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16 R8C 2A/B Washer Platform

R8C Series – Flash MCU

Microcomputer Development Environment System

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R8C 2A/B Washer Platform

R5F212ACSNFA
R5F212BCSNFA

User's Manual

RS-SH

1st Edition

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PREFACE

About this manual

This user's manual is written for Washing Machine platform using Renesas R8C 2A/B. It describes using of platform board and operation specification of washer software. Please use this user's manual to understand on how to operate the platform board, which also can help user to be familiar with Renesas R8C series MCU for washing machine application.

Section 1 About this platform

Gives an general notification about using the emulation platform

Section 2 User interface

Describes the user interface such as LCD & Led display, jumpers and keys.

Section 3 Operation

This part introduces the washer platform program executing and operation logic.

Section 4 Software realization

This part introduces the MCU resource using and software realization strategy.

Appendix:

Washer platform program table

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1. About this platform

1.1 Platform general introduction

- This platform is designed for washing machine software validation and emulation, and it can be used as prototype or reference platform for actual washing machine design. The function this platform realized is introduced in the following part of this manual.

- To simulate the washer functions, Jumpers and LEDs are used to represent some actual sensor inputs and outputs control. And we also realized all the actual washer function in hardware design, which can help customer enable their needed function very conveniently.

- For the AC driving part, All of the **triacs** used on this platform is **Renesas triac** products that well match consumer and home appliance electrical characters and requirement, customer can do the testing and evaluation very conveniently with this platform.

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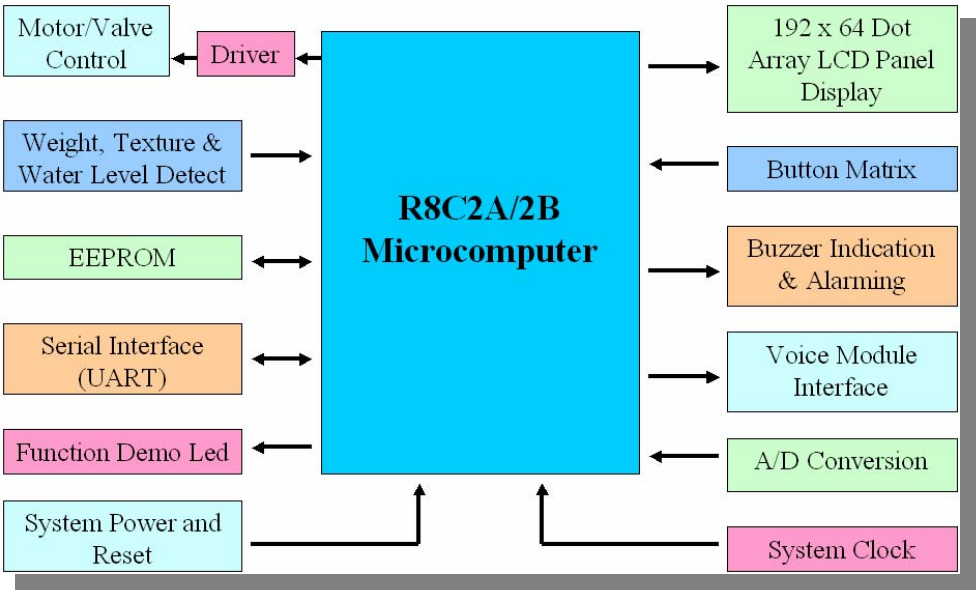
1.1 Washing Function Outline

1), LCD display (192 x 64 dots)
2), Error detection and alarming
3), Auto power off function
4), Voice module interface
5), Weight/texture detection
6), Water level detection
7), Automatism washing program
8), Unbalance detection and correct
9), Tube dry function
10), Preset function
11), Serial communication
12), A/D for analog input processing
13), I2C EEPROM communication



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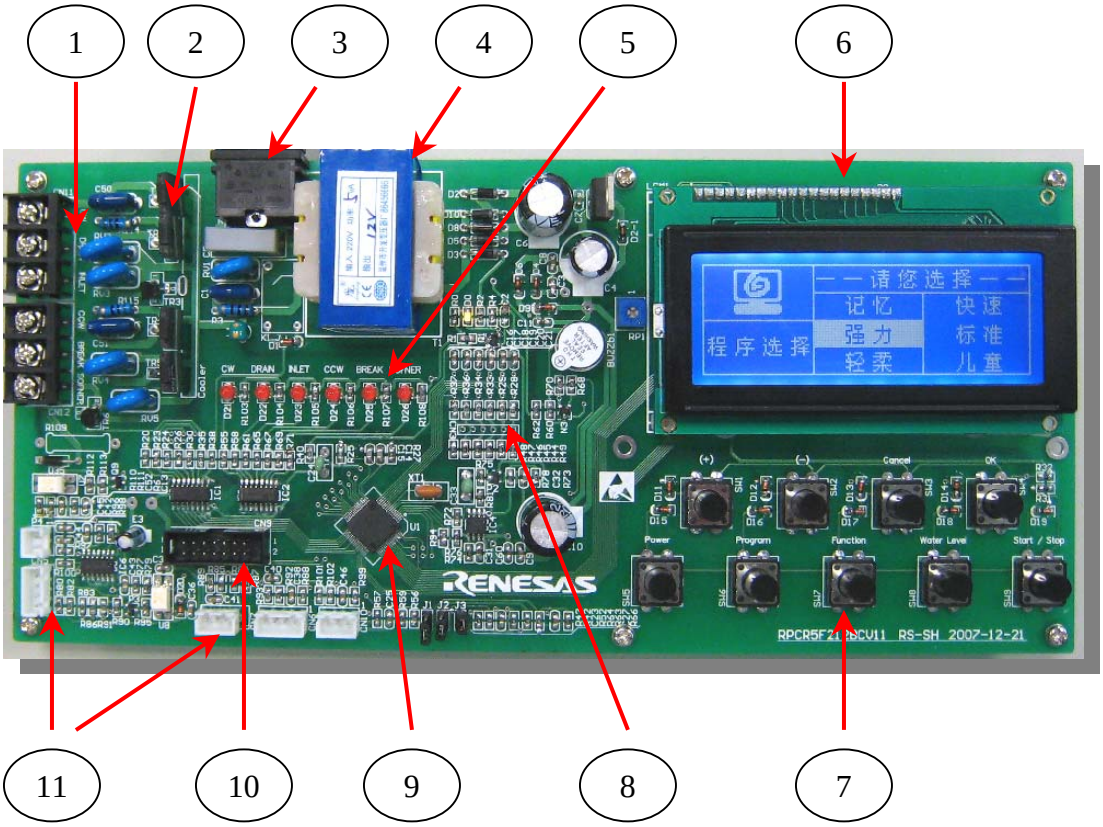
1.2 Platform overview



Notes:

1, AC driving output portion, including washer motor driving and valve driving
2, **Renesas Triac** array, in this platform, especially, all the **triacs** use **Renesas** products
3, AC power input port. **AC power controller "K1" is not mounted on the board for security consideration because if "K1" switched on, system 5V is floating on 220V AC**
4, AC to DC transformer (220V AC ~ 12V DC)
5, AC driving output simulation LED array
6, Dot array LCD module (192 x 64 dots)
7, Key array for setting the platform
8, Voice interface (reserved)
9, R8C 2A/B MCU (R5F212ACSNFA or R5F212BCSNFA)
10, E8 emulator interface
11, Water level input, AD interface and UART interface

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1.3 Platform board introduction

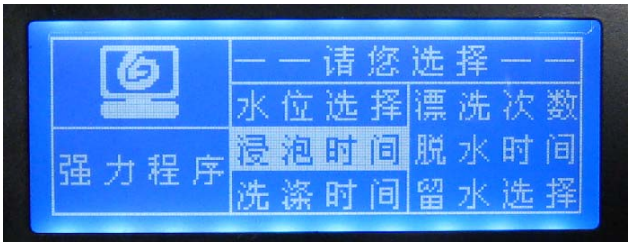
In this part, the function of the washer platform will be introduced and user can get to know how to use this platform as demo platform or as reference for new model design because this platform enable or at least reserve even all the peripheral function modules of **Renesas MCU R8C 2A/B**. Father more, we specially unutilized **Renesas Triac** as the AC driving output control, which is idea for washer application, we provide them on the platform for customer evaluation and testing.

1.3.1 LCD display function and setting introduction

The LCD display contain 4 levels of menu, the first level is automatic washing program setting menu; the second level is parameter setting menu for selected program; the third level is dedicated water level, special function, and dedicated time parameter setting; the fourth level is washer program running status displaying menu, in which user can browse the detail program setting. Below is the example of each level of the menu.

1), First level menu, this level contains 2 pages which show the available program items and allows user to select which washing program the platform will run by pressing “confirm” key, then the LCD displays the second level menus. Bu pressing “ + ” or “ – ” key user can shift the selection.

1. First level menu



2. Second level menu

2), Second level menu, this level also contains 2 pages which show water level setting button, soak time setting button, wash time setting button, rinse time setting button, spin time setting button, save water button, and preset button, by pressing the “confirm” key, LCD will display the third level of menu, which is for detail washer running parameter selection. By pressing “ + ” or “ – ” key user can shift the selection.

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3), Third level menu, this level contains 7 pages that show the detail washer running parameter setting, by pressing " + " or " – " key can select the available number of certain parameter such as water level, soak time, wash time and etc.

