Table of contents

Third-party motors/optional measuring systems

Third-party motors/optional measuring systems

> ⓘ Third-party motors and optional measuring systems are only supported with AXS–V–03RS and above in the integrated safety technology in ctrlX DRIVEplus.

> ⓘ If it is not a motor encoder but an optional encoder which has been connected to the optional slot XG20 [XG20.1 and XG20.2 for the double-axis device], this encoder has to comply with the requirements below.

> ⓘ Please make sure that the encoder can be evaluated by the corresponding encoder option.
>
> For "SafeMotion", the evaluation of a safe encoder takes place at the **XG20** interface [XG20.1 and XG20.2 for the double-axis device] **or** at the **XG21** interface [XG21.1 and XG21.2 for the double-axis device].

In conjunction with the optional safety technology module "SafeMotion", the requirements on the **measuring system** used which are mentioned below must be complied with for **third-party motors/optional measuring systems** so that the measuring system can be used as a safety technology encoder:

Encoders with ACUROlink interface

Encoders with ACUROlink interface have to comply with the following requirements so that they can be used as safety technology encoders in safety-related applications up to SIL 3 or Category 3, PL e:

- **Necessary encoder properties:**

  - **Baud rate:** 10 MBaud in cyclic operation
  - **Resolution:** Only rotational encoders with a resolution which is a multiple of 2^n may be used.

- **Limit speed:** The encoder speed should not exceed the value of 15,000 rpm in the application.
- **Mechanics:** Only rotary encoders are supported. The connection of encoder shaft and motor shaft or encoder housing and motor housing has to be dimensioned such that accidental loosening or breakage of the connection can be excluded. The specifications of the encoder manufacturer regarding the connection of encoder shaft and motor shaft or encoder housing and motor housing have to be complied with.
  ⓘ **Take remaining risks into consideration:** see marginal note ↘ "Important instructions regarding inadequate connections of encoder shaft and motor shaft or encoder housing and motor housing".
- **Reliability:** The "Mission Time" and the "Proof Test Interval" of the encoder have to be complied with. After the "Mission Time" has elapsed, the encoder has to be decommissioned. When the "Proof Test Interval" is over, a "Proof Test" has to be carried out with the encoder **or** the encoder has to be decommissioned.
  Note: The ctrlX DRIVE system does not monitor or log the "Mission Time".
  Other encoder-specific parameters such as the maximum number of revolutions/cycles have to be complied with (see

EN 61800−5−3).

- **"Encoder - ctrlX DRIVE" wiring:** The encoder has to be **directly** connected to the respective interface [XG20 (or XG20.1 and XG20.2 for double-axis devices]; mere plug-in connectors are allowed. **Branches** to other evaluation devices, a third-party supply, interconnecting active units or switching between encoders **are not allowed**.

> ⚠ **DANGER!**
>
> ## Lethal injury and/or property damage caused by variations in the position detection
>
> If the Encoders with ACUROlink interface is used as safety technology encoder, the **safe** position resolution of the encoder may be lower than the actual encoder resolution. This may lead to an undetected position deviation between detected and actual position for all safety functions of the safe position. This must be considered in the risk assessment of the machine.

> ℹ The velocity of the encoder is recorded at an interval of 1 ms with a tolerance of ±0.5 %. The resulting tolerance of the actual value for the velocity has to be taken into account for the risk assessment at the machine!

Encoders with EnDat 2.2 interface

Encoders with EnDat 2.2 interface have to comply with the following requirements so that they can be used as safety technology encoders in safety-related applications up to SIL 2 or Category 3, PL d:

- **Measuring device types:**
  Functionally safe measuring instruments with a merely serial data transfer via EnDat 2.2

  - Absolute length measuring device
  - Single-turn rotary encoder
  - Multi-turn rotary encoder with gearbox
  - Multi-turn-rotary encoder with battery buffer

