

# 4-wire resistive Touch Screen Controller

## BU21021GUL

### ●General Description

BU21021GUL is a resistive touch screen controller, which is capable of detecting 2 points touch with a legacy 4-wire resistive touch screen. BU21021GUL is capable of detecting X/Y coordinates, touch pressure in 1 point detection mode, and a pair of X/Y coordinates in 2 point detection mode.

It is also capable of recognizing multiple finger gestures from coordinate data variation and notifying to host with gesture detection flags respectively.

BU21021GUL employs embedded CPU for noise filtering, coordinate calculation, gesture detection and other signal processing required on a chip.

### ●Feature

- Legacy 4-wire resistive touch screen is applicable
- 1 point / 2 points touch detection
- On chip coordinate generation
- Multiple gesture detections
- 3V single power supply
- Higher coordinate resolution with 12-bit SAR A/D converter
- On chip clock generator
- Selectable HOST I/F(IFSEL pin)  
4-wire SPI / 2-wire serial bus

### ●Application Circuit Example

(2-wire serial I/F, Slave address=B8h, non-use EEPROM)

### ●Key Specification

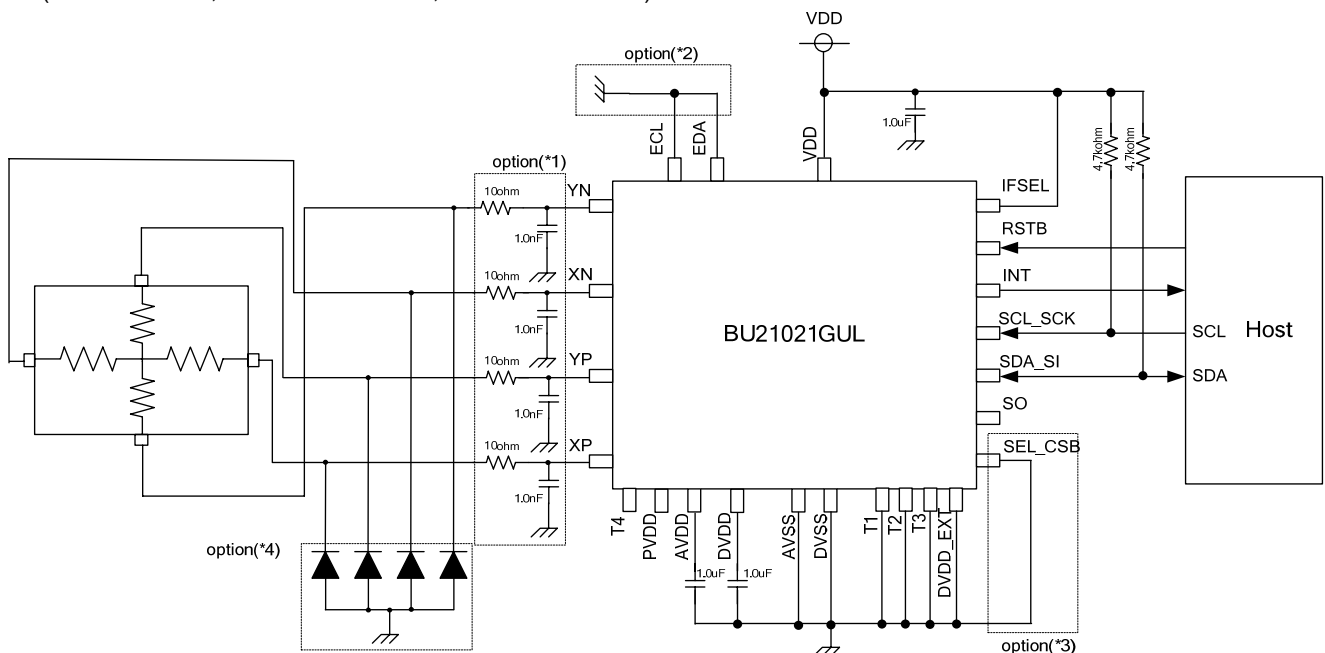
■ Power supply voltage	2.7V to 3.6V
■ Temperature range	-20°C to 85°C
■ Standby current	5.0uA (Max.)
■ Sleep current	60uA (Typ.)
■ Operating current	4.0mA (Typ.)
■ Coordinate resolution	12bit

### ●Package

VCSP50L2      2.70 mm x 2.65 mm x 0.55(max) mm

### ●Application

- Equipments with user Interface employing 4-wire resistive touch screen.
- Mobile phone, Tablet PC, PDA or other portable information devices.
- Digital still camera, Digital video camera, portable TV or other Audio-visual devices.
- Note PC, Touch screen monitor, printer or other PC peripherals.



