

The Brakes must be able to manage all possible situations!

Haldex



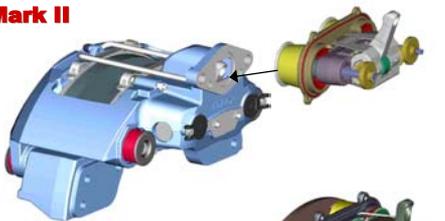
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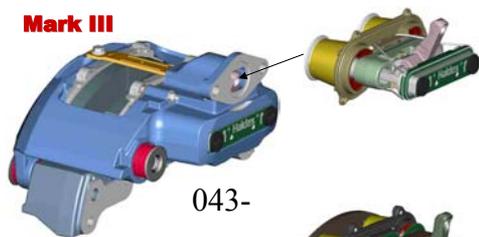
Development

Haldex

Mark II

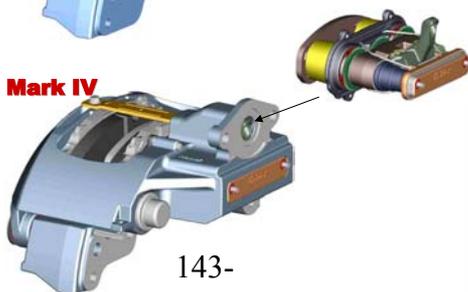


Mark III



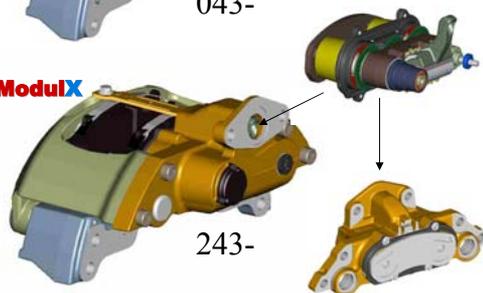
043-

Mark IV



143-

ModuX



243-

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The Haldex concept

Haldex

- Modular design
- Two piece calliper
- Quadruple slide pins
- Unhanded
- Low hysteresis actuator
- Twin tappets / spindles
- Heat protected tappet bellows
- Clearance sensing adjuster
- Repairable
- Spare parts kits available



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Two piece caliper

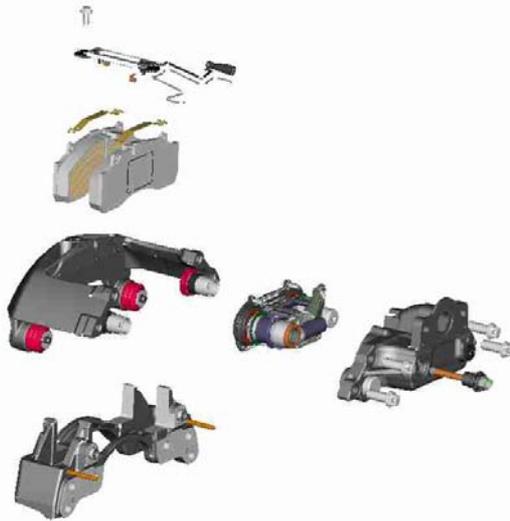
Haldex

- Completely unhanded
- Light weight and small package size
- Accommodates different rotor thickness by changing one piece
- No sealing elements subject to high loads



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Common application module

- Twin Tappets
- One self contained application unit for multiple brake sizes
- High efficiency with cylindrical roller bearings
- Serviced as an assembly
- Silicone rubber bellows
- Heat protecting springs (Optional)

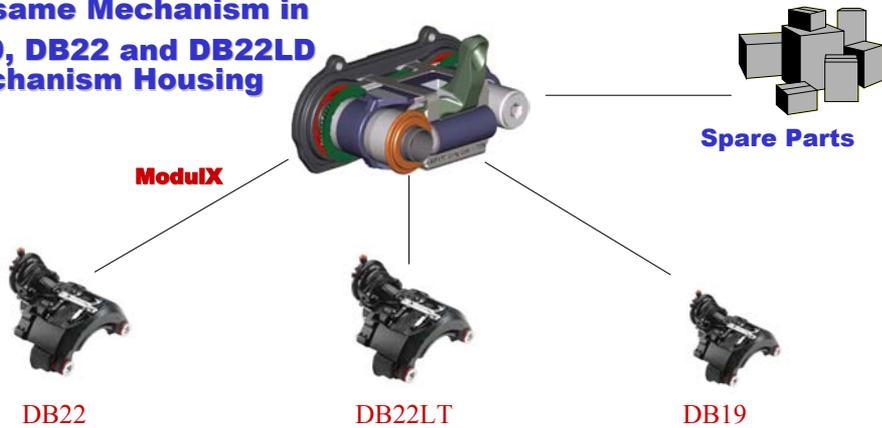
Mechanism/
application
module



Mechanism / Housing

Haldex

The same Mechanism in
DB19, DB22 and DB22LD
Mechanism Housing



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Unhanded

Haldex

The 4 slide pins makes it possible to:

- Fit the same brake both left and right hand side
- Carrier and calliper parts built to receive the forces in both directions of rotation
- Less parts in stock, less number of parts to manage



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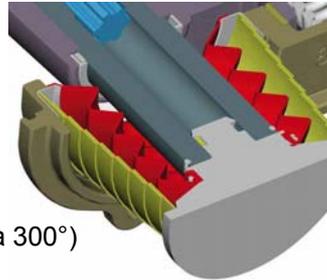
A sensible part of the Disc Brake

Haldex

Tappet protection

- Protection Springs - protection against heat radiation and physical damages (peak à 300°)
- Rubber bellows – protection against water and dirt ingress.

(Operation Temperature -60° to $+250^{\circ}$, peak à 300°)



An important function : The sliding function

Haldex

- Stainless steel slide pins for improved stability and corrosion resistance
- Self lubricating, Teflon® slide bearings for low friction
- Dust protected with silicon rubber bellows
- Protective solid cover in calliper
- One kit fits 3 brake sizes



Corrosion test

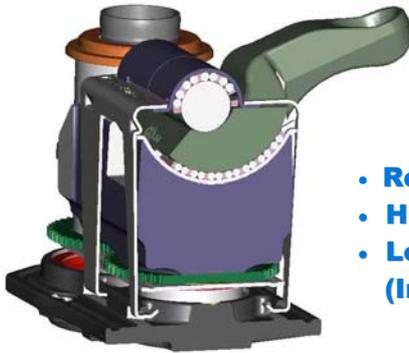
14 days (Haldex)

3 days (competitor)



2 x 2 needle bearings = low hysteresis

Haldex

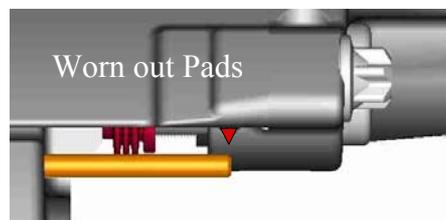
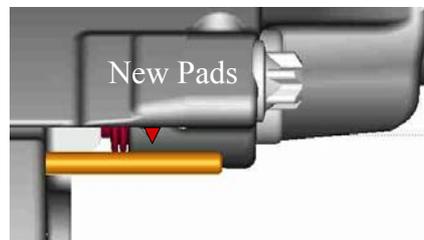


- **Reduced friction**
- **High efficiency**
- **Low Hysteresis**
(Important for proper ABS-function)

