ATAVRRZ200 Demonstration Kit AT86RF230 (2450 MHz band) Radio Transceiver

User Guide

Section 1

1.1 Organization....1-1
1.2 General Description....1-1
1.3 Demonstration kit features....1-2
1.4 Included in the kit....1-2

Section 2

2.1 Hardware assembly....2-1
2.2 Starting and using the network....2-1

Section 3

3.1 Z-Link RCBs....3-1
3.2 Display Board....3-1

Section 4

4.1 Channel Scan....4-1
4.2 End Device Association & Network Configuration....4-2
4.3 Network Operation....4-2

Section 5

5.1 Starting the network....5-1
5.2 Reconfiguring the network....5-3
5.3 Using the network....5-3

Section 6

6.1 Atmel AVR Studio installation....6-1
6.2 Overview of the programming process....6-1
6.2.1 Programming the Display Board....6-2
6.2.2 Programming the RCB....6-2
6.2.3 How to re-program the RCB MAC address....6-3

Section 7

Section 1 Introduction

Congratulations on your purchase of the Atmel® AVR® Z-Link™ ATAVRRZ200 Demonstration kit. The demonstration kit is intended to exceed a point-to-point demonstration (Such as two nodes communicating data etc.) The application running on the Z-Link devices show how it is possible to independently assign them with different functionality over the wireless link.

1.1 Organization

This User Guide describes how to use the Demonstration kit. The remainder of this subsection gives a brief description of how the document is organized. Section 2, “Getting Started” describes how to assemble the hardware, and how to easily start the demonstration application (configure and monitor the network). Detailed hardware and software descriptions are contained in Section 3 and Section 4 respectively. Section 5 describes in further detail how to manage the network from a central control unit (The Display Board). Section 6 contains directions on how to program the AVR microcontroller running the network application on the Radio Controller Boards (RCBs). A troubleshooting chart can be found in Section 7.

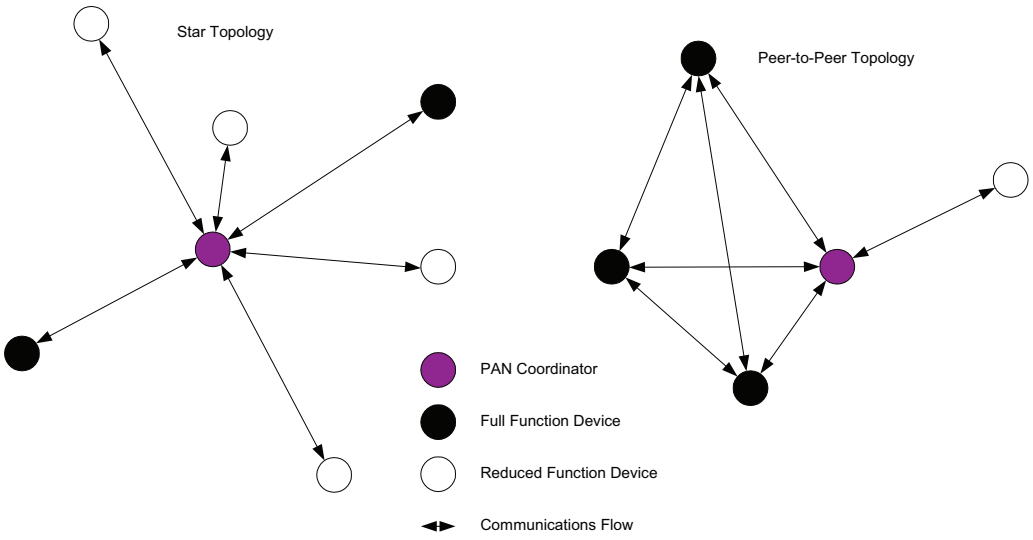
1.2 General Description

Depending on the application requirements, the LR-WPAN (Low Rate-Wireless Personal Area Network) may operate in either of two topologies: the star topology or the peer-to-peer topology. Both are shown in Figure 1-1. In the star topology the communication is established between devices and a single central controller, called the PAN coordinator. A device typically has some associated application and is either the initiation point or the termination point for network communications. A PAN coordinator may also have a specific application, but it can be used to initiate, terminate, or route communication around the network. The PAN coordinator is the primary controller of the PAN (Personal Area Network). Applications that benefit from a star topology include home automation, personal computer (PC) peripherals, toys and games, and personal health care.

The peer-to-peer topology also has a PAN coordinator; however, it differs from the star topology in that any device can communicate with any other device as long as they are in range of one another. Peer-to-peer topology allows more complex network formations to be implemented, such as mesh networking topology.

