



# Radio Enabled Products using Radio Modules

**Using radio modules to enable connectivity of electronic and consumer products, for wireless communication and the IoT.**

**How to approach the Radio, EMC and Safety regulatory approvals for radio modules and equipment which contain radio modules.**

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Hello to you. Who am I writing to? Who would be reading this article? It's actually part of the problem with this topic; that many of the people who need this information are unaware that the topic actually applies to them. I meet people who tell me: "I don't need to know about radio module compliance or the Radio Equipment Directive (RED) because I just make this cool new IT gadget (for the home, car, clothing, etc.). It uses CE Marked modules to connect to a phone and uses GPS to know the location". Of course, they really do need to know, because they are now a manufacturer of radio equipment. Or, I hear: "I don't need to know about the FCC rules for radio testing because I bought a pre-certified radio module"; but again, that is another mistake.

In this article I will give an overview of the basic requirements for North America (the FCC for the USA and ISED for Canada); and also, the European Union (EU) and the Radio Equipment Directive (RED) or EMC Directive (EMCD).

Before we go any further, I want to say something critical to this topic, and to regulatory compliance in general. Anyone involved in getting equipment approved for use by meeting the regulatory requirements needs to learn to separate the topic of "testing" from "approvals". "Testing" (or other forms of technical assessment) is an engineering assessment or set of measurements, typically with the purpose of identifying whether a product can pass some technical limits or not. Often it is performed by a test lab and it could be used to determine if the hardware can pass or fail the test standard. "Approvals", on the other hand, is the administrative and legal process for getting the product authorized for sale, marketing, placing on the market, etc. Please keep that difference clear in your head at all times. Remember that "testing" and "approvals" are not the same thing.

A device may pass the tests in the standard, but it may not be authorized for use until the correct legal procedures have been followed. A product may appear to be legally authorized but may not pass the tests when taken to a measurement site or test lab. Sometimes a change to a product could require re-testing but not re-approval. Sometimes a change to a product could require re-approval but not re-testing. I hope you get the idea.



To really understand this topic of radio enabled equipment using radio modules, we need to begin by looking at the radio module itself and the compliance requirements for the radio module.

This is looking at the industry from the view of the radio module manufacturer. You may already be gazing out of the window in boredom if you do not actually make the radio module, but it is important for the installer to know the legal and technical status of the module they purchased. After that, we will look at the topic from the point of view of the installer.

I hope you are ready with an Americano coffee and maybe a snack, as we begin with North America because the requirements and the situation are most simple there. We will move on to the requirements for the EU later.

In North America, the FCC andISED Canada both require 'certification' for radio transmitters. Certification does not just mean it passed some tests. Certification is a formal procedure to register a product with the relevant national authority and provide them with the technical details of that product. For example, for the FCC the manufacturer would test their transmitter and then get it certified by a TCB, such that the FCC hold a technical file of the product, including all the test results. The same applies with ISED Canada. The FCC ID or ISED certification number on a radio transmitter relates directly to the certification filing for that product, held by the FCC and ISED.

Certification applies to most transmitters, but it is possible to get a special type of certification which is specific to radio modules intended to be installed into other equipment; known as "modular approval".

It is not mandatory for the module manufacturer to get their module certified for USA and Canada; therefore, modules can be sold to installers with certification, or without certification. It is also possible to certify a module as just any other normal radio transmitter, without the 'modular approval'; but then it would only be certified for use as a radio on its own, which is not the intention of most module manufacturers.

So, the FCC and ISED have an established and mature 'modular approvals' process. It is a special type of certification that allows the certification of the radio transmitter module to remain valid, even after the module is installed into a host. A transmitter certified without this 'modular approval' process cannot keep its certification when installed inside a host, in most cases.

