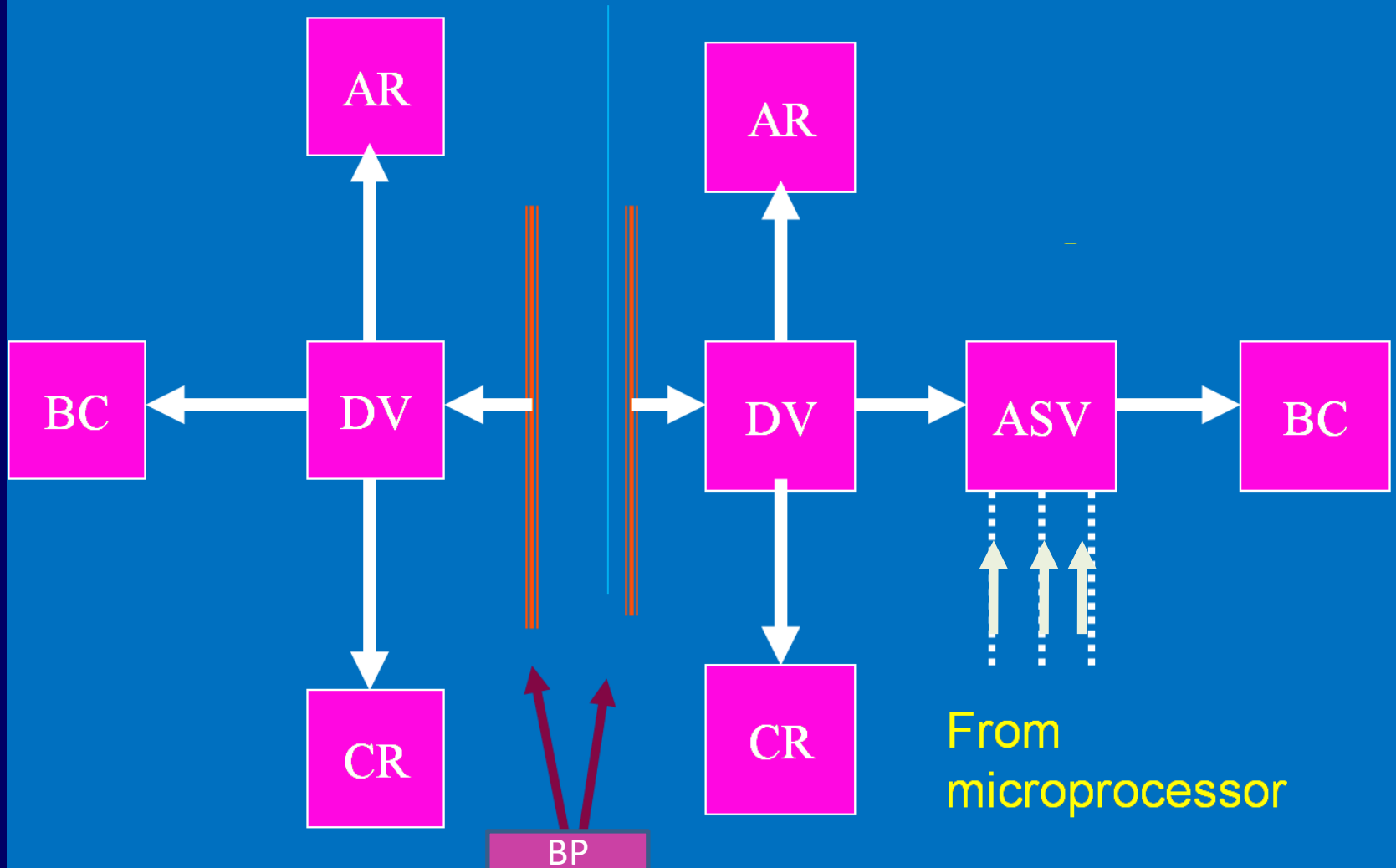


LHB COACH BRAKE SYSTEM AND WSP SYSTEM

Salient Features

- ❑ Almost no brake rigging.
- ❑ Microprocessor based WSP.
- ❑ Wheel turning frequency reduced.
- ❑ Centralised control for complete coach.
- ❑ Use of Emergency Brake Accelerator for sharp emergency application in complete train set.

Schematic Diagram: ICF vs LHB



MECHANICAL AND PNEUMATIC SYSTEM OF LHB BRAKE

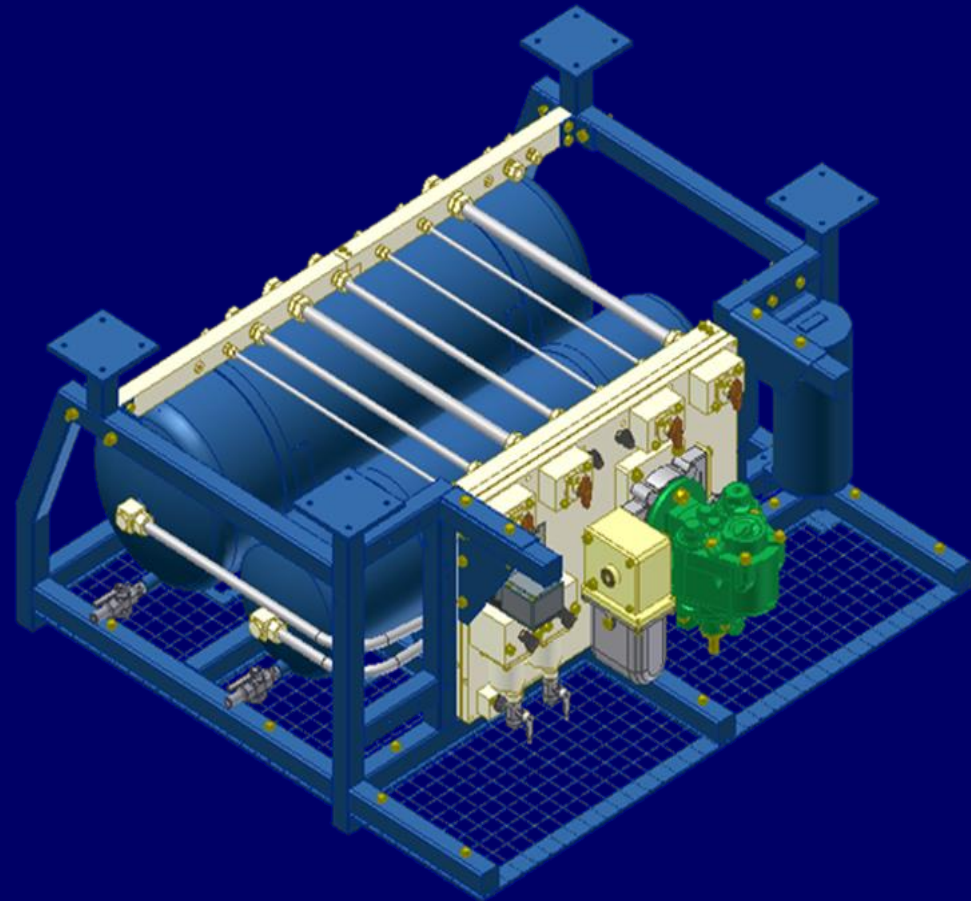
Brake Equipments on Under frame

Brake Container

❑ Consists of

- ❖ Brake control panel
- ❖ Reservoirs
 - One 125L for brake application only (Protected by check valve)
 - One 75L for toilets as well as brake
 - One Control reservoir 6L for DV

❑ Weight -350 kg (with all equipment)



