



# **ZF-Intarder – The Wear-Free Continuous Brake for Coaches and Intercity Buses**

Commercial Vehicle Technology



# Agenda

1. Product and Sales, Benefit
2. Technology and Operation
3. Competition Topics

# 01

## Product and Sales, Benefit



# Development

## Retarder Systems for Commercial Vehicles

| System                        | ZF-Retarder<br>Hydrodynamic<br>auxiliary brake                                    | ZF-Intarder<br>First<br>generation                                                 | ZF-Intarder<br>Second<br>generation                                                 | ZF-Intarder<br>Third<br>generation                                                  |
|-------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Application                   | Heavy truck<br>Medium truck<br>Coach                                              | Heavy truck<br>Medium truck<br>Coach<br>Intercity bus                              | Heavy truck<br>Medium truck<br>Coach<br>Intercity bus                               | Heavy truck<br>Medium truck<br>Coach<br>Intercity bus                               |
| Principle                     | Dual flow                                                                         | Single flow                                                                        | Single flow                                                                         | Single flow                                                                         |
| Operating modes               | Manual, 1 automatic                                                               | Manual, 3 automatic                                                                | Manual, 3 automatic                                                                 | Manual, 3 automatic                                                                 |
| Max. brake torque [Nm]        | 2,500                                                                             | 3,200                                                                              | 3,200                                                                               | 4,000                                                                               |
| Max. braking performance [kW] | 300                                                                               | 420                                                                                | 500                                                                                 | 600                                                                                 |
|                               | <b>1987</b>                                                                       | <b>1993</b>                                                                        | <b>2000</b>                                                                         | <b>2006</b>                                                                         |
|                               |  |  |  |  |

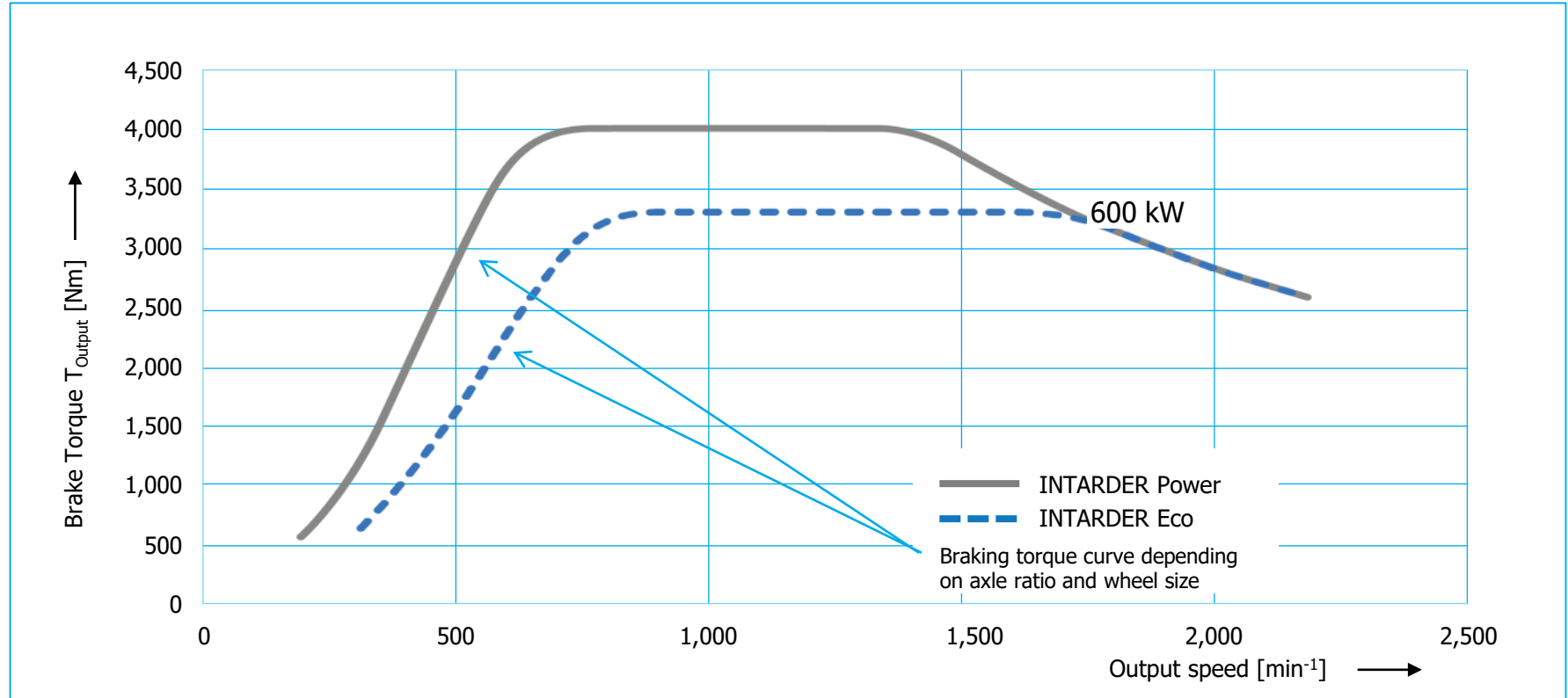
# Product Data

|                                           |                                                                           |
|-------------------------------------------|---------------------------------------------------------------------------|
| <b>Operating modes</b>                    | Bremsomat • Bremsomatic • Bremsomatic + Tempomat                          |
| <b>Braking stages</b>                     | 5                                                                         |
| <b>Brake torque [Nm]</b>                  | AS Tronic • EcoShift:<br>4,000 (Power) or 3,300 (Eco)                     |
| <b>Brake power [kW]</b>                   | Max. 600 (short-time)                                                     |
| <b>Idle speed performance</b> (1,500 rpm) | 1.4 kW (Power); 1.1 kW (Eco)                                              |
| <b>Noise [db(A)]</b>                      | 80                                                                        |
| <b>Weight of Intarder unit [kg]</b>       | Approx. 65 (depending on version)                                         |
| <b>Operating principle</b>                | Hydrodynamic hydraulic brake                                              |
| <b>Control</b>                            | Electronic (CAN communication)                                            |
| <b>Oil supply</b>                         | Together with the transmission                                            |
| <b>Cooling and heating function</b>       | Via the vehicle cooler for the transmission and the Intarder              |
| <b>Compatibility</b>                      | With ABS systems, EBS                                                     |
| <b>Release</b>                            | According to the Directive on the Transportation of Hazardous Goods (GGV) |



# Brake Torque Chart

## Intarder 3



# One Idea – Many Fields of Application

## Truck



## Crane



## Bus



## Rail



# Customers in the Bus Segment

**MAN**



**Renault**



**Van Hool**



**Ayats**



**Mercedes-Benz**



**Setra**



**Neoplan**



**Prevost**



# The Highlights

## ZF-Intarder – for the modern bus

- Integrated retarder system
- Optimal scope of effect
- Fading and wear-free braking
- Integration in brake management

**ZF-INTARDER**



ZF-Intarder – The Wear-Free Continuous Brake for Coaches and Intercity Buses



# Always in a Clear Lead – in Your Interest

## The ZF-Intarder stands for ...

- a reliable retarder system,
- controlled driving,
- comfort with full-scale safety,
- increasing the average speed,
- eco-friendliness.