- **Supply voltage:** Only safe Encoders with EnDat 2.2 interface with a 12 V supply voltage are supported.
- **Resolution:** Encoders with a resolution of a maximum of 48 bit are supported.
- **Limit speed:** Only rotary encoders with a maximum allowed speed of 20,000 rpm can be used. Rotary encoders with an allowed speed higher than 20,000 rpm may only be used in connection with a safety function that monitors the speed for exceedance of the maximum value of 20,000 rpm (e.g. "Safe maximum speed").
  In this case, the maximum acceleration must not exceed 250 000 rad/s² if the encoder supports this.
- **Mechanics:** The connection of encoder shaft and motor shaft, of encoder housing and motor housing or the fixing device of the reading head for linear encoders has to be sized so that accidental loosening or breakage of the connection can be excluded. The specifications of the encoder manufacturer regarding the connection of encoder shaft and motor shaft, encoder housing and motor housing or the fixing device of the reading head for linear encoders have to be complied with.
  ℹ **Take remaining risks into consideration:** see marginal note ↘ "Important instructions regarding inadequate connections of encoder shaft and motor shaft or encoder housing and motor housing".
- **Reliability:** The "Mission Time" and the "Proof Test Interval" of the encoder have to be complied with. After the "Mission Time" has elapsed, the encoder has to be decommissioned. When the "Proof Test Interval" is over, a "Proof Test" has to be carried out with the encoder **or** the encoder has to be decommissioned.

Note: The ctrlX DRIVE system does not monitor or log the "Mission Time".
Other encoder-specific parameters such as the maximum number of revolutions/cycles have to be complied with (see EN 61800−5−3).

- **"Encoder - ctrlX DRIVE" wiring:** The encoder has to be **directly** connected to the respective interface [XG21 (or XG21.1 and XG21.2 for double-axis devices]; mere plug-in connectors are allowed. **Branches** to other evaluation devices, a third-party supply, interconnecting active units or switching between encoders **are not allowed**.

> ⚠️ **DANGER!**
>
> ## Lethal injury and/or property damage caused by variations in the position detection
>
> If an Encoders with EnDat 2.2 interface is used as safety technology encoder, the **safe** position resolution of the encoder may be lower than the actual encoder resolution. This may lead to an undetected position deviation between detected and actual position for all safety functions of the safe position. This must be considered in the risk assessment of the machine.

> ℹ️ The velocity of the encoder is recorded at an interval of 1 ms with a tolerance of ±3 %. The resulting tolerance of the actual value for the velocity has to be taken into account for the risk assessment at the machine!

Encoders with sine signals (1 Vpp)

Encoders with sine signals (1 Vpp) have to comply with the following requirements so that they can be used as safety technology encoders in safety-related applications up to SIL 2 or Category 3, PL d:

- All requirements specified in the operating instructions of the safety technology encoder with regard to assembly, electrical installation and maintenance must be taken into account.
- **Signal generation:** The analog position signals (sin, cos) have to be generated and processed in analog form. Synthetic signal generation is not allowed.
  Only optical encoders, or encoders that have been considered according to DIN EN 61800−5−3 and whose error pattern has been taken into account in the FMEA, may be used.
  A failure of the transmitter diode must result in invalid signal levels (e.g. upper or lower threshold).
  Stuck-at errors of the analog position signals (sin, cos) in the allowed range cannot be detected by SafeMotion. The suitability of the encoder must be checked by the machine manufacturer in each individual case.
- **Safety characteristics:** The safe fault fraction (SFF) must be >90% (according to DIN EN 61800−5−2 / EN 61508). The DC_{avg} must be at least 90% and the $MTTF_d$ >30 years (according to DIN EN ISO 13849).
- **Signal transmission:** The analog position signals (sin, cos) have to be transmitted in differential form. The differential signal amplitude levels have to be between 0.8 V_{pp} and 1.2 V_{pp}.
- **Resolution:** It is only allowed to use rotary encoders with a resolution of 1..180000 DP/rev or linear encoders with a resolution of 1 nm..100 mm.
- **Cutoff frequency (-3dB):** The frequency of the encoder signals should not be higher than a maximum of 400 kHz.
- **Dynamic response:** The frequency slope of the encoder signals must not exceed 1.59E6 DP/s^2.
- **Mechanics:** The connection of encoder shaft and motor shaft, of encoder housing and motor housing or the fixing device of the reading head for linear encoders has to be sized so that accidental loosening or breakage of the connection can be excluded. The specifications of the encoder manufacturer regarding the connection of encoder shaft and motor shaft, encoder housing and motor housing or the fixing device of the reading head for linear encoders

have to be complied with.

ℹ **Take remaining risks into consideration:** see marginal note ↘ "Important instructions regarding inadequate connections of encoder shaft and motor shaft or encoder housing and motor housing".

