CONTENTS

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NEWswire
IoT Gateway Trio, XBee Wireless Connectivity Kit, and Rad Tolerant Transceivers

TECH SERIES
Wi GaN: Radiated EMI Filter Design

PRODUCT WATCH
Arrow Inside the Lab: ARRadio Development Kit

Wireless Signal-chain Components from Analog Devices

New Product Insights: Linear Technology, Texas Instruments, Analog Devices

TECH REPORT
Integrated Capacitive Sensing and Bluetooth Low Energy

INDUSTRY INTERVIEW
Embedded Wireless Modules Inspire New IoT Innovations
Interview with Bill Steinike – VP of Business Development for Laird’s Connectivity Solutions
IoT Gateway Trio

Without the right hardware, IoT is still a thing of the future and hard-to-grasp concept. AAEON is set to popularize this concept with the launch of AIOT-QA, AIOT-QG, and AIOT-QM IoT gateways.

Running on the Intel® Quark™ X1000 Series SoCs, AAEON’s trio of IoT-specific gateways are created and built to enable an IoT lifestyle both indoors and outdoors. Along with the low-power consuming chips, the devices are equipped with the Wind River Intelligent Platform, Linux support, McAfee Embedded Control security technology, and Bluetooth/ WiFi/ 3G connectivity to ensure the most flexible and secure option for implementing IoT.

The AIOT-QA and AIOT-QG are built similarly for indoor use, with the former attuned for industrial automation with a DIN-rail mountable design, while the latter towards general-purpose applications. Both devices carry I/Os such as Analog-to-Digital Converters (ADC) and DI/Os that are beneficial for allowing the system to understand parameters such as temperatures, humidity, luminance, water level, etc. for autonomous monitoring and control.

The AIOT-QM is the most “outgoing” member of the three with its IP67 design and a wide operating temperature range of -20 ~ 70°C, making it conducive for outdoor use. All of its onboard I/Os, such as LAN, USB, COM, ADC, and DI/O are specially designed with M12 connectors to discourage intrusion of solid and liquid and reinforce protection against them. As such, mating connectors are required to realize the device’s true potential.

“The launch of the AIOT, or AAEON IoT product line eliminates the distance the populace often felt towards IoT, which is always too far-fetched to be a reality” said Rita Liang, Product Manager of AAEON’s Design and Manufacturing Division. “The gateway trio will be the first step bringing the wonders of IoT to the masses.”

New XBee Wireless Connectivity Kit

Digi-Key Electronics and Digi-International announces the availability of the New XBee® Wireless Connectivity Kit from Digi International. The kit has two XBee Grove Development Boards, two XBee RF Modules and micro-USB cables. The Wireless Connectivity Kit helps developers gain an understanding of how to incorporate wireless connectivity into their solution, as well as create prototypes for testing proofs-of-concept.

With more than 10 million XBee modules deployed, the technology is proven to enable fast time-to-market, design flexibility, low development costs, and excellent range for those seeking to incorporate wireless capabilities into a whole new range of products and solutions. The new connectivity kit offers beginners and experienced designers and engineers alike the opportunity to easily incorporate wireless communications into their designs.

“This is another step in our relationship with Digi-Key to enable hundreds of thousands of engineers to realize the value that wireless connectivity can bring to their solution and how easy it is to incorporate,” said David Stein, Vice President, Global Semiconductors at Digi-Key. “We’re excited to continue introducing offerings that showcase the exceptional capabilities of the XBee product line.”

Digi-Key has created a dedicated site allowing engineers to become more familiar with the extent of XBee capabilities and determine which XBee solutions are best suited to their needs. The site is located at XBee Dev Kits & Selection Guide. The XBee Wireless Connectivity Kit includes:

- XBee Grove Development Boards (2)
- XBee 802.15.4 modules w/ PCB antenna (2)
- Micro USB cables (2)

“By providing this solution, engineers can quickly understand all the value that wireless connectivity can bring to their solution and how easy it is to incorporate,” said David Stein, Vice President, Global Semiconductors at Digi-Key. “We’re excited to continue introducing offerings that showcase the exceptional capabilities of the XBee product line.”

“Working with Digi-Key provides an efficient way to expose all types of designers to the entire breadth of innovative wireless capabilities Digi International offers—and demonstrates how easy it can be to incorporate reliable, scalable and secure wireless connectivity within a variety of products and solutions.”

Source: AAEON

Source: Digi-Key
Intersil Corporation announced its first radiation tolerant 3.3V controller area network (CAN) transceivers that are fully QML-V qualified and compliant with the ISO11898-2 physical layer standard. The three new ISL7202xSEH CAN transceivers provide reliable serial data transmission between a CAN controller and CAN bus at speeds up to 1Mbps. Up to 120 of Intersil’s ISL7202xSEH transceivers can be connected to a single CAN bus to reduce cabling/harness size, weight and power (SWAP) costs. This weight and mass reduction of up to 18% allows system engineers to add millions of dollars in satellite functionality, and eliminate the extra cabling and tradeoffs associated with current point-to-point interface solutions.