VWI, Visual Wear Indicator

Haldex

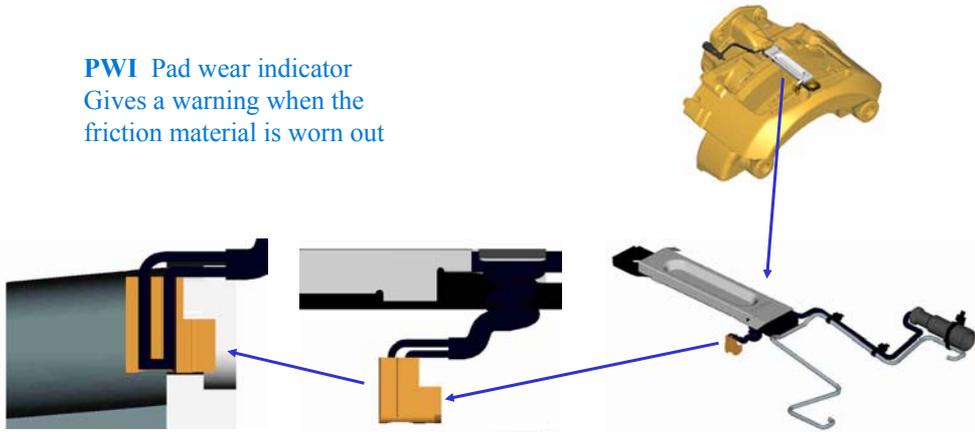
- **Casted arrow on the caliper**
- **Slotted steel pin seated in the carrier**
- **The distance from the arrow to the end of the slotted pin indicates remaining friction material**



Wear indication system, PWI

Haldex

PWI Pad wear indicator
Gives a warning when the friction material is worn out

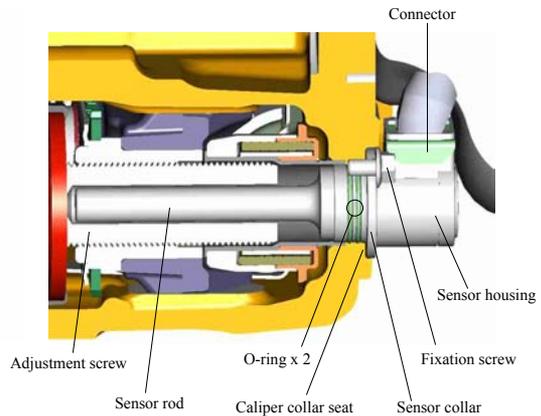


Type of wiring and connector according to customer demand

Wear indication system, PWS

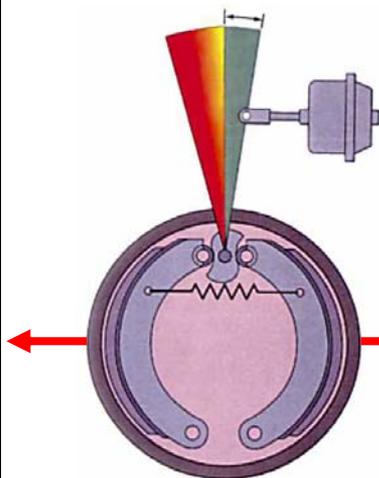
Haldex

PWS Pad wear sensor
CWS Continuous wear sensor



Limits of the drum brake

Haldex



Decreasing efficiency at ~300°
Extended brake chamber stroke.

Increased temperature =
increased elasticity
of the wheel brake
components.



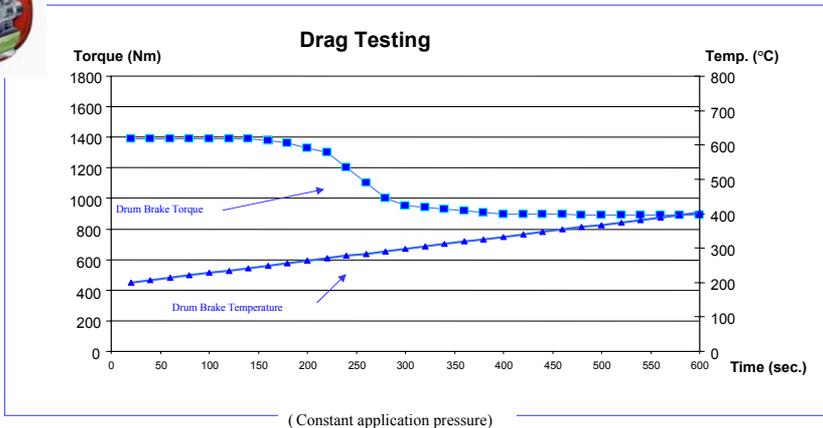
Dyno comparison test

Haldex



Drum Brake Characteristic

Haldex



Haldex Disc Brake

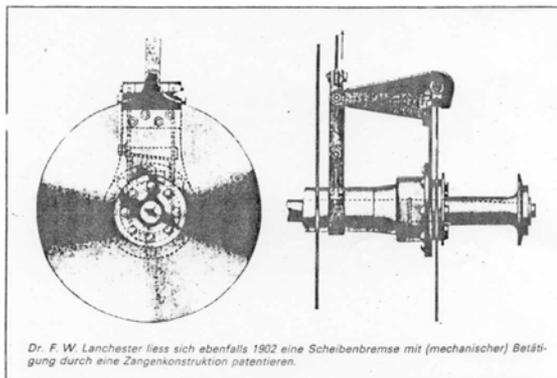
Haldex



The idea isn't new !

Haldex

BRÉMSEN



DISC BRAKES

- 1902 Patent Lanchester
- 1950 Jaguar - Le Mans
- 1960 Passenger cars
- 1990 Truck
- 1996 Truck break through
- 1997 Trailers
- 2006 Physical laws still valid

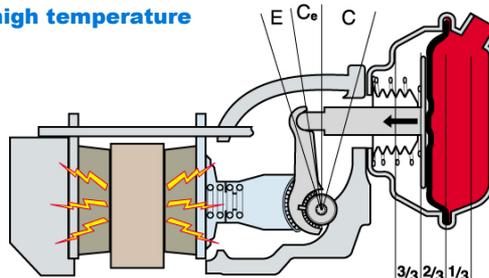
The Disc Brake really has been around for a while - - -

Haldex Disc Brake

Haldex

Application pressure per Cm^2 on the friction material is 4 times higher in the disc brake than in the drum brake

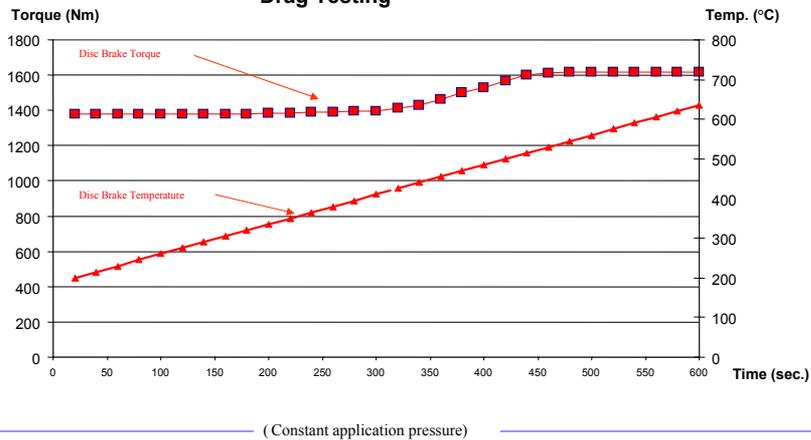
- More efficient at higher temperature
- Less stroke extension at high temperature
- Less elasticity at high temperature



