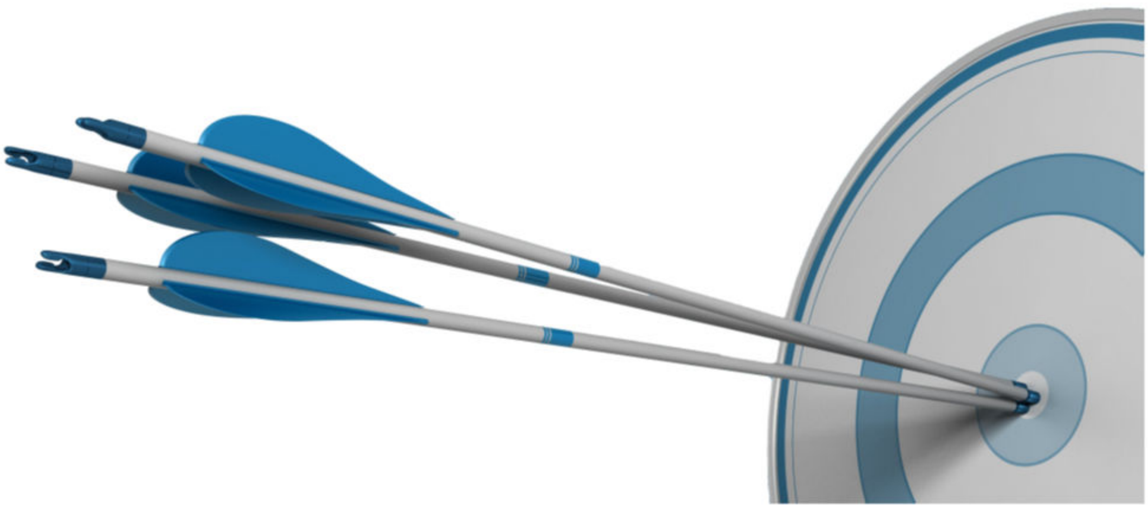
Technical note
00840-0500-6129, Rev AA
September 2022

Safety Deviation

formerly known as "Safety Accuracy"



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Definition of Safety Deviation

The term “safety deviation” is used in functional safety related discussions and predates the international IEC 61508 standard which is the base for today’s considerations.

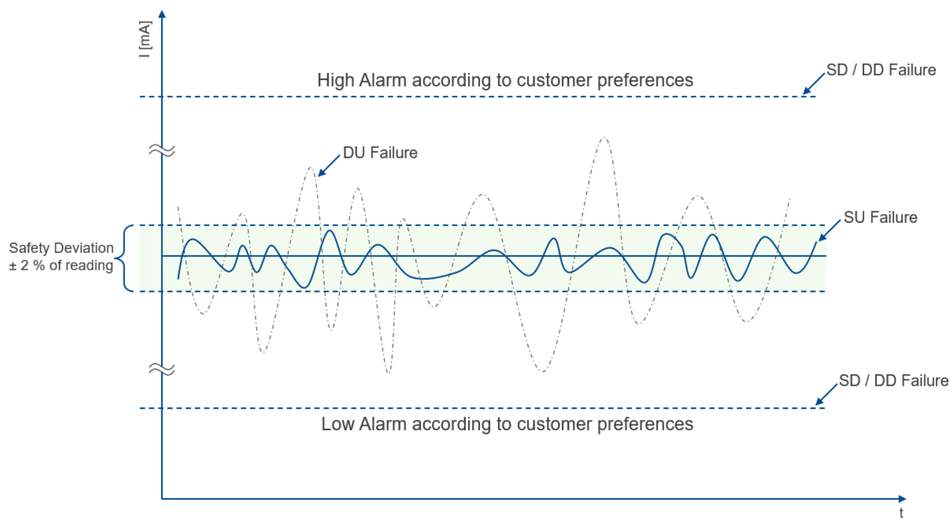
Safety deviation - which was formerly known as safety accuracy - describes the possible change in output signal from a device. This possible change is not detectable by internal diagnostics or through the FMEDA (Failure Modes, Effects, and Diagnostics Analysis). One example could be internal component failures. Being conservative of the safety deviation (which can be found in the safety manual of a product) should be considered by engineers while setting the trip point and should always be in respect to the safer direction.

When the FMEDA process was developed several decades ago, the concept of safety accuracy was implemented for analog devices. This is to consider component drifts and failures. After vigorous discussions between industry experts, were raised about realistic considerations it pointed out that 2% deviation should be the value to be defined for trip points.

What does it mean in detail?

Failure definition

Figure 1: Failure categories



λ_{SD} (Safe detected)	Safe failure which can be detected. This failure will have an impact on the output as it moves to the defined failure mode. Failure mode behavior definition is in customer responsibility. This failure has no effect on measurement accuracy.

Contents

λ_{SU} (Safe undetected)	Safe failure which can't be detected. The output could vary within the defined safety deviation range of ±2%. Therefor the λ_{SU} value has to be checked on how probable that behavior is.
λ_{DD} (Dangerous detected)	Dangerous failure which can be detected by internal diagnostics. They result in failure mode behavior, same as for λ_{SD}. This failure has also no effect on measurement accuracy.
λ_{DU} (Dangerous undetected)	Dangerous failure which cannot be detected by the device. That means that the output signal could be out of the range of the ±2% safety deviation.

What to check out when looking for failure rates

The λ_{DU} numbers should be as low as possible to avoid unsafe situations.

