

## DS90CR218 +3.3V Rising Edge Data Strobe LVDS 21-Bit Channel Link Receiver - 75 MHz

Check for Samples: [DS90CR218](#)

### FEATURES

- 20 to 75 MHz Shift Clock Support
- 50% Duty cycle on receiver output clock
- Best-in-Class Set & Hold Times on TxINPUTs and RxOUTPUTs
- Low Power Consumption
- Tx + Rx Powerdown Mode <400µW (max)
- ±1V Common-Mode Range (around +1.2V)
- Narrow Bus Reduces Cable Size and Cost
- Up to 1.575 Gbps Throughput
- Up to 197 Mbytes/sec Bandwidth
- 345 mV (typ) Swing LVDS Devices for Low EMI
- PLL Requires No External Components
- Rising Edge Data Strobe
- Compatible with TIA/EIA-644 LVDS Standard
- Low Profile 48-Lead TSSOP Package

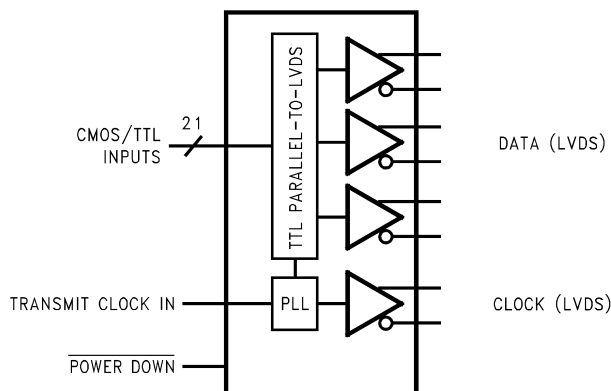
### DESCRIPTION

The DS90CR217 transmitter converts 21 bits of CMOS/TTL data into three LVDS (Low Voltage Differential Signaling) data streams. A phase-locked transmit clock is transmitted in parallel with the data streams over a fourth LVDS link. Every cycle of the transmit clock 21 bits of input data are sampled and transmitted. The DS90CR218 receiver converts the three LVDS data streams back into 21 bits of CMOS/TTL data. At a transmit clock frequency of 75 MHz, 21 bits of TTL data are transmitted at a rate of 525 Mbps per LVDS data channel. Using a 75 MHz clock, the data throughput is 1.575 Gbit/s (197 Mbytes/sec).

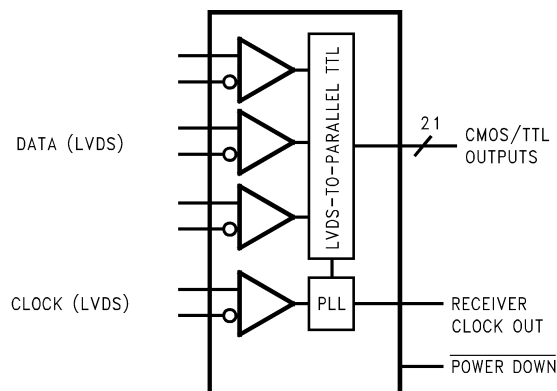
Complete specifications for the DS90CR217 are located in the DS90CR217/DS90CR218A datasheet. The DS90CR217 supports clock rates from 20 to 85 MHz.

This chipset is an ideal means to solve EMI and cable size problems associated with wide, high-speed TTL interfaces.

### BLOCK DIAGRAM



**Figure 1. DS90CR217**  
See Package Number DGG-48 (TSSOP)



**Figure 2. DS90CR218**  
See Package Number DGG-48 (TSSOP)



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## Pin Diagram

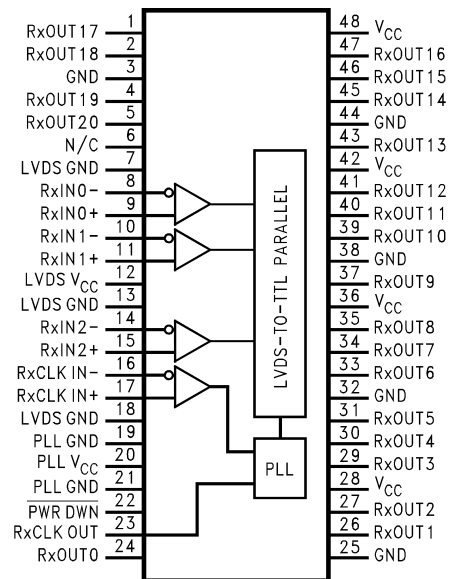
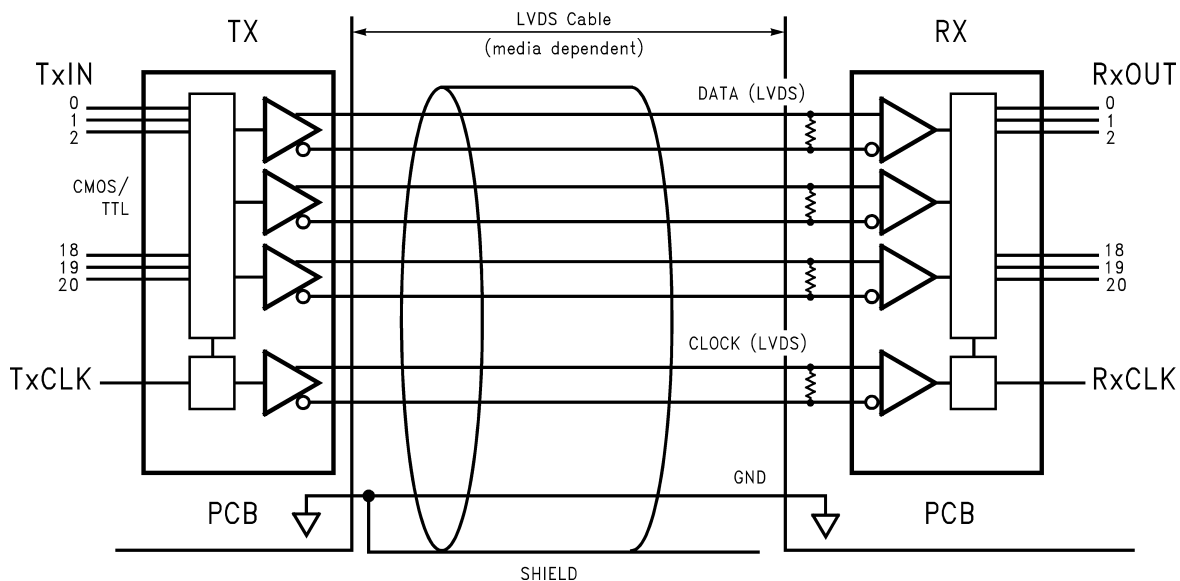


