Series 9

Ethernet/IP

Industrial Communication Option

Publication Reference : 120/16605-01

Issue B

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NDC Technologies
Bates Road,
Maldon, Essex CM9 5FA, UK

Phone +44 (0)1621 852244
Fax +44 (0)1621 856180
www.ndc.com

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Ethernet/IP User's Manual

Part Number: 120/16605-01

Issue: B

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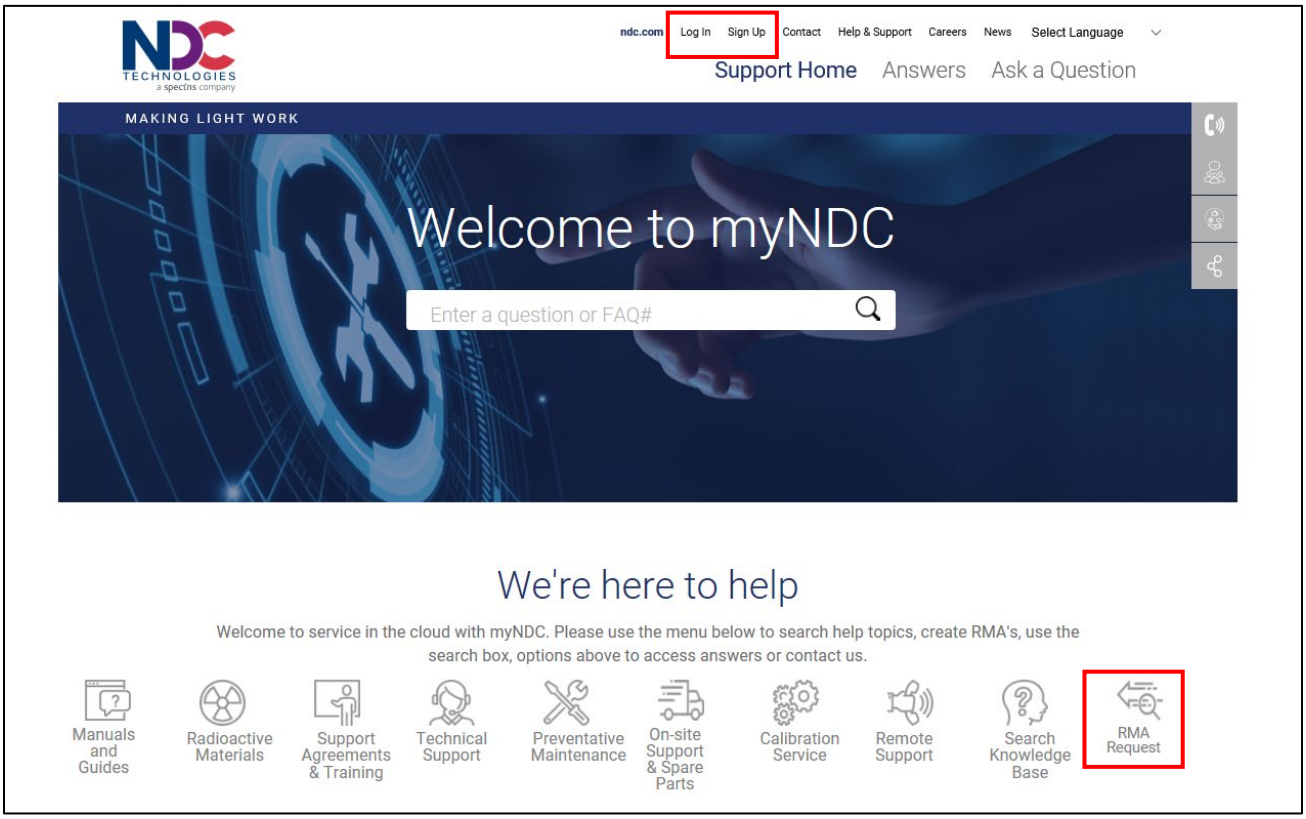

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Caution

- **The equipment described in this manual contains high potential voltages. Isolate the mains supply from the equipment during interconnection and maintenance.**
- **If the gauge is not installed and used in the manner prescribed in this manual, the safety protection afforded by the equipment may be impaired.**
- **For complete electrical safety in operation, the equipment has been supplied with double-pole neutral fusing incorporated. Do not modify in any way.**

Storage & Unpacking

Storage

Pending installation, store between 0°C and 70°C at less than 60% relative humidity. Allow the equipment to regain ambient temperature prior to installation.

Unpacking

Note: Before unpacking your on-line gauge, make sure you check off all the items against the packing list.

Retain the packaging used to ship all parts of your system, so that in the event that the equipment needs to be returned, it can be suitably re-packed for its safe return.

Open the packaging carefully and remove each item. Take the items to a clean room for inspection. Check that all the items on the Packing Note / Scope of Supply, have been supplied. Check that they are free from external damage, the connectors are free from dirt, and the cables are not chaffed or kinked.

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CHAPTER 1

1 Introduction

The following supplement should be read in conjunction with the Series 9 User guide to ensure a reasonable level of familiarity with the gauge.

The Ethernet/IP communications functionality is a built-in service of the Series 9 gauges. It has been certified by the ODVA laboratories in Ann Arbor.

EtherNet/IP utilizes the regular Ethernet network. The Ethernet/IP service is started automatically by a system script.

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CHAPTER 2

2 Ethernet/IP Implementation

The Series 9 Ethernet/IP data model is **128** bytes in and **128** bytes out during the cyclical data exchange with the attached controller. Depending on the customer using the gauge, there will be different profiles in the form of .xml files. These profile files will describe the data that will served by the gauge to the controller and the data that the controller will send to the gauge, usually in the form of configuration commands. These profile/configuration files are loaded automatically by the software.

The S9 EIP implementation will use assembly object 112 (128 bytes) to receive data from the PLC, and assembly object 100 (128 bytes) to send data to the PLC.

The default **RPI** (Requested Packet Interval) of the Ethernet/IP connection is 100 ms. Customers may experiment with other settings, but the minimum RPI is 32 ms.

2.1 Supported CIP Objects

The Gauge provides all of the required objects for a generic EtherNet/IP device. The full list of objects (and codes) supported by the Gauge is shown below:

- (0x01) **Identity**
- (0x02) **Message Router**
- (0x04) **Assembly**
- (0x06) **Connection Manager**
- (0xF6) **Ethernet Link**
- (0xF5) **TCP/IP**

These **Identity** and **Assembly** objects contain settings specific to Series 9 Gauges. These settings are detailed in the following sections.

Note: TCP/IP settings (e.g. IP address, network mask, DHCP, etc.) cannot be changed through EtherNet/IP objects, but may be set using GaugeToolsXL.

