

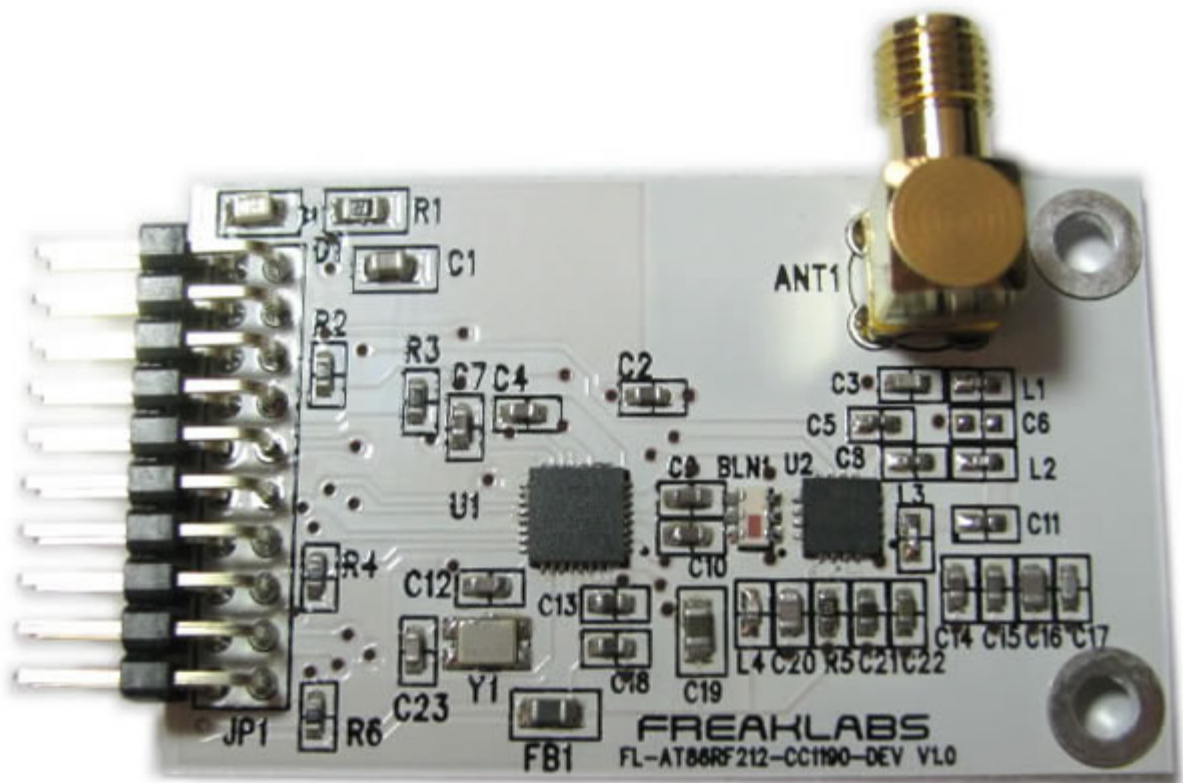
FREAKLABS

Rapid Prototyping Platform

High Power 900 MHz 802.15.4 Radio Board

FL-AT86RF212-CC1190-DEV v1.0

User Guide v1.0A



Document Revision History

<i>Date</i>	<i>Description</i>
2010-05-27	Document creation

Specifications

The FreakLabs FL-AT86RF212-CC1190-DEV 900 MHz modular radio board is designed to be an easy way to rapidly prototype and evaluate using high powered radios for wireless sensor networks. It comes with the Atmel AT86RF212 900 MHz radio which conforms to the IEEE 802.15.4 wireless protocol. It also sports a high power front end transmit amplifier and low noise receive amplifier to improve the communications range of the radio.

This board was originally designed to evaluate high power radios for research work in environmental monitoring applications. In a remote location, a wireless sensor network often consists of a localized sensor network to collect data and a long distance link to a location where the data can be processed or forwarded into the internet.

This board is also good to evaluate the performance of a high power radio in environments that are either harsh or difficult for lower power radios to communicate. This is often the case in industrial environments where the background RF noise may drown out signals coming from lower power radios. Building automation is also difficult for low power radios since there are usually many obstacles to an RF signal such as ceilings, floors, walls, and furniture. This is often seen when communications occurs across multiple floors of a building.

