Inverter Circuit for IH Cooker

SW Guide

RD206-SWGUIDE-01

TOSHIBA ELECTRONIC DEVICES & STORAGE CORPORATION

Contents

1. Introduction

This Guide describes the software (SW) of IH Cooker (hereafter referred to as this reference design) using GT20N135SRA IGBT designed for Home Appliances. The block diagram and circuit of hardware (HW) controlled by the SW specified in this guide is shown below.

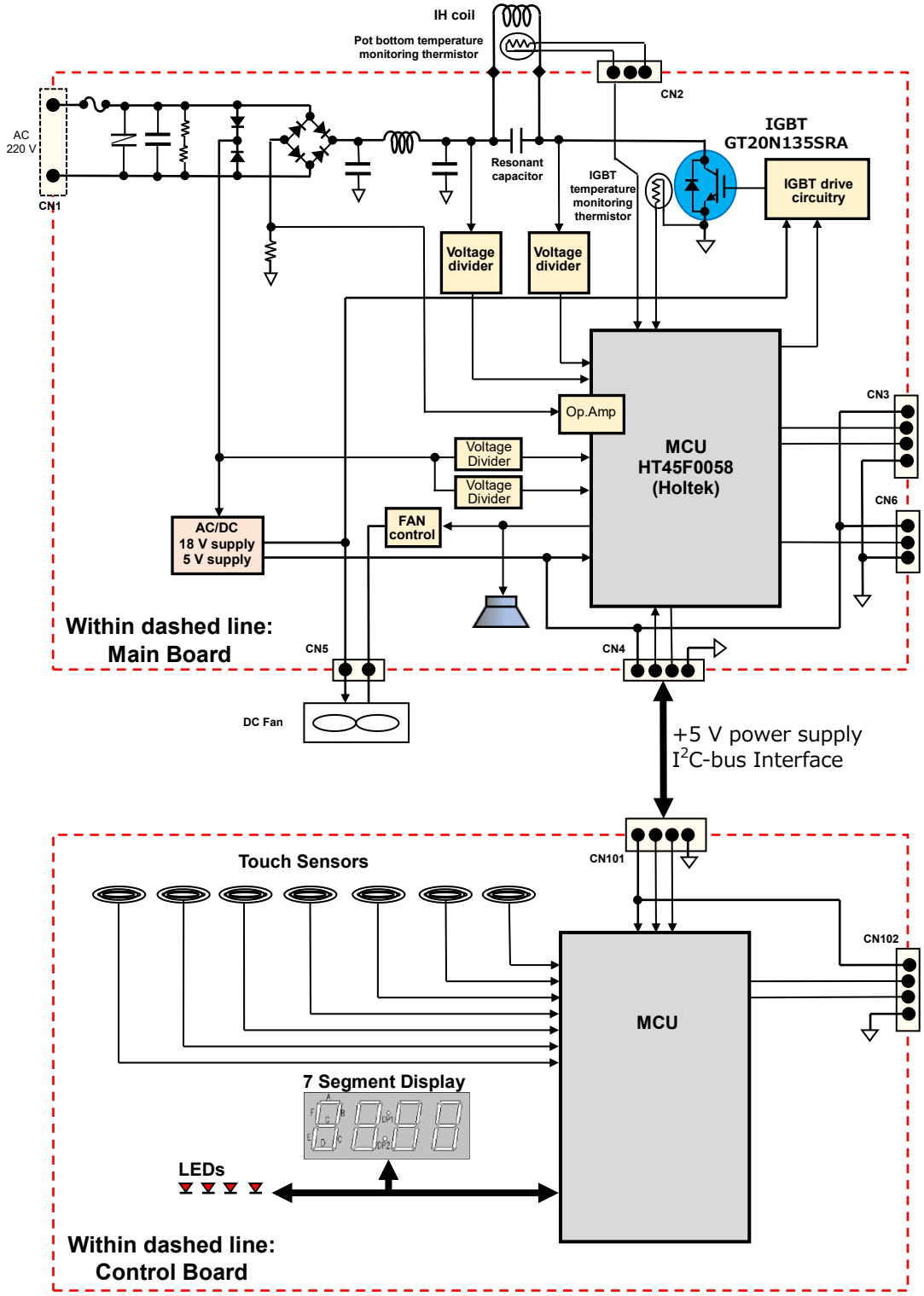

Fig. 1.1 Block Diagram of IH Cooker

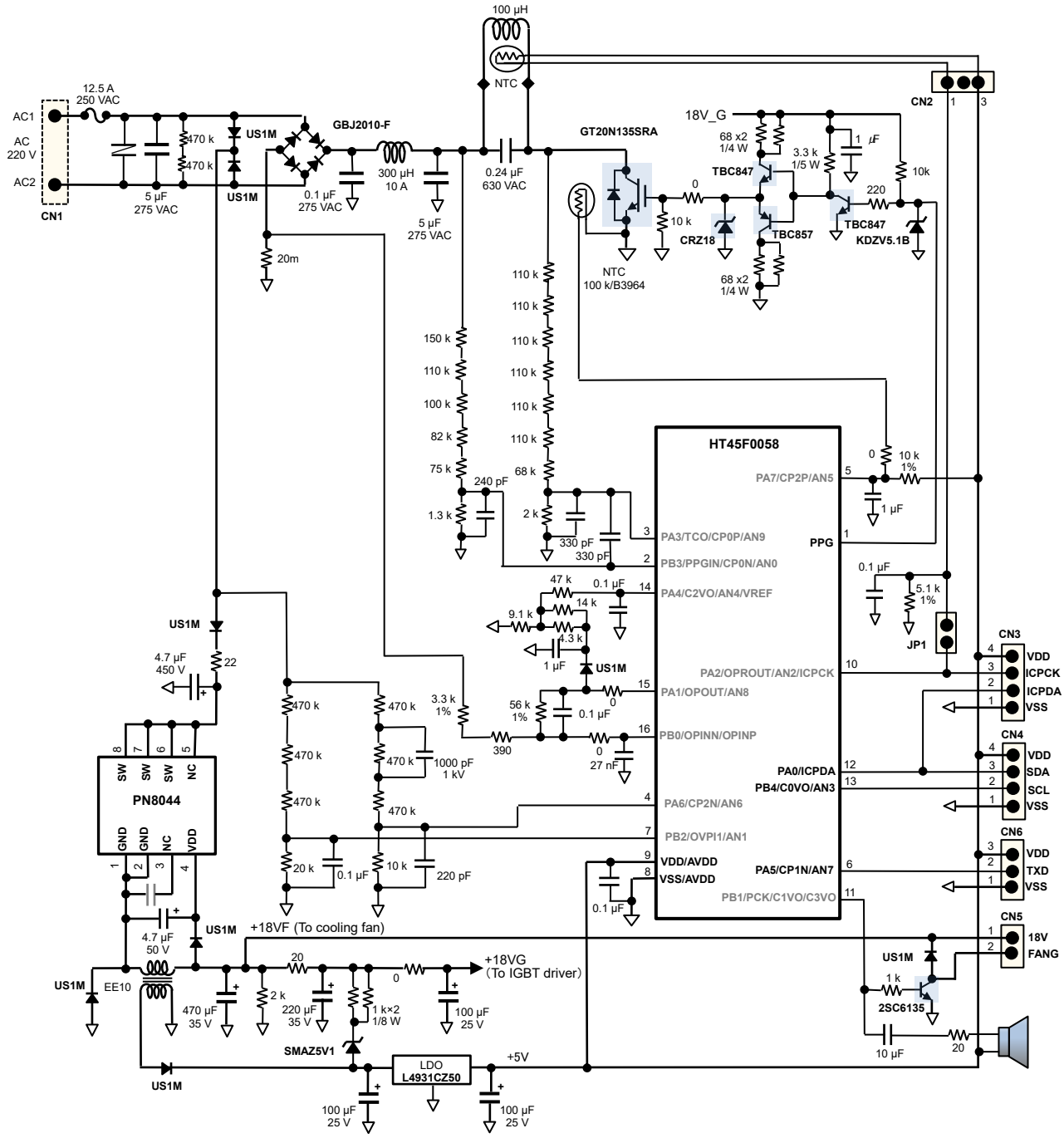

Fig. 1.2 Circuit of Main Board

2. Software Files

Following table shows the files of Source code for this reference design.

