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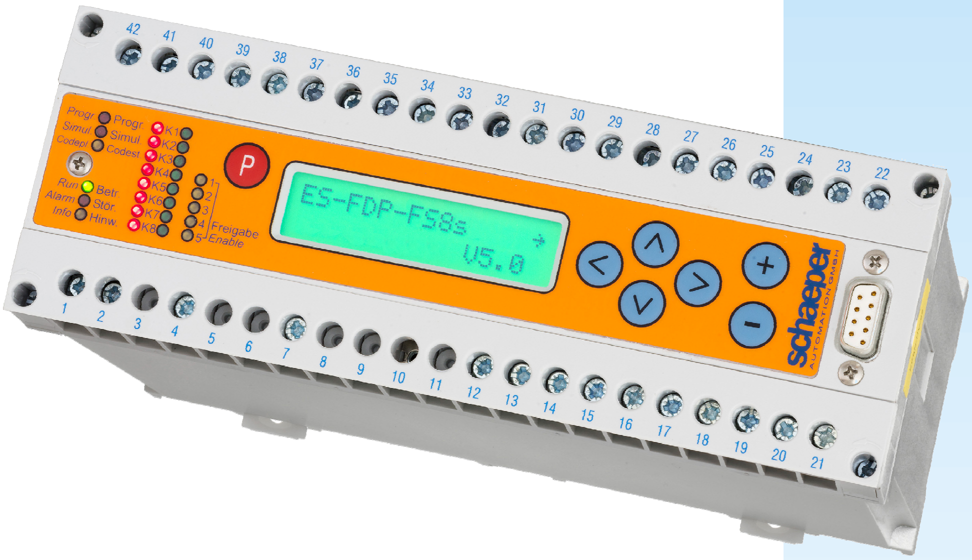
ES-FDP-FS2s ... ES-FDP-FS8s

Digital Slip and Frequency Monitors

Operating Instructions



Differences to the Device Versions ES-FDP-FS2n resp. ES-FDP-FS8n

The devices ES-FDP-FS..s and ES-FDP-FS..n differ primarily by the new front panel with membrane keyboard. The arrangement of the operating elements is slightly different, and with the new ES-FDP-FS8s resp. -FS2s version, additionally the states of the enable inputs are indicated by LEDs. The LED for the programming mode is now located outside the programming button on the front of the panel.

The devices are connection- and function-compatible, all programmable parameters as well as the programming procedure are unchanged.

Differences to the Device Versions ES-FDP-F...x resp. ES-FDP-S...x

All switch and monitoring functions which were realized with the devices of the series ES-FDP-F…x resp. ES-FDP-S…x can also be programmed with the new versions ES-FDP-FS.. . Also the allocation of the terminals has remained the same, devices of the versions ES-FDP-F…x and ES-FDP-S…x can be replaced by the versions ES-FDP-FS.. without wiring changes.

The device versions ES-FDP-FS… are designed with a new, up-to-date microcontroller. The immunity to interference was increased considerably again by this.

The texts on the display can alternatively be displayed in German or English.

The programming of the display contrast is eliminated since the up-to-date display is readable well from a wide viewing angle.

Free allocation of the switching channels for monitoring one of the two input frequencies or the frequency ratio.

At programmed window functions the passing through the window will be recognized even if there is no measurement inside the window (example: a measurement above the window, the next below the window, cf. chapter 4.6.9, p. 23).

A programmed averaging function has no more influence on the open circuit monitoring. For a faster detection of an open circuit always the current measured input frequency is evaluated (not the average value).

Also for the calculation of the quotients an averaging function can be activated.

The acknowledgment of error numbers in the display self-test is not made by the key ⊳ any more but by pressing the keys Ⓟ and ⊖ simultaneously.

The programming of the device can be protected by a password in addition to the code plug.

The operating time of the device is recorded and can be read on the display.

The number of operating cycles is recorded one by one for every output relay and can be read on the display.

The minimum and maximum values of the measurands are recorded during operation and can be read on the display.

The device offers the following new functions with the software V4.1

- Switching functions with programmed self-holding (lock) are available.
- There are new window switching functions which switch only at falling frequency.

Important Differences to the Device Versions ES-FDP-F...a resp. ES-FDP-S...a

Between the new device versions **ES-FDP-FS..** and the older versions **ES-FDP-F…a** resp. **ES-FDP-S…a** there are some differences particularly in the terminal assignment which must be paid attention to at an equipment exchange. (See chapter 16: „Appendix: Differences to the Device Versions ES-FDP-F122a … ES-FDP-F285a resp. ES-FDP-S222a … ES-FDP-S285a“).

Important information

For a high degree of operating safety, the unit has a **Watchdog**, an **EEPROM and Flash-EPROM with software write protection** in order to prevent a change of the programmed parameters with strong external interferences. **However, one hundred percent safety can not be achieved with a one-processor system. The system must therefore have a redundant system for safety-orientated use.**

The danger of a change of the programmed data due to extreme external interferences is minimized if the code plug is removed during the operation of the device.

Other versions of the device:

- **Drive monitor ES-FDP-AW1,** monitoring of position, synchronisation, shaft break, slip, speed, standstill, … All functions of the ES-FDP-FS and the ES-SVGL as well as additional tools to monitor the drive are combined in one device.

- **Digital crane frequency control system, ES-FDP-KR...,** Standard and two-step operation

- **Signal pre-processor, ES-SV11.2,** supplementary device for use with the digital slip monitor **ES-FDP-FS...,** includes sensor supply, rotational direction recognition by evaluation of 2 phase signal, open circuit monitoring. See also chapter 2.3, p. 12.

- **Digital Synchronization monitor ES-SVGL2,** for monitoring synchronization. Includes sensor supply, rotational direction recognition by evaluation of 2 phase signal, open circuit monitoring.

Note:

This document has been translated with the greatest of care and expertise. We would like to categorically point out, however, that only the information contained in the German version is binding! This version has been enclosed or can be requested.

These operating instructions for the digital slip and frequency monitors ES-FDP-FS... are for the device as it stands September 2018. The current software-version is **V5.0.**

Subject to changes without notice.

Application

Types **FS2s** (2 switching outputs, 2 enable inputs) and **FS8s** (8 switching outputs, 5 enable inputs) are slip and frequency monitors from the series **ES-FDP** (for further versions see page 4). These devices can be used to monitor the frequency ratios **Q** and frequencies **f**, in order to, e.g., recognize **slipping on conveyor belts** or **breaks in shafts and couplings.** It can be used at the same time to monitor **overspeeds and low speeds**. If a drive rod has broken the device can be used to lower the load in a controlled manner by providing the emergency brake with a two-step signal.

General characteristics

☺ extremely space-saving

☺ frequency ratio - (slip -) and frequency or speed measurements

☺ especially easy to program using large L.C.-Display with back-lighting

☺ Display with plain text, alternatively German or English-language

☺ protection from unauthorized programming using a code plug

☺ double -LED-display (red/green) for relay status

☺ up to 8 relay outputs (optional triac or transistor outputs)

☺ programmable time delay for the switching outputs

☺ analogue output, current or voltage, (Option)

☺ open circuit monitoring

☺ up to 5 enable outputs (with programmable time delay) which can be allocated to the switching channels as required

☺ simulation mode for function test

☺ measuring inputs are electrically isolated from the other in and outputs

☺ Flash-EPROM and EEPROM for programmable values (no batteries required), with software write protection for extremely high data safety

☺ high noise immunity (watchdog, redundant data storage for automatic error recognition)

☺ easy to service due to **removable screw-on terminal strip, thus enabling the devices to be changed quickly without the danger of wiring errors**

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1 Introduction: Example of a Shaft -break Monitor

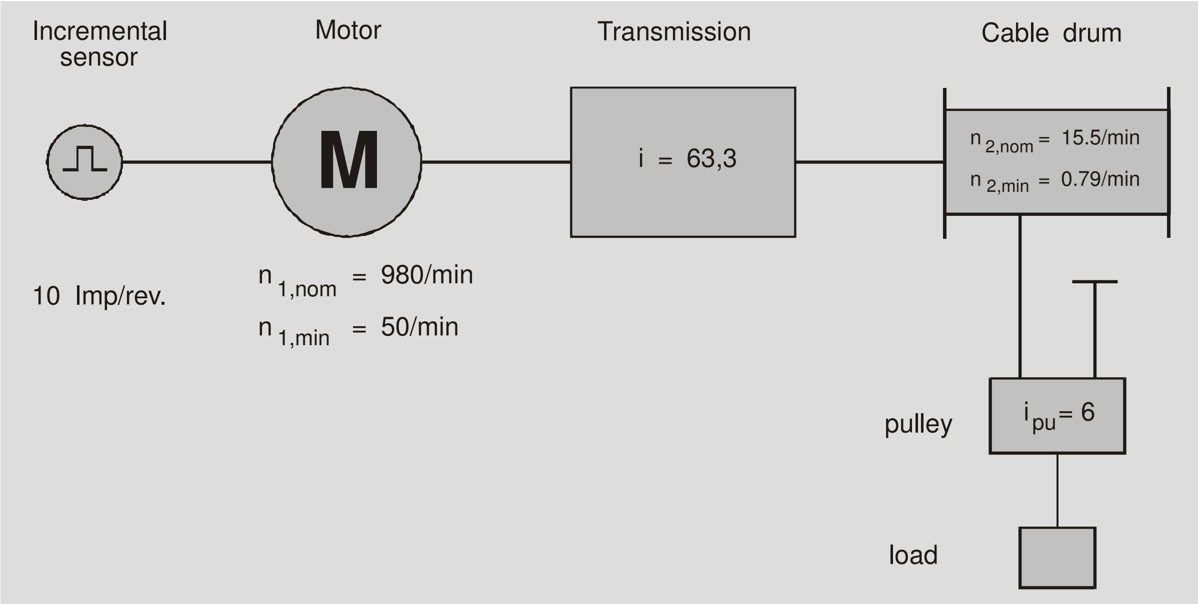


Fig. 1: Example of a lifting device to be monitored

For the example outlined the slip and frequency monitor **ES-FDP-FS8s** can carry out the monitoring for shaft breaks, overspeed and open circuit. The monitoring is based on the evaluation of two input frequencies; i.e. the speed of the motor and of the drum must be converted into frequency signals using incremental sensors, AC-tachos, using proximity switches to detect cams or toothed discs or using any other method.

In this example, the speed of the motor is picked up by an incremental sensor. To record the drum movement cams can be fitted to the outside of the flanged wheel. Proximity switches are then used to produce a signal.

The limiting values for monitoring the speeds can be programmed directly in rpm, the conversion of these into input frequencies is carried out internally by the device. Similarly the transmission ratios are programmed directly without conversion factors.

An example of the programming for the above monitoring task is described in detail in the chapter: “Example of an Application”, page 37.

2 Mode of Operation

2.1 Measurement Principle

The input signals to the two measurement inputs are processed using filters and the times of the edges of the impulses (or the zero crossings for AC-input signals) are stored. The frequencies **f1** and **f2** of the input signals are determined by period-duration measurements (resolution: ≤0,5µs). About every 8 ms the device checks whether the input impulses have been received and evaluates them (frequency and quotient calculations, switching commands to the relays).

2.1.1 Calculation of the Frequencies

For frequencies > about 120 Hz the measuring time of around 8 ms means that an average of several input impulses is used. At lower frequencies the frequency is calculated new for each incoming impulse. The frequency values calculated in this way are evaluated in order to, e.g., monitor for overspeeds, open circuits or for a speed dependant enable control. Normally the frequency range is 0,1 ... 4000 Hz. A downward extended frequency range of 0,001 ... 4000 Hz is also possible.

2.1.2 Calculation of the Quotients

If both input frequencies are > about 120 Hz, the quotient **Q** is calculated by dividing **Q = f1/f2**. If at least one of the frequencies is lower, the input signal cycles are compared. An average is determined for the high input frequency for the cycle duration of the lowest, i.e. the measurement times for both inputs are matched before the division is carried out (cf. Fig. 2).

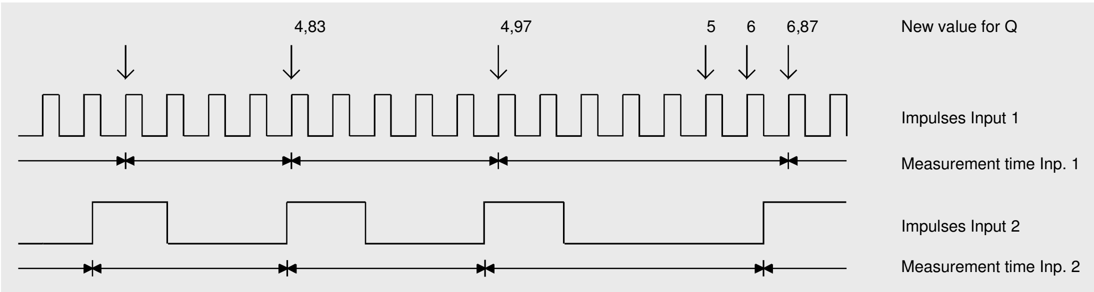


Fig. 2: Measurement times for the calculation of the quotients

If no impulse is received at one input (e.g. due to a open circuit) **Q** changes in jumps with every impulse to the other input, ensuring that the relay is activated quickly.

If the equipment is stopped, the frequency ratio **Q** is undefined. Furthermore, a change in rotational direction in general leads to a short-term change in the frequency ratio. In both cases the enable signal must be interrupted, in order to avoid switching errors.

During this interruption in the enable signal there is the possibility to set the quotient **Q** to a set value - **Q-Reset** - in order to avoid incorrect switching (due to the undefined value of **Q**) when the enable signal is re-applied. After the enable has been re-applied the device immediately evaluates any inconsistencies between the input impulses and the **Q-Reset**-value and makes any necessary corrections to the quotient. Depending on the impulse sequence at the measurement inputs, the current quotient is usually correctly determined after 2 impulses of the lowest input frequency, at the latest after 3. This possibility to program **Q-Reset** means that, in nearly every case, there is no need to program a starting delay time for the enabling.

2.1.3 Evaluation of the Measured Values

2 to 8 switching channels are available for monitoring the input frequencies and quotients (cf. Table 1). The lowest and highest permissible value for the variable being monitored can be programmed to any desired value, and the switching function of the output channel can be made to fit the special monitoring problem in various ways (cf. chapter “Switching Functions for the Relays”, page 32). When values deviate from the reference value, the switching off can be carried out immediately or after a programmed delay time. The activation of all switching channels can be made dependent on enabling signals.

2.1.4 Speed Measurements

In order to make the programming as easy and as clear as possible, there is the possibility of changing the evaluation of every switching channel from frequency **(f)** to speed **(n)** measurement. When using speed measurements, all values are programmed in rpm. Even the quotient can either be programmed as the ratio of the frequencies **Qf=f1/f2**, or as the ratio of the speeds **Qn=n1/n2**. The conversion to frequency, necessary for the internal evaluation, is carried out by the device evaluating the programmed number of pairs of poles.

2.2 Versions of the Device

	ES-FDP-FS2s	ES-FDP-FS8s
Measurement inputs	2	2
Enable inputs	2	5
Switching channels	2 (**K1** and **K2**)	8 (**K1** - **K8**)

Table 1: Versions of the devices ES-FDP-FS..s

2.2.1 Measurement Inputs

As can be seen from Table 1 the devices are fitted with two measuring inputs. Both input signals are monitored separately, each using the switching channels allocated. The monitoring functions of the measuring inputs 1 and 2 are independent and do not have any influence on each other.

Both measuring inputs and the sensor supplies are galvanically connected but electrically isolated from all other in- and outputs.

