Datasheet

PROGRAMMABLE TIMING CONTROL HUB FOR INTEL BASED SYSTEMS

ICS9LRS3187B

Recommended Application:

CK505 version 1.1 clock, with fully integrated voltage regulators and series resistors

Output Features:

- 2 - CPU differential low power push-pull pairs
- 1 - SRC differential low power push-pull pair
- 1 - SATA differential low power push-pull pair
- 1 - DOT differential low power push-pull pair
- 1 - REF, able to drive 3 loads, 14.318MHz
- 1 - 27MHz_SS/non_SS single-ended output pair

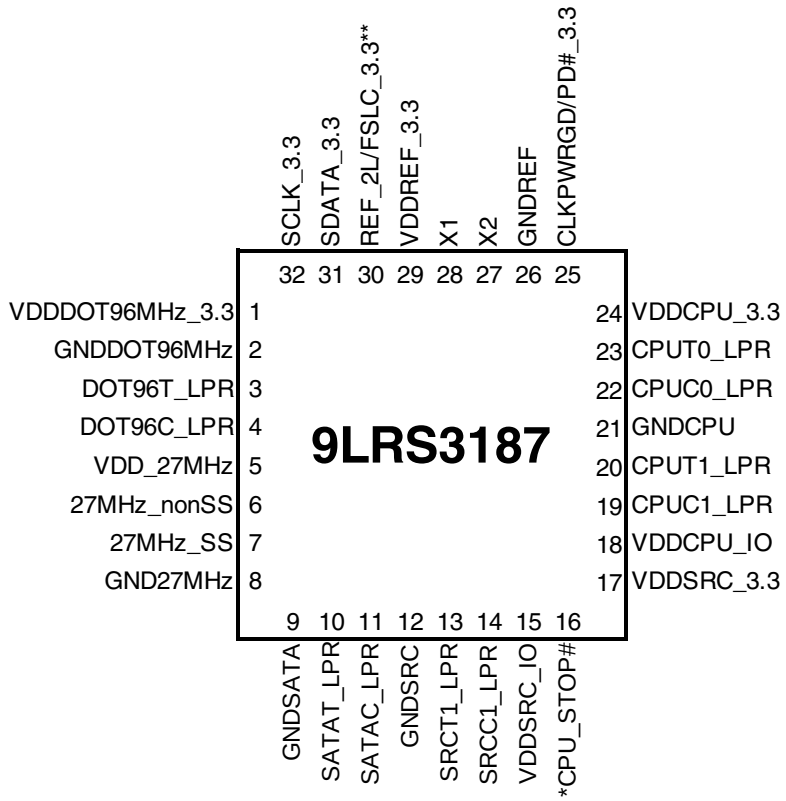
Features/Benefits:

- Supports spread spectrum modulation, 0 to -0.5% down spread for CPU and SRC clocks
- Uses external 14.318MHz crystal, external crystal load caps are required for frequency tuning
- Available in commercial (0 to +70°C) and industrial (-40 to +85°C) temperature ranges
- Meets PCIe Gen2 specifications

Key Specifications:

- CPU outputs cycle-cycle jitter <85ps
- SRC outputs cycle-cycle jitter <125ps
- +/- 100ppm frequency accuracy on all clocks

Pin Configuration



** Internal Pull-Down Resistor

* Internal Pull-Up Resistor

32-pin MLF

Pin Description

Pin#	Pin Name	Type	Pin Description
1	VDDDOT96MHz_3.3	PWR	Power pin for the 96MHz output 3.3V.
2	GNDDOT96MHz	PWR	Ground pin for the 96MHz output
3	DOT96T_LPR	OUT	True DOT96 output with integrated 33ohm series resistor. No 50ohm resistor to GND needed.
4	DOT96C_LPR	OUT	Complement DOT96 output with integrated 33ohm series resistor. No 50ohm resistor to GND needed.
5	VDD_27MHz	PWR	Power pin for the 27MHz output 3.3V.
6	27MHz_nonSS	OUT	3.3V Single-ended 27MHz non-spread clock.
7	27MHz_SS	OUT	3.3V Single-ended 27MHz spread clock.
8	GND27MHz	OUT	Ground pin for the 27MHz outputs.
9	GNDSATA	PWR	Ground pin for the SATA outputs.
10	SATAT_LPR	OUT	True clock of differential 0.8V push-pull SATA/SRC output with integrated 33ohm series resistor. No 50ohm resistor to GND needed.
11	SATAC_LPR	OUT	Complementary clock of differential 0.8V push-pull SATA/SRC output with integrated 33ohm series resistor. No 50ohm resistor to GND needed.
12	GNDSRC	PWR	Ground pin for the SRC outputs
13	SRCT1_LPR	OUT	True clock of differential 0.8V push-pull SRC output with integrated 33ohm series resistor. No 50ohm resistor to GND needed.
14	SRCC1_LPR	OUT	Complementary clock of differential 0.8V push-pull SRC output with integrated 33ohm series resistor. No 50ohm resistor to GND needed.
15	VDDSRC_IO	PWR	1.05V to 3.3V from external power supply
16	*CPU_STOP#	IN	Stops all CPU clocks, except those set to be free running clocks
17	VDDSRC_3.3	PWR	Supply for SRC clocks, 3.3V nominal
18	VDDCPU_IO	PWR	1.05V to 3.3V from external power supply
19	CPUC1_LPR	OUT	Complementary clock of differential pair 0.8V push-pull CPU outputs with integrated 33ohm series resistor. No 50 ohm resistor to GND needed.
20	CPUT1_LPR	OUT	True clock of differential pair 0.8V push-pull CPU outputs with integrated 33ohm series resistor. No 50 ohm resistor to GND needed.
21	GNDCPU	PWR	Ground pin for the CPU outputs.
22	CPUC0_LPR	OUT	Complementary clock of differential pair 0.8V push-pull CPU outputs with integrated 33ohm series resistor. No 50 ohm resistor to GND needed.
23	CPUT0_LPR	OUT	True clock of differential pair 0.8V push-pull CPU outputs with integrated 33ohm series resistor. No 50 ohm resistor to GND needed.
24	VDDCPU_3.3	PWR	Supply for CPU clocks, 3.3V nominal
25	CLKPWRGD/PD#_3.3	IN	Notifies CK505 to sample latched inputs, or PWRDWN# mode
26	GNDREF	PWR	Ground pin for the REF outputs.
27	X2	OUT	Crystal output, Nominally 14.318MHz
28	X1	IN	Crystal input, Nominally 14.318MHz
29	VDDREF_3.3	PWR	Power pin for the XTAL and REF clocks, nominal 3.3V
30	REF_2/FSLC_3.3**	I/O	14.318 MHz reference clock, which can drive 2 loads / 3.3V tolerant input for CPU frequency selection. Refer to input electrical characteristics for Vil_FS and Vih_FS values.
31	SDATA_3.3	I/O	Data pin for SMBus circuitry, 3.3V tolerant
32	SCLK_3.3	IN	Clock pin of SMBus circuitry, 3.3V tolerant.

General Description

The **ICS9LRS3187B** is a CK505 clock synthesizer. The **ICS9LRS3187B** provides a single-chip solution for Intel based systems. The **ICS9LRS3187B** is driven with a 14.318MHz crystal.