Disc Brake Characteristic



Drag Testing

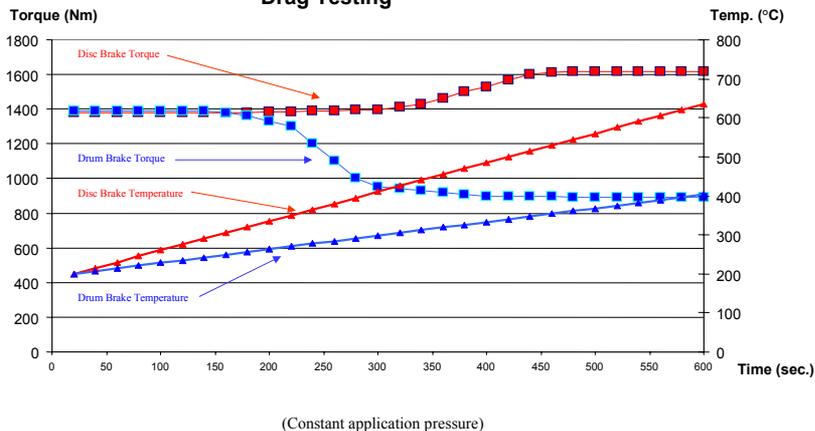


(Constant application pressure)

Characteristic: Drum Brake compared to Disc Brake



Drag Testing

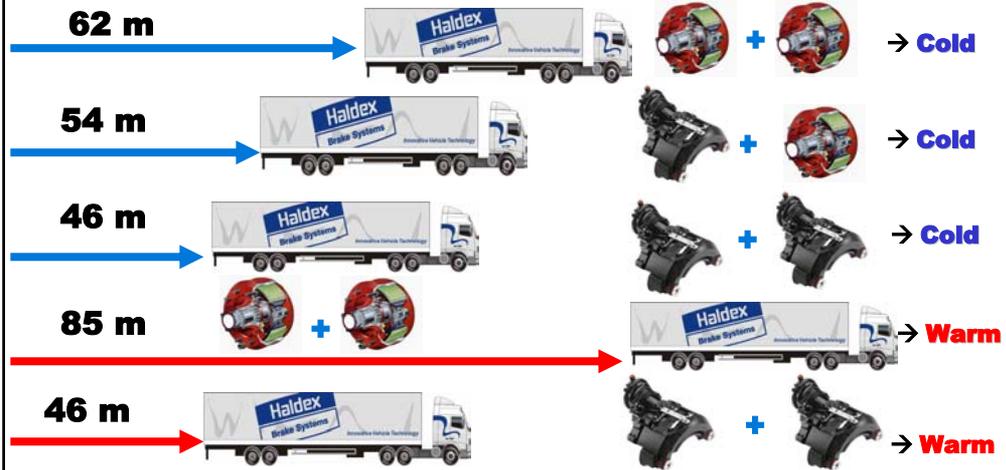


(Constant application pressure)

Safety → Brake Distance

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Tractor + semi-trailer, 40 tonnes, speed 85 Km/h



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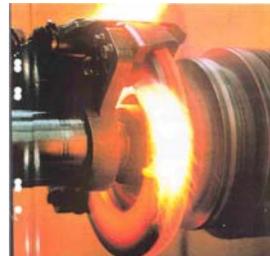
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Product Testing

Haldex

- Dynamometer test
- Torque test (Chucker)
- Dirt Chamber
- Fatigue (Puls test)
- Vibration test (Hydropuls)
- Vehicles (Lab)
- Vehicle field test



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Product Testing

Haldex

- Dynamometer test
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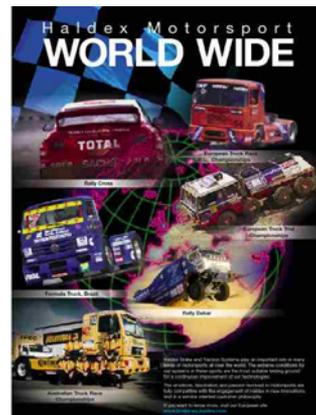
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Truck Racing

Haldex

- Our participation in various Truck Racing Cups, shows that Haldex Disc Brake manage tough conditions with very good results.
- The low hysteresis is one of the reasons for our good results.

**Haldex Standard
Production Disc Brakes !**

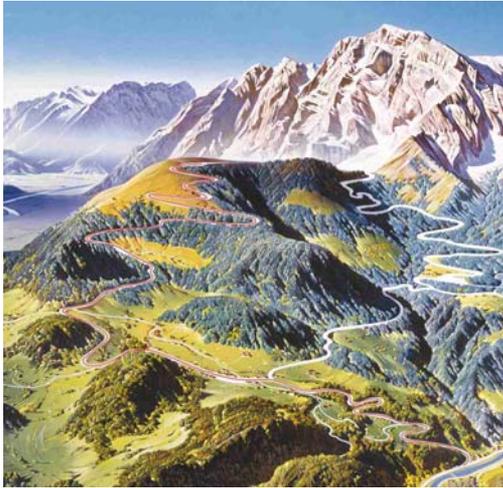


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Haldex Disc Brakes reduces the risk for fading brakes

Haldex



- Haldex Disc Brakes are tested in the German Alps. Rossfeld mountain is a well-known alpine distance for testing.

Rossfeld mountain, southern Germany

Peak: 1600 metres above sea level

Test track: 11 km

Altitude difference: 1000 m

Average gradient: 9.1%

Maximum gradient: 14%

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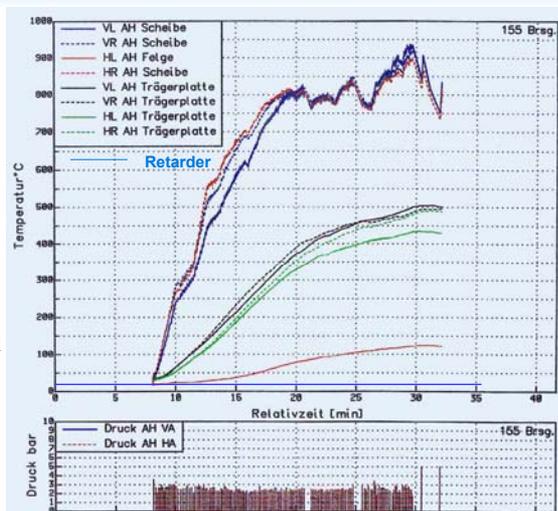
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Rossfeld Test

Haldex

- Two-axle drawbar trailer
- Single wheels
- Total weight: 18 tonnes
- Descent time: 23 minutes
- Brakes applied ~150 times
- Speed increased to 35Km/h thereafter, by braking, reduced to 25Km/h, increased to 35Km/h again etc.



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Special Tool Kit

Haldex

Haldex Disc Brake

Service Manual

(Not included in Tool Kit P/N 81918)

Tool Kit P/N 81918

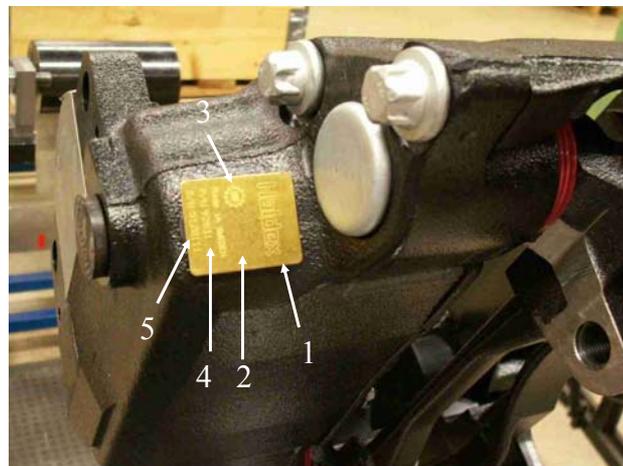


Product Identification

Haldex

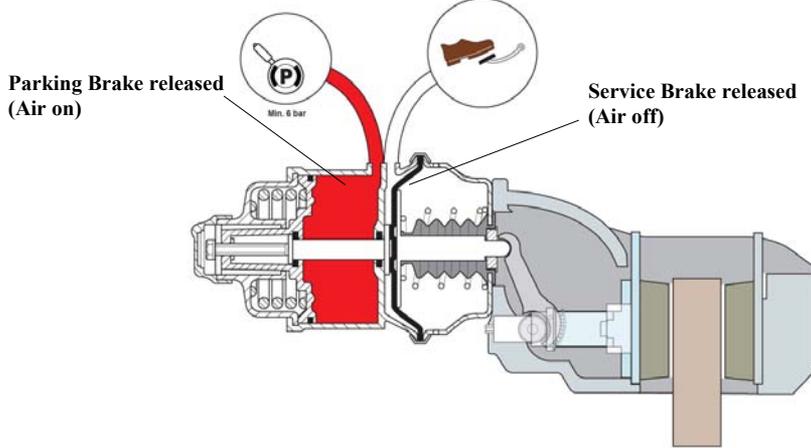
Explanation

1. Haldex/OEM logo
2. OEM P/N (if required)
3. Haldex EC (origin)
4. Haldex P/N
5. Haldex S/N 5120111
5 = year, 2005
12 = week No. of the year
0111 = sequential No.



