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DNP-211

DNP3 Master to Modbus TCP Server Gateway



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Version	Author	Date	Description		
1.00	Ming	2021/10/06	First Released Revision		
1.01	Ming	2022/06/01	Added DNP-211 Reader instructions		
1.02	Ming	2023/09/28	Added instructions for wiring problems		
			and corrected restart instructions for		
			uploading configuration files		

Document Revision

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1. Introduction

1.1. DNP3 Introduction

DNP3 (Distributed Network Protocol 3) is a communication protocol used between automation components. The protocol is formulated with reference to IEC 870-5. The purpose is to unify the communication method of SCADA so that SCADA can use the DNP3 protocol to communicate with master stations, remote terminal units (RTUs), intelligent electronic devices (IEDs), etc., and are mainly used in utilities such as electric and water companies.

The DNP3 protocol has certain of reliability and allows reliable communications in the adverse environments that electric utility automation systems are subjected to being specifically designed to overcome distortion induced by electromagnetic interference (EMI), aging components, and poor transmission media. A large number of CRC check codes are used in the protocol to ensure the accuracy of data. It is suitable for high security, Data communication field of medium speed and medium amount of data.

1.2. Modbus TCP Introduction

Modbus TCP is a variant of the Modbus family of simple, vendor-neutral communication protocols intended for supervision and control of automation equipment. Specifically, it covers the use of Modbus messaging in an "Intranet" or "Internet" environment using the TCP/IP protocols. The most common use of the protocols at this time is for Ethernet attachment of PLC's, I/O modules, and gateways to other simple field buses or I/O networks.

1.3. About DNP-211

DNP-211 is a gateway that supports DNP3 master and Modbus TCP server protocol conversion. As long as the master device supports Modbus TCP protocol, it can connect the existing DNP3 network with the Ethernet-based master device. For DNP3 network, DNP-211 is a DNP3 master device. It supports several commonly used data groups and variables and can communicate with slave devices. From the perspective of Modbus TCP network, DNP-211 is a Modbus TCP server, which can receive commands from Modbus TCP client, and process these commands to reply or send related DNP3 data. All DNP3 I/O data and Modbus mapping can be configured through DNP-211 utility software.

1.4. Features

- Read / Write DNP3 outstations via Modbus TCP
- Configurable DNP3 Master
- Configurable Modbus TCP server
- Support Data Group 1, 10, 12, 20, 30, 40, 41
- Support Modbus function code 1, 2, 3, 4, 15, 16
- Provides Modbus register of connection status of DNP3 outstations
- Supports up to 32 DNP3 outstations
- Supports up to 16 Modbus client connections

1.5. Specifications

System	
CPU	Cortex-A8, 1 GHz
SDRAM	512 MB
Flash	512 MB
FRAM	64 КВ
LED Indicators	PWR (Power), RUN (System run), L1 (Firmware run),
	L2 (Modbus TCP connection), L3 (DNP3 connection)
Communication Ports	

VGA		1 (reserved)				
Ethorpot		RJ-45 x 2, 10/100/1000 Based-TX (Auto-negotiating,				
		Auto MDI/MDI-X, LED indicators)				
USB 2.0		2 (reserved)				
Console Po	rt	RS-232 (RxD, TxD and GND); Non-isolated				
ttyO2		RS-485 (Data+, Data-); Non-isolated				
ttyO4		RS-232 (RxD, TxD and GND); Non-isolated				
ttyO5		RS-485 (Data+, Data-); 2500 VDC isolated				
Protocol	_					
	Identity	Modbus TCP server				
Modbus	Function	1, 2, 3, 4, 15, 16				
	Connection	Max. 16 Modbus TCP clients				
	Identity	DNP3 master				
	Connection	Max. 5 MMS clients				
	Group	1, 10, 12, 20, 30, 40, 41				
בסואט		DI: 8192				
DIVES		DO: 8192				
	Data Point	Count: 2048				
		AI: 2048				
		AO: 2048				
Power						
Supply Volt	age	+12 to +48 VDC				
Consumpti	on	4.8 W				
Connector		3-pin Removable Terminal Block				
Mechanism	า					
Dimensions		35 mm x 167 mm x 119 mm				
Casing		Metal				
Installation		DIN-Rail				
Environment						
Operating ⁻	Temp.	-25°C ~ +75°C				
Storage Ter	np	-30°C ~ +85°C				
Humidity		10 ~ 90% RH, non-condensing				

