

## +3.3V Programmable LVDS Transmitter 24-Bit Flat Panel Display Link-87.5 MHz

Check for Samples: [DS90C385A](#)

### FEATURES

- Pin-to-Pin Compatible to DS90C383, DS90C383A and DS90C385
- No Special Start-Up Sequence Required between Clock/Data and /PD Pins. Input Signals (Clock and Data) can be Applied Either Before or After the Device is Powered.
- Support Spread Spectrum Clocking up to 100kHz Frequency Modulation and Deviations of  $\pm 2.5\%$  Center Spread or -5% Down Spread
- "Input Clock Detection" Feature Will Pull All LVDS Pairs to Logic Low When Input Clock is Missing and When /PD Pin is Logic High
- 18 to 87.5 MHz Shift Clock Support
- Tx Power Consumption < 147 mW (typ) at 87.5MHz Grayscale
- Tx Power-Down Mode < 60  $\mu$ W (typ)
- Supports VGA, SVGA, XGA, SXGA(Dual Pixel), SXGA+(Dual Pixel), UXGA(Dual Pixel).
- Narrow Bus Reduces Cable Size and Cost
- Up to 2.45 Gbps Throughput
- Up to 306.25Megabyte/sec Bandwidth
- 345 mV (typ) Swing LVDS Devices for Low EMI
- PLL Requires No External Components
- Compliant to TIA/EIA-644 LVDS standard
- Low Profile 56-lead TSSOP Package

### DESCRIPTION

The DS90C385A is a pin to pin compatible replacement for DS90C383, DS90C383A and DS90C385. The DS90C385A has additional features and improvements making it an ideal replacement for DS90C383, DS90C383A and DS90C385. family of LVDS Transmitters.

The DS90C385A transmitter converts 28 bits of LVCMOS/LVTTL data into four LVDS (Low Voltage Differential Signaling) data streams. A phase-locked transmit clock is transmitted in parallel with the data streams over the fifth LVDS link. Every cycle of the transmit clock 28 bits of input data are sampled and transmitted. At a transmit clock frequency of 87.5 MHz, 24 bits of RGB data and 3 bits of LCD timing and control data (FPLINE, FPFRAME, DRDY) are transmitted at a rate of 612.5Mbps per LVDS data channel. Using a 87.5 MHz clock, the data throughput is 306.25Mbytes/sec. This transmitter can be programmed for Rising edge strobe or Falling edge strobe through a dedicated pin. A Rising edge or Falling edge strobe transmitter will interoperate with a Falling edge strobe FPDLink Receiver without any translation logic.

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

### Block Diagram

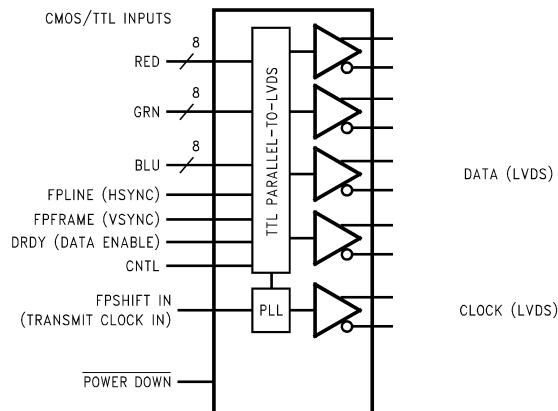


Figure 1. DS90C385A



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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)</sup>

Supply Voltage ( $V_{CC}$ )		-0.3V to +4V
CMOS/TTL Input Voltage		-0.5V 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		-65°C to +150°C
Lead Temperature (Soldering, 4 seconds)		+260°C
Maximum Package Power Dissipation Capacity at 25°C	TSSOP Package	1.63 W
Package Derating		12.5 mW/°C above +25°C
ESD Rating	HBM, 1.5k $\Omega$ , 100pF	7kV
	EIAJ, 0 $\Omega$ , 200 pF	500V
Latch Up Tolerance at 25°C		$\pm 100$ mA

- (1) "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be ensured. 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.

