Description and Overview

of the options for the

Brake and Temperature Monitoring

for electromagnetically released

PRECIMA Spring-Applied Brakes

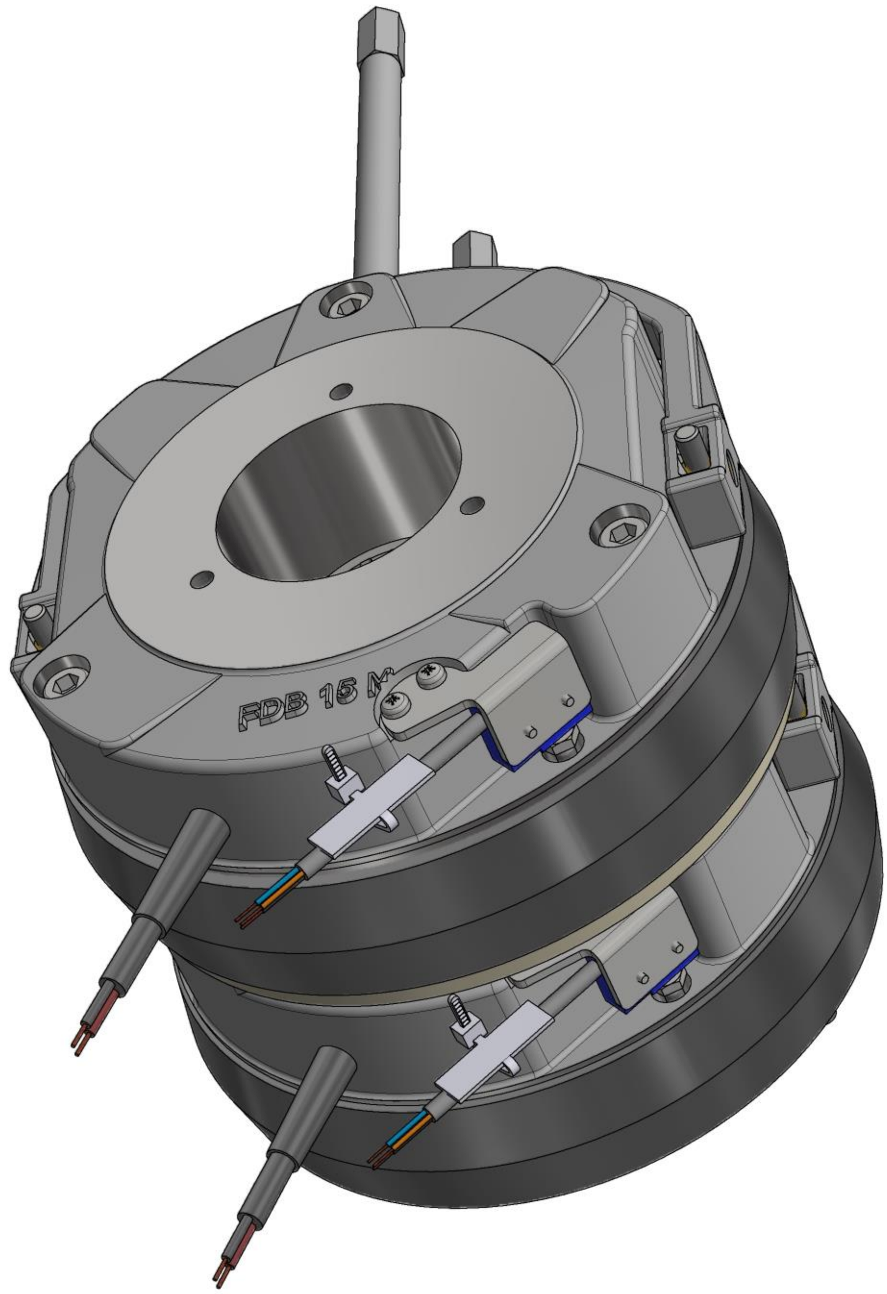


Table of contents

1. General Information about Brake Monitoring

Preliminary note: The following explanations assume an understanding of the basic functioning of an electromagnetically released spring-applied brake (➔ for structure and function see. Chapter 3 in the General Introduction to the Operating and Assembly Instructions (...) *).*

1.1 Purpose

The **brake monitoring options** ,depending on the given requirements, represent a useful, but generally not necessary, addition to a PRECIMA spring-applied brake. This means that the actual function of the brake, as described in the G*eneral Introduction (...)*, is not changed by the monitoring. However, e.g. through the better interaction with the unit to be braked (generally an electric motor), it can reduce the wear on the rotor or minimize the need for periodic checks by the user.