Functional Block Diagram

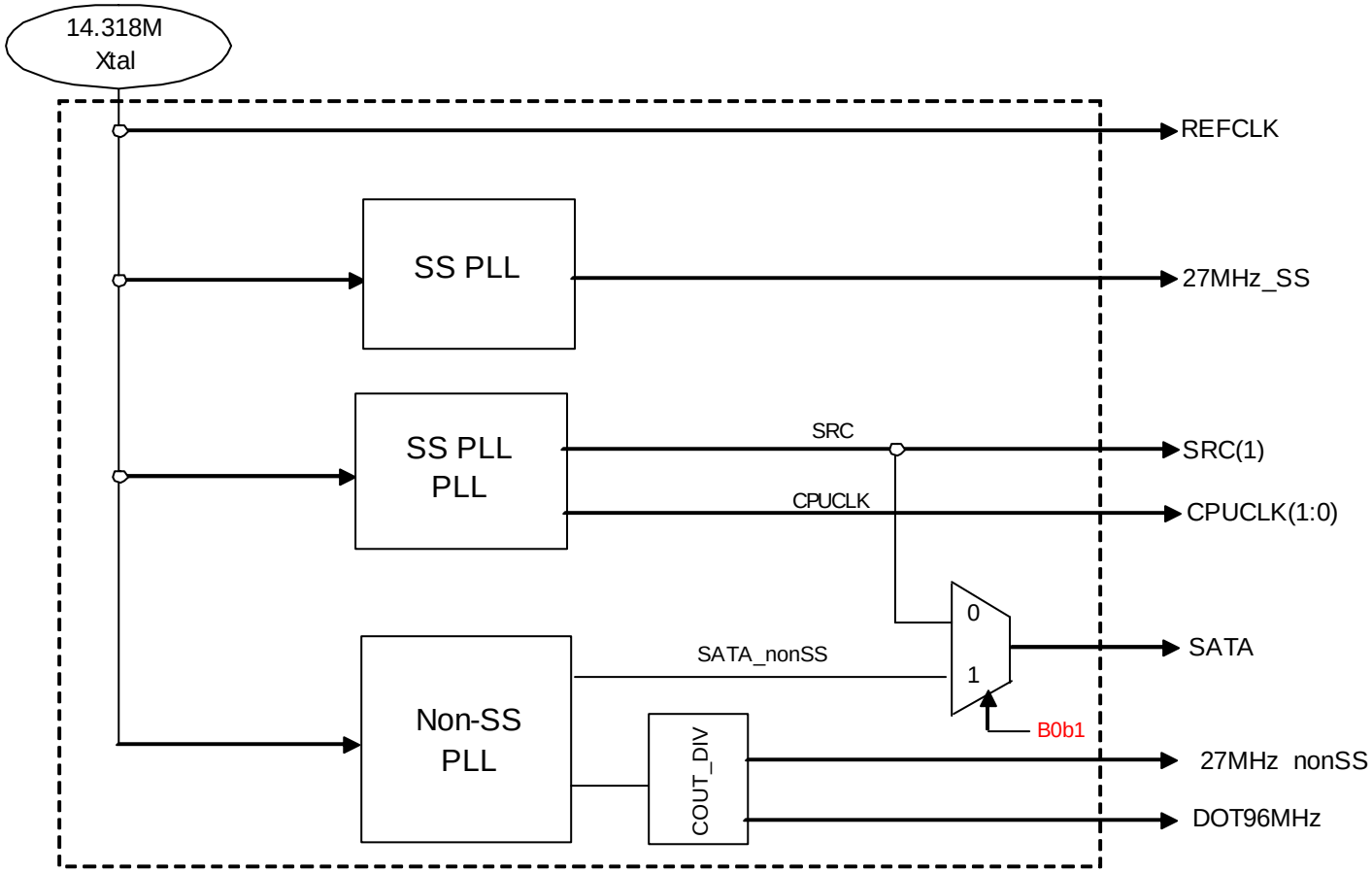


Table: Power Distribution

Ground	VDD_IO	VDD 3.3V	Output
2		1	DOT96
8		5	27M
9	15	17	SATA
12	15	17	SRC
21	18	24	CPU
26		29	REF

Table 1: CPU Frequency Select Table

FS_LC B0b7	CPU MHz	SRC MHz	REF MHz	DOT MHz
0 (Default)	133.33	100.00	14.318	96.00
1	100.00			

1. FS_LC is a low-threshold input.Please see V_{IL_FS} and V_{IH_FS} specifications in the Input/Supply/Common Output Parameters Table for correct values. Also refer to the Test Clarification Table.

Table 2: pin 6, 7 Configuration

B1b3	B1b2	B1b1	Pin 6	Pin 7	Spread	Comment
			MHz	MHz	%	
0	0	0	27MHz_nonSS	27MHz_SS	-1.75%	
0	0	1	27MHz_nonSS	27MHz_SS	+-0.5%	
0	**1**	**0**	**27MHz_nonSS**	**27MHz_SS**	**-0.5%**	**Default**
0	1	1	27MHz_nonSS	27MHz_SS	-1%	
1	0	0	27MHz_nonSS	27MHz_SS	-1.5%	
1	0	1	27MHz_nonSS	27MHz_SS	-2%	
1	1	0	27MHz_nonSS	27MHz_SS	-0.75%	
1	1	1	27MHz_nonSS	27MHz_SS	-1.25%	

Table 3: IO_Vout select table

B9b2	B9b1	B9b0	IO_Vout
0	0	0	0.3V
0	0	1	0.4V
0	1	0	0.5V
0	1	1	0.6V
1	0	0	0.7V
1	0	1	0.8V
1	1	0	0.9V
1	1	1	1.0V

CPU Power Management Table

PD#	CPU_STOP#	SMBus Reg. OE	CPU1	CPU1#	CPU0	CPU0#
1	**1**	Enable	Running	Running	Running	Running
0	X	Enable	Low/20K	Low	Low/20K	Low
1	**0**	Enable	High	Low	High	Low
1	X	**Disable**	Low/20K	Low	Low/20K	Low
M1			Running	Running	Low/20K	Low

SRC and DOT96MHz Power Management Table

PD#	CPU_STOP#	SMBus Reg. OE	SRC	SRC#	DOT	DOT#
0	X	Enable	Low/20K	Low	Low/20K	Low
1	X	Enable	Running	Running	Running	Running
1	X	**Disable**	Low/20K	Low	Low/20K	Low
M1			Low/20K	Low	Low/20K	Low

Singled-ended Power Management Table

PD#	CPU_STOP#	SMBus Reg. OE	27M	REF
1	X	Enable	Running	Running
0	X	Enable	Low	Hi-Z
1	X	**Disable**	Low	Low
M1			Low	Hi-Z

General SMBus serial interface information for the ICS9LRS3187B

How to Write:

- Controller (host) sends a start bit.
- Controller (host) sends the write address D2 (H)
- IDT clock will ***acknowledge***
- Controller (host) sends the beginning byte location = N
- IDT clock will ***acknowledge***
- Controller (host) sends the data byte count = X
- IDT clock will ***acknowledge***
- Controller (host) starts sending ***Byte N through Byte N + X -1***
- IDT clock will ***acknowledge*** each byte ***one at a time***
- Controller (host) sends a Stop bit

How to Read:

- Controller (host) will send start bit.
- Controller (host) sends the write address D2 (H)
- IDT clock will ***acknowledge***
- Controller (host) sends the begining byte location = N
- IDT clock will ***acknowledge***
- Controller (host) will send a separate start bit.
- Controller (host) sends the read address D3 (H)
- IDT clock will ***acknowledge***
- IDT clock will send the data byte count = X
- IDT clock sends ***Byte N + X -1***
- IDT clock sends ***Byte 0 through byte X (if $X_{(H)}$ was written to byte 8)***.
- Controller (host) will need to acknowledge each byte
- Controller (host) will send a not acknowledge bit
- Controller (host) will send a stop bit

Index Block Write Operation

Controller (Host)			IDT (Slave/Receiver)
T	starT bit		
Slave Address $D2_{(H)}$			
WR	WRite		
			ACK
Beginning Byte = N			
			ACK
Data Byte Count = X			
			ACK
Beginning Byte N		X Byte	
			ACK
◇			
◇			◇
◇			◇
			◇
Byte N + X - 1			
			ACK
P	stoP bit		