The ISL72026SEH, ISL72027SEH and ISL72028SEH 3.3V CAN transceivers deliver ultra-high performance in the most demanding environments by leveraging Intersil’s proprietary silicon on insulator process, which provides single event latch-up (SEL) and single event burn-out (SEB) robustness in heavy ion environments. With the emergence of all-electric propulsion satellites that maximize payload but take longer to reach final orbit, customers require higher total dose testing for mission assurance. Intersil’s CAN transceivers are low dose rate tested up to 75krad on a wafer-by-wafer basis, and apply single event transient (SET) mitigation techniques to reduce system level bit error rates, providing predictable performance. They are also “cold spare” redundant capable, allowing the connection of additional unpowered transceivers to the CAN bus. This mission critical capability maximizes system life.

The ISL7202xSEH family offers a number of unique features: The ISL72026SEH includes a loopback test capability that allows node diagnostics and reporting while the system is transmitting data. It also includes a listen mode feature that powers down the driver circuitry while keeping the receiver active to listen for data on the bus, and then activates the driver after data is received. The ISL72027SEH also offers split termination output using the Vref pin to provide a Vcc/2 output reference. This improves network electromagnetic compatibility and stabilizes the bus voltage, preventing it from drifting to a high common-mode voltage during inactive periods. The ISL72028SEH includes a low power shutdown mode that switches off the driver and receiver to draw 50uA for power conservation.

“Implementing the full CAN bus protocol within a spacecraft will be a major improvement over previously used interface protocols,” said Gianluca Furano, on-board computer engineer at the European Space Agency. “Once we adapt a total CAN bus protocol, we expect satellites will achieve sensible mass and power reductions and manufacturers will have the ability to add several millions of dollars of functional capability.”

“Our space flight customers are anxious to replace their point-to-point data transmission solutions with space-qualified, radiation tolerant CAN transceivers,” said Philip Chesley, senior vice president of Precision Products at Intersil. “The ISL7202xSEH devices provide superior performance and meet the mission assurance needs of their satellite payload systems.”

**Key Features and Specifications**

- Electrically screened to SMD 5962-15228, and compatible with ISO11898-2
- Delivers 4kV human body model (HBM) ESD protection on all pins
- 3.0V to 3.6V supply range, -7V to +12V common-mode input voltage range, 5V tolerant logic inputs, and bus pin fault protection to +/-20V terrestrial and +/-18V in orbit
- Cold spare powered down devices do not affect active devices operating in parallel
- Three selectable driver rise and fall times
- Glitch free bus I/O during power-up and power-down

Source: Intersil Corporation
In the previous installment of Wi GaN, we presented a comparison of radiated EMI generated by the class E and ZVS class D amplifiers driving a wireless power system coil using eGaN FETs [1, 2]. In this installment, we present a method to design a suitable EMI filter that can reduce unwanted frequencies to levels within radiated EMI specifications, and do this without negatively impacting the performance of the wireless power coil. In addition, the overall radiated EMI design aspects will also be covered.
Radiated EMI Design Challenges
Many designers are faced with the challenges of meeting EMI requirements, and in particular radiated EMI. For wireless power systems, the challenges are increased due to the system being an intentional radiator and any unwanted frequencies must be aggressively managed before power is transferred to the radiator (coil). Following the golden rules of EMI, one must start EMI abatement as far back in the system as possible [2]. This means reducing emissions from the source before trying to filter it at the radiator. A comparison between the class E and ZVS class D amplifiers, popular choices for wireless power, reveal that the class E generates higher magnitude of lower-frequency content and even order harmonics. The ZVS class D amplifier, however, generates significantly lower-magnitude harmonics at the lower frequencies but higher at higher frequencies as shown in the simulated [1, 2, 3] results of Figure 1. Fortunately, this is more compatible with an infinite-zero EMI filter design as the further the frequencies are from the fundamental operating frequency, the easier it becomes to attenuate.

Realization of a Radiated EMI filter for Wireless Power Transfer
Classic EMI filters are not suitable for wireless power transfer as they negatively impact the coil tuning. For this reason, a ground-up approach to an EMI filter design was presented in [2]. Various filter types were analyzed and it was concluded that only the Chebyshev Type I filter was suitable for wireless power transfer, and is shown in Figure 2 (below) for a 5th order implementation.

The impact of the standard EMI filter on the tuned coil impedance is shown in Figure 3 (next page) where the green traces represent the original coil impedance that the amplifier needs to drive, and the blue traces represent what happens when an EMI filter is inserted. The impact of an inappropriately designed EMI filter significantly alters the reflected impedance response of the tuned coil circuit, and can lead to incorrect system operation and can overstress the amplifier. The EMI filter design therefore must be modified to become compatible with the tuned coil.

The basic 5th order filter is modified by making the shunt branches appear as open circuits at the fundamental frequency. Once this was achieved the filter circuit reduces to that of a

Figure 1. Coil Voltage EMI comparison between single-ended class E and ZVS class D amplifiers.

Figure 2. Realization of a radiated EMI filter for wireless power transfer based on a 5th order Chebyshev Type I Filter that includes both differential-mode and common-mode implementation.
single inductor at the fundamental frequency only, while preserving the filtering effect on its harmonics. This inductor can be tuned out using a series capacitor, effectively creating a short circuit that completely eliminates the EMI filter from the amplifier and coil at the fundamental frequency only. Lastly, a common mode choke is added for common-mode EMI filtering. The complete filter is shown in Figure 2 (previous page).

