nanoSTAKE® dataPLUS™

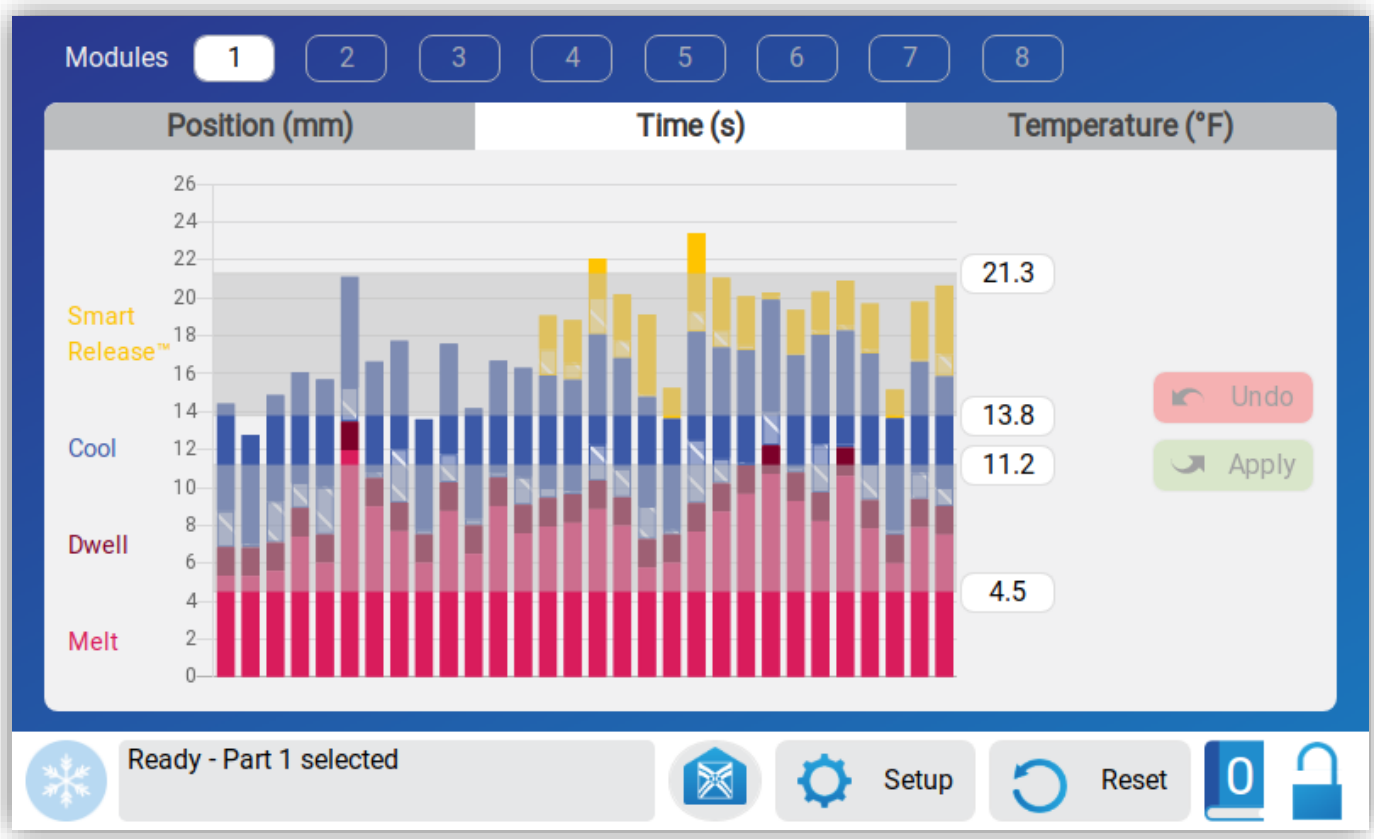


Table of Contents

Introduction 3
Activation 3
System Controller Network Configuration 4
Modbus Server Port 5
Modbus Holding Register Layout 5
System Data 6
Fault Data 7
Cycle Data 9
High Speed Data 9
Allen-Bradley Plugin 10
Gateway Installation 10
Gateway Configuration 11
AOI Installation Instructions 12
Usage 14
Multiple nanoSTAKE Systems with a Single PLC 16
Further Information 18

Introduction

dataPLUS™ network communication enables the nanoSTAKE System Controller to share data with a PLC or other device over an ethernet connection by performing the role of a **Modbus TCP** Server. dataPLUS is limited to acting as a data monitor and cannot be used to control the System Controller. **dataPLUS supports a maximum of 16 modules per system.**

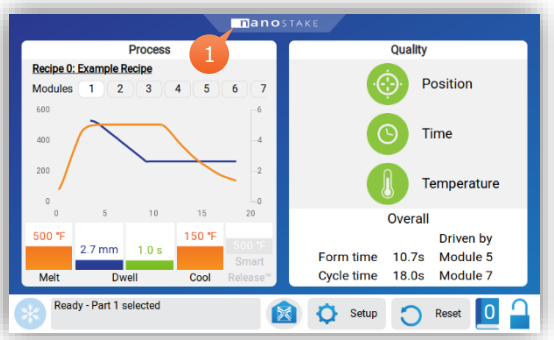
An Allen-Bradley Add-On Instruction (AOI) is available for CompactLogix and ControlLogix PLCs running v32+. This is the only plug-in available at this time. If the option is purchased, Extol will provide a pre-configured gateway as Allen-Bradley does not natively support Modbus for some strange reason. See the Allen-Bradley Plugin section for more information.

