# DS90UR903Q/DS90UR904Q 10 - 43MHz 18 位彩色 FPD-Link II 串行器和解串器

## 1 特性

- 10MHz 至 43MHz 输入并行端口时钟 (PCLK) 支持
- 210Mbps 至 903Mbps 数据吞吐量
- 单个差分对互连
- 具有 DC 平衡编码的嵌入式时钟以支持 AC 耦合互连
- 能够驱动长达 10 米的屏蔽双绞线
- 用于器件配置的 $I^2C$ 兼容串口
- 单个硬件器件寻址引脚
- LOCK（锁定）输出报告引脚以验证链路完整性
- 集成端接电阻器
- 1.8V 或 3.3V 兼容并行总线接口
- 1.8V 单电源
- 符合 ISO 10605 静电放电 (ESD) 以及 IEC 61000-4-2 ESD 标准
- 汽车应用级产品：符合 AEC-Q100 2 级要求
- 温度范围：-40°C 至 +105°C
- 解串器上无需基准时钟
- 可编程接收均衡
- 电磁干扰 (EMI) / 电磁兼容性 (EMC) 迁移
  - DES 可编程展频 (SSCG) 输出
  - DES 接收器交错输出

## 2 应用范围

- 汽车显示系统
  - 中央信息显示屏
  - 导航显示屏
  - 后座娱乐系统

## 3 说明

DS90UR903Q/DS90UR904Q 芯片组提供一个具有高速正向通道的 FPD-Link II 接口，用来实现单一差分对上的数据传输。 此串化器/解串器对针对图形主机控制器与显示模块间的直接连接。 这个芯片组非常适合于将视频数据驱动至要求 18 位色深（RGB666 + HS，VS 和 DE）的显示屏。 此串化器转换一个单个高速串行数据流上的 21 位数据。 这个单个串行数据流通过消除并行数据与时钟路径间的偏差，简化了印刷电路板 (PCB) 走线和电缆上的宽数据总线传输。 这样，通过限制数据路径的宽度，大大节省了系统成本，相应地减少了 PCB 层数、电缆宽度以及连接器尺寸和引脚数量。

解串器输入提供均衡控制来补偿较长距离介质上的损耗。 内部 DC 均衡编码/解码被用来支持 AC 耦合互连。

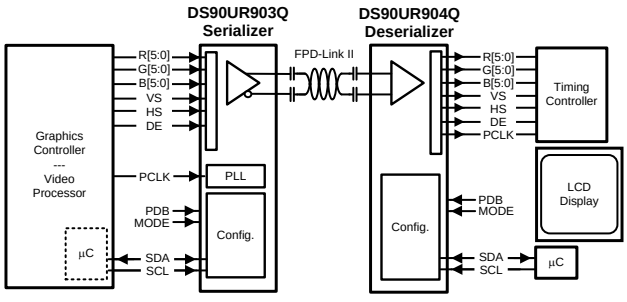
此串化器采用 40 引脚超薄型四方扁平无引线 (WQFN) 封装，而解串器采用 48 引脚 WQFN 封装。

器件信息(1)

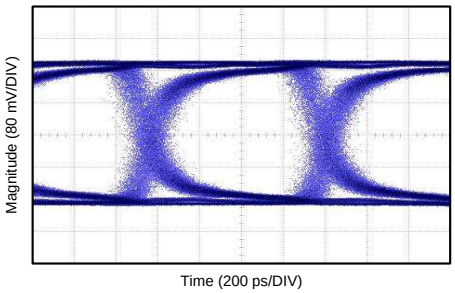
| 部件号 | 封装 | 封装尺寸（标称值） |
|---|---|---|
| DS90UR903Q-Q1 | WQFN RTA (40) | 6.00mm x 6.00mm |
| DS90UR904Q-Q1 | 超薄四方扁平无引线 (WQFN) RHS (48) | 7.00mm x 7.00mm |

(1) 如需了解所有可用封装，请见数据表末尾的可订购产品附录。

简化电路原理图




典型眼图



# 目录

**1** 特性 ... 1
**2** 应用范围 ... 1
**3** 说明 ... 1
**4** 修订历史记录 ... 2
**5** **Pin Configuration and Functions** ... 3
**6** **Specifications** ... 6
6.1 Absolute Maximum Ratings ... 6
6.2 Handling Ratings ... 6
6.3 Recommended Operating Conditions ... 6
6.4 Thermal Information ... 7
6.5 Electrical Characteristics ... 7
6.6 Recommended Serializer Timing for PCLK ... 9
6.7 Serial Control Bus AC Timing Specifications (SCL, SDA) - $I^2C$ Compliant (See Figure 1) ... 10
6.8 Serial Control Bus DC Characteristics (SCL, SDA) - $I^2C$ Compliant ... 11
6.9 Serializer Switching Characteristics ... 15
6.10 Deserializer Switching Characteristics ... 16
6.11 Typical Characteristics ... 17
**7** **Detailed Description** ... 18
7.1 Overview ... 18
7.2 Functional Block Diagram ... 18
7.3 Feature Description ... 19
7.4 Device Functional Modes ... 20
7.5 Programming ... 20
7.6 Register Maps ... 22
**8** **Application and Implementation** ... 26
8.1 Application Information ... 26
8.2 Typical Applications ... 26
**9** **Power Supply Recommendations** ... 31
**10** **Layout** ... 32
10.1 Layout Guidelines ... 32
10.2 Layout Example ... 32
**11** 器件和文档支持 ... 35
11.1 文档支持 ... 35
11.2 相关链接 ... 35
11.3 商标 ... 35
11.4 静电放电警告 ... 35
11.5 术语表 ... 35
**12** 机械封装和可订购信息 ... 35

## 4 修订历史记录

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

**Changes from Revision B (April 2013) to Revision C** — **Page**

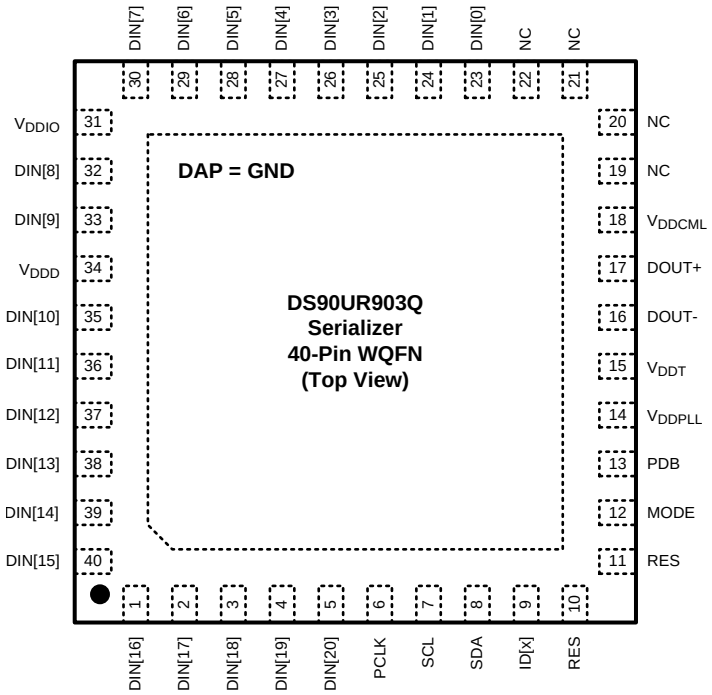
- 已添加 更改了数据表流程和布局以符合全新的 TI 标准。 添加了以下部分：应用和实施；电源相关建议；布局；器件和文档支持；机械、封装和订购信息 ... 1
- Added additional thermal charateristics ... 7
- Changed test condition $V_{in}$ to $V_{ddio}$ ... 7
- Added power up sequencing information and timing diagram. ... 29
- Added application graphics of the serializer CML output. ... 30

**Changes from Revision A (April 2013) to Revision B** — **Page**

- Changed layout of National Data Sheet to TI format ... 30

# 5 Pin Configuration and Functions

**40 Pin Serializer – DS90UR903Q**
**Package RTA**
**Top View**




**DS90UR903Q Serializer Pin Functions**

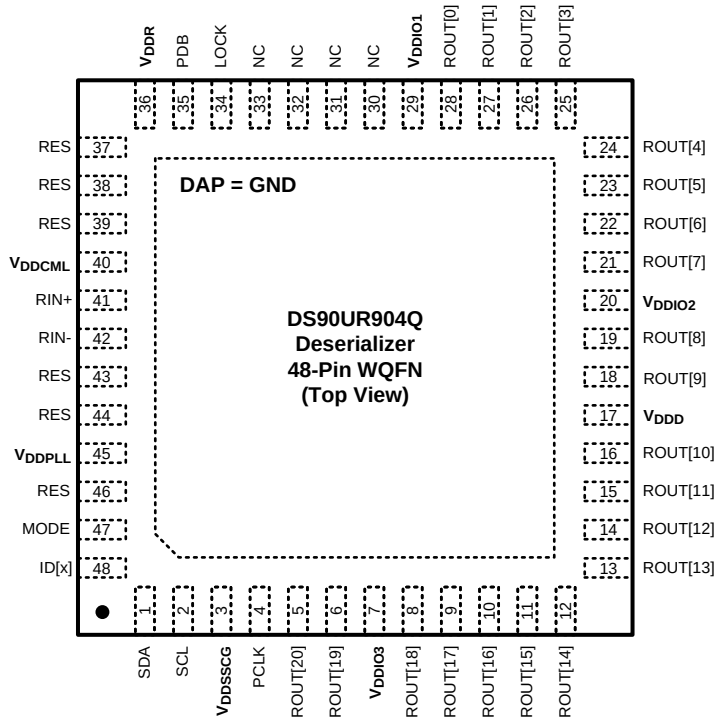
| PIN | | I/O, TYPE | DESCRIPTION |
|---|---|---|---|
| NAME | NUMBER | | |
| **LVCMOS PARALLEL INTERFACE** | | | |
| DIN[20:0] | 5, 4, 3, 2, 1, 40, 39, 38, 37, 36, 35, 33, 32, 30, 29, 28, 27, 26, 25, 24, 23 | Inputs, LVCMOS w/ pull down | Parallel data inputs. |
| PCLK | 6 | Input, LVCMOS w/ pull down | Pixel Clock Input Pin. Strobe edge set by TRFB control register. |
| **SERIAL CONTROL BUS - $I^2C$ COMPATIBLE** | | | |
| SCL | 7 | Input, Open Drain | Clock line for the serial control bus communication<br>SCL requires an external pull-up resistor to $V_{DDIO}$. |
| SDA | 8 | Input/Output, Open Drain | Data line for the serial control bus communication<br>SDA requires an external pull-up resistor to $V_{DDIO}$. |
| MODE | 12 | Input, LVCMOS w/ pull down | $I^2C$ Mode select<br>MODE = H, -**REQUIRED**. The MODE pin must be set HIGH to allow $I^2C$ configuration of the serializer. |
| ID[x] | 9 | Input, analog | Device ID Address Select<br>Resistor to Ground and 10 kΩ pull-up to 1.8V rail. See Table 1 |
| **CONTROL AND CONFIGURATION** | | | |
| PDB | 13 | Input, LVCMOS w/ pull down | Power down Mode Input Pin.<br>PDB = H, Serializer is enabled and is ON.<br>PDB = L, Serailizer is in Power Down mode. When the Serializer is in Power Down, the PLL is shutdown, and IDD is minimized. Programmed control register data are NOT retained and reset to default values |
| RES | 10, 11 | Input, LVCMOS w/ pull down | Reserved.<br>This pin MUST be tied LOW. |
| NC | 22, 21, 20, 19 | | No Connect |

## DS90UR903Q Serializer Pin Functions (continued)

| PIN | | I/O, TYPE | DESCRIPTION |
|---|---|---|---|
| NAME | NUMBER | | |
| **FPD-LINK II INTERFACE** | | | |
| DOUT+ | 17 | Output, CML | Non-inverting differential output. The interconnect must be AC Coupled with a 100 nF capacitor. |
| DOUT- | 16 | Output, CML | Inverting differential output. The interconnect must be AC Coupled with a 100 nF capacitor. |
| **POWER AND GROUND** (1) | | | |
| VDDPLL | 14 | Power, Analog | PLL Power, 1.8V ±5% |
| VDDT | 15 | Power, Analog | Tx Analog Power, 1.8V ±5% |
| VDDCML | 18 | Power, Analog | CML Power, 1.8V ±5% |
| VDDD | 34 | Power, Digital | Digital Power, 1.8V ±5% |
| VDDIO | 31 | Power, Digital | Power for I/O stage. The single-ended inputs and SDA, SCL are powered from $V_{DDIO}$. $V_{DDIO}$ can be connected to a 1.8V ±5% or 3.3V ±10% |
| VSS | DAP | Ground, DAP | DAP must be grounded. DAP is the large metal contact at the bottom side, located at the center of the WQFN package. Connected to the ground plane (GND) with at least 16 vias. |

(1) See Power Up Requirements and PDB PIN.

**48 Pin Deserializer - DS90UR904Q**
**Package RHS**
**Top View**



## DS90UR904Q Deserializer Pin Descriptions

| PIN | | I/O, TYPE | DESCRIPTION |
|---|---|---|---|
| NAME | NUMBER | | |
| **LVCMOS PARALLEL INTERFACE** | | | |
| ROUT[20:0] | 5, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 21, 22, 23, 24, 25, 26, 27, 28 | Outputs, LVCMOS | Parallel data outputs. |
| PCLK | 4 | Output, LVCMOS | Pixel Clock Output Pin.<br>Strobe edge set by RRFB control register. |
| **SERIAL CONTROL BUS - $I^2C$ COMPATIBLE** | | | |
| SCL | 2 | Input, Open Drain | Clock line for the serial control bus communication<br>SCL requires an external pull-up resistor to $V_{DDIO}$. |
| SDA | 1 | Input/Output, Open Drain | Data line for the serial control bus communication<br>SDA requires an external pull-up resistor to $V_{DDIO}$. |
| MODE | 47 | Input, LVCMOS w/ pull up | $I^2C$ Mode select<br>MODE = H -**REQUIRED**. The MODE pin must be set HIGH to allow $I^2C$ configuration of the deserializer. |
| ID[x] | 9 | Input, analog | Device ID Address Select<br>Resistor to Ground and 10 kΩ pull-up to 1.8V rail. See Table 2 |
| **CONTROL AND CONFIGURATION** | | | |
| PDB | 35 | Input, LVCMOS w/ pull down | Power down Mode Input Pin.<br>PDB = H, Deserializer is enabled and is ON.<br>PDB = L, Deserializer is in Power Down mode. When the Deserializer is in Power Down. Programmed control register data are NOT retained and reset to default values. |
| LOCK | 34 | Output, LVCMOS | LOCK Status Output Pin.<br>LOCK = H, PLL is Locked, outputs are active<br>LOCK = L, PLL is unlocked, ROUT and PCLK output states are controlled by OSS_SEL control register. May be used as Link Status. |
| RES | 37, 38, 39, 43, 44, 46 | - | Reserved.<br>Pin 46: This pin MUST be tied LOW.<br>Pin 37, 43, 44: Leave pin open.<br>Pins 38, 39: Route to test point or leave open if unused. |
| NC | 30, 31, 32, 33 | | No Connect |
| **FPD-LINK II INTERFACE** | | | |
| RIN+ | 41 | Input, CML | Noninverting differential input. The interconnect must be AC Coupled with a 100 nF capacitor. |
| RIN- | 42 | Inputt, CML | Inverting differential input. The interconnect must be AC Coupled with a 100 nF capacitor. |
| **POWER AND GROUND (1)** | | | |
| VDDSSCG | 3 | Power, Digital | SSCG Power, 1.8V ±5%<br>Power supply must be connected regardless if SSCG function is in operation. |
| VDDIO1/2/3 | 29, 20, 7 | Power, Digital | LVCMOS I/O Buffer Power, The single-ended outputs and control input are powered from $V_{DDIO}$. $V_{DDIO}$ can be connected to a 1.8V ±5% or 3.3V ±10% |
| VDDD | 17 | Power, Digital | Digital Core Power, 1.8V ±5% |
| VDDR | 36 | Power, Analog | Rx Analog Power, 1.8V ±5% |
| VDDCML | 40 | Power, Analog | 1.8V ±5% |
| VDDPLL | 45 | Power, Analog | PLL Power, 1.8V ±5% |
| VSS | DAP | Ground, DAP | DAP must be grounded. DAP is the large metal contact at the bottom side, located at the center of the WQFN package. Connected to the ground plane (GND) with at least 16 vias. |

(1) See Power Up Requirements and PDB PIN.

# 6 Specifications

## 6.1 Absolute Maximum Ratings (1) (2)

| PARAMETER | MIN | MAX | UNIT |
|---|---|---|---|
| Supply Voltage – $V_{DDn}$ (1.8V) | −0.3 | +2.5 | V |
| Supply Voltage – $V_{DDIO}$ | −0.3 | +4.0V | V |
| LVCMOS Input Voltage I/O Voltage | −0.3 | (VDDIO + 0.3V) | V |
| CML Driver I/O Voltage ($V_{DD}$) | −0.3 | ($V_{DD}$ + 0.3V) | V |
| CML Receiver I/O Voltage ($V_{DD}$) | −0.3 | ($V_{DD}$ + 0.3V) | V |
| Junction Temperature | | +150 | °C |
| Maximum Package Power Dissipation Capacity | | $1/\theta_{JA}$ above +25° | °C/W |

(1) "Absolute Maximum Ratings" indicate limits beyond which damage to the device may occur, including inoperability and degradation of device reliability and/or performance. Functional operation of the device and/or non-degradation at the Absolute Maximum Ratings or other conditions beyond those indicated in the Recommended Operating Conditions is not implied. The Recommended Operating Conditions indicate conditions at which the device is functional; the device should not be operated beyond such conditions.
(2) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/ Distributors for availability and specifications.

