EZLink™ Fast Prototyping Modules—User Guide

1. Overview

EZLink™ is the name provided to a group of modules designed to help designers swiftly generate prototype solutions. The EZLink modules are created from superset devices from a number of Silicon Labs portfolios. The use of superset products means the designer has more flexibility and can switch off blocks that are not needed for a given prototype.

A transceiver allows designers to operate the device as a transmitter, receiver, or transceiver.

1.1. Available Modules

RF Family	RFIC	Microcontroller
EZRadio®	Si4421	C8051F930
EZRadioPRO™	Si4432	C8051F930

1.2. Kit Contents

Each EZLink kit contains:

- EZLink Peripherals Board (2)
- EZLink Fast Prototyping Module (2)
- USB Cable (2)
- WDS CDROM
- User Guide

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2. Introduction

The EZLink modules are designed to provide designers with the ability to prototype a solution in the shortest period of time. The modules come in a very small form factor such that they may be inserted into an existing finished product, allowing the ability to demonstrate wireless capabilities or verify performance of the EZRadio or EZRadioPRO parts in the end application.

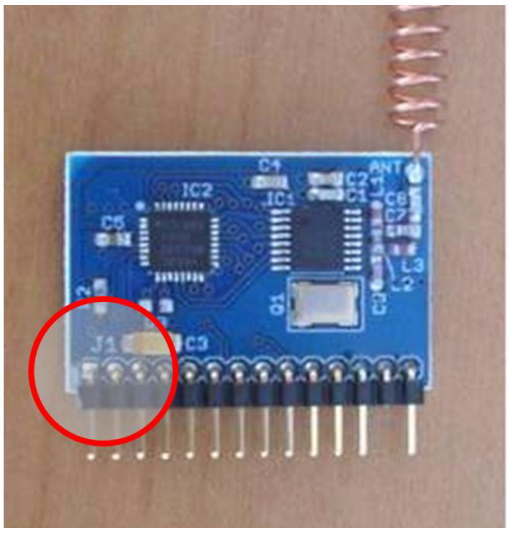

Figure 1. EZLink Radio Module

Note: The WHITE silkscreen marking in the lower left of the module is used to denote the correct orientation of the module to the peripherals board.

3. Functional Description

The radio modules contain the RF transceiver, a 50 Ω matching circuit for the 915/868 MHz*, the necessary external components (quartz crystal, power supply decoupling capacitors, etc.) and a small spiral antenna.

The module also contains a microcontroller for configuring and controlling the radio. The power, programming pins and some of the available I/O connections are available via the connector and routed to the peripheral board for easy access.

***Note:** In order to operate at 434 MHz, matching network values are published on the schematics (See Figure 9, “EZLink Radio Module Schematic (Si4421/C8051F930),” on page 14 and Figure 12, “EZLink Radio Module Schematic (Si443x/C8051F930),” on page 21).

The peripheral board is designed to provide access to commonly used interfaces such as battery, USB, and debug connections. For prototyping purposes the peripheral board also has LEDs, a push button, and test points. To help with the module orientation, the module’s connector is keyed and the silkscreen has a white triangle to point to the antenna end.

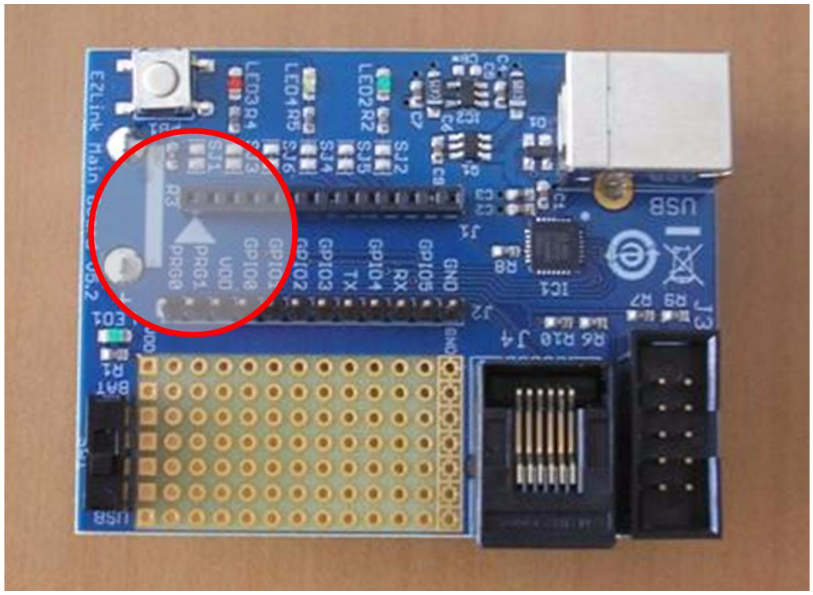

Figure 2. EZLink Main Board

Note: The white triangle is used to denote the correct orientation of the module and the peripheral board.

