

Controlling a DM1 Pro, DG1, or DH1 via Modbus TCP using an easyE4 nano PLC

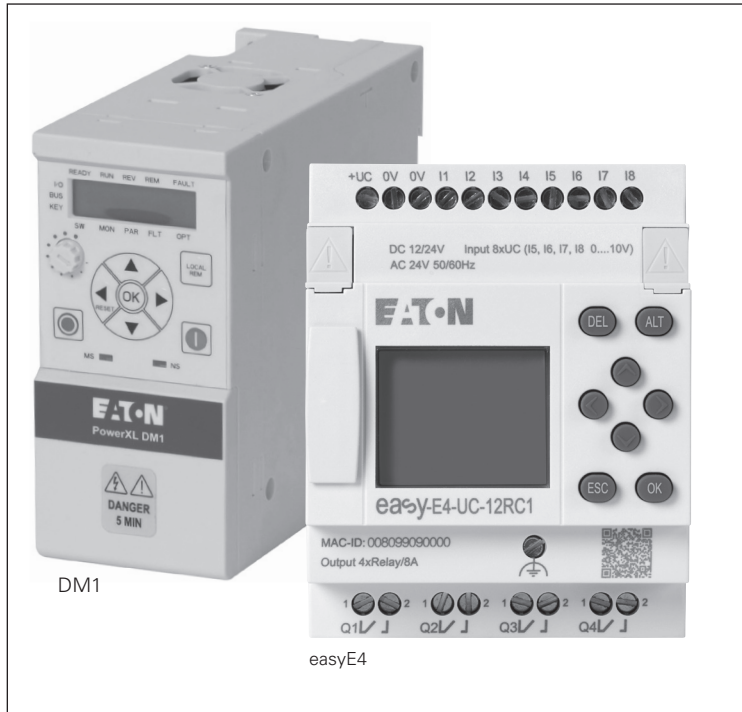


Figure 1. DM1 and easyE4 models

Introduction

Many applications such as pumping, air compressors, and vacuum systems use a PLC to control motors using a variable frequency drive (VFD). The PLC can control motors that can run at various speeds, stagger start and stop commands to the drives, and extract data such as fault codes for diagnostics, along with many other use cases. In this application note, an easyE4 will be connected to a DM1 Pro, DG1, or DH1 to illustrate how to control the drive with a low-cost nano PLC using Modbus® TCP. The easyE4 and the DM1 Pro drive can be seen in **Figure 1**.

This application note is used with the example program "E4 to DM1 Demo.e70" and will walk you through the necessary steps to establish communications between the drive and the PLC. Another important note, is that version 7.30 of easySoft or newer, as well as version 1.30 of firmware or newer are required to use the easyE4 as a Modbus TCP master. Also, the example program was designed to be used with easyE4 models that have a built-in display screen as seen in **Figure 1**.

Understanding the easyE4 data mapping to DM1 Pro, DG1, and DH1

Understanding the relationship between the easyE4 marker bits, bytes, and words is important as they are used in the example program to buffer the communication data passed between the E4 and the VFD. In the easyE4 memory, the marker bits, bytes, words, and double words all overlap one another. The operand table, which can be found in the help file within easySoft, details the layout of the Marker field relationship. **Figure 2** shows how they relate to each other.

For an example of how this overlapping is used within the supplied program, let's focus on marker word 21, which is copied to analog output QA10 that is mapped to the control word of the DM1 Pro drive. Marker word 21 can also be represented by markers 321–336, marker

bytes 41–42, or the lower half of marker double word 11. Therefore, individual marker bits can be manipulated, and they inherently change the marker words, etc. So, by setting M323, MW21 will have a value of 8 (2³), which is copied to the analog output word QA10 that is mapped to DM1 Pro Register 200 (Control Word).

