EE SENIOR DESIGN
PROJECT STATEMENT OF WORK
HOVERDRONE GAMES BATTERY & POWER MGMT

TEXAS STATE UNIVERSITY
INGRAM SCHOOL OF ENGINEERING

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SPONSOR NXP
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Revision History			
Version	**Date**	**Description**	**Author**
0.1.1	01/30/2019	Sponsor Preparations	Jason
0.1.2	02/05/2019	Business Need	Paul
0.1.3	02/11/2019	Sponsor Support Elements, Product and Project Scope Description finalized	Mustafa, Jason, An, and Paul
0.1.4	02/13/2019	Executive Summary	Jason

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1. EXECUTIVE SUMMARY

Jason Blackert:

Our product is a peripheral Battery Management System (BMS) that is intended to be used for the Hoverdrone Games challenges. The MC33772B board contains and manages six battery cells and is intended to be cascaded with identical boards for more intensive applications. The sponsor requires this product for the Hoverdrone Games, however the intended use of this system is for an open-source platform across many applications. Some applications include MAVLink, UAVCAN, PX4, and the S32 Design studio will help incorporate the board with these platforms. Additionally, it will be used by NXP, so that others may easily use and benefit from this project. The team will be testing a new board and providing evaluation on the health and safety of the battery cells. This includes, validating battery measurements in a test environment and test the MC33772B temperature boundaries. The battery management system will be interfaced with a variety of peripheral devices and will identify and format the messages being passed with the software. We will be using NFC which is Near Field Communication which will be implemented separately of the BMS and will allow monitoring state of charge information without plugging it in. A stretch goal is to enhance, develop, and work with the software framework module that identifies more conditions of the battery cell health, state of charge, and log cycles.

2. BUSINESS NEED

By Paul Fonseca

The business purpose of this project is to provide an open source hardware and software design to be used by the DroneCode.org community in the NXP HoverGames challenges. This challenge aims to promote the use of smart batteries in today's commercial UAV's such as drones and rovers. This Initiative focuses on advancing the use of smart batteries to create more sophisticated devices in a world that's constantly evolving. The tested and validated Smart Battery Design and Operational Software will enable anyone to turn a normal drone battery into a smart one. Overall, this board will give the general public the ability to not only advance their commercial drones and rovers into more sophisticated ones but will also serve to help launch our society into a more technologically advanced one. The BMS will not only help monitor the batteries of UAV's but will also pave the way to be used in other devices and applications, leading to the possibility of more efficient and safer scenarios in our society.

3. PRODUCT SCOPE DESCRIPTION

Jason Blackert

A). Interface

The main hardware for the Battery Management System is a prototype board RDDRONE-BMS772, and it will be tested and validated in its main functions in this project. Once proven that the board is working properly with its software fully operational, development of state of charge and state

of health applications will commence. This BMS board will be able to interface with drones and other UAV's using UAV Can and other software features.

B). Features of MC33772B Board

Features	**Description**
Battery Current Measurement	Up to 200A peak and 90A DC Continuous with an accuracy of 1% for the complete chain
Cell balancing operation during charging	
Cell temperature measurement	+/- 2°C accuracy (including AFE, PCB and NTC inaccuracies)
Maximum ambient temperature	Maximum allowed Ambient temperature = 60°C
Maximum battery cell temperature while charging	Maximum battery cell charging temperature = 40°C
Maximum battery cell discharging temperature	Maximum battery cell discharging temperature = 55°C
Battery shutdown in case of overcharging or transportation mode	<80µA leakage current
Automatic sleep mode	<200µA current consumption on the battery (SLEEP mode)
Authentication of the battery	
Diagnostics to verify the safe operation of the battery	
CAN communication following UAVCAN protocol	every 100ms. CAN connector = 4-pin connector from the JST-GH series (SM04B-GHS-TB)
NFC communication with user to configure battery and get main battery parameters	shipping mode, number of cells, capacity, chemistry, Voltages, temperatures, current, power, capacity, health, fault.
SWD and JTAG debugging interface	using J-Link Mini EDU shipped with HoverGames kit
Interface connections	SPI and IIC (I2C)

C.) Product performance

Features	**Performance Targets**
Cycle Testing	Using the Battery Monitoring System to create flags to help test and monitor the health of each battery cell.
S32 Software	Base NXP software to conduct testing

