



RUI/Gateway & Modbus® RTU Configuration & Programming Example Using an Allen-Bradley MicroLogix 1200 PLC

Purpose and Scope of this White Paper

Purpose:

This paper has been written for those needing assistance in how to get started using the EZ-ZONE® RUI/Gateway to serve as a bridge between dissimilar networks; in this case, between Modbus® RTU and Watlow's Standard Bus. The following pages demonstrate some simple configuration steps enabling the connection and then some simple programming which will facilitate movement of data between the RUI/Gateway and the Allen-Bradley (AB) MicroLogix 1200 Programmable Logic Controller (PLC).

Scope:

The scope of this paper is not meant to be an exhaustive discussion in configuring the RUI/Gateway, for this work has already been completed and published in two other EZ-ZONE user manuals. For instance, if needing assistance in setting the `Com` instance 2 parameters or if you are simply looking for general information pertaining to Modbus RTU as it is used with EZ-ZONE controls, point your internet browser to the Watlow website (<http://www.watlow.com>) and download the EZ-ZONE PM Communications user manual and or the EZ-ZONE RUI/Gateway user manual.

Likewise, from the PLC perspective, what is demonstrated is some basic ladder logic that best illustrates the movement of data from one side of the network to the other. What is covered in this paper follows:

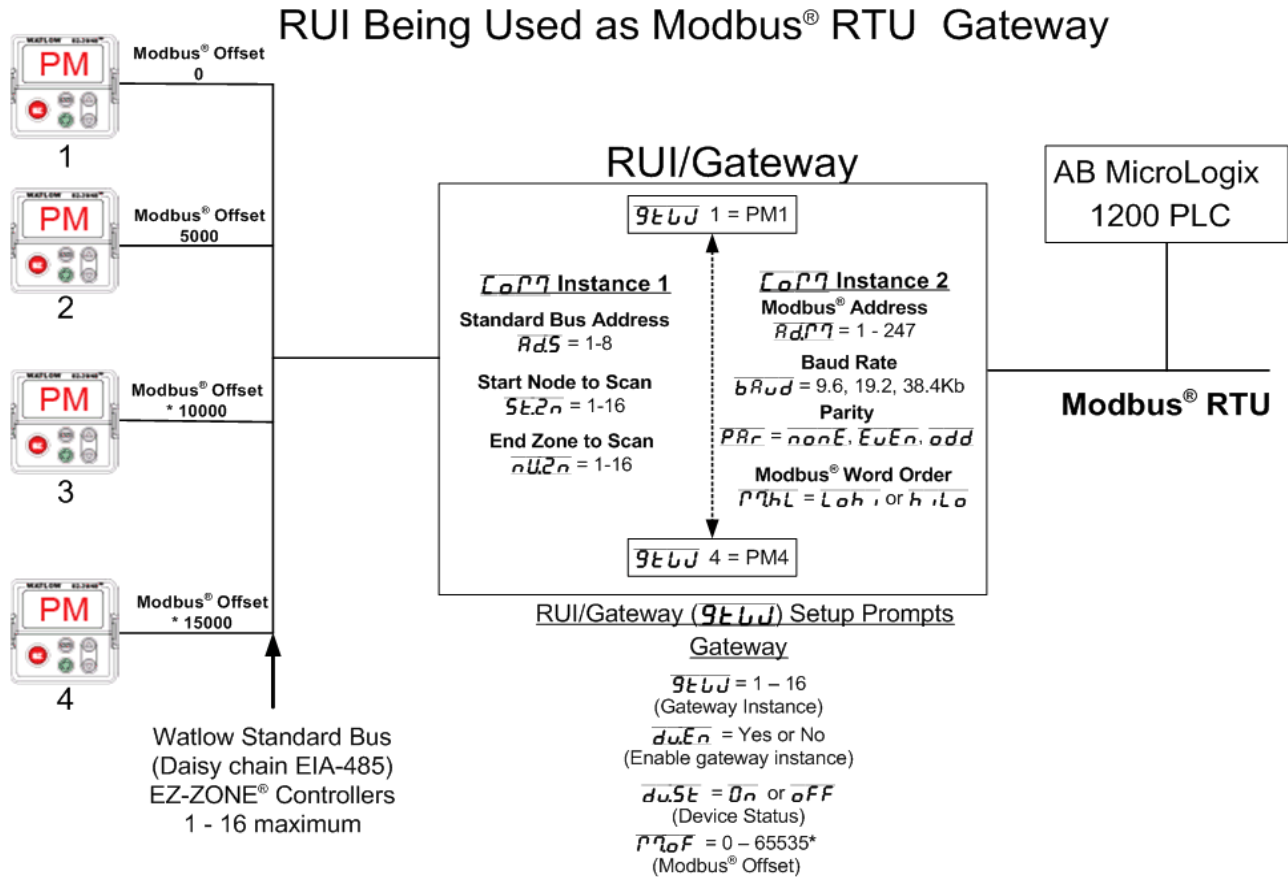
- General information pertaining to the RUI/Gateway Com instance 1 and 2 configuration parameters
- Understanding and using the EZ-ZONE EEPROM (Non-volatile Save)
- Explanation and use of the Modbus offset prompt in the RUI/Gateway
- PLC channel configuration
- Providing PLC access to the same parameter (i.e., Process Variable, instance 1) from various EZ-ZONE PM controls on the Standard Bus side of the network.
- Understanding the PM User Programmable Memory Blocks as used over Modbus
- Reconfiguring the User Programmable Memory Blocks to user defined preferences



