

# PTN3356R1

ROM-based low-power DisplayPort to VGA adapter

Rev. 2.2 — 16 August 2016

Product data sheet

## 1. General description

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PTN3356R1 is a ROM-based DisplayPort to VGA adapter optimized primarily for motherboard applications, to convert a DisplayPort signal from the chip set to an analog video signal that directly connects to the VGA connector. PTN3356R1 integrates a DisplayPort receiver, a high-speed triple video digital-to-analog converter that supports a wide range of display resolutions, for example, VGA to WUXGA (see [Table 8](#)).

PTN3356R1 supports two DisplayPort lanes operating at either 2.7 Gbit/s or 1.62 Gbit/s per lane.

PTN3356R1 supports I<sup>2</sup>C-bus over AUX per *DisplayPort standard* ([Ref. 1](#)), and bridges the VESA DDC channel to the DisplayPort Interface.

PTN3356R1 is powered from a 3.3 V power supply and consumes approximately 200 mW of power for video streaming in WUXGA resolution and 410  $\mu$ W of power in Low-power mode. The VGA output is powered down when there is no valid DisplayPort source data being transmitted. PTN3356R1 also aids in monitor detection by performing load sensing on RGB lines and reporting sink connection status to the source.

## 2. Features and benefits

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### 2.1 VESA-compliant DisplayPort converter

- Main Link: 1-lane and 2-lane modes supported
  - ◆ HBR (High Bit Rate) at 2.7 Gbit/s per lane
  - ◆ RBR (Reduced Bit Rate) at 1.62 Gbit/s per lane
  - ◆ BER (Bit Error Rate) better than 10<sup>-9</sup>
  - ◆ DisplayPort Link down-spreading supported
- 1 MHz AUX channel
  - ◆ Supports native AUX CH syntax
  - ◆ Supports I<sup>2</sup>C-bus over AUX CH syntax
- Active HIGH Hot Plug Detect (HPD) signal to the source

### 2.2 VESA-compliant eDP extensions

- Supports Alternate Scrambler Seed Reset (ASSR)
- Supports Alternate Enhanced Framing mode - Enhanced Framing

### 2.3 DDC channel output

- I<sup>2</sup>C-Over-AUX feature facilitates support of MCCS, DDC/CI, and DDC protocols (see [Ref. 2](#))



## 2.4 Analog video output

- VSIS 1.2 compliance ([Ref. 3](#)) for supported video output modes
- Analog RGB current-source outputs
- 3.3 V VSYNC and HSYNC outputs
- Pixel clock up to 240 MHz
- Triple 8-bit Digital-to-Analog Converter (DAC)
- Direct drive of double terminated 75  $\Omega$  load with standard 700 mV (peak-to-peak) signals

## 2.5 General features

- Monitor presence detection through load detection scheme. Connection/disconnection reported via HPD IRQ and DPCD update.
- Wide set of display resolutions are supported<sup>1</sup>:
  - ◆ 1920 × 1440, 60 Hz, 18 bpp, 234 MHz pixel clock rate
  - ◆ 2048 × 1152, 60 Hz (reduced blanking), 24 bpp, 162 MHz pixel clock rate
  - ◆ 2048 × 1536, 50 Hz (reduced blanking), 24 bpp, 167.2 MHz pixel clock rate
  - ◆ WUXGA: 1920 × 1200, 60 Hz, 18 bpp, 193 MHz pixel clock rate
  - ◆ WUXGA: 1920 × 1200, 60 Hz (reduced blanking), 24 bpp, 154 MHz pixel clock rate
  - ◆ UXGA: 1600 × 1200, 60 Hz, 162 MHz pixel clock rate
  - ◆ SXGA: 1280 × 1024, 60 Hz, 108 MHz pixel clock rate
  - ◆ XGA: 1024 × 768, 60 Hz, 65 MHz pixel clock rate
  - ◆ SVGA: 800 × 600, 60 Hz, 40 MHz pixel clock rate
  - ◆ VGA: 640 × 480, 60 Hz, 25 MHz pixel clock rate
  - ◆ Any resolution and refresh rates are supported from 25 MHz up to 180 MHz pixel clock rate at 24 bpp, or up to 240 MHz pixel clock rate at 18 bpp
- Bits per color (bpc) supported<sup>1</sup>
  - ◆ 6, 8 bits supported
  - ◆ 10, 12, 16 bits supported by truncation to 8 MSBs
- All VGA colorimetry formats (RGB) supported
- Power modes (when the application design is as per [Figure 4](#))
  - ◆ Active-mode power consumption: ~200 mW at WUXGA, 1920 × 1200, 60 Hz (18 bpc)
  - ◆ 410  $\mu$ W at Low-power mode
- Supports flexible choice of timing reference
  - ◆ On-board oscillator with external crystal, ceramic resonator
  - ◆ Different frequencies supported: 24 MHz, 25 MHz, 27 MHz
- ESD protection: 7 kV HBM
- Single power supply (3.3 V) for easy integration in the platforms
- Commercial temperature range: 0 °C to 85 °C
- 32-pin HVQFN, 5 mm × 5 mm × 0.85 mm (nominal); 0.5 mm pitch; lead-free package

1. Except for color depth beyond 8 bits, display resolutions and refresh rates are only limited to those which a standard 2-lane DisplayPort configuration is able to support over 2.7 Gbit/s per lane of DP Main Link.

### 3. Applications

- Notebook computers, tablets and desktop PCs
- Dongles, adapters, docking stations

### 4. Ordering information

Table 1. Ordering information

| Type number | Topside mark | Package |  |          |
|-------------|--------------|---------|--|----------|
|             |              | Name    | Description  | Version  |
| PTN3356R1BS | 356R1        | HVQFN32 | plastic thermal enhanced very thin quad flat package; no leads; 32 terminals; 5 × 5 × 0.85 mm <sup>[1]</sup> | SOT617-3 |

[1] Maximum height is 1 mm.

#### 4.1 Ordering options

Table 2. Ordering options

| Type number | Orderable part number | Package | Packing method                             | Minimum order quantity | Temperature                       |
|-------------|-----------------------|---------|--|------------------------|-----------------------------------|
| PTN3356R1BS | PTN3356R1BSMP         | HVQFN32 | Reel 13" Q2/T3 *standard mark SMD dry pack | 6000                   | T <sub>amb</sub> = 0 °C to +85 °C |

## 5. Functional diagram

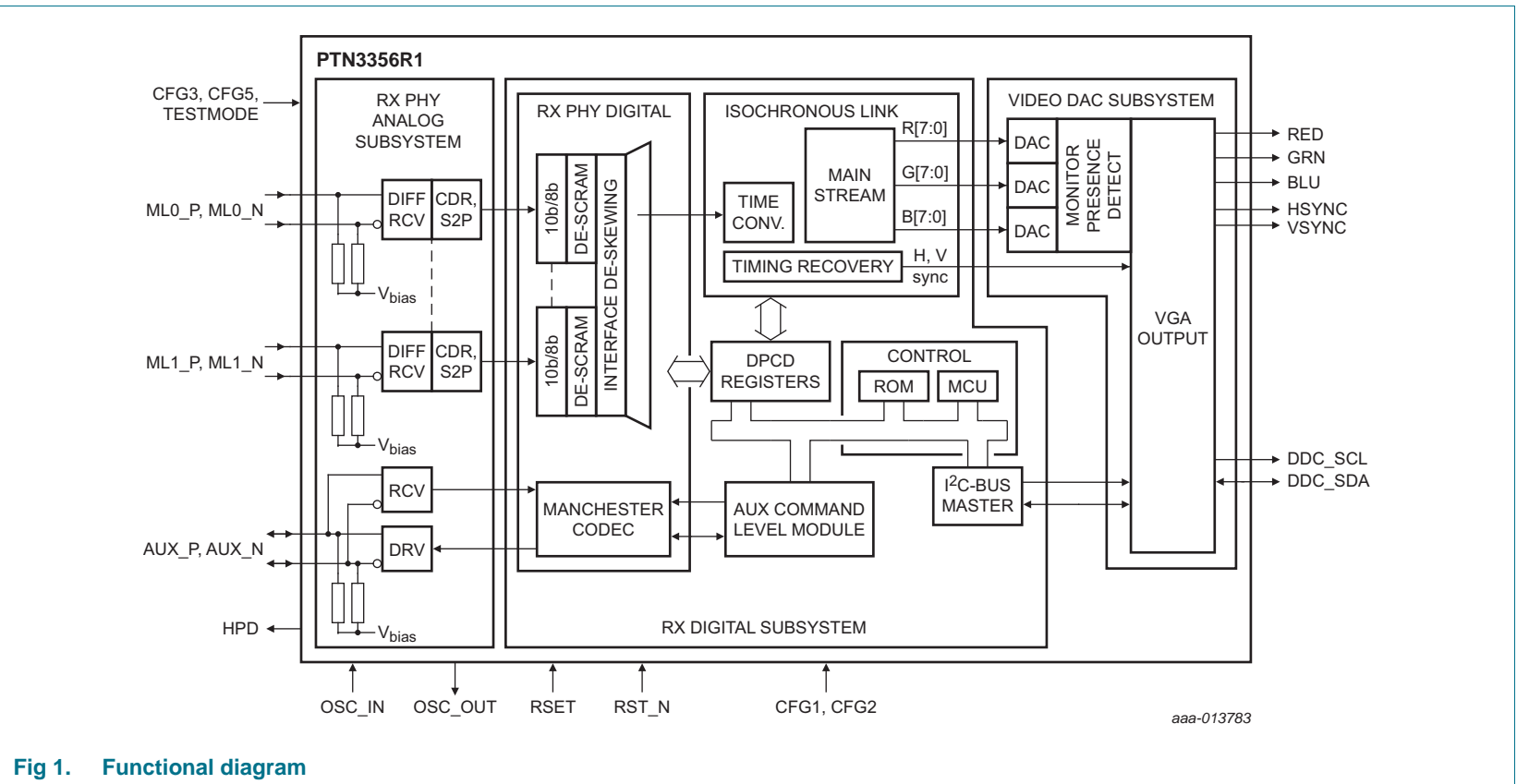
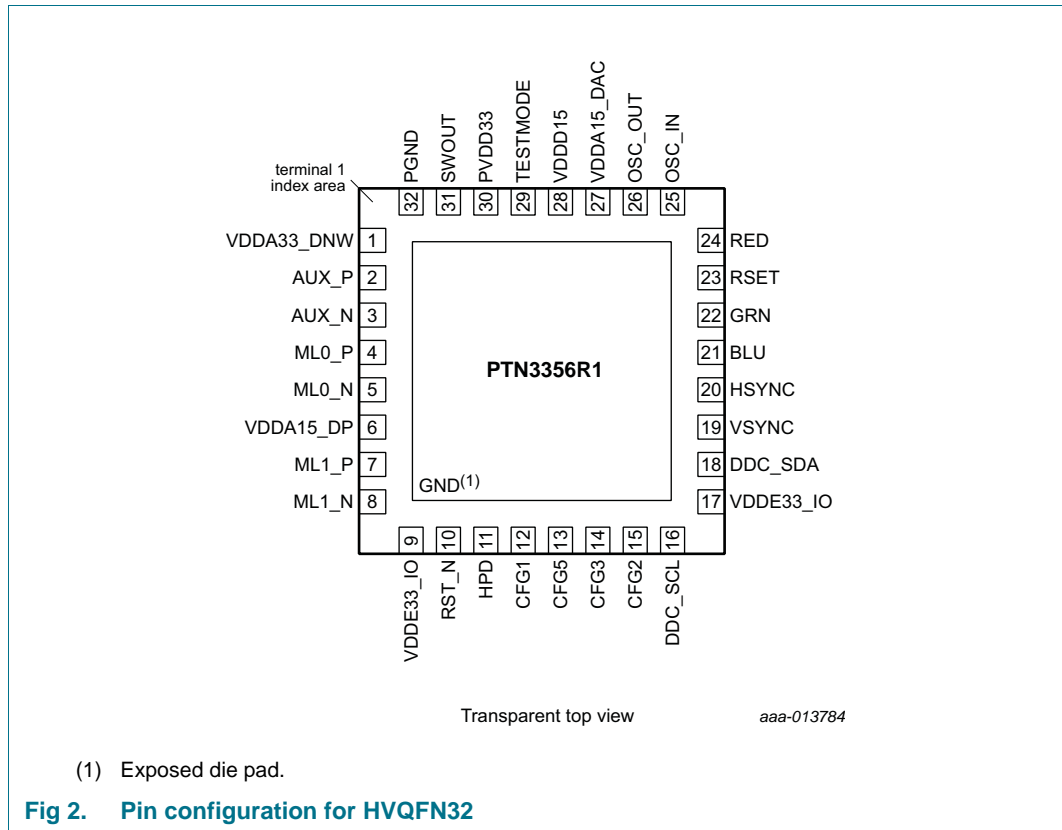


