CASE STUDY

PCB Redesign for a Reputed Japanese Control Valves Manufacturer for HART & ATEX Compliance

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UTTHUNGA TECHNOLOGIES

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Engineering Transformation

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The Client

One of the leading Japanese OEM, specializing in Marketing, Production and Field servicing of automatic control valves.

Challenge Faced by The Client

The client had the challenge of their device's PCB design not meeting the HART Standards & specifications. They had concerns with managing inventory as they had multiple board assembly for their product.

They wanted their control valve products to comply with the intrinsic safety design requirements needed to operate in the hazardous areas of the oil and gas rigs both off shore and on shore. The devices should also work with the low voltage input.

Scope of Work

The project kick-off started with the requirement analysis and understanding of the client's needs.

- Analyze the existing device instruction manual for specifications in depth. This provided a clear picture on the specifications, architecture, installation, calibration and maintenance procedures currently followed by the client.
- Identify the group and class of the device to meet the certification requirements and comply with the ATEX certification. We also referred to the IS/IEC 60079.11.2006[1] handbook and identified the guidelines for the client's device from the standards.

[1] **IEC 60079-11:2011 specifies the construction and testing of intrinsically safe apparatus intended for use in an explosive atmosphere and for associated apparatus, which is intended for connection to intrinsically safe circuits, which enter such atmospheres.**

- Plan for functional and module testing to identify the device characteristics that clearly helps in understanding each modules characteristics, selection of components, firmware/hardware functionalities.
- Perform HART physical layer testing on the existing device as per the FCG certification to get the physical HART characteristics of the client's device. This helps in understanding the gaps with respect to certification as well selection of the HART signal conditioning and power distribution for the modules.
- Investigate the current device schematics and the source code structure, design flow to identify the gaps in meeting the HART pre-compliance, compliance voltage, intrinsic safety as per IEC.60079.11 standards.

Solutions Provided by Utthunga

Based on the analysis of the schematics, code and the compliance gaps identified during the initial requirement analysis, and the subsequent firmware/hardware/functional/module testing performed on the client's device, Utthunga offered the below solutions for the client's challenges.

- PCB Design Schematics Solutions

Investigated existing PCB design schematics for each component and identified the obsolesce of some of the parts which are not meeting the environmental characteristics of the IEC.60079.11 standards. Utthunga recommended alternate parts that comply with the standards.

To satisfy the intrinsic safety requirement, PCB design also contributes as a major constraint in terms of placement/routing/track thickness/track capacitance/track inductance for the hazardous exposed circuit. Utthunga addressed all the constraints in a single board as per client requirement. (The existing board is stack of 4 boards)

- Electrical Solutions

In order to meet the low compliance voltage and HART impedance requirement we have designed a unique patentable circuit (Patent pending) based on the shunt regulator which helped in clamping the voltage across input terminals regardless of the input current and maintain a dynamic impedance.

- Redesign Hardware Architecture

In the existing device, the high value inductor coil parameter was not meeting the intrinsic entity parameters used for HART compliance. To meet the intrinsic safety

requirement, Utthunga redesigned the existing power distribution circuit of the device, which was a major change in the current hardware architecture.

- Outcome of the architecture redesign

- By redesigning the hardware architecture with the above circuit, the high value inductor coil was successfully removed and thus the entity parameter requirement was achieved.
- The hardware architecture redesign with the above circuit required the power consumption of less than 20mW. This required the major active components like microcontroller and ADC to be replaced without deviating the functionality of the existing device.
- After changing the hardware architecture, Utthunga designed the PCB schematics for EMI/EMC/ESD/EFT/Surge/Intrinsic safety requirements with the proper selection of components and PCB designing.

- Software Solutions

Firmware wise, we helped port the existing code since there were major changes in the components like microcontroller, ADC and LCD (local UI changes) compared to the existing device. To achieve the low power consumption requirement, the software code was restructured and implemented for all possible modes without changing the client's device functionality.

- Compliance & Certifications

Utthunga has in-house facility and highly qualified HART test engineers for conducting the functionality and HART pre-compliance testing. We helped them test and validate the designs.

Utthunga helped them work with the external labs for the EMI/EMC pre-compliance tests to get CE-marking. We also collaborated with UL-Japan for the preliminary review of the design to obtain the ATEX certification.

Technology / Products Used

- MSP430 Ultra low power family microcontroller
- HART 7
- Dynamic Impedance Control
- LCD DMA Mode

Implementation and Specific Learnings

- Dynamic impedance control circuit implementation (Patentable Circuit)
- PID control flow
- Working experience with position transmitter
- Intrinsic safety design and documentation
- Intrinsic safety compliance testing

Benefits for the Customer

The client was able to achieve tangible benefits in various aspects of their manufacturing

- Reduced inventory, as they had to make only one PCB instead of four PCB's.
- Reduce complications in manufacturing.
- Due to intrinsic safety features, products becomes more adaptable for working under hazardous conditions.
- Low power consumption by the device, which helped multiple devices to work in an array.

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