

WHITEPAPER

CHANGES TO IEC 61496 AND EN 61496-1, AND THEIR CONSEQUENCES FOR USING ELECTRO-SENSITIVE PROTECTIVE DEVICES

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SUMMARY

A substantial change in the revised version of IEC 61496-1 concerns the correlation of the PL or SIL to the type of a suitable protective device.

Since the requirements for the systematic capabilities of the light curtain are not fully covered by the safety integrity level (SIL) according to IEC 62061 or the performance level (PL) according to ISO 13849, the current version of IEC 61496 is designed to define the relationship between the type and the PL or SIL in the area of operator protection.

It is expected that the revision of IEC 61496 will have an impact not only in the EU, but also on approvals in countries such as China, Japan, the USA, and Australia.

In the EU, the revised version EN 61496-1:2013-11 was published for the first time in an Official Journal in April 2014, and is therefore considered harmonized. For manufacturers whose presumption of conformity is based on aspects such as the harmonized standard, there is an obligation to consider all significant developments regarding the "state of the art" since it can no longer be presumed that the machine fulfills certain fundamental health and safety requirements.

Inhaltsverzeichnis

Revision of IEC 61496-1 and EN 61496-1	3
Substantial change to IEC 61496-1 and EN 61496-1	3
Selecting an opto-electronic protective device	3
Expected regional effects.....	4
CE conformity for machines in the EU.....	4
Conclusion	6

Revision of IEC 61496-1 and EN 61496-1

The International Electrotechnical Commission (IEC) is an international standards organization that publishes authoritative international principles for corresponding national standards or legally binding instructions for action/directives.

IEC 61496-1 specifies general requirements for the design, construction, and testing of electro-sensitive protective devices. The revised version was published on April 5, 2012. It replaces IEC 61496-1:2004-02 (edition 2) and its amendment AMD1:2008-01. In the EU, CENELEC published EN 61496-1:2013-11 in parallel to this. The European Commission published this version for the first time in the Official Journal of the EU in April 2014, under Machinery Directive 2006/42/EC. May 10, 2015 was defined as the end of the transition period for the presumption of conformity of predecessor document EN 61496-1:2004-05 in conjunction with amendment EN 61496-1/A1:2008-08.

Substantial change to IEC 61496-1 and EN 61496-1

A substantial change to the standard affects the requirements and selection of suitable electro-sensitive protective devices for operator protection on dangerous machines. The relationship between the safety integrity levels (SIL)/performance levels (PL) – which are applied to safety-related control systems in machine safety applications – and the safety levels of electro-sensitive protective devices (i.e., the type) has been defined. Using this relationship, along with a risk assessment, an electro-sensitive protective device should be chosen to ensure the appropriate level of risk reduction. In this way, the type for electro-sensitive protective devices and the standards for functional safety ISO 13849-1 and IEC 62061 are bridged. In practice, this revision affects the use of type 2 safety light curtains in applications that specifically require safety integrity level (SIL) 2 or performance level (PL) d.

Selecting an opto-electronic protective device

Once the required safety level has been determined as part of the risk assessment and in accordance with the numerical method of IEC 62061 (SIL) or the risk graph (PL) of ISO 13849, the question of how to implement the technical protective measures arises. With electro-sensitive protective devices such as safety light curtains, there are specific criteria which have to be taken into consideration.

The requirements for the systematic capabilities of the light curtain are not completely covered by IEC 62061 or ISO 13849. In addition to detection capability, aspects such as reliability also have to be considered to achieve the required risk reduction level. The detection capability describes the ability to reliably detect objects of a certain size (e.g., 14, 30, 40 mm for safety light curtains), thus resulting in switching of the outputs (OSSDs or safety-related data interfaces) for the opto-electronic protective device. It is one of the main parameters for defining use; e.g., for detecting fingers, hands, or persons, and for defining the minimum distance to the hazardous point. The safety level, based on the type classification, also takes into account how reliable the detection capability is.

Requirements for optical sources of interference (sunlight, different lamp types, devices of the same design, etc.), reflective surfaces, misalignment during normal operation or the reflective properties of various objects in safety laser scanners play an important role in this regard. Other examples of systematic capabilities that also have to be considered include device behavior in the event of a fault and electromagnetic compatibility.

The current version of IEC 61496-1 and the revised version of EN 61496-1 clearly define the relationship of the type to the PL or SIL in the context of operator protection. An ESPE shall fulfill both requirements for the type in question and those of the PL and/or SIL assigned to it (see Table 1).

