

# **DS90CR216A,DS90CR286A**

*DS90CR286A/DS90CR286AQ/DS90CR216A +3.3V Rising Edge Data Strobe LVDS*

*Receiver 28-Bit Channel Link - 66 MHz, +3.3V Rising Edge Strobe LVDS*

*Receiver 21-Bit Channel Link - 66 MHz*



Literature Number: SNLS043E

## +3.3V Rising Edge Data Strobe LVDS Receiver 28-Bit Channel Link - 66 MHz, +3.3V Rising Edge Strobe LVDS Receiver 21-Bit Channel Link - 66 MHz

### General Description

The DS90CR286A receiver converts the four LVDS data streams (Up to 1.848 Gbps throughput or 231 Megabytes/sec bandwidth) back into parallel 28 bits of CMOS/TTL data. Also available is the DS90CR216A that converts the three LVDS data streams (Up to 1.386 Gbps throughput or 173 Megabytes/sec bandwidth) back into parallel 21 bits of CMOS/TTL data. Both Receivers' outputs are Rising edge strobe.

Both devices are offered in TSSOP packages.

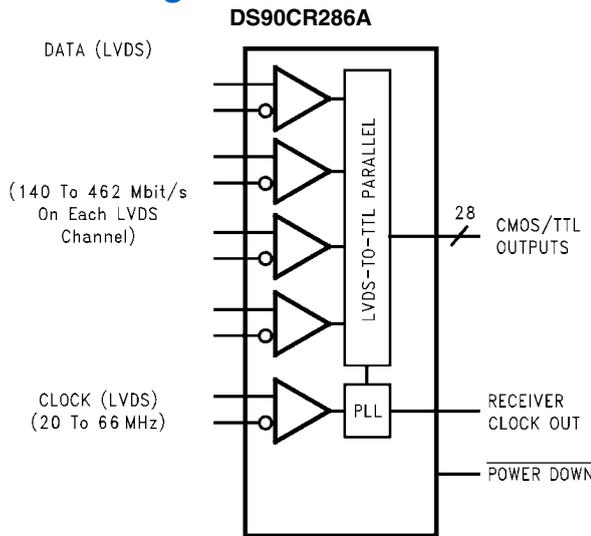
The DS90CR286A / DS90CR216A devices are enhanced over prior generation receivers and provided a wider data valid time on the receiver output.

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

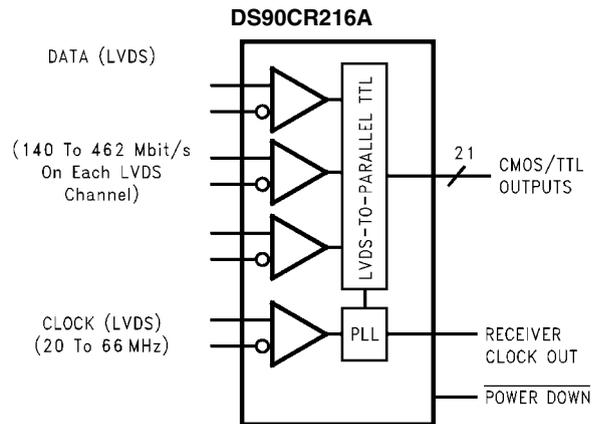
### Features

- 20 to 66 MHz shift clock support
- 50% duty cycle on receiver output clock
- Best-in-Class Set & Hold Times on RxOUTPUTs
- Rx power consumption <270 mW (typ) @66MHz Worst Case
- Rx Power-down mode <200µW (max)
- ESD rating >7 kV (HBM), >700V (EIAJ)
- PLL requires no external components
- Compatible with TIA/EIA-644 LVDS standard
- Low profile 56-lead or 48-lead TSSOP package
- Operating Temperature: -40°C to +85°C
- Automotive Q grade available - AEC-Q100 grade 3 qualified

### Block Diagrams



Order Number **DS90CR286AMTD, DS90CR286AQMT**  
See NS Package Number MTD56



Order Number **DS90CR216AMTD**  
See NS Package Number MTD48

## 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 ( $V_{CC}$ )	-0.3V to +4V
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	-65°C to +150°C
Lead Temperature (Soldering, 4 sec)	+260°C
Maximum Package Power Dissipation Capacity @ 25°C	
MTD56 (TSSOP) Package:	
DS90CR286AMTD	1.61 W
MTD48 (TSSOP) Package:	
DS90CR216AMTD	1.89 W
Package Derating:	

DS90CR286AMTD	12.4 mW/°C above +25°C
DS90CR216AMTD	15 mW/°C above +25°C
ESD Rating	
(HBM, 1.5 k $\Omega$ , 100 pF)	> 7 kV
(EIAJ, 0 $\Omega$ , 200 pF)	> 700V