Spring Brake Chamber

Haldex



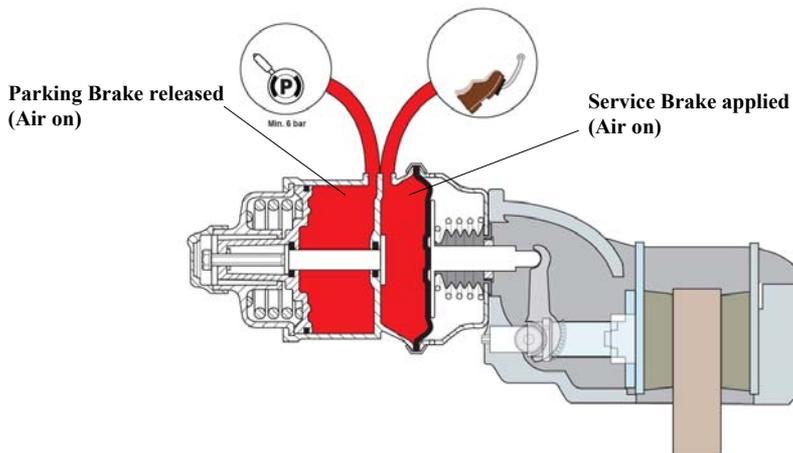
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Spring Brake Chamber

Haldex



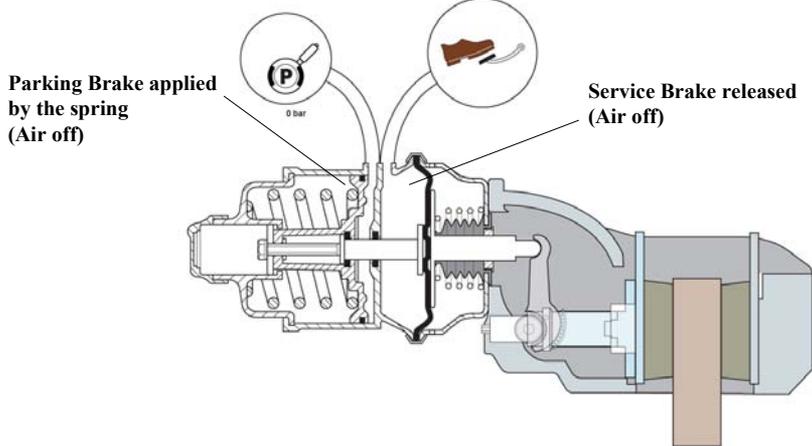
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Spring Brake Chamber

Haldex

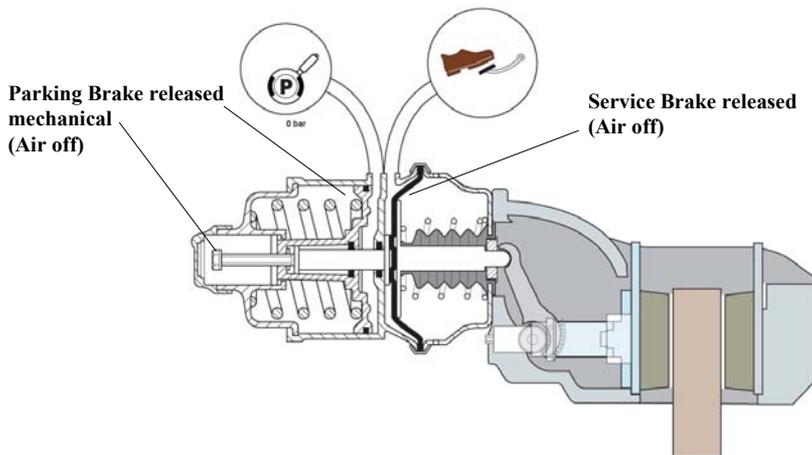


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Spring Brake Chamber

Haldex



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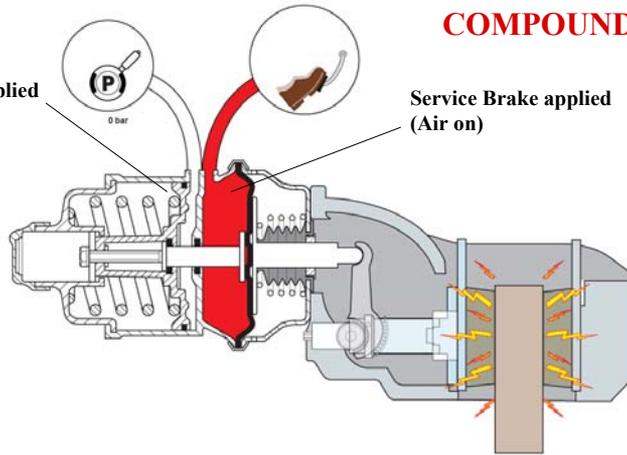
Spring Brake Chamber

Haldex

COMPOUNDING !

Parking Brake applied
(Air off)

Service Brake applied
(Air on)



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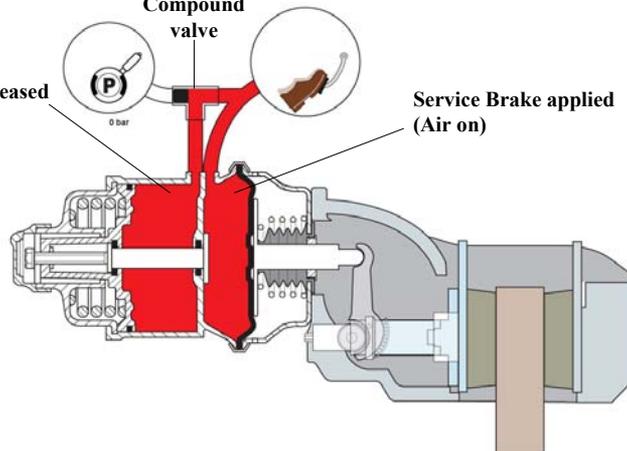
Spring Brake Chamber

Haldex

Anti
Compound
valve

Parking Brake released
(Air on)

Service Brake applied
(Air on)



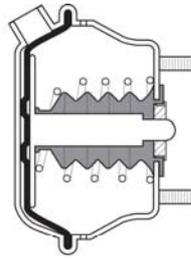
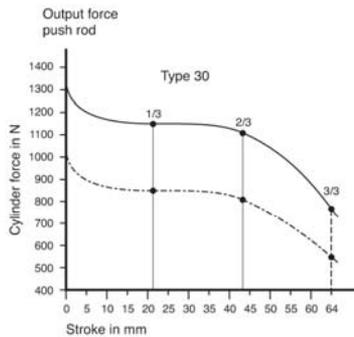
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Service Brake Chamber

