

Application Note #1168:

Modbus - Establish Communications - Hints

Introduction

This document is a supplement to GP-Pro EX Device/PLC Connections Manuals. Refer to the manual to connect the device and configure the driver.. For supplemental information about Modbus serial cabling between your 3rd party device and Pro-face equipment refer to Application note #1167 “3rd Party Modbus Serial Cabling Tips”. More information about Modbus cabling and communications is available on the Internet from the Modbus Organization at: http://www.modbus.org/docs/Modbus_over_serial_line_V1_02.pdf

The information contained here applies to devices that follow the Modbus standard for communications. Other customized “Modbus” like drivers are available in GP-Pro EX that are tailored to communicate with slave devices such as Emerson Control Techniques, IAI, Koyo - Automation Direct, Mitsubishi Heavy Industries, RKC, Yokagawa, and Yaskawa. Information later in this document may be useful in connecting to these devices as well.

Select the Correct Modbus Driver

GP-Pro EX offers 5 Modbus standard PLC/Device drivers.

Serial

In most Modbus serial applications an HMI is the master and the connected devices are slaves. The Modbus serial protocol allows each slave only one master. The GP-Pro EX multi-link feature can be used to share slave data over Ethernet with other Pro-face HMIs.

GP-Pro EX includes two serial Modbus master drivers:

- The **Schneider Electric SA, MODBUS SIO Master** is easy to configure and works in most applications. It allows up to 16 slave devices.
- The **Modbus-IDA General MODBUS SIO Master** is more adaptable to slave devices such as temperature controllers and VF drives. It includes a user definable feature to limit access to areas of Modbus memory. Connect up to 31 slave devices.

Configure slave devices to use Modbus RTU protocol rather than Modbus ASCII when possible. If a slave device is Modbus serial ASCII only choose the Modbus IDA General Modbus SIO Master driver in GP-Pro EX. Then, in the Device/PLC Communications Settings, change the default RTU setting to ASCII.

Ethernet

The Modbus TCP protocol allows multiple clients (masters). The number of clients (masters) that can connect to a Modbus TCP server (slave) at any one time is limited by the number of simultaneous TCP connections the server (slave) device can handle.

GP-Pro EX includes two Ethernet Modbus TCP master drivers:

- The **Schneider Electric SA, MODBUS TCP Master** is easy to configure and works in most applications. It allows up to 16 slave devices
- The **Modbus-IDA General MODBUS TCP Master** is more adaptable to field devices such as temperature controllers and VF drives. It allows up to 16 slave devices.

Slave

If the HMI is to be a slave (client) and the connected device is the master (server) choose the **Schneider Electric SA MODBUS SLAVE** driver. This driver can be configured for either **serial** or **Ethernet (TCP)** connections.

Configuring and Establishing Communications

When connecting a 3rd party device for the first time we recommend starting with a simple single screen test project connected to a single slave (client).

Modbus Serial

- Select a Modbus PLC/Device driver
- Set the Speed (Baud rate) to match the connected device setting.
- Verify the Parity, Data Length, and Stop Bit default settings match the slave device. If they are not available begin with the default settings.
- Set “Wait to Send” to match the device. This setting may be referred to as “wait to transmit”, TX Wait Time, or “wait to send”. This parameter is configurable in most slave devices. If this information is not available begin with the Device/PLC driver default setting. Exception: If the default driver setting is 0 begin with 4msec.
- If you are using standard Modbus cabling (no handshaking lines) Flow Control remains at default.
- In the Device Specific Settings set the Slave Equipment Address to match the slave node address.
 - *Jump to the section “All Modbus Masters” below*

Modbus TCP

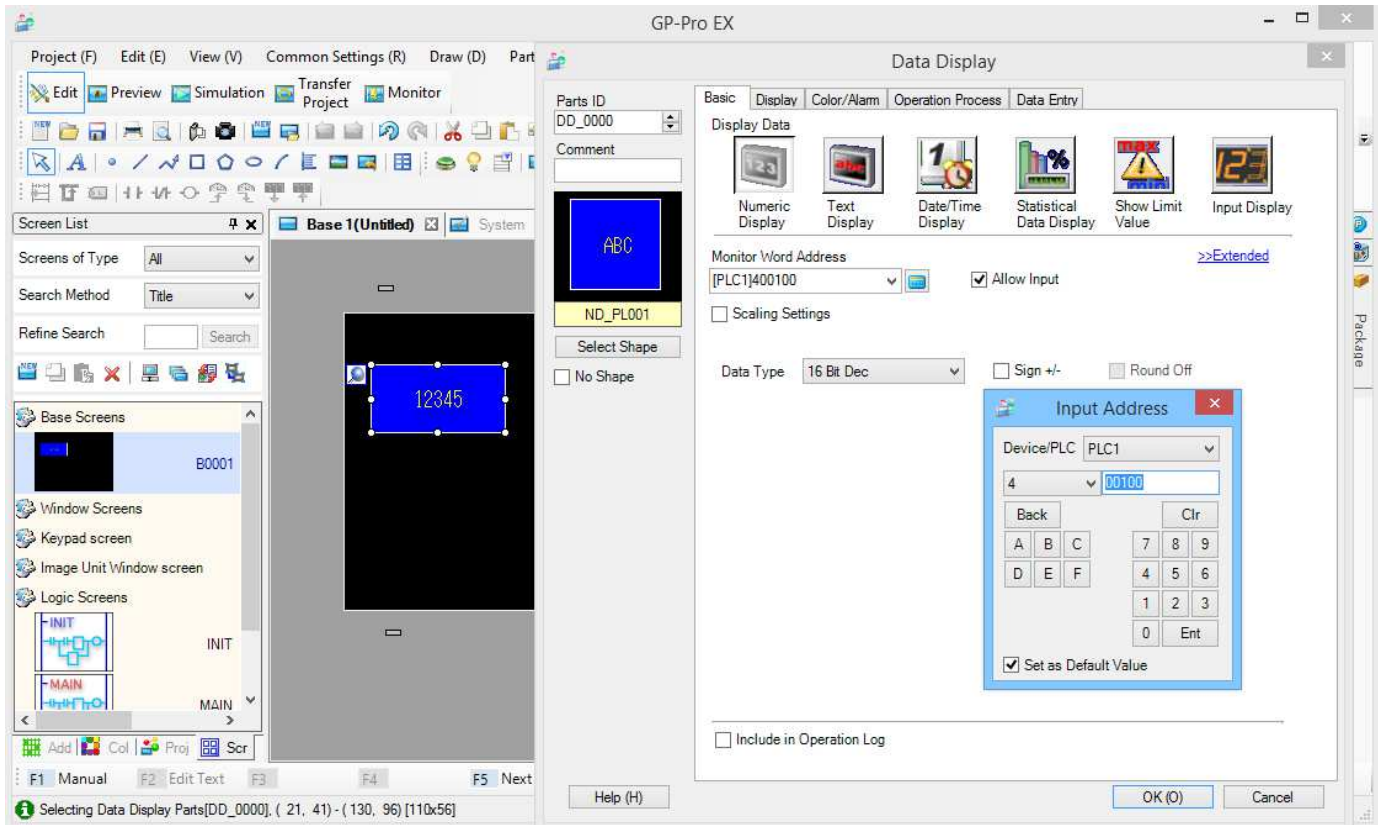
- Select a Modbus PLC/Device driver
- Set the Speed (Baud rate) to match the connected device setting.
- For Modbus TCP the Wait to Send value is typically 0 unless the device is accessed through a TCP to serial bridge. If so follow the bridge instructions for this setting.
- The “Port No.” should be 502 in the Pro-face equipment and the connected device.
- For Modbus TCP the Unit ID is typically 255 regardless of the device unit ID. (Unit ID = 255 is a broadcast setting). Exception: if the IP address is a Modbus TCP to serial bridge follow the bridge instructions for this setting.
 - *Continue with the section below.*

All Modbus Masters

- If you wish to view registers in IEC format in GP-Pro EX select “IEC61131 Syntax”. (This is not necessary for functional purposes since communications to a slave device remains exactly the same)
- In the Display Unit > System Area set the System Area Start Address. Do not enable the System Data Area. It can always be enabled later after communication is established. Do not assume that because the System Data Area is unchecked that the System Start Address is not monitored. Ideally this is a readable address that maintains a constant value.
- In Watchdog Settings if the Address is “<unknown>” enter any valid Modbus address. Do not change the Watchdog Timer Settings from 0 Seconds.
- Create a single screen application with a numeric data entry field in the 400000 range (%MW if using IEC addressing). Select a register greater than 400001 or %MW1. Choose a single register in the slave device that is 16 bit integer, allows read/write

access, is not locked, and permits change via a Modbus connection. For simplicity do not include other memory ranges or bit variables in the initial test project.

