Altium

# IoT Resource Bundle

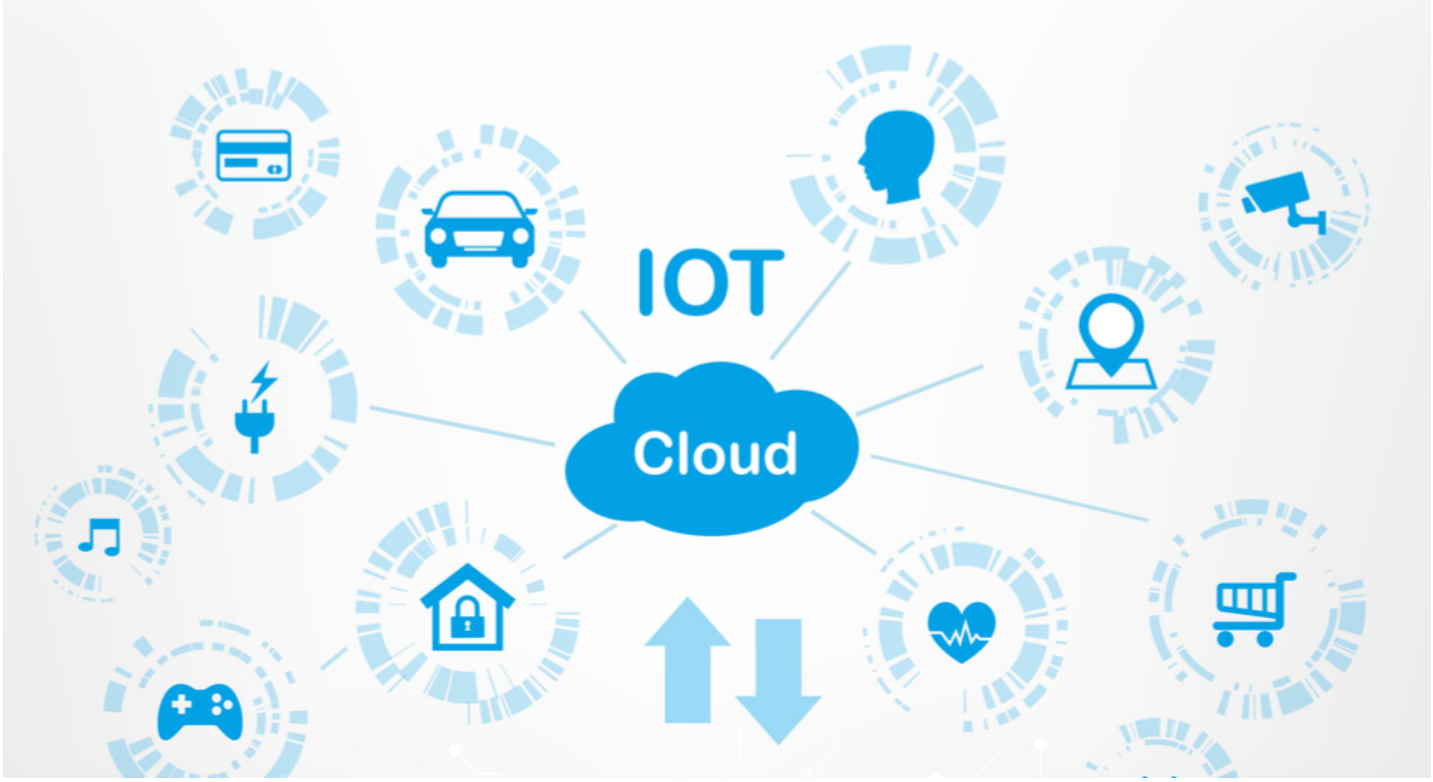
# THE INTERNET OF THINGS RESOURCE BUNDLE FOR PCB DESIGNERS

From the early days of printed circuit boards, the electronics industry has made huge strides in board materials, copper printing methods, miniaturization, rigid-flex, ELIC, EDA, and much more. Many of the devices we use in our homes, our vehicles, and in our workplaces would not be possible without this continuous evolution of PCB design and technology. The scope of creativity from individuals is unbounded. While the infrastructure for IoT can, and probably must, be designed and built by organizations, the applications for IoT will need to be realized through a network effect that enables creative individuals of all shapes and sizes to contribute. We hope to make PCB design accessible to electronics designers across the spectrum of design and development and enable the future of technology realization.

Join us as we explore topics in the IoT and PCB design, including:

- Flexible PCBs and the Internet of Things: How the Landscape of PCB Design is Rapidly Changing
- Flexible Future: The Industries That Are Forcing You To Learn Rigid Flex PCB Design
- Design Techniques to Help you Keep up with Increasing PCB Complexity
- Choosing the Best Communication Configuration for Your IoT Device Network
- Designing PCBs for IoT: How to Plan for FCC Certification
- How to Choose a Test Lab for FCC Certification of IoT Products

# FLEXIBLE PCBS AND THE INTERNET OF THINGS




As a PCB Designer, I know that my field of work has morphed radically over the last two decades. Fresh out of school in the mid-1990's, all of my early projects centered on either of two main areas: computers or computer peripherals. Sure, there was the odd stereo or clock radio, but 90% of the time I was working on a desktop motherboard or something close to it. This meant that, on an average day, my design efforts had a lot of real estate to work with. All on a two layer board, too. It was a different time. Thankfully, it didn't stay like that forever.