4. EZLink Peripheral Board

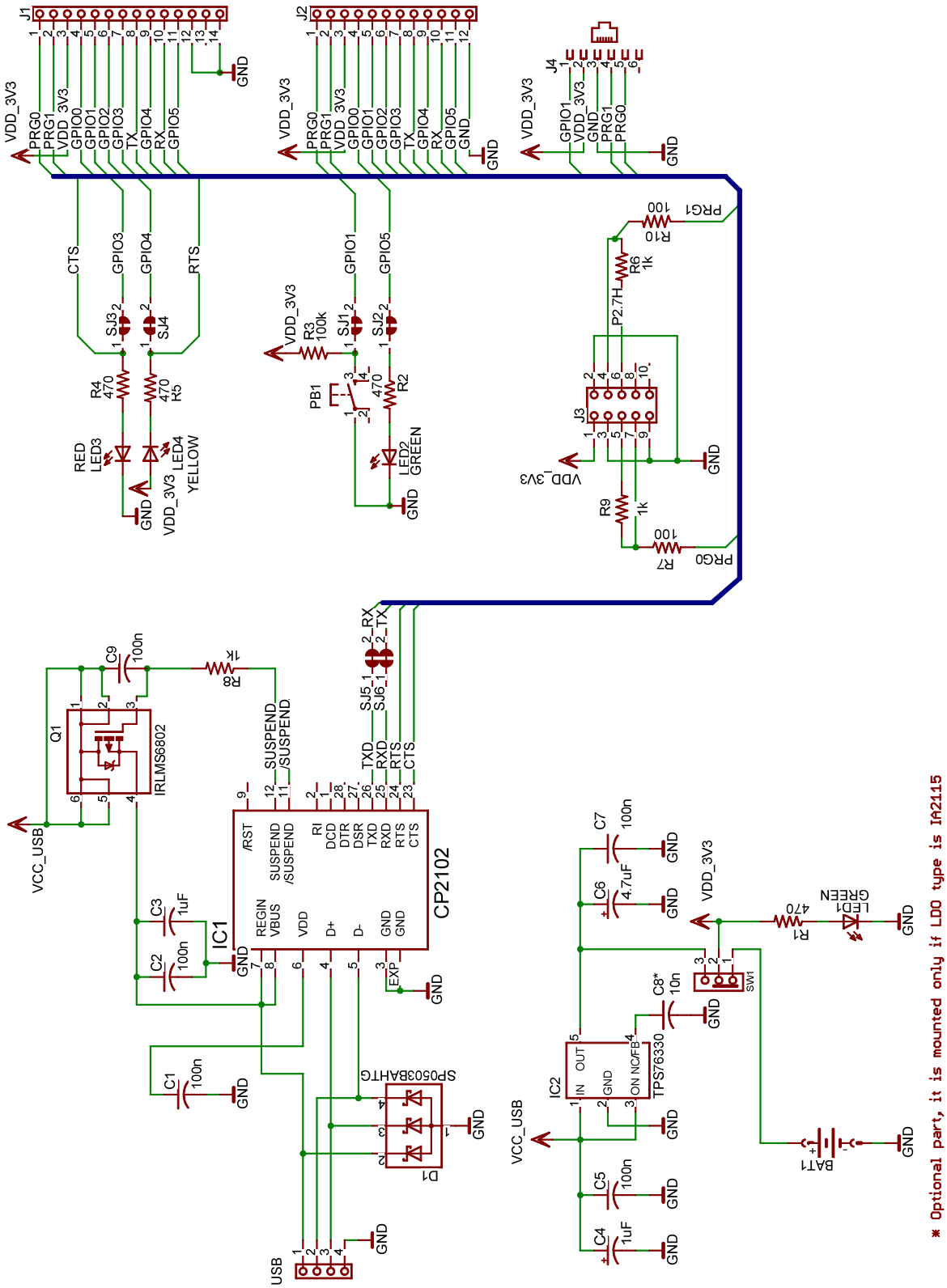

Figure 3. EZLink Peripheral Board Schematic

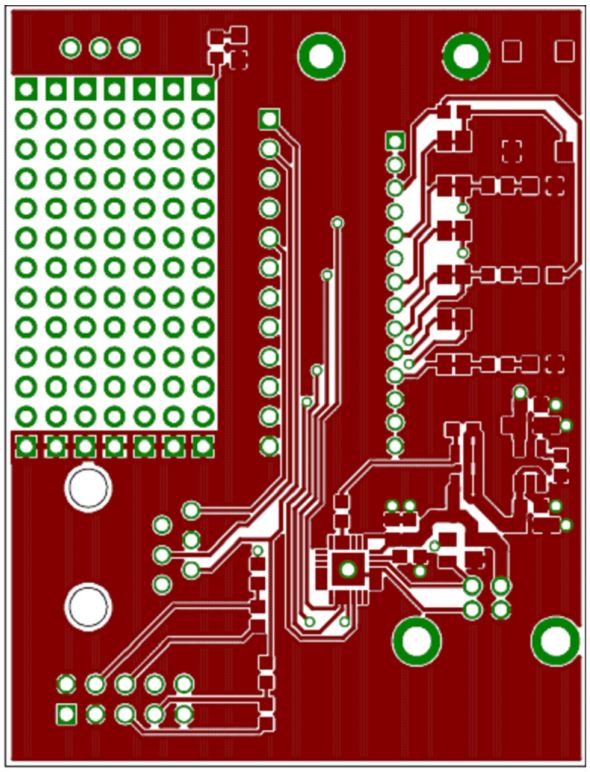

Figure 4. EZLink Peripheral Board Top Side

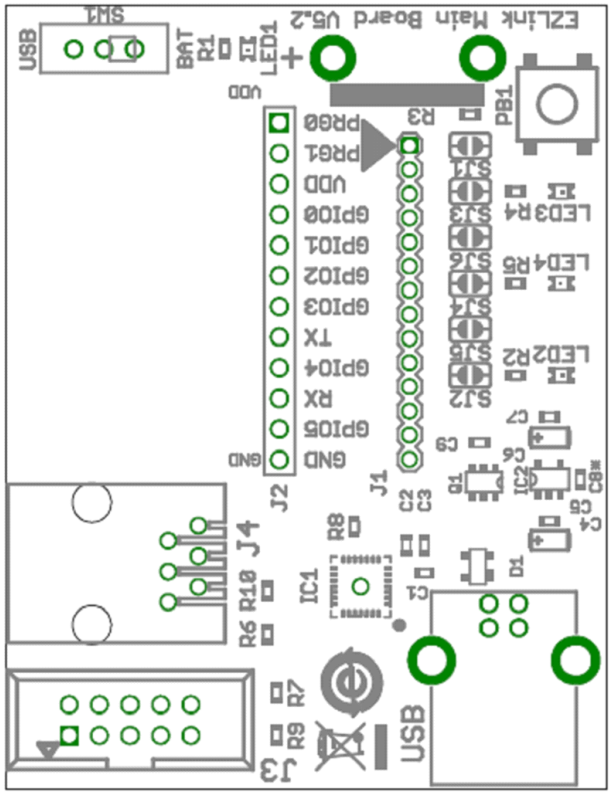

Figure 5. EZLink Peripheral Board Top Placements

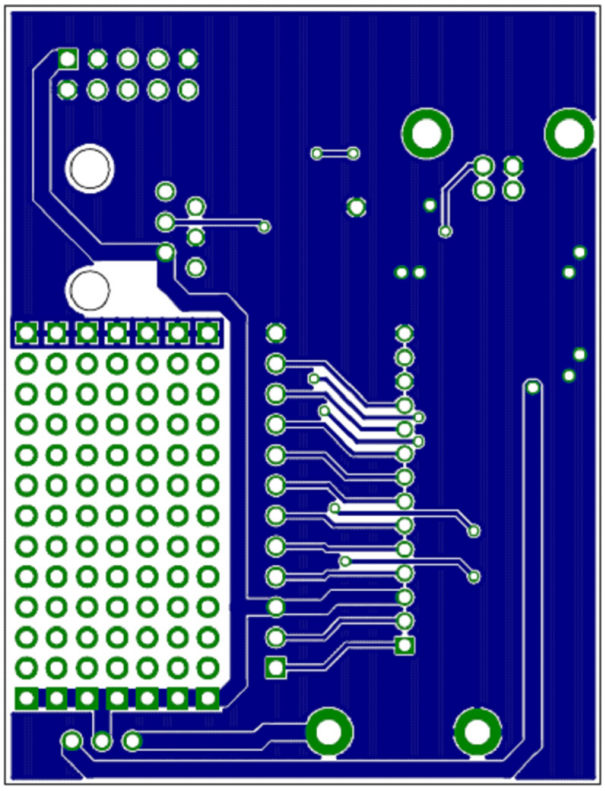

Figure 6. EZLink Peripheral Board Bottom Side

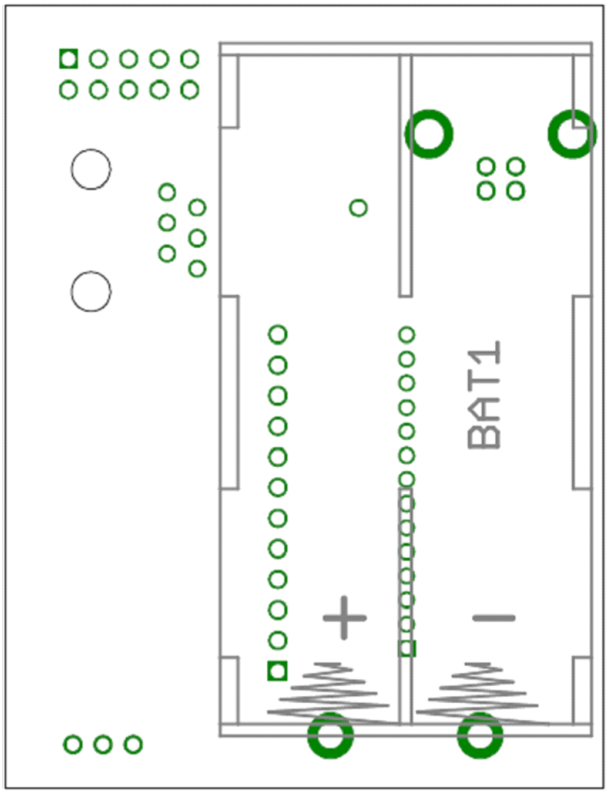

Figure 7. EZLink Peripheral Board Bottom Placements

5. EZLink Fast Prototyping Kits

EZLink Fast Prototyping kits contain two EZLink peripheral boards and two EZLink SIL radio modules. In their factory state the modules come preloaded with example firmware. The source code for the firmware can be found on the EZLink page of the WDS CD-ROM and is designed to create a framework from which prototype applications can be developed.

The firmware provides two basic functionalities:

- A “Ping-Pong” application
- A chat application

5.1. The Ping Pong Application

The Ping Pong application is designed to operate as a standalone demonstration.

Upon button press, the initial (primary) module transmits a packet. The transmission of the packet is illustrated by the red LED blinking. If the secondary module is on, a reply will be sent and depicted by the green LED blinking on the primary unit.

The firmware is designed to show the use of acknowledgements between radios. In a real-life application should the acknowledgement not have been received by the primary module, then a 'retry' would be sent by the primary node.

- PB1 (LINK) button: Used to transmit a packet.
- LED4 (yellow) LED: ON when the demo is in command mode.