## 6.2 Handling Ratings

| | | | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| $T_{stg}$ | Storage temperature range | | –65 | 150 | °C |
| $V_{(ESD)}$ | Electrostatic discharge | Human body model (HBM), per AEC Q100-002 (1) | -8 | +8 | kV |
| | | Charged device model (CDM), per AEC Q100-011 | -1 | +1 | |
| | | Machine Model (MM) | -250 | +250 | V |
| ESD Rating (IEC 61000-4-2)<br>$R_D$ = 330Ω, $C_S$ = 150pF | | Air Discharge<br>(DOUT+, DOUT-, RIN+, RIN-) | -25 | +25 | kV |
| | | Contact Discharge<br>(DOUT+, DOUT-, RIN+, RIN-) | -10 | +10 | |
| ESD Rating (ISO10605)<br>$R_D$ = 330Ω, $C_S$ = 150/330pF<br>$R_D$ = 2KΩ, $C_S$ = 150/330pF | | Air Discharge<br>(DOUT+, DOUT-, RIN+, RIN-) | -15 | +15 | |
| | | Contact Discharge<br>(DOUT+, DOUT-, RIN+, RIN-) | -10 | +10 | |

(1) AEC Q100-002 indicates HBM stressing is done in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

## 6.3 Recommended Operating Conditions

| | | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|
| Supply Voltage ($V_{DDn}$) | | 1.71 | 1.8 | 1.89 | V |
| LVCMOS Supply Voltage ($V_{DDIO}$) (1.8V) | | 1.71 | 1.8 | 1.89 | V |
| LVCMOS Supply Voltage ($V_{DDIO}$) (3.3V) | | 3.0 | 3.3 | 3.6 | V |
| Supply Noise | $V_{DDn}$ (1.8V) | | | 25 | mVp-p |
| | $V_{DDIO}$ (1.8V) | | | 25 | mVp-p |
| | $V_{DDIO}$ (3.3V) | | | 50 | mVp-p |
| Operating Free Air Temperature ($T_A$) | | -40 | +25 | +105 | °C |
| PCLK Clock Frequency | | 10 | | 43 | MHz |

## 6.4 Thermal Information(1)

| THERMAL METRIC(2) | | DS90UR903Q 40L WQFN | DS90UR904Q 48L WQFN | UNIT |
|---|---|---|---|---|
| | | RTA | RHS | |
| | | 40 PINS | 48 PINS | |
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 31.9 | 30.0 | °C/W |
| $R_{\theta JC(top)}$ | Junction-to-case (top) thermal resistance | 18.5 | 11.1 | |
| $R_{\theta JB}$ | Junction-to-board thermal resistance | 8.1 | 6.9 | |
| $\psi_{JT}$ | Junction-to-top characterization parameter | 0.3 | 0.1 | |
| $\psi_{JB}$ | Junction-to-board characterization parameter | 8.1 | 6.9 | |
| $R_{\theta JC(bot)}$ | Junction-to-case (bottom) thermal resistance | 3.5 | 2.4 | |

(1) For soldering specifications, see SNOA549
(2) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, SPRA953.

## 6.5 Electrical Characteristics(1) (2) (3)

Over recommended operating supply and temperature ranges unless otherwise specified.

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **LVCMOS DC SPECIFICATIONS 3.3V I/O (SER INPUTS, DES OUTPUTS, CONTROL INPUTS AND OUTPUTS)** | | | | | | |
| $V_{IH}$ | High Level Input Voltage | $V_{DDIO}$ = 3.0V to 3.6V | 2.0 | | $V_{DDIO}$ | V |
| $V_{IL}$ | Low Level Input Voltage | $V_{DDIO}$ = 3.0V to 3.6V | GND | | 0.8 | V |
| $I_{IN}$ | Input Current | $V_{IN}$ = 0V or 3.6V<br>$V_{DDIO}$ = 3.0V to 3.6V | -20 | ±1 | +20 | µA |
| $V_{OH}$ | High Level Output Voltage | $V_{DDIO}$ = 3.0V to 3.6V<br>$I_{OH}$ = -4 mA | 2.4 | | $V_{DDIO}$ | V |
| $V_{OL}$ | Low Level Output Voltage | $V_{DDIO}$ = 3.0V to 3.6V<br>$I_{OL}$ = +4 mA | GND | | 0.4 | V |
| $I_{OS}$ | Output Short Circuit Current | $V_{OUT}$ = 0V | | -39 | | mA |
| $I_{OZ}$ | TRI-STATE Output Current | PDB = 0V,<br>$V_{OUT}$ = 0V or $V_{DD}$ | -20 | ±1 | +20 | µA |
| **LVCMOS DC SPECIFICATIONS 1.8V I/O (SER INPUTS, DES OUTPUTS, CONTROL INPUTS AND OUTPUTS)** | | | | | | |
| $V_{IH}$ | High Level Input Voltage | $V_{DDIO}$ = 1.71V to 1.89V | 0.65 $V_{DDIO}$ | | $V_{DDIO}$ +0.3 | V |
| $V_{IL}$ | Low Level Input Voltage | $V_{DDIO}$ = 1.71V to 1.89V | GND | | 0.35 $V_{DDIO}$ | V |
| $I_{IN}$ | Input Current | $V_{IN}$ = 0V or 1.89V<br>$V_{DDIO}$ = 1.71V to 1.89V | -20 | ±1 | +20 | µA |
| $V_{OH}$ | High Level Output Voltage | $V_{DDIO}$ = 1.71V to 1.89V<br>$I_{OH}$ = −4 mA | $V_{DDIO}$ - 0.45 | | $V_{DDIO}$ | V |
| $V_{OL}$ | Low Level Output Voltage | $V_{DDIO}$ = 1.71V to 1.89V<br>$I_{OL}$ = +4 mA | GND | | 0.45 | V |
| $I_{OS}$ | Output Short Circuit Current | $V_{OUT}$ = 0V | | -20 | | mA |
| $I_{OZ}$ | TRI-STATE Output Current | PDB = 0V,<br>$V_{OUT}$ = 0V or $V_{DD}$ | -20 | ±1 | +20 | µA |

(1) The Electrical Characteristics tables list ensured specifications under the listed Recommended Operating Conditions except as otherwise modified or specified by the Electrical Characteristics Conditions and/or Notes. Typical specifications are estimations only and are not ensured.
(2) Current into device pins is defined as positive. Current out of a device pin is defined as negative. Voltages are referenced to ground except VOD, ΔVOD, VTH and VTL which are differential voltages.
(3) Typical values represent most likely parametric norms at 1.8V or 3.3V, $T_A$ = +25°C, and at the Recommended Operation Conditions at the time of product characterization and are not ensured.

## Electrical Characteristics[1] [2] [3] (continued)

Over recommended operating supply and temperature ranges unless otherwise specified.

| PARAMETER | | TEST CONDITIONS | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| **CML DRIVER DC SPECIFICATIONS (DOUT+, DOUT-)** | | | | | | | |
| $\|V_{OD}\|$ | Output Differential Voltage | $R_T$ = 100Ω, Figure 5 | | 268 | 340 | 412 | mV |
| $\Delta V_{OD}$ | Output Differential Voltage Unbalance | $R_L$ = 100Ω | | | 1 | 50 | mV |
| $V_{OS}$ | Output Differential Offset Voltage | $R_L$ = 100Ω Figure 5 | | $V_{DD\ (MIN)}$ - $V_{OD\ (MAX)}$ | $V_{DD}$ - $V_{OD}$ | $V_{DD\ (MAX)}$ - $V_{OD\ (MIN)}$ | V |
| $\Delta V_{OS}$ | Offset Voltage Unbalance | $R_L$ = 100Ω | | | 1 | 50 | mV |
| $I_{OS}$ | Output Short Circuit Current | DOUT+/- = 0V | | | -27 | | mA |
| $R_T$ | Differential Internal Termination Resistance | Differential across DOUT+ and DOUT- | | 80 | 100 | 120 | Ω |
| **CML RECEIVER DC SPECIFICATIONS (RIN+, RIN-)** | | | | | | | |
| $V_{TH}$ | Differential Threshold High Voltage | Figure 7 | | | | +90 | mV |
| $V_{TL}$ | Differential Threshold Low Voltage | | | -90 | | | |
| $V_{IN}$ | Differential Input Voltage Range | RIN+ - RIN- | | 180 | | | mV |
| $I_{IN}$ | Input Current | $V_{IN}$ = $V_{DD}$ or 0V, $V_{DD}$ = 1.89V | | -20 | ±1 | +20 | µA |
| $R_T$ | Differential Internal Termination Resistance | Differential across RIN+ and RIN- | | 80 | 100 | 120 | Ω |
| **SER/DES SUPPLY CURRENT *DIGITAL, PLL, AND ANALOG VDD** | | | | | | | |
| $I_{DDT}$ | Serializer (Tx) VDDn Supply Current (includes load current) | $R_T$ = 100Ω WORST CASE pattern Figure 2 | VDDn = 1.89V PCLK = 43 MHz Default Registers | | 62 | 90 | mA |
| | | $R_T$ = 100Ω RANDOM PRBS-7 pattern | | | 55 | | |
| $I_{DDIOT}$ | Serializer (Tx) VDDIO Supply Current (includes load current) | $R_T$ = 100Ω WORST CASE pattern Figure 2 | VDDIO = 1.89V PCLK = 43 MHz Default Registers | | 2 | 5 | mA |
| | | | VDDIO = 3.6V PCLK = 43 MHz Default Registers | | 7 | 15 | |
| $I_{DDTZ}$ | Serializer (Tx) Supply Current Power-down | PDB = 0V; All other LVCMOS Inputs = 0V | $V_{DDn}$ = 1.89V | | 370 | 775 | µA |
| $I_{DDIOTZ}$ | | | $V_{DDIO}$ = 1.89V | | 55 | 125 | |
| | | | $V_{DDIO}$ = 3.6V | | 65 | 135 | |

## Electrical Characteristics[1] [2] [3] (continued)

Over recommended operating supply and temperature ranges unless otherwise specified.

| PARAMETER | | TEST CONDITIONS | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| $I_{DDR}$ | Deserializer (Rx) VDDn Supply Current (includes load current) | $V_{DDn}$ = 1.89V<br>$C_L$ = 8 pF<br>WORST CASE Pattern<br>Figure 2 | PCLK = 43 MHz<br>SSCG[3:0] = ON<br>Default Registers | | 60 | 96 | mA |
| | | $V_{DDn}$ = 1.89V<br>$C_L$ = 8 pF<br>RANDOM PRBS-7 Pattern | PCLK = 43 MHz<br>Default Registers | | 53 | | |
| $I_{DDIOR}$ | Deserializer (Rx) VDDIO Supply Current (includes load current) | $V_{DDIO}$ = 1.89V<br>$C_L$ = 8 pF<br>WORST CASE Pattern<br>Figure 2 | PCLK = 43 MHz<br>Default Registers | | 21 | 32 | |
| | | $V_{DDIO}$ = 3.6V<br>$C_L$ = 8 pF<br>WORST CASE Pattern | PCLK = 43 MHz<br>Default Registers | | 49 | 83 | |
| $I_{DDRZ}$ | Deserializer (Rx) Supply Current Power-down | PDB = 0V; All other LVCMOS Inputs = 0V | $V_{DDn}$ = 1.89V | | 42 | 400 | µA |
| $I_{DDIORZ}$ | | | $V_{DDIO}$ = 1.89V | | 8 | 40 | |
| | | | $V_{DDIO}$ = 3.6V | | 350 | 800 | |

## 6.6 Recommended Serializer Timing for PCLK[1]

Over recommended operating supply and temperature ranges unless otherwise specified.

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $t_{TCP}$ | Transmit Clock Period | 10 MHz – 43 MHz | 23.3 | T | 100 | ns |
| $t_{TCIH}$ | Transmit Clock Input High Time | | 0.4T | 0.5T | 0.6T | ns |
| $t_{TCIL}$ | Transmit Clock Input Low Time | | 0.4T | 0.5T | 0.6T | ns |
| $t_{CLKT}$ | PCLK Input Transition Time<br>Figure 8 | | 0.5 | | 3 | ns |
| $f_{OSC}$ | Internal oscillator clock source | | | 25 | | MHz |

(1) Recommended Input Timing Requirements are input specifications and not tested in production.

## 6.7 Serial Control Bus AC Timing Specifications (SCL, SDA) - I²C Compliant (See Figure 1)

Over recommended supply and temperature ranges unless otherwise specified.

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **RECOMMENDED INPUT TIMING REQUIREMENTS (1)** | | | | | | |
| $f_{SCL}$ | SCL Clock Frequency | | >0 | | 100 | kHz |
| $t_{LOW}$ | SCL Low Period | $f_{SCL}$ = 100 kHz | 4.7 | | | µs |
| $t_{HIGH}$ | SCL High Period | | 4.0 | | | µs |
| $t_{HD:STA}$ | Hold time for a start or a repeated start condition | | 4.0 | | | µs |
| $t_{SU:STA}$ | Set Up time for a start or a repeated start condition | | 4.7 | | | µs |
| $t_{HD:DAT}$ | Data Hold Time | | 0 | | 3.45 | µs |
| $t_{SU:DAT}$ | Data Set Up Time | | 250 | | | ns |
| $t_{SU:STO}$ | Set Up Time for STOP Condition | | 4.0 | | | µs |
| $t_r$ | SCL & SDA Rise Time | | | | 1000 | ns |
| $t_f$ | SCL & SDA Fall Time | | | | 300 | ns |
| $C_b$ | Capacitive load for bus | | | | 400 | pF |
| **SWITCHING CHARACTERISTICS (2)** | | | | | | |
| $t_{HD:DAT}$ | Data Hold Time | | 0 | | 3.45 | µs |
| $t_{SU:DAT}$ | Data Set Up Time | | 250 | | | ns |
| $t_f$ | SCL & SDA Fall Time | | | | 300 | ns |

(1) Recommended Input Timing Requirements are input specifications and not tested in production.
(2) Specification is ensured by design.

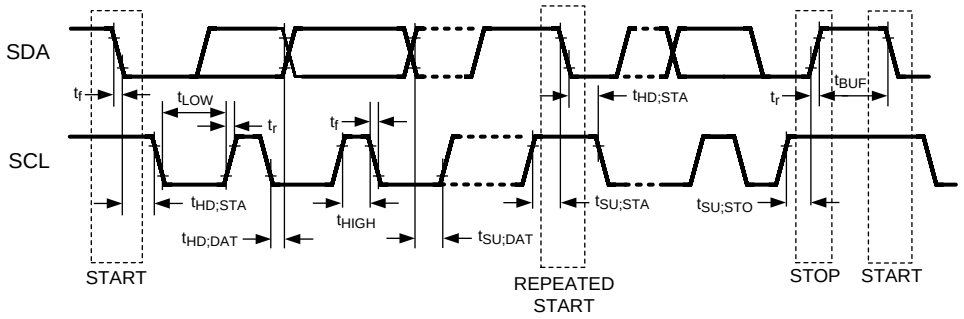



**Figure 1. Serial Control Bus Timing**

## 6.8 Serial Control Bus DC Characteristics (SCL, SDA) - I²C Compliant

Over recommended supply and temperature ranges unless otherwise specified.

