



## DS90CF561/DS90CF562 LVDS 18-Bit Color Flat Panel Display (FPD) Link

### General Description

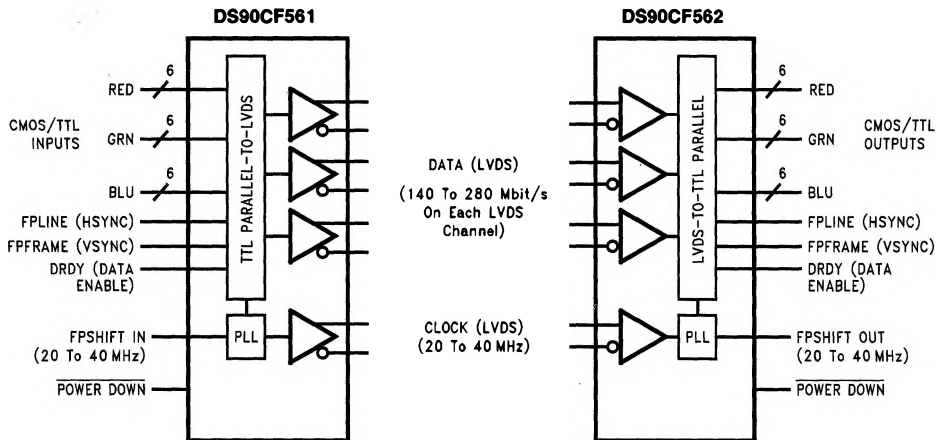
The DS90CF561 transmitter converts 21 bits of CMOS/TTL data into three LVDS (Low Voltage Differential Signaling) data streams. A phase-locked transmit clock is transmitted in parallel with the data streams over a fourth LVDS link. Every cycle of the transmit clock 21 bits of input data are sampled and transmitted. The DS90CF562 receiver converts the LVDS data streams back into 21 bits of CMOS/TTL data. At a transmit clock frequency of 40 MHz, 18 bits of RGB data and 3 bits of LCD timing and control data (FPLINE, FPFRRAME, DRDY) are transmitted at a rate of 280 Mbps per LVDS data channel. Using a 40 MHz clock, the data throughput is 105 Megabytes per second. These devices are offered with falling edge data strobes for convenient interface with a variety of graphics and LCD panel controllers.

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

### Features

- Up to 105 Megabyte/sec bandwidth
- Narrow bus reduces cable size
- 345 mV swing LVDS devices for low EMI
- Low power CMOS design
- Power down mode
- PLL requires no external components
- Low profile 48-lead TSSOP package
- Falling edge data strobe
- Compatible with TIA/EIA-644 LVDS standard

### Block Diagrams

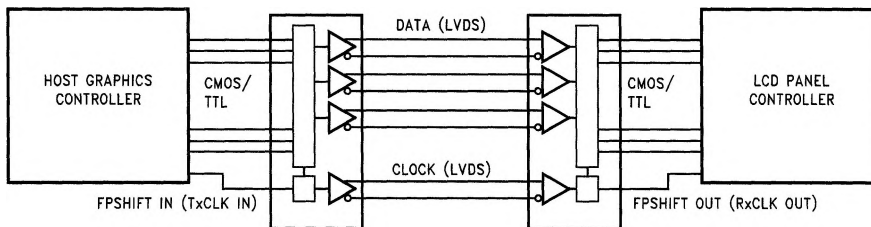


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Order Number DS90CF561MTD  
See NS Package Number MTD48

Order Number DS90CF562MTD  
See NS Package Number MTD48

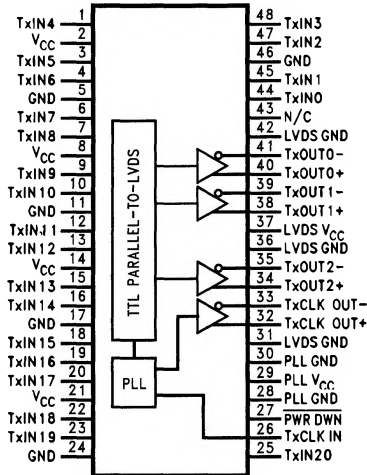
### Application



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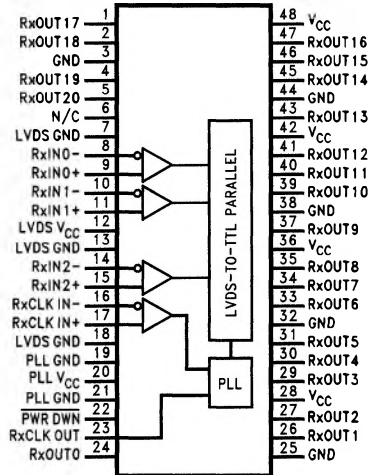
# Connection Diagrams

