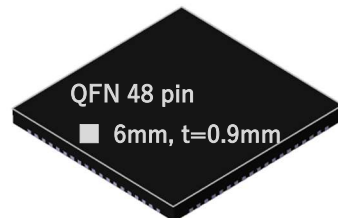


Features

HSLCMB001A is an automotive IC with a built-in capacitive sensing circuit and 32-bit CPU.

- CPU 32-bit RISC CPU (SYNOPSYS ARC EM4™ 21MHz Max)
- MTP : NVM with ECC Function
 - Main memory : 40K bytes (4096 bytes x 10 sectors)
 - Information memory : 512 bytes (128 bytes x 4 sectors)
- RAM : SRAM with ECC function 8K bytes
- Capacitive sensing function
 - Absolute self-capacitance detection/mutual capacitance detection supported
 - Capacitive sensing circuit : 2 channels (multi-bit 2nd order $\Delta \Sigma$ ADC)
 - Number of sensing electrodes : 16 ports (8-port/ 1-channel)
 - Sensor drive frequency : 58.33 / 70 / 87.5 kHz (sine wave)
 - Oversampling ratio : 60
 - Sampling times : 120 to 4080 times
- Supply Voltage range : 4.75~5.5V(Common source is used for I/O)
- Current consumption
 - Absolute self-capacitance sensing : 14.5 mA (TYP.)
 - DeepStandby : 21 μ A (TYP.)
- Package QFN 48 pin (□6mm, t=0.9mm)
- Interface
 - SPI : 1 MHz Max
 - EUART : LIN supported
- GPIO port
 - Digital GPIO : 8 ports (Also used as SPI/EUART/PWM. 5V I/O)
 - DC voltage measurement : 2ADC inputs are available by MUX

(Simultaneous detection with capacitive detection is not available. 5V I/O)
- Oscillation Circuit
 - 42MHz : System Clock Source (Possible to use Crystal Resonator)
 - 32kHz : Timer clock source for the intermittent operation
- Reliability test criteria : AEC-Q100 Grade2 (-40 ~ 105 ° C)
- Functional safety : ASIL-B compliant



