Application Report

SWRA393C–June 2013

AN112 - Using the CC1190 Front End With CC112x and CC120x Under EN 300 220

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ABSTRACT

This application report outlines the expected performance when using a CC1120-CC1190 design under EN 300 220-1 V2.3.1 [5] in the 869.4-869.65 MHz frequency sub-band (g3). The maximum allowed output power in the 869.4-869.65 MHz sub-band is +27 dBm (500 mW).

For details on the regulatory limits in the 863-870 MHz SRD frequency bands, see the ETSI EN 300 220-1 V2.3.1 [5] and ERC recommendation 70-03 [6] that can be downloaded from www.etsi.org and www.ero.dk.

The application report is also applicable to CC1121, CC1125, and CC120x.

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1 Introduction

The CC112x family of devices is fully integrated single-chip radio transceivers designed for high performance at very low power and low-voltage operation in cost effective wireless systems. All filters are integrated, removing the need for costly external IF filters. The device is mainly intended for the Industrial, Scientific and Medical (ISM) and Short Range Device (SRD) frequency bands at 164-192 MHz, 410-480 MHz and 820-960 MHz.

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

Table 1. Abbreviations

EB	Evaluation Board
EVM	Evaluation Module
HGM	High Gain Mode
LNA	Low Noise Amplifier
LGM	Low Gain Mode
PA	Power Amplifier
PCB	Printed Circuit Board
PER	Packet Error Rate
RF	Radio Frequency
RSSI	Receive Signal Strength Indicator
RX	Receive, Receive Mode
TrxEB	SmartRF Transceiver EB
TX	Transmit, Transmit Mode

2 Absolute Maximum Ratings

The absolute maximum ratings and operating conditions listed in the CC1120 data sheet [1] and the CC1190 data sheet [3] must be followed at all times. Stress exceeding one or more of these limiting values may cause permanent damage to any of the devices.

3 Electrical Specifications

Note that the characteristics in this section are only valid when using the CC1120-CC1190EM 868 MHz reference design [4] and register settings recommended by the SmartRF Studio software [7].

3.1 Operating Conditions

Table 2. Operating Conditions

Parameter	Min	Max	Unit
Operating Frequency	850	950	MHz
Operating Supply Voltage	2.0	3.6	V
Operating Temperature	-40	+85	°C

3.2 Current Consumption

T_C = 25°C, V_{DD} = 3.0 V, f = 869.525 MHz if nothing else is stated. All parameters are measured on the CC1120-CC1190EM 868 MHz reference design [4] with a 50 Ω load.

Table 3. Current Consumption

Parameter	Condition	Typical	Unit
Receive Current, HGM1	1.2 kbps, 2FSK, ±4 kHz deviation	24	mA
	50 kbps, 2GFSK, ±25 kHz deviation	25	
	200 kbps, 4GFSK, ±82.76 kHz deviation	25	
Receive Current, LGM	1.2 kbps, 2FSK, ±4 kHz deviation	21	mA
	50 kbps, 2GFSK, ±25 kHz deviation	22	
	200 kbps, 4GFSK, ±82.76 kHz deviation	22	
Transmit Current	PA_CFG2 = 0x77 (+27dBm)	475	mA
	PA_CFG2 = 0x6F (+26dBm)	411	
	PA_CFG2 = 0x6B (+25dBm)	376	
	PA_CFG2 = 0x66 (+24dBm)	324	
	PA_CFG2 = 0x63 (+23dBm)	295	
	PA_CFG2 = 0x60 (+22dBm)	266	
	PA_CFG2 = 0x5D (+21dBm)	239	
	PA_CFG2 = 0x5A (+20dBm)	213	
	PA_CFG2 = 0x58 (+19dBm)	197	
	PA_CFG2 = 0x55 (+18dBm)	176	
	PA_CFG2 = 0x53 (+17dBm)	163	
Power Down Current		370	nA

3.3 Receive Parameters

T_C = 25°C, V_{DD} = 3.0 V, f = 869.525 MHz if nothing else is stated. All parameters are measured on the CC1120-CC1190EM 868 MHz reference design [4] with a 50 Ω load.

Table 4. Receive Parameters

Parameter	Condition	Typical	Unit
Sensitivity [(1)], HGM	1.2 kbps, 2FSK, ±4 kHz deviation, 10 kHz RX filter bandwidth, see Figure 1.	-126	dBm
	50 kbps, 2GFSK, ±25 kHz deviation, 100 kHz RX filter bandwidth, see Figure 2.	-113	
	150 kbps, 4GFSK, ±82.76 kHz deviation, 200 kHz RX filter bandwidth	-107	
	200 kbps, 4GFSK, ±82.76 kHz deviation, 200 kHz RX filter bandwidth, see Figure 3	-106	
	4.8 kbps, ASK, 66.6 kHz RX filter bandwidth	-117	
Sensitivity [(1)], LGM	1.2 kbps, 2FSK, ±4 kHz deviation, 10 kHz RX filter bandwidth, see Figure 4.	-116	dBm
	50 kbps, 2GFSK, ±25 kHz deviation, 100 kHz RX filter bandwidth, see Figure 5.	-102	
	200 kbps, 4GFSK, ±82.76 kHz deviation, 200 kHz RX filter bandwidth, see Figure 6.	-98	
Saturation, HGM	Maximum input power level for 1% BER	+10	
Saturation, LGM	Maximum input power level for 1% BER	+10	
Selectivity and Blocking, HGM	1.2 kbps, 2FSK, ±4 kHz deviation (see Figure 7 and Figure 8).		dB
	±2 MHz from wanted signal	80	
	±10 MHz from wanted signal	94	
	50 kbps, 2GFSK, ±25 kHz deviation (see Figure 9 and Figure 10).		dB
	±2 MHz from wanted signal	67	
	±10 MHz from wanted signal	81	
Spurious emission, HGM	Radiated measurement @ 3.6 GHz	-61	dBm

(1) Sensitivity limit is defined as 1% bit error rate (BER). Packet length is 3 bytes.

3.3.1 Typical RX Performance vs. Temperature and V_{DD}

T_C = 25°C, V_{DD} = 3.0 V, f = 869.525 MHz if nothing else is stated. All parameters are measured on the CC1120-CC1190EM 868 MHz reference design [4] with a 50 Ω load.

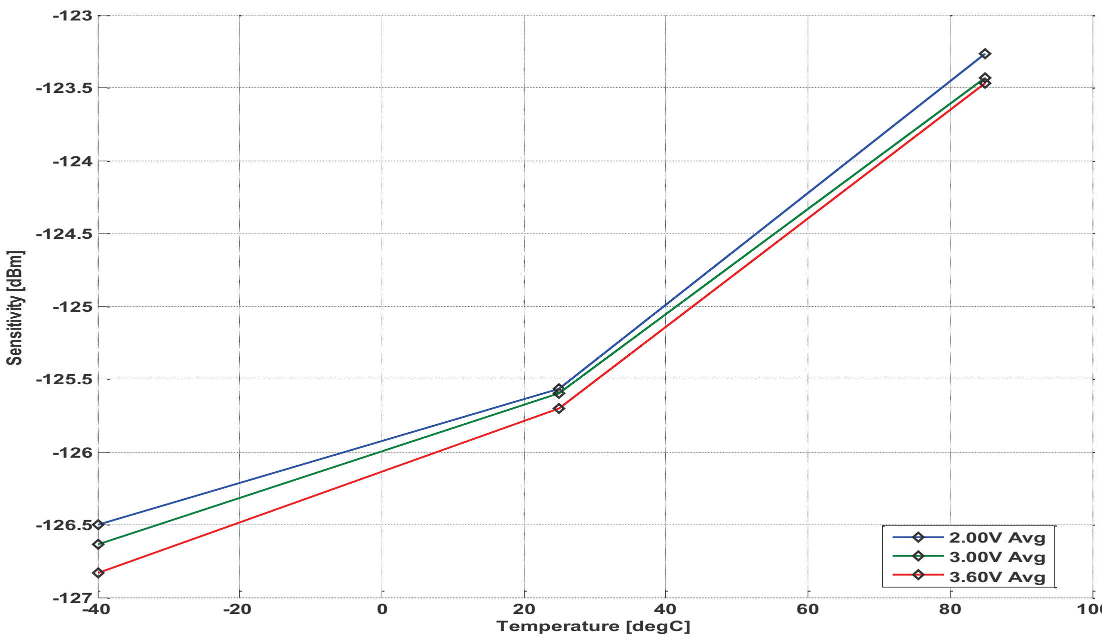

Figure 1. Typical Sensitivity vs. Temperature and Power Supply Voltage, HGM, 1.2 kbps

