Eight Output Differential Buffer for PCI-Express

Recommended Application:

DB800 Intel Yellow Cover part with PCI-Express support.

Output Features:

- 8 - 0.7V current-mode differential output pairs
- Supports zero delay buffer mode and fanout mode
- Bandwidth programming available

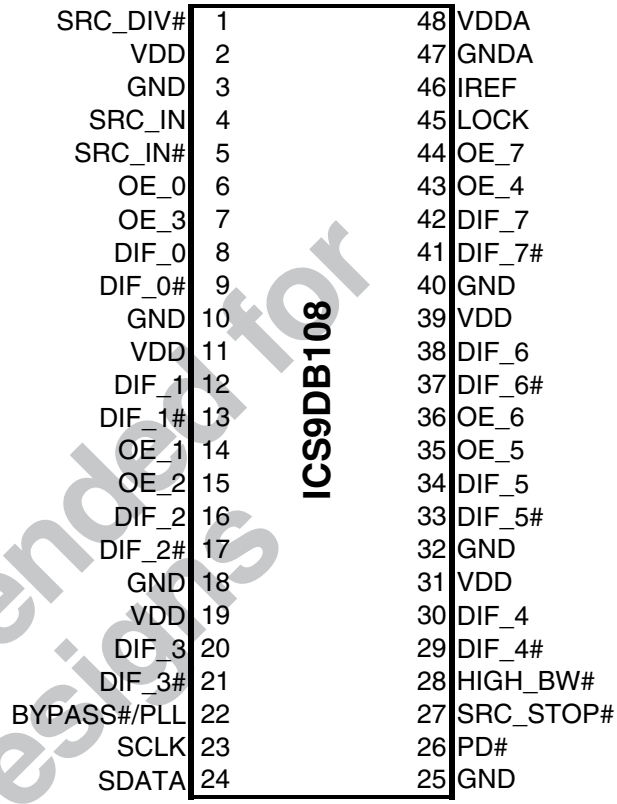
Key Specifications:

- Outputs cycle-cycle jitter < 50ps
- Outputs skew: 50ps
- +/- 300ppm frequency accuracy on output clocks

Features/Benefits:

- Supports tight ppm accuracy clocks for Serial-ATA
- Spread spectrum modulation tolerant, 0 to -0.5% down spread and +/- 0.25% center spread
- Supports undriven differential output pair in PD# and SRC_STOP# for power management.

Pin Configuration



48-pin SSOP & TSSOP

Not recommended for new designs

© 2019 Renesas Electronics Corporation

Pin Description

PIN #	PIN NAME	PIN TYPE	DESCRIPTION
1	SRC_DIV#	IN	Active low Input for determining SRC output frequency SRC or SRC/2. 0 = SRC/2, 1= SRC
2	VDD	PWR	Power supply, nominal 3.3V
3	GND	PWR	Ground pin.
4	SRC_IN	IN	0.7 V Differential SRC TRUE input
5	SRC_IN#	IN	0.7 V Differential SRC COMPLEMENTARY input
6	OE_0	IN	Active high input for enabling outputs. 0 = tri-state outputs, 1= enable outputs
7	OE_3	IN	Active high input for enabling outputs. 0 = tri-state outputs, 1= enable outputs
8	DIF_0	OUT	0.7V differential true clock outputs
9	DIF_0#	OUT	0.7V differential complement clock outputs
10	GND	PWR	Ground pin.
11	VDD	PWR	Power supply, nominal 3.3V
12	DIF_1	OUT	0.7V differential true clock outputs
13	DIF_1#	OUT	0.7V differential complement clock outputs
14	OE_1	IN	Active high input for enabling outputs. 0 = tri-state outputs, 1= enable outputs
15	OE_2	IN	Active high input for enabling outputs. 0 = tri-state outputs, 1= enable outputs
16	DIF_2	OUT	0.7V differential true clock outputs
17	DIF_2#	OUT	0.7V differential complement clock outputs
18	GND	PWR	Ground pin.
19	VDD	PWR	Power supply, nominal 3.3V
20	DIF_3	OUT	0.7V differential true clock outputs
21	DIF_3#	OUT	0.7V differential complement clock outputs
22	BYPASS#/PLL	IN	Input to select Bypass(fan-out) or PLL (ZDB) mode 0 = Bypass mode, 1= PLL mode
23	SCLK	IN	Clock pin of SMBus circuitry, 5V tolerant.
24	SDATA	I/O	Data pin for SMBus circuitry, 5V tolerant.

