

**WHEEL SLIDE  
PROTECTION DEVICE  
(WSP)**

**Speed Sensor**



**WSP-Electronic**



**WSP-Valve**

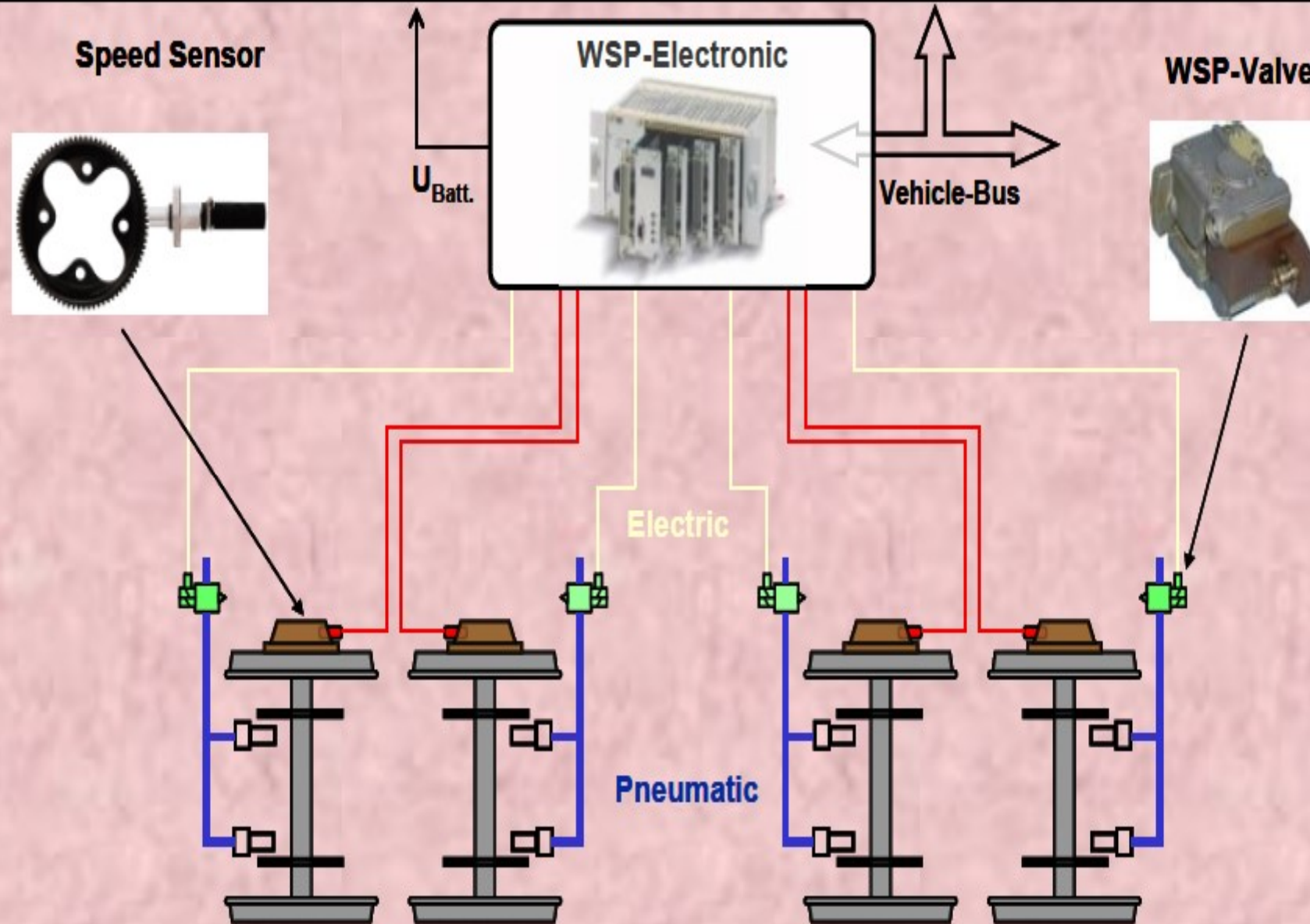


$U_{\text{Batt.}}$

**Vehicle-Bus**

**Electric**

**Pneumatic**



# Introduction

LHB coaches have been introduced in services on some of the premier trains on Indian Railways with state of art features. One of the important feature provided in these coaches are-