The measuring inputs are available with the following types:

– for 3-wire proximity switches (PNP or NPN switching, s. type plate)
– for 2-wire proximity switches
– for potential-free contact
– for direct voltage impulses U ≥ 10 V, impulse width ≥ 0,12 ms (max. 50 V)
– for alternating voltage U_{eff} ≥ 1,5 V + 0,1 V/Hz (low-pass behavior for interference suppression, max. 400 V)

Other input voltages as special designs.

With the standard version input frequencies between 0,1 ... 4000 Hz can be processed. Models are available for 0,001 ... 4000 Hz.

The connection diagram for the measuring inputs can be found in the section: „Allocation of Terminals“ on page 42.

2.2.2 Sensor Supply

The standard version of the device is equipped with a voltage supply for two 3 wire proximity switches (20...24 V DC, max. 35 mA total current). If the device has been fitted with measuring inputs for 2 wire proximity switches then the sensor supply has also been designed especially for this type of sensors.

2.2.3 Enable Inputs

There are max. 5 enable inputs available for the arming of the monitoring functions, which can be allocated to the relays as required. Each enable can be allocated an individual time delay. The device is available with different enable input voltages (12V, 24V, 110V, 230V AC/DC).

The enable inputs 1,2 and 5 are galvanically connected, and the enable inputs 3 and 4 are galvanically connected. The enable inputs are electrically isolated from all other in- and outputs.

When operating with direct voltage the common ground must be connected to terminal 13 and to terminal 40 (ground enable). The enable inputs 1...5 can be operated with positive or with negative DC voltage.

When operating with alternating voltage the neutral conductor must be connected to terminal 13 and to terminal 40.

2.2.4 Switching Channels

The switching channels usually operate relays. Other designs for the output stage (triac, transistor) are available on request. The allocation of the switching channels to the measuring inputs is freely programmable.

2.2.5 Notes

One of the variables **Q, f1** or **f2** can be output for display or control purposes using the analogue output (option).

The various groups of in- and outputs (measurement, enabling-inputs, analogue outputs) are electrically isolated from each other.

In order to reduce the temperature in the device it is recommended that the device is installed with a distance of 2 - 3 mm to all other fittings.

Note: The device must only be programmed when the main plant is switched off, because during the programming the outputs can switch in an undefined manner.

2.3 Signal Pre-processing Device ES-SV11

The signal pre-processing device **ES-SV11** can be used to achieve an additional improvement in the reliability of the system.

The device supplies the sensors with max. 2 x 100 mA. It prepares the output impulses for a further evaluation in the slip and frequency monitor **ES-FDP-FS..** by debouncing the impulses. In addition, it has a rotational direction recognition with error alarm and produces an appropriate enabling signal for the slip monitor.

With suitable sensors the **ES-SV11** enables the sensor supply to be checked for short circuits and interruptions. Errors which occur are indicated using an error message contact.

3 Displays and Operation

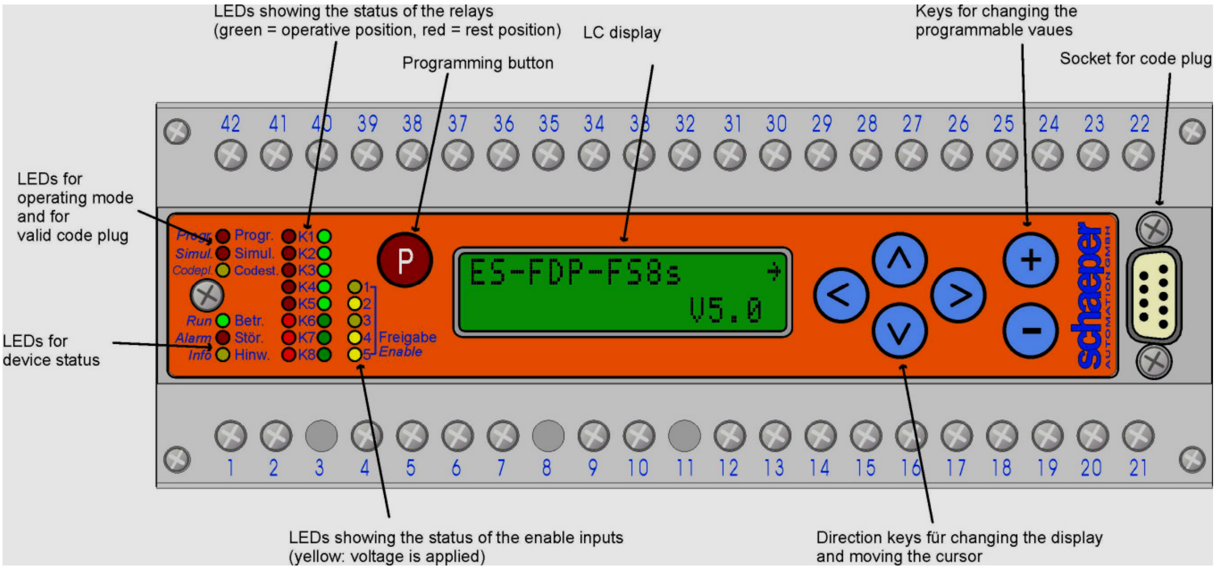


Fig. 3: Operating elements of the device

3.1 LED Indicators

Run (green)	Mains voltage is connected and the self-test is finished.
Alarm (red)	The program flow has been disturbed by external influences (e.g. considerable interference from switched lines, EMP) or due to an internal error in the device in such a manner that the device can not function properly. After the automatic error correction has been finished the LED is switched off, the LED **Info** remains on up to reading the error number (see chapter 5). If no automatic error correction is possible the LED **Alarm** remains on permanently. Measures for the resumption of operation are described in chapter 5, "Device Errors" (see page 26).
Info (yellow)	This LED indicates disturbing influences which only occur temporarily, thus enabling preventative measures to be taken. The LED lights up after occurrence of an error, however does not go out until acknowledged or until the interruption of the supply voltage. To acknowledge: see chapter 5, "Device Errors" (page 26).
K1 to K8 (green and red)	The status of the 8 frequency channels or the relays allocated to them red → rest position green → operative position
Enable 1 to 5 (yellow)	Enable signal is applied to the corresponding enable input
Progr. (red, flashing)	The programming mode is activated
Simul. (red)	The device is working in simulated operation (instead of `f1` or `f2`, `fT` appears in the display, resp. `nT` instead of `n1` or `n2`, resp. `QT` instead of `Qf` or `Qn`).
Codepl. (yellow)	Valid code plug is connected Programming possible

3.2 LC-Display

3.2.1 Back-lighting

For better readability with poor light conditions, the LC-Display is equipped with back-lighting. The lighting is activated with the press of any key and automatically goes out approx. 3 minutes after the last key is pressed.

3.2.2 Basic Display and Software-Version

After the power supply has been connected, the device responds by giving its type identification in the upper line. The version-No. **V** of the software will be shown in the lower line.

```
ES-FDP-FS8s    →
          V5.0
```

3.2.3 Selecting the Displays

The sequence of the displays is shown in Table 2 (page 14). The left column shows the **main displays**. There is a main display for every function of the device. There is an **auxiliary display** (right column in the table) when not all the information fits into one display. The arrow → in the main displays indicates the existence of an auxiliary display.

The displays are selected using the cursors (∧, ∨, <, >). The main displays are obtained using the keys ∧ and ∨ (for sequence see Table 2). The key > calls up the auxiliary display belonging to the current main display (if available). The keys < and ∧ or ∨ bring back the respective main display. An exception is the area of the service information, here only the key < leads back to the respective main display, since the keys ∧ or ∨ are used to access the associated sub-displays.

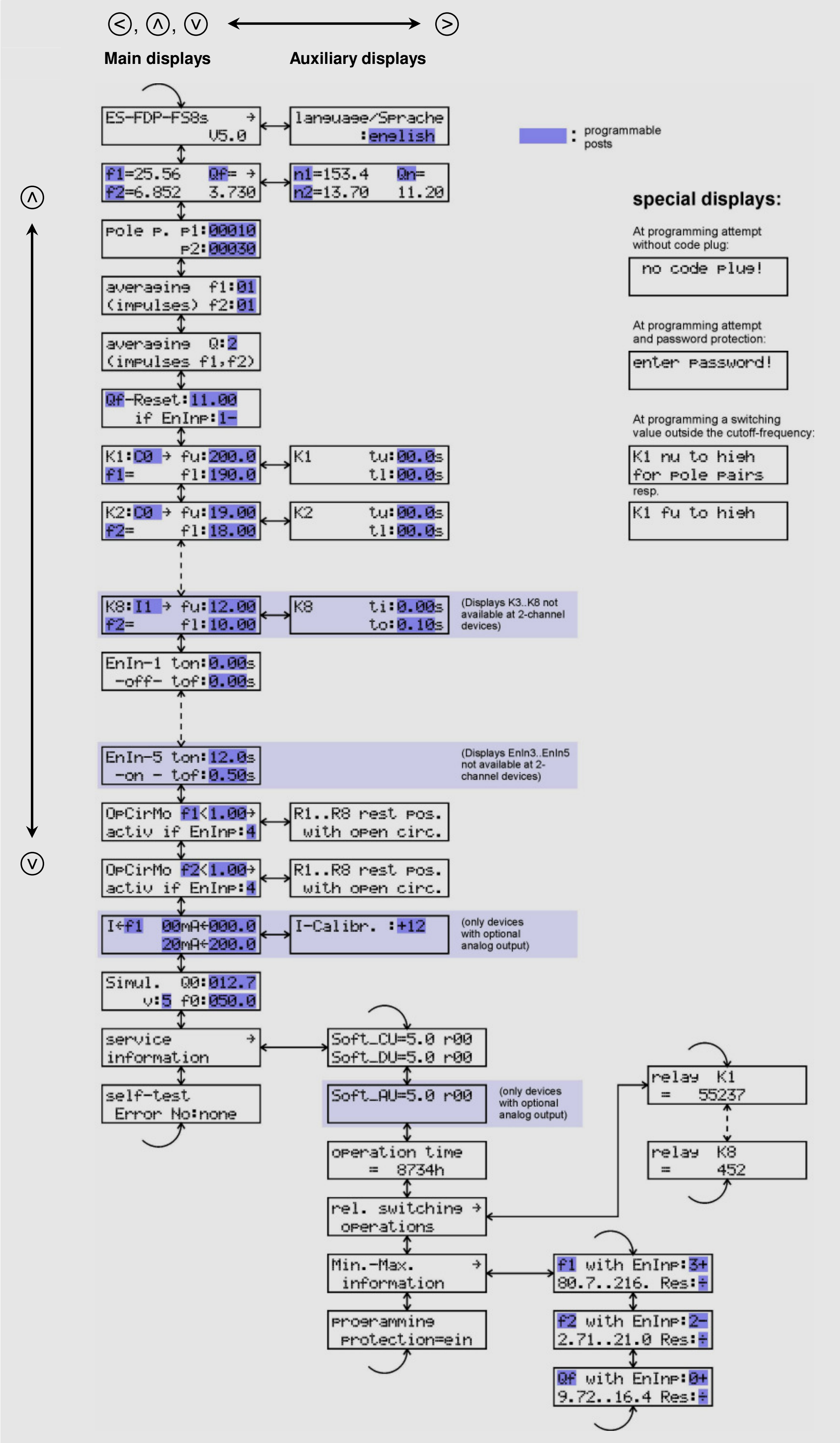


Table 2: Sequence of the displays

ES-FDP-..	Device specification	**EnIn-..**	Enabling input
V..	Software version	**ton:..**	Response delay for enabling (s)
Language/ Sprache	Selection of the display-language	**tof:..**	Drop-off time delay for enabling (s)
f1=.., f2=..	Frequency at measuring input 1 or 2 (Hz)	**-on-**	Signal to enabling input
n1=.., n2=..	Speed at measuring input 1 or 2 (rpm)	**-off-**	No signal to enabling input
Qf=.., Qn=..	Ratio of frequencies (Quotient), Qf=f1/f2 resp. Qn=n1/n2	**OpCirMo**	Display for programming open circuit monitoring
<min	Appears in the display if the measured frequency is lower than the input frequency range.	**EnInp:..**	Allocated enabling input
Pole p. p1:.., p2:..	Number of pairs of poles (resp. impulses/turn) for measuring input 1 and 2 (for speed measurements)	**..activ**	Open circuit monitoring is programmed
averaging	Averaging of the measurement over a programmable number of input impulses	**OpCi**	Appears in the display instead of the measured frequency when the open circuit monitoring has responded
Qf-Reset:.., Qn-Reset:..	Set value for Q, for resetting the quotient to an initial value	**Simul.**	Simulation mode
K..	Switching channel	**Q0:..**	Initial frequency ratio for the simulation mode
fu:.., nu:..	Upper switching value for frequency, speed	**f0:..**	Initial frequency for the simulation mode
fl:.., nl:..	Lower switching value for frequency, speed	**v:..**	Speed with which the values change in simulation mode
Qu:..	Upper switching value for frequency ratios (quotient)	**fT=.., nT=.., QT=..**	Simulated value during simulation mode
Ql:..	Lower switching value for frequency ratios (quotient)	**I←.., U←..**	Optional analogue output: Allocation of the analogue output to f1 (n1), f2 (n2) or Qf (Qn)
tu:..	Relay switching delay at upper switching value for hysteresis switching function	**..mA←.. ..V←..**	Optional analogue output: allocation of a analogue value to a frequency (speed) or quotient
tl:..	Relay switching delay at lower switching value for hysteresis switching function	**I-Calibr.:, U-Calibr.:**	Optional analogue output: Calibration of maximal value
ti:.., to:..	Relay switching delays for window switching function	**Soft_CU=**	revision numbers of the software of the central unit
→	Indication of a further display, right	**Soft_DU=**	revision numbers of the software of the display unit
→→	A time delay has been programmed for this output	**Soft_AU=**	revision numbers of the software of the analogue unit

Table 3: Meaning of the display texts

3.2.4 Display of the Measured Values

The current measured values are displayed in the second place of the display sequence:

```
f1=*****   Qf= →      n1=*****   Qn=
f2=*****   *****      n2=*****   *****
```

*****: current values

The measured values for the frequencies **f1**, **f2**, for the speeds **n1**, **n2** and for the ratios **Qf**, **Qn** (quotient **f1/f2** or **n1/n2**) are displayed here. Measured values for the frequencies **f1** or **f2** are in Hz, measured values for the speeds **n1** or **n2** are in rpm. Each of the two displays can be configured to display 1 to 3 of the measured values depending on need. If OPCi is displayed instead of a frequency this means that the open circuit monitoring has responded. If the open circuit monitoring is not active the display will show `<min` if the frequency falls below the minimum frequency (0,1 Hz in the standard version). If values over 9999 must be displayed, a "k" as a thousand multiplier appears. Thus, the display `14k30` for example, represents a value of 14300.

If the quotient remains at a constant value due to an active **Q-Reset** function (by applying a corresponding enable signal at the allocated enable input, cf. chapter "Q-Reset", page 19), this will be shown by `Qr=*****` instead of `Qf=*****` or `Qn=*****`.

The current measured values are, likewise, shown in the displays for the switching channels **K1 ... K8.** The variable that is being monitored by the selected switching channel is showed in the display. Furthermore, the situation at the enabling inputs is shown in the displays **EnIn-1 ... EnIn-5**. An `-on-` or `-off-` is shown, providing information about whether there is voltage applied to the enabling inputs.

3.3 Programming

3.3.1 Code Plug

A code plug is needed to programme the device. This is plugged into the socket on the front panel (cf. Fig. 3, S. 12). The plug may only be removed after the programming procedure has been finished.

