RECONFIGURABLE CONTROLLER FOR INDUSTRIAL APPLICATIONS

Vladimir Mladenov Mladenov, Todor Mladenov Mladenov

Faculty of Computer Systems and Control, Faculty of Communications and Communications Technologies, Technical University of Sofia, 8, Kliment Ochridski St., Sofia - 1000, Bulgaria, tel.: +359 2 965 21 34, e-mail: v_mladenov@mail.bg, dsptexas@mail.bg

Keywords: CPLD, microcontroller, finite state machine

In this paper an efficient, low cost, easy configurable and reconfigurable controller is presented. It targets industrial and highly demanding applications but it is still quite easy to make. A comparison with classical relay logic device is done.

INTRODUCTION

The device that is to be presented is designed to facilitate and shorten the time needed for implementing relay logic for industrial applications. A block schematic is shown on fig. 1.

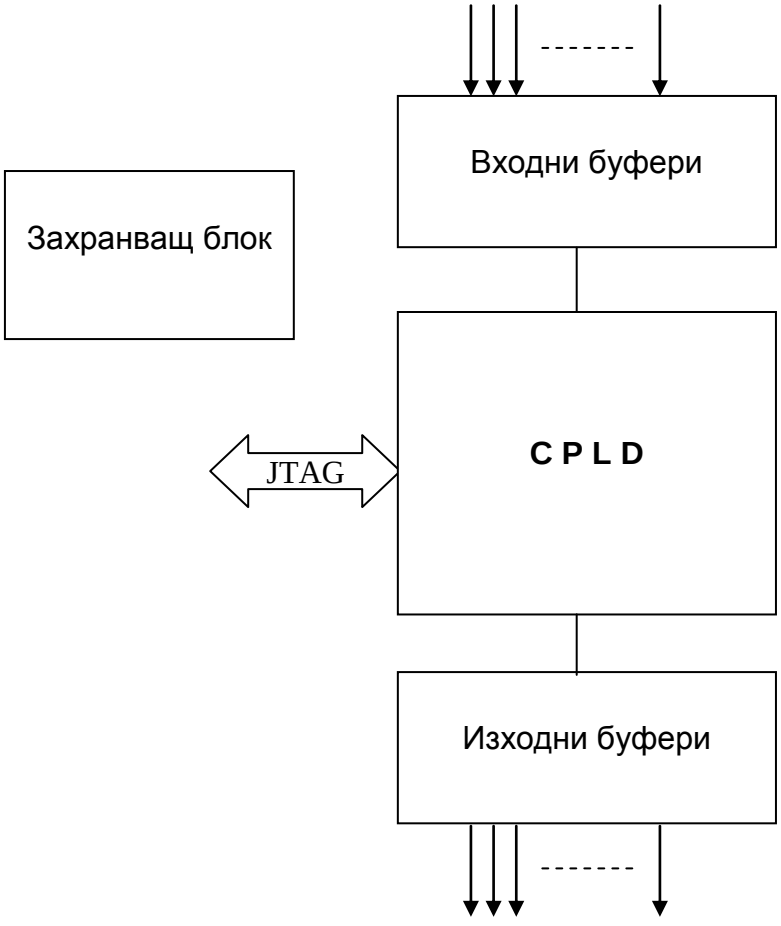

fig. 1

ELECTRICAL SCHEMATIC

Schematic diagram is shown on fig. 2.

