

## INVERTER

# E510



## Communication Addendum

■ Modbus RTU / ASCII

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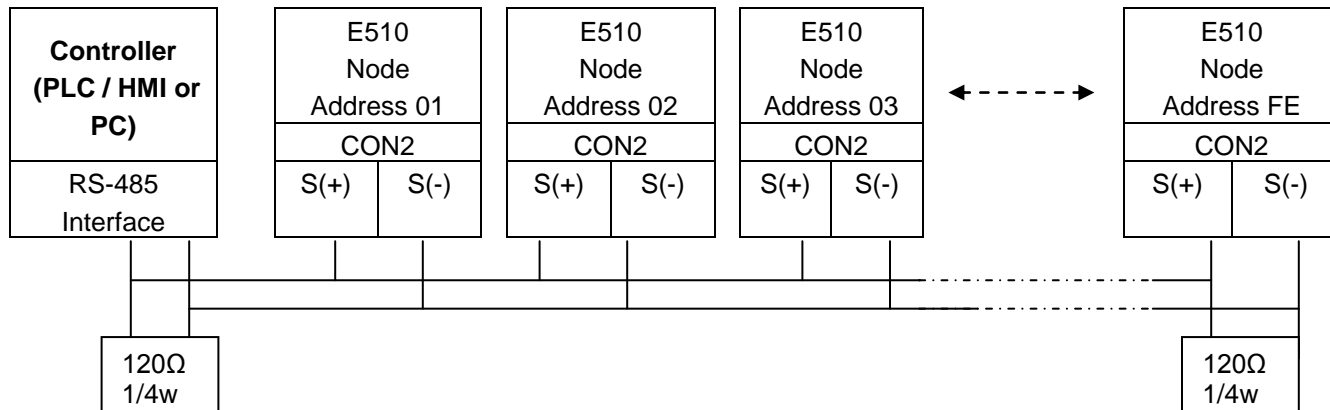
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# 1.0 Modbus Protocol Descriptions

## 1.0.1 Communication Connection and Data Frame

The inverter can communicate with a PC or PLC via RS485 using the Modbus RTU or Modbus ASCII protocol. The maximum frame length is 80 bytes.

### Network Connection



**\*\* Terminate the communications line with a (120 ohm, 1/4 watt) resistor at both ends.**

**CON2 Pin out**

PIN	Signal	PIN	Signal
1	RS-485 S+ signal	5	Tx signal
2	RS-485 S- signal	6	RS-485 S- signal
3	RS-485 S+ signal	7	VCC of isolated 5V power supply
4	Rx signal	8	GND of isolated 5V power supply

For RS-485 communication use pin 1 or pin 3 for S (+) and pin 2 or pin 6 for S (-)

## Data Format Frame

### Data Frame for ASCII Mode

STX(3AH)	Start Bit = 3AH
Node Address Hi	Communication Address(Station):
Node Address Lo	
Function Hi	Function Code (command):
Function Lo	
Command Start Address	Command Start byte:
Command Start Address	
Command Start Address	
Command Start Address	
Data length	The length of the command:
Data length	
Data length	
Data length	
LRC Check Hi	LRC Check Code:
LRC Check Lo	
END Hi	End Byte:
END Lo	END Hi=CR(0DH), END Li = LF(0AH)

### Data Frame for RTU Mode

Master (PLC etc.) sends request to follower (inverter), and the follower sends a response to the master (PC, PLC). The data received is illustrated here.

The data length varies depending on the command (Function).

Node Address
Function Code
DATA
CRC CHECK
Signal Interval

\*\* The inverter response time is 10ms.

#### Node Address

00H: Broadcast to all the drivers

01H: to the No. 01 inverter

0FH: to the No.15 inverter

10H: to the No.16 inverter and so on....., max to No. 254 (FEH)

#### Function Code

03H: Read the register contents

06H: Write a WORD to register  
 08H: Loop test  
 10H: Write several data to register (complex number register write)

**Checksum Calculation**

**LRC**

ex. NODE ADDRESS	01H	
FUNCTION	03H	
COMMAND	01H	
		00H
+ DATA LENGTH	0AH	
-----		
Checksum	F1H	0FH ----- 2's complement
CS (H)		46H (ASCII)
CS (L) =	31H (ASCII)	

**CRC**

CRC Check: CRC code covers the content from node address to DATA. Please calculate it according to the following methods.

