SWLNA for 2.4GHz Band Applications

KA29223K
Datasheet

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■ IMPORTANT NOTICE

Regarding the specifications of this product, it is considered that you have agreed to the quality level and disclaimer described below.

Support for industry standards and quality standards

Functional safety standards for automobiles ISO26262	**No**
AECQ-100	**No**
Market failure rate	**50Fit**

Disclaimer

1. When the application system is designed using this IC, please design the system at your own risk. Please read, consider, and apply appropriate usage notes and description in this standard.

2. When designing your application system, please take into the consideration of break down and failure mode occurrence and possibility in semiconductor products. Measures on the systems such as, but not limited to, redundant design, mitigating the spread of fire, or preventing glitch, are recommended in order to prevent physical injury, fire, social damages, etc. in using the Nuvoton Technology Japan Corporation (hereinafter referred to as NTCJ) products.

3. When using this IC, for each actual application systems, verify the systems and the all functionality of this IC as intended in application systems and the safety including the long-term reliability at your own risk

4. Please use this IC in compliance with all applicable laws, regulations and safety-related requirements that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. NTCJ shall not be held responsible for any damage incurred as a result of this IC being used not in compliance with the applicable laws, regulations and safety-related requirements.

5. This IC does not have any security functions using cryptographic algorithms, such as authentication, encryption, tampering detection.

6. Unless this IC is indicated by NTCJ to be used in applications as meeting the requirements of a particular industry standard (e.g., ISO 9001, IATF 16949, ISO 26262, etc.), this IC is neither designed nor intended for use in such environments for that applications. NTCJ shall not be held responsible for not meeting the requirements of a particular industry standard.

7. Using IC that have been indicated as compliant with industry functional safety standards does not warrant that the application meets the requirements of industry functional safety standards. NTCJ shall not be held responsible for the application compliance with requirements of the particular industry functional safety standard.

8. Unless this IC is indicated by NTCJ to be used in applications as meeting the requirements of a particular quality standard (e.g., AECQ-100, etc.), this IC is neither designed nor intended for use in such the environments for that applications. NTCJ shall not be held responsible for not meeting the requirements of a particular quality standard.

9. In case of damages, costs, losses, and/or liabilities incurred by NTCJ arising from customer's non-compliance with above from 1 to 8, customer will indemnify NTCJ against every damages, costs, losses and responsibility.

KA29223K

SWLNA for 2.4 GHz Band Applications

■ Overview

—KA29223K is a LNA (Low Noise Amplifier)-IC integrated SW(SP3T) for 2.4GHz Band applications .
—Realizing high performance by using 0.3 μm CMOS process.
—TX mode , BT mode , RX mode / High Gain , RX mode / Low Gain are controlled by integrated CMOS logic circuit .
—Achieving miniaturization by using small size Chip Size Package with solder bump .

■ Features

—Low voltage operation	+3.3 V typ.	
—Low current consumption	11.5 mA typ.	(RX mode / High Gain)
	100 uA typ.	(RX mode / Low Gain)
	80 uA typ.	(TX mode , BT mode)
	25 uA typ.	(ALL Off mode)
—High gain	12.5 dB typ.	(RX mode/High Gain)
—Low noise figure	1.7 dB typ.	(RX mode/High Gain)
—Low Insertion Loss	0.55dB typ.	(BT mode)
	0.60dB typ.	(TX mode)