1 Summary

1.1 Block Diagram

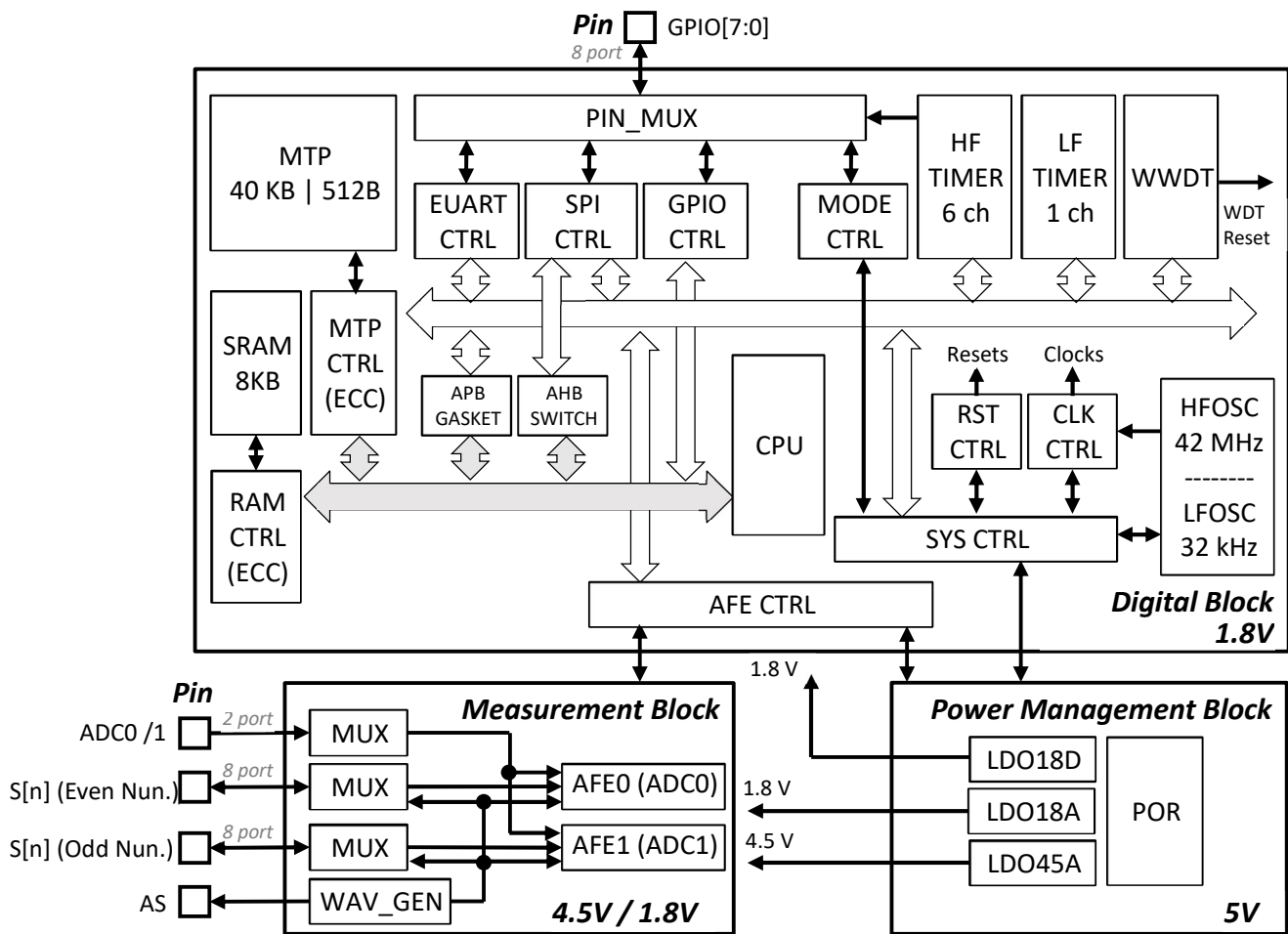


Figure 1-1 : Block Diagram

1.2 Block Summary

Table 1-1 : Block Summary

Block	Description
CPU	32Bit RISC CPU (SYNOPSYS ARC EM4™ 21 MHz Max)
MTP	Non-Volatile Memory ➤ Main Memory : 40KByte (4096 Byte × 10 sector) ➤ Information Memory : 512Byte (128 Byte × 4 sector)
MTP_CTRL(ECC)	MTP Controller with ECC function
GPIO_CTRL	GPIO Controller
SPI_CTRL	SPI Controller
EUART_CTRL	EUART Controller
MODE CTRL	MODE Controller
HF TIMER	High Frequency Timer
LF TIMER	Low Frequency Timer
WWDT	Window Watchdog Timer
SRAM	Static Random Access Memory 8k Byte
RAM CTRL (ECC)	RAM Controller with ECC function
APB GASKET	Advanced Peripheral Bus Gasket
AHB SWITCH	Advanced High-Performance Bus Switching
SYS CTRL	System Controller
RST CTRL	Reset Controller
CLK CTRL	Clock Controller
AFE_CTRL	AFE Controller
HFOSC	High Frequency Oscillator (42MHz)
LFOSC	Low Frequency Oscillator (32kHz)
LDO18D	Low Dropped Out (LDO) Regulator (1.8V) for Digital
LDO18A	Low Dropped Out (LDO) Regulator (1.8V) for Analog
LDO45A	Low Dropped Out (LDO) Regulator (4.5V) for Analog
POR	Voltage Monitoring Circuit
AFE (ADC)	Analog Front End (Capacitance to Voltage Converter) Analog Digital Converter (Multi bit 2nd order $\Delta \Sigma$ ADC)
WAV_GEN	Wave generation Circuit