- (1) Load a 16-bit register with FFFF hex (all 1's). Call this CRC register.
- (2) Exclusive OR the first 8-bit byte of the message, the low-order byte of the 16-bit CRC register, putting the result in the CRC register.
- (3) Shift the CRC register one bit to the right (toward the LSB), Zero-filling the MSB, Extract and examines the LSB.
- (4) (If the LSB was 0): Repeat Steps (3) (another shift)  
 (If the LSB was 1): Exclusive OR the CRC register with the polynomial value A001 hex (1010 0000 0000 0001), putting the result in CRC register.
- (5) Repeat Steps (3) and (4) until 8 shifts been performed. When this is done, a complete 8-bit byte will be processed.
- (6) Repeat Steps (2) through (5) for next 8-bit byte of the message, Continue doing this until all bytes have been processed. The final content in the CRC register is the CRC value. When sending the CRC value, the Low-order byte should be sent firstly, then the High-order byte. For example, CRC value: 1241 Hex, the high-order byte should be set to 41hex and low-order byte 12hex.

**CRC calculate program (C language):**

```

UWORD ch_sum ( UBYTE long , UBYTE *rxdbuff )
{
    BYTE i = 0;
    UWORD wkg = 0xFFFF;
    while ( long-- ) {
        wkg ^= rxdbuff++;
        for ( i = 0 ; i < 8; i++ ) {
            if ( wkg & 0x0001 ) {
                wkg = ( wkg >> 1 ) ^ 0xa001;
            }
            else {
                wkg = wkg >> 1;
            }
        }
    }
    return( wkg );
}

```

ASCII Mode	
STX	‘:’
Address	‘0’
	‘1’
Function	‘8’
	‘6’
Exception code	‘5’
	‘1’
LRC Check	‘2’
	‘8’
END	‘CR’
	‘LF’

RTU Mode		
Node Address	02H	
Function	83H	
Exception code	52H	
CRC-16	High	C0H
	Low	CDH

During a communication error the drive will response with an Exception Code and send a message back to the main system consisting of a Function Code that is “ANDED (and 80h)” with 80 Hex.

Exception code	Content
01	Function code error
02	Register number error
03	Number error
04	DATA setting error
05	Write mode error

## 1.0.2 Register and Data Format

### Command Data (Read / Write)

Register No.	Bit	Content
2500H	Reserved	
2501H	0	Operation Command      1 : Run      0 : Stop
	1	Reverse Command      1 : Reverse      0 : Forward
	2	External Fault      1 : Fault
	3	Fault Reset      1 : Reset
	4	Reserved
	5	Reserved
	6	Multi-function Comm S1 1 : "ON"
	7	Multi-function Comm S2 1 : "ON"
	8	Multi-function Comm S3 1 : "ON"
	9	Multi-function Comm S4 1 : "ON"
	A	Multi-function Comm S5 1 : "ON"
	B	Multi-function Comm S6 1 : "ON"
	C	Relay R1      1 : "ON"
	D	Relay R2      1 : "ON"
E~F	Reserved	
2502H	Frequency Command	
2503~251FH	Reserved	

**Note:** Write a zero into the register for not used bit; do not write data to a reserved register.

**Monitor Data (Read-only)**

Register No.		Bit	Content	
2520H	State Signal	0	Operation	1 : Run      0 : Stop
		1	Direction	1 : Reverse    0 : Forward
		2	Inverter ready	1 : ready      0 : Not ready
		3	Fault	1 : Abnormal
		4	Data setting error	1 : "ON"
		5-F	Reserved	
2521H	Error Description	0	-	31 Err4
		1	OH	32 Err5
		2	OC	33 Err6
		3	LV	34 Err7
		4	OV	35 Err8
		5	Reserved	36 Reserved
		6	External BB (bb)	37 Reserved
		7	CTER	38 EPR1
		8	PDER	39 EPR2
		9	EPR	40 OVSP
		10	ATER	41
		11	OL3	42
		12	OL2	43
		13	OL1	44
		14	EFO	45
		15	External bb (E.S.)	46
		16	LOC	
		17	Reserved	
		18	OC-C	
		19	OC-A	
		20	OC-D	
		21	OC-S	
		22	Reserved	
		23	LV-C	
		24	OV-C	
		25	OH-C	
		26	STP0	
		27	STP1	
		28	STP2	
		29	Err1	
		30	Err2	
2522H	DI State		Multi-function Comm S1	1 : "ON"
		1	Multi-function Comm S2	1 : "ON"
		2	Multi-function Comm S3	1 : "ON"
		3	Multi-function Comm S4	1 : "ON"
		4	Multi-function Comm S5	1 : "ON"



