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National Semiconductor

SCAN921821
Dual 18-Bit Serializer with Pre-emphasis, IEEE 1149.1 (JTAG), and At-Speed BIST

General Description

The SCAN921821 is a dual channel 18-bit serializer featuring signal conditioning, boundary SCAN, and at-speed BIST. Each serializer block transforms an 18-bit parallel LVCMOS/LVTTL data bus into a single Bus LVDS data stream with embedded clock. This single serial data stream with embedded clock simplifies PCB design and reduces PCB cost by narrowing data paths that in turn reduce PCB size and layers. The single serial data stream also reduces cable size, the number of connectors, and eliminates clock-to-data and data-to-data skew.

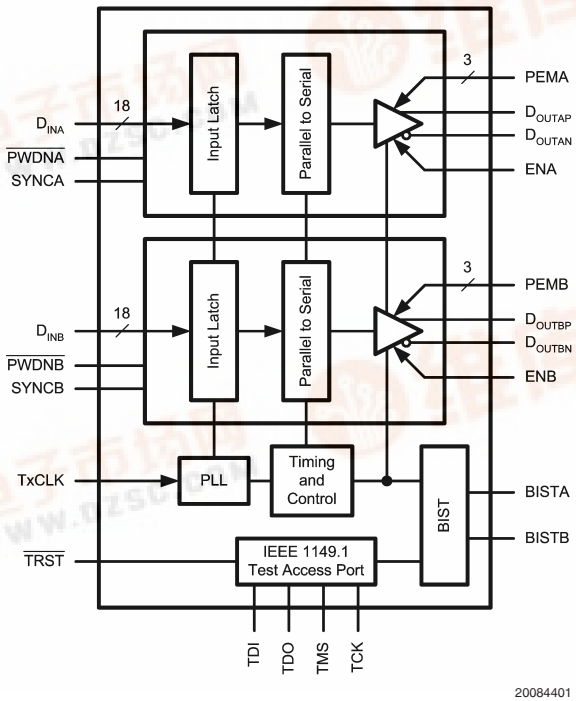
Each channel also has an 8-level selectable pre-emphasis feature that significantly extends performance over lossy interconnect. Each channel also has its own powerdown pin that saves power by reducing supply current when the channel is not being used.

The SCAN921821 also incorporates advanced testability features including IEEE 1149.1 and at-speed BIST PRBS pattern generation to facilitate verification of board and link integrity

Features

- 15-66 MHz Dual 18:1 Serializer with 2.376 Gbps total throughput
- 8-level selectable pre-emphasis on each channel drives lossy cables and backplanes
- >15kV HBM ESD protection on Bus LVDS I/O pins
- Robust BLVDS serial data transmission with embedded clock for exceptional noise immunity and low EMI
- Power saving control pin for each channel
- IEEE 1149.1 "JTAG" Compliant
- At-Speed BIST - PRBS generation
- No external coding required
- Internal PLL, no external PLL components required
- Single +3.3V power supply
- Low power: 260 mW (typ) per channel at 66 MHz with PRBS-15 pattern
- Single 3.3 V supply
- Fabricated with advanced CMOS process technology
- Industrial −40 to +85˚C temperature range
- Compact 100-ball FBGA package

Block Diagram



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SCAN921821 - Dual 18-Bit Serializer with Pre-emphasis, IEEE 1149.1 (JTAG), and At-Speed BIST

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

Supply Voltage (V_{DD})	−0.3V to +4V
Supply Voltage (V_{DD}) Ramp Rate	< 30 V/ms
LVCMOS/LVTTL Input Voltage	−0.3V to (V_{DD} +0.3V)
LVCMOS/LVTTL Output Voltage	−0.3V to (V_{DD} +0.3V)
Bus LVDS Driver Output Voltage	−0.3V to +3.9V
Bus LVDS Output Short Circuit Duration	10ms
Junction Temperature	+150˚C
Storage Temperature	−65˚C to +150˚C
Lead Temperature (Soldering, 4 seconds)	+220˚C
Maximum Package Power Dissipation at 25˚C	
FBGA-100	3.57 W
Derating Above 25˚C	28.57 mW/˚C
Thermal resistance θ_{JA}	35˚C/W
θ_{JC}	11.1˚C/W
ESD Rating	
HBM, 1.5 KΩ, 100 pF	
All pins	>8 kV
Bus LVDS pins	>15 kV
MM, 0Ω, 200 pF	>1200 V
CDM	>2 kV

