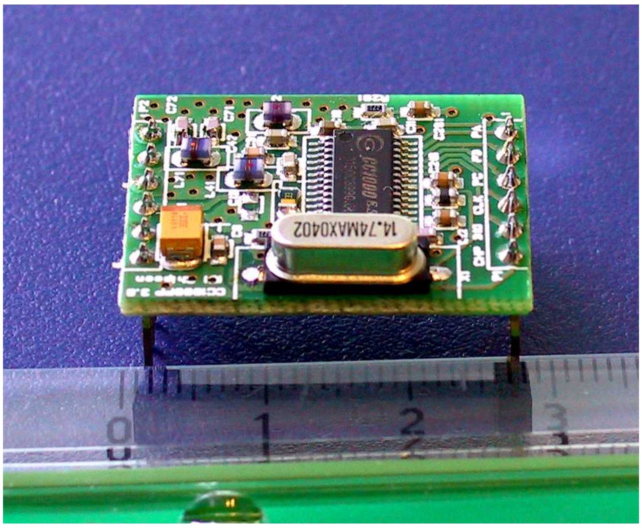
Chipcon Products
from Texas Instruments

User Manual

Rev. 1.22

CC1000PP Plug and Play Module



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Introduction

The CC1000 is a very flexible and feature-rich single-chip very low-power RF transceiver. Chipcon has designed the CC1000PP plug-and-play module to serve as a reference layout and enable very quick prototyping of an RF system.

The tiny CC1000PP module (28x20 mm) contains all RF components required for proper operation. This includes all the components mentioned in the CC1000 application circuit (see datasheet for details), as well as a reference crystal and a LC output filter. The layout is based on a standard, inexpensive 2-layer 1.6mm thick FR-4 PCB process, and has been carefully optimised by Chipcon. Components are mounted on one side only, the component side is used for signal routing, and the “solder” (reverse) side is used for a ground plane.

The CC1000PP layout can easily be used as a reference layout by importing it into a PCB CAD program. Chipcon provides the layout in the industry-standard Gerber format. To download the files, please visit the Chipcon web site.

As the CC1000PP module contains only the components required for operation, the layout does not require major modifications when used to make a custom PCB, the user can merely delete the connector pins at each end of the module. But it is very important that the component placement, routing and vias are not altered if the same performance is to be achieved.

If a four layer PCB is to be used, either the two top layers should be used for the RF part, or layer 1 and 4. Layer 4 should then be the ground plane and layers 2 and 3 should be masked off.

In a ready-built form, the CC1000PP is ideal for quick prototyping. The module may be connected to a prototyping board or PCB containing the rest of the system. The CC1000 can in this way be tested in a complete system without having to create a custom RF PCB layout.

Full documentation is provided for this module, including schematics and PCB layout. This information can be downloaded from Chipcon’s web site.

Typical performance

The table below shows typical performance at 3 V / 25°C.

Parameter	**CC1000PP-433**	**CC1000PP-868**		**Unit**
	433 MHz	**868 MHz**	**915 MHz**	
Sensitivity, 2.4 kBaud	-111	-107	-105	dBm
Output power, max	8	2.5	0.5	dBm
RF frequency accuracy	± 10	± 10	± 10	ppm
LO leakage	-68	-62	-59	dBm
2^{nd} harmonic	<-36	<-30	<-40 dBc	dBm
3^{rd} harmonic	<-30	<-30	<-40 dBc	dBm
Current consumption, TX	24	23	23	mA
Current consumption, RX	9.7	11.7	11.7	mA
Current consumption, PD	100	100	100	nA

Mechanical dimensions and component placement

The CC1000PP module measures 28x20mm, and has been designed for a two-sided 1.6mm thick PCB using industry-standard FR-4 board material. Components are mounted on only one side, and the result is a very small, inexpensive module that can satisfy regulation requirements.

On each end of the board are connectors for interfacing the module to an external system. An external antenna, and a 2.1-3.6V power supply should be connected to the top connector (P2). The RSSI/IF signal can also be accessed via this connector. The lower connector (P1) can be used to connect an external micro-controller to the data- and configuration interface of the CC1000.

