SSD2541

Advance Information

23 Driving x 14 Sensing
Capacitive Touch Panel Controller

Appendix: IC Revision history of SSD2541 Specification

Version	Change Items	Effective Date
0.10	1st Release	24-Jul-13
1.0	1st Release for Advanced information	08-Oct-13
1.1	Updated “16 Package information” for QFN48.	11-Jan-16

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TABLES

FIGURES

1 GENERAL DESCRIPTION

SSD2541 is an all in one capacitive touch panel driver that integrated the power circuits, driving and sensing circuits into a single MCU based chip. It can drive capacitive type touch panel with up to 23 driving and 14 sensing lines

2 FEATURES

- Operating voltage for IIC communication:
  - VCI: 2.5 ~ 3.3V
  - VDDIO: 1.65 ~ 3.3V
- 6V to 8V(max.) driving voltage with external booster Caps
- 5 steps in 0.5V increment programmable driving voltage control
- 16 bit MCU core
- 16k x 16-bit Internal ROM
- Support up to 896x1472 touch resolution
- Support 100Hz sampling rate
- Support up to 23 driving and 14 sensing pins
- Fully programmable driver scanning order
- 8 choices for Touch Screen Orientation control
- Provide (X,Y) coordinates and number of touch points with force index
- Support up to 10 fingers
- Automatic mode switching (Normal, Idle)
- Auto calibration for each cross-over point
- Support IIC (up to 400kbits/sec) interface for Android OS
- Supports high-ohm ITO (100kohm) up to 7-inch panel size
- Features “short I/O tester” for all sense pins
- Supports various type of panels with no ground shielding layer
- Supports various ITO patterns
- Supports pressure sensing
- Package: QFN48, QFN40

3 ORDERING INFORMATION

Ordering Part Number	Drive	Sense	Package Form	MOQ / MPQ	Remark
SSD2541QN5	21	12	QFN-48 (Tray)	490/4900	IIC
SSD2541QN6	16	11	QFN-40 (Tray)	490/4900	IIC

Table 3-1: Ordering Information

4 BLOCK DIAGRAM

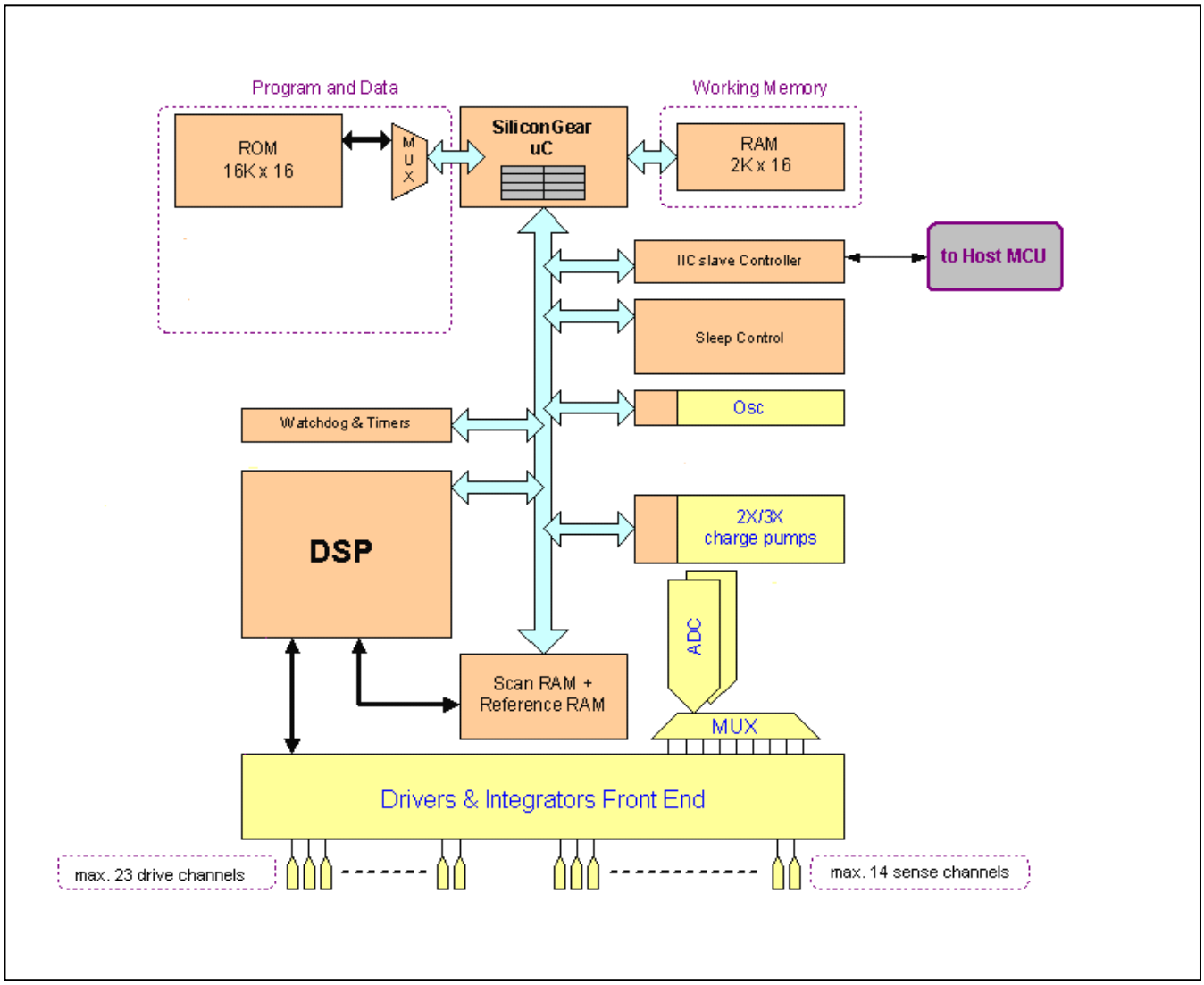


Figure 4-1: SSD2541 Block Diagram

5 PIN ARRANGEMENT

5.1 QFN 48 Pin Assignments

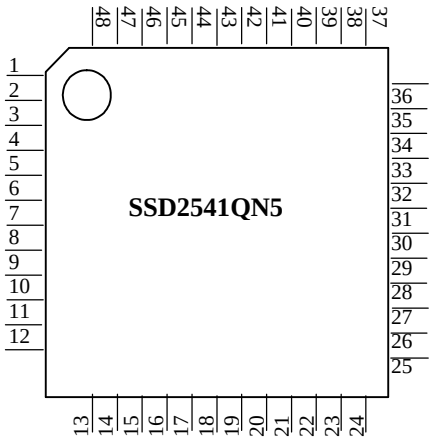


Figure 5-1: Pin-out Diagram – 48 pins QFN (Top view)

Pin #	Signal Name	Pin #	Signal Name	Pin #	Signal Name	Pin #	Signal Name
1	/IRQ	13	C3XN	25	DRIVE10	37	SENSE01
2	SLAVE_SDA	14	VOUT	26	DRIVE11	38	SENSE02
3	SLAVE_SCL	15	DRIVE00	27	DRIVE12	39	SENSE03
4	STYPE	16	DRIVE01	28	DRIVE13	40	SENSE04
5	VDDIO	17	DRIVE02	29	DRIVE14	41	SENSE05
6	VCI	18	DRIVE03	30	DRIVE15	42	SENSE06
7	BIAS	19	DRIVE04	31	DRIVE16	43	SENSE07
8	AVSS	20	DRIVE05	32	DRIVE17	44	SENSE08
9	VCORE	21	DRIVE06	33	DRIVE18	45	SENSE09
10	C2XP	22	DRIVE07	34	DRIVE19	46	SENSE10
11	C2XN	23	DRIVE08	35	DRIVE20	47	SENSE11
12	C3XP	24	DRIVE09	36	SENSE00	48	/RESET

Table 5-1 : 48 pins QFN Pin Assignment Table

5.2 QFN 40 Pin Assignments

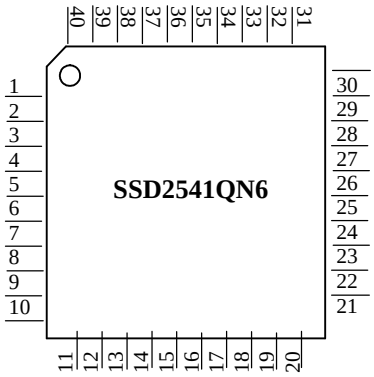


Figure 5-2: Pin-out Diagram – 40 pins QFN (Top view)