- LED3 (red) LED: ON during packet transmission.
- LED2 (green) LED: ON when a packet arrives (acknowledgement arrived).

5.2. The Chat Application

The firmware, when used with the EZLink Chat program (available on the WDS CDROM), provides an instant messenger type application. This application demonstrates the transmission and receipt of real time data via the RF link.

In this mode of operation two RF 'modems' can be connected to two PC's via their USB port and a simple RF link can be established. (Note: the USB port is converted to a Virtual COM port by the firmware of the USB chip).

The EZLink chat software is a simple terminal program.

The main window is divided into two sections. The panel on the left side is the Received Data. This panel displays received characters sent from the radio modem to the PC. The data which is sent by the PC to the radio modem can be seen in the right side panel. Depending on whether module is in the normal state or the command state determines whether the information is sent or retrieved from the air. Normal and Command States are explained later.

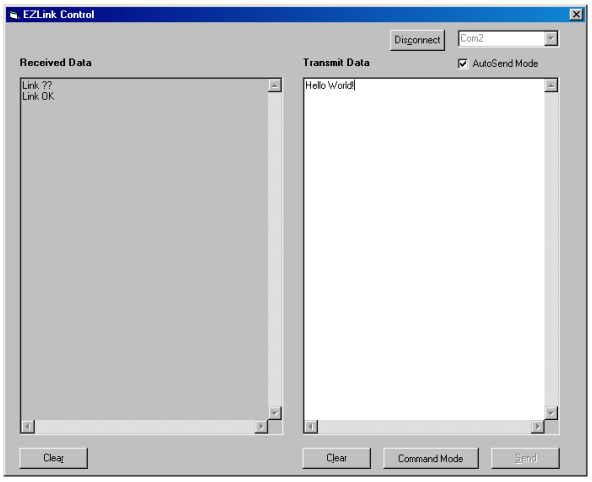

Figure 8. EZLink Control Software

5.3. Platforms

RF Family: EZRadio

RFIC: Si4421

Microcontroller: C8051F930

The modem firmware in the radio module has two modes of operation:

- Standalone Mode
- PC Mode

5.3.1. Standalone Mode

In standalone mode, basic RF operations can be achieved. When PB1 button is pressed a message is sent and LED3 (red) will blink. If the second radio modem receives the message, it replies by sending an acknowledgement. The LED2 (green) will then blink if the acknowledgement packet is received correctly.