Figure 3. DS90CR218

## Typical Application



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

## Absolute Maximum Ratings<sup>(1)(2)</sup>

|                                              |                                       |                              |
|----------------------------------------------|---------------------------------------|------------------------------|
| Supply Voltage ( $V_{CC}$ )                  |                                       | -0.3V to +4V                 |
| CMOS/TTL Input Voltage                       |                                       | -0.5V to ( $V_{CC} + 0.3V$ ) |
| CMOS/TTL Output Voltage                      |                                       | -0.3V to ( $V_{CC} + 0.3V$ ) |
| LVDS Receiver Input Voltage                  |                                       | -0.3V to ( $V_{CC} + 0.3V$ ) |
| Junction Temperature                         |                                       | +150°C                       |
| Storage Temperature Range                    |                                       | -65°C to +150°C              |
| Lead Temperature<br>(Soldering, 4 sec.)      |                                       | +260°C                       |
| Maximum Package Power Dissipation @<br>+25°C | DGG0048A (TSSOP) Package<br>DS90CR218 | 1.89 W                       |
| Package Derating<br>DS90CR218                |                                       | 15 mW/°C above +25°C         |
| ESD Rating                                   | (HBM, 1.5kΩ, 100pF)                   | > 7kV                        |
|                                              | (EIAJ, 0Ω, 200pF)                     | > 700V                       |
| Latch Up Tolerance @ 25°C                    |                                       | > ±300mA                     |

- (1) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/ Distributors for availability and specifications.
- (2) "Absolute Maximum Ratings" are those values 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. "Electrical Characteristics" specify conditions for device operation.

## Recommended Operating Conditions

|                                          | Min | Nom | Max | Units            |
|------------------------------------------|-----|-----|-----|------------------|
| Supply Voltage ( $V_{CC}$ )              | 3.0 | 3.3 | 3.6 | V                |
| Operating Free Air Temperature ( $T_A$ ) | -10 | +25 | +70 | °C               |
| Receiver Input Range                     | 0   |     | 2.4 | V                |
| Supply Noise Voltage ( $V_{CC}$ )        |     |     | 100 | mV <sub>PP</sub> |

## Electrical Characteristics

Over recommended operating supply and temperature ranges unless otherwise specified

| Symbol                                 | Parameter                         | Conditions                        | Min  | Typ <sup>(1)</sup> | Max      | Units |
|----------------------------------------|-----------------------------------|-----------------------------------|------|--------------------|----------|-------|
| <b>CMOS/TTL DC SPECIFICATIONS</b>      |                                   |                                   |      |                    |          |       |
| $V_{IH}$                               | High Level Input Voltage          |                                   | 2.0  |                    | $V_{CC}$ | V     |
| $V_{IL}$                               | Low Level Input Voltage           |                                   | GND  |                    | 0.8      | V     |
| $V_{OH}$                               | High Level Output Voltage         | $I_{OH} = -0.4$ mA                | 2.7  | 3.3                |          | V     |
| $V_{OL}$                               | Low Level Output Voltage          | $I_{OL} = 2$ mA                   |      | 0.06               | 0.3      | V     |
| $V_{CL}$                               | Input Clamp Voltage               | $I_{CL} = -18$ mA                 |      | -0.79              | -1.5     | V     |
| $I_{IN}$                               | Input Current                     | $V_{IN} = 0.4V, 2.5V$ or $V_{CC}$ |      | +1.8               | +10      | μA    |
|                                        |                                   | $V_{IN} = GND$                    | -10  | 0                  |          | μA    |
| $I_{OS}$                               | Output Short Circuit Current      | $V_{OUT} = 0V$                    |      | -60                | -120     | mA    |
| <b>LVDS RECEIVER DC SPECIFICATIONS</b> |                                   |                                   |      |                    |          |       |
| $V_{TH}$                               | Differential Input High Threshold | $V_{CM} = +1.2V$                  |      |                    | +100     | mV    |
| $V_{TL}$                               | Differential Input Low Threshold  |                                   | -100 |                    |          | mV    |
| $I_{IN}$                               | Input Current                     | $V_{IN} = +2.4V, V_{CC} = 3.6V$   |      |                    | ±10      | μA    |
|                                        |                                   | $V_{IN} = 0V, V_{CC} = 3.6V$      |      |                    | ±10      | μA    |

- (1) Typical values are given for  $V_{CC} = 3.3V$  and  $T_A = +25°C$ .

