CUBIC
TRANSPORTATION SYSTEMS, INC.
A member of the Cubic Corporation family of companies

USER MANUAL

for the

Cubic Transportation Systems, Inc.

Tri-Reader™

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Proprietary Notice

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A.00	June 12, 2002	Initial release.
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Table of Contents

List of Figures

List of Tables

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GO CARD® is a registered trademark of Cubic Transportation Systems, Inc.
Tri-Reader™ is a trademark of Cubic Transportation Systems, Inc.

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CHAPTER 1 CTS Tri-Reader™

1.1 Introduction

The Cubic Transportation Systems, Inc. (CTS) Tri-Reader 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 will be responsible for direct communication with a Contactless Smart Card (CSC), which is a type of radio frequency (RF) tag. The naming refers to the fact that 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 not be done by the Tri-Reader itself, but rather by the central processing unit (CPU) to which it is a slave. Unsolicited messages will only be passed from the Tri-Reader to the CPU when the unit is told to search for and report any CSCs found to be present. Beyond establishing the card's presence and performing collision detection, the Tri-Reader will be a “dumb” data link between the CPU and the card.

The firmware on the Tri-Reader 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 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 will communicate the card type to the CPU.
4. The Tri-Reader will pass data to and from the CSC by using the appropriate protocol for modulation and demodulation of the signal.

1.2 Tri-Reader Antenna Type

The Tri-Reader is a loop antenna with a diameter of 75 mm.

1.3 Tri-Reader Interface to Central Processing Unit

There will be a one-to-one (RS422) link between the Tri-Reader and the CPU. They will operate as a single Remote Ticketing Device.

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

1.4 RF Communication

All RF communication between the Tri-Reader 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 will be self-tunable via software resident in the local control processor. The modulation/demodulation scheme will also be automatically selected by the local controller.

1.4.1 RF Field Strength

The magnetic field strength is 10 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 6 Vrms.

1.4.2 Modulation Types

The signals for communication between the Tri-Reader 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 fc/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 fc/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 Printed Circuit Board Size

The Tri-Reader is a 86.5 CPU x 86.5 CPU circular board. Thickness, including components and antenna, is 18 mm, except for the RJ45 connector which extends 10 mm above the components on the back of the board, giving a maximum thickness of 28 mm.

1.6 Tri-Reader Physical Interfaces

The following physical interfaces apply to the Tri-Reader:

1. The Tri-Reader is powered from 8 to 28 Vdc. It can draw a maximum current of 1.5A (at startup) and dissipates up to 5 Watts. This can be supplied either via an external power connector (J11) or it can be tapped from the CPU, in which case it will come in on the RJ45 serial comms connector (see the pinouts below).

2. The Tri-Reader comms can be set to be either RS232 or RS422/485 levels. RS232 mode is selected by soldering a 0 ohm resistor into the R35 location. Leaving R35 unpopulated selects RS422/485.

3. The 3-bit multi-drop unit ID (Unit_ID) of a Tri-Reader needs to be set if more than one Tri-Reader is to be multi-dropped to a single host computer. If it is unconnected, the unit ID defaults to 001b. Multi-dropping is only possible if RS485 is used. There are pull-up resistors on the Unit_ID lines, so only zeroes have to be driven/tied to a CMOS logic low level.

4. If the user desires to operate the Tri-Reader interface at 115,200 bps, the Unit_ID currently has to be set to 000b. Otherwise, the baud rate will be fixed at 921,600 bps.

5. 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 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 transmit (232Tx) line and should be connected to the host computer Rx input (pin 2 on a normal DB9).

6. If RS422 or RS485 is used, a one-to-one RJ45 cable to the CPU board can be used. Otherwise, 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.

7. The Tri-Reader has an onboard tri-color LED indicator, so the external buzzer and LED outputs are optional. The two external LED outputs are buffered copies of the lines that drive the onboard LED and can drive 100 mA and withstand 60V, so they can be used to drive relays if required.

