System Requirement Specification (SyRS)

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Executive Summary

The System Requirements Specification (SyRS) for the Electrical Subsystem of Harley Davidson Road King (FLHR) Touring Motorcycle is a comprehensive document that outlines the necessary requirements for the safe and reliable operation of the motorcycle's electrical subsystem. The SyRS includes detailed information on the purpose, background, objectives, operational concept, capability gaps, system requirements, supporting architecture products/diagrams, recommendations, and project schedule, cost/scope estimates, and RVTM to stakeholder requirements specification and other sources.

The SyRS is intended to ensure that the electrical subsystem of the Harley Davidson Road King (FLHR) Touring Motorcycle is functioning optimally and free of limitations or issues. Through the SyRS, capability gaps are identified and prioritized based on their impact on motorcycle performance and safety. To meet the objectives of the SyRS, a set of system requirements and measures of performance (MOPs) are established. These requirements and MOPs are designed to ensure the safe and efficient operation of the motorcycle's electrical subsystem under various operating scenarios.

In addition to the system requirements, supporting architecture products/diagrams are included to illustrate the design of the subsystem and its integration with the motorcycle's overall system. Based on the analysis, the SyRS recommends pursuing material solution development to address capability gaps and ensure that the electrical subsystem meets the specified requirements. The project schedule and cost/scope estimates provide an overview of the timeline and resources required for development.

Finally, the SyRS includes a Requirements Verification Traceability Matrix (RVTM), which links the system requirements to stakeholder requirements specification and other sources. The RVTM ensures that all stakeholder requirements are addressed in the system requirements.

In summary, the SyRS is a critical document that outlines the requirements and specifications necessary for the safe and efficient operation of the electrical subsystem of the Harley Davidson Road King (FLHR) Touring Motorcycle.

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1.0 Introduction

This section of the document will outline the overall purpose of the System Requirements Specification (SyRS). This section specifically will highlight the purpose and scope of what will be conveyed within the SyRS.

1.1 Purpose

This document's purpose is to articulate the system's requirement definition (SRD) process, specifically for the Harley Davidson FLHR electrical sub-system. That is to use the stakeholders feedback and requirements to form a technical solution that will conform to the operational needs of the end users. This document will also outline the major stakeholders involved and the traceability of requirements back to said stakeholders.

1.2 Scope

The scope of this document is to only outline the system requirements pertaining to the electrical subsystem of the FLHR system. All other subsystems within the overarching system are to be developed outside of the jurisdiction of this project and will not form any part of this document. This document will capture the requirements that will be necessary to support the operational needs of the system over its lifecycle.

1.2.1 Assumptions

Assumptions made in the formation of this document and for the sake of the project include the following:

- All other subsystems will be successfully integrated with the electrical system
- The electrical subsystem is purpose built for the FLHR and is not compatible with other systems
- All requirements captured in this document will be used in the final design of the system and will be cohesive throughout the project

1.3 Background

The Harley Davidson Road King is a touring style motorcycle that is widely used in the market across the globe. It is a robust design allowing for cutting edge technology and performance to merge. The FLHR system is decomposed into seven subsystems that cohesively form the overarching design. The electrical subsystem is one of the most critical components of the entire

system; without the use of the electrical components included in the subsystem, the FLHR ultimately will not function. This document will serve as a way to illustrate what requirements were specified for the system so that it can be traced back through the systems development process and ultimately used during the systems life cycle.

1.4 Stakeholders

All stakeholders directly involved in the project, through engineering, production, operations, and end users, highlighted in this section.