# Advantages for the Vehicle Manufacturer

## ZF-Intarder:

- Compatible with all ZF coach transmissions
- Simple installation
- Few interfaces
- Perfectly harmonized overall system
- No additional transmission cooling



ZF-Intarder – The Wear-Free Continuous Brake for Coaches and Intercity Buses



# Advantages for the Vehicle Owner

## The advantages:

- Improved safety
- Reduced operating costs
- Increased payload
- Higher average speeds



# Advantages for the Driver

## Safety at the ultimate level - at even higher diving comfort

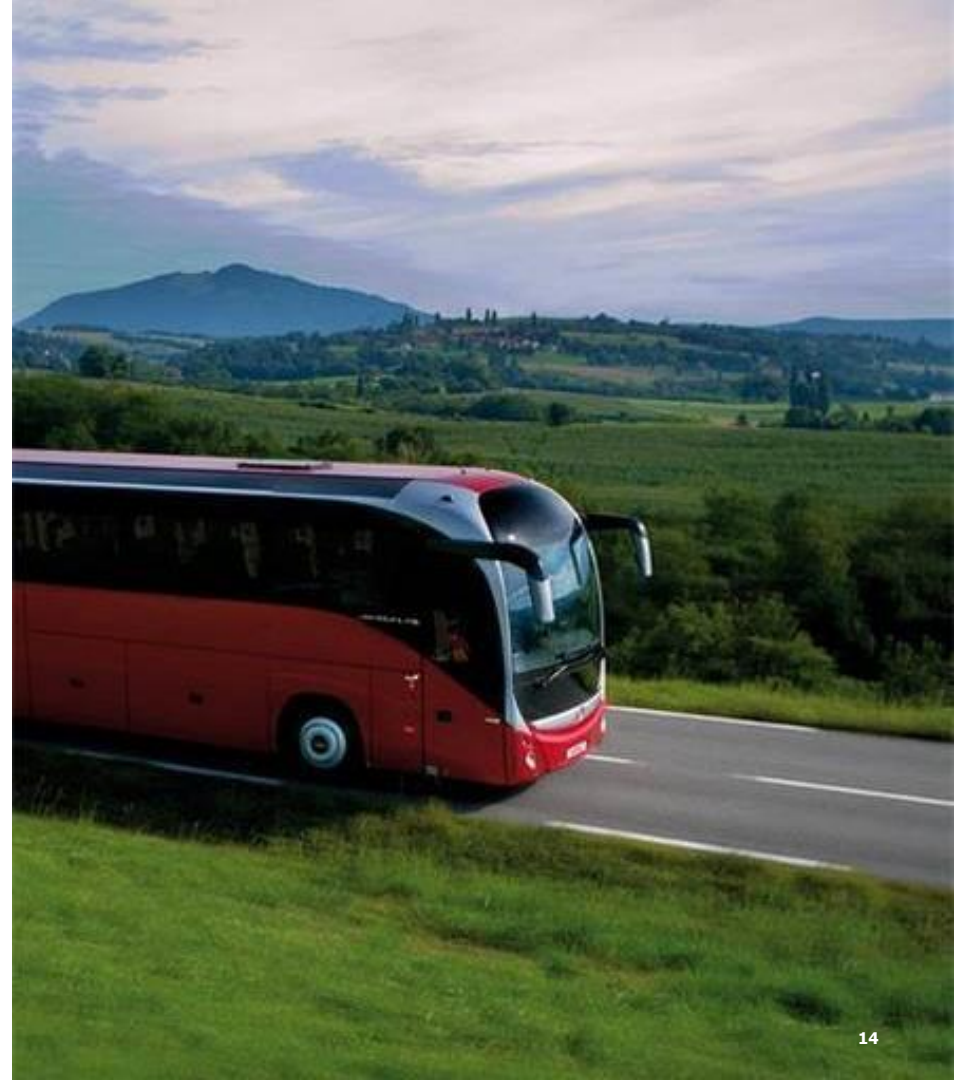
- Fading-free continuous braking
- No interruption of the brake power
- Individually adapted braking performance
- Braking without excessive engine speeds
- Safety systems that are always active
- Consistent driving/riding style



# Benefits to the Environment

## The ZF-Intarder stands for:

- less wear on brakes,
- lower noise emission levels,
- reduced fuel consumption,
- environmentally friendly materials,
- less used oil.



# AS Tronic with ZF-Intarder Installation Advantages

- Simple transmission installation also with the Intarder
- Free access to output flange
- Unchanged propshaft



**Further Information**  
about function and operation of the ZF Intarder,  
see the separate module packages "Intarder".