## Recommended Operating Conditions

	Min	No m	Max	Units
Supply Voltage ( $V_{CC}$ )	3.0	3.3	3.6	V
Operating Free Air Temperature ( $T_A$ )	-40	+25	+85	°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	Max	Units	
<b>CMOS/TTL DC SPECIFICATIONS (For PowerDown Pin)</b>							
$V_{IH}$	High Level Input Voltage		2.0		$V_{CC}$	V	
$V_{IL}$	Low Level Input Voltage		GND		0.8	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	$\mu$ A	
		$V_{IN} = GND$	-10	0		$\mu$ A	
<b>CMOS/TTL DC SPECIFICATIONS</b>							
$V_{OH}$	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	
$I_{OS}$	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	$V_{IN} = +2.4V, V_{CC} = 3.6V$			$\pm 10$	$\mu$ A	
		$V_{IN} = 0V, V_{CC} = 3.6V$			$\pm 10$	$\mu$ A	
<b>RECEIVER SUPPLY CURRENT</b>							
ICCRW	Receiver Supply Current Worst Case	$C_L = 8$ pF, Worst Case Pattern, DS90CR286A (Figures 1, 2), $T_A = -10^\circ C$ to $+70^\circ C$	$f = 33$ MHz		49	65	mA
			$f = 37.5$ MHz		53	70	mA
			$f = 66$ MHz		81	105	mA
ICCRW	Receiver Supply Current Worst Case	$C_L = 8$ pF, Worst Case Pattern, DS90CR286A (Figures 1, 2), $T_A = -40^\circ C$ to $+85^\circ C$	$f = 40$ MHz		53	70	mA
			$f = 66$ MHz		81	105	mA
ICCRW	Receiver Supply Current Worst Case	$C_L = 8$ pF, Worst Case Pattern, DS90CR216A (Figures 1, 2), $T_A = -10^\circ C$ to $+70^\circ C$	$f = 33$ MHz		49	55	mA
			$f = 37.5$ MHz		53	60	mA
			$f = 66$ MHz		78	90	mA
ICCRW	Receiver Supply Current Worst Case	$C_L = 8$ pF, Worst Case Pattern, DS90CR216A (Figures 1, 2), $T_A = -40^\circ C$ to $+85^\circ C$	$f = 40$ MHz		53	60	mA
			$f = 66$ MHz		78	90	mA

Symbol	Parameter	Conditions	Min	Typ	Max	Units
ICCRZ	Receiver Supply Current Power Down	Power Down = Low Receiver Outputs Stay Low during Power Down Mode		10	55	μA

**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 device should be operated at these limits. The tables of "Electrical Characteristics" specify conditions for device operation.

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

**Note 3:** 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  $V_{OD}$  and  $\Delta V_{OD}$ ).

## Receiver Switching Characteristics

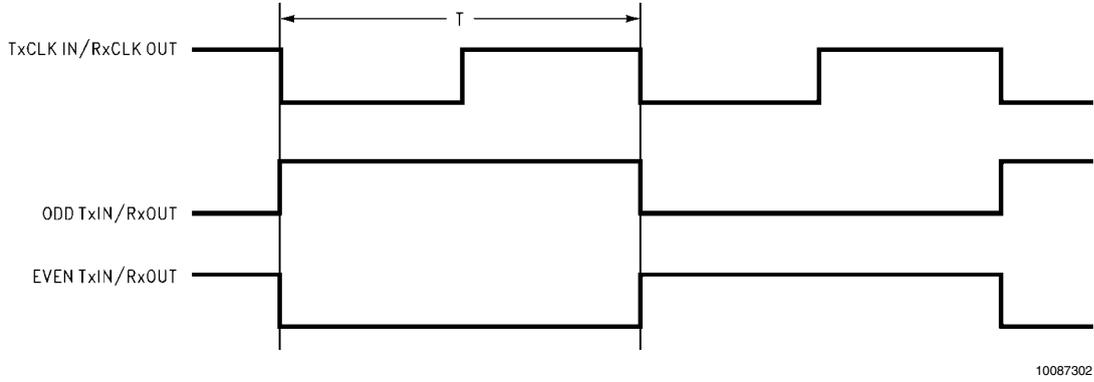
Over recommended operating supply and temperature ranges unless otherwise specified

Symbol	Parameter	Min	Typ	Max	Units	
CLHT	CMOS/TTL Low-to-High Transition Time (Figure 2)		2	5	ns	
CHLT	CMOS/TTL High-to-Low Transition Time (Figure 2)		1.8	5	ns	
RSPos0	Receiver Input Strobe Position for Bit 0 (Figure 9, Figure 10)	f = 40 MHz	1.0	1.4	2.15	ns
RSPos1	Receiver Input Strobe Position for Bit 1		4.5	5.0	5.8	ns
RSPos2	Receiver Input Strobe Position for Bit 2		8.1	8.5	9.15	ns
RSPos3	Receiver Input Strobe Position for Bit 3		11.6	11.9	12.6	ns
RSPos4	Receiver Input Strobe Position for Bit 4		15.1	15.6	16.3	ns
RSPos5	Receiver Input Strobe Position for Bit 5		18.8	19.2	19.9	ns
RSPos6	Receiver Input Strobe Position for Bit 6		22.5	22.9	23.6	ns
RSPos0	Receiver Input Strobe Position for Bit 0 (Figure 9, Figure 10)	f = 66 MHz	0.7	1.1	1.4	ns
RSPos1	Receiver Input Strobe Position for Bit 1		2.9	3.3	3.6	ns
RSPos2	Receiver Input Strobe Position for Bit 2		5.1	5.5	5.8	ns
RSPos3	Receiver Input Strobe Position for Bit 3		7.3	7.7	8.0	ns
RSPos4	Receiver Input Strobe Position for Bit 4		9.5	9.9	10.2	ns
RSPos5	Receiver Input Strobe Position for Bit 5		11.7	12.1	12.4	ns
RSPos6	Receiver Input Strobe Position for Bit 6		13.9	14.3	14.6	ns
RSKM	RxIN Skew Margin (Note 4) (Figure 11)	f = 40 MHz	490			ps
		f = 66 MHz	400			ps
RCOP	RxCLK OUT Period (Figure 3)		15	T	50	ns
RCOH	RxCLK OUT High Time (Figure 3)	f = 40 MHz	10.0	12.2		ns
RCOL	RxCLK OUT Low Time (Figure 3)		10.0	11.0		ns
RSRC	RxOUT Setup to RxCLK OUT (Figure 3)		6.5	11.6		ns
RHRC	RxOUT Hold to RxCLK OUT (Figure 3)		6.0	11.6		ns
RCOH	RxCLK OUT High Time (Figure 3)	f = 66 MHz	5.0	7.6		ns
RCOL	RxCLK OUT Low Time (Figure 3)		5.0	6.3		ns
RSRC	RxOUT Setup to RxCLK OUT (Figure 3)		4.5	7.3		ns
RHRC	RxOUT Hold to RxCLK OUT (Figure 3)		4.0	6.3		ns
RCCD	RxCLK IN to RxCLK OUT Delay @ 25°C, $V_{CC} = 3.3V$ (Note 5)(Figure 4)		3.5	5.0	7.5	ns
RPLLS	Receiver Phase Lock Loop Set (Figure 5)				10	ms
RPDD	Receiver Power Down Delay (Figure 8)				1	μs