- (\*1) For Noise protection.  
 (\*2) EEPROM interface PIN.  
 (\*3) Please connect to VDD when use as slave address = "BAh"  
 (\*4) For ESD protection, (Zener diode / TVS diode)

Figure 1. Application circuit example

## ● Pin Layout

	1	2	3	4	5
A	T4	PVDD	DVDD	VDD	DVSS
B	XP		AVDD	AVSS	DVDD_EXT
C	XN	YP	RSTB	T1	T2
D	YN	SEL_CSB	SO	T3	IFSEL
E	ECL	EDA	SCL_SCK	SDA_SI	INT

Top view

Figure 2. Pin Layout

## ● Pin Descriptions

Pin no.	Pin Name	I/O	Description				Equivalent circuit
D1	YN	I/O	YN channel input.				D
C1	XN	I/O	XN channel input.				D
C2	YP	I/O	YP channel input.				D
B1	XP	I/O	XP channel input.				D
A1	T4	I/O	Test input / output.				D
A2	PVDD	O	Regulator output for touch screen voltage supply.				D
B3	AVDD	O	Regulator output for analog circuit.				D
A3	DVDD	I/O	Regulator output for digital circuit				D
B4	AVSS	-	Analog ground.				-
A4	VDD	-	Chip power supply.				-
A5	DVSS	-	Digital ground.				-
B5	DVDD_EXT	I	Digital power supply select. (L=internal, H=external)				A
C3	RSTB	I	Reset (Low active)				C
C4	T1	I	Test input.				A
C5	T2	I	Test input.				A
D4	T3	I	Test input.				A
D5	IFSEL	I	Host interface select. (L=4-wire SPI, H=2-wire serial)				A
D3	SO	O	2-wire serial	High impedance	4-wire SPI	Data output	E
E5	INT	O	Interrupt				E
D2	SEL_CSB	I	2-wire serial	Slave address select	4-wire SPI	Chip select	C
E4	SDA_SI	I/O	2-wire serial	Data input / output	4-wire SPI	Data input	B
E3	SCL_SCK	I	2-wire serial	Clock input	4-wire SPI	Clock input	B
E2	EDA	I/O	SDA for EEPROM				B
E1	ECL	I/O	SCL for EEPROM				B

(\*1) Bypass AVDD and DVDD to GND with 1.0 uF capacitor and PVDD and T4 need terminal opening.

(\*2) Digital voltage can be supplied by DVDD when DVDD\_EXT=H.

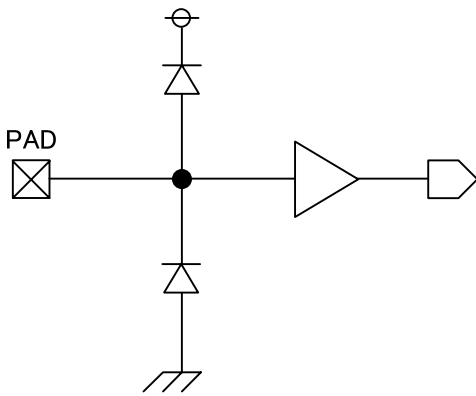
(\*3) ECL and EDA need pull-up with 4.7kΩ resistor in use case. If not use, connect to GND.

(\*4) SCL\_SCK and SDA\_SI need pull-up with over 4.7kΩ resistor and SO need terminal opening when use 2-wire serial I/F.

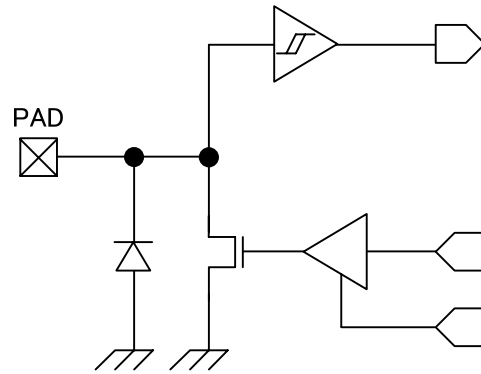
(\*5) Above parameters are only recommended for use. Absolute reliability is not guaranteed.

