Electric Drive Component Manufacturing: Magna E-Car Systems of America, Inc.

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Magna E-Car Systems of America, Inc.
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Overview

Timeline
• Start Date: July 1, 2010
• End Date: June 30, 2013
• 25% Complete

Barriers
• Unexpected delays in program timing
  – OEM customer design changes and delays
  – Installation of manufacturing equipment and tooling

Budget
• Total Project Funding
  – DOE $40,000,000
  – Magna E-Car - $47,402,116

• DOE Funding
  – FY2010-$7.1M
  – FY2011-$23.7M

Partners
• Magna E-Car USA, LP
• Magna Powertrain USA, Inc.
• VEHMA International of America, Inc.
Relevance

Project Objectives

• Increase production capacity and validate production capability of advanced automotive electric drive component manufacturing plants in the U.S.
  – Completion of the activities required to manufacture and supply electric drive systems to existing OEM customer projects supporting long-term economic growth
  – Creation and validation of production capability of advanced automotive electric drive vehicle components for electric vehicle production programs in the U.S. spurring economic activity
  – Preparation of a newly acquired facility to house the manufacturing activities that are supported by this project creating new engineering and manufacturing jobs

• 2011 Objectives
  – Continue production software development for:
    • VCU –motor control; vehicle communication with charger, battery, DC-to-DC and TCM
    • TCM –torque management software
  – Continue the industrialization of the manufacturing facility
  – Perform Validation Prototype (VP) build for the OEM customer and supplier readiness reviews
Approach

- **Go/No Go Decision Point**
  - Completed when Magna E-Car was awarded a production program with lead OEM for calendar year 2011 Start of Production

- **Facility Utilization and Production Preparation**
  - NEPA and Certificate of Occupancy Approved January 2011

- **Overall Milestone Status**
  - All programs continue to follow component-level Program Management Plan timing with minimal delays
## Milestones

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Component</th>
<th>Start Date</th>
<th>End Date</th>
<th>% Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procurement of Production Assembly Equipment – Procure and build of</td>
<td>VCU</td>
<td>10/2010</td>
<td>03/2011</td>
<td>55</td>
</tr>
<tr>
<td>required production equipment in support of production</td>
<td>MCU and Motor</td>
<td>07/2009</td>
<td>04/2011</td>
<td>75</td>
</tr>
<tr>
<td>M1 Engineering Validation Build – Initial build of first level design</td>
<td>BCCM</td>
<td>03/2011</td>
<td>04/2011</td>
<td>0</td>
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<tr>
<td>validation components using production-intent designs for engineering</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>development</td>
<td></td>
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<tr>
<td>Verification Prototype (VP) Build Part Procurement – SCM function</td>
<td>VCU</td>
<td>10/2010</td>
<td>03/2011</td>
<td>60</td>
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<tr>
<td>including the kick-off and procurement of all tools and components</td>
<td>MCU and Motor</td>
<td>05/2010</td>
<td>02/2011</td>
<td>100</td>
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<tr>
<td>needed to assemble VP-level components for engineering validation</td>
<td></td>
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<tr>
<td>Final Data Judgment (FDJ) – Complete all validation testing, and freeze</td>
<td>VCU, MCU and Motor</td>
<td>01/2011</td>
<td>01/2011</td>
<td>100</td>
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<tr>
<td>engineering designs to allow kick-off and procurement of production</td>
<td></td>
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<tr>
<td>Installation of Line at Production Facility – Install and test purchased</td>
<td>VCU</td>
<td>10/2010</td>
<td>03/2011</td>
<td>15</td>
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<tr>
<td>production assembly equipment in the Magna E-Car production facility</td>
<td>MCU and Motor</td>
<td>10/2010</td>
<td>04/2011</td>
<td>35</td>
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<tr>
<td>Verification Prototype – Production-intent builds to satisfy specific</td>
<td>VCU</td>
<td>03/2011</td>
<td>03/2011</td>
<td>0</td>
</tr>
<tr>
<td>test requirements and ensure vehicle compatibility and design</td>
<td>MCU and Motor</td>
<td>02/2011</td>
<td>03/2011</td>
<td>0</td>
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<tr>
<td>completeness</td>
<td></td>
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<tr>
<td>VP Validation Testing – VP component- and vehicle-level testing is</td>
<td>VCU</td>
<td>04/2011</td>
<td>08/2011</td>
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<tr>
<td>completed using VP-level parts to validate conformance to all objectives</td>
<td>MCU and Motor</td>
<td>03/2011</td>
<td>06/2011</td>
<td>35</td>
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<tr>
<td>of production tooled components</td>
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<tr>
<td>Production Part Approval Process (PPAP) – Phase I, II, III PPAP</td>
<td>VCU</td>
<td>08/2011</td>
<td>09/2011</td>
<td>0</td>
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<tr>
<td>Final Engineering Completion (FEC) and Launch Readiness (LR) – All</td>
<td>VCU, MCU and Motor</td>
<td>10/2011</td>
<td>10/2011</td>
<td>0</td>
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<td>issues have been resolved and final approval to proceed to tooling trial</td>
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<td>is given</td>
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<tr>
<td>Mass Production (MP1) – Start of production at Magna E-Car production</td>
<td>BMU, VTM, VCU,</td>
<td>2011</td>
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<tr>
<td>facility</td>
<td>MCU, Motor, BCCM</td>
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Technical Accomplishments and Progress