**Note 4:** 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 - RSPos). This margin allows for LVDS interconnect skew, inter-symbol interference (both dependent on type/length of cable), and clock jitter (less than 250 ps).

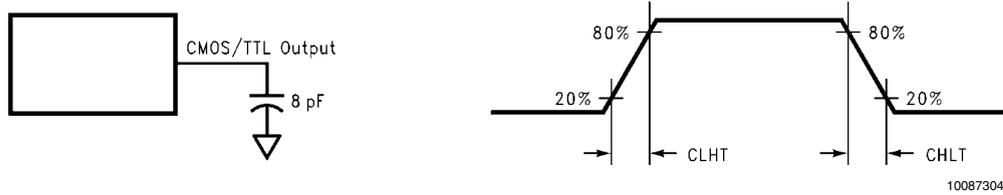
**Note 5:** Total latency for the channel link chipset is a function of clock period and gate delays through the transmitter (TCCD) and receiver (RCCD). The total latency for the 215/285 transmitter and 216A/286A receiver is:  $(T + TCCD) + (2 \cdot T + RCCD)$ , where T = Clock period.

## AC Timing Diagrams



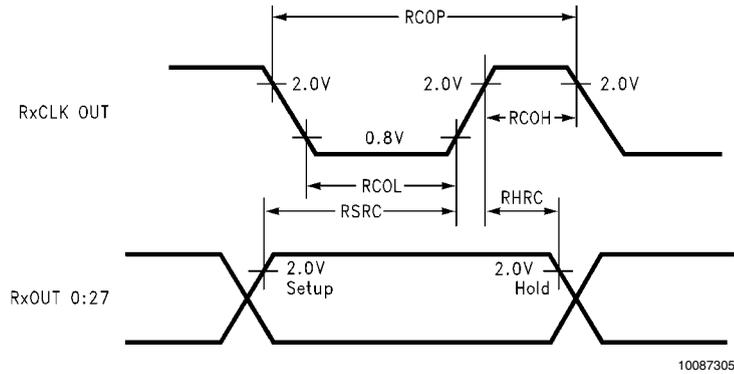
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FIGURE 1. "Worst Case" Test Pattern



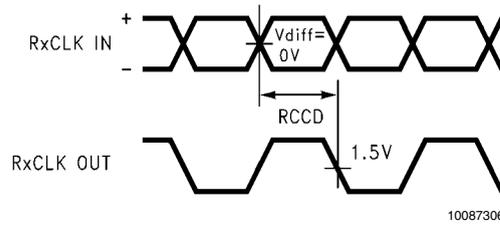
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FIGURE 2. DS90CR286A/DS90CR216A (Receiver) CMOS/TTL Output Load and Transition Times



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FIGURE 3. DS90CR286A/DS90CR216A (Receiver) Setup/Hold and High/Low Times



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FIGURE 4. DS90CR286A/DS90CR216A (Receiver) Clock In to Clock Out Delay