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Configuring the EZ-ZONE RUI/Gateway

1. Prior to looking closer at the RUI/Gateway configuration prompts let's first take a look at the network used in this discussion.



* The RUI allows for a maximum entry of 9999 due to the limitations of the 7 segment display. To enter an offset > 9999 EZ-ZONE® configurator software must be used.

2. Some notables regarding the graphic above. In the steps that follow we are going to focus on three of the prompts shown: a. Gateway Instance (*Inst*) b. Gateway enable (*En*) c. Modbus offset (*Off*)
3. Notice in the graphic in step 1 that the RUI/Gateway has 2 “Com” instances. Com instance 1 will always be Standard Bus and Com instance 2 will always be the user protocol of choice,



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in this case, Modbus RTU. If a step-by-step example is needed to fully configure the RUI/Gateway download the appropriate user manual as suggested on the first page of this document.

4. To implement the network shown in step two, the following settings will need to be entered:

Gateway Instance	Enable Gateway Instance	Modbus Offset
9555 = 1	duEn = Yes	r7oF = 0
9555 = 2	duEn = Yes	r7oF = 5000
9555 = 3	duEn = Yes	r7oF = *10000
9555 = 4	duEn = Yes	r7oF = *15000

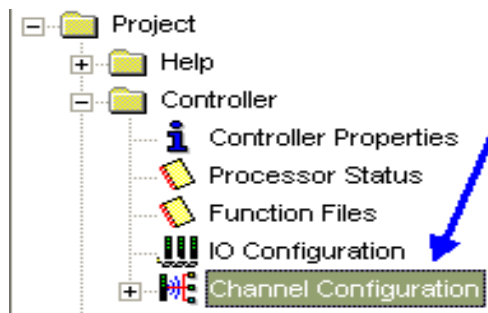
Further explanation of these prompts and their associated enumerated values will follow.

* The RUI allows for a maximum entry of 9999 due to the limitations of the 7 segment display. To enter an offset > 9999 EZ-ZONE Configurator software must be used.

5. After completing the configuration as shown above as well as any CoP7 instance 1 settings for the Standard Bus side the configuration for the RUI/Gateway is complete.