### Recommended Operating Conditions

	Min	Nom	Max	Unit
Supply Voltage ( $V_{CC}$ )	3.0	3.3	3.6	V
Operating Free Air Temperature ( $T_A$ )	-10	+25	+70	°C
Supply Noise Voltage ( $V_{CC}$ )			200	mV <sub>PP</sub>
TxCLKIN frequency	18		87.5	MHz

## Electrical Characteristics

Over recommended operating supply and temperature ranges unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
LVCMOS/LVTTL DC SPECIFICATIONS							
V <sub>IH</sub>	High Level Input Voltage		2.0		V <sub>CC</sub>	V	
V <sub>IL</sub>	Low Level Input Voltage		0		0.8	V	
V <sub>CL</sub>	Input Clamp Voltage	I <sub>CL</sub> = -18 mA		-0.79	-1.5	V	
I <sub>IN</sub>	Input Current	V <sub>IN</sub> = 0.4V, 2.5V or V <sub>CC</sub>		+1.8	+10	μA	
		V <sub>IN</sub> = GND	-10	0		μA	
LVDS DC SPECIFICATIONS							
V <sub>OD</sub>	Differential Output Voltage	R <sub>L</sub> = 100Ω	250	345	450	mV	
ΔV <sub>OD</sub>	Change in V <sub>OD</sub> between complimentary output states				35	mV	
V <sub>OS</sub>	Offset Voltage <sup>(1)</sup>		1.13	1.25	1.38	V	
ΔV <sub>OS</sub>	Change in V <sub>OS</sub> between complimentary output states				35	mV	
I <sub>OS</sub>	Output Short Circuit Current	V <sub>OUT</sub> = 0V, R <sub>L</sub> = 100Ω		-3.5	-5	mA	
I <sub>OZ</sub>	Output TRI-STATE® Current	Power Down = 0V, V <sub>OUT</sub> = 0V or V <sub>CC</sub>		±1	±10	μA	
TRANSMITTER SUPPLY CURRENT							
ICCTW	Transmitter Supply Current, Worst Case	R <sub>L</sub> = 100Ω, C <sub>L</sub> = 5 pF, Worst Case Pattern (Figure 2 Figure 4 ) "Typ" values are given for V <sub>CC</sub> = 3.6V and T <sub>A</sub> = +25°C, "Max" values are given for V <sub>CC</sub> = 3.6V and T <sub>A</sub> = -10°C	f = 25 MHz		31	45	mA
			f = 40 MHz		37	50	mA
			f = 65 MHz		48	60	mA
			f = 87.5 MHz		55	65	mA
ICCTG	Transmitter Supply Current, 16 Grayscale	R <sub>L</sub> = 100Ω, C <sub>L</sub> = 5 pF, 16 Grayscale Pattern (Figure 3 Figure 4 ) "Typ" values are given for V <sub>CC</sub> = 3.6V and T <sub>A</sub> = +25°C, "Max" values are given for V <sub>CC</sub> = 3.6V and T <sub>A</sub> = -10°C	f = 25 MHz		29	40	mA
			f = 40 MHz		33	45	mA
			f = 65 MHz		39	50	mA
			f = 87.5 MHz		44	55	mA
ICCTZ	Transmitter Supply Current, Power Down	Power Down = Low Driver Outputs in TRI-STATE® under Power Down Mode		17	150	μA	

(1)  $V_{OS}$  previously referred as  $V_{CM}$ .

## Recommended Transmitter Input Characteristics

Over recommended operating supply and temperature ranges unless otherwise specified

Symbol	Parameter	Min	Typ	Max	Unit
TCIT	TxCLK IN Transition Time (Figure 6)	1.0		6.0	ns
TCIP	TxCLK IN Period (Figure 7)	11.42	T	55.55	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
TXIT	TxIN , and PWR DOWN pin Transition Time	1.5		6.0	ns
TXPD	Minimum pulse width for PWR DOWN pin signal	1			us

## Transmitter Switching Characteristics

Over recommended operating supply and temperature ranges unless otherwise specified

