STA2 Datasheet

64-Channel CMOS Analog Switch IC

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Preliminary

The world is driven by analog

GENERAL DESCRIPTION

The STA IC is a monolithic CMOS device containing 64 independently selectable switches. These switches are fabricated with an advanced submicron CMOS process that provides low power dissipation, low on resistance, low leakage currents, and high signal bandwidth. The STA IC is designed to operate in 3.3V for digital circuits and 5V for analog switches. Each switch can operate with a wide input and output voltage range. The off-leakage current is only 30nA at room temperature of 25°C.

All digital inputs have 0.8-V to 2.4-V input noise margin to ensure TTL/CMOS-logic compatibility when using a 3.3-V power supply.

FEATURE

3.3V logic-compatible input (V_{IH}=2.4V, V_{IL}=0.8V)
Dual supply operation: 3.3V for digital, 5V for analog.
Analog signal frequency: DC-to-1MHz
Low on-resistance: 1Ω (@typ)
Wide range analog input from 0V to 5V
Chip-ID programmable with OTP memory
Multi-channel switch control
Switching control using CMOS IF command
180-pin FBGA package

APPLICATIONS

Data-acquisition systems
Mechanical reed-relay replacement
Communication systems

FUNCTIONAL DIAGRAM

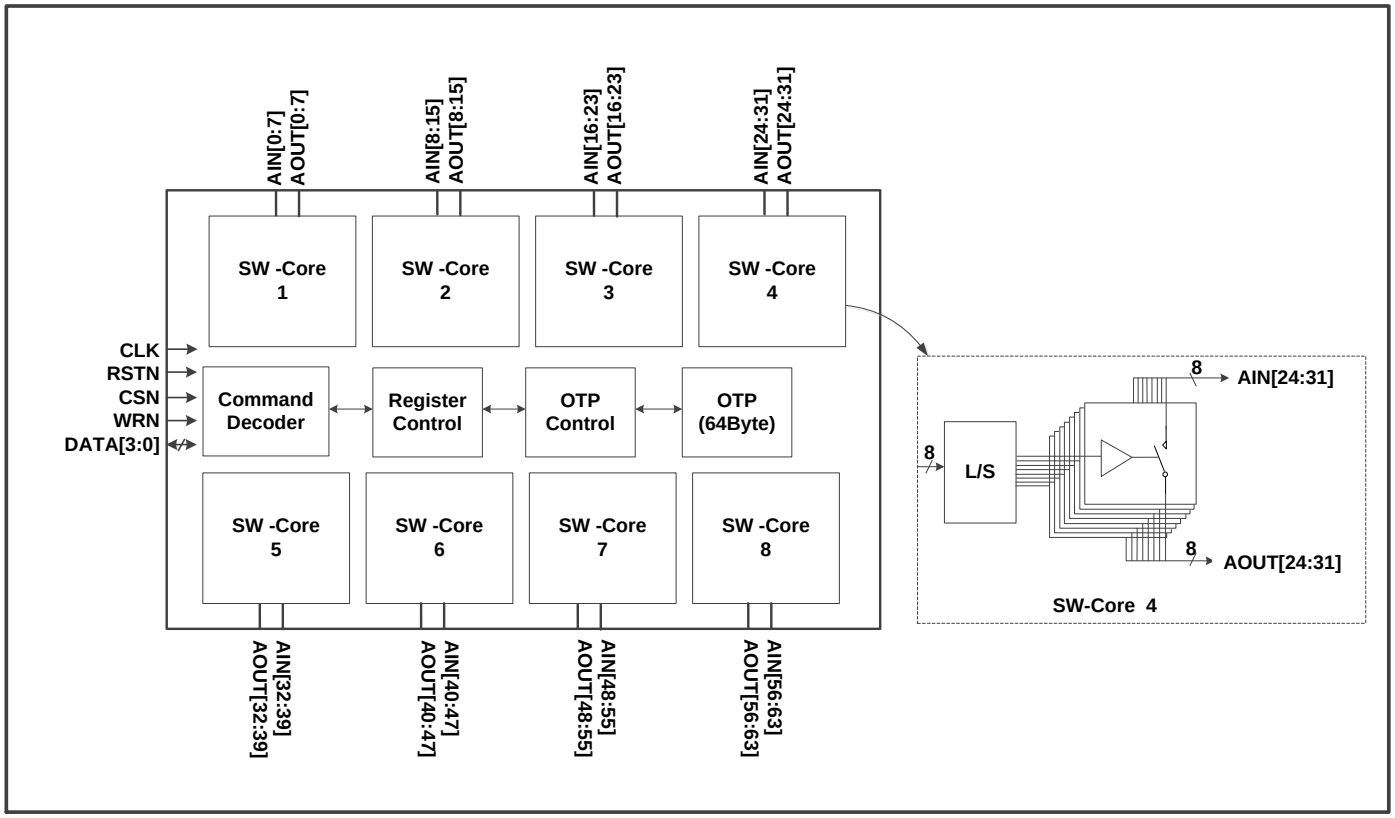


Figure 1. Functional Diagram

ABSOLUTE MAXIMUM RATINGS

(All Voltages Referenced to GND, Unless Otherwise Noted.)

AVDD (for Analog Switch).....-0.3V to +6V
DVDD (for Digital Control).....-0.3V to +4.5V
Voltage at any digital pin .....-0.3V to +4.5V
Voltage at any analog pin ……..…- 0.3V to +6V
Continuous current into any terminal 50mA
Peak current into analog switch I/O…….....100mA
(current pulse with 1ms and 10% duty cycle)

Operating temperature range .....-40°C to +85°C
Storage temperature range .....-65°C to +125°C
Junction temperature.....+150°C
ESD protection on all pins (HBM, MM)……≥2kV, 200V

Notice: Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at those or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

AVDD=5.0V, AVSS=0V, DVDD=3.3V, DVSS=0V, and TA = +25°C, unless otherwise noted.

PARAMETER		SYMBOL	CONDITION	VALUE			UNIT
				MIN	TYP	MAX	
POWER SUPPLIES							
Analog Supply Voltage		AVDD		4.5	5	5.5	V
Digital Supply Voltage		DVDD		3.0	3.3	3.6	V
Analog Ground Voltage		AVSS		-	0	-	V
Digital Ground Voltage		DVSS		-	0	-	V
ANALOG SWITCH							
Signal Range	Input Range	V_{AIN}		0		AVDD	V
	Output Range	V_{AOUT}		0		AVDD	V
Channel On Current		I_{CH_ON}	AVDD=5V, V_{AIN}=0V or 5V			50	mA
Switch On-resistance		R_{ON}	V_{AIN}=0V to AVDD , I_{CH_ON}=-1mA		1	3	Ω
Leakage Current	Source Off Leakage Current	I_{S_OFF}	AVDD=5V, V_{AIN} =5, V_{AOUT}=0V		0.05	1	uA
	Drain Off Leakage Current	I_{D_OFF}	AVDD=5V, V_{AIN}=0V, V_{AOUT}=5V		0.05	1	uA
	Channel On Leakage Current	I_{CH_OFF}	AVDD=5V, V_{AIN}=0V or 5V		0.05	1	uA

ELECTRICAL CHARACTERISTICS (Continued)

AVDD=5.0V, AVSS=0V, DVDD=3.3V, DVSS=0V, and TA = +25°C, unless otherwise noted.

PARAMETER		SYMBOL	CONDITION	VALUE			UNIT
				MIN	TYP	MAX	
DIGITAL I/O							
Logic Input Voltage	Input High	V_{IH}		0.7* DVDD			V
	Input Low	V_{IL}				0.3* DVDD	V
Logic Input Current	Input High	I_{IH}		-1		1	uA
	Input Low	I_{IL}		-1		1	uA
SWITCH DYNAMIC CHARACTERISTICS							
Switching Time	Turn ON Time	t_{ON}	Clock base (calculate for special condition)		175		ns
	Turn OFF Time	t_{OFF}			235		ns
Capacitance	Input Off-Capacitance	C_{AIN_OFF}			150		pF
	Output Off-Capacitance	C_{AOUT_OFF}			150		pF
	Output On-Capacitance	C_{AOUT_ON}			300		pF
Off-Isolation			No Load, f_{SW}=1MHz	-16			dB
Channel-to-Channel Crosstalk			No Load, f_{SW}=1MHz	-41			dB
POWER CONSUMPTION							
Analog Operating Current (AVDD)	Static	I_{AVDD_ST}	AVDD=5V			1	uA
	Dynamic	I_{AVDD_DYN}	AVDD=5V, f_{SW}=1.25MHz (Note1), All switch On/Off operating simultaneously			50	mA
Digital Operating Current (DVDD)	Static	I_{DVDD_ST}	DVDD=3.3V			1	uA
	Dynamic	I_{DVDD_DYN}	DVDD=3.3V, f_{CLK}=10MHz (Note1), Combined operation of Reset, Group-On and DUT-Reject			400	uA

Note1 : The f_{CLK} is the frequency of digital signal CLK.

When the f_{CLK} is 10MHz, the maximum switching frequency (f_{SW}) is 1.25MHZ (1-clock command).

TIMING CHARACTERISTICS

AVDD=5.0V, AVSS=0V, DVDD=3.3V, DVSS=0V, and TA = +25°C, unless otherwise noted.

