

**User Manual**  
Rev. 2.0  
**CC1020/1070DK Development Kit**

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## Introduction

The CC1020 single chip transceiver and the CC1070 single chip transmitter provide extensive features and great flexibility, which make the chips suitable for a very large number of applications and system requirements. The CC1020 and CC1070 are especially suited for narrowband systems. The CC1020/1070DK development kit is primarily designed to make it easy for designers to evaluate transceiver and transmitter performance and in a minimum of time develop their own applications.

The CC1020/1070DK development kit includes two CC1020EB evaluation boards, two CC1020EMX evaluation modules and one CC1070EM evaluation module. The CC1020EMX includes the CC1020 transceiver chip with the external components necessary for operation. The CC1070EM includes the CC1070 transmitter chip with the external components necessary for operation. The evaluation modules are mounted onto the CC1020EB, which is equipped with a voltage regulator and a PC interface circuitry. Using the CC1020EB connected to a PC running the SmartRF® Studio software, various CC1020 and CC1070 system parameters can be changed and tested.

Technical features:

### **CC1020 :**

- RF output power up to +10/+5 dBm programmable in 1 dB steps at 433/868 MHz respectively
- High sensitivity (up to -121 dBm for a 12.5 kHz channel)
- Low Adjacent Channel Power (ACP)
- High Adjacent Channel Rejection (ACR)
- Integrated bit synchronizer
- Image rejection mixer
- Automatic Frequency Control which reduces the crystal accuracy requirement
- Digital RSSI and carrier sense indicator

### **CC1070 :**

- RF output power up to +10/+8 dBm programmable in 1 dB steps at 433/868 MHz respectively
- Low Adjacent Channel Power (ACP)

This user manual describes how to get started with the CC1020/1070DK development kit. You will also find description on the CC1020EB, CC1020EMX, CC1070EM and advice on how to develop your own applications. For details on CC1020 and CC1070 please refer to the corresponding data sheet. For details on how to use the SmartRF® Studio software please refer to the SmartRF® Studio user manual.

## CC1020/1070DK Development Kit Contents

Your SmartRF® CC1020/1070DK development kit should contain the following items:

Item	Quantity	Comment
CC1020EB evaluation board	2	
CC1020EMX evaluation module	2	
CC1070EM evaluation module	1	
PC parallel port extension cable	2	
Adapter	6	25-pin D-sub, male-female, 3 m
Antenna	2	SMA male- BNC female
CC1020 samples	5	50Ω, $\lambda/4$ monopole, SMA male
CC1070 samples	5	
CC1020/1070 Quick Start User Manual	1	

## CC1020EB Evaluation Board

The CC1020EB evaluation board includes the following items:

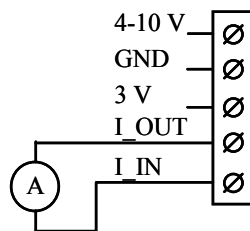
- 4-10 V to 3 V voltage regulator
- Possibility to apply a 3 V voltage source directly (chosen by the switch on the board)
- Voltage-level interface circuitry between the CC1020 or CC1070 chip (3 V) and the parallel port of the computer (5 V)
- Connector for a PC parallel port cable
- Connectors for modulation data in/out and synchronisation clock output
- 2 x 10 female connectors for connection to CC1020 or CC1070 evaluation module (described later)

### Description

The CC1020EB constitutes of three main parts. These are the sockets for the evaluation module (RF-section), the voltage supply and the PC-interface. The CC1020EB includes a number of components for maximum flexibility. However, only a minor part of these components are required in an actual application. Check the CC1020 and CC1070 datasheets for typical application circuits.

### Voltage supply

The user can choose between applying a 4-10 V non-regulated supply voltage or a 3 V regulated supply voltage by setting a switch on the board (SPDT). If a non-regulated supply voltage is applied, an on board regulator generates a regulated 3 V supply. A diode prevents damage if the wrong polarity is used for the non-regulated input. The connector has five contacts as shown in Figure 1. In addition to the three supply voltage contacts, there are two contacts, which can be used to measure the CC1020 or CC1070 DC current. A short jumper is placed between these two contacts for the circuit to work in the default configuration. If you want to measure the DC current, replace the jumper with an ampere meter as shown in Figure 1.



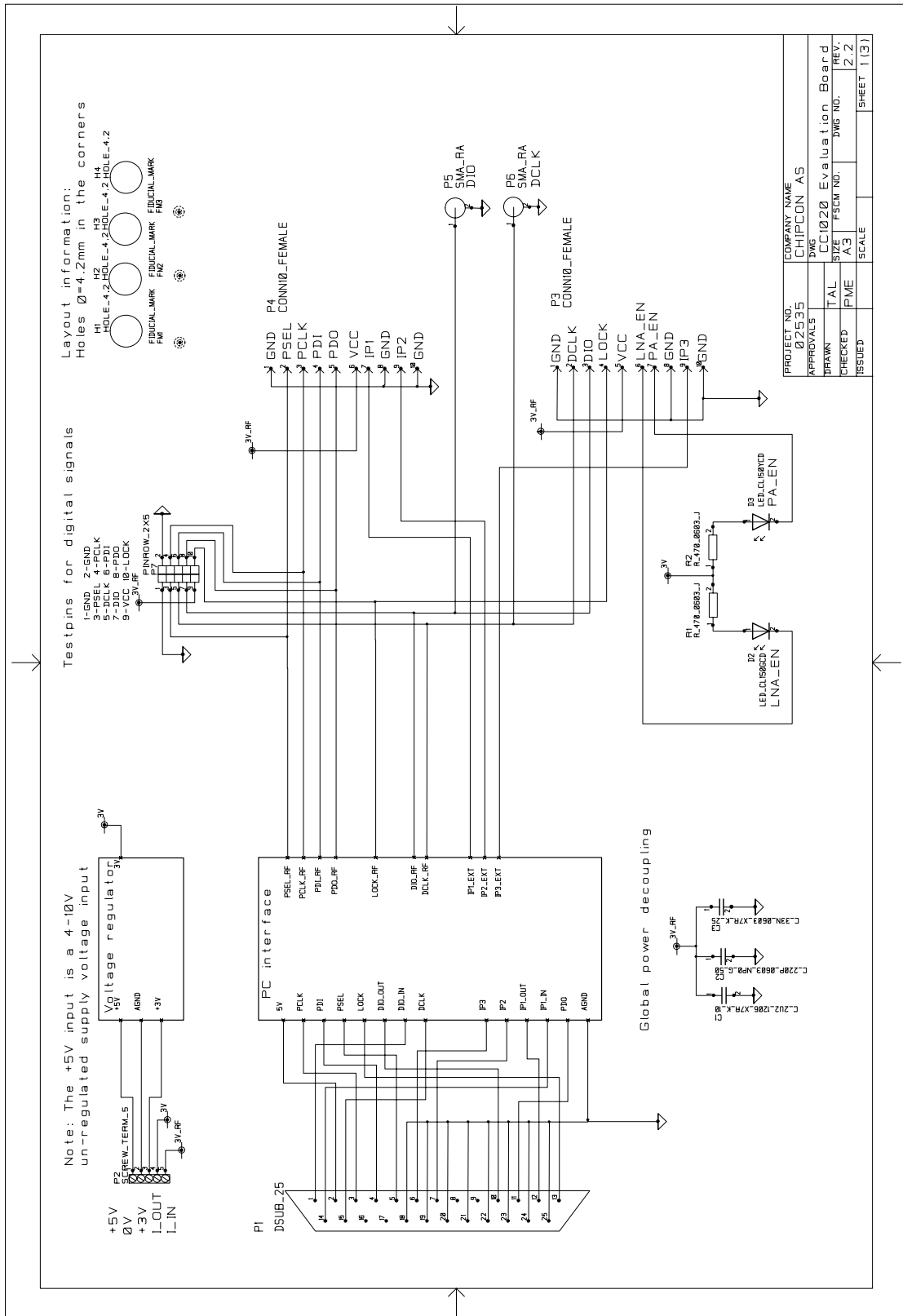
**Figure 1: The voltage supply connector with an ampere meter attached**

**Important:** For narrowband applications phase noise is a critical parameter. Make sure your voltage supply has sufficiently low noise performance so as not to degrade your measurements.

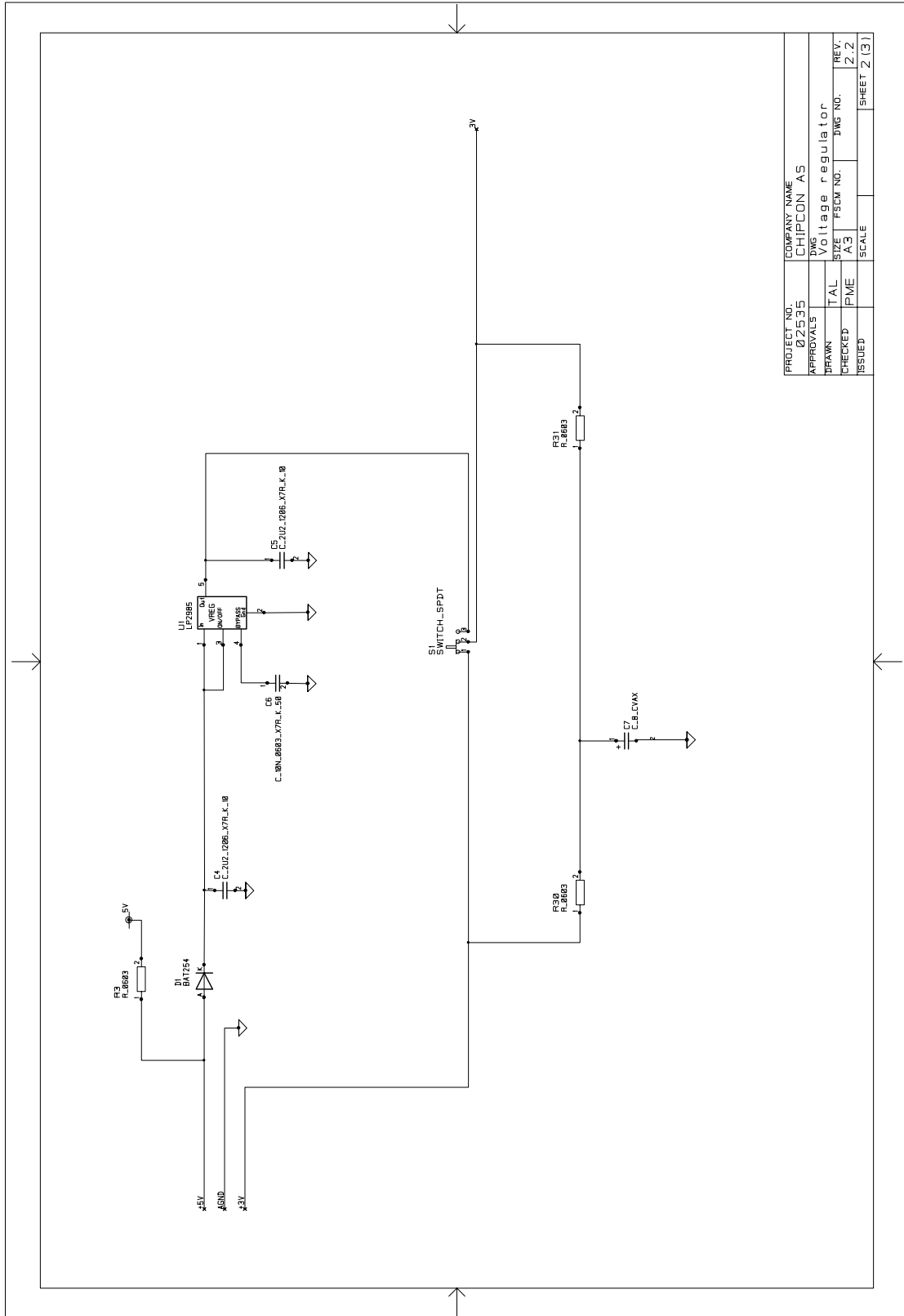
### PC-interface

The PC-interface is a 5-to/from-3 V level shift circuit, which buffers all control lines. The various CC1020 and CC1070 system parameters can be changed through the PC interface by running the SmartRF® Studio software.