Symbol	Parameter	Min	Typ	Max	Unit
LLHT	LVDS Low-to-High Transition Time (Figure 5)		0.75	1.4	ns
LHLT	LVDS High-to-Low Transition Time (Figure 5)		0.75	1.4	ns
TPPos0	Transmitter Output Pulse Position (Figure 13) <sup>(1)</sup>	f = 25MHz			
TPPos1	Transmitter Output Pulse Position				
TPPos2	Transmitter Output Pulse Position				
TPPos3	Transmitter Output Pulse Position				
TPPos4	Transmitter Output Pulse Position				
TPPos5	Transmitter Output Pulse Position				
TPPos6	Transmitter Output Pulse Position				
TPPos0	Transmitter Output Pulse Position (Figure 13) <sup>(1)</sup>	f = 40 MHz			
TPPos1	Transmitter Output Pulse Position				
TPPos2	Transmitter Output Pulse Position				
TPPos3	Transmitter Output Pulse Position				
TPPos4	Transmitter Output Pulse Position				
TPPos5	Transmitter Output Pulse Position				
TPPos6	Transmitter Output Pulse Position				
TPPos0	Transmitter Output Pulse Position (Figure 13) <sup>(1)</sup>	f = 65 MHz			
TPPos1	Transmitter Output Pulse Position				
TPPos2	Transmitter Output Pulse Position for Bit 2				
TPPos3	Transmitter Output Pulse Position for Bit 3				
TPPos4	Transmitter Output Pulse Position				
TPPos5	Transmitter Output Pulse Position				
TPPos6	Transmitter Output Pulse Position				
TPPos0	Transmitter Output Pulse Position (Figure 13) <sup>(1)</sup>	f = 87.5 MHz			
TPPos1	Transmitter Output Pulse Position				
TPPos2	Transmitter Output Pulse Position				
TPPos3	Transmitter Output Pulse Position				
TPPos4	Transmitter Output Pulse Position				
TPPos5	Transmitter Output Pulse Position				
TPPos6	Transmitter Output Pulse Position				
TSTC	Required TxIN Setup to TxCLK IN (Figure 7) at 85MHz	2.5			ns
THTC	Required TxIN Hold to TxCLK IN (Figure 7) at 87.5 MHz	0.5			ns
TCCD	TxCLK IN to TxCLK OUT Delay. Measure from TxCLK IN edge to immediately crossing point of differential TxCLK OUT by following the positive TxCLK OUT. 50% duty cycle input clock is assumed. (Figure 8)	3.086		7.211	ns
	Measure from TxCLK IN edge to immediately crossing point of differential TxCLK OUT by following the positive TxCLK OUT. 50% duty cycle input clock is assumed. (Figure 9)	2.868		6.062	ns

(1) The Minimum and Maximum Limits are based on statistical analysis of the device performance over process, voltage, and temperature ranges. This parameter is functionality tested only on Automatic Test Equipment (ATE).

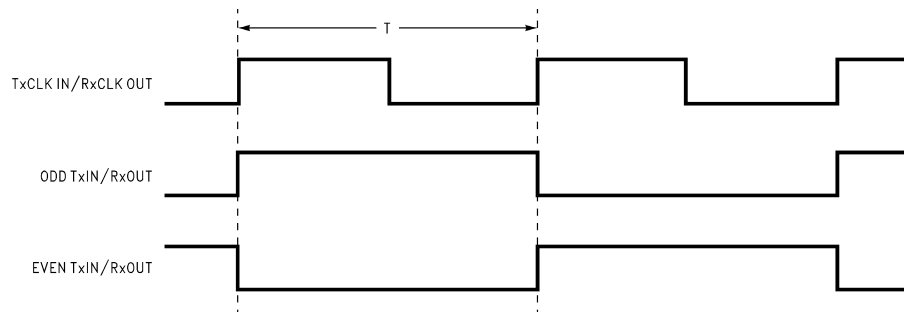
## Transmitter Switching Characteristics (continued)

Over recommended operating supply and temperature ranges unless otherwise specified

Symbol	Parameter	Min	Typ	Max	Unit
SSCG	Spread Spectrum Clock support; Modulation frequency with a linear profile. <sup>(2)</sup>	f = 25 MHz	100kHz ±2.5%/-5%		
		f = 40 MHz	100kHz ±2.5%/-5%		
		f = 65 MHz	100kHz ±2.5%/-5%		
		f = 87.5 MHz	100kHz ±2.5%/-5%		
TPLLS	Transmitter Phase Lock Loop Set (Figure 10)			10	ms
TPDD	Transmitter Power Down Delay (Figure 12)			100	ns

- (2) Care must be taken to ensure TSTC and THTC are met so input data are sampling correctly. This SSCG parameter only shows the performance of tracking Spread Spectrum Clock applied to TxCLK IN pin, and reflects the result on TxCLKOUT+ and TxCLKOUT- pins.

