Rainbow FW Specification

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| --- | --- | --- | --- |
| Department: | HACH |  |  |
| Project Name: | Rainbow | Version: | V0.8 |
| Doc Reference Nb.: | RB FW Spec | Date: | 2016-10-19 |

Executive definition & objectives:

**This template is intended for**

Show the firmware spec against the Product Specification from BU.

This document has to contain the product architecture that will later be used as a reference and major input for the Implementation & Validation phase.

For identified critical component the detailed design at component level will be described in Technical Specification.

|  |  |  |
| --- | --- | --- |
| Deliverable Name | Rainbow FW Specification | Toll Gate |
| TG1 |  |
| TG2 |  |
| TG3 |  |
| TG4 |  |
| TG5 |  |
| TG6 |  |

|  |  |  |  |
| --- | --- | --- | --- |
| Status | Draft | In Review | Official |

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| --- | --- | --- |
| Roles | Function | Name |
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| Approvers | Product Planner  Project Leader |  |

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| --- | --- | --- | --- | --- |
| Document Revision History | | | | |
| Version | Date yyyy/mm/dd | Authors | Modifications Details | Feedback File |
| V0.1 | 2016-10-31 | Paul Li | Creation |  |
| V0.2 | 2016-11-08 | Paul Li | Update to add some requirements mentioned in Shimadzu user manual |  |
| V0.3 | 2016-11-09 | Paul Li | After review |  |
| V0.4 | 2016-11-18 | Paul Li | Update IO/Calibration/Auto Range |  |
| V0.5 | 2017-05-10 | Paul Li | Update the priority of clean/measure/calibration  Update safety related measure  Make note about likely changed requirements due to new PS. |  |
| V0.6 | 2017-7-19 | Paul Li | Fix the requirements except 4.13 and 4.19 with Planner (goubo) and system engineer(april); |  |
| V0.7 | 2017-10-18 | Paul Li | After open discussing with planner(Goubo), UI designer(Biwen) and system enigneer(April) Update the schedule about free trigger;  Update diagnosis part after internal discussion with team.  Update to add device state and safety measures. |  |
| V0.8 | 2017-10-19 | Paul Li | Add PCB test requirements, tobe reviewed |  |

|  |  |  |  |
| --- | --- | --- | --- |
| Linked Documents | | | |
| Name | Reference | Author | Comments |
| Rainbow performance specification |  | Liu Hanchao |  |
| Rainbow System PS |  | Diao,jie |  |
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# Purpose

The purpose of this document is the measure and control board software functional requirement specification for the Rainbow project.

# Definitions, Acronyms, and Abbreviations

## Definitions

|  |  |
| --- | --- |
| **Term** | **Definition** |
| EEPROM | Electrical Erasable Programmable Read Only Memory |
| HMI/UI | Human Machine Interface Board |
| LRV | Lower Range Value |
| URV | Upper Range Value |
| AO/CO | Current output |
| HAL | Stm32 Hal driver released by ST |
| CMDs | Commands implemented by communication. |

## Document Conventions

Software requirements are identified using the following in-line table format:

| Ident. | Definition / Motivation | Priority | Source |
| --- | --- | --- | --- |
|  |  | **Stability** |

Each field is described in the following list:

**Ident.** A unique identifier for the Requirement

**Priority** one of: **M**andatory / **D**esirable / **F**uture

**Stability** one of: **C**ommitted (Agreed by approvers) / **N**ot yet agreed / **L**ikely to change

# Non Functional Requirements

## General

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| NFR\_G\_1 | **Microcontroller**  The P for Control board is Stm32f429II  The P for IO/AO board is Stm32f072 | **Stability**  C |

## Software Verification and Validation

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| NFR\_SW\_1 | **Static Code Analysis**  The “*Static Code Analysis*” of C-Code shall be performed with the PC-Lint tool and passed with the warning level 3. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| NFR\_SW\_2 | **Module Test**  The “*Module Test*” in this project scope will check the operations and their relations within the system.  If required, a specific test container environment could be used to simulate the module input signal.  The Module test should be implemented mostly as **code automated test** to make regression tests simpler.  The Module test will be done by the developer and reviewed with the code review procedure  **Code Coverage**  The Module tests shall cover all implemented functions. If the Module test of a single function makes no sense because functionality is only testable together with another function (e.g. in low level hardware interface functions), then it is allowed to test these functions together in one Module test. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| NFR\_SW\_3 | **Code Review**  For the “*Code Review*” procedure a second developer checks the implementation by using the code review questionnaire and his experience about embedded software behavior.  The Code Review shall be carried out for the complete source code. | **Stability**  C |

