TECO Westinghouse

INVERTER

F510

Communication - Addendum

- Modbus RTU / ASCII
- BACNet
- Metasys N2
- Profibus

DOCUMENT - TECO-F510-AC001
Ver 01: 2015.03

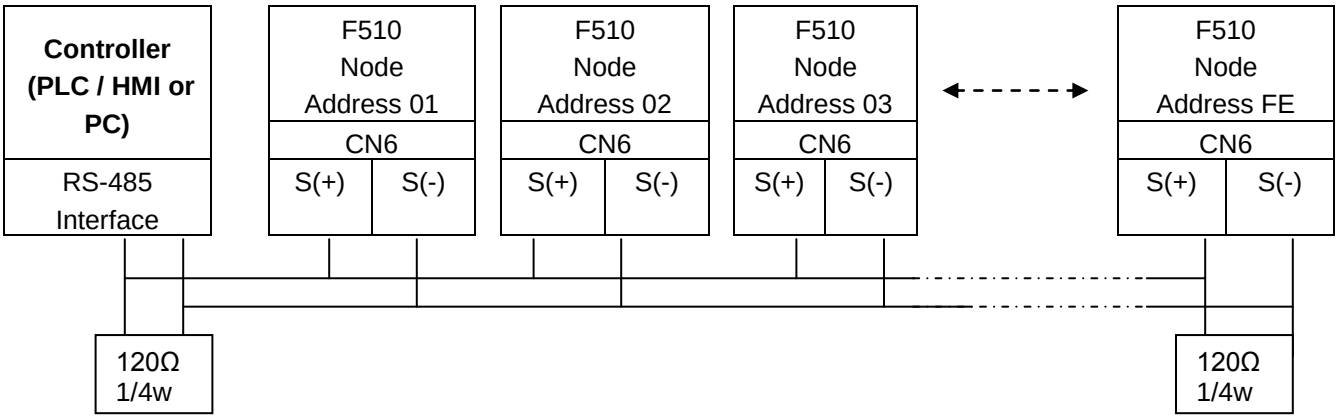
Table of Contents

1.0 Modbus Protocol Descriptions

1.0.1 Communication Connection and Data Frame

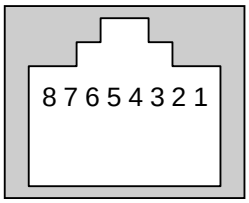
The inverter can communicate with a PC or PLC via RS485 using the Modbus RTU or Modbus ASCII protocol. The maximum frame length is 80 bytes.

Network Connection



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

CN6 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): 2-digit ASCII Code
Node Address Lo	
Function Hi	Function Code (command): 2-digit ASCII Code
Function Lo	
Command Start Address	Command Start byte: 4-digit ASCII Code
Command Start Address	
Command Start Address	
Command Start Address	
Data length	The length of the command: 4-digit ASCII Code
Data length	
Data length	
Data length	
LRC Check Hi	LRC Check Code: 2-digit ASCII Code
LRC Check Lo	
END Hi	End Byte: END Hi=CR(0DH), END Li = LF(0AH)
END Lo	

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

0FH ---------- 2's complement
Checksum F1H
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 (all1'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

1.0.2 Register and Data Format

Command Data (Read / Write)

Register No.		Bit	Content
2500H	Reserved		
2501H	Operation Signal	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	Reserved
		D	Reserved
		E	Inverter mode 1 : “ON”
		F	Reserved
2502H		Frequency Command (Unit: 0.01Hz)	
2503H		Reserved	
2504H		Reserved	
2505H		AO1 (0 ~ 1000): Voltage (0.00V ~ 10.00V); Current (4mA~20mA)	
2506H		AO2 (0 ~ 1000): Voltage (0.00~10.00V); Current (4mA~20mA)	
2507H		DO	
2508H		Reserved	
2509H		Reserved	
250AH		Reserved	
250BH		Reserved	
250CH		Reserved	
250DH		Reserved	
250EH		Reserved	
250FH		Reserved	
2510H		G12-00 H-WORD	
2511H		G12-00 L-WORD	

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 : Fault	
		4	Warning	1 :“ON”	
		5	Zero Speed	1 :“ON”	
		6	Is440V	1 :“ON”	
		7	Frequency Agree	1 :“ON”	
		8	Set Frequency Agree	1 :“ON”	
		9	Frequency Detection 1	1 :“ON”	
		A	Frequency Detection 2	1 :“ON”	
		B	UnderVoltage	1 :“ON”	
		C	Baseblock	1 :“ON”	
		D	Freq Ref. not from Comm.	1 :“ON”	
		E	Seq. not from Comm.	1 :“ON”	
		F	OverTorque	1 :“ON”	

Register No.		Bit		Bit	
2521H	Error Description	0		31	Reserved
		1	UV	32	Reserved
		2	OC	33	Reserved
		3	OV	34	Reserved
		4	OH1	35	Reserved
		5	OL1	36	Low Suction Fault
		6	OL2	37	Low Suction Fault (with retry)
		7	OT	38	CF07
		8	UT	39	Low Flow Fault
		9	SC	40	High Flow Fault
		10	Ground OC	41	Reserved
		11	Fuse blown	42	Low Pressure Fault
		12	Input Phase Loss	43	High Pressure Fault
		13	Output Phase Loss	44	Feedback Loss
		14	Reserved	45	Reserved
		15	Reserved	46	Motor Overheat (OH4)
		16	Reserved		
		17	External Fault 01		
		18	External Fault 02		
		19	External Fault 03		
		20	External Fault 04		
		21	External Fault 05		
		22	External Fault 06		
		23	Reserved		
		24	Reserved		
		25	Feedback Fault		
		26	Keypad Removed		

		27	Modbus External Fault			
		28	CE			
		29	STO			
		30	Reserved			

2522H	DI State		Multi-function Comm S1
		1	Multi-function Comm S2
		2	Multi-function Comm S3
		3	Multi-function Comm S4
		4	Multi-function Comm S5
		5	Multi-function Comm S6
		6	Reserved
		7	Reserved
		8	Reserved
		9	Reserved
		A	Reserved
		B	Reserved
		C	Reserved
		D	Reserved
		E	Reserved
		F	Reserved

2523H	Frequency Command
2524H	Output Frequency
2525H	Reserved
2526H	DC Voltage Command
2527H	Output Current

2528H								
0	No alarm	18	EF2	36	SE03	54	BB6
1	OV	19	EF3	37	SE04	55	Reserved
2	UV	20	EF4	38	SE05	56	Reserved
3	OL2	21	EF5	39	HPERR	57	LOPb
4	OH2	22	EF6	40	EF	58	HIPb
5	Reserved	23	Reserved	41	CTRLE	59	LSCFT
6	OT	24	Reserved	42	SUME	60	LOPb
7	Reserved	25	CLA	43	RDP	61	RETRY
8	Reserved	26	CLB	44	Reserved	62	SE07
9	UT	27	Reserved	45	OL1	63	SE08
10	Reserved	28	Reserved	46	Reserved	64	HIPb
11	Reserved	29	USP	47	SE10	65	OH1
12	Reserved	30	RDE	48	Reserved	66	FIRE
13	CE	31	WRE	49	BB1		
14	Reserved	32	FB	50	BB2		
15	Reserved	33	VRYE	51	BB3		
16	EF0	34	SE01	52	BB4		
17	EF1	35	SE02	53	BB5		

2529H	Digital Output State
252AH	AO1 (0 ~ 1000): Voltage (0.00V ~ 10.00V); Current (4mA~20mA)
252BH	AO2 (0 ~ 1000): Voltage (0.00~10.00V); Current (4mA~20mA)

252CH			Analog Input 1
252DH			Analog Input 2
252EH			Reserved
252FH			F510 Check

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

* Data amount is register amount x 2

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

1.0.3 Parameter Data

Function	Register No	Function	Register No	Function	Register No
Group 0		Group 0		Group 1	
0-00	0000H	0 – 43	002BH	1 – 00	0100H
0-01	0001H	0 – 44	002CH	1 – 01	0101H
0-02	0002H	0 – 45	002DH	1 – 02	0102H
0-03	0003H	0 – 46	002EH	1 – 03	0103H
0-04	0004H	0 – 47	002FH	1 – 04	0104H
0-05	0005H	0 – 48	0030H	1 – 05	0105H
0-06	0006H	0 – 49	0031H	1 – 06	0106H
0-07	0007H	0 – 50	0032H	1 – 07	0107H
0-08	0008H	0 – 51	0033H	1 – 08	0108H
0-09	0009H	0 – 52	0034H	1 – 09	0109H
0-10	000AH	0 – 53	0035H	1 – 10	010AH
0-11	000BH	0 – 54	0036H	1 – 11	010BH
0-12	000CH	0 – 55	0037H	1 – 12	010CH
0-13	000DH	0 – 56	0038H	1 – 13	010DH
0-14	000EH			1 – 14	010EH
0-15	000FH			1 – 15	010FH
0-16	0010H				
0-17	0011H				
0-18	0012H				
0-19	0013H				
0-20	0014H				
0-21	0015H				
0-22	0016H				
0-23	0017H				
0-24	0018H				
0-25	0019H				
0-26	001AH				
0-27	001BH				
0-28	001CH				
0-29	001DH				
0-30	001EH				
0-31	001FH				
0-32	0020H				
0 – 33	0021H				
0 – 34	0022H				
0 – 35	0023H				
0 – 36	0024H				
0 – 37	0025H				
0 – 38	0026H				
0 – 39	0027H				
0 – 40	0028H				
0 – 41	0029H				
0 – 42	002AH				

Function	Register No	Function	Register No	Function	Register No
Group 2		Group 3		Group 3	
2 – 00	0200H	3 – 00	0300H	3 – 33	0321H
2 – 01	0201H	3 – 01	0301H	3 – 34	0322H
2 – 02	0202H	3 – 02	0302H	3 – 35	0323H
2 – 03	0203H	3 – 03	0303H	3 – 36	0324H
2 – 04	0204H	3 – 04	0304H	3 – 37	0325H
2 – 05	0205H	3 – 05	0305H	3 – 38	0326H
2 – 06	0206H	3 – 06	0306H	3 – 39	0327H
2 – 07	0207H	3 – 07	0307H	3 – 40	0328H
2 – 08	0208H	3 – 08	0308H		
2 – 09	0209H	3 – 09	0309H		
2 – 10	020AH	3 – 10	030AH		
2 – 11	020BH	3 – 11	030BH		
2 – 12	020CH	3 – 12	030CH		
2 – 13	020DH	3 – 13	030DH		
2 – 14	020EH	3 – 14	030EH		
2 – 15	020FH	3 – 15	030FH		
2 – 16	0210H	3 – 16	0310H		
2 – 17	0211H	3 – 17	0311H		
2 – 18	0212H	3 – 18	0312H		
2 – 19	0213H	3 – 19	0313H		
2 – 33	0221H	3 – 20	0314H		
2 – 34	0222H	3 – 21	0315H		
		3 – 22	0316H		
		3 – 23	0317H		
		3 – 24	0318H		
		3 – 25	0319H		
		3 – 26	031AH		
		3 – 27	031BH		
		3 – 28	031CH		
		3 – 29	031DH		
		3 – 30	031EH		
		3 – 31	031FH		
		3 – 32	0320H		