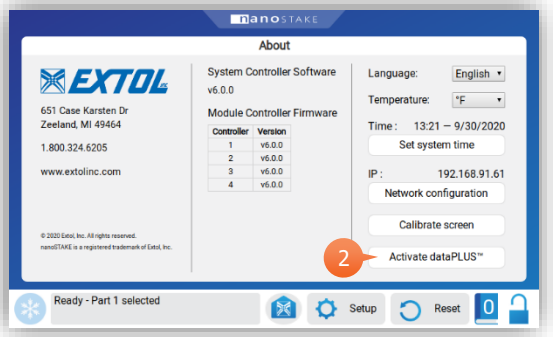
Activation

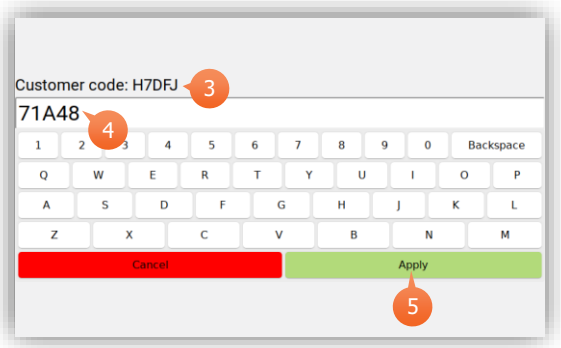
dataPLUS is a purchased option and must be activated prior to use. If you purchased it with the original order it may already be activated for you. If not, please follow the activation procedure below to enable dataPLUS.

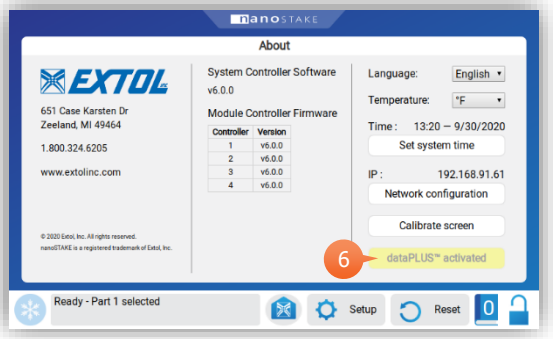
Browse to the About screen by tapping on the *nanoSTAKE* logo at the top of most screens (1). Tap on the *Activate dataPLUS™* button (2). This brings up a pop-up with a prompt containing a five-digit alphanumeric code* (3). Provide this code to an Extol salesperson and they will reply with a complementary activation code—enter the activation code into the prompt (4) and tap *Apply* (5). The button will highlight yellow and show *dataPLUS™ activated* (6).

** This code does not change over time and may be recorded for later activation.*





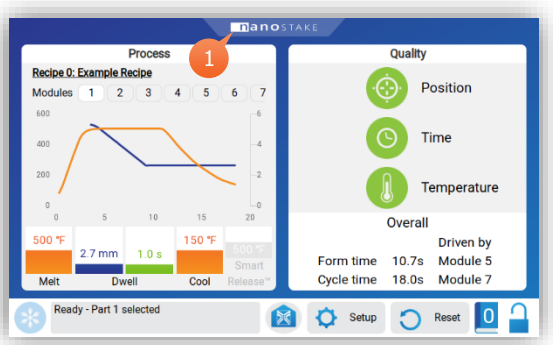




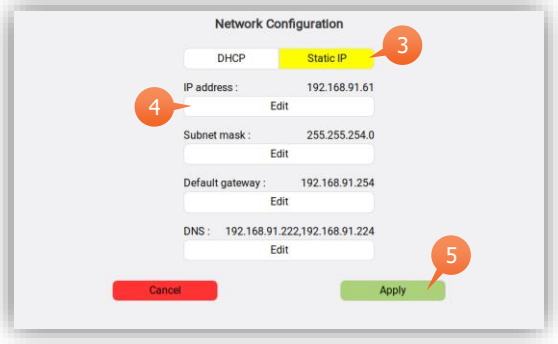
System Controller Network Configuration

The System Controller's IP address will need to be configured to be on the same network as the receiving device (e.g. PLC, gateway).

To do so, go to the About screen by tapping on the *nanoSTAKE* logo at the top of most screens (1), then go to *Network Configuration* (2). Usually a static configuration is required—switch to a *Static IP* (3), then *Edit* each item as necessary (4). Finally *Apply* the settings (5).







Modbus Server Port

The System Controller's Modbus server uses port **5020**.

Modbus Holding Register Layout

Although the Modbus protocol has four potential blocks of registers, the System Controller currently utilizes only one block. The block of registers that has been implemented contains the *Holding Registers.* Each Holding Register is 16 bits wide. Data types that exceed 16 bits are stored across multiple registers, and data types that are smaller than 16 bits may be packed together with other pieces of data into a single register.