**CC1020EB Schematics**

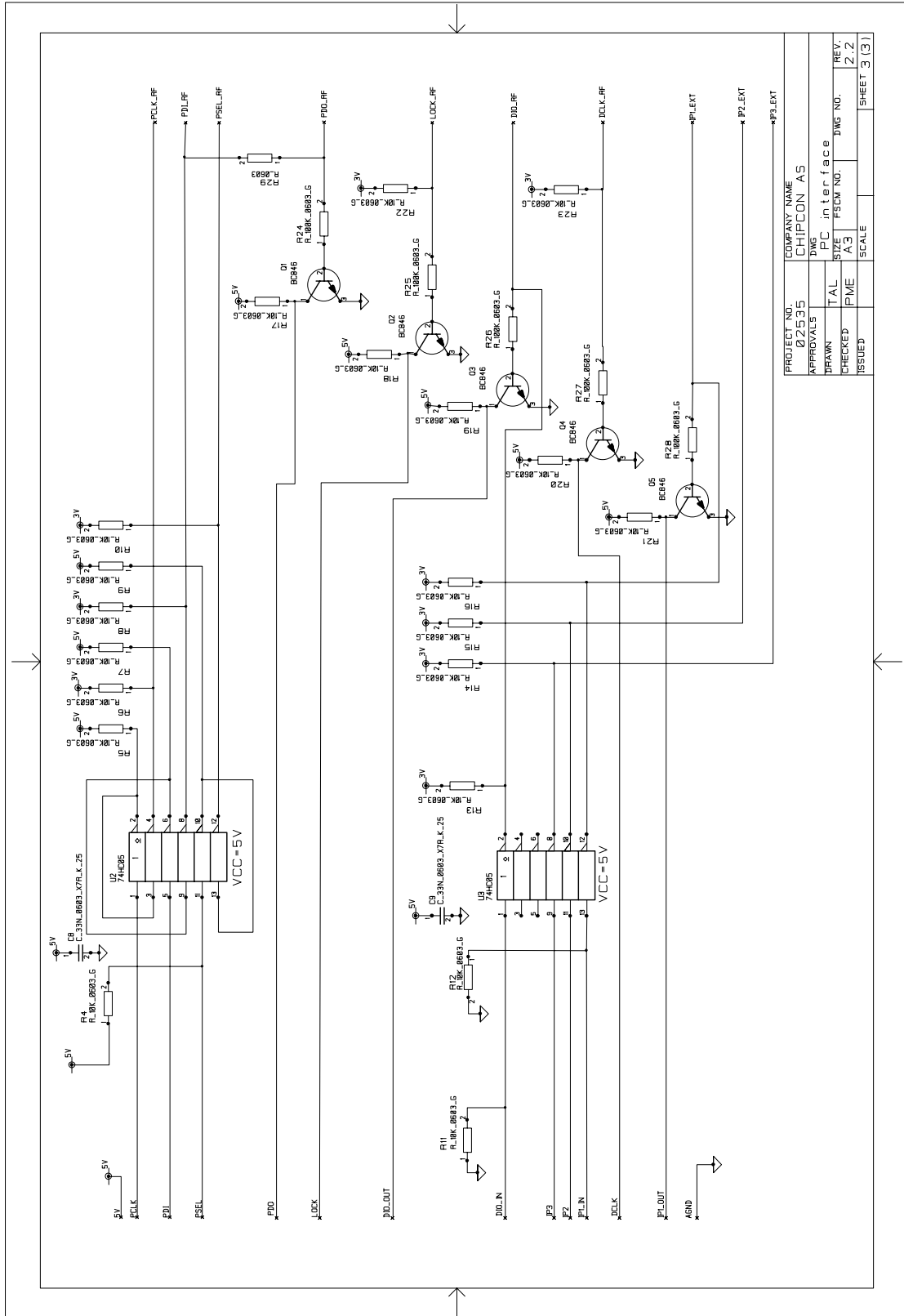


**Figure 2. CC1020EB top level schematic**



PROJECT NO.	02535	COMPANY NAME	CHIPCON AS
APPROVALS	DWS	DWS	Voltage regulator
DRAWN	TAL	SIZE	A3
CHECKED	PVE	FSCM NO.	DWS NO.
ISSUED		SCALE	REV.
			2.2
			SHEET 2 (3)

**Figure 3. CC1020EB voltage regulator schematic**



PROJECT NO.	02535	COMPANY NAME	CHIPCON AS
APPROVALS	DWS	PC interface	
DRAWN	TAL	SIZE	A3
CHECKED	PME	FSCM NO.	DWS NO.
ISSUED		SCALE	2.2
			SHEET 3 (3)

**Figure 4. CC1020EB PC interface schematic**



### CC1020EB Bill of Materials

Voltage regulator			
Reference	Description	Value	Part
C4	Capacitor 1206	2.2 uF	C_2U2_1206_X7R_K_10
C5	Capacitor 1206	2.2 uF	C_2U2_1206_X7R_K_10
C6	Capacitor 0603	10 nF	C_10N_0603_X7R_K_50
C7	Capacitor low ESR		Not used
R3	Resistor 0603		Not used
R30	Resistor 0603		Not used
R31	Resistor 0603		Not used
D1	Diode, Si		BAT254
S1	SPDT switch		SWITCH_SPDT
U1	Voltage regulator		LP2985, 3V, National Semiconductor

PC interface			
Reference	Description	Value	Part
C8	Capacitor 0603	33 nF	C_33N_0603_X7R_K_25
C9	Capacitor 0603	33 nF	C_33N_0603_X7R_K_25
Q1	BJT, Si, NPN, small signal		BC846
Q2	BJT, Si, NPN, small signal		BC846
Q3	BJT, Si, NPN, small signal		BC846
Q4	BJT, Si, NPN, small signal		BC846
Q5	BJT, Si, NPN, small signal		BC846
R4	Resistor 0603	10 kΩ	R_10K_0603_G
R5	Resistor 0603	10 kΩ	R_10K_0603_G
R6	Resistor 0603	10 kΩ	R_10K_0603_G
R7	Resistor 0603	10 kΩ	R_10K_0603_G
R8	Resistor 0603	10 kΩ	R_10K_0603_G
R9	Resistor 0603	10 kΩ	R_10K_0603_G
R10	Resistor 0603	10 kΩ	R_10K_0603_G
R11	Resistor 0603	10 kΩ	R_10K_0603_G
R12	Resistor 0603	10 kΩ	R_10K_0603_G
R13	Resistor 0603	10 kΩ	R_10K_0603_G
R14	Resistor 0603	10 kΩ	R_10K_0603_G
R15	Resistor 0603	10 kΩ	R_10K_0603_G
R16	Resistor 0603	10 kΩ	R_10K_0603_G
R17	Resistor 0603	10 kΩ	R_10K_0603_G
R18	Resistor 0603	10 kΩ	R_10K_0603_G
R19	Resistor 0603	10 kΩ	R_10K_0603_G
R20	Resistor 0603	10 kΩ	R_10K_0603_G
R21	Resistor 0603	10 kΩ	R_10K_0603_G
R22	Resistor 0603	10 kΩ	R_10K_0603_G

R23	Resistor 0603	10 k $\Omega$	R_10K_0603_G
R24	Resistor 0603	100 k $\Omega$	R_100K_0603_G
R25	Resistor 0603	100 k $\Omega$	R_100K_0603_G
R26	Resistor 0603	100 k $\Omega$	R_100K_0603_G
R27	Resistor 0603	100 k $\Omega$	R_100K_0603_G
R28	Resistor 0603	100 k $\Omega$	R_100K_0603_G
R29	Resistor 0603		Not used
U2	Hex inverter, oc		74HC05
U3	Hex inverter, oc		74HC05

Evaluation board			
Reference	Description	Value	Part
C1	Capacitor 1206	2.2 uF	C_2U2_1206_X7R_K_10
C2	Capacitor 0603	220 pF	C_220P_0603_NP0_G_50
C3	Capacitor 0603	33 nF	C_33N_0603_X7R_K_25
R1	Resistor 0603	470 $\Omega$	R_470_0603_J
R2	Resistor 0603	470 $\Omega$	R_470_0603_J
D2	LED, green, SMD		LED_CL150GCD
D3	LED, yellow, SMD		LED_CL150YCD
H1	Circuit Board Support		
H2	Circuit Board Support		
H3	Circuit Board Support		
H4	Circuit Board Support		
P1	D-Sub, 25 pin		DSUB_25
P2	5 pin terminal, screw		SCREW_TERM_5
P3	Connector, 0.9mm pin female		CONN10_FEMALE
P4	Connector, 0.9mm pin female		CONN10_FEMALE
P5	SMA connector		SMA_RA (Right angle)
P6	SMA connector		SMA_RA (Right angle)
P7	Pinrow, 2x5		PINROW_2X5