Similarly, the overlapping of the data types can also be used to break down the value of the DM1 Pro Status word into individual marker bits. Register 2100 of DM1 Pro is mapped to IA12 and then copied to MW22. The individual bits of MW22 can then be referenced by accessing M337–M352. **Table 1** shows the setup of all data passed between the easyE4 and a single DM1 Pro in the example program.

Bit	128...121	120...113	112...105	104...97	96...89	88...81	80...73	72...65	64...57	56...49	48...41	40...33	32...25	24...17	16...9	8...1
Byte	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Word	8	7	6	5	4	3	2	1	16	15	14	13	12	11	10	9
DWord	4	3	2	1	16	15	14	13	12	11	10	9	8	7	6	5
Bit	256...249	248...241	240...233	232...225	224...217	216...209	208...201	200...193	192...185	184...177	176...169	168...161	160...153	152...145	144...137	136...129
Byte	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
Word	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
DWord	8	7	6	5	4	3	2	1	16	15	14	13	12	11	10	9
Bit	384...377	376...369	368...361	360...353	352...345	344...337	336...329	328...321	320...313	312...305	304...297	296...289	288...281	280...273	272...265	264...257
Byte	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
Word	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9
DWord	12	11	10	9	8	7	6	5	4	3	2	1	16	15	14	13

Figure 2. Operand table

Table 1. easyE4 data mapping

Item	Marker	E4 MW	Analog	DM1 MB register
Modbus Last Err			IA10	
Unit ID			IA11	
Control Word	C-Run	M321	21.00	QA10
	C-Rev	M322	21.01	
	C-Reset	M323	21.02	
		M324	21.03	
		M325	21.04	
		M326	21.05	
		M327	21.06	
	C-Bypass-Relay	M328	21.07	
	C-Net-Ref	M329	21.08	
	C-Net-Cntrl	M330	21.09	
		M331	21.10	
		M332	21.11	
		M333	21.12	
		M334	21.13	
		M335	21.14	
		M336	21.15	
Speed Ref			QA11	2002
Status Word	S-Ready	M337	22.00	IA12
	S-Run	M338	22.01	
	S-Reverse	M339	22.02	
	S-Fault	M340	22.03	
	S-Alarm	M341	22.04	
	S-At Speed	M342	22.05	
		M343	22.06	

Item	Marker	E4 MW	Analog	DM1 MB register
Status Word	M344	22.07		
	M345	22.08		
	M346	22.09		
	M347	22.10		
	M348	22.11		
	M349	22.12		
	M350	22.13		
	M351	22.14		
	M352	22.15		
Process Data In 1	FB Torque Reference %	0.01	QA12	2004
Process Data In 2	FB Set Point 1		QA13	2005
Process Data In 3	FB Feedback 1		QA14	2006
Process Data In 4	Accel Time (s)	0.1	QA15	2007
Process Data In 5	Decel Time (s)	0.1	QA16	2008
Process Data In 6	Current Limit (s)	0.1	QA17	2009
Process Data In 7	N/A		QA18	2010
Process Data In 8	N/A		QA19	2011
Process Data Out 1	Output Freq		IA13	2103
Process Data Out 2	Motor Speed		IA14	2104
Process Data Out 3	Motor Current		IA15	2105
Process Data Out 4	Motor Torque		IA16	2106
Process Data Out 5	Motor Power		IA17	2107
Process Data Out 6	Motor Voltage		IA18	2108
Process Data Out 7	DC Bus Voltage		IA19	2109
Process Data Out 8	Fault Number		IA20	2110

easyE4 Modbus TCP master setup and mapping

Now that data mapping and the overlapping of data types has been covered, we will discuss how to set up the Modbus TCP master and map the data in the easyE4.

First, add a Modbus TCP server to the project by clicking and dragging a device into the project window as seen in **Figure 3**.

