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IH COOKER DEMO SPECIFICATION

RENESAS SYSTEM SOLUTIONS (BEI JING) CO., LTD.

SHEN ZHEN BRANCH

RSSZEUM0002 – 0100 Rev.1.00

CONTENT

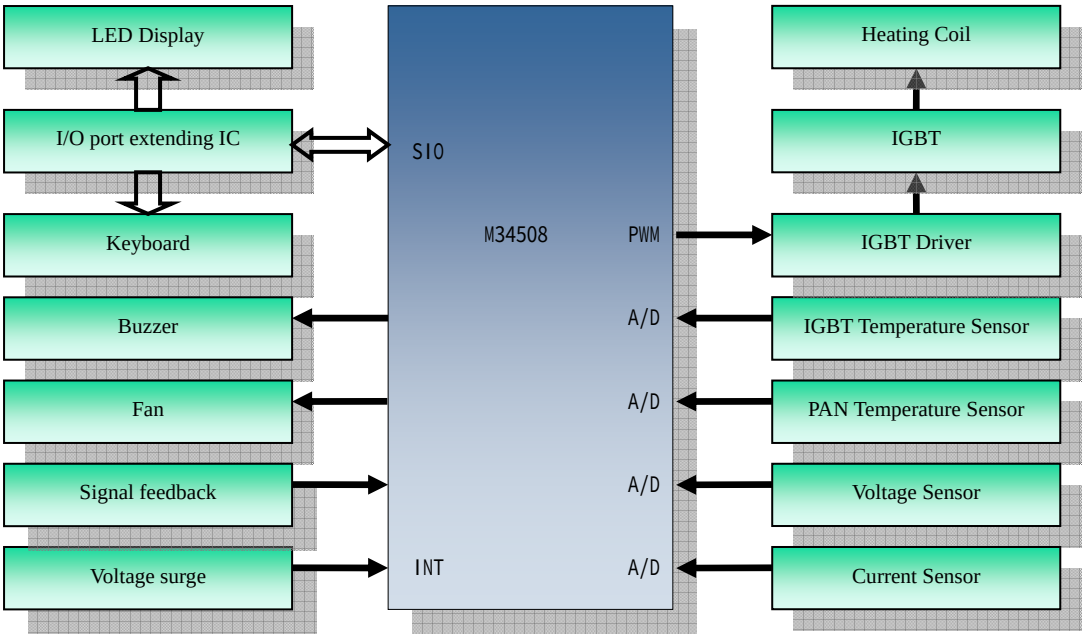
1. Outline
2. MCU board description
   - 2.1 Panel diagram
   - 2.2 Keyboard definition
   - 2.3 Display definition
   - 2.4 I/O port definition of M34508 port
3. Work mode
   - 3.1 Mode transition figure
   - 3.2 Mode transition condition
   - 3.3 Error description
4. Function description
5. Program flow chart
   - 5.1 Interrupt assignment
   - 5.2 Flow chart
6. Appendix A Function description (Chinese version)
7. Appendix B Schematic circuit of MCU board
8. Appendix C Program list, refer to the file “IHC.ASM”

1. OUTLINE

The IH cooker works based on the electromagnetism induction theory, a varying current passing through a coil will generate a varying magnetic field, the pan's metal will heat up in the varying magnetic field.

Generally, the IH cooker is controlled by a MCU, this MCU sends out a PWM wave to IGBT to control the firepower of the IH cooker, it monitors the temperature, current, voltage signal to protect the IGBT, and it also performs the human interface function.

This IH cooker demo uses RENESAS MCU M34508G4, the system diagram is shown on the following figure.



The main function of this IH cooker demo is as following.

.6 levels constant temperature cooking
.6 levels constant firepower cooking
.1 ~ 99 minute time cooking
.Flexible and easy to set
.Error alarm and dependable protection

Electric characteristic

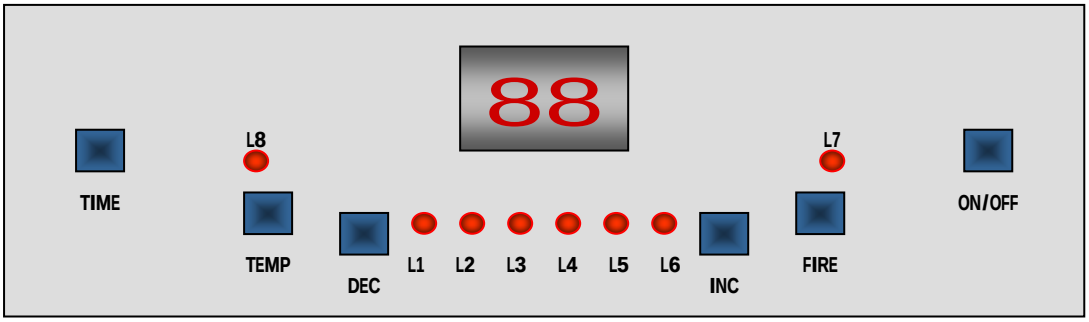
. Rated voltage: 220V 50Hz AC
. Rated power: 2000W