	Type 1	Type 2	Type 3	Type 4
Safety performance according to IEC 62061 and/or ISO 13849-1	-	SIL 1 and SILCL 1 and/or PL c	SIL 2 and SILCL 2 and/or PL d	SIL 3 and SILCL 3 and/or PL e

Table 1: Relationship of the types to the PL or SIL according to IEC 61496-1 and EN 61496-1

Even if a type 2 ESPE is assigned to SIL 1 or PL c because of systematic capabilities, the failure rate PFHd of this sub-system should be lower than the representative limit values (see Table 2). This is because a safety chain usually consists of multiple sub-systems. The resulting PFHd value is made up of the sum of the individual PFHd values.

Performance level (EN 13849-1)	Probability of dangerous failure per hour [1/h]	Safety integrity level according to EN IEC 62061
PL b	$3 \times 10^{-6} \leq PFH_b < 10^{-5}$	SIL 1
PL c	$10^{-6} \leq PFH_b < 3 \times 10^{-6}$	SIL 1
PL d	$10^{-7} \leq PFH_b < 10^{-6}$	SIL 2
PL e	$10^{-8} \leq PFH_b < 10^{-7}$	SIL 3

Table 2: Listed limit values of the PFHD for SIL and PL

In practice, IEC 62061 and ISO 13849 are often specified for electro-sensitive protective devices in addition to IEC 61496 and EN 61496-1. These two standards apply to applications in machine safety and refer to the more fundamental IEC 61508 at various points. If an SIL is specified according to IEC 61508, this gives the user the opportunity to apply an ESPE outside of the typical sector of mechanical engineering.

Specific application requirements based on other standards (such as the process industry or railway applications) also have to be checked in this context. In Table 3, the suitable safety level of an ESPE is described from the point of view of a safety-related application. If SIL/SILCL 1 or PLr c is required, an opto-electronic protective device that corresponds to type 2 or higher from IEC 61496 or EN 61496-1 shall be used accordingly. In the case of a type 2 light curtain, for example, a type 4 would also be permitted in this type of application, as its systematic capabilities are higher. Type 3 is not defined for light curtains and is not described in the corresponding section of standard IEC 61496-2 or EN 61496-1. Examples of type 3 sensors are safety laser scanners or safety camera systems. Conversely, a type 2 light curtain would not be permitted in applications which require SIL 2, SILCL 2, or PLr d according to the safety level to be achieved.

	Type 1	Type 2	Type 3	Type 4
For a safety function that involves an ESPE, the maximum PL or SIL that the ESPE can achieve is as follows:	-	SIL 1 and/or PL, c	SIL 2 and/or PL, d	SIL 3 and/or PL, e

Table 3: Maximum achievable PL and SIL classification for each type according to IEC 61496-1 and EN 61496-1

Expected regional effects

China, Japan, the USA, and Australia usually implement IEC standards in the form of national standards. In the past, transition periods have taken several years. IEC standards can form the basis for approvals as well as liability assessments on a national level. Acceptance at regional approval centers (such as UL in the USA) is carried out either directly on the basis of edition 3 of IEC 61496 or via the national standards that have been implemented from this. This may involve modifications on a national level in each case.