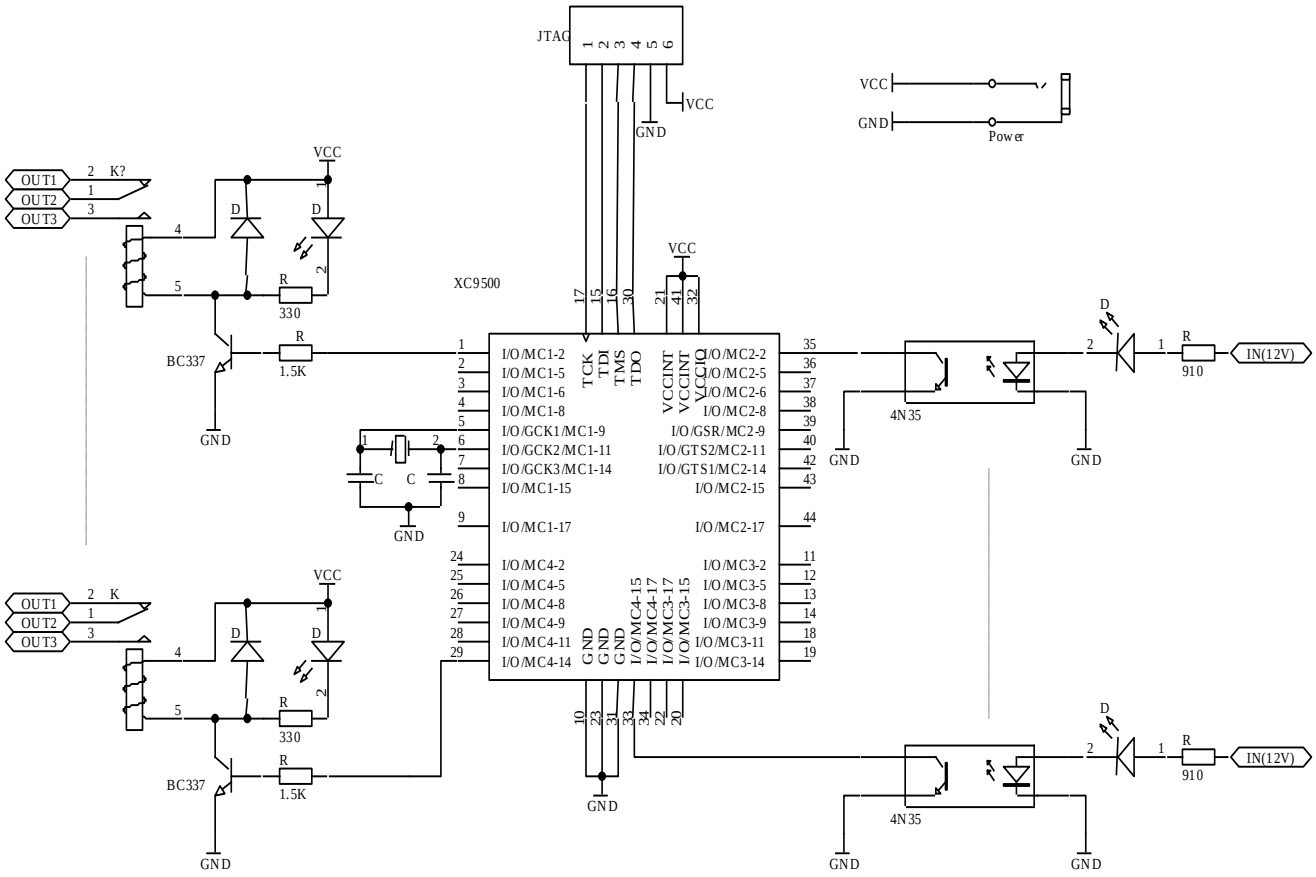

fig. 2

Here the above shown blocks are represented with their electrical equivalents. Input signals are optically separated from CPLD inputs. CPLD outputs drive mechanical relays. A quartz oscillator is formed and JTAG and power connectors are shown.

IMPLEMENTATION COMPARISON

A schematic, controlling industrial air-conditioning system (fig. 3), is created and compared with relay logic one (fig. 4) for testing its functionality.