Real machine figure



2. MCU BOARD DESCRIPTION

2.1 Panel diagram



2.2 Keyboard definition

. ON/OFF key, start/stop cooking
. TIME key, set cooking time
. FIREPOWER key, set cooking firepower
. TEMPERATURE key, set cooking temperature
. INC key, increase value in time/temp/firepower setting
. DEC key, decrease value in time/temp/firepower setting

2.3 Display definition

.2 DIGITS LED MODULE: Display the cooking time or error information
.L1 – L6: Display the cooking temperature or firepower
Constant temperature: 70℃, 110℃, 150℃, 180℃, 210℃, 240℃
Constant firepower: Heat Preservation, Low, Low-Mid, Middle, Mid-High, High
.L7: Indicate the constant firepower cooking
.L8: Indicate the constant temperature cooking

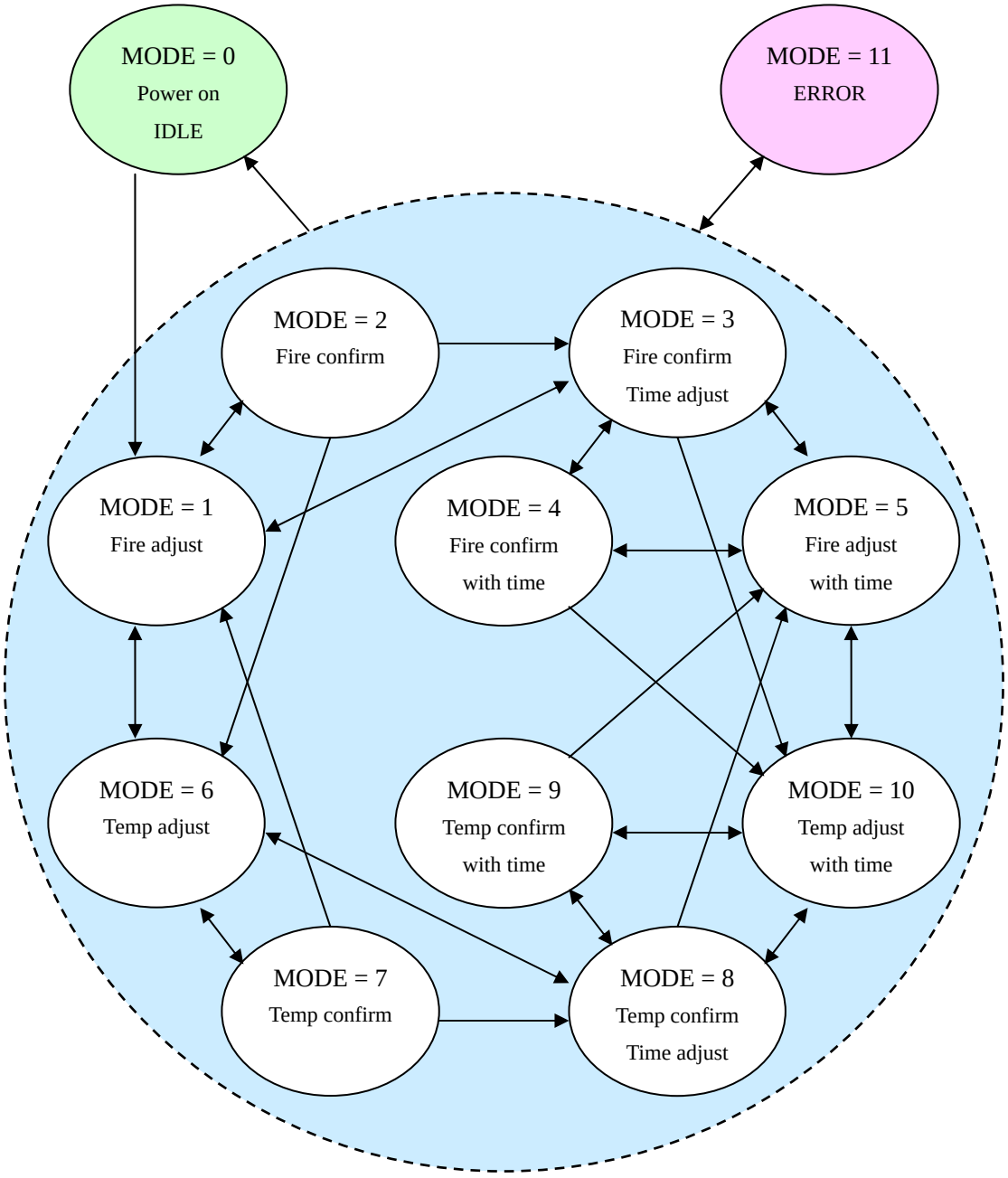
2.4 I/O port definition of M34508 port is shown on the following table.

