** radio-chips. The **DVK-2 base-kit** is the development platform for applications based on the **AX8052F1xx** micro-controller family. With the available radio **add-on-kits** it becomes the ideal platform for radio performance evaluation and radio system development. The **DVK-2** is compatible with **AX-RadioLab**, **AX-MicroLab** and **AxCode::Blocks** development software for the PC.
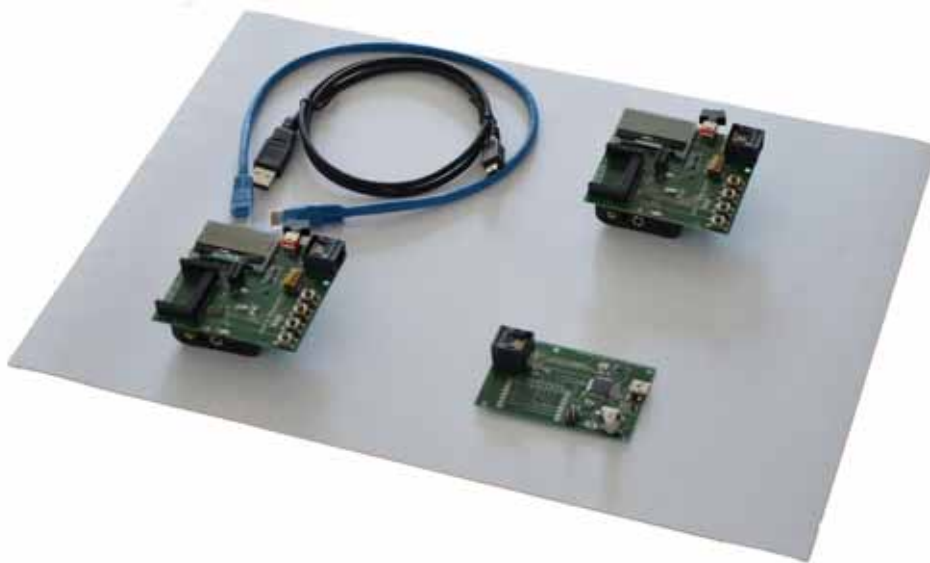
The **DVK-2** comes with:

- 2x mainboards with radio-module connectors for one radio **add-on-kit** module, **AX8052F100** 20 MIPS ultra-low-power micro-controller, LCD display, 4 buttons, 2 LED, AX debug connector and battery connector for 3 AA batteries

- 1x **AXDBG** debug adapter

- 1x Mini USB cable

- 1x AX-Debug cable (Ethernet cable).

1.2.   DVK-2 add-on-kits

For evaluation of **AXSEM** radio IC a variety of **add-on-kits** are available. A radio **add-on-kit** consists of a pair of radio modules (and depending on region, frequency, distributor a pair of antennas). Depending on the radio product the kit can consist of two

identical or two different[1] modules. The pictures below show the two different modules of the AX5043-868 **add-on-kit**.
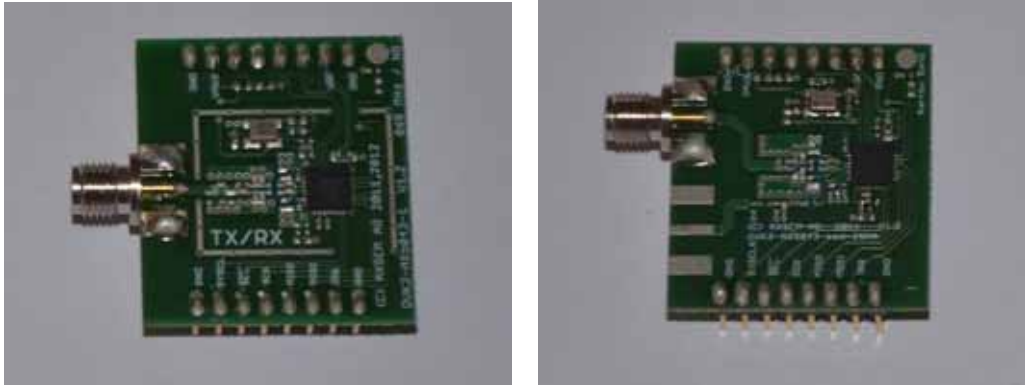
The left module has a TX/RX port and the right module a TX/RX port with SMA connector and a single ended TX-only port without SMA connector.

The following radio **add-on-kits** are available:

- **AX5043-868 add-on-kit** (2 modules)
- **AX5043-433 add-on-kit** (2 modules)
- **AX5043-169 add-on-kit** (2 modules)
- **AX5051-868 add-on-kit** (2 modules)
- **AX5151-868 add-on-kit** (2 modules)
- **AX5042-868 add-on-kit** (2 modules)

For transmitter only evaluation the following transmitter modules are available

- **AX5031-868 module**
- **AX5131-868 module**

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[1] AX5043 **add-on-kits** are normally shipped with two different modules, a module with an RX/TX RF port and a module with an RX/TX plus a TX-only port.