PARAMETER	SYMBOL	CONDITION	VALUE			UNIT
			MIN	TYP	MAX	
DIGITAL I/O SIGNALS						
CLK Period	t_{PERIOD}				20	ns
DATA to CLK Setup Time	t_{DS}		10			ns
DATA to CLK Hold Time	t_{DH}		5			ns
CSN to CLK Setup Time	t_{CS}		10			ns
CSN to CLK Hold Time	t_{CH}		5			ns
WRN to CLK Setup Time	t_{WS}		10			ns
WRN to CLK Hold Time	t_{WH}		5			ns
POWER AND RESET SEQUENCE						
Power-up Period	t_{PU}		500			us
Power-down Period	t_{PD}		500			us
Power-on Reset Time	t_{RST}		2			us
Chip-ID Read Routine Time	t_{IDRD}		2			us
SWITCH ON/OFF TIMING DIAGRAM						
Switch Control Enable Time	t_{SWEN}		1			us
1-Clock Command Control Time	t_{SW1}				3	cycle
2-Clock Command Control Time	t_{SW2}				6	cycle

Timing Diagram of Digital I/O Signals

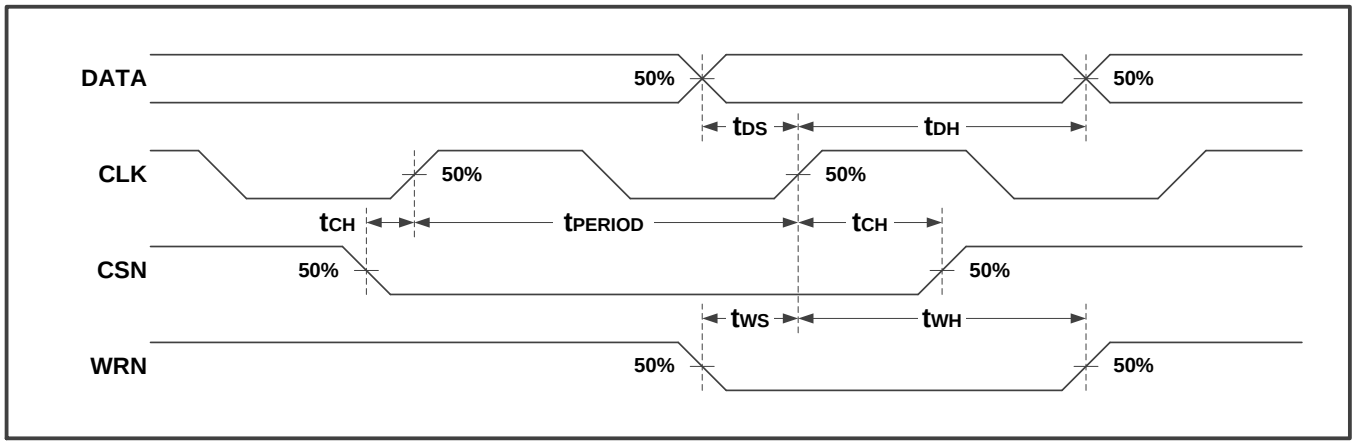


Figure 2. Timing Diagram of Digital Signals

Power and Reset sequence

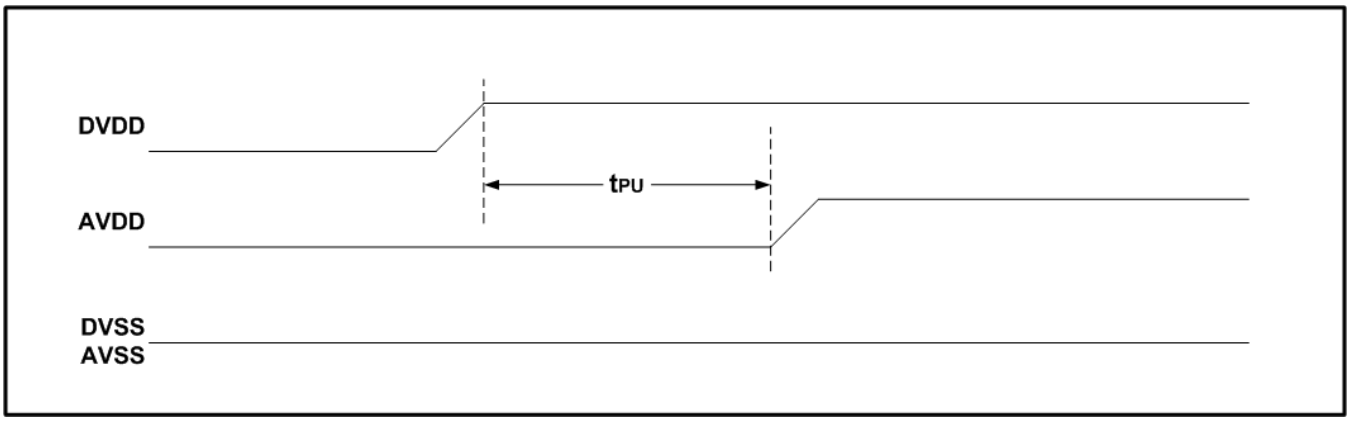


Figure 3. Power-up Sequence

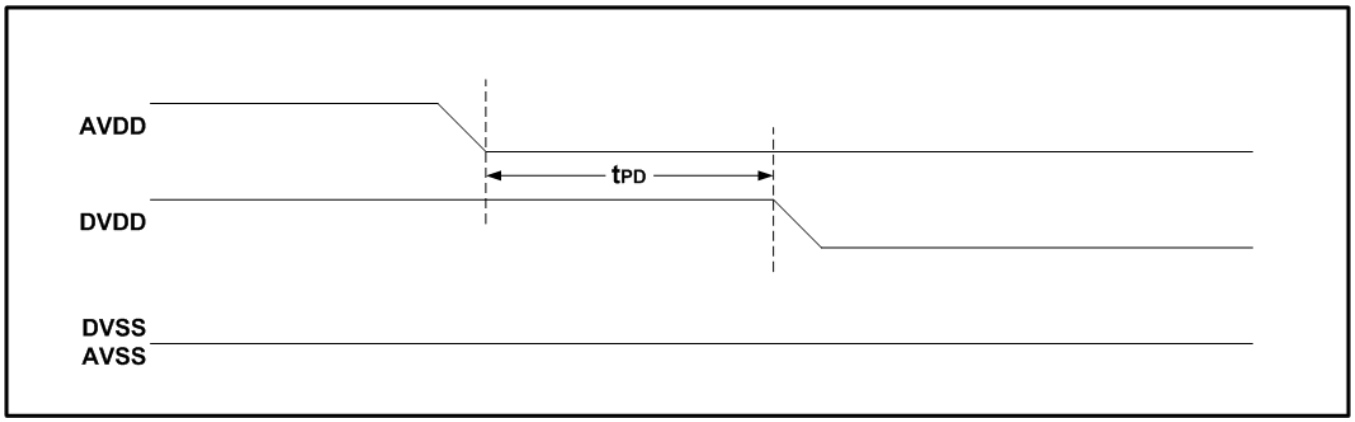


Figure 4. Power-down Sequence

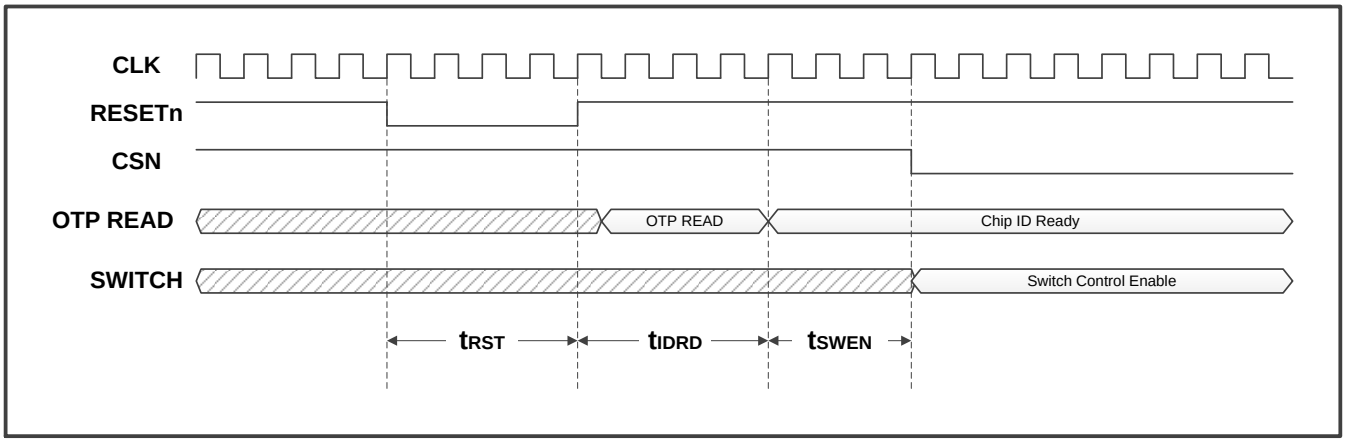


Figure 5. Reset and Stand-by Sequence

Switch On/Off Timing Diagram

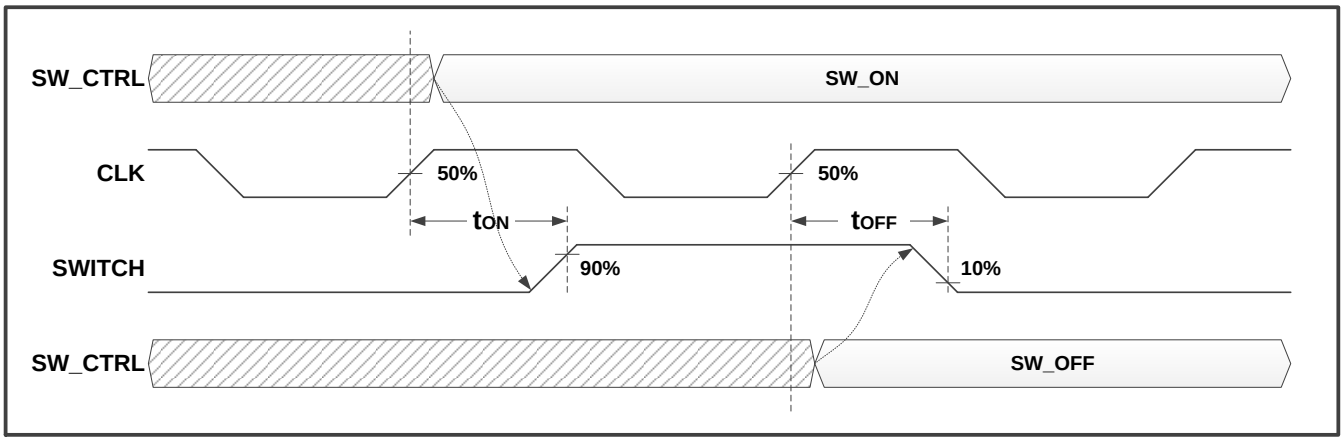


Figure 6. Switch On/Off Timing Diagram

PIN MAPPING TABLE

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
A	DATA[2]	DATA[1]	CLK	WRN	VPP	AOUT[60]	AIN[60]	AOUT[56]	AIN[56]	AOUT[52]	AIN[55]	AIN[54]	AIN[53]	AIN[52]	A
B	DATA[3]	DATA[0]	PAGE_UP	CSN	DVSS	AOUT[61]	AIN[61]	AOUT[57]	AIN[57]	AOUT[53]	AOUT[51]	AOUT[50]	AOUT[49]	AOUT[48]	B
C	DVDD	DVSS	TEST_IN	RSTN	DVDD	AOUT[62]	AIN[62]	AOUT[58]	AIN[58]	AOUT[54]	AIN[51]	AIN[50]	AIN[49]	AIN[48]	C
D	AVSS	AVDD	AVSS	AVSS	DVSS	AOUT[63]	AIN[63]	AOUT[59]	AIN[59]	AOUT[55]	AVSS	AVSS	AVDD	AVSS	D
E	AIN[0]	AIN[1]	AIN[2]	AIN[3]	AVDD	AVSS	AVSS	AVDD	AVSS	AVDD	AOUT[47]	AOUT[46]	AOUT[45]	AOUT[44]	E