1.2 Function monitoring

During function monitoring, the monitoring element (microswitch or sensor ➔ see 2.2) **detects the current switching status** (released / applied) **of the brake.**

In relation to the switching of the brake (applying the voltage ➔ the brake releases, i.e. the braking/holding torque is cancelled or interrupting the voltage ➔ the brake is applied, i.e. the braking/holding torque builds up), the **function monitoring** provides an **independent feedback** as to whether and when the intended effect occurs or has occurred. The **armature plate**, which on the one hand is placed onto the magnet housing by the electromagnetic force during brake release and on the other hand is pressed on the rotor by the spring force during brake application, is the **suitable actuator** for the microswitch or sensor. Depending on the technical design of the monitoring element, it can be actuated directly or indirectly (via a screw inserted into the armature plate). **Figure 1.1 a/b** shows an example of the two switching states in a sectional view of the area of the armature plate/monitoring element (here: sensor).

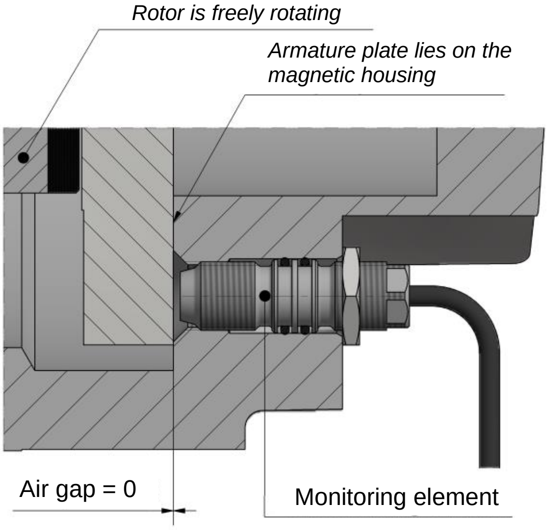


Figure 1.1 a:
Brake monitoring / brake released
(section view)

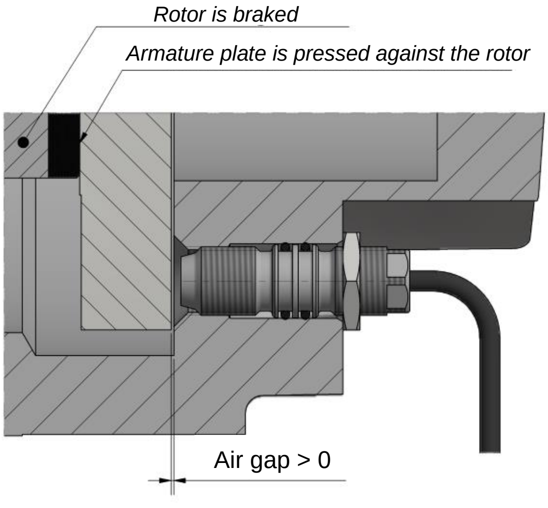


Figure 1.1 b:
Brake monitoring / brake applied
(section view)

In analogy with or in continuation of the safety concept on which the spring-applied brake is based (power failure leads to the application of the brake; braking torque generation is independent of the power supply), the microswitch or sensor should generally be used **as a normally open contact** (N/O). This means that a signal is only given when the brake is released and the monitoring element is working, but not when the brake is applied or when the monitoring is faulty (e.g. because the connection cable is broken). A motor that only starts when the air signal is present would therefore not start despite the brake being actually released and this alone would indicate an error in the monitoring system.

1.3 Wear monitoring

During wear monitoring, the monitoring element (microswitch only ➔ see 2.1) **detects** if a predefined **air gap is exceeded** when the brake is applied.

The arrangement is identical to that for function monitoring, as shown in Figure 1.1 a/b. Differently from it, however, in wear monitoring **the switching status** of the monitoring element **does not change** during normal brake operation. This only happens when, after a certain operating time of the brake, the **friction linings of the rotor** are so **worn** that the switching point of the microswitch is reached through the resulting increase in the air gap when the brake is applied. Taking into account the tolerances of the components and the accuracy of the monitoring element, this switching point or the corresponding air gap is set close to the maximum permissible air gap or the minimum permissible rotor thickness (= wear limit). A change in the switching status then indicates that the brake **needs to be readjusted** soon (as far as possible) or the **rotor needs to be replaced** shortly.