Fast forward to today, and I'm still designing PCB's in the computer space. Big beige boxes aren't the name of the game anymore - instead, it's all about the Internet of Things (IoT). Through these embedded computers, a whole new category of gadgets and devices has opened up, especially those under the "smart home" moniker.

Coffee makers, kettles, refrigerators, lighting, watches, and even cars are all picking up this 21st-century technology. Integrating features like cloud control, remote access, and even machine learning (your air conditioner turns on as you commute back from work), it really is starting to feel like the future. Of course, for us PCB designers and electrical engineers, it means a lot more than party tricks and fuzzy logic toasters.

## INTERNET OF THINGS: MORE COMPLICATED THAN YOU MIGHT EXPECT

For obvious reasons, building a PCB for an IoT device is a real challenge. Space, for instance, is at a premium. Most IoT products are small appliances, controls, or wearables directed at the consumer market, who like things neat and compact. Moreover, many of

these devices are not designed with the hardware in mind. Instead, it's all about the aesthetic, which means irregularly-shaped small spaces for hardware. Then, there's the matter of performance. No one's going to be thrilled if their fridge needs to "load," and if takes a lot of oomph to get that smartwatch to bring up YouTube.

Your PCB will probably be packed with IC's and at least one SoC, if not two. Finally, we need to consider reliability; consumers who buy these gadgets will expect them to "just work." This means whatever design choices you make need to have rock solid foundations. There just isn't room for error (or anything else for that matter) like there used to be. So then, now that you're all scared and apprehensive, what are the smart designers doing?

## FLEXIBLE PCB'S: AN IOT PROJECT'S BEST FRIEND

Allow me to share some personal experience with you. The simple two layer boards I reminisced about are a no-go. They just can't do enough with small form factors. Now you're probably thinking, "well what about high-density, multilayer boards?" Sure, that's technically correct, but in my experience, they're more trouble than they're worth.

With plenty of IoT products (especially wearables) on the move, those boards break too easily. Not only that, they need a flat space to fit in. There's a better answer and it looks like everyone making IoT devices thinks so too. Flexible PCB's have become the go-to in the IoT space, elevating a formerly obscure type of PCB to newfound prominence.

Made from layers of polyimide, flexible PCB's are capable of the same specifications of rigid circuit boards. They are widely adaptable without sacrificing long-term reliability and have demonstrated success in IoT applications. More importantly, their flexible nature lets them fit easily into the small and unconventional geometry of many IoT products.

On more than a few projects, I've been able to take advantage of the space behind curved faceplates and bases. I didn't need as many connectors and ribbon cables either, and we all know how bulky they can be. Potentially, you could even create a common design that is able to fit within several IoT products of varying form factor (my boss loved that one). Flexible PCB's and the IoT - it is a match made in heaven.

With so many companies big and small running after a piece of the IoT pie, you'll probably be working on an IoT project in the near future. Naturally, if you're as skeptical as I am, you might be apprehensive designing a Flexible PCB. Given the existing challenges associated with an IoT project, why would you want to make things more complicated?

But much like the "chicken and egg" problem, the expanding IoT market has both improved and been enabled by flexible PCB's. About 8 years ago I can remember seeing some prototype flexible PCB's while meeting a vendor, and they were admittedly very simple. Today, modern techniques like SMT, microvias, multi-layer substrates and BGA IC's are readily applied.

Thanks to better economy-of-scale, manufacturers can provide these features for cheaper. On the same budget, the range of design options on flex PCB's has expanded dramatically. In fact, in a cost-benefit analysis, Rigid PCB's are no longer an instant winner. They've gotten stronger too, and as a result, possess greater reliability.

There is, however, one thing that *hasn't* changed, and that's the design process itself. The workflow in your PCB CAD environment will

be very similar: laying out traces, selecting and placing components, adding additional layers. On top of that, many recent design packages are bred to deal with flex designs and will give you insight on selecting dimensions and geometry. Honestly, even if you're not totally "sold" on Flexible PCB's, the landscape of PCB design will keep changing to make IoT happen. If they're not good enough today, then they're going to be great tomorrow.

As a fellow designer, I hope you're as enthusiastic as I am working with flexible PCB's. Both the technology and the design tools are much improved. Before you dive into the world of the IoT, it's a good idea to take stock of the tools and resources at your disposal.

Flexible PCB's have certainly transformed, but what about your PCB design package? Is it equipped to deal with the latest and greatest?

Altium offers multiple solutions that scale to your needs while optimizing workflow; software packages built to deal with the nuanced challenges of creating successful IoT products. With support for flexible PCB design, exhaustive testing tools, and an intuitive interface, Altium's software is a reliable, trustworthy foundation for your next IoT project.

# FLEXIBLE FUTURE: GET READY AND LEARN RIGID FLEX PCB DESIGN

Do you ever feel like time is a passing a little more quickly than it should? It seems like just yesterday I was growling in frustration as I learned how to use dial-up internet. Now I growl in frustration as I attempt to figure out how to set up my state-of-the-art broadband router. It seems like as soon as I master the current technology, it's time for the next big thing and I have to start all over again.