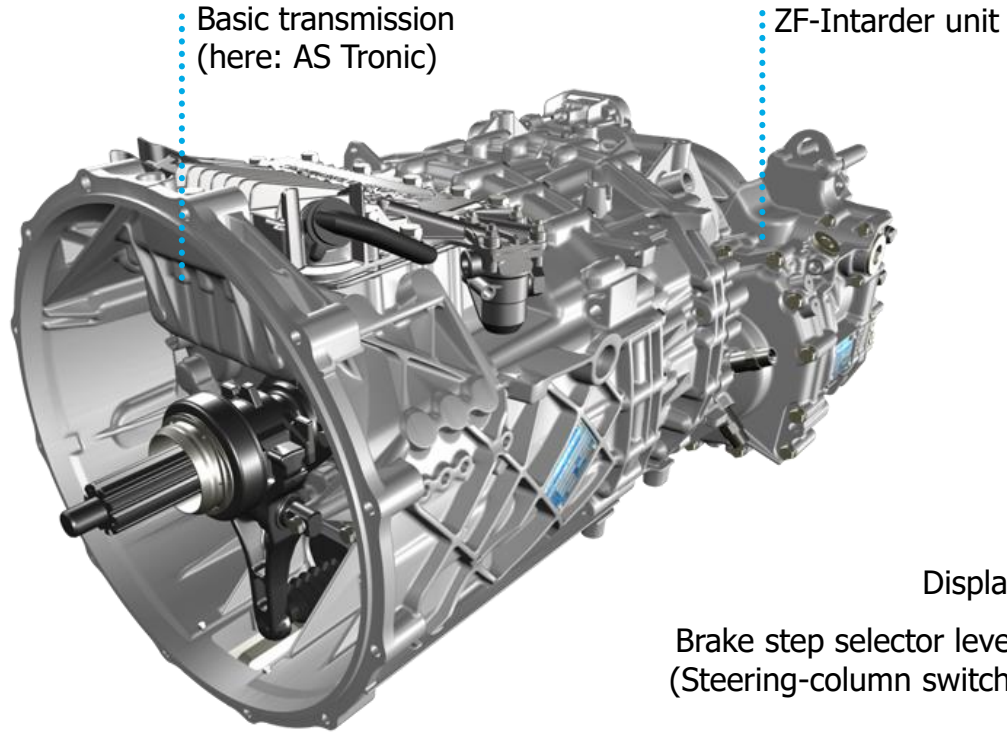


# 02

## Technology and Operation



# A View Into the Retarder System



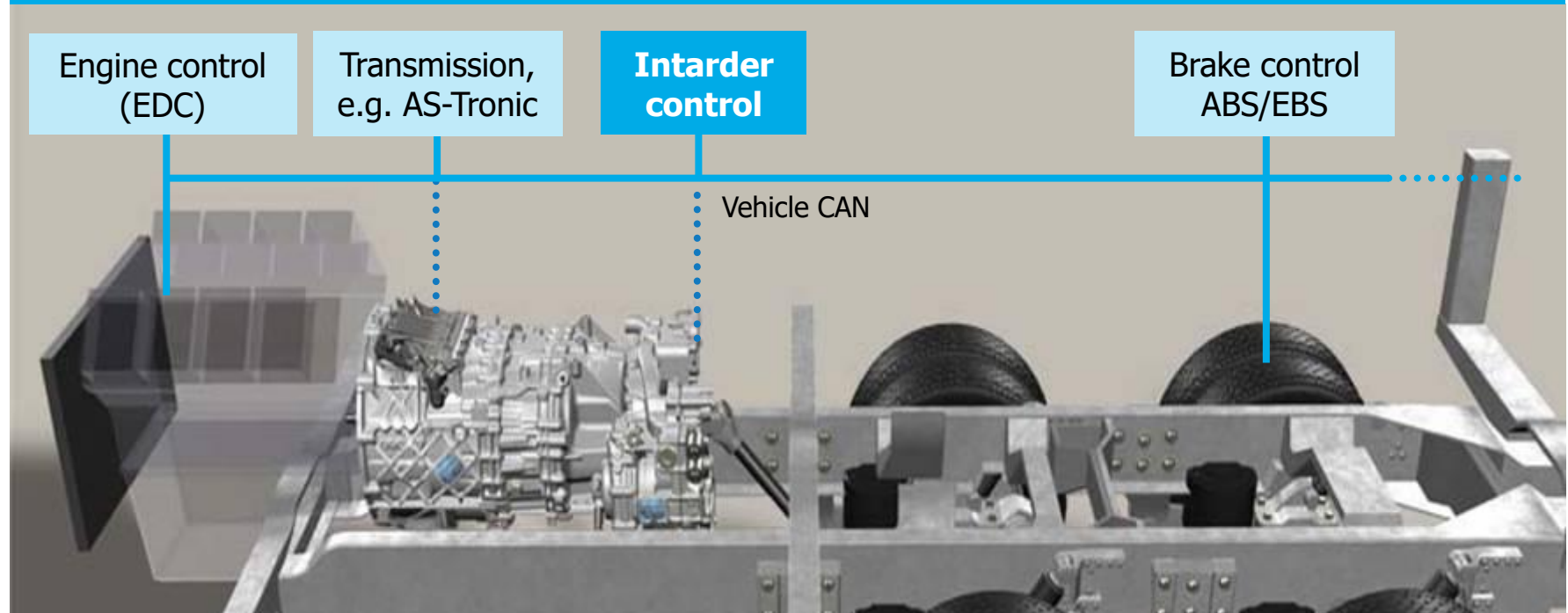
Display

Brake step selector lever  
(Steering-column switch)

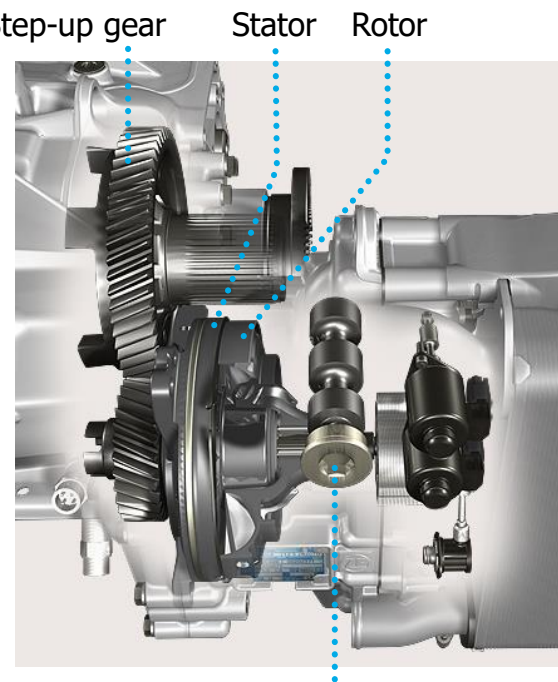
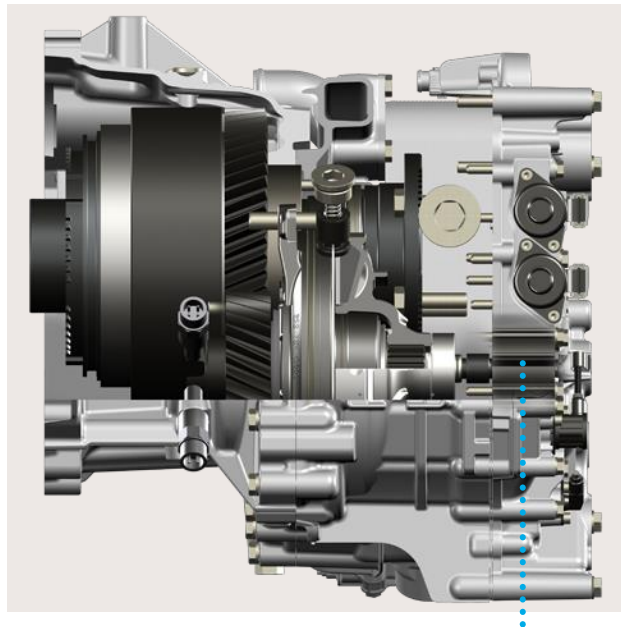
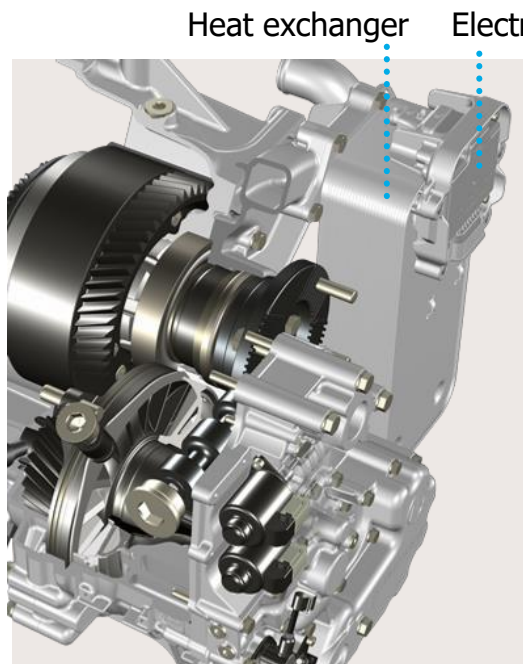