Self-healing functions can be added at the network/application layers to automatically replace a failed PAN coordinator. This demonstration kit shows how it is possible to change the role of a network device over the wireless link. Such functionality is beneficial in self-healing networks.

Figure 1-1. Star and peer-to-peer topology examples



1.3 Demonstration kit features

- Network devices can be configured and reconfigured wirelessly from a PAN coordinator (Display Board)
- Simple application interface (pushbutton switches and LEDs)
- Wide application usage
- Choice of RCB application software
- How to use the Atmel IEEE 802.15.4 communication-stack
- Non-beacon-enabled network
- IEEE 802.15.4 compliant

1.4 Included in the kit

The kit features two component types: the Display Board and the Radio Controller Boards (RCBs). The following items are included in the kit.

- Display Board (1) with AA Batteries (2)
- AT86RF230 RCBs (5) with PCB Antenna and two AAA Batteries each
- CDROM containing:
  - AVR Studio® 4
  - WinAVR™ 20060421
  - Atmel RCB and Display Board firmware
  - User Guide
- AVRISP mkII In-System Programmer (Used for programming firmware)
- AC Adaptor furnishing 3V (used to power the Display Board only)

Section 2 Getting Started

This section provides brief instructions to get the Demonstration kit up and running in the shortest amount of time. Persons reading this section should be familiar with wireless networking; otherwise, read section 3 and section 4 for a full description of the Demonstration kit. This Demonstration kit is fully self-contained, no external hardware or software is required to conduct the network demonstration. However, in the event RCB or Display board reprogramming is desired, a PC is required.

2.1 Hardware assembly

The hardware is assembled by following the steps listed below. Pictures with itemized callouts are shown in Section 3.

1. Assemble the five RCBs by inserting two AAA batteries.
2. Assemble the Display Board by inserting two AA batteris at the bottom of the board and connecting any RCB.

2.2 Starting and using the network

Network device activity is monitored in two places: the network monitor screen and on the RCBs designated LED units. The following steps describe device monitoring and the reconfiguration of network devices over the wireless link.

For more detailed information about the following steps, see Section 5, running the demonstration.

1. On the Display Board, move the power switch toward the edge of the board (BAT).
2. When the Atmel splash screen is displayed, move the power switch on the attached RCB away from the antenna to the ON position.
3. Observe the LCD display indicate channel scan.
4. One at a time, sequentially turn on the four remaining RCBs.
5. Observe as the devices associate with the PAN coordinator (Display) and populate the Configure screen on the LCD.
6. After all the RCBs are associated, press the SW1 button on the Display Board to switch to the network monitor screen.
7. Locate the RCBs associated as Switches by checking the MAC address shown on the Network Monitor screen with the MAC address printed on the labels attached to each RCB. Observe the LED illumination on an RCB designated as an LED Unit and also the count increment in the network monitor screen.
8. Press SW1 to return to the Configure screen.

Note: In the following steps, at a minimum, one RCB must be assigned the function of a Switch Unit and one RCB must be assigned the function of an LED Unit.

9. Randomly change the functionality of the RCBs in the Configure screen by first selecting the desired unit by pressing the joystick up or down, then press SW2 to change the function to either an LED unit or one of the three switch units.
10. Press SW1 to return to Network Monitor mode and observe the new function of the units.
11. When finished, return all power switches to the OFF position.
12. Please consult Table 7-1 if problems are encountered.
13. RCBs must contain a valid MAC address. If the MAC address was reset to FF-FF-FF-FF-FF-FF-FF-FF you must reprogram the MAC address as outlined in section 6.2.3..

