User Manual

for the

Driver Control Unit Version 2

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CUBIC

For a world on the move™

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REVISION STATUS

(Template Revision Date: 01 Jun 05)

Revision	Date	Description
A.00		Initial release.

Author	Date	Lead Software Engineer	Date
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Mechanical Engineering	**Date**	**Electrical Engineering**	**Date**
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Technical Editor	**Date**	**Received by Configuration Management**	**Date**

Safety Instructions

1. Read these safety instructions carefully.
2. Keep this user manual for later reference.
3. Disconnect this equipment from AC/DC outlet before cleaning. Do not use liquid or spray detergents for cleaning.
4. For pluggable equipment, the power outlet shall be installed near the equipment and shall be easily accessible.
5. Keep this equipment away from humidity.
6. Put this equipment on a reliable surface during installation. Dropping it or letting it fall could cause damage.
7. Do not leave this equipment in an environment unconditioned where the storage temperature under -20°C (-4°F) or above 140°C (104°F), it may damage the equipment.
8. The openings on the enclosure are for air convection hence protects the equipment from overheating. DO NOT COVER THE OPENINGS.
9. Make sure the voltage of the power source is correct before connecting the equipment to the power outlet.
10. Place the power cord such a way that people can not step on it. Do not place anything over the power cord. The voltage and current rating of the cord should be greater than the voltage and current rating marked on the product.
11. All cautions and warnings on the equipment should be noted.
12. If the equipment is not used for long time, disconnect it from the power source to avoid being damaged by transient over-voltage.
13. Never pour any liquid into ventilation openings. This could cause fire or electrical shock.
14. Never open the equipment. For safety reasons, the equipment should be opened only by qualified service personnel.
15. If any of the following situations arises, get the equipment checked by service personnel:
    a. The power cord or plug is damaged.
    b. Liquid has penetrated into the equipment.
    c. The equipment has been exposed to moisture.
    d. The equipment does not work well or you cannot get it to work according to user manual.
    e. The equipment has been dropped and damaged.
    f. The equipment has obvious signs of breakage.
16. **CAUTION:** The computer is provided with a battery-powered real-time clock circuit. There is a danger of explosion if battery is incorrectly replaced. Replace only with same or equivalent type recommended by the manufacture. Discard used batteries according to the manufacturer's instructions.
17. This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions:

    (1) this device may not cause harmful interference, and
    (2) this device must accept any interference received, including interference that may cause undesired operation.
18. **CAUTION:** Always completely disconnect the power cord from your chassis whenever you work with the hardware. Do not make connections while the power is on. Sensitive electronic components can be damaged by sudden power surges.
19. **CAUTION:** Always ground yourself to remove any static charge before touching the motherboard, backplane, or add-on cards. Modern electronic devices are very sensitive to static electric charges. As a safety precaution, use a grounding wrist strap at all times. Place all electronic components on a static-dissipative surface or in a static-shielded bag when they are not in the chassis.
20. **CAUTION:** Any unverified component could cause unexpected damage. To ensure the correct installation, please always use the components (ex. screws) provided with the accessory box.
21. Caution text concerning lithium batteries:

ADVARSEL!
Lithiumbatteri - Eksplosionsfare ved fejlagtig håndtering.

1. UDSKIFTNING MÅ KUN SKE MED BATTERI AF SAMME

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1. INTRODUCTION

1.1 SCOPE

The purpose of this Cubic Transportation Systems, Inc., (Cubic) Design Information Bulletin (DIB) is to provide the mechanical and electrical design details of the Cubic Driver Control Unit Version 2 (DCU2). This document will be maintained by revision and updates as the design progresses. Specific references to suppliers may be changed for the final product configuration.

