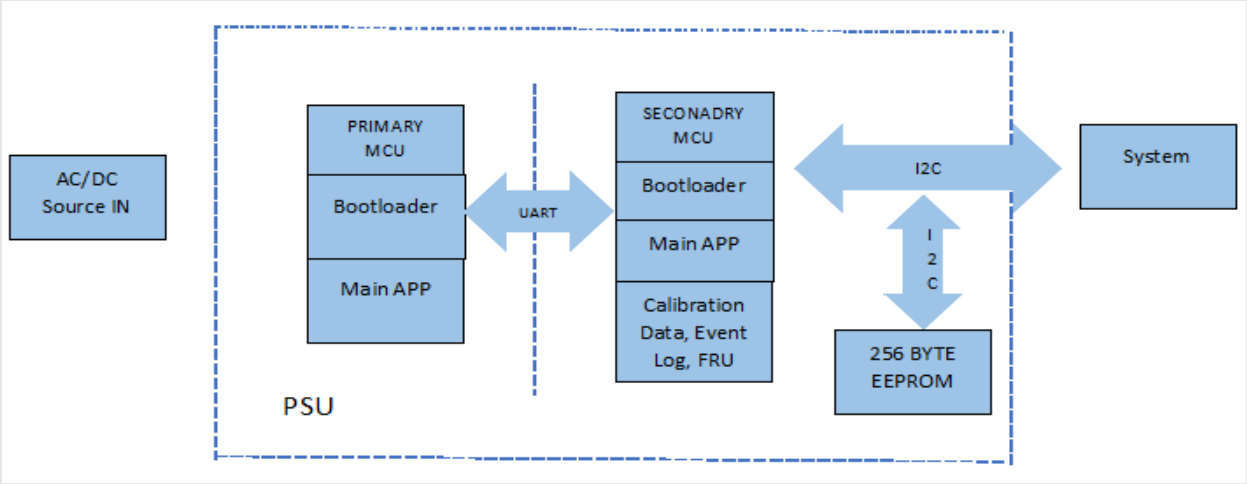
PS-1603-X01 Firmware Specification

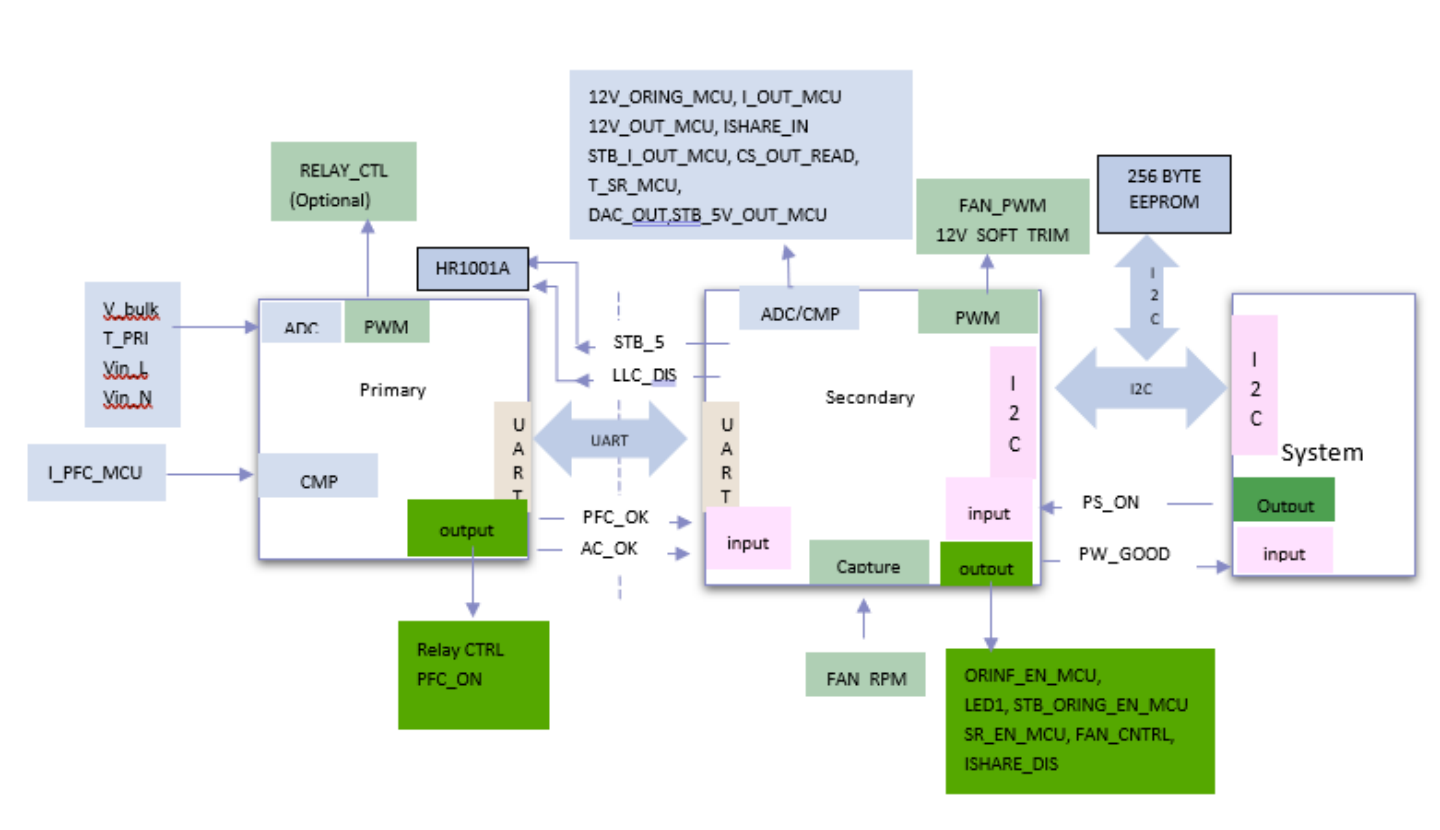
Revision	Date	Author	Comments
0.0	12/Jan/2021	Chen Wu Heng Huang Shuang Cai	Initial version

1. ARCHITECTURE

1.1 ARCHITECTURE WITH BLOCK DIAGRAM



1.2 ARCHITECTURE WITH SIGNALS



1.3 MAIN PROGRAM BRIEF

1.3.1 PRIMARY MCU MAIN PROGRAM

A) Power ON/OFF Sequence Control
B) Vac_Line, Vac_Neutral, Iac, Vbulk detection
C) Inrush Current protection
D) Brown out / in protection
E) PFC OVP, UVP, OCP, OTP Protection
F) PFC bus voltage output ON /OFF
G) UART Inter communication
H) Energy Calculation
I) Calibration(optional)

1.3.2 SECONDARY MCU MAIN PROGRAM

A) Power ON/OFF Sequence Control
B) System Application (State machine)
C) 12V and 5V STB OVP, UVP, OCP protection
D) Current Sharing PID Control Loop
E) Remote Sense
F) LED Control
G) FAN Control
H) Temperature Sensor
I) UART Inter communication
J) I2C to EEPROM
K) PMBUS communication
L) Event Log Management
M) Calibration & Relevant Data Management (Optional)

2. TARGET MICRO-P REQUIREMENT

- Primary Microcontroller: Microchip DSPIC33EP32GS502
- Memory: 16 Kbyte
- Speed: 70 MIPS
- Watchdog: Enable

Secondary Microcontroller: Microchip dsPIC33EP64GS504T -I/ML

- Memory: 64 Kbyte
- Speed: 70 MIPS
- Watchdog: Enable

3. GENERAL MICRO-P PINOUT DESCRIPTION

3.1 PRIMARY PIN ASSIGNMENT

Pin No	Pin Configuration	Pin Function	Pin Direction	PSU Signal / function	Details

1	AN2	Analog	Input	V_bulk	bulk vtg f/b
2	AN3	Analog	Input	I_PFC_MCU	PFC current for monitor and reporting
3	AN4	Analog	Input	T_PFC	Primary heatsink temperature
4	AN5	Analog	Input	VDC_MCU	Vbulk_sense
5	Vss	POWER		3V3_GND	POWER
6	RB1	GPIO	Output	PFC_OK_PRI(to sec)	AC OK signal to sec MCU
7	RB2	GPIO	Output	AC_OK_PRI (to sec)	PFC OK signal to sec MCU
8	RP35	Uart	Input	PRI_RX	Communication with secondary MCU
9	RP36	Uart	Output	PRI_TX	Communication with secondary MCU
10	VDD	POWER		3V3_P	POWER
11	RB8	GPIO	Input	TP	TEST_POINT
12	RB15	GPIO	Output	LED1	Status Indicator
13	RB5	GPIO	Output	DEBUG	DEBUG
14	PGED1	Programming	In/Out	PGED1	Programming
15	PGEC1	Programming	Output	PGEC1	Programming
16	Vss	POWER		3V3_PVSS	POWER
17	Vcap	Cap	MCU Capacitor		MCU Capacitor
22	PWM1H/RA4	PWM/GPIO	Output	Relay CTRL	Inrush Relay signal
23	RA3	GPIO	Output	PFC_ON_H	Enable PFC Signal
24	AVss	POWER		3V3_AGND	POWER
25	AVDD	POWER		3V3_P_A	POWER
26	MCLR	MCU RESET	Input	MCLR_PRI	MCU RESET
27	AN0	Analog	Input	Vin_L	Input line voltage
28	AN1	Analog	Input	Vin_N	Input neutral vtg