Similarly to the function monitoring, a microswitch used as a **normally open contact** would indicate that the wear limit will soon be reached and, if necessary, that an error has occurred in the monitoring system, as the element would always be activated in normal operation. When used as a **normally closed contact**, on the contrary, failure before and after reaching the switching point is not readily recognizable.

2. The Brake Monitoring Elements

2.1 Overview / areas of application

Figure 2.1 below shows an overview of the versions of the monitoring elements discussed here, differentiated according to their **design** and type of **installation** on one side and the **functional principle** (microswitch or sensor) on the other. The main **areas of application** in relation to the size of the brake (but still without taking into account the individual series) and the **usage type** (function and/or wear monitoring) can be found in the matrix table.

For the two microswitches mentioned above, which were introduced first, there is no corresponding sensor that could alternatively and interchangeably be used in the same magnet housing. However, such an exchange is possible with the newer types. The specification of a minimum size refers to the required installation space in the magnet housing, the differentiation and / *or* the possibility of installing only one or two microswitches or sensors. The latter is necessary for function and wear monitoring in a brake, since no monitoring element currently enables both. Furthermore, sensors are currently not suitable for wear monitoring (cf. 2.2.2).

A special case is the *maximum* size for the combination of cubic design / directly operated / wear monitoring: The limited overtravel beyond the actuation point only allows the setting of a maximum air gap which is useful for smaller brakes, although the installation itself would of course also be possible for larger ones.

Design + Type of Installation	Cylindrical design / screwed on the back	Cylindrical design / axially screwed in		Cubic design / laterally attached	
		Size M8	Size M12	directly operated	actuated via rocker
Operating principle	fit to be sealed for brakes IP 66/67				
Micro switch	Function *or* Wear monitoring from size BR20 on from size 13 on Function and Wear monitoring from size BR150 on from size 23 on	**Function and Wear monitoring from size BR10 on from size 10 on** ⬍	**Function *or* Wear monitoring from size BR40 on from size 15 on** **Function and Wear monitoring from size BR150 on from size 23 on** ⬍	**Function *or* (*up to size BR60 up to size 17*) Wear monitoring** ⬍	Function *or* Wear monitoring
Sensor (Inductive Sensor)	X	**Function m. from size BR10 on from size 10 on**	**Function monitoring from size BR150 on from size 23 on**	**Function monitoring**	X

⬍ = similar geometry, compatible

Figure 2.1: Overview of the areas of application for the monitoring elements

Note: Size information (e.g. from size BR20 / from size 13) refers to the corresponding designations of Getriebebau NORD (1st information) and of PRECIMA (2nd information)

2.2 Functional principle

2.2.1 Microswitch

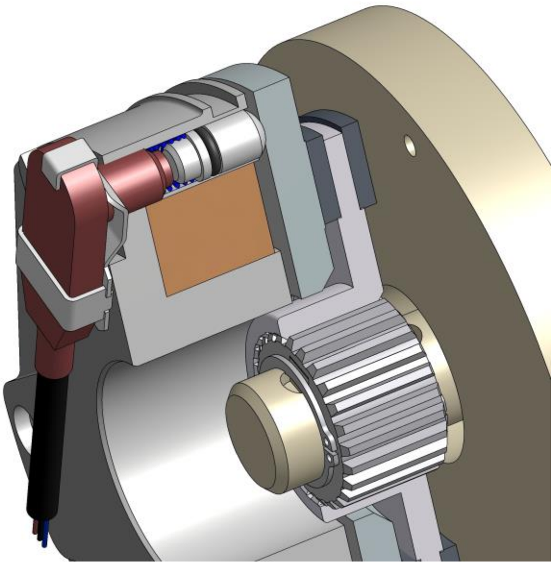
The microswitches used are **mechanically** (directly or indirectly by the armature plate) **actuated snap-action switching elements** , i.e. at a certain switching point, which can be changed by modifying the screw-in depth of the switch in the housing or of the actuating screw in the armature plate, the transition from *not switched* to *switched* and vice versa takes place without intermediate status. The difference between the switching point and the reset point (= hysteresis) must be taken into account when adjusting the setting.

