RL78/G1H, RAA604S00

Transceiver characteristics when changing RF components

Introduction

This document describes an example of transmission and reception characteristics when RF components recommended by our company are changed as a BOM cost reduction method for boards using RL78/G1H (LSI chip for sub-GHz-band wireless communications).

Although it describes RL78/G1H, it is possible to reduce BOM cost of RAA604S00 by the same method.

Note: The contents of this document are provided as an example for reference and do not guarantee the signal quality in systems. When implementing this example into an existing system, thoroughly evaluate the product in the overall system and apply the contents of this document at your own responsibility.

Target Device

RL78/G1H

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1. Overview

When designing a board using RL78 / G1H, a matching circuit is required in the RF port. The matching circuit consists of L (inductor) and C (capacitor), and we recommend using a wire-wound type for the inductor.

In general, wire-wound inductors have high Q value and good RF characteristics can be obtained. On the other hand, it is expensive and not suitable for cost reduction.

This document describes an example of transmission and reception characteristics when the wire-wound inductor is changed to an inexpensive multi-layer inductor.

2. Board description

2.1 Target board

The example characteristics described in this document are measured using the board of the application note in Table 1.

Table 1 Target board

Contents	Application note No,	Title
4-layer board	R01AN3694	Design data of Evaluation board
2-layer board	R01AN4555	Design data of two-layer Evaluation board

2.2 Matching circuit

Figures 1 and Table 2 show the RL78 / G1H matching circuit configuration and components information. It uses 3 wire-wound inductors. We changed them to multi-layer inductors and evaluated the transmission and reception characteristics.

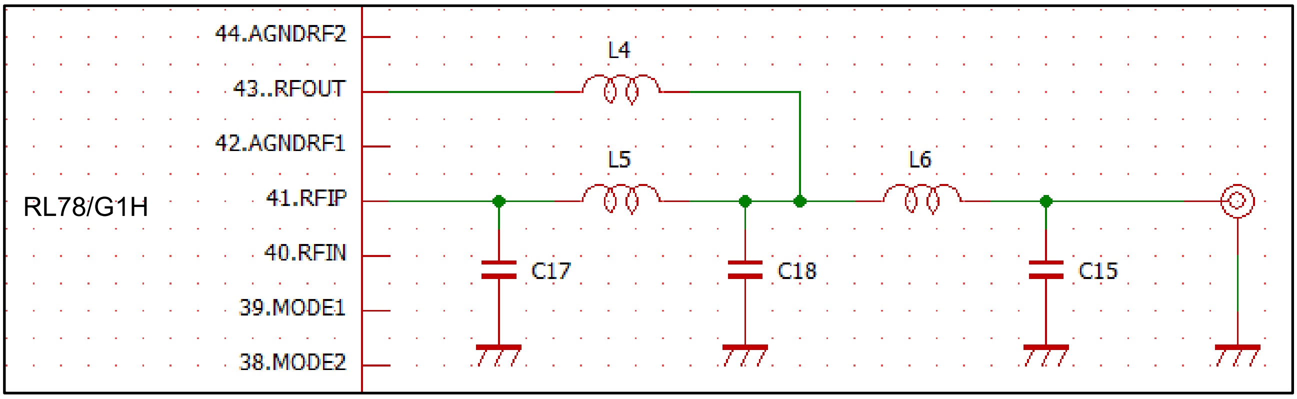

Figure 1 Matching circuit configuration

Table2 Components information

Part	Description	Before change		After change	
		Part number	Type	Part number	Type
L4	2.2 nH	LQW15AN2N2C10	Wire-wound	LQG15HS2N2S02	Multi-layer
L5	5.6 nH	LQW15AN5N6C10	Wire-wound	LQG15HS5N6S02	Multi-layer
L6	5.6 nH	LQW15AN5N6C10	Wire-wound	LQG15HS5N6S02	Multi-layer
C17	4.7 pF	GRM1552C1H4R7CZ01D	Multi-layer	No change	
C18	5.6 pF	GRM1552C1H5R6CA01D	Multi-layer	No change	
C15	3.3 pF	GRM1553C1H3R3CZ01D	Multi-layer	No change	

3. Characteristic example of 4-layer board

3.1 EU Band (863～876MHz)

3.1.1 TX Power / TX Current

Condition：Power Supply = 3.0V, Temperature = Room, Signal = Sin wave

The maximum transmit power is reduced about 0.2dB by the inductor change.

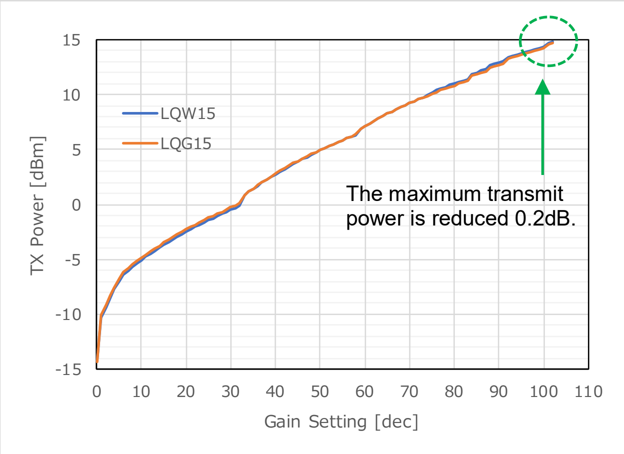

Figure 2 TX Power (863.1MHz)

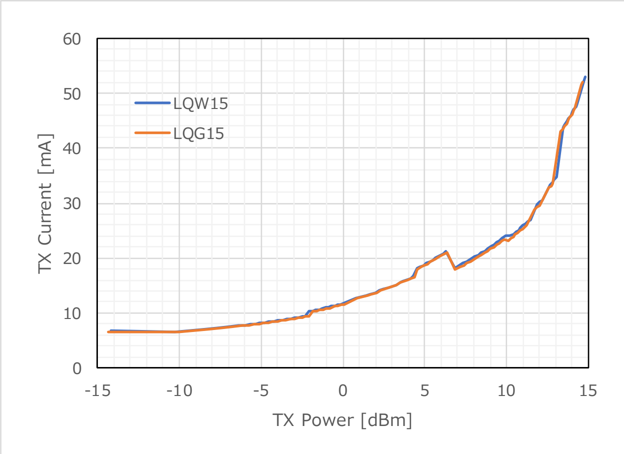

Figure 3 TX Current (863.1MHz)

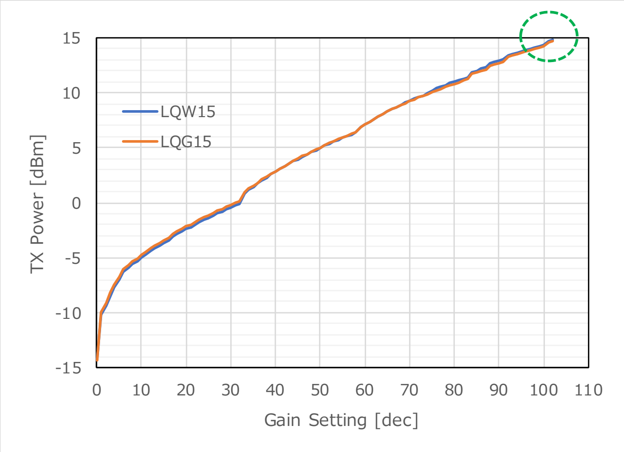

Figure 4 TX Power (869.3MHz)

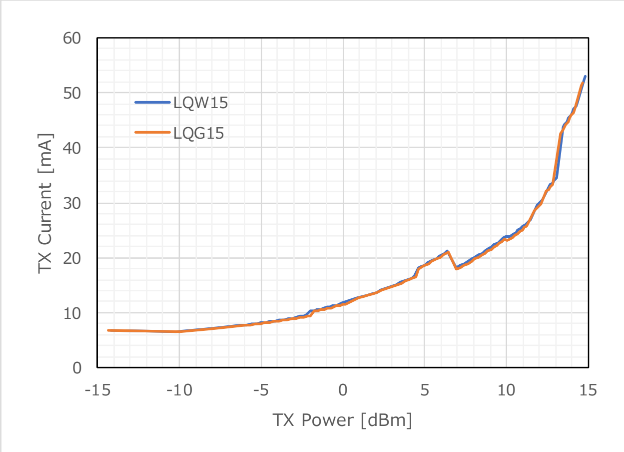

Figure 5 TX Current (869.3MHz)

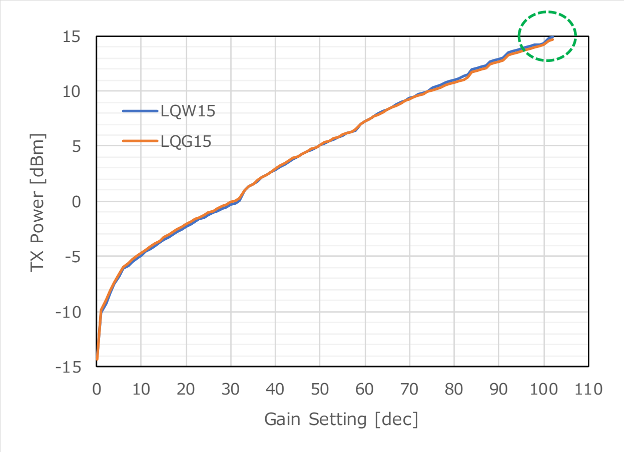

Figure 6 TX Power (875.5MHz)

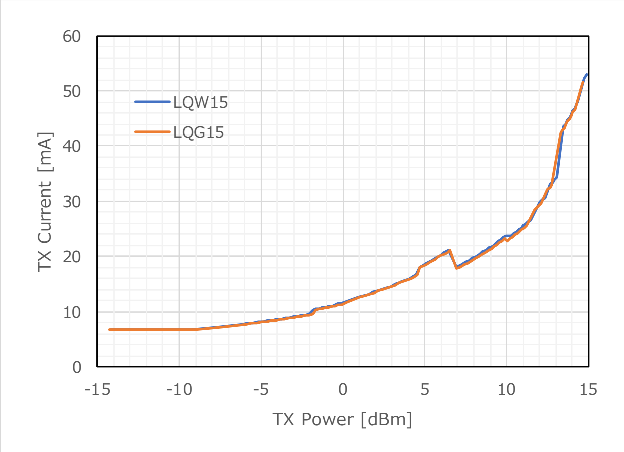

Figure 7 TX Current (875.5MHz)

3.1.2 TX Harmonics Response

Condition : Power Supply = 3.0V, Temperature = Room, Signal = Sin wave, Gain Setting = 102(dec)

The harmonic response is affected by the inductor change. However, there is enough margin for the standard. The circle in the figure shows the degraded part.
The spec line in the figure shows ETSI standard (EN 300 220).

