Datasheet

Capacitive Proximity Sensor Controller ICs

Capacitive Proximity Sensor Controller IC

BD21143GWL

General Description

The BD21143GWL is an ultra-low power capacitive sensor controller IC for application which is required the proximity detection and embedded an automatic calibration and a temperature drift compensation.

Key Specifications

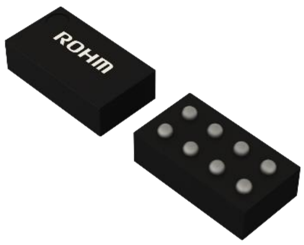
■ Power Supply Voltage Range:	1.65 V to 3.6 V
■ Operating Temperature Range:	-40 °C to +85 °C
■ Operating Current:	20 µA (Typ)
■ Standby Current:	0.6 µA (Typ)
■ Scan Period:	30 ms to 60 s

Features

- 3 Capacitive Sensor Pins
- Ultra-Low Power Consumption
- Self-Capacitance Measurements
- Capacitive Resolution Down to 0.002 fF
- Capacitive Load Capability Up to 200 pF
- Automatic Calibration
- Temperature Drift Compensation
- Capacitive Cancel Drive
- 400 kHz I²C Serial Interface
- Open Drain Interrupt Pin

Package

Package	W (Typ) x D (Typ) x H (Max)
UCSP50L1C (8Pin)	1.7 mm x 0.94 mm x 0.57 mm

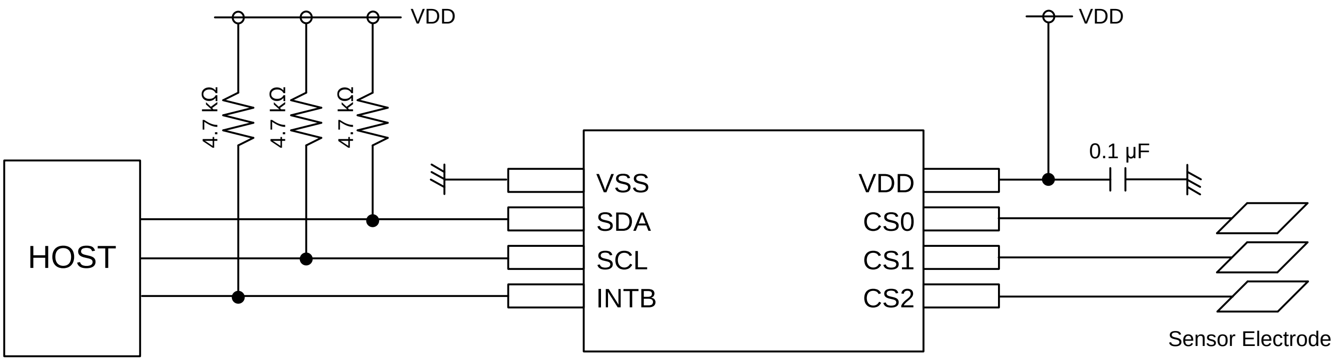


UCSP50L1C

Applications

- SAR (Specific Absorption Rate) Compliant Systems
- Mobile Phones
- Wearable Devices
- Tablets
- Laptop Computers

Typical Application Circuit

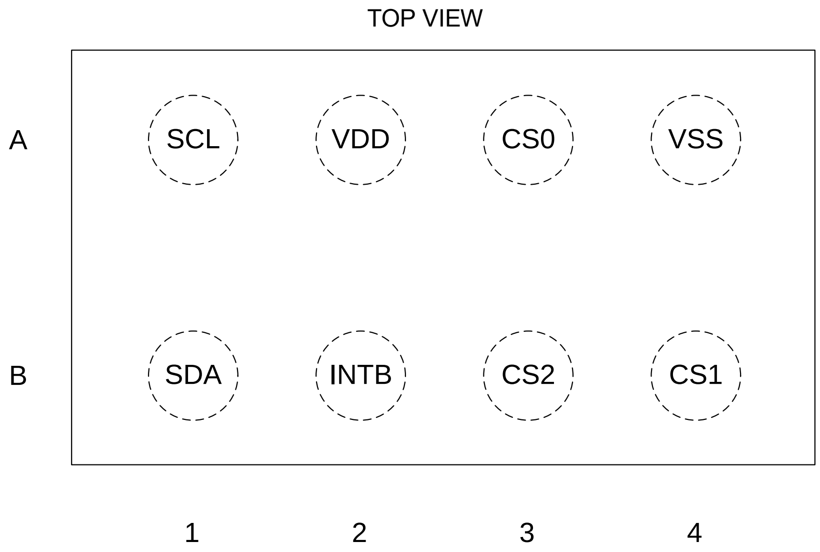


(Note 1) The pull-up resistors must be connected to VDD.
Choose the value of the pull-up resistors so as to meet I²C Serial Bus Interface Electrical Characteristics.

〇Product structure : Silicon integrated circuit 〇This product has no designed protection against radioactive rays.

Contents

Pin Configuration

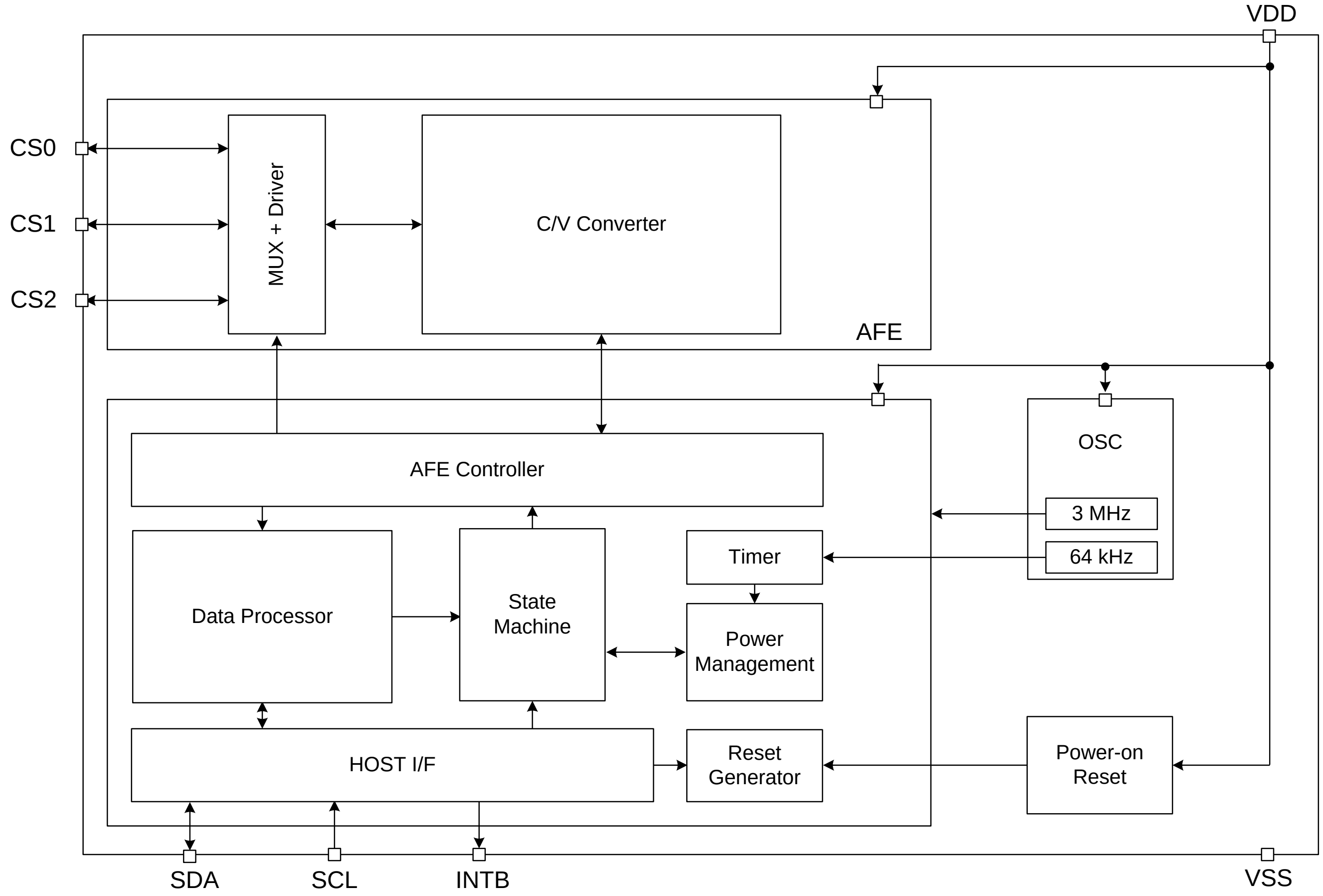


Pin Description

Pin No.	Pin Name	I/O Type	Function	Initial Condition
A1	SCL	IN	Host interface pin: Serial clock line. Require external pull-up resistor.	HIZ
A2	VDD	-	Power	-
A3	CS0	IN/OUT	Sensor pin(Note 2)	Low
A4	VSS	-	Ground	-
B1	SDA	IN/OUT	Host interface pin: Serial data line. Require external pull-up resistor.	HIZ
B2	INTB	OUT	Interrupt pin: Active low interrupt. Require external pull-up resistor.	Low
B3	CS2	IN/OUT	Sensor pin(Note 2)	Low
B4	CS1	IN/OUT	Sensor pin(Note 2)	Low

(Note 2) If not used, this pin must be left as an open circuit.

Block Diagram



Description of Block

AFE (Analog Front End) (including MUX, Driver, C/V Converter)
This block converts from capacitance to voltage and the voltage to digital value for each sensor.

OSC
This block consists of two oscillators that are 3 MHz and 64 kHz.
The 3 MHz oscillator supplies system clock to AFE, Data Processor and State Machine. The 64 kHz oscillator supplies scan period clock to Timer for Power Management.