**DS90CF561**



TL/F/12485-3

**DS90CF562**



TL/F/12485-4

DS90CF561/DS90CF562

## 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 +6V                 |
| CMOS/TTL Input Voltage               | -0.3V to ( $V_{CC} + 0.3V$ ) |
| CMOS/TTL Output Voltage              | -0.3V to ( $V_{CC} + 0.3V$ ) |
| LVDS Receiver Input Voltage          | -0.3V to ( $V_{CC} + 0.3V$ ) |
| LVDS Driver Output Voltage           | -0.3V to ( $V_{CC} + 0.3V$ ) |
| LVDS Output Short Circuit Duration   | continuous                   |
| Junction Temperature                 | +150°C                       |
| Storage Temperature Range            | -65°C to +150°C              |
| Lead Temperature (Soldering, 4 sec.) | +260°C                       |

Maximum Power Dissipation @ +25°C

MTD48 (TSSOP) Package:

DS90CF561

1.98W

DS90CF562

1.89W

Package Derating: DS90CF561 16 mW/°C above +25°C

DS90CF562 15 mW/°C above +25°C

This device does not meet 2000V ESD rating (Note 4).

## Recommended Operating Conditions

|  | Min | Nom | Max | Units |
|--|-----|-----|-----|-------|
| Supply Voltage ( $V_{CC}$ )              | 4.5 | 5.0 | 5.5 | V     |
| Operating Free Air Temperature ( $T_A$ ) | -10 | +25 | +70 | °C    |
| Receiver Input Range                     | 0   | 2.4 |     | V     |

## Electrical Characteristics

Over recommended operating supply and temperature ranges unless otherwise specified

| Symbol                                 | Parameter  | Conditions                                  | Min                             | Typ   | 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                          | 3.8                             | 4.9   |          | V     |
| $V_{OL}$                               | Low Level Output Voltage                               | $I_{OL} = 2$ mA                             |                                 | 0.1   | 0.3      | V     |
| $V_{CL}$                               | Input Clamp Voltage                                    | $I_{CL} = -18$ mA                           |                                 | -0.79 | -1.5     | V     |
| $I_{IN}$                               | Input Current  | $V_{IN} = V_{CC}, GND, 2.5V$ or 0.4V        |                                 | ±5.1  | ±10      | µA    |
| $I_{OS}$                               | Output Short Circuit Current                           | $V_{OUT} = 0V$                              |                                 |       | -120     | mA    |
| <b>LVDS DRIVER DC SPECIFICATIONS</b>   |  |   |                                 |       |          |       |
| $V_{OD}$                               | Differential Output Voltage                            | $R_L = 100\Omega$                           | 250                             | 290   | 450      | mV    |
| $\Delta V_{OD}$                        | Change in $V_{OD}$ between Complimentary Output States |   |                                 |       | 35       | mV    |
| $V_{CM}$                               | Common Mode Voltage                                    |   | 1.1                             | 1.25  | 1.375    | V     |
| $\Delta V_{CM}$                        | Change in $V_{CM}$ between Complimentary Output States |   |                                 |       | 35       | V     |
| $V_{OH}$                               | High Level Output Voltage                              |   |                                 | 1.3   | 1.6      | V     |
| $V_{OL}$                               | Low Level Output Voltage                               |   | 0.9                             | 1.07  |          | V     |
| $I_{OS}$                               | Output Short Circuit Current                           |   | $V_{OUT} = 0V, R_L = 100\Omega$ |       | -2.9     | -5    |
| $I_{OZ}$                               | Output TRI-STATE® Current                              | Power Down = 0V, $V_{OUT} = 0V$ or $V_{CC}$ |                                 | ±1    | ±10      | µA    |
| <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  | $V_{IN} = +2.4V$                            | $V_{CC} = 5.5V$                 |       | ±10      | µA    |
|  |  | $V_{IN} = 0V$                               |                                 |       | ±10      | 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  $V_{CC} = 5.0V$  and  $T_A = +25^\circ C$ .