Recommended Operating Conditions

	Min	Nom	Max	Units
Supply Voltage (V_{DD})	3.15	3.3	3.45	V
Operating Free Air Temperature (T_A)	−40	+25	+85	˚C
Clock Rate	15		66	MHz
Supply Noise			100	mV p-p

DC Electrical Characteristics

Over recommended operating supply and temperature ranges unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
LVCMOS/LVTTL Input DC Specifications						
V_{IH}	High Level Input Voltage		2.0		V_{DD}	V
V_{IL}	Low Level Input Voltage		GND		0.8	V
V_{CL}	Input Clamp Voltage	I_{CL} = −18 mA	−1.5	-0.7		V
I_{INH}	High Level Input Current	$V_{IN} = V_{DD} = V_{DDMAX}$	−20	±2	+20	µA
I_{INL}	Low Level Output Current	$V_{IN} = V_{SS}$, $V_{DD} = V_{DDMAX}$	−10	±2	+10	µA
1149.1 (JTAG) DC Specifications						
V_{IH}	High Level Input Voltage		2.0		V_{DD}	V
V_{IL}	Low Level Input Voltage		GND		0.8	V
V_{CL}	Input Clamp Voltage	I_{CL} = −18 mA	−1.5	-0.7		V
I_{INH}	High Level Input Current	$V_{IN} = V_{DD} = V_{DDMAX}$	-20		+20	µA
I_{INL}	Low Level Output Current	$V_{IN} = V_{SS}$, $V_{DD} = V_{DDMAX}$	-200		+200	µA
V_{OH}	High Level Output Voltage	I_{OH} = −9 mA	2.3		V_{DD}	mV
V_{OL}	Low Level Output Voltage	I_{OL} = 9 mA	GND		0.5	mV
I_{OS}	Output Short Circuit Current	V_{OUT} = 0 V	-100	-80	-50	mA
I_{OZ}	Output Tri-state Current	$\overline{PWDN}$ or EN = 0.8V, V_{OUT} = 0 V	-10		+10	µA
		$\overline{PWDN}$ or EN = 0.8V, V_{OUT} = VDD	-30		+30	µA

DC Electrical Characteristics (Continued)

Over recommended operating supply and temperature ranges unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Units
Bus LVDS Output DC Specifications							
V_{OD}	Output Differential Voltage (DO+) - (DO-)	*Figure 10*, R_L = 100Ω		450	500	550	mV
ΔV_{OD}	Output Differential Voltage Unbalance				2	15	mV
V_{OS}	Offset Voltage			1.05	1.2	1.25	V
ΔV_{OS}	Offset Voltage Unbalance				2.7	15	mV
Q_{POV}	Pre-Emphasis Output Voltage Ratio $\lvert V_{ODPRE} / V_{OD} \rvert$	Pre-Emphasis Level = 1		1.10	1.24	1.35	
		Pre-Emphasis Level = 2		1.35	1.47	1.55	
		Pre-Emphasis Level = 3		1.55	1.70	1.80	
		Pre-Emphasis Level = 4		1.80	1.91	1.95	
		Pre-Emphasis Level = 5		1.95	2.08	2.20	
		Pre-Emphasis Level = 6		2.10	2.21	2.35	
		Pre-Emphasis Level = 7		2.15	2.30	2.50	
I_{OS}	Output Short Circuit Current	DO = 0V, Din = H, $\overline{PWDN}$ and EN = 2.4V		-10	-25	-75	mA
I_{OZ}	TRI-STATE Output Current	$\overline{PWDN}$ or EN = 0.8V, DO = 0V (Note 4)		-10	± 1	+10	µA
		$\overline{PWDN}$ or EN = 0.8V, DO = VDD (Note 4)		-55	± 6	+55	µA
Power Supply Current (DVDD, PVDD and AVDD Pins)							
I_{DD}	Total Supply Current (includes load current)	C_L = 15pF, R_L = 100 Ω	f = 66 MHz, PRBS-15 Pattern		160	225	mA
			f = 66 MHz, Worst Case Pattern (Checker-Board Pattern)		180		mA
I_{DDP}	Total Supply Current with Pre-Emphasis (includes load current)	C_L = 15pF, R_L = 100 Ω	f = 66 MHz, PRBS-15 Pattern		240		mA
			f = 66 MHz, Worst Case Pattern (Checker-Board Pattern)		280	325	mA
I_{DDX}	Supply Current Powerdown	$\overline{PWDN}$ = 0.8V, EN = 0.8V			1.0	3.0	mA