CC1020EB Assembly Drawing

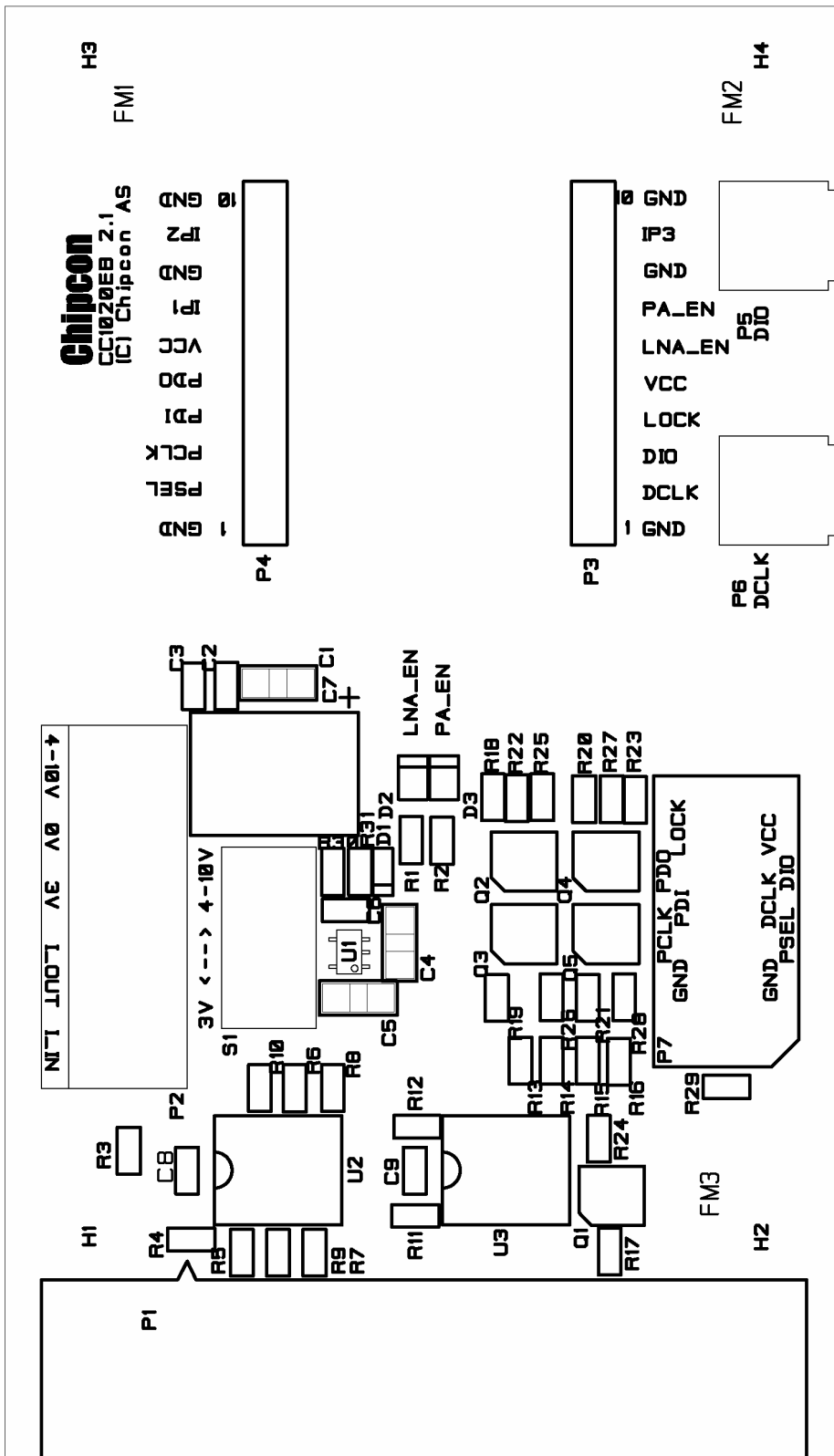


Figure 5. CC1020EB PCB assembly drawing

CC1020EB Layout

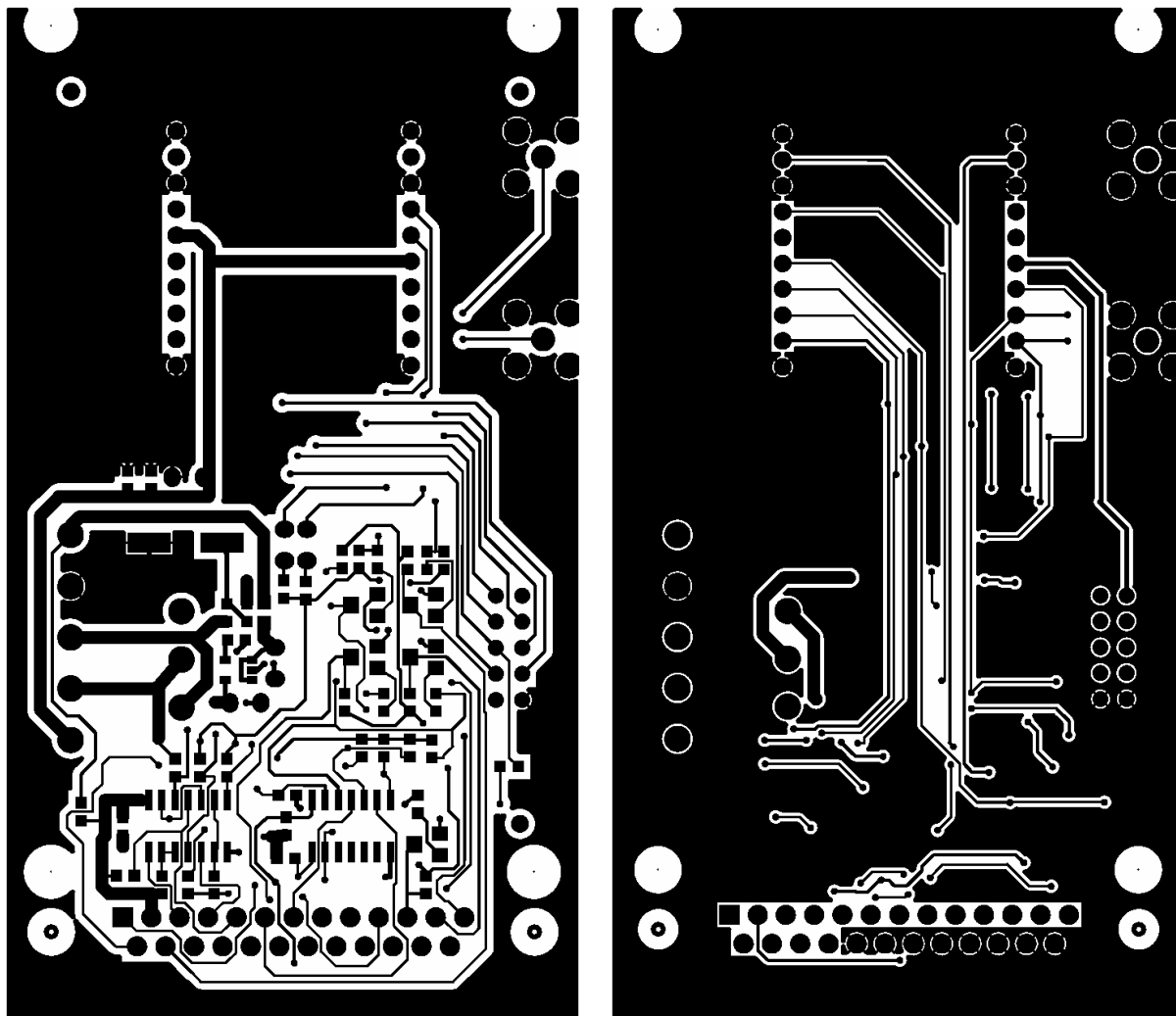


Figure 6. CC1020EB PCB layout. Layer 1 (top) and Layer 2 (bottom)

## CC1020EMX and CC1070EM Evaluation Modules

The CC1020EMX evaluation module includes the following items:

- A SmartRF® **CC1020** transceiver chip
- Antenna input/output matching network
- Connector for antenna (50 Ω SMA)
- 2 x 10 male connectors for connection to CC1020EB evaluation board

The CC1020EMX is distributed in two versions, 433 MHz and 868/915 MHz, and the difference is the frequency band of operation. The operating frequency band is marked on the CC1020EMX evaluation module.

- The 433 MHz CC1020EMX-433 evaluation module is optimised for 12.5/25 kHz channel spacing
- The 868/915 MHz CC1020EMX-868 evaluation module is optimised for 25 kHz channel spacing

The CC1070EM evaluation module includes the following items:

- A SmartRF® **CC1070** transmitter chip
- Antenna output matching network
- Connector for antenna (50 Ω SMA)
- 2 x 10 male connectors for connection to CC1020EB evaluation board

The CC1070EM is distributed in two versions, 433 MHz and 868/915 MHz, and the difference is the frequency band of operation. The operating frequency band is marked on the CC1070EM evaluation module.

- The 433 MHz CC1070EM-433 evaluation module is optimised for 12.5/25 kHz channel spacing.
- The 868/915 MHz CC1070EM-868 evaluation module is optimised for 25 kHz channel spacing.

### Description

The CC1020EMX evaluation module consists of a CC1020 transceiver chip with external components. The CC1070EM evaluation module consists of a CC1070 transmitter chip with external components. The different components are explained below.

#### *The loop filter*

The loop filter consists of two resistors (R2 and R3) and three capacitors (C6-C8). C7 and C8 may be omitted in applications where high loop bandwidth is desired. The values mounted on the CC1020EMX and CC1070EM can be used for data rates up to 4.8 kBaud. For higher data rates use the component values calculated in the SmartRF® Studio software program or use the values given in Table 1.

Data rate (kBAud)	Deviation (kHz)	C6 (nF)	C7 (pF)	C8 (pF)	R2 (kΩ)	R3 (kΩ)	Comment
Up to 4.8	Up to ±2.4	220	8200	2200	1.5	4.7	12.5 kHz channel spacing
		100	3900	1000	2.2	6.8	25 kHz channel spacing
9.6	±4.8	56	2200	560	3.3	10	
19.2	±9.6	15	560	150	5.6	18	
38.4	±19.2	3.9	120	33	12	39	
76.8	±38.4	1.0	27	3.3	27	82	
153.6	±76.8	0.2	1.5	-	47	150	

**Table 1. PLL loop filter component values for different data rates**

#### *Bias resistor*

The precision bias resistor R1 is used to set an accurate bias current.

#### *The LOCK signal*

A LOCK signal is connected to the PC parallel port interface to be monitored by the SmartRF® Studio software. The signal tells you when the synthesiser frequency is in lock. It is also available at a test pin and is active low.

This digital output can also be configured to other functions. Please refer to the CC1020 and CC1070 data sheets for details.

#### *Input/output matching and filtering*

The CC1020 input/output matching network and the CC1070 output matching network are optimised for either 433 MHz or 868 MHz operation.

- The CC1020 input/output matching network consists of L1, L2, C1 and C3 (see Figure 11 and Figure 12)
- The CC1070 output matching network consists of L2, C2 and C3 (see Figure 15 and Figure 16)

The component values are calculated in the SmartRF® Studio software program. Using the specified matching network component values gives an optimum match at the specified operating frequency. Minor tuning of the component values may be necessary to compensate for layout parasitics at other frequencies or other PCB layouts.

#### *The crystal oscillator*

The crystal frequency is 14.7456 MHz. The crystal oscillator, X1, circuit has a trimmer capacitor, CT1, which reduces the initial tolerance of the crystal to zero by careful adjustment using a precision frequency counter. The crystal used has ±10 ppm accuracy and changes ±10 ppm over the -10 to +60 °C temperature range. The loading capacitors (C4 and C5) are designed for a 16 pF crystal load. It is also possible to use an external clock signal. Be sure to remove the crystal if an external clock is used. When using a low amplitude sine wave (300 mVpp) as external clock signal the signal must be connected to XOSC\_Q1 using a DC block (10 nF). Set XOSC\_BYPASS='0' in the INTERFACE register. A full-swing digital external clock can also be used. In this case set XOSC\_BYPASS='1' and do not use a DC block capacitor.

### *LC filter*

An LC-filter attenuates the spurious emission in transmit mode.