Pin	Port	Function definition	I/O
1	VDD	Power supply +5V	-
2	VSS	Power supply GND	-
3	XIN	OSC	-
4	XOUT	OSC	-
5	CNVSS	GND connection	I
6	RESET	Reset input	I
7	P21/AIN1	Analog input of current	I
8	P20/AIN0	Analog input of pan temperature	I
9	D3/AIN5	Analog input of voltage	I
10	D2/AIN4	Analog input of IGBT temperature	I
11	D1	IGBT enable control	O
12	D0	Fan control	O
13	P13/INT	Voltage surge interrupt	I

14	P12/CNTR0	PWM output	O
15	P11/CNTR1	Buzzer control	O
16	P10	Signal feedback input	I
17	P03	LED control	O
18	P02/SCK	SIO clock	O
19	P01/SOUT	SIO output	O
20	P00/SIN	LED control	O

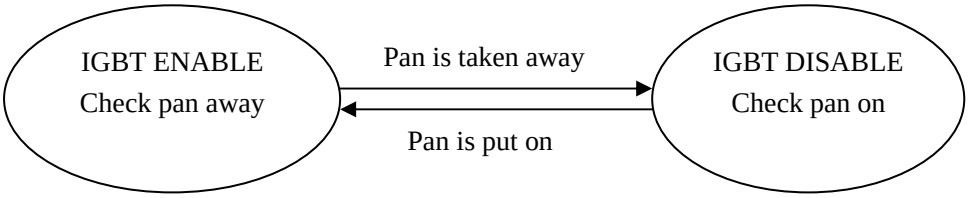
3. WORK MODE

3.1 The mode transition figure is as following.



.Inside of the dashed line circle is working mode, outside of the dashed line circle is stop mode

.In working mode (inside of the dashed line circle), the IGBT will work if the pan is on the IHC, as the following figure.



3.2 The mode transition condition is shown on the following table.

FROM		TO	CONDITION
0	Idle	1	Press ON/OFF key
1	Firepower adjust, no time	2	After 5 second
		3	Press TIME key
		6	Press TEMP key
2	Firepower confirm, no time	1	Press INC or DEC key
		3	Press TIME key
		6	Press TEMP key
3	Firepower confirm, time adjust	1	Press TIME key
		4	After 5 second
		5	Press FIRE key
		10	Press TEMP key
4	Firepower confirm with time	3	Press TIME key
		5	Press INC or DEC key
		10	Press TEMP key
5	Firepower adjust with time	3	Press TIME key
		4	After 5 second
		10	Press TEMP key
6	Temperature adjust, no time	7	After 5 second
		8	Press TIME key
		1	Press FIRE key
7	Temperature confirm, no time	1	Press FIRE key
		6	Press INC or DEC key
		8	Press TIME key
8	Temperature confirm, time adjust	5	Press FIRE key
		6	Press TIME key
		9	After 5 second
		10	Press TEMP key
9	Temperature confirm with time	5	Press FIRE key

		8	Press TIME key
		10	Press INC or DEC key
10	Temperature adjust with time	5	Press FIRE key
		8	Press TIME key
		9	After 5 second
11	Error	X	Voltage or current error become normal
X	Working mode	0	Press ON/OFF key or work over
		11	Error occur

3.3 The error description is shown on the following table.

Error display	Error description	Alarm condition
E1	Temperature of pan is over high	T_PAN > 250℃ continues for 3S
E2	Temperature of IGBT is over high	T_IGBT > 80℃ continues for 3S
E3	Current is over high	I > 9.5A
E4	Voltage is over low	V < 130V continues for 3S
E5	Voltage is over high	V > 250V
E6	Rt of pan is short	Rt_PAN -> 0
E7	Rt of pan is cut	Rt_PAN -> ∞
E8	Rt of IGBT is short	Rt_IGBT -> 0
E9	Rt of IGBT is cut	Rt_IGBT -> ∞

.For all the error, if it occurs, the system will send out a long time beep to alarm, and go in to the error mode, the corresponding error number will be displayed and flashed.