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{IH}$ | Input High Level | SDA and SCL | 0.7 x $V_{DDIO}$ | | $V_{DDIO}$ | V |
| $V_{IL}$ | Input Low Level Voltage | SDA and SCL | GND | | 0.3 x $V_{DDIO}$ | V |
| $V_{HY}$ | Input Hysteresis | SDA and SCL | | >50 | | mV |
| $I_{OZ}$ | TRI-STATE Output Current | PDB = 0V<br>$V_{OUT}$ = 0V or $V_{DD}$ | -20 | ±1 | +20 | µA |
| $I_{IN}$ | Input Current | SDA or SCL,<br>Vin = $V_{DDIO}$ or GND | -20 | ±1 | +20 | µA |
| $C_{IN}$ | Input Pin Capacitance | | | <5 | | pF |
| $V_{OL}$ | Low Level Output Voltage | SCL and SDA<br>$V_{DDIO}$ = 3.0V<br>$I_{OL}$ = 1.5mA | | | 0.36 | V |
| | | SCL and SDA<br>$V_{DDIO}$ = 1.71V<br>$I_{OL}$ = 1mA | | | 0.36 | V |

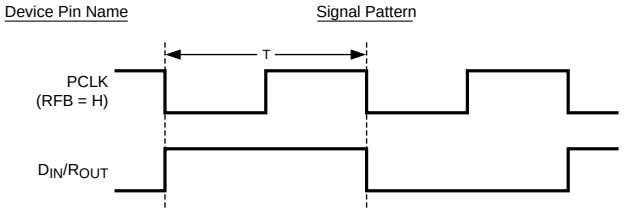



**Figure 2. "Worst Case" Test Pattern**

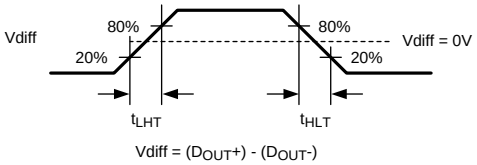



**Figure 3. Serializer CML Output Load and Transition Times**

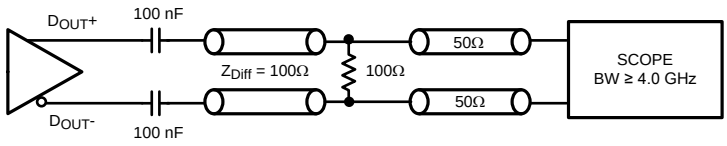



**Figure 4. Serializer CML Output Load and Transition Times**

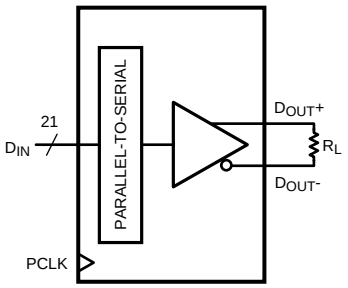



**Figure 5. Serializer VOD DC Diagram**

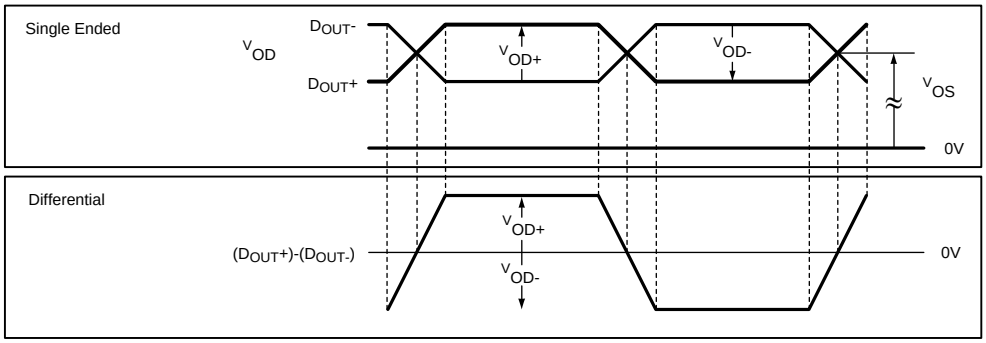



**Figure 6. Serializer VOD DC Diagram**

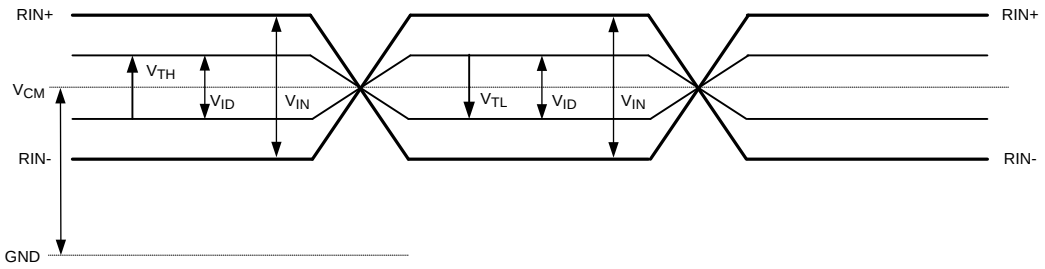



**Figure 7. Differential VTH/VTL Definition Diagram**

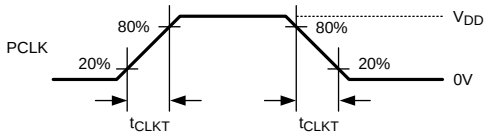



**Figure 8. Serializer Input Clock Transition Times**

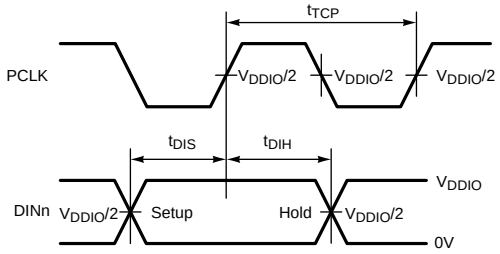



**Figure 9. Serializer Setup/Hold Times**

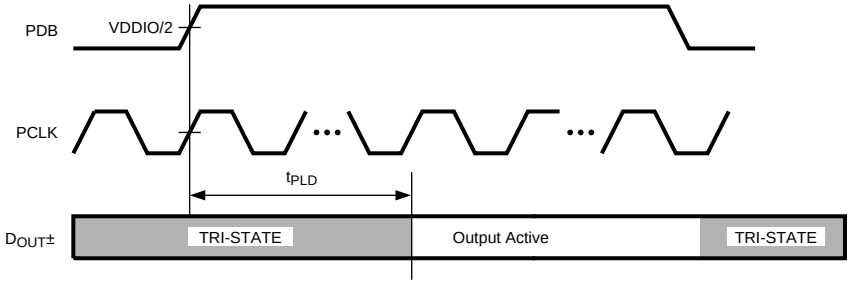



**Figure 10. Serializer Data Lock Time**

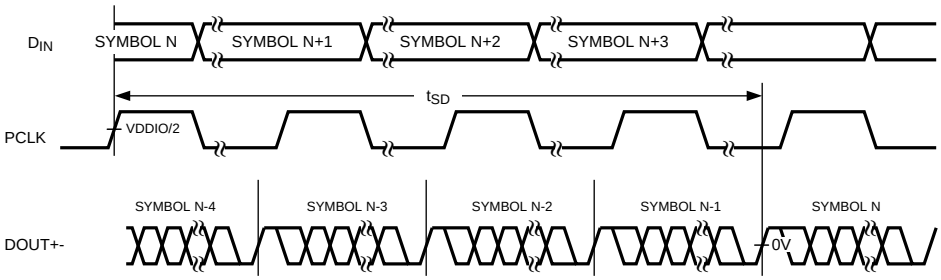



**Figure 11. Serializer Delay**

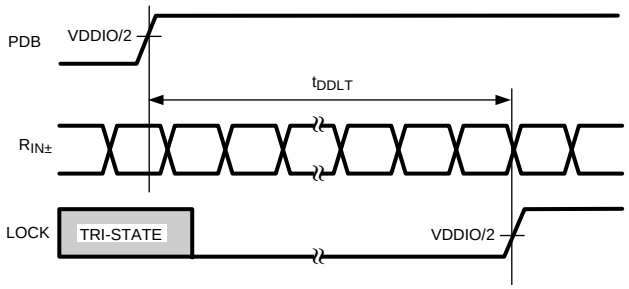



**Figure 12. Deserializer Data Lock Time**

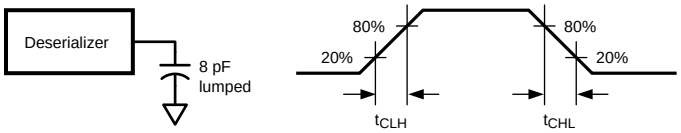



**Figure 13. Deserializer LVCMOS Output Load and Transition Times**

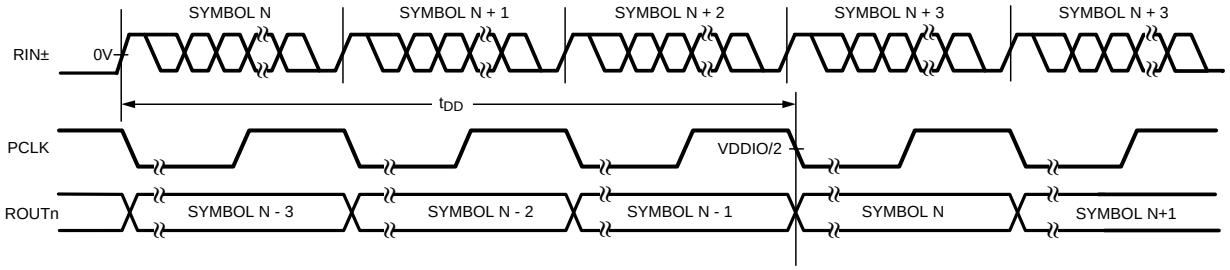



**Figure 14. Deserializer Delay**

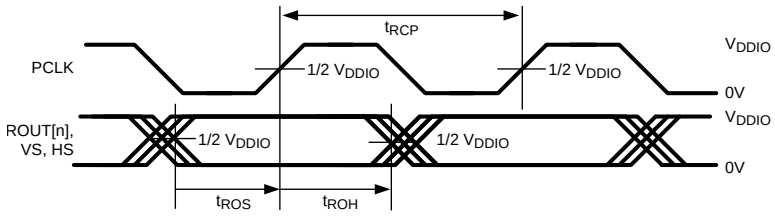



**Figure 15. Deserializer Output Setup/Hold Times**

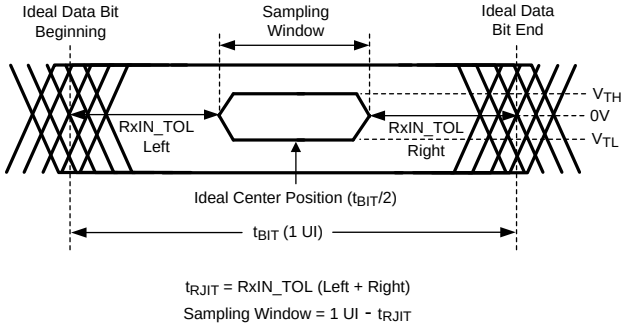



**Figure 16. Receiver Input Jitter Tolerance**

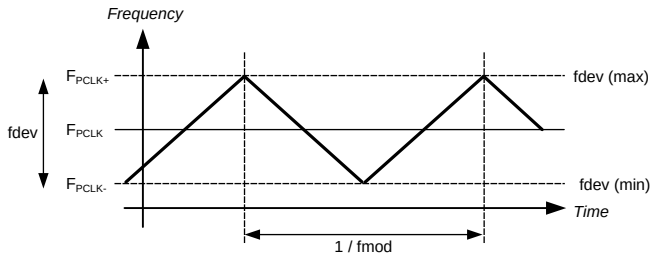



**Figure 17. Spread Spectrum Clock Output Profile**

## 6.9 Serializer Switching Characteristics

Over recommended operating supply and temperature ranges unless otherwise specified.

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $t_{LHT}$ | CML Low-to-High Transition Time | $R_L$ = 100Ω<br>Figure 3 | | 150 | 330 | ps |
| $t_{HLT}$ | CML High-to-Low Transition Time | $R_L$ = 100Ω<br>Figure 3 | | 150 | 330 | ps |
| $t_{DIS}$ | Data Input Setup to PCLK | Serializer Data Inputs<br>Figure 9 | 2.0 | | | ns |
| $t_{DIH}$ | Data Input Hold from PCLK | | 2.0 | | | ns |
| $t_{PLD}$ | Serializer PLL Lock Time | $R_L$ = 100Ω (1) (2) | | 1 | 2 | ms |
| $t_{SD}$ | Serializer Delay | $R_T$ = 100Ω<br>PCLK = 10–43 MHz<br>Register 0x03h b[0] (TRFB = 1)<br>Figure 11 | 6.386T + 5 | 6.386T + 12 | 6.386T + 19.7 | ns |
| $t_{JIND}$ | Serializer Output Deterministic Jitter | Serializer output intrinsic deterministic jitter . Measured (cycle-cycle) with PRBS-7 test pattern<br>PCLK = 43 MHz (3) (4) | | 0.13 | | UI |
| $t_{JINR}$ | Serializer Output Random Jitter | Serializer output intrinsic random jitter (cycle-cycle). Alternating-1,0 pattern.<br>PCLK = 43 MHz (3) (4) | | 0.04 | | UI |
| $t_{JINT}$ | Peak-to-peak Serializer Output Jitter | Serializer output peak-to-peak jitter includes deterministic jitter, random jitter, and jitter transfer from serializer input. Measured (cycle-cycle) with PRBS-7 test pattern.<br>PCLK = 43 MHz (3) (4) | | 0.396 | | UI |
| $\lambda_{STXBW}$ | Serializer Jitter Transfer Function -3 dB Bandwidth | PCLK = 43 MHz<br>Default Registers<br>Figure 18 (3) | | 1.90 | | MHz |
| $\delta_{STX}$ | Serializer Jitter Transfer Function (Peaking) | PCLK = 43 MHz<br>Default Registers<br>Figure 18 (3) | | 0.944 | | dB |
| $\delta_{STXf}$ | Serializer Jitter Transfer Function (Peaking Frequency) | PCLK = 43 MHz<br>Default Registers<br>Figure 18 (3) | | 500 | | kHz |

(1) $t_{PLD}$ and $t_{DDLT}$ is the time required by the serializer and deserializer to obtain lock when exiting power-down state with an active PCLK
(2) Specification is ensured by design.
(3) Typical values represent most likely parametric norms at 1.8V or 3.3V, $T_A$ = +25°C, and at the Recommended Operation Conditions at the time of product characterization and are not ensured.
(4) UI – Unit Interval is equivalent to one ideal serialized data bit width. The UI scales with PCLK frequency.

## 6.10 Deserializer Switching Characteristics

Over recommended operating supply and temperature ranges unless otherwise specified.

| PARAMETER | | TEST CONDITIONS | PIN/FREQ. | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| $t_{RCP}$ | Receiver Output Clock Period | $t_{RCP} = t_{TCP}$ | PCLK | 23.3 | T | 100 | ns |
| $t_{PDC}$ | PCLK Duty Cycle | Default Registers SSCG[3:0] = OFF | PCLK | 45 | 50 | 55 | % |
| $t_{CLH}$ | LVCMOS Low-to-High Transition Time | $V_{DDIO}$: 1.71V to 1.89V or 3.0 to 3.6V, $C_L$ = 8 pF (lumped load) Default Registers Figure 13 (1) | PCLK | 1.3 | 2.0 | 2.8 | ns |
| $t_{CHL}$ | LVCMOS High-to-Low Transition Time | | | 1.3 | 2.0 | 2.8 | |
| $t_{CLH}$ | LVCMOS Low-to-High Transition Time | $V_{DDIO}$: 1.71V to 1.89V or 3.0 to 3.6V, $C_L$ = 8 pF (lumped load) Default Registers Figure 13 (1) | Deserializer ROUTn Data Outputs | 1.6 | 2.4 | 3.3 | ns |
| $t_{CHL}$ | LVCMOS High-to-Low Transition Time | | | 1.6 | 2.4 | 3.3 | |
| $t_{ROS}$ | ROUT Setup Data to PCLK | $V_{DDIO}$: 1.71V to 1.89V or 3.0V to 3.6V, $C_L$ = 8 pF (lumped load) Default Registers | Deserializer ROUTn Data Outputs | 0.38T | 0.5T | | ns |
| $t_{ROH}$ | ROUT Hold Data to PCLK | | | 0.38T | 0.5T | | |
| $t_{DD}$ | Deserializer Delay | Default Registers Register 0x03h b[0] (RRFB = 1) Figure 14 | 10 MHz–43 MHz | 4.571T + 8 | 4.571T + 12 | 4.571T + 16 | ns |
| $t_{DDLT}$ | Deserializer Data Lock Time | Figure 12 (2) | 10 MHz–43 MHz | | | 10 | ms |
| $t_{RJIT}$ | Receiver Input Jitter Tolerance | Figure 16, Figure 19 (3) (4) | 43 MHz | | 0.53 | | UI |
| $t_{RCJ}$ | Receiver Clock Jitter | PCLK SSCG[3:0] = OFF (1) (5) | 10 MHz | | 300 | 550 | ps |
| | | | 43 MHz | | 120 | 250 | |
| $t_{DPJ}$ | Deserializer Period Jitter | PCLK SSCG[3:0] = OFF (1) (6) | 10 MHz | | 425 | 600 | ps |
| | | | 43 MHz | | 320 | 480 | |
| $t_{DCCJ}$ | Deserializer Cycle-to-Cycle Clock Jitter | PCLK SSCG[3:0] = OFF (1) (7) | 10 MHz | | 320 | 500 | ps |
| | | | 43 MHz | | 300 | 500 | |
| fdev | Spread Spectrum Clocking Deviation Frequency | LVCMOS Output Bus SSC[3:0] = ON Figure 17 | 20 MHz–43 MHz | | ±0.5% to ±2.0% | | % |
| fmod | Spread Spectrum Clocking Modulation Frequency | | 20 MHz–43 MHz | | 9 kHz to 66 kHz | | kHz |

(1) Specification is ensured by characterization and is not tested in production.
(2) $t_{PLD}$ and $t_{DDLT}$ is the time required by the serializer and deserializer to obtain lock when exiting power-down state with an active PCLK
(3) UI – Unit Interval is equivalent to one ideal serialized data bit width. The UI scales with PCLK frequency.
(4) $t_{RJIT}$ max (0.61UI) is limited by instrumentation and actual $t_{RJIT}$ of in-band jitter at low frequency (<2 MHz) is greater 1 UI.
(5) $t_{DCJ}$ is the maximum amount of jitter measured over 30,000 samples based on Time Interval Error (TIE).
(6) $t_{DPJ}$ is the maximum amount the period is allowed to deviate measured over 30,000 samples.
(7) $t_{DCCJ}$ is the maximum amount of jitter between adjacent clock cycles measured over 30,000 samples.

