

System Requirements Document

(SRD)

Whiteboard Cleaner

|  |  |  |
| --- | --- | --- |
| **Enschede, August 21, 2018** |  |  |
| **Mechatronica** |  |  |
| **Version 0.1** |  |  |
| **Opgesteld door:** | **Klas: EMT2** | **Group: 4** |
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**Version management**

|  |  |  |  |  |
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| **Version** | **Date** | **Author** | **Changes made** | |
| 0.1 | 5-4-2018 | Jordy van Dillen | Initial version | |
|  |  | Lieke Nijhof |  |  |
|  |  | Steven Visch |  |  |
|  |  | Rens Buschers |  |  |
| 1.0 | 12-4-2018 | Jordy van Dillen | - | Consistent terms used (device/robot => |
|  |  | Lieke Nijhof |  | system) |
|  |  |  | - | Corrected double requirements |
|  |  |  | - Corrected ‘broken English’ in | |
|  |  |  |  | requirements |
|  |  |  | - | Added function (Un)mounting |
|  |  |  | - | Corrected functional diagrams |
|  |  |  | - | Removed unnecessary chapter |



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**1 Goal**

**1.1 Main goal of the project**

The goal of the project is to design a system that can clean a whiteboard with dimensions of a Saxion whiteboard. The system needs to be fixed to a whiteboard and will clean the whiteboard within a certain period of time. The system shouldn’t take up too much space on the board. Besides the system needs to be easy to use so that a lot of teachers can use the system, and move them to another whiteboard.

With the requirements provided by the client, the project group will design a system that can clean a whiteboard and meets all the requirements.

**1.2 Overview of document**

This document defines the functional and system requirements of the system.

Chapter 2 covers the user scenarios and user requirements:

* User requirements
* Multiple user scenarios

Chapter 3 covers the functional aspects:

* The functions of the system
* Functional requirements to be fulfilled
* External interfaces
* Requirements imposed on its external interfaces

Chapter 4 covers the technical (or design) aspects:

* Safety requirements (CE)
* Cost
* Physical properties (dimensions, weight etc.)
* Environmental (temperature, humidity)
* Mechanical design (weight, eraser type)
* Electrical and electronical design (power supply)

Chapter 5 covers the quality system test plan:

* Requirement verification
* Selection of 5 CTQ’s



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**2 User description**

**2.1 Interested parties**

The various stakeholders which are related to this project will be displayed below, an explanation will be provided per stakeholder.

**2.1.1 Main stakeholders:**

* Client: Vincent Schut, head of the LSD comity
* Customer: Teachers at Saxion University of Applied Sciences
* The R&D (Research and Development) team, consisting of: o Jordy van Dillen

o Lieke Nijhof o Steven Visch o Rens Buschers

**2.1.2 Secondary stakeholders:**

* Supervisors of the project group: o Gerdine Meijer

o Vincent Schut

* The Finance department of Saxion University of Applied Sciences
* The development team

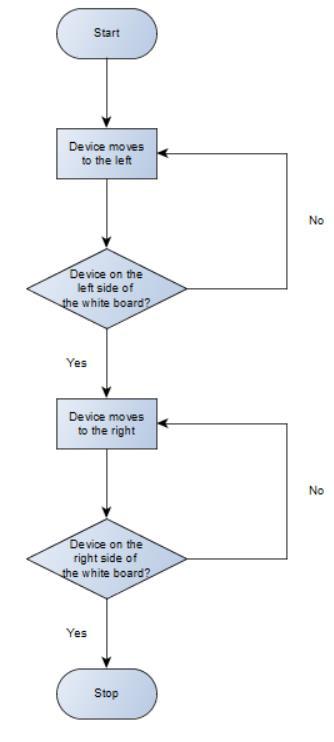
**2.2 User requirements**

* The maximum weight of the system is restricted to the maximum lifting weight according to the ARBO/FNV.
* The system must have maximum dimensions with the height of the whiteboard, the width of an A4 and the same depth.
* The system must be able to work on a normal wall socket.
* The system must have a maximum manufacturing costs of 50.000 euro’s for 50 pieces.
* The system may not have a disturbing color.
* The system may not make more noise than an electric toothbrush.
* The system must be able to be turned on and off
* The system shall not move while emergency stop is pressed down.
* The system must be able to show its status.