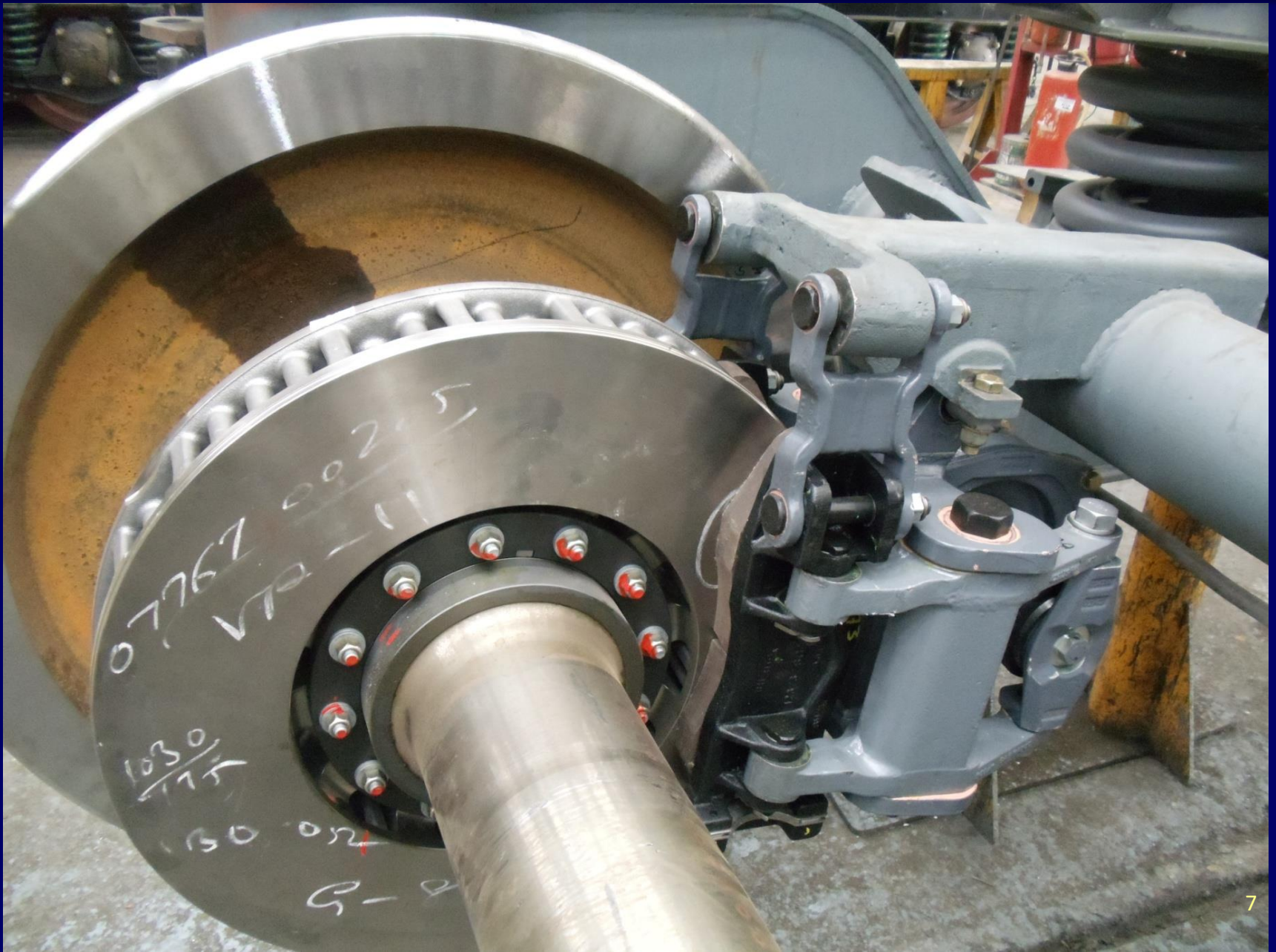
Brake control panel

❑ Consists of:

- ❖ Test fittings (To Check FP, BP, CR & BC Pressure)
- ❖ Isolating cocks for F P, Toilet, Bogie-1 and Bogie-2.
- ❖ Filters for BP and FP
- ❖ Distributor valve
- ❖ Pressure switch (to operate WSP)
- ❖ Check valve.



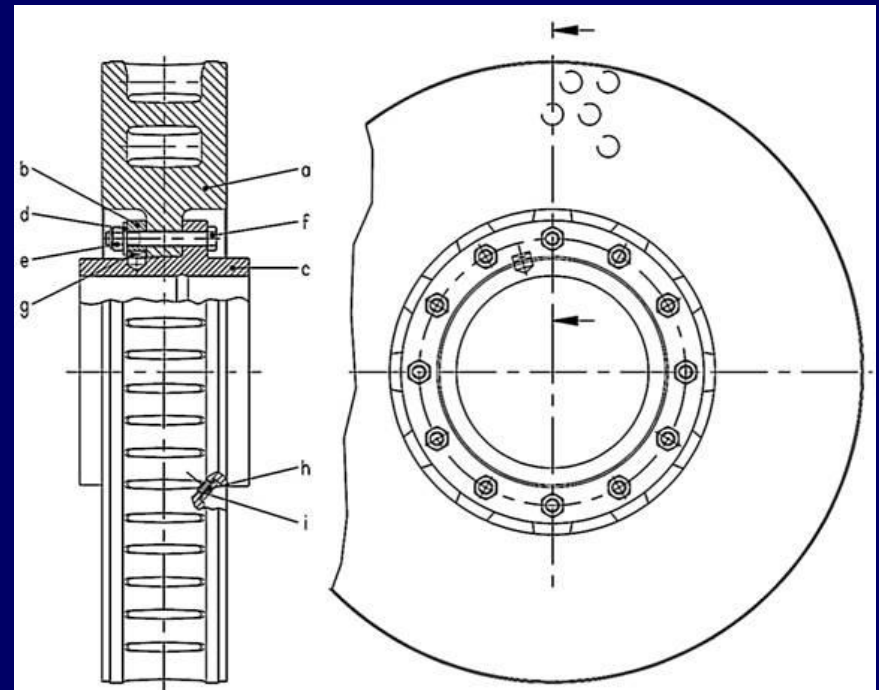
Brake Components on Axle



Brake Disc

❑ Consists of

- ❖ A gray cast iron friction ring(a) with integral
 - Crosswise cooling ribs
 - Carry off the heat.
 - Hub (c)



a. Friction ring
b. Clamping ring
c. Hub
d. Spring washer
e. Hexagon nut

f. Hex-head bolt
g. Anti-twist stud
h. Screw plug
i. Sealing ring

Brake Equipments on pipe line

❑ Emergency Brake accelerator

- ❖ Actuates on any rapid pressure reduction in BP, equivalent to emergency application.
- ❖ Allows the BP to vent locally via a large orifice.



Requirement of WSP

- ❑ Poor Adhesion
- ❑ Because of high speed as 160 km/h and the EBD of 1200 m, the adhesion could be insufficient to sustain the brake rate demanded during emergency breaking, especially when the surface of the rail is wet and slippery.

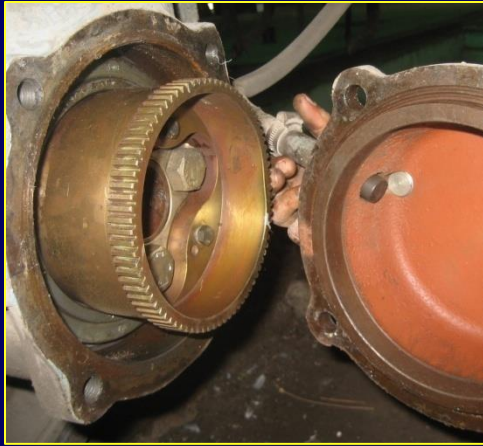
Introduction of WSP

- ❑ A BC pressure regulation device.
- ❑ Adjusts the braking force to the wheel-rail friction (adhesion) so as to *make optimum use of available adhesion*
 - To optimize the braking distance and
 - To prevent wheel sliding.
- ❑ For 160 kmph & above WSP is recommended as requirement.

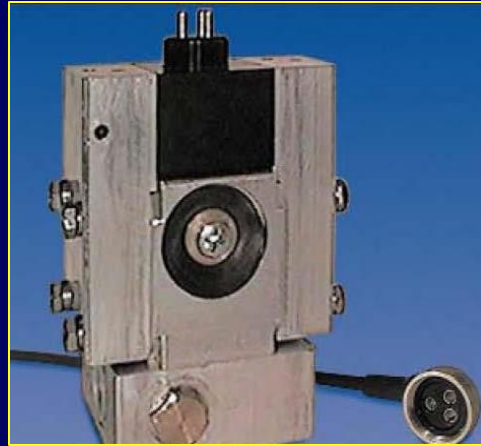
Main Components

- ❖ Speed sensor
- ❖ Anti skid valve/dump valve
- ❖ Microprocessor control unit
- ❖ Pressure switch.