## Electrical Characteristics (continued)

Over recommended operating supply and temperature ranges unless otherwise specified

| Symbol                                       | Parameter                          | Conditions                                                          | Min        | Typ <sup>(1)</sup> | Max | Units |
|----------------------------------------------|------------------------------------|---------------------------------------------------------------------|------------|--------------------|-----|-------|
| <b>RECEIVER SUPPLY CURRENT<sup>(2)</sup></b> |                                    |                                                                     |            |                    |     |       |
| I <sub>CCRW</sub>                            | Receiver Supply Current Worst Case | C <sub>L</sub> = 8 pF,<br>Worst Case Pattern<br>(Figure 4 Figure 5) | f = 33 MHz | 49                 | 60  | mA    |
|                                              |                                    |                                                                     | f = 40 MHz | 53                 | 65  | mA    |
|                                              |                                    |                                                                     | f = 66 MHz | 78                 | 95  | mA    |
|                                              |                                    |                                                                     | f = 75 MHz | 90                 | 105 | mA    |
| I <sub>CCRZ</sub>                            | Receiver Supply Current Power Down | PWR DWN = Low<br>Receiver Outputs Stay Low during<br>Powerdown Mode |            | 15                 | 55  | μA    |

(2) Current into device pins is defined as positive. Current out of device pins is defined as negative. Voltages are referenced to ground unless otherwise specified (except V<sub>TH</sub> and V<sub>TL</sub>).

## Receiver Switching Characteristics

Over recommended operating supply and temperature ranges unless otherwise specified

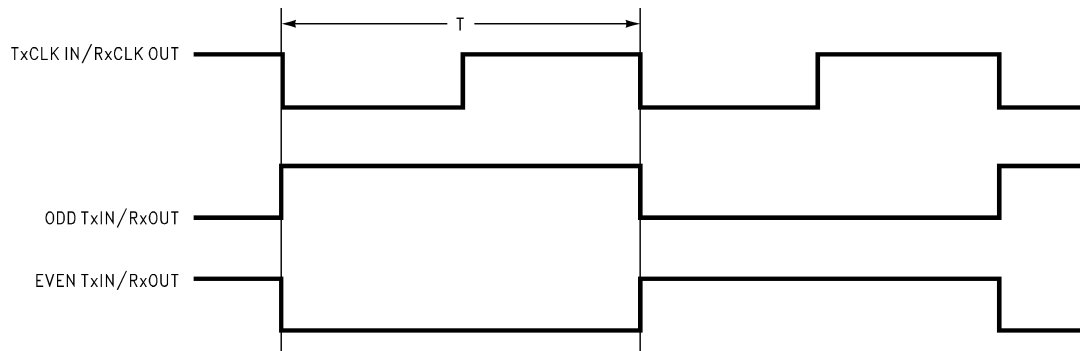
| Symbol | Parameter                                                                            |            | Min   | Typ <sup>(1)</sup> | Max   | Units |
|--------|--------------------------------------------------------------------------------------|------------|-------|--------------------|-------|-------|
| CLHT   | CMOS/TTL Low-to-High Transition Time (Figure 5)                                      |            |       | 2.0                | 3.5   | ns    |
| CHLT   | CMOS/TTL High-to-Low Transition Time (Figure 5)                                      |            |       | 1.8                | 3.5   | ns    |
| RSPos0 | Receiver Input Strobe Position for Bit 0 (Figure 11)                                 | f = 75 MHz | 0.58  | 0.95               | 1.32  | ns    |
| RSPos1 | Receiver Input Strobe Position for Bit 1                                             |            | 2.49  | 2.86               | 3.23  | ns    |
| RSPos2 | Receiver Input Strobe Position for Bit 2                                             |            | 4.39  | 4.76               | 5.13  | ns    |
| RSPos3 | Receiver Input Strobe Position for Bit 3                                             |            | 6.30  | 6.67               | 7.04  | ns    |
| RSPos4 | Receiver Input Strobe Position for Bit 4                                             |            | 8.20  | 8.57               | 8.94  | ns    |
| RSPos5 | Receiver Input Strobe Position for Bit 5                                             |            | 10.11 | 10.48              | 10.85 | ns    |
| RSPos6 | Receiver Input Strobe Position for Bit 6                                             |            | 12.01 | 12.38              | 12.75 | ns    |
| RSKM   | Receiver Skew Margin (when used with DS90CR217) <sup>(2)</sup> (Figure 12)           | f = 75 MHz | 380   |                    |       | ps    |
| RCOP   | RxCLK OUT Period (Figure 6)                                                          |            | 13.33 | T                  | 50    | ns    |
| RCOH   | RxCLK OUT High Time (Figure 6)                                                       | f = 75 MHz | 3.6   | 5                  | 6.0   | ns    |
| RCOL   | RxCLK OUT Low Time (Figure 6)                                                        |            | 3.6   | 5                  | 6.0   | ns    |
| RSRC   | RxOUT Setup to RxCLK OUT (Figure 6)                                                  |            | 3.5   |                    |       | ns    |
| RHRC   | RxOUT Hold to RxCLK OUT (Figure 6)                                                   |            | 3.5   |                    |       | ns    |
| RCCD   | RxCLK IN to RxCLK OUT Delay @ 25°C, V <sub>CC</sub> = 3.3V <sup>(3)</sup> (Figure 7) |            | 3.4   | 5.0                | 7.3   | ns    |
| RPLLS  | Receiver Phase Lock Loop Set (Figure 8)                                              |            |       |                    | 10    | ms    |
| RPDD   | Receiver Powerdown Delay (Figure 10)                                                 |            |       |                    | 1     | μs    |

(1) Typical values are given for V<sub>CC</sub> = 3.3V and T<sub>A</sub> = +25°C.

