A Novel Stalwart Design for Automatic Washing Machine Using VHDL

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Abstract:

As described by digital system the language VHDL is widely used in the circuit design, its own advantages to be able to use software language describe hardware features that makes it has good readability, portability, etc. Its advantages not only reduce the hardware development cycle but also greatly reduce development costs. This paper practically describes the characteristics and application of VHDL and takes the automatic washing machine as examples to illustrate the practicality of HDL. The result of simulation shows this method is feasibility and effectiveness.

Keywords: Hardware description languages; Automatic washing machine, Hardware description language designer series, Field programmable gate arrays (FPGA).

1. INTRODUCTION

In recent years, with the development of science and technology, the design of electronic systems also produce a revolutionary change, a new class of development tools relate to electronic systems are spreading quickly. Hardware Description language (HDL) is a method to Description of digital circuit. ^DL describes a certain function of digital circuit usually has one or more files composition. According to certain rules (or grammar) HDL describes documents after the compilation, and uses the electronic system design automation (EDA) tools to comprehensive, just can be transformed into practical circuit. In recent years, with the rapid development of EDA and large scale programmable of logic device, ^DL can hierarchical description and simulation of any electronic components characteristics, so that the circuit designers and developers could describe the feature of the circuit freely, which can build the bridge of communication and exchange data between chip designers and producers.

Introduction to VHDL language

With better clothing came in the need for better washing, this led to invention of tools for washing, first washing machine was a broom with four claws at the bottom to move the clothes around a tub or a bucket. In modern days fully automated ones based on microcontroller, it's evident that washing machines have come a long way. Washing machines are gradually emerging as a ubiquitous dhobi in Indian homes. Today market is flooded with many models, each vaunting of a large number of features and specialties [2]. A washing machine is a machine to wash laundry, such as clothing and sheets. The word is mostly applied only to machines that use water as opposed to dry cleaning (which uses alternative cleaning fluids, and is performed by specialist businesses) or ultrasonic cleaners. Washing process comprises immersing, dipping, rubbing, or scrubbing in water usually accompanied by detergent, or bleach. The simplest machines may merely agitate clothes in water while switched on; automatic machines on the other hand may fill, empty, wash, spin, and heat in a cycle. Washing machines are of two types by function:

1. **Semi Automatic:** In semi-automatic machines the controls are not completely automatic and manual intervention is required. These are top loading twin tub machines where the washer and the dryer are separate units. So the task of loading and unloading a couple of extra times. These are preferable where running water is not available.

2. **Fully Automatic:** A fully automatic, on the other hand, can be either front or top loading and there is no manual intervention needed—drop the clothes, turn the machine on, and wait for it to finish washing and drying. Fully automatic machines require a dedicated running water supply from a tap. The whole process is carried out in a single tub. The washer, dominantly, would function almost entirely the same way it does now, but the clothes would be cleaned with a fluid other than water [4]. This would almost completely remove the need for water. The clothes are dropped in the tub, water and detergent is added, then wash cycle is programmed according to the requirement. The washing machine does washing, rising, and drying and notifies with beeps when it is through with all the tasks.

II.CLASSIFICATION OF WASHING MACHINES

There is further classification of washing machines on the basis of how clothes are fed in to the machine. On this basis machines are divided into two types top loaded and front loaded.

1. Top loaded machine: Top loading machines use two vertical drums with an agitator to pull the clothes down in the center as it moves back and forth. The center then pushes them back up on the

outside of the basket. This motion is repeated for a determined amount of time. The inside drum is able to move and is perforated so water can escape. The outer drum holds the water. Top loaders use much more water than the front loaders.

Top loaders allow to removing the clothes easily, without having to bend, even during power failure. These machines are compact and require normal detergents for washing. Clothes can be added even if the wash cycle has begun. The larger the drum, the loading and the unloading is more convenient. [5].

2. Front loaded machine: Front-loading washing machines requires less water and energy, as compared to conventional machines. All front-loading machines use the tumble wash action for washing clothes. Front loaders are usually more expensive. However, these consume less water and dry clothes much faster than the top loading machine; thereby reduce the consumption of energy [1].

Front loaders cannot be open midway through a wash cycle. This type of loader use detergents producing less lather and, if the power fails, door can't open due to water present in the drum [5]. The objective of this paper is to show the development of ASIC for a washing machine. As of now making of the IC specifically for washing machines and it is not used in other applications. Verification of the software code with the logical flowchart of the washing machine is done. The simulation results obtained are inconformance with the logical flow of the working of fully automatic washing machine.