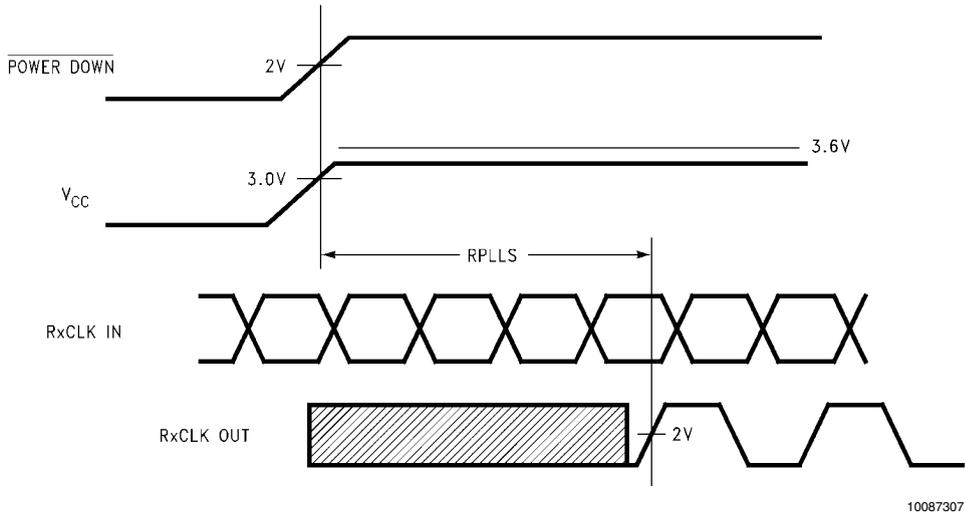


FIGURE 5. DS90CR286A/DS90CR216A (Receiver) Phase Lock Loop Set Time

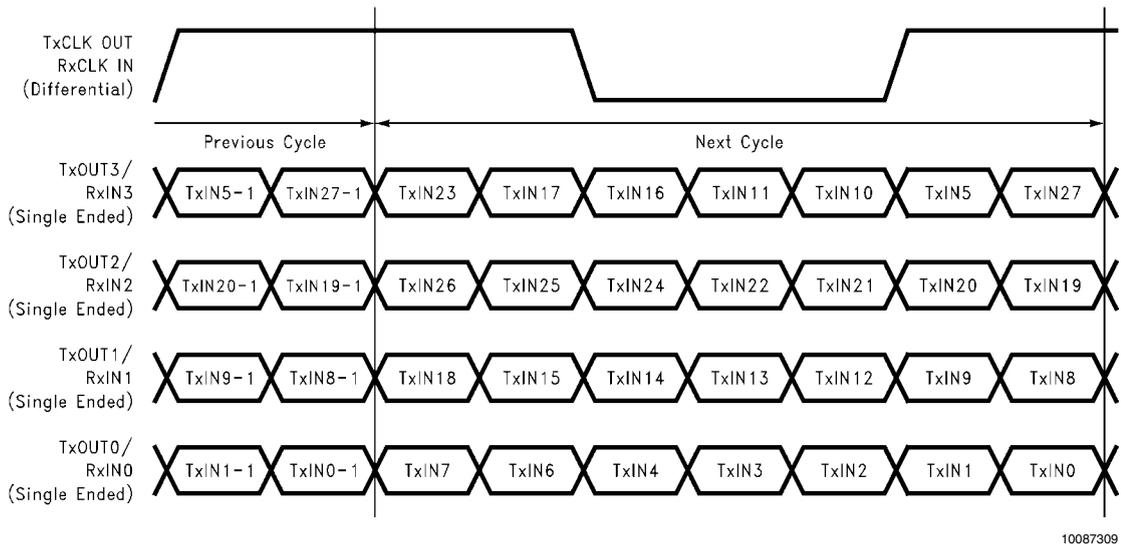


FIGURE 6. 