2. AXDBG Debug Adapter Overview

The **AXDBG** debug adapter is the interface between the PC and the mainboards. It can be used for programming and debugging the **AX8052F1xx** family of micro-controllers. It interfaces on the computer side with low level drivers and the **AXSDB** software interface, which is then used by other **AXSEM** software products. The **AXSDB** can also be used in mass production with the scriptable **AXSDB** software.
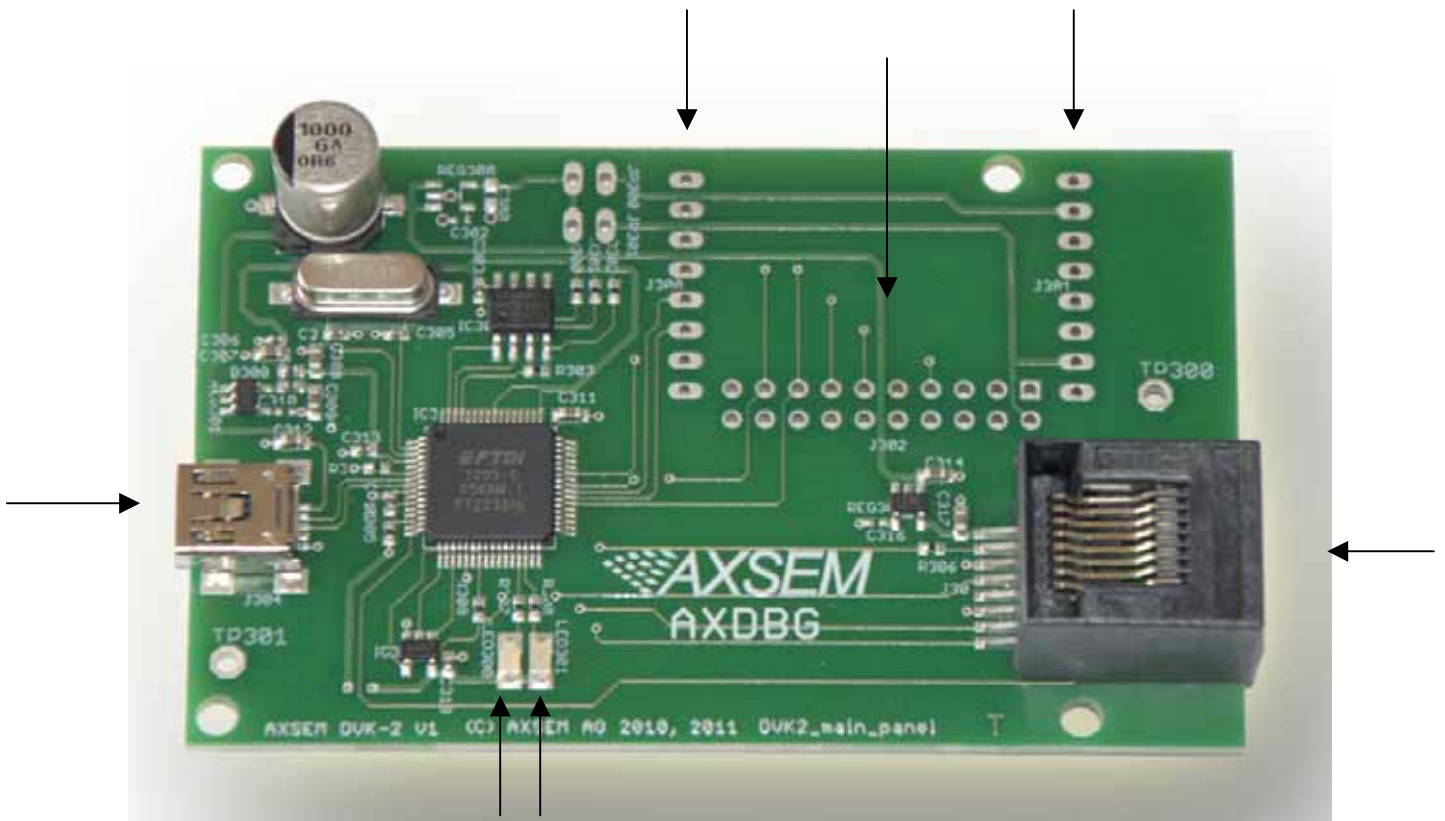
The **AXDBG** has the following interfaces and indicators:

- AX debug link RJ45 connector

- mini USB PC interface

- LED red indicating the debug link is active, MCU in debug mode

- LED green indicating a program is executed on the MCU

- Optional module connectors (not used by actual AXSEM software prducts)

3. Main Board Overview (MB)

A **DVK-2** mainboard is the core of the **DVK-2** development system. It uses an **AX8052F100** as a versatile ultra-low-power micro-controller. The mainboard is designed to evaluate **AXSEM** radio IC as well as being a platform for code development and testing.
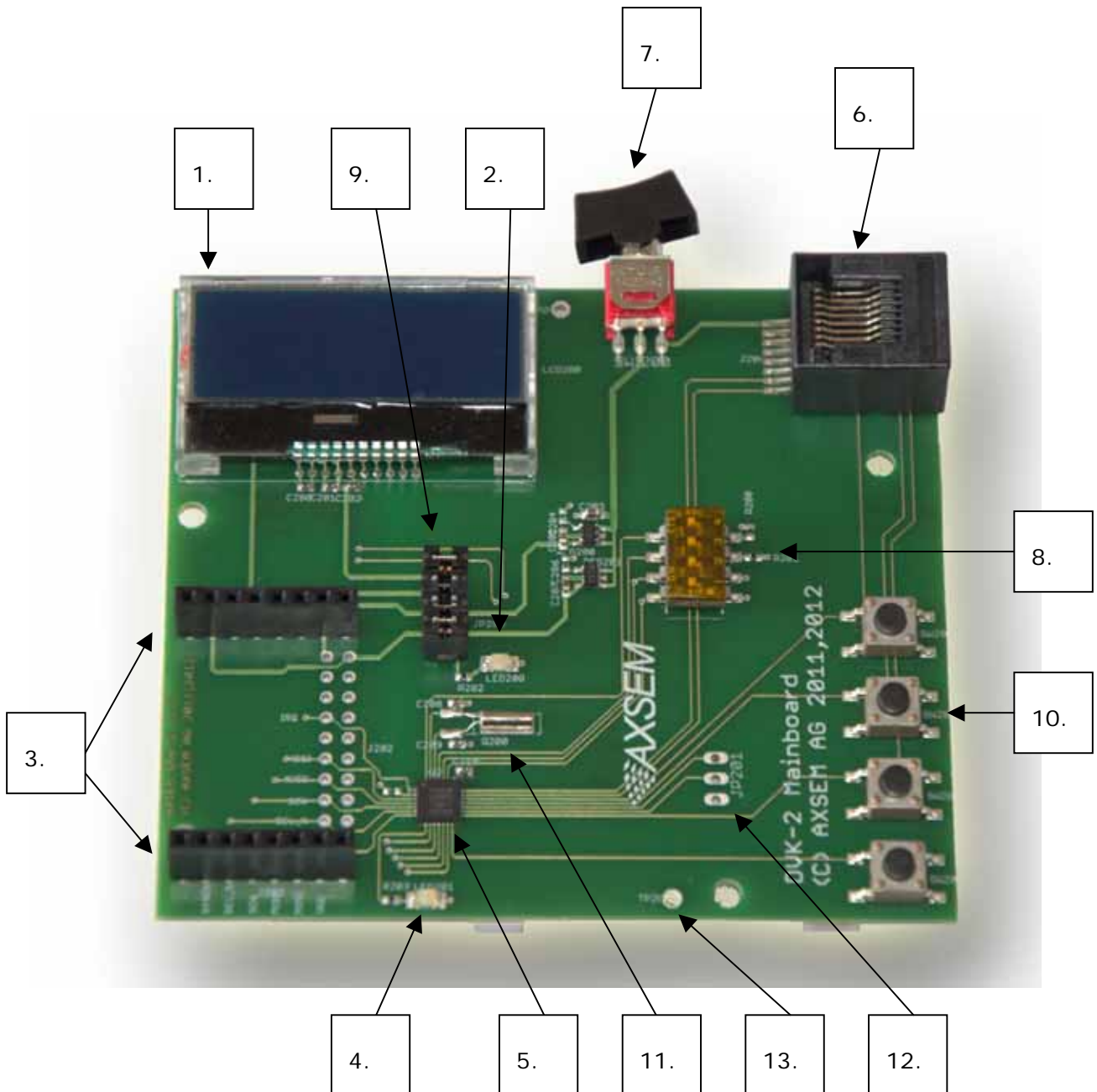
The **DVK-2** mainboard is equipped with the following components:

