CC112x/CC1175/CC120x Operation in 274-320 MHz Frequency Band

By Charlotte Stephansen

Keywords

- *FCC Section 15.231*
- *CC1120*
- *CC1121*
- *CC1125*
- *CC1175*
- *CC120x*

1 Introduction

The CC1120 is a fully integrated single-chip radio transceiver designed for high performance at very low power and low voltage operation in cost effective wireless systems. The CC1120 provides extensive hardware support for packet handling, data buffering, burst transmissions, clear channel assessment, link quality indication and Wake-On- Radio.

This application note outlines the expected performance when using the CC1120EM 274-320 MHz reference design (see Section 6). The CC1120 can be used in applications targeting compliance with FCC section 15.231. This application note assumes the reader is familiar with CC1120 and FCC 15.231 regulatory requirements. The reader is referred to [1] and [2] for details.

The application note is also applicable for CC1121, CC1125, CC1175 (TX part only), and CC120x.

Table of Contents

2 Abbreviations

FCC	Federal Communications Commission
EM	Evaluation Module
RX	Receive, Receive Mode
TX	Transmit, Transmit Mode
BER	Bit Error Rate
RF	Radio Frequency
BOM	Bill of Material

3 Absolute Maximum Ratings

The absolute maximum ratings and operating conditions listed in the CC1120 datasheet [1] must be followed at all times. Stress exceeding one or more of these limiting values may cause permanent damage to the device.

4 Electrical Specifications

Note that the characteristics given in Chapter 4 are only valid when using the CC1120EM 274-320 MHz reference design (see Section 6) with a 50 Ω load and register settings recommended by the SmartRF Studio software [3]. T_C = 25°C, VDD = 3.0 V and f = 315 MHz if nothing else is stated.

4.1 Operating Conditions

Parameter	Min	Max	Unit
Operating Frequency[1]	274	320	MHz
Operating Supply Voltage	2.0	3.6	V
Operating Temperature	-40	+85	°C

Table 4.1. Operating Conditions

4.2 Current Consumption

Parameter	Condition	Typical	Unit
RX Peak Current	1.2 kbps, Reception at the Sensitivity Level	22.5	mA
Transmit Current[2]	PA_CFG2 = 0x7F (+16 dBm) PA_CFG2 = 0x7A (+15 dBm) PA_CFG2 = 0x68 (+10 dBm) PA_CFG2 = 0x5C (+5 dBm) PA_CFG2 = 0x51 (0 dBm) PA_CFG2 = 0x46 (-5 dBm) PA_CFG2 = 0x42 (-20 dBm)	53 50 34 27 23 21 19	mA

Table 4.2. Current Consumption

[1] There will be spurious signals at n/2·crystal oscillator frequency (n is an integer number). RF frequencies at n/2·crystal oscillator frequency should therefore be avoided.
[2] The CC1120 RF output power is controlled by the 6 bit value in the PA_CFG2[5:0] register. The power settings are a small subset of all the possible PA register settings.

4.3 Receive Parameters

Parameter	Condition	Typical	Unit
Sensitivity, High Performance Mode[3]	1.2 kbps, 2FSK, ±4 kHz deviation, 10 kHz channel filter. See Figure 4.1.	-124	dBm
	38.4 kbps, 2GFSK[4], ±20 kHz deviation, 100 kHz channel filter. See Figure 4.2.	-111	dBm
	200 kbps, 4GFSK[3], ±83 kHz deviation (outer symbols), 200 kHz channel filter. See Figure 4.3.	-104	dBm
Selectivity and Blocking	1.2 kbps, 2FSK, ±4 kHz deviation, 10 kHz channel filter. Wanted signal 3 dB above the sensitivity level. Unmodulated interferer. See Figure 4.4 and Figure 4.5. ±12.5 kHz from wanted signal ±25 kHz from wanted signal ±1 MHz from wanted signal ±2 MHz from wanted signal ±10 MHz from wanted signal	 60 61 81 84 86	 dB