**WHEEL SLIDE PROTECTION DEVICE (WSP).**

Presently railways is having two types of processors (WSP's) in service:

1. M/s Knorr Bremse India Ltd.
2. M/s Faiveley India Ltd. (earlier known as M/s Sab Wabco)

# Working Principle

During the course of brake application, there are possibilities of skidding/sliding/locking of individual axle. Above situations are likely to cause damage to wheel sets. The WSPs provided in the system avoids wheel sliding, also cuts the maintenance cost. Speed sensors, the part of the system detect the speed of the wheel & sends signal to the processor unit.

The processor unit evaluates the received signal from speed sensor of the vehicle & generates signals enabling the dump valve/antiskid valves to control the brake cylinder pressure in case of any locking/skidding.

The control on the brake cylinder pressure is instantaneous to the wheel to rail adhesion, keeping the wheels within their optimum range of skidding.

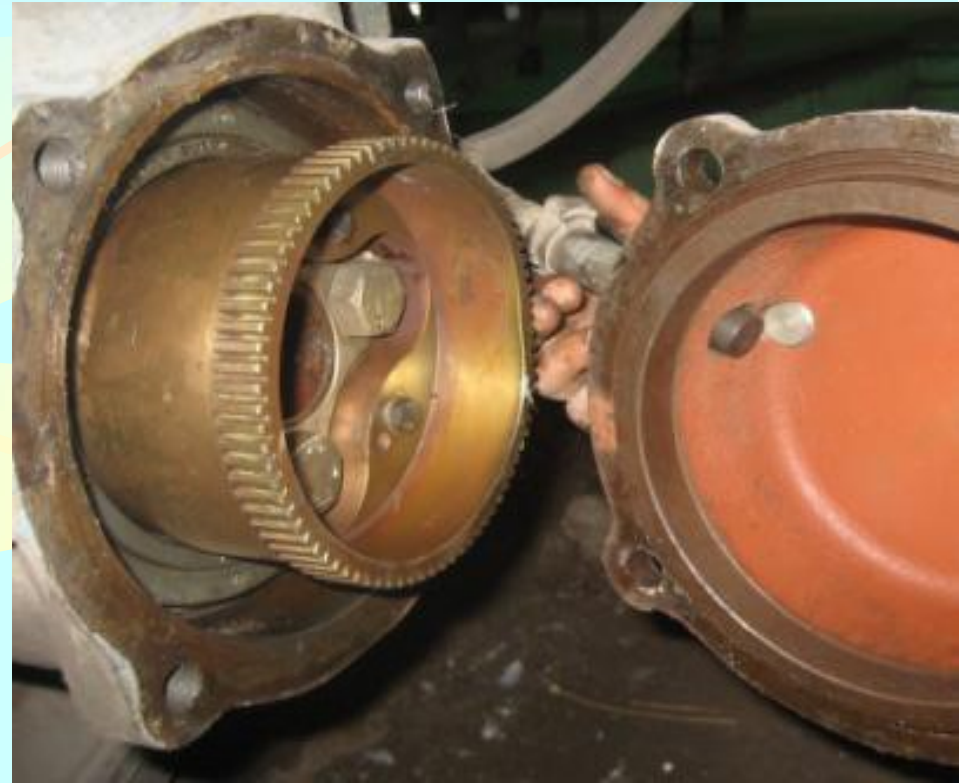
The WSP has some of the major parts.

