MONITORING OF MOTOR AND MACHINERY BRAKE STATUS AND PERFORMANCE
On
HEAVY MOVABLE STRUCTURES

By
Lawrence E. Chizmar, Jr. Bubenzer Bremsen America, LLC

ABSTRACT
The wide application of both drum and caliper disc-type motor and machinery brakes on heavy movable structures is well-known. The installation locations and sometimes infrequent use of these brakes present challenges to the maintenance personnel charged with ensuring that the brakes are fully-functional and ready for service when required. Monitoring systems that can be installed on new brakes and retrofitted to existing brakes can be a valuable tool for on-site and remote monitoring of bridge brake status and performance.

DETERMINING BRIDGE BRAKE OPERATIONAL STATUS
Modern drum and caliper disc-type bridge brakes are designed to provide long service lives, with reduced maintenance and parts requirements. Features such as automatic wear compensation, quick-change linings, visible torque scales etc. coupled with electro-hydraulic thrusters for brake release are designed to minimize brake maintenance time. These maintenance-friendly features can, however, have a downside. The brakes can simply be left alone for long periods of time, given the infrequent use of the brakes, and with the assumption that the brakes are "maintenance free". Anyone who works with machinery of any type knows that "maintenance-free" simply does not exist in the real world.

The question for the maintenance team thus becomes: " how do we know that our brakes are in proper adjustment and ready for service?". One way to answer that question is to have the brakes checked regularly for lining thickness, equal lift-off of the linings when the brakes are released, thruster reserve stroke etc. The brakes can also be observed in operation to verify that linings aren't dragging, torque is properly set etc. A checklist can be provided to the maintenance worker to record a written verification that the brake status was OK when checked. There are two potential problems with this approach: such checks are only "snapshots" of the brake condition at the time it was checked, and the checklist can sometimes be filled-in routinely and at times "remotely" without the checks actually being performed.

Now comes a better solution. By using sensors that can be installed onto new or existing bridge brakes, both on-site, visible monitoring and remote monitoring of brake status and performance can be accomplished.

Diagram #1 attached details the five measuring points and sensors available in a computer monitored brake (CMB) full monitoring system. Diagram #4 attached details the three measuring points available in a visual status-reading (VSR) monitoring system.

Figure 1 RESERVE STROKE OF THE THRUSTER

An analog linear transducer is used to indicate when the thruster reserve stroke reaches the acceptable minimum. Insufficient reserve stroke can cause the Thruster ram to bottom-out before full braking torque is applied by the brake. Thruster stroke decreases as linings wear, and must be reset at or before the Thruster reserve stroke (typically 10mm above bottom-out).

Figure 2 ACTUAL BRAKING FORCE APPLIED

An analog DMS measuring pin-type transducer indicates the actual braking force applied whenever the brake is set. (This may ultimately become a requirement for all new brakes).

Figure 3 LINING TEMPERATURE INDICATORS

Two analog PT100 temperature sensors indicate the actual temperature of both brake linings. Lining temperature difference is used to indicate when one of the linings is dragging.

Figure 4 LINING WEAR INDICATORS

Two binary wear contacts measure the actual wear of the linings, and indicate when minimum lining thickness is reached.

Figure 5 DISC RPM INDICATOR

One optical or alternative inductive transmitter is used to measure the RPM of the brake disc. Disc RPM in combination with actual braking force applied is used to monitor the dynamic coefficient of friction during emergency stops.

All sensor data is read by the CMB microprocessor and can be transmitted to and interfaced with the drive control, or read-out on a stand alone, touch screen device, or maintenance compurter. (See Diagram #2.) Typical data screens are shown in Diagram #3. The CMB Microprocessor stores data on a continual basis for up to 90 days. Status reports can be printed out either locally or at the central maintenance office for use in diagnostic reports and maintenance planning. The savings in maintenance time and in avoidance of unexpected brake failure can readily pay for the initial installation of the CMB system.

A simpler, less-costly monitoring system is also available which monitors three of the five brake operating characteristics and is known as the VSR (Visual Status Readout) monitoring system. Diagram #4 shows the LED readout device used in the VSR system which monitors three of the five measuring points used in the CMB system: thruster reserve stroke, lining temperatures and lining thicknesses. These are the same as Figures #1, #3, and #4 of the CMB system.

The readout is by way of red and green LEDs (light-emitting diodes) mounted in the front of the VSR control enclosure which mounts onto the brake spring tube, and within the overall outside dimensions of the brake. The enclosure is fitted with a combined push-to-test and reset

pushbutton which lights up all the LEDs in the enclosure in non-problem mode, and resets a flashing LED after an out-of-tolerance situation has been rectified. Thus in normal operating mode, depressing the pushbutton indicates that all of the LEDs are functioning. When the pushbutton is released, if all 3 measuring points are within normal range, all of the green LEDS remain lighted.

If any or all of the measuring points are out of normal range, the associated red LED will light up and flash. The VSR system also includes a 10 Amp dry contact so that an alarm buzzer or light can also be used to indicate an out-of-range situation with any or all measuring points. The alarm indication is reset after correcting the out-of-range measuring point, and pushing the reset pushbutton. As shown in the schematic Diagram #5, the VSR system is powered by 110-240VAC, single phase.

Installation of the CMB and VSR sensors is straightforward as indicated by Diagram #6. The thruster reserve stroke sensor fits over the thruster end cap and bolts to the top of the thruster. Installation of the two round temperature sensors and lining thickness sensors is accomplished by fitting them into the two round holes at the top of the brake linings and securing the sensors to the lining baseplate by drilling a hole and inserting a set screw. The DMS measuring pin requires one new lining shoe, and the optical sensor for RPM indication is fitted to the brake spring tube with a bracket. Both the CMB and VSR systems are sold as kits for new or retrofit installations.

SUMMARY

The use of remote monitoring not only answers the question " How do we know the brakes are really ready for service?", but also reduces maintenance cost and improves monitoring accuracy by providing continuous brake status feedback in simple or extremely detailed formats. If the VSR system is utilized, merely glancing at the enclosures on the brakes and noting that all the LEDs are green indicates that the brakes are ready for service, or if a red LED is flashing, what the problem is. If the CMB system is used, remote indication of brake status can be provided in the diagnostics of the drive system, on a local monitor or in a remote central maintenance office. In either case, maintenance time and money will be saved, and unexpected brake failures will be minimized.

Diagram #1

Measuring points

Five measuring points on the individual brake supply the operation management with in-depth information on the brake status.

STROKE
an analog linear transducer measures the position of the reserve stroke of the brake actuator (figure 1).
FORCE
one analog DMS-measuring pin indicates the actual braking force for the brake (figure 2).
TEMERATURE
two analog PT 100 temperature sensors record the actual temperature of the linings (figure 3).
PAD WEAR
two binary wear contacts measure the actual wear of the linings (figure 4).
DISC RPM
one optical or alternative inductive transmitter measure the RPM`s of the brake disc. This data is needed for monitoring of the friction factor during emergency stops (figure 5).

All these readings are logged by the CMB unit and can then be transmitted to the drive control or to a stand-alone unit. Information transmission from the CMB unit can take place by digital radio data or by interbus S.

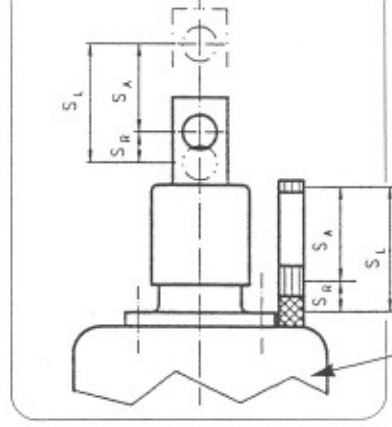


fig. 1 **stroke**

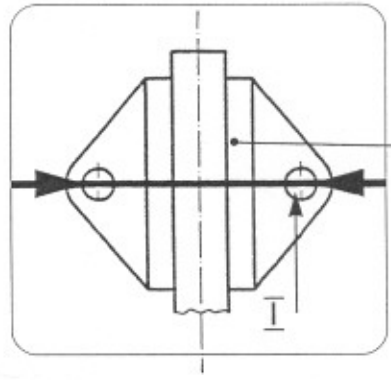


fig. 2 **force**

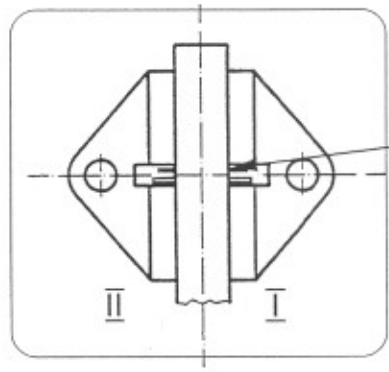


fig. 3 **temperatures**

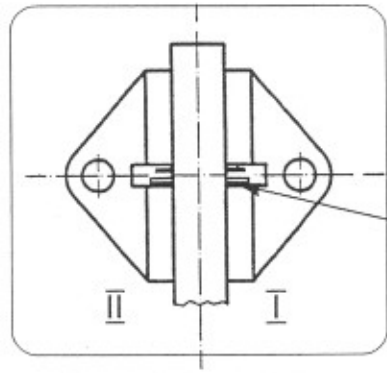


fig. 4 **wear**

fig. 5 **speed**

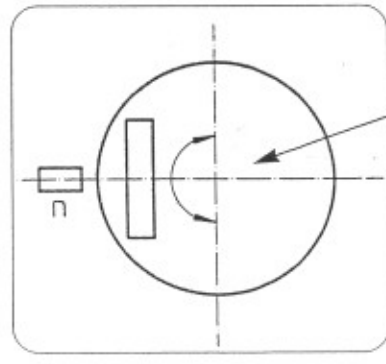
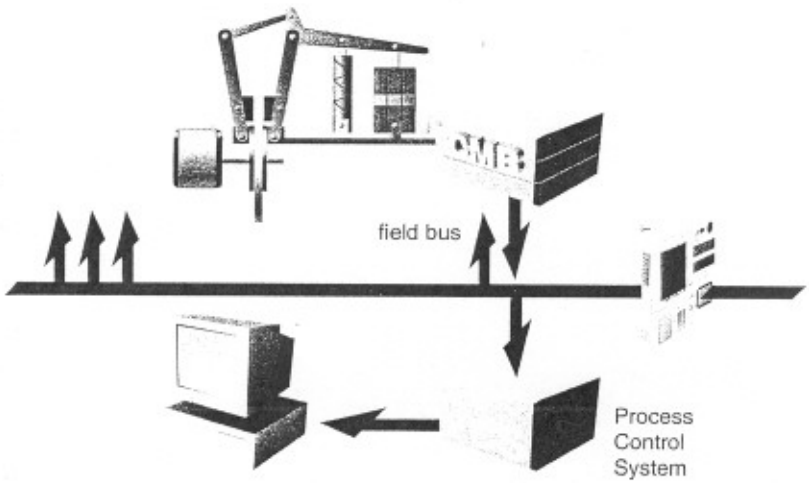
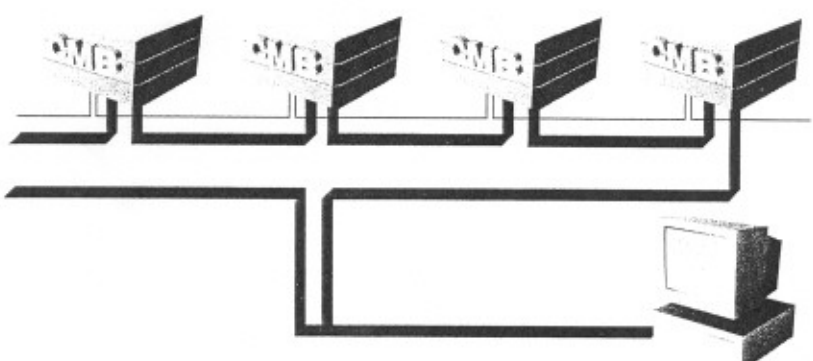