Table 2.1 List of Source Code Files

File Name	Description
startup1_l.asm	Startup code
ADC.c	Functions of A/D conversion
ADC.h	Header of ADC.c
Beep_Fan_dcf.c	Functions of buzzer and fan control
Beep_Fan_dcf.h	Header of Beep_Fan_dcf.c
CMP_OPA_Calibrate.c	Calibration of op amp and comparators
CMP_OPA_Calibrate.h	Header of CMP_OPA_Calibrate.c
I2C.c	Functions of I2C
I2C.h	Header of I2C.c
Include.h	Header of Interrupt.c
Interrupt.c	Functions of interrupt handler
Interrupt.h	Header of Interrupt.c
main.c	Initialization and main loop
Main.h	Header of main.c
MyType.h	Definition of types and constants
POT_Detect.c	Functions of pot detection
POT_Detect.h	Header of POT_Detect.c
PPG_IGBT_Control.c	Functions of IGBT gate pulse control
PPG_IGBT_Control.h	Header of PPG_IGBT_Control.c
Protection.c	Functions of various protection
Protection.h	Header of Protection.c
Timer.c	Functions of timer control
Timer.h	Header of Timer.c
Uart_Debug.c	Functions of UART debug output
Uart_Debug.h	Header of Uart_Debug.c
UI_Test.c	Functions of control board communication
UI_Test.h	Header of UI_Test.c
PowCalculate.h	Header of PowCalculate.lib
PowCalculate.lib	Power calculation library (binary)

3. Software Flowchart

The flowchart of the software is shown below.