1. LCD display with 2 lines of 16 characters each

2. Power indicator LED

3. DVK-2 radio module connectors

4. Programmable indicator LED

5. **AX8052F100** micro-controller

6. AX debug link RJ45 connector

7. Power supply switch (select between debug link powered and battery powered operation)

8. 4 dip switches

9. 4 power-supply jumpers:

    a. Power for the LCD-display backlight

    b. Power of the radio-module

    c. Auxiliary power of the radio-module (TCXO, module recognition)

    d. Power for the **AX8052F100** micro-controller on the mainboard

10. 4 buttons

11. 32.768 kHz crystal

12. UART connect

13. GND test point

4. Batteries and Modules

4.1. Batteries

Three AA batteries can be inserted on the bottom side of the **DVK-2** mainboard. The polarity is indicated on the picture below. The power switch toggles between battery powered and debug-link powered operation. There is no OFF position if batteries are inserted and the debug-link is connected.
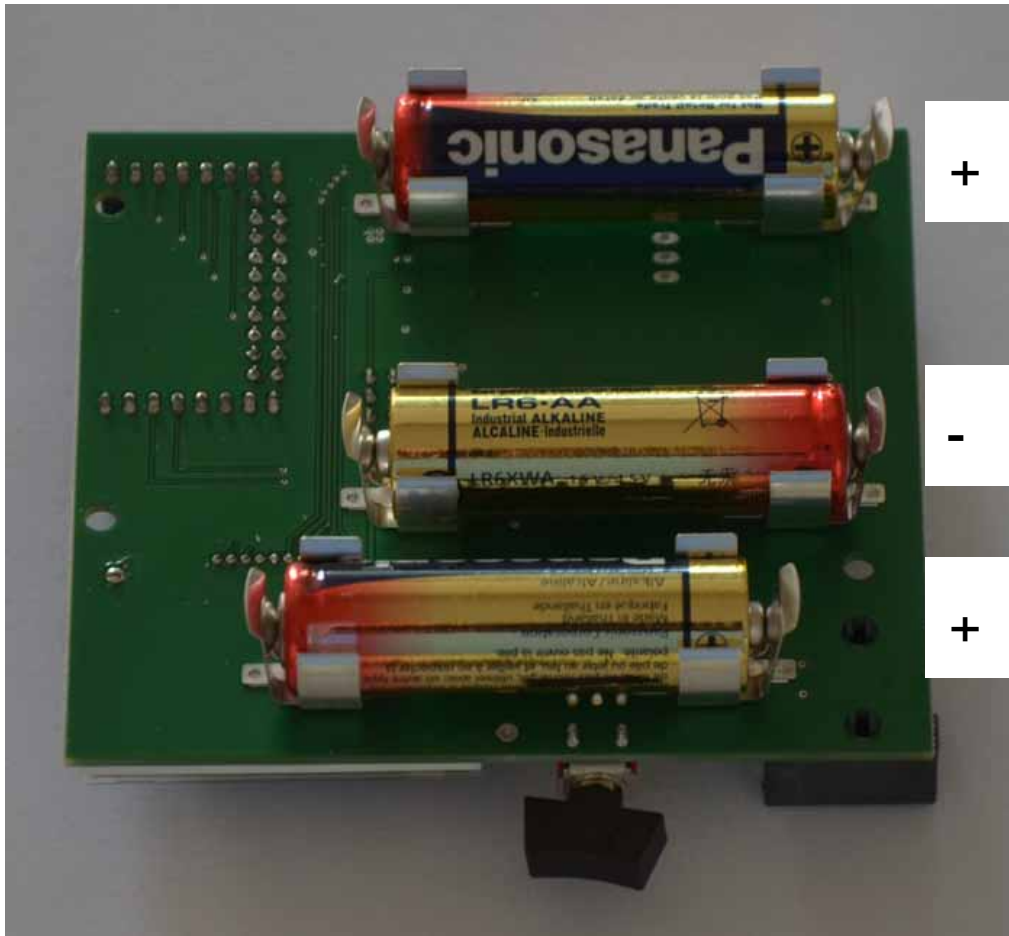
4.2.   Modules

One radio module can be connected to the main board. The **DVK-2** modules have to be connected to the main board with the SMA connector facing outside.

Note: There is no safeguard for polarity or wrong insertion of modules.

5. Various Antennas

Different types of antennas can be used with the **AXSEM** radio modules. The kits come without antenna but any 50 Ohm antenna designed for a frequency matching the radio module and being equipped with a male SMA connector can be used. Be aware that antenna performance can vary a lot between different makes of antennas.

1   2   3   4   5   6   7

Antennas in the picture:

1. 868 MHz dipole (two grey rings, often used by **AXSEM**)

2. 915 MHz dipole (two yellow rings, often used by **AXSEM**)

3. 868 MHz monopole

4. 868 MHz monopole

5. 433 MHz monopole

6. 868 MHz monopole

7. 868 MHz monopole

6. Software required to work with the DVK-2

Depending on your application and add-on-kit you need to use different AXSEM software.

