RL78/G1H, RAA604S00

Guidelines for wireless evaluation

R01AN3943EJ0100
Rev.1.00
Jun 29, 2017

Introduction

This application note introduces the measurement procedure and precautions of radio evaluation and example of field test.

Note: The contents of this document are provided as an example for reference and do not guarantee the signal quality in systems. When measuring by yourself, please use within the testing facility such as anechoic chamber for strict observance of the radio wave law, or obtain the technical standard conformity certificate.

Target Device

RL78/G1H, RAA604S00

Contents

1. Overview

This application note introduces the measurement procedure and precautions of radio evaluation and example of the field test. The communication distance varies depending on the installation condition of the antenna and various environmental conditions around the surroundings such as obstacles. Therefore, in order to obtain the original communication characteristics of the radio, it is recommended to measure according to the precautions described in this manual.

1.1 Related documents

The following document is related to the application note. Also to this document when using this application note,

- Design Guidelines for a Pattern Antenna(R01AN3776)

2. Advance preparation

2.1 Antenna matching

Before the radio evaluation, it is necessary first to match the antenna to the desired frequency band. If the antenna matching is misaligned, radio waves can not be radiated efficiently. Since the monopole antenna used in this document uses ground for one side of the dipole antenna, antenna characteristics will change depending on the size of the board. Therefore, it is necessary to adjust the antenna matching for each board to be used. To adjust the matching circuit, attach a semi-rigid cable to the feed point of the antenna end and confirm while checking the VSWR with the network analyzer. For detailed adjustment method, refer to the application note (R01AN 3766).

3. Evaluation procedure

3.1 Attach an antenna

Attach antennas to both transmitter and receiver respectively. As shown in Figure 3-1, when the dipole antenna stands vertically, the horizontal plane becomes omnidirectional, so connect the antenna so that it is horizontal with the ground plane of the evaluation board and use it vertically. If the directivity of the antenna changes, the optimum gain can not be obtained.