Index Block Read Operation

Controller (Host)		IDT (Slave/Receiver)	
T	starT bit		
Slave Address $D2_{(H)}$			
WR	WRite		
		ACK	
Beginning Byte = N			
		ACK	
RT	Repeat starT		
Slave Address $D3_{(H)}$			
RD	ReaD		
		ACK	
		Data Byte Count = X	
ACK			
		X Byte	Beginning Byte N
ACK			
			◇
◇			◇
◇			◇
◇			
			Byte N + X - 1
N	Not acknowledge		
P	stoP bit		

Byte 0 FS Readback and PLL Selection Register

Bit	Pin	Name	Description	Type	0	1	Default
7	-	FSLC	CPU Freq. Sel. Bit	R			Latch
6	-	Reserved	Reserved	RW	-	-	0
5	-	Reserved	Reserved	RW	-	-	1
4	-	iAMT_EN	Set via SMBus	RW (Sticky "1")	Legacy Mode	iAMT Enabled	0
3		Reserved	Reserved	RW			0
2	-	Reserved	Reserved	RW			0
1	-	SATA_SEL	Select source for SATA clock	RW	SATA (SRC2 100MHz_SS) = SRC_Main	SATA (100MHz non_SS) = SATA PLL	0
0	-	PD_Restore	1 = on Power Down de-assert return to last known state 0 = clear all SMBus configurations as if cold power-on and go to latches open state This bit is ignored and treated at '1' if device is in iAMT mode.	RW	Configuration Not Saved	Configuration Saved	1

Byte 1 DOT96 Select and PLL3 Quick Config Register,

Bit	Pin	Name	Description	Type	0	1	Default
7		Reserved	Reserved	RW	-	-	1
6		SRC_PLL_SSC_SEL	Select 0.5% down or center SSC	RW	Down spread	Center spread	0
5		Reserved	Reserved	RW	-	-	1
4		Reserved	Reserved	RW			0
3		27SS PLL CF2	27SS PLL Quick Config Bit 2	RW	See Table 2: pin 6/7 Configuration		0
2		27SS PLL _CF1	27SS PLL Quick Config Bit 1	RW			1
1		27SS PLL CF0	27SS PLL Quick Config Bit 0	RW			0
0		Reserved	Reserved	RW	-	-	1

Byte 2 Output Enable Register

Bit	Pin	Name	Description	Type	0	1	Default
7		REF_3L_OE	Output enable for REF0, if disabled output is tri-stated	RW	Output Disabled	Output Enabled	1
6		Reserved	Reserved	RW	-	-	1
5		Reserved	Reserved	RW	-	-	1
4		Reserved	Reserved	RW	-	-	1
3		Reserved	Reserved	RW	-	-	1
2		Reserved	Reserved	RW	-	-	1
1		Reserved	Reserved	RW	-	-	1
0		Reserved	Reserved	RW	-	-	1

Byte 3 Output Enable Register

Bit	Pin	Name	Description	Type	0	1	Default
7		Reserved	Reserved	RW	-	-	1
6		Reserved	Reserved	RW	-	-	1
5		Reserved	Reserved	RW	-	-	1
4		Reserved	Reserved	RW	-	-	1
3		Reserved	Reserved	RW	-	-	1
2		Reserved	Reserved	RW	-	-	1
1		Reserved	Reserved	RW			1
0		Reserved	Reserved	RW	-	-	1

Byte 4 Output Enable and Spread Spectrum Disable Register

Bit	Pin	Name	Description	Type	0	1	Default
7		Reserved	Reserved	RW	-	-	1
6		SATA_OE	Output enable for SATA	RW	Output Disabled	Output Enabled	1
5		SRC1_OE	Output enable for SRC1	RW	Output Disabled	Output Enabled	1
4		DOT96_OE	Output enable for DOT96	RW	Output Disabled	Output Enabled	1
3		CPU1_OE	Output enable for CPU1	RW	Output Disabled	Output Enabled	1
2		CPU0_OE	Output enable for CPU0	RW	Output Disabled	Output Enabled	1
1		27SS_ON	Enable 27SS's spread modulation	RW	Spread Disabled	Spread Enabled	1
0		SRC_SSC_ON	Enable SRC's spread modulation	RW	Spread Disabled	Spread Enabled	1

Byte 5 Reserved Register

Bit	Pin	Name	Description	Type	0	1	Default
7		Reserved	Reserved	RW	-	-	1
6		Reserved	Reserved	RW	-	-	1
5		Reserved	Reserved	RW	-	-	1
4		Reserved	Reserved	RW	-	-	1
3		Reserved	Reserved	RW	-	-	1
2		Reserved	Reserved	RW	-	-	1
1		Reserved	Reserved	RW	-	-	1
0		Reserved	Reserved	RW	-	-	1

Byte 6 Slew Rate Control Register

Bit	Pin	Name	Description	Type	0	1	Default
7		Reserved	Reserved	RW	-	-	0
6		Reserved	Reserved	RW	-	-	0
5		REF Slew	Slew Rate Control	RW	2 V/ns	1 V/ns	0
4		Reserved	Reserved	RW	-	-	0
3		27MHz Slew	Slew Rate Control	RW	2 V/ns	1 V/ns	0
2		Reserved	Reserved	RW	-	-	0
1		Reserved	Reserved	RW	-	-	0
0		Reserved	Reserved	RW	-	-	0

Byte 7 Vendor ID/ Revision ID

Bit	Pin	Name	Description	Type	0	1	Default
7		Rev Code Bit 3	Revision ID	**R**	Vendor specific		X
6		Rev Code Bit 2		**R**			X
5		Rev Code Bit 1		**R**			X
4		Rev Code Bit 0		**R**			X
3		Vendor ID bit 3	Vendor ID ICS is 0001, binary	**R**			0
2		Vendor ID bit 2		**R**			0
1		Vendor ID bit 1		**R**			0
0		Vendor ID bit 0		**R**			1

Byte 8 Device ID and Output Enable Register

Bit	Pin	Name	Description	Type	0	1	Default
7		**Device_ID3**	**Table of Device identifier codes, used for differentiating between CK505 package options, etc.**	**R**	**See Device ID Table**		**1**
6		**Device_ID2**		**R**			**0**
5		**Device_ID1**		**R**			**0**
4		**Device_ID0**		**R**			**0**
3		Reserved	Reserved	RW	-	-	0
2		Reserved	Reserved	RW	-	-	0
1		27MHz_nonSS_OE	Output enable for 27MHz_nonSS	RW	Disabled	Enabled	1
0		27MHz_SS_OE	Output enable for 27MHz_SS	RW	Disabled	Enabled	1

Byte 9 Output Control Register

Bit	Pin	Name	Description	Type	0	1	Default
7		Reserved	Reserved	RW	-	-	0
6		Reserved	Reserved	**R**	-	-	0
5		Reserved	Reserved	RW	-	-	1
4		Reserved	Reserved	RW	-	-	0
3		Reserved	Reserved	RW	-	-	0
2		IO_VOUT2	IO Output Voltage Select (Most Significant Bit)	RW	See Table 3: V_IO Selection (Default is 0.8V)		1
1		IO_VOUT1	IO Output Voltage Select	RW			0
0		IO_VOUT0	IO Output Voltage Select (Least Significant Bit)	RW			1

Byte 10 Output Control Register

Bit	Pin	Name	Description	Type	0	1	Default
7		Reserved	Reserved	RW	-	-	0
6		Reserved	Reserved	RW	-	-	0
5		Reserved	Reserved	RW	-	-	0
4		Reserved	Reserved	RW	-	-	0
3		Reserved	Reserved	RW	-	-	0
2		Reserved	Reserved	RW	-	-	0
1		CPU 1 Stop Enable	Enables control of CPU1 with CPU_STOP#	RW	Free Running	Stoppable	1
0		CPU 0 Stop Enable	Enables control of CPU 0 with CPU_STOP#	RW	Free Running	Stoppable	1