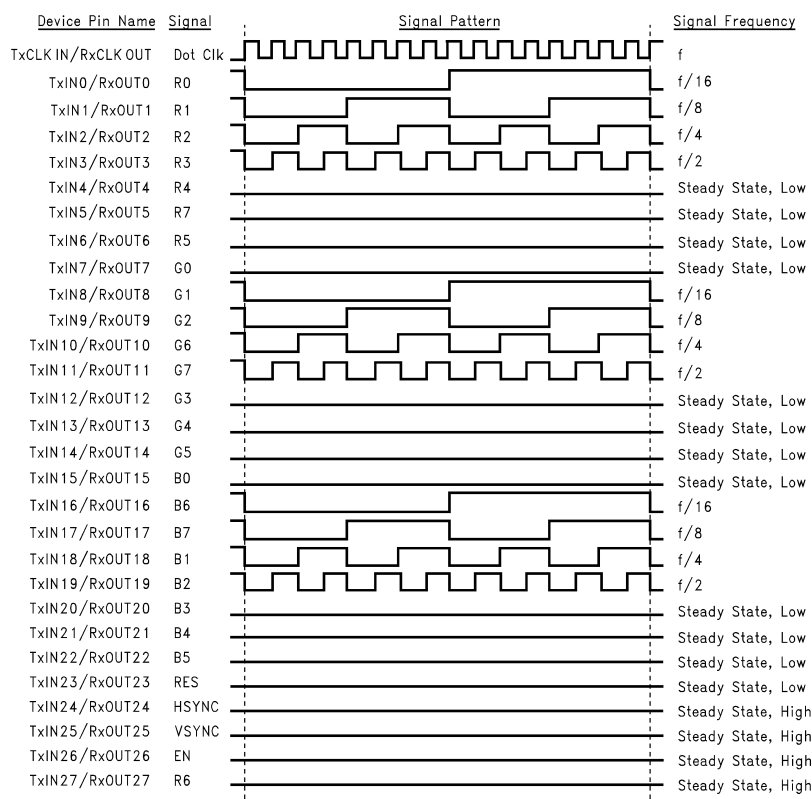
### AC Timing Diagrams



- A. The worst case test pattern produces a maximum toggling of digital circuits, LVDS I/O and LVCMOS/LVTTL I/O.  
 B. Figure 2 and Figure 3 show a falling edge data strobe (TxCLK IN/RxCLK OUT).

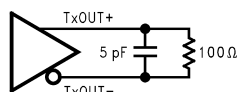
**Figure 2. "Worst Case" Test Pattern**

## AC Timing Diagrams (continued)

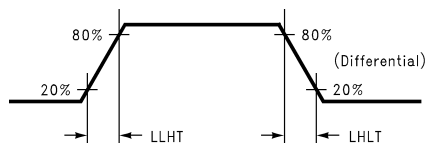


- The 16 grayscale test pattern tests device power consumption for a "typical" LCD display pattern. The test pattern approximates signal switching needed to produce groups of 16 vertical stripes across the display.
- [Figure 2](#) and [Figure 3](#) show a falling edge data strobe (TxCLK IN/RxCLK OUT).
- Recommended pin to signal mapping. Customer may choose to define differently.

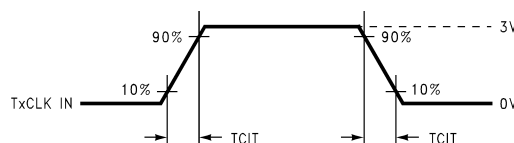
**Figure 3. "16 Grayscale" Test Pattern - DS90C385A**



**Figure 4. DS90C385A (Transmitter) LVDS Output Load. 5pF is shown as board loading**



**Figure 5. DS90C385A (Transmitter) LVDS Transition Times**



**Figure 6. DS90C385A (Transmitter) Input Clock Transition Time**

## AC Timing Diagrams (continued)

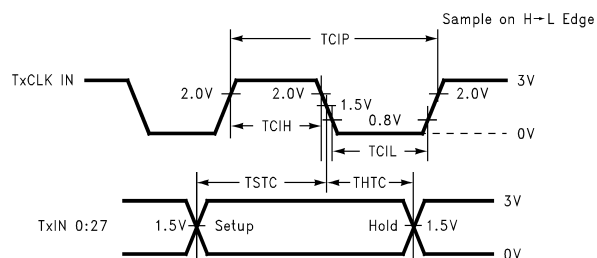


Figure 7. DS90C385A (Transmitter) Setup/Hold and High/Low Times with R\_FB pin = GND (Falling Edge Strobe)