■ Applications

—Wireless LAN / Bluetooth

■ Package

— 11Pin Chip Size Package with solder bump
Size : 0.711 mm × 0.923 mm × 0.3 mm

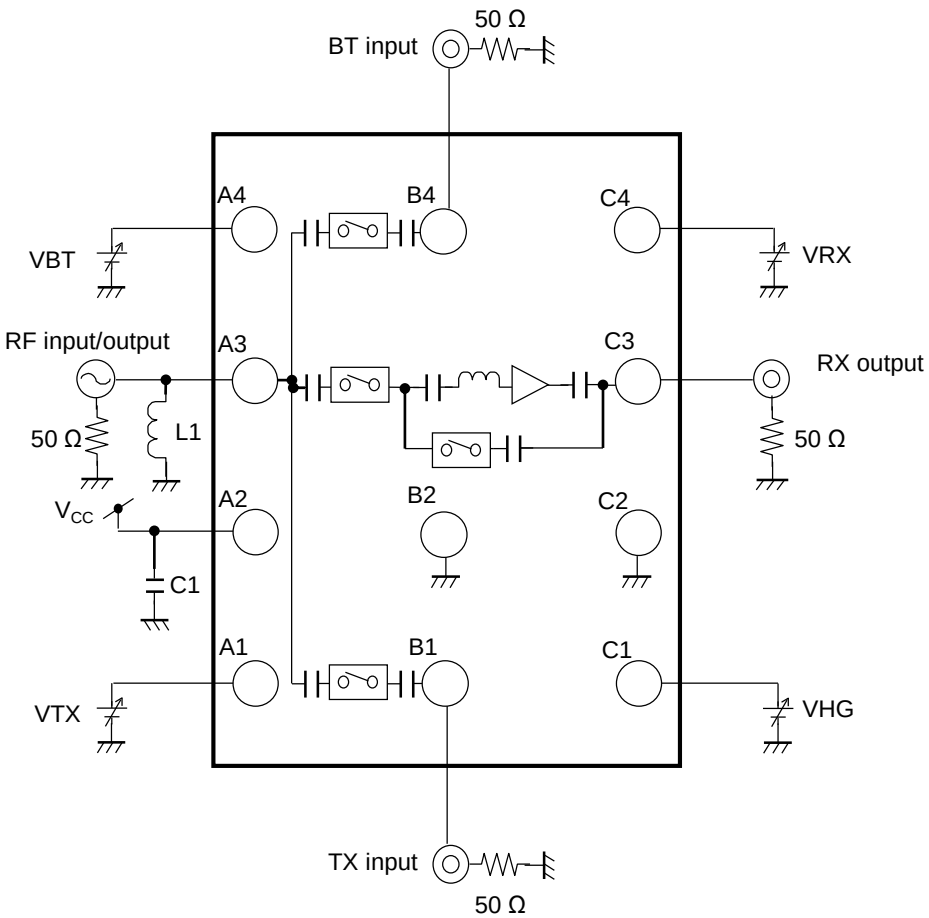
■ Type

—CMOS IC

CONTENTS

■ Application Circuit Example (Block Diagram)

(Top View)



- External Components

Components	Size	Value	Part Number	Vendor
L1	0603	2.5 nH	LQP03T2N5B04	Murata
C1	0603	0.1 uF	GRM033B30J104KE18	Murata

Notes)

—This application circuit is an example. The operation of mass production set is not guaranteed. You should perform enough evaluation and verification on the design of mass production set. You are fully responsible for the incorporation of the above application circuit and information in the design of your equipment.

—This block diagram is for explaining functions. The part of the block diagram may be omitted, or it may be simplified.

■ Pin Descriptions

Pin No.	Pin name	Type	Description
A1	VTX	Input	TX mode SW
A2	VCC	Power Supply	V_{CC}
A3	RFC	Input/Output	RF input/output
A4	VBT	Input	BT mode SW
B1	TX	Input	TX input
B2	GND	Ground	GND
B4	BT	Input	BT input
C1	VHG	Input	High Gain/Low Gain SW
C2	GND	Ground	GND
C3	RX	Output	RX output
C4	VRX	Input	RX mode SW

■ Absolute Maximum Ratings

Note)Absolute maximum ratings are limit values which do not result in damages to this IC, and IC operation is not guaranteed at these limit values.

A No.	Parameter	Symbol	Rating	Unit	Notes
1	Supply voltage	V_{CC}	3.7	V	*1
2	Supply current	I_{CC}	20	mA	—
3	Operating ambient temperature	T_{opr}	-40 to +85	°C	*2
4	Storage temperature	T_{stg}	-55 to +150	°C	*2

Notes) *1 : The values under the condition not exceeding the above absolute maximum ratings.
*2 : Except for the operating ambient temperature and storage temperature, all ratings are for T_a = 25°C.