Timing Requirements for TCLK

Over recommended operating supply and temperature ranges unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_{TCP}	Transmit Clock Period		15.2	T	66.7	ns
t_{TCIH}	Transmit Clock High Time		0.4T	0.5T	0.6T	ns
t_{TCIL}	Transmit Clock Low Time		0.4T	0.5T	0.6T	ns
t_{CLKT}	TCLK Input Transition Time			3	6	ns
t_{JIT}	TCLK Input Jitter	(Note 5)			80	ps (RMS)

AC Electrical Characteristics

Over recommended operating supply and temperature ranges unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Units
Serializer AC Specifications						
t_{LLHT}	Bus LVDS Low-to-High Transition Time	*Figure 2*, (Note 5) R_L = 100Ω, C_L=10pF to GND		0.3	0.4	ns
t_{LHLT}	Bus LVDS High-to-Low Transition Time			0.3	0.4	ns
t_{DIS}	DIN (0-17) Setup to TCLK	*Figure 4*, (Note 5) R_L = 100Ω, C_L=10pF to GND	1.9			ns
t_{DIH}	DIN (0-17) Hold from TCLK		0.6			ns
t_{HZD}	DO ± HIGH to TRI-STATE Delay	*Figure 5* R_L = 100Ω, C_L=10pF to GND		3.9	10	ns
t_{LZD}	DO ± LOW to TRI-STATE Delay			3.5	10	ns
t_{ZHD}	DO ± TRI-STATE to HIGH Delay			3.2	10	ns
t_{ZLD}	DO ± TRI-STATE to LOW Delay			2.4	10	ns
t_{SPW}	SYNC Pulse Width	*Figure 7*, R_L = 100Ω	$5*t_{TCP}$		$6*t_{TCP}$	ns
t_{PLD}	Serializer PLL Lock Time	*Figure 6*, R_L = 100Ω	$510*t_{TCP}$		$1024*t_{TCP}$	ns
t_{SD}	Serializer Delay	*Figure 8* , R_L = 100Ω	t_{TCP} + 2.5	t_{TCP} + 4.5	t_{TCP} + 6.5	ns
t_{SKCC}	Channel to Channel Skew			70		ps
t_{RJIT}	Random Jitter	Room Temperature, V_{DD} = 3.3V, 66 MHz		6.1		ps (RMS)
t_{DJIT}	Deterministic Jitter *Figure 9*, (Note 5)	15 MHz	-390		320	ps
		66 MHz	-60		30	ps
1149.1 (JTAG) AC Specifications						
f_{MAX}	Maximum TCK Clock Frequency	C_L = 15pF, R_L = 500 Ω	25			MHz
t_S	TDI or TMS Setup to TCK, H or L		2.4			ns
t_H	TDI or TMS Hold from TCK, H or L		2.8			ns
t_{W1}	TCK Pulse Width, H or L		10			ns
t_{W2}	$\overline{TRST}$ Pulse Width, L		10			ns
t_{REC}	Recovery Time, $\overline{TRST}$ to TCK		2			ns

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" specifies conditions of device operation.

Note 2: Typical values are given for V_{CC} = 3.3V and T_A = +25˚C.

Note 3: Current into device pins is defined as positive. Current out of device pins is defined as negative. Voltages are referenced to ground except VOD, ΔVOD, VTH and VTL which are differential voltages.

Note 4: I_{OZ} is measured at each pin. The DOUT pin not under test is floated to isolate the TRI-STATE current flow.

Note 5: Guaranteed by Design (GBD) using statistical analysis.

