



# vMaker Environment Sensor Theory of Operation and Technical description

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Models:

vMaker-18

vMaker-15

vMaker-03

Draft version – for FCC and CE evaluation

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## Meeting the FCC Part 15 requirements

### §15.212 Modular transmitters.

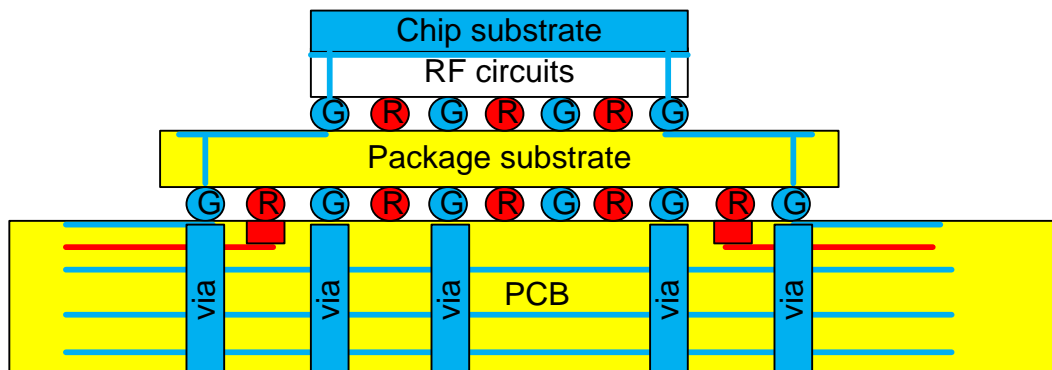
(a) Single modular transmitters consist of a completely self-contained radiofrequency transmitter device that is typically incorporated into another product, host or device. Split modular transmitters consist of two components: a radio front end with antenna (or radio devices) and a transmitter control element (or specific hardware on which the software that controls the radio operation resides). All single or split modular transmitters are approved with an antenna. All of the following requirements apply, except as provided in paragraph (b) of this section.

The vMaker products do not have a dedicated control hardware unit. vMaker products are single-board units that are used in conjunction with a hosting computer/laptop/tablet/smartphone, which run the controlling software driver, similarly to WiFi and similar adaptors. The vMaker board attaches to the hosting platform through a USB interface. Therefore, the unit is a **single modular transmitter**. The vMaker boards have on-board soldered antennas, and the units are approved with these antennas.

(1) Single modular transmitters must meet the following requirements to obtain a modular transmitter approval.

(i) The radio elements of the modular transmitter must have their own shielding. The physical crystal and tuning capacitors may be located external to the shielded radio elements.

The radio elements of vMaker are shielded in the following manner. The radio circuitry of vMaker is confined to the VYYR2401 RFIC SoC component. The VYYR2401 component is packaged in a “flip-chip” manner, meaning that all the RF circuitry is sandwiched between the package substrate’s ground layer and the chip’s ground layer and the conducting chip’s substrate. The two are interconnected through multiple ground bumps (much denser than the applicable wavelengths), creating effectively a Faraday cage to the RF components. Only the RF ports which are connected to the antennas leave this shielded region.



(ii) The modular transmitter must have buffered modulation/data inputs (if such inputs are provided) to ensure that the module will comply with part 15 requirements under conditions of

excessive data rates or over-modulation.

The data signals are buffered by the USB interconnection, and further by the data bus of VYYR2401 component. The modulation of radio signals is performed internally to the VYYR2401 and is not driven directly by the data inputs.

(iii) The modular transmitter must have its own power supply regulation.

vMaker has on-board voltage regulators (four TPS62065DSGR regulators)

(iv) The modular transmitter must comply with the antenna and transmission system requirements of §§15.203, 15.204(b) and 15.204(c). The antenna must either be permanently attached or employ a “unique” antenna coupler (at all connections between the module and the antenna, including the cable). The “professional installation” provision of §15.203 is not applicable to modules but can apply to limited modular approvals under paragraph (b) of this section.

Antennas are soldered (permanently attached) to the vMaker PCB.