Function	Register No	Function	Register No	Function	Register No
Group 4		Group 5		Group 5	
4 – 00	0400H	5 – 00	0500H	5 – 33	0521H
4 – 01	0401H	5 – 01	0501H	5 – 34	0522H
4 – 02	0402H	5 – 02	0502H	5 – 35	0523H
4 – 03	0403H	5 – 03	0503H	5 – 36	0524H
4 – 04	0404H	5 – 04	0504H	5 – 37	0525H
4 – 05	0405H	5 – 05	0505H	5 – 38	0526H
4 – 06	0406H	5 – 06	0506H	5 – 39	0527H
4 – 07	0407H	5 – 07	0507H	5 – 40	0528H
4 – 08	0408H	5 – 08	0508H	5 – 41	0529H
4 – 09	0409H	5 – 09	0509H	5 – 42	052AH
4 – 10	040AH	5 – 10	050AH	5 – 43	052BH
4 – 11	040BH	5 – 11	050BH	5 – 44	052CH
4 – 12	040CH	5 – 12	050CH	5 – 45	052DH
4 – 13	040DH	5 – 13	050DH	5 – 46	052EH
4 – 14	040EH	5 – 14	050EH	5 – 47	052FH
4 – 15	040FH	5 – 15	050FH	5 – 48	0530H
4 – 16	0410H	5 – 16	0510H		
4 – 17	0411H	5 – 17	0511H		
4 – 18	0412H	5 – 18	0512H		
4 – 19	0413H	5 – 19	0513H		
4 – 20	0414H	5 – 20	0514H		
		5 – 21	0515H		
		5 – 22	0516H		
		5 – 23	0517H		
		5 – 24	0518H		
		5 – 25	0519H		
		5 – 26	051AH		
		5 – 27	051BH		
		5 – 28	051CH		
		5 – 29	051DH		
		5 – 30	051EH		
		5 – 31	051FH		
		5 – 32	0520H		

Function	Register No	Function	Register No	Function	Register No
Group 6		Group 6		Group 7	
6 – 00	0600H	6 – 33	0621H	7 – 00	0700H
6 – 01	0601H	6 – 34	0622H	7 – 01	0701H
6 – 02	0602H	6 – 35	0623H	7 – 02	0702H
6 – 03	0603H	6 – 36	0624H	7 – 03	0703H
6 – 04	0604H	6 – 37	0625H	7 – 04	0704H
6 – 05	0605H	6 – 38	0626H	7 – 05	0705H
6 – 06	0606H	6 – 39	0627H	7 – 06	0706H
6 – 07	0607H	6 – 40	0628H	7 – 07	0707H
6 – 08	0608H	6 – 41	0629H	7 – 08	0708H
6 – 09	0609H	6 – 42	062AH	7 – 09	0709H
6 – 10	060AH	6 – 43	062BH	7 – 10	070AH
6 – 11	060BH	6 – 44	062CH	7 – 11	070BH
6 – 12	060CH	6 – 45	062DH	7 – 12	070CH
6 – 13	060DH	6 – 46	062EH	7 – 13	070DH
6 – 14	060EH	6 – 47	062FH	7 – 14	070EH
6 – 15	060FH			7 – 15	070FH
6 – 16	0610H			7 – 16	0710H
6 – 17	0611H			7 – 17	0711H
6 – 18	0612H			7 – 18	0712H
6 – 19	0613H			7 – 19	0713H
6 – 20	0614H			7 – 20	0714H
6 – 21	0615H			7 – 21	0715H
6 – 22	0616H			7 – 22	0716H
6 – 23	0617H			7 – 23	0717H
6 – 24	0618H			7 – 24	0718H
6 – 25	0619H			7 – 25	0719H
6 – 26	061AH			7 – 26	071AH
6 – 27	061BH			7 – 27	071BH
6 – 28	061CH			7 – 28	071CH
6 – 29	061DH			7 – 29	071DH
6 – 30	061EH				
6 – 31	061FH				
6 – 32	0620H				

Function	Register No	Function	Register No	Function	Register No
Group 8		Group 9		Group 10	
8 – 00	0800H	9 – 00	0900H	10 – 00	0A00H
8 – 01	0801H	9 – 01	0901H	10 – 01	0A01H
8 – 02	0802H	9 – 02	0902H	10 – 02	0A02H
8 – 03	0803H	9 – 03	0903H	10 – 03	0A03H
8 – 04	0804H	9 – 04	0904H	10 – 04	0A04H
8 – 05	0805H	9 – 05	0905H	10 – 05	0A05H
8 – 06	0806H	9 – 06	0906H	10 – 06	0A06H
8 – 07	0807H	9 – 07	0907H	10 – 07	0A07H
8 – 08	0808H	9 – 08	0908H	10 – 08	0A08H
8 – 09	0809H	9 – 09	0909H	10 – 09	0A09H
8 – 10	080AH	9 – 10	090AH	10 – 10	0A0AH
8 – 11	080BH			10 – 11	0A0BH
8 – 12	080CH			10 – 12	0A0CH
8 – 13	080DH			10 – 13	0A0DH
8 – 14	080EH			10 – 14	0A0EH
8 – 15	080FH			10 – 15	0A0FH
8 – 16	0810H			10 – 16	0A10H
8 – 17	0811H			10 – 17	0A11H
8 – 18	0812H			10 – 18	0A12H
8 – 19	0813H			10 – 19	0A13H
8 – 20	0814H			10 – 20	0A14H
8 – 21	0815H			10 – 21	0A15H
8 – 22	0816H			10 – 22	0A16H
8 – 23	0817H			10 – 23	0A17H
8 – 24	0818H			10 – 24	0A18H
8 – 25	0819H			10 – 25	0A19H
8 – 26	081AH			10 – 26	0A1AH
8 – 27	081BH			10 – 27	0A1BH
8 – 28	081CH			10 – 28	0A1CH
8 – 29	081DH			10 – 29	0A1DH
8 – 30	081EH			10 – 30	0A1EH
8 – 31	081FH			10 – 31	0A1FH
8 – 32	0820H			10 – 32	0A20H
8 – 33	0821H			10 – 33	0A21H
8 – 34	0822H			10 – 34	0A22H
8 – 35	0823H			10 – 35	0A23H
8 – 36	0824H			10 – 36	0A24H
8 – 37	0825H			10 – 37	0A25H
8 – 38	0826H			10 – 38	0A26H
8 – 39	0827H			10 – 39	0A27H

Function	Register No	Function	Register No	Function	Register No
Group 11		**Group 12**		**Group 12**	
11 – 00	0B00H	11 – 33	0B21H	12 – 00	0C00H
11 – 01	0B01H	11 – 34	0B22H	12 – 01	0C01H
11 – 02	0B02H	11 – 35	0B23H	12 – 02	0C02H
11 – 03	0B03H	11 – 36	0B24H	12 – 03	0C03H
11 – 04	0B04H	11 – 37	0B25H	12 – 04	0C04H
11 – 05	0B05H	11 – 38	0B26H	12 – 05	0C05H
11 – 06	0B06H	11 – 39	0B27H	12 – 06	0C06H
11 – 07	0B07H	11 – 40	0B28H	12 – 07	0C07H
11 – 08	0B08H	11 – 41	0B29H	12 – 08	0C08H
11 – 09	0B09H	11 – 42	0B2AH	12 – 09	0C09H
11 – 10	0B0AH	11 – 43	0B2BH	12 – 10	0C0AH
11 – 11	0B0BH	11 – 44	0B2CH	12 – 11	0C0BH
11 – 12	0B0CH	11 – 45	0B2DH	12 – 12	0C0CH
11 – 13	0B0DH	11 – 46	0B2EH	12 – 13	0C0DH
11 – 14	0B0EH	11 – 47	0B2FH	12 – 14	0C0EH
11 – 15	0B0FH	11 – 48	0B30H	12 – 15	0C0FH
11 – 16	0B10H	11 – 49	0B31H	12 – 16	0C10H
11 – 17	0B11H	11 – 50	0B32H	12 – 17	0C11H
11 – 18	0B12H	11 - 51	0B33H	12 – 18	0C12H
11 – 19	0B13H	11 – 52	0B34H	12 – 19	0C13H
11 – 20	0B14H	11 – 53	0B35H	12 – 20	0C14H
11 – 21	0B15H	11 – 54	0B36H	12 – 21	0C15H
11 – 22	0B16H	11 – 55	0B37H	12 – 22	0C16H
11 – 23	0B17H	11 – 56	0B38H	12 – 23	0C17H
11 – 24	0B18H	11 – 57	0B39H	12 – 24	0C18H
11 – 25	0B19H	11 – 58	0B3AH	12 – 25	0C19H
11 – 26	0B1AH	11 – 59	0B3BH	12 – 26	0C1AH
11 – 27	0B1BH	11 – 60	0B3CH	12 – 27	0C1BH
11 – 28	0B1CH	11 – 61	0B3DH	12 – 28	0C1CH
11 – 29	0B1DH	11 – 62	0B3EH	12 – 29	0C1DH
11 – 30	0B1EH	11 – 63	0B3FH	12 – 30	0C1EH
11 – 31	0B1FH	11 – 64	0B40H	12 – 31	0C1FH
11 - 32	0B20H	11 – 65	0B41H	12 - 32	0C20H