3.2 SECONDARY MCU PIN ASSIGNMENT

Pin No	Pin Configuration	Pin Function	Pin Direction	PSU Signal	Details
1	PGEC1	programming	Output		programming
2	RC4	GPIO	Input	PS_A1	address Select
3	RC5	GPIO	Input	PS_A2	address Select
4	RC6	GPIO	Input	PFC_OK_SEC	pfc status
5	RC3	GPIO	Input	PS_A0	address Select
6	Vss	POWER		3V3_SGND	POWER
7	Vcap	Cap		MCU Capacitor	MCU Capacitor

8	RB11	GPIO	Output	ORING_EN_MCU	ORing gate signal
9	RB12	GPIO	Output	POK	pok
10	PWM2H	PWM	Output	12V_SOFT_TRIM	12V software trimming
11	RB14	GPIO	Input	FAN_SPEED	Measure FAN RPM
12	PWM1H	PWM	Output	FAN_PWM	PWM control for FAN
13	RA3	GPIO	Input	PSON / REMOTE ON	ps on/off
14	RC0	GPIO	Input	AC_OK_SEC	ac ok signal from primary
15	RC13	GPIO	Output	LLC_DIS	LLC primary gate driver disable
16	AVss	POWER		3V3_Avss	POWER
17	AVDD	POWER		3V3_S_A	POWER
18	MCLR	MCU RESET	Input	MCU RESET	MCU RESET
19	RC11	GPIO	Output	STB_ORING_EN_MCU	ENABLE STANDBY ORING
20	RC12	GPIO	Output	SR_EN_MCU	ENABLE SR
21	AN0	Analog	Input	12V_ORING_MCU	output voltage before ORing
22	AN1	Analog	Input	I_OUT_MCU	PSU output current
23	AN2	Analog	Input	12V_OUT_MCU	PSU output voltage
24	AN3	Analog	Input	ISHARE_INT	current share internal voltage
25	AN4	Analog	Input	STB_5V_OUT_MCU	5V SB Voltage sense
26	AN5	Analog	Input	STB_I_OUT_MCU	standby current sense
27	RP57	UART	Input	SEC_RX	communication with primary MCU
28	RP58	UART	Output	SEC_TX	communication with primary MCU
29	VDD	POWER		3V3_S	POWER
30	VSS	POWER		3V3_S_vss	POWER
31	RC1	GPIO	Output	12V_DROOP	output pwm
32	AN6	Analog	Input	CS_OUT_READ	Input ADC, for current share
33	AN7	Analog	Input	T_SR_MCU	SR heatsink temp sensing
34	DACOUT1	Analog	Ouput	DAC_OUT	DAC_OUT for current share
35	RB4	GPIO	Input	ISHARE_DIS	Current share disable
37	ASDA1	I2C	In/Out	PMBUS_SDA	Pmbus data line
38	ASCL1	I2C	Output	PMBUS_SCL	Pmbus clock line
39	VSS	POWER		3V3_S_Vss	POWER
40	VDD	POWER		3V3_S	POWER
41	SDA2	I2C	In/Out	I2C_EEPROM_SDA	EEPROM

42	SCL2	I2C	Output	I2C_EEPROM_SCL	EEPROM
43	RB5	GPIO	Output	LED1	Status LED
44	PGED1	Programming	In/Out	PGED1	programming

4. I/O PINS

4.1 PRIMARY SIDE

4.1.1 OUTPUT PIN

Pin #	Pin name	Initial State	Connect to	I/O Level definition
6	RB1	L	PFC_OK_PRI	Logic 0 : PFC OK Logic 1 : PFC Not OK
7	RB2	H	AC_OK_PRI	Logic 0 : AC OK Logic 1 : AC Not OK
22	RA4	H	Inrush Relay CTRL	Logic 0: ON Logic 1: OFF
23	RA3	L	PFC_ON	Logic 0 : Disable Logic 1 : Enable

4.1.2 ANALOG TO DIGITAL MEASUREMENT

Pin #	Pin Name	Connect to	Scale
1	AD2	V_bulk	0Vi/0V ~ 472Vi/3.3V
2	AD3	I_PFC_MCU	0Vac/0V ~ 321Vac/3.3V or 0Vdc/0V ~ 454Vdc/3.3V
3	AD4	T_PRI	? 10K NTC
27	AN0	Vin_L	0Vac/0V ~ 295Vac/3.3V
28	AN1	Vin_N	0Vac/0V ~ 295Vac/3.3V

4.2 SECONDARY SIDE

4.2.1 INPUT PINS

Pin #	Pin name	Connect to	I/O Level definition
2	RC4	PS_A1	Logic 0: I2C address value for zero Logic 1: I2C address value for one
3	RC5	PS_A2	Logic 0: I2C address value for zero Logic 1: I2C address value for one
4	RC6	PFC_OK_SEC	Logic 0: PFC OK Logic 1: PFC NOT OK
5	RC3	PS_A0	Logic 0: I2C address value for zero Logic 1: I2C address value for one
13	RB5	PSON	Logic 0: PS_OFF Logic 1: PS_ON
14	RA3	AC_OK__SEC	Logic 0: AC GOOD Logic 1:AC NOT GOOD

4.2.2 OUTPUT PINS

Pin #	Pin name	Initial State	Connect to	I/O Level definition
8	RB11	L	ORINF_EN_MCU	Logic 0: Oring disable Logic 1: Oring enable
9	RB12	L	PW_GOOD	Logic 0: Power not Good Logic 1: Power Good
15	RC13	L	LLC_DIS	Logic 0: LLC IC disable Logic 1: LLC IC enable
43	RB5	L	LED1	Logic 0: No AC power available Blinking: AC Present / +5VSB on (Main DC Output OFF) Logic 1: Power Supply ON and OK
19	RC11	L	STB_ORING_EN_MCU	Logic 0: standby oring disable Logic 1: standby oring enable
20	RC12	L	SR_EN_MCU	Logic 0: SR disable Logic 1: SR enable
36	RC2	L	FAN_CNTRL	Logic 0: FAN disable Logic 1: FAN enable
35	RB4	L	ISHARE_DIS	Logic 0: Disable current sharing Logic 1: Enable current sharing

4.2.3 ANALOGUE PINS

Pin #	Pin Name	Connect to	Scale
21	AN0	12V_ORING_MCU	0V/0Vdc ~ 16.23V/3.3Vdc
22	AN1	I_OUT_MCU	0A/0V ~ ? 60A/3.3V
23	AN2	12V_OUT_MCU	0V/0Vdc ~ 16.23V/3.3Vdc
24	AN3	ISHARE_IN	0A/0V ~ ? 10.584V/3.3V
25	AN4	STB_5V_OUT_MCU	0A/0V ~ 6V/3.3V
26	AN5	STB_I_OUT_MCU	0A/0V ~ 0.5A/3.3V
32	AN6	CS_OUT_READ	0A/0V ~ ? A/3.3V
33	AN7	T_SR_MCU	10K NTC
34	DACOUT1	DAC_OUT	

- Resolution: 12-bits, reference voltage 3.3V.

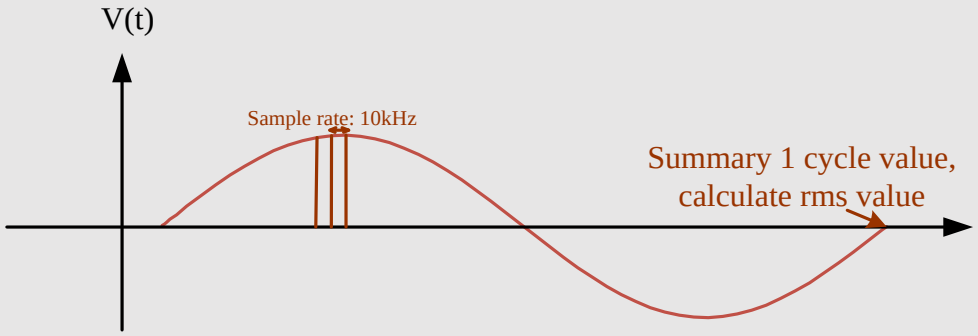
4.2.4 PWM PINS

Pin #	Pin Name	Connect to	Description
12	PWM1H	FAM_PWM	
22	PWM2H	12V_SOFT_TRIM	
		12V_DROOP	

5. 5. A/D DETECTION METHOD

5.1 AC INPUT

5.1.1 AC SLOW-SPEED DETECTION



i. x_1、x_2... x_n are sampling points in one period of input AC source and captured in the fixed rate (sampling frequency fs is 10kHz)

ii. Estimated voltage in Peak value is calculated by Vin.

5.2 DC INPUT

- Digital filter, Sample rate: ? 2kHz
- PFC bus low pass filter: ? 100Hz

5.3 PFC OUTPUT

- Digital filter, Sample rate: ? 2kHz
- PFC bus low pass filter: ? 100Hz

6. PROTECTION

6.1 PFC PROTECTION

6.1.1 BUS VOLTAGE

Bus Detection	FW Delay Time	Value	Protect
PFC Bus voltage – OVP - Low	120ms	450v	Disable PFC_OK, PFC disable ,Latch PFC and 12 main Vout
PFC Bus voltage – OVP - High	2ms	460v	Disable PFC_OK, PFC disable ,Latch PFC and 12 main Vout
PFC Bus voltage – UVP - Drop	1ms	335/330v	Disable PFC_OK, auto restart

6.1.2 OTP

Temp Detection	Delay time	Value	Recovery Value	Protect
PFC Over temp	10s	110C	60C	Disable PFC_OK, wait Recovery value

6.1.3 INPUT VOLTAGE

Input Detection	Delay time	Value	Recovery Value	Protect
Vin OVP - AC	72ms	295V	264V	PFC Relay Turn off, PFC not OK, PFC disable. Auto Restart.
Vin UVP - AC	2ms	74.55 V	85.84V	PFC Relay Turn off, PFC not OK, PFC disable. Auto Restart.
Vin OVP - DC	72ms	310V	288V	PFC Relay Turn off, PFC not OK, PFC disable. Auto Restart.
Vin UVP - DC	2ms	110V	125V	PFC Relay Turn off, PFC not OK, PFC disable. Auto Restart.