■ Operating supply voltage range

Parameter	Symbol	Range	Unit	Notes
Supply voltage range	V_{CC}	3.0 to 3.6	V	*

Note) * :The values under the condition not exceeding the above absolute maximum ratings.

■ Allowable Current and Voltage Range

Notes) — Allowable current and voltage ranges are limit ranges which do not result in damages to this IC, and IC operation is not guaranteed within these limit ranges.
— Voltage values, unless otherwise specified, are with respect to GND.
— Do not apply external currents or voltages to any pin not specifically mentioned.

Pin No.	Pin name	Range	Unit	Notes
A1	VTX	-0.3 to (Vcc + 0.3)	V	*4
A3	RFC	—	V	*1
A4	VBT	-0.3 to (Vcc + 0.3)	V	*4
B1	TX	—	V	*2
B4	BT	—	V	*2
C1	VHG	-0.3 to (Vcc + 0.3)	V	*4
C3	RX	—	V	*3
C4	VRX	-0.3 to (Vcc + 0.3)	V	*4

Note) *1 : RF signal input / output pin.
Maximum input / output power at TX mode and BT mode is 27 dBm.
Maximum input power at RX mode / High Gain is 0 dBm.
Maximum input power at RX mode / Low Gain is 10 dBm.
*2 :RF signal input pin.
Maximum input power at TX mode and BT mode is 27 dBm.
*3 : RF signal output pin.
*4 : (VCC + 0.3) V must not be exceeded 3.7 V

■ Electrical Characteristics at V_{CC} = 3.3 V

Note)T_a = 25°C±2°C unless otherwise specified.

B No.	Parameter	Symbol	Test Circuit	Conditions	Limits			Unit	Note
					Min	Typ	Max		
DC electrical characteristics									
DC-1	Supply current RX mode / High Gain	I_{CC}RXHS	1	V_{CC} current at RX mode / High Gain No input signal	—	11.5	15	mA	—
DC-2	Supply current RX mode / Low Gain	I_{CC}RXLS	1	V_{CC} current at RX mode / Low Gain No input signal	—	100	150	uA	—
DC-3	Supply current TX mode	I_{CC}TXS	1	V_{CC} current at TX mode No input signal	—	80	130	uA	—
DC-4	Supply current BT mode	I_{CC}BTS	1	V_{CC} current at BT mode No input signal	—	80	130	uA	—
DC-5	SW current (High Voltage)	IIHS	1	Current at VRX,VTX,VBT,VHG pin VIH = V_{CC}	—	13	26	uA	—
DC-6	SW Input Voltage (High Level)	VIHS	1	—	1.6	3.3	—	V	—
DC-7	SW Input Voltage (Low Level)	VILS	1	—	—	0	0.3	V	—
DC-8	Supply current ALL Off mode	IccOFFS	1	V_{CC} current at ALL Off mode No input signal	—	25	50	uA	—

■ Electrical Characteristics (continued) at V_{CC} = 3.3 V

Note)T_a = 25°C±2°C, fRX = 2.442 GHz, PRX = –10 dBm, CW unless otherwise specified.

B No.	Parameter	Symbol	Test Circuit	Conditions	Limits			Unit	Note
					Min	Typ	Max		
AC electrical characteristics		RX Mode / High Gain (VRX=3.3V, VHG=3.3V, VTX=0V, VBT=0V)							
A-1	Power Gain	GRXHS	1	RFC to RX	10.0	12.5	15.0	dB	—
AC electrical characteristics		RX Mode / Low Gain (VRX=3.3V, VHG=0V, VTX=0V, VBT=0V)							
B-1	Power Gain	GRXLS	1	RFC to RX	-10.0	-8.0	-6.0	dB	—
AC electrical characteristics		TX Mode (VRX=0V, VHG=0V, VTX=3.3V, VBT=0V)							
C-1	Insertion Loss	ILTXS	1	RFC to TX	—	0.60	0.90	dB	—
AC electrical characteristics		BT Mode (VRX=0V, VHG=0V, VTX=0V, VBT=3.3V)							
D-1	Insertion Loss	ILBTS	1	RFC to BT	—	0.55	0.85	dB	—

■ Electrical Characteristics (Reference values for design) at V_{CC} = 3.3 V

Note)T_a = 25°C±2°C, fRX = 2.442 GHz, PRX = –10 dBm, CW unless otherwise specified.
The characteristics listed below are reference values derived from the design of the IC and are not guaranteed by inspection. If a problem does occur related to these characteristics, we will respond in good faith to user concerns.