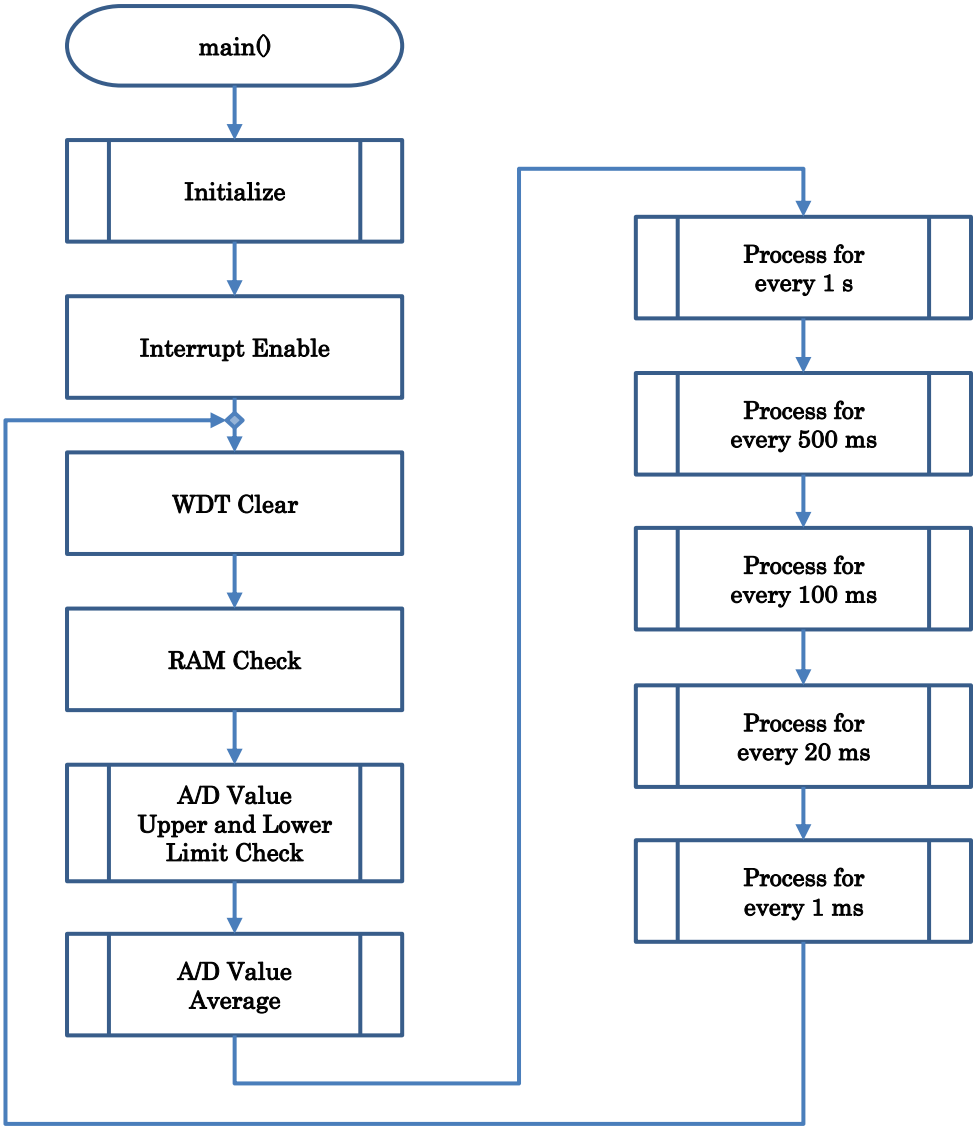

Fig. 3.1 Software Flowchart

4. Data Acquisition from ADC

Following parameters are read using Analog to Digital Converter:

- IGBT temperature
- Pot bottom temperature
- Power supply voltage
- Electric current

Method of Reading Data:

10 samples are taken and average of 8 samples are taken after ignoring the maximum and minimum values.

1. Sampling cycle starts every 20 ms in the “Process for every 20 ms” block.
2. For taking a sample, Analog to Digital conversion is performed at every 1 ms interrupt.
3. Systems takes average of samples for all four parameters.
4. System waits for next sampling cycle.

Meaning of ADC Output Values:

1. IGBT temperature
   For more description refer to MyType.h

Table. 4.1 IGBT Temperature and ADC Value Relation

IGBT Temp.	A/D Value	Symbol
-	253	c_NTC_OPENCIRCUIT
50	199	-
52	196	-
63	176	-
65	171	c_T_IGBT_RECOVER
68	166	-
78	145	-
83	135	c_T_IGBT_POWERDROP1
85	124	-
85	131	-
88	124	c_T_IGBT_POWERDROP
100	100	-
105	92	c_T_IGBT_OTEMP
110	84	-
-	3	c_NTC_SHORTCIRCUIT

