Capacitive Controller ICs

Capacitive Switch Controller IC

BU21077MUV

General Description

BU21077MUV is a capacitive switch controller for switch operation.
BU21077MUV has programmable MPU and it control the sensing sequence and how to use value of sensor. It is possible to reduce operational current with devising a sensing sequence.

Features

- Programmable MPU
- 8 Capacitive Sensor Ports
- 2-Wire Serial Bus Interface
- Single Power Supply
- Built-in Power-On-Reset and Oscillator

Applications

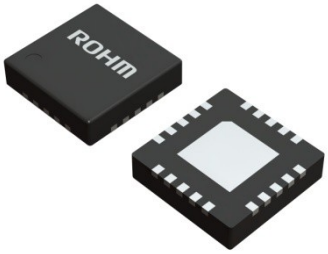
- Portable Device such as Smart Phone, PDA.
- Electronic Device with Multi Switches
- Information Appliance such as Projector
- AV Appliance such as Digital TV, HDD Recorder
- PC / PC Peripheral Equipment such as Laptop PC

Key Specifications

- Input Voltage Range 2.7 to 5.5V
- Operating Temperature Range -20 to +85°C

Package

VQFN020V4040 4.00 ㎜×4.00 ㎜×1.00 ㎜



Typical Application Circuit

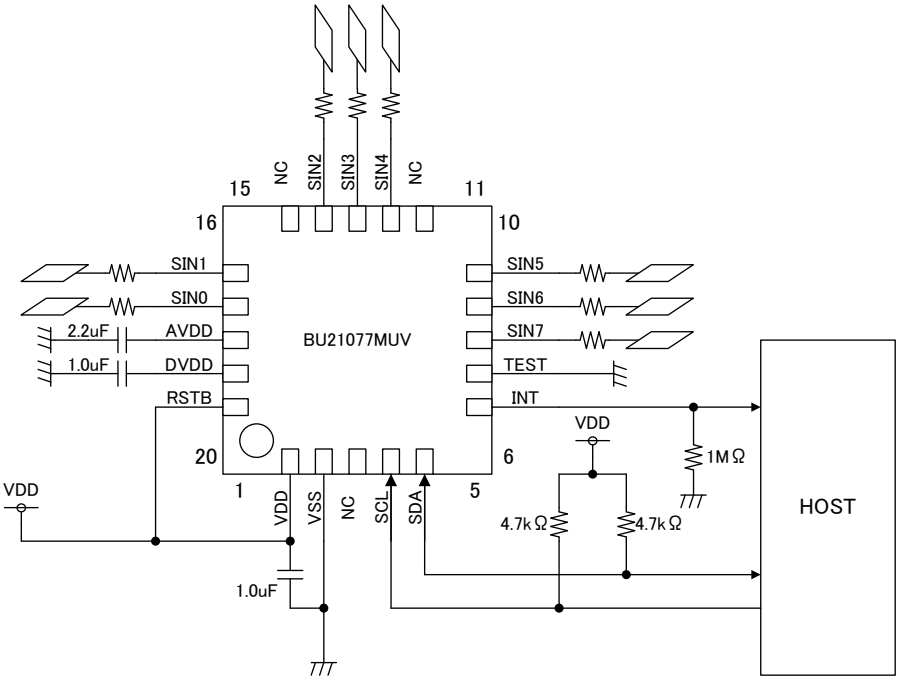


Figure 1. Typical Application Circuit

○Product structure : Silicon monolithic integrated circuit ○This product has no designed protection against radioactive rays

Pin Configurations

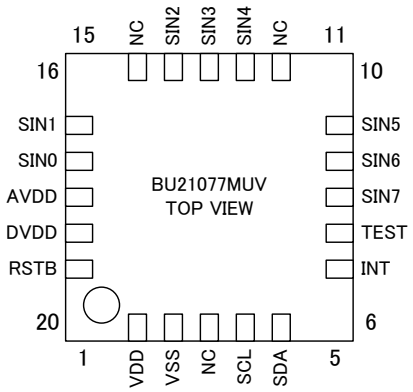


Figure 2. Pin Configurations

Pin Descriptions

Pin No.	Pin Name	I/O	Functions	Note	Power	Initial Condition	I/O Equivalent Circuit
1	VDD	Power	Power		-	-	-
2	VSS	Ground	Ground		-	-	-
3	NC	-	-		-	-	-
4	SCL	In	Host-I/F SCL pin		VDD	Hi-Z	b
5	SDA	InOut	Host-I/F SDA pin		VDD	Hi-Z	b
6	INT	Out	Interrupt output		VDD	Hi-Z	b
7	TEST	In	Test input	Fix ‘L’ at the normal operation	VDD	Hi-Z	c
8	SIN7	InOut	Sensor 7		AVDD	Hi-Z	a
9	SIN6	InOut	Sensor 6		AVDD	Hi-Z	a
10	SIN5	InOut	Sensor 5		AVDD	Hi-Z	a
11	NC	-	-		-	-	-
12	SIN4	InOut	Sensor 4		AVDD	Hi-Z	a
13	SIN3	InOut	Sensor 3		AVDD	Hi-Z	a
14	SIN2	InOut	Sensor 2		AVDD	Hi-Z	a
15	NC	-	-		-	-	-
16	SIN1	InOut	Sensor 1		AVDD	Hi-Z	a
17	SIN0	InOut	Sensor 0		AVDD	Hi-Z	a
18	AVDD	Power	LDO output for analog blocks		-	-	-
19	DVDD	Power	LDO output for digital blocks		-	-	-
20	RSTB	In	Reset bar input	Active ‘L’	VDD	Hi-Z	c

I/O Equivalent Circuits

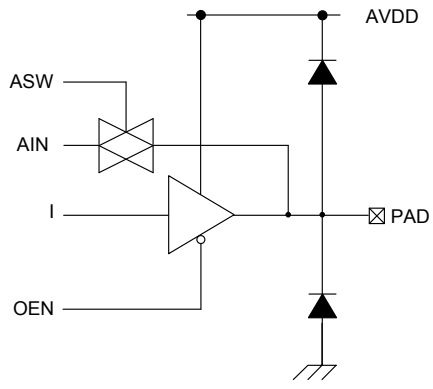


Figure 3. I/O Equivalent Circuit (a)

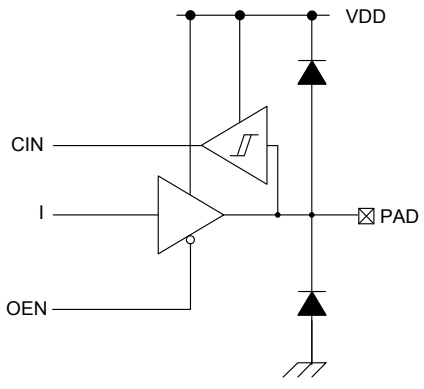


Figure 4. I/O Equivalent Circuit (b)

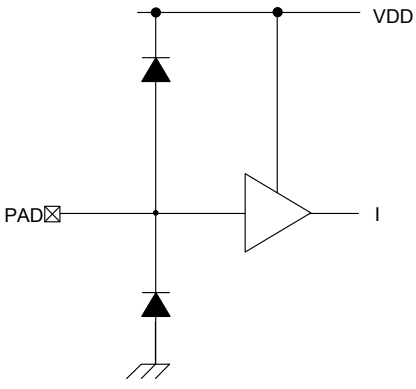


Figure 5. I/O Equivalent Circuit (c)

