ENGINEERING
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Functional Safety Applications
DST P92S pressure sensor

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Functional Safety & Legislation

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Standards for the Safety of Machinery containing Electronic Control Units

Directive of Machinery 2006/42/EG

EN ISO 13849-1
- PLd
- Cat 2
- DC medium
- CCF 70 points
- MTTF high > 100 years

EN IEC 61508
- SIL2
- 1001D architecture
- HFT 0
- SFF 94%
- PFH $2.3*10^{7}$

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Performance Level PL and Safety Integrity **Level SIL** (IEC 62061 or IEC 61508)

- Up to PL c a simplified procedure is possible: no quantitative determination of PL necessary
- For a detailed procedure Markov-modelling, reliability block diagrams, etc. must be applied
- For levels PL d and PL e the standard EN IEC 61508 must be applied for a calculation of the PL (probability of dangerous failures per hour)

Performance Level (PL) (ISO 13849-1)	Average probability of dangerous failure per hour PFH (1/h)	SIL (IEC 61508-1, high/ continuous mode of operation)
a	≥ 10-5 up to < 10-4	No correspondence
b	≥ 3 × 10.6 up to < 10-5	1
c	10-6 up to < 3 × 10-6	1
d	≥ 10-7 up to < 10-6	2
e	≥ 10-8 up to < 10-7	3

- 10^{-6} = 0,000001 fails / hours
- 360 days / year ; 8 hours / day = 2880 hours / year
- Meaning 1 dangerous fail every 347 years

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Our Solution

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DST P92S - Safety Pressure Transmitter

Danfoss **DST P92S** sensors meet the requirements of Safety Integrity Level 2 (**SIL2**) to EN 61508 and thereby also the requirements of **Performance Level d** to EN 13849-1. This means they are approved for safety functions on mobile and stationary machines. They support the functional safety and contribute to meeting the safety targets of the entire machine.
DST P92S is 3rd party certified through **TÜV** Rheinland

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Main Technical Information

- SIL 2 compliant
- PL d compliant

- Intelligent Category 2 architecture

- Over all accuracy:
  - <=1.0% FS
  - (0…+80°C)
  - <=1.5% FS
  - (-25…+85°C)
  - <=2.5% FS
  - (-40…85°C)

- Operating temperature -40…+85°C

- M12 connection

- Measuring element in stainless steel

- Outputs: 4-20 mA/20-4 mA (3-wire technology)

Connections:
- G 1/4” DIN 3852

- TÜV approved
- E1 approved
- CE certified

- IP67 protected

- 0-40 bar to 0-600 bar

- Time constant <1mS

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Value Proposition

Moisture and harness check

- Start up and cyclic diagnosis. Performs moisture check to detect moisture in the cable interface and electrical connector
- Identifies EMC interference

Start-Up Diagnosis

- Uses an intelligent start-up diagnostic sequence. After powering up the transmitter all relevant parameters are checked. If a failure is detected the output signal is taken to a safe state

Cyclic Diagnosis

- During normal operation the cyclic diagnosis guaranties a correct function of the P92S. Faults as internal- and external harness-faults are detected

Small in size

- Is small in size (Hex 22) makes P92S easier to fit in almost every environment

Immune to moisture ingress in even the harshest environment

- Hermetic Sealed Housing seals the transmitter
- M12 connector with top mounted O-ring seals the connector

Reliable certification

- SIL2 and TÜV approved - a confirmation from a third party

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Applications in Focus

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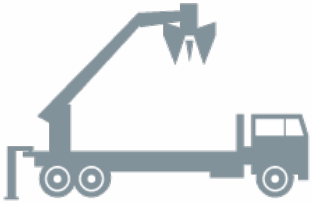
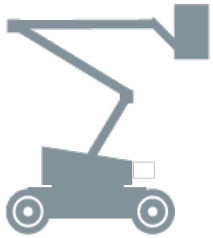
Mobile Hydraulic Machinery