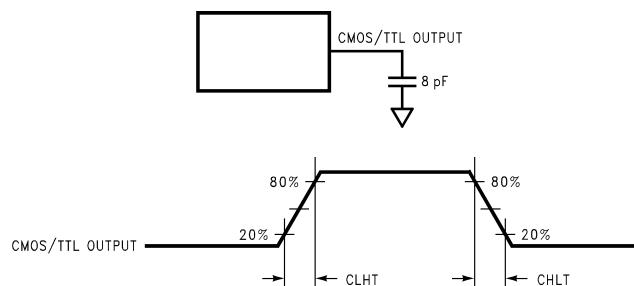
(2) Receiver Skew Margin is defined as the valid data sampling region at the receiver inputs. This margin takes into account the transmitter pulse positions (min and max) and the receiver input setup and hold time (internal data sampling window). This margin allows LVDS interconnect skew, inter-symbol interference (both dependent on type/length of cable), and source clock jitter less than 250 ps.

(3) Total latency for the channel link chipset is a function of clock period and gate delays through the transmitter (TCCD) and receiver (RCCD). The total latency for the 217/287 transmitter and 218/288 receiver is: (T + TCCD) + (2\*T + RCCD), where T = Clock period.

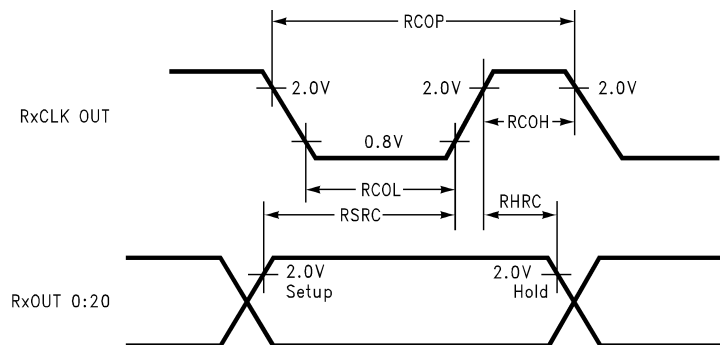
## AC Timing Diagrams



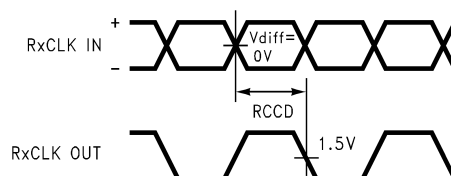
**Figure 4. "Worst Case" Test Pattern**



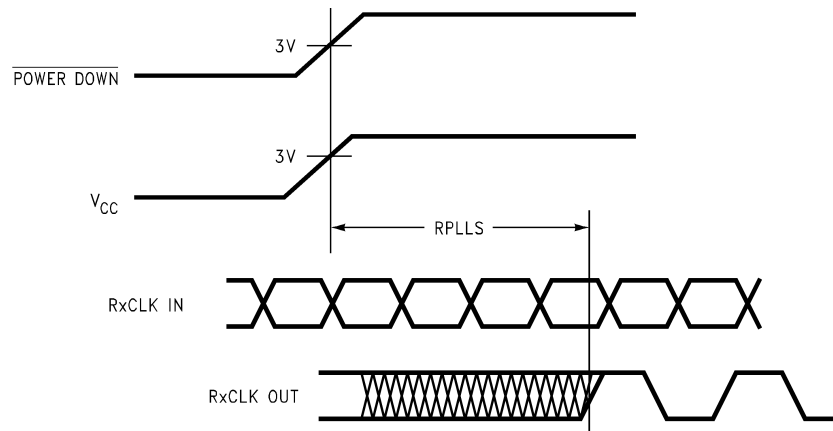
**Figure 5. DS90CR218 (Receiver) CMOS/TTL Output Load and Transition Times**



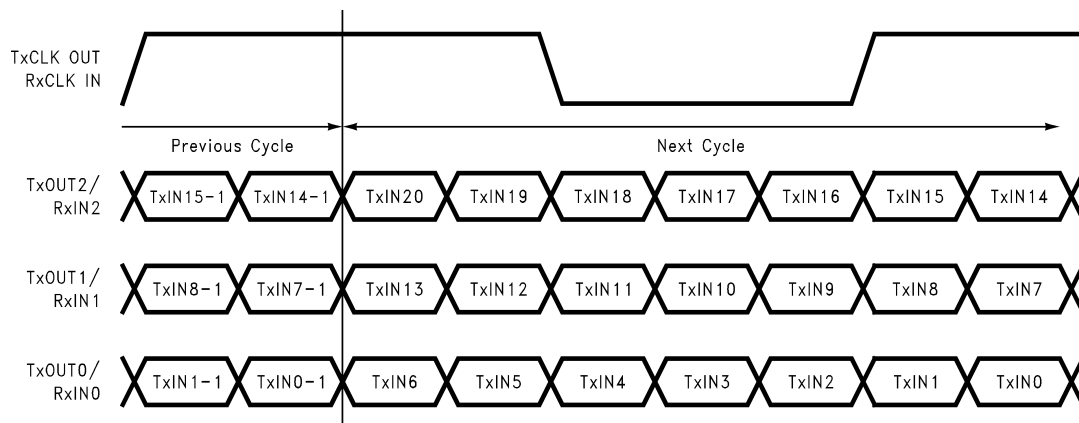
**Figure 6. DS90CR218 (Receiver) Setup/Hold and High/Low Times**