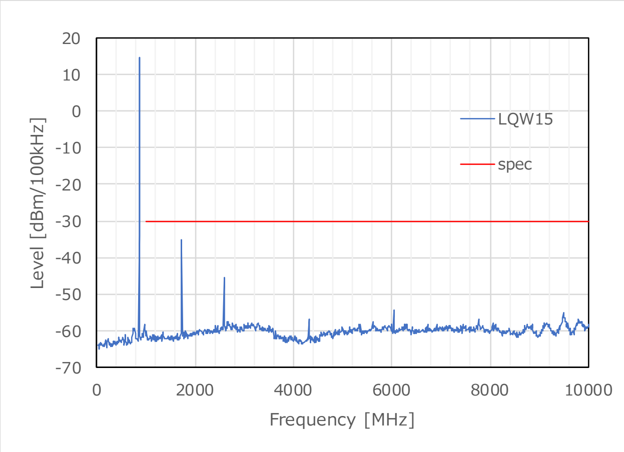

Figure 8 TX Harmonics_LQW15 (863.1MHz)

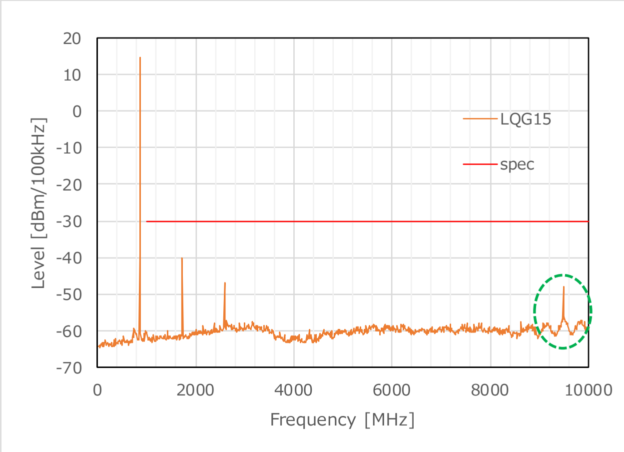

Figure 9 TX Harmonics_LQG15 (863.1MHz)

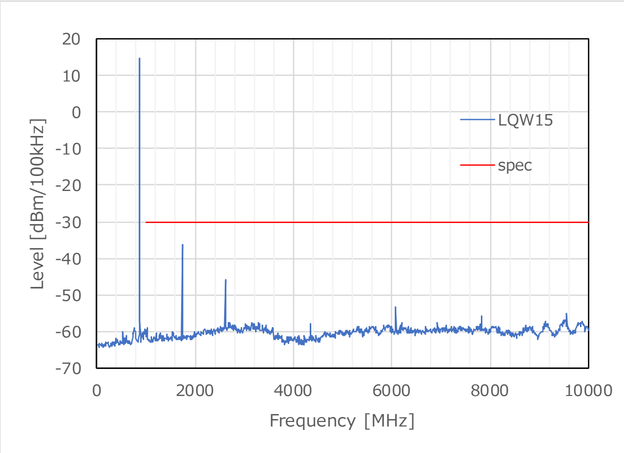

Figure 10 TX Harmonics_LQW15 (869.3MHz)

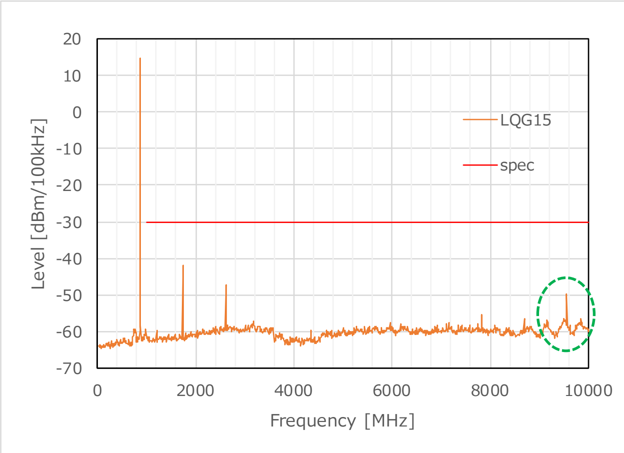

Figure 11 TX Harmonics_LQG15 (869.3MHz)

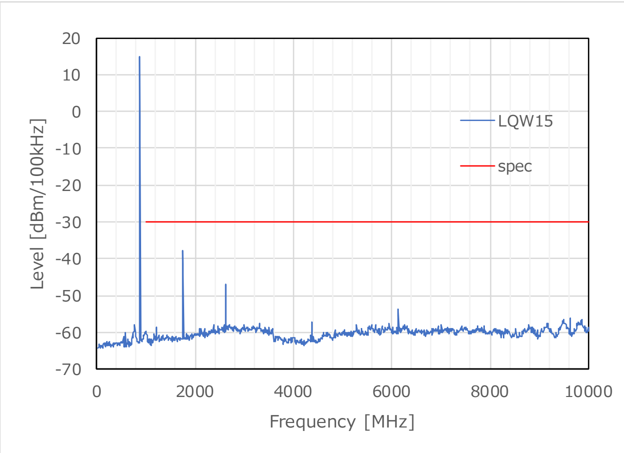

Figure 12 TX Harmonics_LQW15 (875.5MHz)

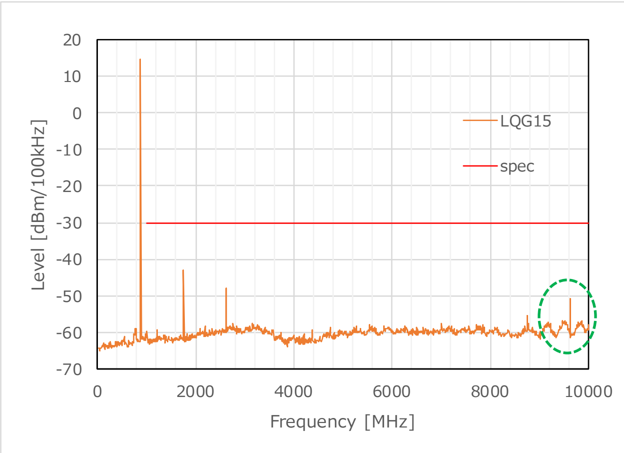

Figure 13 TX Harmonics_LQG15 (875.5MHz)

3.1.3 RX Sensitivity

Condition：Power Supply = 3.0V, Temperature = Room, Data Rate = 50kbps(m=0.5)

There is no degradation of RX sensitivity by the inductor change.

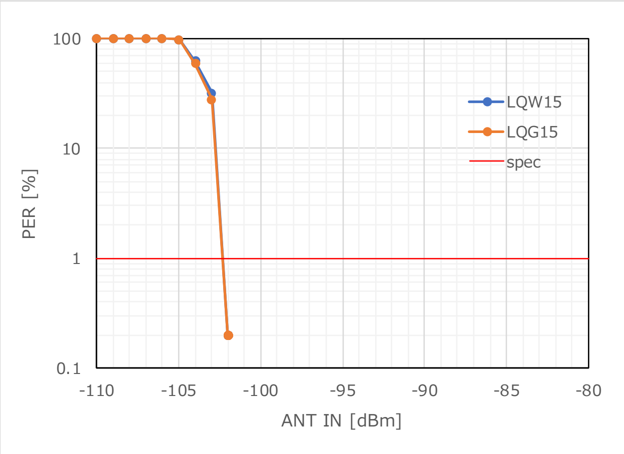

Figure 14 RX Sensitivity_PER (863.1MHz)

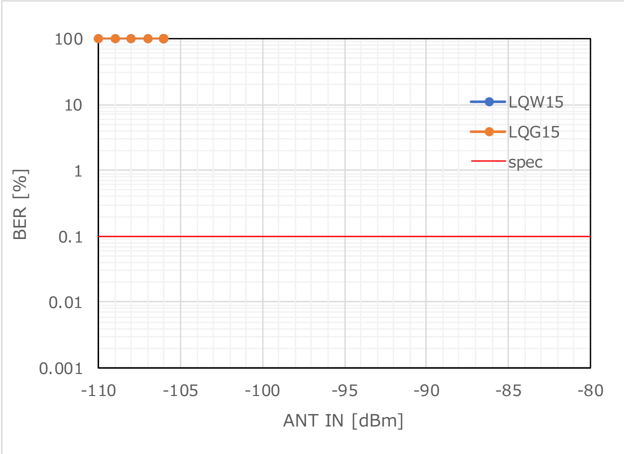

Figure 15 RX Sensitivity_BER (863.1MHz)

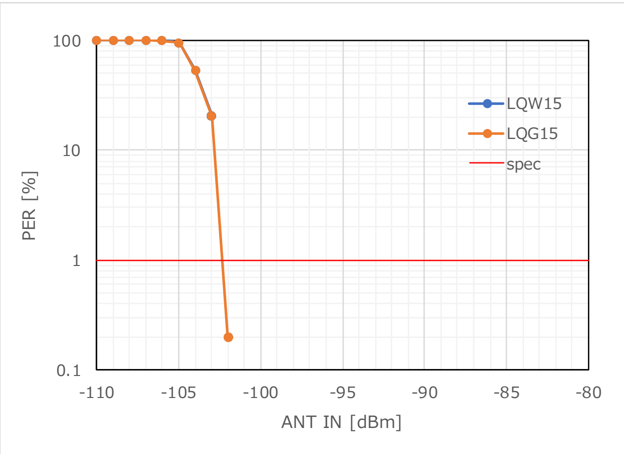

Figure 16 RX Sensitivity_PER (869.3MHz)