If the key Ⓟ is pressed without the code plug connected, the following will appear:

```
no code plug!
```

3.3.2 Programming Sequence

The significance of the programmable parameters in the individual displays is explained in chapter 4, "Programming the Functions", see page 17. The sequence for the programming is always the same and is carried out as shown in **Table 4**. It is not possible to change a value unintentionally because two keys must be pressed at the same time. Even if the programming key Ⓟ is pressed accidentally, the programming mode can be left simply by following step 6.

	key to be used
1. Select required display	(∧), (∨), (<), (>)

2. Switch on programming mode
`K4:A1 → fu:20.0`
`f2 fl:18.0`
(The LED **Progr.** will be flashing and in the display the cursor "_" will appear)
	Ⓟ

3. Move the cursor to the value which is to be adjusted	(∧), (∨), (<), (>)
4. Set the desired value (separate for each digit) (a flashing cursor fills the whole character field)	Ⓟ and ⊕ (simultaneously) or Ⓟ and ⊖ (simultaneously)
5. Repeat steps 3. and 4. until all values in the display have been set	
6. Programming of the values and leaving programming mode	⊕ and ⊖ (simultaneously) (do not press Ⓟ !)

Table 4: Programming sequence

Switching function	- A B C D E F G H I K L M N O P Q
Addendum to the switching function	s k
Number of an enable input	1 2 3 4 5 resp. 1 2, at some functions 0 and/or ÷ are also programmable
Switchover of the enable activity	- +
Digits for switching values, delay times, etc.	0 1 2 3 4 5 6 7 8 9 .
Assignment to the measured value	f1 f2 n1 n2 Qf Qn
Language	deutsch english

Table 5: Permissible values for programming

Only values which have been defined can be programmed (cf. **Table 5**). The number of an enable input allocated to a particular switching channel can only be set at a number between 1 and 5 (resp. between 1 and 2 for 2-channel devices). For switching values and time delays the decimal point can also be moved. The decimal point cannot be moved to the first position for time delays.

Example: For programming the switching value "50", the following have identical meanings:

50.00 050.0 0050. 00050

But: .50.0 is taken as 0,5 due to the first decimal point!

Warning: The device should only be programmed when the main plant is switched off, because the outputs can switch in an undefined way during the programming procedure.

4 Programming the Functions

4.1 Display Language

Here the language of the display texts can be switched over between **deutsch** (German) and **english**:

```
language/Sprache
       :english
```

The display texts which appear if the German language is selected are described in the German-language version of the operating instructions.

4.2 Configuration of the displays for the measuring values

The current measured values are displayed in the second place of the display sequence:

```
f1=*****    Qf= →     n1=*****    Qn=
f2=*****    *****     n2=*****    *****
```

*****: current values

Each of the two displays can be configured, which of the measurands **f1**, **f2**, **n1**, **n2**, **Qf**, or **Qn** shall be displayed. 1 to 3 measurands can be shown each display. For the lower as well as for the right value in the displays it is possible to program a blank „ “ instead of one of the available measurands, then no measurement is displayed there.

4.3 Pole pairs (resp. impulses per revolution)

If some of the switching channels are programmed for the measurement of speed the device must carry out the conversion of the initial frequencies in speeds. Therefore the number of pairs of poles (when using AC tachos) or the number of graduation marks (= impulses per revolution, with incremental sensors) must be programmed. This happens in the following display:

```
Pole P. P1:00010
        P2:00030
```

With the programmed pole pairs P1, P2 and the input frequencies f1, f2 the speeds result as follows:

$$n1 = \frac{f1}{p1} \cdot 60 \qquad \text{and} \qquad n2 = \frac{f2}{p2} \cdot 60 \qquad [\text{rpm}]$$

The rotary sensors must be selected such, that the permissible frequency range of the device is not exceeded. If, after a reprogramming of the pole pair numbers, the programmed speeds for one or several switching channels correspond to a frequency which is over the permissible cut-off frequency of 4 kHz, the following message is shown on the display for approx. 3 seconds (example for switching channel 4):

```
K4 nu to high
for Pole Pairs
```

The yellow LED **Info** lights at the same time. To acknowledge see chapter 5.

4.4 Averaging functions

With some applications it cannot be ensured that the input impulses which are being received are at regular intervals. If a driving apparatus is monitored with, e.g., incremental sensors with a high resolution, it is possible that play or vibrations can lead to an irregular signal. The frequency fluctuates around a mean value; the short frequency increases can cause an unwanted activation of the monitoring relay. Irregular input impulses could also be caused when sampling a toothed ring with proximity switches if the teeth are not evenly distributed. Using the averaging function, the device can be made less sensitive to such situations. The means are not taken over a fixed time period but over a programmable number of input impulses.

```
averaging  f1:32
(impulses) f2:01
```

The number of input impulses over which an average is to be taken is set for input 1 and input 2 separately. The max. averaging number is 32.

A programmed averaging function for **f1** and **f2** only affects the calculation of the frequencies **f1**, **f2** or speeds **n1**, **n2** **and has no influence on the calculation of the ratios Qf, Qn**. Also for the open circuit monitoring always the current measured input frequency is evaluated (and not the average value), in order to reach a faster recognition of an open circuit.

The averaging for the calculation of the quotient is programmed in the following display. An averaging value up to 8 impulses is programmable here.

```
averaging  Q:8
(impulses f1,f2)
```

At the calculation of the quotient the measuring period is chosen such, that **at least the programmed averaging number of impulses** has appeared **on each of the two frequency inputs**. Example: An averaging value of 8 is programmed for the quotient: The averaging is carried over the period of 8 input impulses of the slower frequency input.

The determination of the average values for a fixed number of input impulses has the advantage of doing so over a fixed period of time that even the irregularities which occur with very infrequently occurring impulses are filtered out. At the same time, a short reaction time is achieved with a high frequency, because the fast impulse sequence means that the measuring time is respectively shortened (especially important for monitoring overspeed).

A special feature of the devices ES-FDP-FS... is that they do not simply wait for the programmed number of impulses and then give an evaluation, but every incoming input impulse is evaluated (if there are not several pulses in one measurement period, then there is only one evaluation). This is made possible by the fact that the times of the last input impulses are stored internally. Each new input impulse is calculated with the previous ones (according to the programmed average number) and the average value for the frequency is used for the evaluation and to drive the switching channels.

4.5 Q-Reset

In order to avoid unwanted switching of the output relays for the quotients **Q** when starting or changing the rotational direction of the driving gear, the quotient can be adjusted to a set value **Qr (Q-Reset)**, dependent of an enable signal. This value **Qr** must be the same as the value **Q** when the driving gear is running trouble-free. Also, when the voltage supply is first switched on the device sets the quotients initially to the set value **Qr** in order to avoid incorrect switching until the current value of the ratio **Q** has been calculated.

```
Qf-Reset:11.00
   if EnInp:1-
```

On the top left of the display the selection between Qf and Qn defines, whether the **Q-Reset** value is programmed as a ratio of frequencies or as a ratio of speeds. Behind Qf–Reset: resp. Qn–Reset: the corresponding set value **Qr** is programmed.

In the second line the allocation to an enable input 1 … 5 is defined, and, directly behind this, whether the **Q-Reset** shall be triggered by an active enable signal + or by an interruption of the enable signal –. At exchange of a device of the prior version **ES-FDP-S285** bzw. **ES-FDP-S222** with the actual version **ES-FDP-FS…**, a "–" must be programmed here for reaching the same device function.

The **Q-Reset** function controlled by an enable signal is disabled if the allocated enable input is set at ÷. In this case the ratio **Q** is only set to the set value **Qr** after the turn on of the supply voltage.

```
Qf-Reset:11.00
   if EnInp:÷
```

If the driving gear switching device cannot provide a short break in the enabling signal (min. 150 ms) during a change in rotational direction, then this interruption can be produced with the help of an unused switching channel (see page 39).

4.6 Switching Channels

The monitoring of the frequencies (speeds) and the quotients is carried out by the switching channels (**K1** to **K2** or, respectively, to **K8**). The allocation of the switching channels **K1** to **K8** to one of the measurands f1, f2, n1, n2, Qf or Qn can be programmed freely.

The switching behavior of every switching channels can be programmed independently. This is done by programming a switching function, the allocation of an enabling input, by the switching values and, if necessary, by programming a delay time (**Table 6**).

Main display and auxiliary display for a switching channel (the programmable parameters have been underlined)
`K1:A4s→→fu:22.25` `K1 tu:0.05s`
`f2 fl:18.55` `tl:00.0s`
	K1: first frequency channel selected
	→→ Indication of a programmed delay time in auxiliary display
	Main display:
	f2 Assignment to measuring value f2
	A selected switching function
	4 enable input 4 has been allocated
	s Operation with self-holding (lock)
	22.25 upper switching value **fu** (or **nu** or **Qu**)
	18.55 lower switching value **fl** (or **nl** or **Ql**)
	Auxiliary display:
	0.05 Delay time **tu** programmed at 0,05s
	00.0 no delay time **tl** programmed

Table 6: Programmable parameters for the switching channel

4.6.1 Assignment to the measured value

On the left of the second line of the display the assignment to the measuring value is shown. Every switching channel can be configured for the supervision of one of the two initial frequencies or speeds or for the supervision of the frequency or speed ratio by programming of f1, f2, n1, n2, Qf or Qn.

4.6.2 Switching Function

The switching channel is shown on the left of the upper line of the display. The letter after the colon indicates the switching function. It is possible to program **hysteresis switching functions A ... H** (**Table 10**, page 32) and **window switching functions I ... Q** (**Table 12**, page 34). With the software version V4.1 switching functions can also be programmed self-holding (with lock) and there are specific window switching functions operating only with falling frequency (see Section 4.6.4 and **Table 11**, **Table 13** and **Table 14**).

Hysteresis switching functions A ... H: Because two switching values **Su** and **Sl** (**S** stands for **f** or **n** or **Q**) can be programmed there is a switching hysteresis produced (**Su** - **Sl**). This enables the relay to be kept in a stable condition.

Window switching function I ... Q: The upper switching value **Su** and the lower switching value **Sl** means that a window area is determined. The relay switches if the measured value moves out of this programmed window. The switching values for the window function have no switching hysteresis.

Function "–": is programmed if the switching channel is not needed. The relay will remain permanently in the rest position, independent of the input signal.

4.6.3 Enabling Allocation

The digit after the switching function represents the number of the enabling input which is allocated to the frequency channel. If here the digit 0 is programmed in then the respective switching channel is always activated, i.e. an enable signal is not necessary.

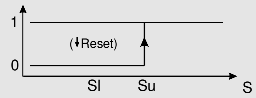
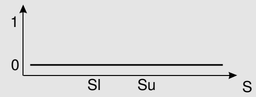
4.6.4 Special switching functions with self-holding (lock)

With the software version V4.1 special switching functions with self-holding (lock) are available. The programming of such a special function is carried out by changing the digit behind the number for the assignment of the enable input. A blank “ “ as default is programmed here. If an "s" is programmed instead, the programmed switching function works with self-holding (lock) (see **Table 11:** Hysteresis switching functions with programmed self-holding (lock), and **Table 13:** Window switching functions with programmed self-holding (lock)). The programming is only possible if an enable input is assigned, because this enable input is used for the reset of the self-holding.

Example for the self-holding: The switching channel is programmed as follows:

```
K3:A4s→   fu:40.0 | K3      tu:0.00s
f1=****   fl:40.0 |         tl:0.00s
```

The switching function A, if programmed with self-holding, is defined as follows (see **Table 11:** Hysteresis switching functions with programmed self-holding (lock)):

Switching function	Enable (Reset-) signal switched on	Enable (Reset-) signal switched off
A (s)		

In any case, as long as the enable signal is turned off, the relay is in rest position (reset condition). After switching on the enable signal the relay will remain at rest position, while the programmed frequency of 40.0Hz is not exceeded. If this frequency is exceeded once, then the relay switches to operative position and remains there until a reset is made by interruption of the enable signal.

Caution! After the end of the reset condition (the enable signal returns) the relay only remains in the rest position when, at least for the time **tl**, the frequency was smaller than 40.0Hz. Therefore, for most applications **tl** has to be programmed to 0.

4.6.5 Special window switching functions for falling frequency

With the software version V4.1 special window switching functions for falling frequency are available. The programming of such a special function is carried out by changing the digit behind the number for the assignment of the enable input.

If a „**k**“ is programmed here with a window switching function, the relay only will switch if the frequency runs into the window from above (sinking frequency) and will not switch, if the frequency runs into the window from below (increasing frequency). The corresponding switching functions are shown in **Table 14**. This special switching functions are specially useful for the device version ES-FDP-KR85n (crane frequency control) for counter operation.

CAUTION! For a switching it must be ensured that the upper window frequency was really exceeded before!

4.6.6 Switching Values

The upper switching value **fu** (for the frequencies) or **nu** (for the speeds) or **Qu** (for the ratios of frequency or speed) is shown on the right hand side of the upper line. The lower switching value **fl, nl** or **Ql** is shown directly beneath it. The two values **fu,fl**, **nu,nl** or **Qu,Ql** determine the **switching hysteresis** (switching function **A**...**H**) or the **switching window** (switching function **I**...**Q**).

The switching values for the quotients can be set to any value in the range 0,001 ... 99999. Values of Qf > 40000, however, can not occur in the specified input frequency range.

Restriction of the allowed range of speed ratio Qn with software to V4.2:

If switching values for Qn (speed ratio) are programmed, then, with software to V4.2, the valid area is limited to **Qn <4000000/p1**, where p1 is the number of impulses per revolution of sensor 1. For example, when the number of impulses per revolution p1 is 4000, a maximum value of Qn = 1000 can be programmed. For normal applications, values so high are not needed. A programming of higher values, however, leads to a malfunction, the unit will switch at too low values of Qn, which are max. half as large as the programmed values.

For devices with software from V4.3 there is no such restriction.

The programming of frequencies is in Hz, the switching values can be set to any value in the range between 0,1 ... 4000 Hz.

The programming of switching values for speed is in rpm, the values which are possible depend on the programmed number of pairs of poles **p1** or **p2** (frequency range 0,1 ... 4000 Hz must be respected). For **p1** = **2,** values can be set between 3 ... 99999 rpm (99999 is the maximum value due to the 5-digit number); for **p1** = **20**, switching values can be programmed between 0,3 ... 12000 rpm. In general, the following is valid:

$$n1 = \frac{f1}{p1} \cdot 60 \qquad n2 = \frac{f2}{p2} \cdot 60 \qquad [rpm]$$

4.6.7 Breach of the cut-off frequency at the programming of the switching values

If a frequency is programmed at a higher value than 4000Hz, the following message appears for about 3 seconds (the example is shown for switching channel **K4**):

```
K4 fu to high
```

If a speed is programmed at a value which corresponds at a frequency > 4000Hz, the following message appears for about 3 seconds (the example is shown for switching channel **K4**):

```
K4 nu to high
for pole pairs
```

Simultaneously with the messages the yellow LED **Info** lights. The switching values must be corrected so that they are in the permissible frequency range of the device. An acknowledgment of the error message must then be carried out to reset the **Info** LED (see chapter 5).

4.6.8 Time Delay for the Switching Channels

A double arrow →→ in the main display for a switching channel indicates that the respective output has a time delay (when time delay has not been programmed a single arrow → indicates the presence of an auxiliary display, cf. chapter “LC-Display”, page 13). The display for the delay times can be called up using the key (>).

K1:I1→→ fu:12.00 f1=**** fl:10.00	K1 ti:0.00s to:0.10s
K2:C0 → fu:160.0 f2=**** fl:158.0	K2 tu:00.0s tl:00.0s

****: current value

The delay times can be programmed for times between 0 ... 65 s.

With switching functions **A**...**H** (Hysteresis) the delay time **tu** is effective when the upper switching values **fu, nu** or **Qu** are exceeded, if the value goes under the lower switching values **fl, nl** or **Ql** the time **tl** is valid.