This 'modular approval' therefore gives the transmitter 'super-powers' in compliance terms, and there are additional requirements associated with that. The radio module must pass all the tests associated with the transmitter (for example, if it is a Bluetooth module, it must pass the Bluetooth tests); but also, there are other requirements specific only to the modular approval. The radio module must meet a set of important criteria. You should check FCC §15.212 and ISED RSP-100 issue 12 section 8 for the details; but in general the radio module must have a shield over its transmitter section (to help reduce coupling of signals between the module and host), it must have a form of voltage regulation (such that the final transmitter section of the module will see the same voltage, regardless of the supply from the host), it must be tested stand-alone (ideally on the end of a length of cable, but a test jig can be used if the module manufacturer can ensure the jig does not affect the testing), the module manufacturer must have control over the antenna used with their module, the module must be labelled with its own FCC ID and ISED certification number, etc.



Of course, these items do not provide a guarantee that the radio module transmitter will continue to pass all the tests when installed in the host product. You might ask me why the module must have these things, if they do not provide a guarantee that the module will continue to pass the tests when installed into the host? Well, as an engineer, I could note that the use of a shield, voltage regulator and fixed antenna do provide a good level of confidence that interference between the module and the host product are minimized; but there are never any guarantees. And, from a legal point of view, it's in the rules, so that's that.

So, the radio module manufacturer tests their module, in a stand-alone configuration, then certifies it as a radio transmitter and also as a radio module, with 'modular approval' written on the FCC Grant and ISED certificate. It can then be used in any host, for any condition (within a few conditions of use parameters, mostly associated with RF exposure compliance).

If the radio module does not meet all those regulatory requirements, such as it does not have a shield, or does not have voltage regulation, or was not tested stand-alone; then it is possible to get a 'limited modular approval' certification of the module, whereby the module is tested and certified with the host it is intended to be used with, and the 'limited modular approval' (LMA) applies to the module with the host identified at the time of certification. This would allow the certification of the LMA module certification to remain valid when used within that host, or other hosts sharing the same conditions.

When we look at the two sides of our compliance challenge, the testing and the authorization, we can see that the radio module with 'modular approval' passes the EMC and radio tests when tested alone, and also the certification means that the TCB has reviewed the file and uploaded it to the FCC and ISED. The radio module therefore has an FCC ID and an ISED certification number, associated with the technical files held by the FCC and ISED.

There is something which often confuses people about modular approvals, and that is the text on the FCC Grant. Most FCC Grants have a rather confusing statement which says: "Must not be co-located with any other transmitter" or "Must not be used within 20 cm of a person". What this really means is that the radio module manufacturer did not perform an assessment of what could happen when the module is installed next to another transmitter, or used in close proximity to a body. This is not a failing by the module manufacturer; they simply did not do that co-location assessment because they don't know where it will be installed, or what other transmitters could exist in the final product. Actually, that note on the FCC Grant does not mean "cannot" or "must not" and those terms are very misleading. The text on the FCC Grant basically means; "if you want to co-locate it with another transmitter that is transmitting at the same time, or put it close to the body, you're going to need to get that checked out, and it is important". It does not really mean "Cannot do it"; it actually means "Cannot do it, without some additional effort". A better Grant note would be "Co-location of this transmitter with another transmitter would require the use of FCC multi-transmitter product procedures"; and you will see that type of note on many modular Grants these days. It's a bit like saying "This hasn't been assessed for co-location (and simultaneous transmission) with another transmitter yet; so, if you want to combine this module with another transmitter which is transmitting at the same time, you are going to need to buy a calculator to sum some vales, and also consider that mode when you're at the test lab checking your emissions".



I want to point out that one of the most important documents for certification of a radio module is not actually the module's test report. The test report is important of course and will be reviewed carefully by the TCB; but perhaps more important is the installation instructions of the module. The module is specifically certified with this 'modular approval' process, for the intention of installation into other devices. The installation instructions to the company installing the module are really critical here.

In particular, with regard to the antenna. The installation instructions of the module must make it very clear to the installer, which antenna(s) they can use. In the case of the modules which provide only an RF pin or solder pad for an antenna path which will be built into the host's board, the precise design of the antenna path must be clearly detailed in the installation instructions; including copper track widths, track corner angles, layout, etc. It's a lot more than just "use an antenna with x dBi gain".