F	AOUT[0]	AOUT[1]	AOUT[2]	AOUT[3]	AVSS					AVSS	AIN[47]	AIN[46]	AIN[45]	AIN[44]	F
G	AIN[4]	AIN[5]	AIN[6]	AIN[7]	AVDD					AVSS	AOUT[43]	AOUT[42]	AOUT[41]	AOUT[40]	G
H	AOUT[4]	AOUT[5]	AOUT[6]	AOUT[7]	AVSS					AVDD	AIN[43]	AIN[42]	AIN[41]	AIN[40]	H
J	AIN[8]	AIN[9]	AIN[10]	AIN[11]	AVSS					AVSS	AOUT[39]	AOUT[38]	AOUT[37]	AOUT[36]	J
K	AOUT[8]	AOUT[9]	AOUT[10]	AOUT[11]	AVDD	AVSS	AVDD	AVSS	AVSS	AVDD	AIN[39]	AIN[38]	AIN[37]	AIN[36]	K
L	AIN[12]	AIN[13]	AIN[14]	AIN[15]	AOUT[19]	AIN[23]	AOUT[23]	AIN[27]	AOUT[27]	AIN[31]	AOUT[31]	AVSS	AIN[35]	AOUT[35]	L
M	AOUT[12]	AOUT[13]	AOUT[14]	AOUT[15]	AOUT[18]	AIN[22]	AOUT[22]	AIN[26]	AOUT[26]	AIN[30]	AOUT[30]	AVSS	AIN[34]	AOUT[34]	M
N	AVSS	AVDD	AVSS	AVSS	AOUT[17]	AIN[21]	AOUT[21]	AIN[25]	AOUT[25]	AIN[29]	AOUT[29]	AVDD	AIN[33]	AOUT[33]	N
P	AIN[16]	AIN[17]	AIN[18]	AIN[19]	AOUT[16]	AIN[20]	AOUT[20]	AIN[24]	AOUT[24]	AIN[28]	AOUT[28]	AVSS	AIN[32]	AOUT[32]	P
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	

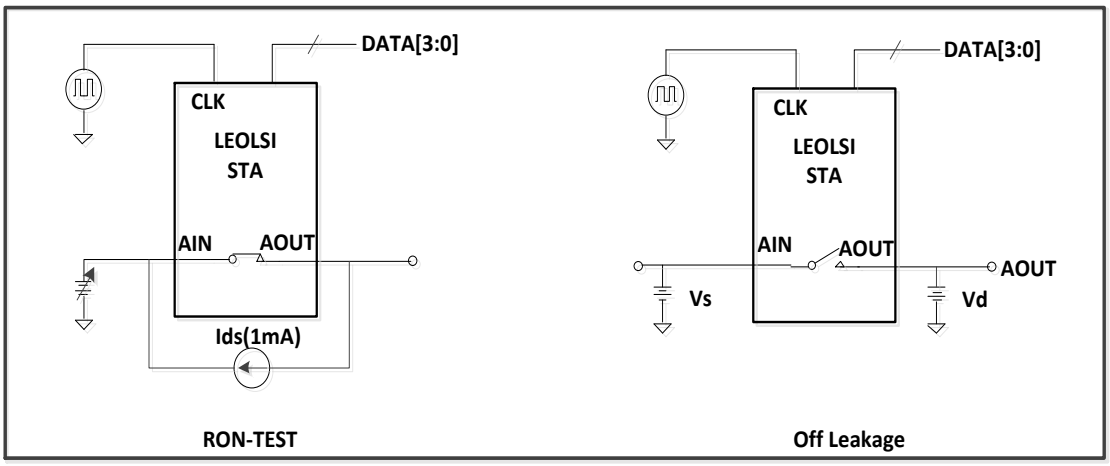
LSW9002
STA2
(Top View)

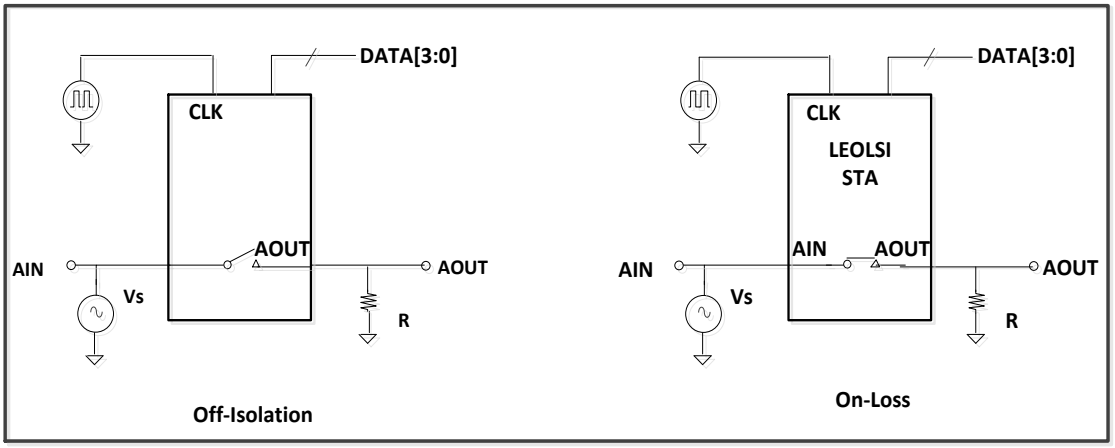
PIN DESCRIPTIONS

PIN NAME	I/O	Descriptions
CLK	DI	System clock
RSTN	DI	System reset. Active Low
CSN	DI	Chip select. Active Low
WRN	DI	Data write enable. Active Low
DATA[3:0]	DIO	Data bus
TEST_IN	DI	Tied to GND in Normal mode
PAGE_UP	DI	Tied to GND in Normal mode
VPP	PWR	Tied to GND in Normal mode
AIN[63:0]	AI	Analog switch input
AOUT[63:0]	AO	Analog switch output
AVDD	PWR	Analog Power
AVSS	GND	Analog Ground
DVDD	PWR	Digital Power
DVSS	GND	Digital Ground

AI: analog input **AO: analog output**
DI: digital Input **DIO: digital Input / Output**
PWR: power **GND: ground**

TEST CIRCUITS





Off isolation=20log(V_{AOUT}/V_{AIN}), On Loss=20log(V_{AOUT}/V_{AIN})

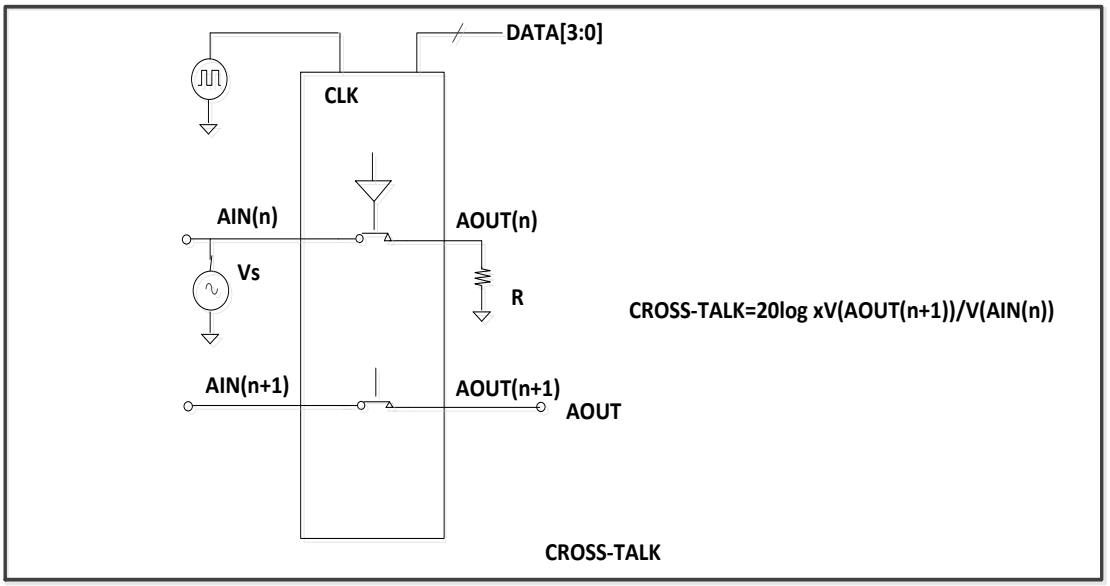
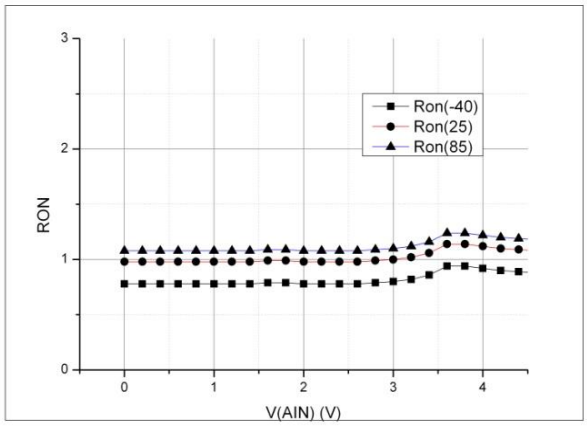
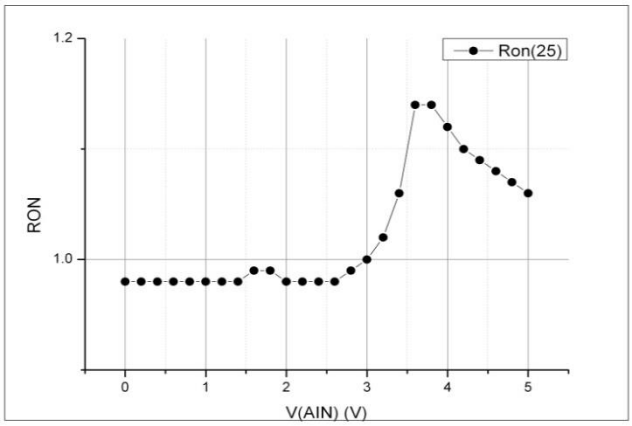