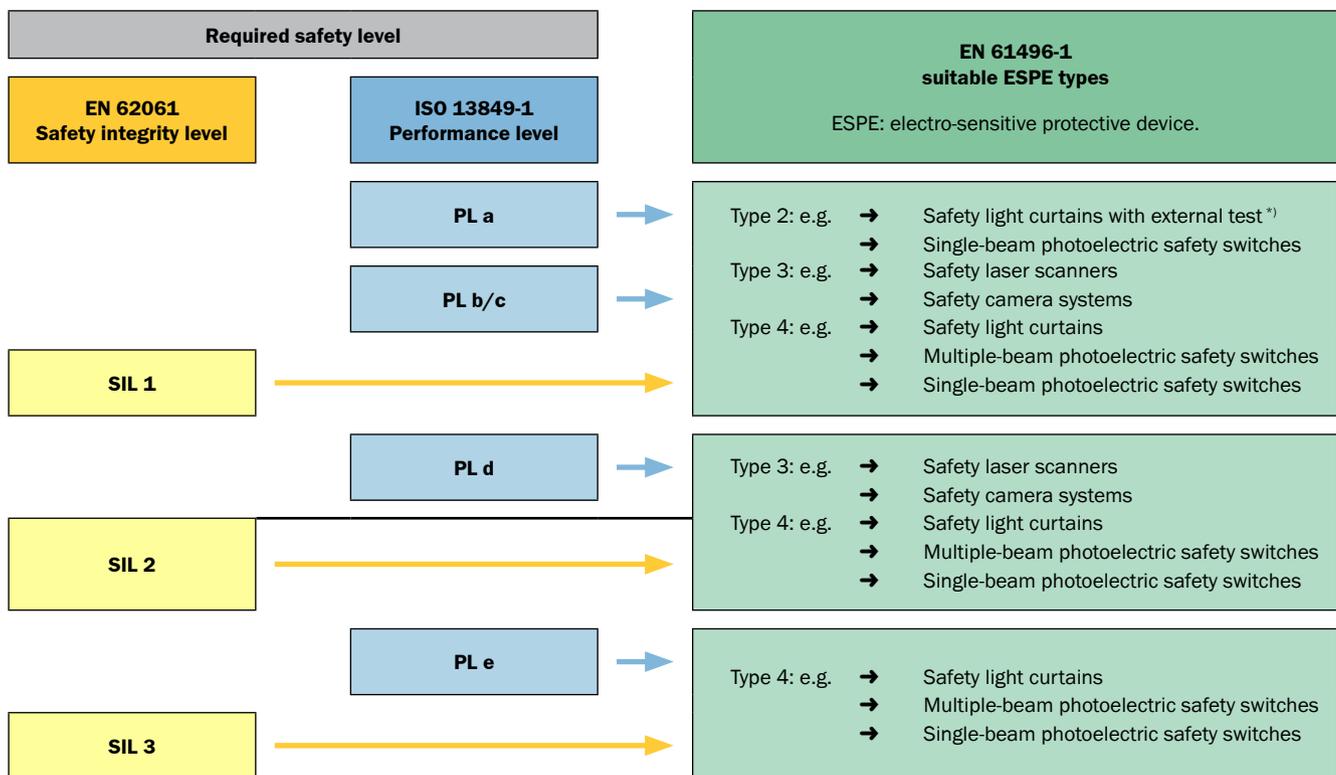
In Europe, the transition from EN 954 to EN ISO 13849 for operator protection in the area of machine safety initially led to discussion concerning how to select a suitable technical protection measure. Since, as expected, EN 61496-1:2013-11 follows the template that the current IEC standard has set, there is a clear correlation between the required safety level and the corresponding ESPE type as a harmonized standard.

CE conformity for machines in the EU

Applying a harmonized standard – something which makes it possible to presume conformity – remains voluntary. Manufacturers can decide for themselves whether they wish to use harmonized standards. If they decide against applying a harmonized standard, however, they have to prove that the machines fulfill the key requirements of the Machinery Directive 2006/42/EC by applying other specifications.

Furthermore, they are obliged to consider all significant developments in the "state of the art", which could mean it is no longer possible to presume that machines that already have an EC type examination certificate still fulfill certain basic health and safety requirements. This shall be decided every time the basis for a standard is changed, for example, and is a continual process. For the machine manufacturer, this situation means that – by the end of the transition period on May 10, 2015, at the very latest – using a type 2 ESPE in SIL 2/PL d applications will no longer be an option if harmonized standards are fully taken into account.

Proving sufficient systematic capabilities of an ESPE in a machine without using the harmonized standard EN 61496-1 is complex and involves high costs for the machine manufacturer. This also applies to its extensions IEC 61496-2 (applicable to single-beam, multiple-beam photoelectric safety switches and safety light curtains) and IEC 61496-3 (applicable to safety laser scanners).



^{*)} See technical data for the required external tests and their requirement rates.

Figure 1: Achievable reliability of safety functions with opto-electronic protective devices

Figure 1 shows the options available for choosing an ESPE in accordance with the required level of risk minimization, and with respect to the revised version of EN 61496-1.

Additional guidelines for choosing type 2 or 4 for active opto-electronic protective devices (single-beam and multiple-beam photoelectric safety switches, safety light curtains) can be found in the available product standards for special machine types (C standards; see the standards list in the Official Journal of the European Union at: www.ec.europa.eu/enterprise)

Conclusion

At the end of the transition period of EN 61496-1 – May 10, 2015 – using a type 2 safety light curtain (in particular) in applications categorized as SIL 2/PL d according to a risk assessment will no longer be an option if harmonized standards are fully taken into account. If a PL d safety level is required, a type 4 safety light curtain shall be used.

REFERENCES

EN 61496-1:2013-11: Safety of machinery – Electro-sensitive protective equipment – Part 1: General requirements and tests (IEC 61496-1:2012)

IEC 61496-1:2012: Safety of machinery – Electro-sensitive protective equipment – Part 1: General requirements and tests

ISO 13849-1:2006: Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design

EN 62061:2005/A1:2013: Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems