ASMEDIA TECHNOLOGY INC

ASM1166 SATA Host Controller Datasheet

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Environmentally hazardous materials are not used in this product.

Revision History

Rev.	Date	Description
0.1	May 2, 2019	First release
0.2	July 8, 2019	Fix pin description
0.3	Aug 27, 2019	1. Add strapping information in pin description 2. Change strapping pin note 3. Fix UPE_CLK* to PECLK* 4. Add chip temperature information 5. Add chip power consumption data

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1. Introduction

ASM1166, a SATA host controller(AHCI) with upstream PCIe Gen3 x2 and downstream six SATA Gen3 ports. It's a low latency, low cost and low power AHCI controller. With six SATA ports and cascaded port multipliers, ASM1166 can enable users to build up various high speed IO systems, including server, high capacity system storage or surveillance platforms.

1.1 Features of ASM1166

PCIe interface

- 1-, 2- lane PCIe® connecting with root port
- Automatic detection of lane configuration on boot-up
- Supporting transfer rate of 2.5Gb(250MB/s), 5Gb(500MB/s) or 8Gb(1GB/s) per lane
- Support L0s/L1/L23/L3 power saving states
- Support L1 substate deep power saving mode
- Support LTR
- Support AER
- Support SRIS
- Max Payload Size = 512Byte

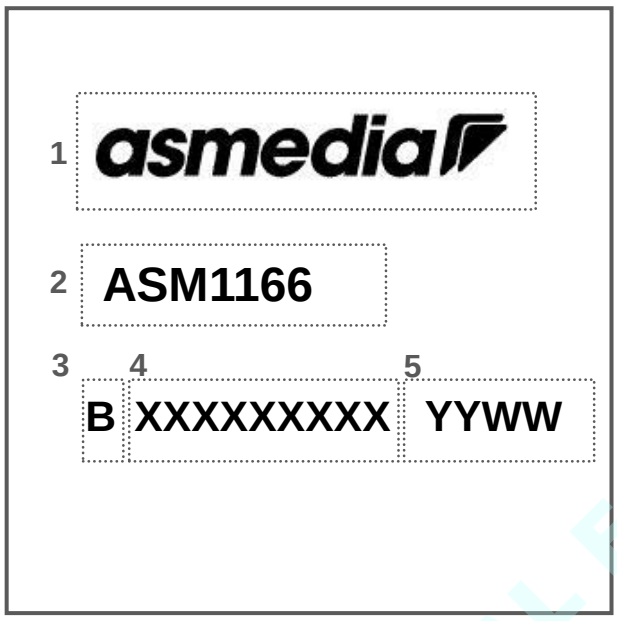
SATA interface

- AHCI SPEC Rev. 1.4
- Six SATA Gen3 (6GBps) ports
- Support NCQ
- Support SATA LED
- Supported port multiplier command based switching
- Support Partial/Slumber power management
- Support Device Sleep power management

General Features

- 25MHz Crystal
- Support SSC for both PCIe and SATA
- GPIO for extra IO control
- Package type: 10x10 QFN88