Block Diagram

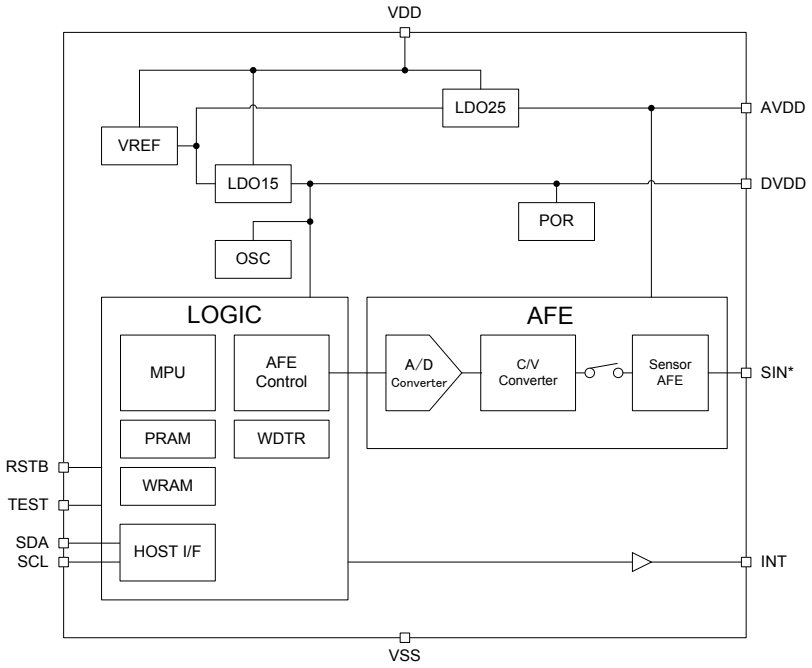


Figure 6. Block Diagram

Description of Blocks

●Sensor AFE, C/V Converter
Convert from capacitance to voltage for each sensor.
●A/D Converter
Convert from analog value to digital value.
●LDO25
2.5V output LDO for Sensor AFE, C/V Converter, and A/D converter.
●LDO15
1.5V output LDO for OSC and Logic blocks.
●OSC
Oscillator.
●POR
Power-On-Reset for system reset.
●MPU
Control sensor and sequence by program.
●PRAM
8kbyte Program RAM of MPU. It needs to download program from host.
●WRAM
Working RAM for MPU.
●HOST I/F
2-wire serial bus interface compatible with I2C protocol.
●AFE Control
Control sequencer for Sensor AFE, C/V Converter, and A/D Converter.
●WDTR
Watchdog timer reset. It issues a reset when the MPU is hang-upped.

Absolute Maximum Ratings

(Ta = 25°C)

Parameter	Symbol	Rating	Unit
Power Supply Voltage	VDD	-0.5 to +7.0	V
Input Voltage	V_{IN}	-0.5 to VDD + 0.3	V
Operating Temperature Range	T_{opr}	-20 to +85	°C
Storage Temperature Range	T_{stg}	-55 to +125	°C
Power Dissipation	P_d	0.55 (Note 1)	W
Maximum Junction Temperature	T_{jmax}	125	°C

(Note 1) Derate by 5.5mW/°C when operating above Ta=25°C (mounted in 1-layer 74.2×74.2×1.6mm board with 10.22mm^2 surface capper area)
P_d of IC is 0.27W and derate by 2.7mW/°C when operating above Ta=25°C.

Caution: Operating the IC over the absolute maximum ratings may damage the IC. The damage can either be a short circuit between pins or an open circuit between pins and the internal circuitry. Therefore, it is important to consider circuit protection measures, such as adding a fuse, in case the IC is operated over the absolute maximum ratings.

Recommended Operating Condition

(Ta = -20 to +85°C)

Parameter	Symbol	Rating	Unit
Power Supply Voltage	VDD	2.7 to 5.5	V

Electrical Characteristics

(Ta = 25°C, VDD = 3.3V, VSS = 0V)

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
Input High Voltage	V_{IH}	VDD x 0.7	-	VDD + 0.3	V	
Input Low Voltage	V_{IL}	VSS - 0.3	-	VDD x 0.3	V	
Output High Voltage	V_{OH}	VDD - 0.5	-	VDD	V	I_{OH} = -4mA
Output Low Voltage	V_{OL}	VSS	-	VSS + 0.5	V	I_{OL} = +4mA
OSC Frequency 1	f_{OSC1}	45	50	55	MHz	
OSC Frequency 2	f_{OSC2}	51.2	64	76.8	kHz	
DVDD Voltage	V_{DVDD}	1.35	1.50	1.65	V	
AVDD Voltage	V_{AVDD}	2.40	2.50	2.60	V	

Host Interface

BU21077MUV has 2-wire serial bus interface. It is compatible with I2C protocol and BU21077MUV is a slave device. Slave address of BU21077MUV is 5Ch (Shown 7-bit). And it supports Standard-mode (100 KHz) and Fast-mode (400 kHz). It has sequential read for reduce access time.