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**2.3 User scenario(s)**

****

**Figure 1: flowchart system**

This flowchart describes the main process of the system. The additional scenarios are described in the following part of this chapter.



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**2.3.1 User scenario 1:**

-The system will be switched on

-The system moves over the whiteboard, while it stays against the whiteboard -The system cleans the space it has passed -The system is at the end of the whiteboard

-The system goes back to its initial position

**2.3.2 User scenario 2:**

-The system is off

-The user switches the brushes

**2.3.3 User scenario 3:**

-The system is off

-The user takes the system of the whiteboard

-The user attaches the system to another whiteboard

**2.3.4 User scenario 4:**

-The system will be turned on

-The system moves over the whiteboard, while it stays against the whiteboard -The system cleans the space it has passed -The emergency stop is pushed

-The system stops all his actions

**2.3.5 User scenario 5:**

-The emergency stop is pushed

-The system stops all its actions

-The emergency stop is released

-The system goes back to its initial position



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**2.4 User requirements**

**User scenario 1: Run whiteboard-cleaner**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Number** | **Requirement** | **Minimum/** | **Value** | **Unit** |
|  |  | **maximum/** |  |  |
|  |  | **equal** |  |  |
| GE0101 | The user needs to be able to turn the system | = | True |  |
|  | on/off |  |  |  |
| GE0102 | The system needs to stay against the | = | True |  |
|  | whiteboard |  |  |  |
| GE0103 | The system needs to be able to move over | = | True |  |
|  | the whiteboard |  |  |  |
| GE0104 | The system needs to stay on the whiteboard | = | True |  |
| GE0105 | The system needs to clean the whiteboard | = | True |  |
| GE0106 | The system needs to go to its initial position | = | True |  |
|  | when it’s finished cleaning. |  |  |  |
| **User scenario 2: Switch brushes** | |  |  |  |
| **Number** | **Requirement** | **Minimum/** | **Value** | **Unit** |
|  |  | **maximum/** |  |  |
|  |  | **equal** |  |  |
| GE0201 | The user must be able to replace the brushes | = | True |  |
|  | with the standard whiteboard brushes Saxion |  |  |  |
|  | provides. |  |  |  |
| Note: See chapter 6.1 for more information | |  |  |  |
| **User scenario 3: Mounting/ unmount** | |  |  |  |
| **Number** | **Requirement** | **Minimum/** | **Value** | **Unit** |
|  |  | **maximum/** |  |  |
|  |  | **equal** |  |  |
| GE0301 | The user needs to be able to carry the system | = | True |  |
| GE0302 | The user needs to be able to mount and | = | True |  |
|  | unmount the system of the board |  |  |  |



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
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| **User scenario 4: Run cleaner -> emergency stop** | |  |  |  |  |
| **Number** | **Requirement** | **Minimum/** | **Value** | **Unit** |  |
|  |  | **maximum/** |  |  |  |
|  |  | **equal** |  |  |  |
| GE0401 | The user must be able to turn on the system | = | True |  |  |
| GE0402 | The user needs to be able to push the | = | True |  |  |
|  | emergency stop |  |  |  |  |
| GE0403 | The system should be attached to a | = | True |  |  |
|  | whiteboard |  |  |  |  |
| GE0404 | The system needs to be able to move over | = | True |  |  |
|  | the whiteboard |  |  |  |  |
| GE0405 | The system needs to stay on the whiteboard | = | True |  |  |
|  | when attached and does not come loose |  |  |  |  |
| GE0406 | The system needs to clean the whiteboard | = | True |  |  |
| GE0407 | The system needs to stop all its actions when | = | True |  |  |
|  | the emergency stop is pressed |  |  |  |  |
| **User scenario 5: Emergency stop -> startposition** | |  |  |  |  |
| **Number** | **Requirement** | **Minimum/** | **Value** | **Unit** |  |
|  |  | **maximum/** |  |  |  |
|  |  | **equal** |  |  |  |
| GE0501 | The system needs to go back to the begin | = | True |  |  |
|  | position after the emergency stop is released |  |  |  |  |



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**3 Functional description and requirements**

