Application Note

An Overview of TI Transmitter Products for Ultrasound Applications

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ABSTRACT

Texas Instruments offers a wide range of transmitter products specifically meant for ultrasound imaging applications. The products vary on multiple factors and are meant to address specific systems and imaging applications within ultrasound systems.

This application note shows the different types of transmitters in Texas Instruments' portfolio and helps customers select the right part for the application.

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1 Introduction to Ultrasound Transmitters

Ultrasound imaging is a widely popular technology that uses high frequency sound waves to produce images of structures inside the body. The technology is non-invasive, safe and uses non-ionizing radiation (sound waves) for imaging. Figure 1-1 shows the overall block diagram of an ultrasound system. Transmitters are one of the key components in an ultrasound system which are used to generate high voltage signals that are required to excite the transducer. The transducer converts the received electrical impulse from the transmitter and converts the impulse into sound waves and vice-versa during imaging.

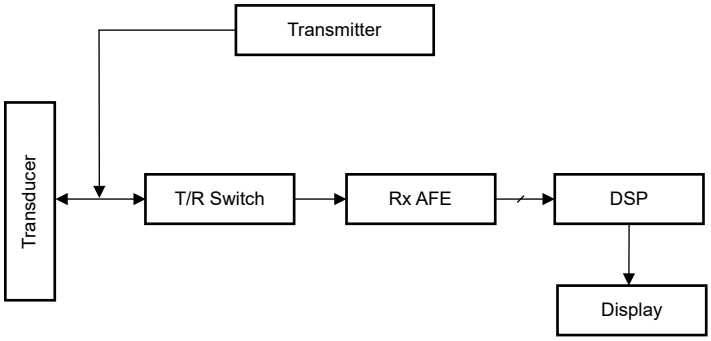

Figure 1-1. Block Diagram of an Ultrasound System

2 TI Ultrasound Transmitter Portfolio

Depending on the application and required performance, ultrasound transmitters can vary widely in terms of the channel integration, current drive, compactness, performance parameters like transmit beamforming and apodization, and so on. TI offers a wide range of products intended to be used in different applications that require different performance metrics. Table 2-1 displays the ultrasound product portfolio of TI and offers an insight on some of the critical parameters required while selecting a part for a specific application.

Table 2-1. Portfolio of Ultrasound Transmitter Products from Texas Instruments

TX Part Number	Pulser Type	Channel Count	Waveform Level	Beamforming Type and Resolution	Current Drive(A)	HD2PC Performance	Package Size (mm^2)	Transmit Apodization
TX75E16	Digital	16	5 Level	On-Chip, 1.56ns	2 in 5-Level 4 in 3-Level	45dBc at 5MHz	10 × 10	Not possible
TX7364	Digital	64	3 Level	On-Chip, 2.5ns	1	40dBc at 5MHz	12 × 12	Not possible
TX08D	Linear+Digital	8/8	5 Level	On-Chip, 2ns	2 in 5-Level 4 in 3-Level 2.8 for Lin-Amp	45dBc at 5MHz	12 × 12	Possible
TX73H32	Digital	32	3 Level	On-Chip, 2.5ns	2	43dBc at 5MHz	12 × 12	Not possible
TX73L64	Digital	64	3 Level	On-Chip, 2.5ns	1	40dBc at 5MHz	12 × 12	Not possible

3 Transmitter Part Selection Guide

There are several kinds of ultrasound systems available in the market, each of which cater to different performance range and ultrasound applications. Figure 3-1 displays the different types of ultrasound systems and the respective trends in performance, cost and size.

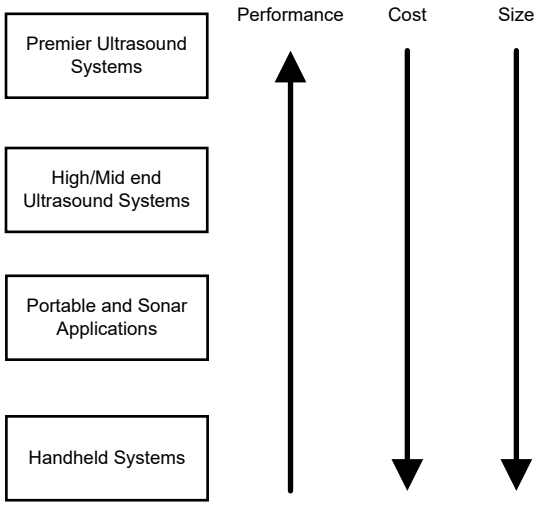

Figure 3-1. Types of Ultrasound Systems

The following sections provide an insight into some of the important specifications required and the potential transmitter parts that can be used in the system.

3.1 Premier Ultrasound Cart Systems

Premier ultrasound systems offer good performance in terms of imaging and support a multitude of imaging modes such as B-, mode, CW-mode, Elastography, PW Mode, and so on. These systems often require high performance transmitters to improve image quality, and being a cart-based system, performance is generally considered over other factors such as power and area.