Table 4.3. Receive Parameters

4.4 Transmit Parameters

Parameter	Condition	Typical	Unit
Output power	PA_CFG2 = 0x7F PA_CFG2 = 0x7A PA_CFG2 = 0x68 PA_CFG2 = 0x5C PA_CFG2 = 0x51 PA_CFG2 = 0x46 PA_CFG2 = 0x42	+16 +15 +10 +5 0 -5 -20	dBm
Harmonics and Spurious Emission with PA_CFG2 = 0x7F	Conducted Harmonics except 2nd and 3rd Conducted 2nd Harmonic Conducted 3rd Harmonic	< -54 33 -54	dBm dBc dBm

Table 4.4. Transmit Parameters

[3] Sensitivity limit is defined as 1% bit error rate (BER). RF frequencies at n/2·crystal oscillator frequency (n is an integer number) should be avoided due to spurious signals at these frequencies which could lead to degraded sensitivity.
[4] BT = 0.5 used in all GFSK measurements

4.5 Typical RX Performance

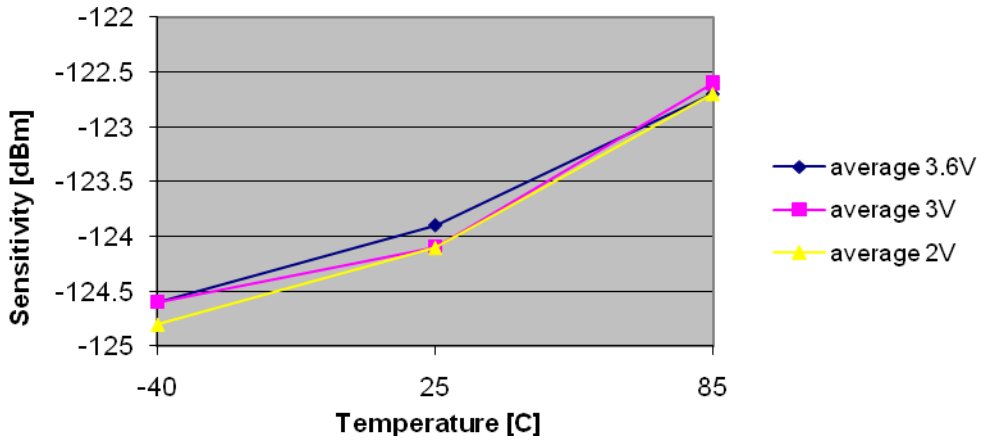

Figure 4.1. Typical Sensitivity vs. Temperature and Power Supply Voltage, 1.2 kbps

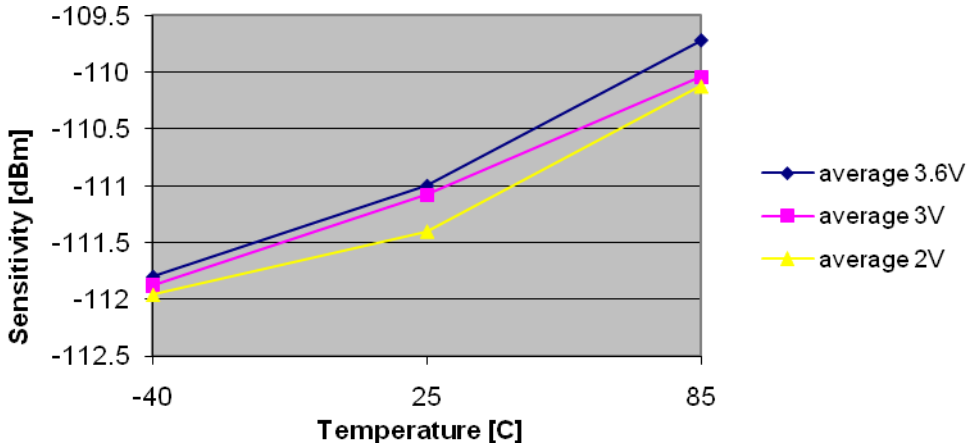

Figure 4.2. Typical Sensitivity vs. Temperature and Power Supply Voltage, 38.4 kbps