© 2019 Renesas Electronics Corporation

Pin Description (Continued)

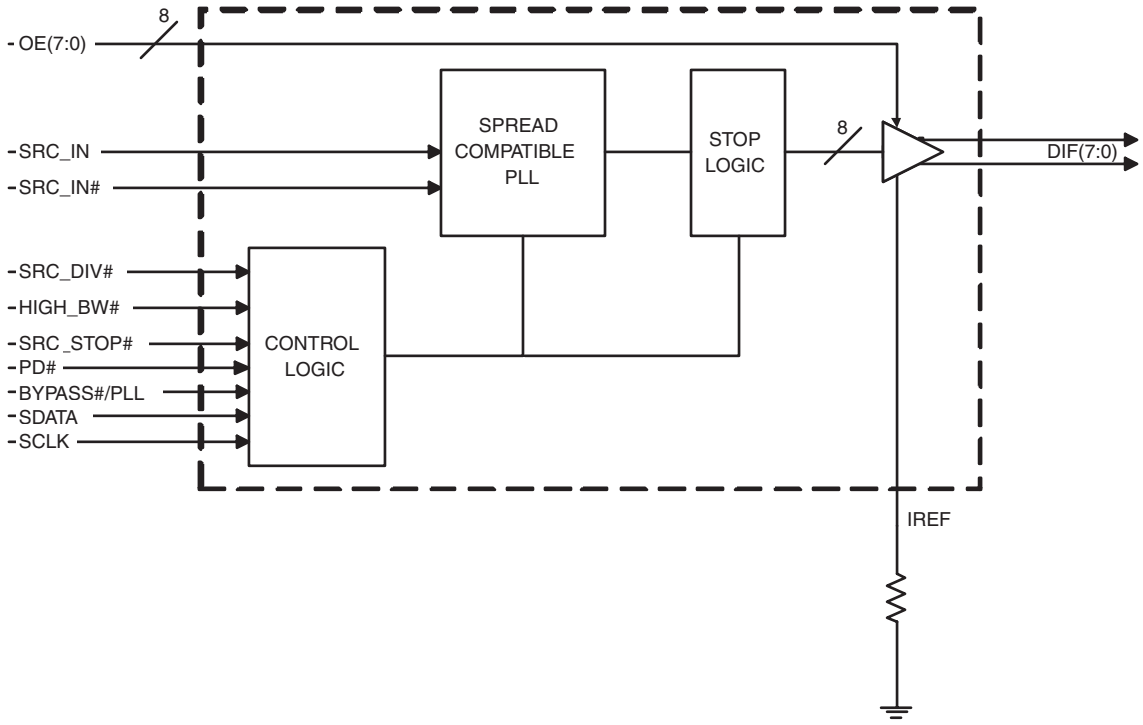
PIN #	PIN NAME	PIN TYPE	DESCRIPTION
25	GND	PWR	Ground pin.
26	PD#	IN	Asynchronous active low input pin used to power down the device. The internal clocks are disabled and the VCO and the crystal are stopped.
27	SRC_STOP#	IN	Active low input to stop diff outputs.
28	HIGH_BW#	PWR	3.3V input for selecting PLL Band Width 0 = High, 1= Low
29	DIF_4#	OUT	0.7V differential complement clock outputs
30	DIF_4	OUT	0.7V differential true clock outputs
31	VDD	PWR	Power supply, nominal 3.3V
32	GND	PWR	Ground pin.
33	DIF_5#	OUT	0.7V differential complement clock outputs
34	DIF_5	OUT	0.7V differential true clock outputs
35	OE_5	IN	Active high input for enabling outputs. 0 = tri-state outputs, 1= enable outputs
36	OE_6	IN	Active high input for enabling outputs. 0 = tri-state outputs, 1= enable outputs
37	DIF_6#	OUT	0.7V differential complement clock outputs
38	DIF_6	OUT	0.7V differential true clock outputs
39	VDD	PWR	Power supply, nominal 3.3V
40	GND	PWR	Ground pin.
41	DIF_7#	OUT	0.7V differential complement clock outputs
42	DIF_7	OUT	0.7V differential true clock outputs
43	OE_4	IN	Active high input for enabling outputs. 0 = tri-state outputs, 1= enable outputs
44	OE_7	IN	Active high input for enabling outputs. 0 = tri-state outputs, 1= enable outputs
45	LOCK	OUT	3.3V output indicating PLL Lock Status. This pin goes high when lock is achieved.
46	IREF	IN	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.
47	GNDA	PWR	Ground pin for the PLL core.
48	VDDA	PWR	3.3V power for the PLL core.