Note: Some vendors provide the Modbus data register address as an "offset". In that case the 4 in the left Input Address field is assumed. The "offset" +1 is entered in the right field. If you choose to use IEC addressing select %M in the left field and enter the "offset" in the right field. (refer to the picture below)



Note about devices that support 32 bit words only: If your device has only 32 bit data registers select the appropriate 32 bit Data Type in the test project Data Display. Device addressing is 16 bit word oriented. Therefore 32 bit words use 2 addresses in the device. (Example: One 32 bit word would occupy 400010 and 400011 or %MW9 and %MW10.) Use a register greater than 400002 or %MW2.

Communication Errors

Connect the slave (client) device to the Pro-face unit. Download the GP-Pro EX project. If an error appears on the Pro-face unit press the button next to the error with a blue bar. A window with the complete text of all error messages will appear. Refer to the software documentation for a description of the error(s). See section T.4 "Problems with communication with connected devices" in the GP-Pro EX Reference Manual. The suggestions below are additional things to consider: (Help > Manual >Reference Manual)

If no data appears on the screen and an error appears:

- **Modbus Serial**
 - Verify the slave Modbus RTU address (node number) matches the Slave Equipment Address setting in GP-Pro EX.

- Verify the serial communications settings match the slave equipment.
- Check if slave device is in “Run” mode and Modbus communications is enabled.
- Check for cabling or grounding problems.
- Be sure to have a signal common wire connected. (3rd wire if RS485 2-wire or RS232, 5th wire if RS485 4-wire) If the device does not have a signal common connection use signal ground on that end. If neither exists try connecting the common wire to the device frame or earth ground on the device end.
- If the serial connection is 2 wire RS485 consider:
 - Interchanging the A and B leads. (D1 and DO or TXRX+ and TXRX-)
 - In some installations a polarization circuit might be required.
- Set the Wait to Send to 10msec and try again. If still no response try 20 msec. In the case of RS485 2-wire try interchanging the A and B leads again.
- **Modbus TCP**
 - TCP connection open error can be any Ethernet network issue from cabling to subnet mask.
 - Client (master) and server (slave) must be on the same subnet.
 - Port No. setting on server (slave) must match the Individual Device Setting This setting should be 502.
 - A crossover cable or hub/switch must be used between the Pro-face equipment and the connected device.
 - Both devices must have fixed IP addresses. (not DHCP)
 - In the case on an LT4000M verify the Ethernet cable is not connected to the wrong RJ45 (serial) port.
 - If you are using a SP5000 display the other Ethernet port on the unit must be assigned to DHCP or a separate subnet even if it is not connected.
 - Unit ID must be 255 or match the node number setting of the server (slave).
- **All Modbus Masters**
 - Remove the numeric entry variable from the test project and download it again.
 - If the error no longer appears the memory location that was used for the data display may be write only (i.e. not readable) or read access is not permitted via a Modbus connection.
 - If the error still appears the System Start Address may be write only (i.e. not readable) or read access is not permitted via a Modbus connection.
 - The Watchdog Settings if the Address is “<unknown>”.
 - Check if the System Start address in the slave is a 16 bit register and a constant value. Try another system start address.
 - Many slave devices such as drives and sensors require smaller max query settings. One way to determine if this is the case is go to Individual Device Settings > max Query.
 - Change all register max query settings to 2 words.
 - Change all the Coil/Discrete Input settings to 16
 - Change the “Single Bit manipulation to Coil/Discrete Input” setting. Try again. If it does not solve the issue return it to the default setting.
 - If the project is not a simple newly created project as described in this document:
 - Check the Symbol Editor for word or bit symbols without an Address.
 - Verify the Language Change Feature is not enabled.

If some data appears on the screen but a communication error still appears:

- If an error appears only after trying to enter a new value with a data entry keypad:
 - The new value may be overwritten by the slave (server) device
 - The register is read-only
 - Write permission is not enabled in the slave (server) device.
Try another memory address.
- *Modbus Serial only:* If an error appears and data is displayed in the numeric field
 - Increase Wait to Send to 10msec. If not successful try 20msec.
 - Check for cabling or grounding problems.
 - Be sure to have a signal common wire connected.
- Try changing the settings in individual device settings.
 - Change all register max query settings to 2 words.*
 - Change all the Coil/Discrete Input settings to 16.
Try again. (in very few cases a device may require a register max query setting of 1)
- If the above changes did not work try the “Single Bit manipulation to Coil/Discrete Input” setting. Try again.
- The memory location may be read only or write only or not accessible in the slave (server) device by the HMI. Try removing the numeric entry box from the project to see if the error disappears.
- Increase the Wait to Send to 10msec and try again. If not successful try 20msec.
- *Modbus TCP only:* Try setting a wait state even when using Modbus TCP. It will slow the requests to the device reducing the communication load on the device and reduce network traffic. Set the Wait to Send to 10msec. If not successful try 20msec.

