



CASE STUDY /

Ansys + ZF Group

“Ansys medini analyze helped us to provide functional safety analysis for hardware, software and systems based on and fully compliant to architecture models.”

Günter Gäbelein

Safety Assessor / ZF Friedrichshafen AG

ZF Group Harmonizes and Accelerates Functional Safety Analysis with Ansys medini analyze

Automotive systems supplier ZF Friedrichshafen AG utilizes Ansys medini analyze to drive agility, innovation, and efficiency in its embedded safety systems development and verification process. Ansys medini analyze has already reduced the time involved in functional safety analysis by up to 50%.

Today's passenger cars and commercial vehicles incorporate complex, integrated electronic systems — many of which are developed by ZF Group. ZF continually enhances its systems in the areas of digital connectivity and automation to allow vehicles to see, think, and act. The company is supporting the world's automakers in realizing their vision for autonomous driving, electric mobility, and other innovations via its best-in-class technology solutions.

/ Ansys medini analyze + ZF Group

According to Günter Gäbelein, Safety Assessor at ZF Friedrichshafen AG, "As a systems supplier for passenger cars, commercial vehicles, and industrial technology, ZF Friedrichshafen AG places great emphasis on agility and innovation. To support exciting developments like autonomous driving and electric mobility, our R&D process must be fast, cost effective, and technically precise. More and more projects are taking advantage of synergies provided by medini analyze. In a medium-size project, more than 300 hours of effort can be saved by the one-tool solution and the interfaces to third-party tools for architectures. ZF is a strong advocate for model-based engineering, and medini analyze helps to reduce the complexity of analysis for embedded systems."

/ Challenges

The global automotive industry continuously pushes to improve its time to market and reduce its costs while meeting functional safety demands. Embedded systems from automotive suppliers must be capable of operating reliably and safely under challenging environmental conditions. Since 2014, ZF has been a pioneer in applying medini analyze to its functional safety engineering practices, delivering significant benefits in terms of consistency and completeness of work products. In the past different tools were used for failure modes and effects analysis (FMEA), fault tree analysis (FTA), and hardware fault metric analysis, and the consistency between architecture models and the analyses was always a time-consuming challenge.

In the past, ZF product lines were using different standards for failure rates and modes. Therefore, the comparison of designs was difficult, although similar designs were used.

Tool classification and qualification according to ISO-26262 seem to be a challenge in every project worldwide. Although the topic "Confidence in the Use of Software Tools" is well described in ISO 26262-8:2018, project teams often do not know what to do. In most projects, the classification of software tools is based on reuse from source projects and lessons learned and are therefore well done. However, according to the qualification of software tools, evidence that measures from tool qualification have been performed is often missing.

/ Ansys Products Used

- Ansys medini analyze

/ Engineering Solution

- Many systems engineering teams at ZF have used medini analyze for functional safety analysis since 2014, making ZF an early adopter.
- Customized FMEA and FMEDA worksheets derived from architecture models are always in sync.
- Evidence for the compliance between FTA and the architecture models can be provided by customized checklists derived from the architectures.
- ZF's Corporate Functional Safety Group recommends medini analyze for delivery of ISO-26262 work products.
- The ZF hardware part library provides harmonized failure modes and catalogs data for more than 22,000 electronic components based on ZF part numbers.

