

Cubic Transportation Systems Limited
AFC House, Honeycrock Lane,
Salfords, Redhill, RH1 5LA, UK
+44 1737 782200 +44 1737 789756 (fax)
www.cts.cubic.com

RE FCC ID: LVCTR4

To the certification reviewer:

We are hereby applying for **limited** modular approval of the above-referenced FCC ID, based on compliance with the criteria (in bold) as detailed below (in plain text).

Sincerely,



Tom Vilhelmsen
Engineering Fellow

Part 15 Unlicensed Single Modular Transmitter Approval Justification per 15.212

(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.

(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 signalling 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

(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.

Parts of the RF circuit are not shielded, hence seeking limited modular approval.

The module consists of 3 boards:

1. Antenna board with the antenna coil for generating the RF H-field, the carrier frequency crystal oscillator and the NFC Controller Frontend IC (NXP PN5180) for controlling the transmitter, receiver and communicating with the microprocessor
2. Secure Board (the host to the Antenna Board), containing the security microprocessor (in addition to DDR and Flash Storage), serial communication to the Antenna Board (SPI Protocol) and the regulated power supplies (Of note the regulated 3V3 for the Antenna Board controller IC Host's Interface).
3. A non-secure Expansion Board, containing the serial communication circuits, power input connectors and the regulated power supplies (Of note the 5.17V regulated power supply for the antenna transmitter supply).

The 3 boards are stacked in the order listed above, with multi-pin interconnections.

- The Antenna Board contains the antenna coil (two turns, approx. 78 mm in diameter) and is completely covered by a shield, the centre of the PCB acts as a shield (grounded copper) for the receiver front end IC (commercial IC from NXP). The antenna coil is shielded by two grounded, horse shoe shaped patterns on the top of the PCB to increase the immunity from external E-fields and to reduce the conducted emissions at the operating frequency, and the back of the PCB is covered with Laird MHLL-000 0.2mm thick ferrite. Note, the PN5180 is not directly shielded on the underside of Antenna Board but shielding for this is provided by the ground planes mentioned on the next board that is directly underneath this, it is for this reason we request limited modular approval and specify that this area shall always be shielded by a ground plane by the connecting board underneath.
- The NFC frontend controller IC on the Antenna Board contains the transmitter, receiver, modulation and demodulation circuitry and all analog processing is integrated in the package, only digital signals are exposed to the Secure Board (host).
- The Secure Board has a continuous ground plane (on layers 1,3,4,6,9,11 and 14) to act as shield and path of least resistance
- The continuous ground planes on the non-secure expansion board also act as a shield for the Secure Board and Antenna Board.
- The ground connection between the non-secure expansion board and the Secure Board is made by multiple ground connections in the 120-pin connector and through 2 power pins on 4-pin power connector. The ground connection between the Secure Board and Antenna Board is made through multiple ground connections on the 40-pin connector on the centre of the board.
- The non-secure expansion board and Secure Board contain no RF circuits.
- The ferrite shield on the rear side of the Antenna Board also eliminates influence from nearby metal surfaces.

(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.

There is no direct connection from the outside to the modulation circuit. Modulation and demodulation occur on the NFC controller frontend IC. The NFC controller frontend IC on the Antenna Board receives commands and data packets (digital data) from the microprocessor on the Secure Board (host) and modulates the RF field accordingly. The NFC frontend controller IC is responsible for all analog processing and only digital signal lines are exposed from the frontend IC on the Antenna Board to the Secure Board (host).

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

For limited modular approval it is required that the Antenna Board is provided with a regulated 5.17V power supply for the transmitter circuit. The tolerance of this voltage must be within 3%. A nominal 3.3V (min. 2.7V – max 3.6V) power supply for the digital control logic must also be provided.

The TR4 module regulates the incoming power before feeding it to the transmitter and controller circuit. The TR4 module is designed to operate from input voltages from 8Vdc to 30Vdc. This voltage gets regulated to 5.17V on the non-secure expansion board for powering the transmitter circuit on the Antenna Board. This 5.17V is also regulated to 3.3V by the Secure Board for the digital control logic on the Antenna Board.

(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.

The antenna is connected to the Secure Board through a 40-pin miniature board to board connector. These boards are screwed in place and covered with tamper evident seals.

Note: For security purposes separation of the Antenna Board from the Secure Board will also trigger a tamper event (in the microprocessor on the Secure Board) rendering the TR4 module inoperable until the module has been returned to an approved workshop for inspection and restoration of the module's functionality. This restoration process cannot be performed remotely and is only possible in approved workshops.

(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 centimetres to ensure 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)).

The Antenna Board was tested with the Secure Board (host) and the non-secure expansion board which together form the TR4 device.

The Antenna Board does not require any additional shielding other than what is built with the Antenna Board as default i.e. the ferrite material on the underside. The Secure Board provides additional shielding to the underside of the Antenna Board by means of its continuous ground planes (on layers 1,3,4,6,9,11 and 14).

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

A label with the module's FCC ID number is permanently attached to the top of the Antenna Board.

If the module is integrated in a device, the device will be fitted with a label as specified in the user manual:

When the TR4 is installed into a device, such that the FCC ID number on the TR4 is not visible from the outside of the device, an additional label must be provided. This additional label must be placed on the outside of the device so as to be visible before installation of the device. This label must show the following wording:

"Contains FCC ID: LVCTR4"

This must be a permanent label that has a life expectancy at least equal to that of the life of the equipment to which it is attached. The text must be legible, with good contrast and a minimum of 8 point type size.

This is a mandatory legal requirement of the FCC. Failure to provide such marking invalidates the FCC's authorization for operation of the TR4.

(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.

Instructions are included in the user manual.

(viii) Radio frequency devices operating under the provisions of this part are subject to the radio frequency radiation exposure requirements specified in §§1.1307(b), 1.1310, 2.1091, and 2.1093 of this chapter, as appropriate. Applications for equipment authorization of modular transmitters under this section must contain a statement confirming compliance with these requirements. The modular transmitter must comply with any applicable RF exposure requirements in its final configuration. Technical information showing the basis for this statement must be submitted to the Commission upon request.

The module meets the RF exposure requirements and is within the limits set forth in *KDB 447498 D01 General RF Exposure Guidance v06*.

The module operates at 13.56MHz, where the absorption rate in the human body is very low.

The emitted magnetic field strength is also compliant with the world-wide ISO14443 and EMVco standards.