Power-on Reset
This block is Power-on Reset circuit. It supplies system reset.

AFE Controller
This block is the sequencer to generate the timing to control AFE.

State Machine
This block manages the state of the IC based on results of data processing and commands from the host.

Data Processor
This block processes the sensor data for detecting proximity, compensation drift, self-calibration timing etc.

Power Management
This block manages the analog blocks for power saving.

Timer
This block measures the scan period time for Power Management using 64 kHz clock.

Reset Generator
This block generates reset for the system from Power-on Reset and the Software Reset command.

HOST I/F
This block has 2-wire serial bus interface compatible with I^2C protocol and an open drain interrupt pin.

Absolute Maximum Ratings (Ta = 25°C)

Parameter	Symbol	Rating	Unit
Power Supply Voltage	V_{DD}	-0.3 to +4.5	V
Input Pin Voltage	V_{IN}	-0.3 to V_{DD} + 0.3	V
Maximum Junction Temperature	Tjmax	150	°C
Storage Temperature Range	Tstg	-55 to +150	°C

Caution 1: *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.*

Caution 2: *Should by any chance the maximum junction temperature rating be exceeded the rise in temperature of the chip may result in deterioration of the properties of the chip. In case of exceeding this absolute maximum rating, design a PCB with thermal resistance taken into consideration by increasing board size and copper area so as not to exceed the maximum junction temperature rating.*

Thermal Resistance

Parameter	Symbol	Thermal Resistance (Typ)	Unit
UCSP50L1C			
Junction to Ambient	θ_{JA}	107.5	°C/W

Layer Number of Measurement Board	Material	Board Size
Single	FR-4	41 mm x 51 mm x 1.6 mmt

Top	
Copper Pattern	Thickness
Footprints and Traces	35 µm

Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Unit
Power Supply Voltage	V_{DD}	1.65	1.80	3.60	V
Operating Temperature	Topr	-40	+25	+85	°C

Electrical Characteristics (Unless otherwise specified V_{DD} = 1.8 V Ta = 25 °C)

Parameter	Symbol	Limit			Unit	Conditions
		Min	Typ	Max		
Input High Voltage	V_{IH}	V_{DD} x 0.7	-	V_{DD} + 0.3	V	-
Input Low Voltage	V_{IL}	V_{SS} - 0.3	-	V_{DD} x 0.3	V	-
Output High Voltage	V_{OHCS}	V_{DD} x 0.7	-	V_{DD}	V	I_{OH} = -1 mA (The CSm (m = 0 to 2) pins)
Output Low Voltage	V_{OLCS}	V_{SS}	-	V_{DD} x 0.3	V	I_{OL} = +1 mA (The CSm (m = 0 to 2) pins)
	V_{OL1}	V_{SS}	-	V_{SS} + 0.4	V	I_{OL} = +3 mA (The SDA/INTB pins)
	V_{OL2}	V_{SS}	-	V_{SS} + 0.6	V	I_{OL} = +6 mA (The SDA/INTB pins)
Standby Current	I_{STBY}	-	0.6	5.0	µA	-
Active Current	I_{ACT}	-	20	-	µA	Active Sensor: 3 sensors Scan Period: 30 ms Sensing Integration: 128 times Sensing Frequency: 500 kHz Sensor Pins: No load

Interface Specification

2-wire Serial Bus Interface
Compatible with I^{2}C Protocol
Support Slave Mode Only
7-bit Slave Address = 0x6A
Support Sequential Read and Sequential Write

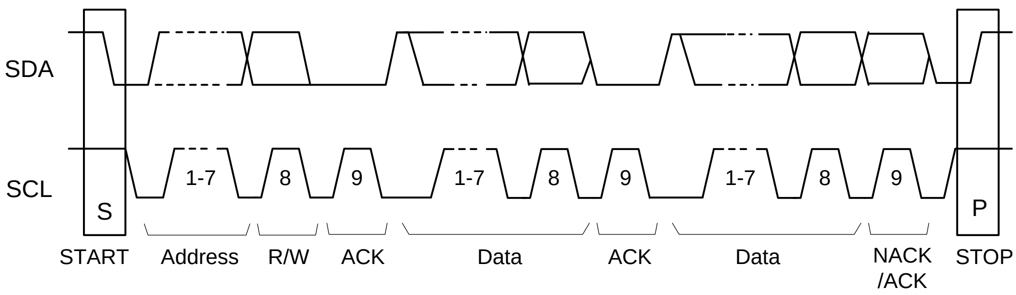


Figure 1. 2-wire Serial Bus Data Format

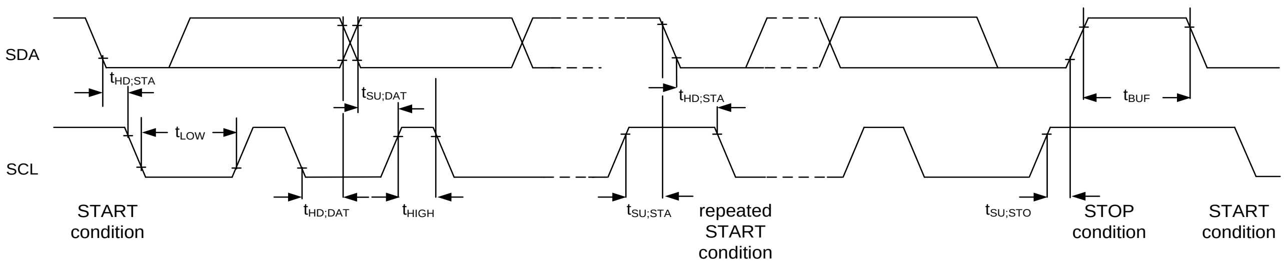


Figure 2. 2-wire Serial Bus Data Timing Chart

2-wire Serial Bus Interface Electrical Characteristics (Unless otherwise specified V_{DD} = 1.8 V Ta = 25 °C)

Parameter	Symbol	Limit			Unit	Conditions
		Min	Typ	Max		
SCL Clock Frequency	f_{SCL}	0	-	400	kHz	-
Hold Time (repeated) START Condition	$t_{HD;STA}$	0.6	-	-	μs	-
Low Period of the SCL Clock	t_{LOW}	1.3	-	-	μs	-
High Period of the SCL Clock	t_{HIGH}	0.6	-	-	μs	-
Data Hold Time	$t_{HD;DAT}$	0	-	-	μs	-
Data Set-up Time	$t_{SU;DAT}$	0.1	-	-	μs	-
Set-up Time for a Repeated START Condition	$t_{SU;STA}$	0.6	-	-	μs	-
Set-up Time for STOP Condition	$t_{SU;STO}$	0.6	-	-	μs	-
Bus Free Time between STOP and START Condition	t_{BUF}	1.3	-	-	μs	-

Interface Specification - continued

2-wire Serial Bus Protocol

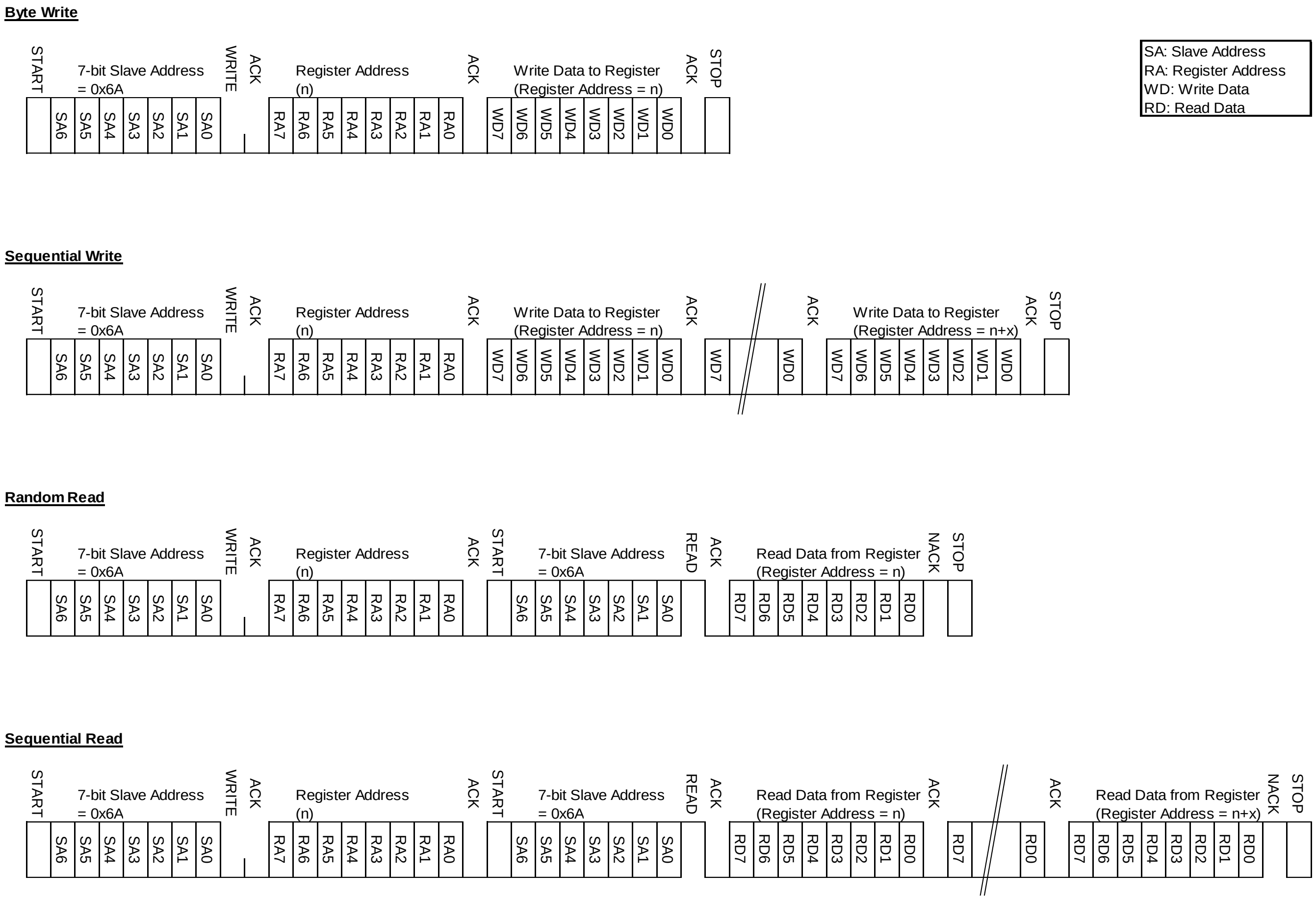
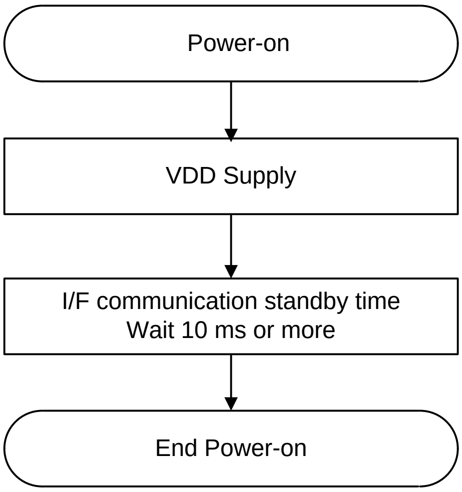