2 Pin

2.1 Pin Diagram

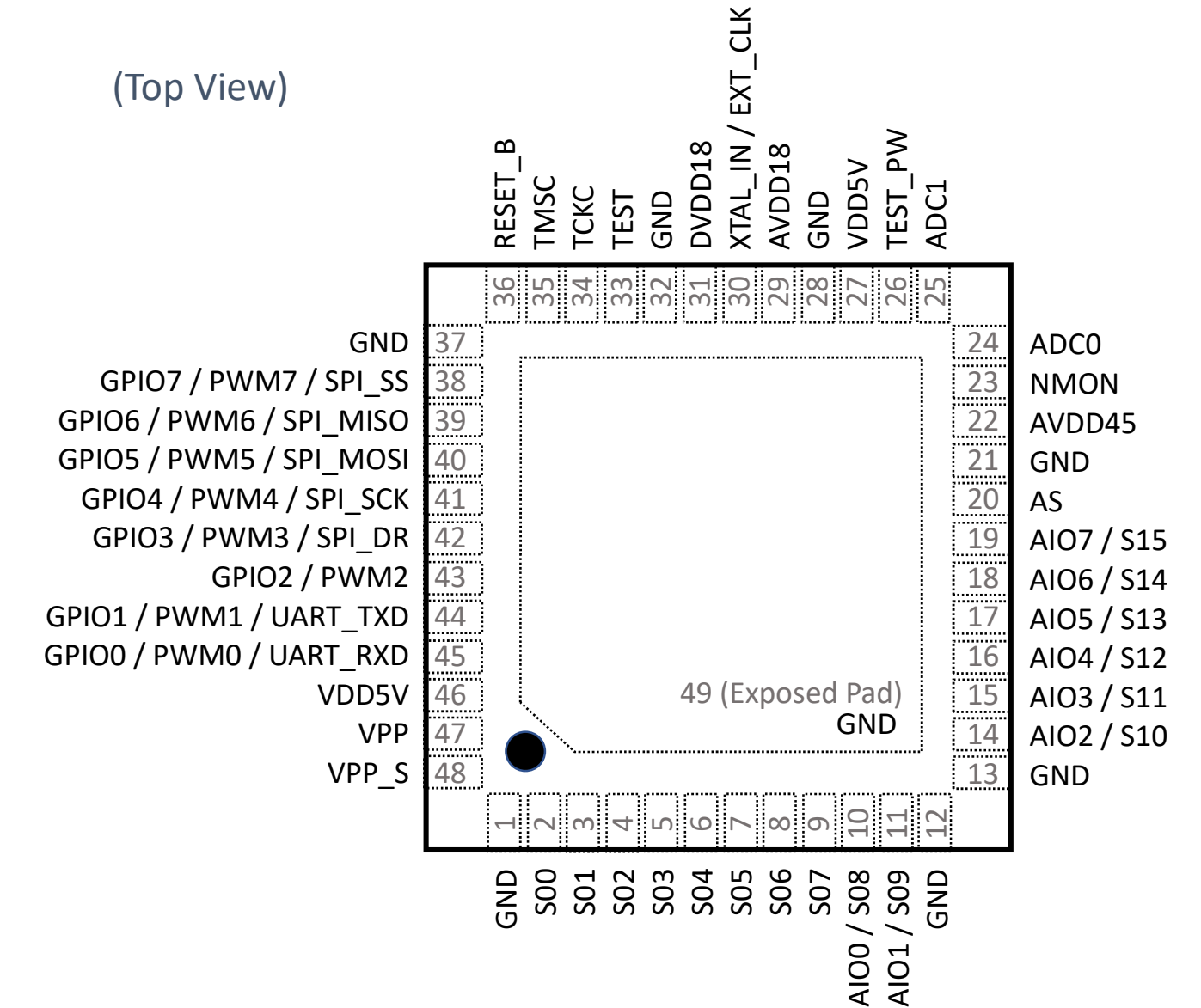


Figure 2-1 : Pin Diagram

2.2 Pin Description

Table 2-1 : Pin Description

#	Name	Domain	IO ※	Function	
1	GND	-	Ground	Ground	
2	S00	AVDD45	A-IO	Sensor Electrode	
3	S01	AVDD45	A-IO	Sensor Electrode	
4	S02	AVDD45	A-IO	Sensor Electrode	
5	S03	AVDD45	A-IO	Sensor Electrode	
6	S04	AVDD45	A-IO	Sensor Electrode	
7	S05	AVDD45	A-IO	Sensor Electrode	
8	S06	AVDD45	A-IO	Sensor Electrode	
9	S07	AVDD45	A-IO	Sensor Electrode	
10	S08 / AIO0	AVDD45	A-/D- IO	Sensor Electrode / General Purpose IO	
11	S09 / AIO1	AVDD45	A-/D- IO	Sensor Electrode / General Purpose IO	
12	GND	-	Ground	Ground	
13	GND	-	Ground	Ground	
14	S10 / AIO2	AVDD45	A-/D- IO	Sensor Electrode / General Purpose IO	
15	S11 / AIO3	AVDD45	A-/D- IO	Sensor Electrode / General Purpose IO	
16	S12 / AIO4	AVDD45	A-/D- IO	Sensor Electrode / General Purpose IO	
17	S13 / AIO5	AVDD45	A-/D- IO	Sensor Electrode / General Purpose IO	
18	S14 / AIO6	AVDD45	A-/D- IO	Sensor Electrode / General Purpose IO	
19	S15 / AIO7	AVDD45	A-/D- IO	Sensor Electrode / General Purpose IO	
20	AS	AVDD45	A-O	Active Shield	
21	GND	-	Ground	Ground	
22	AVDD45	AVDD45	A-IO	4.5V Internal LDO Output for Analog	
23	NMON	VDD5V	A-O	Node Signal Monitor for Test	
24	ADC0	VDD5V	A-I	DC Level ADC Input	
25	ADC1	VDD5V	A-I	DC Level ADC Input	