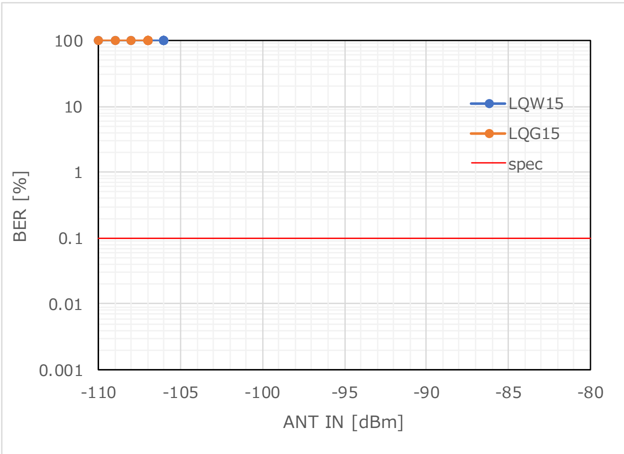

Figure 17 RX Sensitivity_BER (869.3MHz)

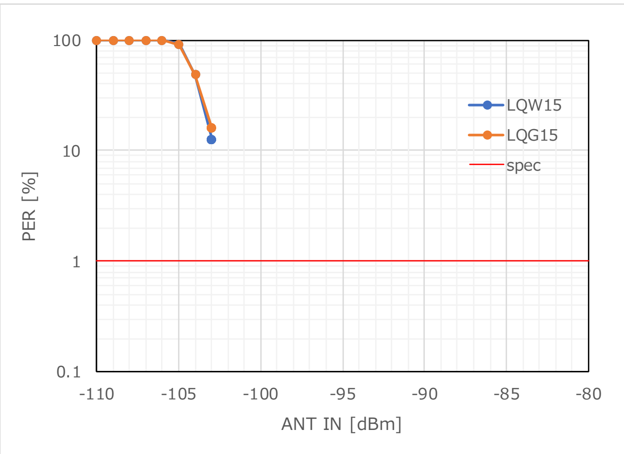

Figure 18 RX Sensitivity_PER (875.5MHz)

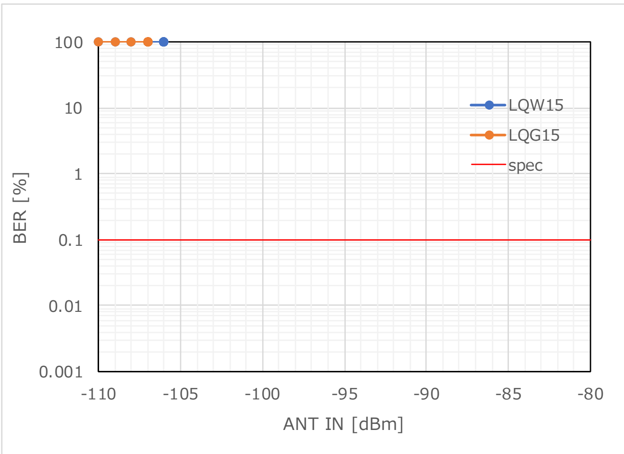

Figure 19 RX Sensitivity_BER (875.5MHz)

3.2 US Band (902～928MHz)

3.2.1 TX Power / TX Current

Condition：Power Supply = 3.0V, Temperature = Room, Signal = Sin wave

The maximum transmit power is reduced about 0.3dB by the inductor change.

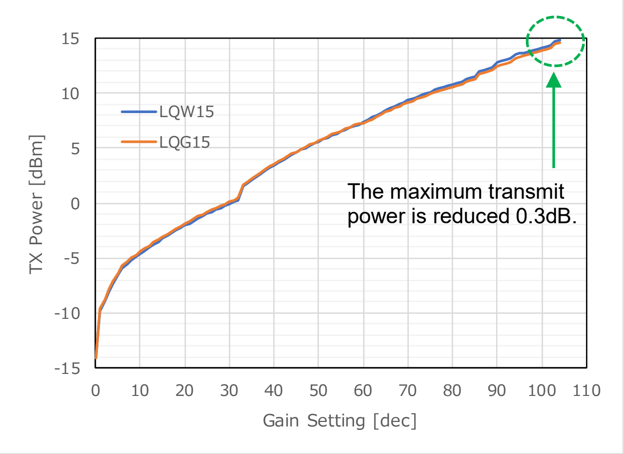

Figure 20 TX Power (902.2MHz)

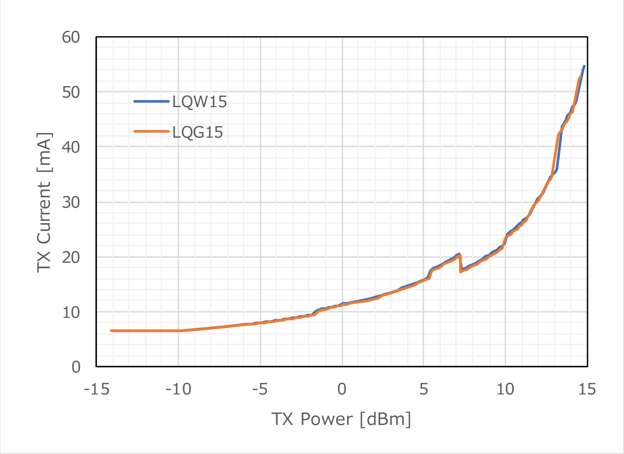

Figure 21 TX Current (902.2MHz)

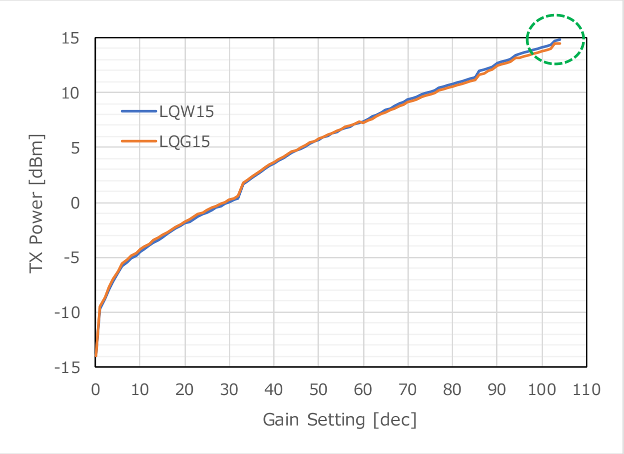

Figure 22 TX Power (915.0MHz)

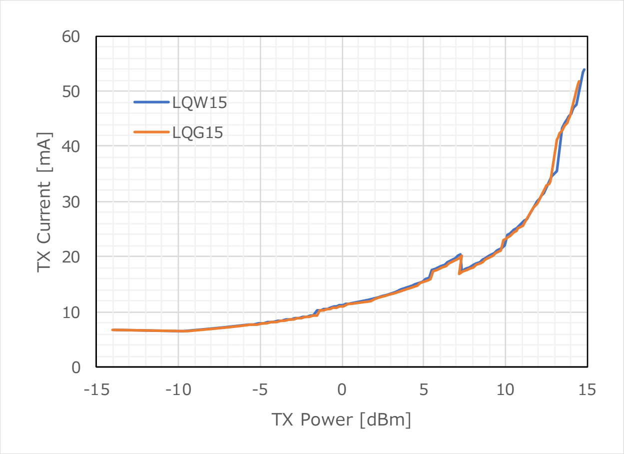

Figure 23 TX Current (915.0MHz)

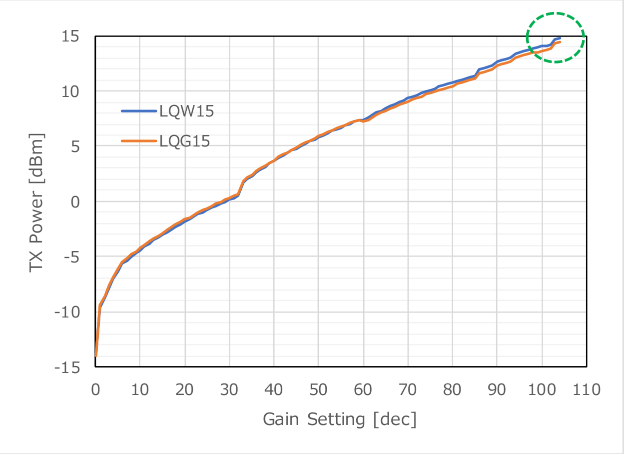

Figure 24 TX Power (927.8MHz)

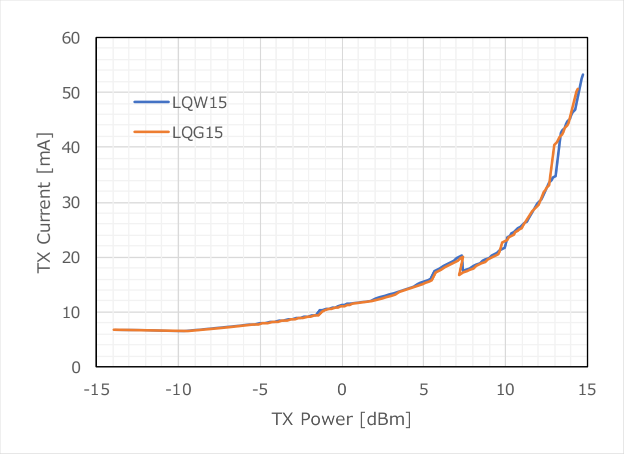

Figure 25 TX Current (927.8MHz)

3.2.2 TX Harmonics Response

Condition : Power Supply = 3.0V, Temperature = Room, Signal = Sin wave, Gain Setting = 104(dec)

The harmonic response is affected by the inductor change. However, there is enough margin for the standard. The circle in the figure shows the degraded part.
The spec line in the figure shows FCC standard (FCC Part 15.247).