(v) The modular transmitter must be tested in a stand-alone configuration, *i.e.*, the module must not be inside another device during testing for compliance with part 15 requirements. Unless the transmitter module will be battery powered, it must comply with the AC line conducted requirements found in §15.207. AC or DC power lines and data input/output lines connected to the module must not contain ferrites, unless they will be marketed with the module (see §15.27(a)). The length of these lines shall be the length typical of actual use or, if that length is unknown, at least 10 centimeters to insure that there is no coupling between the case of the module and supporting equipment. Any accessories, peripherals, or support equipment connected to the module during testing shall be unmodified and commercially available (see §15.31(i)).

vMaker receives its power supply through a USB cable from the hosting device or a battery pack.

(vi) The modular transmitter must be equipped with either a permanently affixed label or must be capable of electronically displaying its FCC identification number.

vMaker has a silk-screen printed FCC ID.

(A) If using a permanently affixed label, the modular transmitter must be labeled with its own FCC identification number, and, if the FCC identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: “Contains Transmitter Module FCC ID: XYZMODEL1” or “Contains FCC ID: XYZMODEL1.” Any similar wording that expresses the same meaning may be used. The Grantee may either provide such a label, an example of which must be included in the application for equipment authorization, or, must provide adequate instructions along with the module which explain this requirement. In the latter case, a copy of these instructions must be included in the application for equipment authorization.

The vMaker boards will all have a silk-screen printed FCC ID label on them. The manual will detail the location of the label on the board. The manual shall advise the users to affix a label saying “Contains FCC ID: 2AHIS-VMaker” if the vMaker is installed so that the on-board label is not visible.

(B) If the modular transmitter uses an electronic display of the FCC identification number, the information must be readily accessible and visible on the modular transmitter or on the device in which it is installed. If the module is installed inside another device, then the outside of the device into which the module is installed must display a label referring to the enclosed module. This exterior label can use wording such as the following: “Contains FCC certified transmitter module(s).” Any similar wording that expresses the same meaning may be used. The user manual must include instructions on how to access the electronic display. A copy of these instructions must be included in the application for equipment authorization.

The FCC ID will be written into the vMaker’s nonvolatile memory which can be read and displayed by the user application through the programming interface. The programming manual will detail the way to read out the FCC ID electronically

(vii) The modular transmitter must comply with any specific rules or operating requirements that ordinarily apply to a complete transmitter and the manufacturer must provide adequate instructions along with the module to explain any such requirements. A copy of these instructions must be included in the application for equipment authorization.

The User Manual shall contain instructions on locating the vMaker device and on installing and using the accompanying software as to meet the regulatory requirements.

(viii) The modular transmitter must comply with any applicable RF exposure requirements in its final configuration.

See the Part 15F and other related data in the rest report. The average transmit power of vMaker devices is far below the RF exposure threshold.

(2) Split modular transmitters must meet the requirements in paragraph (a)(1) of this section, excluding paragraphs (a)(1)(i) and (a)(1)(v), and the following additional requirements to obtain a modular transmitter approval.

To the best of our judgment the vMaker device is a single modular product. Nevertheless, the requirements are addressed below.

(i) Only the radio front end must be shielded. The physical crystal and tuning capacitors may be located external to the shielded radio elements. The interface between the split sections of the modular system must be digital with a minimum signaling amplitude of 150 mV peak-to-peak. The radio is shielded by the virtue of being confined to VYYR2401 RFIC. See (a)(1) for further explanation. The interface between split sections is USB interface, which has larger than 150 mV peak-to-peak signaling.

(ii) Control information and other data may be exchanged between the transmitter control elements and radio front end.

Control information and data are exchanged between the transmitter control elements (host device) and radio front end through an USB interface.

(iii) The sections of a split modular transmitter must be tested installed in a host device(s) similar to that which is representative of the platform(s) intended for use.

The vMaker device meets this requirement by being mounted externally to the hosting device with the antennas facing out, either as a bare board, or in a protective case made of thin

electromagnetically nearly transparent plastic sheet. The case has negligible effect on antenna pattern and gain.

