TEXAS INSTRUMENTS
TX7516
ZHCSO76A – JUNE 2021 – REVISED MARCH 2022

带有 T/R 开关和片上波束成形器的 TX7516 五级 16 通道发送器

1 特性

- 发送器支持：
  - 16 通道五级脉冲发生器和有源发送/接收 (T/R) 开关
- 五级脉冲发生器：
  - 输出电压最大值：±100V
  - 输出电压最小值：±1V
  - 输出电流最大值：2A
  - 支持 4A 输出电流模式。
  - 真正归零以将输出电压对地放电
  - 第二谐波在 5 MHz 频率下为 -45 dBc
  - –3 dB 带宽，1 kΩ || 240 pF 负载
    - 20 MHz（针对 ±100V 电源）
    - 25 MHz（针对 ±70V 电源）
    - 35 MHz（针对 4A 模式下的 ±100V 电源）
  - 集成抖动：频率为 100 Hz 至 20 kHz 时的测量值为 100 fs
  - CW 模式近端相位噪声：5 MHz 信号（1 kHz 偏移）时为 –154 dBc/Hz
  - 接收功率极低：1mW/ch
- 有源发送/接收 (T/R) 开关，具有：
  - 8Ω 导通电阻
  - 导通和关断时间：100 ns
  - 瞬态干扰：10 mV_{pp}
- 片上波束形成器，具有：
  - 基于通道的 T/R 开关控制
  - 延迟分辨率：半个波束形成器时钟周期，不低于 2 ns
  - 最大延迟：2^{14} 个波束形成器时钟周期
  - 波束形成器时钟速度最大值：320 MHz
  - 每通道模式控制，具有 2K 不同级别。
  - 全局和局部重复模式，为横波成像启用长持续时间模式
  - 支持 120 个延迟分布
- 高速（最大值：400 MHz）双通道 LVDS 串行编程接口。
  - 低编程时间：针对延迟用户更新，< 500 ns
  - 32 位校验和功能可检测错误的 SPI 写入
- 支持 CMOS 串行编程接口（不高于 50 MHz）
- 内部温度传感器和自动热关断
- 无需特定电源时序
- 错误标志寄存器，用于检测故障情况
- 用于浮动电源和偏置电压的集成无源器件
- 小型封装：FC-BGA-144 (10mm × 10mm)，间距为 0.8mm

2 应用

- 超声波成像系统
- 压电式驱动器
- 探头内置超声波成像

3 说明

TX7516 是一款适用于超声成像系统的高度集成、高性能发送器解决方案。该器件共设有 16 个脉冲发生器电路、16 个发送/接收开关（称为 T/R 或 TR 开关），并支持片上和片外波束形成器 (TxBF)。该器件还集成片上浮动电源，可减少所需高压电源的数量。

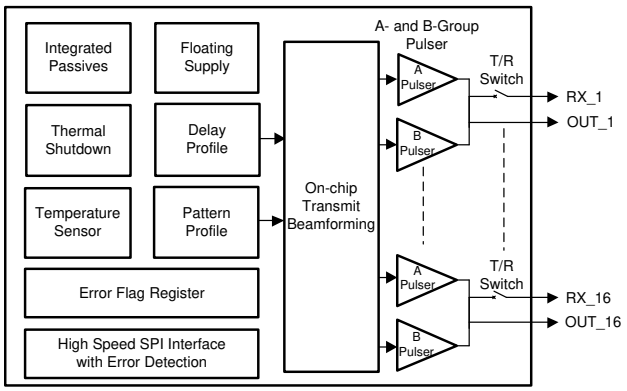
TX7516 有一个脉冲发生器电路，可生成五级高压脉冲（高达 ±100V），这些脉冲用于激发超声波传感器的多个通道。该器件共支持 16 个输出。输出电流最大值为 2A。

该器件可用作许多应用的发射器解决方案，比如超声成像、无损检测、声纳、激光雷达、海洋导航系统、大脑成像系统等。

器件信息

器件型号	封装(1)	封装尺寸（标称值）
TX7516	FC-BGA (144)	10.0mm × 10.0mm

(1) 如需了解所有可用封装，请参阅数据表末尾的可订购产品附录。



简化方框图

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4 Revision History

注：以前版本的页码可能与当前版本的页码不同

Changes from Revision * (June 2021) to Revision A (March 2022)	Page
• 将器件状态从*预告信息*更改为*量产数据*	1

5 说明（续）

TX7516（在此数据表中被称为器件）是一款用于激发超声传感器的高度集成发送器解决方案。器件集成了 16 个脉冲发生器和 16 个 T/R 开关、片上波束形成器和图形发生器。