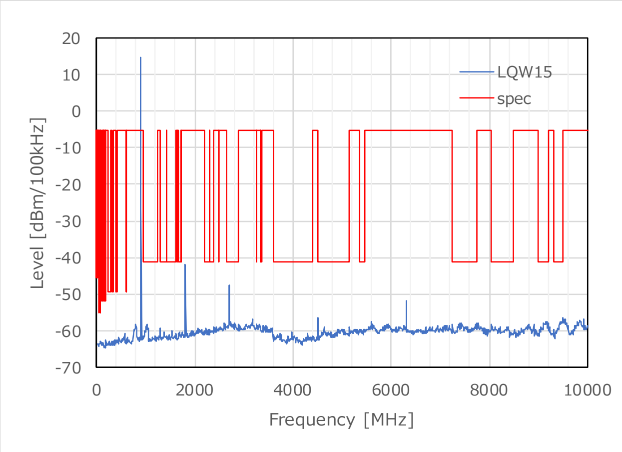

Figure 26 TX Harmonics_LQW15 (902.2MHz)

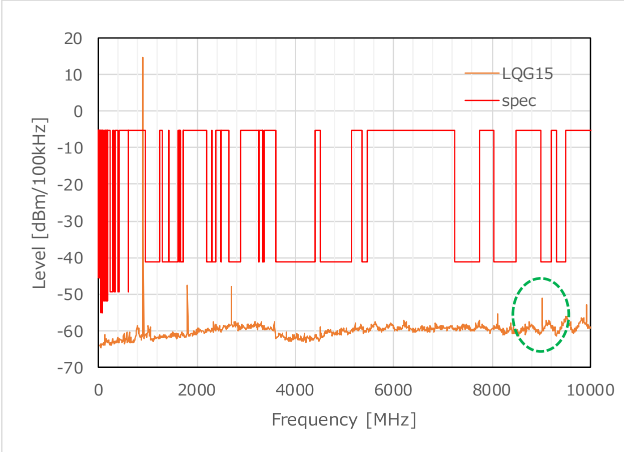

Figure 27 TX Harmonics_LQG15 (902.2MHz)

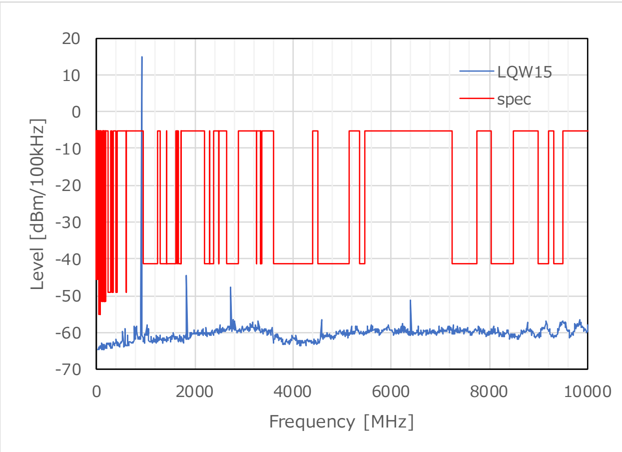

Figure 28 TX Harmonics_LQW15 (915.0MHz)

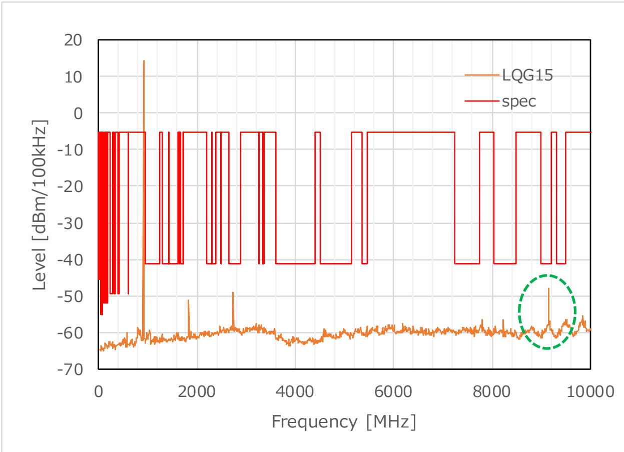

Figure 29 TX Harmonics_LQG15 (915.0MHz)

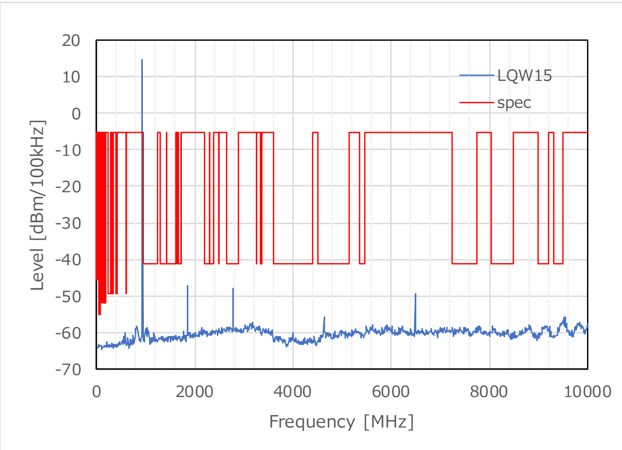

Figure 30 TX Harmonics_LQW15 (927.8MHz)

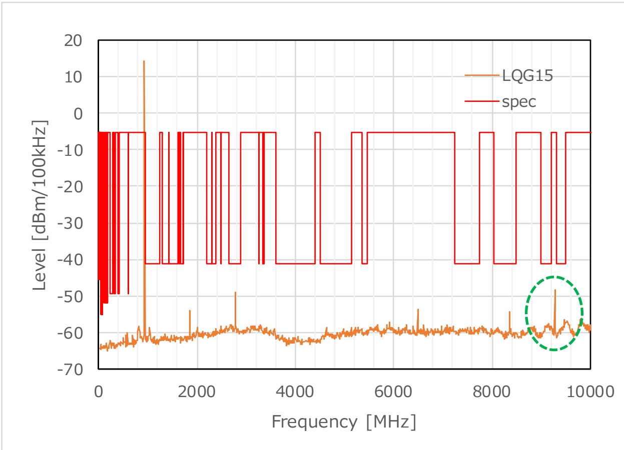

Figure 31 TX Harmonics_LQG15 (927.8MHz)

3.2.3 RX Sensitivity

Condition : Power Supply = 3.0V, Temperature = Room, Data Rate = 50kbps(m=1)

There is no degradation of RX sensitivity by the inductor change.

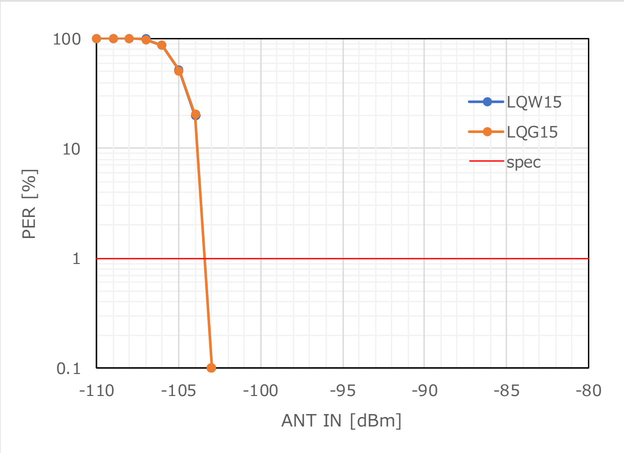

Figure 32 RX Sensitivity_PER (902.2MHz)

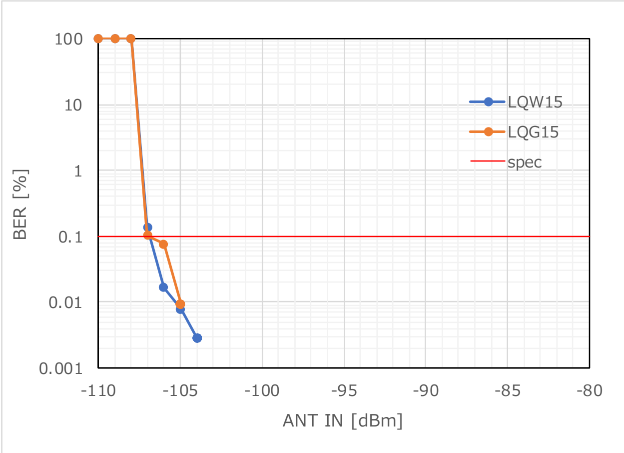

Figure 33 RX Sensitivity_BER (902.2MHz)

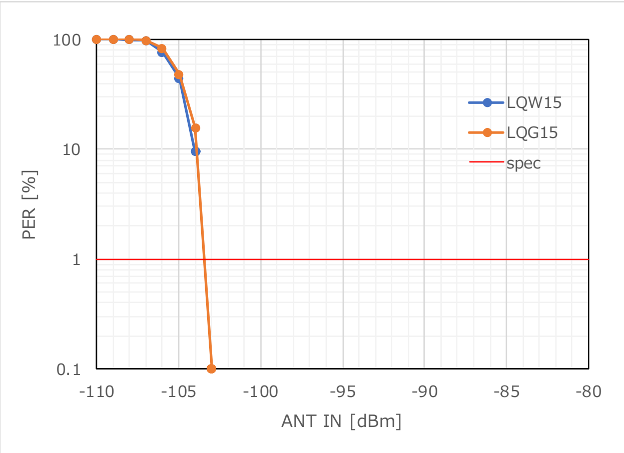

Figure 34 RX Sensitivity_PER (915.0MHz)

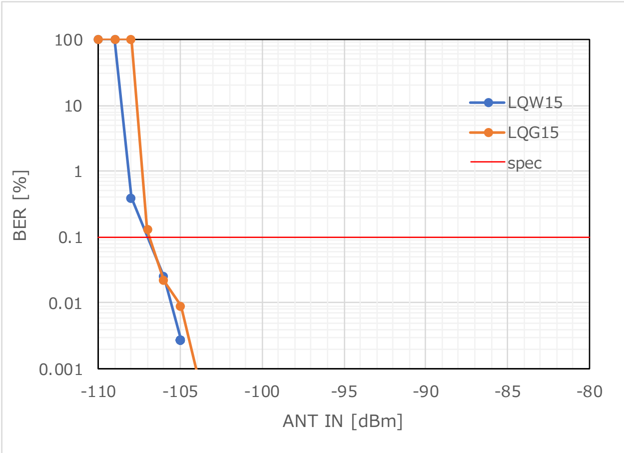

Figure 35 RX Sensitivity_BER (915.0MHz)