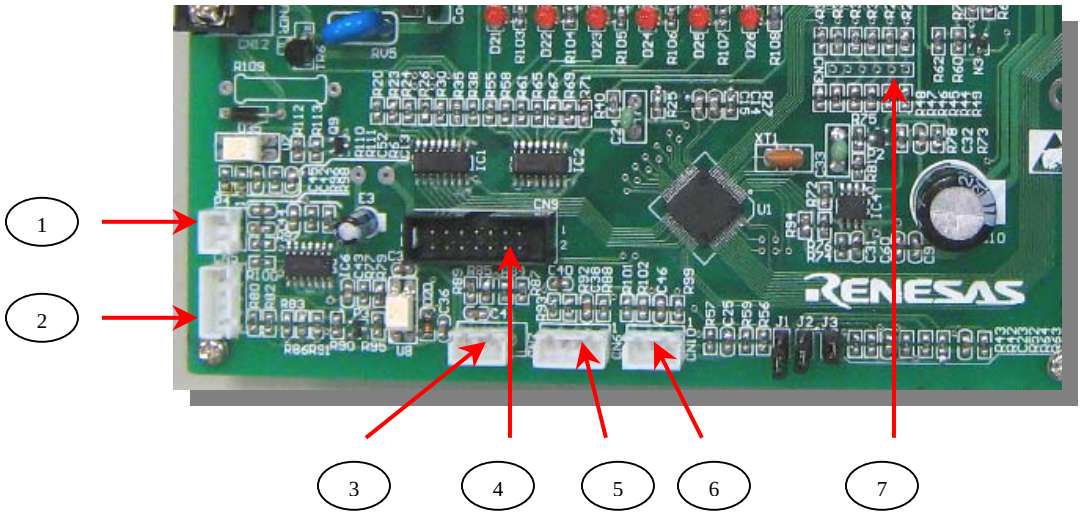
3. Third level menu

4. Fourth level menu

4), Fourth level menu, this level contains only 1 page which shows the platform running status, user can browse their setting by pressing " + " key, the highlighted area will change the content displayed accordingly.

1.3.2 Available interface introduction

Below picture shows the available interface provided or reserved for future using on this platform, for detail, please refer to the Notes.



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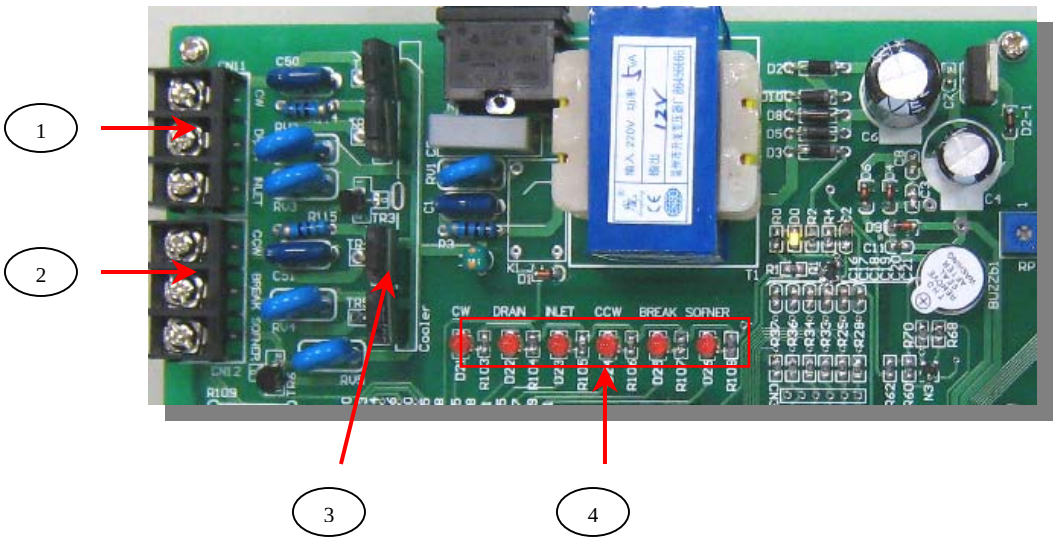
Notes:

1, Water level sensor input port
2, UART2 interface (use +5V logical level)
3, UART1 interface (use +5V logical level)
4, Renesas emulator E8 interface
5, AD interface (use AN1 port)
6, AD interface (use AN0 port)
7, Voice module interface (reserved, also can be use as other customized function)

1.3.3 AC driving output port introduction

Below picture shows the AC driving output ports and the function simulation LEDs, which include motor and valve AC driving output, for detail, please refer to the Notes.



Notes:

1, AC driving output port (including CW, Drain, and Inlet output)
2, AC driving output port (including CCW, Softener, and Break output)
3, Renesas Triac array (BCR8PM-14LE, BCR2PM-14LE, BCR08AM-14A)
4, Function simulation LED (simulate the AC driving output functions)

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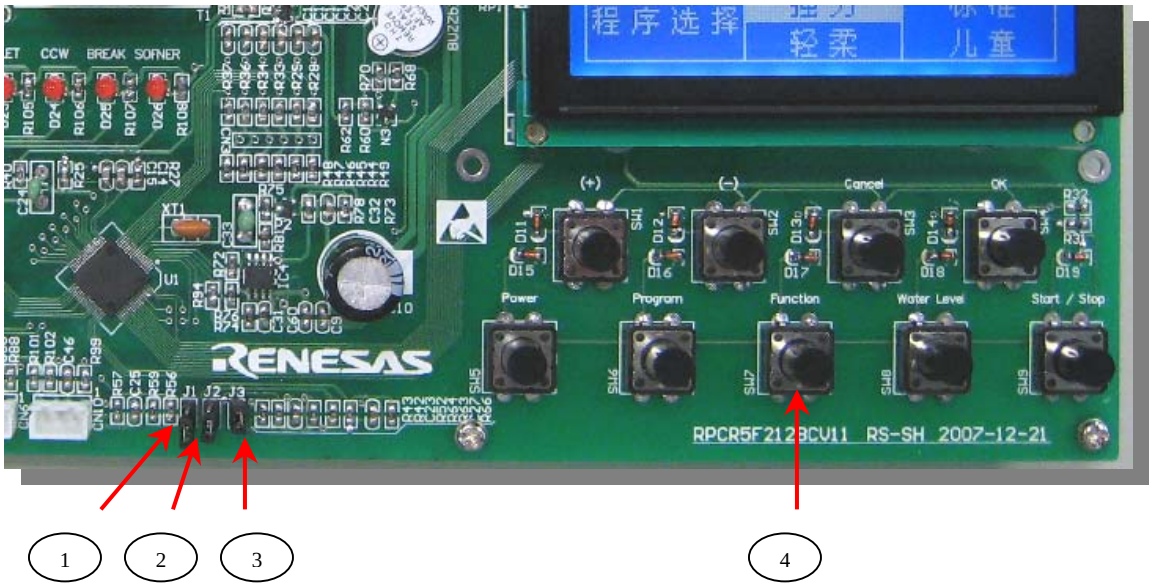
1.3.4 Key and jumper input port introduction

Below picture shows the external jumpers and key array for setting the platform, the jumper is used to indicate currently the platform is in which status and the key is used to setting the running parameters in any kind of the status.



Notes:

1, **J1**: Door open / close status indication jumper, in demo mode, this jumper is used as door open / close detection; jumper “on” means door is closed; jumper “ off ” means door is open. In debugging mode, this jumper is used as water level input, “on” mean water reaches user setting value; “off” means water does not reach user setting value.

2, **J2:** Unbalance sensor input indication jumper, in demo mode, this jumper is used as unbalance detection; jumper “on” means unbalance happened; jumper “ off ” means unbalance not happened. In debugging mode, this jumper is used to decrease main “soak” and “wash” time, while this jumper switched “on” once and then switched “ off ”, the “soak” and “wash” time will be decreased to 30 seconds motor cycling, which can help user speed up system debugging and validation.

3, **J3:** Machine type selecting indication jumper, in demo mode, this jumper is reserved (this platform just use one type machine) for washing machine type selection function, by judging the jumper status, washer s/w can run different washing program. And in this platform, this

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jumper is used for the s/w to determine which mode the platform is running after system power on; jumper “on” means platform is running in debugging mode, jumper “off” mean platform is running in demo mode.

4, Key input, including “ Power ”, “ Start / Stop ”, “ Program ”, “ Function ”, “ Water Level ”, “ + ”, “ - ”, “ Cancel ”, and “ OK ” key, for detail key functions, please refer to Part 2: User inter face.

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2. User interface

2.1 Platform key introduction

This part will introduce platform key pressing rule and the LCD display function based on key and platform running status.

After “ Power ” key pressed, the platform is in initial mode, all key are valid, and during preset running, only “ + ” and “ Start / Stop ” key are valid. Below table shows the valid and invalid key in relative program running mode:

Status / Key	Stand By	Initial	Run	Stop	Preset	Demo/ Debug Run
“ Power ”	○	○	○	○	○	○
“ Program ”	×	○	×	○	×	×
“ Function ”	×	○	×	○	×	×
“ Water Level ”	×	○	×	○	×	×
“ Start / Stop ”	×	○	○	○	○	○
“ + ”	×	○	○	○	○	○
“ - ”	×	○	×	○	×	×
“ Cancel ”	×	○	×	○	×	×
“ OK ”	×	○	×	○	×	×

2.1.1 “ Power ” key introduction

When “ Power ” key pressed, the platform will run in “ Initial ” mode, all keys are valid for setting the platform.

- The platform will turn to “ Stand By ” mode if “ Start / Stop ” key have not been pressed within 5 minutes since any key pressed (or no key pressed) in this mode.

- When the program runs to the end, the platform will run to “ Stand By ” mode.

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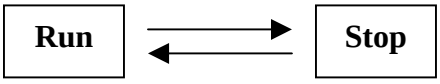
- In any mode expect " Stand By " mode, when " Power " key pressed, the platform with run into " Stand By " mode.
- The LCD backlight is turned off in " Stand By " mode.