Section 3 Hardware Description

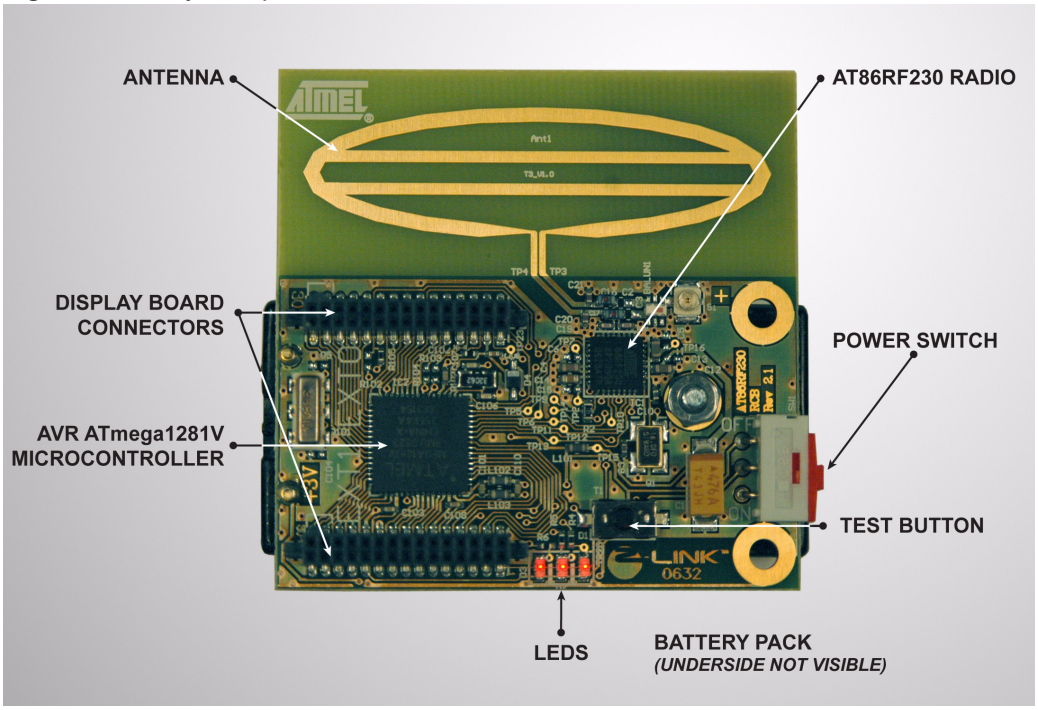
This section contains a description of the hardware furnished with the Demonstration Kit.

3.1 Z-Link RCBs

The five RCBs are identical and each contains a radio and microcontroller. The microcontroller contains the application firmware needed to run the demonstration. This aplication is linked to the MAC (Medium Access Control), PHY, and HAL layers that communicate with the AT86FR230.

The key components of the RCB are shown in Figure 3-1.

Figure 3-1. Key Components of the RCB



3.2 Display Board

The Display Board is used to configure and monitor the network devices. Key components of the Display Board are shown in Figure 3-2. An RCB mounted on the Display Board is shown in Figure 3-3, and the connectors on the Display Board are shown in Figure 3-4.