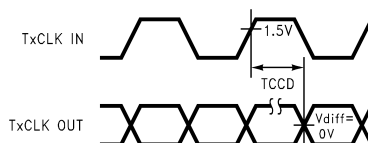


Figure 8. DS90C385A (Transmitter) Clock In to Clock Out Delay with R\_FB pin = VCC

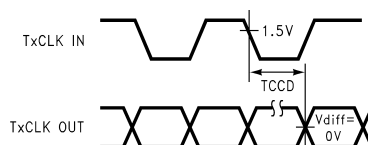


Figure 9. DS90C385A (Transmitter) Clock In to Clock Out Delay with R\_FB pin = GND

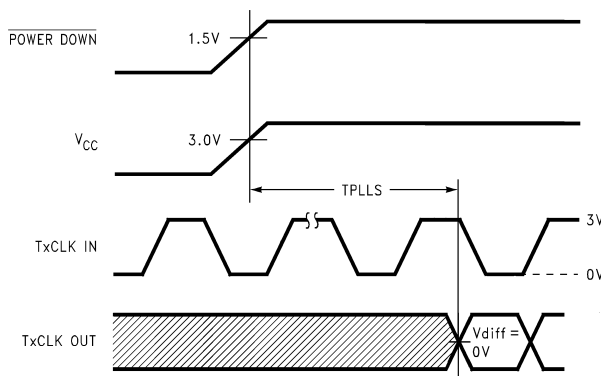
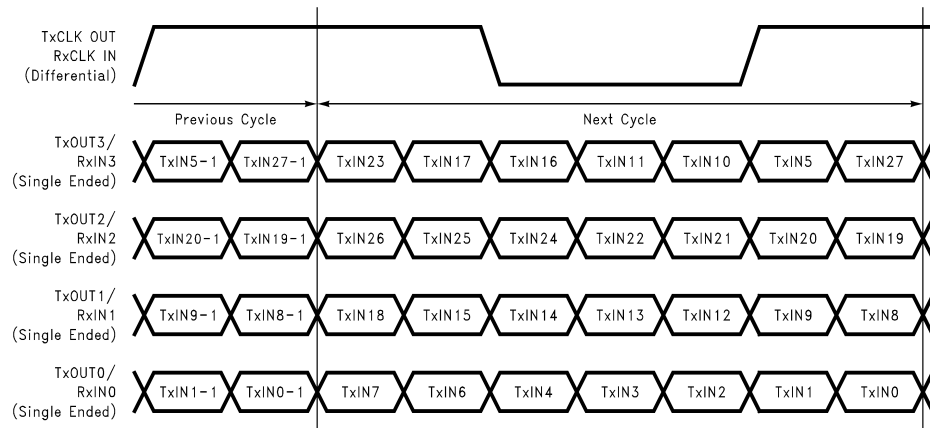
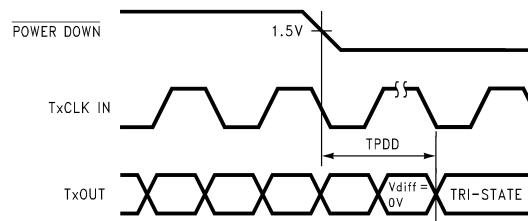


Figure 10. DS90C385A (Transmitter) Phase Lock Loop Set Time

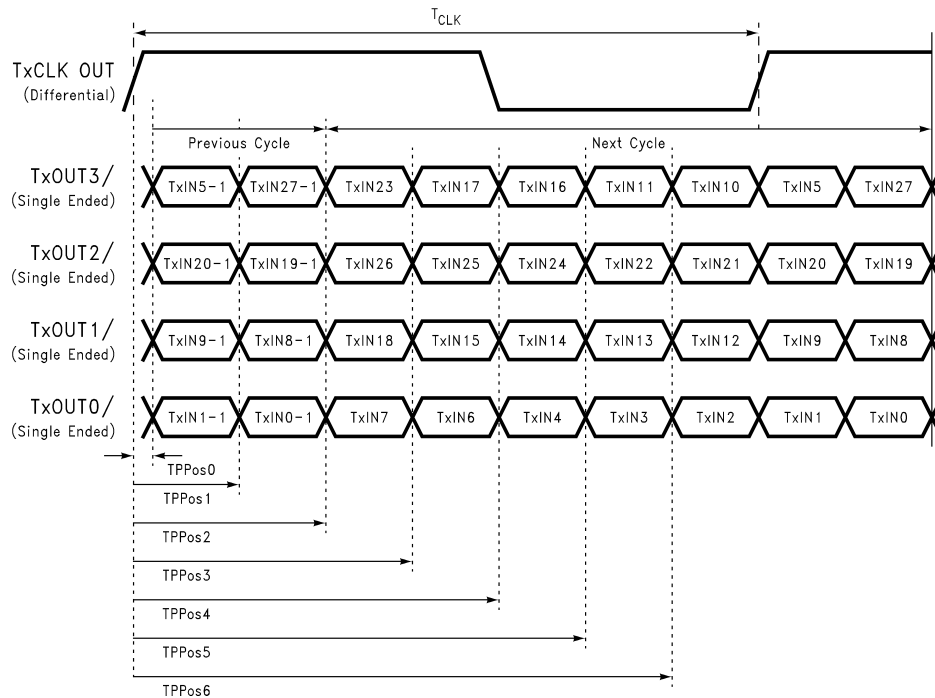
### AC Timing Diagrams (continued)