2.1 Principle of automatic washing machine

The inside bucket of fully-automatic washing machine has many small holes, through them the water bucket between the inside and outside is interlinked, electromagnetic valve pumps the water in and out. When the water fills in the control system the electromagnetic valve opens up, this allows the water to be fed into outer barrel. During drainage, the control system lets the drain electromagnetic valve open up, so the water by outer barrel drains out. When dehydrating, the control system will close valve and by turning on washing motor driving internal vats to dry. High, middle and low water level control switches are used to detect the high, middle and low water level. Start button activates the washing machine; stop button is used to manually stop water, drainage, dehydration and alarm. Drainage button is to achieve manual drainage [3].

2.2 Working of automatic washing machine

As discussed earlier there are two types of washing machines, the top loader and the front loader. With either machine it is filled with clothing or other linens, some detergent is added and it turns on. They are directly hooked to water lines which bring water into the drum and mixes with the

detergent. Then they agitate or bounce the clothing through the soapy water, thereby cleaning out the dirt and soil. The machines go into a spin cycle and pull all the water back out of the clothing. Once more, water fills the tub and rinses out the remaining soap. Again, with high speed spinning it spins out the water and leaves the clothes dried [1]. The functional block diagram of a washing machine is shown below in fig

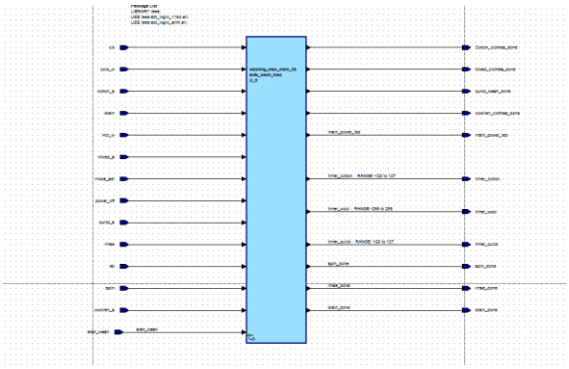

Fig 1 The functional block diagram of a washing machine

3. WASHING TECHNIQUE:

There are two washing techniques used in washing machine. One of the techniques is widely used in top loaded washing machine and the other is used in front loaded washing machine or say fully automatic washing machine. These techniques are explained below:

1. Agitator wash technique: In this technique, a rod with fin is used at the centre of the washing machine. A rubbing action of an agitator squeezes the dirt out of clothes. But it restricts the space and the clothes tend to get entangled. This technique is used in top loaded washing machine [5], [6]. The spinning requirements on vertical axis washers are much less so this part of the control is reasonably simple. However the agitation phase requirements are more complicated to achieve [7].

2. Tumble wash technique: This technique is used in front loading washing machine. This type of machine contains steel drum. This drum rotates along a horizontal axis and the clothes present inside the tub rub against its metal surface due to centrifugal action. The cleaning done by this technique is superior but there is a risk of ruining gentle fabrics [5], [6]. During the tumble action, the motor runs at low rpm clockwise and counter clockwise with a very high torque requirement. During the spin the motor is always in field weakening, so the motor works always very far from its nominal speed [7].

Washing module

1. To begin with the wash process it needs to be check if the water is available for washing from the water supply into the machine or not, if the water supply is feeding in water into the machine properly then the process advances further.

2. After validating the water supply move on to detergent check in the detergent container. If detergent is available for washing, the process continues. If for some reason the detergent is not present in the detergent container

then it needs to be added.

3. As next part of the process, water is filled in the drum for specific duration, after that water valve closes. This is done in order to prevent any overflowing of water in machine, as it can lead to inefficient washing and damage to the machine parts and also to provide the Hot and cold water conditions we need to keep the respective pipes to either of them ie both Hot and cold valve positions.

4. The drum of the machine needs to rotate in order to perform the wash action. For this purpose the motor starts which in turn rotates the washing drum, and stops after specific time once the wash process is completed.

5. Once the wash process is completed the water is drained out. Hie drainage of water is essential as there is a need to feed in fresh water for the next module i.e. rinsing.

Rinsing module

1. To begin with the rinse process again it needs to be check if the water is available for rinsing or not, if the water supply is feeding in water into the machine properly then the process advances further.

2. The door of the machine needs to be checked if it's properly closed. If the door is not closed it can lead to leakage of water from the machine. If the door is found to be closed then process moves further.

3. As next part of the process, after water is filled in the drum for specific duration, water valve closes. This is done in order to prevent any overflowing of water in machine.

4. The drum of the machine needs to rotate in order to perform the rinse action. For this purpose the motor starts which in turn rotates the drum, and stops after specific time.

5. Once the rinse process is completed the water is drained out. The drainage of water is essential as need to remove all the remaining dirt on clothes, so that the process can move further to the next module i.e. drying.

6. In the end it needs to be checked that there should be no trap in the drain pipe. If found it has to be removed as a trap or blockage in the drain pipe can lead to water logging inside the machine.

