

# 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)

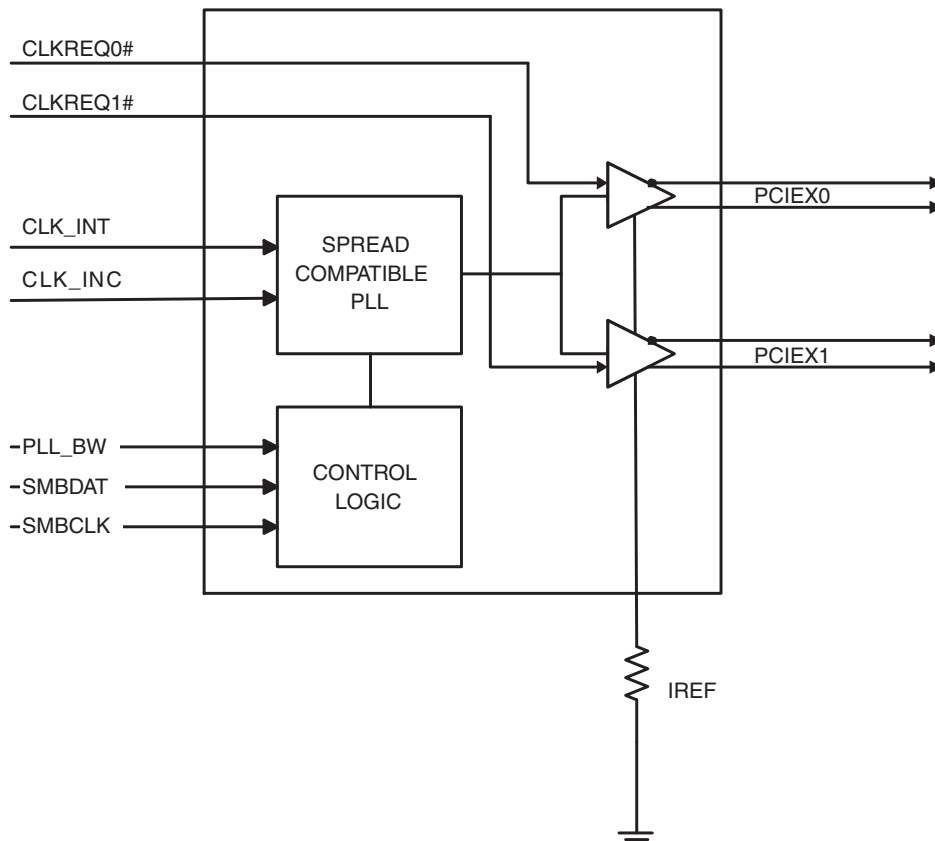
## Features/Benefits

- 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



## Pin Configuration

PLL_BW	1	ICS9DB102	20	VDDA
CLK_INT	2		19	GND A
CLK_INC	3		18	IREF
**CLKREQ0#	4		17	**CLKREQ1#
VDD	5		16	VDD
GND	6		15	GND
PCIEXT0	7		14	PCIEXT1
PCIEXC0	8		13	PCIEXC1
VDD	9		12	VDD
SMBDAT	10		11	SMBCLK

**Note:** Pins preceded by '\*\*' 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	INPUT	3.3V input for selecting PLL Band Width 0 = low, 1 = high
2	CLK_INT	INPUT	"True" reference clock input.
3	CLK_INC	INPUT	"Complementary" reference clock input.
4	**CLKREQ0#	INPUT	Output enable for SRC/PCI Express output pair '0' 0 = enabled, 1 = tri-stated
5	VDD	POWER	Power supply, nominal 3.3V
6	GND	POWER	Ground pin.
7	PCIEXT0	OUTPUT	True clock of differential PCI Express pair.
8	PCIEXC0	OUTPUT	Complement clock of differential PCI Express pair.
9	VDD	POWER	Power supply, nominal 3.3V
10	SMBDAT	I/O	Data pin of SMBUS circuitry, 5V tolerant
11	SMBCLK	INPUT	Clock pin of SMBUS circuitry, 5V tolerant
12	VDD	POWER	Power supply, nominal 3.3V
13	PCIEXC1	OUTPUT	Complement clock of differential PCI Express pair.
14	PCIEXT1	OUTPUT	True clock of differential PCI Express pair.
15	GND	POWER	Ground pin.
16	VDD	POWER	Power supply, nominal 3.3V
17	**CLKREQ1#	INPUT	Output enable for SRC/PCI Express output pair '1' 0 = enabled, 1 = tri-stated
18	IREF	OUTPUT	This pin establishes the reference current for the differential current-mode output pairs. This pin requires a fixed precision resistor tied to ground in order to establish the appropriate current. 475 ohms is the standard value.
19	GND A	POWER	Ground pin for the PLL core.
20	VDDA	POWER	3.3V power for the PLL core.

