Application Report
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CC1190 Evaluation Module for 868 MHz

Torstein Ermesjø

ABSTRACT

The CC1190 is a range extender for 850-950 MHz RF transceivers, transmitters, and wireless microcontrollers (MCUs). It increases the link budget by providing a power amplifier (PA) for increased output power and a low-noise amplifier (LNA) with low noise figure for improved receiver sensitivity, in addition to switches and RF matching for simple design of high performance wireless systems.

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1 Absolute Ratings

The absolute maximum ratings and operating conditions listed in the CC1190 data sheet [1] must be followed at all times. Stress exceeding one or more of these limiting values may cause permanent damage to any of the devices.

2 Operating Conditions

Table 1. Operating Conditions

Parameter	Min	Max	Unit
Operating Frequency	850	950	MHz
Operating Supply Voltage	2.0	3.7	V
Operating Temperature	-40	+85	°C

3 Electrical Characteristics

Table 2. Electrical Characteristics With SAW Filter in Rx and Tx Path

Parameter	Test Conditions	Typ	Unit
T_c=25°C, V_{DD} = 3 V, f_{RF} = 869.525 MHz, HGM = '1' unless otherwise noted.			
Receive current	P_{IN} = -40 dBm	3.7	mA
Transmit current	P_{IN} = 10 dBm, P_{OUT} = 25.5 dBm	358	mA
	P_{IN} = 13 dBm, P_{OUT} = 25.8 dBm	379	mA
RF Receive with SAW filter			
Gain P_{IN}= -40 dBm		7.1	dB
Gain variation over power supply	2.0 V – 3.6 V, P_{IN} = -40 dBm	0.5	dB
RF Transmit with SAW filter			
Gain	P_{IN} = -20 dBm	23	dB
Maximum output power	P_{IN} = 13 dBm, V_{DD} = 3.6 V	27	dBm
Output power, P_{OUT}	P_{IN} = -10 dBm	13.5	dBm
	P_{IN} = 0 dBm	22.4	dBm
	P_{IN} = 6 dBm	24.9	dBm
	P_{IN} = 10 dBm	25.5	dBm
	P_{IN} = 13 dBm	25.8	dBm
Power Added Efficiency, PAE	P_{IN} = 10 dBm	30	%
Output power variation over power supply	2.0 V – 3.6 V, P_{IN} = 10 dBm	5.1	dB
Output power variation over temperature	-40° - 85°, P_{IN} = 10 dBm	1.8	dB
Second harmonic power	P_{IN} = 13 dBm	-38	dBm
Third harmonic power	P_{IN} = 13 dBm	-42	dBm

Table 3. Electrical Characteristics Without SAW Filter in Rx and Tx Path

Parameter	Test Conditions	Typ	Unit
T_c=25°C, V_{DD} = 3 V, f_{RF} = 869.525 MHz, HGM = '1' unless otherwise noted.			
Receive current	P_{IN} = -40 dBm	3.7	mA
Transmit current	P_{IN} = 10 dBm, P_{OUT} = 25.5 dBm	375	mA
RF Receive without SAW filter			
Gain	P_{IN}= -40 dBm	10.5	dB
Gain variation over power supply	2.0 V – 3.6 V, P_{IN} = -40 dBm	0.5	dB
RF Transmit without SAW filter			
Gain	P_{IN} = -20 dBm	25.7	dB
Maximum output power	P_{IN} = 13 dBm, V_{DD} = 3.6 V	26.9	dBm
Output power, P_{OUT}	P_{IN} = -10 dBm	15.7	dBm
	P_{IN} = 0 dBm	23.4	dBm
	P_{IN} = 6 dBm	25.1	dBm
	P_{IN} = 10 dBm	25.5	dBm
Power added efficiency, PAE	P_{IN} = 10 dBm	30	%
Output power variation over power supply	2.0 V – 3.6 V, P_{IN} = 10 dBm	5.1	dB
Output power variation over temperature	-40° - 85°, P_{IN} = 10 dBm	1.8	dB
Second harmonic power	P_{IN} = 10 dBm	-38	dBm
Third harmonic power	P_{IN} = 10 dBm	-41	dBm

When a SAW filter is used the input power to the board could be higher than without due to the attenuation in the SAW filter. Max input power on the CC1190 pins is 10 dBm.

The Tx measurements were done with a signal generator. The harmonics are then generated by the CC1190 PA going into compression and the SAW filter at the input will not influence this.

4 Design Details

For information on the schematic, see Appendix A.

- You can select whether an SMA (mount R21) or a PCB antenna (mount R22) should be used as output.
- J1 (SMA connector) is intended to be used as input when a SAW filter is needed at the PA input/LNA output. This is dependent on the phase noise of the device using CC1190 as a PA in Tx and the blocking requirements for the system in Rx. (1)
- J2 (SMA connector) should be used when a SAW filter is not needed.
- R103 can be removed in cases where PA_IN and LNA_OUT are used independent of each other.
- C111 and L111 are added to provide better matching to the selected SAW filter.
- The mounted SAW filter has a center frequency equal to 869 MHz.
- The shield is required to pass radiated testing.
- In a final product, it is recommended to consider system ESD protection and, as a minimum, add an ESD diode to the antenna input if it is possible for you to touch the antenna.

(1) The maximum output power depends on the regulation the system has to comply to and the modulation, frequency, data rate and phase noise of the source used as input to the CC1190 PA.

