WHITE PAPER

Best Practices in Hazardous Area IPC Design

Bringing control to where it's never been before

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Abstract

As the oil and gas industry moves toward the digital age, control and asset management is becoming more safe and efficient. However, to ensure that your oil and gas operation will run continuously, mission-critical panel computing systems cannot be delicate and hard to repair. Searing heat causes display blackouts and LCD motion blur, and corrupts the output of onboard components in unpredictable ways. For most platforms, system stability can't be guaranteed until the average temperature rises above 0°C, or falls below 50°C. Sunlight obscures visibility and micro-abrasions on touchscreens quickly degrade control functionality. In this paper, we show how the industry is changing the conventional definition of both HMI and industrial panel computers (IPCs) by reinforcing enterprise IT technology with industrial design principles to successfully bring the control room to the field operation—no matter the location.

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Moxa is a leading manufacturer of industrial networking, computing, and automation solutions. With over 25 years of industry experience, Moxa has connected more than 30 million devices worldwide and has a distribution and service network that reaches customers in more than 70 countries. Moxa delivers lasting business value by empowering industry with reliable networks and sincere service for automation systems. Information about Moxa's solutions is available at www.moxa.com.

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INTRODUCTION

In the oil fields of Alberta, Canada, well-head operators struggle to deploy control panels that are capable of enduring the cold winds and ice of the harsh winters. Conversely, in Saudi Arabia, searing temperatures and corrosive sands demolish panel computers and control assets at a rapid pace. While the environments of oil and gas fields are diverse around the globe, they all share a commonality of being in harsh and often remote locations. Three key features are defining success in the use of panel computers at oil and gas control operations: robust modular design, screen visibility, and thermodynamic construction.

INDUSTRIAL PANEL COMPUTER (IPC) ADOPTION TRENDS

Organization

In the past, PCs were only suitable for use in extensive SCADA systems, where control was reserved for the mild conditions of the comfortable, climate-controlled offices of the enterprise environment. But as the Industrial Internet of Things proliferates and expands to industrialized petroleum extraction and production, the opportunity to leverage distributed control systems (DCS) with relatively inexpensive and extremely powerful IPCs has become a highly viable alternative.

Today, manufacturing execution software systems (MES) are advancing DCS functionality at a rapid pace. IPCs are displacing PLCs and RTUs due to their scalability, flexibility, and processing power. Field engineers and operators can manage numerous extraction points and assets at the same time from a single drilling platform or remote site control center.

After a decade of Ethernet and fiber expansion throughout the process automation sector, operational and diagnostic data is abundant at every layer of the operation. In other words, more and more information must be acquired and analyzed, translating into a significant increase in data rates. The only way to achieve high speed, front-end data collection and analysis is with a faster CPU. IPC's are solving that problem by greatly increasing the processing power field operators have at their fingertips at each moment, bringing increased visibility, higher network availability, and lower operational risk to upstream and downstream applications alike.

CHALLENGES IN IPC ADOPTION

The benefits of device control and increased processing power that IPCs offer over PLCs and RTU solutions have conventionally come with their fair share of tradeoffs. With this increase in power and control, IPCs also bring an uncomfortable level of platform complexity. Failures in a unit's display conventionally warrant expensive and slow repair processes—especially in remote oil and gas networks. IPC failures potentially mean downtime in production; something that cannot be tolerated, even if IPCs offer significant value in data acquisition and control. Modularity and simplicity are key attributes to any control technology in process automation because modularity and simplicity equate to fast repair process and limited downtime risk.

Remote locations and oil and gas often go hand-in-hand. For example, an offshore rig sending a $10k HMI unit back to the manufacturer for repairs requires an 8-12 week lead-time, over $2000 in shipping costs, and significant loss of productivity and network visibility. This scenario may be common since IPCs have traditionally not been truly industrialized. Often, IPCs were merely traditional panel computers packaged in a robust housing. Little thought or testing was placed into intelligent heating solutions, internal heat distribution, advanced touchscreen technology, and convection housing. IPCs were very expensive, bulky, and non-ergonomic, or they were quick to fail and hard to service and replace. For good reason, like with Ethernet a decade prior, the oil and gas industry has maintained a cautious view when it comes to IPC adoption.

