# SP3T Antenna-Switch for 2.4GHz Band Applications

# KA29242K
# Datasheet



For additional information or question, please contact Nuvoton Technology Corporation Japan
www.nuvoton.co.jp

## ■ 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.

# KA29242K

## Broadband SP3T Antenna Switch for 2.4 GHz Band Applications

### ■ Overview

—KA29242K is a SP3T Antenna Switch-IC for Wireless LAN, Bluetooth and General Purpose Middle-Power Wireless Applications.
—Realizing high performance by using 0.3 μm CMOS process.
—Available for Low voltage control switching.
—Available for Shutdown mode for blocking disturbing wave from other High-Power Wireless Applications.
—Achieving miniaturization by using small size Chip Size Package with solder bump .

### ■ Features

| | | |
|---|---|---|
| —Operating voltage | VDD = 2.7 to 5.0 V | |
| —Low current consumption | 12 μA typ. | |
| | 8 μA typ. | (Shutdown) |
| —Low Insertion Loss | 0.50dB typ. | (f=2442MHz) |

### ■ Applications

—Wireless LAN / Bluetooth
—General Purpose Middle-Power Wireless Applications

### ■ Package

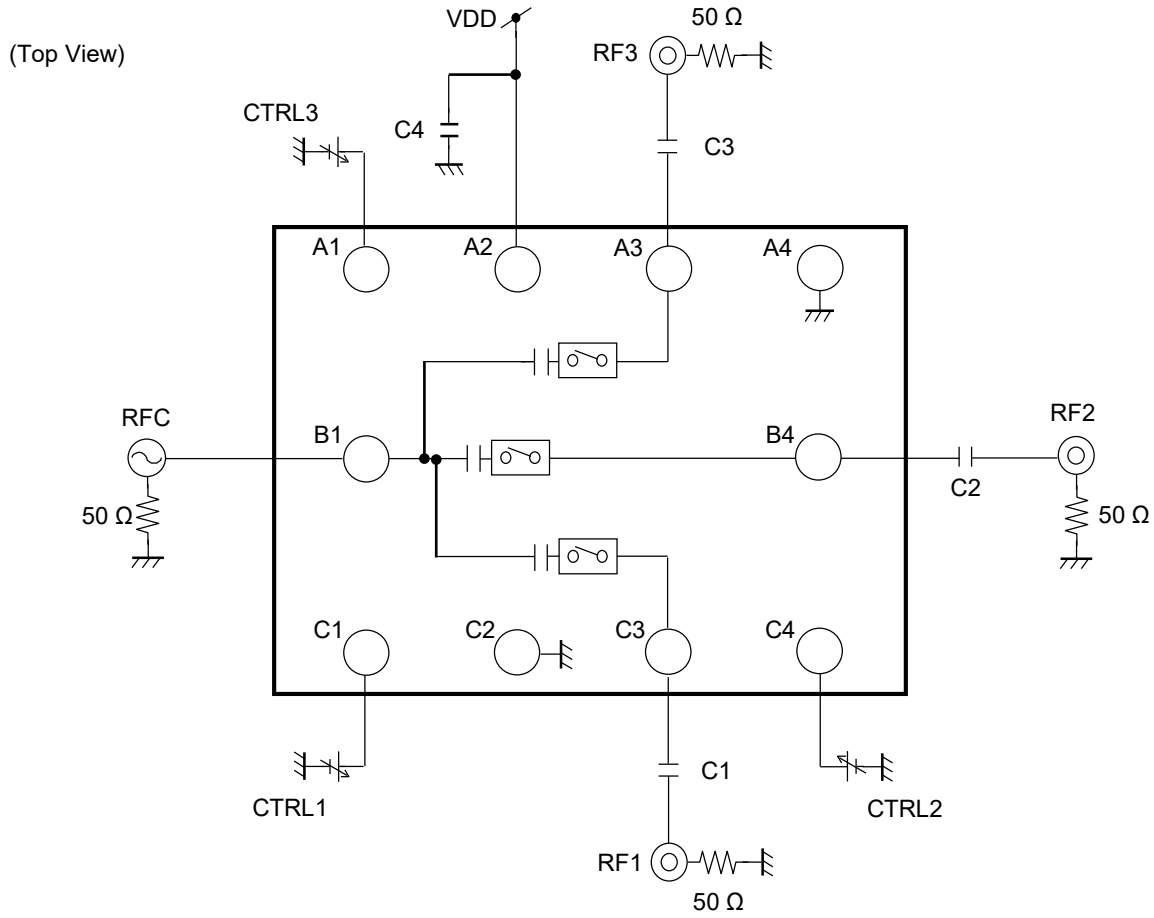
— 10Pin Chip Size Package with solder bump
Size : 0.807 mm × 0.601 mm × 0.3 mm