2.2.2 Sensor

The sensors used are **inductive proximity switches** which, like the microswitches, are actuated directly by the armature plate or by a screw that is inserted in it. However, this actuation is carried out without contact by mere approach of the metallic object (armature plate itself, screw head). The adjustment is done in the same way as for the microswitches, the solenoid of the brake has no influence on the function. The combination of a larger switching distance and a relatively precise switching point, which is necessary for wear monitoring, is problematic. As long as there is no satisfactory solution, the use of the sensors is limited to the function monitoring.

2.3 Design and installation

2.3.1 Cylindrical / screwed on the back



The microswitch shown in the section view of **Figure 2.2** represents the oldest design used, which can be employed both with open (as shown here) and closed brakes. The switch itself is completely sealed and, in the second case, the tappet actuating it seals the through hole in the interior of the brake via an O-ring. There is no analogue sensor in this form.

Figure 2.2:
Cylindrical design / screwed on the back
(Sectional view)

2.3.2 Cylindrical / axially screwed in

The newer alternative to the microswitch according to 2.3.1 or Figure 2.2 is the design shown in **Figure 2.3 a** with its interchangeable counterpart in the form of an inductive proximity switch (**Figure 2.3 b**). Sealing against the through hole is provided by two O-rings, which are guided in the grooves of the switch housing. Depending on the size of the brake, the M8
and M12 versions can be employed only in single or double arrangement for functional or wear

monitoring (sensor only for function monitoring, cf. 2.2.2). Generally there is no rear protrusion as in the design according to 2.3.1, however, with smaller brakes, additional space is required to guide the cable. Corresponding values can be found in the respective dimension sheets of the standard brakes with microswitch / sensor.

Note: The designations M8 and M12 refer to the screw-in thread of the monitoring elements (M8x0.75 or M12x1) and are therefore indicative of their size.

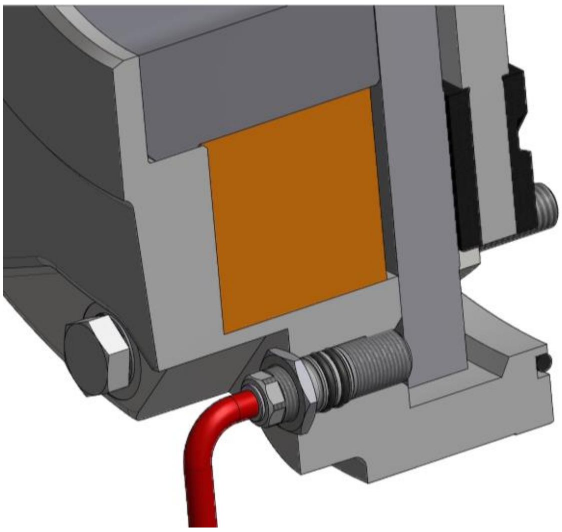


Figure 2.3 a:
Cylindrical design / axially screwed in / microswitch (sectional view)

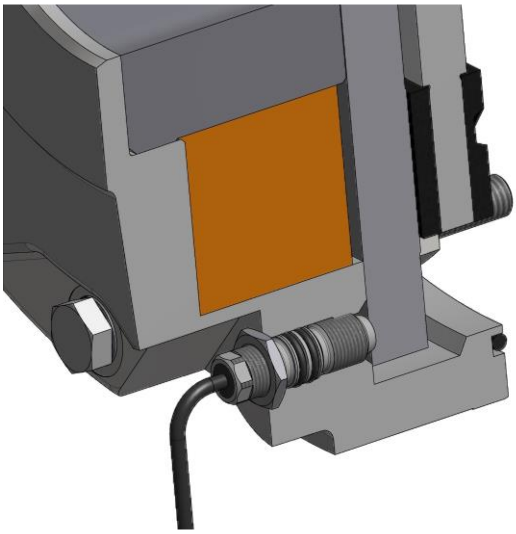


Figure 2.3 b:
Cylindrical design / axially screwed in / Sensor (sectional view)

2.3.3 Cubic / laterally attached

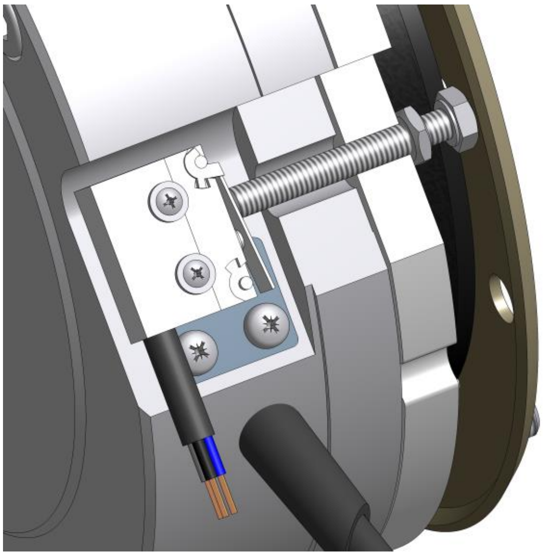


Figure 2.4:
Cubic design / laterally attached / actuated via rocker (partial sectional view)