- For CC1020 at 433 MHz the LC filter is a T-type filter topology (L70, L71 and C72) in Figure 11
- For CC1020 at 868 MHz the LC filter is a  $\pi$ -type filter topology (C71, C72 and L70) in Figure 12
- For CC1070 the LC filter is a T-type filter topology for both 433 MHz and 868/915 MHz (L71, L72 and C71) in Figure 15 and Figure 16

### *Power supply decoupling and filtering*

Power supply decoupling and filtering must be used. The placement and size of the decoupling capacitors and the power supply filtering are very important to achieve the best performance for narrowband applications. The CC1020EMX and CC1070EM evaluation modules should be used as reference designs and should be followed very closely. The PCB Gerber-files are available from the Chipcon web site (<http://www.chipcon.com>).

### *LNA\_EN and PA\_EN*

CC1020 has two digital output pins, PA\_EN and LNA\_EN, which can be used to control an external LNA, PA or an external Rx/Tx switch. Both PA\_EN and LNA\_EN are used to control the external Rx/Tx switch on the CC1020EMX. These outputs can also be used as general digital output control signals. Please see the CC1020 data sheet for details. PA\_EN and LNA\_EN are connected to two LEDs on the CC1020EB. In order to utilize this option, two 0  $\Omega$  resistors, R25 and R26, must be soldered onto the CC1020EMX.

CC1070 has one digital output pin, PA\_EN, which can be used to control an external PA. This output can also be used as general digital output control signals. Please see the CC1070 data sheet for details. PA\_EN is connected to a LED on the CC102EB. In order to utilize this option, a 0  $\Omega$  resistor, R25, must be soldered onto the CC1070EM.

### *The configuration interface*

The microcontroller uses 3 or 4 I/O pins for the configuration interface (PDI, PDO, PCLK and PSEL). PDO should be connected to an input at the microcontroller. PDI, PCLK and PSEL must be microcontroller outputs. One I/O pin can be saved if PDI and PDO are connected together and a bi-directional pin is used at the microcontroller. Please see the CC1020 and CC1070 data sheets for details.

In the CC1020/1070DK all configuration data is initialised by the SmartRF® Studio software.

### *DIO and DCLK*

The modulation input/output (DIO for CC1020 and DI for CC1070) and the data clock (DCLK) are connected to separate connectors. The connectors are of type SMA female.

The CC1020 and CC1070 can be used with NRZ (Non-Return-to-Zero) data or Manchester (also known as bi-phase-level) encoded data. CC1020 can also synchronize the data from the demodulator and provide the data clock at DCLK.

CC1020 and CC1070 can be configured for three different data formats:

#### *Synchronous NRZ mode:*

In transmit mode CC1020 and CC1070 provide the data clock at DCLK, and DIO (DI) is used as data input. Data is clocked into CC1020 and CC1070 at the rising edge of DCLK. The data is modulated at RF without encoding.

In receive mode CC1020 performs the synchronization and provides the received data clock at DCLK and data at DIO. The data should be clocked into the interfacing circuit at the rising

edge of DCLK as shown in Figure 7. As an option the LOCK pin can be used as data output in this mode during reception. Please see the CC1020 data sheet for further details.

*Synchronous Manchester encoded mode:*

In transmit mode CC1020 and CC1070 provide the data clock at DCLK, and DIO (DI) is used as data input. Data is clocked into CC1020 and CC1070 at the rising edge of DCLK and should be in NRZ format. The data is modulated at RF with Manchester code. The encoding is done by CC1020 and CC1070. In this mode the effective bit rate is half the baud rate due to the coding.

In receive mode CC1020 performs the synchronization and provides received data clock at DCLK and data at DIO. CC1020 does the decoding and NRZ data is presented at DIO. The data should be clocked into the interfacing circuit at the rising edge of DCLK as shown in Figure 8. As an option the LOCK pin can be used as data output in this mode during reception. Please see the CC1020 data sheet for further details.

*Transparent Asynchronous UART mode:*

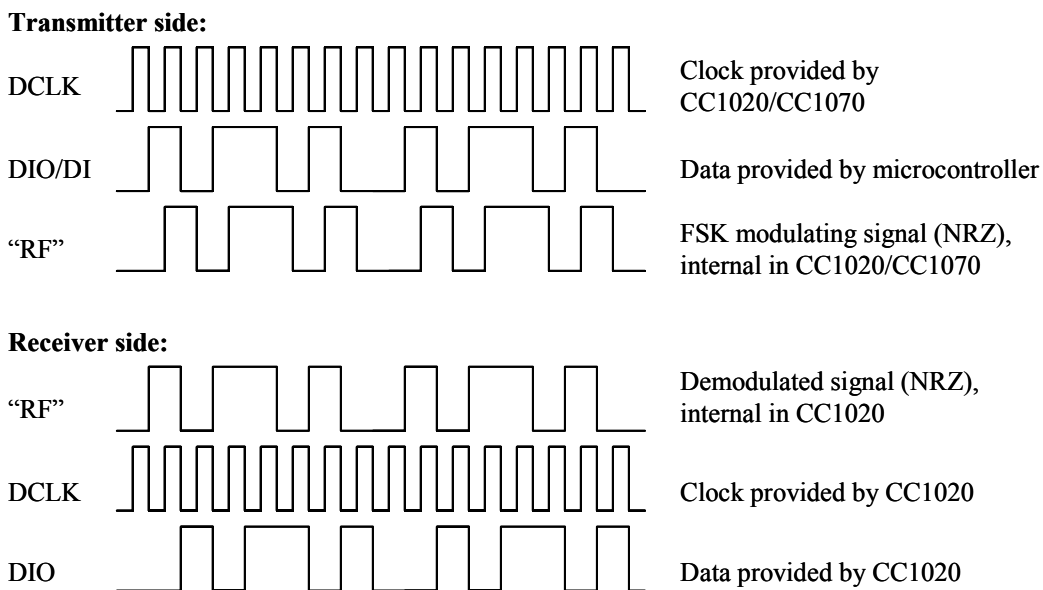
In transmit mode CC1020 and CC1070 use DIO (DI) as data input. The data is modulated at RF without synchronization or encoding.

With CC1020 in receive mode the raw data signal from the demodulator is sent to the output (DIO). No synchronization or decoding of the signal is performed in CC1020 and should be done by the interfacing circuit. As an option the DCLK pin can be used as data output in this mode during reception. See Figure 9. Please see the CC1020 data sheet for further details.

*Manchester encoding and decoding:*

In the *Synchronous Manchester* encoded mode CC1020 and CC1070 use Manchester coding when modulating the data. The CC1020 also performs the data decoding and synchronization. The Manchester coding is based on transitions; a "0" is encoded as a low-to-high transition, a "1" is encoded as a high-to-low transition. See Figure 10.

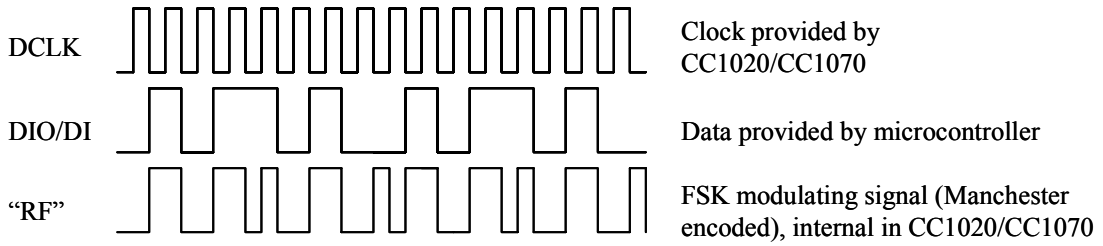
The Manchester coding ensures that the signal has a constant DC component, which is necessary in some FSK demodulators. Using this mode also ensures compatibility with the CC400/CC900 designs.