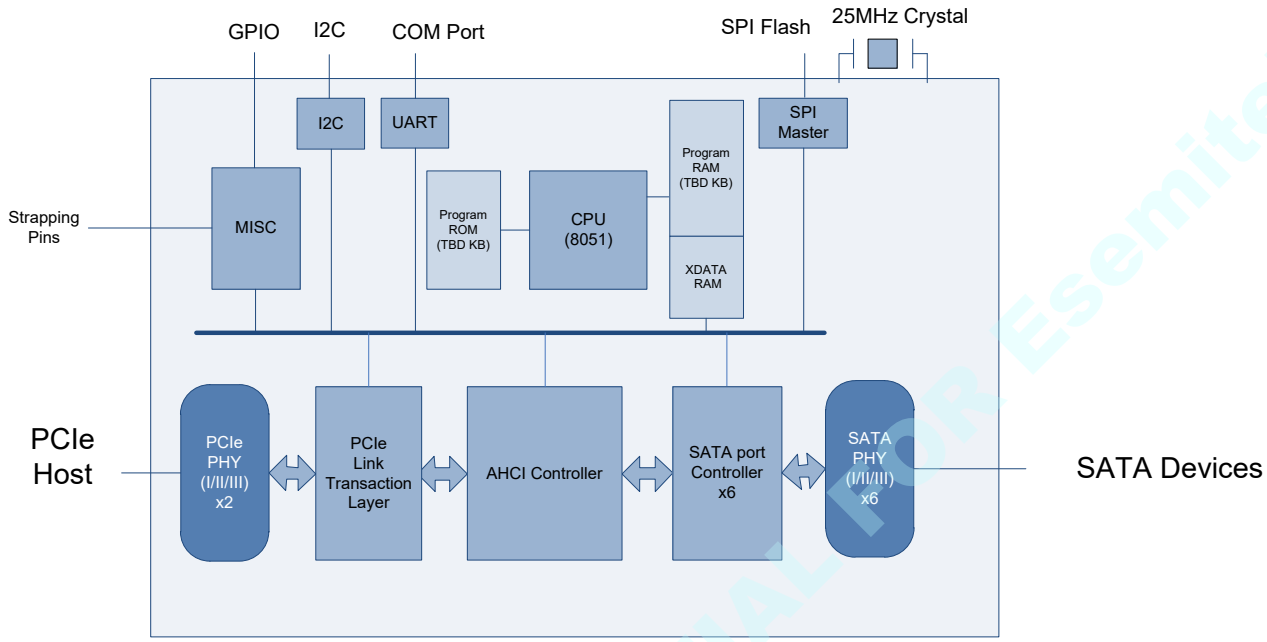
1.2 Branding and Part Number



1. asmedia: ASMedia Logo
2. ASM1166: Product Name
3. B: Version of ASMedia Logo
4. XXXXXXXXX: Serial No. Reserved for Vendor
5. YYWW: Date Code

1.3 ASM1166 Block Diagram

Figure 1 ASM1166 Block Diagram



2. Function Description

2.1 SATA port/LED/DEVSLP mapping

Table 1 SATA port / LED / DEVSLP mapping

SATA port	LED	DEVSLP
ST(R)XP(N)0	LED_S0	DEVSLP0
ST(R)XP(N)1	LED_S1	DEVSLP1
ST(R)XP(N)2	LED_S2	DEVSLP2
ST(R)XP(N)3	LED_S3	DEVSLP3
ST(R)XP(N)4	LED_S4	DEVSLP4
ST(R)XP(N)5	LED_S5	DEVSLP5