In " Initial " mode, the LCD will display the first level menu, which allow user to select the dedicated washer program.

2.1.2 " Start / Stop " key introduction

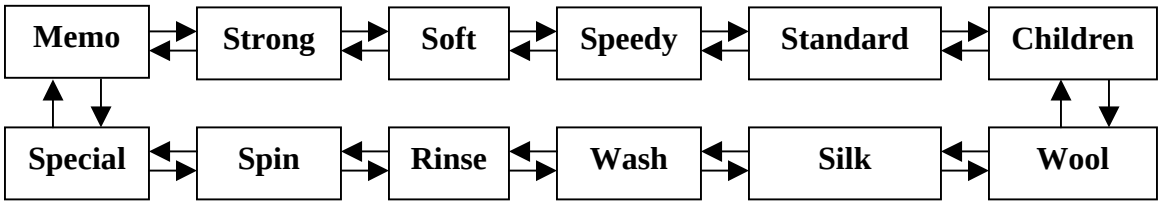
The " Start / Stop " key change the platform running status like below:



- While in " Stop ", all loading is off and the LCD displays the fourth level menu.
- While "Start / Stop" key pressed again, the program is resumed.

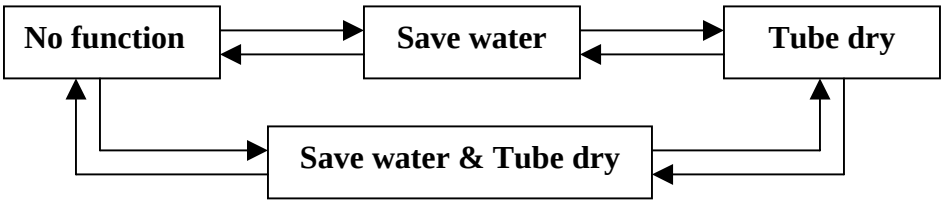
2.1.3 " Program " key introduction

When " Program " key pressed, the LCD display the first Level Menu and user can shift program selection button by pressing " + " or " – " key. Below figure shows the rule.



2.1.4 " Function " key introduction

When " Function " key pressed, the LCD display the third Level Menu and user can shift the function select button by pressing " + " or " – " key. Below figure shows the rule.



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2.1.5 “ Water Level ” key introduction

When “Water Level” key pressed, the LCD displays the third Level Menu and user can shift the function selection button by pressing “ + ” or “ – ” key. There are 10 levels of water can be selected, from “ 1 ” to “ 10 ”, which increased by pressing “ + ” key and decreased by pressing “ – ” key.

During “ Soak ”, “ Wash ”, “ Rinse ” process is running, when “ Water Level ” key pressed, the inlet valve will be switched on and Inlet process running, after release “ Water Level ”key, the Inlet process stop and valve is switched off. However, if the water level is over protection level, this function is invalid.

The motor cycle stream will be changed according to the water level setting changed by user. When “ Speedy ” program selected, the default water level setting is “ 3 ” and cannot be changed.

In automatic washing program, the soak time is set by washing software according to the water level changing; in water level “ 1 ”, “ 2 ”, “ 3 ”, “ 4 ”, the soak time is 10 minutes; in water level “ 5 ”, “ 6 ”, “ 7 ”, the soak time is 20 minutes; in water level “ 8 ”, “ 9 ”, “ 10 ”, the soak time is 30 minutes.

Usually, the rinse water level is one level higher than wash water level, but if water level 10 selected, the rinse water level use the setting value.

2.1.6 “ + ” & “ - ” key introduction

User can shift the program or parameter setting button by pressing “ + ” or “ - ” key in relative level of the display menu, the highlighted items on LCD will roll over accordingly.

2.1.7 “ OK ” & “ Cancel ” key introduction

When “ OK ” key pressed, the selected program or parameter is set (on LCD, it’s the highlighted item), and the LCD menu display changed to the next level, and when the “ Cancel ” key pressed, the LCD menu level change back to the above level and allow user to re-select the program or parameter that have already been set.

2.2 Platform LCD display introduction

The platform LCD display have 4 levels of menu as described in the first part of this document, and there are many buttons in each of these menus, which can be highlighted by shifting the “ + ” or “ - ” key, then by pressing the “ OK ” key, user can select the dedicated function or the available parameters in current menu.

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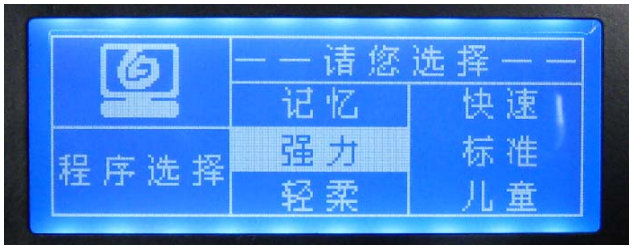
2.2.1 Program setting menu

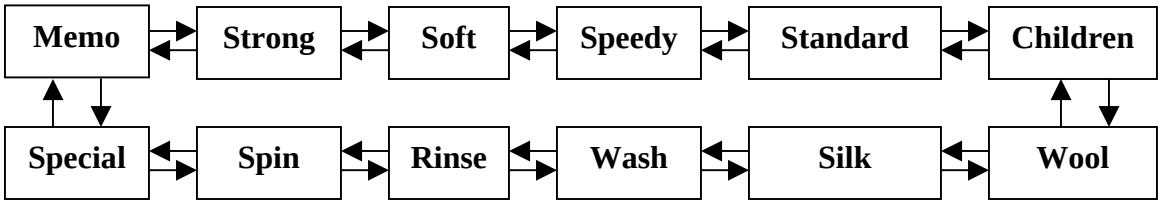
This is the first level menu of the LCD display structure, and there are two pages and 12 buttons that delicately represent the available washing programs that can be executed by the platform. The default highlighted button is “ Memo ”, by pressing “ + ” or “ - ” key user can shift and highlight the relative button, which shows in below figure, then after user press “ OK ” key, the highlighted program is selected and the second level menu will display.



1, First page

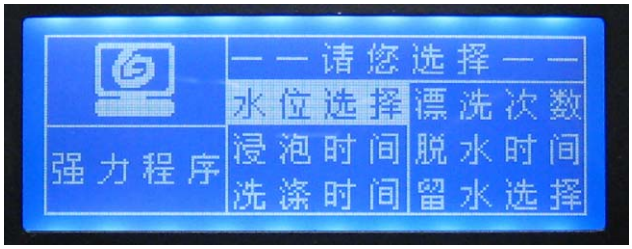
2, Second page

Note: The special program can only be selected after the “ Tubedry ” function is enabled in “ Function ” setting menu.

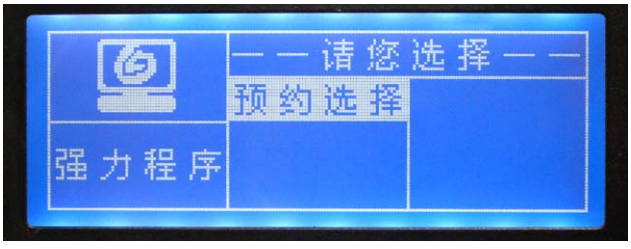


2.2.2 Running parameter option menu

This is the second level menu of the LCD display structure, and there are two pages and 7 buttons that represent the parameter option items. The default highlighted button is “ Water Level ”, by pressing “ + ” or “ - ” key user can shift and highlight the relative button, which shows in below figure. By pressing “ OK ” key, the next level menu will display.



1, First page



2, Second page

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Especially, the next level menus below “ Wash ”, “ Rinse ”, “ Spin ” and “ Special ” program are different from the normal parameter setting menu. The menu below “ Wash ” program just has “ Wash Time ” and “ Water Level ” options; the menu below “ Rinse ” program just has “ Rinse Time ”, “ Spin Time ” and “ Water Level ” options; the menu below “ Spin ” program just has “ Spin Time ” option; the menu after “ Special ” program just has “ Tubedry ” option. Please note that, after user select “ Tubedry ”, the LCD will go back to the first level menu.

Note: The save water function can only be selected after the “ Save Water ” function is enabled in “ Function ” setting menu.

2.2.3 Dedicated parameter setting menu

This is the third level menu of the LCD display structure, and there are 7 pages of menu that dedicatedly display the parameters according to the button that user selected in the second level menu. The default menu page is “ Water Level ”, by pressing “ + ” or “ - ” key user can shift up and down the available parameter values, then if “ OK ” key pressed, the current displayed value is selected and the LCD will set back to the above level menu for user to select other parameter options.

2.2.3.1 Water level setting display

This is the menu page for user to set the water level during the washing program running. The default displayed value is “ Level 6 ”, by pressing “ + ” or “ - ” key user can shift up and down the available water level values from “ Level 1 ” to “ level 10 ”.

1, Water level setting

2, Soak time setting

2.2.3.2 Soak time setting display

This is the menu page for user to set the soak time of selected washing program. The default displayed value is “ 0 minute ”, by pressing “ + ” or “ - ” key user can shift up and down the available soak time values from “ 0 minutes ” to “ 40 minutes ”.