Fig 1. Functional diagram

## 6. Pinning information

### 6.1 Pinning



### 6.2 Pin description

**Table 3. Pin description**

| Symbol     | Pin | Type                            | Description   |
|------------|-----|---------------------------------|---|
| VDDA33_DNW | 1   | power                           | 3.3 V power supply  |
| AUX_P      | 2   | self-biasing differential input | DisplayPort AUX channel positive input  |
| AUX_N      | 3   | self-biasing differential input | DisplayPort AUX channel negative input  |
| ML0_P      | 4   | self-biasing differential input | DisplayPort Main Link lane 0 positive input                                       |
| ML0_N      | 5   | self-biasing differential input | DisplayPort Main Link lane 0 negative input                                       |
| VDDA15_DP  | 6   | power                           | 1.5 V power supply for DisplayPort PHY; power provided to this pin from SWOUT pin |
| ML1_P      | 7   | self-biasing differential input | DisplayPort Main Link lane 1 positive input                                       |
| ML1_N      | 8   | self-biasing differential input | DisplayPort Main Link lane 1 negative input                                       |

Table 3. Pin description ...continued

| Symbol             | Pin | Type                          | Description  |
|--------------------|-----|-------------------------------|--|
| VDDE33_IO          | 9   | power                         | 3.3 V power supply for I/O   |
| RST_N              | 10  | 3.3 V digital input           | Reset input active LOW; pulled up to $V_{DD(3V3)}$ internally                  |
| HPD                | 11  | 3.3 V digital I/O             | DisplayPort Hot Plug Detection output  |
| CFG1               | 12  | 5 V open-drain I/O            | General purpose configuration pin CFG1   |
| CFG5               | 13  | 3.3 V digital I/O             | Configuration pin supporting trinary input                                     |
| CFG3               | 14  | 3.3 V digital I/O             | Reserved   |
| CFG2               | 15  | 5 V open-drain I/O            | General purpose configuration pin CFG2   |
| DDC_SCL            | 16  | 5 V open-drain I/O            | DDC I <sup>2</sup> C-bus clock   |
| VDDE33_IO          | 17  | power                         | 3.3 V power supply for I/O   |
| DDC_SDA            | 18  | 5 V open-drain I/O            | DDC I <sup>2</sup> C-bus data  |
| VSYNC              | 19  | 3.3 V 50 $\Omega$ digital I/O | Vertical sync  |
| HSYNC              | 20  | 3.3 V 50 $\Omega$ digital I/O | Horizontal sync  |
| BLU                | 21  | analog output                 | Blue DAC analog output   |
| GRN                | 22  | analog output                 | Green DAC analog output  |
| RSET               | 23  | input                         | Resistor for DAC output reference control                                      |
| RED                | 24  | analog output                 | Red DAC analog output  |
| OSC_IN             | 25  | input                         | Crystal oscillator input   |
| OSC_OUT            | 26  | output                        | Crystal oscillator output  |
| VDDA15_DAC         | 27  | power                         | 1.5 V power supply for DAC; power provided to this pin from SWOUT pin          |
| VDDD15             | 28  | power                         | 1.5 V power supply for digital core; power provided to this pin from SWOUT pin |
| TESTMODE           | 29  | input                         | Test mode selection for CFG/JTAG   |
| PVDD33             | 30  | power                         | 3.3 V power supply for switching regulator                                     |
| SWOUT              | 31  | power                         | Switching regulator output   |
| PGND               | 32  | ground                        | Ground for switching regulator   |
| GND <sup>[1]</sup> | -   | power                         | central supply ground connection (exposed die pad)                             |

- [1] HVQFN32 package die supply ground is connected to exposed center pad. Exposed center pad must be connected to supply ground for proper device operation. For enhanced thermal, electrical, and board level performance, the exposed pad must be soldered to the board using a corresponding thermal pad on the board and for proper heat conduction through the board, thermal vias must be incorporated in the PCB in the thermal pad region.

## 7. Functional description

Referring to [Figure 1 “Functional diagram”](#), the PTN3356R1 performs protocol conversion from VESA DisplayPort specification to VESA VGA output. At the physical layer, PTN3356R1 implements the advanced DisplayPort Front-end technology (Auto receive equalization, Clock Data Recovery) to support the objectives of delivering excellent Signal Integrity (SI) performance, and consuming very low power consumption. The PTN3356R1 integrates a DisplayPort receiver (according to *VESA DisplayPort standard*, [Ref. 1](#)) and a high-speed triple 8-bit video digital-to-analog converter that supports a wide range of video resolutions (see [Table 8 “Display resolution and pixel clock rate<sup>\[1\]</sup>”](#)), up to a pixel clock rate of 240 MHz. The PTN3356R1 supports one or two DisplayPort Main Link lanes operating at either in 2.7 Gbit/s or 1.62 Gbit/s per lane.

PTN3356R1 comprises the following functional blocks:

- DP Main Link
- DP AUX CH (Auxiliary Channel)
- DPCD (DisplayPort Configuration Data)
- VGA monitor detection
- Video DAC

The RGB video data with corresponding synchronization references are extracted from the main stream video data. Main stream video attribute information is also extracted. This information is inserted once per video frame during the vertical blanking period by the DP source. The attributes describe the main video stream format in terms of geometry, timing, and color format. The original video clock and video stream are derived from these main link data.

The PTN3356R1 internal DPCD registers can be accessed by the DP source via the DP AUX channel. The monitor's DDC control bus may also be controlled via the DP AUX channel. PTN3356R1 implements the standard DisplayPort I<sup>2</sup>C-over-AUX protocol conversion to provide DP source access to the VGA plug DDC-I<sup>2</sup>C interface. The PTN3356R1 passes through sink-side status change (for example, hot-plug events) to the source side, through HPD interrupts and DPCD registers.

### 7.1 DisplayPort Main Link

The DisplayPort main link consists of two AC-coupled differential pairs. The 50 Ω termination resistors are integrated inside PTN3356R1.

The PTN3356R1 supports HBR at 2.7 Gbit/s and RBR at 1.62 Gbit/s per lane.

### 7.2 DisplayPort auxiliary channel (AUX CH)

The AUX CH is a half-duplex, bidirectional channel between DisplayPort source and sink. It consists of one differential pair transporting self-clocked data at 1 Mbit/s. The PTN3356R1 integrates the AUX CH replier (or slave), and responds to transactions initiated by the DisplayPort source AUX CH requester (or master).

The AUX CH uses the Manchester-II code for the self-clocked transmission of signals; every 'zero' is represented by LOW-to-HIGH transition, and 'one' represented by HIGH-to-LOW transition, in the middle of the bit time.

### 7.3 DPCD registers

DPCD registers that are part of the VESA DisplayPort standard are described in detail in [Ref. 1](#). The following describes the specific implementation by PTN3356R1 only.

PTN3356R1 DisplayPort receiver capability and status information about the link are reported by DisplayPort Configuration Data (DPCD) registers, when a DP source issues a read command on the AUX CH. The DP source device can also write to the link configuration field of DPCD to configure and initialize the link. The DPCD is DisplayPort v1.2a compliant.

PTN3356R1 specific capabilities are made available to DP source in the relevant DPCD read/write registers. In line with the DisplayPort standard ([Ref. 1](#)), the specific Link controls are also made available to initialize and maintain the DisplayPort Link.

It is the responsibility of the DP source to issue commands only within the capability of the PTN3356R1 as defined in the 'Receiver Capability Field' in order to prevent undefined behavior. PTN3356R1 specific DPCD registers are listed in [Table 4](#).

#### 7.3.1 PTN3356R1 specific DPCD register settings

**Table 4. PTN3356R1 specific DPCD registers**

| DPCD register <a href="#">[1]</a> | Description   | Power-on Reset value | Read/write over AUX CH |
|-----------------------------------|---|----------------------|------------------------|
| <b>Receiver Capability Field</b>  |   |                      |                        |
| 0000Ch                            | I <sup>2</sup> C-bus speed control capabilities bit map. Speed control is not supported through DPCD register. Default speed of 50 kbit/s is supported.   | 00h                  | read only              |
| 0000Dh                            | eDP_CONFIGURATION_CAP.<br>Bit 0 = ALTERNATE_SCRAMBLER_RESET_CAPABLE. A setting of 1 indicates that this is an eDP device that can use the eDP alternate scrambler reset value of FFFFh.<br>Bit 1 = FRAMING_CHANGE_CAPABLE. A setting of 1 indicates that this is an eDP device that uses only Enhanced Framing independently of the setting by the source of ENHANCED_FRAME_EN.<br>Bit 2 = reserved for eDP. Read 0.<br>Bit 3 = DPCD_DISPLAY_CONTROL_CAPABLE. A setting of 1 indicates that display control registers starting at address 00700h are enabled.<br>Bits 7:4 = reserved for eDP. Read all zeros. | 03h                  | read only              |
| <b>Link Configuration Field</b>   |   |                      |                        |
| 00109h                            | I <sup>2</sup> C-bus speed control capabilities bit map. Speed control is not supported and the default speed of 50 kbit/s is supported. Writes are ignored and reads would get zeros.  | 00h                  | read/write             |



Table 4. PTN3356R1 specific DPCD registers ...continued

| DPCD register [1]                   | Description  | Power-on Reset value         | Read/write over AUX CH |
|-------------------------------------|--|------------------------------|------------------------|
| 0010Ah                              | <p>Bit 0 = ALTERNATE_SCRAMBLER_RESET_ENABLE. Source sets to 1 to select the alternate scrambler reset. Writes ignored if ALTERNATE_SCRAMBLER_RESET_CAPABLE = 0. Power-on default value = 0.</p> <p>Bit 1 = FRAMING_CHANGE_ENABLE. Source sets to 1 to select the framing change. Writes ignored if FRAMING_CHANGE_CAPABLE = 0. Power-on default value = 0.</p> <p>Bits 6:2 = reserved. Read all zeros.</p> <p>Bit 7 = PANEL_SELF_TEST_ENABLE (not supported in PTN3356R1).</p> | 00h                          | read/write             |
| <b>Branch device specific field</b> |  |                              |                        |
| 00500h                              | BRANCH_IEEE_OUI 7:0<br>Branch vendor 24-bit IEEE OUI.<br>NXP OUI = 00  | 00h                          | read only              |
| 00501h                              | BRANCH_IEEE_OUI 15:8<br>NXP OUI = 60   | 60h                          | read only              |
| 00502h                              | BRANCH_IEEE_OUI 23:16<br>NXP OUI = 37  | 37h                          | read only              |
| 00503h                              | ID string = 3356N2   | 33h                          | read only              |
| 00504h                              |  | 33h                          | read only              |
| 00505h                              |  | 35h                          | read only              |
| 00506h                              |  | 36h                          | read only              |
| 00507h                              |  | 4Eh                          | read only              |
| 00508h                              |  | 32h                          | read only              |
| 00509h                              |  | Hardware revision level v1.1 | 10h                    |
| 0050Ah                              | Firmware/software major revision level   | 01h                          | read only              |
| 0050Bh                              | Firmware/software minor revision level   | 02h                          | read only              |
| 0050Ch to 005FFh                    | RESERVED   |                              | read only              |

[1] Byte fields that are not explicitly listed are by definition reserved ('RES') and their default value is 0h.