# Communication in the Driveline

## Connection to the bus's CAN system with conventional setup

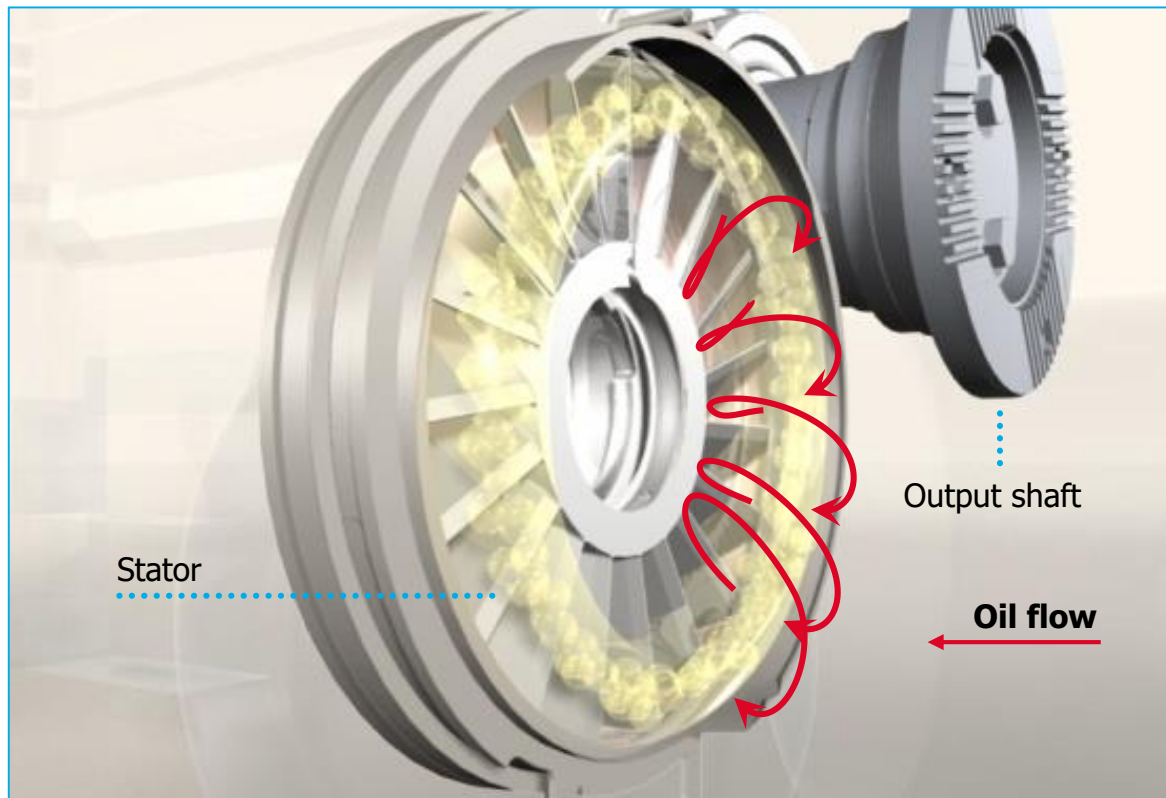
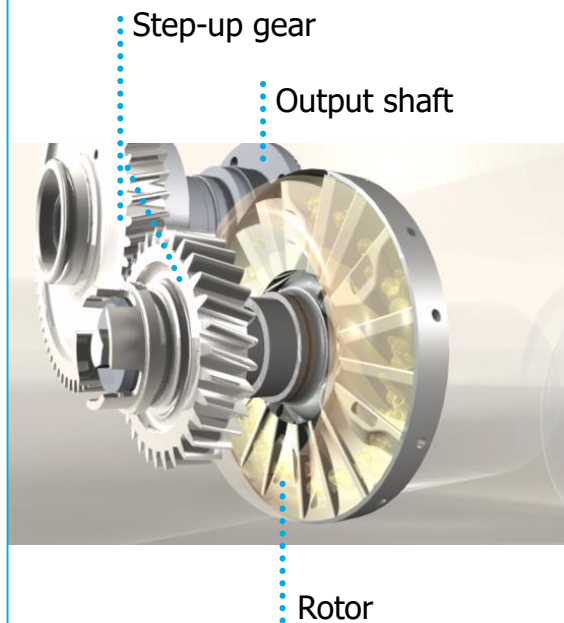