The main feature of this board, as opposed to the standalone FreakLabs AT86RF212 radio board is that the front end has a 500 mW power amplifier which is 50x the transmit power of the standalone radio. It also has a receive amplifier with a typical gain of 11 dB or almost 16x the receive power of the standalone board. It also comes with an RP-SMA external antenna connector for connection to a wide array of antennas including omni-directional antennas or high gain directional antennas which can provide even greater range. This board is also supported by the FreakLabs Chibi simplified 802.15.4 stack which provides a quick way to evaluate the radio performance.

Peripherals

There are two main peripherals on this board. The first is the Atmel AT86RF212 900 MHz 802.15.4 radio. The AT86RF212 has a lot of built-in hardware to handle many of the time sensitive or repetitive tasks in the 802.15.4 specification such as automatic ACK generation, frame filtering based on address, auto-CRC generation and checking, AES encryption, automatic retries, and auto transmit after checking for a clear channel.

Some other nice features of the radio are that it supports the European 868 MHz and North American 916 MHz bands. There are also different modulation schemes that can be chosen based on requirements. The highest bitrates use O-QPSK modulation which can handle up to 1 Mbps data rates in proprietary mode or 250 kbps in IEEE 802.15.4 compliant mode. The modulation

QUICK SPECS

Radio: Atmel
AT86RF212, 900
MHz

Front End: TI
CC1190, 27 dBm
Tx (500 mW), 11.6
dB Rx

Connectors: 1 USC
Peripheral

Antenna: RP-SMA
external antenna

can also be changed to BPSK which yields approximately 5-10x improvement in receiver sensitivity and thus greater range. However using BPSK, the data rate goes down to 20-40 kbps.

This board also uses the TI CC1190 RF front end which incorporates a 500 mW (27 dBm) power amplifier and an 11 dB low noise amplifier. This increases the communications range tremendously. The chip also supports a low power sleep mode and a pin to control switching between high gain mode and normal mode. In high gain mode, the full power of the front end is available on both transmit and receive sides. In normal mode, the transmit power amplifier is scaled down to approximately 250 mW (24 dBm) and the low noise amplifier is off.

Connectors

The universal serial connector (USC) interface is standard for all of the FreakLabs development boards. The FL-AT86RF212-CC1190-DEV board contains a peripheral-side universal serial connector.

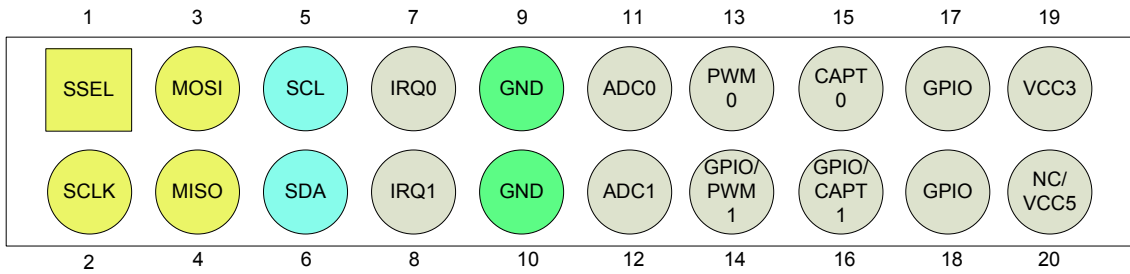
Universal Serial Connector Pinouts

The FL-AT86RF212-CC1190-DEV radio board supports the Universal Serial Connector (USC) v1.1. The connector supports an SPI bus, I2C bus, 2 interrupts, 2 analog inputs, 1 PWM output, 1 timer/capture input, 6 GPIOs, 3.3V supply, and optional 5V supply. All pins except power pins can also be used as GPIO if there is no need for the principal function. In the case of the radio board, only the SPI bus, 1 interrupt, and a few GPIO pins are used.