**Figure 11. 28 Parallel TTL Data Inputs Mapped to LVDS Outputs - DS90C385A**



**Figure 12. Transmitter Power Down Delay**

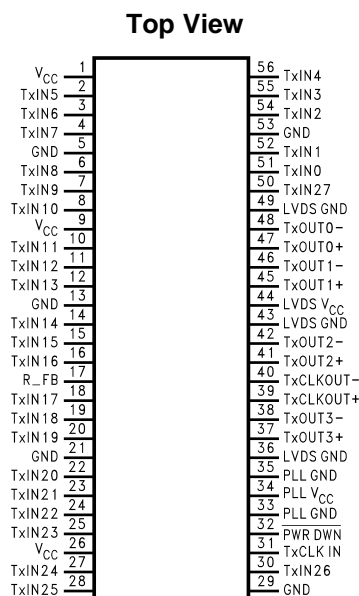


**Figure 13. Transmitter LVDS Output Pulse Position Measurement - DS90C385A**



**DS90C385A DGG (TSSOP) Package Pin Descriptions — FPD Link Transmitter**

Pin Name	I/O	No.	Description
TxIN	I	28	LVTTL level input. This includes: 8 Red, 8 Green, 8 Blue, and 4 control lines—FPLINE, FPFRAME and DRDY (also referred to as HSYNC, VSYNC, Data Enable).
TxOUT+	O	4	Positive LVDS differential data output.
TxOUT-	O	4	Negative LVDS differential data output.
TxCLKIN	I	1	LVTTL level clock input. Pin name TxCLK IN.
R_FB	I	1	LVTTL level programmable strobe select (See <a href="#">Table 1</a> ).
TxCLK OUT+	O	1	Positive LVDS differential clock output.
TxCLK OUT-	O	1	Negative LVDS differential clock output.
PWR DOWN	I	1	LVTTL level input. When asserted (low input) TRI-STATE the outputs, ensuring low current at power down.
V <sub>CC</sub>	I	3	Power supply pins for LVTTL inputs.
GND	I	5	Ground pins for LVTTL 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.

**Pin Diagram for TSSOP Package**


**Order Number DS90C385AMT  
DGG Package**

## APPLICATION INFORMATION

The DS90C385A is backward compatible with the DS90C385, DS90C383A, DS90C383 in TSSOP 56-lead package, and it is a pin-for-pin replacements.

This device DS90C385A also features reduced variation of the TCCD parameter which is important for dual pixel applications. (See AN-1084)

This device may also be used as a replacement for the DS90CF583 (5V, 65MHz) and DS90CF581 (5V, 40MHz) FPD-Link Transmitters with certain considerations/modifications:

1. Change 5V power supply to 3.3V. Provide this 3.3V supply to the  $V_{CC}$ , LVDS  $V_{CC}$  and PLL  $V_{CC}$  of the transmitter.
2. The DS90C385A transmitter input and control inputs accept 3.3V LVTTTL/LVCMOS levels. They are not 5V tolerant.
3. To implement a falling edge device for the DS90C385A, the R\_FB pin may be tied to ground OR left unconnected (an internal pull-down resistor biases this pin low). Biasing this pin to  $V_{CC}$  implements a rising edge device.

### TRANSMITTER INPUT PINS

The TxIN and control input pins are compatible with LVCMOS and LVTTTL levels. These pins are not 5V tolerant.