Pin #	Signal Name	Pin #	Signal Name	Pin #	Signal Name	Pin #	Signal Name
1	/IRQ	11	C2XN	21	DRIVE11	31	SENSE02
2	SLAVE_SDA	12	VOUT	22	DRIVE12	32	SENSE03
3	SLAVE_SCL	13	DRIVE03	23	DRIVE13	33	SENSE04
4	STYPE	14	DRIVE04	24	DRIVE14	34	SENSE05
5	VDDIO	15	DRIVE05	25	DRIVE15	35	SENSE06
6	VCI	16	DRIVE06	26	DRIVE16	36	SENSE07
7	BIAS	17	DRIVE07	27	DRIVE17	37	SENSE08
8	AVSS	18	DRIVE08	28	DRIVE18	38	SENSE09
9	VCORE	19	DRIVE09	29	SENSE00	39	SENSE10
10	C2XP	20	DRIVE10	30	SENSE01	40	/RESET

Table 5-2 : 40 pins QFN Pin Assignment Table

6 PIN DESCRIPTIONS

Key:

I = Input
O =Output
IO = Bi-directional (input/output)
P = Power pin
Hi-Z = High impedance

6.1 Power

Pin Name	Type	RESET# State	Description
VDDIO	P	N/A	This pin is power supply input for I/O buffer
VCI	P	N/A	This pin is power supply input for analog circuit
DVSS	P	N/A	This pin is ground for logic
AVSS	P	N/A	This pin is ground for analog

6.2 Logic

Pin Name	Type	RESET# State	Description
/RESET	I	VCHS	This is Reset pin for the chip
/IRQ	O	VDDIO	This is Interrupt pin for Interrupt request
SLAVE_ SDA	IO	Hi-Z	IIC data pin
SLAVE_ SCK	I	Hi-Z	IIC clock input pin
STYPE00, STYPE01	I	Hi-Z	Bus interface mode selection pin. STYPE means STYPE00 and STYPE01 bonded together. STYPE1 / STYPE0 / IIC Addr 0 / 0 / 0x48 0 / 1 / 0x49 1 / 0 / 0x4A 1 / 1 / 0x4B

6.3 Analog

Pin Name	Type	RESET# State	Description
C2XP	IO	VCI/VCHS	Booster pin. Connect a capacitor to C2N
C2XN	IO	VCI/VCHS	Booster pin. Connect a capacitor to C2P
C3XP	IO	VCI/VCHS	Booster pin. Connect a capacitor to C3N
C3XN	IO	VCI/VCHS	Booster pin. Connect a capacitor to C3P
VOUT	P	VCI/VCHS	Output power supply for booster. Connect a capacitor for stabilization
BIAS	P	VCI/VCHS	Regulated voltage supply for sensor circuit. Connect a capacitor for stabilization
VCORE	P	N/A	Regulated voltage supply for logic circuit. Connect a capacitor for stabilization

6.4 Input and Output

Pin Name	Type	RESET# State	Description
SENSE00 – SENSE13	I	Hi-Z	Sensor input pins
DRIVE00 – DRIVE22	O	VCHS	Driver output pins

7 FUNCTIONAL BLOCK DESCRIPTIONS

7.1 STYPE0, STYPE1

In SSD2541, the addresses for IIC interface are listed as below. STYPE means STYPE00 and STYPE01 bonded together.

STYPE 1	STYPE 0	IIC Address
0	0	0x48
0	1	0x49
1	0	0x4A
1	1	0x4B

7.2 MCU

This block is a 16bit MCU core.

7.3 ADC

This block is an analog to digital converter for converting the sensing signal to digital data.

7.4 Analog Booster circuit

This block generates the high output driving voltage for the driving pins.

7.5 IIC interface (Slave)

This block is used to communicate with the MCU.
It supports the mandatory slave feature showed below.

- START Condition
- STOP Condition
- Acknowledge

With the addition of 16-bit MCU, system flow control has been changed from hardware logic to firmware code.

7.6 14 pins Sensing input

This block is the sensing circuit.

7.7 23 pins driving Output Amplifier

This block is the driving output circuit.

8 COMMAND TABLE

Reg No. Hex	Name	Function	Read/Write/Command	Byte of parameter	Parameter
0x00	NOP				
0x01	SW_RESET	Async software reset	W	2	Dummy byte 0x00
0x02	DEVICE_ID	Read Device ID	R	2	[15:0]: report "2541" in BCD
0x04	SLEEP_OUT_REG	Clock is back	W	2	[15:0]: Dummy bytes
0x05	SLEEP_IN_REG	Shut down everything that is controlled by clock	W	2	[15:0]: Dummy bytes
0x06	DRIVE_SENSE_NO_REG	Set No# of Driving Electrode Set No# of Sensing Electrode	RW	2	[12:8]: Number of Drive line - 1 [5:0]: Number of Sense line - 1
0x07	DRIVE_LINE0_REG	Select Drive pin, slew rate and group (left/right side of panel)	RW	2	[8]: Drive line group (left/right) [7:5]: Slew rate [4:0]: Drive pin select
0x08	DRIVE_LINE1_REG	Select Drive pin, slew rate and group (left/right side of panel)	RW	2	[8]: Drive line group (left/right) [7:5]: Slew rate [4:0]: Drive pin select
0x09	DRIVE_LINE2_REG	Select Drive pin, slew rate and group (left/right side of panel)	RW	2	[8]: Drive line group (left/right) [7:5]: Slew rate [4:0]: Drive pin select
0x0A	DRIVE_LINE3_REG	Select Drive pin, slew rate and group (left/right side of panel)	RW	2	[8]: Drive line group (left/right) [7:5]: Slew rate [4:0]: Drive pin select
0x0B	DRIVE_LINE4_REG	Select Drive pin, slew rate and group (left/right side of panel)	RW	2	[8]: Drive line group (left/right) [7:5]: Slew rate [4:0]: Drive pin select
0x0C	DRIVE_LINE5_REG	Select Drive pin, slew rate and group (left/right side of panel)	RW	2	[8]: Drive line group (left/right) [7:5]: Slew rate [4:0]: Drive pin select
0x0D	DRIVE_LINE6_REG	Select Drive pin, slew rate and group (left/right side of panel)	RW	2	[8]: Drive line group (left/right) [7:5]: Slew rate [4:0]: Drive pin select
0x0E	DRIVE_LINE7_REG	Select Drive pin, slew rate and group (left/right side of panel)	RW	2	[8]: Drive line group (left/right) [7:5]: Slew rate [4:0]: Drive pin select
0x0F	DRIVE_LINE8_REG	Select Drive pin, slew rate and group (left/right side of panel)	RW	2	[8]: Drive line group (left/right) [7:5]: Slew rate [4:0]: Drive pin select
0x10	DRIVE_LINE9_REG	Select Drive pin, slew rate and group (left/right side of panel)	RW	2	[8]: Drive line group (left/right) [7:5]: Slew rate [4:0]: Drive pin select
0x11	DRIVE_LINE10_REG	Select Drive pin, slew rate and group (left/right side of panel)	RW	2	[8]: Drive line group (left/right) [7:5]: Slew rate [4:0]: Drive pin select
0x12	DRIVE_LINE11_REG	Select Drive pin, slew rate and group (left/right side of panel)	RW	2	[8]: Drive line group (left/right) [7:5]: Slew rate [4:0]: Drive pin select
0x13	DRIVE_LINE12_REG	Select Drive pin, slew rate and group (left/right side of panel)	RW	2	[8]: Drive line group (left/right) [7:5]: Slew rate [4:0]: Drive pin select
0x14	DRIVE_LINE13_REG	Select Drive pin, slew rate and group (left/right side of panel)	RW	2	[8]: Drive line group (left/right) [7:5]: Slew rate [4:0]: Drive pin select
0x15	DRIVE_LINE14_REG	Select Drive pin, slew rate and group (left/right side of panel)	RW	2	[8]: Drive line group (left/right) [7:5]: Slew rate [4:0]: Drive pin select
0x16	DRIVE_LINE15_REG	Select Drive pin, slew rate and group (left/right side of panel)	RW	2	[8]: Drive line group (left/right) [7:5]: Slew rate [4:0]: Drive pin select
0x17	DRIVE_LINE16_REG	Select Drive pin, slew rate and group (left/right side of panel)	RW	2	[8]: Drive line group (left/right) [7:5]: Slew rate [4:0]: Drive pin select
0x18	DRIVE_LINE17_REG	Select Drive pin, slew rate and group (left/right side of panel)	RW	2	[8]: Drive line group (left/right) [7:5]: Slew rate [4:0]: Drive pin select
0x19	DRIVE_LINE18_REG	Select Drive pin, slew rate and group (left/right side of panel)	RW	2	[8]: Drive line group (left/right) [7:5]: Slew rate [4:0]: Drive pin select
0x1A	DRIVE_LINE19_REG	Select Drive pin, slew rate and group (left/right side of panel)	RW	2	[8]: Drive line group (left/right) [7:5]: Slew rate [4:0]: Drive pin select
0x1B	DRIVE_LINE20_REG	Select Drive pin, slew rate and group (left/right side of panel)	RW	2	[8]: Drive line group (left/right) [7:5]: Slew rate [4:0]: Drive pin select
0x1C	DRIVE_LINE21_REG	Select Drive pin, slew rate and group (left/right side of panel)	RW	2	[8]: Drive line group (left/right) [7:5]: Slew rate [4:0]: Drive pin select