Kit	Matching Software

DVK-2 base-kit, no module attached	• AX8052IDE package
	    o AXCode::Blocks
	    o AXSDB
	    o LibMF
	    o SDCC
	• AX-MicroLab

DVK-2 base-kit with AX5043 add-on	• AX8052IDE package
	    o AXCode::Blocks
	    o AXSDB
	    o LibMF
	    o SDCC
	• AX-RadioLab
	• AX-RadioLab-POCSAG (not free of charge)
	• Pre-installed PER-test

DVK-2 base-kit with AX5051 add-on or AX5151 add-on	• AX8052IDE package
	    o AXCode::Blocks
	    o AXSDB
	    o LibMF
	    o SDCC
	• AX-RadioLab51
	• Pre-installed PER-test

DVK-2 base-kit with AX5042 add-on, AX5031 add-on or AX5131-add-on	• AX8052IDE package
	    o AXCode::Blocks
	    o AXSDB
	    o LibMF
	    o SDCC
	• AX-ParamCalc
	• AX-Easy_packet
	• Pre-installed PER-test[2]

Note: **AX-MicroLab** and **AX-RadioLAB** use the **AX8052IDE** software package in the background. Therefore the **AX8052IDE** software package has to be installed and configured before installation of the other software. For configuration run **AxCode::Blocks** and set **SDCC** as default compiler.

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[2] Note: **AX5031** and **AX5131** modules are transmitters only and do not work on mainboards programmed as receiver

7. Configuration of AxCode::Blocks

After starting **AxCode::Blocks** for the first time the user has to select **SDCC** as the default compiler. The following window will pop-up. After this configuration process you are ready to go.

Note: To delete an **AxCode::Blocks** configuration you have to delete the directory C:\Documents and Settings\user\Application Data\axcodeblocks.
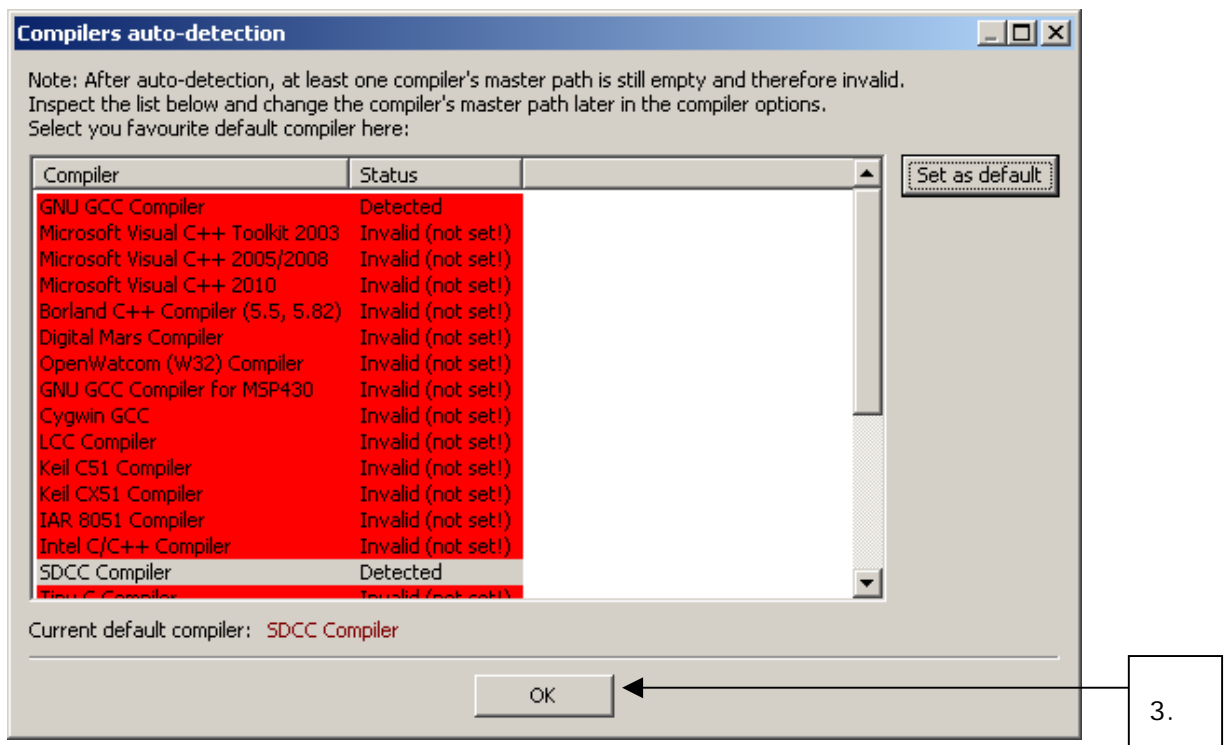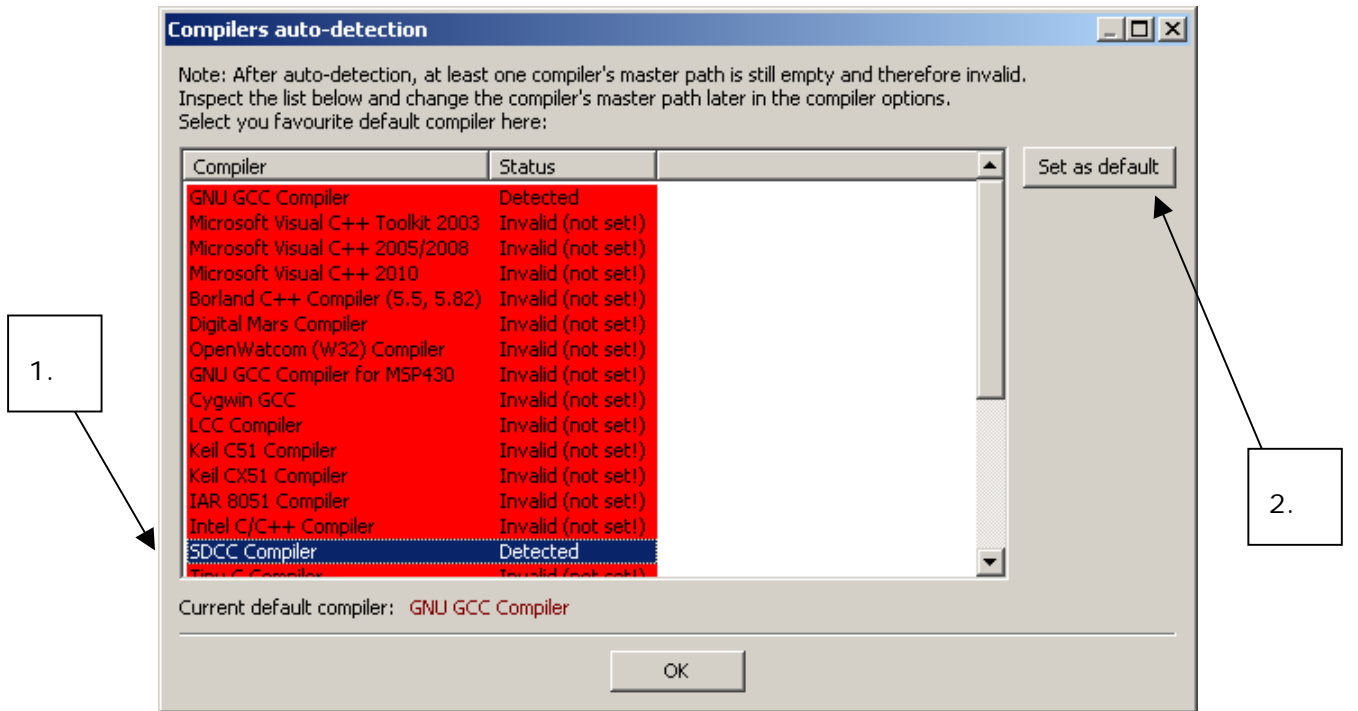
8. Connecting the DVK-2 to a PC

