4-wire resistive Touch Screen Controller

BU21021GUL

Pb Free
ROHM Electronic Components

RoHS
Directive Compliance

● 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

● Key Specification

■ Power supply voltage	2.7V to 3.6V
■ Temperature range	-20℃ to 85℃
■ 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.

● Application Circuit Example

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

(*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)
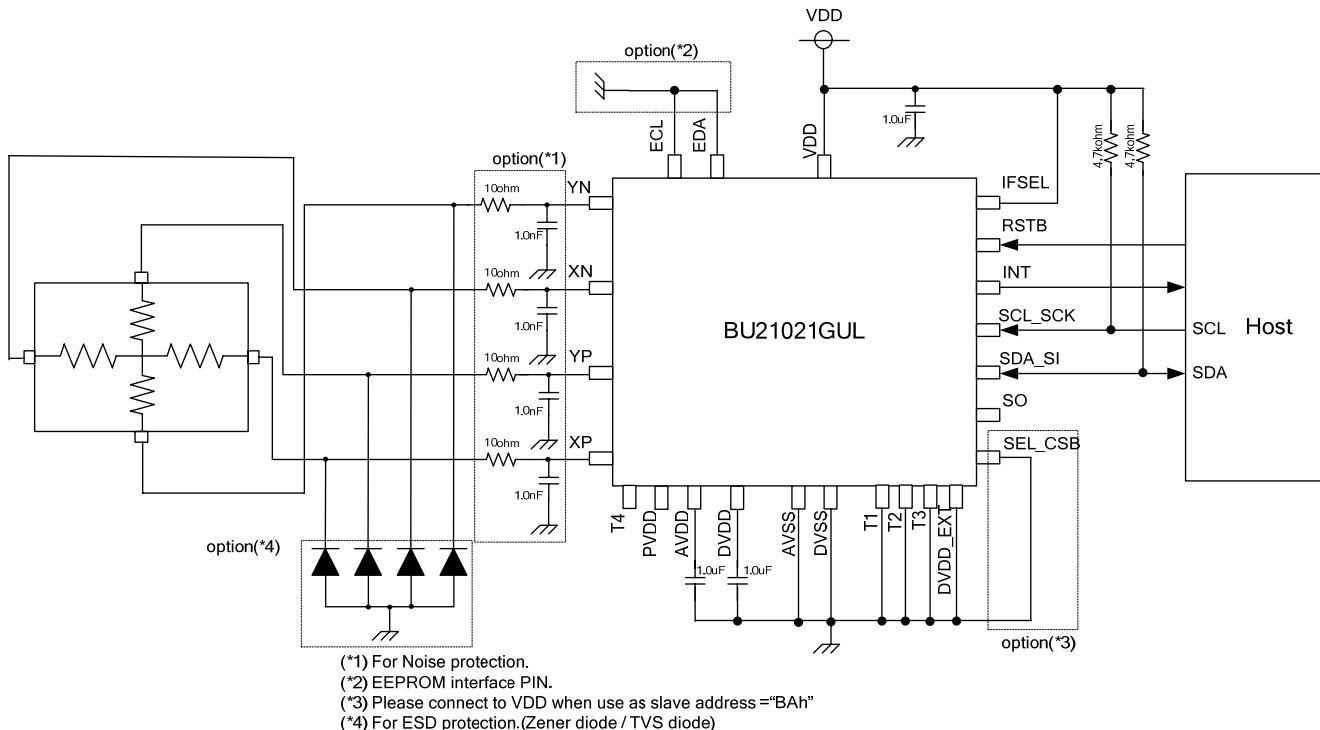
Figure 1. Application circuit example

○Product structure : Silicon monolithic integrated circuit   ○This product is not designed protection against radioactive rays

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●**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 resister in use case. If not use, connect to GND.
(*4) SCL_SCK and SDA_SI need pull-up with over 4.7kΩ resister 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.