1.2 DEFINITIONS, ACRONYMS, AND ABBREVIATIONS

ABS	Acrylonitile Butadiene Styrene
AVL	Automatic Vehicle Location
CID	Card Interface Device
CPU	Central Processing Unit
Cubic	Cubic Transportation Systems, Inc.
DCB	Driver Control Board
DCU	Driver Control Unit
DIB	Design Information Bulletin
DRAM	Dynamic RAM
EIDE	Enhanced Integrated Device Electronics
EMC	Electromagnetic Compatibility
GPS	Global Positioning System
I/O	Input/Output
IEEE	Institute of Electrical and Electronic Engineers
IVLU	Intelligent Vehicle Control Unit
LCD	Liquid Crystal Display
LV	Light Validator
MTBR	Mean Time Between Failure
MTTR	Mean Time To Repair
PCB	Printed Circuit Board
PCMCIA	Personal Computer Memory Card International Association
POR	Power-on Reset
SBC	Single Board Computer
SICB	Smart I/O Control Board
SMA	Sub Miniature version A—a type of connector
SOM	System On Module
STN	Super Twist Nematic
USB	Universal Serial Bus
VGA	Video Graphic Array
WLAN	Wireless Local Area Network

2. GENERAL DESCRIPTION

The DCU2 serves as the intelligent controller for the on-board vehicle fare collection systems. It houses the control Printed Circuit Board (PCB) that provides the main processing function, wireless data transfer, and on-board interfaces to the Card Interface Device (CID). The DCU2 is also capable of interfacing to the Farebox, the Computer-Aided Design/Automatic Vehicle Location (CAD/AVL) system and the vehicle radio system. The DCU2 provides the driver display and selection buttons to facilitate seamless operation of on-board systems.

The DCU2 provides the primary interface between the bus system and the vehicle operator. It provides the mechanism for the driver to input information about the current location and destination (route or service and terminus point). The DCU2 also details information for ticket processing.

The DCU2 provides feedback to the driver by means of a Liquid Crystal Display (LCD) with Light Emitting Diode (LED) Backlight that is readable in both day and night lighting conditions.

Input from the driver is provided by an integrated keypad enabling fast and simple selection of the correct fare for the passenger in order to reduce the minimum dwell time at bus stops.

3. SPECIFICATION

A design with basic components that is configurable with different options to fit varying global market requirements. The general specification as follows:

- A design including basic components:
  - Sunlight readable color liquid crystal display (LCD)
  - Keypad
  - A central processing unit (CPU),
  - Dynamic random access memory (DRAM), Flash Memory, and Static Random Access Memory (SRAM)
  - One Universal Serial Bus (USB) interfaces
  - One Ethernet Port
  - Three Serial I/O Ports
  - External Connector panel (COM1-RS232(DB-9), USB,LAN (RJ-45), COM4-RS485 & COM2-RS422 (DB-9), GPS (SMA), PWR)
  - Stereo audio enunciator,
- A design providing optional software and hardware interface connectivity to internal devices such as:
  - A Wireless local area network (WLAN) Card via one USB port
  - A Global Positioning System (GPS) card via TTL serial com 3
  - Bluetooth
  - A design including Software and hardware interface direct connectivity to external devices such as
    - A GFI Farebox, via Serial port Com1
    - Light Validators (LV), via Serial port Com 2
    - A Passenger Interface Module (PIM) via USB and serial Com2
    - An optional Smart I/O unit (5500 08003) via USB, that is used as an I/O expansion to add additional serial and parallel ports to the DCU2. The DCU2 would able to interface with other serial communication (J1708) and input devices such as Intelligent Vehicle Control Unit (IVLU), punch input, emergency switch, door sensors, head sign, wheel lifts/ramps status through this or a similar Smart I/O Unit;
    - passenger counter via Serial port or Smart I/O
- A design meeting the environmental conditions aboard a bus;

- A design capable of withstanding irregular input dc power and providing a means of maintaining its operation without seriously disrupting the driver's operation.

