EV CONTROLLER II

REQUIREMENTS SPECIFICATION

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Revision History

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1. Introduction

This is the Requirements Specification (RS) for the EV Controller II project.

1.1 Purpose

The purpose of this RS is to specify the requirements for development of the software and hardware to control the operation of an electric traction motor.

1.2 Scope

This document shall contain all the requirements for the EV Controller software and hardware.

1.3 Definitions, acronyms, and abbreviations

EV Electric Vehicle
RS Requirements Specification
PWM Pulse Width Modulation
ICE Internal Combustion Engine
LCD Liquid Crystal display

1.4 References

The following documents form a part of this specification to the extent specified. In the case of conflict between a cited document and this specification, this specification shall be considered a superseding document.

Data Sheets

Maxim MAX110/MAX111 19-0283 Rev 3 3/96 data sheet
Intel 8752 Manual
Maxim MAX232 data sheet
7805 data sheet
LCD display data sheet
New Micros Manual

2. Overall description

This section describes general factors that affect the product and its requirements. Items presented in these subparagraphs are **not** requirements but provide **background information** for the requirements specified in section 3.

2.1 Product perspective

This document describes the software and hardware for the whole traction control system.

2.2 Product functions

The primary purpose of the EV Controller is to provide speed control based on pedal position for the traction motor. Secondary functions include providing traction motor current limiting, battery pack charge monitoring, error detection , logging and safty overides.

The EV Controller shall perform the following:

- Measure pedal position
- Measure battery current
- Measure battery voltage
- Generate a PWM signal between 0-100% at ~20,000Hz
- If the software enters a failure mode it must turn the PWM off (0%).
- Limit battery current
- Put the system in low power mode when idle.
- Monitor battery charge.
- Status will be reported through an RS-232 port
- Control the bypass relay
- Monitor the charger hatch and prevent motion when open

2.3 Illegible Tc (2.3) Tj 16.5 0 TD 0 1 112 -0.31

2.5 The VA box.

This unit will measure the main pack battery voltage and battery current.

2.6 The Pedal

The pedal will produce a position value using optical encoding and end of travel switches.

2.7 LCD Display

The LCD display will be mounted in the dash of the vehicle and will provide information on the state of the vehicle to the driver.

2.8 CPU Module

The CPU module will consist of the New Micros board and associated electronics and will be located under the dash.

2.9 User characteristics

It is desirable to make the operation of the EV as similar to an ICE vehicle as possible.

2.10 Constraints

A board from New Micros will be used as a base for this project. Power supplies and a PWM will be added to this board. The board is based on the 8051 running on an 11.05 MHz clock. The code is to be written in "C".

3. Specific requirements

The following paragraphs specify the software and hardware requirements of the EV Controller in sufficient detail to enable designers to design the system to satisfy these requirements, and testers to validate that the designed system satisfies the requirements.

3.1 Environmental Requirements

All components shall operate under the following conditions.

- Operate over Temp -20 to 110 degrees Fahrenheit.
- Units shall be sealed against the environment.
- Aux supply voltage of 8-16 volts
- Main pack supply of 50-100 Volts

3.2 CPU Module

3.2.1 Power

The CPU Module shall be provide with three power sources:

- Continuous 12 volts
- Acc power (none run)
- Ignition power (run condition)

3.2.2 RS-232

An RS-232 port shall be provided (outgoing only). The RS232 data stream shall contain:

- Battery Voltage
- Battery Current
- % PWM
- Battery state of charge
- RPM
- Time and Date
- Errors messages

3.2.3 PWM

A PWM output shall be provided at CMOS levels. The PWM shall be created by hardware. Minimum frequency of operation shall be 20kHz. At power up the PWM shall be zero.

3.2.4 LED

An LED shall be provided on the exterior of the CPU Module. The LED shall blink at a 2 second rate under software control

3.2.5 Charger Door Switch Input

The PWM shall be disabled when the charger door switch is opened.
The safety line shall be open when the charger door switch is open.
When the Charger door switch is closed and the PWM is at zero the AtoD box may be calibrated at zero current.

3.3 The Driver

3.3.1 Isolation

The drive shall maintain electrical isolation between the Aux. battery (12V) and the traction batteries (72).

3.3.2 Input

The PWM input shall be at CMOS (5v) levels.

3.3.3 Output

The output voltage shall be powered from the traction batteries.
Output shall be adequate to drive the power amp to a full on condition.