Well my PCB designer friends, it's time for you to learn the next big thing in PCB design: flex and rigid flex. In the fast growing world of PCBs, flexible PCBs are growing the fastest. The Internet of Things (IoT), wearable electronics, and flexible displays are all pushing the industry towards flexible and rigid-flex PCBs. That means it's time for you to roll your eyes, let out a sigh, and start to learn the design principles for the next generation of PCBs.

## FLEXIBLE PCBS ARE GROWING QUICKLY

Learning new design techniques hurts, but money can help ease the pain. The global PCB market is growing, with some studies estimating the market will grow to $73.8 billion in 2021 from $63.5 billion in 2016. A large portion of this growth is expected to be from flexible PCBs. Some reports project flexible PCBs to grow to $15.2 billion by 2020 and $27 billion by 2022. I may not give a hoot about next gen PCBs, but I will holler for a dollar. Flexible PCBs are already outpacing rigid PCBs. In 2014 rigid PCB sales decreased slightly, while flexible PCB sales increased. Adapt or die is the law of nature and of the PCB design world. If you stay in the past with only rigid designs, you'll get left behind.

## INDUSTRIES PUSHING FLEXIBLE PCBS

It's one thing to observe that flexible PCBs are growing, and another to know which industries are pushing that trend. Currently, the Internet of Things and wearable electronics are largely responsible for flexible PCB growth. I believe that flexible displays will become another catalyst in the near future.

## THE INTERNET OF THINGS

The Internet of Things is one electronics industry that is on the cusp of explosive growth. This growth means you'll soon be designing a lot more PCBs for IoT devices. Many of these new IoT PCBs will need to be flexible PCBs.

Take "smart" LED strip lighting for example. LED strip lighting needs to be flexible along its length so that people can bend it into whatever shape they need. Eventually, people will want things like smart towels that tell you if your hair is dry, or connected tissues that send people alerts to say "bless you." By their nature, these kinds of devices will require flexible PCBs.

Flexible PCBs can also be used to fit small 3D form factors. 3D printed PCBs are still on the horizon, so you have to get a bit creative to fill those awkward spaces. Rigid flex designs can let you fold your boards into rectangles, cubes, or octahedrons, and fit them into spaces where a flat board just wouldn't do. You may have to learn origami as well as rigid-flex design.

## WEARABLE DEVICES

I know you love PCBs so much you would wear them if you could. Well, today is your lucky day. Wearable electronic devices are on the rise, with sales expected to reach $30.6 billion by 2020. That much money could buy you a whole PCB wardrobe.

Wearable electronics are often embedded into clothes, and therefore need to be flexible. Sensoria's smart socks, for example, have sensors and a chip embedded in the fabric of a sock. Your socks and this idea may stink, but you'll just have to hold your nose and take the plunge. Wearable devices like this that require flexible PCBs are everywhere. From belts to baby hats our clothing is fast becoming connected, and most of it will need flexible PCBs.

Some wearable PCBs, like the one on the Shockbox, will need to be flexible in order to resist shock and vibration. Shockbox makes sensors that can be integrated into sports helmets. These sensors are supposed to reduce risk of concussion by providing parents and coaches data on head impact forces. To measure force the sensors must experience force. As rigid PCBs are much more likely to crack when experiencing dynamic forces these kinds of devices will need flexible PCBs.