Configuration & Programming the PLC Using RSLogix 500

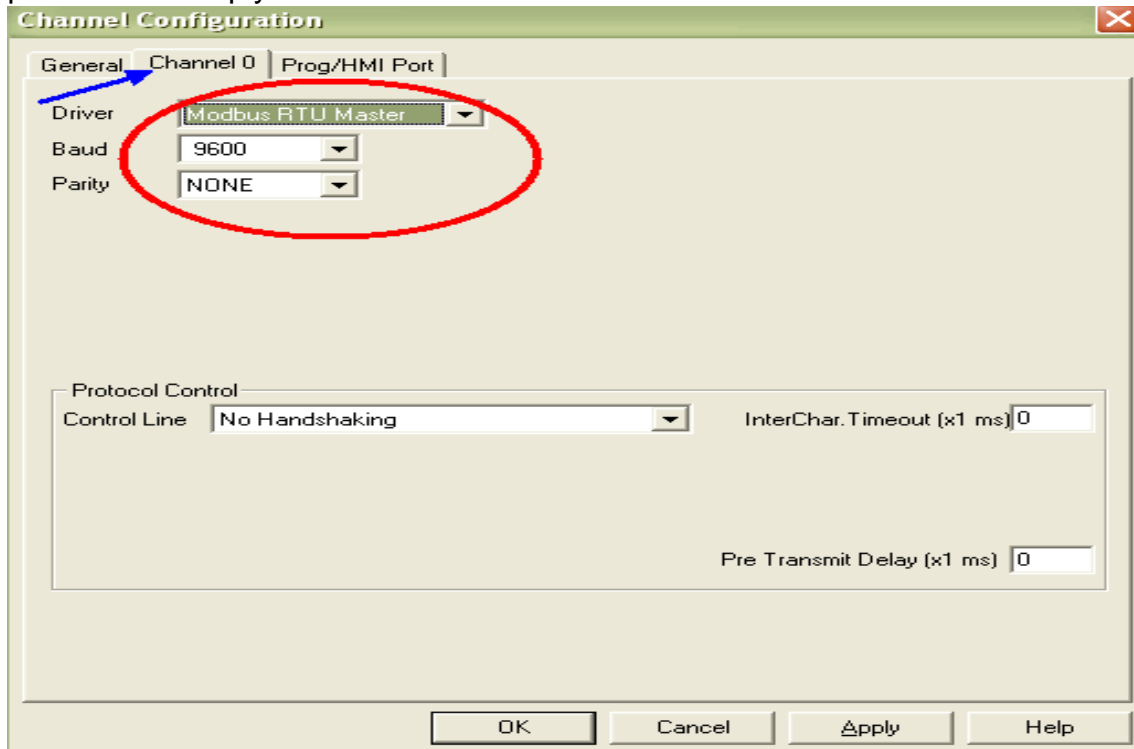
6. This particular PLC is one of many devices on the market today that utilize the Modbus RTU protocol. It is important to keep in mind that this paper and the steps that follow focus specifically on the RUI/Gateway as it is used with the AB MicroLogix 1200 PLC. It should also be noted that it is assumed by the writer that the reader has an understanding of RSLogix 500 software and its embedded tools to create projects, files, etc...for these steps are intentionally omitted to minimize the size of this paper.
7. The following screen shots capture some of the more significant steps to successfully establish communications between the PLC (channel 0) and the EZ-ZONE RUI/Gateway (CoP7 instance 2) running Modbus RTU. Using RSLogix 500, open up a project or create a new one. Once opened or created, proceed to double click on "Channel Configuration" as shown below.





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8. Click on the tab identified as “Channel 0” and set it as shown. The configuration shown below reflects the EZ-ZONE defaults. Change the parameters to meet your network requirements or if acceptable as is simply click OK to finish.



9. In step 4 some prompts were shown indicating further explanation would follow, well, here we are.

The Gateway Instance and the Gateway Enable prompts must be set as shown in step 4 for this particular network. The Gateway Instance corresponds to the address given to the PM control and the Gateway Enable simply requires a “Yes” or “No” response.

When trying to read or write to any given parameter in a destination PM control it is important to keep in mind that there is a unique Modbus address set aside for each. As an example, note that as found in the EZ-ZONE PM Communications user manual under the “Operations Page” Process Value 1 (PV1) is given a Modbus address of *360 & 361 with a data type of floating point. As shown in the graphic in step one of this document there are four PM controls on the Standard Bus side of the network where within each PM they have the same address for PV1. As read through the RUI/Gateway, if it is desired to read PV1 of PM3 the Modbus



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offset (OFF) must be observed and used. So, in this particular case, the appropriate address to be read would be **410361 not 40361 where the offset as shown in step 5 for PM3 is 10000. Based on this network configuration, if it is desired to read PV1 from each of the four PM

controls on the Standard Bus side of the network the following addresses would correlate to each:

PV1 of PM1 = **400361 (offset = 0)

PV1 of PM2 = 405361 (offset = 5000)

PV1 of PM3 = 410361 (offset = ***10000)

PV1 of PM4 = 415361 (offset = 15000)

- * Modbus registers as found in the various EZ-ZONE user manuals may appear to omit the designator “4” for Holding Register. For all references to Modbus registers in this document and other EZ-ZONE manuals as well, the “4” is assumed where Modbus registers are 1-based.
- ** The Modbus application protocol specification allows for an address range of 0 - 65,535. There may be occasions when using the RUI/Gateway where it will be required to exceed the conventional Modbus addressing range of 0 - 9999 due to the needed offsets; this is the case in the example above and those that follow below. Some software packages do not support 6 digit Modbus addressing. For this reason, it is recommended that this functionality be considered prior to purchase.
- *** The RUI allows for a maximum entry of 9999 due to the limitations of the 7 segment display. To enter an offset > 9999 EZ-ZONE Configurator software must be used.