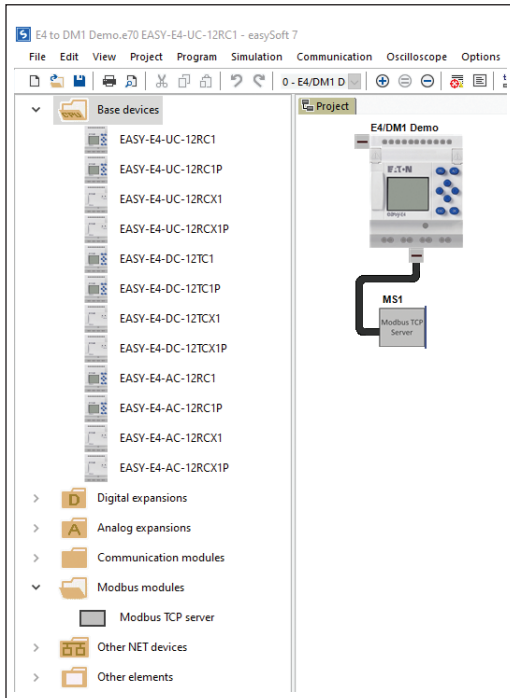


Figure 3. Adding Modbus TCP server

Next, assign the IP address of the drive to the expansion parameter tab as shown in **Figure 4**.

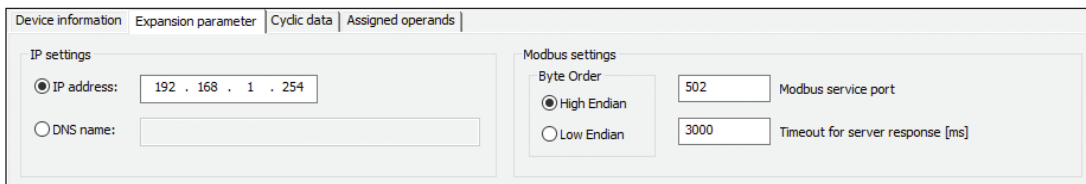


Figure 4. IP address

Cyclical data is exchanged from the program to the Modbus server, in this case the drive, using analog inputs and outputs. This is where you add all the data exchanges between the PLC and the drive. You will need to configure the entries as required in the chart. See **Figure 5** for all of the data exchanges in the example program and note that in the DM1 Pro, DH1, and DG1, all registers we are communicating to are Holding Registers.

Device information Expansion parameter Cyclic data Assigned operands										
<input type="checkbox"/> Skip all requests <div> <div>Modbus Register #</div> <div> <input checked="" type="checkbox"/> Reset registers on timeout </div> <div>Type of data exchange</div> </div>										
General			1. request			2. request (FC23: write)				
Unit ID	Update rate	Function code	Start addr.	No. of items	Op. class	Start addr.	No. of items	Op. class	-	+
1	1	100	FC3 - Read Multiple Holding Registers	2100	1	IA16			-	+
2	1	100	FC3 - Read Multiple Holding Registers	2103	8	IA16			-	+
3	1	100	FC6 - Write Single Holding Register	2000	1	QA16			-	+
4	1	100	FC6 - Write Single Holding Register	2002	1	QA16			-	+
5	1	100	FC16 - Write Multiple Holding Registers	2004	8	QA16			-	+
6										+

Figure 5. Data exchanges

Once the Modbus registers have been defined, they will appear on the assigned operator tab. The Modbus registers will then need to be manually added to internal registers within the easyE4. The input mapping from the drive to the PLC can be seen in **Figure 6**. Note that in this example, IA10 and IA11 are part of the Modbus TCP server, IA12 to IA20 are the Status Word, Output Frequency, and Process Data Out.