## 6.11 Typical Characteristics

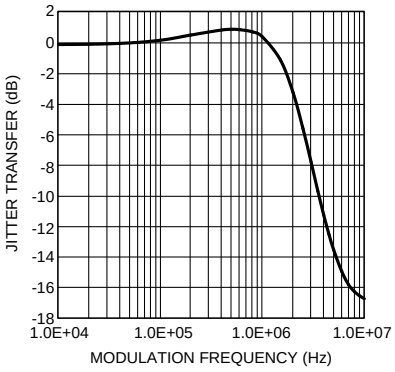



**Figure 18. Typical Serializer Jitter Transfer Function Curve at 43 MHz**

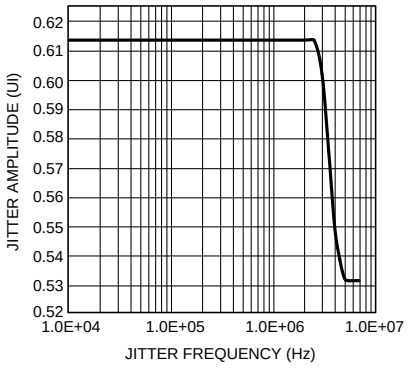



**Figure 19. Typical Deserializer Input Jitter Tolerance Curve at 43 MHz**

# 7 Detailed Description

## 7.1 Overview

The DS90UR903Q/904Q FPD-Link II chipset is intended for video display applications. The Serializer/ Deserializer chipset operates from a 10 MHz to 43 MHz pixel clock frequency. The DS90UR903Q transforms a 21-bit wide parallel LVCMOS data bus into a single high-speed differential pair. The high-speed serial bit stream contains an embedded clock and DC-balance information which enhances signal quality to support AC coupling. The DS90UR904Q receives the single serial data stream and converts it back into a 21-bit wide parallel data bus.

## 7.2 Functional Block Diagram

### 7.2.1 Typical Application Diagram

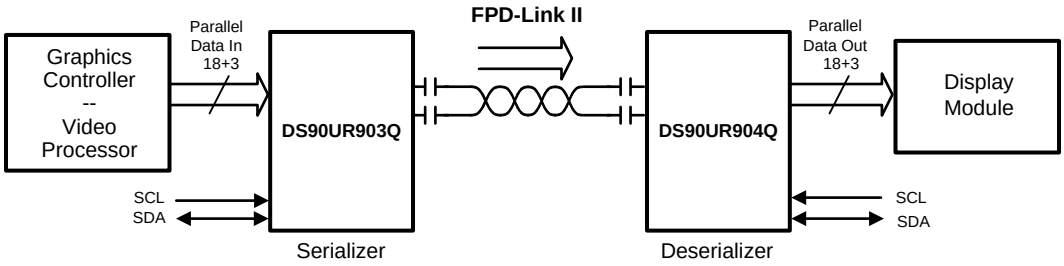



**Figure 20. Typical Application Circuit**

### 7.2.2 Block Diagrams

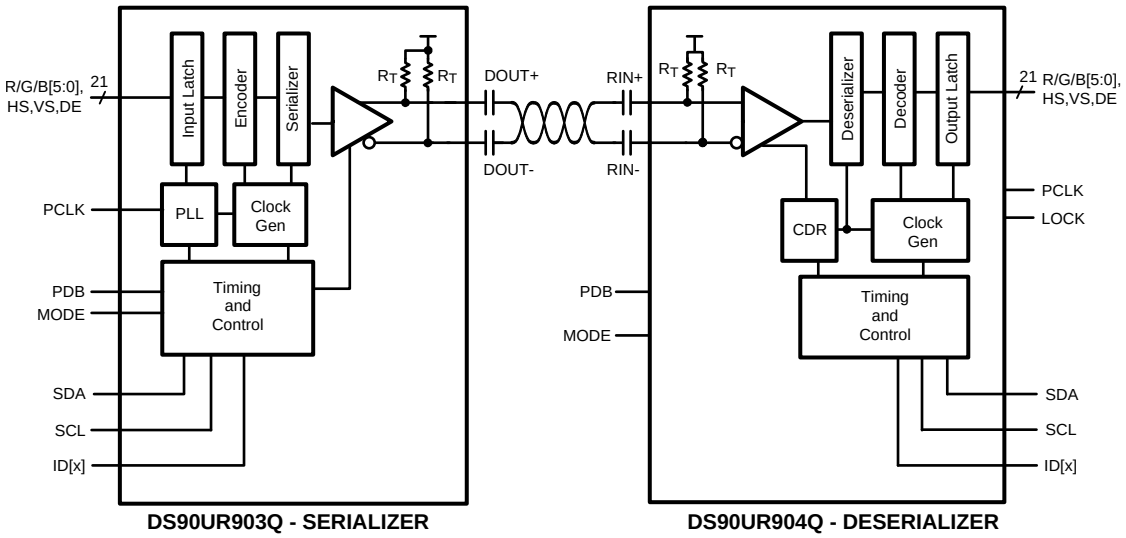



**Figure 21. Block Diagram**

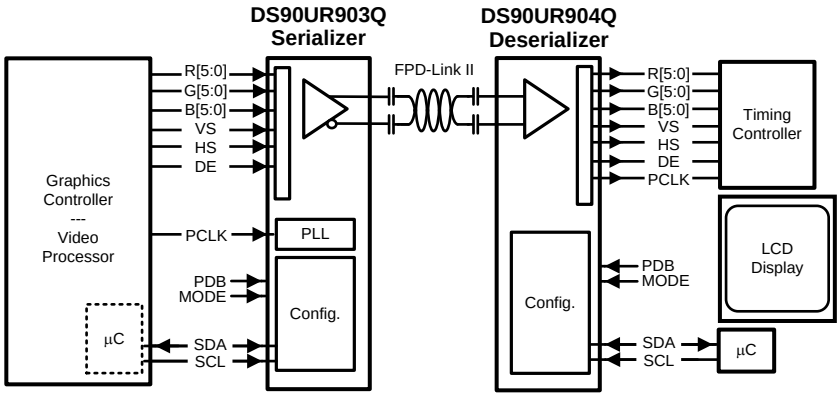



**Figure 22. Application Block Diagram**

## 7.3 Feature Description

### 7.3.1 Serial Frame Format

The DS90UR903Q/904Q chipset will transmit and receive a pixel of data in the following format:

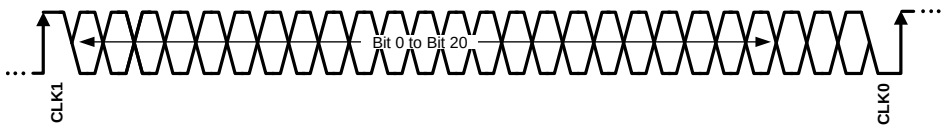



**Figure 23. Serial Bitstream for 28-bit Symbol**

The High Speed Serial Channel is a 28-bit symbol composed of 21 bits of data containing video data & control information transmitted from Serializer to Deserializer. CLK1 and CLK0 represent the embedded clock in the serial stream. CLK1 is always HIGH and CLK0 is always LOW. This data payload is optimized for signal transmission over an AC coupled link. Data is randomized, balanced and scrambled.

### 7.3.2 Signal Quality Enhancers

#### *7.3.2.1 Des - Receiver Input Equalization (EQ)*

The receiver inputs provided input equalization filter in order to compensate for loss from the media. The level of equalization is controlled via register setting.

### 7.3.3 Emi Reduction

#### *7.3.3.1 Des - Receiver Staggered Output*

The Receiver staggered outputs allows for outputs to switch in a random distribution of transitions within a defined window. Outputs transitions are distributed randomly. This minimizes the number of outputs switching simultaneously and helps to reduce supply noise. In addition it spreads the noise spectrum out reducing overall EMI.

#### *7.3.3.2 Des Spread Spectrum Clocking*

The DS90UR904Q parallel data and clock outputs have programmable SSCG ranges from 9 kHz–66 kHz and ±0.5%–±2% from 20 MHz to 43 MHz. The modulation rate and modulation frequency variation of output spread is controlled through the SSC control registers.

## 7.4 Device Functional Modes

### 7.4.1 LVCMOS VDDIO Option

1.8V or 3.3V SER Inputs and DES Outputs are user selectable to provide compatibility with 1.8V and 3.3V system interfaces.

### 7.4.2 Powerdown

The SER has a PDB input pin to ENABLE or Powerdown the device. The modes can be controlled by the host and is used to disable the Link to save power when the remote device is not operational. An auto mode is also available. In this mode, the PDB pin is tied High and the SER switches over to an internal oscillator when the PCLK stops or not present. When a PCLK starts again, the SER will then lock to the valid input PCLK and transmits the data to the DES. In powerdown mode, the high-speed driver outputs are static (High).

The DES has a PDB input pin to ENABLE or Powerdown the device. This pin can be controlled by the system and is used to disable the DES to save power. An auto mode is also available. In this mode, the PDB pin is tied High and the DES will enter powerdown when the serial stream stops. When the serial stream starts up again, the DES will lock to the input stream and assert the LOCK pin and output valid data. In powerdown mode, the Data and PCLK outputs are set by the OSS_SEL control register.

### 7.4.3 Pixel Clock Edge Select (TRFB/RRFB)

The TRFB/RRFB selects which edge of the Pixel Clock is used. For the SER, this register determines the edge that the data is latched on. If TRFB register is 1, data is latched on the Rising edge of the PCLK. If TRFB register is 0, data is latched on the Falling edge of the PCLK. For the DES, this register determines the edge that the data is strobed on. If RRFB register is 1, data is strobed on the Rising edge of the PCLK. If RRFB register is 0, data is strobed on the Falling edge of the PCLK.

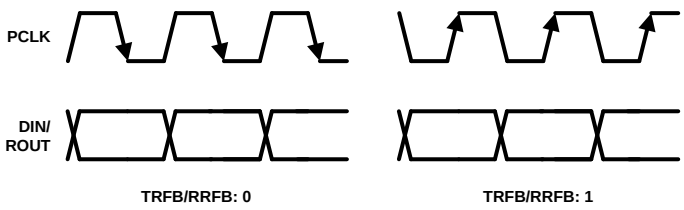



**Figure 24. Programmable PCLK Strobe Select**

## 7.5 Programming

### 7.5.1 Description of Serial Control Bus

An integrated $I^2C$ slave controller is embedded in each of the DS90UR903Q Serializer and DS90UR904Q Deserializer. It must be used to access and program the extra features embedded within the configuration registers. Refer to Table 3 and Table 4 for details of control registers.

### 7.5.2 ID[X] Address Decoder

The ID[x] pin is used to decode and set the physical slave address of the Serializer/Deserializer ($I^2C$ only) to allow up to six devices on the bus using only a single pin. The pin sets one of six possible addresses for each Serializer/Deserializer device. The pin must be pulled to VDD (1.8V, NOT VDDIO)) with a 10 kΩ resistor and a pull down resistor (RID) of the recommended value to set the physical device address. The recommended maximum resistor tolerance is 0.1% worst case (0.2% total tolerance).

## Programming (continued)

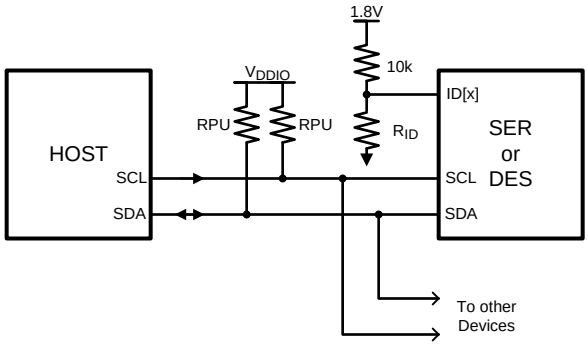



**Figure 25. Serial Control Bus Connection**

**Table 1. ID[x] Resistor Value – DS90UR903Q**

| ID[x] RESISTOR VALUE - DS90UR903Q Ser | | |
|---|---|---|
| **RESISTOR RID Ω (±0.1%)** | **ADDRESS 7'b(1)** | **ADDRESS 8'b 0 APPENDED (WRITE)** |
| 0<br>GND | 7b' 101 1000 (h'58) | 8b' 1011 0000 (h'B0) |
| 2.0k | 7b' 101 1001 (h'59) | 8b' 1011 0010 (h'B2) |
| 4.7k | 7b' 101 1010 (h'5A) | 8b' 1011 0100 (h'B4) |
| 8.2k | 7b' 101 1011 (h'5B) | 8b' 1011 0110 (h'B6) |
| 12.1k | 7b' 101 1100 (h'5C) | 8b' 1011 1000 (h'B8) |
| 39.0k | 7b' 101 1110 (h'5E) | 8b' 1011 1100 (h'BC) |

(1) Specification is ensured by design.

**Table 2. ID[x] Resistor Value – DS90UR904Q**

| ID[x] RESISTOR VALUE - DS90UR904Q Des | | |
|---|---|---|
| **RESISTOR RID Ω (±0.1%)** | **ADDRESS 7'b(1)** | **ADDRESS 8'b 0 APPENDED (WRITE)** |
| 0<br>GND | 7b' 110 0000 (h'60) | 8b' 1100 0000 (h'C0) |
| 2.0k | 7b' 110 0001 (h'61) | 8b' 1100 0010 (h'C2) |
| 4.7k | 7b' 110 0010 (h'62) | 8b' 1100 0100 (h'C4) |
| 8.2k | 7b' 110 0011 (h'63) | 8b' 1101 0110 (h'C6) |
| 12.1k | 7b' 110 0100 (h'64) | 8b' 1101 1000 (h'C8) |
| 39.0k | 7b' 110 0110 (h'66) | 8b' 1100 1100 (h'CC) |

(1) Specification is ensured by design.

## 7.6 Register Maps

**Table 3. DS90UR903Q Control Registers**

| ADDR (HEX) | NAME | BITS | FIELD | R/W | DEFAULT | DESCRIPTION |
|---|---|---|---|---|---|---|
| 0 | $I^2C$ Device ID | 7:1 | DEVICE ID | RW | 0xB0'h | 7-bit address of Serializer; 0x58'h (1011_000X'b) default |
| | | 0 | SER ID SEL | | | 0: Device ID is from ID[x]<br>1: Register $I^2C$ Device ID overrides ID[x] |
| 1 | Reset | 7:3 | RESERVED | | 0x00'h | Reserved |
| | | 2 | RESERVED | RW | 0 | Reserved |
| | | 1 | DIGITAL RESET0 | RW | 0<br>self clear | 1: Resets the device to default register values. Does not affect device $I^2C$ Bus or Device ID |
| | | 0 | DIGITAL RESET1 | RW | 0<br>self clear | 1: Digital Reset, retains all register values |
| 2 | Reserved | 7:0 | RESERVED | | 0x20'h | Reserved |
| 3 | Reserved | 7:6 | RESERVED | | 11'b | Reserved |
| | VDDIO Control | 5 | VDDIO CONTOL | RW | 1 | Auto VDDIO detect<br>Allows manual setting of VDDIO by register.<br>0: Disable<br>1: Enable (auto detect mode) |
| | VDDIO Mode | 4 | VDDIO MODE | RW | 1 | VDDIO voltage set<br>Only used when VDDIOCONTROL = 0<br>0: 1.8V<br>1: 3.3V |
| | RESERVED | 3 | RESERVED | RW | 1 | Reserved |
| | RESERVED | 2 | RESERVED | | 0 | Reserved |
| | PCLK_AUTO | 1 | PCLK_AUTO | RW | 1 | Switch over to internal 25 MHz Oscillator clock in the absence of PCLK<br>0: Disable<br>1: Enable |
| | TRFB | 0 | TRFB | RW | 1 | Pixel Clock Edge Select:<br>0: Parallel Interface Data is strobed on the Falling Clock TRFB 0 TRFB RW 1 Edge.<br>1: Parallel Interface Data is strobed on the Rising Clock Edge. |
| 4 | Reserved | 7:0 | RESERVED | | 0x80'h | Reserved |
| 5 | Reserved | 7:0 | RESERVED | RW | 0x40'h | Reserved |
| 6 | Reserved | 7:0 | RESERVED | RW | 0xC0'h | Reserved |
| 7 | Reserved | 7:0 | RESERVED | RW | 0x00'h | Reserved |
| 8 | Reserved | 7:0 | RESERVED | | 0x00'h | Reserved |
| 9 | Reserved | 7:0 | RESERVED | | 0x01'h | Reserved |
| A | Reserved | 7:0 | RESERVED | | 0x00'h | Reserved |
| B | Reserved | 7:0 | RESERVED | | 0x00'h | Reserved |
| C | Reserved | 7:3 | RESERVED | | 0x00'h | Reserved |
| | PCLK Detect | 2 | PCLK DETECT | R | 0 | 1: Valid PCLK detected<br>0: Valid PCLK not detected |
| | Reserved | 3 | RESERVED | | 0 | Reserved |
| | Reserved | 0 | RESERVED | R | 0 | Reserved |
| D | Reserved | 7:0 | RESERVED | | 0x11'h | Reserved |
| E | Reserved | 7:0 | RESERVED | | 0x01'h | Reserved |
| F | Reserved | 7:0 | RESERVED | | 0x03'h | Reserved |
| 10 | Reserved | 7:0 | RESERVED | | 0x03'h | Reserved |
| 11 | Reserved | 7:0 | RESERVED | | 0x03'h | Reserved |
| 12 | Reserved | 7:0 | RESERVED | | 0x03'h | Reserved |