- **Reliability:** The "Mission Time" and the "Proof Test Interval" of the encoder have to be complied with. After the "Mission Time" has elapsed, the encoder has to be decommissioned. When the "Proof Test Interval" is over, a "Proof Test" has to be carried out with the encoder **or** the encoder has to be decommissioned.
  Note: The ctrlX DRIVE system does not monitor or log the "Mission Time".
  Other encoder-specific parameters such as the maximum number of revolutions/cycles have to be complied with (see EN 61800–5–3).
- **"Encoder - ctrlX DRIVE" wiring:** The encoder has to be **directly** connected to the respective interface [XG21 (or XG21.1 and XG21.2 for double-axis devices]; mere plug-in connectors are allowed. **Branches** to other evaluation devices, a third-party supply, interconnecting active units or switching between encoders **are not allowed**.

> ℹ
> - The maximum error of the relative position in the safe evaluation of the encoder can be one signal period (4 quadrants).
> - The velocity of the encoder is recorded at an interval of 1 ms with a tolerance of ±3 %. The resulting tolerance of the actual value for the velocity has to be taken into account for the risk assessment at the machine!

Encoders with sine signals (1 Vpp) and EnDat 2.1 interface

Encoders with sine signals (1 Vpp) and EnDat 2.1 interface have to comply with the following requirements so that they can be evaluated by SafeMotion:

- **Functional** Encoders with sine signals (1 Vpp) and EnDat 2.1 interface must comply with the requirements for Encoders with sine signals (1 Vpp) (see ↘ "Encoders with sine signals (1 Vpp)").
- Encoders with sine signals (1 Vpp) and EnDat 2.1 interface have to comply with the following requirements so that they can be used as safety technology encoders in safety-related applications up to SIL 2 or Category 3, PL d:
  - All requirements specified in the operating instructions of the safety technology encoder with regard to assembly, electrical installation and maintenance must be taken into account.
  - **Signal generation:** The analog position signals (sin, cos) have to be generated and processed in analog form. Synthetic signal generation is not allowed.
    Only optical encoders, or encoders that have been considered according to DIN EN 61800–5–3 and whose error pattern has been taken into account in the FMEA, may be used.
    A failure of the transmitter diode must result in invalid signal levels (e.g. upper or lower threshold).
    Stuck-at errors of the analog position signals (sin, cos) in the allowed range cannot be detected by SafeMotion. The suitability of the encoder must be checked by the machine manufacturer in each individual case.
  - **Safety characteristics:** The safe fault fraction (SFF) must be >90% (according to DIN EN 61800–5–2 / EN 61508). The DC_{avg} must be at least 90% and the $MTTF_d$ >30 years (according to DIN EN ISO 13849).
  - **Signal transmission:** The analog position signals (sin, cos) have to be transmitted in differential form. The differential signal amplitude levels have to be between 0.8 V_{pp} and 1.2 V_{pp}.
  - **Resolution:** It is only allowed to use rotary encoders with a resolution of 1..180000 DP/rev or linear encoders with a resolution of 1 nm..100 mm.
  - **Cutoff frequency (-3dB):** The frequency of the encoder signals should not be higher than a maximum of 400 kHz.
  - **Dynamic response:** The frequency slope of the encoder signals must not exceed 1.59E6 DP/s^2.
  - **Mechanics:** The connection of encoder shaft and motor shaft, of encoder housing and motor housing or the fixing device of the reading head for linear encoders has to be sized so that accidental loosening or breakage of the connection can be excluded. The specifications of the encoder manufacturer regarding the connection of encoder shaft and motor shaft, encoder housing and motor housing or the fixing device of the reading head for linear

encoders have to be complied with.

🛈 **Take remaining risks into consideration:** see marginal note ↘ "Important instructions regarding inadequate connections of encoder shaft and motor shaft or encoder housing and motor housing".

- **Reliability:** The "Mission Time" and the "Proof Test Interval" of the encoder have to be complied with. After the "Mission Time" has elapsed, the encoder has to be decommissioned. When the "Proof Test Interval" is over, a "Proof Test" has to be carried out with the encoder **or** the encoder has to be decommissioned.
Note: The ctrlX DRIVE system does not monitor or log the "Mission Time".
Other encoder-specific parameters such as the maximum number of revolutions/cycles have to be complied with (see EN 61800–5–3).
- **"Encoder - ctrlX DRIVE" wiring:** The encoder has to be **directly** connected to the respective interface [XG21 (or XG21.1 and XG21.2 for double-axis devices]; mere plug-in connectors are allowed. **Branches** to other evaluation devices, a third-party supply, interconnecting active units or switching between encoders **are not allowed**.