26	TEST_PW	VDD5V	D-I (PD)	External Power Mode Select for Test ('H' active)	
27	VDD5V	VDD5V	Power	5V from External Power Regulator	
28	GND	-	Ground	Ground	
29	AVDD18	AVDD18	A-IO	1.8V Internal LDO Output for Analog	
30	XTAL_IN / EXT_CLK	DVDD18	A-IO	Crystal oscillator Interface (42MHz) / External Clock In	
31	DVDD18	DVDD18	A-IO	1.8V Internal LDO Output for Digital	
32	DGND	-	Ground	Ground for Digital	
33	TEST	VDD5V	D-I (PD)	Test Mode Select ('H' active)	
34	TCKC	VDD5V	D-I	Test Clock Port for ARC Debugger	
35	TMSC	VDD5V	D-IO	Test Serial Data Port for ARC Debugger	
36	RESET_B	VDD5V	D-I (PU)	Hardware Reset ('L' active)	
37	GND	-	Ground	Ground	
38	GPIO7 / PWM7 / SPI_SS	VDD5V	D-IO	General Purpose IO / Pulse Width Modulation Output	/ SPI Slave Select ('L' active)
39	GPIO6 / PWM6 / SPI_MISO	VDD5V	D-IO		/ SPI Master in Slave Out
40	GPIO5 / PWM5 / SPI_MOSI	VDD5V	D-IO		/ SPI Master Out Slave In
41	GPIO4 / PWM4 / SPI_SCK	VDD5V	D-IO		/ SPI Serial Clock
42	GPIO3 / PWM3 / SPI_DR	VDD5V	D-IO		/ SPI Data Ready
43	GPIO2 / PWM2	VDD5V	D-IO		-
44	GPIO1 / PWM1 / UART_TXD	VDD5V	D-IO		/ UART Transmit Data
45	GPIO0 / PWM0 / UART_RXD	VDD5V	D-IO		/ UART Receive Data
46	VDD5V	VDD5V	Power	5V from External Power Regulator	
47	VPP	V _{PP}	Power	MTP Program Voltage	
48	VPP_S	V _{PP}	Power	MTP Program Voltage for Measure	
49	GND	-	Ground	Ground (Exposed Pad)	

