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National Semiconductor

November 20, 2008

DS90CP02
1.5 Gbps 2x2 LVDS Crosspoint Switch

General Description

The DS90CP02 is a 1.5 Gbps 2 x 2 LVDS crosspoint switch optimized for high-speed signal routing and switching over lossy FR-4 printed circuit board backplanes and balanced cables. Fully differential signal paths ensure exceptional signal integrity and noise immunity. The non-blocking architecture allows connections of any input to any output or outputs.

Wide input common mode range allows the switch to accept signals with LVDS, CML and LVPECL levels; the output levels are LVDS. A very small package footprint requires a minimal space on the board while the flow-through pinout allows easy board layout. The 3.3V supply, CMOS process, and LVDS I/O ensure high performance at low power over the entire industrial -40 to +85°C temperature range.

Features

- 1.5 Gbps per channel
- Low power: 70 mA in dual repeater mode @1.5 Gbps
- Low output jitter
- Non-blocking architecture allows 1:2 splitter, 2:1 mux, crossover, and dual buffer configurations
- Flow-through pinout
- LVDS/BLVDS/CML/LVPECL inputs, LVDS Outputs
- Single 3.3V supply
- Separate control of inputs and outputs allows for power savings
- Industrial -40 to +85°C temperature range
- 28-lead LLP-28 space saving package

Block Diagram

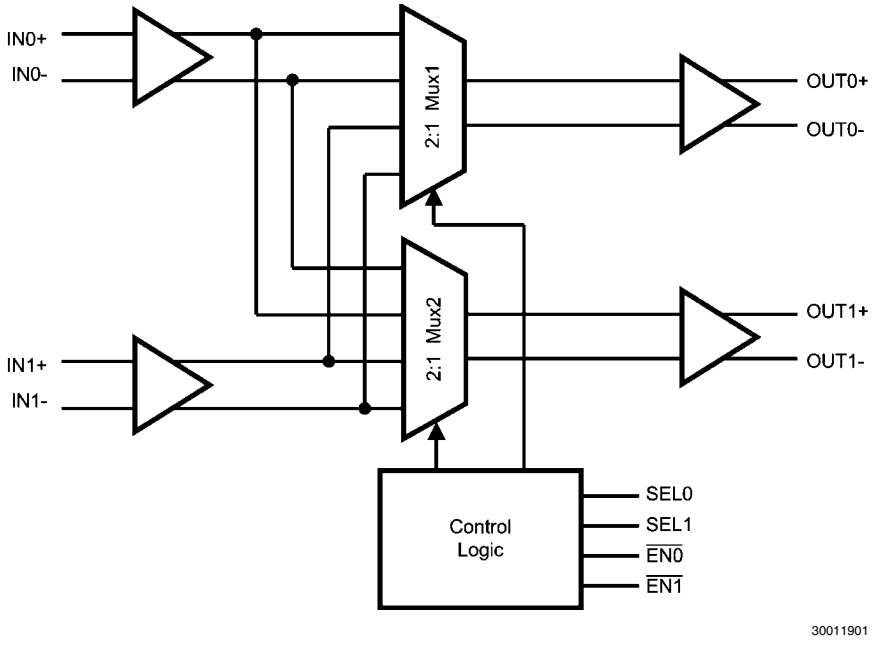
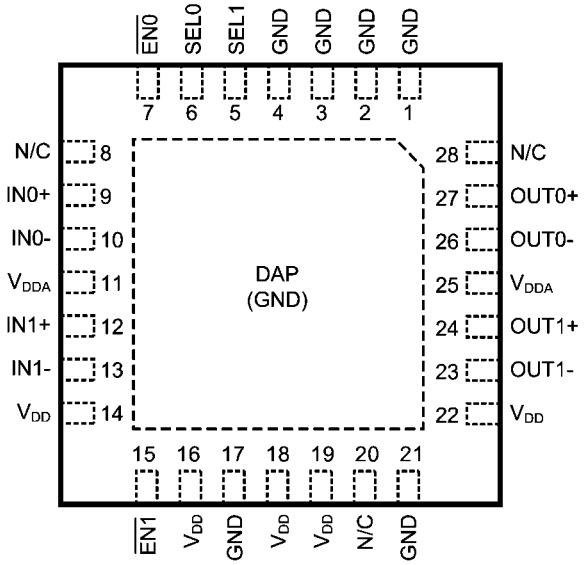