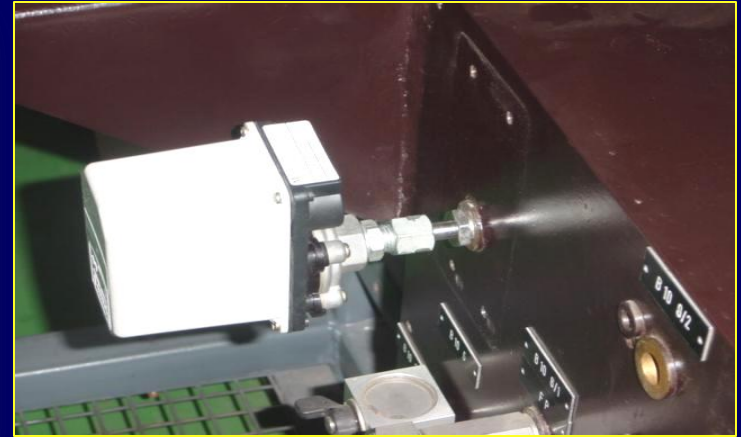
Main Components



Phonic wheel and
Speed sensor



Anti skid valve/dump valve

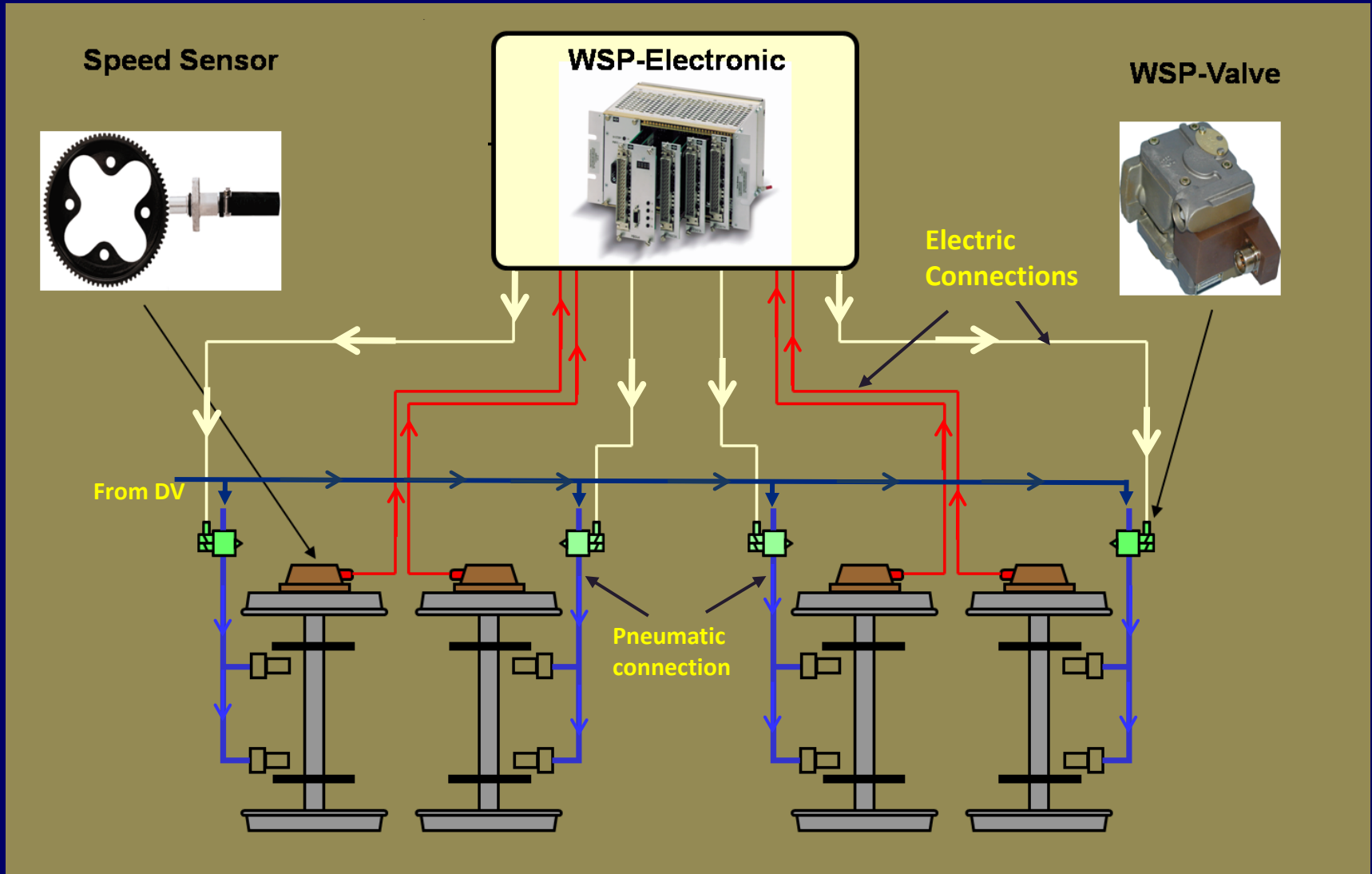


Pressure switch



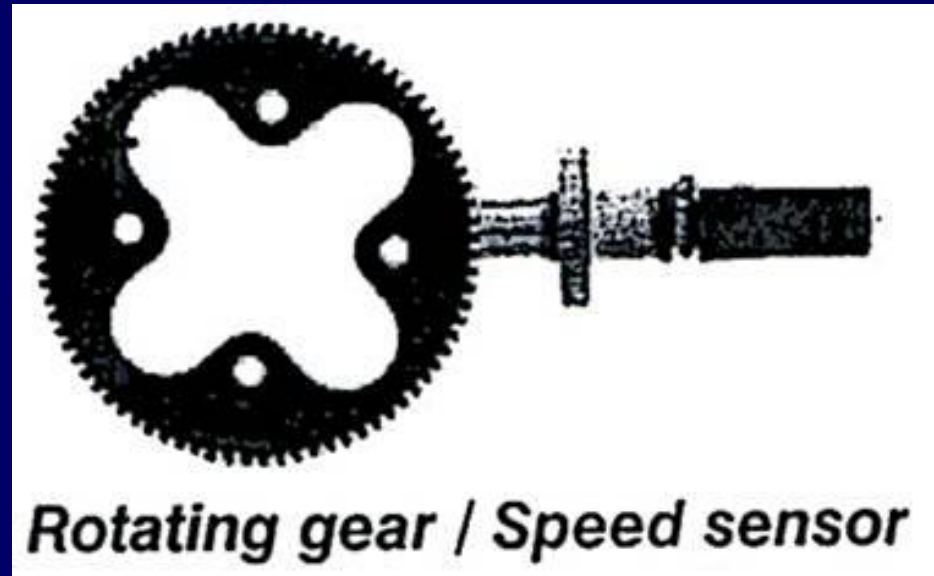
Microprocessor control unit

Pneumatic & Electrical Connections



Speed Sensor (pulse generator)

- ❑ **Comprises**
 - ❖ A magnetic sensor and
 - ❖ A toothed gear.
- ❖ **Gap is maintained between toothed gear and sensor.**
- ❑ **No wear.**