※ A- : Analog , D- : Digital , IO : In/Out , I : In , O : Out , PD : with Pull-Down , PU : with Pull-Up

3 Package Information

Table 3-1 : Package Sizes

項目	Sign	MIN	TYP	MAX	Unit	Comment
Z	A	0.80	0.85	0.90	mm	-
-	A1	-	-	0.05	mm	-
-	A2	-	(0.65)	-	mm	-
-	A3	-	(0.20)	-	mm	-
Lead Width	b	0.15	0.20	0.25	mm	-
X	D	5.925	6.00	6.075	mm	-
-	D2	-	(4.70)	-	mm	-
Y	E	5.925	6.00	6.075	mm	-
-	E2	-	(4.70)	-	mm	-
Lead Length	L	0.30	0.40	0.50	mm	-
Lead Pitch	e	0.35	0.40	0.45	mm	-
Lead Position	F	2.15	2.20	2.25	mm	-

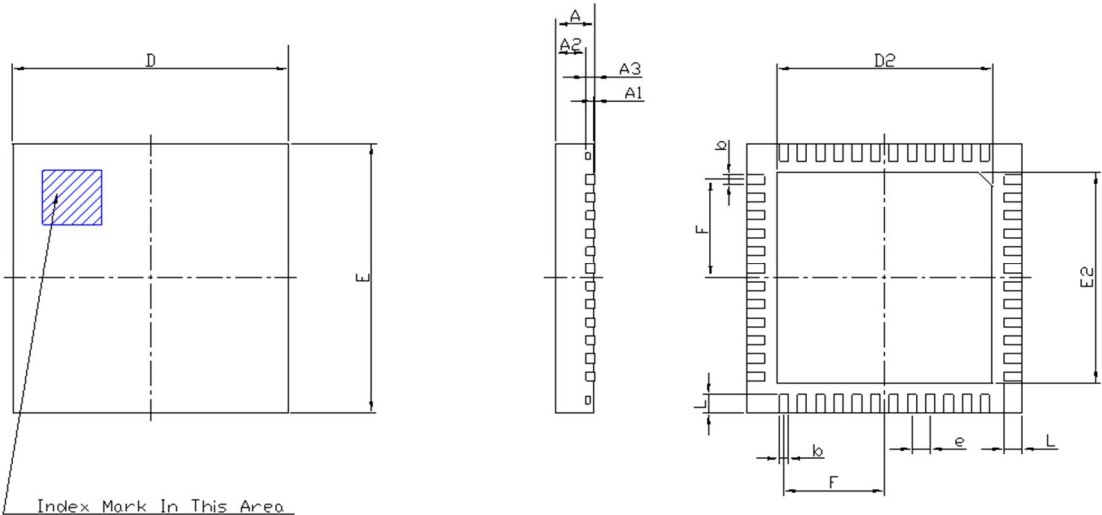


Figure 3-1 : Package Sizes

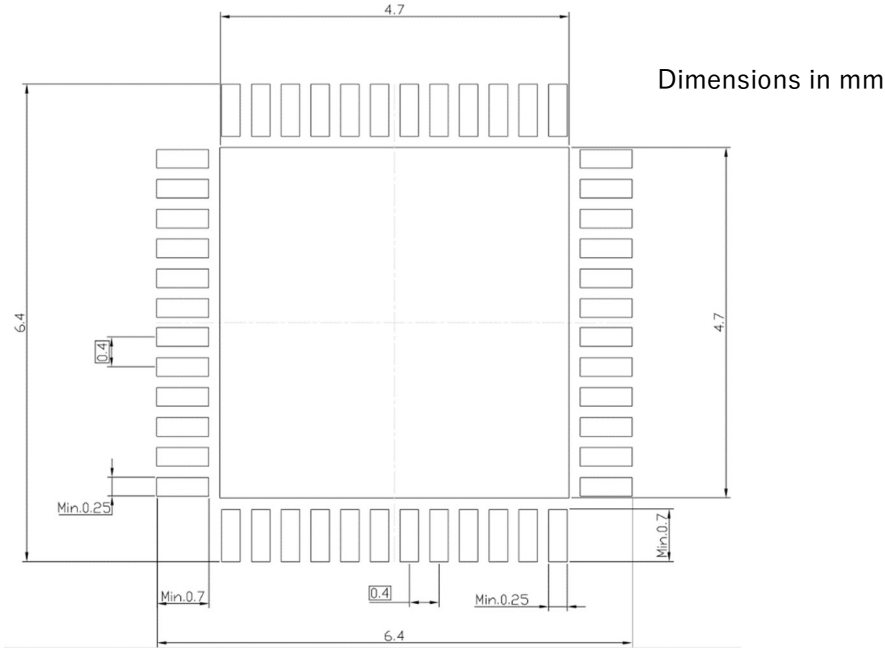


Figure 3-2 : Recommended Land Pattern

4 Reference Circuit Diagram

Table 4-1 : Recommended external parts

Parameter	Symbol	Unit	Condition	Min.	Typ.	Max.
VDD5V bypass CAP1	C1 ※1	uF		0.9	1.0	-
VDD5V bypass CAP2	C2 ※1	uF		0.9	1.0	-
AVDD45 bypass CAP	C3 ※1	uF		0.9	1.0	1.2
AVDD18 bypass CAP	C4 ※1	uF		0.9	1.0	1.2
DVDD18 bypass CAP	C5 ※1	uF		0.9	1.0	1.2
Crystal Resonator	XTL	MHz	Not required when you use internal clock source	41	42	43

※1 Possible to connect small capacitance capacitor parallel, as high frequency noise solution