.For E3, E4, E5, if the corresponding condition become normal, the system will go back to work mode automatically.

.For E1, E2, E6, E7, E8, E9, if the corresponding condition become normal, the system can not go back to work mode automatically, it needs to power on again artificially.

4. FUNCTION DESCRIPTION

.Power on

Buzzer sends out a long time beep, LED module displays “0”, all the LED turns off, IGBT is disable, system goes to IDLE mode.

.Go to working mode

Press ON/OFF key in IDLE, system goes to working mode, Buzzer sends out a long time beep, LED indicates low-middle firepower and flash, after 5 seconds, LED stops flashing, this firepower will be confirmed and send out, IGBT becomes enable if there is the pan.

.Constant temperature cooking

Press TEMP key in the working mode, constant temperature LED turns on, the temperature LED flash, press INC or DEC key can adjust cooking temperature, after 5 seconds, LED stops flashing, this temperature is confirmed.

.Constant firepower cooking

Press FIRE key in the working mode, constant firepower LED turns on, the firepower LED flash, press INC or DEC key can adjust cooking temperature, after 5 seconds, LED stops flashing, this firepower is confirmed and send out.

The target firepower of the constant firepower cooking is shown as following table.

Firepower lovel	Keep T	Low	Low-Mid	Middle	Mid-High	High
Power output（W）	640	860	1120	1380	1680	2000

.Time cooking

Press TIME key in the working mode, LED module will flash, press INC or DEC key can set the cooking time, the setting range is 1 ~ 99 minutes, after 5 seconds, LED module stops flashing, this time setting is confirmed, after cooking for this setting time, buzzer sends out a long time beep, it stops cooking and goes to idle mode.

If time is set to 0 minute, it means no time setting, so the cooking time has no limit.

.Go to idle mode

Press ON/OFF key in the working mode, buzzer sends out a long time beep, it stops cooking and goes to idle mode.

.Auto turn off protection

In working mode, if no key is pressed for 2 hours, the system will turn off automatically.

.Go to error mode

If the temperature, voltage, current or Rt error occurs, buzzer sends out a long time beep, system goes to error mode, LED module displays error information and flash, refer to the “error description table”.

.Pan detection

In working mode, if the pan is taken away, system will send out pan detection signal and beep for a short time every 3 seconds, if the pan is detected, IGBT will be enable and the cooking will begin. If the pan can not be detected for 120 seconds, system will go to idle mode.

.Fan control

In working mode, the fan is always on. If it is not in working mode, the fan will be on when T_IGBT > 50℃, the fan will be off when T_IGBT < 40℃.