🛈
- The maximum error of the relative position in the safe evaluation of the encoder can be one signal period (4 quadrants).
- The velocity of the encoder is recorded at an interval of 1 ms with a tolerance of ±3 %. The resulting tolerance of the actual value for the velocity has to be taken into account for the risk assessment at the machine!
- **Commissioning information:** The zero point shifting of the safe encoder must be set to "0" (0x3108:03="0").

Encoders with sine signals (1 Vpp) and HIPERFACE interface

Encoders with sine signals (1 Vpp) and HIPERFACE interface have to comply with the following requirements so that they can be used by SafeMotion:

- **Functional** Encoders with sine signals (1 Vpp) and HIPERFACE interface must comply with the requirements for Encoders with sine signals (1 Vpp) (see ↘ "Encoders with sine signals (1 Vpp)"").
- Encoders with sine signals (1 Vpp) and HIPERFACE interface have to comply with the following requirements so that they can be used as **safety technology encoders** in safety-related applications up to SIL 2 or Category 3, PL d:

  - All requirements specified in the operating instructions of the safety technology encoder with regard to assembly, electrical installation and maintenance must be taken into account.
  - **Signal generation:** The analog position signals (sin, cos) have to be generated and processed in analog form. Synthetic signal generation is not allowed.
  Only optical encoders, or encoders that have been considered according to DIN EN 61800–5–3 and whose error pattern has been taken into account in the FMEA, may be used.
  A failure of the transmitter diode must result in invalid signal levels (e.g. upper or lower threshold).
  Stuck-at errors of the analog position signals (sin, cos) in the allowed range cannot be detected by SafeMotion. The suitability of the encoder must be checked by the machine manufacturer in each individual case.
  - **Safety characteristics:** The safe fault fraction (SFF) must be >90% (according to DIN EN 61800–5–2 / EN 61508). The DC_{avg} must be at least 90% and the $MTTF_d$ >30 years (according to DIN EN ISO 13849).
  - **Signal transmission:** The analog position signals (sin, cos) have to be transmitted in differential form. The differential signal amplitude levels have to be between 0.8 V_{pp} and 1.2 V_{pp}.
  - **Resolution:** It is only allowed to use rotary encoders with a resolution of 1..180000 DP/rev or linear encoders with a resolution of 1 nm..100 mm.
  - **Cutoff frequency (-3dB):** The frequency of the encoder signals should not be higher than a maximum of 400 kHz.
  - **Dynamic response:** The frequency slope of the encoder signals must not exceed 1.59E6 DP/s^2.
  - **Mechanics:** The connection of encoder shaft and motor shaft, of encoder housing and motor housing or the fixing device of the reading head for linear encoders has to be sized so that accidental loosening or breakage of the

connection can be excluded. The specifications of the encoder manufacturer regarding the connection of encoder shaft and motor shaft, encoder housing and motor housing or the fixing device of the reading head for linear encoders have to be complied with.

ℹ Take remaining risks into consideration: see marginal note ↘ "Important instructions regarding inadequate connections of encoder shaft and motor shaft or encoder housing and motor housing".

- **Reliability:** The "Mission Time" and the "Proof Test Interval" of the encoder have to be complied with. After the "Mission Time" has elapsed, the encoder has to be decommissioned. When the "Proof Test Interval" is over, a "Proof Test" has to be carried out with the encoder **or** the encoder has to be decommissioned.
  Note: The ctrlX DRIVE system does not monitor or log the "Mission Time".
  Other encoder-specific parameters such as the maximum number of revolutions/cycles have to be complied with (see EN 61800−5−3).
- **"Encoder - ctrlX DRIVE" wiring:** The encoder has to be **directly** connected to the respective interface [XG21 (or XG21.1 and XG21.2 for double-axis devices]; mere plug-in connectors are allowed. **Branches** to other evaluation devices, a third-party supply, interconnecting active units or switching between encoders **are not allowed**.

