

## §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.

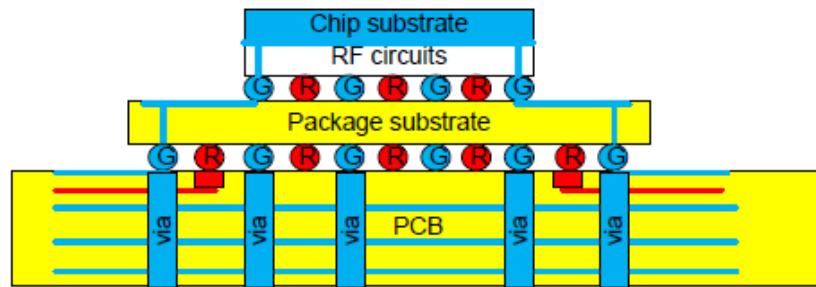
The vSense products do not have a dedicated control hardware unit. vSense products are single-board units that are used in conjunction with a hosting computer/laptop/tablet/smartphone, which run the controlling software driver, similarly to WiFi and similar adaptors. The vSense board attaches to the hosting platform through a USB interface. Therefore, the unit is a single modular transmitter. The vSense 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 vSense are shielded in the following manner. The radio circuitry of vSense is confined to the VYR2401 RFIC SoC component. The VYR2401 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.  
vSense 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 vSense PCB or embedded into it.

(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)).  
vSense 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.  
vSense 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 vSense 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-VSENSE" if the vSense 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 vSense'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 vSense 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 vSense 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 vSense 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.  
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.
- (ii) 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 vSense 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.
- (iii) 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 vSense boards. The software drivers ensure that the user controls the vSense boards only through predefined APIs, and that the user does not access control and configuration of vSense directly. The software driver reads out from vSense'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, vSense meets all of the requirements for regular modular approval, and no limitations should be imposed.