(\*6) When VDD is not supplied, state of RSTB="H" is prohibition.

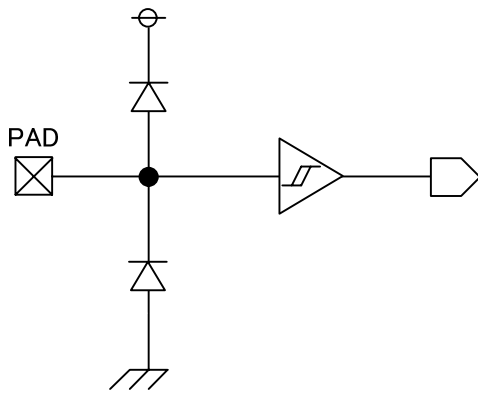
● I/O equivalent circuits



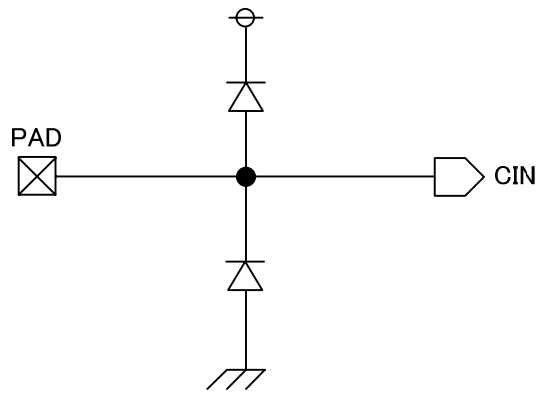
Equivalent circuit A



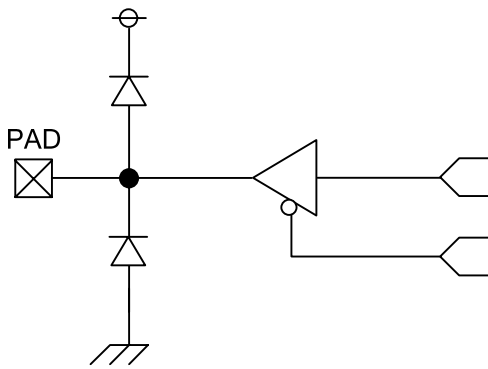
Equivalent circuit B



Equivalent circuit C



Equivalent circuit D



Equivalent circuit E

Figure 3. I/O equivalent circuits

**● Overview**

BU21021GUL is a resistive touch screen controller, which is capable of detecting 2 points touch with a legacy 4-wire resistive touch screen. It is composed of 32-bit CPU, 12-bit SAR A/D converter, clock oscillator, and voltage regulators power supply, and operates at a single power supply ranging from 2.7 to 3.6V. BU21021GUL is capable of detecting X/Y coordinates, touch pressure in 1 point detection mode, and a pair of X/Y coordinates in 2 point detection mode.

It is also capable of recognizing multiple finger gestures from coordinate data variation and notifying to host with gesture detection flags respectively. BU21021GUL employs embedded CPU for noise filtering, coordinate calculation, gesture detection and other signal processing required on a chip.

BU21021GUL senses panel terminal voltages periodically, filters noise, then calculates coordinates in its operation mode. Host will be noticed by a interrupt signal (INT) when resister values are updated.

**1 point detection**

Touch detection and touch pressure detection are processed on chip, and BU21021GUL operates as a legacy resistive touch controller employing 4-wire resistive touch screen.

BU21021GUL has 2 point touch detection function, which prevents itself from common misdetection of single 'midpoint' coordinate output.

**2 points detection**

2 point detection is held by monitoring electric condition of a touch sensor and calculating coordinates on each axis. The process is different from legacy 1 point touch detection, therefore BU21021GUL requires setup of panel parameter in advance.

BU21021GUL automatically detects ether 1 point or 2 points touch input.

**Gesture detection**

BU21021GUL is able to detect 1 point flick gesture for 4 directions and 2 point ZOOM IN/OUT, PINCH/SPREAD and rotate gestures respectively. Gesture detection events are reported to host as detection flags and interrupt. Each of gesture detection sensitivities can be set as register parameters respectively.

(Note) Gesture flags only repot its events. Operation speed and movement have to be calculate on host using coordinate data.

**Auto power on / off function**

Auto power off function will power off to sleep condition in order to reduce power consumption when no touch input is detected. BU21021GUL will automatically change to operation state when touch event is detected in sleep state.

