

AD2428 Automotive Safety Application Note



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Guidelines AD2428 ISO26262:2018 Proven-In-Use

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About this document

This Application Note summarizes the formal automotive functional safety proven in use analysis performed on the AD2428 product family of A²B (Automotive Audio Bus) transceivers. Analog Devices Inc. (ADI) interpretation of ISO 26262:2018 part 8, clause 14 (Proven in use argument) in the context of the AD2428 demonstrates compliance with all the requirements in ISO 26262:2018 part 8, clause 14 which are addressable by a component supplier to support safety integrity level requirements up to ASIL B.

AD2428 Product Overview

The AD2428 transceiver block diagram is shown in Figure 1 and a typical Communication System Block Diagram of an A²B communications is illustrated in Figure 2. Here, a single-main node and multiple subordinate nodes are connected over a single unshielded twisted pair cable. The main node transceiver is controlled by the host. The host generates a periodic synchronization signal (SYNC) on the I²S/TDM interface at a fixed frequency (selectable either 44.1 kHz or 48 kHz), to which all A²B nodes synchronize. Communication over the A²B bus occurs in periodic superframes at this rate. Data is transferred at the A²B system bit clock (SYSBCLK) rate, which is 1024 times faster than the superframe rate (49.152 MHz for a frame rate of 48 kHz, 45.158 MHz for a frame rate of 44.1 kHz). Each superframe is divided into periods of

downstream transmission, upstream transmission, and no transmission (where the bus is not driven).

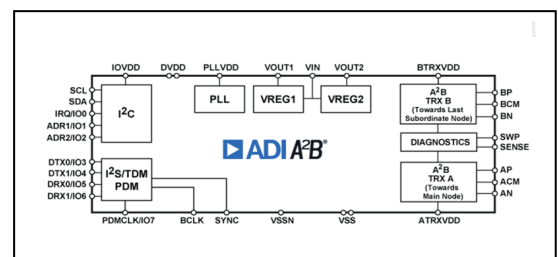


Figure 1: Block Diagram of the AD2428

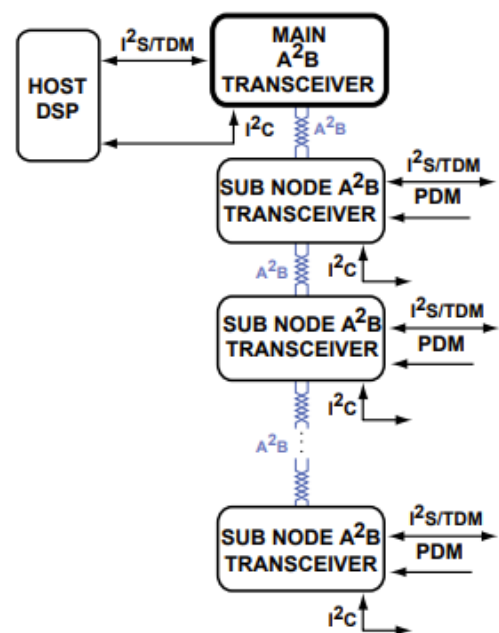


Figure 2: The Communication System Block Diagram shows an A²B Communications System

The AD2428 product family has been released in the market since November 2018. It is a commercial off-the-shelf (COTS) product which has been developed according to the ADI product development process as an automotive QM (Quality Managed) hardware element suitable for integration into automotive systems. It was not

developed in accordance with the ISO 26262 set of standards. In the sense of ISO 26262 there were no ASIL-A/B/C/D classified safety requirements assigned to the product during the development. However, there is substantial field data available for the AD2428 to provide PIU analysis.

Scope for the System Integrator

It is the integrator's responsibility to evaluate whether the AD2428 PIU application note is sufficient and suitable to support the integration of AD2428 QM part into the safety-related system.

Product Evaluation

The AD2428 product family includes several device derivatives that are differentiated by operating temperature. Only the "W" grade parts, which are qualified for Automotive Applications and tested across the full automotive temperature range, are considered for the PIU analysis data set and are defined as the PIU candidates. In addition, only shipments to automotive customers are considered for the PIU analysis shipment volume.