AC Timing Diagrams and Test Circuits

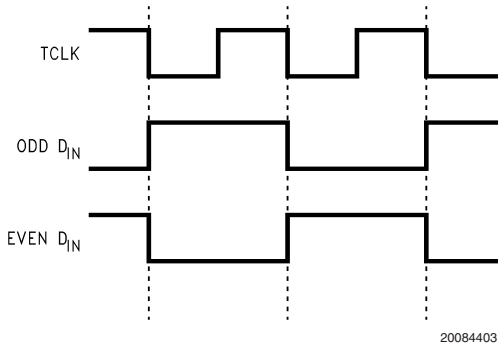


FIGURE 1. "Worst Case" Serializer IDD Test Pattern

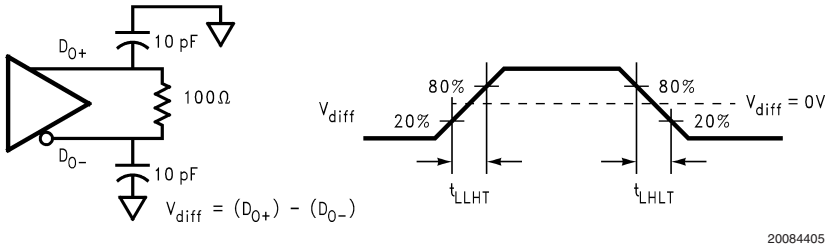


FIGURE 2. Serializer Bus LVDS Distributed Output Load and Transition Times

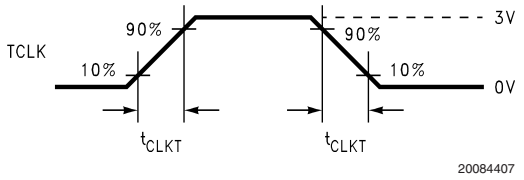


FIGURE 3. Serializer Input Clock Transition Time

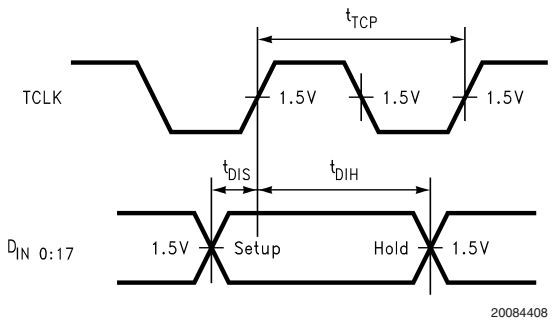
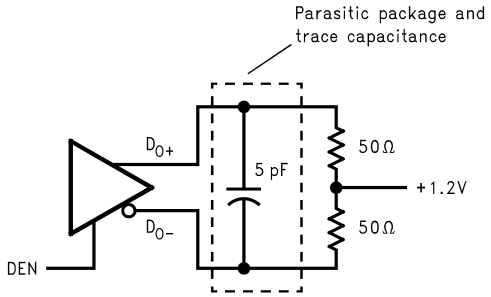


FIGURE 4. Serializer Setup/Hold Times

AC Timing Diagrams and Test Circuits (Continued)



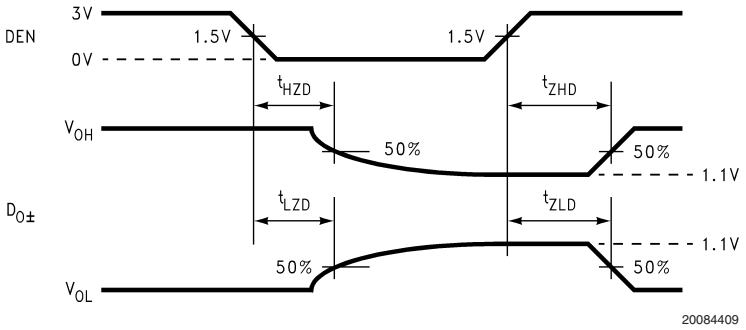


FIGURE 5. Serializer TRI-STATE Test Circuit and Timing

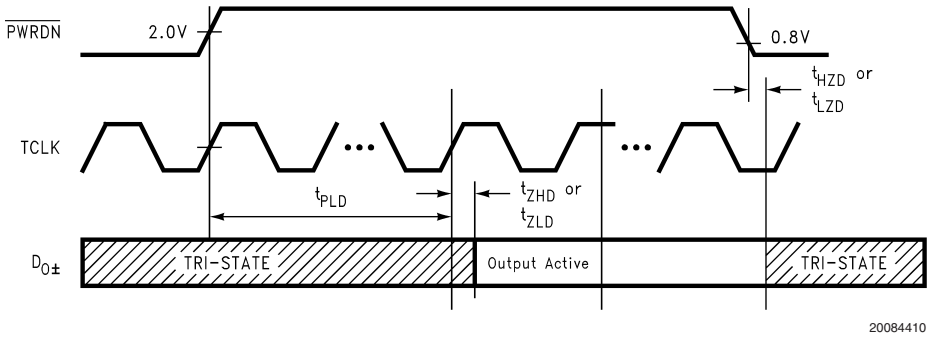


FIGURE 6. Serializer PLL Lock Time, and $\overline{PWRDN}$ TRI-STATE Delays

AC Timing Diagrams and Test Circuits (Continued)