This function is able to be enabled / disabled, and threshold level of sleep state transition is able to be set by registers.

**Host interface**

BU21021GUL works as slave device of HOST MCU connected 2-wire serial bus or 4-wire SPI.

It is selectable by IFSEL pin condition.

(IFSEL=GND : 4-wire SPI, IFSEL=VDD : 2-wire serial bus)

**EEPROM**

Firmware has to be downloaded on BU21021GUL in order to realize these functions. The file size of firmware is 16kB (16384 bytes). A "HOST interface" and "external EEPROM" can be chosen as the download method.

**DVDD external supply setup**

In the case there exists 1.8V power supply on application system, the external 1.8V supply can be applicable to DVDD in order to reduce sleep power consumption to 10uA.

## ●Block Diagram

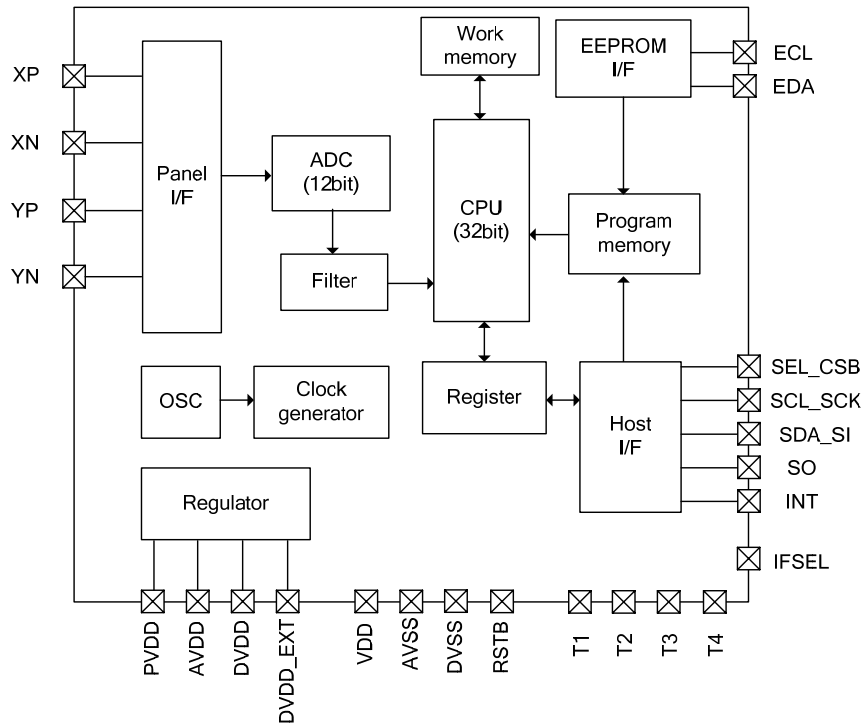


Figure 4. Block Diagram

## ●Description of Blocks

- Screen-I/F : 4-wire touch screen interface
- ADC : 12-bit SAR A/D converter
- OSC : 20MHz oscillator for internal block
- Regulator : Internal power supply.  
DVDD can be supplied from external
- Clock generator : System clock and internal timing generation
- CPU : Noise filtering, dual touch detection and touch coordinates generation
- Work memory : CPU work memory
- Program memory : CPU program memory
- EEPROM-I/F : External EEPROM-I/F for CPU program memory downloads
- Host-I/F : 4-wire SPI I/F / 2-wire serial bus I/F
- Filter : Median average filter (Maximum 16 data)

### ● Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit	Conditions
Power-supply voltage	VDD	-0.3 to 4.5	V	
Input voltage	VIN	VSS-0.3 to VDD+0.3	V	
Power dissipation	Pd	910 <sup>*1</sup>	mW	
Storage temperature range	Tstg	-50 to 125	°C	

\*1 Ambient temperature reduces a permission loss by 9.10mW per case more than 25 degree Celsius, 1degree Celsius. Condition: Assembly on the Epoxy-Glass (50x58x1.75mm)

### ● Recommended Operating Conditions

Parameter	Symbol	Rating			Unit	Conditions
		Min	Typ	Max		
Power-supply voltage	VDD	2.7	3.0	3.6	V	
Digital power-supply voltage	DVDD	1.62	1.80	1.98	V	DVDD_EXT = H
Operating temperature range	Topr	-20	25	85	°C	

### ● Electrical Characteristics

At Ta = 25°C, VDD = 3.0V, unless otherwise noted.