0x1D	DRIVE_LINE22_REG	Select Drive pin, slew rate and group (left/right side of panel)	RW	2	[8]: Drive line group (left/right) [7:5]: Slew rate [4:0]: Drive pin select
0x25	OP_MODE_REG	Set Operating Mode	RW	2	[7:0]: Frame scan period in millisecond. 0x00 to enter IDLE mode.
0x27	FREQ_HOPPING_REG	Enable frequency hopping	RW	2	[13:8] high freq [5:0]: low freq
0x28	SENSE_OFFSET_REG	Change the start position of sense lines. Can be any number from 0 to 43	RW	2	[5:0]: Sense line Offset
0x30	INT_TIMING_REG	Set the start time of integration window Set the end time of integration window	RW	2	[11:8]: Start time in unit of 125ns. [3:0] End time in unit of 125ns.
0x33	MIN_AREA_REG	Define Min. Finger Area	RW	2	[7:0]: Min. area for a valid finger detection
0x34	MIN_LEVEL_REG	Define Min. Finger Level	RW	2	[8:0]: Min. amplitude for a valid finger detection
0x35	MIN_WEIGHT_REG	Define Min. Finger Weight	RW	2	[15:0]: Min. weight threshold for a valid finger detection
0x36	MAX_AREA_REG	Define Max. Finger Area	RW	2	[7:0]: Max. area for a valid finger detection
0x3A	CG_METHOD_REG	Select finger CG calculation method Select blending % in hybrid CG calculation.	RW	2	[9:8]: 0 = Weighted average 1 = Curve fitting 2 = Hybrid [7:2]: Reserved [1:0]: Weighted Average / Curve Fitting 00 = 50% / 50% 01 = 75% / 25% 10 = 25% / 75%
0x47	EDGE_SUPPRESS1_REG	Set edge suppress top and bottom	RW	2	[15:8] Edge suppress top [7:0] Edge suppress bottom
0x48	EDGE_SUPPRESS2_REG	Set edge suppress Left and Right	RW	2	[15:8] Edge suppress left [7:0] Edge suppress right
0x49	EDGE_SUPPRESS3_REG	Set edge suppress topleft and topright	RW	2	[15:8] Edge suppress topleft [7:0] Edge suppress topright
0x4A	EDGE_SUPPRESS4_REG	Set edge suppress bottomleft and bottomright	RW	2	[15:8] Edge suppress bottomleft [7:0] Edge suppress bottomright
0x50	HOP_LEVEL_REG		RW	2	[15:0]: hopping level
0x57	PRESS_SCALE_REG	Set pressure scaling factor	RW	2	[2:0]: 0: finger weight[8:1] 1: finger weight[9:2] ... 6: finger weight[14:7] 7: finger weight[15:8]
0x65	ORIENTATION_REG	Remap finger coordinates according to different orientation	RW	2	[15:3]: Reserved [2:0]: 000: Normal 001: Y-Invert 010: X-Invert 011: X-Invert + Y-Invert 100: Transpose 101: Transpose + X-Invert (270 deg) 110: Transpose + Y-Invert (90 deg) 111: Transpose + X-Invert + Y-Invert
0x66	X_SCALING_REG	Set scaling factor for X coordinate.	RW	2	[15:0]: X scaling factor in 0#.##_####_####_#### binary format.
0x67	Y_SCALING_REG	Set scaling factor for Y coordinate.	RW	2	[15:0]: Y scaling factor in 0#.##_####_####_#### binary format.
0x68	X_OFFSET_REG	Set Offset in X direction	RW	2	[15:0]: X offset in basic resolution unit. (+/-)
0x69	Y_OFFSET_REG	Set Offset in Y direction	RW	2	[15:0]: Y offset in basic resolution unit (+/-)
0x79	TOUCH_STATUS	Touch Status	R	2	[13]: Finger09 detected [12]: Finger08 detected [11]: Finger07 detected [10]: Finger06 detected [9]: Finger05 detected [8]: Finger04 detected [7]: Finger03 detected [6]: Finger02 detected [5]: Finger01 detected [4]: Finger00 detected [3]: Abnormal status detected [2]: Large Object detected [1]: FIFO overflow [0]: FIFO data valid
0x7A	EVENT_MSK_REG	Event Mask	RW	2	[5]: FM stands for Finger Move [4]: FL stands for Finger Leave [3]: FE stands for Finger Enter [0]: Reserved

0x7B	IRQ_MSK_REG	IRQ Mask	RW	2	[15:14]: reserved [13]: Finger09 status mask [12]: Finger08 status mask [11]: Finger07 status mask [10]: Finger06 status mask [9]: Finger05 status mask [8]: Finger04 status mask [7]: Finger03 status mask [6]: Finger02 status mask [5]: Finger01 status [4]: Finger00 status mask [3]: Abnormal status mask [2]: Large Object status mask [1]: FIFO overflow status mask [0]: FIFO data valid status mask
0x7C	FINGER00_REG	Finger00 Coordinate	R	4	[31:24]: X-coordinate[7:0] [23:16]:Y-coordinate[7:0] [15:12]: X-coordinate [11:8] [11:8]: Y-coordinate [11:8] [7:0]: Pressure Index
0x7D	FINGER01_REG	Finger01 Coordinate	R	4	[31:24]: X-coordinate[7:0] [23:16]:Y-coordinate[7:0] [15:12]: X-coordinate [11:8] [11:8]: Y-coordinate [11:8] [7:0]: Pressure Index
0x7E	FINGER02_REG	Finger02 Coordinate	R	4	[31:24]: X-coordinate[7:0] [23:16]:Y-coordinate[7:0] [15:12]: X-coordinate [11:8] [11:8]: Y-coordinate [11:8] [7:0]: Pressure Index
0x7F	FINGER03_REG	Finger03 Coordinate	R	4	[31:24]: X-coordinate[7:0] [23:16]:Y-coordinate[7:0] [15:12]: X-coordinate [11:8] [11:8]: Y-coordinate [11:8] [7:0]: Pressure Index
0x80	FINGER04_REG	Finger04 Coordinate	R	4	[31:24]: X-coordinate[7:0] [23:16]:Y-coordinate[7:0] [15:12]: X-coordinate [11:8] [11:8]: Y-coordinate [11:8] [7:0]: Pressure Index
0x81	FINGER05_REG	Finger05 Coordinate	R	4	[31:24]: X-coordinate[7:0] [23:16]:Y-coordinate[7:0] [15:12]: X-coordinate [11:8] [11:8]: Y-coordinate [11:8] [7:0]: Pressure Index
0x82	FINGER06_REG	Finger06 Coordinate	R	4	[31:24]: X-coordinate[7:0] [23:16]:Y-coordinate[7:0] [15:12]: X-coordinate [11:8] [11:8]: Y-coordinate [11:8] [7:0]: Pressure Index
0x83	FINGER07_REG	Finger07 Coordinate	R	4	[31:24]: X-coordinate[7:0] [23:16]:Y-coordinate[7:0] [15:12]: X-coordinate [11:8] [11:8]: Y-coordinate [11:8] [7:0]: Pressure Index
0x84	FINGER08_REG	Finger08 Coordinate	R	4	[31:24]: X-coordinate[7:0] [23:16]:Y-coordinate[7:0] [15:12]: X-coordinate [11:8] [11:8]: Y-coordinate [11:8] [7:0]: Pressure Index
0x85	FINGER09_REG	Finger09 Coordinate	R	4	[31:24]: X-coordinate[7:0] [23:16]:Y-coordinate[7:0] [15:12]: X-coordinate [11:8] [11:8]: Y-coordinate [11:8] [7:0]: Pressure Index
0x8B	EDGE_REMAP_REG	Remap the boundary coordinate of touch panel by x1.5	RW	2	[0] 0: disable edge coordinate remapping 1: enable edge coordinate remapping
0xA2	INIT_RST	Reset Init Reference Procedure	RW	2	Write 0x0001 to activiate the init reference procedure again
0xD5	DRIVE_LEVEL_REG	Select Driving voltage	RW	2	Reserved