Truck mounted crane

Telescopic loader/ Telehandler

Garbage truck



Aerial work platform

Concrete pump

DST P92S SIL 2 certified pressure sensor designed for safety-related applications within mobile hydraulics, with an extended temperature range and suitable for aggressive media. DST P92S is 3rd party certified through **TÜV** Rheinland

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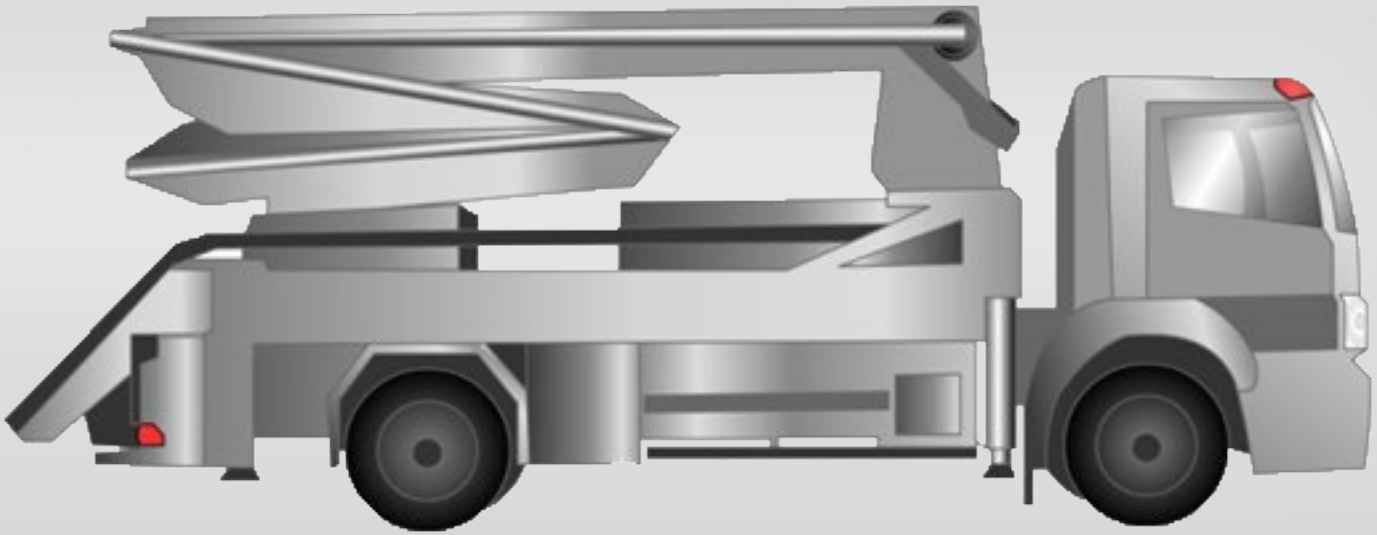
Stabilizing Legs prevents tilting

- **Concrete pump**
  Stabilizing the supporting legs are used to balance the vehicle to prevent tilting during operation.
  Using a DST P92 pressure sensor in combination with the controller ensures that the stabilizing legs are properly deployed or pulled in place during operation ensuring that safety is not jeopardized



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Boom Control Prevents Tilting

- **Mobile crane**
  Boom control are used to limit the operators handling the equipment in a dangerous way preventing tilting during operation.
  Using a DST P92 pressure sensor in combination with the controller, position and angle sensors ensures that the boom is not operated in a way that jeopardizes the safety.