3. Pin Assignment

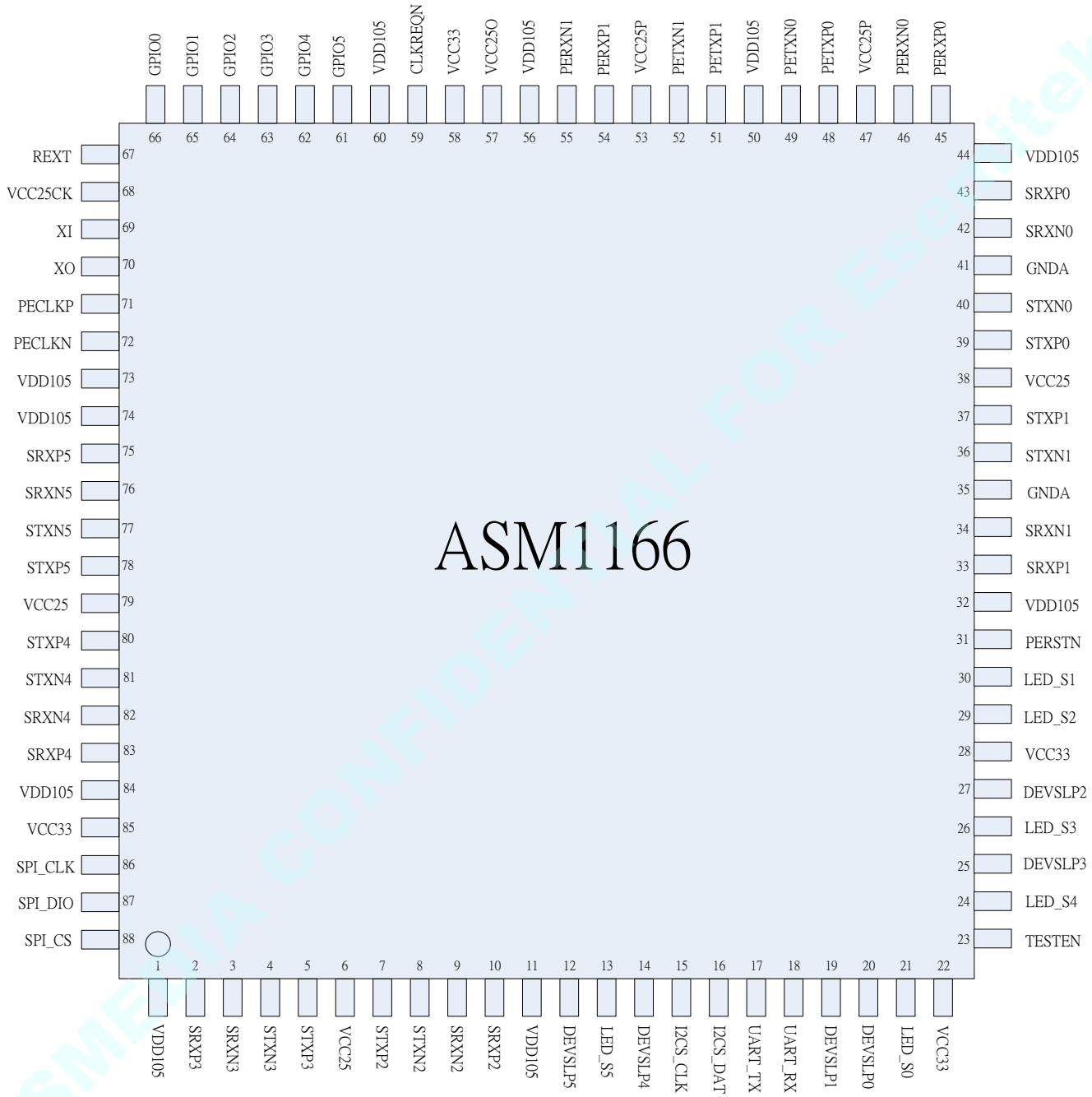


Figure 2 Pin Assignment

4. Pin Descriptions

4.1 Upstream PCI Express ® Interface

Table 2 Upstream Interface

Pin Name	Pin No.	Type	Voltage	Functional Description
PERXP0	45	A-I	VDD105 VCC25	Upstream PCIe® Lane 0 Receive positive
PERXN0	46	A-I		Upstream PCIe® Lane 0 Receive negative
PERXP1	54	A-I		Upstream PCIe® Lane 1 Receive positive
PERXN1	55	A-I		Upstream PCIe® Lane 1 Receive negative
PETXP0	48	A-O		Upstream PCIe® Lane 0 Transmit positive
PETXN0	49	A-O		Upstream PCIe® Lane 0 Transmit negative
PETXP1	51	A-O		Upstream PCIe® Lane 1 Transmit positive
PETXN1	52	A-O		Upstream PCIe® Lane 1 Transmit negative
PECLKP	71	A-I		PCIe® clock input positive
PECLKN	72	A-I		PCIe® clock input negative
CLKREQN	59	OD	VCC33	PCIe® clock request
PERSTN	31	I	VCC33	PCIe® reset
REXT	67	A-I	VCC25	External Reference Resistor with 12.1K ohm to GND for PCI Express