## Register Maps (continued)

**Table 3. DS90UR903Q Control Registers (continued)**

| ADDR (HEX) | NAME | BITS | FIELD | R/W | DEFAULT | DESCRIPTION |
|---|---|---|---|---|---|---|
| 13 | General Purpose Control Reg | 7:0 | GPCR[7]<br>GPCR[6]<br>GPCR[5]<br>GPCR[4]<br>GPCR[3]<br>GPCR[2]<br>GPCR[1]<br>GPCR[0] | RW | 0x00'h | 0: LOW<br>1: HIGH |

**Table 4. DS90UR904Q Control Registers**

| ADDR (HEX) | NAME | BITS | FIELD | R/W | DEFAULT | DESCRIPTION |
|---|---|---|---|---|---|---|
| 0 | $I^2C$ Device ID | 7:1 | DEVICE ID | RW | 0xC0'h | 7-bit address of Deserializer;<br>0x60h<br>(1100_000X) default |
| | | 0 | DES ID SEL | | | 0: Device ID is from ID[x]<br>1: Register $I^2C$ Device ID overrides ID[x] |
| 1 | Reset | 7:3 | RESERVED | | 0x00'h | Reserved |
| | | 2 | RESERVED | RW | 0 | Reserved |
| | | 1 | DIGITALRESET0 | RW | 0<br>self clear | 1: Resets the device to default register values. Does not affect device $I^2C$ Bus or Device ID |
| | | 0 | DIGITALRESET1 | RW | 0<br>self clear | 1: Digital Reset, retains all register values |
| 2 | RESERVED | 7:6 | RESERVED | | 00'b | Reserved |
| | Auto Clock | 5 | AUTO_CLOCK | RW | 0 | 1: Output PCLK or Internal 25 MHz Oscillator clock<br>0: Only PCLK when valid PCLK present |
| | OSS Select | 4 | OSS_SEL | RW | 0 | Output Sleep State Select<br>0: Outputs = TRI-STATE, when LOCK = L<br>1: Outputs = LOW , when LOCK = L |
| | SSCG | 3:0 | SSCG | | 0000'b | SSCG Select<br>0000: Normal Operation, SSCG OFF (default)<br>0001: fmod (kHz) PCLK/2168, fdev ±0.50%<br>0010: fmod (kHz) PCLK/2168, fdev ±1.00%<br>0011: fmod (kHz) PCLK/2168, fdev ±1.50%<br>0100: fmod (kHz) PCLK/2168, fdev ±2.00%<br>0101: fmod (kHz) PCLK/1300, fdev ±0.50%<br>0110: fmod (kHz) PCLK/1300, fdev ±1.00%<br>0111: fmod (kHz) PCLK/1300, fdev ±1.50%<br>1000: fmod (kHz) PCLK/1300, fdev ±2.00%<br>1001: fmod (kHz) PCLK/868, fdev ±0.50%<br>1010: fmod (kHz) PCLK/868, fdev ±1.00%<br>1011: fmod (kHz) PCLK/868, fdev ±1.50%<br>1100: fmod (kHz) PCLK/868, fdev ±2.00%<br>1101: fmod (kHz) PCLK/650, fdev ±0.50%<br>1110: fmod (kHz) PCLK/650, fdev ±1.00%<br>1111: fmod (kHz) PCLK/650, fdev ±1.50% |

**Table 4. DS90UR904Q Control Registers (continued)**

| ADDR (HEX) | NAME | BITS | FIELD | R/W | DEFAULT | DESCRIPTION |
|---|---|---|---|---|---|---|
| 3 | RESERVED | 7:6 | RESERVED | | 11'b | Reserved |
| | VDDIO Control | 5 | VDDIO CONTROL | RW | 1 | Auto voltage control<br>0: Disable<br>1: Enable (auto detect mode) |
| | VDDIO Mode | 4 | VDDIO MODE | RW | 0 | VDDIO voltage set<br>0: 1.8V<br>1: 3.3V |
| | RESERVED | 3 | RESERVED | RW | 1 | Reserved |
| | RESERVED | 2 | RESERVED | RW | 0 | Reserved |
| | RESERVED | 1 | RESERVED | | 0 | Reserved |
| | RRFB | 0 | RRFB | RW | 1 | Pixel Clock Edge Select<br>0: Parallel Interface Data is strobed on the Falling Clock Edge<br>1: Parallel Interface Data is strobed on the Rising Clock Edge. |
| 4 | EQ Control | 7:0 | EQ | RW | 0x00'h | EQ Gain<br>00'h = ~0.0 dB<br>01'h = ~4.5 dB<br>03'h = ~6.5 dB<br>07'h = ~7.5 dB<br>0F'h = ~8.0 dB<br>1F'h = ~11.0 dB<br>3F'h = ~12.5 dB<br>FF'h = ~14.0 dB |
| 5 | RESERVED | 7:0 | RESERVED | | 0x00'h | Reserved |
| 6 | RESERVED | 7 | RESERVED | | 0 | Reserved |
| | RESERVED | 6:4 | RESERVED | RW | 000'b | Reserved |
| | RESERVED | 3:0 | RESERVED | RW | 1111'b | Reserved |
| 7 | RESERVED | 7:0 | RESERVED | RW | 0xB0'h | Reserved |
| 8:17 | RESERVED | 7:0 | RESERVED | RW | 0x00'h | Reserved |
| 18 | RESERVED | 7:0 | RESERVED | | 0x00'h | Reserved |
| 19 | RESERVED | 7:0 | RESERVED | | 0x01'h | Reserved |
| 1A | RESERVED | 7:0 | RESERVED | | 0x00'h | Reserved |
| 1B | RESERVED | 7:0 | RESERVED | | 0x00'h | Reserved |
| 1C | RESERVED | 7:3 | RESERVED | | 0x00'h | Reserved |
| | RESERVED | 2 | RESERVED | | 0 | Reserved |
| | Signal Detect Status | 1 | | R | 0 | 0: Active signal not detected<br>1: Active signal detected |
| | LOCK Pin Status | 0 | | R | 0 | 0: CDR/PLL Unlocked<br>1: CDR/PLL Locked |
| 1D | Reserved | 7:0 | RESERVED | | 0x17'h | Reserved |
| 1E | Reserved | 7:0 | RESERVED | | 0x07'h | Reserved |
| 1F | Reserved | 7:0 | RESERVED | | 0x01'h | Reserved |
| 20 | Reserved | 7:0 | RESERVED | | 0x01'h | Reserved |
| 21 | Reserved | 7:0 | RESERVED | | 0x01'h | Reserved |
| 22 | Reserved | 7:0 | RESERVED | | 0x01'h | Reserved |
| 23 | General Purpose Control Reg | 7:0 | GPCR[7]<br>GPCR[6]<br>GPCR[5]<br>GPCR[4]<br>GPCR[3]<br>GPCR[2]<br>GPCR[1]<br>GPCR[0] | RW | 0x00'h | 0: LOW<br>1: HIGH |

**Table 4. DS90UR904Q Control Registers (continued)**

| ADDR (HEX) | NAME | BITS | FIELD | R/W | DEFAULT | DESCRIPTION |
|---|---|---|---|---|---|---|
| 24 | RESERVED | 0 | RESERVED | RW | 0 | Reserved |
| 25 | RESERVED | 7:0 | RESERVED | R | 0x00'h | Reserved |
| 26 | RESERVED | 7:6 | RESERVED | RW | 00'b | Reserved |
| | | 5:0 | RESERVED | RW | 0 | Reserved |

# 8 Application and Implementation

## 8.1 Application Information

The DS90UR903Q/904Q chipset is intended for interface between a host (graphics processor) and a Display. It supports a 21 bit parallel video bus for 18-bit color depth (RGB666) display format. In a RGB666 configuration, 18 color bits (R[5:0], G[5:0], B[5:0]), Pixel Clock (PCLK) and three control bits (VS, HS and DE) are supported across the serial link.

The DS90UR903Q Serializer accepts a 21-bit parallel data bus. The parallel data is converted into a single differential link. The DS90UR904Q Deserializer extracts the clock/control information from the incoming data stream and reconstructs the 21-bit parallel data.

Camera applications are also supported by the DS90UR903Q/904Q chipset. The host controller/processsor is connected to the deserializer, while the CMOS image sensor provides data to the serializer.

## 8.2 Typical Applications

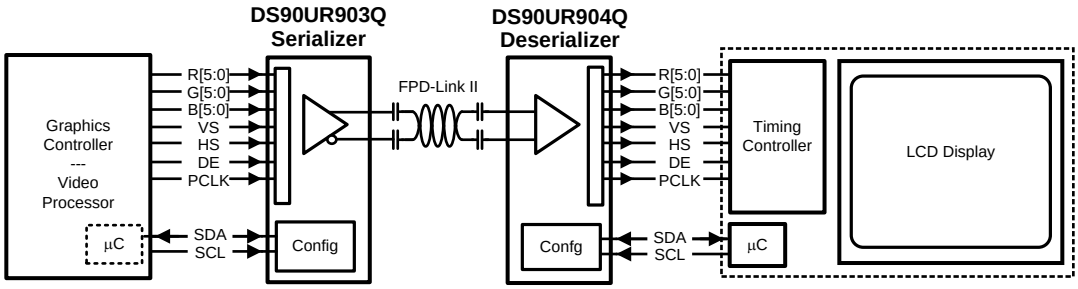



**Figure 26. Typical Display System Diagram**

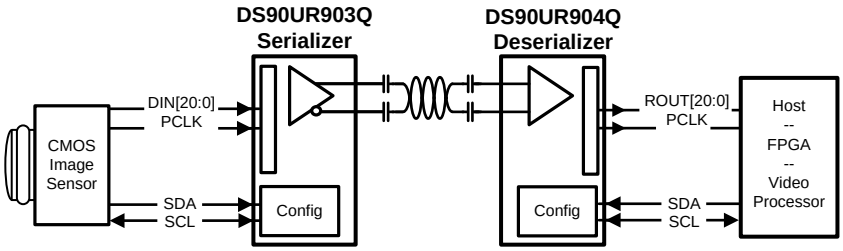



**Figure 27. Typical Camera System Diagram**

### 8.2.1 Design Requirements

For the typical design applications, use the following as input parameters.

**Table 5. Design Parameters**

| Design Parameter | Example Value |
|---|---|
| VDDIO | 1.8 V or 3.3 V |
| VDDn | 1.8 V |
| AC Coupling Capacitor for DOUT± and RIN± | 100 nF |
| PCLK Frequency | 43 MHz |

### 8.2.2 Detailed Design Procedure

#### *8.2.2.1 Typical Application Connection*

Figure 28 shows a typical connection of the DS90UR903Q Serializer for an 18-bit application. The CML outputs require 0.1 µF AC coupling capacitors to the line. The line driver includes internal termination. Bypass capacitors are placed near the power supply Terminals. System GPO (General Purpose Output) signals control the PDB and MODE Terminals. The interface to the host is with 1.8 V LVCMOS levels, thus the VDDIO Terminal is connected also to the 1.8V rail. The optional Serial Bus control is used in this example, thus SCL and SDA are connected to the system and the ID[x] Terminal is connected to a resistor divider.

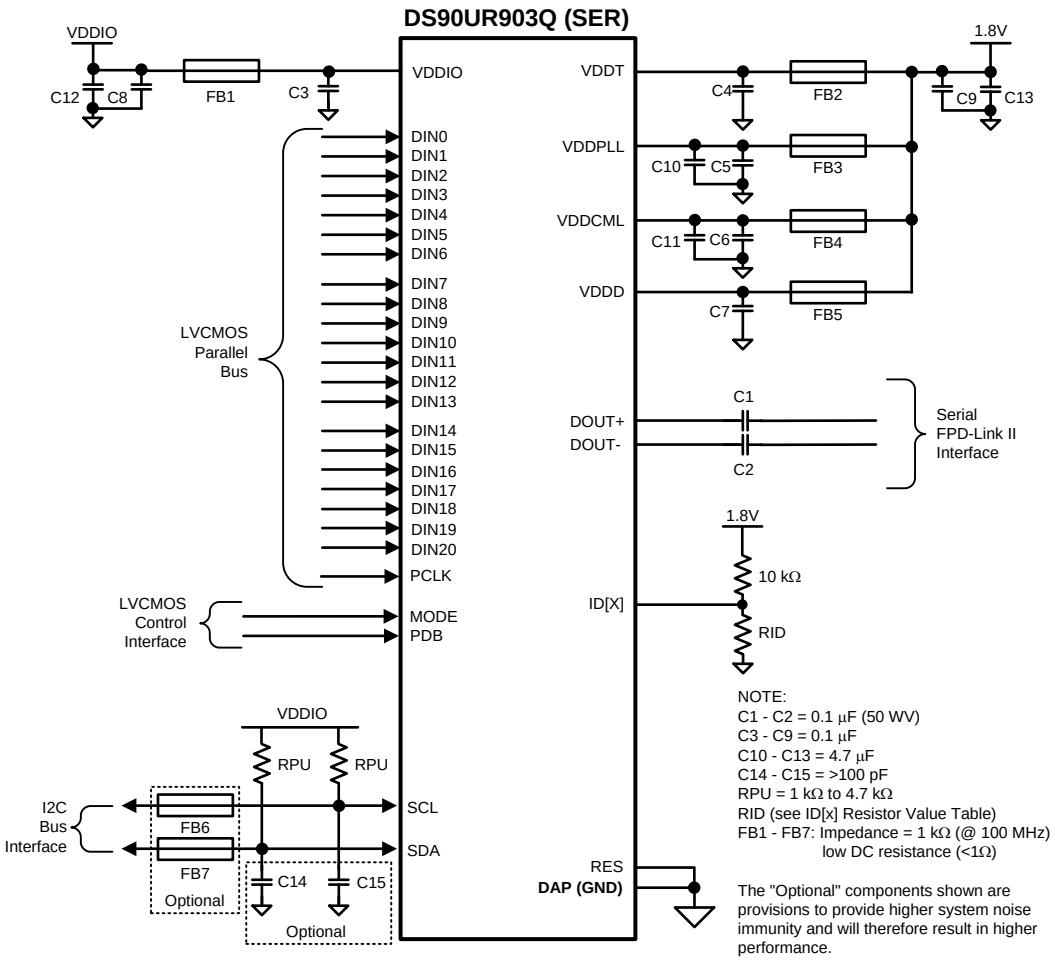
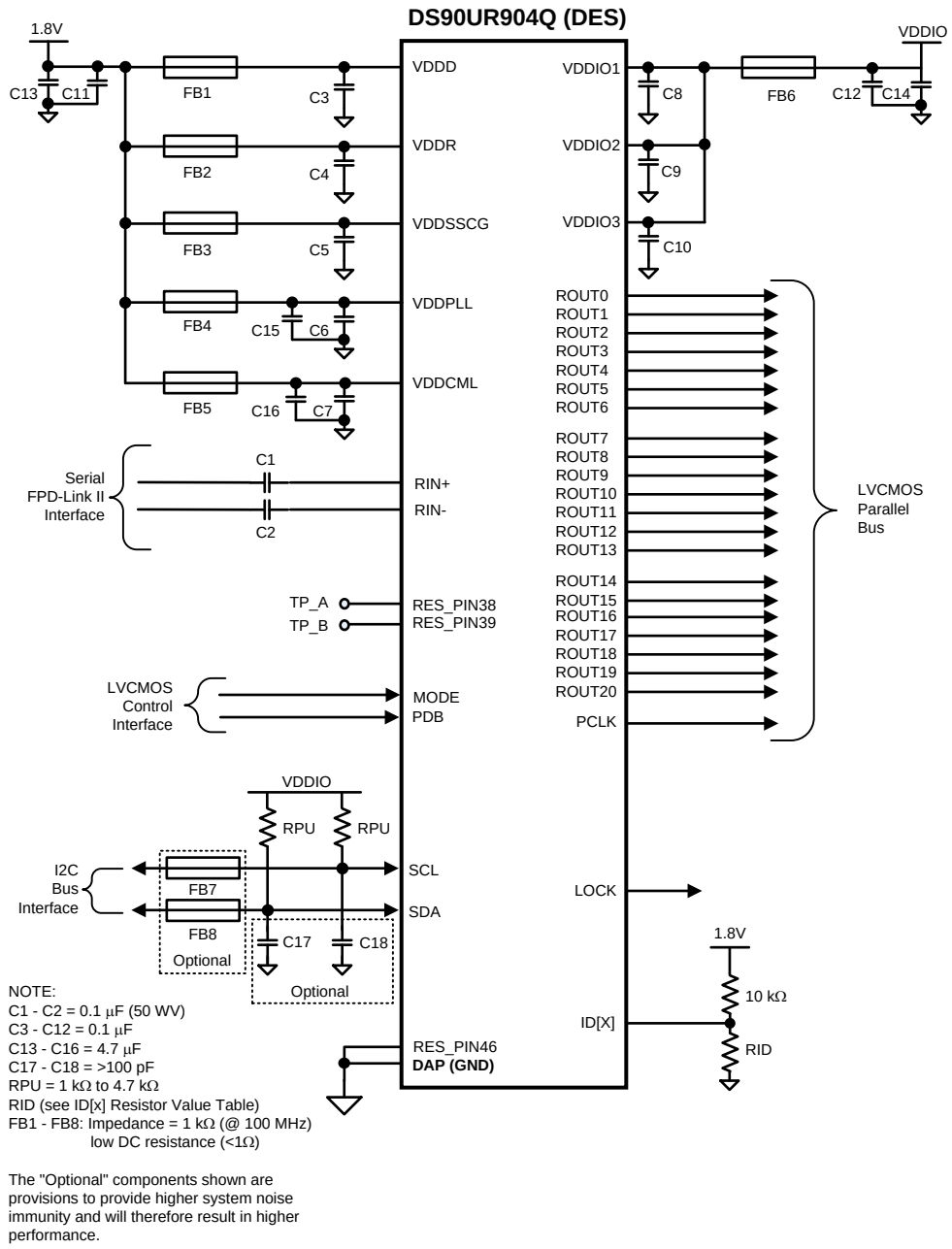



**Figure 28. DS90UR903Q Typical Connection Diagram — Pin Control 40-Pin WQFN (RTA Package)**

Figure 29 shows a typical connection of the DS90UR904Q Deserializer for an 18-bit application. The CML inputs utilize 0.1 µF coupling capacitors to the line and the receiver provides internal termination. Bypass capacitors are placed near the power supply Terminals. System GPO (General Purpose Output) signals control the PDB and the MODE Terminals. The interface to the target display is with 3.3V LVCMOS levels, thus the VDDIO Terminal is connected to the 3.3 V rail. The optional Serial Bus control is used in this example, thus SCL and SDA are connected to the system and the ID[x] Terminal is connected to a resistor divider. LOCK is monitored by a system GPI (General Purpose Input).




