TLE4941plusC

ISO 26262:2018 Proven in Use Candidate

About this document

This Application Note explains Infineon's interpretation of ISO 26262:2018 part 8, clause 14 (Proven in use argument) in the context of the TLE4941plusC and demonstrates its compliance with all the requirements in ISO 26262:2018 part 8, clause 14 which are addressable by a component supplier to support safety requirements up to ASIL B(D).

Definition of Proven in Use Candidate

The product TLE4941plusC described in this safety application note has been developed according to the Infineon product development process as a QM part, automotive quality rules and methods are applied as defined in IATF 16949, but 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. Technical Safety Requirements are assumed for the application and used for the Proven in Use calculation.

Scope and purpose

This document provides supporting information for evaluation of the capabilities to implement the Product in functional safety related application. You are obliged to ensure conformity with the relevant requirements of ISO 26262, such as e.g. ISO 26262:2018 Clause 8-14.

In particular you are obliged to obtain the available product safety documents and to respect the information and information updates provided by Infineon Technologies.

In the event that you merely resell the Product, you are obliged to ensure that your customers obtain the available product documents and that your customers respect the information and information updates provided by Infineon Technologies.

Information updates are provided via Product Change Notification ("PCN"), Info Note or Early Problem Notification (EPN) or any other written communication to customers or distributors that have ordered the Product within the last 5 years. The complete updated safety document is available via the Infineon sales office.

Intended audience

This Application Note is written for experienced hardware and software engineers, system integrators and functional safety managers involved in the design or development of a safety-related system who are considering integrating the TLE4941plusC into their system.

Table 1 Devices covered by this document

Name	Description and features	Ordering Code	Package
TLE4941plusC	Differential Wheel Speed Sensor	SP001952932	PG-SSO-2-53

Table of contents

1 ISO 26262:2018 & Infineon Magnetic Speed Sensor

ISO 26262:2018 defines the development of electric and electronic automotive systems regarding their functional safety. The aim of this standard is to reduce failures and malfunction of such systems. Development process depends on the ASIL (Automotive Safety Integrity Level) of the target system and can range from ASIL A to ASIL D. Systems like steering or braking for example, are rated with the highest level ASIL D. There, a failure can lead to an uncontrollable vehicle and may cause fatal injuries.

For devices with sufficient relevant field data regarding safety-related incidents, the proven in use argument according to ISO 26262:2018 part 8, clause 14 may be applied. QM parts (including products that were not developed according to ISO 26262) identified by Infineon as part 8, clause 14 candidates are supported by sufficient proven in use credits.

Chapters 2 and 3 of this Application Note provide the rationale for the calculation and the results of the analysis to prove that TLE4941plusC is compliant with all the requirements in ISO 26262:2018 part 8, clause 14 which are addressable by a component supplier to support safety requirements up to ASIL B(D), according to proven in use argumentation.

1.1 Scope for the system integrator

It is the integrator's responsibility to evaluate whether the provided safety-related documentation is sufficient and suitable to support the integration of QM part into the safety-related system. This includes classification of the device based on the intended use case, details for performing necessary device evaluation in the system into which it is integrated, and data to support system level safety analysis. In particular, requirements from ISO26262:2018 part 8, clauses 14.4.2.4, 14.4.2.5, 14.4.2.6 need to be fulfilled by the system integrator in order to use the proven in use argumentation.

1.2 Required additional reading

This document is limited to those technical actions that are required to ensure compliance with the relevant safety standards. Other documents, such as the latest data sheet [1] and Safety Analysis Summary Report [2] [3] must be referred to for information outside the scope of this document. A list of the relevant documents can be found in the references. Please ensure to use the latest version of the relevant documents.

2 ISO 26262:2018 Proven in Use Argumentation

A Proven in use argument is an alternate means of compliance with the ISO 26262 series of standards that may be used in the case of reuse of existing items or elements when field data is available.

According to part 8, clause 14.2(c), *the motivation for using the argument for proven in use includes a candidate being in the field prior to the release of the ISO 26262 series of standards.* TLE4941plusC falls exactly into this category, as it is being used in the field since 2011 in automotive wheel speed sensing systems, before ISO 26262 series of standards were released.

Additionally, according to part 8, clause 14.2, two important points need to be considered when preparing a proven in use argument:

- *the changes, if any, that could have impacted the candidate since its previous evaluation period; and*
- *the relevance of field data during the previous evaluation period of the candidate.*

With regards to TLE4941plusC, there have been no changes with an impact to the product since the beginning of production.