### ■ Type

—CMOS IC

# CONTENTS

■ Application Circuit Example (Block Diagram)




• External Components

| Components | Size | Value | Part Number | Vendor |
|---|---|---|---|---|
| C1 | 0603 | 100 pF | GRM0332C1E101JD01 | Murata |
| C2 | 0603 | 100 pF | GRM0332C1E101JD01 | Murata |
| C3 | 0603 | 100 pF | GRM0332C1E101JD01 | Murata |
| C4 | 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 | CTRL3 | Input | Switch Control for RF3 |
| A2 | VDD | Power supply | Power supply |
| A3 | RF3 | Input/Output | RF port controlled by CTRL3 |
| A4 | GND | Ground | Ground |
| B1 | RFC | Input/Output | RF bidirectional antenna port |
| B4 | RF2 | Input/Output | RF port controlled by CTRL2 |
| C1 | CTRL1 | Input | Switch Control for RF1 |
| C2 | GND | Ground | Ground |
| C3 | RF1 | Input/Output | RF port controlled by CTRL1 |
| C4 | CTRL2 | Input | Switch Control for RF2 |

## ■ 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 | $V_{CC}$ | 5.5 | V | *1 |
| 2 | Supply current | $I_{CC}$ | 5 | mA | — |
| 3 | Operating ambient temperature | $T_{opr}$ | -40 to +85 | °C | *2 |
| 4 | Storage temperature | $T_{stg}$ | -55 to +125 | °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.

## 1.9 Operating supply voltage range

| Parameter | Symbol | Range | Unit | Notes |
|---|---|---|---|---|
| Supply voltage range | $V_{CC}$ | 2.7 to 5.0 | 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 | CTRL3 | - 0.3 to 3.7 | V | — |
| A3 | RF3 | — | V | *1 |
| B1 | RFC | — | V | *1 |
| B4 | RF2 | — | V | *1 |
| C1 | CTRL1 | - 0.3 to 3.7 | V | — |
| C3 | RF1 | — | V | *1 |
| C4 | CTRL2 | - 0.3 to 3.7 | V | — |

Note) *1 : RF signal input / output pin. Do not apply DC current.
Maximum input / output power is + 34 dBm.

## ■ Electrical Characteristics at $V_{DD}$ = 3.6 V

Note)$T_a$ = 25°C±2°C No RF signal input, unless otherwise specified.

| B No. | Parameter | Symbol | Test Circuit | Conditions | Limits | | | Unit | Notes |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Min | Typ | Max | | |
| DC electrical characteristics | | | | | | | | | |
| DC-1 | Supply current | $I_{DD}$ | 1 | CTRL1 = 1.8 V, CTRL2 = 0 V, CTRL3 = 0 V<br>or CTRL1 = 0 V, CTRL2 = 1.8 V, CTRL3 = 0 V<br>or CTRL1 = 0 V, CTRL2 = 0 V, CTRL3 = 1.8 V | 4 | 12 | 20 | uA | — |
| DC-2 | Shutdown current | $I_{OFF}$ | 1 | CTRL1 = CTRL2 = CTRL3 = 0 V | — | 8 | 16 | uA | — |
| DC-3 | Control current (High Voltage) | $I_{CTRL}$ | 1 | CTRL1 = CTRL2 = CTRL3 = 3.6 V | — | 6 | 10 | uA | — |
| DC-4 | Control Voltage (High Level) | VIH | 1 | — | 1.6 | 1.8 | 3.6 | V | — |
| DC-5 | Control Voltage (Low Level) | VIL | 1 | — | — | 0 | 0.3 | V | — |

■ Electrical Characteristics (continued) at $V_{DD}$ = 3.6 V

Note)$T_a$ = 25°C±2°C, fin = 2.442 GHz, Pin = 0 dBm, CW unless otherwise specified.