Organization	Type	Main Interests	Impact
Harley Davidson	Major	The overall development of project and day to day operations	High
Customer	Minor	The outcome of the system and overall function of final product	Low
HD Electronics Component manufacturer	Major	Primary enabler to Harley Davidson for electrical components	High

Table 1.0 Stakeholders

2.0 Objectives

The overarching objective of the SyRS is to list the specification and requirements to be used in the systems development that will be able to be traced both forward and backwards through the whole project. This document should provide an adequate list of both function and non-functional domain requirements to be used in the systems operations. Additionally the influence stakeholders within the project (reference table 1.0) will be outlined here too. THe Operational Concepts by which the system will operate will be highlighted in this document as well. Objectives of the project overall can be broken down into the following:

- Engineer electrical subsystem and respective components for use on all FLHR motorcycles
- Develop stakeholders needs and requirements and interpet to construct architecture necessary for production
- Define requirements both functional and nonfunctional for daily operation of the system amongst all stakeholders and users
- Describes what a finalized form of the system will contain and operate like
- Develop all requirements that will be used in order achieve the project's mission
- Provide one source of truth for entire project to adhere to

These objectives will help develop the system in a manner that conforms with both INCOSE standards and keep in practice with ISO 15288 standards for systems engineering.

3.0 Operational Concept

The operational concept (OpsCon) seeks to break down the Concept of Operations and show on a more macro level of the system and how it is interfaced with by stakeholders and developers. The main objective of the Ops Con is to describe what the system will do and not focus on its means. The overarching objective as stated is the development and integration of an electrical subsystem into the FLHR system. The electrical system will feature the necessary components in order to be successfully integrated into the overall system. These components will consist of all electrical components in the system critical to its operation, including:

- Ignition Switch
- Starter motor

- Relays/coil packs
- Instrumentation
- Stator
- Fuses
- Battery

These components will be built into the system and will be specified in order to match power requirements and needs for the FLHR. The engineering team will take stakeholder requirements and compare them against comparable components for sub-tier manufacturers in order to develop the needed components. Once these components are specified they will be acquired and assembled in order to be tested. The system will undergo rigorous verification and validation testing in order to prove that all components meet specification and will be useful throughout the systems life cycle. Once the system has passed its testing it will be ready to enter full rate production (FRP) and will begin the mass production and integration of the new electrical subsystem into the FLHR.

At this point in the project Harley Davidson (HD) and sub tier suppliers will interface with the system through day to day manufacturing operations as well as performing the enabling processes of contracting and receiving electrical components necessary to produce the electrical system. Once this process is cleared it will then fall on HD to create the system within their facility and integrate with the rest of FLHR. After this has been accomplished the team at HD will send the FLHR to distributors in order to give access to end users or customers. These end users will interface with the system by way of operating the motorcycle for daily activities and provide continuous feedback to HD on possible improvements and quality issues. This feedback loop will lead to possible improvements of the electrical subsystem as production continues and for the next generation of electrical subsystem to be used. When the time has come to engineer a new generation, testing will be conducted in order to see what components do not need updating and will offer the best returns to keep implemented in the system. The rest of the components will either be sold off as spares to aftermarket support companies or decommissioned and disposed of or recycled by the guidelines set forth in ISO 14000.

4.0 Capability Gaps

Capability gaps refer to the lack of ability of an organization to successfully and efficiently attain its targeted results is referred to as having capability gaps. Some significant factors for prioritizing capacity shortages in the context of the Management of Engineering Systems for the Road King (FLHR) Touring Motorcycle SyRS are:

Gathering needs: If the motorbike system's needs are not effectively gathered, capability gaps may develop. To make sure that the system satisfies the demands of the users, the team must be able to recognize, evaluate, and prioritize requirements.

System Integration: The development of the motorbike system must take into account how well each component interacts with the others. If the team is unable to integrate the many motorcycle system components and subsystems, capability gaps may develop.

Risk management: If there are weaknesses in the capacity to recognize, evaluate, and manage the risks connected to the motorbike system, capability gaps may develop. To guarantee that the bike's engine system complies with safety and reliability criteria, a strong risk administration system is required.

Testing and Validation: If the motorcycle system cannot be tested and validated, capability gaps may develop. The motorbike system must undergo a thorough testing and validation procedure to make sure it satisfies all performance, safety, and legal standards.

Documentation and communication: If there is a deficiency in the motorcycle system's capacity to record and communicate its requirements, design, and test findings, capability gaps may develop. To guarantee that all stakeholders are aware of the capabilities, constraints, and performance of the motorbike system, efficient records, and interactions are required.

