SOFTWARE MANUAL

RF POWER AMPLIFIER

CA3900BW3-5560R-SL

R&K Company Limited

Date	Author	Authorized	Document number	Version
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Revision History

Version	Date	Author(s)	Revision Note
1	September 21, 2017	K. Nishimura	Original
2	October 13, 2017	K. Nishimura	Reflection of SLAC's Review
3	October 18, 2017	K. Nishimura	Reflection of SLAC's Review

1. Function Overview

This product is controlled by programmable logic. You can read all status by controlling various functions.

1.1. Construction

This product is constructed with 1 control Unit and 4 Final Amp Units and PS Unit.
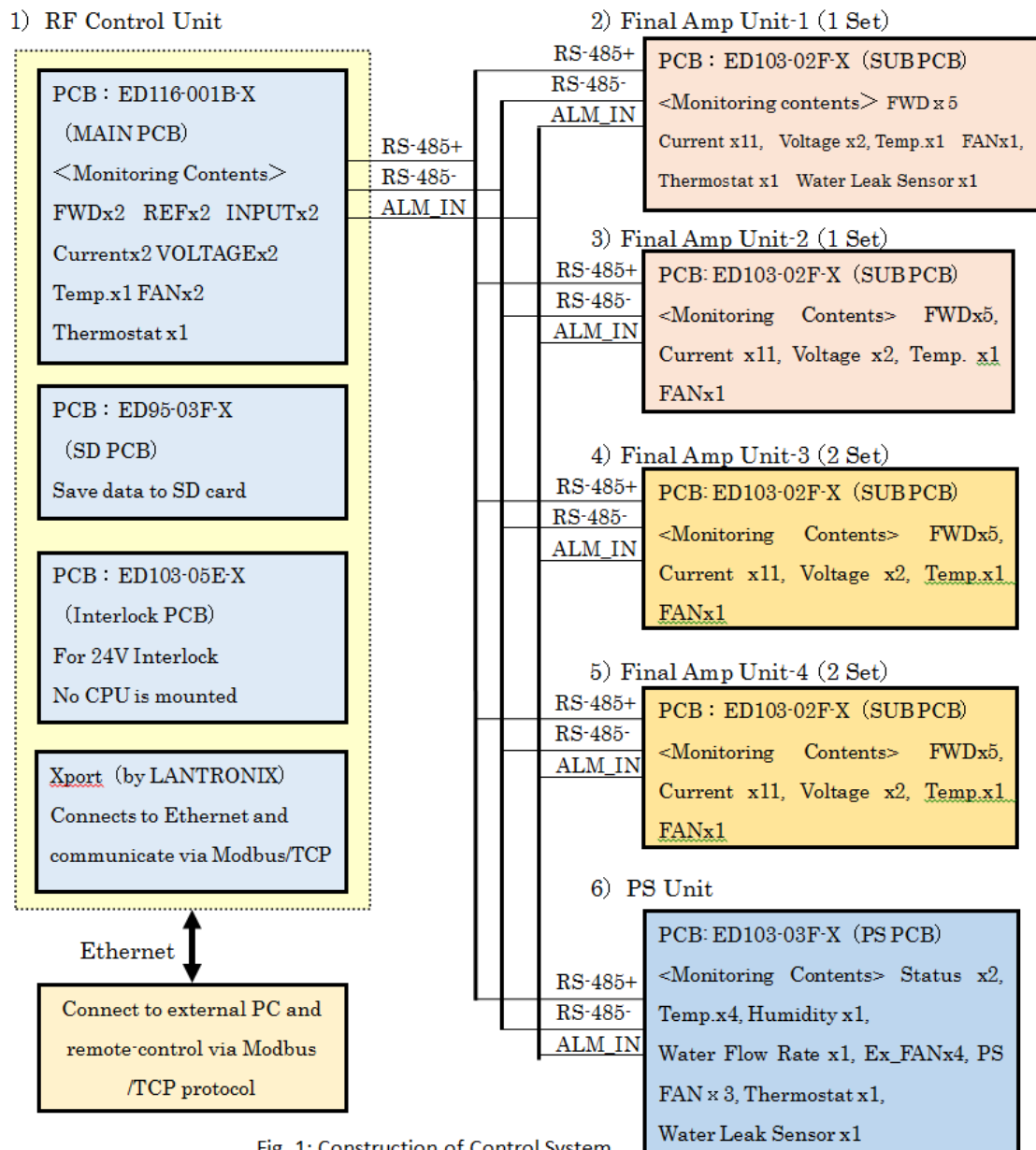
1) RF Control Unit

PCB : ED116-001B-X
(MAIN PCB)
<Monitoring Contents>
FWDx2 REFx2 INPUTx2
Currentx2 VOLTAGEx2
Temp.x1 FANx2
Thermostat x1

PCB : ED95-03F-X
(SD PCB)
Save data to SD card

PCB : ED103-05E-X
(Interlock PCB)
For 24V Interlock
No CPU is mounted

Xport （by LANTRONIX)
Connects to Ethernet and
communicate via Modbus/TCP

Ethernet

Connect to external PC and
remote-control via Modbus
/TCP protocol

RS-485+
RS-485-
ALM_IN

2) Final Amp Unit-1 (1 Set)

RS-485+
RS-485-
ALM_IN

PCB : ED103-02F-X (SUB PCB)
<Monitoring contents＞ FWD x 5
Current x11, Voltage x2, Temp.x1 FANx1,
Thermostat x1 Water Leak Sensor x1

3) Final Amp Unit-2 (1 Set)

RS-485+
RS-485-
ALM_IN

PCB: ED103-02F-X (SUB PCB)
<Monitoring   Contents>   FWDx5,
Current x11, Voltage x2, Temp. x1
FANx1

4) Final Amp Unit-3 (2 Set)

RS-485+
RS-485-
ALM_IN

PCB: ED103-02F-X (SUB PCB)
<Monitoring   Contents>   FWDx5,
Current x11, Voltage x2, Temp.x1
FANx1

5) Final Amp Unit-4 (2 Set)

RS-485+
RS-485-
ALM_IN

PCB : ED103-02F-X (SUB PCB)
<Monitoring   Contents>   FWDx5,
Current x11, Voltage x2, Temp.x1
FANx1

6) PS Unit

RS-485+
RS-485-
ALM_IN

PCB: ED103-03F-X (PS PCB)
<Monitoring   Contents> Status x2,
Temp.x4, Humidity x1,
Water Flow Rate x1, Ex_FANx4, PS
FAN x 3, Thermostat x1,
Water Leak Sensor x1

Fig. 1: Construction of Control System

1.2. Control Interface

This product has a network interface.

　・Network Interface　　　：　Modbus/TCP

1.3. Monitoring System

The system monitors and records the statuses of the Control Module, the four Final Amplifier (FA) Modules and the Power Supply (PS) Module. The recorded information can be viewed via the Modbus interface in real time. These data are also recorded to a SD card.

1.4. Protection Function

This product has following protection functions.

　・Interlock : When an abnormal status occurs internally or externally that adversely affects its continued operation, the unit is shut down and a fault signal (24 V indicator) is generated.

　・Warning : When abnormal status occurs internally that warrants the operators attention, warning registers are set that can be viewed via Modbus, but the operation of the unit continues without change.

2. Function Information

Information of each function is as following.

2.1. Control Construction

2.1.1. Controller Module

Controller Unit is controlled by Main PCB. It collects data which is taken by SSA by polling

It controls the SSA by processing orders from control interface.

Table 1: Control system

Category	Type name	Number	Specification
Main PCB	ED116-001B-X	1	①CPU:PIC24EP256GU810 ②Input Port x16 ③Output Port x8 ④Open Collector Output Port x 8 ⑤LED Output Port x8 ⑥10ADC Input Port (12bit) ⑦2DAC Output Port (MCP4822) ⑧RS-485 (LTC2850) ⑨RX,TX ⑩Real Time Clock（DS3232SN） ⑪EEPROM（24LC16B）
SD PCB	ED95-03F-X	1	①CPU:PIC24FJ256GB106 ②EEPROM(24LC16B) ③SD-SLOT
Xport	Xport (LANTRONIX)	1	①Module to convert RX TX to Ethernet ②Modbus/TCP ③MAC address is displayed on the Front Panel
Debug PCB	ED116-004B-X	1	①CPU:PIC24FJ256GB110 CPU software is updated via Ethernet
SUB PCB	ED116-002B-X	4	①CPU:PIC24HJ64GP206A ②Input Port x11 ③Output Port x2 ④ADC Input Port x18 ⑤RS-485（LTC2850）

Category	Type name	Number	Specification
PS PCB	ED116-003B-X	1	①CPU:PIC24HJ64GP206A
			②Input Port x13
			③Output Port x5
			④ADC Input Port x7
			⑤RS-485 （LTC2850）

All CPU software can be updated via Ethernet

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2.1.2. SSA Unit

SSA Units are controlled by CPU (PIC24HJ64GA206A) by Microchip. It monitors and measures the internal status of SSA. Measured values are sent by polling of the Main PCB.

Table 2: Monitoring Items

Parameter	Resolution (bit)	Sampling rate (Kilo Samples per Second)	Note
Device current	12 bit	100	FA Unit
Drain Voltage	12 bit	100	FA Unit
Module Forward power	12 bit	100	FA Unit
900W Forward power	12 bit	100	Controller Unit
50W Reflection power	12 bit	100	Controller Unit
Input power	12 bit	100	Controller Unit
Device Current	12 bit	100	Controller Unit
Heat Sink temperature	12 bit	100	Controller Unit
Heat Sink temperature	12 bit	100	FA Unit, PS Unit
Heat Sink thermostat	1 bit	-	FA Unit, PS Unit, Controller Unit
AC/DC Power Supply voltage	12 bit	100	FA Unit
AC/DC Power Supply alarm	1 bit	-	PS Unit
FAN speed (1/4 rpm)	12 bit	-	FA Unit, Controller Unit, PS Unit
Humidity	12 bit	100	PS Unit
Water flow	12 bit	100	PS Unit
Water temperature	12 bit	100	PS Unit
Air temperature	12 bit	100	Controller Unit
Heat Exchanger temperature	12 bit	100	PS Unit
480 VAC Phase Loss	12 bit	100	PS Unit

2.2. Control Interface

2.2.1. XPort setting

   The Xport settings are editable by the Lantronix "Device Installer.exe" program. The Xport initial settings are given in Table 3.

Table 3: Unit1 XPort setting

	XPort
IP Address	169.254.170.1
	169.254.100.[serial #]
Subnet Mask	255.255.0.0
Default Gateway	0.0.0.0
DNS Server	0.0.0.0
CPU Performance Mode	High
Protocol	RS232
Flow Control	None
Baud Rate	230400bps
Data Bits	8
Parity	None
Stop Bits	1
Local Port	502
Remote Port	0
Remote Host	0.0.0.0

2.2.2. Communication protocol

The unit is monitored and controlled via Modbus commands through Ethernet.

The IP address is assigned automatically and the Port is 502.

Table 4: Modbus/TCP

Transaction Identifier	Protocol Identifier	Length	Unit Identifier
2byte	2byte	2byte	1byte
0xXXXX	0xXXXX	0xXXXX	0xXX

Response returns same one as received Header

(Transaction identifier, Protocol identifier, Unit identifier)

<Function Code>

Supports following Function Code.

<0x03 Read Holding Registers>

Read only.

One or continuous registers read is enabled. (125 max.)