**7.4 VGA monitor detection**

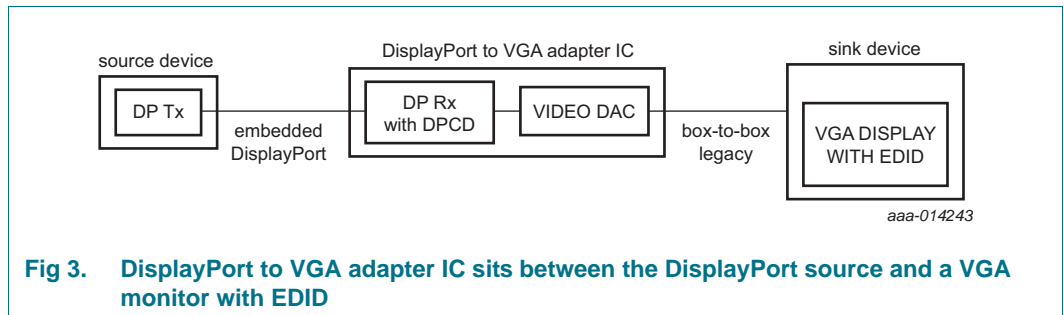
The PTN3356R1 implements a robust scheme for VGA monitor detection. It senses presence or absence of VGA monitor load termination (75 Ω) by pulsing the RGB lines. The load sensing operation is performed periodically to determine the latest VGA connectivity status. If the VGA monitor is disconnected, then the detection logic informs the host platform via IRQ\_HPD signal.

**7.5 EDID handling**

Figure 3 shows a DisplayPort-to-analog video converter between the DisplayPort source and a VGA monitor. The PTN3356R1 implements a DP I<sup>2</sup>C-Over-AUX protocol, providing for DP source access to the monitor’s DDC bus. With this, the monitor’s EDID data is made available to DP source for access at any time.

It is the responsibility of the source to choose only video modes which are declared in the EDID and to adjust the DisplayPort link capabilities (link rate and lane count) to provide the necessary video bandwidth. The PTN3356R1 does not cache or modify the EDID to match the capabilities of the DisplayPort link data.

If the DisplayPort source drives display modes that are not specified in the EDID mode list, the PTN3356R1 does not detect such conditions, and it depends entirely on the VGA display on what is being displayed.



**Fig 3. DisplayPort to VGA adapter IC sits between the DisplayPort source and a VGA monitor with EDID**

**7.6 Triple 8-bit video DACs and VGA outputs**

The triple 8-bit video DACs output a 700 mV (peak-to-peak) analog video output signal into 37.5 Ω load, as is the case of a doubly terminated 75 Ω cable. The DAC is capable of supporting the maximum pixel rate supported by a two-lane DP link (240 MHz).

**7.6.1 DAC reference resistor**

An external reference resistor must be connected between pin RSET and ground. This resistor sets the reference current which determines the analog output level, and is specified as 1.2 kΩ with a 1 % tolerance. This value allows a 0.7 V (peak-to-peak) output into a 37.5 Ω load (for example, double-terminated 75 Ω coaxial cable).

## 8. Power-up and reset

PTN3356R1 has built-in power-on reset circuitry which automatically sequences the part through reset and initialization. In addition, there is a dedicated pin (RST\_N) to control/effect reset operation externally. This provides flexibility at the platform level for debug or application purpose.

Before link is established, the PTN3356R1 holds VSYNC and HSYNC signals LOW and blanks the RGB signals.

While the PTN3356R1 performs power-on initialization,

- The HPD signal is driven LOW, to indicate to the DisplayPort source that the PTN3356R1 is not ready for AUX channel communication. Once the device is initialized, the HPD level is produced based on CFG1/CFG2 setting
- The RGB outputs are disabled
- The VSYNC and HSYNC outputs are maintained LOW as long as there is no active video streaming from the DisplayPort source.

## 9. Configurability

The PTN3356R1 delivers flexibility for application usage by providing configurability via two options:

- Configuration pins CFG1, CFG2, CFG5, and TESTMODE
- DP-AUX vendor-specific configuration registers

The pins provide limited application board level configurability, whereas vendor-specific configuration registers deliver ultimate flexibility. The configuration pin changes (static, dynamic) are reflected in the IC behavior.

The configuration pin definitions are as follows:

- CFG1, CFG2 are used as dedicated configuration pins with binary leveled I/O. The use of these configuration pins is defined in [Table 7](#).
- Configuration pin CFG5 selects OSC\_IN clock frequency setting. [Table 5](#) captures the pin definition.

**Table 5. CFG5 pin definition**

| Configuration input | OSC_IN clock frequency setting |
|---------------------|--------------------------------|
| HIGH                | 24 MHz                         |
| LOW                 | 25 MHz                         |
| OPEN                | 27 MHz                         |

The TESTMODE pin is used to indicate selection of JTAG or configuration for CFG1, CFG2 and CFG5. [Table 6](#) defines the possible combinations of TESTMODE pin.

Table 6. TESTMODE pin definition

| Pin value | Mode selection                              |
|-----------|---|
| LOW       | Configuration pin functionality is selected |
| OPEN      | Configuration pin functionality is selected |
| HIGH      | JTAG functionality is selected.             |

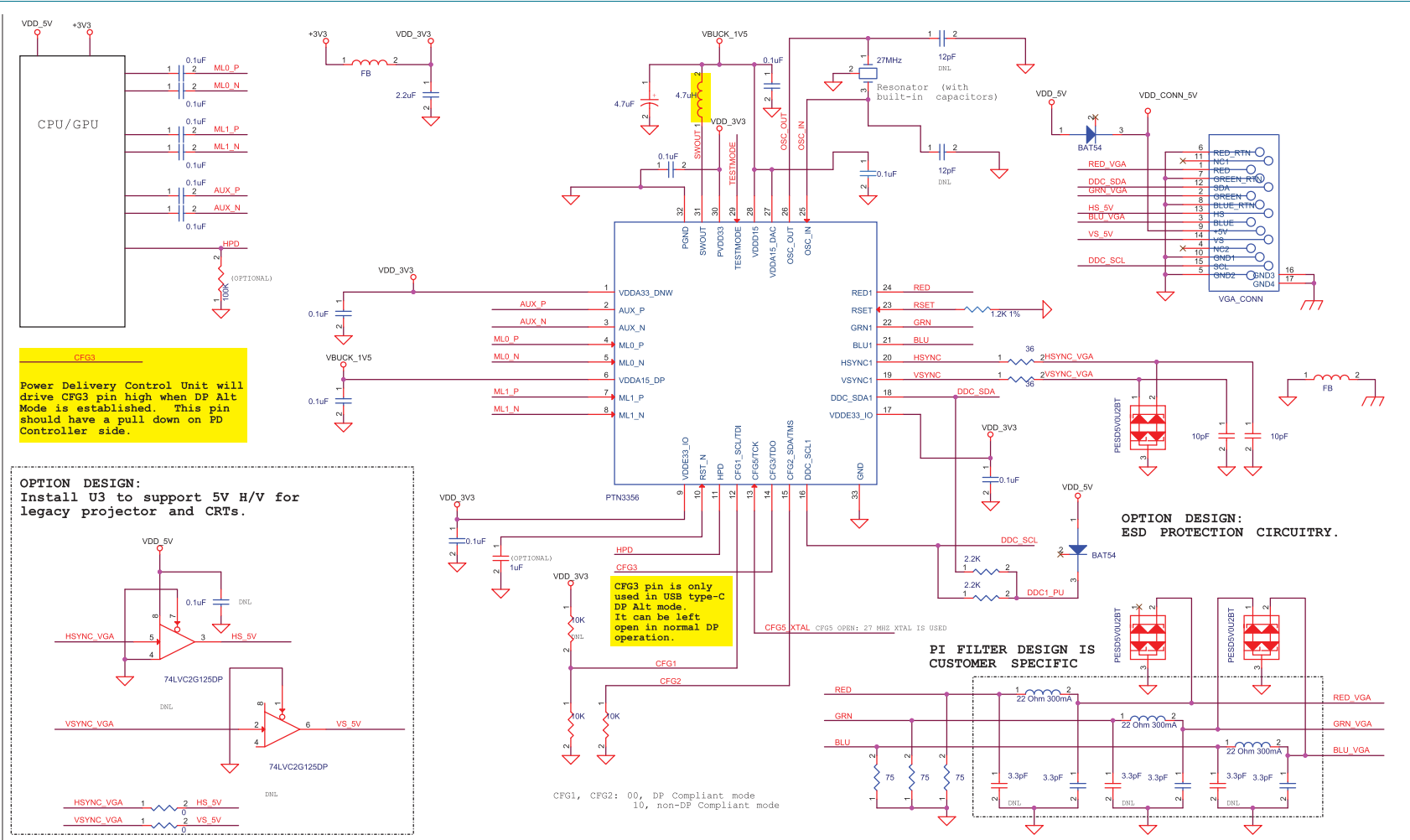
CFG1, CFG2 can be used in configuration pin mode. PTN3356R1 automatically detects the mode in which these pins are used. If they are used as Configuration pins, [Table 7](#) determines the possible and allowed combinations for these pin settings.

Table 7. CFG1/CFG2 pin definitions

| Pin value | System behavior                                 |
|-----------|---|
| 00        | Compliant HPD behavior                          |
| 01        | Most interoperable (non-compliant) HPD behavior |
| 10        | Most interoperable (non-compliant) HPD behavior |
| 11        | (Default) Compliant behavior                    |

## 10. Application design-in information

With its maximum integration features, the PTN3356R1 has low BOM requirement at the platform application level. [Figure 4](#) illustrates the PTN3356R1 usage in a system application context. On the DP side, it is connected to DP source and the VGA side, it is connected to VGA connector. The PTN3356R1 system application requires the following components additionally: supply decoupling capacitors, DC blocking capacitors, pull-up/down resistors, (optional) inductor for DC-to-DC converter, crystal oscillator. For more details on reference design information, contact NXP team.



Part shaded in yellow is extra component required in DC-to-DC converter mode to achieve low power performance.

Fig 4. Application with DC-to-DC converter mode

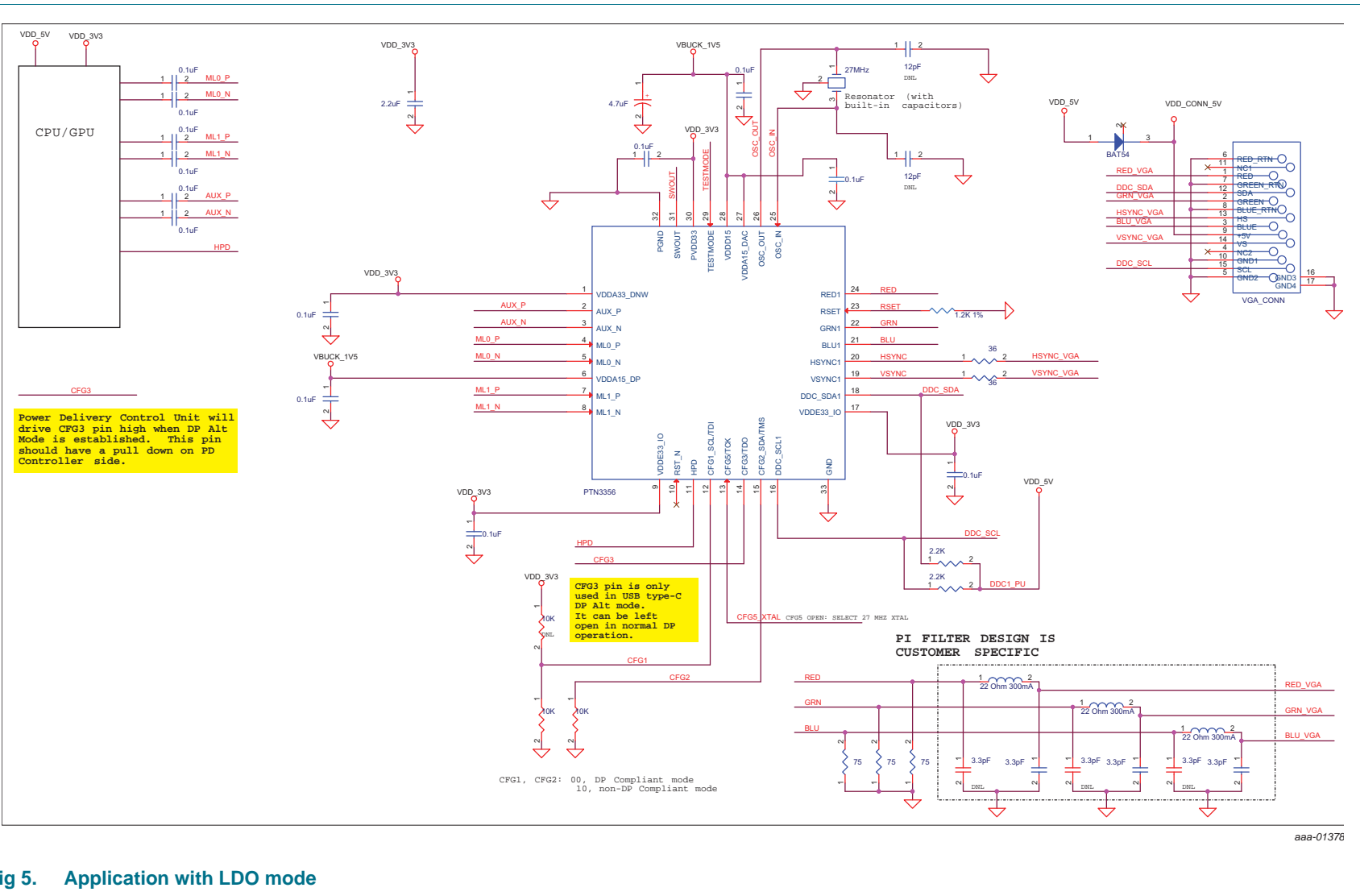


Fig 5. Application with LDO mode

## 10.1 Display resolution

[Table 8](#) lists some example display resolutions and clock rates that PTN3356R1 supports. (Refer to [Footnote 1 on page 2.](#))