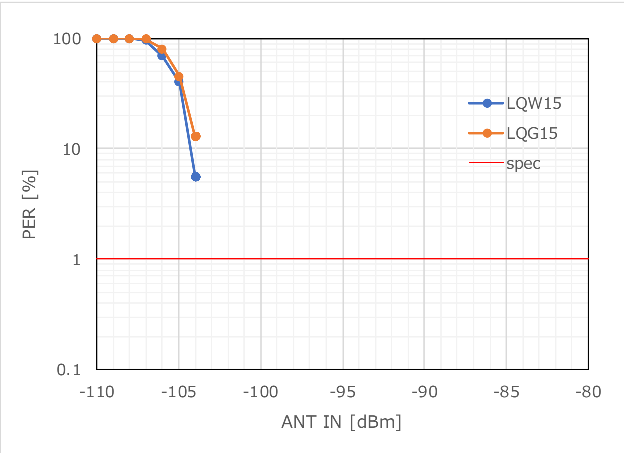

Figure 36 RX Sensitivity_PER (927.8MHz)

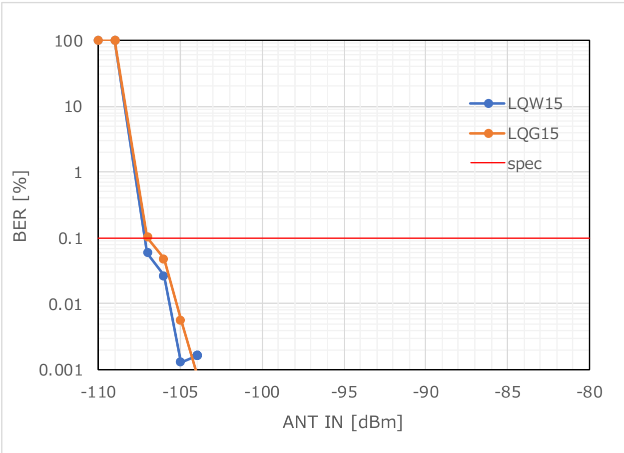

Figure 37 RX Sensitivity_BER (927.8MHz)

4. Characteristic example of 2-layer board

4.1 EU Band (863～876MHz)

4.1.1 TX Power / TX Current

Condition：Power Supply = 3.0V, Temperature = Room, Signal = Sin wave

The maximum transmit power is reduced about 0.2dB by the inductor change.

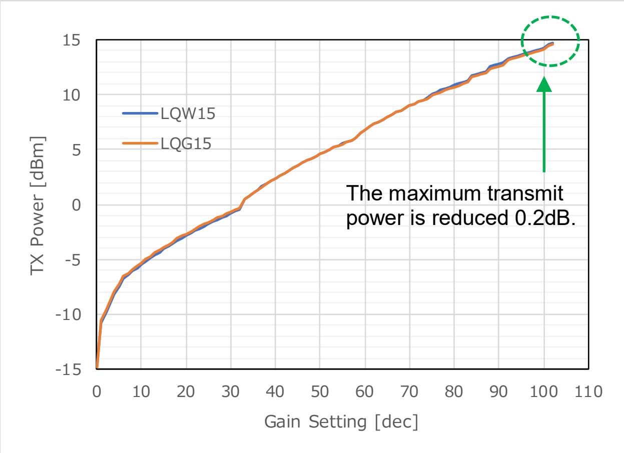

Figure 38 TX Power (863.1MHz)

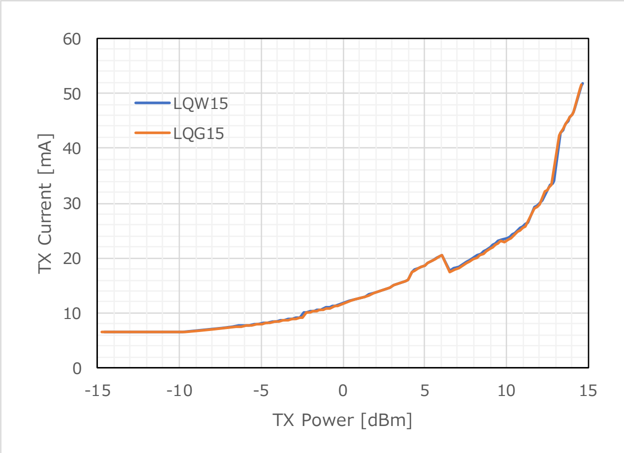

Figure 39 TX Current (863.1MHz)

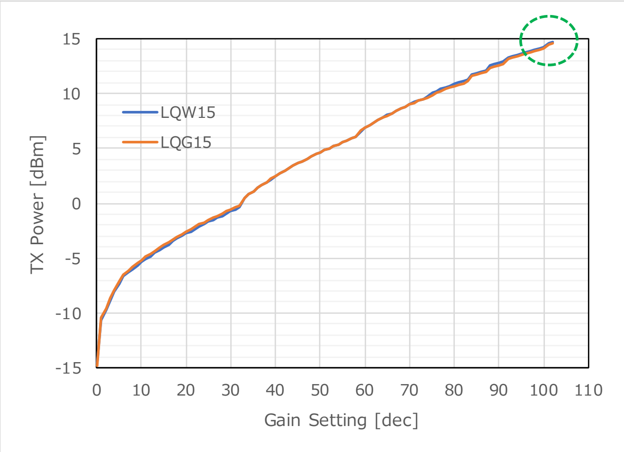

Figure 40 TX Power (869.3MHz)

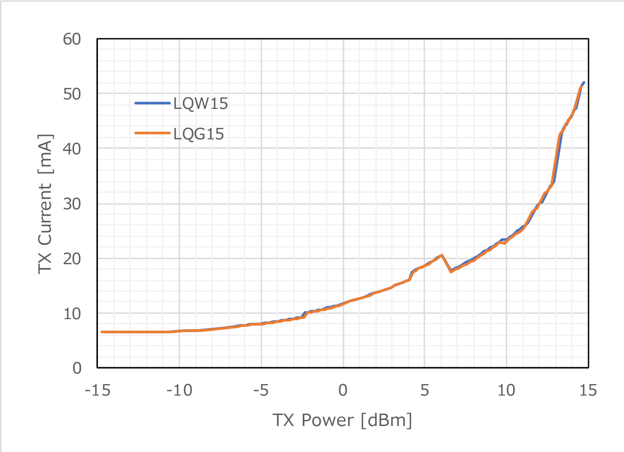

Figure 41 TX Current (869.3MHz)

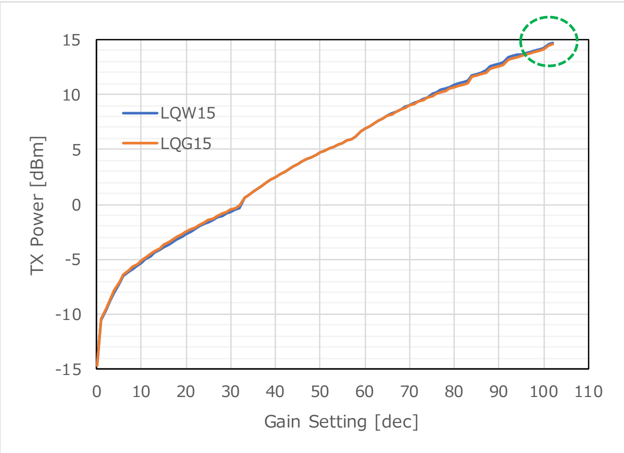

Figure 42 TX Power (875.5MHz)

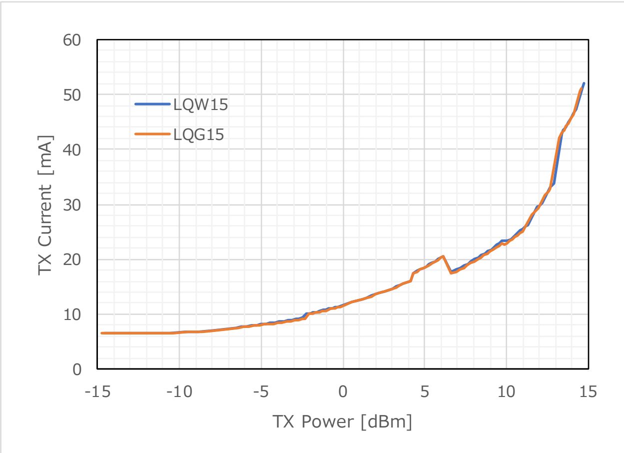

Figure 43 TX Current (875.5MHz)

4.1.2 TX Harmonics Response

Condition：Power Supply = 3.0V, Temperature = Room, Signal = Sin wave, Gain Setting = 102(dec)

The harmonic response is affected by the inductor change. However, there is enough margin for the standard. The circle in the figure shows the degraded part.
The spec line in the figure shows ETSI standard (EN 300 220).

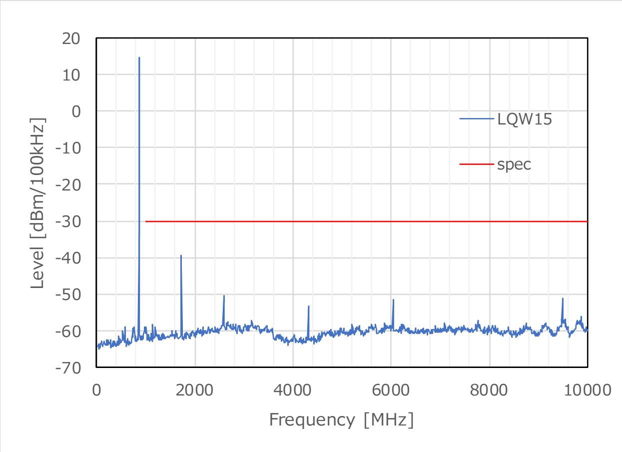

Figure 44 TX Harmonics_LQW15 (863.1MHz)

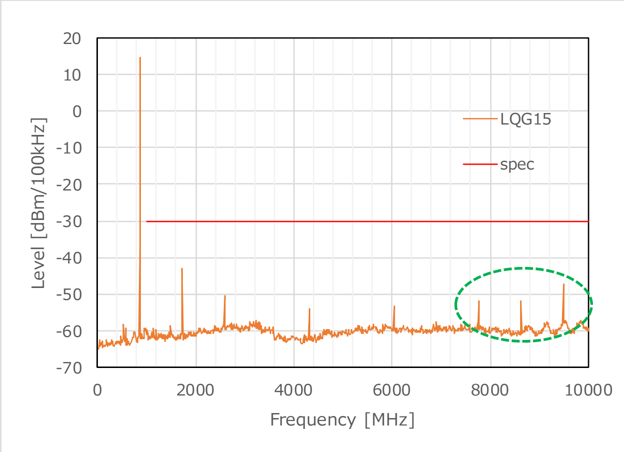

Figure 45 TX Harmonics_LQG15 (863.1MHz)