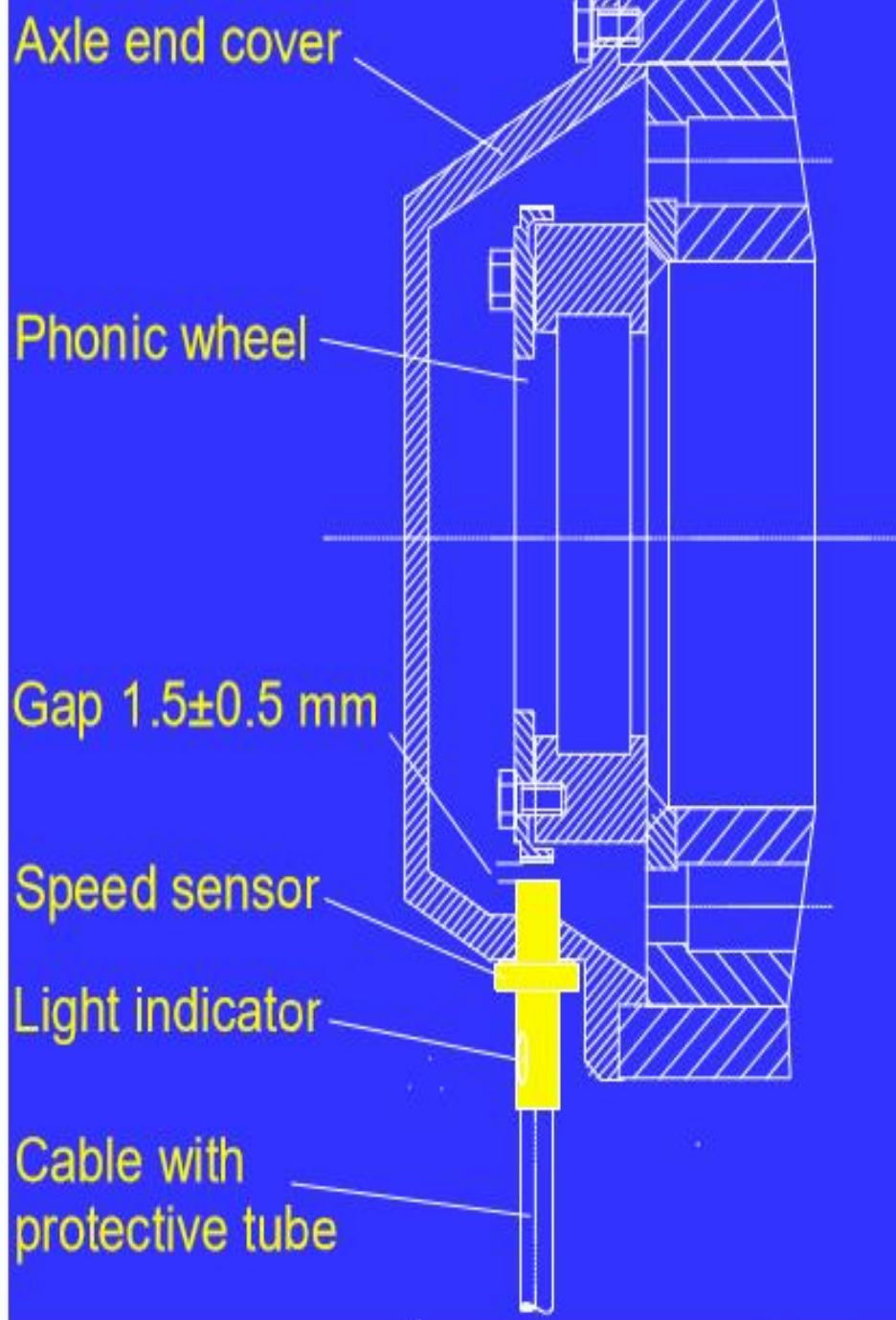




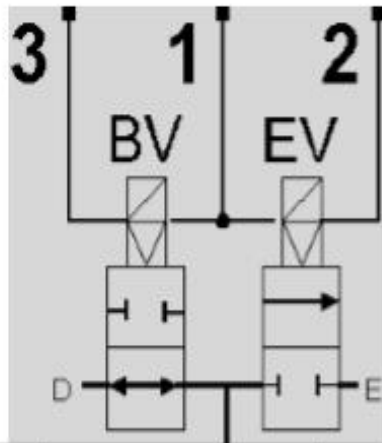
Speed Sensor



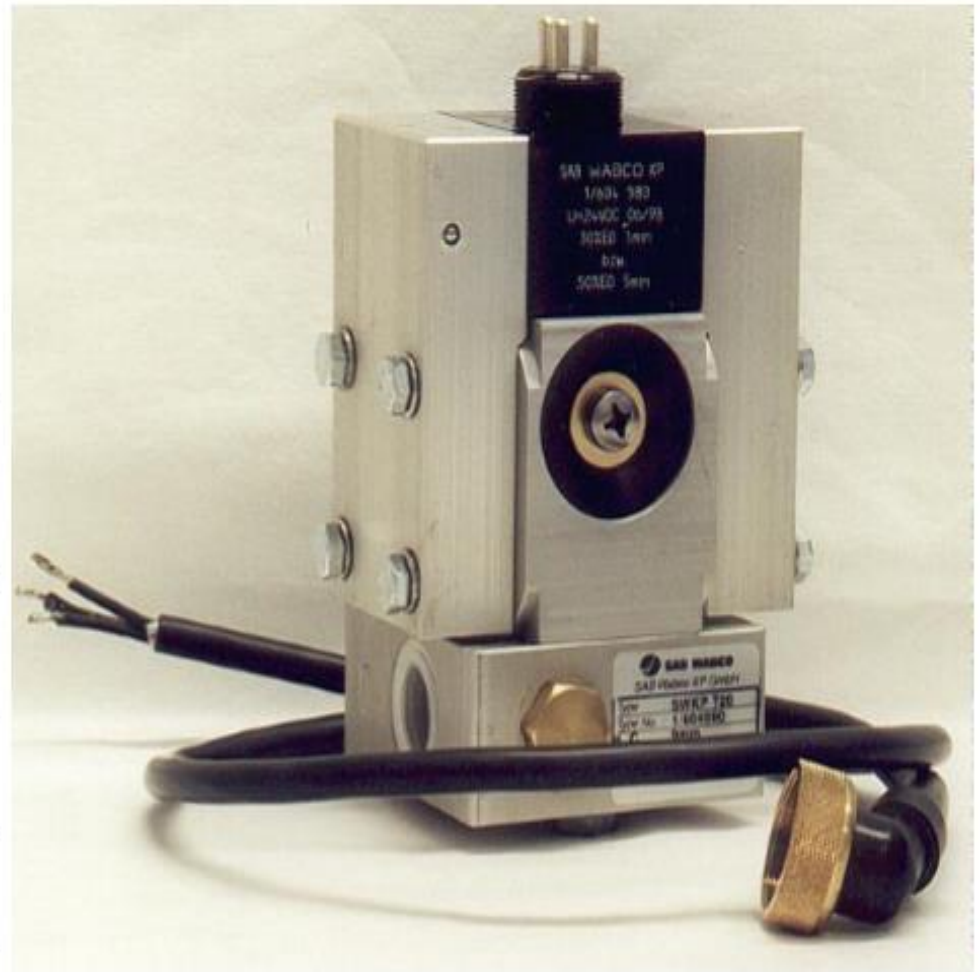
- ❖ Sensors have reverse - polarity protection and short - circuit proof
- ❖ Type tested for EN 50 155 & EN 50121-3-2
- ❖ LED indicator for visual verification of speed sensor functioning
- ❖ Power consumption <100 mW
- ❖ Frequency range 1Hz - 12kHz
- ❖ Recommended gap between sensor & phonic wheel 1.5 ± 0.5 mm



➤ Dump Valve

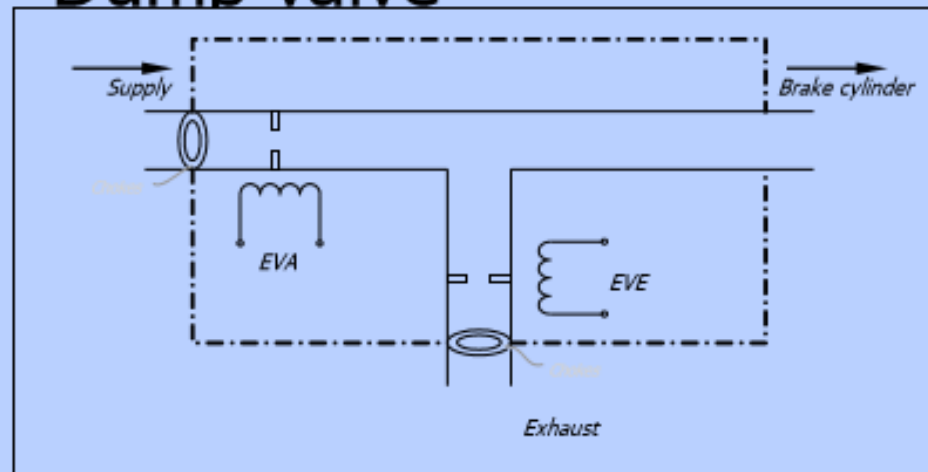
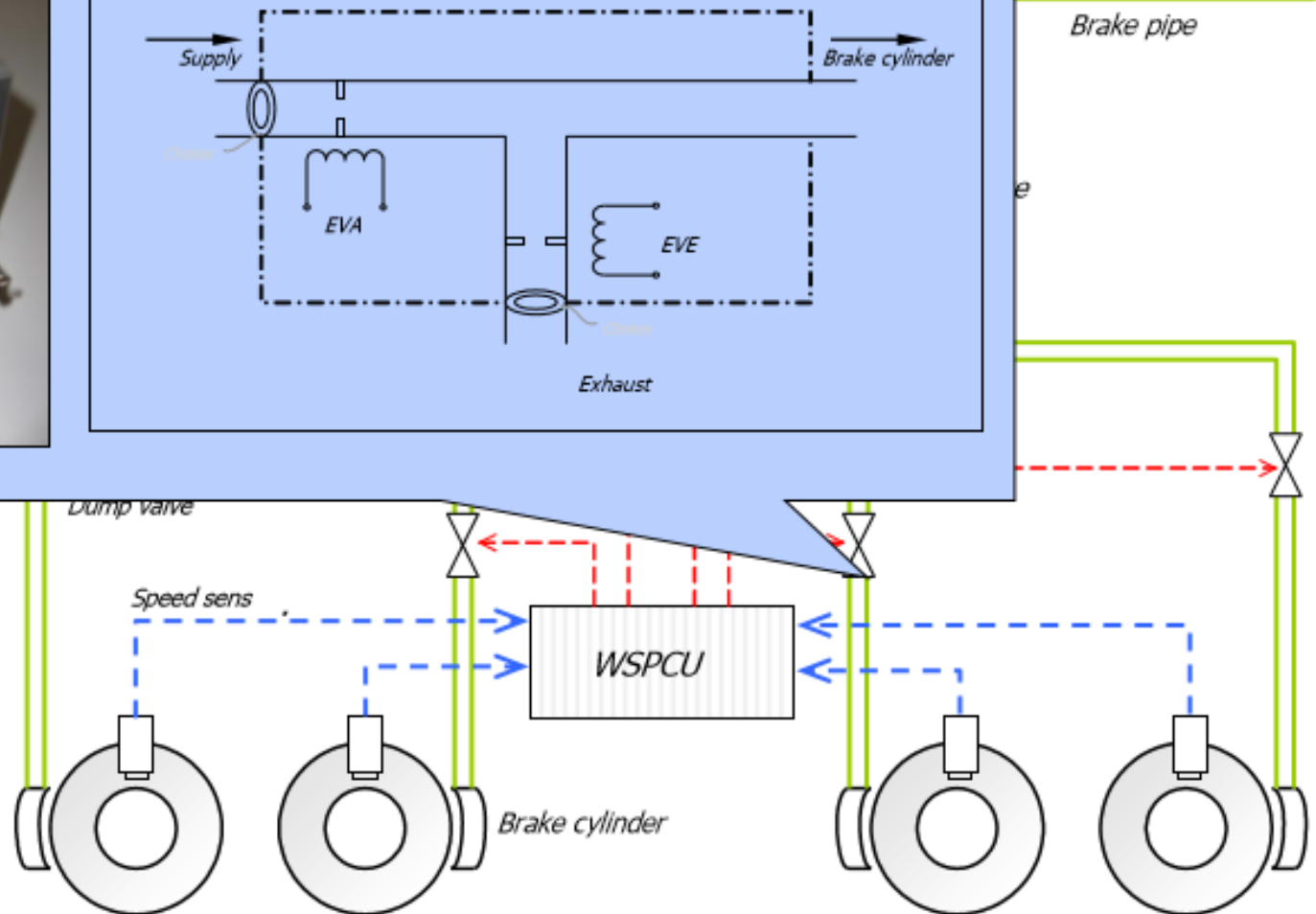


Inlet solenoid BV	Outlet solenoid EV	Brake cylinder pressure C
0 Volt	0 Volt	increasing / decreasing
24 Volt	0 Volt	hold
24 Volt	24 Volt	decreasing



❖ 3/2 dump valve adjusts the brake cylinder pressure to maximize the braking effort for any given wheel/rail interface coefficient of friction as per logic algorithm.