Function	Register No	Function	Register No	Function	Register No
Group 12		Group 12		Group 13	
12 – 33	0C21H	12 – 73	0C49H	13 – 00	0D00H
12 – 34	0C22H	12 – 74	0C4AH	13 – 01	0D01H
12 – 35	0C23H	12 – 75	0C4BH	13 – 02	0D02H
12 – 36	0C24H	12 – 76	0C4CH	13 – 03	0D03H
12 – 37	0C25H			13 – 04	0D04H
12 – 38	0C26H			13 – 05	0D05H
12 – 39	0C27H			13 – 06	0D06H
12 – 40	0C28H			13 – 07	0D07H
12 – 41	0C29H			13 – 08	0D08H
12– 42	0C2AH			13 – 09	0D09H
12 – 43	0C2BH			13 – 10	0D0AH
12 – 44	0C2CH			13 – 11	0D0BH
12– 45	0C2DH			13 – 12	0D0CH
12 – 46	0C2EH			13 – 13	0D0DH
12 – 47	0C2FH				
12 – 48	0C30H				
12 – 49	0C31H				
12 – 50	0C32H				
12 – 51	0C33H				
12 – 52	0C34H				
12 – 53	0C35H				
12 – 54	0C36H				
12 – 55	0C37H				
12 – 56	0C38H				
12 – 57	0C39H				
12 – 58	0C3AH				
12 – 59	0C3BH				
12 – 60	0C3CH				
12 – 61	0C3DH				
12 – 62	0C3EH				
12 – 63	0C3FH				
12 – 64	0C40H				
12 – 65	0C41H				
12 – 66	0C42H				
12 – 67	0C43H				
12 – 68	0C44H				
12 – 69	0C45H				
12 – 70	0C46H				
12 – 71	0C47H				
12 – 72	0C48H				
12 – 73	0C49H				
12 – 70	0C46H				
12 – 71	0C47H				
12 – 72	0C48H				

Function	Register No	Function	Register No	Function	Register No
Group 14		Group 14		Group 15	
14 – 00	0E00H	14 – 44	0E2CH	15 – 00	0F00H
14 – 01	0E01H	14 – 45	0E2DH	15 – 01	0F01H
14 – 02	0E02H	14 – 46	0E2EH	15 – 02	0F02H
14 – 03	0E03H	14 – 47	0E2FH	15 – 03	0F03H
14 – 04	0E04H			15 – 04	0F04H
14 – 05	0E05H			15 – 05	0F05H
14 – 06	0E06H			15 – 06	0F06H
14 – 07	0E07H			15 – 07	0F07H
14 – 08	0E08H			15 – 08	0F08H
14 – 09	0E09H			15 – 09	0F09H
14 – 10	0E0AH			15 – 10	0F0AH
14 – 11	0E0BH			15 – 11	0F0BH
14 – 12	0E0CH			15 – 12	0F0CH
14 – 13	0E0DH			15 – 13	0F0DH
14 – 14	0E0EH			15 – 14	0F0EH
14 – 15	0E0FH			15 – 15	0F0FH
14 – 16	0E10H			15 – 16	0F10H
14 – 17	0E11H			15 – 17	0F11H
14 – 18	0E12H			15 – 18	0F12H
14 – 19	0E13H			15 – 19	0F13H
14 – 20	0E14H			15 – 20	0F14H
14 – 21	0E15H			15 – 21	0F15H
14 – 22	0E16H			15 – 22	0F16H
14 – 23	0E17H			15 – 23	0F17H
14 – 24	0E18H			15 – 24	0F18H
14 – 25	0E19H			15 – 25	0F19H
14 – 26	0E1AH			15 – 26	0F1AH
14 – 27	0E1BH			15 – 27	0F1BH
14 – 28	0E1CH			15 – 28	0F1CH
14 – 29	0E1DH			15 – 29	0F1DH
14 – 30	0E1EH			15 – 30	0F1EH
14 – 31	0E1FH			15 – 31	0F1FH
14 – 32	0E20H			15 – 32	0F20H
14 – 33	0E21H				
14 – 34	0E22H				
14 – 35	0E23H				
14 – 36	0E24H				
14 – 37	0E25H				
14 – 38	0E26H				
14 – 39	0E27H				
14 – 40	0E28H				
14 – 41	0E29H				
14 – 42	0E2AH				
14 – 43	0E2BH				

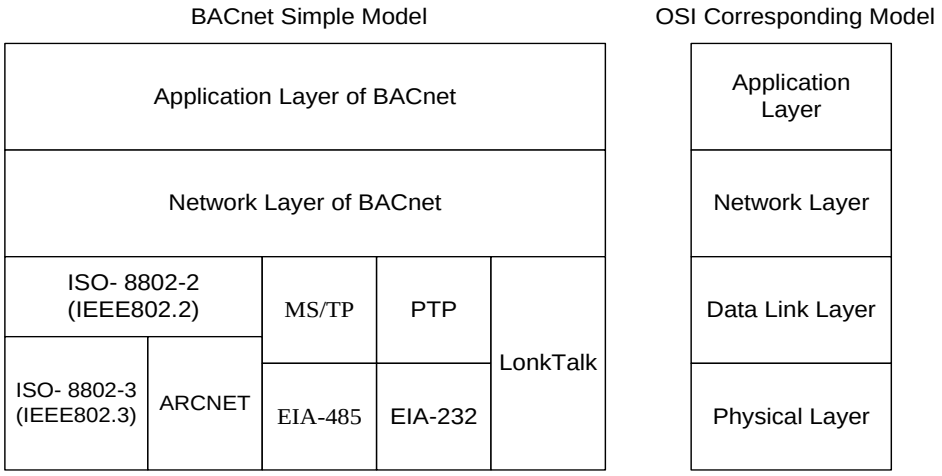
Function	Register No	Function	Register No	Function	Register No
Group 16		**Group 17**		**Group 18**	
16 – 00	1000H	17 – 00	1100H	18 – 00	1200H
16 – 01	1001H	17 – 01	1101H	18 – 01	1201H
16 – 02	1002H	17 – 02	1102H	18 – 02	1202H
16 – 03	1003H	17 – 03	1103H	18 – 03	1203H
16 – 04	1004H	17 – 04	1104H	18 – 04	1204H
16 – 05	1005H	17 – 05	1105H	18 – 05	1205H
16 – 06	1006H	17 – 06	1106H	18 – 06	1206H
16– 07	1007H	17 – 07	1107H		
16 – 08	1008H	17 – 08	1108H		
16 – 09	1009H	17– 09	1109H		
16 – 10	100AH	17 – 10	110AH		
16 – 11	100BH	17 – 11	110BH		
16 – 12	100CH	17 – 12	110CH		
16 – 13	100DH	17 – 13	110DH		
16 – 14	100EH				
16 – 15	100FH				
16 – 16	1010H				
16 – 17	1011H				
16 – 18	1012H				
16 – 19	1013H				
16 – 20	1014H				
16 – 21	1015H				
16 – 22	1016H				
16 – 23	1017H				
16 – 24	1018H				
16 – 25	1019H				
16 – 26	101AH				
16 – 27	101BH				
16 – 28	101CH				
16 – 29	101DH				
16 – 30	101EH				
16 – 31	101FH				
16 – 32	1020H				
16 – 33	1021H				
16 – 34	1022H				
16 – 35	1023H				
16 – 36	1024H				
16 – 37	1025H				

Function	Register No	Function	Register No	Function	Register No
Group 20		Group 21		Group 22	
20 – 00	1400H	21 – 00	1500H	22 – 00	1600H
20 – 01	1401H	21 – 01	1501H	22 – 01	1601H
20 – 02	1402H	21 – 02	1502H	22 – 02	1602H
20 – 03	1403H	21 – 03	1503H	22 – 03	1603H
20 – 04	1404H	21 – 04	1504H	22 – 04	1604H
20 – 05	1405H	21 – 05	1505H	22 – 05	1605H
20 – 06	1406H	21 – 06	1506H	22 – 06	1606H
20 – 07	1407H	21 – 07	1507H	22 – 07	1607H
20 – 08	1408H	21 – 08	1508H	22 – 08	1608H
20 – 09	1409H			22 – 09	1609H
20 – 10	140AH			22 – 10	160AH
20 – 11	140BH			22 – 11	160BH
20 – 12	140CH			22 – 12	160CH
20 – 13	140DH			22 – 13	160DH
20 – 14	140EH			22 – 14	160EH
20 – 15	140FH			22 – 15	160FH
20 – 16	1410H			22 – 16	1610H
20 – 17	1411H			22 – 17	1611H
20 – 18	1412H			22 – 18	1612H
20 – 33	1421H			22 – 19	1613H
20 – 34	1422H			22 – 20	1614H
20 – 35	1423H			22 – 21	1615H
				22 – 22	1616H

Function	Register No	Function	Register No	Function	Register No
Group 23		Group 23		Group 24	
23 – 00	1700H	23 – 44	172CH	24 – 00	1800H
23 – 01	1701H	23 – 45	172DH	24 – 01	1801H
23 – 02	1702H	23 – 46	172EH	24 – 02	1802H
23 – 03	1703H	23 – 47	172FH	24 – 03	1803H
23 – 04	1704H	23 – 48	1730H	24 – 04	1804H
23 – 05	1705H	23 – 49	1731H	24 – 05	1805H
23 – 06	1706H	23 – 50	1732H	24 – 06	1806H
23 – 07	1707H	23 – 51	1733H		
23 – 08	1708H	23 – 52	1734H		
23 – 09	1709H	23 – 53	1735H		
23 – 10	170AH	23 – 54	1736H		
23 – 11	170BH	23 – 55	1737H		
23 – 12	170CH	23 – 56	1738H		
23 – 13	170DH	23 – 57	1739H		
23 – 14	170EH	23 – 58	173AH		
23 – 15	170FH				
23 – 16	1710H				
23 – 17	1711H				
23 – 18	1712H				
23 – 19	1713H				
23 – 20	1714H				
23 – 21	1715H				
23 – 22	1716H				
23 – 23	1717H				
23 – 24	1718H				
23 – 25	1719H				
23 – 26	171AH				
23 – 27	171BH				
23 – 28	171CH				
23 – 29	171DH				
23 – 30	171EH				
23 – 31	171FH				
23 – 32	1720H				
23 – 33	1721H				
23 – 34	1722H				
23 – 35	1723H				
23 – 36	1724H				
23 – 37	1725H				
23 – 38	1726H				
23 – 39	1727H				
23 – 40	1728H				
23 – 41	1729H				
23 – 42	172AH				
23 – 43	172BH				

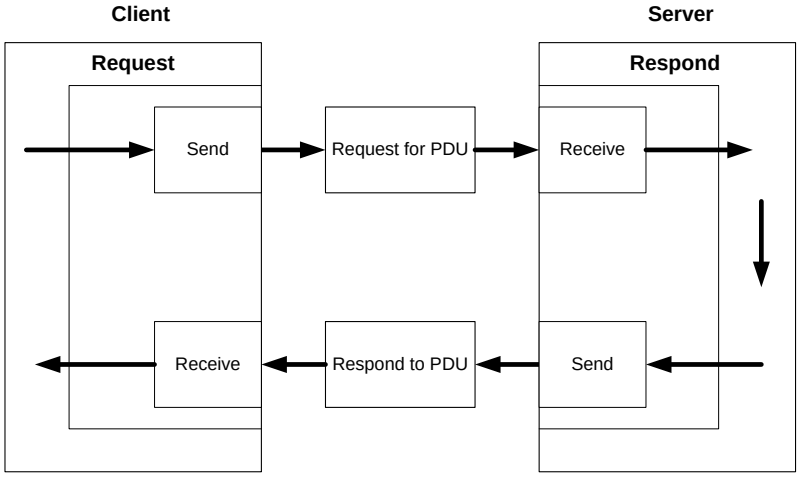
1.1 BACnet Protocol Descriptions

BACnet is in compliance with four-layers of the seven-layer structure models in OSI (Open Systems Interconnection) of International Standard Organization (ISO). The four-layers are application layer, network layer, data link layer and physical layer. BACnet uses “object” and “properties.” All BACnet devices are controlled via the property of the objects. Every controller with BACnet devices is considered an object collector so that every controller device can execute different functions supported by the objects to control and monitor a BACnet device.

