Software Requirements Specifications of Integrative Project

**TABLE OF CONTENTS**

1 INTRODUCTION 2

1.1 Document overview 2

1.2 Abbreviations and Glossary 2

1.2.1 Abbreviations 2

1.3 References 2

1.3.1 Project References 2

1.3.2 Standard and regulatory References 2

1.4 Conventions 3

2 REQUIREMENTS 5

2.1 States 5

2.2 Functionalities and Performance 5

2.3 SW\_Configuration 8

2.4 GRAPHIC\_UNIT\_INTERFACE 9

2.5 System Integration 9

2.5.1 Hardware resources 9

2.5.2 Software resources 10

2.6 Verification\_ Transfer function 10

3 VERIFICATION METHODS - STRATEGY 11

4 REQUIREMENTS TRACEABILITY 14

5 CRITICAL REQUIREMENTS 15

# INTRODUCTION

## Document overview

This document presents the software requirements specifications of software development project.

It describes:

* Requirements of functionalities, performances, interfaces, environment …
* Tests principles and definitions of validation methods of requirements,
* The compliance of requirements to customer needs,
* The relative importance and precedence of requirements

## Abbreviations and Glossary

### Abbreviations

RPM

LCD

PWM

SRS

ADC

## References

### Project References

| # | Document Identifier | Document Title |
| --- | --- | --- |
| [R1] | ID | [Integrative Project](stakeholder/20190527%20Requisitos%20del%20proyecto%20integrador%20CESEQ.pdf) |

### Standard and regulatory References

|  |  |  |
| --- | --- | --- |
| # | Document Identifier | Document Title |
| [STD1] | 1.2.1. "SPICE", "CMMI" | [ISO/IEC 15504, CMMI](https://ingertec.com/cmmi-o-iso-iec-15504/)  [ISO/IEC 9899-2011](stakeholder/ISO_IEC9899.pdf)  [ISO/IEC 9899:tc2](stakeholder/ISO-IEC-9899-tc2.pdf)  [CMMI](stakeholder/2018.08.31.SPICE_CMMI.V2.pdf) |
| [STD2] | Code standard | [Programming Standards](stakeholder/ESTANDARESDEPROGRAMACION.pdf) |

## Conventions

|  |  |
| --- | --- |
| Requirement ID | SRS-Power input -001 |
| Title | Main power input |
| Description | The power voltage supply shall be from 9 to 12 Volts DC. |
| Version | V1.0 |
| Requirement ID | SRS-Work load frequency range-002 |
| Title | Main work load frequency range |
| Description | The frequency work load shall be in the f = 100 Hz to f = 1 kHz, range. |
| Version | V1.0 |
| Requirement ID | SRS-PWM Duty Cycle-003 |
| Title | Main duty cycle |
| Description | The PWM duty cycle shall be defined after working frequency, from 0 – 100% |
| Version | V1.0 |
| Requirement ID | SRS-Set point (Speed)-004 |
| Title | Main set- point range |
| Description | The set point shall be defined within the range 0 to 3280 RPM. |
| Version | V1.0 |
| Requirement ID | SRS-Display behaviour-005 |
| Title | Main information displayed |
| Description | The LCD shall display the motor speed, set point and duty cycle percentage. |
| Version | V1.0 |

# REQUIREMENTS

## States

Software functions work in three states:

* Starting: the software loads its components;
* In use: all the functionalities of the software are available to the users;
* Stopping: the software is being stopped.

Note:

A more detailed definition of the states is defined in the [Software design document](../3)%20Design/9.%20SoftwareDesignDocument_20190621.docx).

## Functionalities and Performance

This is the core of the SRS. It contains the purpose of the software expressed in technical requirements.

|  |  |
| --- | --- |
| Requirement ID | SRS-MOTOR VOLTAGE |
| Title | Motor voltage |
| Description | Hardware function shall deliver from 9 to 12V |
| Version | V1.0 |
| **Requirement ID** | **SRS-CARD VOLTAGE** |
| Title | Card voltage |
| Description | Hardware function shall deliver 5V |
| Version | V1.0 |

