WHITEPAPER

UNDESIRED BLAST EFFECTS

Explosion Protection of MSR Devices

Explosion protection is of crucial importance. Especially in the chemical and petrochemical industry. When measuring control and closed-loop control devices (MSR devices) require approval as explosion-protected equipment, the requirements of explosion protection must be integrated in the development process when developing an MSR device. An economical way is worth the money. Since the development duration is as short as possible, the provider maximizes his profit. The project duration is also reflected in the production costs.

For low-power measuring and automatic control devices, intrinsically safe (Ex-i) ignition protection plays the most important role is. The approval of explosion-protected equipment is only possible at a few certification bodies. The waiting periods are therefore correspondingly long. Moreover, complex tests must be carried out sometimes. Therefore, optimum preparation procedure can take between two and twelve months. Moreover, if the approval is not prepared carefully and accompanied accordingly, this period is extended. For market introduction and market success, an optimal project management of all activities is therefore a must in all phases of device development. It is important not to increase the later product costs by the measures of explosion protection and thus reduce the competitiveness.

The example of a 2-wire 4-2OmA transmitter for physical quantities – such as, temperature, pressure, angle, etc. – shows how project duration and thus product costs can be controlled.

The 5 Steps to Serial Production

These five factors constitute an optimum development process:

Step 1 – the requirement specification
The customer describes the final product based on technical data, desired completion date and achievable sales price.

Step 2 – the solution specification
The development department carries out a feasibility study, which in the end describes the solution to the requirements of the specifications.

Step 3 – a functional model
The development department creates a model in which the main technical data is reproduced.

Step 4 – the prototype
The functional model is revised so that all technical data conform to the solution specification.

Step 5 – the zero series
The production takes over the technical documentation of the prototype and produces a small series. Then, the product is optimised for production.

General Bases

The legal basis for explosion protection in Europe is the ATEX product directive 2014/34/EU, whose content in Germany is protected by the Explosion Protection – Product Ordinance 11. ProdSV is transposed into national law. The design and test conditions for devices that are to be approved according to ATEX are laid down in the IEC 60079-0 ff.

For low-power measuring and automatic control devices, the intrinsic safety (Ex-i) type of protection described in IEC 60079-11 plays the most important role.

The approval of explosion-protected equipment is only possible with a few certification bodies, with correspondingly long waiting periods. In Germany, for example: Physikalisch Technische Bundesanstalt PTA, Dekra Exam, TÜV Rheinland and ZelmEx.

Step 1:
Preparation of The Requirement Specification

In order to save time and thus costs, it is essential that the technical data for the explosion protection are already known for the requirement specification. For example: later use in group I or II; in category 1, 2 or 3; in gas group A, B or C; in the temperature class T1 to T6 (see 2014/34/EU and/or IEC 60079-0). These data depend solely on the target market of the product. Therefore, the customer knows and specifies them. The development department only takes them over.

Step 2:
Feasibility Study / Transition to Solution Specification

Already in the feasibility study it is conceived, how the explosion protection is to be realized and which costs for development and product are derived from it. First, a block diagram is created for the complete function of the product. In the case of a 4-20mA transmitter could look as shown in Figure 1.

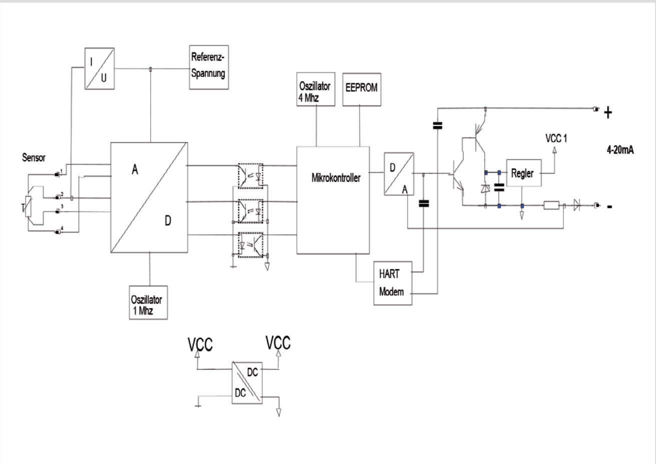

Figure 1 - Example of an equivalent circuit diagram

As a type of protection for 2-wire transmitter – the entire device is thus supplied from the 4-20mA current loop – intrinsic safety is selected (Ex-i according to IEC 60079-11).

In the same way as a block diagram was created for the function, an Ex equivalent circuit diagram is drawn up for the necessary measures of explosion protection, in which only the components that should ensure explosion protection are drawn. The equivalent circuit could look as shown in Figure 2.

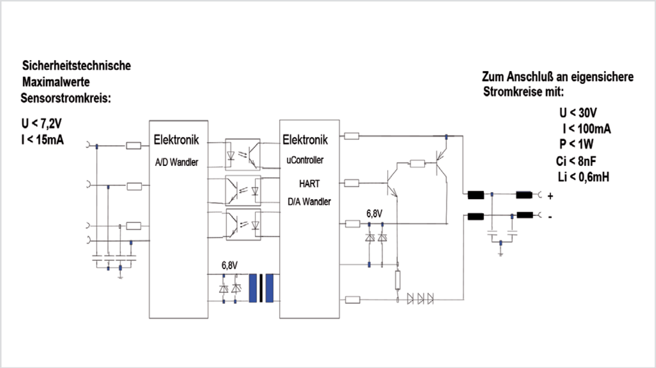

Figure 2 - Example of an equivalent circuit

If the equivalent circuit diagram has been created, a power loss must be estimated for the individual components in the event of a fault or, if feasible, calculated. Thus, the size of the corresponding components is determined. Moreover, the surface temperature of all components is estimated in case of failure. This is necessary because an ignition leading to explosion cannot only be caused by sparking, but also by hot surfaces. An experienced development engineer recognises whether the components should be cast for better heat dissipation.

