

## SN65LVDS822 Flatlink™ LVDS Receiver

### 1 Features

- 4:27 LVDS-to-CMOS Deserializer
- Pixel Clock Range of 4 MHz to 54 MHz, for Resolutions of 160 × 120 to 1024 × 600
- Special 2:27 Mode With 14x Sampling Allows Using Just Two Data Lanes
- Very Low EMI With 3-Way Selectable CMOS Slew Rate
- Supports Single 3.3-V Power Supply;  $V_{DDIO}$  Allows 1.8 V to 3.3 V for Flexible Panel Support
- Clock Output is Rising or Falling Edge
- Bus-Swap Feature for Flexible PCB Layout
- Integrated Switchable Input Termination
- All Input Pins are Failsafe;  $\pm 3$  kV HBM ESD Protection
- 7-mm x 7-mm 48-Pin VQFN With 0.5-mm Pitch
- Compatible With TIA/EIA-644-A Transmitters

### 2 Applications

- Printers
- Appliances With an LCD
- Digital Cameras



### 3 Description

The SN65LVDS822 is an advanced FlatLink™ low-voltage differential signal (LVDS) receiver designed on a modern CMOS process. The device has several unique features, including three selectable CMOS output slew rates, CMOS output voltage support of 1.8 V to 3.3 V, a pinout swap option, integrated differential termination (configurable), an automatic low-power mode, and deserialization modes of 4:27 and 2:27. The device is compatible with TI FlatLink™ transmitters such as the SN75LVDS83B, SN65LVDS93A, and standard industry LVDS transmitters that comply with TIA/EIA 644-A.

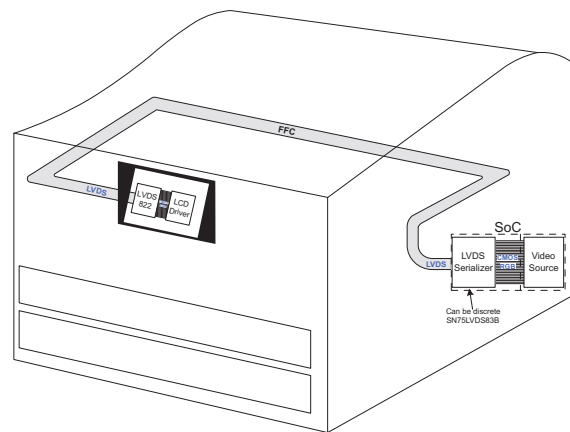
The SN65LVDS822 features an automatic low-power Standby Mode, activated when the LVDS clock is disabled. The device enters an even lower-power Shutdown Mode with a low voltage applied to pin SHTDN#.

The SN65LVDS822 is packaged in a 48-pin 7-mm x 7-mm Plastic Quad Flatpack No-Lead (QFN) with a 0.5-mm pin pitch, and operates through an industrial ambient temperature range of  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .

#### Device Information<sup>(1)</sup>

PART NUMBER	PACKAGE	BODY SIZE (NOM)
SN65LVDS822	VQFN (48)	7.00 mm x 7.00 mm

(1) For all available packages, see the orderable addendum at the end of the datasheet.



## Table of Contents

<b>1 Features</b> .....	<b>1</b>	9.1 Overview .....	<b>19</b>
<b>2 Applications</b> .....	<b>1</b>	9.2 Functional Block Diagram .....	<b>19</b>
<b>3 Description</b> .....	<b>1</b>	9.3 Feature Description .....	<b>20</b>
<b>4 Revision History</b> .....	<b>2</b>	9.4 Device Functional Modes .....	<b>21</b>
<b>5 Description (Continued)</b> .....	<b>3</b>	<b>10 Application and Implementation</b> .....	<b>22</b>
<b>6 Pin Configuration and Functions</b> .....	<b>4</b>	10.1 Application Information .....	<b>22</b>
<b>7 Specifications</b> .....	<b>7</b>	10.2 Typical Application .....	<b>24</b>
7.1 Absolute Maximum Ratings .....	<b>7</b>	<b>11 Power Supply Recommendations</b> .....	<b>26</b>
7.2 Handling Ratings .....	<b>7</b>	11.1 Decoupling Capacitor Recommendations .....	<b>26</b>
7.3 Recommended Operating Conditions .....	<b>8</b>	<b>12 Layout</b> .....	<b>26</b>
7.4 Thermal Information .....	<b>9</b>	12.1 Layout Guidelines .....	<b>26</b>
7.5 DC Electrical Characteristics .....	<b>10</b>	12.2 Layout Example .....	<b>27</b>
7.6 Power Supply Characteristics .....	<b>10</b>	<b>13 Device and Documentation Support</b> .....	<b>28</b>
7.7 Switching Characteristics .....	<b>11</b>	13.1 Trademarks .....	<b>28</b>
7.8 Typical Characteristics .....	<b>16</b>	13.2 Electrostatic Discharge Caution .....	<b>28</b>
<b>8 Parameter Measurement Information</b> .....	<b>17</b>	13.3 Glossary .....	<b>28</b>
8.1 Test Patterns .....	<b>17</b>	<b>14 Mechanical, Packaging, and Orderable Information</b> .....	<b>28</b>
<b>9 Detailed Description</b> .....	<b>19</b>		

## 4 Revision History

### Changes from Revision A (October 2013) to Revision B

**Page**

<ul style="list-style-type: none"> <li>Added <i>Pin Configuration and Functions</i> section, <i>Handling Rating</i> table, <i>Feature Description</i> section, <i>Device Functional Modes</i>, <i>Application and Implementation</i> section, <i>Power Supply Recommendations</i> section, <i>Layout</i> section, <i>Device and Documentation Support</i> section, and <i>Mechanical, Packaging, and Orderable Information</i> section .....</li> </ul>	<b>1</b>
---	----------

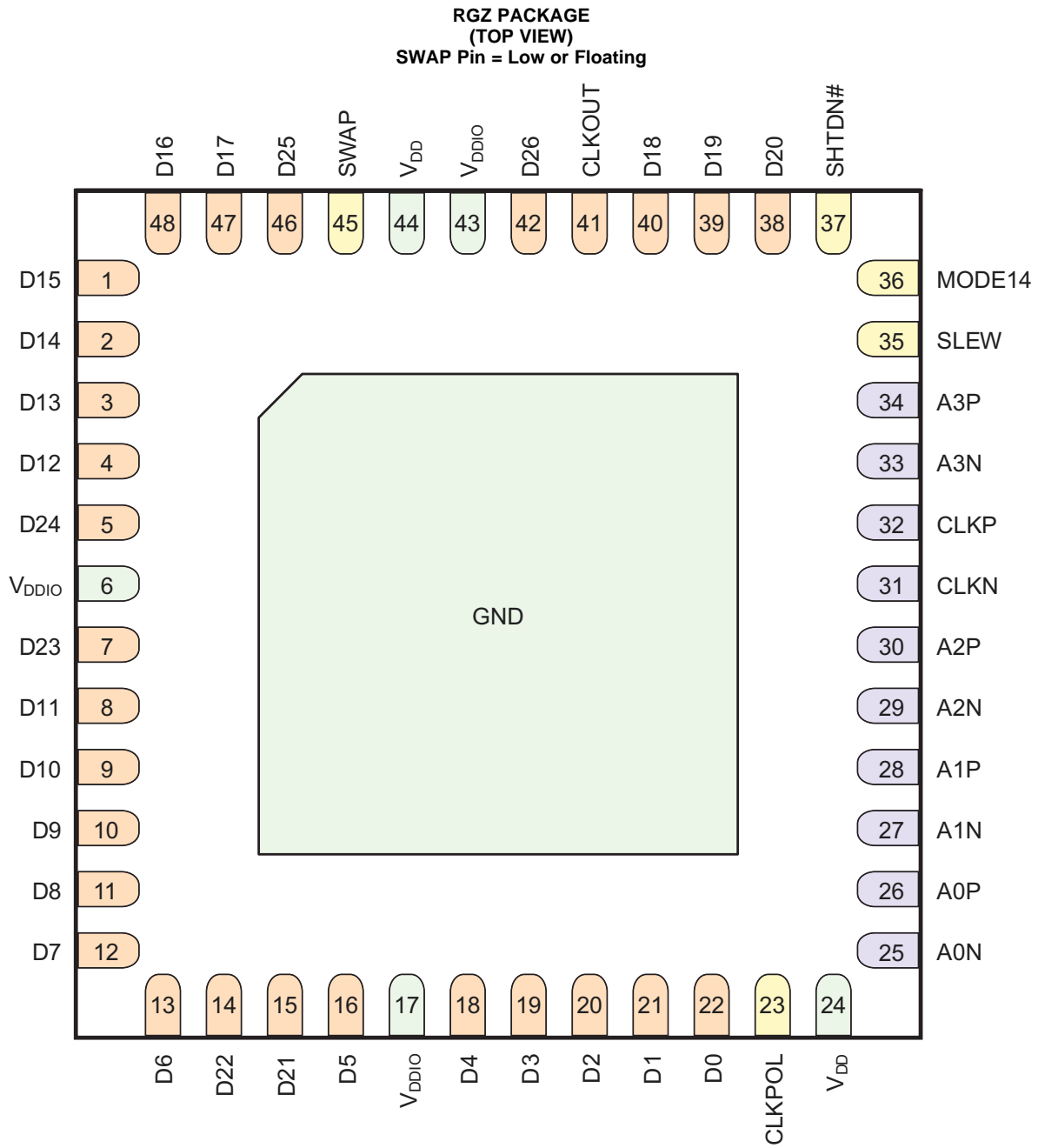
## 5 Description (Continued)