## Other

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| NFR\_O\_1 | **Dynamic memory**  Dynamic memory allocation shall not be used to avoid allocation/de allocation problems. With exception when those code are reviewed. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| NFR\_O\_2 | **Manufacturing**  The manufacturing shall be able to read and write all the parameters of the device. | **Stability**  C |

# Functional Requirements

## General

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_G\_1 | **EEP Storage**  All the configuration parameter shall be stored in EEPROM. The data shall be protected in case of error data.  Device shall have data integrity when line power is down. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_G\_2 | **Write protection**  The system could be configured as write-protected after the data is change. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_G\_3 | **RTC**  Shall enable the RTC and revord the RTC time in data log  The RTC shall be able to be configured outside. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_G\_4 | **CPU Load**  Shall calculate CPU Load during run-time. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_G\_6 | **Watch Dog**   1. Trigger HW-WatchDog cyclically. 2. Supervise deadlocks and long time no execution of tasks. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_G\_7 | **System Reset**   1. Shall support device reset; 2. Shall save all non-volatile data before reset. 3. The reset or startup action shall be stored in event log; | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_G\_8 | **Temperature**  Shall measure environment temperature, colorimeter temperature and other temperature(such as sample) | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_G\_9 | **Instrument information**   1. S/N 2. Type of instrument, 3. SW version 4. HW version | **Stability**  C |

## Non-Volatile Data Storage

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_NV\_1 | **Non-Volatile Storage**   1. Customer configurations for the transmitter shall be saved within 1 second once the parameter changed. 2. The NV data shall be possible to be initialized by Communication. 3. Faults should be recognized (CRC16 protection) and repaired (Shadow copy). 4. Errors should be recognized. 5. Format NV data could be enabled by specific CMDs. 6. Customers are not allowed to format factory calibration data. 7. Cyclic asynchronous saving for frequently changed data. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_NV\_2 | **Operation of Non-Volatile Storage**   1. Reset to Default, Provide a method to reset variables to default stored in ROM or NV memory. 2. Load Rom Default. Provide a method to initialize variables with ROM default value. 3. Save As Default. Provide a method to save variables as default which also be saved in NV memory. | **Stability**  C |

## Shell

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_SP\_1 | **Shell**   1. Use one UART port with fix setting, 115200, 8, 1, none. 2. Shall support putty as the remote console. 3. Shall support following commands: 4. Read Object 5. Write Object 6. Read Memory 7. Write Memory | **Stability**  C |

## Device State

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_DS\_1 | **Device State**   1. Idle State 2. No flow action except MIX idle function. 3. Heat ctrl is keeping running all the time. 4. Device could receive and execute the trigger actions. 5. Device could execute schedule action. 6. Busy State 7. Device is executing trigger action or schedule actions. 8. Stop/Break sate 9. Device action -> Stop or Break is called. After reset, device is entering idle state first. 10. Device stop schedule but trigger action is accepted. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_DS\_2 | **Device Action**   1. Stop Action:    1. Device could go to stop state any time;    2. When enter stop state, device needs to do following things: 2. Stop current flow and schedule action; 3. Clear all trigger actions; 4. Stop schedule; 5. Do flush or other related post action.    1. Device could only receive trigger actions from UI when enter Stop state; 6. Start Action 7. Scheduled action is executed with highest priority. 8. Device could execute the trigger actions in order when device is idle. 9. Break Action 10. Same as stop action, but without post actions. 11. Device could receive trigger actions always. 12. Device shall recover from break state after reset. | **Stability**  C |

## Schedule

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_SCH\_1 | **Schedule Priority**   1. Three actions below are able to be configured as periodically, and the priorities when scheduled at the sametime: 2. Cleaning (highest) 3. Calibration (high) 4. Measure (low) 5. Each action shall be complementged when missed in schedlued time. ~~Exception when device is in service mode, the missed action shall not be complemented.~~ 6. The triggered action(clean,calibration and measure) with the same range index could be recognized one scheduled action. | **Stability**  C |