Development of a state of charge estimation	
State of health of the battery.	
S32 Design Studio Development	Validate the format of messages sent and received by software-
UAVCAN interactions with the drone and I2C (SBUS)	Validate Communications between all the critical hardware in the system
MAVLink	Validate the format of messages sent and received by software
Dronecode.org	Validate the format of messages sent and received by software
PX4 Development (Stretch Goal)	Extending the software interface

4. PROJECT SCOPE DESCRIPTION

An Nguyen:

DRI	Task	Dur, days	Start	End
An	Set up SharePoint site. Organized necessary folders and uploaded relevant documents.	1	1/28/2019	1/29/2019
Jason	Team meetup and project preparation questions for sponsor.	4	1/31/2019	2/4/2019
Jason	Create a document detailing important objectives the sponsor required for BMS.	3	2/4/2019	2/7/2019
Jason	Split up the SOW workload	3	2/4/2019	2/7/2019
Paul	SOW - Business Need	4	2/4/2019	2/8/2019
Mustafa	SOW - Sponsor Support Element	4	2/4/2019	2/8/2019
An	SOW - Scope Description	9	2/4/2019	2/13/2019
Jason	Hardcopy of Statement of Work	5	2/13/2019	2/18/2019
Jason	Acquiring S32K MCU, BMS772, S32 design studio	2	2/20/2019	2/22/2019
An	Work on Functional Specification	14	2/20/2019	3/6/2019
Paul	Initial Design Review	30	3/4/2019	4/3/2019
Jason	Coordinate Hardcopy of Functional Spec	11	2/28/2019	3/11/2019
Mustafa	BMS772 board bring up and evaluation	11	3/1/2019	3/12/2019
Jason	Test/familiarize S32 design studio	16	3/3/2019	3/19/2019
Jason	Updated Functional Spec	26	3/15/2019	4/10/2019
Jason	Labor Cost Schedule Doc	12	4/10/2019	4/22/2019
Jason	Final Design Review	2	4/15/2019	4/17/2019
Paul	Begin to create flags using the BMS	32	3/15/2019	4/16/2019
An	Software framework for MAVLINK, PX4, UAVCAN	32	3/16/2019	4/17/2019

An	Test Plan	19	4/12/2019	5/1/2019
Mustafa	Software framework module which detects and identifies the battery, logs cycles etc.	22	5/3/2019	5/25/2019
Jason	Temperature testing	20	5/26/2019	6/15/2019
An	Safety testing	26	6/17/2019	7/13/2019
Paul	Current/ Voltage testing	26	5/9/2019	6/4/2019
Jason	UAVCAN Evaluations	22	6/7/2019	6/29/2019
An	PX4 Evaluations	23	7/1/2019	7/24/2019
Paul	I2C Evaluations	21	7/25/2019	8/15/2019
Mustafa	NFC Functionality	16	8/16/2019	9/1/2019
Mustafa	Progress Presentations	18	9/1/2019	9/19/2019
Paul	Create Website tutorial for BMS	24	9/7/2019	10/1/2019
Jason	Validation of battery measurements	19	9/10/2019	9/29/2019
An	Develop state of charge	19	10/1/2019	10/20/2019
Paul	Develop state of health	21	10/20/2019	11/10/2019
Jason	Project functionality test	31	10/10/2019	11/10/2019
Jason	Final Presentation Preparation	25	11/10/2019	12/5/2019

5. SPONSOR SUPPORT ELEMENTS

Mustafa Bahrani

Sponsor Support Elements		
Element	**First Needed**	**Needed Until**
Faculty advisor weekly meetings	01/20/19	05/07/19
Received references and software details from sponsor	02/04/19	TBD
S32 Design Studio Licensing	02/06/19	05/07/19
SOW review & signature & NDA	02/15/19	02/18/19
Board-Shipped from France	03/15/19	TBD

6. APPROVALS

The signatures of the people below indicate an understanding in the purpose and content of this document by those signing it. By signing this document, you indicate that you approve of the proposed project outlined in this Statement of Work and that the next steps may be taken to create a Functional Specification and proceed with the project.

Approver Name	Title	Signature	Date
Jason Blackert	Project Manager		
Alfonso de la Morena	D2 Project Manager		
Dr. Stapleton	Faculty Sponsor		
Mr. Iain Galloway	Sponsor		
Dr. McClellan	Instructor		