Eliminate the mystery about safety…

Be confident in UR robots. UR robots are 3rd party certified

Global safety standards for all industrial robots[1]

ISO 10218-1: Manufacturer of robots

ISO 13849-1 & -2: Provides safety requirements and guidance on the principles for the design and integration of safety-related parts of control systems (SRP/CS), including safety software.

Global safety requirements for robot systems

ISO 10218-2: Integrator of **robot systems**

A risk assessment is **mandatory** for the **robot system** because it is a **completed machine**. A **risk assessment** is the overall process comprising a risk analysis and a risk evaluation. This means identifying all risks and reducing these risks to an appropriate level (See ISO 12100).

ISO 13849-1 & -2: Safety-related parts of control systems

ISO/TS 15066 is NOT a standard; it is a Technical Specification with additional guidance and requirements for **collaborative applications**. An informative annex includes a research study on pain thresholds. It has been adopted by various countries including in Europe. USA adopted it as a technical report (RIA TR R15.606).

Global acceptance of ISO 10218-1 and ISO 10218-2

ISO 10218-1, -2 have been adopted as key safety standards for industrial robots by many countries including:

- Europe: Harmonized, shown as EN ISO 10218-1 & -2
- USA: National adoption as ANSI/RIA R15.06
- Canada: National adoption as CAN/CSA Z434
- Japan: National adoption as JIS B 8433-1 & -2
- Republic of Korea: National adoption as KS B ISO 10218-1 & -2

Regulations about machine safety in EU countries

All machines installed within EU shall comply with the essential health and safety requirements listed in ANNEX I of the Machinery Directive (MD) 2006/42/EC.

It is not required to comply with any standard, however, ISO 10218-1, ISO 10218-2 and ISO 13849-1 are harmonized under the MD. Harmonized standards have an "EN" prefix, e.g. EN ISO 10218. Complying with a **harmonized standard** provides conformity with the **relevant MD essential requirements.**

- For a completed machine (robot system), the following is required:
- A risk assessment of the intended use(s);
- Instructions for use;
- A CE Declaration of Conformity (DOC);
  A DOI *(Declaration of Incorporation) is provided for incomplete or partial machines. Robots are incomplete machines. A DOI is provided to enable integrators to CE mark their robot system.*
- Marking, including the CE mark, on the **completed machine (robot system)** according to ANNEX III;
- A supplier's "technical file", to be stored for 10 years.

3rd party safety certifications for all UR robots

ISO 10218-1: the global safety standard for industrial robots, including those with power and force limiting (PFL) capabilities for collaborative operation.

- UR Generation 3 (CB3): TÜV Rheinland Certificate # 72190266 01
- UR e-Series: TÜV Nord Certificate # 44 207 14097607

Safety functions are certified according to ISO 13849-1, enabling compliance with § 5.4, 5.10.2, 5.10.5, & 5.12.3. *UR robots' safety functions, including Power Limit and Force Limiting, are always active. Two parameters for each safety function limit can be configured: normal & reduced.*

UR robots' Safeguard Stop is a Category 2 stop according to § 5.10.2 with the below functional safety performance.

- UR Generation 3 (CB3): PLd Cat 2 except the Emergency Stop which is PLd Category 3.
  Exceeding any safety limit parameter causes a protective stop.
  TÜV Nord Certificate # 72182503 01
- UR e-Series safety functions are PLd Cat 3, PLUS new "stopping time" & "stopping distance" safety functions.
  Safety limit parameters will NOT be exceeded; a protective stop could be initiated to prevent exceeding any limit.
  TÜV Nord Certificate # 44 207 14097610

Certificates available in user manuals and online.

Key safety clauses from ISO 10218-1

§ 5.10: Robots designed for collaborative operation shall comply with 1 or more of the requirements in § 5.10.2 through § 5.10.5

§ 5.10.2 safety-rated monitored stop

A Category 2 stop according to IEC 60204-1, monitored according to functional safety requirements in § 5.4.

UR robots: Safeguard Stop safety function fulfils § 5.10.2.

§ 5.10.5 power and force limiting by inherent design or control

Power and force limiting of the robot shall comply with § 5.4. If any parameter limit is exceeded, a protective stop shall be issued. Whether an application is collaborative is determined by the application risk assessment. ISO 10218-2 is used for the robot system and robot application – collaborative or non-collaborative.

§ 5.12.3 safety-rated soft axis and space limiting

Soft limits are software-defined limits to robot motion. Space limiting is used to define any geometric shape which may be used as an inclusionary or exclusionary zone, either limiting robot motion within the defined space, or preventing the robot from entering the defined space.

With UR robots, the following can be used for § 5.12.3:

- Safety Boundaries (Planes);
- Joint Position Limits;
- Pose Limits for the tool flange and TCP.
  With the e-Series, Pose Limits also include the elbow, and two configurable tool offset points with a radius.

---

1) ISO robot safety standards are developed by ISO TC (Technical Committee) 299, with industrial robots handled by WG (Working Group) 3. Universal Robots is a very active participant in TC299 WG3.

