innotec GmbH

Michael Kieviet

michael.kieviet@innotecsafety.com

“Industrie 4.0”

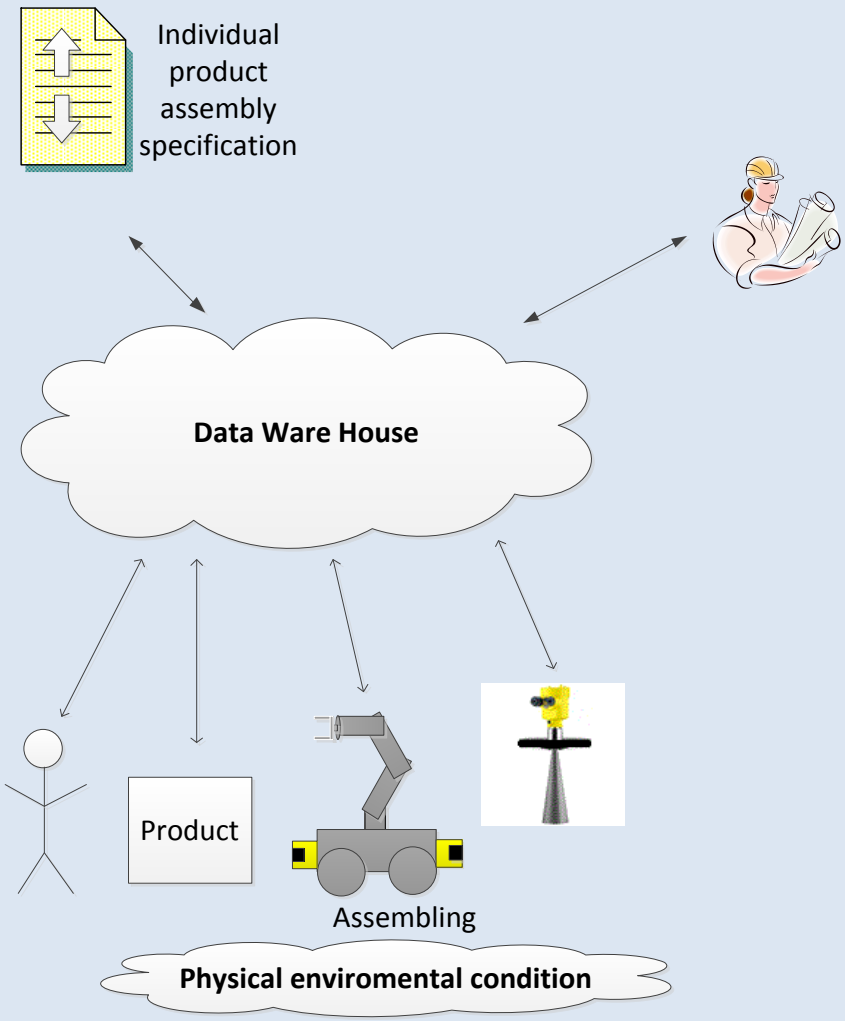
4.*’0’* Information Technology (Cyber Physical Systems)

3. Automation (Use of Computers, PLCs)

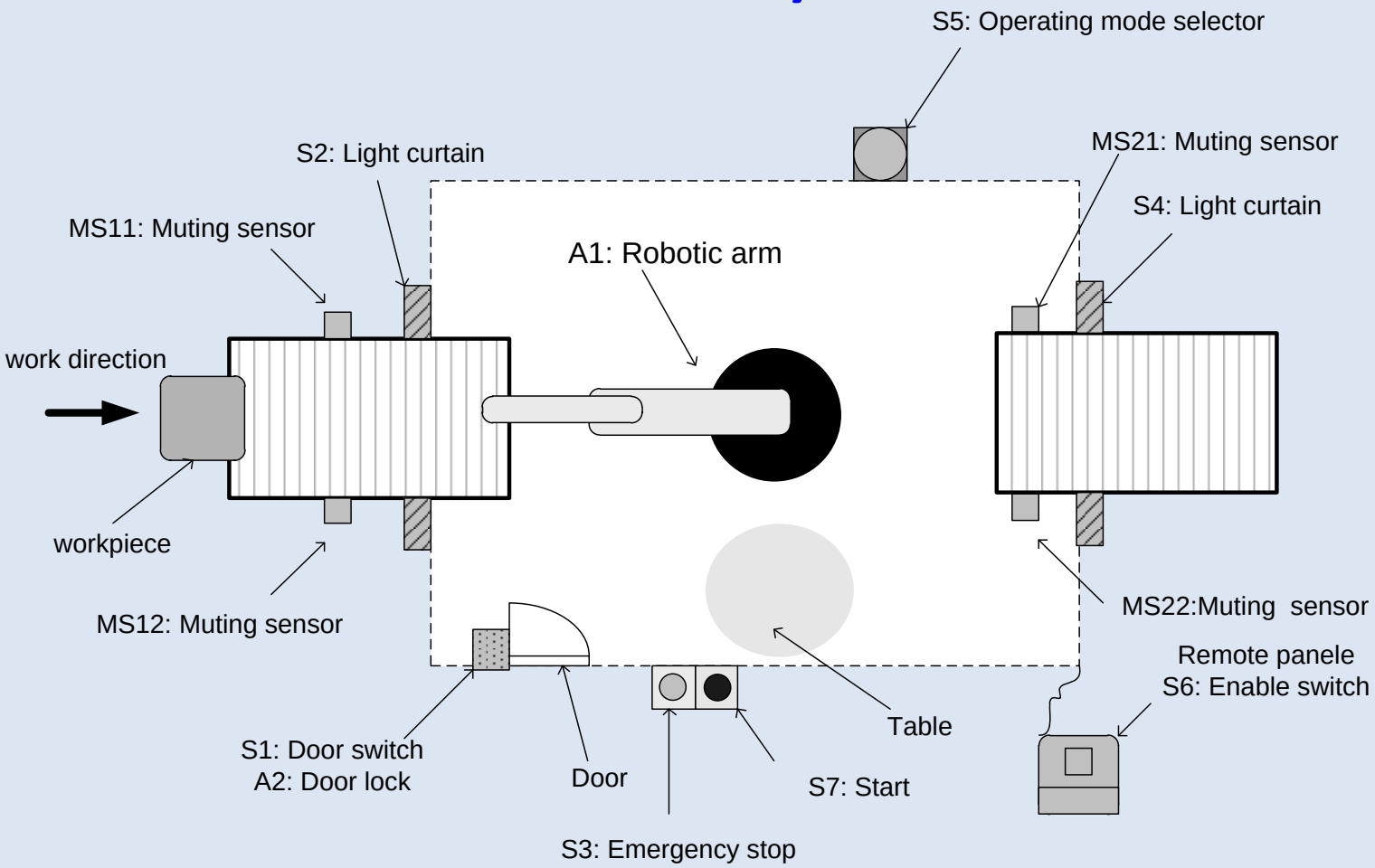
2. Revolution Electricity (Use of Assembly Lines)

1. Revolution Mechanization (Use of Steam Engines)

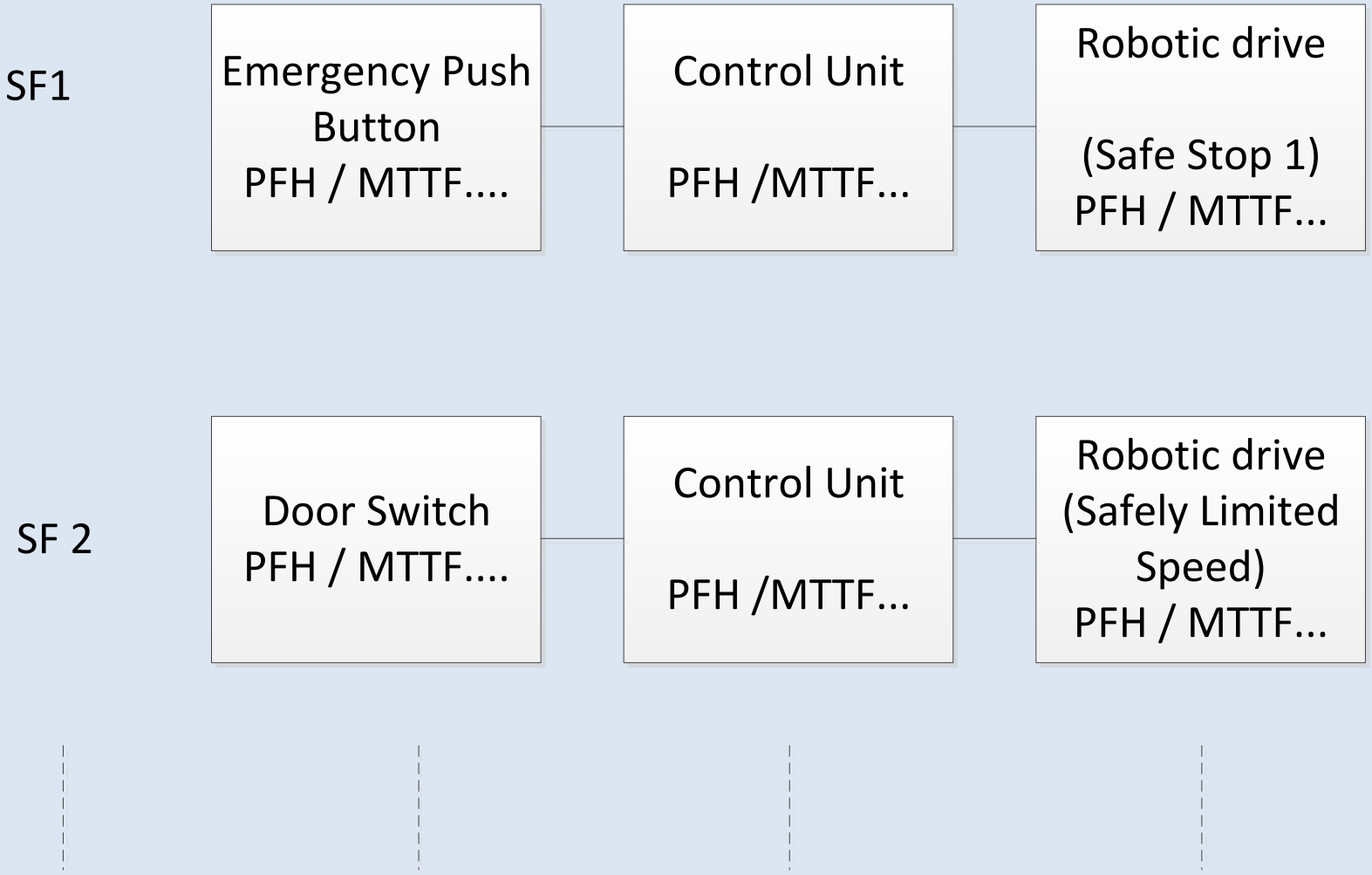
Cyber Physical Systems (CPS)



CPS: Challenges for the Functional Safety



Conventional safety functions



Roboter standards

- ISO 10218 – 1 Robots and robotic devices -- Safety requirements for industrial robots -- Part 1: Robots

- ISO 10218 - 2 Robots and robotic devices -- Safety requirements for industrial robots -- Part 2: Robot systems and integration

- ISO 13482:2014 Robots and robotic devices -- Safety requirements for personal care robots (e.g Household)