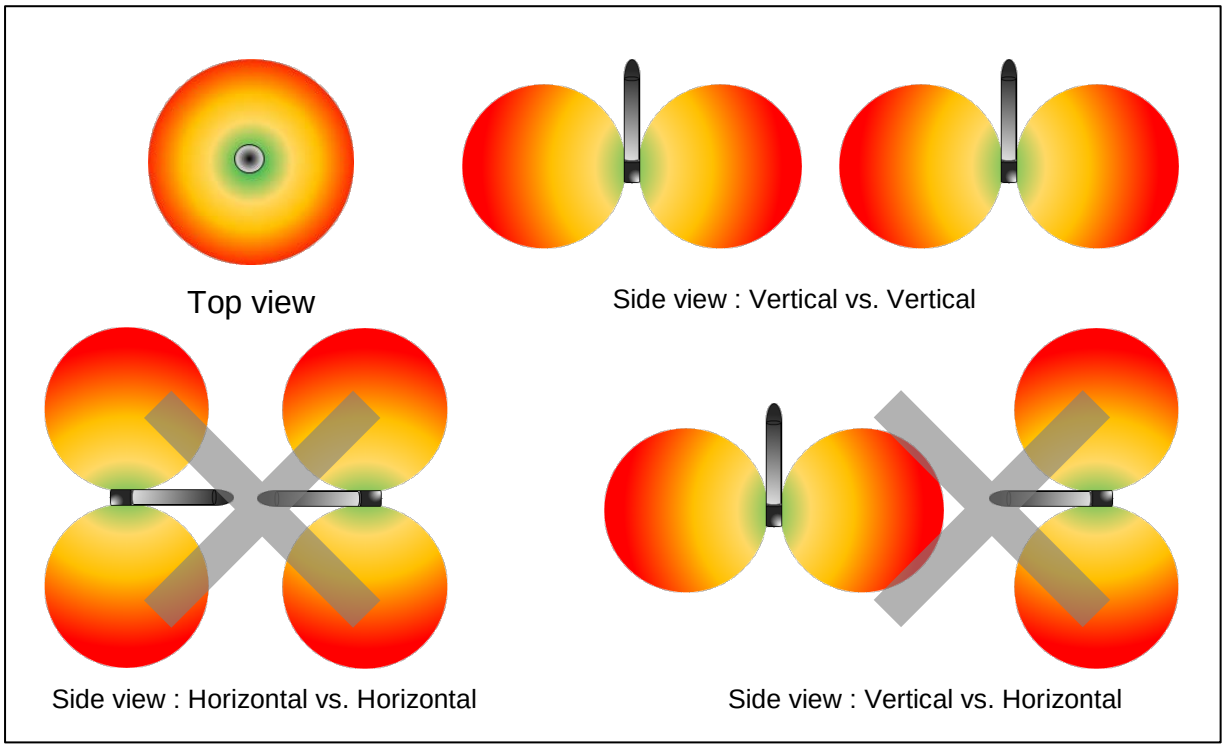


Figure 3-1 Radio field intensity and directivity of antenna

3.2 Installation of an evaluation board

3.2.1 Direction of an antenna

When installing the evaluation board, it is necessary to match the polarization plane of the antenna of both transmitter and receiver. Since the radio waves have a vibration direction, the communication distance will not lengthen because loss will increase if polarization planes are not matched.

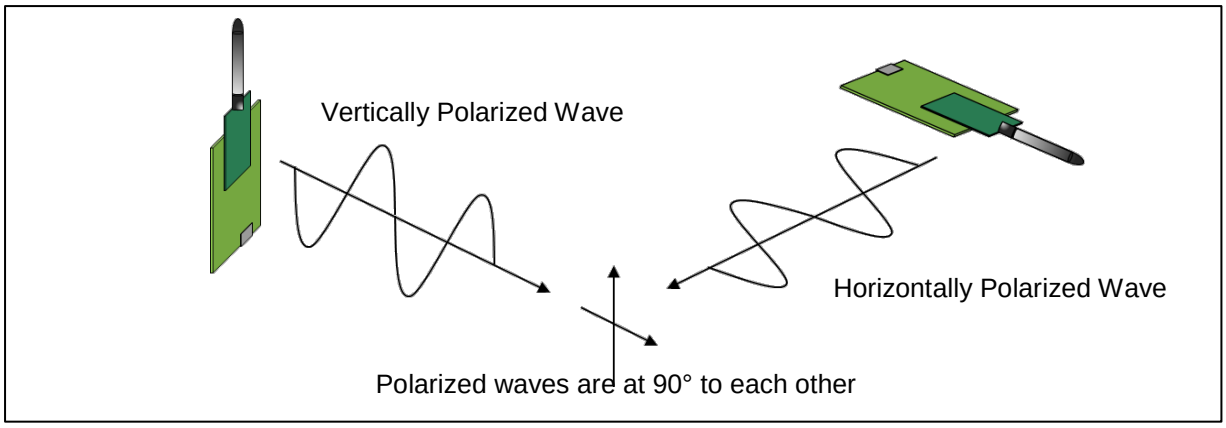


Figure 3-2 Antenna polarization

3.2.2 Height of an antenna

Use a tripod or the like to eliminate the influence of obstacles and install the evaluation board as high as possible. Also, please install so that both transmitter and receiver are at the same height.

3.2.3 Around the antenna

Please do not install anything within one wavelength from the antenna. Keep it away from the metal as much as possible in order to remarkably degrade characteristics in particular. When installing the evaluation board, in order to prevent the resonance frequency from shifting to the low frequency side due to the wavelength shortening effect of the dielectric, please fix with curing tape to foamed styrol. Also, since the human body likewise affects the frequency, measure it away from the evaluation board as much as possible, for example by using a long cable.