This is perhaps a good time to point out that FCC and ISED approvals only really deal with the output or emissions of devices. Testing for the USA and Canada consists of transmitter output performance, EMC spurious emissions and the risks of RF exposure from the transmitter. With a few rare exceptions, such as the Dynamic Frequency Selection (DFS) testing of 5 GHz WiFi, all tests are based on outputs from the transmitter and digital circuitry.

Now we look at the world from the point of view of the company installing that radio module into their host product, to sell to North America. Arguably, it is the more difficult role. Many installers think that all the work has already been done for them and they can just install the module and relax.

It is true that the installer typically has less testing to do and can completely avoid the legal aspect of certification, so there is a benefit to using a good, certified, radio module. However, the installer also has decisions to make and inherits some responsibility for the overall technical compliance.

Remember that there is a difference between testing compliance and authorisation!

The manufacturer of the final product will take the radio module, install it into their device (let's call it the host device) and therefore create a new product, which we shall call the final radio product. Until this point, their host was perhaps not even a radio product at all and maybe they just applied FCC Part 15 subpart B; with testing to §15.107 and §15.109, and an appropriate ISED standard, such as ICES-003. Most likely they use the supplier's Declaration of Conformity (sDoC) authorization route for their host product. Now they have installed the radio module and they can still apply the sDoC for the general electronics of their device, known as the unintentional radiator part, but they cannot ignore the fact that it now also contains a radio transmitter. Let's start by looking at the legal equipment authorization requirements.

The module is a transmitter and must be certified, such that the details of the transmitter are reviewed by a TCB and then uploaded to the FCC and ISED. Well, the good news here is that the radio module manufacturer already did that! They already supplied all those circuit diagrams, parts lists, labels, test reports and installation instructions to the TCB, who in turn uploaded them to the FCC and ISED.



The radio module manufacturer did all that work, so it is most likely that the installer does not need to certify the transmitter part of the final radio product. The modular approval process therefore reduces or eliminates the requirements for the installer to certify the radio part of their new, final radio product. If the radio module's label cannot be seen in the final radio product, the installer must mark their product to indicate that the module is installed, by putting the text "Contains FCC ID: XXXXX" and "Contains IC: YYYY-YYY" on the label of their product, where XXXX is the FCC ID of the radio module and YYYY-YYY is the ISED certification number of the radio module. Remember, the final radio product is not certified at this point; it is the radio module that is certified, and remains certified when installed into the host. Depending on what else exists within the host product, most likely the final radio product does not require certification at all.

There is no limit to the number of modules an installer can include in a final radio product, and therefore you could have multiple "Contains FCC ID: XXXXX" statements, written many times, referencing multiple module FCC IDs. If the host does require certification for some reason, you could have the final radio product certified with its own FCC ID and ISED Certification number; and additionally, the "Contains:" statement for the pre-certified radio module.

That's the regulatory approval of the transmitter taken care of, but what about the technical testing? The installer, or manufacturer of the final radio product, is responsible for ensuring that the final radio product does meet all the technical requirements for that type of product, which is also now a radio transmitted, based on the installation of the radio module. Simply put; modular approval means that the installer does not need to certify the radio transmitter hardware, but it does not mean that the installer does not need to test the radio transmitter performance and transmitter emissions of their final radio product.

Firstly, the inclusion of the radio module may have affected the testing of the digital device or general electronics of the host product. This refers to the emissions of the product when operating as an unintentional radiator, with the transmitter off. Let's say you have a host with a clock frequency of 30 MHz, which means you have historically been performing your §15.109 emissions testing up to 1 GHz for your Part 15 subpart B sDoC, in accordance with §15.33(b). Now you install a Bluetooth or 2.4 GHz WiFi module into your device, so now you have a signal at 2.4 GHz in your device. This even needs to be considered when your product is not transmitting, or your unintentional emissions, which means you now must perform your §15.109 emissions testing up to  $\geq 12.4$  GHz for your Part 15 subpart B sDoC.