© 2019 Renesas Electronics Corporation

General Description

ICS9DB108 follows the Intel DB400 Differential Buffer Specification. This buffer provides four SRC clocks for PCI-Express, next generation I/O devices. **ICS9DB108** is driven by a differential input pair from a CK409/CK410 main clock generator, such as the ICS952601 or ICS954101. **ICS9DB108** can run at speeds up to 200MHz. It provides ouputs meeting tight cycle-to-cycle jitter (50ps) and output-to-output skew (50ps) requirements.

Block Diagram



© 2019 Renesas Electronics Corporation

Absolute Max

Symbol	Parameter	Min	Max	Units
VDD_A	3.3V Core Supply Voltage		4.6	V
VDD_In	3.3V Logic Supply Voltage		4.6	V
V_{IL}	Input Low Voltage	GND-0.5		V
V_{IH}	Input High Voltage		V_{DD}+0.5V	V
Ts	Storage Temperature	-65	150	°C
Tambient	Ambient Operating Temp	0	70	°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 = 0 - 70°C; Supply Voltage V_{DD} = 3.3 V +/-5%

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
Input High Voltage	V_{IH}	3.3 V +/-5%	2		V_{DD} + 0.3	V	
Input Low Voltage	V_{IL}	3.3 V +/-5%	GND - 0.3		0.8	V	
Input High Current	I_{IH}	V_{IN} = V_{DD}	-5		5	uA	
Input Low Current	I_{IL1}	V_{IN} = 0 V; Inputs with no pull-up resistors	-5			uA	
	I_{IL2}	V_{IN} = 0 V; Inputs with pull-up resistors	-200			uA	
Operating Supply Current	$I_{DD3.3OP}$	Full Active, C_L = Full load;			250	mA	
Powerdown Current	$I_{DD3.3PD}$	all diff pairs driven			60	mA	
		all differential pairs tri-stated			12	mA	
Input Frequency[3]	F_i	V_{DD} = 3.3 V	80	100/133 166/200	220	MHz	3
Pin Inductance[1]	L_{pin}				7	nH	1
Input Capacitance[1]	C_{IN}	Logic Inputs	1.5		5	pF	1
	C_{OUT}	Output pin capacitance			6	pF	1
PLL Bandwidth	BW	PLL Bandwidth when PLL_BW=0		4		MHz	1
		PLL Bandwidth when PLL_BW=1		2		MHz	1
Clk Stabilization[1,2]	T_{STAB}	From V_{DD} Power-Up and after input clock stabilization or de-assertion of PD# to 1st clock			1	ms	1,2
Modulation Frequency		Triangular Modulation	30		33	kHz	1
Tdrive_SRC_STOP#		DIF output enable after SRC_Stop# de-assertion			10	ns	1,3
Tdrive_PD#		DIF output enable after PD# de-assertion			300	us	1,3
Tfall		Fall time of PD# and SRC_STOP#			5	ns	1
Trise		Rise time of PD# and SRC_STOP#			5	ns	2

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

[2]See timing diagrams for timing requirements.