To effectively manage the engineering systems for the Road King (FLHR) Touring Motorcycle System Requirements Specification (SyRS) and guarantee that the motorcycle system achieves the expected results, it is imperative to close these capability gaps.

5.0 System Requirements (with MOPs):

The specifications that outline what a system is anticipated to do and the manner in which it is anticipated to operate are known as system requirements. The following are some critical considerations for system requirements with MOPs (Methods of Procedure) in the framework of the Management of Engineering Systems for the Road King (FLHR) Touring Motorcycle System Requirements Specification (SyRS):

Performance criteria: The motorcycle system's requirements for performance, such as accelerated motions, maximum speed, halting distance, fuel economy, and handling, must be distinctly stated. To make sure the performance criteria are satisfied, MOPs should contain techniques for measuring and testing performance.

Safety Requirements: Identification, analysis, and definition of the safety requirements for the motorbike system are necessary. Procedures for ensuring that the motorcycle system complies with all applicable safety requirements, such as wreck testing, possibly fire prevention, and testing for emission levels, should be included in MOPs.

Reliability Requirements: The expected mean time between failures (MTBF), maintenance intervals, and replacement techniques must all be specified as part of the motorbike system's reliability requirements. MOPs should outline examination, maintenance levels, and repair procedures as well as other measures to guarantee that each motorcycle system satisfies these dependability standards.

User Interface Requirements: The display screen, controls, and navigation systems, as well as other user interface components, for the motorbike system, must be specified. Methods such as testing and feedback systems should be part of MOPs to guarantee that the client's experience satisfies the demands of the riders.

Regulation Requirements: The motorbike system must adhere to all relevant regulations, including those governing emissions, noise levels, and safety. MOPs should have processes in place for testing, certifying, and documenting compliance with these standards.

Overall, the effective administration of the engineering systems for the Road King (FLHR) Touring Motorcycle System Requirements Specification (SyRS) depends on these system requirements and MOPs. The motorcycle system may satisfy client needs while assuring the safety, dependability, and regulatory compliance by precisely specifying and testing these criteria.

6.0 Supporting Architecture

Several types of diagrams can be used to describe the architecture of the electrical system in a motorcycle, like the Harley Davidson 2016 Road King manual. Components such as the battery, alternator, voltage regulator, starter motor, ignition system, lighting system, and various sensors make up the electrical system.

A block diagram can provide a high-level view of the major components and their interconnections, which is useful for identifying key interfaces between subsystems. A wiring diagram can provide a detailed view of the individual wires and connections between components, which can help identify potential sources of electrical problems. A schematic diagram can show the electrical connections and components in a circuit, providing insight into the specific operation of individual components. A functional flow block diagram can show the functions performed by a system and their interconnections, providing a view of the overall flow of information and energy through the system.

When creating a system requirement specification, these diagrams can be used to describe the architecture of the electrical system in a Harley Davidson 2016 Road King manual. To obtain references for specific engine parts mentioned, the motorcycle's owner's manual or service

manual can be consulted. These diagrams can be useful for understanding the structure and operation of the motorcycle's electrical system and identifying potential sources of issues.