IEC61800-5.2 safe drive function

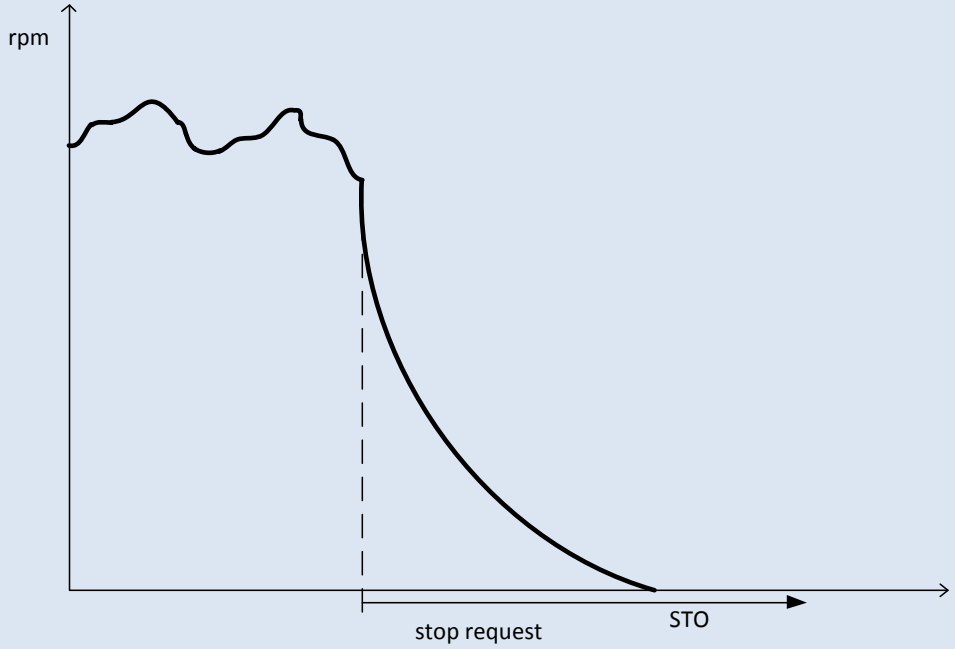
Acronym	Function
STO	Safe Torque Off
SS1	Safe Stop 1
SS2	Safe Stop 2
SOS	Safe Operating Stop
SLA	Safety –Limited Acceleration
SLS	Safety-Limited Speed
SLT	Safety-Limited Torque

IEC61800-5.2 safe drive function

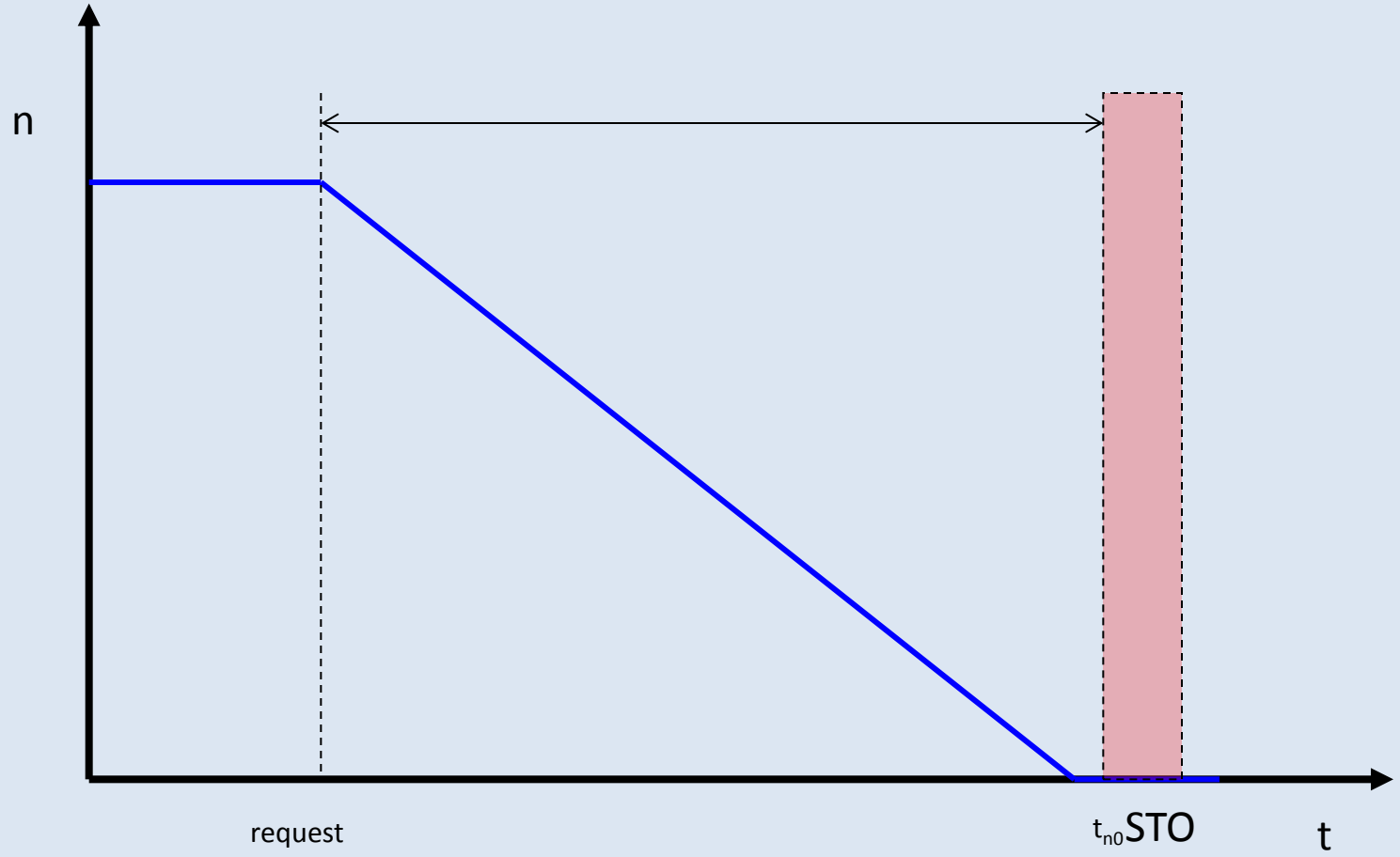
Acronym	Function
SLP	Safety-Limited Position
SLI	Safety-Limited Increment
SDI	Safe Direction
SMT	Safe Motor Temperature
SBC	Safe Brake Control
SCA	Safe Cam
SSM	Safe Speed Monitor

Safe Torque off, STO)

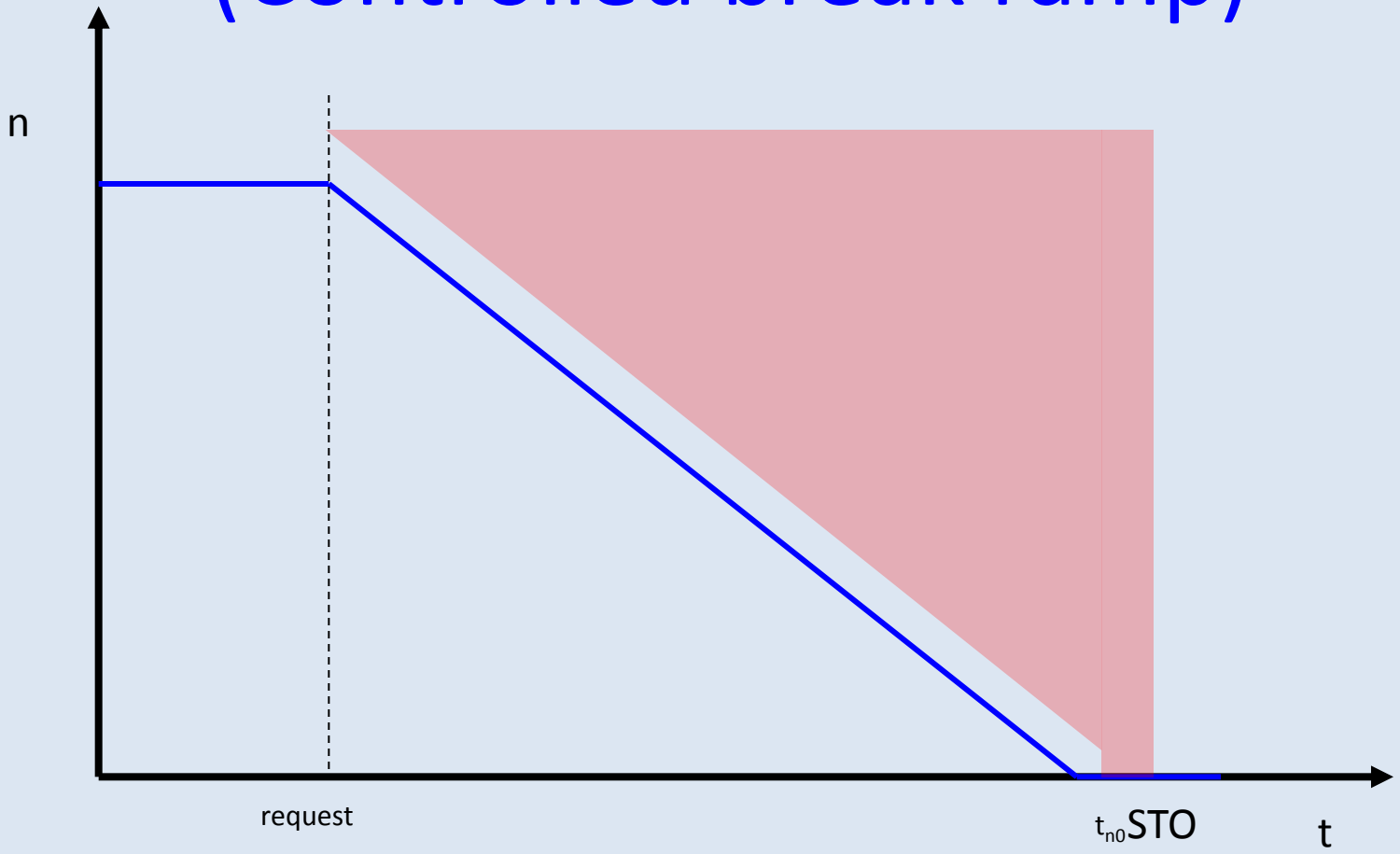
The drive stops without any break moment.
This is similar to IEC 60204-1, Category 0.