Figure 7. Test Circuits

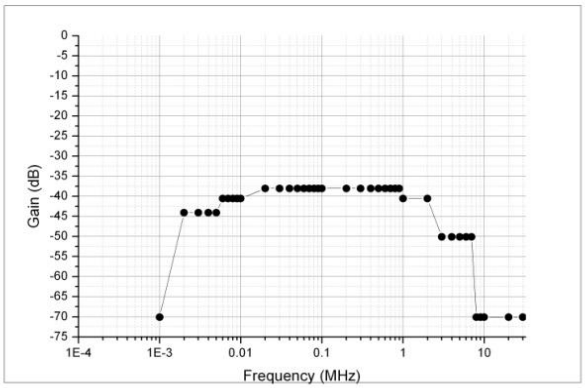
TEST RESULTS



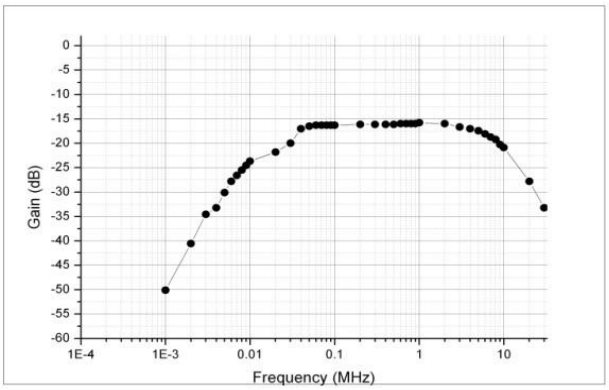
On-resistance vs. vain



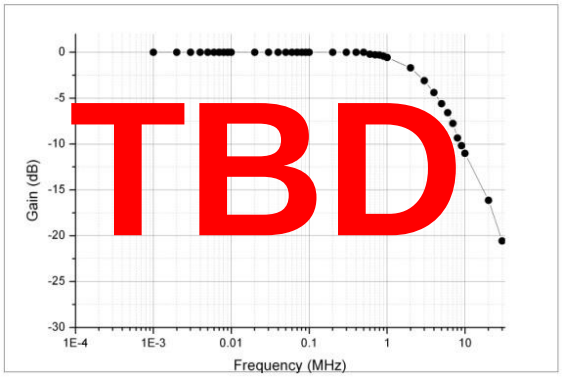
On-resistance(room temp) vs. vain



Cross talk vs. Frequency



Isolation vs. Frequency



On Loss vs. Frequency

Figure 8. Test Results

DETAIL DESCRIPTIONS

Definitions

The STA IC consists of 8 cores which consist of 8 switches, hence it has 64 switches. The device provides one Chip-ID and it can be programmed in internal OTP memory. On the other hand, the eight Core-IDs are fixed in the device. The internal switch structure is shown in Figure 9. The Channel-ID is implicated in user defined commands interpreted in Digital Interface section.