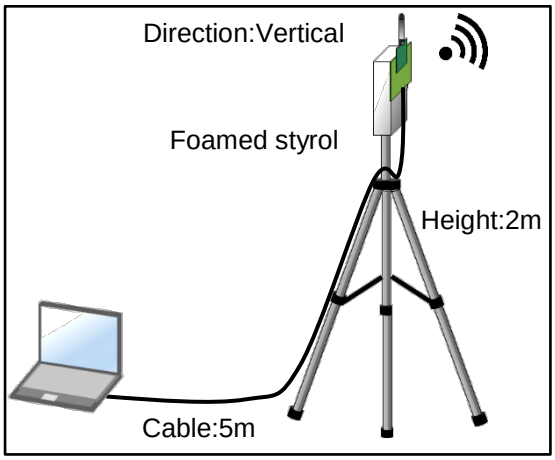


Figure 3-3 Transmitting side

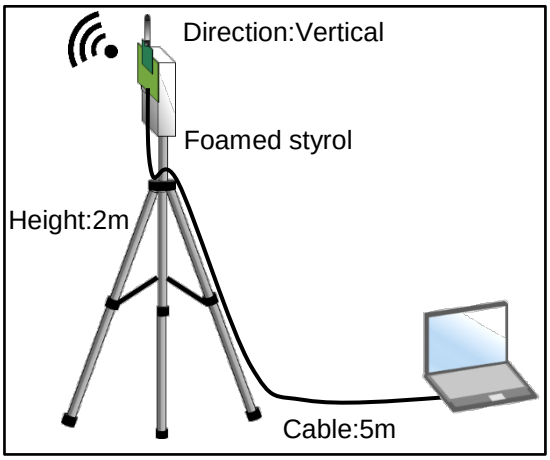


Figure 3-4 Receiving side

3.3 Connect the evaluation boat and the laptop with a USB cable

Connect the laptop and the evaluation board with a USB cable and execute each function by command from the laptop. At this time there is a possibility that reception sensitivity may deteriorate due to USB radiation noise, so wire the USB cable vertically to the antenna. In addition, as shown in Figure 3-5, it is necessary to suppress the emission of noise by using a ferrite core, an EMI filter or the like as necessary. When connecting to a laptop with a serial conversion (FTDI) cable without using the USB port of the evaluation board, please take measures against shielding and separate the distance between the evaluation board and the laptop sufficiently.

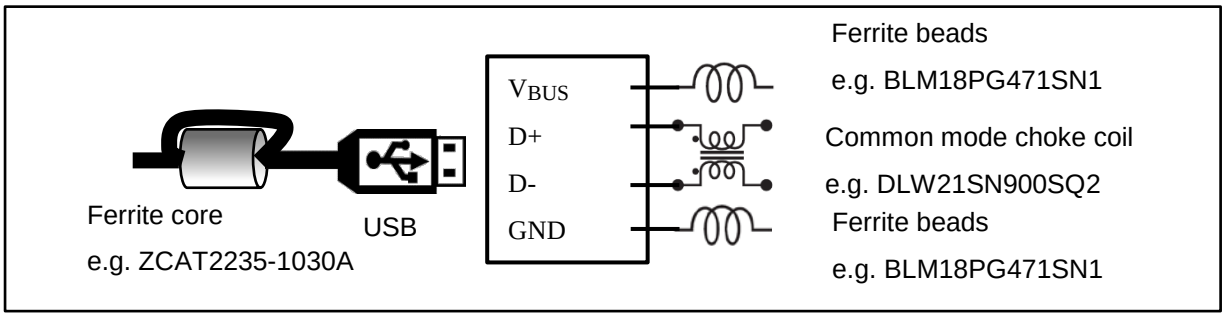


Figure 3-5 Example of USB noise suppression

3.4 Run terminal software

Activate terminal software (Tera Term etc.) and configure the serial port. When the RF characteristics evaluation program starts up, it becomes possible to enter commands.

3.5 Enter commands on the laptop

3.5.1 Executing the command of the receiver

Enter the command in Table 3-1 to the receiver and put it in the packet reception state.

Table 3-1 measurement commands of receiver

command (and SetData[Dec])? >tfband 9	―Frequency band setting(e.g. Japan)
command (and SetData[Dec])? >tfsk 2	―Modulation setting(e.g. 100kbps_m=1)
command (and SetData[Dec])? >t2 30	―Channel number setting(e.g. 926.7MHz)
command (and SetData[Dec])? >tberpn9 1	―PN9 mode setting
command (and SetData[Dec])? >tberlen 20	―Frame length setting(e.g. 20byte)
command (and SetData[Dec])? >tfcs 4	―FCS length setting(e.g. 4byte)
command (and SetData[Dec])? >tdw 0	―Data whitening setting(OFF)
command (and SetData[Dec])? >t7 0x11	―BER reception state

3.5.2 Execute the command of the transmitter

Enter the commands in Table 3-2 on the transmitter and transmit 1000 packets.