Based on the draft specifications presented in [2], the new filter design for the circuit of Figure 2 was determined and yielded the following component values:

\[
\begin{align*}
C_3 &= 172 \text{ pF} \\
L_1 &= 800 \text{ nH} \\
L_2 &= 1530 \text{ nH} \\
L_4 &= 943 \text{ nH} \\
C_1 = C_2 &= 800 \text{ pF} \\
L_5 &= 689 \text{ nH} \\
\end{align*}
\]

\[L_6\] was omitted from the differential mode analysis as the common-mode choke differential inductance is partially included in \(L_1\).

Filter Analysis
An analysis of both the original Chebyshev and modified filters reveal the transfer functions shown in Figure 4. The modified filter response pole around 11 MHz does not pose an issue as the amplifier does not generate those frequencies during operation. While the modified filter sacrifices some performance against the original, the required attenuation specifications are still met for use with an eGaN FET-based ZVS class D amplifier.

Filter Performance
The simulated Attenuation performance of the EMI filter, operating in differential mode and delivering 14W into the load, is shown in Figure 5 together with the adjusted FCC [4, 7] and EN standards [5, 6, 7]. The adjusted radiated EMI standards were determined from several measurements and adjusted as if measured directly across the source coil. From figure 5 it is clear that the modified filter design can be used to meet the full-radiated EMI standard across the entire extended frequency range from 1MHz through 1GHz with at least 7dB of margin.

![Figure 4. Differential-mode EMI filter transfer functions for a 5th order Chebyshev implementation (blue) and modified for wireless power implementation (green).](image)

![Figure 5. EMI filter performance plotted with the adjusted radiated EMI standards.](image)
It should be noted that the EMI filter components introduce losses that show up as pass band attenuation. In this analysis, inductors were assumed to have a quality factor of 75.

Additional Wireless System Radiated EMI Design Discussion

Filtering unwanted energy from entering the source coil is only one important step to radiated EMI abatement for a wireless power system. Often neglected is the other end, where power is provided to the system. This is because many times one assumes that since the power source has already been filtered, it does not require additional filtering. Unfortunately, EMI can be introduced back to the power supply and radiated as an E-field by means of the power cord acting as an antenna, shown in Figure 6. It is therefore extremely important to filter the power entry point. Since the power supply may be isolated, it becomes difficult to attach the source board to earth, making EMI abatement more difficult.

To ensure that the printed circuit board also does not act as an EMI antenna, the layout design is critical. In this case, after filtering, all high frequency components must be placed inside the green area of the board, as shown in Figure 6. The red exclusion zone is meant to ensure stray fields are partially dealt with, resulting in a limited ability to radiate. This red zone should be kept clear of all but critical components.

Summary

eGaN FETs and integrated circuits are helping to enable wireless power solutions yielding new topologies, such as the ZVS class D, and higher efficiency performance than traditional MOSFETs. With these new application capabilities, come new challenges such as EMI abatement as was presented in this column. eGaN FETs have lower input capacitance ($C_{iss}$), output capacitance ($C_{oss}$), an excellent miller ratio, and lack of reverse recovery ($Q_{rr}$). These factors combined result in lower EMI energy generation, and if generated, are higher in frequency where attenuation increases making it easier to abate. The lack of reverse recovery losses, and hence reverse recovery EMI generation, compared to MOSFETs is significant as that energy can be several orders on magnitude higher than those associated with gate power and output capacitance.

EMI filtering for wireless power is the next challenge having addressed the reduction of EMI generation using eGaN FETs. The variable reflected impedance nature of a wireless power source coil makes it difficult to apply traditional EMI filter solutions and RF techniques. A modified 5th order Chebyshev Type I EMI filter design that is compatible with a wireless power source coil was presented. It was shown that it is possible to design an EMI filter that meets the specifications required yet maintain compatibility with the source coil.

References


[6] European Norm. EN55011 Group 2 Class B


Visit www.epc.co.com for more information.

eGaN® FET is a registered trademark of Efficient Power Conversion Corporation.
Welcome to Inside the Lab with Arrow Electronics, the web series dedicated to exploring the latest in technology and electronics. Today we’re talking about the ARRadio SDR development platform using the ARRadio and Cyclone V SoC board, which is the result of collaboration efforts between Arrow, Altera, Analog Devices, and Terasic to demonstrate the benefits of ADI’s AD9361.

**KEY FEATURES**

- Operates in the 70MHz to 6.0GHz range
- Tunable channel bandwidth
- Superior receiver sensitivity
- Configurable digital interface to a processor
- Phase and frequency synchronization

**ARRadio SDR Development Platform**

The AD9361 is a complete 2 × 2 RF agile transceiver on a single IC, integrating RF, mixed signal, and digital functionality that can be configured for use with multiple communication standards in the 70MHz to 6GHz range and channel bandwidths from 200kHz to 56MHz. The concept of SDR is nothing new, with the idea being that a single, highly configurable radio is able to service multiple frequency bands and differing protocols. This provides tremendous benefits over systems that require multiple radios, including reduced size, power consumption, system complexity, and design risk. However, implementing SDR has often proved to be a challenge in its own right. Arrow’s ARRadio board accelerates the prototyping and development of a complete radio system utilizing the AD9361. The SoC board boots the linux drivers via the microSD card to configure over 8000 settings within the AD9361.

The AD9361 provides designers with a high-level of integration that facilitates the development of SDR, and the ARRadio coupled with the Altera Cyclone V provides an easy-to-use platform for rapid development.