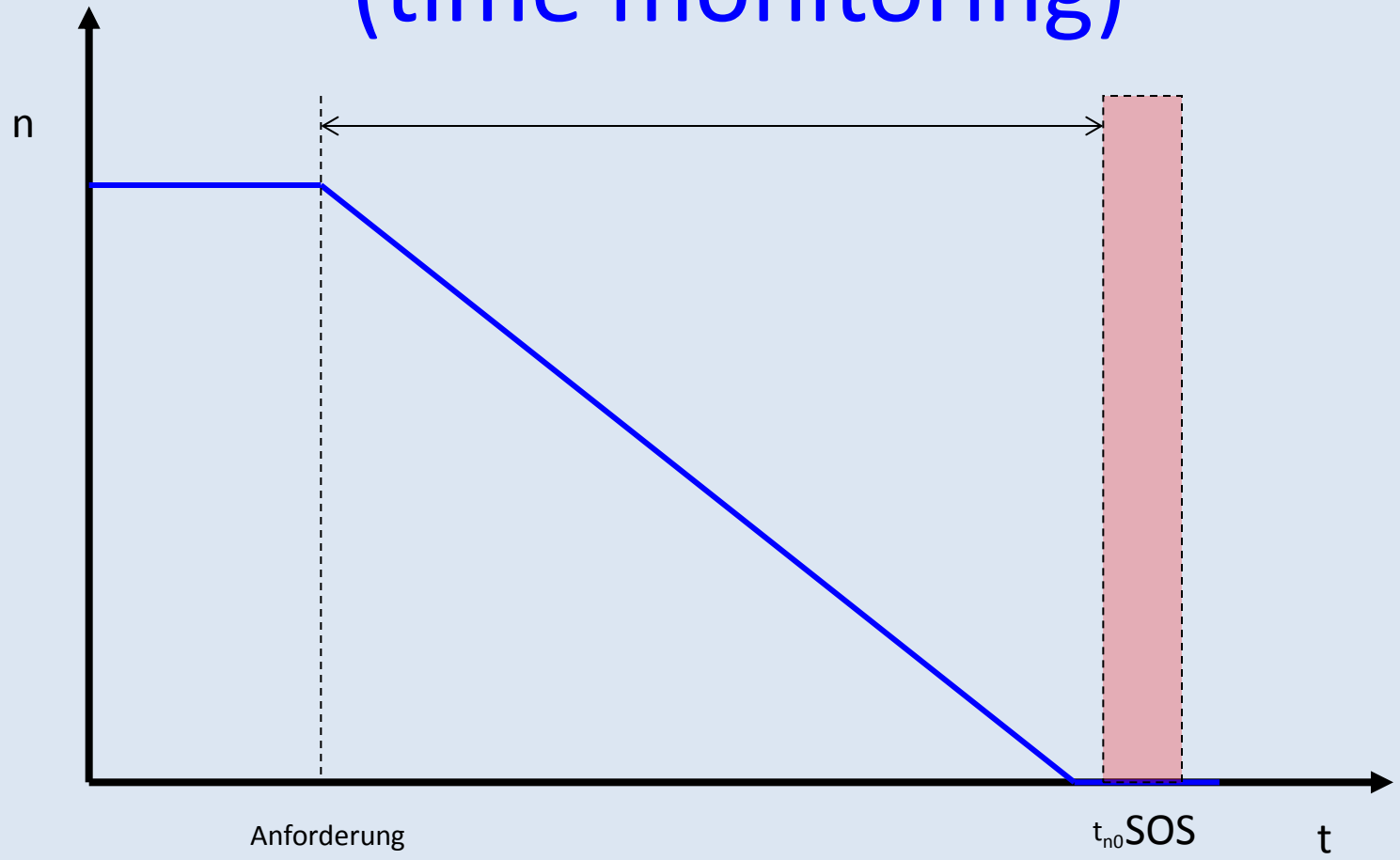
Safe stop 1, SS1 time monitored



Safe stop 1, SS1)
(Controlled break ramp)



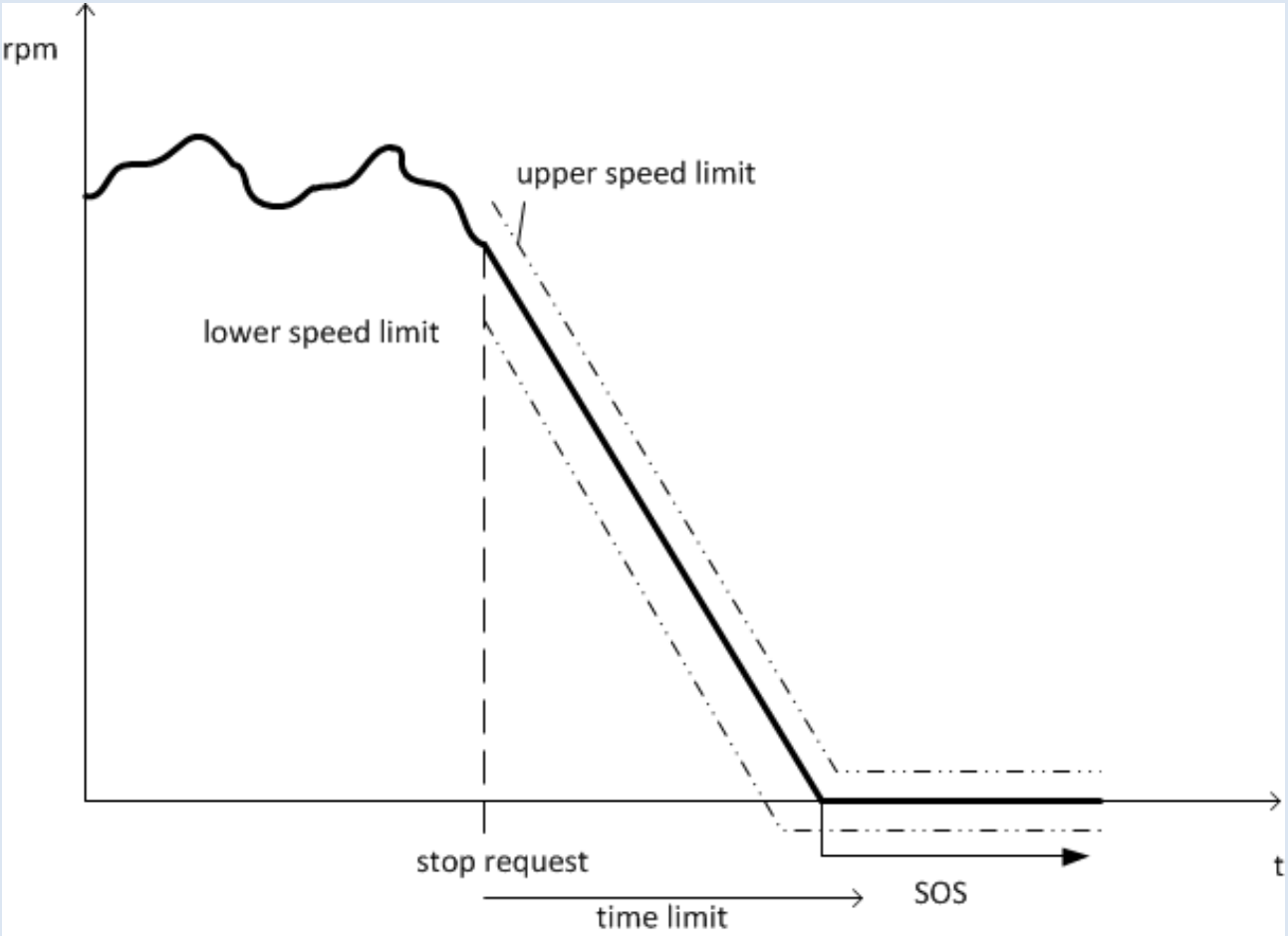
Sicherer Stopp 2 (Safe stop 2, SS2) (time monitoring)



Safe operating stop (SOS)

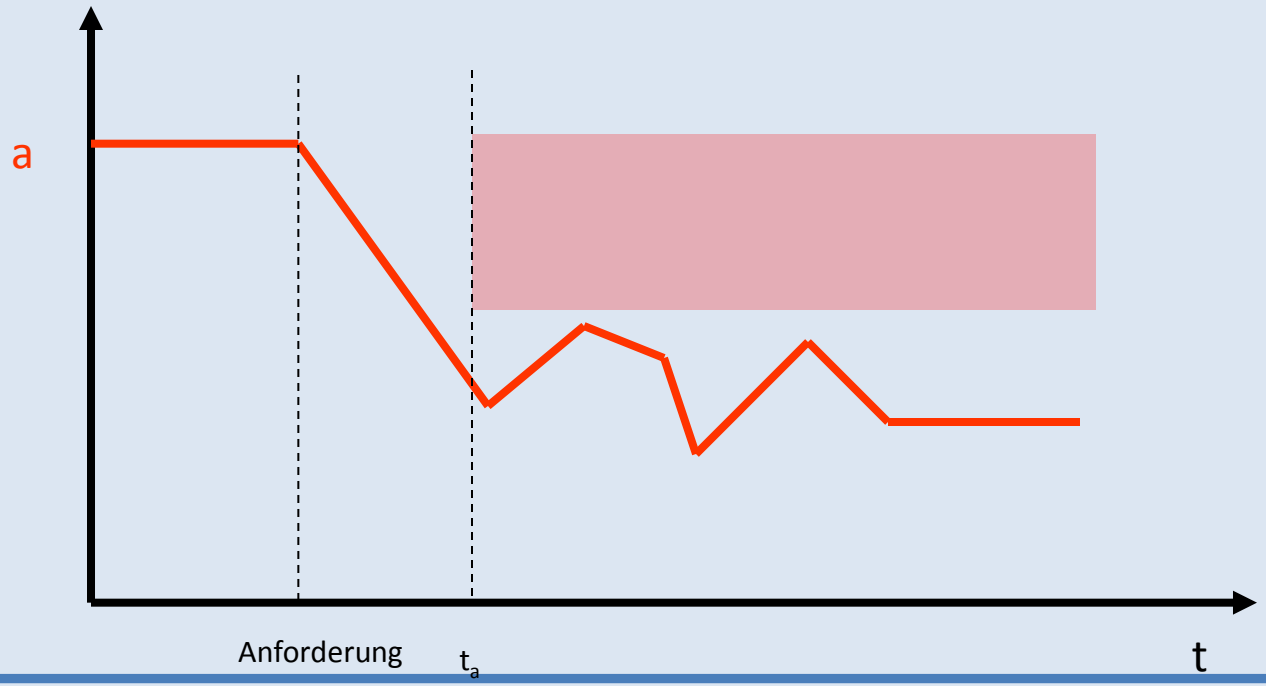
The SOS-Function avoids, that the Motor rotats more than a amout of movements around the stop position. The inverter controlls the motor and adjust the position also if external torques exist.