**Note 3:** Current into device pins is defined as positive. Current out of device pins is defined as negative. Voltages are referenced to ground unless otherwise specified (except  $V_{OD}$  and  $\Delta V_{OD}$ ).

**Note 4:** ESD Rating: HBM (1.5 kΩ, 100 pF)

PLL  $V_{CC} \geq 1000V$

All other pins  $\geq 2000V$

EIAJ (0Ω, 200 pF)  $\geq 150V$

**Electrical Characteristics** (Continued)

Over recommended operating supply and temperature ranges unless otherwise specified

| Symbol                            | Parameter                                | Conditions  | Min          | Typ | Max | Units |    |
|-----------------------------------|--|---|--------------|-----|-----|-------|----|
| <b>TRANSMITTER SUPPLY CURRENT</b> |  |   |              |     |     |       |    |
| I <sub>CC</sub> TW                | Transmitter Supply Current, Worst Case   | R <sub>L</sub> = 100Ω, C <sub>L</sub> = 5 pF, Worst Case Pattern (Figures 1, 3) | f = 32.5 MHz |     | 34  | 46    | mA |
|                                   |  |   | f = 37.5 MHz |     | 36  | 48    | mA |
| I <sub>CC</sub> TG                | Transmitter Supply Current, 16 Grayscale | R <sub>L</sub> = 100Ω, C <sub>L</sub> = 5 pF, Grayscale Pattern (Figures 2, 3)  | f = 32.5 MHz |     | 27  | 42    | mA |
|                                   |  |   | f = 37.5 MHz |     | 28  | 43    | mA |
| I <sub>CC</sub> TZ                | Transmitter Supply Current, Power Down   | Power Down = Low  |              | 1   | 10  | μA    |    |
| <b>RECEIVER SUPPLY CURRENT</b>    |  |   |              |     |     |       |    |
| I <sub>CC</sub> RW                | Receiver Supply Current, Worst Case      | C <sub>L</sub> = 8 pF, Worst Case Pattern (Figures 1, 4)                        | f = 32.5 MHz |     | 55  | 75    | mA |
|                                   |  |   | f = 37.5 MHz |     | 60  | 80    | mA |
| I <sub>CC</sub> RG                | Receiver Supply Current, 16 Grayscale    | C <sub>L</sub> = 8 pF, 16 Grayscale Pattern (Figures 2, 4)                      | f = 32.5 MHz |     | 35  | 55    | mA |
|                                   |  |   | f = 37.5 MHz |     | 37  | 58    | mA |
| I <sub>CC</sub> RZ                | Receiver Supply Current, Power Down      | Power Down = Low  |              | 1   | 10  | μA    |    |

**Switching Characteristics**

Over recommended operating supply and temperature ranges unless otherwise specified

| Symbol | Parameter   | Min        | Typ  | Max   | Units |    |
|--------|---|------------|------|-------|-------|----|
| LLHT   | LVDS Low-to-High Transition Time (Figure 3)       |            | 0.75 | 1.5   | ns    |    |
| LHLT   | LVDS High-to-Low Transition Time (Figure 3)       |            | 0.75 | 1.5   | ns    |    |
| CLHT   | CMOS/TTL Low-to-High Transition Time (Figure 4)   |            | 3.5  | 6.5   | ns    |    |
| CHLT   | CMOS/TTL High-to-Low Transition Time (Figure 4)   |            | 2.7  | 6.5   | ns    |    |
| TCIT   | TxCLK IN Transition Time (Figure 5)               |            |      | 8     | ns    |    |
| TCCS   | TxOUT Channel-to-Channel Skew (Note A) (Figure 6) |            |      | 350   | ps    |    |
| TSSPW  | Tx Sub-Symbol Pulse Width (Figure 6)              | f = 20 MHz | 5.5  | 7     | 8     | ns |
| RCCS   | RxIN Channel-to-Channel Skew (Note B)             |            |      | 700   | ps    |    |
| TCIP   | TxCLK IN Period (Figure 7)                        | 25         | T    | 50    | ns    |    |
| TCIH   | TxCLK IN High Time (Figure 7)                     | 0.35T      | 0.5T | 0.65T | ns    |    |
| TCIL   | TxCLK IN Low Time (Figure 7)                      | 0.35T      | 0.5T | 0.65T | ns    |    |
| TSTC   | TxIN Setup to TxCLK IN (Figure 7)                 | 8          |      |       | ns    |    |
| THTC   | TxIN Hold to TxCLK IN (Figure 7)                  | 2.5        | 2    |       | ns    |    |
| RCOP   | RxCLK OUT Period (Figure 8)                       | 25         | T    | 50    | ns    |    |