		5	Multi-function Comm S6	1 :“ON”
		6	Relay R1	1 :“ON”
		7	Relay R2	1 :“ON”
		8	Reserved	
		9	Reserved	
		A	Reserved	
		B	Reserved	
		C	Reserved	
		D	Reserved	
		E	Reserved	
		F	Reserved	
2523H			Frequency Command (100/1Hz)	
2524H			Output Frequency (100/1Hz)	
2525H			Output Voltage (10/1V)	
2526H			DC Voltage Command (1/1V)	
2527H			Output Current (10/1A)	
2529H			Output torque	
252AH			PID feedback (100% / fmax , 10/1% )	
252BH			PID input (100% / fmax, 10/1%)	
252CH			TM2 AVI input value (1000 / 10V) *1	
252DH			TM2 ACI input value (1000 / 10V) *1	
252EH~252FH			reserved	

**Note:** Write a zero into the register for not used bit; do not write data to a reserved register.

## Read Holding Register [03H]

Read consecutive holding registers. The address of the first holding register is specified in the protocol  
 Example: Read frequency command from the inverter with node address 1.

### ASCII Mode

#### Command Message

3AH	STX
30H	Node Address
31H	
30H	Function
33H	
30H	Starting Register
31H	
32H	
33H	
30H	Number of Registers
30H	
30H	
31H	
?	LRC CHECK
?	
0DH	END
0AH	

#### Response Message (Normal)

3AH	STX
30H	Node Address
31H	
30H	Function
33H	
30H	Data Length
32H	
31H	Data
37H	
37H	
30H	
?	LRC CHECK
?	
0DH	END
0AH	

#### Response Message (Error)

3AH	STX
30H	Node Address
32H	
38H	Function
33H	
35H	Exception code
32H	
?	LRC CHECK
?	
0DH	END
0AH	

### RTU Mode

#### Command Message

Node Address	01 H	
Function	03H	
Starting Register	High	01H
	Low	23H
Number of Registers	High	00H
	Low	01H
CRC-16	High	74H
	Low	3CH

#### Response Message (Normal)

Node Address	01H	
Function	03H	
Data Length	02H	
Data	High	17H
	Low	70H
CRC-16	High	AFH
	Low	82H

#### Response Message (Error)

Node Address	02H	
Function	83H	
Exception code	52H	
CRC-16	High	C0H
	Low	CDH

## Loop back test [08H]

Check the communication between the master and the follower (inverter). The data used can be arbitrary.

### ASCII Mode

#### Command Message

3AH	STX
30H	Node Address
31H	
30H	Function
38H	
30H	Test Code
30H	
30H	
30H	
41H	DATA
35H	
33H	
37H	
?	LRC CHECK
?	
0DH	END
0AH	

#### Response Message (Normal)

3AH	STX
30H	Node Address
31H	
30H	Function
38H	
30H	Test Code
30H	
30H	
30H	
41H	DATA
35H	
33H	
37H	
?	LRC CHECK
?	
0DH	END
0AH	

#### Response Message (Error)

3AH	STX
30H	Node Address
31H	
38H	Function
38H	
32H	Exception code
30H	
?	LRC CHECK
?	
0DH	END
0AH	

### RTU Mode

#### Command Message

Node Address		01 H
Function		08H
Test Code	High	00H
	Low	00H
DATA	High	A5H
	Low	37H
CRC-16	High	DAH
	Low	8DH

#### Response Message (Normal)

Node Address		01H
Function		08H
Test Code	High	00H
	Low	00H
DATA	High	A5H
	Low	37H
CRC-16	High	DAH
	Low	8DH

#### Response Message (Error)

Node Address		01H
Function		88H
Exception code		20H
CRC-16	High	47H
	Low	D8H

## Write Single Holding Register [06H]

Write single holding register. The register address of the holding register is specified in the message.