Safe operating stop (SOS)



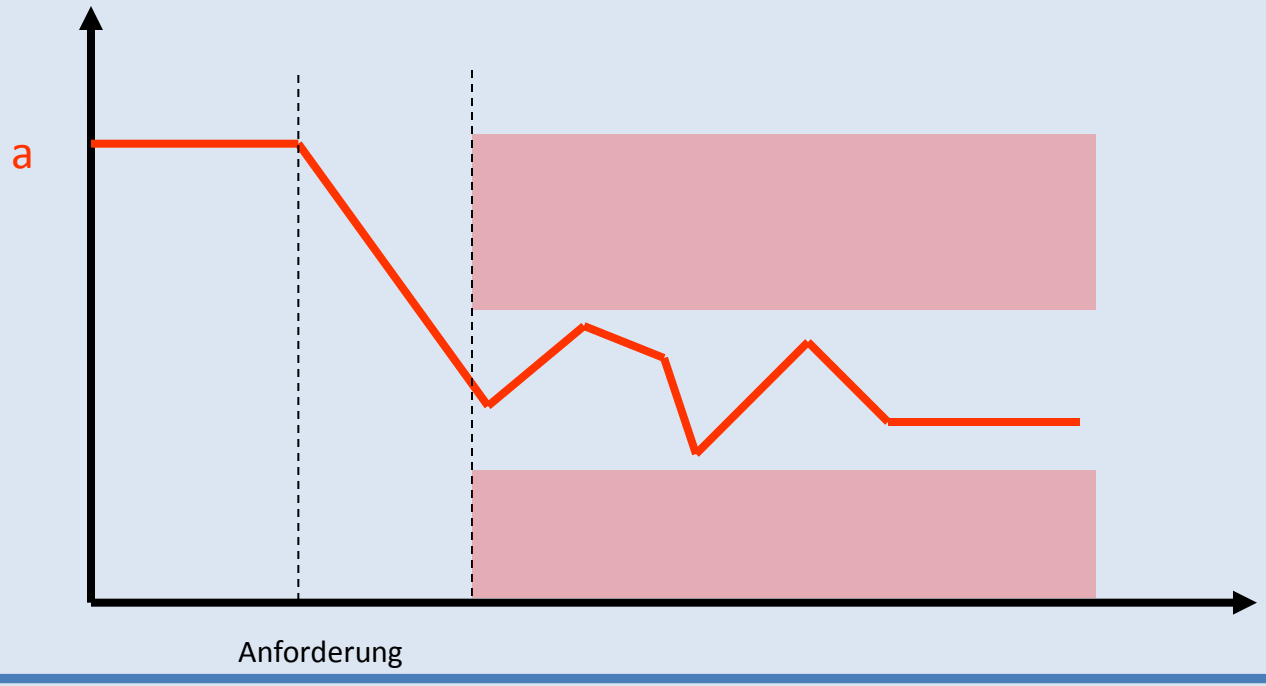
Safely-limited acceleration, SLA

The SLA-Function avoids the exceeding of the acceleration limit of the motor.



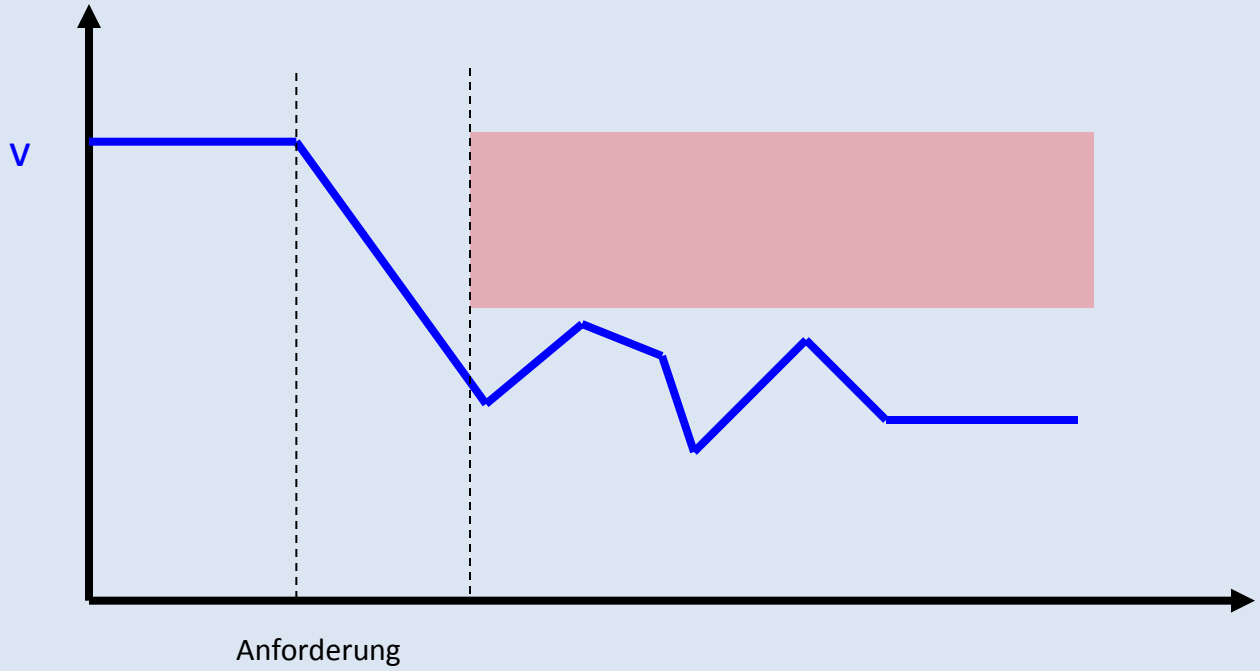
Safe acceleration range, SAR

The SAR-Function avoids the exceeding of the acceleration limits of the motor.



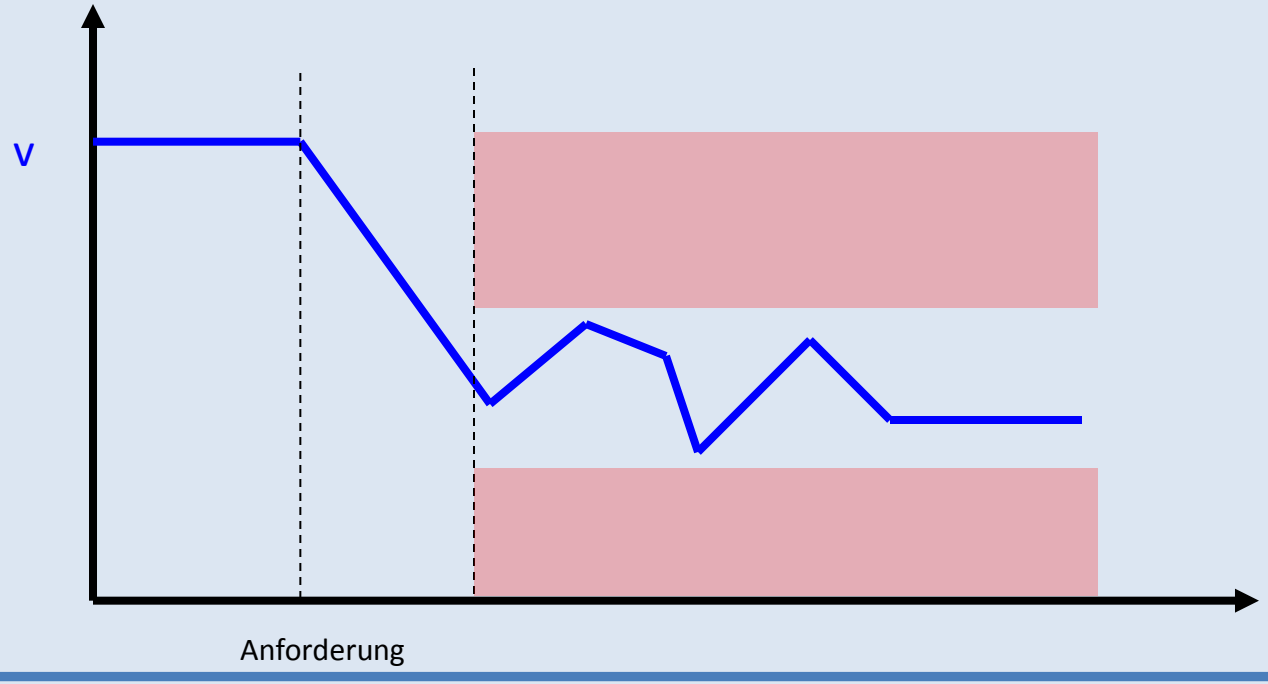
Safely limited speed, SLS

The SLS-Function avoids the exceeding of the speed limit of the motor.



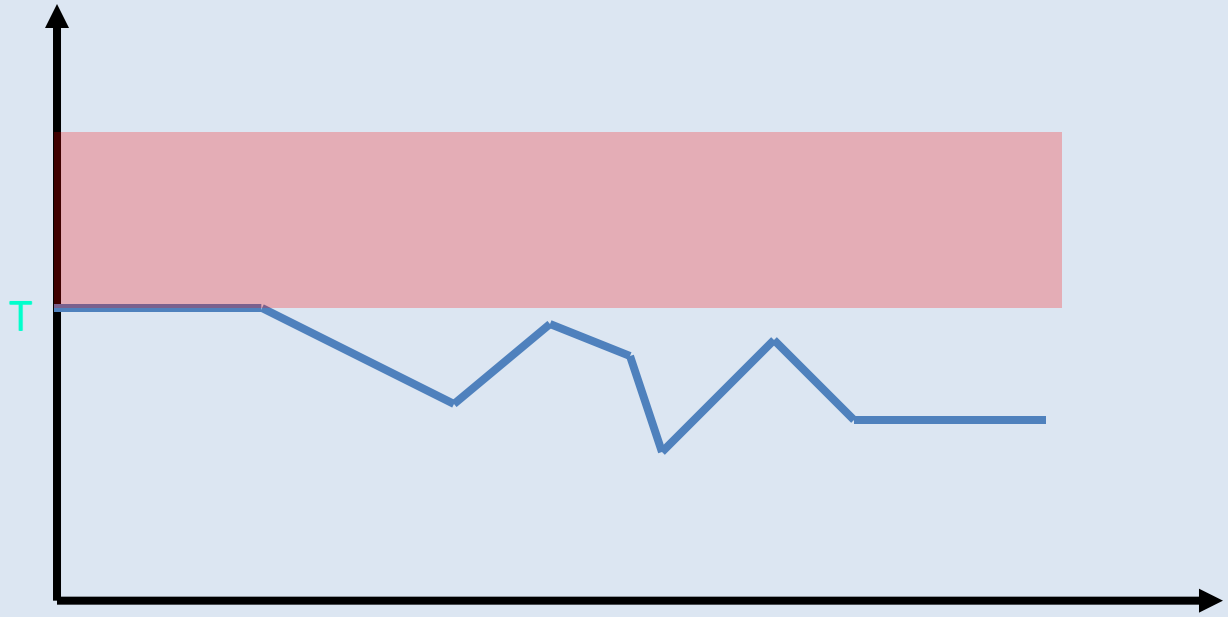
Safe speed range, SSR

The SSR-Function avoids the exceeding of the speed limits of the motor.



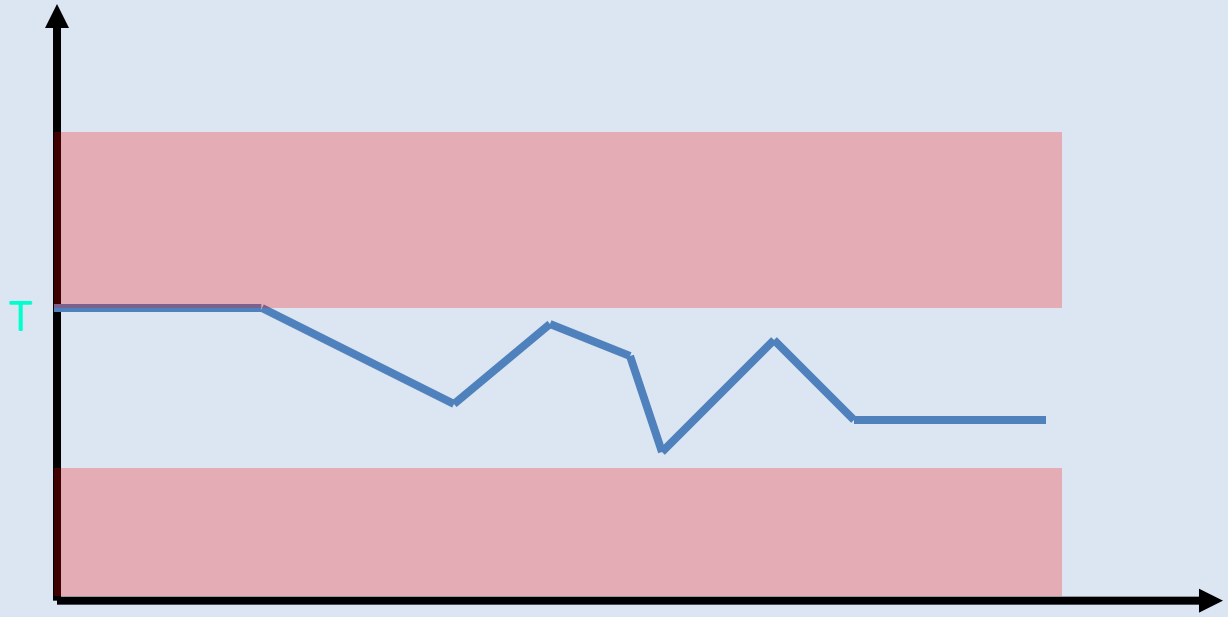
Safely-limited torque, SLT

The SLTA-Function avoids the exceeding of the torque or force limit of the motor.



