Systematic Approach of APC to Enable Early Detection of Abnormal Pressure for TPMS (Tire Pressure Monitoring Systems) BE Testing Process

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Abstract
The Backend sites of Infineon Technologies are implementing APC throughout nearly all the Backend processes. We leap through challenges to enhance productivity and quality in Backend by the use of a systematic approach of APC. With the real time monitoring of process and equipment data as well as equipment alarms the early detection to process deviations and abnormalities is enabled.

A Tire Pressure Monitoring System (TPMS) chip (Figure 1) is manufactured in Infineon Sensor Malacca since the year 2005. This single package IC consists of pressure and acceleration sensor devices. The TPMS chip is tested with a PTV (Pressure, Temperature, and Voltage) tester according to the electrical functionality and is calibrated with pressure and temperature compensation to achieve a highly accurate sensor system. As this chip is used in automotive industry, this is crucial to ensure the PTV machine pressure supply is within the defined specifications and remains stable during testing. So the team decided to implement APC for the real time PTV pressure monitoring.

This paper demonstrates how APC helps to detect violations in PTV and how proactive actions can be taken before a device failure or abnormality occurs.

Process Data Acquisition

A PTV tester consists of a 4 sites pressure leak free enclosed and sealed compartment. Different ranges of pressure can be supplied from the main controller also known as DPI controller to the individual pressure ports according to the test specification during testing. The main controller then distributes the supply equally to the 4 sites. (Figure 3). The PTV machine Pressure Controller output values and the 4 sites individual pressure reference read out values from the transducer are programmed to send data to the APC system through the Infineon network. (Figure 2)

APC Trend Analysis and Fault Classification

Several studies were carried out to analyze the pressure trends in APC Trend - Infineon's standard APC software - and the potential failure modes. Analysis shows that different modes of failure from mechanical parts contribute to different trend patterns. Analyzing the trend, all the pressure site shifts could be caused by the faulty controller. A change to a calibrated controller is needed for this case.

A leakage in piping or NC (Normally Closed) valve or loose screw shows a downward shift in all pressure sites across the time. Replacement of piping or valve or tightening the connector is required.

APC Trend is also capable to configure calculated keynumbers (from parameters) – the pressure reference range between all sites is calculated from the pressure reference of 4 sites. The increase in the pressure site range indicates a leakage in piping or NO (Normally Open) valve or a loose screw. Further analysis shows that we are able to determine which pressure site deviates most from the standard and a check on the mechanical parts can be done on the problematic site.

A calculated keynumber for the range between Pressure Controller and Pressure Site enable the detection for worn out o ring in the pressure block. The pressure range controller- site reference trend shows a shift in this case.

For some cases it may appear a different failure mode. From the APC trend we could see a downward shift for all the sites and the same time or one site may deviate from the other sites. This indicates there is potential of NC (Normally Closed) valve or loosened screw and NO (Normally Open) valve or loosened screw.

Using APC trend, we are able to drill down to the root cause faster compared to the conventional way – trial and error at a high cost.

Limits are set in APC Trend and recommended actions are defined.

Conclusion

APC helps to enhance process control and improve production capabilities - which lead to better yield sustainability and stability. APC also facilitate detection of abnormalities in the equipment and provide a continuous learning platform for engineers to study and correlate the data with the failure mode.