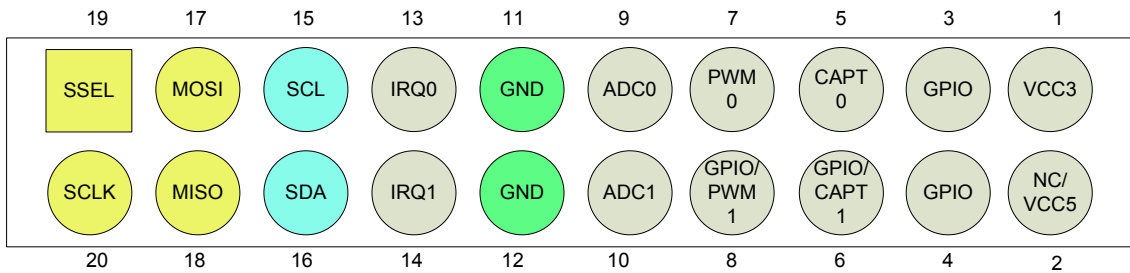
The connector consists of a host side which is a 20-pin, female, right-angle header and a peripheral side which is a 20-pin, male, right-angle header. The host side connector will always be on MCU boards and the peripheral connector will be found on peripheral boards that interface to the MCU boards.

The reason right angle connectors were chosen was so that the complete system can be level. This makes it easier to access individual signals and pins, as well as make modifications to the circuit. The following diagram shows the pinouts of the connectors:

Universal Serial Connector v1.1 – Host (MCU) side



Universal Serial Connector v1.1 – Peripheral side



The specific pinout of the universal serial peripheral connector of the FL-AT86RF212-DEV board can be found below:

USC Peripheral Connector (JP1)			
<i>Pin</i>	<i>Description</i>	<i>Pin</i>	<i>Description</i>
1	VCC3	2	NC
3	NC	4	NC
5	NC	6	NC
7	RST_n	8	SLP/TR
9	NC	10	HGM (High Gain Mode)
11	GND	12	GND
13	INT	14	NC
15	NC	16	NC
17	MOSI	18	MISO
19	SS_n (SPI Select)	20	SCLK

