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Two Output Differential Buffer for PCIe Gen1 & Gen2

ICS9DB102

Description

The **ICS9DB102** zero-delay buffer supports PCI Express clocking requirements. The **ICS9DB102** is driven by a differential SRC output pair from an ICS CK410/CK505-compliant main clock. It attenuates jitter on the input clock and has a selectable PLL Band Width to maximize performance in systems with or without Spread-Spectrum clocking.

Output Features

- 2 - 0.7V current mode differential output pairs (HCSL)

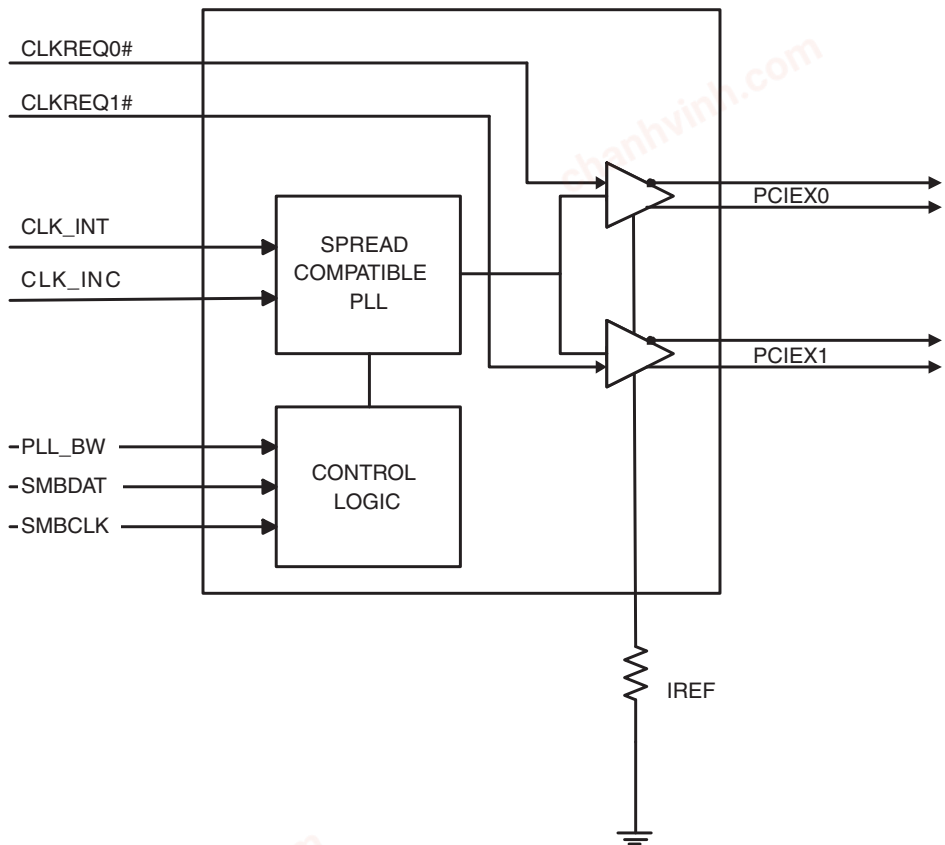
Features/Benefits

- CLKREQ# pin for outputs 1 and 4/output enable for Express Card applications
- PLL or bypass mode/PLL can dejitter incoming clock
- Selectable PLL bandwidth/minimizes jitter peaking in downstream PLL's
- Spread Spectrum Compatible/tracks spreading input clock for low EMI
- SMBus Interface/unused outputs can be disabled
- Industrial temperature range available