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●**I/O equivalent circuits**
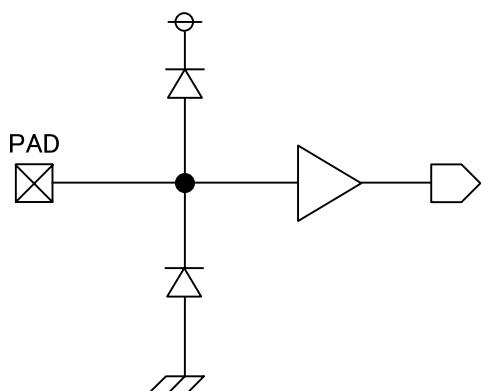
Equivalent circuit A
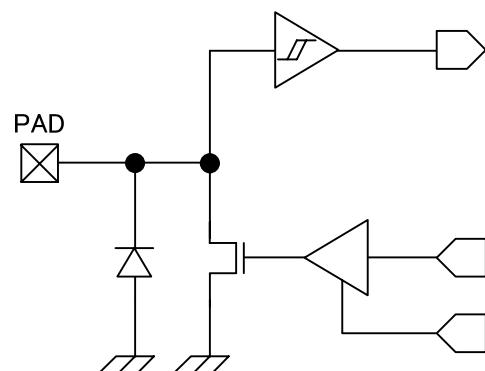
Equivalent circuit B
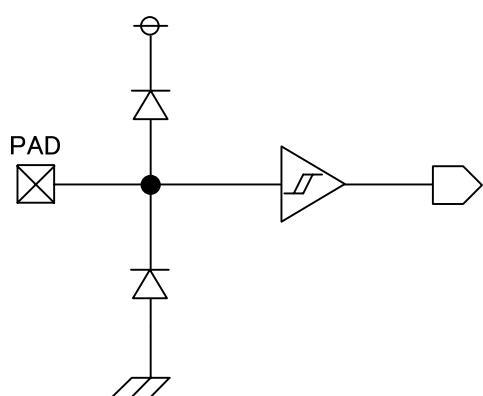
Equivalent circuit C

Equivalent circuit D

CIN
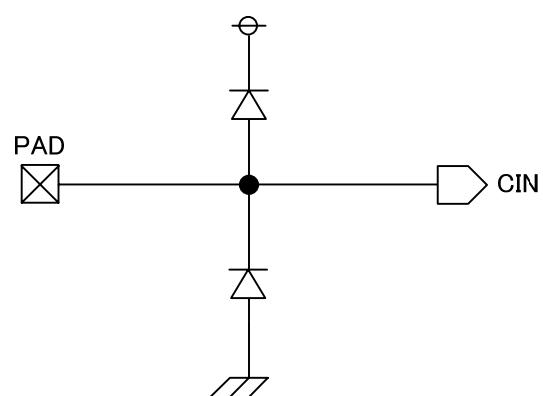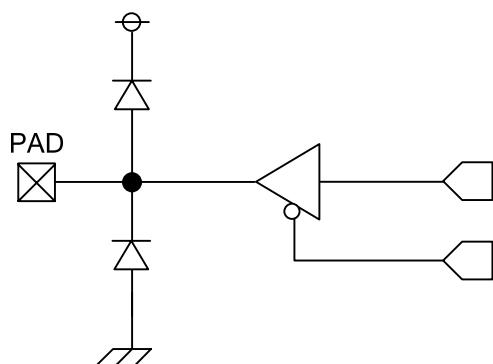
Equivalent circuit E