**Table 8.** Display resolution and pixel clock rate<sup>[1]</sup>

| Display type | Active video |          | Total frame              |                       | Bits per pixel | Vertical frequency (Hz) | Pixel clock (MHz) | Data rate (Gbit/s) | Standard type     |
|--------------|--------------|----------|--------------------------|-----------------------|----------------|-------------------------|-------------------|--------------------|-------------------|
|              | Horizontal   | Vertical | Horizontal total (pixel) | Vertical total (line) |                |                         |                   |                    |                   |
| VGA          | 640          | 480      | 800                      | 525                   | 24             | 59.94                   | 25.175            | 0.76               | Industry standard |
| SVGA         | 800          | 600      | 1056                     | 628                   | 24             | 60.317                  | 40.000            | 1.20               | VESA guidelines   |
| XGA          | 1024         | 768      | 1344                     | 806                   | 24             | 60.004                  | 65.000            | 1.95               | VESA guidelines   |
| XGA+         | 1152         | 864      | 1600                     | 900                   | 24             | 75                      | 108.000           | 3.24               | VESA standard     |
| HD           | 1360         | 768      | 1792                     | 795                   | 24             | 60.015                  | 85.500            | 2.56               | VESA standard     |
| HD/WXGA      | 1366         | 768      | 1792                     | 798                   | 24             | 59.79                   | 85.501            | 2.57               | VESA standard     |
| HD/WXGA      | 1280         | 720      | 1650                     | 750                   | 24             | 60                      | 74.250            | 2.23               | CEA standard      |
| WXGA         | 1280         | 800      | 1680                     | 831                   | 24             | 59.81                   | 83.500            | 2.50               | CVT               |
| WXGA         | 1280         | 800      | 1696                     | 838                   | 24             | 74.934                  | 106.500           | 3.19               | CVT               |
| WXGA         | 1280         | 800      | 1712                     | 843                   | 24             | 84.88                   | 122.500           | 3.68               | CVT               |
| SXGA-        | 1280         | 960      | 1800                     | 1000                  | 24             | 60                      | 108.000           | 3.24               | VESA standard     |
| SXGA         | 1280         | 1024     | 1688                     | 1066                  | 24             | 60.02                   | 108.000           | 3.24               | VESA standard     |
| SXGA         | 1280         | 1024     | 1688                     | 1066                  | 24             | 75.025                  | 135.001           | 4.05               | VESA standard     |
| SXGA         | 1280         | 1024     | 1728                     | 1072                  | 24             | 85.024                  | 157.500           | 4.72               | VESA standard     |
| SXGA+        | 1400         | 1050     | 1864                     | 1089                  | 24             | 59.978                  | 121.749           | 3.65               | CVT               |
| WXGA+        | 1440         | 900      | 1904                     | 934                   | 24             | 59.887                  | 106.499           | 3.19               | CVT               |
| HD+          | 1600         | 900      | 1800                     | 1000                  | 24             | 60 (RB)                 | 108.000           | 3.24               | VESA standard     |
| UXGA         | 1600         | 1200     | 2160                     | 1250                  | 24             | 60                      | 162.000           | 4.86               | VESA standard     |
| UXGA         | 1600         | 1200     | 2160                     | 1250                  | 24             | 65                      | 175.500           | 5.27               | VESA standard     |
| WSXGA+       | 1680         | 1050     | 2240                     | 1089                  | 24             | 59.954                  | 146.249           | 4.39               | CVT               |
| FHD          | 1920         | 1080     | 2200                     | 1125                  | 24             | 60                      | 148.500           | 4.46               | CEA standard      |
| WUXGA        | 1920         | 1200     | 2592                     | 1245                  | 18             | 59.885                  | 193.251           | 4.35               | CVT               |
| WUXGA        | 1920         | 1200     | 2080                     | 1235                  | 24             | 59.95 (RB)              | 154.000           | 4.62               | CVT RB            |
| 2.76M3       | 1920         | 1440     | 2600                     | 1500                  | 18             | 60                      | 234.000           | 5.27               | VESA standard     |
| QWXGA        | 2048         | 1152     | 2250                     | 1200                  | 24             | 60 (RB)                 | 162.000           | 4.86               | CVT RB            |
| QXGA         | 2048         | 1536     | 2128                     | 1573                  | 24             | 49.95 (RB)              | 167.20            | 5.02               | CVT RB            |

[1] Contact NXP team for other monitor timings not listed in this table.

The available bandwidth over a 2-lane HBR DisplayPort v1.2a link limits pixel clock rate support to:

- 240 MHz at 6 bpc
- 180 MHz at 8 bpc

10.2 Power supply filter

Sufficient decoupling capacitance to ground should be connected from each  $V_{DD}$  pin directly to ground to filter supply noise.

10.3 DAC terminations

Typically, the VGA RGB outputs are (doubly) terminated. Figure 6 shows an example VGA application. A  $75\ \Omega$  termination is used to terminate inside the motherboard, and another  $75\ \Omega$  termination is typically used inside the RGB monitor. The load sensing mechanism assumes this double termination. Figure 7 is another example of VGA application with  $50\ \Omega$  PCB trace impedance with  $150\ \Omega$  terminations.

In general, it is left to the system integrator to decide on their specific implementation.

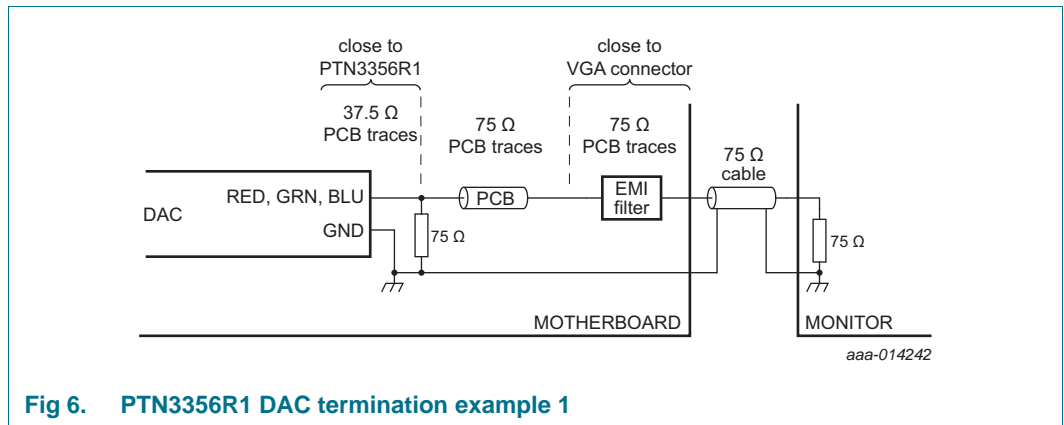


Fig 6. PTN3356R1 DAC termination example 1

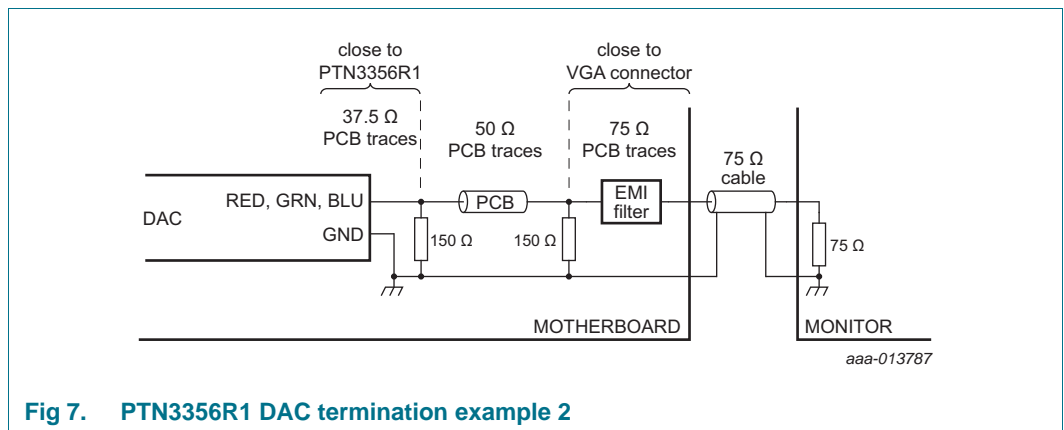


Fig 7. PTN3356R1 DAC termination example 2



## 10.4 Timing reference

PTN3356R1 requires a crystal or ceramic resonator for a stable VGA clock timing reference. Resonators have a higher frequency tolerance than crystals, but have the advantage of integrated capacitors and therefore a small PCB area and potentially lower cost.

**Table 9. Required crystal specifications (SMD components)**

| Crystal parameters                   | Specifications           |
|--------------------------------------|--------------------------|
| Frequency                            | 24 MHz, 25 MHz or 27 MHz |
| Operation mode                       | Fundamental              |
| Frequency tolerance                  | ±1 % maximum             |
| Frequency stability over temperature | ±0.4 % maximum           |
| Load capacitance ( $C_L$ )           | 18 pF                    |
| Shunt capacitance                    | < 2 pF                   |
| Equivalent Series Resistance (ESR)   | < 150 $\Omega$           |

## 11. Limiting values

**Table 10. Limiting values**

In accordance with the Absolute Maximum Rating System (IEC 60134).

| Symbol        | Parameter                       | Conditions              | Min  | Max                 | Unit |
|---------------|---------------------------------|-------------------------|------|---------------------|------|
| $V_{DD(3V3)}$ | supply voltage (3.3 V)          |                         | -0.3 | +4.6                | V    |
| $V_I$         | input voltage                   | 3.3 V CMOS inputs       | -0.3 | $V_{DD(3V3)} + 0.5$ | V    |
| $T_{stg}$     | storage temperature             |                         | -65  | +150                | °C   |
| $V_{ESD}$     | electrostatic discharge voltage | HBM <a href="#">[1]</a> | -    | 7000                | V    |
|               |                                 | CDM <a href="#">[2]</a> | -    | 1000                | V    |

[1] Human Body Model: ANSI/ESDA/JEDEC JDS-001-2012 (Revision of ANSI/ESDA/JEDEC JS-001-2011), ESDA/JEDEC Joint standard for ESD sensitivity testing, Human Body Model - Component level; Electrostatic Discharge Association, Rome, NY, USA; JEDEC Solid State Technology Association, Arlington, VA, USA.

[2] Charged Device Model: JESD22-C101E December 2009 (Revision of JESD22-C101D, October 2008), standard for ESD sensitivity testing, Charged Device Model - Component level; JEDEC Solid State Technology Association, Arlington, VA, USA.