## Trigger

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_SCH\_1 | **Trigger**   1. Those actions below with specific range index could be triggered.    1. Drain    2. Flush    3. Prime    4. Offline Measurement    5. Online Measurement    6. Standard 0 verification    7. Standard 1 verification    8. Measure    9. Calibration    10. Clean    11. Specific flow steps    12. Disable Schedule    13. Recovery from Stop(Enable schedule). 2. Actions shall be executed in order when device is idle. 3. The trigger could be triggerred by UI,IO and Modbus. 4. The new triggerred action is pushed in queue and is executed in order. 5. Trigger action has lower priority against schedule task. | **Stability**  C |

## Measurement

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_MEA\_1 | **Deep Flush**   1. The flush volume could be configured below in service mode. 2. flush time (30~120 sec) 3. Deep flush could be configured by user as enabled for each measurement. | **Stability**  L |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_MEA\_2 | **Measure Average**  The average measure points shall be configurable 2 ~ 5;   1. >3: remove the max and min point, then do average ; 2. =3: remove the max and min point, then middle value 3. <3: average value | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_MEA\_3 | **Retest option:**   1. This option could be enabled when average is not enabled. 2. When measurement is out of threshold below, do retest again; use the last test result as final result; 3. The Threshold high 4. The Threshold Low | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_MEA\_4 | **Measure Mode**  Two different work mode;   1. Periodic 2. The intervals could be: 0 (continuous), 30min, 60min… and 24hours 3. Starts time: YYYY-MM-DD HH:MM:SS format. 4. If the measurement could not be executed in measurement interval time, the measure is executed as continuously. 5. Trigger   Periodic measure shall not be executed | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_MEA\_5 | **Alarm**  User shall be able to configure the alarm value for below alarms.   1. low alarm 2. high alarm | **Stability**  C |

## Calibration

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_CAL\_1 | **Calibration Mode**  Two different work mode;   1. Periodic 2. The intervals could be: 1 ~ 7 Days (internal unit : hours) 3. Starts time: YYYY-MM-DD HH:MM:SS format. 4. If calibration failed or no calibration results in set time, the device shall use idle time to complement the missed calibration. This shall only be executed when idle. 5. Trigger   Periodic calibration shall not be executed | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_CAL\_2 | **Calibration Post Action**  Two different options;   1. Flushing (when deep flush is enabled, use deep flush) 2. None | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_CAL\_3 | **Calibration Configuration**   1. Standard calibration: 2. Zero solution: Measure for 2 times, take the second reading 3. Std solution: Measure for 2 times, take the second reading 4. Calibration maximum points shall be 3 respectively; 5. Advanced calibration: 6. Zero solution: Measure for 3 times, take the third reading 7. Std solution: Measure for 3 times, take average of last two reading 8. Calibration maximum points shall be 5 respectively; 9. ~~Absorbance deviation for calibration points. Threshold setting to 1% ~ 5%, typically 3%; Deviation between each two of data points in same standard concentration exceeds the threshold will trigger additional calibration points;~~ 10. If calibration points are not enough in same standard concentration will trigger calibration failure then intermediate data are dropped; 11. Alarm shall be issued when calibration failed 1 time. | **Stability**  L |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_CAL\_4 | **Adaption factor**   1. Correction factor respectly for different measure range: Value Range: 0.95 ~ 1.05; To multiple with measurement result after deducted offset; 2. Offset 3. Low range, 0.1~30 mg/L<±0.6 4. Middle/High range, 1~100 mg/L±6 5. Extend range, 10~500 mg/L±60 6. Adaption factor should not be applied on history data | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_ CAL \_5 | **Calibration Validation**   1. No defaults value from factory; 2. Have range check for the calibration value; 3. Do auto-calibration when no valid calibration and schedule is enabled. 4. Calibration failed: 5. Must issue warning; 6. Continues to do calibration when retry times smaller than set value; 7. If not find valid calibration value, device shall stop current calibration and issues alarm; 8. The new measured data shall have tag about calibration failure, and calc with last valid calibration slope and offset. 9. New calibration could be executed when schedule or triggerred. | **Stability**  L |

