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

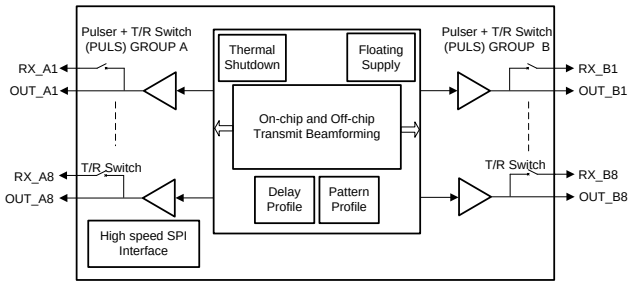
The TX7316 is a highly integrated, high-performance transmitter solution for ultrasound imaging system. The device has total 16 pulser circuits (PULS), 16 transmit/receive (T/R) switches, and supports both on-chip and off-chip beamformer (TxBF). The device also integrates on-chip floating power supplies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

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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.

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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

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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.

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PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TX7316ZCX	ACTIVE	NFBGA	ZCX	216	136	Green (RoHS & no Sb/Br)	SNAGCU	Level-3-260C-168 HR	0 to 70	TX7316	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.
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(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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

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

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

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