1) Request

Table 5: Request packet format (0x03)

Transaction Identifier		Protocol Identifier		Length		Unit Identifier	Function	Starting Address		Quantity of Registers	
byte0	byte1	byte2	byte3	byte4	byte5	byte6	byte7	byte8	byte9	byte10	byte11
Hi	Lo	Hi	Lo	Hi	Lo	1 byte	1 byte	Hi	Lo	Hi	Lo
0xXX	0xXX	0xXX	0xXX	0x00	0x06	0xXX	0x03	0x00	0x02	0x00	0x03

2) Response

Table 6: Response packet format (0x03)

Transaction Identifier		Protocol Identifier		Length		Unit Identifier	Function	Byte court	Data 1		Data 2		Data 3	
byte0	byte1	byte2	byte3	bite4	byte5	byte6	byte7	byte8	byte9	byte10	byte11	byte12	byte13	byte14
Hi	Lo	Hi	Lo	Hi	Lo	1 byte	1 byte	1 byte	Hi	Lo	Hi	Lo	Hi	Lo
0xXX	0xXX	0xXX	0xXX	0x00	0x09	0xXX	0x03	0x06	0xXX	0xXX	0xXX	0xXX	0xXX	0xXX

3) Exception Response

Table 7: Exception response packet format (0x03)

Transaction Identifier		Protocol Identifier		Length		Unit Identifier	Function	Exception Code
byte0	byte1	byte2	byte3	byte4	byte5	byte6	byte7	byte8
Hi	Lo	Hi	Lo	Hi	Lo	1 byte	1 byte	1 byte
0xXX	0xXX	0xXX	0xXX	0x00	0x03	0xXX	0x83	0xXX

Table 8: Exception code (0x03)

Exception Code	MODBUS Name	Comments
0x01	Illegal Function Code	The function code is unknown by the server
0x02	Illegal Data Address	Address specification outside the allowed range
0x03	Illegal Data Value	Specified value outside the allowed range
0x04	Processing abnormality	Write protect setting

<0x06 Write Single Register>

Write only to a single register

This command is used to:

- DC Enable/Disable
- RF Enable/Disable
- Voltage control setting of each switching power supply
- Fault Reset
- Reboot
- Time setting

1) Request

Table 9: Request packet format (0x06)

Transaction Identifier		Protocol Identifier		Length		Unit Identifier	Function	Register Address		Register Value	
byte0	byte1	byte2	byte3	byte4	byte5	byte6	byte7	byte8	byte9	byte10	byte11
Hi	Lo	Hi	Lo	Hi	Lo	1 byte	1 byte	Hi	Lo	Hi	Lo
0xXX	0xXX	0xXX	0xXX	0x00	0x06	0xXX	0x06	0x00	0x02	0x01	0x03

2) Response

Table 10: Response packet format (0x06)

Transaction Identifier		Protocol Identifier		Length		Unit Identifier	Function	Register Address		Register Value	
byte0	byte1	byte2	byte3	byte4	byte5	byte6	byte7	byte8	byte9	byte10	byte11
Hi	Lo	Hi	Lo	Hi	Lo	1 byte	1 byte	Hi	Lo	Hi	Lo
0xXX	0xXX	0xXX	0xXX	0x00	0x08	0xXX	0x06	0x00	0x02	0x01	0x03

3) Exception Response

Table 11: Exception response packet format (0x06)

Transaction Identifier		Protocol Identifier		Length		Unit Identifier	Function	Exception Code
byte0	byte1	byte2	byte3	byte4	byte5	byte6	byte7	byte8
Hi	Lo	Hi	Lo	Hi	Lo	1 byte	1 byte	1 byte
0xXX	0xXX	0xXX	0xXX	0x00	0x03	0xXX	0x86	0xXX

Table 12: Exception code (0x06)

Exception Code	MODBUS Name	Comments
0x01	Illegal Function Code	The function code is unknown by the server
0x02	Illegal Data Address	Address specification outside the allowed range
0x03	Illegal Data value	Specified value outside the allowed range
0x04	Processing abnormality	Write protect setting
0x05	No Action	
0x0B	Timeout	The CPU specified by the unit ID does not exist.

\<Register Map>

Below is the list of Register Map. Address offset is enabled.

Note:

➢ When Faulted, the default state is: DC Disabled (PS Output Control Voltage = 700mV) and RF Disabled. The reason for the fault is listed in at Address 13, 14, 177-179.

Reset Operation
1. Send a "Fault Reset" command (Address 5) with argument = 1 if Internal Fault and 2 if External Fault
2. Send a "DC Enable" command (Address 1)
3. Send the "PS Output Control Voltage" command (Address 3 and 4) for the two PSs
4. Send the "RF Enable" command (Address 2)

➢ Warnings
When these errors are detected, the information will be listed at Address 15 and 180-190 but SSA operation continues as before the error detection.

To remove these warnings:
1. Check what causing the warning and remove or fix the error cause.
2. Send the "Fault Reset" command (Address 5) with argument = 4. SSA operation continues as before sending the reset command.

➢ Multiplier for the data read back
Multiply the data valve by the 'Multiplier' in the table below to convert the value to the units listed.

\<Table13: Register Map>

Address	Address	Description	Function	Display Range	Multiplier	Unit	Permitted Raw Value	Threshold (Lower)	Threshold (Upper)	command /status	Error Code	Error Type	Error Operation	Reset Operation
1	0x0001	DC Enable/Disable	0x03,06	0 or 1	n/a	n/a	0 or 1	n/a	n/a	0: Disable 1: Enable	n/a	n/a	n/a	n/a
2	0x0002	RF Enable/Disable	0x03,06	0 or 1	n/a	n/a	0 or 1	n/a	n/a	0: Disable 1: Enable	n/a	n/a	n/a	n/a
3	0x0003	PS Output Control Voltage1 (Powers FA1-2, corresponds with RF Input 1 and RF Output 1)	0x03,06	0 – 4095	1	mV	700 - 2620	n/a	n/a	Operation Value	n/a	n/a	n/a	n/a
4	0x0004	PS Output Control Voltage2 (Powers FA3-4, corresponds with RF Input 2 and RF Output 2)	0x03,06	0 – 4095	1	mV	700 - 2620	n/a	n/a	Operation Value	n/a	n/a	n/a	n/a
5	0x0005	Fault Reset	0x06	1	n/a	n/a	1, 2, 4	n/a	n/a	1: Internal 2: External 4: Warning	n/a	n/a	n/a	n/a
6	0x0006	X-Port Reboot	0x06	1	n/a	n/a	1	n/a	n/a	1: Reboot	n/a	n/a	n/a	n/a

Address	Address	Description	Function	Display Range	Multiplier	Unit	Permitted Raw Value	Threshold (Lower)	Threshold (Upper)	command /status	Error Code	Error Type	Error Operation	Reset Operation
7	0x0007	System Reboot	0x06	1	n/a	n/a	1	n/a	n/a	1: Reboot	n/a	n/a	n/a	n/a
9	0x0009	-	-	-	-	-	-	-	-	-	-	-	-	-
10	0x000a	Fault Sum (Internal and External)	0x03	0 - 33	n/a	n/a	Read only	n/a	n/a	0: No Fault	n/a	n/a	n/a	n/a
11	0x000b	Warning Sum	0x03	0 - 96	n/a	n/a	Read only	n/a	n/a	0: No Warning	n/a	n/a	n/a	n/a
12	0x000c													
13	0x000d	Internal Fault Error Code (This code Indicates the first Fault that occurred.)	0x03	0 or 31 - 580	n/a	n/a	Read only	n/a	n/a	0: No Error 31 - 590: Error	See Error code list	Internal	DC: Disable RF: Disable	Default
14	0x000e	External Fault Error Code (This code Indicates the first Fault that occurred.)	0x03	0 or 511 - 525	n/a	n/a	Read only	n/a	n/a	0: No Error 511 - 525: Error (Bit)	Fault1: 511 Fault2: 512 Fault3: 514 Fault4: 518	External	DC: Disable RF: Disable	Default
15	0x000f	Warning Code (This code Indicates the last Warning that occurred.)	0x03	0 or 1 - 552	n/a	n/a	Read only	n/a	n/a	0: No Error 1 - 552: Error	See Error code list	Warning	Notification Only	Remove Cause
16	0x0010	Input Drive Power1	0x03	0 - 3300	1	mV	Read only	0mV	2500mV	Operation Value	501	Internal	DC: Disable RF: Disable	Default
17	0x0011	Forward Power1	0x03	0 – 1200	1	W	Read only	0W	990W	Operation Value	502	Internal	DC: Disable RF: Disable	Default
18	0x0012	Reflected Power1	0x03	0 - 1200	1	W	Read only	0W	50W	Operation Value	503	Internal	DC: Disable RF: Disable	Default
19	0x0013	Input Drive Power2	0x03	0 - 3300	1	mV	Read only	0mV	2500mV	Operation Value	504	Internal	DC: Disable RF: Disable	Default
20	0x0014	Forward Power2	0x03	0 - 1200	1	W	Read only	0W	990W	Operation Value	505	Internal	DC: Disable RF: Disable	Default
21	0x0015	Reflected Power2	0x03	0 - 1200	1	W	Read only	0W	50W	Operation Value	506	Internal	DC: Disable RF: Disable	Default
22	0x0016	Pre AMP Current1	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	507	Warning	Notification Only	Remove Cause
23	0x0017	Pre AMP Current2	0x03	0 -10.0	0.1	A	Read only	0A	+4.0A	Operation Value	508	Warning	Notification Only	Remove Cause
24	0x0018	Power Supply +12Voltage	0x03	0 - 14.0	0.1	V	Read only	+10.0V	+14.0V	Operation Value	509	Internal	DC/RF Disable	Default
25	0x0019	Power Supply -12Voltage	0x03	0 - 14.0	0.1	V	Read only	-10.0V	-14.0V	Operation Value	510	Internal	DC/RF Disable	Default

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Address	Address	Description	Function	Display Range	Multiplier	Unit	Permitted Raw Value	Threshold (Lower)	Threshold (Upper)	command /status	Error Code	Error Type	Error Operation	Reset Operation
26	0x001a	Control Unit Air Temperature	0x03	0 - 125.0	0.1	degC	Read only	+10.0degC	+60.0degC	Operation Value	541	Internal	DC: Disable RF: Disable	Default
27	0x001b	Thermostat Status	0x03	0 or 1	n/a	n/a	Read only	n/a	n/a	0: OK 1: Alarm	542	Internal	DC: Disable RF: Disable	Default
28	0x001c	Water Leak Status	0x03	0 or 1	n/a	n/a	Read only	n/a	n/a	0: OK 1: Alarm	531	Internal	DC: Disable RF: Disable	Default
29	0x001d	Control Unit Fan Speed	0x03	0 - 12000	1	rpm	Ready only	6300rpm	11700rpm	Operation Value	551	Warning	Notification Only	Remove Cause
30	0x001e	Pre AMP Fan Rotation Speed	0x03	0 - 12000	1	rpm	Ready only	6300rpm	11700rpm	Operation Value	552	Warning	Notification Only	Remove Cause
31	0x001f	Power Supply +24Voltage	0x03	0 – 26.0	0.1	V	Read only	+22.0V	+26.0V	Operation Value	521	Internal	DC/RF Disable	Default
32	0x0020	FA1 Current1	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	101	Warning	Notification Only	Remove Cause
33	0x0021	FA1 Current2	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	102	Warning	Notification Only	Remove Cause
34	0x0022	FA1 Current3	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	103	Warning	Notification Only	Remove Cause
35	0x0023	FA1 Current4	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	104	Warning	Notification Only	Remove Cause
36	0x0024	FA1 Current5	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	105	Warning	Notification Only	Remove Cause
37	0x0025	FA1 Current6	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	106	Warning	Notification Only	Remove Cause
38	0x0026	FA1 Current7	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	107	Warning	Notification Only	Remove Cause
39	0x0027	FA1 Current8	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	108	Warning	Notification Only	Remove Cause
40	0x0028	FA1 Current9	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	109	Warning	Notification Only	Remove Cause
41	0x0029	FA1 Current10	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	110	Warning	Notification Only	Remove Cause
42	0x002a	FA1 Drive Amp Current	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	111	Warning	Notification Only	Remove Cause
43	0x002b	FA1 Module Power1	0x03	0 - 200	1	W	Read only	0W	150W	Operation Value	121	Warning	Notification Only	Remove Cause
44	0x002c	FA1 Module Power2	0x03	0 - 200	1	W	Read only	0W	150W	Operation Value	122	Warning	Notification Only	Remove Cause