With the switching functions **I**...**Q** (window) the delay time **ti** is valid if the value **f,n** or **Q** enters **into** the window area. The time **to** is valid when the measured value goes **out** of the window area. It is completely irrelevant whether the measured value is increasing or decreasing when it enters or leaves the window area (cf. Fig. 4).

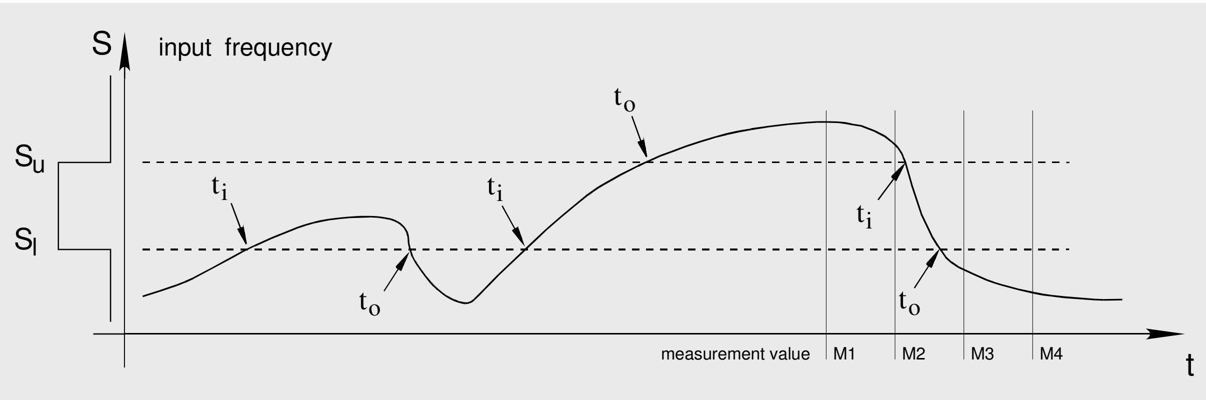


Fig. 4: Example of the validity of the time delays **ti** and **to** for a window switching function

4.6.9 Programming of the Switching Delay for Recognizing a Window for certain

For fast frequency changes and switching windows tolerated narrowly it can happen that when passing through the window no measurement lies in the switching window. In the example (cf. Fig. 4) the measurement M2 is above the switching window, the following measurement M3 already below the window. In order to get switched the accompanying relay nevertheless, a time delay **to** must be programmed and **ti** must be set to 0. The time **to** may not be chosen too short due to the relay delay times and the response times of the post-connected equipment so that passing through the window can be evaluated for certain.

```
K4:I5→→ fu:51.00    K4       ti:0.00s
f2=**** fl:49.00             to:0.20s
```

****: current value

4.7 Enable Delay Times

It is possible to programme an operate delay time **ton** and a drop-off delay time **tof**, each between 0 and 65 seconds for every enable input. The respective displays are **EnIn-1** to **EnIn-5:**

```
EnIn-1 ton:1.50s
 -on-  tof:2.00s
```

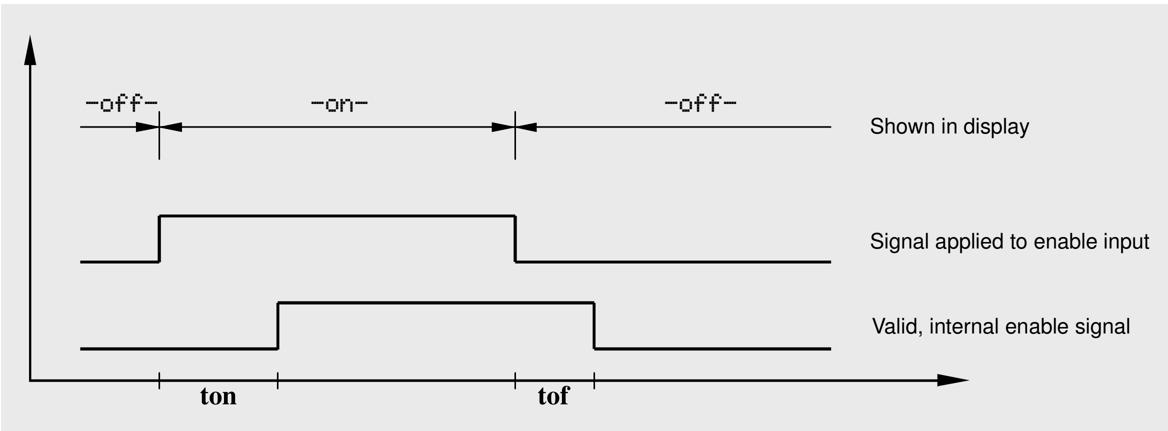


Fig. 5: Delay times for enabling

Fig. 5 shows the validity of the times **ton** and **tof.** Whether a signal is present at the enable inputs is indicated on the front panel by LEDs. In addition, an -on- or -off- appears in the corresponding display.

The enable inputs **EnIn-3** to **EnIn-5** are only available with types **ES-FDP-FS8s**.

4.8 Open Circuit Monitoring

This function enables all switching outputs **K1** to **K2** or to **K8** to be switched to the rest position if the frequency falls below a minimum.

```
OpCirMo f1<1.00→    K1..K8 rest pos.
activ if EnInp:4     with open circ.

OpCirMo f2<0.50→    K1..K8 rest pos.
activ if EnInp:5     with open circ.
```

The open circuit monitoring can be set independently for both input frequencies **f1** and **f2** (or speeds **n1** and **n2**). It is possible to reprogramm between f1 and n1 (resp. f2 and n2), thus the switching value can be entered as speed or frequency.

If an open circuit is detected then the switching outputs are switched to the rest position irrespective of the switching function which has been programmed for normal operation. **Warning:** the frequency (speed) must be programmed at a value below the lowest value which can occur during normal operation.

To bypass the starting procedure this function can be activated using an enable input (also time delayed). Only when the enable signal is applied, the open circuit monitoring is activated. The digit after `EnInp:` can be programmed and indicates the enable input allocated. The digit `0` indicates that the open circuit monitoring is always activated.

If, instead of a digit, a "`÷`" is programmed then the open circuit monitoring is deactivated and after the programming has been completed the display changes as follows. To re-activate simply re-programme with a digit.

```
OpCirMo f2
    with EnInp:÷
```

If the open circuit monitoring has been operated this is indicated in the display for the input frequency with `OpCi` (example: display for a switching channel):

```
K2:C0 → fu:160.0
f2=OpCi fl:158.0
```

```
K2       tu:00.0s
         tl:00.0s
```

Warning: The frequency must be programmed at a value under the lowest frequency which can occur during regular operation.

4.8.1 Open Circuit Monitoring with Programmed Averaging Function

With the current device version **ES-FDP-FS…n** a programmed averaging function has no more influence on the open circuit monitoring. For fast recognizing of an open circuit always the current measured input frequency is evaluated (not the average value).

4.9 Analogue Output (Option)

The **ES-FDP-FS...** can be fitted with an additional analogue output for current (**I**) or voltage (**U**). The smallest and largest value of a frequency (speed) or frequency (speed) ratio to be output can be defined by any current or voltage within the ranges: 0 mA ... 20 mA and 0 V ... 10 V.

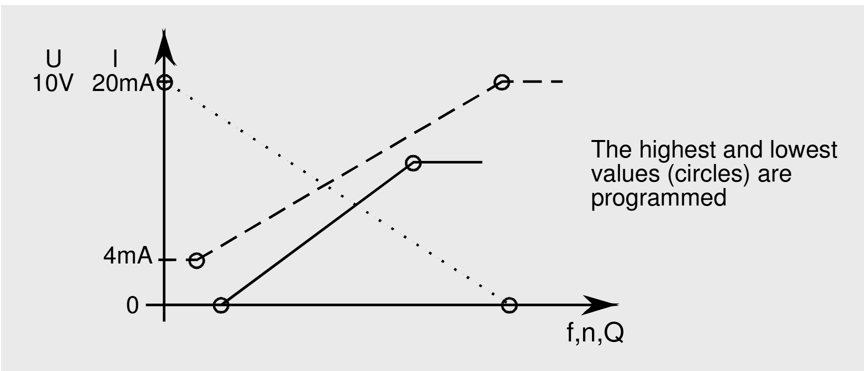


Fig. 6: Example showing the possibility of programming the analogue output to any desired value

The programming is carried out in the following display:

```
I←f2   00mA←000.0
       20mA←160.0
```

```
I-Calibr. :+03
```

or for voltage output:

```
U←Qf    00V←010.0
        10V←015.0
```

```
U-Calibr. :+12
```

The allocation of an analogue output to one of the input frequencies (or speeds) or quotients can be programmed, as required, by selecting `I` (or `U`) ← `f1`, `f2`, `n1`, `n2`, `Qf`, or `Qn`. Furthermore, the current or voltage values and the respective switching values (frequency, speed, quotient) are programmed in the main display. The maximum value is adjusted in the auxiliary display (key ⓧ), thus enabling, e.g. the tolerances of a display instrument or, for voltage outputs, line resistance to be taken into account. The value is programmed by adjusting a set value on a connected display instrument. This programming is only possible if there is no input frequency at the device. After entering the programming mode for `I-Calibr.` or `U-Calibr.` the programmed maximum value is automatically output.

After the adjustment has been carried out the maximum error for the standard design is 2% (based on $\mathbf{I}_{max.}$ = 20 mA or $\mathbf{U}_{max.}$ = 10V).

The analogue output is electrically isolated from all other in- and outputs.

4.10 Simulation mode

The display for the simulation mode is laid out as follows:

```
Simul.  Q0:11.00
    v:8 f0:010.0
```

The initial frequency ratio **Q0** and the initial frequency **f0** can be programmed for the simulation and are effective instead of the measured values when it is activated. The simulation mode is activated and switched off by pressing the keys ⊕ and ⊖ at the same time. When the test simulation is activated (only possible when the code plug is connected) the simulated values (quotient, frequency, speed) are changed by pressing the keys ⊕ (value increases) or ⊖ (value decreases). The speed of the change during simulation is determined by the programmable value **v**.

Activation is only possible if one of the switching channels **K1** to **K8** is shown in the display. If the channel shown uses the frequencies (or speeds) then the respective input frequency (or speed) is simulated when the test mode is switched on. The display changes from `f1` or `f2` to `fT` (from `n1` or `n2` to `nT`). The test simulation does not only effect the switching channel shown but all switching channels which have been allocated to evaluate the simulated input frequency (or speed). The simulation does not, however, effect the switching channels which evaluate the ratio **Q**. The frequency (speed) ratio **Q** is simulated by activating the test mode when the displayed channel evaluates the ratio **Q** (the display changes from `Qf=****` (resp. `Qn=****`) to `QT=****`).

Activation is blocked as long as one of the two input frequencies is above the smallest measurable frequency (0,1 Hz for the standard design). The device switches the simulation off when there is a voltage to the measuring inputs or the code plug is disconnected. If there is no voltage to the measuring inputs, the test mode can be activated immediately after the device supply has been switched on.

For reasons of safety the simulation should only be activated when the main plant is switched off!

4.11 Password Programming Protection

For safety reasons against an unauthorized change of the programmed parameters a password-programming protection can be activated in addition to the code plug. If the password-programming protection is active and a programming attempt is made by pressing the button Ⓟ (with inserted code plug) the following display appears:

```
enter password!
```

On request the operator of the device will get information about the activation of the password-programming protection by request of an additional data sheet.

5 Device Errors

5.1 Self-test

During operation the device permanently executes a self-test. At occurring errors the LEDs **Info** and possible **Alarm** on the front light up. The **Alarm** LED indicates a serious error which prevents the correct operation of the device. The device usually eliminates the error automatically and resumes the normal operation. The **Info** LED lights on until acknowledgment. The current error number can be read in the display **self-test**.

```
self-test
 Error No:***
```

***: current error number

If several error numbers are stored, these are called after each other by pressing the button ⊳ repeatedly. To acknowledge the error number displayed currently keep the key Ⓟ pushed down and press the key ⊖ simultaneously, with the code plug connected. This is to do repeatedly until the word none appears instead of an error number. For the purpose of a later fault analysis the error nos. should be noted down. An interruption of the mains voltage also leads to deleting stored error numbers and resetting the **Info** LED.

If after a serious disturbance no error correction is possible, the **Alarm** LED lights permanently. This occurs for example if extreme disturbing influences have changed the programmed parameters in the EEPROM or in the flash memory. In this case all relays are switched to idle state. The essential measures are described in the subsequent chapters.

5.2 Meaning of the Error Messages

Extreme external disturbing influences may cause faults in the program flow or in the stored data. The device recognizes these by the self-test and executes the corresponding corrections. The faults tracked down and the measures of the correction are characterized by the error numbers (cf. Table 7). So the error number indicates respectively the effect of the disturbance; the causes, (i.e. the interference sources) cannot be recognized by a test program.

In the column "location of the fault" in Table 7 there are listed, where the fault has appeared:

- **CU** = central unit, responsibly for the evaluation of the input signals and the combination with the programmed parameters
- **DU** = display unit, responsible for the operating of the controls and for driving the LEDs and the LC-display.
- **AU =** analogue unit, responsible for the generation of the PWM signal, which is used for the analogue output (suitable only for devices with optional analogue output)

Error-Number	Location of the Fault	Meaning	Required Measures (cf. Table 9)
001	DU, CU	Incompatible software in central unit and display unit	1
002	CU	Data in the EEPROM and in the front plate are not corresponding	2
003	CU	Forbidden data in the EEPROM	2
004	CU	Configuration data in the microcontroller is faulty	1
005	CU, AU	Incompatible software between central unit and analogue unit	1
009	CU	Watchdog timer has had effect and has triggered Reset	3
010	CU	Reset was triggered because of low voltage	4
011	CU	Other forbidden Reset condition appeared	3
012	CU	Cycle time wasn't kept to	3
013	CU	Available time for data exchange between central unit and display unit (or analogue unit) was exceeded.	3
017	CU	Forbidden values in switching registers	3
018	CU	Forbidden values in registers for the data interchange control	3
019	CU	Wrong values in registers for the Capture control (frequency recording)	3
020	CU	Reserved	3
021	CU	Reading the EEPROM couldn't be executed correctly, possible because a forbidden write operation was still active	3
022	CU	Fault appeared at a parameter reprogramming (Differences in more than 2 parameter blocks)	3
023	CU	Data in the RAM do not correspond to the values transmitted by the display unit	2
025	CU	No i2c bus connection to the display unit	3
026	CU	Bus collision at i2c data transmission appeared	3
027	CU	No Acknowledge of the I2c slave	3
028	CU	Received i2c data have check sum errors	3
029	CU	Reserved	3
030	CU	No i2c connection to the analogue unit.	3
032	CU	Reserved for equipment testing.	3
033	DU	Display unit does not receive any data of the central unit	3
034	DU	Check sum error at received data	3
035	DU	Data error of the stored parameters in flash memory (cf. chapter 5.3)	3
036	DU	Error of the i2c slave state machine	3
037	DU	Reserved for tests	3
038	DU	Error at the recording of the relay-switching cycles	3
039	DU	Error at the recording of the service data	3
040	DU	programmed switching values are above the cut-off frequency of the device	5
041	DU	Watchdog timer has had effect and has triggered Reset	3
042	DU	Reset was triggered because of low voltage	4
043	DU	Other forbidden Reset condition appeared	3
044	DU	Forbidden interrupt occurred	3
045	DU	Configuration data in the microcontroller is faulty	1

Table 7: Error numbers at the self-test

Error-Number	Location of the Fault	Meaning	Required Measures (cf. Table 9)
049	AU	Failure of program flow in the analogue unit	3
050	AU	Reset was triggered because of low voltage	4
051	AU	Received i2c data have check sum errors	3
052	AU	Temporarily no data reception from the central unit	3

Table 8: Additional error numbers for devices with optional analogue output

Required Measure	
1	Interrupt power supply and switch on again. If furthermore the error appears, the device must be sent in for repair to the manufacturer. Otherwise note down error number and inform the manufacturer.
2	Interrupt power supply and switch on again. If furthermore the error appears, programmed parameters are changed by extreme disturbing influences. This is recognized by redundant storage. Select an arbitrary programmable display, switch on the programming mode and finish normally. Parameters do not have to be changed to this. The device corrects all perhaps faulty data to permissible values. Perhaps further info messages will be reported which have to be acknowledged. **Attention: A following check of all programmed data is absolutely required.** Note down error number and inform the manufacturer.
3	Acknowledge error, note down error number and inform the manufacturer.
4	Acknowledge error, remove external cause for undervoltage or short-time voltage drops at the operational location.
5	Reprogram switching values in a way that the permissible frequency range of the device is not exceeded. Afterwards the error has to be acknowledged.