5.3.2. PC Mode

PC mode is designed to allow users the ability to modify some of the RF parameters of the module.

On initial connection of the module to a PC, users will be prompted to install the Silicon Labs Virtual COM port driver.

The driver can be downloaded from the following WEB site page:

https://www.silabs.com/products/mcu/Pages/USBtoUARTBridgeVCPDrivers.aspx

The Virtual COM port settings of the radio modules are as follows:

- Data rate is 9.6 kbps
- 1 stop bit
- No parity bit
- No handshake

In PC mode, there are two further states of operation:

- Normal State: Data can be sent.
- The Command State: RF parameters can be modified.

PC mode is activated by pulling the RTS signal of the Virtual COM port low, the EZLink Chat program provides a button in order to perform this. In PC mode the radio parameters can be changed and after a reset the values are maintained.

5.3.3. PC Mode—Normal State

In the normal state the firmware waits for characters on the Virtual COM port.

If a character is received, it is immediately sent to the transmit buffer. If the transmit buffer becomes full (40 characters) or a 1s timeout occurs after the last character is received, then the module generates an RF packet and the packet is transmitted.

5.3.4. PC Mode—Command State

The following control commands are available in command mode:

- To review the modules firmware version
  "I <ENTER>"

  Typical Reply: EZLink demo (C8051F930 + Si4421)
  Radio modem V1.0 915 Mhz
  Silicon Labs, 2008

- "To see a list of available commands
  "? <ENTER>"

  Typical Reply:

F=n	: Set the RF channel (0–59)
D=n	: Set the RF data rate (0–32000)
P=n	: Set the rf output power (0–7)
S?	: Print the current settings
I	: Print firmware version information

- "To review the current radio settings
  "S? <ENTER>"

  Typical Reply:

Channel:	0
Data rate:	9600
RF power:	7

- "To change the centre frequency of the RF signal (RF Channel)
  "F = x<ENTER>", where x is the channel number (eg. 0 … 59)

  Typical Answer: OK

- "To change the data rate of the RF signal
  "D = x<ENTER>", where x is the data rate in bps. (eg. 0 … 32000)

  Typical Answer: OK

- "To change the relative output power
  "P = x<ENTER>", where x is the relative output power setting. (eg. 0 … 7)

  Typical Answer: OK

Note: Sending the "S?" command after the "Fx, Dx, or Px" commands allows users to confirm the new setting.

Using the PC Mode Command State the radio parameters can be changed according to the following tables:

- RF frequency channel:
  This parameter changes the carrier frequency of the RF output spectrum.

  Valid settings of this parameter are:

  a. With the 915 MHz firmware image loaded into the module
     0 … 59. If a different value is used, the firmware will set the center frequency to 900.84 MHz.

Table 1. Frequency Assignment for the 915 MHz Band

Ch Nr.	Center Freq. [MHz]	Ch Nr.	Center Freq. [MHz]	Ch Nr.	Center Freq. [MHz]
0	900.84	20	910.44	40	920.04
1	901.32	21	910.92	41	920.52
2	901.80	22	911.40	42	921.00
3	902.28	23	911.88	43	921.48
4	902.76	24	912.36	44	921.96
5	903.24	25	912.84	45	922.44
6	903.72	26	913.32	46	922.92
7	904.20	27	913.80	47	923.40
8	904.68	28	914.28	48	923.88
9	905.16	29	914.76	49	924.36
10	905.64	30	915.24	50	924.84
11	906.12	31	915.72	51	925.32
12	906.60	32	916.20	52	925.80
13	907.08	33	916.68	53	926.28
14	907.56	34	917.16	54	926.76
15	908.04	35	917.64	55	927.24
16	908.52	36	918.12	56	927.72
17	909.00	37	918.60	57	928.20
18	909.48	38	919.08	58	928.68
19	909.96	39	919.56	59	929.16

b. With the 868 MHz firmware image loaded into the module
0 … 13. If a different value is used, the firmware will set the center frequency to 900.84 MHz.

Table 2. Frequency Assignment for the 868 MHz Band

Ch Nr.	Center Freq. [MHz]
0	863.55
1	864.00
2	864.45
3	864.90
4	865.35
5	865.80
6	866.25
7	866.70
8	867.15
9	867.60
10	868.05
11	868.50
12	868.95
13	869.40

c. With the 434 MHz firmware image loaded into the module
0 … 3. If a different value is used, the firmware will set the center frequency to 433.33 MHz.

Note: Users should change the antenna and the values of the matching network for 433 MHz band operation.

Table 3. Frequency Assignment for the 434 MHz Band

Ch Nr.	Center Freq. [MHz]
0	433.33
1	433.66
2	433.99
3	434.32

- RF relative output power:
  This parameter changes the RF output power (Pmax).
  Valid settings of the parameter are: 0 … 7. If a different value is used, the firmware will set the lowest output power.

Table 4. Relative Output Power

Setting	Relative Output Power [dB]
7	0
6	–2.5
5	–5
4	–7.5
3	–10
2	–12.5
1	–15
0	–17.5

- RF data rate:
  This parameter changes the data rate of the RF data.
  Valid settings of the parameter are: 600 … 32000 (in bps). If a lower or higher value is used, the firmware will set the minimum (600 bps) or the maximum (32 kbps) accordingly.