The microswitch shown in the partial section view of **Figure 2.4** represents the oldest design of the side-mounted type, which is generally used **only with open brakes** and in a **single arrangement**. Although the switch itself is completely sealed, actuation by a screw fixed onto the armature plate does not allow the same level of sealing (IP66) for the whole brake. By moving the rocker to the opposite side, the actuating travel beyond the switching point can be increased to such an extent that it can also be used for wear monitoring. There is no analogue sensor in this form.

The newer alternative to the microswitch according to Figure 2.4 is the design shown in **Figure 2.5 a** with its interchangeable counterpart in the form of an inductive proximity switch (**Figure 2.5 b**). The actuation is now no longer carried out via a rocker, but directly through the screw head (= rotation of the actuating screw by 180° compared to the old version). By default, only one microswitch can be attached to a brake and used for function or (for smaller brakes, see 2.1 and Figure 2.1) wear monitoring, but the sensor (as for the cylindrical design) is suitable only for function monitoring, see 2.2.2.

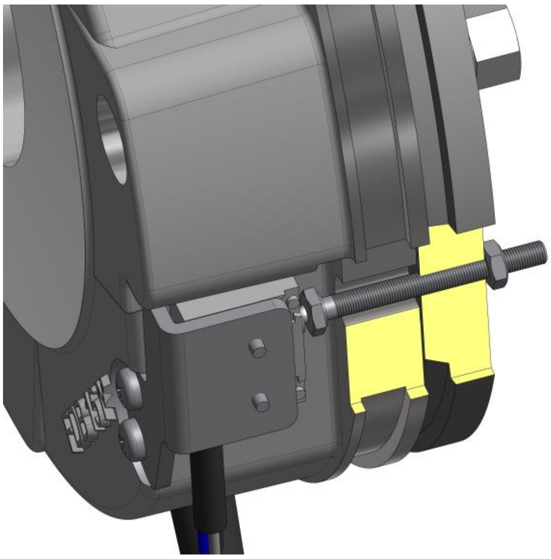


Figure 2.5 a:
Cubic design / laterally attached / directly operated / microswitch (partial sectional view)

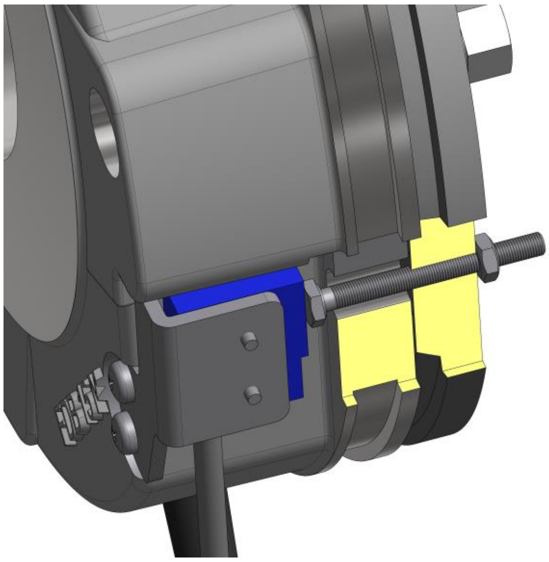


Figure 2.5 b:
Cubic design / laterally attached / directly operated / sensor (partial sectional view)

2.3.4 Retrofittability and interchangeability

The use of microswitches and sensors on PRECIMA spring-applied brakes requires correspondingly prepared magnet housings. For economic reasons, they generally do not present the necessary geometry, with the only exception of housings for brakes, which are already equipped with that option. Subsequent retrofitting is therefore usually not possible for the brake types FDB/FDR, FDW and FDD/FDT .

There is no interchangeability between old and new versions of the cylindrical and cubic design, only microswitches can be exchanged with (if available) sensors of the same design and size (see Figure 2.1).