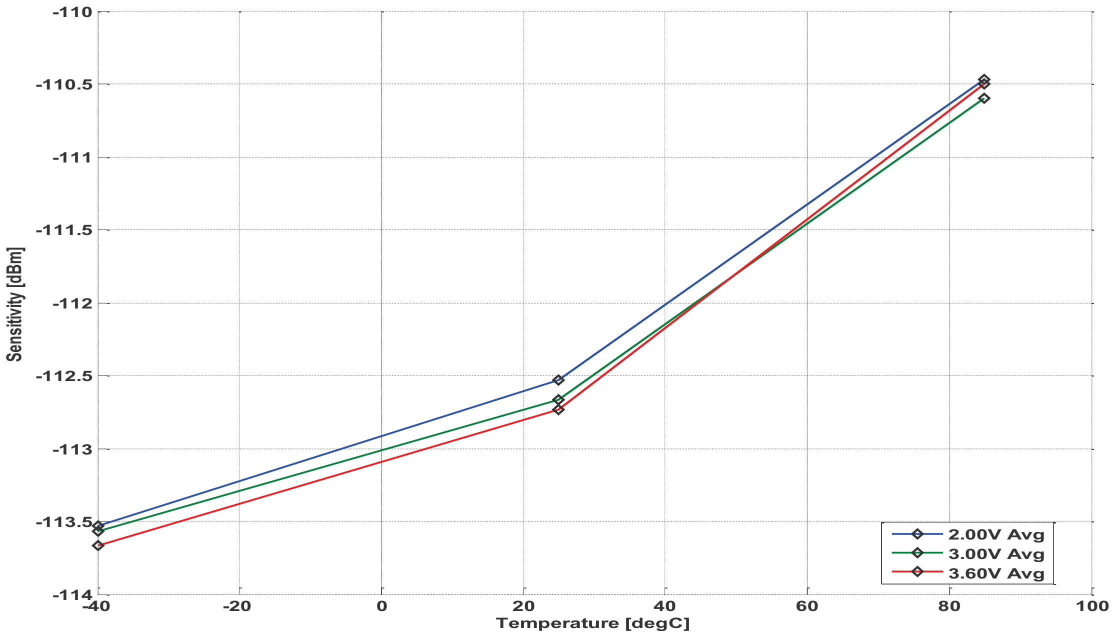

Figure 2. Typical Sensitivity vs. Temperature and Power Supply Voltage, HGM, 50 kbps

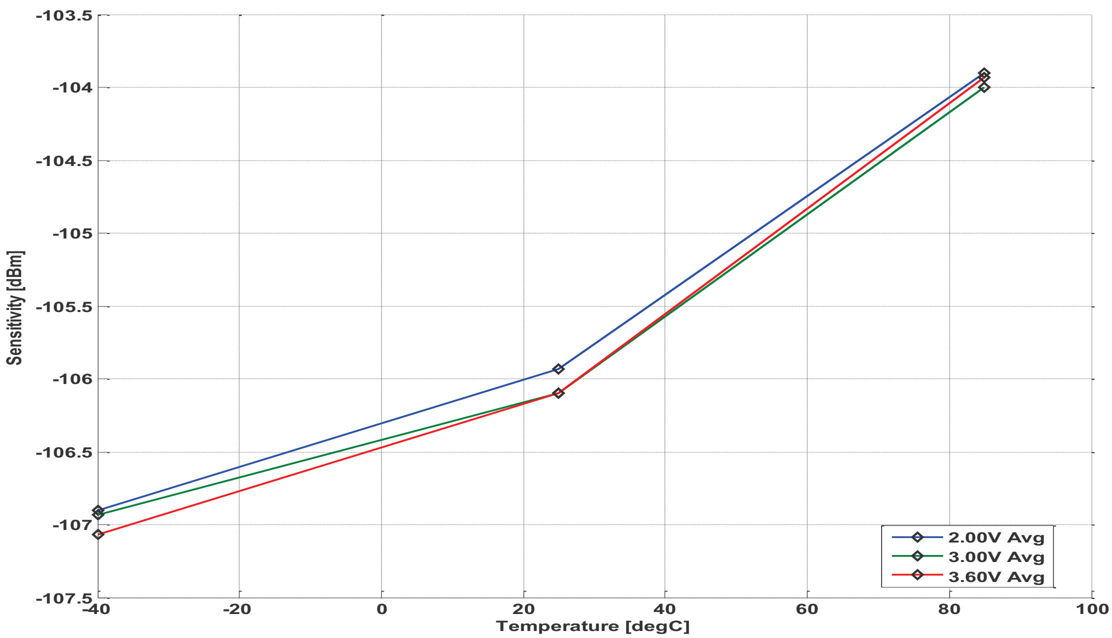

Figure 3. Typical Sensitivity vs. Temperature and Power Supply Voltage, HGM, 200 kbps

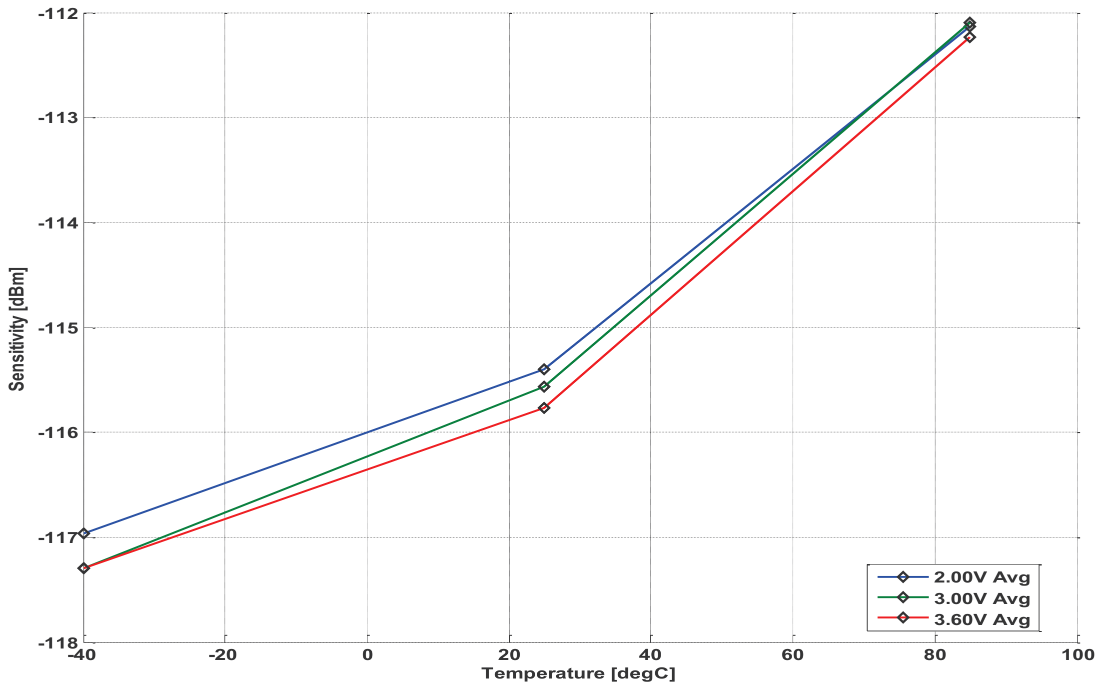

Figure 4. Typical Sensitivity vs. Temperature and Power Supply Voltage, LGM, 1.2 kbps