FIGURE 1. DS90CP02 Block Diagram

Pin Descriptions

Pin Name	Pin Number	I/O, Type	Description
DIFFERENTIAL INPUTS COMMON TO ALL MUXES			
IN0+ IN0–	9 10	I, LVDS	Inverting and non-inverting differential inputs. LVDS, Bus LVDS, CML, or LVPECL compatible.
IN1+ IN1–	12 13	I, LVDS	Inverting and non-inverting differential inputs. LVDS, Bus LVDS, CML, or LVPECL compatible.
SWITCHED DIFFERENTIAL OUTPUTS			
OUT0+ OUT0–	27 26	O, LVDS	Inverting and non-inverting differential outputs. OUT0± can be connected to any one pair IN0±, or IN1±. LVDS compatible .
OUT1+ OUT1–	24 23	O, LVDS	Inverting and non-inverting differential outputs. OUT1± can be connected to any one pair IN0±, or IN1±. LVDS compatible .
DIGITAL CONTROL INTERFACE			
SEL0, SEL1	6 5	I, LVTTL	Select Control Inputs
$\overline{EN0}$, $\overline{EN1}$	7 15	I, LVTTL	Output Enable Inputs
N/C	8, 20, 28		Not Connected
POWER			
V_{DD}	11, 14, 16, 18, 19, 22, 25	I, Power	V_{DD} = 3.3V ±0.3V. At least 4 low ESR 0.01 µF bypass capacitors should be connected from V_{DD} to GND plane.
GND	DAP, 1, 2, 3, 4, 17, 21	I, Power	Ground reference to LVDS and CMOS circuitry. For the LLP package, the DAP is used as the primary GND connection to the device. The DAP is the exposed metal contact at the bottom of the LLP-28 package. It should be connected to the ground plane with at least 4 vias for optimal AC and thermal performance.

Connection Diagram



LLP Top View
DAP = GND

Configuration Select Truth Table

SEL0	SEL1	$\overline{EN0}$	$\overline{EN1}$	OUT0	OUT1	Mode
0	0	0	0	IN0	IN0	1:2 Splitter (IN1 powered down)
0	1	0	0	IN0	IN1	Dual Channel Repeater
1	0	0	0	IN1	IN0	Dual Channel Switch
1	1	0	0	IN1	IN1	1:2 Splitter (IN0 powered down)
0	1	0	1	IN0	PD	Single Channel Repeater (Channel 1 powered down)
1	1	0	1	IN1	PD	Single Channel Switch (IN0 and OUT1 powered down)
0	0	1	0	PD	IN0	Single Channel Switch (IN1 and OUT0 powered down)
0	1	1	0	PD	IN1	Single Channel Repeater (Channel 0 powered down)
X	X	1	1	PD	PD	Both Channels in Power Down Mode
0	0	0	1			Invalid State*
1	0	0	1			Invalid State*
1	0	1	0			Invalid State*
1	1	1	0			Invalid State*

PD = Power Down mode to minimize power consumption
X = Don't Care
* Entering these states is not forbidden, however device operation is not defined in these states.