- PFC Recovery time please ref. to **8. PFC START TIME SEQUENCE**

6.2 PROTECTION TIMING AND PMBUS FLAG

6.2.1 PAGE 0

Event	12V main output shut down once trigger	12V Can Auto recovery once the condition return to normal	79H	7AH	7BH	7CH	7DH	7EH	81H	Event trigger --> Bit assert (unmask)	Event trigger --> SMBAlert assert (unmask)	Event trigger --> PSU shut down
12V OVP	YES	NO	8860	C0	00	00	00	00	00	40us	40us	45us
12V OCP	YES	NO	4850	00	A0	00	00	00	00	1.2 s	1.2 s	1.2 s
12V UVP	YES	NO	8840	30	00	00	00	00	00	1.2 s	1.2 s	1.2 s
FAN FAULT	YES	NO	0C40	00	00	00	00	00	80	15 s	15 s	15 s
FAN Override	NO	YES	0000	00	00	00	00	00	08	1s	1s	1s
AC INPUT UVP	YES	YES	2848	00	00	30	00	00	00	0.5~ 0.6 sec	0.5~ 0.6 sec	0.5~ 0.6 sec
AC INPUT OVP	YES	YES	2840	00	00	C0	00	00	00	4~6 AC cycle	4~6 AC cycle	4~6 AC cycle

6.2.2 PAGE 1

Event	12V main output shut down once trigger	12V Can Auto recovery once the condition return to normal	79H	7AH	7BH	7CH	7DH	7EH	81H	Event trigger --> Bit assert (unmask)	Event trigger --> SMBAlert assert (unmask)	Event trigger --> PSU shut down
OTP1	YES	YES	0844	00	00	00	C0	00	N/A	5 s	5 s	5 s
OTP2	YES	YES	0846	00	00	00	C0	00	N/A	5 s	5 s	5 s
Standby Fault (5Vstb OVP)	YES	YES	8860	C0	00	00	00	00	N/A	20us	20us	20us
Standby Fault (5Vstb UVP)	YES	YES	8840	30	00	00	00	00	N/A	120 ms	120 ms	120 ms

Standby Fault (5Vstb OCP)	YES	YES	4850	00	80	00	00	00	N/A	120 ms	120 ms	120 ms

6.3 PROTECTION SETTING POINT

6.3.1 PROTECTION SETTING POINT FOR PMBUS CMD

Command code	Warning & Fault	FW default value	HW default value
0x40 (VOUT_OV_FAULT_LIMIT)	Vout OV FAULT	DC: 13.5 V	N/A
0x4A (IOUT_OC_WARN_LIMIT)	Iout OC warning	DC: 50.4A	N/A
0x46 (IOUT_OC_FAULT_LIMIT)	Iout OC fault	DC: 52.8A	N/A
	Constant Current Limit	N/A	54A
	5VSB OVP	DC: 5.91	DC: 6.13 V
	5VSB OVW	DC: 5.63	N/A
	5VSB UVP	DC: 4.46	N/A
	5VSB OCP	DC: ? 0.8 A	N/A
	5VSB OCW	DC: ? 0.6A	N/A
0x51 (OT_WARN_LIMIT, PAGE1)	OT warning (Ambient)	Ambient OT warning: 55 C	N/A
0x51 (OT_WARN_LIMIT, PAGE0)	OT warning (Hotspot)	Hotspot OT warning: 100 C	N/A
0x4F (OT_FAULT_LIMIT, PAGE1)	OTP (Ambient)	Ambient OT Fault: 67 C	N/A
0x4F (OT_FAULT_LIMIT, PAGE0)	OTP (Hotspot)	Hotspot OT warning: 110 C	N/A
	OTP recovery (Ambient)	Ambient OT Recovery: 52 C	N/A
	OTP recovery (Hotspot)	Hotspot OT Recovery: 80 C	N/A
	Fan Fault	FAN RPM < 500 RPM,	N/A

6.3.2 UNIT_OFF POINT

Recovery point same as Vin_UV_fault and Vin_OV_fault recovery point.

Status_Input (7CH)	FW default value
UNIT_OFF (UV)	AC:74.55 Vac
UNIT_OFF (OV)	AC: 295 Vac

6.4 PROTECTION RECOVER AND ALERT RECOVER DESCRIPTION

Event	Recovery Method	After Recovery, 12V turn on time
12V OVW	Clear Fault(0x03), PS_ON_OFF	-
12V OCW	Clear Fault(0x03), PS_ON_OFF	-
12V OVP	PS_ON_OFF	Follow PS_ON_OFF startup time
12V OCP	PS_ON_OFF	Follow PS_ON_OFF startup time
12V UVP	PS_ON_OFF	Follow PS_ON_OFF startup time
OTW 1	Clear Fault(0x03), PS_ON_OFF	-
OTP1	Back to recover temp, but	3 sec

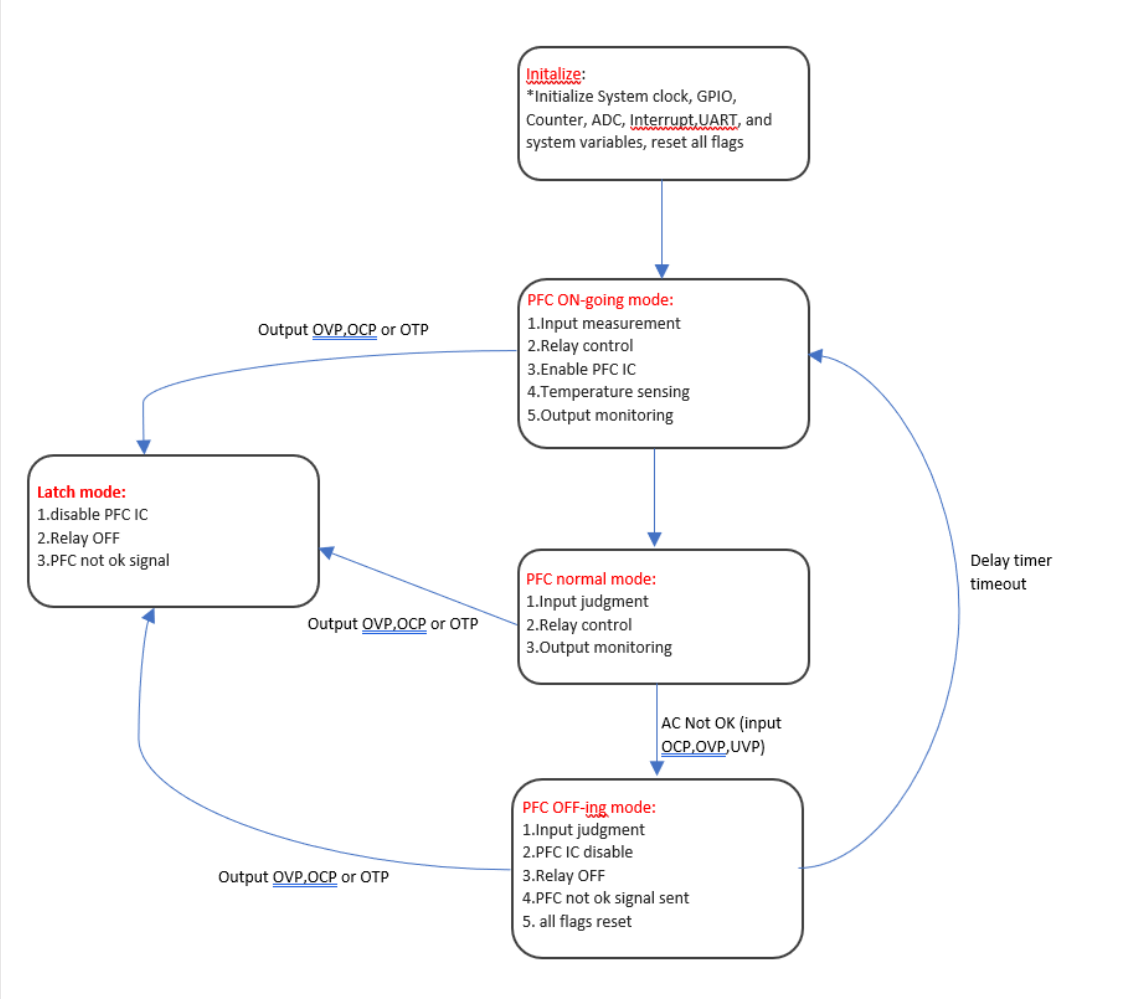
	Fault flag clear only by Clear Fault(0x03)	
OTW2 (2nd hot-spot)	Clear Fault(0x03), PS_ON_OFF	-
OTP2 (2nd hot-spot)	Back to recover temp, but Fault flag clear only by Clear Fault(0x03)	3 sec
FAN FAULT	PS_ON_OFF	Follow PS_ON_OFF startup time
Standby Fault (5Vstb OVP)	Back to recover voltage	until fault clear, every 5sec retry.
Standby Fault (5Vstb UVP)	Back to recover voltage	until fault clear, every 5sec retry.
Standby Fault (5Vstb OCP)	Back to recover current	until fault clear, every 5sec retry.
AC INPUT UVW	Clear Fault(0x03), PS_ON_OFF	-
AC INPUT UVP	Back to recovery voltage	0.4s~0.9s
AC INPUT OVP	Back to fault recovery voltage	0.4s~0.9s
AC INPUT OVW	Clear Fault(0x03), PS_ON_OFF	-