Table 9: Required measures after appearance of errors

5.3 Data-Error of the stored Parameters in the Flash-Memory

The programmable parameters of the device are stored in the flash memory of the display unit. A change of the programmed data is very improbable. A storage of faulty data is e. g. possible if directly during the completion of a programming the power supply breaks down. If the device detects faulty data in the flash memory at the self-test the red **Alarm** LED lights and all relays are switched to idle state. At selecting of the main display for the self-test the following message is shown:

```
self-test
 data error    →
```

Pressing the button ⊳ directly leads to the display in which the error has appeared. The programming mode is selected, all programmed values have to be checked for correctness and corrected if necessary. After that the programming must be completed normally by pressing the buttons ⊕ and ⊖ simultaneously.

If furthermore "data-error" appears after calling of the self-test display, then the programmed parameters of another display are faulty and the process must be repeated until when selecting the self-test display the error number 035 will be displayed. This is triggered by the faulty data in the flash memory and must be acknowledged certainly now.

5.4 Programming of switching values above the cut-off frequency

If at the programming of switching values the permitted cut-off frequency of the device (max. 4000 Hz) is not taken into account, the yellow **info** LED starts burning and, immediately after the programming, a corresponding message appears in the display for approx. 3 seconds (example of switching channel 4):

```
K4 fu to high
```

resp.

```
K4 nu to high
for pole pairs
```

As long as these values are not corrected, furthermore on the display self-test appears the error no **040**, and on the display directly below (push the key ⓥ) the following message is shown:

```
self-test
limit error    →
```

After selecting this display, and pressing the button ⊳ one reaches directly the display in which a too high switching value is programmed. After correction of all switching values which were programmed higher than the permissible cut-off frequency the acknowledge of the error no **040** can be carried out.

5.5 Wiring of the Enable Inputs

In some cases the cause of a disturbance can be an extreme switching over-voltage at an enable input. **An external wiring with varistors or load resistances can help in this case.**

Example for enable control with 230V, AC: Suitable are load resistances R=10kΩ/10W or varistors for 275V which are suitable for operating directly at line voltage.

5.6 Wear of Relay Contacts at inductive Loads

If the output relays switch inductive loads (e. g. contactors) they should be protected by a damping circuit. Otherwise the generated arc when switching off may cause high wear of the contacts and may lead to unit faults in awkward cases (the yellow **Info** – LED will light).

With contactors with 230VAC control voltage RC circuits bring good results, but varistor circuits decrease the arc only insignificantly. For the dimensioning the wirings suggested by the contactor manufacturers should be used, since these are particularly coordinated with the respective types.

Pay attention that each damping circuit of the contactors can entail an increase of the switch-off delay time.

5.7 Blown Fuse

The device fuse is soldered onto the printed circuit board next to the transformer. To change it, the terminal strips should be unscrewed and removed and the head-plate loosened with a screw-driver as shown on Fig. 11 on page 44. Now the plugged-in circuit boards can be removed from the housing.

A fuse of the type **TR5 160mA/250V, slow-blow** should be soldered in.

Care must be taken when re-assembling that the plug contacts are seated correctly!

6 Service-Information

Information about the device state is summarized under the main display service-information. The operating time of the device as well as the number of the operating cycles of the relay contacts can be seen here. Furthermore it is shown here, whether the password programming-protection of the device is active.

6.1 Software-Revision Numbers

The revision numbers of the software of the device are listed in the first side display of the service information.

```
Soft_CU=********
Soft_DU=********
```

********: Revision numbers of the operational software

Soft_CU describes the software version of the central unit, **Soft_DU** describes the software version of the display processor.
If the device is equipped with an analogue output, then the software version of the analogue unit **Soft_AU** is shown in the following display. This display is dropped at devices without analogue output.

```
Soft_AU=********
```

********: Revision numbers of the operational software

6.2 Operating Time

This display gives information about the operating time of the device (= mains voltage on).

```
operation time
    =******h
```

******: Operating time in hours

The accumulated operating time is stored in the permanent memory every 10 minutes only. Due to this procedure there will be accumulated too little operating time at every power-on period of the device up to 10 minutes. A correct recording therefore presupposes that the normal power-on period of the device is respectively several hours.

6.3 Operating Cycles of the Relays

The operating cycles of the individual output relays K1..K8 are shown in the side displays of this display.

```
rel. switching →      relay  K1
operations             =********

                      relay  K2
                       =********
                          :
```

********: operating cycles of the relays

These values are also stored in the permanent memory every 10 minutes only. Exactly as in the case of the operating time the part of the cycles that arises at every power-on period of the device up to 10 minutes will not be taken into account. Again a correct recording therefore presupposes a respectively long power-on period of the device.

6.4 Recording of the minimum and maximum Values of the Measurands

To determine the behavior of the machinery, it is often helpful when the appearing maximum and minimum values during operation are detected. The device carries out this recording independently for the initial frequencies and for the quotient, and still the respective recording can be made dependent on an enable signal. The programming is carried out in the following displays:

```
Min.-Max.      →
 information
```

```
f1 with EnInp:3+
****..**** Res:÷
```

```
f2 with EnInp:0+
****..**** Res:÷
```

```
Qf with EnInp:2-
****..**** Res:÷
```

`****..****`: Current minimum and maximum values

The monitored measurand is shown on the left above. Instead of `f1` it is possible to program `n1`, corresponding `n2` instead of `f2`, and `Qn` instead of `Qf`.

The upper display in the example has to be interpreted as follows: `f1` is the measured value, the programming `3+` for the enable input indicates that the enable signal 3 must be switched on, so that the recording is carried out. If there is no signal at the enable input 3, the recording of the minimum and maximum values is interrupted and is continued only when the enable signal is switched on again. If the programming for the enable allocation is `EnInp:3-`, then the recording is always carried out when the enable signal 3 is inactive. The programmable values for the enabling allocation are from `1` to `5` or `0`. `0` means that the recording of the values is always active, independently of the enable signals (the `+` or `-` behind is without significance in this case).

If an enabling allocation is programmed, the enable delay times (programmed in the related displays) are taken into account.

The result of the min. to max. acquisition is displayed in the lower line. On the left side the minimum value is shown, and after the two points `..` the peak value is shown. A reset of the values is carried out by the `Res:÷` being changed in `Res:R` in the lower line (carried out as a normal programming).

At the acquisition of the minimum and maximum values an averaging programmed for the corresponding measurand is taken into account. For recording the min. max. values without averaging, the averaging numbers for the frequencies and the quotient must be programmed to "`1`" in the corresponding displays.

The recorded min. max. values are stored in the permanent memory every 10 minutes only. Due to this procedure it can happen that a peak value, which has appeared within the last 10 minutes before an interruption of the power supply, is not included.

6.5 Programming Protection

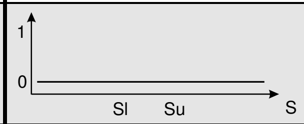
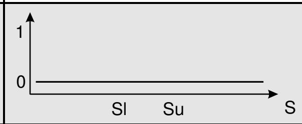
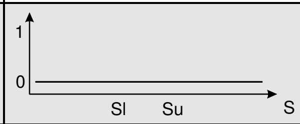
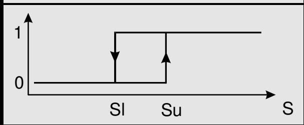
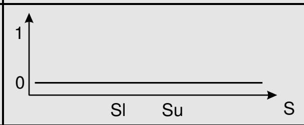
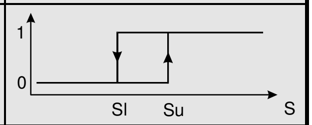
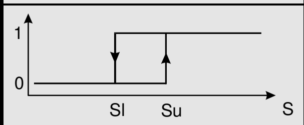
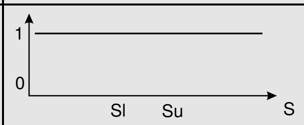
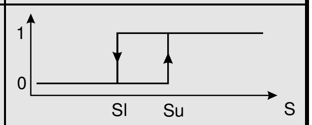
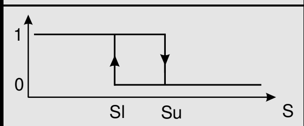
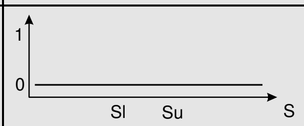
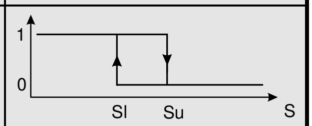
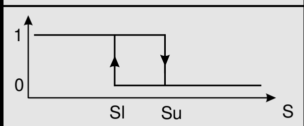
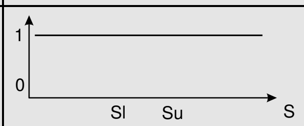
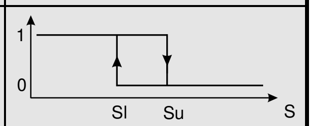
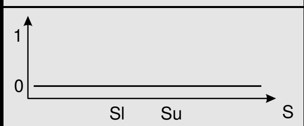
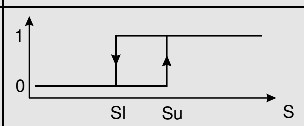
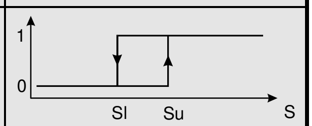
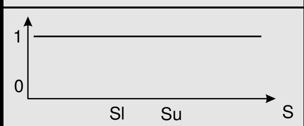
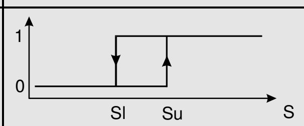
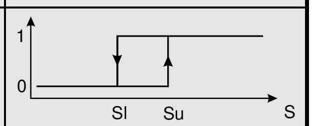
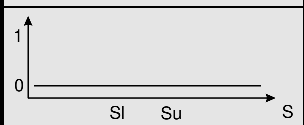
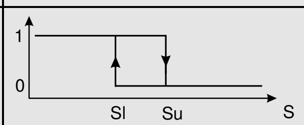
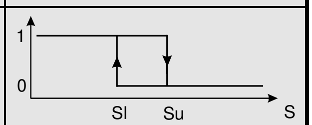
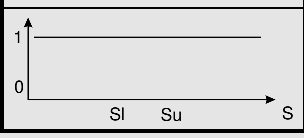
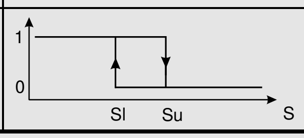
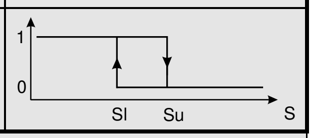
This display shows, whether the password programming-protection of the device is active. The operator of the device will receive information to the password programming-protection on request in form of a separate data sheet.

```
Programming
 protection=off
```

or

```
Programming
 protection=on
```

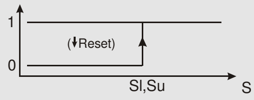
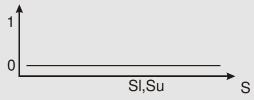
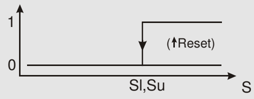
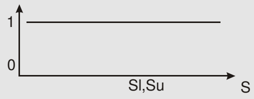
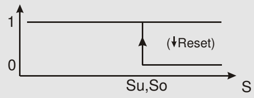
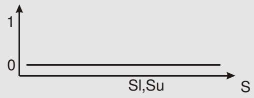
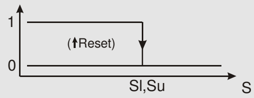
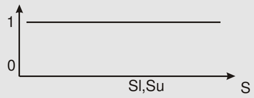
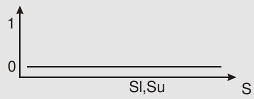
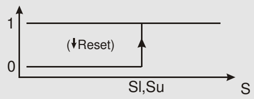
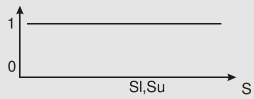
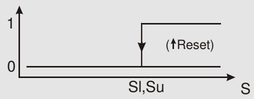
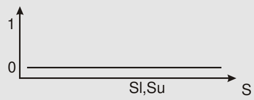
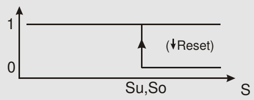
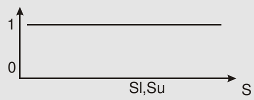
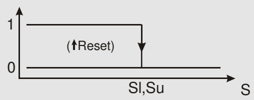
7 Switching Functions for the Relays

	Programming of the associated enable input		
	1,2,3,4, or 5		Ø
programmed switching function	Relay status when the signal to the associated enable input is: Switched on	Relay status when the signal to the associated enable input is: switched off	Relay status (independent of the enable signal)
-			
A			
B			
C			
D			
E			
F			
G			
H			

1: Make contact
0: Rest contact

Su: programmed upper switching value (Qu, fu or nu)
Sl: programmed lower switching value (Ql, fl or nl)

Table 10: Programmable hysteresis switching functions for the relays and their dependency on the enable signal

programmed switching function	Programming of the associated enable (reset-) input: 1,2,3,4, or 5 (Ø not possible with switching functions with lock) Relay status when the signal to the associated reset (enable-) input is switched on	switched off	
A (s)			Reset is carried out if **no** signal is applied at the corresponding enable input
B (s)			
C (s)			
D (s)			
E (s)			Reset is carried out if a signal is applied at the corresponding enable input
F (s)			
G (s)			
H (s)			

1: Make contact
0: Rest contact

Sl,Su: programmed switching value (Ql,Qu, fl,fu or nl,nu).
It is Sl=Su with the switching functions A(s) .. H(s).