Click the image below to watch a video demonstration of the ARRadio Starter Kit.

For more information, visit [Arrow.com](http://Arrow.com).
For this Arrow New Product Insights, we will highlight Analog Devices’ AD9625 12-bit 2.6 gigasamples per second ADC with ADI’s HMC7044, and ADA4961. Together, these components can be implemented in a high-speed signal chain for applications including radar, military and aerospace communications, and high performance spectrum analyzers, digital storage oscilloscopes, and other instrumentation.

**The AD9625**

The AD9625 is a 12-bit 2.6 gigasamples per second analog-to-digital converter. It features an analog input that can be ac- or dc-coupled in differential or single-ended modes with a full power bandwidth of 3.2 gigahertz. The AD9625 is designed for sampling wide bandwidth analog signals up to the second Nyquist zone and boasts exceptional spurious-free dynamic range. The device integrates a reference generator, two independent decimate by 8 or decimate by 16 filters, and outputs data over a JESD204B-based output configurable with up to 8 lanes. Time stamping is supported to simplify synchronization of multiple converters.

**Analog Devices’ HMC7044**

The HMC7044 is a high performance, 3.2 gigahertz, 14-output jitter attenuator with JESD204B. It is capable of performing reference selection and generation of ultralow phase noise frequencies and is the preferred clocking solution for the AD9625. Generating up to 7 D clock and SYSREF clock pairs, the HMC7044 is specifically designed with features to ensure data converter frame alignment across the system. These outputs can also be configured to support different signaling standards, including CML, LVDS, LVPECL, and LVCMMOS, and meets the requirements of GSM and LTE base station designs.

**The ADA4961**

The ADA4961 is a 3.2 GHz high performance BiCMOS RF differential gain amplifier that is ideally suited for driving the input of the AD9625 in ac-coupled applications. It features a slew rate of 12,000 volts per microsecond, digitally adjustable voltage gain from negative 6 to positive 15 dB, and a 100 ohm input impedance and 50 ohm dynamic output impedance that eliminates the need for termination resistors. To drive the AD9625 in an ac-coupled applications, consider ADI’s ADL5565 6 GHz ultrahigh dynamic range differential amplifier.

Analog Device’s ADP2164 is a 4-amp, high efficiency, step-down DC-to-DC regulator using constant frequency pulse width modulation for excellent stability as well as transient response. This small, four millimeter by four millimeter LFCSP packaged device works at a high one point two megahertz frequency, allowing for small external components, decreasing overall footprint requirements. Key features of the ADP2164 include over current and over voltage protect, thermal shutdown, undervoltage lockout and an integrated soft start to limit inrush current.

Analog Device’s AD9361 is a highly integrated radio frequency transceiver designed for use in both 3G and 4G base station applications. It integrates all digital blocks, RF, and mixed signals to cover all transceiver functions with one device. Highly programmable, this broadband transceiver can be used with multiple communication standards such as frequency division duplex and time division duplex systems. Besides self-calibration and automatic gain control systems, the AD9361 includes several test modes for designers to debug their design during prototyping.

The ARRadio Development Kit is a collaboration between Arrow, Analog Devices, and Terasic, which helps accelerate prototyping a complete radio system using next-generation FPGA connectivity. Using the AD9361 in conjunction with Altera’s Cyclone Five SoC kit, Terasic’s transceiver board connects to the SOCKIT programmable logic development board by Arrow to reduce time to market. Supporting MIMO radio as well as phase and frequency synchronization, the ARRadio is a complete dual or single channel integrated wideband transceiver on a single chip operating in the 70MHz to 6GHz range.

Linear Technology’s LTC2123 is optimized for digitizing high frequency signals with a large dynamic range, and is perfect for exacting communications applications. An SPI port allows user programmability to customize settings according to needs and overflow underflow indicators work in conjunction with the JESD204B protocol for robust transmission to the host. These features make this ideal for any communications applications as well as specific uses in medical imaging, measurement instrumentation, and cellular base stations.

Texas Instruments’ ADS42J849 introduces a buffered input that is sequentially converted by a series of small resolution stages. The signal propagates through these stages every clock cycle, giving a twenty-three clock cycle data latency. This allows for a uniform input impedance across a wide range of input frequencies, making them ideal for a wide range of applications including, but not limited to, broadband wireless, software defined radio, and repeaters.

Analog Devices’ AD9250 was designed to solve the issue of using a single carrier with two separate antennas while still retaining the capability of sampling two independent signals without affecting signal quality. For ease of use and to minimize footprint, programming and control is accomplished with a 3-pin SPI serial interface. The AD9250 is able to sample anywhere from 0MHz to 300MHz, the AD9250 is ideal for applications such as smart antenna systems, radar receivers, and multimode digital receivers.
The Bluetooth low energy (BLE) protocol has established itself as a formidable choice for wireless communication where multiple slave devices need to talk to a single master device. Factors that favor Bluetooth over competing communication protocols include:

1. Multi-vendor interoperability due to a very high rate of industry adoption. As per the Bluetooth Special Interest Group (SIG), by 2018, 90% of smartphones will support BLE. The adoption rate is high among other host devices such as PCs and smart TVs as well.

2. Published communication range of 100m.

3. Ultra-low peak, average, and idle power consumption, enabling most BLE slave devices to run for years on coin cell batteries.