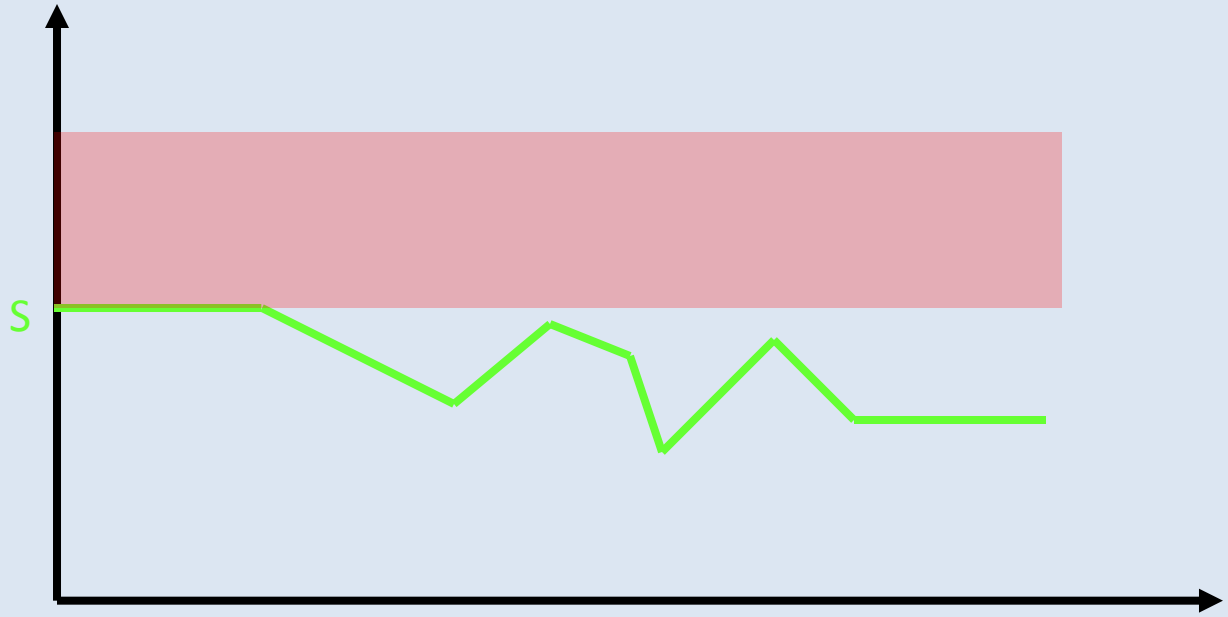
Safe torque range, STR

The STR-Function avoids the exceeding of the torque or force range of the motor.



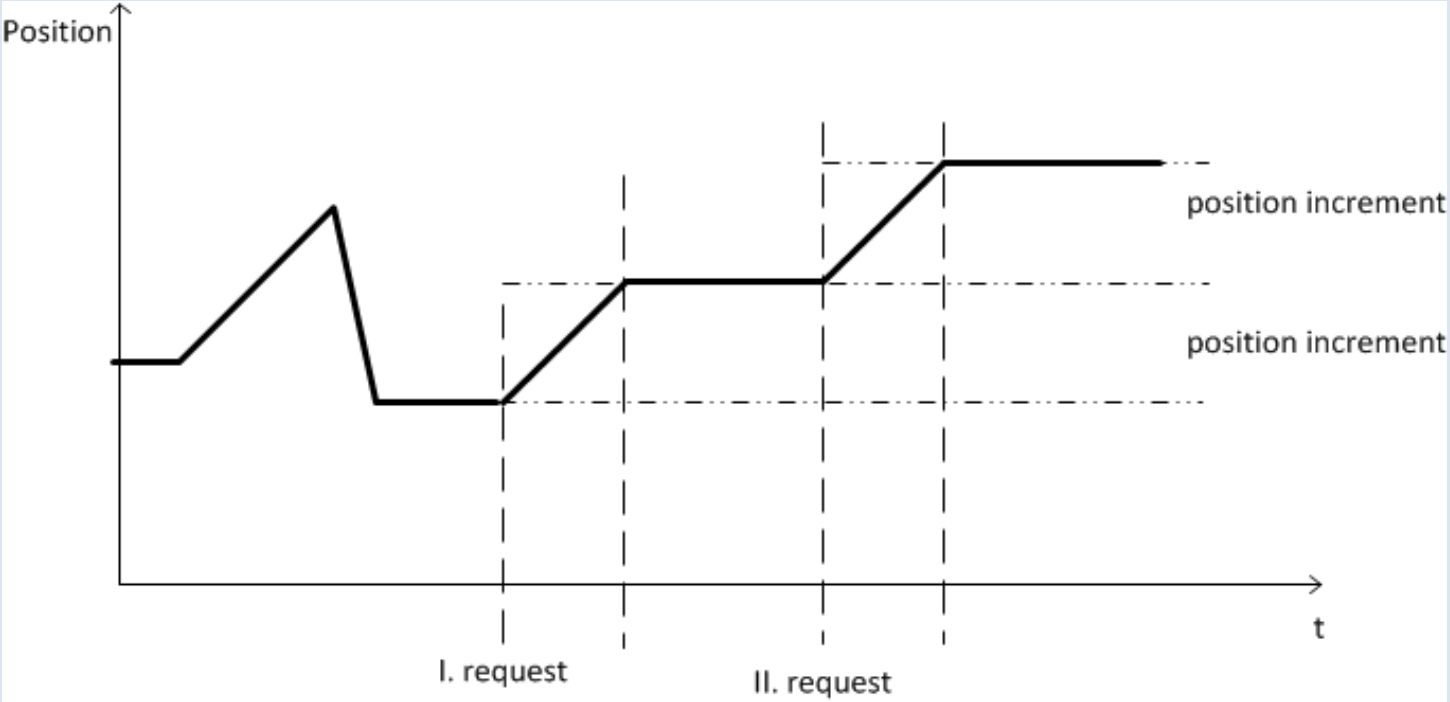
Safely-limited position, SLP

The SLP-Function avoids the exceeding of a defined position.