EZ-ZONE EEPROM

10. Prior to getting started with the programming examples it is important to note that the EZ-ZONE family of controls has an on-board EEPROM to back up user settings in the event of a power loss. By default, the non-volatile save parameter is enabled over Com instance 1 and disabled over Com instance 2. Being that the RUI/Gateway is connected to the EZ-ZONE controls over Standard Bus on Com instance 1, changes made over the network as well as any changes made from the RUI are saved to the EEPROM. The user needs to be aware that the EEPROM will need to be disabled if frequent writes are driven through the RUI/Gateway to the destination EZ-ZONE controls on Standard Bus. The rate at which writes to EEPROM occur could be very fast when connected to a PLC on the Modbus side (in the millisecond range). With this being said, it should be considered carefully as to whether or not this parameter should remain enabled on Com instance 1. To avoid premature EEPROM failure (~1,000,000 writes) it is recommended that the user disable the non-volatile save parameter in normal operation.



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Non-volatile Save Parameters:

Data Type - unsigned integer
EZ-ZONE ST Modbus register - 2420
EZ-ZONE PM Modbus register - 2494
Enabled = 106
Disabled = 59

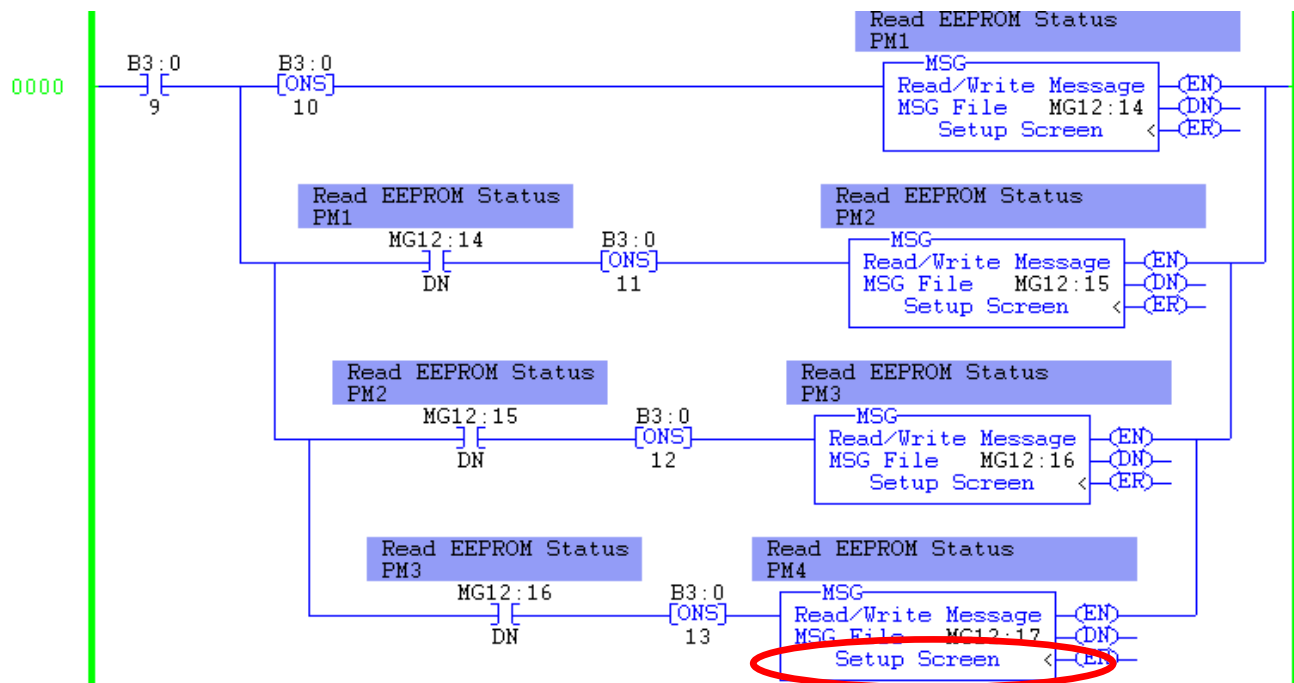
When using the EZ-ZONE ST control, if it is desired that a specific set point be returned after a power down condition, take the following steps:

- Enable EEPROM writes by writing 106 to Modbus address 2421 (1-based Modbus addressing)
- Write the desired set point to the ST control where it will be written to EEPROM
- Disable EEPROM writes by writing 59 to Modbus address 2421

If using a PM control, simply follow the same procedure changing the Modbus address to 2495.

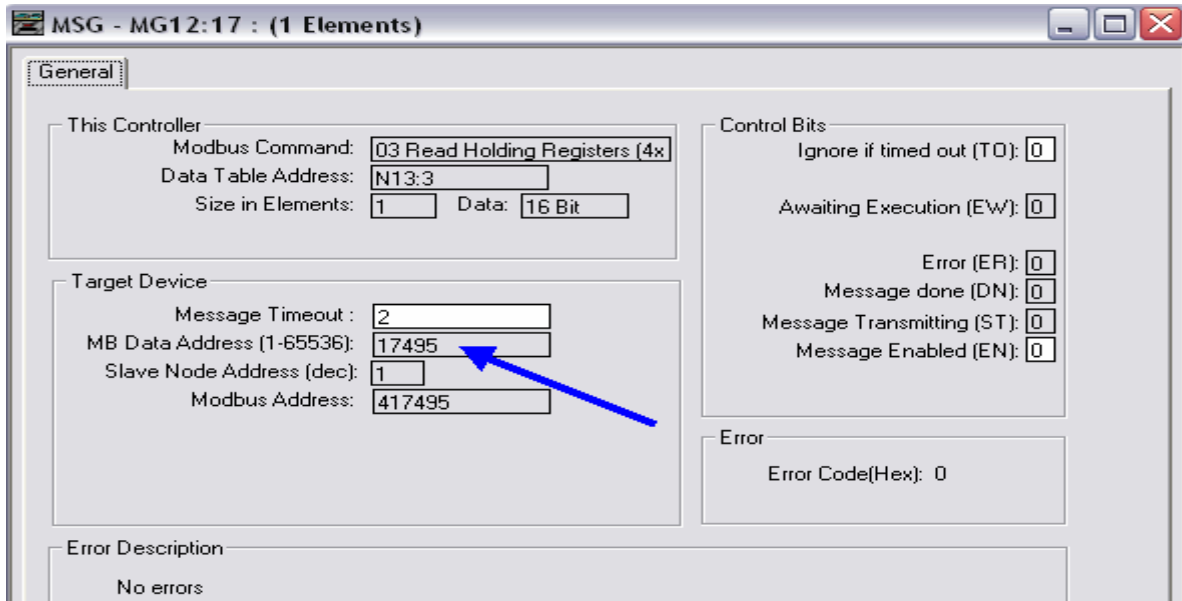
- The screen shot below illustrates some simple ladder logic where when enabled will read Modbus register 2494 from each of the four PM controls on the network as illustrated in step one. The configuration for PM4 follows on the following page.