5.4. Message Format

The modem demo uses the following message format:

Table 5. Packet Structure

Preamble (4 bytes)	Synchron Pattern (2 bytes)	Packet Length (1 byte)	Payload (up to 40 bytes)
0xAA 0xAA 0xAA 0xAA	0x2D 0xD4	0x01	0x00

1. The Preamble is designed to synchronize the PLL of the transmitter and receiver together.
2. The Synchron byte is a pattern field designed the receiver recognize the beginning of the data.
3. The Packet length defines how many bytes make up the payload.
4. The Payload is the physical data which needs to be sent through the RF link.

If the PB1 (LINK) button is pressed while PC Mode is in the command state, the node sends a message with the following payload: "**Link ??**". If the second board receives the message, it sends back an acknowledgement message with the following payload: "**Link OK**".

6. EZLink C8051F930/Si4421 Radio Module

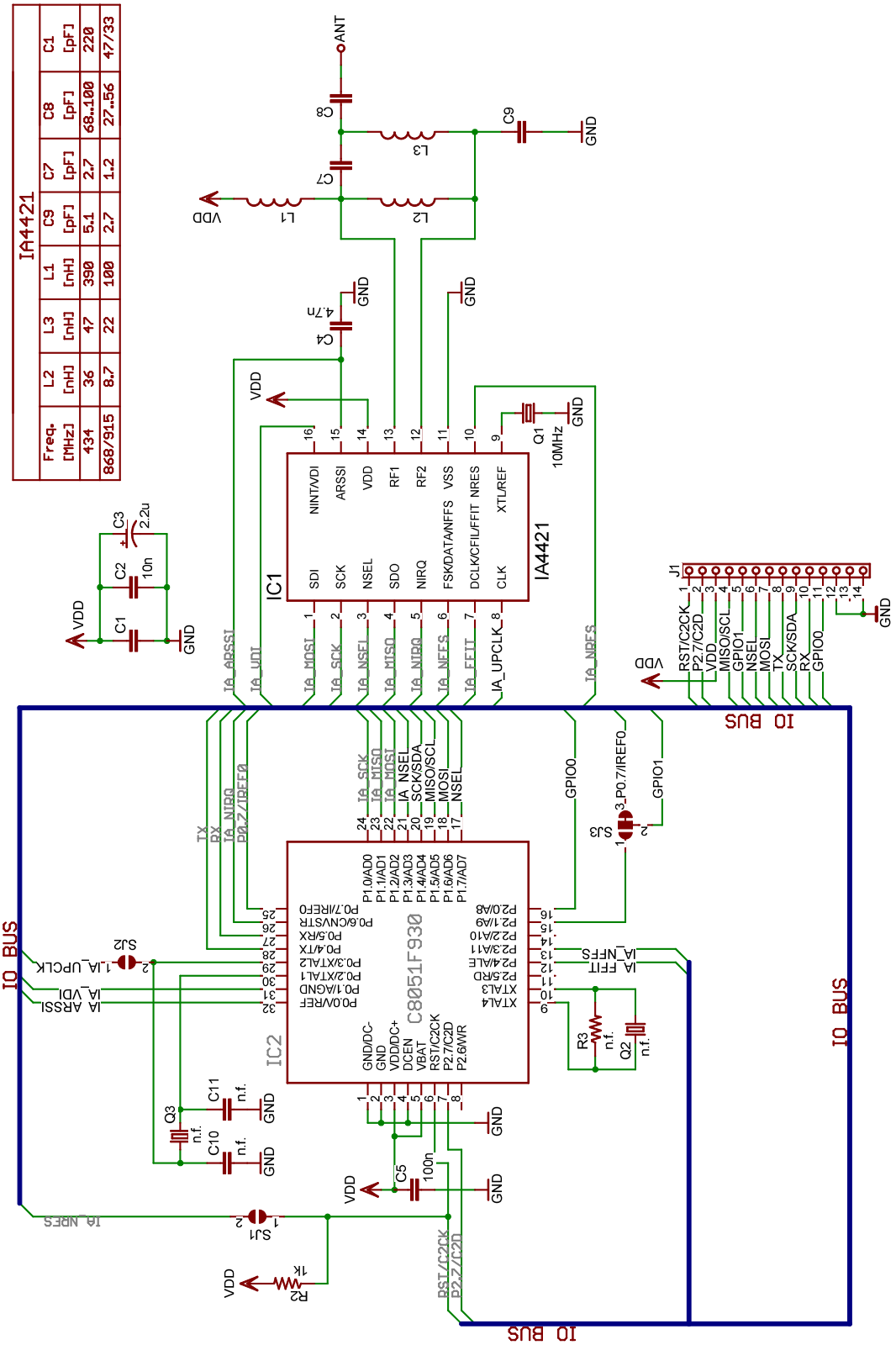

Figure 9. EZLink Radio Module Schematic (Si4421/C8051F930)