## Clean

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_CL\_1 | **Clean**   1. Two different work mode; 2. Periodic    1. The intervals could be: 0.5 ~ 7 Days (internal unit : hour)    2. Starts time: YYYY-MM-DD HH:MM:SS format.    3. If clean is not acted in set time, the device shall use idle time to complement the missed clean. This shall only be executed when idle. 3. Trigger   Periodic clean shall not be executed   1. Post cleaning operation: 2. Flushing 3. Calibration 4. None | **Stability**  C |

## Auto Range

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D Planner |
| --- | --- | --- | --- |
| FR\_AR\_1 | **Range**  Three different measure ranges implemented in devices   1. ULR: Measure range 0.02~ 15 2. LR: Measure range 0.05 ~ 30 3. MR: Measure range 1 ~ 100 4. HR: Measure range 100 ~ 1000\* | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  Planner |
| --- | --- | --- | --- |
| FR\_AR\_2 | **Auto Range Mode**  Device shall be able to configure the device measure range as below:   1. Auto range 1: (the actual used range could be ULR, LR, MR, HR for dilution mode); 2. Auto range 2: (the actual used range could be ULR, LR, MR); 3. Fixed range: 4. ULR 5. LR 6. MR 7. HR | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_AR\_3 | **Fix Range Warning**  Device shall issue warning in fixed range when the measured value is out of the fix range. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_ AR \_4 | **Auto Range Adjust**  When auto range is enabled:   1. User shall be able to set a preset range. 2. Calibration with corresponding standards is exectued immediately when scheduled measure(include the triggerred measure with current range index) is out of range. 3. Only when the scheduled/triggerred measure is not finished, the missed measure is complemented immedately. | **Stability**  L |

## Preheat

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_HEAT\_1 | 1. The target temperature shall be controled with PID to the set value, and the difference shall be controled within±0.5℃. 2. The PID control shall be disabled when enviroment temperature higher than target set temperature. 3. Two different target temperatures against the high or normal enviroment temperature. 4. Temperature out of ctrl shall issue alarm and stop heat ctrl output. | **Stability**  C |

## 4~20mA Current Output

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_CO\_1 | Shall output current in range 3-23mA. | **Stability**  L |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_CO\_2 | Shall be connected to the Measurement Value against the specific configured high and low range. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_CO\_3 | Shall be possible to simulate AO in the range from 3 mA to 23 mA. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_CO\_4 | Shall be able to be calibrated with special CMDs and UI | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_CO\_5 | **Work Mode when Exception**   1. Active: device output current measure result no matter high or low. 2. Hold: device output last valid measure result. 3. Transfer: device output one preset analogue value. | **Stability**  C |

## IO board

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_IO\_1 | The valid digital input signal is down slope and hold at least 2 seconds. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_IO\_2 | **Digital Input Functions**   1. Device shall act immediately when device is idle and valid input. 2. Device shall keep the trigger action in queue when device is in busy mode; 3. Trigger functions below with current range index is open for DI when device is not in stop state: 4. Drain 5. Flush 6. Prime 7. Offline Measurement 8. Online Measurement 9. Standard 0 verification 10. Standard 1 verification 11. Measure 12. Calibration 13. Clean 14. Specific flow steps 15. Disable Schedule | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_IO\_3 | **Relay Output Functions**   1. Switch on/off continuous: 2. Interval time 3. Holding time, 4. Start time, (start time is in format YYYY-MM-DD HH:MM:SS) 5. Alarm: Switch on when: 6. Low alarm 7. high alarm 8. Event: Switch on when any alarm or error 9. Trigger pretreatment: 10. Start time (start time is in format YYYY-MM-DD HH:MM:SS) 11. Measurement delay time | **Stability**  C |

## Safety Measures

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_SM\_1 | **RAM Test**   1. RAM test at start up and also at run-time. It includes: 2. Address bus test. 3. Data bus test and. 4. Data retention test. 5. If this test fails, a software reset is executed. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_SM\_2 | **Rom Test**  Rom integrity shall be checked during startup. If error happens, system is reset to bootloader. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_SM\_3 | **Ram Data Protection**  Shall provide protection during run-time for fluid and measure parameters. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_SM\_4 | **Monitor task state**  Shall have measures to monitor task state during runtime in case task failed or error-execution. | **Stability**  C |