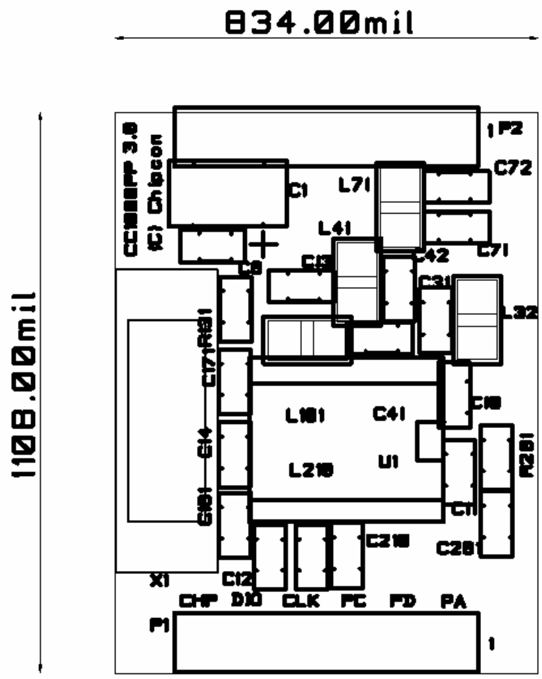

Figure 1. Mechanical drawing of CC1000PP module (not to scale)

To ensure optimum RF performance, an external antenna should be soldered directly to the antenna terminals, or a 50 Ohm microstrip line should be used from the antenna terminal to the external antenna connector. For applications not demanding optimum RF performance, a pin-row connector may be used to connect the antenna signal to another PCB, but be aware that this can lead to non-optimal sensitivity and output power, and that measurements using this arrangement should not be used to characterise the RF performance of CC1000. For more information on antennas, please see Chipcon application note AN003.

Circuit diagram

The circuit diagram of the CC1000PP is shown below. There are two versions of the CC1000PP module, the CC1000PP-433 for 433 MHz operation, and the CC1000PP-868 for operation in the 868 MHz and 902-928 MHz bands. Since the 868 version covers both the European 868 MHz band and the US 902-928 MHz band, one system can be used in both Europe and the US using the same hardware, changing the frequency by software control.

The circuit is similar to the application circuit shown in the CC1000 data sheet, with an added LC filter to reduce emitted harmonics.

The value of the matching components, the VCO inductor and the LC filter will depend on the operating frequency. Bills of materials are supplied for both versions. For operating frequencies other than those listed here, please use the latest version of SmartRF® Studio to calculate the component values.

Pinouts for the connectors are given in the table below. The position of pin number 1 is indicated on the top silkscreen of the PCB. An abbreviated description of the pin functions of P1 is also printed on the silkscreen.

P1		P2	
Pin	**Function**	**Pin**	**Function**
1	PALE	1	GND
2	PDATA	2	ANTENNA
3	PCLK	3	GND
4	DCLK	4	VDD (2.1 – 3.6 V)
5	DIO	5	RSSI / IF
6	CHP_OUT / LOCK	6	GND