Application Information

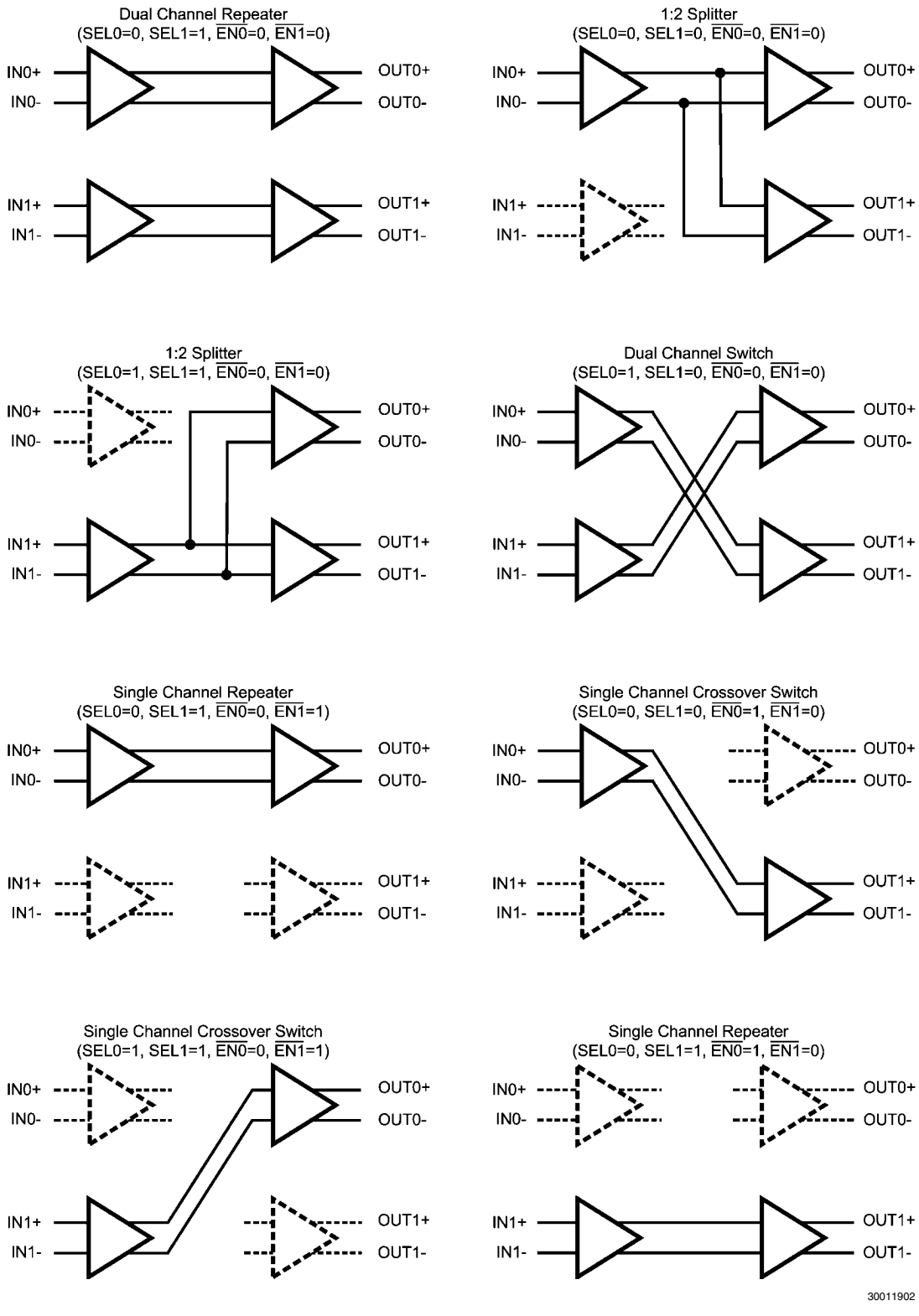


FIGURE 2. DS90CP02 Configuration Select Decode

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 +4.0V
CMOS Input Voltage	−0.3V to (V_{DD} +0.3V)
LVDS Receiver Input Voltage	−0.3V to +3.6V
LVDS Driver Output Voltage	−0.3V to +3.6V
LVDS Output Short Circuit Current	40mA
Junction Temperature	+150°C
Storage Temperature	−65°C to +150°C
Lead Temperature (Soldering, 4sec.)	+260°C
Maximum Package Power Dissipation at 25°C	
LLP-28	4.31 W
Derating above 25°C	
LLP-28	34.5 mW/°C
Thermal Resistance, θ_{JA}	
LLP-28	29°C/W
ESD Rating	
HBM, 1.5 kΩ, 100 pF	6.5 kV
EIAJ, 0Ω, 200 pF	>250V

Recommended Operating Conditions

	Min	Typ	Max	Unit
Supply Voltage (V_{DD}– GND)	3.0	3.3	3.6	V
Receiver Input Voltage	0		3.6	V
Operating Free Air Temperature	−40	25	85	°C
Junction Temperature			150	°C

Electrical Characteristics

Over recommended operating supply and temperature ranges unless other specified.