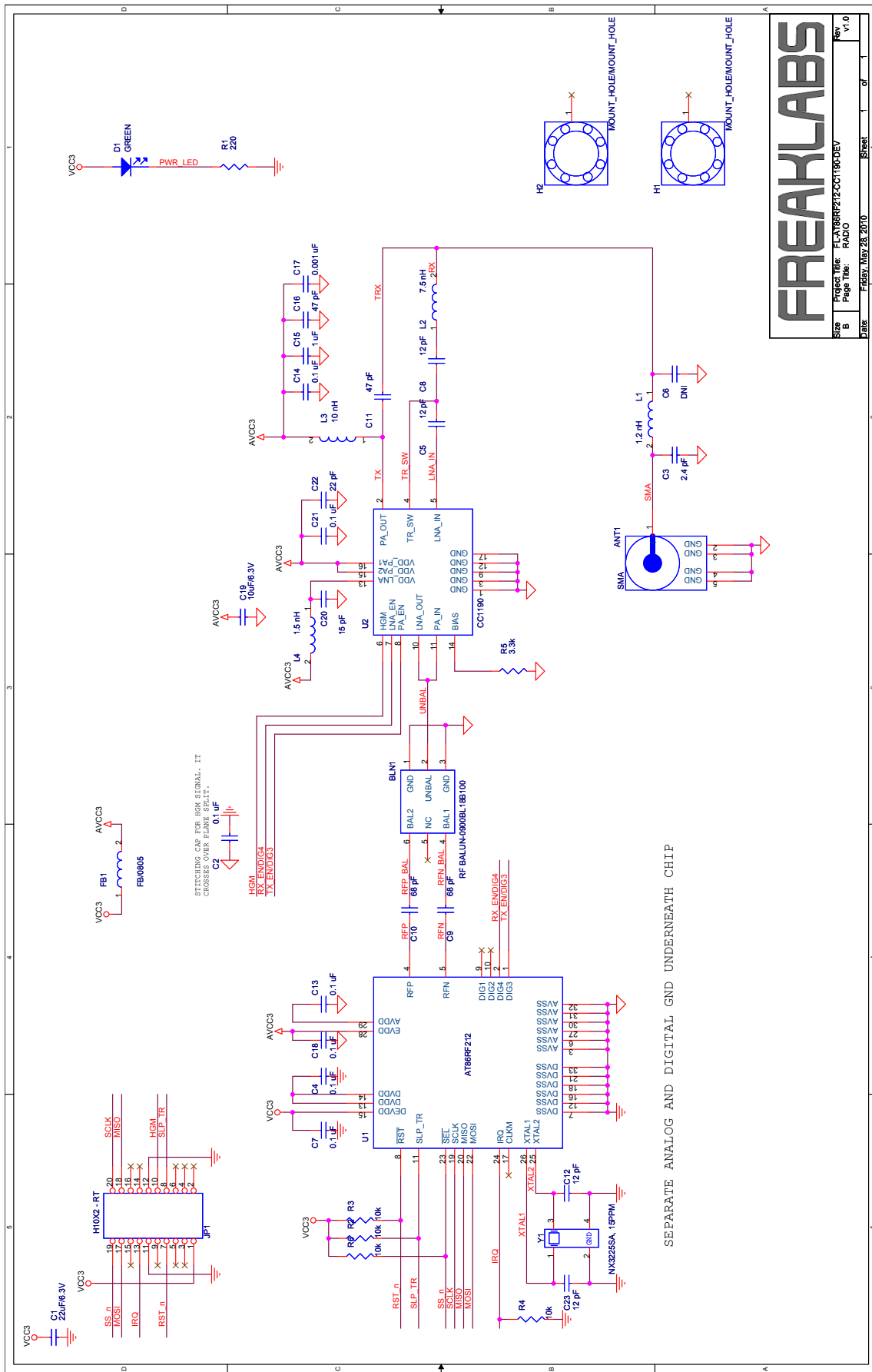
Disclaimer

The FL-AT86RF212-CC1190-DEV board is NOT FCC approved. It is designed for testing, experimentation, and evaluation purposes only and is not meant to be used commercially. It is the

user's responsibility to verify that usage of this board will not violate local regulation concerning radio communications.

Schematics

Schematics can be found on the following page:



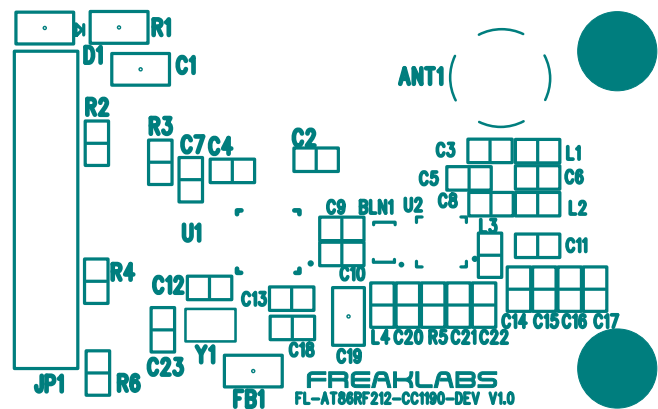
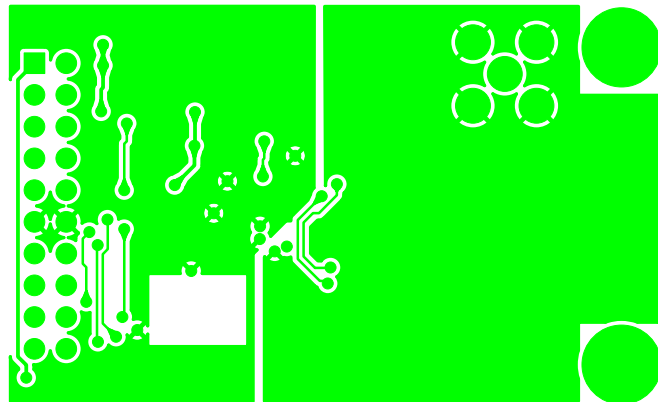
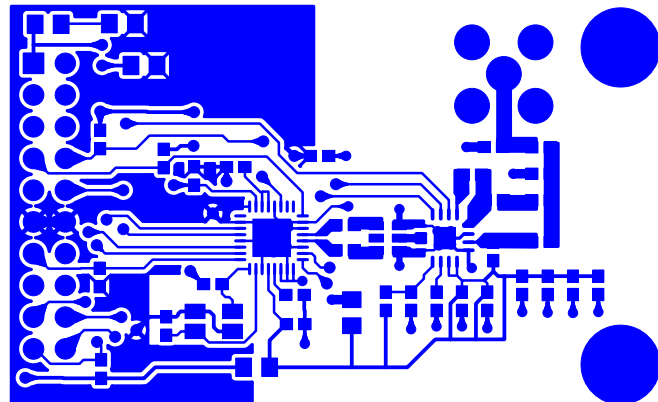
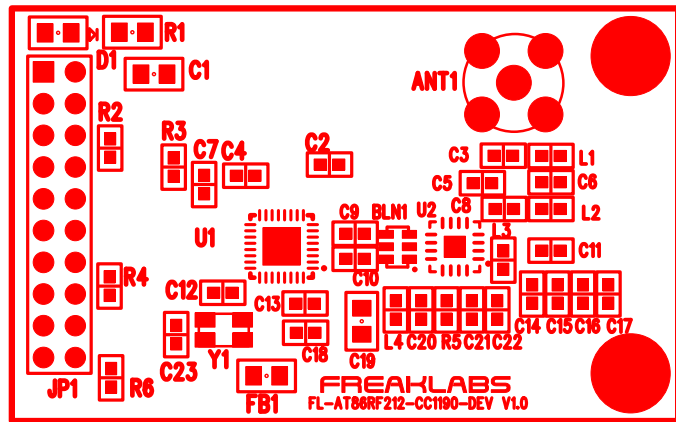
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Project Name:	FL-AT86RF212-CC1190-DEV	Rev:	v1.10
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Date:	FRBY, May 28, 2010		