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**
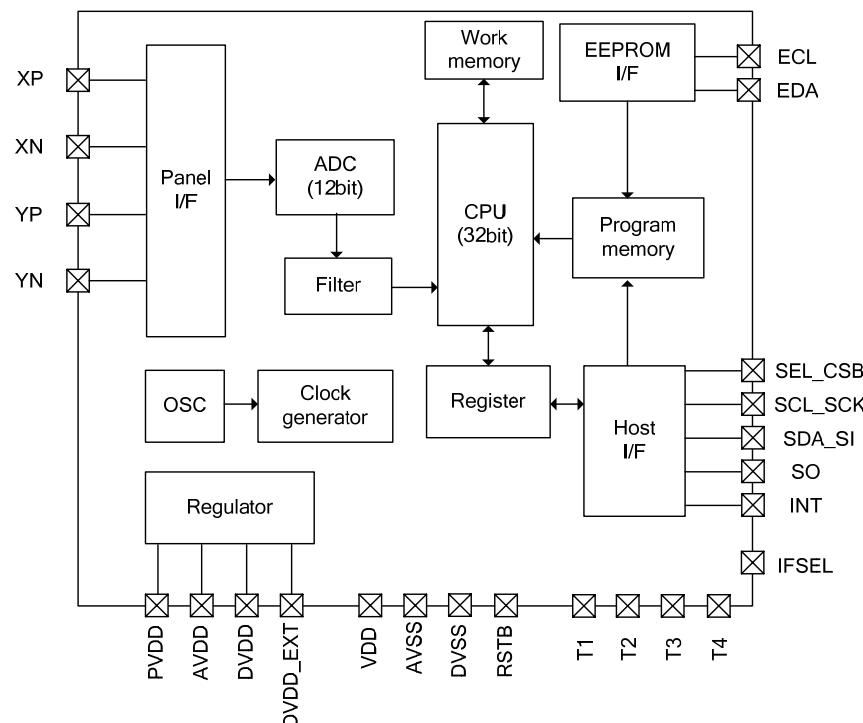
Figure 4. Block Diagram

●**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)

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●**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[*1]	mW	
Storage temperature range	Tstg	-50 to 125	℃	

*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	℃	

●**Electrical Characteristics**

At Ta = 25℃, 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.

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●**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.
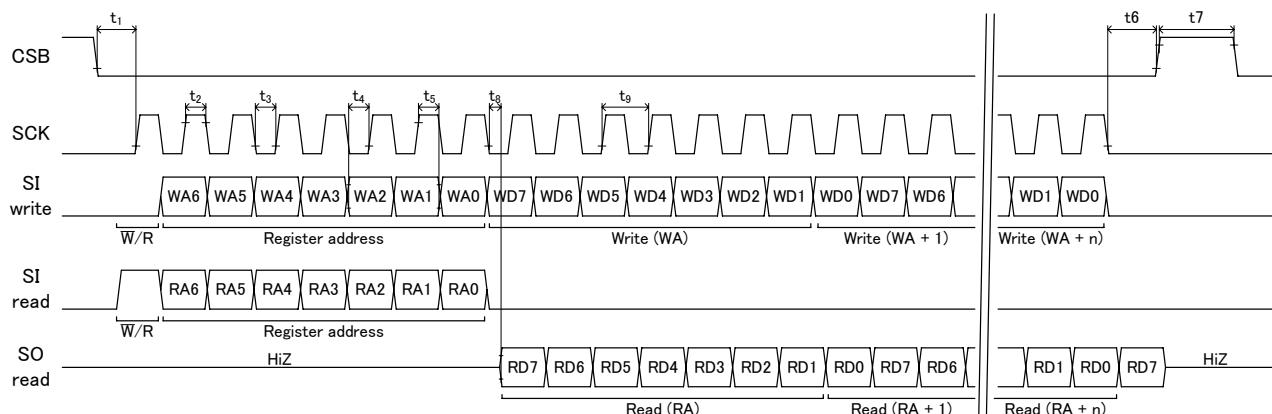
Figure 5. Timing specification (4-wire SPI)

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_1	30	-	-	ns	
'H' width of SCK	t_2	30	-	-	ns	
'L' width of SCK	t_3	30	-	-	ns	
SI setup time	t_4	20	-	-	ns	
SI holding time	t_5	20	-	-	ns	
CSB holding time	t_6	20	-	-	ns	
'H' width of CSB	t_7	50	-	-	ns	
SO output delay time	t_8	-	-	15	ns	
SCK frequency	t_9	-	-	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)
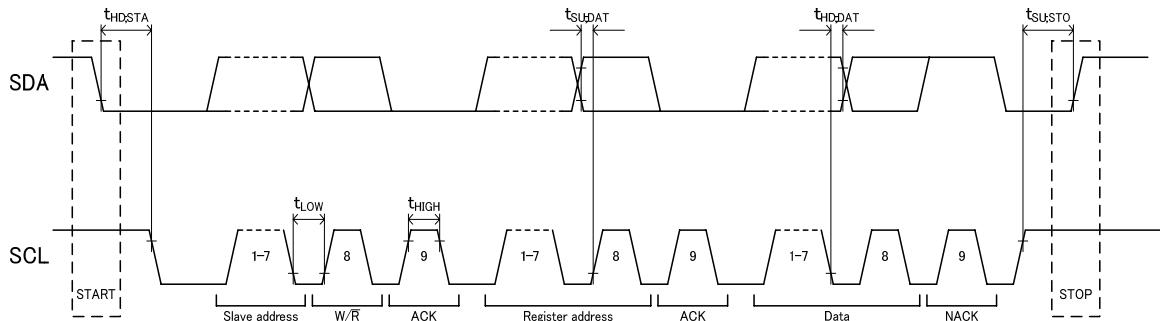
Figure 6. Timing specification (2-wire serial)