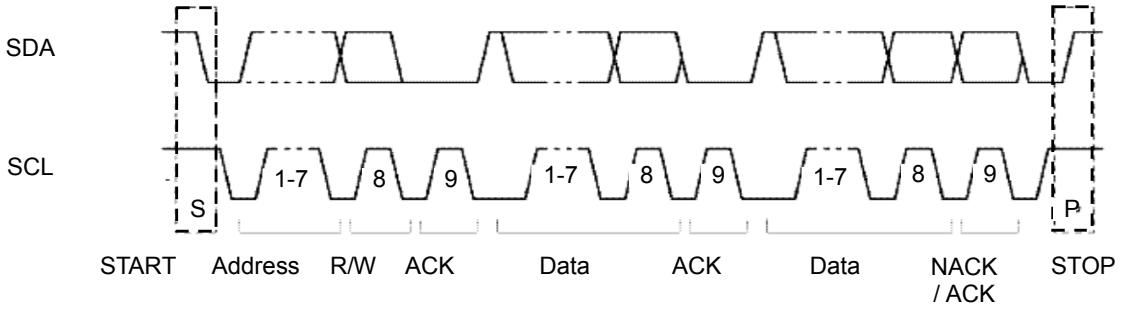


Figure 7. 2-wire Serial Bus Interface Data Format

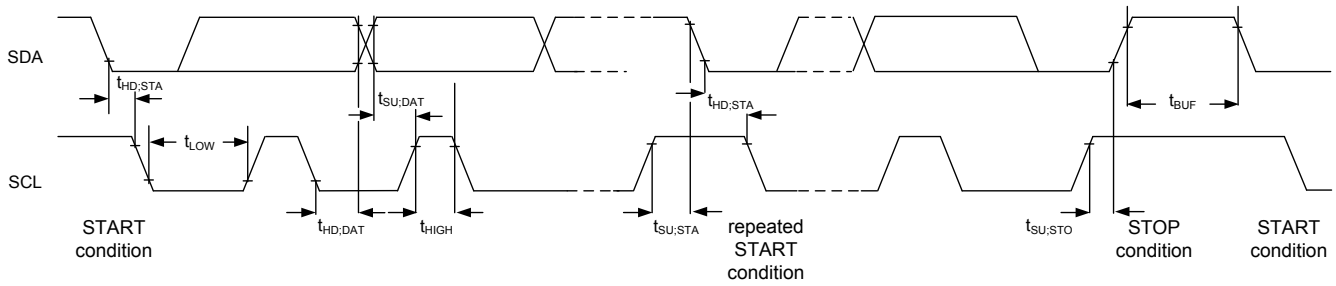


Figure 8. 2-wire Serial Bus Interface Timing Chart

Parameter	Symbol	Standard-mode		Fast-mode		Unit
		Min	Max	Min	Max	
SCL Clock Frequency	f_{SCL}	0	100	0	400	kHz
Hold Time for (Repeated) START Condition	$t_{HD;STA}$	4.0	-	0.6	-	µs
Low Period of SCL	t_{LOW}	4.7	-	1.3	-	µs
High Period of SCL	t_{HIGH}	4.0	-	0.6	-	µs
Data Hold Time	$t_{HD;DAT}$	0.1	3.45	0.1	0.9	µs
Data Setup Time	$t_{SU;DAT}$	0.25	-	0.1	-	µs
Setup Time for Repeated Start Condition	$t_{SU;STA}$	4.7	-	0.6	-	µs
Setup Time for STOP Condition	$t_{SU;STO}$	4.0	-	0.6	-	µs
Bus Free Time Between STOP and START Condition	t_{BUF}	4.7	-	1.3	-	µs