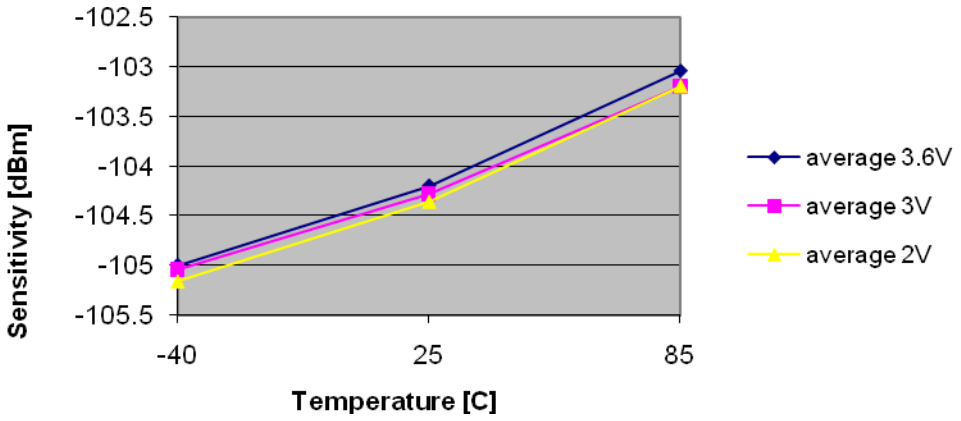

Figure 4.3. Typical Sensitivity vs. Temperature and Power Supply Voltage, 200 kbps

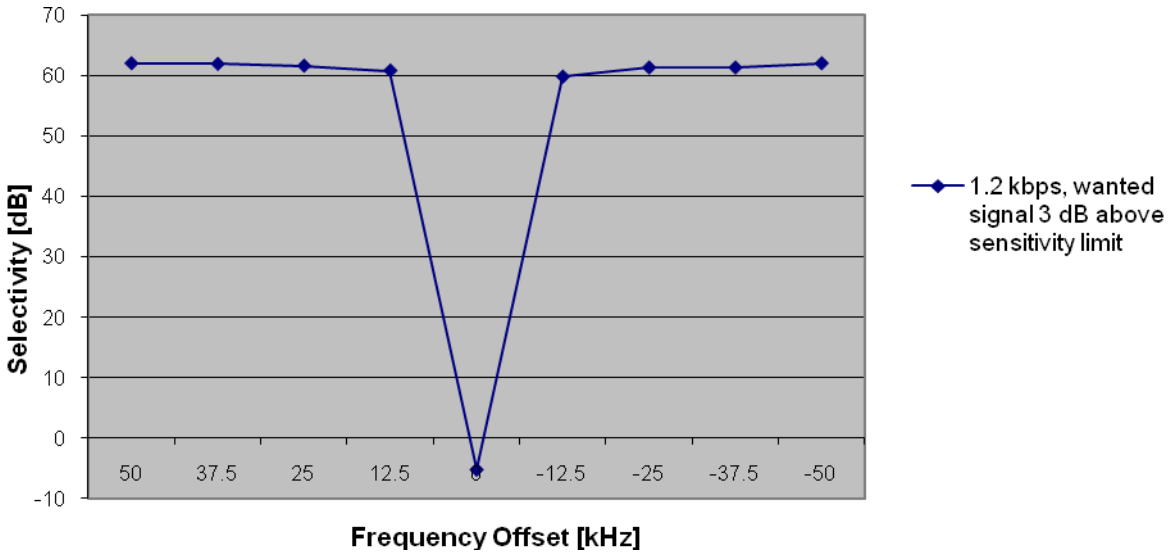

Figure 4.4. Typical Selectivity, 1.2 kbps, Unmodulated Interferer

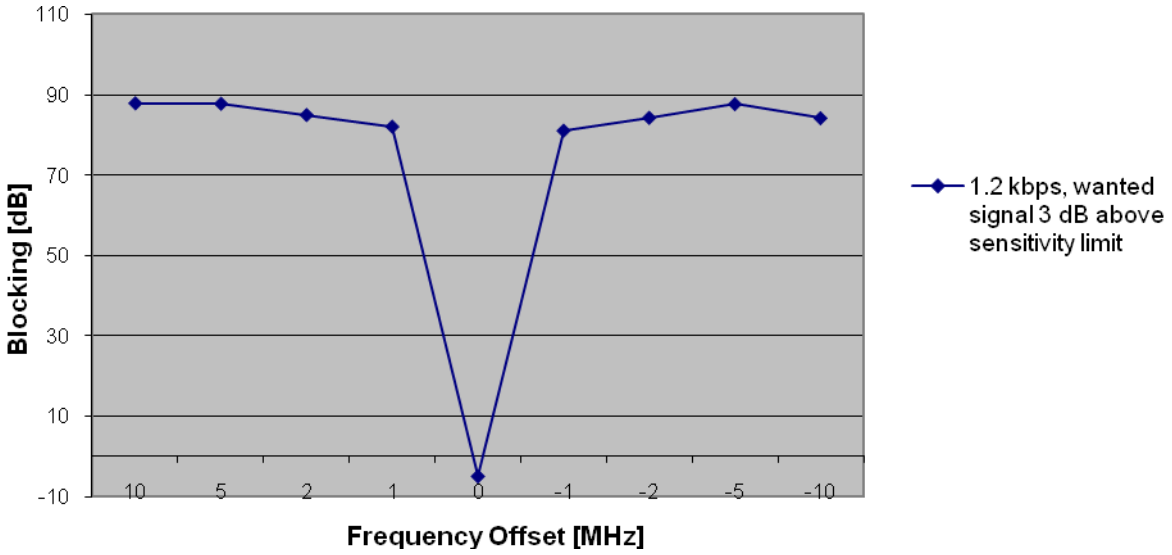

Figure 4.5. Typical Blocking 1.2 kbps, Unmodulated Interferer

4.6 Typical TX Performance

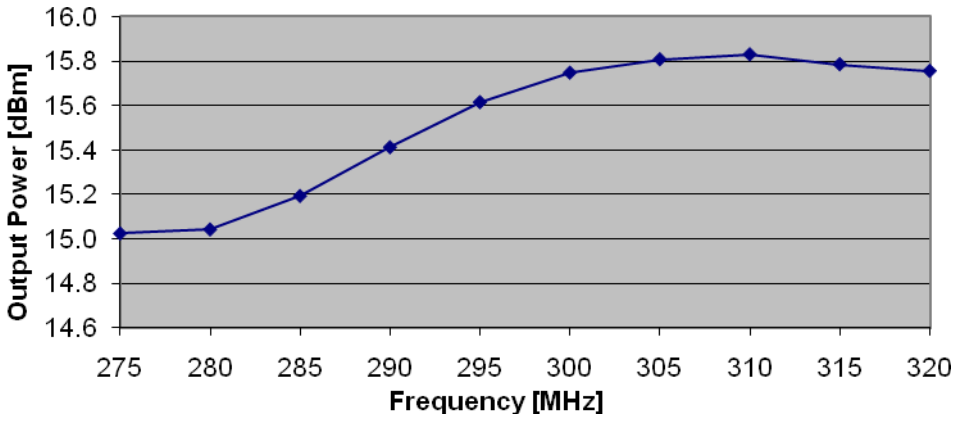

Figure 4.6. Typical Output Power vs. Frequency. PA_CFG2 = 0x7F

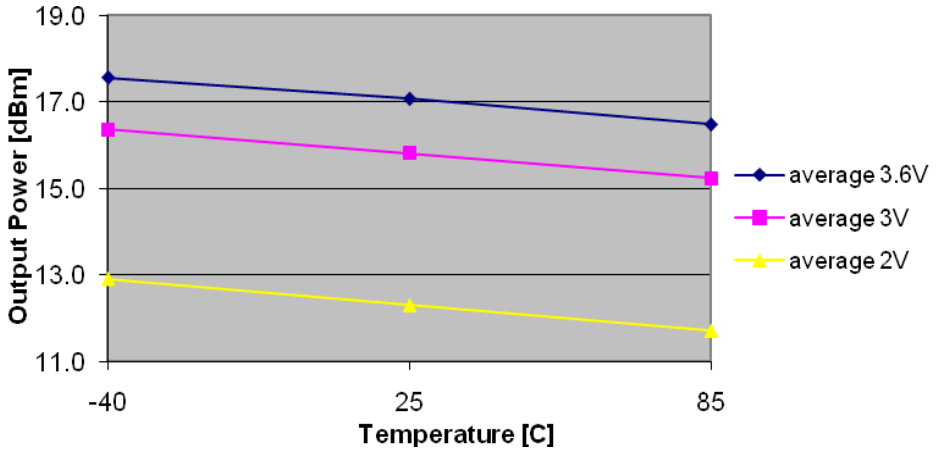

Figure 4.7. Typical Output Power vs. Temperature and Power Supply Voltage. PA_CFG2 = 0x7F

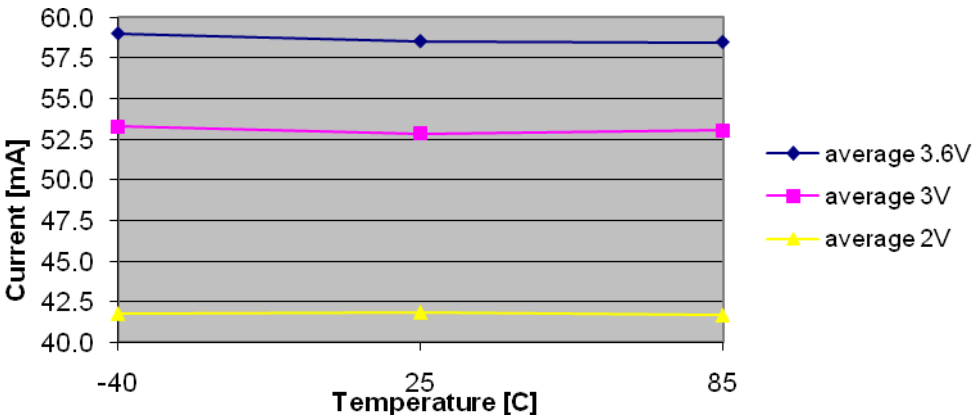

Figure 4.8. Typical TX Current vs. Temperature and Power Supply Voltage. PA_CFG2 = 0x7F

5 FCC Part 15.231

In the US, the Federal Communications Commission (FCC) regulates the use of frequencies for wireless communication. The FCC rules and regulations are codified in Title 47 of the Code of Federal Regulations (CFR). Part 15 of this code applies to radio frequency devices operating at unlicensed frequencies and is often colloquially referred to as *FCC Part 15*. This section gives a short summary of FCC section 15.231 regulatory requirements. For more in depth information refer to FCC rules (www.fcc.gov) [2] and [4].

The EIRP limits for the fundamental frequency according to FCC section 15.231 are given Figure 5.1. Section 15.231(a) defines control applications. Other periodic applications fall under section 15.231(e). As an example, 15.231(a) and 15.231(e) limit the output power at 315 MHz to -19.6 dBm and -27.6 dBm respectively.

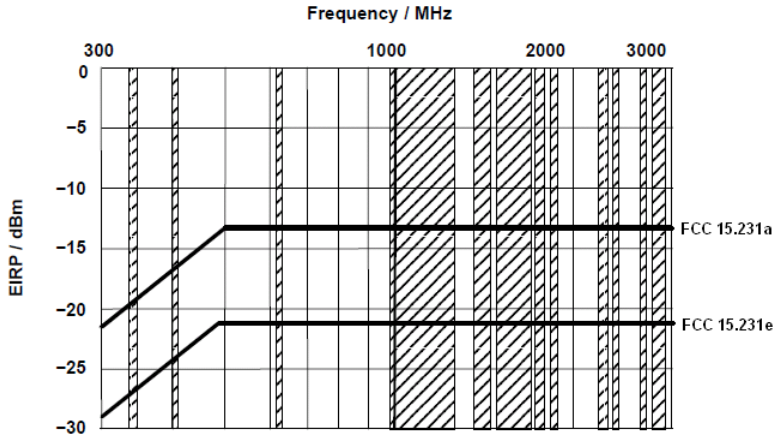

Figure 5.1. EIRP Limits According to Section 15.231 and Restricted Bands According to Section 15.205