Additionally, for TLE4941plusC it has to be understood that there is no opportunity to modify its use case, since it is a 2 pin device which only has to be placed in a magnetic field which periodically changes depending on the rotation position of the monitored axis. Electrically its 2 pins have to be connected with a stabilized supply voltage source. The ECU that receives the speed sensor signal has to measure the current consumption in order to detect the pulses, e.g. with a shunt resistor in the supply path. Even in case of a change of the system ECU the use case of TLE4941plusC would stay unchanged.

In Chapter 3 the input data and assumptions used to support the proven in use argumentation are explained in details.

Note: Text in Italic in this Chapter is taken from ISO26262:2018 part 8, clause 14

3 Proven in Use Analysis

3.1 Inputs & assumptions

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: 2011;
- System: wheel speed sensing;
- Product volume until June 2019 ≥ 843.000.000 pieces;
- Field fails received by Infineon since start of production = 40 pieces (only the failures happening in the field (> 0 km) and not during vehicle tests and verification are considered).

Additionally, the following assumptions have been done:

- Operational hours of a vehicle per year = 500 hours (1.37 hours per day), according to IEC62380 recommendations (Chapter 5.8.3);
- Storage and delivery time (before TLE4941plusC is used in a car) = 0.5 year:
- Observation time for the year of delivery is counted by 0.5 years as average observation time for devices which are delivered distributed over this year.

Please note that the assumptions above are conservative (normally cars drive more than 500 hours per year and storage and delivery time is typically within three months).

Additionally, devices which are delivered less than 1.5 years before the proven in use evaluation are not taken into account for the calculation. This already includes 0.5 years headroom for the production time and storage time at Tier1 and OEM (see ISO 26262 part 8, clause 14.4.5.2.3).

With the assumptions above, the accounted observation time in 2020 for the samples which were delivered in 2011 is:

$$t_{obs}(2011) = 2020 - 2011 + 0.5 - 0.5 = 9\ years$$

3.2 Service time calculation

Since observable incidents have been found in the collected data of TLE4941plusC, the necessary minimum evaluation period $t_{service}$ has be calculated as

$$t_{\text{service}} = t_{\text{MTTF}} \times \frac{\left(\chi_{\text{CL};2f+2}\right)^2}{2}$$

Where:

- *CL is the confidence level as an absolute value (e.g. 0.7 for 70%);*
- T_{MTTF} *is the mean time to failure (1/failure rate);*
- *f is the number of safety-related incidents* multiplied by the correction factor n (see Chapter 3.3);
- $(\chi_{\alpha,\nu})^2$ *is the chi-squared distribution with error probability* α *and* ν *degrees of freedom*.

Note: Text in Italic in this Chapter is taken from ISO26262:2018 part 8, clause 14

3.3 Correction factor explanation

In the calculation it is considered that not all field returns will reach Infineon through the supply chain via OEM and Tier1.

In general all partners in the supply chain are implementing ISO26262 part 7 clause 7.4.1.1. (field monitoring process) since 2011. Consequently it is assumed that the probability of field returns to be forwarded to IFX for analysis should increase over the observation period.

It is further assumed that the probability that a device with a potential safety related failure will be reported to Infineon depends on the severity of the impact in the application. In cases where systematic issues cause repetitive safety incidents of a similar pattern the probability of reporting to IFX is assumed to be higher than for single random cases.

Furthermore it is assumed that the probability that a device which caused a safety related incident in the field is higher during the warranty period of the car. After the warranty period the probability for FAR reporting is low and most likely only cases with a severe impact will reach Infineon.

Finally the return probability also depends on the field return handling process of the OEM and the Tier1 which can also lead to different decisions in different supply chains.

Unfortunately all these probabilities cannot be quantified precisely and evidences for the return rate are not available. In order to handle this uncertainty the calculation is done in a way that quantifies by which correction factor (as defined in ISO26262:2018 part 11, clause 4.6.2.2) the requirements of this clause are over fulfilled.

The resulting tolerable correction factor for TLE4941plusC is calculated in Chapter 3.5.

In order to set a limit for the acceptance of the calculated tolerable correction factor, it is assumed that the return probability during at least 2 years warranty time of the car is at least 10%, after this time the return probability is conservatively assumed to be 0.

With a constant failure rate the amount of incidents in the field is conservatively assumed to be 10 times higher than the annually reported number during the car's warranty period of 2 years. This failure rate stays constant even though nothing is assumed to be reported to IFX anymore when the warranty period is over.

Based on this assumption the number of cases that appear during the observation time $t_{obs}(2011)$ for the devices delivered in the first year of the observation period (see ISO26262:2018 part 14, clause 4.5.2.2) are by a factor of $n = \frac{t_{obs}(2011)}{(2\ years \times 10\%)} = 45$ higher than the ones reported to IFX.