Address	Address	Description	Function	Display Range	Multiplier	Unit	Permitted Raw Value	Threshold (Lower)	Threshold (Upper)	command /status	Error Code	Error Type	Error Operation	Reset Operation
45	0x002d	FA1 Module Power3	0x03	0 - 200	1	W	Read only	0W	150W	Operation Value	123	Warning	Notification Only	Remove Cause
46	0x002e	FA1 Module Power4	0x03	0 - 200	1	W	Read only	0W	150W	Operation Value	124	Warning	Notification Only	Remove Cause
47	0x002f	FA1 Module Power5	0x03	0 - 200	1	W	Read only	0W	150W	Operation Value	125	Warning	Notification Only	Remove Cause
48	0x0030	FA1 Power Supply Voltage1	0x03	0 - 100.0	0.1	V	Read only	+10.0V	+50.0V	Operation Value	131	Warning	Notification Only	Remove Cause
49	0x0031	FA1 Power Supply Voltage2	0x03	0 - 100.0	0.1	V	Read only	+10.0V	+50.0V	Operation Value	132	Warning	Notification Only	Remove Cause
50	0x0032	FA1 Heat Sink Temperature	0x03	0 - 125.0	0.1	degC	Read only	+10.0degC	+60.0degC	Operation Value	141 or 142	Internal	DC: Disable RF: Disable	Default
51	0x0033	FA1 Fan Rotation Speed	0x03	0 - 12000	1	rpm	Read only	5250rpm	9750rpm	Operation Value	151	Warning	Notification Only	Remove Cause
52	0x0034	FA2 Current1	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	201	Warning	Notification Only	Remove Cause
53	0x0035	FA2 Current2	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	202	Warning	Notification Only	Remove Cause
54	0x0036	FA2 Current3	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	203	Warning	Notification Only	Remove Cause
55	0x0037	FA2 Current4	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	204	Warning	Notification Only	Remove Cause
56	0x0038	FA2 Current5	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	205	Warning	Notification Only	Remove Cause
57	0x0039	FA2 Current6	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	206	Warning	Notification Only	Remove Cause
58	0x003a	FA2 Current7	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	207	Warning	Notification Only	Remove Cause
59	0x003b	FA2 Current8	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	208	Warning	Notification Only	Remove Cause
60	0x003c	FA2 Current9	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	209	Warning	Notification Only	Remove Cause

Address	Address	Description	Function	Display Range	Multiplier	Unit	Permitted Raw Value	Threshold (Lower)	Threshold (Upper)	command /status	Error Code	Error Type	Error Operation	Reset Operation
61	0x003d	FA2 Current10	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	210	Warning	Notification Only	Remove Cause
62	0x003e	FA2 Drive Amp Current	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	211	Warning	Notification Only	Remove Cause
63	0x003f	FA2 Module Power1	0x03	0 - 200	1	W	Read only	0W	150W	Operation Value	221	Warning	Notification Only	Remove Cause
64	0x0040	FA2 Module Power2	0x03	0 - 200	1	W	Read only	0W	150W	Operation Value	222	Warning	Notification Only	Remove Cause
65	0x0041	FA2 Module Power3	0x03	0 - 200	1	W	Read only	0W	150W	Operation Value	223	Warning	Notification Only	Remove Cause
66	0x0042	FA2 Module Power4	0x03	0 - 200	1	W	Read only	0W	150W	Operation Value	224	Warning	Notification Only	Remove Cause
67	0x0043	FA2 Module Power5	0x03	0 - 200	1	W	Read only	0W	150W	Operation Value	225	Warning	Notification Only	Remove Cause
68	0x0044	FA2 Power Supply Voltage1	0x03	0 - 100.0	0.1	V	Read only	+10.0V	+50.0V	Operation Value	231	Warning	Notification Only	Remove Cause
69	0x0045	FA2 Power Supply Voltage2	0x03	0 - 100.0	0.1	V	Read only	+10.0V	+50.0V	Operation Value	232	Warning	Notification Only	Remove Cause
70	0x0046	FA2 Heat Sink Temperature	0x03	0 - 125.0	0.1	degC	Read only	+10.0degC	+60.0degC	Operation Value	241 or 242	Internal	DC: Disable RF: Disable	Default
71	0x0047	FA2 Fan Rotation Speed	0x03	0 - 12000	1	rpm	Read only	5250rpm	9750rpm	Operation Value	251	Warning	Notification Only	Remove Cause
72	0x0048	FA3 Current1	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	301	Warning	Notification Only	Remove Cause
73	0x0049	FA3 Current2	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	302	Warning	Notification Only	Remove Cause
74	0x004a	FA3 Current3	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	303	Warning	Notification Only	Remove Cause
75	0x004b	FA2 Current4	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	304	Warning	Notification Only	Remove Cause

Address	Address	Description	Function	Display Range	Multiplier	Unit	Permitted Raw Value	Threshold (Lower)	Threshold (Upper)	command /status	Error Code	Error Type	Error Operation	Reset Operation
76	0x004c	FA3 Current5	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	305	Warning	Notification Only	Remove Cause
77	0x004d	FA3 Current6	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	306	Warning	Notification Only	Remove Cause
78	0x004e	FA3 Current7	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	307	Warning	Notification Only	Remove Cause
79	0x004f	FA3 Current8	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	308	Warning	Notification Only	Remove Cause
80	0x0050	FA3 Current9	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	309	Warning	Notification Only	Remove Cause
81	0x0051	FA3 Current10	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	310	Warning	Notification Only	Remove Cause
82	0x0052	FA3 Drive Amp Current	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	311	Warning	Notification Only	Remove Cause
83	0x0053	FA3 Module Power1	0x03	0 - 200	1	W	Read only	0W	150W	Operation Value	321	Warning	Notification Only	Remove Cause
84	0x0054	FA3 Module Power2	0x03	0 - 200	1	W	Read only	0W	150W	Operation Value	322	Warning	Notification Only	Remove Cause
85	0x0055	FA3 Module Power3	0x03	0 - 200	1	W	Read only	0W	150W	Operation Value	323	Warning	Notification Only	Remove Cause
86	0x0056	FA3 Module Power4	0x03	0 - 200	1	W	Read only	0W	150W	Operation Value	324	Warning	Notification Only	Remove Cause
87	0x0057	FA3 Module Power5	0x03	0 - 200	1	W	Read only	0W	150W	Operation Value	325	Warning	Notification Only	Remove Cause
88	0x0058	FA3 Power Supply Voltage1	0x03	0 - 100.0	0.1	V	Read only	+10.0V	+50.0V	Operation Value	331	Warning	Notification Only	Remove Cause
89	0x0059	FA3 Power Supply Voltage2	0x03	0 - 100.0	0.1	V	Read only	+10.0V	+50.0V	Operation Value	332	Warning	Notification Only	Remove Cause
90	0x005a	FA3 Heat Sink Temperature	0x03	0 - 125.0	0.1	degC	Read only	+10.0degC	+60.0degC	Operation Value	341 or 342	Internal	DC: Disable RF: Disable	Default
91	0x005b	FA3 Fan Rotation Speed	0x03	0 - 12000	1	rpm	Read only	5250rpm	9750rpm	Operation Value	151	Warning	Notification Only	Remove Cause

Address	Address	Description	Function	Display Range	Multiplier	Unit	Permitted Raw Value	Threshold (Lower)	Threshold (Upper)	command /status	Error Code	Error Type	Error Operation	Reset Operation
92	0x005c	FA4 Current1	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	401	Warning	Notification Only	Remove Cause
93	0x005d	FA4 Current2	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	402	Warning	Notification Only	Remove Cause
94	0x005e	FA4 Current3	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	403	Warning	Notification Only	Remove Cause
95	0x005f	FA4 Current4	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	404	Warning	Notification Only	Remove Cause
96	0x0060	FA4 Current5	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	405	Warning	Notification Only	Remove Cause
97	0x0061	FA4 Current6	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	406	Warning	Notification Only	Remove Cause
98	0x0062	FA4 Current7	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	407	Warning	Notification Only	Remove Cause
99	0x0063	FA4 Current8	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	408	Warning	Notification Only	Remove Cause
100	0x0064	FA4 Current9	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	409	Warning	Notification Only	Remove Cause
101	0x0065	FA4 Current10	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	410	Warning	Notification Only	Remove Cause
102	0x0066	FA4 Drive Amp Current	0x03	0 - 10.0	0.1	A	Read only	0A	+4.0A	Operation Value	411	Warning	Notification Only	Remove Cause
103	0x0067	FA4 Module Power1	0x03	0 - 200	1	W	Read only	0W	150W	Operation Value	421	Warning	Notification Only	Remove Cause
104	0x0068	FA4 Module Power2	0x03	0 - 200	1	W	Read only	0W	150W	Operation Value	422	Warning	Notification Only	Remove Cause
105	0x0069	FA4 Module Power3	0x03	0 - 200	1	W	Read only	0W	150W	Operation Value	423	Warning	Notification Only	Remove Cause
106	0x006a	FA4 Module Power4	0x03	0 - 200	1	W	Read only	0W	150W	Operation Value	424	Warning	Notification Only	Remove Cause
107	0x006b	FA4 Module Power5	0x03	0 - 200	1	W	Read only	0W	150W	Operation Value	425	Warning	Notification Only	Remove Cause
108	0x006c	FA4 Power Supply Voltage1	0x03	0 - 100.0	0.1	V	Read only	+10.0V	+50.0V	Operation Value	431	Warning	Notification Only	Remove Cause

Address	Address	Description	Function	Display Range	Multiplier	Unit	Permitted Raw Value	Threshold (Lower)	Threshold (Upper)	command /status	Error Code	Error Type	Error Operation	Reset Operation
109	0x006d	FA4 Power Supply Voltage2	0x03	0 - 100.0	0.1	V	Read only	+10.0V	+50.0V	Operation Value	432	Warning	Notification Only	Remove Cause
110	0x006e	FA4 Heat Sink Temperature	0x03	0 - 125.0	0.1	degC	Read only	+10.0degC	+60.0degC	Operation Value	441 or 442	Internal	DC: Disable RF: Disable	Default
111	0x006f	FA4 Fan Rotation Speed	0x03	0 - 12000	1	rpm	Read only	5250rpm	9750rpm	Operation Value	451	Warning	Notification Only	Remove Cause
112	0x0070	480VAC Out Status	0x03	0 - 7	n/a	n/a	Read only	bit2(L3) 0 0 0 0 1 1 1 1	bit1(L2) 0 0 1 1 0 0 1 1	bit0(L1) 0 1 0 1 0 1 0 1	480V Present L1 Loss L2 Loss L1, L2 Loss L3 Loss L1, L3 Loss L2, L3 Loss 480V OFF	No Error Internal Internal Internal Internal Internal Internal Internal	DC: Disable RF: Disable	Default
113	0x0071	PS Unit Power Supply Fault	0x03	0 - 6	1	pc(s)	Read only	n/a	n/a	Operation Value	n/a	n/a	n/a	n/a
114	0x0072	PS Unit Air Temperature	0x03	0 - 125.0	0.1	degC	Read only	+10.0degC	+60.0degC	Operation Value	004	Internal	DC: Disable RF: Disable	Default
115	0x0073	Heat Exchanger Inlet Air Temperature	0x03	0 - 125.0	0.1	degC	Read only	+10.0degC	+45.0degC	Operation Value	005	Internal	DC: Disable RF: Disable	Default
116	0x0074	Inlet LCW Temperature	0x03	0 - 70.0	0.1	degC	Read only	+22.0degC	+38.0degC	Operation Value	010	Internal	DC: Disable RF: Disable	Default
117	0x0075	Outlet LCW Temperature	0x03	0 - 70.0	0.1	degC	Read only	+22.0degC	+45.0degC	Operation Value	011	Internal	DC: Disable RF: Disable	Default
118	0x0076	Moisture	0x03	0 - 99.0	0.1	%	Read only	n/a	n/a	Operation Value	n/a	n/a	n/a	n/a
119	0x0077	Outlet LCW Flow Rate	0x03	0 - 80.0	0.1	L/min.	Read only	10.0L/min	30.0L/min	Operation Value	009	Internal	DC: Disable RF: Disable	Default