Dump valve



Microprocessor Control Unit

- ❑ Analyse all 4 input speed sensor's signal frequencies.
- ❑ Evaluates all the frequencies.
- ❑ Generates signals for anti-skid valve to control the BC pressure.

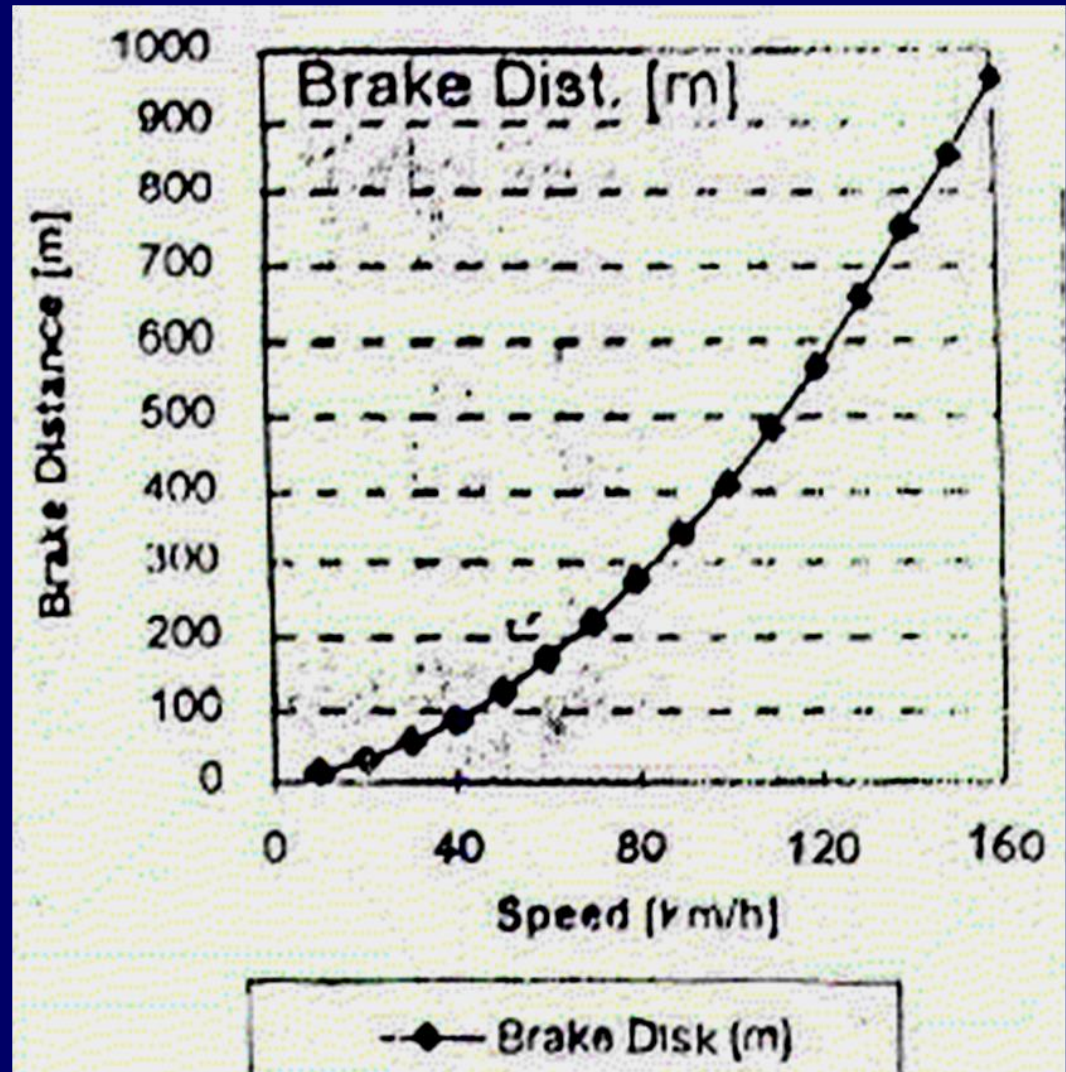
Braking Distance w.r.t. Speed of Train

Composition of
Train

2 Loco+

2 Powercar+

16 C/Car



Braking Distance Test Results

- ❑ Designed Braking Distance: 1200m at 160 kmph
- ❑ Results of braking distance trial of 18 coaches loaded-16 C/car+1EC/car+1P/car at 160kmph
 - ❖ Dry rail condition,
 - Emergency application- 1077 m.
 - Full service application- 1312 m.
 - ❖ Wet rail condition
 - Emergency application- 1094 m.

Wheel Slide Protection Principle

- ❑ Operates as a BC pressure regulation device.
- ❑ Made up of two micro processor-
 - ❖ Driven modules which control the state of adhesion of the axles.
 - ❖ Supervisor module for diagnostic purposes.
- ❑ In the case of change of state of the adhesion, the device
 - ❖ adjusts the braking force to the present adhesion conditions.

Wheel Slide Protection Principle

- ❑ System implements 4 axles-4 channels configuration and visualizes the use of 4 pneumatic devices for each axle.
- ❑ The intervention affects one axle at a time and is of the tachometric (speed comparison) and accelerometer type.
- ❑ Speed signal derived also for CDTs.

Development Of The Threshold Speed

❑ Upper threshold speed

- ❖ Above which the axle involved is loosing adhesion.
- ❖ A fixed 1.5km/h + approx. 6% of the real speed is referenced.

❑ Lower threshold speed

- ❖ The threshold speed gap according to the real speed of the vehicle, above which the axle involved is considered as “skidding” by the system,
- ❖ The air pressure is discharged from the respective BC.
- ❖ A fixed 2.5km/h + approx. 25% of the real speed is referenced up to app 100kmph.

Development Of Deceleration Criteria

❑ DEC

- ❖ The maximum allowed deceleration for each axle above which the BC pressure is modulated.
 - ❖ The discharge of the BC may take place although the V2 threshold was not exceeded.
- ❑ The V1, V2 and DEC are a function of the instant speed of the vehicle.
- ❑ The ACC criterion is a fixed value.

Speed Computation

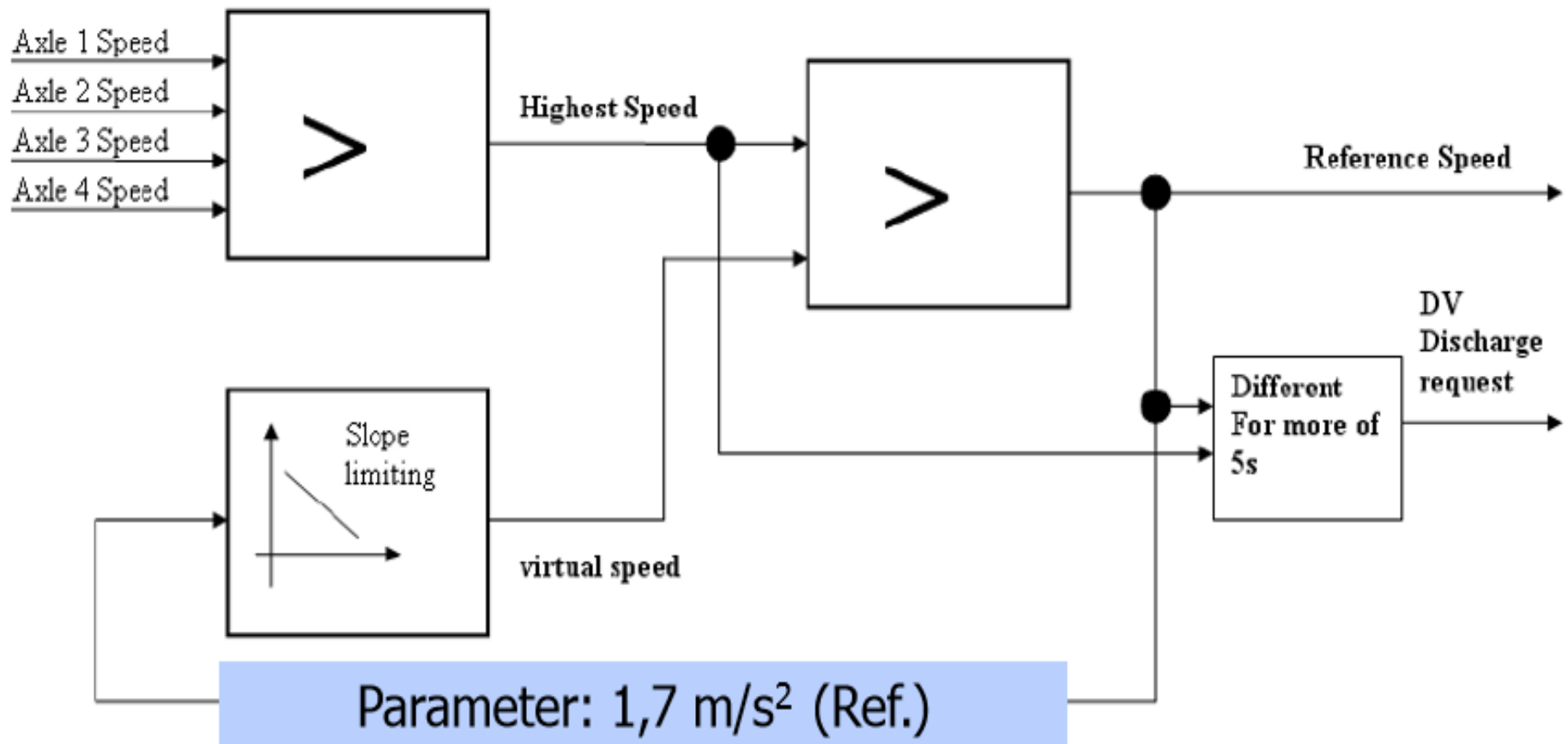
❑ Reference speed (V_r):