PCB Layout

PCB layout file order:

1. Assembly drawing
2. Top Layer
3. Bottom Layer
4. Silkscreen



Bill of Materials

<i>Quantity</i>	<i>Reference</i>	<i>Manufacturer</i>	<i>Part Number</i>	<i>Description</i>
1	ANT1	ChangHong	SMA-02-113-TGG	RP-SMA Connector
1	BLN1	Johanson Technology	0900BL18B100	900 MHz balun
1	C1	Various		22uF/6.3V, 0805, MLCC
7	C2, C4, C7, C13, C14, C18, C21	Various		0.1uF/50V, 0603
1	C3	Johanson Technology	251R14S2R4BV4T	2.4 pF, 0603, Hi-Q RF capacitor
4	C5, C8, C12, 23	Taiyo Yuden	UMK105CG120JV-F	12 pF, 0402, NPO, high frequency capacitor
1	C6	n/a		DNI
2	C9,C10	Murata	ERB1885C2E-680JDX5D	68 pF, 0603, NPO, high Q RF capacitor
2	C11,C16	Taiyo Yuden	UMK105CG470JV-F	47 pF, 0402, NPO, high frequency capacitor
1	C15	Various		1uF/50V, 0603
1	C17	Various		0.001 uF
1	C19	Various		10uF/6.3V, 0805, MLCC
1	C20	Various		15 pF/50V, 0603
1	C22	Various		22 pF/50V, 0603
1	D1	Various		Green LED, 0805
1	FB1	Various		Ferrite Bead, 0805
1	JP1	Various		10x2 Right angle header, male, 0.100"
1	L1	Taiyo Yuden	HK10051N2S-T	1.2 nH, 0402, high frequency inductor
1	L2	Taiyo Yuden	HK10057N5J-T	7.5 nH, 0402, high frequency inductor
1	L3	Taiyo Yuden	HK100510NJ-T	10 nH, 0402, high frequency inductor
1	L4	Taiyo Yuden	HK10051N5S-T	1.5 nH
1	R1	Various		220 ohms, 0805
4	R2, R3, R4, R6	Various		10 kohms, 0603
1	R5	Various		3.3k, 1%
1	U1	Atmel	AT86RF212-ZU	900 MHz, 802.15.4 radio

Quantity	Reference	Manufacturer	Part Number	Description
1	U2	TI	CC1190RGVT	High power RF front end
1	Y1	NDK	NX3225SA	16 MHz crystal, 15 ppm