Parameter	Symbol	Rating			Unit	Conditions
		Min	Typ	Max		
Low-level input voltage	VIL	VSS-0.5	-	0.2xVDD	V	
High-level input voltage	VIH	0.8xVDD	-	VDD+0.5	V	
Low-level output voltage	VOL	-	-	VSS+0.4	V	
High-level output voltage	VOH	VDD-0.4	-	-	V	
Standby current	Ist	-	-	5	uA	RSTB=L
Sleep current1	Icc1	-	60	100	uA	DVDD_EXT=L
Sleep current2	Icc2	-	10	20	uA	DVDD_EXT=H (*1)
Operating current	Idd	-	4	8	mA	No load
Clock frequency	Freq	15	20	24	MHz	

\*1 The supply of digital power (1.8V) is needed from the terminal DVDD.

●HOST-I/F timing specification (4-wire SPI)

(Note: SCK=SCL\_SCK, SI=SDA\_SI, CSB=SEL\_CSB and SO=SO)

4-wire SPI has the burst write and burst read.

The automatic address increment is done until 0x5F. After address 0x5F is accessed, it is not changed.

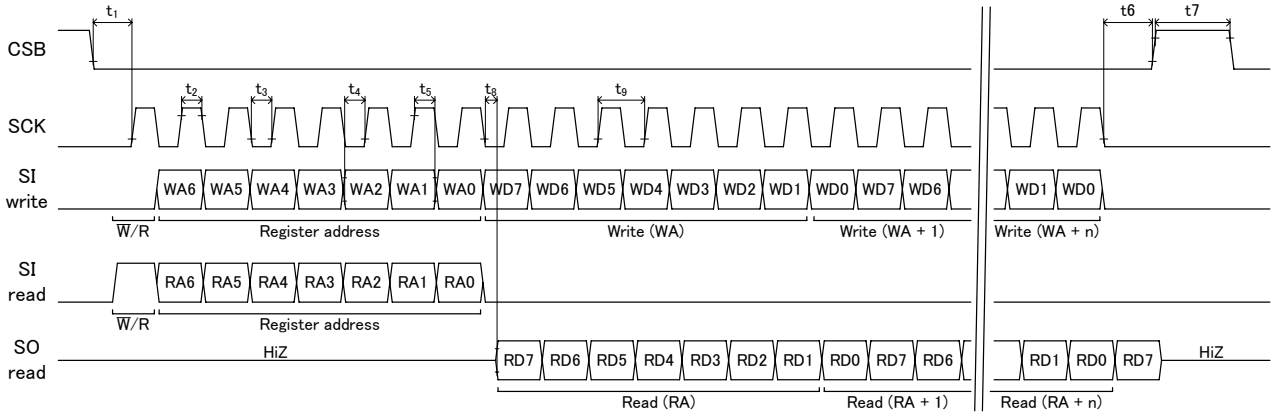


Figure 5. Timing specification (4-wire SPI)

Table 1. Timing Requirements: 4-wire SPI at VDD = 3.0V, Ta = 25°C

Parameter	Symbol	Rating			Unit	Conditions
		Min	Typ	Max		
CSB setup time	t <sub>1</sub>	30	-	-	ns	
'H' width of SCK	t <sub>2</sub>	30	-	-	ns	
'L' width of SCK	t <sub>3</sub>	30	-	-	ns	
SI setup time	t <sub>4</sub>	20	-	-	ns	
SI holding time	t <sub>5</sub>	20	-	-	ns	
CSB holding time	t <sub>6</sub>	20	-	-	ns	
'H' width of CSB	t <sub>7</sub>	50	-	-	ns	
SO output delay time	t <sub>8</sub>	-	-	15	ns	
SCK frequency	t <sub>9</sub>	-	-	15	MHz	

●HOST-I/F timing specification (2-wire serial)

(Note: SCL=SCL\_SCK, SDA=SDA\_SI)

2-wire serial has the burst write and burst read.

The automatic address increment is done until 0x5F. After address 0x5F is accessed, it is not changed.

This 2-wire serial I/F is not corresponded to re-start command. Send start condition after send stop condition.

The slave address of 2-wire serial is B8h / BAh which is decided by the state of the terminal SEL\_CSB.

