Why WSP system?

- To avoid insufficient wheel/rail adhesion when the train is braking
- To make optimum use of available adhesion when braking thereby optimizing the stopping distances
- To prevent locked (sliding) wheels due to uncontrolled sliding and resulting in wheel damage
Schematic diagram of WSP system

Microcomputer wheel slide protection system SWKP AS20

Train control lines
Traction, Braking ..

To control valve

Exhaust valve

Exhaust valve

Brake cylinder pressure 1-4

G1 .. G4: speed sensor

G1 .. G4: speed sensor

Bogie I
Axle 1
Axle 2
Bogie II
Axle 3
Axle 4

Microcomputer wheel slide protection system SWKP AS20

G1 .. G4: speed sensor

Bogie I
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Axle 3
Axle 4

Train control lines
Traction, Braking ..

To control valve

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Brake cylinder pressure 1-4
Architectures

WSP Control Unit

- Dump valve
- Speed sens
- Brake cylinder

Brake reservoir

WSPCU

Distributor/Relay Valve

Brake pipe

16.09.2014

FT
Dump valve

Supply

EVA

EVE

Exhaust

Brake cylinder

WSPCU

Brake pipe

Speed sens

Brake cylinder

Dump valve

FT

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• Fixed parameter is used to generate the virtual axle speed

• In case of all axle sliding, a software timeout (5s) releases the pressure of one axle till it recovers the ref-speed, with 3s time limit

• This algorithm is used in WSP system
Reference Speed in Real case

Ref Speed = Highest among Axles Speed

Ref Speed = Virtual Speed
Calculated with Constant Slope
Braking with WSP _Axle Control

- Speed
- Acceleration
- Valve control
- Brake cylinder pressure

Graphs showing the relationship between speed, acceleration, valve control, and brake cylinder pressure over time (t1 to t6).
- 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
Speed Sensor Installation

- Axle end cover
- Phonic wheel
- Gap 1.5±0.5 mm
- Speed sensor
- Light indicator
- Cable with protective tube

16.09.2014
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.
Static verification of WSP-System can be performed by pressing CPU push-button 2 (Test) for at least 3s.

The indication “89” appears and the following function takes place:

- All brake cylinders of axles 1-4 starts vented in succession
- Starting with axle 1 the correct alignment of the dump valve and speed sensor check performed in this stage.
- Test failure will result in inaccurate axle speeds being measured and
- False pressure values are set in the dump valves.

Figure below shows the connection between venting process of the dump valves and the modulation of the light indicator of the speed sensor.
CPU board has 5 push buttons

- Push button 1 to read the diagnostic fault code.
- Push button 2 for test purposes when pushed for 3s the display will indicate “89” and CPU will enter into the test program to test WSP system.
- Push button 3 to clear the history of fault code when pressed 3 sec. and also will display Clear.
- Push button 4 when pressed for 3s will check all the door-control.
- Push button 4 when pressed for 3s will display total Kilometer run in the form of 8 digits. First press will show first part of 8 digits. Second press will indicate the last four digits.
<table>
<thead>
<tr>
<th>Display Code</th>
<th>Failure code</th>
<th>Failure cause</th>
<th>Corrective action</th>
</tr>
</thead>
<tbody>
<tr>
<td>72/73</td>
<td>10</td>
<td>Hardware watchdog of solenoid valve of axle1 is triggered</td>
<td>Acknowledgement the failure, continue the operation.</td>
</tr>
<tr>
<td>72/73</td>
<td>11</td>
<td>Short circuit or interruption of speed sensor of Axle1</td>
<td>Check the wires for short circuit or interruption.</td>
</tr>
<tr>
<td>72/73</td>
<td>13</td>
<td>Short circuit of solenoid valve of Axle 1.</td>
<td>Wires or solenoids of the dump valve should be checked for short circuits, acknowledge the failure</td>
</tr>
<tr>
<td>72/73</td>
<td>14</td>
<td>Interruption of solenoid valve of Axle 1.</td>
<td>Wires or solenoids of the dump valve should be checked for interruption, acknowledge the failure</td>
</tr>
<tr>
<td>72/73</td>
<td>20</td>
<td>Hardware watchdog of solenoid valve of axle2 is triggered</td>
<td>Acknowledgement the failure, continue the operation.</td>
</tr>
<tr>
<td>72/73</td>
<td>21</td>
<td>Short circuit or interruption of speed sensor of Axle2</td>
<td>Check the wires for short circuit or interruption.</td>
</tr>
<tr>
<td>72/73</td>
<td>23</td>
<td>Short circuit of solenoid valve of Axle 2.</td>
<td>Wires or solenoids of the dump valve should be checked for short circuits, acknowledge the failure</td>
</tr>
<tr>
<td>72/73</td>
<td>24</td>
<td>Interruption of solenoid valve of Axle 2.</td>
<td>Wires or solenoids of the dump valve should be checked for interruption, acknowledge the failure</td>
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<td>72/73</td>
<td>30</td>
<td>Hardware watchdog of solenoid valve of axle3 is triggered</td>
<td>Acknowledgement the failure, continue the operation.</td>
</tr>
<tr>
<td>72/73</td>
<td>31</td>
<td>Short circuit or interruption of speed sensor of Axle3</td>
<td>Check the wires for short circuit or interruption.</td>
</tr>
<tr>
<td>72/73</td>
<td>33</td>
<td>Short circuit of solenoid valve of Axle 3.</td>
<td>Wires or solenoids of the dump valve should be checked for short circuits, acknowledge the failure.</td>
</tr>
<tr>
<td>72/73</td>
<td>34</td>
<td>Interruption of solenoid valve of Axle 3.</td>
<td>Wires or solenoids of the dump valve should be checked for interruption, acknowledge the failure.</td>
</tr>
<tr>
<td>72/73</td>
<td>40</td>
<td>Hardware watchdog of solenoid valve of axle4 is triggered</td>
<td>Acknowledgement the failure, continue the operation.</td>
</tr>
<tr>
<td>72/73</td>
<td>41</td>
<td>Short circuit or interruption of speed sensor of Axle4</td>
<td>Check the wires for short circuit or interruption.</td>
</tr>
<tr>
<td>72/73</td>
<td>43</td>
<td>Short circuit of solenoid valve of Axle 4.</td>
<td>Wires or solenoids of the dump valve should be checked for short circuits, acknowledge the failure.</td>
</tr>
<tr>
<td>72/73</td>
<td>44</td>
<td>Interruption of solenoid valve of Axle 4.</td>
<td>Wires or solenoids of the dump valve should be checked for interruption, acknowledge the failure.</td>
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<td>95</td>
<td>20</td>
<td>Hardware watchdog of solenoid valve of axle2 is triggered</td>
<td>Acknowledge the failure, continue the operation.</td>
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</table>
| 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.  
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<td>Short circuit of solenoid valve of Axle 3.</td>
<td>1. Check the wires and valve for short circuit acknowledge the failure.</td>
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Thank you for your attention