Address	Address	Description	Function	Display Range	Multiplier	Unit	Permitted Raw Value	Threshold (Lower)	Threshold (Upper)	command /status	Error Code	Error Type	Error Operation	Reset Operation
120	0x0078	PS Unit Power Supply Fault Status	0x03	0 - 63 (3F)	n/a	n/a	Read only	n/a	n/a	bt5 P.S. 6 bt4 P.S. 5 bt3 P.S. 4		>=2 Fault 1 Warning 0 No Error	Fault if 2 or more PSs fail, Warning if only 1 fails	Remove Cause
										bt2 P.S. 3 bt1 P.S. 2 bt0 P.S. 1		>=2 Fault 1 Warning 0 No Error		
121	0x0079	Heat Exchanger Unit Fan1 Rotation Speed	0x03	0 - 12000	1	rpm	Read only	6300rpm	11700rpm	Operation Value	031	Warning	Notification Only	Remove Cause
122	0x007a	Heat Exchanger Unit Fan2 Rotation Speed	0x03	0 - 12000	1	rpm	Read only	6300rpm	11700rpm	Operation Value	032	Warning	Notification Only	Remove Cause
123	0x007b	Heat Exchanger Unit Fan3 Rotation Speed	0x03	0 - 12000	1	rpm	Read only	6300rpm	11700rpm	Operation Value	033	Warning	Notification Only	Remove Cause
124	0x007c	Heat Exchanger Unit Fan4 Rotation Speed	0x03	0 - 12000	1	rpm	Read only	6300rpm	11700rpm	Operation Value	034	Warning	Notification Only	Remove Cause
125	0x007d	PS Unit Fan1 Rotation Speed	0x03	0 - 12000	1	rpm	Read only	5250rpm	9750rpm	Operation Value	035	Warning	Notification Only	Remove Cause
126	0x007e	PS Unit Fan2 Rotation Speed	0x03	0 - 12000	1	rpm	Read only	5250rpm	9750rpm	Operation Value	036	Warning	Notification Only	Remove Cause
127	0x007f	PS Unit Fan3 Rotation Speed	0x03	0 - 12000	1	rpm	Read only	2590rpm	4810rpm	Operation Value	037	Warning	Notification Only	Remove Cause
128	0x0080	Year for Calendar	0x03,06	15 - 99	1	Year	15 - 99	n/a	n/a	Operation Value	n/a	n/a	n/a	n/a
129	0x0081	Month for Calendar	0x03,06	1 - 12	1	Month	1 - 12	n/a	n/a	Operation Value	n/a	n/a	n/a	n/a
130	0x0082	Date for Calendar	0x03,06	1 - 31	1	Date	1 - 31	n/a	n/a	Operation Value	n/a	n/a	n/a	n/a
131	0x0083	Hour for Calendar	0x03,06	0 - 23	1	Hour	0 - 23	n/a	n/a	Operation Value	n/a	n/a	n/a	n/a
132	0x0084	Minute for Calendar	0x03,06	0 - 59	1	Minute	0 - 59	n/a	n/a	Operation Value	n/a	n/a	n/a	n/a
133	0x0085	Main Software Version Number	0x03	n/a	XXX	Version	Read only	n/a	n/a	Operation Value	n/a	n/a	n/a	n/a

Address	Address	Description	Function	Display Range	Multiplier	Unit	Permitted Raw Value	Threshold (Lower)	Threshold (Upper)	command /status	Error Code	Error Type	Error Operation	Reset Operation
134	0x0086	Main Software Revision Number	0x03	n/a	XXX	Number	Read only	n/a	n/a	Operation Value	n/a	n/a	n/a	n/a
135	0x0087	SD Software Version	0x03	n/a	XXX	Version	Read only	n/a	n/a	Operation Value	n/a	n/a	n/a	n/a
136	0x0088	SD Software Revision Number	0x03	n/a	XXX	Number	Read only	n/a	n/a	Operation Value	n/a	n/a	n/a	n/a
137	0x0089	Sub Software Version	0x03	n/a	XXX	Version	Read only	n/a	n/a	Operation Value	n/a	n/a	n/a	n/a
138	0x008a	Sub Software Revision Number	0x03	n/a	XXX	Number	Read only	n/a	n/a	Operation Value	n/a	n/a	n/a	n/a
139	0x008b	PS Software Version	0x03	n/a	XXX	Version	Read only	n/a	n/a	Operation Value	n/a	n/a	n/a	n/a
140	0x008c	PS Software Revision Number	0x03	n/a	XXX	Number	Read only	n/a	n/a	Operation Value	n/a	n/a	n/a	n/a
141	0x008d													
142	0x008e													
143	0x008f	PS Output Control Voltage Upper Limit	0x03,06	0 - 2620	1	mV	Read Write	n/a	2620mV	Operation Value	n/a	n/a	n/a	n/a
144	0x0090	Input Drive Power Upper Limit	0x03,06	0 - 3300	1	mV	Read Write	n/a	2500mV	Operation Value	n/a	n/a	n/a	n/a
145	0x0091	Forward Power Upper Limit	0x03,06	0 – 1200	1	W	Read Write	n/a	990W	Operation Value	n/a	n/a	n/a	n/a
146	0x0092	Reflected Power Upper Limit	0x03,06	0 - 1200	1	W	Read Write	n/a	50W	Operation Value	n/a	n/a	n/a	n/a
147	0x0093	Air or Heatsink Temperature Upper Limit	0x03,06	0 - 125.0	0.1	degC	Read Write	n/a	+60.0degC	Operation Value	n/a	n/a		n/a
148	0x0094	Air or Heatsink Temperature Lower Limit	0x03,06	0 - 125.0	0.1	degC	Read Write	+10.0degC	n/a	Operation Value	n/a	n/a	n/a	n/a
149	0x0095	Heat Exchanger Inlet Air Temperature Upper Limit	0x03,06	0 - 125.0	0.1	degC	Read Write	n/a	+45.0degC	Operation Value	n/a	n/a	n/a	n/a
150	0x0096	Heat Exchanger Inlet Air Temperature Lower Limit	0x03,06	0 - 125.0	0.1	degC	Read Write	+10.0degC	n/a	Operation Value	n/a	n/a	n/a	n/a
151	0x0097	Outlet LCW Flow Upper Limit	0x03,06	0 - 80.0	0.1	L/min.	Read Write	n/a	30.0L/min	Operation Value	n/a	n/a	n/a	n/a
152	0x0098	Outlet LCW Flow Lower Lim	0x03,06	0 - 80.0	0.1	L/min.	Read Write	10.0L/min	n/a	Operation Value	n/a	n/a	n/a	n/a
153	0x0099	Inlet LCW Temperature Upper Limit	0x03,06	0 - 70.0	0.1	degC	Read Write	n/a	+38.0degC	Operation Value	n/a	n/a	n/a	n/a
154	0x009a	Inlet LCW Temperature Lower Limit	0x03,06	0 - 70.0	0.1	degC	Read Write	+22.0degC	n/a	Operation Value	n/a	n/a	n/a	n/a

Address	Address	Description	Function	Display Range	Multiplier	Unit	Permitted Raw Value	Threshold (Lower)	Threshold (Upper)	command /status	Error Code	Error Type	Error Operation	Reset Operation
155	0x009b	Outlet LCW Temperature Upper Limit	0x03,06	0 - 70.0	0.1	degC	Read Write	n/a	+45.0degC	Operation Value	n/a	n/a	n/a	n/a
156	0x009c	Outlet LCW Temperature Lower Limit	0x03,06	0 - 70.0	0.1	degC	Read Write	+22.0degC	n/a	Operation Value	n/a	n/a	n/a	n/a
157	0x009d	Current Upper Limit	0x03,06	0 - 20.0	0.1	A	Read Write	n/a	+4.0A	Operation Value	n/a	n/a	n/a	n/a
158	0x009e	Module Power Upper Limit	0x03,06	0 - 900	1	W	Read Write	n/a	150W	Operation Value	n/a	n/a	n/a	n/a
159	0x009f	FA Power Supply Voltage Upper Limit	0x03,06	0 - 100.0	0.1	V	Read Write	n/a	+48.0V	Operation Value	n/a	n/a	n/a	n/a
160	0x00a0	FA Power Supply Voltage Lower Limit	0x03,06	0 - 100.0	0.1	V	Read Write	+10.0V	n/a	Operation Value	n/a	n/a	n/a	n/a
161	0x00a1	+12V Power Supply Voltage Upper Limit	0x03,06	0 - 100.0	0.1	V	Read Write	n/a	+14.0V	Operation Value	n/a	n/a	n/a	n/a
162	0x00a2	+12V Power Supply Voltage Lower Limit	0x03,06	0 - 100.0	0.1	V	Read Write	+10.0V	n/a	Operation Value	n/a	n/a	n/a	n/a
163	0x00a3	-12V Power Supply Voltage Upper Limit	0x03,06	0 - 100.0	0.1	V	Read Write	n/a	-14.0V	Operation Value	n/a	n/a	n/a	n/a
164	0x00a4	-12V Power Supply Voltage Lower Limit	0x03,06	0 - 100.0	0.1	V	Read Write	-10.0V	n/a	Operation Value	n/a	n/a	n/a	n/a
165	0x00a5	Fan1 Rotation Speed Upper Limit	0x03,06	0 - 12000	1	rpm	Read Write	n/a	11700rpm	Operation Value	n/a	n/a	n/a	n/a
166	0x00a6	Fan1 Rotation Speed Lower Limit	0x03,06	0 - 12000	1	rpm	Read Write	6300rpm	n/a	Operation Value	n/a	n/a	n/a	n/a
167	0x00a7	Fan2 Rotation Speed Upper Limit	0x03,06	0 - 12000	1	rpm	Read Write	n/a	9750rpm	Operation Value	n/a	n/a	n/a	n/a
168	0x00a8	Fan2 Rotation Speed Lower Limit	0x03,06	0 - 12000	1	rpm	Read Write	5250rpm	n/a	Operation Value	n/a	n/a	n/a	n/a
169	0x00a9	Fan3 Rotation Speed Upper Limit	0x03,06	0 - 12000	1	rpm	Read Write	n/a	4810rpm	Operation Value	n/a	n/a	n/a	n/a

Address	Address	Description	Function	Display Range	Multiplier	Unit	Permitted Raw Value	Threshold (Lower)	Threshold (Upper)	command /status	Error Code	Error Type	Error Operation	Reset Operation
170	0x00aa	Fan3 Rotation Speed Lower Limit	0x03,06	0 - 12000	1	rpm	Read Write	2590rpm	n/a	Operation Value	n/a	n/a	n/a	n/a
171	0x00ab	Last RF Disable Year/Month	0x03	17-99/1-12	1	n/a	Read Only	n/a	n/a	Operation Value	n/a	n/a	n/a	n/a
172	0x00ac	Last RF Disable Date/Hour	0x03	1-31/0-23	1	n/a	Read Only	n/a	n/a	Operation Value	n/a	n/a	n/a	n/a
173	0x00ad	Last RF Disable Minute/Second	0x03	0-59/0-59	1	n/a	Read Only	n/a	n/a	Operation Value	n/a	n/a	n/a	n/a
174	0x00ae	Last Reboot Year/Month	0x03	17-99/1-12	1	n/a	Read Only	n/a	n/a	Operation Value	n/a	n/a	n/a	n/a
175	0x00af	Last Reboot Date/Hour	0x03	1-31/0-23	1	n/a	Read Only	n/a	n/a	Operation Value	n/a	n/a	n/a	n/a
176	0x00b0	Last Reboot Minute/Second	0x03	0-59/0-59	1	n/a	Read Only	n/a	n/a	Operation Value	n/a	n/a	n/a	n/a