Figure 3. 2-wire Serial Bus Data Protocol

Power-on Sequence

The IC is accessible from the host after the build-in Power-on Reset circuit supplies system reset.

Power-on Flowchart



Power-on Timing

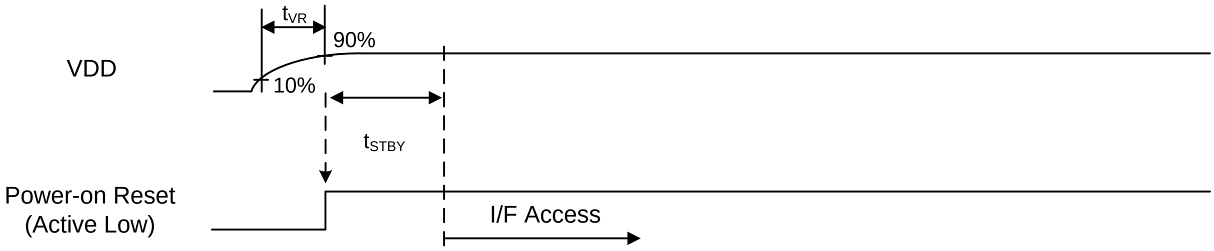


Figure 4. Power-on Timing Chart

Power-on Timing Characteristics (Unless otherwise specified V_{DD} = 1.8 V Ta = 25 °C)

Parameter	Symbol	Limit			Unit	Conditions
		Min	Typ	Max		
VDD Rise Time	t_{VR}	0.1	-	10	ms	-
I/F Communication Standby Time	t_{STBY}	-	-	10	ms	-

Power-on Sequence - continued

Power-restart Timing

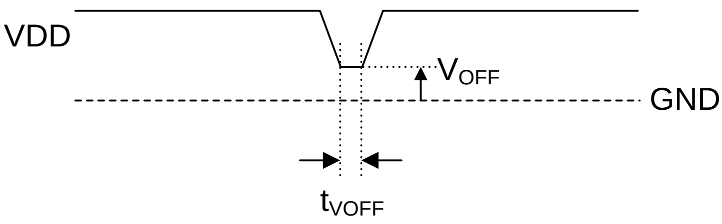


Figure 5. Power-restart Timing Chart

Power-restart Timing Characteristics (Unless otherwise specified V_{DD} = 1.8 V, Ta = 25 °C)

Parameter	Symbol	Limit			Unit	Conditions
		Min	Typ	Max		
Maximum Power-off Voltage	V_{OFF}	-	-	0.5	V	-
Minimum Restart Width *(Note 3)*	t_{VOFF}	50	-	-	ms	-

(Note 3) Power-on Reset is not guaranteed when the time of VDD ≤ 0.5 V is less than 50 ms at power restarting.

Register Map

The time setting in this datasheet is based on the value when the oscillator is typical (3 MHz and 64 kHz).
The default value is the value after initialization by reset.
Reserved bits should be left to their default value.

Address	Register Name	R/W	Default Value	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
0x00	IRQ_FIN	R	0x01	IRQ_FIN_FAILCAL	IRQ_FIN_OVFCAL	IRQ_FIN_STUCKCAL	IRQ_FIN_PERCAL	IRQ_FIN_SOFTCAL	Reserved	IRQ_FIN_SCAN	IRQ_FIN_INI
0x01	IRQ_PROX_S	R	0x00	Reserved	IRQ_FAR_S_CS2	IRQ_FAR_S_CS1	IRQ_FAR_S_CS0	Reserved	IRQ_CLS_S_CS2	IRQ_CLS_S_CS1	IRQ_CLS_S_CS0
0x02	IRQ_PROX_C	R	0x00	Reserved	IRQ_FAR_C_CS2	IRQ_FAR_C_CS1	IRQ_FAR_C_CS0	Reserved	IRQ_CLS_C_CS2	IRQ_CLS_C_CS1	IRQ_CLS_C_CS0
0x03	IRQ_TRIG_CAL	R	0x00	Reserved	IRQ_OVF_CS2	IRQ_OVF_CS1	IRQ_OVF_CS0	Reserved	IRQ_STUCK_CS2	IRQ_STUCK_CS1	IRQ_STUCK_CS0
0x04	IRQ_FAILCAL	R	0x00	Reserved	Reserved	Reserved	Reserved	Reserved	IRQ_FAILCAL_CS2	IRQ_FAILCAL_CS1	IRQ_FAILCAL_CS0
0x05	STATE	R	0x00	STATE_IC		STATE_C_CS2	STATE_C_CS1	STATE_C_CS0	STATE_S_CS2	STATE_S_CS1	STATE_S_CS0
0x06	DATA_USE_CS0	R	n/a	DATA_USE_CS0[15:8] / CALC_CAP_CS0[15:8]							
0x07		R	n/a	DATA_USE_CS0[7:0] / CALC_CAP_CS0[7:0]							
0x08	DATA_USE_CS1	R	n/a	DATA_USE_CS1[15:8] / CALC_CAP_CS1[15:8]							
0x09		R	n/a	DATA_USE_CS1[7:0] / CALC_CAP_CS1[7:0]							
0x0A	DATA_USE_CS2	R	n/a	DATA_USE_CS2[15:8] / CALC_CAP_CS2[15:8]							
0x0B		R	n/a	DATA_USE_CS2[7:0] / CALC_CAP_CS2[7:0]							
0x0C	DATA_SENS_CS0	R	n/a	DATA_SENS_CS0[15:8] / CTCAP_CS0[15:8]							
0x0D		R	n/a	DATA_SENS_CS0[7:0] / CTCAP_CS0[7:0]							
0x0E	DATA_SENS_CS1	R	n/a	DATA_SENS_CS1[15:8] / CTCAP_CS1[15:8]							
0x0F		R	n/a	DATA_SENS_CS1[7:0] / CTCAP_CS1[7:0]							
0x10	DATA_SENS_CS2	R	n/a	DATA_SENS_CS2[15:8] / CTCAP_CS2[15:8]							
0x11		R	n/a	DATA_SENS_CS2[7:0] / CTCAP_CS2[7:0]							
0x12	DATA_BASE_CS0	R	n/a	DATA_BASE_CS0[15:8] / OCCAP_CS0[15:8]							
0x13		R	n/a	DATA_BASE_CS0[7:0] / OCCAP_CS0[7:0]							
0x14	DATA_BASE_CS1	R	n/a	DATA_BASE_CS1[15:8] / OCCAP_CS1[15:8]							
0x15		R	n/a	DATA_BASE_CS1[7:0] / OCCAP_CS1[7:0]							
0x16	DATA_BASE_CS2	R	n/a	DATA_BASE_CS2[15:8] / OCCAP_CS2[15:8]							
0x17		R	n/a	DATA_BASE_CS2[7:0] / OCCAP_CS2[7:0]							
0x18	DATA_REF_CS0	R	n/a	DATA_REF_CS0[15:8] / DATA_CALC_CAP_CS0[15:8]							
0x19		R	n/a	DATA_REF_CS0[7:0] / DATA_CALC_CAP_CS0[7:0]							
0x1A	DATA_REF_CS1	R	n/a	DATA_REF_CS1[15:8] / DATA_CALC_CAP_CS1[15:8]							
0x1B		R	n/a	DATA_REF_CS1[7:0] / DATA_CALC_CAP_CS1[7:0]							
0x1C	DATA_REF_CS2	R	n/a	DATA_REF_CS2[15:8] / DATA_CALC_CAP_CS2[15:8]							
0x1D		R	n/a	DATA_REF_CS2[7:0] / DATA_CALC_CAP_CS2[7:0]							
0x1E-0x1F	Reserved	R	0x00	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
0x20	CFG_CS0	R/W	0x00	CFG_CS2_EN_CS0		CFG_CS1_EN_CS0		Reserved	Reserved	Reserved	EN_CS0
0x21	CFG_CS1	R/W	0x00	CFG_CS2_EN_CS1		Reserved	Reserved	CFG_CS0_EN_CS1		Reserved	EN_CS1
0x22	CFG_CS2	R/W	0x00	Reserved	Reserved	CFG_CS1_EN_CS2		CFG_CS0_EN_CS2		Reserved	EN_CS2
0x23	GAIN_CS0	R/W	0x20	Reserved	Reserved	GAIN_CS0					
0x24	GAIN_CS1	R/W	0x20	Reserved	Reserved	GAIN_CS1					
0x25	GAIN_CS2	R/W	0x20	Reserved	Reserved	GAIN_CS2					
0x26	TH_CLS_S_CS0	R/W	0x01	TH_CLS_S_CS0[15:8]							
0x27		R/W	0x00	TH_CLS_S_CS0[7:0]							
0x28	TH_CLS_S_CS1	R/W	0x01	TH_CLS_S_CS1[15:8]							
0x29		R/W	0x00	TH_CLS_S_CS1[7:0]							
0x2A	TH_CLS_S_CS2	R/W	0x01	TH_CLS_S_CS2[15:8]							
0x2B		R/W	0x00	TH_CLS_S_CS2[7:0]							
0x2C	TH_FAR_S_CS0	R/W	0x00	TH_FAR_S_CS0[15:8]							
0x2D		R/W	0x80	TH_FAR_S_CS0[7:0]							
0x2E	TH_FAR_S_CS1	R/W	0x00	TH_FAR_S_CS1[15:8]							
0x2F		R/W	0x80	TH_FAR_S_CS1[7:0]							
0x30	TH_FAR_S_CS2	R/W	0x00	TH_FAR_S_CS2[15:8]							
0x31		R/W	0x80	TH_FAR_S_CS2[7:0]							
0x32	PRE_TH_S_CS0	R/W	0x44	Reserved	PRE_TH_FAR_S_CS0			Reserved	PRE_TH_CLS_S_CS0		
0x33	PRE_TH_S_CS1	R/W	0x44	Reserved	PRE_TH_FAR_S_CS1			Reserved	PRE_TH_CLS_S_CS1		
0x34	PRE_TH_S_CS2	R/W	0x44	Reserved	PRE_TH_FAR_S_CS2			Reserved	PRE_TH_CLS_S_CS2		