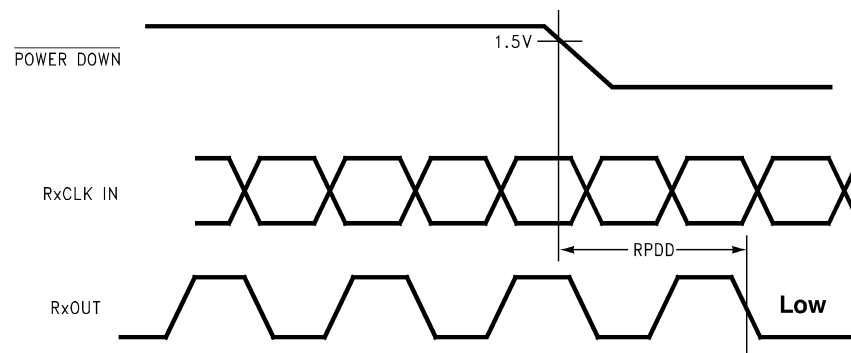
**Figure 7. DS90CR218 (Receiver) Clock In to Clock Out Delay**



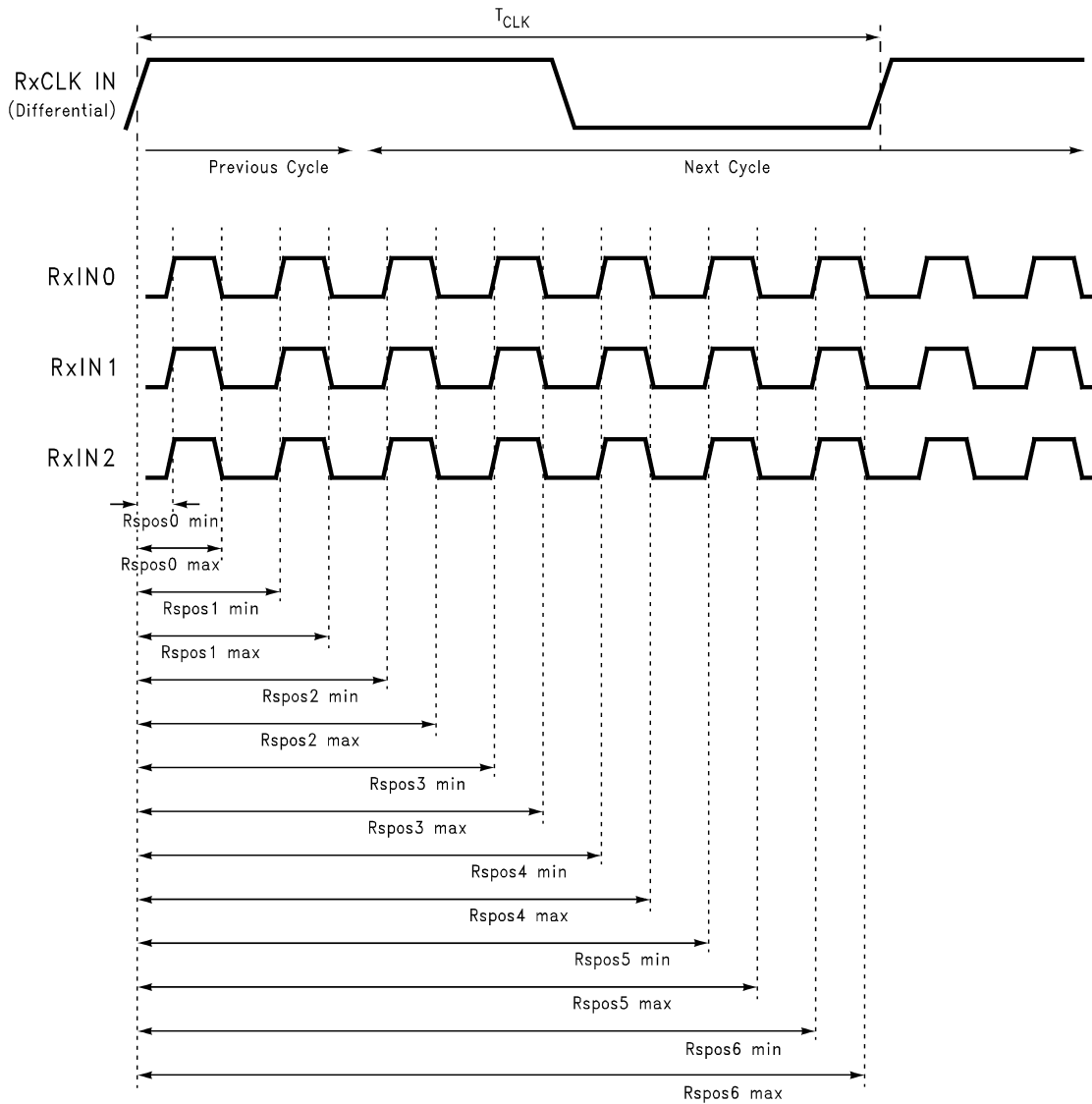
**Figure 8. DS90CR218 (Receiver) Phase Lock Loop Set Time**