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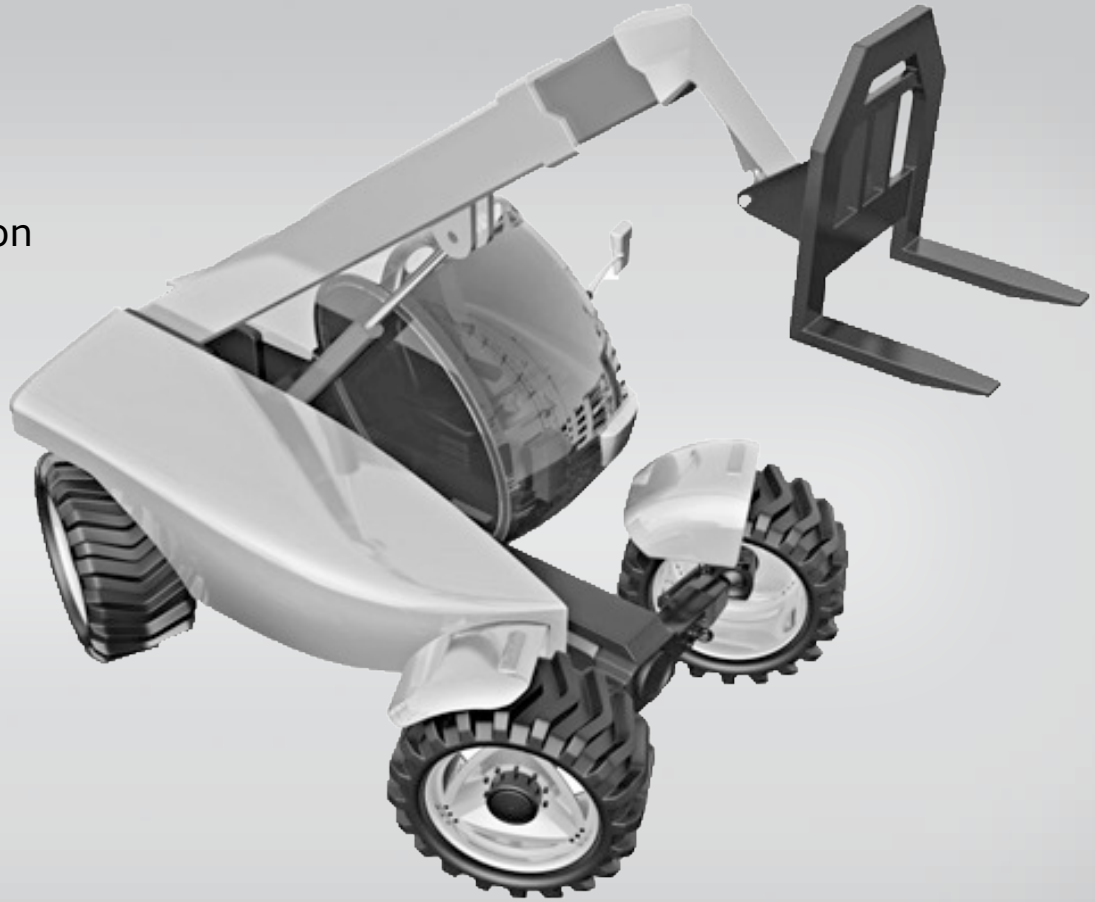
Boom Control Prevents Tilting

- **Telehandler**
  Boom control on tele handlers is decreasing the risk of tilting the machine during operation.
  DST P92 pressure sensor in combination with angle and position sensors provides input to the controller that limits height, speed and weight on the machine