## 12. Recommended operating conditions

**Table 11. Operating conditions**

| Symbol          | Parameter                       | Conditions                                | Min | Typ            | Max | Unit       |
|-----------------|---------------------------------|---|-----|----------------|-----|------------|
| $V_{DD(3V3)}$   | supply voltage (3.3 V)          |   | 2.8 | 3.3            | 3.6 | V          |
| $t_r$           | rise time                       | supply voltage                            | -   | -              | 10  | ms         |
| $V_I$           | input voltage                   | 3.3 V CMOS inputs                         | 0   | 3.3            | 3.6 | V          |
|                 |                                 | SDA and SCL inputs with respect to ground | 0   | 5              | 5.5 | V          |
| $R_{ext(RSET)}$ | external resistance on pin RSET | between RSET (pin 21) and GND             | -   | $1.20 \pm 1\%$ | -   | k $\Omega$ |
| $T_{amb}$       | ambient temperature             | commercial grade                          | 0   | -              | 85  | °C         |

## 13. Characteristics

### 13.1 Current consumption, power dissipation and thermal characteristics

**Table 12. Current consumption, power dissipation and thermal characteristics**

Over operating free-air temperature range, unless otherwise noted.

| Symbol               | Parameter                                   | Conditions  | Min | Typ | Max | Unit |
|----------------------|---|---|-----|-----|-----|------|
| I <sub>DD</sub>      | supply current                              | normal operation, WUXGA / 193 MHz pixel clock; V <sub>DD(3V3)</sub> = 3.3 V | -   | 60  | -   | mA   |
|                      |   | Low power D3 mode; V <sub>DD(3V3)</sub> = 3.3 V                             | -   | 124 | -   | μA   |
| P                    | power dissipation                           | normal operation, WUXGA / 193 MHz pixel clock (reduced blanking)            |     |     |     |      |
|                      |   | Buck converter mode; PTN3356R1 being used as per <a href="#">Figure 4</a>   | -   | 200 | -   | mW   |
|                      |   | LDO mode; PTN3356R1 being used as per <a href="#">Figure 5</a>              | -   | 405 | -   | mW   |
| R <sub>th(j-a)</sub> | thermal resistance from junction to ambient | in free air for SOT617-3  | -   | 45  | -   | K/W  |

**Table 13. Device characteristics**

Over operating free-air temperature range, unless otherwise noted.

| Symbol               | Parameter         | Conditions   | Min | Typ | Max | Unit |
|----------------------|-------------------|--|-----|-----|-----|------|
| t <sub>startup</sub> | start-up time     | device start-up time from power-on to HPD = HIGH; VGA monitor remains connected at power-on <sup>[1]</sup> ; RST_N = HIGH; supply voltage within operating range to specified operating characteristics                | -   | -   | 100 | ms   |
| t <sub>w(rst)</sub>  | reset pulse width | device is supplied with valid supply voltage   | 10  | -   | -   | μs   |
| t <sub>d(rst)</sub>  | reset delay time  | device reset delay time from RST_N toggling (LOW to HIGH) until HPD goes HIGH; VGA monitor remains connected at power-on <sup>[1]</sup> ; supply voltage within operating range to specified operating characteristics | -   | -   | 100 | ms   |

[1] VGA monitor remains connected at power-on — this condition is applicable only when PTN3356R1 is used in most interoperable (non-compliant) HPD mode (that is, CFG1/CFG2 is '01' or '10').

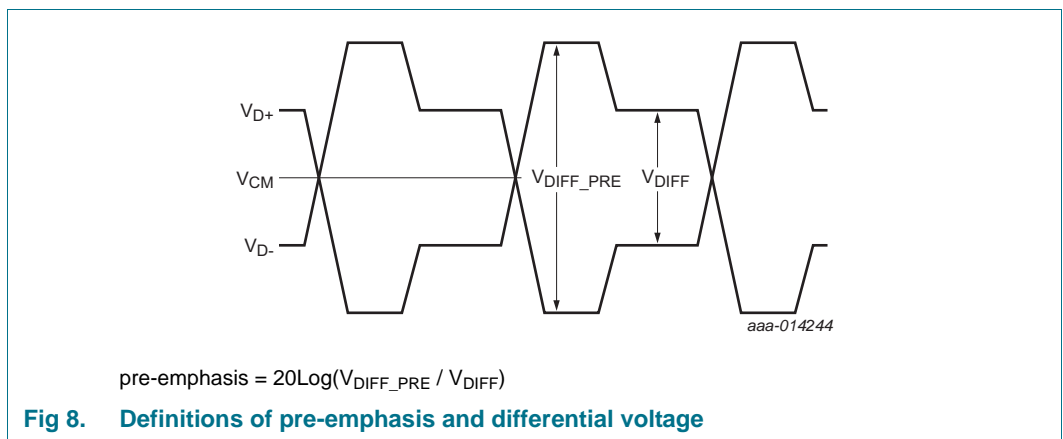
### 13.2 DisplayPort receiver main link

**Table 14. DisplayPort receiver main link characteristics<sup>[1]</sup>**

Over operating free-air temperature range, unless otherwise noted.

| Symbol                           | Parameter  | Conditions                                 | Min | Typ | Max | Unit |
|----------------------------------|--|--|-----|-----|-----|------|
| UI                               | unit interval  | for high bit rate<br>(2.7 Gbit/s per lane) | -   | 370 | -   | ps   |
|                                  |  | for low bit rate<br>(1.62 Gbit/s per lane) | -   | 617 | -   | ps   |
| $\Delta f_{\text{DOWN\_SPREAD}}$ | link clock down spreading                                | [2]  | 0.0 | -   | 0.5 | %    |
| $V_{\text{RX\_DIFFp-p}}$         | differential input peak-to-peak voltage                  | at RX package pins                         |     |     |     |      |
|                                  |  | for high bit rate [3]                      | 120 | -   | -   | mV   |
|                                  |  | for reduced bit rate [3]                   | 40  | -   | -   | mV   |
| $V_{\text{RX\_DC\_CM}}$          | RX DC common mode voltage                                | [4]  | 0   | -   | 2.0 | V    |
| $I_{\text{RX\_SHORT}}$           | RX short-circuit current limit                           | [5]  | -   | -   | 50  | mA   |
| $C_{\text{RX}}$                  | AC coupling capacitor                                    | on DP Main Link and AUX inputs             | 75  | -   | 200 | nF   |
| $f_{\text{RX\_TRACK\_BW\_HBR}}$  | jitter closed loop tracking bandwidth (High Bit Rate)    | [6]  | 10  | -   | 20  | MHz  |
| $f_{\text{RX\_TRACK\_BW\_RBR}}$  | jitter closed loop tracking bandwidth (Reduced Bit Rate) | [6]  | 5.4 | -   | 20  | MHz  |

- [1] Ref. 1 supersedes in case of any mismatch of specification items.
- [2] Up to 0.5 % down spread is supported. Modulation frequency range of 30 kHz to 33 kHz must be supported.
- [3] Informative; refer to Figure 8 for definition of differential voltage.
- [4] Common mode voltage is equal to  $V_{\text{bias\_RX}}$  voltage.
- [5] Total drive current of the input bias circuit when it is shorted to its ground.
- [6] The measurements are always taken with PRBS7 test signal. Minimum CDR closed loop tracking bandwidth at the receiver when the input is a PRBS7 pattern.



### 13.3 DisplayPort receiver AUX CH

**Table 15. DisplayPort receiver AUX CH characteristics**<sup>[1]</sup>

Over operating free-air temperature range, unless otherwise noted.

| Symbol                    | Parameter                             | Conditions          | Min                 | Typ | Max  | Unit |
|---------------------------|---------------------------------------|---------------------|---------------------|-----|------|------|
| UI                        | unit interval                         | AUX                 | <sup>[2]</sup> 0.4  | 0.5 | 0.6  | μs   |
| t <sub>jit(cc)</sub>      | cycle-to-cycle jitter time            | transmitting device | <sup>[3]</sup> -    | -   | 0.04 | UI   |
|                           |                                       | receiving device    | <sup>[4]</sup> -    | -   | 0.05 | UI   |
| V <sub>AUX_DIFFp-p</sub>  | AUX differential peak-to-peak voltage | transmitting device | <sup>[5]</sup> 0.39 | -   | 1.38 | V    |
|                           |                                       | receiving device    | <sup>[5]</sup> 0.32 | -   | 1.36 | V    |
| R <sub>AUX_TERM(DC)</sub> | AUX CH termination DC resistance      | informative         | -                   | 100 | -    | Ω    |
| V <sub>AUX_DC_CM</sub>    | AUX DC common-mode voltage            |                     | <sup>[6]</sup> 0    | -   | 2.0  | V    |
| V <sub>AUX_TURN_CM</sub>  | AUX turnaround common-mode voltage    |                     | <sup>[7]</sup> -    | -   | 0.3  | V    |
| I <sub>AUX_SHORT</sub>    | AUX short-circuit current limit       |                     | <sup>[8]</sup> -    | -   | 90   | mA   |
| C <sub>AUX</sub>          | AUX AC coupling capacitor             |                     | <sup>[9]</sup> 75   | -   | 200  | nF   |

[1] [Ref. 1](#) supersedes in case of any mismatch of specification items.

[2] Results in the bit rate of 1 Mbit/s including the overhead of Manchester II coding.

[3] Maximum allowable UI variation within a single transaction at connector pins of a transmitting device. Equal to 24 ns maximum. The transmitting device is a source device for a request transaction and a sink device for a reply transaction.

[4] Maximum allowable UI variation within a single transaction at connector pins of a receiving device. Equal to 30 ns maximum. The transmitting device is a source device for a request transaction and a sink device for a reply transaction.

[5]  $V_{AUX\_DIFFp-p} = 2 \times |V_{AUX+} - V_{AUX-}|$ .

[6] Common-mode voltage is equal to V<sub>bias\_TX</sub> (or V<sub>bias\_RX</sub>) voltage.

[7] Steady-state common-mode voltage shift between transmit and receive modes of operation.

[8] Total drive current of the transmitter when it is shorted to its ground.

[9] The AUX CH AC coupling capacitor placed both on the DisplayPort source and sink devices.

### 13.4 HPD characteristics

**Table 16. HPD characteristics**<sup>[1]</sup>

Over operating free-air temperature range, unless otherwise noted.

| Symbol                        | Parameter                               | Conditions                                   | Min | Typ | Max | Unit |
|-------------------------------|---|--|-----|-----|-----|------|
| <b>Output characteristics</b> |   |  |     |     |     |      |
| V <sub>OH</sub>               | HIGH-level output voltage               | I <sub>OH</sub> = 2 mA                       | 2.4 | -   | -   | V    |
| V <sub>OL</sub>               | LOW-level output voltage                | I <sub>OL</sub> = -2 mA                      | -   | -   | 0.4 | V    |
| I <sub>OSH</sub>              | HIGH-level short-circuit output current | drive HIGH; cell connected to ground         | -   | -   | 16  | mA   |
| I <sub>OSL</sub>              | LOW-level short-circuit output current  | drive LOW; cell connected to V <sub>DD</sub> | -   | -   | 15  | mA   |

[1] [Ref. 1](#) supersedes in case of any mismatch of specification items.

### 13.5 DDC/CFG1, CFG2 characteristics

**Table 17. DDC/CFG1, CFG2 characteristics**

V<sub>CC</sub> = 4.5 V to 5.5 V<sup>[1]</sup>. Over operating free-air temperature range, unless otherwise noted.

| Symbol                        | Parameter                    | Conditions   | Min                        | Typ | Max                         | Unit |
|-------------------------------|------------------------------|--|----------------------------|-----|-----------------------------|------|
| <b>Input characteristics</b>  |                              |  |                            |     |                             |      |
| V <sub>IH</sub>               | HIGH-level input voltage     |  | 0.7 × V <sub>DD(3V3)</sub> | -   | 5.5                         | V    |
| V <sub>IL</sub>               | LOW-level input voltage      |  | -0.5                       | -   | +0.3 × V <sub>DD(3V3)</sub> | V    |
| V <sub>I(hys)</sub>           | hysteresis of input voltage  |  | 0.1 × V <sub>DD(3V3)</sub> | -   | -                           | V    |
| I <sub>LI</sub>               | input leakage current        | V <sub>I</sub> = 5 V                                 | -                          | -   | 10                          | μA   |
| <b>Output characteristics</b> |                              |  |                            |     |                             |      |
| I <sub>OL</sub>               | LOW-level output current     | V <sub>OL</sub> = 0.4 V                              | 3.0                        | -   | -                           | mA   |
| I <sub>O(sc)</sub>            | short-circuit output current | drive LOW;<br>cell connected to V <sub>DD(3V3)</sub> | -                          | -   | 40.0                        | mA   |
| C <sub>io</sub>               | input/output capacitance     | V <sub>I</sub> = 3 V or 0 V                          |                            |     |                             |      |
|                               |                              | V <sub>DD(3V3)</sub> = 3.3 V                         | -                          | 6   | 7                           | pF   |
|                               |                              | V <sub>DD(3V3)</sub> = 0 V                           | -                          | 6   | 7                           | pF   |

[1] V<sub>CC</sub> is the pull-up voltage for DDC/CFG1, CFG2.