(iv) Manufacturers must ensure that only transmitter control elements and radio front end components that have been approved together are capable of operating together. The transmitter module must not operate unless it has verified that the installed transmitter control elements and radio front end have been authorized together. Manufacturers may use means including, but not limited to, coding in hardware and electronic signatures in software to meet these requirements, and must describe the methods in their application for equipment authorization.

Vayyar supplies software drivers for communicating with and controlling vMaker boards. The software drivers ensure that the user controls the vMaker boards only through predefined APIs, and that the user does not access control and configuration of vMaker directly. The software driver reads out from vMaker's nonvolatile memory the permissible values and value ranges, and checks that the configuration requests through the API do not exceed these ranges.

(b) A limited modular approval may be granted for single or split modular transmitters that do not comply with all of the above requirements, e.g., shielding, minimum signaling amplitude, buffered modulation/data inputs, or power supply regulation, if the manufacturer can demonstrate by alternative means in the application for equipment authorization that the modular transmitter meets all the applicable part 15 requirements under the operating conditions in which the transmitter will be used. Limited modular approval also may be granted in those instances where compliance with RF exposure rules is demonstrated only for particular product configurations. The applicant for certification must state how control of the end product into which the module will be installed will be maintained such that full compliance of the end product is always ensured.

To the best of our judgment, vMaker meets all of the requirement for regular modular approval, and no limitations should be imposed.

### **§15.519 Technical requirements for hand held UWB systems.**

(a) UWB devices operating under the provisions of this section must be hand held, *i.e.*, they are relatively small devices that are primarily hand held while being operated and do not employ a fixed infrastructure.

The vMaker device is a smartphone-sized board, often used in conjunction with a smartphone as a hosting device, primarily in a handheld manner. See also response to (a)(2).

(1) A UWB device operating under the provisions of this section shall transmit only when it is sending information to an associated receiver. The UWB intentional radiator shall cease transmission within 10 seconds unless it receives an acknowledgement from the associated receiver that its transmission is being received. An acknowledgment of reception must continue to be received by the UWB intentional radiator at least every 10 seconds or the UWB device must cease transmitting.

The vMaker transmitter does not have a continuous transmission mode at all. The transmissions are invoked for performing a scan, one-at-a-time, by the application on the hosting device.

Whenever a scan is completed, vMaker ceases its transmission immediately, without waiting at all, until next scan is invoked, per applicative need, by the host.

(2) The use of antennas mounted on outdoor structures, e.g., antennas mounted on the outside of a building or on a telephone pole, or any fixed outdoors infrastructure is prohibited. Antennas may be mounted only on the hand held UWB device.

The User Manual shall contain a statement that when the vMaker device is used outdoors, it is prohibited to mount it on buildings, telephone poles or any other fixed infrastructure.

(3) UWB devices operating under the provisions of this section may operate indoors or outdoors.

(b) The UWB bandwidth of a device operating under the provisions of this section must be contained between 3100 MHz and 10,600 MHz.

See test report.

(c) The radiated emissions at or below 960 MHz from a device operating under the provisions of this section shall not exceed the emission levels in §15.209. The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz:

Frequency in MHz	EIRP in dBm
960-1610	-75.3
1610-1990	-63.3
1990-3100	-61.3
3100-10600	-41.3
Above 10600	-61.3

(d) In addition to the radiated emission limits specified in the table in paragraph (c) of this section, UWB transmitters operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of no less than 1 kHz:

Frequency in MHz	EIRP in dBm
1164-1240	-85.3
1559-1610	-85.3

(e) There is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency at which the highest radiated emission occurs,  $f_M$ . That limit is 0 dBm EIRP. It is acceptable to employ a different resolution bandwidth, and a correspondingly different peak emission limit, following the procedures described in §15.521.

See test report.

### §15.521 Technical requirements applicable to all UWB devices.

(a) UWB devices may not be employed for the operation of toys. Operation onboard an aircraft, a ship or a satellite is prohibited.

This requirement will be quoted in the User Manual

(b) Manufacturers and users are reminded of the provisions of §§15.203 and 15.204.