- ❖ An estimate of the real speed of the vehicle.
- ❖ Device takes the fastest axle's speed as V_r .
- ❖ If all the axles lose adhesion simultaneously,
 - The DEC criteria is followed until at least one axle regains adhesion.

❑ Peripheral speed measurement (V_p):

- ❖ BC pressure is regulated by ASV,
 - In order to keep V_p between V_1 and V_2 , i.e. the most favourable zone for restoring adhesion.

Reference Speed



**Ref Speed =
Highest among
Axles Speed**

**Ref Speed =
Virtual Speed**

**Calculated with
Constant Slope**

Speed and Acceleration Criteria

- ❑ Speed comparison (V1):

$$V1 = V_r - \left(1.5 \text{ km/h} + \frac{6 * V_r}{100} \right)$$

- ❑ Speed comparison (V2):

$$V2 = V_r - \left(2.5 \text{ km/h} + \frac{25 * V_r}{100} \right)$$

- ❑ Axle negative acceleration criterion(DEC):
- ❑ Axle positive acceleration criterion(ACC):

Pneumatic Assembly Control Logic

❑ Reduce BC pressure if

- ❖ $V_i \leq V_2$ or
- ❖ $A_i \leq DEC$

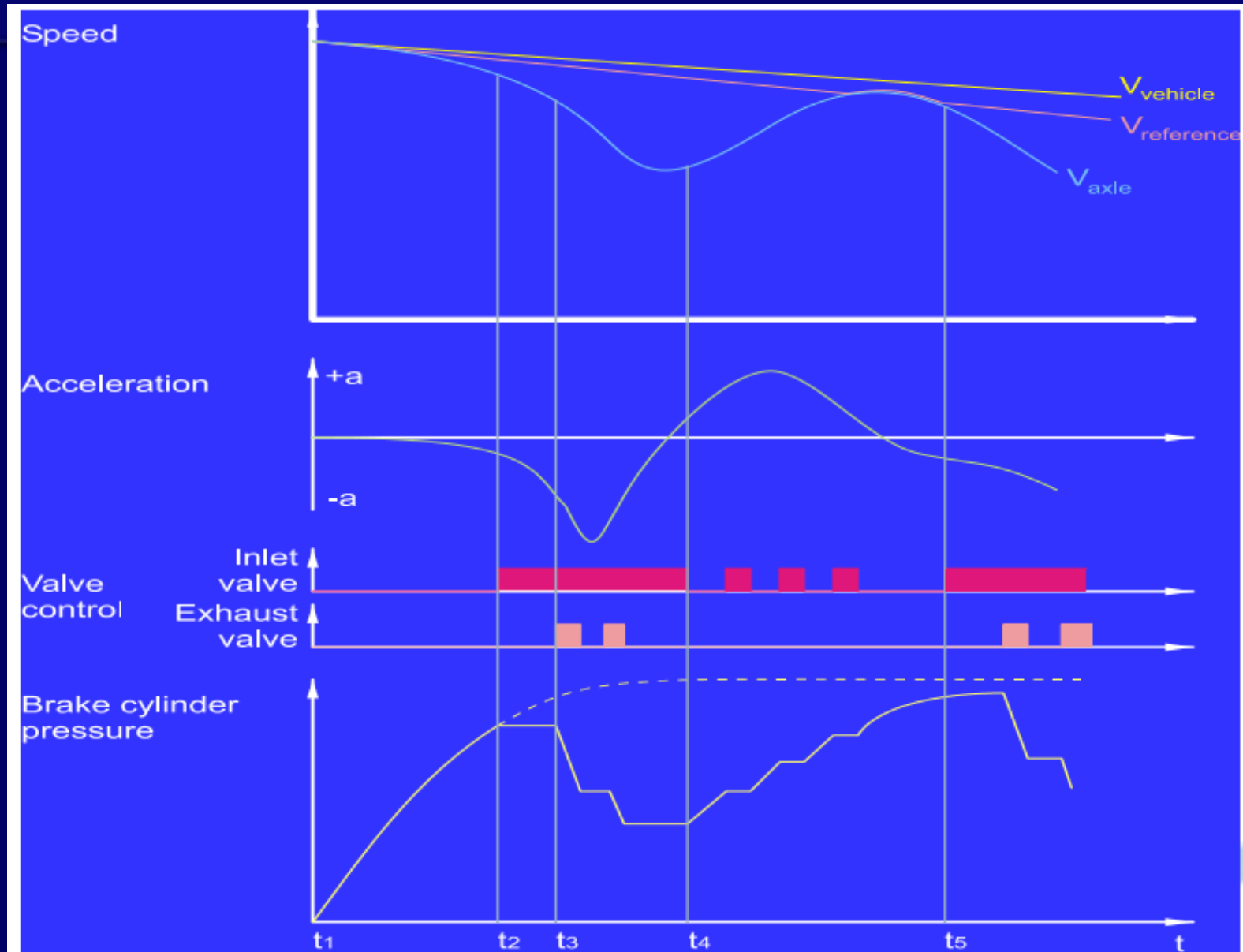
❑ Restore BC pressure if

- ❖ $V_i \geq V_1$ or
- ❖ $A_i \geq ACC$

❑ Maintain BC pressure if

- ❖ $V_2 \leq V_i \leq V_1$ or
- ❖ $DEC \leq A_i \leq ACC$

Control Logic Of Pneumatic Device



WSP - Field Test Data

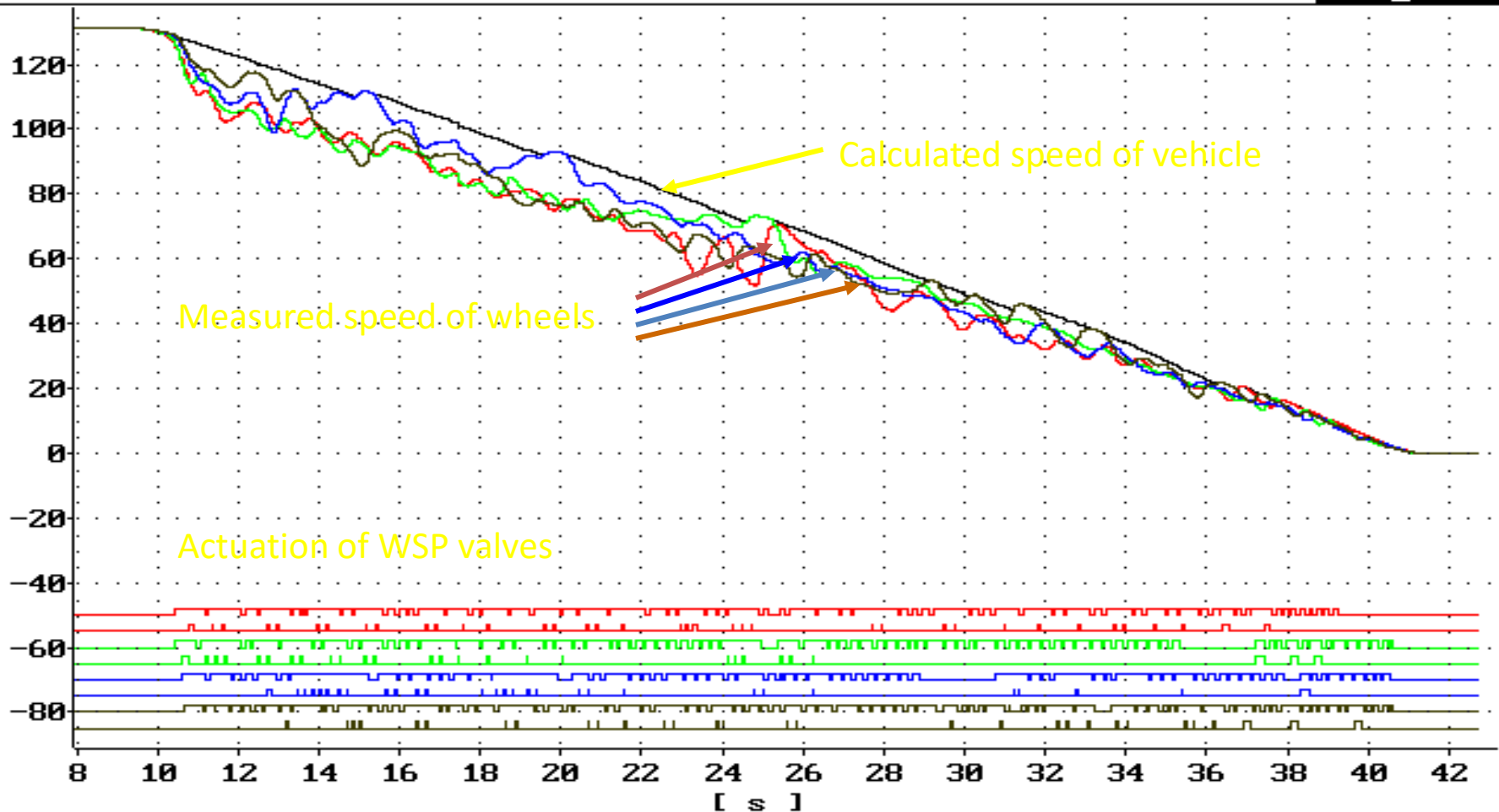
Gleitschutzmessung Muster. Reisezugwagen. 4 Geber. 4 Ventile
130km/h. Schiene besprüht.
FR-10-12-99 17:10:58 27k 43s 67Hz