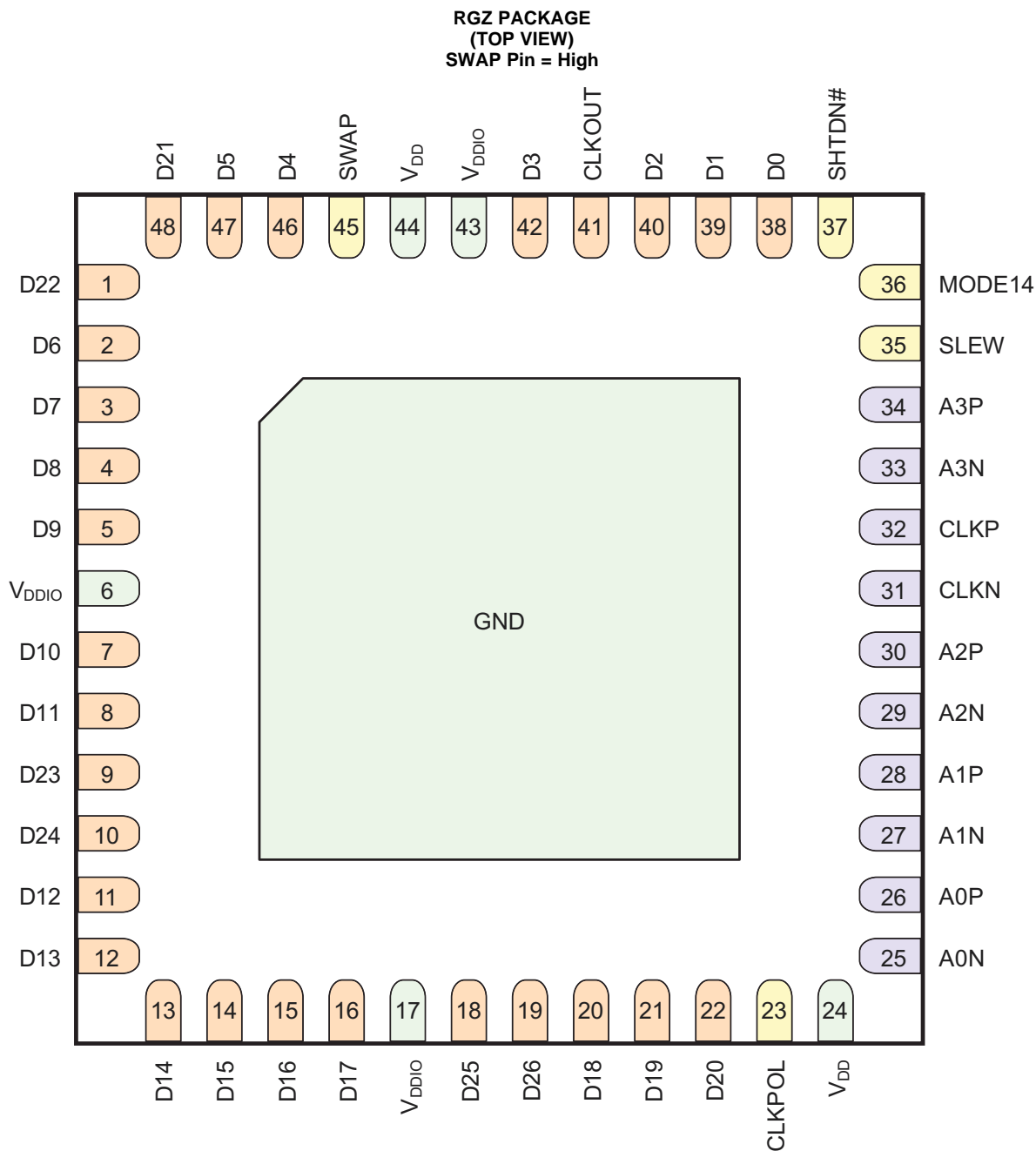
A clock frequency range of 4 MHz to 54 MHz is supported in the standard 7x mode, which is to be used with LVDS data rates of 28 Mbps to 378 Mbps. The 14x mode supports 4 MHz to 27 MHz, for LVDS data rates of 56Mbps to 378 Mbps. The LVDS clock frequency always matches the CMOS output clock frequency. DC common mode voltage is monitored on clock line for normal operation. The device is designed to support resolutions as low as 1/16th VGA (160 × 120), and as high as 1024 × 600, with 60 frames per second and 24-bit color.

The SN65LVDS822 features an automatic low-power standby mode, activated when the LVDS clock is disabled. The device enters an even lower-power shutdown mode with a low voltage applied to pin SHTDN#. In both low-power modes, all CMOS outputs drive low. All input pins have fail-safe protection that prevents damage from occurring before power supply voltages are high and stable.

The SN65LVDS822 is packaged in a 48-pin 7-mm x 7-mm Plastic Quad Flatpack No-Lead (QFN) with a 0.5-mm pin pitch, and operates through an industrial ambient temperature range of –40°C to 85°C.

## 6 Pin Configuration and Functions





**SN65LVDS822**

SLLSEE8B – SEPTEMBER 2013 – REVISED SEPTEMBER 2014

[www.ti.com](http://www.ti.com)
**Pin Functions**

PIN		I/O	DESCRIPTION
NAME	NO.		
A0P, A0N	26, 25	LVDS Input	LVDS Data Lane 0
A1P, A1N	28, 27		LVDS Data Lane 1
A2P, A2N	30, 29		LVDS Data Lane 2
A3P, A3N	34, 33		LVDS Data Lane 3
CLKP, CLKN	32, 31		LVDS Clock
	(SWAP = L / H)	CMOS Output	Data bus output
D0	22 / 38		
D1	21 / 39		
D2	20 / 40		
D3	19 / 42		
D4	18 / 46		
D5	16 / 47		
D6	13 / 2		
D7	12 / 3		
D8	11 / 4		
D9	10 / 5		
D10	9 / 7		
D11	8 / 8		
D12	4 / 11		
D13	3 / 12		
D14	2 / 13		
D15	1 / 14		
D16	48 / 15		
D17	47 / 16		
D18	40 / 20		
D19	39 / 21		
D20	38 / 22		
D21	15 / 48		
D22	14 / 1		
D23	7 / 9		
D24	5 / 10		
D25	46 / 18		
D26	42 / 19		
CLKOUT	41		Clock output for the data bus

**Pin Functions (continued)**

PIN		I/O	DESCRIPTION
NAME	NO.		
SWAP	45	CMOS Input	Selects the CMOS output pinout, and also controls differential input termination. Low – Default pinout, R <sub>ID</sub> connected Floating – Default pinout, R <sub>ID</sub> disconnected (requires external termination) High – Swapped pinout, R <sub>ID</sub> connected
MODE14	36		Sets the number of LVDS serial bits per lane per clock period. Low – 7 bits (see <a href="#">Figure 16</a> ) High – 14 bits; only lanes A0 and A2 are used (see <a href="#">Figure 17</a> )
CLKPOL	23		CLKOUT polarity Low – D[26:0] is valid during the CLKOUT falling edge Floating – Reserved; do not use High – D[26:0] is valid during the CLKOUT rising edge
SHTDN#	37		Shutdown Mode; Active-Low
SLEW	35		Sets the CMOS output slew rate Low – Slowest rise/fall time Floating – Medium rise/fall time High – Fastest rise/fall time
VDD	24, 44	Power Supply	Main power supply; 3.3 V
VDDIO	6, 17, 43		Power supply for CMOS outputs; 1.8 V to 3.3 V
GND	Thermal Pad		Reference Ground

## 7 Specifications

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

		MIN	MAX	UNIT
Supply voltage range <sup>(2)</sup> , V <sub>DD</sub> , V <sub>DDIO</sub>		-0.3	4	V
Voltage range at any input terminal	When V <sub>DDIO</sub> > 0 V	-0.5	4	V
Voltage range at any output terminal	When V <sub>DDIO</sub> ≤ 0 V	-0.5	V <sub>DDIO</sub> + 0.7	
Maximum junction temperature, T <sub>J</sub>			125	°C

- (1) Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under [Recommended Operating Conditions](#) is not implied. Exposure to absolute maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltage values are with respect to the GND terminals

### 7.2 Handling Ratings

		MIN	MAX	UNIT	
T <sub>stg</sub>	Storage temperature range	-65	150	°C	
V <sub>(ESD)</sub>	Electrostatic discharge	Human body model <sup>(1)</sup> (all pins)	-3	3	V
		Charged device model <sup>(2)</sup> (all pins)	-1.5	1.5	

- (1) In accordance with JEDEC Standard 22, Test Method A114-B
- (2) In accordance with JEDEC Standard 22, Test Method C101

### 7.3 Recommended Operating Conditions

		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V <sub>DD</sub>	Main power supply		3	3.3	3.6	V
V <sub>DDIO</sub>	Power supply for CMOS outputs		1.65		3.6	V
V <sub>NOISE</sub>	Power supply noise (peak-to-peak)	f <sub>NOISE</sub> < 1 MHz			100	mV
		f <sub>NOISE</sub> > 1 MHz			50	
T <sub>A</sub>	Operating free-air temperature		–40		85	°C
T <sub>C</sub>	Case temperature				98	°C
<b>LVDS CLOCK (CLKP, CLKN)</b>						
f <sub>CLK</sub>	LVDS clock frequency	MODE14 = Low	4		54	MHz
		MODE14 = High	4		27	
		Standby Mode			0.5	
t <sub>DC</sub>	LVDS clock duty cycle	MODE14 = Low		57%		
		MODE14 = High		50%		
<b>LVDS INPUTS (A0P, A0N, A1P, A1N, A2P, A2N, A3P, A3N, CLKP, CLKN)</b>						
V <sub>ID</sub>	Input differential voltage <sup>(1)</sup>	V <sub>AXP</sub> – V <sub>AXN</sub>   and  V <sub>CLKP</sub> – V <sub>CLKN</sub>	90		600	mV
ΔV <sub>ID</sub>	Input differential voltage variation between lanes		–10%		10%	
V <sub>CM</sub>	Input common mode voltage <sup>(1)</sup>		V <sub>ID</sub>  /2		2.4 ·  V <sub>ID</sub>  /2	V
ΔV <sub>CM</sub>	Input common mode voltage variation between lanes		–100		100	mV
t <sub>R/F(VID)</sub>	LVDS V <sub>ID</sub> rise/fall time <sup>(2)</sup>	MODE14 = Low	f <sub>CLK</sub> = 4 MHz to 14 MHz		3	ns
			f <sub>CLK</sub> = 14 MHz to 22 MHz		2	
			f <sub>CLK</sub> = 22 MHz to 30 MHz		1.5	
			f <sub>CLK</sub> = 30 MHz to 54 MHz		1	
		MODE14 = High	f <sub>CLK</sub> = 4 MHz to 7 MHz		3	
			f <sub>CLK</sub> = 7 MHz to 11 MHz		2	
			f <sub>CLK</sub> = 11 MHz to 15 MHz		1.5	
			f <sub>CLK</sub> = 15 MHz to 27 MHz		1	
<b>CMOS OUTPUTS (D[26:0], CLKOUT)</b>						
C <sub>L</sub>	Capacitive load on the outputs			10		pF

(1) See [Figure 1](#).

(2) See [Figure 6](#). Defined from 20% to 80% of the differential voltage transition. Faster edge rates are generally preferred, as they provide more timing margin.



## 7.4 Thermal Information

THERMAL METRIC <sup>(1)</sup>		SN65LVDS822	UNIT
		RGZ	
		48 PINS	
$\theta_{JA}$	Junction-to-ambient thermal resistance <sup>(2)</sup>	30.1	°C/W
$\theta_{JCTop}$	Junction-to-case (top) thermal resistance <sup>(3)</sup>	18.1	
$\theta_{JB}$	Junction-to-board thermal resistance <sup>(4)</sup>	6.9	
$\psi_{JT}$	Junction-to-top characterization parameter <sup>(5)</sup>	0.2	
$\psi_{JB}$	Junction-to-board characterization parameter <sup>(6)</sup>	6.9	
$\theta_{JCbott}$	Junction-to-case (bottom) thermal resistance <sup>(7)</sup>	0.7	

- (1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, [SPRA953](#).
- (2) The junction-to-ambient thermal resistance under natural convection is obtained in a simulation on a JEDEC-standard, high-K board, as specified in JESD51-7, in an environment described in JESD51-2a.
- (3) The junction-to-case (top) thermal resistance is obtained by simulating a cold plate test on the package top. No specific JEDEC-standard test exists, but a close description can be found in the ANSI SEMI standard G30-88.
- (4) The junction-to-board thermal resistance is obtained by simulating in an environment with a ring cold plate fixture to control the PCB temperature, as described in JESD51-8.
- (5) The junction-to-top characterization parameter,  $\psi_{JT}$ , estimates the junction temperature of a device in a real system and is extracted from the simulation data for obtaining  $\theta_{JA}$ , using a procedure described in JESD51-2a (sections 6 and 7).
- (6) The junction-to-board characterization parameter,  $\psi_{JB}$ , estimates the junction temperature of a device in a real system and is extracted from the simulation data for obtaining  $\theta_{JA}$ , using a procedure described in JESD51-2a (sections 6 and 7).
- (7) The junction-to-case (bottom) thermal resistance is obtained by simulating a cold plate test on the exposed (power) pad. No specific JEDEC standard test exists, but a close description can be found in the ANSI SEMI standard G30-88.