Key Specifications

- Cycle-to-cycle jitter < 35ps
- Output-to-output skew < 25ps

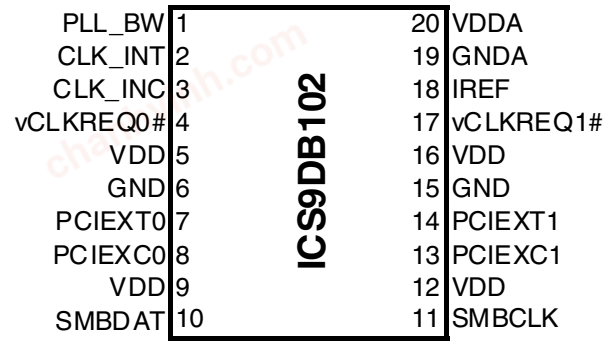
Functional Block Diagram



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Pin Configuration



Note: Pins preceeded by ' v ' have internal 120K ohm pull down resistors

20-pin SSOP & TSSOP

Power Groups

Pin Number		Description
VDD	GND	
5,9,12,16	6,15	PCI Express Outputs
9	6	SMBUS
20	19	IREF
20	19	Analog VDD & GND for PLL core

Pin Description

PIN #	PIN NAME	PIN TYPE	DESCRIPTION
1	PLL_BW	IN	3.3V input for selecting PLL Band Width 0 = low, 1= high
2	CLK_INT	IN	True Input for differential reference clock.
3	CLK_INC	IN	Complementary Input for differential reference clock.
4	vCLKREQ0#	IN	Output enable for PCI Express output pair 0. 0 = enabled, 1 =disabled
5	VDD	PWR	Power supply, nominal 3.3V
6	GND	PWR	Ground pin.
7	PCIEXT0	OUT	True clock of differential PCI_Express pair.
8	PCIEXC0	OUT	Complementary clock of differential PCI_Express pair.
9	VDD	PWR	Power supply, nominal 3.3V
10	SMBDAT	I/O	Data pin of SMBUS circuitry, 5V tolerant
11	SMBCLK	IN	Clock pin of SMBUS circuitry, 5V tolerant
12	VDD	PWR	Power supply, nominal 3.3V
13	PCIEXC1	OUT	Complementary clock of differential PCI_Express pair.
14	PCIEXT1	OUT	True clock of differential PCI_Express pair.
15	GND	PWR	Ground pin.
16	VDD	PWR	Power supply, nominal 3.3V
17	vCLKREQ1#	IN	Output enable for PCI Express output pair 1. 0 = enabled, 1 =disabled
18	IREF	OUT	This pin establishes the reference for the differential current-mode output pairs. It requires a fixed precision resistor to ground. 475ohm is the standard value for 100ohm differential impedance. Other impedances require different values. See data sheet.
19	GNDA	PWR	Ground pin for the PLL core.
20	VDDA	PWR	3.3V power for the PLL core.

Note:
Pins preceeded by ' v ' have internal 120K ohm pull down resistors

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Absolute Max

Symbol	Parameter	Min	Max	Units
VDDA	3.3V Core Supply Voltage		V_{DD} + 0.5V	V
VDD	3.3V Output Supply Voltage	GND - 0.5	V_{DD} + 0.5V	V
Ts	Storage Temperature	-65	150	°C
Tcase	Case Temperature		115	°C
ESD prot	Input ESD protection human body model	2000		V