- SEL\_CSB = "L" : Slave Address = B8h ( 7bit = 5Ch + W/R bit )
- SEL\_CSB = "H" : Slave Address = BAh ( 7bit = 5Dh + W/R bit )

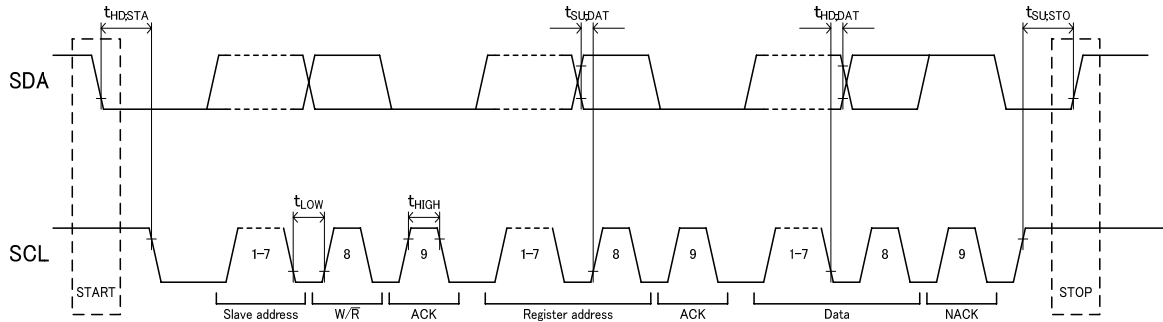


Figure 6. Timing specification (2-wire serial)

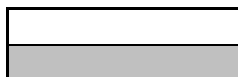
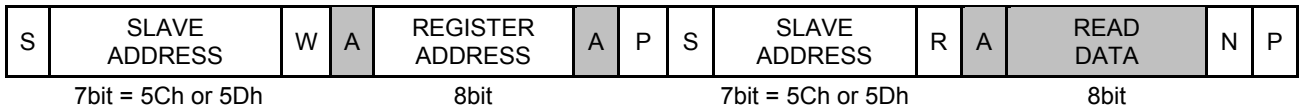
Table 2. Timing Requirements: 2-wire serial at VDD = 3.0V, Ta = 25°C

Parameter	Symbol	Rating			Unit	Condition
		Min	Typ	Max		
SCL clock frequency	f <sub>SCL</sub>	0	-	400	kHz	
START hold time	t <sub>HD:STA</sub>	0.6	-	-	us	
"L" width of SCL	t <sub>LOW</sub>	1.3	-	-	us	
"H" width of SCL	t <sub>HIGH</sub>	0.6	-	-	us	
Data hold time	t <sub>HD:DAT</sub>	0.1	-	-	us	
Data setup time	t <sub>SU:DAT</sub>	0.1	-	-	us	
STOP setup time	t <sub>SU:STO</sub>	0.6	-	-	us	

• Write Protocol



• Read Protocol



- S : START condition
- P : STOP condition
- R : data direction READ (SDA HIGH)
- W : data direction WRITE (SDA LOW)
- A : acknowledge (SDA LOW)
- N : not acknowledge (SDA HIGH)

Figure 7. Read/Write Protocol



● Typical Application circuit

BU21021GUL has two selectable host interfaces (4-wire SPI and 2-wire serial).  
The figure below shows the example of circuit when each interface is used.  
(Show by the terminal display though BU21021GUL is CSP package.)

- Option(\*1) For reject and reduce the noise from touch screen / LCD module or wiring.
- Option(\*2) It is not necessary to mount EEPROM when firmware download setting is host.  
Connect to ECL/EDA to VSS.
- Option(\*3) In using with Slave address = BAh case, connect SEL\_CSb to VDD.