Data that spans multiple registers is laid out in a little-endian format so that the lower 16 bits are in the lower register and the higher 16 bits are in the higher register.

The following tables represent the various pieces of data that can be requested from the System Controller by the PLC.

The *Address* column indicates the Modbus address of the data in the Holding Register data block.

Gaps in the Modbus address range exist to reserve space for future additions to the exportable data. These gaps are indicated by ellipses.

System Data

Address (4xxxx)	Data Name	Notes
0	Active Module Count	Represents how many modules have been added on the System Controller *Setup* screen. 16-bit integer
1-2	Most Recent Cycle ID	Starts at 0 and continues to increment for every cycle executed over lifetime of System Controller. 32-bit integer
3	System State	Represents the current state of the System Controller. 16-bit integer. Values can be interpreted as follows: 0: Undefined 1: Ready 2: In Cycle: Heating 3: In Cycle: Forming 4: In Cycle: Cooling 5: Cycle Complete 6: Faulted 7: Not Enabled 8: Resetting 9: Taring Module Temp 10: Validation: Ready 11: Validation: Boss Check 12: Validation: Final Check 13: Validation: Complete 14: Validation: Fault 15: In Cycle: Smart Release™ 16: Output Forcing
4	Cycle Data Flag	Toggles when all cycle data has arrived.

Fault Data

Each field in the Fault Data section can be interpreted as a bitmask where each bit corresponds to an individual module. If the 0th bit of a field is True, *Module 1* is experiencing the corresponding fault. If the 1st bit of a field is True, *Module 2* is experiencing the corresponding fault. In this way, a single 16-bit register can simultaneously represent the fault status of 16 modules. See the main User Manual for more information on each item.

Address (4xxxx)	Fault Description	Data Name
246	The bit corresponding to a specific module will be True in this register if the module is currently experiencing any fault whatsoever	Faulted
247	Overtemp 1000-1100 °F	Fault Code 3010
248	Overtemp 1100-1200 °F	Fault Code 3011
249	Overtemp 1200-1300 °F	Fault Code 3012
250	Overtemp 1300-1400 °F	Fault Code 3013
251	Overtemp 1400-1500 °F	Fault Code 3014
252	Overtemp 1500-1600 °F	Fault Code 3015
253	Overtemp 1600-1700 °F	Fault Code 3016
254	Overtemp 1700-1800 °F	Fault Code 3017
255	Overtemp 1800-1900 °F	Fault Code 3018
256	Overtemp > 1900 °F	Fault Code 3019
257	Heater overpower	Fault Code 3020
258	Heater overpower, no heat	Fault Code 3021
259	Heater overpower, undertemp	Fault Code 3022
260	Heater overtime	Fault Code 3030
261	Heater overenergy	Fault Code 3040
262	Heater no power	Fault Code 3023
…	…	…
267	Boss position low	Fault Code 4011
268	Boss position high	Fault Code 4012
269	Final position low	Fault Code 4021
270	Final position high	Fault Code 4022
271	Final position drift low	Fault Code 4031
272	Final position drift high	Fault Code 4032
…	…	…
287	Temp sensor out of range	Fault Code 5010
288	Temp sensor out of spec	Fault Code 5020
289	Melt temp low	Fault Code 5031
290	Melt temp high	Fault Code 5032
291	Start select without temp sensor tare	Fault Code 5040
292	Cool temp low	Fault Code 5051
293	Cool temp high	Fault Code 5052
294	Smart Release temp low	Fault Code 5061
295	Smart Release temp high	Fault Code 5062

296	Idle temp low	Fault Code 5071
297	Idle temp high	Fault Code 5072
298	Verify tare temp low	Fault Code 5081
299	Verify tare temp high	Fault Code 5082
…	…	…
307	Melt undertime	Fault Code 6031
308	Melt overtime	Fault Code 6032
309	Melt overtime with heater fault	Fault Code 6033
310	Cooling delay overtime	Fault Code 6040
311	Smart Release undertime	Fault Code 6051
312	Smart Release overtime	Fault Code 6052
313	Cycle undertime	Fault Code 6061
314	Cycle overtime	Fault Code 6062
315	Lost Enable signal	Fault Code 6070
316	Platen full stroke overtime	Fault Code 6080
317	Premature platen liftoff	Fault Code 6090
…	…	…
327	Cooling overtime	Fault Code 7010
…	…	…
337	Communication lost	Fault Code 10000
…	…	…
347	Invalid configuration received	Fault Code 11000
348	Incompatible Module Controller firmware version	Fault Code 11010
350	Module Controller ambient temperature high	Fault Code 11022
351	Module Controller Enable relay malfunction	Fault Code 11030

Cycle Data

Data in this section represents values gathered in the most recently completed cycle. Each piece of data in this section occupies 16 registers, each corresponding to a particular module. See the main User Manual for more information on each item.