Electrical Characteristics - Input/Supply/Common Output Parameters

T_A = Tambient; Supply Voltage V_{DD} = 3.3 V +/-5%

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
Tambient	Tambcom	Commercial range	0		70	°C	1
	Tambind	Industrial range	-40		85	°C	1
Input High Voltage	V_{IH}	3.3 V +/-5%	2		V_{DD} + 0.3	V	1
Input Low Voltage	V_{IL}	3.3 V +/-5%	V_{SS} - 0.3		0.8	V	1
Input High Current	I_{IH}	V_{IN} = V_{DD}	-5		5	uA	1
Input Low Current	I_{IL1}	V_{IN} = 0 V; Inputs with no pull-up resistors	-5			uA	1
	I_{IL2}	V_{IN} = 0 V; Inputs with pull-up resistors	-200			uA	1
Operating Supply Current	$I_{DD3.3OP}$	Full Active, C_L = Full load;		75	100	mA	1
		all differential pairs tri-stated		27	50	mA	1
Input Frequency[3]	F_i	V_{DD} = 3.3 V	99	100	101	MHz	1
Pin Inductance[1]	L_{pin}				7	nH	1
Input Capacitance[1]	C_{IN}	Logic Inputs			5	pF	1
	C_{OUT}	Output pin capacitance			4.5	pF	1
Clk Stabilization[1,2]	T_{STAB}	From V_{DD} Power-Up to 1st clock			1.8	ms	1
Modulation Frequency		Triangular Modulation	30		33	kHz	1
Spread Spectrum Modulation Frequency	f_{MOD}	Lexmark Modulation	25		45	KHz	1
OE# Latency	$t_{LATOE\#}$	DIF start after OE# assertion DIF stop after OE# deassertion	1		3	cycles	1,2
PLL Bandwidth	BW	PLL Bandwidth when PLL_BW=0	400	500	1000	KHz	1
		PLL Bandwidth when PLL_BW=1	2	2.5	3	MHz	1
SMBus Voltage	V_{DD}		2.7		5.5	V	1
Low-level Output Voltage	$V_{OLSMBUS}$	@ I_{PULLUP}			0.4	V	1
Current sinking at V_{OL} = 0.4 V	I_{PULLUP}	SMBus SDATA pin	4			mA	1
SCLK/SDATA Clock/Data Rise Time	T_{RI2C}	(Max VIL - 0.15) to (Min VIH + 0.15)			1000	ns	1
SCLK/SDATA Clock/Data Fall Time	T_{FI2C}	(Min VIH + 0.15) to (Max VIL - 0.15)			300	ns	1

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

[2]Time from deassertion until outputs are >200mV

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Electrical Characteristics - PCIEX 0.7V Current Mode Differential Pair

T_A = Tambient; V_{DD} = 3.3 V +/-5%; C_L =2pF, R_S=33.2Ω, R_P=49.9Ω, I_{REF} = 475Ω

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
Current Source Output Impedance	Zo	$V_O = V_x$	3000			Ω	1
Voltage High	VHigh	Statistical measurement on single ended signal using	660		850	mV	1,3
Voltage Low	VLow		-150		150		1,3
Max Voltage	Vovs	Measurement on single ended signal using absolute value.			1150	mV	1,3
Min Voltage	Vuds		-300				1,3
Crossing Voltage (abs)	Vcross(abs)		250	350	550	mV	1,3
Crossing Voltage (var)	d-Vcross	Variation of crossing over all edges		12	140	mV	1,3
Long Accuracy	ppm	see Tperiod min-max values			0	ppm	1,2
Average period	Tperiod	100.00MHz nominal	9.9970		10.0030	ns	2
		100.00MHz spread	9.9970		10.0533	ns	2
Absolute min period	Tabsmin	100.00MHz nominal/spread	9.8720			ns	1,2
Rise Time	t_r	V_{OL} = 0.175V, V_{OH} = 0.525V	175		700	ps	1
Fall Time	t_f	V_{OH} = 0.525V V_{OL} = 0.175V	175		700	ps	1
Rise Time Variation	d-t_r			30	125	ps	1
Fall Time Variation	d-t_f			30	125	ps	1
Input to Output Delay	t_{pd}	PLL Mode.	0		150	ps	1
	t_{pdbyp}	Bypass mode	3.7		4.2	ns	1
Duty Cycle	d_{t3}	Measurement from differential wavefrom	45		55	%	1
Output-to-Output Skew	t_{sk3}	V_T = 50%			25	ps	1
Jitter, Cycle to cycle	$t_{jcyc-cyc}$	PLL mode. Measurement from differential wavefrom			35	ps	1
	$t_{jcyc-cycbyp}$	Additve Jitter in Bypass Mode			30	ps	1

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

[2] The 9DB102 does not add a ppm error to the input clock

[3]$I_{REF} = V_{DD}/(3xR_R)$. For R_R = 475Ω (1%), I_{REF} = 2.32mA. I_{OH} = 6 x I_{REF} and V_{OH} = 0.7V @ Z_O=50Ω.