4. Data transfer rates up to 1Mbps.

These advantages make BLE a best-fit choice for many Internet of Things (IoT) based devices, wearable electronics, wireless PC peripherals, remote controls, and other devices. In fact, the very advent of BLE has inspired innovators across the globe to create applications never fathomed before.
In a very simplistic sense, most BLE slave devices effectively capture an input and transfer the information using BLE to the client (i.e., a PC or smartphone). Thus, the key functionality of a BLE slave device can be identified as capturing the input, processing the input, and transmitting that processed input to the client (host) wirelessly using the BLE protocol.

When we consider the functionality of capturing an input we identify two segments:

**Segment 1:** Devices that capture input using sensors (i.e., sensor input devices or SIDs)

**Segment 2:** Devices that capture input from a human user (i.e., human input devices or HIDs)

Consider a heart rate monitor, which uses a sensor to capture a person’s heart rate. The information can be processed and then transmitted out to the client (PC or phone). In this case, the user just needs to wear the device and doesn’t need to manually enter an input.

Now consider a wireless mouse that communicates to a PC wirelessly using BLE. In this case, the user manually provides the inputs (in the form of clicks and scrolls), which prompts the question: “How will this difference impact the way the device is designed?”

### Human Input BLE Device Design Challenges

To capture a human user input, we can either use a button, slider, and/or rotor combination. This input can be mechanical or we can use capacitive sensing. In the case of the former, we can use sensors to detect the user interaction with the mechanical components or connect the mechanical components to the controller directly. Once captured, the inputs are processed by an MCU and transmitted out to the client via the BLE stack.

There are numerous devices available in the market today that integrate the BLE stack with a microcontroller (MCU). This enables developers to build single-chip systems similar to that of a sensor input device.

However, using mechanical components lead to compromised reliability and ergonomics. Buttons are susceptible to wear and tear, which leads to premature death of the device. Due to these limitations, many industries are replacing mechanical user interfaces with capacitive sensing-based alternatives.

Using capacitive sensing-based user input introduces different challenges altogether. For many architectures, two chips are required instead of one—one chip for the capacitive sensing implementation and the other for BLE implementation. This causes an increase in the PCB size that, in turn, increases the overall cost of manufacturing. There is also the problem of power management. The system would need additional clocks to coordinate the standby time of the two chips. In almost all cases, it can be expected that products utilizing BLE (remote control, mouse, etc.) will be battery operated. Thus, maximizing battery life is extremely important.

These scenarios lead us to the need of having a single chip that integrates capacitive sensing and BLE together. Apart from the aforementioned problems, there are few other issues that designers need to address. One major consideration is the degradation of the touch sensing SNR (signal-noise-ratio) due to curved/thick overlays and radio emissions. SNR for touch sensing defines the capability of a device to distinguish between the expected input signal—in this case human touch—and noise. Thus, degradation of SNR increases the device’s rate of failure to accurately differentiate between an actual touch and noise, leading to behaviors like false touches. Imagine the response if a user is watching an exciting football match but the channel keeps changing due to false touches originating from the touch sensing remote control?

At this point, it would be useful to recapitulate the basics of capacitive sensing and then use the same knowledge to understand how false touches originate. A capacitive sensor is nothing but a conductive pad placed on the PCB. Between the sensor and the ground there is capacitance known as parasitic capacitance (Cp). The overlay is placed on top of the sensor. When the user touches the capacitive button, he is actually touching the top of the overlay. This adds a finger capacitance to the sensor (Cf).

A capacitive sensor is nothing but a conductive pad placed on the PCB.
Thus, the sensor capacitance before touch = \( C_p \) (baseline).

The sensor capacitance on touch = \( C_p + C_f \) (capacitors connected in parallel).

An MCU periodically scans the sensor to detect changes in capacitance (i.e., from \( C_p \) to \( C_p + C_f \)). The period of scanning is defined as the scan rate.

Noise signals could have comparable magnitude. It therefore can become difficult for the MCU to distinguish between the real signal and noise (and so consequently leading to false touches).

In the case of a curved overlay—an example application would be a touch mouse—the \( C_f \) is reduced by the airgap (reduction in permittivity) between the sensor and overlay. This again causes the above mentioned problem. In the case of BLE slave devices, a third factor that impacts the accuracy of touch sensing is the "noise" due to the Bluetooth radio signal.

These factors combined create reasons why the signal is reduced while there is an increase in noise. Typically, MCUs use SNR to determine between a signal and a noise. When both are comparable, designing a robust product becomes more complicated.

There are many methods available to counter these issues. However, many of these traditional methods often lead to an increase in BOM cost (i.e., because of the additional components required), design time, and design cost (e.g., more person hours). Moreover, due to these challenges, multiple iterations spins may be required during the design process, further increasing cost and delaying the final product.

There is another set of challenges that designers encounter during the design of BLE slave devices. This set is common to both HID and non-HID devices and relates to the BLE stack. A tactical challenge is the need for multiple tools for developing, programming, and testing a BLE application. Also understanding the BLE specification published by the Bluetooth SIG is on its own a tedious process. Designers need a very deep understanding of the spec for the purpose of firmware development. There are also periodic updates to the specification, requiring continuous development. Not complying with updates backdates a device and reduces its interoperability. To accommodate updates “on-the-air,” additional memory needs to be available to the device. When external memory is added, it is usually interfaced to the MCU. Thus, access to this memory is via the MCU, which increases power consumption and may cause the processor to be blocked during the processing of updates.