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

© 2019 Renesas Electronics Corporation

Electrical Characteristics - DIF 0.7V Current Mode Differential Pair

T_A = 0 - 70°C; 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[1]	$V_O = V_x$	3000			Ω	1
Voltage High	VHigh	Statistical measurement on single ended signal using oscilloscope math function.	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
Min Voltage	Vuds		-300				1
Crossing Voltage (abs)	Vcross(abs)		250		550	mV	1
Crossing Voltage (var)	d-Vcross	Variation of crossing over all edges			140	mV	1
Long Accuracy	ppm	see Tperiod min-max values			0	ppm	1,2
Average period	Tperiod	200MHz nominal	4.9985		5.0015	ns	2
		200MHz spread	4.9985		5.0266	ns	2
		166.66MHz nominal	5.9982		6.0018	ns	2
		166.66MHz spread	5.9982		6.0320	ns	2
		133.33MHz nominal	7.4978		7.5023	ns	2
		133.33MHz spread	7.4978		5.4000	ns	2
		100.00MHz nominal	9.9970		10.0030	ns	2
		100.00MHz spread	9.9970		10.0533	ns	2
Absolute min period	T_{absmin}	200MHz nominal	4.8735			ns	1,2
		166.66MHz nominal/spread	5.8732			ns	1,2
		133.33MHz nominal/spread	7.3728			ns	1,2
		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				125	ps	1
Fall Time Variation	d-t_f				125	ps	1
Duty Cycle	d_{t3}	Measurement from differential wavefrom	45		55	%	1
Skew	t_{sk3}	V_T = 50%			50	ps	1
Jitter, Cycle to cycle	$t_{jcyc-cyc}$	PLL mode, Measurement from differential wavefrom			50	ps	1
		BYPASS mode as additive jitter			50	ps	1

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

[2] All Long Term Accuracy and Clock Period specifications are guaranteed with the assumption that the input clock complies with CK409/CK410 accuracy requirements

[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.

© 2019 Renesas Electronics Corporation

General SMBus serial interface information for the ICS9DB108

How to Write:

- Controller (host) sends a start bit.
- Controller (host) sends the write address $DC_{(h)}$
- ICS clock will ***acknowledge***
- Controller (host) sends the begining 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 $DC_{(h)}$
- ICS clock will ***acknowledge***
- Controller (host) sends the begining byte location = N
- ICS clock will ***acknowledge***
- Controller (host) will send a separate start bit.
- Controller (host) sends the read address $DD_{(h)}$
- 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
- Controllor (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 $DC_{(h)}$			
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 $DC_{(h)}$			
WR	WRite		
		ACK	
Beginning Byte = N			
		ACK	
RT	Repeat starT		
Slave Address $DD_{(h)}$			
RD	ReaD		
		ACK	
		Data Byte Count = X	
ACK			
		X Byte	Beginning Byte N
ACK			
			◇
◇			◇
◇			◇
◇			
			Byte N + X - 1
N	Not acknowledge		
P	stoP bit		

© 2019 Renesas Electronics Corporation

SMBus Table: Frequency Select Register, READ/WRITE ADDRESS (DC/DD)

Byte 0	Pin #	Name	Control Function	Type	0	1	PWD
Bit 7	-		PD# drive mode	RW	driven	Hi-Z	0
Bit 6	-		SRC_Stop# drive mode	RW	driven	Hi-Z	0
Bit 5	-		Reserved	RW	Reserved		X
Bit 4	-		Reserved	RW	Reserved		X
Bit 3	-		Reserved	RW	Reserved		X
Bit 2	-		PLL_BW# adjust	RW	High BW	Low BW	1
Bit 1	-		BYPASS#/PLL	RW	fan-out	ZDB	1
Bit 0	-		SRC_DIV#	RW	x/2	1x	1

SMBus Table: Output Control Register

Byte 1	Pin #	Name	Control Function	Type	0	1	PWD
Bit 7	42,41	DIF_7	Output Control	RW	Disable	Enable	1
Bit 6	38,37	DIF_6	Output Control	RW	Disable	Enable	1
Bit 5	34,33	DIF_5	Output Control	RW	Disable	Enable	1
Bit 4	30,29	DIF_4	Output Control	RW	Disable	Enable	1
Bit 3	20,21	DIF_3	Output Control	RW	Disable	Enable	1
Bit 2	16,17	DIF_2	Output Control	RW	Disable	Enable	1
Bit 1	12,13	DIF_1	Output Control	RW	Disable	Enable	1
Bit 0	8,9	DIF_0	Output Control	RW	Disable	Enable	1