Device information

Expansion parameter

Cyclic data

Assigned operands

Device MS1: Modbus TCP server

Bit inputs

Bit outputs

Analog inputs

Analog outputs

Diagnostics alarm

Analog input	Description	Assigned
LAST_ERR	Last error code	IA10
UNIT_ID	Unit ID	IA11
R1R_HR2100	Unit 1, Holding registe...	IA12
R2R_HR2103	Unit 1, Holding registe...	IA13
R2R_HR2104	Unit 1, Holding registe...	IA14
R2R_HR2105	Unit 1, Holding registe...	IA15
R2R_HR2106	Unit 1, Holding registe...	IA16
R2R_HR2107	Unit 1, Holding registe...	IA17
R2R_HR2108	Unit 1, Holding registe...	IA18
R2R_HR2109	Unit 1, Holding registe...	IA19
R2R_HR2110	Unit 1, Holding registe...	IA20

Operand	15	Analog input	Description	Comment
IA10	<==	MS1 - LAST_...	Last error code	
IA11	<==	MS1 - UNIT_ID	Unit ID	
IA12	<==	MS1 - R1R_...	Unit 1, Holding regis...	Status Word
IA13	<==	MS1 - R2R_...	Unit 1, Holding regis...	Output Frequency
IA14	<==	MS1 - R2R_...	Unit 1, Holding regis...	Motor Speed
IA15	<==	MS1 - R2R_...	Unit 1, Holding regis...	Motor Current
IA16	<==	MS1 - R2R_...	Unit 1, Holding regis...	Motor Torque
IA17	<==	MS1 - R2R_...	Unit 1, Holding regis...	Motor Power
IA18	<==	MS1 - R2R_...	Unit 1, Holding regis...	Motor Voltage
IA19	<==	MS1 - R2R_...	Unit 1, Holding regis...	DC Bus Voltage
IA20	<==	MS1 - R2R_...	Unit 1, Holding regis...	Fault Number

Figure 6. Input mapping

Similarly, the outputs to the drive also need to be mapped. Note that QA10 to QA19 are the Control Word, Speed Reference, and Process Data In. See **Figure 7**.

Device information

Expansion parameter

Cyclic data

Assigned operands

Device MS1: Modbus TCP server

Bit inputs

Bit outputs

Analog inputs

Analog outputs

Diagnostics alarm

Analog output	Description	Assigned		Operand	10	Analog output	Description	Comment
R3W_HR2000	Unit 1, Holding registe...	QA10	<div></div> <div></div>	QA10	=>	MS1 - R3W_...	Unit 1, Holding regis...	Control Word
R4W_HR2002	Unit 1, Holding registe...	QA11		QA11	=>	MS1 - R4W_...	Unit 1, Holding regis...	Speed_Ref
R5W_HR2004	Unit 1, Holding registe...	QA12		QA12	=>	MS1 - R5W_...	Unit 1, Holding regis...	FB Torque Reference %
R5W_HR2005	Unit 1, Holding registe...	QA13		QA13	=>	MS1 - R5W_...	Unit 1, Holding regis...	FB Set Point
R5W_HR2006	Unit 1, Holding registe...	QA14		QA14	=>	MS1 - R5W_...	Unit 1, Holding regis...	FB Feedback
R5W_HR2007	Unit 1, Holding registe...	QA15		QA15	=>	MS1 - R5W_...	Unit 1, Holding regis...	Accel Time (s)
R5W_HR2008	Unit 1, Holding registe...	QA16		QA16	=>	MS1 - R5W_...	Unit 1, Holding regis...	Decel Time (s)
R5W_HR2009	Unit 1, Holding registe...	QA17		QA17	=>	MS1 - R5W_...	Unit 1, Holding regis...	Current limit (a)
R5W_HR2010	Unit 1, Holding registe...	QA18		QA18	=>	MS1 - R5W_...	Unit 1, Holding regis...	N/A
R5W_HR2011	Unit 1, Holding registe...	QA19		QA19	=>	MS1 - R5W_...	Unit 1, Holding regis...	N/A

Figure 7. Output mapping

Configuring the drive settings

The settings on the DM1 Pro, DG1, and DH1 need to be modified from the default parameters to enable Modbus TCP communications and put the drive into remote-control mode. Note that the parameters that need to be modified are similar between all three drives but have different parameter numbers.