Symbol	Parameter	Conditions	Min	Typ (Note 2)	Max	Units
LVTTL DC SPECIFICATIONS (SEL0, SEL1, $\overline{EN1}$, $\overline{EN2}$)						
V_{IH}	High Level Input Voltage		2.0		V_{DD}	V
V_{IL}	Low Level Input Voltage		GND		0.8	V
I_{IH}	High Level Input Current	$V_{IN} = V_{DD} = V_{DDMAX}$	−10		+10	µA
I_{IL}	Low Level Input Current	$V_{IN} = V_{SS}$, $V_{DD} = V_{DDMAX}$	−10		+10	µA
C_{IN1}	Input Capacitance	Any Digital Input Pin to V_{SS}		3.5		pF
V_{CL}	Input Clamp Voltage	I_{CL} = −18 mA	−1.5	−0.8		V
LVDS INPUT DC SPECIFICATIONS (IN0±, IN1±)						
V_{TH}	Differential Input High Threshold (Note 3)	V_{CM} = 0.8V or 1.2V or 3.55V, V_{DD} = 3.6V		0	100	mV
V_{TL}	Differential Input Low Threshold	V_{CM} = 0.8V or 1.2V or 3.55V, V_{DD} = 3.6V	−100	0		mV
V_{ID}	Differential Input Voltage	V_{CM} = 0.8V to 3.55V, V_{DD} = 3.6V	100			mV
V_{CMR}	Common Mode Voltage Range	V_{ID} = 150 mV, V_{DD} = 3.6V	0.05		3.55	V
C_{IN2}	Input Capacitance	IN+ or IN– to V_{SS}		3.5		pF
I_{IN}	Input Current	V_{IN} = 3.6V, $V_{DD} = V_{DDMAX}$ or 0V	−10		+10	µA
		V_{IN} = 0V, $V_{DD} = V_{DDMAX}$ or 0V	−10		+10	µA
LVDS OUTPUT DC SPECIFICATIONS (OUT0±, OUT1±)						
V_{OD}	Differential Output Voltage, 0% Pre-emphasis (Note 3)	R_L = 100Ω between OUT+ and OUT–	250	400	575	mV
ΔV_{OD}	Change in V_{OD} between Complementary States		−35		35	mV
V_{OS}	Offset Voltage (Note 4)		1.09	1.25	1.475	V
ΔV_{OS}	Change in V_{OS} between Complementary States		−35		35	mV
I_{OS}	Output Short Circuit Current, One Complementary Output	OUT+ or OUT– Short to GND		−60	-90	mA
C_{OUT}	Output Capacitance	OUT+ or OUT– to GND when TRI-STATE		5.5		pF

Symbol	Parameter	Conditions	Min	Typ (Note 2)	Max	Units
SUPPLY CURRENT (Static)						
I_{CC0}	Supply Current	All inputs and outputs enabled and active, terminated with differential load of 100Ω between OUT+ and OUT-.		42	60	mA
I_{CC1}	Supply Current - one channel powered down	Single channel crossover switch or single channel repeater modes (1 channel active, one channel in power down mode)		22	30	mA
I_{CC2}	Supply Current - one input powered down	Splitter mode (One input powered down, both outputs active)		30	40	mA
I_{CCZ}	TRI-STATE Supply Current	Both input/output Channels in Power Down Mode		1.4	2.5	mA
SWITCHING CHARACTERISTICS—LVDS OUTPUTS (*Figures 3*, *4*)						
t_{LHT}	Differential Low to High Transition Time	Use an alternating 1 and 0 pattern at 200 Mb/s, measure between 20% and 80% of V_{OD}.	70	150	215	ps
t_{HLT}	Differential High to Low Transition Time		50	135	180	ps
t_{PLHD}	Differential Low to High Propagation Delay	Use an alternating 1 and 0 pattern at 200 Mb/s, measure at 50% V_{OD} between input to output.	0.5	2.4	3.5	ns
t_{PHLD}	Differential High to Low Propagation Delay		0.5	2.4	3.5	ns
t_{SKD1}	Pulse Skew	$\lvert t_{PLHD} - t_{PHLD} \rvert$		55	120	ps
t_{SKCC}	Output Channel to Channel Skew	Difference in propagation delay (t_{PLHD} or t_{PHLD}) among all output channels in Splitter mode (any one input to all outputs).	0	130	315	ps
t_{JIT}	Jitter (Note 5)	RJ - Clock Pattern 750 MHz (Note 6)		1.4	2.5	psrms
		DJ - K28.5 Pattern 1.5 Gbps (Note 7)		42	75	psp-p
		TJ - PRBS 2^{23}-1 Pattern 1.5 Gbps (Note 8)		93	126	psp-p
t_{ON}	LVDS Output Enable Time	Time from $\overline{ENx}$ to OUT± change from TRI-STATE to active.	50	110	150	ns
t_{OFF}	LVDS Output Disable Time	Time from $\overline{ENx}$ to OUT± change from active to TRI-STATE.		5	12	ns
t_{SW}	LVDS Switching Time SELx to OUT±	Time from configuration select (SELx) to new switch configuration effective for OUT±.		110	150	ns