Note A: This limit based on bench characterization.

Note B: This limit assumes a maximum cable skew of 350 ps.

## Switching Characteristics

Over recommended operating supply and temperature ranges unless otherwise specified (Continued)

| Symbol | Parameter   |            | Min  | Typ | Max  | Units |
|--------|---|------------|------|-----|------|-------|
| RCOH   | RxCLK OUT High Time (Figure 8)  | f = 20 MHz | 21.5 |     |      | ns    |
|        |   | f = 40 MHz | 10.5 |     |      | ns    |
| RCOL   | RxCLK OUT Low Time (Figure 8)   | f = 20 MHz | 19   |     |      | ns    |
|        |   | f = 40 MHz | 6    |     |      | ns    |
| RSRC   | RxOUT Setup to RxCLK OUT (Figure 8)                                       | f = 20 MHz | 14   |     |      | ns    |
|        |   | f = 40 MHz | 4.5  |     |      | ns    |
| RHRC   | RxOUT Hold to RxCLK OUT (Figure 8)  | f = 20 MHz | 16   |     |      | ns    |
|        |   | f = 40 MHz | 6.5  |     |      | ns    |
| TCCD   | TxCLK IN to TxCLK OUT Delay @ 25°C,<br>V <sub>CC</sub> = 5.0V (Figure 9)  |            | 5    |     | 9.7  | ns    |
| RCCD   | RxCLK IN to RxCLK OUT Delay @ 25°C,<br>V <sub>CC</sub> = 5.0V (Figure 10) |            | 7.6  |     | 11.9 | ns    |
| TPLLS  | Transmitter Phase Lock Loop Set (Figure 11)                               |            |      |     | 10   | ms    |
| RPLLS  | Receiver Phase Lock Loop Set (Figure 12)                                  |            |      |     | 10   | ms    |