| B No. | Parameter | Symbol | Test Circuit | Conditions | Limits | | | Unit | Notes |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Min | Typ | Max | | |
| AC electrical characteristics | RFC to RF1 ON (CTRL1 = 1.8 V, CTRL2 = 0 V, CTRL3 = 0 V) | | | | | | | | |
| A-1 | Insertion Loss 2G_1 | IL2G_1 | 1 | RFC-RF1 | — | 0.5 | 0.75 | dB | — |
| AC electrical characteristics | RFC to RF2 ON (CTRL1 = 0 V, CTRL2 = 1.8 V, CTRL3 = 0 V) | | | | | | | | |
| B-1 | Insertion Loss 2G_2 | IL2G_2 | 1 | RFC-RF2 | — | 0.5 | 0.75 | dB | — |
| AC electrical characteristics | RFC to RF3 ON (CTRL1 = 0 V, CTRL2 = 0 V, CTRL3 = 1.8 V) | | | | | | | | |
| C-1 | Insertion Loss 2G_3 | IL2G_3 | 1 | RFC-RF3 | — | 0.55 | 0.8 | dB | — |

## ■ Electrical Characteristics (Reference values for design) at $V_{DD}$ = 3.6 V

Note)$T_a$ = 25°C±2°C, fin = 2.442 GHz, Pin = 0 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 | Notes |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Min | Typ | Max | | |
| AC electrical characteristics RFC to RF1 ON (CTRL1 = 1.8 V, CTRL2 = 0 V, CTRL3 = 0 V) | | | | | | | | | |
| A-2 | Isolation RF1mode_RFC_RF2 | ISO2G_11 | 1 | RFC-RF2 | 26 | 28 | — | dB | — |
| A-3 | Isolation RF1mode_RFC_RF3 | ISO2G_12 | 1 | RFC-RF3 | 25 | 27 | — | dB | — |
| A-4 | Isolation RF1mode RF1_RF2 | ISO2G_13 | 1 | RF1-RF2 | 26 | 28 | — | dB | — |
| A-5 | Isolation RF1mode RF1_RF3 | ISO2G_14 | 1 | RF1-RF3 | 26 | 28 | — | dB | — |
| A-6 | Isolation RF1mode RF2_RF3 | ISO2G_15 | 1 | RF2-RF3 | 21 | 23 | — | dB | — |
| A-7 | Input 0.1dB Compression 2G_1 | P0.1 2G_1 | 1 | RFC-RF1 | 28 | 32 | — | dBm | — |
| A-8 | Switching Time (On -> Off) | ST2G_11 | 1 | On -> Off , 90% -> 10% | — | 460 | 640 | ns | — |
| A-9 | Switching Time (Off -> On) | ST2G_12 | 1 | Off -> On , 10% -> 90% | — | 330 | 550 | ns | — |
| A-10 | Return Loss RFC | S11_2G_1 | 1 | RFC | 12 | 18 | — | dB | — |
| A-11 | Return Loss RF1 | S22_2G | 1 | RF1 | 12.5 | 20 | — | dB | — |

■ Electrical Characteristics (Reference values for design, continued) at $V_{DD}$ = 3.6V

Note)$T_a$ = 25°C±2°C, fin = 2.442 GHz, Pin = 0 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 | Notes |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Min | Typ | Max | | |
| AC electrical characteristics RFC to RF2 ON (CTRL1 = 0 V, CTRL2 = 1.8 V, CTRL3 = 0 V) | | | | | | | | | |
| B-2 | Isolation RF2mode_ RFC_RF1 | ISO2G_2 1 | 1 | RFC-RF1 | 26 | 28 | — | dB | — |
| B-3 | Isolation RF2mode_RFC_RF3 | ISO2G_2 2 | 1 | RFC-RF3 | 22 | 25 | — | dB | — |
| B-4 | Isolation RF2mode RF1_RF2 | ISO2G_2 3 | 1 | RF1-RF2 | 26 | 28 | — | dB | — |
| B-5 | Isolation RF2mode RF1_RF3 | ISO2G_2 4 | 1 | RF1-RF3 | 26 | 28 | — | dB | — |
| B-6 | Isolation RF2mode RF2_RF3 | ISO2G_2 5 | 1 | RF2-RF3 | 26 | 28 | — | dB | — |
| B-7 | Input 0.1dB Compression 2G_2 | P0.1 2G_2 | 1 | RFC-RF2 | 28 | 32 | — | dBm | — |
| B-8 | Switching Time (On -> Off) | ST2G_21 | 1 | On -> Off , 90% -> 10% | — | 460 | 640 | ns | — |
| B-9 | Switching Time (Off -> On) | ST2G_22 | 1 | Off -> On , 10% -> 90% | — | 330 | 550 | ns | — |
| B-10 | Return Loss RFC | S11_2G_ 2 | 1 | RFC | 12 | 18 | — | dB | — |
| B-11 | Return Loss RF2 | S33_2G | 1 | RF2 | 12.5 | 20 | — | dB | — |