**Example:** Write a 60.00Hz frequency command to node address 1.

### ASCII Mode

#### Command Message

3AH	STX
30H	Node Address
31H	
30H	Function
36H	
30H	Starting Register
31H	
30H	
32H	
31H	DATA
37H	
37H	
30H	
?	LRC CHECK
?	
0DH	END
0AH	

#### Response Message (Normal)

3AH	STX
30H	Node Address
31H	
30H	Function
36H	
30H	Starting Register
31H	
30H	
32H	
31H	DATA
37H	
37H	
30H	
?	LRC CHECK
?	
0DH	END
0AH	

#### Response Message (Error)

3AH	STX
30H	Node Address
31H	
38H	Function
36H	
35H	Exception code
32H	
?	LRC CHECK
?	
0DH	END
0AH	

### RTU Mode

#### Command Message

Node Address	01 H	
Function	06H	
Start No	High	01H
	Low	02H
DATA	High	17H
	Low	70H
CRC-16	High	27H
	Low	E2H

#### Response Message (Normal)

Node Address	01H	
Function	06H	
Start No	High	01H
	Low	02H
DATA	High	17H
	Low	70H
CRC-16	High	27H
	Low	E2H

#### Response Message (Error)

Node Address	01H	
Function	86H	
Exception code	52H	
CRC-16	High	C3H
	Low	9DH

## Write Multiple Holding Register [10H]

Write multiple holding registers. The address of the first holding register is specified in the message.

**Example:** Write a 60.00Hz frequency command to node address 1 and enable FWD run command.

### ASCII Mode

#### Command Message

3AH	STX
30H	Node Address
31H	
31H	Function
30H	
30H	Starting Register
31H	
30H	
31H	
30H	Number of Registers
30H	
30H	
32H	
30H	Number of Bytes*
34H	
30H	DATA 1
30H	
30H	
31H	
31H	DATA 2
37H	
37H	
30H	
?	LRC CHECK
?	
0DH	END
0AH	

#### Response Message (Normal)

3AH	STX
30H	Node Address
31H	
31H	Function
30H	
30H	Starting Register
31H	
30H	
31H	
30H	Number of Registers
30H	
30H	
32H	
?	LRC CHECK
?	
0DH	END
0AH	

#### Response Message (Error)

3AH	STX
30H	Node Address
31H	
39H	Function
30H	
35H	Exception code
32H	
?	LRC CHECK
?	
0DH	END
0AH	

\* Number of bytes is register amount x 2

## RTU Mode

Command Message

Node Address		01H
Function		10H
Starting Register	High	01H
	Low	01H
Number of Registers	High	00H
	Low	02H
Number of Bytes*		04H
DATA 1	High	00H
	Low	01H
DATA 2	High	17H
	Low	70H
CRC-16	High	60H
	Low	27H

Response Message (Normal)

Node Address		01H
Function		10H
Starting Register	High	01H
	Low	01H
Number of Registers	High	00H
	Low	02H
CRC-16	High	11H
	Low	F4H

Response Message (Error)

Node Address		01H
Function		90H
Exception code		52H
CRC-16	High	CDH
	Low	FDH

\* Data amount is register amount x 2

### 1.0.3 Parameter Data

Function	Register No	Function	Register No	Function	Register No
<b>Group 0</b>		<b>Group 1</b>		<b>Group 2</b>	
00-00	0000H	01-00	0100H	02-00	0200H
00-01	0001H	01-01	0101H	02-01	0201H
00-02	0002H	01-02	0102H	02-02	0202H
00-03	0003H	01-03	0103H	02-03	0203H
00-04	0004H	01-04	0104H	02-04	0204H
00-05	0005H	01-05	0105H	02-05	0205H
00-06	0006H	01-06	0106H	02-06	0206H
00-07	0007H	01-07	0107H	02-07	0207H
00-08	0008H	01-08	0108H	02-08	Reserved
00-09	0009H	01-09	0109H	02-09	Reserved
00-10	000AH	01-10	010AH	02-10	Reserved
00-11	000BH	01-11	010BH	02-11	Reserved
00-12	000CH	01-12	010CH	02-12	Reserved
00-13	000DH	01-00	0100H	02-13	Reserved
00-14	000EH			02-14	020EH
00-15	000FH			02-15	020FH
00-16	0010H			02-16	0210H
00-17	0011H				
00-18	0012H				
00-19	0013H				
00-20	0014H				