# AC Timing Diagrams

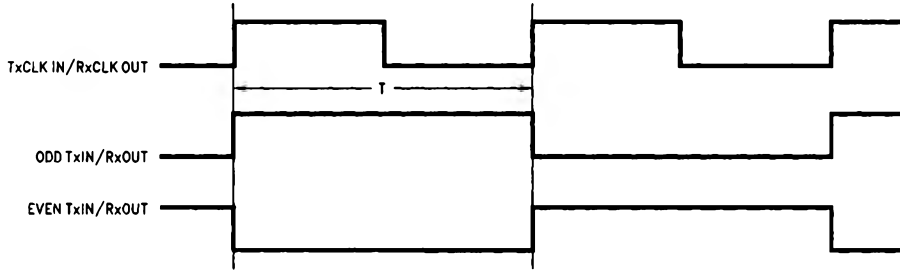


FIGURE 1. "Worst Case" Test Pattern

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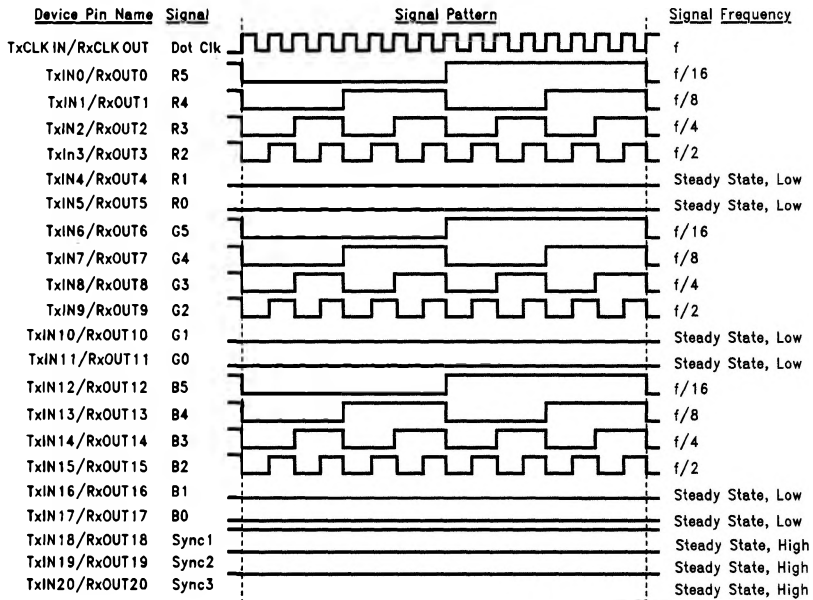


FIGURE 2. "16 Grayscale" Test Pattern

TL/F/12485-6

**Note 1:** The worst case test pattern produces a maximum toggling of device digital circuitry, LVDS I/O and TTL I/O.

**Note 2:** The 16 grayscale test pattern tests device power consumption for a "typical" LCD display pattern. The test pattern approximates signal switching needed to produce groups of 16 vertical stripes across the display.

**Note 3:** Figure 1 and Figure 2 show a falling edge data strobe (TxCLK IN/RxCLK OUT).

AC Timing Diagrams (Continued)

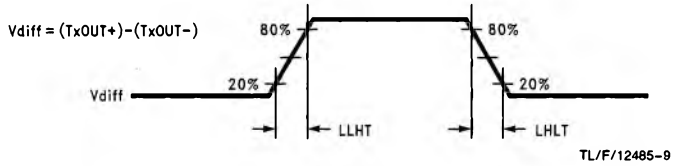
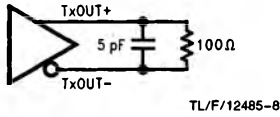


FIGURE 3. DS90CF561 (Transmitter) LVDS Output Load and Transition Timing

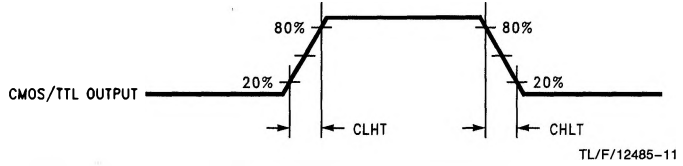
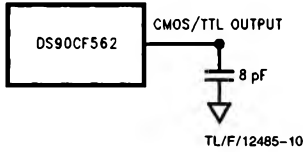


FIGURE 4. DS90CF562 (Receiver) CMOS/TTL Output Load and Transition Timing

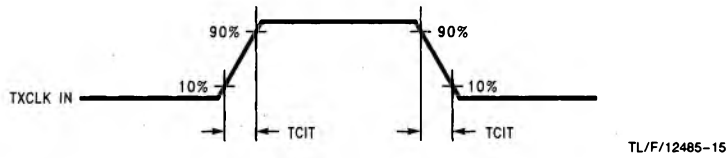
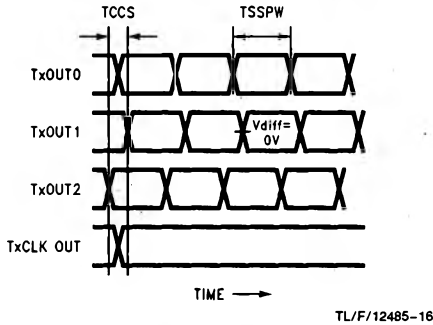


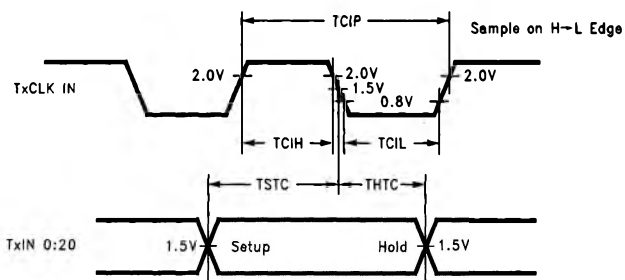
FIGURE 5. DS90CF561 (Transmitter) Input Clock Transition Time