## 7.5 DC Electrical Characteristics

over operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP <sup>(1)</sup>	MAX	UNIT
<b>LVDS INPUTS (A0P, A0N, A1P, A1N, A2P, A2N, A3P, A3N, CLKP, CLKN)</b>						
R <sub>ID</sub>	Differential input termination resistance <sup>(1)</sup>	SWAP = Low or High	80		132	Ω
C <sub>ID</sub>	Differential input capacitance	Measured across differential pairs		1		pF
R <sub>PU</sub>	Pull-up resistor for standby detection	Measured from each input to V <sub>DD</sub>	90			kΩ
I <sub>I</sub>	Input leakage current	V <sub>DD</sub> = 3.6 V; R <sub>ID</sub> disconnected; One P/N terminal is swept from 0 V to 2.4 V while the other is 1.2 V			70	μA
<b>CMOS INPUTS (SWAP, MODE14, CLKPOL, SHTDN#, SLEW)</b>						
C <sub>IN</sub>	Input capacitance for CMOS inputs			2		pF
V <sub>IK</sub>	Input clamp voltage	I <sub>I</sub> = -18 mA	-1.2			V
V <sub>IH</sub>	High-level input voltage		0.8 x V <sub>DD</sub>			V
V <sub>IL</sub>	Low-level input voltage				0.2 x V <sub>DD</sub>	V
<b>3-STATE CMOS INPUTS (SWAP, CLKPOL, SLEW)</b>						
V <sub>F</sub>	Floating voltage	V <sub>IN</sub> = High impedance		V <sub>DD</sub> /2		V
I <sub>IH</sub>	High-level input current (through pull-down)	V <sub>IN</sub> = 3.6 V			36	μA
I <sub>IL</sub>	Low-level input current (through pull-up)	V <sub>IN</sub> = GND, V <sub>DD</sub> = 3.6 V	-36			μA
<b>2-STATE CMOS INPUTS (MODE14, SHTDN#)</b>						
I <sub>IH</sub>	High-level input current (through pull-down)	V <sub>IN</sub> = 3.6 V			20	μA
I <sub>IL</sub>	Low-level input current	V <sub>IN</sub> = GND	0			μA
<b>CMOS OUTPUTS (D[26:0], CLKOUT)</b>						
V <sub>OH</sub>	High-level output voltage	SLEW = Low; I <sub>OH</sub> = -250 μA	0.8 x V <sub>DDIO</sub>		V <sub>DDIO</sub>	V
		SLEW = Floating; I <sub>OH</sub> = -500 μA	0.8 x V <sub>DDIO</sub>		V <sub>DDIO</sub>	
		SLEW = High; I <sub>OH</sub> = -1.33 mA	0.8 x V <sub>DDIO</sub>		V <sub>DDIO</sub>	
V <sub>OL</sub>	Low-level output voltage	SLEW = Low; I <sub>OL</sub> = 250 μA	0		0.5	V
		SLEW = Floating; I <sub>OL</sub> = 500 μA	0		0.5	
		SLEW = High; I <sub>OL</sub> = 1.33 mA	0		0.5	

 (1) When V<sub>DD</sub> = 0 V, the connection of R<sub>ID</sub> is unknown.

## 7.6 Power Supply Characteristics

over recommended operating conditions (unless otherwise noted)

PARAMETER	TEST CONDITIONS <sup>(1)(2)</sup>		TYP	MAX <sup>(1)</sup>	UNIT	
I <sub>DD</sub>	Total average supply current of V <sub>DD</sub> and V <sub>DDIO</sub>	Grayscale pattern; outputs terminated with 10 pF; MODE14 = Low, V <sub>DD</sub> = 3.3 V, V <sub>DDIO</sub> = 1.8 V	SLEW = Low; f <sub>CLK</sub> = 10 MHz	24.6		mA
		Grayscale pattern; outputs terminated with 10pF; MODE14 = Low, V <sub>DD</sub> = V <sub>DDIO</sub> = 3.3 V	SLEW = Low; f <sub>CLK</sub> = 10 MHz	25.7		
			SLEW = Float; f <sub>CLK</sub> = 20 MHz	30.9		
			SLEW = High; f <sub>CLK</sub> = 54 MHz	51.5		
		1010 pattern; outputs terminated with 10 pF; MODE14 = Low, V <sub>DD</sub> = V <sub>DDIO</sub> = 3.6 V	SLEW = Float; f <sub>CLK</sub> = 20 MHz	48.2	59	mA
			SLEW = High; f <sub>CLK</sub> = 54 MHz	101.7	124	
Standby Mode	LVDS inputs are open; CMOS inputs held static; Outputs terminated with 10 pF	f <sub>CLK</sub> < 500 kHz; V <sub>CM-CLKP/N</sub> ≤ 0.80 x V <sub>DD</sub>	4	7	mA	
		V <sub>CM-CLKP/N</sub> > 0.95 x V <sub>DD</sub>	75	130		
		SHTDN# = Low	4	20	μA	
P <sub>D</sub>	Power Dissipation	Grayscale pattern; outputs terminated with 10 pF; MODE14 = Low, V <sub>DD</sub> = 3.3 V, V <sub>DDIO</sub> = 1.8 V	SLEW = Low; f <sub>CLK</sub> = 10 MHz	83		mW
		1010 pattern; outputs terminated with 10 pF; MODE14 = Low, V <sub>DD</sub> = V <sub>DDIO</sub> = 3.6 V	SLEW = High; f <sub>CLK</sub> = 54 MHz	366	446	

 (1) Grayscale and 1010 test patterns are described by [Figure 5](#) to [Figure 6](#) and [Table 1](#) to [Table 2](#).

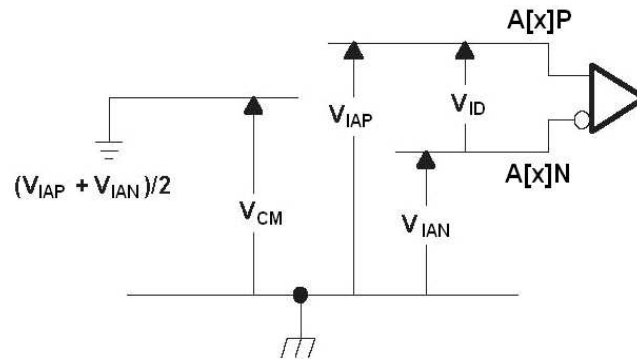
 (2) Standby Mode can be entered in two ways: f<sub>CLK</sub> = zero to 500 kHz, or a high V<sub>CM</sub> on the LVDS clock. If the LVDS transmitter device disables its clock driver to a high-impedance state, the SN65LVDS822's integrated R<sub>PU</sub> will pull V<sub>CM</sub> high for the lower-power Standby state.

## 7.7 Switching Characteristics

over recommended operating conditions (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP <sup>(1)</sup>	MAX	UNIT		
<b>INPUT TO OUTPUT RESPONSE TIME</b>							
$t_{PD}$	Propagation delay of data	Measured from CLK input to CLKOUT		$2.4/f_{CLK}$	s		
$t_{PWRUP}$	Enable time, exiting Shutdown	From Shutdown Mode, time from SHTDN# pulled High to valid output data (see Figure 9)		2	ms		
$t_{WAKE}$	Enable time, exiting Standby	From Standby Mode, time from when CLK input starts switching to valid output data		2	ms		
$t_{PWRDN}$	Disable time, entering Shutdown	From Active Mode, time from SHTDN# pulled Low until all outputs are static-Low		11	$\mu$ s		
$t_{STANDBY}$	Disable time, entering Standby	From Active Mode, time from CLK input stopping until all outputs are static-Low		3	$\mu$ s		
$f_{BW}$	PLL bandwidth <sup>(1)</sup>	Tested from CLK input to CLKOUT		$6\% \times f_{CLK}$	Hz		
<b>LVDS INPUTS (A0P, A0N, A1P, A1N, A2P, A2N, A3P, A3N, CLKP, CLKN)</b>							
$t_{RSKM}$	Receiver input skew margin <sup>(2) (3) (4)</sup>		MODE14 = Low	$1/(14 \times f_{CLK}) - 620E-12$	s		
			MODE14 = High	$1/(28 \times f_{CLK}) - 620E-12$			
$t_{SU1}$	LVDS data setup time required before internal clock edge	$t_{R/F(VID)} = 600$ ps $V_{ID} = 90$ mV See Figure 2			620	ps	
$t_{H1}$	LVDS data hold time required after internal clock edge					620	ps
<b>CMOS OUTPUTS (D[26:0], CLKOUT)</b>							
$t_{DCYC}$	Duty cycle of CLKOUT	MODE14 = Low	CLKPOL = Low		43%		
			CLKPOL = High		57%		
		MODE14 = High		50%			
$t_{R/F}$	CMOS output rise and fall time (20% to 80%)	$C_L = 10$ pF	SLEW = Low	10	15	20	ns
			SLEW = Floating	5	7.5	10	
			SLEW = High	1.3	2.1	3	
$t_{SU2}$	Setup time available for the downstream receiver <sup>(5)</sup>	MODE14 = Low; $C_L = 10$ pF	SLEW = Low	$0.38/f_{CLK} - 2.2E-9$			s
			SLEW = Floating	$0.38/f_{CLK} - 1.2E-9$			
			SLEW = High	$0.38/f_{CLK} - 0.7E-9$			
		MODE14 = High; $C_L = 10$ pF	SLEW = Low	$0.45/f_{CLK} - 2.5E-9$			
			SLEW = Floating	$0.45/f_{CLK} - 1.5E-9$			
			SLEW = High	$0.45/f_{CLK} - 1E-9$			
$t_{H2}$	Hold time available for the downstream receiver <sup>(5)</sup>	MODE14 = Low; $C_L = 10$ pF	SLEW = Low	$0.52/f_{CLK} - 18.2E-9$			s
			SLEW = Floating	$0.52/f_{CLK} - 9.2E-9$			
			SLEW = High	$0.52/f_{CLK} - 3.7E-9$			
		MODE14 = High; $C_L = 10$ pF	SLEW = Low	$0.45/f_{CLK} - 18.5E-9$			
			SLEW = Floating	$0.45/f_{CLK} - 9.5E-9$			
			SLEW = High	$0.45/f_{CLK} - 4E-9$			

- (1) The PLL bandwidth describes the typical highest modulation frequency that can be tracked. If the LVDS transmitter device generates a spread spectrum, the LVDS clock and data must stay synchronized throughout modulation. The SN65LVDS822 will track and pass through modulation, and the downstream CMOS receiver must be able to track it.
- (2) Receiver Input Skew Margin ( $t_{RSKM}$ ) is the timing margin available for transmitter output pulse position ( $t_{PPOS}$ ), interconnect skew, and interconnect inter-symbol interference.  $t_{RSKM}$  represents the remainder of the serial bit time not taken up by the receiver strobe uncertainty. The  $t_{RSKM}$  assumes a bit error rate better than  $10^{-12}$ .
- (3)  $t_{RSKM}$  is indirectly proportional to: internal setup and hold time uncertainty, ISI, duty cycle distortion from the front end receiver, skew mismatch between LVDS clock and data, and PLL cycle-to-cycle jitter.
- (4) LVDS input timing defined here is based on a simulated statistical analysis across process, voltage, and temperature ranges.
- (5) See Figure 3 and Figure 4.