Register Map - continued

Address	Register Name	R/W	Default Value	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
0x35	CTCAP_CS0	R/W	0x00	EN_CTCAP_CS0	Reserved	Reserved	SET_CTCAP_CS0				
0x36	CTCAP_CS1	R/W	0x00	EN_CTCAP_CS1	Reserved	Reserved	SET_CTCAP_CS1				
0x37	CTCAP_CS2	R/W	0x00	EN_CTCAP_CS2	Reserved	Reserved	SET_CTCAP_CS2				
0x38	OCCAP_CS0	R/W	0x00	EN_OCCAP_CS0	Reserved	Reserved	Reserved	SET_OCCAP_CS0[11:8]			
0x39		R/W	0x00	SET_OCCAP_CS0[7:0]							
0x3A	OCCAP_CS1	R/W	0x00	EN_OCCAP_CS1	Reserved	Reserved	Reserved	SET_OCCAP_CS1[11:8]			
0x3B		R/W	0x00	SET_OCCAP_CS1[7:0]							
0x3C	OCCAP_CS2	R/W	0x00	EN_OCCAP_CS2	Reserved	Reserved	Reserved	SET_OCCAP_CS2[11:8]			
0x3D		R/W	0x00	SET_OCCAP_CS2[7:0]							
0x3E	TH_CLS_C_CS0	R/W	0x80	TH_CLS_C_CS0[15:8]							
0x3F		R/W	0x00	TH_CLS_C_CS0[7:0]							
0x40	TH_CLS_C_CS1	R/W	0x80	TH_CLS_C_CS1[15:8]							
0x41		R/W	0x00	TH_CLS_C_CS1[7:0]							
0x42	TH_CLS_C_CS2	R/W	0x80	TH_CLS_C_CS2[15:8]							
0x43		R/W	0x00	TH_CLS_C_CS2[7:0]							
0x44	TH_FAR_C_CS0	R/W	0x00	TH_FAR_C_CS0[15:8]							
0x45		R/W	0x00	TH_FAR_C_CS0[7:0]							
0x46	TH_FAR_C_CS1	R/W	0x00	TH_FAR_C_CS1[15:8]							
0x47		R/W	0x00	TH_FAR_C_CS1[7:0]							
0x48	TH_FAR_C_CS2	R/W	0x00	TH_FAR_C_CS2[15:8]							
0x49		R/W	0x00	TH_FAR_C_CS2[7:0]							
0x4A	OFS_CALC_C_CS0	R/W	0x00	OFS_CALC_C_CS0[15:8]							
0x4B		R/W	0x00	OFS_CALC_C_CS0[7:0]							
0x4C	OFS_CALC_C_CS1	R/W	0x00	OFS_CALC_C_CS1[15:8]							
0x4D		R/W	0x00	OFS_CALC_C_CS1[7:0]							
0x4E	OFS_CALC_C_CS2	R/W	0x00	OFS_CALC_C_CS2[15:8]							
0x4F		R/W	0x00	OFS_CALC_C_CS2[7:0]							
0x50	SCAN_PERIOD	R/W	0x01	Reserved	Reserved	Reserved	Reserved	SCAN_PERIOD			
0x51	FREQ	R/W	0x00	TAP_MEDIAN		Reserved	Reserved	Reserved	Reserved	SAMP_FREQ	
0x52	INTEG	R/W	0x03	Reserved	INTEG_CAL			Reserved	INTEG_SENS		
0x53	DEBOUNCE	R/W	0x00	Reserved	Reserved	NUM_DEB_C		Reserved	Reserved	NUM_DEB_S	
0x54	FIL_SENS	R/W	0x01	Reserved	Reserved	Reserved	Reserved	FIL_SENS			
0x55	FIL_BASE	R/W	0x14	FIL_BASE_FAR				FIL_BASE_CLS			
0x56	PERCAL	R/W	0x00	PERCAL							
0x57	TH_OVS_S	R/W	0x80	TH_OVF_S							
0x58	STUCK_S	R/W	0x00	STUCK_S							
0x59	MSK_IRQ_FIN	R/W	0x00	MSK_ IRQ_FIN_FAILCAL	MSK_ IRQ_FIN_OVFCAL	MSK_ IRQ_FIN_STUCKCAL	MSK_ IRQ_FIN_PERCAL	MSK_ IRQ_FIN_SOFTCAL	Reserved	MSK_ IRQ_FIN_SCAN	Reserved
0x5A	MSK_IRQ_PROX_S	R/W	0x00	Reserved	MSK_ IRQ_FAR_S_CS2	MSK_ IRQ_FAR_S_CS1	MSK_ IRQ_FAR_S_CS0	Reserved	MSK_ IRQ_CLS_S_CS2	MSK_ IRQ_CLS_S_CS1	MSK_ IRQ_CLS_S_CS0
0x5B	MSK_IRQ_PROX_C	R/W	0x00	Reserved	MSK_ IRQ_C_CS2	MSK_ IRQ_C_CS1	MSK_ IRQ_C_CS0	Reserved	Reserved	Reserved	Reserved
0x5C	MSK_IRQ_TRIG_CAL	R/W	0x00	Reserved	MSK_ IRQ_OVF_CS2	MSK_ IRQ_OVF_CS1	MSK_ IRQ_OVF_CS0	Reserved	MSK_ IRQ_STUCK_CS2	MSK_ IRQ_STUCK_CS1	MSK_ IRQ_STUCK_CS0
0x5D	MSK_IRQ_FAILCAL	R/W	0x00	Reserved	Reserved	Reserved	Reserved	Reserved	MSK_ IRQ_FAILCAL_CS2	MSK_ IRQ_FAILCAL_CS1	MSK_ IRQ_FAILCAL_CS0
0x5E	DIS_TRIG_CAL	R/W	0x00	Reserved	DIS_ CAL_OVF_CS2	DIS_ CAL_OVF_CS1	DIS_ CAL_OVF_CS0	Reserved	DIS_ CAL_STUCK_CS2	DIS_ CAL_STUCK_CS1	DIS_ CAL_STUCK_CS0
0x5F	DIS_FAILCAL	R/W	0x00	SEL_READ_C	SEL_READ_TYPE_C	PAUSE_BASE_ STAT_CLS_S	SEL_TH_FAR_S	Reserved	DIS_ CAL_FAILCAL_CS2	DIS_ CAL_FAILCAL_CS1	DIS_ CAL_FAILCAL_CS0
0x60	CLR_IRQ_FIN	R/W	0x00	Reserved	Reserved	Reserved	Reserved	CLR_ IRQ_FIN_SCAN	CLR_ IRQ_FIN_CAL	CLR_ IRQ_FIN_SOFTCAL	CLR_ IRQ_FIN_INI
0x61	CLR_IRQ_PROX_S	R/W	0x00	Reserved	CLR_ IRQ_FAR_S_CS2	CLR_ IRQ_FAR_S_CS1	CLR_ IRQ_FAR_S_CS0	Reserved	CLR_ IRQ_CLS_S_CS2	CLR_ IRQ_CLS_S_CS1	CLR_ IRQ_CLS_S_CS0
0x62	CLR_IRQ_PROX_C	R/W	0x00	Reserved	CLR_ IRQ_FAR_C_CS2	CLR_ IRQ_FAR_C_CS1	CLR_ IRQ_FAR_C_CS0	Reserved	CLR_ IRQ_CLS_C_CS2	CLR_ IRQ_CLS_C_CS1	CLR_ IRQ_CLS_C_CS0
0x63	CLR_IRQ_TRIG_CAL	R/W	0x00	Reserved	CLR_ IRQ_OVF_CS2	CLR_ IRQ_OVF_CS1	CLR_ IRQ_OVF_CS0	Reserved	CLR_ IRQ_STUCK_CS2	CLR_ IRQ_STUCK_CS1	CLR_ IRQ_STUCK_CS0
0x64	CLR_IRQ_FAILCAL	R/W	0x00	Reserved	Reserved	Reserved	Reserved	Reserved	CLR_ IRQ_FAILCAL_CS2	CLR_ IRQ_FAILCAL_CS1	CLR_ IRQ_FAILCAL_CS0
0x65-0x6C	Reserved	R/W	0x00	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
0x6D	SOFT_RST	R/W	0x00	SOFT_RST[15:8]							
0x6E		R/W	0x00	SOFT_RST[7:0]							
0x6F	CNT	R/W	0x00	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	SOFTCAL	ACT

Register Description

IRQ (0x00 to 0x04), IRQ MASK (0x59 to 0x5D), IRQ CLEAR (0x60 to 0x64)

IRQ: When any IRQ bit (0x00 to 0x04) is 1, the INTB pin is low. When all IRQ bits (0x00 to 0x04) are 0, the INTB pin is high due to pull-up resistor.