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Electrical Characteristics - PLL Parameters

T_A = Tambient; Supply Voltage V_{DD} = 3.3 V +/-5%

Group	Parameter	Description	Min	Typ	Max	Units	Notes
PLL Jitter Peaking	$j_{peak-hibw}$	(PLL_BW = 1)	0	1	2.5	dB	1,4
PLL Jitter Peaking	$j_{peak-lobw}$	(PLL_BW = 0)	0	1	2	dB	1,4
PLL Bandwidth	pll_{HIBW}	(PLL_BW = 1)	2	2.5	3	MHz	1,5
PLL Bandwidth	pll_{LOBW}	(PLL_BW = 0)	0.4	0.5	1	MHz	1,5
Jitter, Phase	$t_{jphasePLL}$	PCIe Gen 1 phase jitter (1.5 - 22 MHz)		40	108	ps	1,2,3
		PCIe Gen 2 jitter (8-16 MHz, 5-16 MHz) Hi-Band >1.5MHz (PLL_BW=1)		2.7	3.1	ps rms	1,2,3
		PCIe Gen 2 jitter (8-16 MHz, 5-16 MHz) Hi-Band >1.5MHz (PLL_BW=0)		2.2	3.1	ps rms	1,2,3
		PCIe Gen 2 jitter (8-16 MHz, 5-16 MHz) Lo-Band <1.5MHz		1.3	3	ps rms	1,2,3

NOTES:

1. Guaranteed by design and characterization, not 100% tested in production.
2. See http://www.pcisig.com for complete specs
3. Device driven by 932S421BGLF or equivalent
4. Measured as maximum pass band gain. At frequencies within the loop BW, highest point of magnification is called PLL jitter peaking.
5. Measured at 3 db down or half power point.

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SRC Reference Clock			
Common Recommendations for Differential Routing	Dimension or Value	Unit	Figure
L1 length, route as non-coupled 50ohm trace	0.5 max	inch	1
L2 length, route as non-coupled 50ohm trace	0.2 max	inch	1
L3 length, route as non-coupled 50ohm trace	0.2 max	inch	1
Rs	33	ohm	1
Rt	49.9	ohm	1

Down Device Differential Routing			
L4 length, route as coupled microstrip 100ohm differential trace	2 min to 16 max	inch	1
L4 length, route as coupled stripline 100ohm differential trace	1.8 min to 14.4 max	inch	1

Differential Routing to PCI Express Connector			
L4 length, route as coupled microstrip 100ohm differential trace	0.25 to 14 max	inch	2
L4 length, route as coupled stripline 100ohm differential trace	0.225 min to 12.6 max	inch	2