# Setup



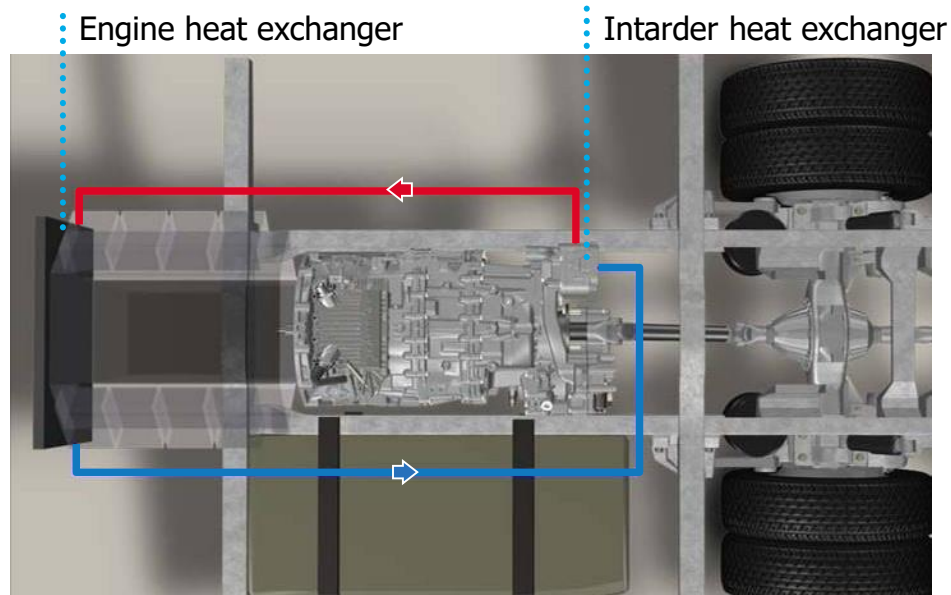
# Function Intarder

## The Intarder's drive

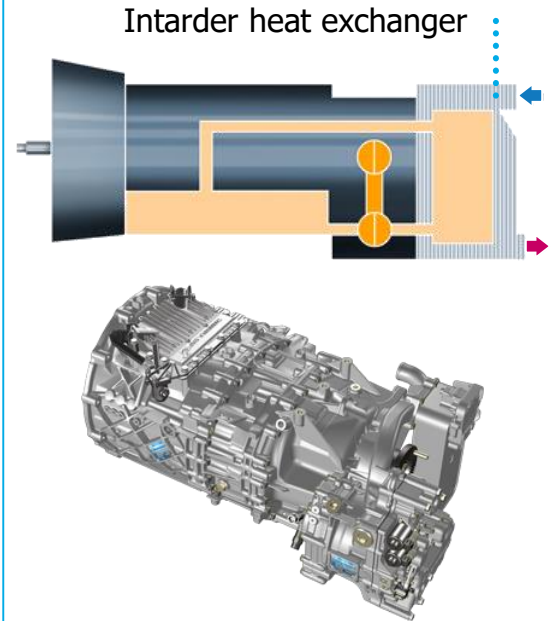


# Coolant Circuit

## Cooling water circuit between the Intarder and the engine

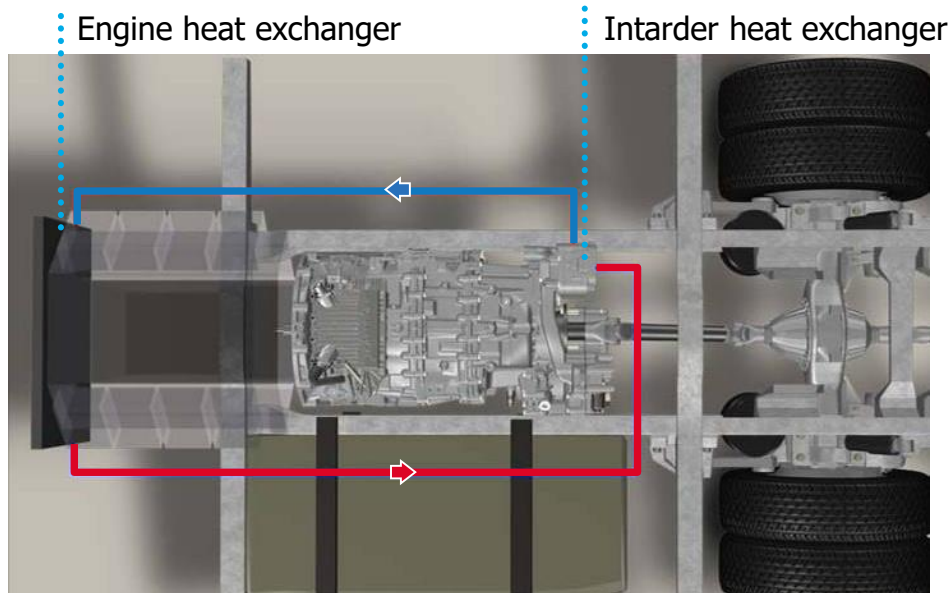


## Oil circuit between the Intarder and the transmission

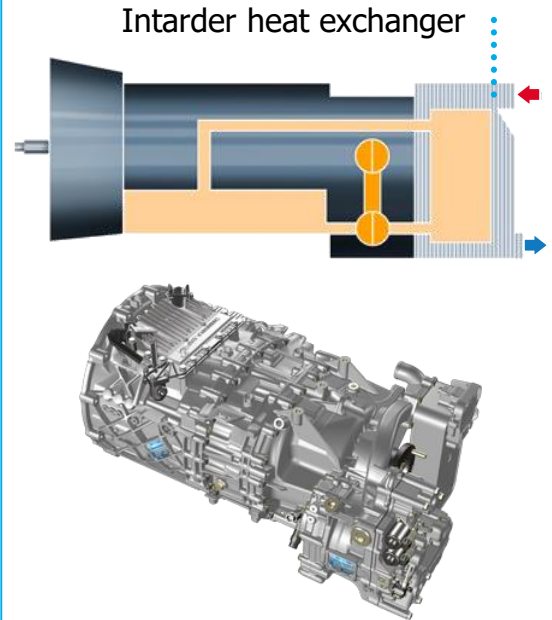


# The "Heating Circuit"

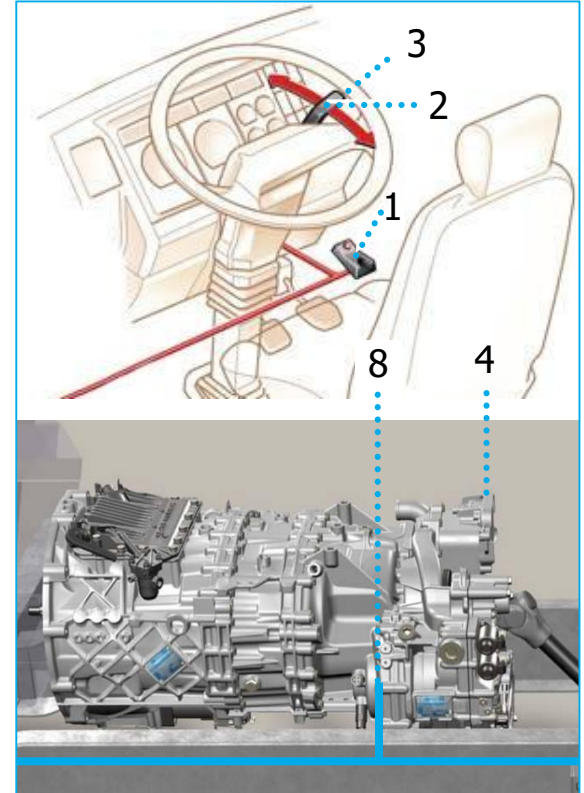
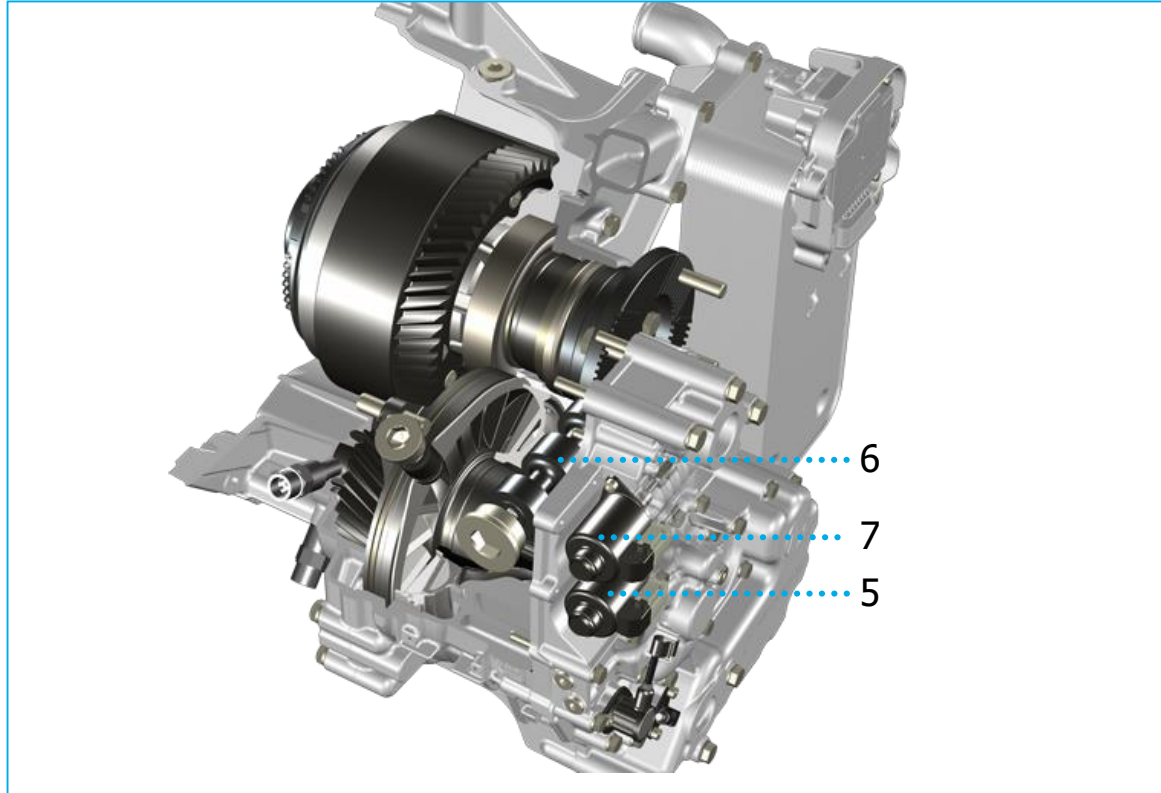
## Cooling water circuit between the Intarder and the engine



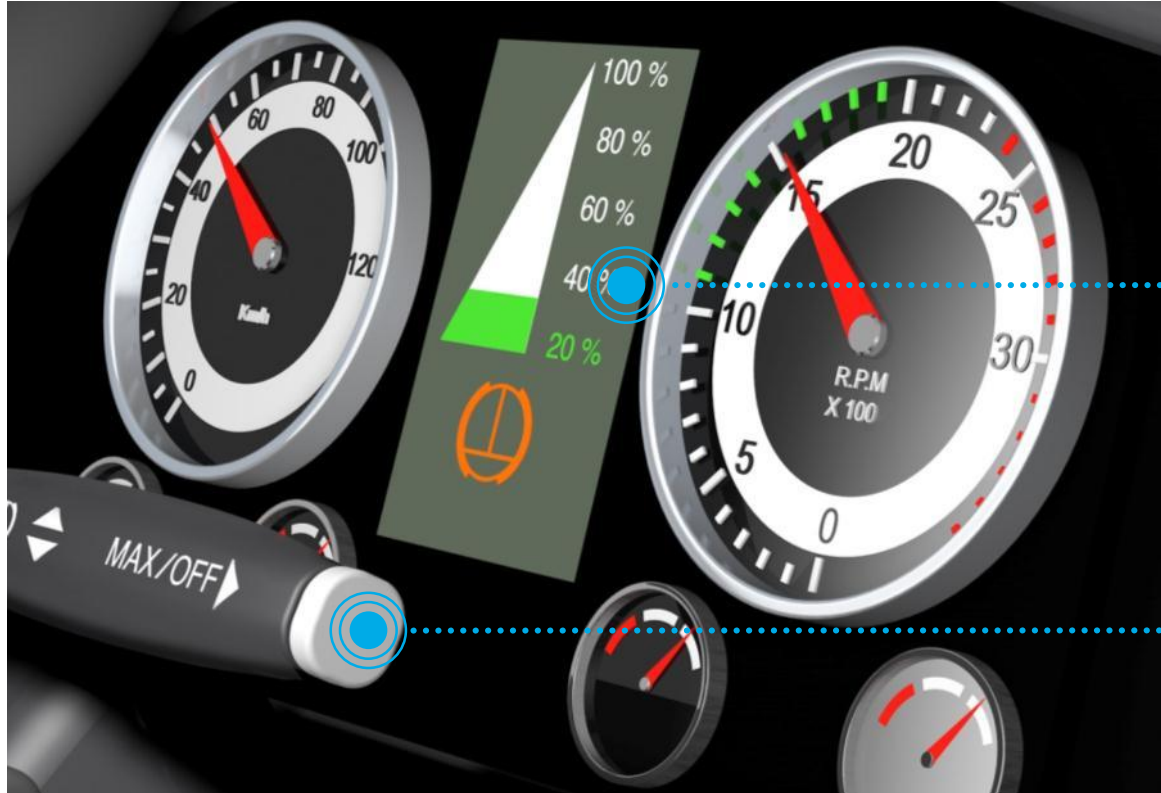
## Oil circuit between the Intarder and the transmission