© 2019 Renesas Electronics Corporation

SMBus Table: Output Control Register

Byte 2	Pin #	Name	Control Function	Type	0	1	PWD
Bit 7	42,41	DIF_7	Output Control	RW	Reserved		0
Bit 6	38,37	DIF_6	Output Control	RW	Free-run	Stoppable	0
Bit 5	34,33	DIF_5	Output Control	RW	Free-run	Stoppable	0
Bit 4	30,29	DIF_4	Output Control	RW	Reserved		0
Bit 3	20,21	DIF_3	Output Control	RW	Reserved		0
Bit 2	16,17	DIF_2	Output Control	RW	Free-run	Stoppable	0
Bit 1	12,13	DIF_1	Output Control	RW	Free-run	Stoppable	0
Bit 0	8,9	DIF_0	Output Control	RW	Reserved		0

SMBus Table: Output Control Register

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

SMBus Table: Vendor & Revision ID Register

Byte 4	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

© 2019 Renesas Electronics Corporation

SMBus Table: DEVICE ID

Byte 5		Pin #	Name	Control Function	Type	0	1	PWD
Bit 7	-		Device ID 7 (MSB)		RW	Reserved		0
Bit 6	-		Device ID 6		RW	Reserved		0
Bit 5	-		Device ID 5		RW	Reserved		0
Bit 4	-		Device ID 4		RW	Reserved		0
Bit 3	-		Device ID 3		RW	Reserved		1
Bit 2	-		Device ID 2		RW	Reserved		0
Bit 1	-		Device ID 1		RW	Reserved		0
Bit 0	-		Device ID 0		RW	Reserved		0

SMBus Table: Byte Count Register

Byte 6		Pin #	Name	Control Function	Type	0	1	PWD
Bit 7	-		BC7	Writing to this register configures how many bytes will be read back.	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	-	-	0
Bit 0	-		BC0		RW	-	-	1

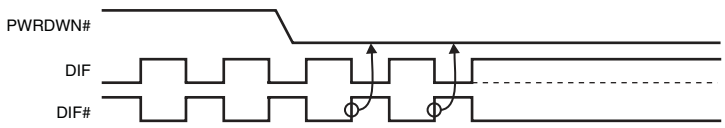
© 2019 Renesas Electronics Corporation

PD#, Power Down

The PD# pin cleanly shuts off all clocks and places the device into a power saving mode. PD# must be asserted before shutting off the input clock or power to insure an orderly shutdown. PD is asynchronous active-low input for both powering down the device and powering up the device. When PD# is asserted, all clocks will be driven high, or tri-stated (depending on the PD# drive mode and Output control bits) before the PLL is shut down.

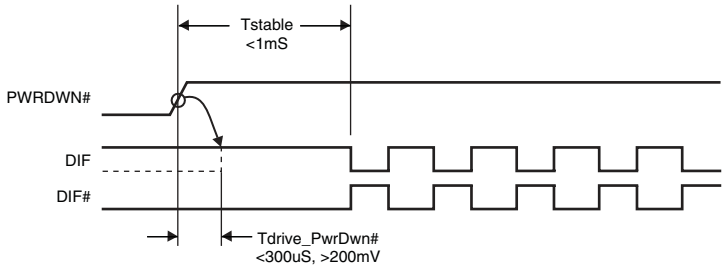
PD# Assertion

When PD# is sampled low by two consecutive rising edges of DIF#, all DIF outputs must be held High, or tri-stated (depending on the PD# drive mode and Output control bits) on the next High-Low transition of the DIF# outputs. When the PD# drive mode bit is set to '0', all clock outputs will be held with DIF driven High with 2 x I_{REF} and DIF# tri-stated. If the PD# drive mode bit is set to '1', both DIF and DIF# are tri-stated.



PD# De-assertion

Power-up latency is less than 1 ms. This is the time from de-assertion of the PD# pin, or VDD reaching 3.3V, or the time from valid SRC_IN clocks until the time that stable clocks are output from the device (PLL Locked). If the PD# drive mode bit is set to '1', all the DIF outputs must driven to a voltage of >200 mV within 300 ms of PD# de-assertion.



© 2019 Renesas Electronics Corporation

SRC_STOP#

The SRC_STOP# signal is an active-low asynchronous input that cleanly stops and starts the DIF outputs. A valid clock must be present on SRC_IN for this input to work properly. The SRC_STOP# signal is de-bounced and must remain stable for two consecutive rising edges of DIF# to be recognized as a valid assertion or de-assertion.