1. Speed Sensor.
2. Phonic wheel.
3. Microprocessor.
4. Dump valves.
5. Pressure switch.

## *Speed Sensor*

The speed sensors are fixed on one end of the axle box cover with the help of two bolts. During fitment the gap between sensor probe & phonic wheel plays vital role. The gap can be adjusted with the help of shims & measured through the peephole in axle box cover.

The main function of speed sensor is to pickup the signals with the rotation of phonic wheel mounted on axle end & convey to microprocessor.



The air gap between the rotating gear  
(Phonic wheel) & speed sensors probe should be  
Knorr Bremse = 0.4 to 1.4 mm  
Faiveley =  $1.5 \pm 0.5$  mm

## *Phonic wheel*

A phonic wheel is installed on one end of each axle. The phonic wheel is a toothed wheel (gear type). The purpose of this toothed wheel is to alter the internal inductance of the adjacent sensor. The change in internal inductance is evaluated as axle speed of various axles on a coach. During fitment, concentric movement of phonic wheel should be ensured. The eccentric movement of phonic wheel may cause signal errors, damage of speed sensor probe.



# *Microprocessor*

Microprocessor is the heart of the WSP system. This gathers the signals from phonic wheel & speed sensors, evaluates the vehicle speed. Moreover, during brake application, it monitors & bridges the sharp drop of speed of a particular axle/wheel, enabling the dump valve to control/adjust the brake cylinder pressure.

Each processor is provided with LED display & some test buttons. This LED displays various codes which can be decoded & the health of WSP system can be evaluated.

## ***Dump valve/Anti skid valve***

A dump valve is provided for each axle of the vehicle. These dump valves are a type of solenoid valves, connected with the air pressure line of brake cylinder. Dump valve/antiskid valve should be fitted close to the brake cylinders.

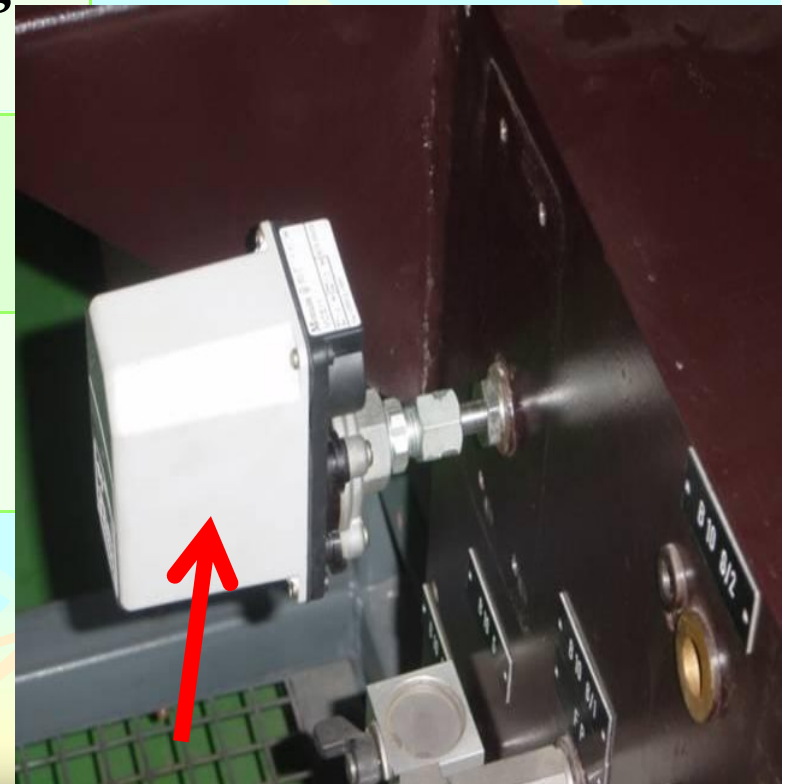
These dump valves allow to deplete the air available in brake cylinder line during brake application based on the signals from WSP microprocessor.