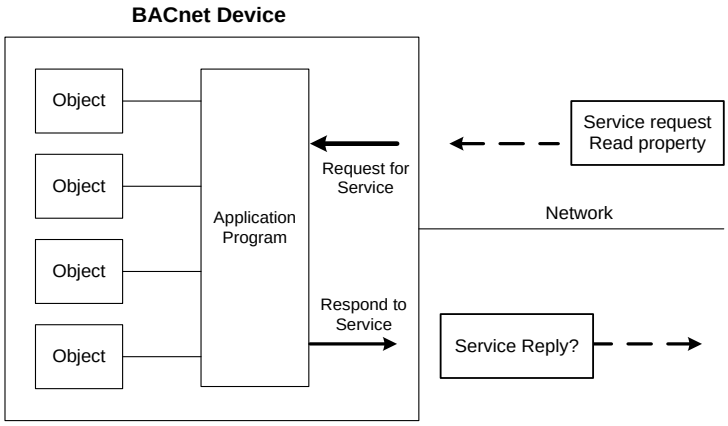


1.1.1 BACnet Services

Services provide commands to save or control information and functions for the purpose of monitoring and control. Example, a BACnet device receives information or a command to handle a request from another BACnet device therefor the two devices have to support the same service. To complete the exchange of these service messages, requires implementation of the communication protocol application layer. Therefore, services are parts of the communication protocol data unit (PDU) in the application layer and build the communication modes between the Server – Client. Client will send a service request to the Server and the Server needs to respond to Client to execute this service. Refer to the following figure.

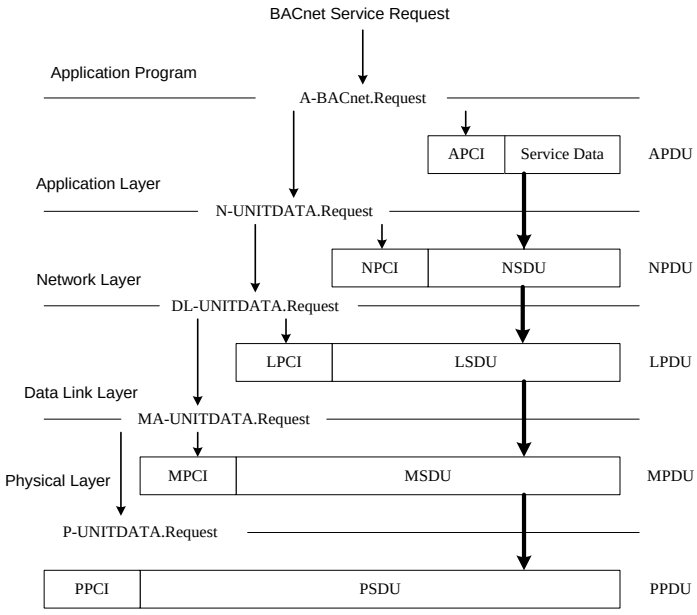


All BACnet devices use application programs to manage and handle services. Example: Application program has to display the status of every input so it requires sending the service request to the object of another device to update its display with the input status. The application program of the device needs to respond to the service request. Refer to the following figure.



1.1.2 BACnet Protocol Structure

The BACnet communication protocol is implemented by way of a protocol stack composed of stacked layer types. Refer to the following figure.



When an application program sends a BACnet service request, it is handled by the BACnet node in the application layer via the application program interface. The request is sent to the application layer and application protocol data unit (APDU) consists of Application Protocol Control Information (APCI) and Service Data of application program. It then passes the APDU downward to the BACnet request program in the network layer. APDU becomes Network Layer Protocol Data Unit (NPDU) composed of Network Service Data Unit (NSDU) and Network Protocol Control Information (NPCI) and the data link layer and physical layer complete the service request for the packet.

1.1.3 BACnet Specifications

The F510 inverter has a built-in BACnet MS/TP communication protocol. Control or monitor the inverter via BACnet allowing for reading and writing of specific parameters. The BACnet implementation supports the following standard objects:

- **Inverter Objects**
- **Analog Input**
- **Analog Output**
- **Analog Value**
- **Digital Input**
- **Digital Output**
- **Digital Value**

Refer to Table 4.7.3.1 for property information of each object. User can retrieve object properties using the dedicated BACnet software to control or monitor the inverter.

Table 4.6.3.1 Object and property supporting list

Property	Inverter (DEV)	Analog Input (AI)	Analog Output (AO)	Analog Value (AV)	Digital Input (BI)	Digital Output (BO)	Digital Value (BV)
Object_Identifier	V	V	V	V	V	V	V
Object_Name	V	V	V	V	V	V	V
Object_Type	V	V	V	V	V	V	V
System_Status	V						
Vendor_Name	V						
Vendor_ Identifier	V						
Model_Name	V						
Firmware_Revision	V						
Applocation_Software_Supported	V						
Protocol_Version	V						
Protocol_Revision	V						
Protocol_Services_Supported	V						
Protocol_Object_Type_Supported	V						
Object_List	V						
Max_APDU_Length_Accepted							
Segmentation_Supported							
APDU_Timeout							
Number_Of_APDU_Retries							
Max_Masters	V						
Max_Info_Frames	V						
Device_Address_Binding							
Location	V						
Presnent_Value		V	V	V	V	V	V
Status_Flags							
Event_State							
Reliability							
Out_Of_Service							
Units		V	V	V			
Priority_Array							
Relinquish_Default							
Polarity							
Inactive_Text							
Active_Text							

1.1.4 BACnet Object Properties

This section gives an overview of the BACnet objects supported by the inverter.

Refer to Table 4.6.4.1 for the inverter property information.

Refer to Table 4.6.4.2 ~ Table 4.7.4.7 for object information that the inverter supports.

Table 4.6.4.1 – Inverter property list

Property	Inverter
Object_Identifier	DEV
Object_Name	TECO F510
Object_Type	8
System_Status	0
Vendor_Name	TECO F510
Vendor_ Identifier	461
Model_Name	TECO.Inc
Firmware_Revision	0.14
Application_Software_Supported	0.14
Protocol_Version	1
Protocol_Revision	5
Protocol_Services_Supported	{ readProperty , writeProperty , who is }
Protocol_Object_Type_Supported	{ Analog_Input , Analog_Output, Analog_Value Binary_ Input, Binary_Output, Binary_Value, Device}
Max_Masters	127
Max_Info_Frames	1
Location	R.O.C

Table 4.6.4.2 Analog input property list (READ)

No.	Object Name	Description	Unit	Classification	Range
AI0	**TM2 AIN**	AI1 input	Volt	R	0 - 10
AI1	**TM2 AIN2**	AI2 input	Volt	R	0 - 10
AI2	**Error code**	Recent fault message	No Units	R	0 - 45
AI3	**Freq cmd**	Frequency command	Hz	R	0 - 60
AI4	**Frequency**	Output frequency	Hz	R	0 - 60
AI5	**Current**	Output current	Amps	R	
AI6	**Control Mode**	Control mode	No Units	R	0 - 2
AI7	**Motor R-Volt**	Motor rated voltage	Volt	R	
AI8	**Motor R-HP**	Motor rated power	horsepower	R	
AI9	**Motor R-RPM**	Motor rated rotation speed	No Units	R	
AI10	**Motor R-Hz**	Motor rated frequency	Hz	R	
AI11	**CarrierFreq**	Carrier frequency	kHz	R	4 - 16
AI12	**Comm Station**	INV communication station	No Units	R	1 - 254
AI13	**BaudRate**	Baudrate setting	No Units	R	0 - 3
AI14	**BacnetSel**	Communication mode selection	No Units	R	0 - 1
AI15	**DevInstance**	Inverter number	No Units	R	1 - 254

Table 4.6.4.3 – Analog output property list (READ/ WRITE)