2.Hardware

2.1. Dimensions



Unit: mm

2.2. Appearance



2.3. LED Indicator

There are five LEDs to indicate the various states of the DNP-211. Since the power-on time of DNP-211 is about 1 minute, if you need to observe the status of these LEDs, please wait 1 minute after powering on. The following is the illustration of these five LEDs.



LED Name	LED Status	Description		
	ON	Power on		
PVK	OFF	Power failure		
DUN	Blink	OS is running		
KUN	OFF	OS stops running		
11	Flash every second	Firmware is running		
L L	Other	Firmware stops running		
12	Flash every 500 ms	Modbus TCP disconnected		
LZ	OFF	No Warning		
12	Flash every 500 ms	At least one DNP3 outstation disconnected		
LS	OFF	No Error		
L1, L2, L3	All constant light	GatewayConfig.toml file error		

*After connecting the DNP-211 to the power supply, please wait for 1 minute to complete the startup process. When the "RUN" LED starts flashing and the "PWR" LED remains on, it means that the startup has been completed. If The "L1" LED blinks once per second, indicating that the firmware is running.

3. Getting Started With DNP-211

3.1. Preparations for Devices

In addition to the DNP-211, please prepare the following:

- 1. Power Supply: +12 ~ +48 VDC (Ex: DP-665)
- 2. Ethernet Hub or Switch (Ex: NS-205)
- 3. **PC/NB:** Can connect to the network and set the network

3.2. Hardware Wiring and setting rules

In order to avoid abnormalities when using Ethernet and RS-485, please follow the following usage rules:

1. **Do not** plug in the network cable if the LAN (LAN1 or LAN2) is not used on DNP-211.



2. When both LAN1 and LAN2 are enabled, they **cannot** be set to the same network segment.



3. When both LAN1 and LAN2 are enabled, they must be connected to two separate networks.



4. Modbus TCP and DNP3 devices have no fixed LAN settings.



5. When using RS-485 to connect to DNP3 devices, all devices set to the same RS-485 port must be ensured to be connected during the initial connection when the DNP-211 is powered on.

```
Outstation 1 

Outstation 2 
Outstation 3 all at ttyO2
                                                     All Outstations failed
                                                      ICP
DAS
                            Outstation
                                                                        Outstation
                                 1
                                                                             1
                                                                      Outstation 2
                            Outstation
                                 2
                                                                           2
                 ttyO2
                                                            ttyO2
                            Outstation
                                                                        Outstation
                                 3
                                                                             3
```

6. RS-485 DNP3 devices can be decentralized to three RS-485 ports on the DNP-211.

Configuration:

Configuration:

Outstation 1 at ttyO2 Outstation 2 at ttyO4 Outstation 3 at ttyO5



3.3. DNP-211 Utility

3.3.1. Download DNP-211 Utility

https://www.icpdas.com/en/download/show.php?num=8036&model=DNP-211 Download DNP_211_Utility_vxxx.zip file and extract it.

DNP_211_Utility_v100.zip	2021/9/30 下午 0	壓縮的 (zipped)	343 KB
名稱	修改日期	類型	大小
DNP_211_Utility_v100.exe	2021/9/30 上午 1	應用程式	53 KB
Renci.SshNet.dll	2021/1/24 下午 0	應用程式擴充	786 KB

3.3.2. DNP-211 Utility Introduction

DNP-211 Utility is utility software for DNP-211 module to generate dedicated connection settings and I/O mapping table. After opening DNP_211_Utility, the screen is as follows:

Gateway Type DNP3 Master to Modbus Slave 🗸 Set LAN Export Modbus Map									
Gateway IP 192.168.0.1 Port 502 Upload Import									
ComPort Baud 115200 - Databit 8 - Parity None - Stopbit One -									
DNP3 Master ID 1 Modbus Slave ID 1 Slave Amount 1									
IO Parameter									
Communication Mode TCP ~ Remote IP 192.168.255.1 Remote Port 20000									
Outstation ID 2									
Set Outstation Config: None									
IO Setting									
I/O Setting									
or of the second									
Start Index Amount Output mode Select and Operate									
Start Index Amount Output mode Select and Operate Description Add Delete									
Start Index Amount Output mode Select and Operate Description Add Delete Item Num Group/Variation Start Index Amount Output mode									
Start Index Amount Output mode Select and Operate Description Add Delete Item Num Group/Variation Start Index Amount Output mode Description * Item Num Group/Variation Start Index Amount Output mode Description									
Start Index Amount Output mode Select and Operate Description Add Delete Item Num Group/Variation Start Index Amount * Output mode Description									
Start Index Amount Output mode Select and Operate Description Add Delete Item Num Group/Variation Start Index Amount Output mode * Item Num Item Num Start Index Item Num									
Start Index Amount Output mode Select and Operate Description Add Delete Item Num Group/Variation Start Index Amount Output mode * Image: Start Index Image: Start Index Amount Output mode Description									

DNP-211 Communication Configure 🖶 DNP-211 Utility v1.02 Х Gateway Type DNP3 Master to Modbus Slave Set LAN Modbus Map Export Gateway IP | 192.168.0.1 Port 502 Upload Import ComPort Baud 115200 Databit 8 Parity None 🗸 Stopbit One \sim DNP3 Master ID 1 Modbus Slave ID 1 Slave Amount 1 (**1**)

Gateway Type: Display gateway type of the DNP-211.

Gateway IP: Modbus TCP IP address of the DNP-211 (*).

Port: Modbus TCP port of the DNP-211

ComPort Baud: Com port data baud rate of DNP3 side (ttyO2, 4, 5).

Databit: Com port data bit of DNP3 side (ttyO2, 4, 5).

Parity: Com port data parity of DNP3 side (ttyO2, 4, 5).

Stopbit: Com port data stop bit of DNP3 side (ttyO2, 4, 5).

DNP3 Master ID: Master ID, cannot be the same as slave (0 ~ 65519).

Modbus Slave ID: Modbus ID of the DNP-211 (0 ~ 255).

Slave Amount: Number of DNP3 slaves.

* The IP setting here is only for the configuration file, it will not modify the IP of DNP-211. If you want to change the IP of DNP-211, you need to click the "Set LAN" button to change it.

DNP3 Outstation Communication Configure

1 2 3 4
- IO Parameter
Communication Mode TCP ~ Remote IP 172.17.12.2 Remote Port 20000 Outstation ID 2
Set Outstation Config: None
1 2 3 4
- IO Parameter
Communication Mode UDP ~ Remote IP 172.17.12.2 Remote Port 20000
Outstation ID 2 Source IP 192.168.255.1 Source Port 20000
Set Outstation Config: None

1 2 3 4	
IO Parameter	
Communication Mode Serial ~ ComPort ttyO2 ~	
Outstation ID 2	
Set Outstation Config: None	

Number tab: Select outstation

Communication Mode: Select connection mode (TCP, UDP, Serial)

TCP mode:

Remote IP, Remote Port: IP and port of target outstation. UDP mode:

Remote IP, Remote Port: IP and port of target outstation.

Source IP, Source Port: IP and port of the DNP-211.

Serial mode:

ComPort: Select the Com port connected to outstation.

Outstation ID: DNP3 outstation ID (0~65519).

Set button: Set the connection parameter of the selected outstation.