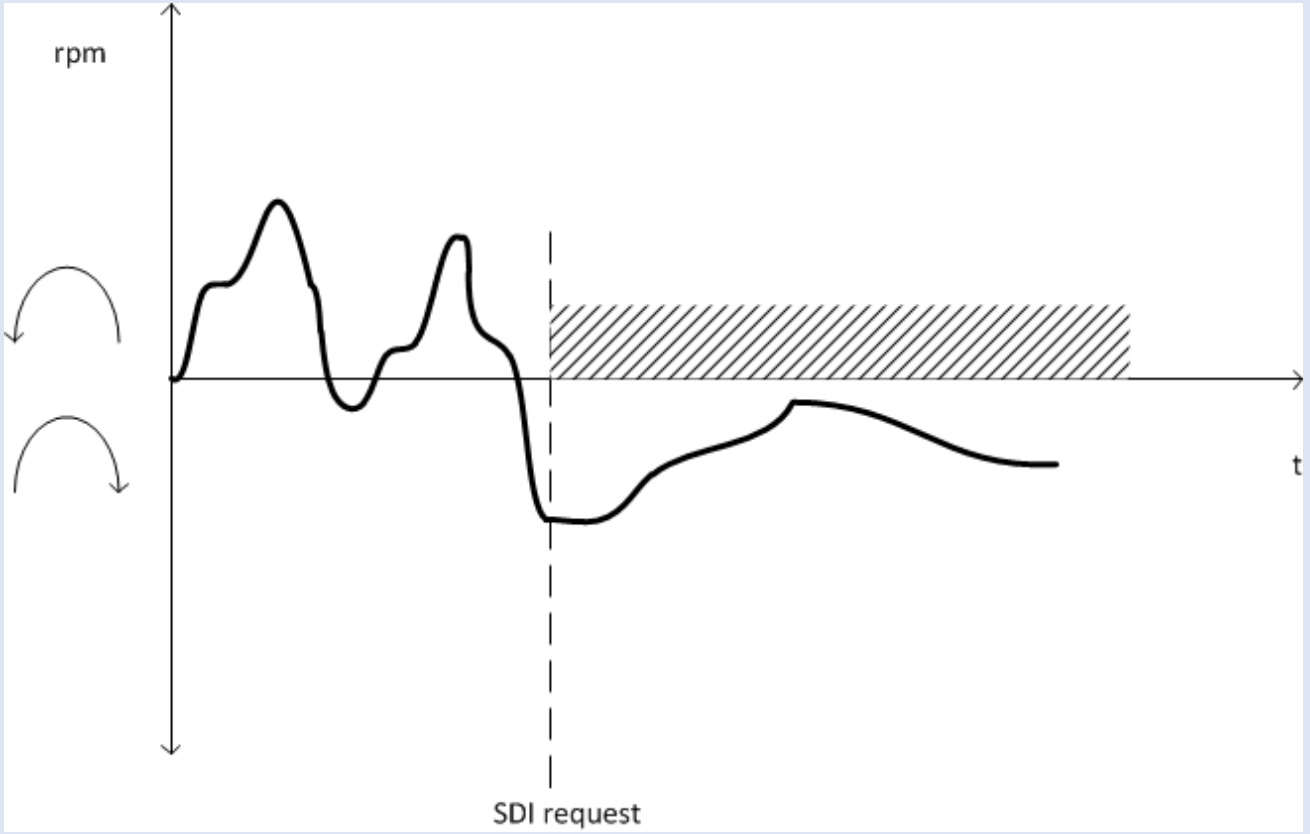
Safely-limited increment, SLI

The SLI-Function avoids the exceeding of a defined increment



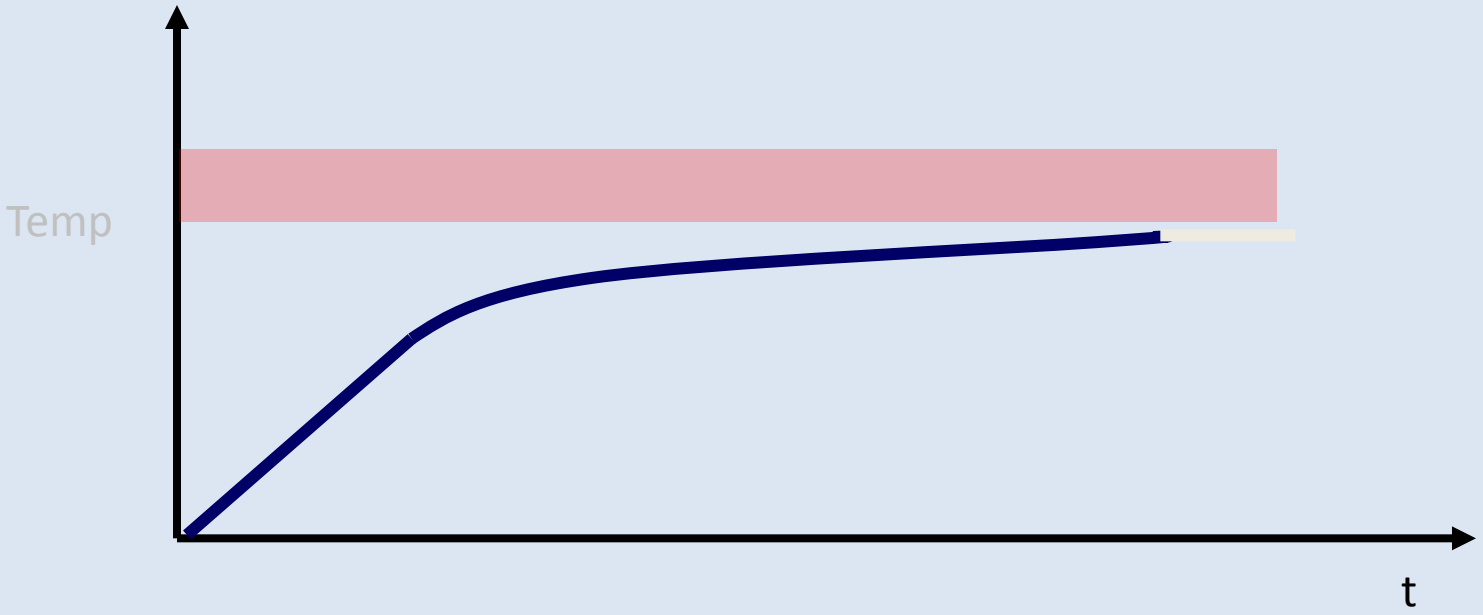
Safe direction, SDI

The SDI-Function avoids that the motor runs in the wrong direction.



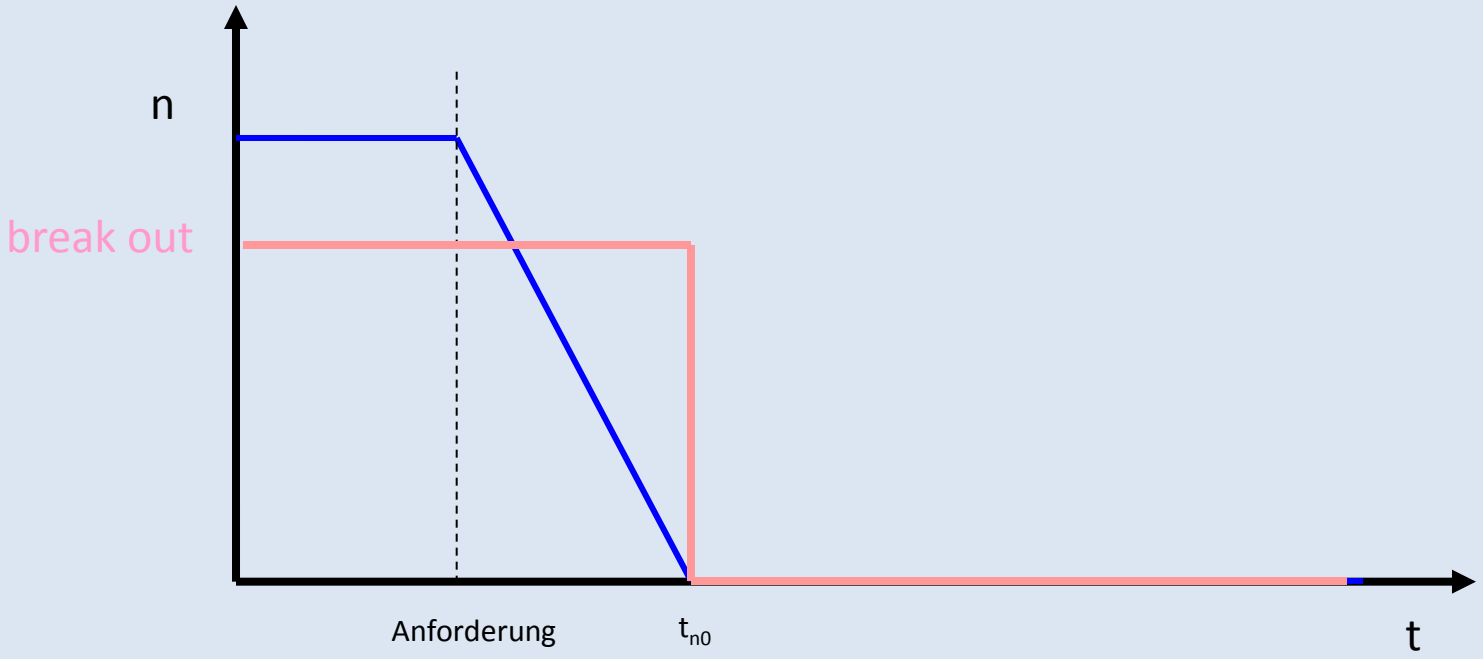
Safe motor temperature, SMT

The SLI-Function avoids the exceeding of a defined motor temperature



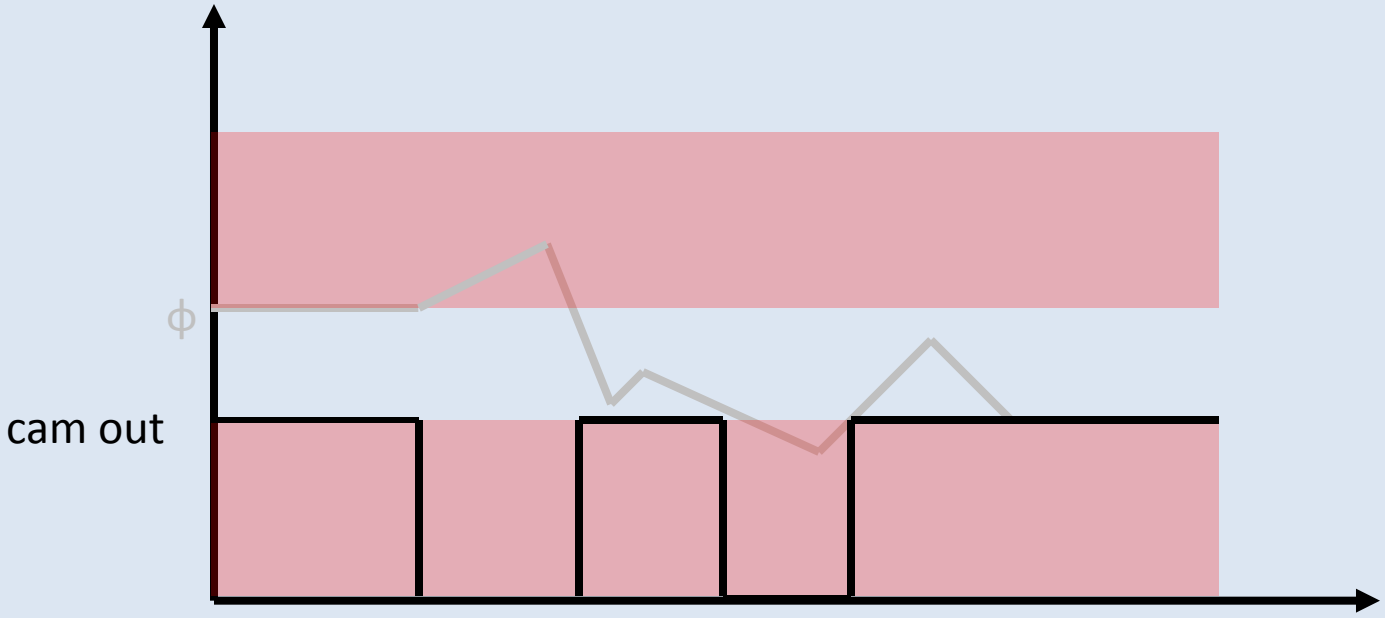
Safe brake control, SBC

The SBC-Function provide a safe ouput for control a mechanical break



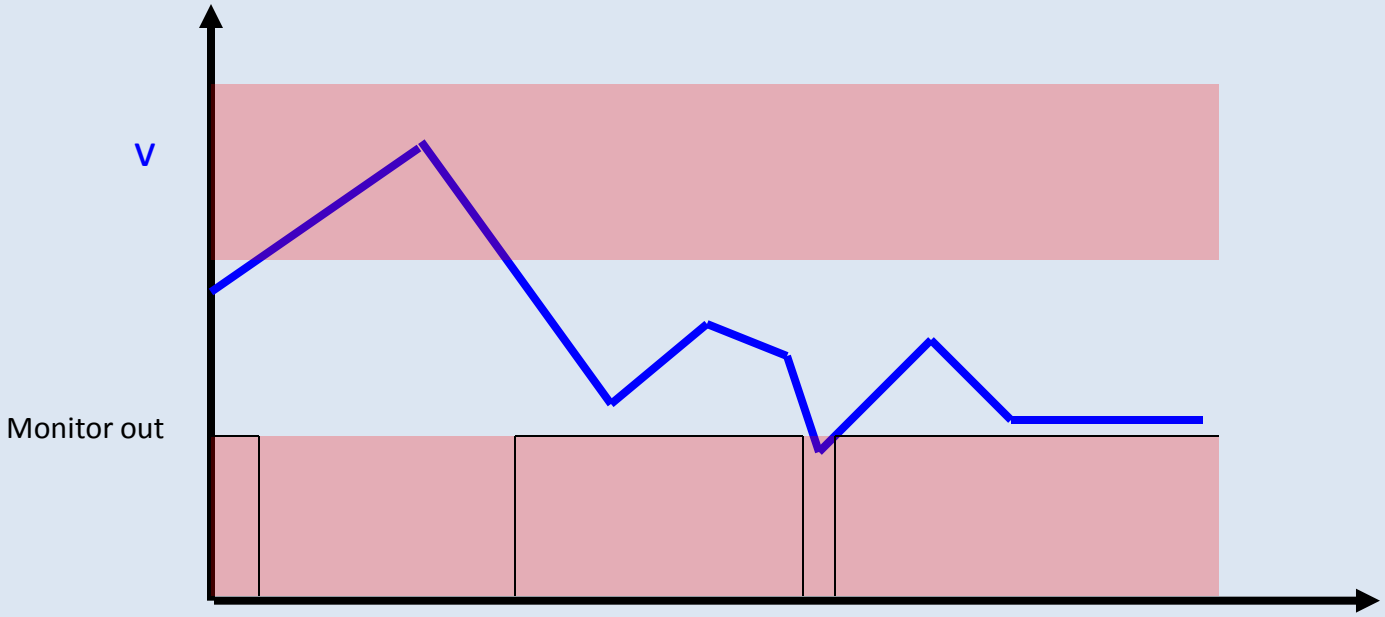
Safe cam, SCA

The SCA-Funktion provide a safe output signal in relation to the axle angle of the drive.