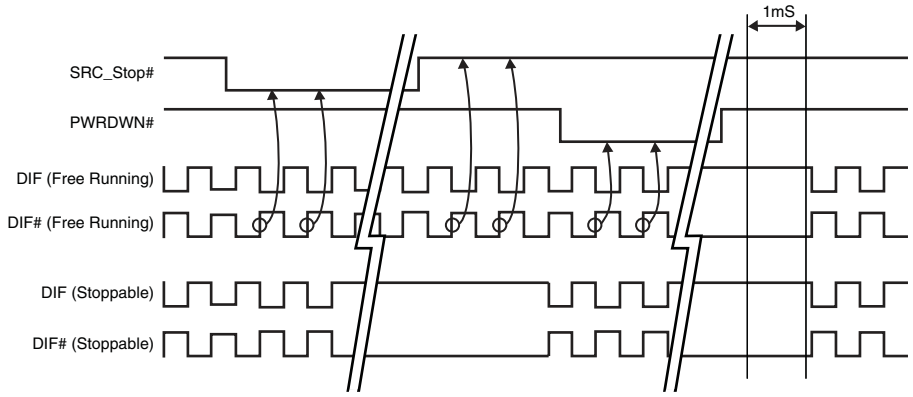
SRC_STOP# - Assertion

Asserting SRC_STOP# causes all DIF outputs to stop after their next transition (if the control register settings allow the output to stop). When the SRC_STOP# drive bit is '0', the final state of all stopped DIF outputs is DIF = High and DIF# = Low. There is no change in output drive current. DIF is driven with $6xI_{REF}$. DIF# is not driven, but pulled low by the termination. When the SRC_STOP# drive bit is '1', the final state of all DIF output pins is Low. Both DIF and DIF# are not driven.

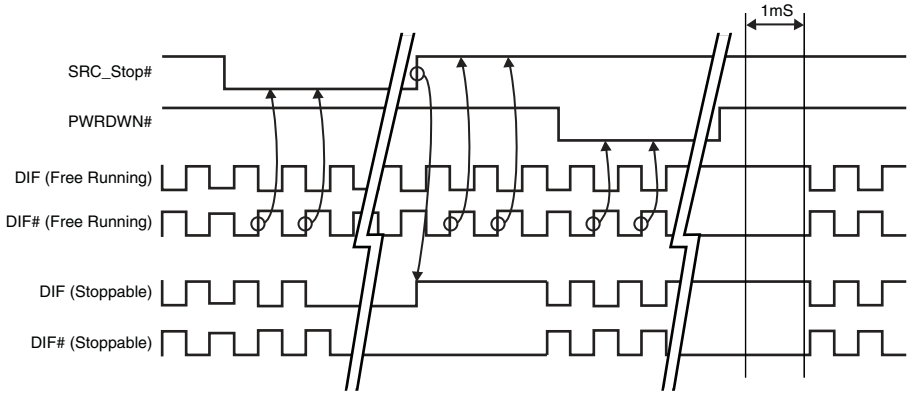
SRC_STOP# - De-assertion (transition from '0' to '1')

All stopped differential outputs resume normal operation in a glitch-free manner. The de-assertion latency to active outputs is 2-6 DIF clock periods, with all DIF outputs resuming simultaneously. If the SRC_STOP# drive control bit is '1' (tri-state), all stopped DIF outputs must be driven High (>200 mV) within 10 ns of de-assertion.

SRC_STOP_1 (SRC_Stop = Driven, PD = Driven)