Address (4xxxx)	Data Name	Data Description
615-630	Boss Position	Boss position in microns (µm)
631-646	Dwell Position	Dwell position in microns (µm)
647-662	Final Position	Final position in microns (µm)
679-694	Heat Time	Heat time in milliseconds (ms)
695-710	Boss Time *	Boss time in milliseconds (ms)
711-726	Melt Time *	Melt time in milliseconds (ms)
727-742	Dwell Time	Dwell time in milliseconds (ms)
743-758	Cool Wait Time *	Cool wait time in milliseconds (ms)
759-774	Cool Time *	Cool time in milliseconds (ms)
775-790	Smart Release Wait Time *	Smart Release wait time in milliseconds (ms)
791-806	Smart Release Time	Smart Release time in milliseconds (ms)
807-822	Total Time *	Total time in milliseconds (ms)
…	…	…
839-854	Boss Temperature	Boss temperature in degrees Fahrenheit (°F) **
855-870	Melt Temperature	Melt temperature in degrees Fahrenheit (°F) **
871-886	Cool Wait Temperature	Cool wait temperature in degrees Fahrenheit (°F) **
887-902	Cool Temperature	Cool temperature in degrees Fahrenheit (°F) **
903-918	Smart Release Temperature	Smart Release temperature in degrees Fahrenheit (°F) **
…	…	…
951-966	Melt Energy	Heater melt energy in milli-per-unit (milli-p.u.)

** Times greater than 65535 ms will be truncated.*

*** Temperature units are independent of user interface selection.*

High Speed Data

That data in this section is kept separate from other data sections to allow high frequency polling of time sensitive values.

Address (4xxxx)	Data Name	Notes
5555-5556	System Uptime	System Controller uptime in seconds. 32-bit integer

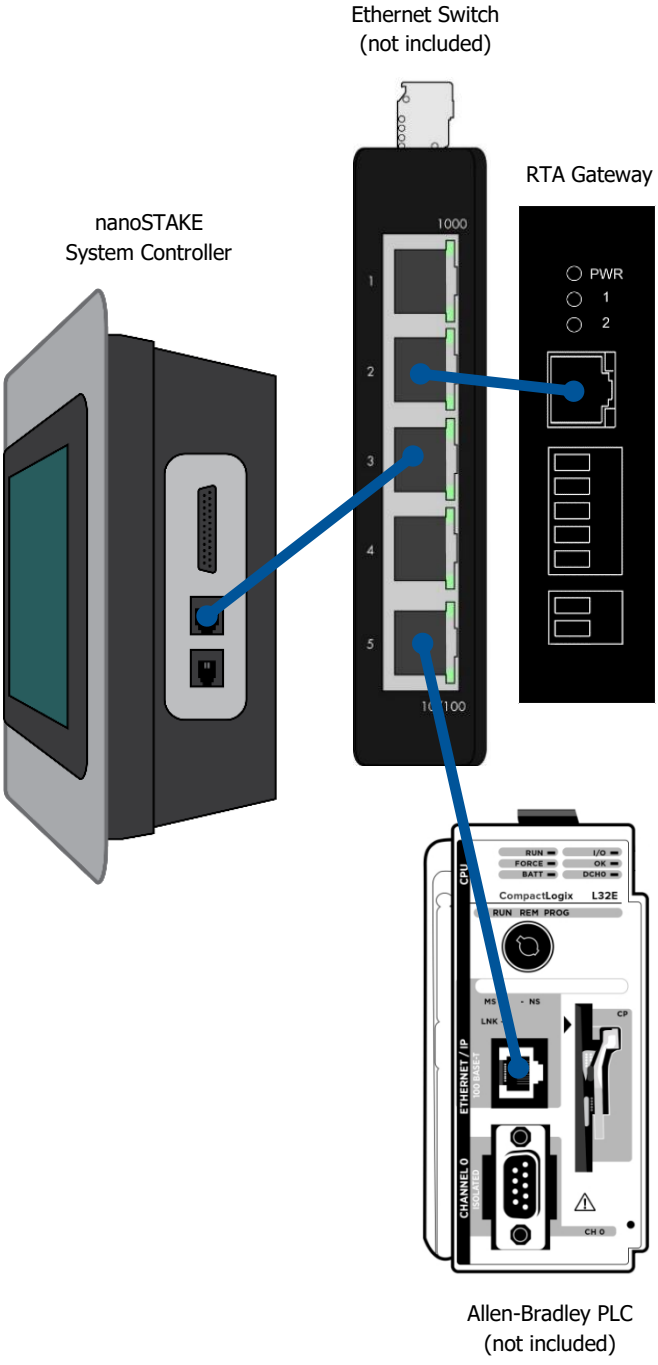
Allen-Bradley Plugin

Gateway Installation

A Modbus TCP to Ethernet/IP gateway that has been configured to work with dataPLUS may have been provided. If so, install the gateway by first mounting it on DIN rail inside an electrical enclosure.

Next provide 24 VDC power to the two-position removable terminal block. The five-position terminal block is not used.