Architecture Checklist PhysicalSystemBehaviour - Training SysArc - Example

Architecture Checklist PhysicalSystemBehaviour

type filter text

Task/Requirement	inherited ASIL	assigned ASIL	Related Artifacts	modified	FTA Event	effective Kind	Comment	Ch
PhysicalSystemBehaviour			PhysicalSystemBehaviour					
SafetyMeasures			SafetyMeasures					
TemperaturMonitor			TemperaturMonitor					
DetectOverTemperaturMicro		NONE	DetectOverTemperaturMicro					
µC operated outside specified temperature	[B]		[MF145] µC operated outside specified temperature		[E53] [DetectOverTemperaturMicro] [MF145] µC operated outside specified temperature	INTERMEDIATE		
MonitorTemperature			MonitorTemperature					
TemperaturSensor			TemperaturSensor					
configure()			configure()					
threshold value not provided	[B]		[MF131] threshold value not provided		[E71] [configure()] [MF131] threshold value not provided	BASE		
threshold value incorrect			[MF132] threshold value incorrect				no related FTA Events	
not configured			[MF133] not configured				no related FTA Events	
configured incorrectly			[MF134] configured incorrectly				no related FTA Events	
ProvideTemperatureValue()			ProvideTemperatureValue()					
actual temperature value not provided			[MF135] actual temperature value not provided				no related FTA Events	
ReportOverTemperature			ReportOverTemperature					
Over temperature alarm not triggered	[B]		[MF136] Over temperature alarm not triggered		[E58] [ReportOverTemperature] [MF136] Over temperature alarm not triggered	BASE		
SafetyManagementUnit			SafetyManagementUnit					
TriggerSafetyInterrupt()			TriggerSafetyInterrupt()					
[MF127] CPU alarm not provided					[E71] [TriggerSafetyInterrupt()]			

- A customized ZF master template provides customized worksheets supporting compliance between architecture models and all safety analyses.
- ZF has customized trainings to harmonize the use of medini analyze across projects and divisions.
- Effort for software tool classification and qualification can be dramatically reduced by an integrated prequalified tool database and a fully automated generation of the tool classification and qualification report.

medini analyze

File Edit Project Traces Report Search Window Help

Model Browser

type filter text

- Integrated HW Part Library
 - Failure_Mode_Library
 - ZF HW Part Library [Mission Profile]
 - Integrated HW Part Library
 - [230736-201] CONN, NON-HEADER Female 26 Comp
 - [34116014A] CAP, CERM 10nF 10% 100V
 - [34116016A] CAP, CERM 100nF 10% 50V
 - [34116021A] CAP, CERM 100nF 10% 16V
 - [34116025A] CAP, CERM 470pF 10% 50V
 - [34116046A] DIODE, STRY 40V 1A
 - [34120337A] RES, THKF 13kohm 1% 0.1W
 - [34122472A] CAP, CERM 4700nF 10% 16V
 - [34124423A] CAP, ALIC 100uF 35V
 - [34126358A] RES, THKF 0.0604kohm 1% 0.5W
 - [34126502A] RES, THKF 0.022kohm 5% 0.5W
 - [34128687A] POWER-SUPPLY, SW-MODE Buck 0.37MI
 - [34128717A] RES, THKF 33kohm 1% 0.1W
 - [34128718A] RES, THKF 18kohm 1% 0.1W
 - [34130606A] CAP, CERM Fail Safe 4.7uF 10% 50V
 - [34130610A] CAP, CERM 22nF 10% 25V
 - [34130802A] CAP, CERM 1000pF 10% 100V
 - [34132455A] RES, THKF 0.1kohm 1% 0.1W
 - [34132546A] DIODE, STRY 40V 4A
 - [34132681A] RES, THKF 0.0022kohm 5% 0.25W
 - [34133601A] RES, THKF 3.9kohm 1% 0.1W
 - [34133903A] RES, THKF 100kohm 1% 0.1W
 - [34140576A] CAP, CERM 330nF 10% 16V
 - [34141472A] RES, THKF 0.866kohm 1% 0.1W
 - [34144003A] CAP, CERM 4700nF 10% 50V

Properties

[34130606A] C11004 : CAP, CERM Fail Safe 4,7uF 10% 50V

Base Failure Rate : 1.613963 FIT Transient Rate : 0.0 FIT Failure Rate of nested elements :

Safety Raw Failure Rate : 1.613963 FIT

Failures Mode : user defined catalog sum of failure modes percentage of parent: 0.0 %

Prediction Catalog Data : Catalog: Edition SN29500-1, Note 1: July 2011
Category: Passive Components (Part 4), Sub-Category: Capacitor
Type: Ceramic MDK/MDC (z.B. X7R, X5R)
Quality grade: GP

Scaling enabled at type

Variables :