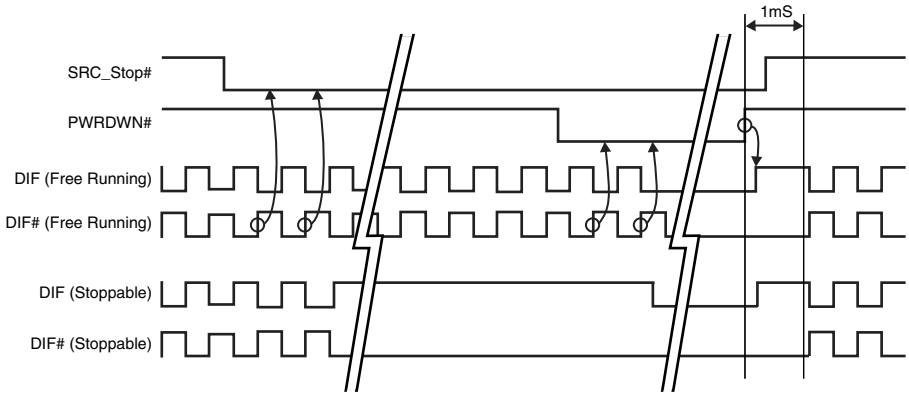


SRC_STOP_2 (SRC_Stop =Tristate, PD = Driven)

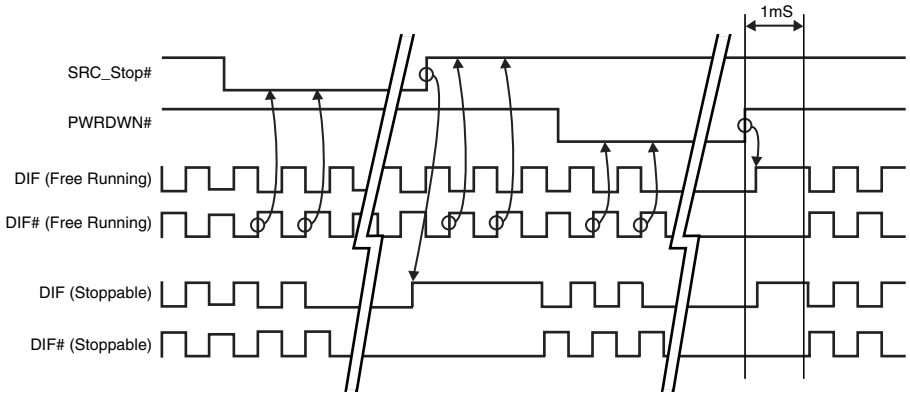


© 2019 Renesas Electronics Corporation

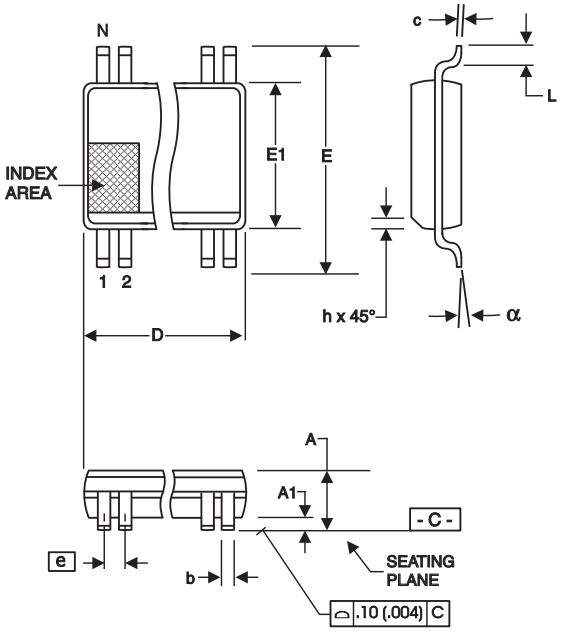
SRC_STOP_3 (SRC_Stop = Driven, PD = Tristate)



SRC_STOP_4 (SRC_Stop = Tristate, PD = Tristate)



© 2019 Renesas Electronics Corporation



SYMBOL	In Millimeters COMMON DIMENSIONS		In Inches COMMON DIMENSIONS	
	MIN	MAX	MIN	MAX
A	2.41	2.80	.095	.110
A1	0.20	0.40	.008	.016
b	0.20	0.34	.008	.0135
c	0.13	0.25	.005	.010
D	SEE VARIATIONS		SEE VARIATIONS	
E	10.03	10.68	.395	.420
E1	7.40	7.60	.291	.299
e	0.635 BASIC		0.025 BASIC	
h	0.38	0.64	.015	.025
L	0.50	1.02	.020	.040
N	SEE VARIATIONS		SEE VARIATIONS	
α	0°	8°	0°	8°