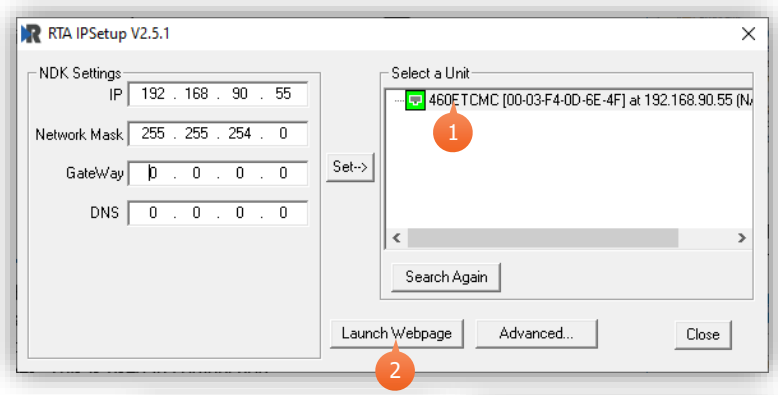
Finally, use RJ45 cables to connect the System Controller, gateway, and PLC to an Ethernet switch. In most cases **a separately purchased Ethernet switch is required**; in rare cases the second Ethernet port on the PLC can be used instead.



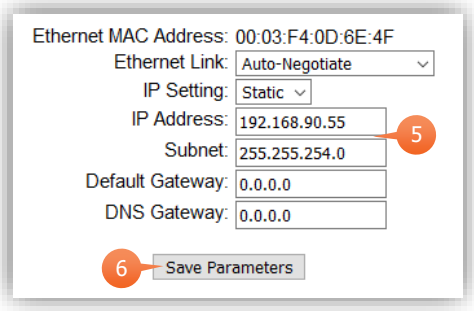
Gateway Configuration

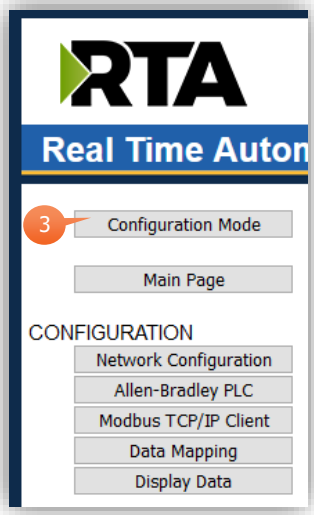
Next you will need to configure the gateway's network settings. (Don't forget to also configure the System Controller's network, see System Controller Network Configuration.)

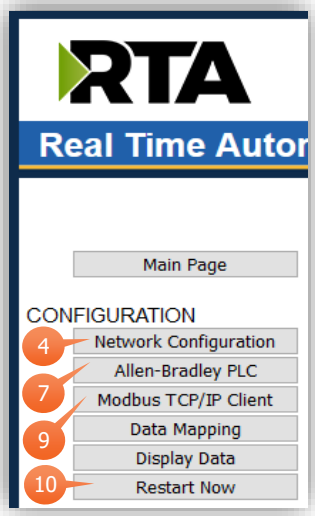
First you need to discover its current IP address. Download and run the application *IPSetup.exe* which can be found on RTA's website (https://www.rtautomation.com/460-gateway-support/). When it runs it will search for any gateways on the network. Select the gateway you are configuring (1) and click *Launch Webpage* (2).



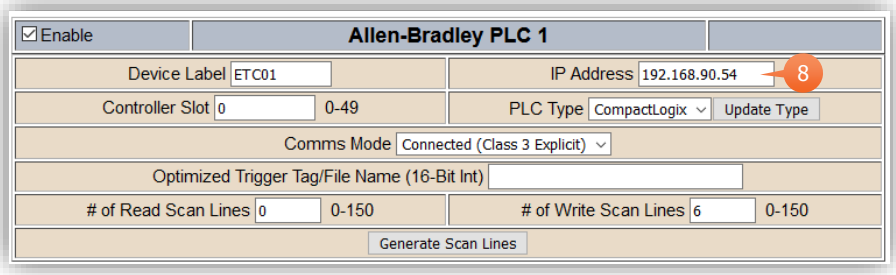
Once the webpage loads click on *Configuration Mode* (3), press *OK* when prompted, and then click on *Network Configuration* (4). Edit the network settings (5), then click *Save Parameters* (6).







Next browse to the *Allen-Bradley PLC* page (7). Configure the IP address (8) and PLC type if necessary. Then click one of the *Save Parameters* buttons.



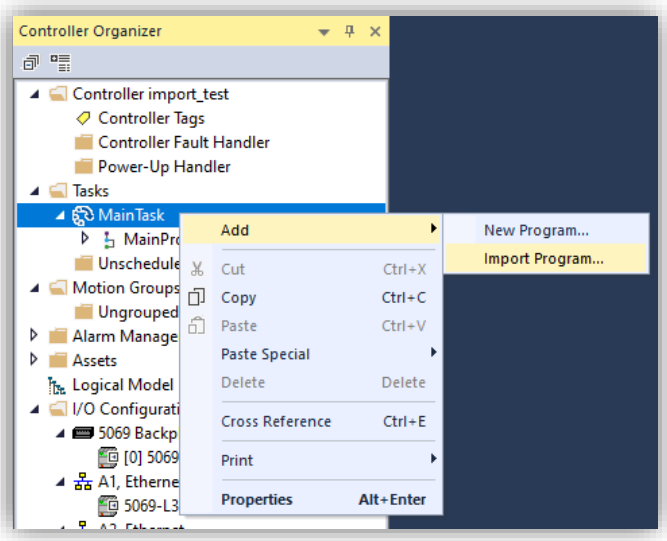
Next click on *Modbus TCP/IP Client* (9) and set the IP address to match the System Controller's. Click *Save Parameters*.