The BLE radio output requires an additional BALUN (balanced to unbalanced) network to tune the output impedance to the standard 50 ohms impedance. Some BLE MCUs/SoCs integrate the BALUN while other do not. When the BALUN is not integrated, it has to be set up using external inductors and capacitors. This can require up to 9 external components, dramatically complicating antennae matching network (AMN) tuning.

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The good news is that a good number of the above challenges can be overcome at the very beginning of the design by choosing the right chip.

**Choosing the Right Chip for Your HID BLE Product**

Chips should be chosen with the overall end objectives in mind—a simple design requiring minimum components that deliver high performance while consuming minimal power. Fortunately, there are a wide range of Bluetooth chipset options available in the market today. Each of these chips have different value propositions. Click here to read an article with more details.

However, when it comes to single-chip architecture supporting both capacitive sensing and BLE, there are not many alternatives available. Cypress Semiconductor’s PRoC BLE utilizes Cypress’s CapSense technology that has high market acceptance. In addition, the PRoC BLE keeps all the USPs of CapSense intact. Along with CapSense, the presence of the Bluetooth low energy subsystem makes PRoC BLE a turnkey solution for HID BLE products. Beyond integrating the core functions, PRoC BLE addresses design issues such as:

1. Presence of good amount of embedded Flash (up to 128KB) and SRAM (up to 16KB) to facilitate over the air update to the BLE spec. PRoC BLE also has DMA (Direct Memory access) that helps to access the memory directly without CPU intervention.
2. Flexible low power modes that help the devices achieve good level of power savings
3. Ease of design with PSoC Creator armed with BLE component. The integrated ready to use BLE protocol stack makes design less tedious by enabling designers to take the advantages of BLE without actually mastering the BLE specification. There is also in-built support for Bluetooth SIG adopted profiles and services. There are features available to help build customer profiles and services.

Click here for more details on the PRoC BLE solution.

To get started with PRoC BLE:

1. Download the PSoC Creator IDE: [www.cypress.com/creator](http://www.cypress.com/creator)
2. Buy a kit based on your application. For common applications like touch mouse and remote control there are RDKs available. For other applications there are standard Kits and Modules available.
3. Also check out the following application note: [http://www.cypress.com/file/140661/download](http://www.cypress.com/file/140661/download)
Most high school jobs are just a way for students to earn a little extra spending money or build up some savings to pay for college. For Bill Steinike, however, a part-time high school job at Wisconsin-based LS Research (LSR) kicked off a career that has led him to the helm of that company and to a role as one of the thought leaders in the wireless design industry.
At the recommendation of an electronics teacher in high school, Steinike got an internship at LSR lending a hand to members of the engineering team. That gave him a chance to learn and apprentice under a team of experienced electronic engineers led by LSR founder Larry Schotz, who was highly respected in the audio technology circles, and who had started LSR because he believed that wireless was going to be a big emerging trend. Schotz was right about that hunch, and he was right to keep that high school kid around. Steinike became a fixture at the company, working there throughout high school and during college while he earned his engineering degree. Steinike joined LSR full time after graduating and has been with the company for more than 20 years, leading the firm as president for the past 14 years during a period of dramatic growth driven by demand for its wireless modules and design services. The company’s unique set of products and services have proven to be indispensable for companies designing products with wireless connectivity, and the company’s growth recently led global electronics company Laird to acquire LSR and make it a cornerstone of its connectivity business. Steinike, whose new title reflects his role as a member of Laird’s leadership team, recently spoke with EEWeb about the growth of wireless in the emerging Internet of Things, the challenges of wireless design, and what lies ahead with his role at Laird and for the industry as a whole.

It’s rare nowadays for people to be at a single company for so long, let alone for it to start way back in high school. What was LSR like back then? What kinds of projects were the engineers working on?

I feel really lucky to have gotten a chance to work alongside talented engineers helping with real-world design projects at such a young age. I was fascinated with electronics, and that internship made me realize I wanted to devote my career to this. There was no way to know I would end up working at LSR for so long, but they kept asking me to come back whenever I could balance it with my schoolwork. Looking back, it’s amazing how different the industry is now compared to then.

LSR was always in the wireless domain, but back then “wireless” meant something pretty different than the world of IoT and smartphone technology we have today. When LSR was founded back in the 1980s, most of the work it was doing was related to AM/FM tuner design work, which was important at the time. After all, that was the age of portable boom boxes, and hi-fi stereos and the first Walkmans. All of those devices needed wireless tuners, and chances are that if you had a product like that back then that someone at LSR played a role in it.

That was a solid business, but the growth really started once the ISM (industrial, scientific, and medical) radio bands were opened up to industries in the latter half of the 1980s. The availability of more spectrum was a huge catalyst for growth in the commercial use of wireless, and LSR happened to have great expertise in that area. Customers were looking for wireless expertise that they didn’t have in house, and they started knocking on our door.

That’s when LSR really started to branch out and add more services, right?

Yes. One of the biggest additions we made was when we added EMC testing for our customers in the mid 1990s. There were a lot of companies that were trying to get wireless products to market, but they would often fail their EMC tests to gain FCC certifications. They needed expert help to create a compliant product, and we had the right know-how and technology and processes to help them with that, not to mention the design engineers who could help them if significant challenges were identified.