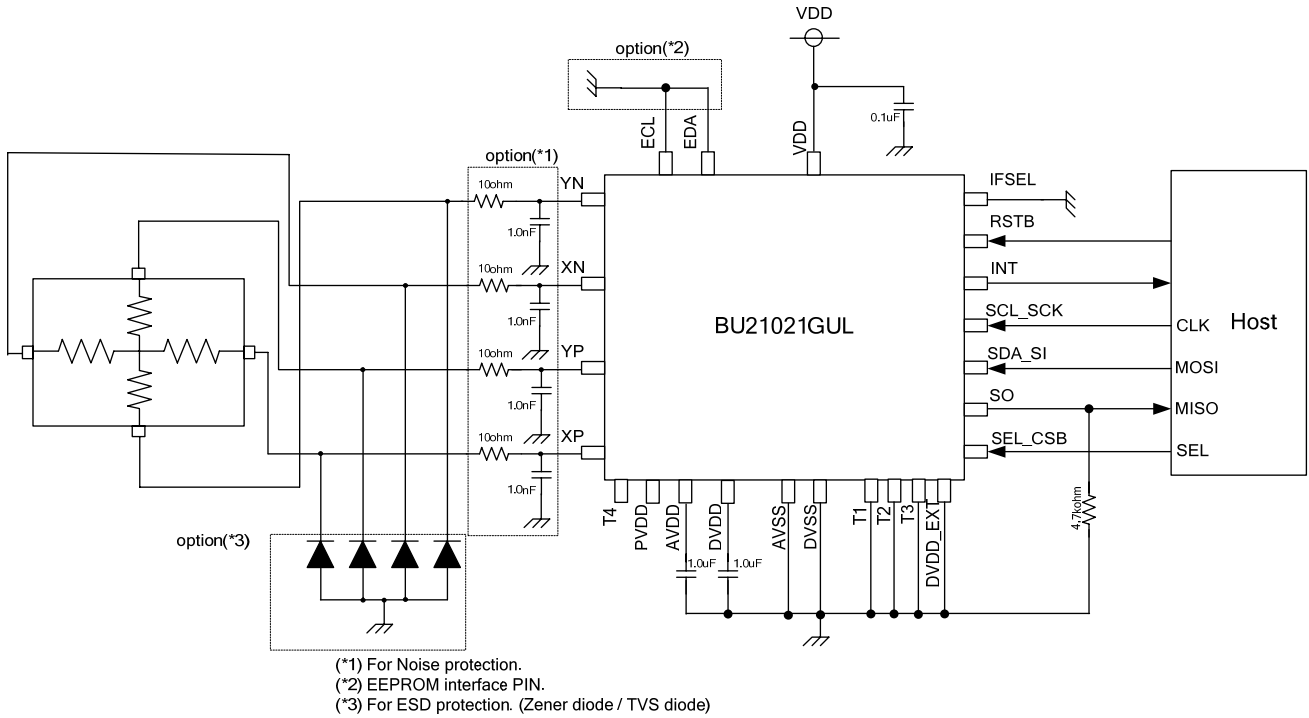


Figure 8. Application circuit 1 (4-wire SPI)

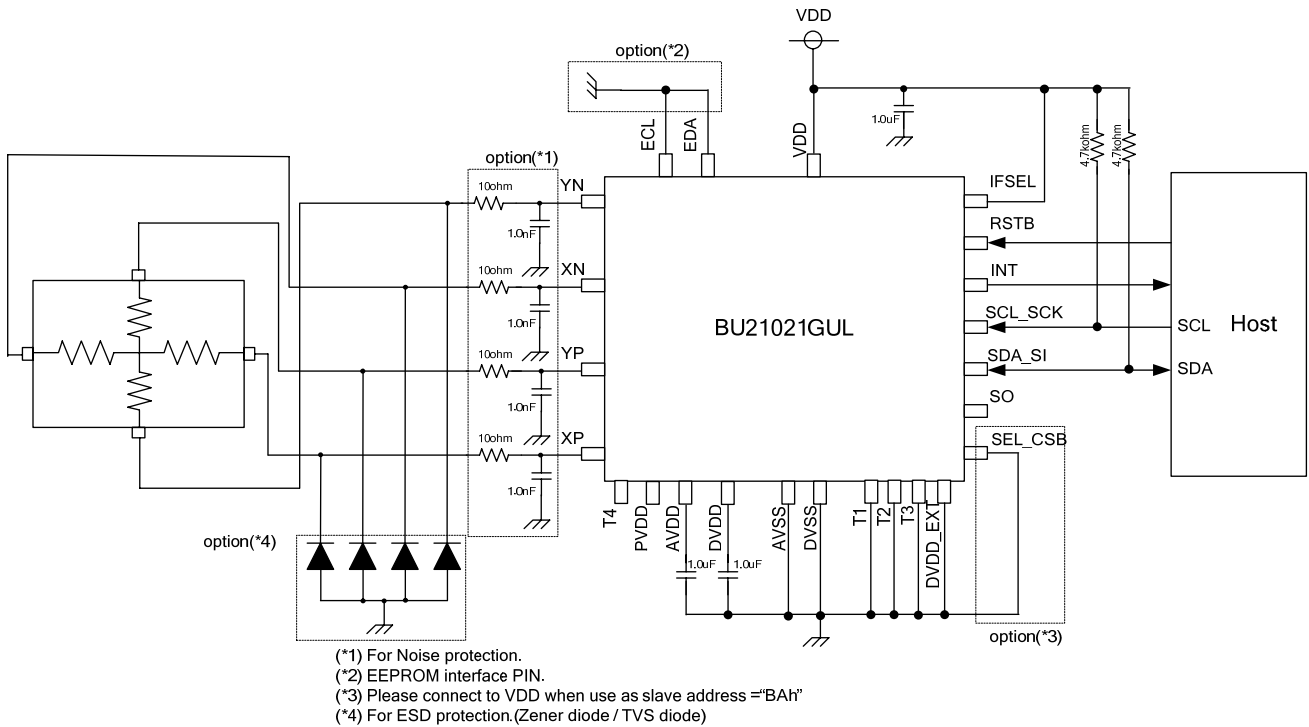
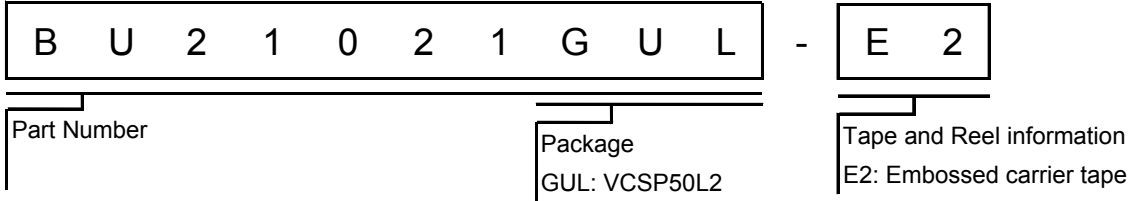