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

Parameter	Symbol	Rating			Unit	Condition
		Min	Typ	Max		
SCL clock frequency	f_{SCL}	0	-	400	kHz	
START hold time	$t_{HD:STA}$	0.6	-	-	us	
"L" width of SCL	t_{LOW}	1.3	-	-	us	
"H" width of SCL	t_{HIGH}	0.6	-	-	us	
Data hold time	$t_{HD:DAT}$	0.1	-	-	us	
Data setup time	$t_{SU:DAT}$	0.1	-	-	us	
STOP setup time	$t_{SU:STO}$	0.6	-	-	us	

・Write Protocol

S	SLAVE ADDRESS	W	A	REGISTER ADDRESS	A	WRITE DATA	A	P
	7bit = 5Ch or 5Dh			8bit		8bit		

・Read Protocol

S	SLAVE ADDRESS	W	A	REGISTER ADDRESS	A	P	S	SLAVE ADDRESS	R	A	READ DATA	N	P
	7bit = 5Ch or 5Dh			8bit				7bit = 5Ch or 5Dh			8bit		

(white)	from Master to Slave
(gray)	from Slave to Master
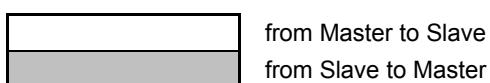
S	: START condition
P	: STOP condition
R	: data direction READ (SDA HIGH)
W	: data direction WRITE (SDA LOW)
A	: acknowledge (SDA LOW)
N	: not acknowledge (SDA HIGH)

Figure 7. Read/Write Protocol

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●**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.
                Please connect EEPROM when firmware download setting is EEPROM.
Option(*3)   In using with Slave address = BAh case, connect SEL_CSB to VDD.
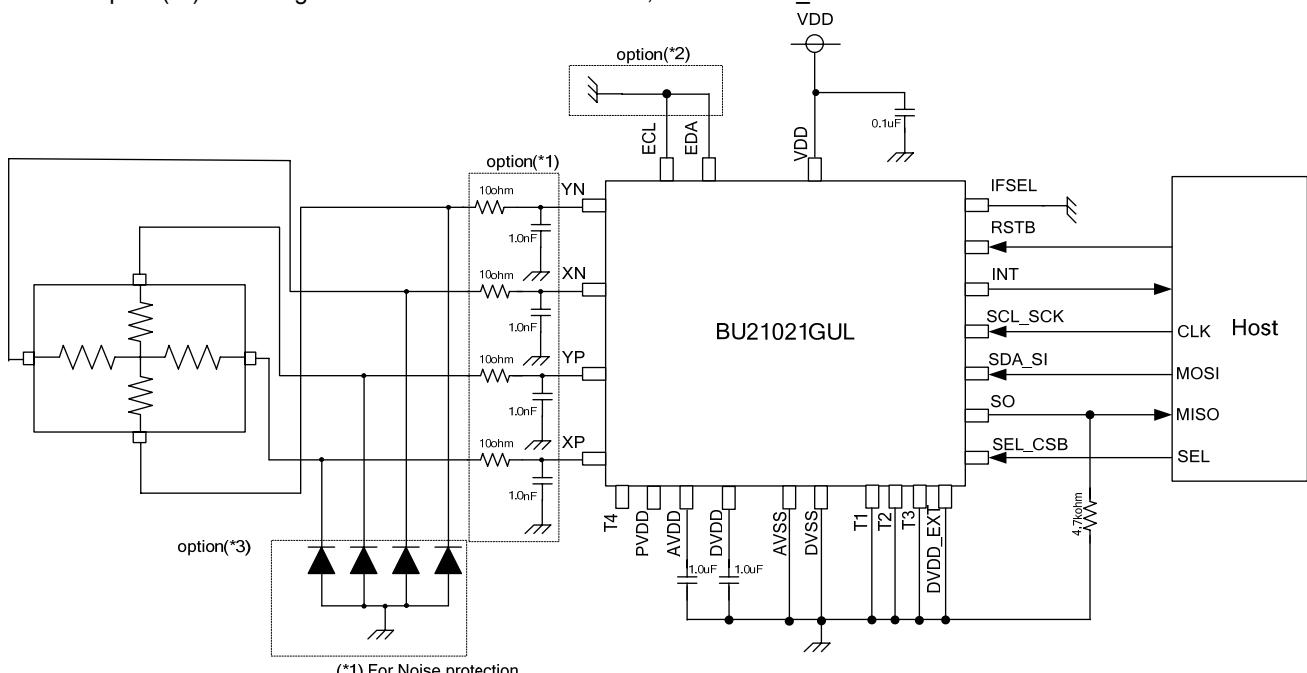
(*1) For Noise protection.
(*2) EEPROM interface PIN.
(*3) For ESD protection. (Zener diode / TVS diode)