■ Electrical Characteristics (Reference values for design, continued) at $V_{DD}$ = 3.6V

Note)$T_a$ = 25°C±2°C, fin = 2.442 GHz, Pin = 0 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 | Notes |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Min | Typ | Max | | |
| AC electrical characteristics RFC to RF3 ON (CTRL1 = 0 V, CTRL2 = 0 V, CTRL3 = 1.8 V) | | | | | | | | | |
| C-2 | Isolation RF3mode_ RFC_RF1 | ISO2G_31 | 1 | RFC-RF1 | 26 | 28 | — | dB | — |
| C-3 | Isolation RF3mode_RFC_RF2 | ISO2G_32 | 1 | RFC-RF2 | 24 | 27 | — | dB | — |
| C-4 | Isolation RF3mode RF1_RF2 | ISO2G_33 | 1 | RF1-RF2 | 24 | 26 | — | dB | — |
| C-5 | Isolation RF3mode RF1_RF3 | ISO2G_34 | 1 | RF1-RF3 | 26 | 28 | — | dB | — |
| C-6 | Isolation RF3mode RF2_RF3 | ISO2G_35 | 1 | RF2-RF3 | 26 | 28 | — | dB | — |
| C-7 | Input 0.1dB Compression 2G_3 | P0.1 2G_3 | 1 | RFC-RF3 | 28 | 32 | — | dBm | — |
| C-8 | Switching Time (On -> Off) | ST2G_31 | 1 | On -> Off , 90% -> 10% | — | 460 | 640 | ns | — |
| C-9 | Switching Time (Off -> On) | ST2G_32 | 1 | Off -> On , 10% -> 90% | — | 390 | 600 | ns | — |
| C-10 | Return Loss RFC | S11_2G_3 | 1 | RFC | 12 | 17 | — | dB | — |
| C-11 | Return Loss RF3 | S44_2G | 1 | RF3 | 12 | 18 | — | dB | — |

■ Electrical Characteristics (Reference values for design, continued) at $V_{DD}$ = 3.6V

Note)$T_a$ = 25°C±2°C, fin = 2.442 GHz, Pin = 0 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 | Notes |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Min | Typ | Max | | |
| AC electrical characteristics Shutdown (CTRL1 = 0 V, CTRL2 = 0 V, CTRL3 = 0 V) | | | | | | | | | |
| D-1 | Shutdown Isolation | ISO_OFF_2G | 1 | RFC-RF1, RFC-RF2, RFC-RF3 | 16 | 24 | — | dB | — |

## ■ Control Pin Mode Table

Note)See parameters B No. DC-4 / B No. DC-5 in the Electrical Characteristics for control voltage retention ranges.

| Pin No. | Description | Pin State | | Remarks |
|---|---|---|---|---|
| | | Low | High | |
| C1 | Switch Control for RF1 | RFC to RF1 OFF | RFC to RF1 ON | — |
| C4 | Switch Control for RF2 | RFC to RF2 OFF | RFC to RF2 ON | — |
| A1 | Switch Control for RF3 | RFC to RF3 OFF | RFC to RF3 ON | — |