B No.	Parameter	Symbol	Test Circuit	Conditions	Reference values			Unit	Note
					Min	Typ	Max		
AC electrical characteristics		RX Mode / High Gain (VRX=3.3V, VHG=3.3V, VTX=0V, VBT=0V)							
E-1	Noise Figure	NFRXH	1	RFC to RX	—	1.7	2.2	dB	—
E-2	Input Power 1dB Compression	IP1dBRXH	1	RFC to RX	-11	-6.5	—	dBm	—
E-3	IIP3 +10 MHz offset	IIP3RXH	1	f1 = fRX + 10 MHz f2 = fRX + 20 MHz Input 2 signals (f1, f2)	2	4	—	dBm	—
E-4	Reverse Isolation	ISORXH	1	RX to RFC	23.5	26	—	dB	—
E-5	Isolation RFC_BT	ISORXH_1	1	RFC to BT	14	17	—	dB	—
E-6	Isolation RFC_TX	ISORXH_2	1	RFC to TX	23.5	26.5	—	dB	—
E-7	Isolation BT_RFC	ISORXH_3	1	BT to RFC	19	22	—	dB	—
E-8	Isolation BT_RX	ISORXH_4	1	BT to RX	15	19	—	dB	—
E-9	Isolation BT_TX	ISORXH_5	1	BT to TX	27	30	—	dB	—
E-10	Isolation RX_BT	ISORXH_6	1	RX to BT	25	28	—	dB	—
E-11	Isolation RX_TX	ISORXH_7	1	RX to TX	29	33	—	dB	—
E-12	Isolation TX_RFC	ISORXH_8	1	TX to RFC	27	29.5	—	dB	—
E-13	Isolation TX_BT	ISORXH_9	1	TX to BT	26	29	—	dB	—
E-14	Isolation TX_RX	ISORXH_10	1	TX to RX	18	23	—	dB	—

■ Electrical Characteristics (Reference values for design, continued) at V_{CC} = 3.3 V

Note)T_a = 25°C±2°C, fRX = 2.442 GHz, PRX = –10 dBm, CW unless otherwise specified.
The characteristics listed below are reference values derived from the design of the IC and are not guaranteed by inspection.
If a problem does occur related to these characteristics, we will respond in good faith to user concerns.

B No.	Parameter	Symbol	Test Circuit	Conditions	Reference values			Unit	Note
					Min	Typ	Max		
AC electrical characteristics		RX Mode / Low Gain (VRX=3.3V, VHG=0V, VTX=0V, VBT=0V)							
F-1	Isolation RFC_BT	ISORXL_1	1	RFC to BT	22	25	—	dB	—
F-2	Isolation RFC_TX	ISORXL_2	1	RFC to TX	27	31	—	dB	—
F-3	Isolation BT_RX	ISORXL_3	1	BT to RX	22.5	24.5	—	dB	—
F-4	Isolation BT_TX	ISORXL_4	1	BT to TX	25	28	—	dB	—
F-5	Isolation RX-TX	ISORXL_5	1	RX to TX	33.5	36	—	dB	—

■ Electrical Characteristics (Reference Values for Design , continued) at V_{CC} = 3.3 V

Note)T_a = 25°C±2°C, fRX = 2.442 GHz, PRX = –10 dBm, CW unless otherwise specified.
The characteristics listed below are reference values derived from the design of the IC and are not guaranteed by inspection.
If a problem does occur related to these characteristics, we will respond in good faith to user concerns.