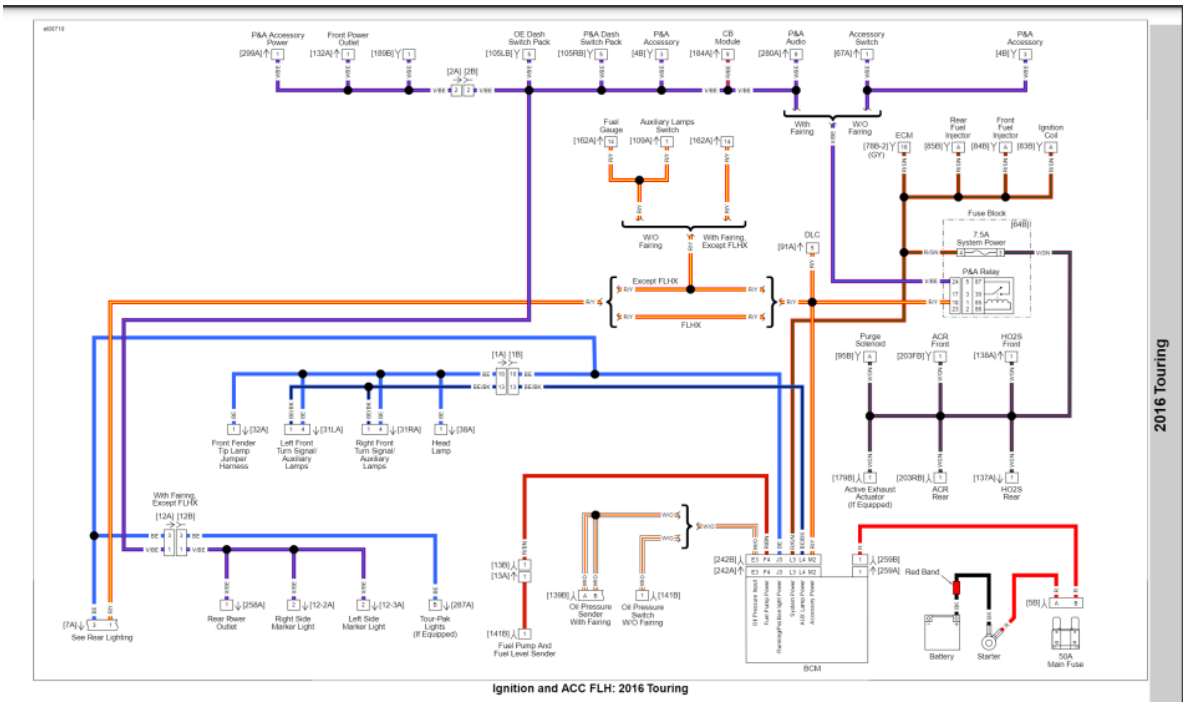

Figure 1.0 Ignition and ACC FLH:2016 Touring

(Harley Davidson Touring Model Service Manual,2016)

7.0 Recommendations for Solution Development

To develop material solutions for the electrical-based system of a Harley Davidson 2016 Road King manual, the team should take several steps. Firstly, they need to clearly define the system requirements using system engineering principles. This involves identifying the specific components of the electrical system, such as the battery, alternator, voltage regulator, starter motor, ignition system, lighting system, and sensors, and specifying their functions and interconnections. They can document this information in a system requirement specification, which serves as a roadmap for the development process.

Next, the team should identify and evaluate potential material solutions based on their ability to meet the system requirements. This may involve conducting research on available components and technologies, as well as considering factors such as cost, reliability, and performance. Once they have selected a suitable material solution, they can build and test a prototype to validate its performance and ensure that it meets the requirements specified in the system requirement specification.

Overall, the pursuit of material solution development for the electrical-based system of a Harley Davidson 2016 Road King manual requires a systematic approach that integrates system engineering principles with material science and technology. The team can obtain references for specific parts of the engine from the motorcycle's owner's manual or service manual.

8.0 Project Overview

8.1 Project Schedule

In Systems Engineering, a project schedule is a critical tool used to plan and organize project tasks in a way that ensures timely and successful project completion. It is a timeline that includes a sequence of tasks, their start and end dates, durations, and dependencies. The schedule outlines the planned timeline for the project and provides a roadmap to achieve project objectives within a specified time frame. The project schedule for the electric based system in Harley Davidson 2016 road king can be developed using project management tools such as the Gantt chart or the critical path method (CPM). The schedule should include all the activities required to design, develop, test, and implement the electric based system. The schedule should also include milestones, dependencies, and durations of each activity. It is essential to ensure that the project schedule is realistic, achievable, and adheres to the project timeline. Additionally, it is important to allow for contingency time to address unforeseen issues that may arise during the project (US Department of Transportation, 2017).

8.2 Cost/Scope Estimates

Cost/scope estimates refer to the projected budget and scope of work required to complete a project. The cost estimate provides an estimate of the total cost of the project, including direct and indirect costs, while the scope estimate outlines the activities and deliverables required to complete the project successfully. The cost/scope estimates for the electric based system in Harley Davidson 2016 road king can be developed using cost estimation techniques such as parametric estimating, analogous estimating, and bottom-up estimating. These techniques involve breaking down the electrical system into smaller components, estimating the cost of each component, and then summing up the costs to determine the total cost of the system. It is important to ensure that the cost/scope estimates are accurate and realistic to avoid underestimating or overestimating the project cost (INCOSE, 2015).