### TRANSMITTER INPUT CLOCK/DATA SEQUENCING

Unlike the DS90C385, DS90C(F)383A/363A, the DS90C385A does not require any special requirement for sequencing of the input clock/data and PD (PowerDown) signal. The DS90C385A offers a more robust input sequencing feature where the input clock/data can be inserted after the release of the PD signal. In the case where the clock/data is stopped and reapplied, such as changing video mode within Graphics Controller, it is not necessary to cycle the PD signal. However, there are in certain cases where the PD may need to be asserted during these mode changes. In cases where the source (Graphics Source) may be supplying an unstable clock or spurious noisy clock output to the LVDS transmitter, the LVDS Transmitter may attempt to lock onto this unstable clock signal but is unable to do so due the instability or quality of the clock source. The PD signal in these cases should then be asserted once a stable clock is applied to the LVDS transmitter. Asserting the PWR DOWN pin will effectively place the device in reset and disable the PLL, enabling the LVDS Transmitter into a power saving standby mode. However, it is still generally a good practice to assert the PWR DOWN pin or reset the LVDS transmitter whenever the clock/data is stopped and reapplied but it is not mandatory for the DS90C385A.

### SPREAD SPECTRUM CLOCK SUPPORT

The DS90C385A can support Spread Spectrum Clocking signal type inputs. The DS90C385A outputs will accurately track Spread Spectrum Clock/Data inputs with modulation frequencies of up to 100kHz (max.) with either center spread of  $\pm 2.5\%$  or down spread -5% deviations.

### POWER SOURCES SEQUENCE

In typical applications, it is recommended to have  $V_{CC}$ , LVDS  $V_{CC}$  and PLL  $V_{CC}$  from the same power source with three separate de-coupling bypass capacitor groups. There is no requirement on which VCC entering the device first.

### Typical Application

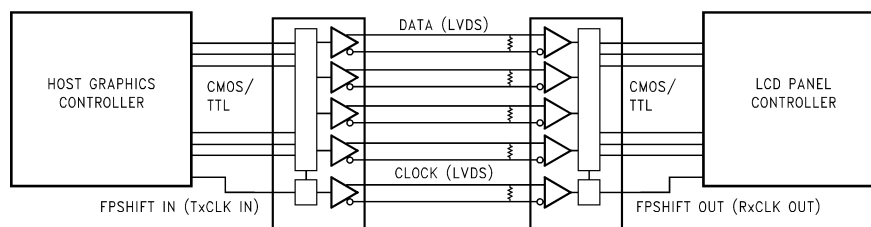


Figure 14. Typical Application

**Table 1. Truth Table – Programmable Transmitter  
(DS90C385A)**

Pin	Condition	Strobe Status
R_FB	R_FB = $V_{CC}$	Rising edge strobe
R_FB	R_FB = GND or NC	Falling edge strobe

REVISION HISTORY

Changes from Revision J (April 2013) to Revision K	Page
• Changed layout of National Data Sheet to TI format .....	<a href="#">11</a>

## PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
DS90C385AMT/NOPB	ACTIVE	TSSOP	DGG	56	34	Green (RoHS & no Sb/Br)	CU SN	Level-2-260C-1 YEAR	-10 to 70	DS90C385AMT	<a href="#">Samples</a>
DS90C385AMTX	ACTIVE	TSSOP	DGG	56	1000	TBD	Call TI	Call TI	-10 to 70	DS90C385AMT	<a href="#">Samples</a>
DS90C385AMTX/NOPB	ACTIVE	TSSOP	DGG	56	1000	Green (RoHS & no Sb/Br)	CU SN	Level-2-260C-1 YEAR	-10 to 70	DS90C385AMT	<a href="#">Samples</a>

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Top-Side Marking for that device.

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**TAPE AND REEL INFORMATION**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
DS90C385AMTX	TSSOP	DGG	56	1000	330.0	24.4	8.6	14.5	1.8	12.0	24.0	Q1
DS90C385AMTX/NOPB	TSSOP	DGG	56	1000	330.0	24.4	8.6	14.5	1.8	12.0	24.0	Q1

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
DS90C385AMTX	TSSOP	DGG	56	1000	367.0	367.0	45.0
DS90C385AMTX/NOPB	TSSOP	DGG	56	1000	367.0	367.0	45.0

## DGG (R-PDSO-G\*\*)

## PLASTIC SMALL-OUTLINE PACKAGE

48 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-153



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