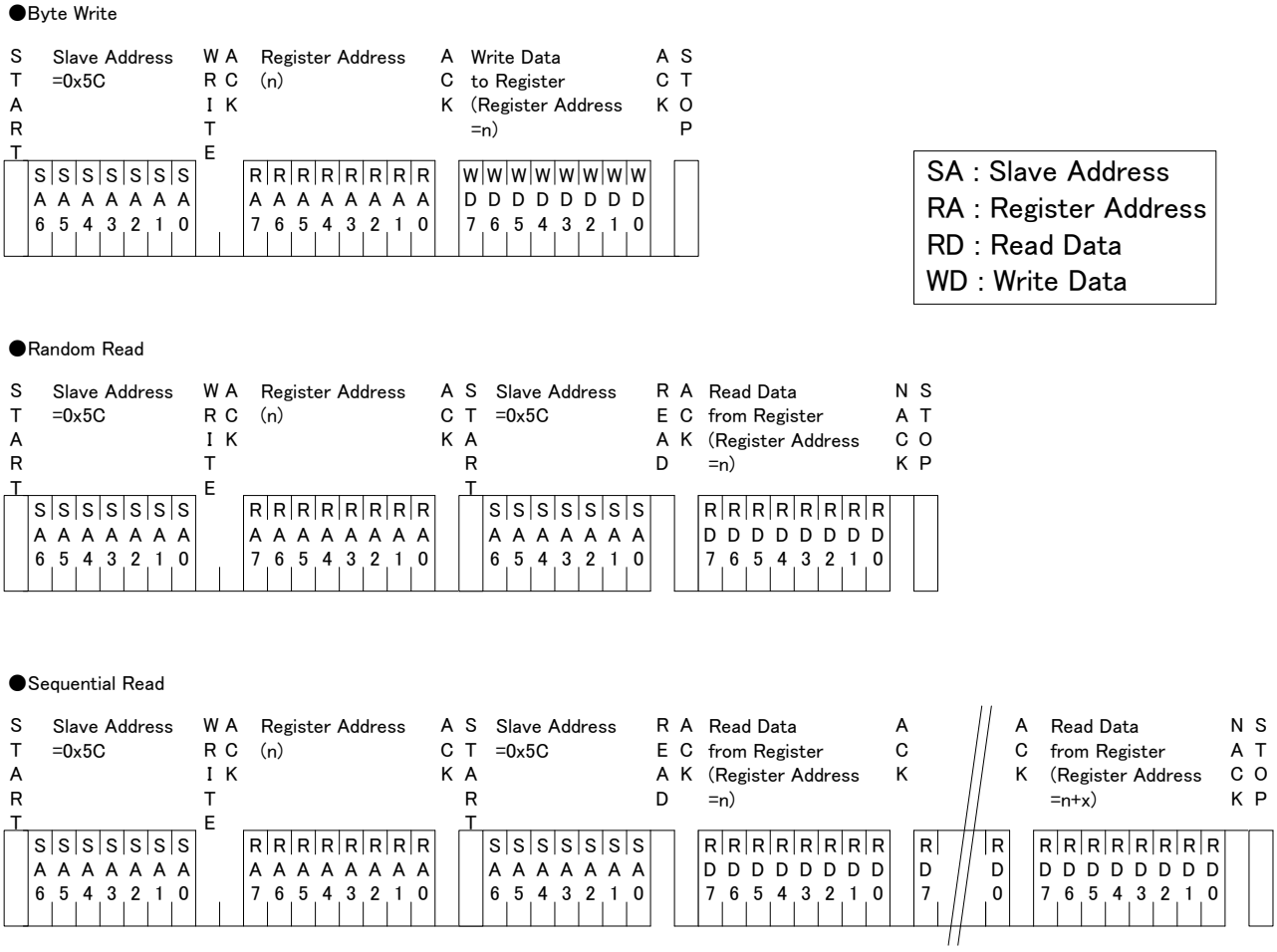


Figure 9. 2-wire Serial Bus Protocol

Power on Sequence

The power supply pin is only VDD. AVDD and DVDD are generated by built-in LDO, these are not necessary to supply from external.
When the voltage level of RSTB change form low to High after VDD supplying, LDO is wakeup and DVDD voltage is raised. And built-in power on reset (POR) circuit release the system reset and host interface is enable After DVDD voltage reach the normal voltage range.
RSTB pin can not need to be controlled by host and connects to the VDD, because the BU21077MUV has POR circuit. If the RSTB pin is connected to the VDD, the system reset is release automatically after VDD supplying.

Recommended Value of External Capacitors

C_1	1.0uF	Decoupling capacitor for VDD
C_2	1.0uF	Decoupling capacitor for DVDD
C_3	2.2uF	Decoupling capacitor for AVDD