Figure 8. Application circuit 1 (4-wire SPI)
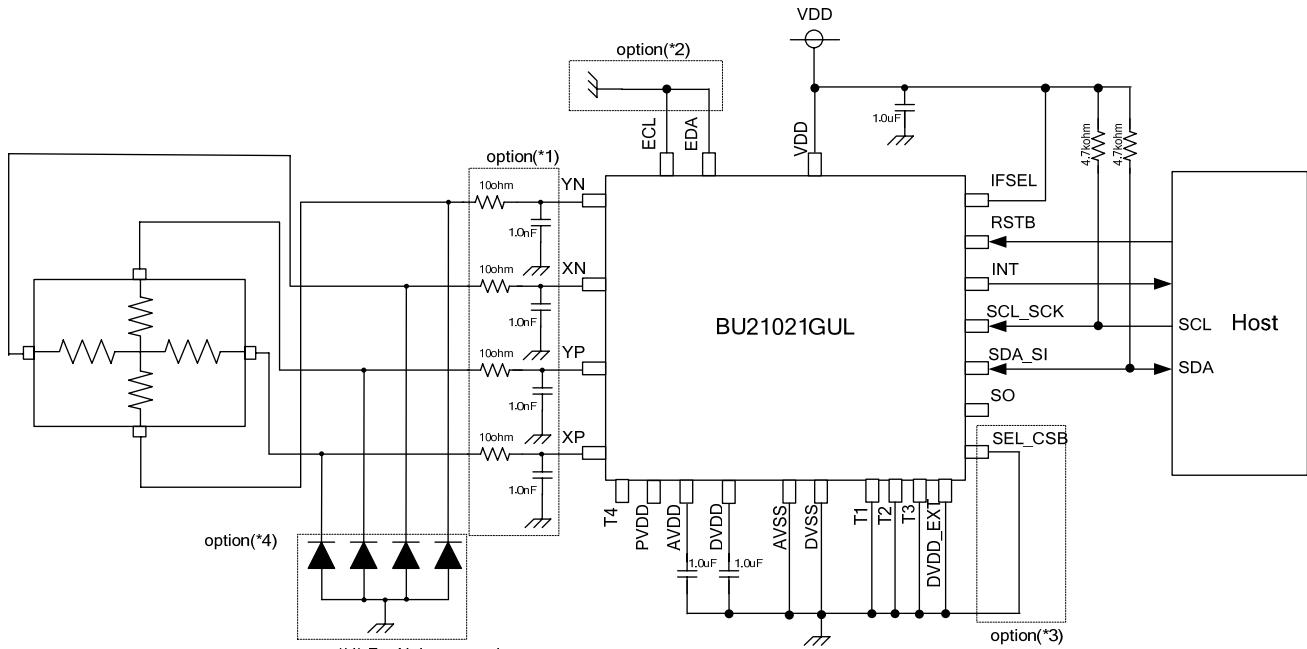
(*1) For Noise protection.
(*2) EEPROM interface PIN.
(*3) Please connect to VDD when use as slave address ="BAh"
(*4) For ESD protection.(Zener diode / TVS diode)