**Note:**

Pins preceded by '\*\*' have internal 120K ohm pull down resistors

## 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<sub>A</sub> = Tambient; Supply Voltage V<sub>DD</sub> = 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 <sub>IH</sub>	3.3 V +/-5%	2		V <sub>DD</sub> + 0.3	V	1
Input Low Voltage	V <sub>IL</sub>	3.3 V +/-5%		V <sub>SS</sub> - 0.3	0.8	V	1
Input High Current	I <sub>IH</sub>	V <sub>IN</sub> = V <sub>DD</sub>	-5		5	uA	1
Input Low Current	I <sub>IL1</sub>	V <sub>IN</sub> = 0 V; Inputs with no pull-up resistors	-5			uA	1
	I <sub>IL2</sub>	V <sub>IN</sub> = 0 V; Inputs with pull-up resistors	-200			uA	1
Operating Supply Current	I <sub>DD3.3OP</sub>	Full Active, C <sub>L</sub> = Full load;		75	100	mA	1
		all differential pairs tri-stated		27	50	mA	1
Input Frequency <sup>3</sup>	F <sub>i</sub>	V <sub>DD</sub> = 3.3 V	80	100	105	MHz	1
Pin Inductance <sup>1</sup>	L <sub>pin</sub>				7	nH	1
Input Capacitance <sup>1</sup>	C <sub>IN</sub>	Logic Inputs			5	pF	1
	C <sub>OUT</sub>	Output pin capacitance			4.5	pF	1
Clk Stabilization <sup>1,2</sup>	T <sub>STAB</sub>	From V <sub>DD</sub> Power-Up to 1st clock			1.8	ms	1
Modulation Frequency		Triangular Modulation	30		33	kHz	1
Spread Spectrum Modulation Frequency	f <sub>MOD</sub>	Lexmark Modulation	25		45	KHz	1
PLL Bandwidth	BW	PLL Bandwidth when PLL_BW=0		400		KHz	1
		PLL Bandwidth when PLL_BW=1		1.2		MHz	1
SMBus Voltage	V <sub>DD</sub>		2.7		5.5	V	1
Low-level Output Voltage	V <sub>OL</sub> SMBUS	@ I <sub>PULLUP</sub>			0.4	V	1
Current sinking at V <sub>OL</sub> = 0.4 V	I <sub>PULLUP</sub>	SMBus SDATA pin	4			mA	1
SCLK/SDATA Clock/Data Rise Time	T <sub>RI2C</sub>	(Max V <sub>IL</sub> - 0.15) to (Min V <sub>IH</sub> + 0.15)			1000	ns	1
SCLK/SDATA Clock/Data Fall Time	T <sub>FI2C</sub>	(Min V <sub>IH</sub> + 0.15) to (Max V <sub>IL</sub> - 0.15)			300	ns	1

<sup>1</sup>Guaranteed by design and characterization, not 100% tested in production.

### Electrical Characteristics - PCIeX 0.7V Current Mode Differential Pair

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

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
Current Source Output Impedance	Zo	$V_O = V_x$	3000			$\Omega$	1
Voltage High	VHigh	Statistical measurement on single ended signal using	660		850	mV	1,3
Voltage Low	VLow		-150		150		
Max Voltage	Vovs	Measurement on single ended signal using absolute value.			1150	mV	1,3
Min Voltage	Vuds		-300				
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 <sub>r</sub>	$V_{OL} = 0.175V$ , $V_{OH} = 0.525V$	175		700	ps	1
Fall Time	t <sub>f</sub>	$V_{OH} = 0.525V$ $V_{OL} = 0.175V$	175		700	ps	1
Rise Time Variation	d-t <sub>r</sub>			30	125	ps	1
Fall Time Variation	d-t <sub>f</sub>			30	125	ps	1
Input to Output Delay	t <sub>pd</sub>	PLL Mode.	0		150	ps	1
	t <sub>pdbyb</sub>	Bypass mode	3.7		4.2	ns	1
Duty Cycle	d <sub>t3</sub>	Measurement from differential waveform	45		55	%	1
Output-to-Output Skew	t <sub>sk3</sub>	$V_T = 50\%$			25	ps	1
Jitter, Cycle to cycle	t <sub>jycyc-cyc</sub>	PLL mode. Measurement from differential waveform			35	ps	1
	t <sub>jycyc-cycbyp</sub>	Additive Jitter in Bypass Mode			30	ps	1

<sup>1</sup>Guaranteed by design, not 100% tested in production.

