RR5207

Tri-Reader 4 (TR4)

User Manual

WBS: 21-3001.3825.2205

Document Number: 4400-46002

Revision: A

22 May 2020

Release Priority: Routine

Security Classification: Cubic Unrestricted

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Federal Communications Commission (FCC) Notice

The following Federal Communications Commission (FCC) notices apply:

1. The user is cautioned that changes or modifications to the Reader that are not expressly approved by Cubic could void the user's authority to operate this equipment.

2. "NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

   - Reorient or relocate the receiving antenna.

   - Increase the separation between the equipment and the receiver.

   - Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

   - Consult the dealer or an experienced radio/TV technician for help."

0 Preliminaries

0.1 Published By

Cubic Transportation Systems Limited, AFC House, Honeycrock Lane, Salfords, Surrey, UK, RH1 5LA

0.2 Approvals

| Checked & Approved

Document required on Engineers tablet?
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0.3 Document History

Rev.	Date	Author	Change Description Summary / DRM #
A	22-05-2020	C. Curtin	Initial Release

0.4 Detailed Reason for Change / Change Description for this Revision

This Revision (A): Initial Release

0.5 Internal Distribution

Name	Department	Name	Department

0.6 External Distribution

Name	Organisation	Name	Organisation

0.7 Bibliography

0.7.1 Glossary and Abbreviations / Acronyms

AFC	Automated fare collection
CSC	Contactless Smart Card
CTSL	Cubic Transportation Systems Limited
FCC	Federal Communications Commission
hot list	A list of smart cards, downloaded to revenue equipment, flagging the cards due to various types of misuse, loss, or failure to collect. Patron may be notified to replace card or card may be rejected at device or permanently disabled.
LED	light emitting diode
P2PE	Point-to-point encryption
PCI	Payment Card Industry
PIN	Personal Identification Number
POI	Point of Interaction
PTS	PIN Transaction Security
RF	Radio Frequency
RTD	Remote Ticketing Device
TfL	Transport for London
Vdc	Volts, direct current

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1 Introduction

The Cubic Transportation Systems, Ltd. (Cubic) TR4 serves as the front end for a remote ticketing device used for Automated Fare Collection (AFC) in public transportation systems (e.g., bus, rail, subway, etc.).

It can be used in ticket validators, ticket vending machines, gates, and other AFC equipment. This equipment can be on board vehicles or in fixed ground locations.

The TR4 will be responsible for direct communication with a contactless smart card (CSC), which is a type of radio frequency (RF) tag. The design caters for CSCs and devices (e.g. smartphones and smart watches that can provide the same functionality as a CSC following the specifications of ISO14443 Type A and Type B.

1.1 Requirement and Scope

This document provides an overview of Cubic's TR4's operation, including components and required regulatory notices.

1.2 Overview

Interpretation of the information stored on the CSC, as well as the processing of the revenue collection transaction, will be done by the TR4 itself, based on 'fare-tables' and 'hotlists' provided by the host computer.

The firmware on the TR4 is designed to be updated in-system using FLASH-based technology. It will therefore be possible to cater, within limits, for different CSC types and configurations—if required in the future.

The communication is as follows:

1. The TR4 will power the CSC (or the device's antenna) through radiation by an induced RF field.
2. By sequencing through the communication protocols for the different cards, it will detect the card type by checking for the associated response.
3. Once the card type and therefore its communication mechanism is known, the TR4 will read and write data on the card according to the fare rules in the fare-tables.
4. The TR4 will pass data to and from the CSC (or device) by using the appropriate protocol for modulation and demodulation of the signal.