There are no antenna connectors; antennas are permanently attached.

(c) Emissions from digital circuitry used to enable the operation of the UWB transmitter shall comply with the limits in §15.209, rather than the limits specified in this subpart, provided it can be clearly demonstrated that those emissions from the UWB device are due solely to emissions from digital circuitry contained within the transmitter and that the emissions are not intended to be radiated from the transmitter's antenna. Emissions from associated digital devices, as defined in §15.3(k), e.g., emissions from digital circuitry used to control additional functions or capabilities other than the UWB transmission, are subject to the limits contained in Subpart B of this part.

See test report

(d) Within the tables in §§15.509, 15.511, 15.513, 15.515, 15.517, and 15.519, the tighter emission limit applies at the band edges. Radiated emission levels at and below 960 MHz are based on measurements employing a CISPR quasi-peak detector. Radiated emission levels above 960 MHz are based on RMS average measurements over a 1 MHz resolution bandwidth. The RMS average measurement is based on the use of a spectrum analyzer with a resolution bandwidth of 1 MHz, an RMS detector, and a 1 millisecond or less averaging time. Unless otherwise stated, if pulse gating is employed where the transmitter is quiescent for intervals that are long compared to the nominal pulse repetition interval, measurements shall be made with the pulse train gated on. Alternative measurement procedures may be considered by the Commission.

For testing vMaker, the transmissions will be invoked by the host device continuously, back-to-back.

(e) The frequency at which the highest radiated emission occurs,  $f_M$ , must be contained within the UWB bandwidth.

See test report

(f) Imaging systems may be employed only for the type of information exchange described in their specific definitions contained in §15.503. The detection of tags or the transfer of data or voice information is not permitted under the standards for imaging systems.

The vMaker device is licensed under the provisions of 15.519 “handheld devices” rules.

(g) When a peak measurement is required, it is acceptable to use a resolution bandwidth other than the 50 MHz specified in this subpart. This resolution bandwidth shall not be lower than 1 MHz or greater than 50 MHz, and the measurement shall be centered on the frequency at which the highest radiated emission occurs,  $f_m$ . If a resolution bandwidth other than 50 MHz is employed, the peak EIRP limit shall be  $20 \log (RBW/50)$  dBm where RBW is the resolution bandwidth in megahertz that is employed. This may be converted to a peak field strength level at 3 meters using  $E(\text{dBuV/m}) = P(\text{dBm EIRP}) + 95.2$ . If RBW is greater than 3 MHz, the application for certification filed with the Commission must contain a detailed description of the test procedure, calibration of the test setup, and the instrumentation employed in the testing.

The peak power measurement is tested with a 28 MHz RBW, by using a Rodhe-Schwartz ESU model EMI test receiver. The receiver was put in a max-hold mode while sweeping the entire 3.1-10.6 GHz band. The measurements were performed at 1 meter distance using the appropriate 104.7 dB correction factor. In view of the credibility of Rodhe-Schwartz equipment, and the ample margin of 11 dB achieved, we believe we fully meet the requirements of 15.519 in view of 15.521(g).

(h) The highest frequency employed in §15.33 to determine the frequency range over which radiated measurements are made shall be based on the center frequency,  $f_c$ , unless a higher frequency is generated within the UWB device. For measuring emission levels, the spectrum shall be investigated from the lowest frequency generated in the UWB transmitter, without going below 9 kHz, up to the frequency range shown in §15.33(a) or up to  $f_c + 3/(\text{pulse width in seconds})$ , whichever is higher. There is no requirement to measure emissions beyond 40 GHz provided  $f_c$  is less than 10 GHz; beyond 100 GHz if  $f_c$  is at or above 10 GHz and below 30 GHz; or beyond 200 GHz if  $f_c$  is at or above 30 GHz.

Tests are performed up to 40 GHz.

(i) The prohibition in §2.201(f) and 15.5(d) of this chapter against Class B (damped wave) emissions does not apply to UWB devices operating under this subpart.

(j) Responsible parties are reminded of the other standards and requirements cross referenced in §15.505, such as a limit on emissions conducted onto the AC power lines.