<sup>2</sup> The 9DB102 does not add a ppm error to the input clock

<sup>3</sup> $I_{REF} = V_{DD}/(3 \times R_R)$ . For  $R_R = 475\Omega$  (1%),  $I_{REF} = 2.32mA$ .  $I_{OH} = 6 \times I_{REF}$  and  $V_{OH} = 0.7V @ Z_O=50\Omega$ .

## Electrical Characteristics - PLL Parameters

$T_A$  = Tambient; Supply Voltage  $V_{DD} = 3.3\text{ V} \pm 5\%$

Group	Parameter	Description	Min	Typ	Max	Units	Notes
PLL Jitter Peaking	$j_{\text{peak-hibw}}$	(PLL_BW = 1)	0	1	2.5	dB	1,4
PLL Jitter Peaking	$j_{\text{peak-lobw}}$	(PLL_BW = 0)	0	1	2	dB	1,4
PLL Bandwidth	$p_{\text{ll\_HIBW}}$	(PLL_BW = 1)	2	2.5	3	MHz	1,5
PLL Bandwidth	$p_{\text{ll\_LOBW}}$	(PLL_BW = 0)	0.4	0.5	1	MHz	1,5
Jitter, Phase	$t_{\text{jphasePLL}}$	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.

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
$R_s$	33	ohm	1
$R_t$	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

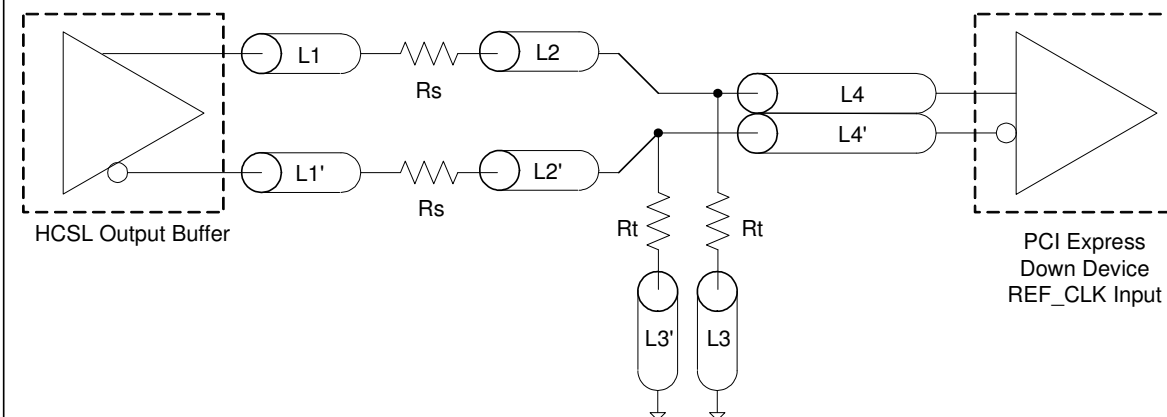
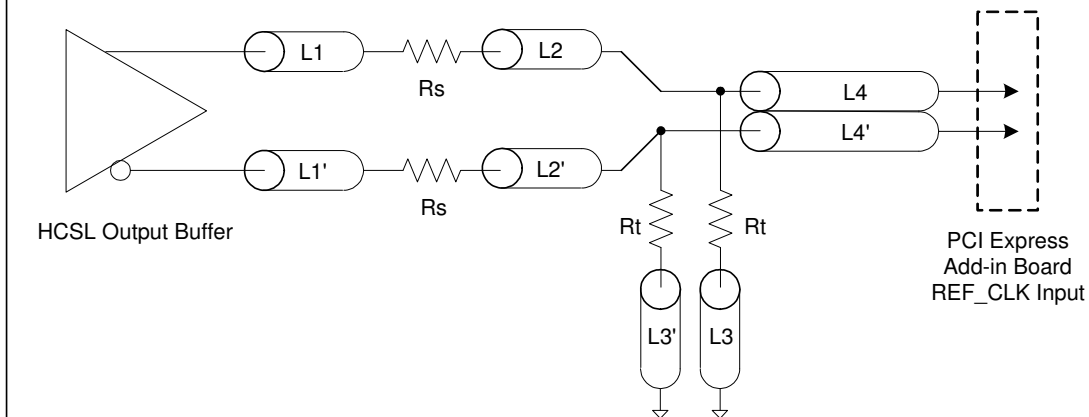


Figure 2: PCI Express Connector Routing



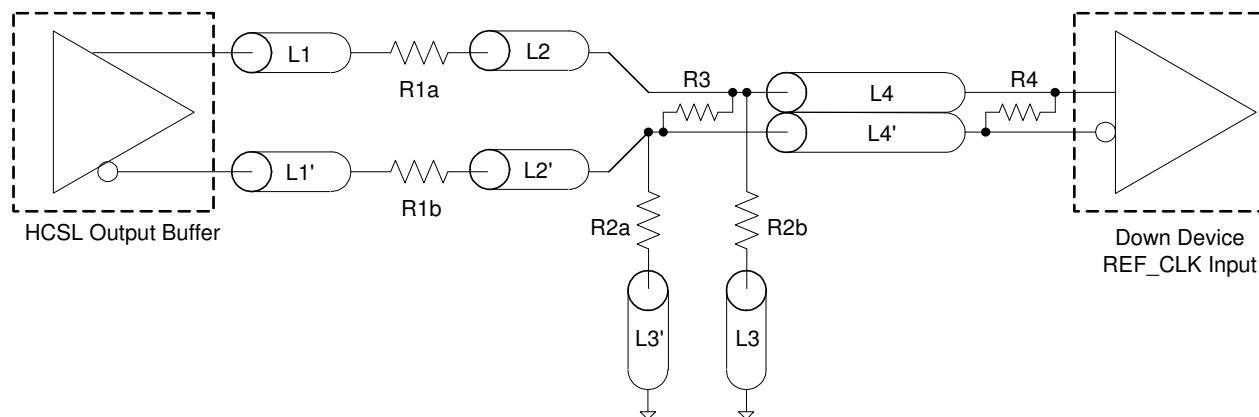
**Alternative Termination for LVDS and other Common Differential Signals (figure 3)**

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

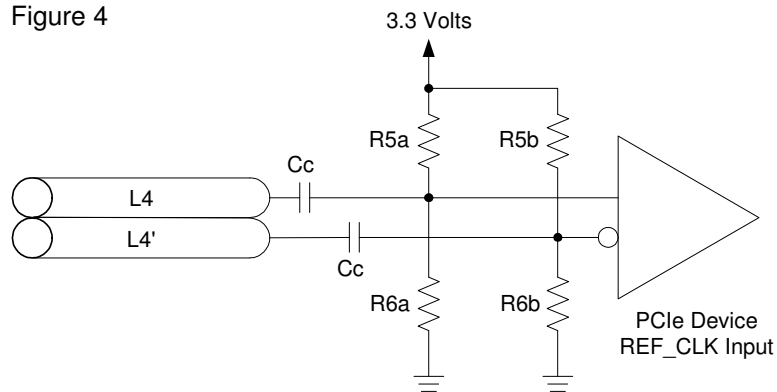
Figure 3



**Cable Connected AC Coupled Application (figure 4)**

Component	Value	Note
R5a, R5b	8.2K 5%	
R6a, R6b	1K 5%	
Cc	0.1 $\mu$ F	
Vcm	0.350 volts	

Figure 4



## General SMBus serial interface information for the ICS9DB102

### How to Write:

- Controller (host) sends a start bit.
- Controller (host) sends the write address  $D4_{(h)}$
- ICS clock will **acknowledge**
- Controller (host) sends the beginning byte location = N
- ICS clock will **acknowledge**
- Controller (host) sends the data byte count = X
- ICS clock will **acknowledge**
- Controller (host) starts sending **Byte N through Byte N + X - 1**
- ICS 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  $D4_{(h)}$
- ICS clock will **acknowledge**
- Controller (host) sends the beginning byte location = N
- ICS clock will **acknowledge**
- Controller (host) will send a separate start bit.
- Controller (host) sends the read address  $D5_{(h)}$
- ICS clock will **acknowledge**
- ICS clock will send the data byte count = X
- ICS clock sends **Byte N + X - 1**
- ICS 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)		ICS (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)		ICS (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	
ACK			Beginning Byte N
○			○
○			○
○			○
		Byte N + X - 1	
N	Not acknowledge		
P	stoP bit		