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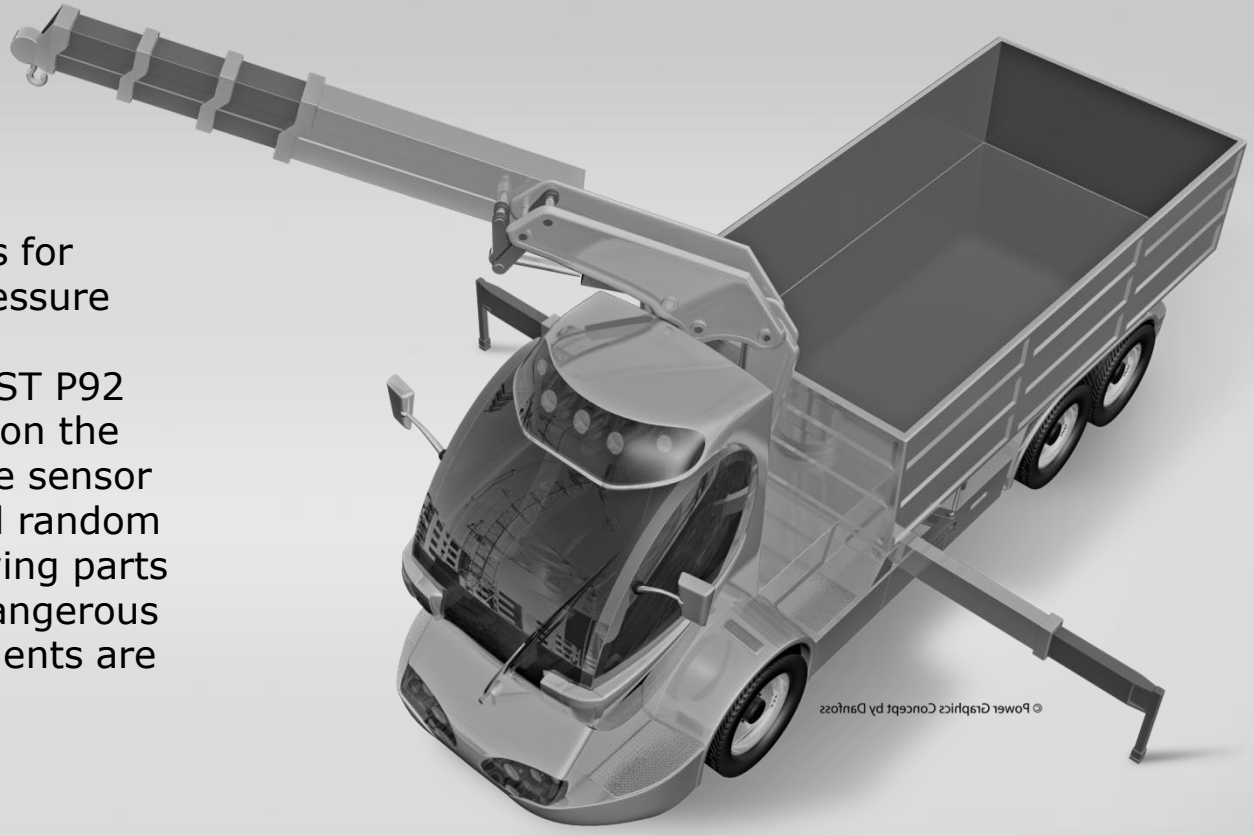
Detecting Failures on Main Hydraulic Cylinder

- **Truck mounted crane**
  In machine control systems for cranes, lifting platforms pressure sensors are typical used.
  By the use of one or two DST P92 pressure sensors mounted on the main hydraulic cylinder. The sensor detects system failures and random error functions so that moving parts are shut down in case of dangerous operation and serious accidents are avoided.



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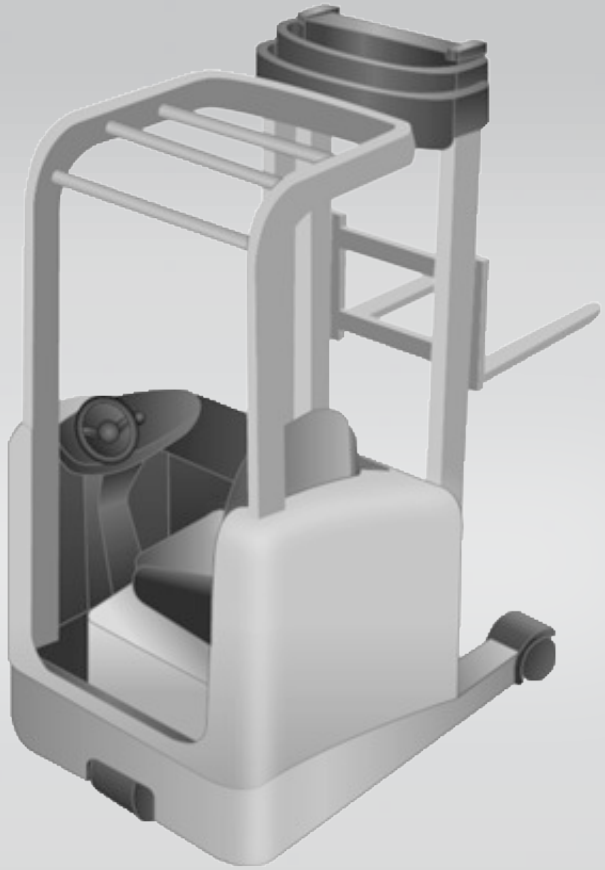
Tower Control Prevents Tilting

