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Design for Connectivity: Key Areas to Evaluate in Designing IIOT and IOT Products

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Design for Connectivity: Key Areas to Evaluate in Designing IIOT and IOT Products

By Robert Alvord

The internet of things (IOT) and industrial IOT (IIOT) are opening the door to a broad range of new products facilitating cost saving automation, remote user control and enhanced security in smart buildings and industrial installations. That said, designing for connectivity requires a strong focus on identifying failure and security risks, plus overcoming constraints inherent in the operating environment.

SigmaTron International is an electronics contract manufacturer whose services include product development support for IOT and IIOT products. This whitepaper looks at some of the typical challenges that should be considered in designing products in used in IOT or IIOT applications.

Key Areas to Analyze Early in Product Development

Often product design teams focus primarily on the form, fit and function of the product, utilizing component specifications to determine which parts to design in. Areas where surprises can develop include:

- Hardware/firmware security
- Battery usage
- Operating environment constraints
- Antenna design and signal strength.

Hardware/Firmware Security

While the cloud a device will operate it is normally selected for its security and ease of connectivity relative to the application, devices can still be vulnerable to hacking. Design considerations should consider the following:

- If the device is installed in common areas of a building, has a tamper-proof housing been designed to limit the ability of someone to break in and hijack the device?
- What protections have been designed in to ensure program and internal buss security?
- What security is present within the IC and firmware to limit reprogramming to authorized users such as building management or field service? Many ICs have features which support added security in this area.

Battery Usage

If the device is battery-operated or relies on battery power as a backup, a battery budget and design for low power need to be in place early. Use of a communication channel on low power with long quiet periods is another factor that needs to be designed in early if battery power will be used.

Operating Environment

The operating environment represents the area of most surprises. Walls, stone/brickwork, metal frameworks, pipes and tresses can all reduce signal strength and add to multi-pathing. Elevators, air handling equipment or industrial processing equipment can add electrical noise. RF communication data sheets typically list signal strength range based on an open field environment. That range can be significantly reduced inside structures, which can have an impact on antenna choice.

Issues to determine prior to hardware design include:

- What will be the device's orientation within the environment? This determines preferred antenna placement within the device. Even deciding that the device will have a back side that is placed against a wall or floor can help in this design decision.
- Are there interfering RF sources where you expect the device to operate? Wi-Fi range and speed can be reduced by a proliferation of Wi-Fi in the vicinity
- What type of antenna is best for the operating environment? The more challenging the environment the more work needs to be put into antenna design.

Antenna Design and Signal Strength

Antenna design is one of the most important aspects of an IOT or IIOT device, because it ultimately determines how reliably the device can interact within its network. When there is line of sight or minimal environmental interference between device and the receiving antenna, the application should work well. Using an FCC-approved module simplifies design and testing. However, if the integrated antenna is inside of a box, there needs to be space between antenna and any components, printed circuit board (PCB) and walls. The rule of 1/4 or even 1/10 wavelength is not easily attainable, so there will likely be some detuning due to parts nearby which will lower the overall range.

Modules with an external antenna connection are a better choice for difficult operating environments or longer distances. This adds complexity to the design process since FCC testing may be required. However, it provides more flexibility to connect antenna outside of the box. Another option is installing the antenna on the inside wall of the box. Both of these options have off-the-shelf antenna solutions. In many operating environments, effective solutions are possible with minimum of RF design work. Operating environments with significant connectivity constraints may require RF design work to overcome signal strength issues.

Utilizing a Design and Manufacturing Partner

Originally, the basic premise of outsourcing was that manufacturing was a commodity activity and that divesting it would free up OEM resources and cash for R&D and marketing. While that works in a business school case study, the reality is that truly leveraging the benefits of outsourcing requires that product development and manufacturing work in tandem to optimize the manufacturing process. This effort is further enhanced when the contract manufacturer has an engineering team experienced in procurement and manufacturing challenges, as this expertise can be blended to into the product development effort to solve common issues before they cause extra iterations in the design cycle or defects in the factory or the field.

SigmaTron International offers its customers scalable product engineering and manufacturing support. Its engineering services can range from a complete product development effort to optimization of existing products. Internally, its design engineering group offers a joint development model for companies needing product development support aligned with its design competencies.

The design engineering group uses a shared development business model to engineer customer-owned products which may license some of its proprietary software. The team's product development expertise includes:

- Software-driven controls
- Analog controls
- Micro-processor controls
- Switching power supplies
- Near field communications (NFC)
- Smart grid data streams
- A broad range of human interface user I/Os
- Variable speed drives for small frame motors
- Industrial design
- Packaging.

A key benefit of this type of gap filling engineering capability is that it allows engineering resources to be customized to customer needs, in some cases providing "as needed" engineering support over the entire life of the product and in subsequent generations. The team's expertise with a broad range of communications and display technologies aligns well with the evolving nature of many consumer products and instrumentation applications.

Most importantly, this approach not only fills a gap in new technology expertise. It also fills gaps in manufacturing and test expertise related to use of those new technologies. Newer technologies often challenge manufacturing and test capabilities. Engineering team members who continually interface with manufacturing activities understand where those issues are likely to occur and can make recommendations in component choices or layout decisions to ensure the design complies with manufacturing and test design rules.

SigmaTron is able provide a tailored manufacturing solution for its customers that can be as limited as PCBA assembly and as complex as system integration, fulfillment to end market and repair depot support.

This scalable solution approach offers customers the ability to build different product lines in different facilities when their requirements don't fit a single facility option. Forecasting and production layout is optimized for those projects. For example, SigmaTron's facility in Elk Grove Village, IL has a box build area that has been optimized for smaller volume box build production enabling unrelated products to share the efficiencies and economies of scale of a standardized work cell arrangement, even though project volumes don't justify a dedicated workcell. Workstations are designed for easy changeover and a dedicated team supports the area, ensuring correct materials are stocked point of use as needed and everything is in place to support the products being built that day. Conversely, SigmaTron's facilities in

China and Vietnam have been optimized for high volume production. Its facilities in Mexico support both medium and high volume production. U.S. facilities support a range of project volumes, as well.

Spending time early in the IOT/IIOT product development process identifying security risks and operating environment constraints can reduce design iterations and overall product development time. Recognizing that information in product data sheets often represents a best case scenario can help ensure that part selections perform as planned in the real world. Working with a design and manufacturing partner experienced in these technologies adds expertise and can improve efficiency in the overall product realization process.

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