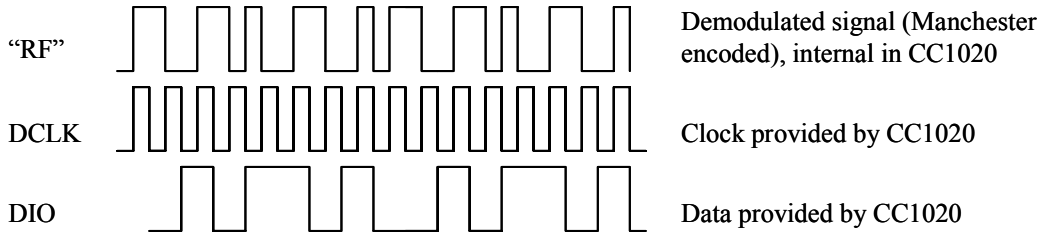
**Figure 7. Synchronous NRZ mode**



**Transmitter side:**

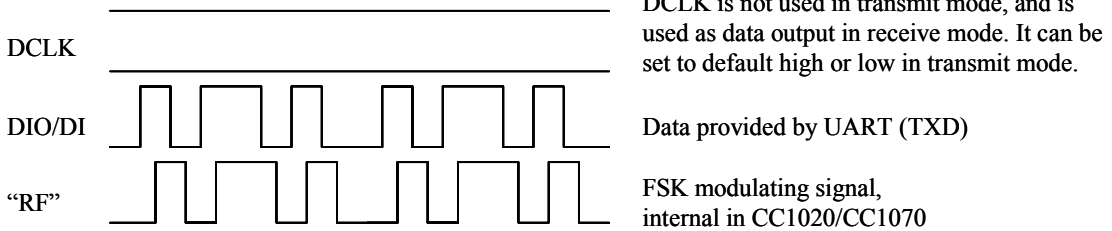


**Receiver side:**

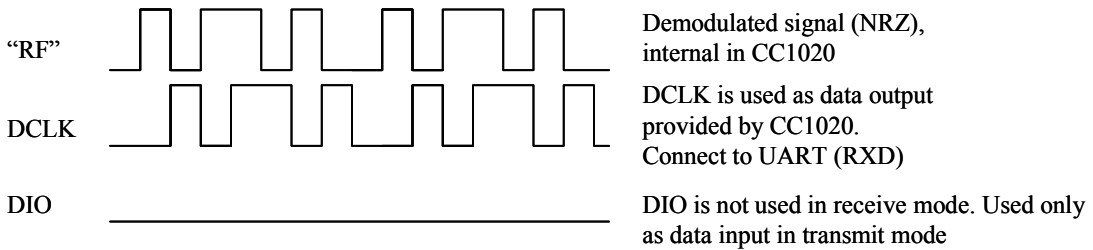


**Figure 8. Synchronous Manchester encoded mode**

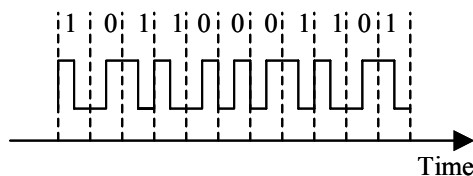
**Transmitter side:**



**Receiver side:**



**Figure 9. Transparent Asynchronous UART mode**



**Figure 10. Manchester encoding**

CC1020EMX-433 Schematic

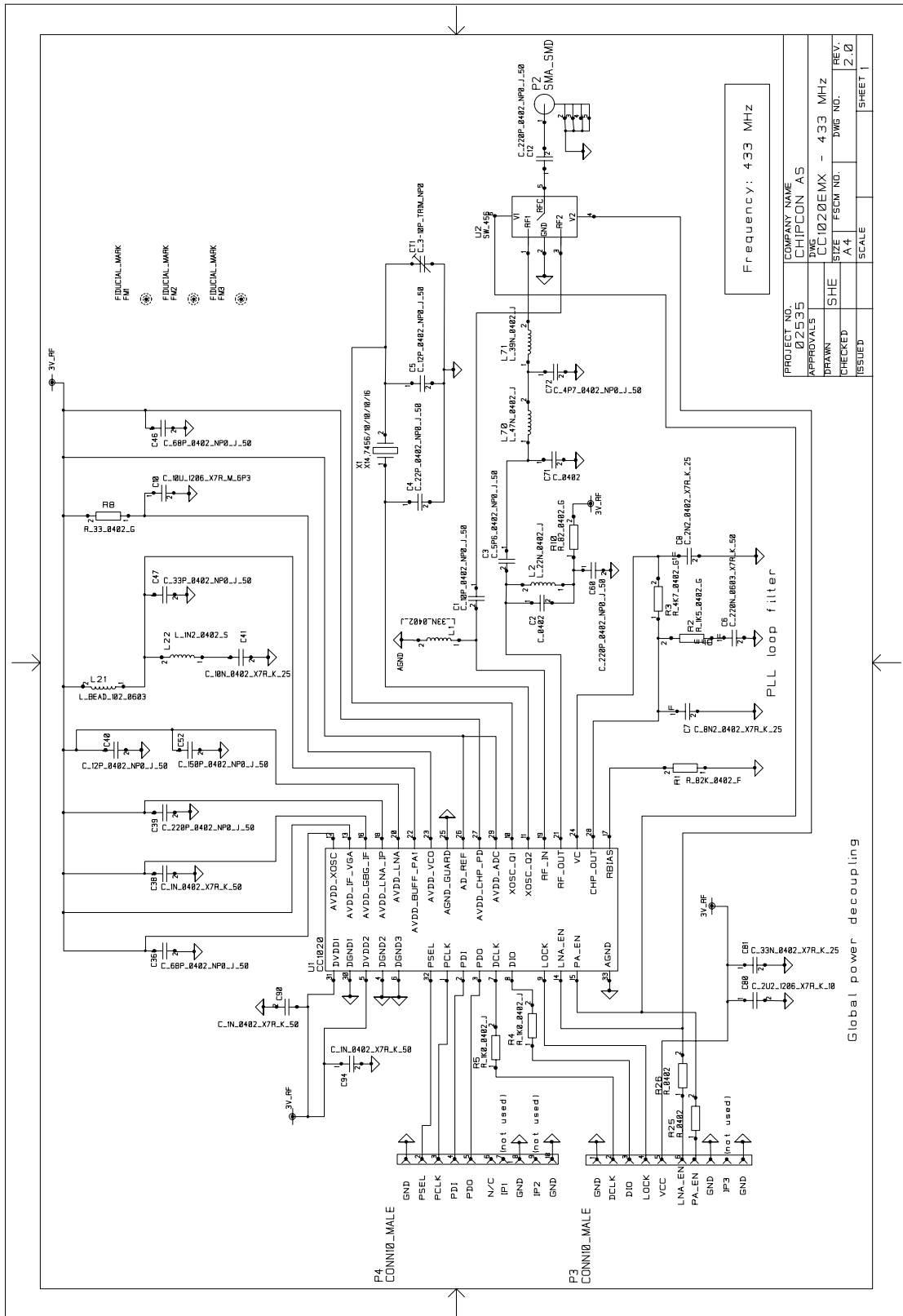


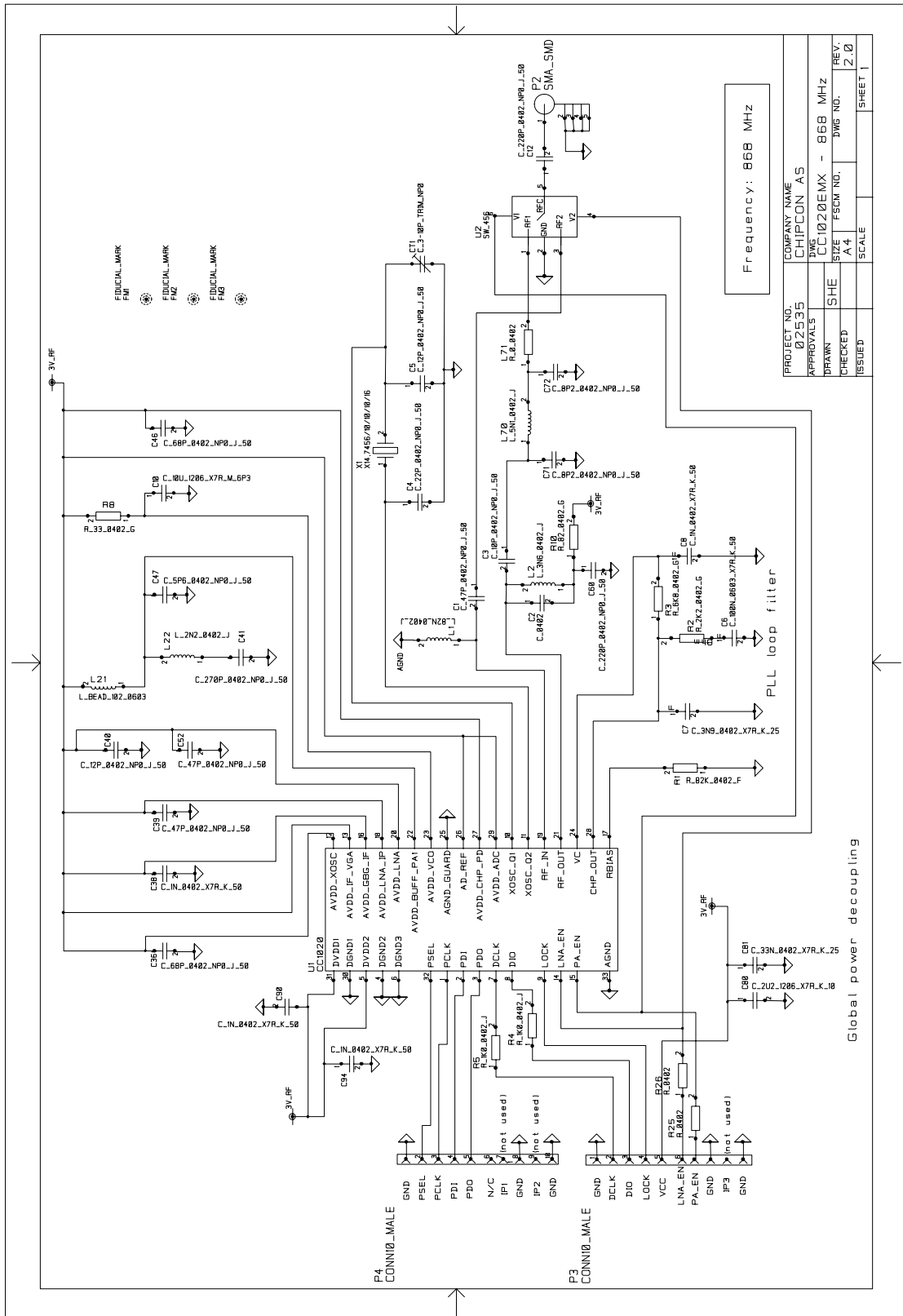
Figure 11. CC1020EMX-433 MHz schematic

### CC1020EMX-433 Bill of Materials

RF part 433 MHz			
Reference	Description	Value	Part
C1	Capacitor 0402	10 pF	C_10P_0402_NP0_J_50
C2	Capacitor 0402		Not used
C3	Capacitor 0402	5.6 pF	C_5P6_0402_NP0_J_50
C4	Capacitor 0402	22 pF	C_22P_0402_NP0_J_50
C5	Capacitor 0402	12 pF	C_12P_0402_NP0_J_50
C6	Capacitor 0603	220 nF	C_220N_0603_X7R_K_50
C7	Capacitor 0402	8.2 nF	C_8N2_0402_X7R_K_25
C8	Capacitor 0402	2.2 nF	C_2N2_0402_X7R_K_25
C10	Capacitor 1206	10 uF	C_10U_1206_X7R_M_6P3
C12	Capacitor 0402	220 pF	C_220P_0402_NP0_J_50
C36	Capacitor 0402	68 pF	C_68P_0402_NP0_J_50
C38	Capacitor 0402	1 nF	C_1N_0402_X7R_K_50
C39	Capacitor 0402	220 pF	C_220P_0402_NP0_J_50
C40	Capacitor 0402	12 pF	C_12P_0402_NP0_J_50
C41	Capacitor 0402	10 nF	C_10N_0402_X7R_K_25
C46	Capacitor 0402	68 pF	C_68P_0402_NP0_J_50
C47	Capacitor 0402	33 pF	C_33P_0402_NP0_J_50
C52	Capacitor 0402	150 pF	C_150P_0402_NP0_J_50
C60	Capacitor 0402	220 pF	C_220P_0402_NP0_J_50
C71	Capacitor 0402		Not used
C72	Capacitor 0402	4.7 pF	C_4P7_0402_NP0_J_50
C80	Capacitor 1206	2.2 uF	C_2U2_1206_X7R_K_10
C81	Capacitor 0402	33 nF	C_33N_0402_X7R_K_25
C90	Capacitor 0402	1 nF	C_1N_0402_X7R_K_50
C94	Capacitor 0402	1 nF	C_1N_0402_X7R_K_50
CT1	Trimmer Capacitor		C_3-10P_TRIM_NP0
L1	Inductor 0402	33 nH	L_33N_0402_J
L2	Inductor 0402	22 nH	L_22N_0402_J
L21	EMI filter bead		L_BEAD_102_0603
L21	Inductor 0402	1.2 nH	L_1N2_0402_S
L70	Inductor 0402	47 nH	L_47N_0402_J
L71	Inductor 0402	39 nH	L_39N_0402_J
P2	Surface-mount SMA, straight		SMA_SMD
P3	Connector, 0.9mm pin, male		CONN10_MALE
P4	Connector, 0.9mm pin, male		CONN10_MALE
R1	Resistor 0402	82 k $\Omega$	R_82K_0402_F
R2	Resistor 0402	1.5 k $\Omega$	R_1K5_0402_G
R3	Resistor 0402	4.7 k $\Omega$	R_4K7_0402_G
R4	Resistor 0402	1 k $\Omega$	R_1K0_0402_J
R5	Resistor 0402	1 k $\Omega$	R_1K0_0402_J
R8	Resistor 0402	33 $\Omega$	R_33_0402_G
R10	Resistor 0402	82 $\Omega$	R_82_0402_G
R25	Resistor 0402		Not used

R26	Resistor 0402		Not used
U1	Single chip transceiver		CC1020
U2	GaAs SPDT switch, DC – 3.0 GHz		SW_456
X1	Crystal, HC-49-SMD		X14.7456/10/10/10/16

