



USER MANUAL

for the

Cubic Transportation Systems, Inc.

Tri-Reader 2

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Trademarks

Cubic[®] is a registered trademark of Cubic Corporation.

GO CARD[®] is a registered trademark of Cubic Transportation Systems, Inc.

Tri-Reader[®] is a registered trademark of Cubic Transportation Systems, Inc.

CHAPTER 1 **Cubic Tri-Reader 2**

1.1 **Introduction**

The Cubic Transportation Systems, Inc. (Cubic) Tri-Reader[®] 2 will serve as a front end for a remote ticketing device used for automatic 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 onboard vehicles or in fixed ground locations. The Tri-Reader 2 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 Type A, Type B, and **GO CARD[®]**.

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 2 itself, based on faretables and hot-lists provided by the host computer.

The firmware on the Tri-Reader 2 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 so required for the future.

In broad terms, the communication task will therefore proceed as follows:

1. The Tri-Reader 2 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 2 will read and write data on the card according to the fare rules in the faretables.
4. The Tri-Reader 2 will pass data to and from the CSC by using the appropriate protocol for modulation and demodulation of the signal.

1.2 Tri-Reader 2 Antenna Type

The Tri-Reader 2 is a loop antenna with a diameter of 78 mm.

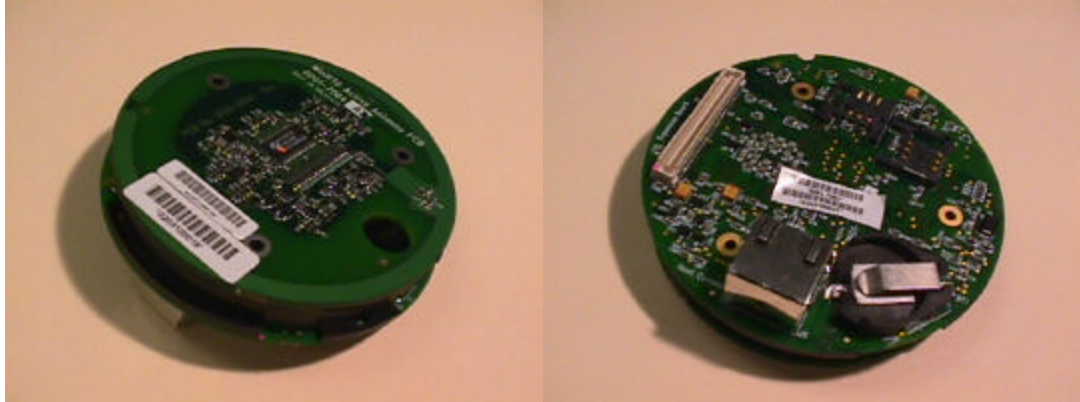


Figure 1. Tri-Reader 2 Antenna

1.3 Tri-Reader 2 Interface to Host Unit

There will be a one-to-one (RS422) link between the Tri-Reader 2 and the Host unit. The Tri-Reader 2 will operate as a single Remote Ticketing Device (RTD).

A shielded RJ45 connector connects the Tri-Reader 2 to the Host unit. This link is for the serial data.

1.4 RF Communication

All RF communication between the Tri-Reader 2 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 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.

1.4.1 RF Field Strength

The magnetic field strength is approximately 8 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 6 V_{rms}, but the antenna is fitted with a balanced shield, reducing the apparent common mode voltage to 0.

1.4.2 Modulation Types

The signals for communication between the Tri-Reader 2 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 kbit/s. Card-to-reader, ASK - Manchester, load modulation - subcarrier $f_c/16$, 847.5 kHz, 106 kbit/s.

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

Type **GO CARD**: Reader-to-card, ASK 8% modulation index NRZ, 115.2 kbit/s. Card-to-reader, ASK-NRZ load modulation, 115.2 kbit/s.

1.5 Tri-Reader 2 Printed Circuit Board Size

The Tri-Reader 2 consists of an 86.5 mm diameter circular digital 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.

1.6 Tri-Reader 2 Physical Interfaces

The following physical interfaces apply to the Tri-Reader 2:

1. The Tri-Reader 2 is powered from 5 to 28 Vdc. It can draw a maximum current of 1.5A (at startup) and dissipates up to 2 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 2 comms can be set to be either RS232 or RS422/485 levels. RS232 mode is selected by software.
3. The Tri-Reader 2 automatic baud rate detection between 9,600 bps and 921,600 bps.
4. If RS232 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 2 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 2 transmit (232Tx) line and should be connected to the host computer Rx input (pin 2 on a normal DB9).
5. If RS422 or RS485 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 2 has an onboard tri-color LED indicator.
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 1 provides the J5 pinouts.

Table 1. J5 Pinouts

| Pin Number | Name | Description |
|------------|--------------|--|
| 1 | 485RxH | Tri-Reader 2 RS422/RS485 Receive high. |
| 2 | 232Rx_485RxL | Tri-Reader 2 RS232 Receive or RS422/RS485 Receive low. |
| 3 | 485TxH | Tri-Reader 2 RS422/RS485 Transmit high. |
| 4 | 5_TO_28V | Power Supply Input (5 to 28 Vdc). |
| 5 | GND | Power Supply Ground. |
| 6 | 232Tx_485TxL | Tri-Reader 2 RS232 Transmit or RS422/RS485 Transmit low. |
| 7 | 5_TO_28V | Power Supply Input (5 to 28 Vdc). |
| 8 | GND | Power Supply Ground. |

1.7 Notices

1.7.1 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 2 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."

1.7.2 Industry Canada Notices

The following Industry Canada notices apply:

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device."