Sichere Geschwindigkeitsüberwachung (Safe speed monitor, SSM)

Die SSM-Funktion liefert ein sicheres Ausgangssignal, um anzuzeigen, ob die Motordrehzahl unterhalb eines festgelegten Grenzwertes liegt.



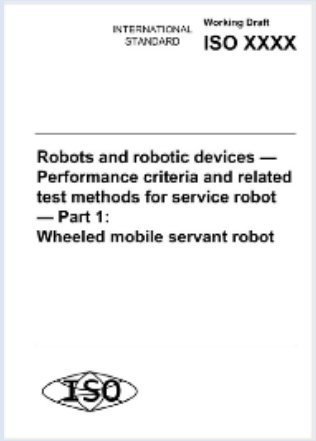
CPS: Additional technical risks

From the safety point of view some technical risks have been added. For instance:

- RFID –Tag will authorize the wrong assembling specification and also to the wrong safety parameter set.
- The access to the date ware house is enabled and the current the safety parameter set isn't the right one for the product.
- The safety parameter set can be manipulated in the data ware house (conscious or unconscious).

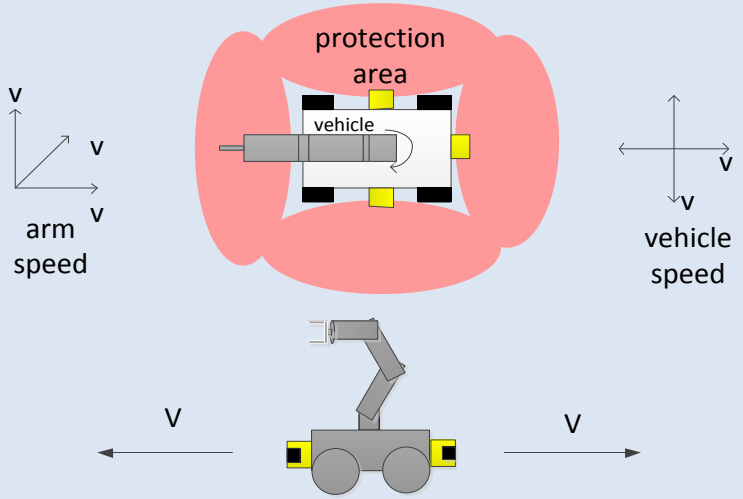
Collaborating Robotic means

Interaction with humans being


INTERNATIONAL STANDARD
Working Draft
ISO XXXX

Robots and robotic devices — Performance criteria and related test methods for service robot — Part 1: Wheeled mobile servant robot

ISO

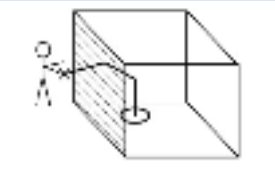


ISO/DTS 15066

Robots and robotic devices –
Safety requirements for industrial robots – Collaborative operation

(still under development)

4 Concepts of ISO/DTS 15066

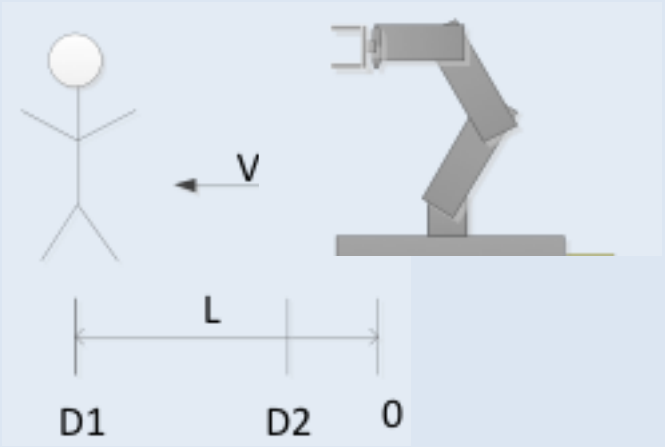


- Manually controlled (Hand in Hand Concept)
- Automatic controlled during production cycle
- Stop the movement at specified boarder points
- Manually controlled via Joystick or Enable-Switch

<u>Safety Function</u>

Safely Limited Speed (PL d, Cat. 3)

4 Concepts of ISO/DTS 15066



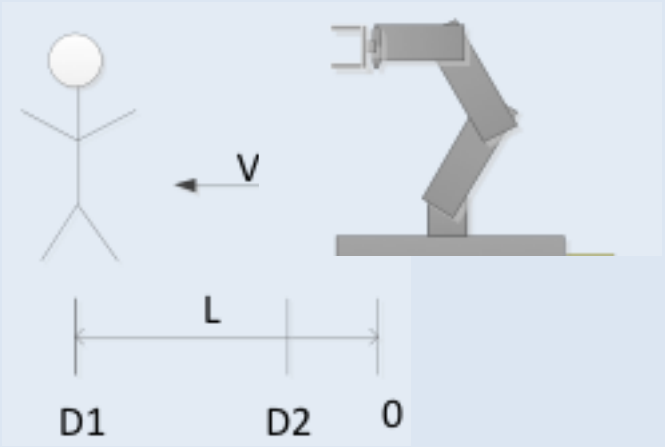
- Speed and Distance controlled (e.g. by Laserscanner)

<u>Safety Function</u>

Safely Limited Speed (PL d, Cat. 3)

Safe Distances according EN ISO 13855

4 Concepts of ISO/DTS 15066



- Stop in any kind of distance-limit exceeding (e.g. by Laserscanner)

<u>Safety Function</u>

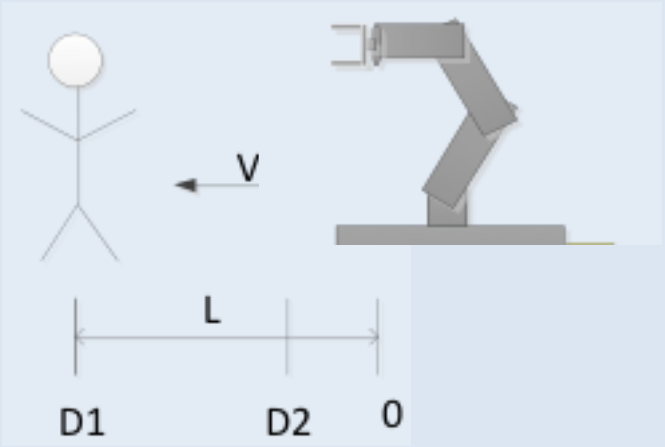
Safely Limited Speed (PL d, Cat. 3)

Safe Operating Stop

Safe Distances according EN ISO 13855

No automatic restart

4 Concepts of ISO/DTS 15066



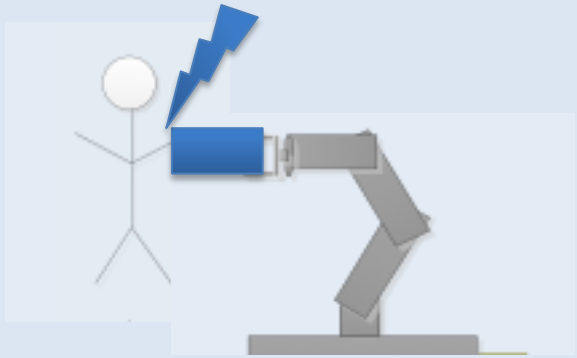
- Speed and Distance controlled (e.g. by Laserscanner)

<u>Safety Function</u>

Safely Limited Speed (PL d, Cat. 3)

Safe Distances according EN ISO 13855

4 Concepts of ISO/DTS 15066



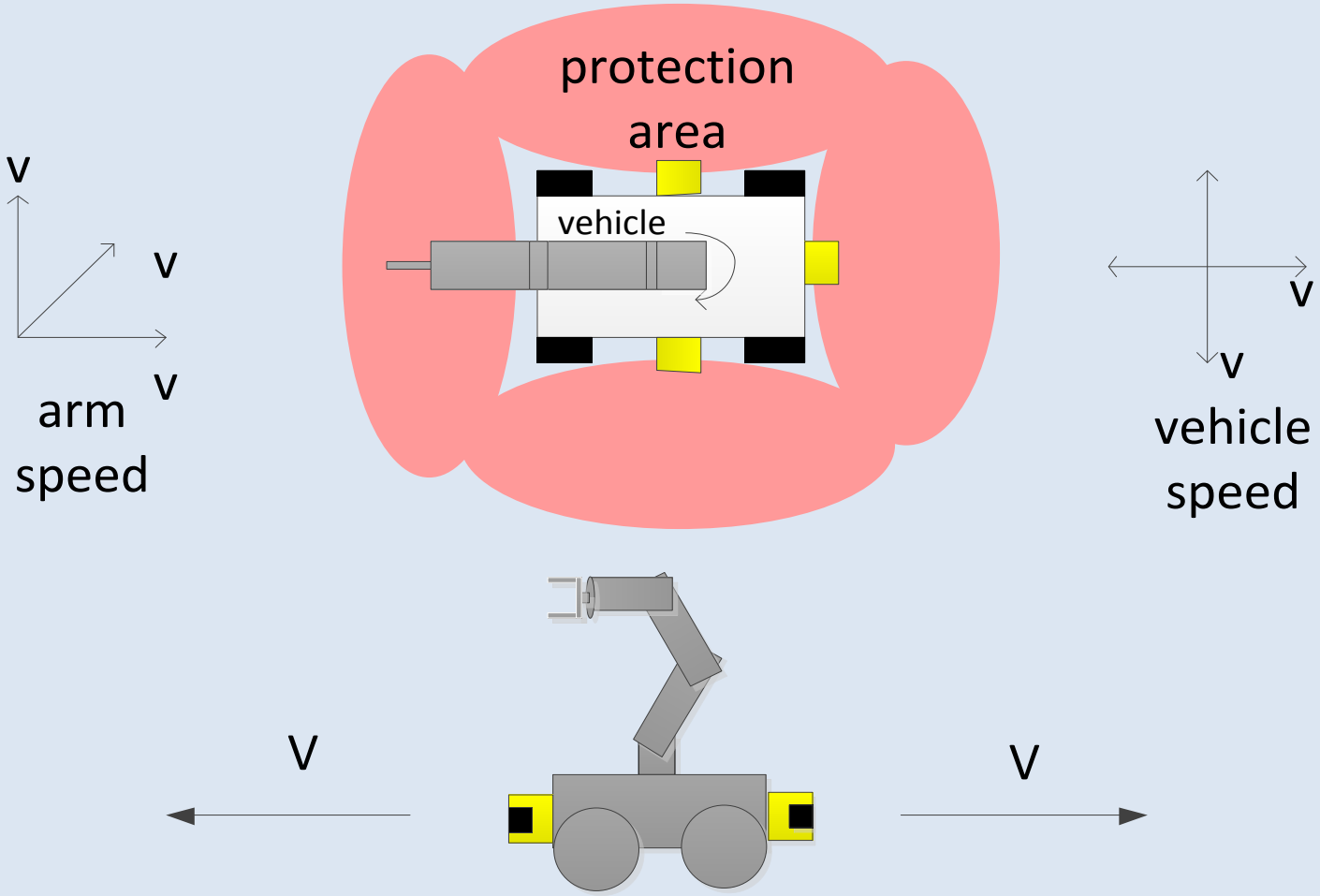
- Power an Force reduced (Intrinsic Safety)
- Max. 80W or 150N