With pulsed transmissions, it may be possible to transmit at power levels above the prescribed limits given by section 15.231. This is because an averaging detector is called for in the measurements. The averaging window of this detector is 100 ms. If the transmission burst is less than 100 ms, the transmit power can be increased by 20·log(100 ms/TX on-time), up to a maximum increase of 20 dB.

As an example, if the transmit duration in any 100 ms window is maximum 10 ms you can transmit up to -19.6 dBm + 20*log(100/10) = +0.4 dBm output power under 15.231(a) at 315 MHz .

The spurious emission limit, when operating in the frequency bands defined by section 15.231, must be at least 20 dB below the fundamental unless it falls within one of the restricted bands defined in section 15.205 (see shaded areas in Figure 5.1). The spurious emissions that falls within the restricted bands defined in section 15.205 must fulfil the spurious emission limits given in section 15.209, see Table 5.1.

Frequency	Electrical Field Strength	Corresponding EIRP
30 ... 88 MHz	100 µV/m	– 55.2 dBm
88 ... 216 MHz	150 µV/m	– 51.7 dBm
216 ... 960 MHz	200 µV/m	–49.2 dBm
> 960 MHz	500 µV/m	–41.2 dBm

Table 5.1. Spurious Emission Limits According to Section 15.209

6 CC1120EM 274-320 MHz Reference Design

The CC1120EM 274-320 MHz reference design is based on the CC1120EM 420-470 MHz reference design [5] with changes to component values in the TX and RX path only. The changes in the BOM are described in Table 6.1 and also shown in Figure 6.1. For the full schematic design and also the recommended layout, please refer to the CC1120EM 420-470 MHz [5]. The reference design also includes the gerber files. It is highly recommended to follow the reference design for optimum performance.

Component	CC1120EM 420-470 MHz BOM	CC1120EM 274-320 MHz BOM
L191	56nH +/- 5%, 0402, Murata LQW15xx series	82nH +/- 5%, 0402, Murata LQW15xx series
L192, L201	27nH +/- 5%, 0402, Murata LQW15xx series	56nH +/- 5%, 0402, Murata LQW15xx series
L193	15nH +/- 5%, 0402, Murata LQW15xx series	27nH +/- 5%, 0402, Murata LQW15xx series
C181, C191, C201	5.1pF +/- 0.25%, 0402 NPO, Murata GRM1555C series	6.8pF +/- 0.25%, 0402 NPO, Murata GRM1555C series