6.5 REPORTING UPDATE TIME

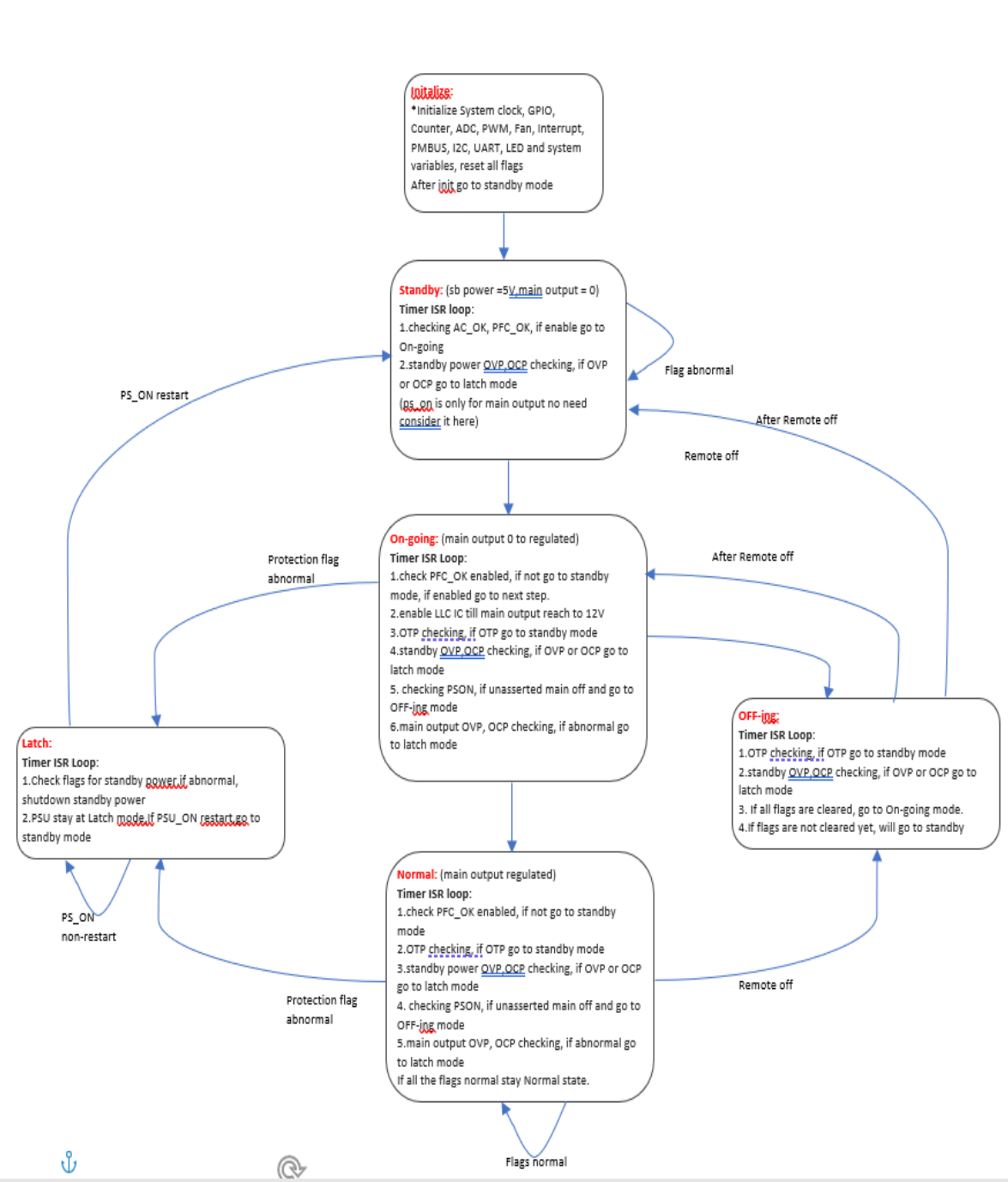
Report Item	Update Time (s)	Accuracy (%)
Vin	20 ms	+/-5%
Iin	640 ms	+/-5%
Pin	160 ms	+/-5%
Vout	10.24 ms	+/-5%v
Iout	163.84 ms	+/-5%
Pout	163.84 ms	+/-5%
Tinlet	*640 us*	*+/-5°C*
Tpri	250 ms	+/-5°C
Tsec	640 us	+/-5°C
Fan	Updated every cycle	+/-5%