[2] [Table 17](#) applies to CFG1 and CFG2 pins as they operate as I<sup>2</sup>C-bus I/O but only used as CFG pins.

## 13.6 DAC

**Table 18. DAC characteristics**

Over operating free-air temperature range, unless otherwise noted.

| Symbol              | Parameter                    | Conditions | Min  | Typ        | Max  | Unit |
|---------------------|------------------------------|------------|------|------------|------|------|
| $N_{res(DAC)}$      | DAC resolution               |            | -    | -          | 8    | bit  |
| $f_{clk}$           | clock frequency              |            | -    | -          | 240  | MHz  |
| $\Delta I_{o(DAC)}$ | DAC output current variation | DAC-to-DAC | -    | -          | 4    | %    |
| INL                 | integral non-linearity       |            | -1   | $\pm 0.25$ | +1   | LSB  |
| DNL                 | differential non-linearity   |            | -0.5 | $\pm 0.1$  | +0.5 | LSB  |
| $V_{o(DAC)max}$     | maximum DAC output voltage   |            | 665  | 700        | 770  | mV   |
| $C_{o(DAC)}$        | DAC output capacitance       |            | -    | 3.5        | -    | pF   |
|                     | DAC noise injection ratio    |            | -1.5 | -          | +1.5 | %    |

## 13.7 HSYNC, VSYNC characteristics

**Table 19. HSYNC and VSYNC characteristics**

Over operating free-air temperature range, unless otherwise noted.

| Symbol                        | Parameter                               | Conditions   | Min | Typ | Max | Unit |
|-------------------------------|---|--|-----|-----|-----|------|
| <b>Output characteristics</b> |   |  |     |     |     |      |
| $V_{OH}$                      | HIGH-level output voltage               | $I_{OH} = 8 \text{ mA}$ ;<br>$V_{DD(3V3)} = 3.3 \text{ V} \pm 10 \%$ | 2.4 | -   | -   | V    |
| $V_{OL}$                      | LOW-level output voltage                | $I_{OL} = -8 \text{ mA}$   | -   | -   | 0.5 | V    |
| $I_{OSH}$                     | HIGH-level short-circuit output current | drive HIGH;<br>cell connected to ground                              | [1] | -   | 100 | mA   |
| $I_{OSL}$                     | LOW-level short-circuit output current  | drive LOW;<br>cell connected to $V_{DD}$                             | [1] | -   | 100 | mA   |

[1] The parameter values specified are simulated and absolute values.

## 13.8 Configuration pins CFG3, CFG5, TESTMODE

**Table 20. Configuration pins characteristics**

Over operating free-air temperature range, unless otherwise noted.

| Symbol                                | Parameter                | Conditions                                   | Min                      | Typ | Max                      | Unit             |
|---------------------------------------|--------------------------|--|--------------------------|-----|--------------------------|------------------|
| <b>Input characteristics</b>          |                          |  |                          |     |                          |                  |
| $V_{IH}$                              | HIGH-level input voltage |  | $0.7 \times V_{DD(3V3)}$ | -   | -                        | V                |
| $V_{IL}$                              | LOW-level input voltage  |  |                          |     | $0.3 \times V_{DD(3V3)}$ | V                |
| <b>Weak pull-down characteristics</b> |                          |  |                          |     |                          |                  |
| $I_{pd}$                              | pull-down current        | $V_I = V_{DD(3V3)}$                          | 15                       | 30  | 70                       | $\mu\text{A}$    |
| $I_{pu}$                              | pull-up current          | $V_I = 0 \text{ V}$                          | 25                       | 55  | 90                       | $\mu\text{A}$    |
| $R_{ext}$                             | external resistance      | external resistor used on configuration pins | -                        | -   | 10                       | $\text{k}\Omega$ |

## 13.9 RST\_N

**Table 21. RST\_N characteristics**

Over operating free-air temperature range, unless otherwise noted.

| Symbol                       | Parameter                    | Conditions         | Min                      | Typ | Max                      | Unit          |
|------------------------------|------------------------------|--------------------|--------------------------|-----|--------------------------|---------------|
| <b>Input characteristics</b> |                              |                    |                          |     |                          |               |
| $V_{IH}$                     | HIGH-level input voltage     |                    | $0.7 \times V_{DD(3V3)}$ | -   | -                        | V             |
| $V_{IL}$                     | LOW-level input voltage      |                    | -                        | -   | $0.3 \times V_{DD(3V3)}$ | V             |
| $I_{pu(RST\_N)}$             | pull-up current on pin RST_N | $V_I = 0\text{ V}$ | 25                       | 55  | 90                       | $\mu\text{A}$ |



14. Package outline

HVQFN32: plastic thermal enhanced very thin quad flat package; no leads; 32 terminals; body 5 x 5 x 0.85 mm

SOT617-3

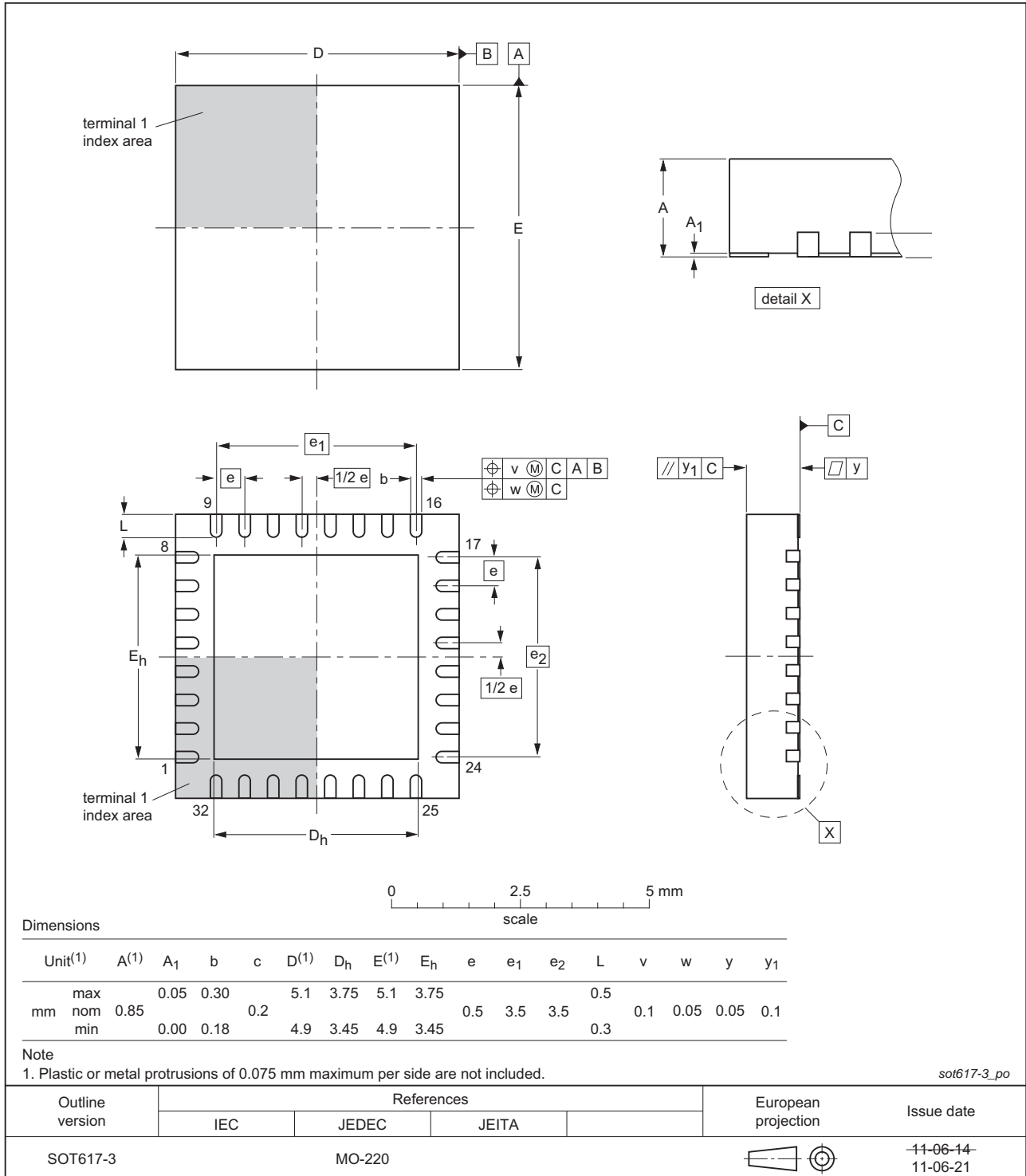


Fig 9. Package outline SOT617-3 (HVQFN32)