IRQ_FIN_INI (0x00[0]): Finish Initialize IC by Power-on Reset or the Software Reset command. This bit is cleared by writing 1 to CLR_IRQ_FIN_INI (0x60[0]) or ACT (0x6F[0]) (Start AFE sensing).
IRQ_FIN_SCAN (0x00[1]): Finish sensing of all sensors by scan period.
IRQ_FIN_SOFTCAL (0x00[3]): Finish Software Calibration by command from the host.
IRQ_FIN_PERCAL (0x00[4]): Finish Periodical Calibration.
IRQ_FIN_STUCKCAL (0x00[5]): Finish Stuck Calibration.
IRQ_FIN_OVFCAL (0x00[6]): Finish Overflow Calibration.
IRQ_FIN_FAILCAL (0x00[7]): Finish Recalibration occurred by calibration fail.

IRQ_CLS_S_CSm (m = 0 to 2) (0x01[2:0]): Detect Close state judged by Sensing Data.
IRQ_FAR_S_CSm (m = 0 to 2) (0x01[6:4]): Detect Far state judged by Sensing Data.

IRQ_CLS_C_CSm (m = 0 to 2) (0x02[2:0]): Detect Close state judged by Capacitance Value.
IRQ_FAR_C_CSm (m = 0 to 2) (0x02[6:4]): Detect Far state judged by Capacitance Value.

IRQ_STUCK_CSm (m = 0 to 2) (0x03[2:0]): Detect Stuck condition.
IRQ_OVF_CSm (m = 0 to 2) (0x03[6:4]): Detect Overflow condition for dynamic range.
IRQ_FAILCAL_CSm (m = 0 to 2) (0x04[2:0]): Detect Calibration fail.

IRQ MASK: IRQ bit (except IRQ_FIN_INI (0x00[0])) has an IRQ Mask bit (0x59 to 0x5D).
0: IRQ bit is not masked (Default)
1: IRQ bit is masked

MSK_IRQ_FIN_SCAN (0x59[1]): Mask bit for IRQ_FIN_SCAN.
MSK_IRQ_FIN_SOFTCAL (0x59[3]): Mask bit for IRQ_FIN_SOFTCAL.
MSK_IRQ_FIN_PERCAL (0x59[4]): Mask bit for IRQ_FIN_PERCAL.
MSK_IRQ_FIN_STUCKCAL (0x59[5]): Mask bit for IRQ_FIN_STUCKCAL.
MSK_IRQ_FIN_OVFCAL (0x59[6]): Mask bit for IRQ_FIN_OVFCAL.
MSK_IRQ_FIN_FAILCAL (0x59[7]): Mask bit for IRQ_FIN_FAILCAL.

MSK_IRQ_CLS_S_CSm (m = 0 to 2) (0x5A[2:0]): Mask bit for IRQ_CLS_S_CSm.
MSK_IRQ_FAR_S_CSm (m = 0 to 2) (0x5A[6:4]): Mask bit for IRQ_FAR_S_CSm.

MSK_IRQ_C_CSm (m = 0 to 2) (0x5B[6:4]): Mask bit for IRQ_CLS_C_CSm and IRQ_FAR_C_CSm.

MSK_IRQ_STUCK_CSm (m = 0 to 2) (0x5C[2:0]): Mask bit for IRQ_STUCK_CSm.
MSK_IRQ_OVF_CSm (m = 0 to 2) (0x5C[6:4]): Mask bit for IRQ_OVF_CSm.
MSK_IRQ_FAILCAL_CSm (m = 0 to 2) (0x5D[2:0]): Mask bit for IRQ_FAILCAL_CSm.

IRQ CLEAR: IRQ bit is cleared by writing 1 to IRQ CLEAR (0x60 to 0x64).
CLR_IRQ_FIN_INI (0x60[0]): Clear bit for IRQ_FIN_INI.
CLR_IRQ_FIN_SOFTCAL (0x60[1]): Clear bit for IRQ_FIN_SOFTCAL.
CLR_IRQ_FIN_CAL (0x60[2]): Clear bit for IRQ_FIN_PERCAL, IRQ_FIN_STUCKCAL, IRQ_FIN_OVFCAL and IRQ_FIN_FAILCAL.
CLR_IRQ_FIN_SCAN (0x60[3]): Clear bit for IRQ_FIN_SCAN.

CLR_IRQ_CLS_S_CSm (m = 0 to 2) (0x61[2:0]): Clear bit for IRQ_CLS_S_CSm.
CLR_IRQ_FAR_S_CSm (m = 0 to 2) (0x61[6:4]): Clear bit for IRQ_FAR_S_CSm.

CLR_IRQ_CLS_C_CSm (m = 0 to 2) (0x62[2:0]): Clear bit for IRQ_CLS_C_CSm.
CLR_IRQ_FAR_C_CSm (m = 0 to 2) (0x62[6:4]): Clear bit for IRQ_FAR_C_CSm.

CLR_IRQ_STUCK_CSm (m = 0 to 2) (0x63[2:0]): Clear bit for IRQ_STUCK_CSm.
CLR_IRQ_OVF_CSm (m = 0 to 2) (0x63[6:4]): Clear bit for IRQ_OVF_CSm.
CLR_IRQ_FAILCAL_CSm (m = 0 to 2) (0x64[2:0]): Clear bit for IRQ_FAILCAL_CSm.

Register Description - continued

State (0x05)

State of IC and Proximity state.

STATE_IC (0x05[7:6]):
0: Standby.
1: Calibration.
2: Idle.
3: Sensing.

STATE_S_CSm (m = 0 to 2) (0x05[2:0]):
0: Not Proximity state (Far state) judged by Sensing Data.
1: Proximity state (Close state) judged by Sensing Data.

STATE_C_CSm (m = 0 to 2) (0x05[5:3]):
0: Not Proximity state (Far state) judged by Capacitance Value.
1: Proximity state (Close state) judged by Capacitance Value.

Sensing Data (0x06 to 0x1D), Setting Offset Capacitance Value (0x4A to 0x4F)

2-byte data of each sensor. Data range is from 0 to 65535 (0xFFFF).

In the case SEL_READ_C (0x5F[7]) is 0,
DATA_USE_CSm (m = 0 to 2) (0x06 to 0x0B): Sensing Data without drift. This value is compared to threshold.
DATA_SENS_CSm (m = 0 to 2) (0x0C to 0x11): Sensing Data filtered by Low Path Filter.
DATA_BASE_CSm (m = 0 to 2) (0x12 to 0x17): Sensing Data to detect environment drift.
DATA_REF_CSm (m = 0 to 2) (0x18 to 0x1D): Reference Offset Data.

In the case SEL_READ_C (0x5F[7]) is 1,
CALC_CAP_CSm (m = 0 to 2) (0x06 to 0x0B): Capacitance Value. 1 count is about 0.01 pF. This value is compared to threshold.
CTCAP_CSm (m = 0 to 2) (0x0C to 0x11): Parameter Value of Integrated Capacitance for Charge Transfer.
OCCAP_CSm (m = 0 to 2) (0x12 to 0x17): Parameter Value of Integrated Capacitance for Offset Compensation.
DATA_CALC_CAP_CSm (m = 0 to 2) (0x18 to 0x1D): Sensing Data to calculate Capacitance Value.

OFS_CALC_C_CSm (m = 0 to 2) (0x4A to 0x4F): Setting Offset Capacitance Value. 1 count is about 0.01 pF.
Capacitance Value is calculated from Sensing Data and Integrated Capacitance Parameter.
OFS_CALC_C_CSm is signed 2's complement format.
CALC_CAP_CSm = Calculated Capacitance Value + OFS_CALC_C_CSm.

Register Description - continued

Configuration Sensors (0x20 to 0x22)

EN_CSm (m = 0 to 2) (0x20[0], 0x21[0], 0x22[0]):
0: Not use sensor pin (Default)
1: Use sensor pin

CFG_CSx_EN_CS0 (x = 1 and 2) (0x20[5:4], 0x20[7:6]): Configuration the CSx pin during the CS0 pin is sensing.
CFG_CSx_EN_CS1 (x = 0 and 2) (0x21[3:2], 0x21[7:6]): Configuration the CSx pin during the CS1 pin is sensing.
CFG_CSx_EN_CS2 (x = 0 and 1) (0x22[3:2], 0x22[5:4]): Configuration the CSx pin during the CS2 pin is sensing.
0: HIZ (Default)
1: GND
2: Capacitive Cancel Drive
3: Do not use

Sensitivity (0x23 to 0x25)

GAIN_CSm (m = 0 to 2) (0x23 to 0x25): The smaller the value, the higher the sensitivity. It is prohibited to set 0.