Figure 3-2. Key Components of the Display Board

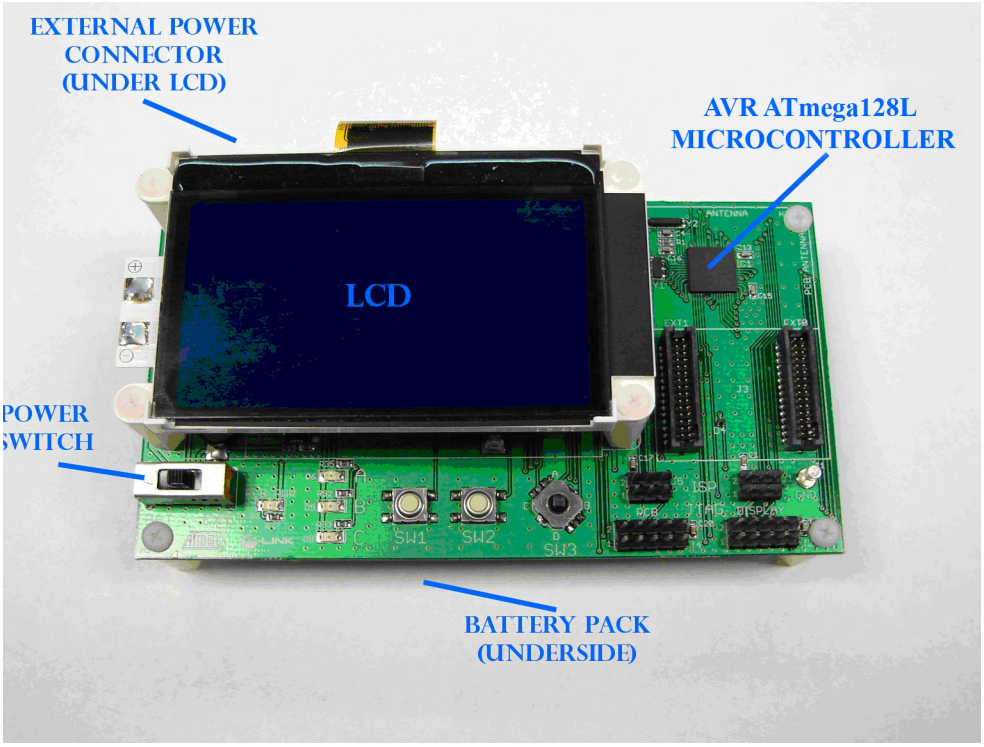


Figure 3-3. RCB Mounted on the Display Board

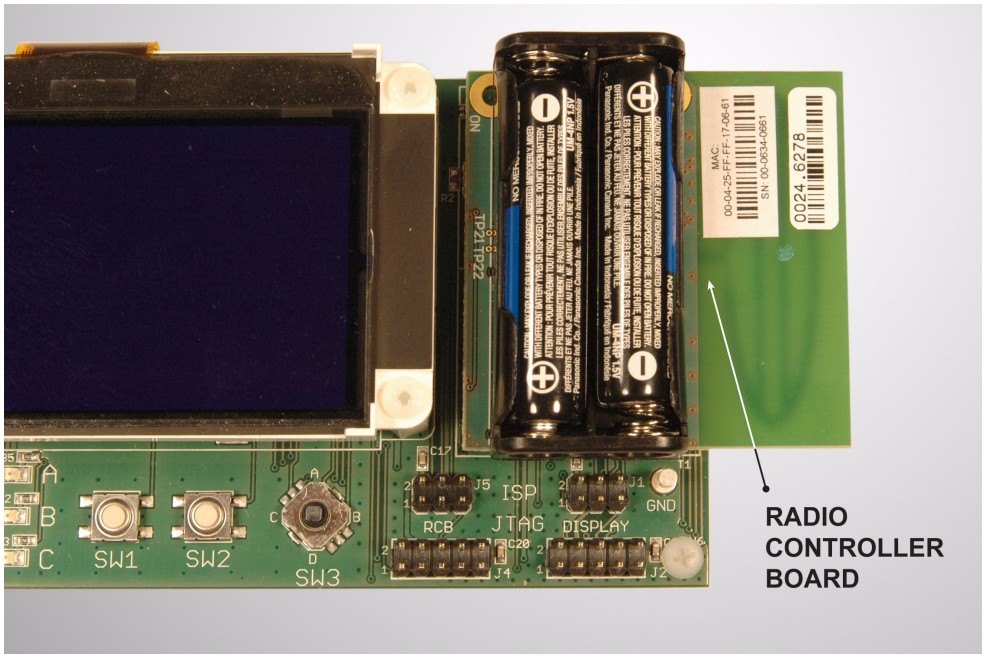
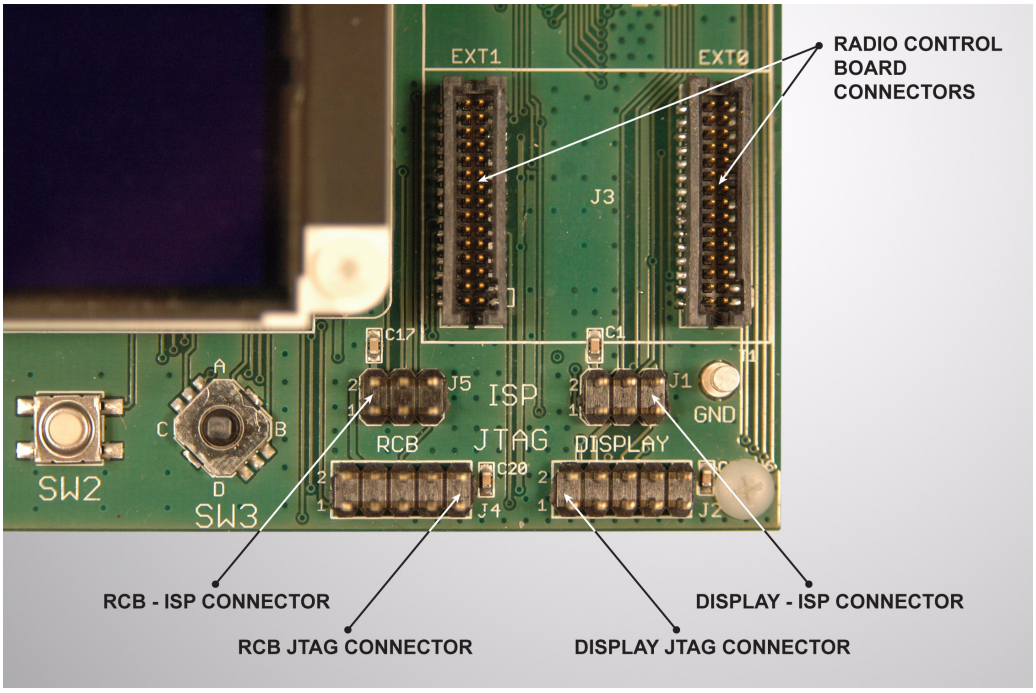