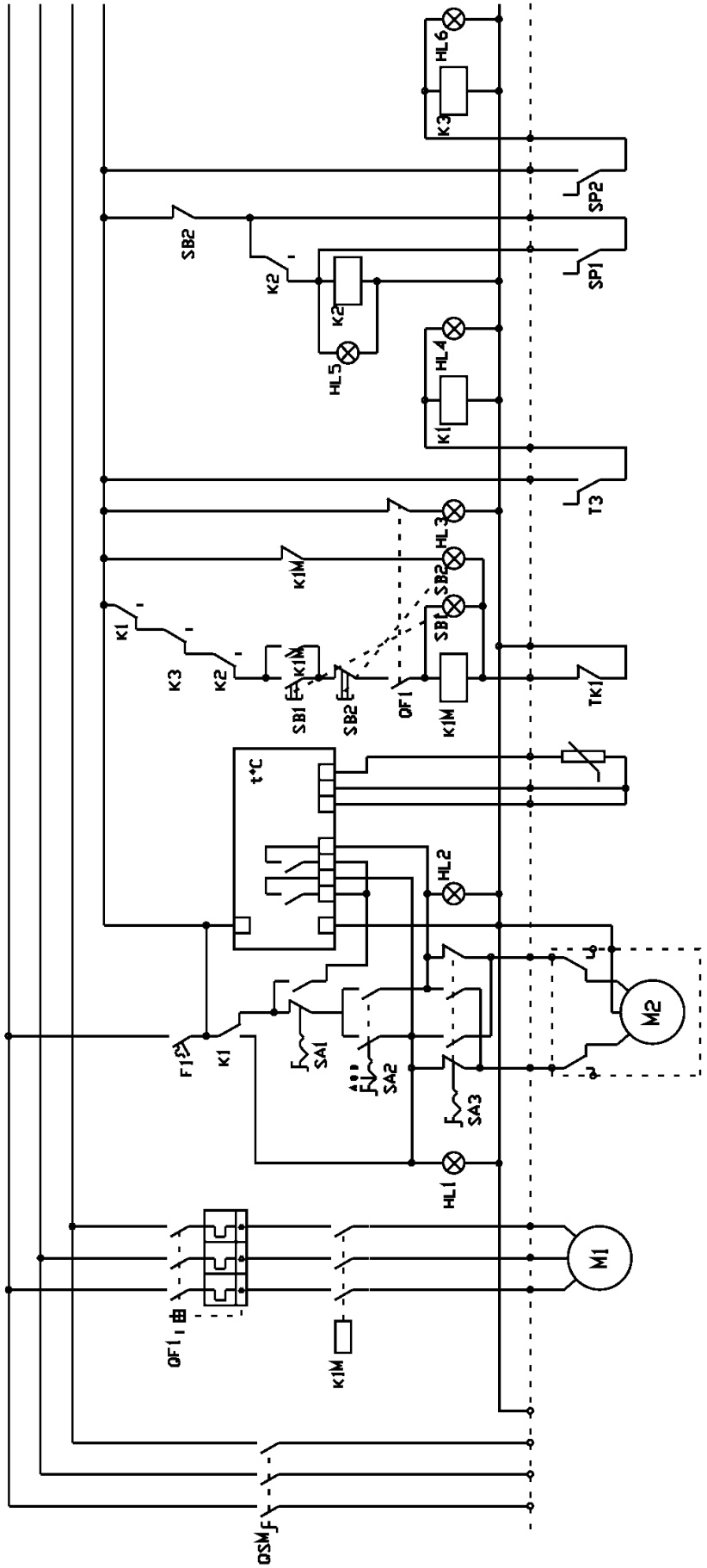
HL6
K3
SP2
SB2
K2
K2
SP1
HL5
HL4
K1
T3
HL3
KIM
SB2
SB1
K1
K3
K2
KIM
SB1
SB2
QF1
KIM
TK1
t°C
HL2
M2
F1
K1
SA1
SA2
SA3
HL1
M1
QF1
KIM
QSM