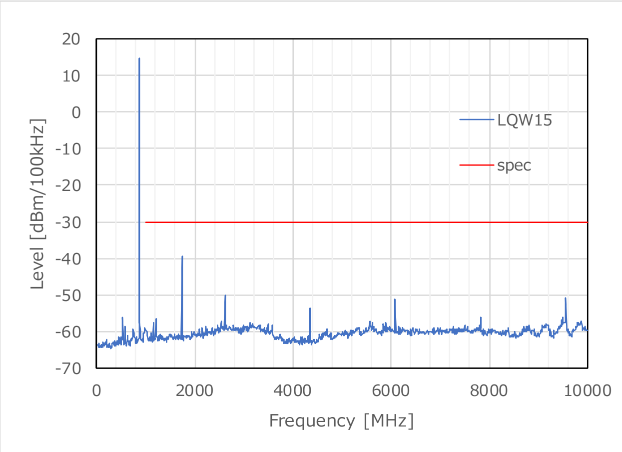

Figure 46 TX Harmonics_LQW15 (869.3MHz)

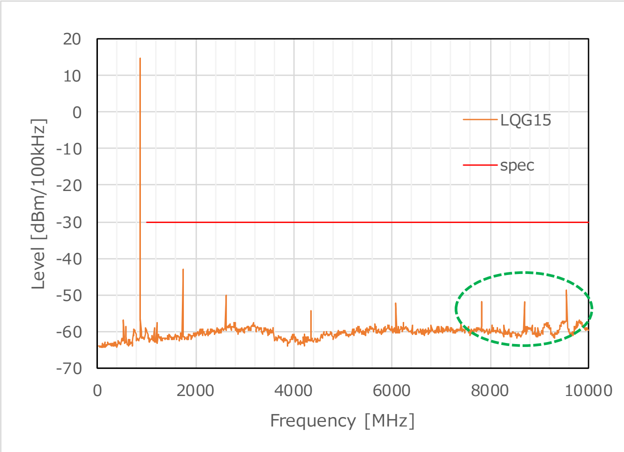

Figure 47 TX Harmonics_LQG15 (869.3MHz)

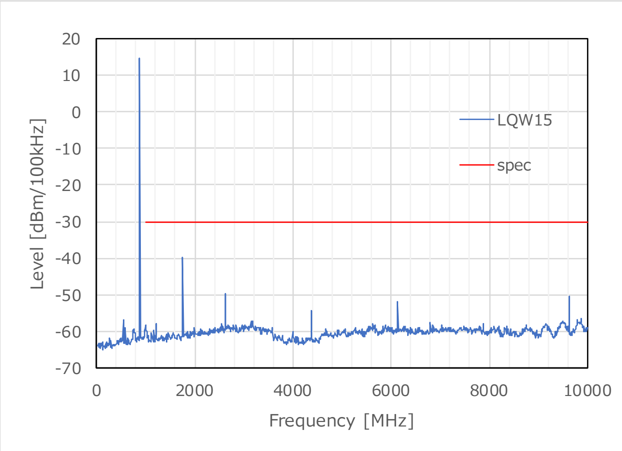

Figure 48 TX Harmonics_LQW15 (875.5MHz)

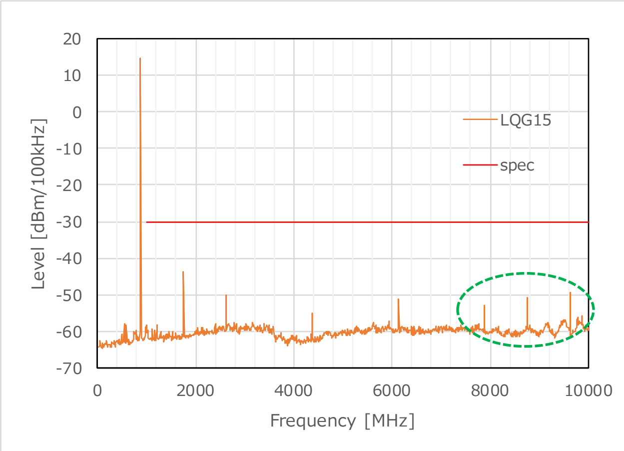

Figure 49 TX Harmonics_LQG15 (875.5MHz)

4.1.3 RX Sensitivity

Condition : Power Supply = 3.0V, Temperature = Room, Data Rate = 50kbps(m=0.5)

There is no degradation of RX sensitivity by the inductor change.

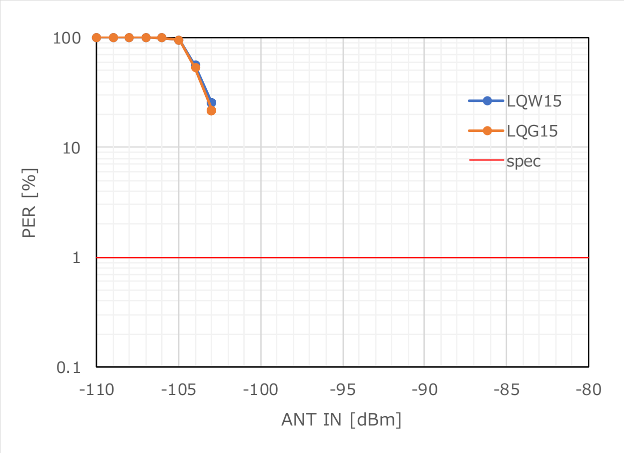

Figure 50 RX Sensitivity_PER (863.1MHz)

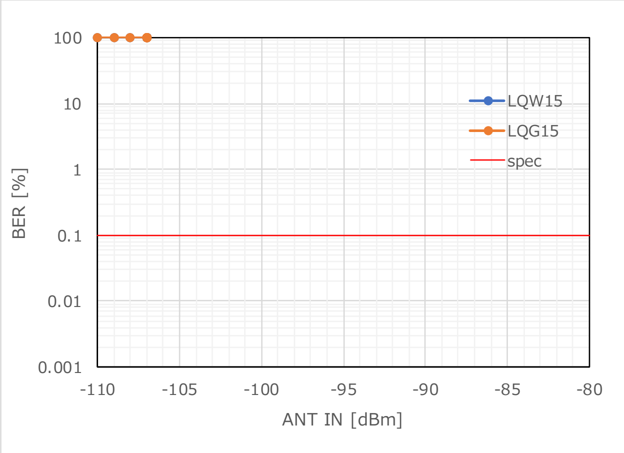

Figure 51 RX Sensitivity_BER (863.1MHz)

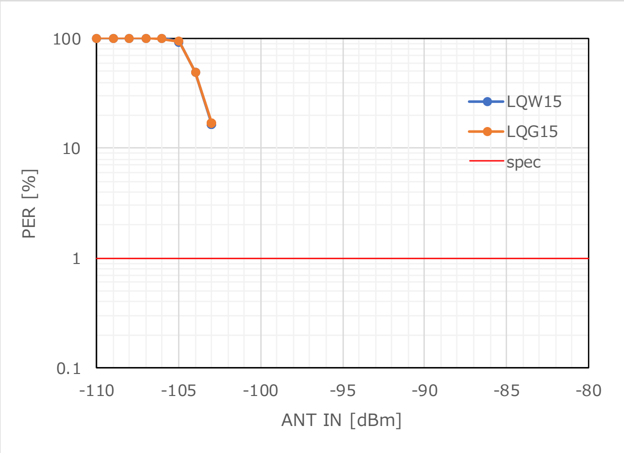

Figure 52 RX Sensitivity_PER (869.3MHz)

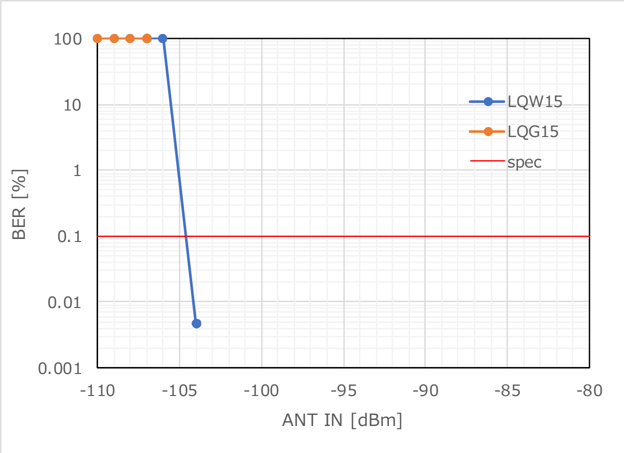

Figure 53 RX Sensitivity_BER (869.3MHz)

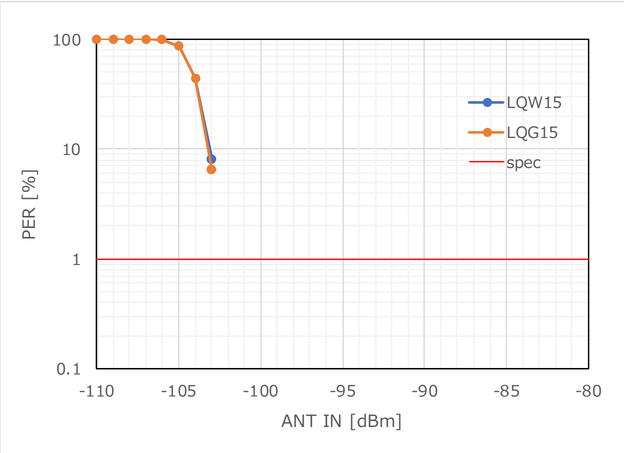

Figure 54 RX Sensitivity_PER (875.5MHz)

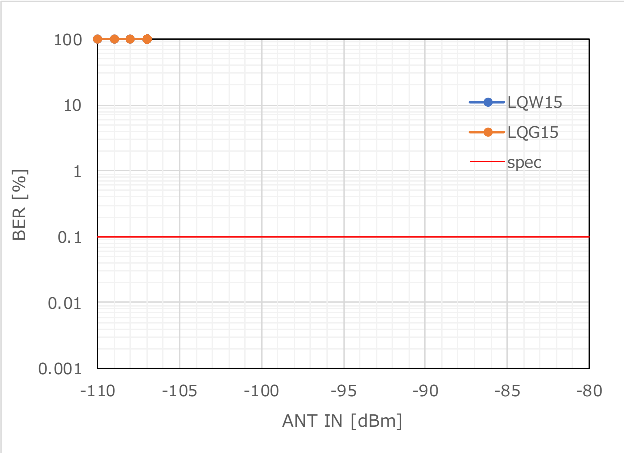

Figure 55 RX Sensitivity_BER (875.5MHz)

4.2 US Band (902～928MHz)

4.2.1 TX Power / TX Current

Condition：Power Supply = 3.0V, Temperature = Room, Signal = Sin wave

The maximum transmit power is reduced about 0.3dB by the inductor change.