**Figure 1. FlatLink™ Input Voltage Definitions**

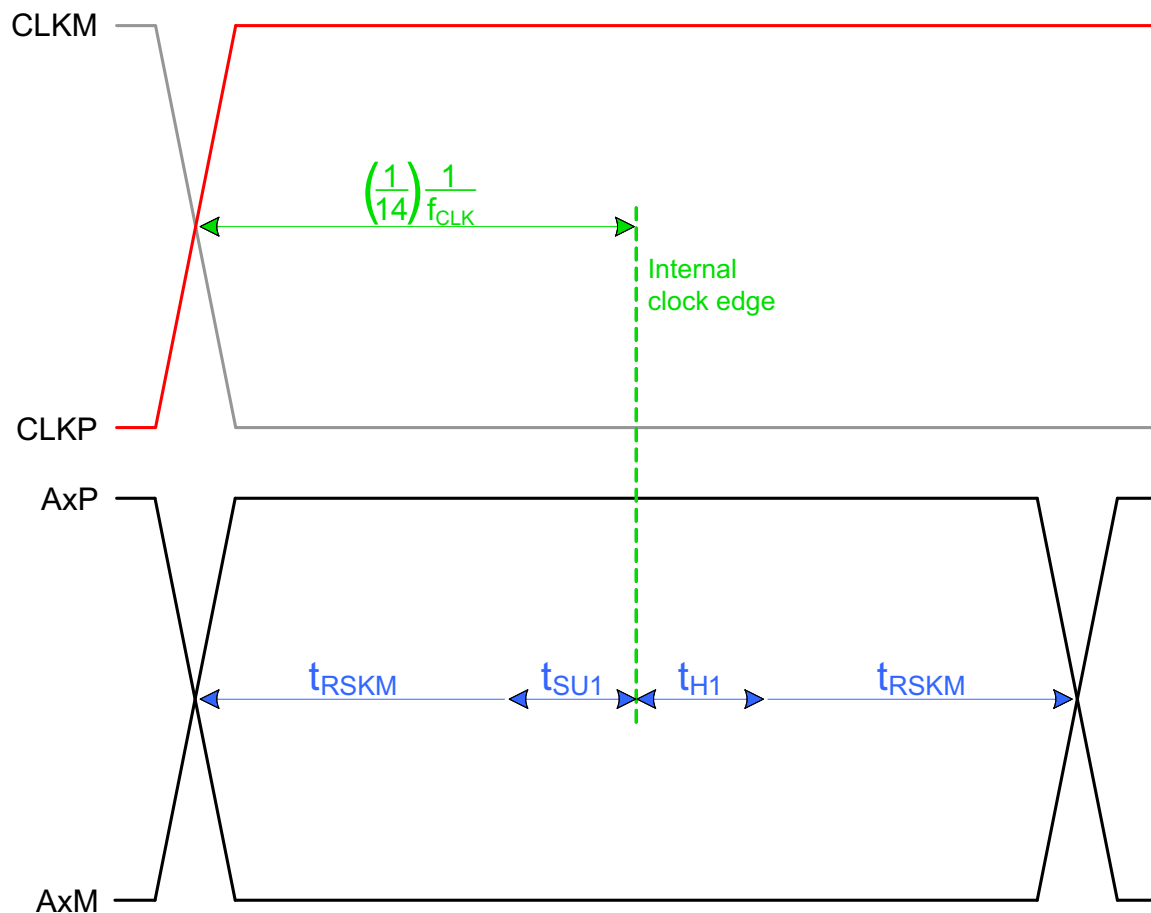
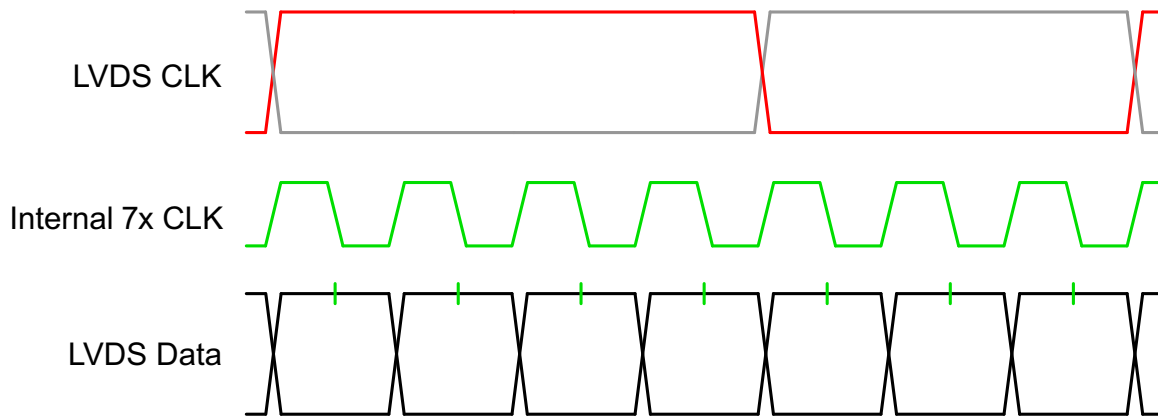


Figure 2. LVDS Input Timing (MODE14 = Low)

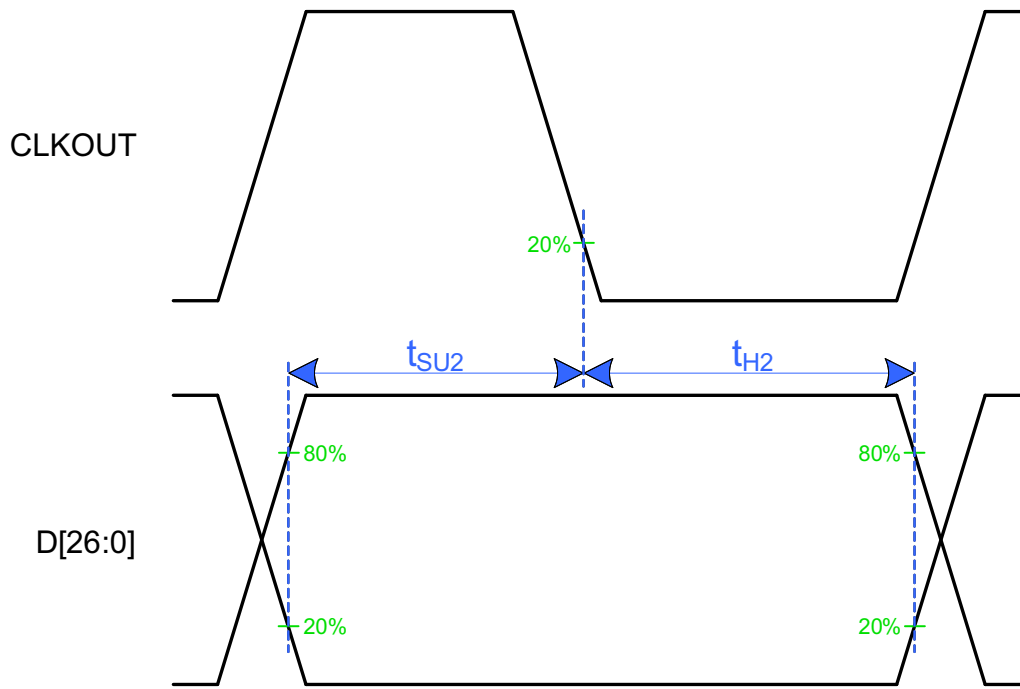


Figure 3. CMOS Output Timing (CLKPOL = Low)

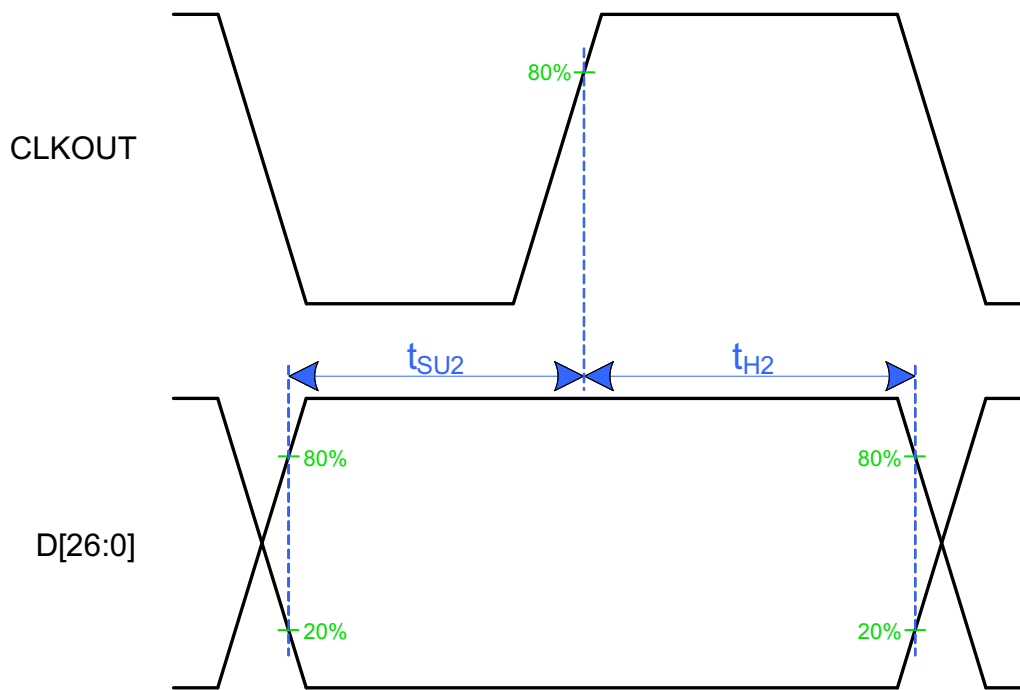


Figure 4. CMOS Output Timing (CLKPOL = High)

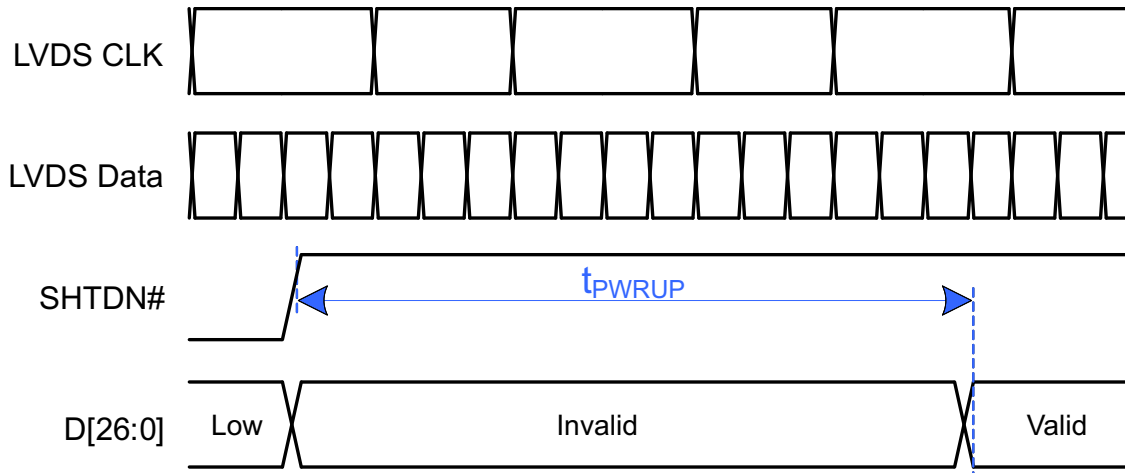


Figure 5. Time to Exit Shutdown Mode

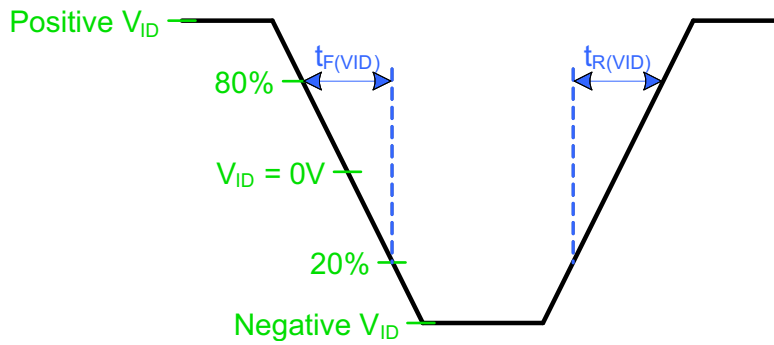


Figure 6. LVDS Rise/Fall Time (Differential Voltage)