Table 3-2 measurement commands of transmitter

command (and SetData[Dec])? >tttl 1	―ARIB STD-T108 60 minutes mode is enable
command (and SetData[Dec])? >ttxopt 1	―CCA is executed
command (and SetData[Dec])? >tfband 9	―Frequency band setting(e.g. Japan)
command (and SetData[Dec])? >tfsk 2	―Modulation setting(e.g. 100kbps_m=1)
command (and SetData[Dec])? >t2 30	―Channel number setting(e.g. 926.7MHz)
command (and SetData[Dec])? >t4 93	―Transmission output power setting(e.g. +13dBm)
command (and SetData[Dec])? >t5 20	―Transmission packet length setting(e.g. 20byte)
command (and SetData[Dec])? >tpl 8	―Preamble length setting(e.g. 8byte)
command (and SetData[Dec])? >tberpn9 1	―PN9 mode setting
command (and SetData[Dec])? >tfcs 4	―FCS length setting(e.g. 4byte)
command (and SetData[Dec])? >tdw 0	―Data whitening setting(OFF)
command (and SetData[Dec])? >t6 1000	―Transmit 1000 packets(e.g. 1000packet)

3.5.3 Confirm the result displayed on the receiver

After confirming that the transmission has finished 1000 packets, when the receiving side terminates the packet reception state with the return key, the result shown in Table 3-3 is displayed.

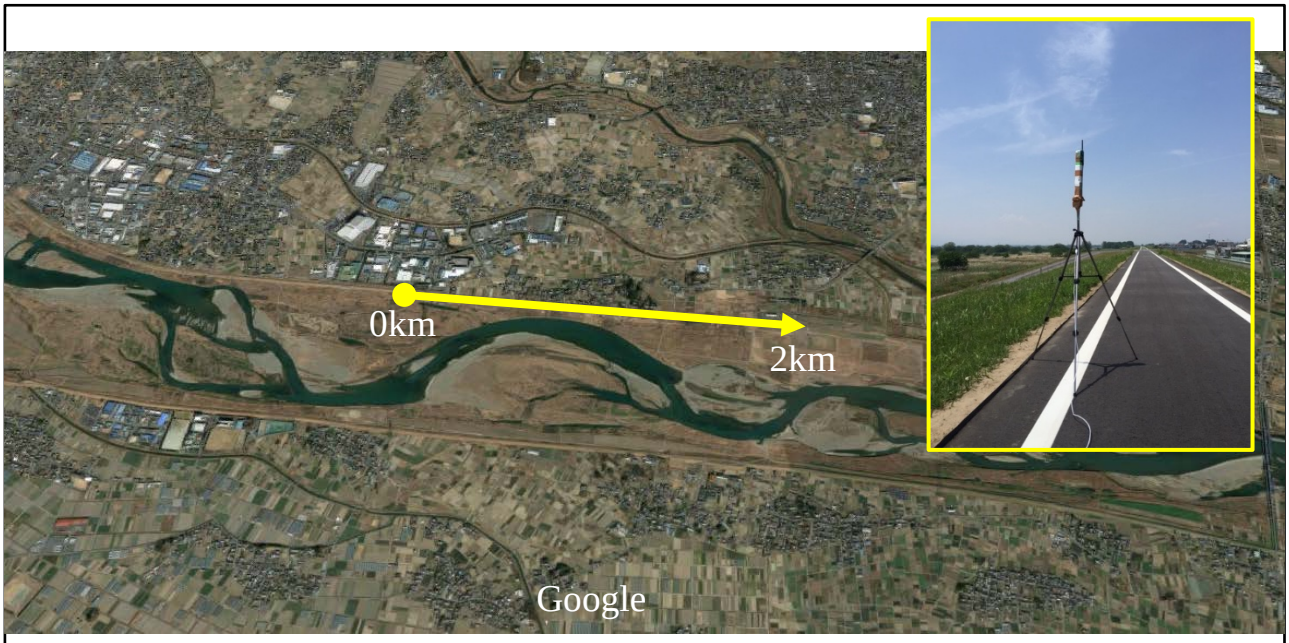
Table 3-3 measurement results of receiver

TotalPckt=1000 OKPckt=1000 NGPckt=0(NowNG=0) TotalBit=0001F400h OKBit=0001F400h NGBit=00000000h(NowNG=0000h) BER = 0.00% RSSI= -34dBm(Ave), -34dBm(Max), -34dBm(Min) LQI = 255(Ave), 255(Max), 255(Min)

4. Reference case

4.1 Field test results

We measured the communication distance on a cycling road where better prospects and long straight line continues along the Tone River. At this time, both the transmitter and the receiver are fixed with a tripod at a height of 2m from the ground, and the orientation of the antenna is set perpendicular to the ground (vertically polarized wave). Connect the wireless device and the laptop with a 5m USB cable, operated the laptop at a distance. In this test, 1,000 packets were transmitted every 200 meters from the transmitter, and the packet error rate was measured on the receiver side.



