



**Federal Communications Commission
Office of Engineering and Technology
Laboratory Division**

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**MODULAR TRANSMITTER INTEGRATION GUIDE—
GUIDANCE FOR HOST PRODUCT MANUFACTURERS**

1.0 INTRODUCTION

Many modern products are taking advantage of wireless transmitter modules that have been FCC certified by a module manufacturer to demonstrate compliance with the FCC rules. Wireless modules today are integrated transmitter circuits that are imbedded in both simple and complex host products. When using certified transmitter modules, it is necessary for the host product manufacturer or host integrator to have a good understanding of RF engineering and electromagnetic compatibility (EMC) concepts and principles, and knowledge of FCC regulations.

Leveraging the certification of a modular transmitter has the advantage of reducing subsequent FCC filing requirements, but there are limitations on host product manufacturers in making modifications or changes to the modular transmitter and the types of antennas that can be used in final products. Host product manufacturers are responsible to follow the integration guidance and to perform a limited set of transmitter module verification testing, to ensure the end product is in compliance with the FCC rules. Also host product manufacturers are responsible for all additional equipment authorization and testing for technical requirements not covered by the module grant (e.g., unintentional radiator Part 15 Subpart B requirements, or transmitters used in the host that are not certified modules).

2.0 GENERAL GUIDANCE

It is strongly recommended that host product manufacturers using a certified modular transmitter address the following items:

- a) Account for all FCC compliance requirements, including those for digital circuitry (unintentional radiators) and transmitters. The host product manufacturer needs to also consider the FCC requirements for certified modular transmitter being used in the host product and maintain documentation on how the host product with the certified modular transmitter complies with the FCC rules.¹
- b) Review the integration instructions provided for the certified modular transmitter(s) and ensure that all the items are properly addressed.

¹ Most end products today are regulated under multiple FCC rules and may be authorized under different equipment authorization procedures. For example, an end product could be authorized under Parts 22, 24, and 27 for cellular frequencies, Part 15 for Wi-Fi and Bluetooth, using certified modules, and SDoC for the Part 15 digital circuitry (unintentional radiator) and receiver portions of the device.

If the modular transmitter is authorized as a limited module, for full compliance the integration instructions must be followed to ensure that the conditions that limited the original module grant are clearly addressed. If the instructions are inadequate, the integrator must work with the module grantee to address the issues.

- c) Confirm that the integration instructions for RF exposure requirements are followed for the host product. The integration instructions should provide instructions equivalent to one of the following:
 - i) The host product operating conditions must be such that there is a minimum separation distance of 20 cm (or possibly greater than 20 cm) between the antenna radiating structures and nearby persons. The host manufacturer is obligated to confirm the use conditions of the host product to ensure that the distance specified in the instructions is met. In this case the host product is classified as either a mobile device or a fixed device for RF exposure purposes; or
 - ii) The modular transmitter is authorized to be used in a specific type of host platform and installed such that it can be operated at closer than 20 cm to users or nearby persons. The modular transmitter may also be certified to be used with other specific certified modules which transmit simultaneously.² In this case the integration instructions will be very detailed about the specific host conditions and which modular transmitters may be used together. See KDB Publication 447498 for RF exposure compliance guidance.
- d) Obtain the required equipment authorization for the applicable unintentional radiator functions (Part 15 Subpart B) of the host product, and if required any additional testing and certification for any other included transmitters or devices not authorized as a certified modular transmitter.
- e) Perform testing on the product with the transmitter³ or transmitters operating to confirm that the host product meets the FCC requirements. This investigation of the final product can be done by spot checking emissions from the device while operating the host as a composite system (with all the transmitters operating simultaneously).⁴ This testing is performed with the host product configured in typical operational modes to check the fundamental-frequency and spurious emissions for compliance with all the applicable rules.
- f) Label the product appropriately; see [KDB Publication 784748](#).

If the integration instructions do not contain clear directions for limited modules or for RF exposure compliance, the host product manufacturer must contact the module manufacturer responsible for the FCC certification.

² Modules are typically tested in a stand-alone mode and thus the simultaneous transmission conditions must be evaluated by the integrator. Evaluating compliance for a host using certified modules and/or a stand-alone product requires: addressing EMC requirements specified in Section 2.947(f) for composite system testing and for simultaneous transmission.

³ Verifying a transmitter by testing for spurious emissions is necessary even if only one module is installed in the host.

⁴ A composite system is a device or product that incorporates one or multiple different transmitters and/or RF devices, each are operating under different FCC rules. For example, this may include a host product using one module certified under Section 15.247 integrated in an unintentional radiator device under Part 15 Subpart B.