4.2 Downstream SATA Interface

Table 3 Downstream SATA Interface

Pin Name	Pin No.	Type	Voltage	Functional Description
SRXP0	43	A-I	VDD105 VCC25	SATA Port 0 Receive positive
SRXN0	42	A-I		SATA Port 0 Receive negative
STXP0	39	A-O		SATA Port 0 Transmit positive
STXN0	40	A-O		SATA Port 0 Transmit negative
SRXP1	33	A-I		SATA Port 1 Receive positive
SRXN1	34	A-I		SATA Port 1 Receive negative
STXP1	37	A-O		SATA Port 1 Transmit positive
STXN1	36	A-O		SATA Port 1 Transmit negative
SRXP2	10	A-I		SATA Port 2 Receive positive
SRXN2	9	A-I		SATA Port 2 Receive negative
STXP2	7	A-O		SATA Port 2 Transmit positive
STXN2	8	A-O		SATA Port 2 Transmit negative
SRXP3	2	A-I		SATA Port 3 Receive positive
SRXN3	3	A-I		SATA Port 3 Receive negative
STXP3	5	A-O		SATA Port 3 Transmit positive
STXN3	4	A-O		SATA Port 3 Transmit negative
SRXP4	83	A-I		SATA Port 4 Receive positive
SRXN4	82	A-I		SATA Port 4 Receive negative
STXP4	80	A-O		SATA Port 4 Transmit positive
STXN4	81	A-O		SATA Port 4 Transmit negative
SRXP5	75	A-I		SATA Port 5 Receive positive
SRXN5	76	A-I		SATA Port 5 Receive negative
STXP5	78	A-O		SATA Port 5 Transmit positive
STXN5	77	A-O		SATA Port 5 Transmit negative
LED_S0	21	OD	VCC33	SATA Port 0 LED
LED_S1	30	OD		SATA Port 1 LED
LED_S2	29	OD		SATA Port 2 LED

LED_S3	26	OD		SATA Port 3 LED
LED_S4	24	OD		SATA Port 4 LED
LED_S5	13	OD		SATA Port 5 LED
DEVSLP0	20	I/O		SATA Port 0 Device Sleep / GPIO
DEVSLP1	19	I/O		SATA Port 1 Device Sleep / GPIO
DEVSLP2	27	I/O		SATA Port 2 Device Sleep / GPIO
DEVSLP3	25	I/O		SATA Port 3 Device Sleep / GPIO
DEVSLP4	14	I/O		SATA Port 4 Device Sleep / GPIO
DEVSLP5	12	I/O		SATA Port 5 Device Sleep / GPIO

4.3 Miscellaneous Pins

Table 4 Miscellaneous Pins

Pin Name	Pin No.	Type	Voltage	Functional Description
TESTEN	23	I	VCC33	Test enable
UART_TX	17	O		UART Transmit /test purpose (Strapping of SRIS mode, SRIS_EN#)
UART_RX	18	I		UART Receive
SPI_SDIO	87	I/O		SPI Interface, Data in/out (Strapping of SATA SSC enable, SSSC_EN)
SPI_CLK	86	I/O		SPI Interface, Clock (Strapping of PCIe SSC enable, PSSC_EN)
SPI_CS	88	O		SPI Interface, Chip Select
I2CS_CLK	15	I/O		I2C clock
I2CS_DAT	16	I/O		I2C data
XI	69	I		Crystal in
XO	70	O		Crystal out
GPIO0	66	I/O		General Purpose Input/Output 0
GPIO1	65	I/O		General Purpose Input/Output 1
GPIO2	64	I/O		General Purpose Input/Output 2
GPIO3	63	I/O		General Purpose Input/Output 3
GPIO4	62	I/O		General Purpose Input/Output 4
GPIO5	61	I/O		General Purpose Input/Output 5

4.4 Power/Ground Pins

Table 5 Power/Ground Pins

Pin Name	Pin No.	Voltage/GND	Description
VCC25	6, 38, 79	2.5V	PHY power (PCIe)
VCC25P	47, 53	2.5V	PHY power (SATA)
VCC25CK	68	2.5V	PHY power (Clock Gen)
VCC25O	57	2.5V	LDO power output
VCC33	22, 28, 58, 85	3.3V	Digital IO Power
VDD105	1, 11, 32, 44, 50, 56, 60, 73, 74, 84	1.05V	Core Logic Power
GNDA	35, 41	Ground	Chip Ground

4.5 Strap Information

Table 6 Strap Information

Strapping pins	Function
TESTEN	Test mode enable 1: Test mode 0: Function mode
SRIS_EN#	SRIS mode 1: SRIS mode disable 0: SRIS mode enable
PSSC_EN	PCIe SSC enable 1: PCIe SSC enable 0: PCIe SSC disable
SSSC_EN	SATA SSC enable 1: SATA SSC enable 0: SATA SSC disable

Note: PSSC_EN is available only when SRISP_EN# = 1'b0. If SRISP_EN# = 1'b1, PCIe SSC follows 100MHz clock source.