**CC1020EMX-868/915 Schematic**



**Figure 12. CC1020EMX-868/915 MHz schematic**

### CC1020EMX-868/915 Bill of Materials

RF part 868 MHz			
Reference	Description	Value	Part
C1	Capacitor 0402	47 pF	C_47P_0402_NP0_J_50
C2	Capacitor 0402		Not used
C3	Capacitor 0402	10 pF	C_10P_0402_NP0_J_50
C4	Capacitor 0402	22 pF	C_22P_0402_NP0_J_50
C5	Capacitor 0402	12 pF	C_12P_0402_NP0_J_50
C6	Capacitor 0603	100 nF	C_100N_0603_X7R_K_50
C7	Capacitor 0402	3.9 nF	C_3N9_0402_X7R_K_25
C8	Capacitor 0402	1 nF	C_1N_0402_X7R_K_50
C10	Capacitor 1206	10 uF	C_10U_1206_X7R_M_6P3
C12	Capacitor 0402	220 pF	C_220P_0402_NP0_J_50
C36	Capacitor 0402	68 pF	C_68P_0402_NP0_J_50
C38	Capacitor 0402	1 nF	C_1N0_0402_X7R_K_50
C39	Capacitor 0402	47 pF	C_47P_0402_NP0_J_50
C40	Capacitor 0402	12 pF	C_12P_0402_NP0_J_50
C41	Capacitor 0402	270 pF	C_270P_0402_NP0_J_50
C46	Capacitor 0402	68 pF	C_68P_0402_NP0_J_50
C47	Capacitor 0402	5.6 pF	C_5P6_0402_NP0_J_50
C52	Capacitor 0402	47 pF	C_47P_0402_NP0_J_50
C60	Capacitor 0402	220 pF	C_220P_0402_NP0_J_50
C71	Capacitor 0402	8.2 pF	C_8P2_0402_NP0_J_50
C72	Capacitor 0402	8.2 pF	C_8P2_0402_NP0_J_50
C80	Capacitor 1206	2.2 uF	C_2U2_1206_X7R_K_10
C81	Capacitor 0402	33 nF	C_33N_0402_X7R_K_25
C90	Capacitor 0402	1 nF	C_1N_0402_X7R_K_50
C94	Capacitor 0402	1 nF	C_1N_0402_X7R_K_50
CT1	Trimmer Capacitor		C_3-10P_TRIM_NP0
L1	Inductor 0402	82 nH	L_82N_0402_J
L2	Inductor 0402	3.6 nH	L_3N6_0402_J
L21	EMI filter bead		L_BEAD_102_0603
L22	Inductor 0402	2.2 nH	L_2N2_0402_J
L70	Inductor 0402	5.1 nH	L_5N1_0402_J
L71	Resistor 0402	0 $\Omega$	R_0_0402
P2	Surface-mount SMA, straight		SMA_SMD
P3	Connector, 0.9mm pin, male		CONN10_MALE
P4	Connector, 0.9mm pin, male		CONN10_MALE
R1	Resistor 0402	82 k $\Omega$	R_82K_0402_F
R2	Resistor 0402	2.2 k $\Omega$	R_2K2_0402_G
R3	Resistor 0402	6.8 k $\Omega$	R_6K8_0402_G
R4	Resistor 0402	1 k $\Omega$	R_1K0_0402_J
R5	Resistor 0402	1 k $\Omega$	R_1K0_0402_J
R8	Resistor 0402	33 $\Omega$	R_33_0402_G
R10	Resistor 0402	82 $\Omega$	R_82_0402_G
R25	Resistor 0402		Not used

R26	Resistor 0402		Not used
U1	Single chip transceiver		CC1020
U2	GaAs SPDT switch, DC – 3.0 GHz		SW_456
X1	Crystal, HC-49-SMD		X14.7456/10/10/10/16

CC1020EMX Assembly Drawings

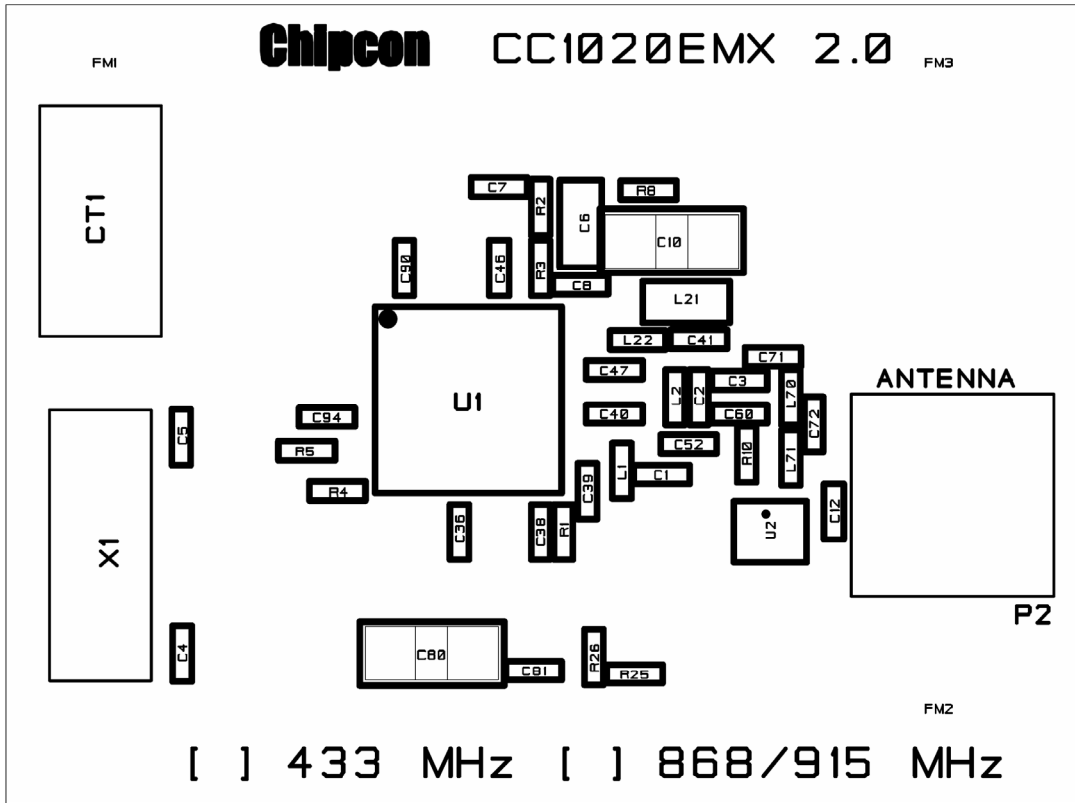


Figure 13. CC1020EMX PCB top level assembly drawing

CC1020EMX Layout

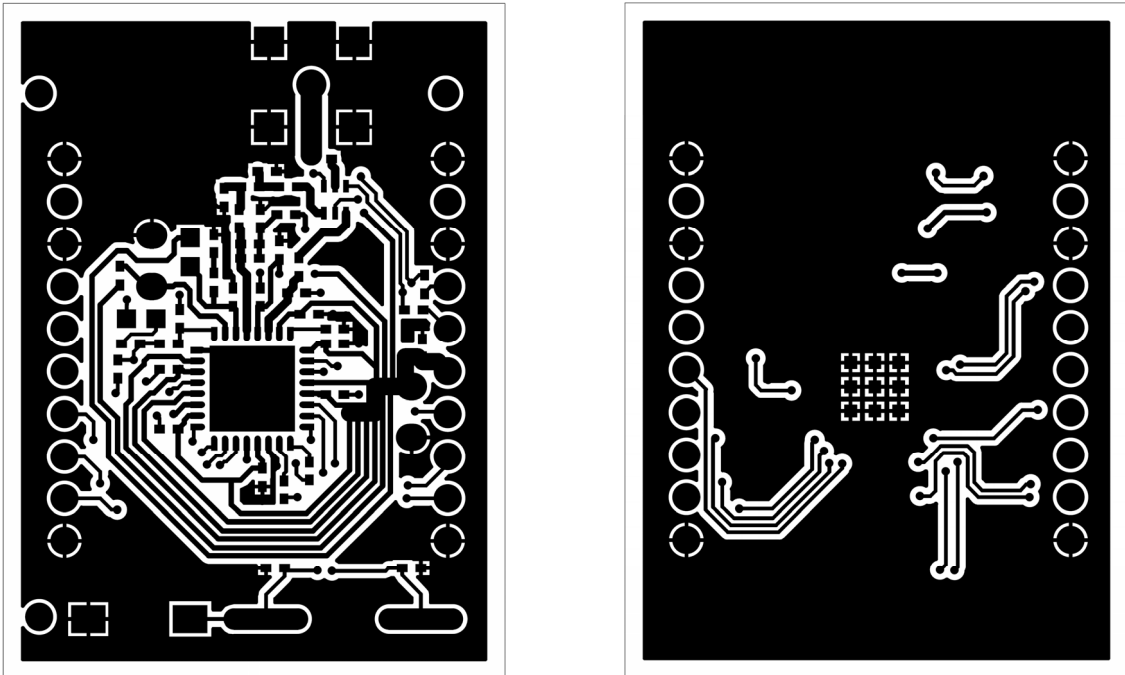
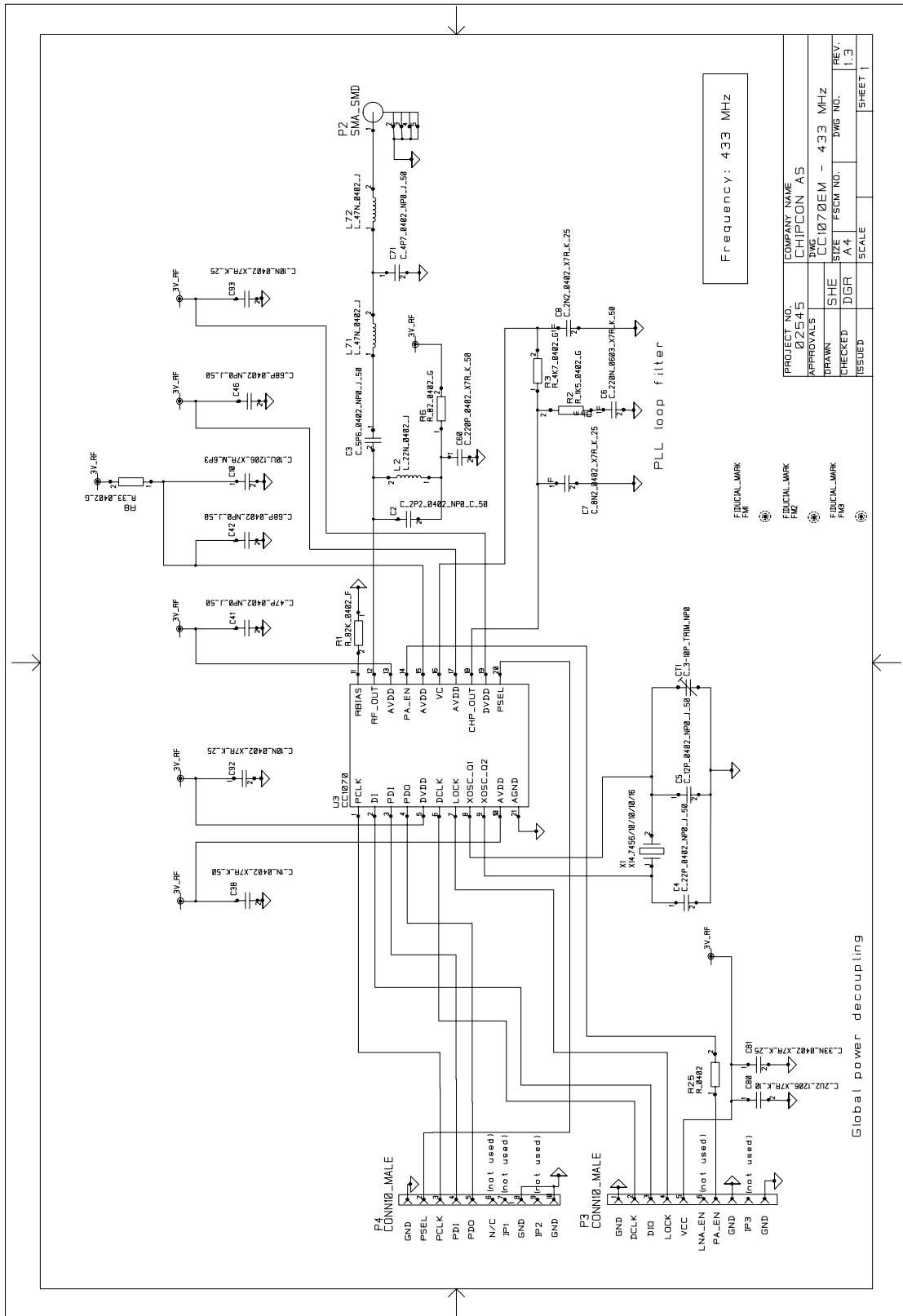