Finally click *Restart Now* (10) to restart the gateway. If applicable, see the section Multiple nanoSTAKE Systems with a Single PLC to further configure the gateway for that purpose.

AOI Installation Instructions

Allen-Bradley PLCs programmed with Rockwell Logix Designer v32+ have a plugin available that organizes and presents the data more cleanly, and which consists of an add-on instruction and a few user-defined data types. This is used in conjunction with a pre-configured Real Time Automation Gateway to convert Modbus TCP to Ethernet/IP. Follow these instructions to install or update the plugin in Logix Designer.

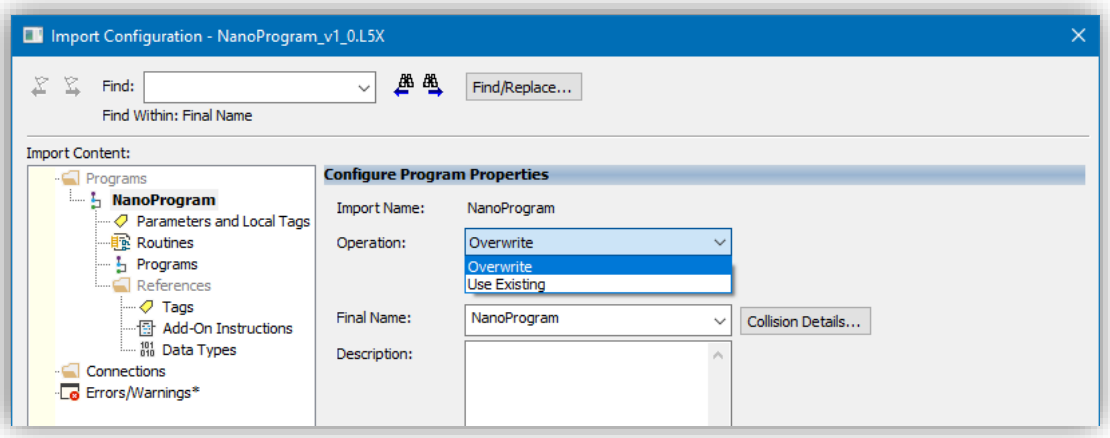
1) From the Controller Organizer, right-click on the MainTask and select Add > Import Program…



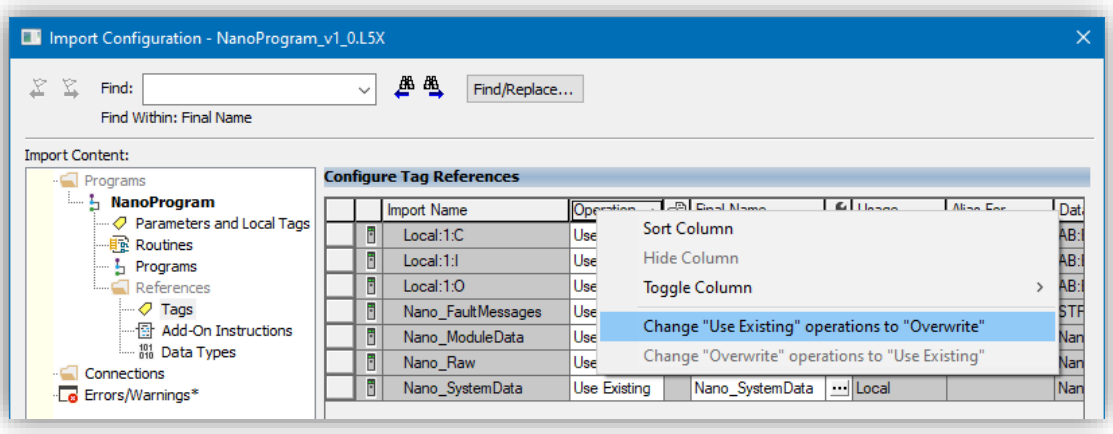
2) Browse to and select the *nanoSTAKE dataPLUS PLC plugin vX.Y.L5X* file. (X.Y being the plugin version number).

3) If upgrading from a previous version make sure to change everything from 'Use Existing' to 'Overwrite' (four places total).

   a. 1) NanoProgram.



b. 2) References > Tags, 3) References > Add-On Instructions, and 4) References > Data Types. Right-click on the column header to change all items at once under each category.



4) Click OK.

5) Resize the Controller Tag *Nano_FaultMessage*. This should be sized large enough for each Module to have at least a few faults each. Three to five messages per module is recommended. An even larger array size is encouraged, memory permitting; conversely a smaller array size is permissible if memory is a concern, although not all messages may be displayed if there are too many.

6) (Optional) Resize the Controller Tag *Nano_ModuleData* to match the number of nanoSTAKE modules present. This is not required but will optimize memory usage.

7) (Optional) Move the NanoProgram into a periodic task if the MainTask's scan times are too long. The period is application dependent.