No.	Object Name	Description	Unit	Classification	Range
AO0	**Set frequency**	Frequency command	Hz	R/W	0 - 60
AO1	**TB2 AO1**	Output voltage1	Volt	R	0 - 10
AO2	**TB2 AO2**	Output voltage2	Volt	R	0 - 10
AO3	**Motor R-Amp**	Motor rated current	Amps	R/W	0-65535
AO4	**PwrL Sel**	Momentary stop and restart selection	No Units	R	0 - 2
AO5	**RestartSel**	Number of Fault Auto-Restart Attempts	No Units	R	0 – 10
AO6	**RestartDelay**	Fault Auto-Restart Time	seconds	R	0 - 800
AO7	**FreqCommand1**	Speed frequency setting-stage 0	Hz	R/W	0 - 400
AO8	**FreqCommand2**	Speed frequency setting-stage 1	Hz	R/W	0 - 400
AO9	**FreqCommand3**	Speed frequency setting-stage 2	Hz	R/W	0 - 400
AO10	**FreqCommand4**	Speed frequency setting-stage 3	Hz	R/W	0 - 400
AO11	**FreqCommand5**	Speed frequency setting-stage 4	Hz	R/W	0 - 400
AO12	**FreqCommand6**	Speed frequency setting-stage 5	Hz	R/W	0 - 400
AO13	**FreqCommand7**	Speed frequency setting-stage 6	Hz	R/W	0 - 400
AO14	**FreqCommand8**	Speed frequency setting-stage 7	Hz	R/W	0 - 400
AO15	**FreqCommand9**	Speed frequency setting-stage 8	Hz	R/W	0 - 400
AO16	**FreqCommand10**	Speed frequency setting-stage 9	Hz	R/W	0 - 400
AO17	**FreqCommand11**	Speed frequency setting-stage 10	Hz	R/W	0 - 400
AO18	**FreqCommand12**	Speed frequency setting-stage 11	Hz	R/W	0 - 400
AO19	**FreqCommand13**	Speed frequency setting-stage 12	Hz	R/W	0 - 400
AO20	**FreqCommand14**	Speed frequency setting-stage 13	Hz	R/W	0 - 400
AO21	**FreqCommand15**	Speed frequency setting-stage 14	Hz	R/W	0 - 400
AO22	**FreqCommand16**	Speed frequency setting-stage 15	Hz	R/W	0 - 400
AO23	**RunMode**	Main run command source selection	No Units	R/W	0 - 2
AO24	**ReverseOper**	Direction locked command	No Units	R/W	0 - 1
AO25	**StoppingSel**	Stop modes selection	No Units	R/W	0 - 1
AO26	**FrequenceComm**	Main frequency command source selection	No Units	R/W	0 - 5
AO27	**FreqUpperLim**	Upper limit frequency	Hz	R/W	0 - 400
AO28	**FreqLowerLim**	Lower limit frequency Hz R	Hz	R/W	0 - 400
AO29	**Acc Time1**	Acceleration time 1	seconds	R/W	0 - 3600
AO30	**Dec Time1**	Deceleration time 1	seconds	R/W	0 - 3600

Table 4.7.4.4 Analog value property list (READ/ WRITE)

No.	Object Name	Description	Unit	Classification	Range
AV0	**PID – P Gain**	Proportional gain (P)	No Units	R/W	0 - 10
AV1	**PID – I Time**	Integral time (I)	No Units	R/W	0 - 100
AV2	**PID – D Time**	Differential time (D)	No Units	R/W	0 – 10

Table 4.7.4.5 Digital input property list (READ)

No.	Object Name	Description	Unit	Classification	Range
BI0	**Run/Stop**	Operation status	Stop / Run	R	0 - 1
BI1	**Direction**	Operation direction	FWD/REV	R	0 - 1
BI2	**status**	Inverter status	OK/Fault	R	0 - 1
BI3	**Abnormal**	Error occurs	Close/Open	R	0 - 1
BI4	**DI_1 status**	S1 status	Close/Open	R	0 - 1
BI5	**DI_2 status**	S2 status	Close/Open	R	0 - 1
BI6	**DI_3 status**	S3 status	Close/Open	R	0 - 1
BI7	**DI_4 status**	S4 status	Close/Open	R	0 - 1
BI8	**DI_5 status**	S5 status	Close/Open	R	0 - 1
BI9	**DI_6 status**	S6 status	Close/Open	R	0 - 1

Table 4.6.4.6 Digital output property list (READ/ WRITE)

No.	Object Name	Description	Unit	Classification	Range
BO0	**RY1 status**	Relay output 1 status	Close/Open	R	0 - 1
BO1	**RY2 status**	Relay output 2 status	Close/Open	R	0 - 1
BO2	**RY3 status**	Relay output 3 status	Close/Open	R	0 - 1

Table 4.7.4.7 Digital value property list (READ/ WRITE)

No.	Object Name	Description	Unit	Classification	Range
BV0	**RUN/STOP**	RUN/STOP	Stop / Run	R/W	0 - 1
BV1	**FWD/REV**	FWD/REV	FWD/REV	R/W	0 - 1

1.2 MetaSys N2 Communication Protocol

1.2.1 Introduction and Setup

This section describes Metasys N2 communication protocol. Connect Metasys controller to terminal S+ and S- of the RS485 and check that the Baud rate setting of parameter 09-02 is set to 9600 bps. To enable Metasys protocol set communication mode selection parameter 09-01 to 2 (MetaSys).

1.2.2 MetaSys N2 Specification

Serial Communication Interface	RS-485
Maximum Numbers of Connection	255 MetaSys N2 follower standard
Communication Speed	9600 (BPS)
Data Format	● Data byte: 8 byte ● Stop byte: 1 byte ● No parity
Access to Data	● 15 Analog input ● 10 Digital input ● 34 Analog Output ● 5 Digital output
Commands Supported	Support the following command 0/0 : Time Setting Command 0/4, 0/5 : Poll Command 0/8 : Warm Reset Command 1 : Read Command 2 : Write Command F : Identify Device Command
	The following Override command is enabled but it will not clear automatically after 10 minutes. 7/2/3 : AO Override command 7/2/4 : BO Override command The following command will respond but not execute this action. 7/3 : Remove Override command 7/2/1 : AI Override command 7/2/2 : BI Override command

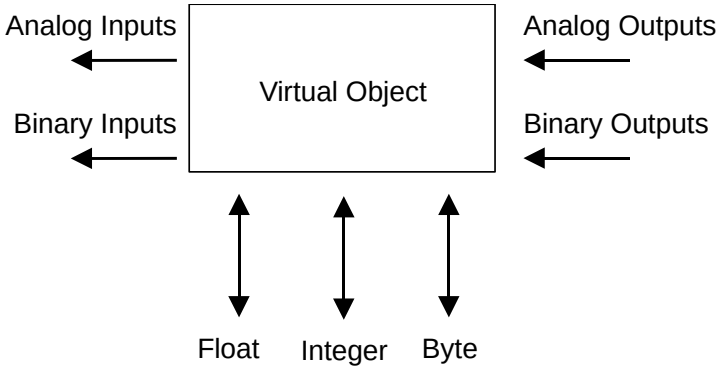
1.2.3 Definition of MetaSys N2 Communication Protocol

MetaSys N2 is a communication protocol developed by Johnson Control Company. MetaSys N2 communication protocol uses a Master/Follower configuration. Each N2 Follower has to set to a unique N2 address that can range from 1 to 255.

The data for each N2 Follower is displayed by the object and Network Point Type (NPT) and is supports seven types of objects:

No.	NPT Name	NPT (abbreviation)	Description
1	Analog input	AI	32-bit, IEEE- Standard floating-point
2	Binary input	BI	1-bit
3	Analog output	AO	32-bit, IEEE- Standard floating-point
4	Binary output	BO	1-bit
5	Internal floating-point	ADF	32-bit, IEEE- Standard floating-point
6	Internal integer	ADI	16-bit
7	Internal Bytes	DB	8-bit

The input and output are mainly used by the N2 network. The input is the data send from the N2 Follower to N2 network and the output is the data sent from the N2 network to the N2 Follower.



The object of N2 Follower has grouping and every group data can be set the address of 0-255, abbreviated for NPA (Network Point Address).

Every object consists of a property that holds object data (AI and AO object), object status (BI and BI object data), and message handling (if COS can respond or not). Each property can be read or changed but the data value of analog output and digital output requires an Override command to modify the data value.

N2 supports a Change of State function (COS) that allows object of AO, BI, and BO to automatically report a change of data and respond back using a poll message.

N2 Follower device starts communicating with the N2 Network controller after receiving an identifier command.

1.2.4. MetaSys N2 Communication Protocol in F510 Model

F510 models support four NPTs: AI, AO, BI and BO, it does not support the following functions:

- JCI property or field.
- Analog Alarm and Analog Warning for AI. The fields can read or changed but are not used.
- Override function for AI and BI.
- Override function in AO and BO do not restore back to default value when releasing the override.

The followings are the supporting properties list in AI, AO, BI and BO for F510 models:

(1) AI Property List

No.	Data Type	Description	Notes
1	Byte	Object Configuration	READ/ WRITE
2	Byte	Object Status	READ ONLY
3	Float	Analog Input Value	READ ONLY

(2) BI Property List

No.	Data Type	Description	Notes
1	Byte	Object Configuration	READ/ WRITE
2	Byte	Object Status	READ ONLY

(3) AO Property List

No.	Data Type	Description	Notes
1	Byte	Object Configuration	READ/ WRITE
2	Byte	Object Status	READ ONLY
3	Float	Current Value	READ/ Override

(4) BO Property List

No.	Data Type	Description	Notes
1	Byte	Object Configuration	READ/ WRITE
2	Byte	Object Status	READ/ Override
3	Integer	Minimum On-time	READ/ WRITE
4	Integer	Minimum On-time	READ/ WRITE
5	Integer	Maximum Cycles/Hour	READ/ WRITE

The followings are parameters F510 models can read and write via MetaSys communication.

Analog input property list (READ)

No.	Object Name	F510 Parameters	Unit	Classification	Range
AI1	Motor R-RPM	02-03 Motor Rated Rotation Speed	No Units	R	0 ~ 60000
AI2	Motor R-Volt	02-04 Motor Rated Voltage	Volt	R	0~240.0/0~480.0
AI3	Motor R-HP	02-05 Motor Rated Power	horsepower	R	0~600.00
AI4	Motor R-Hz	02-06 Motor Rated Frequency	Hz	R	0.00 ~ 400.00
AI5	Comm Station	09-00 INV Communication Station Address	No Units	R	1 - 254
AI6	CommSel	09-01 Communication Mode Selection	No Units	R	0 ~ 3
AI7	BaudRate	09-02 Baud Rate Setting	No Units	R	0 ~ 5
AI8	CarrierFreq	11-01 Carrier Frequency	kHz	R	0 ~ 16
AI9	Freq cmd	12-16 Frequency Command	Hz	R	0.00 ~ 400.00
AI10	Frequency	12-17 Output Frequency	Hz	R	0.00 ~ 400.00
AI11	Current	12-18 Output Current	Amps	R	0.0~6553.5
AI12	Control Mode	12-24 Control Mode	No Units	R	0 ~ 5
AI13	TM2 AIN	12-25 AI1 Input	Volt	R	0 ~ 100.0
AI14	TM2 AIN2	12-26 AI2 Input	Volt	R	0 ~ 100.0
AI15	Error code	12-45 Recent Fault Message	No Units	R	0 ~ 45

Analog output property list (READ/ Write)