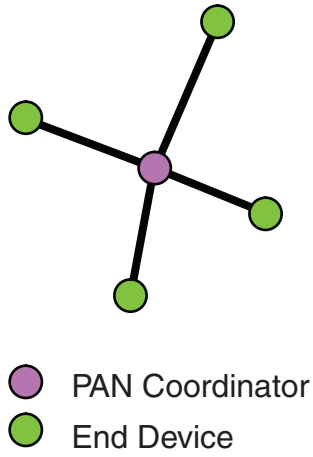
Figure 3-4. Display Board connectors



Section 4 Functional Overview

This section describes how the software furnished with the kit is used to demonstrate a simple IEEE 802.15.4 network operating with a star topology. The star network is shown below in Figure-4.1 and consists of a Personal Area Network (PAN) Coordinator and a number of End Devices (in the case of this kit). The distinguishing feature of a star network topology is that communication between End Devices is always routed through the PAN Coordinator. Direct communication between End Devices is never allowed.

Figure 4-1. Simple star network



4.1 Channel Scan

The process of creating a network begins with the PAN Coordinator. Upon power up, the PAN Coordinator must select a channel on which to create its network. The PAN Coordinator does this by broadcasting a Beacon Request message. The PAN Coordinator repeats this broadcast on all channels from 11 to 26 in search of a channel without a PAN Coordinator. If the channel is in use by another network, that network's PAN Coordinator will respond with a Beacon. However, if the channel is unoccupied, the Beacon Request will not be answered. By default, the lowest unoccupied channel of the scan becomes the channel on which the network will form.

4.2 End Device Association & Network Configuration

As each End Device is turned on, it performs an active scan of all channels from 11 to 26, broadcasting a Beacon Request and recording all information that it receives from all PAN Coordinator beacons. The End Device will then select the channel that corresponds to the PAN Coordinator with the correct PAN ID value that it is searching for. The End Device will attempt to “associate” to the PAS Coordinator. Sucessful association will result in a network address assignment to the End Device. By default, the software in this kit assigns the first associated End Device the function of LED (output), the second associated End Device the function of Switch 1 (input), the third – Switch 2, and the fourth – Switch 3. Pressing SW1 on the PAN Coordinator completes the configuration of the network and allows the End Devices to operate as defined.

4.3 Network Operation

Now that the network configuration is complete, pressing the pushbutton switch (T1) on the End Device corresponding to Switch 1 will send a message to the PAN Coordinator to notify the End Device corresponding to LED, D1, to toggle its state. Similarly, End Devices corresponding to Switches 2 and 3 control LEDs D2 and D3 respectively. Additional End Device information is captured and displayed on the LCD screen during normal network operation. This includes the total number of times Switch 1, 2, and 3 were pressed, the power level in dBm of the received packet betwen the End Device and the PAN, as well as the current state of each LED. Additional details with regard to changing the network configuration are described in the next section.

Section 5 Running the Demonstration

The Demonstration Kit consists of five RCB nodes, one of which is connected into the Display Board and will act as a PAN Coordinator. Starting the network and experimenting with network reconfiguration are discussed in the following subparagraphs.

Note: The following paragraph discusses starting the network with the PAN Coordinator started first and then the nodes coming online in random sequence. The network can also be started with the nodes being started first and then the PAN Coordinator coming online and establishing the network. A combination of these two approaches can also be used.

5.1 Starting the network

After the RCB is connected to the Display Board, the power switch on the Display Board should be moved to BAT for battery power, or EXT for AC Adaptor power. The Atmel splash screen is displayed on the LCD display similar to that shown in Figure 5-1.

Figure 5-1. Atmel splash screen



Note: While the Display Board can be powered from an ac adaptor or batteries, all of the RCBs must have batteries installed.

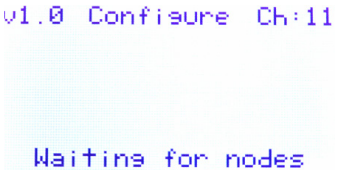
While the splash screen is displayed, move the power switch on the attached RCB to ON (towards the LCD screen). The RCB will then scan all channels in the 2450 MHz band - Channels 11 (2405 MHz) through 26 (2480 MHz) for other active PANs. The display during channel scan is shown in Figure 5-2.

Figure 5-2. Screen during Channel scan



The RCB firmware will determine if a PAN exists on each channel and select the lowest channel where there is no conflicting PAN. When a channel is selected (11 in this case), the display will be similar to Figure 5-3.

Figure 5-3. Channel selected and waiting for nodes.



The four remaining RCBs can now be powered on in random order. Figure 5-4 through Figure 5-7 shows the Configure screen as the nodes are powered on.