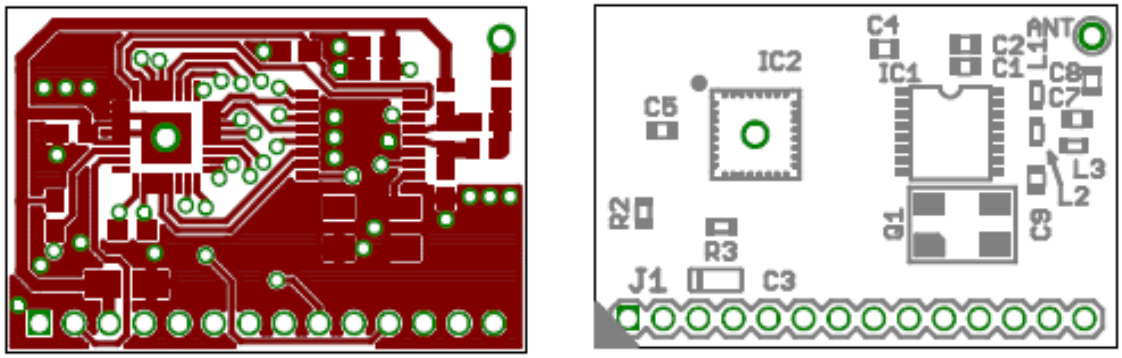

Figure 10. EZLink Radio Module Top Side

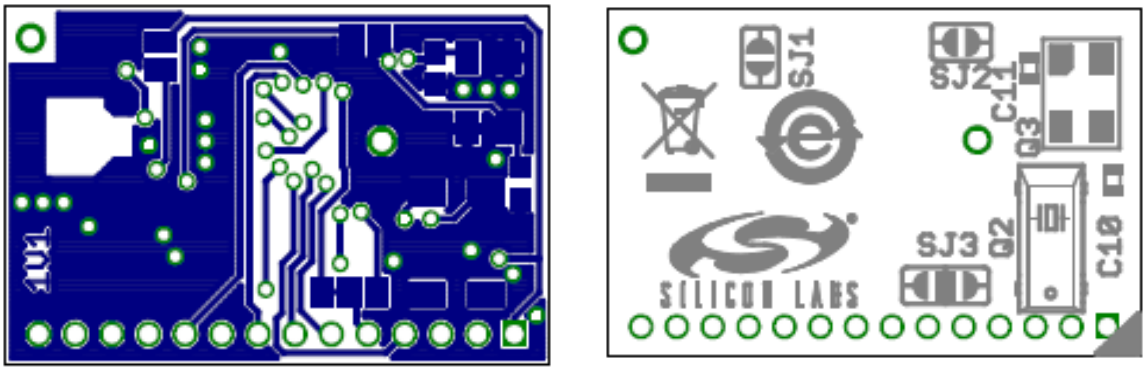

Figure 11. EZLink Radio Module Bottom Side

6.1. Platforms

RF Family: EZRadioPRO

RFIC: Si4432

Microcontroller: C8051F930

The modem firmware in the radio module has three modes of operation:

- Standalone Mode
- PC Mode
- Si4421 Compatible Mode

6.1.1. Standalone Mode

In standalone mode, basic RF type operations can be achieved. When PB1 button is pressed a message is sent and LED3 (red) will blink. If the second radio modem receives the message, it replies by sending an acknowledgement. The LED2 (green) will then blink if the acknowledgement packet is received correctly.

6.1.2. PC Mode

PC mode is designed to allow users the ability to modify some of the RF parameters of the module.

On initial connection of the module to a PC, users will be prompted to install the Silicon Labs Virtual COM port driver.

The driver can be downloaded from the following WEB site page:

https://www.silabs.com/products/mcu/Pages/USBtoUARTBridgeVCPDrivers.aspx

The Virtual COM port settings of the radio modules are as follows:

- Data rate is 9.6 kbps
- 1 stop bit
- No parity bit
- No handshake

In PC mode, there are two further states of operation:

- Normal State: Data can be sent.
- The Command State: RF parameters can be modified.

PC mode is activated by pulling the RTS signal of the Virtual COM port low, the EZLink Chat program provides a button in order to perform this. In PC mode the radio parameters can be changed and after a reset the values are maintained.

6.1.3. PC Mode—Normal State

In the normal state the firmware waits for characters on the Virtual COM port.

If a character is received, it is immediately sent to the transmit buffer. If the transmit buffer becomes full (40 characters) or a 1 s timeout occurs after the last character is received, then the module generates an RF packet and the packet is transmitted.

6.1.4. PC Mode—Command State

The following control commands are available in command mode:

- To review the modules firmware version
  "I <ENTER>"
  Typical Reply: EZLink demo (C8051F930 + Si4432)
  Radio modem V1.0 915 Mhz
  Silicon Labs, 2008

- To ask the module for a list of available commands
  "? <ENTER>"
  Typical Reply:
  F=n : Set the RF channel
  2.4 kbps: channel number: 0–59
  4.8 kbps: channel number: 0–59
  9.6 kbps: channel number: 0–59
  19.2 kbps: channel number: 0–51
  38.4 kbps: channel number: 0–44
  57.6 kbps: channel number: 0–36
  115.2 kbps: channel number: 0–28
  D=n : Set the RF data rate (0–6)
  0 : DR: 2.4 kbps, DEV: ±36 kHz, BBBW: 75.2 kHz
  1 : DR: 4.8 kbps, DEV: ±45 kHz, BBBW: 95.3 kHz
  2 : DR: 9.6 kbps, DEV: ±45 kHz, BBBW: 99.6 kHz
  3 : DR: 19.2 kbps, DEV: ±9.6 kHz, BBBW: 28.8 kHz
  4 : DR: 38.4 kbps, DEV: ±19.2 kHz, BBBW: 57.6 kHz
  5 : DR: 57.6 kbps, DEV: ±28.8 kHz, BBBW: 86.4 kHz
  6 : DR: 115.2 kbps, DEV: ±57.6 kHz, BBBW: 172.8 kHz
  P=n : Set the rf output power (0–3)
  0 : +11 dBm
  1 : +14 dBm
  2 : +17 dBm
  3: +20 dBm
  S? : Print the current settings
  I : Print firmware version information

- To review the current radio settings
  "S? <ENTER>"
  Typical Reply:
  Channel: 0
  Data rate: 2 (DR:9.6 kbps, DEV: ±45 kHz, BBBW: 99.6 kHZ)
  RF power: 3 (+20 dBm)

- To change the centre frequency of the RF signal (RF Channel)
  "F = x<ENTER>", (where x is the channel number (eg. 0 … 59)
  Typical Answer: OK

- To change the data rate of the RF signal
  "D = x<ENTER>", where x is the data rate in bps. (eg. 0 … 6)
  Typical Answer: OK

- To change the relative output power
  "P = x<ENTER>", where x is the relative output power setting. (eg. 0 … 3)
  Typical Answer: OK

(Note: Sending the "S?" command after the "Fx, Dx or Px" commands allows users to confirm the new setting.)