2.1.1 Identity Object (0x01)

Services

- (0x01) **Get_Attributes_All (GAA)**
- (0x0E) **Get_Attribute_Single (GAS)**

Instances

(0x01) The only instance

Instance Attributes

- (0x01) **Vendor ID** = 732
- (0x02) **Device Type** = 0x002b
- (0x03) **Product Code** = 600
- (0x04) **Revision**: major = 1, minor = 1
- (0x05) **Status**: indicates the actual status of the device
- (0x06) **Serial Number**: the last four digits of the MAC address forming a 32-bit integer: (MAC2, MAC3, MAC4, MAC5)
- (0x07) **Product Name** = “Generic NDC EtherNet/IP Device”

Class attributes are also supported − please refer to the specification the CIP networks Library, Volume 1, Chapter 5: Object Library, Part 2, Section 5-1: Identity Object.

Example 1: Get all identity information of the Gauge

Service = 0x01 (GAA) Class = 0x01 (Identity) Instance = 0x01 (The only supported instance)

Example 2: Get product name

Service = 0x0e (GAS) Class = 0x01 (Identity) Instance = 0x01 (The only supported instance) Attribute = 0x07 (Product Name)

2.1.2 Assembly Object (0x04)

Services

- (0x0E) **Get_Attribute_Single (GAS)**
- (0x10) **Set_Attribute_Single (SAS)**
- (0x18) **Get_Member (GM)**
- (0x19) **Set_Member (SM)**

Instances

- (100) Data produced by the Gauge (input to network)
- (112) Data consumed by the Gauge (output from network)

The two static instances offer exactly the same parameters in the same order. Any ‘read-only’ parameters in the consumed assembly will have no effect on the Gauge.

The list of parameters may be edited with GaugeToolsXL. See Chapter 7 - Selecting Protocol Parameters.

Example

If the Gauge has two channels, then by default it will have 2 Outputs, 2 Application Codes, 2 Spans, 2 Trims, and 1 Gauge Status. This equates to an assembly of 4 x 9 bytes (36 bytes).

Data byte ordering is little endian by default – in accordance with the protocol specification.

Run-time assembly instance services are not supported.

Instance Attributes

- (0x01) **Number of Members in List**
- (0x02) **Member List**
- (0x03) **Data**
- (0x04) **Size**

Class attributes are also supported − please refer to the CIP networks Library, Volume 1, Chapter 5: Object Library, Part 2 Section 5-5: Assembly Object.

Example 1: Get number of exposed parameters

Service = 0x0e (GAS) Class = 0x04 (Assembly) Instance = 0x03 (Produced) Attribute = 0x01 (Number of Members in List)

Example 2: Get produced data

Service = 0x0e (GAS) Class = 0x04 (Assembly) Instance = 0x03 (Produced) Attribute = 0x03 (Data)

Result: data as CIP ARRAY of BYTE, length = 4 * (number of members)

Example 3: Set consumed data member

Service = 0x19 (SM) Class = 0x04 (Assembly) Instance = 0x04 (Consumed) Attribute = 0x02 (Member List) or 0x03 (Data) Member = 1-based index of member Data = 4 bytes long array representing the new value of the parameter

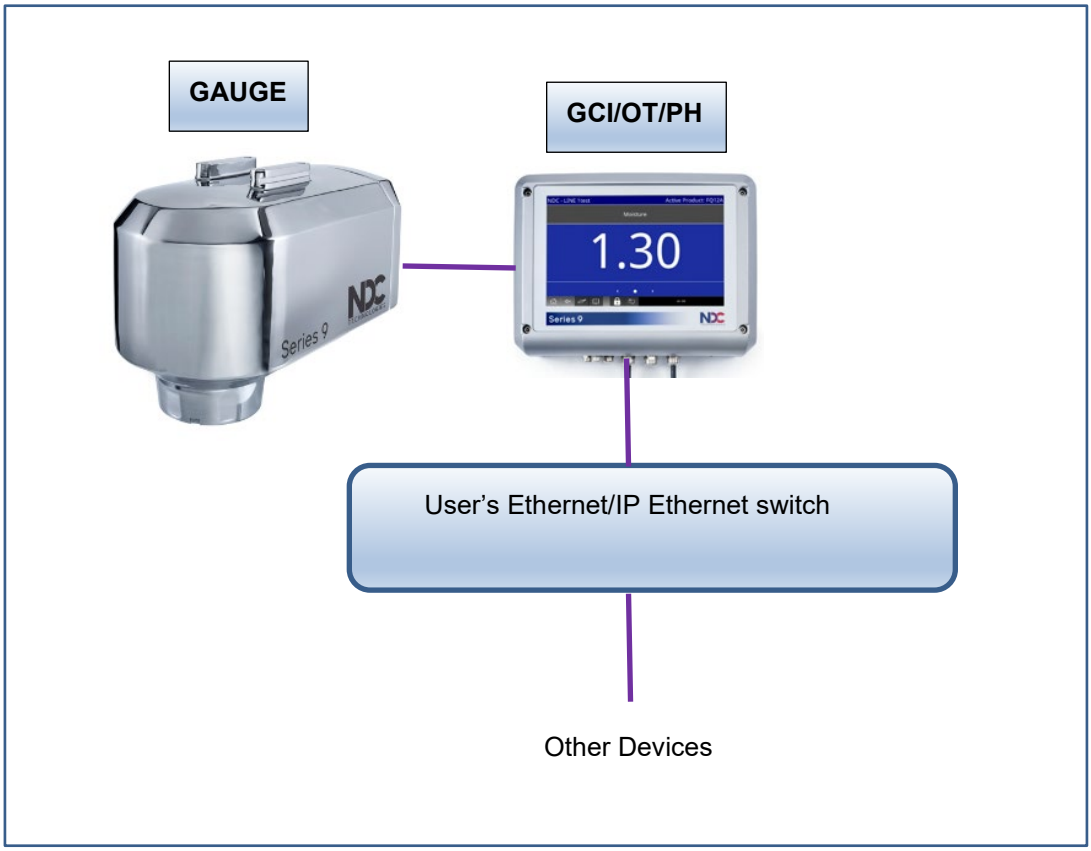
Note: On some systems, the member index is sent as the first two bytes of data – in this case, the data array contains 6 bytes.