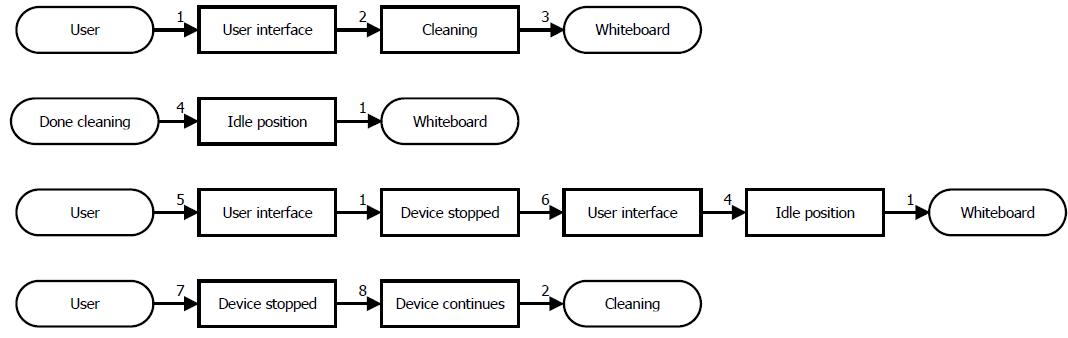
**3.1 Functional description**

This system needs to fulfil multiple functions, besides cleaning the whiteboard. As described in the previous chapter, the system has 5 different scenarios it needs to comply to. With each of these given scenarios, functions can be extracted. These functions are:

1. **Idling**: staying in idle position
2. **Moving**: moving on the surface of the whiteboard
3. **Cleaning**: cleaning the whiteboard
4. **homing**: going back to idle position after cleaning
5. **Emergency** stop: performing an emergency stop
6. **Resetting**: recovering from emergency stop
7. **Detecting**: The system detects any kind of resistance
8. **(Un)mounting**: The device is mounted to- and unmounted from the whiteboard

**3.2 Functional architecture**

The 4 main functional architectures which the products needs to fulfil are given in the flowcharts below. All the actions at the arrows are numbered, and these numbers correspond to the main functions given in chapter 3.1.



**3.2.1 User scenario 1: Cleaning**

**Function 1: Idling**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Number** | **Requirement** | **Minimum/** | **Value** | **Unit** |
|  |  | **maximum/** |  |  |
|  |  | **equal** |  |  |
| FE0101 | The system is located in its pre-defined idle | = | True | - |
|  | position on the whiteboard |  |  |  |
| FE0102 | The system does not move when in idle | = | True |  |
|  | position |  |  |  |



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
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| **Function 2: Moving** | |  |  |  |  |
| **Number** | **Requirement** | **Minimum/** | **Value** | **Unit** |  |
|  |  | **maximum/** |  |  |  |
|  |  | **equal** |  |  |  |
| FE0201 | The system detects whether it is attached to | = | True |  |  |
|  | the board |  |  |  |  |
| FE0202 | The systems is able to move along the width | = | True |  |  |
|  | of the whiteboard |  |  |  |  |
| FE0203 | The systems is able to move along the height | = | True |  |  |
|  | of the whiteboard\* |  |  |  |  |

Notes: \*Only if design fulfils this requirement. If not, this requirement can be ignored.

**Function 3: Cleaning**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Number** | | **Requirement** | **Minimum/** | **Value** | **Unit** |
|  |  |  | **maximum/** |  |  |
|  |  |  | **equal** |  |  |
| FE0301 | | The system needs to clean the whiteboard | = | True |  |
| FE0302 | | The system moves while cleaning the | = | True |  |
|  |  | whiteboard |  |  |  |
| FE0303 | | The system cleans the whiteboard’s surface | ≥ | 90 | % |
|  |  | by a significant amount |  |  |  |
| FE0304 | | Cleaning time (operation time) | < | 60 | Seconds |
| **Function 4: Homing** | | |  |  |  |
| **Number** | | **Requirement** | **Minimum/** | **Value** | **Unit** |
|  |  |  | **maximum/** |  |  |
|  |  |  | **equal** |  |  |
| FE0401 | | When finished cleaning, the system moves | = | True |  |
|  |  | back to its idle position |  |  |  |
| FE0402 | | When at idle position, the system stops | = | True |  |
|  |  | moving |  |  |  |
| **Function 5: Emergency stop** | | |  |  |  |
| **Number** |  | **Requirement** | **Minimum/** | **Value** | **Unit** |
|  |  |  | **maximum/** |  |  |
|  |  |  | **equal** |  |  |
| FE0501 | While moving, the system stops when the | | = | True |  |
|  |  | emergency switch is pressed |  |  |  |
| FE0502 | The system shall not move while emergency | | = | True |  |
|  |  | stop is pressed down. |  |  |  |
| FE0503 | The emergency stop button does not reset | | = | True |  |
|  |  | itself\* |  |  |  |