- A design meeting various mounting and ergonomic requirements on or next to the driver dashboard;

- A design meeting the requirements for ease of software and hardware maintenance and unit replacement aboard buses;

- Faster installation and removal times than DCU1 but this will initially (if necessary) be accomplished via in line connector system

3.1 SPECIFICATION DETAIL

3.1.1 Electrical

Casework as DCU1 but option to provide mini USB via the bottom panel cutout
Keypad as DCU1 but with more granular backlighting & longer lasting keypad graphics
Power Supply as DCU1 but improved hold up time to 500 mSec
Improved Battery performance to support Real Time Clock, SRAM, & GPS for five years
4.7 inch diagonal ¼ VGA graphics LCD. Color Transflective STN 320 X240 (LED Backlight) with more granular backlighting than DCU1
ARM11 Freescale iMX31 Processor with sleep modes
256MB DDR SDRAM
256MB NAND Flash
256 KByte SRAM with battery backup
One 10/100 Ethernet LAN
One V2.0 USB Ports
RS232 and RS422/RS485 x 1 - all opto isolated
TTL Serial port - internal GPS
Internal 802.11b/g (WPA2) via USB, with internal strip antenna
Internal Ublox LEA-5S GPS module via TTL serial port, Antenna via SMA Connector
Internal SD Slot –for up to 2GB SD Card
Internal Bluetooth
Internal 2-ch Stereo Speakers
Operating temperature -20°C to +60 °C except LCD
Other Environmental, EMC, FCC

3.1.2 Mechanical

Captive screws on CTS back panel.
Dimension: 230mm(W) x 160mm(H) x 92mm (D)
Weight: 1,714 g

3.1.3 OS and Software Support

- CE Builder
- IMG Info

WinCE for v 5.0 Requirements:
- Complete WinCE 5.0 BSP
  - Include the following utilities

    - Registry Editor
    - Notepad
    - File Explorer
- WinCE 5.0 kernel image:
  The kernel image contain the latest drivers for
    - WiFi Card
        - WEP & WPA2
    - USB drivers
    - Cubic custom drivers
        - Smart I/O,
        - GPS
        - Hecon Printer
- Include support for Power Management via the following modes:
    - On - Device is actively used
    - Suspend - Device is suspended. In this state, the device on mode can be resumed via a key-press
    - Off - Device is off.
- Additional Software and/or documentation to install image onto the DCU2

4. COMPONENT DESCRIPTIONS

4.1 HOUSING

The DCU2 housing was made of a toughened high-impact plastic (ABS Polyac PA-765) suitable for the bus environment. The housing provides resistance to breakage by physical attack and resistance to internal damage due to liquid ingress. The housing is capable of withstanding heavy vibration without adverse effect. The external housing consists of two parts, the base and the cover.

The housing is designed to provide environmental protection including Electromagnetic Compatibility (EMC) protection and an IP54 water sealing.

The design of the case takes into the account the installation of an 802.11b/g WLAN internal antenna

The overall size of the DCU2 is 230 mm (W) × 160 mm (H) × 92 mm (D). A perspective view of the conceptual industrial design of the DCU2 is shown in Figure 1.