Figure 14. CC1020EMX PCB layout. Layer 1 (top) and Layer 2 (bottom)



**CC1070EM-433 Schematic**

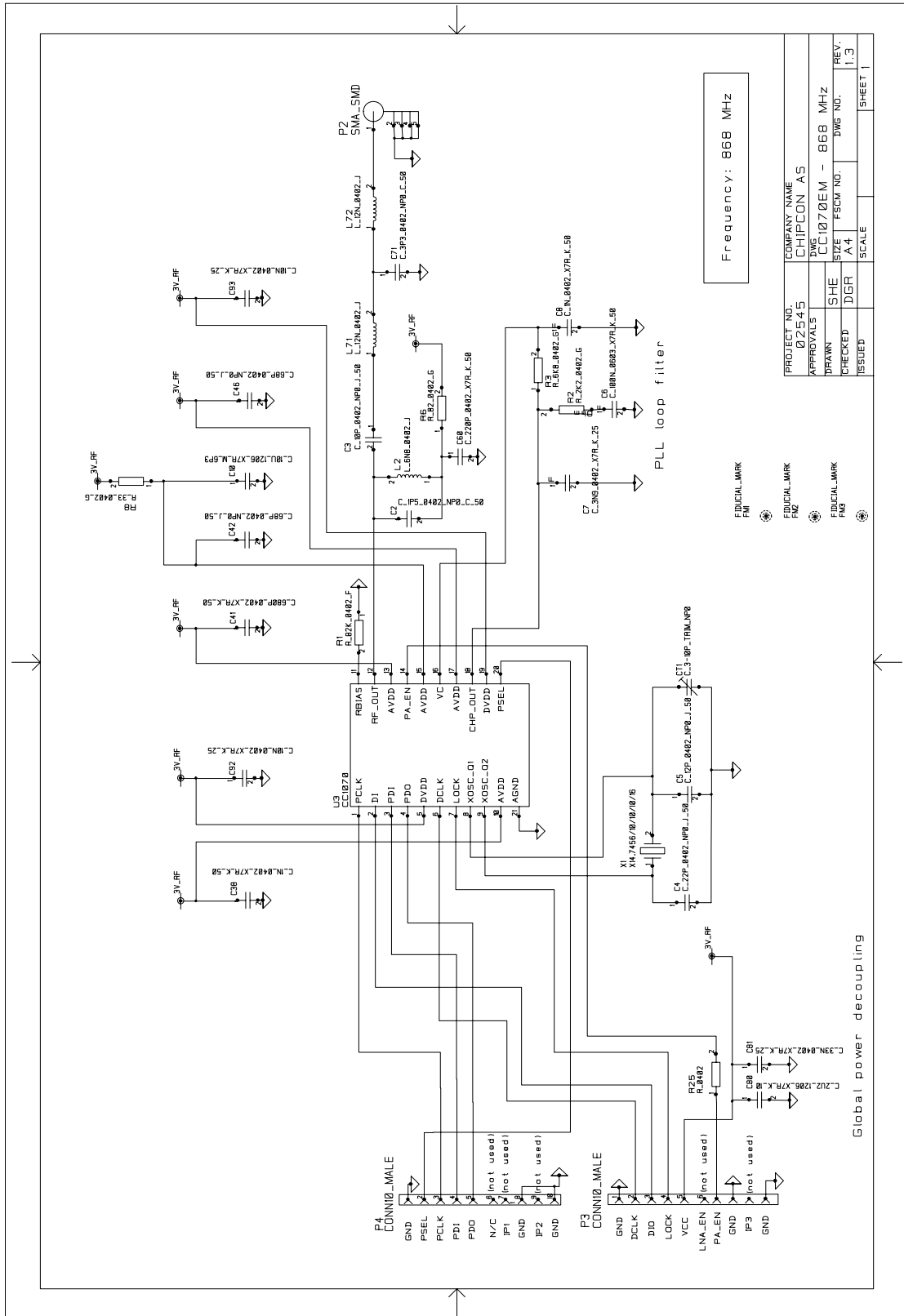


**Figure 15. CC1070EM-433 MHz schematic**

### CC1070EM-433 Bill of Materials

RF part 433 MHz			
Reference	Description	Value	Part
C2	Capacitor 0402	2.2 pF	C_2P2_0402_NP0_C_50
C3	Capacitor 0402	5.6 pF	C_5P6_0402_NP0_J_50
C4	Capacitor 0402	22 pF	C_22P_0402_NP0_J_50
C5	Capacitor 0402	12 pF	C_12P_0402_NP0_J_50
C6	Capacitor 0603	220 nF	C_220N_0603_X7R_K_50
C7	Capacitor 0402	8.2 nF	C_8N2_0402_X7R_K_25
C8	Capacitor 0402	2.2 nF	C_2N2_0402_X7R_K_25
C10	Capacitor 1206	10 uF	C_10U_1206_X7R_M_6P3
C38	Capacitor 0402	1 nF	C_1N_0402_X7R_K_50
C41	Capacitor 0402	47 pF	C_47P_0402_NP0_J_50
C42	Capacitor 0402	68 pF	C_68P_0402_NP0_J_50
C46	Capacitor 0402	68 pF	C_68P_0402_NP0_J_50
C60	Capacitor 0402	220 pF	C_220P_0402_X7R_K_50
C71	Capacitor 0402	4.7 pF	C_4P7_0402_NP0_J_50
C80	Capacitor 1206	2.2 uF	C_2U2_1206_X7R_K_10
C81	Capacitor 0402	33 nF	C_33N_0402_X7R_K_25
C92	Capacitor 0402	10 nF	C_10N_0402_X7R_K_25
C93	Capacitor 0402	10 nF	C_10N_0402_X7R_K_25
CT1	Trimmer Capacitor		C_3-10P_TRIM_NP0
L2	Inductor 0402	22 nF	L_22N_0402_J
L71	Inductor 0402	47 nF	L_47N_0402_J
L72	Inductor 0402	47 nF	L_47N_0402_J
P2	Surface-mount SMA, straight		SMA_SMD
P3	Connector, 0.9mm pin, male		CONN10_MALE
P4	Connector, 0.9mm pin, male		CONN10_MALE
R1	Resistor 0402	82 kΩ	R_82K_0402_F
R2	Resistor 0402	1.5 kΩ	R_1K5_0402_G
R3	Resistor 0402	4.7 kΩ	R_4K7_0402_G
R6	Resistor 0402	82 Ω	R_82_0402_G
R8	Resistor 0402	33 Ω	R_33_0402_G
R25	Resistor 0402		Not used
U3	Single chip transmitter		CC1070
X1	Crystal, HC-49-SMD		X14.7456/10/10/10/16

**CC1070EM-868/915 schematic**



**Figure 16. CC1070EM-868/915 MHz schematic**

**CC1070EM-868/915 bill of materials**

RF part 868 MHz			
Reference	Description	Value	Part
C2	Capacitor 0402	1.5 pF	C_1P5_0402_NP0_C_50
C3	Capacitor 0402	10 pF	C_10P_0402_NP0_J_50
C4	Capacitor 0402	22 pF	C_22P_0402_NP0_J_50
C5	Capacitor 0402	12 pF	C_12P_0402_NP0_J_50
C6	Capacitor 0603	100 nF	C_100N_0603_X7R_K_50
C7	Capacitor 0402	3.9 nF	C_3N9_0402_X7R_K_25
C8	Capacitor 0402	1 nF	C_1N_0402_X7R_K_50
C10	Capacitor 1206	10 uF	C_10U_1206_X7R_M_6P3
C38	Capacitor 0402	1 nF	C_1N_0402_X7R_K_50
C41	Capacitor 0402	680 pF	C_680P_0402_X7R_K_50
C42	Capacitor 0402	68 pF	C_68P_0402_NP0_J_50
C46	Capacitor 0402	68 pF	C_68P_0402_NP0_J_50
C60	Capacitor 0402	220 pF	C_220P_0402_X7R_K_50
C71	Capacitor 0402	3.3 pF	C_3P3_0402_NP0_J_50
C80	Capacitor 1206	2.2 uF	C_2U2_1206_X7R_K_10
C81	Capacitor 0402	33 nF	C_33N_0402_X7R_K_25
C92	Capacitor 0402	10 nF	C_10N_0402_X7R_K_25
C93	Capacitor 0402	10 nF	C_10N_0402_X7R_K_25
CT1	Trimmer Capacitor		C_3-10P_TRIM_NP0
L2	Inductor 0402	6.8 nH	L_6N8_0402_J
L71	Inductor 0402	12 nH	L_12N_0402_J
L72	Inductor 0402	12 nH	L_12N_0402_J
P2	Surface-mount SMA, straight		SMA_SMD
P3	Connector, 0.9mm pin, male		CONN10_MALE
P4	Connector, 0.9mm pin, male		CONN10_MALE
R1	Resistor 0402	82 kΩ	R_82K_0402_F
R2	Resistor 0402	2.2 kΩ	R_2K2_0402_G
R3	Resistor 0402	6.8 kΩ	R_6K8_0402_G
R6	Resistor 0402	82 Ω	R_82_0402_G
R8	Resistor 0402	33 Ω	R_33_0402_G
R25	Resistor 0402		Not used
U3	Single chip transmitter		CC1070
X1	Crystal, HC-49-SMD		X14.7456/10/10/10/16