## ■ Truth Table

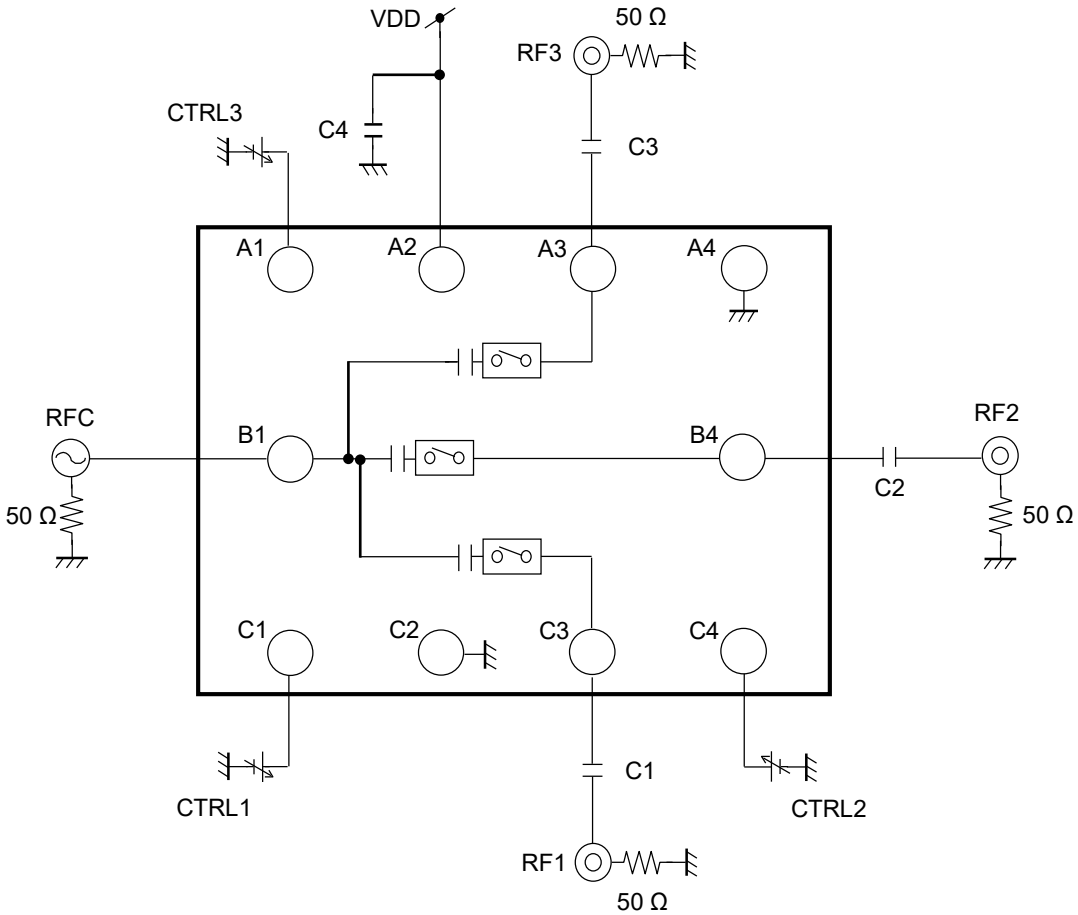
Note)See parameters B No. DC-4 / B No. DC-5 in the Electrical Characteristics for control voltage retention ranges.

| State | CTRL1 | CTRL2 | CTRL3 |
|---|---|---|---|
| RFC to RF1 ON | High | Low | Low |
| RFC to RF2 ON | Low | High | Low |
| RFC to RF3 ON | Low | Low | High |
| Shutdown (all RF ports OFF) | Low | Low | Low |

## ■ Test Circuit Diagram

• Test Circuit 1

(Top View)



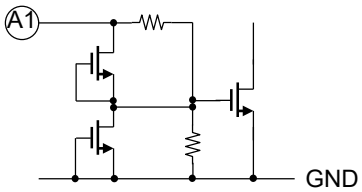
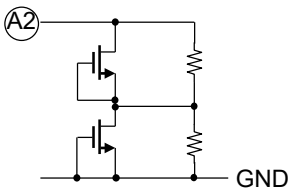
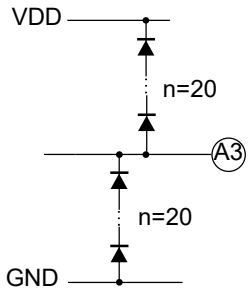