Secondly, you need to understand what you have done with regard to the radio transmitter performance of your final radio product. Sure, we know the radio module passed the tests when it was stand-alone or on a test jig, but those results do not represent the compliance of the final radio product. We have no way to predict if the combination of module and host will pass or fail the tests, and you may be surprised to learn that a very high number of installations do actually fail the tests at first, until the installer fixes them. Installers may need to re-work how they install their module until the final radio product is passing the FCC and ISED transmitter tests. Therefore, the installer is responsible for checking the transmitter tests on their final radio product. I am not saying you must fully perform every radio transmitter test. I would say that some test cases are unlikely to change if the module has been installed correctly without modification; such as signal bandwidth, duty cycle, hopping requirements, etc. However, the output power or e.i.r.p. and spurious emissions are really unknown until the manufacturer of the final radio product does their own measurements.



There's often someone who will optimistically say that the enclosure of the host product should provide shielding to any radio signals from the module, and that if the module passed the output power and emissions tests while on a jig or stand-alone, then the emissions and output power would only be lower when installed in the host. However, attending a simple radio class or spending any time in a test lab will teach you that the host could shield the signals from the module, or could direct and re-radiate the signals from the module, or signals could couple from the module such that they become signals from the host, or create new signals by mixing with signals already in the host, or some other thing which nobody quite expected.

If I could accurately predict EMC test results without making any measurements, I would be writing my memoirs from a warm beach, not writing a technical article for you from my office.

So, you should be confident that the final radio product does pass the tests and most likely that means some measurements at a test lab; such as an e.i.r.p. measurement and a check of the spurious emissions. Due to the inclusion of the radio module, the final product is now a radio transmitter or intentional radiator, so your spurious emissions investigation would be performed up to the frequencies specified in §15.33(a) for unlicensed transmitters, or §2.1057 for licensed transmitters. In our example of a Bluetooth or 2.4 GHz WiFi, it means testing to  $\geq 24.8$  GHz for the transmitter emissions from the final radio product.

If you have installed multiple radio modules, or the final radio product contains multiple radio transmitters, and they could transmit at the same time, then they must be tested in that way. This is not a formalised test with clear instructions about how many modes and channels you must test. This is the installer's responsibility to test until they have established that the final radio product meets the technical requirements.

If it sounds like I have over simplified things so that you have a hope in reading this article before you retire, you would be correct. There are some cases with exceptions or deviations to what I have told you here. Let me give you some examples:

If the radio module is co-located with another transmitter and both can transmit at the same time in the same band, you need to check if the combined output powers exceed the total limit for that band, and the combined emissions pass the tests. If the radio module was certified for use at  $>20$  cm from a person (known as 'mobile') and you want to install it into a device used near the body (known as 'portable'), the radio module manufacturer will need to update their module certification for you.

If you use an antenna different to the one that was certified with the radio module, the radio module manufacturer will need to update their module certification for you. If the module is a solder down type with an RF pin or pad, and if you're not sure if your antenna path trace is identical to the one used on the test jig by the module manufacturer, then you need to check with the radio module manufacturer; and if they tell you that your trace layout is not within their parameters, the radio module manufacturer will need to update their module certification for you. ...and these are just a few of the most obvious examples.

When I talk about changes to the module certification, I mean a thing called a "Permissive Change", which is a change to a certification, which is permitted within the rules of the FCC and ISED. The radio module



certification is in the name of the radio module manufacturer, so it is their certification to change. Actually, as an alternative to the radio module manufacturer updating their own module certification for you, they could give you permission to put your own FCC ID and ISED certification number onto their module, through a process known as a “Change in ID” (FCC) and “Multiple Listing” (ISED). This allows the installer to take legal control of the module and make their own Permissive Change. The certification would still apply to the module only, not to the final radio product, but the module certification and legal responsibility would be in the name of the installer.