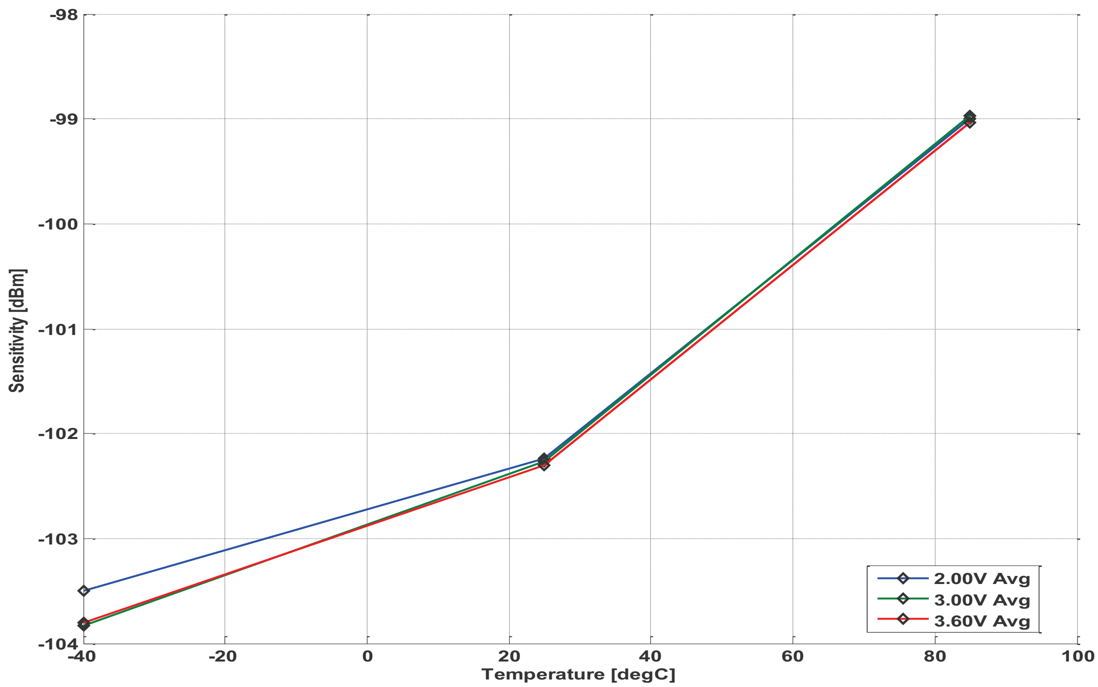

Figure 5. Typical Sensitivity vs. Temperature and Power Supply Voltage, LGM, 50 kbps

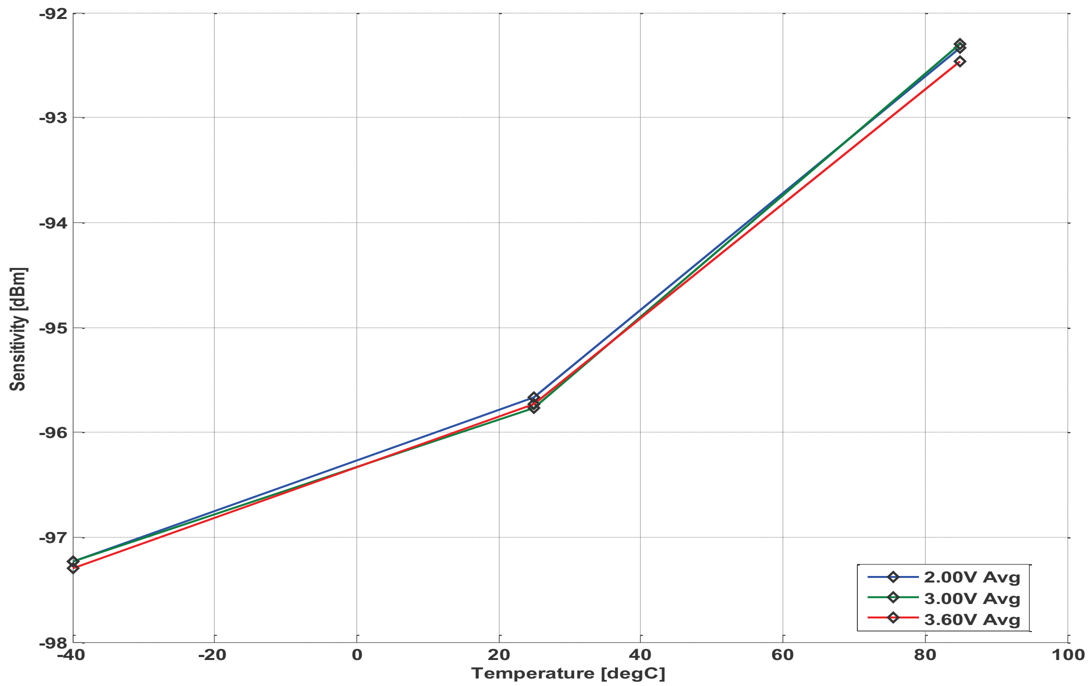

Figure 6. Typical Sensitivity vs. Temperature and Power Supply Voltage, LGM, 200 kbps