Byte 11 Reserved Register

Bit	Pin	Name	Description	Type	0	1	Default
7		Reserved	Reserved	RW			0
6		Reserved	Reserved	RW			0
5		Reserved	Reserved	RW			0
4		Reserved	Reserved	RW			0
3		Reserved	Reserved	RW	-	-	0
2		CPU1_AMT_EN	M1 mode clk enable	RW	Disable	Enable	1
1		PCI-E_GEN2	Determines if PCI-E Gen2 compliant	**R**	non-Gen2	PCI-E Gen2 Compliant	1
0		Reserved	Reserved	RW	-	-	1

Byte 12 Byte Count Register

Bit	Pin	Name	Description	Type	0	1	Default
7		Reserved		RW			0
6		Reserved		RW			0
5		BC5	Read Back byte count register, max bytes = 32	RW			0
4		BC4		RW			0
3		BC3		RW			1
2		BC2		RW			1
1		BC1		RW			0
0		BC0		RW			1

Absolute Maximum Ratings - DC Parameters, Commercial Temperature Range

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	Notes
Maximum Supply Voltage	VDDxxx	Supply Voltage			4.6	V	1
Maximum Supply Voltage	VDDxxx_IO	Low-Voltage Differential I/O Supply			3.8	V	1
Maximum Input Voltage	V_{IH}	3.3V Inputs			4.6	V	1,2
Minimum Input Voltage	V_{IL}	Any Input	GND - 0.5			V	1
Storage Temperature	Ts	-	-65		150	°C	1
Input ESD protection	ESD prot	Human Body Model	2000			V	1,3

Notes: (unless otherwise noted, guaranteed by design and characterization, not 100% tested in production).

[1] Operation under these conditions is neither implied, nor guaranteed.

[2] Maximum VIH is not to exceed VDD

[3] Human Body Model

Electrical Characteristics - Input/Supply/Common Output DC Parameters, Commercial Temperature Range

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	Notes
Ambient Operating Temp	Tambient	-	0		70	°C	
Supply Voltage	VDDxxx	Supply Voltage	3.135		3.465	V	
Supply Voltage	VDDxxx_IO	Low-Voltage Differential I/O Supply	0.9975		3.465	V	5
Input High Voltage	V_{IHSE}	Single-ended 3.3V inputs	2		V_{DD} + 0.3	V	3
Input Low Voltage	V_{ILSE}	Single-ended 3.3V inputs	V_{SS} - 0.3		0.8	V	3
Low Threshold Input- FSC = '1' Voltage	V_{IH_FSC}	3.3 V +/-5%	0.7		3.3	V	4
Low Threshold Input-Low Voltage	V_{IL_FSC}	3.3 V +/-5%	V_{SS} - 0.3		0.35	V	
Input Leakage Current	I_{IN}	$V_{IN} = V_{DD}$, V_{IN} = GND	-5		5	uA	2
Input Leakage Current	I_{INRES}	Inputs with pull up or pull down resistors $V_{IN} = V_{DD}$, V_{IN} = GND	-200		200	uA	
Output High Voltage	V_{OHSE}	Single-ended outputs, I_{OH} = -1mA	2.4			V	1
Output Low Voltage	V_{OLSE}	Single-ended outputs, I_{OL} = 1 mA			0.4	V	1
Operating Supply Current	$I_{DDOP3.3}$	Full Active, C_L = Full load; Idd 3.3V		85	110	mA	
	I_{DDOPIO}	Full Active, C_L = Full load; IDD IO		18	25	mA	5
iAMT Mode Current	$I_{DDiAMT3.3}$	M1 mode, 3.3V Rail		48	60	mA	
	$I_{DDiAMTIO}$	M1 Mode, IO Rail		6	10	mA	5
Powerdown Current	$I_{DDPD3.3}$	Power down mode, 3.3V Rail		6	5	mA	
	I_{DDPDIO}	Power down mode, IO Rail		0	0.1	mA	5
Input Frequency	F_i	V_{DD} = 3.3 V		14.3182	15	MHz	
Pin Inductance	L_{pin}				7	nH	
Input Capacitance	C_{IN}	Logic Inputs	1.5		5	pF	
	C_{OUT}	Output pin capacitance			6	pF	
	C_{INX}	X1 & X2 pins			6	pF	
Clk Stabilization	T_{STAB}	From VDD Power-Up or de-assertion of PD to 1st clock		1.0	1.8	ms	
Tfall_SE	T_{FALL}	Fall/rise time of all 3.3V control inputs from 20-80%			10	ns	1
Trise_SE	T_{RISE}				10	ns	1
SMBus Voltage	V_{DD}		2.7		5.5	V	
Low-level Output Voltage	V_{OLSMB}	@ I_{PULLUP}			0.4	V	
Current sinking at V_{OLSMB} = 0.4 V	I_{PULLUP}	SMB Data Pin	4	5		mA	
SCLK/SDATA Clock/Data Rise Time	T_{RI2C}	(Max VIL - 0.15) to (Min VIH + 0.15)			1000	ns	
SCLK/SDATA Clock/Data Fall Time	T_{FI2C}	(Min VIH + 0.15) to (Max VIL - 0.15)			300	ns	
Maximum SMBus Operating Frequency	F_{SMBUS}				100	kHz	
Spread Spectrum Modulation Frequency	f_{SSMOD}	Triangular Modulation	30	32.54	33	kHz	

Notes: (unless otherwise noted, guaranteed by design and characterization, not 100% tested in production).

[1]Signal is required to be monotonic in this region.

[2] Input leakage current does not include inputs with pull-up or pull-down resistors

[3] 3.3V referenced inputs are: SCLK, SDATA, and CKPWRGD

[4] Frequency Select pins which have tri-level input

[5] If present, not all parts have this feature.

AC Electrical Characteristics - Low Power Differential Outputs, Commercial Temperature Range

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	Notes
Rising Edge Slew Rate	tSLR	Averaging on	2.5	3.7	4	V/ns	2, 3
Falling Edge Slew Rate	tFLR	Averaging on	2.5	3.7	4	V/ns	2, 3
Slew Rate Variation	tSLVAR	Averaging on		3.6	20	%	1, 6
Differential Voltage Swing	VSWING	Averaging off	300			mV	2
Crossing Point Voltage	VXABS	Averaging off	300	446	550	mV	1,4,5
Crossing Point Variation	VXABSVAR	Averaging off		70	140	mV	1,4,9
Maximum Output Voltage	VHIGH	Averaging off			1150	mV	1,7
Minimum Output Voltage	VLOW	Averaging off	-300			mV	1,8
Duty Cycle	DCYC	Averaging on	45	49.8	55	%	2
CPU Skew	CPUSKEW	Averaging on		35	100	ps	
SRC Skew	$t_{SKEWSRC}$	Averaging on, SRC to SATA skew when Byte0, bit 1 = 0		259	350	ps	

NOTES: (unless otherwise noted, guaranteed by design and characterization, not 100% tested in production). C_L = 2pF, Rs = 0 ohms.

[1]Measurement taken for single ended waveform on a component test board (not in system)

[2] Measurement taken from differential waveform on a component test board. (not in system)

[3] Slew rate emastured through V_swing voltage range centered about differential zero

[4] Vcross is defined at the voltage where Clock = Clock#, measured on a component test board (not in system)

[5] Only applies to the differential rising edge (Clock rising, Clock# falling)

[6] Matching applies to rising edge rate for Clock and falling edge rate for Clock#. It is measured using a +/-75mV window centered on the average cross point where Clock rising meets Clock# falling. The median cross point is used to calculate the voltage

[7] The max voltage including overshoot.