## FLEXIBLE DISPLAYS

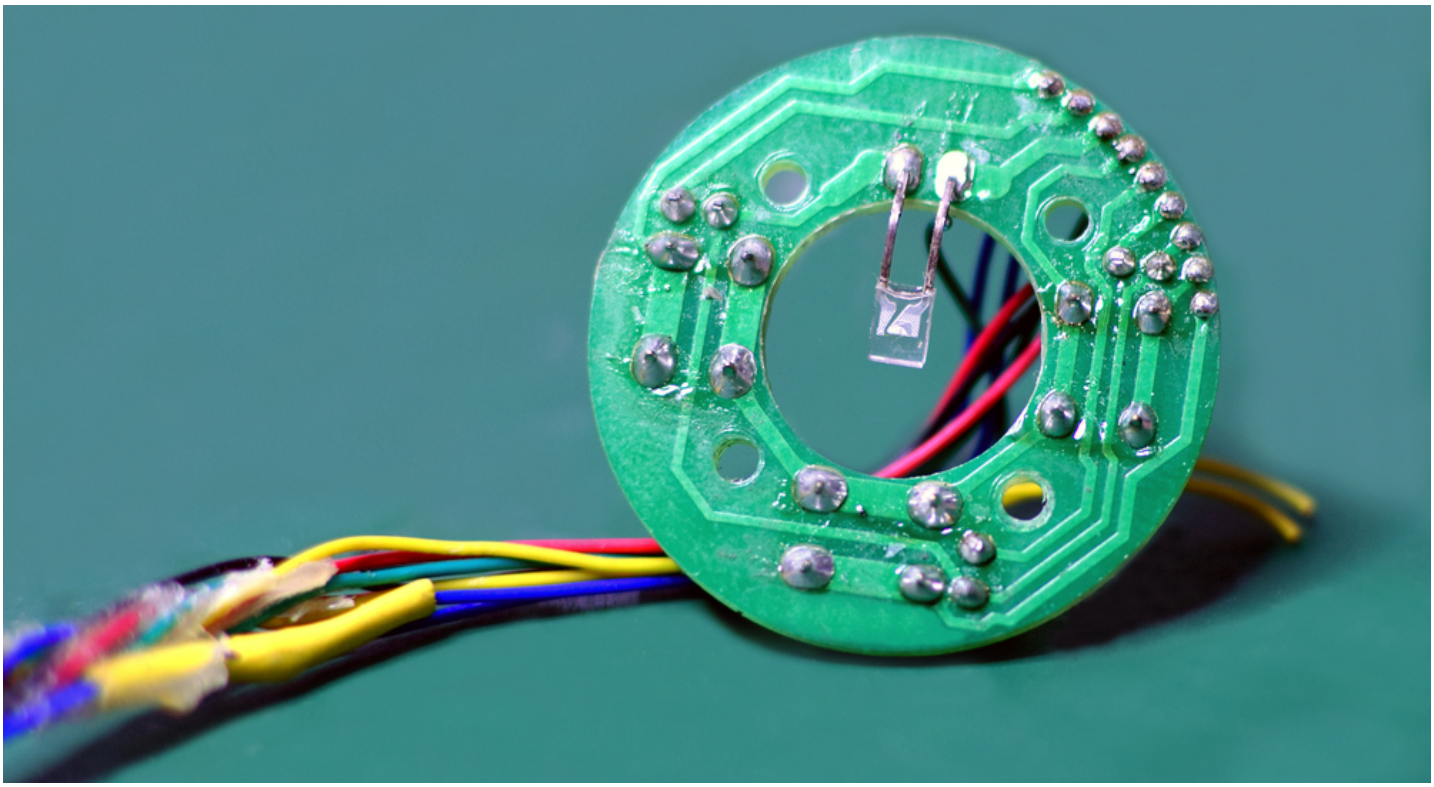
You've probably heard about flexible displays, but have never seen one. I've heard you can find them at the end of a rainbow next to

a Leprechaun's pot of gold. I recently found out that flexible screens actually do exist, they're just not in use yet. Once manufacturing costs come down, flexible screens will make their way into our devices. If the screen is flexible, everything else will have to be bendable as well. The waking nightmare that is a fully flexible PCB design for handheld is electronics is on its way.

If you thought your days of studying ended in college, you were wrong. The Internet of Things, wearable electronics, and flexible displays will force you to learn flex and rigid flex PCB design. So grab a pot of coffee and get ready to burn the midnight oil preparing for the future.

If you're going to be designing the next generation of rigid flex PCBs you'll need software that is as futuristic as smart socks. Altium Designer has pioneered 3D PCB design software to help designers like you master rigid flex design.

# DESIGN TECHNIQUES TO HELP YOU KEEP UP WITH INCREASING PCB COMPLEXITY



Do you ever feel like life is moving a little faster than you are? All these new fangled sayings, apps, hairstyles, etc. In addition to an outdated fashion sense, you're probably getting left behind at complex PCB design as well. Between the advent of the Internet of Things (IoT) and wearable electronics, PCB design requirements are becoming more and more advanced.

You need to keep your eye on the design techniques that can make PCBs smaller, faster, and more flexible in order to keep up with the times. In addition to keeping abreast of design trends, you will likely need training in how to implement the techniques they require.

## SMALLER

One interesting clothing trend right now is everything getting smaller. Shirts tighter, shorts and skirts shorter. PCBs seem to be following this trend as connected devices get smaller and smaller. Yesterday you had to fit a microcomputer in a watch, tomorrow will it be going inside a thumbtack? You have the skills for a watch, but a thumbtack is another story. As PCB sizes decrease, you will need to be up to date on design shrinking solutions such as efficient fanouts and blind/buried vias.

Integrated circuit (IC) manufacturers are answering the call for small with finer pitch packages, which makes your life more complicated. Things like ball grid arrays (BGAs) and quad flat packages (QFPs) are shrinking, which may require more efficient fanout strategies.

High density interconnect (HDI) boards attempt to save real estate simply by jamming everything as close together as possible. In order to really cram everything in there, you'll probably need to use buried and blind vias to make efficient connections inside the board. Beware the dangerous side of smaller, thermal management. A design that worked before may not work if you shrink its layout. Remember to check if your designs can meet heat dissipation requirements with a smaller footprint.

## FASTER

Design trends are often at odds with each other, just like you and those teenagers who won't keep off your grass. The demand for faster circuits has led to designers using more powerful ICs on their boards. Well, usually higher power ICs are larger and run hotter.

With current silicon transistors nearing their minimum size limit we could be looking at a future where chips have to get larger to become faster. As chips get larger, mastery of the efficient design techniques mentioned in the previous section will become more important.

As you well know, more speed means more heat. Hotter ICs will mean planning layouts for thermal management, choosing the perfect thermal interface material, and keeping abreast of new heat dissipation technologies.