One of the key features required for transmitters used in these systems are a capability to produce narrow band transmit waves, fine transmit beamforming and transmit apodization. The TX08D, which is an 8-ch linear amplifier + 8-ch digital pulser is an option for these systems. With eight channels integrated in a single chip, the device offers a high transmit beamforming resolution of 2ns and also offers transmit apodization capability on all the eight channels. With an integrated DAC capable of generating narrow band sine waves and high 2^{nd} harmonic and phase noise performance, TX08D becomes an option for transmitters to be used in premier ultrasound cart systems.

3.2 High and Mid End Ultrasound Cart Systems

Although these systems offer lower image performance than premier cart systems, are more economical and support multiple imaging modes that cater to wide range of applications and segments. Transmit apodization is not considered a requirement in these systems, although the transmitters still require high level of beamforming capability as well as second harmonic and phase noise performance for B-mode and CW-mode imaging respectively.

The TX75E16 is an option for these systems as the device is less expensive as compared to TX08D and features 16 channels integrated in a single device. With a 45dBc of HD2 performance and -154dBc/Hz phase noise performance, the TX75E16 provides a 5-level pulser capable of support multiple imaging modes simultaneously.

3.3 Portable Ultrasound Systems

Portable systems aim for lower power and size in exchange for a slightly inferior performance as compared to premier and high-end systems. For example, portable laptop systems used in field that are adequate for basic to mid-range imaging requirements but are not capable of advanced imaging modes such as elastography, 3D/4D

imaging, advanced doppler modes, and so on. Size and power are critical for these systems and therefore require a high channel integration in the transmitters.

With 32-channels integrated in a single package and a current drive of 2A, the TX73H32 is an option for these systems as the device offers a good balance in performance and area. The device features a 3-level pulser and a high current drive of 2A per channel, the TX73H32 is an option for the imaging modes that portable ultrasound systems generally support.

3.4 Handheld Ultrasound Systems

Handheld ultrasound systems are a recently emerging design in the market, offering a highly compact imaging systems. Handheld probes offer wired and wireless connections and are battery operated, commonly connected to mobile phones while imaging. These handheld probes are similar to portable systems, offering an even higher level of compactness, but at a lower imaging resolution compared to laptop systems. These systems focus heavily on low power, highly integrated transmitters to obtain a pocket-sized design size.

TX7364 and TX73L64, which integrate 64 channels in chip are considered a preferred option for such systems. Both parts offer a current drive of 1A, and are capable of 3-level waveforms, adequate for the basic imaging modes supported by handheld ultrasound systems. For systems that comprise of 128-element transducer array, only two such chips are required for a system, offering a compact system along with a selection of receiver AFE.

3.5 Ultrasound Systems for Sonar Applications

Sonar applications such as fish finding, and so on require a slightly different set of specifications as compared to the conventional medical imaging applications. Sonar applications typically use a low frequency transmit wave (50-150kHz) for high depth imaging. The transmit pulses are also quite long, ranging from several µs to few ms for higher energy transfer. Depending on the application and resolution required, chirp waveforms are also commonly used for increased axial resolution and depth discrimination.

For such applications, TX75E16 is an option if the on-chip beamforming capabilities are sufficient for the required application. With a maximum clock frequency support of 320MHz, TX75E16 offers resolution for chirp waveforms. The device also supports large pattern memory per channel along with multiple pattern compression techniques to reduce the memory requirement for a complex transmit pattern common in sonar applications.

4 Summary

Table 4-1 lists the different segments in ultrasound imaging systems and the corresponding transmitter parts.

Table 4-1. TI Transmitter Parts Designed for Different Ultrasound Systems

Ultrasound Systems	Corresponding Tx Part	Key Features
Premier Ultrasound Systems	TX08D	Transmit Apodization. Excellent gain control.Linear Amplifier for narrowband signals.
High/Mid end Ultrasound Systems	TX75E16	5-level Pulser. 2A current drive. Beamforming resolution of 1.5625ns.
Portable Ultrasound Systems	TX73H32	3-level Pulser. 32-ch integration. 2A current drive.
Handheld Ultrasound Systems	TX7364, TX73L64	3-level Pulser. 64-ch integration. 1A current drive.
Sonar Applications	TX75E16	3-Level and 5-Level waveforms supported. Pattern compression techniques to store complex patterns. Beamforming resolution of 1.5625ns.

5 References

- Texas Instruments, *TX08D 8-Channel Ultrasound Transmitter*, data sheet.
- Texas Instruments, *TX75E16 5-Level, 16-Channel Transmitter with T/R Switch, On-Chip Beamformer, and Enhanced Load Damping Features*, data sheet.
- Texas Instruments, *TX73H32 3-Level, 32-Channel Transmitter with On-Chip Beamformer, T/R Switch*, data sheet.
- Texas Instruments, *TX7364 3-Level, 64-Channel Transmitter with On-Chip Beamformer, T/R Switch*, data sheet.
- Texas Instruments, *TX73L64 3-Level, 64-Channel Transmitter with On-Chip Beamformer, T/R Switch, 32-Channel Multiplexed Receivers with LNA*, data sheet.

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