Ultimately, downtime prevention is the foremost topic in process automation industries, and industrial panel computers have offered a higher risk-to-reward for many in oil and gas, but that is changing.

BEST PRACTICE IN IPC DESIGN

A few industrial automation vendors have led the development of truly robust and reliable IPCs over the last five years, and have a strong track record of successful IPC installations in extreme remote environments ranging from sub-zero to high-heat temperatures. Their ability to meet the industry's stringent demands often rely on three key attributes: modularity, usability, and reliability, listed in order of complexity.

A. Modularity

A key best practice in IPC and industrial HMI design is robust, industry-certified Ex and UL Class One, division Two, modular construction. Fewer parts to assemble equates to faster, cheaper, and easier asset repair and continued service. Most high-end IPCs have a backplane, front plane, and motherboard with the option for an external cable gland for normal I/O, Cable, Zone 2 and dual AC/DC power supply connectivity.

True modularity enables out-of-box functionality, with the ability for customers to stock replacement parts for quick onsite service. Additionally, modularity suggests a fanless IPC, removing the unit's dependence on outside ventilation for internal cooling. This minimalist structure places a reliance on natural convection and low power consumption. By design, industrial panel computers consume less power and generate less heat compared to their enterprise counterparts.

Figure 1: Basic UL Class 1, Division 2 IPC construction with external cable gland

B. Usability

Usability is a broad term that encompasses both visibility and the touchscreen user interface. IPCs have faced the challenge of excelling simultaneously in both of these areas for various reasons, beginning with the dexterous limitations of resistive touch technology and functional limitations of capacitive touch technology.

Resistive touch technology is commonly used for IPCs and HMIs because a more durable screen material can be used, and this type of touchscreen can be operated while wearing gloves, which is a common requirement for oil and gas environments. The limitations of resistive touch have long been its inability to allow for multi touch use, meaning that the user must operate the HMI interface with a single finger or stylus. As the name suggests, commands for resistive touch interfaces are registered by the force of a single point of pressure on the screen.

Capacitive touch is more sensitive and allows the user to utilize multi-touch functions, as are common on smart phones and consumer tablets. The operation of a capacitive touchscreen requires dexterity much more than intuition, but a user must operate the unit with bare fingers, special gloves, or a stylus, since this technology relies on the electrical properties of the human body to detect when and where on the screen the user is touching. Because of this, capacitive displays cannot be used with a mechanical stylus or a gloved hand, making them impractical in industrial environments.

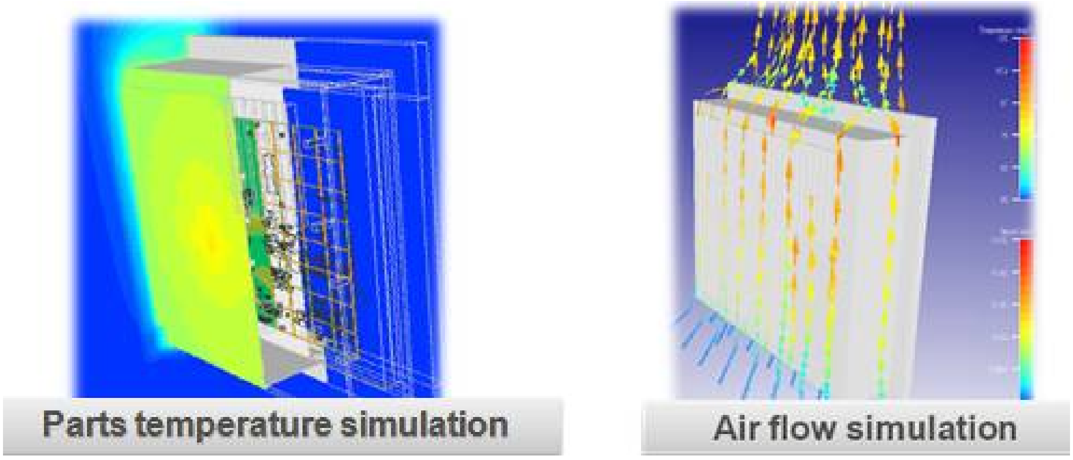
In addition, while resistive touchscreens may be more resistant to abrasion and fracture than conventional capacitive touchscreens, they are still vulnerable to puncture, and screen visibility can be obscured due to the polyester film and air gap spacers that separate the touch interface and the LED screen housing. Dirt, and glare from outside sunlight can quickly impede the user’s ability to operate their IPC in industrial, remote environments exposed to direct sunlight, which is why it is best practice for an IPC to have a nit rating of at least 800 to ensure high visibility when exposed to direct sunlight. A nit rating refers to LED light bar luminance and is measured in units of candela per square meter (cd/m^2). Candela is the SI unit of luminous intensity, and square meter is the SI unit of area.