NOTE:
C1 - C2 = 0.1 μF (50 WV)
C3 - C12 = 0.1 μF
C13 - C16 = 4.7 μF
C17 - C18 = >100 pF
RPU = 1 kΩ to 4.7 kΩ
RID (see ID[x] Resistor Value Table)
FB1 - FB8: Impedance = 1 kΩ (@ 100 MHz)
low DC resistance (<1Ω)

The "Optional" components shown are provisions to provide higher system noise immunity and will therefore result in higher performance.

**Figure 29. DS90UR904Q Typical Connection Diagram — Pin Control 48-Pin WQFN (RHS Package)**

#### 8.2.2.2 AC Coupling

The SER/DES supports only AC-coupled interconnects through an integrated DC balanced decoding scheme. External AC coupling capacitors must be placed in series in the FPD-Link II signal path as illustrated in Figure 30.

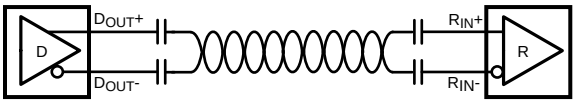



**Figure 30. AC-Coupled Connection**

For high-speed FPD-Link II transmissions, the smallest available package should be used for the AC coupling capacitor. This will help minimize degradation of signal quality due to package parasitics. The I/O's require a 100 nF AC coupling capacitors to the line.

#### 8.2.2.3 Power Up Requirements and PDB PIN

When power is applied, the VDDIO supply needs to reach the expected operating voltage (1.8V or 3.3V) before the other supplies (VDDn) begin to ramp. It is also required to delay and release the PDB input signal after VDD (VDDn and VDDIO) power supplies have settled to the recommended operating voltages. A external RC network can be connected to the PDB pin to ensure PDB arrives after all the VDD have stabilized.

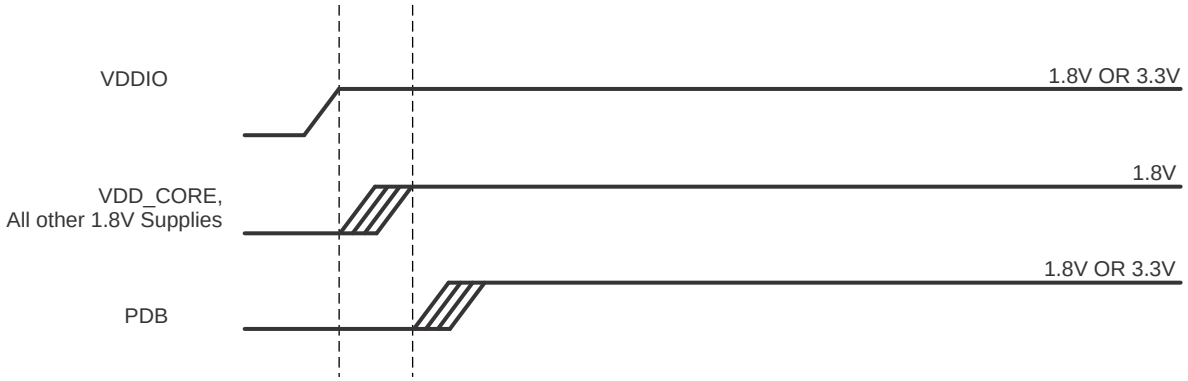



**Figure 31. Power Up Sequence**

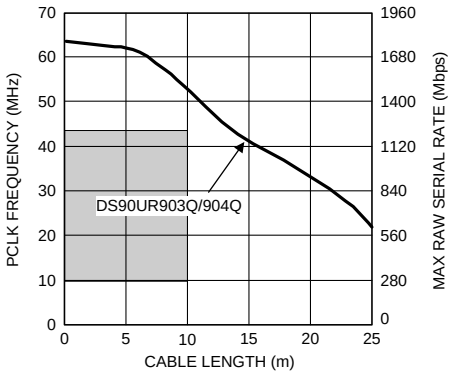
#### 8.2.2.4 Transmission Media

The Ser/Des chipset is intended to be used over a wide variety of balanced cables depending on distance and signal quality requirements. The Ser/Des employ internal termination providing a clean signaling environment. The interconnect for FPD-Link II interface should present a differential impedance of 100 Ohms. Use of cables and connectors that have matched differential impedance will minimize impedance discontinuities. Shielded or un-shielded cables may be used depending upon the noise environment and application requirements. The chipset's optimum cable drive performance is achieved at 43 MHz at 10 meters length. The maximum signaling rate increases as the cable length decreases. Therefore, the chipset supports 50 MHz at shorter distances. Other cable parameters that may limit the cable's performance boundaries are: cable attenuation, near-end crosstalk and pair-to-pair skew.

For obtaining optimal performance, we recommend:

- Use Shielded Twisted Pair (STP) cable
- 100Ω differential impedance and 24 AWG (or lower AWG) cable
- Low skew, impedance matched
- Ground and/or terminate unused conductors

Figure 32 shows the Typical Performance Characteristics demonstrating various lengths and data rates using Rosenberger HSD and Leoni DACAR 538 Cable.




*Note: Equalization is enabled for cable lengths greater than 7 meters

**Figure 32. Rosenberger HSD & Leoni DACAR 538 Cable Performance**

### *8.2.2.5 Serial Interconnect Guidelines*

For full details, see the *Channel-Link PCB and Interconnect Design-In Guidelines* (literature number SNLA008) and the *Transmission Line RAPIDESIGNER Operation and Applications Guide* (literature number SNLA035).

- Use 100Ω coupled differential pairs
- Use the S/2S/3S rule in spacings
  - S = space between the pair
  - 2S = space between pairs
  - 3S = space to LVCMOS signal
- Minimize the number of Vias
- Use differential connectors when operating above 500Mbps line speed
- Maintain balance of the traces
- Minimize skew within the pair

Additional general guidance can be found in the *LVDS Owner's Manual* (literature number SNLA187), which is available in PDF format from the TI LVDS & CML Solutions web site.

### *8.2.2.6 Application Curves*

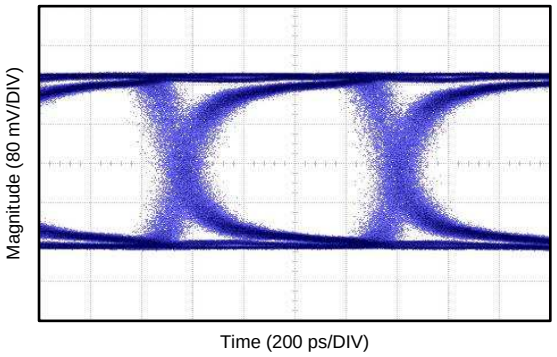



**Figure 33. Serializer Eye Diagram at 1.2 Gbps Line Rate (43MHz Pixel Clock)**

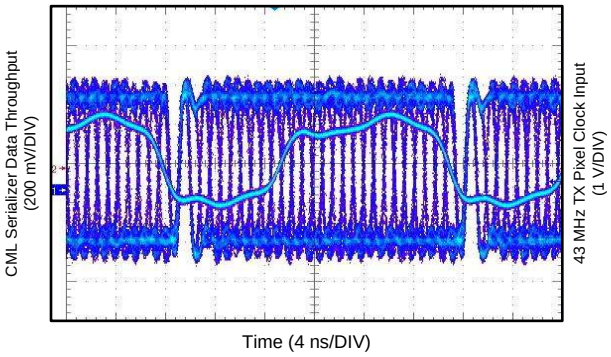



**Figure 34. Serializer CML Output with 43MHz TX Pixel Clock**

# 9 Power Supply Recommendations

These devices are designed to operate from an input core voltage supply of 1.8V. Some devices provide separate power and ground Terminals for different portions of the circuit. This is done to isolate switching noise effects between different sections of the circuit. Separate planes on the PCB are typically not required. Terminal Description tables typically provide guidance on which circuit blocks are connected to which power Terminal pairs. In some cases, an external filter may be used to provide clean power to sensitive circuits such as PLLs.

# 10 Layout

## 10.1 Layout Guidelines

Circuit board layout and stack-up for the Ser/Des devices should be designed to provide low-noise power feed to the device. Good layout practice will also separate high frequency or high-level inputs and outputs to minimize unwanted stray noise pickup, feedback and interference. Power system performance may be greatly improved by using thin dielectrics (2 to 4 mils) for power / ground sandwiches. This arrangement provides plane capacitance for the PCB power system with low-inductance parasitics, which has proven especially effective at high frequencies, and makes the value and placement of external bypass capacitors less critical. External bypass capacitors should include both RF ceramic and tantalum electrolytic types. RF capacitors may use values in the range of 0.01 uF to 0.1 uF. Tantalum capacitors may be in the 2.2 uF to 10 uF range. Voltage rating of the tantalum capacitors should be at least 5X the power supply voltage being used.

Surface mount capacitors are recommended due to their smaller parasitics. When using multiple capacitors per supply pin, locate the smaller value closer to the pin. A large bulk capacitor is recommend at the point of power entry. This is typically in the 50uF to 100uF range and will smooth low frequency switching noise. It is recommended to connect power and ground pins directly to the power and ground planes with bypass capacitors connected to the plane with via on both ends of the capacitor. Connecting power or ground pins to an external bypass capacitor will increase the inductance of the path.

A small body size X7R chip capacitor, such as 0603, is recommended for external bypass. Its small body size reduces the parasitic inductance of the capacitor. The user must pay attention to the resonance frequency of these external bypass capacitors, usually in the range of 20-30 MHz. To provide effective bypassing, multiple capacitors are often used to achieve low impedance between the supply rails over the frequency of interest. At high frequency, it is also a common practice to use two vias from power and ground pins to the planes, reducing the impedance at high frequency.

Some devices provide separate power for different portions of the circuit. This is done to isolate switching noise effects between different sections of the circuit. Separate planes on the PCB are typically not required. Pin Description tables typically provide guidance on which circuit blocks are connected to which power pin pairs. In some cases, an external filter many be used to provide clean power to sensitive circuits such as PLLs.

Use at least a four layer board with a power and ground plane. Locate LVCMOS signals away from the differential lines to prevent coupling from the LVCMOS lines to the differential lines. Closely-coupled differential lines of 100 Ohms are typically recommended for differential interconnect. The closely coupled lines help to ensure that coupled noise will appear as common-mode and thus is rejected by the receivers. The tightly coupled lines will also radiate less.

Information on the LLP style package is provided in the *AN-1187 Leadless Leadframe Package (LLP) Application Report* (literature number SNOA401).

## 10.2 Layout Example

Stencil parameters such as aperture area ratio and the fabrication process have a significant impact on paste deposition. Inspection of the stencil prior to placement of the LLP package is highly recommended to improve board assembly yields. If the via and aperture openings are not carefully monitored, the solder may flow unevenly through the DAP. Stencil parameters for aperture opening and via locations are shown below:

## Layout Example (continued)

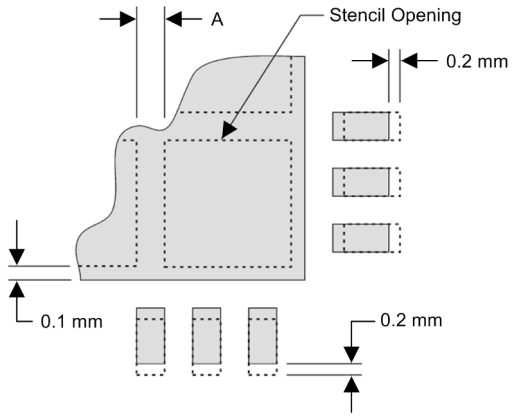



**Figure 35. No Pullback LLP, Single Row Reference Diagram**

**Table 6. No Pullback LLP Stencil Aperture Summary for DS90UR903Q-Q1 and DS90UR904Q-Q1**

| Device | Pin Count | MKT Dwg | PCB I/O Pad Size (mm) | PCB Pitch (mm) | PCB DAP size(mm) | Stencil I/O Aperture (mm) | Stencil DAP Aperture (mm) | Number of DAP Aperture Openings | Gap Between DAP Aperture (Dim A mm) |
|---|---|---|---|---|---|---|---|---|---|
| DS90UR903Q-Q1 | 40 | SNA40A | 0.25 x 0.6 | 0.5 | 4.6 x 4.6 | 0.25 x 0.7 | 1.0 x 1.0 | 16 | 0.2 |
| DS90UR904Q-Q1 | 48 | SNA48A | 0.25 x 0.6 | 0.5 | 5.1 x 5.1 | 0.25 x 0.7 | 1.1 x 1.1 | 16 | 0.2 |

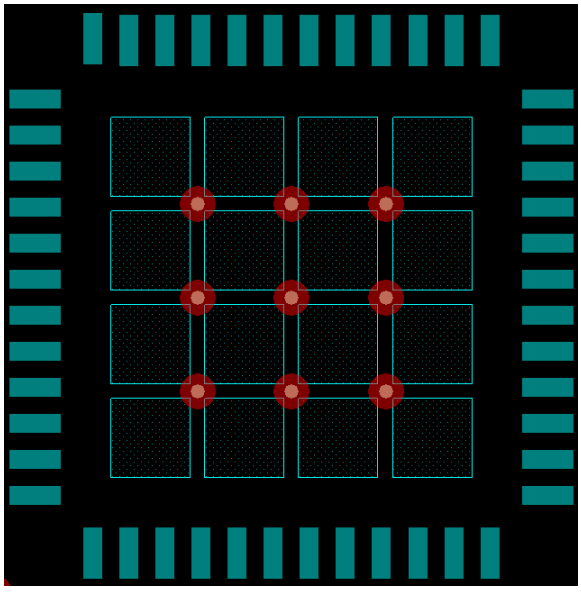


**Figure 36. 48-Pin WQFN Stencil Example of Via and Opening Placement**

The following PCB layout examples are derived from the layout design of the DS90UB903Q-Q1 and DS90UB904Q-Q1 in the SERDESUB-21USB Evaluation Module User's Guide ( SNLU101). These graphics and additional layout description are used to demonstrate both proper routing and proper solder techniques when designing in the Ser/Des pair.