## Diagnosis

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_ DIA \_1 | **Leakage Monitoring**   1. Shall monitor the liquid leakage and issue alarm when leakage is found. 2. Device enter break state when leakage is found. 3. The state is not recoverred until reset is happened. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_ DIA \_2 | **Pump Steps**  Shall store the pump steps and check the lifespan. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_ DIA \_3 | **Reagents usage**  Shall monitor the reagent usage and issue warning or alarm when reagents are below the limit. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_ DIA \_4 | **Tubing usage**  Shall monitor tubing lifespan and issue warning or alarm when reagents are below the limit. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_ DIA \_5 | **Canopen error**  Shall monitor canopen error, alarm or warning are issued when error is found. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_ DIA \_6 | **No Sample Flow**  Shall check sample flow state, the current measure shall be stopped when no sample flow is detected. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_ DIA \_7 | **Temperature**  Shall monitor case temperature, colorimeter temperature, when out of range, alarm or warning shall be issued. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_ DIA \_8 | **Voltage Supply Monitoring**   1. Shall provide a method to check the supply voltage. Issue alarm when power supply high or low is detected. 2. When supply voltage below the setting, the device shall save all the configure data and then reset. 3. The device shall always monitor the power supply and issue to UI or Modbus. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_ DIA \_9 | **Check Optics**  Shall have measure to check dirty of optics, warning shall be issued when dirty is reach limit. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_DIA\_10 | **Current Detector:**   1. Monitor total current usage which shall be used to diagnostic the valve and motor status. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_DIA\_11 | **Humidity**  Device shall detect the humidity of environment. | **Stability**  C |

## Internal Communication

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_ ICAN\_1 | **Communication Address**  Communication address is configured through UI, the default address is 0x03;  Or  **DIP-Switch**  DIP-Switch shall be used as the address for local can communication with UI board. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_ICAN\_2 | 1. Shall provide the internal can bus communication with UI or PC 2. The device is act as the slave which response the CMDs from master. 3. The CMDs support the below functions    1. Read Object    2. Write Object    3. Read Memory    4. Write Memory 4. The can bus communication protocol shall be provided | **Stability**  C |

## Can Open Communication

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_CO\_1 | **CanOpen Slave**   1. Implements the Canopennode in the IO and 4-20mA boards. 2. The eds shall be provided. 3. The hartbeat/sdo/pdo/sync function shall be support. 4. The data exchange shall be limited in 100 ms. 5. The led shall be used to identy the communication status and error status. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_CO\_2 | **CanOpen Master**   1. Implements the Canopensocket in control & measure board. 2. The NMT/ hartbeat/sdo/pdo/sync function shall be support. 3. The master shall be able to found the devices connected. 4. The master shall be able to find the communication or device error and issue the error/warning. 5. The master could be configured outside for the data mapping and IO actions. | **Stability**  L |

## History Data

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_HD\_1 | **Measurement result**   1. Shall save at least 20,000 circulated records. 2. The data log shall include: 3. Time, Date 4. Measurement data, 5. Original signal (4 ABSs), 6. Temperatures, 7. Accompany calibration curve (offset/slope), Range，factor,offset 8. Measurement range index 9. Tag of measurement. 10. Log shall be read back by special CMDs | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_HD\_2 | **Calibration Data**   1. Shall save at least 5,000 circulated records. 2. The data log shall include: 3. time, 4. slope, 5. offset 6. calibration std 0 7. 4 raw abs 8. Temperature (environment + colorimeter +other) 9. Timestamp. 10. calibration std 1 11. 4 raw abs 12. Temperature (environment + colorimeter +other) 13. Timestamp. 14. range index 15. calibration status 16. Log shall be read back by special CMDs | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_HD\_3 | **Raw Measure Data**  This is refer to all measured data include calibration and measurements...etc.   1. Shall save at least 50,000 circulated records. 2. The data log shall include: 3. Time, 4. Temperature 5. 4 raw abs 6. Flag (specify to measurements, calibration..etc) 7. Log shall be read back by special CMDs | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_HD\_4 | **Event Data**   1. Shall save at least 20,000 circulated records. 2. The event log shall include: 3. Every operation including calibration, cleaning, flushing, priming and configuration change should be recorded. 4. Diagnositic event; 5. Log shall be read back by special CMDs | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_HD\_5 | **History Data Protection**   1. All of data cannot be deleted. If the memory is full, the oldest one will be deleted. 2. Two years of data should be saved. 3. Only OPS (factory) could delete data. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D Planner |
| --- | --- | --- | --- |
| FR\_HD\_6 | **Data Filter**   1. Start time & end time + measure or calibration data; 2. Start time & end time + Event type | **Stability**  C |