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

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●**Ordering Information**

| B | U | 2 | 1 | 0 | 2 | 1 | G | U | L | - | E | 2 |

Part Number

Package
GUL: VCSP50L2

Tape and Reel information
E2: Embossed carrier tape
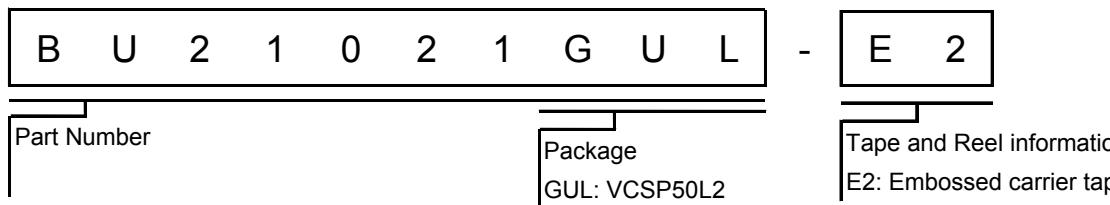
●**Physical Dimension Tape and Reel Information**

VCSP50L2(BU21021GUL)

(Unit : mm)

<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	3000pcs
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

Reel   1pin   Direction of feed

＊Order quantity needs to be multiple of the minimum quantity.
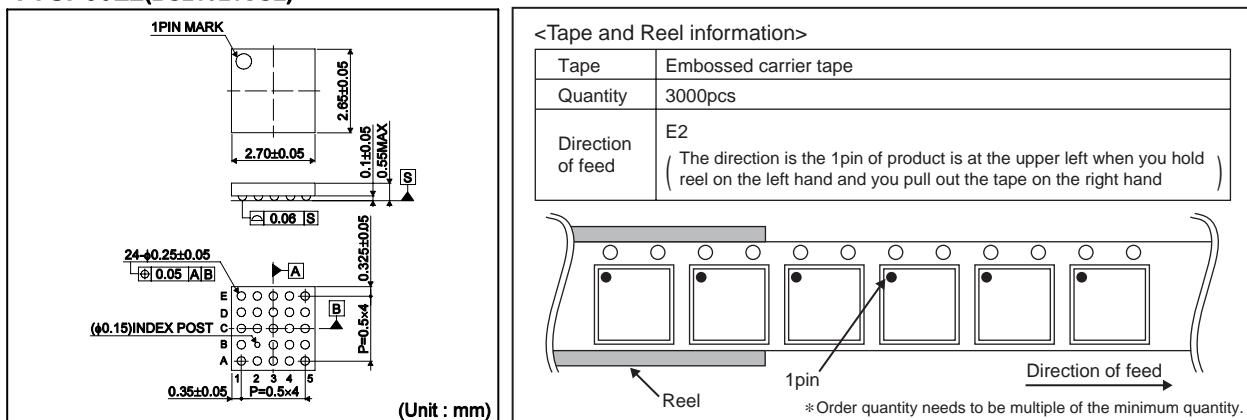
●**Marking Diagram**(TOP VIEW)

1PIN MARK   Lot No.

U21021
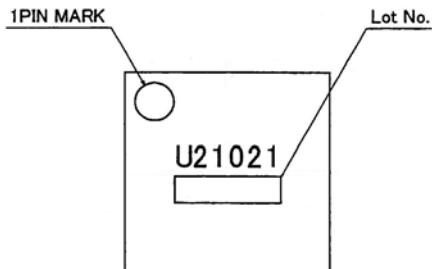
Revision History

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

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JAPAN	USA	EU	CHINA
CLASSⅢ	CLASSⅢ	CLASSⅡb	CLASSⅢ
CLASSⅣ		CLASSⅢ	

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    - [f] Sealing or coating our Products with resin or other coating materials
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    - [h] Use of the Products in places subject to dew condensation

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

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    [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.

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