Table 11: Hysteresis switching functions with programmed self-holding (lock)

(switching functions with programmed self-holding (lock) are available with the software V4.1)

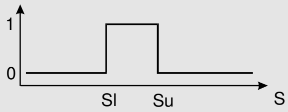
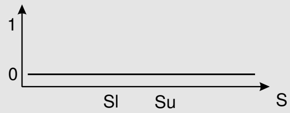
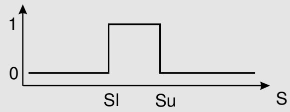
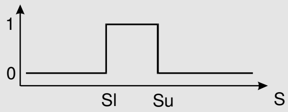
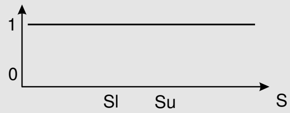
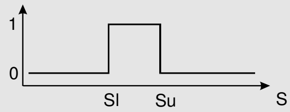
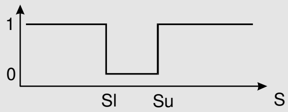
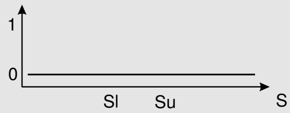
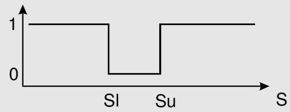
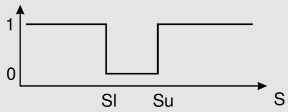
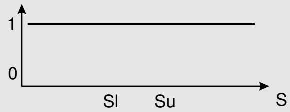
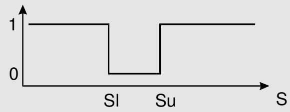
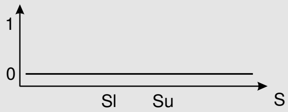
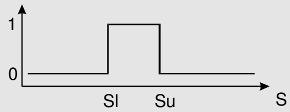
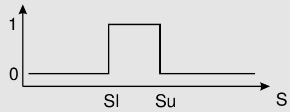
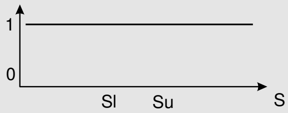
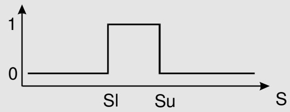
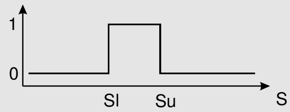
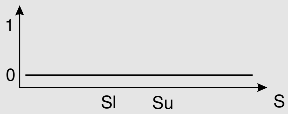
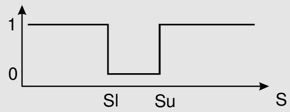
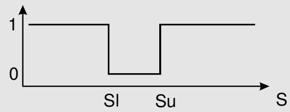
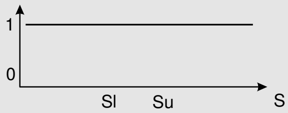
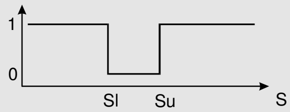
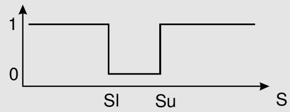
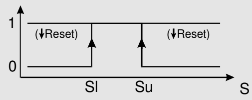
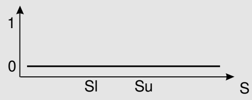
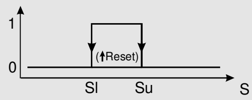
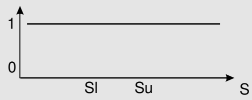
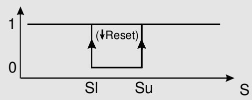
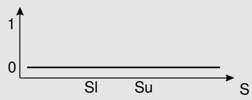
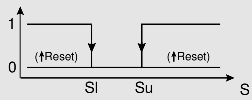
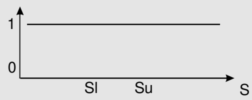
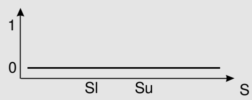
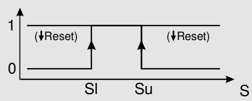
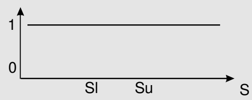
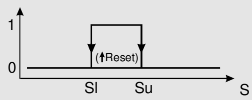
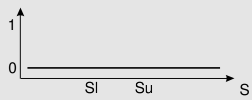
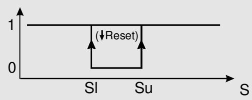
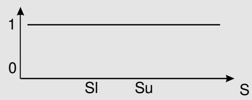
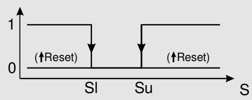
	Programming of the associated enable input		
	1,2,3,4, or 5		Ø
programmed switching function	Relay status when the signal to the associated enable input is:		Relay status (independent of the enable signal)
	Switched on	switched off	
I			
K			
L			
M			
N			
O			
P			
Q			
	1: Make contact 0: Rest contact	Su: programmed upper switching value (Qu, fu or nu) Sl: programmed lower switching value (Ql, fl or nl)	

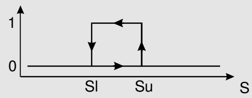
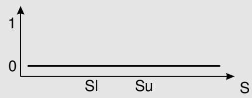
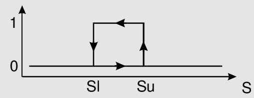
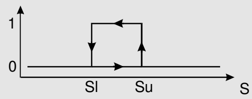
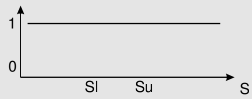
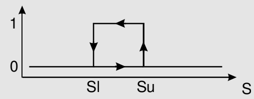
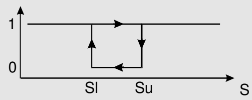
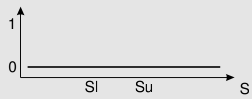
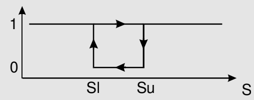
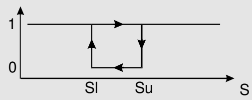
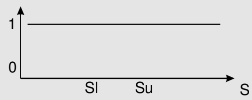
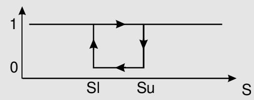
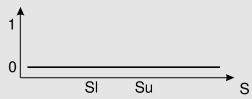
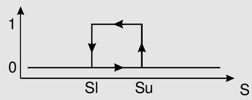
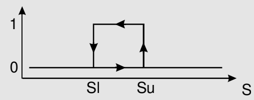
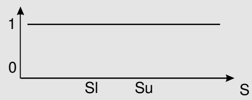
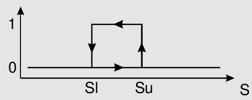
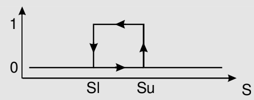
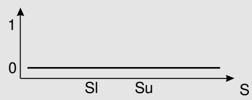
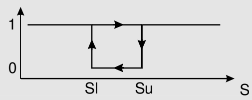
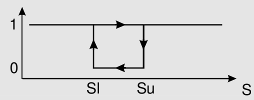
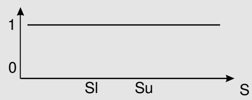
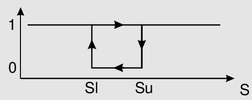
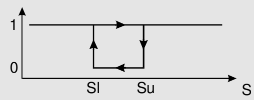
Table 12: Programmable window switching functions for the relays and their dependency on the enable signal

programmed switching function	Programming of the associated enable (reset-) input: 1,2,3,4, or 5 (∅ not possible with switching functions with lock) Relay status when the signal to the associated reset (enable-) input is switched on	switched off	
I (s)			Reset is carried out if **no** signal is applied at the corresponding enable input
K (s)			
L (s)			
M (s)			
N (s)			Reset is carried out if a signal is applied at the corresponding enable input
O (s)			
P (s)			
Q (s)			

1: Make contact Su: programmed upper switching value (Qu, fu or nu)
0: Rest contact Sl: programmed lower switching value (Ql, fl or nl)

Table 13: Window switching functions with programmed self-holding (lock)

(switching functions with programmed self-holding (lock) are available with the software V4.1)

	Programming of the associated enable input		
	1,2,3,4, or 5		Ø
programmed switching function	Relay status when the signal to the associated enable input is: switched on	Relay status when the signal to the associated enable input is: switched off	Relay status (independent of the enable signal)
I (k)			
K (k)			
L (k)			
M (k)			
N (k)			
O (k)			
P (k)			
Q (k)			

1: Make contact
0: Rest contact

Su: programmed upper switching value (Qu, fu or nu)
Sl: programmed lower switching value (Ql, fl or nl)

Table 14: Special window switching functions for falling frequency

(The special window switching functions are available with the software V4.1)

8 Example of an Application

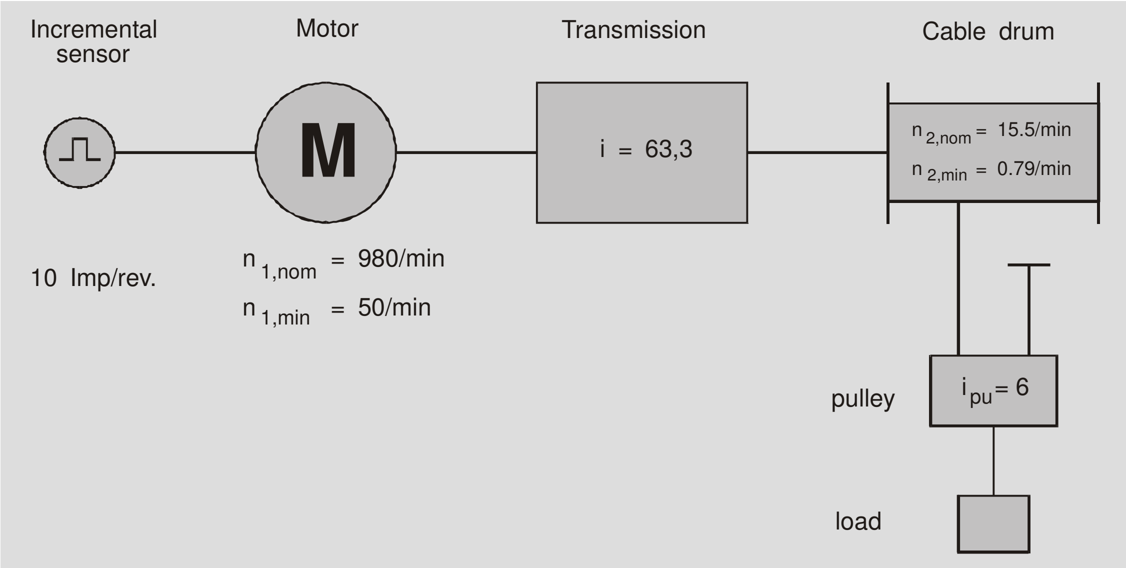


Fig. 7: Example of a lifting gear to be monitored

A shaft break monitor is to be set up for the lifting gear sketched above. If a shaft break suddenly occurs the load should drop a maximum of $s_{load} = 5\ cm$ before the break is detected. Due to the translation of the pulley of $i_{pu} = 6$ the cable may therefore move a distance of $s_{cable} = i_{pu} * s_{load} = 30\ cm.$ With a cable drum diameter of $D = 80\ cm$ the circumference is $U = \pi * D \approx 251\ cm$. The slip monitor **ES-FDP-FS...** would, in the worst case, need approximately the time between 3 impulses from the cable drum sensor to detect the break. Consequently, for a maximum cable distance $s_{cable} = 30\ cm$ until the break is detected, there must be an impulse always after 10 cm of cable. The rotation sensor on the cable drum must, therefore, give at least *U/10 cm = 25,1 impulses/revolution*. This can be done by attaching 26 cams on the circumference of the flanged wheel of the cable drum and detecting them with proximity switches.

A transmission of $i = 63{,}3$ and a nominal motor speed of $n_{1,nom} = 980\ min^{-1}$ gives a cable drum speed of $n_{2,nom} = n_{1,nom} / i = 15{,}482\ min^{-1}$. A figure of $n_{2,min} = 0{,}7899\ min^{-1}$ is reached with a minimal motor speed of $n_{1,min} = 50\ min^{-1}$. The ratio $Qn = n_1/n_2$ for the speed n_1 of the motor and n_2 for the cable drum corresponds to a transmission of $i = 63{,}3$.

These figures can be used to program a slip and frequency monitor **ES-FDP-FS8s** for monitoring the driving gear for shaft breaks, over-speed and failure of the rotation sensor. The procedure for the programming is shown in detail in Table 4 on page 16.

First of all, the number of sensor impulses per revolution is entered, this is necessary for the correct conversion of the input frequencies in speeds. At this, **p1** represents the impulses per rotation of the sensor on the motor, and **p2** is valid for the sensor on the cable drum.

```
Pole p. p1:00010
        p2:00026
```

Next, the **Q-Reset** is programmed. Selecting `Qn-Reset` defines, that the programming is for the ratio of speeds (and not for the ratio of frequencies = `Qf-Reset`). The set value is programmed to `63,30`. Furthermore the Q-Reset is assigned to the enable-input `1` and it is defined, that the **Q-Reset** shall take place at the interruption of the enable signal (`-`).

```
Qn-Reset:63.30
   if EnInp:1-
```

The programming of a **Q-Reset** value avoids unwanted switching during the start-up phase of the driving gear, after the enable signal has been applied. Changes in the direction of rotation can, likewise, cause the quotient **Q** to deviate from the set value. For this reason the quotient monitoring must be switched off temporarily for a change in direction. If this interruption in the enable signal can not be supplied from the control device for the driving gear, it can also be produced with the signal pre-processing device **ES-SV11**, or, with a switching channel from the **ES-FDP-FS...** (see below).

Now the switching channel **K1** can be programmed for the monitoring of the transmission. The assignment of the supervision of the speed ratio is made by programming of **Qn** (bottom left of the display).

It is advantageous to choose a window function for the switching, in order to register both unwanted increases and also decreases in the speed ratios. For safety reasons the output relay **K1** should be in the operative position with a trouble-free driving gear and switch back to the rest position if a shaft break is detected. If the slip monitor is inactivated (by switching off the enable signal), no message should be given, i.e. the output relay must remain in the operative position. This is the response provided by the switching function **K**.

Due to the elasticity in the drive rod, (e.g. at couplings) short-term fluctuations can occur in the speed ratio **Qn.** For this reason the switching threshold for the window function are set at the value **Q** ± 10%, i.e.: **Qu** = 1,1 * 63,3 = **69,63** and **Ql** = 0,9 * 63,3 = **56,97**. Enable input **1** is used to activate. The time delay and enable delay are programmed for **0.00** s.

```
K1:K1 → Qu:69.63    K1      ti:0.00s
Qn=**** Ql:56.97            to:0.00s

EnIn-1 ton:0.00s
 -***- tof:0.00s
```

****: current values

K2 is used to monitor over-speeds for the cable drum. Thus, the measuring is assigned to **n2**. When the speed reaches a level which is too high, the output relay returns to the rest position. This monitoring function is always activated. Therefore, **K2** is programmed with the switching function **C** and the associated enable input set at **0** (permanent activation).

```
K2:C0 → nu:17.00    K2      tu:00.0s
n2=**** nl:15.40            tl:00.0s
```

****: current value

K3 is allocated to the motor speed **n1** and monitors the function of the rotation sensor. If no faults have occurred the driving gear will have reached its minimum speed after a certain amount of time. This fact can be used for an open circuit monitoring. **K3** is assigned the switching function **B** and the enable input **2**, i.e. the output relay is in the operative position as long as the speed **n1** is above the value **45.00** min^{-1}. In this example the enable input **EnIn-2** activates the device with a delay of 0,3 s. The time chosen must be large enough to enable the driving gear to reach the minimum speed set for the sensor monitoring (switching channel **K3**) within this time. If no explicit message is necessary when a faulty sensor is detected the built in open circuit monitor can be programmed accordingly (see below).

```
K3:B2 → nu:46.00    K3      tu:00.0s
n1=**** nl:45.00            tl:00.0s

EnIn-2 ton:0.30s
 -***- tof:0.00s
```

****: current values

K4 monitors the rotation sensor on the cable drum and is programmed in a similar way to **K3**. Because the cable drum only gives a signal every 3 sec at its minimum speed and the device needs two impulses to determine the frequency a higher enable delay time is needed in this case. The enables **EnIn-2** and **EnIn-3** can be connected together externally (bridging the terminal).

```
K4:B3 → nu:0.770
n2=**** nl:0.760
```

```
K4       tu:00.0s
         tl:00.0s
```

```
EnIn-3 ton:6.00s
 -***- tof:0.00s
```

****: current values

K5 can, e.g., be used to produce the enable interruption for changes in rotational direction of the driving gear, in that the enable signal for the **Q-Reset** can be taken over the output relay **K5**. To this **K5** is assigned to the motor speed `n1` and programmed such that the **Q-Reset** is activated if the speed goes below `29.00` rpm. The setting of a relay delay **tu** of `0.15` s ensures that the minimum time for the recognition of the enable interruption is always kept to. **K5** is always activated (enable allocation `0`).

```
K5:C0→→ nu:30.00
n1=**** nl:29.00
```

```
K5       tu:0.15s
         tl:0.00s
```

****: current value

The switching channels **K6** to **K8** and the enable inputs **EnIn-4** to **EnIn-5** are not needed.