C. Reliability

Reliability is achieved by integrating a modular design with operational usability. Both hardware construction and remote access via Simple Network Management Protocol (SNMP) must be considered and seamlessly integrated into an out-of-box solution. SNMP is a globally recognized Internet protocol standard for managing devices on IP networks. Devices that typically support SNMP include routers, switches, servers, workstations, printers, modem racks, and much more.

Beginning with the hardware, reliable IPCs capable of continuous operation in temperatures from below 0°C all the way up to 55°C need to be designed with rapid convection and uniform heat distribution in mind. This design principle is very much correlated with modularity, but takes the design consideration a step further into thermo-dynamic principles. Internal heat-generating units, including the CPU, must be evenly placed between the backplane and screen. Heat concentrated around the CPU is often not even a consideration for typical panel computers and traditional HMI units, but for mission-critical IPCs, temperature management is imperative for maintaining rapid cooling and heating in extreme environments. A vertical backplane heat sink construction for fanless IPCs helps with the convection rate by pulling heat more rapidly away from the unit's core. Using this type of heat sink is best practice for units installed in warm areas or exposed to direct sunlight.

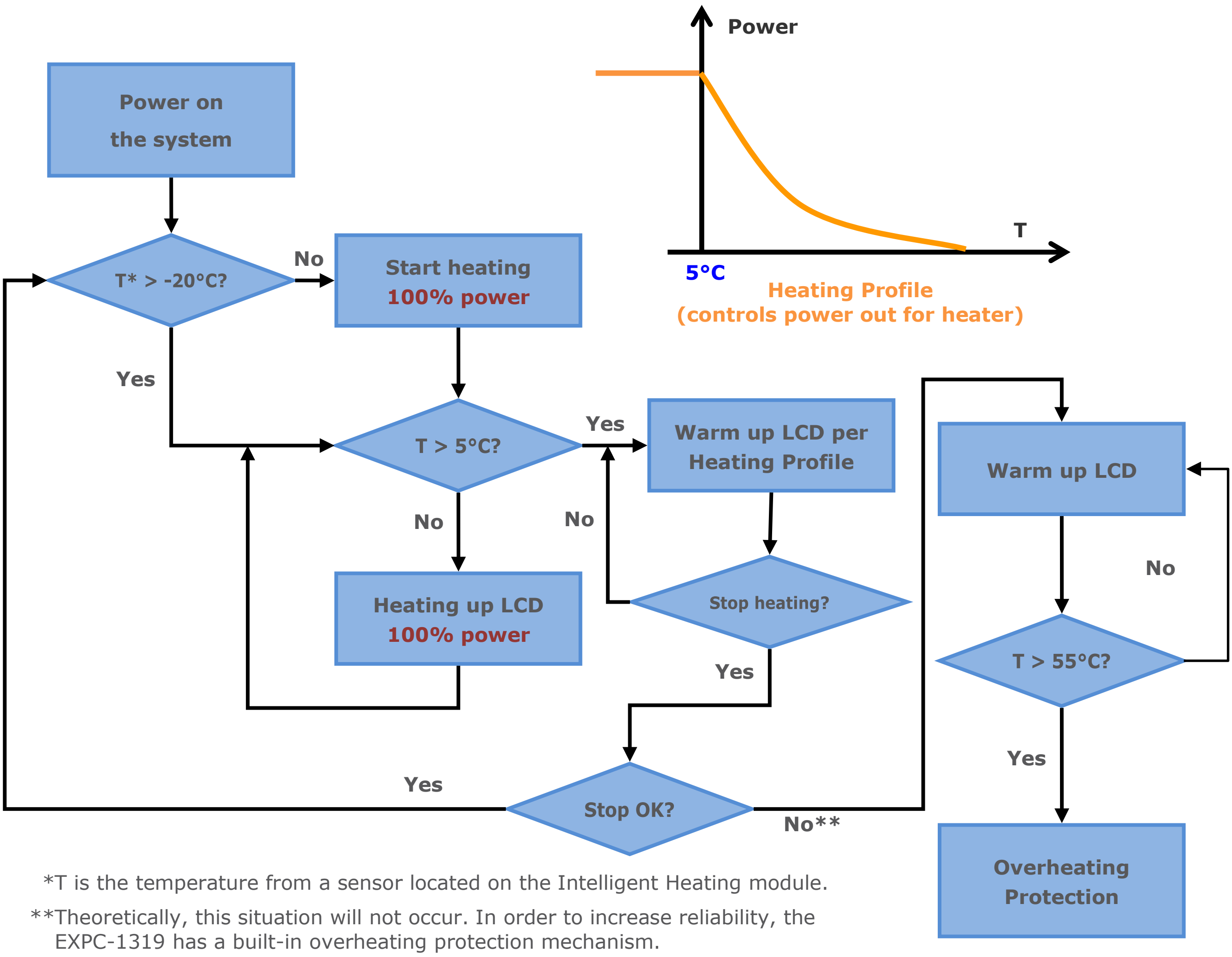
Figure 2: Basic modular disassembly with vertical heat sink construction for maximized convection rate