7. FLOWCHART

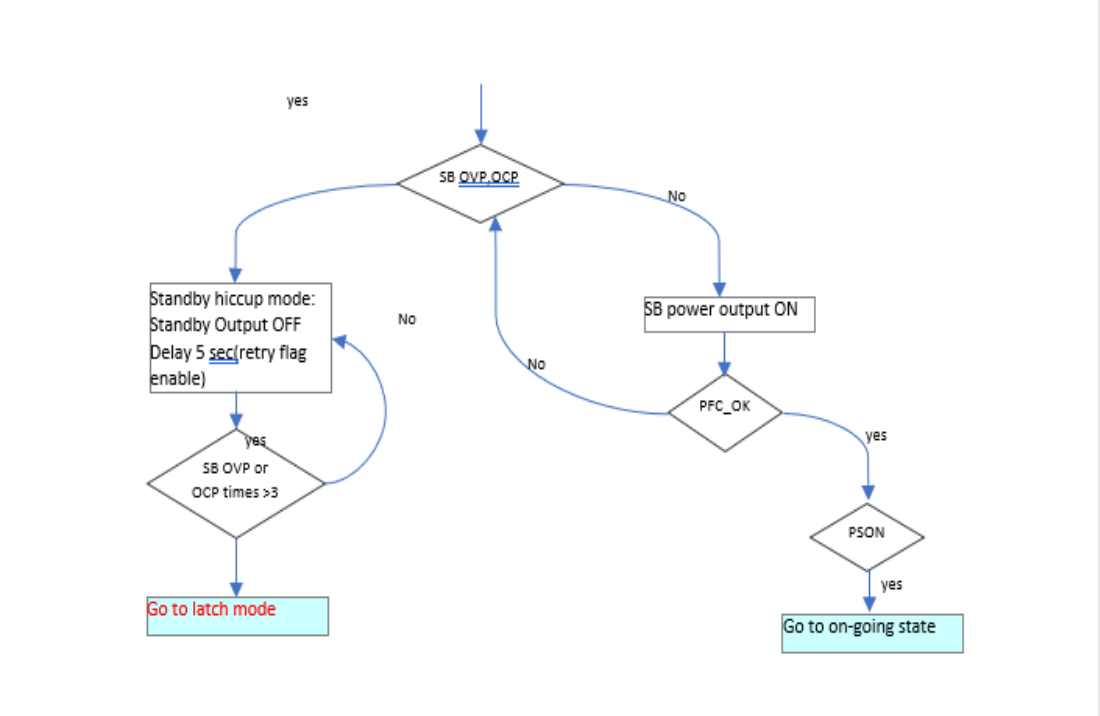
7.1 PROMARY SIDE FLOW CHART



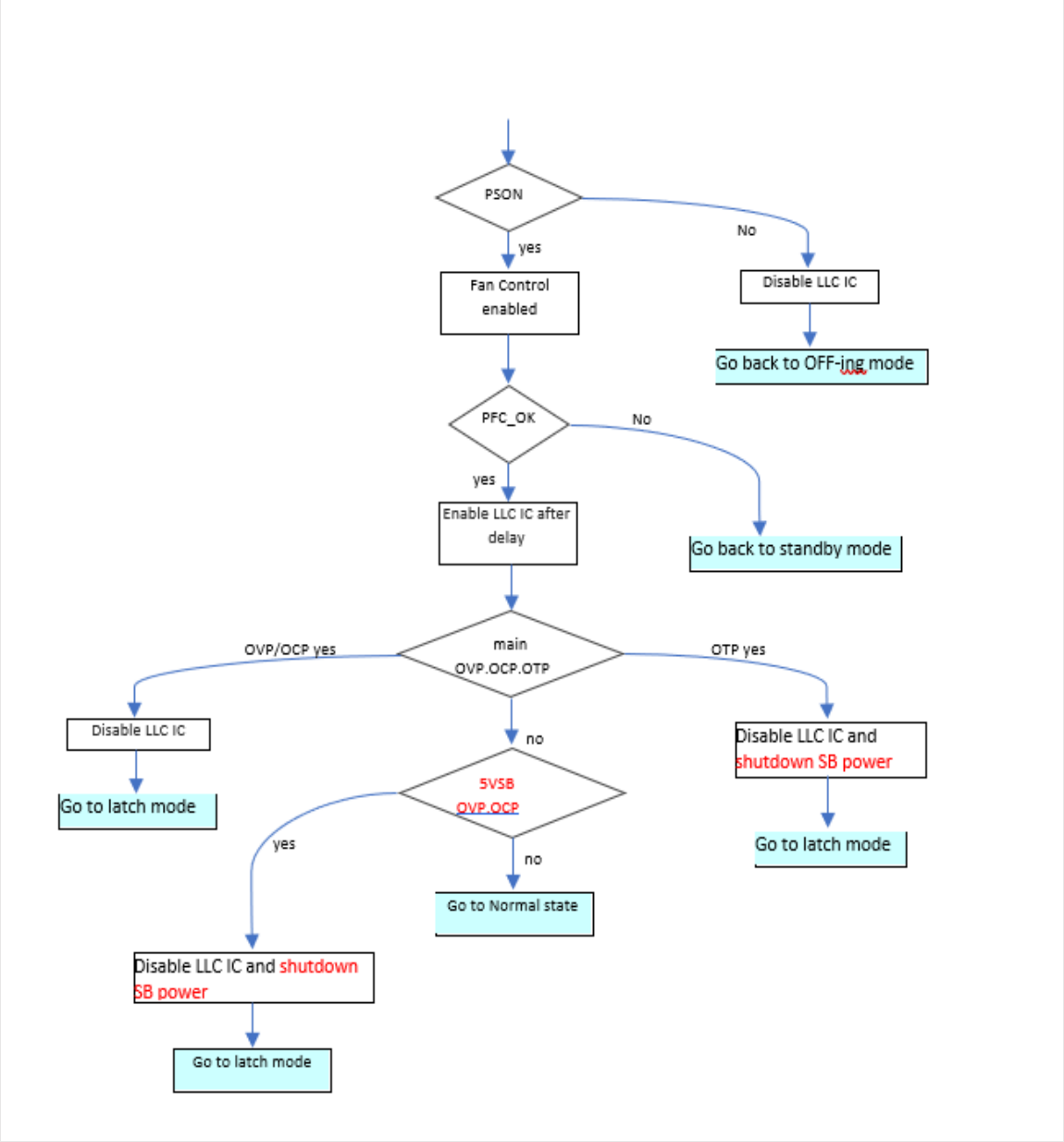
7.2 SECONDARY FLOWCHART OVERVIEW



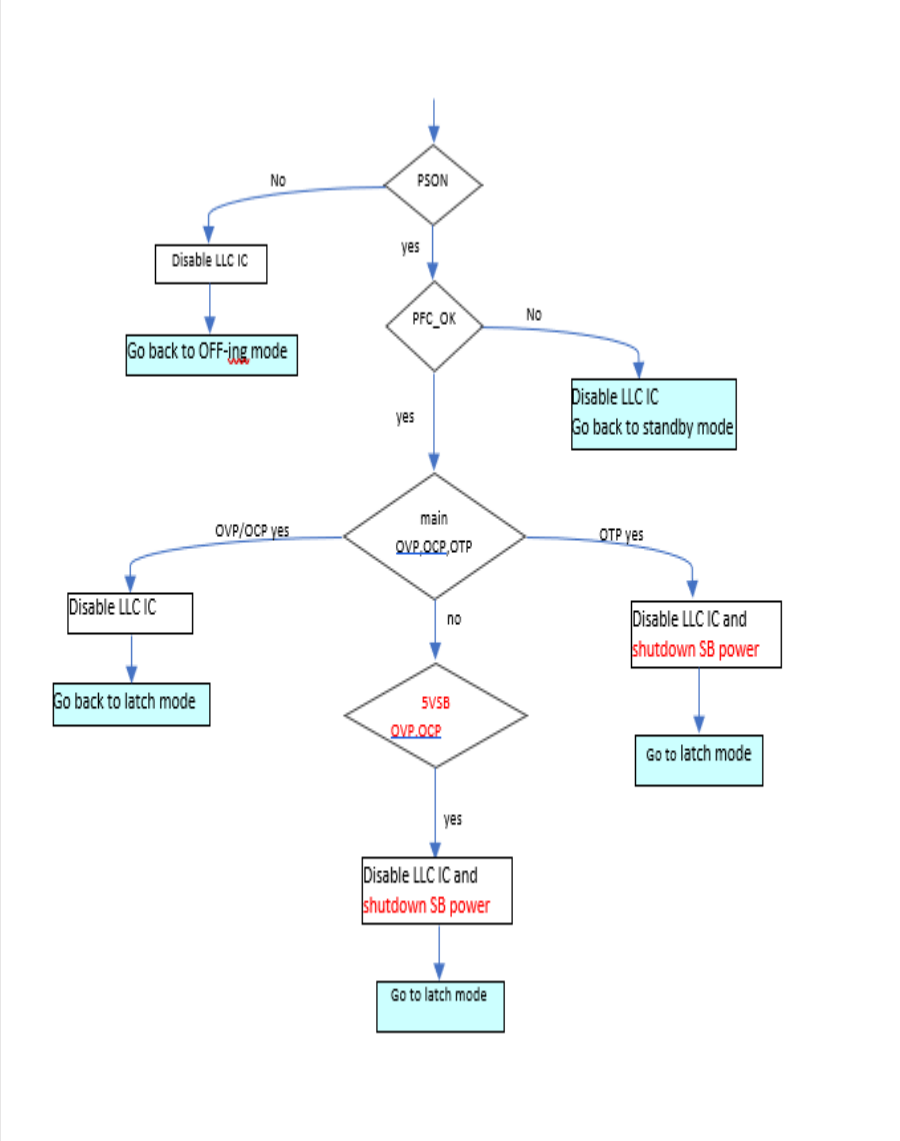
7.2.1 STATE_STANDBY



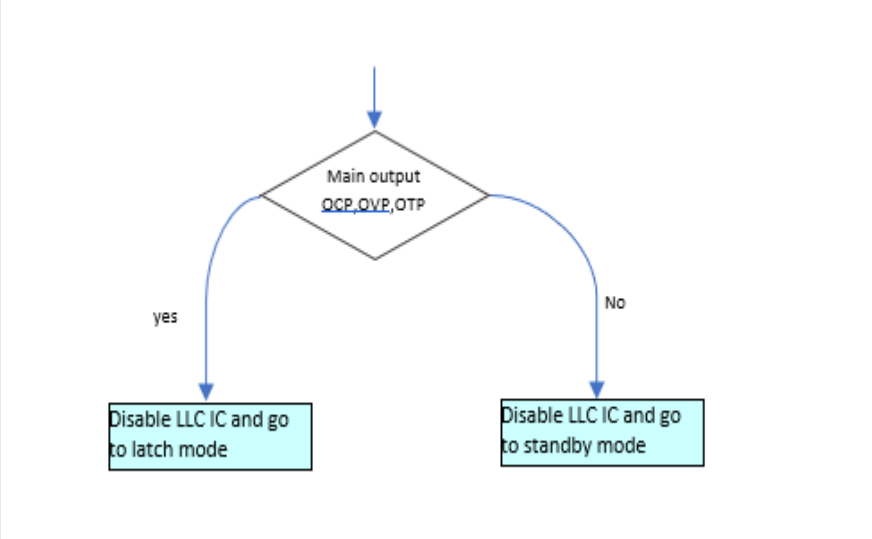
7.2.2 STATE_ONING


PSON
No
yes
Fan Control enabled
Disable LLC IC
Go back to OFF-ing mode
PFC_OK
No
yes
Enable LLC IC after delay
Go back to standby mode
main OVP.OCP.OTP
OVP/OCP yes
OTP yes
Disable LLC IC
Go to latch mode
no
5VSB OVP.OCP
Disable LLC IC and shutdown SB power
Go to latch mode
yes
no
Go to Normal state
Disable LLC IC and shutdown SB power
Go to latch mode