### 7.8 Typical Characteristics



Figure 7. Output Rise & Fall times - SLEW = High

Input: channel 2 (green), Output: channel 1 (yellow)  
Figure 8. Total Output Delay



## 8 Parameter Measurement Information

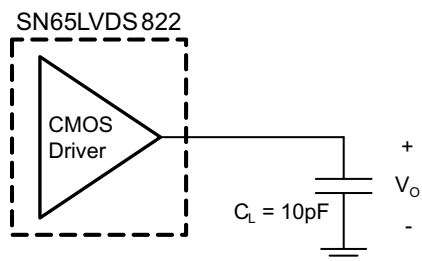


Figure 9. CMOS Output Test Circuit

### 8.1 Test Patterns

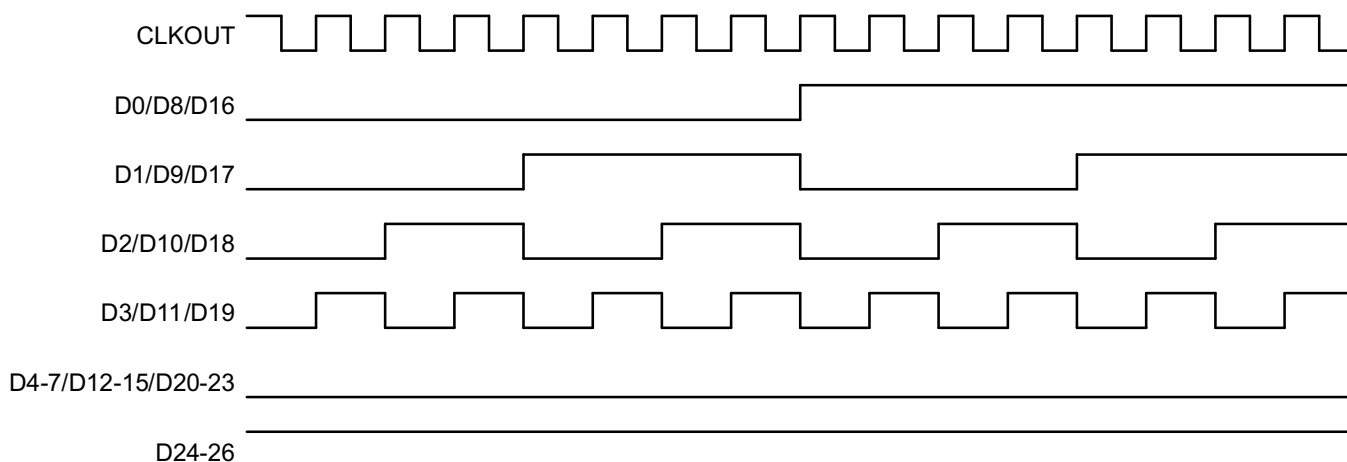
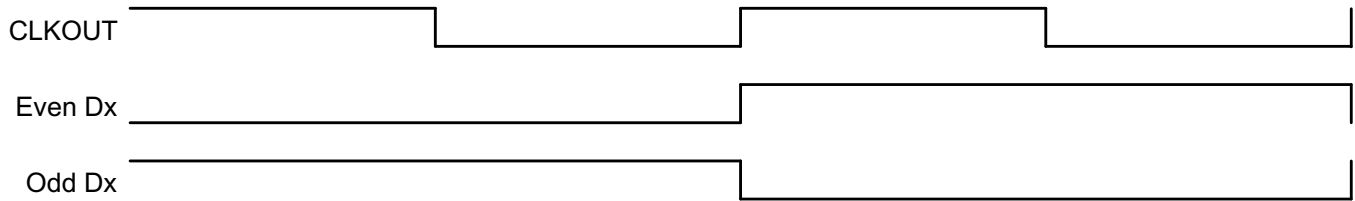


Figure 10. Grayscale Pattern (CLKPOL = Low); Used for Typical Power Data

Table 1. Grayscale Pattern Data; Repeats Every 16 Words

Word	D[26:0]
1	0x7000000
2	0x7080808
3	0x7040404
4	0x70C0C0C
5	0x7020202
6	0x70A0A0A
7	0x7060606
8	0x70E0E0E
9	0x7010101
10	0x7090909
11	0x7050505
12	0x70D0D0D
13	0x7030303
14	0x70B0B0B
15	0x7070707
16	0x70F0F0F



**Figure 11. 1010 Pattern (CLKPOL = Low); Used for Maximum Power Data**

**Table 2. 1010 Pattern Data;  
Repeats Every 2 Words**

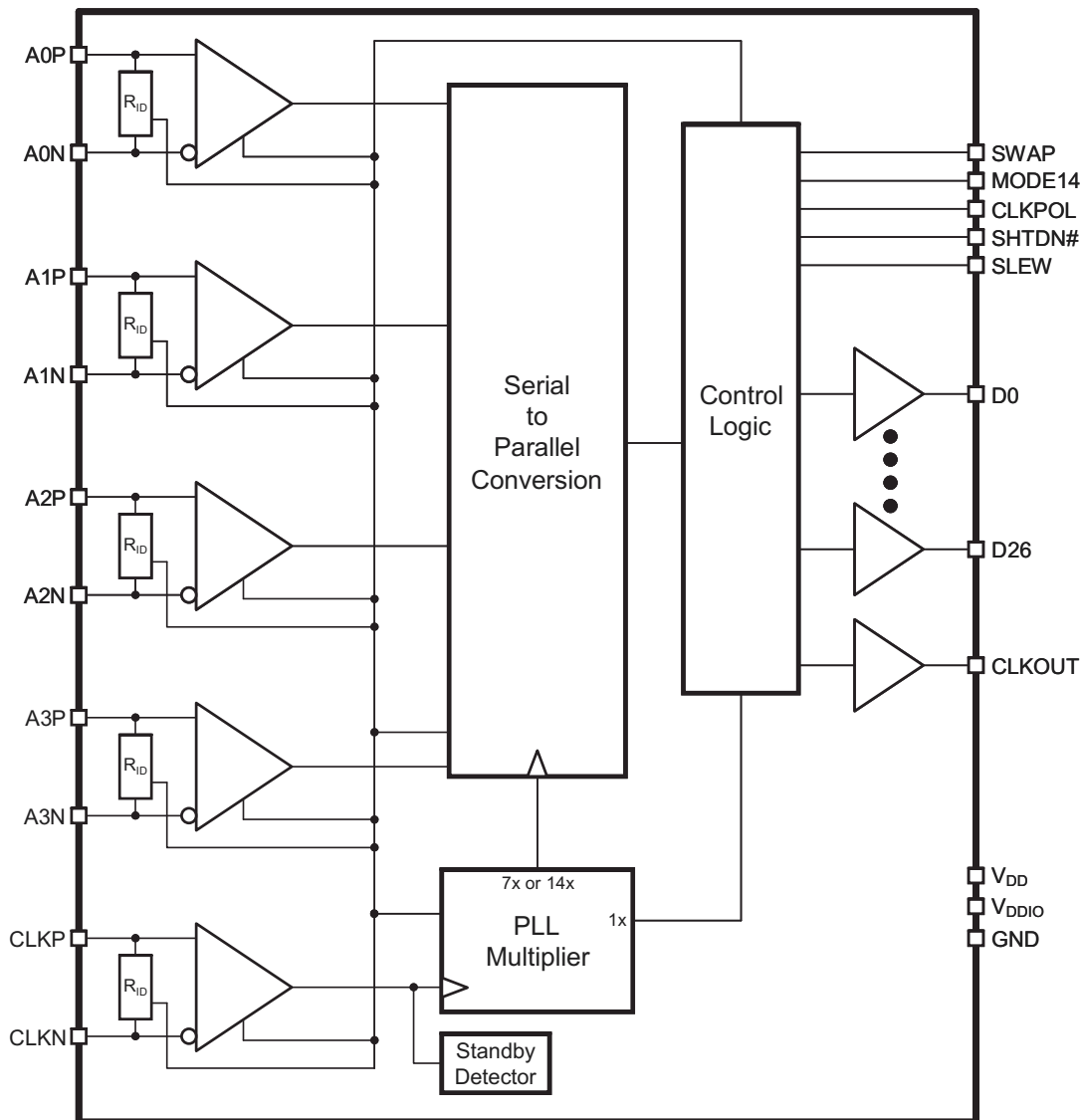
Word	D[26:0]
1	0x2AAAAAA
2	0x5555555

## 9 Detailed Description

### 9.1 Overview

The SN65LVDS822 implements five low-voltage differential signal (LVDS) line receivers: 4 data lanes and 1 clock lane. The clock is internally multiplied by 7 or 14 (depending on pin MODE14), and used for sampling LVDS data. The device operates in either 4-lane 7x mode, or 2-lane 14x mode. Each input lane contains a shift register that converts serial data to parallel. 27 total bits per clock period are deserialized and presented on the CMOS output bus, along with a clock that uses either rising- or falling-edge alignment.

### 9.2 Functional Block Diagram



## 9.3 Feature Description

### 9.3.1 Unused LVDS Data Lanes

When MODE14 = Low and fewer than 4 data lanes are used, or when MODE14 = High and only 1 data lane is used, it's recommended that the unused lanes are biased with a constant differential voltage. This prevents high-frequency noise from toggling the unused receiver, which injects noise into the device. This is not a hard requirement, but it's standard best-practice, and the amount of noise varies system-to-system.

Two implementations are shown below, depending on whether the internal termination  $R_{ID}$  is connected. A reasonable choice for R1 and R2 is 5k $\Omega$ , which produce a nominal  $V_{ID}$  of 34 mV and 0.3 mA of static current. Smaller resistors increase  $V_{ID}$  and noise floor margin, as well as static current.

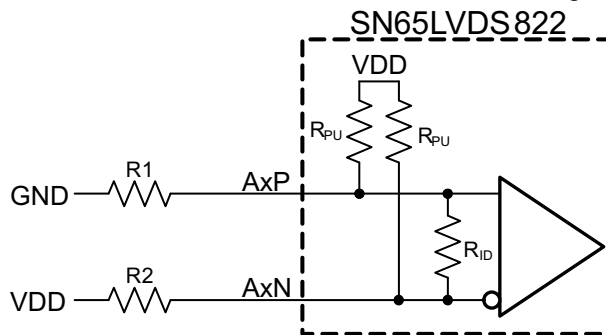


Figure 12. Bias When  $R_{ID}$  is Connected

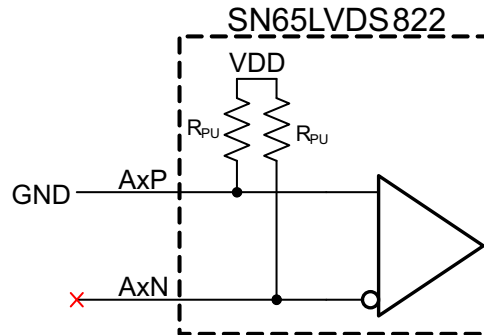


Figure 13. Bias When  $R_{ID}$  is Disconnected

### 9.3.2 Tying CMOS Inputs With Resistors

The  $I_{IH}/I_{IL}$  specifications indicate that 2-state CMOS input pins have an internal pull-down that's a minimum size of 180 k $\Omega$ , and 3-state CMOS input pins have an internal pull-up and pull-down that are a minimum size of 100 k $\Omega$ .