Strap timing requirement

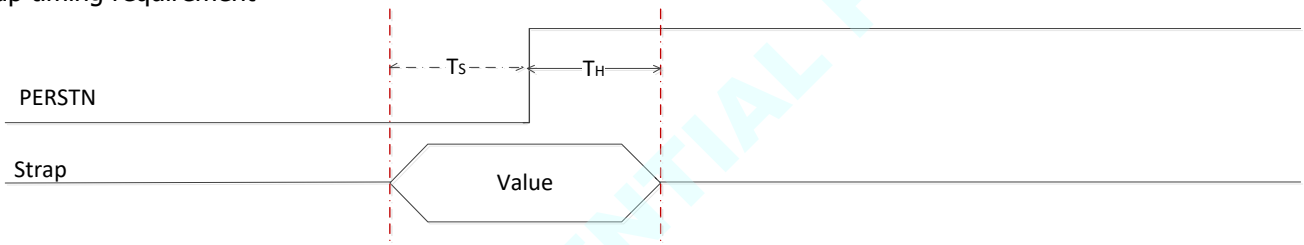


Figure 3 Strap timing diagram

Table 7 Strap timing requirement

	Parameter	Min	Max	Unit
Ts	Setup time for capture	1		ms
TH	Hold time for capture	1		ms

5. Power Sequence and Timing

Power up & Power down sequence

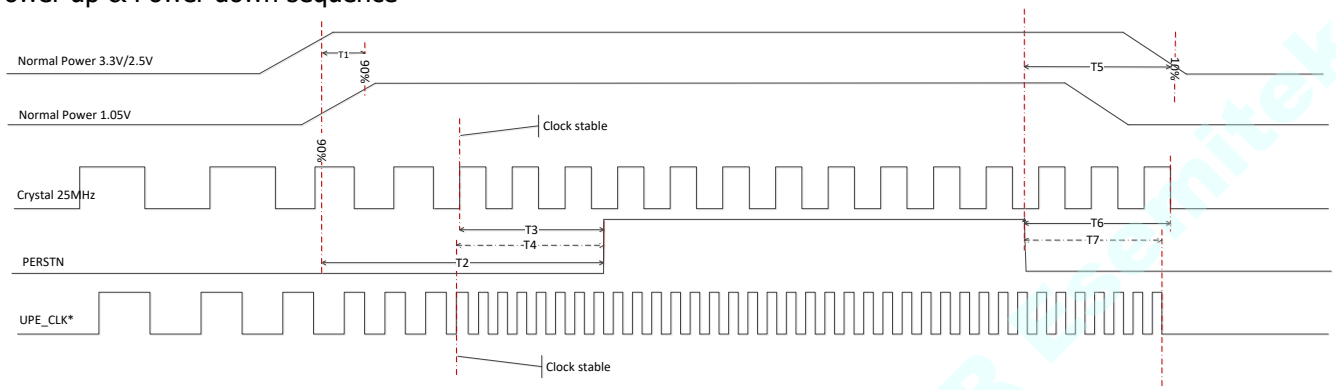


Figure 4 Power Sequence

Table 8 Power Sequence Timing

Symbol	Minimum	Maximum	Description
T1	0us	20ms	Normal power 3.3V/2.5V to Normal power 1.05V
T2	100ms		Normal power 3.3V/2.5V to PERSTN deassert
T3	1ms		Crystal stable to PERSTN deassert
T4	100us		UPE_CLK* stable to PERSTN deassert
T5	1us		PERSTN asserted to Normal power off
T6	0us		PERSTN assert to Crystal off
T7	0us		PERSTN assert to UPE clock off