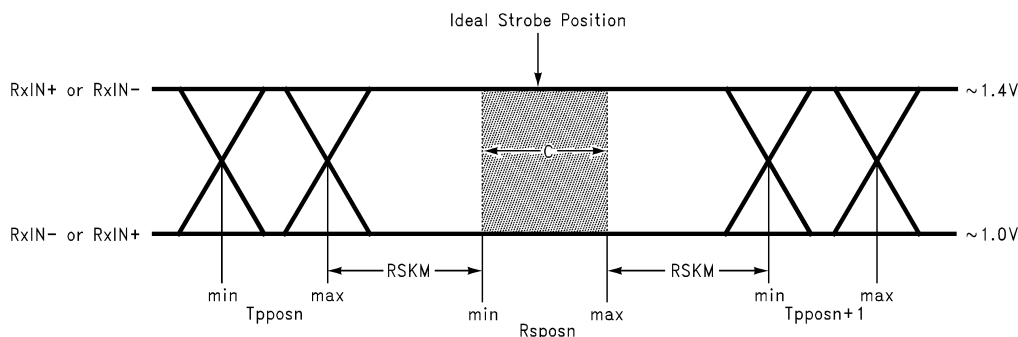
**Figure 9. 21 Parallel TTL Data Inputs Mapped to LVDS Outputs (DS90CR217)**



**Figure 10. Receiver Powerdown Delay**



**Figure 11. Receiver LVDS Input Strobe Position**



C—Setup and Hold Time (Internal data sampling window) defined by Rspos (receiver input strobe position) min and max

Tppos—Transmitter output pulse position (min and max)

$RSKM \geq \text{Cable Skew (type, length)} + \text{Source Clock Jitter (cycle to cycle)}^{(1)} + \text{ISI (Inter-symbol interference)}^{(2)}$

Cable Skew—typically 10 ps–40 ps per foot, media dependent

(1) Cycle-to-cycle jitter is less than 250 ps at 75MHz

(2) ISI is dependent on interconnect length; may be zero

**Figure 12. Receiver LVDS Input Skew Margin (DS90CR217/DS90CR218)**

#### DS90CR218 PIN DESCRIPTION—Channel Link Receiver

| Pin Name             | I/O | No. | Description                                                                      |
|----------------------|-----|-----|----------------------------------------------------------------------------------|
| RxIN+                | I   | 3   | Positive LVDS differential data inputs. <sup>(1)</sup>                           |
| RxIN-                | I   | 3   | Negative LVDS differential data inputs. <sup>(1)</sup>                           |
| RxOUT                | O   | 21  | TTL level data outputs.                                                          |
| RxCLK IN+            | I   | 1   | Positive LVDS differential clock input.                                          |
| RxCLK IN-            | I   | 1   | Negative LVDS differential clock input.                                          |
| RxCLK OUT            | O   | 1   | TTL level clock output. The rising edge acts as data strobe. Pin name RxCLK OUT. |
| PWR DWN              | I   | 1   | TTL level input. When asserted (low input) the receiver outputs are low.         |
| V <sub>CC</sub>      | I   | 4   | Power supply pins for TTL outputs.                                               |
| GND                  | I   | 5   | Ground pins for TTL outputs.                                                     |
| PLL V <sub>CC</sub>  | I   | 1   | Power supply for PLL.                                                            |
| PLL GND              | I   | 2   | Ground pin for PLL.                                                              |
| LVDS V <sub>CC</sub> | I   | 1   | Power supply pin for LVDS inputs.                                                |
| LVDS GND             | I   | 3   | Ground pins for LVDS inputs.                                                     |

(1) These receivers have input failsafe bias circuitry to guarantee a stable receiver output for floating or terminated receiver inputs. Under these conditions receiver inputs will be in a HIGH state. If a clock signal is present, outputs will all be HIGH; if the clock input is also floating/terminated outputs will remain in the last valid state. A floating/terminated clock input will result in a LOW clock output.



## APPLICATIONS INFORMATION

The DS90CR217 and DS90CR218 are backward compatible with the existing 5V Channel Link transmitter/receiver pair (DS90CR213, DS90CR214). To upgrade from a 5V to a 3.3V system the following must be addressed:

1. Change 5V power supply to 3.3V. Provide this supply to the  $V_{CC}$ , LVDS  $V_{CC}$  and PLL  $V_{CC}$ .
2. Transmitter input and control inputs except 3.3V TTL/CMOS levels. They are not 5V tolerant.
3. The receiver powerdown feature when enabled will lock receiver output to a logic low. However, the 5V/66 MHz receiver maintain the outputs in the previous state when powerdown occurred.

The Channel Link devices are intended to be used in a wide variety of data transmission applications. Depending upon the application the interconnecting media may vary. For example, for lower data rate (clock rate) and shorter cable lengths (< 2m), the media electrical performance is less critical. For higher speed/long distance applications the media's performance becomes more critical. Certain cable constructions provide tighter skew (matched electrical length between the conductors and pairs). Twin-coax for example, has been demonstrated at distances as great as 5 meters and with the maximum data transfer of 1.58 Gbit/s. Additional applications information can be found in the following Interface Application Notes:

| AN = ####                           | Topic                                                     |
|-------------------------------------|-----------------------------------------------------------|
| AN-1041 ( <a href="#">SNLA218</a> ) | Introduction to Channel Link                              |
| AN-1108 ( <a href="#">SNLA008</a> ) | PCB Design Guidelines for LVDS and Link Devices           |
| AN-806 ( <a href="#">SNLA026</a> )  | Transmission Line Theory                                  |
| AN-905 ( <a href="#">SNLA035</a> )  | Transmission Line Calculations and Differential Impedance |
| AN-916 ( <a href="#">SNLA219</a> )  | Cable Information                                         |

**CABLES:** A cable interface between the transmitter and receiver needs to support the differential LVDS pairs. The 21-bit CHANNEL LINK chipset (DS90CR217/218) requires four pairs of signal wires and the 28-bit CHANNEL LINK chipset (DS90CR287/288) requires five pairs of signal wires. The ideal cable/connector interface would have a constant 100Ω differential impedance throughout the path. It is also recommended that cable skew remain below 130ps (@ 75 MHz clock rate) to maintain a sufficient data sampling window at the receiver.