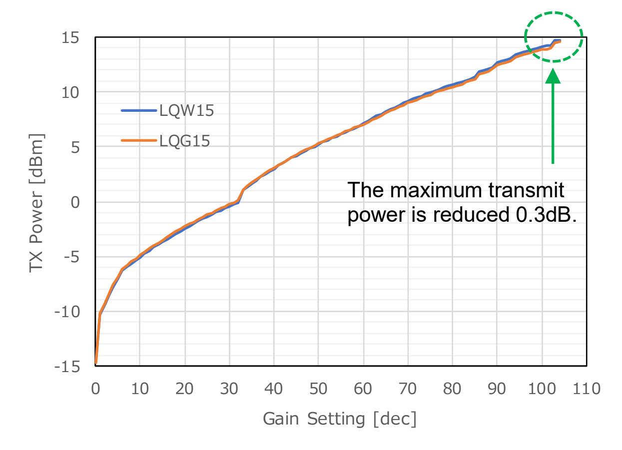

Figure 56 TX Power (902. 2MHz)

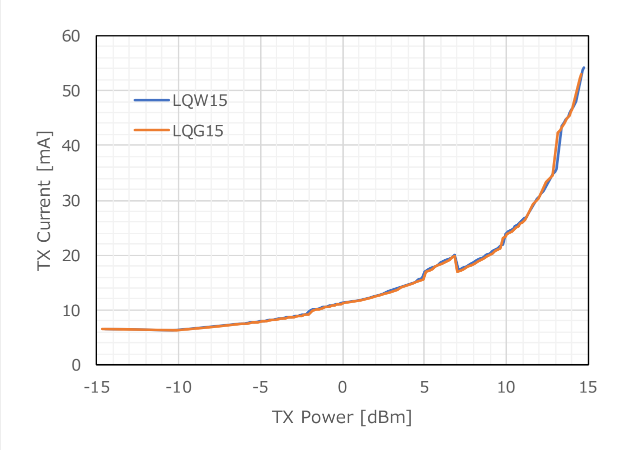

Figure 57 TX Current (902.2MHz)

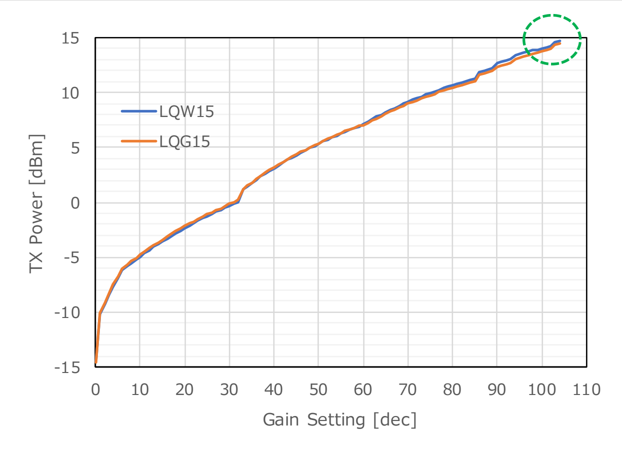

Figure 58 TX Power (915.0MHz)

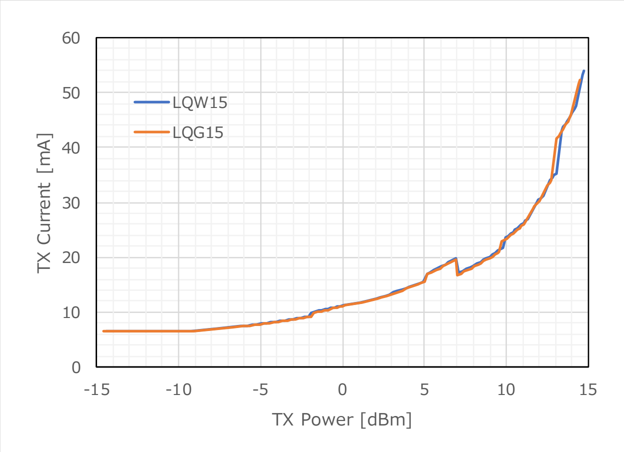

Figure 59 TX Current (915.0MHz)

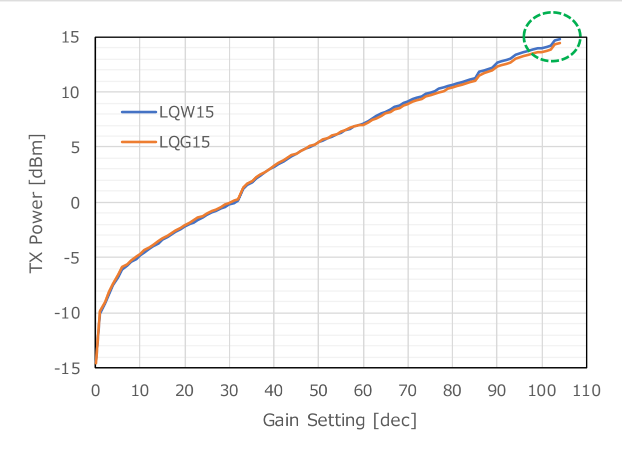

Figure 60 TX Power (927.8MHz)

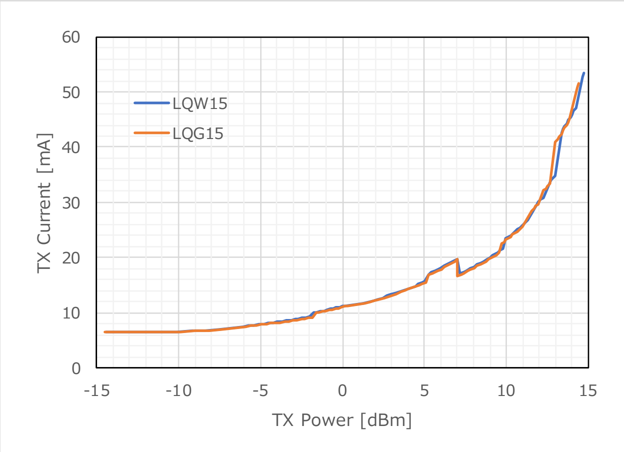

Figure 61 TX Current (927.8MHz)

4.2.2 TX Harmonics Response

Condition：Power Supply = 3.0V, Temperature = Room, Signal = Sin wave, Gain Setting = 104(dec)

The harmonic response is affected by the inductor change. However, there is enough margin for the standard. The circle in the figure shows the degraded part.
The spec line in the figure shows FCC standard (FCC Part 15.247).

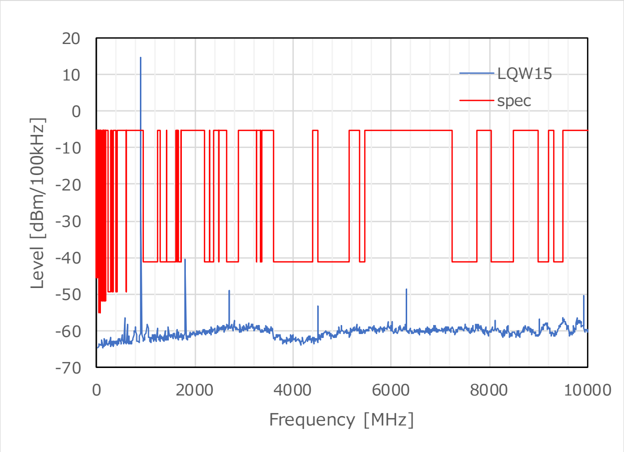

Figure 62 TX Harmonics_LQW15 (902.2MHz)

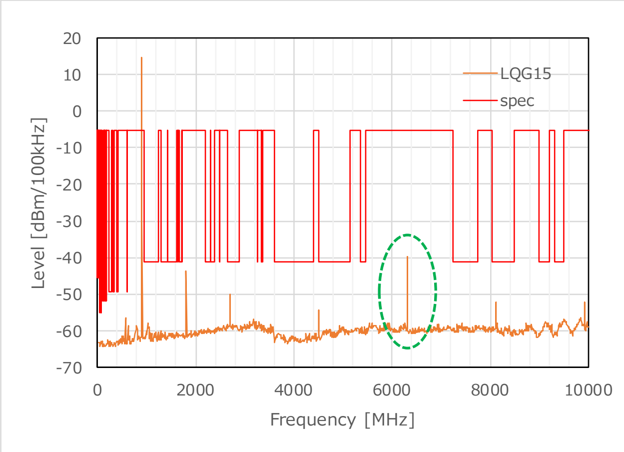

Figure 63 TX Harmonics_LQG15 (902.2MHz)

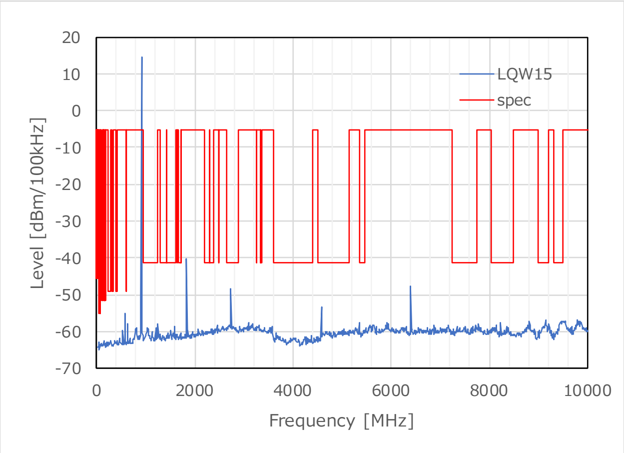

Figure 64 TX Harmonics_LQW15 (915.0MHz)