Table 6.1. BOM CC1120EM 274-320 MHz vs. CC1120EM 420-470 MHz

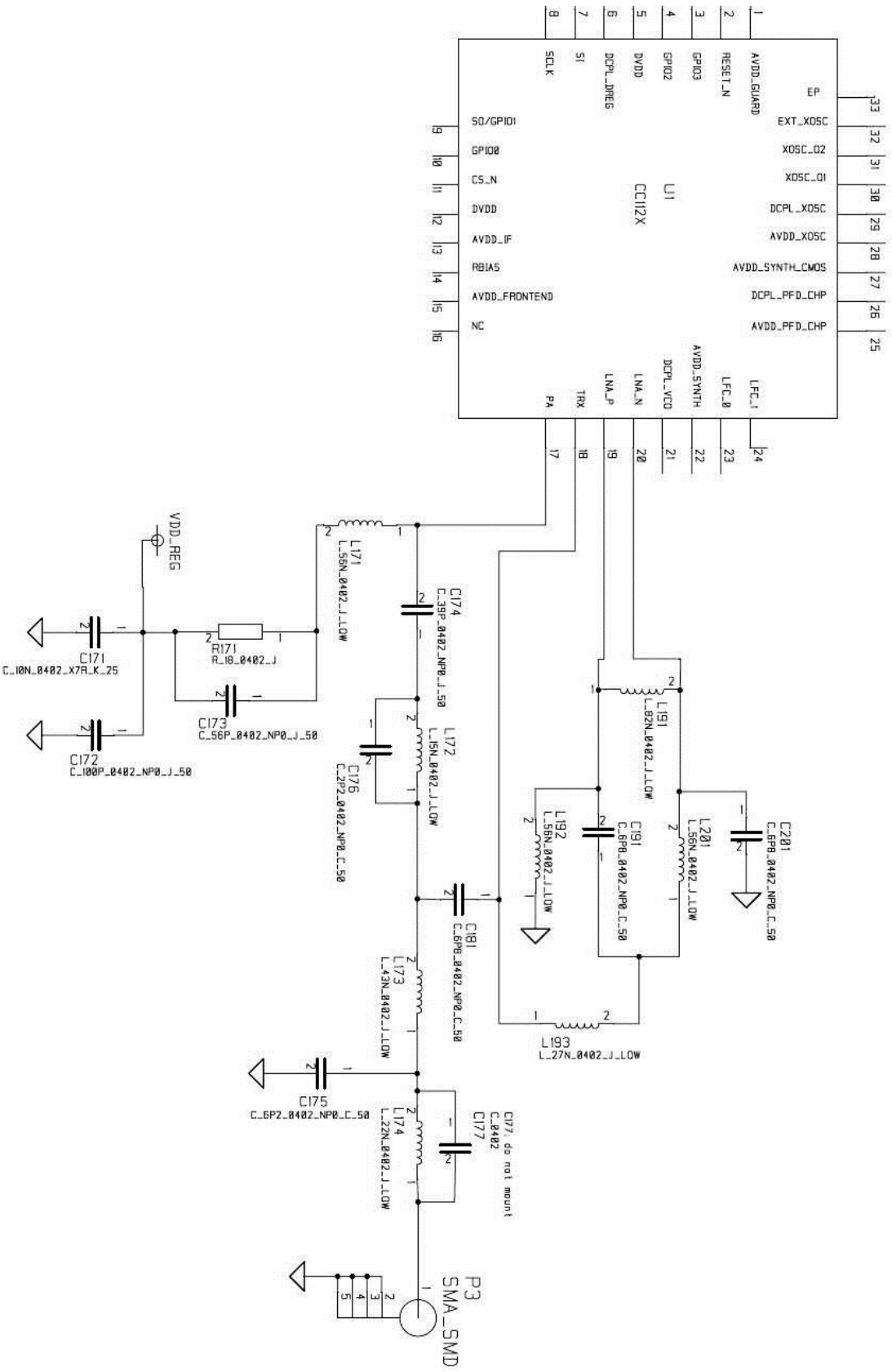

Figure 6.1. CC1120EM 274-320 MHz Schematic, TX and RX path only

7 Disclaimer

The CC1120EM 274-320 MHz reference design is intended for use for ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY and is not considered by TI to be a finished end-product fit for general consumer use. Persons using the reference design must have electronics training and observe good engineering practice standards. This reference design has been tested against FCC section 15.231, but there has been no formal compliance testing at an external test house. It is the end user's responsibility to ensure that his system complies with applicable regulations.

8 References

[1] CC1120 Datasheet (SWRS112.pdf)

[2] FCC rules (www.fcc.gov)

[3] SmartRF™ Studio 7 (SWRC176.zip)

[4] ISM-Band and Short Range Device Regulatory Compliance Overview (SWRA048.pdf)

[5] CC1120EM 420-470 MHz Reference Design (SWRC221.zip)

9 General Information

9.1 Document History

Revision	Date	Description/Changes
SWRA398	2012.06.08	Initial release.
SWRA398A	2013.06.13	Added CC120x to the list of devices

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