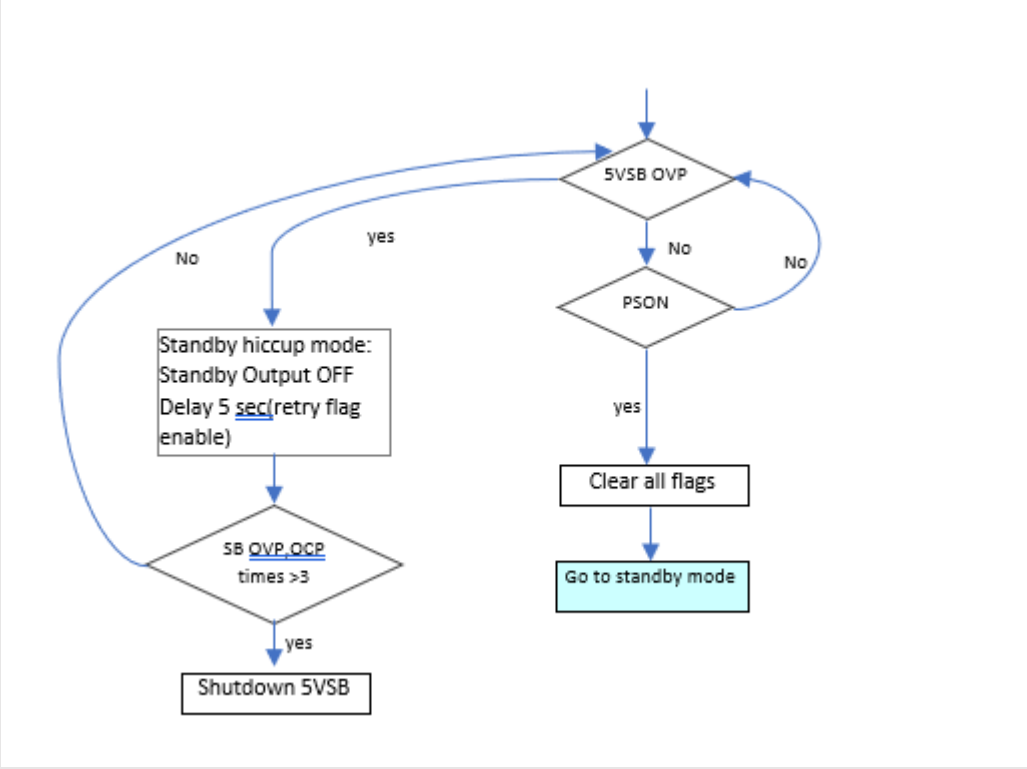
7.2.3 STATE_NORMAL



7.2.4 STATE_OFFING

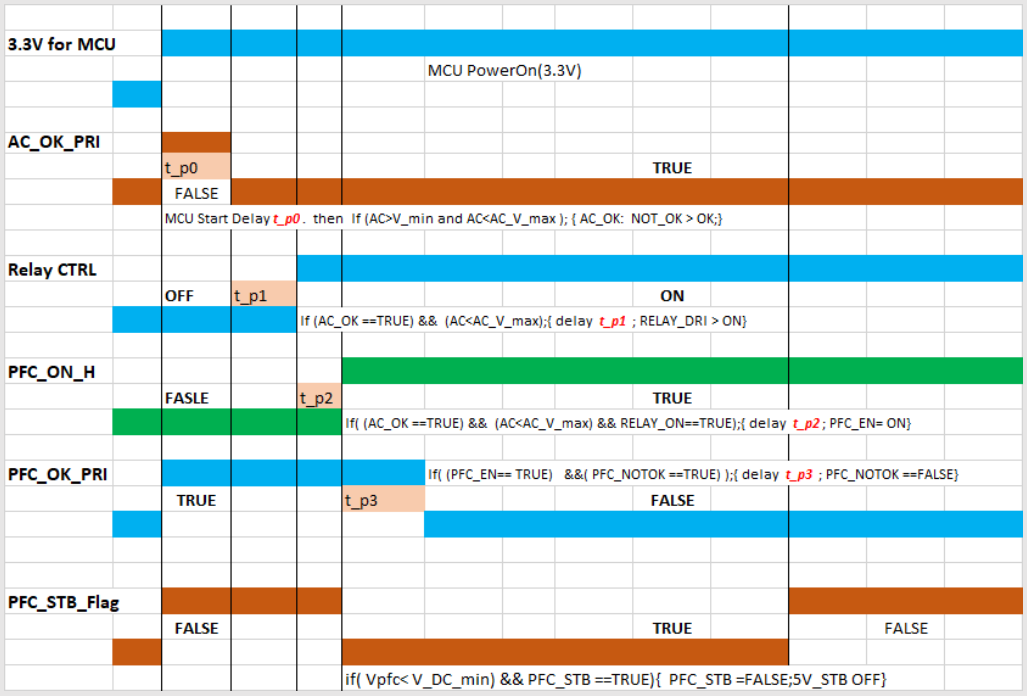


7.2.5 STATE_LATCH



8. TIME SEQUENCE

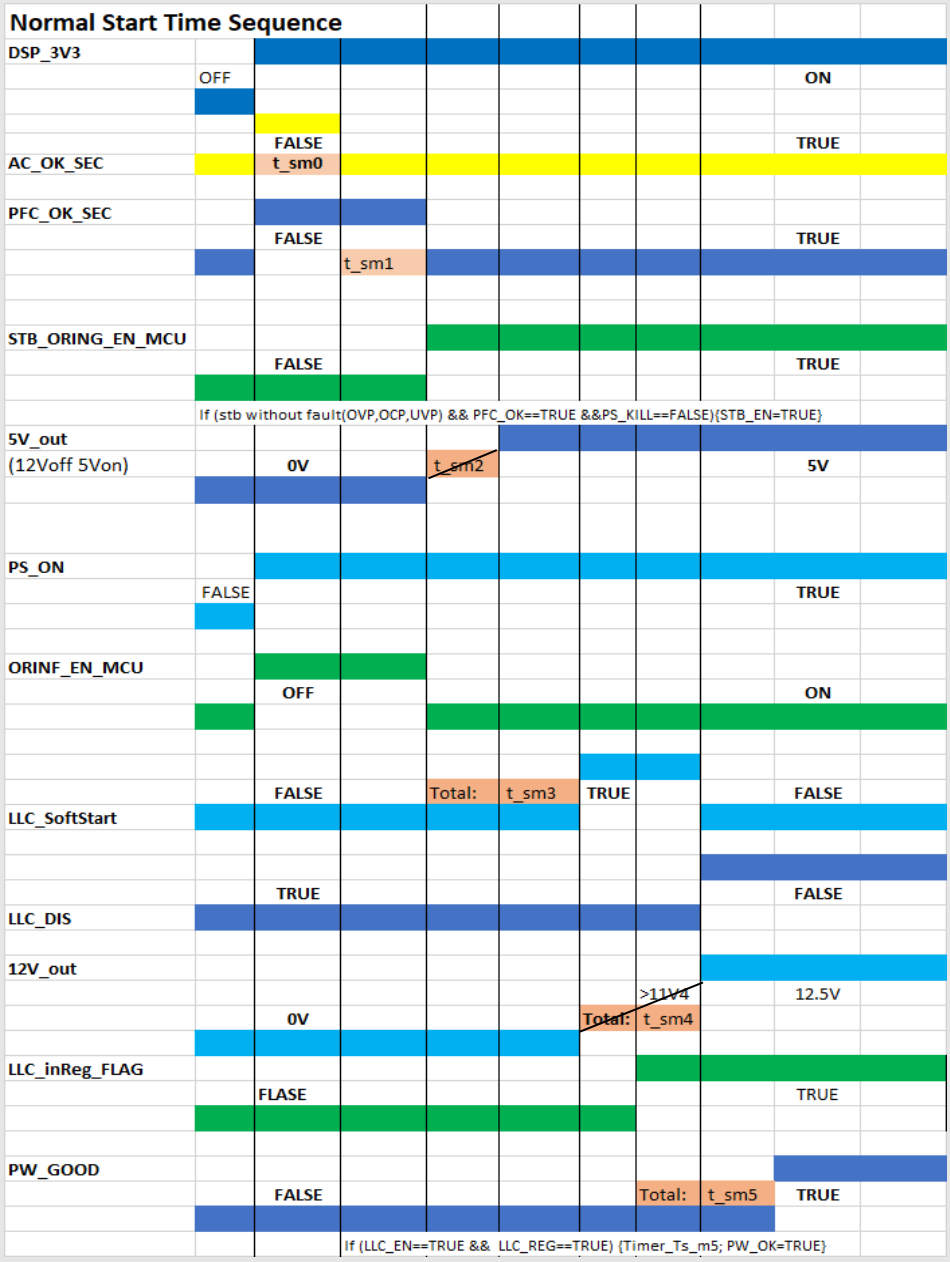
8.1 PRIMARY NORMAL STATE TIME SEQUENCE



Name	Estimate Value	Optimized Value	description
t_p0	220 ms		
t_p1	250 ms		
t_p2	10 ms		
t_p3	50 ms		
V_AC_Min	170 V		
V_AC_Max	295 V		
V_DC_min	250 V		