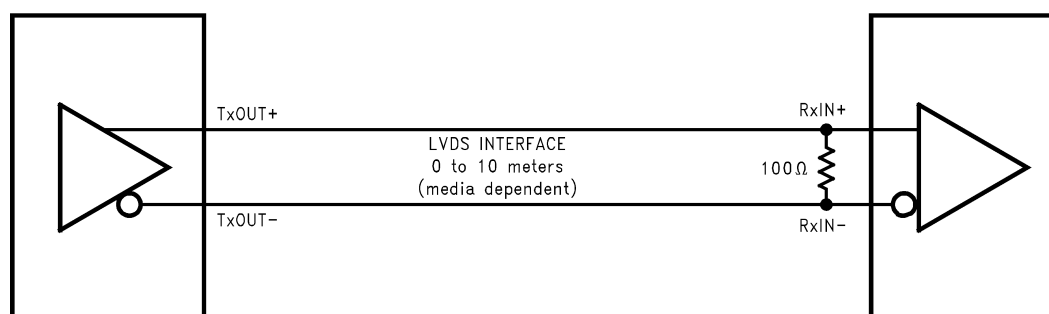
In addition to the four or five cable pairs that carry data and clock, it is recommended to provide at least one additional conductor (or pair) which connects ground between the transmitter and receiver. This low impedance ground provides a common-mode return path for the two devices. Some of the more commonly used cable types for point-to-point applications include flat ribbon, flex, twisted pair and Twin-Coax. All are available in a variety of configurations and options. Flat ribbon cable, flex and twisted pair generally perform well in short point-to-point applications while Twin-Coax is good for short and long applications. When using ribbon cable, it is recommended to place a ground line between each differential pair to act as a barrier to noise coupling between adjacent pairs. For Twin-Coax cable applications, it is recommended to utilize a shield on each cable pair. All extended point-to-point applications should also employ an overall shield surrounding all cable pairs regardless of the cable type. This overall shield results in improved transmission parameters such as faster attainable speeds, longer distances between transmitter and receiver and reduced problems associated with EMS or EMI.

The high-speed transport of LVDS signals has been demonstrated on several types of cables with excellent results. However, the best overall performance has been seen when using Twin-Coax cable. Twin-Coax has very low cable skew and EMI due to its construction and double shielding. All of the design considerations discussed here and listed in the supplemental application notes provide the subsystem communications designer with many useful guidelines. It is recommended that the designer assess the tradeoffs of each application thoroughly to arrive at a reliable and economical cable solution.

**BOARD LAYOUT:** To obtain the maximum benefit from the noise and EMI reductions of LVDS, attention should be paid to the layout of differential lines. Lines of a differential pair should always be adjacent to eliminate noise interference from other signals and take full advantage of the noise canceling of the differential signals. The board designer should also try to maintain equal length on signal traces for a given differential pair. As with any high-speed design, the impedance discontinuities should be limited (reduce the numbers of vias and no 90 degree angles on traces). Any discontinuities which do occur on one signal line should be mirrored in the other line of the differential pair. Care should be taken to ensure that the differential trace impedance match the

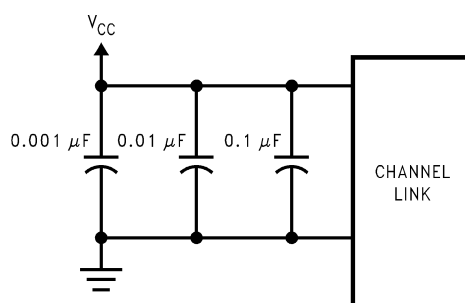
differential impedance of the selected physical media (this impedance should also match the value of the termination resistor that is connected across the differential pair at the receiver's input). Finally, the location of the CHANNEL LINK TxOUT/RxIN pins should be as close as possible to the board edge so as to eliminate excessive pcb runs. All of these considerations will limit reflections and crosstalk which adversely effect high frequency performance and EMI.

**TERMINATION:** Use of current mode drivers requires a terminating resistor across the receiver inputs. The CHANNEL LINK chipset will normally require a single 100Ω resistor between the true and complement lines on each differential pair of the receiver input. The actual value of the termination resistor should be selected to match the differential mode characteristic impedance (90Ω to 120Ω typical) of the cable. Figure 13 shows an example. No additional pull-up or pull-down resistors are necessary as with some other differential technologies such as PECL. Surface mount resistors are recommended to avoid the additional inductance that accompanies leaded resistors. These resistors should be placed as close as possible to the receiver input pins to reduce stubs and effectively terminate the differential lines.



**Figure 13. LVDS Serialized Link Termination**

**DECOUPLING CAPACITORS:** Bypassing capacitors are needed to reduce the impact of switching noise which could limit performance. For a conservative approach three parallel-connected decoupling capacitors (Multi-Layered Ceramic type in surface mount form factor) between each  $V_{CC}$  and the ground plane(s) are recommended. The three capacitor values are 0.1 μF, 0.01 μF and 0.001 μF. An example is shown in Figure 14. The designer should employ wide traces for power and ground and ensure each capacitor has its own via to the ground plane. If board space is limiting the number of bypass capacitors, the PLL  $V_{CC}$  should receive the most filtering/bypassing. Next would be the LVDS  $V_{CC}$  pins and finally the logic  $V_{CC}$  pins.