Temperature management doesn't just involve heat. Industrial field sites in the petroleum industry are more and more often located in remote, distant locations exposed to the most extreme cold the earth has to offer, and the IPCs that serve these field sites must be able to tolerate and work reliably in these extreme environments. To avoid display distortions like white spots and LCD motion blur, IPCs should include internal onboard, automated heating systems that adapt to the rising core temperature as the heating mechanism kicks in. This heater must also evaluate ambient temperatures, maintain the temperature at an optimal threshold when the system itself cannot, and prevent the system from overheating once the internal temperature begins to climb. This solution is realized via a software-driven proportional control loop.

Proportional control loops deliver the greatest power and output efficiency available, but their engineering is by no means straightforward. With a heating element, output is controlled by the amount of power supplied. Truly effective IPC design best practice dictates using proportional heating controls, which call for pulse-width modulation (or PWM) to deliver a spectrum of wattage rather than just the one-two punch provided by a full-on/full-off switch. A sensor, of course, is also needed to monitor heat output, and finally two or three software subsystems are needed to intelligently manage and monitor system temperature. Each of these elements brings with it its own design challenges, increasing the complexity of proportional control systems far beyond simple hysteresis controls that merely control a simple internal heater with "on-off" functionality. Hysteresis, sometimes referred to as "bang-bang" controllers, introduce a host of undesirable side effects or potential points of failure for units deployed in varying temperatures, such as the high desert. Beyond being vastly less efficient, heating solutions using the hysteresis method can diminish power supply stability (leaving the platform prone to crashes) or unnecessarily overheat the computer's internal components, reducing the computer's mean time between failures (MTBF).