fig. 3

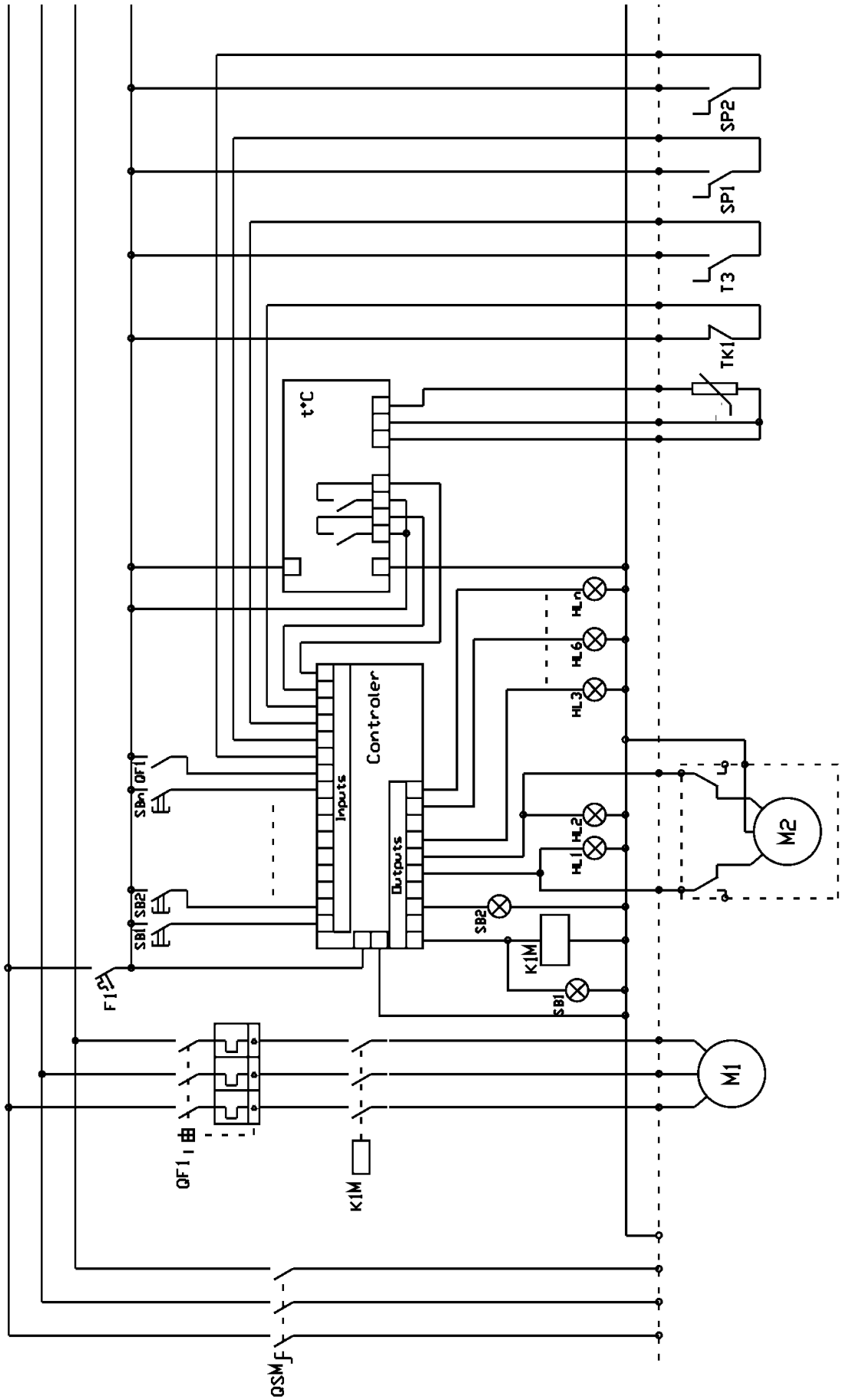
SP2
SP1
T3
TK1
t°C
HL4
HL6
HL3
Controler
Inputs
Outputs
SB1
QF1
SB2
HL2
HL1
M2
K1M
M1
QF1
K1M
QSM

fig. 4

Main features:

Here are listed some of the main results from the above comparison.

- Less cable connections and contacts
- Simple operational circuit that is easy to service
- Short time needed for implementing operational and high power circuits
- Direct connection of digital sensors or buttons and electrical separation of inputs
- Direct connection of indicators, contacts and devices (up to 10 A active load) to outputs
- Logical circuits and finite state machine description with VHDL for well known CPLD device
- Verifying functionality through simulation
- Easy programming through JTAG interface
- Easy reconfigurable without physical changes
- Free software for programming and simulation is available (www.xilinx.com)
- Low cost achieved through simple and efficient solution

PROGRAMMING

The controller behaves as a finite state machine. The functional model is decomposed and converted into functional table (fig. 5).

Input signals					**Current state**					
isFire	isStop	dp1, dp2, dp3, TK1, TK2	isAuto	isManual	stStop	stFire	stError	stStart	stManual	
1	x	x	x	x	stFire	stFire	stFire	stFire	stFire	**New state**
0	1	x	x	x	stStop	stFire	stStop	stStop	stStop	
0	0	1	x	x	stStop	stFire	stError	stError	stError	
0	0	x	1	0	stStart	stFire	stError	stStart	stManual	
0	0	x	0	1	stManual	stFire	stError	stStart	stManual	
					osStop	osFire	osError	osAuto	osManual	
					Output signals					

fig. 5 FSM functional table example

On the left different combinations of input signals are shown. The upper one is with highest priority. On the right there are five possible states. Depending on the input combination and current state, the next state is determined and therefore the output. According to the current state only the corresponding output signal is with high logic level (the others are cleared).

Functional tables are to be described in VHDL. For the above example a Moore finite state machine is used.

Once the model is synthesized, described and tested it has to be loaded in the CPLD matrix through the JTAG interface.

CONCLUSIONS

The device presented reaches high reliability through solving a width variety of problems in a new highly technological way.

REFERENCES

[1] http://www.vhdl-online.de

[2] Михов Г. С., Цифрова схемотехника, ТУ-София, 1998

[3] Красимира В. Филипова, Автоматни модели, ТУ-София, 2000

[4] П. Хоровиц, У. Хилл, Искусство схемотехники, “Мир” Москва, 2003