【Measurement condition】 CH=30(926.7MHz), Output Power=+13dBm(20mW)
Data Rate=100kbps, Modulation=2GFSK, Modulation Index=1
Preamble=8byte, FCS=4byte, Payload=20byte, FEC disabled

Figure 4-1 measurement environment

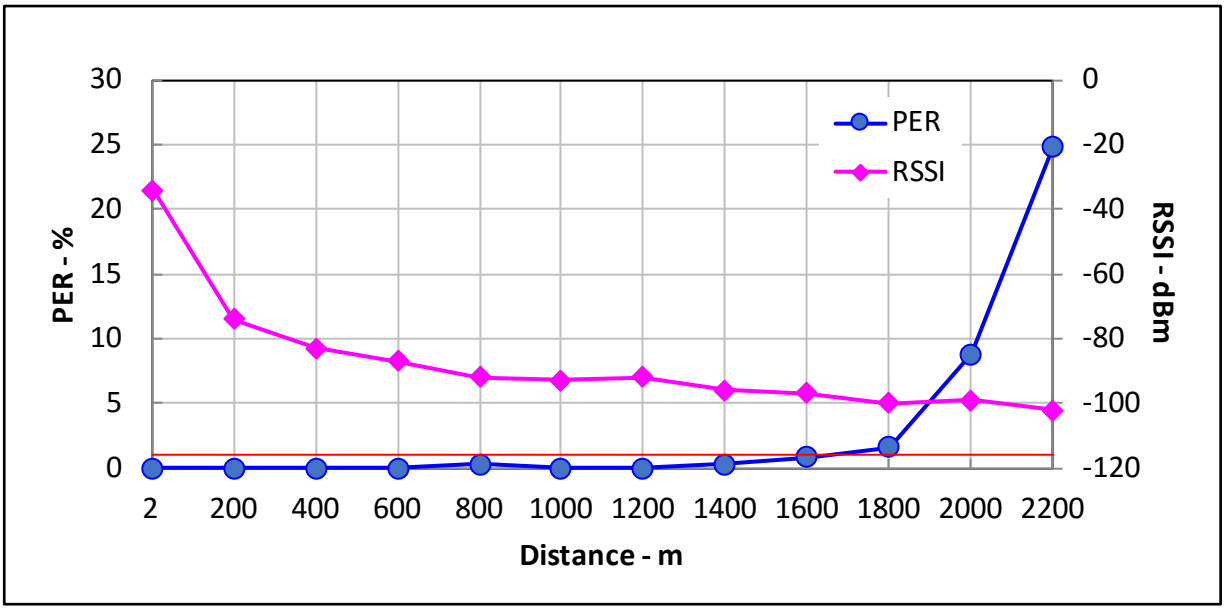


Figure 4-2 Packet error rate in each measurement point

Figure 4-2 shows the packet error rate and RSSI value in each measurement point.