C1070EM Assembly Drawings

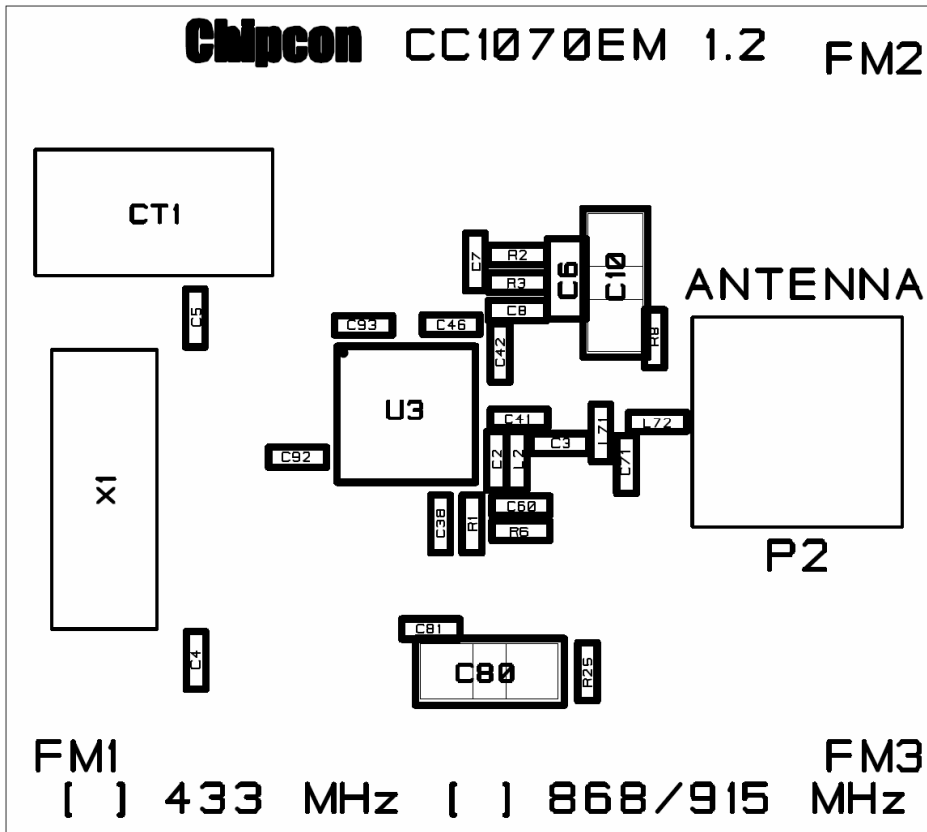


Figure 17. CC1070EM PCB top level assembly drawing

CC1070EM Layout

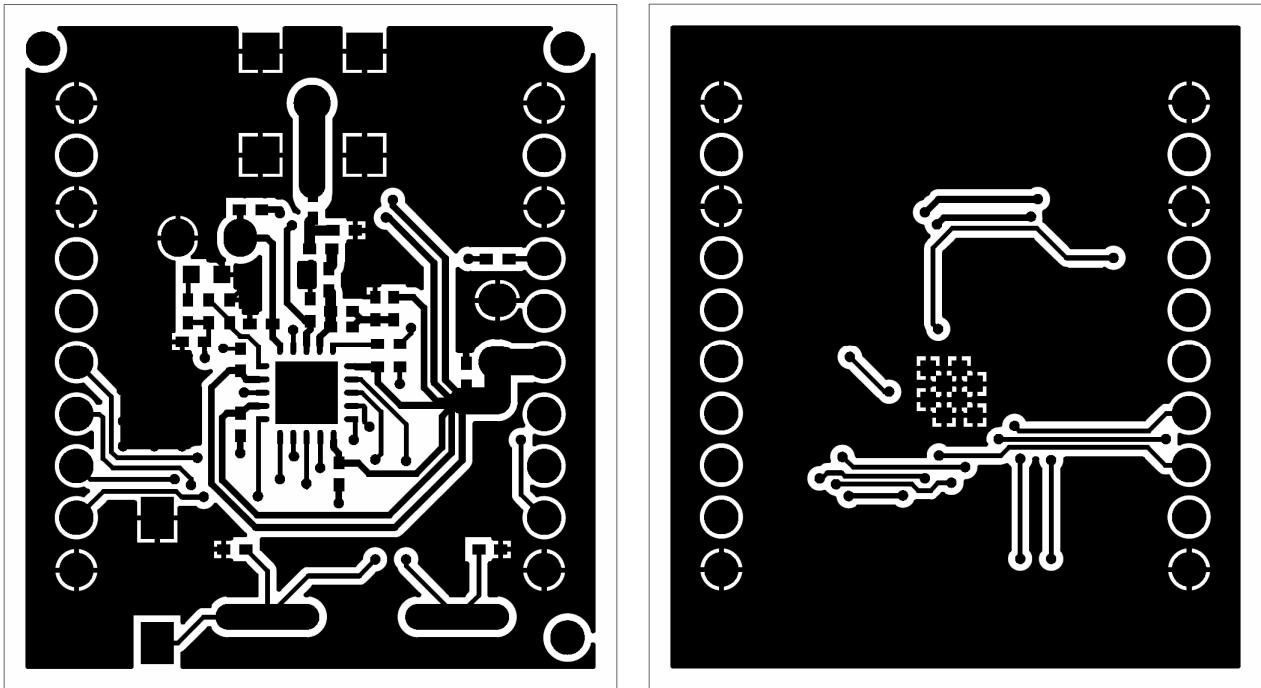


Figure 18. CC1070EM PCB layout. Layer 1 (top) and Layer 2 (bottom)

## Using the CC1020/1070DK Development Kit

The purpose of the CC1020/1070DK development kit is to give users of the integrated CC1020 transceiver and CC1070 transmitter hands-on experience with the chips. Typical set-ups of the CC1020/1070DK are shown in Figure 19 and Figure 20. Each of the CC1020EB evaluation boards is connected to a PC to be programmed by the SmartRF® Studio software.

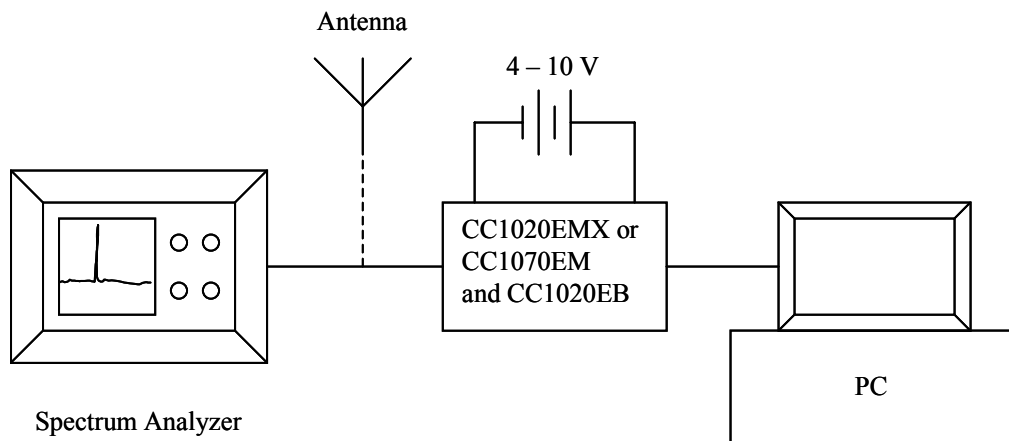
### How to set up a transmitter (CC1020 and CC1070)

The data signal that you want to send in transmit mode can be of either Manchester or NRZ code.

The CC1020 and CC1070 have a built-in test pattern generator that generates a PN9 pseudo random bit sequence. The *PN9\_ENABLE* bit in the *MODEM* register enables the PN9 generator. Please refer to the CC1020 and CC1070 data sheets for further details.

The PN9 generator can be used for transmission of 'real-life' data when measuring narrow-band ACP (Adjacent Channel Power), modulation bandwidth or occupied bandwidth.

The transmitted signal can be studied on a spectrum analyser, sent out on the antenna (see note below) or sent to the receiver via a cable with an attenuator attached.

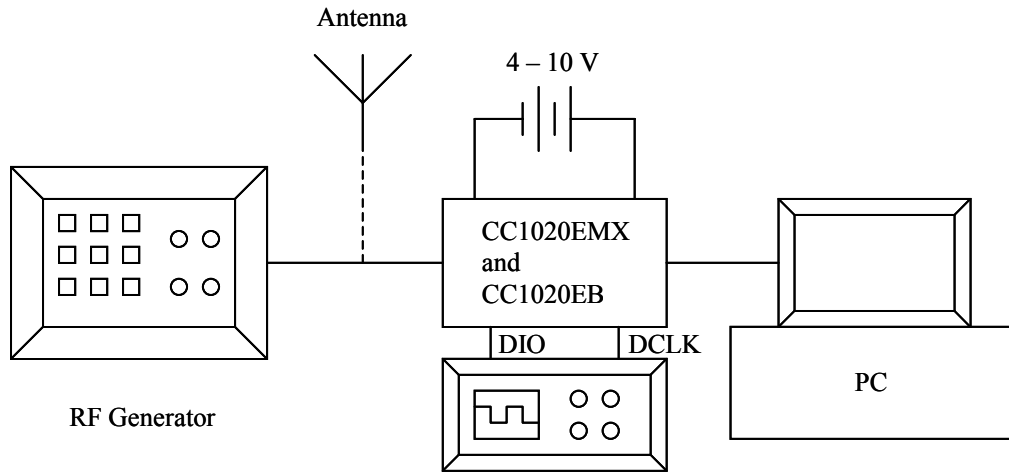


**Figure 19. Equipment set-up in transmit mode**

### How to set up a receiver (CC1020)

With CC1020 in receive mode an RF generator can be connected to the antenna input to provide an ideal RF signal to the circuit board for testing the receiver. Use FSK modulation with appropriate deviation and modulation rate. If you do not have the equipment to send FSK modulation, you can use an RF generator with FM modulation and use an external function generator to modulate the signal with a square wave. If you are in NRZ or UART mode the modulating signal should be equal to the bitrate/2 (= baudrate/2) when sending alternating 0's and 1's. If you are in Manchester mode the modulating frequency should be equal to bitrate/2 (= baudrate/4) when sending alternating 0's and 1's. The RF signal can also come from the transmitter via the antenna. An oscilloscope can be used to observe the signal that is being received.

CC1020 has a built-in feature called AFC (Automatic Frequency Control) that can be used to compensate for frequency drift. The average frequency offset of the received signal (from the nominal IF frequency) can be read in the *AFC* register and can be used to compensate for frequency offsets between transmitter and receiver. Monitor the AFC value and change the RF generator frequency until AFC is close to 0 Hz.



**Figure 20. Equipment set-up in receive mode**

**Important:** The use of radio transceivers is regulated by international and national rules. Before transmitting an RF signal onto the air using an antenna, please contact your local telecommunication authorities to check if you are licensed to operate the transceiver or transmitter.

## General Information

### Document Revision History

Revision	Date	Description/Changes
2.0	November 2004	CC1020EMX reference design changed from 4 layer PCB to 2 layer PCB

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