3.3.4 Safety

A line from the interface box 5 volt supply shall connect to a relay that can disable the driver if the 5 volts should fail.

3.4 The Amplifier

3.4.1 Input

Shall be from the driver.
If the input should be disconnected from the driver it shall be forced low.

3.4.2 Output

- The Amp shall be connected in series with the traction batteries and the motor.
- The Amp shall operate in Class C mode
- The Amp shall operate from 12-120 volts
- The Amp shall operate at 400 amps cont.

3.4.3 Heat sink

- A heat sink with fan powered from the aux. battery shall be provided.
- The FETs shall be connected directly to the heat sink
- The heat sink will be electrically isolated from the vehicle ground.

3.4.4 Safety

To protect the users in case of semiconductor failure, a main power cutoff relay shall be provide. **Note:** In the Postal Van this is provided by the former series/parallel relay.

4. External interface requirements

4.1 User interfaces

4.1.1 LCD Display

The LCD shall display % modulation, battery current, battery voltage, % modulation, and battery charge. Error message may also be displayed

4.1.2 Pedal

The pedal position set the desired speed of operation full down shall be 100% on full up 0%

4.1.3 LED

An LED is provided for debugging purposes and as an indicator that the processor is running normally. During normal operation the LED should blink at a 2-second rate

4.2 Hardware interfaces

4.2.1 LCD

The 2x20 (minimum) LCD shall display messages from the processor. The display shall be back light and mounted to shield it from external light. The display shall go into a low current mode when the vehicle is off. The LCD display shall be mount on the dash and connected to the CPU module by a ribbon cable.

The LCD uses the standard LCD 14-pin interface and command set and is map to two memory locations

4.2.2 VA box

The CPU module shall communicate with the VA box to get the battery voltage and current. The interface is serial and bi-directional.

Additional Requirements:

- The VA box shall maintain traction batteries and aux. battery isolation.
- The VA box shall provide 12 bits of data per conversion
- The VA box shall provide 20 conversions per second.

- The VA box may be put into a low power mode by the CPU Module

Communication with the 2 channels AtoD is by a four wire serial buss with additional wires for power and ground:

- Select line
- Clock Line
- Data line out
- Data line out
- 12V+

The data format and programmable options are described in Maxim data sheet.

4.2.3 Pedal

The CPU Module shall communicate with the pedals optical encoder and end switches. Power for the switches and the encoder shall be provide by the CPU Module. A bi-phase optical encoder and a switch for the up or off position shall measure the pedal position. A second switch shall define the full on or down position. The encoder shall provide at least 50 counts of position information.

The pedal interface consists of a position encoder and an up and down switch. The up switch defines 0% modulation and the bottom switch defines 100% modulation.

Both phase of the encoder output shall be monitored and in case one should fail the PWM shall be set to zero.

Note: In the Postal Van the top and bottom switches are part of the existing equipment

4.2.4 CPU Module

4.2.4.1 RS-232

The RS-232 interface provides a communications path to collect data from the controller. It shall report %modulation, battery voltage, battery current, and battery state of charge, abs pedal position and current limit status.

RS232 Port – Transmit only no handshaking, 9600baud, N, 1
It shall report %modulation, battery voltage, battery current, and battery state of charge, abs pedal position and current limit status. The data shall be in ASCI format and comma delimited. Each data packet shall end in a carriage return and line feed.

The RS-232 hardware is internal to the 8752 see its data sheet for more information

4.2.4.2 PWM

The PWM output is used to drive the traction motor. The pulse width may vary between 0 and 100% depending on pedal position and current limiting.

The PWM is generate by using two counter of a 80c45

4.2.4.3 LED

The LED is controlled by the 8051

4.2.4.4 Ignition

This input indicates that the vehicle is turned on.

4.2.4.5 Run

This input indicates that the vehicle is turned on and the user has activated the saftey loop.

4.2.4.6 Charger Door Hatch

This input indicates that the charger hatch is open.

4.2.4.7 Safety Loop

This input indicates that the vehicles safety loop is active.

4.2.4.8 Safety Loop Output

This output must be on for the safety loop to activate.

4.2.4.9 High Speed Output

This output becomes active when the PWM is at 100% modulation.

4.2.4.10 PWM enable

This output insures that the PWM comes up disabled. This output must be made active before the PWM output is enabled.

5. Functional requirements

5.1 Function Pedal Monitoring

The following paragraphs define the processing associated with the Pedal Position Monitoring.