If the radio module is installed into a small wearable device which is used or held within 20cm of the person (known as ‘portable’) and requires a SAR test (a type of RF exposure test), the modular approval cannot be used and the whole final radio product needs to be tested and certified.

While we’re on the subject of legal control and responsibility, everyone always wants to know who is in trouble if market surveillance finds a non-compliant device. Not that you would ever consider marketing a risky product, of course.

As you can imagine, if market surveillance finds a radio module on the market and test it, and find it is non-compliant, the module manufacturer is in trouble.

But let’s say the market surveillance assess a final radio product, where the manufacturer has an electronic product with “Contains FCC ID: XXXXX” on the label, and the tests show that the combined product fails the FCC’s tests. Who is in trouble then?

Well, to start with, the eyes of the FCC’s enforcement officers will be on both manufacturers; the module manufacturer and the manufacturer of the final radio product. If the radio module is removed from the host and the module is found to pass on its own, but the final system fails, then the radio module manufacturer is no longer of interest to the market surveillance because their product was fine; and it is the installer (manufacturer of the final radio product) who is in trouble.

If the radio module is removed from the host and it turns out that the module fails when tested alone (perhaps because of problems in manufacturing by the module manufacturer), and also it causes the final radio product to fail; then both companies are in trouble because the module manufacturer is selling a non-compliant module and the installer should have noticed that the final radio product does not comply, before they marketed their final product.

The most common mistakes people make with this topic are at the two extremes. Some people say “We installed two radio modules and the Grant says we cannot co-locate it, therefore we must fully test and certify our device”. As you now know, that is not correct. Some people say “We installed a radio module and it is certified, so we do not need to do anything”. As you now know, that is also not correct. The answer lies between those two points.



Ok, pour away your cold coffee and brew yourself a nice hot cup of tea, as we journey across the Atlantic Ocean to the European Union (EU). The EU has Directives, such as the EMC Directive (EMCD) and Radio Equipment Directive (RED). These are trade related Directives but there are technical essential requirements for meeting them.

Have you remembered to keep your mind on the fact that there is a difference between “testing” and “approvals”? I do hope so.

Let us return to the world as viewed by the radio module manufacturer. I keep using the word “radio” and so we look to the Radio Equipment Directive (RED). After much searching, we realise there is no section on radio modules in the RED and there is no section for modular approvals. In fact, we realise there is no certification either! Everything is Declaration of Conformity (DoC) for the RED. The DoC applies to the final radio equipment, and the DoC is created (and signed) by the manufacturer of the final radio equipment, to cover everything within their product. The RED includes assessments of radio performance, EMC performance and product safety (including RF exposure) on any equipment that includes a radio function, transmitter or receiver.

Ok, so there are some exempt devices in the RED, but for economy of time let’s assume you have a very normal consumer or commercial radio equipment which is within scope of the RED.

There is nothing in the RED specific for radio modules, or radios intended for installation into other equipment; and therefore, a radio module is just like any other piece of radio equipment in the EU, assuming it provides the radio function. I acknowledge that some devices are just chips or components for use inside a radio and I’m not talking about those here. I’m talking about a radio module, which would provide a radio function when you complete it with an antenna, a power supply and instructions for communication or determination. You can read the RED if you’re not sure.

In the EU, if the radio module manufacturer has defined their module as radio equipment within scope of the RED, they must CE Mark it to the RED. They do not have the choice to provide it without authorisation, that we saw in North America. They are placing radio equipment on the market in the EU and it must be CE Marked; even if that market is exclusively business-to-business.

The module manufacturer assesses the radio module, which most likely includes testing, then they create their DoC, and CE Mark the module to the RED. You may know that there is a Notified Body role and that the Notified Body can issue a certificate called an EU Type Examination Certificate; but this is an examination certificate used by the manufacturer to support their DoC; it is not a certification or product approval.