# *Pressure switch*

Pressure switch is provided on brake control panel. The purpose of pressure switch is to activate the WSP when the pressure reaches as given below.

<b>System make</b>	<b>Working on pressure</b>	<b>Pressure range</b>
Knorr Bremse	BP Pressure	0.2 Kg/cm <sup>2</sup> – 0.5 Kg/cm <sup>2</sup>
Sab Wabco	FP Pressure	1.5 Kg/cm <sup>2</sup> – 1.7 Kg/cm <sup>2</sup>

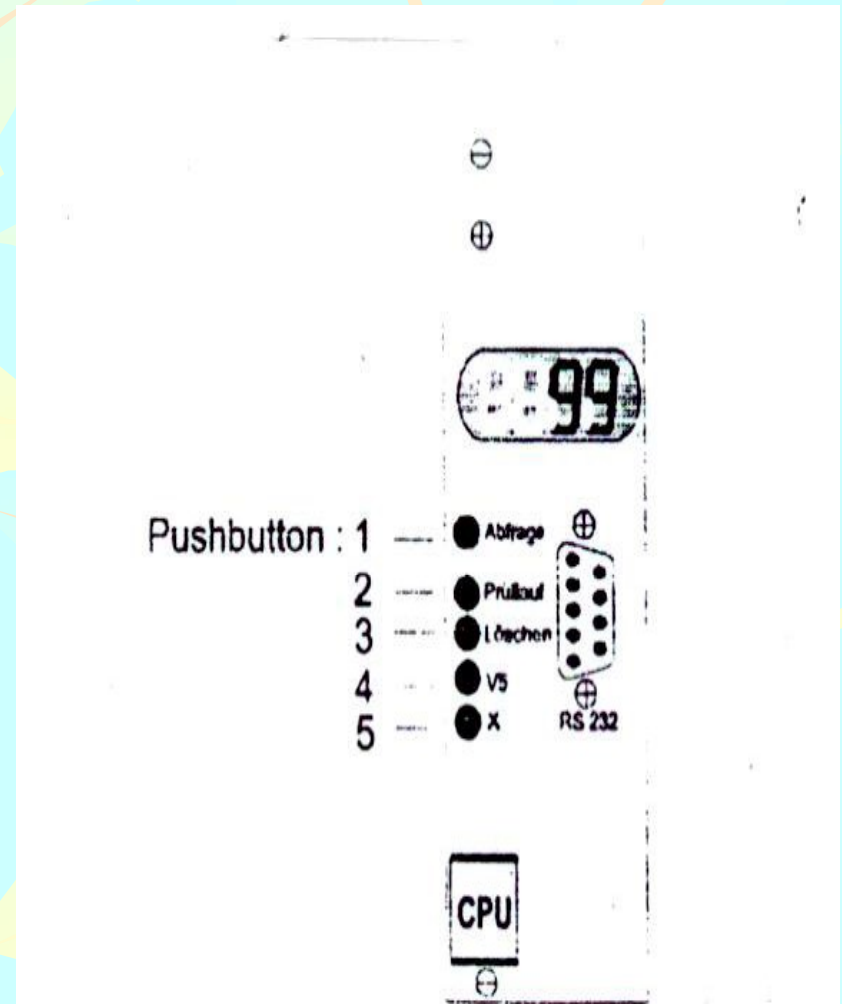


# Testing procedure (Faiveley)

## *Step 1: Diagnostic of Faults*

As push button 1 is pushed & the code displayed is different to 99 (i.e. 95 or 72 or 73) or the system is switched off. The CPU will switch on & by pressing the push button 1 for minimum 3sec, the faults can be displayed. The following functions also take place:

- Indication “88” for 3 sec (7-segment LED test)
- Indication of all faults in a sequence of 3 sec.