Figure 3: Basic Proportional Control Feedback Loop



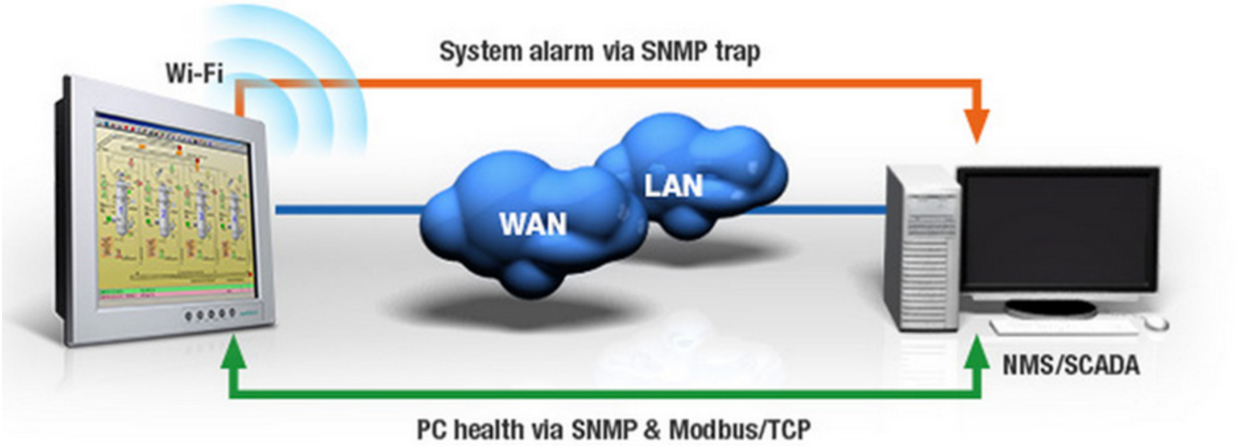
*T is the temperature from a sensor located on the Intelligent Heating module.

**Theoretically, this situation will not occur. In order to increase reliability, the EXPC-1319 has a built-in overheating protection mechanism.

The final test for IPC best practice design is the unit's ability to be monitored and managed remotely. Utilizing SNMP traps, truly industrial PCs can be integrated into their network's inherent alarm system to monitor their own internal diagnostics. CPU time, system temperature, memory usage, power voltage levels, and hard disk capacity are all very important for mission-critical applications, making it imperative that network operators monitor these items at all times. With internal diagnostic software, IPCs can now issue alarms to remind the user to conduct preventative maintenance and care operations to avert unit failures before they occur.

In addition, with SNMP remote accessibility, IPC solutions can realize embedded auto-recovery functionality. Computers that repeatedly run the same software often suffer system slowdowns. Re-installation or re-writing the OS image is the usual solution. To aid in this troublesome maintenance task, industry-leading IPCs are equipped with embedded auto-recovery software, allowing the IPC to immediately and automatically recognize the network it is managing when it reboots after an unexpected shutdown. Smart Recovery automatically rewrites the OS to its pristine post-install state, and can be configured for a variety of events.

Figure 4: System Alarm via Simple Network Management Protocol (SNMP)



SUCCESS IN THE FIELD

A multinational, global leader in drilling rig platforms and drawworks control solutions reached out to Moxa for an IPC solution that could be reliably deployed in their drilling rig control consoles around the world. These drilling installations operate in conditions and climates that are among the most extreme on the globe. In each of these integrated control systems, the control console could be subject to temperatures far below 0°C and above 50°C. The IPC solution needed to be UL industrial certified, robust and modular in design, and provide the software configuration flexibility needed for the firm to install their own proprietary control software for controlling the thousands of throttles, clutches, brakes, and safety systems that each operator must regulate on a daily basis.

This international provider of advanced drilling solutions selected the Moxa EXPC-1319 IPC due to its strict adherence to industrial certifications and robust design principles, and its ability to reduce replacement time and associated inventory costs, and minimize human error. With a simple three-piece, sleek, and ergonomic design, the EXPC-1319 series provided this customer with a reliable and repeatable way to provide their global customers with a reliable and quality integrated control system that could perform in environments ranging from the frozen tundra of Alberta, to the searing deserts of Saudi Arabia.

CONCLUSION

The Industrial Panel Computers (IPCs) now being deployed in the same manner that simple Human to Machine Interfaces (HMIs) once were are pushing the reach of Distributed Control Systems (DCS) far beyond what was once thought possible. Like the proliferation of smart mobile computing devices in the consumer high-tech world, faster processing speeds have enabled field engineers in the oil and gas world to use IPCs to simultaneously control more assets in the field. However, certain design features must be considered when selecting an IPC solution. Best in quality IPCs emphasize a robust, industry-certified modular design. They employ a resistive or resistive/capacitive combination technology with display nit rating between 800 and 1000, or higher. In addition, truly reliable IPCs subject to both hot and cold temperatures use intelligent heating solutions instead of hysteresis mechanisms.