2.4 Special applications

The detection of the brake status (released or applied) generally refers to the actuation in regular operation (electrical actuation). A special application of brake monitoring is the **monitoring of the manual release position** (actuated / not actuated). This is not generally guaranteed by normal function monitoring or , conversely, it can also generate an ambiguous signal: For example, the status of a mechanically released brake with a locked manual release (which of course could not fulfil its function as a safety brake) could not be distinguished from an electrically released one simply by means of a microswitch actuated by the armature plate.

3. Selection of the Brake Monitoring Elements

3.1 Overview

Figure 3.1 below shows the criteria and technical data relevant to the selection and use of the monitoring elements in addition to Figure 2.1 (Overview of the areas of application), and it lists the data sheets of the respective switches and the associated setting and test instructions.

Design + Type of Installation		Cylindrical design / screwed on the back	Cylindrical design / axially screwed in				Cubic design / laterally attached		
			Size M8		Size M12		directly operated		actuated via rocker
Criterion	*Characteristic*	Micro switch	Micro switch	Sensor	Micro switch	Sensor	Micro switch	Sensor	Micro switch
Brake type	*open*								
	closed								
Brake series	*FDB / FDR*								
	FDW								
	FDD / FDT								
Usage type	*Function*	*from size BR20 on from size 13 on*	*from size BR10 on from size 10 on*		*from size BR40 on from size 15 on*				
	Wear						*up to size BR60 up to size 17 *)*		***)*
	Function & Wear	*from size BR150 on from size 23 on*			*from size BR150 on from size 23 on*				
Supply voltage	*= DC*	*up to 30 V*	*up to 30 V*	*10...36 V*			*10...30 V*		*up to 30 V*
	~ AC	*up to 250 V*			*230 V*				*up to 250 V ***)*
Ambient temperature	*+100/105°C*								****)*
	+85°C								
	-20/-25°C								
	-40°C								
Material of external cable ➔ Switch data sheet	*Silikon*	*T90-032 T90-145*			*T90-322*				
	PUR							*T90-344*	
	PVC	*T90-169*	*T90-334*	*T90-341*		*T90-323*	*T90-288 *) T90-362*		****) T90-143 T90-144 **) T90-274*
Adjustment ➔ Instruction	*Function*	*T90-079*	*T90-347*	*T90-225*	*T90-253*	*T90-225*	*APA 073*	*APA 075*	*APA 021*
	Wear	*T90-082*	*T90-353*		*T90-309*		*APA 076*		*APA 070*

[grey box] = Combination available (with additional information if necessary) [white box] = Combination not available

Figure 3.1: Overview of the selection data for the monitoring elements

3.2 Assignment to type / series

The assignment of the monitoring elements to the type and to the series or vice versa is very simple:

- **Any of the switches** can be fitted in the basic series of the **open brake** (= FDB; provided the magnet housing is suitably designed, see 2.3.4). There are only restrictions regarding the size: in smaller brakes, certain switches cannot be implemented at all or only in single arrangement, but not in a double one (for function and wear monitoring) due to space constraints.

- The same applies to the derived **double rotor brakes** (= FDR)

- **Any of the sealable switches** can be installed in the basic series of the **closed brake** (= FDW; see also Figure 2.1). As with the open brakes, there are restrictions in terms of size (see above).

- With the **double brakes** (= FDD), only the cubic or **side-mounted** microswitches and sensors are installed by default, since they can be used in any size and are unproblematic with regard to the cable routing of the monitoring element (brake 1, which is screwed on first, is completely covered in the axial direction by the intermediate flange, which is used to mount brake 2).

- The **single brakes in theatre version** (= FDT) as derived "half FDD" also receive only the microswitches and sensors mentioned there as standard.

3.3 Voltage ranges

The voltage ranges shown in **Figure 3.1** represent the first selection criterion, whereby **all microswitches and sensors** are suitable for uniform low voltage ≦ **30 V**, but not always for AC voltage. Usage with AC voltage also precludes a subsequent change to DC voltage. In specific cases of application, the special data sheet for the respective switch must also be observed with regard to minimum/maximum switching currents and switching capacities.