# Mode of Operation - Control Unit



# Operation



## Example: MAN

Display

Brake step selector lever  
with integrated main switch

# 03

## Competition Topics



# ZF-Intarder: All Competitive Advantages at a Glance

## **The only retarder fully integrated into the transmission: shared oil circuit**

The transmission is continuously heated or cooled with the Intarder as needed:

- Increases transmission efficiency and reduces fuel consumption through better operating temperatures
- Transmission protected against overheating; no additional cooler required for hot countries, not even in applications with noise encapsulation

Much lighter and more compact than a fitted retarder

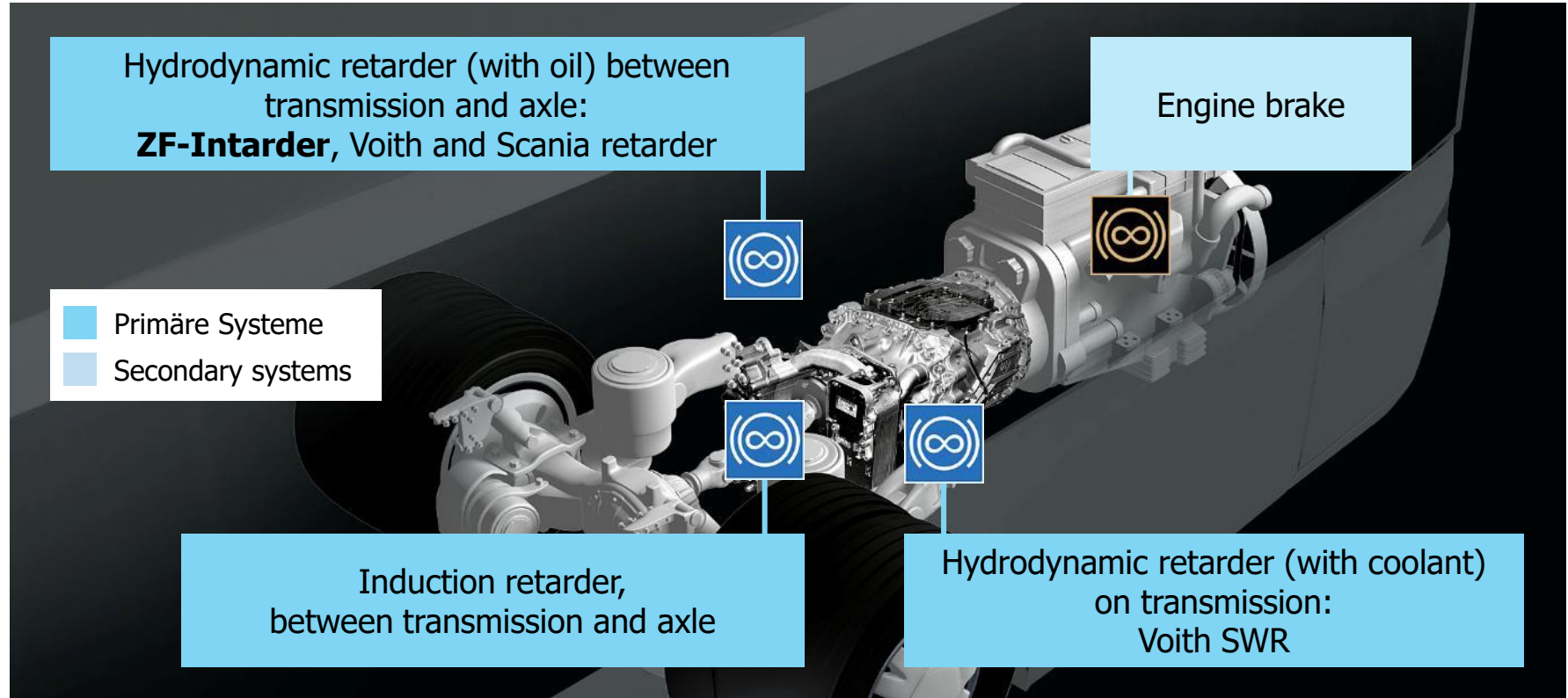


## **Particular advantages over induction retarders which result from the full integration into the transmission:**

- Much lighter and more compact; additional payloads of up to 180 kg
- High continuous braking power due to efficient cooling via the vehicle coolant circuit
- Propeller shaft remains unchanged

# Non-Wearing Brake Systems for Buses

## Overview



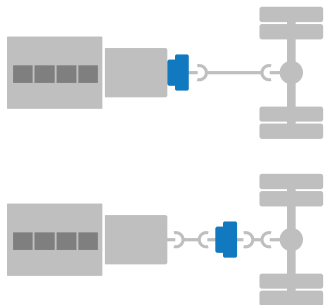
# Non-Wearing Brake Systems for Buses

## System comparison

|                                    | Primary systems                                                                                                                                           | Secondary systems                                                                                                                                                                                                                                                                                  |
|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Input                              | By the engine                                                                                                                                             | By the driven wheels                                                                                                                                                                                                                                                                               |
| Braking power                      | Rotational speed and gear-dependent                                                                                                                       | Vehicle speed-dependent                                                                                                                                                                                                                                                                            |
| High braking effect                | At speeds up to 45 km/h                                                                                                                                   | At speeds exceeding 45 km/h                                                                                                                                                                                                                                                                        |
| Braking effect during gear changes | Yes for powershift transmissions<br>No for manual transmissions                                                                                           | Yes                                                                                                                                                                                                                                                                                                |
| Main field of application          | City and intercity buses                                                                                                                                  | Coaches and long-distance coaches                                                                                                                                                                                                                                                                  |
| Examples                           | <ul style="list-style-type: none"> <li>• Primary retarder, e.g. in EcoLife</li> <li>• Engine brake (rarely used on buses due to noise control)</li> </ul> | <ul style="list-style-type: none"> <li>• Hydrodynamic oil retarder, e.g. <b>ZF-Intarder</b> or Voith and Scania retarders</li> <li>• Hydrodynamic water retarder: Voith Aquatarder SWR</li> <li>• Induction retarder, e.g. from Telma</li> <li>• Secondary retarder, e.g. in Voith DIWA</li> </ul> |

# Advantages of Integrated Retarders Over External Retarders

## External retarder (inline)



### Characteristics

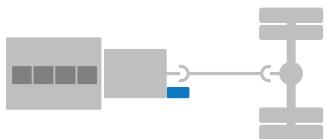
- Fitted directly on the transmission or installed somewhere between the transmission and the driven axle
- Connected to the propeller shaft; works with its speed

### Advantage

- Can be retrofitted on some drivelines; however, installation on the transmission usually requires a special transmission version

## Integrated retarder (offline)

### Example: ZF-Intarder



### Characteristics

- Fitted on the transmission in parallel
- Boost retarder, works with gear ratio
  - retarder speed higher than propeller shaft speed