2.2.3.3 Wash time setting display

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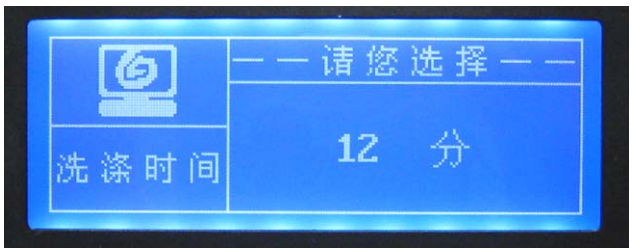
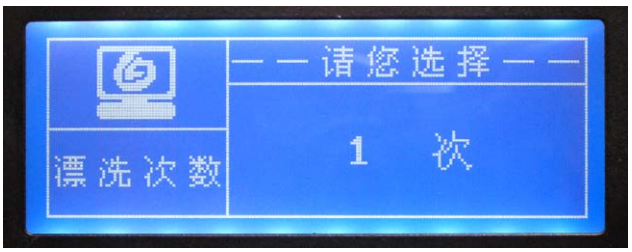
This is the menu page for user to set the wash time of the selected washing program. The default displayed value is “ 12 minutes ”, by pressing “ + ” or “ - ” key user can shift up and down the available wash time values from “ 0 minutes ” to “ 25 minutes ”.



1, Wash time setting



2, Rinse time setting

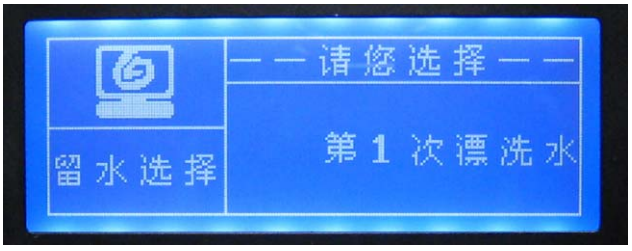
2.2.3.4 Rinse time setting display

This is the menu page for user to set the Rinse time of the selected washing program. The default displayed value is “ 1 time ”, by pressing “ + ” or “ - ” key user can shift up and down the available rinse time values from “ 0 time ” to “ 4 times ”.

2.2.3.5 Spin setting display

This is the menu page for user to set the spin time of the selected washing program. The default displayed value is “ 6 minutes ”, by pressing “ + ” or “ - ” key user can shift up and down the available spin time values from “ 0 minute ” to “ 9 minutes ”.

1, Spin time setting



2, Save water setting

2.2.3.6 Save water setting display

This is the menu page for user to set the save water function of the selected washing program. The default displayed value is “ The first time rinse water ”, by pressing “ + ” or “ - ” key user can shift up and down the available save water parameter values as below (cycle over):

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" The first time rinse water "→ " The second time rinse water " → " The third time rinse water " → " The first & second time rinse water " → " The second & third time rinse water " → " The first & second & third time rinse water " → (no display) →" The first time rinse water " →…

If only two times or less rinse time selected, the display value will pass over the items that include the non-selected rinse time. For example, if only 2 times rinse selected, the display cycle is as below:

" The first time rinse water "→ " The second time rinse water " → " The first & second time rinse water " → (no display) →" The first time rinse water " →…

While user select save water function, the drain process will be paused in the end of a rinse process, the buzzer buzzes 20 times (0.5s on 0.5s off) to indicate the save water is ongoing, and at the same time, platform LCD will display how many save water time is left during current program setting. After user press " Start / Stop " key, the drain valve is switched open and the washing program resumes. If user does not press the " Start / Stop " key within 4 hours, washing program will start the drain process and run the unfinished program.

For program left time calculation, if save water function selected, the time that the washer wait for user to release save water function is not included in the running time.

2.2.3.7 Preset setting display

This is the menu page for user to set the preset time of the selected washing program. The default displayed value is " 2 hours ", by pressing " + " or " - " key user can shift up and down the available preset running time from " 2 hours " to " 24 hours "; there is no " 0 hour " and " 1 hour " option, instead, after option " 24 hours " there is an no display items inserted before cycle to " 2 hours " option.

If " OK " key pressed, the preset function is enabled and the preset is running after " Start / Stop " key pressed; and the fourth level menu will display preset left time and other selected washing program parameters. The preset program start time is calculated using preset time subtracting the program longest running time and then adding 15 minutes.

During preset running, if " Start / Stop " key pressed, preset running is paused and washing program allows user to change the program setting. If " Power " key pressed, the preset running is canceled and platform is shut down, in this case, user needs to set again the washing program.

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1, Preset time setting

2, Running status display

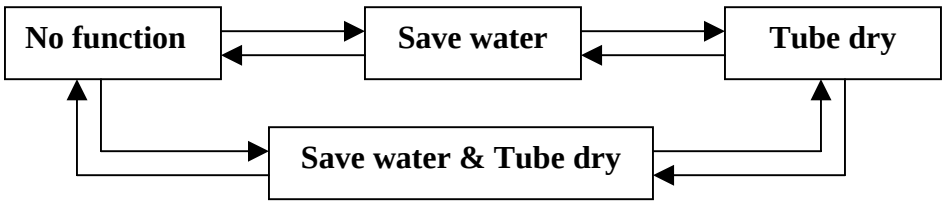
2.2.3 Platform running status display menu

This is the fourth level menu of the LCD display structure, and there is only 1 page that displays the washing program running status and user program setting. In this level menu, only " Start / Stop " key and " + " key are valid. By pressing " + " key, user can browse the selected program parameters; by pressing " Start / Stop " key, the program will paused and allows user to set again the washing program in stop status. The display content is as below by pressing " + " key in 4th level (cycle over):

" Program left time "→ " Soak time " → " Wash time " → " Rinse time " →" Spin time " →" Function selected " **…**

2.2.4 Function setting menu introduction

This is the menu page for user to set the special function during the washing program running. The default setting is " No function selected ", by pressing " + " or " - " key user can shift up and down the available functions from " No function selected " to " All function selected ". Below figure shows the function selection setting rule.



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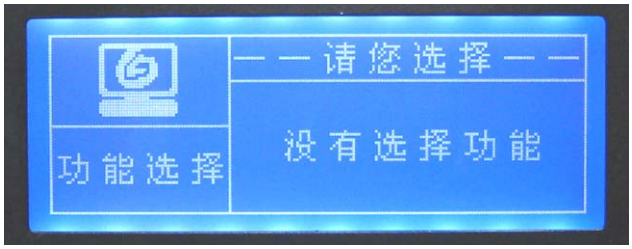
Below is the function setting menu page:



1, Function setting

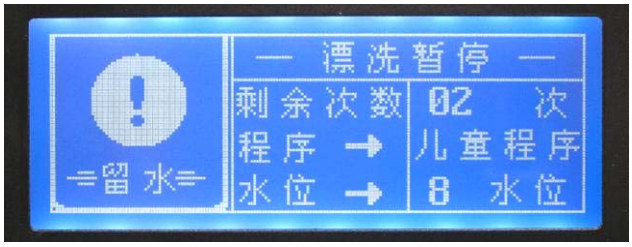
2, Cover page

2.2.5 Cover page menu introduction

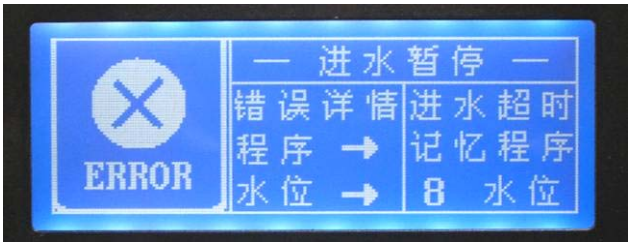
Actually, before the first level menu displayed, there is a cover page menu display, which shows Renesas company information. This page will show on screen for 3 seconds after “ Power ” key pressed in “ Stand By ” mode, then LCD will display the first level menu.

2.2.5 Save water menu introduction

When save water function selected, the washer program will not start the drain process in the end of selected rinse process. The buzzer will buzz to remind user the save water is happening, and LCD will display the save water page, the left times displayed includes current rinse time. Below shows the detail.



1, Save water display



2, Error display

2.2.5 Error menu introduction

When error occurs, the washer program will pause current process and buzzer begin to alarming, and LCD will display the error status page; the detail error situation is also displayed. The above shows the error page while inlet error occurs.

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2.3 Jumper introduction

On the platform, the 3 jumpers are used for detecting the external parameter value or the environment setting for the platform. Below describe the details:

JUMPs	Function Indicate	Comment
Jump 1 *	Water Level status	ON: Full Off: Not full
Jump 2 *	Lid status	ON: Close Off: Open
Jump 3 *	Demo mode selection	ON: Debugging mode Off: Demo mode

As platform running in debugging and demo mode, the jumper functions are different, below shows the function detail:

- J1: Door open / close status indication jumper, in demo mode, this jumper is used as door open / close detection; jumper “on” mean door is closed; jumper “ off ” mean door is open. In debugging mode, this jumper is used as water level input, “on” mean water reaches to user setting value; “off” means water does not reach user setting value.

- J2: Unbalance sensor input indication jumper, in demo mode, this jumper is used as unbalance detection; jumper “on” mean unbalance happened; jumper “ off ” mean unbalance not happened. In debugging mode, this jumper is used to decrease main “soak” and “wash” time, while this jumper switched “on” once and then switched “ off ”, the “soak” and “wash” time will be decreased to 30 seconds motor cycling, which can help user speed up system debugging and validation.

- J3: Machine type selecting indication jumper, in demo mode, this jumper is reserved (this platform just use one type machine) for washing machine type selection function, by judging the jumper status, washer s/w can run different washing program. And in this platform, this jumper is used for the s/w to determine which mode the platform is running after system power on; jumper “on” means platform is running in debugging mode, jumper “off” mean platform is running in demo mode.

2.4 LED indicator

The platform have 7 LEDs for displaying platform board power status and the AC output situation. Below table show the function of each LED:

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LED	Function	Description
D0	Power led	While AC power connected and system 5V is ready, this led is on
D21	CW led	While this Led on, it indicates the CW triac is switched on.
D22	Drain led	While this Led on, it indicates the drain triac is switched on.
D23	Inlet led	While this Led on, it indicates the inlet triac is switched on.
D24	CCW led	While this Led on, it indicates the CCW triac is switched on.
D25	Reserved led	This Led is reserved for future function extension, which is named as “BREAK”
D26	Softener led	While this Led on, it indicates the CW triac is switched on.