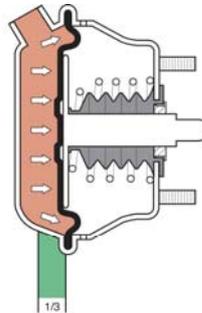
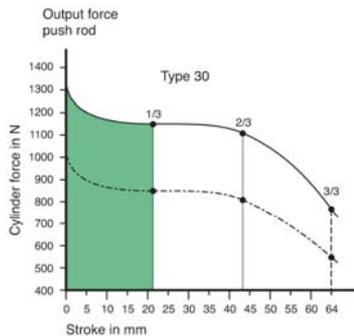
Haldex



Cylinder force depending on diaphragm position:
 — at 6.0 bar
 - - - at 2.0 bar
 ····· max. stroke

Service Brake Chamber

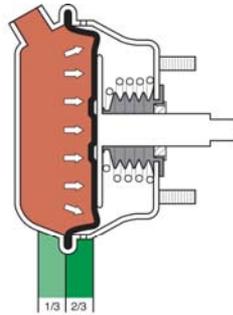
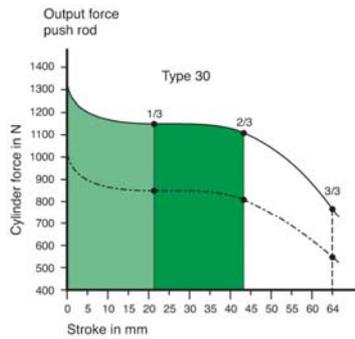
Haldex



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Service Brake Chamber

Haldex

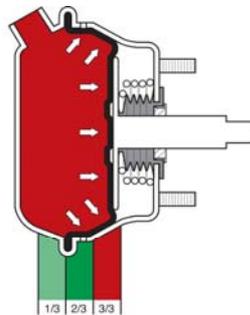
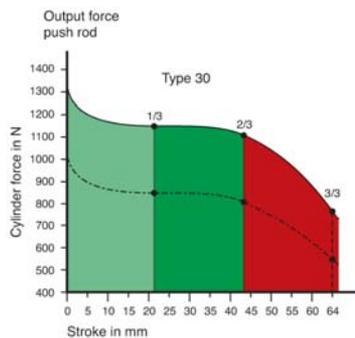


Cylinder force depending on diaphragm position:

- at 6.0 bar
- at 2.0 bar
- max. stroke

Service Brake Chamber

Haldex

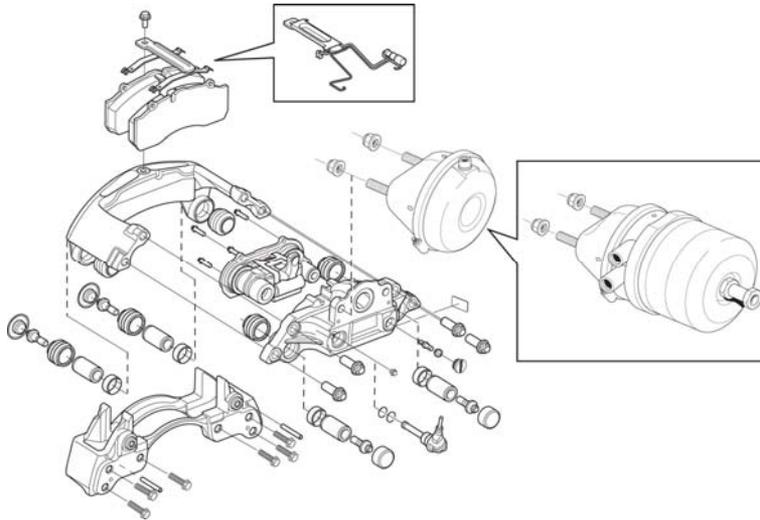


Cylinder force depending on diaphragm position:

- at 6.0 bar
- at 2.0 bar
- max. stroke

Haldex Disc Brake, exploded view

Haldex



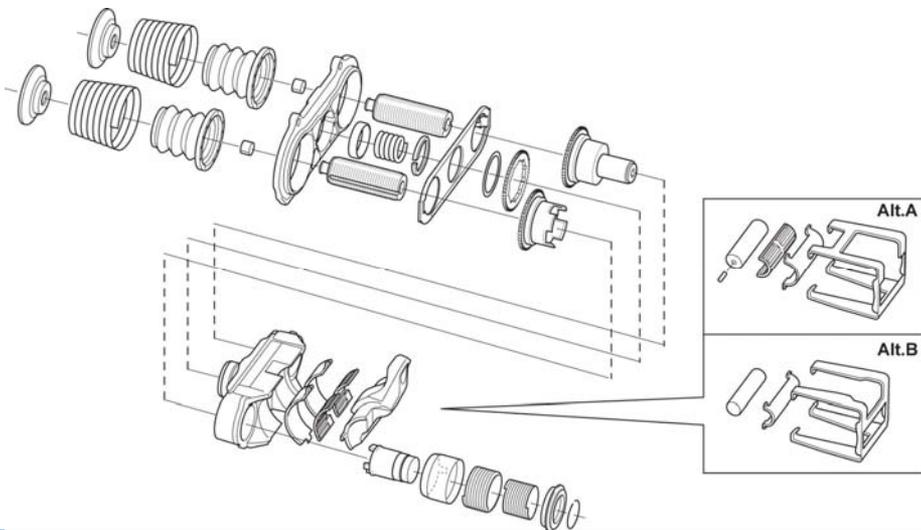
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Mechanism, exploded view

Haldex



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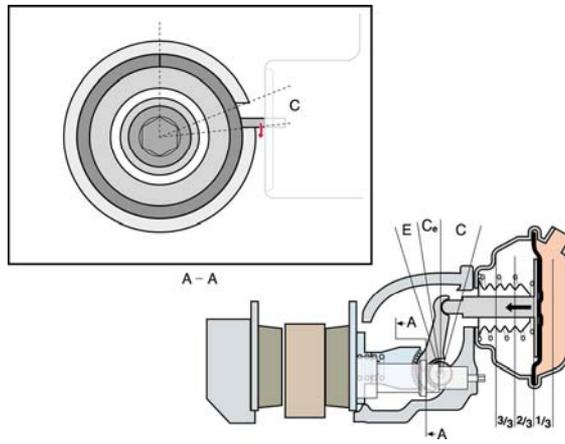
42

Function description

Haldex

Application

C = clearance



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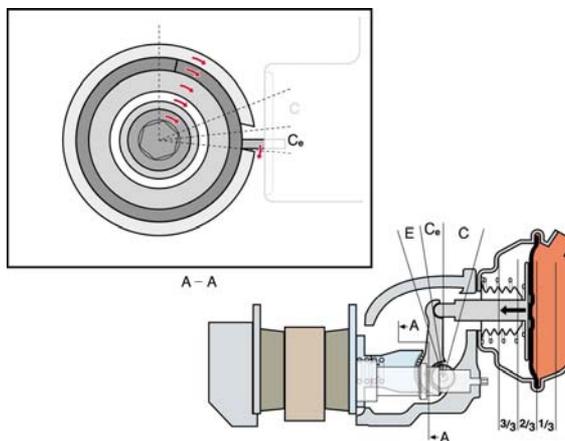
Function description

Haldex

Ce = excessive clearance

Application

Ce = excessive clearance



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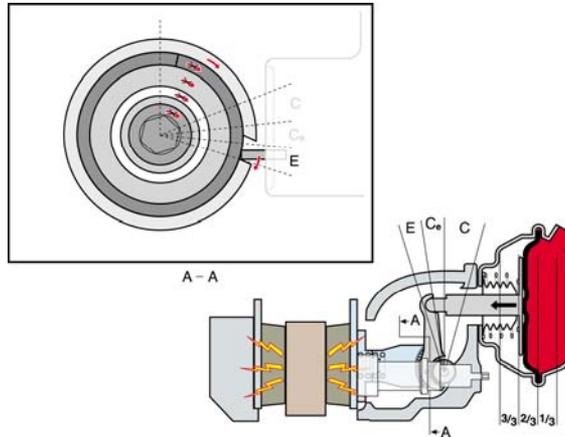
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Function description Elasticity