Derive	Description	Name	Value	Unit
<input type="checkbox"/>	Operating voltage	U	12.0	V
<input checked="" type="checkbox"/>	Ambient temperature	T_amb	1-20, 43	°C

1559M of 2421M

SW Tool/Use case description	Use Case used at project	Revision	Potential Failure Causes	Potential malfunction	Justification for the possibility of violating a safety requirement	Safety requirement violation potential	Confidence of detecting malfunction of the tool	Justification for Tool Error Detection	Measures to increase detection (Tool Qualification)	Qualification Method
[F176] Renumber Functions	<input type="checkbox"/>		Medini scripts Malfunction of customized script	[MF315] Functions renumbered incorrectly	Effects from SW tool malfunction [E223] Functions have a unique identifier which is not impacted by inconsistent numbers	impossible	none			
[F175] Renumber FTA Events	<input type="checkbox"/>		Medini scripts Malfunction of customized script	[MF314] FTA Events renumbered incorrectly	Effects from SW tool malfunction [E222] FTA events have a unique identifier which is not impacted by inconsistent numbers	impossible	none			
[F173] derive_variables_from_library_to_project	<input checked="" type="checkbox"/>		Medini scripts Malfunction of customized script	[MF312] Variables to be specified at BOM are derived incorrectly	Effects from SW tool malfunction [E220] Incorrect derived variables may have an impact on the calculation of failure rates	possible	high	The inconsistencies will be detected during the HW Fault Metric Analysis by process (expected variables not available).		
[F174] deriveTeta_U	<input checked="" type="checkbox"/>		Medini scripts Malfunction of customized script	[MF313] Teta_U derived incorrectly from BOM to Mission Profile	Effects from SW tool malfunction [E221] Incorrect derived variables may have an impact on the calculation of failure rates	possible	high	The inconsistencies will be detected during the HW Fault Metric Analysis by process (no failure rates according to missing Teta_U from Mission Profile).		
[F171] create DFA checklist from FMEA worksheet	<input checked="" type="checkbox"/>		Medini scripts Malfunction of customized script	[MF310] DFA checklist is incorrect (missing or incorrect list items compared with FMEA worksheet)	[E218] The DFA checklist is used for the analysis of dependent failures. Some cutsets could be missed at	possible	medium	A comparison of the safety analysis and the checklist can identify inconsistencies. However, inconsistencies in future safety analysis	[TCL_Medini_7] Run test suite "ZF Profiling Test Suite" at each local installation	Validation of the software tool

/ Benefits

- The use of medini analyze for functional safety analysis has optimized the time involved in this process by up to 50% for the delivery of specific work products – making the entire embedded system development cycle much faster while ensuring transparent consistency, traceability, and completeness.
- Interfaces between medini analyze and SysML tools keep safety analyses (FMEA, FMEDA, FTA) and architecture models in sync.
- Time-consuming manual work for the identification of failure modes and rates is eliminated by the ZF hardware part library. ZF engineers can focus on the analysis of the failure effects.
- The effort for manual work according to tool classification and qualification can be reduced dramatically. The integrated collection of prequalified tools provides evidence for project-independent measures according to tool qualification. ZF engineers can focus on project-dependent measures only.
- ZF training courses help to harmonize safety analyses and provides a strong guideline for a further reduction of the effort.
- ZF engineers on many projects have found medini analyze's model-based approach very intuitive and user-friendly, making even the most complex of electronics architectures easy to understand and visualize.

/ Company Description

ZF is a global technology company and supplies systems for passenger cars, commercial vehicles, and industrial technology, enabling the next generation of mobility. ZF allows vehicles to see, think, and act. In the four technology domains – vehicle motion control, integrated safety, automated driving, and electric mobility – ZF offers comprehensive solutions for established vehicle manufacturers and newly emerging transport and mobility service providers. ZF electrifies different kinds of vehicles. With its products, the company contributes to reducing emissions and protecting the planet. In 2021, ZF had 157,549 employees worldwide with approximately 260 locations in 41 countries and achieved sales of €38.3 billion EUR.

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