If communications are established and incorrect data appears:

Some 3rd party devices use a different bit order or byte order. In the case of 32 bit values such as double word and floating point sometimes the word order is swapped.

- Verify that a 16 bit value is located at the expected address in both devices. It is common for the addressing to be offset by one word. One way to do this is to place 3 consecutive numeric entry fields on the screen. (Example 400101, 400102, 400103 or %M101, %M102, %M103. Monitor the same addresses in the 3rd party device. Check if the data is written to the correct address when a change is made on the HMI and not the address above or below it to determine the address offset.
- If the data is written to the correct address, but appears to be the wrong value, try entering a value of 1 from the HMI. If the resulting value in the device is a large number the byte order may be reversed between the units. The byte order can be switched in the HMI using script.
- If the data is written to the correct address, the next step is to test a 32 bit integer. If the value is incorrect change the “Double Word order” selection in Device/PLC Individual Device Settings. It is helpful to place 3 consecutive numeric entry fields on the screen set to 32 bits to verify whether the problem is swapped words or the registers are offset. (Example 400101, 400102, 400103 or %M101, %M102, %M103.)

Hint when using string data: If string characters are swapped in LS memory try USR memory for string data.

If the test program works but the final project has communication errors:

Review the sections above that address the problem you encounter. Finally review the Gap and Span section below.

Optimize Modbus Performance

- Set “Wait to Send” to the optimum value for your situation to obtain best performance.
 - Most devices operate properly using the default setting in GP-Pro EX and setting the slave to match.
 - Setting too low may result in slow communications.
 - Setting too high results in slow communications
 - In the case of Modbus TCP the “Wait to Send” should be set to 0. Exception is when the connection is through a Modbus TCP to serial bridge.
- Use the lessor of either the default setting or the highest value the slave device allows for Max Query settings. (Boundary in the Modbus IDA driver)
- As much as possible minimize the number of memory address blocks accessed in the slave. Widely scattered random addresses separate data requests. All Modbus addresses configured in the system area, data logging, alarms, logic, and global scripts as well as the current screen are continuously polled in the connected device

About Gap and Span

For optimum performance most modern protocol drivers read a contiguous block of memory whenever data from registers requested are near to one another. These read block requests are recalculated by the driver for optimum performance each time a screen change happens. Data requests include all registers used in ladder and scripts whether they execute or not, the current screen, recipes, data logging, system area, and etc. One or more of these problems may be encountered.

- The field device cannot handle such a large request. Some PLCs for example can only respond to memory requests of 72 words or less. Solution: In this case we would set the Max Query “Boundary” (Span) to the largest word block size the PLC can handle, 72. Some small field devices can only handle 2 or even in rare cases 1 word in a request.
- Read problems can be encountered when registers with different access permissions are intermixed in a device. For example if an application needs the driver to read 400001, 400002, 400010, 400013 and if the driver is set to read the default block size the driver will request 400001 – 400013. Now suppose the register 400005 is write only. The 3rd party device will respond with a read error message. To solve this problem we set the read block size to a lower number in the HMI driver to accommodate the 3rd party device. In this example the read block size could be set to 6. In most cases the block size should be an even number.
- Read problems can be encountered when the project addresses very large blocks of registers without sufficient gaps between blocks. One problem is when a 32 bit word bridges 2 large read blocks. Another problem is read blocks overlapping. To prevent these situations access blocks of registers no longer than the Span setting. Then skip a block of addresses (gap) greater than ½ the Span.

For more information on Pro-face and our full line of HMI, Operator Interface and Industrial PC products please visit our web site at www.profaceamerica.com.

For technical support email: support@profaceamerica.com or call: 800-289-9266.

© 2016 Pro-face America. Specifications may change without notice. Pro-face is a registered trademark of Digital Corporation. Other brand or product names are the property of their respective owners.