Note 1: "Absolute Maximum Ratings" are the ratings beyond which the safety of the device cannot be guaranteed. They are not meant to imply that the device should be operated at these limits.

Note 2: Typical parameters are measured at V_{DD} = 3.3V, T_A = 25°C. They are for reference purposes, and are not production-tested.

Note 3: Differential output voltage V_{OD} is defined as ABS(OUT+–OUT–). Differential input voltage V_{ID} is defined as ABS(IN+–IN–).

Note 4: Output offset voltage V_{OS} is defined as the average of the LVDS single-ended output voltages at logic high and logic low states.

Note 5: Jitter is not production tested, but guaranteed through characterization on a sample basis.

Note 6: Random Jitter, or RJ, is measured RMS with a histogram including 1500 histogram window hits. The input voltage = V_{ID} = 500mV, 50% duty cycle at 750MHz, $t_r = t_f$ = 50ps (20% to 80%).

Note 7: Deterministic Jitter, or DJ, is measured to a histogram mean with a sample size of 350 hits. The input voltage = V_{ID} = 500mV, K28.5 pattern at 1.5 Gbps, $t_r = t_f$ = 50ps (20% to 80%). The K28.5 pattern is repeating bit streams of (0011111010 1100000101).

Note 8: Total Jitter, or TJ, is measured peak to peak with a histogram including 3500 window hits. Stimulus and fixture jitter has been subtracted. The input voltage = V_{ID} = 500mV, 2^{23}-1 PRBS pattern at 1.5 Gbps, $t_r = t_f$ = 50ps (20% to 80%).

