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*User Manual*  
*for the*  
*Cubic Transportation Systems, Inc.*  
*Tri-Reader® 3*

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**CUBIC**

*For a world on the move™*

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**GO CARD<sup>®</sup>** is a registered trademark of Cubic Transportation Systems, Inc.

Tri-Reader<sup>®</sup> is a registered trademark of Cubic Transportation Systems, Inc.

### Federal Communications Commission Notices

The following Federal Communications Commission (FCC) notices apply:

1. The user is cautioned that changes or modifications to the Tri-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."

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## REVISION STATUS

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## 1. INTRODUCTION

The Cubic Transportation Systems, Inc. (Cubic) Tri-Reader<sup>®</sup> 3 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 Tri-Reader 3 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 at least three types of CSC, namely ISO14443 Type A, Type B, and **GO CARD<sup>®</sup>**.

### 1.1 PURPOSE AND SCOPE

This document provides an overview of Cubic's Tri-Reader 3 operation, including components and required Federal Communications Commission (FCC) 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 Tri-Reader 3 itself, based on faretables and hotlists provided by the host computer.

The firmware on the Tri-Reader 3 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 communications is as follows:

1. The Tri-Reader 3 will power the CSC 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 Tri-Reader 3 will read and write data on the card according to the fare rules in the faretables.
4. The Tri-Reader 3 will pass data to and from the CSC by using the appropriate protocol for modulation and demodulation of the signal.

### 1.3 ACRONYMS AND ABBREVIATIONS

AFC	automated fare collection
CSC	contactless smart card
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
RF	radio frequency
RTD	remote ticketing device
Vdc	Volts, direct current

## 2. TRI-READER COMPONENTS

### 2.1 TRI-READER 3 ANTENNA TYPE

The Tri-Reader 3 is a loop antenna with a diameter of 78 mm.

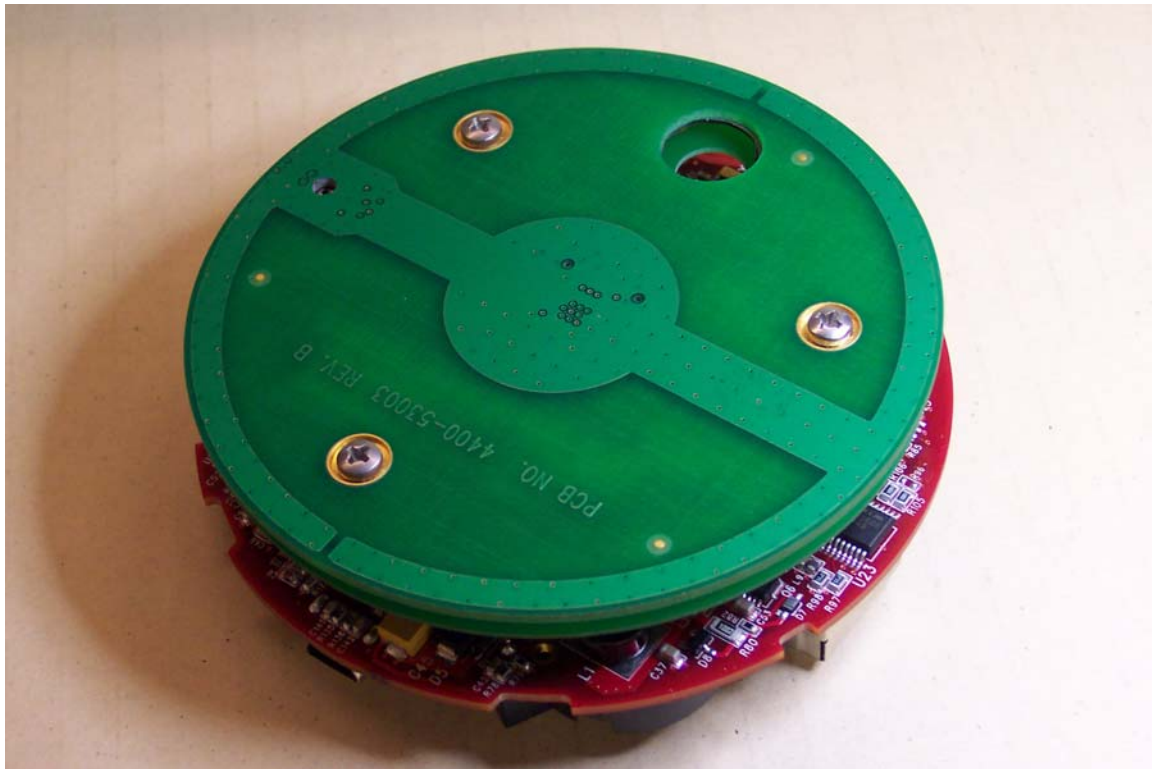


Figure 2-1. Tri-Reader 3 Antenna

### 2.2 TRI-READER 3 INTERFACE TO HOST UNIT

There will be a one-to-one (RS-422/RS-232) link between the Tri-Reader 3 and the host unit. The Tri-Reader 3 will operate as a single Remote Ticketing Device (RTD). A shielded RJ45 connector connects the Tri-Reader 3 to the host unit. This link is for the serial data.