Threshold for Sensing Data (0x26 to 0x31)

TH_CLS_S_CSm (m = 0 to 2) (0x26 to 0x2B): Threshold for sensing data to detect Close state.
Condition for Detect Close state:
DATA_USE_CSm > 32768 (0x8000) + TH_CLS_S_CSm
Settable range: 0x0008 < TH_CLS_S_CSm < 0x7FFF

TH_FAR_S_CSm (m = 0 to 2) (0x2C to 0x31): Threshold for sensing data to detect Far state.
Condition for Detect Far state:
DATA_USE_CSm < DATA_REF_CSm - TH_FAR_S_CSm (In the case SEL_TH_FAR_S (0x5F[4]) = 0)
DATA_USE_CSm < 32768 (0x8000) + TH_FAR_S_CSm (In the case SEL_TH_FAR_S (0x5F[4]) = 1)
Settable range: 0x0008 < TH_FAR_S_CSm < 0x7FFF

2^{nd} Threshold for Sensing Data (0x32 to 0x34)

2^{nd} Threshold Sensing Data is for Drift Detect.

PRE_TH_CLS_S_CSm (m = 0 to 2) (0x32[2:0], 0x33[2:0], 0x34[2:0]):
2^{nd} Threshold Sensing Data at Far state = TH_CLS_S_CSm x PRE_TH_CLS_S_CSm / 8
In the condition that (DATA_SENS_CSm - DATA_BASE_CSm > 2^{nd} Threshold Sensing Data at Far state) before detect Close state, DATA_BASE_CSm is not update and Drift Detect is pause.
When detected Close state, Drift Detect is restart.
When PRE_TH_CLS_S_CSm is 0, always detect drift.

PRE_TH_FAR_S_CSm (m = 0 to 2) (0x32[6:4], 0x33[6:4], 0x34[6:4]):
2^{nd} Threshold Sensing Data at Close state = TH_FAR_S_CSm x PRE_TH_FAR_S_CSm / 8
In the condition that (DATA_BASE_CSm - DATA_SENS_CSm > 2^{nd} Threshold Sensing Data at Close state) before detect Far state, DATA_BASE_CSm is not update and Drift Detect is pause.
When detect Far state, Drift Detect is restart.
When PRE_TH_FAR_S_CSm is 0, always detect drift.

Threshold for Capacitance Value (0x3E to 0x49)

TH_CLS_C_CSm (m = 0 to 2) (0x3E to 0x43): Threshold for Capacitance Value to detect Close state.
Condition for detect Close state:
CALC_CAP_CSm > TH_CLS_C_CSm

TH_FAR_C_CSm (m = 0 to 2) (0x44 to 0x49): Threshold for Capacitance Value to detect Far state.
Condition for detect Far state:
CALC_CAP_CSx < TH_FAR_C_CSm

Setting constraint: TH_CLS_C_CSm > TH_FAR_C_CSm

Register Description - continued

Configuration Sensing (0x50 to 0x55)

Common parameters for all sensors.
Do not use settings that the Sensing Time exceeds the Scan Period.
Sensing Time = (Number of Using sensor pins) x (Number of Sensing Integration at Normal Sensing) / (Sensing Frequency)

SCAN_PERIOD (0x50[3:0]): Interval Time between Sensing and Next Sensing. AFE and OSC stop during Idle.
0: Do not use
1: 30 ms (Default)
2: 60 ms
3: 90 ms
4: 120 ms
5: 180 ms
6: 240 ms
7: 300 ms
8: 450 ms
9: 1 s
10: 5 s
11: 10 s
12: 20 s
13: 30 s
14: 45 s
15: 60 s

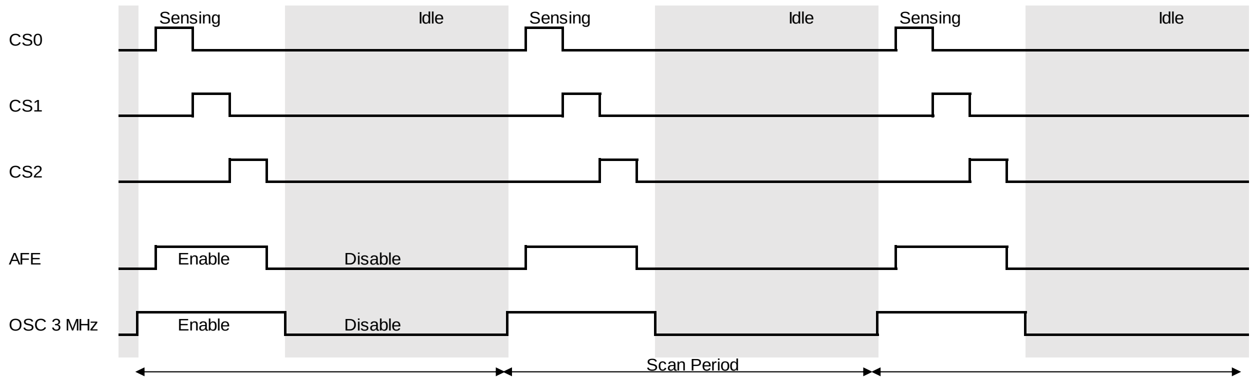
SAMP_FREQ (0x51[1:0]): Sensing Frequency.
0: 500 kHz (Default)
1: 250 kHz
2: 125 kHz
3: 62.5 kHz

TAP_MEDIAN (0x51[7:6]): Tap of Median Filter for RAW Sensing Data.
0: 1 data (Default)
1: 3 data
2: 5 data
3: 7 data

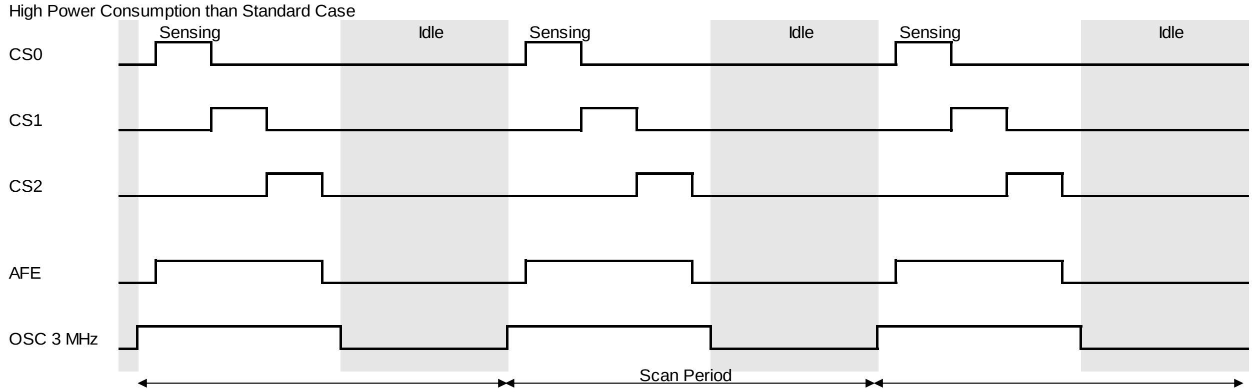
INTEG_SENS (0x52[2:0]): Number of Sensing Integration at Normal Sensing.
INTEG_CAL (0x52[6:4]): Number of Sensing Integration at Calibration.
0: 64 times (Default of INTEG_CAL)
1: 128 times
2: 256 times
3: 512 times (Default of INTEG_SENS)
4: 1024 times
5: 2048 times
6: 4096 times
7: 8192 times

Configuration Sensing - continued

Case : Standard



Case : Long Sensing Period (Low Sampling Frequency, High Integration)
High Power Consumption than Standard Case



Case : Few Sensor Port
Low Power Consumption than Standard Case

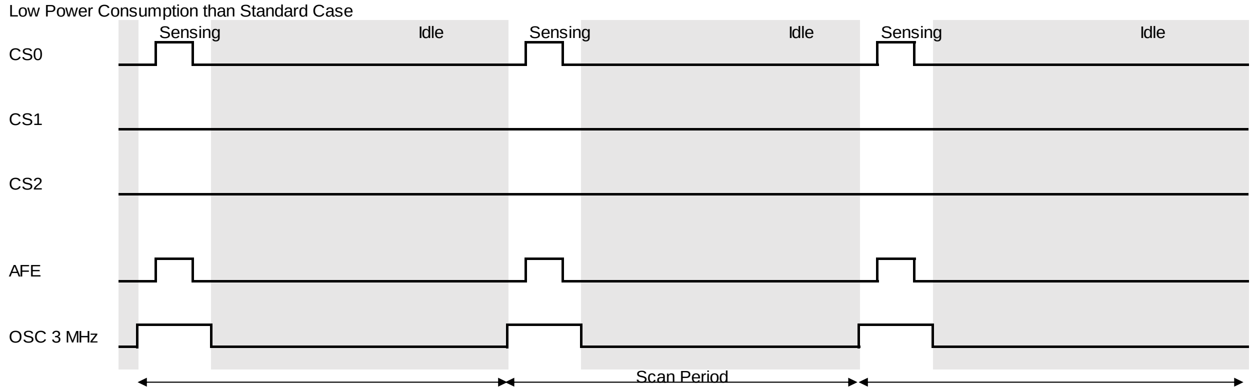


Figure 6. Power Consumption for Configuration Sensing (Fixed Scan Period)

Configuration Sensing - continued

NUM_DEB_S (0x53[1:0]): The number of consecutive scans for debouncer to detect Close / Far state by Sensing Data.
NUM_DEB_C (0x53[5:4]): The number of consecutive scans for debouncer to detect Close / Far state by Capacitance Value.
0: 1 consecutive scan (Default)
1: 2 consecutive scans
2: 4 consecutive scans
3: 8 consecutive scans

FIL_SENS (0x54[3:0]): Low Path Filter setting for DATA_SENS_CSm.

FIL_BASE_CLS (0x55[3:0]): Low Path Filter setting for DATA_BASE_CSm
when DATA_BASE_CSm ≤ DATA_SENS_CSm.

