TEXAS INSTRUMENTS

TX7316

SLOSE35B –MARCH 2019–REVISED JULY 2019

TX7316 Three-Level, 16-Channel or Five-Level, 8-Channel Transmitter With 2.4-A Pulser, T/R Switch, and Integrated Transmit Beamformer

1 Features

- Transmitter supports:
  - 16-channel 3-level or 8-channel 5-level pulser and active transmit/receive (T/R) switch
  - Very low power on-chip beamforming mode (5-level mode):
    - In receive-only mode: 17 mW
    - In transmit-receive mode: 598 mW
    - In CW mode (0.6-A mode): 1.97 W
    - In global power-down mode: 4.3 mW
- 3-level, 5-level pulser:
  - Maximum output voltage: ±100 V
  - Minimum output voltage: ±1 V
  - Maximum output current: 2.4 A to 0.6 A
  - Maximum clamp current: 1 A to 0.25 A (in 3-level mode)
  - Maximum clamp current: 2 A to 0.5 A (in 5-level mode)
  - Second harmonic of –45 dBc at 5 MHz
  - CW mode jitter: 100 fs measured from 100 Hz to 20 kHz
  - CW mode close-in phase noise: –154 dBc/Hz at 1 kHz offset for 5 MHz signal
  - Supports 4.8-A mode in 5-level mode
  - –3-dB Bandwidth with 1-kΩ || 240-pF load
    - 20 MHz (For ±100-V supply in 2.4-A mode)
    - 36 MHz (For ±100-V supply in 4.8-A mode)
    - 25 MHz (For ±70-V supply in 2.4-A mode)
- Active transmit/receive (T/R) switch with:
  - ON/OFF control signal
  - Turnon resistance of 12 Ω
  - Bandwidth: 50 MHz
  - HD2: -50 dBc
  - Turnon time: 0.5 μs
  - Turnoff time: 1.75 μs
  - Transient glitch: 50 mV$_{PP}$
- Off-chip beam former with:
  - Jitter cleaning using synchronization feature
  - Maximum synchronization clock frequency: 200 MHz
- On-chip beam former with:
  - Delay resolution: one beamformer clock period, minimum 5 ns

- Maximum delay: 2^{13} beamformer clock period
- Maximum beamformer clock speed: 200 MHz
- On-chip RAM to store
  - 16 Delay profiles
  - 48/28 pattern-profiles for 3- or 5-level mode
- High-speed (100 MHz maximum) 1.8-V and 2.5-V CMOS serial programming interface
- Automatic thermal shutdown
- No specific power sequencing requirement in 3-level mode
- Small package: NFBGA-216 (15 mm × 10 mm) with 0.8-mm pitch

2 Applications

- Ultrasound imaging system
- Piezoelectric driver
- In-probe ultrasound imaging

3 Description

The TX7316 is a highly integrated, high-performance transmitter solution for ultrasound imaging system. The device has total 16 pulser circuits (PULS), 16 transmit/receive (T/R) switches, and supports both on-chip and off-chip beamformer (TxBF). The device also integrates on-chip floating power supplies that reduce the number of required high voltage power supplies.

Device Information[1]

PART NUMBER	PACKAGE[1]	BODY SIZE (NOM)
TX7316	NFBGA (216)	15.0 mm × 10.0 mm

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

Simplified Block Diagram
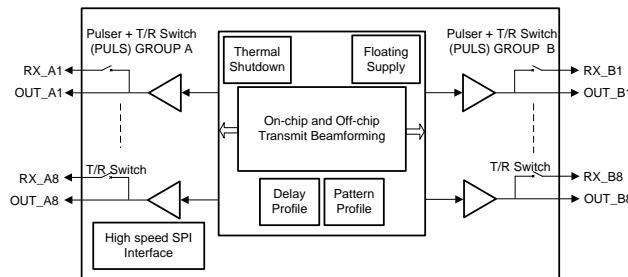
An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.

4 Revision History

Changes from Revision A (March 2019) to Revision B **Page**

• Changed *Feature*: In CW mode: 2.98 W To: In CW mode (0.6-A mode): 1.97 W... 1
• Changed *Feature*: Second harmonic of –40 dBc at 5 MHz To: Second harmonic of –45 dBc at 5 MHz 1
• Added *Feature*: 36 MHz (For ±100-V supply in 4.8-A mode).. 1
• Changed *Feature*: Turnoff time: 1.6 µs To: Turnoff time: 1.75 µs. 1

Changes from Original (May 2019) to Revision A **Page**

• Changed the document status From: *Advanced Information* To: *Production* data 1
• Changed from Pulsar to Pulser across the document.. 1
• Changed the values of *CW* and *global power-down* modes 1
• Changed the supply voltage value in *–3-dB Bandwidth with 1-kΩ || 240-pF load* feature. 1

Product Folder Links: *TX7316*

5   Description (continued)

The TX7316 (referred to as device in this data sheet) has a pulser circuit that generates three-level high voltage pulses (up to ±100 V) that can be used to excite multiple channels of an ultrasound transducer. The device supports total 8 outputs for 5-level mode and 16 outputs for 3-level mode. The maximum output current is configurable from 2.4 A to 0.6 A.

A T/R switch under OFF state protects the receiver circuit by providing high isolation between the high-voltage transmitter and the low-voltage receiver when the pulser is generating high-voltage pulses. When the transducer is receiving echo signals, the T/R switch turns ON and connects the transducer to the receiver. The ON/OFF operation of the T/R switch is either controlled by an external pin or controlled by on-chip beamforming engine in the device. The T/R switch offers 12-Ω impedance in the ON state.