28 Parallel TTL Data Inputs Mapped to LVDS Outputs - DS90CR286A

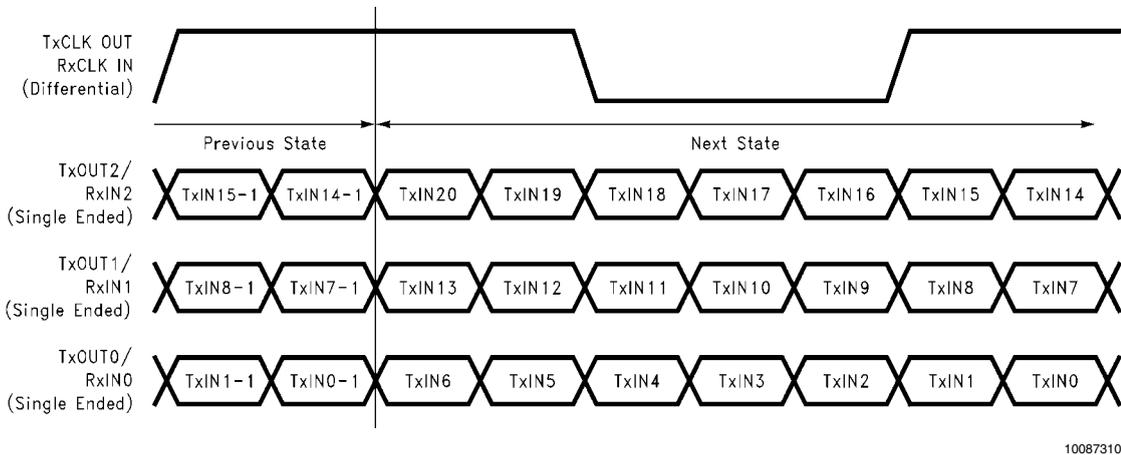


FIGURE 7. 21 Parallel TTL Data Inputs Mapped to LVDS Outputs - DS90CR216A

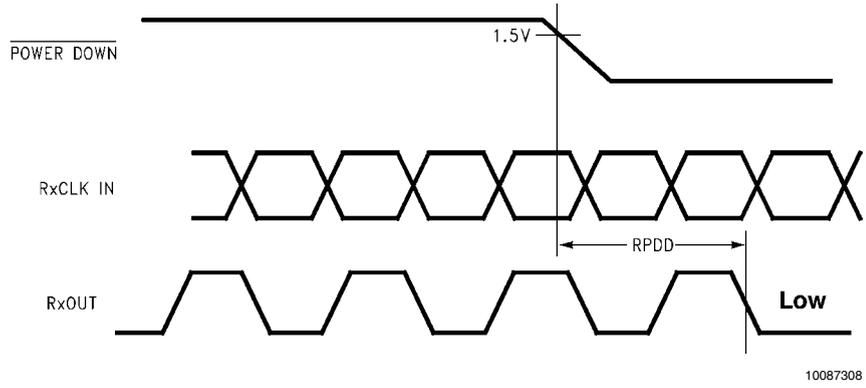