CHAPTER
3

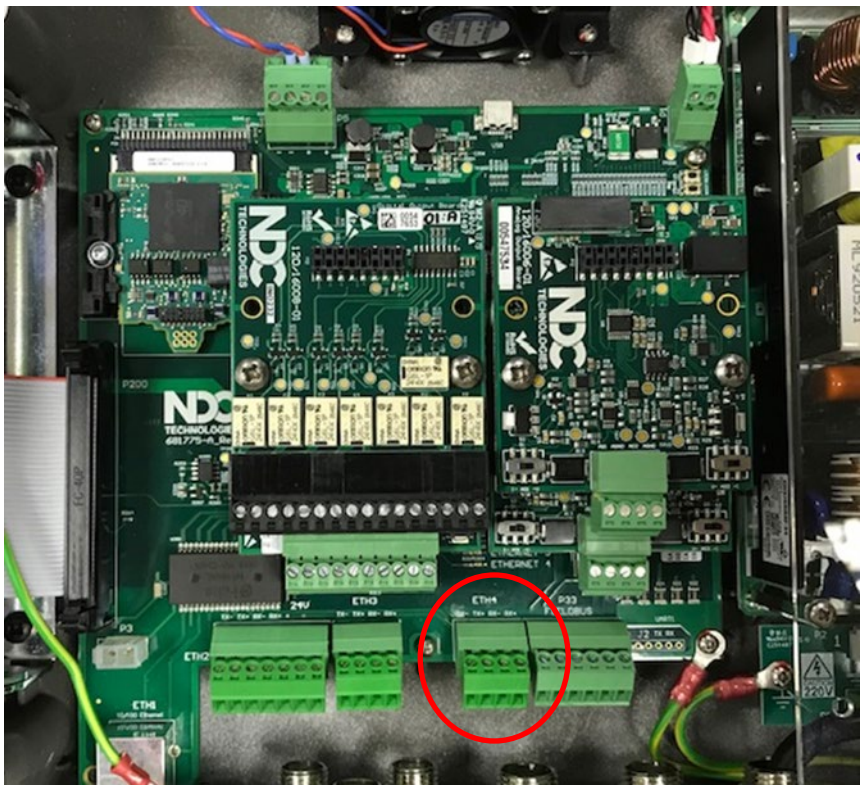
3 Physical Connection

The Ethernet/IP connection is made through one of the following three peripherals that is connected to the gauge:

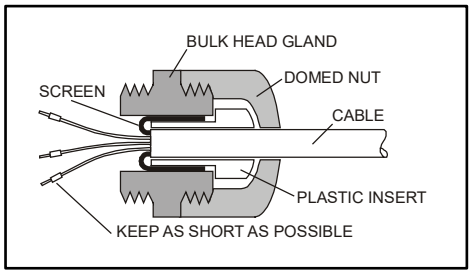
- Gauge Control Interface (GCI)
- Operator Terminal (OT)
- Power Hub (PH)



The Ethernet/IP connection point is the same in all the units - through a screw termination block marked ETH4, as circled in red in the photo below.



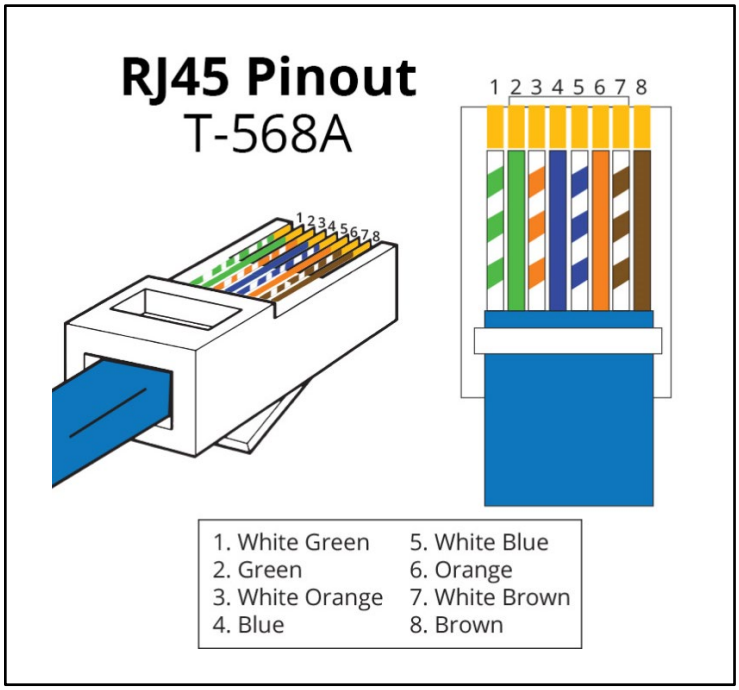
Only Cat5e or Cat6 twisted pair cable should be used, with the screen terminated to the metal gland as depicted below.



The signal terminations are as follows:

4 way	Name	Wire Colour
1	Tx-	White Green
2	Tx+	Green
3	Rx-	White Orange
4	Rx+	Orange

For reference, the RJ45 connector wire colours are shown below.



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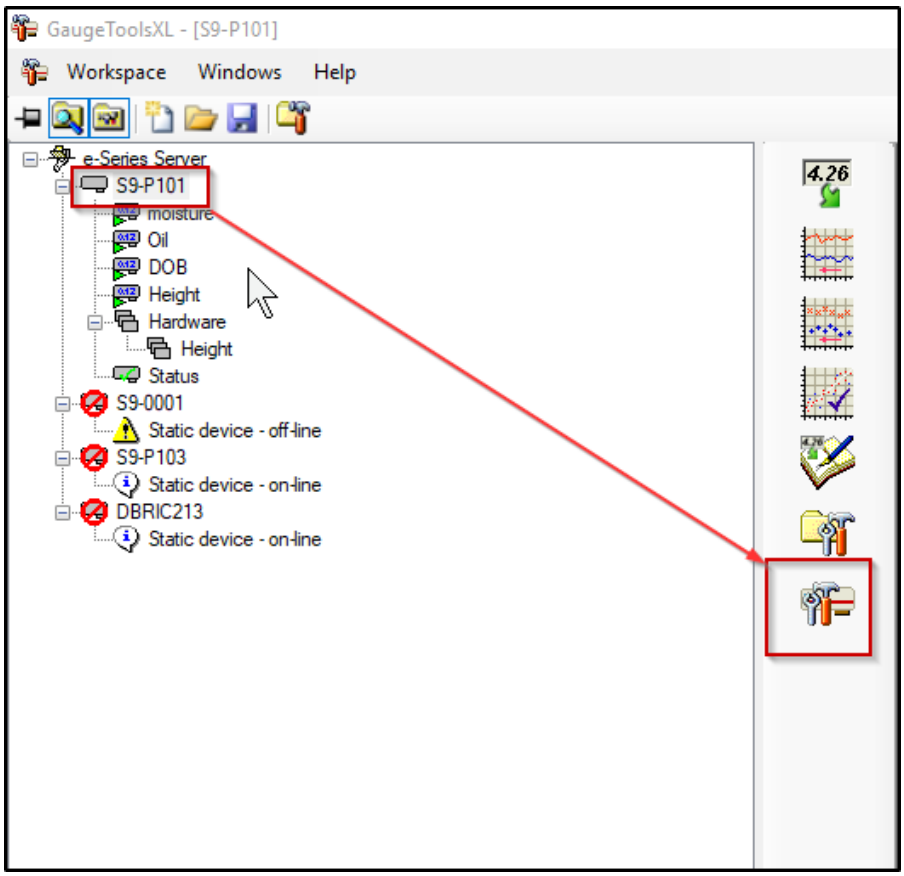
CHAPTER
4