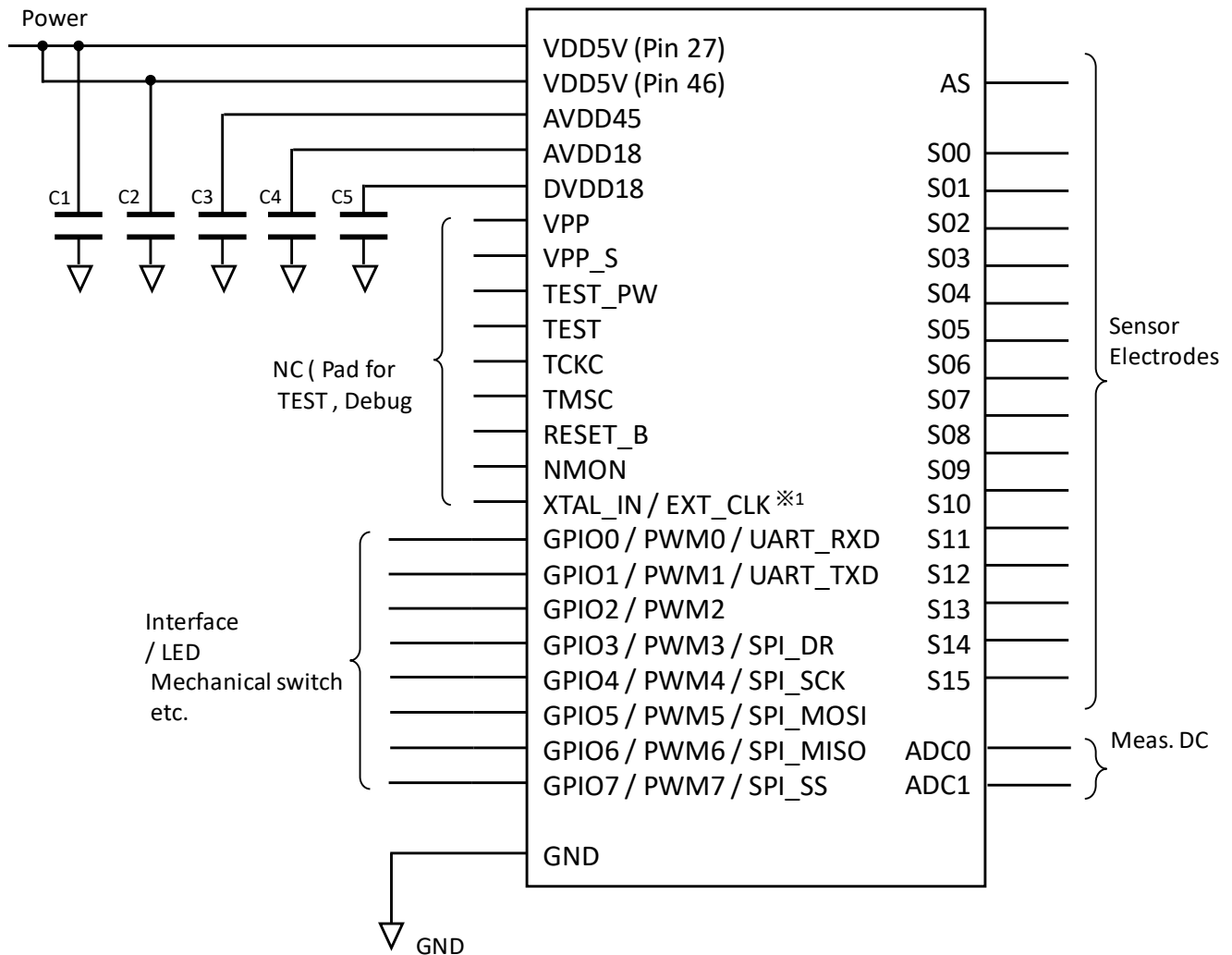


Figure 4-1 : Reference circuit diagram

※1 Uses when you use external resonator.

5 Sensor Specification

5.1 Absolute Self-Capacitance Sensing

Table 5-1 : Sensor Spec. (Absolute Self-Capacitance sensing)

Parameter	Symbol	Unit	Condition	Min.	Typ.	Max.
Sensing Capacitance	Crg	pF		0		3
Shield leak Capacitance	Crgl	pF		0		15
Shield Capacitance	Crs	pF	1) Crgl $\geq$ 2pF 2) Crgl < 2pF	1) 0 2) 0		1) 130 2) 90
Shield Load Capacitance	Csg	pF		0		1500
All the resistance on the current route to sensing electrode	Rrr	k Ω		0		150 ※
All the resistance on the current route to drive electrode	Rss	k Ω		0		50 ※

[Note] Depends on sensor RC distribution and Crg size/position. Requires confirmation at product configuration