FIGURE 8. DS90CR286A/DS90CR216A (Receiver) Power Down Delay

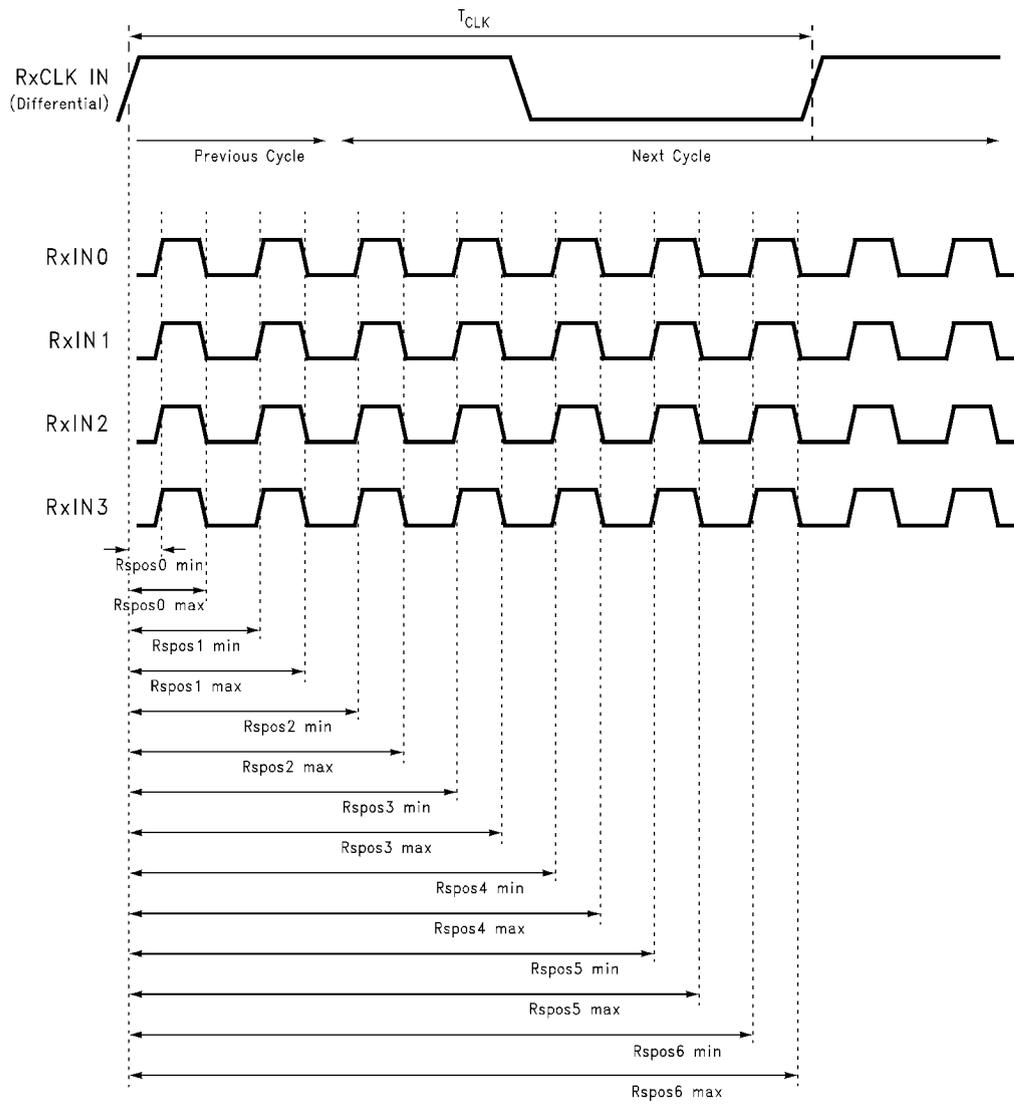
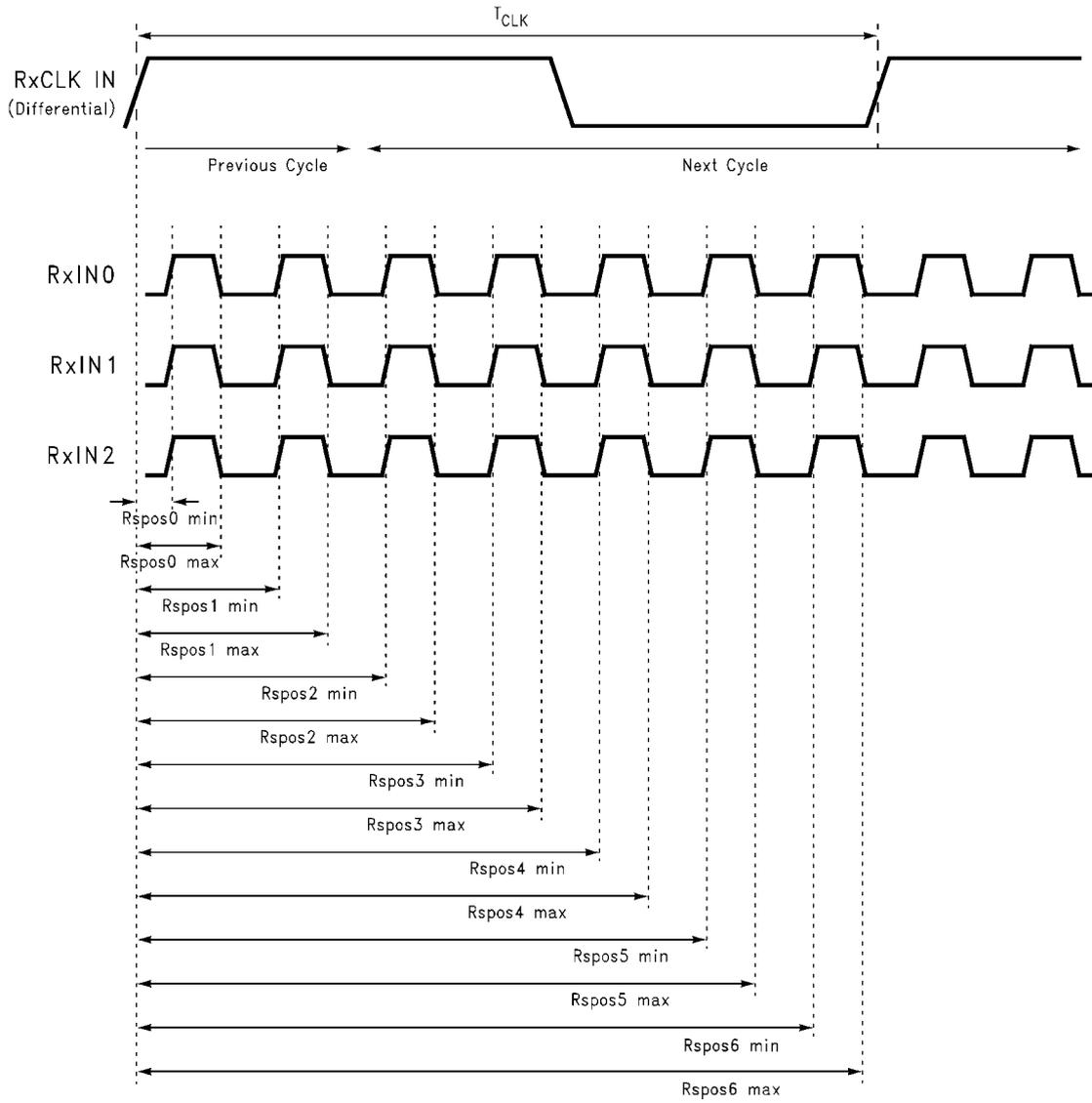
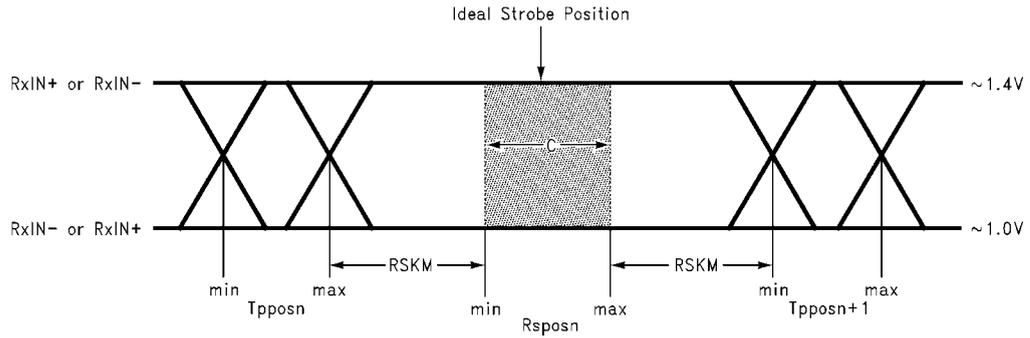