Figure 1: Down Device Routing

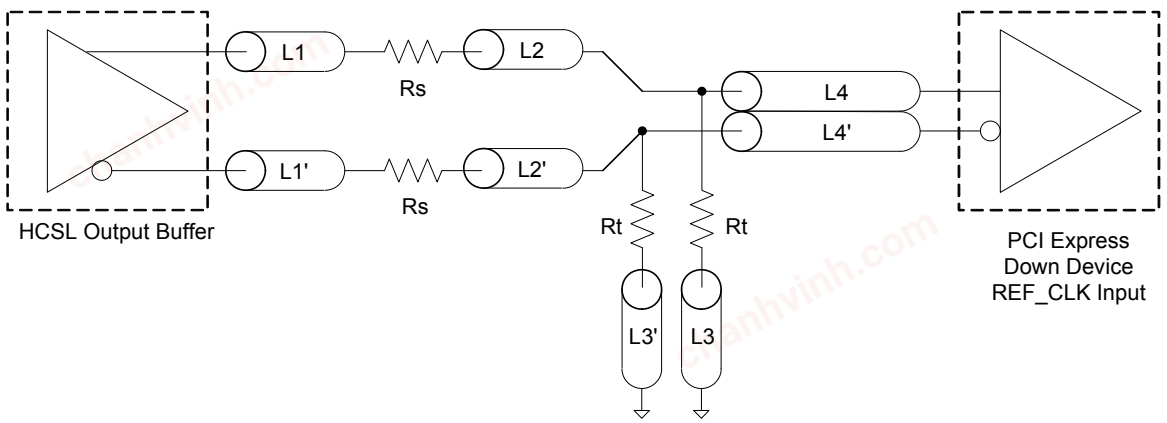
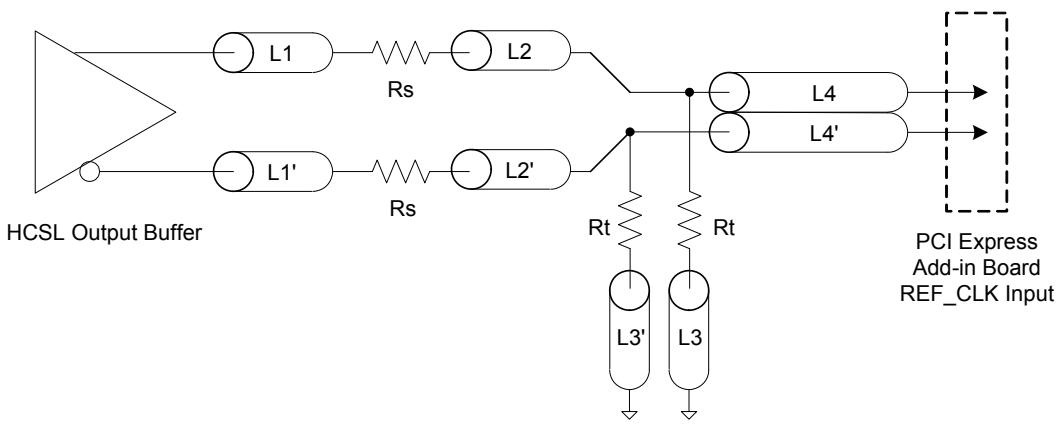


Figure 2: PCI Express Connector Routing



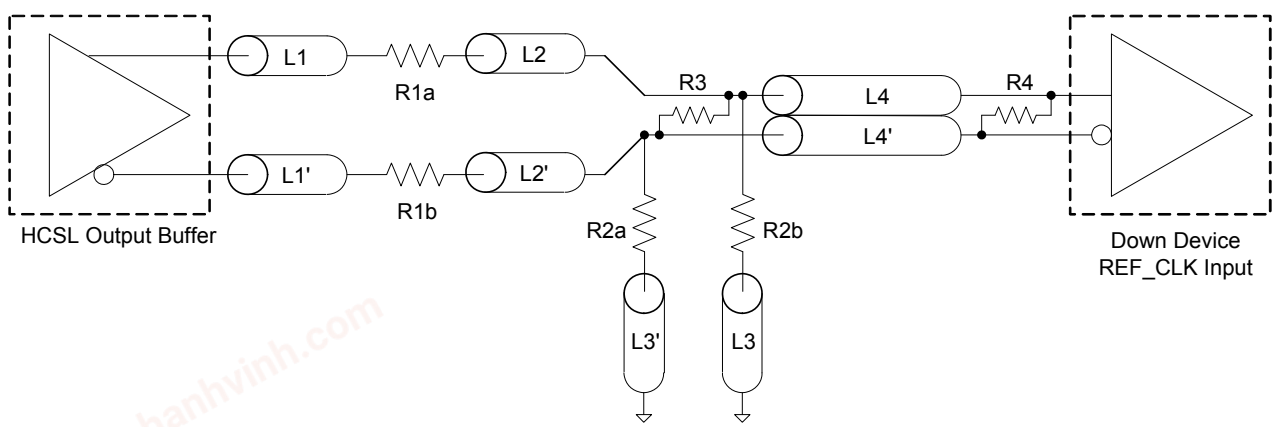
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Alternative Termination for LVDS and other Common Differential Signals (figure 3)							
Vdiff	Vp-p	Vcm	R1	R2	R3	R4	Note
0.45v	0.22v	1.08	33	150	100	100	
0.58	0.28	0.6	33	78.7	137	100	
0.80	0.40	0.6	33	78.7	none	100	ICS874003i-02 input compatible
0.60	0.3	1.2	33	174	140	100	Standard LVDS