4.2 Test circuit

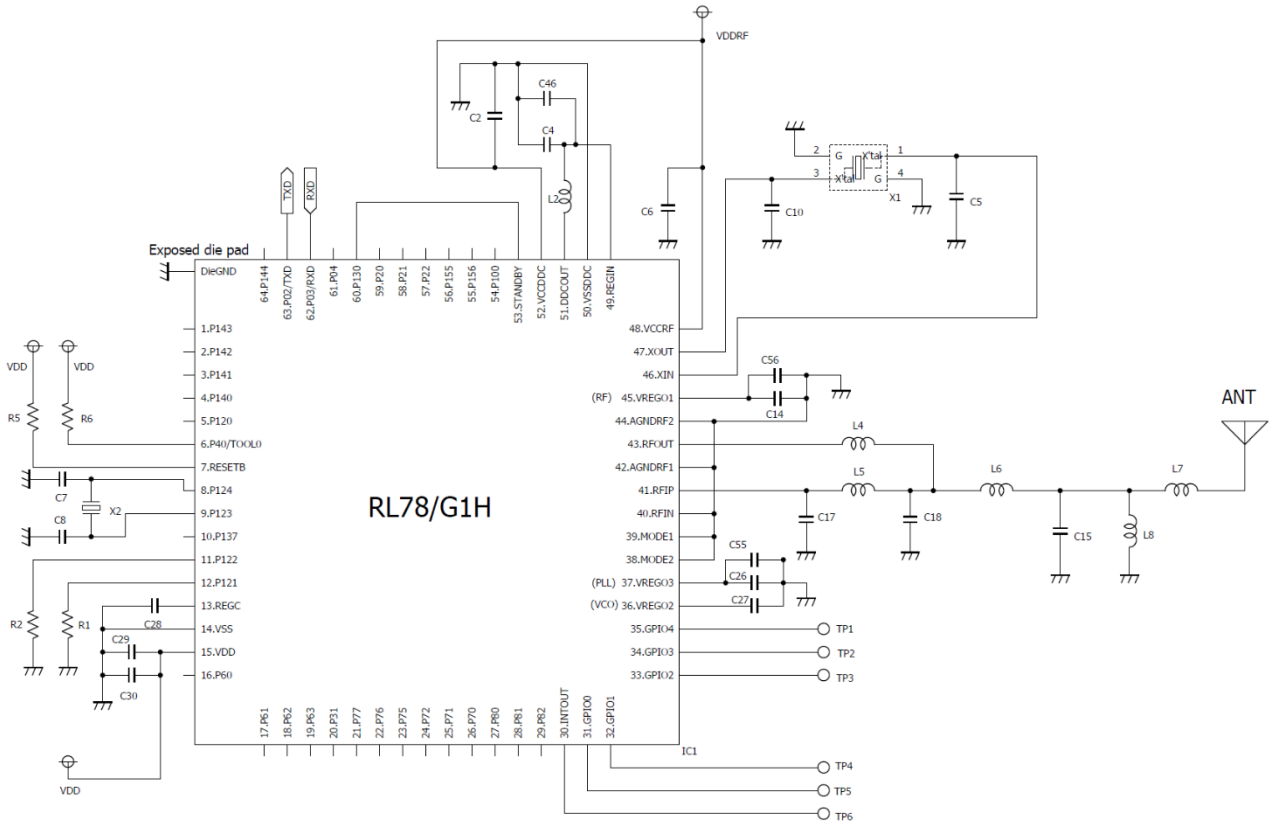


Table 4-1 Bill of materials

Parts ID	Description	Parts Number	Parts ID	Description	Parts Number
C2	1uF	GRM155B31C105KA12D	L2	10uH	MLZ1608M100WT
C4	1uF	GRM155B31C105KA12D	L4	2.2nH	LQW15AN2N2C10D
C5	8pF	GRM1555C1H8R0DA01D	L5	5.6nH	LQW15AN5N6C10D
C6	2.2uF	GRM155R60G225ME15D	L6	5.6nH	LQW15AN5N6C10D
C7	5pF	GRM1555C1H5R0C	L7	2.4nH	LQW15AN2N4B00
C8	5pF	GRM1555C1H5R0C	L8	13nH	LQW15AN13NG00
C10	8pF	GRM1555C1H8R0DA01D	R1	100k	RK73B1ETTP104J
C14	1uF	GRM155B31C105KA12D	R2	100k	RK73B1ETTP104J
C15	3.3pF	GRM1555C1H3R3BA01D	R5	10k	RK73B1ETTP103J
C17	4.7pF	GRM1552C1H4R7CA01D	R6	10k	RK73B1ETTP103J
C18	5.6pF	GRM1555C1H5R6BA01D	X1	Crystal resonator 48MHz	CX1612DB48000B0WPNC1
C26	1uF	GRM155B31C105KA12D	X2	Crystal resonator 32.768kHz	SSP-T7-FL 3.7pF
C27	1uF	GRM155B31C105KA12D	IC1	RL78/G1H	R5F11FLL
C28	1uF	GRM155B31C105KA12D	ANT	Pole Antenna	NWX-282XSAXX
C29	1uF	GRM155B31C105KA12D			
C30	-	Not mounted			
C46	47pF	GRM1552C1H470JA01D			
C55	-	Not mounted			
C56	-	Not mounted			

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Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Jun 29, 2017	-	First edition issued

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

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   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 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. Unused pins should be handled as described under Handling of Unused Pins in the manual.

2. Processing at Power-on

   The state of the product is undefined at the moment 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 moment 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 moment 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 moment when power is supplied until the power reaches the level at which resetting has been specified.

3. Prohibition of Access to Reserved Addresses

   Access to reserved addresses is prohibited.

   — The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.

4. Clock Signals

   After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has 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. Moreover, 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.

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   Before changing from one product to another, i.e. to a product with a different part number, confirm that the change will not lead to problems.

   — The characteristics of Microprocessing unit or Microcontroller unit products in the same group but having a different part number may differ in terms of the 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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