## ***Step 2: Test***

To test the system, push button 2 (Test) to be pressed for at least 3sec. The indication “89” appears and following functions take place:

All the brake cylinders of axles 1 - 4 are vented in succession. The correct alignment of dump valve and speed sensor of all the axles starting from axle 1 is checked. Any failure in this will result in inaccurate axle speeds being measured which causes false pressure values are set in the dump valves.

**Note:** The axles are measured as 1 & so on from opposite side, where the microprocessor is fitted.

### ***Step 3: Clearing of failure memory***

By pressing the push button 3 for minimum 3 sec, the following function takes place

Indication of “cLr”

Clearing of all historical faults.

### ***Step 4: Door test (Not in use)***

### ***Step 5: X/ Kilometer counter***

By pressing the push button for minimum 3 sec, the distance will be shown on the display. The distance is value with 8 positions and is divided into two parts. At first, most significant part is shown on display followed by the least significant part.

# *Defect codes with Troubleshooting*

<b>Code in Display</b>	<b>Failure code</b>	<b>Failure cause</b>	<b>Corrective action</b>
72/73	10	Hardware watchdog of solenoid valve of axle 1 is triggered.	Acknowledge the failure, continue the operation.
72/73	11	Short circuit or interruption of speed sensor of axle 1	Check the wires for short circuit or interruption
72/73	13	Short circuit of solenoid valve of axle1	Wires or solenoid of the dump valve should be checked for short circuits, acknowledge the failure.

<b>Code in Display</b>	<b>Failure code</b>	<b>Failure cause</b>	<b>Corrective action</b>
72/73	14	Interruption of solenoid valve of axle 1	Wires or solenoid of the dump valve should be checked for interruption, acknowledge the failure.
72/73	20	Hardware watchdog of solenoid valve of axle 2 is triggered.	Acknowledge the failure, continue the operation.
72/73	21	Short circuit or interruption of speed sensor of axle 2	Check the wires for short circuit or interruption



<b>Code in Display</b>	<b>Failure code</b>	<b>Failure cause</b>	<b>Corrective action</b>
72/73	23	Short circuit of solenoid valve of axle2	Wires or solenoid 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 solenoid of the dump valve should be checked for interruption, acknowledge the failure.
72/73	30	Hardware watchdog of solenoid valve of axle 3 is triggered.	Acknowledge the failure, continue the operation.

<b>Code in Display</b>	<b>Failure code</b>	<b>Failure cause</b>	<b>Corrective action</b>
72/73	31	Short circuit or interruption of speed sensor of axle 3	Check the wires for short circuit or interruption
72/73	33	Short circuit of solenoid valve of axle 3	Wires or solenoid 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 solenoid of the dump valve should be checked for interruption, acknowledge the failure.

<b>Code in Display</b>	<b>Failure code</b>	<b>Failure cause</b>	<b>Corrective action</b>
72/73	40	Hardware watchdog of solenoid valve of axle 4 is triggered.	Acknowledge the failure, continue the operation.
72/73	41	Short circuit or interruption of speed sensor of axle 4	Check the wires for short circuit or interruption
72/73	43	Short circuit of solenoid valve of axle 4	Wires or solenoid of the dump valve should be checked for short circuits, acknowledge the failure.

<b>Code in Display</b>	<b>Failure code</b>	<b>Failure cause</b>	<b>Corrective action</b>
72/73	44	Interruption of solenoid valve of axle 4	Wires or solenoid of the dump valve should be checked for interruption, acknowledge the failure.
95	10	Hardware watchdog of solenoid valve at axle 1 is triggered.	Acknowledge the failure, continue the operation.
95	11	Short circuit or interruption of connection between speed sensor at axle 1 and WSP	<ol style="list-style-type: none"> <li>1. Check the wires for short circuit or interruption.</li> <li>2. Replace speed sensor, acknowledge the failure.</li> </ol>