Table 1. Connector pinouts

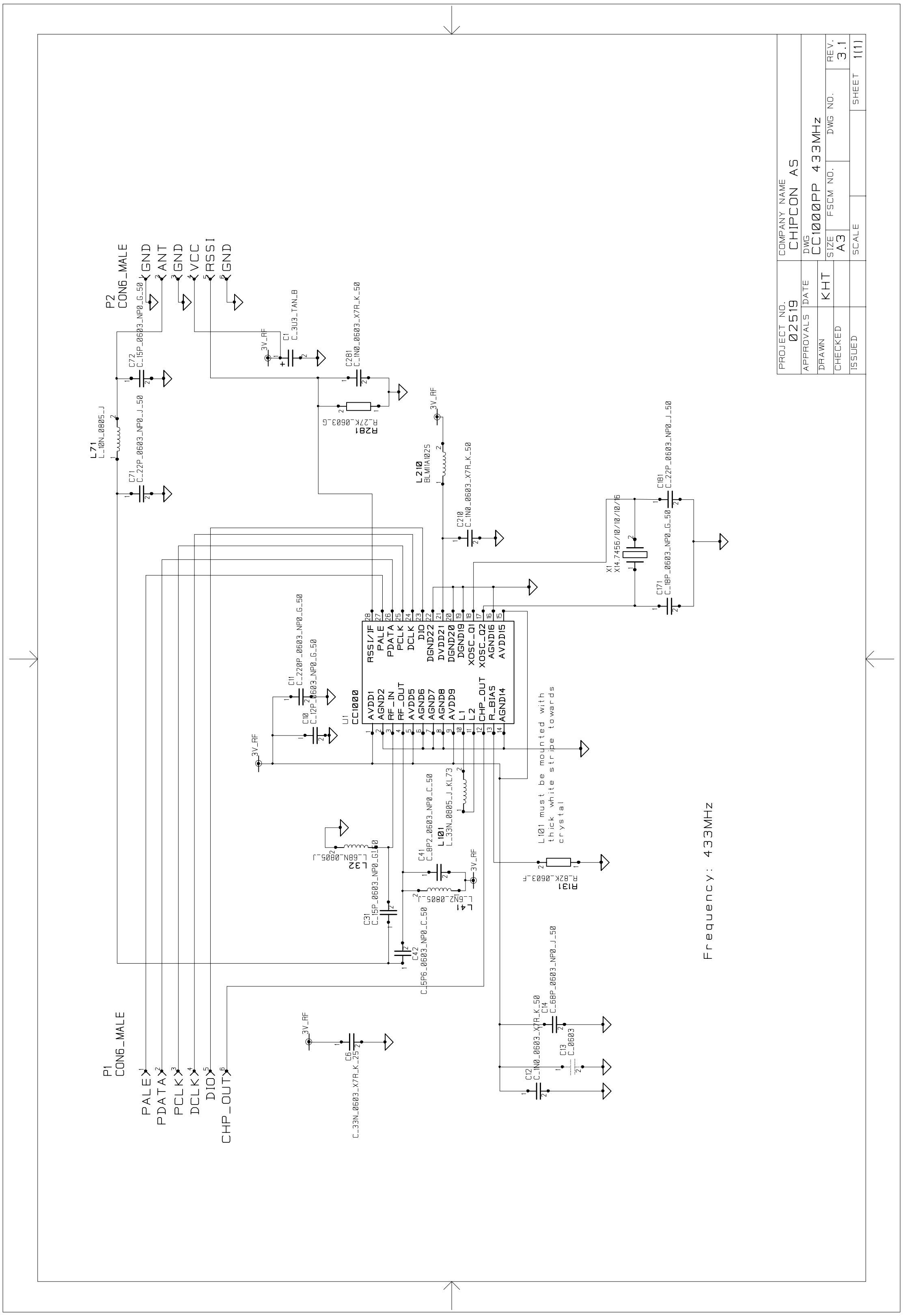

Figure 2. Schematic for 433 MHz version

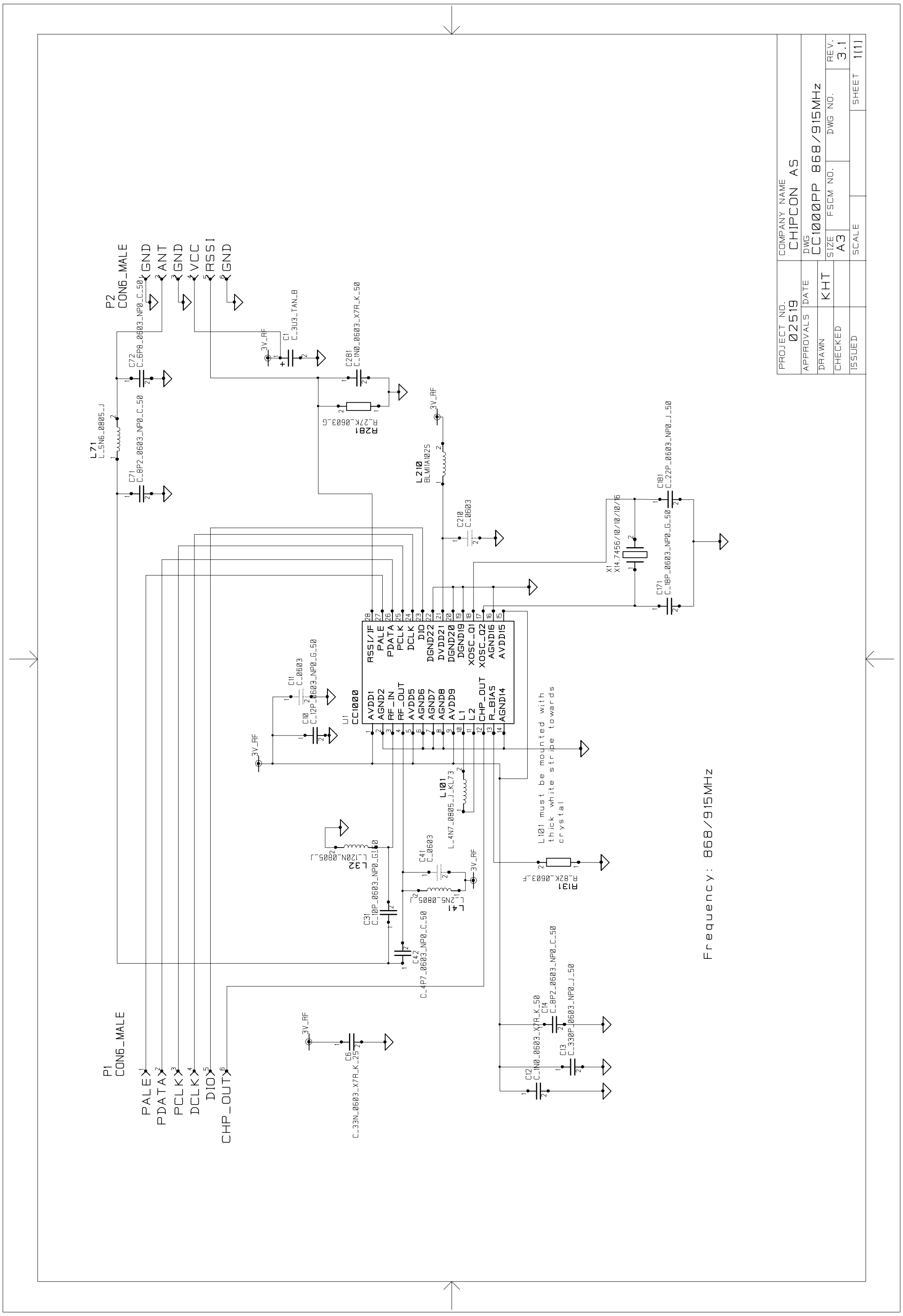

Figure 3. Schematic for 868/915 MHz version

Layout

RF circuits working at high frequencies are very sensitive to the physical layout of the PCB. Chipcon has carefully optimised the layout of the CC1000PP in order to provide good RF performance. Chipcon strongly recommends that you use this layout as it is, and that you do not attempt to modify it.

LO leakage is a critical parameter. To meet the ETSI requirement of –57 dBm, coupling from the VCO to the antenna or the matching network must be carefully controlled. The VCO inductor must be of the specified type and be mounted with the correct alignment if LO leakage is to meet specifications. The L101 VCO inductor should be oriented with the thick white stripe facing the crystal. To prevent coupling via the power supply, the specified decoupling capacitors must be mounted as shown.

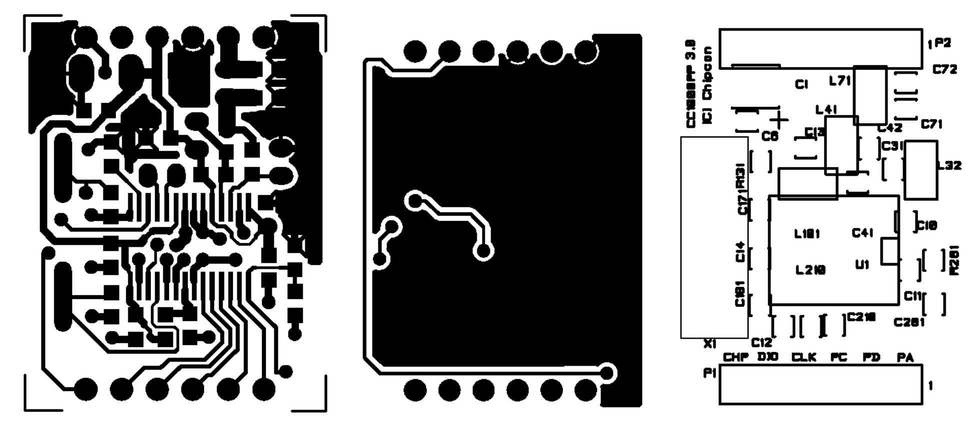

Figure 4. Top and bottom PCB layout, top silkscreen

Antennas

The CC1000PP can be used together with any type of single-sided antenna. Loop antennas can also be used by grounding one side. If the antenna's impedance is not close to 50 ohms, matching components should be used to match it to 50 ohms. A quarter-wave wire antenna can be used directly by removing pins 1, 2 and 3 from P2 and soldering in a piece of wire of the correct length (one quarter wavelength).

Frequency	¼ wavelength
433 MHz	16.4 cm
868 MHz	8.2 cm
915 MHz	7.8 cm

Table 2: 1/4 wavelength for common frequencies

For more information about antennas, please see application note AN003.

Bill of materials

The CC1000 is designed to be used together with low cost passive components. The components specified for the CC1000PP are the same as those listed in the data sheet. The only critical component is the VCO inductor, which must be the exact type listed in order for LO leakage to meet specifications. All other capacitors and inductors are non-critical, and any manufacturer or type may be used as long as they match the specifications in the component list. The boards manufactured by Chipcon uses Coilcraft HQ-series inductors, some of the inductor values may not be available from all manufacturers. Substituting nearby values may be possible.