Read Non-volatile Save Parameter from Each of Four PM Controls

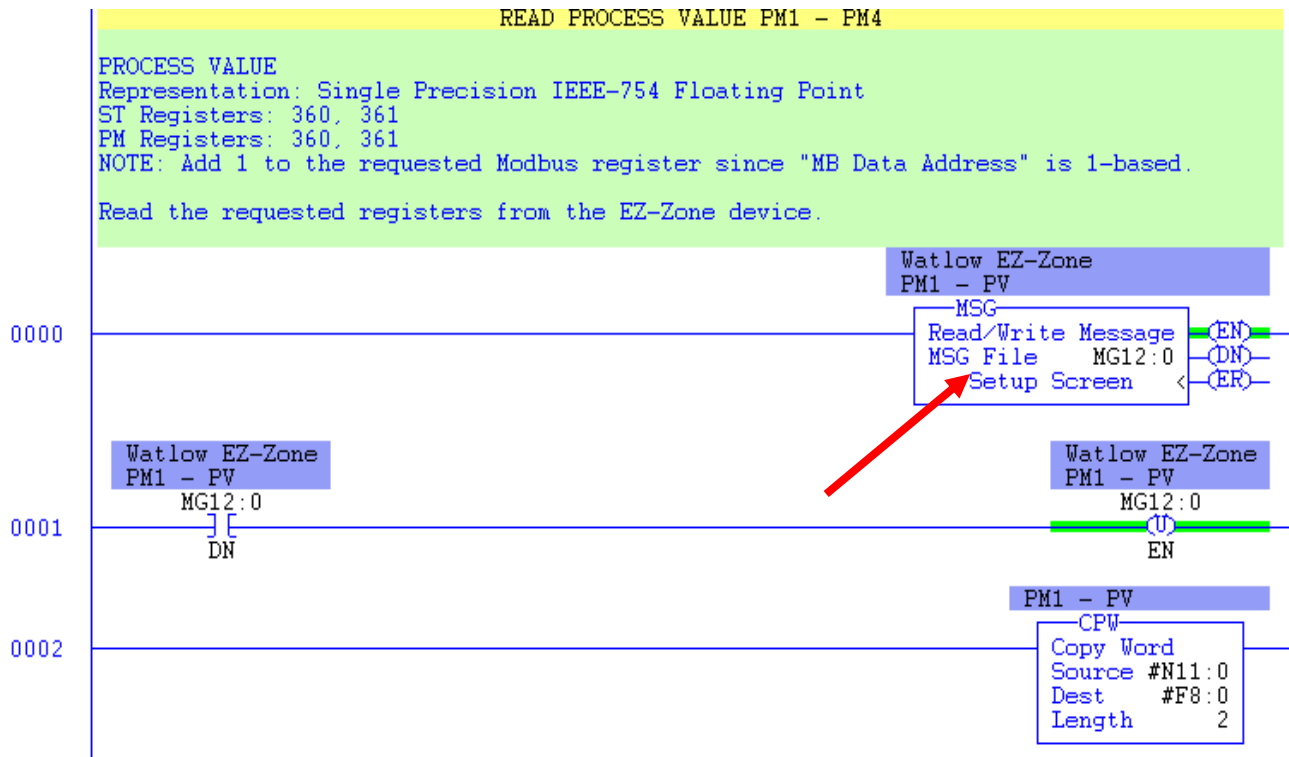




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12. Below, the screen shot illustrates some logic that can read the process variable from PM1. N11:0 & 1 (CPW) represent the destination of the MSG instruction where they are copied to F8:0 making the PV available and used in other rungs of logic.





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13. In the above screen shot notice that the MSG instruction requires some setup (red arrow). The screen shot below reflects this configuration.

MSG - MG12:0 : (1 Elements)

General

This Controller

Modbus Command: 03 Read Holding Registers (4x)