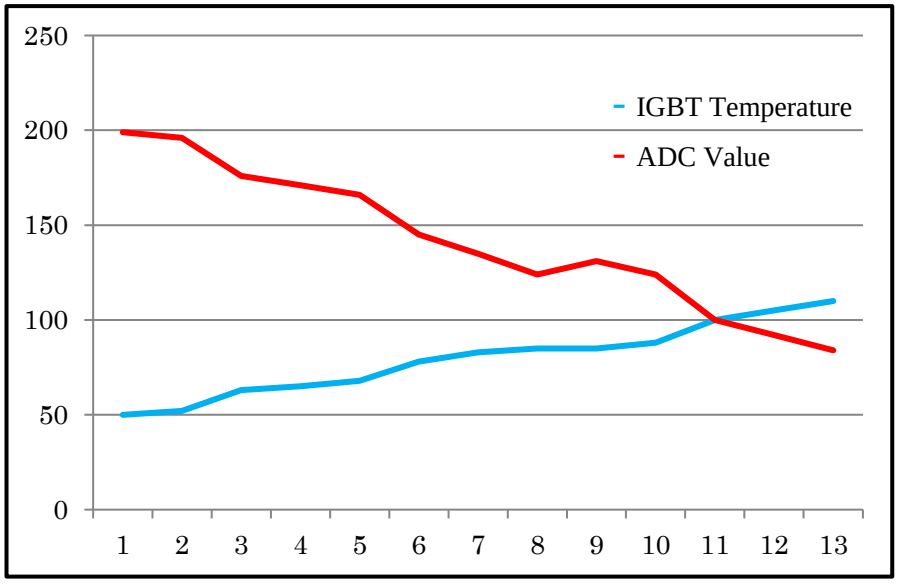

Fig. 4.1 IGBT Temperature and ADC Value Relation Chart

2. Pot bottom temperature
   For more description refer to MyType.h

Table 4.2 Pot Bottom Temperature and ADC Value Relation

PAD Temperature	A/D Value	Symbol
-	3	c_NTC_SHORTCIRCUIT
40	17	-
60	22	c_T_PAD_RECOVER
90	35	-
100	45	-
105	82	-
108	88	-
110	92	-
130	101	-
148	108	-
150	116	-
155	119	-
160	149	-
167	181	-
170	184	-
175	188	c_T_PAD_OTEMP、c_T_PAD_OTEMP1
235	195	-
240	208	-
260	236	-
280	246	-
-	253	c_NTC_OPENCIRCUIT

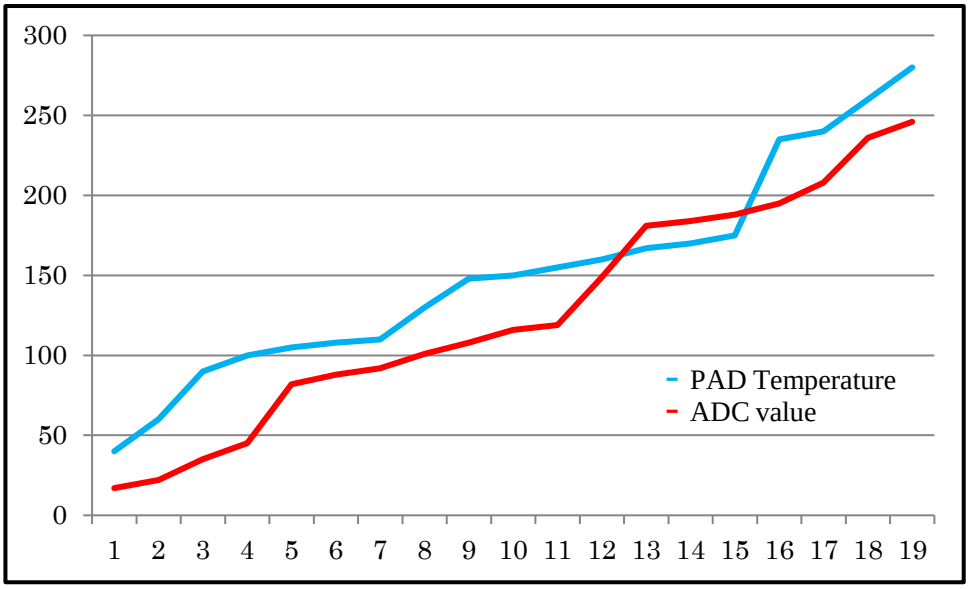

Fig. 4.2 Pot Bottom Temperature and ADC Value Relation Chart

3. Power supply voltage
   For more description refer to MyType.h

Table 4.3 Power Supply Voltage and ADC Value Relation

Power Supply Voltage	A/D Value	Power Supply Voltage	A/D Value
70	45	195	126
75	48	200	129
80	52	205	132
90	58	210	135
100	65	215	139
110	71	220	142
120	77	225	145
130	84	230	148
140	87	235	152
145	94	240	155
150	97	245	158
160	103	250	161
170	110	260	168
180	116	270	174
185	119	275	177
190	123	285	184