<b>Code in Display</b>	<b>Failure code</b>	<b>Failure cause</b>	<b>Corrective action</b>
95	13	Short circuit at solenoid valve of axle 1.	<ol style="list-style-type: none"> <li>1. Check the wires and valve for short circuit, acknowledge the failure.</li> <li>2. Replace solenoid valve, acknowledge the failure.</li> </ol>
95	14	Interruption of solenoid valve of axle 1	<ol style="list-style-type: none"> <li>1. Check the wires and valve for interruptions, acknowledge the failure.</li> <li>2. Replace solenoid valve, acknowledge the failure.</li> </ol>
95	20	Hardware watchdog of solenoid valve of axle 2 is triggered.	Acknowledge the failure, continue the operation.

<b>Code in Display</b>	<b>Failure code</b>	<b>Failure cause</b>	<b>Corrective action</b>
95	21	Short circuit or interruption of connection between speed sensor of axle 2 and WSP	<ol style="list-style-type: none"> <li>1. Check the wires for short circuit or interruption.</li> <li>2. Replace speed sensor, acknowledge the failure.</li> </ol>
95	23	Short circuit at solenoid valve of axle 2.	<ol style="list-style-type: none"> <li>1. Check the wires and valve for short circuit, acknowledge the failure.</li> <li>2. Replace solenoid valve, acknowledge the failure.</li> </ol>
95	24	Interruption of solenoid valve of axle 2.	<ol style="list-style-type: none"> <li>1. Check the wires and valve for interruptions, acknowledge the failure.</li> <li>2. Replace solenoid valve, acknowledge the failure.</li> </ol>

<b>Code in Display</b>	<b>Failure code</b>	<b>Failure cause</b>	<b>Corrective action</b>
95	30	Hardware watchdog of solenoid valve of axle 3 is triggered.	Acknowledge the failure, continue the operation.
95	31	Short circuit or interruption of Connection between speed sensor of axle 3 and WSP	<ol style="list-style-type: none"> <li>1. Check the wires for short circuit or interruption.</li> <li>2. Replace speed sensor, acknowledge the failure.</li> </ol>
95	33	Short circuit at solenoid valve of axle 3.	<ol style="list-style-type: none"> <li>1. Check the wires and valve for short circuit, acknowledge the failure.</li> <li>2. Replace solenoid valve, acknowledge the failure.</li> </ol>

<b>Code in Display</b>	<b>Failure code</b>	<b>Failure cause</b>	<b>Corrective action</b>
95	34	Interruption of solenoid valve of axle 3.	<ol style="list-style-type: none"> <li>1. Check the wires and valve for interruptions, acknowledge the failure.</li> <li>2. Replace solenoid valve, acknowledge the failure.</li> </ol>
95	40	Hardware watchdog of solenoid valve of axle 4 is triggered.	Acknowledge the failure, continue the operation.
95	41	Short circuit or interruption of Connection between speed sensor of axle 4 and WSP	<ol style="list-style-type: none"> <li>1. Check the wires for short circuit or interruption.</li> <li>2. Replace speed sensor, acknowledge the failure.</li> </ol>



<b>Code in Display</b>	<b>Failure code</b>	<b>Failure cause</b>	<b>Corrective action</b>
95	43	Short circuit at solenoid valve of axle 4.	<ol style="list-style-type: none"><li>1. Check the wires and valve for short circuit, acknowledge the failure.</li><li>2. Replace solenoid valve, acknowledge the failure.</li></ol>
95	44	Interruption of solenoid valve of axle 4	<ol style="list-style-type: none"><li>1. Check the wires and valve for interruptions, acknowledge the failure.</li><li>2. Replace solenoid valve, acknowledge the failure.</li></ol>