Step 1: To interface with the user the **DVK-2** uses a suite of software on a PC.

- **AX8052IDE** package (Installs **AxCode::Blocks**, **AXSDB**, LibMF support libraries, the **SDCC** C-compiler and low-level drivers)

- **AX-RadioLab**

- **AX-RadioLab51**

- **AX-MicroLab**

Make sure that the **AX8052IDE** software is installed before connecting the **AXSDB** to the computer and before installing the other **AXSEM** software. Otherwise you may experience difficulties in installing the driver later. **AX-RadioLab, AX-RadioLab51** or **AX-MicroLab** may be installed later, depending on the users intentions.

All necessary software can be downloaded at www.axsem.com .

Step 2: Connect the **AXDBG** via the USB cable to the computer. Since the driver is already installed the computer should report 2 "USB Serial Converters" in your Device Manager.
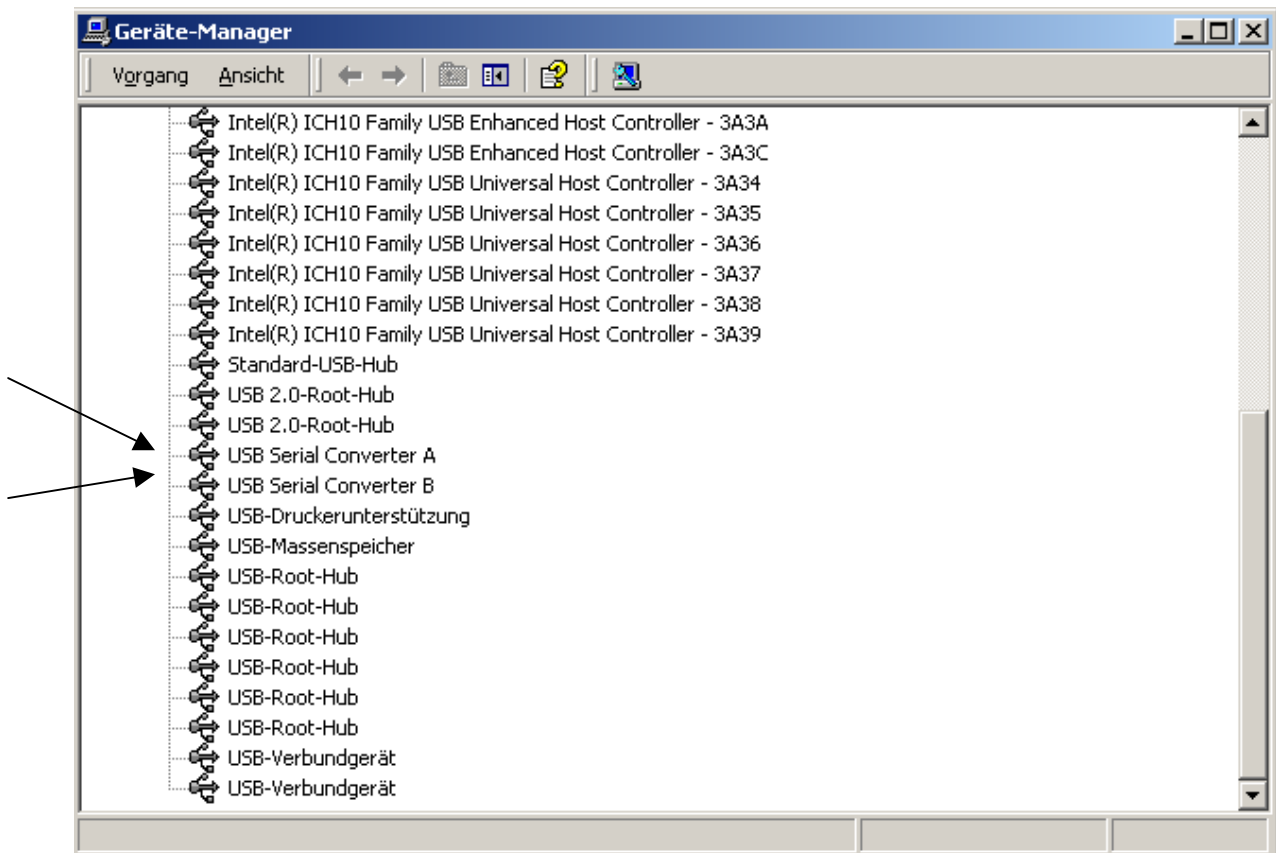
Step 3: Connect a **DVK-2** mainboard via the blue RJ45 cable to the **AXDBG** debug adapter.

The base system is now ready for testing e.g. with **AX-MicroLab** for a start.

Note: If powered via the debug adapter the user can see voltage changes on the mainboard if the current consumption changes. This is caused by a cascade of two 3.3V regulators, on the AXSDB and on the mainboard. The effect is visible in changes of the back light of the LCD display. It does not occur with battery powered operation. This is fixed on the newest versions of the DVK-2.