0xD7	ADC_RANGE_SEL_REG	Select ADC Vref range	RW	2	VrefH VrefL [2:0]: 000: VCI/2 + 0.35 VCI/2 - 0.35 001: VCI/2 + 0.40 VCI/2 - 0.40 010: VCI/2 + 0.45 VCI/2 - 0.45 011: VCI/2 + 0.50 VCI/2 - 0.50 100: VCI/2 + 0.60 VCI/2 - 0.60 101: VCI/2 + 0.70 VCI/2 - 0.70 110: VCI/2 + 0.80 VCI/2 - 0.80 111: VCI/2 + 0.90 VCI/2 - 0.90
0xD8	BIAS_RES	Select Sense line biasing resistance	RW	2	[2:0]: 0 = 5.0k 1= 6.5k 2 = 8.3k 3 = 10.8k 4 = 14k 5 = 18k 6 = 23k 7 = 30k
0xDB	INTG_CAP_REG	Set integrator cap value	RW	2	[2]: CI2 [1]: CI1 [0]: CI0

9 COMMAND DESCRIPTIONS

No Operation (R00h)
No Operation for this command.

Software Reset (R01h)
A dummy byte (e.g. 0x00) should be sent after this command for the software reset.

Read Device ID Register (R02h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
R	1	0	0	1	0	0	1	0	1
R	2	0	1	0	0	0	0	0	1

This register returned the Device ID “2541h”.

System Enable (R04h)
A dummy byte (e.g. 0x00) should be sent after this command to enable the system clock.

System Disable (R05h)
A dummy byte (e.g. 0x00) should be sent after this command to disable the system clock.

Drive and Sense Line Number Register (R06h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--	--	--	Drive_No				
RW	2			Sense_No					

The number of driving lines can be set up to maximum 23.

Drive_No	Number of Driving Lines
00000	1
00001	2
:	:
:	Step = 1
:	:
10101	22
10110	23 (default)

The number of sensing lines can be set up to maximum 14.

Sense_No	Number of Sensing Lines
000000	1
000001	2
:	:
:	Step = 1
:	:
001100	13
001101	14 (default)

Select Drive Pin for 1st Drive Line (R07h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--							Group
RW	2	--			Drive pin selection				

Select Drive Pin for 2nd Drive Line (R08h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--							Group
RW	2	--			Drive pin selection				

Select Drive Pin for 3rd Drive Line (R09h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--							Group
RW	2	--			Drive pin selection				

Select Drive Pin for 4th Drive Line (R0Ah)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--							Group
RW	2	--			Drive pin selection				

Select Drive Pin for 5th Drive Line (R0Bh)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--							Group
RW	2	--			Drive pin selection				

Select Drive Pin for 6th Drive Line (R0Ch)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--							Group
RW	2	--			Drive pin selection				

Select Drive Pin for 7th Drive Line (R0Dh)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--							Group
RW	2	--			Drive pin selection				

Select Drive Pin for 8th Drive Line (R0Eh)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--							Group
RW	2	--			Drive pin selection				

Select Drive Pin for 9th Drive Line (R0Fh)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--							Group
RW	2	--			Drive pin selection				

Select Drive Pin for 10th Drive Line (R10h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--							Group
RW	2	--			Drive pin selection				

Select Drive Pin for 11th Drive Line (R11h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--							Group
RW	2	--			Drive pin selection				

Select Drive Pin for 12th Drive Line (R12h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--							Group
RW	2	--			Drive pin selection				

Select Drive Pin for 13th Drive Line (R13h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--							Group
RW	2	--			Drive pin selection				

Select Drive Pin for 14th Drive Line (R14h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--							Group
RW	2	--			Drive pin selection				

Select Drive Pin for 15th Drive Line (R15h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--							Group
RW	2	--			Drive pin selection				

Select Drive Pin for 16th Drive Line (R16h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--							Group
RW	2	--			Drive pin selection				

Select Drive Pin for 17th Drive Line (R17h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--							Group
RW	2	--			Drive pin selection				

Select Drive Pin for 18th Drive Line (R18h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--							Group
RW	2	--			Drive pin selection				

Select Drive Pin for 19th Drive Line (R19h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--							Group
RW	2	--			Drive pin selection				

Select Drive Pin for 20th Drive Line (R1Ah)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--							Group
RW	2	--			Drive pin selection				

Select Drive Pin for 21st Drive Line (R1Bh)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--							Group
RW	2	--			Drive pin selection				

Select Drive Pin for 22nd Drive Line (R1Ch)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--							Group
RW	2	--			Drive pin selection				

Select Drive Pin for 23rd Drive Line (R1Dh)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--							Group
RW	2	--			Drive pin selection				

Operation Mode Register (R25h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--	--	--	--	--	--	--	--
RW	2	Op_Mode							

Idle Mode - In Idle Mode, no scanning activities will be performed. Set 0 to enter idle mode.

Operation Mode - In Operation Mode, the frame scan rate is 0~100Hz. Any value >0 will be interrupted as frame period in milliseconds.

When reading, this command is used to check when the controller change from Idle Mode to Operating Mode (or vice versa):

(1) When going from Idle Mode to Operating Mode, this command will report 0x00 until charge bump is ready.

(2) When going from Operating Mode to Idle Mode, this command will report provious set value until the completion of frame scan.

Frequency Hopping Register (R27h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--	--	High_freq					
RW	2	--	--	Low_freq					

Setting the range of frequency hopping; and conbining with R50h to set the hoping level.

Sense Line Offset Register (R28h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--	--	--	--	--	--	--	--
RW	2	--	--	Sense_Offset					

Number of sense lines must be reduced accordingly.

For example, if the number of sense lines is 30 with offset is 4, the sense lines [4:33] are used.

Integration Window Timing Setting (R30h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--	--	--	--	Start_Time			
RW	2	--	--	--	--	End_Time			

Integration START time should be smaller than END time. Unit in 125ns per division.

Min Finger Area Setting Register (R33h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--	--	--	--	--	--	--	--
RW	2	Min_Area							

If the touching area detected is bigger than Min_Area, the system will report “valid finger”.

Min Finger Level Setting Register (R34h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--	--	--	--	--	--	--	--
RW	2	Min_Area							

If the touching level detected is bigger than Min_Level, the system will report “valid finger”.

Min Finger Weight Setting Register (R35h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	Min_Weight							
RW	2	Min_Weight							

Similar to Min Finger Area, user can define also the weight of a valid finger touch.
Weight means the summation of the signal level within the touch area. Weight is as a function of finger area (R33h) and finger level (R34h).

Max Finger Area Setting Register (R36h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--	--	--	--	--	--	--	--
RW	2	Max_Area							

For any touching detected, the system will count the cover area of the touch point and determine if it is a valid finger touch. If the touching area is over Max_Area, the system will report Large Object rather than a finger touch.