Haldex

Application

E = elasticity



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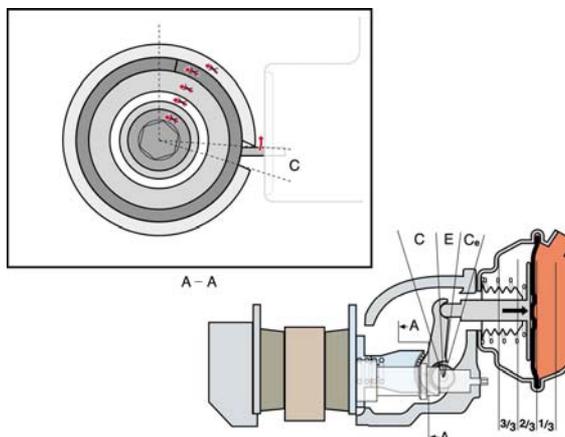
47

Function description Clearance

Haldex

Release

C = clearance



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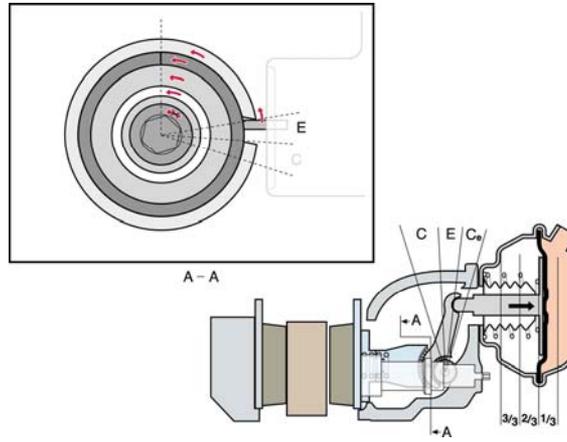
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Function description Elasticity

Haldex

Release

E = elasticity



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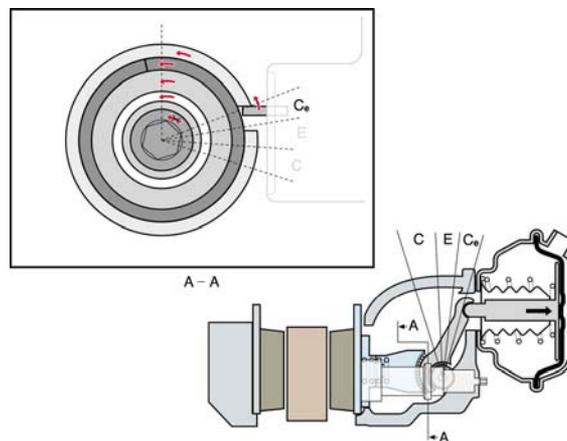
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Function description Excessive Clearance

Haldex

Release / back
in rest position

C_e = excessive
clearance



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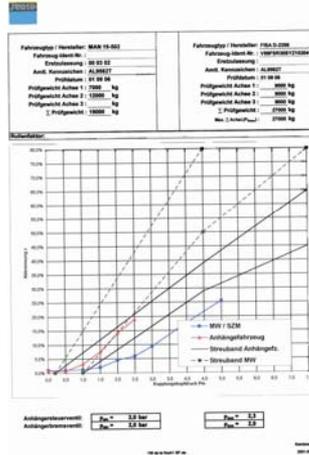
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HALDEX Disc Brake Rolling Road Test

Haldex



Zugabstimmung:
Diagramm MW / SZM und Anhängelast



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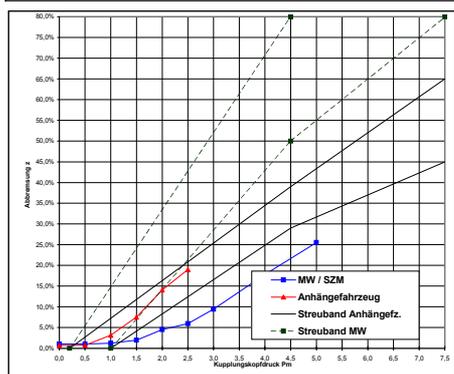
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Rolling Road Test

Haldex

Fahrzeugtyp / Hersteller: MAN 19.322, de la Huz	Fahrzeugtyp / Hersteller: FSA D.3356
Fahrzeug-Ident-Nr.: AL 9952 T	Fahrzeug-Ident-Nr.: R-2090-BBD
Erstzulassung: 00 09 06	Erstzulassung: 01 09 06
Amtl. Kennzeichen: AL 9952 T	Amtl. Kennzeichen: AL 9952 T
Prüfdatum: 01 09 06	Prüfdatum: 01 09 06
Prüfgewicht Achse 1: 7000 kg	Prüfgewicht Achse 1: 9000 kg
Prüfgewicht Achse 2: 12000 kg	Prüfgewicht Achse 2: 2000 kg
Prüfgewicht Achse 3: 12000 kg	Prüfgewicht Achse 3: 9000 kg
Σ Prüfgewicht: 18000 kg	Σ Prüfgewicht: 27000 kg
	Max. Z-Achslast (P _{max}): 27000 kg

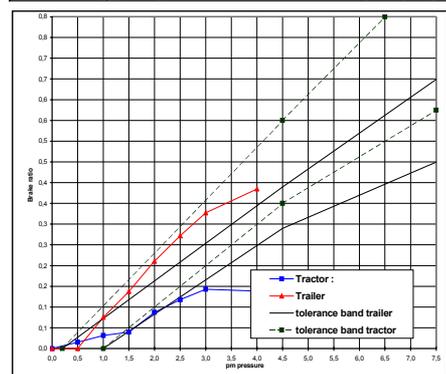
Rollenfaktor:



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Make / Typ: DAF/DF-430 Gines Camacho	Make / Typ: HERMANS
Vehicle Identification No.: ZLRTX50E463739	Vehicle Identification No.: V58CALALS1V865482
First registration: 25.04.07	First registration: 22.04.07
Licence number: GR-9514-AM	Licence number: R-8666-BBF
Date of test: 08.08.08	Date of test: 13.11.02
Actual weight axle 1 [kg]: 6660 kg	Actual weight axle 1 [kg]: 7000 kg
Actual weight axle 2 [kg]: 12000 kg	Actual weight axle 2 [kg]: 2000 kg
Actual weight axle 3 [kg]: 12000 kg	Actual weight axle 3 [kg]: 7000 kg
? Actual weight [kg]: 18750 kg	? Actual weight [kg]: 21200 kg
	Max. 7 axle weight (P _{max}): 21200 kg

