Protocol for Solar Inverter Family

Release Note

Version	Date	Modification	*Prepared by*		*Approved by*	
1.0	20110713	The First draft of this document	ivan		team	
1.1	20110714	1. added restriction for AP's and inverter's address 2. modified the initial value of inverter's address from 0xFF to 0x7F	ivan		ivan	

1 General information

The guide is to give you the definition of the protocol between Inverter and AP (Application Program, such as EzLogger, EzExplorer, ATS, etc). Through the protocol, data packet will be transmitted between AP and Inverter. Generally, the data packet is regarded as a frame which includes: 2 Bytes Header, 1 Byte Source, Destination Address, control code and Function code, alterable Data parts and 2 Bytes Checksum. AP communicates with Inverter through USB port or RS485 port and its baud rate is set to 9600, besides, data length is 8 bits. The AP is master and Inverter is slave. **There can be several slaves in the communication network, but only one master in it**. Firstly each Inverter must send the register instruction to AP and AP will allocate a unique address for each Inverter after it has received the register request. The detailed illustration is as follows:

1.1 Packet Communication Method

- It is necessary to get address from AP for each Inverter and the register address is unique for each Inverter.
- The communication method is as follows: AP is master and Inverter is slave, that is, firstly AP sends out the instruction to each Inverter and Inverter executes the operation when receiving its own instruction. Inverter can't initiatively send the instruction.
- The packet must include the sender and receiver address when AP sends query or control instruction to each Inverter. These instructions will be seen by all on-line Inverters. But the Inverter can only do when the instruction is suitable to its own address and the packet should include the sender and receiver address when Inverter responds to the instruction in the same way.
- AP routine query using the periodic query method **(10sec as one period)**
- It will firstly be sent when AP needs to write the data or allocate address while the routine query will be postponed.
- If AP can't receive the correct response to the sent command in 0.5Sec, AP will send the instruction again after 0.5Sec(the least interval between instructions). When it can't receive the response for 3 times either, AP will cancel the register and no longer send the instruction to the address.

1.2 Inverter Address Allocation

- If an unregistered Inverter (state =0) wants to enter the communication network, it should send the register request instruction when it has received the 'off-line query' from AP. The request should **include register request code and its serial number**. AP will reply it (the content also should include **allocate address code and corresponding serial number and the address allocated**) after AP has received the information and allocated the address.
- The address will be used for the identification code for any communication after Inverter has finished the register program. The serial number for this machine will no longer be used.
- It need not wait before sending register request instruction after an unregistered Inverter receives the 'off-line query' info for the first time from AP. It will send again the register request instruction after several 'off-line query' intervals if the Inverter can't receive the response from AP (it is possibly due to noise or disturbances

between every two Inverters). In order to get the different register time, the interval times will alter according to the serial number of machine.

- When register conflicts, the rules of interval times are as follows:
  - There is no wait and then to directly send for the first time , SN= the serial number of machine.
  - If it does not succeed , the second wait times=SN%15, SN=SN/15.
  - The third wait times= SN%15, SN=SN/15.
  - The fourth wait times= SN%15, SN=SN/15.

    in turn
- If AP can't receive the responses to an Inverter during 3 loops consecutively (3 times per loop), it will consider that communication has been halted, then cancel the register and no longer query address info.
- It will consider the communication has been halted if Inverter can't receive any its own instructions in excess of 10 minutes. The Inverter state will be set unregistered automatically. When receiving 'off-line query' again, the Inverter will register again and resume communication.
- The first bit of AP's address should be 1 and the first bit of Inverter's address should be 0.

2 Packet Format

2.1. Packet Format

Table 2-1

Header	Source Address	Destination Address	Control Code	Function Code	Data length
2 Bytes(0xAA 0x55)	1 Byte	1 Byte	1 Byte	1 Byte	1 Byte(N)

Data0	Data1	Data2	Data3	...	Data(N-1)	Checksum
1 Byte	1 Byte	1 Byte	1 Byte	1 Byte	1 Byte	2 Bytes

2.2 Description

Table 2-2

	Description
Header:	the header of each packet (0xAA 0x55).
Source Address	designate the sender address
Destination Address	designate the receiver address

Control Code	there are 2 kinds: 1. Register(0x00) 2. Read(0x01) 3. Excute(0x03)
Function Code	to be descripted
Data length	designate the data length. (0 if there is no data column)
Data0,1,2..N	data column
Checksum	Header + Source/Dstination Address + Control Code +Function Code + Data length +Data0 + .. +Data (N-1)

Note:

When sending the MSB will be firstly transmitted as a packet of word format.