Select CG calculation method (R3Ah)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--	--	--	--	--	--	CG	
RW	2	--	--	--	--	--	--	Hybrid_pent	

This command is used to improve the stability of different panel, and with selection of blending percentage in hybrid CG calculation

CG	CG Calcuation Method
00	Weighted Average
01	Curve Fitting
10	Hybrid

Hybrid_pent	Weighted Average	Curve Fitting
00	50%	50%
01	75%	25%
10	25%	75%
11	Reserved	Reserved

Edge Suppression 1 Register (R47h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	Top							
RW	2	Bottom							

Edge Suppression 2 Register (R48h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	Left							
RW	2	Right							

Edge Suppression 3 Register (R49h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	Top_left							
RW	2	Top_right							

Edge Suppression 4 Register (R4Ah)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	Bottom_left							
RW	2	Bottom_right							

Hopping Level Register (R50h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	Hopping_lv							
RW	2	Hopping_lv							

Pressure Scaling Register (R57h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--	--	--	--	--	--	--	--
RW	2						Press_factor		

Orientation Register (R65h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--	--	--	--	--	--	--	--
RW	2						Orientation		

Orientation	Description
000	Normal
001	Y-invert
010	X-invert
011	X-invert + Y-invert
100	Transpose
101	Transpose + X-invert
110	Transpose + Y-invert
111	Transpose + X-invert + Y-invert

X Scaling Register (R66h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	X_scaling							
RW	2	X_scaling							

Y Scaling Register (R67h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	Y_scaling							
RW	2	Y_scaling							

X Offset Register (R68h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	X_offset							
RW	2	X_offset							

Y Offset Register (R69h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	Y_offset							
RW	2	Y_offset							

Touch Status (R79h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
R	1	--		F9	F8	F7	F6	F5	F4
R	2	F3	F2	F1	F0	AS	LO	--	

This register showed the status of the touch detection. When a touch event is detected, the IRQ signal will set to low and at least one bit on this register will set to "1" to indicate the touch status. This register is "0" if the IRQ signal is high.

Register	Name	Function
F9	Finger9 Detected	This bit will set to "1" indicating the present of 10th finger
F8	Finger8 Detected	This bit will set to "1" indicating the present of 9rd finger
F7	Finger7 Detected	This bit will set to "1" indicating the present of 8nd finger
F6	Finger6 Detected	This bit will set to "1" indicating the present of 7th finger
F5	Finger5 Detected	This bit will set to "1" indicating the present of 6rd finger
F4	Finger4 Detected	This bit will set to "1" indicating the present of 5nd finger
F3	Finger3 Detected	This bit will set to "1" indicating the present of 4th finger
F2	Finger2 Detected	This bit will set to "1" indicating the present of 3rd finger
F1	Finger1 Detected	This bit will set to "1" indicating the present of 2nd finger
F0	Finger0 Detected	This bit will set to "1" when 1st finger touch detected
AS	Abnormal status	This bit will set to "1" when abnormal status detected.
LO	Large Object	If a touch detected with touch area over Max Finger Area (R16h), this bit will set to "1"

Event Mask (R7Ah)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	Reserved							
RW	2	--	--	FM	FL	FE	--	--	--

IRQ Mask (R7Bh)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	---		F9	F8	F7	F6	F5	F4
RW	2	F3	F2	F1	F0	AS	LO	OF	VF

Finger01-10 (X,Y) coordinates, press weight index. (R7Ch – R85h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
R	1	x-coor[7:0]							
R	2	y-coor[7:0]							
R	3	x-coor[11:8]				y-coor[11:8]			
R	4	weight index[7:0]							

SSD2541 can detect maximum of 10 fingers touch on the panel. Ten registers are used to report the x-y coordinate of the 10 fingers if present and only the most concurrent coordinates are reported.

The first touch point will put to R7Ch and the second touch point will put to R7Dh and so on. Once the finger number had been assigned, the system will keep tracking the same finger and update the latest x-y coordinate to same register until the finger leaving the touch screen.

Enable edge coordinate remapping (R8Bh)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--	--	--	--	--	--	--	--
RW	2	--							Edge_Enable_Vref

Edge_Enable	Function
0	Disable edge coordinate remapping
1	Enable edge coordinate remapping

Reset Init Reference Procedure (RA2h)

A 0x0001 should be sent after this command to activate the init reference procedure again

Select Driving voltage level (RD5h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	Reserved							
RW	2	Reserved							

Select ADC Vref range (RD7h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--	--	--	--	--	--	--	--
RW	2	--					Vref		

Vref	VrefH	VrefL
000	VCI/2+0.35	VCI/2-0.35
001	VCI/2+0.40	VCI/2-0.40
010	VCI/2+0.45	VCI/2-0.45
011	VCI/2+0.50	VCI/2-0.50
100	VCI/2+0.60	VCI/2-0.60
101	VCI/2+0.70	VCI/2-0.70
110	VCI/2+0.80	VCI/2-0.80
111	VCI/2+0.90	VCI/2-0.90

Select Sense line biasing resistance (RD8h)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--	--	--	--	--	--	--	--
RW	2	--					BIAS_RES		

Setting the sense line biasing resistance

BIAS_RES	Resistance
000	5.0k
001	6.5k
010	8.3k
011	10.8k
100	14k
101	18k
110	23k
111	30k

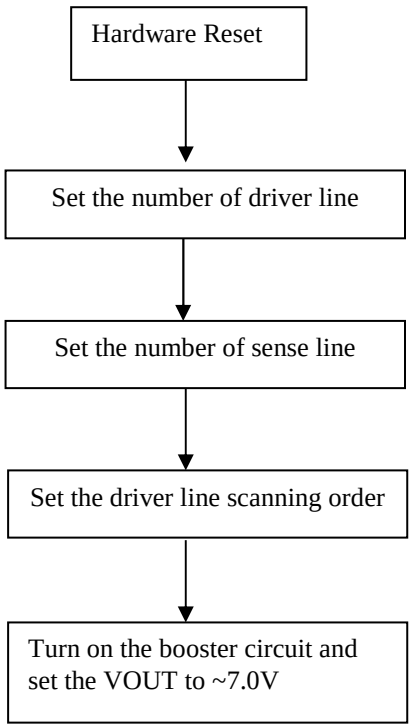
Set integrator cap value (RDBh)

R/W	Parameter	IB7	IB6	IB5	IB4	IB3	IB2	IB1	IB0
RW	1	--	--	--	--	--	--	--	--
RW	2	--					CI2	CI1	CI0

10 REGISTERS

VDDIO = VCI = 2.775V

1.) Hardware Reset
2.) Set the number of driver lines.
3.) Set the number of sense lines.
4.) Set the driver line scanning order.
5.) Turn on the booster circuit and set the VOUT to ~7.0V.



11 MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CORE}	Supply Voltage for Logic	-0.3 to +2.0	V
V_{DDIO}	Supply Voltage for I/O	-0.3 to +4.0	V
V_{CI}	Input Voltage	VSS -0.3 to +5.0	V
I	Current Drain Per Pin Excluding V_{CORE} and V_{SS}	25	mA
T_A	Operating Temperature	-40 to +85	°C
T_{STG}	Storage Temperature	-65 to +150	°C

Table 11-1: Maximum Ratings (Voltage Referenced to V_{SS})

Maximum ratings are those values beyond which damages to the device may occur. Functional operation should be restricted to the limits in the Electrical Characteristics tables or Pin Description section

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit. For proper operation it is recommended that V_{CI} and V_{OUT} be constrained to the range $V_{SS} < V_{DDIO} \leq V_{CI} < V_{OUT}$. Reliability of operation is enhanced if unused input is connected to an appropriate logic voltage level (e.g., either V_{SS} or V_{DDIO}). Unused outputs must be left open. This device may be light sensitive. Caution should be taken to avoid exposure of this device to any light source during normal operation. This device is not radiation protected.