脉冲发生器电路产生五级高压脉冲（高达 ±100V），输出电流最大值为 2A。当脉冲发生器发射高压脉冲时，T/R 开关关闭，保护低压接收电路不受损坏。当传感器接收回波信号时，T/R 开关导通并将传感器连接到接收器。T/R 开关的开/关操作由器件中内置的片上波束形成引擎控制。T/R 开关在导通状态下提供 8Ω 的阻抗。

超声波传输依靠定义传输方向的不同的延迟值来激发多个传感器元件。这种操作被称为传输波束形成。TX7516 支持不同通道的交错式脉冲，从而实现传输波束形成。

在片上波束形成器模式下，不同通道脉冲的延迟分布会存储在器件内。器件支持的传输波束形成器延迟分辨率为一个波束形成器时钟周期，延迟不超过 2^{14} 个波束形成器时钟周期。内部图形发生器依据分布 RAM 中的图形分布生成输出脉冲图形。每个通道都有自己的 RAM，长度为 960 字节。图形具有全局和局部重复特征。此功能可用于生成长图形，并可用于横波成像。

这些图形分布和延迟分布是使用高速 (400MHz) 串行外设接口写入的。高速写入可能容易出错。因此，该器件具有校验和功能来检测 SPI 写入中的错误。

为防止器件因配置不当而损坏，内部错误标志寄存器可检测故障情况并自动将器件配置为关断模式。

该器件集成了浮动电源和内部偏置电压所需的所有去耦电容器。这显著减少了所需外部电容器数量。TX7516 采用 144 引脚 10mm × 10mm FC-BGA 封装（ALH 封装），额定工作温度范围为 0°C 至 70°C。

6 Device and Documentation Support

6.1 Document Support

表 6-1. Terms Commonly Used in the Data Sheet

Abbreviation	Comment
PRT	Pulse Repetition Time. Represent TR_BF_SYNC period
PRF	Pulse Repetition Frequency. Represent TR_BF_SYNC frequency
Receive Mode	Duration in which T/R switch of all the channels are in ON state
High voltage supplies	AVDDP_HV_A, AVDDP_HV_B, AVDDM_HV_A, and AVDDM_HV_B are collectively referred as high voltage supplies
High voltage supplies	AVDDP_5, AVDDM_5, and AVDDP_1P8 supplies are collectively referred as low voltage supplies
A-side supplies	AVDDP_HV_A and AVDDM_HV_A is referred as A-side supplies
B-side supplies	AVDDP_HV_A and AVDDM_HV_A is referred as B-side supplies
SPI	Serial program interface

6.2 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.

6.3 支持资源

TI E2E™ 支持论坛是工程师的重要参考资料，可直接从专家获得快速、经过验证的解答和设计帮助。搜索现有解答或提出自己的问题可获得所需的快速设计帮助。

链接的内容由各个贡献者“按原样”提供。这些内容并不构成 TI 技术规范，并且不一定反映 TI 的观点；请参阅 TI 的《使用条款》。

6.4 Trademarks

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6.5 Electrostatic Discharge Caution