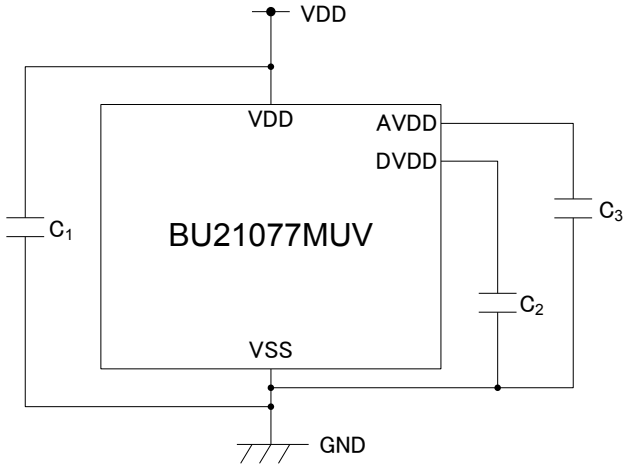


Figure 10. Arrangement of External Capacitors

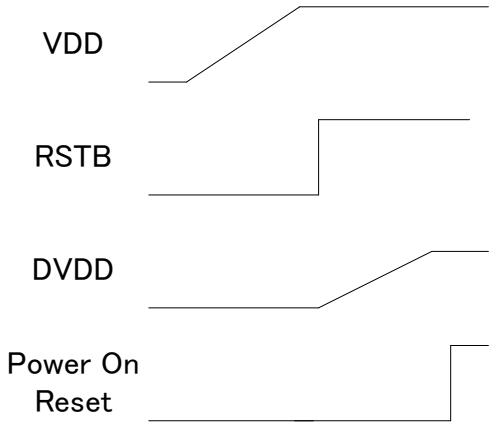


Figure 11. Power on Sequence (Controlled RSTB)

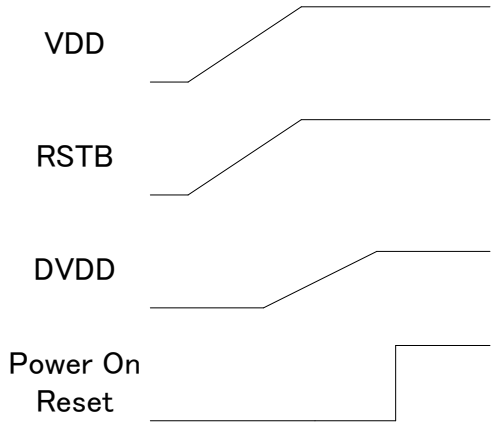


Figure 12. Power on Sequence (VDD Shorted RSTB)

Operational Notes

1. **Reverse Connection of Power Supply**
   Connecting the power supply in reverse polarity can damage the IC. Take precautions against reverse polarity when connecting the power supply, such as mounting an external diode between the power supply and the IC's power supply terminals.

2. **Power Supply Lines**
   Design the PCB layout pattern to provide low impedance supply lines. Separate the ground and supply lines of the digital and analog blocks to prevent noise in the ground and supply lines of the digital block from affecting the analog block. Furthermore, connect a capacitor to ground at all power supply pins. Consider the effect of temperature and aging on the capacitance value when using electrolytic capacitors.

3. **Ground Voltage**
   Ensure that no pins are at a voltage below that of the ground pin at any time, even during transient condition.

4. **Ground Wiring Pattern**
   When using both small-signal and large-current ground traces, the two ground traces should be routed separately but connected to a single ground at the reference point of the application board to avoid fluctuations in the small-signal ground caused by large currents. Also ensure that the ground traces of external components do not cause variations on the ground voltage. The ground lines must be as short and thick as possible to reduce line impedance.

5. **Thermal Consideration**
   Should by any chance the power dissipation rating be exceeded the rise in temperature of the chip may result in deterioration of the properties of the chip. The absolute maximum rating of the Pd stated in this specification is when the IC is mounted on a 74.2mm x 74.2mm x 1.6mm glass epoxy board with 10.22mm^2 copper areas. In case of exceeding this absolute maximum rating, increase the board size and copper area to prevent exceeding the Pd rating.

6. **Recommended Operating Conditions**
   These conditions represent a range within which the expected characteristics of the IC can be approximately obtained. The electrical characteristics are guaranteed under the conditions of each parameter.

7. **Rush Current**
   When power is first supplied to the IC, it is possible that the internal logic may be unstable and inrush current may flow instantaneously due to the internal powering sequence and delays, especially if the IC has more than one power supply. Therefore, give special consideration to power coupling capacitance, power wiring, width of ground wiring, and routing of connections.

8. **Operation Under Strong Electromagnetic Field**
   Operating the IC in the presence of a strong electromagnetic field may cause the IC to malfunction.

9. **Testing on Application Boards**
   When testing the IC on an application board, connecting a capacitor directly to a low-impedance output pin may subject the IC to stress. Always discharge capacitors completely after each process or step. The IC's power supply should always be turned off completely before connecting or removing it from the test setup during the inspection process. To prevent damage from static discharge, ground the IC during assembly and use similar precautions during transport and storage.

10. **Inter-pin Short and Mounting Errors**
    Ensure that the direction and position are correct when mounting the IC on the PCB. Incorrect mounting may result in damaging the IC. Avoid nearby pins being shorted to each other especially to ground, power supply and output pin. Inter-pin shorts could be due to many reasons such as metal particles, water droplets (in very humid environment) and unintentional solder bridge deposited in between pins during assembly to name a few.