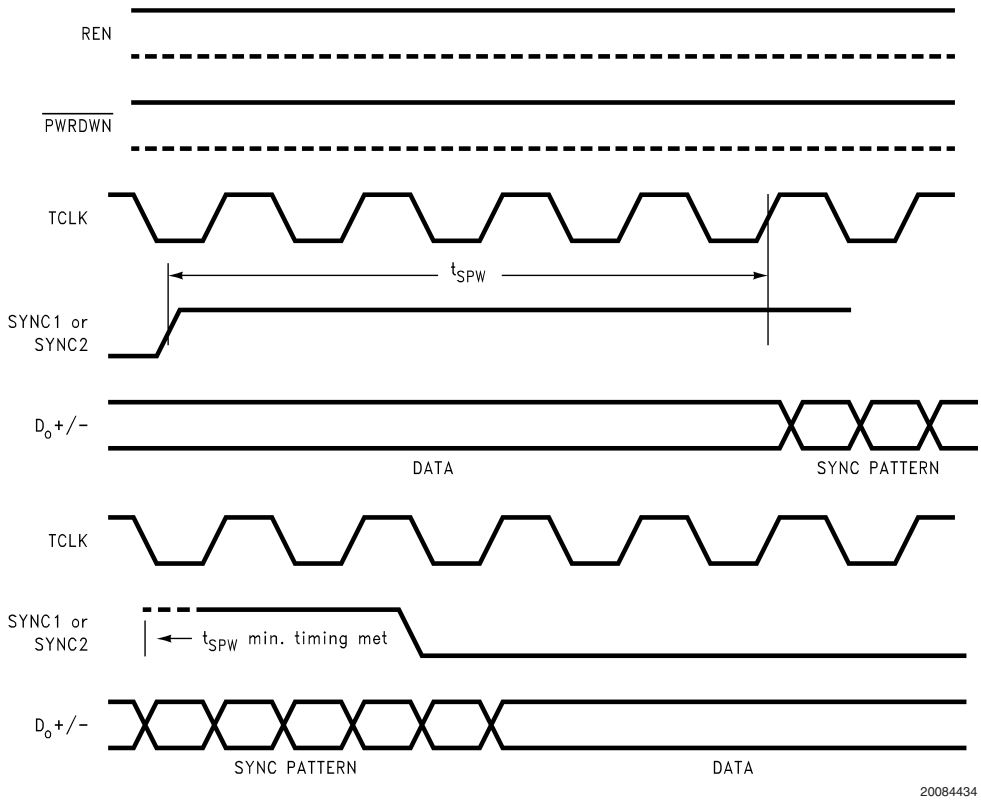


FIGURE 7. SYNC Timing Delay

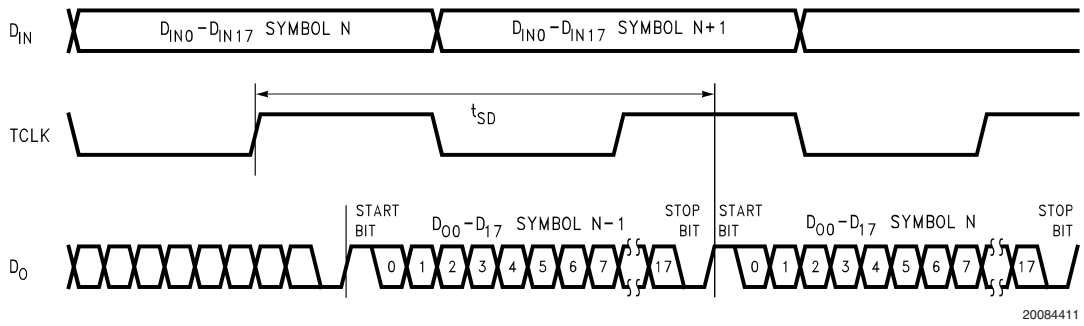


FIGURE 8. Serializer Delay

AC Timing Diagrams and Test Circuits (Continued)