- Note 1: Measurements at  $V_{diff} = 0V$
- Note 2: TCCS measured between earliest and latest initial LVDS edges.
- Note 3: TxCLK OUT Differential High  $\rightarrow$  Low Edge for DS90CF561  
TxCLK OUT Differential Low  $\rightarrow$  High Edge for DS90CR561

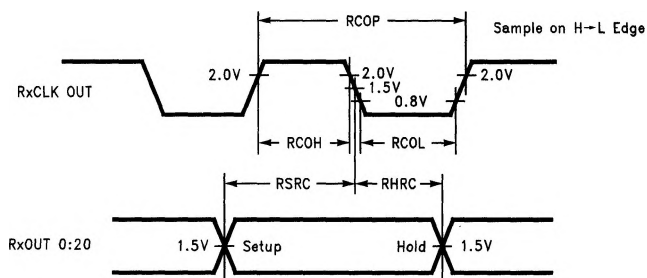
FIGURE 6. DS90CF561 (Transmitter) Channel-to-Channel Skew and Pulse Width

# AC Timing Diagrams (Continued)



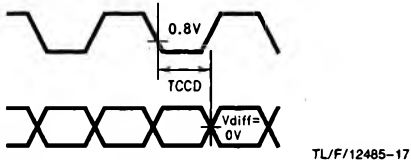
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FIGURE 7. DS90CF561 (Transmitter) Setup/Hold and High/Low Times



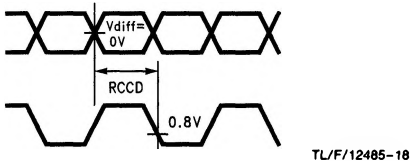
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FIGURE 8. DS90CF562 (Receiver) Setup/Hold and High/Low Times



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FIGURE 9. DS90CF561 (Transmitter) Clock In to Clock Out Delay

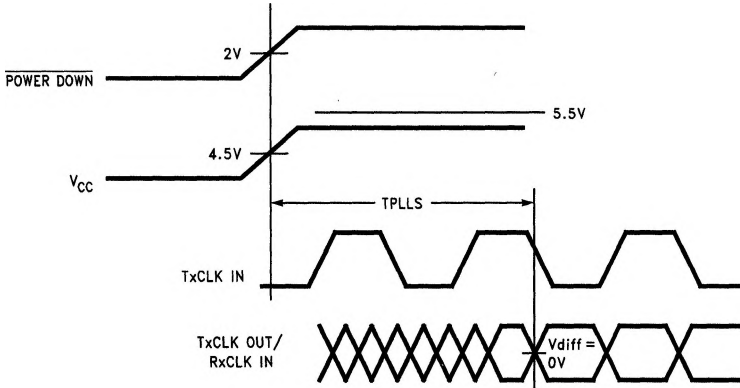


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FIGURE 10. DS90CF562 (Receiver) Clock In to Clock Out Delay

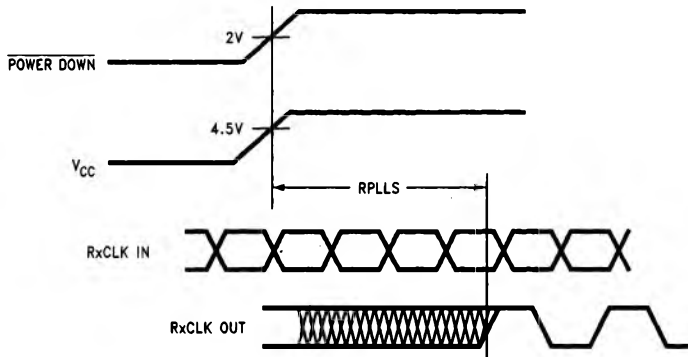


AC Timing Diagrams (Continued)



TL/F/12485-14

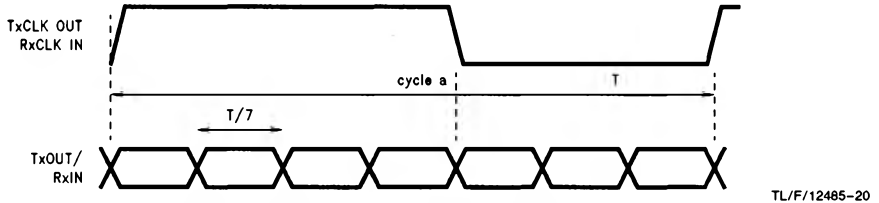
FIGURE 11. DS90CF561 (Transmitter) Phase Lock Loop Set Time