8.2 SECONDARY NORMAL STATE TIME SEQUENCE

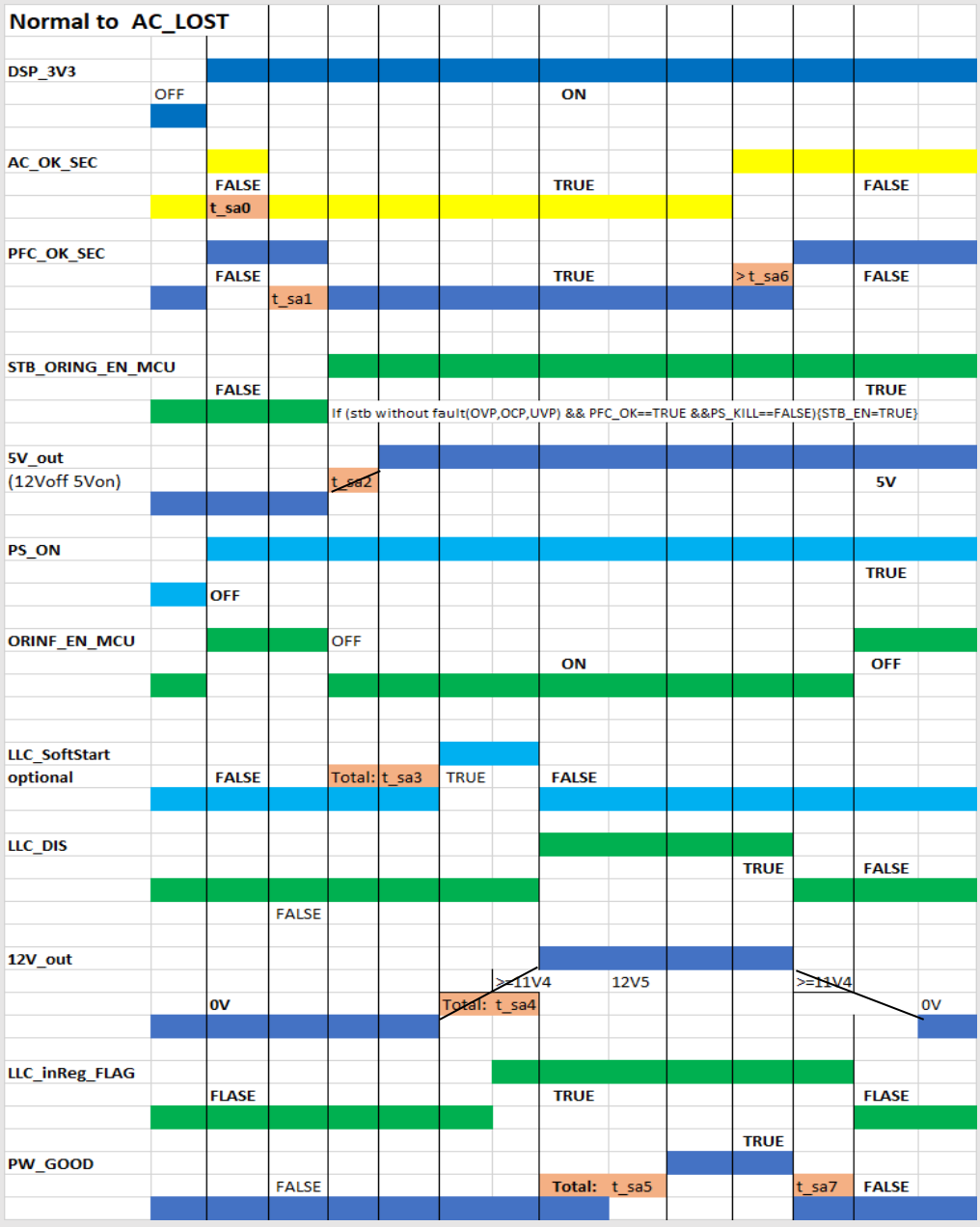
8.2.1 NORMAL SEQUENCE



Name	Estimate Value	Optimized Value	Description
t_sm0	220 ms		
t_sm1	310 ms		
t_sm2	25 ms		
t_sm3	250 ms		
t_sm4	27 ms		
t_sm5	200 ms		

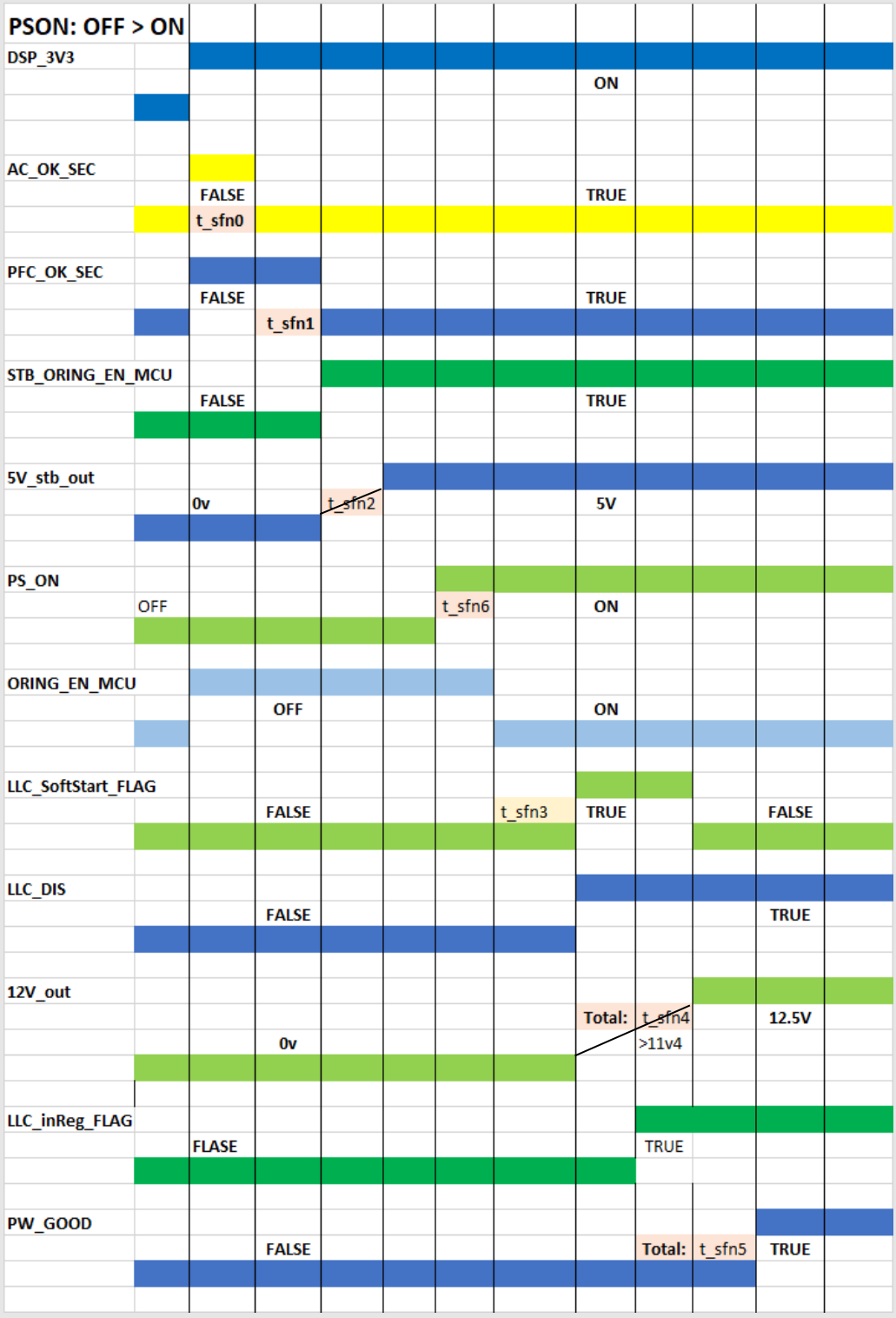
Summary fault flag: include Fan lock, 12Vmain Output OVP, UVP, OCP, OTP and PS_ON(Low), PFC_OK)SEC (High), Standby OVP, UVP, OCP.

8.2.2 FAULT STATE TIME SEQUENCE -> AC_LOST



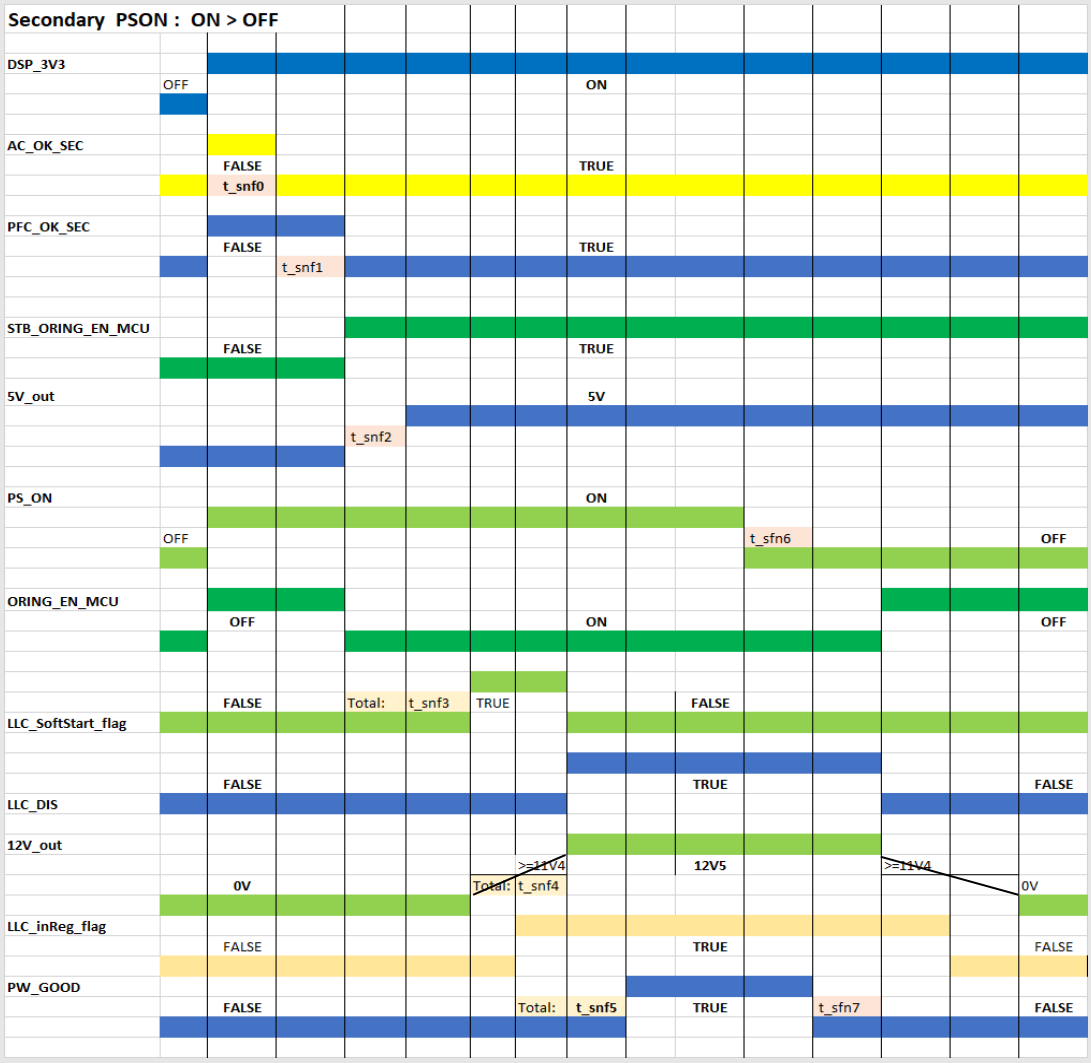
Name	Estimate Value	Optimized Value	Description
t_sa0	220 ms		
t_sa1	310 ms		
t_sa2	25 ms		
t_sa3	250 ms		
t_sa4	27 ms		
t_sa5	200 ms		
t_sa6	50 ms		
t_sa7	5 ms		