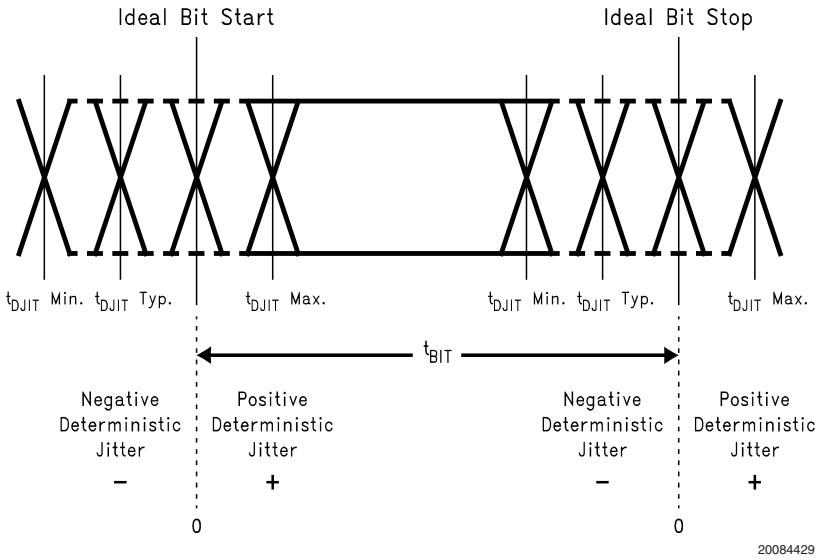
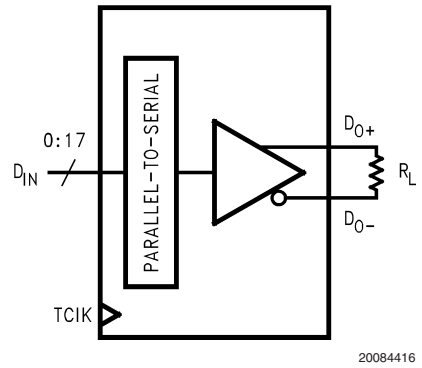


FIGURE 9. Deterministic Jitter and Ideal Bit Position



V_{OD} = $(DO^{+})-(DO^{-})$.

Differential output signal is shown as (DO+)−(DO−), device in Data Transfer mode.