<u>Safety Function</u>

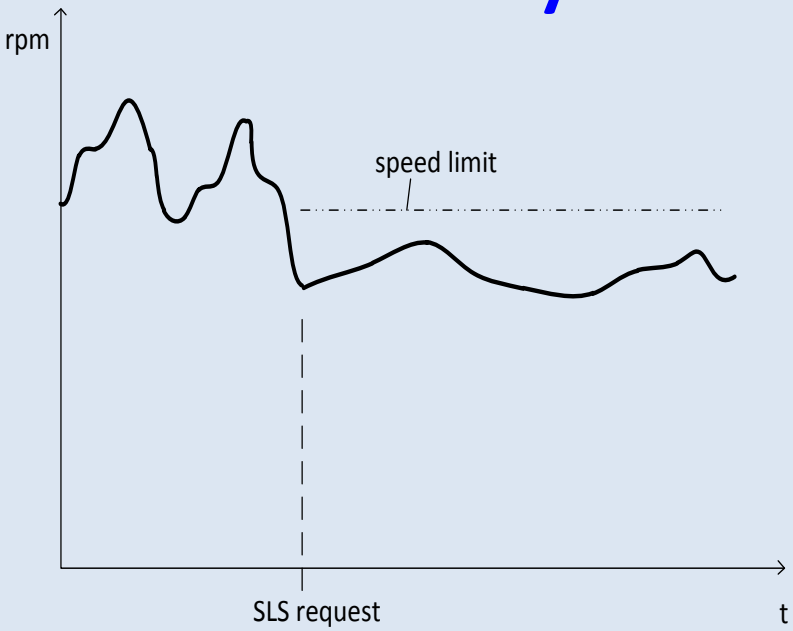
Safely Limited Torque (PL d, Cat. 3)

Safely Limited Speed (PL d, Cat. 3)

Superposition in collaborating Systems

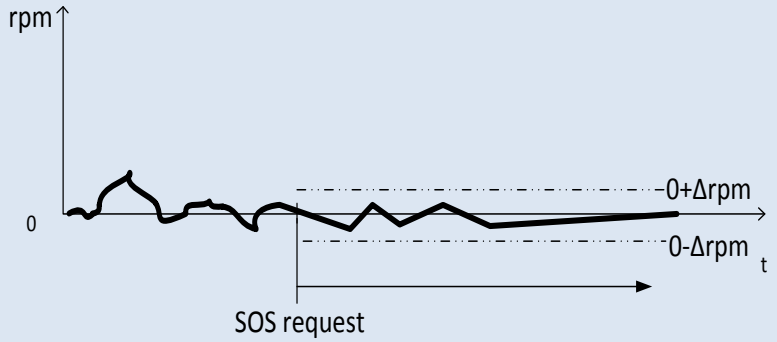


Safety Functions

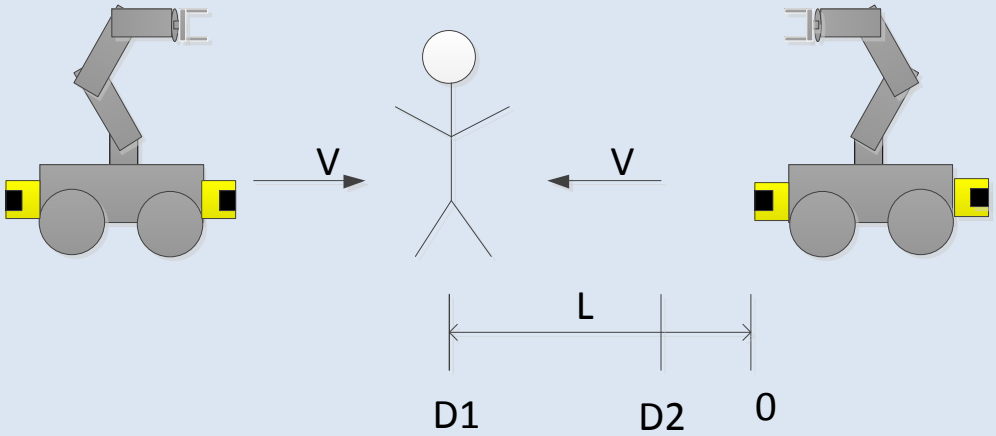


Safely Limited Speed (SLS)

Safe Operating Stop

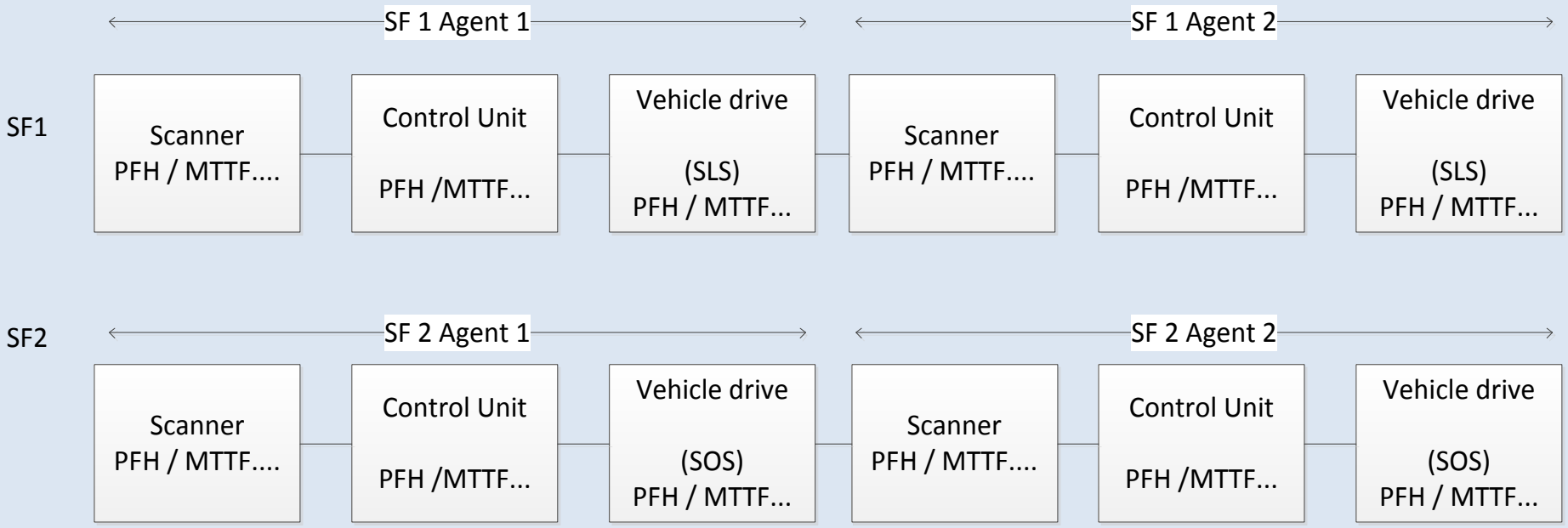


Mobile CPS



SF1	Scanner PFH / MTTF....	Control Unit PFH /MTTF...	Vehicle drive (SLS) PFH / MTTF...
SF2	Scanner PFH / MTTF....	Control Unit PFH /MTTF...	Vehicle drive (SOS) PFH / MTTF...

Combination of Safety Function



Combination of Safety Functions

Combinations of safety functions

SF1 A2 ^ SF2 A2

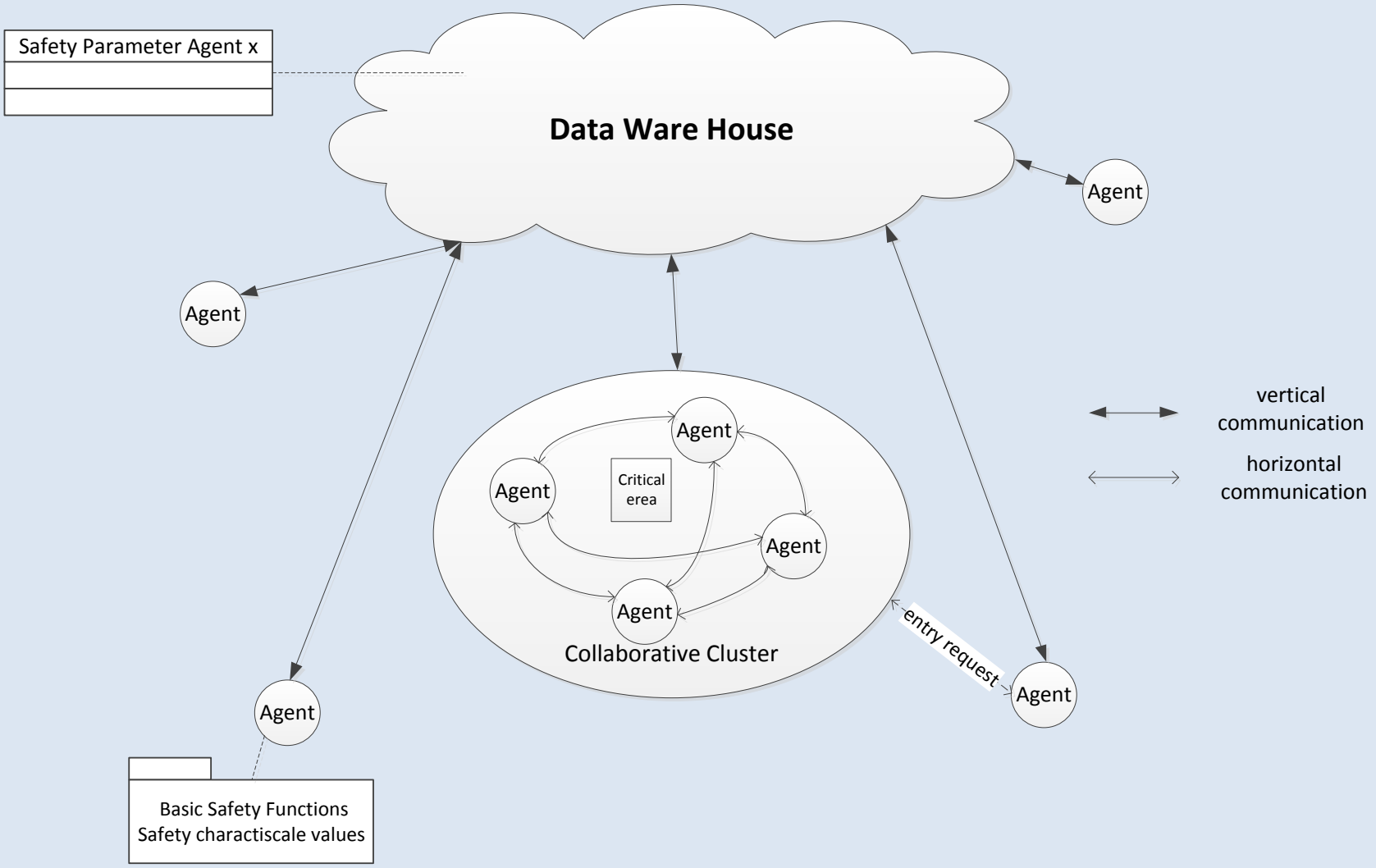
˅ SF2 A2 ^ SF2A1

˅ SF1 A1 ^ SF2A2

˅ SF1 A1 ^ SF2A1

SF: Safe Function
A: Agent

Collaborative Cluster



Thank you for your attention!