• External Components

| Components | Size | Value | Part Number | Vendor |
|---|---|---|---|---|
| C1 | 0603 | 100 pF | GRM0332C1E101JD01 | Murata |
| C2 | 0603 | 100 pF | GRM0332C1E101JD01 | Murata |
| C3 | 0603 | 100 pF | GRM0332C1E101JD01 | Murata |
| C4 | 0603 | 0.1 uF | GRM033B30J104KE18 | Murata |

## ■ Technical Data

— I/O block circuit diagram and pin function descriptions

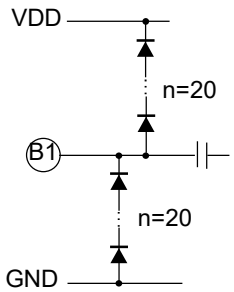
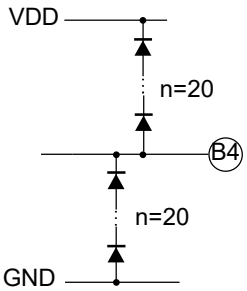
Note) The characteristics listed below are reference values derived from the design of the IC and are not guaranteed.

| Pin No. | Waveform and voltage | Internal circuit | Impedance | Description |
|---|---|---|---|---|
| A1 | — |  | 680 kΩ | Switch Control for RF3 |
| A2 | 3.6 V |  | 1.5 MΩ | Power supply |
| A3 | — |  | — | RF port controlled by CTRL3 |
| A4 | 0 V | — | — | Ground |

■ Technical Data( continued.)

— I/O block circuit diagram and pin function descriptions

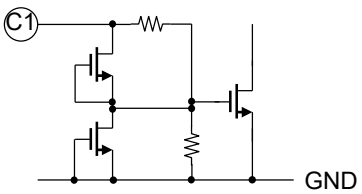
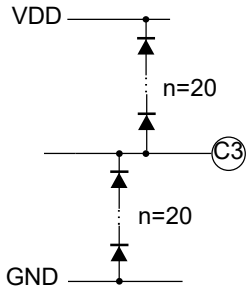
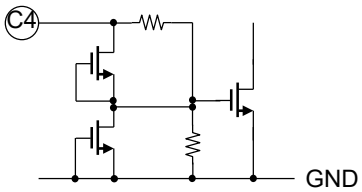
Note) The characteristics listed below are reference values derived from the design of the IC and are not guaranteed.

| Pin No. | Waveform and voltage | Internal circuit | Impedance | Description |
|---|---|---|---|---|
| B1 | — |  | — | RF bidirectional antenna port |
| B4 | — |  | — | RF Port controlled by CTRL2 |

■ Technical Data( continued. )

— I/O block circuit diagram and pin function descriptions

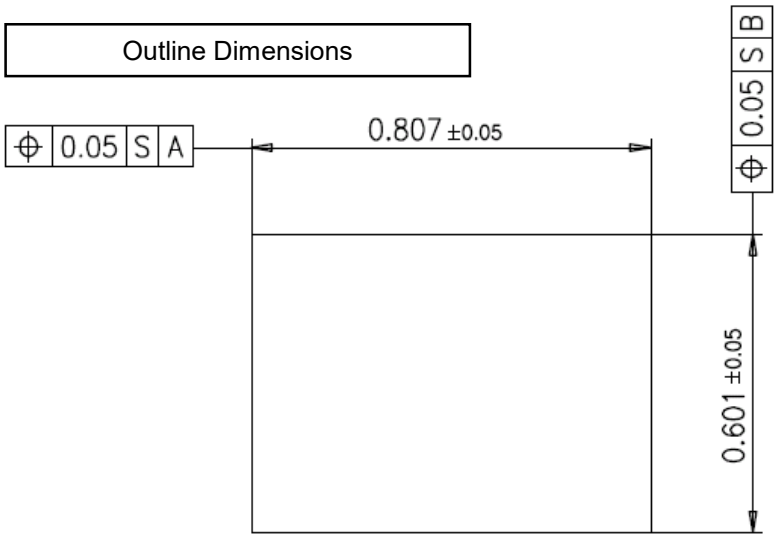
Note) The characteristics listed below are reference values derived from the design of the IC and are not guaranteed.