[8] The min voltage including undershoot.

[9] The total variation of all Vcross measurements in any particular system. Note this is a subset of V_cross min/mas (V_Cross absolute) allowed. The intent is to limit Vcross induced modulation by setting C_cross_delta to be smaller than V_Cross absolute

Clock Jitter Specs - Low Power Differential Outputs, Commercial Temperature Range

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	Notes
CPU Jitter - Cycle to Cycle	CPUJC2C	Differential Measurement		50	85	ps	1
SRC/SATA Jitter - Cycle to Cycle	SRCJC2C	Differential Measurement		50	125	ps	1,2
DOT Jitter - Cycle to Cycle	DOTJC2C	Differential Measurement		50	250	ps	1
SRC Phase Jitter	$t_{jphasePLL}$	PCIe Gen 1		35	86	ps (p-p)	1,2,3
	$t_{jphaseLo}$	PCIe Gen 2 10kHz < f < 1.5MHz		1.8	3	ps (RMS)	1,2,3
	$t_{jphaseHigh}$	PCIe Gen 2 1.5MHz < f < Nyquist (50MHz)		2.3	3.1	ps (RMS)	1,2,3

NOTES: (unless otherwise noted, guaranteed by design and characterization, not 100% tested in production). C_L = 2pF, Rs = 0 ohms.

[1]JItter specs are specified as measured on a clock characterization board. System designers need to take special care not to use these numbers, as the in-system performance will be somewhat degraded. The receiver EMTS (chispet or CPU) will have the receiver jitter specs as measured in a real system.

[2] Phase jitter requirement: The designated Gen2 outputs will meet the reference clock jitter requirements from the PCI Express Gen2 Base Spec. The test is performed on a component test board under quiet conditions with all outputs on.

[3]See http://www.pcisig.com for complete specs

Electrical Characteristics - REF-14.318MHz, Commercial Temperature Range

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	Notes
Long Accuracy	ppm	see Tperiod min-max values	-100	0	100	ppm	2, 4
Clock period	Tperiod	14.318MHz output nominal	69.82033	69.84129	69.86224	ns	2, 3
Absolute min/max period	Tabs	14.318MHz output nominal	69.83400		70.84800	ns	2
CLK High Time	THIGH		29.97543		38.46654	V	
CLK Low time	TLOW		29.57543		38.26654	V	
Output High Current	IOH	VOH @MIN = 1.0 V, VOH@MAX = 3.135 V	-33		-33	mA	
Output Low Current	IOL	VOL @MIN = 1.95 V, VOL @MAX = 0.4 V	30		38	mA	
Rising/Falling Edge Slew Rate	t_{SLEW}	Measured between 0.8 to 2.0 V	1	1.7	4	V/ns	1
Duty Cycle	dt1	VT = 1.5 V	45	53	55	%	2
Jitter, Cycle to cycle	tjcyc-cyc	VT = 1.5 V		115	1000	ps	2

NOTES: (unless otherwise noted, guaranteed by design and characterization, not 100% tested in production).

[1]Edge rate in system is measured from 0.8V to 2.0V.

[2] Duty cycle, Peroid and Jitter are measured with respect to 1.5V

[3] The average period over any 1us period of time

[4] Using frequency counter with the measurment interval equal or greater that 0.15s, target frequency is 14.318180 MHz

Electrical Characteristics - 27MHz_Spread / 27MHz_NonSpread, Commercial Temperature Range

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	Notes
Long Accuracy	ppm	see Tperiod min-max values	-50		50	ppm	1,2
			-15		15		1,2,3
Clock period	T_{period}	27.000MHz output nominal	37.0365		37.0376		
Output High Current	I_{OH}	VOH @MIN = 1.0 V, VOH@MAX = 3.135 V	-29		-23	mA	1
Output Low Current	I_{OL}	VOL @MIN = 1.95 V, VOL @MAX = 0.4 V	29		27	mA	1
Rising/Falling Edge Slew Rate	$t_{slewr/f}$	Rising/Falling edge rate	1	2	4	V/ns	1
Duty Cycle	d_{t1}	V_T = 1.5 V	45	50.4	55	%	1
Jitter, 27MHz_NonSpread Output	t_{lti}	Long Term (10us)		485	800	ps	
	t_{jpk-pk}	V_T = 1.5 V	-100		100	ps	
	$t_{jcyc-cyc}$	V_T = 1.5 V		57	120	ps	
Jitter, 27MHz_Spread Output	$t_{jcyc-cyc}$	V_T = 1.5 V SS% <= 1.5% pk to pk		82	200	ps	4
		V_T = 1.5 V, SS% > 1.5% pk to pk		134	200	ps	4

NOTES: (unless otherwise noted, guaranteed by design and characterization, not 100% tested in production).

[1]Edge rate in system is measured from 0.8V to 2.0V at default slew rate control setting.

[2] All Long Term Accuracy and Clock Period specifications are guaranteed assuming that REF out is at 14.31818MHz

[3] At nominal temperature and voltage.

[4] Long term and peak to peak jitter do not apply to the 27MHz spreading output. The spread modulation directly impacts these values.

Absolute Maximum Ratings - DC Parameters, Industrial Temperature Range

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	Notes
Maximum Supply Voltage	VDD_{xxx}	Supply Voltage			4.6	V	1
Maximum Supply Voltage	VDD_{xxx_IO}	Low-Voltage Differential I/O Supply			3.8	V	1
Maximum Input Voltage	V_{IH}	3.3V Tolerant Inputs			4.6	V	1,2
Minimum Input Voltage	V_{IL}	Any Input	GND - 0.5			V	1
Storage Temperature	Ts	-	-65		150	°C	1
Input ESD protection	ESD prot	Human Body Model	2000			V	1,3

Notes: (unless otherwise noted, guaranteed by design and characterization, not 100% tested in production).

[1] Operation under these conditions is neither implied, nor guaranteed.

[2] Maximum VIH is not to exceed VDD

[3] Human Body Model

Electrical Characteristics - Input/Supply/Common Output DC Parameters, Industrial Temperature Range