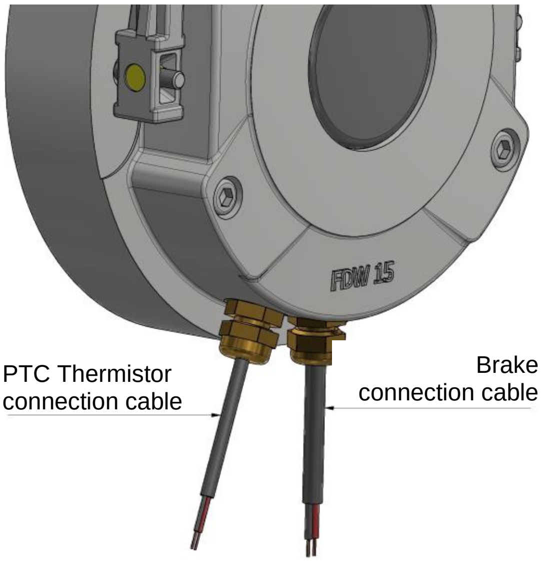
For the CSA conformity of a brake with microswitch or sensor, this monitoring element must always be employed with a Class 2 power supply or a Class 2 transformer at a low voltage ≦ 30 V and at a maximum apparent power ≦ 100 VA!

3.4 Temperature ranges

The temperature range of **-20 ... + 85°C** is covered by all microswitches and sensors, temperatures exceeding this range limit the selection. As with the voltage ranges according to 3.3, the data sheet of the respective switch should also be taken into account in the specific case of application.

4. Temperature Monitoring

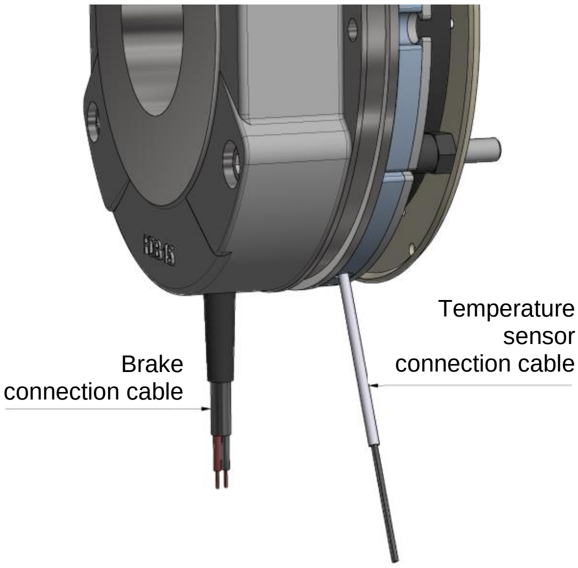
4.1 Monitoring of the magnet housing (ATEX version)



For temperature monitoring of the magnet housing, as implemented in the FDW brake in ATEX version shown in **Figure 4.1**, there is a PTC thermistor inside the housing, whose rapid change in resistance when the limit temperature is reached can be used to detect overheating of the brake. The connection cable of the PTC thermistor is led out of the housing through a second cable gland next to that of the brake connection cable (connection of the coil for switching the brake). For the ATEX version, see also: *Operating and Assembly Instructions BRE IP66 (Precima FDW).*

Figure 4.1:
Temperature monitoring magnet housing / FDW brake. ATEX version

4.2 Monitoring of the armature plate



While the temperature monitoring of the magnet housing is used by default (ATEX) for closed brakes, the monitoring of the armature plate can be provided as a special option for open brakes (**Figure 4.2**). The temperature sensor used here (PT 100) changes its resistance value in line with the temperature and can therefore be used in the same way as the PTC thermistor described in 4.1: if a certain resistance is exceeded, the brake is overheating. Due to the arrangement of the sensor in the armature plate, inadmissible heating, e. g. due to the constant grinding of the rotor, can be detected more quickly here.

Figure 4.2:
Temperature monitoring armature plate / FDB brake

4.3 Special versions

The use of a PT 100 for monitoring the housing temperature in a closed brake as a special version is unproblematic in terms of design; similar use in an open brake is also conceivable. Instead of a PTC thermistor or a temperature sensor, a bimetallic switch can also fulfil the monitoring function. The combination of a sensor in the armature plate and a closed housing may be more difficult. Due to the movement of the armature plate (bridging the air gap when the brake is switched), the connecting cable within the brake must be routed in an accordingly flexible way without being endangered by external tensile forces.

Document history

Issue	Version	Description
05.2020	*0.0*	*Created*
09.2021	*1.0*	*PRECIMA type (FDB, FDW, …) as general brake* ***type*** *designation; BR5...BR1000 as NORD-specific brake* ***size*** *designation (instead of BRE… etc.)*