## GREEN PCBS

Ever wonder what happens to all those event t-shirts that you wear once and then give away? They eventually get shipped to Africa and find a second life in the dirt cheap used clothing markets. Unfortunately, when PCBs are dumped overseas they are not usually reused. While many PCBs are green in color, they're not very green from an environmental standpoint. With a projected 34 billion connected devices by 2020, PCBs will soon need to be a bit more green. PCB designers will soon need to be prepared to make "green" design choices along with the more traditional ones.

Research is now being conducted into using bio-based materials for PCB substrates. There are a wide variety of materials available that could be used in "green" substrates, all with differing mechanical properties. The advantage is that choosing one or the other will give your board specific mechanical properties, flex, strength, etc. The disadvantage is that designers may soon require the knowledge to choose between chicken feather fibers and keratin fibers for their substrates.

Biobased technologies will also allow substrates to have different electrical properties. The new resins being tested will allow a designer to specify such properties as the dielectric constant for their substrate. I don't know which dielectric constant to use for specific applications, do you? Designers will soon need to know a lot more about material sciences in order to take full advantage of "green" substrates.

## TRAINING

Keeping up with the latest news and blogs about cutting edge design techniques will definitely help you keep your PCBs in fashion. However, your extracurricular reading should still be supplemented with structured training.

*This could be the next IoT application*

There has been much talk recently about whether or not there is a shortage of PCB design engineers. Whichever side you find yourself on, I think we can all agree that the need for more complex PCBs has left the industry with a shortage of skills. Even when employers find engineers to hire, they often lack the skills required for advanced PCB design.

Those same skills are difficult to obtain. Right now most designers are left on their own to figure out PCB design for themselves. While this method currently works, PCB requirements will soon become so advanced they'll leave self-taught designers in the dust. Training designers is the only way to ensure that they will have the skills to meet the growing demand for increasingly complex PCB designs.

The world of PCB design is accelerating quickly, and those who do not adapt will be left behind. If you're worried you might be in that category, talk to your manager about getting some training in new design techniques that can help you design for the future.

While I was suffering through my electrical engineering studies in college, my sister was enjoying the lighter course load of fashion and design. Of course, I helped her as she went through her required math courses. She ended up helping me as well, by upgrading my terrible fashion sense to a mediocre one.

Your PCB design software should be like my sister and show you the way when you're in uncharted territory. With documentation outlining features like interactive routing, blind and buried via use, and more Altium PCB design software is ready to help keep your designs looking good.

# CHOOSING THE BEST COMMUNICATION CONFIGURATION FOR YOUR IOT DEVICE NETWORK

It's all set, you have perfected the design of the latest state-of-the-art IoT fork and you're feeling unstoppable. Nothing could throw a wrench in your plans now...except maybe your fork's network connection. What's the difference between a smart fork that can't connect and an ordinary fork? You paid a lot more for the smart one!

That's why it's imperative that you choose the correct network configuration for your IoT product.

Upfront planning and testing of the network communication you want to use for your IoT product can make a huge difference in a successful product deployment. I learned this lesson when I ended up hiking through calf-deep mud, with thumb sized mosquitos and actual alligators to install an extra base station that we hadn't planned for.

We had tested this IoT system in a park and didn't consider how much vegetation would be blocking the sensors in the field. In practice, the transmitter range was halved and the number of receivers was doubled.

Unless you're really desperate to spend more time on field installations, it's important to understand how and where your IoT system will be deployed. That helps you plan for the connectivity, network support, and scalability needs of your product.

## WHAT DOES MY NETWORK NEED?

When you start planning your IoT network, you'll have two types of communication components to consider: the transmitters (Tx) and receivers (Rx). The transmitters are connected to the actual sensors, buttons, or other information collection modules that are doing most of the work in an IoT system. The receivers collect the data from the transmitters that are within range. The Rx might store or display the data before it is uploaded to the cloud.

## WHAT IS THE BEST NETWORK FOR MY SYSTEM?

Before you start designing anything for an IoT system, you should decide what kind of network you need for good communications coverage between the Rx/x (we pronounced them "ricks" and "ticks"). It's important to design the system as a whole, and plan how modules will communicate and over what distance. Otherwise, you'll be telling all the kids how back in your day, you had to slog through mud and alligators to put up extra base stations. There are three basic configurations for an IoT system:

- Devices that upload directly to the cloud: In some situations, your device may upload directly to the cloud, usually via wifi, a cellular network, or even satellites. Since reaching a cell tower, or outer space is a long transmission distance, this approach usually requires a higher transmission power from your devices.

- A custom network of only your devices: Using a custom base station gives you a lot of control over hardware selection and security. You need to make sure that you select communication hardware that has enough transmission range to cover the distance between your base station, and each Tx module you want to receive data from. Learn from my mistakes, and test this type of setup in the most realistic environment possible. It's likely that the range listed in the hardware specs are probably "best case scenario" distances. The actual transmission range can be affected by walls, vegetation, or anything else that obscures the line-of-sight between the base station and a module.

Also, unless you want a closed system, you'll still need a way to access your data from the base station. That could be another transmitter, a hardline into the network, or physically accessing the base station with a USB drive.