- **Forklift**
  Tower control on forklifts are decreasing the risk of tilting the machine during operation. DST P92 pressure sensors in combination with angle and position sensors provides input to the controller that limits height, speed and weight on the machine



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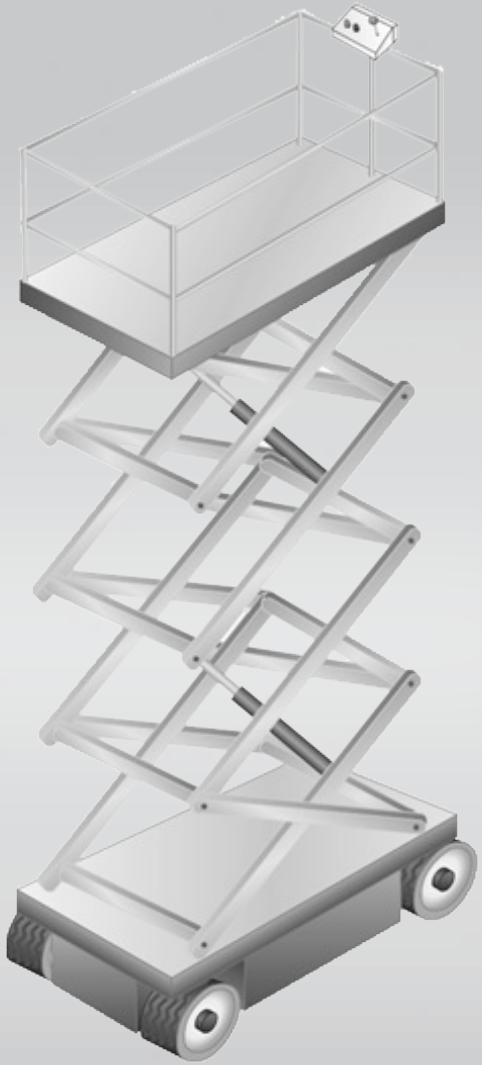
Machine Control Prevents Failures

- **Scissor lift**
  In machine control systems lifting platforms pressure sensors are typical used.
  With a DST P92 pressure sensor mounted on the manifold block. The sensor detects system failures and random error functions so that moving parts are shut down in case of dangerous operation and serious accidents are avoided.