This estimate is again conservative in the sense that it takes the worst case correction factor from the oldest parts (2011), which is higher than the one of younger parts that are still within or shortly exceeding the warranty period of the car.

Consequently the proven in use credit can be granted if the correction factor for the calculation of the criterion given in this clause is larger than n = 45.

Chapter 3.5 shows that with the assumptions from Chapter 3.1 and Chapter 3.3, TLE4941plusC is compliant with all the requirements in ISO 26262:2018 part 8, clause 14 which are addressable by a component supplier to support safety requirements up to ASIL B(D).

3.4 Technical Safety Requirements

In the sense of ISO 26262 there were no ASIL-A/B/C/D classified safety requirements assigned to the product during the development. Technical Safety Requirements are assumed for the application and used for the Proven in Use calculation.

Wheel speed sensing systems (e.g. ABS, EPS…) are rated up to ASIL D, but thanks to ASIL decomposition the ASIL level assigned to the sensor is typically ASIL B(D) for the following two Technical Safety Requirements (TSR):

- TSR1: The number of pulses shall not be higher than 102% of the real value;
- TSR2: The number of pulses shall not be lower than 98% of the real value.

Hence, to avoid systematic failures to be propagated into the system, calculations were performed also with ASIL D target to support ASIL B(D) if required by the system integrator.

Please note that the decomposition from ASIL D item safety goals or system safety requirements to ASIL B(D) safety requirements as stated in this document for the Infineon wheel speed sensor has to be part of the system integrator safety concept.

3.5 Results

Results for proven in use calculation according to ISO 26262:2018 part 8, clause 14, based on Infineon “proven in use calculator” are shown in Table 2 (for ASIL B) and Table 3 (for ASIL B(D)).

Table 2 Results to support integration of TLE4941plusC into ASIL B systems

Correction factor (ISO 26262:2018 part 11, clause 4.6.2.2)	Cumulated operating time until June 2019 [h]	ISO 26262 required cumulated operating time for ASIL B [h]	Assessment of results
469 (Maximum for ASIL B)	1.89E+12	1.88E+12	PASS

Table 3 Results to support integration of TLE4941plusc into ASIL B(D) systems

Correction factor (ISO 26262:2018 part 11, clause 4.6.2.2)	Cumulated operating time until June 2019 [h]	ISO 26262 required cumulated operating time for ASIL D [h]	Assessment of results
46 (Maximum for ASIL B(D))	1.89E+12	1.86E+12	PASS

Note: As explained in Chapter 3.3 a correction factor of “n” means that only one out of “n” sensors failing in the field is received by Infineon. The customer has to agree that the maximum correction factor used for the calculation is sufficiently high.

In conclusion, TLE4941plusC is compliant with all the requirements in ISO 26262:2018 part 8, clause 14 which are addressable by a component supplier to support safety requirements up to ASIL B(D), according to proven in use argumentation.

4 References

[1] TLE4941plusC Datasheet, latest version

[2] TLE4941plusC Safety Analysis Summary Report based on SN 29500

[3] TLE4941plusC Safety Analysis Summary Report based on IEC 62380

Revision history

Document version	Date of release	Description of changes
1.0	2020.11.17	First version of this document

Trademarks
All referenced product or service names and trademarks are the property of their respective owners.

Edition 2020-11-17

Published by

Infineon Technologies AG

81726 Munich, Germany

Do you have a question about this document?

Email: erratum@infineon.com

Document reference
AppNote Number

IMPORTANT NOTICE

The information contained in this application note is given as a hint for the implementation of the product only and shall in no event be regarded as a description or warranty of a certain functionality, condition or quality of the product. Before implementation of the product, the recipient of this application note must verify any function and other technical information given herein in the real application. Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind (including without limitation warranties of non-infringement of intellectual property rights of any third party) with respect to any and all information given in this application note.

The data contained in this document is exclusively intended for technically trained staff. It is the responsibility of customer's technical departments to evaluate the suitability of the product for the intended application and the completeness of the product information given in this document with respect to such application.

For further information on the product, technology delivery terms and conditions and prices please contact your nearest Infineon Technologies office (**www.infineon.com**).

WARNINGS

Due to technical requirements products may contain dangerous substances. For information on the types in question please contact your nearest Infineon Technologies office.

Except as otherwise explicitly approved by Infineon Technologies in a written document signed by authorized representatives of Infineon Technologies, Infineon Technologies' products may not be used in any applications where a failure of the product or any consequences of the use thereof can reasonably be expected to result in personal injury.