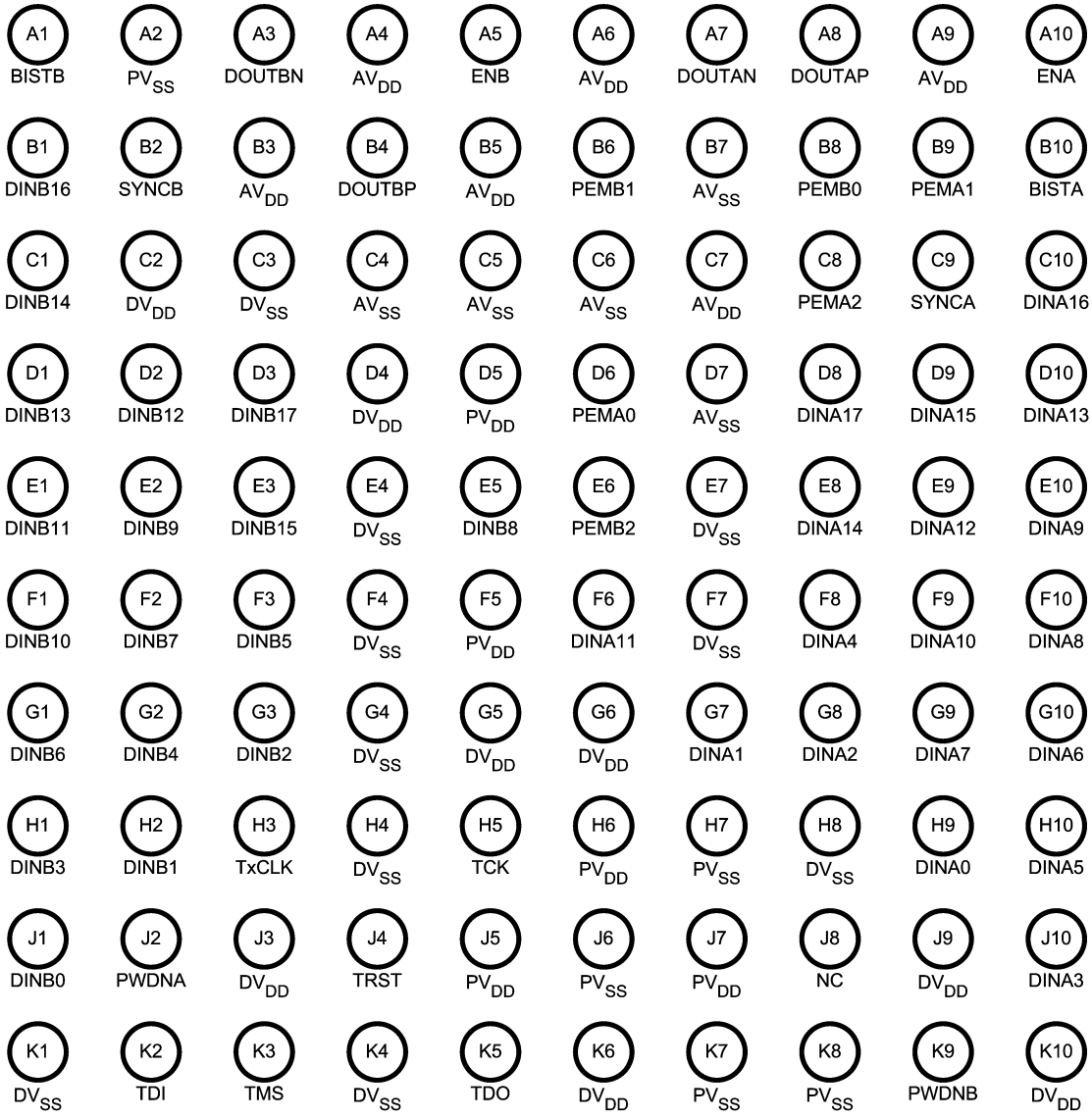
FIGURE 10. V_{OD} Diagram

Pre-emphasis Truth Table

PEM LEVEL	PEM2	PEM1	PEM0
0	L	L	L
1	L	L	H
2	L	H	L
3	L	H	H
4	H	L	L
5	H	L	H
6	H	H	L
7	H	H	H

Pin Diagram

SCAN921821TVV
Top View



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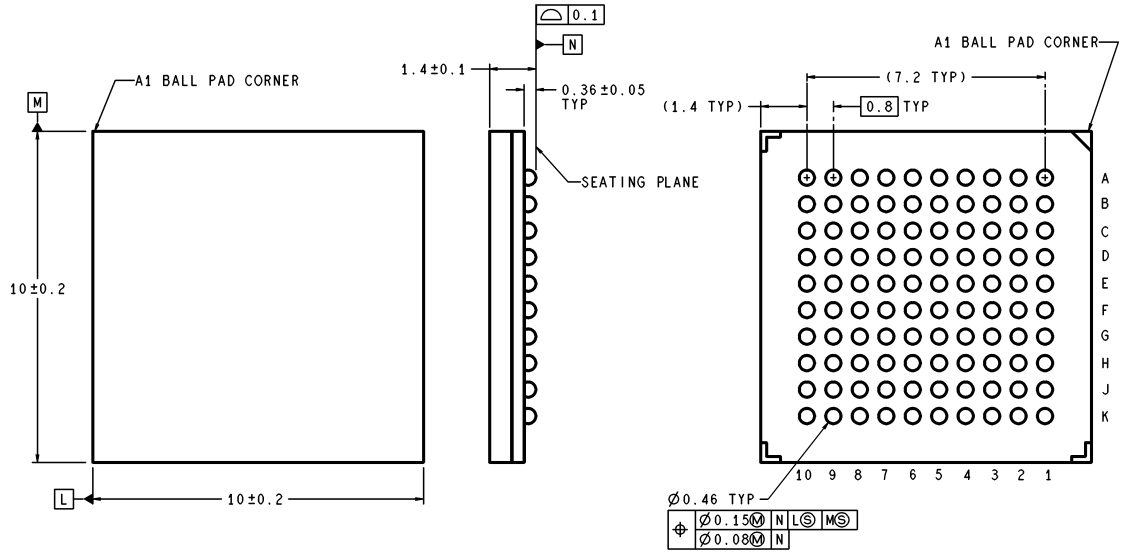
Pin Descriptions