**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

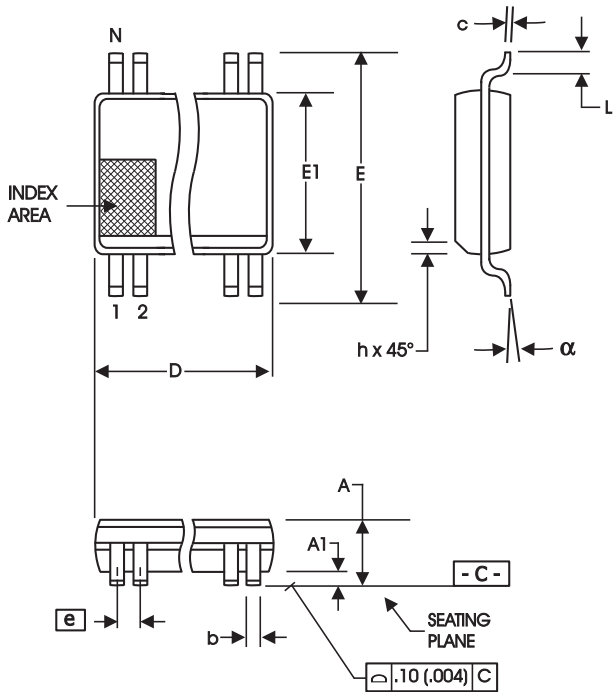
**SMBus Table: DEVICE ID**

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

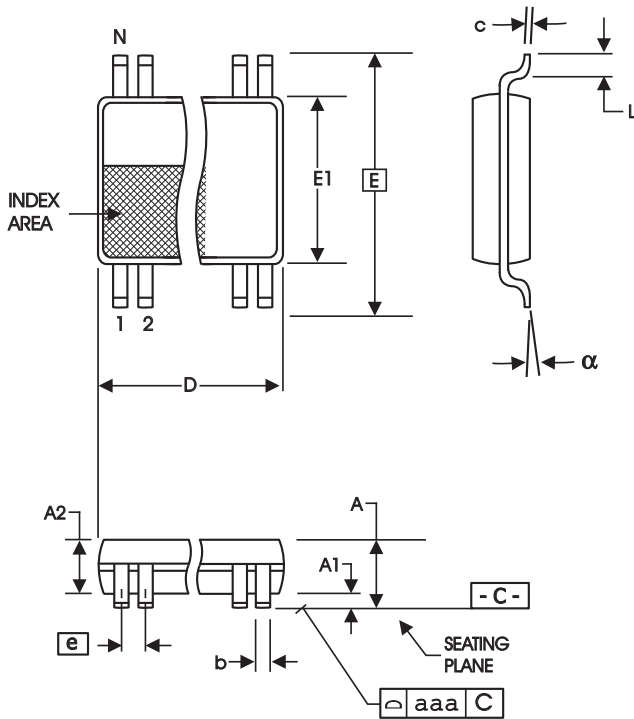
## 20-Pin SSOP Package Drawing and Dimensions



20-Lead, 150 mil SSOP (QSOP)

SYMBOL	In Millimeters		In Inches	
	COMMON DIMENSIONS	COMMON DIMENSIONS	COMMON DIMENSIONS	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	SEE VARIATIONS		SEE VARIATIONS	
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	SEE VARIATIONS		SEE VARIATIONS	
a	0°	8°	0°	8°
ZD	SEE VARIATIONS		SEE VARIATIONS	

## 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		In Inches	
	COMMON DIMENSIONS		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	SEE VARIATIONS		SEE VARIATIONS	
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	SEE VARIATIONS		SEE VARIATIONS	
a	0°	8°	0°	8°
aaa	--	0.10	--	.004

### VARIATIONS

N	D mm.		D (inch)	
	MIN	MAX	MIN	MAX
20	6.40	6.60	.252	.260

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).

## Revision History

Rev.	Originator	Issue Date	Description
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.
G		12/14/2007	Updated General SMBus Interface Information.
H		10/29/2008	Corrected "HCSL" typos.
J		1/15/2010	1. Added I-temp electricals 2. Changed datasheet title 3. Updated Input Frequency parameter 4. Updated ordering information
K	RW	4/1/2010	Updated ordering info for Rev B

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