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

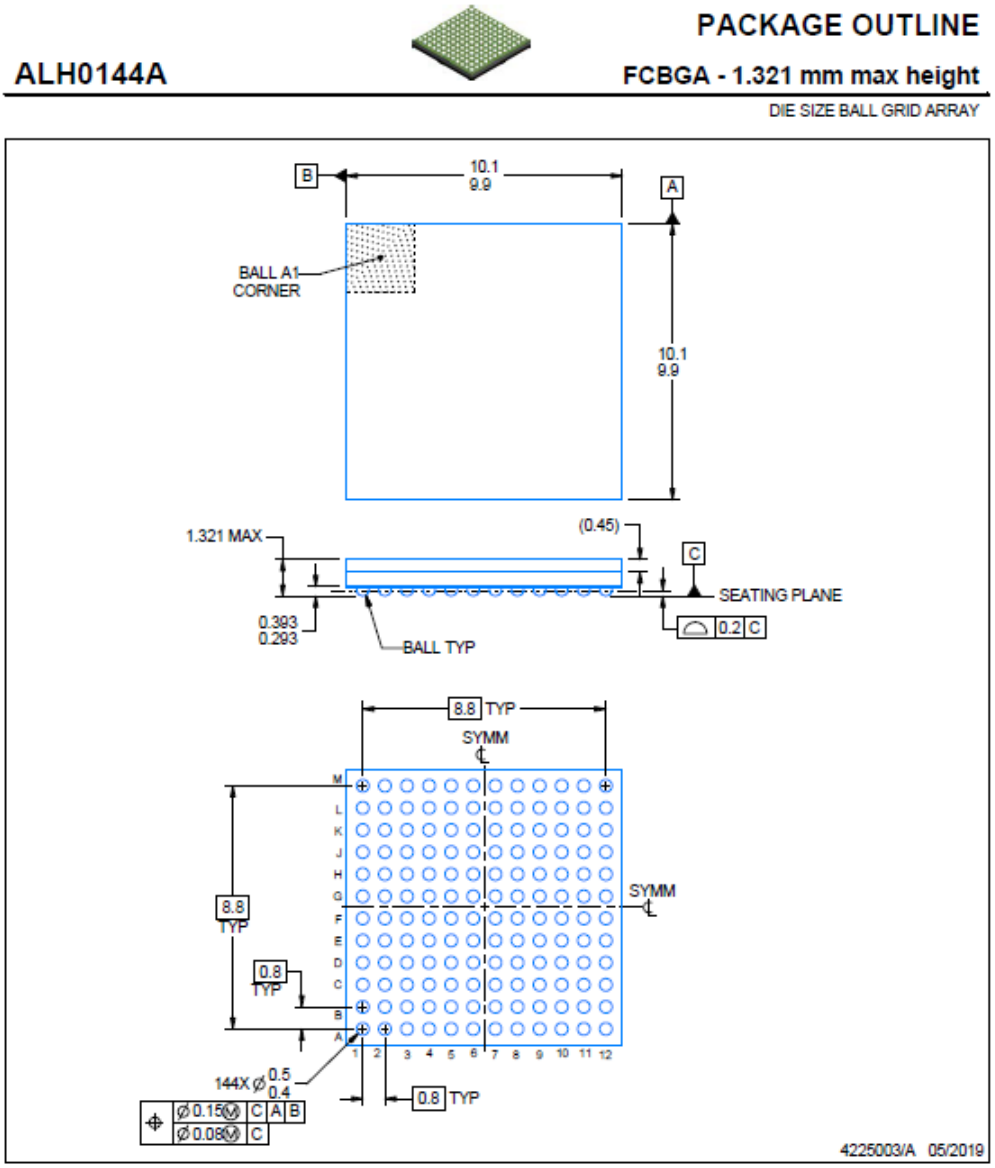
6.6 术语表

TI 术语表　　本术语表列出并解释了术语、首字母缩略词和定义。

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 datasheet, refer to the left-hand navigation.

7.1 Mechanical Data



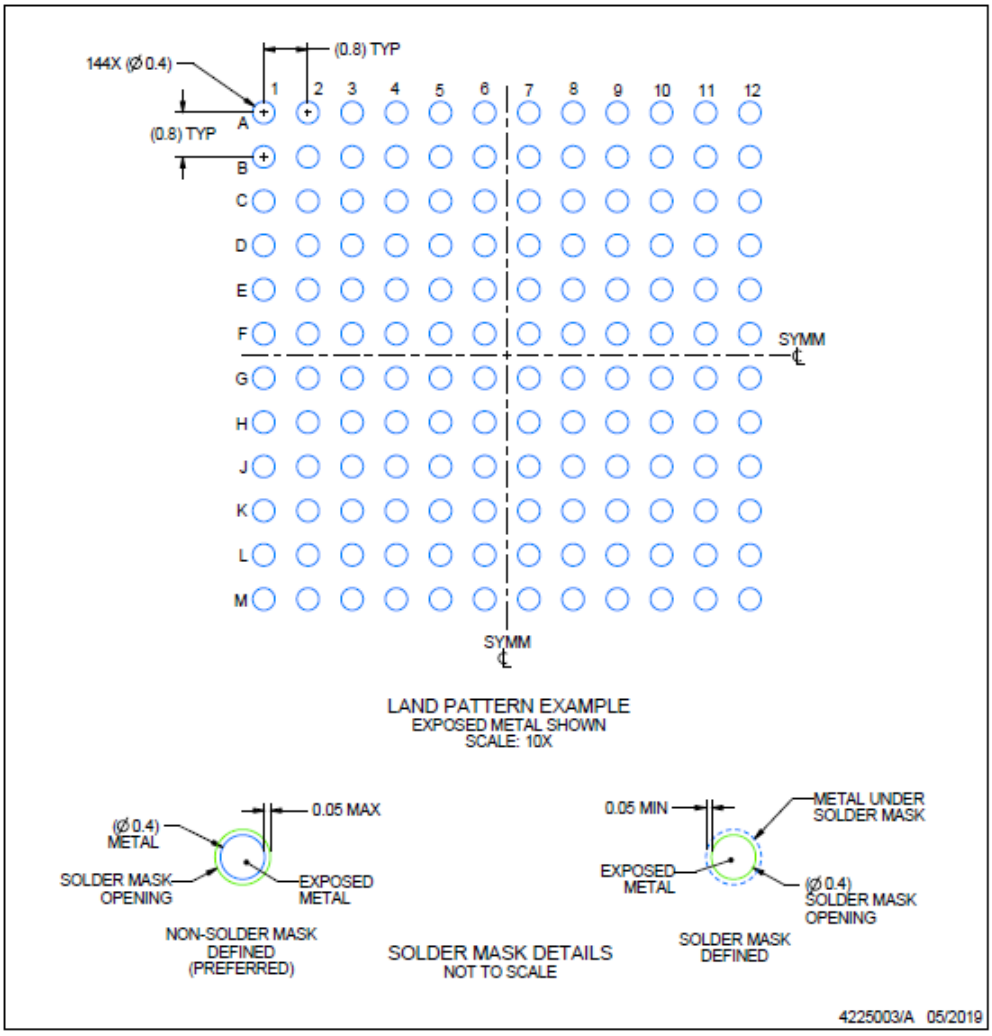
NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