Timing Diagrams

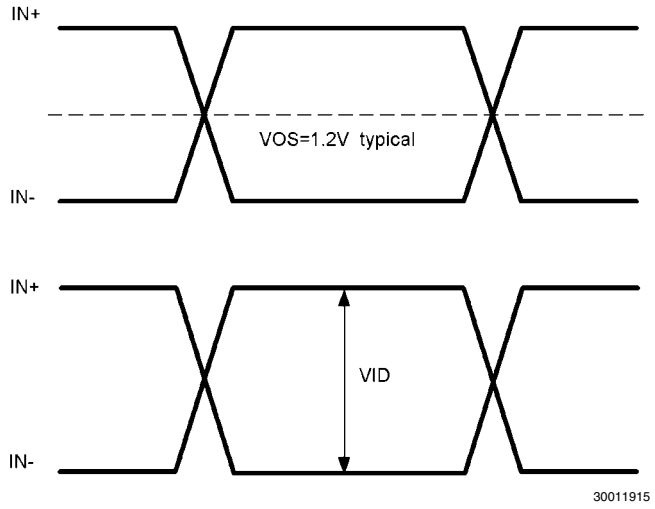


FIGURE 3. LVDS Signals

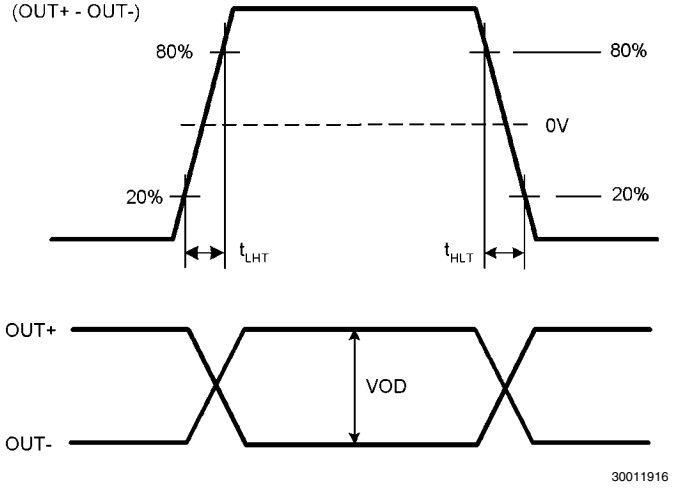


FIGURE 4. LVDS Output Transition Time

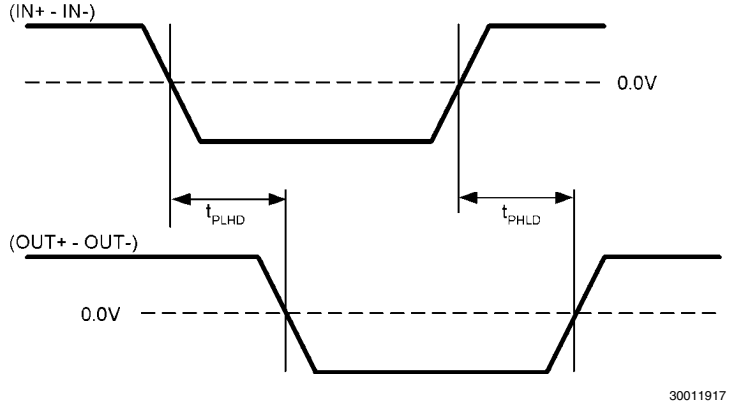


FIGURE 5. LVDS Output Propagation Delay

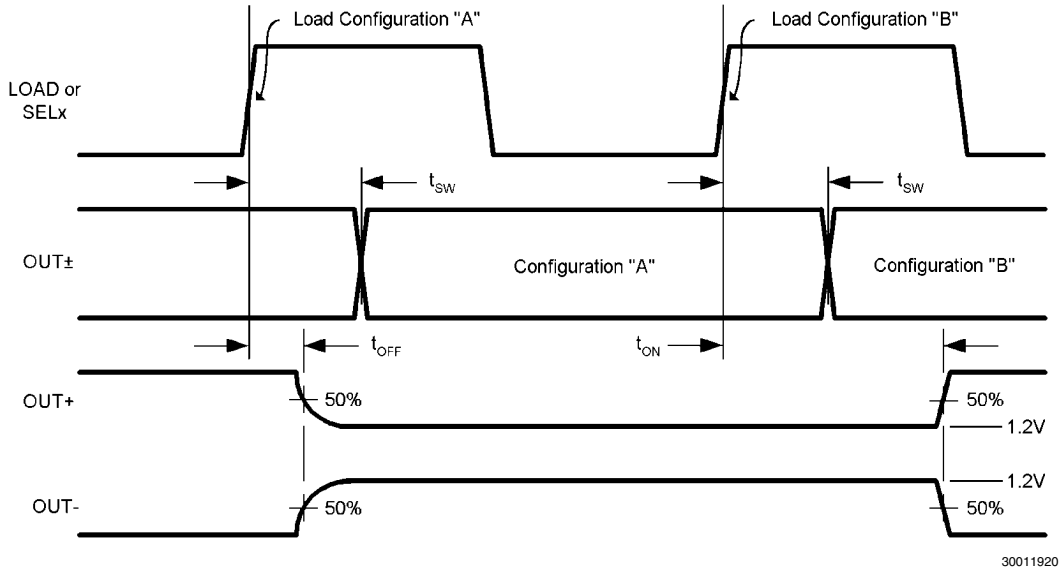
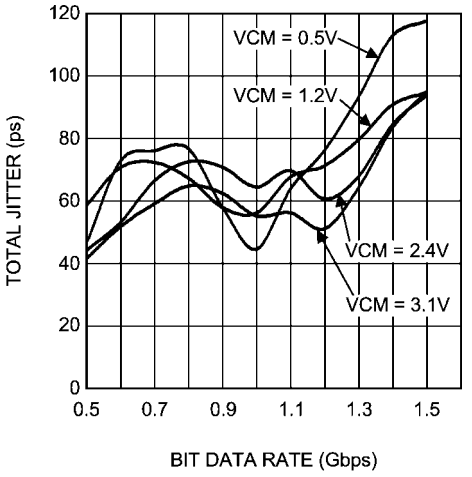