| Pin No. | Waveform and voltage | Internal circuit | Impedance | Description |
|---|---|---|---|---|
| C1 | — |  | 590 kW | Switch Control for RF1 |
| C2 | 0 V | — | — | Ground |
| C3 | — |  | — | RF port controlled by CTRL1 |
| C4 | — |  | 790 kW | Switch Control for RF2 |

■ PACKAGE INFORMATION ( Reference Data )

Unit:mm

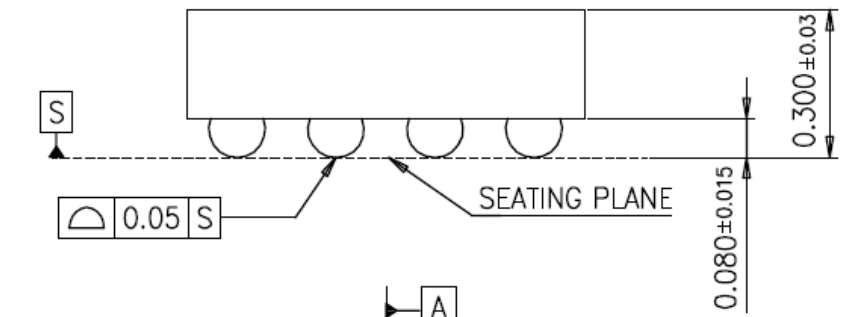
Outline Dimensions

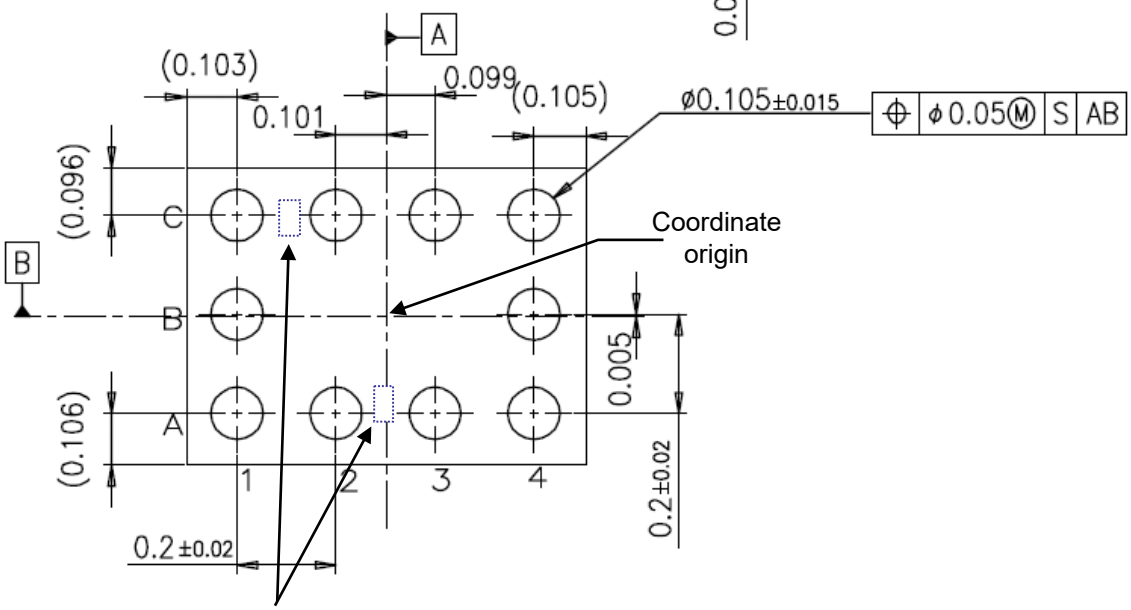



PIN Location on Bottom View

※ Coordinate origin is defined as 0,0

| Pin | X | Y |
|---|---|---|
| A1 | -0.301 | -0.195 |
| A2 | -0.101 | -0.195 |
| A3 | 0.099 | -0.195 |
| A4 | 0.299 | -0.195 |
| B1 | -0.301 | 0.005 |
| B4 | 0.299 | 0.005 |
| C1 | -0.301 | 0.205 |
| C2 | -0.101 | 0.205 |
| C3 | 0.099 | 0.205 |
| C4 | 0.299 | 0.205 |




Unique mark is indicated in PI opening.

## ■ 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.

## 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<br>2. Remove important notice page from previous version page 21<br>3. Added usage notes on page20,21 |

## 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.**