Customers valued that we didn’t simply provide them with a pass/fail report. We worked with them to identify the source of the issue if their products wasn’t passing the testing. It’s proven to be a great business for us, and it continues to be since FCC and other international certifications are as important as ever. In 2014, we added another advanced testing chamber to keep up with demand and to ensure we are equipped to keep up with the ever-evolving standards from bodies like the FCC, Industry Canada, and the EU. Our goal is to take the risk out of testing and to help make it simpler for customers.

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Another big strategic decision we made was in 2010 when we decided to productize our expertise in the form of certified RF modules. Embedded certified modules are a way for customers to implement wireless in their design with considerably less up-front NRE, design risk, and development time. Each module incorporates the expertise and labor of a wide range of specialized skills that are impractical for most companies to bring together for a product design project—allowing companies to dramatically accelerate the design timeline for a project. For example, an appliance company who is designing a refrigerator or washing machine with smart features that are wirelessly enabled can simply use an embedded certified module and bypass a huge number of steps that would otherwise require half a dozen experts with difficult-to-find skills. Plus the modules are already certified, which is a huge time and cost saver.

The common theme here is that wireless is hard, but it doesn’t have to be. It can be simplified if you have the right help. With that as our guiding principle, we’ve had a lot of success with the modules and services we offer.

Can we talk more about the wireless modules you provide? What are some of the benefits of using the modular approach as opposed to integrating wireless at the chip level?

Leveraging certified RF modules means our customers don’t have to staff strong RF engineers and invest the capital outlay for the assortment of lab equipment necessary to design and validate wireless transceivers and communication devices, or to focus on the complexities of antenna design and implementation. This includes the embedded software, or firmware, development required to integrate a radio into a product design. In today’s world of wireless, it’s the software that’s become a critical component to ensure that data is shared reliably over the air. The economics of that investment really starts to buckle under the weight of itself for customers that are not doing significant volumes, say less than fifty- or a hundred-thousand units annually.

In addition, the time and money investment to secure certification to sell their wireless products into all the various markets they target certainly adds up as well. Just looking at traditional markets like North America and Europe, experience has shown us that when a customer designs with a pre-certified module, they save between $30 and $50K in certification costs alone. And the desire to expand into new markets around the globe is a huge trend in the industry today for obvious reasons, which ultimately means the certification costs and complexity continue to increase. The modular approach—utilizing an RF module with a breadth of certifications and antenna options—offers a better solution to effectively minimize all that cost, time, and risk.

Manufacturing is the other big factor for customers to consider when it comes to producing a wireless product. The skillsets of their own manufacturing capabilities, not to mention the know-how to set up the proper test fixtures to test the RF products, may create a significant stumbling block at a point when they feel they are near the finish line of their product development efforts. Utilizing a modular approach offers significant help in simplifying the manufacturing process as well.

It’s all about simplifying wireless. Embedded wireless modules reduce complexity and make some of the most difficult parts of wireless design very simple, which is why these modules are going to be a critical building block of so many IoT solutions in the days and years ahead.
As a go-to partner for wireless development, you’re certainly immersed in IoT, too. What do you see happening in that market?

Yes, a lot of our focus right now is on supporting the IoT design projects that customers are working on. We are absolutely seeing interest in the Internet of Things permeating all different industries and business sectors. At this early stage, we see some customers who have a fully-realized vision for the products they want to create, while others are just at the point of defining an internal “IoT strategy” to capitalize on these technologies. What’s exciting for us is how we help customers no matter where they may be on that continuum.

It’s really just in the past few years where we are now seeing actual IoT deployments and product concepts from companies that can truly differentiate their products, providing entirely new product categories and services for their markets, all thanks to the power of IoT and wireless technologies.

Are the design challenges with IoT projects similar to other kinds of wireless design?

Yes, wireless is hard and IoT is no different. The challenges are similar, but they can often be greater in complexity with IoT designs projects because of issues such as the small size of the product, the limited power since many devices are battery-operated, the locations where they will be used, and so on. Those are primarily related to the product itself. In the case of IoT, one of the areas where companies need a lot of help is on the other elements of a connected product that are just as important as the device itself. IoT products like a smart appliance use that wireless connectivity to connect to a cloud, and that is what enables them to be controlled remotely via smartphone, serviced remotely by manufacturers, etc. Virtually every IoT device in the world is a cloud-connected product, and that brings an element of IT complexity that many product companies are not comfortable with. After all, they are an appliance company, not IBM. They are an industrial sensor company, not H-P.

But when you design an IoT product, the development effort spans far beyond the company’s traditional “product”, whether that’s a home appliance or a factory pump sensor or a wearable device. It requires expertise and extensive development on the cloud server side, as well as the user interface which typically is a mobile or web-based app these days. That’s a lot for most organization’s engineering teams to be able to bite off, so partnering with a wireless development firm or leveraging an IoT platform-as-a-service solution like Laird offers becomes a lifeline for meeting their business objectives and timelines.

Let’s talk about security since that is a hot topic when it comes to wireless products, especially in the cloud-connected world of IoT. What are the main security concerns involved with developing IoT devices?

No matter what the product application, security is one of the biggest concerns in the IoT space. Security has always been a big issue in LSR’s world of wireless development—when you are sending data over the air, you are always vulnerable in terms of who can see that data and how they can penetrate your system. That gets further complicated in the IoT infrastructure because now you have multiple entry points within a system, from mobile devices, to the cloud, to the device itself.