2.5 Automatic weight/texture detection

This function have not been enabled in release version of platform s/w because this functions performance depends on the real washer motor type and features, so the platform just implement h/w of this function, which can be conveniently used or modified by customer.

2.6 Water level detection

In this platform, the s/w just use “ 0 ” and “ 1 ” to judge washer water level, “ 0 ” indicates the water does not reach user setting level, “ 1 ” indicates the water reached the user set value. We did not use the pulse type water level detection because this function also depends on customer side sensor and system hardware and mechanical features, thus as the same with weight and texture detection, we also implemented the h/w for pulse type water level detection.

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2.7 Buzzer

The platform used one buzzer for washer running status indication and alarming. When “ Power ” key pressed, the buzzer will buzz one time; when save water function is executing, the buzzer will buzz 20 times (0.5 second on, 0.5 second off) every 15 minutes; and when system error happen, the buzzer will also buzz 20 times (0.5 second on, 0.5 second off) every 15 minutes. All these functions are described in relative part that use buzzer.

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3. Operation

3.1 Modes of Operation

As the platform would be used as demo platform or prototype washer in test and validation, we set two kinds of mode that the platform can run by judging external jumper status.

3.1.1 Platform running mode

The platform runs in modes:

Debugging Mode: In this mode, user can debug the platform s/w and the program running style is the same with real washer running style except that “ J1 ” and “ J2 ” is used as water and washing status detection.

Demo Mode: In this mode, after “ Power ” key pressed, the platform runs washer program automatically and when the program finished the platform will resume and run the same program again. During automatic program running, user can press “Start/Stop” key to pause the program and set the program manually, then by pressing “Start/Stop” key, the platform will run user set program and after user set program finished, the platform will run automatic program again.

3.1.2 Platform running status

In any mode of the platform, the washer program would be in one of below statuses, according to these statuses, washer s/w run logically to execute washing machine functions.

Stand By: Waiting for “ Power ” key to turn on the controller; only power LED display are on. In this mode, the MCU is running.

Initial: The platform is ready for setting by user, by press “ Start / Stop ” key, the platform will begin to run user set program.

Stop: During the platform is running program, if “ Start / Stop ” key pressed, the platform will turn to “ Stop ” mode and all output are off.

Run: The platform is running user set program.

Preset: The platform is running in preset mode

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3.2 Washing function introduction

This part introduces the washing program main function execution, which includes inlet, drain, soak, wash, rinse and spin process program operation. Below table shows the general guideline of washing program operation.

Process	AC Loading
Soak, Wash	Motor L, R Cycle
Rinse	Motor L, R Cycle
Inlet	Inlet Valve: ON
Drain	Drain Motor: ON
Intermittent spin	Drain Motor: ON Motor R: ON/OFF Intermittently
Spin	Drain Motor: ON Motor R: ON
Spray spin	Drain Motor: ON Motor R: ON/OFF Intermittently Inlet Valve: ON/OFF Intermittently
Inertial spin	Drain Motor: ON Motor R: OFF
Brake	Drain Motor: OFF Motor R: OFF

3.2.1 Water supply process (Inlet)

In this platform, the s/w just use “ 0 ” and “ 1 ” to judge washer water level, “ 0 ” indicates water does not reach user setting value, “ 1 ” indicates the water reached the user setting value. Below are the water supply function details:

- While inlet process starting, the Inlet triac switched on and supply water to user setting water level, the time set for inlet process is 2 minutes, while this process exceeds 2 minutes, washing program will stop time counting; and if this process finished in less than two minutes, the process running time still calculated as 2 minutes.

- While water level does not reach the user setting value in 20 minutes, platform will alarm and start to run error processing program.

- During “ soak ”, “ wash ” and “ rinse ” process, if water level drop one or more levels lower than user setting value, platform will pause current process and start inlet process, the process running time counting is stopped at this time. While the platform executing the last time rinse inlet, the softener inlet valve switched on for 10 seconds at the same time the inlet valve switched on. While water level does not reach the user setting value in 20 minutes, platform will alarm and start to run error processing program.

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- At the first time inlet of the rinse-spin type, if water level failed to rise up 2 levels in 2 minutes, the program will change to normal type rinse instead of rinse-spin type.

- If user setting water level value is higher than the 4th level, while water reach to the 3rd level, washing program begin to run the next step process, and washing motor run with the corresponding stream based on the rising water level, which will last till water reaching user setting value.

- During inlet running, if lid is open, platform will alarm and run the error processing program.

3.2.2 Drain process

In drain process, the drain triac switched on till water is drained off, after that, the platform will keep draining for 60 seconds and then begins to run the next step process. The time set for drain process is 2 minutes, while this process exceeds 2 minutes, washing program will stop time counting; and if the process finished in less than two minutes, the process running time still calculated as 2 minutes.

If there is even no water in the tube at the beginning of drain process, the platform still keep draining for 10 seconds and then platform starts to run the next step process. If the tube has not been drained off in 8 minutes, platform will alarm and start to run error processing program.

3.2.3 Soak process

Based on the available soak time setting, washing program separate washing motor cycle time as 3 types and 4 kinds of combinations as below. During soak running, if lid is open, platform will alarm and run the error processing program.

- Below are the 3 types of the motor cycles:

  A: 2 minutes motor cycle + 3 minutes stop
  B: 1 minutes motor cycle + 4 minutes stop
  C: 1 minutes motor cycle + 9 minutes stop

- Below are the 4 kinds of motor cycle combinations based on A, B and C motor cycle types:

  a), 10 minutes group (A, B);
  b), 20 minutes group (A, B, C);
  c), 30 minutes group (A, B, C, C);
  d), 40 minutes group (A, B, C, C, C);

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3.2.4 Wash process

Wash process runs different type of motor cycles according to user selected washing programs. This part introduces wash process in relative program. For details, please refer to the program tables. During wash running, if lid is open, platform will alarm and run the error processing program.

a), In " Standard " program, wash process runs with below rules:

- If " soak " process selected, wash process starts the main stream washing motor cycle (motor cycling time use wash set time subtracting 30 seconds) and then runs 30 seconds balance washing motor cycle.

- If full automatic program enabled, the wash process runs as following procedure: Weight detection → Texture detection → Inlet for water drop → Wash for set time → Balance for 30 seconds. Especially, as we did not enable the weight and texture detection function in s/w, the platform will not distinguish whether or not the full automatic program is enabled.

- If the full automatic program not enabled, wash process starts the main stream washing motor cycle (motor cycling time use wash set time subtracting 30 seconds) and then runs 30 seconds balance washing motor cycle.

b), In " Memo ", " Strong " and " Soft " program, after inlet to user setting water level, wash process starts the main stream washing motor cycle (motor cycling time use wash set time subtracting 30 seconds) and then runs 30 seconds balance washing motor cycle.

c), In " Wool " and " Silk " program, after inlet to user setting water level, wash process starts the main stream washing motor cycle (motor cycling time use wash set time subtracting 30 seconds) and then runs 30 seconds balance washing motor cycle.

3.2.5 Rinse process

Rinse process has two types, one is rinse with water inlet to user setting level, and the other is rinse-spin type. For details, please refer to the program tables. During rinse running, if lid is open, platform will alarm and run the error processing program.

a), Rinse with water inlet to user setting water level:

- After inlet to user setting water level, wash process starts the main stream washing motor cycle (motor cycling time use wash set time subtracting 30 seconds) and then runs 30 seconds balance washing motor cycle.

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b), Rinse-Spin type:

Washing program starts with spin process, and at the same time, the inlet valve open and close with 35/30 seconds cycles (for details, please refer to the program table).

3.2.5 Spin process

Spin process has four steps, there are intermittent spin, continuous spin, inertial spin and bake, and in some program the spin process may be with the inlet on (rinse-spin type). During spin running, if lid is open, platform will alarm and run the error processing program. Below is the description of the spin process.

a), In intermittent spin, the motor run clockwise with 4s/3s on/off cycles.

b), In continuous spin, the motor run clockwise continuously.

c), Spay spin is the process that during spin, the inlet valve open and close with 35/30 seconds cycles (for details, please refer to the program table).

d), In inertial spin, the motor is turned off with drain valve on, and the tube keep running by the inertial motion. If the lid is open, this process paused but it does not need to judge the balance status.

e), While brake occurs, drain valve and drain motor are turned off, this process lasts for 5 seconds, the tube is braked by the mechanical part.

f), While spin running, the washing motor keep turned off for 7 seconds after the drain motor and valve switched on for waiting the mechanical parts being ready.

g), During spin running, if lid is open or unbalance happen, platform will alarm and run the error processing program. At this time, washing motor is stopped and drain motor and valve is switched off, and the tube is braked by mechanical parts.

h), If unbalance happen, the program will stop spin process and inlet to user setting water level value, then starts wash process with balance stream for 60 seconds, after that, washing program will resume drain and spin process. If unbalance happen again after 2 times adjusting, platform will alarm and run the error processing program. During unbalance adjusting, the program left time will be increased accordingly.