### Advantages

- Very light and compact, partially or fully integrated into the transmission
- High braking effect even at low vehicle speeds
- Propeller shaft remains unchanged

# ZF-Intarder Compared to Other Oil Retarders

## Main competitors

### ZF-INTARDER



#### Integrated retarder

- Variants: Eco Intarder (3,300 Nm) or Power Intarder (4,000 Nm)
- Used by Daewoo, Higer, Hino, Hyundai, Irizar, MAN, Neoplan, Iveco Bus, Tamsa, Van Hool, VDL and many others
- Around 1,000,000 Intarders sold

#### Voith

##### Integrated retarders



VR 115 E  
for Daimler up to Euro 5  
max. 3,750 Nm



VR 3250  
for Volvo  
max. 3,250 Nm

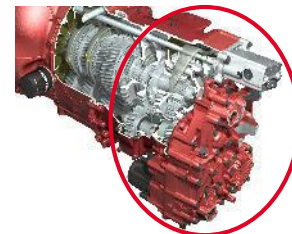
##### External retarders

- VR 123+ / VR 119, produced in India
- VR 120 E, produced in China



#### Scania

##### Integrated retarder



R3500  
for Scania buses only  
max. 3,500 Nm

# Advantages of the ZF-Intarder Over Other Integrated Oil Retarders

Fully integrated into the transmission = shared oil circuit

## Benefits:

- Transmission is heated and cooled: higher efficiency and protection from overheating, even in applications with noise encapsulation
- Only one oil change for transmission and retarder

Long oil change intervals

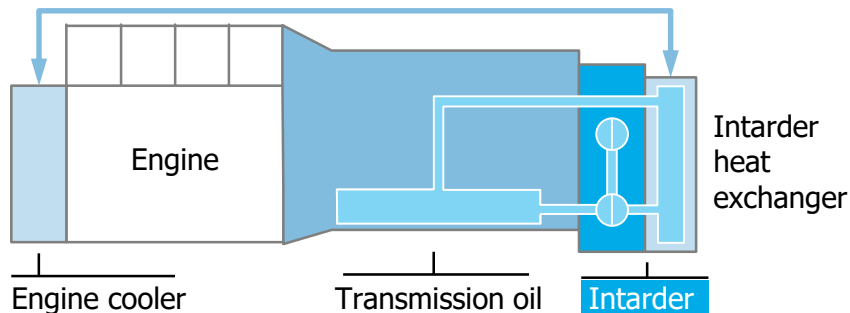
Low power-to-weight ratio

| ZF-Intarder          | Voith                   | Scania               |
|----------------------|-------------------------|----------------------|
| + Yes                | — No                    | — No                 |
| + Up to 540,000 km   | — Up to 200,000 km      | — Up to 240,000 km   |
| + 16,8 kg / 1,000 Nm | + 15-18,2 kg / 1,000 Nm | — 26,8 kg / 1,000 Nm |

# Advantage of ZF-Intarder Over Other Oil Retarders:

## Transmission is heated and cooled

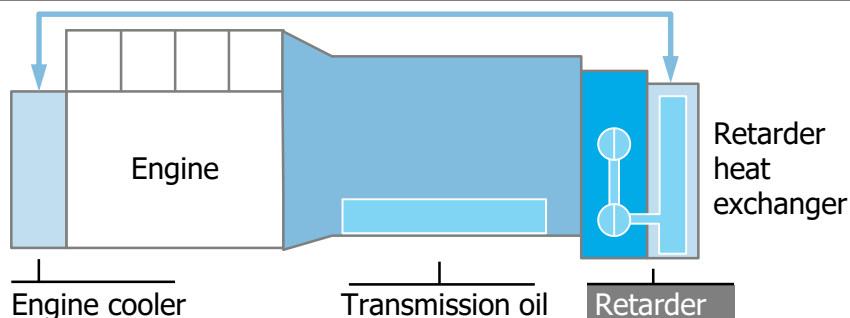
### Intarder



### Only the Intarder is fully integrated into the transmission

- Shared oil and heating circuit
- The transmission is continuously heated or cooled with the Intarder as needed

### Other oil retarders, e.g. from Voith and Scania



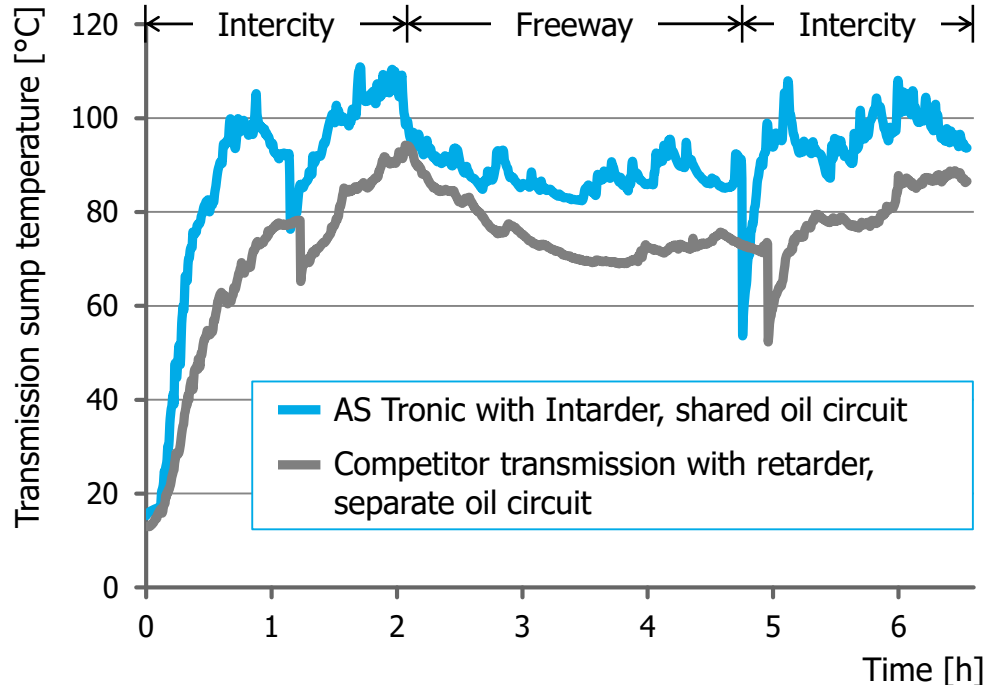
### Benefits

- Transmission temperature more quickly and steadily to optimal range; transmission oil temperature 15°C higher on average
- Results:
  - Higher degree of efficiency
  - 0.2 % lower fuel consumption\*
- Transmission does not overheat; no additional cooler required for hot countries, not even in applications with noise encapsulation

\* Comparison value from long-distance haulage truck

# In Detail: Higher Transmission Temperature = Lower Fuel Consumption

Measurement with two trucks: one with the Intarder and one with a conventional retarder



## Result

- Transmission temperature about 15°C higher on average
- Transmission reaches operating temperature of 80°C in 47 minutes, approx. 1 hour earlier
- Losses reduced by 150 W
- **Transmission heating alone reduces fuel consumption by 0.2 %**

## Measurement conditions:

Two semitrailers, Euro 6, 40 t, freeway and intercity shares, vehicle speed and outside temperature comparable; reductions that can be achieved with a coach are of similar magnitude

# ZF-Intarder Compared to Voith Aquatarder SWR (Secondary Water Retarder)

**ZF-INTARDER**



## **Braking medium: transmission oil**

- Two variants:
  - Eco: max. braking torque of 3,300 Nm
  - Power: max. braking torque of 4,000 Nm
- Used by more than 20 OEMs in conjunction with ZF transmissions
- Around 1,000,000 Intarders produced