## 15. Packing information

### 15.1 Packing method

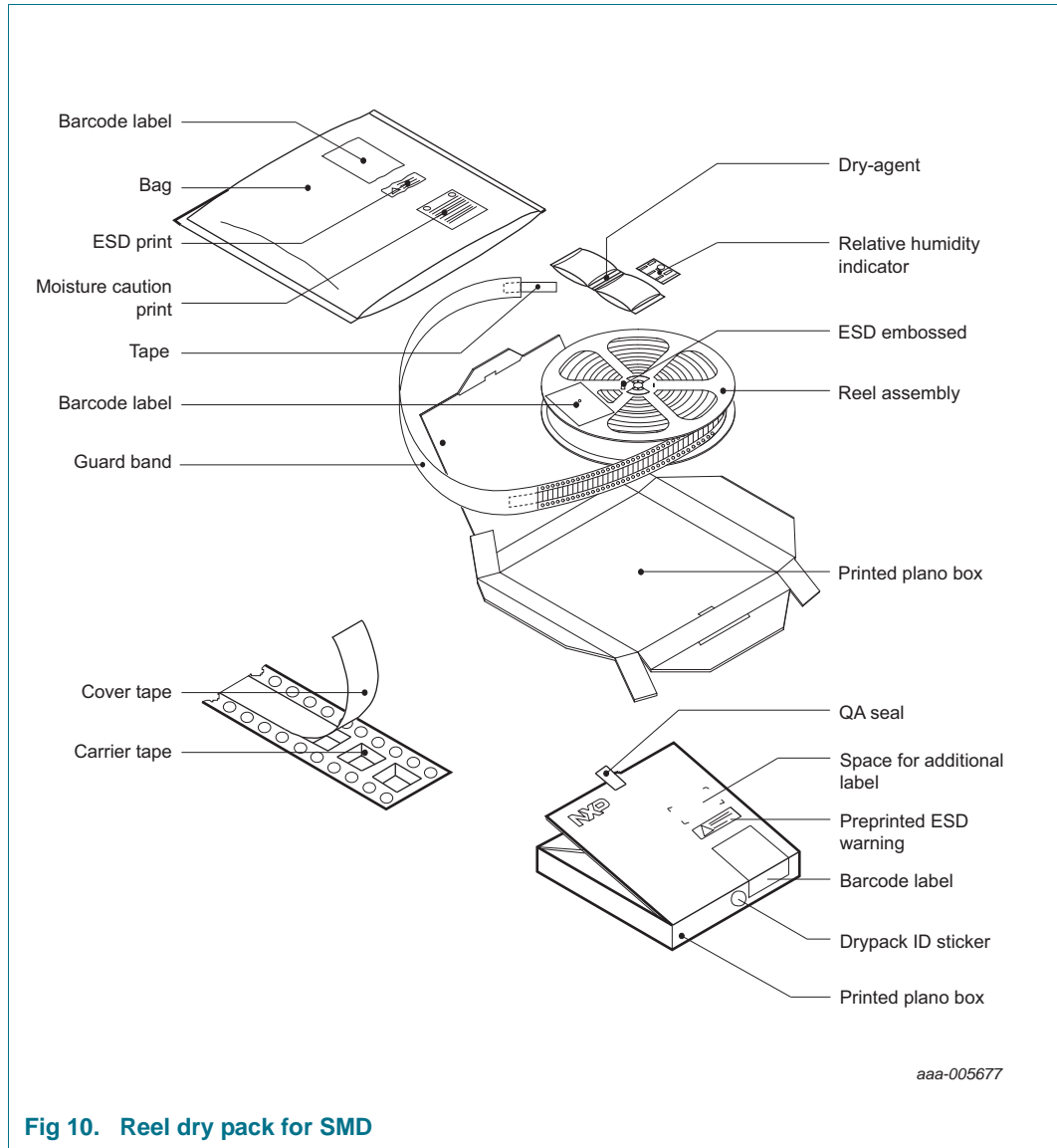


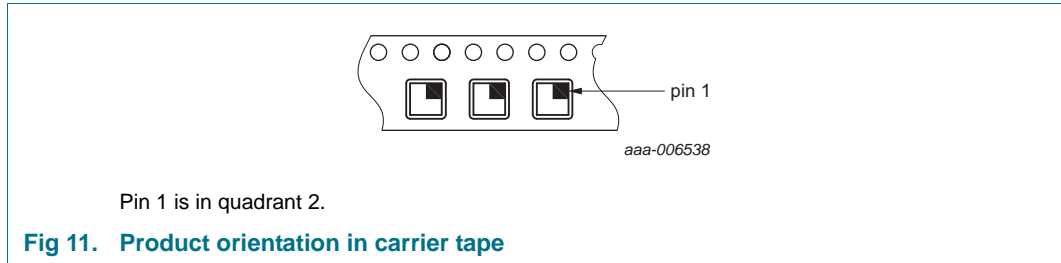
Fig 10. Reel dry pack for SMD

Table 22. Dimensions and quantities

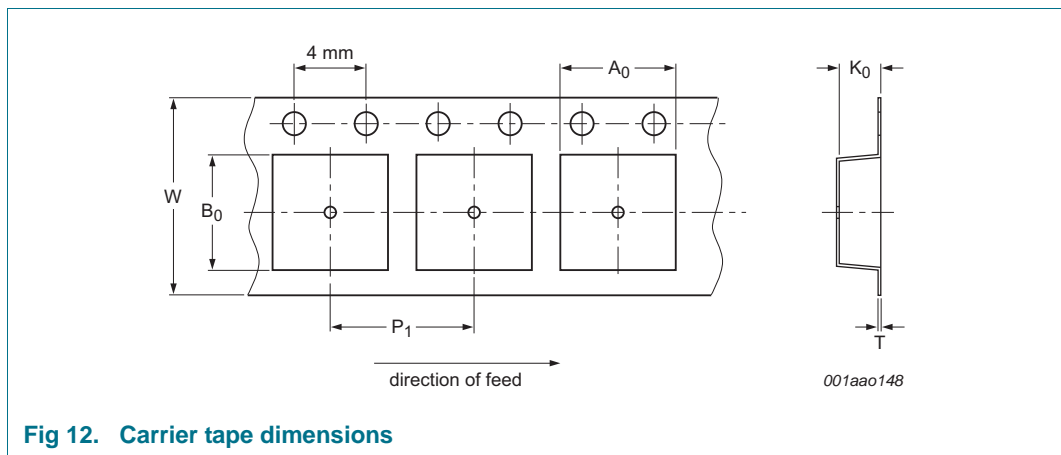
| Reel dimensions<br>d × w (mm) <sup>[1]</sup> | SPQ/PQ<br>(pcs) | Reels per<br>box | Outer box dimensions<br>l × w × h (mm) |
|--|-----------------|------------------|--|
| 330 × 12                                     | 6000            | 1                | 341 × 338 × 39                         |

[1] d = reel diameter; w = tape width.

### 15.2 Product orientation



### 15.3 Carrier tape dimensions



**Table 23. Carrier tape dimensions**

In accordance with IEC 60286-3.

| A <sub>0</sub> (mm) | B <sub>0</sub> (mm) | K <sub>0</sub> (mm) | T (mm)      | P <sub>1</sub> (mm) | W (mm)   |
|---------------------|---------------------|---------------------|-------------|---------------------|----------|
| 5.3 ± 0.1           | 5.3 ± 0.1           | 1.10 ± 0.1          | 0.30 ± 0.05 | 8 ± 0.1             | 12 ± 0.3 |

15.4 Reel dimensions

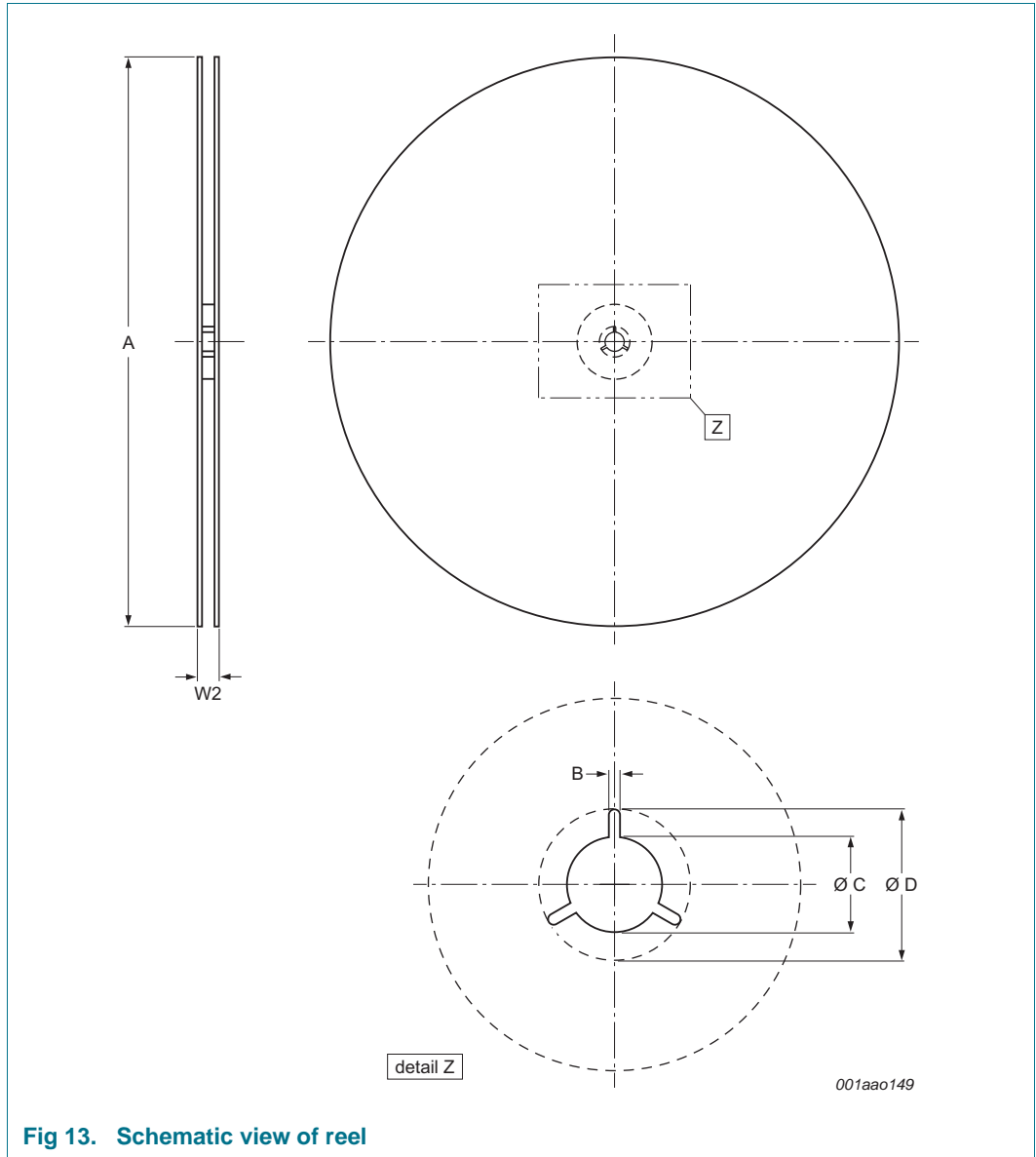


Fig 13. Schematic view of reel

Table 24. Reel dimensions  
In accordance with IEC 60286-3.

| A [nom] (mm) | W2 [max] (mm) | B [min] (mm) | C [min] (mm) | D [min] (mm) |
|--------------|---------------|--------------|--------------|--------------|
| 330          | 18.4          | 1.5          | 12.8         | 20.2         |

15.5 Barcode label

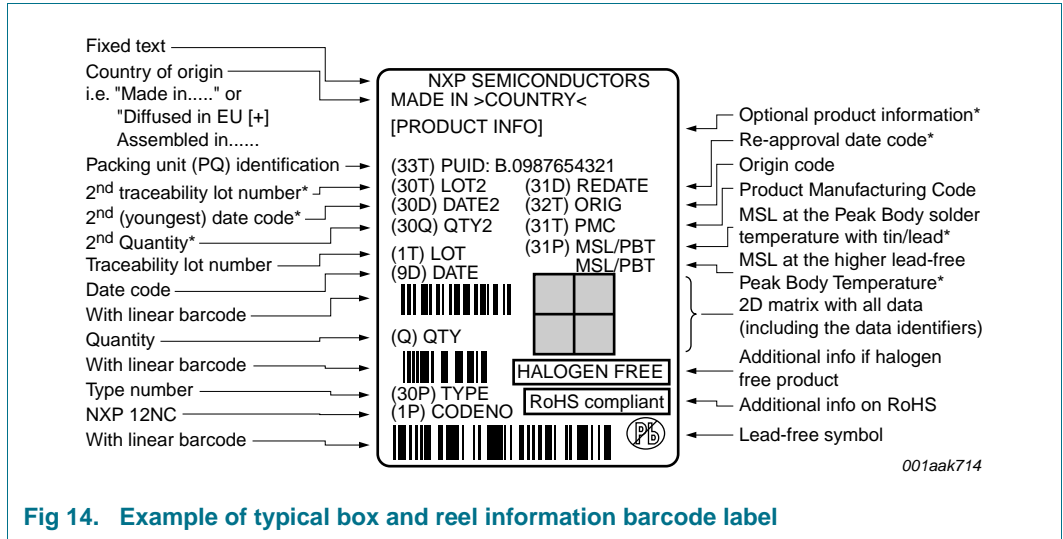


Fig 14. Example of typical box and reel information barcode label

Table 25. Barcode label dimensions

| Box barcode label<br>l × w (mm) | Reel barcode label<br>l × w (mm) |
|---------------------------------|----------------------------------|
| 100 × 75                        | 100 × 75                         |

## 16. Soldering of SMD packages

This text provides a very brief insight into a complex technology. A more in-depth account of soldering ICs can be found in Application Note *AN10365 "Surface mount reflow soldering description"*.

### 16.1 Introduction to soldering

Soldering is one of the most common methods through which packages are attached to Printed Circuit Boards (PCBs), to form electrical circuits. The soldered joint provides both the mechanical and the electrical connection. There is no single soldering method that is ideal for all IC packages. Wave soldering is often preferred when through-hole and Surface Mount Devices (SMDs) are mixed on one printed wiring board; however, it is not suitable for fine pitch SMDs. Reflow soldering is ideal for the small pitches and high densities that come with increased miniaturization.

### 16.2 Wave and reflow soldering

Wave soldering is a joining technology in which the joints are made by solder coming from a standing wave of liquid solder. The wave soldering process is suitable for the following:

- Through-hole components
- Leaded or leadless SMDs, which are glued to the surface of the printed circuit board

Not all SMDs can be wave soldered. Packages with solder balls, and some leadless packages which have solder lands underneath the body, cannot be wave soldered. Also, leaded SMDs with leads having a pitch smaller than ~0.6 mm cannot be wave soldered, due to an increased probability of bridging.

The reflow soldering process involves applying solder paste to a board, followed by component placement and exposure to a temperature profile. Leaded packages, packages with solder balls, and leadless packages are all reflow solderable.