Figure 5-4. First device found, assign as LED

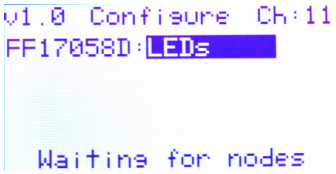


Figure 5-5. Second device found, and assigned as Switch 1 (Toggles LED1)

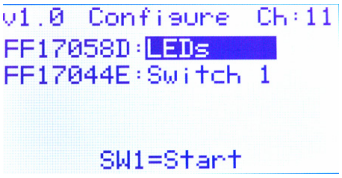


Figure 5-6. Third device found, and assigned as Switch 2 (Toggles LED2)

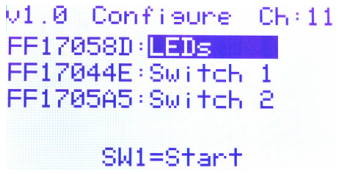
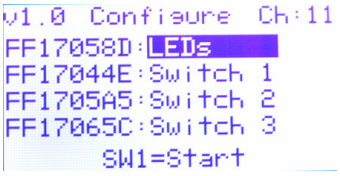


Figure 5-7. Fourth device found, and assigned as Switch 3 (Toggles LED3)



The Configure screen is used to reconfigure the network nodes. After the nodes have been configured in this screen, **SW1** toggles the display between the Configure screen and the Network Monitor screen shown in Figure 5-8.

Figure 5-8. Network monitor screen



5.2 Reconfiguring the network

All configurations of the network nodes are performed in the Configure screen on the Display Board.

Note: This demonstration requires at least two nodes to associate with the PAN Coordinator. This is because the demonstration expects a minimum of one LED device and one switch device.

With the Configure screen displayed, the functions of the device can be changed by using the joystick to highlight the device's existing function. When the function is highlighted, pressing SW2 will cycle between the available options (**Switch** or **LEDs**). Consult Figure 5-4 through Figure 5-7 and their captions.

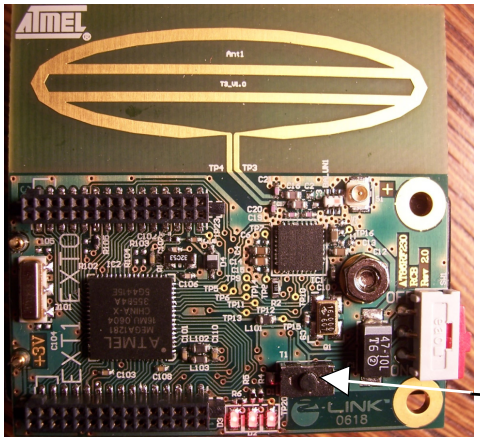
The switch functions on the Display Board are shown below.

- SW1: Toggles the display between the Configure screen (Figure 5-7) and the Network Monitor screen (Figure 5-8).
- SW2:
  1. When the Configure screen (Figure 5-7) is displayed, pressing this button changes the highlighted function of the device. The functions are:
  - LED
  - Switch 1
  - Switch 2
  - Switch 3
- Joystick: The joystick up and down switch are used to highlight the device function on the Configure screen (Figure 5-7).
- Joystick Push: By pressing down on the joystick, the PAN Coordinator will attempt to communicate to all devices. If any devices are out of range or become disassociated, they will be removed from the network table.

5.3 Using the network

Each RCB has a Test button and three LEDs. Figure 5-9 shows an RCB with all three LED's illuminated:

Figure 5-9. RCB Test button



Each RCB configured as an LED unit will show the state of the switch device's value (on or off). The value of the LEDs will also be shown on the Display Board in the network monitor screen. The LEDs are disabled on devices configured as switch devices. If an RCB is configured as an LED unit and has gone out of range, a message "Device out of Range" will be displayed for the associated device.

When a switch device's Test button is pressed, a data frame is constructed and the device's MAC transmits the frame to the PAN coordinator. When the PAN coordinator receives the frame (data indication) it updates (toggles) the state of the LED associated with the switch device. The data representing the new state of the LEDs is transmitted to all devices that are configured for LEDs. When the LED device receives the dataframe it updates its internal record of LED states, displays the state on the physical LEDs and the transaction is finished. If a switch device goes out of range from the PAN Coordinator, the center LED will flash briefly to notify that it is out of range.

The Network Monitor screen will always reflect the current state of the LEDs on the LED devices as well as a running sum of the button pushes for each of the switch devices. This running sum count will be cleared after leaving the network monitor mode.

Section 6 Re-programming Display and RCB Firmware

This demonstration kit includes resources needed to reprogram the RCB Firmware. The following paragraphs overview the installation and use of the Atmel AVRISP mkII In-system Programmer.

The AVRISP and JTAGICE are other tools supplied by Atmel that can be used for programming the RCBs. If the STK500 ISP port is used, be sure to remove the VTARGET jumper. This should be done to prevent voltage conflicts between the STK500 platform and RCB.