EXAMPLE BOARD LAYOUT

ALH0144A — **FCBGA - 1.321 mm max height**

DIE SIZE BALL GRID ARRAY



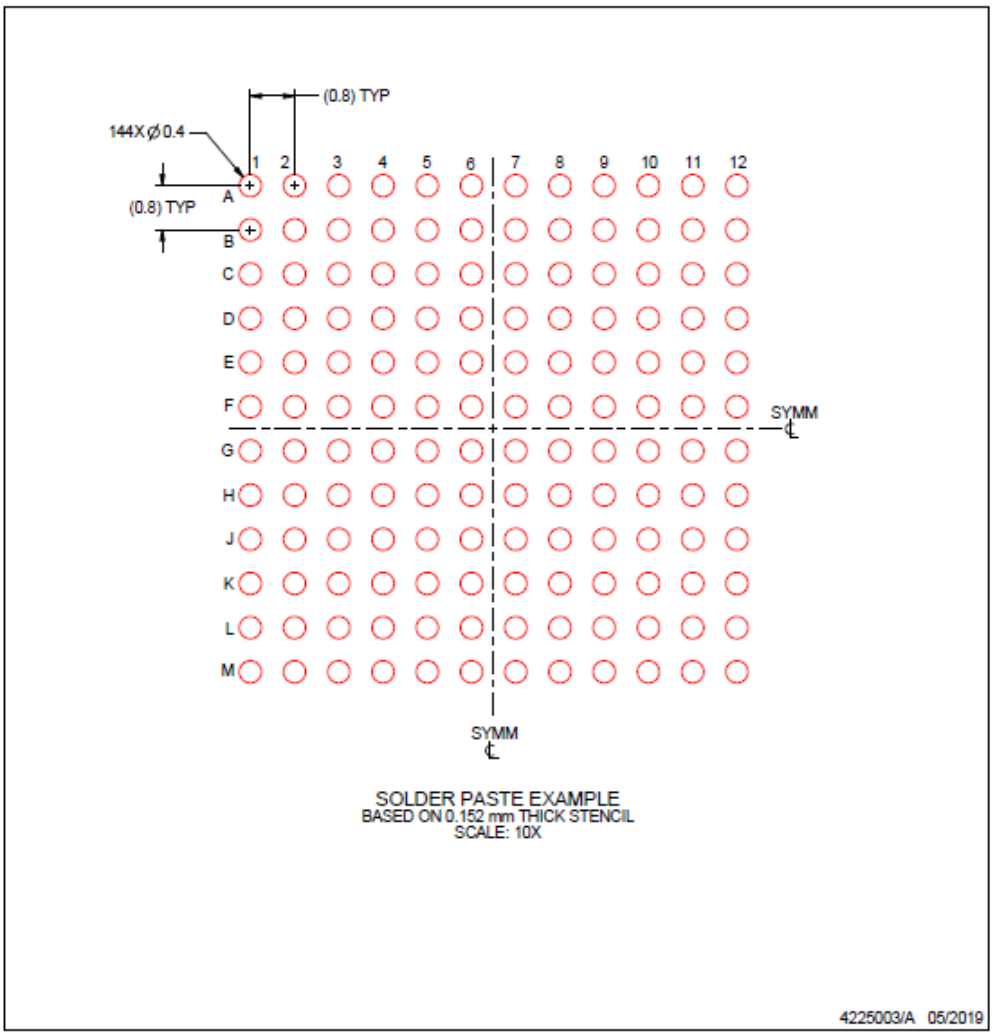
NOTES: (continued)

3. Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints. See Texas Instruments Literature No. SPRU811 (www.ti.com/lit/spru811).

EXAMPLE STENCIL DESIGN

ALH0144A — **FCBGA - 1.321 mm max height**

DIE SIZE BALL GRID ARRAY



SOLDER PASTE EXAMPLE
BASED ON 0.152 mm THICK STENCIL
SCALE: 10X

4225003/A 05/2019

NOTES: (continued)

4. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TX7516ALH	ACTIVE	FCCSP	ALH	144	240	RoHS & Green	SNAGCU	Level-3-260C-168 HR	0 to 70	TX7516	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".
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Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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

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

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

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