Key characteristics in both wave and reflow soldering are:

- Board specifications, including the board finish, solder masks and vias
- Package footprints, including solder thieves and orientation
- The moisture sensitivity level of the packages
- Package placement
- Inspection and repair
- Lead-free soldering versus SnPb soldering

### 16.3 Wave soldering

Key characteristics in wave soldering are:

- Process issues, such as application of adhesive and flux, clinching of leads, board transport, the solder wave parameters, and the time during which components are exposed to the wave
- Solder bath specifications, including temperature and impurities

### 16.4 Reflow soldering

Key characteristics in reflow soldering are:

- Lead-free versus SnPb soldering; note that a lead-free reflow process usually leads to higher minimum peak temperatures (see [Figure 15](#)) than a SnPb process, thus reducing the process window
- Solder paste printing issues including smearing, release, and adjusting the process window for a mix of large and small components on one board
- Reflow temperature profile; this profile includes preheat, reflow (in which the board is heated to the peak temperature) and cooling down. It is imperative that the peak temperature is high enough for the solder to make reliable solder joints (a solder paste characteristic). In addition, the peak temperature must be low enough that the packages and/or boards are not damaged. The peak temperature of the package depends on package thickness and volume and is classified in accordance with [Table 26](#) and [27](#)

**Table 26. SnPb eutectic process (from J-STD-020D)**

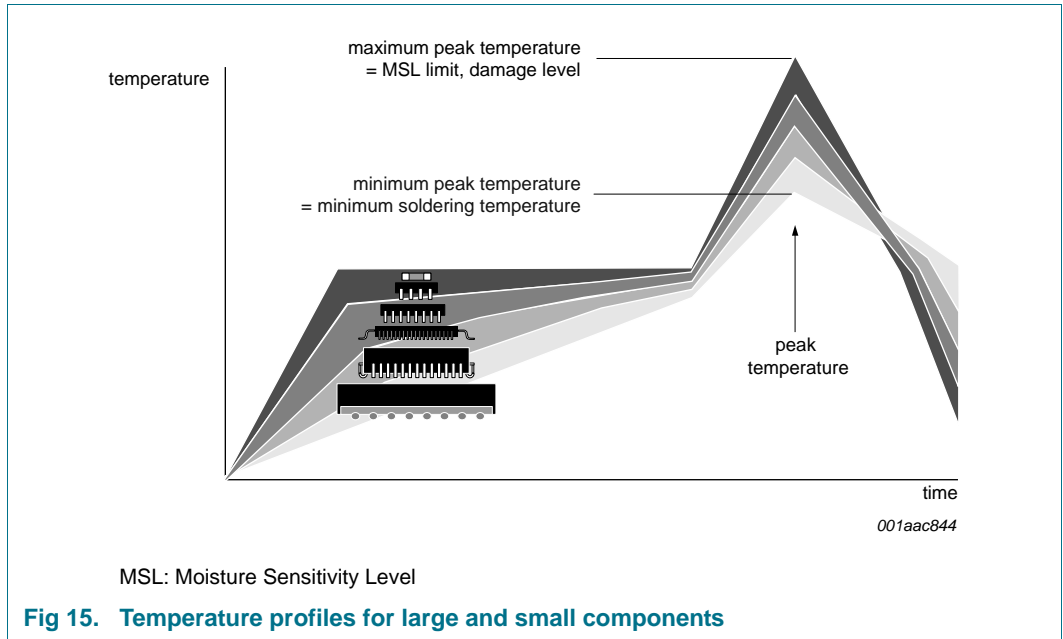
| Package thickness (mm) | Package reflow temperature (°C) |       |
|------------------------|---------------------------------|-------|
|                        | Volume (mm <sup>3</sup> )       |       |
|                        | < 350                           | ≥ 350 |
| < 2.5                  | 235                             | 220   |
| ≥ 2.5                  | 220                             | 220   |

**Table 27. Lead-free process (from J-STD-020D)**

| Package thickness (mm) | Package reflow temperature (°C) |             |        |
|------------------------|---------------------------------|-------------|--------|
|                        | Volume (mm <sup>3</sup> )       |             |        |
|                        | < 350                           | 350 to 2000 | > 2000 |
| < 1.6                  | 260                             | 260         | 260    |
| 1.6 to 2.5             | 260                             | 250         | 245    |
| > 2.5                  | 250                             | 245         | 245    |

Moisture sensitivity precautions, as indicated on the packing, must be respected at all times.

Studies have shown that small packages reach higher temperatures during reflow soldering, see [Figure 15](#).



For further information on temperature profiles, refer to Application Note AN10365 “Surface mount reflow soldering description”.



### 17. Soldering: PCB footprints

Footprint information for reflow soldering of HVQFN32 package

SOT617-3

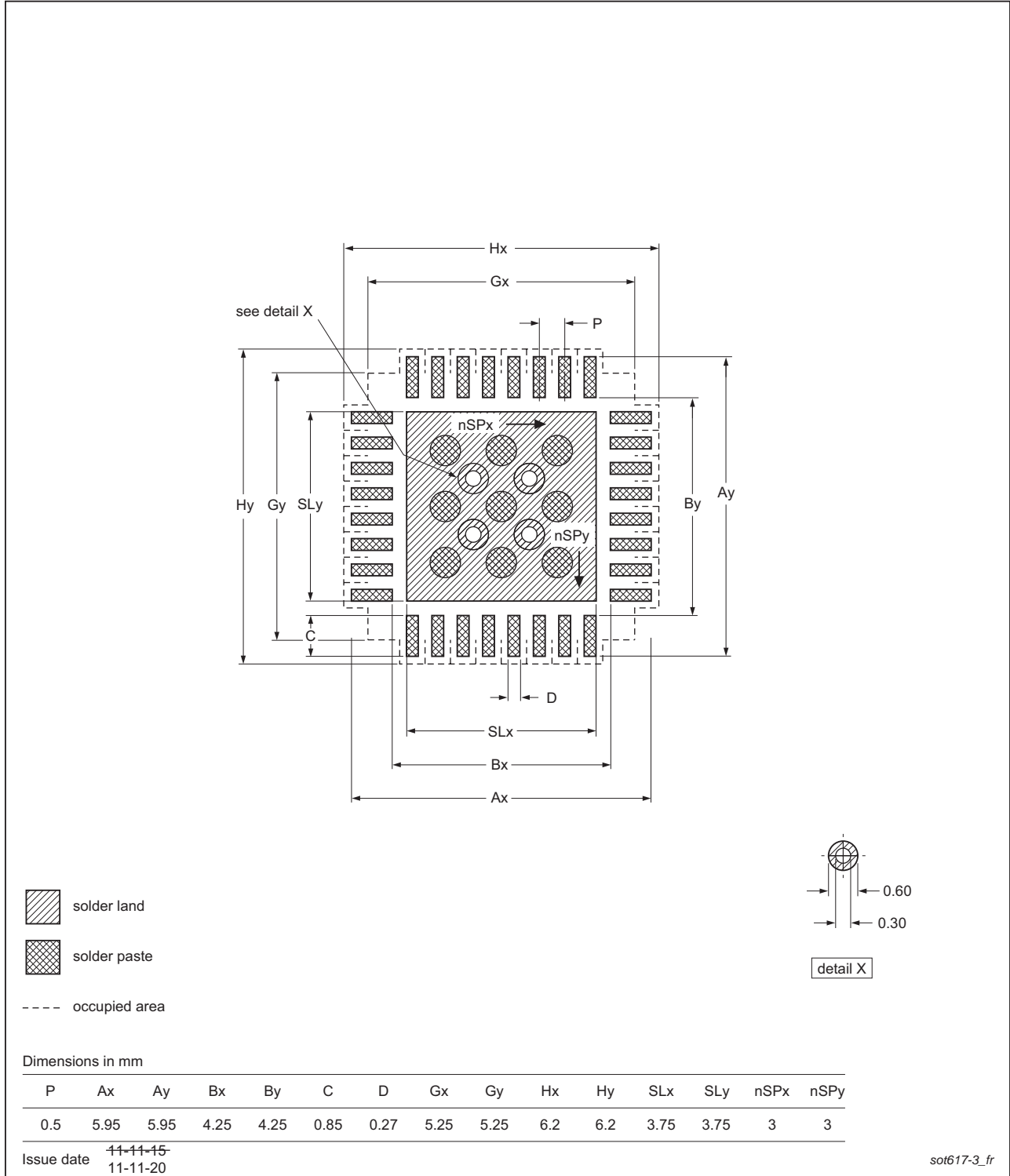


Fig 16. PCB footprint for SOT617-3 (HVQFN32); reflow soldering

## 18. Abbreviations

Table 28. Abbreviations

| Acronym              | Description                               |
|----------------------|---|
| AUX CH               | Auxiliary Channel                         |
| BER                  | Bit Error Rate                            |
| bpc                  | bits per color                            |
| bpp                  | bits per pixel                            |
| BoM                  | Bill of Materials                         |
| CDM                  | Charged-Device Model                      |
| CEA                  | Consumer Electronic Association           |
| CMOS                 | Complementary Metal-Oxide Semiconductor   |
| CVT                  | Coordinated Video Timings                 |
| CVT RB               | CVT Reduced Blanking                      |
| DAC                  | Digital-to-Analog Converter               |
| DDC                  | Display Data Channel                      |
| DJ                   | Deterministic Jitter                      |
| DP                   | DisplayPort (VESA)                        |
| DPCD                 | DisplayPort Configuration Data            |
| ECC                  | Error Correction Code                     |
| EDID                 | Extended Display Identification Data      |
| eDP                  | embedded DisplayPort                      |
| ESD                  | ElectroStatic Discharge                   |
| HBM                  | Human Body Model                          |
| HBR                  | High Bit Rate                             |
| HDCP                 | High-bandwidth Digital Content Protection |
| HPD                  | Hot Plug Detect                           |
| I <sup>2</sup> C-bus | Inter-Integrated Circuit bus              |
| IEC                  | International Electrotechnical Commission |
| I/O                  | Input/Output                              |
| LSB                  | Least Significant Bit                     |
| MCCS                 | Monitor Control Command Set (VESA)        |
| MSB                  | Most Significant Bit                      |
| QXGA                 | Quad eXtended Graphics Array              |
| RB                   | Reduced Blanking                          |
| RBR                  | Reduced Bit Rate                          |
| RGB                  | Red/Green/Blue                            |
| ROM                  | Read-Only Memory                          |
| SSC                  | Spread Spectrum Clocking                  |
| SVGA                 | Super Video Graphics Array                |
| SXGA                 | Super eXtended Graphics Array             |
| TJ                   | Total Jitter                              |
| UI                   | Unit Interval                             |

Table 28. Abbreviations ...continued

| Acronym | Description                             |
|---------|---|
| UXGA    | Ultra eXtended Graphics Array           |
| VESA    | Video Electronics Standards Association |
| VGA     | Video Graphics Array                    |
| VSIS    | Video Signal Interface Standard         |
| WUXGA   | Wide Ultra eXtended Graphics Array      |
| XGA     | eXtended Graphics Array                 |

## 19. References

- [1] **VESA DisplayPort Standard** — Version 1, Revision 2a; March 2012
- [2] **Display Data Channel Command Interface Standard** — Version 1.1; October 29, 2004
- [3] **Video Signal Standard (VSIS)** — Version 1, Rev. 2; December 12, 2002
- [4] **IEC 61000-4-2, Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques** — ElectroStatic Discharge (ESD) immunity test, edition 2.0, 2008-12

## 20. Revision history

Table 29. Revision history

| Document ID     | Release date   | Data sheet status    | Change notice | Supersedes      |
|-----------------|--|----------------------|---------------|-----------------|
| PTN3356R1 v.2.2 | 20160816   | Product data sheet   | -             | PTN3356R1 v.2.1 |
| Modifications:  | <ul style="list-style-type: none"> <li>• Removed 500 piece MOQ</li> </ul>  |                      |               |                 |
| PTN3356R1 v.2.1 | 20150716   | Product data sheet   | -             | PTN3356R1 v.2   |
| Modifications:  | <ul style="list-style-type: none"> <li>• Removed "COMPANY CONFIDENTIAL" watermark</li> </ul>   |                      |               |                 |
| PTN3356R1 v.2   | 20150629   | Product data sheet   | -             | PTN3356R1 v.1   |
| Modifications:  | <ul style="list-style-type: none"> <li>• Updated <a href="#">Figure 7</a></li> <li>• Changed data sheet status to Product</li> <li>• ESD HBM changed to 7 kV</li> <li>• <a href="#">Table 2</a>: Added 500 piece minimum order quantity</li> </ul> |                      |               |                 |
| PTN3356R1 v.1   | 20140911   | Objective data sheet | -             | -               |

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### 21.1 Data sheet status

| Document status <sup>[1][2]</sup> | Product status <sup>[3]</sup> | Definition  |
|-----------------------------------|-------------------------------|---|
| Objective [short] data sheet      | Development                   | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet    | Qualification                 | This document contains data from the preliminary specification.                       |
| Product [short] data sheet        | Production                    | This document contains the product specification.                                     |

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL <http://www.nxp.com>.

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