5 Radiated Performance

For radiated testing, it is possible to use either an external antenna connected to the SMA connector or the PCB antenna.

The radiated performance was tested in an anechoic chamber with the W5017 antenna from Pulse, which is part of the CC1120DK, as well the PCB antenna. The PCB antenna is tuned to resonate @869 MHz when the board is positioned in RF neutral surroundings. The antenna needs to be retuned in a final product as the board surroundings (for example, plastic enclosure, casing) will detune the antenna. The efficiency of the PCB antenna is dependent on the size of the ground plane and efficiency equal to [3] is possible given a ground plane with dimensions larger than ¼ wave length.

A +7.2 dBm CW was applied from a signal generator directly to the CC1190 input. With the W5017 antenna, this gave 24.7 dBm total radiated power; for the PCB antenna, the total radiated power is 21.0 dBm. In both cases, the second and third harmonics are below –30 dBm.

6 Control Pins

The three digital control pins (PA_EN, LNA_EN, HGM) have built-in level-shifting functionality, meaning that if CC1190 is operating from a 3.6 V supply voltage, the control pins will still sense > 1.6 V signals as logical '1'.

Table 4. CC1190 Control Pins

PA_EN	LNA_EN	HGM	Mode of operation
0	0	Don't care	Power down
0	1	0	Rx Low Gain Mode
0	1	1	Rx High Gain Mode
1	0	0	Tx Low Gain Mode
1	0	1	Tx High Gain Mode

7 References

1. *CC1190 850–950 MHz RF Front End Data Sheet* (SWRS089)
2. ETSI EN 300 220-1 v2.4.1: http://www.etsi.org/deliver/etsi_en/300200_300299/30022001/02.04.01_60/en_30022001v020401p.pdf
3. *Miniature Helical PCB Antenna for 868 MHz or 915/920 MHz*: http://www.ti.com/lit/an/swra416/swra416.pdf

Schematic

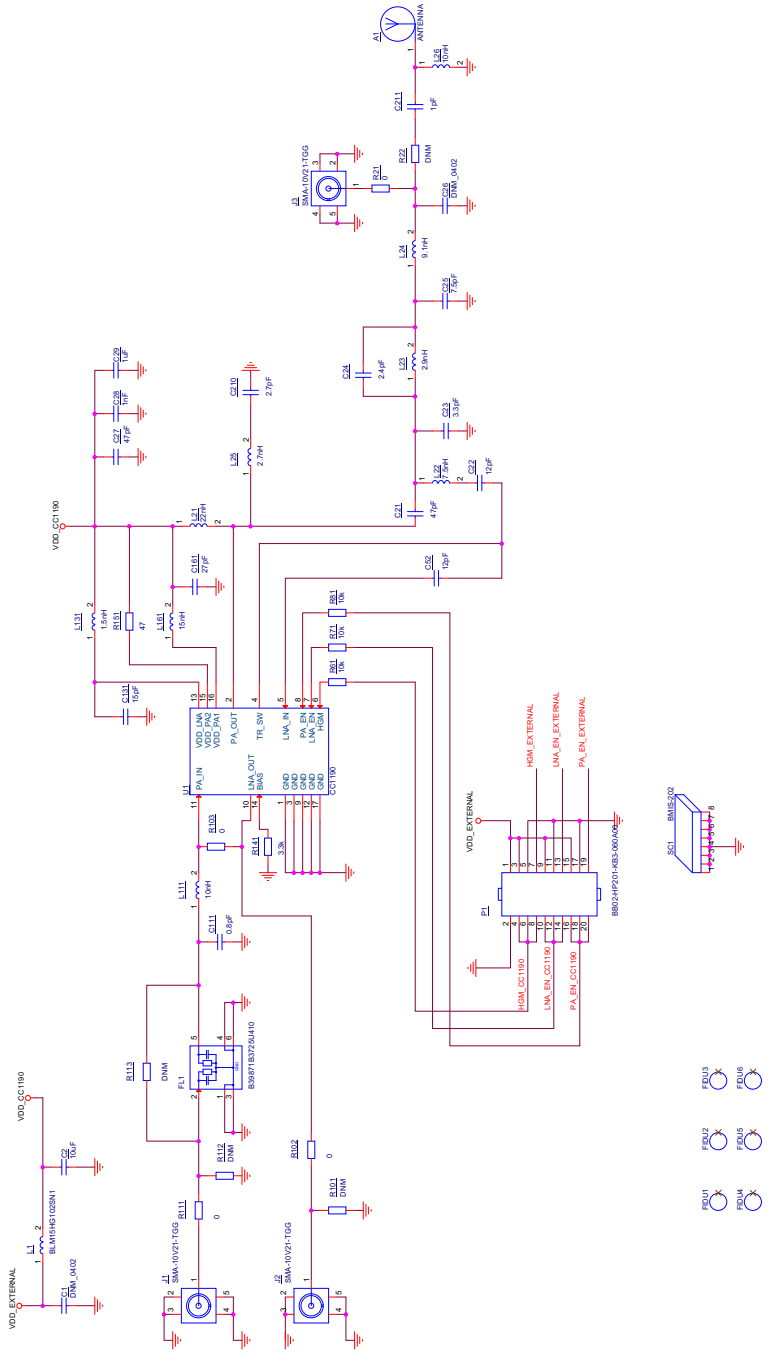

Figure 1. CC1190EM_868 MHz Schematic

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