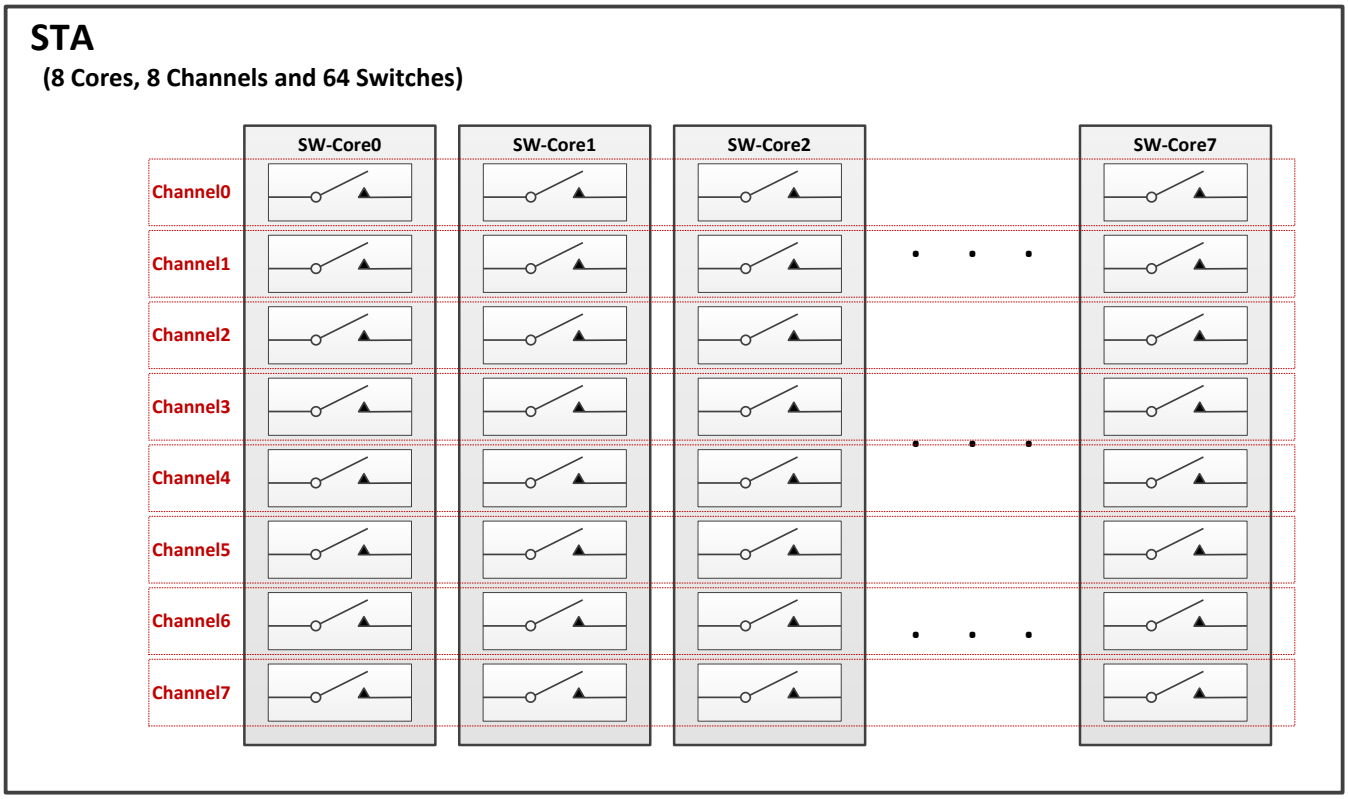


Figure 9. STA IC Internal Switch Structure and Definitions – Cores and Channels

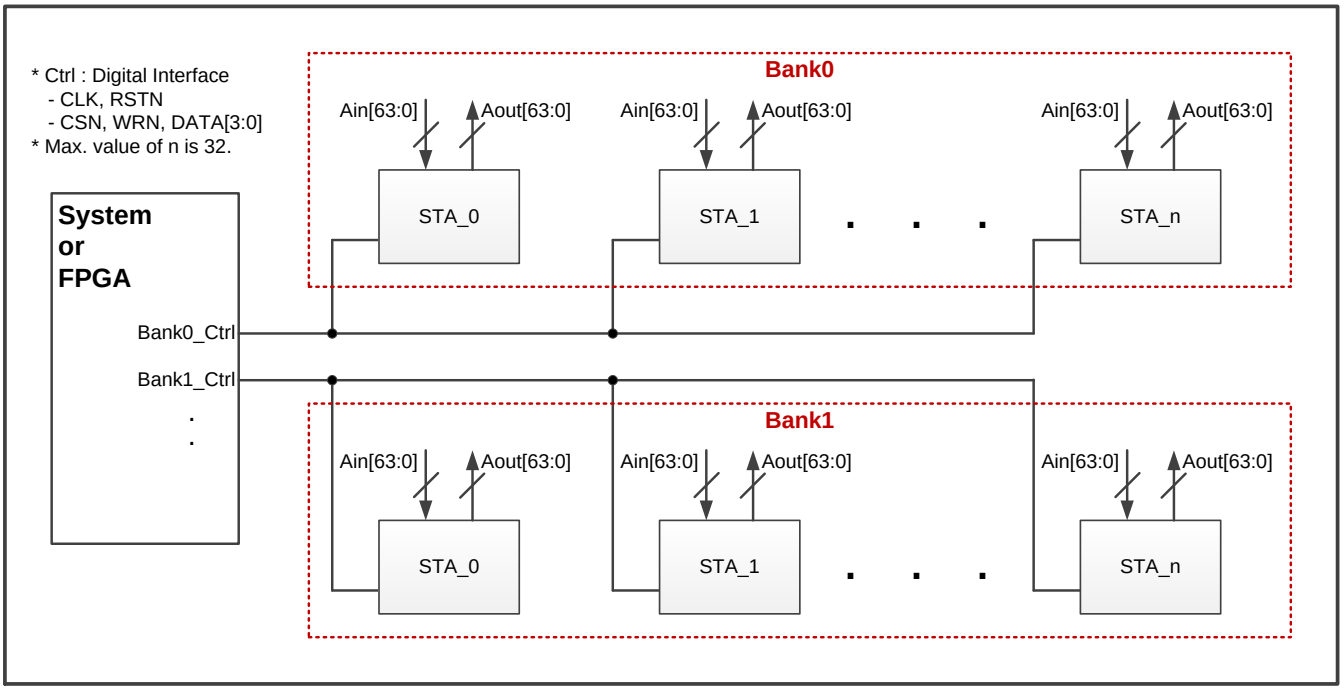


Figure 10. STA IC Application Structure and Definitions – Banks and Controls

In system application, two or more STA ICs can be controlled by the same digital interface - control and data signals such as CLK, RESETN, CSN, WRN and DATA[3:0] shown in Figure 10 and these STA IC network can be called as 'bank'. Because the Chip-ID is assigned in 5-bit address, the maximum number of STA IC in one bank is 32. Similarly, the Core-ID is assigned in 3-bit address hence 8 Cores are in one STA IC. The user can not apply the Chip-ID and the Core-ID to 1-clock command but to 2-clock command. Refer to Figure 12 and 13.

- ***Bank***

The bank means STA network connected by the same digital interface - control and data signals such as CLK, RESETN, CSN, WRN and DATA[3:0]. Refer to the Figure 10.

- ***Reject***

The individual switch control logic can be rejected from all commands. After entering reject state in which the switch is off, no command alters on/off state of rejected switch except the command 'INITIAL_ALL', 'CANCEL_REJECT' and external RSTN.

Digital Interface

- ***1-Clock Command***

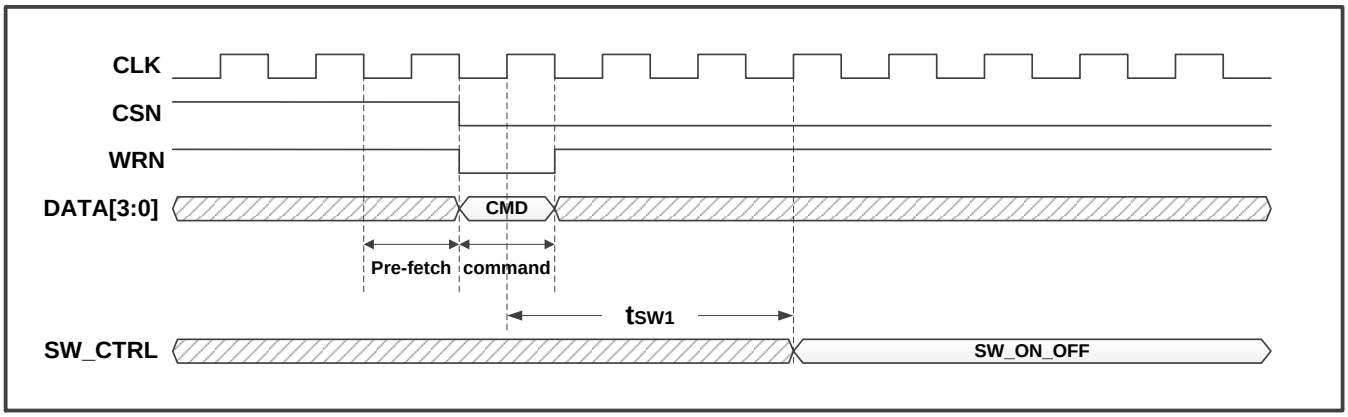


Figure 11. 1-Clock Command Control Timing Diagram

The 1-clock command is applied to all cores and all switches. Furthermore, this command is applied to all STA ICs in the same bank. The 'CMD' in Figure 11 means command which defines following modes:

Command	Value	Function
NORMAL	0x0	Returns to normal mode from Load mode (release all chip selection)
LOAD_ALL	0x1	Selects all chips to load(apply) the same commands
VIRTUAL	0x2	Programming mode for test
CLEAR_ALL	0x3	Makes all switches off
ENABLE_ALL	0x4	Makes all switches on
INITIAL_ALL	0x5	Initializes all switches releasing reject condition and making them on

- ***2-Clock Command***

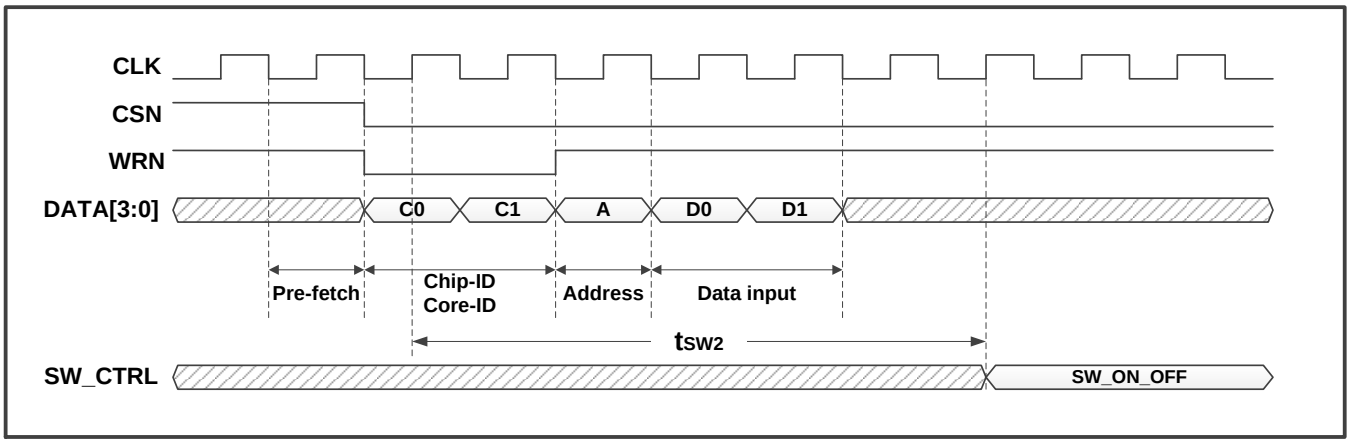


Figure 12. 2-Clock Command Control Timing Diagram

The '2-clock command' can control 8 Cores individually as well as simultaneously. Especially, the case of simultaneous 8 Core control can explain Channel-level switch control and it means that the users do not access Channel-ID directly.

In 2-clock command protocol, the signal DATA[3:0] can represent several items 'C0', 'C1', 'A', 'D0' and 'D1' shown in Figure 12 and these can be interpreted like as Figure 13.

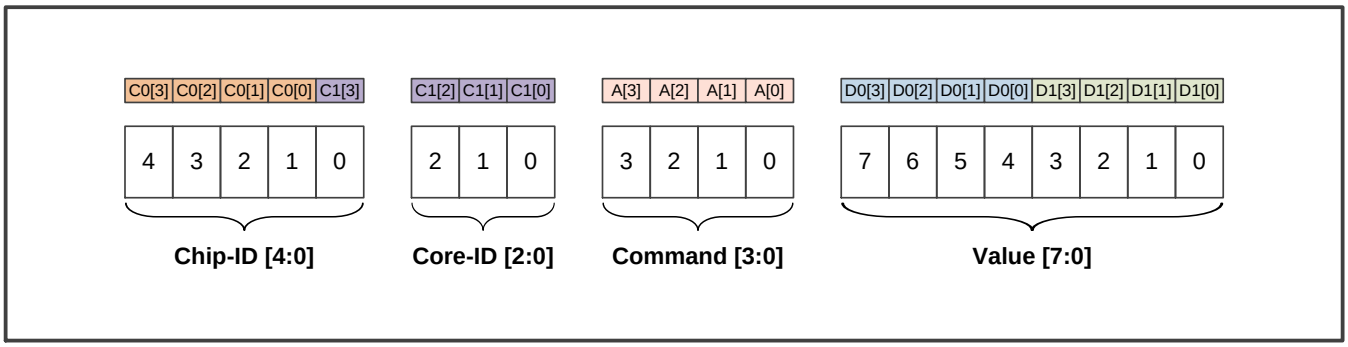


Figure 13. Interpretation of DATA[3:0] Signals in 2-Clock Command

The 'C0' and 'C1' are Chip-ID and Core-ID items and the address 'A' defines switch control Command. The Data 'D0' and 'D1' means the next state Value of 8 individual switches.

The 2-Clock command has three types of control.

- CHL(Chip-level) : applied to all chips in the same bank (both Chip-ID and Core-ID are ignored)
- CRL(Core-level) : applied to all cores of selected chip (Chip-ID is referred but Core-ID is ignored)
- SWL(Switch-level) : applied to selected switches of selected core (both Chip-ID and Core-ID are referred)

When the MSB of Command[3:0] is low, the Value[7:0] is applied to all Cores. Otherwise, the MSB of Command[3:0] is high, the Value[7:0] is applied to one Core selected by Core-ID[2:0].

The detail 2-Clock commands are given below.