Address	Address	Description	Function	Display Range	Multiplier	Unit	Permitted Raw Value	Threshold (Lower)	Threshold (Upper)	command /status	Error Code	Error Type	Error Operation	Reset Operation
177	0x00b1	Fault Status1	0 x 03	n/a	n/a	n/a	n/a	n/a	bit15- bit14 bit13 bit12 bit11 bit10 bit9 bit8 bit7 bit6 bit5 bit4 bit3 bit2 bit1 bit0	0 0 External Fault4 External Fault3 External Fault2 External Fault1 Water Leak Thermostat 0 Control Unit Temperature ReflectedPower2 Forward Power2 Input Power2 Reflected Power1 Forward Power1 Input Power1	Fault	RF/DC Disable	Default

Address	Address	Description	Function	Display Range	Multiplier	Unit	Permitted Raw Value	Threshold (Lower)	Threshold (Upper)	command /status	Error Code	Error Type	Error Operation
178	0x00b2	Fault Status2	n/a 0x03	n/a	n/a	n/a	n/a	n/a	bit15 bit14 bit13 bit12 bit11 bit10 bit9 bit8 bit7 bit6 bit5 bit4 bit3 bit2 bit1 bit0	0 FA5 Temperature FA4 Temperature FA3 Temperature FA2 Temperature FA1 Temperature Outlet LCW Flow Outlet LCW Temperature 0 Inlet LCW Temperature Heat Exchanger Temperature PS Temperature Power Supply Fault AC480V Phase Loss(L1) AC480V Phase Loss(L2) AC480V Phase Loss(L3)	Fault	RF/DC Disable	Default

Address	Address	Description	Function	Display Range	Multiplier	Unit	Permitted Raw Value	Threshold (Lower)	Threshold (Upper)	command /status		Error Code	Error Type	Error Operation
179	0x00b3	Fault Status3	0x03	n/a	n/a	n/a	n/a	n/a	bit15	0		fault	RF/DC Disable	Default
									bit14	0				
									bit13	0				
									bit12	0				
									bit11	0				
									bit10	0				
									bit9	0				
									bit8	0				
									bit7	0				
									bit6	0				
									bit5	0				
									bit4	0				
									bit3	0				
									bit2	+24Voltage				
									bit1	-12Voltage				
									bit0	+12Voltage				

Address	Address	Description	Function	Display Range	Multiplier	Unit	Permitted Raw Value	Threshold (Lower)	Threshold (Upper)	command /status		Error Code	Error Type	Error Operation
180	0x00b4	Warning, Control Unit	n/a 0x03	n/a	n/a	n/a	n/a	n/a	bit15	0		Warning	Notification Only	Remove Cause
									bit14	0				
									bit13	0				
									bit12	0				
									bit11	0				
									bit10	0				
									bit9	Pre Amp Fan Speed				
									bit8	Control Unit Fan Speed				
									bit7	0				
									bit6	0				
									bit5	0				
									bit4	0				
									bit3	0				
									bit2	0				
									bit1	Pre Amp Current2				
									bit0	Pre Amp Current1				

Address	Address	Description	Function	Display Range	Multiplier	Unit	Permitted Raw Value	Threshold (Lower)	Threshold (Upper)	command /status		Error Code	Error Type	Error Operation
181	0x00b5	Warning, FA1-1	n/a 0x03	n/a	n/a	n/a	n/a	n/a	bit15	0		Warning	Notification Only	Remove Cause
									bit14	0				
									bit13	0				
									bit12	0				
									bit11	FA1 Drive Amp Current				
									bit10	FA1 Current10				
									bit9	FA1 Current9				
									bit8	FA1 Current8				
									bit7	0				
									bit6	FA1 Current7				
									bit5	FA1 Current6				
									bit4	FA1 Current5				
									bit3	FA1 Current4				
									bit2	FA1 Current3				
									bit1	FA1 Current2				
									bit0	FA1 Current1				

Address	Address	Description	Function	Display Range	Multiplier	Unit	Permitted Raw Value	Threshold (Lower)	Threshold (Upper)	command /status		Error Code	Error Type	Error Operation
182	0x00b6	Warning, FA1-2	n/a 0x03	n/a	n/a	n/a	n/a	n/a	bit15	0		Warning	Notification Only	Remove Cause
									bit14	0				
									bit13	0				
									bit12	0				
									bit11	0				
									bit10	0				
									bit9	0				
									bit8	FA1 Fan Speed				
									bit7	0				
									bit6	FA1 Voltage1				
									bit5	FA1 Voltage2				
									bit4	FA1-Module Power5				
									bit3	FA1 Module Power4				
									bit2	FA1 Module Power3				
									bit1	FA1 Module Power2				
									bit0	FA1 Module Power1				

Address	Address	Description	Function	Display Range	Multiplier	Unit	Permitted Raw Value	Threshold (Lower)	Threshold (Upper)		command /status	Error Code	Error Type	Error Operation
183	0x00b7	Warning, FA2-1	n/a 0x03	n/a	n/a	n/a	n/a	n/a	bit15	0	Warning	Notification Only	Remove Cause
									bit14	0			
									bit13	0			
									bit12	0			
									bit11	FA2 Drive Amp Current			
									bit10	FA2 Current10			
									bit9	FA2 Current9			
									bit8	FA2 Current8			
									bit7	0			
									bit6	FA2 Current7			
									bit5	FA2 Current6			
									bit4	FA2 Current5			
									bit3	FA2 Current4			
									bit2	FA2 Current3			
									bit1	FA2 Current2			
									bit0	FA2 Current1			

Address	Address	Description	Function	Display Range	Multiplier	Unit	Permitted Raw Value	Threshold (Lower)	Threshold (Upper)	command /status		Error Code	Error Type	Error Operation
184	0x00b8	Warning, FA2-2	n/a 0x03	n/a	n/a	n/a	n/a	n/a	bit15	0		Warning	Notification Only	Remove Cause
									bit14	0				
									bit13	0				
									bit12	0				
									bit11	0				
									bit10	0				
									bit9	0				
									bit8	FA2 Fan Speed				
									bit7	0				
									bit6	FA2 Voltage1				
									bit5	FA2 Voltage2				
									bit4	FA2-Module Power5				
									bit3	FA2 Module Power4				
									bit2	FA2 Module Power3				
									bit1	FA2 Module Power2				
									bit0	FA2 Module Power1				

Address	Address	Description	Function	Display Range	Multiplier	Unit	Permitted Raw Value	Threshold (Lower)	Threshold (Upper)	command /status		Error Code	Error Type	Error Operation
185	0x00b9	Warning, FA3-1	n/a 0x03	n/a	n/a	n/a	n/a	n/a	bit15	0		Warning	Notification Only	Remove Cause
									bit14	0				
									bit13	0				
									bit12	0				
									bit11	FA3 Drive Amp Current				
									bit10	FA3 Current10				
									bit9	FA3 Current9				
									bit8	FA3 Current8				
									bit7	0				
									bit6	FA3 Current7				
									bit5	FA3 Current6				
									bit4	FA3 Current5				
									bit3	FA3 Current4				
									bit2	FA3 Current3				
									bit1	FA3 Current2				
									bit0	FA3 Current1				

Address	Address	Description	Function	Display Range	Multiplier	Unit	Permitted Raw Value	Threshold (Lower)	Threshold (Upper)	command /status		Error Code	Error Type	Error Operation
186	0x00ba	Warning, FA3-2	n/a 0x03	n/a	n/a	n/a	n/a	n/a	bit15	0		Warning	Notification Only	Remove Cause
									bit14	0				
									bit13	0				
									bit12	0				
									bit11	0				
									bit10	0				
									bit9	0				
									bit8	FA3 Fan Speed				
									bit7	0				
									bit6	FA3 Voltage1				
									bit5	FA3 Voltage2				
									bit4	FA3-Module Power5				
									bit3	FA3 Module Power4				
									bit2	FA3 Module Power3				
									bit1	FA3 Module Power2				
									bit0	FA3 Module Power1				

Address	Address	Description	Function	Display Range	Multiplier	Unit	Permitted Raw Value	Threshold (Lower)	Threshold (Upper)	command /status		Error Code	Error Type	Error Operation
187	0x00bb	Warning, FA4-1	n/a 0x03	n/a	n/a	n/a	n/a	n/a	bit15	0		Warning	Notification Only	Remove Cause
									bit14	0				
									bit13	0				
									bit12	0				
									bit11	FA4 Drive Amp Current				
									bit10	FA4 Current10				
									bit9	FA4 Current9				
									bit8	FA4 Current8				
									bit7	0				
									bit6	FA4 Current7				
									bit5	FA4 Current6				
									bit4	FA4 Current5				
									bit3	FA4 Current4				
									bit2	FA4 Current3				
									bit1	FA4 Current2				
									bit0	FA4 Current1				

Address	Address	Description	Function	Display Range	Multiplier	Unit	Permitted Raw Value	Threshold (Lower)	Threshold (Upper)	command /status		Error Code	Error Type	Error Operation
188	0x00bc	Warning, FA4-2	n/a 0x03	n/a	n/a	n/a	n/a	n/a	bit15	0		Warning	Notification Only	Remove Cause
									bit14	0				
									bit13	0				
									bit12	0				
									bit11	0				
									bit10	0				
									bit9	0				
									bit8	FA4 Fan Speed				
									bit7	0				
									bit6	FA4 Voltage1				
									bit5	FA4 Voltage2				
									bit4	FA4-Module Power5				
									bit3	FA4 Module Power4				
									bit2	FA4 Module Power3				
									bit1	FA4 Module Power2				
									bit0	FA4 Module Power1				
189	0x00bd	Warning, PS 1	n/a 0x03	n/a	n/a	n/a	n/a	n/a	bit15	0		Warning	Notification Only	Remove Cause
									bit14	0				
									bit13	0				
									bit12	0				
									bit11	0				
									bit10	0				
									bit9	0				
									bit8	0				
									bit7	0				
									bit6	0				
									bit5	Power Supply6				
									bit4	Power Supply5				
									bit3	Power Supply4				
									bit2	Power Supply3				
									bit1	Power Supply2				
									bit0	Power Supply1				

Address	Address	Description	Function	Display Range	Multiplier	Unit	Permitted Raw Value	Threshold (Lower)	Threshold (Upper)	command /status		Error Code	Error Type	Error Operation
190	0x00be	Warning, PS 2	n/a 0x03	n/a	n/a	n/a	n/a	n/a	n/a	bit15	0	Warning	Notification Only	Remove Cause
										bit14	0			
										bit13	0			
										bit12	0			
										bit11	0			
										bit10	0			
										bit9	0			
										bit8	0			
										bit7	0			
										bit6	PS Fan3 Speed			
										bit5	PS Fan2 Speed			
										bit4	PS Fan1 Speed			
										bit3	Heat Exchanger Fan4 Speed			
										bit2	Heat Exchanger Fan3 Speed			
										bit1	Heat Exchanger Fan2 Speed			
										bit0	Heat Exchanger Fan1 Speed			

<Error code>

Below is the list of Error Code.

When you read register 13～15, the codes below are displayed if any errors have occurred.