Drying Module

1. After the rinsing has been done, to start with drying process it needs to be checked if the door is closed. This is an obvious check as if the door is not closed it can lead to leakage of water from the machine. If the door is found to be closed then process moves further.

2. The drum of the machine needs to rotate in order to perform the drying

action. For this purpose the motor start which in turn rotates the drum in single direction either clockwise or counter clockwise, and at the same time drain valve is also open so that water drains out through the drain pipe, and the process stops after specific time once the clothes have dried out properly.

Higher the spins speed, the dryer the clothes at the end of the washing cycle and hence the shorter the drying time. Thus a high spin speed results in less washing time.

3. When the water drains out completely from the laundry the buzzer beep to indicate that the drying process is completed. Hence the whole washing process is completed.

4. In the end, when the buzzer beeps, switch off the power supply and the dried clothes can be taken out of the machine

SIMULATION RESULTS:

INPUT SIGNAL	DESCRIPTION
clk	The system clock for the controller
cold_w	Cold water transition state
cotton_s	Cotton clothes state
drain	Drain state
Hot_w	Hot water transition state
Mixed_s	Mixed Clothes state
mode_sel	Mode select for cotton or mixed or woolen clothes
power_off	Power off state
quick_s	Daily wear clothes washing state
rinse	Rinse state
rst	Reset all conditions
spin	Spin state
start_wash	Start wash for all different modes
woollen_s	Woolen state
OUTPUT SIGNAL	Completion of rinse state
rinse_done	Completion of rinse state
quick_wash_done	Completion of rinse state
spin_done	Completion of rinse state
Mixed_clothes_done	Completion of rinse state
main_power_led	Main power is on and continue from the resume state

timer_cotton	Cotton timing condition
drain_done	Drain done condition
timer_quick	Woolen clothes timing condition
timer_wool	Completion of Cotton state
Cotton_clothes_done	Completion of Woolen state
woollen_clothes_done	

STATE DIAGRAM FOR THE PROPOSED DESIGN

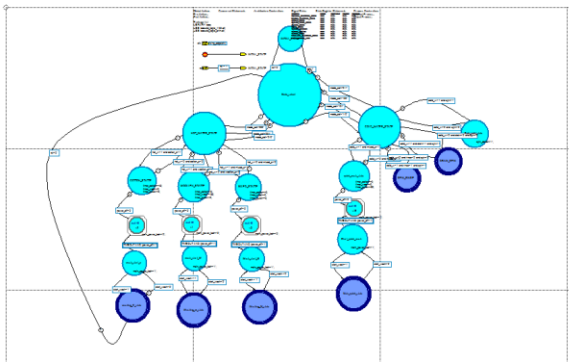

Fig. 2. RTL view

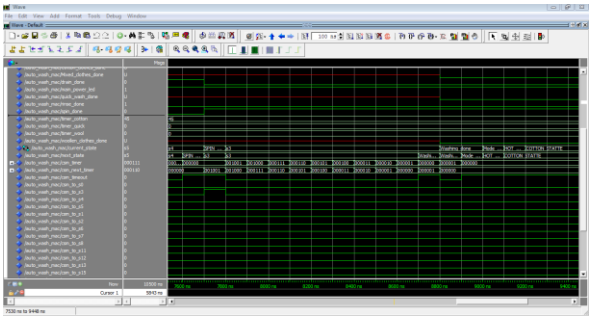

Fig. 3. Simulation results

The RTL view for the IC on the basis of the VHDL code has beenobtained. The RTL view is shown below in fig.2This RTL view gives the pictorial view of IC pins. All the pins onthe right side are the output pins and all pins on the left side arethe input pins. The descriptions of the I/O pins are given in table.1. How many I/O pins will be present in the IC? It can be easilycounted from the fig. 2. After the synthesis of VHDL code, testbench for the same is to be drawn, set the values of all inputs inthe form (0 or 1) accordingly then simulate the test bench to getthe simulation results. Simulation results give the output in theform (0 or 1) with respect to the set inputs. When reset signal ison, all of the signals set zeros; then if the start button is on, themachine will enter in water filling state for washing. As long aswashing process is not completed, washing machine willautomatically execute the process according to the predetermined.After the completion of whole washing process buzzer beep. The simulation results as shown in fig.3

4. CONCLUSION

In this paper software designing of an IC for a fully automatic washing machine is done. The type of machine taken into consideration is front loaded washing machine. The aim of this research is to

replace the microcontroller with ASIC which could reduce the board area and number of peripherals. The software code for the IC has been completed using VHDL. The simulation results confirm the expected working of the code. The next step would be to obtain the schematic using Cadence and then form the layout for the IC.

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