FIL_BASE_FAR (0x55[7:4]): Low Path Filter setting for DATA_BASE_CSm
when DATA_BASE_CSm > DATA_SENS_CSm.

Low Path Filter formula:

$$y[i] = \frac{1}{2^n}\left(x[i] + \left((2^n - 1) \times y[i-1]\right)\right)$$

where:
n is Low Path Filter setting value.
$x[i]$ is input value of Low Path Filter.
$y[i]$ is output value of Low Path Filter.
$y[i-1]$ is previous output value of Low Path Filter.

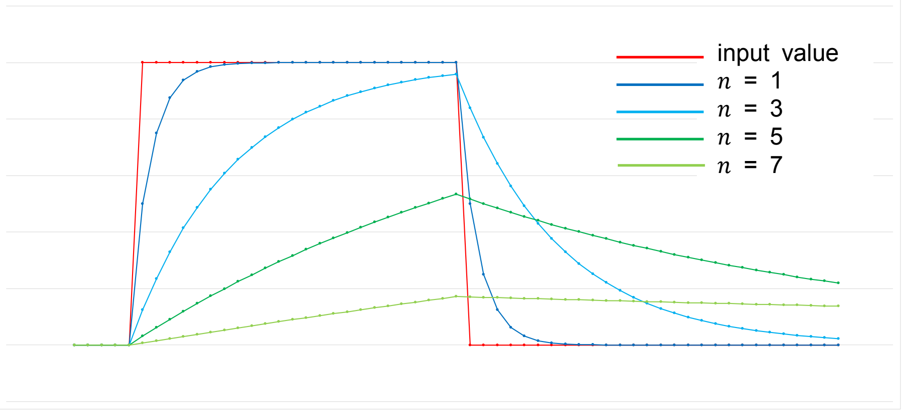


Figure 7. Low Path Filter Characteristic

Register Description - continued

Calibration (0x56 to 0x58 and 0x5E to 0x5F)

PERCAL (0x56): Periodical Calibration
When PERCAL is 0, Periodical Calibration is disabled.
Periodical Calibration Interval = Scan Period x PERCAL x 16
When there is at least one sensor detecting Close state, Periodical Calibration Interval is not measured and Periodical Calibration is disabled.
When the scan times reach to Periodical Calibration Interval, all sensors are calibrated (Periodical Calibration).
When Periodical Calibration is finished, IRQ_FIN_PERCAL is set to 1.

TH_OVF_S (0x57): Threshold for Overflow
When TH_OVF_S is 0, Overflow detection and Calibration Fail detection are disabled.
At Normal Sensing:
Overflow condition: | DATA_BASE_CSm - 32768 (0x8000) | > TH_OVF_S x 128
When it detects Overflow condition on any sensor, all sensors are calibrated (Overflow Calibration).
When Overflow Calibration is finished, IRQ_FIN_OVFCAL is set to 1.
At Calibration:
Calibration fail condition: | DATA_MED_CSm - 32768 (0x8000) | > TH_OVF_S x 128
DATA_MED_CSm is median filtered RAW Sensing Data.
When it detects calibration fail condition on any sensor, all sensors are recalibrated (Recalibration).
When Recalibration is finished, IRQ_FIN_FAILCAL is set to 1.

STUCK_S (0x58): Stuck Time
When STUCK_S is 0, Stuck detection is disabled.
Stuck Time = Scan Period x STUCK_S x 4
When Close state times reach to Stuck Time on any sensor, it detects Stuck condition and all sensors are calibrated (Stuck Calibration).
When Stuck Calibration is finished, IRQ_FIN_STUCKCAL is set to 1.

DIS_CAL_STUCK_CAL_CSm (m = 0 to 2) (0x5E[2:0]): Set disabled Stuck Calibration when CSm (m = 0 to 2) detects Stuck condition.
0: Enable Stuck Calibration (Default)
1: Disable Stuck Calibration

DIS_CAL_OVF_CAL_CSm (m = 0 to 2) (0x5E[6:4]): Set disabled Overflow Calibration when CSm (m = 0 to 2) detects Overflow condition.
0: Enable Overflow Calibration (Default)
1: Disable Overflow Calibration

DIS_CAL_FAILCAL_CSm (m = 0 to 2) (0x5F[2:0]): Set disabled Recalibration when CSm (m = 0 to 2) detects Calibration fail condition.
0: Enable Recalibration (Default)
1: Disable Recalibration

Software Reset (0x6D to 0x6E)

SOFT_RST (0x6D to 0x6E): The Software Reset 2-byte Command. When this register is 0xAA55, Software Reset is released at the timing of I^2C Stop Condition.
Since the oscillator must be stopped for a reliable Software Reset, so execute a Software Reset once to stop the oscillator, and then execute the Software Reset again.
Software Reset requires the oscillator to be stopped. So perform a Software Reset once to stop the oscillator, and then perform a Software Reset again.

Control (0x6F)

ACT (0x6F[0]):
0: Stop AFE sensing. State of IC is Standby.
1: Start AFE sensing. State of IC is Active.

SOFTCAL (0x6F[1]):
0: Not Act Software Calibration.
1: Act Software Calibration.
It needs Software Calibration at the first start AFE sensing.

Register Description - continued

Other Function (0x5F[7:4])

SEL_READ_C (0x5F[7]): Select Read Data from 0x06 to 0x1D. Refer to Sensing Data (0x06 to 0x1D).

SEL_READ_TYPE_C (0x5F[6]): Select the type of DATA_CALC_CAP_CSm. DATA_CALC_CAP_CSm is Sensing Data to calculate Capacitance Value.
0: DATA_CALC_CAP_CSm is RAW Sensing Data.
1: DATA_CALC_CAP_CSm is USE Sensing Data.

PAUSE_BASE_STAT_CLS_S (0x5F[5]): Select Drift Detect when Close state is.
0: Drift Detect continues.
1: Drift Detect is pause.

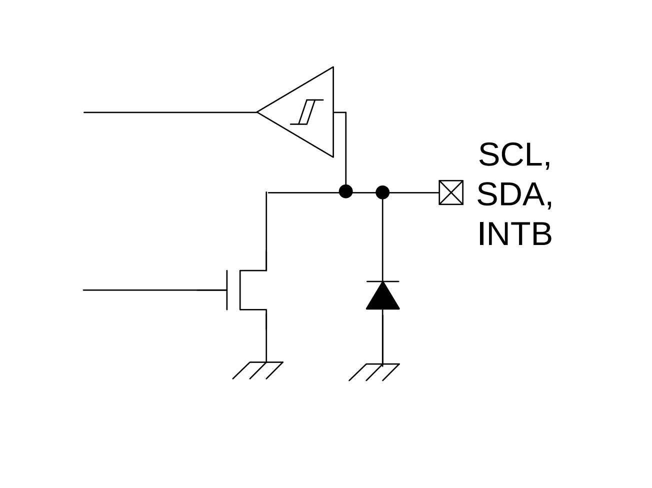
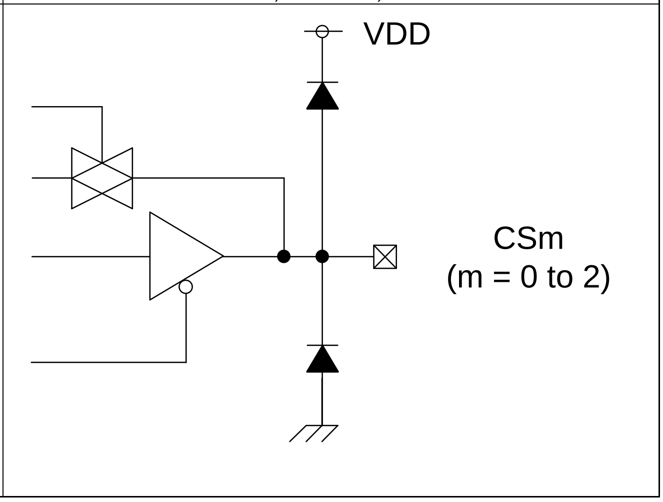
SEL_TH_FAR_S (0x5F[4]): Select condition for Detect Far state. Refer to Threshold for Sensing Data (0x26 to 0x31).

Configuration Integrated Capacitance Parameter (0x35 to 0x3D)

EN_CTCAP_CSm (m = 0 to 2) (0x35[7], 0x36[7], 0x37[7]): Select parameter value of Integrated Capacitance for Charge Transfer.
0: Use the parameter from calibration result.
1: Use the SET_CTCAP_CSm (m = 0 to 2) (0x35[4:0], 0x36[4:0], 0x37[4:0]).

EN_OCCAP_CSm (m = 0 to 2) (0x38[7], 0x3A[7], 0x3C[7]): Select the parameter value of Integrated Capacitance for Offset Compensation
0: Use the parameter from calibration result.
1: Use the SET_OCCAP_CSm (m = 0 to 2) (0x38 to 0x3D).
This value is 12-bit signed 2's complement format. The range of SET_OCCAP_CSm is ±2047.

I/O Equivalent Circuit

A1. SCL, B1. SDA, B2. INTB	A3. CS0, B4. CS1, B3. CS2
	

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 pins.

2. **Power Supply Lines**
   Design the PCB layout pattern to provide low impedance supply lines. 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. **Recommended Operating Conditions**
   The function and operation of the IC are guaranteed within the range specified by the recommended operating conditions. The characteristic values are guaranteed only under the conditions of each item specified by the electrical characteristics.

6. **Inrush 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.

7. **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.

8. **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.

9. **Unused Input Pins**
   Input pins 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 pins should be connected to the power supply or ground line.