Advanced diagnostics are capable to reduce the amount of λ_{DU}. They can detect more issues than standardized self-diagnostics which only covers device issues. Advanced diagnostics can detect issues beyond the transmitter itself like the 4-20 mA loop or the process connections like impulse lines. This will result in a safer plant.

The λ_{DU} values will be shifted into λ_{DD} failures, and as a consequence, this will make the installation safer since the λ_{DD} are not affecting the measurement accuracy.

Nevertheless, you should keep an eye on the total amount of failures, even if they are categorised as safe or detected. Once the number of detected failures is very high, you will get confronted with a higher spurious false trip rate.

From safety perspective, that is not an issue but your goal should be to run a plant as long as possible without any interruption – unless it is not safe anymore.

How to compare λ_{DU} values to see how safe a device is

High λ_{DU} numbers mean that you lean to run more often in an inaccurate mode without knowing. That means the lower the λ_{DU} value the better it is for your safety application.

The other λ values does not seem to be that critical as they are safe and/or detected but especially the sum of detected failures shouldn't be too high as these will increase your false trip rates and reduce the availability of your plant. There won't be any safety issue for your plant but there must be an economic equilibrium between safety and availability.

What is the impact of customers considerations in SIS applications?

Safety budget

To many customers, 2% as a safety budget sounds a lot. But did they ever consider the total performance error of the device in a real-world application? Despite the high accuracy values, you will find additional information in datasheets which you need to consider. The influences from process, environment, and long-term drift are real and must be considered for the mission time.

Therefore, you will find detailed information in the technical product datasheets or manuals of each device.

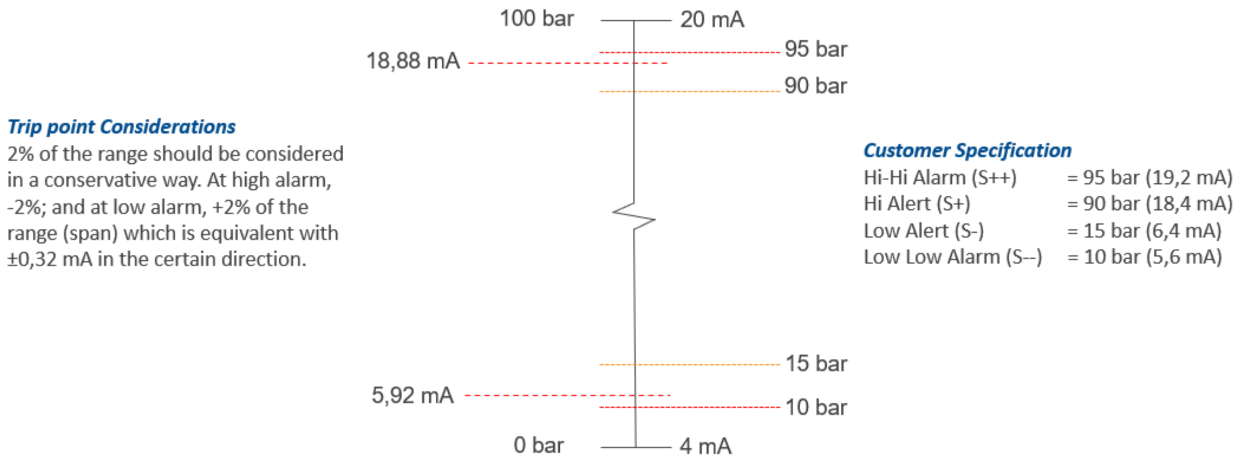
TPE (total performance error) calculations should be done to determine calibration intervals for example.

Keep in mind that your device should be able to stay at least within this 2% accuracy range like the safety deviation is defined to keep your safety function acting properly when needed.

Every measurement principle has its own technical data. For some, the environmental temperature change might be the biggest issue. Others may be affected by the process temperature or the turndown that they are used for.

Trip point considerations

Figure 2: Setting the trip point



Note
±2% of 4-20 mA (16 mA range) is equal to ±0,32 mA as Safety Deviation.

Emerson's Measurement Solutions products

Emerson has the broadest portfolio of Safety Certified devices. For more details on these products, please check the Safety Measurement Products website.

Table 1: Pressure safety certified devices

Pressure	
Rosemount 3051S transmitter	
Rosemount 3051 transmitter	
Rosemount 2051 transmitter	

Table 2: Temperature safety certified devices

Temperature	
Rosemount 3144P transmitter	
Rosemount 644 transmitter	
Rosemount 248 transmitter	

Table 3: Tank gauging safety certified devices

Tank Gauging	
Rosemount 5900S 2-in-1 radar level transmitter	
Rosemount 5900C guided wave radar	

Table 4: Level safety certified devices

Level	
Rosemount 5408 non-contacting radar	

Table 4: Level safety certified devices *(continued)*

Level	
Rosemount 5300 guided wave radar	
Rosemount 2140 SIS level switch vibrating fork	
Rosemount 2130 level switch vibrating fork	
Rosemount 2120 level switch vibrating fork	

Table 5: Flow safety certified devices

Flow	
Micro Motion 5700 transmitter	
Micro Motion 4200 transmitter	
Micro Motion 1700/2700 transmitter	 

Table 5: Flow safety certified devices *(continued)*

Flow	
Micro Motion 8800 vortex flowmeter	

Table 6: Flame and gas safety certified devices

Flame and gas	
Rosemount 935 open path combustible gas detector	
Rosemount 936 open path combustible gas detector	
Rosemount 975 multi-spectrum infrared flame detector	

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For more information: **Emerson.com**

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