- A hybrid approach: Here your devices send data to a base station receiver that can transmit the data to the cloud. Creating your own base station (either custom hardware or an application that runs on existing phones or computers) requires additional overhead. However, it's a nice compromise between transmission power and infrastructure costs.

Be aware that any base station that contains both a receiver and a transmitter will require additional testing for its FCC certification before you can sell or deploy that product.

## WHERE WILL YOUR PRODUCT BE USED?

If you aren't certain what network approach is best, then consider where your system will be used. Environmental conditions and obstacles, like weather, walls, and plants can affect transmission range. You might also have existing infrastructure, like a cell tower or wifi network, that your product can utilize.

- Outdoors: Products outside, but still near a home might be able to access a household wifi network. Usually, a system out in the wilderness needs to transmit farther, which requires more power. You'll probably want a base station that can receive data from several nearby modules, and upload everything it collects. We used a base station but lost transmission range due to vegetation growth, so I recommend testing the communication under a variety of conditions. It will help you to avoid last minute changes to installation locations, and how much hardware is actually required.

- Household and Wearables: Something like a Dash button at home, or a Fitbit that hangs out with you all day, can probably use your phone or computer as a base station (over wifi or Bluetooth) rather than requiring a custom solution for your system. Smart fork designers, this section is for you!

- Industrial: Any system that collects proprietary or sensitive data will need to be especially concerned with security. A custom

base station with restricted access to the data is one way to keep sensitive data out of the wrong hands.

Planning and designing for your IoT network setup in advance will save a lot of trouble down the road. Testing the network layout under a range of conditions is also hugely important, and would have saved me a lot of bug bites. More importantly, it also would have saved us thousands of dollars in additional hardware and installation costs. This is the kind of mistake easily made in new products and can cost you time, money, and customers.

Fortunately, once you've planned your communication configuration, you can use PCB tools like Altium Vault to help you identify and manage the parts that will meet your performance requirements. By selecting the right parts at the beginning, you'll set yourself up for a successful product deployment. After you've successfully designed and tested your product, you can reuse the communications section of the design for new versions and products with modular design tools.

# HOW TO PLAN FOR FCC CERTIFICATION WHEN DESIGNING PCBS FOR IOT

When I worked on my first internet of things (IoT) product, I was at a startup that was just past the two guys in the garage stage. I was literally the third employee. We were all smart, enthusiastic, and entirely focused on the proof of concept of our design. As the newcomer, I assumed that there was a plan in place for finalizing our product, getting any certifications or approvals, and getting it to market. Spoiler alert--I was completely wrong. We learned the hard way that no matter how amazing your IoT product is, no one will appreciate it if you can't get it certified and on the market.

I knew IoT was everywhere, or it was going to be. You could wear smartwatches or fitness trackers, order detergent from a button in the laundry room, and have your crockpot text you that dinner is ready. With IoT being ubiquitous in our day-to-day lives, I assumed that gaining any certification would be trivial.

All of these IoT devices depend on being able to transmit their information back to MU-TH-ER, or whatever you call "the cloud" if you're not an Alien fan. All that radio frequency (RF) transmission is regulated by the Federal Communications Commission (FCC), to ensure that devices aren't encroaching on each others' approved frequencies or broadcasting at unsafe power levels.

Wantonly adding RF modules on your products can lead to enormous fines if your products aren't properly tested and certified. These fines are often per transmitter per day of a violation, so costs rack up quickly if you've already deployed a system.

While we didn't get fined, we had plenty of other issues with certification. Do not underestimate the importance of planning ahead for certification before your product is launched, or even designed. Certification is expensive and time-consuming. I assure you, you

want to design for it on day one and avoid a respin because you didn't pass the certification testing.

## WHAT KIND OF TESTING AND CERTIFICATION DO I NEED?

Selecting a module depends on your application requirements, and can be an extensive process. There are several online comparison tools to help you identify what will work best for you, like AT&T's Module Library. You'll end up with a module in one of two categories.

### Full EMC Compliance Testing and Registration

Most devices will require a range of testing to make sure that they are not producing any electromagnetic emission that exceeds the limits set by the FCC. This is followed with paperwork to certify and register your device. All receiver designs will need to be fully certified, but you may be able to simplify things for your transmitters with a modular certification.

### Modular Certification

Some modules are basically "pre-certified" and have already gone through the most extensive part of the FCC certification. You still need to get your completed system tested for unintentional emissions, but the bulk of the testing is done. I recommend this approach for a first-time foray into IoT design.

## OKAY, BUT HOW DOES THIS AFFECT MY DESIGN?

There are various flavors of black magic that go into any RF design, like grounding, noise reduction, and impedance matching. It's also possible for many elements of your system to unintentionally become antennas, transmitting or receiving outside of your design specifications.

This means that small changes to a design can shift the RF emission frequency, cause spurious emissions, change the output power, and have your system producing outputs in places you never expected. Add that all up and you get a failed certification testing.

To eliminate those problems, there are several things to keep in mind as you're designing your PCB.

- Minimize trace length.
- Keep high-speed components close to each other, especially in mixed signal designs.
- Use good grounding practices.
- Isolate your inputs. High sensitivity inputs may even require a separate routing layer.
- Use bypass capacitors to reduce noise around DC components.