FIGURE 9. DS90CR286A (Receiver) LVDS Input Strobe Position



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FIGURE 10. DS90CR216A (Receiver) LVDS Input Strobe Position



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

Tppos—Transmitter output pulse position (min and max)

RSKM = Cable Skew (type, length) + Source Clock Jitter (cycle to cycle) (*Note Cycle-to-cycle jitter is less than TBD ps at 66 MHz. ) + ISI (Inter-symbol interference) (Note ISI is dependent on interconnect length; may be zero. )*

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

**Note 6:** Cycle-to-cycle jitter is less than TBD ps at 66 MHz.

**Note 7:** ISI is dependent on interconnect length; may be zero.

**FIGURE 11. Receiver LVDS Input Skew Margin**

## DS90CR286A Pin Descriptions — MTD56 Package — 28-Bit Channel Link Receiver

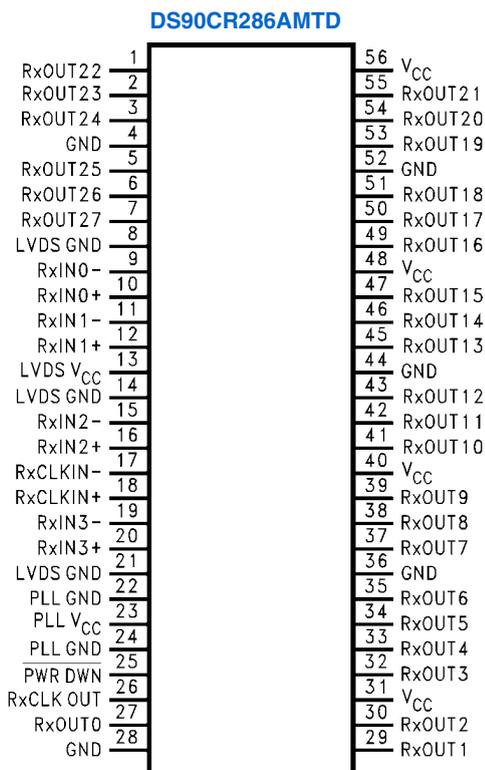
Pin Name	I/O	No	Description
RxIN+	I	4	Positive LVDS differential data inputs.
RxIN-	I	4	Negative LVDS differential data inputs.
RxOUT	O	28	TTL level data outputs.
RxCLK IN+	I	1	Positive LVDS differential clock input.
RxCLK IN-	I	1	Negative LVDS differential clock input.
RxCLK OUT	O	1	TTL level clock output. The rising edge acts as data strobe.
PWR DOWN	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.

## DS90CR216A Pin Descriptions — MTD48 Package — 21-Bit Channel Link Receiver

Pin Name	I/O	No	Description
RxIN+	I	3	Positive LVDS differential data inputs. ( <i>Note 8</i> )
RxIN-	I	3	Negative LVDS differential data inputs. ( <i>Note 8</i> )
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.
PWR DOWN	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.

**Note 8:** 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.

## Pin Diagram for TSSOP Packages



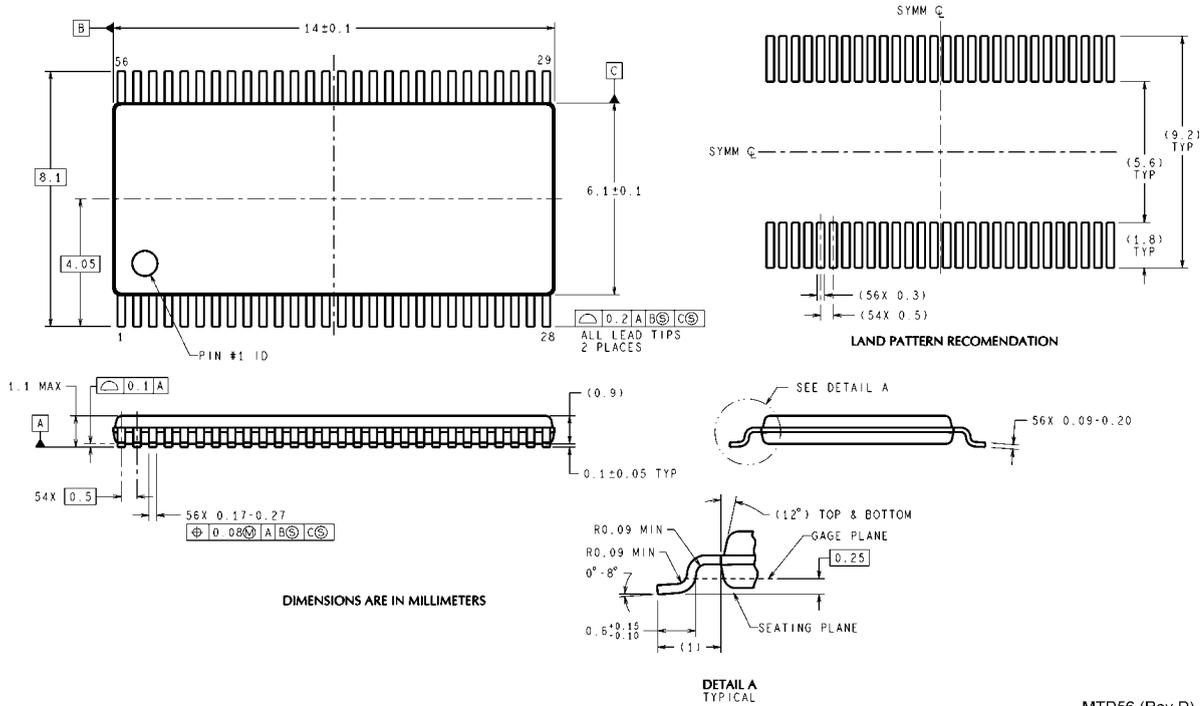
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DS90CR216AMTD

RxOUT17	1	48	V <sub>CC</sub>
RxOUT18	2	47	RxOUT16
GND	3	46	RxOUT15
RxOUT19	4	45	RxOUT14
RxOUT20	5	44	GND
N/C	6	43	RxOUT13
LVDS GND	7	42	V <sub>CC</sub>
RxIN0-	8	41	RxOUT12
RxIN0+	9	40	RxOUT11
RxIN1-	10	39	RxOUT10
RxIN1+	11	38	GND
LVDS V <sub>CC</sub>	12	37	RxOUT9
LVDS GND	13	36	V <sub>CC</sub>
RxIN2-	14	35	RxOUT8
RxIN2+	15	34	RxOUT7
RxCLK IN-	16	33	RxOUT6
RxCLK IN+	17	32	GND
LVDS GND	18	31	RxOUT5
PLL GND	19	30	RxOUT4
PLL V <sub>CC</sub>	20	29	RxOUT3
PLL GND	21	28	V <sub>CC</sub>
PWR DWN	22	27	RxOUT2
RxCLK OUT	23	26	RxOUT1
RxOUT0	24	25	GND