**Figure 14. CHANNEL LINK Decoupling Configuration**

**CLOCK JITTER:** The CHANNEL LINK devices employ a PLL to generate and recover the clock transmitted across the LVDS interface. The width of each bit in the serialized LVDS data stream is one-seventh the clock period. For example, a 75 MHz clock has a period of 13.33 ns which results in a data bit width of 1.90 ns. Differential skew ( $\Delta t$  within one differential pair), interconnect skew ( $\Delta t$  of one differential pair to another) and clock jitter will all reduce the available window for sampling the LVDS serial data streams. Care must be taken to ensure that the clock input to the transmitter be a clean low noise signal. Individual bypassing of each  $V_{CC}$  to ground will minimize the noise passed on to the PLL, thus creating a low jitter LVDS clock. These measures provide more margin for channel-to-channel skew and interconnect skew as a part of the overall jitter/skew budget.

**COMMON-MODE vs. DIFFERENTIAL MODE NOISE MARGIN:** The typical signal swing for LVDS is 300 mV centered at +1.2V. The CHANNEL LINK receiver supports a 100 mV threshold therefore providing approximately 200 mV of differential noise margin. Common-mode protection is of more importance to the system's operation due to the differential data transmission. LVDS supports an input voltage range of Ground to +2.4V. This allows for a  $\pm 1.0V$  shifting of the center point due to ground potential differences and common-mode noise.

**TRANSMITTER INPUT CLOCK:** The transmitter input clock must always be present when the device is enabled ( $\overline{\text{PWR DWN}} = \text{HIGH}$ ). If the clock is stopped, the  $\overline{\text{PWR DWN}}$  pin must be used to disable the PLL. The  $\overline{\text{PWR DWN}}$  pin must be held low until after the input clock signal has been reapplied. This will ensure a proper device reset and PLL lock to occur.

**POWER SEQUENCING AND POWERDOWN MODE:** Outputs of the CHANNEL LINK transmitter remain in TRI-STATE until the power supply reaches 2V. Clock and data outputs will begin to toggle 10 ms after  $V_{CC}$  has reached 3V and the Powerdown pin is above 1.5V. Either device may be placed into a powerdown mode at any time by asserting the Powerdown pin (active low). Total power dissipation for each device will decrease to 5  $\mu\text{W}$  (typical).

The transmitter input clock may be applied prior to powering up and enabling the transmitter. The transmitter input clock may also be applied after power up; however, the use of the  $\overline{\text{PWR DWN}}$  pin is required. Do not power up and enable ( $\overline{\text{PWR DWN}} = \text{HIGH}$ ) the transmitter without a valid clock signal applied to the TxCLK IN pin.

The CHANNEL LINK chipset is designed to protect itself from accidental loss of power to either the transmitter or receiver. If power to the transmit board is lost, the receiver clocks (input and output) stop. The data outputs (RxOUT) retain the states they were in when the clocks stopped. When the receiver board loses power, the receiver inputs are shorted to  $V_{CC}$  through an internal diode. Current is limited (5 mA per input) by the fixed current mode drivers, thus avoiding the potential for latchup when powering the device.

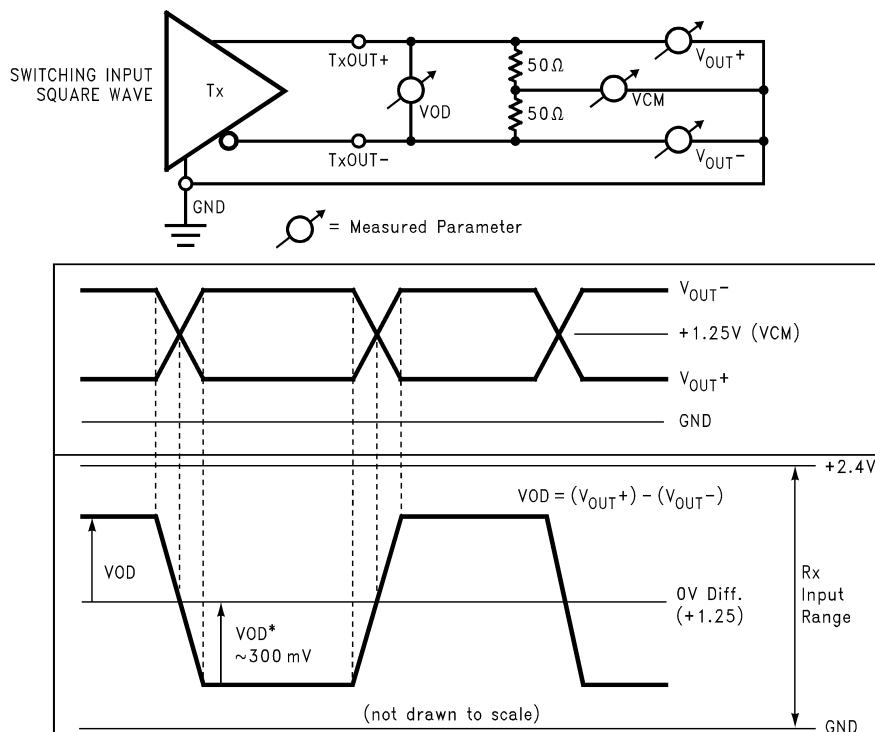


Figure 15. Single-Ended and Differential Waveforms

## REVISION HISTORY

### Changes from Revision D (April 2013) to Revision E

### Page

- Changed layout of National Data Sheet to TI format ..... [11](#)

## IMPORTANT NOTICE

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|                               |                                                                                          |
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