5. PROGRAM FLOW CHART

5.1 Interrupt assignment

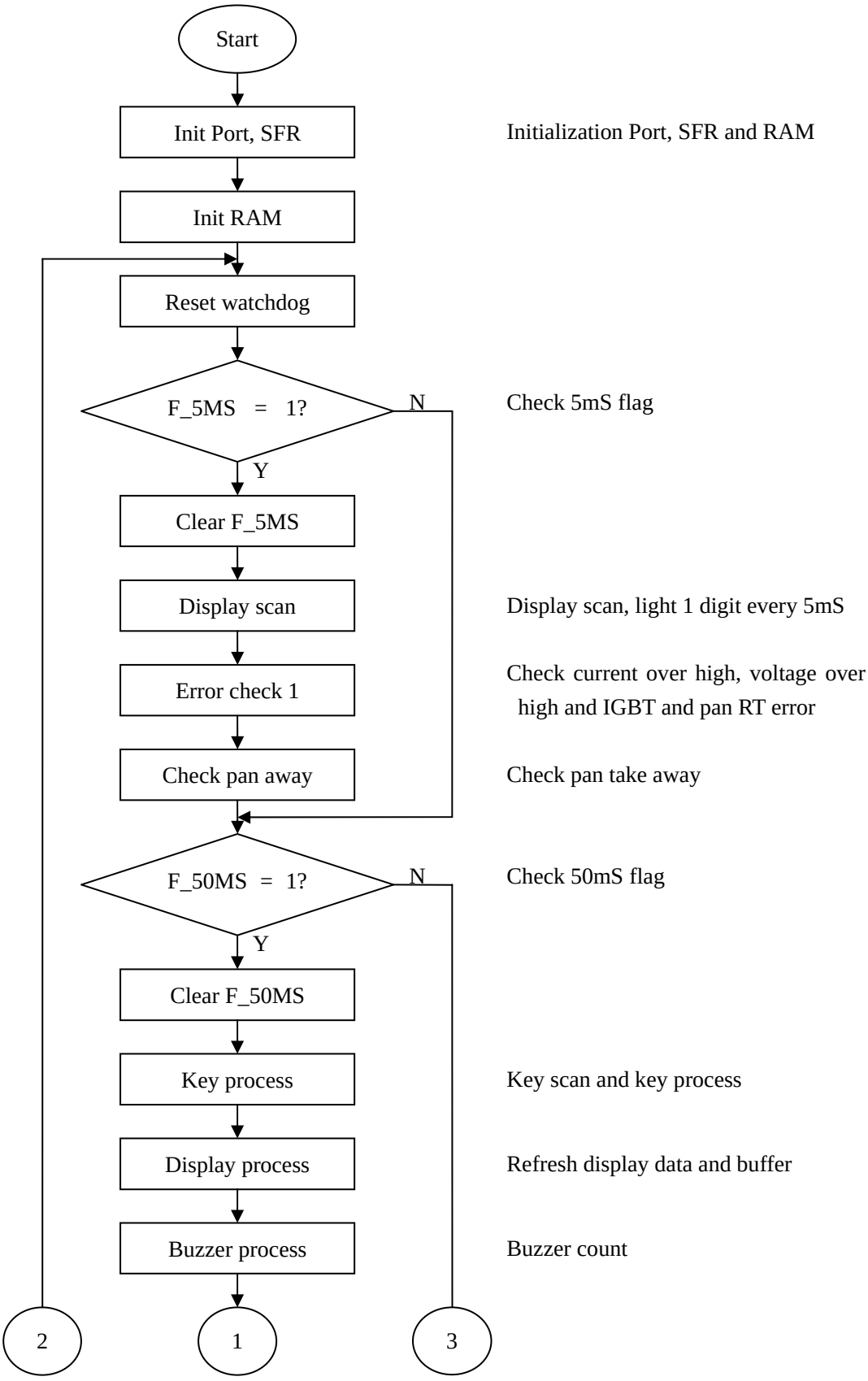
. TIMER1: For PWM and Buzzer control, the PWM period is 250uS, the