## SMART COMPONENT SELECTION IS AS IMPORTANT AS YOUR LAYOUT

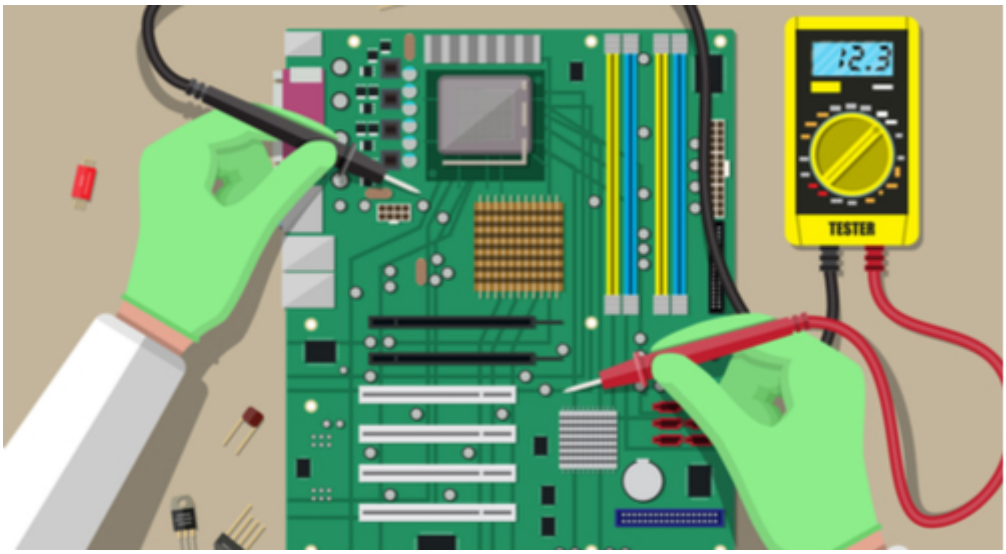
Our first design used commercial sensors from a small company (probably smaller than ours) that was thrilled at a chance to increase their sales. For various reasons, they never certified their sensors. This made for a fun surprise when we connected them to our control board at a prescan (a cheap, unofficial test where they check for obvious problems). The tech said, "Wow. Those things are screaming. That is the worst I've ever seen."

Those words carried weight, as he had 12 years of experience testing products. At the time, it felt like the end of the world.

To avoid this scenario, do a little research up front on your components. This will save you from scrambling around trying to find shielding solutions or changing your hardware. Remember to look beyond your PCB and try to eliminate troublesome components in the entire system.

- A single faulty component can interfere with your whole device. Check whether you're including any components, like sensors with long traces, that can propagate issues to the system as a whole.
- Beware of wires and cables connecting to external components as they can become little electromagnetic radiators of chaos.
- Every single oscillator in your system is a possible source of trouble. Choose components that have been included in other successful designs, and shield them whenever possible to avoid the MHz screams we saw in our test.
- If you are using a modular certification, you can only use the module with antennas that were approved in the original certification or you will have to start from scratch.

Finally, the testing may require you to connect and disconnect any inputs, outputs, or power supplies. Make sure your connectors can survive unplugging without any adverse effects on your board!




*Proper planning for FCC certification at the start will take you in the right direction*

Certification can be a confusing process, so it's important to plan ahead and minimize your issues down the road. Fortunately, there are tools that can help.

Professional PCB Design Software used in conjunction with Altium Vault helps you to identify components used successfully used in previous designs, or that meet your specific requirements to pass certification easily. Some RF modules are already included. (The same company, Linx Technologies, also offers a nice overview of certification.)

Once you have a successful design, you can reuse modules from that design for your next IoT product to make both the design and certification easier.

# HOW TO CHOOSE A TEST LAB FOR FCC CERTIFICATION OF YOUR IOT PRODUCT

I've been an engineer in some very heavily regulated industries where products are tested out the wazoo to make sure they're safe. Even so, getting FCC certification for an IoT product was still a significant endeavor. Choosing the right company to perform the testing is the most important decision for success with minimum expense and agony.

## WHAT'S A TEST LAB AND WHY WOULD I NEED ONE?

It was a surprise to both my boss and I that we needed an FCC certification. The chief engineer had selected our IoT RF (radio frequency) module specifically because it said pre-certified. It had seemed like a safe assumption that we could go wild with sales and installation as soon as we were done manufacturing.

Imagine my shock when I found a single bolded paragraph in the User Guide. It said that, at a minimum, we needed to test any product containing this module for unintentional emissions and the product probably still needed a full certification.

Lesson learned: You should actually read any and all documentation for all components going into your system. Even if you don't have an RF module, you may have "unintentional radiators" in your system. Check the FCC rules (listed in FCC Part 15B) to see what applies to your design. If like me, you're starting out with little experience with the FCC Rules, you should find someone who is. I started with my local IEEE Section. You can search their consultant network even if you aren't a member.

If you need any kind of FCC certification or verification for your product, then you'll need a test lab to do it.