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3.2.6 Error detection and alarm

During washing program running, 8 type of error detection is enabled and the platform will start alarming and begin to run the error processing program if error occur. At this time, the LCD will display relative error status information. Below table shows the error type and detail information, especially, the error code is used by washer software but will not be displayed on LCD:

Error type	Description	Error code	Buzzing	Error release
Preset lid open	The lid is opened during preset program running	E0	20 times 0.5s/0.5s on off buzzing in every 15 minutes	Open and close lid one time
Abnormal Drain	Drain over 8 minutes	E1		
Abnormal lid open	At the starting moment of wash, rinse and spin process, the lid is open.	E2		
Abnormal spin	Spin unbalance happen	E3		
Abnormal inlet	Inlet over 20 minutes	E4		

3.2.7 Washing stream

The washing stream is defined by the washing motor on / off time cycles, below tables show the stream option in relative program running, which also is related to the AC power frequency.

Main stream		High	Middle	Low	Balance stream
Memo	50Hz	1.0/0.7	0.8/0.7	0.6/0.6	0.2/0.5
	60Hz	0.8/0.8	0.6/0.7	0.5/0.6	
Speedy	50Hz	/	/	0.7/0.7	
	60Hz	/	/	0.6/0.8	
Child	50Hz	0.9/0.7	0.7/0.7	0.5/0.6	
	60Hz	0.8/0.8	0.6/0.7	0.4/0.6	
Strong	50Hz	1.1/0.8	0.9/0.8	0.6/0.6	
	60Hz	0.9/0.8	0.8/0.8	0.5/0.6	
Standard	50Hz	1.0/0.7	0.8/0.7	0.6/0.6	
	60Hz	0.8/0.8	0.6/0.7	0.5/0.6	

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Soft	50Hz	0.9/0.7	0.7/0.7	0.5/0.6	
	60Hz	0.8/0.8	0.6/0.7	0.4/0.6	
Wool	50Hz	0.4/0.6	0.3/0.6	0.2/0.6	None
	60Hz	0.3/0.6	0.2/0.6	0.1/0.6	

Below table shows strengthened stream option in “ Memo ”, “ Standard ”, “ Strong ” and “ Soft ” programs:

Strong stream	High		Middle		Low
	50Hz	60Hz	50Hz	60Hz	
Memo/Standard/Strong	1.4/0.6	1.2/0.6	1.2/0.5	1.0/0.6	None
Soft	1.3/0.6	1.1/0.6	1.1/0.5	0.9/0.6	

In these programs, the main stream and the strong stream executed alternately at high and middle water level, which is combined with 2 minutes main stream and 20 seconds strong steam.

3.2.8 Softener inlet

In the last time rinse, at the beginning of the inlet process, there is a 10 seconds softener inlet process at the same time with water inlet. Which is described in the inlet process.

3.2.9 Platform demo program

The platform will run demo program by when jumper 3 in “ off ” status. After “ Power ” key pressed, the program will run automatic washer program without user setting. During this mode, the platform will run automatic washer program repeatedly, which mean after finishing one time program running the platform will resume another time program running with the same setting.

3.2.10 Power down recovery

The platform enabled the power down recovery function using R8C 2A/2B MCU Voltage Detection function. For technical details, please refer to the schematic and s/w source code.

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4. Software Realization

4.1 MCU resource arrangement

Below form introduces the resource arrangement of R8C 2A/2B MCU for this platform. The Schematic of the platform is attached at the end of this manual.

	Port	Pin	Comment
I/O port	Port 0	P00 ~ P03	LCD data line
		P04 ~ P05	LCD control line
	Port 1	P10-P13	LCD data line
		P14	Softener LED output control
		P15	Reserved LED control
		P16	Load testing input
		P17	Water level detection input
	Port 2	P20-P24	key scan output
		P25-P26	key scan input
		P27	Voice module control
	Port 3	P30	Drain triac control
		P31	Buzzer control output
		P32	INT2 input
		P33	Jmper1 input
		P34	Jmper2 input
		P35	Jmper3 input
		P36	CW triac control
		P37	LCD backlight control

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	Port	Pin	Comment
I/O port	Port 4	P43 ~ P44	I2C bus for EEPROM R/W
		P45	CW triac control
	Port 5	P50 ~ P54	Voice module control
	Port 6	P61 ~ P62	LCD control line
		P63 ~ P64	UART communication
		P65	Inlet triac control
		P66 ~ P67	UART communication
	Port 8	P80	Softener triac control
		P81	AC power cutting off control
		P82	CW LED output control
		P83	Drain LED output control
		P84	Inlet LED output control
		P85	CCW LED output control
		P86	Reserved LED output control
A/D	AN0, AN1	P06 ~ P07	A/D conversion
Interrupt	Timer A	_____	Used as the system 4ms base timer
	Timer B	_____	Used as key scan and buzzer timer
	INT2	P32 / INT2	Used as AC frequency detection
	Vdet2	_____	Used to detect unexpected power down situation.

4.2 Washing program structure introduction

The figure below shows the platform s/w structure and almost all the functions in C source code, and the interrupt routine is also included.

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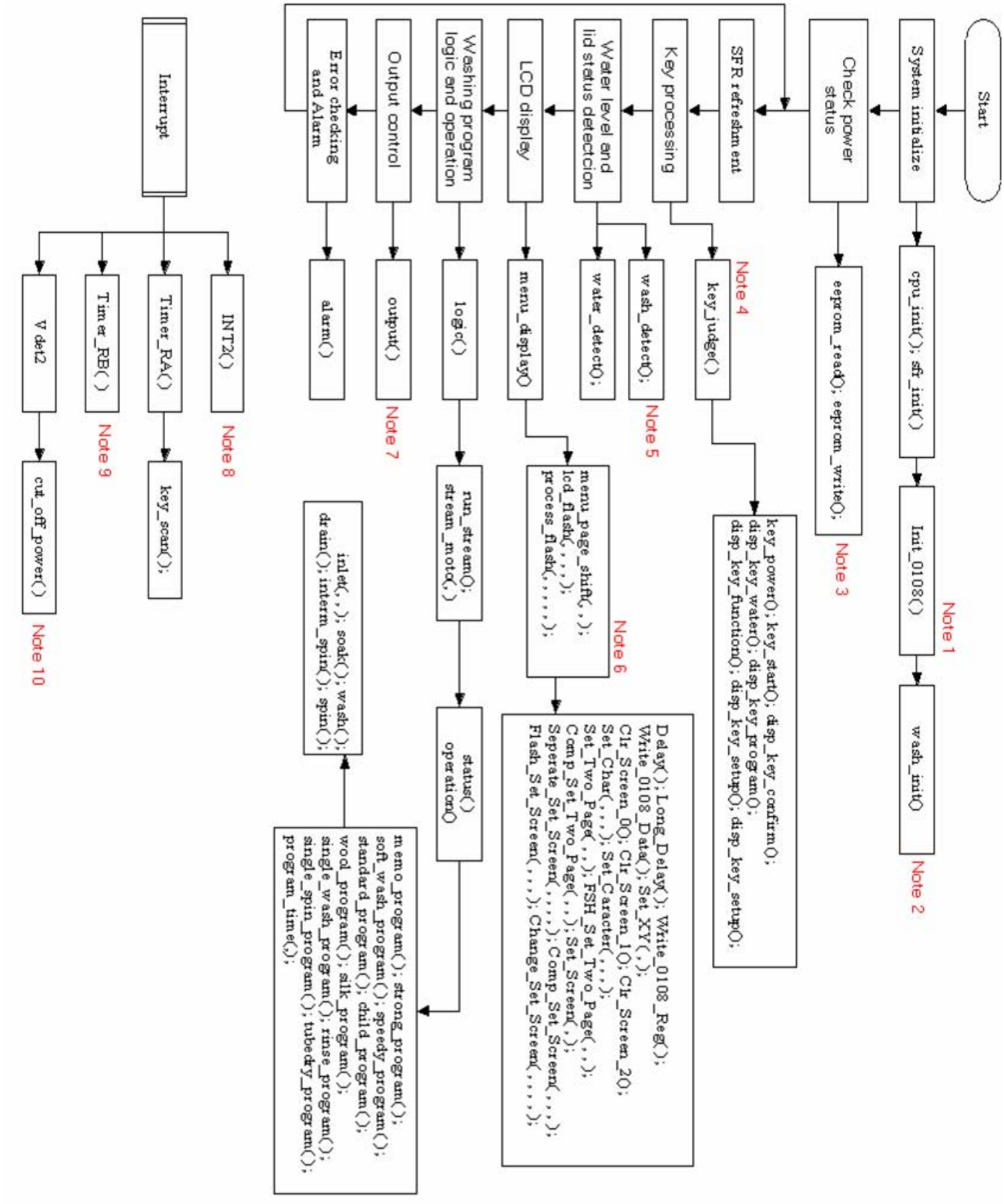

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Below notes introduces above software structure figure, based on which user can get known of platform function software realization. The “ , ” in the C functions indicates corresponding function prototype has one or more arguments.

Note:

1, The “ Init_0108() ” is the C function that initialize LCD and the variables of the LCD driver.

2, The “ wash_init() ” is the C function that initialize all the variables used during platform running.

3, The “ eeprom_read() ” is used to check platform power status and executes the power down recovery function if necessary, which is realized by reading the flag in certain address of the EEPROM, if the flag is “ 1 ”, it’s mean before current power on, there is an unexpected power down happened and power down recovery function need to be executed; if the flag is “ 0 ”, it’s mean current power on is an normal power on process.

The “ eeprom_write() ” is used to copy the content in certain RAM address of R8C 2A/2B to EEPROM for saving the variables that is on using at the time of voltage detection interrupt occurs, and especially, this function sets the power status flag to indicate an unexpected power down happens. During power down recovery running, the saved variables will be write back to RAM of R8C 2A/2B.

4, The “ key_judge ” function is used to handle user key pressing. In this function, the LCD display flags and system status flags were set.

5, “ wash_detct ” is used in platform debugging mode, this function will detect the jumper 2 status and decide whether or not the “Soak ” and “ Wash ” will be decreased.