B No.	Parameter	Symbol	Test Circuit	Conditions	Reference values			Unit	Note
					Min	Typ	Max		
AC electrical characteristics		TX Mode (VRX=0V, VHG=0V, VTX=3.3V, VBT=0V)							
G-1	Input Power 0.1dB Compression	IP01dBTX	1	RFC to TX	27	31	—	dBm	—
G-2	Isolation RFC_BT	ISOTX_1	1	RFC to BT	26	29	—	dB	—
G-3	Isolation RFC_RX	ISOTX_2	1	RFC to RX	25	35.5	38	dB	—
G-4	Isolation BT_RX	ISOTX_3	1	BT to RX	26	29	—	dB	—
G-5	Isolation BT_TX	ISOTX_4	1	BT to TX	30	35	—	dB	—
G-6	Isolation RX_TX	ISOTX_5	1	RX to TX	25	35	38	dB	—
AC electrical characteristics		BT Mode (VRX=0V, VHG=0V, VTX=0V, VBT=3.3V)							
H-1	Input Power 0.1dB Compression	IP01dBBT	1	RFC to BT	27	31	—	dBm	—
H-2	Isolation RFC_RX	ISOBT_1	1	RFC to RX	33	38	—	dB	—
H-3	Isolation RFC_TX	ISOBT_2	1	RFC to TX	28.5	31	—	dB	—
H-4	Isolation BT_RX	ISOBT_3	1	BT to RX	30	34	—	dB	—
H-5	Isolation BT_TX	ISOBT_4	1	BT to TX	30	34	—	dB	—
H-6	Isolation RX_TX	ISOBT_5	1	RX to TX	35	40	—	dB	—

■ Control Pin Mode Table

Note)See parameters B No. DC-6/ B No.DC-7 in the Electrical Characteristics for control voltage retention ranges.

Pin No.	Description	Pin voltage		Remarks
		Low	High	
A1	TX mode SW	—	TX Mode	—
A4	BT mode SW	—	BT Mode	—
C1	High Gain / Low Gain SW	Low Gain	High Gain	—
C4	RX mode SW	—	RX Mode	—

■ Truth Table

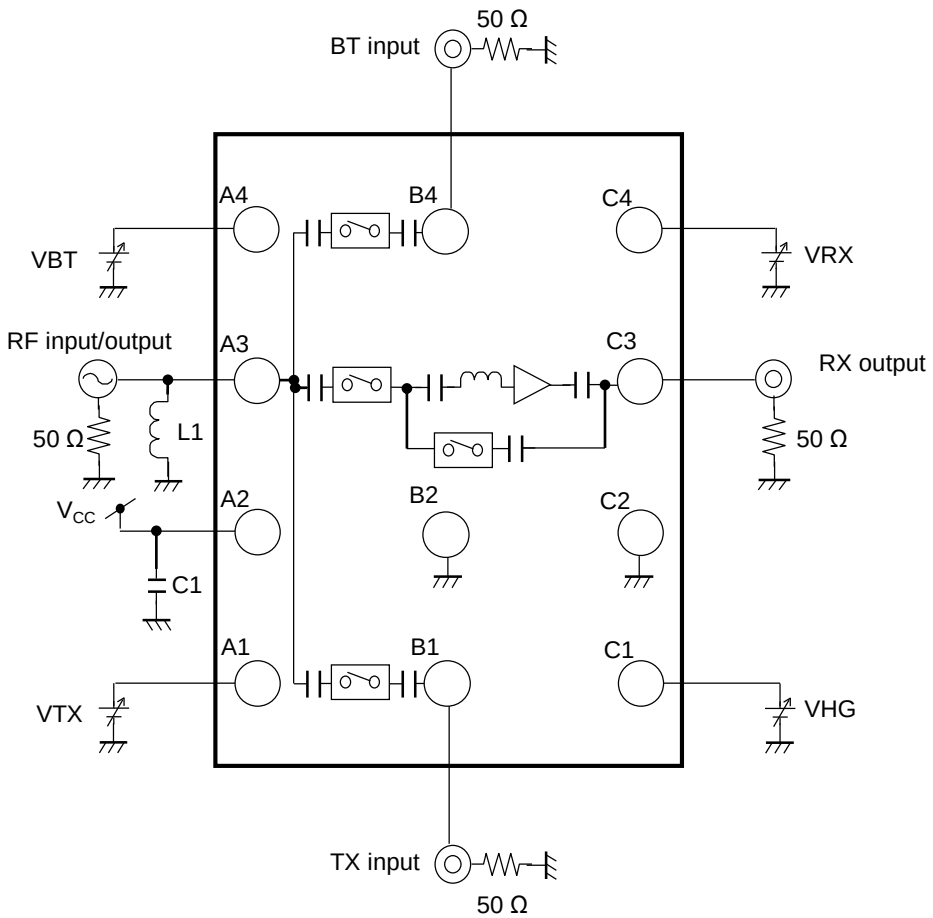
Note)See parameters B No. DC-6/ B No.DC-7 in the Electrical Characteristics for control voltage retention ranges.