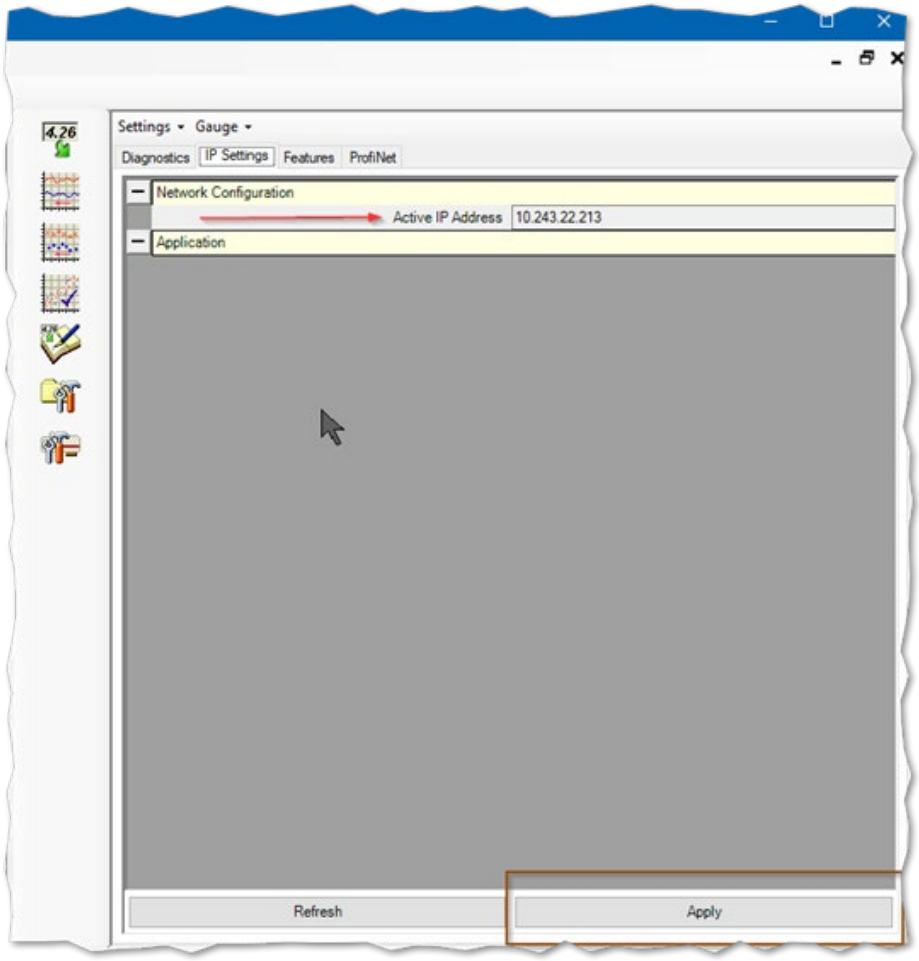
4 IP Address Settings

The S9 IP address can be confirmed or changed through **GaugeToolsXL** as follows:

1. Start **GaugeToolsXL** and drag the Gauge node to the “Gauge Utility” icon.



2. Select the **IP Settings** tab and enter the required values.



3. Click **Apply** to use the new settings.

The host computer's original settings may now be re-applied.

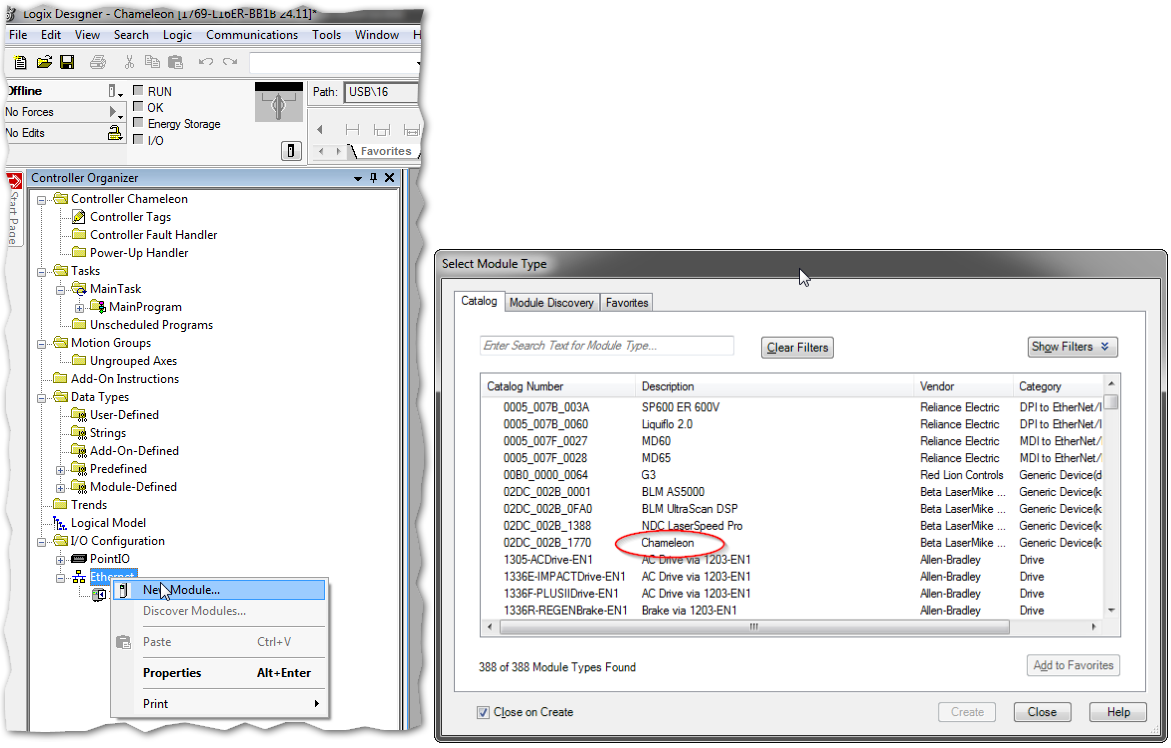
CHAPTER 5

5 Ethernet/IP Connection Setup

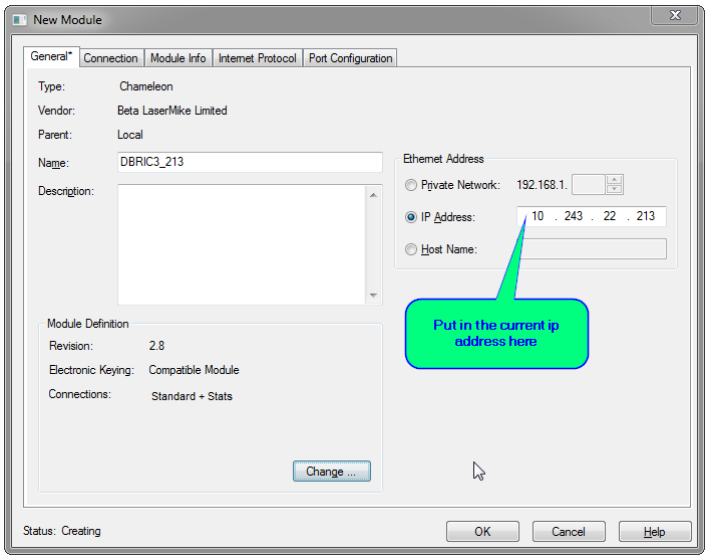
5.1 Allen-Bradley PLC

With the Allen-Bradley PLC, you will need a configuration file (**xxx.eds**). The software that runs in conjunction with the Allen-Bradley PLC is called **Studio 5000**.