Using the PC Mode Command State the radio parameters can be changed according to the following tables:

- RF frequency channel:
  This parameter changes the carrier frequency of the RF output spectrum. The number of available RF frequency channels is related to the data rate.
  Valid settings of this parameter are:
  a. With the 915 MHz firmware image loaded into the module.

Table 6. Frequency Assignment for the 915 MHz Band

	2.4 kbps	4.8 kbps	9.6 kbps	19.2 kbps	38.4 kbps	57.6 kbps	115.2 kbps
Max channel number	60	60	60	52	45	37	29
Start frequency (MHz)	900.84	900.84	900.84	900.84	900.84	900.84	900.84
Step frequency (kHz)	480	480	480	550	640	780	1000

If a different value is used, the firmware will set the center frequency to 900.84 MHz.

b. With the 868 MHz firmware image loaded into the module.

Table 7. Frequency Assignment for the 868 MHz Band

	2.4 kbps	4.8 kbps	9.6 kbps	19.2 kbps	38.4 kbps	57.6 kbps	115.2 kbps
Max channel number	14	14	14	11	10	8	6
Start frequency (MHz)	863.55	863.55	863.55	863.7	863.62	863.75	864
Step frequency (kHz)	450	450	450	550	640	780	1000

If a different value is used, the firmware will set the center frequency to 863.55 MHz.

c. With the 434 MHz firmware image loaded into the module.

Table 8. Frequency Assignment for the 434 MHz Band

	2.4 kbps	4.8 kbps	9.6 kbps	19.2 kbps	38.4 kbps	57.6 kbps	115.2 kbps
Max channel number	4	4	4	3	3	2	1
Start frequency (MHz)	433.33	433.33	433.33	433.53	433.47	433.61	433.91
Step frequency (kHz)	330	330	330	390	450	360	

If a different value is used, the firmware will set the center frequency to 433.33 MHz.

- RF relative output power:
  This parameter changes the RF output power (Pmax).
  Valid settings of the parameter are: 0 … 7. If a different value is used, the firmware will set the lowest output power.

Table 9. Relative Output Power

Setting	Output Power [dBm]
3	+20
2	+17
1	+14
0	+11

- RF data rate:
  This parameter changes the data rate of the RF data.
  Valid settings of the parameter are: 0–6. If a lower or higher value is set, the firmware will set the default (9.6 kbps) accordingly.

Table 10. Data Rate

	Data Rate	Deviation	Baseband Bandwidth
0	2.4 kbps	±36 kHz	75.2 kHz
1	4.8 kbps	±45 kHz	95.3 kHz
2	9.6 kbps	±45 kHz	99.6 kHz
3	19.2 kbps	±9.6 kHz	28.8 kHz
4	38.4 kbps	±19.2 kHz	57.6 kHz
5	57.6 kbps	±28.8 kHz	86.4 kHz
6	115.2 kbps	±57.6 kHz	172.8 kHz

6.2. Si4421 Compatible Mode

In the Si4421 compatible mode, the radio modem will work with RF EZLink nodes based upon the Si4421 Transceiver. In order to configure the node such that it operates in the Si4421 compatible mode, hold down PB1 while powering up the node.

The functionality of the node in Si4421 compatibility mode is similar to the Standalone Mode and PC Mode in the normal state. Si4421 compatibility mode simply adjust the RF parameters so that communication is possible

RF parameters: In this mode there is only one available data rate, 9.6 kbps.

If the "S?" command is sent to the module while in PC mode, the module will reply with the following information:

EZLink demo (C8051F930 + Si4432)

Radio modem V1.0 915 MHz

Silicon Labs, 2008

Si4421 compatible mode

6.3. Message Format

The modem demo uses the following message format:

Table 11. Packet Structure

Preamble (4 bytes)	Synchron Pattern (2 bytes)	Packet Length (1 byte)	Payload (up to 40 bytes)
0xAA 0xAA 0xAA 0xAA	0x2D 0xD4	0x01	0x00

1. The Preamble is designed to synchronize the PLL of the transmitter and receiver together.
2. The Synchron byte is a pattern field designed the receiver recognize the beginning of the data.
3. The Packet length defines how many bytes make up the payload.
4. The Payload is the physical data which needs to be sent through the RF link.

If the PB1 (LINK) button is pressed while PC Mode is in the command state, the node sends a message with the following payload: "**Link ??**". If the second board receives the message, it sends back an acknowledgement message with the following payload: "**Link OK**".