# *Table of Failure Codes*

<b>Axle</b>	<b>Code</b>	<b>Description</b>
1	10	Safety shut - down MV (Dump Valve)
	11	Short circuit / interruption GE (Speed Sensor)
	13	Short circuit MV (Dump Valve)
	14	Interruption MV (Dump Valve)
2	20	Safety shut - down MV (Dump Valve)
	21	Short circuit / interruption GE (Speed Sensor)
	23	Short circuit MV (Dump Valve)
	24	Interruption MV (Dump Valve)
3	30	Safety shut - down MV (Dump Valve)
	31	Short circuit / interruption GE (Speed Sensor)
	33	Short circuit MV (Dump Valve)
	34	Interruption MV (Dump Valve)

<b>Axle</b>	<b>Code</b>	<b>Description</b>
4	40	Safety shut - down MV (Dump Valve)
	41	Short circuit / interruption GE (Speed Sensor)
	43	Short circuit MV (Dump Valve)
	44	Interruption MV (Dump Valve)
	70/71	Failure in electronic card RE (relay output)
	72	WSP disturbance, one axle
	73	WSP disturbance, several axles
	HF	Global hardware failure
	Pr	Processor
	EP	EPROM
	EE	EEPROM
	Hd	Hardware watchdog

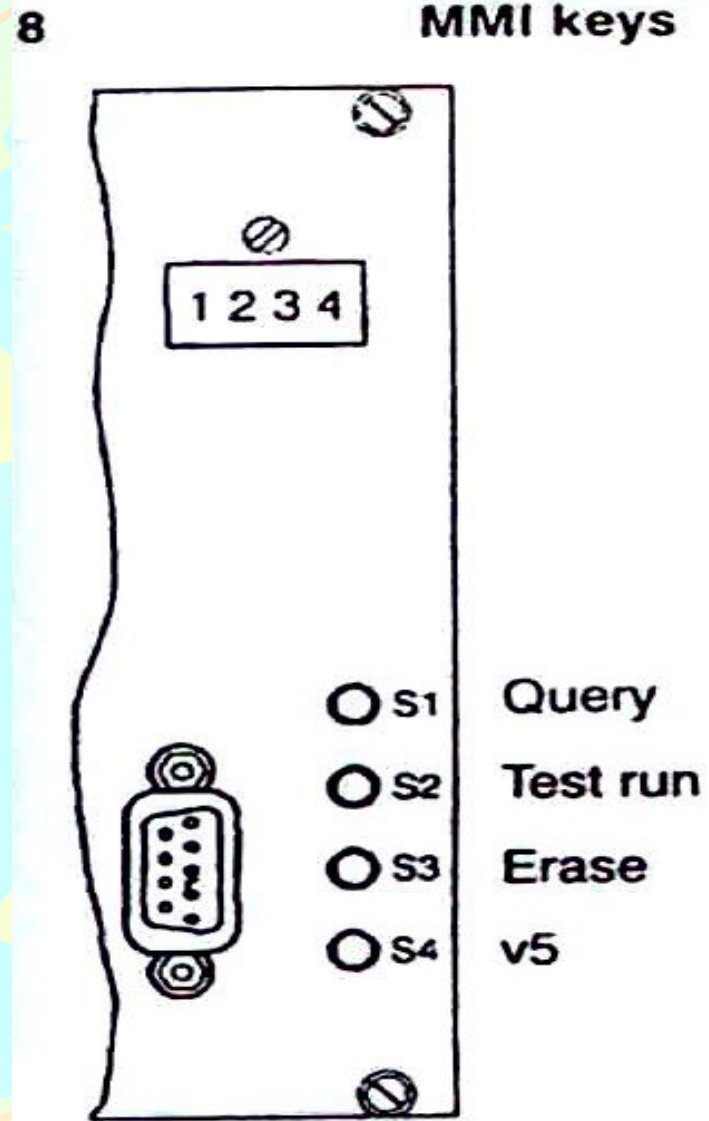
<b>Axle</b>	<b>Code</b>	<b>Description</b>
	8888	Segment test
	89	Test run
	95	Intermittent fault
	99	Good indication



# Testing procedure (Knorr Bremse)

## *Test run:*

By pressing the keys on MMI, three different test runs can be performed. The test runs are terminated automatically when a speed signal higher than 03 kmph is identified.