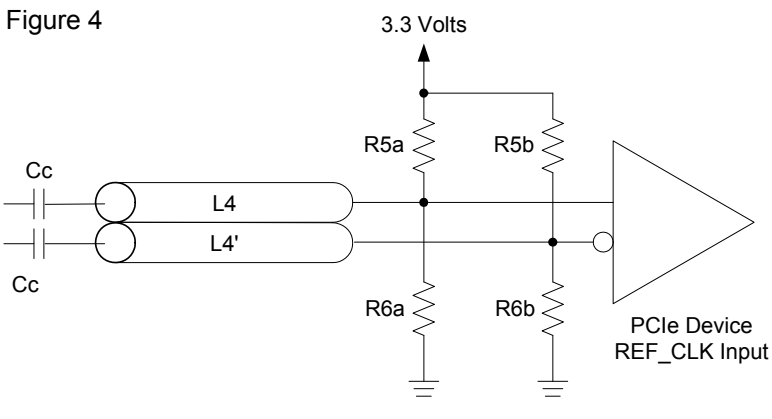
R1a = R1b = R1
R2a = R2b = R2

Figure 3



Cable Connected AC Coupled Application (figure 4)		
Component	Value	Note
R5a, R5b	8.2K 5%	
R6a, R6b	1K 5%	
Cc	0.1 µF	
Vcm	0.350 volts	

Figure 4



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General SMBus serial interface information for the ICS9DB102

How to Write:

- Controller (host) sends a start bit.
- Controller (host) sends the write address D4 (h)
- IDT clock will ***acknowledge***
- Controller (host) sends the begining 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 D4 (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 D5 (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
- Controllor (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 D4(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 D4(h)		
WR	WRite	
		ACK
Beginning Byte = N		
		ACK
RT	Repeat starT	
Slave Address D5(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	

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SMBus Table: Device Control Register, READ/WRITE ADDRESS (D4/D5)

Byte 0	Pin #	Name	Control Function	Type	0	1	PWD
Bit 7	-	SW_EN	Enables SMBus Control	RW	Functions controlled by SMBus registers	Functions controlled by device pins	1
Bit 6	-	RESERVED		RW	-		X
Bit 5	-	RESERVED		RW	-		X
Bit 4	-	RESERVED		RW	-		X
Bit 3	-	RESERVED		RW	-		X
Bit 2	-	RESERVED		RW	-		X
Bit 1	-	PLL BW #adjust	Selects PLL Bandwidth	RW	Low BW	High BW	1
Bit 0	-	PLL Enable	Bypasses PLL for board test	RW	PLL bypassed (fan out mode)	PLL enabled (ZDB mode)	1

SMBus Table: Output Enable Register

Byte 1	Pin #	Name	Control Function	Type	0	1	PWD
Bit 7	-	RESERVED		RW	-		X
Bit 6	-	RESERVED		RW	-		X
Bit 5	-	RESERVED		RW	-		X
Bit 4	-	RESERVED		RW	-		X
Bit 3	-	RESERVED		RW	-		X
Bit 2	-	RESERVED		RW	-		X
Bit 1	-	RESERVED		RW	-		X
Bit 0	-	RESERVED		RW	-		X

SMBus Table: Function Select Register

Byte 2	Pin #	Name	Control Function	Type	0	1	PWD
Bit 7		RESERVED		RW	-		X
Bit 6		RESERVED		RW	-		X
Bit 5	-	RESERVED		RW	-		X
Bit 4	-	RESERVED		RW	-		X
Bit 3	-	RESERVED		RW	-		X
Bit 2	-	RESERVED		RW	-		X
Bit 1	-	RESERVED		RW	-		X
Bit 0	-	RESERVED		RW	-		X