VTX	VBT	VHG	VRX	Mode
High	Low	Low	Low	TX mode
Low	High	Low	Low	BT mode
Low	Low	High	High	RX mode / High Gain
Low	Low	Low	High	RX mode / Low Gain
Low	Low	Low	Low	ALL Off mode

■ Test Circuit Diagram

- Test Circuit 1

(Top View)



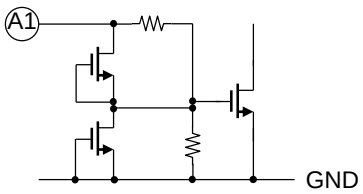
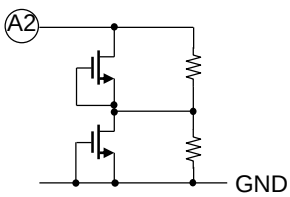
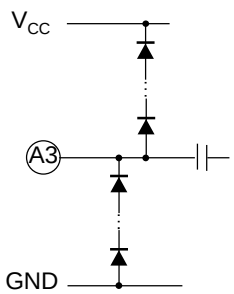
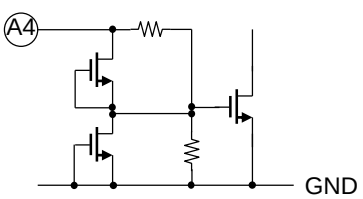
- External Components

Components	Size	Value	Part Number	Vendor
L1	0603	2.5 nH	LQP03T2N5B04	Murata
C1	0603	0.1 uF	GRM033B30J104KE18	Murata

■ Technical Data

— I/O block circuit diagram and pin function descriptions

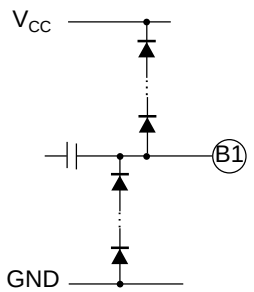
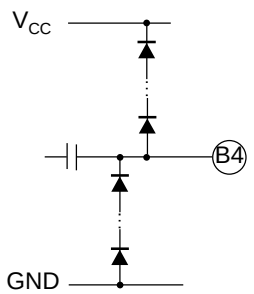
Note) The characteristics listed below are reference values derived from the design of the IC and are not guaranteed.

Pin No.	Waveform and voltage	Internal circuit	Impedance	Description
A1	—		300 kΩ	TX mode SW
A2	3.3 V		3.1 MΩ	Vcc
A3	—		—	RF input/output
A4	—		300 kΩ	BT mode SW

■ Technical Data(continued.)

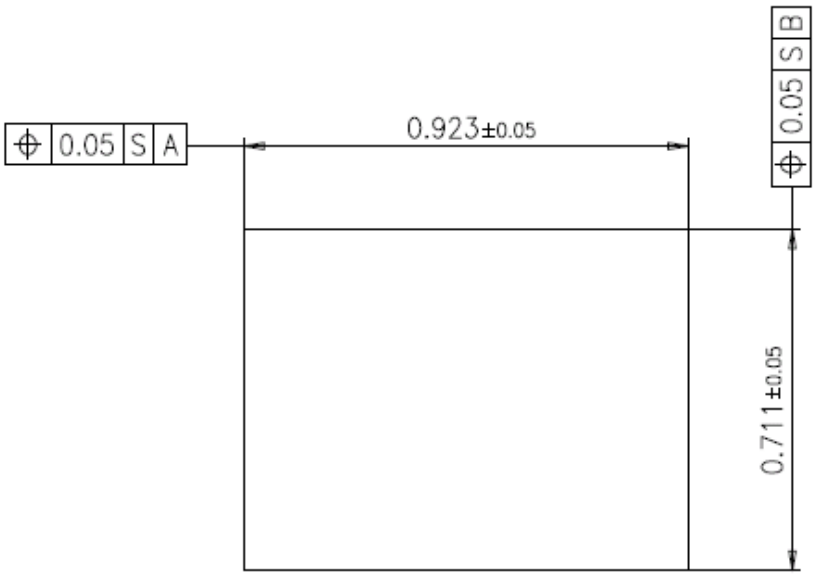
— I/O block circuit diagram and pin function descriptions

Note) The characteristics listed below are reference values derived from the design of the IC and are not guaranteed.

Pin No.	Waveform and voltage	Internal circuit	Impedance	Description
B1	—		—	TX input
B2	—	—	—	GND
B4	—		—	BT input

■ PACKAGE INFORMATION (Reference Data)

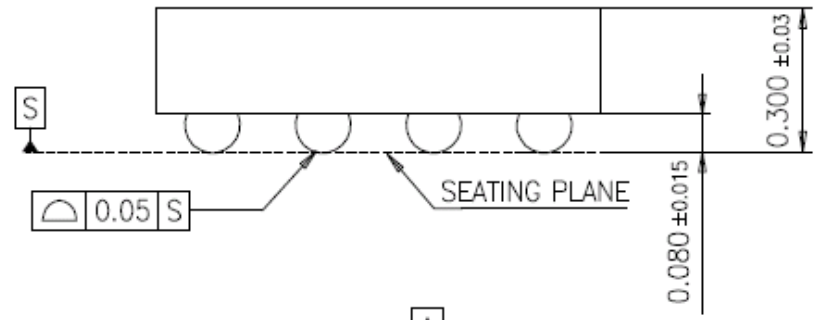
Unit:mm

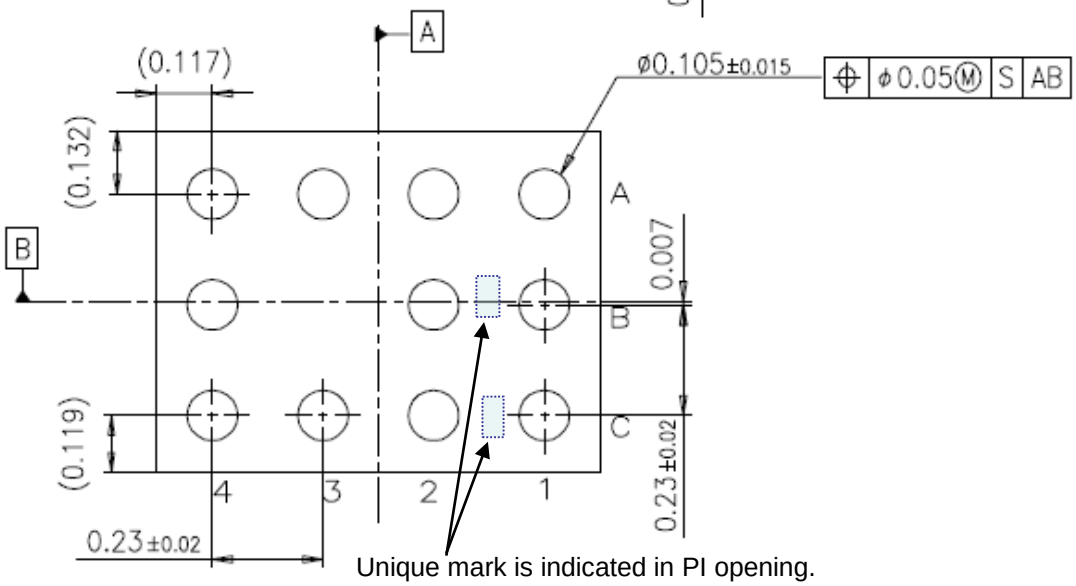


PIN Location on Bottom View

※ Coordinate origin is defined as 0,0

Pin	X	Y
A1	0.345	0.223
A2	0.115	0.223
A3	-0.115	0.223
A4	-0.345	0.223
B1	0.345	-0.007
B2	0.115	-0.007
B4	-0.345	-0.007
C1	0.345	-0.237
C2	0.115	-0.237
C3	-0.115	-0.237
C4	-0.345	-0.237