No.	Object Name	F510 Parameters	Unit	Classification	Range
AO1	Set frequency	Register 2502H	Hz	R/W	0 ~ 400.00
AO2	AO1	Register 2505H	Volt/ Amps	R	0.00 ~ 100.00
AO3	AO2	Register 2506H	Volt/ Amps	R	0 .00 ~ 100.00
AO4	RunSource	00-02 Main Run Command Source Selection	No Units	R/W	0 ~ 4
AO5	FrequenceComm	00-05 Main Frequency Command Source Selection	No Units	R/W	0 ~ 6
AO6	FreqUpperLim	00-12 Upper Limit Frequency	Hz	R/W	0 – 109
AO7	FreqLowerLim	00-13 Lower Limit Frequency	Hz	R/W	0 - 109
AO8	Acc Time1	00-14 Acceleration Time 1	seconds	R/W	0 ~ 6000.0
AO9	Dec Time1	00-15 Deceleration Time 1	seconds	R/W	0 ~ 6000.0
AO10	Motor R-Amp	02-01 Motor Rated Current	Amps	R/W	1 ~ 999.9
AO11	FreqCommand1	05-01 Frequency Setting of	Hz	R/W	0 ~ 400.00

No.	Object Name	F510 Parameters	Unit	Classification	Range
		Speed-Stage 0			
AO12	FreqCommand2	06-01 Frequency Setting of Speed-Stage 1	Hz	R/W	0 ~ 400.00
AO13	FreqCommand3	06-02 Frequency Setting of Speed-Stage 2	Hz	R/W	0 ~ 400.00
AO14	FreqCommand4	06-03 Frequency Setting of Speed-Stage 3	Hz	R/W	0 ~ 400.00
AO15	FreqCommand5	06-04 Frequency Setting of Speed-Stage 4	Hz	R/W	0 ~ 400.00
AO16	FreqCommand6	06-05 Frequency Setting of Speed-Stage 5	Hz	R/W	0 ~ 400.00
AO17	FreqCommand7	06-06 Frequency Setting of Speed-Stage 6	Hz	R/W	0 ~ 400.00
AO18	FreqCommand8	06-07 Frequency Setting of Speed-Stage 7	Hz	R/W	0 ~ 400.00
AO19	FreqCommand9	06-08 Frequency Setting of Speed-Stage 8	Hz	R/W	0 ~ 400.00
AO20	FreqCommand10	06-09 Frequency Setting of Speed-Stage 9	Hz	R/W	0 ~ 400.00
AO21	FreqCommand11	06-10 Frequency Setting of Speed-Stage 10	Hz	R/W	0 ~ 400.00
AO22	FreqCommand12	06-11 Frequency Setting of Speed-Stage 11	Hz	R/W	0 ~ 400.00
AO23	FreqCommand13	06-12 Frequency Setting of Speed-Stage 12	Hz	R/W	0 ~ 400.00
AO24	FreqCommand14	06-13 Frequency Setting of Speed-Stage 13	Hz	R/W	0 ~ 400.00
AO25	FreqCommand15	06-14 Frequency Setting of Speed-Stage 14	Hz	R/W	0 ~ 400.00
AO26	FreqCommand16	06-15 Frequency Setting of Speed-Stage 15	Hz	R/W	0 ~ 400.00
AO27	PwrL Sel	07-00 Momentary Power Loss/Fault Restart Selection	No Units	R	0 ~ 1
AO28	RestartDelay	07-01 Fault Auto-Restart Time	seconds	R	0 ~ 7200
AO29	RestartSel	07-02 Number of Fault Auto-Restart Attempts	No Units	R	0 ~ 10
AO30	StoppingSel	07-09 Stop Mode Selection	No Units	R/W	0 - 1
AO31	PID – P Gain	10-05 Proportional Gain (P)	No Units	R/W	0 ~ 10.00
AO32	PID – I Time	10-06 Integral Time (I)	No Units	R/W	0 ~ 100.00
AO33	PID – D Time	10-07 Differential Time (D)	No Units	R/W	0 – 10.00
AO34	ReverseOper	11-00 Direction Lock Selection	No Units	R/W	0 ~ 2

Binary input property list (READ)

No.	Object Name	No Action / Action	Classification	Range
BI1	Run/ Stop	Stop/ Run	R	0 - 1
BI2	Direction	Forward/ Reverse	R	0 - 1
BI3	Status	OK/ Fault	R	0 - 1
BI4	Abnormal	Off/ On	R	0 - 1
BI5	DI_1 Status	Off/ On	R	0 - 1
BI6	DI_2 Status	Off/ On	R	0 - 1
BI7	DI_3 Status	Off/ On	R	0 - 1
BI8	DI_4 Status	Off/ On	R	0 - 1
BI9	DI_5 Status	Off/ On	R	0 - 1
BI10	DI_6 Status	Off/ On	R	0 - 1

Binary output property list (READ/ WRITE)

No.	Object Name	No Action / Action	Classification	Range
BO1	Run/ Stop	Stop/ Run	R/W	0 - 1
BO2	Forward/ Reverse	Forward/ Reverse	R/W	0 - 1
BO3	RY1 Status	Off/ On	R	0 - 1
BO4	RY2 Status	Off/ On	R	0 - 1
BO5	RY3 Status	Off/ On	R	0 - 1

MetaSys N2 Error Code List

Error Code	Cause
00	No identify command received at power up
01	Command not supported
02	Check Code Error
03	Data received exceeds 256 bytes
05	Incorrect command length
10	Data is out of the range
11	Save undefined fields or dedicated JCI fields
12	The parameter read only

1.3 Profibus Communication Option Card

1.3.1 Introduction

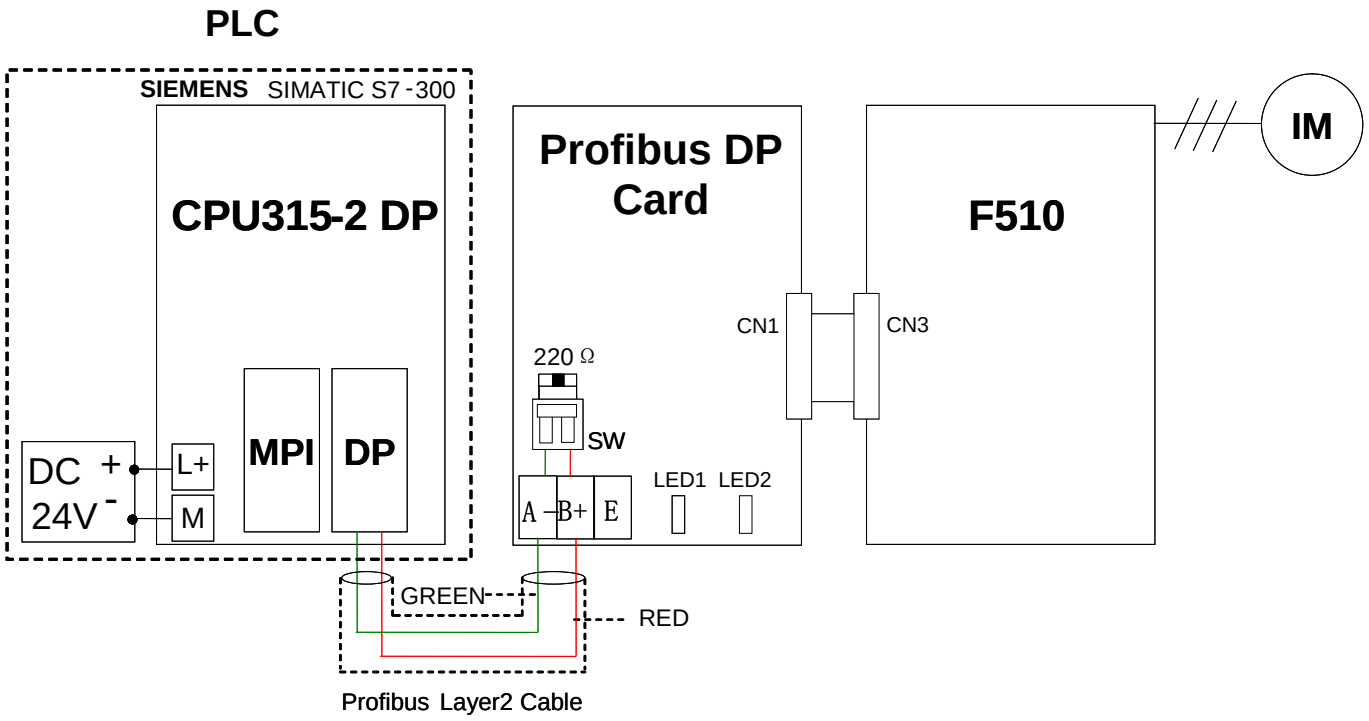
This is a detailed description and application setup for the F510 Profibus DP communication option card (JN5-CM-PMUS).

1.3.2 Specifications (JN50CM-PBUS)

The RS-485 port becomes unavailable for communication when the Profibus card is used.

Specification	Description								
Main Function	Connect F510 inverter with Profibus-DP network								
Suitable Inverter	F510 Series								
Mounting Base	Connector on F510 Control Board								
Maximum Connection	32 DP-Slave nodes								
Auto-Baud Search(bit/Sec)	9.6K	19.2K	93.75K	187.5K	500K	1.5M	3M	6M	12M
Transmission Distance(m)	1200	1200	1200	1000	400	200	100	100	100
Connection Medium	Profibus Layer 2 Cable								
Optic Coupler Isolation	Common Mode Rejection Vcm=50V,dV/dt=5000V/uSec								
Access Parameter	16 Words in, 16 Words out								
Terminal Resistor	DIP Switch Setting On Board								
LED Indication	Operation, Profibus communication								
Dimension	101 mm x 40.5 mm								