Pin Name	Pin Count	I/O, Type	Description
DATA PINS			
DINA0-17	18	I, LVCMOS	Transmitter inputs. There is a pull-down circuitry on each of these pins which are active if respective $\overline{\text{PWDNA}}$ or $\overline{\text{PWDNB}}$ pin is pulled high.
DINB0-17	18		
DOUTAP	1	O,BLVDS	Inverting and non-inverting differential transmitter outputs.
DOUTAN	1		
DOUTBP	1		
DOUTAN	1		
TIMING AND CONTROL PINS			
TxCLK	1	I, LVCMOS	Transmitter reference clock. Used to strobe data at the inputs and to drive the transmitter PLL. There is a pull-up circuitry on this pin which is always active.
ENA	1	I, LVCMOS	Transmitter outputs enable pins. There is a pull-down circuitry on each of these pins that are active if corresponding $\overline{\text{PWDNA}}$ or $\overline{\text{PWDNB}}$ pin is pulled high. When these pins are set to LOW, the transmitter outputs will be disabled. The PLL will remain locked.
ENB	1		
$\overline{\text{PWDNA}}$	1	I, LVCMOS	Stand-by mode pins. There is a pull-down circuitry on each of these pins that are always active. When these pins are set to LOW, the transmitter will be put in low power mode and the PLL will lose lock.
$\overline{\text{PWDNB}}$	1		
SYNCA	1	I, LVCMOS	Transmitter synchronization pins. There is a pull-down circuitry on each of these pins that are active if corresponding $\overline{\text{PWDNA}}$ or $\overline{\text{PWDNB}}$ pin is pulled high. When these pins are set to HIGH, the transmitter will ignore incoming data and send SYNC patterns to provide a locking reference to receiver(s).
SYNCB	1		
PRE-EMPHASIS PINS			
PEMA0-2	3	I, LVCMOS	8-level pre-emphasis selection pins. There is a pull-down circuitry on each of these pins which are active if corresponding $\overline{\text{PWDNA}}$ or $\overline{\text{PWDNB}}$ pin is pulled high.
PEMB0-2	3		
JTAG PINS			
TDI	1	I, LVCMOS	Test Data Input to support IEEE 1149.1. There is a pull-up circuitry on this pin which is always active.
TDO	1	O, LVCMOS	Test Data Output to support IEEE 1149.1.
TMS	1	I, LVCMOS	Test Mode Select Input to support IEEE 1149.1. There is a pull-up circuitry on this pin which is always active.
TCK	1	I, LVCMOS	Test Clock Input to support IEEE 1149.1. There is no failsafe circuitry on this pin.
$\overline{\text{TRST}}$	1	I, LVCMOS	Test Reset Input to support IEEE 1149.1. There is a pull-up circuitry on this pin which is always active.
BIST PINS			
BISTA	1	I, LVCMOS	BIST selection pins. These pins select which transmitter will generate a PRBS like data. There is a pull-down circuitry on these pins which are active if corresponding $\overline{\text{PWDNA}}$ or $\overline{\text{PWDNB}}$ pin is pulled high.
BISTB	1		
POWER PINS			
AVDD	6	I, POWER	Power Supply for the LVDS circuitry.
DVDD	8	I, POWER	Power Supply for the digital circuitry.
PVDD	5	I, POWER	Power Supply for the PLL and BG circuitry.
AVSS	5	I, POWER	Ground reference for the LVDS circuitry.
DVSS	10	I, POWER	Ground reference for the digital circuitry.
PVSS	5	I, POWER	Ground reference for the PLL and BG circuitry.
OTHER PINS			
NC	1	N/A	Not connected.

Physical Dimensions inches (millimeters) unless otherwise noted



DIMENSIONS ARE IN MILLIMETERS

SLC100A (Rev B)

Dimensions shown in millimeters only
Order Number SCAN921821TSM
NS Package Number SLC100A

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