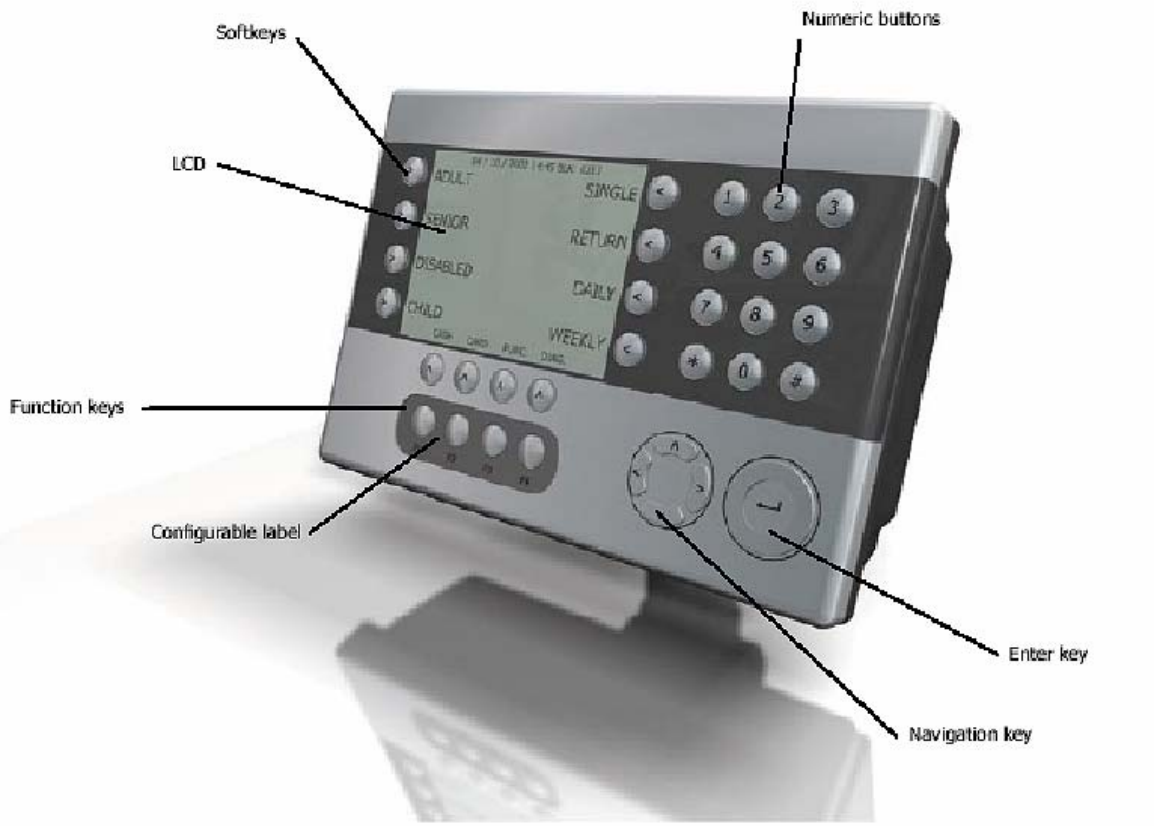


Figure 1. DCU2 Industrial Design

4.1.1 Mounting

The mounting is designed to withstand the shock and vibration requirements in the bus environment. A minimum of four M3 threaded mounting holes are required on the back cover of the DCU2 for mounting the assembly to the existing adjustable mounting bracket. The mounting holes are able to accommodate up to 6mm (0.236-in) length screws. The mounting allows some degree of 3-D adjustment such that drivers of various heights can view and operate the DCU2 In addition, the mounting is adjustable in order to move the LCD screen away from direct sunlight. Different mounting fixtures are used to mount the DCU2 to either the vehicle dashboard or to an existing mounting post in the bus. Site surveys of customer buses are typically used to determine the mounting approach.

4.1.1.1 Physical Security

The mounting of the DCU2 can be secured in place by security button head screws or accessories as a measure of theft prevention.
An additional in back panel design that allows for quick removal/install will be undertaken by Cubic.

4.2 DISPLAY

- The display is sunlight readable transflective 4.7-in diagonal color graphics LCD (resulting in a useable size of approximately 4-in × 3-in). The display provides full graphics screen capability and the resolution of the LCD is ¼ VGA with a 320 × 240 dot matrix.

- The screen is backlit with Light Emitting Diode (LED) and can be viewed across all normal lighting conditions, including day and night operation. The display has variable brightness backlighting and contrast level under software control capable of 128 levels of brightness.

4.3 KEYPAD

The keypad provides for the following 33 keys (see Figure 2):

- Twelve-key numeric keypad: 0 to 9, *, and # keys.

- Four direction keys: Left, Right, Up and Down arrow keys for menu navigation.

- One Large “Return Symbol” (↵) key.

- Twelve soft keys (1×4’s) located on the left, right, and bottom sides of the display, with arrow symbols.

- Four Function keys (1×4) located below the bottom soft keys. A replaceable polycarbonate backlit custom legend shall be located around the bottom set of function keys. The default custom legend shall have the following graphics: TRIP, MENU, CTRL and GPS (or RTT, PRTT, HOME, and T/A)

- The keys are designed to be fully water resistant. Graphics on keys are wear resistant and not rub off under normal use.