## Maintenance

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_MT\_1 | **Real-time Signal**   1. Temperatures 2. Detector current and absorbance 3. Operation step 4. Liquid levels of reagents and standards 5. Pump and valve state 6. IO state 7. Warning/Error information | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D Planner |
| --- | --- | --- | --- |
| FR\_MT\_2 | **Diagnosis information**   1. Leakage voltage 2. Power supply current and voltage 3. Liquid levels of reagents and standards 4. Pump and valve usage 5. Pump pipe usage 6. Warning/Error information | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D Planner |
| --- | --- | --- | --- |
| FR\_MT\_3 | **Configuration**   1. Reset liquid level(reagent) 2. Restore rom defaults (this shall only be used in factory mode) 3. Reset Pump pipe usage 4. Deep Flush mode | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D Planner |
| --- | --- | --- | --- |
| FR\_MT\_4 | **Operation interfaces 1**  Trigger the below functions:   1. Prime 2. Drain 3. Flush | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  Planner |
| --- | --- | --- | --- |
| FR\_MT\_5 | **Operation interfaces 2**  Device needs to be in break state to have below functions:   1. Trigger Service Measure 2. Trigger Service Calibration 3. Trigger Service Clean | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  Planner |
| --- | --- | --- | --- |
| FR\_MT\_6 | **Operation interfaces 3**  Device needs to be in break state to have below functions:   1. Fluid control: 2. Pumps 3. Valves 4. Premix stirring bar 5. Heater | **Stability**  C |

## Bootloader

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_BL\_1 | **Reuse Can Port**  Shall reuse Can Port to communicate with PC/UI. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_BL\_2 | Shall have CRC16 check for Rom Integration. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_BL\_3 | **Update CB Code**  Shall support updating CB firmware code. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_BL\_4 | **Version Code**  Shall support getting version code.  The version code includes:   1. CB SW-version code. 2. Boot loader version code. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_BL\_5 | **Update Watch Dog**  Shall manage periodic updates of Watch Dog to prevent Reset during re-programming. | **Stability**  C |

## PCB TEST

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_PCB\_1 | **Communication Interfaces**  Shall have test for the communication interfaces   1. Serialport 2. Can interfaces | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_PCB\_2 | **Valve&Motor Ctrl**  Shall have interfaces to test the 10 valves and 4 motors | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_PCB\_3 | **Storage**  Shall have interfaces for to test EEProm & SPI Flash | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_PCB\_4 | **Temperature Sensor**  Shall provide temperature. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_PCB\_5 | **Power supply Monitor**  Shall have interfaces to monitor the power supply. | **Stability**  C |

| Ident. | Definition / Motivation | **Priority**  M | Source  R&D |
| --- | --- | --- | --- |
| FR\_PCB\_6 | **IO State**  Shall have interfaces to provide the input IO(switch) state. | **Stability**  C |

# Review - Check list:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | yes | no | N.A. |
| 1. | Does the specification define all currently known requirements that the product/system finally has to perform? | **X** |  |  |
| 2. | Is the overall description enough detailed to understand the defined requirements? | **X** |  |  |
| 3. | Are all known stakeholders considered? | **X** |  |  |
| 4. | Are all constraints defined? | **X** |  |  |
| 5. | Are all requirements complete, consistent, correct and understandable? | **X** |  |  |
| 6. | Are all requirements necessary? | **X** |  |  |
| 7. | Are all requirements feasible? | **X** |  |  |
| 8. | Are all requirements testable and traceable? | **X** |  |  |
| 9. | Are all commitments correct? | **X** |  |  |
| 10. | Are all non-functional requirements correct? | **X** |  |  |
| 11. | Are all used abbreviations and technical expressions explained? | **X** |  |  |
| 12. | Are all referenced documents in the reference list? | **X** |  |  |
| 13. | Are all requirements referenced? | **X** |  |  |
| 14. | Are all dependencies to other requirement documents considered? | **X** |  |  |
| 15. | Is this template used in a correct manner? | **X** |  |  |
| 16. | Are all open issues transferred to the defects table? | **X** |  |  |

**Remarks:**

**Defects**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| No. | Checkpoint | Description | Major Defect | done  Date |
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