## **Step 1 - “Valve control” test run**

By pressing the key “S2” one sec, the valve control test run starts.

The display will show “8888” for the first three seconds & then switches to “89”. Faults found by the test are displayed at the end of the run. Volatile faults that have occurred at some time on the move and disappeared again in the meantime (e.g. loose contacts), are displayed as number “95”. After the test run has been completed, the code “99” is again shown on the display.

All the brake cylinders of axles 1 - 4 are vented in succession. The alignment of anti skid valve and speed sensor of all the axles starting from axle 1 are checked. Any failure will result in inaccurate axle speeds being measured which causes false pressure values are set in the anti skid valves.

**Step 2 –“Door control” test run (Not in use)**

# *Fault memory*

## *(A) Retrieving faults from memory*

The display return code “99” if the fault memory is empty & no keys are pressed. The display shows code number “95”, if any volatile faults are in memory.

Press key “S1” to start the query. To begin with, the display reads “8888”.

All current faults are displayed for three seconds each. The display subsequently reads “95” & then shows the volatile faults.



### *(B) Erasing faults from memory*

The fault memory is erased when the erase key “S3” is pressed for about one second. However, persistent faults will be entered instantly again in the fault memory.

### ***Service Terminal:***

An interface PC can be connected with port on MMI RS 232 for monitoring diagnostic output of the system.

## Defects analysis & trouble shooting (Knorr Bremse)

<b>Display</b>	<b>Fault</b>	<b>Problem Source</b>	<b>Connected with</b>
02	Digital I/Os	Board EB01A	
03	Central processing unit	Board MB04A	
10	Time out	Board MB04A	Wheelset 1
11	Short circuit / open circuit	Speed sensor 1/feeder	
12	Signal error	Speed sensor 1/feeder	
13	Short circuit	Dump Valve 1/feeder	
14	Open circuit	Dump Valve 1/feeder	
15	Safety monitor defective(test run)	Board MB04A	

<b>Display</b>	<b>Fault</b>	<b>Problem Source</b>	<b>Connected with</b>
20	Time out	Board MB04A	Wheelset 2
21	Short circuit / open circuit	Speed sensor 2/feeder	
22	Signal error	Speed sensor 2/feeder	
23	Short circuit	Dump Valve 2/feeder	
24	Open circuit	Dump Valve 2/feeder	
25	Safety monitor defective(test run)	Board MB04A	
30	Time out	Board MB04A	Wheelset 3
31	Short circuit / open circuit	Speed sensor 3/feeder	
32	Signal error	Speed sensor 3/feeder	
33	Short circuit	Dump Valve 3/feeder	
34	Open circuit	Dump Valve 3/feeder	
35	Safety monitor defective(test run)	Board MB04A	

<b>Display</b>	<b>Fault</b>	<b>Problem Source</b>	<b>Connected with</b>
40	Time out	Board MB04A	Wheelset 4
41	Short circuit / open circuit	Speed sensor 4/feeder	
42	Signal error	Speed sensor 4/feeder	
43	Short circuit	Dump Valve 4/feeder	
44	Open circuit	Dump Valve 4/feeder	
45	Safety monitor defective(test run)	Board MB04A	
70	Speed signal fault, door control		
71	Speed signal fault, electromag track brake	Board EB01A	
72	Fault at one wheelset		

<b>Display</b>	<b>Fault</b>	<b>Problem Source</b>	<b>Connected with</b>
73	Fault at several wheelsets		
74	Safety monitor fault	Board MB04A	
c8	Activation fault, cumulative fault signaling	Board EB01A	
S2	Connector defect board EB01A	Board EB01A	
S3	Connector defect board MB04A	Board MB04A	
8888	Display test		
89	Test running		
95	Volatile faults		
99	System good		

**Thank you**