Notes: This means that the emergency stop button is of a locking type. The user needs to perform an action in order to reset the system



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
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| **Function 6: Resetting** | |  |  |  |  |
| **Number** | **Requirement** | **Minimum/** | **Value** | **Unit** |  |
|  |  | **maximum/** |  |  |  |
|  |  | **equal** |  |  |  |
| FE0601 | The user needs to provide input in order to | = | True |  |  |
|  | reset the system |  |  |  |  |
| FE0602 | The system moves back to idle position after | = | True |  |  |
|  | emergency stop button has been released |  |  |  |  |
| **Function 7: Detection** | |  |  |  |  |
| **Number** | **Requirement** | **Minimum/** | **Value** | **Unit** |  |
|  |  | **maximum/** |  |  |  |
|  |  | **equal** |  |  |  |
| FE0701 | The system shall be able to sense any kind of | = | True |  |  |
|  | resistance from objects on the whiteboard |  |  |  |  |
| FE0702 | The system stops moving if the user | = | True |  |  |
|  | interferes with the system |  |  |  |  |
| FE0703 | The device stops moving if the edge of the | = | True |  |  |
|  | board is detected |  |  |  |  |
| **Function 8: (Un)mounting** | |  |  |  |  |
| **Number** | **Requirement** | **Minimum/** | **Value** | **Unit** |  |
|  |  | **maximum/** |  |  |  |
|  |  | **equal** |  |  |  |
| FE0801 | The device needs to be mounted on a | = | True |  |  |
|  | whiteboard |  |  |  |  |
| FE0802 | The device needs to stay attached to a | = | True |  |  |
|  | whiteboard when mounted\* |  |  |  |  |
| FE0803 | The device can be unmounted from the | = | True |  |  |
|  | whiteboard |  |  |  |  |

Notes: \*It should not fall off the whiteboard when mounted.

**3.3 External interfaces**

**3.3.1 External interfaces**

The whiteboard-cleaner is compatible with a selection of whiteboards which are already being used in class and has to connect to different external interfaces. All the external interfaces that are relevant will be discussed in this chapter. External interfaces:

* User interface
* Power supply
* Whiteboard



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**3.3.2 Requirement through external interfaces**

**External interface 1: User interface**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Number** | **Requirements** | **Minimum/** | **Value** | **Unit** |
|  |  | **maximum/** |  |  |
|  |  | **equal** |  |  |
| EIE0101 | Can be started with one action | = | True |  |
| EIE0102 | The product can display its current state | = | True |  |
|  | (on/off, emergency). |  |  |  |
| EIE0103 | Start button available | = | True |  |
| EIE0104 | Emergency button available | = | True |  |
| EIE0105 | Power indicator LED available | = | True |  |
| EIE0106 | Error indicator LED available | = | True |  |
| **External interface 2: Power supply** | |  |  |  |
| **Number** | **Requirements** | **Minimum/** | **Value** | **Unit** |
|  |  | **maximum/** |  |  |
|  |  | **equal** |  |  |
| EIE0201 | Connection to mains power supply | = | True |  |
| EIE0202 | Power supply voltage (primary) | = | 230 | VAC |
| EIE0204 | Plug type\* | = | Euro |  |
| EIE0205 | Plug type\* | = | Schuko |  |

Notes: \*One of these plug types has to be used. If Euro plug is used, EIE0205 can be ignored, and if Schuko is used, EIE0204 can be ignored.