6.1 Atmel AVR Studio installation

Double click on the AVR Studio installer included on the CD. Atmel recommends that you accept the default installation parameters.

6.2 Overview of the programming process

Both the Display Board firmware and the RCB firmware are imaged through the Display Board using the AVRISP mkII In-System Programmer.

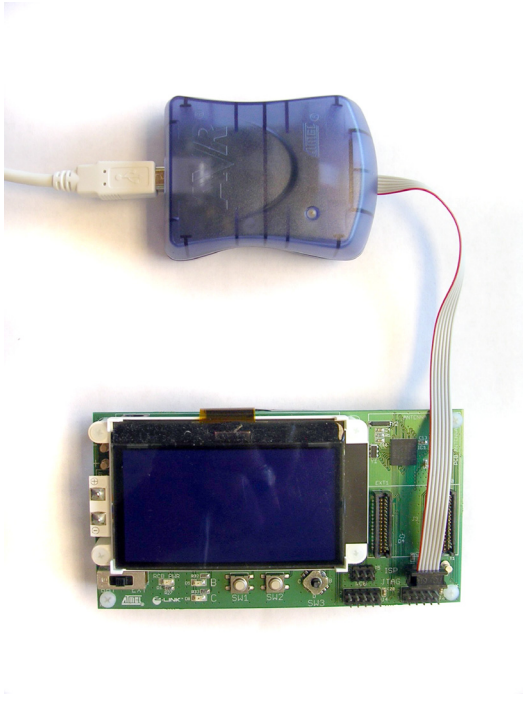


Figure 6-1. Display Board Layout

6.2.1 Programming the Display Board

The following steps show how to re-program the ATmega128 microcontroller located on the Display Board.

Remove RCB from Display board.

1. Connect the 6-pin cable from the AVRISP mkII to the Display ISP connector (upper right) on the Display Board. Verify that the Display Board is powered on.
2. Start AVR Studio. From the Tools menu, select Program AVR, and select Connect. Choose AVRISP mkII from the list of platforms and the port where it is connected. Press the Connect button. The AVRISP mkII programming window should now be visible." Note space between 'AVR' and 'Studio'.
3. In the Program tab, select the target Device as ATmega128.
4. Ensure that the following fuse settings are selected using AVR Studio in the Fuses tab:
   - JTAG Interface Enabled; [JTAGEN=0]
   - Preserve EEPROM memory through the Chip Erase cycle; [EESAVE=0]
   - Preserve EEPROM memory through chip erase cycle. [EESAVE=0]
   - Boot programming section size=4096 words Boot start address=$F000; [BOOTSZ=00]; default value
   - Brown-out detection level at VCC=2.7V; [BODLEVEL=1]
   - Int. RC Osc. 8 MHz; Start-up time: 6 CK + 4ms; [CKSEL=0100 SUT=01]".
   - The final fuse value written is 0xFF, 0x91, 0xD4.
5. Go back to the Program tab, in the Flash section, browse to the location of the input HEX file and select the filename: rz200_display_board_v1_0.hex. Press Program and verify that the process terminates successfully.
6. Alternatively, fuse settings can be altered using JTAG ICE mkII. In this case, the Serial program downloading (SPI) enabled; [SPIEN=0] fuse must be checked.

6.2.2 Programming the RCB

The following steps show how to re-program the ATmega1281 microcontroller located on the RCBs.

1. Connect RCB to the Display board. Connect the 6-pin cable from the AVRISP mkII to the RCB ISP connector (upper left) on the Display Board. Verify that the RCB is powered on (move the switch away from the antenna).
2. Start AVR Studio. From the Tools menu, select Program AVR, and select Connect. Choose AVRISP mkII from the list of platforms and the port where it is connected. Press the Connect button. The AVRISP mkII programming window should now be visible.
3. In the Program tab, select the target Device as ATmega1281.
4. Ensure that the following fuse settings are selected in the Fuses tab:
   - Brown-out detection disabled; [BODLEVEL=111]
   - JTAG Interface Enabled; [JTAGEN=0]
   - Preserve EEPROM memory through chip erase cycle. [EESAVE=0]
   - Boot program section size=4096 words Boot start address=$F000; [BOOTSZ=00]; default value
   - Int. RC Osc. 8 MHz; Start-up time: 6 CK + 65ms; [CKSEL=0100 SUT=01]
   - The final fuse value written is 0xFF, 0x91, 0xE2.

5. Go back to the Program tab, in the Flash section, browse to the location of the input HEX file and select the filename: rz200_v1_0.hex. Press Program and verify that the process terminates successfully.
6. Alternatively, fuse settings can be altered using JTAG ICE mkII. In this case, the Serial program downloading (SPI) enabled; [SPIEN=0] fuse must be checked.