8.2.3 FAULT PSON OFF > ON



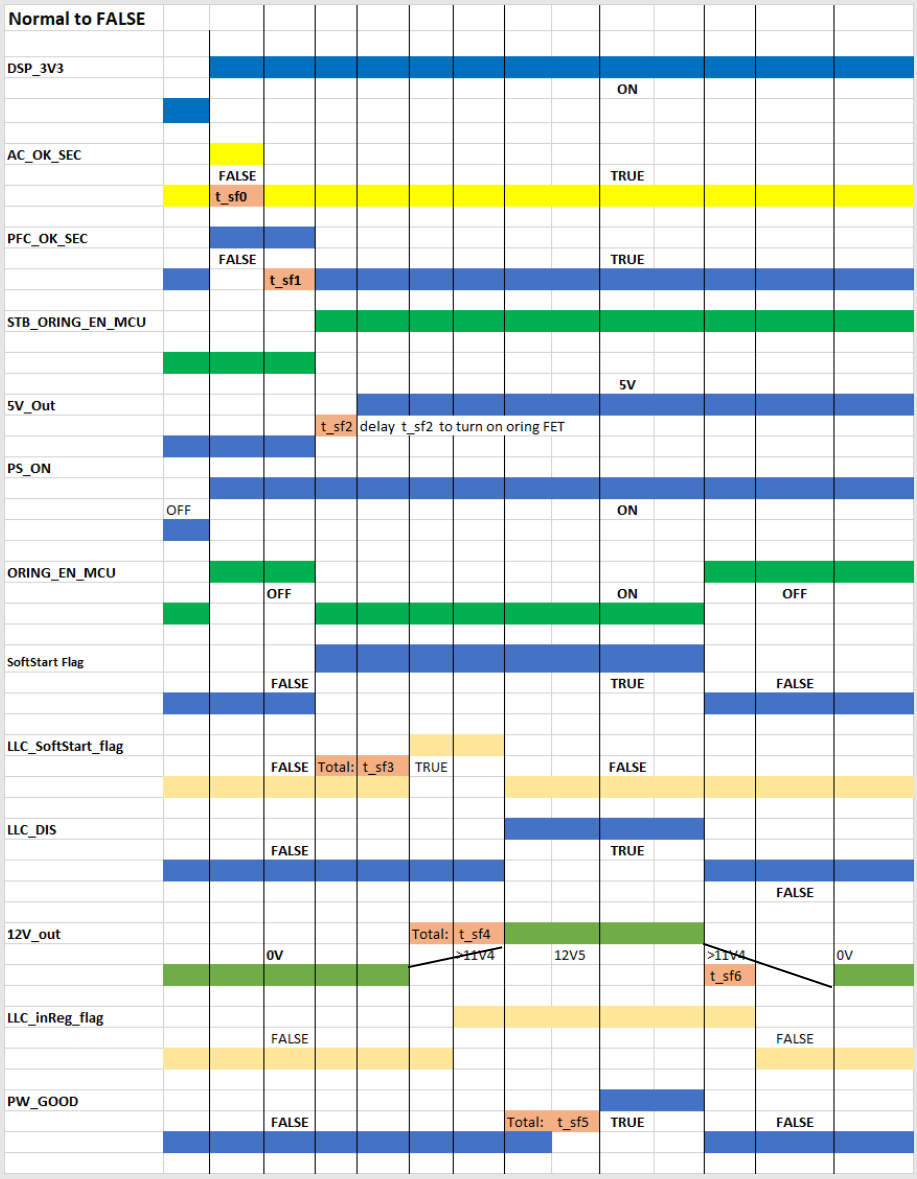
Name	Estimate Value	Optimized Value	Description
t_sfn0	220 ms		
t_sfn1	310 ms		
t_sfn2	25 ms		
t_sfn3	250 ms		
t_sfn4	27 ms		
t_sfn5	200 ms		
t_sfn6	20 ms		

8.2.4 FAULT STATE TIME SEQUENCE -> PS_ON TO PS_OFF



Name	Estimate Value	Optimized Value	Description
t_snf0	220 ms		
t_snf1	310 ms		
t_snf2	25 ms		
t_snf3	250 ms		
t_snf4	27 ms		
t_snf5	200 ms		
t_snf6	10ms		
t_snf7	3ms		

8.2.5 NORMAL TO FALSE



Name	Estimate Value	Optimized Value	Description
t_sf0	220 ms		
t_sf1	310 ms		
t_sf2	25 ms		
t_sf3	250 ms		
t_sf4	27 ms		
t_sf5	200 ms		
t_sf6	5 ms		

9. OHERT CONTROL

9.1 PMBUS COMMUNICATION

Reference: PS-1603-X01 PMBUS Spec.xlsx

9.2 RS232 COMMUNICATION

9.2.1 SETTING

115200bps, N, 8, 1

9.2.2 PROTOCOL

Reference: PS-1603-X01 RS232 Spec.xlsx

9.3 BOOTLOADER

OPTIONAL FUNCTION ; REFERENCE: PS-1603-X01 BOOTLOADER.DOCX(TBD)

9.4 FAN SPEED CONTROL

The maximum fan speed is limited to make sure the acoustical noise is less than 38.5 dB(A) at the condition of 100 VAC, 100 % load and 30 °C ambient temperature. Fan speed varies linearly with the temperature.
To keep the noise low the fan will be turned off under the following conditions:

1. in standby mode
2. when main output load is less than 10 %
3. when the ambient temperature is lower than a typical value 18 °C

9.5 LED

LED_STATUS	DISPLAY
No AC power available	LED OFF
AC Present / +5VSB on (Main DC Output OFF)	BLINK_GREEN(1Hz)
Power Supply ON and OK	LED_ON

9.6 FW VERSION RULE

Bootloader version	Primary Side version	PSU Model Name	Secondary Side version
2 letter	2 letter	2 letters	2 letters
05	0E	6A	03

9.7 CALIBRATION

Reference: PS-1603-X01 CALIBRATION Spec.docx (TBD)

10. BLACK BOX FAULT LOGGING

When a fault condition occurs, the PSU must save certain status registers into non-volatile memory. The PSU must save a record of this data for the last five fault events. The history will be accessed via the MFR_PAGE command (E4h). If the history fills up, delete the oldest record and shift the remaining records down the queue following FIFO.

The MFR_POS_TOTAL for the Real-Time Data entry in black box fault logging (MFR_PAGE 0xFF) should not be cleared prior to PSU manufacturer shipment. All other black box data (MFR_PAGE 0x00-0x*NN*) should be cleared prior to PSU manufacturer shipment.

AWS Black Box Log PMBus CMD Table:

MFR_PAGE(0XE4)		
MFR_PAGE	Refers to	Comments
0XFF	Real time data (default value)	When a fault condition occurs, the PSU must save certain status registers into non-volatile memory. The PSU must save a record of this data for the last five fault events. The history will be accessed via the MFR_PAGE command (E4h). If the history fills up, delete the oldest record and shift the remaining records down the queue following FIFO. Up to 17 black box events can be recorded.
0X00	Fault history 1 (newest fault event)	
0X01	Fault history 2	
0X02	Fault history 3	
0X03	Fault history 4	
0X04	Fault history 5	
0X05 ~0X10	Option additional fault history locations	

Sensors to save upon *each fault event table*			
Command Number	Command Name	Command Number	Command Name
0x79	STATUS_WORD	0x8D	READ_TEMPERATURE_1 (Ambient)
0x7A	STATUS_VOUT	0x8E	READ_TEMPERATURE_2 (Primary side)
0x7B	STATUS_IOUT	0x8F	READ_TEMPERATURE_3 (Secondary side)
0x7C	STATUS_INPUT	0x90	READ_FAN_SPEED_1
0x7D	STATUS_TEMPERATURE	0x91	READ_FAN_SPEED_2
0x7E	STATUS_CML	0x96	READ_POUT
0x81	STATUS_FANS_1_2	0x97	READ_PIN
0x88	READ_VIN	0xD0	MFR_FW_REVISION
0x89	READ_IIN	0xE5	MFR_POS_TOTAL
0x8B	READ_VOUT	0xE6	MFR_POS_LAST
0x8C	READ_IOUT	0xE7	BMC_UNIX_TIMESTAMPS

MFR_POS_TOTAL(0XE5)

MFR_POS_TOTAL will respond with 4 bytes representing the total number of power on seconds the power supply has been turned on and delivering energy to the main output since it was manufactured in linear encoding following the PMBus specification for bit and byte order. The command is read only.

MFR_POS_LAST(0XE6)
MFR_POS_LAST will respond with 4 bytes representing ***the number of power on seconds*** the power supply has been turned on and delivering energy to the main output in linear encoding following the PMBus specification for bit and byte order. When the main output is not delivering energy, the PSU must hold the current value. The command is read only.

Log fetch
1. Write Byte to CMD 0X10 ->WRITE_PROTECT Disable -> 0x00
2. Write Byte to CMD 0XE4 -> Fault history 1 (newest fault event) -> 0x00
3. Read Black Box event log -> Read fault event 1 table, EX: read cmd 0x79~7E,..etc.
4. If you want to read other older fault events, change the value from item 2, for example: Fault history 2 -> 0x01
5. Write Byte to CMD 0XE4 -> 0XFF -> Real time data (default value). Expressed as the current information, there is no black box fault event.