Function	Register No	Function	Register No	Function	Register No
<b>Group 3</b>		<b>Group 4</b>		<b>Group 5</b>	
03-00	0300H	04-00	0400H	05-00	0500H
03-01	0301H	04-01	0401H	05-01	0501H
03-02	0302H	04-02	0402H	05-02	0502H
03-03	0303H	04-03	0403H	05-03	0503H
03-04	0304H	04-04	0404H	05-04	0504H
03-05	0305H	04-05	0405H	05-05	0505H
03-06	0306H	04-06	0406H	05-06	0506H
03-07	0307H	04-07	0407H	05-07	0507H
03-08	0308H	04-08	0408H	05-08	0508H
03-09	0309H	04-09	0409H	05-09	0509H
03-10	030AH	04-10	040AH	05-10	050AH
03-11	030BH	04-11	040BH	05-11	050BH
03-12	030CH	04-12	040CH	05-12	050CH
03-13	030DH	04-13	040DH	05-13	050DH
03-14	030EH	04-14	040EH	05-14	050EH
03-15	030FH	04-15	040FH	05-15	050FH
03-16	0310H			05-16	0510H
03-17	0311H			05-17	0511H
03-18	0312H			05-18	0512H
03-19	0313H			05-19	0513H
03-20	0314H			05-20	0514H
03-21	0315H			05-21	0515H
03-22	0316H			05-22	0516H
03-23	0317H			05-23	0517H
03-24	0318H			05-24	0518H
03-25	0319H			05-25	0519H
03-26	031AH			05-26	051AH
				05-27	051BH
				05-28	051CH
				05-29	051DH
				05-30	051EH
				05-31	051FH
				05-32	0520H
				05-33	0521H
				05-34	0522H
				05-35	0523H
				05-36	0524H



Function	Register No	Function	Register No	Function	Register No
<b>Group 3</b>		<b>Group 4</b>		<b>Group 5</b>	
				05-37	0525H
				05-38	0526H
				05-39	0527H
				05-40	0528H
				05-41	0529H
				05-42	052AH
				05-43	052BH
				05-44	052CH
				05-45	052DH
				05-46	052EH
				05-47	052FH
				05-48	0530H

Function	Register No	Function	Register No	Function	Register No
<b>Group 6</b>		<b>Group 6</b>		<b>Group 7</b>	
06-00	0600H	06-43	062BH	07-00	0700H
06-01	0601H	06-44	062CH	07-01	0701H
06-02	0602H	06-45	062DH	07-02	0702H
06-03	0603H	06-46	062EH	07-03	0703H
06-04	0604H	06-47	062FH	07-04	0704H
06-05	0605H			07-05	0705H
06-06	0606H			07-06	0706H
06-07	0607H			07-07	0707H
06-08	0608H			07-08	0708H
06-09	0609H			07-09	0709H
06-10	060AH			07-10	070AH
06-11	060BH			07-11	070BH
06-12	060CH			07-12	070CH
06-13	060DH			07-13	070DH
06-14	060EH			07-14	070EH
06-15	060FH				
06-16	0610H				
06-17	0611H				
06-18	0612H				
06-19	0613H				
06-20	0614H				
06-21	0615H				
06-22	0616H				
06-23	0617H				
06-24	0618H				
06-25	0619H				
06-26	061AH				
06-27	061BH				
06-28	061CH				
06-29	061DH				
06-30	061EH				
06-31	061FH				
06-32	0620H				
06-33	0621H				
06-34	0622H				
06-35	0623H				
06-36	0624H				
06-37	0625H				
06-38	0626H				
06-39	0627H				
06-40	0628H				
06-41	0629H				
06-42	062AH				