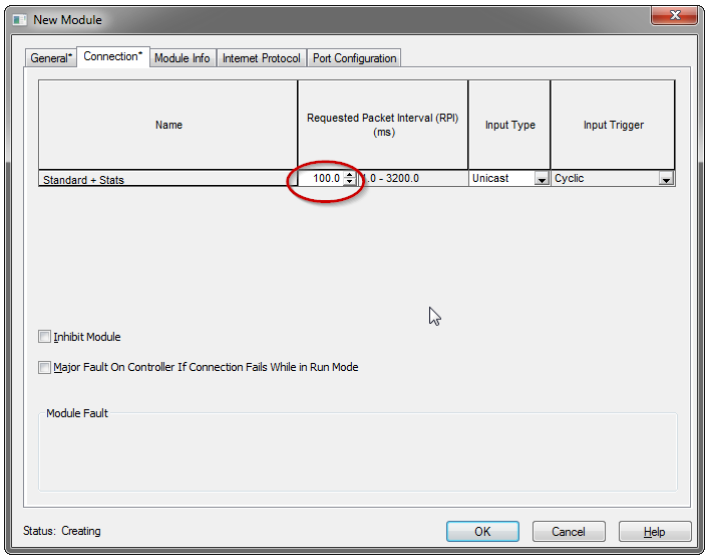
1. Once Studio 5000 is running, create a new project and add the Series 9 (Chameleon) gauge to it.



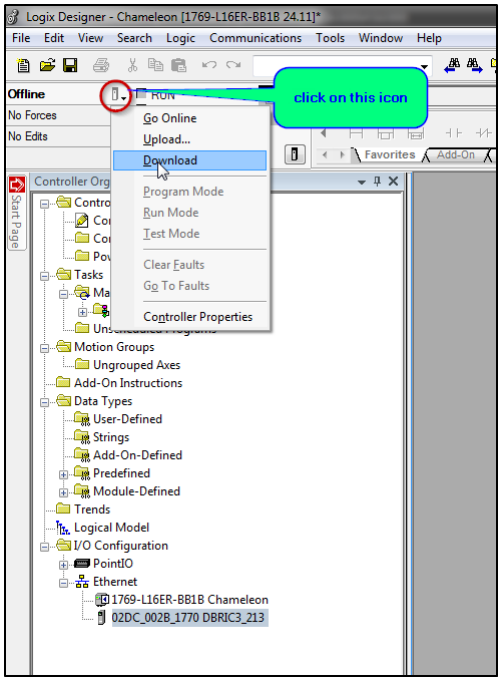
2. Once the new module is created, a window will pop up that will allow the entry of the Chameleons' current IP address. The IP address of the gauge must be within the subnet of the PLC.



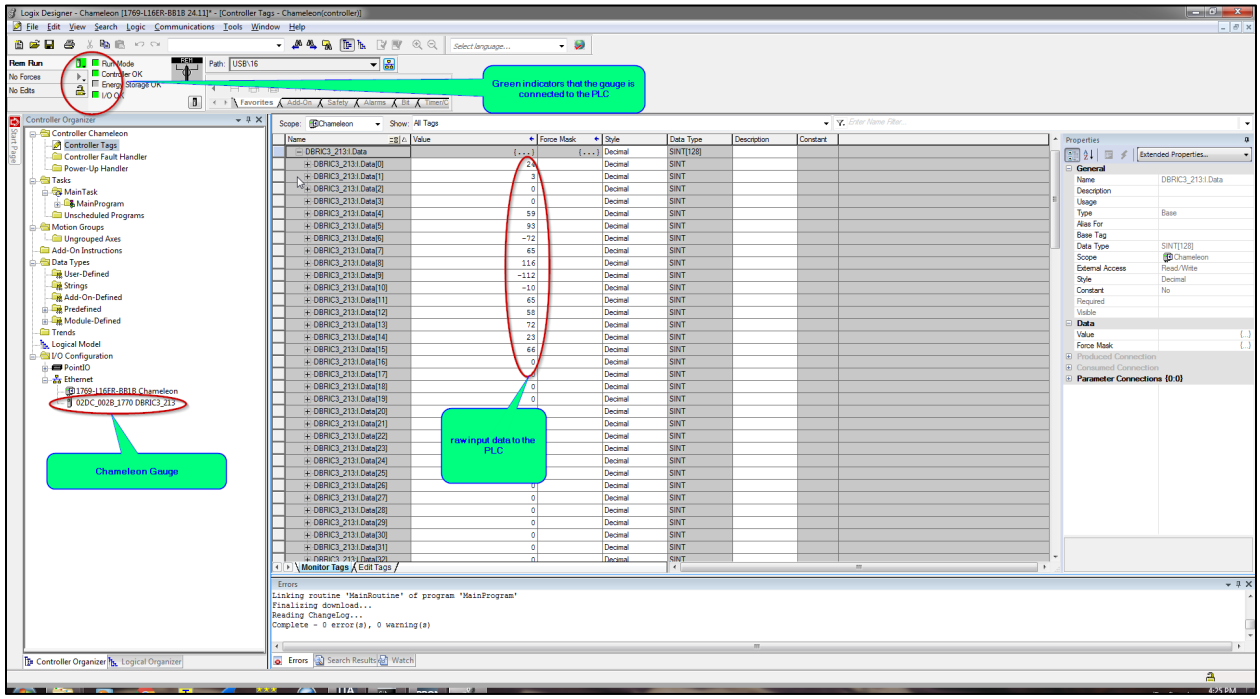
3. Set the RPI to 100.



4. Download the project to the PLC.



5. Once the project is downloaded into the PLC, the tool will ask if it should be put into “RUN” mode. Click yes, and the connection will be made.



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CHAPTER 6

6 Ethernet/IP Configuration File

When the EtherNet/IP service starts, one of the initial tasks it does is to load the EtherNetIP_IO Config.xml parameter configuration file. This parameter configuration file describes the EtherNet/IP local parameters, IP Settings, Fieldbus Outputs, Fieldbus Inputs and Fieldbus explicit messages (if any). The default contents of the configuration file are described below.

All parameter data is 32-bit and is transmitted in little endian format.

PLC Inputs (Outputs from the gauge)

Buffer Index	Name	Type	Description
0	Gauge Status	Unsigned 32 bit integer	Gauge Status[1]
4	Gauge Warnings	Unsigned 32 bit integer	Gauge Warnings[2]
8	Channel 1 Output	32 bit Float (REAL)	The Units of the measured value depend on the target material and the application (e.g. moisture [%]).
12	Channel 2 Output	32 bit Float (REAL)	The Units of the measured value depend on the target material and the application (e.g. moisture [%]).
16	Channel 3 Output	32 bit Float (REAL)	The Units of the measured value depend on the target material and the application (e.g. moisture [%]).
20	Channel 4 Output	32 bit Float (REAL)	The Units of the measured value depend on the target material and the application (e.g. moisture [%]).