- Communication Parameter

Table 2-3

Parameter	Value
Speed	9600bps
Data bit	8
Parity	None
Stop bit	1

- Communication timing

Table 2-5

Timing parameter	Value
Delay before Inverter begins to send response	<0.5 Sec
Inter-character delay	<0.2 Sec
The interval time between sending same instructions twice	>0.5 Sec
Time out for Inverter communication	10 Min

3 Instruction Set

3.1. Control Code :0x00 'Register'

Table 3-1

Control code	Function code	Vector	Description
0x00	0x00	AP →Inverter	Off-line Query
0x00	0x80	Inverter→AP	Register Request
0x00	0x01	AP →Inverter	Allocate Register Address
0x00	0x81	Inverter→AP	Address Confirm

0x00	0x02	AP →Inverter	Remove Register
0x00	0x82	Inverter→AP	Remove Confirm

Notice： Before slave registers, the address initialized as 0x7F

Off-line Query Data Packet Format：

Header	Source Address	Destination Address	Control Code	Function Code	Data length
2 Bytes(0xAA 0x55)	0b1*******	0x7F	0x00	0x00	0

Checksum
2 Bytes

Register Request Data Packet Format：

Header	Source Address	Destination Address	Control Code	Function Code	Data length
2 Bytes(0xAA 0x55)	0x7F	0b1*******	0x00	0x80	16

Data0	Data1	Data2	Data3	...	Data(N-1)	Checksum
SN1	SN2	SN3	SN4	...	SN16	2 Bytes

Allocate Register Address Data Packet Format：

Header	Source Address	Destination Address	Control Code	Function Code	Data length
2 Bytes(0xAA 0x55)	0b1*******	0x7F	0x00	0x01	17

Data0	Data1	Data2	Data3	...	Data(N-2)	Data(N-2)	Checksum
SN1	SN2	SN3	SN4	...	SN16	Address	2 Bytes

Address Confirm Data Packet Format：

Header	Source Address	Destination Address	Control Code	Function Code	Data length
2 Bytes(0xAA 0x55)	Address	0b1*******	0x00	0x81	0

Checksum
2 Bytes

Notice：The source address in Address Confirm data packet is address allocated from AP

Remove Register Data Packet Format：

Header	Source Address	Destination Address	Control Code	Function Code	Data length
2 Bytes(0xAA 0x55)	0b1*******	Address	0x00	0x02	0

Checksum
2 Bytes

Remove Confirm Data Packet Format：

Header	Source Address	Destination Address	Control Code	Function Code	Data length
2 Bytes(0xAA 0x55)	Address	0b1*******	0x00	0x82	0

Checksum
2 Bytes

Notice：After removed from network the address of inverter changes back to 0x7F and status as off-line. And will response if it receives off-line query command.

3.2. Control Code :0x01 'Read'

Table3-2

Control code	Function code	Vector	Description
0x01	0x01	AP →Inverter	Query Running Info
0x01	0x81	Inverter→AP	Response Running Info
0x01	0x02	AP →Inverter	Query ID Info
0x01	0x82	Inverter→AP	Response ID Info
0x01	0x03	AP →Inverter	Query Setting Info
0x01	0x83	Inverter→AP	Response Setting Info

3.2.1. 'Running Info List' : (Function Code : 0x81)

Table 3-3

Data Index	Measuring Channels	Unit	Description	Length

0x00	Vpv1	0.1V	PV1 voltage	2 Bytess
0x01	Vpv2	0.1V	PV2 voltage	2 Bytes
0x02	Ipv1	0.1A	PV1 current	2 Bytes
0x03	Ipv2	0.1A	PV2 current	2 Bytes
0x04	Vac1	0.1V	Phase L1 voltage	2 Bytes
0x05	Vac2	0.1V	Phase L2 voltage	2 Bytes
0x06	Vac3	0.1V	Phase L3 voltage	2 Bytes
0x07	Iac1	0.1A	Phase L1 current	2 Bytes
0x08	Iac2	0.1A	Phase L2 current	2 Bytes
0x09	Iac3	0.1A	Phase L3 current	2 Bytes
0x0A	Fac1	0.01Hz	Phase L1 frequency	2 Bytes
0x0B	Fac2	0.01Hz	Phase L2 frequency	2 Bytes
0x0C	Fac3	0.01Hz	Phase L3 frequency	2 Bytes
0x0D	Pac	1W	Feeding power	2 Bytes
0x0E	Work Mode	NA	Work Mode Table3-6	2 Bytes
0x0F	Temperature	0.1 degree C	Inverter internal temperature	2 Bytes
0x10	Error Message H	NA	Failure description for status 'failure' Table3-7	2 Bytes
0x11	Error Message L	NA	Failure description for status 'failure' Table3-7	2 Bytes
0x12	E-Total H	0.1KW.Hr	Total Feed Energy to grid	2 Bytes
0x13	E-Total L	0.1KW.Hr	Total Feed Energy to grid	2 Bytes
0x14	h-Total H	Hr	Total feeding hours	2 Bytes
0x15	h-Total L	Hr	Total feeding hours	2 Bytes
0x16	TmpFaultValue	0.1 Degree C	Temperature fault value	2 Bytes
0x17	PV1FaultValue	0.1V	PV1 voltage fault value	2 Bytes
0x18	PV2FaultValue	0.1V	PV2 voltage fault value	2 Bytes
0x19	Line1VFaultValue	0.1V	Phase L1 voltage fault value	2 Bytes
0x1A	Line2VFaultValue	0.1V	Phase L2 voltage fault value	2 Bytes
0x1B	Line3VFaultValue	0.1V	Phase L3 voltage fault value	2 Bytes
0x1C	Line1FFaultValue	0.01Hz	Phase L1 frequency fault value	2 Bytes
0x1D	Line2FFalutValue	0.01Hz	Phase L2 frequency fault value	2 Bytes
0x1E	Line3FFaultValue	0.01Hz	Phase L3 frequency fault value	2 Bytes
0x1F	GFCIFaultValue	1mA	GFCI fault value	2 Bytes
0x20	E-Day	0.1KW.Hr	Feed Engery to grid in today	2 Bytes