VARIATIONS

N	D mm.		D (inch)	
	MIN	MAX	MIN	MAX
48	15.75	16.00	.620	.630

Reference Doc.: JEDEC Publication 95, MO-118

10-0034

Ordering Information

9DB108yFLxT

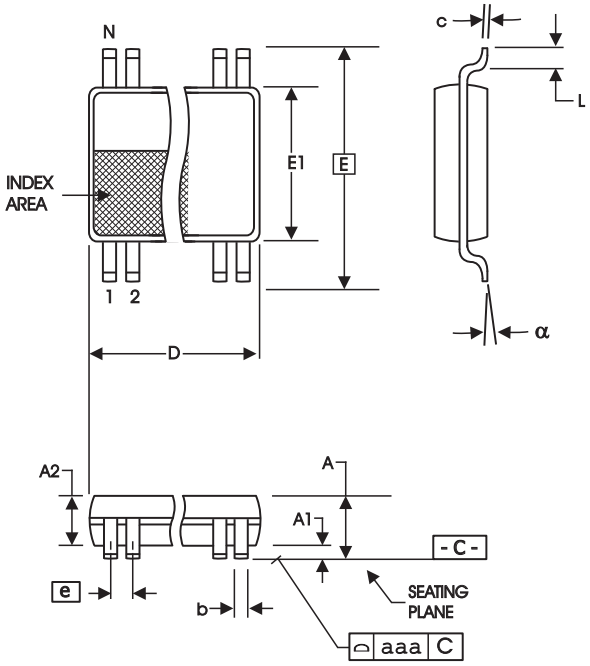
Example:

XXXX y F Lx T

- **Designation for tape and reel packaging**
- **LF or LN = Lead Free, RoHS Compliant (Optional)**
- **Package Type**
  F = SSOP
- **Revision Designator** (will not correlate with datasheet revision)
- **Device Type**

0723G—12/02/08

© 2019 Renesas Electronics Corporation



48-Lead, 6.10 mm. Body, 0.50 mm. Pitch TSSOP
(240 mil) (20 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	0.17	0.27	.007	.011
c	0.09	0.20	.0035	.008
D	SEE VARIATIONS		SEE VARIATIONS	
E	8.10 BASIC		0.319 BASIC	
E1	6.00	6.20	.236	.244
e	0.50 BASIC		0.020 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
48	12.40	12.60	.488	.496

Reference Doc.: JEDEC Publication 95, MO-153

10-0039

Ordering Information

9DB108yGLxT

Example:

XXXX y G Lx T

- **Designation for tape and reel packaging**
- **LF or LN = Lead Free, RoHS Compliant (Optional)**
- **Package Type**
  G = TSSOP
- **Revision Designator** (will not correlate with datasheet revision)
- **Device Type (consists of 3 to 7 digit numbers)**

0723G—12/02/08

© 2019 Renesas Electronics Corporation

Revision History

Rev.	Issue Date	Description	Page #
E	10/26/2005	Updated LF Ordering Information to LF or LN.	14, 15
F	12/17/2000	Updated SMBus Serial Interface Information.	7
G	12/2/2008	removed Ics prefix from ordering information	14-15

IMPORTANT NOTICE AND DISCLAIMER

RENESAS ELECTRONICS CORPORATION AND ITS SUBSIDIARIES (“RENESAS”) PROVIDES TECHNICAL SPECIFICATIONS AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for developers skilled in the art designing with Renesas products. You are solely responsible for (1) selecting the appropriate products for your application, (2) designing, validating, and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. Renesas grants you permission to use these resources only for development of an application that uses Renesas products. Other reproduction or use of these resources is strictly prohibited. No license is granted to any other Renesas intellectual property or to any third party intellectual property. Renesas disclaims responsibility for, and you will fully indemnify Renesas and its representatives against, any claims, damages, costs, losses, or liabilities arising out of your use of these resources. Renesas' products are provided only subject to Renesas' Terms and Conditions of Sale or other applicable terms agreed to in writing. No use of any Renesas resources expands or otherwise alters any applicable warranties or warranty disclaimers for these products.

(Rev.1.0 Mar 2020)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Contact Information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit:
www.renesas.com/contact/

Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

© 2020 Renesas Electronics Corporation. All rights reserved.