9. Operation with AX-MicroLab

AX-MicroLab is a great starting point for micro-controller code development with the **AX8052F1xx** family of micro-controllers. It creates a framework of code for different applications and helps to configure the functions of the micro-controller.
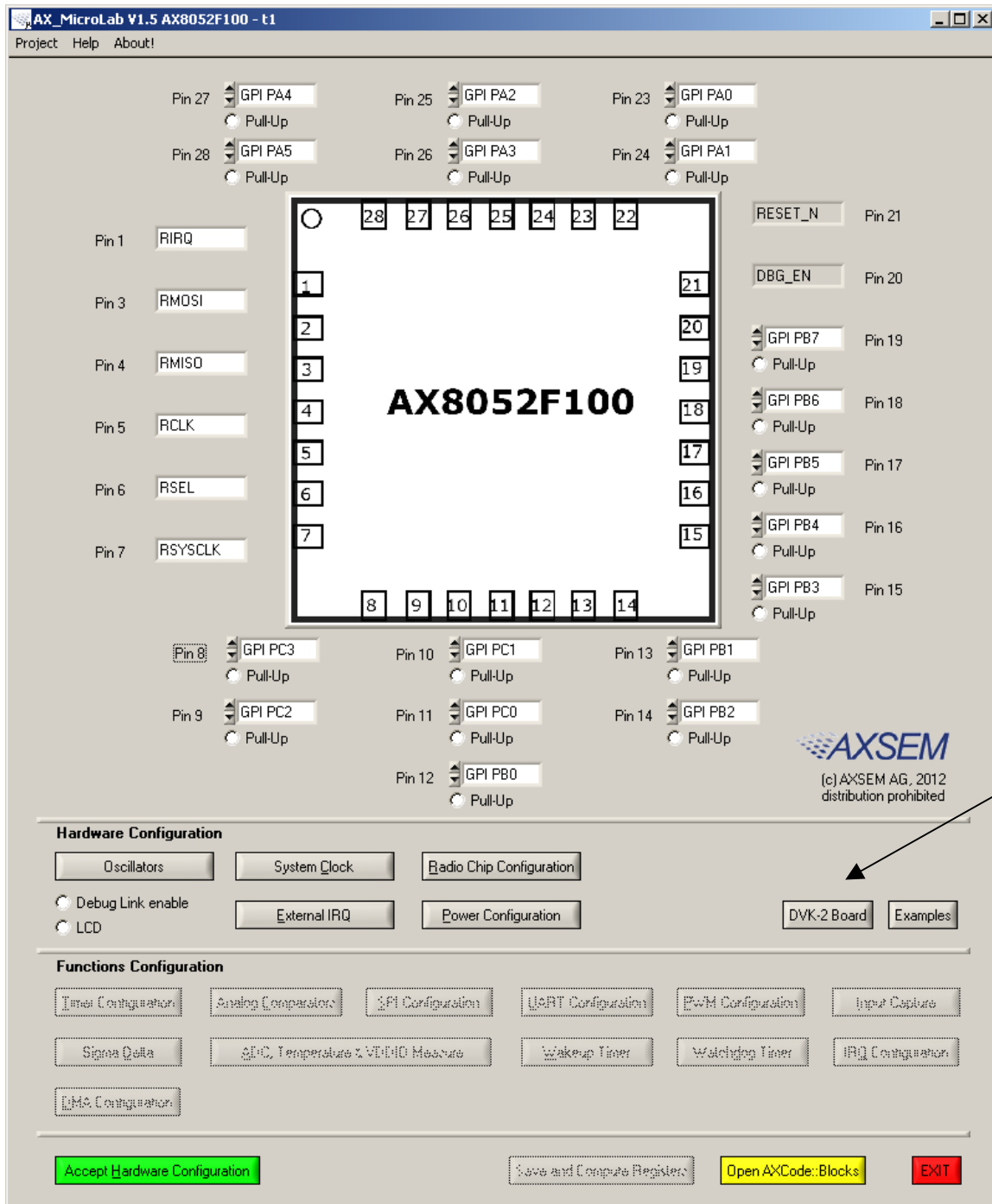
AX-MicroLab has a "DVK-2 Board" button (see arrow) to create a **DVK-2** compatible configuration quickly. For details look in the **AX-MicroLab** documentation, which is available at www.axsem.com .

10. Pre-installed PER-test

The **DVK-2** mainboards come with a pre-installed software for tests with **DVK-2** radio **add-on** modules. The pre-installed software recognises most **AXSEM** radio **add-on** modules and automatically starts testing packet error rate. One **DVK-2** mainboard is programmed with a transmitter the other with a receiver. Just plug in batteries, attach radio modules and set the power supply switch to battery. For longer range use antennas. The transmitter indicates the number of the last transmitted packet, while the receiver indicates the packet error rate (PER), the RSSI and the frequency offset. Walk around and check out for the great distance you can achieve.

Note: The SW does not accurately sense AX5043 modules for 433 and 169 MHz and modules with 48 MHz TCXO. For those modules it is recommended to use AX-RadioLab.

The pre-installed SW running on the main boards can be downloaded from the **AXSEM** web-page www.axsem.com . Open slave.cbp in **AxCode::blocks** to download the receiver and master.cbp to download the transmitter. The project main.cbp allows to toggle between transmitter and receiver by pressing SW4 during power-up.

The radio parameters of this software cannot be changed. It is recommended to use **AX-RadioLab** or **AX-RadioLab51** for in depth testing. With **AX5042** and **AX5031** we recommend **AX-ParamCalc** with **AX-Easy_Packet** as development and testing platform.

10.1. Transmitter side

The transmitter sends a standard **AXSEM** HDLC packet every second.

The LCD display shows:

AXSEM RF: AX50xx
          0051 (the last transmitted packet number)

Transmit parameter:

868.3 MHz
100 kbps
max power
FSK, deviation h=0.5
duty cycle ~1s

10.2.   Receiver side

The application on the **AX8052F100** receives the data packets from the transmitter and shows packet error rate, signal strength and frequency offset.

The LCD display shows:

P:0014 O:00397
L:0000 R: -034

P is the number of received packets
L is the number of lost packets
O is the frequency offset in Hz
**R** is the receiver strength indicator (RSSI) in dBm

Note: The receiver screen updates only if a valid packet was received.

Note: If the transmitter is reset during the test, the P and L values become invalid.