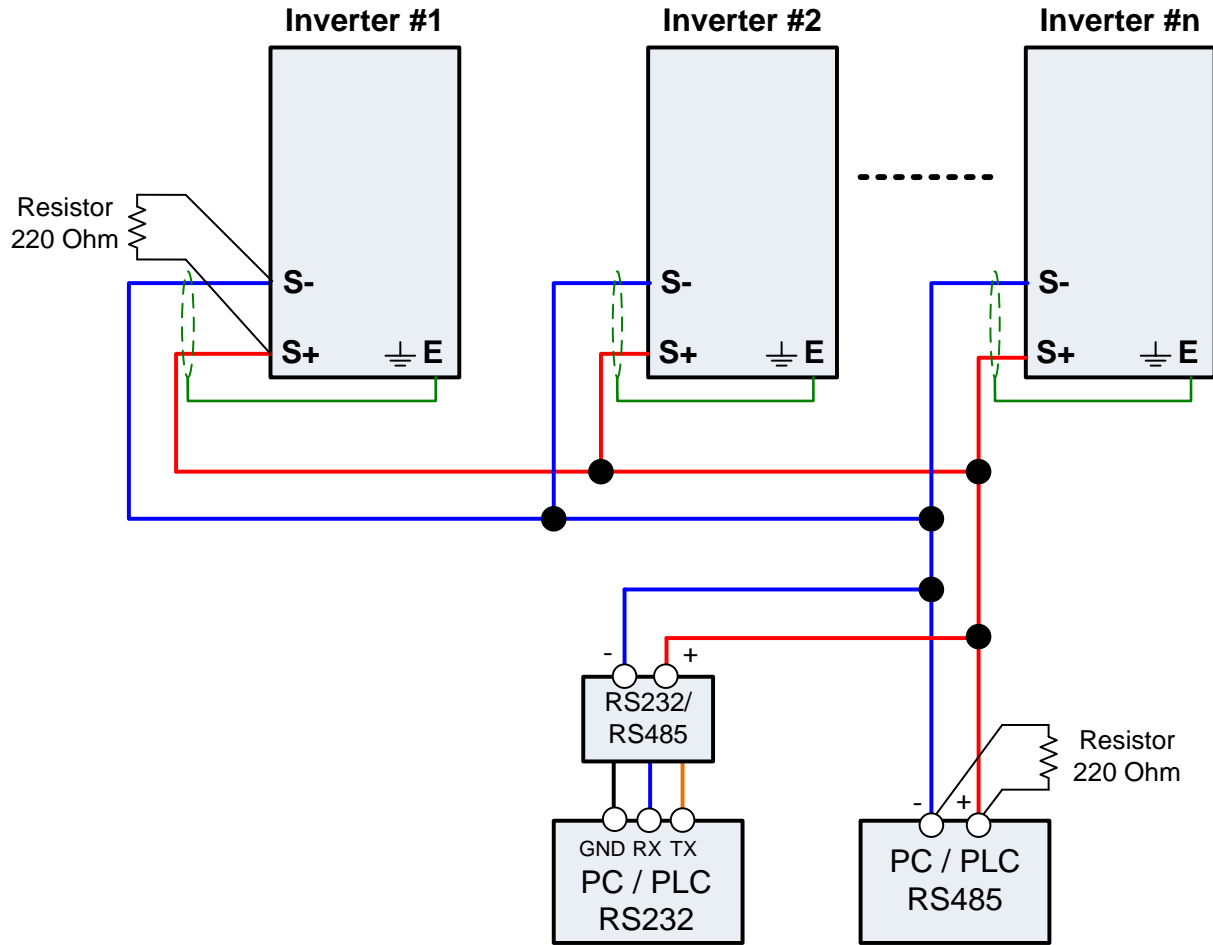
Function	Register No	Function	Register No	Function	Register No
<b>Group 11</b>		<b>Group 12</b>		<b>Group 13</b>	
11 – 00	0B00H	12 – 00	0C00H	12 – 00	0C00H
11 – 01	0B01H	12 – 01	0C01H	12 – 01	0C01H
11 – 02	0B02H	12 – 02	0C02H	12 – 02	0C02H
11 – 03	0B03H	12 – 03	0C03H	12 – 03	0C03H
11 – 04	0B04H	12 – 04	0C04H	12 – 04	0C04H
11 – 05	0B05H	12 – 05	0C05H	12 – 05	0C05H
11 – 06	0B06H	12 – 06	0C06H	12 – 06	0C06H
11 – 07	0B07H	12 – 07	0C07H	12 – 07	0C07H
11 – 08	0B08H	12 – 08	0C08H	12 – 08	0C08H
11 – 09	0B09H	12 – 09	0C09H		
11 – 10	0B0AH	12 – 10	0C0AH	<b>Group 15</b>	
11 – 11	0B0BH	12 – 11	0C0BH	15-32	0E20H
11 – 12	0B0CH	12 – 12	0C0CH		
11 – 13	0B0DH	12 – 13	0C0DH		
11 – 14	0B0EH	12 – 14	0C0EH		
11 – 15	0B0FH	12 – 15	0C0FH		
11 – 16	0B10H				
11 – 17	0B11H				

**Note:** The communication addresses for Group 14~15 in “E510 PLC section”, except 15-32.

# Appendix A: Communication Network

## A1.1 RS485 –Network (Modbus)

This section shows a RS485 network consisting of several inverters communicating using the built-in Modbus RTU protocol.



Wiring diagram RS485 Modbus RTU Network

### Notes:

- A PC / PLC controller with a built-in RS-485 interface can be connected directly to the RS-485 network. Use a RS232 to RS485 converter to connect a PC / PLC with a built-in RS-232 interface.
- A maximum of 31 inverters can be connected to the network. Terminating resistors of 220 ohm must be installed at both end of the network.

**TECO**   **Westinghouse**

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***INVERTER***

**E510**

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**Distributor**

Ver 01: 2015.03