9.0 RVTM to Stakeholder Requirements Specification and Other Sources

The Requirements Verification Traceability Matrix (RVTM) to Stakeholder Requirement Specification and other sources is a tool used in the development of a System Requirements Specification (SyRS) in system engineering. It is used to ensure that all system requirements

are traceable to stakeholder requirements and other sources such as technical standards, regulations, and design specifications.

The RVTM table serves as a documentation tool to establish the relationships between the system requirements and stakeholder requirements, and other sources. It helps to ensure that all system requirements are necessary and linked to specific stakeholder requirements, and that they are validated and verified throughout the design and development process.

According to Blanchard and Fabrycky (2011), the RVTM table provides a systematic method for verifying and validating system requirements, by establishing traceability links between system requirements, stakeholder requirements, and other sources. The table helps to ensure that system requirements are properly validated and verified, and that they are aligned with the expectations and needs of stakeholders.

An RVTM table for the 2016 Road King Motorcycle would look like the following: -

System Requirement ID	**System Requirement Description**	**Stakeholder Requirement ID**	**Technical Standard/ Regulation/ Design Specification (Sources)**	**Verification Method**
S001	The motorcycle shall have a battery capacity of at least 12V, 18Ah	STR1	JASO D5302 (Motorcycle Lead-acid storage batteries)	Battery testing to ensure capacity
S002	The motorcycle shall have a minimum of 3 turn signal indicators	STR2	US DOT Federal Motor Vehicle Safety Standard 108 (FMVSS-108)	Visual inspection of turn signal indicators
S003	The motorcycle shall have a headlight brightness of at least 900 lumens	STR3	ECE Regulation No. 113	Photometric testing of headlight brightness

S004	The motorcycle shall have a charging system capable of producing at least 14V DC	STR1	JASO D 5302 (Motorcycle Lead-acid storage batteries)	Testing of charging system output voltage
S005	The motorcycle shall have a maximum current draw of 20A	STR4	Harley Davidson Engineering Specification 334-050	Electrical load testing of motorcycle system
S006	The motorcycle shall have a starter motor capable of at least 1 kW	STR5	SAE J537 (Heavy-duty Starter Motors-Test Procedures and General Performance Requirements)	Dynamometer testing of starter motor
S007	The motorcycle shall have a minimum of 4 circuit breakers for electrical protection	STR6	National Electrical Code (NEC) Article 240	Visual inspection of circuit breakers
S008	The motorcycle shall have a horn with a sound level of at least 100 dB	STR7	SAE J994 (Minimum Sound Requirements for Horns on Snowmobiles and Motorcycles)	Sound level testing of horn

Table 2.0 RVTM Table to StRS and Other Sources

(International Council on Systems Engineering [INCOSE], 2017)

By using an RVTM table, system engineers can ensure that all system requirements are necessary and linked to specific stakeholder requirements and other sources, and that they are properly validated and verified throughout the design and development process.

10.0 Glossary

- SyRS: System Requirements Specification: a document that outlines the functional and non-functional requirements of a system.
- StRS: Stakeholder Requirement Specification: a document that outlines the requirements of a system from the perspective of its stakeholders.
- RVTM: Requirements Verification Traceability Matrix: a document that links requirements to the tests used to verify them.
- MSRP: Manufacturer's suggested retail price: the price recommended by the manufacturer for a product to be sold at retail.
- MTBF: Mean Time Between Failures: a measure of the reliability of a system, calculated as the average time between failures.
- MOE's: Measures of Effectiveness (MOEs): quantitative measures used to assess the performance of a system or process.
- ABS: Anti-Lock Braking Systems: a safety system that prevents the wheels of a vehicle from locking up during braking.
- MPG: Miles per gallon: a measure of fuel efficiency in transportation systems.
- FRP: Full Rate Production: the stage in the development of a system where it is being produced at the maximum rate possible.
- OpsCon: Operational Concept: a document that describes how a system will be used in its intended operational environment.
- SRD: System's Requirement Definition: a document that defines the requirements of a system in detail.
- MOPs: Methods of Procedure: step-by-step instructions for carrying out a specific task or process.
- CPM: Critical Path Method: a project management technique used to identify the critical path of a project and ensure that it is completed on time.