12 DC CHARACTERISTICS

DC Characteristics (Unless otherwise specified, Voltage Referenced to V_{SS}, T_A = -40 to 85°C)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{DDIO}	Power supply pin of I/O pins	Recommend Operating Voltage Possible Operating Voltage	1.65	-	3.3	V
V_{CI}	Booster Reference Supply Voltage Range (3)	Recommend Operating Voltage Possible Operating Voltage	2.5 or V_{DDIO}	-	3.3	V
$I_{sleep}1$	Sleep mode current (V_{CI} pin)	VDDIO=1.8V, VCI=3.3V	-	10	50	uA
$I_{sleep}2$	Sleep mode current (V_{DDIO} pin)		-	1	10	uA
I_{dp}	Operating mode current	VDDIO=1.8V, VCI=3.3V $I_{DP} = I_{VDDIO} + I_{VCI}$	-	9	13	mA
VOUT	VOUT booster efficiency	See Note1	70	85	-	%
VOH1	Logic High Output Voltage	Iout=-100uA	0.9 * V_{DDIO}	-	V_{DDIO}	V
VOL1	Logic Low Output Voltage	Iout=100uA	0	-	0.1 * V_{DDIO}	V
VIH1	Logic High Input voltage		0.8 * V_{DDIO}	-	V_{DDIO}	V
VIL1	Logic Low Input voltage		0	-	0.2 * V_{DDIO}	V
I_{OH}	Logic High Output Current Source	$V_{OH} = V_{DDIO}$-0.4V	50	-	-	µA
I_{OL}	Logic Low Output Current Drain	V_{OL} = 0.4V	-	-	-50	µA
I_{OZ}	Logic Output Tri-state Current Drain Source		-1	-	1	µA
I_{IL}/I_{IH}	Logic Input Current		-1	-	1	µA

Table 12-1: DC Characteristics

13 AC CHARACTERISTICS

Conditions:

V_{CI} - V_{SS} = 2.5 to 3.3V
V_{DDIO} = 1.65-3.33V
T_A = 25°C

Symbol	Parameter	Min	Typ	Max	Unit
t_{cycle}	Clock Cycle Time	2.5	-	-	us
t_{HSTART}	Start condition Hold Time	0.6	-	-	us
t_{HD}	Data Hold Time (for "SDA" pin)	0	-	-	ns
t_{SD}	Data Setup Time	100	-	-	ns
t_{SSTART}	Start condition Setup Time (Only relevant for a repeated Start condition)	0.6	-	-	us
t_{SSTOP}	Stop condition Setup Time	0.6	-	-	us
t_R	Rise Time for data and clock pin	-	-	300	ns
t_F	Fall Time for data and clock pin	-	-	300	ns
t_{IDLE}	Idle Time before a new transmission can start	1.3	-	-	us

Note: All timings are based on 20% to 80% of V_{DDIO}-V_{SS}

Table 13-1 :I²C Interface Timing Characteristics

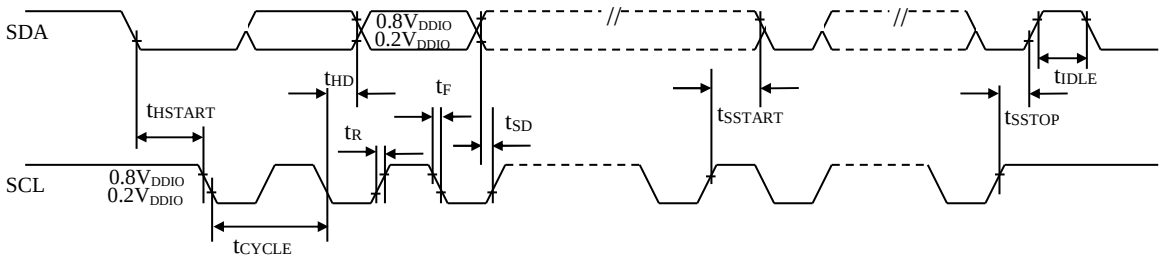


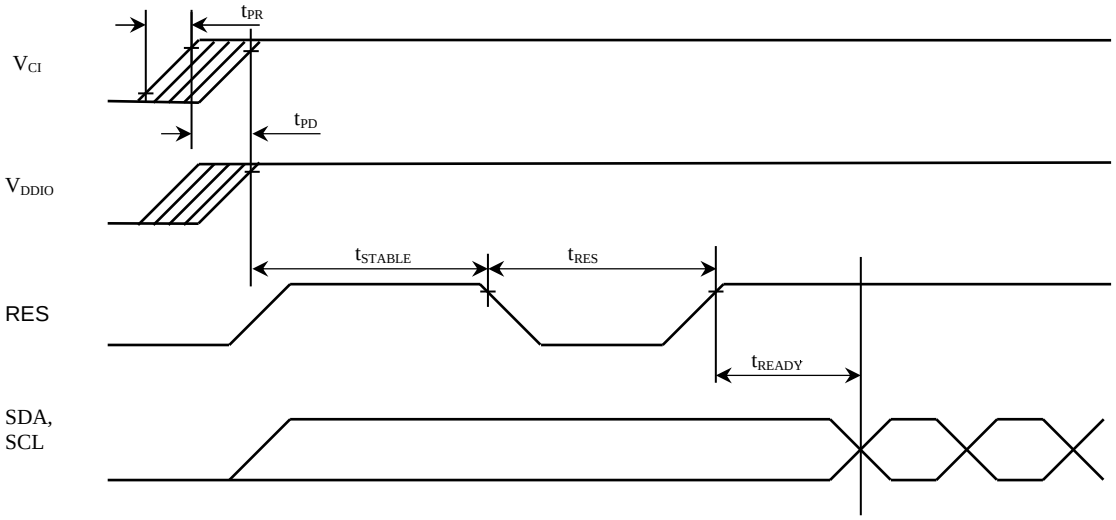
Figure 13-1: I²C Interface Timing Characteristics

14 POWER UP/DOWN SEQUENCE

14.1 Power up

Symbol	Parameter	Min	Typ	Max	Unit
t_{PR}	Power rise time	-	-	30	us
t_{PD}	Power delay time	-	-	30	us
t_{STABLE}	Chip stable time	10	-	-	us
t_{RES}	Reset pulse	4	-	-	us
t_{READY}	Chip need time after hardware reset	10	-	-	ms

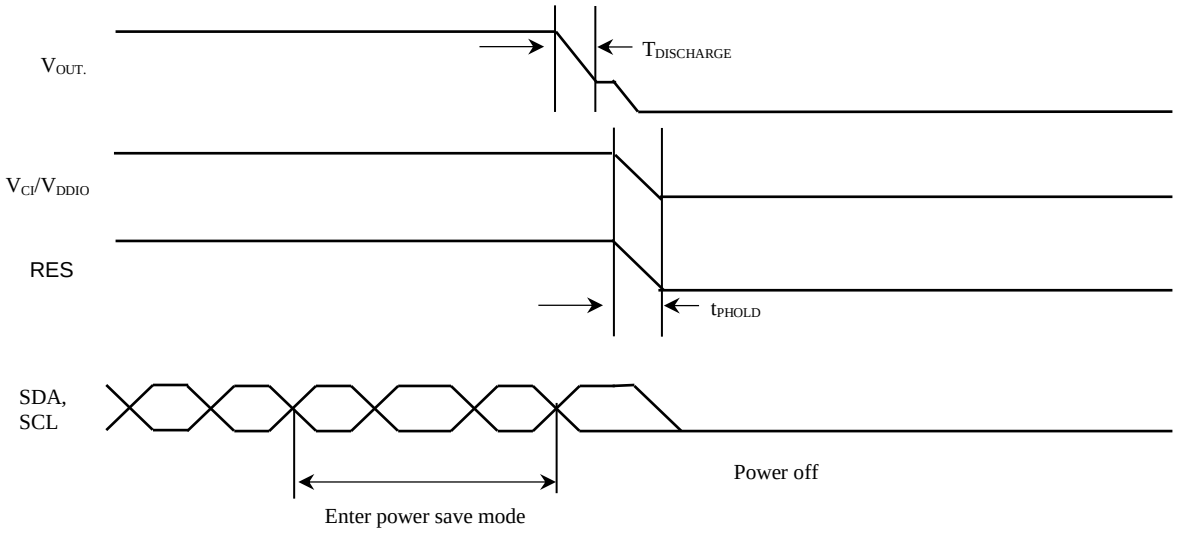
Note: All timings are based on 20% to 80% of V_{DDIO}-V_{SS}



14.2 Power down

Symbol	Parameter	Min	Typ	Max	Unit
$t_{DISCHARGE}$	V_{OUT} discharge wait time	50	-	-	ms
t_{PDOWN}	Power Hold time	50	-	-	ms