> ℹ
> - The maximum error of the relative position in the safe evaluation of the encoder can be one signal period (4 quadrants).
> - The velocity of the encoder is recorded at an interval of 1 ms with a tolerance of ±3 %. The resulting tolerance of the actual value for the velocity has to be taken into account for the risk assessment at the machine!
> - **Commissioning information:** With an Encoders with sine signals (1 Vpp) and HIPERFACE interface that is used as a **safety technology encoder**, the zero point shifting has to be set to "0" (0x3108:03="0").

Encoders with sine signals (1 Vpp) and SSI interface

Encoders with sine signals (1 Vpp) and SSI interface have to comply with the following requirements so that they can be evaluated and used by SafeMotion:

- **Functional** Encoders with sine signals (1 Vpp) and SSI interface must comply with the requirements for Encoders with sine signals (1 Vpp) (see ↘ "Encoders with sine signals (1 Vpp)"").
- Encoders with sine signals (1 Vpp) and SSI interface have to comply with the following requirements so that they can be used as **safety technology encoders** in safety-related applications up to SIL 2 or Category 3, PL d:
  - All requirements specified in the operating instructions of the safety technology encoder with regard to assembly, electrical installation and maintenance must be taken into account.
  - **Signal generation:** The analog position signals (sin, cos) have to be generated and processed in analog form. Synthetic signal generation is not allowed.
    Only optical encoders, or encoders that have been considered according to DIN EN 61800−5−3 and whose error pattern has been taken into account in the FMEA, may be used.
    A failure of the transmitter diode must result in invalid signal levels (e.g. upper or lower threshold).
    Stuck-at errors of the analog position signals (sin, cos) in the allowed range cannot be detected by SafeMotion. The suitability of the encoder must be checked by the machine manufacturer in each individual case.
  - **Safety characteristics:** The safe fault fraction (SFF) must be >90% (according to DIN EN 61800−5−2 / EN 61508). The DC_{avg} must be at least 90% and the $MTTF_d$ >30 years (according to DIN EN ISO 13849).
  - **Signal transmission:** The analog position signals (sin, cos) have to be transmitted in differential form. The differential signal amplitude levels have to be between 0.8 V_{pp} and 1.2 V_{pp}.
  - **Resolution:** It is only allowed to use rotary encoders with a resolution of 1..180000 DP/rev or linear encoders with a resolution of 1 nm..100 mm.
  - **Cutoff frequency (-3dB):** The frequency of the encoder signals should not be higher than a maximum of 400 kHz.

- **Dynamic response:** The frequency slope of the encoder signals must not exceed $1.59E6\ DP/s^2$.
- **Mechanics:** The connection of encoder shaft and motor shaft, of encoder housing and motor housing or the fixing device of the reading head for linear encoders has to be sized so that accidental loosening or breakage of the connection can be excluded. The specifications of the encoder manufacturer regarding the connection of encoder shaft and motor shaft, encoder housing and motor housing or the fixing device of the reading head for linear encoders have to be complied with.
  Ⓘ **Take remaining risks into consideration:** see marginal note ↘ "Important instructions regarding inadequate connections of encoder shaft and motor shaft or encoder housing and motor housing".
- **Reliability:** The "Mission Time" and the "Proof Test Interval" of the encoder have to be complied with. After the "Mission Time" has elapsed, the encoder has to be decommissioned. When the "Proof Test Interval" is over, a "Proof Test" has to be carried out with the encoder **or** the encoder has to be decommissioned.
  Note: The ctrlX DRIVE system does not monitor or log the "Mission Time".
  Other encoder-specific parameters such as the maximum number of revolutions/cycles have to be complied with (see EN 61800–5–3).
- **"Encoder - ctrlX DRIVE" wiring:** The encoder has to be **directly** connected to the respective interface [XG21 (or XG21.1 and XG21.2 for double-axis devices]; mere plug-in connectors are allowed. **Branches** to other evaluation devices, a third-party supply, interconnecting active units or switching between encoders **are not allowed**.

> ⓘ
> - The maximum error of the relative position in the safe evaluation of the encoder can be one signal period (4 quadrants).
> - The velocity of the encoder is recorded at an interval of 1 ms with a tolerance of ±3 %. The resulting tolerance of the actual value for the velocity has to be taken into account for the risk assessment at the machine!

Commissioning information: With an Encoders with sine signals (1 Vpp) and SSI interface that is used as a **safety technology encoder**, the zero point shifting has to be set to "0" (0x3108:03="0").