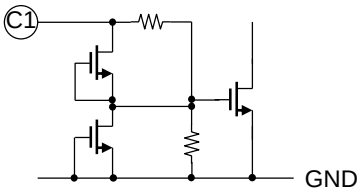
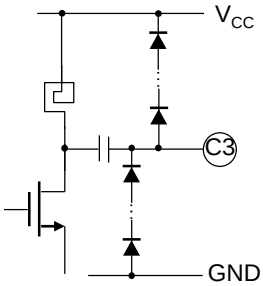
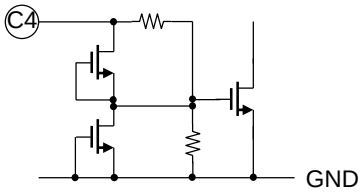


Unique mark is indicated in PI opening.

■ Technical Data(continued.)

— I/O block circuit diagram and pin function descriptions

Note) The characteristics listed below are reference values derived from the design of the IC and are not guaranteed.

Pin No.	Waveform and voltage	Internal circuit	Impedance	Description
C1	—		420 kW	High Gain mode / Low Gain mode SW
C2	—	—	—	GND
C3	—		—	RX output
C4	—		300 kW	RX mode SW

■ Usage Notes

1. Pay attention to the direction of the IC. When mounting it in the wrong direction onto the PCB (printed-circuit-board), it might be damaged.
2. Pay attention in the PCB (printed-circuit-board) pattern layout in order to prevent damage due to short circuit between pins.
   In addition, refer to the Pin Description for the pin configuration.
3. Perform visual inspection on the PCB before applying power, otherwise damage might happen due to problems such as solder-bridge between the pins of the IC. Also, perform full technical verification on the assembly quality, because the same damage possibly can happen due to conductive substances, such as solder ball, that adhere to the IC during transportation.
4. Take notice in the use of this IC that it might be damaged when an abnormal state occurs such as output pin-VCC short (Power supply fault), output pin-GND short (Ground fault), or output-to-output-pin short (load short). Safety measures such as installation of fuses are recommended because the extent of the above-mentioned damage will depend on the current capability of the power supply.
5. Due to the unshielded structure of this IC, functions and characteristics of the IC cannot be guaranteed under the exposure of light. During normal operation or even under testing condition, please ensure that the IC is not exposed to light.
6. Please ensure that your design does not have metal shield parts touching the chip surface as the surface potential is GND voltage.
7. Pay attention to the breakdown voltage of this IC when using.

Pin No.	Pin Name	ESD Model	Standard	ESD Voltage (*1)
A2	VCC	HBM	GND	-900 V
A1	VTX	HBM	VCC	+900 V
A4	VBT	HBM	VCC	+900 V
B2	GND	HBM	VCC	+900 V
C1	VHG	HBM	VCC	+ 900 V
C2	GND	HBM	VCC	+ 900 V
C4	VRX	HBM	VCC	+ 900 V

The other pins are more than +/– 1000V.

(*1) This is the max value which is not broken.

Revision History

Date	Revision	Description
2021.2.2	1.00	1. Initially issued.
2021.9.21	1.01	1. Changed document name from Product Standards to Datasheet.
2022.2.1	1.02	1. Changed important notice on page2 2. Remove important notice page from previous version page 18 3. Added usage notes on page19,20

Important Notice

Nuvoton Products are neither intended nor warranted for usage in systems or equipment, any malfunction or failure of which may cause loss of human life, bodily injury or severe property damage. Such applications are deemed, "Insecure Usage".

Insecure usage includes, but is not limited to: equipment for surgical implementation, atomic energy control instruments, airplane or spaceship instruments, the control or operation of dynamic, brake or safety systems designed for vehicular use, traffic signal instruments, all types of safety devices, and other applications intended to support or sustain life.

All Insecure Usage shall be made at customer's risk, and in the event that third parties lay claims to Nuvoton as a result of customer's Insecure Usage, customer shall indemnify the damages and liabilities thus incurred by Nuvoton.