1.3.3 Wiring Diagram



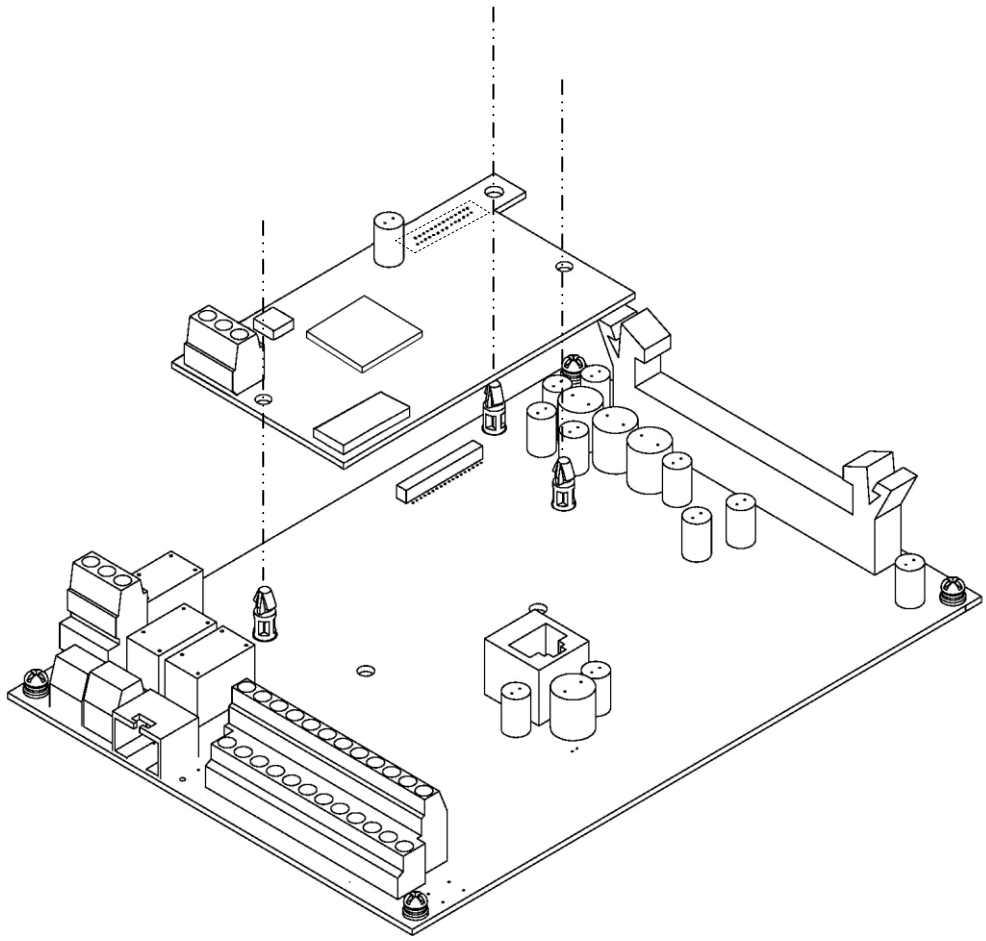
Terminals of JN5-CM-PBUS

Terminal	Function
B+	Profibus sends and receives signals (Positive)
A-	Profibus sends and receives signals (Negative)
E	Connect to the isolation layer of Profibus Cable

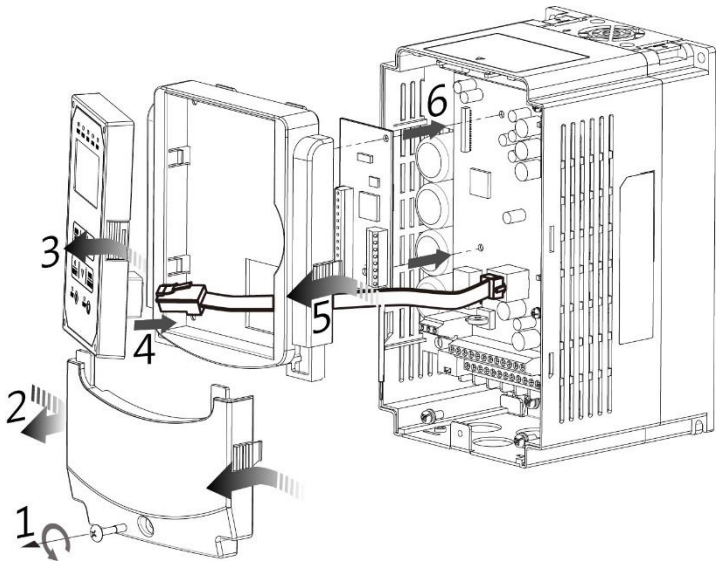
1.3.4 Installation

- Turn on the inverter and check the Software version in parameter 13-01.
- In order to support functions of Profibus-DP communication card, it is necessary to use F510 inverter with software version 1.2 or newer version.
- Set parameters 09-02、00-02、00-05. Please refer to section11.9.6 for the setting of related communication parameter s. Then turn off the inverter.
- Remove the Digital Operator and front cover / terminal cover. Please also refer to Section 3.2.4 for the installation process to remove operator and covers for avoiding damage to the inverter.
- Turn off the inverter and check the CHARGE indicator is OFF.

- Install the Profibus-DP communication card on the control board, with the holes aligned to the locking supports, and the connector CN1 aligned to CN3 (36pin) of the control board. Please refer to the following figure.
    - Connect the Profibus Layer 2 Cable to TB1 on the Profibus-DP Option Card.
    - (The green line is for A-, and the red one is for B+)
    - Set Profibus Address and terminal resistor via SW1 and SW2. (Refer to section 11.9.5 for information of setting of SW1 and SW2.)
    - Turn on Inverter.

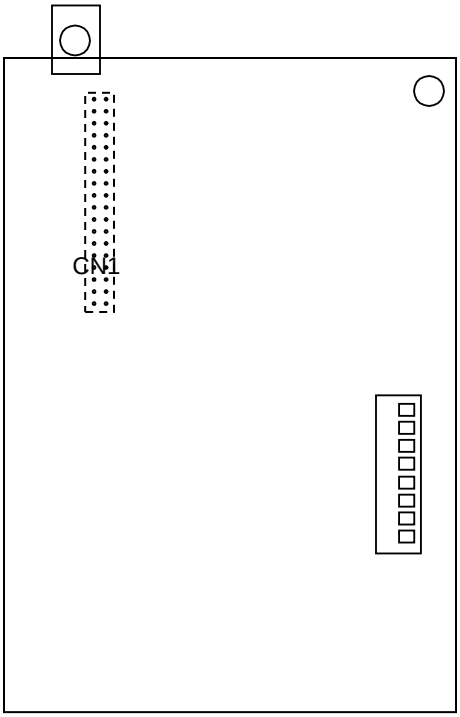


(1) For IP00/ IP20 models



① Unfasten screws on the terminal cover.
② Press the latch on both sides and remove the terminal cover.
③ Press the latch on the side of digital operator to remove it.
④ Disconnect the RJ45 cable from the digital operator.
⑤ Press the latch on both sides of the front cover, and remove the front cover.
⑥ Install option card.
⑦ Follow the instructions above in a reverse order to re-install covers and operator.

1.3.5 Descriptions of Terminals, LEDs and DIP switch



(1) Terminals

Terminals	Description
B+	Profibus Signal (Positive)
A–	Profibus Signal (Negative)
E	Connect to shield of Profibus Cable

(2) LED

LED	Description
LED1 (Red)	LED lights during the Profibus-DP communication.
LED2 (Red)	LED lights while the option card operates without error.

(3) DIP Switch

A. SW1 (Profibus Address. Set SW1-6, 1-7, 1-8 to OFF)

Address	SW1-5	SW1-4	SW1-3	SW1-2	SW1-1
1	OFF	OFF	OFF	OFF	OFF
2	OFF	OFF	OFF	OFF	ON
⋮	⋮				
30	ON	ON	ON	OFF	ON
31	ON	ON	ON	ON	OFF

B. SW2 (Terminal Resistor)

SW2	Description
ON	Enable terminal resistor between B+ and A-
OFF	Disable terminal resistor between B+ and A-

1.3.6 Related Parameters for Communication

The Profibus master PLC can monitor the status of F510 via Profibus DP option card when parameter 09-01 is set to 4 (Profibus). Operating and frequency commands are enabled by the setting of 00-02 to 2 and 00-05 to 3 (communication control). Refer to the following table:

Group	Parameter Name	Setting Range	Default
09-01	Communication Selection	4:Profibus	0
00-02	Main Run Command Source Selection	2:Communication Control	1
00-05	Main Frequency Command Source Selection	3:Communication Control	1

1.3.7 Profibus I/O List

The Profibus master (PLC) configuration defines the Profibus I/O address with a range of 400~431. See table below for Profibus address and related parameters.

(1) Data input (Data sent by the inverter to the PLC)

No.	Profibus address		Bit	Description		
1	PIW400	Signal Status	0	Inverter status	1 : Running	0 : Stop
			1	Direction status	1 : Reverse	0 : Forward
			2	Inverter ready status	1 : Inverter ready	0 : Preparing
			3	Error	1 : Abnormal	
			4	Alarm	1 :“ON”	
			5	Zero Speed	1 :“ON”	
			6	440 class type	1 :“ON”	
			7	Frequency agree	1 :“ON”	
			8	Setting frequency agree	1 :“ON”	
			9	Frequency detection 1	1 :“ON”	
			A	Frequency detection 2	1 :“ON”	
			B	Under voltage	1 :“ON”	
			C	Base Block	1 :“ON”	
			D	Frequency command source	1 : From Profibus protocol	
			E	SeqNotFromComm	1 :“ON”	
			F	Over torque	1 :“ON”	

No.	Profibus address		Bit	Description		
2	PIW402	Fault Content	0	Reserved	30	Reserved
			1	UV	31	Reserved
			2	OC	32	Reserved
			3	OV	33	Reserved
			4	OH1	34	Reserved
			5	OL1	35	Reserved
			6	OL2	36	LSCFT
			7	OT	37	LSCFT (with “retry” funcion)
			8	UT	38	CF07
			9	SC	39	Reserved
			10	GF	40	Reserved
			11	FU	41	Reserved
			12	IPL	42	Reserved
			13	OPL	43	Reserved
			14	Reserved	44	PID Feedback Loss
			15	Reserved	45	Reserved
			16	Reserved	46	OH4
			17	EF1		
			18	EF2		
			19	EF3		
			20	EF4		
			21	EF5		
			22	EF6		
			23	Reserved		
			24	Reserved		
			25	PID Feedback Fault		
			26	Keypad Removed		
			27	Modbus External Fault		
			28	CE		
			29	STO		
3	PIW404	DI Status	0	Programmable digital Input S1		
			1	Programmable digital Input S2		
			2	Programmable digital Input S3		
			3	Programmable digital Input S4		
			4	Programmable digital Input S5		
			5	Programmable digital Input S6		
			6	Reserved		
			7	Reserved		
			8	Reserved		
			9	Reserved		
			A	Reserved		