ModuLab

vReferenz vRad1 vRad2 vRad3 vRad4 BV1 EV1 BV2 EV2 BV3 EV3 BV4 EV4

WSP_TEST





➤ Fault Code - Permanent failure

Display Code	Failure code	Failure cause	Corrective action
72/73	10	Hardware watchdog of solenoid valve of axle1 is triggered	Acknowledgement the failure, continue the operation.
72/73	11	Short circuit or interruption of speed sensor of Axle1	Check the wires for short circuit or interruption.
72/73	13	Short circuit of solenoid valve of Axle 1.	Wires or solenoids of the dump valve should be checked for short circuits, acknowledge the failure.
72/73	14	Interruption of solenoid valve of Axle 1.	Wires or solenoids of the dump valve should be checked for interruption, acknowledge the failure
72/73	20	Hardware watchdog of solenoid valve of axle2 is triggered	Acknowledgement the failure, continue the operation.
72/73	21	Short circuit or interruption of speed sensor of Axle2	Check the wires for short circuit or interruption.
72/73	23	Short circuit of solenoid valve of Axle 2.	Wires or solenoids of the dump valve should be checked for short circuits, acknowledge the failure
72/73	24	Interruption of solenoid valve of Axle 2.	Wires or solenoids of the dump valve should be checked for interruption, acknowledge the failure



Fault Code - Permanent failure

Display Code	Failure code	Failure cause	Corrective action
72/73	30	Hardware watchdog of solenoid valve of axle3 is triggered	Acknowledgement the failure, continue the operation.
72/73	31	Short circuit or interruption of speed sensor of Axle3	Check the wires for short circuit or interruption.
72/73	33	Short circuit of solenoid valve of Axle 3.	Wires or solenoids of the dump valve should be checked for short circuits, acknowledge the failure.
72/73	34	Interruption of solenoid valve of Axle 3.	Wires or solenoids of the dump valve should be checked for interruption, acknowledge the failure
72/73	40	Hardware watchdog of solenoid valve of axle4 is triggered	Acknowledgement the failure, continue the operation.
72/73	41	Short circuit or interruption of speed sensor of Axle4	Check the wires for short circuit or interruption.
72/73	43	Short circuit of solenoid valve of Axle 4.	Wires or solenoids of the dump valve should be checked for short circuits, acknowledge the failure.
72/73	44	Interruption of solenoid valve of Axle 4.	Wires or solenoids of the dump valve should be checked for interruption, acknowledge the failure



Fault Code – Intermittent failure

Display Code	Failure code	Failure cause	Corrective action
95	20	Hardware watchdog of solenoid valve of axle2 is triggered	Acknowledge the failure, continue the operation .
95	21	Short circuit or interruption of connection between speed sensor at axle2 and WSP.	1.Check the wires for short circuit or interruption. 2.Replace speed Sensor, acknowledge the failure. 3.Contact supplier for further information.
95	23	Short circuit of solenoid valve of Axle 2.	1.Check the wires and valve for short circuit acknowledge the failure. 2.Replace solenoid valve, acknowledge the failure. 3.Contact supplier for further information.
95	24	Interruption of solenoid valve of Axle 2.	1.Check the wires and valve for interruptions, acknowledge the failure. 2.Replace solenoid valve, acknowledge the failure. 3.Contact supplier for further information.
95	30	Hardware watchdog of solenoid valve of axle3 is triggered	Acknowledge the failure, continue the operation.
95	31	Short circuit or interruption of connection between speed sensor at axle3 and WSP.	1.Check the wires for short circuit or interruption. 2.Replace speed Sensor, acknowledge the failure. 3.Contact supplier for further information .



Fault Code – Intermittent failure

Display Code	Failure code	Failure cause	Corrective action
95	33	Short circuit of solenoid valve of Axle 3.	1.Check the wires and valve for short circuit acknowledge the failure. 2.Replace solenoid valve,acknowledge the failure. 3.Contact supplier for further information .
95	34	Interruption of solenoid valve of Axle 3.	1.Check the wires and valve for interruptions,acknowledge the failure. 2.Replace solenoid valve,acknowledge the failure. 3.Contact supplier for further information .
95	40	Hardware watchdog of solenoid valve of axle4 is triggered	Acknowledge the failure, continue the operation
95	41	Short circuit or interruption of connection between speed sensor at axle4 and WSP	1.Check the wires for short circuit or interruption. 2.Replace speed Sensor, acknowledge the failure. 3.Contact supplier for further information .
95	43	Short circuit of solenoid valve of Axle 4.	1.Check the wires and valve for short circuit acknowledge the failure. 2.Replace solenoid valve, acknowledge the failure. 3.Contact supplier for further information .
95	44	Interruption of solenoid valve of Axle 4.	1.Check the wires and valve for interruptions,acknowledge the failure. 2.Replace solenoid valve, acknowledge the failure. 3.Contact supplier for further information .