6.2.3 How to re-program the RCB MAC address

The 64-bit IEEE MAC address associated with the RCB is stored in the internal EEPROM of the ATmega1281 that is on the RCB at address 0 (LSB). If the MAC address has been inadvertently erased, the following steps can be followed to reprogram it into the EEPROM. This procedure should not be attempted if the RCB has a valid MAC address. The following steps can only be performed with the JTAGICE mkII while AVRStudio is running in Debug mode. This operation cannot be performed with the AVRISP mkII included in your Demonstration kit.

The following steps reprogram the MAC address and MUST be completed from start to finish once the program memory has been loaded (step 4), otherwise the RCB's MAC address will be overwritten with all FFs.

1. Open AVR Studio.
2. Connect the JTAGICE mkII to the RCB programming header located on the Display Board.
3. From the File Menu, select Open File and open the file rz200_v1_0.hex from the CDROM.
4. In the Save AVR Studio Project File dialog box, select Save to create a project file.
5. In the Select Device and Debug Platform dialog box, select JTAGICE mkII as the debug platform, ATmega1281 as the device, and then select Finish to start the AVR Studio disassembler and load the program memory.
6. Enter drop menu Debug -> JTAGICE mkII Options
7. Select Debug tag
8. In the General area, select the 'Preserve EEPROM contents when reprogramming device' box and hit OK.
9. If the EEPROM Memory window is not already open: from the View tab, open the active HEX file's EEPROM contents by selecting EEPROM from the Memory Window drop down list. The EEPROM memory window should contain all FF's.
10. Starting at location 0 (the upper most left corner of the window), enter the 16 byte MAC address printed on the back of the RCB PCB in reverse order.

Note: The MAC address MUST be written in reverse order in 2 byte pairs, i.e., if the MAC address is 00-04-25-FF-FF-17-01-52, the sequence written into the EEPROM must be entered as 52-01-17-FF-FF-25-04-00 from location 0. The MAC address will automatically be saved to the EEPROM with each keystroke.

11. From the Project tab, select Close Project. You will be prompted to close and end the debug session, select OK.

Caution: In the following step, you must select No. Selecting Yes will cause the MAC address you just entered to be to permanently saved into the demokitfirmware.hex file. This will make the file unuseable for other RCBs.

12. You will then be prompted to save the changes to demokitfirmware.hex. Select No.

Section 7 Troubleshooting

Possible problems and their solution are shown in Figure 7-1.

Table 7-1. Troubleshooting

Problem	Reason	Solution
No response from any board	Power Switch is OFF	Ensure power switch is ON
	Dead Batteries	Check battery condition and replace if necessary
The LEDs on the Z-Link RCB will not illuminate	The RCB is not configured as an LED Unit	Check configuration. Only the LEDs on an LED Unit will illuminate.
	Power Switch is OFF	Ensure power switch is ON
	Dead Batteries	Check battery condition and replace if necessary
The Test Button does nothing	The RCB is not configured as a Switch Unit	Check configuration. Only the Test Buttons on a Switch Unit are active and should illuminate an LED on an LED Unit
	Power Switch is OFF	Ensure power switch is ON
	Dead Batteries	Check battery condition and replace if necessary
The configuration shown in the Configure screen is not transmitted to the network nodes	RCB is not attached to the Display Board	Ensure that the RCB is attached to the Display Board
	Network nodes are out of range	Bring network nodes back into range of the Coordinator
The Test Button does not work	The RCB batteries are dead	Replace batteries
The middle LED on the RCB blinks when I press the Test Button	The RCB is out range to the Coordinator and the Coordinator is not receiving any packets from the RCB	Go back into the range of the Coordinator
	The Coordinator has lost power since going into the Network Monitor mode	Ensure power switch on Coordinator is ON, or check Coordinator battery condition and replace if necessary
RCB lights stay on and the node will not show up in the Configure screen	The RCB will not associate if it loses its MAC address	Reprogram your MAC address (see section 6.2.3)

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Fax: (44) 1355-242-743

RF/Automotive
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Biometrics/Imaging/Hi-Rel MPU/
High Speed Converters/RF Datacom
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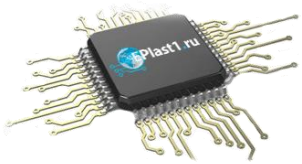
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- Поставка более 17-ти миллионов наименований электронных компонентов;
- Поставка сложных, дефицитных, либо снятых с производства позиций;
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- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits,General Dynamics и др.);

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- Техническая поддержка проекта;
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Как с нами связаться

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