SMBus Table: Vendor & Revision ID Register

Byte 3	Pin #	Name	Control Function	Type	0	1	PWD
Bit 7	-	RID3	REVISION ID	R	-	-	0
Bit 6	-	RID2		R	-	-	0
Bit 5	-	RID1		R	-	-	0
Bit 4	-	RID0		R	-	-	1
Bit 3	-	VID3	VENDOR ID	R	-	-	0
Bit 2	-	VID2		R	-	-	0
Bit 1	-	VID1		R	-	-	0
Bit 0	-	VID0		R	-	-	1

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SMBus Table: DEVICE ID

Byte 4	Pin #	Name	Control Function	Type	0	1	PWD
Bit 7	-			R	-		0
Bit 6	-			R	-		0
Bit 5	-			R	-		0
Bit 4	-		Device ID	R	-		0
Bit 3	-		= 06 Hex	R	-		0
Bit 2	-			R	-		1
Bit 1	-			R	-		1
Bit 0	-			R	-		0

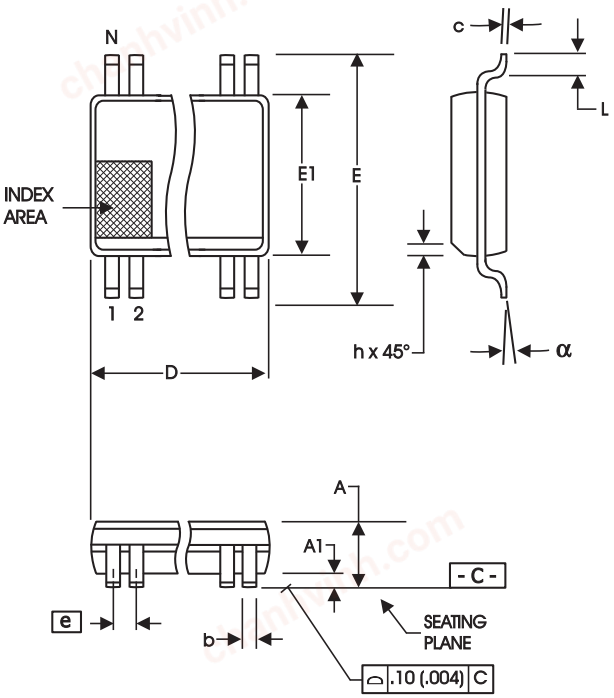
SMBus Table: Byte Count Register

Byte 5	Pin #	Name	Control Function	Type	0	1	PWD
Bit 7	-	BC7		RW	-	-	0
Bit 6	-	BC6		RW	-	-	0
Bit 5	-	BC5		RW	-	-	0
Bit 4	-	BC4		RW	-	-	0
Bit 3	-	BC3	Writing to this register will configure how many bytes will be read back, default is 06 = 6 bytes.	RW	-	-	0
Bit 2	-	BC2		RW	-	-	1
Bit 1	-	BC1		RW	-	-	1
Bit 0	-	BC0		RW	-	-	0

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20-Pin SSOP Package Drawing and Dimensions



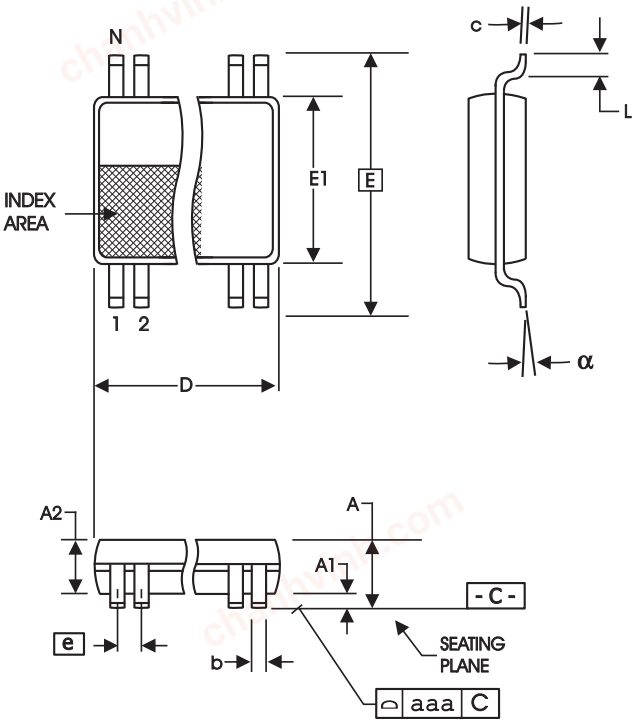
20-Lead, 150 mil SSOP (QSOP)