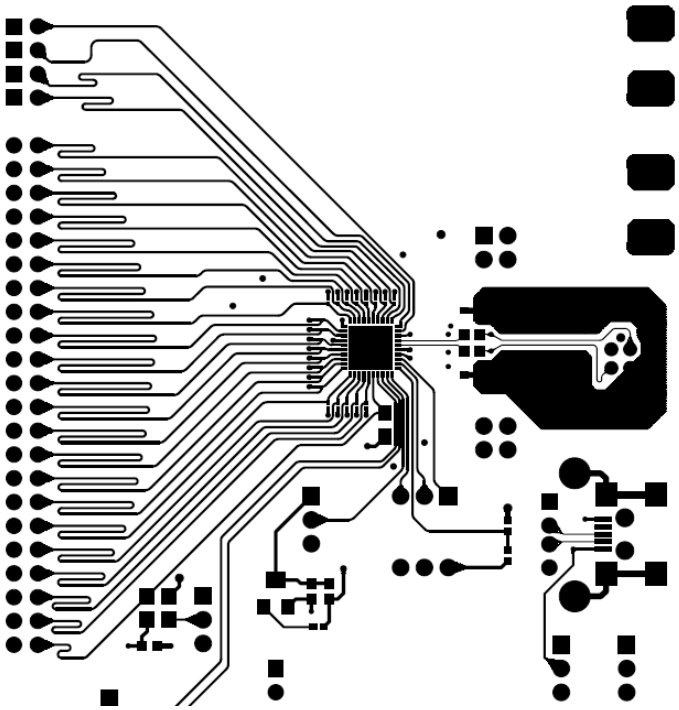


**Figure 37. DS90UR903Q-Q1 Serializer Example Layout**

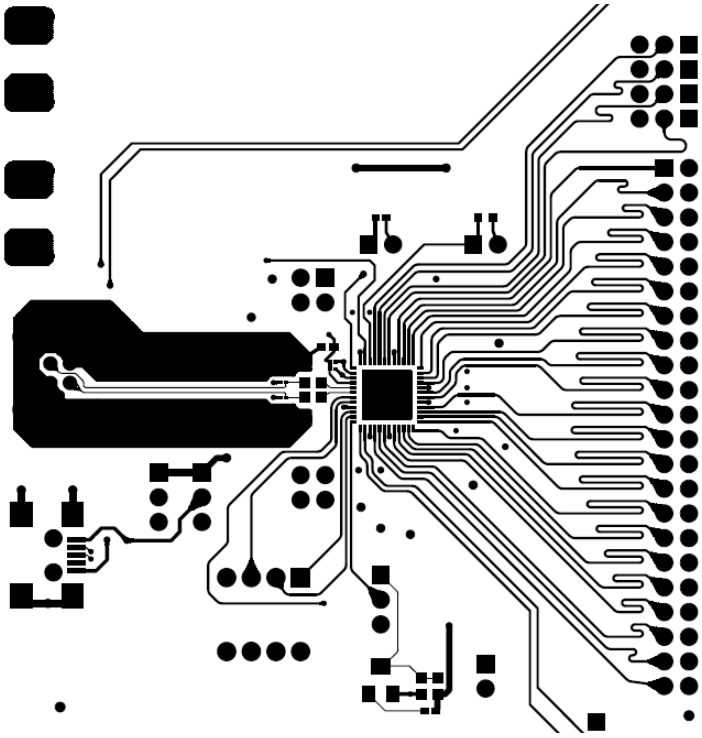


**Figure 38. DS90UR904Q-Q1 Deserializer Example Layout**

# 11 器件和文档支持

## 11.1 文档支持

### 11.1.1 相关文档

相关文档如下：

- 《焊接规范应用报告》，SNOA549
- 《IC 封装热指标应用报告》，SPRA953
- 《通道链路 PCB 和互连设计指南》，SNLA008
- 《传输线路 RAPIDESIGNER 操作和应用指南》，SNLA035
- 《无引线框架封装 (LLP) 应用报告》，SNOA401
- 《LVDS 所有者手册》，SNLA187

## 11.2 相关链接

以下表格列出了快速访问链接。 范围包括技术文档、支持与社区资源、工具和软件，并且可以快速访问样片或购买链接。

表 7. 相关链接

| 部件 | 产品文件夹 | 样片与购买 | 技术文档 | 工具与软件 | 支持与社区 |
|---|---|---|---|---|---|
| DS90UR903Q-Q1 | 请单击此处 | 请单击此处 | 请单击此处 | 请单击此处 | 请单击此处 |
| DS90UR904Q-Q1 | 请单击此处 | 请单击此处 | 请单击此处 | 请单击此处 | 请单击此处 |

## 11.3 商标

All trademarks are the property of their respective owners.

## 11.4 静电放电警告

这些装置包含有限的内置 ESD 保护。 存储或装卸时，应将导线一起截短或将装置放置于导电泡棉中，以防止 MOS 门极遭受静电损伤。

## 11.5 术语表

SLYZ022 — *TI 术语表*。

这份术语表列出并解释术语、首字母缩略词和定义。

# 12 机械封装和可订购信息

以下页中包括机械封装和可订购信息。 这些信息是针对指定器件可提供的最新数据。 这些数据会在无通知且不对本文档进行修订的情况下发生改变。 欲获得该数据表的浏览器版本，请查阅左侧的导航栏。

## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead finish/ Ball material (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DS90UR903QSQ/NOPB | ACTIVE | WQFN | RTA | 40 | 1000 | RoHS & Green | SN | Level-3-260C-168 HR | -40 to 105 | UR903QSQ | Samples |
| DS90UR903QSQE/NOPB | ACTIVE | WQFN | RTA | 40 | 250 | RoHS & Green | SN | Level-3-260C-168 HR | -40 to 105 | UR903QSQ | Samples |
| DS90UR903QSQX/NOPB | ACTIVE | WQFN | RTA | 40 | 2500 | RoHS & Green | SN | Level-3-260C-168 HR | -40 to 105 | UR903QSQ | Samples |
| DS90UR904QSQ/NOPB | ACTIVE | WQFN | RHS | 48 | 1000 | RoHS & Green | SN | Level-3-260C-168 HR | -40 to 105 | UR904QSQ | Samples |
| DS90UR904QSQE/NOPB | ACTIVE | WQFN | RHS | 48 | 250 | RoHS & Green | SN | Level-3-260C-168 HR | -40 to 105 | UR904QSQ | Samples |
| DS90UR904QSQX/NOPB | ACTIVE | WQFN | RHS | 48 | 2500 | RoHS & Green | SN | Level-3-260C-168 HR | -40 to 105 | UR904QSQ | 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 finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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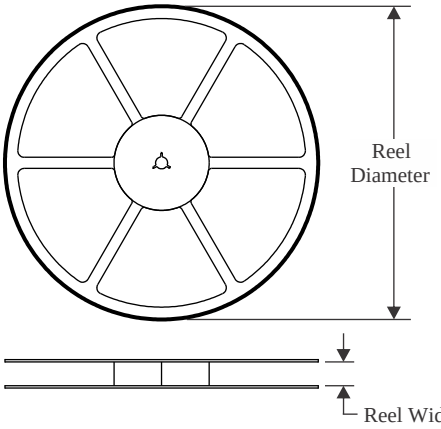
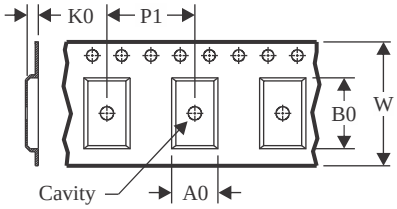
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

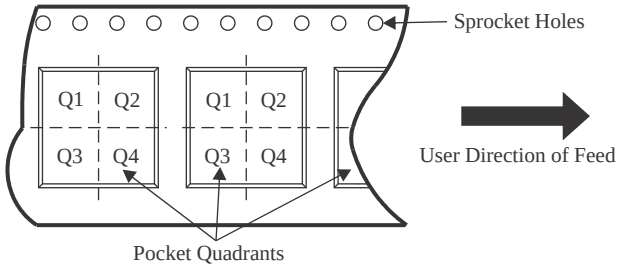



**TAPE DIMENSIONS**




| | |
|---|---|
| A0 | Dimension designed to accommodate the component width |
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

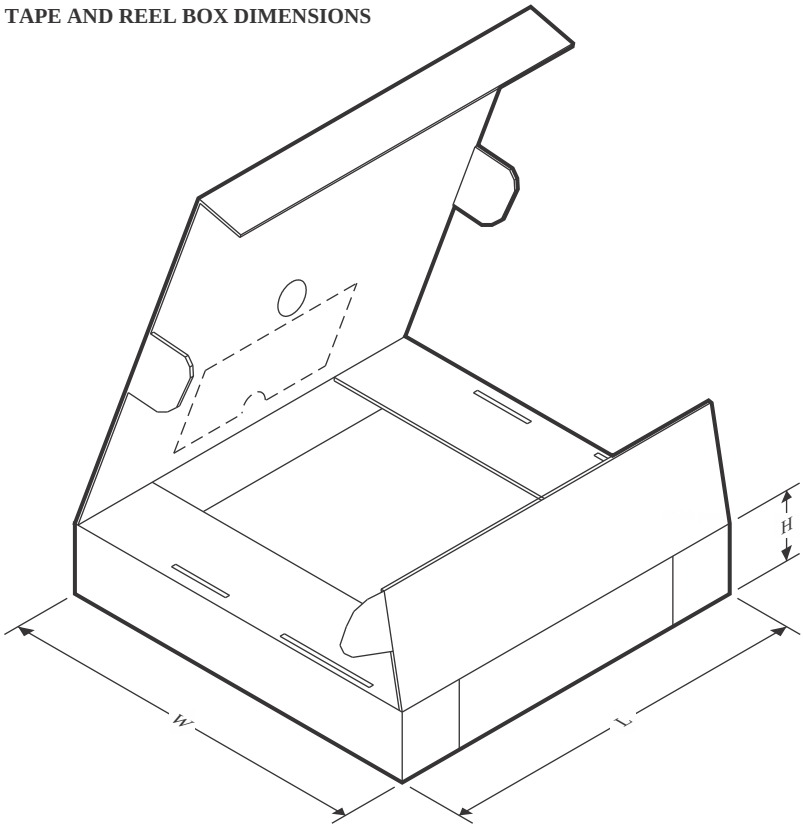
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




*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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DS90UR903QSQ/NOPB | WQFN | RTA | 40 | 1000 | 330.0 | 16.4 | 6.3 | 6.3 | 1.5 | 12.0 | 16.0 | Q1 |
| DS90UR903QSQE/NOPB | WQFN | RTA | 40 | 250 | 178.0 | 16.4 | 6.3 | 6.3 | 1.5 | 12.0 | 16.0 | Q1 |
| DS90UR903QSQX/NOPB | WQFN | RTA | 40 | 2500 | 330.0 | 16.4 | 6.3 | 6.3 | 1.5 | 12.0 | 16.0 | Q1 |
| DS90UR904QSQ/NOPB | WQFN | RHS | 48 | 1000 | 330.0 | 16.4 | 7.3 | 7.3 | 1.3 | 12.0 | 16.0 | Q1 |
| DS90UR904QSQE/NOPB | WQFN | RHS | 48 | 250 | 178.0 | 16.4 | 7.3 | 7.3 | 1.3 | 12.0 | 16.0 | Q1 |
| DS90UR904QSQX/NOPB | WQFN | RHS | 48 | 2500 | 330.0 | 16.4 | 7.3 | 7.3 | 1.3 | 12.0 | 16.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS




*All dimensions are nominal

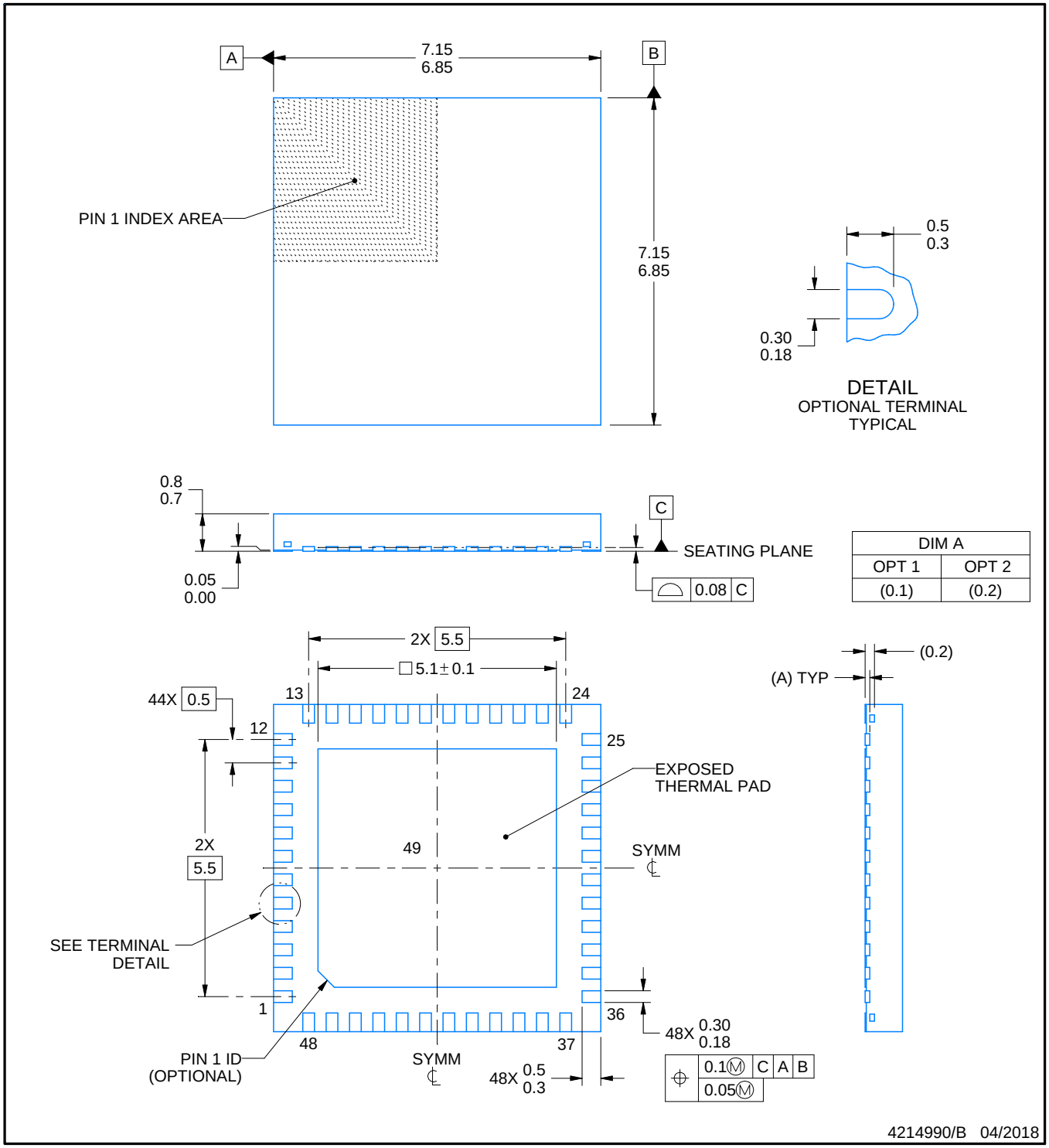
| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| DS90UR903QSQ/NOPB | WQFN | RTA | 40 | 1000 | 356.0 | 356.0 | 36.0 |
| DS90UR903QSQE/NOPB | WQFN | RTA | 40 | 250 | 208.0 | 191.0 | 35.0 |
| DS90UR903QSQX/NOPB | WQFN | RTA | 40 | 2500 | 356.0 | 356.0 | 36.0 |
| DS90UR904QSQ/NOPB | WQFN | RHS | 48 | 1000 | 356.0 | 356.0 | 36.0 |
| DS90UR904QSQE/NOPB | WQFN | RHS | 48 | 250 | 208.0 | 191.0 | 35.0 |
| DS90UR904QSQX/NOPB | WQFN | RHS | 48 | 2500 | 356.0 | 356.0 | 36.0 |

# PACKAGE OUTLINE

## RHS0048A

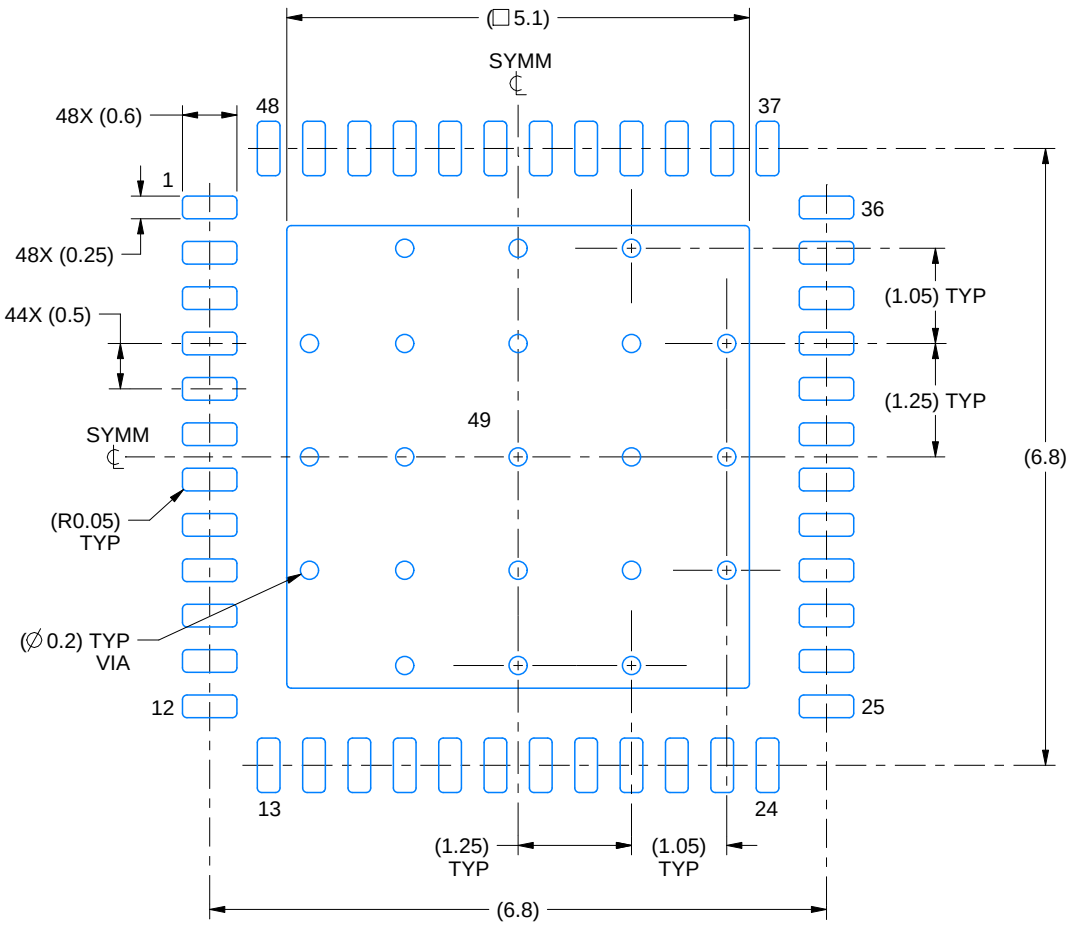
## WQFN - 0.8 mm max height

PLASTIC QUAD FLATPACK - NO LEAD

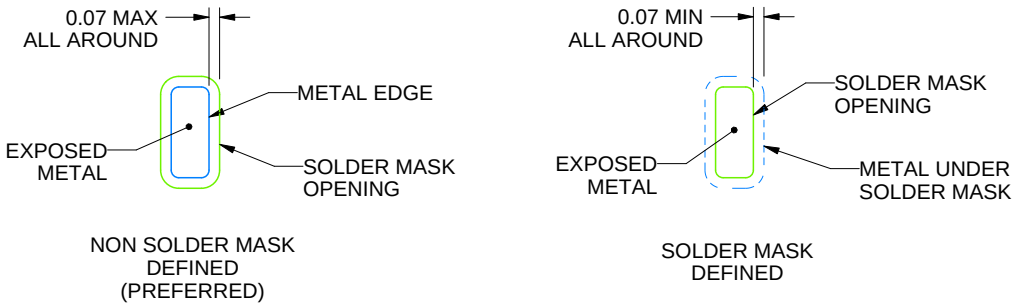



NOTES:

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 thermal and mechanical performance.




LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:12X

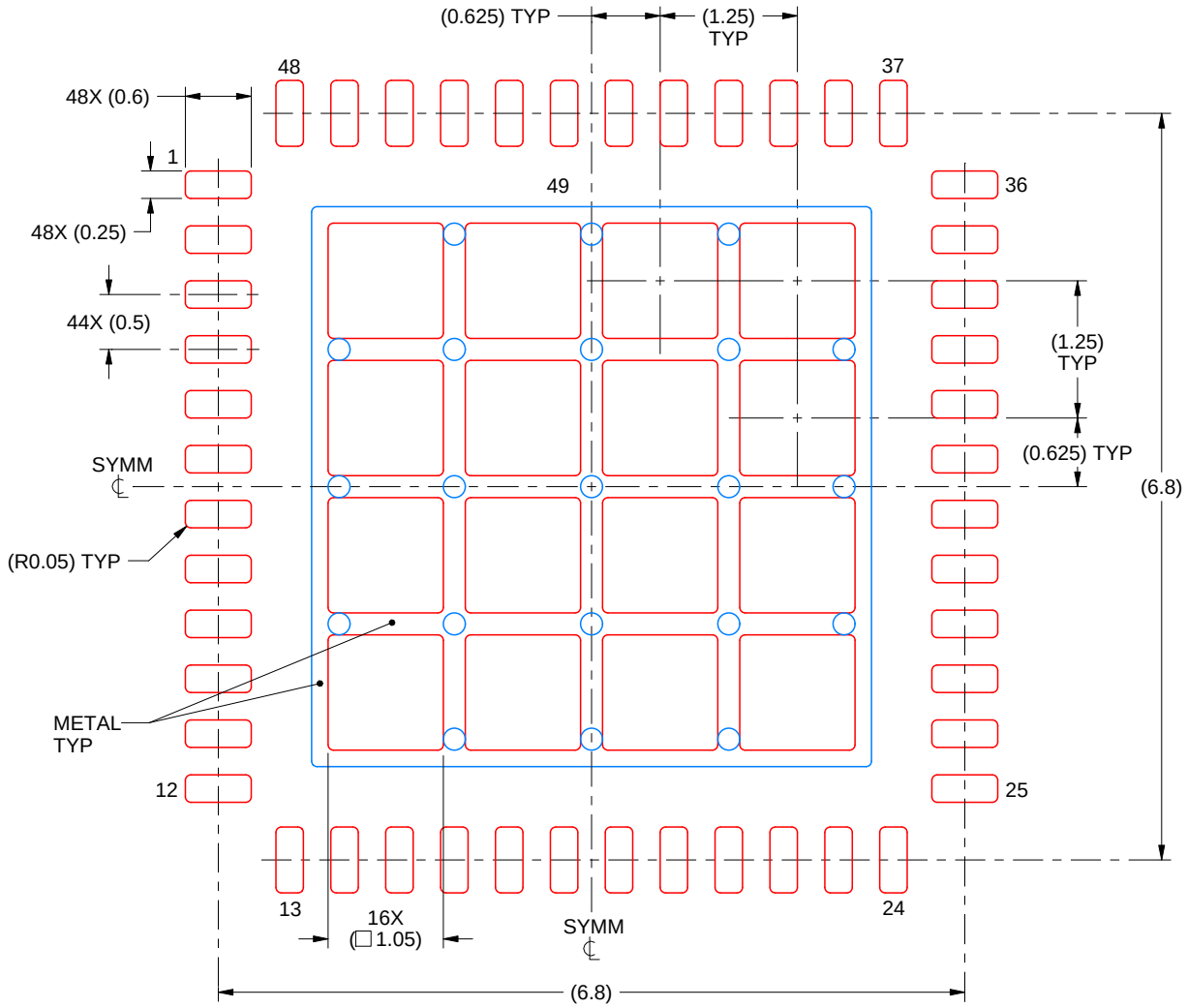



SOLDER MASK DETAILS

4214990/B 04/2018

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).
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.




SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD 49
68% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE
SCALE:15X

4214990/B 04/2018

NOTES: (continued)

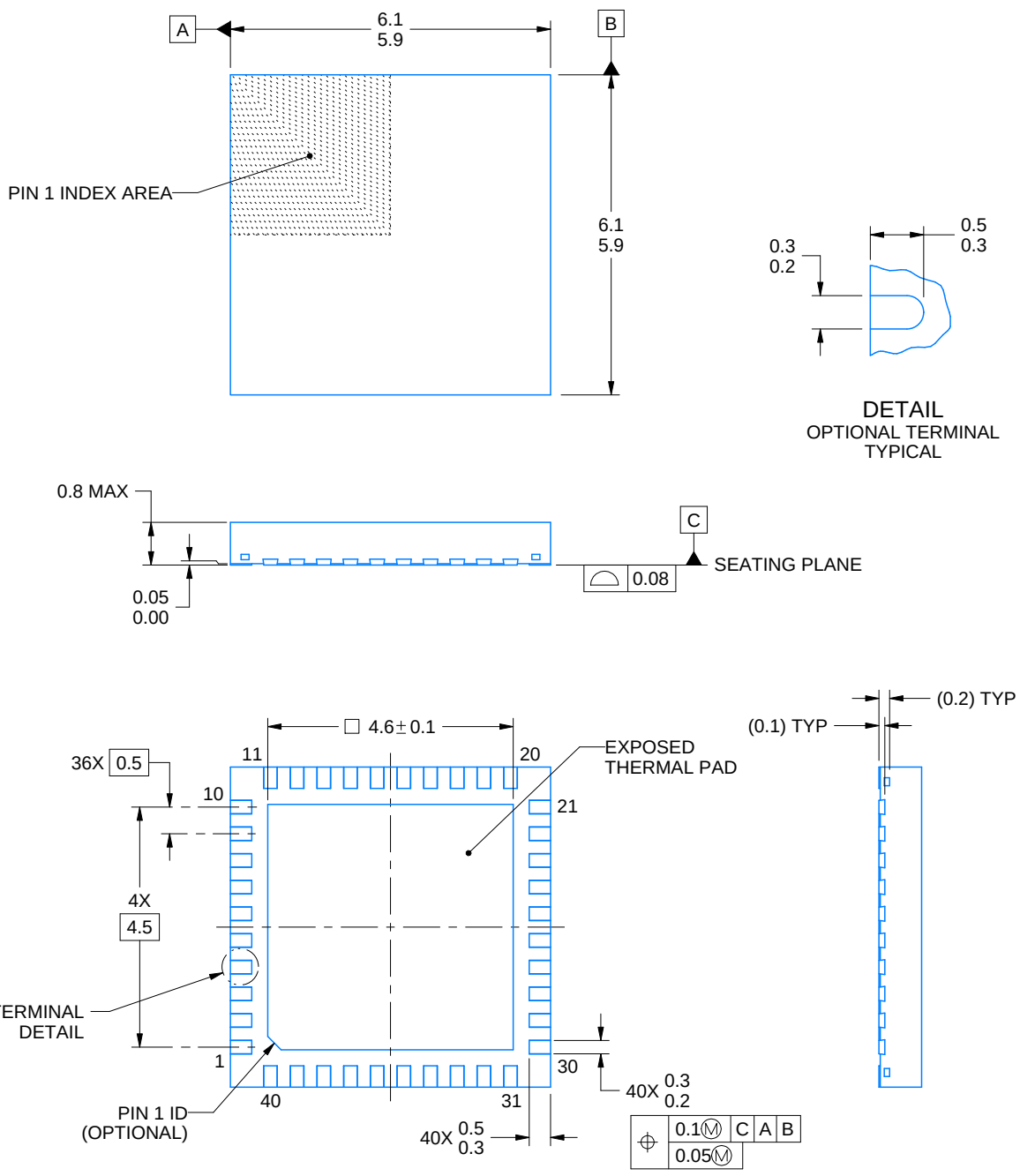
6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

# PACKAGE OUTLINE

## RTA0040A

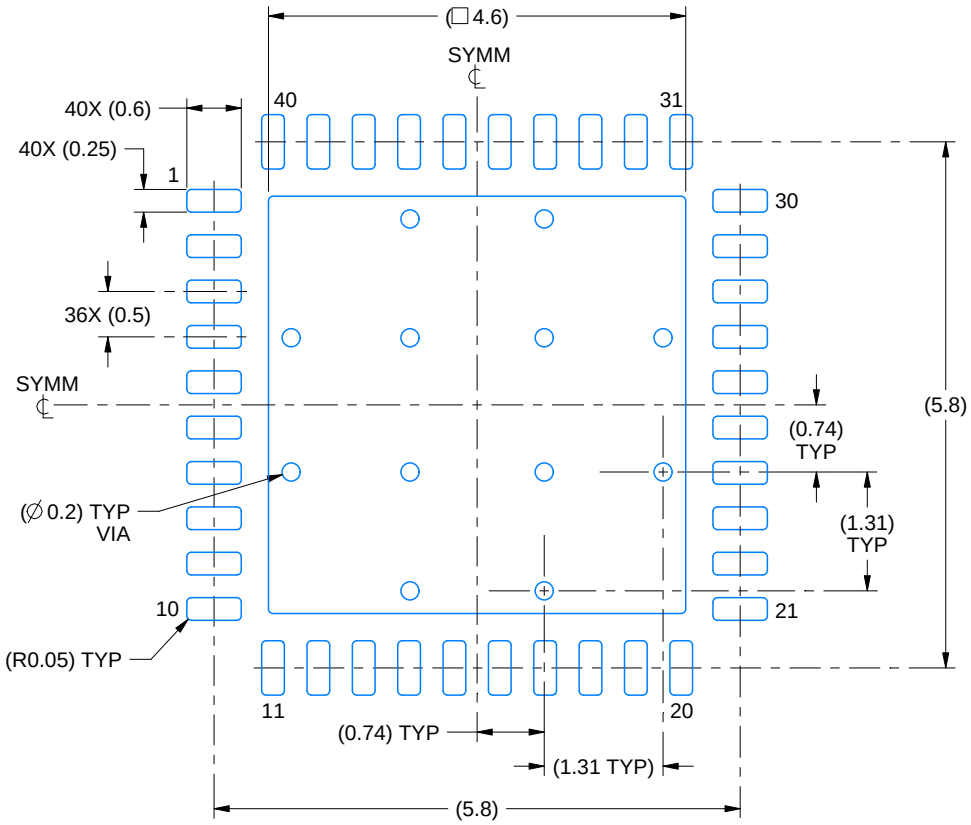
## WQFN - 0.8 mm max height

PLASTIC QUAD FLATPACK - NO LEAD

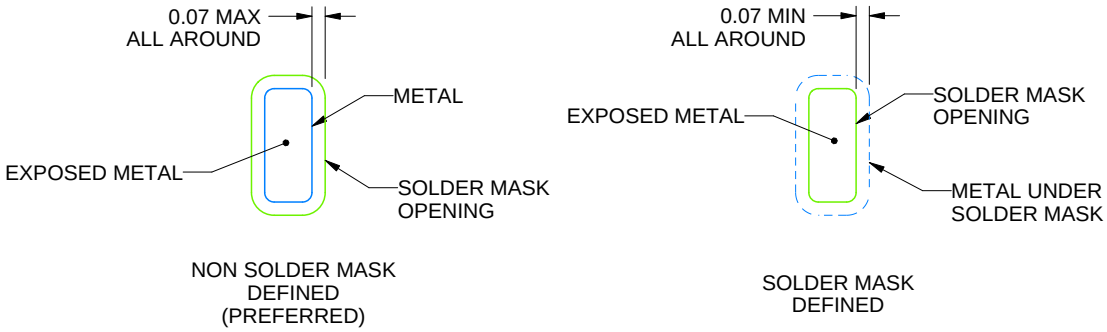



NOTES:

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 thermal and mechanical performance.




LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:12X

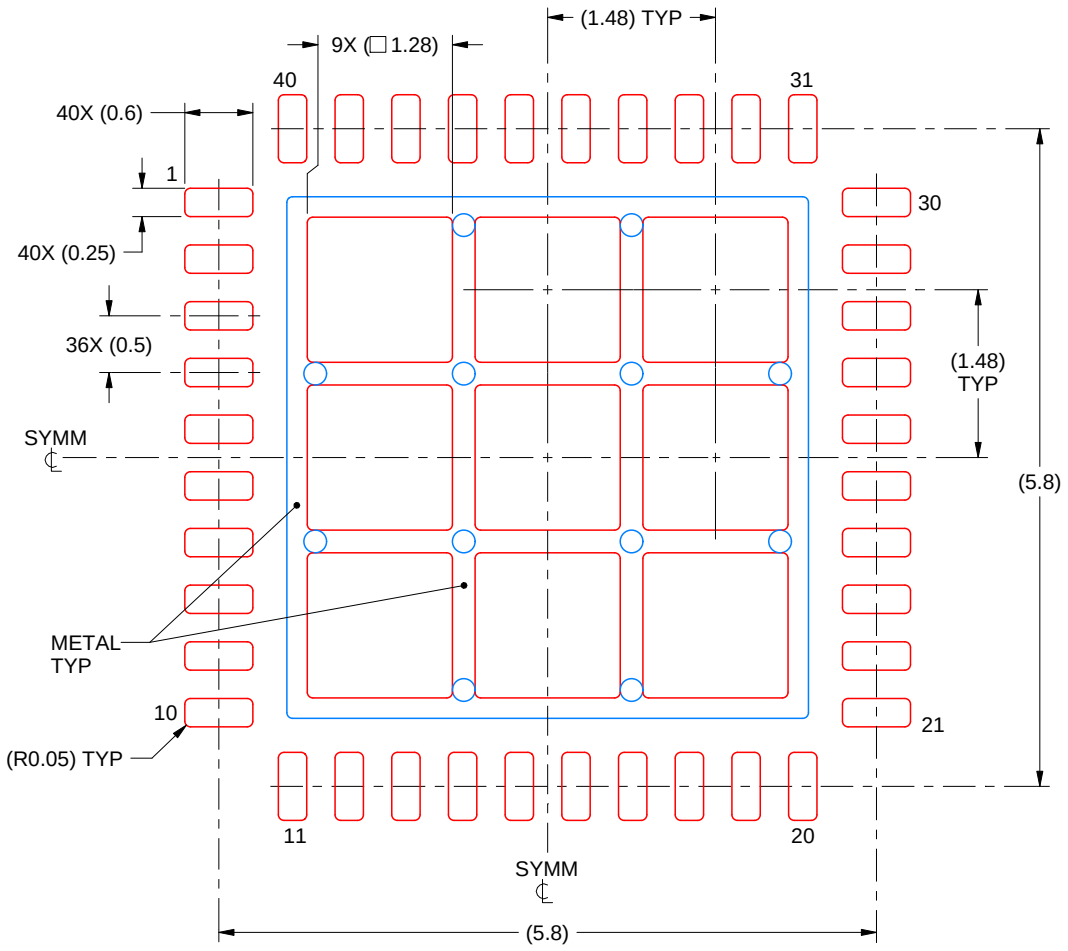



SOLDER MASK DETAILS

4214989/B 02/2017

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).
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.




SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD
70% PRINTED SOLDER COVERAGE BY AREA
SCALE:15X

4214989/B 02/2017

NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

# 重要声明和免责声明

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