### 2.3 RF COMMUNICATION

All RF communication between the Tri-Reader 3 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, and/or **GO CARD** requirements. 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 RF Field Strength

The magnetic field strength is approximately 9 A/m in the center of the antenna and falls off by the third power of the distance. The electric field strength is determined by the voltage applied to the coil as well as the efficiency of the antenna as a radiator. The effective applied voltage is approximately 12 Vrms, but the antenna is fitted with a balanced shield, reducing the apparent common mode voltage to 0.

### 2.3.2 Modulation Types

The signals for communication between the Tri-Reader 3 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  $f_c/16$ , 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  $f_c/16$ , 847.5 kHz, 106 kb.
- Type **GO CARD**: Reader-to-card, ASK 8% modulation index NRZ, 115.2 kb. Card-to-reader, ASK-NRZ load modulation, 115.2 kb.

## 2.4 TRI-READER 3 PRINTED CIRCUIT BOARD SIZE

The Tri-Reader 3 consists of an 86.5 mm diameter circular digital board, an 82 mm diameter circular analog controller board and an 83 mm diameter antenna board. Thickness, including components and antenna board, is 17 mm, except for the RJ45 connector which extends 10 mm above the components on the back of the board, giving a maximum thickness of 27 mm.

## 2.5 TRI-READER 3 PHYSICAL INTERFACES

The following physical interfaces apply to the Tri-Reader 3:

1. The Tri-Reader 3 is powered from 8 to 24 Vdc. It can draw a maximum current of 1.5A (at startup) and dissipates up to 2.8 watts. This can be supplied either via an expansion connector (J8) or it can be tapped from the host communication cable, in which case it will come in on the RJ45 serial comms connector (see the pinouts below).
2. The Tri-Reader 3 comms can be set to be either RS-232 or RS-422/485 levels. RS-232 mode is selected by software.
3. The Tri-Reader 3 has automatic baud rate detection between 9,600 bps and 921,600 bps.
4. If RS-232 is used, only two of the four comms lines on the RJ45 connector are required. Pin 2 on the RJ45 connector is the Tri-Reader 3 receive line (232Rx) and should be connected to the host computer Tx output (pin 3 on a normal DB9). Pin 6 on the RJ45 connector is the Tri-Reader 3 transmit (232Tx) line and should be connected to the host computer Rx input (pin 2 on a normal DB9).

5. If RS-422 or RS-485 is used, 485RxL must be taken to the host transmit low, 485RxH must be taken to the host transmit high, 485TxL must be taken to the host receive low, and 485TxH must be taken to the host receive high.
6. The Tri-Reader 3 has an onboard tri-color LED indicator. In addition to this it has a connector (J3) for interface to external LEDs. Table 2-1 provides the J3 pinouts.
7. The RJ45 communications connector is a shielded type that is mounted in the J5 position. It mates to any standard RJ45 cable connector. Table 2-2 provides the J5 pinouts.

Table 2-1. J3 Pinouts

Pin Number	Name	Description
1	V4p65	Supply voltage for external LEDs
2	GND	Power supply ground
3	EXTLED0	Open drain output for external LED
4	EXTLED1	Open drain output for external LED
5	EXTLED2	Open drain output for external LED
6	EXTLED3	Open drain output for external LED
7	GND	Power supply ground
8	+VBATEXT	Connection for external battery

Table 2-2. J5 Pinouts

Pin Number	Name	Description
1	485RxH	Tri-Reader 3 RS-422/RS-485 receive high
2	232Rx_485RxL	Tri-Reader 3 RS-232 receive or RS-422/RS-485 receive low
3	485TxH	Tri-Reader 3 RS-422/RS-485 transmit high
4	+VINPUT	Power supply input (8 to 24 Vdc)
5	GND	Power supply ground
6	232Tx_485TxL	Tri-Reader 3 RS-232 transmit or RS-422/RS-485 transmit low
7	+VINPUT	Power supply input (8 to 24 Vdc)
8	GND	Power supply ground

## 3. NOTICES

### 3.1 FEDERAL COMMUNICATIONS COMMISSION NOTICE

In addition to the FCC notice on the back of the title page, the following notices apply:

#### **IMPORTANT FCC NOTICE**

When the Tri-Reader 3 is installed into a device, such that the FCC ID number on the Tri-Reader 3 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: LVCTR03”

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 Tri-Reader 3.

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