Data Table Address: N11:0

Size in Elements: 2 Data: 16 Bit

Target Device

Message Timeout: 2

MB Data Address (1-65536): 361

Slave Node Address (dec): 1

Modbus Address: 40361

Control Bits

Ignore if timed out (TO): 0

Awaiting Execution (EW): 0

Error (ER): 0

Message done (DN): 0

Message Transmitting (ST): 0

Message Enabled (EN): 1

Error

Error Code(Hex): 0

Error Description

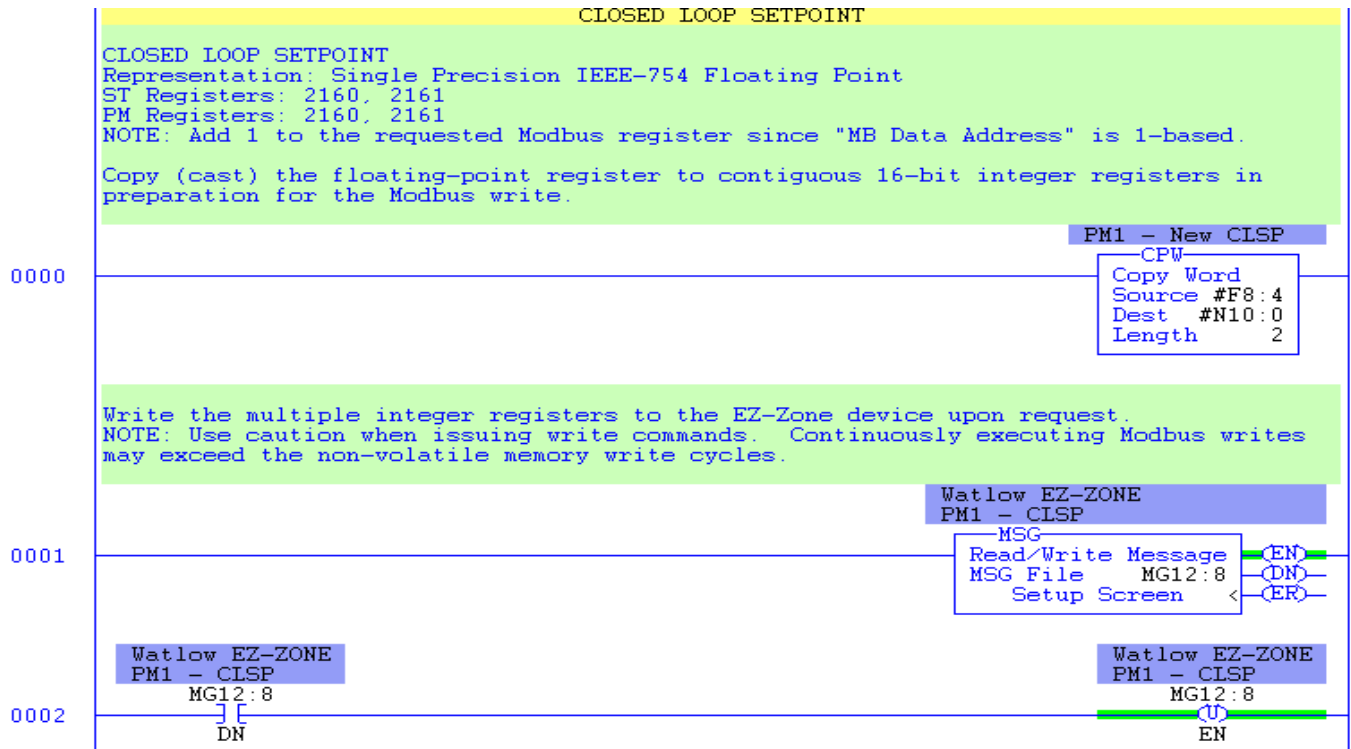
No errors

The logic above can be used to read any available parameters from any EZ-ZONE controller, ST or PM alike. However, **it should be noted that when going through the RUI/Gateway to an EZ-ZONE ST control that the Modbus registers are different from those documented in the ST user manual.** If it is desired to acquire the entire list of Modbus registers for the ST please contact Watlow Technical Support by dialing 1-507-494-5656 or via e-mail:wintechsupport@watlow.com. For the PM control, download the EZ-ZONE PM Communications user manual from Watlow's website.

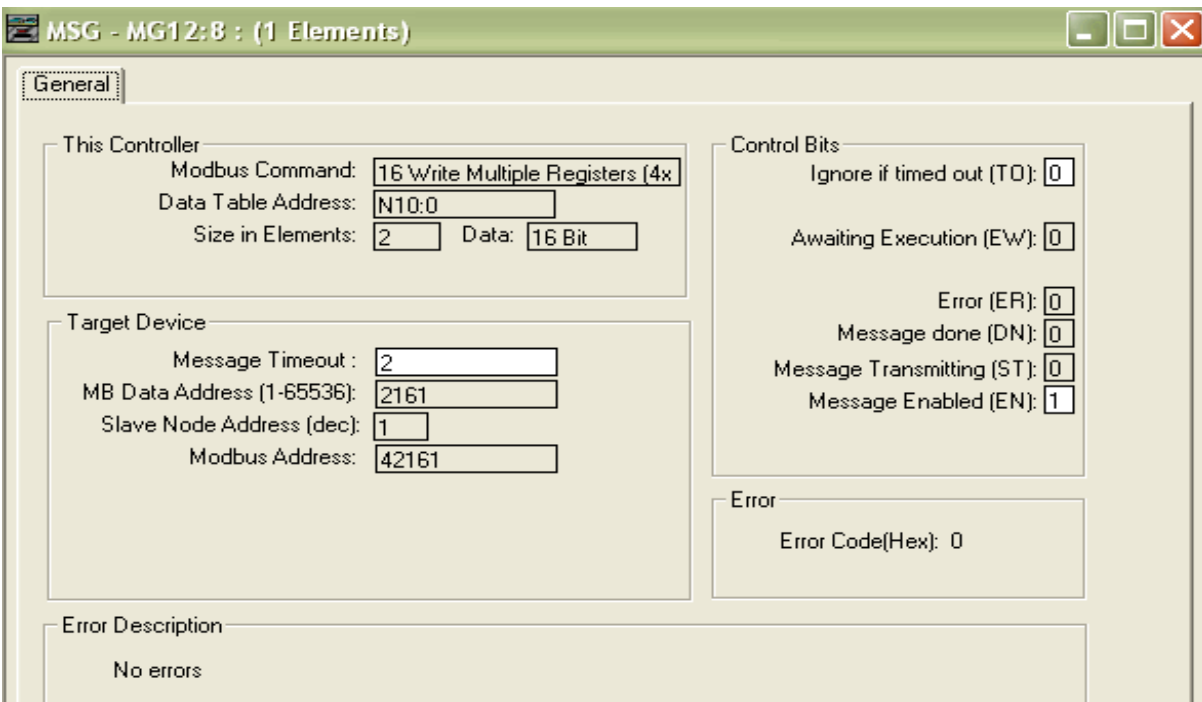
14. In the example that follows, the new element in focus is the closed loop set point (2160 & 2161). The logic below will write the value stored in F8:4 to N10:0 & 1 where the MSG instruction will then write those registers out to PM1 when executed.



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15. Again, the write MSG instruction requires some setup which can be seen below.





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16. To better understand the following discussion and examples download and read the section entitled “User Programmable Memory Blocks” found in the EZ-ZONE PM Communications user manual.

When using the RUI/Gateway equipped with Modbus RTU and while communicating with EZ-ZONE *PM controls a block of 40 parameters or 80 words has been created to serve as the “Assembly Definition Addresses” and another group of 40 parameters or 80 words has been defined as the “Assembly Working Addresses”. The Assembly Definition Addresses are user configurable. Once configured with the Modbus registers of choice, the corresponding Assembly Working Addresses assume that particular parameter as programmed, and will then reflect that parameters actual value. What this means then is that the user can configure a contiguous block of 40 parameters or 80 words to any available parameter of their liking. It is recommended that when doing this configuration that the parameters data type be considered. It is much easier to set up a contiguous block of words of the same data type.