Bill of materials, CC1000PP-433

CC1000PP-433			
Reference	*Description*	*Value / tolerance*	*Part*
C1	Capacitor, tantal	3.3μF	C_3U3_TAN_B
C6	Capacitor 0603	33nF, 10%	C_33N_0603_X7R_K_25
C10	Capacitor 0603	12pF, 5%	C_12P_0603_NP0_J_50
C11	Capacitor 0603	220pF, 5%	C_220P_0603_NP0_J_50
C12	Capacitor 0603	1nF, 10%	C_1N0_0603_X7R_K_50
C13	Capacitor 0603, general		No Not Mount
C14	Capacitor 0603	68pF, 5%	C_68P_0603_NP0_J_50
C31	Capacitor 0603	15pF, 5%	C_15P_0603_NP0_J_50
C41	Capacitor 0603	8.2pF, ±0.25pF	C_8P2_0603_NP0_C_50
C42	Capacitor 0603	5.6pF, ±0.25pF	C_5P2_0603_NP0_C_50
C71	Capacitor 0603	22pF, 5%	C_22P_0603_NP0_J_50
C72	Capacitor 0603	15pF, 5%	C_15P_0603_NP0_J_50
C171	Capacitor 0603	18pF, 5%	C_18P_0603_NP0_J_50
C181	Capacitor 0603	22pF, 5%	C_22P_0603_NP0_J_50
C210	Capacitor 0603	1.0nF, 10%	C_1N0_0603_X7R_K_50
C281	Capacitor 0603	1.0nF, 10%	C_1N0_0603_X7R_K_50
L32	Inductor 0805	68nH, 5%	L_68N_0805_J
L41	Inductor 0805	6.2nH, 5%	L_6N2_0805_J
L71	Inductor 0805	10nH, 5%	L_10N_0805_J
L101	Inductor 0805	33nH, 5%	L_33N_0805_J KOA KL732ATE33NJ
L210	EMI filter bead		BLM18HG102SN1D, Murata
P1	Pin-row connector		CON6_MALE
P2	Pin-row connector		CON6_MALE
R131	Resistor 0603	82kΩ, 1%	R_82K_0603_F
R281	Resistor 0603	27kΩ, 2%	R_27K_0603_G
U1	Single chip transceiver		CC1000
X1	Crystal, HC49-SMD		X14.7456MHz 10/10/10/16, (16pF load)

Bill of materials, CC1000PP-868

CC1000PP-868			
Reference	*Description*	*Value*	*Part*
C1	Capacitor, tantal	3.3μF	C_3U3_TAN_B
C6	Capacitor 0603	33nF, 10%	C_33N_0603_X7R_K_25
C10	Capacitor 0603	12pF, 5%	C_12P_0603_NP0_J_50
C11	Capacitor 0603		Do not mount
C12	Capacitor 0603	1nF, 10%	C_1N0_0603_X7R_K_50
C13	Capacitor 0603	330pF, 5%	C_330P_0603_NP0_J_50
C14	Capacitor 0603	8.2pF, ±0.25pF	C_8P2_0603_NP0_C_50
C31	Capacitor 0603	10pF, 5%	C_10P_0603_NP0_J_50
C41	Capacitor 0603		Do not mount
C42	Capacitor 0603	4.7pF, ±0.25pF	C_4P7_0603_NP0_C_50
C71	Capacitor 0603	8.2pF, ±0.25pF	C_8P2_0603_NP0_C_50
C72	Capacitor 0603	6.8pF, ±0.25pF	C_6P8_0603_NP0_C_50
C171	Capacitor 0603	18pF, 5%	C_18P_0603_NP0_J_50
C181	Capacitor 0603	22pF, 5%	C_22P_0603_NP0_J_50
C210	Capacitor 0603		Do not mount
C281	Capacitor 0603	1nF, 10%	C_1N0_0603_X7R_K_50
L32	Inductor 0805	120nF, 5%	L_120N_0805_J
L41	Inductor 0805	2.5nH, 5%	L_2N5_0805_J
L71	Inductor 0805	5.6nH, 5%	L_5N6_0805_J
L101	Inductor 0805	4.7nH, 5%	L_4N7_0805_J, KOA KL732ATE4N7C
L210	EMI filter bead		BLM18HG102SN1D, Murata
P1	Pin-row connector		CON6_MALE
P2	Pin-row connector		CON6_MALE
R131	Resistor 0603	82kΩ, 1%	R_82K_0603_F
R281	Resistor 0603	27kΩ, 2%	R_27K_0603_G
U1	Single chip transceiver		CC1000
X1	Crystal, HC49-SMD		X14.7456MHz 10/10/10/16, (16pF load)

Disclaimer

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