8. The buzzer line is an unbuffered 5V CMOS level port pin of the onboard Micro. Both buzzer and LED operation is controlled by commands from the CPU board.

9. Resulting states for the external LED lines are listed in Table 1.

Table 1. External LED Line Resulting States

EXT_LED 0	EXT_LED1	LED Color
LO	LO	Off
LO	HI	Red
HI	LO	Green
HI	HI	Yellow

10. J11 is a Molex Micro-fit 10-way SMT top entry connector, 43045-1016 (available from Hamilton-Avnet). A 6-way connector is illustrated in Figure 1 to indicate the location of pin 1. Pin numbers alternate, so pin 2 will be on the opposite side of the connector to pin 1. Table 2 provides the J11 pinouts.

Six station version

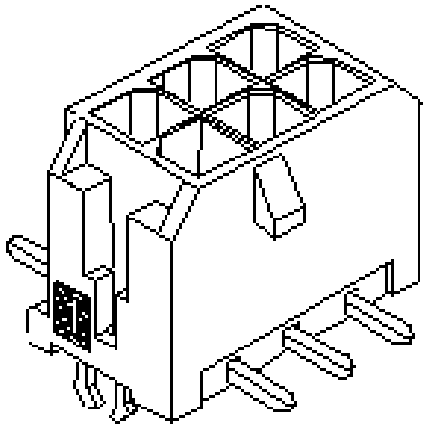

Figure 1. 6-way Connector

Table 2. J11 Pinouts

Pin Number	Name	Description
1	GND	Power Supply Ground
2	Unit_ID0	Multi-drop Unit ID bit 0
3	Unit_ID1	Multi-drop Unit ID bit 1
4	Unit_ID2	Multi-drop Unit ID bit 2
5	8_TO_28V	Power Supply Input (8 to 28 Volts DC)
6	GND	Ground (for Unit_ID)
7	Buzzer	Output for driving external buzzer
8	Ext_LED0	External LED drive bit 0
9	+5V*	5 volts output for external LED or buzzer
10	Ext_LED1	External LED drive bit 1

* This can also be an alternate power supply input.

11. The mating connector for J11 is a Molex Micro-fit 10-way cable plug, 43025-1000 (available from Hamilton-Avnet). An 8-way plug is illustrated in Figure 2. The cable crimp terminals for AWG20-24 wire have part number 43030-0008 if ordered in a bag and 43030-0002 if ordered on a reel.

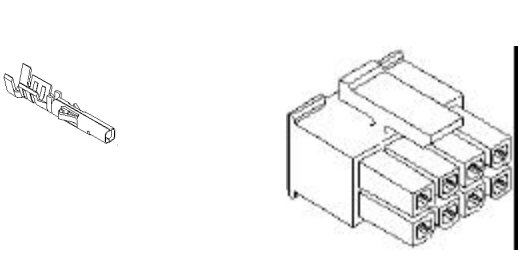

Figure 2. J11 Mating Connector

12. The RJ45 communications connector is a shielded type that is mounted in the J12 position. It mates to any standard RJ45 cable connector. Table 3 provides the J12 pinouts.

Table 3. J12 Pinouts

Pin Number	Name	Description
1	485RxL	Tri-Reader RS422/RS485 Receive low
2	232Rx_485RxH	Tri-Reader RS232 Receive or RS422/RS485 Receive high
3	485TxL	Tri-Reader RS422/RS485 Transmit low
4	8_TO_28V	Power Supply Input (8 to 28 Volts DC)
5	GND	Power Supply Ground
6	232Tx_485TxH	Tri-Reader RS232 Transmit or RS422/RS485 Transmit high
7	8_TO_28V	Power Supply Input (8 to 28 Volts DC)
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 that are not expressly approved by CTS 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 A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense."

1.7.2 Industry Canada Notices

The following Industry Canada notices apply:

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

Cet appareil numérique de la classe A 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."

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