That is where the expertise in building complete wireless systems becomes so invaluable, to identify and eliminate all those vulnerabilities and risks. This will continue to evolve as people figure out new ways to hack into those devices and people get better at adding additional layers of security. We look at it as a system-level problem, addressing the areas that need to be protected in that ecosystem to have a reliable and secure platform.

WIRELESS SYSTEMS ARE ONLY AS SUCCESSFUL AS THEIR ANTENNAS, AND THOSE ANTENNAS ARE DIRECTLY IMPACTED BY THE WORLD AROUND THEM.
When you look at wearable technologies—such as medical, wellness, or fitness products—what are some of the challenges in meeting those demands?

Wearables are a good example because the challenges come primarily in figuring out how to get the devices smaller and smaller with every generation. At the same time, the demand for long battery life is paramount as well, and these two requirements conflict with each other from a design standpoint. Now, when you talk about adding wireless capabilities, a third complexity comes in. In this small form factor with a high-performance battery, there needs to be an antenna placed that will reliably transmit data. Too often, we’ve seen customers struggle because the product design, in terms of size, form factor and materials, are chosen before the RF and antenna design is begun. Wireless systems are only as successful as their antennas, and those antennas are directly impacted by the world around them. So again, the complexity still comes about in how to tie all of those competing performance demands and successfully make a product. Those are the challenges our designers and engineers get to help our customers tackle every day.

Does Laird do the actual industrial design for wearable devices?

Historically, LSR had focused on the wireless, software, or hardware elements alone, working collaboratively with our clients’ industrial designers. The same issue kept arising where our team was being handed a finished design of the enclosure for a product and being forced to design a wireless solution that could succeed in that environment. So a few years ago, we began offering our clients a better solution to get them to market. By having our own Design Studio of industrial designers and mechanical engineers sitting alongside our antenna and RF engineers, working hand in hand, makes all the difference in helping our customers solve real challenging problems. Today’s world of wireless extends all the way out to the mobile phone or tablet serving as the user interface, and so we have rounded out our total solution by also providing user interface design and mobile app development. Ultimately, IoT devices will thrive in the market based on the value and convenience they create for the user. That spans from an antenna design that maximizes range all the way to the UI of the mobile app. This is one of the things that made Laird’s acquisition of LSR such a great fit. Laird is a trusted partner to its customers by delivering connectivity technology through innovation, speed, and reliable fulfillment. So the two organizations have this same holistic understanding of what it takes for IoT to be successful, and with the combined resources and expertise of both companies we will be even better positioned to help companies with fascinating wearable projects and game-changing IoT plans.

How extreme of an environment is the human body for a wearable device? Does it really pose a set of challenges that is different than other environments?

Obviously, wearables are going to be placed very close to the human body and are packed with electronics and a battery, which has metal around it; all of these factors make the human body a very challenging environment for a wireless system. In addition, most wearables are using the 2.4 GHz ISM band, thanks to the prevalence and ubiquity of Bluetooth and Wi-Fi technologies. Microwaves operate at 2.4 GHz as well, but for a very different reason. Because materials made predominantly of water, whether that’s a bowl of soup or in our case, the human body, do a great job of absorbing energy at that frequency. So we are transmitting data from a tiny wireless system at a frequency that is well absorbed by the human body. Certainly a less than ideal environment for a wireless solution.

We worked with some of the very earliest watch manufacturers who were at the leading edge innovating with wireless to create what we today think of as “smart watches.” They sought out our expertise because of this precise challenge. No matter how fashionable their watch appeared, it would fail to win over their customers if it’s unreliable in connecting wirelessly and performing as expected. An optimal blend of fashion and performance must be there for a winning product.
Let’s step back a bit and talk about the bigger picture. What do you see evolving in the wireless industry and for the work you and your team will be doing at Laird?

I’m excited when I think about a lot of advances on the horizon for the wireless space, and I believe a significant proportion of those innovations will continue to come from standards-based technologies like Bluetooth, Wi-Fi, Thread, LoRa, and LTE Cat0, to name just a few. At the same time, silicon manufacturers continue to create smaller, more powerful, more battery-efficient components, which are innovations critical to truly realizing the full potential of the IoT.

I’m also really excited about the role that Laird will be able to play helping customers with the challenges of deploying those technologies and delivering fascinating new products to market. The acquisition is still quite recent, but already it is clear that this is a great fit and that everyone shares the same vision for how we can be helping companies make wireless easier. I’ve only worked for one company in my life, but I already feel at home at Laird and that says a lot.

The industry as a whole is changing. But even though it has changed a lot since back when the engineers here were helping design radio tuners, the nature of the collaboration with customers is still the same. We want to be an extension of their team and a trusted partner who provides wireless expertise and insights to take the difficulty out of using the latest wireless technologies. By simplifying wireless for them, that allows them to stay focused on the features and functionality their customers want, without getting bogged down in the complexity that wireless introduces.

It’s an exciting time for wireless innovation, and I am thankful every day that the 15-year-old version of me all those years ago did what my electronics teacher suggested and sought out an internship here. Wireless technology is changing the world, and all of us in this industry should be proud of the role we are playing in making amazing things that would have sounded like science fiction not that long ago.

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