[1]**Note:** **Status Output** is a bit-encoded word

Bit 0: STATUS_BIT_MOTOR: Fault with main filter wheel motor

Bit 1: STATUS_BIT_LAMP: Lamp error

Bit 2: STATUS_BIT_SIGNAL_LOW: Light signals received by gauge are too low to make a good reading

Bit 3: STATUS_BIT_SIGNAL_HIGH: Light signals received by gauge are too high to make a good reading

Bit 4: STATUS_BIT_WINDOW: Window is contaminated, error threshold of 1.0 reached

Bit 5: STATUS_BIT_TEMPERATURE: The internal temperature of the gauge has exceeded the error level. Can also be triggered for a low temperature error (i.e. gauge is too cold to operate correctly)

Bit 6: STATUS_BIT_INTERNALREF: The internal reference system has failed

Bit 7: STATUS_BIT_VOLTAGE: A bad voltage has been detected on one of the PCBs

Bit 8: STATUS_BIT_SLAVEHEAD: Unable to access slave head (only applies to double-headed gauges like the Haze gauge)

Bit 9: STATUS_BIT_AIRFLOW: The air pressure is out of range, suggesting air flow to the air purge is incorrect

Bit 10: STATUS_BIT_SYNCPULSE: Unable to detect the synchronisation pulse (only applies to double-headed gauges like the Haze gauge)

Bit 11: STATUS_BIT_AUTOSAMPLER: Auto sampler system has failed (only applies to gauges with PowderVision sampling enabled)

Bit 16: STATUS_BIT_SELF_TEST: General hardware error detected at start up

[2]**Note:** **Status Warnings** is a bit-encoded word

Bit 4: STATUS_BIT_WINDOW: Window is contaminated, warning threshold of 0.60 reached

Bit 5: STATUS_BIT_TEMPERATURE: The internal temperature of the gauge has exceeded the warning level. Can also be triggered for a low temperature warning (i.e. gauge is too cold to operate correctly)

PLC Outputs (Inputs to the gauge)

Buffer Index	Name	Type	Description
0	Channel 1 span	32 bit Float (REAL)	Multiplier factor for the Output: Output = (Span * X) + Trim (Where X is the raw measurement value)
4	Channel 1 trim	32 bit Float (REAL)	Offset for the output: Output = (Span * X) + Trim (Where X is the raw measurement value)
8	Channel 1 Application code	Unsigned 32 bit integer	Current application code value for this channel
12	Channel 2 span	32 bit Float (REAL)	Multiplier factor for the Output: Output = (Span * X) + Trim (Where X is the raw measurement value)
16	Channel 2 trim	32 bit Float (REAL)	Offset for the output: Output = (Span * X) + Trim (Where X is the raw measurement value)
20	Channel 2 Application code	Unsigned 32 bit integer	Current application code value for this channel
24	Channel 3 span	32 bit Float (REAL)	Multiplier factor for the Output: Output = (Span * X) + Trim (Where X is the raw measurement value)
28	Channel 3 trim	32 bit Float (REAL)	Offset for the output: Output = (Span * X) + Trim (Where X is the raw measurement value)
32	Channel 3 Application code	Unsigned 32 bit integer	Current application code value for this channel
36	Channel 4 span	32 bit Float (REAL)	Multiplier factor for the Output: Output = (Span * X) + Trim (Where X is the raw measurement value)
40	Channel 4 trim	32 bit Float (REAL)	Offset for the output: Output = (Span * X) + Trim (Where X is the raw measurement value)
44	Channel 4 Application code	Unsigned 32 bit integer	Current application code value for this channel

Note: If a parameter configuration is desired that is different from the default, it can be done with assistance from our Customer Care representatives.

6.1 Parameter Descriptions

Parameter Data Types:

B	Read-only Boolean (TRUE/FALSE) parameter
B	Read-write Boolean (TRUE/FALSE) parameter
F	Read-only floating point parameter
F	Read-write floating point parameter
I	Read-only integer parameter
I	Read-write integer parameter
S	Read-only UNICODE string parameter
S	Read-write UNICODE string parameter

6.1.1 Channel Specific Parameters

- **Output** F

  Measurement value of the specified channel.

  The Units of the measured value depend on the target material and the application (e.g. moisture [%]).

- **Application Code** I

  This value may be set to either the full 32-bit integer application code, or the index into the application set (the application index). This code is used to select the appropriate algorithm in the gauge for the intended measurement - consult NDC for list of codes that can be used with the specific gauge.

- **Application Code Full** I

  This always reflects the full application code, regardless of how the application is selected in Application Code above.

- **Span** F

  Multiplier factor for the output: **Output = (Span * X) + Trim**

  (where **X** is the raw measurement value).

  This parameter is available for all measurements, including temperature.

- **Trim** F

  Offset for the output: **Output = (Span * X) + Trim**

  (where **X** is the raw measurement value).

  This parameter is available for all measurements, including temperature.

- **Response Time** F

  The response time is a process specific averaging function.

  For the Series 9 gauge, it is normally set at a value in the range 0.2 sec to 10 sec. Dependent on product.

6.1.2 General Gauge Parameters

- **Air Pressure** I

  Air pressure value (if air pressure system fitted).

- **Gauge Status and Warnings** I

  See page 6-2 for a description of these parameters.

- **Motor Speed [rpm]** F

  The current speed of the Filter Wheel (motor) in the gauge.

- **Motor Speed Target [rpm]** F

  The desired speed of the Filter Wheel.

- **Motor vibration** F

  Vibration near the filter wheel motor in raw units.

- **Temperature Internal [ºC]** F

  The internal temperature of the gauge. This is typically 15 to 20ºC above the external temperature, and will slowly track any changes in the ambient.

- **Temperature External [ºC]** F

  The product (target material) temperature.

  This is only available on Gauges fitted with an external temperature sensor.

- **Lamp Current [A]** F

  Current through the lamp.

- **Lamp Voltage [V]** F

  Voltage across the lamp.

- **Window Contamination** F

  The Window Contamination level as seen by the user.

  (A clean window will be close to zero and a dirty window >0.5.)

- **CPU Loading [%]** F

  The current % workload of the gauge embedded computer which should on average be no more than 50%.

- **CPU Up Time [s]** I

  Elapsed time from when the Gauge was last switched on.

- **Recipe ID Active** I

  The Recipe that is currently in use.

- **Recipe ID Pending** I

  Uint32 value of the recipe index that will be loaded when written.

6.2 Data Formats

The data formats supported are:

- **Real (Floating Point)**
- **Integer**
- **Boolean**

Each numeric parameter (Float, Integer and Boolean) occupies 4 bytes in the I/O data stream.