We have already learned in this article that North America has transmitter performance and EMC emissions only, with RF exposure as the safety requirement. In the EU however, we have radio transmitter performance, radio receiver performance, EMC emissions, EMC immunity, product safety and RF exposure. The radio module must be assessed to all of these requirements by the module manufacturer, in just the same way that any other radio equipment would be assessed. They cannot leave part of the assessment of their device to the installer.



The module must be fully assessed and the module manufacturer cannot ignore the requirements.

There are no special assessment procedures for radio modules, and the requirement is intended to allow the module to be placed on the market as a radio equipment. There is no 'EU modular approval'. There are no requirements that a module must have a dedicated antenna or voltage regulation, etc.

There are no specific requirements for radios expected to be installed into other equipment.

The RED states that radio equipment shall be assessed for its intended use and intended environment, which is quite simple for most products, but not so simple for radio equipment which is expected to be installed into other products, and in fact the module manufacturer generally does not know which other products it will be installed into, or how it will be installed. For that reason, the most common solution by radio module manufacturers is that the radio module is assessed on a test jig or at the end of a length of cable, and then it is CE Marked as radio equipment, for use on that test jig or cable.

Any other installation condition is not covered in the CE Marking of the module, unless it was part of the assessment by the module manufacturer. CE Marking of the radio module is a declaration by the module manufacturer that the radio module complies with the RED, and the installation instructions and DoC document of the radio module should state the conditions in which it is compliant. The installer should be able to ascertain which antenna, test jig, temperature range, voltage range, software version, etc., was used by the module manufacturer and was therefore part of their assessment and CE Marking. This will help to guide the installer on how much work they will need to do later.

If the radio module has a Type Examination Certificate from a Notified Body, I would hope that level of information should be on the certificate; but it should be in the documents accompanying the radio module to any installer.

The CE Mark on the radio module does not guarantee that the final radio product will comply with the requirements when the module is installed into a host; in the same way that the FCC ID and ISED certification number also do not guarantee that the final radio product will comply with the technical testing aspects of the FCC rules or ISED standards when the module is installed.

I am not trying to say that a CE Mark on a radio module is a useless thing. In fact, radio module manufacturers put a lot of work into developing, testing and assessing their radio modules, to ensure that the market receives a high quality, compliant radio device. To see a CE Mark on a radio module is a sign that the module has passed the tests and has been assessed to the requirements of the RED. At the very least, the installer knows that it is capable of passing all the tests, in at least one condition.



Now we go back again to look at the world from the point of view of the company installing that radio module into their host product. Again, you have a role which includes difficulties and decisions.

As before, the manufacturer of the final product will take the radio module, install it into their device (the host) and therefore create a new final radio product. Until this point, their host was perhaps not even a radio product at all and maybe they had previously applied the EMCD and LVD for EMC and Safety. The host would most likely have appropriate EMC and Safety test standards applied to it. Now, with the inclusion of the radio module, the final radio product comes within scope of the RED; which means that the EMCD and LVD no longer apply to the equipment because EMC and Safety assessments are covered within the RED. The manufacturer of the final radio product takes full responsibility for the new radio equipment. They create their own DoC to the RED for their product, and put the CE Mark on their product.

You could say at this point that the radio module is effectively 'lost' and no longer exists as a piece of equipment itself. It is now part of a larger piece of equipment and is no longer a separate radio. This does not only apply to the things we typically imagine as modules, like a small device without any covers. It applies to any radio equipment (module or not), which is permanently installed into another piece of equipment, before the final product is placed on the market in the EU.

There was no certification of the radio module and there is no certification of the final radio product, so there is no certification to transfer from the module to the host. In North America, we said that the certification of the module could still exist after installation; but there is no certification in the EU for the RED, so there is nothing to remain valid. The radio module had a DoC by the module manufacturer when it was a radio equipment itself; and now the final radio equipment requires a DoC by the final radio equipment manufacturer.

If the radio module previously had a Notified Body EU Type Examination Certificate, that certificate would apply only to the module and would not be transferable to the final radio product, because they are really different products. If the radio technology requires a Notified Body EU Type Examination Certificate, then the final radio manufacturer will need to get that.