**External interface 3: Whiteboard**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Number** | **Requirements** | **Minimum/** | **Value** | **Unit** |
|  |  | **maximum/** |  |  |
|  |  | **equal** |  |  |
| EIE0301 | The whiteboard has a width of max 2 meters | = | True |  |
|  | and min of 10 centimeters. |  |  |  |
| EIE0302 | The whiteboard has a height of 1 meter | = | True |  |



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**4 Technical requirements**

**4.1 Technical requirements**

In this chapter the technical requirements on the design of the system will be defined. The requirements have been divided in multiple parts. This paragraph defines all requirements related to the design of the system.

**Technical requirements**

**4.1.1 Safety**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Number** | **Requirements** | **Minimum/** | **Value** | **Unit** |
|  |  | **maximum/** |  |  |
|  |  | **equal** |  |  |
| TE0101 | Noise level at one meter distance | ≤ | 60 | dB |
| TE0102 | System is protected from improper use | = | True | - |
| TE0103 | User manual | = | True | - |
| TE0104 | Conform to directive 2006/42/EG (CE | = | True | - |
|  | marking) |  |  |  |
| TE0105 | System must be water resistant | = | False | - |
| TE1016 | The system must feature an emergency | = | True |  |
|  | button |  |  |  |
| **4.1.2 Cost** |  |  |  |  |
| **Number** | **Requirements** | **Minimum/** | **Value** | **Unit** |
|  |  | **maximum/** |  |  |
|  |  | **equal** |  |  |
| TE0201 | Price 50 units | ≤ | 50.000 | € |
| **4.1.3 Physical properties** | |  |  |  |
| **Number** | **Requirements** | **Minimum/** | **Value** | **Unit** |
|  |  | **maximum/** |  |  |
|  |  | **equal** |  |  |
| TE0201 | Weight system\* | ≤ | 11,6 | kg |
| TE0202 | Height system | ≤ | 120 | cm |
| TE0203 | Width system | ≤ | 22 | cm |
| TE0204 | Depth system | ≤ | 22 | cm |
| TE0205 | System has to stay against whiteboard | = | True |  |
| TE0206 | System has to have neutral looks | = | True |  |

Note: See chapter 6.2



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**4.1.4 Environmental**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Number** | **Requirements** | **Minimum/** | **Value** | **Unit** |
|  |  | **maximum/** |  |  |
|  |  | **equal** |  |  |
| TE0201 | Ambient high temperature | ≤ | 30 | ᴼC |
| TE0202 | Ambient low temperature | ≥ | 10 | ᴼC |
| TE0203 | Relative humidity | ≤ | 70 | % |
| TE0204 | Conform to directive 2014/30/EU (CE | = | True | - |
|  | marking) |  |  |  |
| TE0205 | Compatible width whiteboard | ≥ | 50 | Cm |
| TE0206 | Compatible height whiteboard | = | 100 | Cm |
| **4.1.5 Mechanical design** | |  |  |  |
| **Number** | **Requirements** | **Minimum/** | **Value** | **Unit** |
|  |  | **maximum/** |  |  |
|  |  | **equal** |  |  |
| TE0201 | Maximum weight of the system (per modular | ≤ | 11,6 | Kg |
|  | part) |  |  |  |
| TE0202 | Compatible with a standard whiteboard brush |  |  |  |
|  | provided by Saxion\* |  |  |  |
| TE0203 | The systems exterior must not have a |  |  |  |
|  | distracting color |  |  |  |
| Note: See chapter 6.1 for more information | |  |  |  |
| **4.1.6 Electrical and electronical design** | |  |  |  |
| **Number** | **Requirements** | **Minimum/** | **Value** | **Unit** |
|  |  | **maximum/** |  |  |
|  |  | **equal** |  |  |
| TE0201 | Conform to directive 2014/35/EU (CE | = | True | - |
|  | marking) |  |  |  |
| TE0202 | Power source type | = | Mains | - |
|  |  |  | outlet |  |
| TE0203 | Current required for normal use | ≤ | 10 | Ampere |
| TE0204 | Voltage primary side of transformer | = | 230 | Volts |
| TE0205 | Maximum voltage at secondary side of | ≤ | 24 | Volts |
|  | transformer |  |  |  |
| TE0206 | Current type at secondary side of transformer | = | Direct | - |
|  |  |  | current |  |



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**5 System test plan**

To validate the system certain aspects have to be tested, 5 CTQs have been selected and for each one a test plan has been set up.