11.0 Appendix(ices)

Appendix(A)- Abbreviations:

- **SyRS: System Requirements Specification**

- **StRS: Stakeholder Requirement Specification**
- **RVTM: Requirements Verification Traceability Matrix**
- **MSRP: Manufacturer's suggested retail price**
- **MTBF: Mean Time Between Failures**
- **MOE's: Measures of Effectiveness (MOEs)**
- **ABS: Anti-Lock Braking Systems**
- **MPG: Miles per gallon**
- **FRP: Full Rate Production**
- **OpsCon: Operational Concept**
- **SRD: System's Requirement Definition**
- **MOPs: Methods of Procedure**
- **CPM: Critical Path Method**

Appendix(b)-Figures/Tables

Organization	Type	Main Interests	Impact
Harley Davidson	Major	The overall development of project and day to day operations	High
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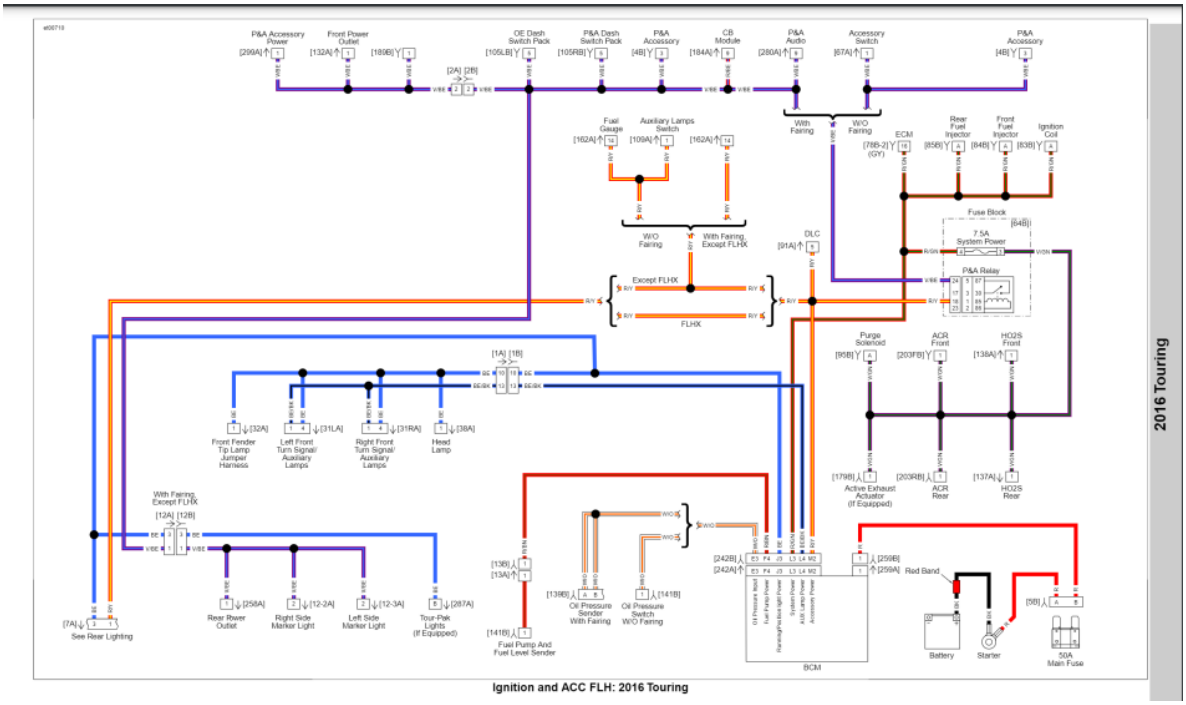

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