Question	Answer
Do UR robots comply with ISO 10218-1 (EN ISO 10218-1)?	Yes, both Generation 3 (CB3) and e-Series are certified to comply with EN ISO 10218-1. Often there are some questions about UR robots and clauses of ISO 10218-1. **§ 5.7.1: Mode selector which can be locked in each position**. *Automatic and manual mode are usability features and not safety functions for UR robots. Mode locking does not contribute to risk reduction for UR robots because the safeguard stop and all safety functions are operational in all modes. If the INTEGRATION risk assessment determines a mode selector is needed, it can be added and integrated as "mode selector" inputs to the UR safety controller.* **§ 5.7.3 and § 5.8.3: Manual control of the robot from inside the safeguarded space** shall be performed with a reduced speed with an **enabling device**… *UR does not know if there will be a safeguarded space or if programming will take place within the safeguarded space of a non-collaborative application. When PFL robots are integrated into collaborative applications, an enabling device might not be required according to ISO/TS 15066.* *If the INTEGRATION risk assessment determines that an enabling device is needed for risk reduction, it can be added and integrated as inputs to the UR safety controller.* **§ 5.12.1: Limiting motion by mechanical stops for axis 1** and comply with § 5.12.2 or § 5.12.3. *UR robots provide axis limiting capabilities completely by § 5.12.3 safety-rated soft axis and space limiting safety functions, It is an acceptable alternate to mechanical stops, achieving the same goal.*
	*UR Robots have been certified to comply with both ISO 10218-1 and ISO 13849. UR robots also comply with the optional collaborative operation requirements of **§ 5.10.2** for safety-rated monitored stop, **§ 5.10.5** for power and force limiting, and **§ 5.12.3** safety-rated soft axis and space limiting. Power and force limiting safety functions enable collaborative applications where contact with people is permitted when contact pressure and forces are acceptable.* • ISO 10218-1 and ISO 13849 are harmonized under the machinery directive. • The robot application determines whether it is collaborative according to the risk assessment. If the application integrates a protective device, e.g. safety laser scanner, with the UR Robot, the application can be a collaborative application according to "Speed and Separation Monitoring".
What is ISO/TS 15066:2016, Technical Specification on Collaborative Robots?	ISO/TS 15066 is a Technical Specification with guidance for collaborative applications to aid integrators. It also includes a research study's results on pain thresholds which can be used for verifying a collaborative (contact permitted) application. Pain thresholds are acknowledged to be more conservative than injury thresholds. Typical workplace safety standards and regulations require an injury-free, not a pain-free workplace.
What is ISO 13849?[1]	ISO 13849-1: provides safety requirements and guidance on the principles for the design and integration of safety-related parts of control systems (SRP/CS), including the design of software. ISO 13849-2: specifies the procedures and conditions to be followed for the validation by analysis and testing of the specified safety functions, the category achieved, and the performance level achieved by the safety-related parts of a control system (SRP/CS) according to ISO 13849-1.
What is a stop category? *See IEC 60204-1*	"Stop Category" is a classification of how a stop operates. It is described in IEC 60204-1 (NFPA79 in North America), as three different categories: • Stop Category 0: A stop by immediate removal of power <to the robot/ robot system>. It is an uncontrolled stop, where the <robot/ robot system> can deviate from the programmed path. • Stop Category 1: A stop with power available to the <robot/ robot system> to achieve the stop <decelerate> and then power is removed after the stop is achieved. It is a controlled stop, where the <robot/ robot system> continues along the programmed path. Power is removed after the stop. • Stop Category 2: A controlled stop with power available <to the robot/ robot system>. The safety-related control system monitors that <robot/ robot system> position is maintained.
What is "Cat 3" or "Category 3"? *See ISO 13849*	Here "Category" refers to the architecture used for functional safety as described in ISO 13849. It is one attribute in the determination of a Performance Level (PL). With Category 3 architecture, a single fault will not lead to a loss of the safety function. "Category 3" is often called "dual channel".
What is "PLd" or "Performance Level d"? *See ISO 13849*	A Performance Level (PL) is a discrete level used to specify the ability of safety-related parts of control systems to perform safety functions under foreseeable conditions. According to ISO 13849, PL=d is highly reliable. PLd is required by ISO 10218 for hazardous robot applications. A PL is described by its PFHd (probability of dangerous failure per hour).
What is the difference between Emergency stop and Safeguard stop?	Emergency stop functions are to be used for emergencies only. Emergency stop is manually activated by a person pressing the Emergency stop pushbutton. Safeguard stop is used to stop the robot in a safe way, typically triggered by protective devices, e.g. light curtains, interlocking devices, safety scanners, other safety inputs to stop.

1) Universal Robots publishes a list of the safety functions associated with both Generation 3 (CB3) and e-Series robots. This describes each safety function including its safety function trigger, outcome of the safety function, PL, Category, and PFHd value.