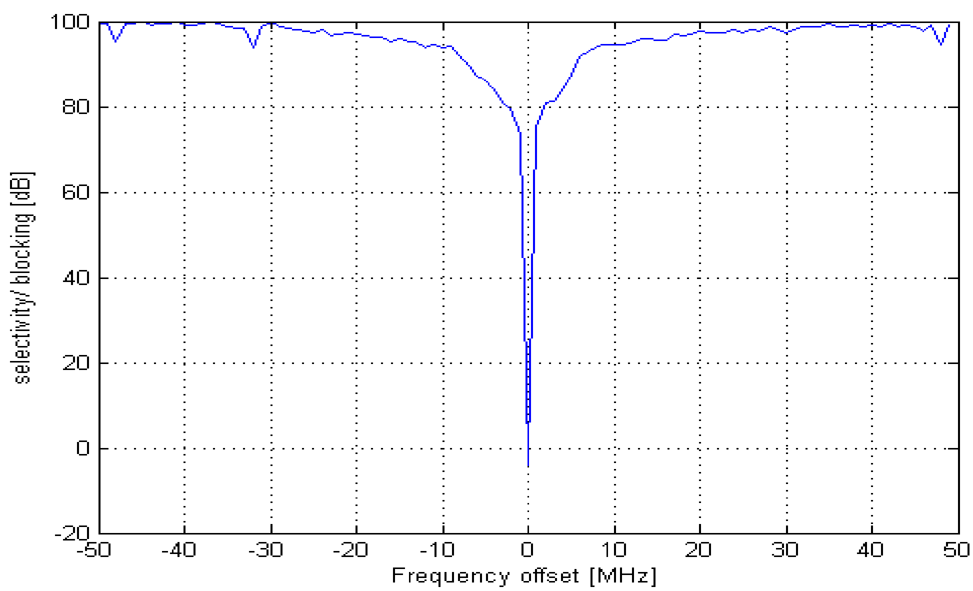

Figure 7. Typical Blocking, 1.2 kbps

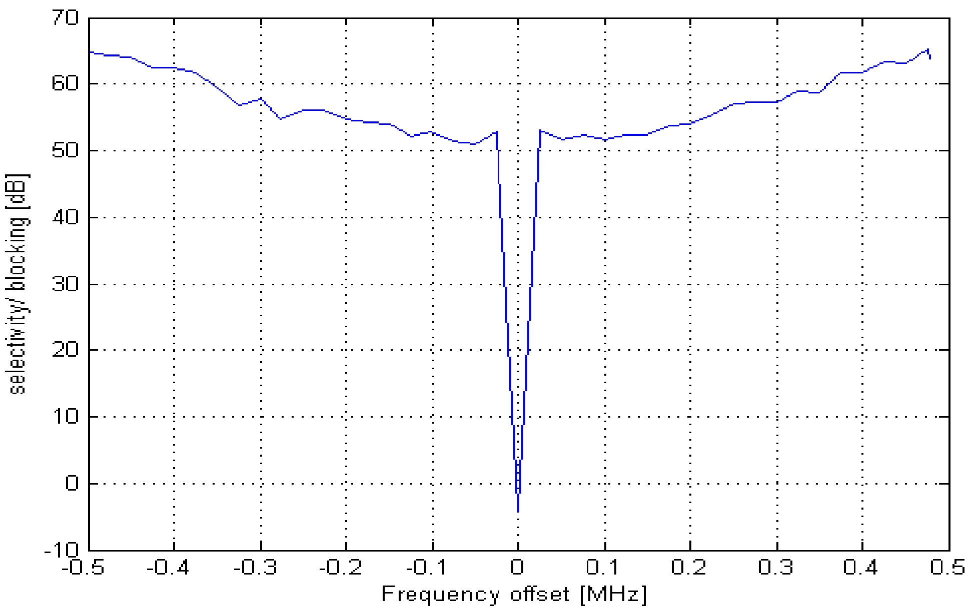

Figure 8. Typical Selectivity, 1.2 kbps

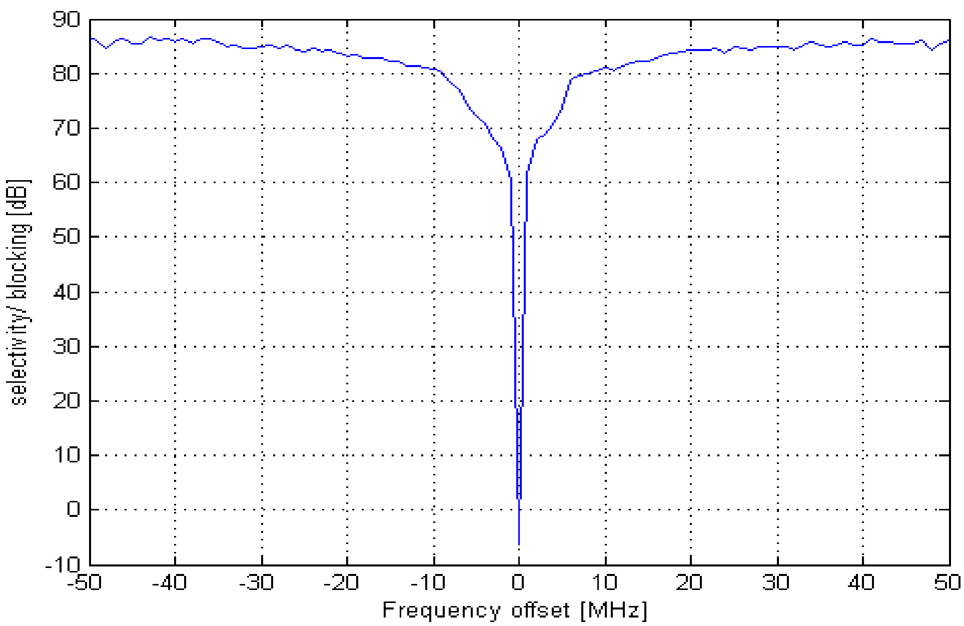

Figure 9. Typical Blocking, 50 kbps

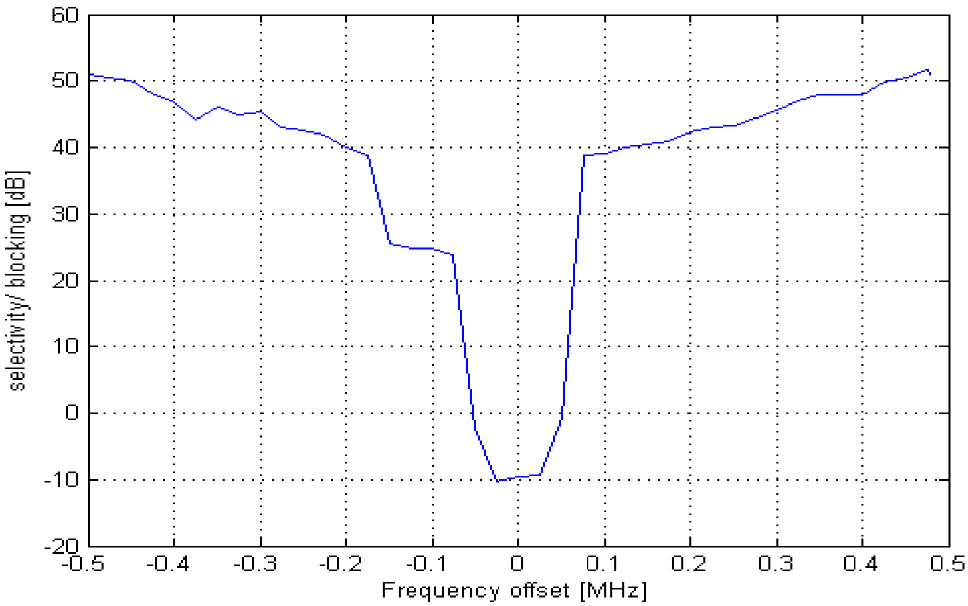

Figure 10. Typical Selectivity, 50 kbps

3.3.2 Received Signal Strength Indicator (RSSI)

The CC1120-CC1190 RSSI readouts can be converted to an absolute level in dBm by subtracting an offset. A CC1120-CC1190 design has a different offset value compared to a standalone CC1120 design due to the CC1190 external LNA gain and the SAW filter insertion loss. Table 5 gives the typical offset value for HGM and LGM. For more details on how to convert the RSSI readout to an absolute power level in dBm, see the CC1120 data sheet [1].

Table 5. Typical RSSI Offset Values

HGM	LGM
107.5	91.5

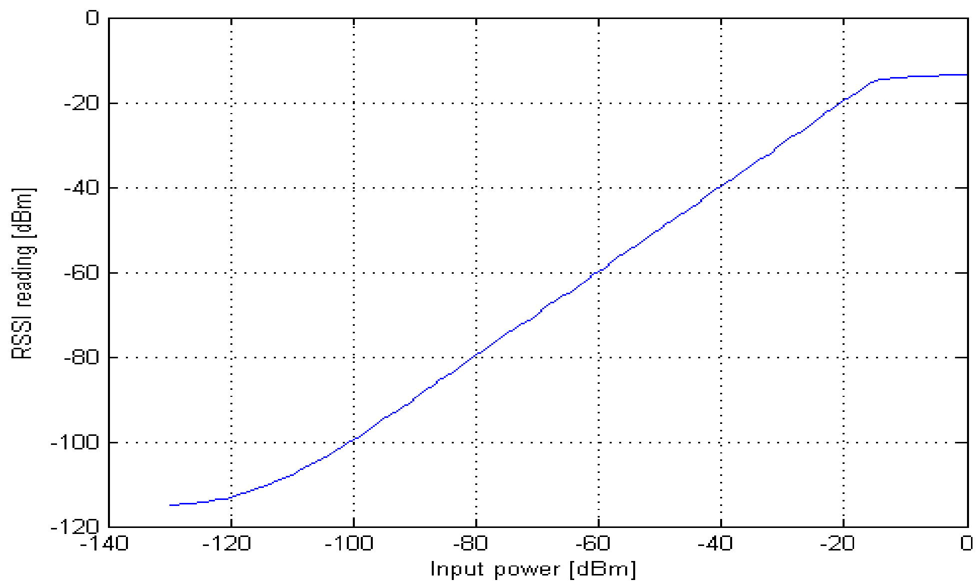

Figure 11. Typical RSSI vs. Input Power Level, HGM, 1.2 kbps, 20 kHz RX BW

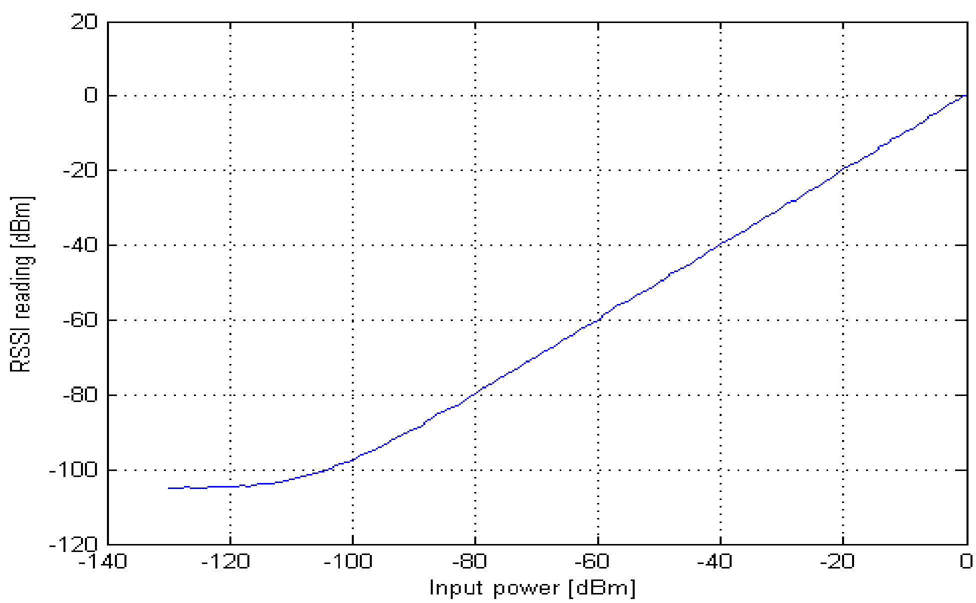

Figure 12. Typical RSSI vs. Input Power Level, LGM, 1.2 kbps, 20 kHz RX BW

3.4 Transmit Parameters

T_C = 25°C, V_{DD} = 3.0 V, f = 869.525 MHz if nothing else is stated. All parameters are measured on the CC1120-CC1190EM 868 MHz reference design [4] with a 50 Ω load, except for the load-pull measurements. Radiated measurements are done with the kit antenna.

Table 6. Transmit Parameters

Parameter	Condition	Typical	Unit
Output power; HGM	PA_CFG2 = 0x77	27	dBm
	PA_CFG2 = 0x6F	26	
	PA_CFG2 = 0x6B	25	
	PA_CFG2 = 0x66	24	
	PA_CFG2 = 0x63	23	
	PA_CFG2 = 0x60	22	
	PA_CFG2 = 0x5D	21	
	PA_CFG2 = 0x5A	20	
	PA_CFG2 = 0x58	19	
	PA_CFG2 = 0x55	18	
	PA_CFG2 = 0x53	17	
Efficiency, HGM	PA_CFG2 = 0x77	35	%
	PA_CFG2 = 0x6F	32	
	PA_CFG2 = 0x6B	29	
	PA_CFG2 = 0x66	26	
	PA_CFG2 = 0x63	23	
	PA_CFG2 = 0x60	21	
Spurious emission with PATABLE = 0x6B, HGM	Conducted below 1 GHz	-56	dBm
	Conducted above 1 GHz	-45	
	Conducted 2nd harmonic	-47	
	Conducted 3rd harmonic	-42	
	Radiated 2nd harmonic	-30	
	Radiated 3rd harmonic	-37	
Modulation bandwidth, HGM	See Figure 17		
Stability, HGM Maximum VSWR with PA_CFG = 0x6B	**+85˚C:** V_{DD}: 3.6 V V_{DD}: 3.0 V	 10 10	
	+25˚C: V_{DD}: 3.6 V V_{DD}: 3.0 V	 3.6 6	
	-40˚C: V_{DD}: 3.6 V V_{DD}: 3.0 V	 2.5 2.5	

3.4.1 Typical TX Performance vs. Temperature and V_{DD}

T_C = 25°C, V_{DD} = 3.0 V, f = 869.525 MHz if nothing else is stated. All parameters are measured on the CC1120-CC1190EM 868 MHz reference design [4] with a 50 Ω load.

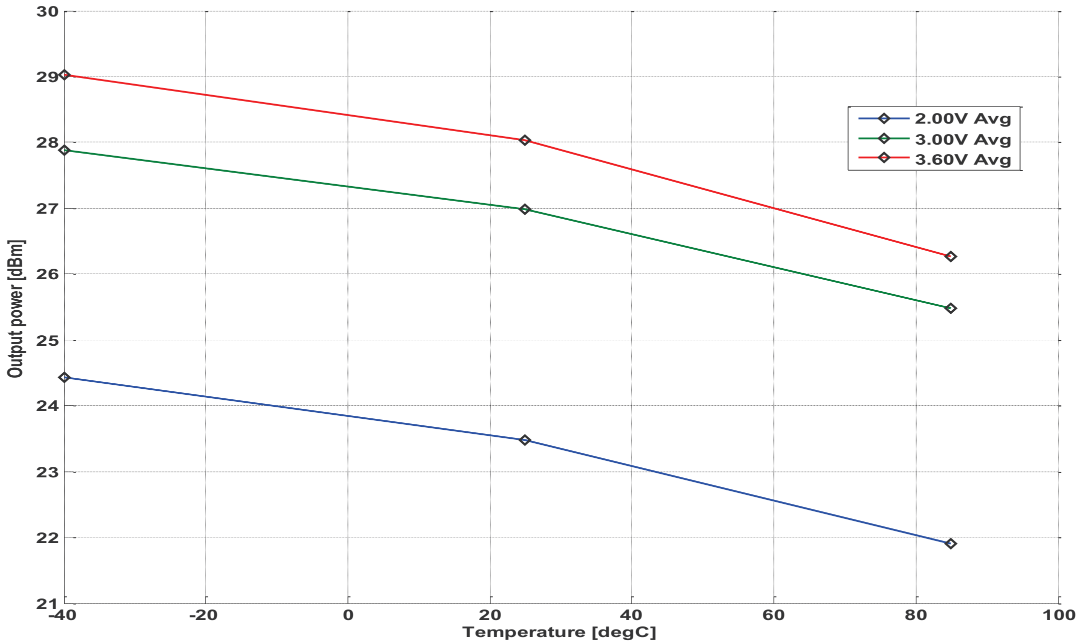

Figure 13. Typical Output Power vs. Temperature and Power Supply Voltage. PA_CFG2 = 0x77

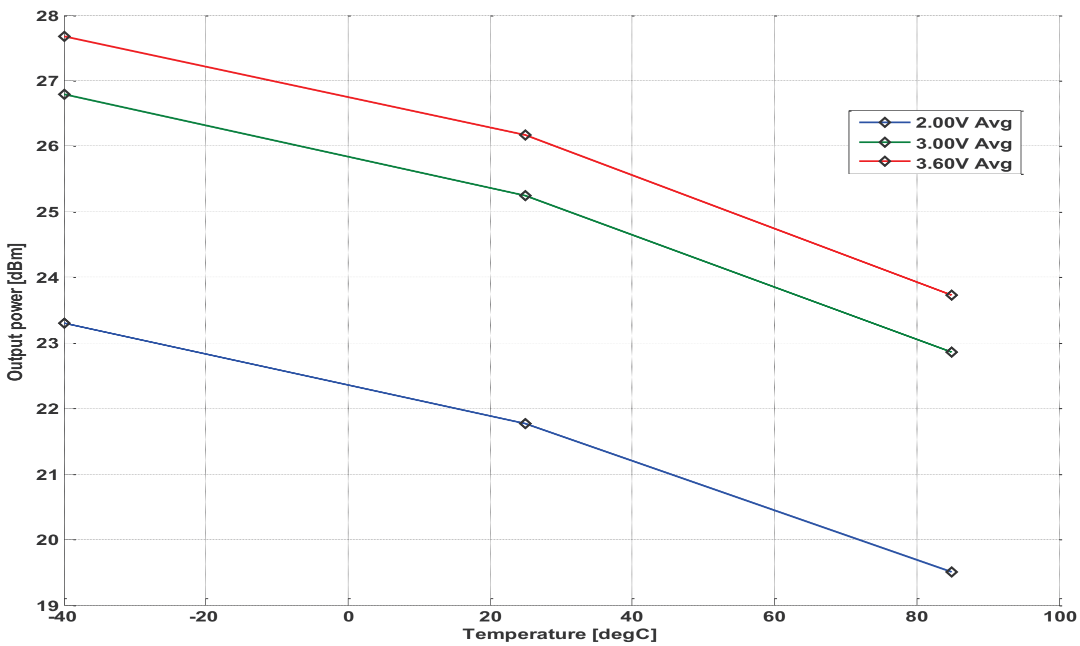

Figure 14. Typical Output Power vs. Temperature and Power Supply Voltage. PA_CFG2 = 0x6B

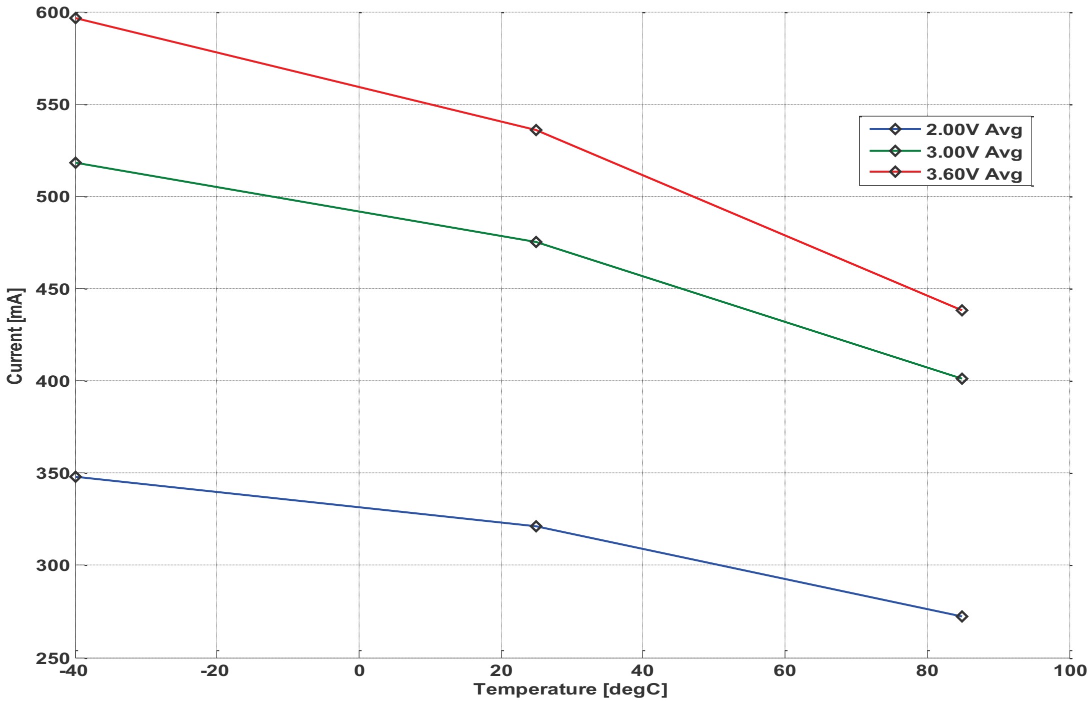

Figure 15. Typical TX Current Consumption vs. Temperature and Power Supply Voltage. PA_CFG2 = 0x77

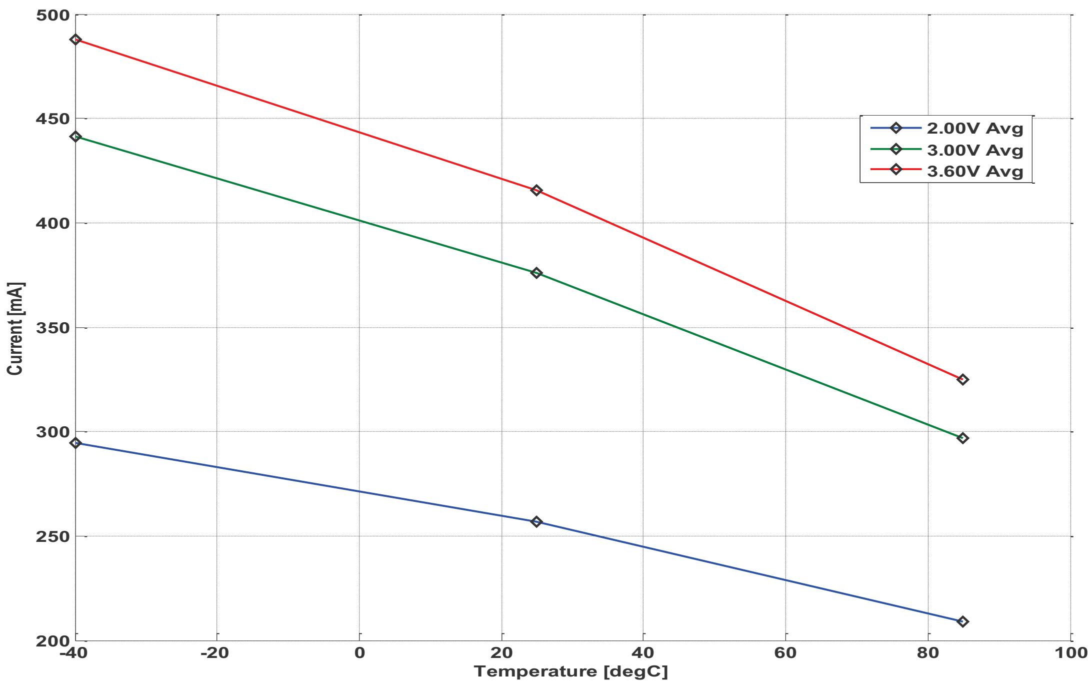

Figure 16. Typical TX Current Consumption vs. Temperature and Power Supply Voltage. PA_CFG2 = 0x6B

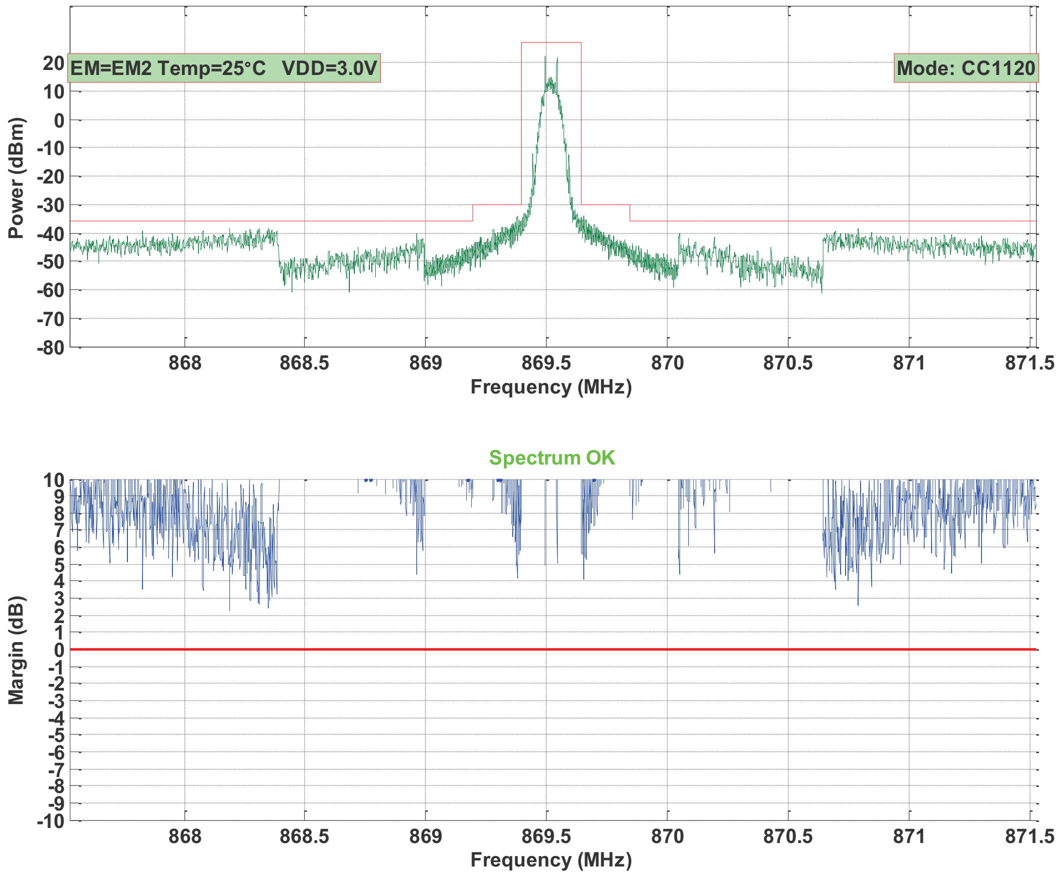

Figure 17. ETSI 300 220, Modulation Bandwidth, Conducted, 50 kbps, PA_CFG2 = 0x77

3.4.2 Typical TX Parameters vs. Load Impedance

The load impedance presented to the CC1190 PA output is critical to the TX performance of the reference design. The load impedance is selected as a compromise between several criteria, such as output power, efficiency and the level of the harmonics. The matching components between the PA output and the antenna should transform 50 Ω antenna impedance to the selected impedance. which the CC1190 PA should see. This is taken care of by the reference design and you should provide a well matched antenna to get the required performance.

In order to measure the performance under different mismatch conditions, the CC1120-CC1190EM 868 MHz reference design is loaded with different impedances at the SMA connector reference plane. A well matched antenna will have impedance inside the black circle in the Smith chart, which illustrates the limit for 10 dB return loss. At each load the output power, current and spurious frequency components are measured. These measurements are known as load-pull measurements.

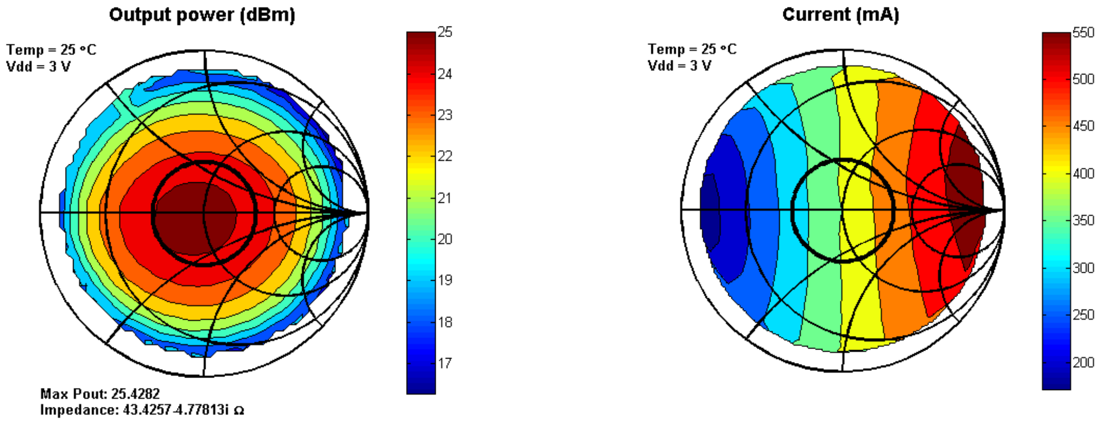

Figure 18. Output Power (left) and Current (right) vs. Load Impedance at SMA Connector at 25°C. PA_CFG2 = 0x6B

Most PAs have the ability to oscillate at unwanted frequencies under certain conditions. The worst conditions are usually high output power, low temperatures, and high V_{DD}. The spurious frequency components are measured under different mismatch conditions as illustrated in Figure 19 and Figure 20. The blue colors indicate that the spurious levels are at the noise floor. The CC1120-CC1190EM 868 MHz reference design is a very robust design, which tolerates high mismatch ratios at high output power, low temperatures, and high V_{DD}.

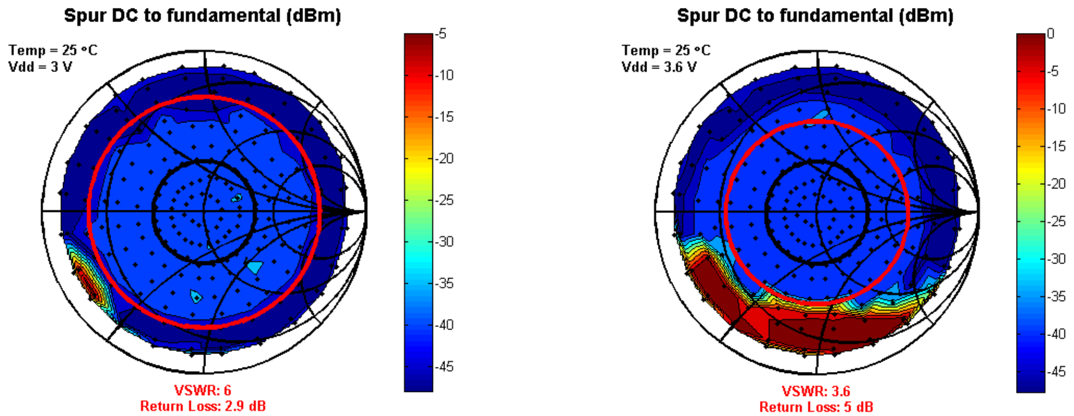

Figure 19. Spurious Frequency Components vs. Load Impedance at SMA Connector at 25°C. PA_CFG2 = 0x6B

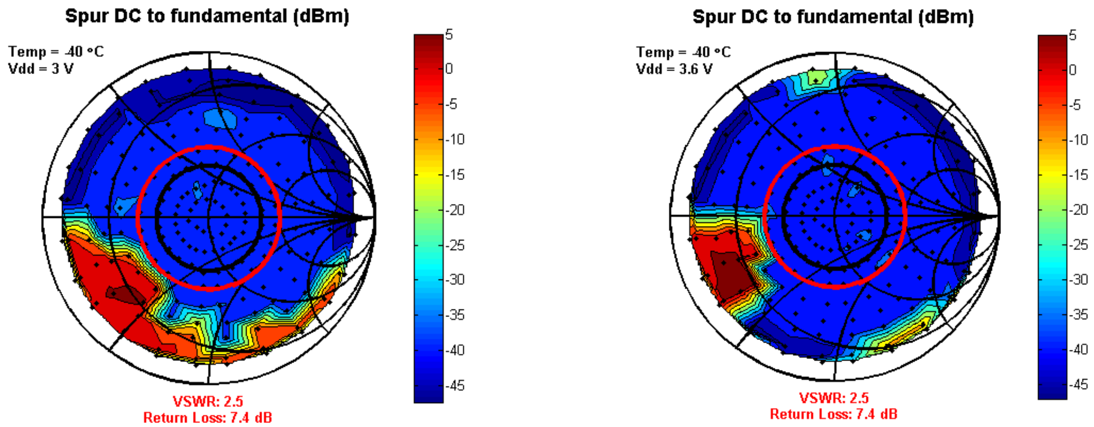

Figure 20. Spurious Frequency Components vs. Load Impedance at SMA Connector at -40°C. PA_CFG2 = 0x6B

3.5 Measurement Equipment

The equipment shown in Table 7 was used for the measurements.

Table 7. Measurement Equipment

Measurement	Instrument Type	Instrument Model
RX	Signal Generator	Rohde and Schwarz SMIQ 3B
TX	Signal Analyzer	Rohde and Schwarz FSG
RX/TX	Power Supply	Agilent E3631A
	Multimeter	Keithley 2000
Stability	Automatic Tuner	Maury MT986EU32
Radiated spurious Emissions	EMC chamber	

4 Controlling the CC1190

There are three digital control pins (PA_EN, LNA_EN, and HGM) that sets the CC1190 mode of operation as shown in Table 8.

Table 8. CC1190 Control Logic

PA_EN	LNA_EN	HGM	Mode of Operation
0	0	X	Power Down
0	1	0	RX LGM
0	1	1	RX HGM
1	0	0	TX LGM
1	0	1	TX HGM

There are different ways of controlling the CC1190 mode of operation in a CC1120-CC1190 design.

- Using CC1120 GPIO0, GPIO2, GPIO3 [(1)] pins to set two of the CC1190 control signals (PA_EN and LNA_EN). The third control signal (HGM) can be hardwired to GND/V_{DD} or connected to an external MCU.
- Using an external MCU to control PA_EN, LNA_EN, and HGM.

(1) GPIO1 is not used since this is the same pin as the SO pin on the SPI interface. The output programmed on this pin will only be valid when CSn is high. For a system where eWOR is used the LNA_EN pin on the CC1190 should be controlled by GPIO3. This is related to the polarity of the CC1120 GPIO pins in SLEEP.

Using an external MCU to set one (or more) digital control signals is the recommended solution for a CC1120-CC1190 design. GPIO0 or GPIO2 are typically programmed to provide a signal related to the CC1120 packet handler engine to the interfacing MCU and GPIO1 is the same pin as the SO pin on the SPI interface. The GPIO pin not used to provide information to the interfacing MCU can be used to control the CC1190.

5 SmartRF Studio and TrxEB

The CC1120-CC1190EM 868 MHz together with SmartRF™ Studio 7 software and TrxEB can be used to evaluate performance and functionality.

5.1 SmartRF Studio

The CC1120-CC1190 can be configured using the SmartRF Studio 7 software . The SmartRF Studio software is highly recommended for obtaining optimum register settings. A screenshot of the SmartRF Studio user interface for CC1120-CC1190 is shown in Figure 21.

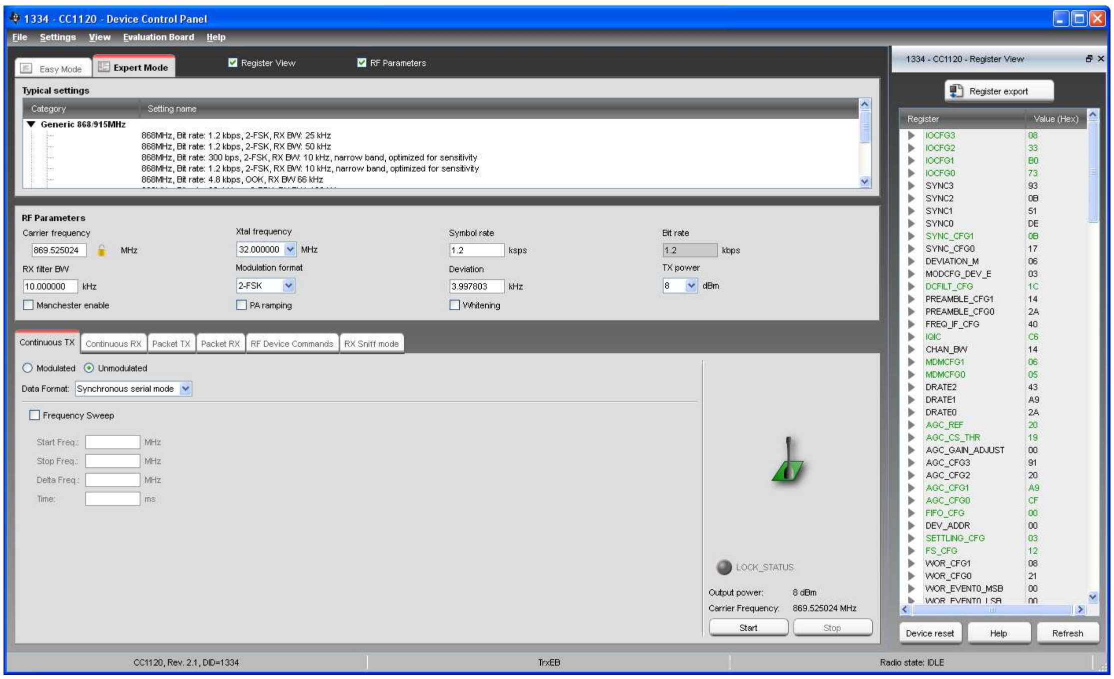

Figure 21. SmartRF Studio 7 User Interface

In order to control the CC1190, you need to set GPIO2 = 0x33 and GPIO0 = 0x73 to set CC1190 in TX and GPIO2 = 0x73 and GPIO0 = 0x33 to set CC1190 in RX.