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	Notes
Ambient Operating Temp	T_{ambind}	Industrial Range	-40		85	°C	
Supply Voltage, Core	VDD_{xxx}	Supply Voltage	3.135	3.3	3.465	V	
Supply Voltage, I/O	VDD_{xxx_IO}	Low-Voltage Differential I/O Supply	0.9975	1.05	3.465	V	5
Input High Voltage	V_{IHSE}	Single-ended 3.3V inputs	2	2.4	V_{DD} + 0.3	V	3
Input Low Voltage	V_{ILSE}	Single-ended 3.3V inputs	V_{SS} - 0.3	0.4	0.8	V	3
Low Threshold Input - High Voltage	V_{IH_FSC}	3.3 V +/-5%, Voltage for which FSC = '1'	0.7		3.3	V	4
Low Threshold Input - Low Voltage	V_{IL_FSC}	3.3 V +/-5%	V_{SS} - 0.3		0.35	V	
Input Leakage Current	I_{IN}	$V_{IN} = V_{DD}$, V_{IN} = GND	-5		5	uA	2
Input Leakage Current	I_{INRES}	Inputs with pull up or pull down resistors $V_{IN} = V_{DD}$, V_{IN} = GND	-200		200	uA	
Output High Voltage	V_{OHSE}	Single-ended outputs, I_{OH} = -1mA	2.4			V	1
Output Low Voltage	V_{OLSE}	Single-ended outputs, I_{OL} = 1 mA			0.4	V	1
Operating Supply Current	$I_{DDOP3.3}$	Full Active, C_L = Full load; Idd 3.3V		92	110	mA	
	I_{DDOPIO}	Full Active, C_L = Full load; IDD IO		18	25	mA	5
iAMT Mode Current	$I_{DDiAMT3.3}$	M1 mode, 3.3V Rail		48	65	mA	
	$I_{DDiAMTIO}$	M1 Mode, IO Rail		6	15	mA	5
Powerdown Current	$I_{DDPD3.3}$	Power down mode, 3.3V Rail		3.2	8	mA	
	I_{DDPDIO}	Power down mode, IO Rail		0	0.05	mA	5
Input Frequency	F_i	V_{DD} = 3.3 V		14.318	15	MHz	
Pin Inductance	L_{pin}			5	7	nH	
Input Capacitance	C_{IN}	Logic Inputs	1.5	4	5	pF	
	C_{OUT}	Output pin capacitance		5	6	pF	
	C_{INX}	X1 & X2 pins		4	6	pF	
Clk Stabilization	T_{STAB}	From VDD Power-Up or de-assertion of PD to 1st clock			1.8	ms	
Tfall_SE	T_{FALL}	Fall/rise time of all 3.3V control inputs from 20-80%			10	ns	1
Trise_SE	T_{RISE}				10	ns	1
SMBus Voltage	V_{DD}		2.7	3.3	5.5	V	
Low-level Output Voltage	V_{OLSMB}	@ I_{PULLUP}			0.4	V	
Current sinking at V_{OLSMB} = 0.4 V	I_{PULLUP}	SMB Data Pin	4	5		mA	
SCLK/SDATA Clock/Data Rise Time	T_{RI2C}	(Max VIL - 0.15) to (Min VIH + 0.15)			1000	ns	
SCLK/SDATA Clock/Data Fall Time	T_{FI2C}	(Min VIH + 0.15) to (Max VIL - 0.15)			300	ns	
Maximum SMBus Operating Frequency	F_{SMBUS}				100	kHz	
Spread Spectrum Modulation Frequency	f_{SSMOD}	Triangular Modulation	30	32.54	33	kHz	

Notes: (unless otherwise noted, guaranteed by design and characterization, not 100% tested in production).

[1]Signal is required to be monotonic in this region.

[2] Input leakage current does not include inputs with pull-up or pull-down resistors

[3] 3.3V referenced inputs are: SCLK, SDATA, and CKPWRGD

[4] Frequency Select pins which have tri-level input

[5] If present, not all parts have this feature.

AC Electrical Characteristics - Low Power Differential Outputs, Industrial Temperature Range

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
Rising Edge Slew Rate	t_{SLR}	Averaging on	2.5	3.7	4.2	V/ns	2, 3
Falling Edge Slew Rate	t_{FLR}	Averaging on	2.5	3.7	4.2	V/ns	2, 3
Slew Rate Variation	t_{SLVAR}	Averaging on		12.2	20	%	1, 6
Differential Voltage Swing	V_{SWING}	Averaging off	300			mV	2
Crossing Point Voltage	VX_{ABS}	Averaging off	300	447	550	mV	1,4,5
Crossing Point Variation	VX_{ABSVAR}	Averaging off		19	140	mV	1,4,9
Maximum Output Voltage	V_{HIGH}	Averaging off		941	1150	mV	1,7
Minimum Output Voltage	V_{LOW}	Averaging off	-300	-43		mV	1,8
Duty Cycle	DCYC	Averaging on	45	49.8	55	%	2
CPU Skew	$t_{SKEWCPU}$	Averaging on		35	100	ps	
SRC Skew	$t_{SKEWSRC}$	Averaging on, SRC to SATA skew when Byte0, bit 1 = 0		288	350	ps	

NOTES: (unless otherwise noted, guaranteed by design and characterization, not 100% tested in production). C_L = 2pF, Rs = 0 ohms.

[1]Measurement taken for single ended waveform on a component test board (not in system)

[2] Measurement taken from differential waveform on a component test board. (not in system)

[3] Slew rate measured through mimimum V_swing voltage range centered about differential zero

[4] Vcross is defined at the voltage where Clock = Clock#, measured on a component test board (not in system)

[5] Only applies to the differential rising edge (Clock rising, Clock# falling)

[6] Matching applies to rising edge rate for Clock and falling edge rate for Clock#. It is measured using a +/-75mV window centered on the average cross point where Clock rising meets Clock# falling. The median cross point is used to calculate the voltage

[7] The max voltage including overshoot.

[8] The min voltage including undershoot.

[9] The total variation of all Vcross measurements in any particular system. Note this is a subset of V_cross min/max (V_Cross absolute) allowed. The intent is to limit Vcross induced modulation by setting C_cross_delta to be smaller than V_Cross absolute

Clock Jitter Specifications - Low Power Differential Outputs, Industrial Temperature Range

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
CPU Jitter - Cycle to Cycle	$CPUJ_{C2C}$	Differential Measurement		55	85	ps	1
SRC Jitter - Cycle to Cycle	$SRCJ_{C2C}$	Differential Measurement		55	125	ps	1
SATA Jitter - Cycle to Cycle	$SATAJ_{C2C}$	Differential Measurement		55	125	ps	1
DOT Jitter - Cycle to Cycle	$DOTJ_{C2C}$	Differential Measurement		55	250	ps	1
SRC Phase Jitter	$t_{jphasePLL}$	PCIe Gen 1		45	86	ps (p-p)	1,2,3
	$t_{jphaseLo}$	PCIe Gen 2 10kHz < f < 1.5MHz		2	3	ps (RMS)	1,2,3
	$t_{jphaseHigh}$	PCIe Gen 2 1.5MHz < f < Nyquist (50MHz)		2.6	3.1	ps (RMS)	1,2,3

NOTES: (unless otherwise noted, guaranteed by design and characterization, not 100% tested in production). C_L = 2pF, Rs = 0 ohms.

[1]JItter specs are specified as measured on a clock characterization board. System designers need to take special care not to use these numbers, as the in-system performance will be somewhat degraded. The receiver EMTS (chispet or CPU) will have the receiver jitter specs as measured in a real system.

[2] Phase jitter requirement: The designated Gen2 outputs will meet the reference clock jitter requirements from the PCI Express Gen2 Base Spec. The test is performed on a component test board under quiet conditions with all outputs on.

[3]See http://www.pcisig.com for complete specs

Electrical Characteristics - REF-14.318MHz, Industrial Temperature Range

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	Notes
Long Accuracy	ppm	see Tperiod min-max values	-100	0	100	ppm	2, 4
Clock period	Tperiod	14.318MHz output nominal	69.82033	69.84129	69.86224	ns	2, 3
Absolute min/max period	Tabs	14.318MHz output nominal	69.83400		70.84800	ns	2
CLK High Time	THIGH		29.97543		38.46654	V	
CLK Low time	TLOW		29.57543		38.26654	V	
Output High Current	IOH	VOH @MIN = 1.0 V, VOH@MAX = 3.135 V	-33		-33	mA	
Output Low Current	IOL	VOL @MIN = 1.95 V, VOL @MAX = 0.4 V	30		38	mA	
Rising/Falling Edge Slew Rate	t_{SLEW}	Measured between 0.8 to 2.0 V	1	1.8	4	V/ns	1
Duty Cycle	dt1	VT = 1.5 V	45	52.8	55	%	2
Jitter, Cycle to cycle	tjcyc-cyc	VT = 1.5 V		122	500	ps	2

NOTES: (unless otherwise noted, guaranteed by design and characterization, not 100% tested in production).

[1]Edge rate in system is measured from 0.8V to 2.0V at default slew rate control setting.