The manufacturer of the final radio product is responsible for fully assessing their equipment to all the essential requirements of the RED; which typically means all the applicable standards, plus anything else they may have identified in their risk assessment.

Product safety would always be assessed for the final radio equipment. Safety of the module was assessed for sitting on a test jig or cable; but now the new final product requires a safety assessment.

If the final radio product is for use at  $\geq 20$  cm from a person or transmits at less than 20 mW, it is possible that the manufacturer of the final radio product would choose to adopt the RF exposure assessment from the radio module.

EMC would also be assessed at the final radio equipment. The radio module was assessed for sitting on a test jig, or at the end of a cable; and only if the final radio equipment is identical to that, do the existing EMC results



apply. If we assume that the final radio equipment is not the previously used test jig, then we are not able to take the EMC testing of the radio module and somehow hope it applies to the final radio equipment.

Again, I imagine myself writing my book titled “how to predict EMC results accurately enough to provide legal evidence, without actually testing” while sipping a Mai Tai in Waikiki.

Most likely the host product may have some other features or modes, not associated with the radio operation, which may have their own EMC product standard, which should also be assessed.

Radio performance testing must be assessed at the final radio product; but the installer may decide that some of those radio tests do not need to be fully repeated, in much the same way as we saw with the FCC and ISED requirements. As we saw before, the installation into the final product could make the radiated radio and EMC performance better, or worse, or the same, or completely different.

Most likely, tests like duty cycle, frequency hopping, etc., would be unlikely to change if the module is installed correctly without any modification. However, the test cases where the change of enclosure could affect it, such as e.i.r.p., spurious emissions, receiver performance, etc., should be investigated; especially if the radio’s antenna is inside the host equipment. As before, the addition of a new type of antenna could affect the radio performance, especially in cases where the module has an RF pin and the antenna trace is part of the installer’s host equipment.

The manufacturer of the final radio product will, after all, be signing a DoC to state that their product does meet the requirements of all those standards.

Again, I have over simplified things for the purpose of getting you back to work quickly. I could, and regularly do, talk for hours or days on this subject.

To check back in with the subject of legal control and responsibility, everyone also wants to know who is in trouble if market surveillance in the EU finds a non-compliant device.

If market surveillance finds a radio module on the market and test it, and find it is non-compliant, the module manufacturer is in trouble.

If market surveillance finds a final product on the market and test it, and find it is non-compliant, the manufacturer of that final product is in trouble.

For both regions, the EU and North America, I am often asked for guidance on how much testing is required on a final radio product, when installing a radio module. Specifically, for those radio test cases like e.i.r.p., spurious emissions, receiver performance, etc., where the module was originally fully tested and now the installer must check it still passes. Must you test every modulation mode? Must you test three channels in every frequency band? Must every test be repeated?



I am sorry to tell you that there is not one answer to satisfy every situation, and it really must be considered on a case by case basis. Even one manufacturer installing different modules into similar models from their range of products, will need to assess each one separately and may find a different approach is needed in each case.

It helps significantly if you have access to the radio module's test reports, and for the FCC this is very easy because they are publicly available on the FCC's website. It also helps if you have expertise in reviewing test results, or if you know someone who can. But it's not a big problem if you don't.

I suspect in reality there are a few different approaches taking place around the world...

I suspect there are module installers who wish to minimise the amount of testing they do; and therefore, have EMC and Radio experts on call to help them interpret each new design. They could study the test reports of the radio module, to identify the channel, mode and modulations which gave the worst-case measurement results. They begin testing at a lab with some initial measurements of the channel and modulation which gave the highest result from the module, then review the new test results from the final radio equipment at each stage. If the test results look ok with comfortable compliance margins, maybe they write a technical justification for why they stopped testing and keep it on file. For the EU, this would go in their risk assessment in their technical documentation. In North America, the manufacturer would keep that evidence in their files. The benefit here is that the minimum amount of testing is performed and no unnecessary test time is wasted. The down side is that you have to employ someone who knows what they are doing and give them time to study the report, interpret the results, and be ready to go back to the lab for more testing if the compliance margins look small, and maybe another channel or mode needs to be tested. You also need a flexible test lab who can maybe help to interpret the test results, and be prepared to extend the test session if the results look close to the limit.