Note: The gateway does not need to be added to the PLC's *I/O Configuration* tree. It operates similarly to an Allen-Bradley PanelView HMI, which also does not need to be added to the tree.

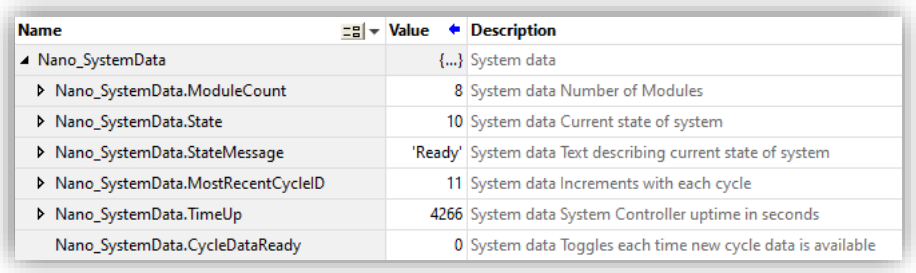
If applicable, see the section Multiple nanoSTAKE Systems with a Single PLC to modify the program for that purpose.

Usage

All interaction takes place through three Controller-scoped tag structures. These are *Nano_SystemData*, *Nano_ModuleData*, and *Nano_FaultMessages* respectively. Each tag has a description that identifies its function. There is a fourth tag, *Nano_Raw*, that will not be used in most cases—this is where raw incoming data lands, and is subsequently processed by the Nano_AOI.

No configuration or interaction with the NanoProgram should be necessary. In fact this separate program is not necessary except to help facilitate importing. The one exception may be altering the text in the *Nano_Constant* string array.

Nano_SystemData



Name	Value	Description
Nano_SystemData	{...}	System data
Nano_SystemData.ModuleCount	8	System data Number of Modules
Nano_SystemData.State	10	System data Current state of system
Nano_SystemData.StateMessage	'Ready'	System data Text describing current state of system
Nano_SystemData.MostRecentCycleID	11	System data Increments with each cycle
Nano_SystemData.TimeUp	4266	System data System Controller uptime in seconds
Nano_SystemData.CycleDataReady	0	System data Toggles each time new cycle data is available

- The *TimeUp* tag may be used as a heartbeat. Keep in mind it may not always update every second.
- The *CycleDataReady* tag should be used to wait to transfer cycle data.

Nano_ModuleData

Module Data consists of cycle data and fault data. Cycle data includes the units for each item.

Fault data consists of BOOLs for each fault type. The descriptions here are for internal use.

The array size can be reduced to the number of Modules present on the nanoSTAKE system.

Name	Description
Nano_ModuleData	
Nano_ModuleData[0]	
Nano_ModuleData[0].CycleData	Cycle Data
Nano_ModuleData[0].CycleData.BossPosition	mm
Nano_ModuleData[0].CycleData.DwellPosition	mm
Nano_ModuleData[0].CycleData.FinalPosition	mm
Nano_ModuleData[0].CycleData.HeatTime	sec
Nano_ModuleData[0].CycleData.BossTime	sec
Nano_ModuleData[0].CycleData.MeltTime	sec
Nano_ModuleData[0].CycleData.DwellTime	sec
Nano_ModuleData[0].CycleData.CoolWaitTime	sec
Nano_ModuleData[0].CycleData.CoolTime	sec
Nano_ModuleData[0].CycleData.SmartReleaseWaitTime	sec
Nano_ModuleData[0].CycleData.SmartReleaseTime	sec
Nano_ModuleData[0].CycleData.TotalTime	sec
Nano_ModuleData[0].CycleData.BossTemperature	degF
Nano_ModuleData[0].CycleData.MeltTemperature	degF
Nano_ModuleData[0].CycleData.CoolWaitTemperature	degF
Nano_ModuleData[0].CycleData.CoolTemperature	degF
Nano_ModuleData[0].CycleData.SmartReleaseTemperature	degF
Nano_ModuleData[0].FaultStatus	Current Fault Status

Name
Nano_ModuleData
Nano_ModuleData[0]
Nano_ModuleData[0].CycleData
Nano_ModuleData[0].FaultStatus
Nano_ModuleData[0].FaultStatus.Faulted
Nano_ModuleData[0].FaultStatus.Overtemp1000_1100
Nano_ModuleData[0].FaultStatus.Overtemp1100_1200
Nano_ModuleData[0].FaultStatus.Overtemp1200_1300
Nano_ModuleData[0].FaultStatus.Overtemp1300_1400
Nano_ModuleData[0].FaultStatus.Overtemp1400_1500
Nano_ModuleData[0].FaultStatus.Overtemp1500_1600
Nano_ModuleData[0].FaultStatus.Overtemp1600_1700
Nano_ModuleData[0].FaultStatus.Overtemp1700_1800
Nano_ModuleData[0].FaultStatus.Overtemp1800_1900
Nano_ModuleData[0].FaultStatus.Overtemp1900Plus
Nano_ModuleData[0].FaultStatus.HeaterOverpower
Nano_ModuleData[0].FaultStatus.HeaterOverpowerNoHeat
Nano_ModuleData[0].FaultStatus.HeaterOverpowerUndertemp
Nano_ModuleData[0].FaultStatus.HeaterNoPower
Nano_ModuleData[0].FaultStatus.HeaterOvertime
Nano_ModuleData[0].FaultStatus.HeaterOverenergy
Nano_ModuleData[0].FaultStatus.BossPositionLow
Nano_ModuleData[0].FaultStatus.BossPositionHigh
Nano_ModuleData[0].FaultStatus.FinalPositionLow
Nano_ModuleData[0].FaultStatus.FinalPositionHigh
Nano_ModuleData[0].FaultStatus.FinalPositionDriftLow
Nano_ModuleData[0].FaultStatus.FinalPositionDriftHigh
Nano_ModuleData[0].FaultStatus.TempSensorOutOfRange
Nano_ModuleData[0].FaultStatus.TempSensorOutOfSpec
Nano_ModuleData[0].FaultStatus.MeltTempLow
Nano_ModuleData[0].FaultStatus.MeltTempHigh
Nano_ModuleData[0].FaultStatus.StartSelectWOTare
Nano_ModuleData[0].FaultStatus.CoolTempLow