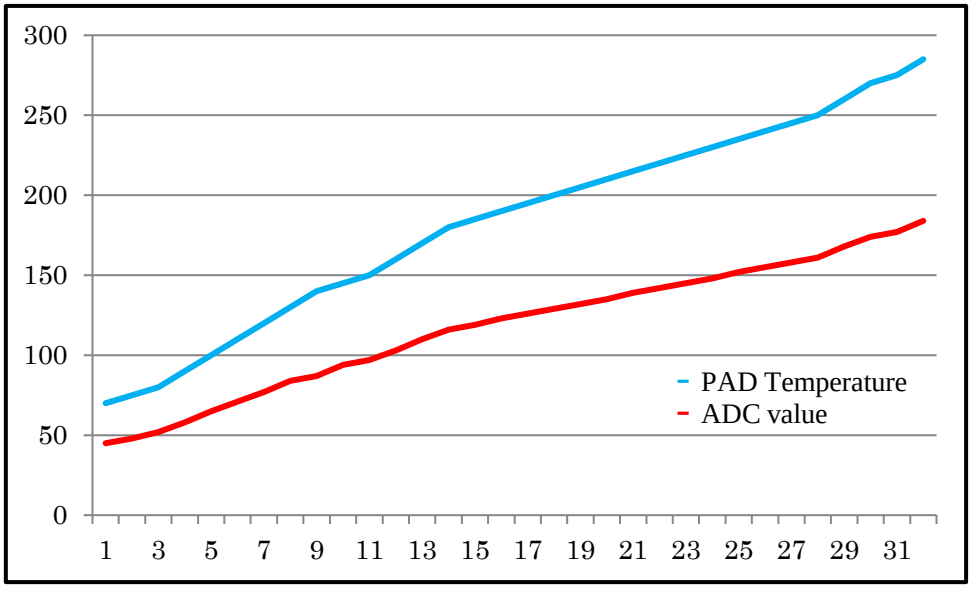

Fig. 4.3 Power Supply Voltage and ADC Value Relation Chart

5. Error Processing

5.1. Power Supply Voltage Upper Limit Error

This error check is carried out using ADC value upper/lower limit check.
If the value indicates 270 V or more, the count is incremented by 1. And when it is confirmed 10 times, it is judged to be an error.
And if the value indicates less than 270 V, the count is decremented by 1.
When it is judged to be an error, the IGBT is turned off, and the error status is recorded in the notification data sent to the DISPLAY_BOARD.
If normal status is maintained for 3 seconds, the error status is cleared in the notification data sent to the DISPLAY_BOARD.

5.2. Power Supply Voltage Low Limit Error

This error check is carried out using ADC value upper/lower limit check.
If the value indicates less than 150 V, the count is incremented by 1. And when it is confirmed 10 times, it is judged to be an error.
And if the value indicates 150 V or more, the count is decremented by 1.
When it is judged to be an error, IGBT is turned off, and the error status is recorded in the notification data sent to the DISPLAY_BOARD.
If normal status is maintained for 3 seconds, the error status is cleared in the notification data sent to the DISPLAY_BOARD.

5.3. Overcurrent

This error check is carried out using ADC value upper/lower limit check.
If the ADC value is 165 or more, the count is incremented by 1. And when it is confirmed 2 times, it is judged to be an error.
And if the value is below 165, the count is decremented by 1.
When it is judged to be an error, the error status is recorded in the notification data sent to the DISPLAY_BOARD.
If normal status is maintained for 3 seconds, the error status is cleared in the notification data sent to the DISPLAY_BOARD.