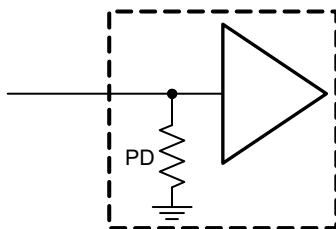


Figure 14. 2-State CMOS Input

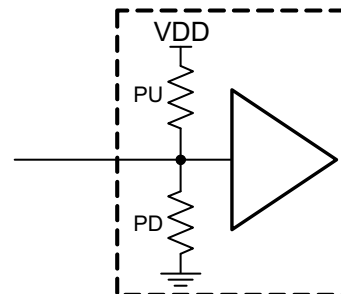


Figure 15. 3-State CMOS Input

CMOS inputs may be directly connected to  $V_{DD}$  or GND, or tied through a resistor. Using a resistor creates a voltage divider network, so it's important to use a small enough resistor to satisfy  $V_{IH}/V_{IL}$  at the pin, and to have voltage margin for system noise. When using a resistor, 5 k $\Omega$  or smaller is recommended. Of course, 3-state inputs may be left unconnected to select their floating pin state.

## 9.4 Device Functional Modes

### 9.4.1 Active Modes

#### 9.4.1.1 4-Lanes 7-Bit Mode

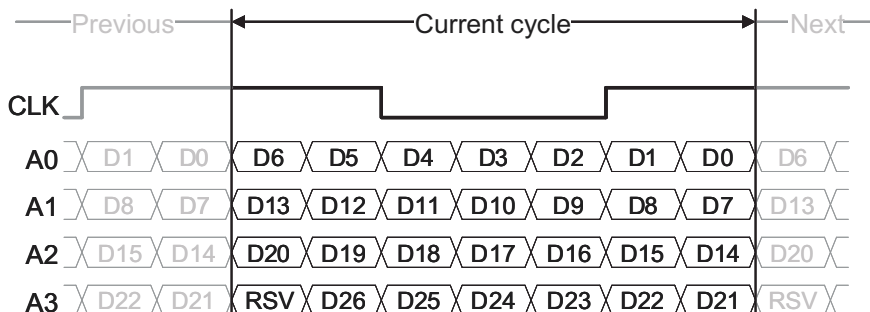


Figure 16. Data Bits Within the LVDS Stream (MODE14 = Low)

#### 9.4.1.2 2-Lanes 14-Bit Mode

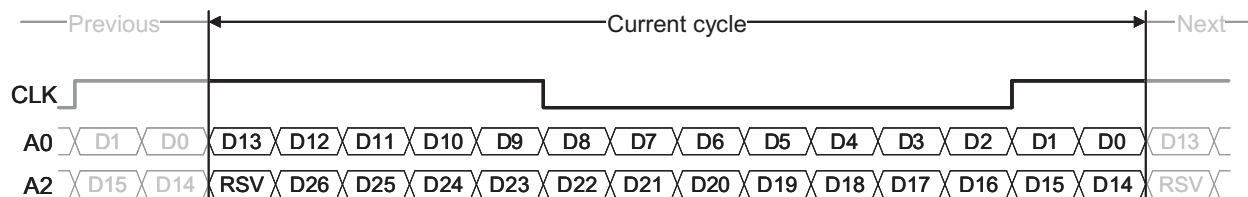


Figure 17. Data Bits Within the LVDS Stream (MODE14 = High)

### 9.4.2 Low-Power Modes

#### 9.4.2.1 Standby Mode

In order to decrease the power consumption, the SN65LVDS822 automatically enters to standby when the LVDS clock is inactive.

#### 9.4.2.2 Shutdown Mode

This is the lower-power mode, and the SN65LVDS822 enters to this mode only when the SHTDN# terminal is tied to low.

#### NOTE

In both low-power modes, all CMOS outputs drive low. All input pins have failsafe protection that prevents damage from occurring before power supply voltages are high and stable.

## 10 Application and Implementation

### NOTE

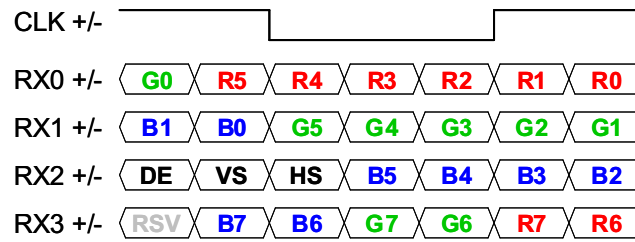
Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

### 10.1 Application Information

#### 10.1.1 Color Bit Mapping

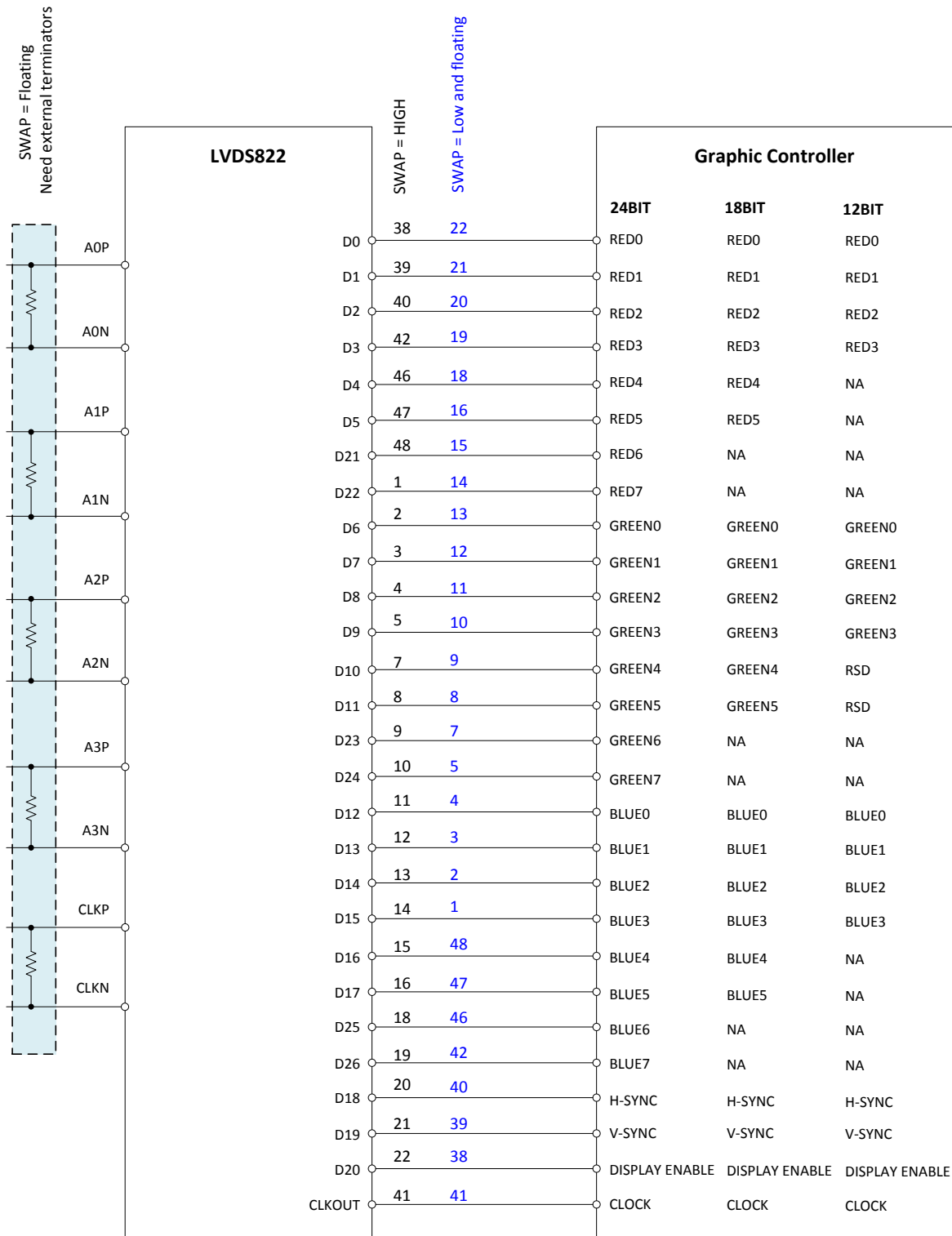
The SN65LVDS822 is a simple deserializer that ignores bit representation in the LVDS stream. The CMOS output pin order was chosen so that if the color mapping within the LVDS stream matches the common VESA standard, the parallel output bus of red/green/blue fans out sequentially, which matches the order that many LCD panels require. Some LCD panels require a reversed order; for those, set pin “SWAP” high to reverse the output bus and simplify PCB routing. [Figure 19](#) shows the application setup when SWAP is in different statuses.

Any color bit mapping is supported, by correctly connecting the output to the panel. However, bit “RSV” is ignored and unavailable for use.



**Figure 18. Common VESA Color Bit Mapping**

Application Information (continued)



NOTE: NA – not applicable, these unused inputs should be left open

Figure 19. Pin Assignments With SWAP

## 10.2 Typical Application

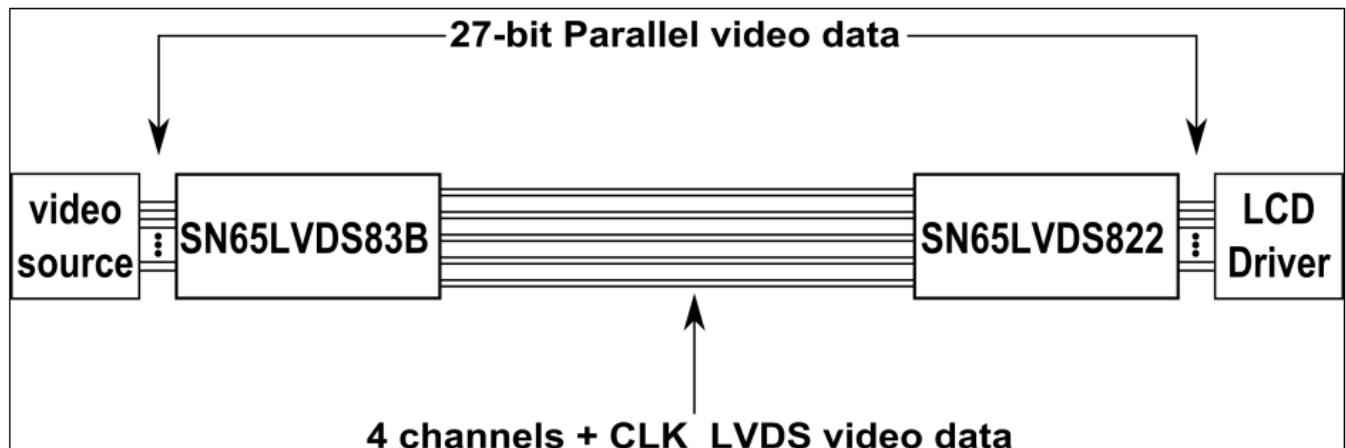


Figure 20. Typical Application

### 10.2.1 Design Requirements

DESIGN PARAMETERS	VALUE
VDD Main Power Supply	3 - 3.6 V
VDDIO Power Supply for CMOS Outputs	1.65 - 3.6 V
Input LVDS Clock Frequency	4 - 54 MHz
RID Differential Input Termination Resistance	80 - 132 $\Omega$
LVDS Input Channels	2 or 4
Output Load Capacitance	1 pF

### 10.2.2 Detailed Design Procedure

#### 10.2.2.1 Power Supply

The implementation operates from the power provided by two banana jack connectors (P1 and P3) common ground. The VDD pin (P1) is connected to the main power supply to the SN65LVDS822 device and must be 3.3 V ( $\pm 10\%$ ). The VDDIO pin (P3) is connected to the power supply of the SN65LVDS822 CMOS outputs and must be in the range of 1.8 to 3.3 V.