6, LCD display function use 3 functions, “ menu_page_shift(, ,) ” is for screen page shifting; “ lcd_flash(, , , ,) ” is for flashing display during parameter setting; “ process_flash(, , , , ,) ” is for status display during washing program running, and these functions call relative LCD driver functions to refresh the screen.

7, The “output() ” function refresh the LED and triac output at in every loop of washing program running.

8, The “ INT2 () ” is used as AC frequency detection.

9, The “ Timer_RB () ” is used for key scan and buzzer.

10, The “ cut_off_power ” is used to detect the unexpected power down situation.

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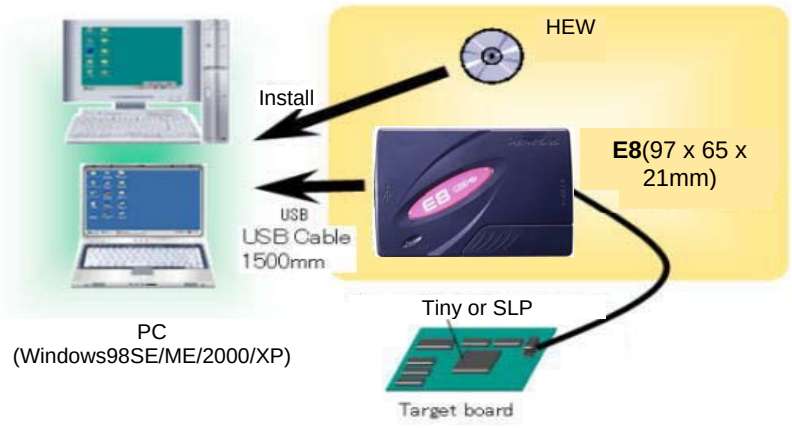
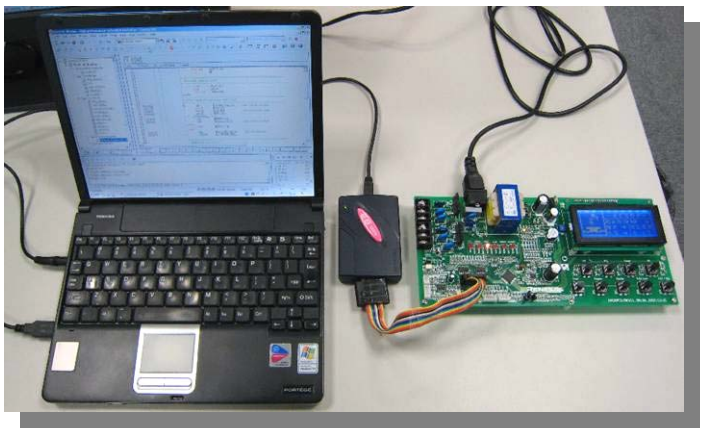
5. Using the Platform

5.1 Platform emulation and debugging

In this part, the configuration of the platform emulation and debugging is introduced. Below figure shows system emulation environment with Renesas Hew and E8 debugger. For detail introduction, please refer to Renesas HEW and E8 debugger user manuals.



Below picture shows the platform debugging with host PC and Renesas E8 debugger. **Please note that, in debugging mode, do not mount "K1" (Relay) onto the board and also do not short Pin 3 and Pin 4 of "K1" on the board, because if Pin 3 and Pin 4 of "K1" shorted, system 5V is floating on 220V AC, which will damage E8 debugger and host PC.**



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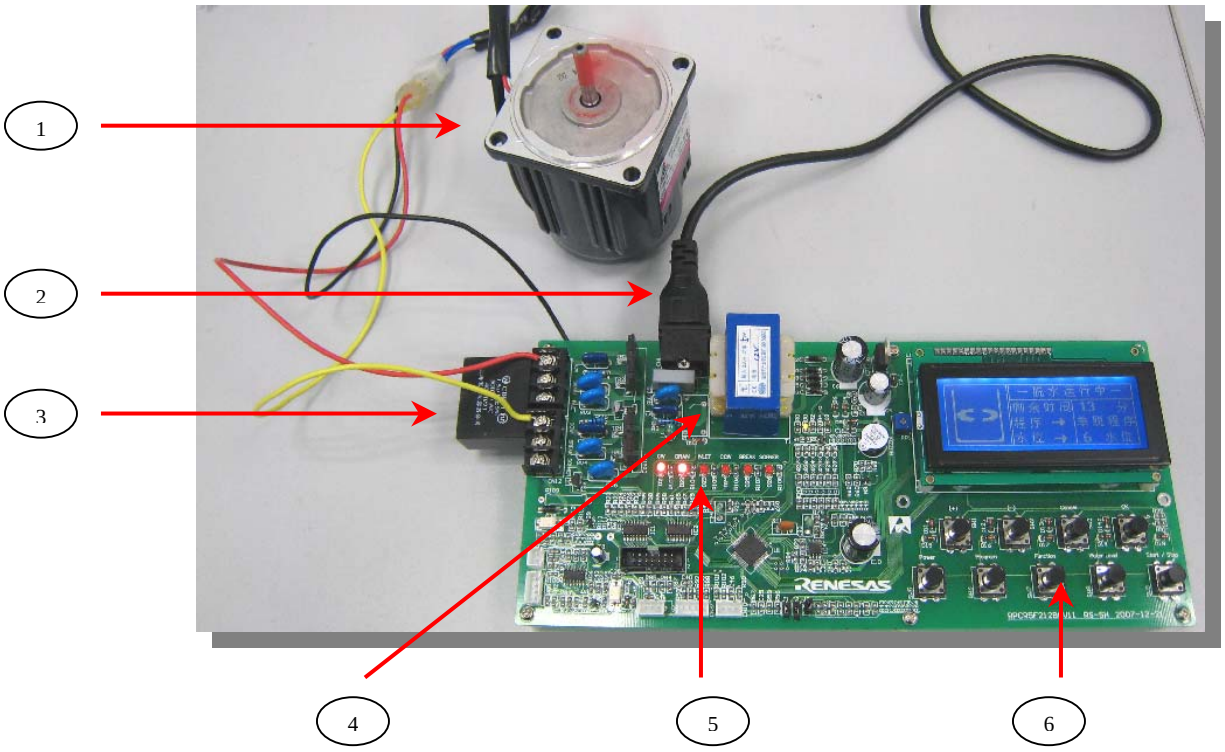
5.2 Test AC output with loading

For testing and evaluating AC driving and washer output function, user needs to connect the AC part on the platform with AC loading.

Firstly user need to mount “K1” onto the board or short Pin 3 and Pin 4 of “K1” for connecting AC power to the output part; then please connect the washing motor and / or system valves (Inlet or Drain) with “CN11” and “CN12”.

Please keep in mind that, while AC power is connected to output part, platform system 5V is floating on 220V AC; therefore, user must take much care of AC power danger when testing the platform. It’s highly recommended that user take special security process for testing the AC output functions.



Notes:

1, AC motor for demo (220V, 90r/min—1250r/min, 15W, 0.16A);
2, AC power input (220V, 50Hz /60Hz);

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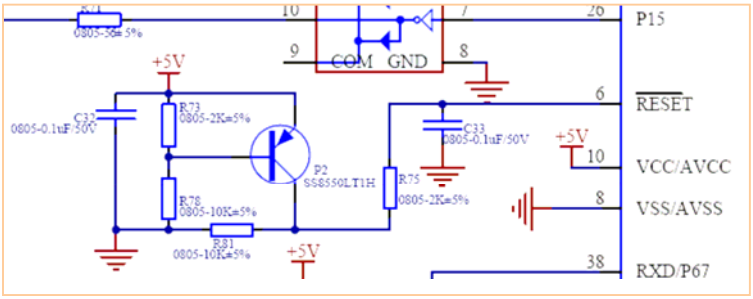
3, AC motor starting capacitor (CBB61, 1.5uF, 500V AC);
4, Relay for control AC power of output part, the designator is “K1” on the board;
5, AC output simulation LEDs, the function is identical with AC output;
6, Key array for setting the platform;

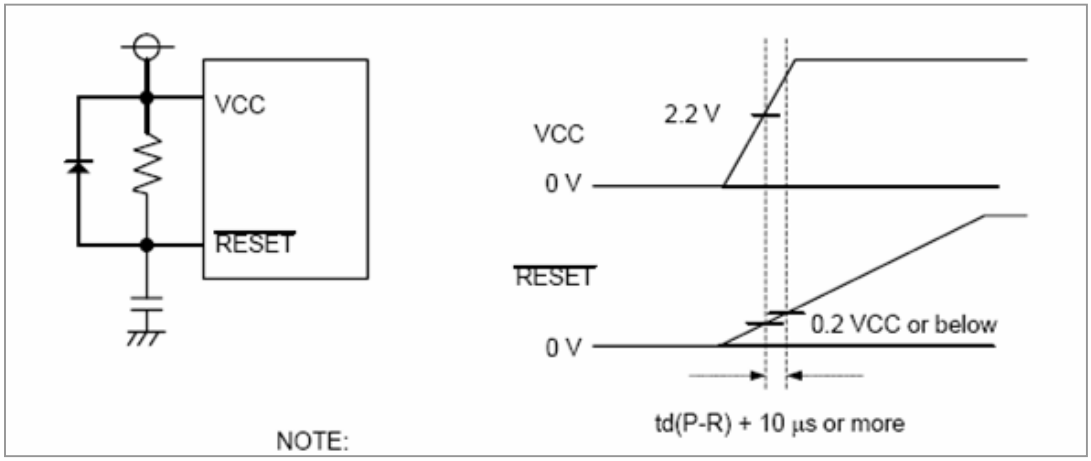
5.3 Test unexpected power down recovery function

For testing the unexpected power down recovery function of the platform, the platform reset circuit need to be reworked. It’s recommend to use RC reset circuit instead of the platform implemented circuit because there is a power drop (nearly 1v) between “+5V” and Reset “high” Level, which make Vdet0, Vdet1 and Vdet2 cannot work normally.