[2] Duty cycle, Peroid and Jitter are measured with respect to 1.5V

[3] The average period over any 1us period of time

[4] Using frequency counter with the measurment interval equal or greater that 0.15s, target frequency is 14.318180 MHz

Electrical Characteristics - 27MHz_Spread / 27MHz_NonSpread, Industrial Temperature Range

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	Notes
Long Accuracy	ppm	see Tperiod min-max values	-50		50	ppm	1,2
			-15		15		1,2,3
Clock period	T_{period}	27.000M outputs, 27M SS with SS OFF	37.0365		37.0376		
Output High Current	I_{OH}	VOH @MIN = 1.0 V, VOH@MAX = 3.135 V	-29		-23	mA	
Output Low Current	I_{OL}	VOL @MIN = 1.95 V, VOL @MAX = 0.4 V	29		27	mA	
Rising/Falling Edge Slew Rate	t_{SLEW}	Measured between 0.8 to 2.0 V	1	2	4	V/ns	1
Duty Cycle	d_{t1}	V_T = 1.5 V	45	50.4	55	%	
Jitter, 27MHz_NonSpread Output	t_{ltj}	Long Term (10us)		485	800	ps	
	t_{jpk-pk}	V_T = 1.5 V	-100		100	ps	
	$t_{jcyc-cyc}$	V_T = 1.5 V		57	120	ps	
Jitter, 27MHz_Spread Output	$t_{jcyc-cyc}$	V_T = 1.5 V SS% <= 1.5% pk to pk		108	200	ps	4
		V_T = 1.5 V, SS% > 1.5% pk to pk		140	200	ps	4

NOTES: (unless otherwise noted, guaranteed by design and characterization, not 100% tested in production).

[1] Edge rate in system is measured from 0.8V to 2.0V at default slew rate control setting.

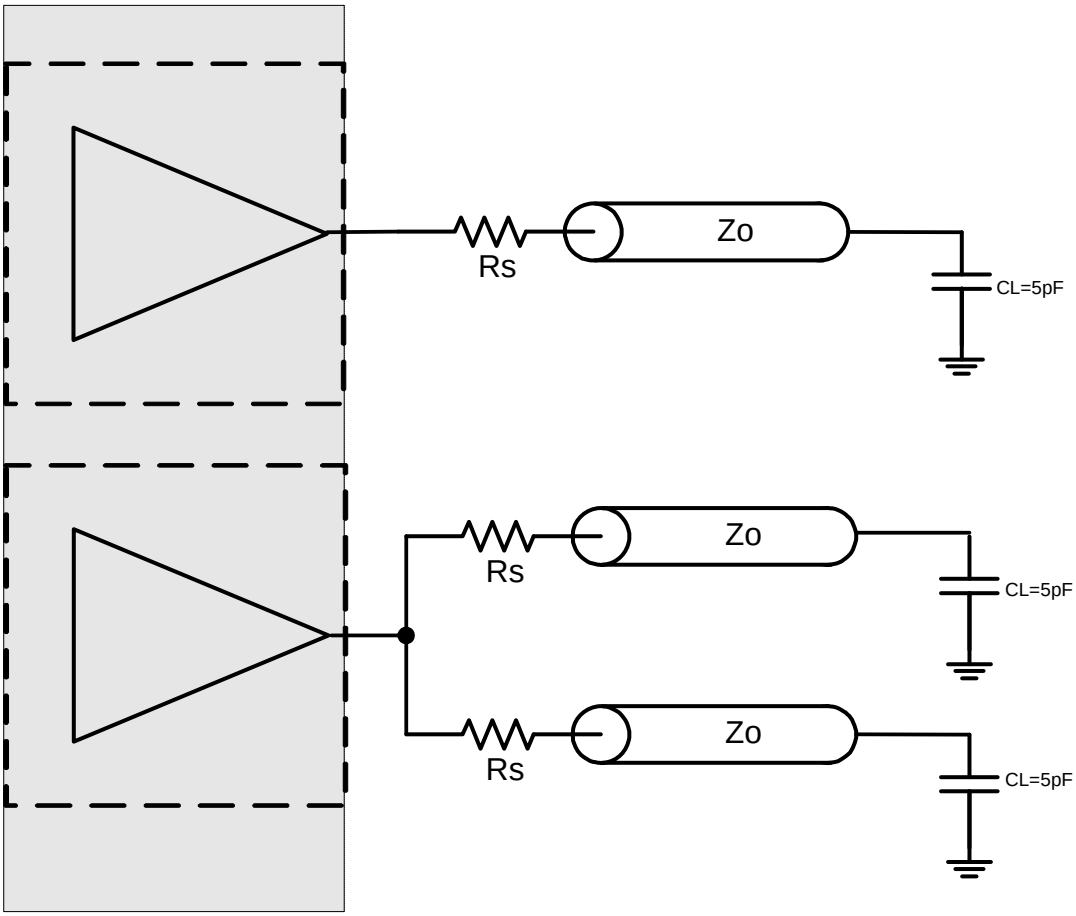
[2] All Long Term Accuracy and Clock Period specifications are guaranteed assuming that REF out is at 14.31818MHz

[3] At nominal temperature and voltage.

[4] Long term and peak to peak jitter do not apply to the 27MHz spreading output. The spread modulation directly impacts these values.

Single Ended Outputs

Test Load



Suggested Suggested termination resistors for various driving conditions are as follows for transmission lines with Zo = 50 ohms:

REF Output	Driving 1 load, Rs = 39 ohms
	Driving 2 loads, Rs = 22 ohms
27M SS and Non-SS outputs	Driving 1 load, Rs = 39 ohms
	Driving 2 loads, Rs = 22 ohms

Clock Periods Differential Outputs with Spread Spectrum Enabled

Measurement Window		1 Clock	1us	0.1s	0.1s	0.1s	1us	1 Clock		
Symbol		- c-c jitter	-SSC	-ppm error	0ppm	+ ppm error	+SSC	+ c-c jitter		
Definition		Absolute Period	Short-term Average	Long-Term Average	Period	Long-Term Average	Short-term Average	Absolute Period		
		Minimum	Minimum	Minimum	Nominal	Maximum	Maximum	Maximum	Units	Notes
Signal Name	SRC 100	9.87400	9.99900	9.99900	10.00000	10.00100	10.05130	10.17630	ns	1,2
	CPU 100	9.91400	9.99900	9.99900	10.00000	10.00100	10.05130	10.13630	ns	1,2
	CPU 133	7.41425	7.49925	7.49925	7.50000	7.50075	7.53845	7.62345	ns	1,2
	CPU 166	5.91440	5.99940	5.99940	6.00000	6.00060	6.03076	6.11576	ns	1,2
	CPU 200	4.91450	4.99950	4.99950	5.00000	5.00050	5.02563	5.11063	ns	1,2
	CPU 266	3.66463	3.74963	3.74963	3.75000	3.75038	3.76922	3.85422	ns	1,2
	CPU 333	2.91470	2.99970	2.99970	3.00000	3.00030	3.01538	3.10038	ns	1,2
	CPU 400	2.41475	2.49975	2.49975	2.50000	2.50025	2.51282	2.59782	ns	1,2

Clock Periods Differential Outputs with Spread Spectrum Disabled

Measurement Window		1 Clock	1us	0.1s	0.1s	0.1s	1us	1 Clock		
Symbol		- c-c jitter	-SSC	-ppm error	0ppm	+ ppm error	+SSC	+ c-c jitter		
Definition		Absolute Period	Short-term Average	Long-Term Average	Period	Long-Term Average	Short-term Average	Absolute Period		
		Minimum	Minimum	Minimum	Nominal	Maximum	Maximum	Maximum	Units	Notes
Signal Name	SRC 100	9.87400		9.99900	10.00000	10.00100		10.17630	ns	1,2
	CPU 100	9.91400		9.99900	10.00000	10.00100		10.13630	ns	1,2
	CPU 133	7.41425		7.49925	7.50000	7.50075		7.62345	ns	1,2
	CPU 166	5.91440		5.99940	6.00000	6.00060		6.11576	ns	1,2
	CPU 200	4.91450		4.99950	5.00000	5.00050		5.11063	ns	1,2
	CPU 266	3.66463		3.74963	3.75000	3.75038		3.85422	ns	1,2
	CPU 333	2.91470		2.99970	3.00000	3.00030		3.10038	ns	1,2
	CPU 400	2.41475		2.49975	2.50000	2.50025		2.59782	ns	1,2
	DOT 96	10.16560		10.41560	10.41670	10.41770		10.66770	ns	1,2