Outstation I/O Configure

-IO Se I/O T	tting ype Bina	ry_Input	→ Group _	Variation G1V	/1 ~					
Start Index 0 Amount 10 Output mode Select and Operate V										
Descr	iption Or	nly For Test			Add D	elete				
	Item Nur	n Group/Variatio	on Start Index	Amount	Output mode	Descrij				
•	1	G1V1	0	10		Only F				
*										
<						>				

I/O Type: Added I/O type of the slave (map with Group_Variation) Group_Variation: Added I/O type of the slave (map with I/O Type) Start Index: Added I/O start address at the DNP3 slave Amount: Amount of the I/O item Output mode: DO / AO output mode (only for write command) Description: User' s self-filled description

Utility Button



Set LAN: Configure the LAN1 and LAN2 IP Address of the DNP-211. Import: Import the existing GatewayConfig.toml configuration file. Export: Export the current settings to the GatewayConfig.toml. Modbus Map: Generate a table of the currently configured Modbus address and DNP3 I/O correspondence.



Upload: Upload the GatewayConfig.toml configuration file or d2m_xxxxxxx.tar.gz firmware file to DNP-211.

Note: After uploading the file and pressing the "OK" button, the DNP-211 will automatically reboot and update the settings or firmware. The reboot time is about 1 minute, please do not turn off the power during this period, otherwise the update will fail.

3.4. DNP-211 Reader

3.4.1. Download DNP-211 Reader

<u>https://www.icpdas.com/en/download/show.php?num=8036&model=DNP-211</u> ■ DNP-211_Reader_v100.exe 2021/7/28下午 0... 應用程式 52 KB

3.4.2. DNP-211 Reader Introduction

DNP-211 Reader is a simple test utility for DNP-211 module. It can import the "toml" file produced by DNP-211 Utility and test the connection and I/O function. The dialog of DNP-211 Reader is as bellow:



First clicked "Import" and selected the configuration file (.toml) produced by DNP-211 Utility to import.

💀 DNP-2	211 Reader	v1.00							-		×
Import	<u>C</u> onnect	<u>D</u> isconnect	<u>S</u> tatus	Output Form	<u>W</u> ind	ows					
		restore				2021/11/8 2021/11/8	上午 1 上午 1	檔案資料夾 檔案資料夾			
		autoexe	.sh			2021/4/8	下午 01	SH 檔案		1 KB	
		d2m ga	teway Confin to	-		2021/9/28	下午 0	福案 TOML 提安	13,	566 KB	
		Usearch	server	Jimi -		2021/8/20	下午 0	相案 描案		2 KB	
											Time _;;

After import the toml file, click "Connect" to connect with DNP-211 module. If successful, DNP-211 Reader will show as below.

DNP-211 Reader v1.00	onnect Status Output For	n Windows		- 🗆 X
DNP-211 Reader v1.00 Import Connect Import Connect Import Label Indet *	onnect Status Qutput For	Image: Windows Image: Label 0 Image: Counter 32 1 Image: Counter 32 1	Index Value 2bit Flag 0 00 2bit 0 0 0 2bit 1 00 0 2bit 1 0 0 Analog Input 16bit Flag 0 Analog Input 16bit Flag 1 Analog Input 16bit 1 1 * 0	×
Input Registers Response O	<[2022-05-31 03:52:29

Disconnect: Disconnect with PC and DNP-211.

Status: Connection status of all Outstations (Modbus 30001 ~ 30032).

	Outstation Id	Status	
•	2	1	
	3	0	
	4	0	
*			

- 0: The setting of the DNP-211 not includes the Outstation.
- 1: The Outstation is waiting for connect.
- 2: The Outstation is On-line.

Output Form: Show the output dialog of every Outstation.

í l	- Outstation 2 Output Dialog		
	○ DO bit mode ○ DO full mode ● AO Output		
	AO Output Channel Select: G41V2: Analog Output 16bit 0 ~		
	Value Range: -32768 ~ +32767		
	Output Value:		
Status Output Form Windows Outstation 2 Outstation 3 Outstation 4	Send		

There are three output forms, DO bit, DO full and AO output.