6. Electrical Characteristic

6.1 Power Rail Specification

6.1.1 Absolute Maximum Ratings

Table 9 Absolute Maximum Ratings

Parameter	Range	Unit
Power Supply for Core Power	-0.5 ~ VDD105 +0.5	V
Power Supply for PHY Power	-0.5 ~ VCC25 +0.5	V
Power Supply for IO Power	-0.5 ~ VCC33 +0.5	V
DC Input Voltage for IO	-0.5 ~ VCC33 +0.5	V
Output Voltage for IO	-0.5 ~ VCC33 +0.5	V
Storage Temperature	JEDEC J-STD-033B MSL 3	
HBM ESD	+/-4KV	
MM ESD	+/-200V	

6.1.2 Recommended Operating Conditions

Table 10 Recommanded Operating Conditions

Symbols	Parameter	Min.	Typ.	Max.	Units
VCC33	Normal Power Supply	3.0	3.3	3.6	V
VCC25	Normal Power Supply	2.25	2.5	2.75	V
VDD105	Normal Power Supply	1.00	1.05	1.1	V
VSUS33	Suspend Power Supply	3.0	3.3	3.6	V
VSUS105	Suspend Power Supply	1.00	1.05	1.1	V
Tj	Operating Junction Temperature	0	25	90	ºC
Tc	Opertating Case Temperature	0	25	85	ºC

6.2 DC Characteristic

Table 11 Electrical Characteristic of Digital Pins (GPIO, Miscellaneous)

Symbols	Parameter	Min.	Typ.	Max.	Units	Remark
V_{IH}	Input High Level	2			V	
V_{IL}	Input Low Level			0.8	V	
V_{HYS}	Input Hysteresis	0.32	0.37	0.4	V	
V_{TH-L2H}	VTH of Schmitt Trigger low to high	1.4	1.6	1.8	V	
V_{TH-H2L}	VTH of Schmitt Trigger high to low	1	1.23	1.4	V	
R_{UP}	Internal Pull-up resistance while Vin=0V	65	96	140	KΩ	
	Internal Pull-up resistance while Vin=VCCH/2 V	38	56	81	KΩ	
I_{IL-UP}	Input pull-up leakage current while Vin=0V	21	34.4	56	uA	
	Input pull-up leakage current while Vin=VCCH/2 V	18	29.4	47	uA	
R_{DOWN}	Internal Pull-down resistance while Vin=0V	59	96	142	KΩ	
	Internal Pull-down resistance while Vin=VCCH/2 V	35	55	79	KΩ	
$I_{IL-DOWN}$	Input pull-down leakage current while Vin=0V	21	34.5	60	uA	
	Input pull-down leakage current while Vin=VCCH/2 V	18	30	50	uA	
V_{OH}	Output High Voltage @IOH	2.4			V	
V_{OL}	Output Low Voltage @IOL			0.4	V	
I_{OH}	Driving Current of Output High	12			mA	
I_{OL}	Driving Current of Output Low	12			mA	

6.3 System Clock Specification

6.3.1 System Clock Description

Table 12 System Clock Description

Clock Domain	Frequency	Source
XI, XO	25MHz	25MHz Crystal
PECLKP, PECLKN	100MHz	Main Clock Generator

6.3.2 System Clock Input Frequency Specification

Table 13 Crystal AC Specification

Symbol	Parameter	Min.	Typ	Max.	Unit
f_{XTAL}	Frequency		25		MHz
$\triangle f_{XTAL}$	Long Term Stability (at 25^0C)	-30		30	ppm
T_C	Temperature Stability	-30		30	ppm
FA	Aging	-5		5	ppm
C_L	Load Capacitance (Single-end mode)		16		pF
C_0	Shunt Capacitance	1	3	7	pF

Table 14 Clock Oscillator Electrical Specification

Symbol	Parameter	Min.	Typ	Max.	Unit
f_{CLK}	Frequency		25		MHz
$\triangle f_{CLK}$	Long Term Stability (all condition)	-150		150	ppm
C_X	External Load Capacitance (Differential mode)		8		pF
C_{TOTAL}	Total External Equivalent Capacitance from XI pin to XO pin (Differential mode)	9	11	15	Pf
R_{TOTAL}	Total External Equivalent Series Resistance from XI pin to XO pin			60	Ω