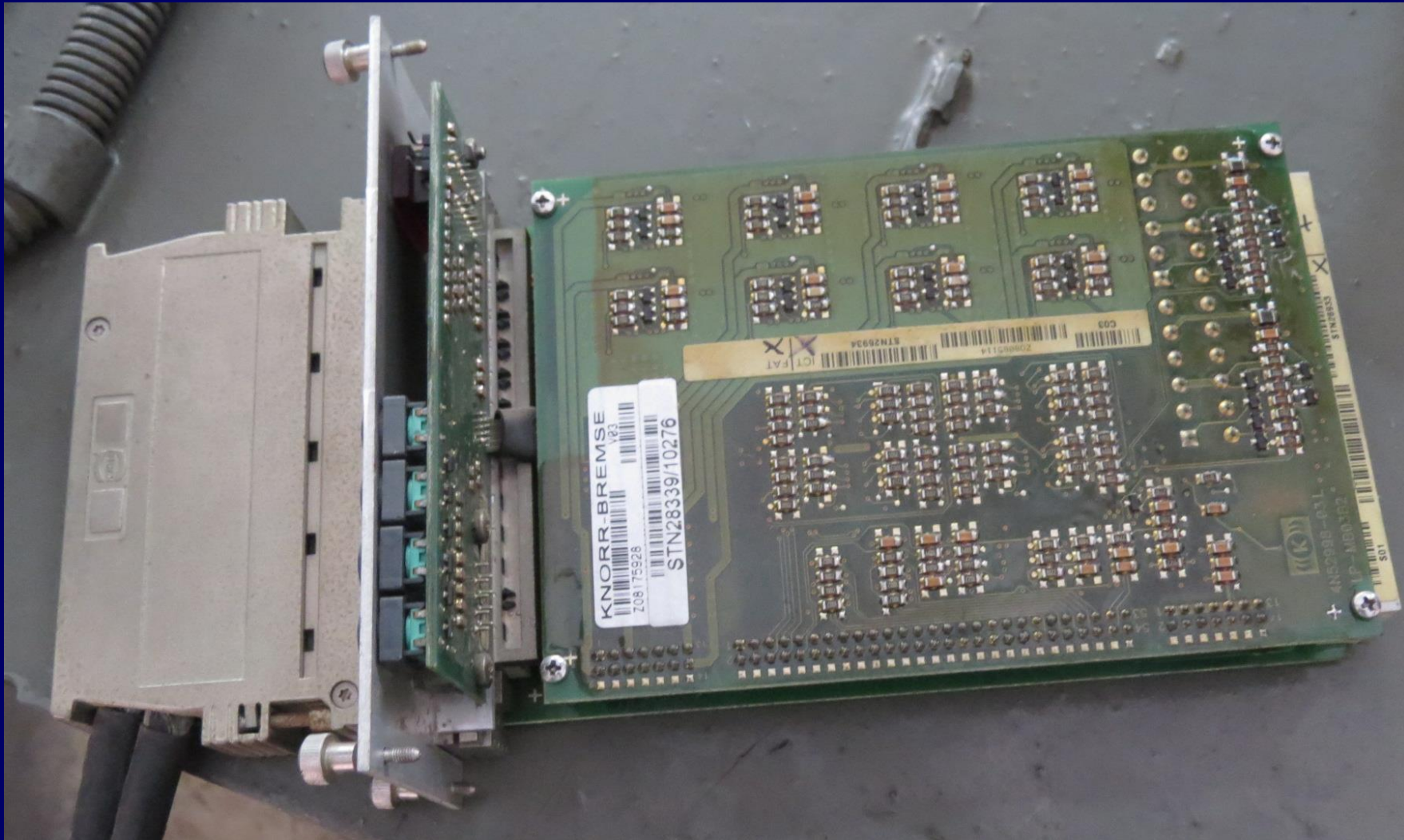


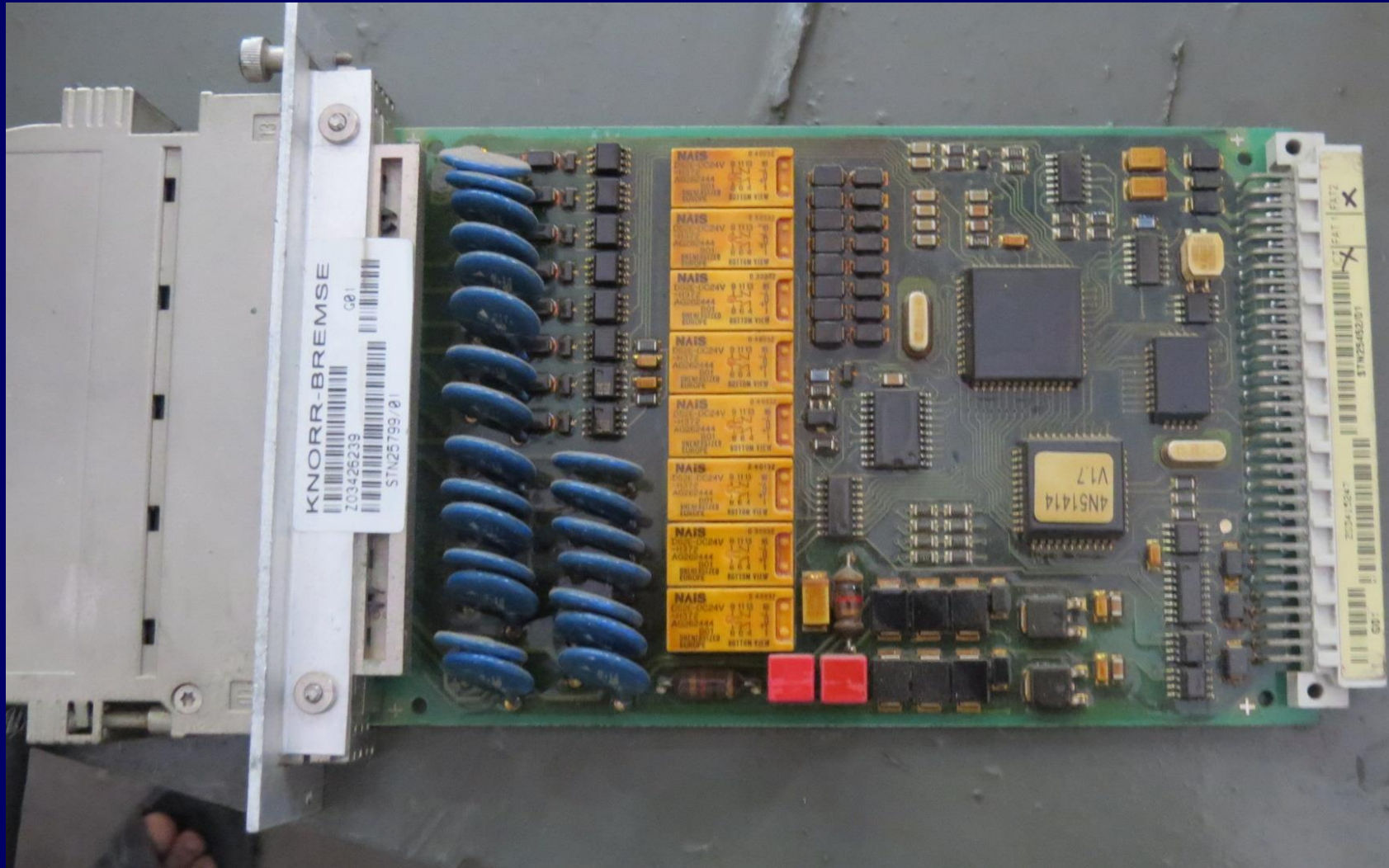


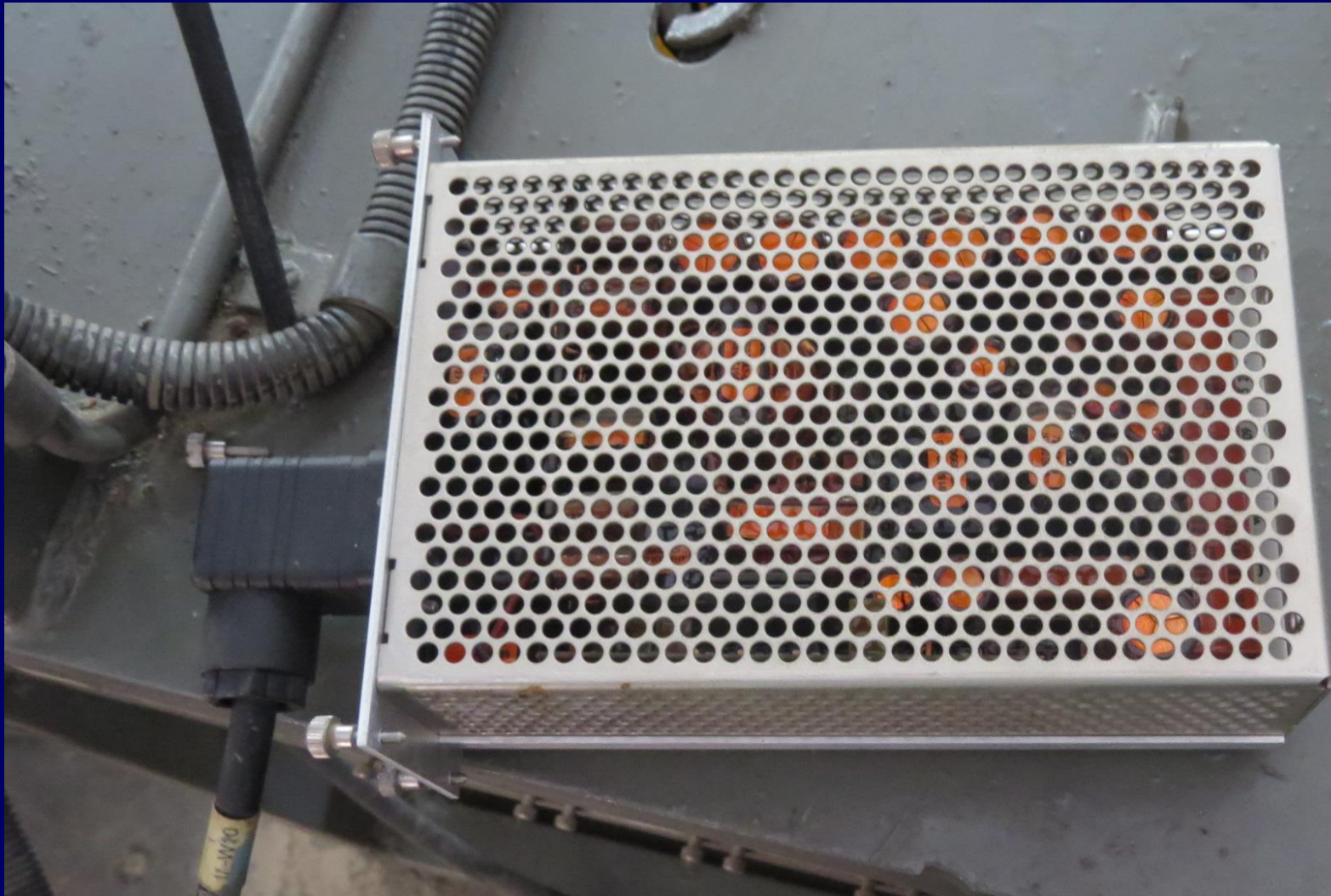












Field Issues

- ❑ Testing and verification
 - Portable Test Device
 - Lab Test Bench
- ❑ Testing of Cards
- ❑ Downloading Performance Data
- ❑ Investigation of Wheel Skid Cases
- ❑ Spare Parts

Thank you