Note:

If the assemblies are modified and if the user sets any of the EZ-ZONE PM controls back to factory defaults, the assemblies for that particular control will be reset to the factory defaults as well. Reprogramming would be required to restore user settings.

*** The EZ-ZONE ST does not support programmable memory blocks.**

17. In the screen shot below, the MSG instruction is configured to read the “Assembly Definition Addresses” as delivered from the factory into PLC registers N10:20 – N10:99.

The rung below will read the default assembly configuration from PM1. Notice that there is no offset applied to the address specified in the configuration of the MSG instruction (Modbus offset is 0 i.e., 40041)

0000

0001

0002

0003

0004

0005



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18. Once the instruction above is executed, interrogation of the PLC data table addresses N10:20 - N10:99 will reveal the factory defaults for the Assembly Definition Addresses (block of 80 words) as they are being read through the RUI/Gateway. As explained in the EZ-ZONE PM Communications user manual and above as well, the enumerated values shown in each of these Modbus registers represents the actual Modbus registers for each of the 80 corresponding Assembly Working Addresses. To find what these Modbus registers actually represent (as in which parameter is actually defined), check out the Operations & Setup pages of the EZ-ZONE PM Communications user manual.

Offset	0	1	2	3	4	5	6	7	8	9
N10:20	1880	1881	2160	2161	2162	2163	1480	1481	1482	1483
N10:30	1530	1531	1532	1533	1580	1581	1582	1583	1630	1631
N10:40	1632	1633	2540	2541	2520	2521	1890	1891	1892	1893
N10:50	1894	1895	1896	1897	1900	1901	1902	1903	1898	1899
N10:60	360	361	362	363	440	441	442	443	1496	1497
N10:70	1546	1547	1596	1597	1646	1647	1328	1329	1348	1349
N10:80	1882	1883	1904	1905	1906	1907	690	691	2520	2521
N10:90	2540	2541	2524	2525	2527	2527	2528	2529	2536	2537

19. Registers 60 & 61 (blue circle above) are shown as “Analog Input 1 Process Value” represented by the enumerated values of 360 and 361 respectively. If reading the associated Assembly Working Address registers 240 & 241, one would find the current Analog Input 1 Process Value for PM1.
20. Changing a parameter in the assembly is EZ. As can be seen below another MSG instruction is configured, in this case, to write the value from N10:100 to address 40109 which represents the 35th pointer of the Assembly Definition Addresses. The value stored in N10:100 is 2177 (see inset graphic) where this will be found (EZ-ZONE PM Communications user manual) to be the Idle Set Point (2176).



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This rung when enabled will write a new element to the 21st pointer of the assembly.

0002 B3:0 B3:0
] [[ONS]
 3 4

MSG
 Read/Write Message (EN)
 MSG File MG12:13 (DN)
 Setup Screen (ER)

MSG - MG12:13 : (1 Elements)

General

This Controller

Modbus Command: 16 Write Multiple Registers (4x)
 Data Table Address: N10:100
 Size in Elements: 2 Data: 16 Bit

Control Bits

Ignore if timed out (TO): 0
 Awaiting Execution (EW): 0
 Error (ER): 0
 Message done (DN): 0
 Message Transmitting (ST): 0
 Message Enabled (EN): 0

Target Device

Message Timeout : 2
 MB Data Address (1-65536): 109
 Slave Node Address (dec): 1
 Modbus Address: 40109

Error

Error Code(Hex): 0

0003

0004

0005

0006

21. After the rung above is executed the 35th pointer (set at factory to "Profile Start") will now be set to "Idle Set Point". The graphic below reflects the new Assembly Definition Addresses. Compare this to the graphic in step 18 above.

N10:20	1880	1881	2160	2161	2162	2163	1480	1481	1482	1483
N10:30	1530	1531	1532	1533	1580	1581	1582	1583	1630	1631
N10:40	1632	1633	2540	2541	2520	2521	1890	1891	1892	1893
N10:50	1894	1895	1896	1897	1900	1901	1902	1903	1898	1899
N10:60	360	361	362	363	440	441	442	443	1496	1497
N10:70	1546	1547	1596	1597	1646	1647	1328	1329	1348	1349
N10:80	1882	1883	1904	1905	1906	1907	690	691	2176	2177
N10:90	2540	2541	2524	2525	2527	2527	2528	2529	2536	2537

22. This particular parameter can be read from or written to. An example as to how to do this on an individual parameter-by- parameter basis can be found in step 12 and 14. However, the real advantage in using and modifying this assembly to the users liking is the ability to do block reads and writes thus minimizing ladder logic. To minimize data type conversions it is suggested that when setting up the assembly that it be setup with similar contiguous data types.