|  |  |
| --- | --- |
| Requirement ID | SRS-SetPoint |
| Title | SetPoint |
| Description | HARDWARE\_CONFIGURATION for the SetPoint shall be defined as designed and specified in the [Integrative Project document](stakeholder/20190527%20Requisitos%20del%20proyecto%20integrador%20CESEQ.pdf), page 6. |
| Version | V1.0 |
| Requirement ID | SRS-SetPoint\_Adjustment |
| Title | Setpoint\_Adjustment |
| Description | HARDWARE\_CONFIGURATION for SetPoint shall set reference values using the potentiometer as defined in the [Integrative Project document](file:///C:\Users\Alumnos\Documents\GitHub\Proyecto_Integrador\ESTRUCTURA%20DEL%20PROYECTO\1)%20Requirements\stakeholder\20190527%20Requisitos%20del%20proyecto%20integrador%20CESEQ.pdf), page 6 – fig 5. |
| Version | V1.0 |
| Requirement ID | SRS- SetPoint\_Noise\_Atenuation |
| Title | Setpoint SetPoint\_Noise\_Atenuation |
| Description | HARDWARE\_CONFIGURATION SetPoint offset value shall be defined by sampling the signal at 100ms period.  Sampling shall be average to yield offset value. |
| Version | V1.0 |
| Requirement ID | SRS- SetPoint\_Reference\_Value\_UART |
| Title | SetPoint\_Reference\_Value\_UART |
| Description | HARDWARE\_CONFIGURATION SetPoint offset values must be tested as defined in the [Integrative Project document](file:///C:\Users\Alumnos\Documents\GitHub\Proyecto_Integrador\ESTRUCTURA%20DEL%20PROYECTO\1)%20Requirements\stakeholder\20190527%20Requisitos%20del%20proyecto%20integrador%20CESEQ.pdf), page 6 using the UART protocol.  Offset\_ updated \_messsage shall be set to 200 ms.  UART\_transmition\_velocity shall be set to 115200 bps |
| Version | V1.0 |

|  |  |
| --- | --- |
| Requirement ID | SRS-PWM frequency |
| Title | HARDWARE\_CONFIGURATION\_PWM |
| Description | HARDWARE\_CONFIGURATION for the PWM shall be defined at a frequency of 100 Hz to 1Khz of duty cycle. |
| Version | V1.0 |
| Requirement ID | SRS-PWM sampling time |
| Title | HARDWARE\_CONFIGURATION\_PWM |
| Description | HARDWARE\_CONFIGURATION for the PWM shall be sampled within a period of 100ms. |
| Version | V1.0 |
| Requirement ID | SRS-PWM expected values |
| Title | HARDWARE\_CONFIGURATION\_PWM |
| Description | HARDWARE\_CONFIGURATION for the interface shall set discreate values of RPM corresponding to percentage of signal duty cycle as defined in value table in the [Integrative Project document](file:///C:\Users\Alumnos\Documents\GitHub\Proyecto_Integrador\ESTRUCTURA%20DEL%20PROYECTO\1)%20Requirements\stakeholder\20190527%20Requisitos%20del%20proyecto%20integrador%20CESEQ.pdf), page 6 – table 1. |
| Version | V1.0 |
| Requirement ID | SRS-PWM |
| Title | HARDWARE\_CONFIGURATION\_PWM |
| Description | HARDWARE\_CONFIGURATION shall set the output of the Hall\_effect sensor to PID input. |
| Version | V1.0 |

## SW\_Configuration

|  |  |
| --- | --- |
| Requirement ID | SRS-Model |
| Title | Speed control |
| Description | Speed control shall compute the PWM control signal with the 100 ms parameter, with the use of the PID algorithm. |
| Version | V1.0 |
| Requirement ID | SRS-Model |
| Title | Speed control |
| Description | Speed control shall set the motor to the RPM, using the ADC feedback and varying voltage from SetPoint |
| Version | V1.0 |
| Requirement ID | SRS-Controller |
| Title | Speed control\_setpoint |
| Description | Setpoint value shall be read every 100ms.   |  |  |  | | --- | --- | --- | | **Potentiometer voltage** | **% PWM** | **Average velocity [RPM]** | | 0 | 0 | 0 | | 0.825 | 25 | 561 | | 1.65 | 50 | 877 | | 2.475 | 75 | 2576 | | 3.3 | 100 | 3234 | |
| Version | V1.0 |
| Requirement ID | SRS-Controller |
| Title | Speed\_transfer function |
| Description | The [transfer function](#_Verification__Transfer_function) shall be used to generate a speed control |
| Version | V1.0 |

## GRAPHIC\_UNIT\_INTERFACE

|  |  |
| --- | --- |
| Requirement ID | SRS- GUI\_Display |
| Title | GUI\_Display |
| Description | GUI\_Display software shall display the following items:  **Name of the project:** Speed Control DC motor  **Duty cycle:** XXX %  **Speed:** XXXX RPM  **SW:** 1.0  **HW:** CESEQ-C001/CESEQ-P001  **Developers:** Gil, Algemiro  Ramirez, Jesus  Sanchez, Luis |
| Version | V1.0 |

## System Integration

Software shall be integrated in the following six steps:

1. Gather requirements as done in this document.
2. Analysis.
3. Architecture design.
4. Systems integration design.
5. Implementation.
6. Maintenance.