**Voith Aquatarder SWR**



## **Braking medium: engine coolant**

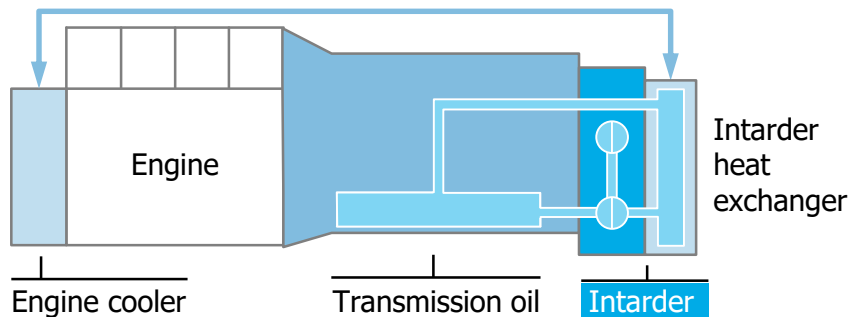
- Only one variant, max. braking torque of 3,500 Nm
- Only available in buses of the Daimler Group from Euro 6 onwards

# Advantages of the ZF-Intarder Over the Voith Aquatarder SWR

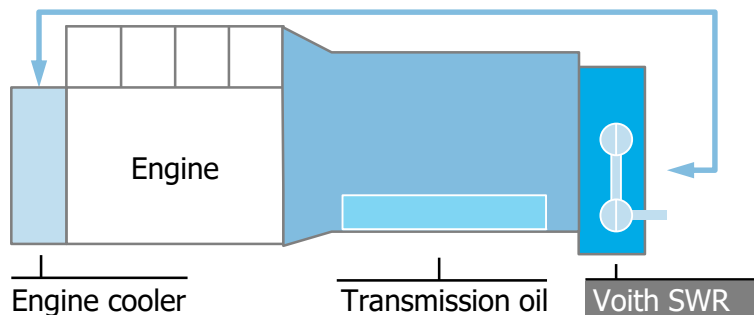
|                                                                         | ZF-Intarder                                                                                                               | Voith Aquatarder SWR                                                           |
|-------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Fully integrated into the transmission = shared oil circuit             | <p>+ Yes</p> <p><b>Benefit:</b> Transmission is heated and cooled – higher efficiency and protection from overheating</p> | <p>— No</p>                                                                    |
| Simple integration into the vehicle without adapting the cooling system | <p>+ Yes</p>                                                                                                              | <p>— No. Modification required, high pressure peaks in the cooling system</p>  |
| One contact for Intarder and transmission; a tested overall system      | <p>+ Yes</p> <p><b>Benefit:</b> Simpler logistics and spare parts management</p>                                          | <p>— Adaptation on non-Voith transmission; Voith is not a systems supplier</p> |

# Advantage of ZF-Intarder Over the Voith Aquatarder SWR: Transmission is heated and cooled

## Intarder with its own heat exchanger



## Voith SWR secondary water retarder



### Only the Intarder is fully integrated into the transmission

- Shared oil and heating circuit
- The transmission is continuously heated or cooled with the Intarder as needed

### Benefits

- Transmission temperature more quickly and steadily to optimal range; transmission oil temperature 15°C higher on average
- Results:
  - Higher degree of efficiency
  - 0.2 % lower fuel consumption
- Transmission does not overheat; no additional cooler required for hot countries, not even in applications with noise encapsulation

\* Comparison value from long-distance haulage truck

# ZF-Intarder Compared to Induction Retarders

## Main competitors



- Hydrodynamic retarder using transmission oil as operating medium
- Fully integrated (offline)
- Max. braking torque of 4,000 Nm (Power) or 3,300 Nm (Eco)

### Electromagnetic retarders

Examples: Telma retarders



- Electromagnetic retarder with solenoids that can be activated
- External (inline)
- Braking torque: up to 3,300 Nm
- Other manufacturers: Klam, Frenelsa, Terca, Kloft, etc.

### Voith Magnetarder



- Retarder with permanent magnets
  - External (inline)
  - Braking torque: 650 Nm, maximum vehicle weight: 16 t
- **for midibuses only, therefore not comparable**

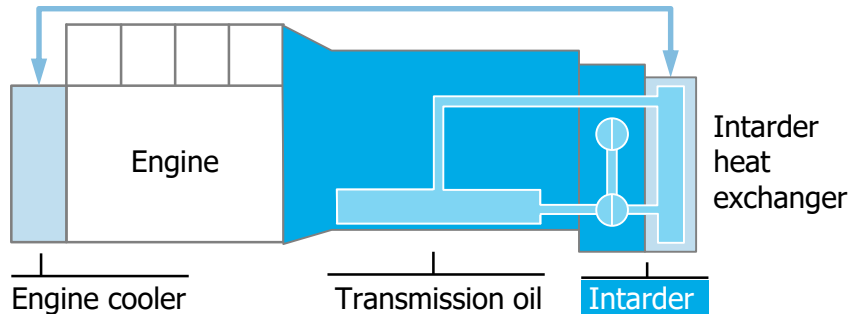
# Advantages of the ZF-Intarder Over Induction Retarders

## Overview

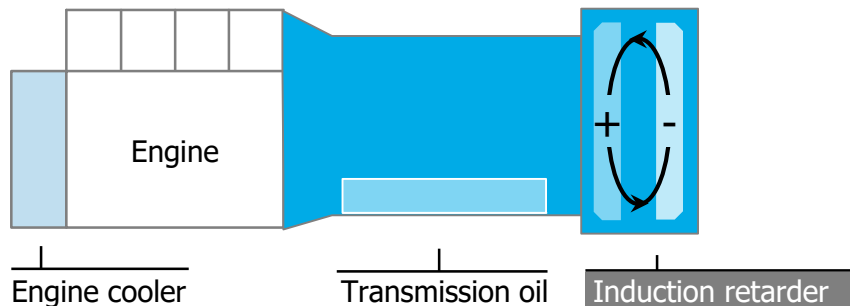
|                                                                                                                               | ZF-Intarder                                                                                                                                                                         | Electromagnetic retarders<br>(e.g. Telma)                      |
|-------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|
| Fully integrated into the transmission:<br>→ shared oil circuit<br><br>→ very light and compact,<br>propeller shaft unchanged | <b>+</b> Yes<br><br><b>Benefit:</b> Transmission is heated and cooled – higher efficiency and protection from overheating<br><br><b>Benefit:</b> additional payload of up to 180 kg | <b>–</b> No<br><br><br><br>Much higher weight due to solenoids |
| High continuous braking power due to efficient cooling                                                                        | <b>+</b> Yes, due to connection to engine cooling system                                                                                                                            | <b>–</b> No cooling medium, major heat transfer to environment |
| One contact for Intarder and transmission; a tested overall system                                                            | <b>+</b> Yes<br><br><b>Benefit:</b> Simpler logistics and spare parts management                                                                                                    | <b>–</b> No, no systems supplier                               |

# Advantage of ZF-Intarder Over Induction Retarders: Transmission is heated and cooled

## Intarder with its own heat exchanger



## Induction retarder



### Only the Intarder is fully integrated into the transmission

- Shared oil and heating circuit
- The transmission is continuously heated or cooled with the Intarder as needed

### Benefits

- Transmission temperature is more quickly and steadily in optimal range; thus higher efficiency and lower fuel consumption\*
- Optional cold-start function quickly heats up engine and passenger area to operating temperature
- Transmission does not overheat; no additional cooler required for hot countries, not even in applications with noise encapsulation

\* Comparison value for long-distance haulage truck: 0.2 % reduction with 15°C higher average transmission temperature, ZF measurements