The AD2428 product family is designed with a specific set of functions and has unique application space use cases. Based on this, its use cases in Automotive are assumed limited to those involving A²B. As ADI does not develop the end solution, the assumed use cases are not guaranteed by the Proven in Use argument.

Proven In Use Analysis

According to the requirements and recommendation of ISO 26262 part 8, clauses 14.4.4 and 14.4.5, the following data has been used as input for the calculation:

- Start of production: November 2018
- System: Automotive Audio Bus for audio system

Product volume until July 23, 2023 $\geq xx^1$

- Field fails received by ADI since start of production xx^2 pieces.

Additionally, the following assumptions have been done:

- Operational hours of a vehicle per year = 481 hours (1.32 hours per day), according to IEC62380 recommendations.
- Storage and delivery time (before AD2428 is used in a car) = 3 months ($\frac{1}{4}$ year)
- Observation time for the year of delivery is counted by $\frac{1}{4}$ years as average observation time for devices which are delivered distributed over this year.

¹ For more detailed information, please contact with ADI sale representative.

² For more detailed information, please contact with ADI sale representative.

The assumptions above are conservative. This already includes 1/4 years headroom for the production time and storage time at Tier1 and OEM (see ISO 26262 part 8, clause 14.4.5.2.3).

The accounted observation time in 2023 for the samples which were delivered in 2019 is:

$$t_{ob}(2023) = 2023 - 2019 + 1/4 - 1/4 = 4$$

Service time calculation

The necessary minimum evaluation period $t_{service}$ has been calculated as:

$$t_{serv} \geq t_{MTT} \times \frac{(\chi_{1-CL;2f+2})^2}{2}$$

Equ.1 - required service hours formula from ISO 26262-8:2018 clause 14

Where:

- f is the number of observed safety-related incidents.
- CL is the confidence level as absolute value (e.g. 0.7 for 70%);
- t_{MTT} is the mean time to failure (1/failure rate)
- $(\chi_{\alpha,v})^2$ is the chi-squared distribution with error probability α and v degrees of freedom.

PIU Calculation Results Based on ADI PIU Calculator

Results for proven in use calculation according to ISO 26262:2018 part 8, clause 14 and ADI PIU calculator are as shown in the Table 1 and Table 2.

Table 1 Accumulated Operation Time Results to Support Integration of AD2428 into ASIL B Systems.

Actual In-Service hours until June 2023 [hours]	Required Minimum Service Period [hours]	Assessment of results
3.84E+10	3.40E+10	PASS

Table 2 Calculated Results for Observable Incident Rate to Support Integration of AD2428 into ASILB Systems

Calculated Observable Incident Rate	ISO 26262 Limits for Observable Incident Rate	Assessment of results
8.84E-9/h	<1E-8/h	PASS

Summary of AD2428 Proven In Use Analysis

The PIU calculation results demonstrate that the metrics for Minimum Service Interval and Incident Rate for an ASIL B solution are met by the AD2428.

The calculated minimum service period required for ASIL B is 3.40E+10 hours. The AD2428 as of June 2023 has an in-service period of 3.84E+10 hours, which satisfies the ASIL B requirement.

The calculated incident rate for the AD2428 is 8.84E-09, which satisfies the ASIL B requirement of $< 1E-08$.

In the above calculation, even though a very conservative customer return number was used, the PIU calculation results for AD2428 can still pass the ASIL B.

References

- [1] ISO 26262-8:2018
- [2] AD2426/7/8 Automotive Audio Bus (A2B) Transceiver Technical Reference (Rev. 1.3)
[ad242x-trm.pdf \(analog.com\)](#)
- [3] AD2426/AD2427/AD2428: Automotive Audio Bus A2B Transceiver Data Sheet (Rev. E)
[AD2426/AD2427/AD2428 \(Rev. E\) \(analog.com\)](#)

Document History

Revision	Description
Rev 01 – October 31, 2023	Added PIU Calculation Results and Reference
Rev 02 – November 20, 2023	Added Modified Calculation Results based on Conservative Customer return number
Rev 03 – February 07, 2024	Updated after the review feedback, Initial release
Rev 04 – March 04, 2024	Hidden Production Volume data