SYMBOL	In Millimeters COMMON DIMENSIONS		In Inches COMMON DIMENSIONS	
	MIN	MAX	MIN	MAX
A	1.35	1.75	.053	.069
A1	0.10	0.25	.004	.010
A2	--	1.50	--	.059
b	0.20	0.30	.008	.012
c	0.18	0.25	.007	.010
D	8.55	8.75	.337	.344
E	5.80	6.20	.228	.244
E1	3.80	4.00	.150	.157
e	0.635 BASIC		0.025 BASIC	
L	0.40	1.27	.016	.050
N	20		20	
a	0°	8°	0°	8°
ZD	1.47		.058	

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20-Pin TSSOP Package Drawing and Dimensions



20-Lead, 4.40 mm. Body, 0.65 mm. Pitch TSSOP
(173 mil) (25.6 mil)

SYMBOL	In Millimeters COMMON DIMENSIONS		In Inches COMMON DIMENSIONS	
	MIN	MAX	MIN	MAX
A	--	1.20	--	.047
A1	0.05	0.15	.002	.006
A2	0.80	1.05	.032	.041
b	0.19	0.30	.007	.012
c	0.09	0.20	.0035	.008
D	6.40	6.60	.252	.260
E	6.40 BASIC		0.252 BASIC	
E1	4.30	4.50	.169	.177
e	0.65 BASIC		0.0256 BASIC	
L	0.45	0.75	.018	.030
N	20		20	
a	0°	8°	0°	8°
aaa	--	0.10	--	.004

Reference Doc.: JEDEC Publication 95, MO-153

10-0035

Ordering Information

Part / Order Number	Shipping Packaging	Package	Temperature
9DB102BFLF	Tubes	20-pin SSOP	0 to +70°C
9DB102BFLFT	Tape and Reel	20-pin SSOP	0 to +70°C
9DB102BFILF	Tubes	20-pin SSOP	-40 to +85°C
9DB102BFILFT	Tape and Reel	20-pin SSOP	-40 to +85°C
9DB102BGLF	Tubes	20-pin TSSOP	0 to +70°C
9DB102BGLFT	Tape and Reel	20-pin TSSOP	0 to +70°C
9DB102BGILF	Tubes	20-pin TSSOP	-40 to +85°C
9DB102BGILFT	Tape and Reel	20-pin TSSOP	-40 to +85°C

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

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Revision History

Rev.	Originator	Issue Date	Description	Page #
F		8/6/2007	1. Added Phase Noise Parameters, Updated input to output delay values. 2. PLL BW moved to PLL parameters table. 3. Added terminations tables.	Various
G		12/14/2007	Updated General SMBus Interface Information.	8
H		10/29/2008	Corrected "HCSL" typos.	1, 6, 7
J		1/15/2010	1. Added I-temp electricals 2. Changed datasheet title 3. Updated Input Frequency parameter 4. Updated ordering information	Various
K	RW	4/1/2010	Updated ordering info for Rev B	
L	DC	9/28/2010	Updated package dimension tables	11, 12
M	RDW	1/27/2011	Updated Termination Figure 4.	7
N	RDW	4/20/2011	Changed pulldown indicator on CLKREQ# pins to correct pin description of those pins.	
P	AT	5/24/2012	Added OE# Latency spec to Common Input/Output Parameters table	3
Q	J. Chao	8/27/2013	Updated PLL Bandwidth specs per latest characterization data,	3

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