Ultrasound transmission relies on the excitation of multiple transducer elements with the delay profile of the excitation across the different elements defining the direction of the transmission. Such an operation is referred to as transmit beamforming. The TX7316 supports staggered pulsing of the different channels, allowing for transmit beamforming. The device supports both off-chip and on-chip beamforming operation.

In the off-chip beamformer mode, the output transition of each pulser and TR switch ON/OFF operation is controlled by external control pins. To eliminate the effect of jitter from the external control signals, the device supports a synchronization feature. When the synchronization feature is enabled, the external control signals are latched using a low-jitter beamformer clock signal.

In the on-chip beamformer mode, the delay profile for the pulsing of the different channels is stored within the device. The device supports a transmit beamformer delay resolution of one beamformer clock period and a maximum delay of 2^{13} beamformer clock periods. An internal pattern generator generates the output pulse patterns based on pattern profiles stored in a profile RAM. Up to 16 beamforming profiles and 48/28 pattern profiles for 3/5-level mode can be stored in the profile RAM. On-chip beamforming mode reduces the number of control signals that must be routed from the FPGA to the device.

TX7316 is available in a 15-mm × 10-mm 216-pin NFBGA package (ZCX package) and is specified for operation from 0°C to 70°C.

6 Device and Documentation Support

6.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

6.2 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

TI E2E™ Online Community *TI's Engineer-to-Engineer (E2E) Community.* Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support *TI's Design Support* Quickly find helpful E2E forums along with design support tools and contact information for technical support.

6.3 Trademarks

E2E is a trademark of Texas Instruments.
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6.4 Electrostatic Discharge Caution

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

6.5 Glossary

SLYZ022 — *TI Glossary*.

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

7 Mechanical, Packaging, and Orderable Information

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

PACKAGE OPTION ADDENDUM

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
TX7316ZCX	Active	Production	NFBGA (ZCX) | 216	136 | JEDEC TRAY (5+1)	Yes	SNAGCU	Level-3-260C-168 HR	0 to 70	TX7316

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts 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.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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PACKAGE MATERIALS INFORMATION

TRAY

L - Outer tray length without tabs

KO - Outer tray height

W - Outer tray width

P1 - Tray unit pocket pitch

CW - Measurement for tray edge (Y direction) to corner pocket center

CL - Measurement for tray edge (X direction) to corner pocket center
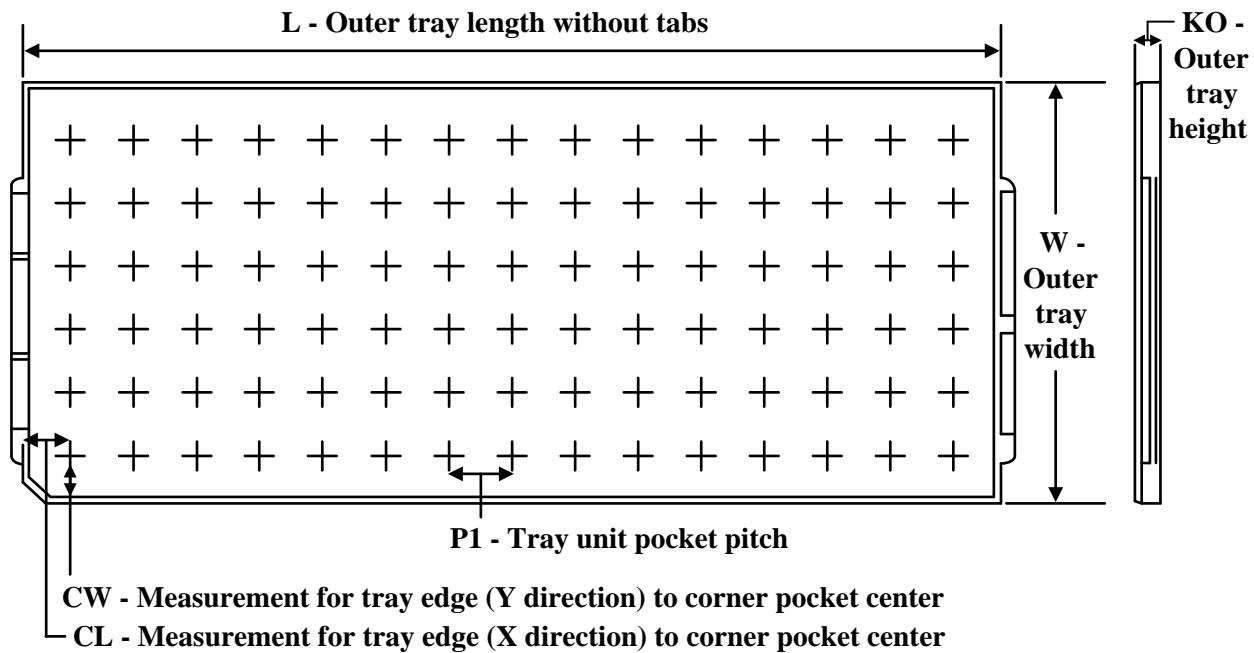
Chamfer on Tray corner indicates Pin 1 orientation of packed units.

*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	Unit array matrix	Max temperature (°C)	L (mm)	W (mm)	K0 (µm)	P1 (mm)	CL (mm)	CW (mm)
TX7316ZCX	ZCX	NFBGA	216	136	8 X 17	150	315	135.9	7620	18.1	12.7	11.95

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