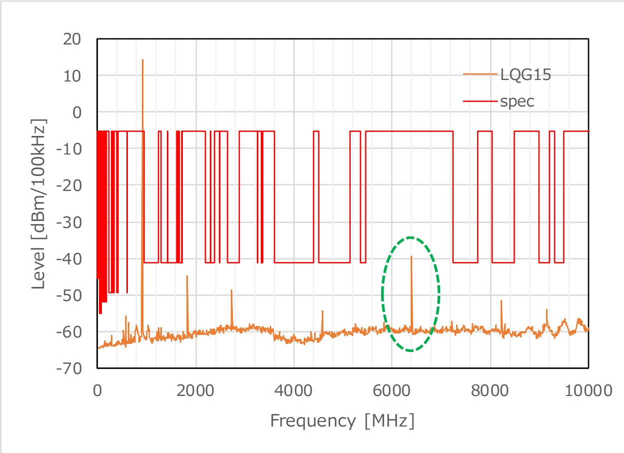

Figure 65 TX Harmonics_LQG15 (915.0MHz)

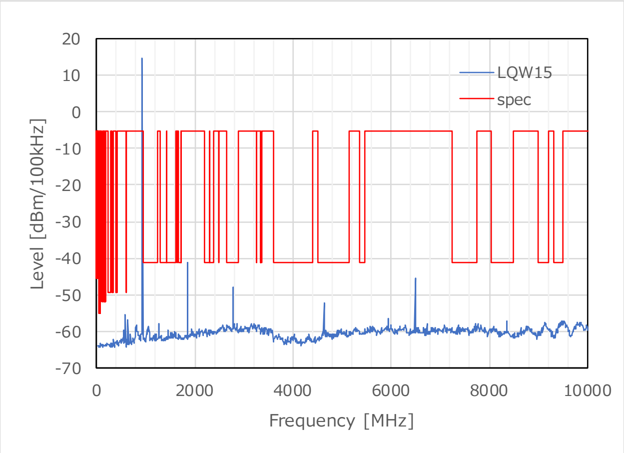

Figure 66 TX Harmonics_LQW15 (927.8MHz)

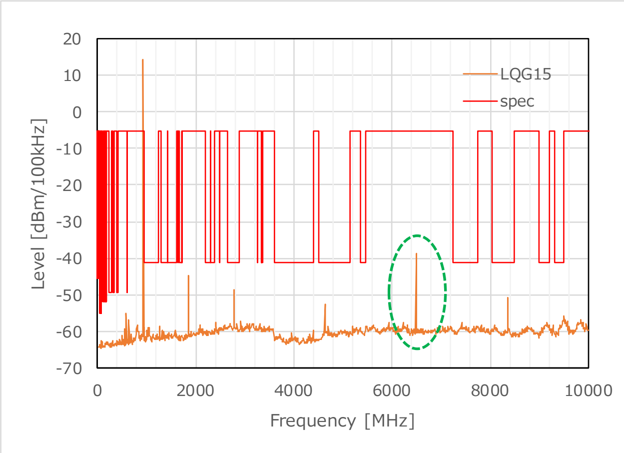

Figure 67 TX Harmonics_LQG15 (927.8MHz)

4.2.3 RX Sensitivity

Condition：Power Supply = 3.0V, Temperature = Room, Data Rate = 50kbps(m=1)

There is no degradation of RX sensitivity by the inductor change.

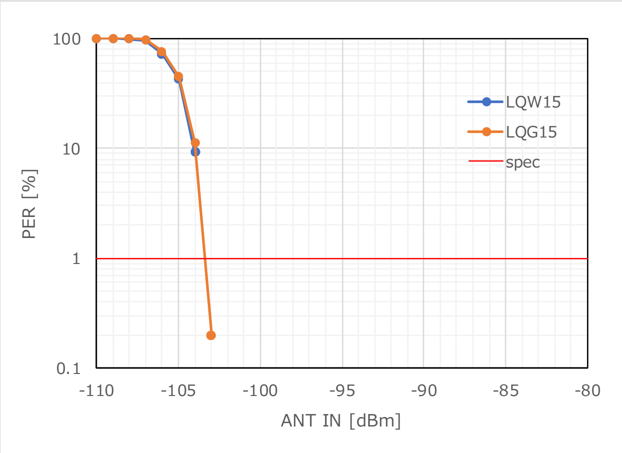

Figure 68 RX Sensitivity_PER (902.2MHz)

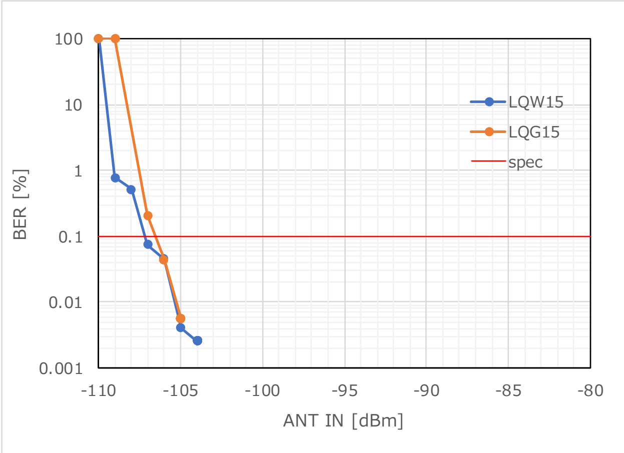

Figure 69 RX Sensitivity_BER (902.2MHz)

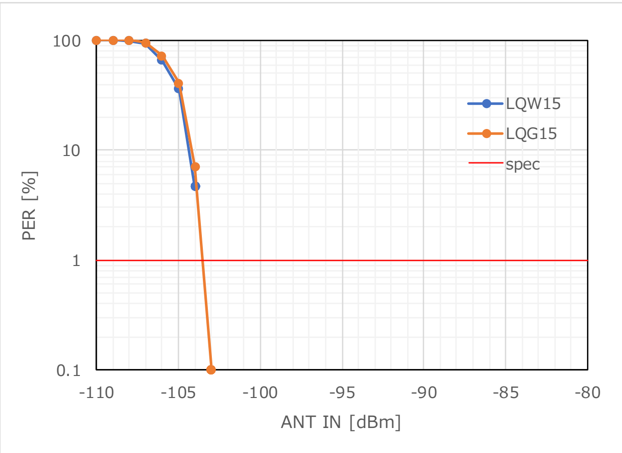

Figure 70 RX Sensitivity_PER (915.0MHz)

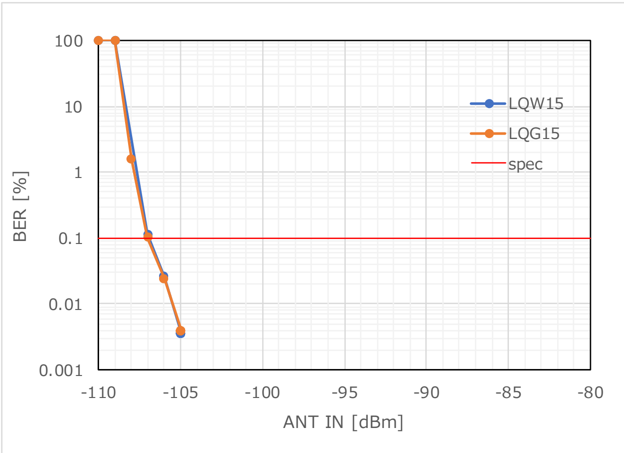

Figure 71 RX Sensitivity_BER (915.0MHz)

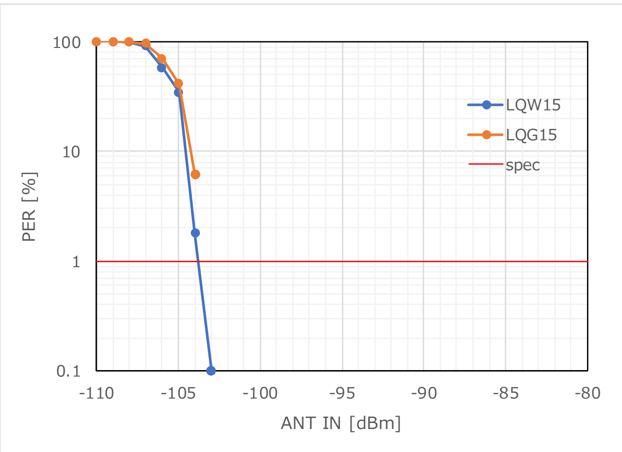

Figure 72 RX Sensitivity_PER (927.8MHz)

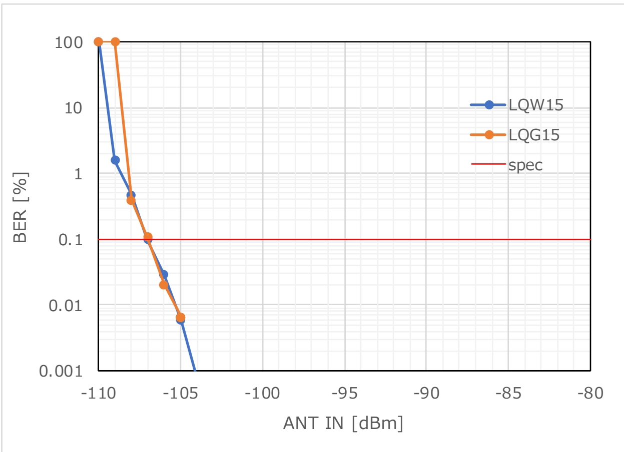

Figure 73 RX Sensitivity_BER (927.8MHz)

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Jun.21.2019	-	First edition issued

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Precaution against Electrostatic Discharge (ESD)

   A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.
2. Processing at power-on

   The state of the product is undefined at the time when power is supplied. The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the time when power is supplied. In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the time when power is supplied until the reset process is completed. In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the time when power is supplied until the power reaches the level at which resetting is specified.
3. Input of signal during power-off state

   Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.
4. Handling of unused pins

   Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of the LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible.
5. Clock signals

   After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is stabilized. When the clock signal is generated with an external resonator or from an external oscillator during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Additionally, when switching to a clock signal produced with an external resonator or by an external oscillator while program execution is in progress, wait until the target clock signal is stable.
6. Voltage application waveform at input pin

   Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).
7. Prohibition of access to reserved addresses

   Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.
8. Differences between products

   Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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Contact information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit: www.renesas.com/contact/.