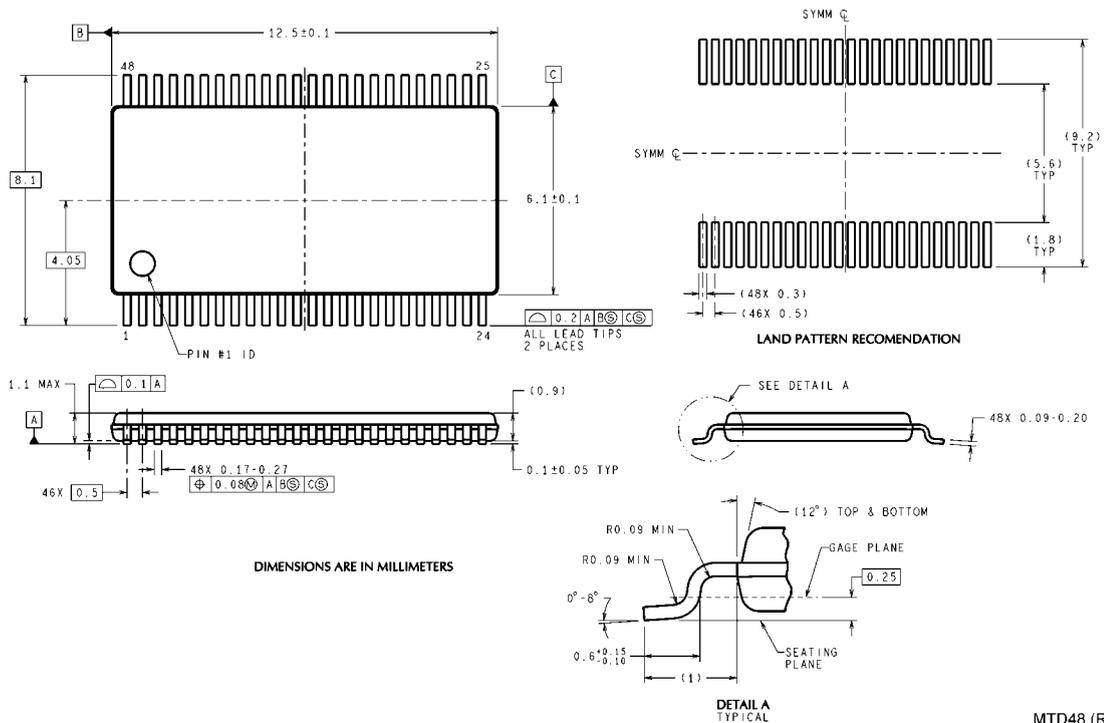
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**Physical Dimensions** inches (millimeters) unless otherwise noted



DIMENSIONS ARE IN MILLIMETERS

**56-Lead Molded Thin Shrink Small Outline Package, JEDEC**  
 Dimensions shown in millimeters only  
 Order Number DS90CR286AMTD, DS90CR286A QMT  
 NS Package Number MTD56



DIMENSIONS ARE IN MILLIMETERS

**48-Lead Molded Thin Shrink Small Outline Package, JEDEC**  
 Dimensions shown in millimeters only  
 Order Number DS90CR216AMTD  
 NS Package Number MTD48

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Interface	<a href="http://www.national.com/interface">www.national.com/interface</a>	Eval Boards	<a href="http://www.national.com/evalboards">www.national.com/evalboards</a>
LVDS	<a href="http://www.national.com/lvds">www.national.com/lvds</a>	Packaging	<a href="http://www.national.com/packaging">www.national.com/packaging</a>
Power Management	<a href="http://www.national.com/power">www.national.com/power</a>	Green Compliance	<a href="http://www.national.com/quality/green">www.national.com/quality/green</a>
Switching Regulators	<a href="http://www.national.com/switchers">www.national.com/switchers</a>	Distributors	<a href="http://www.national.com/contacts">www.national.com/contacts</a>
LDOs	<a href="http://www.national.com/ldo">www.national.com/ldo</a>	Quality and Reliability	<a href="http://www.national.com/quality">www.national.com/quality</a>
LED Lighting	<a href="http://www.national.com/led">www.national.com/led</a>	Feedback/Support	<a href="http://www.national.com/feedback">www.national.com/feedback</a>
Voltage References	<a href="http://www.national.com/vref">www.national.com/vref</a>	Design Made Easy	<a href="http://www.national.com/easy">www.national.com/easy</a>
PowerWise® Solutions	<a href="http://www.national.com/powerwise">www.national.com/powerwise</a>	Applications & Markets	<a href="http://www.national.com/solutions">www.national.com/solutions</a>
Serial Digital Interface (SDI)	<a href="http://www.national.com/sdi">www.national.com/sdi</a>	Mil/Aero	<a href="http://www.national.com/milaero">www.national.com/milaero</a>
Temperature Sensors	<a href="http://www.national.com/tempensors">www.national.com/tempensors</a>	SolarMagic™	<a href="http://www.national.com/solarmagic">www.national.com/solarmagic</a>
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