1, Platform reset circuit

Below figure shows the RC reset circuit connection, the recommended RC value is 30K-100K resister and 104 capacitor. **Please rework the reset circuit with below RC reset circuit.**



2, RC reset circuit

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Appendix:

Below are the platform washing program time tables.

1, Memo program

Program			Memo Program									
Water Level			Low	Middle			High					
Texture			---	Soft	Common	Hard	Soft	Common	Hard			
Soak, Wash		Inlet	●	●	●	●	●	●	●	--	Inlet	Soak, Wash
		Soak	10'	20'	20'	20'	30'	30'	30'		Soak	
		Wash	10'	10'	12'	15'	12'	15'	16'		Wash	
		Balance wash	●	●	●	●	●	●	●	30"	Balance wash	
Rinse		Drain	●	●	●	●	●	●	●	--	Drain	Rinse
		Intermittent Spin	●	●	●	●	●	●	●	30"	Intermittent Spin	
		Spin	●	●	●	●	●	●	●	1.5'	Spin	
		Inertial Spin	●	●	●	●	●	●	●	30"	Inertial Spin	
		Brake	●	●	●	●	●	●	●	5"	Brake	
		Inlet	●	●	●	●	●	●	●	--	Inlet	
		Wash	●	●	●	●	●	●	●	3'	Wash	
		Balance wash	●	●	●	●	●	●	●	30"	Balance wash	
		Drain	●	●	●	●	●	●	●	--	Drain	
		Intermittent Spin	●	●	●	●	●	●	●	30"	Intermittent Spin	
		Spin	●	●	●	●	●	●	●	1.5'	Spin	
		Inertial Spin	●	●	●	●	●	●	●	30"	Inertial Spin	
		Brake	●	●	●	●	●	●	●	5"	Brake	
		Inlet	●	●	●	●	●	●	●	--	Inlet	
		Wash	●	●	●	●	●	●	●	3'	Wash	
		Balance wash	●	●	●	●	●	●	●	30"	Balance wash	
Spin		Drain	●	●	●	●	●	●	●	--	Drain	Spin
		Intermittent Spin	●	●	●	●	●	●	●	30"	Intermittent Spin	
		Spin	●	●	●	●	●	●	●	5'	Spin	
		Inertial Spin	●	●	●	●	●	●	●	30"	Inertial Spin	
		Brake	●	●	●	●	●	●	●	5"	Brake	

2, Standard program

Program			Standard Program									
Water Level			Low	Middle			High					
Texture			---	Soft	Common	Hard	Soft	Common	Hard			
Soak, Wash		Inlet	●	●	●	●	●	●	●	--	Inlet	Soak, Wash
		Soak	10'	20'	20'	20'	30'	30'	30'		Soak	
		Wash	8'	8'	9'	11'	9'	10'	12'		Wash	
		Balance wash	●	●	●	●	●	●	●	30"	Balance wash	
Rinse	Spray Rinse	Drain	●	●	●	●	●	●	●	--	Drain	Rinse
		Intermittent Spin	●	●	●	●	●	●	●	30"	Intermittent Spin	
		Spin	●	●	●	●	●	●	●	15"	Spin	
		Inertial Spray Spin	●	●	●	●	●	●	●	25"	Inertial Spray Spin	
		Spin	●	●	●	●	●	●	●	15"	Spin	
		Inertial Spray Spin	●	●	●	●	●	●	●	25"	Inertial Spray Spin	
		Spin	●	●	●	●	●	●	●	15"	Spin	
		Inertial Spin	●	●	●	●	●	●	●	30"	Inertial Spin	
		Brake	●	●	●	●	●	●	●	5"	Brake	
	Rinse	Inlet	●	●	●	●	●	●	●	--	Inlet	
		Wash	●	●	●	●	●	●	●	2'	Wash	
		Balance wash	●	●	●	●	●	●	●	30"	Balance wash	
Spin		Drain	●	●	●	●	●	●	●	--	Drain	Spin
		Intermittent Spin	●	●	●	●	●	●	●	30"	Intermittent Spin	
		Spin	●	●	●	●	●	●	●	3'	Spin	
		Inertial Spin	●	●	●	●	●	●	●	30"	Inertial Spin	
		Brake	●	●	●	●	●	●	●	5"	Brake	

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3. Strong program

Strong		Program	
●	--	Inlet	Soak, Wash
●	40'	Soak	
●	20'	Wash	
●	30"	Balance wash	
●	--	Drain	Rinse
●	60"	Intermittent Spin	
●	60"	Spin	
●	30"	Inertial Spin	
●	5"	Brake	
●	--	Inlet	
●	5'	Wash	
●	--	Drain	
●	60"	Intermittent Spin	
●	60"	Spin	
●	30"	Inertial Spin	
●	5"	Brake	
●	--	Inlet	
●	5'	Wash	
●	--	Drain	Spin
●	60"	Intermittent Spin	
●	5'	Spin	
●	30"	Inertial Spin	
●	5"	Brake	

4. Wool program

Wool		Program	
●	--	Inlet	Soak, Wash
●	10'	Soak	
●	5'	Wash	
●	30"	Balance wash	
●	--	Drain	Rinse1
●	60"	Intermittent Spin	
●	60"	Spin	
●	30"	Inertial Spin	
●	5"	Brake	
●	--	Inlet	
●	2'	Wash	
●	30"	Balance wash	
●	--	Drain	Rinse2
●	60"	Intermittent Spin	
●	60"	Spin	
●	30"	Inertial Spin	
●	5"	Brake	
●	--	Inlet	
●	2'	Wash	
●	30"	Balance wash	
●	--	Drain	Spin
●	60"	Intermittent Spin	
●	2'	Spin	
●	30"	Inertial Spin	
●	5"	Brake	

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6. Soft program

Soft		Program	
●	--	Inlet	Soak, Wash
●	20'	Soak	
●	10'	Wash	
●	30"	Balance wash	
●	--	Drain	Rinse1
●	60"	Intermittent Spin	
●	60"	Spin	
●	30"	Inertial Spin	
●	5"	Brake	
●	--	Inlet	
●	3'	Wash	
●	30"	Balance wash	
●	--	Drain	Rinse2
●	60"	Intermittent Spin	
●	60"	Spin	
●	30"	Inertial Spin	
●	5"	Brake	
●	--	Inlet	
●	3'	Wash	
●	30"	Balance wash	
●	--	Drain	Rinse3
●	60"	Intermittent Spin	
●	60"	Spin	
●	30"	Inertial Spin	
●	5"	Brake	
●	--	Inlet	
●	3'	Wash	
●	30"	Balance wash	
●	--	Drain	Spin
●	60"	Intermittent Spin	
●	3'	Spin	
●	3"	Inertial Spin	
●	5"	Brake	

5. Child program

Child		Program	
●	--	Inlet	Soak, Wash
●	20'	Soak	
●	10'	Wash	
●	30"	Balance wash	
●	--	Drain	Rinse1
●	60"	Intermittent Spin	
●	60"	Spin	
●	30"	Inertial Spin	
●	5"	Brake	
●	--	Inlet	
●	3'	Wash	
●	30"	Balance wash	
●	--	Drain	Rinse2
●	60"	Intermittent Spin	
●	60"	Spin	
●	30"	Inertial Spin	
●	5"	Brake	
●	--	Inlet	
●	3'	Wash	
●	30"	Balance wash	
●	--	Drain	Rinse3
●	60"	Intermittent Spin	
●	60"	Spin	
●	30"	Inertial Spin	
●	5"	Brake	
●	--	Inlet	
●	3'	Wash	
●	30"	Balance wash	
●	--	Drain	Spin
●	60"	Intermittent Spin	
●	3'	Spin	
●	30"	Inertial Spin	
●	5"	Brake	

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Silk		Program	
●	--	Inlet	Soak, Wash
●	300"	Wash	
●	--	Drain	Rinse
●	60"	Intermittent Spin	
●	60"	Spin	
●	30"	Inertial Spin	
●	5'	Brake	
●	--	Inlet	
●	120"	Wash	
●	--	Drain	
●	60"	Intermittent Spin	
●	60"	Spin	
●	30"	Inertial Spin	
●	5"	Brake	
●	--	Inlet	
●	120"	Wash	
●	--	Drain	Spin
●	60"	Intermittent Spin	
●	120"	Spin	
●	30"	Inertial Spin	
●	5"	Brake	

7. Silk program

Speedy		Program	
●	water level 3	Inlet	Soak, Wash
●	2'	Wash	
●	--	Drain	Rinse
●	20"	Intermittent Spin	
●	30"	Spin	
●	10"	Inertial Spin	
●	5"	Brake	
●	water level 3	Inlet	
●	1'	Wash	
●	--	Drain	Spin
●	20"	Intermittent Spin	
●	1'	Spin	
●	15"	Inertial Spin	
●	5"	Brake	

8. Speedy program

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9. Wash

●	--	Inlet	Wash
●	600"	Wash	
●	30"	Balance wash	

10. Rinse program

●	--	Drain	Rinse
●	60"	Intermittent Spin	
●	60"	Spin	
●	30"	Inertial Spin	
●	5"	Brake	
●	--	Inlet	
●	180"	Wash	
●	30"	Balance wash	

11. Spin program

●	--	Drain	Spin
●	60"	Intermittent Spin	
●	180"	Spin	
●	30"	Inertial Spin	
●	5"	Brake	

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