Nano_FaultMessages is a string array that contains a message for each active fault. This could be piped into a scrolling message banner for example.

The array size can be changed depending on the number of Modules present on the nanoSTAKE system. If the array size is too small not all faults will be shown.

Multiple nanoSTAKE Systems with a Single PLC

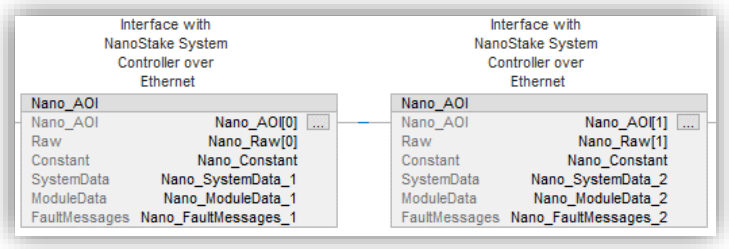
If more than one nanoSTAKE system will be interfacing with a PLC a few things will need to be modified. This consists of adding new AOIs and data tags, and adding servers to the gateway. These instructions assume the gateways have been configured (see Gateway Configuration) and the add-on instruction has been added to the PLC project (see AOI Installation Instructions).

Add new add-on instruction instances to the PLC program

From the Controller Organizer, open the *NanoRoutine* from *Tasks > MainTask > NanoProgram* (assuming this was not relocated after import). First modify the *Nano_AOI* and *Nano_Raw* tag array sizes to match the number of nanoSTAKE systems.

Next create an additional AOI instance for the additional systems, each one using the next index of *Nano*_AOI and *Nano_Raw*.

Lastly rename and/or create new *SystemData*, *ModuleData*, and *FaultMessages* tags for each AOI instance. Note the array sizes of the *ModuleData* and *FaultMessages* tags should be sized appropriately for the number of Modules present on the associated nanoSTAKE system (see Usage section). These three tags may be renamed to be more descriptive.



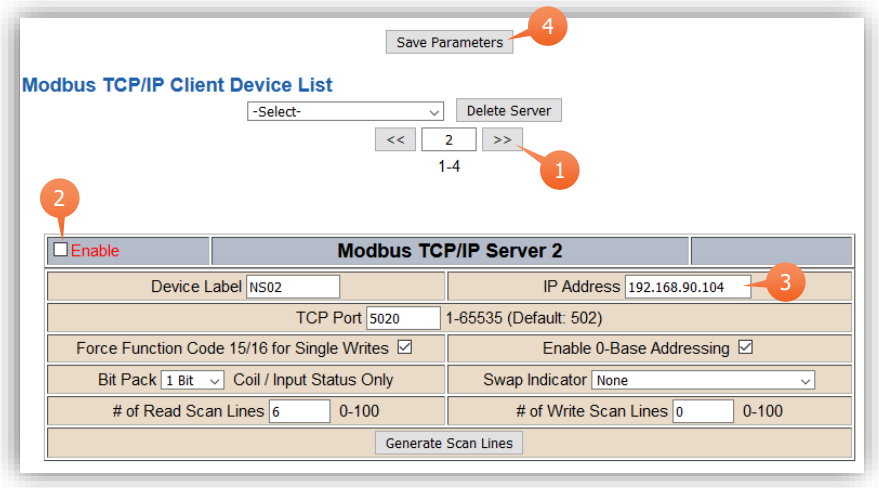
Modify gateway settings

(These instructions assume basic familiarity with the gateway web interface. See Gateway Configuration for more information.)

Launch the gateway's webpage by typing its IP address into an internet browser, then enter *Configuration Mode* and navigate to the *Modbus TCP/IP Client* page. Then click the left arrow button (1) to view additional nanoSTAKE servers.

First check the *Enable* box to activate the server (2). Then modify the IP address (3) to match the corresponding System Controller's address. Then click either *Save Parameters* (4) or a left or right arrow (1) to save changes. Repeat for additional nanoSTAKE systems.

Finally *Restart Now* to make the changes go live.



Further Information

For further information please contact Extol.

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