5.2 TRxEB

If CC1120-CC1190 is used with the TrxEB and the USB controller, the supply range is 3.0 V to 3.6 V.

6 Reference Design

The CC1120-CC1190EM 868 MHz reference design includes the schematic and gerber files . It is highly recommended to follow the reference design for optimum performance. The reference design also includes the bill of materials with manufacturers and part numbers.

6.1 Power Decoupling

Proper power supply decoupling must be used for optimum performance. The capacitors C26, C27 and C30 ensure good RF ground after L21 and, thus, prevent RF leakage into the power supply lines causing oscillations. The power supply filtering consisting of C2, C3 and L2 ensure well defined impedance looking towards the power supply.

6.2 Input/Output Matching and Filtering

The PA and the LNA of the CC1190 are single ended input/output. A balun is required to transform the differential LNA input of the CC1120 to single ended output of the CC1190 PA. The values of the matching components between the SAW filter and the CC1190 PA input are chosen to present optimum source impedance to the CC1190 PA input with respect to stability.

The CC1190 PA performance is highly dependent on the impedance presented at the output, and the LNA performance is highly dependent on the impedance presented at the input. The impedance is defined by L21 and all components towards the antenna. These components also ensure the required filtering of harmonics to pass regulatory requirements.

The layout and component values need to be copied exactly to obtain the same performance as presented in this application report

6.3 Bias Resistor

R141 is a bias resistor. The bias resistor is used to set an accurate bias current for internal use in the CC1190.

6.4 SAW Filter

A SAW is recommended for the CC1120-CC1190 design to attenuate spurs below the carrier frequency that will otherwise violate spurious emission limits under ETSI 300-220. The SAW filter is matched to the CC1190 PA input/LNA output impedance using a series inductor and a shunt capacitor.

6.5 PCB Layout Considerations

The Texas Instruments reference design uses a 1.6 mm (0.062”) 4-layer PCB solution. Note that the different layers have different thickness. It is recommended to follow the recommendation given in the CC1120–CC1190EM 868 MHz reference design to ensure optimum performance.

The top layer is used for components and signal routing, and the open areas are filled with metallization connected to ground using several vias. The areas under the two chips are used for grounding and must be well connected to the ground plane with multiple vias. Footprint recommendation for the CC1190 is given in the CC1190 data sheet .

Layer two is a complete ground plane and is not used for any routing. This is done to ensure short return current paths. The low impedance of the ground plane prevents any unwanted signal coupling between any of the nodes that are decoupled to it.

Layer three is a power plane. The power plane ensures low-impedance traces at radio frequencies and prevents unwanted radiation from power traces. Two different power planes for CC1120 and CC1190 are used and they are surrounded by ground to reduce unwanted radiation from the board.

Layer four is used for routing, and as for layer one, open areas are filled with metallization connected to ground using several vias.

6.6 Shielding

RF shielding is necessary to keep the radiated harmonics below the regulatory limits.

7 References

1. *CC1120 High Performance RF Transceiver for Narrowband Systems* (SWRS112)
2. *CC112X/CC1175 Low-Power High Performance Sub-1 GHz RF Transceivers/Transmitter User's Guide* (SWRU295)

3. *CC1190 850 – 950 MHz RF Front End Data Sheet* (SWRS089)
4. CC1120_CC1190_EM_868_Reference_Design (http://www.ti.com/lit/zip/swrr092)
5. ETSI EN 300 220 V2.3.1: Electromagnetic compatibility and Radio spectrum Matters (ERM); Short Range Devices (SRD); Radio equipment to be used in the 25 MHz to 1000 MHz frequency range with power levels ranging up to 500 mW”
6. CEPT/ERC/Recommendation 70-03: “Relating to the use of Short Range Devices (SRD)”
7. SmartRF Studio 7 v1.12.0 (http://www.ti.com/lit/zip/swrc176)

EVALUATION BOARD/KIT/MODULE (EVM) ADDITIONAL TERMS

Texas Instruments (TI) provides the enclosed Evaluation Board/Kit/Module (EVM) under the following conditions:

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods.

Should this evaluation board/kit not meet the specifications indicated in the User's Guide, the board/kit may be returned within 30 days from the date of delivery for a full refund. THE FOREGOING LIMITED WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

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As noted in the EVM User's Guide and/or EVM itself, this EVM and/or accompanying hardware may or may not be subject to the Federal Communications Commission (FCC) and Industry Canada (IC) rules.

For EVMs **not** subject to the above rules, this evaluation board/kit/module 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. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC or ICES-003 rules, which are designed to provide reasonable protection against radio frequency interference. Operation of the equipment may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

General Statement for EVMs including a radio

User Power/Frequency Use Obligations: This radio is intended for development/professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability of this EVM and its development application(s) must comply with local laws governing radio spectrum allocation and power limits for this evaluation module. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by Texas Instruments unless user has obtained appropriate experimental/development licenses from local regulatory authorities, which is responsibility of user including its acceptable authorization.

For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant

Caution

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

For EVMs annotated as IC – INDUSTRY CANADA Compliant

This Class A or B digital apparatus complies with Canadian ICES-003.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Concerning EVMs including radio transmitters

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concerning EVMs including detachable antennas

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada.

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

Concernant les EVMs avec appareils radio

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

【Important Notice for Users of EVMs for RF Products in Japan】

This development kit is NOT certified as Confirming to Technical Regulations of Radio Law of Japan

If you use this product in Japan, you are required by Radio Law of Japan to follow the instructions below with respect to this product:

1. Use this product in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use this product only after you obtained the license of Test Radio Station as provided in Radio Law of Japan with respect to this product, or
3. Use of this product only after you obtained the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to this product. Also, please do not transfer this product, unless you give the same notice above to the transferee. Please note that if you could not follow the instructions above, you will be subject to penalties of Radio Law of Japan.

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EVALUATION BOARD/KIT/MODULE (EVM) WARNINGS, RESTRICTIONS AND DISCLAIMERS

For Feasibility Evaluation Only, in Laboratory/Development Environments. Unless otherwise indicated, this EVM is not a finished electrical equipment and not intended for consumer use. It is intended solely for use for preliminary feasibility evaluation in laboratory/development environments by technically qualified electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems and subsystems. It should not be used as all or part of a finished end product.

Your Sole Responsibility and Risk. You acknowledge, represent and agree that:

1. You have unique knowledge concerning Federal, State and local regulatory requirements (including but not limited to Food and Drug Administration regulations, if applicable) which relate to your products and which relate to your use (and/or that of your employees, affiliates, contractors or designees) of the EVM for evaluation, testing and other purposes.
2. You have full and exclusive responsibility to assure the safety and compliance of your products with all such laws and other applicable regulatory requirements, and also to assure the safety of any activities to be conducted by you and/or your employees, affiliates, contractors or designees, using the EVM. Further, you are responsible to assure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard.
3. You will employ reasonable safeguards to ensure that your use of the EVM will not result in any property damage, injury or death, even if the EVM should fail to perform as described or expected.
4. You will take care of proper disposal and recycling of the EVM's electronic components and packing materials.

Certain Instructions. It is important to operate this EVM within TI's recommended specifications and environmental considerations per the user guidelines. Exceeding the specified EVM ratings (including but not limited to input and output voltage, current, power, and environmental ranges) may cause property damage, personal injury or death. If there are questions concerning these ratings please contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, some circuit components may have case temperatures greater than 60°C as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during normal operation, please be aware that these devices may be very warm to the touch. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use these EVMs.

Agreement to Defend, Indemnify and Hold Harmless. You agree to defend, indemnify and hold TI, its licensors and their representatives harmless from and against any and all claims, damages, losses, expenses, costs and liabilities (collectively, "Claims") arising out of or in connection with any use of the EVM that is not in accordance with the terms of the agreement. This obligation shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if the EVM fails to perform as described or expected.

Safety-Critical or Life-Critical Applications. If you intend to evaluate the components for possible use in safety critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, such as devices which are classified as FDA Class III or similar classification, then you must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.

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TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

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