If any of the preceding items are not resolved, a host product manufacturer has various options depending on the situation: (1) request that the module manufacturer file a Class II permissive change to address the issue; (2) the host product manufacturer can file a Change in FCC ID (new application) and then file a Class II permissive change; or (3) the host product manufacturer can file for their own approval (new FCC ID) either as a modular transmitter or for the entire host product. The latter approach is further described in KDB Publication 996369 D02.

3.0 HOST PRODUCT TESTING GUIDANCE

3.1 General

Testing of the host product with all the transmitters installed is recommended, to verify that the host product meets all the applicable FCC rules. The radio spectrum is to be investigated with all the transmitters in the final host product functioning to determine that no emissions exceed the highest limit permitted for any one individual transmitter as required by Section 2.947(f). A formal application for certification submission containing the results of this investigation is not required. The host manufacturer is responsible to ensure that when their product operates as intended it does not have any emissions present that are out of compliance that were not present when the transmitters were tested individually.⁵

The following provides general guidance and suggestions to host product manufacturers when installing a certified modular transmitter, on how they may verify the intentional radiator (transmitter) compliance of the composite-system end product.

- a) If the modular transmitter has been fully tested by the module grantee on the required number of channels, modulation types, and modes, it should not be necessary for the host installer to re-test all the available transmitter modes or settings. It is recommended that the host product manufacturer, installing the modular transmitter, perform some investigative measurements to confirm that the resulting composite system does not exceed the spurious emissions limits or band edge limits (e.g., where a different antenna may be causing additional emissions).
- b) The testing should check for emissions that may occur due to the intermixing of emissions with the other transmitters, digital circuitry, or due to physical properties of the host product (enclosure). This investigation is especially important when integrating multiple modular transmitters where the certification is based on testing each of them in a stand-alone configuration. *It is important to note that host product manufacturers should not assume that because the modular transmitter is certified that they do not have any responsibility for final product compliance.*
- c) If the investigation indicates a compliance concern the host product manufacturer is obligated to mitigate the issue. Host products using a modular transmitter are subject to all the applicable individual technical rules as well as to the general conditions of operation in Sections 15.5, 15.15, and 15.29 to not cause interference. The operator of the host product will be obligated to stop operating the device until the interference has been corrected.

3.2 Frequency spectrum to be investigated

For host products with certified modular transmitter, the frequency range of investigation of the composite system is specified by rule in Sections 15.33(a)(1) through (a)(3), or the range applicable to the

⁵ If the host product uses any transmitters that have not been FCC certified as modular transmitter, it is necessary to obtain the required certification for that transmitter.

digital device, as shown in Section 15.33(b)(1), whichever is the higher frequency range of investigation. Two examples are as follows.

- a) A host product with a clock frequency of 30 MHz and dual band Wi-Fi would require an investigation up to 10 times the 5.8 GHz operating frequency or around 60 GHz, or the lower value of 40 GHz as permitted by Section 15.33(a)(1). In this case the Wi-Fi fundamental frequency of the modular transmitter is the highest frequency used.
- b) A host product with a 13.56 MHz transmitter and a clock at 28 MHz would require an investigation range per the table in Section 15.33(b)(1): 1.705-108 MHz to 1 GHz. The highest investigation frequency is determined by Section 15.33(a)(1) through (a)(3), or per the table in Section 15.33(b)(1). In this case, the digital clock rate of the host product is the highest frequency used.

3.3 Operating the host product

When testing the host product, all the transmitters must be operating.⁶ The transmitters can be enabled by using publicly-available drivers and turned on, so the transmitters are active. In certain conditions it might be appropriate to use a technology-specific call box (test set) where accessory devices or drivers are not available.

When testing for emissions from the unintentional radiator, the transmitter shall be placed in the receive mode or idle mode, if possible. If receive mode only is not possible then, the radio shall be passive (preferred) and/or active scanning. In these cases, this would need to enable activity on the communication BUS (i.e., PCIe, SDIO, USB) to ensure the unintentional radiator circuitry is enabled. Testing laboratories may need to add attenuation or filters depending on the signal strength of any active beacons (if applicable) from the enabled radio(s). See ANSI C63.4, ANSI C63.10 and ANSI C63.26 for further general testing details.