## OKAY, HOW DO I FIND A LAB?

I found the test lab we used after going to an IEEE sponsored talk. (I should have gotten my membership reimbursed by work. It's common for some companies to do this, you should ask about it.) If you want to try the IEEE approach, your best bet is to reach out to the EMC Society and ask if anyone has experience or recommendations or talks you could attend.

Alternatively, you can find a lab through a search at the FCC site without talking to any strangers. You should bookmark this site, even if it's not where you start. You'll need to check if the labs you are considering are accredited by the FCC to perform testing. Many test labs do a variety of work besides just FCC certifications, so every lab won't be up to spec for the tests you need.

You can also ask your RF module vendor who certifies their products. It may save time to work with a lab that's familiar with the specific RF characteristics of your module. If things are looking a little off, they may be able to identify the reason more quickly. We got a quote from the lab that certified the module we were using, but they weren't a great fit for what we needed.

## HOW DO I CHOOSE WHICH LAB TO USE?

After your search, you may find several test labs available to you. Picking a good one will make a huge difference in how your testing goes. Here are a few questions to ask as you narrow down your options.

### How do I know if it's a good company?

There's no Yelp for hardware testing labs, so finding reviews can be tough. Ask other engineers in your area for referrals. I promise I'm not getting a commission from IEEE, but they can be so helpful here. At a good tech talk, you might get lunch, and be able to meet test lab employees and their customers. This is better than asking for testimonials from the lab since they probably can't share specifics on their clients.

When you are researching a lab, they should be able to answer any questions you have about the process and requirements. If you aren't sure what to ask them, you can start with these questions.

### Can they do what I need?

What your device is, how it functions, and its size, all affect the testing requirements. Ask the lab about what their capacity is and if they've tested something similar to your product. If you will be selling your product in other countries, make sure they know what the differences in certification requirements are, and that they can perform all of the tests required.

### Do I need other certifications?

If you need other testing and certification done, like getting electrostatic discharge tolerance, or a CE mark (for "Conformité Européene" if you'll be selling in Europe), find out if the same lab can do all the testing for you.

### How much will it cost? What's the lead time?

Price can vary widely. I got two quotes for the same certification on the same system that had a 25% difference in price. As far as I could tell, the only difference was that one lab was in California.

When you request a quote, be sure you also ask about lead time. Smaller labs often have really great service, but get booked up months in advance. Make sure you'll have enough time to test and still get your product to market on schedule.

Where are they located? Can I be present for testing?

It's great to test someplace local, where you can be on hand in case something breaks or there's a question about how the device operates. I went to every moment of the test that I could, and I learned an insane amount. Policies vary by lab, so make sure you ask in advance.

## FINAL QUESTIONS TO ASK BEFORE YOU ACCEPT A QUOTE

If you're ready to get started, take a moment and get a couple final questions answered:

- Do they have a guide for the testing requirements? There should be specific guidance on the hardware setup for testing, such as power supplies and antennas. They may also need to put your system into a test mode, so be prepared to tweak the code in your microcontroller or software interface.

- Is it possible to do pre-screening? A pre-screen is a quick and dirty scan of the system emission, both powered and unpowered. It gives you a chance to see if there are unintentional radiators when a signal is transmitted from the system and if there's unexpected emission when the system is turned on. It's much cheaper than a full test and gives you a chance to fix any problems before you start the full certification process.

- Is there on-site mitigation help? If you do find a problem, you want to be working with someone who will help you figure it out. This is another reason that I learned so much by staying on-site during testing. From putting a ferrite bead on the board, or trying different shielding material, you want someone who knows what the options are and how they might affect the system you're testing.

- What is the filing process? There's a lot of paperwork involved. Make sure there's a clear process for who fills out what, what documentation you'll need to provide, and how the registration process is managed.

## FINAL THOUGHTS

With all the work that goes into a certification, you want to be sure your design is solid, and hopefully reusable in future products. A

great way to do this is use PCB software, like Altium Vault. Altium's Design Data Management tools to keep track of versions and components within your PCB design. Good documentation is key for successful testing, and being able to use your design again.

Contact an Altium representative to learn how unified PCB design tools can help create successful IoT product designs.

# ADDITIONAL RESOURCES

Thank you for reading The Advanced PCB Designer's IoT Resource Bundle. To read more Altium resources, visit the Altium resource center here or join the discussion at the bottom of each original blog post:

- http://resources.altium.com/altium-blog/flexible-pcbs-and-the-internet-of-things-how-the-landscape-of-pcb-design-is-rapidly-changing
- http://resources.altium.com/altium-blog/flexible-future-the-industries-that-are-forcing-you-to-learn-rigid-flex-pcb-design
- http://resources.altium.com/altium-blog/design-techniques-to-help-you-keep-up-with-increasing-pcb-complexity
- http://resources.altium.com/altium-blog/choosing-the-best-communication-configuration-for-your-iot-device-network
- http://resources.altium.com/altium-blog/how-to-plan-for-fcc-certification-when-designing-pcbs-for-iot
- http://resources.altium.com/altium-blog/how-to-choose-a-test-lab-for-fcc-certification-of-your-iot-product
- http://www.iconnect007.com/index.php/article/104573/pcb-design-in-the-age-of-iot/104576/?skin=design