Table 15 UPE_CLK AC Specification

Symbol	Parameter	100 MHz Input		Unit
		Min	Max	
V_{IH}	Differential Input high voltage	+150		mV
V_{IL}	Differential Input low voltage		-150mV	mV
V_{CROSS}	Absolute crossing point voltage	+250	+550	mV
T_{PERIOD_AVG}	Average clock period accuracy	-300	+300	ppm
$T_{CCJITTER}$	Cycle to Cycle jitter		150	ps
T_{DC}	Reference Duty Cycle	40	60	%
Rising Edge Rate	Rising Edge Rate	0.6	4.0	V/ns
Falling Edge Rate	falling Edge Rate	-4.0	-0.6	V/ns

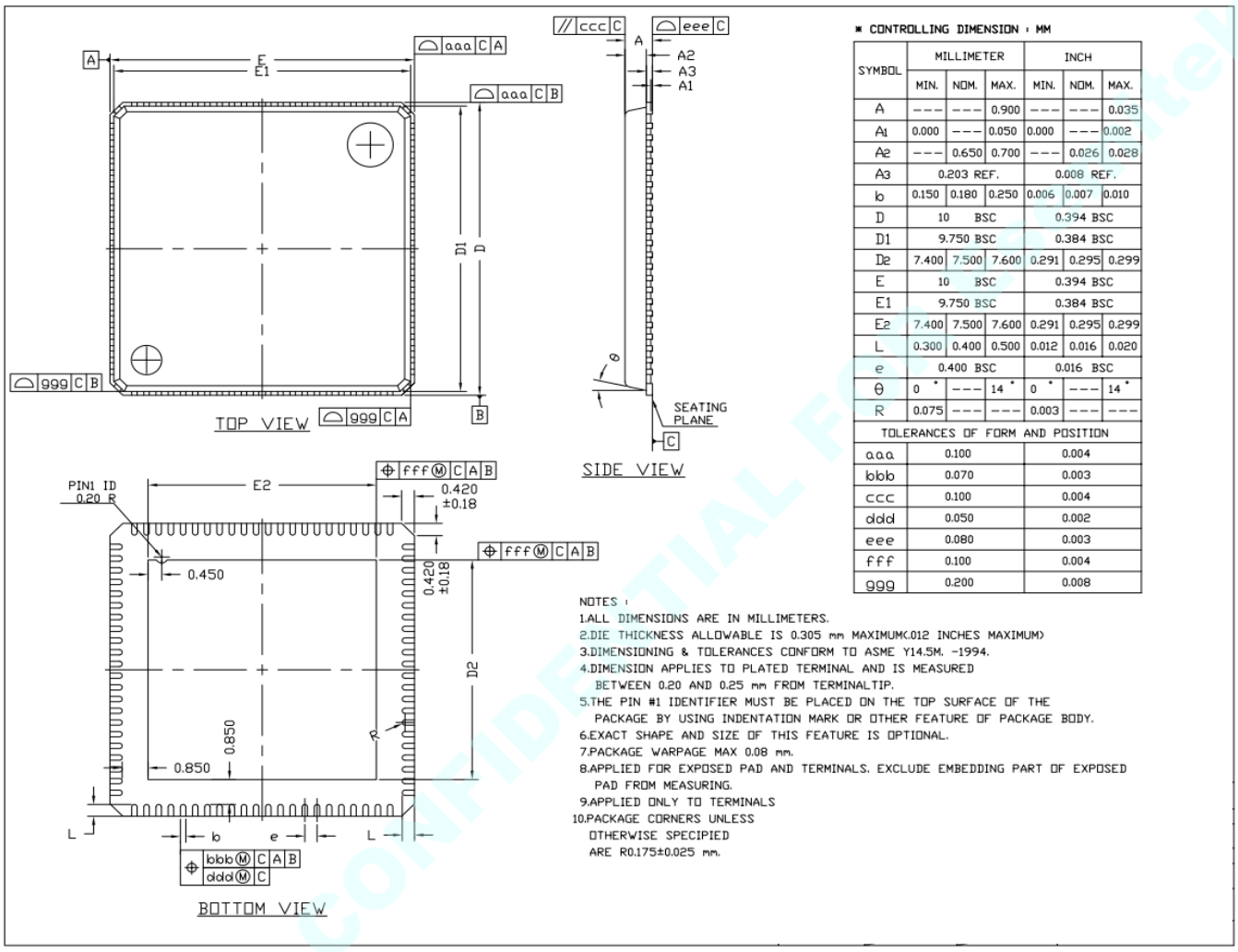
7. Power Consumption

Table 16 power consumption

	Full Running	Idle (L1 enable)	Suspend (Normal power off)
VCC33 (mA)	167	TBD	N/A
VDD105 (mA)	736		N/A
Total Power (mW)	1324		0

8. Package Information

8.1 Package Overview



* CONTROLLING DIMENSION : MM

SYMBOL	MILLIMETER			INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	---	---	0.900	---	---	0.035
A1	0.000	---	0.050	0.000	---	0.002
A2	---	0.650	0.700	---	0.026	0.028
A3	0.203 REF.			0.008 REF.		
b	0.150	0.180	0.250	0.006	0.007	0.010
D	10 BSC			0.394 BSC		
D1	9.750 BSC			0.384 BSC		
D2	7.400	7.500	7.600	0.291	0.295	0.299
E	10 BSC			0.394 BSC		
E1	9.750 BSC			0.384 BSC		
E2	7.400	7.500	7.600	0.291	0.295	0.299
L	0.300	0.400	0.500	0.012	0.016	0.020
e	0.400 BSC			0.016 BSC		
θ	0°	---	14°	0°	---	14°
R	0.075	---	---	0.003	---	---
TOLERANCES OF FORM AND POSITION						
aaa	0.100			0.004		
bbb	0.070			0.003		
ccc	0.100			0.004		
ddd	0.050			0.002		
eee	0.080			0.003		
fff	0.100			0.004		