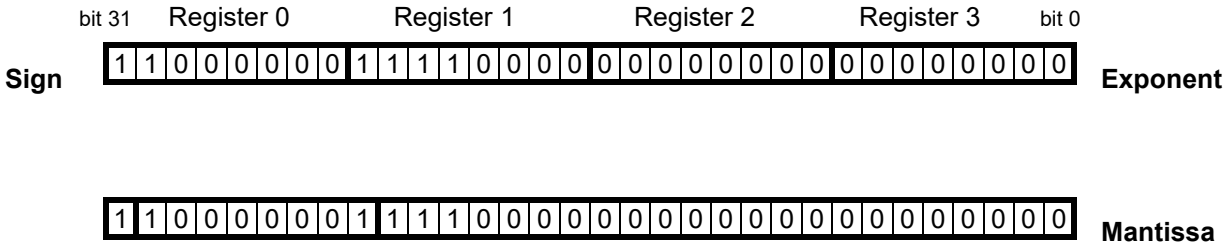
6.2.1 Real (Floating Point)

Values are presented in IEEE 754 single precision format.

- **Bits 0 to 22** Normalised binary mantissa minus 1
- **Bits 23 to 30** Exponent in unsigned, 8 bit, excess 127 format
- **Bit 31** Sign bit

Example

The example below shows the register contents of a Parameter containing a floating-point value of -7.5, and the corresponding bit assignments for IEEE 754.



The mantissa is $1 + [2^{-1} + 2^{-2} + 2^{-3}] = 1.875$
(as the normalized mantissa is always between 1 and 2, the 1 does not need to be stored)

The value is given by the formula:

$$-\ \text{sign} \times \text{mantissa} \times 2^{(\text{exp} - 127)}$$

which in this case is:

$$-1 \times 1.875 \times 2^{(129 - 127)} = -1.875 \times 2^{2}$$

Example

Bytes on the network, little endian

```
0xA4 0x70 0x45 0x41 = 12.34
```

6.2.2 Integer

Integers are converted to a 32-bit unsigned value (even if the parameter is a two-byte signed value).

Example

Bytes on the network, little endian

```
0x15 0xCD 0x5B 0x07 = 123456789
```

6.2.3 Boolean

Boolean values use 32-bits where zero (all bits) represents ‘FALSE’ and non-zero (any bit) represents ‘TRUE’.

Example

Bytes on the network, little endian

```
0x00 0x00 0x00 0x00 = FALSE

0x01 0x00 0x00 0x00 = TRUE
```

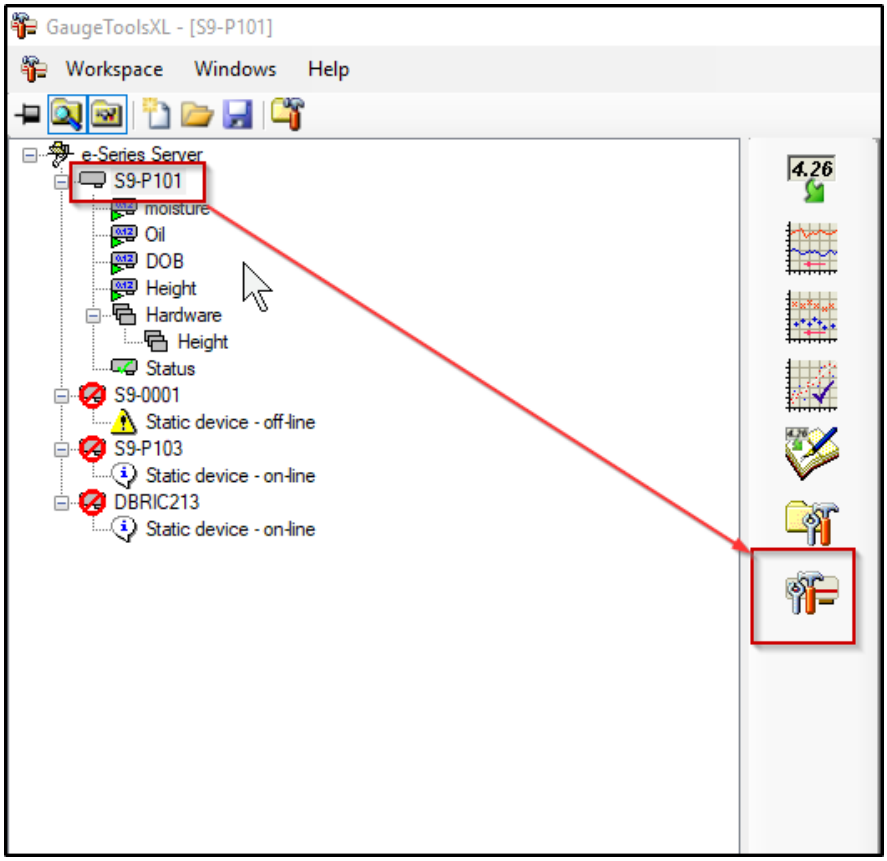
CHAPTER 7

7 Selecting Protocol Parameters

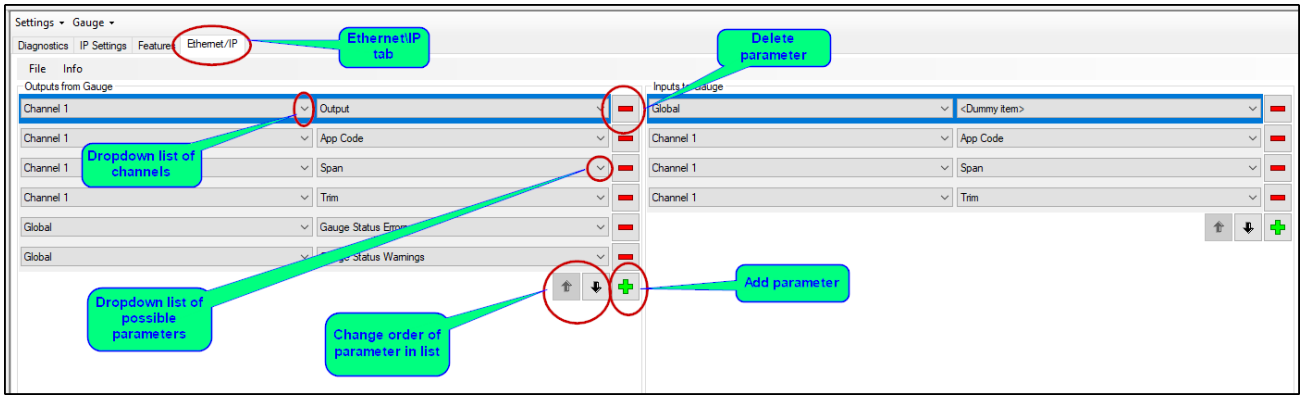
This chapter describes how the GaugeToolsXL utility allows the user to change the order of the Protocol parameters, to add or delete parameters and to upload the changes to the gauge.