Command	Value	Function	Remark
AND_CRL	0x0	Next switch status are produced by bitwise AND operation between current switch status and Data[7:0]. Applied to all cores of the selected chip.	CRL
OR_CRL	0x1	Next switch status are produced by bitwise OR operation between current switch status and Data[7:0]]. Applied to all cores of the selected chip.	CRL
DIRECT_CRL	0x2	Next switch status are produced by Data[7:0] directly. Applied to all cores of the selected chip.	CRL
DIRECT_CHL	0x3	Next switch status are produced by Data[7:0] directly. Applied to all cores of all chips in the same bank.	CHL
REJECT_CRL	0x4	Reject all switches of selected core by bitwise AND operation between current core reject status and Data[7:0].	CRL
-	0x5	Reserved	-
-	0x6	Reserved	-
-	0x7	Reserved	
AND_SWL	0x8	Next switch status are produced by bitwise AND operation between current switch status and Data[7:0]. Applied to the selected core.	SWL
OR_SWL	0x9	Next switch status are produced by bitwise OR operation between current switch status and Data[7:0] . Applied to the selected core.	SWL
DIRECT _SWL	0xa	Next switch status are produced by Data[7:0] directly. Applied to the selected core.	SWL
-	0xb	Reserved	-
REJECT _SWL	0xc	Reject selected switch by bitwise AND operation between current switch reject status and Data[7:0]	SWL
CANCEL_RJT	0xd	Cancel all switch-reject of selected core	-
-	0xe	Reserved	-
-	0xf	Reserved	-