5.4. IGBT Temp Sensor Open Circuit Error

This error check is carried out using ADC value upper/lower limit check in the “processing at every 1 s”.
If the ADC value is 253 or more, it judged to be an error.
When it is judged to be an error, the error status is recorded in the notification data sent to the DISPLAY_BOARD.
It is restored after restart.

5.5. IGBT Temperature Sensor Short Circuit Error

This error check is carried out using ADC value upper/lower limit check in the “processing at every 1 s”.
If the ADC value is 3 or less, it judged to be an error.
When it is judged to be an error, the error status is recorded in the notification data sent to the DISPLAY_BOARD.
It is restored after restart.

5.6. Pot Bottom Temperature Sensor Open Circuit Error

This error check is carried out using ADC value upper/lower limit check in the “processing at every 1 s”.
If the ADC value is 253 or more, it judged to be an error.
When it is judged to be an error, the error status is recorded in the notification data sent to the DISPLAY_BOARD.
It is restored after restart.

5.7. Pot Bottom Temperature Sensor Short Circuit Error

This error check is carried out using ADC value upper/lower limit check in the “processing at every 1 s”.
If the ADC value is 3 or less, it judged to be an error.
When it is judged to be an error, the error status is recorded in the notification data sent to the DISPLAY_BOARD.
It is restored after restart.

5.8. Pot Bottom High Temperature Error

This error check is carried out using ADC value upper/lower limit check.
If the pot bottom temperature is 175 degree or more and the ADC value is below 253, the count is incremented by 1. And when it is confirmed 5 times, it is judged to be an error.
And if above conditions are not met, the count is decremented by 1.
When it is judged to be an error, the IGBT is turned off, and the error status is recorded in the notification data sent to the DISPLAY_BOARD.
When pot bottom temperature goes below 60 degree, the error status is cleared in the notification data sent to the DISPLAY_BOARD.

5.9. IGBT High Temperature Error

This error check is carried out using ADC value upper/lower limit check.
If the IGBT temperature is 105 degree or more and the ADC value is above 3, the count is incremented by 1. And when it is confirmed 5 times, it is judged to be an error.
And if above conditions are not met, the count is decremented by 1.
When it is judged to be an error, the IGBT is turned off, and the error status is recorded in the notification data sent to the DISPLAY_BOARD.
When IGBT temperature goes below 65 degree, the error status is cleared in the notification data sent to the DISPLAY_BOARD.

5.10. No Pot Error

This error check is carried out in the “processing at every 100 ms”.
Detection processing starts due to a decrease in the current flow value.
After one pulse is generated by the PPG, changes at both ends of the coil are counted by the comparator.
If the value is above the threshold value, it is assumed that no pot is set. If cooking is in progress, IGBT is turned off, and the error status is recorded in the notification data sent to the DISPLAY_BOARD.
If the value is less than the threshold value, it is assumed that there is pot, and if cooking is in progress, IGBT is turned on, and the error status is cleared in the notification data sent to the DISPLAY_BOARD.

5.11. IGBT High Temperature Monitoring

This error check is carried out in the “processing at every 1 s”.
If IGBT temperature is 88 degree or more, the count is incremented by 1. And when it is confirmed 5 times, it is judged to be an error.
And if above condition is not met, the count is decremented by 1.
After this error detection, if IGBT temperature goes below 83 degree, the heating is resumed.

5.12. Detection of Surge Current by Hardware

This flag is enabled by CMP2 interrupt, and it is checked in “processing at every 20 ms”.
IGBT is turned off when surge current is detected.
And if it does not recur for 3 s, normal operation is restored.

5.13. Detection of Overcurrent by Hardware

This flag is enabled by CMP3 interrupt, and it is checked in “processing at every 20 ms”.
IGBT is turned off when overcurrent is detected.
And if it does not recur within 1 s for the second time and within 3 seconds for other cases, normal operation is restored.

5.14. Detection of Overvoltage by Hardware

PPG is reset by OVP interrupt. At this time, the flag is enabled, checked by an interrupt of 10 ms, and the PPG is reset after 190 ms.

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