output of buzzer port changes every 250uS, so the frequency is 2KHz

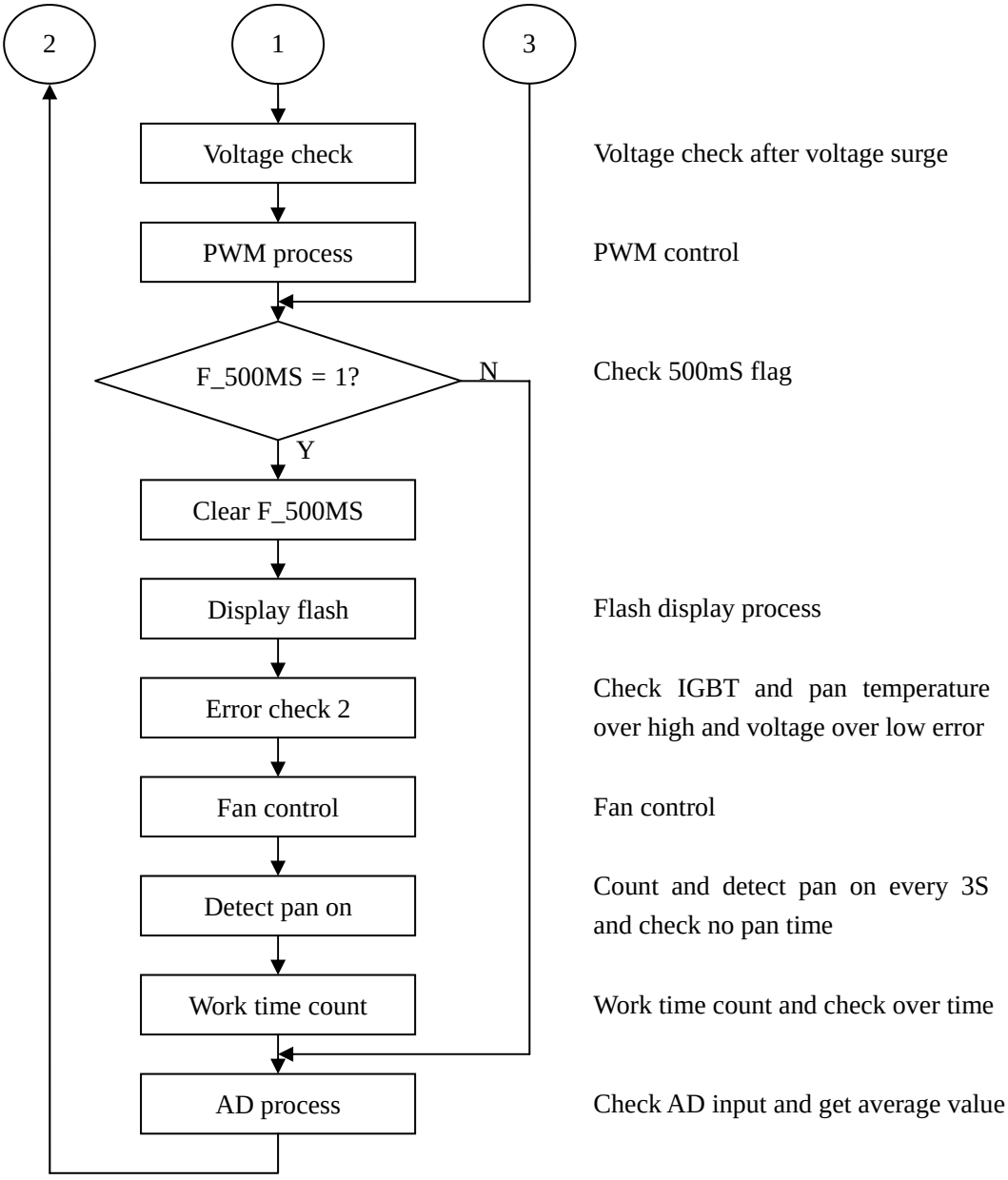
. TIMER2: Basic timer, the timer period is 1mS