The open circuit monitor **OpCirMo** does not need to be activated because in this case the switching channels **K3** and **K4** have been used for this. If the **OpCirMo** function is used to monitor open circuits, the relays for all switching channels are brought to the rest position if the speed goes under a given speed. Therefore, it is no longer possible to recognize which sensor is defect after it has been operated. On the other hand, none of the switching channels are directly occupied so that, in the above example, the channels K3 and K4 can still be used for other switching tasks.

9 General Technical Data

Measurement inputs: Terminals (4), (5), and (7)	for 3-wire proximity switches (PNP or NPN) or 2-wire proximity switches or potential free contact or direct voltage impulses U ≥ 10 V (max. 50 V) , pulse width ≥ 0,12 ms; (input resistance approx. 22 kΩ) or alternating voltage U_{eff} ≥ 1,5 V + 0,1 V/Hz (low-pass behavior for interference suppression, max. 400 V, input resistance approx. 330 kΩ)
Measuring range:	for frequencies: 0,1 ... 4000 Hz (Standard) 0,001 ... 4000 Hz (Option) **(This details apply to symmetrical input impulses.)** for frequency ratios Qf: 0,001 ... 40000 (when programming switching values for speed ratios Qn with devices up to software V4.2, the valid area is limited to **Qn <4000000/p1**, where p1 is the number of impulses per revolution from sensor 1. With Software from V4.3 there is no such restriction.)
Measuring error:	< 0,1% at the permissible ambient temperatures
Measuring principle:	Period-duration measurement
Sensor supply: Terminals (6), (7)	20...24 V=, max. 35 mA total current
Enable inputs: Terminals (12) to (15), (40) to (42)	For 12V (10 ... 40V) AC/DC, or 24V (20 ... 80V) AC/DC, or 115V (97 ... 150V) AC/DC, or 230V (195 ... 260V) AC/DC
Switching outputs: Terminals (16) to (39)	8 (2) relays, 1 change-over contact, 250 V~, 5 A electrical contact life: 1,0 x 10^5 switching cycles at 250V~, 5A / 30V=, 5A and resistive load 3,5 x 10^4 switching cycles at 250V~, 5A and cos φ = 0,4 2,0 x 10^5 switching cycles at 250V~, 2A and cos φ = 0,4
Supply voltage: Terminals (1) and (2)	230V AC, ±10%, 50 ... 60 Hz **Attention: the build-in Varistor for protection against voltage transients is not fuse-protected internally!**
Power consumption:	approx. 15 VA
Fuses:	type TR5 160 mA / 250 V, slow-blow (soldered in)
Ambient temperature:	-10 ... +50 °C (operation) -20 ... +70 °C (storage)
Housing dimensions:	L = 200 mm, W = 75 mm, H = 126 mm with screw and snap-on mounting (DIN 46 277, 35 mm rail)
Behavior in fire:	according to UL: V-0 or VDE 0304: stage I (housing and keys)
Connection terminals:	removable connector block with self-lifting BI-slotted screws for 2x2,5 mm^2; including terminal cover with protection against accidental contact according to VBG 4 and VDE 0106 part 100
Creep resistance:	Insulation group C 250VE/300VG (creeping distance 4 mm); according to DIN 57110 and VDE 0110
Protective system:	IP 40
Mass:	approx. 1300 g

Subject to changes without notice.

10 Device versions and order numbers

Overview of the available device versions:		
Version:	**Order number**	**Short description**
ES-FDP-FS2s	**EF2S-** *ii/fv***	Slip and Frequency monitor with 2 measuring inputs, 2 enable inputs, 2 output relays
ES-FDP-FS8s	**EF8S-** *ii/fv***	Slip and Frequency monitor with 2 measuring inputs, 5 enable inputs, 8 output relays
ES-FDP-FS2si	**EF2S-** *ii/fv*/**AI** **	Slip and Frequency monitor ES-FDP-FS2s with analogue output for current 0(4)...20mA
ES-FDP-FS8si	**EF8S-** *ii/fv*/**AI** **	Slip and Frequency monitor ES-FDP-FS8s with analogue output for current 0(4)...20mA
ES-FDP-FS2su	**EF2S-** *ii/fv*/**AU** **	Slip and Frequency monitor ES-FDP-FS2s with analogue output for voltage 0...10V
ES-FDP-FS8su	**EF8S-** *ii/fv*/**AU** **	Slip and Frequency monitor ES-FDP-FS8s with analogue output for voltage 0...10V

Breakdown of the order number *ii/fv*

ii	Measuring inputs	f	Enable inputs	v	Supply voltage
I1	for DC pulses 10..50V	9	enabling voltage 230V AC/DC	9	230V, 50-60Hz
I2	for DC pulses 20..50V	7	enabling voltage 110V AC/DC	7	110V, 50-60Hz
2D	for 2-wire sensor	2	enabling voltage 24V AC/DC		
3N	for 3-wire sensor NPN	1	enabling voltage 12V AC/DC		
3P	for 3-wire sensor PNP				
T1	for AC speedometer, 1,5...30V				
T9	for AC speedometer, max. 300V				

Example for the order number of a slip and frequency monitor ES-FDP-FS8su (device with 2 measuring inputs, 5 enable inputs, 8 output relays, analogue output for voltage 0..10V), measuring input for DC pulses 10...50V, enabling voltage 24V, und supply voltage 230V:

EF8S-I1/29/AU

EF8S = ES-FDP-FS8s

I1 = DC-pulses 10..50V

2 = Enabling voltage 24V AC/DC

9 = Supply voltage 230VAC

AU = analogue output for voltage 0..10V

11 Allocation of Terminals

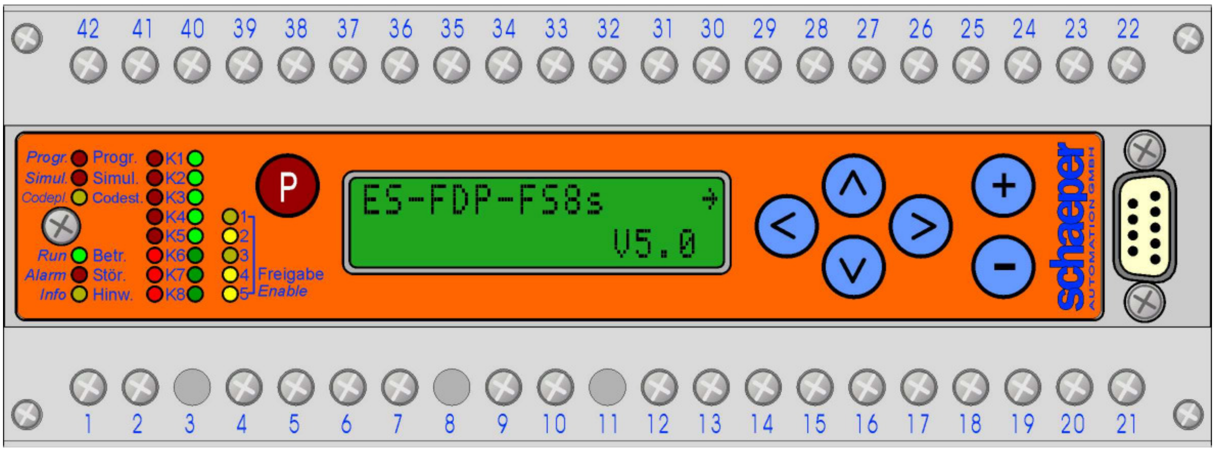


Fig. 8: Front plate and terminal strips

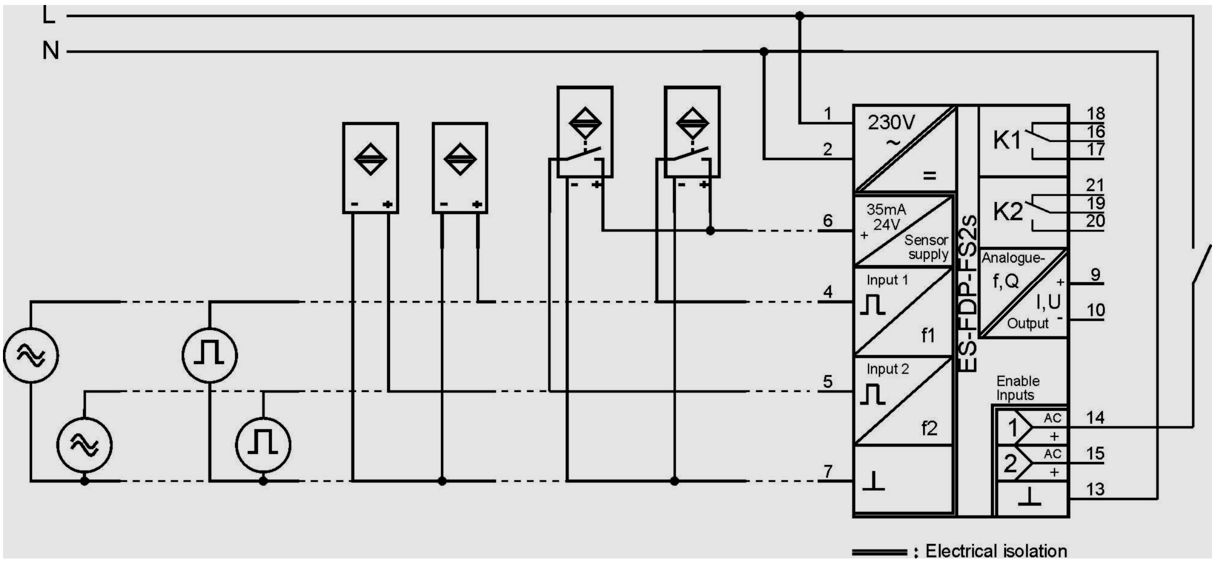


Fig. 9: Connection Example with ES-FDP-FS2s

1,2	Power supply	
4	Input 1	
5	Input 2	
6	Sensor supply **"+"** 20..24V, max. 35 mA	
7	Sensor supply **"–",** Ground for input 1 and input 2	
9	Analogue output **"+"** (Option)	
10	Analogue output **"–"** (Option)	
13	Ground for enable inputs 1, 2, 5 ***–*** *for enable with DC* ***N*** *for enable with AC*	
14	Enable input 1 ***+*** *for enable with DC* ***L*** *for enable with AC*	
15	Enable-input 2 ***+*** *for enable with DC* ***L*** *enable with AC*	
12	Enable-input 5 ***+*** *for enable with DC* ***L*** *for enable with AC*	*
40	Ground for enable inputs 3, 4 ***–*** *for enable with DC* ***N*** *for enable with AC*	*
42	Enable-input 3 ***+*** for enable with *DC* ***L*** *for enable with AC*	*
41	Enable-input 4 ***+*** *for enable with DC* ***L*** *for enable with AC*	*
16,17,18	Relay for the switching channel 1 16 change-over switch 17 make contact 18 rest contact	
19,20,21	Relay for the switching channel 2 19 change-over switch 20 make contact 21 rest contact	
37,38,39	Relay for the switching channel 3 37 change-over switch 38 make contact 39 rest contact	*
34,35,36	Relay for the switching channel 4 34 change-over switch 35 make contact 36 rest contact	*
31,32,33	Relay for the switching channel 5 31 change-over switch 32 make contact 33 rest contact	*
28,29,30	Relay for the switching channel 6 28 change-over switch 29 make contact 30 rest contact	*
25,26,27	Relay for the switching channel 7 25 change-over switch 26 make contact 27 rest contact	*
22,23,24	Relay for the switching channel 8 22 change-over switch 23 make contact 24 rest contact	*

*: only for **ES-FDP-FS8s**

Do not make connections to terminals not listed.

12 Housing Dimensions

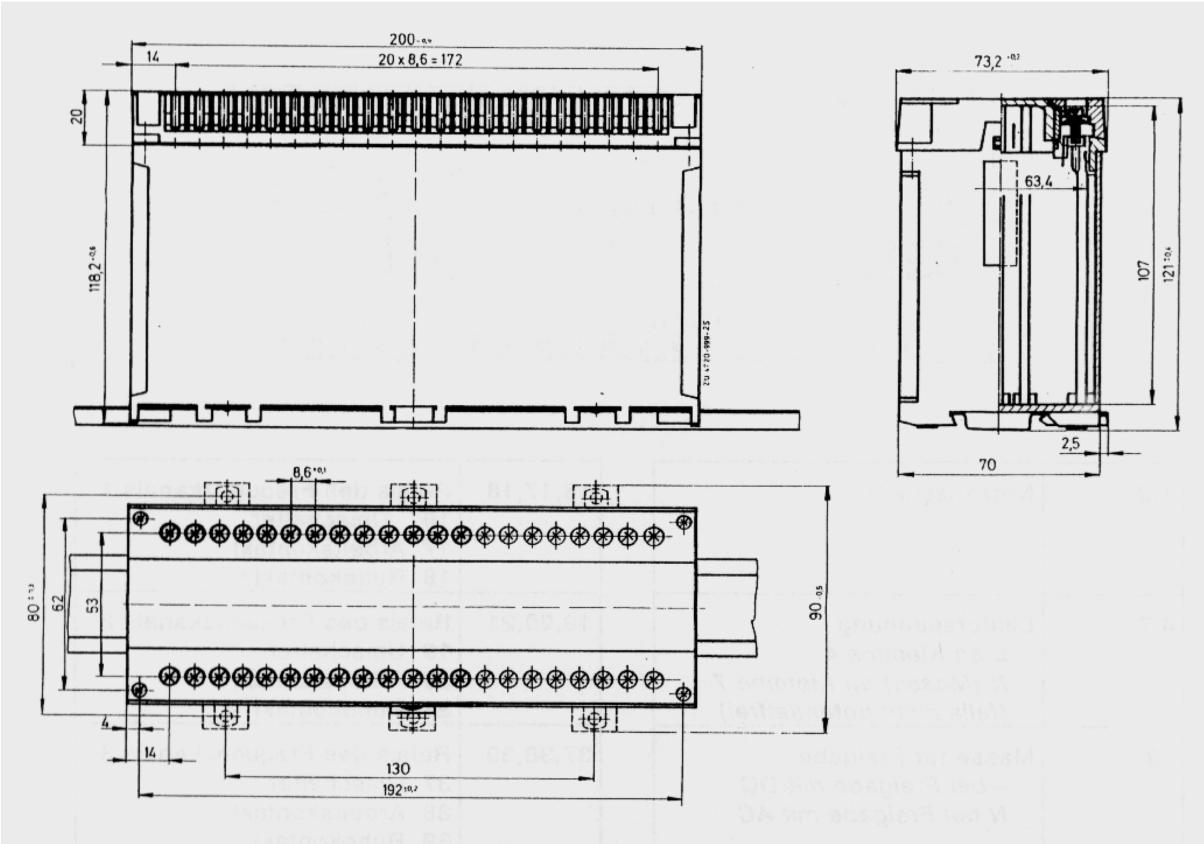


Fig. 10: Housing Dimensions

Removing the terminal strip: The terminal strip is loosened and removed from the device by unscrewing the two outer fastening screws. When changing the device the connector blocks are simply attached to the replacement device and screwed on. It is immediately ready for operation without any wiring work being necessary.

Removing the front plate: Both terminal strips must be removed before the front plate can be removed from the cover. This is then carried out as follows: place a screwdriver with a size of max. 0,6 x 4,5 DIN 5264 in one of the two recesses on the side, a light pressure is used to turn it to the left or right, thus unlatching the projection on the front plate from the casing. The same procedure must be carried out on the opposite side. The front plate can then be removed from the casing.