**5.1 Selection of 5 CTQs**

In order to provide an overview five CTQs (critical to quality) have been selected, for each of these requirements a system test plan will be created and described in chapter 5.2.

|  |  |
| --- | --- |
| **Number** | **Requirement** |
| GE0105 | The system needs to clean the whiteboard |
| FE0304 | Cleaning time < 60 seconds |
| GE0302 | The system must be removable from a |
|  | whiteboard. |
| GE0407 | The system needs to stop all its actions when |
|  | the emergency stop is pressed. |
| GE0201 | The user must be able to replace the brushes |
|  | with the standard whiteboard brushes Saxion |
|  | provides. |
| FE0702 | The system stops moving when the user |
|  | interferes with the system |

**5.2 System test plan**

All of the CTQs are covered in four different tests.

**5.2.1 Test 1 (GE0105, FE0304)**

* Purpose of test

The whiteboard-cleaner needs to be able to properly clean a whiteboard, otherwise it won’t be a useful system. After it is done cleaning, the system needs to go back to its initial position

* Test protocol
  1. Place the system on an appropriate whiteboard.
  2. Put the power plug in the socket (230V, 10A).
  3. Switch on the system.
* Test criteria
  1. The system needs to stay on the whiteboard.
  2. The system has to power on.
  3. The system has to go to its initial (has yet to be determined) position.
  4. The system needs to clean over the whiteboard.
  5. The system needs to return to its initial position within 60 seconds.
  6. The whiteboard has to be clean when the system is finished.
* Processing and evaluation of the results



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The tester will observe whether the system meets the test criteria, for a whiteboard to be clean it has to be around 90-95% clean, a few marks here and there aren’t much of a problem.

**5.2.2 Test 2 (GE407)**

* Purpose of test

The system has to be able to respond when the emergency button is pressed, otherwise it would be dangerous.

* Test protocol
  1. Place the system on an appropriate whiteboard.
  2. Put the power plug in the socket (230V, 10A).
  3. Switch on the system.
  4. While the system is in operation press the emergency stop.
  5. Release the emergency stop when the system has stopped all of its activities.
  6. Wait for the system to go to its initial position
* Test criteria
  1. The system has to stop all of its actions as soon as the emergency stop is pressed.
  2. The system has to return to its initial position when the emergency stop is released.
* Processing and evaluation of the results

The tester will observe whether the system meets the test criteria.

**5.2.3 Test 3 (FE0702)**

* Purpose of test

The system needs to detect whether something is interfering, otherwise someone could get hurt.

* Test protocol
  1. Switch on the system
  2. While the system is in operation hold something next to the system
* Test criteria
  1. The system must stop all of its actions when something is next to the system.
* Processing and evaluation of the results

The tester will observe whether the system stops in time, so the system won’t hit the object held next to it.



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**5.2.4 Test 4 (GE201, GE0302)**

* Purpose of test

The brushes need to be replicable, otherwise the lifespan would be very short.

* Test protocol
  1. Remove the system from the board.
  2. Open the brush clamps.
  3. Replace the brushes.
  4. Close the brush clamps.
  5. Place the system back on the board.
  6. Put the power plug in the socket (230V, 10A)
  7. Switch on the system.
* Test criteria
  1. The clamps must be able to open and close.
  2. The brushes must become free when the clamps open.
  3. The brushes must be fixed when the clamps are closed
* Processing and evaluation of the results

The tester will observe whether the system meets the test criteria.



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**6 External References**

**6.1 Possible whiteboard eraser types**

Saxion University of Applied Sciences provides two possible types of whiteboard eraser.

These are:

* Type 1:

Brand:Staples

|  |  |
| --- | --- |
| Order number: | 7295961 |
| - Type 2: |  |
| Brand: | Office Depot |
| Order number: | 3439503 |

**6.2 Calculation of maximum weight**

The maximum weight of the product is defined by the ARBO regulation. The calculator used for this requirement can be found at the following webpage: <https://www.arbobondgenoten.nl/arbothem/lichblst/lifttest.htm>