#### 10.2.2.2 CMOS Output Bus Connector

*Color Bit Mapping* shows the CMOS output and bit mapping. Because some LCD panels require a reversed order, the SN65LVDS822 device is capable of reversing the output bus and simplifying PCB routing. When the pin is tied to high, the CMOS outputs are in normal order, otherwise the CMOS outputs are in reverse order.

#### 10.2.2.3 Power-Up Sequence

The SN75LVDS822 does not require a specific power up sequence.

It is permitted to power up IOVCC while VCC remains powered down and connected to GND. The input level of the SHTDN during this time does not matter as only the input stage is powered up while all other device blocks are still powered down. It is also permitted to power up all 3.3V power domains while IOVCC is still powered down to GND. The device will not suffer damage. However, in this case, all the I/Os are detected as logic HIGH, regardless of their true input voltage level. Hence, connecting SHTDN to GND will still be interpreted as a logic HIGH; the LVDS output stage will turn on. The power consumption in this condition is significantly higher than standby mode, but still lower than normal mode. The user experience can be impacted by the way a system powers up and powers down an LCD screen. The following sequence is recommended:

Power up sequence (SN75LVDS83B SHTDN input initially low):

1. Ramp up LCD power and SN65LVDS822 (maybe 0.5ms to 10ms) but keep backlight turned off.

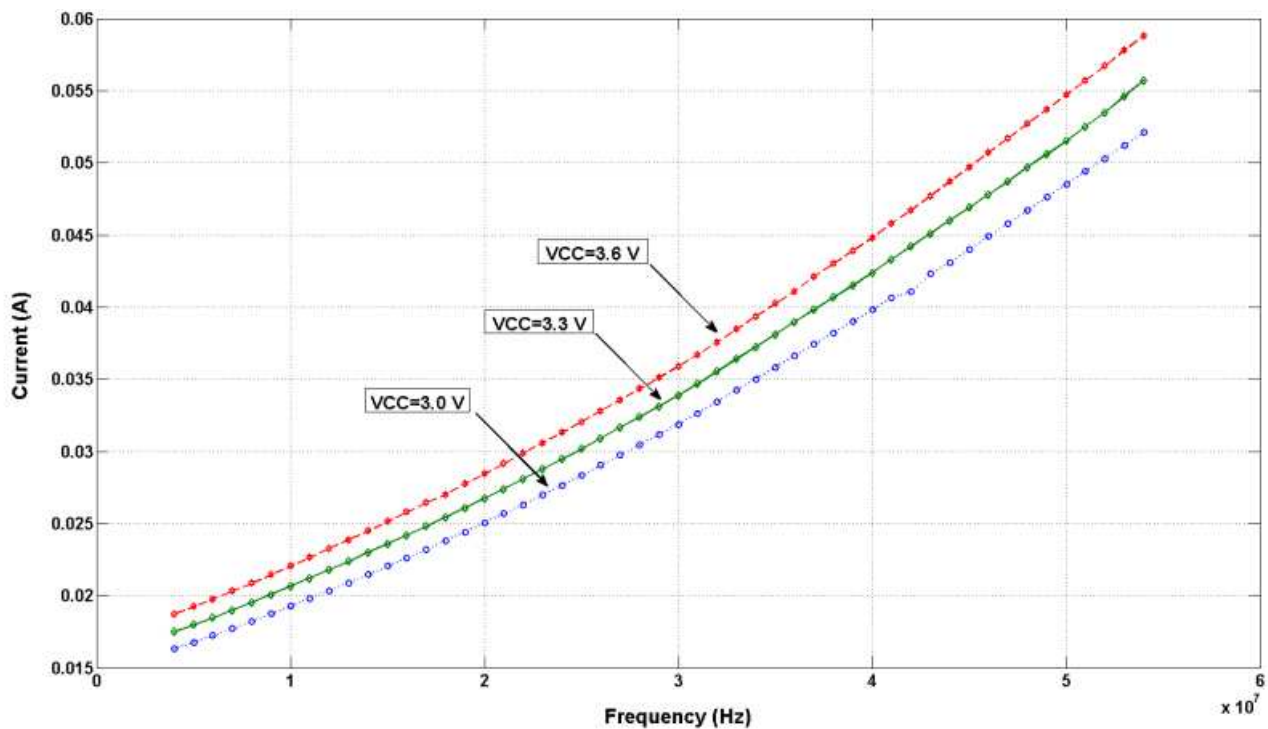


2. Wait for additional 0-200ms to ensure display noise won't occur.
3. Enable video source output; start sending black video data.
4. Toggle LVDS83B shutdown to SHTDN = VIH.
5. Toggle LVDS822 shutdown to SHTDN = VIH.
6. Send > 1 ms of black video data; this allows the LVDS83B to be phase locked, and the display to show black data first.
7. Start sending true image data.
8. Enable backlight.

Power Down sequence (SN75LVDS83B SHTDN input initially high):

1. Disable LCD backlight; wait for the minimum time specified in the LCD data sheet for the backlight to go low.
2. Video source output data switch from active video data to black image data (all visible pixel turn black); drive this for > 2 frame times.
3. Set SN75LVDS83B input SHTDN = GND; wait for 250 ns.
4. Set SN75LVDS822 input SHTDN = GND; wait for 250 ns.
5. Disable the video output of the video source.
6. Remove power from the LCD panel for lowest system power.

### 10.2.3 Application Curve



**Figure 21. Total Current Consumption (VDD & VDDIO)**

## 11 Power Supply Recommendations

### 11.1 Decoupling Capacitor Recommendations

To minimize the power supply noise floor, provide good decoupling near the SN65LVDS822 power pins. It is recommended to place one 0.01- $\mu$ F ceramic capacitor at each power pin, and two 0.1- $\mu$ F ceramic capacitors on each power node. The distance between the SN65LVDS822 and capacitors should be minimized to reduce loop inductance and provide optimal noise filtering. Placing the capacitor underneath the SN65LVDS822 on the bottom of the PCB is often a good choice. A 100-pF ceramic capacitor can be put at each power pin to optimize the EMI performance.

## 12 Layout

### 12.1 Layout Guidelines

Use 45 degree bends (chamfered corners), instead of right-angle (90°) bends. Right-angle bends increase the effective trace width, which changes the differential trace impedance creating large discontinuities. A 45° bends is seen as a smaller discontinuity.

Place passive components within the signal path, such as source-matching resistors or ac-coupling capacitors, next to each other. Routing as in case a) creates wider trace spacing than in b), the resulting discontinuity, however, is limited to a far narrower area.

When routing traces next to a via or between an array of vias, make sure that the via clearance section does not interrupt the path of the return current on the ground plane below.

Avoid metal layers and traces underneath or between the pads off the DisplayPort connectors for better impedance matching. Otherwise they will cause the differential impedance to drop below 75  $\Omega$  and fail the board during TDR testing.

Use solid power and ground planes for 100  $\Omega$  impedance control and minimum power noise.

For a multilayer PCB, it is recommended to keep one common GND layer underneath the device and connect all ground terminals directly to this plane. For 100  $\Omega$  differential impedance, use the smallest trace spacing possible, which is usually specified by the PCB vendor.

Keep the trace length as short as possible to minimize attenuation.

Place bulk capacitors (i.e. 10  $\mu$ F) close to power sources, such as voltage regulators or where the power is supplied to the PCB.

## 12.2 Layout Example

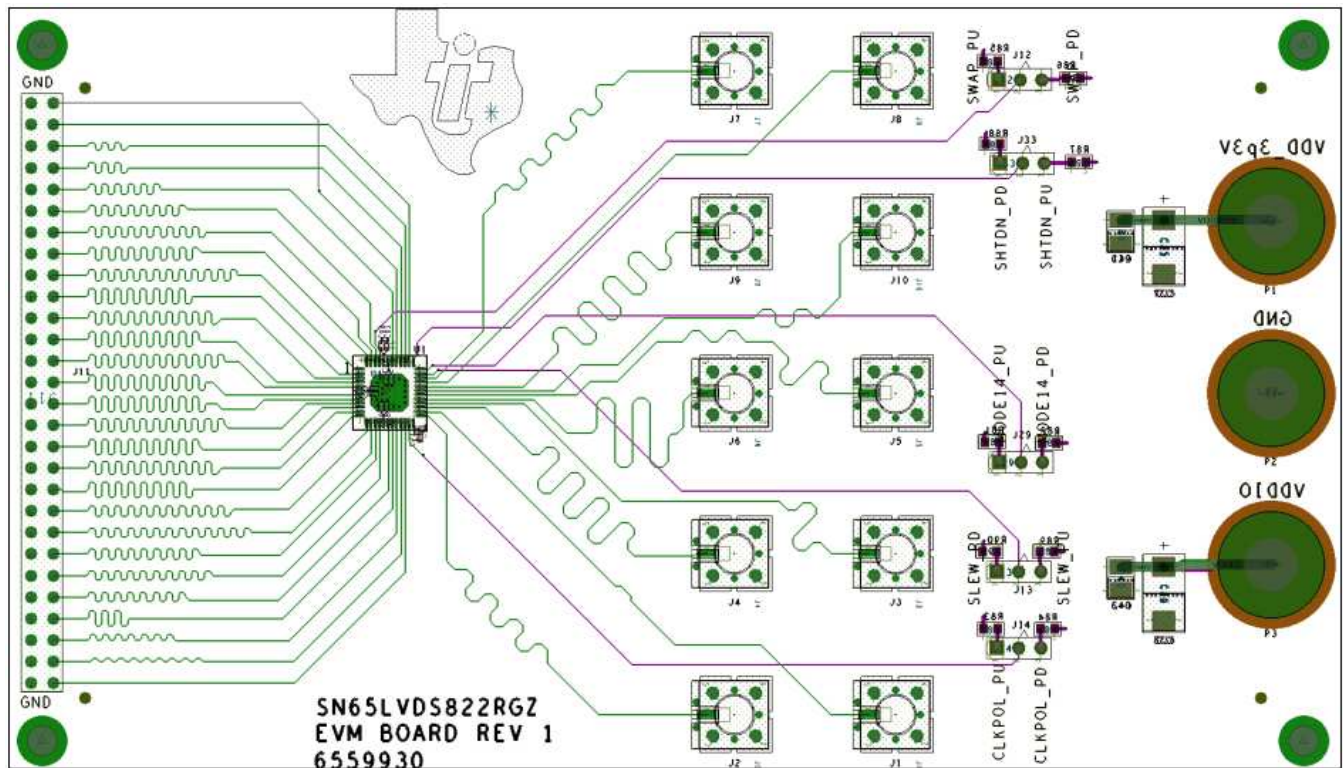


Figure 22. Layout Example

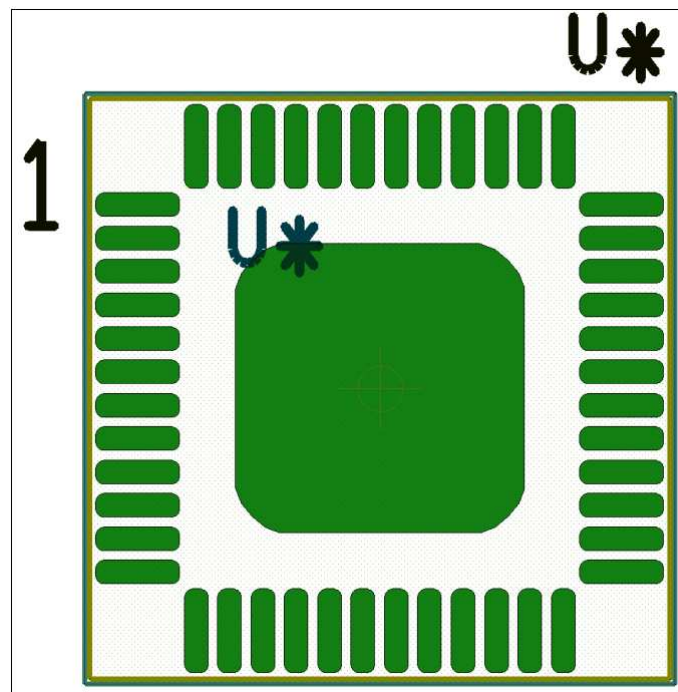


Figure 23. Footprint Example

## 13 Device and Documentation Support

### 13.1 Trademarks

FlatLink is a trademark of Texas Instruments.  
All other trademarks are the property of their respective owners.