Error Code 0: No error

●: Fault (RF Disable, DC Disable)

○: Warning

<Table14: Error Code>

Error Code	Error Name	Threshold	Internal Fault	External Fault	Warning
001	480VAC L1 Status	L1 Fault	●		
002	480VAC L2 Status	L2 Fault	●		
003	480VAC L3 Status	L3 Fault	●		
004	PS Unit Air Temperature	<10℃　or　>60℃	●		
005	Heat Exchanger Inlet Air Temperature	<10℃　or　>45℃	●		
009	Outlet LCW Flow Rate	<10L/min　or　>30L/min	●		
010	Inlet LCW Temperature	<22℃　or　>38℃	●		
011	Outlet LCW Temperature	<22℃　or　>45℃	●		
020	PS Unit Power Supply Fault Status	When more than 1 PS in either set of 3 PSs are faulted	●		
031	Heat Exchanger Unit Fan1 Rotation Speed	<6300rpm　or　>11700rpm			○
Error Code	Error Name	Threshold	Internal Fault	External Fault	Warning
032	Heat Exchanger Unit Fan2 Rotation Speed	<6300rpm　or　>11700rpm			○
033	Heat Exchanger Unit Fan3 Rotation Speed	<6300rpm　or　>11700rpm			○
034	Heat Exchanger Unit Fan4 Rotation Speed	<6300rpm　or　>11700rpm			○
035	PS Unit Fan1 Rotation Speed	<5250rpm　or　>9750rpm			○
036	PS Unit Fan2 Rotation Speed	<5250rpm　or　>9750rpm			○
037	PS Unit Fan3 Rotation Speed	<2800rpm　or　>4810rpm			○

Error Code	Error Name	Threshold	Internal Fault	External Fault	Warning
101	FA1 Current1	>4.0A			○
102	FA1 Current2	>4.0A			○
103	FA1 Current3	>4.0A			○
104	FA1 Current4	>4.0A			○
105	FA1 Current5	>4.0A			○
106	FA1 Current6	>4.0A			○
107	FA1 Current7	>4.0A			○
108	FA1 Current8	>4.0A			○
109	FA1 Current9	>4.0A			○
110	FA1 Current10	>4.0A			○
111	FA1 Drive Amp Current	>4.0A			○
121	FA1 Module Power1	>150W			○
122	FA1 Module Power2	>150W			○
123	FA1 Module Power3	>150W			○
124	FA1 Module Power4	>150W			○
125	FA1 Module Power5	>150W			○
131	FA1 Power Supply Voltage1	<+10.0V　or　>+50.0V			○
132	FA1 Power Supply Voltage2	<+10.0V　or　>+50.0V			○
141	FA1 Heat Sink Temperature	<10.0℃　or　>60.0℃	●		
142	FA1 Thermostat		●		
151	FA1 Fan Rotation Speed	<5250rpm　or　>9750rpm			○

Error Code	Error Name	Threshold	Internal Fault	External Fault	Warning
201	FA2 Current1	>4.0A			○
202	FA2 Current2	>4.0A			○
203	FA2 Current3	>4.0A			○
204	FA2 Current4	>4.0A			○
205	FA2 Current5	>4.0A			○
206	FA2 Current6	>4.0A			○
207	FA2 Current7	>4.0A			○
208	FA2 Current8	>4.0A			○
209	FA2 Current9	>4.0A			○
210	FA2 Current10	>4.0A			○
211	FA2 Drive Amp Current	>4.0A			○
221	FA2 Module Power1	>150W			○
222	FA2 Module Power2	>150W			○
223	FA2 Module Power3	>150W			○
224	FA2 Module Power4	>150W			○
225	FA2 Module Power5	>150W			○
231	FA2 Power Supply Voltage1	<+10.0V　or　>+50.0V			○
232	FA2 Power Supply Voltage2	<+10.0V　or　>+50.0V			○
241	FA2 Heat Sink Temperature	<10.0℃　or　>60.0℃	●		
242	FA2 Thermostat		●		
251	FA2 Fan Rotation Speed	<5250rpm　or　>9750rpm			○

Error Code	Error Name	Threshold	Internal Fault	External Fault	Warning
301	FA3 Current1	>4.0A			○
302	FA3 Current2	>4.0A			○
303	FA3 Current3	>4.0A			○
304	FA3 Current4	>4.0A			○
305	FA3 Current5	>4.0A			○
306	FA3 Current6	>4.0A			○
307	FA3 Current7	>4.0A			○
308	FA3 Current8	>4.0A			○
309	FA3 Current9	>4.0A			○
310	FA3 Current10	>4.0A			○
311	FA3 Drive Amp Current	>4.0A			○
321	FA3 Module Power1	>150W			○
322	FA3 Module Power2	>150W			○
323	FA3 Module Power3	>150W			○
324	FA3 Module Power4	>150W			○
325	FA3 Module Power5	>150W			○
331	FA3 Power Supply Voltage1	<+10.0V or >+50.0V			○
332	FA3 Power Supply Voltage2	<+10.0V or >+50.0V			○
341	FA3 Heat Sink Temperature	<10.0℃ or >60.0℃	●		
342	FA3 Thermostat		●		
351	FA3 Fan Rotation Speed	<5250rpm or >9750rpm			○

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Error Code	Error Name	Threshold	Internal Fault	External Fault	Warning
401	FA4 Current1	>4.0A			○
402	FA4 Current2	>4.0A			○
403	FA4 Current3	>4.0A			○
404	FA4 Current4	>4.0A			○
405	FA4 Current5	>4.0A			○
406	FA4 Current6	>4.0A			○
407	FA4 Current7	>4.0A			○
408	FA4 Current8	>4.0A			○
409	FA4 Current9	>4.0A			○
410	FA4 Current10	>4.0A			○
411	FA4 Drive Amp Current	>4.0A			○
421	FA3 Module Power1	>150W			○
422	FA3 Module Power2	>150W			○
423	FA3 Module Power3	>150W			○
424	FA3 Module Power4	>150W			○
425	FA3 Module Power5	>150W			○
431	FA3 Power Supply Voltage1	<+10.0V　or　>+50.0V			○
432	FA3 Power Supply Voltage2	<+10.0V　or　>+50.0V			○
441	FA3 Heat Sink Temperature	<10.0℃　or　>60.0℃	●		
442	FA3 Thermostat		●		
451	FA3 Fan Rotation Speed	<5250rpm　or　>9750rpm			○

Error Code	Error Name	Threshold	Internal Fault	External Fault	Warning
501	Input Drive Power1	>2500mV	●		
502	Forward Power1	>990W	●		
503	Reflected Power1	>50W	●		
504	Input Drive Power2	>2500mV	●		
505	Forward Power2	>990W	●		
506	Reflected Power2	>50W	●		
507	Pre Amp Current1	>4A			○
508	Pre Amp Current2	>4A			○
509	+12Voltage	0 (No Error)　or　1 (Error)	●		
510	-12Voltage	0 (No Error)　or　1 (Error)	●		
511	External Fault No.1 24V Permit Line	0 (No Error)　or　511 (Error)		●	
512	External Fault No.2 24V Permit Line	0 (No Error)　or　512 (Error)		●	
514	External Fault No.3 24V Permit Line	0 (No Error)　or　514 (Error)		●	
518	External Fault No.4 24V Permit Line	0 (No Error)　or　518 (Error)		●	
521	+24Voltage	<+22V　or　>+26V	●		
531	Water Leak Status	0 (No Error)　or　1 (Error)	●		
541	Control Unit Air Temperature	<10℃　or　>60℃	●		
542	Thermostat Status	0 (No Error)　or　1 (Error)	●		
551	Control Unit Fan Rotation Speed	<6300rpm　or　>11700rpm			○
552	Pre Amp Fan Rotation Speed	<6300rpm　or　>11700rpm			○
570	120VAC OFF or Reboot	After startup of SSAs	●		
580	480VAC Status	If voltage on any of the 3 phases is out of spec	●		
590	Processor Fault	When this fault occurs in the Main CPU, RF is disabled (hard wired). When this fault occurs in any SUB CPU, RF and DC disabled	●		

2.3. RS-485 Communication

After AC120V power is input to the SSA,
①threshold data is read from MAIN PCB's EEPROM.
②Communication to synchronize clock of MAIN and SD PCB begins.
③Communication between Main and each SUB PCB begins, and threshold data is transmitted
④Main PCB submits Requirement of transmission to each SUB PCB, and collect monitored data
⑤Collected data can be confirmed via Modbus Communication, and is saved into SD card.

Description of RS-485

2.3.1. Serial Setting
Communication Setting
Check Sum is provided to prevent malfunction

Table 15: Serial Setting

Item	Value
Baud Rate	115200bps
bit number	8bit
parity	None
Stop bit number	1bit
Check Sum	2byte

2.3.2. Clock setting of SD PCB
For the time-stamp of saved data on SD card, Clock needs to be set.

① Clock data of MAIN PCB is transmitted to SD PCB

Table 16: clock data

Buffer	Item	Data Range
[0]	Year	16-99
[1]	Month	1-12
[2]	Date	1-31
[3]	Week	0-6
[4]	Hour	0-23
[5]	Minute	0-59
[6]	Second	0-59

②According to received data, SD PCBs synchronize their clocks inside of CPU
③Synchronized clock data is transferred to MAIN PCB.
④MAIN PCB compares received data and own ① data. When deviation is less than 1 min., OK command is submitted to SD PCB.
Clock setting is completed as above.
⑤In the case deviation of MAIN PCB clock and SUB PCB is longer than 1 min., whole flow from ①to④ is repeated.
When setting is still not OK with repeating this flow two times, clock setting is finished

2.3.3. Transmitting Threshold Data

Main CPU reads EEPROM's threshold data and save to eep_buff[0][0] – eep_buff[0][27]
Threshold data of each Unit is as below table.

Table 17: PS Unit Threshold Data

Item	Threshold
Temperature Upper limit	<600
Temperature Lower limit	>100
Heat Exchanger Temperature Upper limit	<450
Heat Exchanger Temperature Lower limit	>100
Outlet LCW Flow Rate Upper limit	<300
Outlet LCW Flow Rate Lower limit	>100
Inlet LCW Temperature Upper limit	<380
Inlet LCW Temperature Lower limit	>220
Outlet LCW Temperature Upper limit	<450
Outlet LCW Temperature Lower limit	>220
Fan type1 Speed Upper limit	<11700
Fan type1 Speed Lower limit	>6300
Fan type2 Speed Upper limit	<9750
Fan type2 Speed Lower limit	>5250
Fan type3 Speed Upper limit	<4810
Fan type3 Speed Lower limit	>2590

Table 18:FA Unit1 Threshold Data

Item	Threshold
Current Upper limit	<40
Forward Power Upper limit	<150
Voltage1 Upper limit	<500
Voltage1 Lower limit	>100
Temperature Upper limit	<600
Temperature Lower limit	>100
Fan type2 Speed Upper limit	<9750
Fan type2 Speed Lower limit	>5250

Table 19:FA Unit2 Threshold Data

Item	Threshold
Current Upper limit	<40
Forward Power Upper limit	<150
Voltage1 Upper limit	<500
Voltage1 Lower limit	>100
Temperature Upper limit	<600
Temperature Lower limit	>100
Fan type2 Speed Upper limit	<9750
Fan type2 Speed Lower limit	>5250

Table 20：FA Unit3 Threshold Data

Item	Threshold
Current Upper limit	<40
Forward Power Upper limit	<150
Voltage1 Upper limit	<500
Voltage1 Lower limit	>100
Temperature Upper limit	<600
Temperature Lower limit	>100
Fan type2 Speed Upper limit	<9750
Fan type2 Speed Lower limit	>5250

Table 21:FA Unit4　Threshold Data

Item	Threshold
Current Upper limit	<40
Forward Power Upper limit	<150
Voltage1 Upper limit	<500
Voltage1 Lower limit	>100
Temperature Upper limit	<600
Temperature Lower limit	>100
Fan type2 Speed Upper limit	<9750
Fan type2 Speed Lower limit	>5250

Table 22:Control Unit Threshold Data

Item	Threshold
PS Control Voltage Upper limit	<2520
Input Power Upper limit	<2500
Forward Power Upper limit	<900
Reflected Power Upper limit	<50
Pre Amp Current Upper limit	<40
+12Voltage Upper limit	<140
+12Voltage Lower limit	>100
-12Voltage Upper limit	<140
-12Voltage Lower limit	>100
Temperature Upper limit	<600
Temperature Lower limit	>100
Fan type1 Speed Upper limit	<11700
Fan type1 Speed Lower limit	>6300

Above process is done in the initialization process of MAIN CPU.