11. Working with AX-RadioLab

AX-RadioLab is the most advanced development tool for SRD radio applications. It offers a variety of transmitter and receiver options such as

- Periodic transmission of packets timed with the RC oscillator of the **AX5043**

- Periodic transmission of packets timed with the 32 kHz XTAL oscillator of the MCU

- Transmit on push-button

- Wake-on-radio reception with programmable wake-up interval

- Synchronous transmit and receive with programmable wake-up interval

- Optional acknowledge package send for all modes
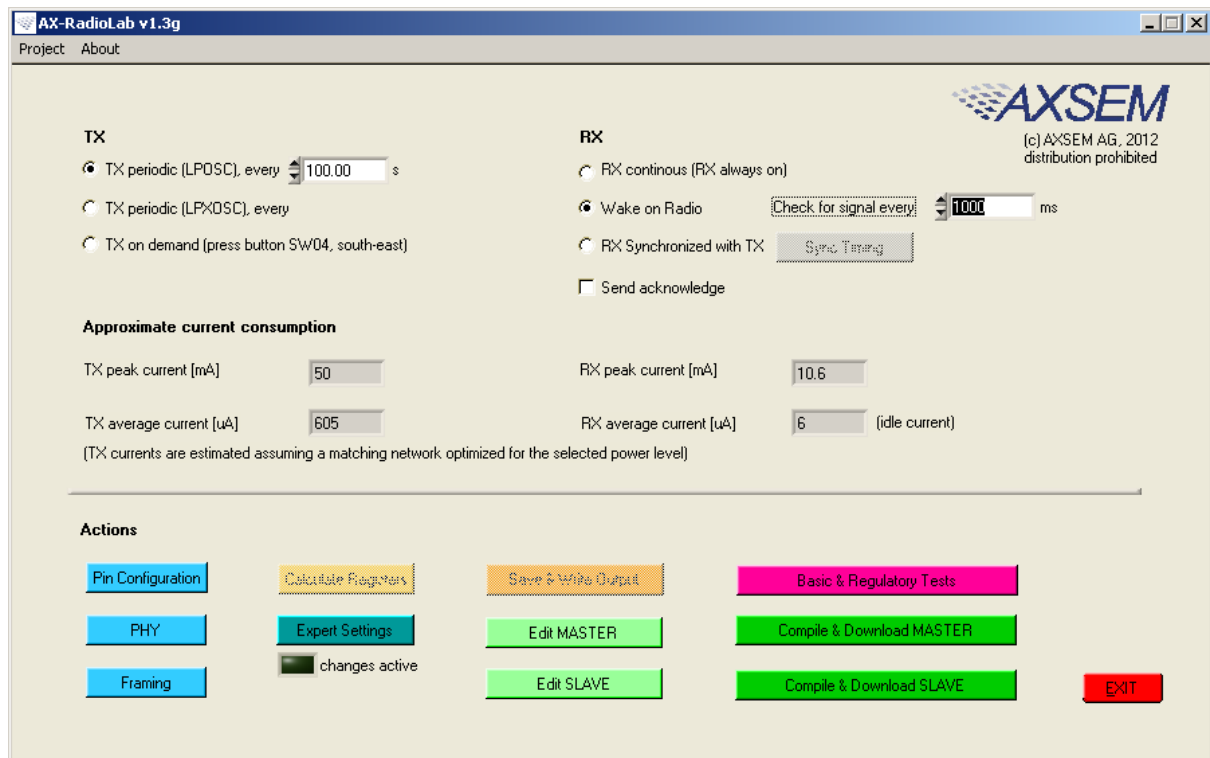
On top of this **AX-RadioLab** also allows to configure the packet format, as well as the PHY.

Since **AX-RadioLab** is a source code generator the developer inherits the entire C-code necessary to run his application. This makes radio code development quick and reliable.

AX-RadioLab also estimates the power consumption of the radio device. For most modes the **AX8052F100** power consumption is negligible. Average and peak currents are indicated for transmitter and receiver.

12. Working with AxCode::Blocks

AxCode::Blocks is the graphical IDE for code development on **AXSEM** micro-controllers. It enables the developer to access all the degugging features of the AXSEM micro-controllers, in particular:

- Unlimited[3] number of break points

- Access to all **AX8052F1xx** MCU registers as well as to all **AXSEM** radio chip registers

- Debug link UART in a window for debugging printf-style without the need of extra hardware

- **SDCC** C-compiler pre-installed and ready to go

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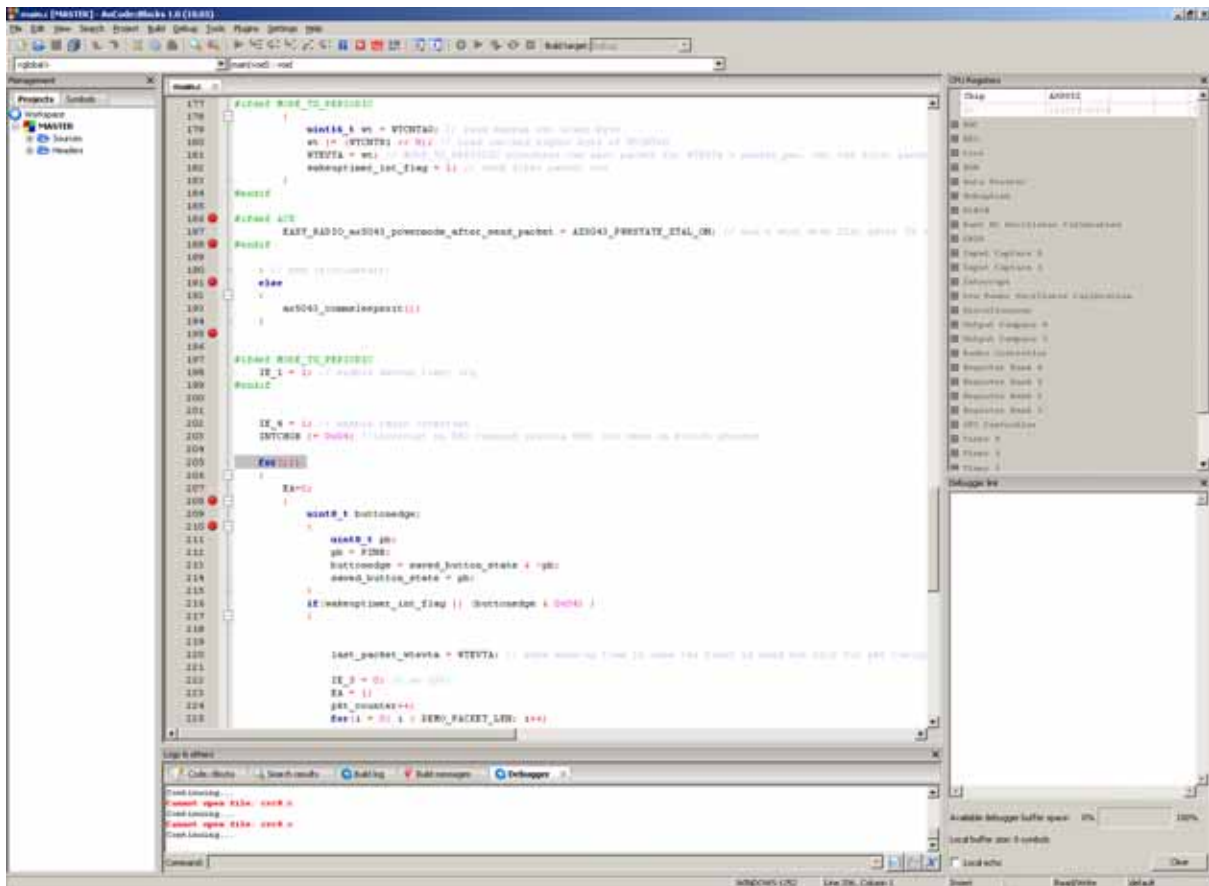
[3] Limited only by memory size