Meanwhile, I suspect there are module installers who do not want to spend money on EMC and Radio experts and don't want to spent time looking over test reports to make justifications. Maybe their test lab has one booking available and getting a second booking later could be difficult. Maybe the test is run by a technician using automated software; which is quick and may not allow for interpretation of partial testing. For those people, they might just say "Just stick it in the lab and test everything". They spend more time and money at the lab, but they spend less time and money in the office.

In reality, it comes down to the balance between cost, time to market, and of course integrity.

I'm sure there are other approaches taken by installers, but let's try not to think about that.

I hope I have not been the voice of doom here. Radio modules are a very popular solution to the problem of product manufacturers wanting a quick radio connectivity solution because their boss told them that IoT is important, without the headache of employing a radio design team. In my experience, radio modules allow manufacturers of typically non-radio products to have access to the latest expertise in radio communication. The FCC ID, ISED certification number and CE Mark are signs of compliance and they indicate a level of quality that installers desire.



It is important for installers to know that you have bought into a great solution for connected business in the 2020s! However, it may not be quite the 'plug it in and forget about it' approached you had assumed or hoped for.

Well, there we are. Somehow, I have used more than 7,000 words and yet only just begun to scratch the surface of this complicated but interesting topic. I have spent the last few years specialising in radio modules and their installation into host equipment, and I really could keep on writing more; but I suspect you have read enough. Your tea is cold and your cake is stale.

When I became a TCB and Notified Body, many years ago, most of the e-mails I received went like this:

"I have a Bluetooth transmitter, please certify it for the FCC and review it as a Notified Body".

Oh, I remember those easy days.

Now, the e-mails I receive go more like this: "I have a product, I installed pre-certified modules for Bluetooth, WiFi, and LTE. Each module is certified and has a CE Mark, so I don't think I need your help as a certification body and I think I have done everything I need; but could you please check my homework?"

My role at work has changed with the evolution of our industry, to meet the society and how we live our wirelessly connected lives in the 2020s. I wonder what the next decade will bring?

If you would like some help with the topic, you should know where to find me...

Michael Derby is a senior regulatory engineer and Director at ACB Europe Ltd., the European team of American Certification Body.

<https://acbcert.com/about-american-certification-body/certification-team-in-europe/>

Michael's role includes technical reviewer and certification body as a TCB for the FCC, FCB for ISED Canada, Notified Body for the RED and EMCD, RCB for Japan and RCB for Hong Kong.

He also spends a lot of time checking the compliance approach and approvals solutions of manufacturers who think they may not be radio manufacturers, but yet they bought a radio module and now they're not quite sure what to do about it.

In addition, Michael likes to get out of the office to give training presentations around the world because this gets him out of his comfort zone and gives him a chance to really share, and test his knowledge in a challenging environment.

Please get in touch for certification, support or training on radio and regulatory compliance topics.



## ACB Europe

Michael began his career in compliance in the late 1980s, when an ESD gun was a two-person lift and nobody knew what a radio module was. He then worked for a commercial EMC test lab in the UK, and a radio test lab in Silicon Valley, California, USA. He has worked for more than 12 years as a certification body and Notified Body, mixing the ingredients of manufacturing and testing into the strange soup of physics, engineering and law, that is EMC and radio compliance.

The first training presentation he gave was many years ago, on the topic of an exciting new concept called WiFi, to allow people access to the internet without wires. It is unknown if this crazy idea will ever catch on.

ACB's head office is in the USA, but Michael reviews radio equipment files, prepares training slides and checks peoples' compliance homework from his office in Winchester, Hampshire, UK.

The content of this article represents the requirements at the time of writing; May 2020.



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