The ‘color’ on the DCU2 membrane keys shall last for 1,000,000 key presses without more than 10% degradation.
The DCU2 membrane keys are made of a material resistant to peeling.

- All keys shall be rated for a minimum of 1 million keystrokes. The reliability of the keypad shall meet the overall reliability of the DCU2.

- All keys and legends shall be LED backlit with the ability to turn the backlight on or off using software control with 16 levels of brightness.

- All keys shall be software configurable.
- Simple single key press detection is required. Multiple, simultaneous, key press operations are not required for normal operation
- All keys shall be as large as possible allowing for single selection using a gloved hand. The keys shall be spaced sufficiently apart to minimize inadvertent selection of adjacent buttons.

Figure 2. Keypad Layout

4.4 DCU2 ELECTRONIC DESIGN

The DCU2 hardware consists of the following main components.

- An Electronics Control Module
- A Power Supply Module
- Large backup battery (for RTC, SRAM, & GPS)
- A Keypad controller PCB
- A I/O Connector PCB (Configurable for different connector arrangements for future models)
- A color LCD with backlight
- A WLAN 802.11 b/g (WPA) card with antenna
- A GPS daughter card
- Mini-USB port that can be accessed via underside of the Housing
- Compact Flash

4.4.1 Operating System

The Microsoft® Windows CE operating system will be used with using version 5.0 or later.

4.4.1.1 Boot loader

Fast boot shall be less than 30 seconds

4.5 POWER SUPPLY MODULE

The DCU2 power supply module shall be designed to operate between 9 Vdc to 36 Vdc and shall include reverse polarity and over-voltage safety protection. Over voltage safety protection must withstand up to 120 Vdc without causing damage to the DCU2's internal circuitry. The power supply module shall regulate the bus-supplied voltage to eliminate power spikes and noise. The provisions taken shall eliminate electronic interference caused by fluorescent light power units, bus alternators, air conditioning units, radio communication units, and other sources that may be found in a bus-operating environment.

The power supply shall include a power hold-up time circuit to maintain operating power for at least 500 milliseconds when the DCU input voltage drops below 9 volts or rises above 36 volts. When the input dc voltage drops below 9 volts or rises above 36 volts, the keyboard PCB provides a warning interrupt signal to the SBC to conduct the orderly shutdown of the application.

The DCU2 does not have to be fully functional when the supply voltage is less than 9V, or more than 36V. When the input voltage is detected to be outside of this operating range, the DCU2 will conduct an orderly shutdown and remain in this shutdown condition while the voltage remains outside of the operating range. However, it is necessary for the DCU2 to automatically return to service when the voltage returns to within the operating range. For example, frequently the bus supply voltage will dip to a level between 9V and 5V for long periods overnight but will not necessarily drop to SBC reset voltage before rising again to the normal operating range. When this occurs, the DCU2 must sustain the voltage drop, and be able to restart automatically in the normal fashion after the input voltage has been restored to 9V or above.

4.6 INTERNAL OEM MODULES

The DCU2 shall be designed to accommodate the following OEM GPS module and the WLAN 802.11b/g adapter.
Internal OEM modules must support the following power modes: On, Idle, Suspend, and Off.

4.6.1 Option for future projects where backwards compatibility is not an issue. i.e. version DCU2 2b

- Sub D connectors replaced by quick connect 10 way connectors (e.g. RJ45 pins or Molex).

5. ENVIRONMENTAL AND AGENCY REQUIREMENTS

The DCU2 is designed to operate under the following conditions:

Electro-magnetic compatibility (EMC):	Immunity: EN61000-6-2 (2001) CE class B, ISO7637-2 Emissions: EN 61000-6-3 (2001) CE class B; e-marking; ISO7673-2; Electrical/electronic devices. This standard is applicable for equipment mounted on vehicles for the European market. Motor Vehicle EMC Directive 2004/104/EC; Annex I, Section 3.2.9.
Operating temperature:	-20 to +60 °C (–4 °F to 140 °F)
Storage temperature:	-30 to +80 °C (–22 °F to 176 °F).
Humidity:	15 to 95 percent Relative Humidity (RH), non-condensing.
Vibration:	MIL-STD 810 (latest revision), Method 514.3, category 8 modified.
Shock:	MIL-STD 810 (latest revision), Method 516-3, procedure I, 20 g, 11ms.
Moisture and Solids Resistance:	EN 60529 (1992) IP54
Flammability:	UL 94 V-0.