13. Installation of Software

Download AX8052-IDE-setup.exe.zip, AX-RadioLab.zip and AX-MicroLAB.zip from www.axsem.com.

The AX8052-IDE-setup.exe.zip has to be unzipped and then comes as windows installer executable, which needs administrator privileges to be executed. It installs the **AxCode::Blocks** IDE, the **SDCC** C-compiler, the LibMF support libraries, the **AXSDB** command line debugger and low level drivers. Check the support page of www.axsem.com for tips and tricks and problem solving with the installation of the IDE, especially in conjunction with 64-bit versions of operating systems.

The **AX-RadioLab** and **AX-MicroLAB** come as zip-file which have to be unzipped into a temporary directory. Run setup.exe in that temporary directory. The temporary directory can be deleted after installation.

Note: The installer requests reboots of the computer, which is not necessary.

Note: If you already have a version installed, the setup.exe first uninstalls the existing version of the software. You have to run the installer a second time to install then the software.

The default location for **AX-RadioLab**, **AX-MicroLAB**, **AxCode::Blocks** and AXSDB is in the *c:\program files\AXSEM* directory. The **SDCC** C-compiler is typically installed directly into the *c:\program* files directory. LibMF and the supporting libraries are installed in the **AXSDB** directory.
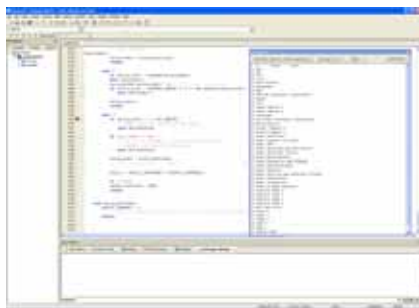
Please check the respective documentations for details.
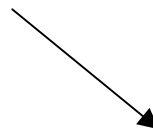
14.   Different SW packages playing together

AX-RadioLab or **AX-MicroLab**
code generator GUI

C-source code project

AxCode::Blocks IDE

AXSDB
command line debugger and low level drivers. Operated in the background. No need for engineer interaction.

DVK-2 hardware

The AX8052-IDE-setup.exe contains all tools for developing and debugging C-source code applications for the **AX8052F1xx** family of micro-controllers.

The **AX-RadioLab** GUI is a code generator, which creates C-code, which can then be compiled and downloaded directly from the **AX-RadioLab** or it can be edited, modified and debugged in the **AxCode::Blocks** IDE.

The user normally starts in the **AX-RadioLab** GUI and creates all necessary configuration and program files. The project can optionally be viewed and modified in **AxCode::Blocks**. Be aware that there are no protective mechanisms in the **AxCode::Blocks** to prevent mal function of modified C-code.

For details look into the documentation of **AX-RadioLab** and **AxCode::Blocks**.

15.   Glossary

AxCode::Blocks: An IDE for **AX8052F1xx** micro-controllers

AX-RadioLab: An application C-code and settings generator for the **AX5043** radio chip running on the **AX8052F100** micro-controller

AX-RadioLab: An application C-code and settings generator for the **AX5051** radio chip running on the **AX8052F100** micro-controller

AX-MicroLab: A C-code and settings generator for **AX8052F1xx** family of micro-controllers

Debug link: The interface between **AXDBG** debug adapter and **AX8052F1xx** micro-controllers

AXDBG: The USB debug adapter for **AX8052F1xx** micro-controllers

AXSDB: A command line debugger using **AXDBG**. It is also fully suitable for use in mass production

SDCC: A C-compiler for **AX8052F1xx** micro-controllers

Main board: The **DVK-2** development board with **AX8052F100** micro-controller and LCD display

DVK-2: The AXSEM development system for micro-controller and radio applications

DVK-2 base-kit: Two mainboards, an **AXDBG** and cables

DVK-2 add-on: Set of two modules with **AXSEM** radio chips

add-on-kit or add-on: Set of two modules with **AXSEM** radio chips

Radio module: Plug-in module for mainboards with **AXSEM** radio chips

AX8052F100: The **AXSEM** ultra-low-power micro-controller used on the **DVK-2** mainboards

LibMF: Support libraries for the **AX8052F100** and the **DVK-2**. It normally if not otherwise mentioned includes the libraries libax5031, libax5031, libax5042, libax5051, libax5043, which are in separate directories

LibMFCrypto: A library which enables the use of the AES or DES functionality of the **AX8052F1xx** micro-controllers

AX-Easy_packet: Software example programs for **AX5042**, **AX5051**, **AX5151**, **AX5031**, **AX5131**, **AX50424**

Pre-installed PER test: A software which is programmed on the DVK-2 mainboards

AX-ParamCalc: GUI application to create configuration files for AX5042, AX5051, AX5151, AX5031, AX5131, AX50424. The configuration files are compatible with AX-Easy_Packet but can also be used in customer specific code

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