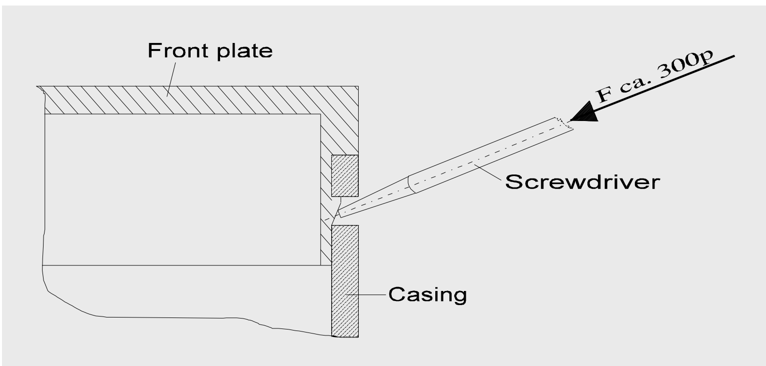


Fig. 11: Removing the front plate

13 Programming Reference Material

ES-FDP-FS2s

(english display text)

Device number:

Date:

Place of assembly:

Construction-No.:

`ES-FDP-FS2s     →` `           V5.0`	`language/Sprache` `        :english`
`__=*****    __= →` `__=*****    *****`	`__=*****    __=` `__=*****    *****`
`pole p. p1:_____` `        p2:_____`	
`averaging  f1:__` `(impulses) f2:__`	
`averaging  Q:_` `(impulses f1,f2)`	
`Q_-Reset:_____` `   if EnInp:__`	
`K1:___→ _u:_____` `__=**** _l:_____`	`K1        t_:____s` `          t_:____s`
`K2:___→ _u:_____` `__=**** _l:_____`	`K2        t_:____s` `          t_:____s`
`EnIn-1 ton:____s` ` -***- tof:____s`	
`EnIn-2 ton:____s` ` -***- tof:____s`	
`OpCirMo _1<____→` `activ if EnInp:_`	`K1..K8 rest pos.` ` with open circ.`
`OpCirMo _2<____→` `activ if EnInp:_`	`K1..K8 rest pos.` ` with open circ.`
`Simulat.QØ:_____` `    v:_ fØ:_____`	

⋮

Options

`I←__   __mA←_____` `        __mA←_____`
`I-Calibr.  :___`
`U←__    __V←_____` `         __V←_____`
`U-Calibr.  :___`

`*..*:` **current values**

Programming reference material

ES-FDP-FS8s

(english display text)

Device number:

Date:

Place of assembly:

Construction-No.:

ES-FDP-FS8s → V5.0	language/Sprache :english
__=***** __= → __=***** *****	__=***** __= __=***** *****
pole p. p1:_____ p2:_____	
averaging f1:__ (impulses) f2:__	
averaging Q:_ (impulses f1,f2)	
Q_-Reset:_____ if EnInp:__	
K1:___→ _u:_____ __=**** _l:_____	K1 t_:____s t_:____s
K2:___→ _u:_____ __=**** _l:_____	K2 t_:____s t_:____s
K3:___→ _u:_____ __=**** _l:_____	K3 t_:____s t_:____s
K4:___→ _u:_____ __=**** _l:_____	K4 t_:____s t_:____s
K5:___→ _u:_____ __=**** _l:_____	K5 t_:____s t_:____s
K6:___→ _u:_____ __=**** _l:_____	K6 t_:____s t_:____s
K7:___→ _u:_____ __=**** _l:_____	K7 t_:____s t_:____s
K8:___→ _u:_____ __=**** _l:_____	K8 t_:____s t_:____s
EnIn-1 ton:____s -***- tof:____s	
EnIn-2 ton:____s -***- tof:____s	
EnIn-3 ton:____s -***- tof:____s	
EnIn-4 ton:____s -***- tof:____s	
EnIn-5 ton:____s -***- tof:____s	
OpCirMo _1<____→ active if	K1..K8 rest pos. with open circ.
OpCirMo _2<____→ active if	K1..K8 rest pos. with open circ.
Simulat.QØ:_____ v:_ fØ:_____	

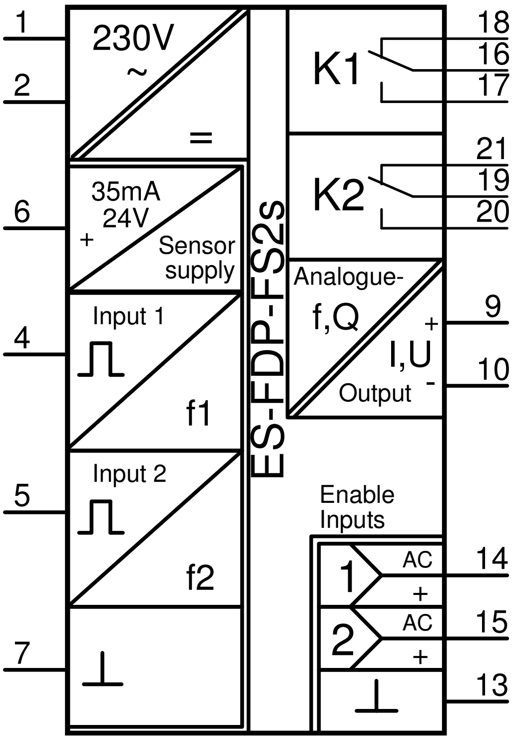
:

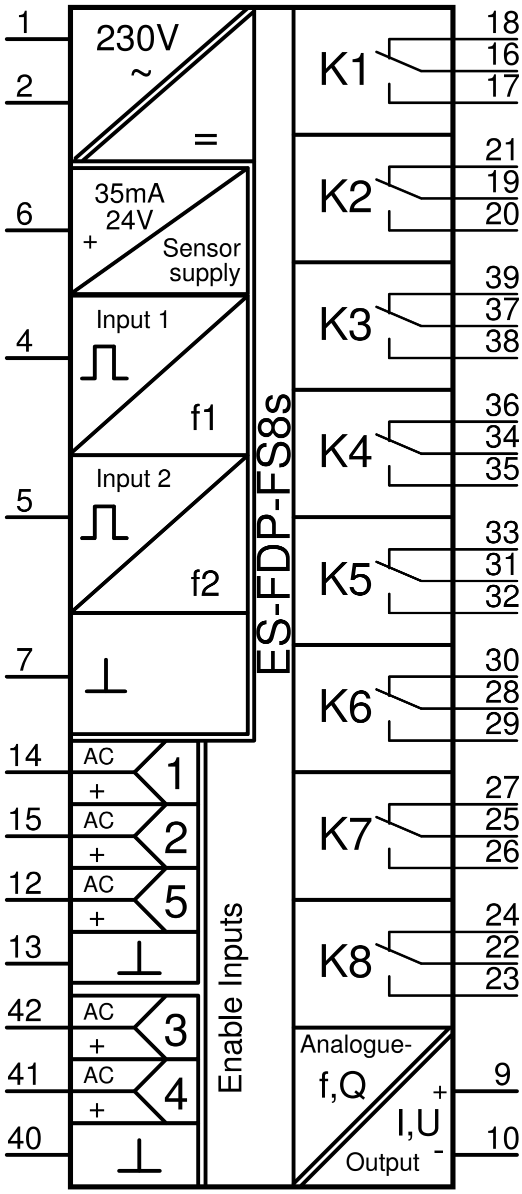
Options

I←__ __mA←_____ __mA←_____
I-Calibr. :___
U←__ __V←_____ __V←_____
U-Calibr. :___

..: **current values**

14 Wiring Symbols





: Electrical isolation

15 Appendix: Tables for calculating a suitable sensor impulse count

The following tables (page 49) serve to determine a suitable sensor impulse count for detecting the rotational movement of the cable drum whilst monitoring the transmission with the ES-FDP-FS8s or ES-FDP-FS2s. Instead of detection with the aid of an incremental sensor, proximity switches can be used to detect cams which should be evenly distributed around the circumference of the cable drum. The latter has the advantage that no additional play and no oscillatory movements occur between the cable drum and the measuring system.

Use of the tables will be explained by means of an example:

For Table 15: The maximum angular offset which can occur as a result of **play and torsion** in the drivetrain between the two measurements points for sensing the rotational movement must be entered as transmission play α_{Sp}. This could be, for example, α_{Sp} = 0.85°.

total transmission play	α_{Sp}	0,85°

The allowable deviation of the quotient corresponds to the value programmed into the slip monitor ES-FDP-FS.. e.g.: In the case of a nominal quotient of Q = 40, the values Ql=35 and Qu=45 will be programmed, corresponding to a permissible deviation of E_Q = 12,5%.

rel. allowed deviation of the quotient	E_Q	0,125

The two values α_{Sp} and E_Q give rise to the minimum required angle between two impulses from the drum, such that the slip monitor will not be triggered due to transmission play and torsion, as well as the maximum impulse count per drum revolution.

min. angle between 2 impulses	$\alpha_{Z,min} = \alpha_{Sp} / E_Q$	6,8°
max. sensor impulse count	$Z_{max} = 360° / \alpha_{Z,min}$	(=52,9) 52

For Table 16: To achieve a reliable recognition of a shaft-break after a preset maximum permissible cable distance on the drum, the drum impulse count may not fall below a minimum value*. This value may be calculated using **Table 16**. As an example for the calculation, a maximum drum cable distance of 30cm for a cable drum diameter of 80cm is assumed. The formula for Z_{min} takes into account that, in the worst case, 3 drum impulses will be needed before the shaft-break is recognized.* **Please note:** After the triggering impulse is detected, the device requires internally a further max. 50msec before the corresponding relay is actuated.

permissible drum cable displacement	S_{Tr}	30cm
winding diameter of the cable drum	D_{Tr}	80cm
min. sensor impulse count	$Z_{min} = 3 * \frac{\pi * D_{Tr}}{S_{Tr}}$	(=25,1) 26

Therefore, for monitoring the equipment in this example, the drum impulse count must lie between 26 and 52.

* Refer also to the chapter “Example of an Application”, page 37.

Digital Slip and Frequency Monitors ES-FDP-FS…

Tables for determining a suitable sensor impulse count for detecting the rotational movement of the cable drum.

Important: the sensor must be connected to the drum with no play.

transmission play	α_{Sp}	
rel. allowed deviation of the quotient	E_Q	
min. angle between 2 impulses	$\alpha_{Z,min} = \alpha_{Sp} / E_Q$	
max. sensor impulse count	$Z_{max} = 360° / \alpha_{Z,min}$	

Table 15: Calculation of the maximum impulse count (per revolution) of the sensor, such that no triggering occurs due to transmission play

permissible drum cable distance	s_{Tr}	
winding diameter of the cable drum	D_{Tr}	
min. sensor impulse count	$Z_{min} = 3 * \frac{\pi * D_{Tr}}{s_{Tr}}$	

Table 16: Calculation of the minimum impulse count (per revolution) of the sensor dependent on the maximum permissible drum cable distance before the shaft-break is recognized

16 Appendix: Differences to the Device Versions ES-FDP-F122a … ES-FDP-F285a resp. ES-FDP-S222a … ES-FDP-S285a

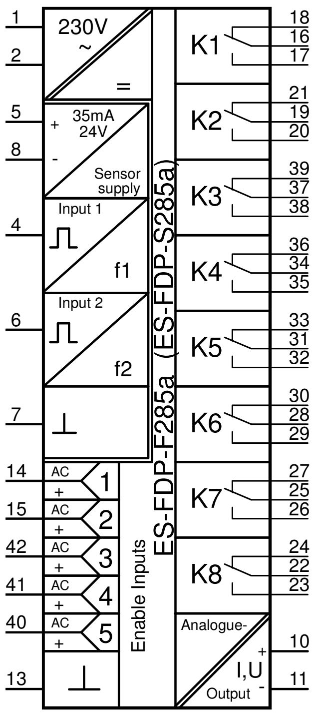
All switching and monitoring functions which could be realized with the devices of the series **ES-FDP-F…x** resp. of the **series ES-FDP-S…x** can also be programmed with the new version **ES-FDP-FS..** . The terminal assignment also has remained the same. **Devices of the version ES-FDP-F…x resp. ES-FDP-S…x can be replaced by the versions ES-FDP-FS.. without wiring changes.**

However, there are some important differences compared with the older device versions ES-FDP-F…a bzw. ES-FDP-S…a, which became necessary for a higher interference immunity, and which are described below:

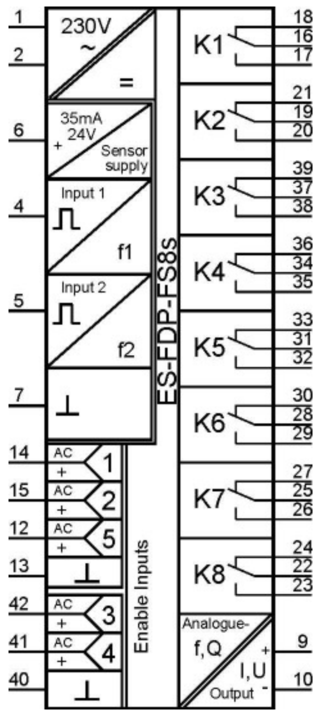
- **The terminal assignment for the measuring inputs were changed (Term. 5,6,7,8)**
- **The terminal assignment of the analogue output were changed (Term. 9,10,11)**
- **The terminal assignment of the enable inputs were changed (Term. 12, 40, 41, 42)**
- **Enable inputs are no longer implemented as wide range inputs. The enabling voltage therefore has to be specified when ordering.**

Comparison of terminal assignment

Circuit diagram for the old device version



Circuit diagram for the new device version



Terminal assignment for the measuring inputs:

The two measuring inputs are now located at terminals 4 and 5 of the device, the sensor supply at terminal 6, and the common ground for the measuring inputs and the sensor supply at terminal 7 of the device. In the old device version, the ground for the measuring inputs for DC signals was at terminal 8, and for AC signals at terminal 7. This has now been standardized. As before, the sensor supply is only available in devices for DC input signals.

Terminal assignment for the enable inputs:

In the old device version, the common enable ground for the 5 enable inputs was located at terminal 13 of the device. In order to reduce the risk of interference, the new version features additional enable ground at terminal 40 for enable inputs 3 and 4 (located on the opposite device side). To this end, enable input 5 had to be moved from terminal 40 to terminal 12.

Terminal assignment for the analogue output:

The analogue output was moved from terminals 10 and 11 to terminals 9 and 10, in order to comply with separating distances to the enable inputs.

Checklist for the re-allocation of the terminals		
Term.8 → Term.7	Move connections from terminal 8 to terminal 7	Terminal 7 is now common ground for measuring inputs and sensor supply.
Term.5 ←→ Term.6	Swap terminal 5 and terminal 6	The terminals for measuring input 2 and sensor supply are swapped compared with the old device version.
Term.40 → Term.12	Move connections from terminal 40 to terminal 12	Enable Input 5 is now on terminal 12.
Term.13 → Term.13 and Term.40	Connect terminal 13 additionally with terminal 40	Enable inputs 3 and 4 now require additional Enable ground at terminal 40.
Term.10 → Term.9	Move connections from terminal 10 to terminal 9	The analogue output is now at terminals 9 and 10.
Term.11 → Term.10	Move the connection from terminal 11 to terminal 10	

New design of the enable inputs

For higher safety against interference with long cables at the enable inputs, the existing wide range inputs (for 24 ... 250 V~ or 20 ... 250 V=) were replaced with inputs for narrower voltage ranges. The new voltage ranges are listed in the following table.

Enable inputs: (please specify when ordering)	12V (10 ... 40V) AC/DC, or 24V (20 ... 80V) AC/DC, or 115V (97 ... 150V) AC/DC, or 230V (195 ... 260V) AC/DC