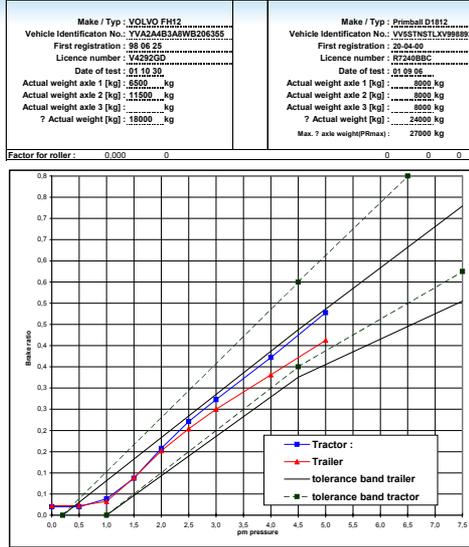
Factor for roller: 0.000 0 0 0 0



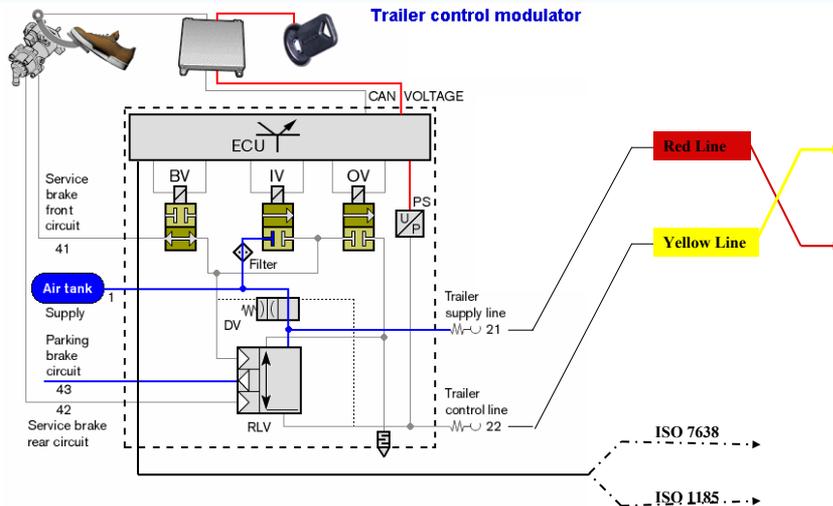
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Rolling Road Test , ideal balance

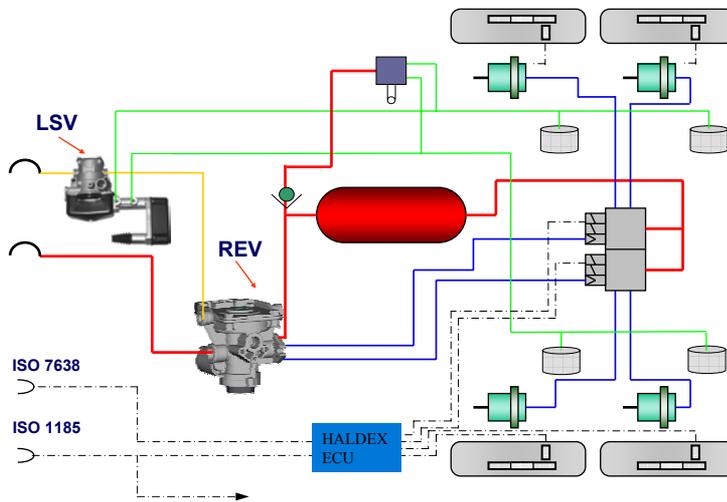


Tractor EBS System



HALDEX Disc Brake

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PROBLEMS ?

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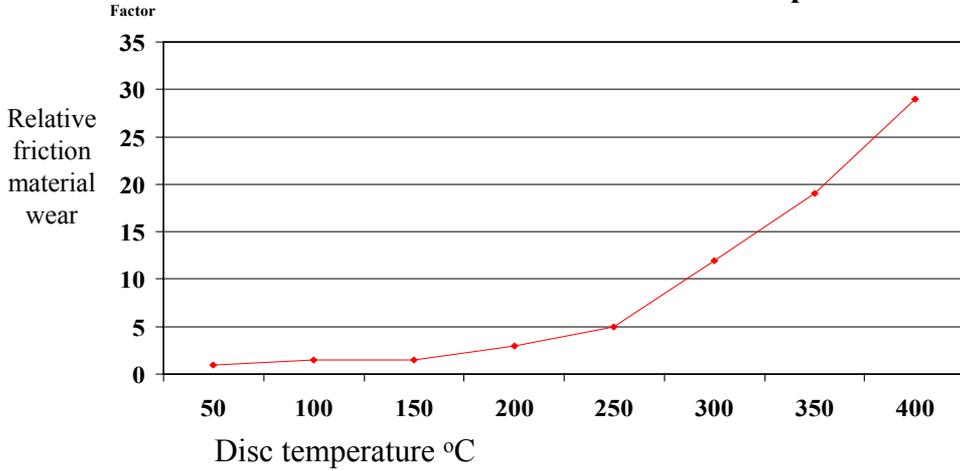
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Thermal overload

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Pad friction material wear in relation to temperature.



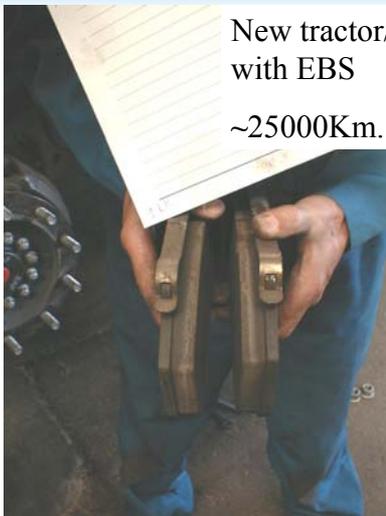
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Thermal Overload

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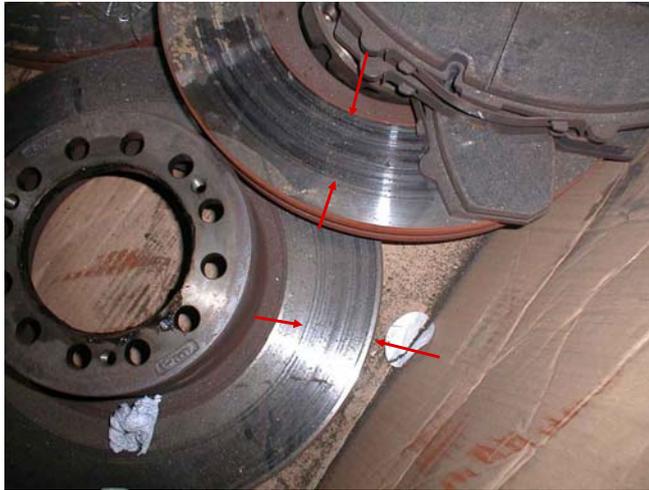
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Thermal Overload

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Heat distortion



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Thermal Overload

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Thermal Overload

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Summary, Thermal Overload:

- Just to change damaged components doesn't solve the problem - the new components will get damaged as well!
- Each axle/vehicle in a combination must perform braking in relation to the weight it is carrying for the moment - dynamics included.

Proper action:

- Change damaged components.
- Identify the root cause to the problem.
- Take action as required for proper repairs/adjustments.
- Verify actions taken.

Importance of harmonisation

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Some other PROBLEMS ?