5.1 ELECTRIC SAFETY

The DCU2 is designed to meet UL and Œ requirements as well as EN60950. The DCU2 will be Œ certified and marked. UL testing will only be performed as required by customer contract.

6. RELIABILITY

- MTBF: 10,000 hours

7. CONNECTOR DETAILS

7.1 DCU 2A CONNECTIONS

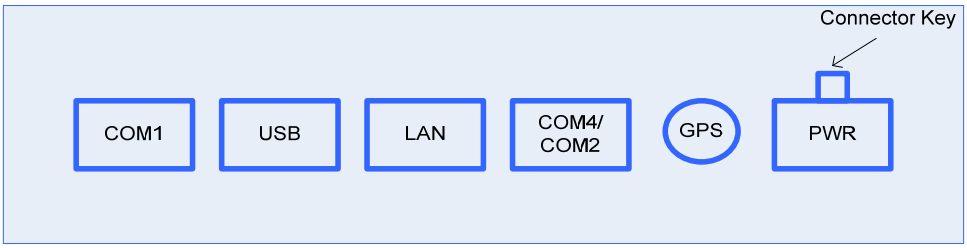


Table 1 Connector Panel for DCU2a

7.1.1 Diagram showing layout of DCU2a External Connector Pin outs

COM1 RS232 interface – DB9 connector

PIN	SIGNAL	PIN	SIGNAL
1	DCE	2	RX
3	TX	4	DTR
5	SG	6	DSR
7	RTS	8	CTS
9	RI		

USB Connectors

PIN	SIGNAL
1	VCCUSB
2	DATA0-
3	DATA0+
4	GND0
5	GND
6	GND

Ethernet Interface – RJ45 connector

PIN	SIGNAL	PIN	SIGNAL
1	TXDATA+	2	TXDATA-
3	RCVDATA+	4	
5		6	RCVDATA-
7		8	

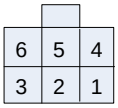
COM2 RS422/485 & COM4 RS485 Interface or COM2 RS422/485 & 12VDC Aux interface (manufacturing configurable) – DB9 connector

PIN	SIGNAL	PIN	SIGNAL
1	C2 485DATA-	2	C2 485DATA+
3	C2 422RX+	4	C2 422RX-
5	GND	6	
7	C4 485DATA+	8	C4 485DATA-
9	485GND		

GPS antenna – SMA connector

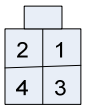
Note ensure this connector in secured such that it cannot rotate when attaching antenna cable

Power input - 6 Pin Molex type (looking at the DCU2 connector panel)



PIN	SIGNAL	PIN	SIGNAL
6	CAPACITOR VCC	3	CHASSIS GND
5	BATTERY VCC	2	BATTERY GND
4	BATTERY VCC	1	CAPACITOR GND

Power input - 4 Pin Molex type for compatibility (looking at the DCU2 connector panel)



PIN	SIGNAL	PIN	SIGNAL
4	BATTERY GND	2	BATTERY VCC
3	BATTERY GND	1	BATTERY VCC

FCC statement

Federal Communication Commission interference statement

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 of the following measures:

Reorient or relocate the receiving antenna.
Increase the separation between the equipment and 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.

To assure continued compliance, any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment. (Example- use only shielded interface cables when connecting to computer or peripheral devices).

FCC Radiation Exposure Statement

This equipment complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:
(1) This device may not cause harmful interference, and
(2) This device must accept any interference received, including interference that may cause undesired operation.

Channel

This equipment marketed in USA is restricted by firmware to only operate on 2.4G channel 1-11.

IC INTERFERENCE Statement

This device complies with RSS-210 of the IC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.