			B	Reserved
			C	Reserved
			D	Reserved
			E	Reserved
			F	Reserved

No.	Profibus address		Bit	Description							
4	PIW406		Frequency command (6000/60Hz)								
5	PIW408		Output frequency (6000/60Hz)								
6	PIW410		Reserved								
7	PIW412		Voltage command (1/0.1V)								
8	PIW414		Output current (1/0.1A)								
9	PIW416	Alarm Content	0	No alarm	19	EF3	38	SE05	57	LOPb	
			1	OV	20	EF4	39	HPERR	58	HIPb	
			2	UV	21	EF5	40	EF	59	LSCFT	
			3	OL2	22	EF6	41	Reserved	60	LOPb	
			4	OH2	23	Reserved	42	Reserved	61	RETRY	
			5	Reserved	24	Reserved	43	RDP	62	Reserved	
			6	OT	25	Reserved	44	Reserved	63	Reserved	
			7	Reserved	26	CLB	45	OL1	64	HIPb	
			8	Reserved	27	Reserved	46	Reserved	65	OH1	
			9	UT	28	Reserved	47	SE10	66	FIRE	
			10	Reserved	29	USP	48	Reserved			
			11	Reserved	30	RDE	49	BB1			
			12	Reserved	31	WRE	50	BB2			
			13	CE	32	FB	51	BB3			
			14	Reserved	33	VRYE	52	BB4			
			15	Reserved	34	SE01	53	BB5			
			16	Reserved	35	SE02	54	BB6			
			17	EF1	36	SE03	55	Reserved			
			18	EF2	37	Reserved	56	Reserved			
10	PIW418	DO Status	0	R1A-R1C output 0: No action 1: output							
			1	R2A-R2C output 0: No action 1: output							
			2	R3A-R3C output 0: No action 1: output							
			3-15	Reserved							
11	PIW420		AO1 (0.00V ~ 10.00V)								
12	PIW422		AO2 (0.00V ~ 10.00V)								
13	PIW424		Analog input 1 (1/0.1%)								
14	PIW426		Analog input 2 (1/0.1%)								
15	PIW428		Reserved								
16	PIW430		Reserved								

(2) Data output (Data sent by the PLC to the inverter)

No.	Profibus address		Bit	Description
1	PQW400	Operating signal	0	Operating command 1 : Run 0 : Stop
			1	Direction command 1 : Reversed 0 : Forward (User can prohibit the direction via parameter 11-00, 0: Allow FWD/REV 1: Allow FWD only 2: Allow REV only)
			2	External fault 1 : Fault
			3	Fault reset 1 : Reset
			4	Reserved
			5	Reserved
			6	Programmable digital Input S1 1 :"ON"
			7	Programmable digital Input S2 1 :"ON"
			8	Programmable digital Input S3 1 :"ON"
			9	Programmable digital Input S4 1 :"ON"
			A	Programmable digital Input S5 1 :"ON"
			B	Programmable digital Input S6 1 :"ON"
			C	Reserved
			D	Reserved
			E	Controller mode 1 : "ON"
			F	Reserved
2	PQW402		Frequency command(6000/60Hz)	
3	PQW404		Reserved	
4	PQW406		Reserved	
5	PQW408		AO1 (0.00V ~ 10.00V)	
6	PQW410		AO2 (0.00V ~ 10.00V)	
7	PQW412	DO Status	0	R1A-R1C output(0: No action 1: output) (It is enabled while 03-11=32)
			1	R2A-R2C output (0: No action 1: output) (It is enabled while 03-12=32)
			2	R3A-R3C output (0:No action 1: output) (It is enabled while 03-39=32)
			3-15	Reserved
8	PQW414		Reserved	
9	PQW416			
10	PQW418			
11	PQW420			
12	PQW422			
13	PQW424			
14	PQW426			
15	PQW428			
16	PQW430			

1.3.8 Error Message

If the Profibus DP option card is unable to communicate with the Profibus network or F510, or the option card is defective, the F510 will display an error message on the digital operator. For the majority of errors, LED1 on the communication option card will flash or be off, showing that a fault is active.

Message in Operator	Option card LED Status	Content	Description
Communication error 1	LED1 Flash	Communication Time-out	Profibus DP option card does not receive any data from Profibus network in specified period.
Communication error 2	LED2 Flash	Dual port RAM Fault	Dual-port RAM Fault.
Communication error 3	LED2 Flash	Dual port RAM Checksum Error	Dual-port RAM Checksum Error while data is being exchanged in Dual-port RAM.
Communication error 4	LED2 Flash	Dual port RAM data error	Dual-port RAM data Error while data is being exchanged in Dual-port RAM

1.3.9 GSD File

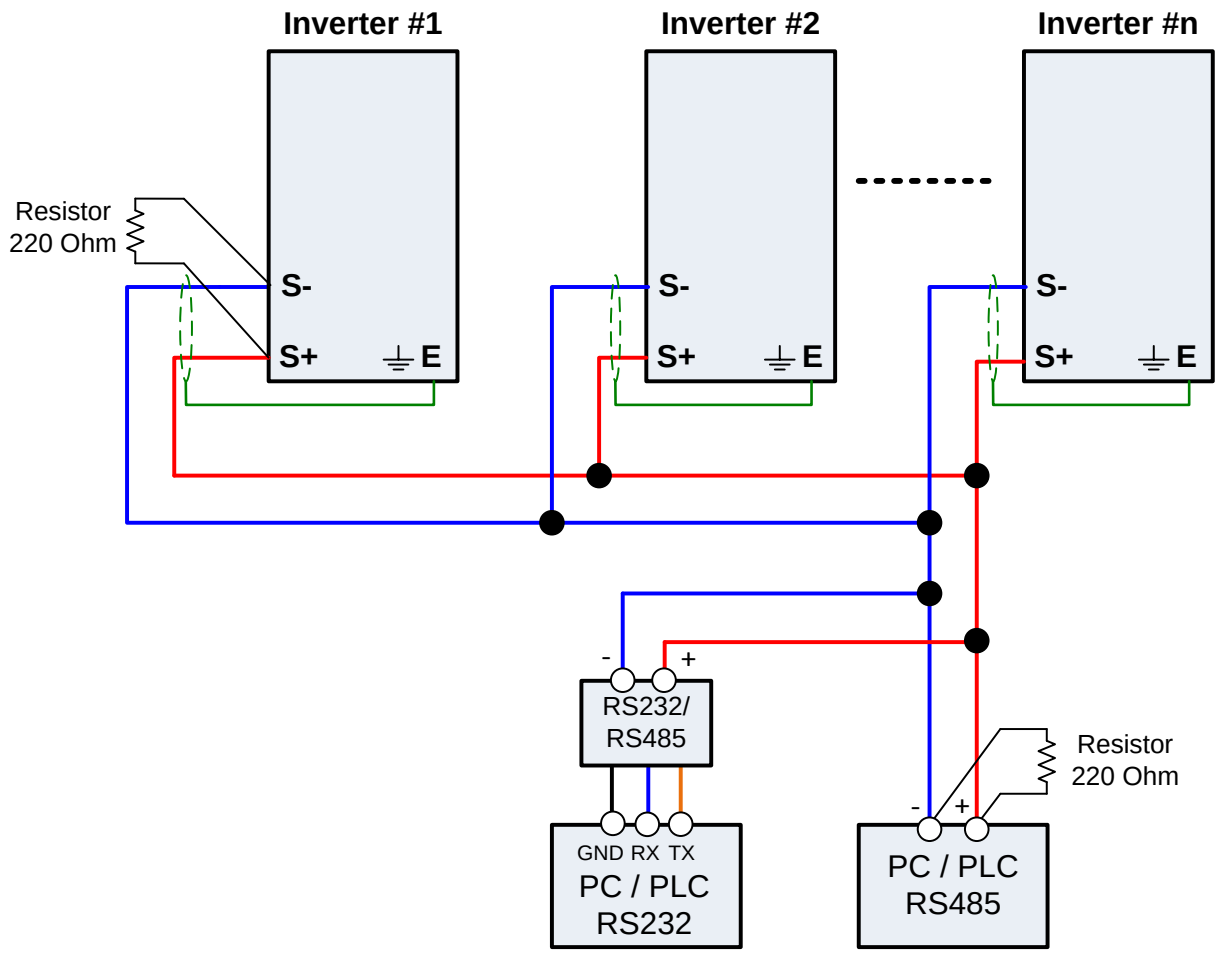
```
;/*********************************************************/
;/* Filename:   F510-P.GSD
;/* ModelName:  TECO AC DRIVES F510
;/* CreateDate: 2012.12.18
;/*********************************************************/
#Profibus_DP
GSD_Revision          = 1
Vendor_Name           = "TECO"
Model_Name            = "F510-P"
Revision              = "Version0.0"
Ident_Number          = 0xF510
Protocol_Ident  = 0                       ;Profibus-DP
Station_Type          = 0                       ;DP Slave
FMS_supp              = 0                       ;Pure DP Device
Hardware_Release= "HW_V1.0"
Software_Release= "SW_V1.0"
;
9.6_supp              = 1
19.2_supp             = 1
93.75_supp            = 1
187.5_supp            = 1
500_supp              = 1
1.5M_supp             = 1
3M_supp               = 1
```

```
6M_supp                = 1
12M_supp            = 1
MaxTsdr_9.6            = 60
MaxTsdr_19.2           = 60
MaxTsdr_93.75    = 60
MaxTsdr_187.5    = 60
MaxTsdr_500            = 100
MaxTsdr_1.5M           = 150
MaxTsdr_3M             = 250
MaxTsdr_6M             = 450
MaxTsdr_12M            = 800
Redundancy             = 0                         ;No Redundancy Supported
Repeater_Ctrl_Sig      = 2                         ;TTL
24V_Pins               = 0                         ;Not Connected
;
Implementation_Type    = "VPC3"
Bitmap_Device                = "DP_NORM"
Bitmap_Diag            = "bmpdia"
Bitmap_SF              = "bmpsf"
;
Freeze_Mode_supp       = 1                 ;Supported
Sync_Mode_supp         = 1                 ;Supported
Auto_Baud_supp         = 1                 ;Supported
Set_Slave_Add_supp     = 0                 ;cannot change via profibus
;
Fail_Safe              = 0
Slave_Family           = 1                 ;Drives Family
Min_Slave_Intervall    = 10                ;PollingCycle:10*100uS=1mS
;
Max_Diag_Data_Len      = 16
Max_User_Prm_Data_Len = 5
Modul_Offset           = 255
Ext_User_Prm_Data_Const(0) = 0x00,0x00,0x00,0x00,0x00
;
Modular_Station        = 1                 ;Modular Device
Max_Module             = 1                 ;Only 1 Module can be inserted
Max_Input_Len          = 32
Max_Output_Len         = 32
Max_Data_Len           = 64
Module                       ="16 Word In,16 Word Out" 0x7f
EndModule
```

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.

Refer to F510 RS-485 Modbus communication manual for more information.

TECO Westinghouse

INVERTER

F510

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