. INT0: Voltage surge interrupt, low voltage enable

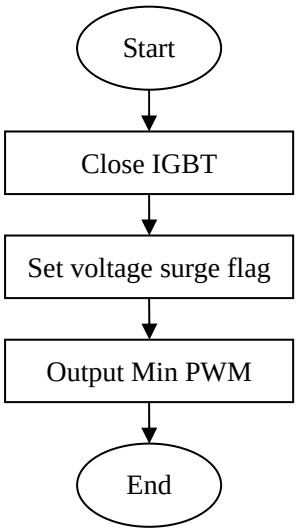
5.2 Flow chart

.Main routine flow chart




2
1
3
Voltage check
Voltage check after voltage surge
PWM process
PWM control
F_500MS = 1?
N
Check 500mS flag
Y
Clear F_500MS
Display flash
Flash display process
Error check 2
Check IGBT and pan temperature over high and voltage over low error
Fan control
Fan control
Detect pan on
Count and detect pan on every 3S and check no pan time
Work time count
Work time count and check over time
AD process
Check AD input and get average value

.INT0 flow chart

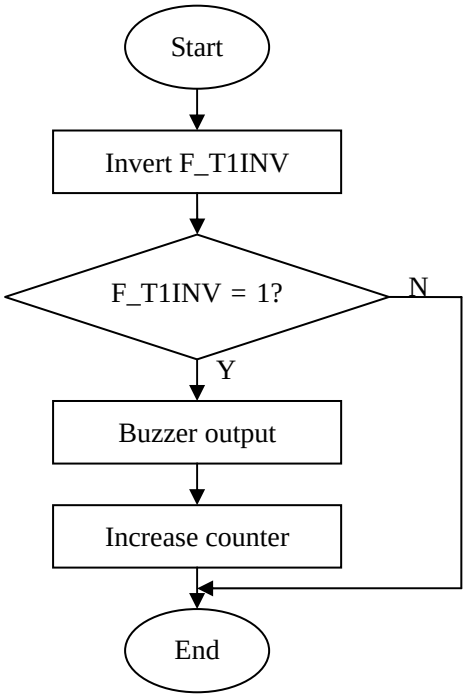


Close IGBT

Set voltage surge flag

Output the minimum PWM

.INTT1 flow chart



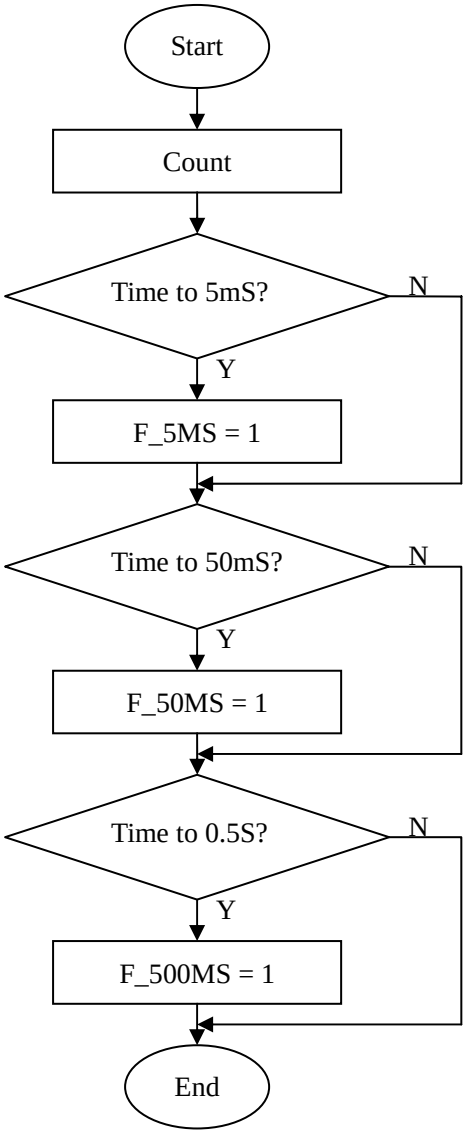
Invert flag F_T1INV

Check F_T1INV = 1?

Buzzer output, invert buzzer port every 0.25mS

Increase counter used in pan detection

.INTT2 flow chart



Timer count

Check time is up to 5mS?

Set 5mS flag

Check time is up to 50mS?

Set 50mS flag

Check time is up to 500mS?

Set 500mS flag

6. APPENDIX A

功 能 说 明

* 上电

蜂鸣器长鸣一声，数码管显示 0，进入待机状态，指示灯全灭，没有功率输出，风扇状态是按温度自动控制。

此时，除“ 开／关 ”键外其余键无效。

* 开关机

在待机状态下，按开关键，蜂鸣器长鸣一声，进入工作状态，火力模式指示灯亮，中低火（默认火力）指示灯闪烁（亮 0.5 秒，灭 0.5 秒）（默认火力为中低火），风机运转。若无按键按下，5 秒后火力指示灯常亮，自动输出中低火力烹调。按“ + ”、“ - ”键可进行火力调节，高火档火力最大，保温档最小。

在工作状态下，按开关键，蜂鸣器长鸣一声，进入待机状态。

* 定温控制方式

在火力控制模式下，按“ 定温 ”键，定温模式指示灯亮，110 度（默认温度）指示灯闪烁。若无按键按下，5 秒后温度指示灯长亮，自动进入 110 度定温控制方式。按“ + ”、“ - ”键可选择温度 70℃、110℃、150℃、180℃、210℃、240℃，指示灯闪烁 5 秒后即确认当前的设定，系统按此设定温度运行。

* 火力控制方式

在定温控制模式下，按“ 火力 ”键，火力模式指示灯亮，中低火（默认火力）指示灯闪烁，表示此时火力选择为中低火。按“ + ”、“ — ”键选择火力：保温、低火、中低火、中火、中高火、高火。若无按键按下，5 秒后火力指示灯常亮，即确认当前的设定，系统按此设定火力运行。

* 定时烹调方式

选择模式后，若无定时设定，数码管显示“ 00 ”。按定时键，数码管闪烁。按“ + ”、“ - ”键可以进行时间调节，00 ~ 99 循环调节，若无按键按下，闪烁 5 秒后自动确认当前时间，系统按此设定时间倒计时烹调。若烹调时间结束，蜂鸣器长鸣一声，进入待机状态。

若设定时间为 00，表示无定时功能，系统按照无定时限制运行。

有定时设定时，按定时键，数码管显示定时剩余时间并闪烁，按“ + ”、“ - ”键可以进行时间调节，此时若无按键按下，闪烁 5 秒后自动确认当前时间；如果在 5 秒内再按定时键，即取消定时，显示 0。

* 锅具检测

在工作状态下，若没有放置合适锅具，系统每 3S 输出一次的检测脉冲，蜂鸣器短响一声，如果锅具合适即开始输出功率，120S 后仍未检测到合适的锅，自动进入待机状态。