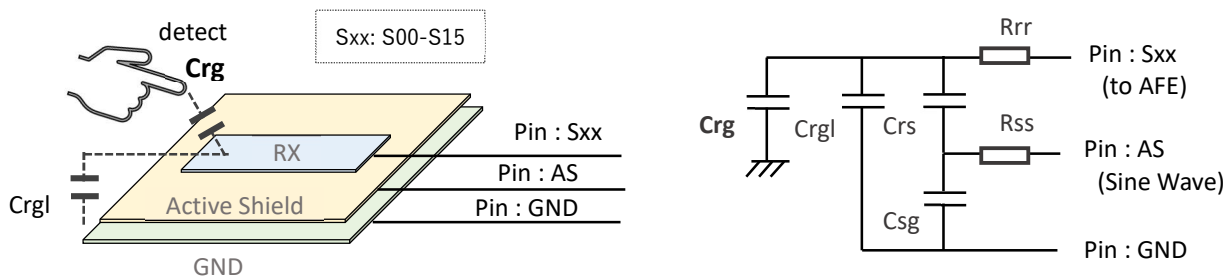


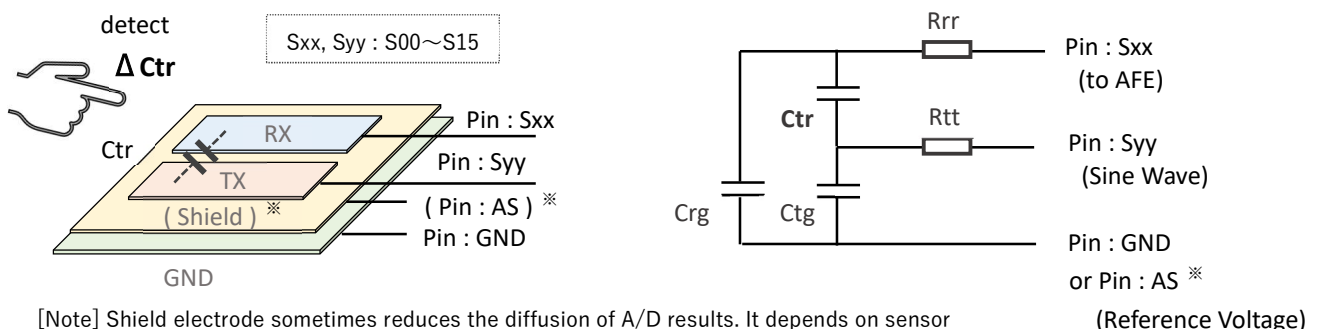
Figure 5-1 : Sensor Model (Absolute Self-Capacitance sensing)

5.2 Mutual Capacitance Sensing

Table 5-2 : Sensor Spec. (Mutual Capacitance Sensing)

Parameter	Symbol	Unit	Condition	Min.	Typ.	Max.
Sensing Capacitance (Offset)	Ctr	pF		0.5		3
Sensing Capacitance (Changed)	$-\Delta Ctr$	pF		-0.12		-0.02
Capacitance between RX-GND	Crg	pF	includes capacitance of AS Pin	15		130
Capacitance between TX-GND	Ctg	pF	includes capacitance of AS Pin	15		130
All Resistance on the current route to RX electrode	Rrr	k Ω		0		30 ※
All Resistance on the current route to TX electrode	Rtt	k Ω		0		30 ※

[Note] Depends on sensor RC distribution and Ctr size/position. Requires confirmation at product configuration



[Note] Shield electrode sometimes reduces the diffusion of A/D results. It depends on sensor location and configuration. In this case, please follow AS-GND Capacitance specification.

Figure 5-2 : Sensor Model (Mutual Capacitance Sensing)

6 Electrical Characteristics

6.1 Absolute Maximum Ratings

Table 6-1 : Absolute Maximum Ratings

Item	Symbol	Unit	Condition	Min.	Max.
Supply Voltage	VDD5V	V		-0.3	6
5.0V_IO Ports Voltage	V _{IN50}	V		-0.3	6
4.5V_IO Port Voltage	V _{IN45}	V		-0.3	6
1.8V_IO Ports Voltage	V _{IN18}	V		-0.3	1.98
Storage temperature	TSTG	°C		-55	125
Allowable power dissipation (105°C)	PD	mow	$\theta_{ja} = 22.0^{\circ}\text{C/W}$	-	450

6.2 Operating Conditions

Table 6-2 : Operating Conditions

Item	Symbol	Unit	Condition	Min.	Typ.	Max.
Supply Voltage	VDD5V	V		4.75	5	5.5
5.0V_IO Ports Voltage	V _{IN50}	V		0	-	VDD5V
4.5V_IO Port Voltage	V _{IN45}	V		0	-	AVDD45
1.8V_IO Ports Voltage	V _{IN18}	V		0	-	DVDD18
Operating Temperature	T _A	°C		-40	25	105
Power up time	t _{VDDR}	ms	Apply constant slope	0.1	-	20
Startup Time	t _{BOOTUP}	ms	Between reset-release and FW start-up	-	-	0.4
Reset Pulse Width	t _{RST}	us		1	-	-