MAIN PCB becomes Master, and submit transmission request to each SUB PCB and PS PCB (Slave).

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Procedure and format of transmission request is as following.

＜Procedure＞

①Confirm Hand Shake Line is High

②Set Hand Shake Line to Low

③Submit 0xff（command of Transmission start）

④Submit 0xa0

⑤Transfer threshold data of PS

⑥Set Hand Shake Line to High

⑦After receiving 0xff from PS, Main CPU wait until receiving 0xb0.

⑧Confirm Hand Shake Line is High

⑨Set Hand Shake Line to Low

⑩Submit 0xff

⑪Submit 0xb1

⑫Transfer threshold data of FA1

⑬Set Hand Shake Line to High

⑭After receiv0ing 0xff from FA1, Main CPU wait until receiving 0xb1.

⑮As similar as above, FA2, FA3, and FA4 transfer their threshold data.

Table 23: Format

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Transmission Start				Address of each PCB			
1	0	1	0				
Response of Reception				0	0	0	1
1	0	1	1				

Table 24: Transmission / Reception Code

Unit	Address Value	Transmission Code	Reception Code
FA Unit1	1	0 x a1	0xb1
FA Unit2	2	0 x a2	0xb2
FA Unit3	3	0 x a3	0xb3
FA Unit4	4	0 x a4	0xb4
PS Unit	0	0 x a0	0xb0

2.3.4. Monitoring System

2.3.4.1. Measurement

RF, Current, Temperature, Flow Rate, Humidity and more monitored contents are converted to voltage and read by A/D Converter in Voltage. The rotation speed of FAN is calculated by monitoring the period of the pulse signal. Other High / Low signals such as thermostat and water leakage are monitored as they are. After power supplied, these monitored items will be periodically monitored without interruption. The measured data will be averaged and sent to the Main PCB.

2.3.4.2. Transmission request by Control Unit (MAIN PCB)

MAIN PCB becomes Master, and submits transmission requests to each SUB PCB and PS PCB (Slave).

Procedure and format of transmission request is as following.

＜Procedure＞

①Confirm Hand Shake Line is High

②Set Hand Shake Line to Low

③Submit 0xff（command of Transmission start）

④Submit 0x40 ＋ address（When address is 1: 0x41）

⑤Set Hand Shake Line to High

Table 25: Format >

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Transmission request		spare		Address of each PCB			
0	1	0	0	0	0	0	1

Table 26: Transmission Code

Unit	Address Value	Transmission Code
FA Unit1	1	0 x 41
FA Unit2	2	0 x 42
FA Unit3	3	0 x 43
FA Unit4	4	0 x 44
PS Unit	0	0 x 40

2.3.4.3. Response by each Unit

A unit received transmission request replies Response of Transmission and its data.

Procedure and format of Response of Transmission is as following.

＜Procedure＞

①Confirm Hand Shake Line is High

②Set Hand Shake Line to Low

③Submit 0xff（command of Transmission start）

④Submit 0x80 ＋ address（When address is 1: 0x81）

⑤After that, transmit 8 bit data to 44 byte (22 data) and transmit 2 byte Check Sum at the end.

⑥Set Hand Shake Line to High

Table 27: Format>

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Response of Transmission		Spare		Address of each PCB			
1	0	0	0	0	0	0	1

Table 28: Transmission Code

Unit	Address Value	Transmission Code
FA Unit1	1	0 x 81
FA Unit2	2	0 x 82
FA Unit3	3	0 x 83
FA Unit4	4	0 x 84
PS Unit	0	0 x 80

When an Internal or External Fault occurs,

① The four 24V indicators are set to zero volts

② RF is disabled.

③ RF Enable LED is turned off.

④ Control voltage setting values of Switching Power Supplies is changed to 700.

⑤ DC is disabled for both supplies.

⑥ DC Enable LED is turned off.

⑦ Internal or External Fault LED is turned on.

⑧ An Error Code is listed in the registers (see Table 14 for a list of Error Codes)

⑨ Fault Status bits are set in the registers

⑩ These faults can be reset via a Modbus command.

Table 31:   Processor Fault

Item	Description	Error Code
Processor Fault	・When Main CPU Faults, Watch Dog output is latched, and its signal turns RF OFF by hard wire and lights up Processor Fault LED ・When SUB CPU Faults, Main CPU causes Internal Fault and lights up Processor Fault and Internal Fault LEDs	590

＜FA1 Unit＞
Monitoring points are Current (11 points), Detection Output (5 points), Voltage (2 points), Temperature (1 point), and FAN Speed (1 point).

Table 32: FA1 Monitoring Item

Data No.	FA1 Unit	Measurement Frequency		Lower Limit	Upper Limit	Error Code
0	FA1 Current1	1ms	ADC	0A	4.0A	101/Warning
1	FA1 Current2	1ms	ADC	0A	4.0A	102/Warning
2	FA1 Current3	1ms	ADC	0A	4.0A	103/Warning
3	FA1 Current4	1ms	ADC	0A	4.0A	104/Warning
4	FA1 Current5	1ms	ADC	0A	4.0A	105/Warning
5	FA1 Current6	1ms	ADC	0A	4.0A	106/Warning
6	FA1 Current7	1ms	ADC	0A	4.0A	107/Warning
7	FA1 Current8	1ms	ADC	0A	4.0A	108/Warning
8	FA1 Current9	1ms	ADC	0A	4.0A	109/Warning
9	FA1 Current10	1ms	ADC	0A	4.0A	110/Warning
10	FA1 Drive Amp Current	1ms	ADC	0A	4.0A	111/Warning
11	FA1 FWD1	1ms	ADC	0W	150W	121/Warning
12	FA1 FWD2	1ms	ADC	0W	150W	122/Warning
13	FA1 FWD3	1ms	ADC	0W	150W	123/Warning
14	FA1 FWD4	100ms	ADC	0W	150W	124/Fault
15	FA1 FWD5	1ms	ADC	0W	150W	125/Warning
16	FA1 Voltage1	1ms	ADC	10.0V	50.0V	131/Warning
17	FA1 Voltage2	1ms	ADC	10.0V	50.0V	132/Warning
18	FA1 Temperature	100ms	I2C	+10degC	+60degC	141/Fault
19	FA1 FAN	1s	Counter	5250rpm	9750rpm	151/Warning
20	Error Status1					
21	Error Status2					

＜FA2 Unit＞

Monitoring points are Current (11 points), Detection Output (5 points), Voltage
(2 points), Temperature (1 point), and FAN Speed (1 point).

Table 33: FA2 Monitoring Item

Data No.	FA1 Unit	Measurement Frequency		Lower Limit	Upper Limit	Error Code
0	FA2 Current1	1ms	ADC	0A	4.0A	201/Warning
1	FA2 Current2	1ms	ADC	0A	4.0A	202/Warning
2	FA2 Current3	1ms	ADC	0A	4.0A	203/Warning
3	FA2 Current4	1ms	ADC	0A	4.0A	204/Warning
4	FA2 Current5	1ms	ADC	0A	4.0A	205/Warning
5	FA2 Current6	1ms	ADC	0A	4.0A	206/Warning
6	FA2 Current7	1ms	ADC	0A	4.0A	207/Warning
7	FA2 Current8	1ms	ADC	0A	4.0A	208/Warning
8	FA2 Current9	1ms	ADC	0A	4.0A	209/Warning
9	FA2 Current10	1ms	ADC	0A	4.0A	210/Warning
10	FA2 Drive Amp Current	1ms	ADC	0A	4.0A	211/Warning
11	FA2 FWD1	1ms	ADC	0W	150W	221/Warning
12	FA2 FWD2	1ms	ADC	0W	150W	222/Warning
13	FA2 FWD3	1ms	ADC	0W	150W	223/Warning
14	FA2 FWD4	100ms	ADC	0W	150W	224/Fault
15	FA2 FWD5	1ms	ADC	0W	150W	225/Warning
16	FA2 Voltage1	1ms	ADC	10.0V	50.0V	231/Warning
17	FA2 Voltage2	1ms	ADC	10.0V	50.0V	232/Warning
18	FA2 Temperature	100ms	I2C	+10degC	+60degC	241/Fault
19	FA2 FAN	1s	Counter	5250rpm	9750rpm	251/Warning
20	Error Status1					
21	Error Status2					

＜FA3 Unit＞

Monitoring points are Current (11 points), Detection Output (5 points), Voltage (2 points), Temperature (1 point), and FAN Speed (1 point).

Table 34: FA3 Monitoring Item

Data No.	FA1 Unit	Measurement Frequency		Lower Limit	Upper Limit	Error Code
0	FA3 Current1	1ms	ADC	0A	4.0A	101/Warning
1	FA3 Current2	1ms	ADC	0A	4.0A	102/Warning
2	FA3 Current3	1ms	ADC	0A	4.0A	103/Warning
3	FA3 Current4	1ms	ADC	0A	4.0A	104/Warning
4	FA3 Current5	1ms	ADC	0A	4.0A	105/Warning
5	FA3 Current6	1ms	ADC	0A	4.0A	106/Warning
6	FA3 Current7	1ms	ADC	0A	4.0A	107/Warning
7	FA3 Current8	1ms	ADC	0A	4.0A	108/Warning
8	FA3 Current9	1ms	ADC	0A	4.0A	109/Warning
9	FA3 Current10	1ms	ADC	0A	4.0A	110/Warning
10	FA3 Drive Amp Current	1ms	ADC	0A	4.0A	111/Warning
11	FA3 FWD1	1ms	ADC	0W	150W	121/Warning
12	FA3 FWD2	1ms	ADC	0W	150W	122/Warning
13	FA3 FWD3	1ms	ADC	0W	150W	123/Warning
14	FA3 FWD4	100ms	ADC	0W	150W	124/Fault
15	FA3 FWD5	1ms	ADC	0W	150W	125/Warning
16	FA3 Voltage1	1ms	ADC	10.0V	50.0V	131/Warning
17	FA3 Voltage2	1ms	ADC	10.0V	50.0V	132/Warning
18	FA3 Temperature	100ms	I2C	+10degC	+60degC	141/Fault
19	FA3 FAN	1s	Counter	5250rpm	9750rpm	151/Warning
20	Error Status1					
21	Error Status2					

＜FA4 Unit＞
Monitoring points are Current (11 points), Detection Output (5 points), Voltage
(2 points), Temperature (1 point), and FAN Speed (1 point).