在正常功率输出状态，把锅具移开，系统立即进入保护状态，停止功率输出，每 3S 输出一次的检测脉冲检测锅具。

* 风扇控制

系统上电后，电磁炉在停止状态下，IGBT 表面温度≥50℃，风扇启动；IGBT 表面温度≤40℃，风扇停止。电磁炉在工作状态下，风扇常开。

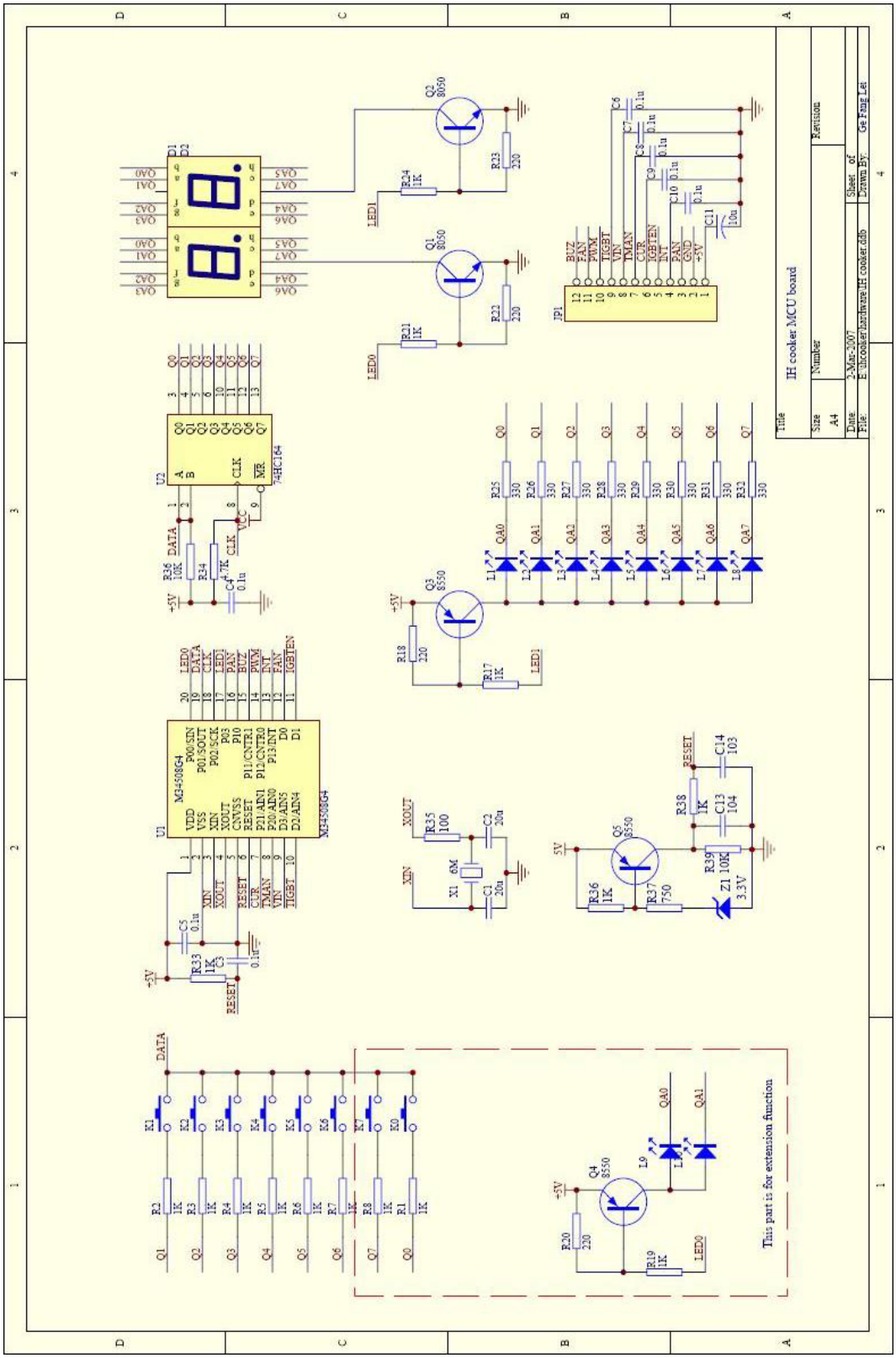
* 超时保护

在工作状态下，若两小时无按键操作，系统自动进入待机状态。

* 故障检测

当系统电压、电流、温度及传感器出现异常时，蜂鸣器长鸣一声，系统进入报警状态，闪烁显示故障代码，请请参考 3.3

7. APPENDIX B
SCHEMATIC CIRCUIT OF MCU BOARD



8. APPENDIX C PROGRAM LIST
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