FIGURE 6. Configuration and Output Enable/Disable Timing

Typical Performance

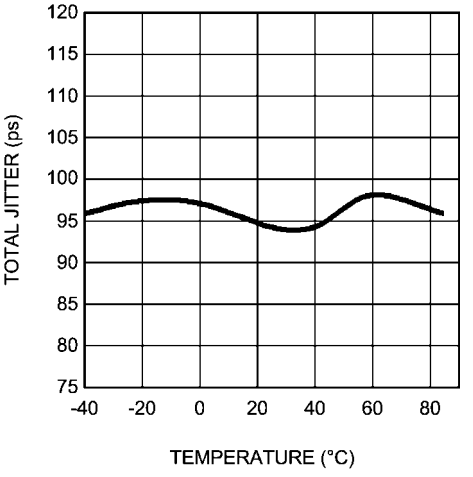
Total Jitter (T_J) vs. Bit Data Rate



30011942

Total Jitter measured at 0V differential while running a PRBS 2^{23}-1 pattern in single channel repeater mode. V_{CC} = 3.3V, T_A = +25°C, V_{ID} = 0.5V

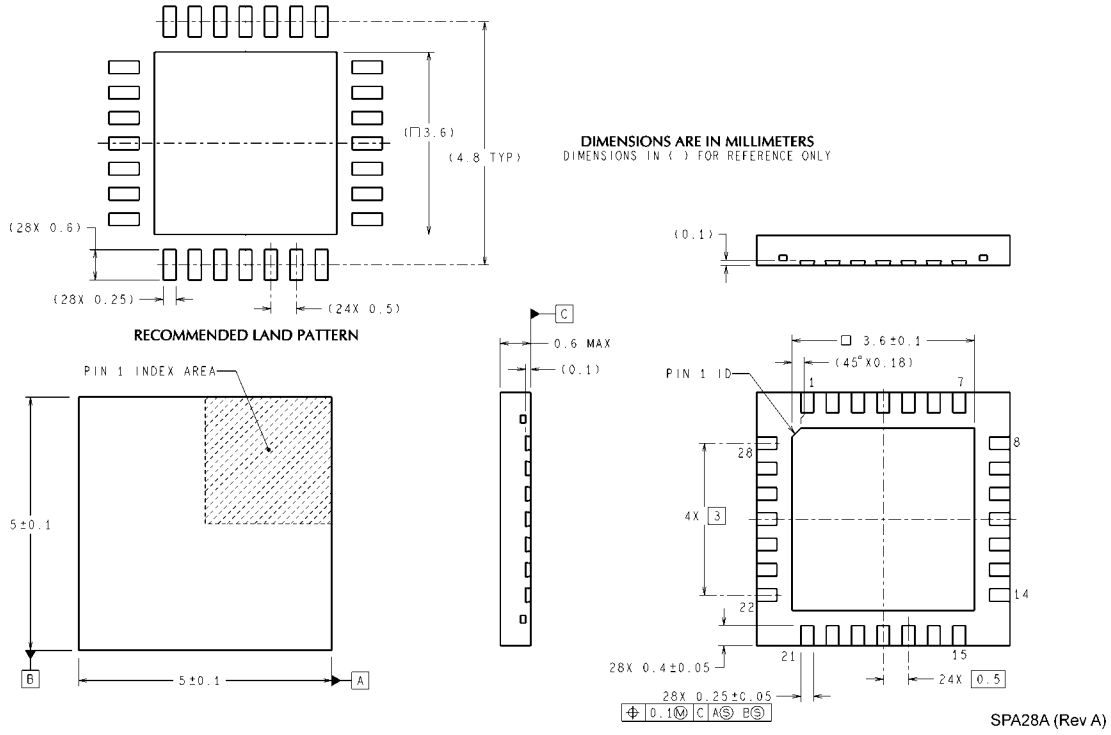
Total Jitter (T_J) vs. Temperature



30011943

Total Jitter measured at 0V differential while running a PRBS 2^{23}-1 pattern in dual channel repeater mode. V_{CC} = 3.3V, V_{ID} = 0.5V, V_{CM} = 1.2V, 1.5 Gbps data rate

Physical Dimensions inches (millimeters) unless otherwise noted



LLP, Plastic, QUAD,
Order Number DS90CP02SP (1000 piece Tape and Reel),
DS90CP02SPX (4500 piece Tape and Reel)
NS Package Number SPA28A

Notes

Notes

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