5.1.1 Introduction

Pedal position used with current liming to determine the percentage of PWM. When the pedal is pressed it moves a quadature optical encoder, this enables the processor to determent the direction of motion. The pedal additionally triggers two position switches. One at the unpressed position this is used to determent the zero modulation position. the other switch is at the full on position and determines the 100% modulation position.

5.1.2 Inputs

Phase 0 (generates an interrupt).
Phase 1 (generates an interrupt).
Top Switch
Bottom Switch

5.1.3 Processing

When the top (unpressed) switch is open the pedal position shall be 0. This requirement has highest piority.

When the bottom switch is closed the pedal position shall be the maximum value for the pedal.

When between the switches the pedal value shall increase with downward motion and decrease with upward. The interrupt of phase zero indicates a new pulse and phase 1 determines the direction. Phase 1 needs to be monitored to be sure it is toggling, if not the PWM shall be shut down.

After the bottom switch is closed the value of encoder counts from the top to bottom switch shall be used to scale the pedal position from 0 to maximum pedal value. Before the bottom switch is closed an estimate value shall be used.

5.1.4 Outputs

A scaled variable indicating the pedal position.

5.2 Function Running Analog to Digital Converter

The following paragraphs define the processing associated with the AtoD converter.

5.2.1 Introduction

The AtoD converter provides battery voltage and battery current for the current limiting function and the charge monitoring function.

5.2.2 Inputs

Data is read with a 4 wire serial interface

5.2.3 Processing

Initialization and calibration shall occur at powerup and when ever needed while the program is running. Zero current is define as when ever the PWM output is 0% and the charge hatch is close.

The software shall alternate between measuring current and voltage.

Voltage rang is 0-100v. Out of bound voltages are errors

Current range –1000 to +1000 Amps Out of bounds readings are errors

There shall be a calibration constant for both voltage and current.

When the vehicle is off and the charger hatch is closed the VA box shall be turned off.

5.2.4 Outputs

This routine shall maintain the current and voltage variables.

5.3 Function PWM generation and Current Limit

5.3.1 Introduction

The percentage PWM determines the power to the motor. The current limit limits the maxim power to motor

5.3.2 Inputs

Present Pedal Position 0-100%
Current reduction a constant
Current Limit a constant
Battery Current

5.3.3 Processing

- PWM = Pedal Position*(current limit – current)/current limit

- If the Pedal Position should become invalid PWM shall be set to 0.
- Lost of AtoD function the PWM shall be set to 0 and the safety line opened
- Lost of safety line the PWM shall be set to zero
- If the charger hatch is open the PWM shall be set to zero and the safety line opened.
- PWM frequency output shall be ~20,000Hz. 0 to 100% modulation.
- When the PWM is operating at 100% the High speed relay shall become active
- When the PWM drops to below 98% the high-speed relay shall become inactive.

5.3.4 Outputs

PWM
High Speed Relay

5.4 Function Battery Charge Monitoring

5.4.1 Introduction

Using data provide by the AtoD this function shall record the energy flow into an out of the battery.

5.4.2 Inputs

Battery Current
Battery Voltage

5.4.3 Processing

Battery Current * Battery Voltage = Power
Sum of Power/time = Charge

5.4.4 Outputs

Charge Value

5.5 Sleep Function

5.5.1 Introduction

To safe on aux battery power certain functions are shut down under idle conditions

5.5.2 Inputs

Acc
IGN
Charger hatch
Charger input is true if Batteries are at 100% or batteries are being charge.

5.5.3 Processing

Shut down after 5 seconds if:

	LCD & Backlight	VA Box	Driver & Pedal	CPU board
Acc	OFF	OFF	OFF	OFF
IGN	OFF	OFF	OFF	OFF
Charger Hatch	ON	OFF	X	OFF
Charger	OFF	OFF	X	OFF

X= don't care

5.5.4 Outputs

Power to:

- VA Box
- LCD
- Driver
- Pedal

6. Qualification provisions

Section	Requirement	Qualification
3.1.1.1	LCD Display	Demonstration
3.1.1.2	Pedal	Demonstration
3.1.1.3	LED	Demonstration
3.1.2.4	RS-232	Demonstration
3.1.2.5	PWM	Test
3.2.2	Function Running Analog to Digital Converter	Test
3.2.3	Function PWM generation and Current Limit	Test
3.2.4	Function Battery Charge Monitoring	Test