### Hardware resources

|  |  |
| --- | --- |
| Requirement ID | SRS-Speed\_Control (SP\_D)- Renesas |
| Title | Hardware configuration |
| Description | SP\_C shall run with the expected response times on a Synergy S7G2 MCU with the following minimal configuration:   * 2 G RAM * Three user LEDs * Two mechanical switches connected directly to microprocessor interrupt pins * QSPI memory (8 MB) * SPI, IIC, CAN, and SCI interface |
| Version | V1.0 [stakeholder\r12um0004eu0100\_synergy\_sk\_s7g2.pdf](stakeholder/r12um0004eu0100_synergy_sk_s7g2.pdf) |

### Software resources

|  |  |
| --- | --- |
| Requirement ID | SRS-SP\_C-SW |
| Title | Software configuration\_ SP\_C-SW |
| Description | SP\_C-SW runs in the following software environment:   * Renesas e2 estudio \_ V6.2.0 * GIUX Studio v5.4.2.9 * MATLAB 2014b |
| Version | V1.0 [stakeholder\Installation Instructions.pdf](stakeholder/Installation%20Instructions.pdf) |

## Verification\_ Transfer function

* Special transfer function shall be modeled and defined using Matlab (Program to generate transfer function is optional).
* The transfer function shall be implemented in the code to control the speed of the motor.

|  |  |
| --- | --- |
| Requirement ID | SRS-MATLAB\_ Transfer function (TF) |
| Title | MATLAB\_R2017b |
| Description | TF shall be delivered on a file generated by MATLAB “TF.m”  [Process\_reference](stakeholder/Controller.docx) |
| Version | V1.0 |

# VERIFICATION METHODS - STRATEGY

The verification methods of the requirements are defined below:

* Inspection (**I**): control or visual verification
  + Control of the physical implementation or the installation of a component. The control verifies that the implementation or the installation of a component is compliant with the requirements of diagrams.
  + Control of the documentation describing a component. The control verifies that the documentation is compliant with the requirements.
* Analysis (**A**): verification based upon analytical evidences
  + Verification of a functionality, performance or technical solution of a component by analyzing the data collected by tests in real conditions, by simulation of real conditions or by an analysis report.
  + Analysis of test data or of design data is used as appropriate to verify requirements.
  + The verification is based upon analytical evidences obtained by calculations, like modeling, simulation and forecasting.
  + Analysis is used when an acceptable level of confidence cannot be established by other methods or if analysis is the most cost-effective solution.
* Demonstration (**D**): verification of operational characteristics, without quantitative measurement
  + Verifying a requirement by demonstration implies that the required functionality specified by a requirement is complete.
  + Demonstration is used when quantitative measurement is not required for verification of the requirements
  + Demonstration includes the control of the technical solutions specified by the non-functional requirements.
* Test (**T**): verification of quantitative characteristics with quantitative measurement
  + Verifying a functionality, performance or technical solution of a component by executing testing scenarios in predefined, controlled and traceable testing conditions.
  + Tests require the use of special equipment, instrumentation, simulation techniques, or the application of established principles and procedures,
  + Data produced during tests is used to evaluate quantitative results and compare them with requirements.

For each requirement of the SRS, a verification method is defined. Method is abbreviated I, A, D or T.