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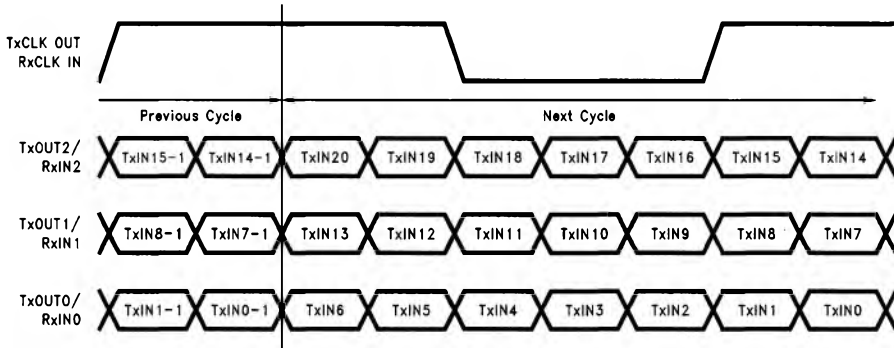
FIGURE 12. DS90CF562 (Receiver) Phase Lock Loop Set Time

**AC Timing Diagrams** (Continued)



**FIGURE 13. Seven Bits of LVDS in One Clock Cycle**

TL/F/12485-20



**FIGURE 14. 21 Parallel TTL Data Inputs Mapped to LVDS Outputs (DS90CF561)**

TL/F/12485-21

**DS90CF561 Pin Description—FPD Link Transmitter**

| Pin Name             | I/O | No. | Description  |
|----------------------|-----|-----|--|
| TxIN                 | I   | 21  | TTL level input. This includes: 6 Red, 6 Green, 6 Blue, and 3 control lines (FPLINE, FPFRAME, DRDY). (Also referred to as HSYNC, VSYNC and DATA ENABLE.) |
| TxOUT+               | O   | 3   | Positive LVDS differential data output   |
| TxOUT-               | O   | 3   | Negative LVDS differential data output   |
| FPSHIFT IN           | I   | 1   | TTL level clock input. The falling edge acts as data strobe.   |
| TxCLK OUT+           | O   | 1   | Positive LVDS differential clock output  |
| TxCLK OUT-           | O   | 1   | Negative LVDS differential clock output  |
| PWR DOWN             | I   | 1   | TTL level input. Assertion (low input) TRI-STATES the outputs, ensuring low current at power down.   |
| V <sub>CC</sub>      | I   | 4   | Power supply pins for TTL inputs   |
| GND                  | I   | 5   | Ground pins for TTL inputs   |
| PLL V <sub>CC</sub>  | I   | 1   | Power supply pin for PLL   |
| PLL GND              | I   | 2   | Ground pins for PLL  |
| LVDS V <sub>CC</sub> | I   | 1   | Power supply pin for LVDS outputs  |
| LVDS GND             | I   | 3   | Ground pins for LVDS outputs   |

**DS90CF562 Pin Description—FPD Link Receiver**

| Pin Name             | I/O | No. | Description   |
|----------------------|-----|-----|---|
| RxIN+                | I   | 3   | Positive LVDS differential data inputs  |
| RxIN-                | I   | 3   | Negative LVDS differential data inputs  |
| RxOUT                | O   | 21  | TTL level data outputs. This includes: 6 Red, 6 Green, 6 Blue, and 3 control lines (FPLINE, FPFRAME, DRDY). (Also referred to as HSYNC, VSYNC and DATA ENABLE.) |
| RxCLK IN+            | I   | 1   | Positive LVDS differential clock input  |
| RxCLK IN-            | I   | 1   | Negative LVDS differential clock input  |
| FPSHIFT OUT          | O   | 1   | TTL level clock output. The falling edge acts as data strobe.   |
| PWR DOWN             | I   | 1   | TTL level input. Assertion (low input) TRI-STATES the outputs, ensuring low current at power down.  |
| 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   |