Note: All timings are based on 20% to 80% of V_{DDIO}-V_{SS}



- *With regards to the Power Off, Vout should be discharged at least below than 5V before turn off the V_{CI}/V_{DDIO} power supplies*

15 APPLICATION EXAMPLES

15.1 Application Diagram for QFN40

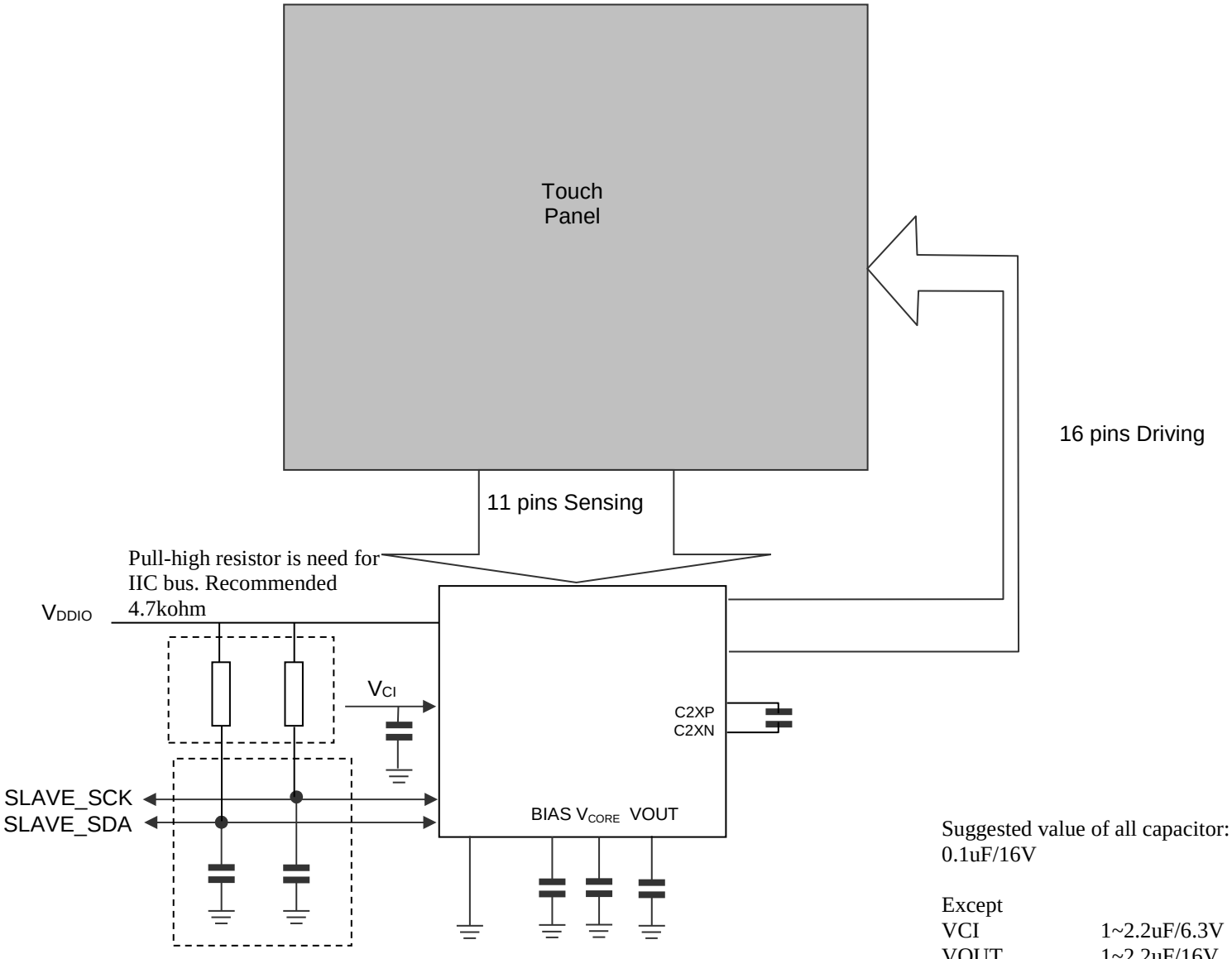
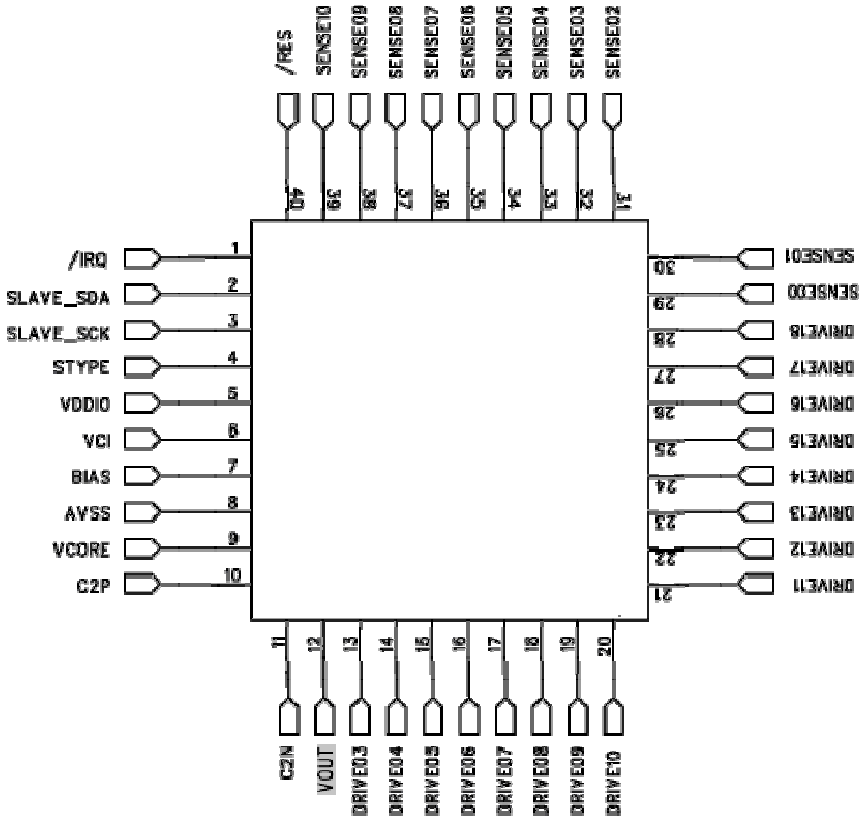
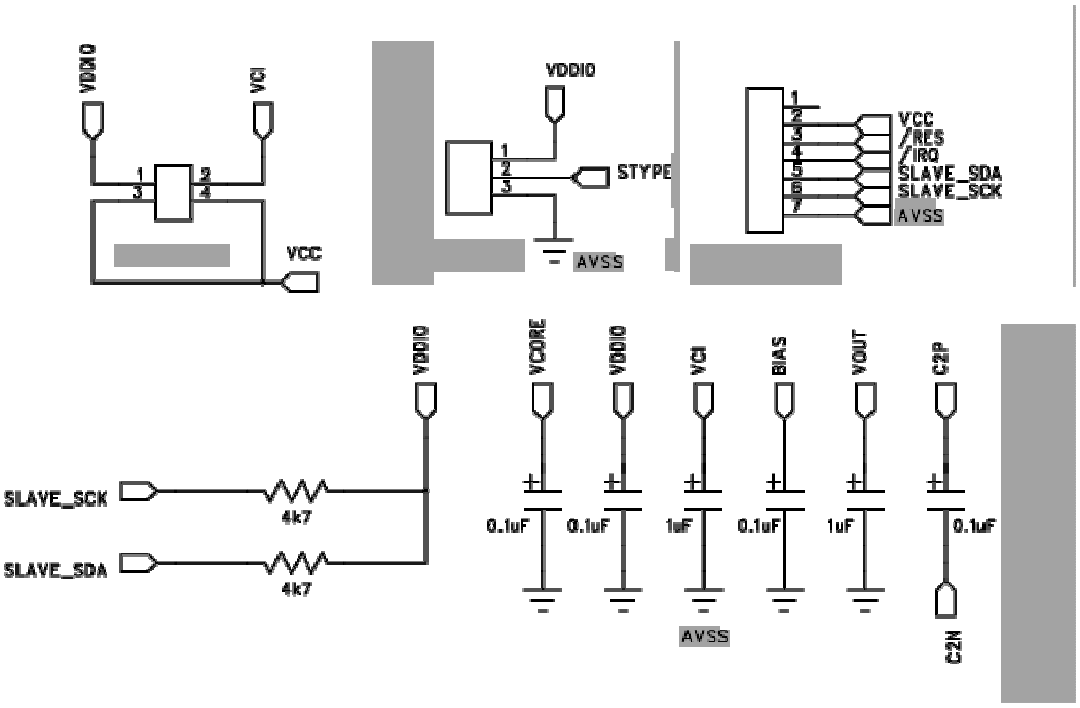