|  |  |  |
| --- | --- | --- |
| **Requirement ID** | **Requirement Title** | **Method** |
| REQ- 001 | Verify that the color of the display background is blue | I |
| REQ- 002 | Verify that Resnesas Sinergy is SK-S7G2 | I |
| REQ- 003 | Verify that Renesas Sinergy is connected to PC to flash SP\_C software | I |
| REQ- 004 | Verify that Motor is connected to the Renesas as shown in diagram. | I |
| REQ- 005 | Verify that firmware version on electronic card is 1.0.1 | I |
| REQ- 006 | Verify that Display is initialized as soon card is on | D |
| REQ- 007 | Verify that SW is flashed to electronic card | D |
| REQ- 008 | Verify that the speed is displayed in rpm | D |
| REQ- 009 | Verify that the result is displayed as per requirement “[SRS- HMI\_Display](#_Human_Machine_Interface)” | D |
| REQ- 010 | Verify that if a value is out of range, a warning is displayed | D |
| REQ- 011 | Verify that Speed Control is implemented using PID algorithm | A |
| REQ- 012 | Verify that PID algorithm is implemented as per modeling in development document and transfer function as per requirement “[SRS-MATLAB\_ Transfer function (TF)](#_Verification__Transfer_function)” | A |
| REQ- 013 | Verify that SetPoint is defined as per requirement “[SRS-Controller](#_SW_Configuration)” | A |
| REQ- 014 | Verify that the PWM is define as per the requirement “[SRS-PWM](#_Functionalities_and_Performance)” | A |
| REQ- 015 | Verify that SP\_C is defined as per output requirements “[SRS-PWM](#_Functionalities_and_Performance)” | A |
| REQ- 016 | Verify that ACD\_thread\_entry is 0% PWM  Verify that ACD\_thread\_entry is 25% PWM  Verify that ACD\_thread\_entry is 50% PWM  Verify that ACD\_thread\_entry is 75% PWM  Verify that ACD\_thread\_entry is 100% PWM | T |
| REQ- 018 | Verify that IC\_thread intput is **p\_arg** | T |
| REQ- 020 | Verify that **Refresh\_screen()** intputs are **IC\_thread**, **ADC\_thread** and **Display\_thread** | T |

Note: do not mistake the two meanings of the word “test” in this document:

* The method of verification, named Test and abbreviated (T), as defined above.
* A test, or test case, is a sequence of actions to verify a requirement. Tests are defined in the software test plan.

Rule of thumb for software, 80% of requirements are verified by demonstration, 15% by inspection and 5% by analysis or test methods.

# REQUIREMENTS TRACEABILITY

Table with traceability of software requirements of this document with user or system requirements.

|  |  |  |
| --- | --- | --- |
| SRS Req. | Req Title | Functional Req. |
| SRS -001 | Power input | SRS-VOLTAGE |
| SRS -002 | Work load frequency range | SRS-Model |
| SRS- 003 | PWM Duty Cycle | SRS-Model |
| SRS-004 | Set point (Speed) | SRS-Controller |
| SRS -005 | Display behavior | SRS- GUI\_Display |

# CRITICAL REQUIREMENTS

|  |  |  |
| --- | --- | --- |
| Requirement ID | Requirement Title | Origin |
| REQ-001 | Customer requirements are extreme | [Risk Analysis](../2)%20Planning/8.%20FMEA_20190405.xls) |
| REQ-002 | Requirement change, unplanned task, time consumption, quality and completeness of project fails. | [Risk Analysis](file:///C:\Users\jesus\Documents\GitHub\Proyecto_Integrador\ESTRUCTURA%20DEL%20PROYECTO\2)%20Planning\8.%20FMEA_20190405.xls) |
| REQ-003 | Team does not set peer reviews to verify that SW implementation meets customer requirements. | [Risk Analysis](file:///C:\Users\jesus\Documents\GitHub\Proyecto_Integrador\ESTRUCTURA%20DEL%20PROYECTO\2)%20Planning\8.%20FMEA_20190405.xls) |
| REQ-004 | Product does not meet customer expectation. | [Risk Analysis](file:///C:\Users\jesus\Documents\GitHub\Proyecto_Integrador\ESTRUCTURA%20DEL%20PROYECTO\2)%20Planning\8.%20FMEA_20190405.xls) |
| REQ-005 | Do not open file if no patient name | [Risk Analysis](file:///C:\Users\jesus\Documents\GitHub\Proyecto_Integrador\ESTRUCTURA%20DEL%20PROYECTO\2)%20Planning\8.%20FMEA_20190405.xls) |
| REQ-006 | Display negative values incorrect | Human factor engineering |
| REQ-007 | Facilities:  Holidays.  • The laboratory is busy.  • UTEQ does not open its facilities.  Externals  • Loss of power.  • Weather  Equipment  • Malfunction | Planning - [Risk](../Software%20Development%20Plan.docx) |
| REQ-008 | Team:  Illness  • Vacations  • Work  Others  • Adviser availability | Planning - [Risk](../Software%20Development%20Plan.docx) |
| REQ-009 | Development environment.  • PC malfunction  • PC not configured  • Wrong configuration | Planning - [Risk](../Software%20Development%20Plan.docx) |