2   TR4 Components

2.1   TR4 Antenna Type

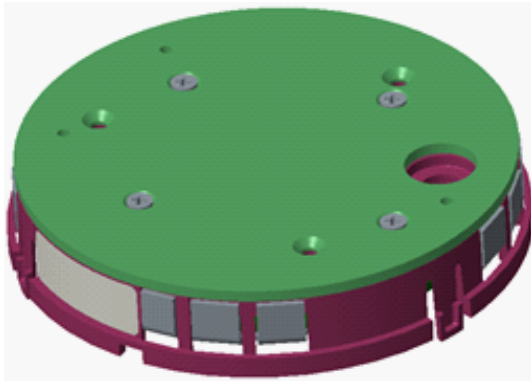The TR4 has a loop antenna with a diameter of 78 mm (shown in Figure 1).
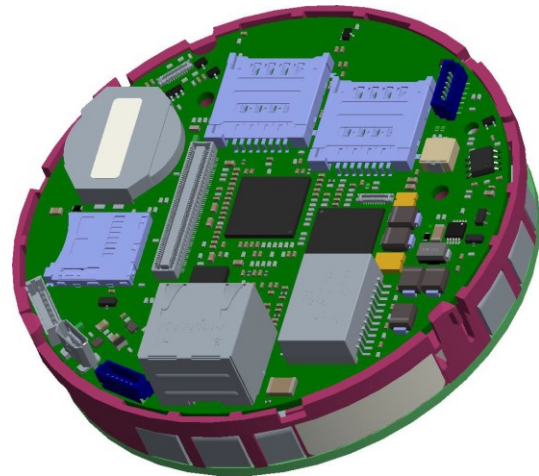

Figure 1: TR4 – Top – Antenna Board is Viewable

Figure 2: TR4 – Underside – Non-Secure Expansion Board Viewable

2.2   TR4 Interface to Host Unit

A shielded RJ45 connector connects the TR4 to the host unit using a 10/100 Base-T Ethernet link.

This is a data link and may be encrypted with P2PE (Point-to-Point encryption).

The TR4 will operate as a single Remote Ticketing Device (RTD).

2.3   RF Communication

All RF communication between the TR4 and the CSC will be accomplished at a carrier frequency of 13.56 MHz according to modulation/demodulation schemes for ISO 14443 Type A, ISO 14443 Type B.

At a minimum, the RF field will be able to power up to three CSCs in close proximity. The transmitter antenna is tuned to its resonance during production. The modulation/demodulation scheme will also be automatically selected by the local controller.

2.3.1   Modulation Types

The signals for communication between the TR4 and the CSC will differ between card types. In some cases, data will be modulated onto a carrier only, while in others a subcarrier will also be present. The modulation schemes used for communication also differ from one card type to another as described below:

CSC Type A: Reader-to-card, ASK 100% modified miller, 106 kb, 212 kb and 424 kb. Card-to-reader, ASK - Manchester, load modulation—subcarrier fc/16, 847.5 kHz, 106 kb, 212 kb and 424 kb.

CSC Type B: Reader-to-card, ASK 10% modulation index NRZ, 106 kb. Card-to-reader, BPSK-NRZ load modulation subcarrier fc/16, 847.5 kHz, 106 kb.

2.4   TR4 Printed Circuit Board Size

The module consists of 3 boards:

1. An Antenna Board, a circular board with a diameter of 83mm, containing the antenna coil (78mm diameter) and the NFC Controller Frontend IC
2. A Secure Board, a circular board with cut-outs and a diameter of 78mm containing the regulated power supplies and the security microprocessor that shall protect the module from tampering to PCI PTS POI 5.1 level of compliance.
3. A non-secure Expansion Board, with a diameter of 82mm, containing the serial communication circuits, power input connectors and the regulated power supplies.

The thickness of the TR4 module is 16 mm, except for the RJ45 connector which extends 13 mm above the components on the back of the non-secure Expansion Board, giving a maximum thickness of 29 mm.

2.5   TR4 Physical Interfaces

The following physical interfaces apply to the TR4:

1. The TR4 is powered from 8 to 30V_{DC}. It can require a maximum of 9.5W at start-up (or during intensive processing operations) and can consume 4.5W during normal operation, reducing to 2.2W if the product is idle. This power can be supplied through the 120-pin connector on the back of the non-secure Expansion Board.
2. Communication Interface – Ethernet 10/100 Base-T – Automatic negotiation

2.6   TR4 Security - PCI PTS POI 5.1

The TR4 has been assessed and found to be complaint to the Payment Card Industry, PIN Transaction Security, Point of Interaction v5.1 security standard; Approval number: 4-60223.

The TR4 contains a Secure Board, this will automatically and irrecoverably erase the encryption keys stored in the device upon the detection of attempted intrusion, tampering or disassembly. This shall render the TR4 inoperable and the module shall need to be sent back to Cubic's PCI approved facility for evaluation and re-commissioning of the module.

3 Notices

3.1   Federal Communications Commission (FCC) Notice

In addition to the FCC notice shown on Page 2, the following notices apply:

IMPORTANT FCC NOTICE

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.