3.4 Emission measurements

- a) Measure the fundamental and unwanted/spurious emissions with the modular transmitter(s) operating in a normal mode.
- b) Perform testing on unwanted (spurious) radiated emissions on the worst-case modulation and channel per frequency range as shown in original filing.
- c) Where the transmitter power is based on ERP/EIRP or field strength, the host product manufacturer should ensure that installation of the modular transmitter has not affected the modular transmitter ERP/EIRP or its field strength rating. It should not be necessary to re-test the transmitter output power of any modular transmitter which has been certified based on conducted power.
- d) When power is not listed on the FCC grant, it should be assumed that the limit is based on field strength and that information will be in the associated test report in the modular transmitter application. The host product manufacturer may want to create a matrix based on test results

⁶ When operating a host product, it may not be necessary to establish communication with another device if the module manufacturer has provided the means, special modes, or instructions that enables a transmitter to simulate or characterize a connection. Module manufactures would provide activation details in their integration instructions.

from original testing and compare that with the results of their own digital device testing to create a list of the parameters to test.

3.5 Antenna gain

- a) In cases where the modular transmitter is certified based on the conducted output power, a change in antenna gain is possible through a Class II permissive change by contacting the module grantee, or filing for a change in FCC ID,⁷ based on the new emissions testing. However, in cases where the modular transmitter is certified based on the ERP/EIRP or radiated field strength, it may not be possible to increase the antenna gain without a corresponding reduction in transmitter output conducted power.
- b) Perform testing on frequency bands where the antenna gain is highest, worst-case band-edges based on original filing, and only on frequency bands where the antenna gain is highest.
- c) For DFS master devices it may be necessary to update the detection threshold.

3.6 Common operational configurations

3.6.1 General

The following sections give some suggestions for common technology types on how the host product manufacturer may operate their product during such investigative measurements. In setting up the following configurations, if the pairing and call box options for testing does not work, then the host product manufacturer should coordinate with the module manufacturer for access to test mode software.

3.6.2 Bluetooth

The product under test is placed into a normal “paired” mode with another Bluetooth device, as per the normal intended use of the product. For example, data transfer, music playing, etc.

Alternatively, a Bluetooth test set may be used (although these may not allow full control of the BT module, i.e., power, channel, and data rate).

3.6.3 Wireless LAN

The product under test is set into a link/association with a partnering WLAN device, as per the normal intended use of the product. To ease testing, the product under test is set to transmit at a high duty cycle, such as by sending a file or streaming some media content.

Alternatively, a Wi-Fi test set may be used.

3.6.4 ZigBee

The product under test is placed into a normal ‘paired’ mode with another ZigBee device, as per the normal intended use of the product (for example, transferring data).

Alternatively, a ZigBee test set may be used.

⁷ See last paragraph in section 2.0 GENERAL GUIDANCE for host manufacturer’s options for making changes.

3.6.5 Cellular (e.g., 2G, 3G, 4G, 5G)

The product under test is placed into a call with a base station simulator to configure the user equipment (“UE”) in a known transmitter configuration. A base station simulator allows the UE to be configured to specific frequency bands, RF channels, and transmitter power levels. If a base station simulator is not available, it is possible to connect the UE to a commercial wireless service to provide a UE connection in either an OATS environment or by coupling the commercial service into an anechoic chamber to radiate the wireless coverage inside the controlled environment. The limitation of using a commercial service is the test setup may not be able to control the technology, RF channel, or frequency band and uplink activity; however, filters and attenuators may be used to control the uplink and downlink levels to provide some deliberate controls over the RF connection. This should be taken into consideration by the manufacturer when deciding if the test results are appropriate for the desired testing.

3.7 Summary

- a) The host product manufacturer should review the modular transmitter test reports; these are publicly available on the FCC website. For example, they will be able to see if the installation of the modular transmitter into the host has caused the transmitter emissions to degrade or remain unchanged. Also, it may be important to identify if the only emissions from the modular transmitter are harmonics of the transmitter. This may be useful in cases such as licensed cellular transmitters, where it may be necessary to test the device outdoors. Testing outdoors is challenging due to ambient emissions, but it may not be a problem when specifically checking cellular harmonic levels.
- b) The preceding test modes examples are provided as only suggestions for a simple way for the host product manufacturer to perform their investigative measurements. However, if the host product manufacturer finds during these investigative measurements that the transmitter emissions from their product are high and likely to exceed the limit, it may be necessary for the host product manufacturer to work with the module manufacturer to consider more thorough investigation and mitigation measures.
- c) Finally, if the host product manufacturer does find that the composite system (host product and modular transmitter) does exceed the spurious emissions or output power limit, it is the responsibility of the host product manufacturer not to market the product in the U.S. Where possible, the host manufacturer and module manufacturer should collaborate to ensure compliance.