Diagram #2



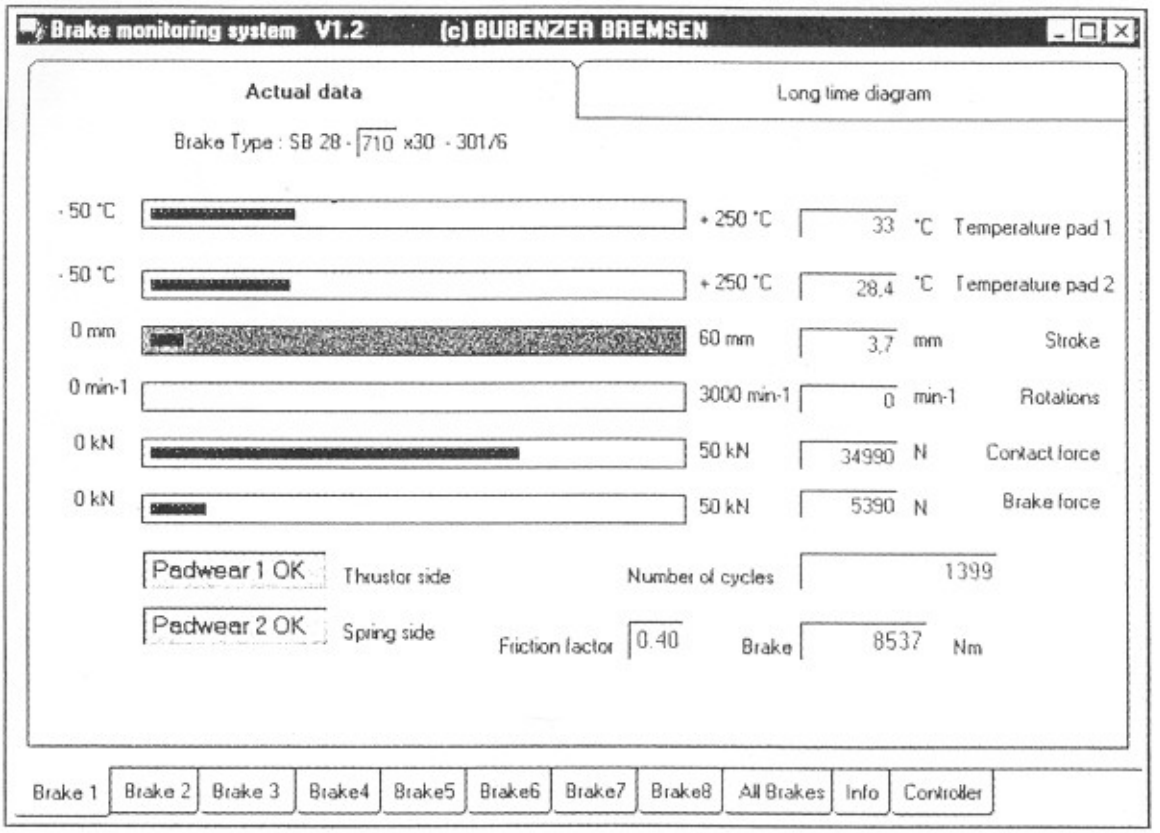
Drive integrated solution

Stand-alone solution

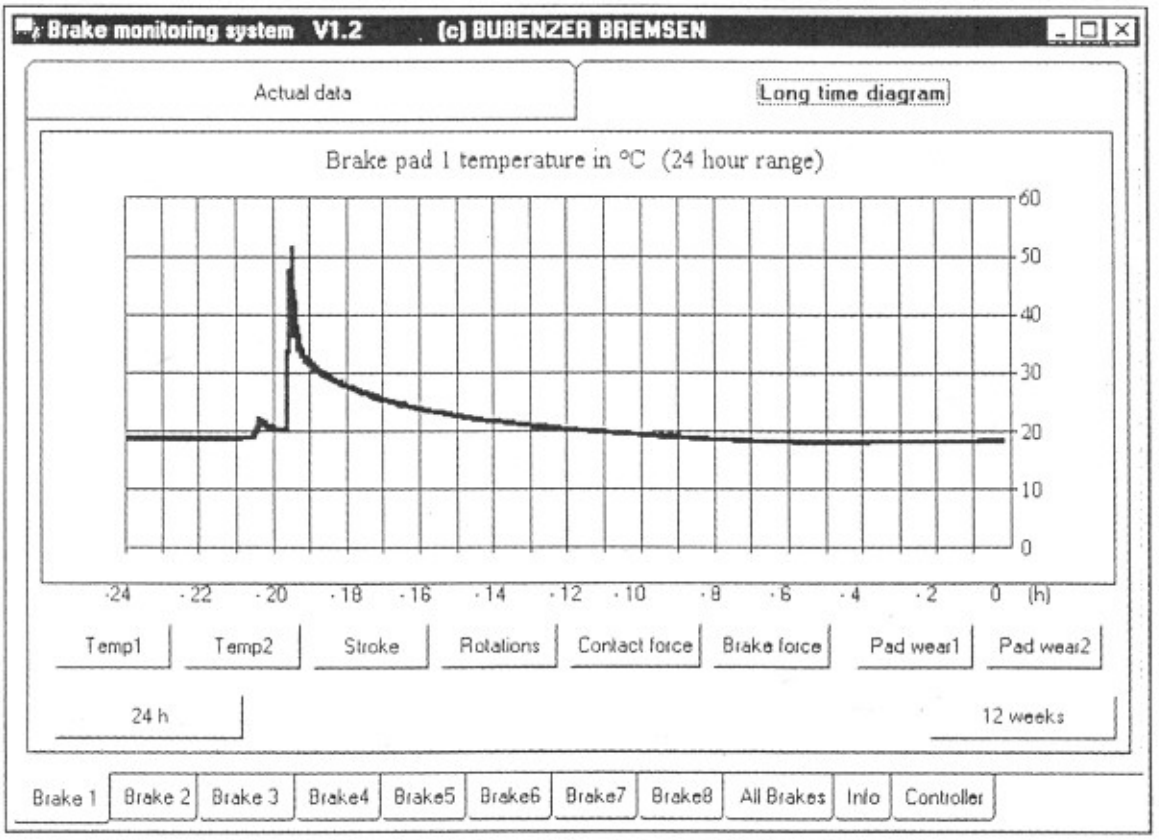


e.g.
Maintenance Office

Diagram #3

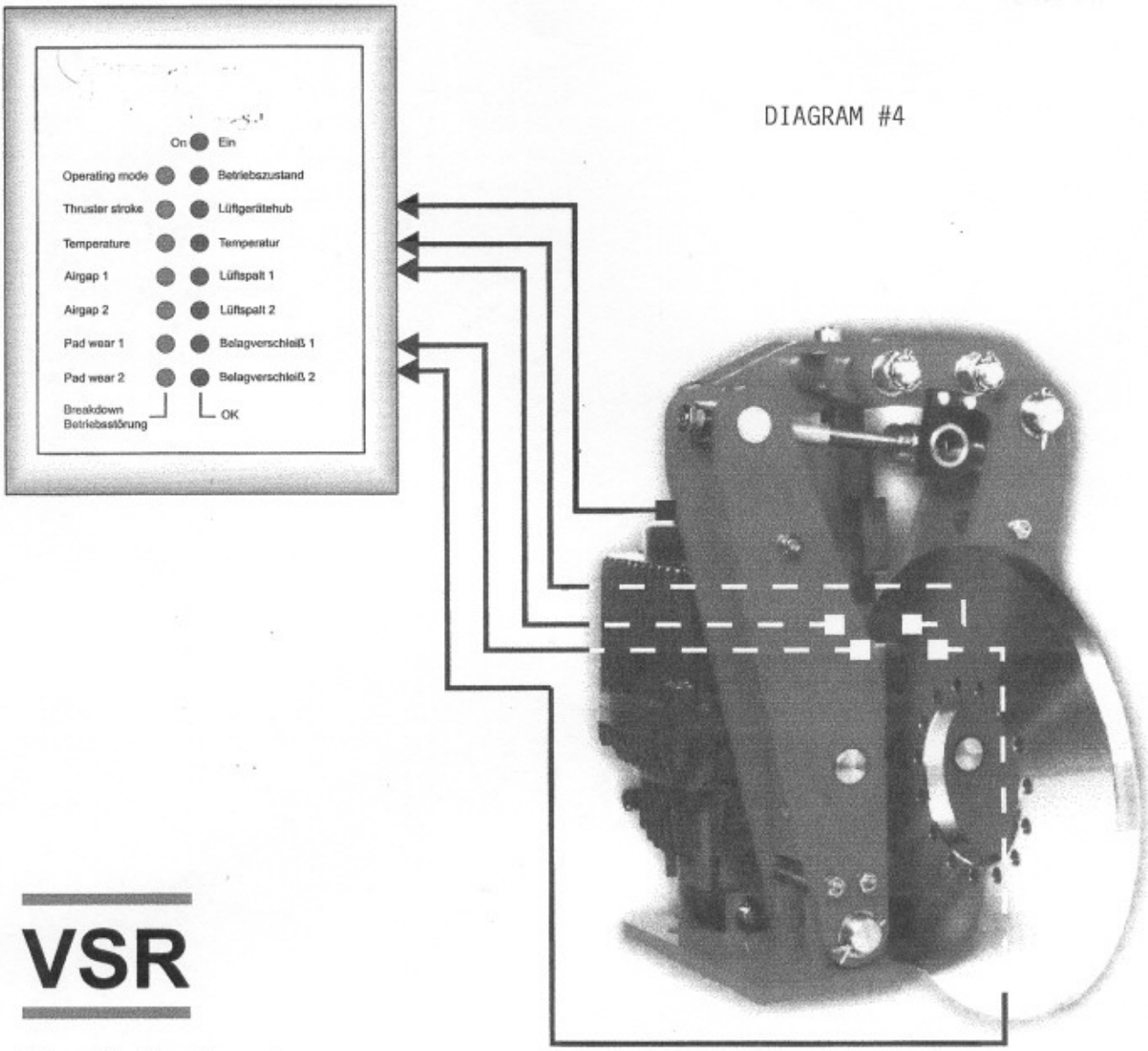


over view



lining temperature status of 24 hours

DIAGRAM #4



VSR

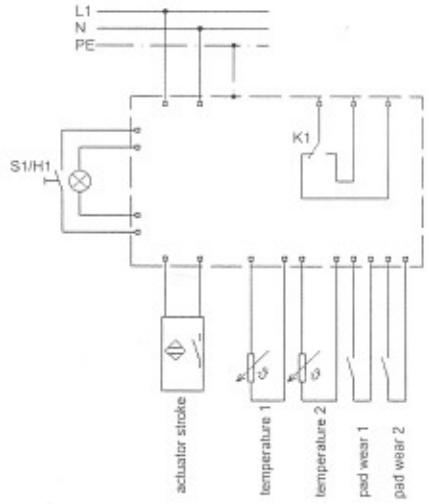
Visual indication of:

- actuator stroke (< 5 mm, > 20 mm, < 55 mm)
- maximum brake pad temperature
- airgap difference between disc and pad surface by measuring the temperature difference between pads caused by unilateral pad rubbing
- pad thickness < 5 mm

Technical Data:

Diagram #5

Operating voltage:	110-120 V or 220-240 V, 50/60 Hz
Scope of supply:	2 PT100 temperature sensors with adapter plug 2 wear sensors with adapter plug 1 actuator stroke sensor 1 electronic box IP65 with cable connection
Optional:	LCD-Module (2 lines with 16 characters each) to indicate the actual operating status in clear text form, like e.g. brake pad temperature or operating cycles.



The operating status of the brake will be indicated by LED´s fitted to an electronic box with transparent screen. The box is additionally fitted with a red flash light push button indicating occuring failures.

As an option, a signal light may be installed in the control room (e. g. in the crane driver cabin) to indicate any brake failure.

During normal brake operation, all green LED´s show green ligth. In case of a failure at the brake the respective green LED extinguishes and the opposite red LED starts flashing.

If in the meantime the indicated failure has been remedied, e. g. through a temperature reduction at the brake pads, both the red and the green LED flash by turns. Pushing the red flash light button will cancel the failure indication and all LED´s will reset to green again.