Operational Notes – continued

11. Unused Input Terminals

Input terminals of an IC are often connected to the gate of a MOS transistor. The gate has extremely high impedance and extremely low capacitance. If left unconnected, the electric field from the outside can easily charge it. The small charge acquired in this way is enough to produce a significant effect on the conduction through the transistor and cause unexpected operation of the IC. So unless otherwise specified, unused input terminals should be connected to the power supply or ground line.

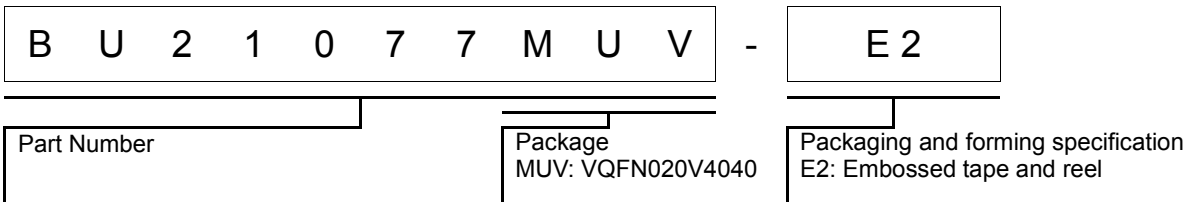
12. Regarding the Input Pin of the IC

In the construction of this IC, P-N junctions are inevitably formed creating parasitic diodes or transistors. The operation of these parasitic elements can result in mutual interference among circuits, operational faults, or physical damage. Therefore, conditions which cause these parasitic elements to operate, such as applying a voltage to an input pin lower than the ground voltage should be avoided. Furthermore, do not apply a voltage to the input terminals when no power supply voltage is applied to the IC. Even if the power supply voltage is applied, make sure that the input terminals have voltages within the values specified in the electrical characteristics of this IC.

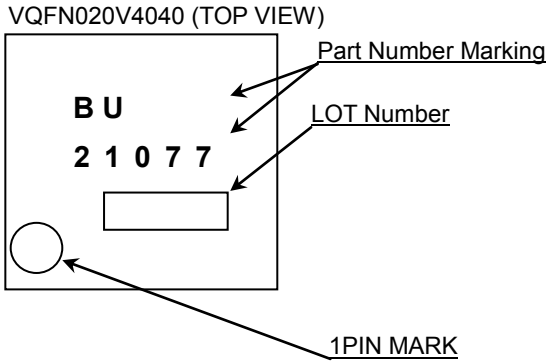
13. Ceramic Capacitor

When using a ceramic capacitor, determine the dielectric constant considering the change of capacitance with temperature and the decrease in nominal capacitance due to DC bias and others.