### 13.2 Electrostatic Discharge Caution



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.

### 13.3 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

## 14 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
SN65LVDS822RGZR	ACTIVE	VQFN	RGZ	48	2500	Green (RoHS & no Sb/Br)	NIPDAU	Level-3-260C-168 HR	-40 to 85	LVDS822	Samples

(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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device 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 Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

**Important Information and Disclaimer:**The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**TAPE AND REEL INFORMATION**

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**


\*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
SN65LVDS822RGZR	VQFN	RGZ	48	2500	330.0	16.4	7.3	7.3	1.1	12.0	16.0	Q2

**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN65LVDS822RGZR	VQFN	RGZ	48	2500	367.0	367.0	38.0

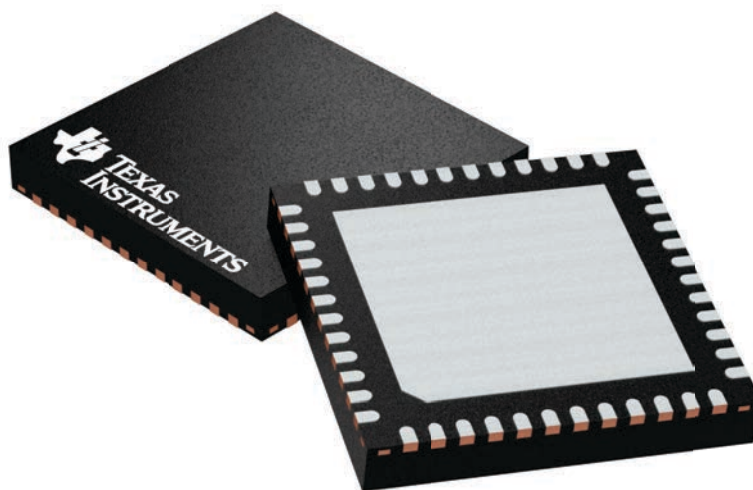
## GENERIC PACKAGE VIEW

**RGZ 48**

**VQFN - 1 mm max height**

7 x 7, 0.5 mm pitch

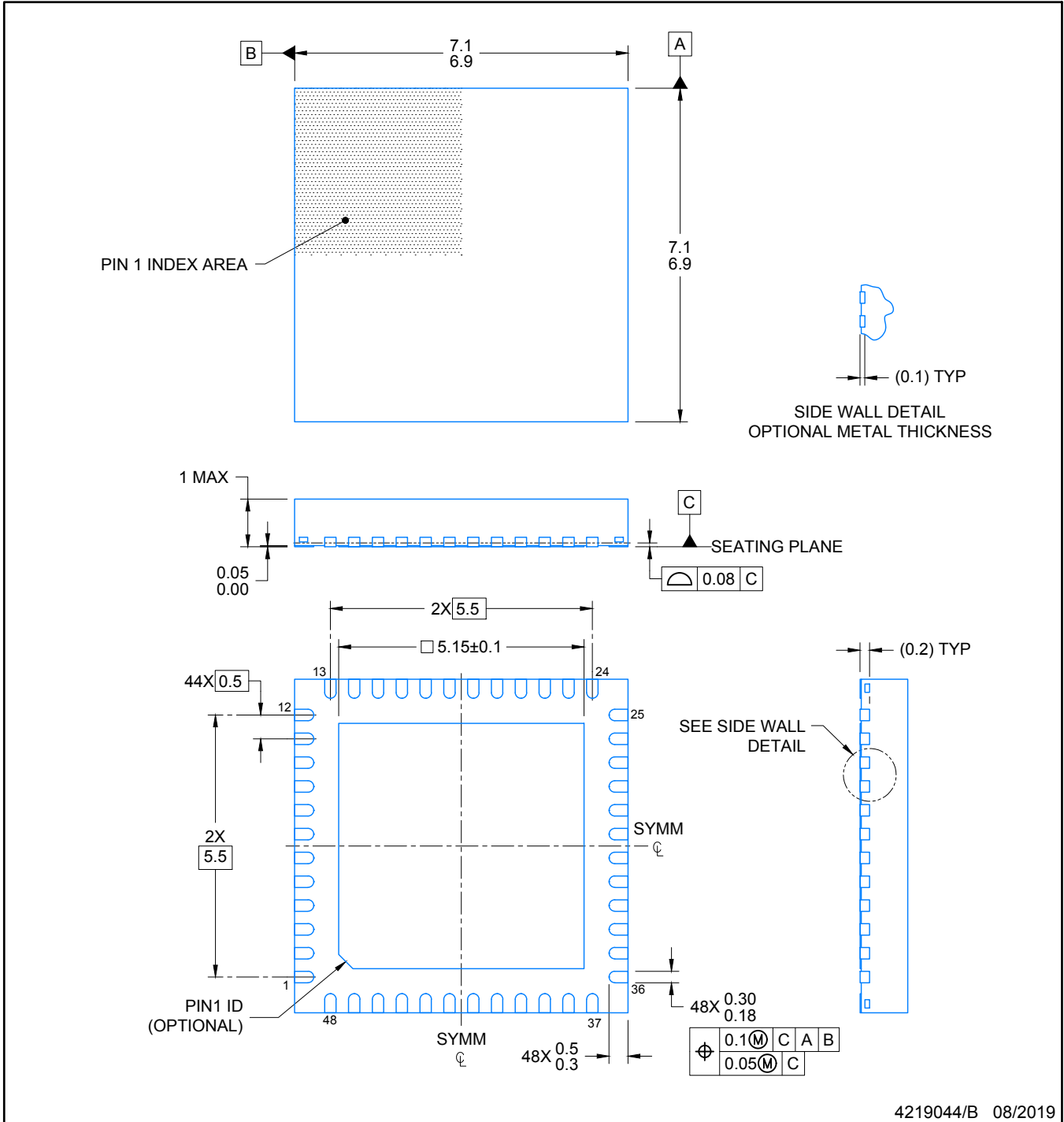
PLASTIC QUADFLAT PACK- NO LEAD



Images above are just a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.

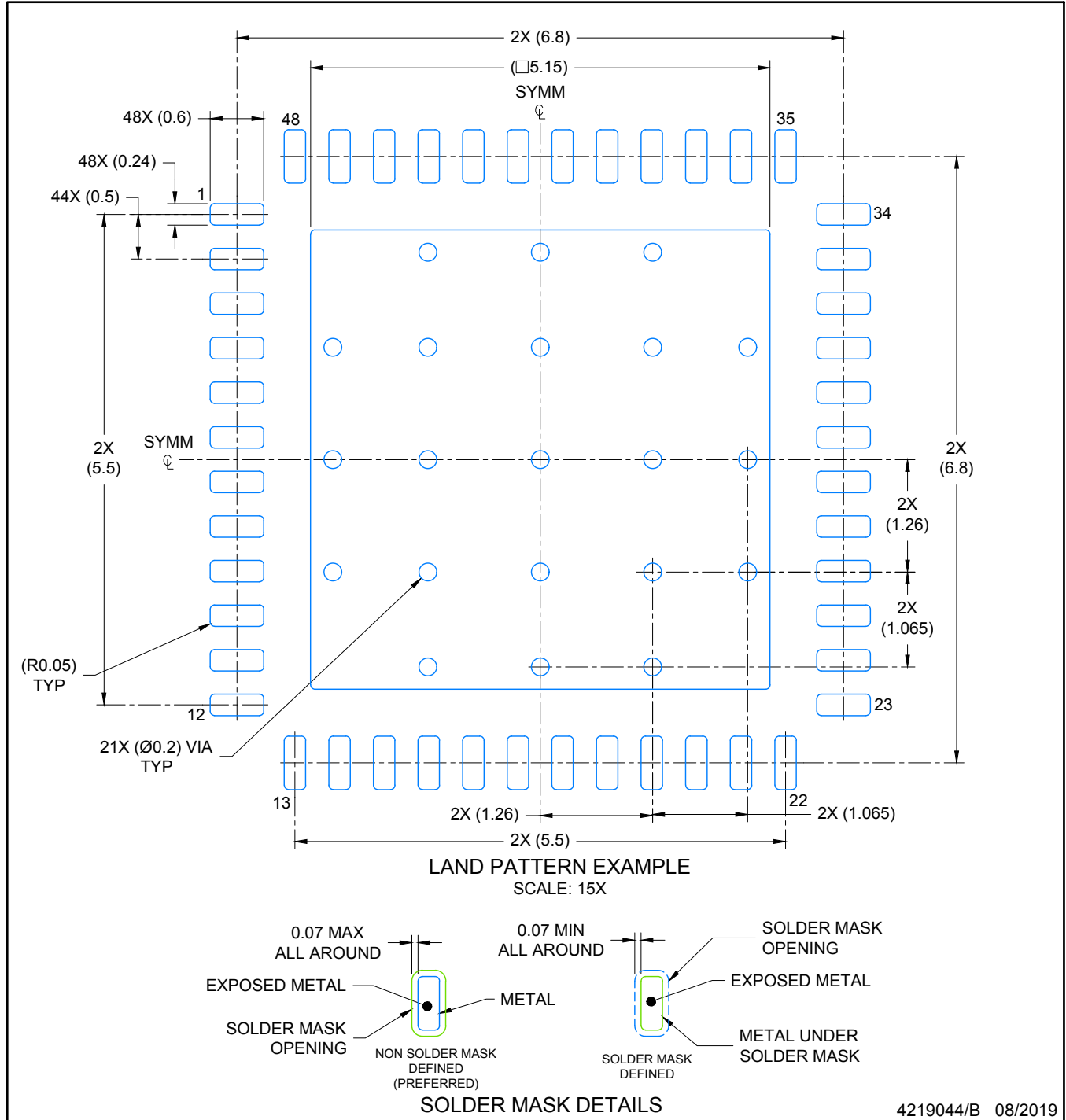
4224671/A





NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for optimal thermal and mechanical performance.



NOTES: (continued)

4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/slua271](http://www.ti.com/lit/slua271)).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.



## IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to TI's Terms of Sale ([www.ti.com/legal/termsofsale.html](http://www.ti.com/legal/termsofsale.html)) or other applicable terms available either on [ti.com](http://ti.com) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2020, Texas Instruments Incorporated