Table 35: FA4 Monitoring Item

Data No.	FA4 Unit	Measurement Frequency		Lower Limit	Upper Limit	Error Code
0	FA4 Current1	1ms	ADC	0A	4.0A	101/Warning
1	FA4 Current2	1ms	ADC	0A	4.0A	102/Warning
2	FA4 Current3	1ms	ADC	0A	4.0A	103/Warning
3	FA4 Current4	1ms	ADC	0A	4.0A	104/Warning
4	FA4 Current5	1ms	ADC	0A	4.0A	105/Warning
5	FA4 Current6	1ms	ADC	0A	4.0A	106/Warning
6	FA4 Current7	1ms	ADC	0A	4.0A	107/Warning
7	FA4 Current8	1ms	ADC	0A	4.0A	108/Warning
8	FA4 Current9	1ms	ADC	0A	4.0A	109/Warning
9	FA4 Current10	1ms	ADC	0A	4.0A	110/Warning
10	FA4 Drive Amp Current	1ms	ADC	0A	4.0A	111/Warning
11	FA4 FWD1	1ms	ADC	0W	150W	121/Warning
12	FA4 FWD2	1ms	ADC	0W	150W	122/Warning
13	FA4 FWD3	1ms	ADC	0W	150W	123/Warning
14	FA4 FWD4	100ms	ADC	0W	150W	124/Fault
15	FA4 FWD5	1ms	ADC	0W	150W	125/Warning
16	FA4 Voltage1	1ms	ADC	10.0V	50.0V	131/Warning
17	FA4 Voltage2	1ms	ADC	10.0V	50.0V	132/Warning
18	FA4 Temperature	100ms	I2C	+10degC	+60degC	141/Fault
19	FA4 FAN	1s	Counter	5250rpm	9750rpm	151/Warning
20	Error Status1					
21	Error Status2					

<PS Unit>

Monitoring points are Phase Loss (3 points), Flow Rate (1 point), Temperature (3 points), and FAN Speed (7 points).

Table 36: PS Monitoring Item

Data No.	DA Unit	Measurement Frequency		Lower Limit	Upper Limit	Cord
0	AC Loss Status	1ms	ADC	–	–	001- 003 /Fault
1		–	–	–		
2	PS Temperature	100ms	I2C	+10degC	+60degC	004/Fault
3	Heat Exchanger Temperature	100ms	I2C	+10degC	+45degC	005/Fault
4	Water Temp Inlet	1ms	ADC	+22degC	+38degC	010/Fault
5	Water Temp Outlet	1ms	ADC	+22degC	+45degC	011/Fault
6	Moisture	1ms	ADC	0%	100%	Read Only
7	Water Flow	1ms	ADC	10L/min	30L/min	009/Fault
8	PS Status	1ms	Port		≥2 (each line) <2	020/Fault 021-026/Warning
9	Ex FAN1	1s	Counter	6300rpm	11700rpm	031/Warning
10	Ex FAN2	1s	Counter	6300rpm	11700rpm	032/Warning
11	Ex FAN3	1s	Counter	6300rpm	11700rpm	033/Warning
12	Ex FAN4	1s	Counter	6300rpm	11700rpm	034/Warning
13	PS FAN1	1s	Counter	5250rpm	9750rpm	035/Warning
14	PS FAN2	1s	Counter	5250rpm	9750rpm	036/Fault
15	PS FAN3	1s	Counter	2810rpm	4810rpm	037/Warning
16						
17						
18						
19						
20	Error Status1	–	–	–	–	
21	Error Status2					

2.3.4.4. Communication Interval

The Main CPU polls the full set of sub-CPUs every 10ms in the following order

PS Unit → FA Unit1 → FA Unit2 → FA Unit3 → FA Unit4

2.3.4.5. Data averaging

In some cases, the data are an average of six (6) measurements, excluding the two (2) highest and two (2) lowest values.

2.4. Protection Function

2.4.1. External Interlocks

When any of the four input 24 VDC External Fault lines drop below 5 VDC, (1) all four 24 VDC Fault Indicator lines are set to zero within 10 microseconds (this is hardwired), (2) the two RF relay switches are opened within 20 milliseconds (this is hardwired) and (3) a shutdown sequence is initiated, that is, the PS voltages are reduced to minimum, the PSs are disabled and the External Fault indictor LED is turned on (this is done through software).

The status of the four input 24 VDC lines can be read via Modbus. Fault information is latched and is resettable by a Reset command.

Table 37: 24 V Fault State Definitions

No Fault State Voltage	24 VDC nominal
Input Impedance of External Fault Lines	4.7 kOhm
Fault State Voltage	< 5 VDC
Output Impedance of the External Fault Indicator Lines	10 kOhm

2.4.2. Warnings

In the SSA module, items such as current, voltage, temperature, etc. are monitored. When the measured values exceed the allowed thresholds, warnings (instead of faults) are issued in some cases as noted in Tables 32-36. These warnings can be monitored via Modbus.

3. Flowchart

3.1. Main CPU Flowchart

Operational Sequence List - these commands can be executed independently of whether the RF and DC are Disabled or Enabled

A) DC Enable/Disable

B) RF Enable/Disable

C) P.S. Output Control Voltage

D) Fault Reset

    1. Internal Fault Reset

    2. External Fault Reset

    3. Warning Reset

E) System Reboot

F) Xport Reboot

G) Read Status

Change Parameter List - these commands will only be executed when the RAS is RF and DC Disabled

A) Forward Power Maximum Limit

B) Reflection Power Maximum Limit

C) Outlet LCW Temperature Limit

D) LCW Flow Rate Limit

E) Heatsink Temperature Limit

F) Voltage Limit

G) Warning Limit

H) Calendar
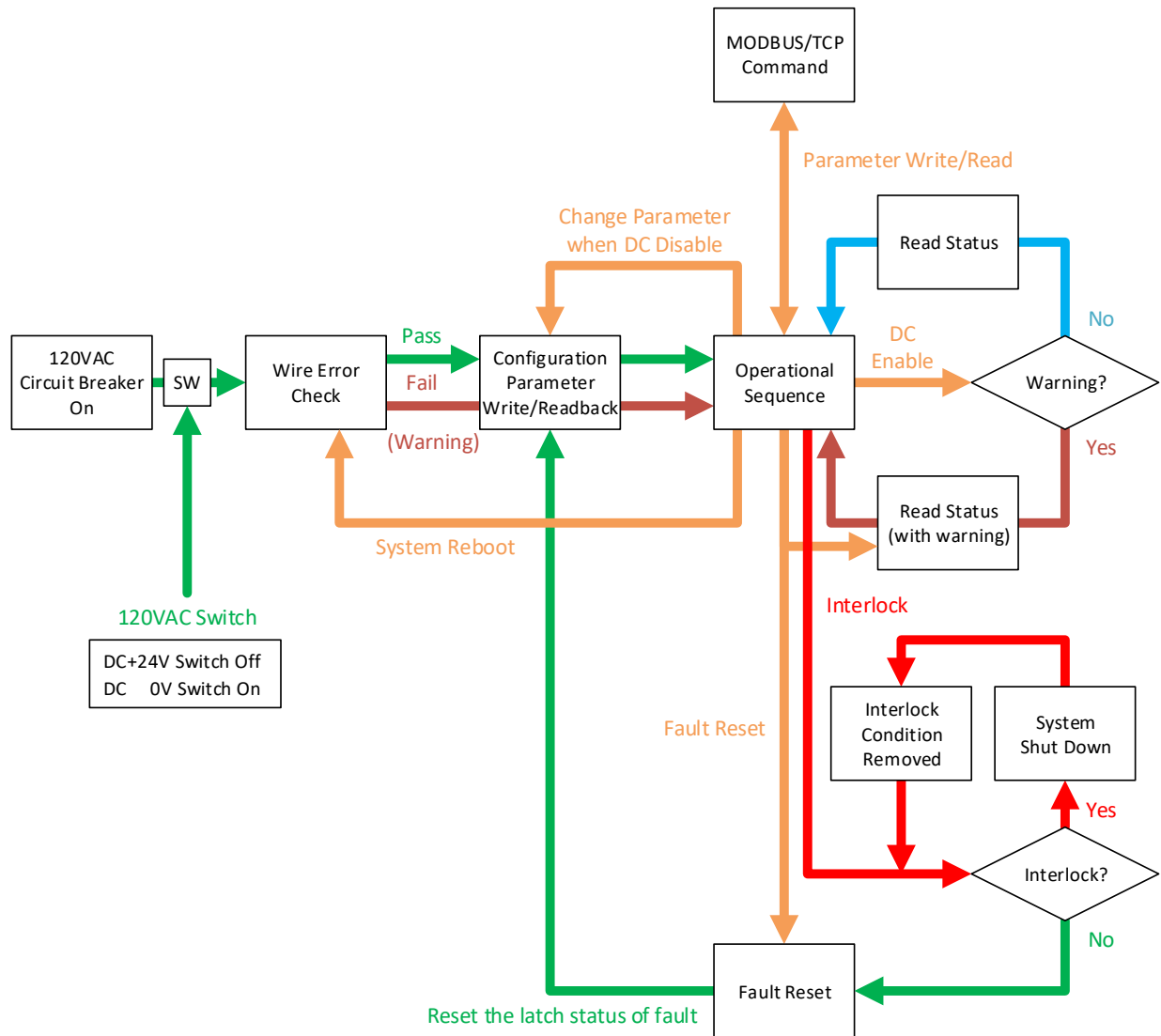
Fig. 2: System flowchart

3.1.1. Boot up / Reboot

The operations below begin when the 120 VAC Circuit Breaker turns ON.

<Boot up>

1) Set CPU port

2) Initialize variable

3) Initialize ADC

4) Initialize Uart1 (Xport)

5) Initialize Uart2 (RS-485)

6) Initialize I2C

7) Initialize Timer

8) Transfer time data from Main board to SD board for adjusting time of SD board.

9) Turn ON +12V power supply of SUB board and PS board.

(Initialization of each board starts)

10) CPU transfers threshold data read from EEPROM to PS Unit, FA1, FA2, FA3, FA4.

11) LED of Internal Fault lights up and Fault Code on Modbus becomes 570.

In waiting state for Reset command of Modbus.

<Reboot>

Save time stamp in EEPROM after receiving Modbus command, and reset Main CPU.

Execute the above 1) through 11), but confirm time stamp of reboot with EEPROM when

initializing I2C (the above 6)) and indicate time stamp of Last Reboot on Modbus.

3.1.2. Change parameter

See "Change Parameter List" in Section 3.1 Main CPU Flowchart for changeable parameters.

Follow the procedure below to change Threshold data and/or Calendar.

< Change of Threshold Data>

1) Have RF and DC disabled by sending Modbus commands.

2) Designate Function0x06 of Modbus/TCP, set address and changed values.

3) Rewrite threshold data of EEPROM.

4) Main CPU is automatically rebooted.

5) Change of threshold is reflected.

*Threshold data cannot be changed unless RF and DC are disabled.

<Change of Calendar>

1) Have RF and DC disabled by sending Modbus commands.

2) Designate Function0x06 of Modbus/TCP, set address and changed values.

3) Rewrite Calendar data of built-in SRAM of DS3232SN.

4) Main CPU is automatically rebooted

5) Change of threshold is reflected.

*Calendar data cannot be changed unless RF and DC are disabled.

3.1.3. Interlock

1) There is an Internal or External Fault.

2) At least one of the Fault Status1, Fault Status2 or Fault Status3 bits are set.

3) An Internal or External Fault Error Code is generated.

4) The system is shutdown (RF Disable and DC Disable).

5) Remove cause of the fault.

6) Issue an Internal or External Fault Reset command via Modbus.

Fault information will be latched even after the cause of the fault is removed. The Fault Reset command is ignored when the cause of an Interlock still exists.

3.1.4. Warning

1) Warning condition occurs.

2) Warning status bit set.

3) A Warning Error Code is generated.

4) Clear Warning by issuing a Warning Reset command via Modbus.

5) Warning bit set again if monitored data is still outside of threshold limits.

When Warning occurs, the warning information can be read from the registers via Modbus/TCP. The SSA module continues to operate, but when a fault such as Thermostat etc. occurs, the RAS shuts off (goes into the Default Interlock state).

3.2. Flowchart

3.2.1. Controller Unit

● Standby

● Solid State Relay on

● Solid State Relay off

3.2.2. PS Unit

● Standby

● Solid State Relay On

● Solid State Relay Off

3.2.3. FA Unit

● Standby

● Solid State Relay On

● Solid State Relay Off