Operational Notes - continued

10. Regarding the Input Pin of the IC

This monolithic IC contains P+ isolation and P substrate layers between adjacent elements in order to keep them isolated. P-N junctions are formed at the intersection of the P layers with the N layers of other elements, creating a parasitic diode or transistor. For example (refer to figure below):

When GND > Pin A and GND > Pin B, the P-N junction operates as a parasitic diode.
When GND > Pin B, the P-N junction operates as a parasitic transistor.

Parasitic diodes inevitably occur in the structure of the IC. The operation of parasitic diodes can result in mutual interference among circuits, operational faults, or physical damage. Therefore, conditions that cause these diodes to operate, such as applying a voltage lower than the GND voltage to an input pin (and thus to the P substrate) should be avoided.

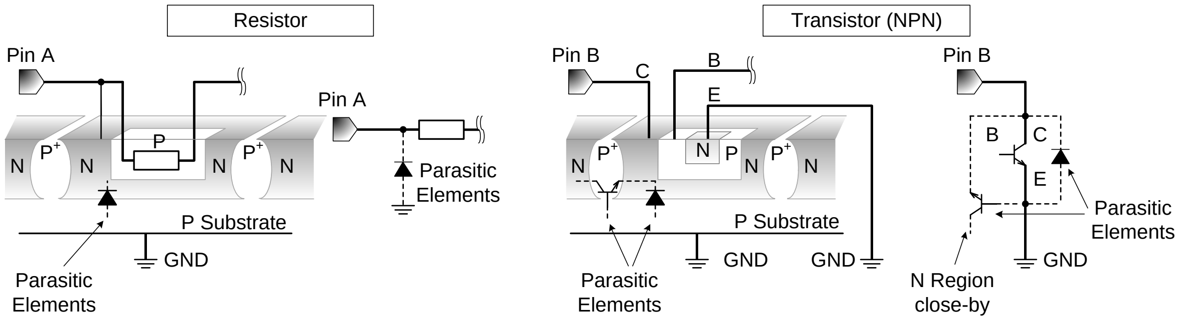


Figure 8. Example of Monolithic IC Structure

11. Ceramic Capacitor

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

12. Over Current Protection Circuit (OCP)

This IC incorporates an integrated overcurrent protection circuit that is activated when the load is shorted. This protection circuit is effective in preventing damage due to sudden and unexpected incidents. However, the IC should not be used in applications characterized by continuous operation or transitioning of the protection circuit.

13. Disturbance Light

In a device where a portion of silicon is exposed to light such as in a WL-CSP and chip products, IC characteristics may be affected due to photoelectric effect. For this reason, it is recommended to come up with countermeasures that will prevent the chip from being exposed to light.

Ordering Information

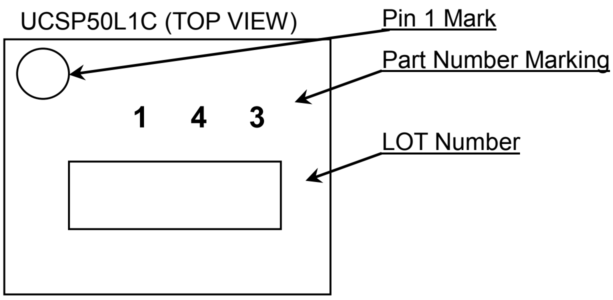
B	D	2	1	1	4	3	G	W	L	-	E2

Package
GWL : UCSP50L1C

Packaging and forming specification
E2 : Embossed tape and reel

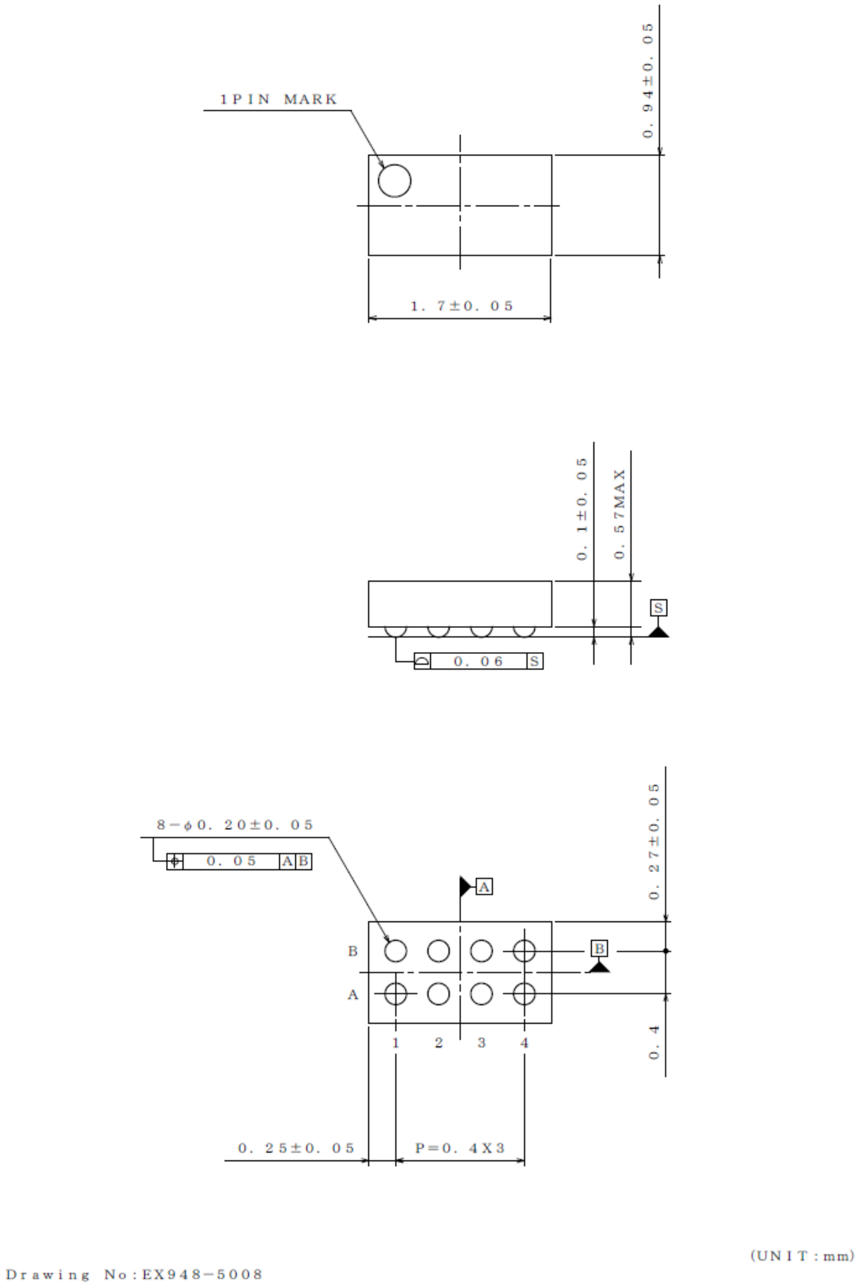
Marking Diagram

UCSP50L1C (TOP VIEW)



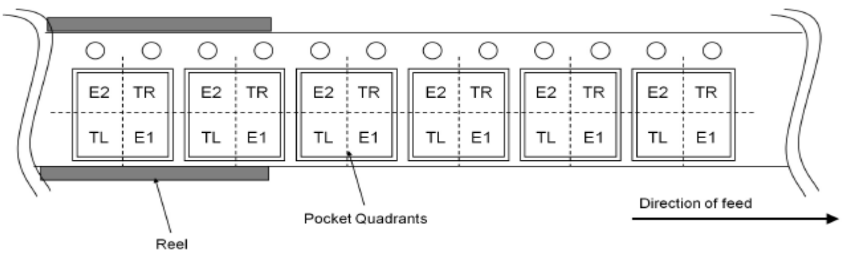
Physical Dimension and Packing Information

Package Name	UCSP50L1C (BD21143GWL)



< Tape and Reel Information >

Tape	Embossed carrier tape
Quantity	3000pcs
Direction of feed	E2 The direction is the pin 1 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



Revision History

Date	Revision	Changes
31.Aug.2020	001	New Release

Notice

Precaution on using ROHM Products

1. Our Products are designed and manufactured for application in ordinary electronic equipment (such as AV equipment, OA equipment, telecommunication equipment, home electronic appliances, amusement equipment, etc.). If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment (Note 1), transport equipment, traffic equipment, aircraft/spacecraft, nuclear power controllers, fuel controllers, car equipment including car accessories, safety devices, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM's Products for Specific Applications.

(Note1) Medical Equipment Classification of the Specific Applications

JAPAN	USA	EU	CHINA
CLASSⅢ	CLASSⅢ	CLASSⅡb	CLASSⅢ
CLASSⅣ		CLASSⅢ	

2. ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
   [a] Installation of protection circuits or other protective devices to improve system safety
   [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

3. Our Products are designed and manufactured for use under standard conditions and not under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc, prior to use, must be necessary:
   [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
   [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
   [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl_2, H_2S, NH_3, SO_2, and NO_2
   [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
   [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 (Exclude cases where no-clean type fluxes is used. However, recommend sufficiently about the residue.) ; 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

1. When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.

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

Precautions Regarding Application Examples and External Circuits

1. If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.

2. You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

Precaution for Electrostatic

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 Cl_2, H_2S, NH_3, SO_2, and NO_2
   [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.

Precaution for Product Label

A two-dimensional barcode printed on ROHM Products label is for ROHM's internal use only.

Precaution for Disposition

When disposing Products please dispose them properly using an authorized industry waste company.

Precaution for Foreign Exchange and Foreign Trade act

Since concerned goods might be fallen under listed items of export control prescribed by Foreign exchange and Foreign trade act, please consult with ROHM in case of export.

Precaution Regarding Intellectual Property Rights

1. All information and data including but not limited to application example contained in this document is for reference only. ROHM does not warrant that foregoing information or data will not infringe any intellectual property rights or any other rights of any third party regarding such information or data.
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General Precaution

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