ggg	0.200			0.008		

NOTES :
1.ALL DIMENSIONS ARE IN MILLIMETERS.
2.DIE THICKNESS ALLOWABLE IS 0.305 mm MAXIMUM(.012 INCHES MAXIMUM)
3.DIMENSIONING & TOLERANCES CONFORM TO ASME Y14.5M. -1994.
4.DIMENSION APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.20 AND 0.25 mm FROM TERMINALTIP.
5.THE PIN #1 IDENTIFIER MUST BE PLACED ON THE TOP SURFACE OF THE PACKAGE BY USING INDENTATION MARK OR OTHER FEATURE OF PACKAGE BODY.
6.EXACT SHAPE AND SIZE OF THIS FEATURE IS OPTIONAL.
7.PACKAGE WARPAGE MAX 0.08 mm.
8.APPLIED FOR EXPOSED PAD AND TERMINALS. EXCLUDE EMBEDDING PART OF EXPOSED PAD FROM MEASURING.
9.APPLIED ONLY TO TERMINALS
10.PACKAGE CORNERS UNLESS OTHERWISE SPECIPIED ARE R0.175±0.025 mm.

Figure 5 Package information

8.2 Chip temperature

Table 17 Chip temperature equation

Symbol	Parameter	How to get?
Ta	Ambient temperature	Measure temperature around chip
Tj	Operating junction temperature	Tj = Θja * power + Ta
Tc	Operating case temperature	Tc = Tj - Ψjt * power
Θja	Junction to Ambient thermal resistance	Provided by package vendor: **24.4**
Ψjt	Junction to top thermal characterization	Provided by package vendor: **0.08**
Power	Chip power consumption	Measure chip power consumption (Max: 1.324 W)

- **Thermal test board condition, please refer to JEDEC JESD51-5**
- **Thermal Test Method Environmental Conditions refer JESD51-2**
- **Example: If chip power consumption is TBDW; Ta=25^{0}C**
  Tj = 24.4 * 1.324 + 25 = 57.3^{0}C
  Tc = 57.3 – 0.08 * 1.324 = 57.2^{0}C