Figure 1: TPMS chip

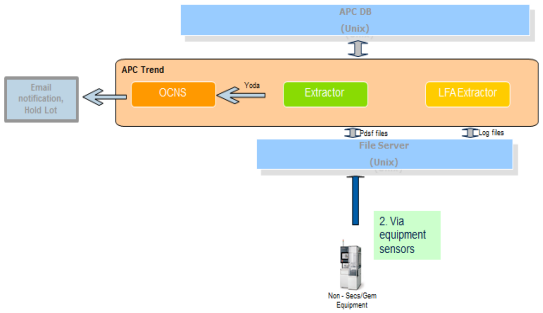
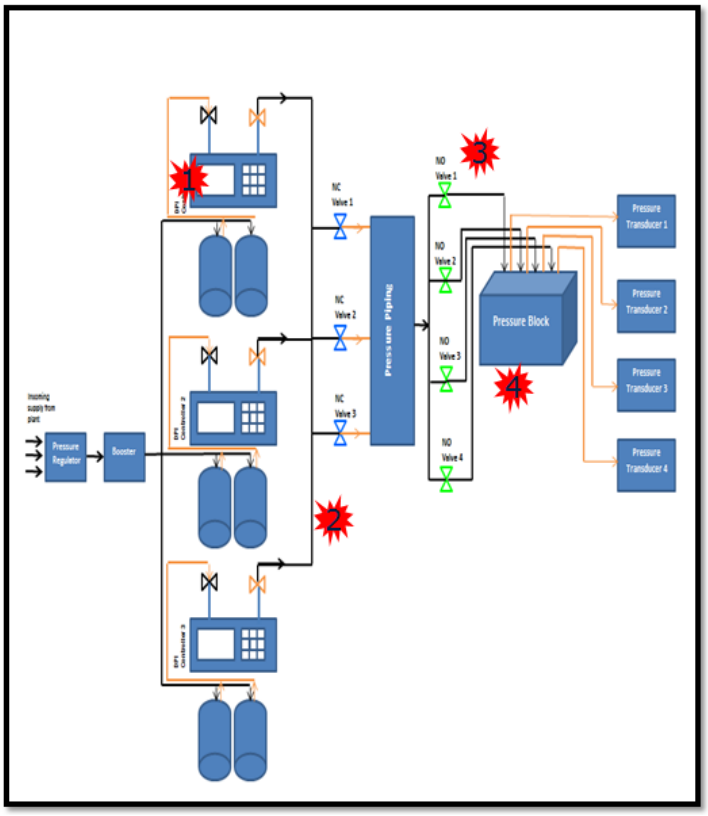


Figure 2: APC Connection Setup



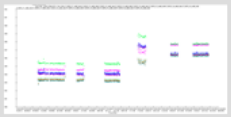
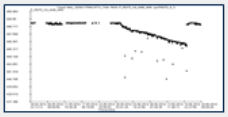
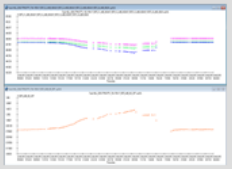
Failure Mode	Potential Failure Mode	APC Trend
1.	Faulty DPI Controller	P_REF all Site 
2	Leakage "NC" piping or Valve, Loose/ worn out screw	P_REF all Site 
2,3	-Leakage "NC" piping or Valve, Loose/ worn out screw -Leakage "NO" piping or Valve, Loose/ Worn out screw.	P_REF all sites, P_REF Site to Site Diff 
4	Worn out O ring	P_CONTROLLER and P_REF Diff 

Figure 3: Failure Mode and APC Trend

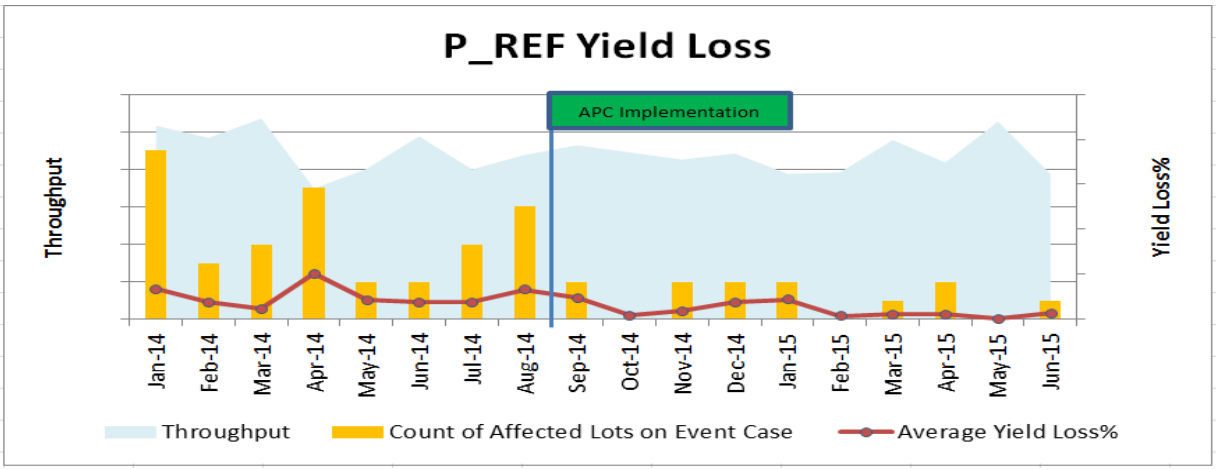


Figure 4: Improvement in Yield Loss and reduction of affected lots with pressure related issue.