Encoders with resolver signals

Encoders with resolver signals have to comply with the following requirements so that they can be used as safety technology encoders in safety-related applications up to SIL 3 or Category 4, PL e:

- **Necessary encoder properties:**

  - **Excitation voltage:** 10 V_{PP} (± 10 %)
  - **Excitation frequency:** 8 kHz (± 10%)
    Resolvers not sized for 8 kHz exciters require a separate check of the resolver in combination with the cable used.
  - **Coupling factor:** 0.5 (± 10%)
  - **Output characteristics:** ohmic resistance R < 100 ohm and inductance L < 20 mH
  - **Phase shift:** 90° between signal A and B

- **Signal generation:** The analog position signals have to be generated and processed in analog form. Synthetic signal generation or any further signal processing is not allowed. Only the excitation voltage generated by the drive may be used.
- **Signal transmission:** The analog position signals have to be transmitted in differential form. The allowed levels of the differential signal amplitudes are between 4 V_{PP} and 6 V_{PP} [related to an excitation voltage of 10 V_{PP} (± 10%) and a coupling factor of 0.5 (± 10%)].
- **Cables:** The maximum allowed cable length is 75 m. The wire pairs in the cable have to be twisted pairwise (A+/A-), (B+/B-), (Vcc/Gnd), and the entire cable has to be shielded.
- **Phase shift:** The allowed phase shift between excitation voltage and the track signals is in the range of -115°.. 20°. This phase shift takes the properties of the resolver and the cable into account.

- **Cutoff frequency (-3dB):** The frequency of the encoder signals must not be higher than a maximum of 675 Hz.
- **Dynamics:** The frequency slope of the encoder signals must not exceed 1.59E6 DP/s^2.
- **Mechanics:** The connection of encoder shaft and motor shaft, of encoder housing and motor housing or the fixing device of the reading head for linear encoders has to be sized so that accidental loosening or breakage of the connection can be excluded. The specifications of the encoder manufacturer regarding the connection of encoder shaft and motor shaft, encoder housing and motor housing or the fixing device of the reading head for linear encoders have to be complied with.

> Take remaining risks into consideration: see marginal note "Important instructions regarding inadequate connections of encoder shaft and motor shaft or encoder housing and motor housing".

- **Reliability:** The "Mission Time" and the "Proof Test Interval" of the encoder have to be complied with. After the "Mission Time" has elapsed, the encoder has to be decommissioned. When the "Proof Test Interval" is over, a "Proof Test" has to be carried out with the encoder **or** the encoder has to be decommissioned.
  Note: The ctrlX DRIVE system does not monitor or log the "Mission Time".
  Other encoder-specific parameters such as the maximum number of revolutions/cycles have to be complied with (see EN 61800–5–3).
- **"Encoder - ctrlX DRIVE" wiring:** The encoder has to be **directly** connected to the respective interface [XG21 (or XG21.1 and XG21.2 for double-axis devices]; mere plug-in connectors are allowed. **Branches** to other evaluation devices, a third-party supply, interconnecting active units or switching between encoders **are not allowed**.

> - If an encoder is used as safety technology encoder, linearity errors in the absolute position detection of SafeMotion of up to 60° relating to one division period cannot be detected. These linearity errors may lead to an undetected positional variation between detected and actual position with all safety functions of the safe absolute position. This must be considered in the risk assessment of the machine!
> - The velocity of the encoder is recorded at an interval of 1 ms with a tolerance of ±3 %. The resulting tolerance of the actual value for the velocity has to be taken into account for the risk assessment at the machine!

Important instructions regarding inadequate connections of encoder shaft and motor shaft or encoder housing and motor housing

If it cannot be excluded that the connection of encoder shaft and motor shaft, encoder housing and motor housing or the fixing device of the reading head for linear encoders accidentally loosens or the connection is interrupted, take the following **remaining risks** into consideration:

- **Combination "rotary or linear encoder with synchronous motor":** Possible incorrect orientation of the commutation may cause positive feedback of the current control loop. In this case, the velocity can inadmissibly increase before the monitoring function triggers.
- **"Optional load-side encoder" or combination "rotary encoder with asynchronous motor":** The encoder may move with the shaft by an angle limited by the connection cable which causes an angle offset. This can result in dangerous movements.
  Loosening of the material measure (e.g., encoder shaft breakage) should not cause any allowed signals; if this error cannot be excluded, take the following remaining risk into consideration: The motor shaft may move at maximum slip speed.