For DM1 Pro:

P1.13	Remote 1 Control Place	Set to Fieldbus
P1.14	Remote 1 Reference	Set to Fieldbus
P12.1.1	IP Address Mode	Set to Static IP
P12.1.6	Static IP Address	192.168.1.254
P12.1.7	Static Subnet Mask	255.255.255.0
P12.3.1	Modbus TCP Enable	Set to Enable

Then place the VFD in remote control using the keypad.

For DH1:

P1.13	Remote 1 Control Place	Set to Fieldbus
P1.14	Remote 1 Reference	Set to Fieldbus
P12.4.1.1	IP Address Mode	Set to Static IP
P12.4.1.6	Static IP Address	192.168.1.254
P12.4.1.7	Static Subnet Mask	255.255.255.0

Then place the VFD in remote control using the keypad.

For DG1:

P1.11	Remote 1 Control Place	Set to Fieldbus
P1.14	Remote 1 Reference	Set to Fieldbus
P12.4.1	IP Address Mode	Set to Static IP
P12.4.6	Static IP Address	192.168.1.254
P12.4.7	Static Subnet Mask	255.255.255.0

Then place the VFD in remote control using the keypad.

Example program notes

The example program “E4 to DM1 Demo.e70” uses the Modbus TCP master to communicate with the DM1/DG1/DH1. It has a simple start and stop function and provides Net_Ref and Net_Control for the drive.

- I1 – Start
- I2 – Stop
- I3 – Drive Reverse
- I4 – Drive Reset
- I5 – Net Ref and Control On/Off
- AI4 – Drive Speed adjustment

The value from analog input AI4 is modified using an LS scaling function to scale it from a raw value of 0 – 4095 to 0 – 10000 (Hz*100) for the drive. The scaled speed reference is passed to the drive through QA11. Please see **Table 1** for all data passed between the drive and the PLC.

Below is the main screen, which is also the startup screen.

```
DM1 37.92Hz Freq
ETM   0/ 35 H/M
☒Ready ☒Run
☐Rev  ☐Fault
☐Alarm ☒At Spd
Press < Button
```

Figure 8. Startup screen

By pressing the left and right arrows on the easyE4, the display on the front of the easyE4 will switch between screens to display different control and status data. By pressing the < button, the Input Status screen can be displayed in the following order. To reset to the main screen, press the < button at any time.

```
Input Status
☒Run  ☒Net Ref
☐Rev  ☒Net Ctl
☐Reset

Press < Button
```

Figure 9. Input Status screen

By pressing the < button again, the Process Data 2 screen shows the second four Data out word from the VFD.

```
Process Data 2
0.0% Motor Pwr
145.3V Motor Vlt
299V DC Bus
0Fault Code
Press < Button
```

Figure 10. Process Data 2 screen

By pressing the < button again, the Process Data In1 screen shows the first three Data in word to the VFD. These are only used if the options are in use in the VFD.

```
Process Data In1
Field Bus
0.00Torque Ref
0Setpoint 1
0FeedBack 1
Press < Button
```

Figure 11. Process Data In1 screen

By pressing the < button again, the Process Data In2 screen displays the second three Data in word to the VFD. These are only used if the options are in use in the VFD.

```
Process Data In2

0.0s Accel Tim
0.0s Decel Tim
0.0A I Limit
Press < Button
```

Figure 12. Process Data In2 screen



Additional information

In the U.S. or Canada, please contact the Technical Resource Center at **1-877-ETN-CARE** or **1-877-326-2273**, option 2, option 6.

All other supporting documentation is located on the Eaton website at **Eaton.com/easy** and **Eaton.com/drives**.

Eaton
1000 Eaton Boulevard
Cleveland, OH 44122
United States
Eaton.com

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