- **Description :**

Table 3-6

Mode	Code	Description
Wait	0x00 0x00	Standby, waits to feeding
Normal	0x00 0x01	Feeding power to grid
Fault	0x00 0x02	Fault happenned, and disconnects from grid

Table 3-7

Bit NO	Error message	Description
Bit31	Internal Communication Failure	Communication between microcontrollers is failure
Bit30	EEPROM R/W Failure	EEPROM cannot be read or written
Bit29	Fac Failure	The grid frequency is out of tolerable range
Bit28	TBD	NA
Bit27	TBD	NA
Bit26	TBD	NA
Bit25	Relay Check Failure	Relay check is failure
Bit24	TBD	NA
Bit23	Vac Consistency Failure	Different value between Master and Slave for grid voltage
Bit22	Fac Consistency Failure	Different value between Master and Slave for grid frequency
Bit21	TBD	NA
Bit20	TBD	NA
Bit19	DC Injection High	The DC injection to grid is too high
Bit18	Isolation Failure	Isolation resistance of PV-plant out of tolerable range
Bit17	Vac Failure	Grid voltage out of tolerable range
Bit16	Fan Failure	Fan Lock
Bit15	PV Over Voltage	Pv input voltage is over the tolerable maximum value
Bit14	Auto Test Failure	Auto test failure
Bit13	Over Temperature	Temperature is too high
Bit12	Internal Version Unmatch	Master and slave firmware version is unmatch
Bit11	DC Bus High	Dc bus is too high
Bit10	Gournd I Failure	Ground current is too high
Bit9	Utility Loss	Utility is unavailable
Bit8	TBD	NA
Bit7	TBD	NA
Bit6	TBD	NA
Bit5	TBD	NA
Bit4	GFCI Consistency Failure	Different value between Master and Slave for GFCI
Bit3	DCI Consistency Failure	Different value between Master and Slave for output DC current
Bit2	TBD	NA
Bit1	AC HCT Failure	The output current sensor is abnormal
Bit0	GFCI Device Failure	The GFCI detecting circuit is abnormal

3.2.2. Respone ID Info Packet Format (Function Code: 0x82)

Table 3-8

Data NO	Length	Content	Description
0~4	5 Bytes	Firmware Ver.	Firmware Version, Example '01.00' = '30h 31h 2Eh 30h 30h'
5~14	10 Bytes	Model Name	Example 'GW3000-SS '
15~30	16 Bytes	NA	Reserved
31~46	16 Bytes	Serial number	Example '13000SSU11000008'
47~50	4 Bytes	Nom_Vpv	Nominal PV voltage: Example 360.0V= '33h 36h 30h 30h' Unit :0.1V
51~62	12 Bytes	Internal Version	Example '410-00000-00'
63	1 Byte	Safety Country Code	Table 3-10

3.2.3. Respone Setting Info Packet Format : (Function Code : 0x83)

Table 3-9

Data NO	Length	Name	Unit	Description
0~1	2 Bytes	Vpv-Start	0.1V	PV start-up voltage
2~3	2 Bytes	T-Start	1Sec	Time to connect grid
4~5	2 Bytes	Vac-Min	0.1V	Minimum operational grid voltage
6~7	2 Bytes	Vac-Max	0.1V	Maximum operational grid voltage
8~9	2 Bytes	Fac-Min	0.01Hz	Minimum operational grid Frequency
10~11	2 Bytes	Fac-Max	0.01Hz	Maximum operational grid Frequency

3.3 Control Code :0x03 'Execute'

Table 3-10

Control code	Function code	Vector	Data Format	Data Length	Description
0x03	0x1B	AP →Inverter	NA	0	Start inverter
0x03	0x9B	Inverter→AP	ACK or NAK	1 byte	Response
0x03	0x1C	AP →Inverter	NA	0	Stop inverter
0x03	0x9C	Inverter→AP	ACK or NAK	1 byte	Response
0x03	0x1D	AP →Inverter	NA	0	Disconnect grid and reconnect
0x03	0x9D	Inverter→AP	ACK or NAK	1 byte	Response
0x03	0x1E	AP →Inverter	0~100(0~100%)	1 byte	Adjust Real Power
0x03	0x9E	Inverter→AP	ACK or NAK	1 byte	Response