Figure 15-1: Application Example

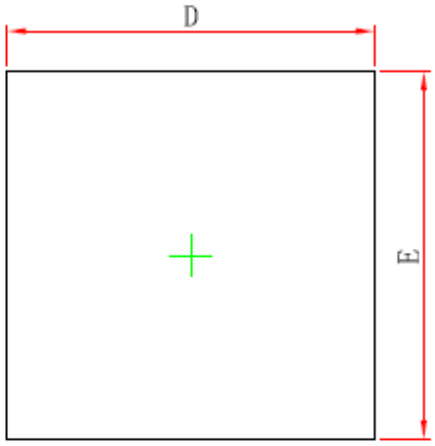
15.2 FPC Schematic Example for QFN40



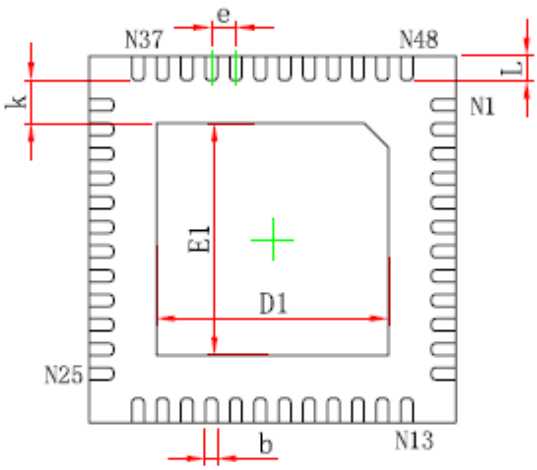


16 PACKAGE INFORMATION

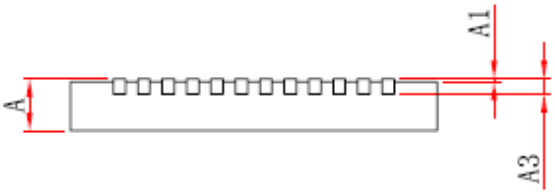
16.1 QFN 48 pins (6x6mm)



Top View



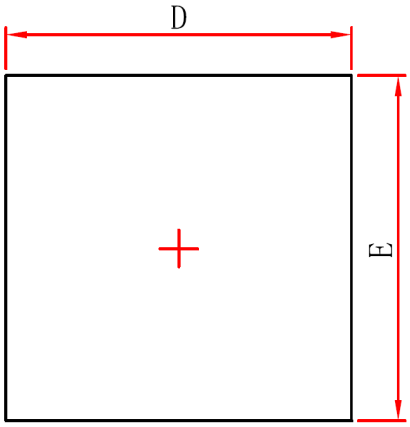
Bottom View



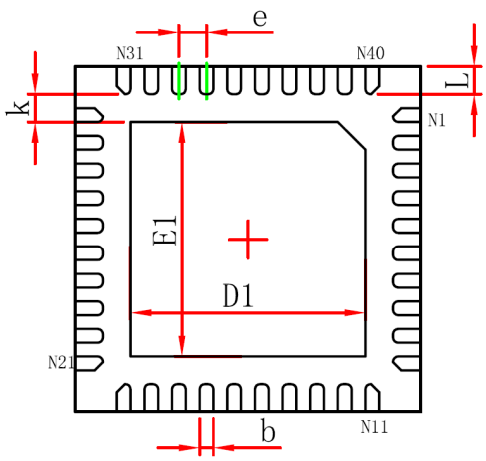
Side View

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.700/0.800	0.800/0.900	0.028/0.031	0.031/0.035
A1	0.000	0.050	0.000	0.002
A3	0.203REF.		0.008REF.	
D	5.924	6.076	0.233	0.239
E	5.924	6.076	0.233	0.239
D1	3.700	3.900	0.146	0.154
E1	3.700	3.900	0.146	0.154
k	0.200MIN.		0.008MIN.	
b	0.150	0.250	0.006	0.010
e	0.400TYP.		0.016TYP.	
L	0.324	0.476	0.013	0.019

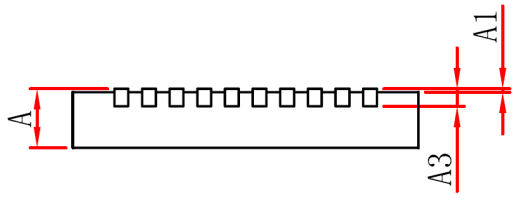
16.2 QFN 40 pins (5x5mm)



Top View



Bottom View



Side View

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.700/0.800	0.800/0.900	0.028/0.031	0.031/0.035
A1	0.000	0.050	0.000	0.002
A3	0.203REF.		0.008REF.	
D	4.924	5.076	0.194	0.200
E	4.924	5.076	0.194	0.200
D1	3.300	3.500	0.130	0.138
E1	3.300	3.500	0.130	0.138
k	0.200MIN.		0.008MIN.	
b	0.150	0.250	0.006	0.010
e	0.400TYP.		0.016TYP.	
L	0.324	0.476	0.013	0.019

16.3 Package orientation

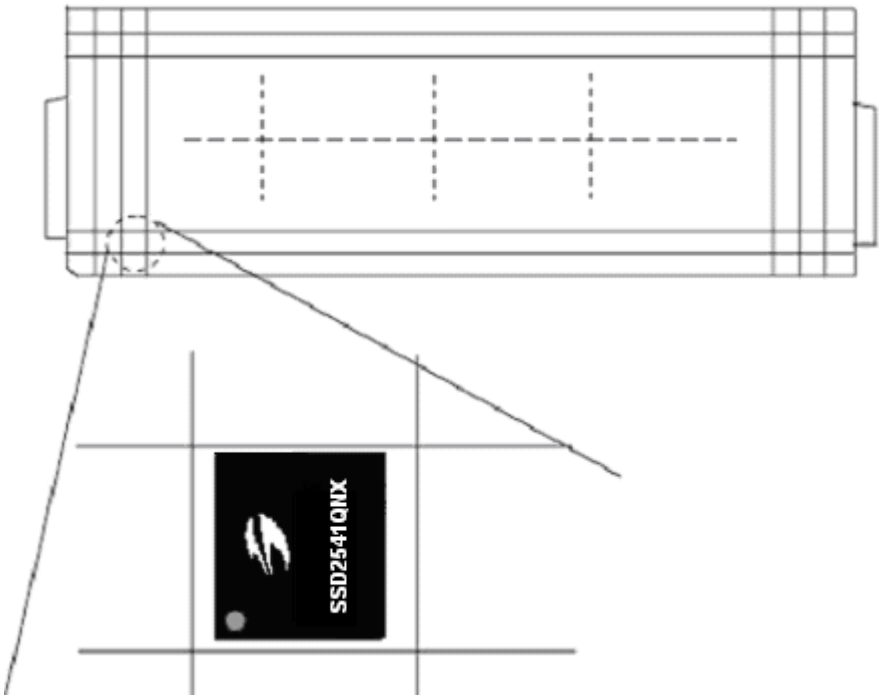


Figure 16-1: SSD2541QN5 / QN6 package orientation

The product(s) listed in this datasheet comply with Directive 2011/65/EU of the European Parliament and of the council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment and People’s Republic of China Electronic Industry Standard SJ/T 11363-2006 “Requirements for concentration limits for certain hazardous substances in electronic information products (电子信息产品中有毒有害物质的限量要求)”. Hazardous Substances test report is available upon request.

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