Notes:

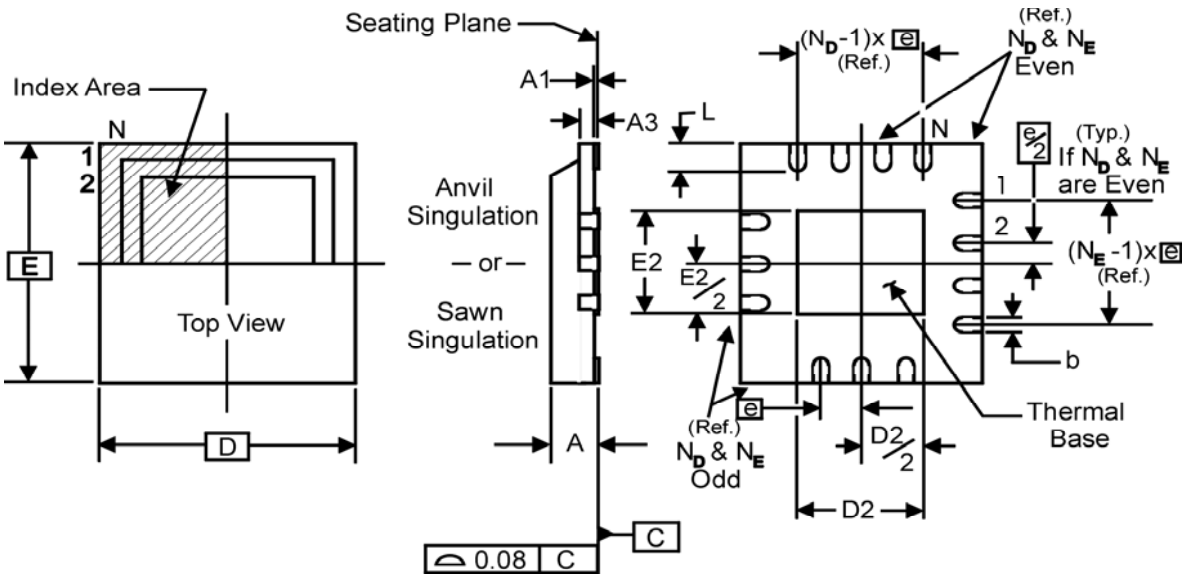
[1]Guaranteed by design and characterization, not 100% tested in production.

[2] All Long Term Accuracy and Clock Period specifications are guaranteed assuming that REFOUT is at 14.31818MHz

Test Clarification Table

Comments	HW		SW		
	FSLC/ TEST_SEL HW PIN	FSLB/ TEST_MODE HW PIN	TEST ENTRY BIT B9b3	REF/N or HI-Z B9b4	OUTPUT
	<2.0V	X	0	0	NORMAL
Power-up w/ TEST_SEL = 1 to enter test mode Cycle power to disable test mode FSLC./TEST_SEL -->3-level latched input If power-up w/ V>2.0V then use TEST_SEL If power-up w/ V<2.0V then use FSLC FSLB/TEST_MODE -->low Vth input TEST_MODE is a real time input	>2.0V	0	X	0	HI-Z
	>2.0V	0	X	1	REF/N
	>2.0V	1	X	0	REF/N
	>2.0V	1	X	1	REF/N
If TEST_SEL HW pin is 0 during power-up, test mode can be invoked through B9b3. If test mode is invoked by B9b3, only B9b4 is used to select HI-Z or REF/N FSLB/TEST_Mode pin is not used. Cycle power to disable test mode, one shot control	<2.0V	X	1	0	HI-Z
	<2.0V	X	1	1	REF/N

B9b3: 1= ENTER TEST MODE, Default = 0 (NORMAL OPERATION)
B9b4: 1= REF/N, Default = 0 (HI-Z)



THERMALLY ENHANCED, VERY THIN, FINE PITCH
QUAD FLAT / NO LEAD PLASTIC PACKAGE

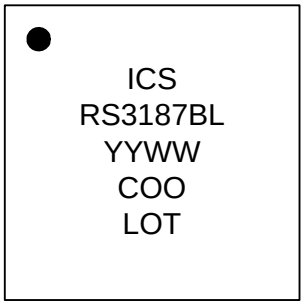
DIMENSIONS

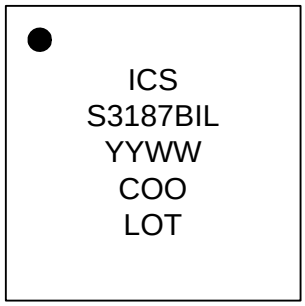
SYMBOL	MIN.	MAX.
A	0.8	1.0
A1	0	0.05
A3	0.20 Reference	
b	0.18	0.3
e	0.50 BASIC	

DIMENSIONS

SYMBOL	ICS 32L TOLERANCE
N	32
N_D	8
N_E	8
D x E BASIC	5.00 x 5.00
D2 MIN. / MAX.	3.0/ 3.3
E2 MIN. / MAX.	3.0/ 3.3
L MIN. / MAX.	0.30 / 0.50

Marking Diagrams





Ordering Information

Part / Order Number	Shipping Package	Package	Temperature
9LRS3187BKLF	Tubes	32-pin MLF	0 to +70° C
9LRS3187BKLFT	Tape and Reel	32-pin MLF	0 to +70° C
9LRS3187BKILF	Tubes	32-pin MLF	-40 to +85° C
9LRS3187BKILFT	Tape and Reel	32-pin MLF	-40 to +85° C

"LF" suffix to the part number are the Pb-Free configuration and are RoHS compliant.
"B" is the device revision designator (will not correlate to the datasheet revision).

Revision History

A	04/13/10	RDW	Released to final	
B	04/15/10	RDW	Revised Commercial and Industrial Electrical Tables for Consistency	
C	06/02/10	LPL	Added Features bullet: Meets PCIe Gen2 Specifications	1
D	10/01/10	LPL	Updated pins 1/2 descriptions	2
E	04/29/11	RDW	Updated marking diagrams	19
F	11/04/11	DC	Updated CPU/SRC specs under Key Specifications	1

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Данный компонент на территории Российской Федерации

Вы можете приобрести в компании MosChip.

Для оперативного оформления запроса Вам необходимо перейти по данной ссылке:

http://moschip.ru/get-element

Вы можете разместить у нас заказ для любого Вашего проекта, будь то серийное производство или разработка единичного прибора.

В нашем ассортименте представлены ведущие мировые производители активных и пассивных электронных компонентов.

Нашей специализацией является поставка электронной компонентной базы двойного назначения, продукции таких производителей как XILINX, Intel (ex.ALTERA), Vicor, Microchip, Texas Instruments, Analog Devices, Mini-Circuits, Amphenol, Glenair.

Сотрудничество с глобальными дистрибьюторами электронных компонентов, предоставляет возможность заказывать и получать с международных складов практически любой перечень компонентов в оптимальные для Вас сроки.

На всех этапах разработки и производства наши партнеры могут получить квалифицированную поддержку опытных инженеров.

Система менеджмента качества компании отвечает требованиям в соответствии с ГОСТ Р ИСО 9001, ГОСТ РВ 0015-002 и ЭС РД 009

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