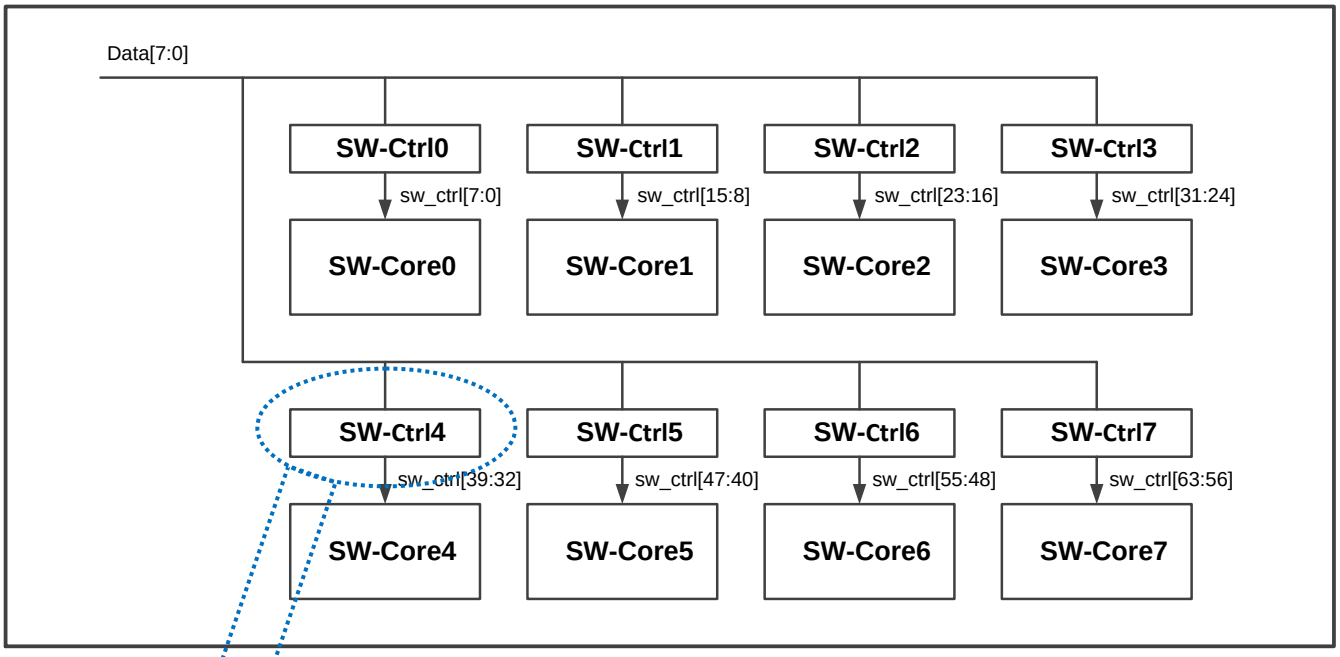


Figure 14. Switch Control Structure for 2-Clock Command

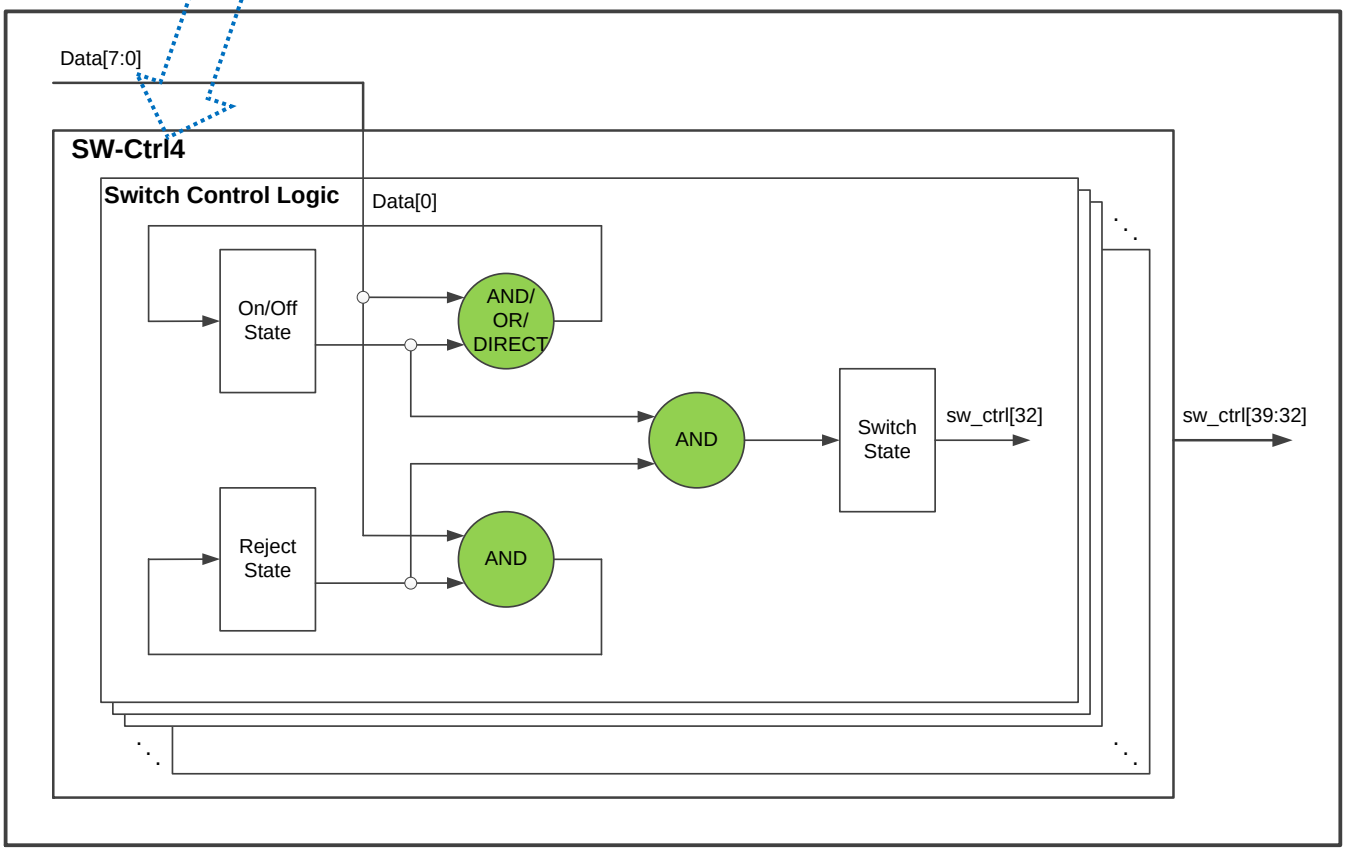


Figure 15. Basic Concept of 2-Clock Command Switch Control

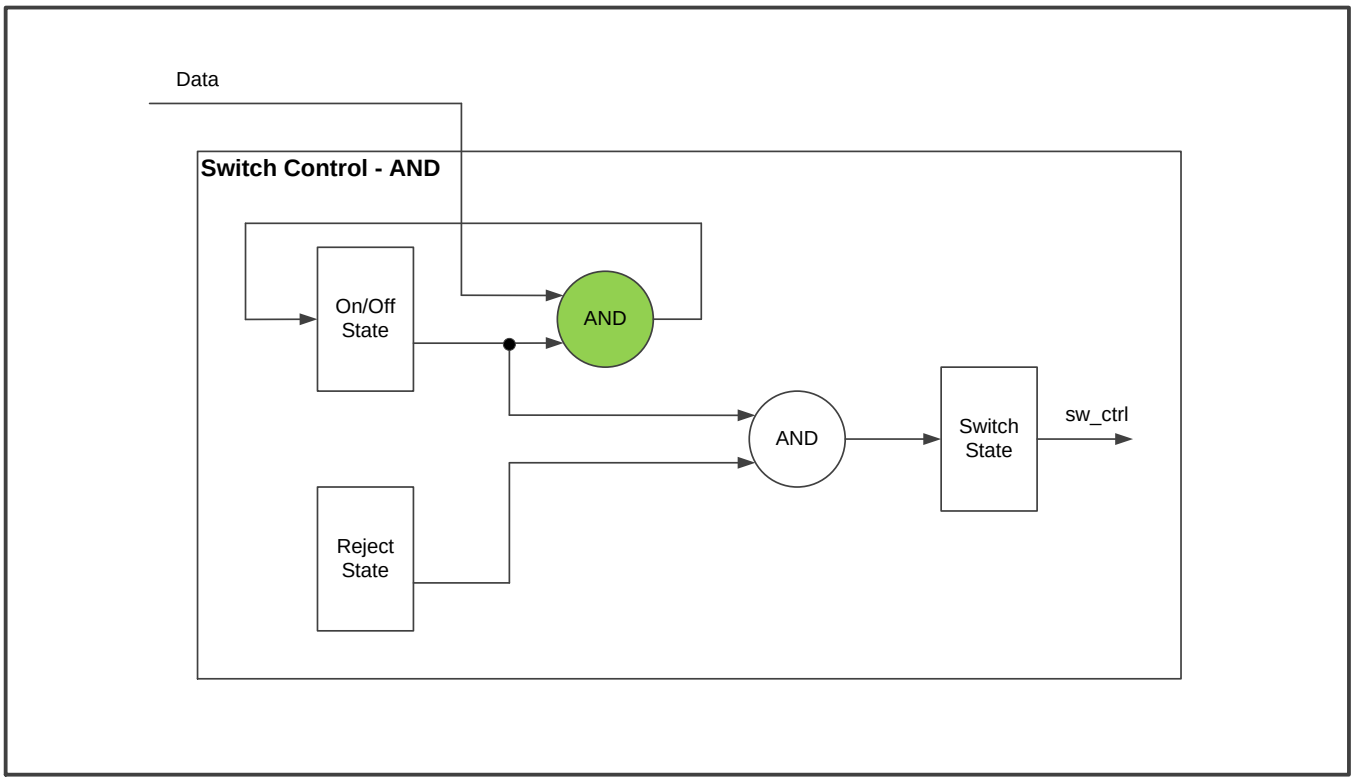


Figure 16. 2-Clock Command Switch Control - AND

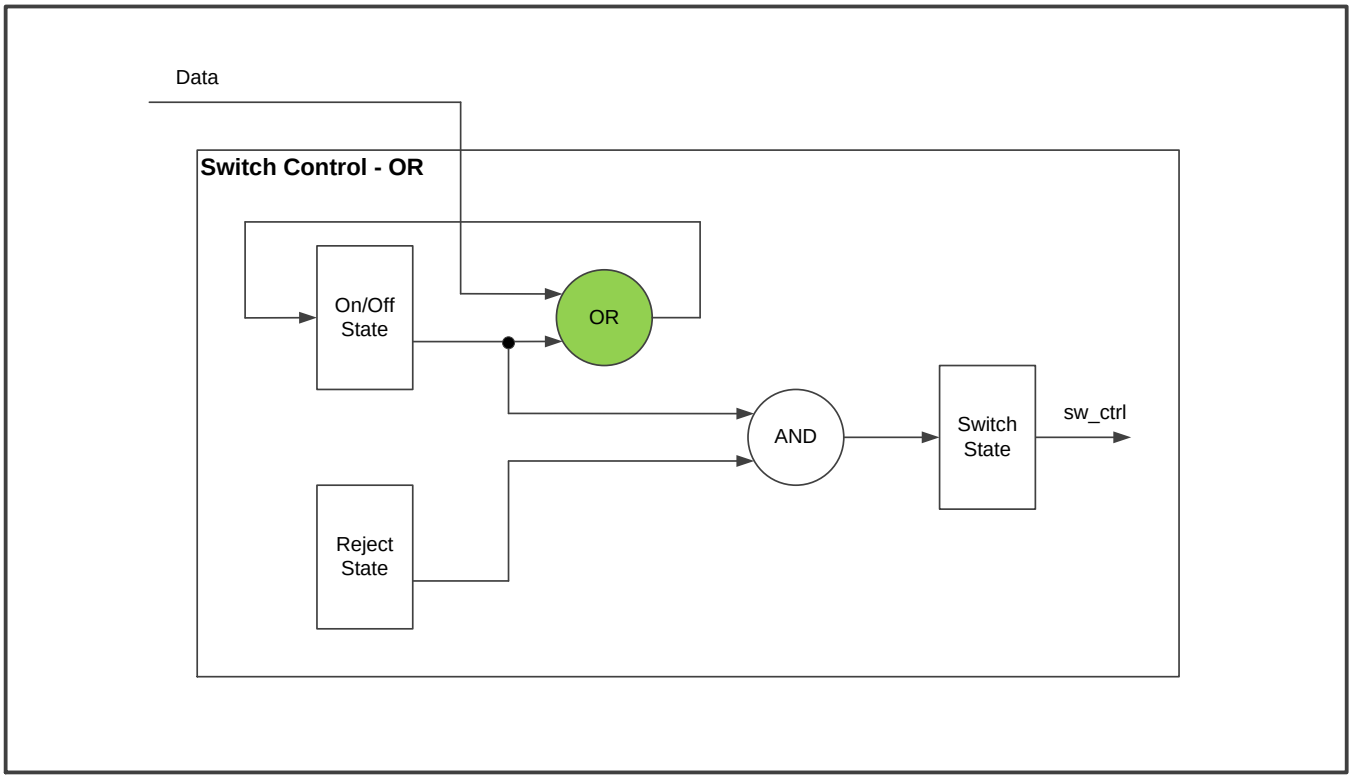


Figure 17. 2-Clock Command Switch Control - OR

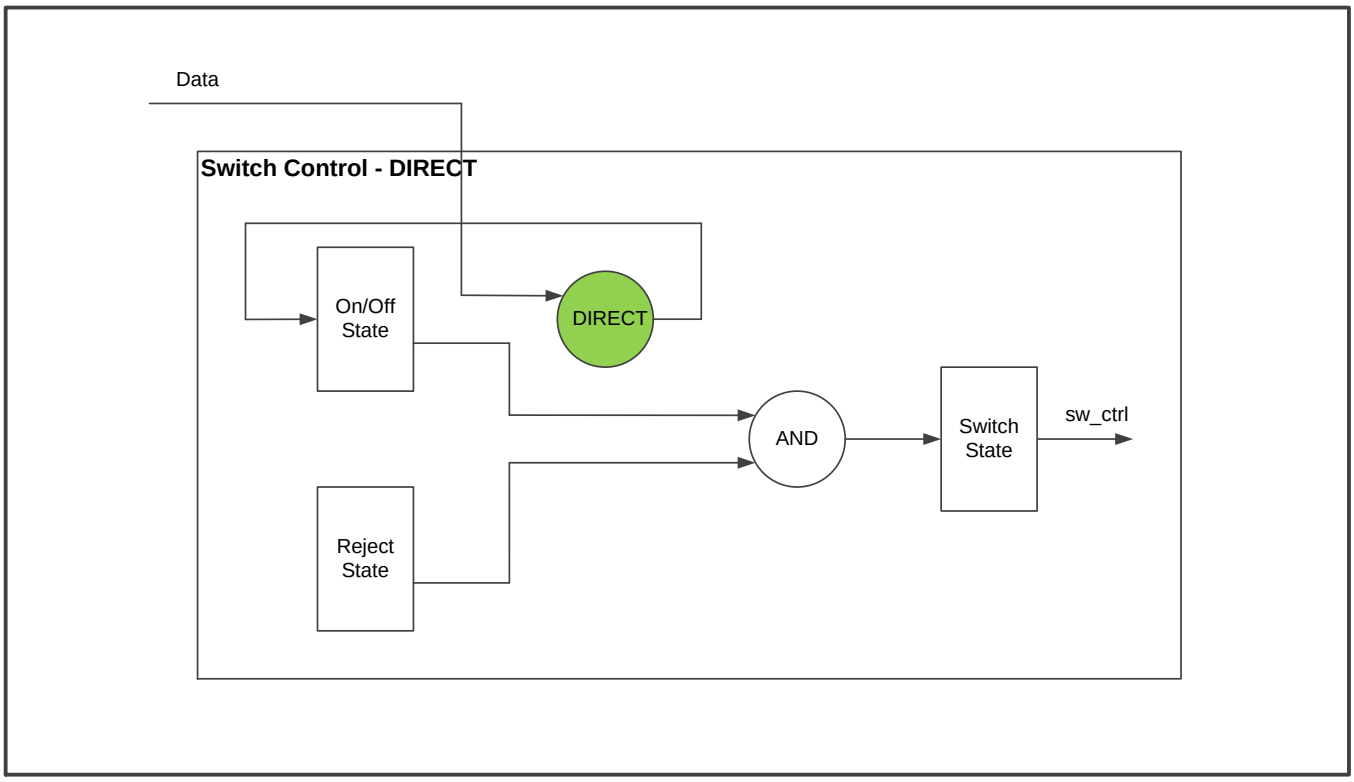


Figure 18. 2-Clock Command Switch Control - DIRECT

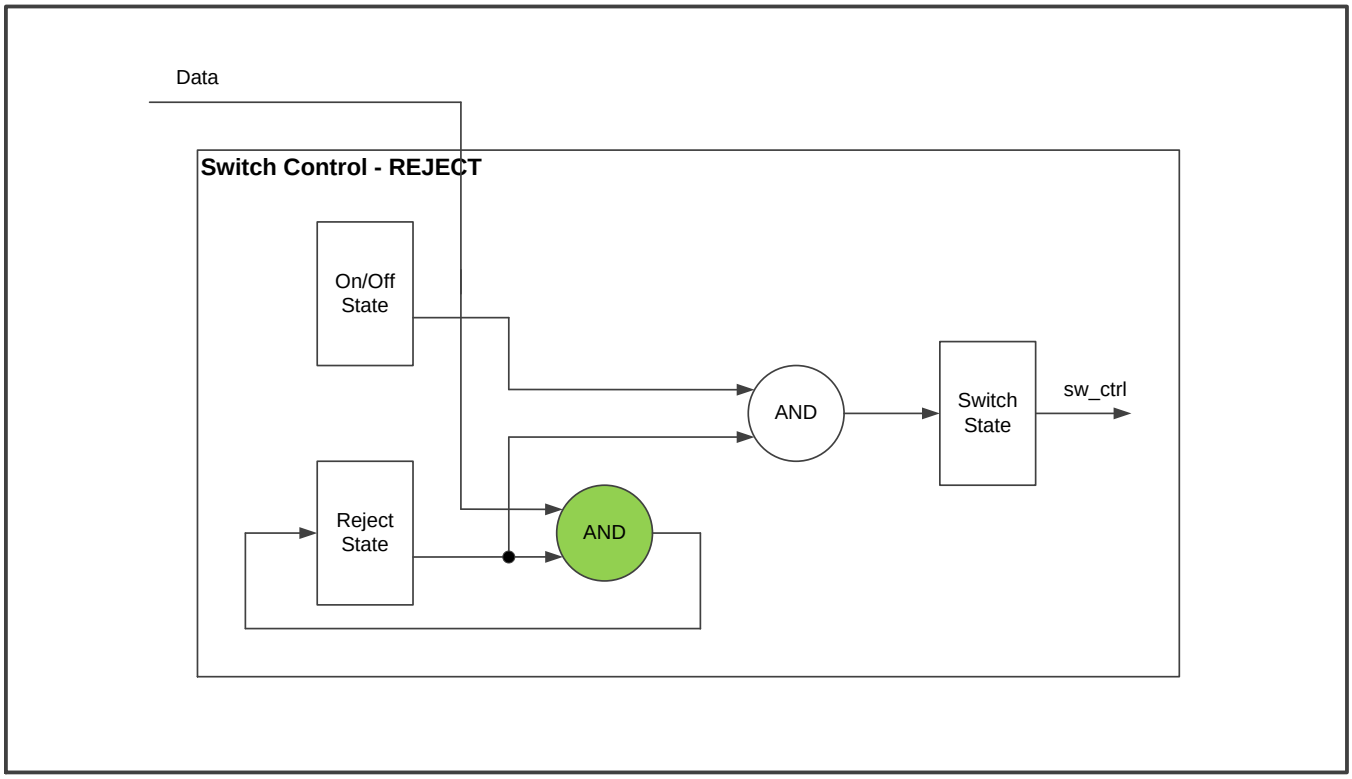


Figure 19. 2-Clock Command Switch Control - REJECT

APPLICATION EXAMPLE

The STA IC receives serial input data synchronized with a clock signal.
Most of all, to achieve maximum control speed in PCB, simulation using IBIS model should be carried out.

1. TEST_IN, PAGE_UP and VPP pins should be connected to ground through 20-kΩ (pull-down) resistor.
2. CSN pin should be connected to digital power through 20-kΩ (pull-up) resistor.
3. To guarantee the control speed, any resistor or capacitor should not be connected to CLK and DATA pins.