7. EZLink C8051F930/Si4432 Radio Module

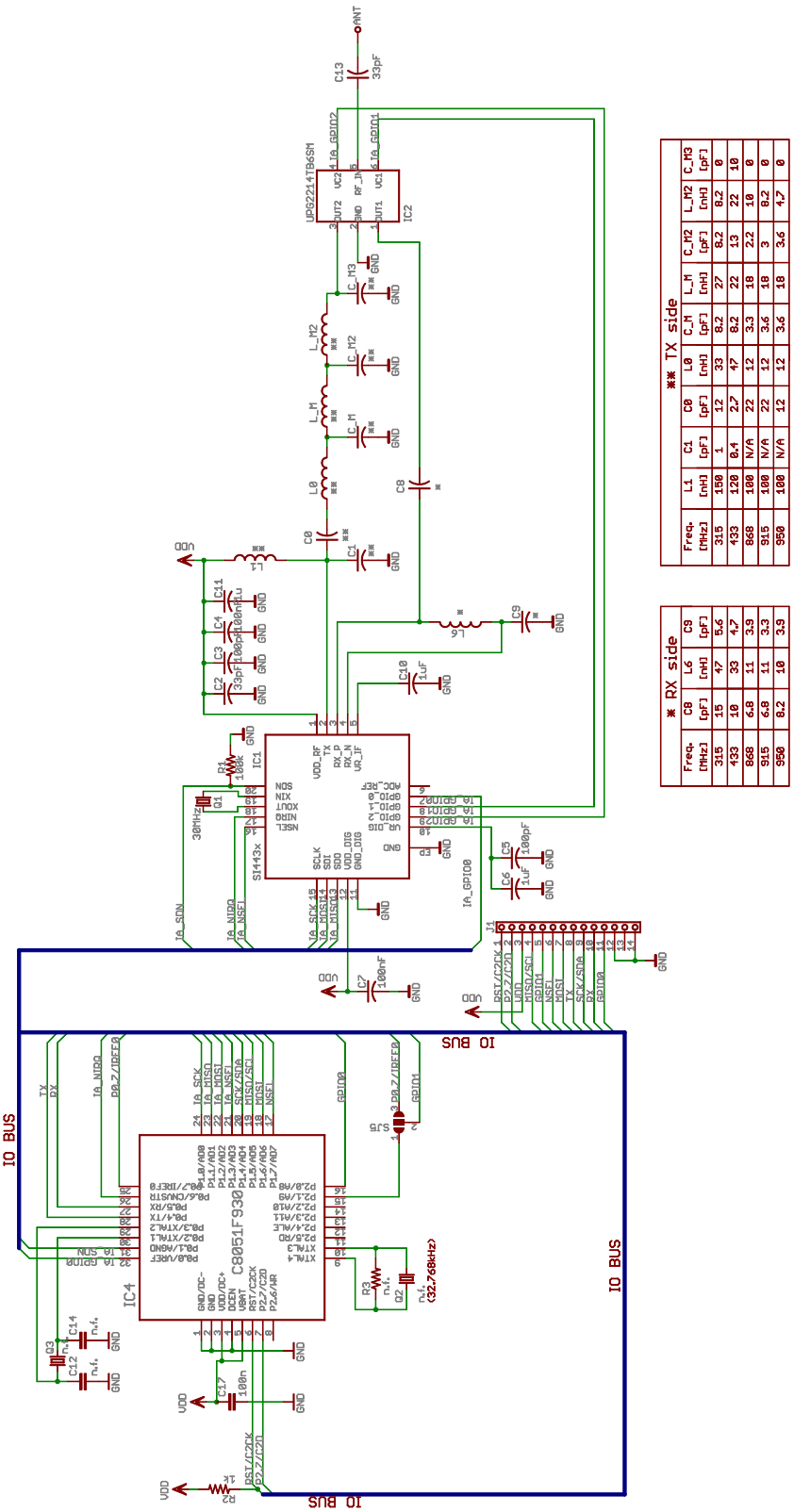

Figure 12. EZLink Radio Module Schematic (Si443x/C8051F930)

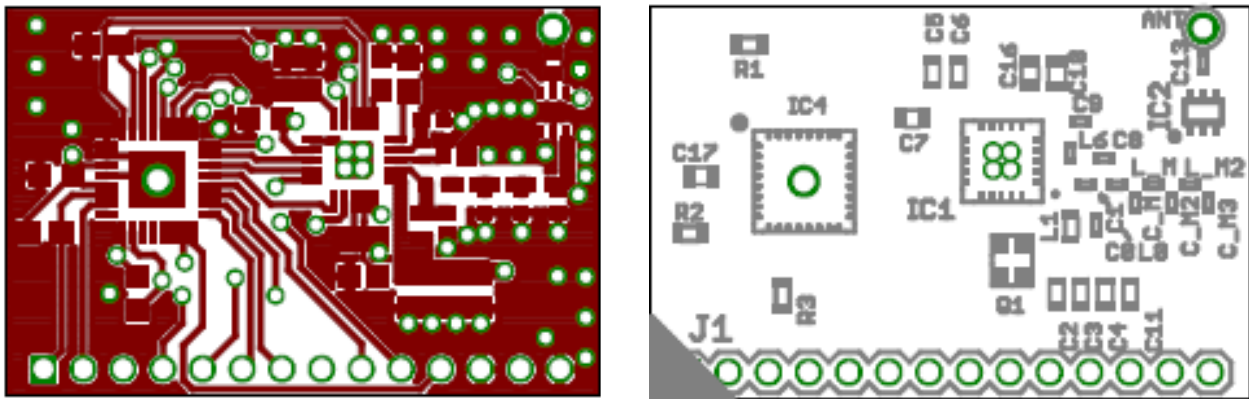

Figure 13. EZLink Radio Module Top Side and Top Place

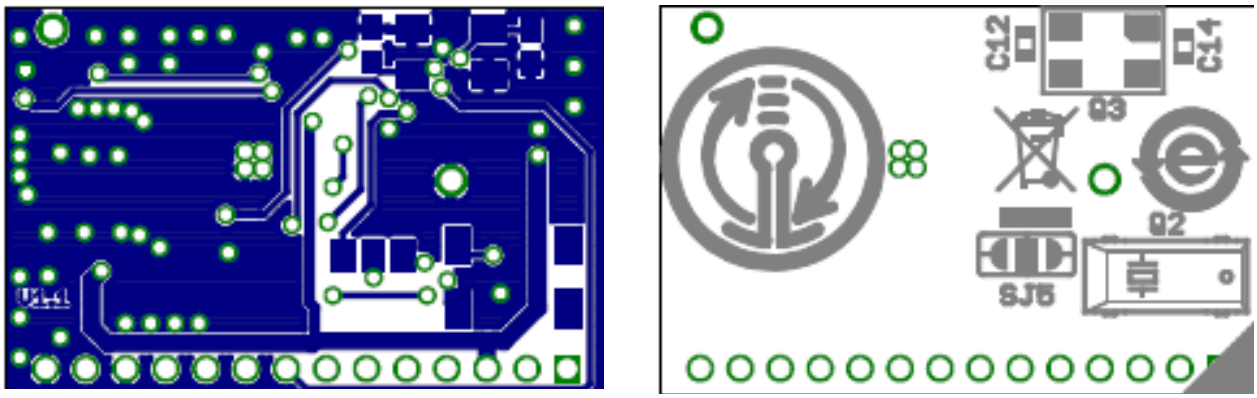

Figure 14. EZLink Radio Module Bottom Side

NOTES:

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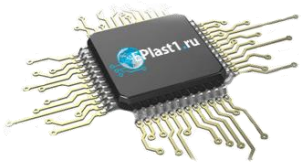
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



Как с нами связаться

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