🖳 Outstation 4 Output Dialog	
● DO bit mode ○ DO full mode (⊃ AO Output
DO bit output mode	
Bit Range: 0 ~ 6 Amou	int: 7
Start bit: 0 Output Amou	int: 7
Prompt: output data len = 1 byte	
Value: 7F	
	Send

DO bit mode:

This mode can output several DO bits simply. As above, there are 7 DO points, bit0 ~ bit6. Fill the "Start bit" and "Output Amount" bits and input the output value (hex) such as 7F. Finally click "Send" to send the command, the "7F" command will let DO bit0 ~ bit6 all ON.

🖳 Outstation 4 Ou	tput Dialog	
O DO bit mod	e 💿 DO full mode	○ AO Output
DO full output Bit Range: 0 ~ Output bit: 0	mode 6 Am (Can only o	ount: 7 output 1 bit per time)
Control Code None Pulse On Pulse Off Latch On Latch Off	 None O Clear None O Close Count (0 ~ 255): On Time (ms): Off Time (ms): 	Pending Operation O Trip 1 0 0
		Send

DO full mode:

This mode can output only one DO bit will complex function as above. This interface only provides command options, as for the detailed description and support of each function, please refer to the instruction manual of the user' s Outstation.

🖳 Outstation 2 Outp			
○ D0 bit mode	○ DO full mode	 AO Output 	
AO Output	G41V2: Applog O	utput 16kit 0	
Value Range	-32768 ~ +32767		
Output Value			
Output Value.			
		Send	

AO Output:

This mode can select AO channel to output. Fill in the decimal value to be output in the "Output Value" field, and finally press the "Send" button to output the command.

Windows: Show input form of every Outstation.



Appendix A: Modbus Map

The Modbus Map function of DNP-211 Utility can export the mapping table of Modbus and DNP3 as below: **Register field:** Modbus address, 0xxxx: DO, 1xxxx: DI, 3xxxx: AI, 4xxxx: AO **Slave field:** DNP3 Outstation ID **Group field:** I/O type of the Outstation **Variation field:** Variation of the I/O type **Channel field:** I/O channel number

Note: AI address is start from 30033, because 30001 ~ 30032 are the connection status of all Outstations.

	А	В	С	D	E	F	
1	Register	Slave	Group	Variation	Channel		
2	10001	2	1	1	0		
3	10002	2	1	1	1		
4	10003	2	1	1	2		
5	10004	2	1	1	3		
6	10005	2	1	1	4		
7	10006	2	10	1	0		
8	10007	2	10	1	1		
9	10008	2	10	1	2		
10	10009	2	10	1	3		
11	10010	2	10	1	4		
12	30033	2	20	1	0		
13	30036	2	20	1	1		
14	40001	2	41	2	0		
15	40002	2	41	2	1		
16	40003	2	41	2	2		
17	10011	3	10	1	0		
18	10012	3	10	1	1		
19	10013	3	10	1	2		
20	10014	3	10	1	3		
21	10015	2	10	1	А		

Appendix B: Mapping Rule

Function	Modbus⊷		DNP	Orou in a		
FUNCTION	Name.₀	Data Type⊮	Name⊬	Data Type∉	Group	
Binary Output⊷	Coil₽	bit₽	Control Relay Output Block (CROB)↔	bite	12₽	
Analog Output.₀	Holding Register₊	16-bit integer₊	Analog Output _e	16 / 32 bit integer 32 / 64 bit float@	41∻	
			Control Relay Output Block (CROB)⊷	5 words₽	12₽	
Discoularies	Discrete Input _*	bit⊷	Binary Inpute	bite	1₽	
binary input₽			CROB₽	bite	10 ₽	
Analog Input∘	Input Register₊	16-bit integer∘	Analog Input₀	16 / 32 bit integer 32 / 64 bit float₀	30⊷	
			16-bit integer⊷	Analog Output.	16 / 32 bit integer 32 / 64 bit float@	40⊷
			Binary Input with flage	16-bit integere	1₽	
			CROB with flage	16-bit integer.	10 ₽	
Counter Input.	Input Registere	16-bit integer₽	Counter Input.	16 / 32 bit integere	20⊷	
DNP3 Connection	Input Register.	16-bit integer₽	Slave Status.	16-bit integere	None₽	