4. 10uF and 0.1uF decoupling capacitors should be connected to between AVDD and AVSS, and the same capacitors to between DVSS and DVSS.

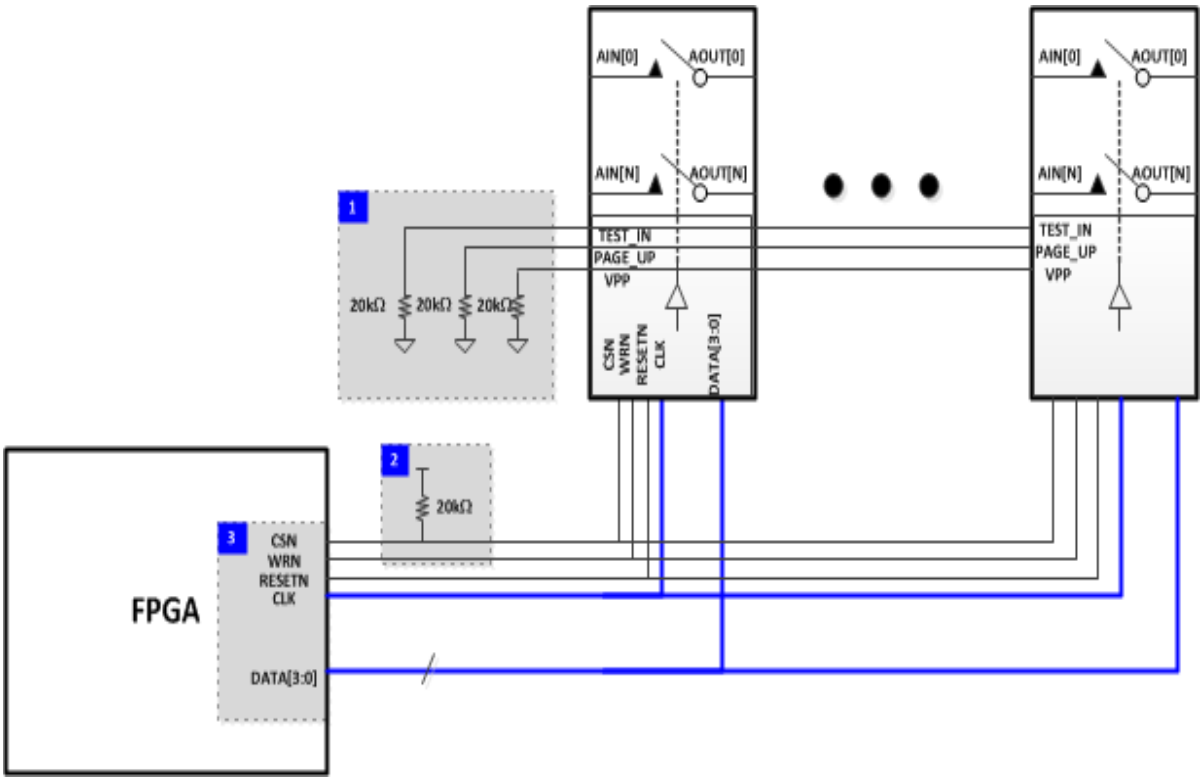
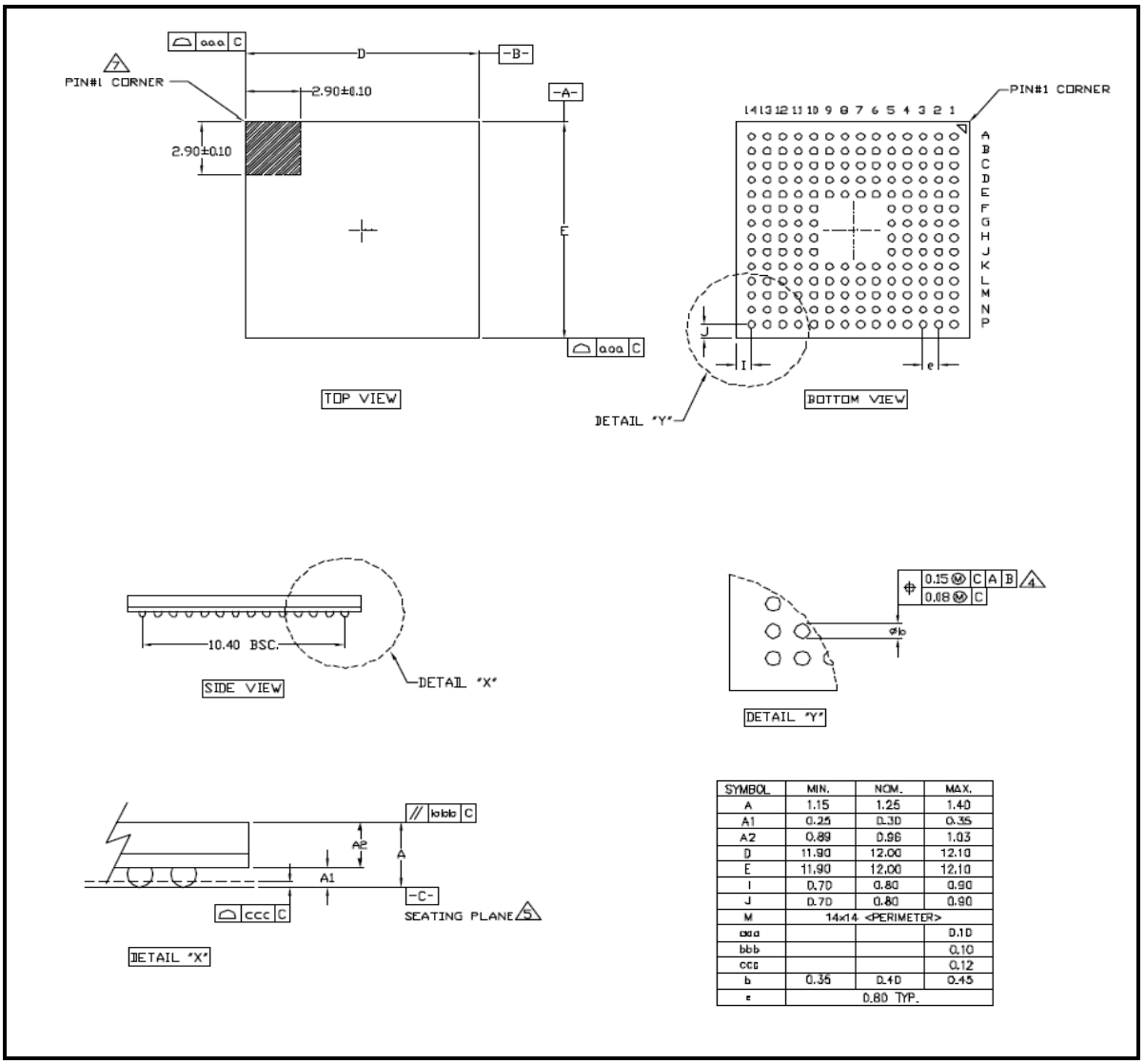


Figure 20. Application Example of PCB design

PACKAGE INFORMATION



SYMBOL	MIN.	NOM.	MAX.
A	1.15	1.25	1.40
A1	0.25	0.30	0.35
A2	0.89	0.95	1.03
D	11.90	12.00	12.10
E	11.90	12.00	12.10
I	0.70	0.80	0.90
J	0.70	0.80	0.90
M	14x14 <PERIMETER>		
aaa			0.10
bbb			0.10
ccc			0.12
b	0.35	0.40	0.45
e	0.80 TYP.		

REVISION HISTORY

Revision	Date	Description
0.0	2012-06	Initial draft
1.0	2013-11	Revised format
1.1	2014-03	Gain loss graph in figure 8 was changed as TBD.
1.2	2014-06	AVSS power up sequence
1.3	2015-04	Decoupling capacitors for AVDD-AVSS and DVDD-DVSS

DOCUMENT INFORMATION

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Product code: STA2
Product description: Analog Switch IC
Document revision: 1.3
Revision date: 2015-04

The world is driven by analog

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