Doubts regarding the feasibility of the Ex-concept can now be agreed on with the approval authority.

The solution specification arises from the findings of the feasibility study. It is compared with the requirements specification, discussed with the departments involved and the customer, and then released. Now the development phase of the functional model begins.

The feasibility study has a considerable impact on design shape and product costs. Therefore, the project should be considered holistically here. Pointing out several possibilities is now advisable instead of already setting points. In the actual development, decision can be made more carefully, which is ultimately realised.

Critical details that are not recognised in this phase can subsequently lead to time-consuming redesigns and thus time delays, thus, to actually avoidable costs. For the overall project, a detailed feasibility study always pays off. It enables a realistic solution´s specification, both for technical data, development and product costs. It thus minimises the development risk.

A feasibility study is also useful for other parameters, such as electromagnetic compatibility (EMC) or device safety.

Step 3:
Development Phase of The Functional Model

Now the complete electronics, mechanics and electro-mechanics are defined. The individual circuit components and all measures for explosion protection are calculated.

OUR TIP: Both developers and the testing authority benefit from all Ex-relevant components that are specially marked in the circuit diagram!

For the functional model, a laboratory or a Europe card structure of the complete circuit are dispensable. More useful is a layout of the printed circuit boards, which corresponds to the series product, especially the consideration of necessary clearance and creep distances for the explosion protection measures.

Experience shows that mistakes are possible and can be made in all stages of development. In order to arrive at the series product with as few redesign phases as possible, it is therefore necessary to observe all boundary conditions in the functional model. In the later prototype phase, any errors can be corrected and series production can be achieved with just one redesign phase. For this, however, measurement value acquisition and sensor technology must be defined sufficiently. If this is not the case, an upstream phase of basic development would make sense.

When documenting the functional model, the feasibility study again is a relief as framework for development documentation. If the technical data of the products are specified in the solution specification, the necessary tests of the functional model can be derived directly from the latter. The test results are documented and compared with the solution specifications. This allows also the people who are not directly involved in the development process to evaluate the development outcome.

If the function is satisfactory and the necessary changes in the redesign are not of a fundamental nature, it is already possible, with the functional model, to apply for approval of the product as an explosion-protected equipment at the approval authority (for example at PTB). To do this, the corresponding documents, such as, parts lists, circuit diagrams, Ex equivalent circuit diagram and description of the explosion protection measures are prepared and submitted.

OUR TIP: It is very likely that the application will be dealt with swiftly and easily before filing an application with the responsible administrator. Any ambiguity can be avoided and missing documents can be submitted in due time. Also, the necessary measurements regarding component heating and their implementation can be defined and possible deficiencies or misjudgements can be avoided in the following prototype phase.

Following coordination with the approval authority, the application for approval is prepared and submitted accordingly. The period from submission of the application to the actual examination by the expert is available for necessary measurements on the functional model.

Field tests can be carried out in parallel with the approval as explosion-protected equipment (only in non-explosion hazardous areas). The results can be included in the first series production.

OUR TIP: Early field tests avoid teething problems of the first series devices that could not be detected in the laboratory tests.

Step 4:
Creation of The Prototype

When all participants agree with the result of the functional model plus the necessary changes and improvements that are defined, the prototype phase can start. In particular, the findings of the tests carried out will be incorporated and the deficiencies plus weaknesses identified by the approval authority will be addressed. The heating measurements on the functional model should be carried out at the latest to incorporate necessary changes, such as the inclusion of additional heat sinks or cooling surfaces. The probability is high that the approval authority will have no objections that would lead to a new redesign.

Based on the created prototype, the technical data of the product can now be verified. If all the data is satisfactory, the definitive documents will be handed over for review by the approval authority.

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Step 5:
The Zero Series Starts

All technical data have already been verified on the prototype. The objective of the zero series is to identify manufacturing issues and critical work processes prior to the start of production. Whether the technical data of the prototype can be reproduced in series production or not, must now be proven. Also, the production is now familiar with the product and can prepare for the start of production in a qualified manner.

OUR TIP: At this stage, the employees should be prepared intensively for the required production and test steps regarding to the explosion protection measures.

Already now, good preparatory work can pay off: If the application for approval as explosion-proof equipment was already made during the functional model phase, the approval can often already be expected in the course of zero series production and the last step with regard to the production of the device can be carried out.

In accordance with Directive 2014/34 / EU and its Annex IV, the manufacturer must demonstrate the conformity of his quality system by means of tests with regard to manufacturing, inspection, testing and storage facilities at the notified body.

Now the serial production and release for sale can start.

Summary

Such a project process enables the development of a production-ready product within a short time and with minimum development risk. The approval as explosion-proof equipment is already completed at the start of series production. There are no delayed market launches due to standard variants (not Ex) and inching of the Ex variant. A decisive competitive advantage, since even with explosion-proof equipment, given development time until market maturity and product life cycles are getting shorter and shorter. Only parallel activities enable a rapid development phase.

References

ATEX 114 – 2014/34/EU

IEC60079-0 – IEC60079-0: Electrical apparatus for potentially explosive atmospheres
Areas: General provisions

IEC60079-11 – Electrical apparatus for potentially explosive atmospheres
Areas: Intrinsic safety „i“

What can MESCO do for you?

Implementation is often problematic for small and medium-sized enterprises, either due to limited development capacity or limited expertise in explosion protection. The inclusion of a development partner complements both. External specialists reduce the risk and accelerate the market introduction. The development of an explosion-proof equipment can be fast and successful. Do not hesitate to contact us.

…where ideas turn into success!