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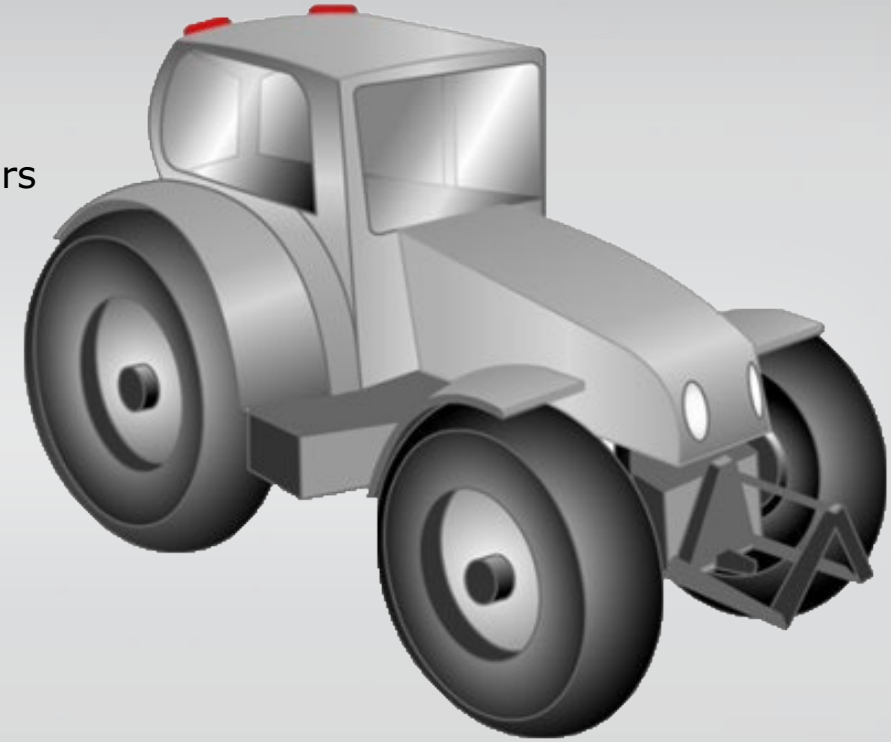
Avoiding Power Loss in the Transmission

- **Tractor**
  CVT (Continuously Variable Transmission) is an automatic transmission commonly used in tractors. There are several pressures that need to be controlled constantly. Clutch control ensures that the clutch is engaged. Line pressure control uses 2 DST P92 pressure sensors for balancing the pressure inside the transmission to avoid power loss.



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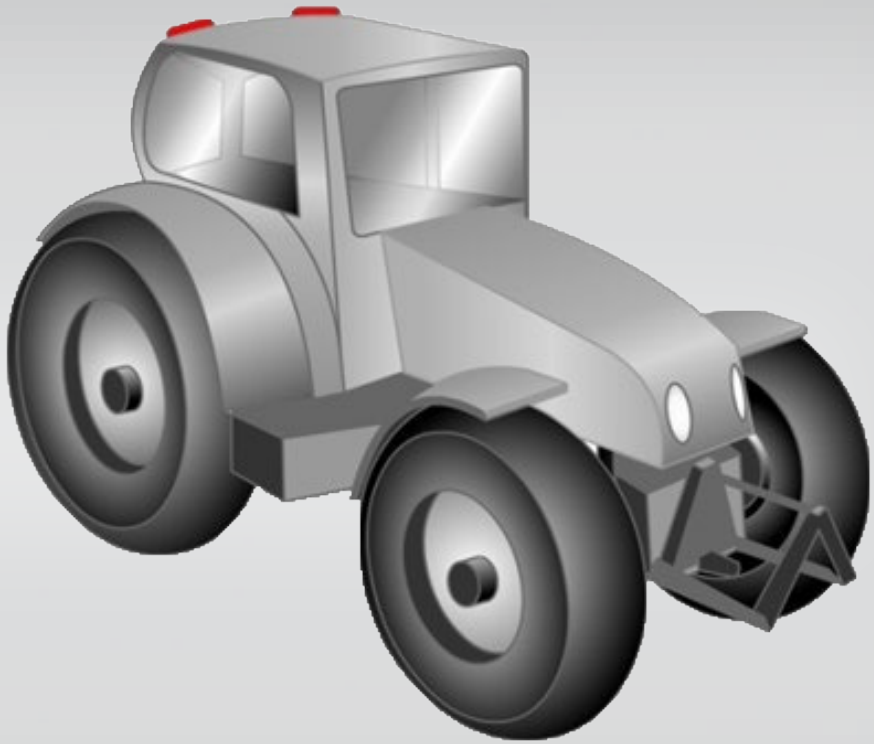
Giving Signal from the Steering System

- **Tractor**
  New tractors have often two steering systems: Steering through a GPS and steering with a manual steering wheel.
  DST P92 pressure sensors give a signal when the steering wheel is manually operated.



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