Power Plant: Motor and Motor Control Unit (MCU)

• Engineering designs released
• Design Validation (DV) testing:
  – Several prototypes built
  – Motor passed all critical DV test

• Supply Chain Management
  – Production suppliers kicked off for Verification Prototype (VP) build
  – Conducted Advanced Product Quality Planning (APQP) and supplier readiness reviews

• Production
  – Kicked off production tooling
  – Completed assembly equipment build
Technical Accomplishments and Progress

Vehicle Control Unit (VCU)

- Engineering designs released
- Testing
  - Design Validation (DV) testing: First-level production design
  - OEM durability testing completed: First durability vehicle test cycle
- Supply Chain Management
  - Production suppliers kicked off for Verification Prototype (VP) build
  - Conducted Advanced Product Quality Planning (APQP) and supplier readiness reviews
- Production
  - Kicked off production tooling
  - Released assembly equipment orders for procurement

Battery Charger Converter Module (BCCM)

- Built and began testing eight prototypes
- Completed the Engineering Development (ED) test plan
  - Limited ED testing completed
- Initiated next generation design based on issues discovered on original design
  - Revised MOSFET cooling strategy to increase thermal stability
Technical Accomplishments and Progress

Manufacturing Facilities

• Component Manufacturing – Grand Blanc Township, Michigan
  – Completed production floor and office upgrades
  – Certificate of Occupancy received January 2011
  – Approximately 12 new hires to support engineering, quality and manufacturing activities were added to the project

• End-of-Line Assembly – Muncie, Indiana
  – Completed fabrication of the assembly and end-of-line equipment
  – Prepared facility for receipt of manufacturing and assembly equipment
  – Integrated the battery emulation system to the dynamic test system
Technical Accomplishments and Progress

Testing Facilities

- Vehicle Integration, Materials Testing & Validation Facility – Auburn Hills, Michigan
  - Equipment acquisition and calibration complete (90%)
  - Received pack and cell validation and cycling equipment
Collaborations / Partnerships

Magna E-Car Systems of America, Inc.
- Primary Recipient

Magna E-Car USA, LP
- Engineering, development and testing of VCU, MCU and Motor
- Assembly and manufacturing of VCU, MCU and Motor

Magna Powertrain USA, Inc.
- Development and manufacturing of gearbox
- Assembly and integration of the electric powertrain assembly

VEHMA International of America, Inc.
- Development and manufacturing of the cradle for the powertrain assembly
Future Work

Vehicle Integration

- Software validation for functional safety and calibration released
- Completion of all Verification Prototype (VP) deliverables
- Continue production software development

MCU and Motor

- Complete PPAP (Production Prototype Approval Process) and DVP (Design Validation Plan)
- Continue industrialization of the manufacturing facility
- Begin Process Validation (PV) testing
- Final engineering completion, launch readiness and start of mass production

BCCM

- Release and finalize second-level production designs
- Continue prototype build and engineering validation
Summary

- Program continues to follow projected timeline, milestones and budget with minimal delays
  - Customer design changes major contributor of delay
- Facilities upgraded and prepared for manufacturing
  - Manufacturing, assembly and testing equipment procured and continues installation and testing
- Components designed, prototypes built and undergoing various levels of development testing and validation
  - Increased cost and timing for low volume component manufacturing is primary barrier
- Validation and industrialization to continue at both manufacturing and end-of-line assembly facilities
  - Mass production to begin in 2011
  - Creation of additional engineering and manufacturing jobs expected
  - Continue commercialization development plans with OEM customers spurring sustainable economic growth