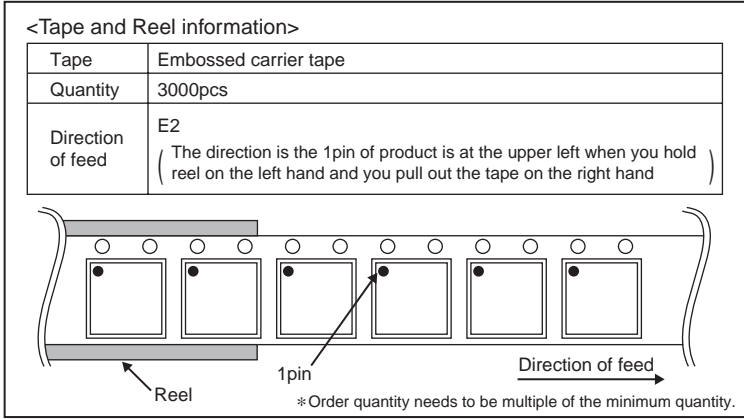
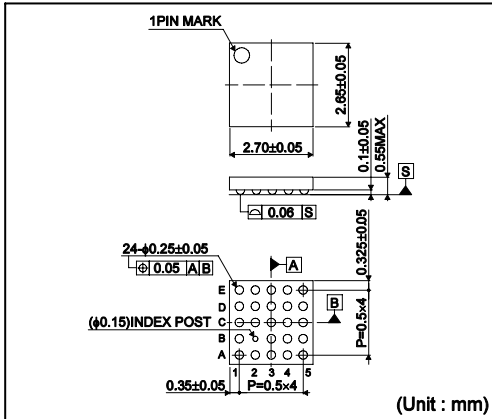
Figure 9. Application circuit 2 (2-wire serial bus)

● Ordering Information

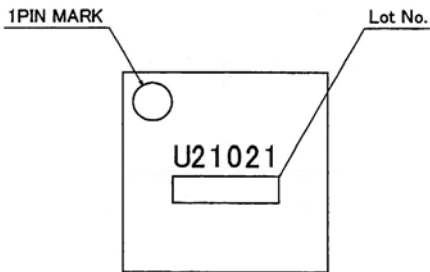


● Physical Dimension Tape and Reel Information

VCSP50L2(BU21021GUL)



● Marking Diagram(TOP VIEW)



## Revision History

Date	Revision	Changes
2012/06/19	001	New Release
2016/11/30	002	P1 Correct temperature range (old) -25°C to 85°C (new) -20°C to 85°C P1, P9 Change application circuit Add capacitor between VDD and ground Change the symbol of ESD protection diode

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