Ordering Information

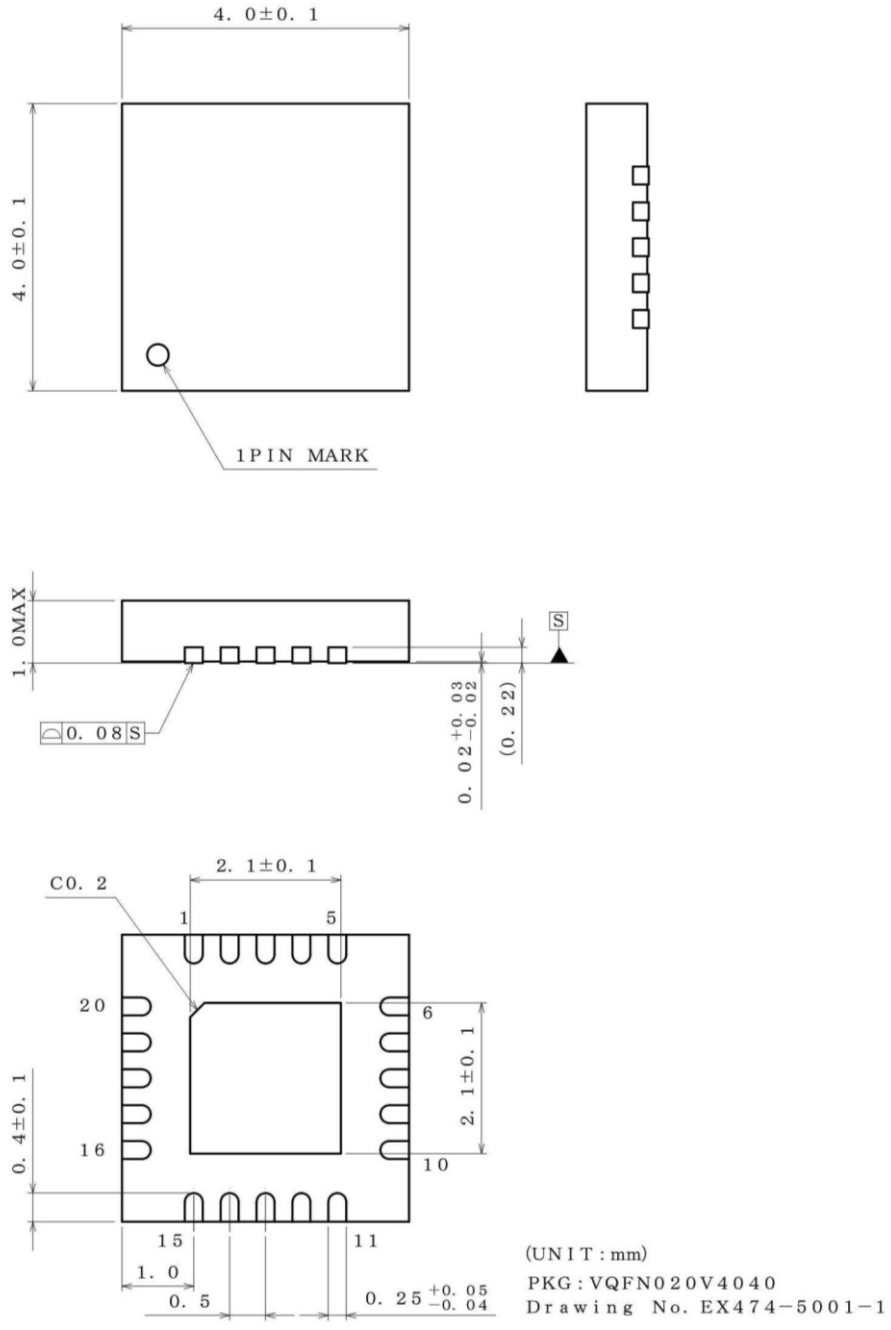


Marking Diagram



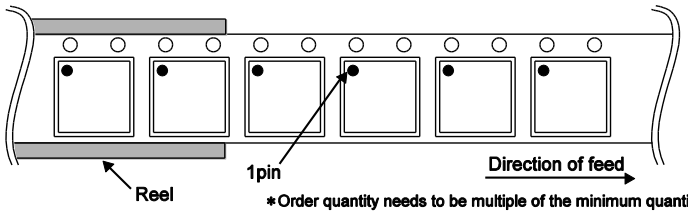
Physical Dimension, Tape and Reel Information

Package Name	VQFN020V4040



<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	2500pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)



*Order quantity needs to be multiple of the minimum quantity.

Revision History

Date	Revision	Changes
29.Aug.2013	001	New Release
14.Jul.2016	002	P3 Correct clerical error (old) MUP (new) MPU P7 Correct recommended value of decoupling capacitor for VDD (old) 0.1uF (new) 1.0uF

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JAPAN	USA	EU	CHINA
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CLASSⅣ		CLASSⅢ	

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   [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
   [f] Sealing or coating our Products with resin or other coating materials
   [g] Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
   [h] Use of the Products in places subject to dew condensation

4. The Products are not subject to radiation-proof design.

5. Please verify and confirm characteristics of the final or mounted products in using the Products.

6. In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse. is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.

7. De-rate Power Dissipation depending on ambient temperature. When used in sealed area, confirm that it is the use in the range that does not exceed the maximum junction temperature.

8. Confirm that operation temperature is within the specified range described in the product specification.

9. ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

Precaution for Mounting / Circuit board design

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2. In principle, the reflow soldering method must be used on a surface-mount products, the flow soldering method must be used on a through hole mount products. If the flow soldering method is preferred on a surface-mount products, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

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This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of Ionizer, friction prevention and temperature / humidity control).

Precaution for Storage / Transportation

1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
   [a] the Products are exposed to sea winds or corrosive gases, including Cl2, H2S, NH3, SO2, and NO2
   [b] the temperature or humidity exceeds those recommended by ROHM
   [c] the Products are exposed to direct sunshine or condensation
   [d] the Products are exposed to high Electrostatic

2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.

3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.

4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

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