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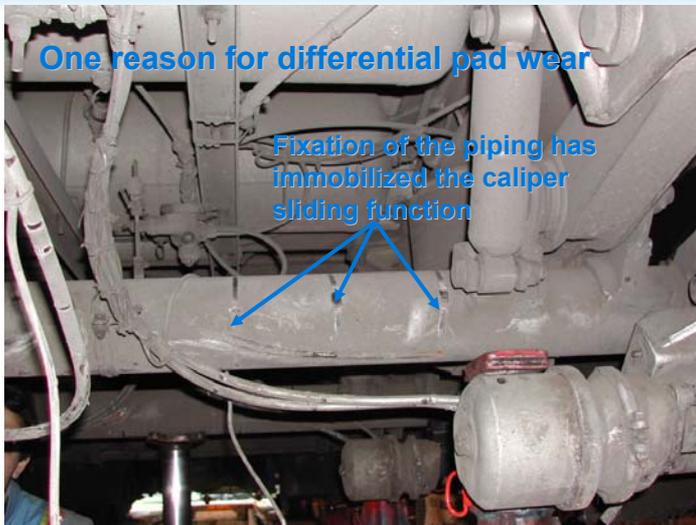
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Accelerated wear of inner pad

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One reason for differential pad wear

Fixation of the piping has immobilized the caliper sliding function



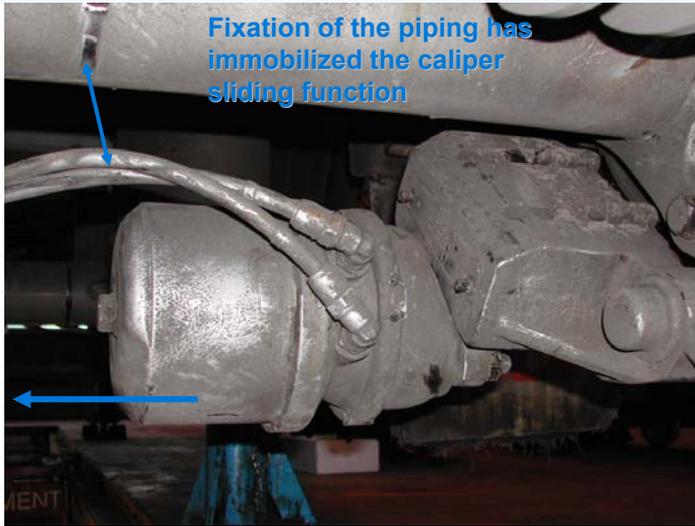
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Pad wear, inner/outer

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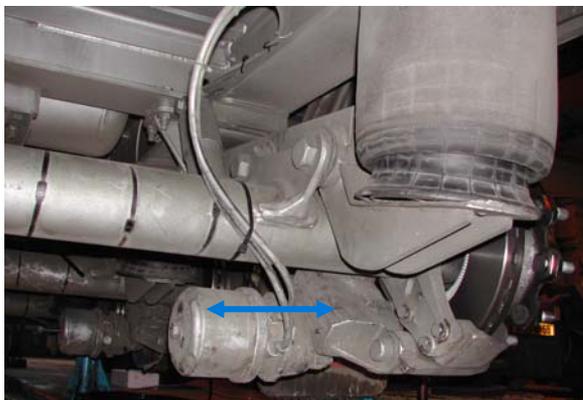
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Equal wear on inner/outer pad

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Wear compensation: The caliper must be allowed to have free floating, without influence of directing forces, throughout the complete caliper travel (needed for compensation of pad wear).

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Damaged thrust plates

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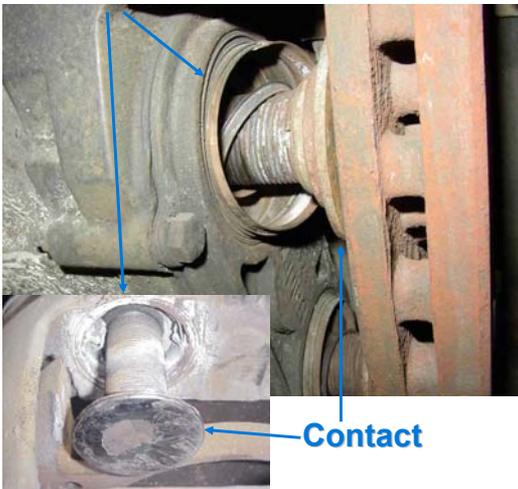


The thrust plate has been in contact with the disc = worn out pads, including the back plate! (Inspections?)

Contact damages

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Bellows burnt



Wheel bearing break down



Impossible to release the brake adjustment enough to fit new pads?

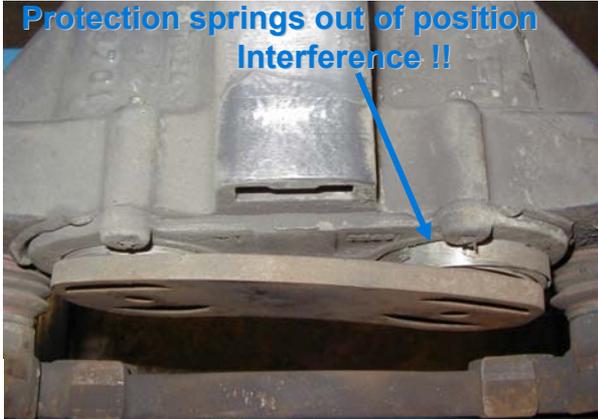
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Thermal overload:
overheated/crystallized
grease



Change bellows, clean /put
new high temp. grease on
the adjustment screws and
- - - rectify the root cause!

Protection springs out of position
Interference !!



Note! The protection spring must be put
back in its ordinary position!

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Water ingress → corrosion

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Sealing joints



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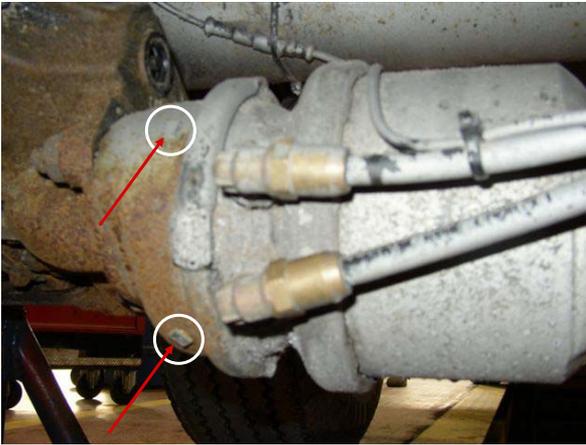
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Water ingress → functional disorder

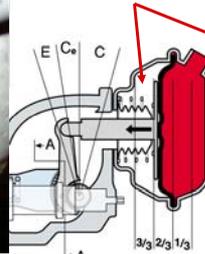
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All plugs in the brake chamber housing fitted !



This means no ventilation = vacuum will immobilize the brake chamber = the disc brake will not work!

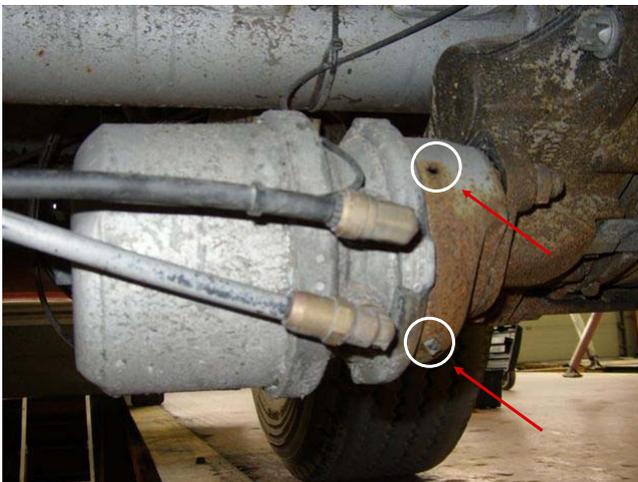
This will/may be identified as a non functional disc brake !



Vacuum!

Water ingress → functional disorder

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The upper plug is removed

The bottom plug is fitted

The brake chamber housing will be filled with water = at temperature below 0° C the water will freeze which will/may immobilize the brake chamber, damage the diaphragm etc.

Immobilized brake chamber will/may be identified as a non functional disc brake!

Water - dirt – accelerated wear

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**Life is
not always so easy !**

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Water - dirt – accelerated wear

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Without protection



With protection

Pad wear: 20 - 30 Km = 7mm !

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Conclusion

Are disc brakes the ultimate solution?

As with all mechanical devices they have their limitations, but provided that the application is correctly designed and the distribution is properly made, they are probably nearer to the ultimate than any other braking device available today.

2006 *Physical laws are still valid !*

I didn't know all that !