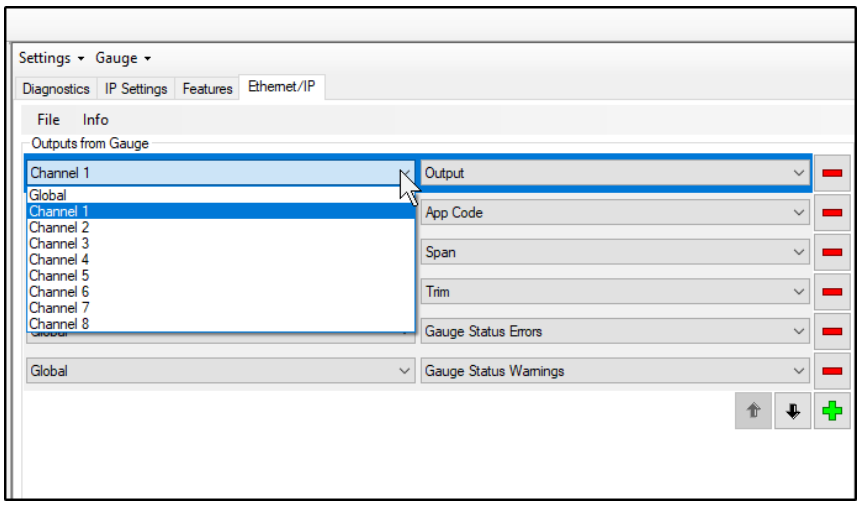
The GaugeToolsXL User's Manual details the installation and operation of the GaugeToolsXL software package.

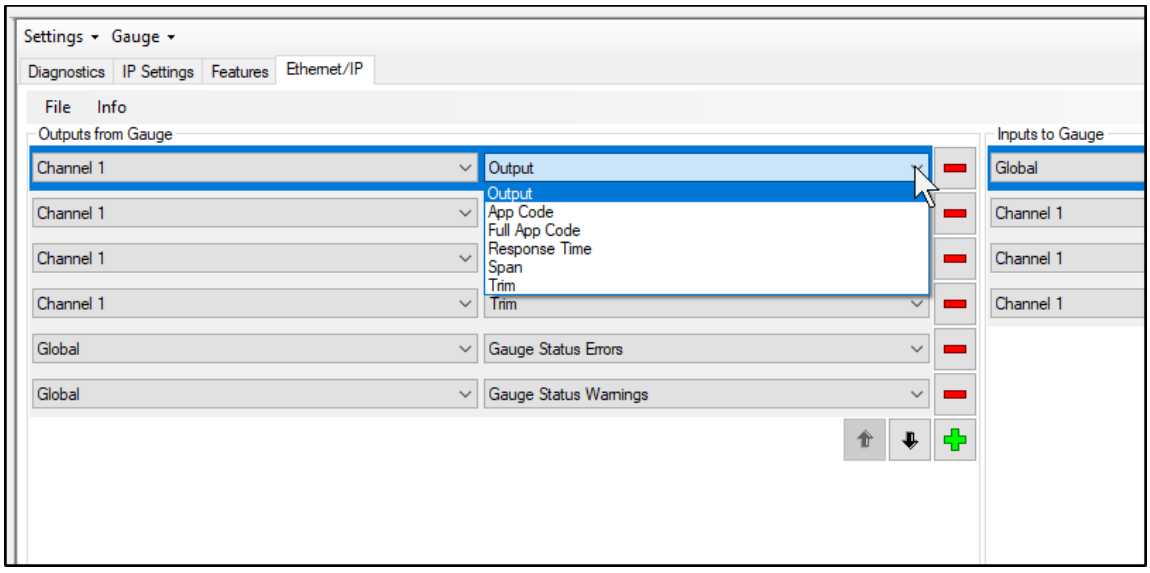
1. Start **GaugeToolsXL** and drag the Gauge node to the "Gauge Utility" icon.



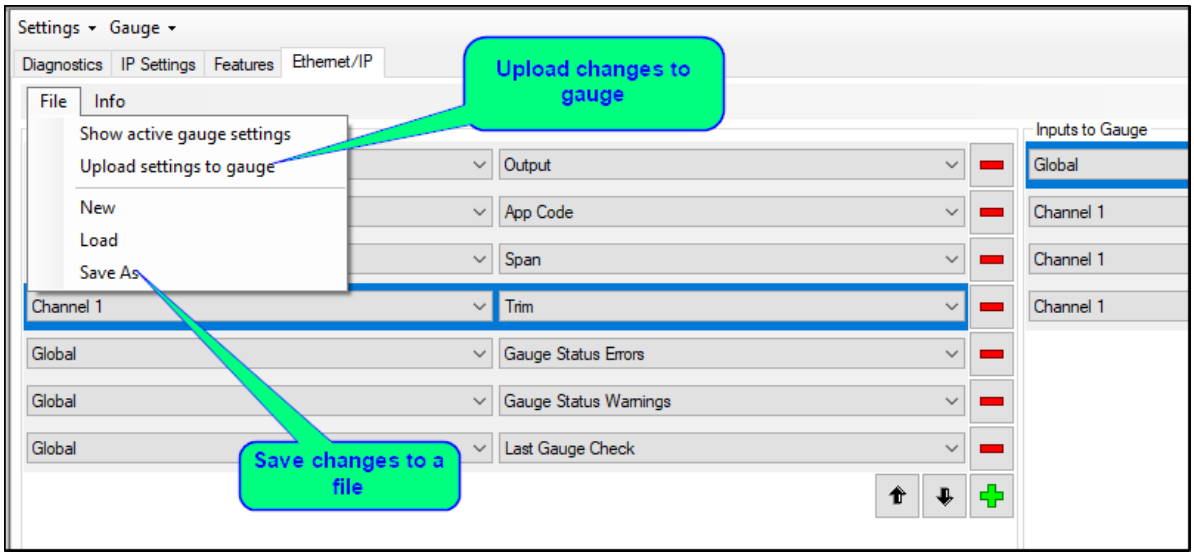
2. Select the **Ethernet/IP** tab:





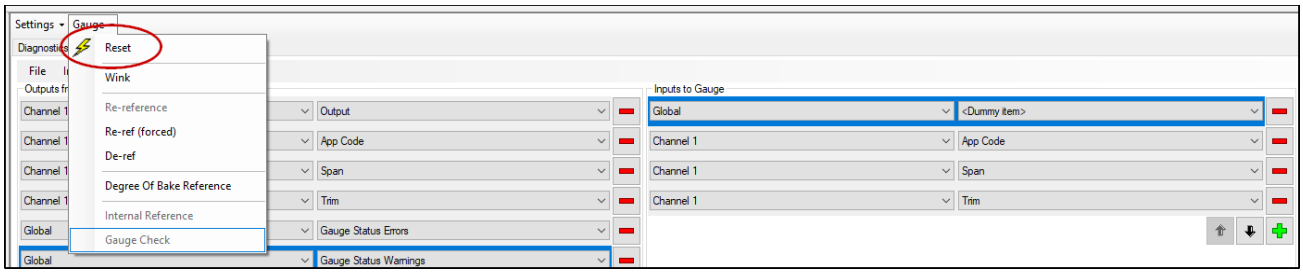


3. Once the desired changes have been made, then it is possible to upload the changes to the gauge or save the changes to a file.



4. When uploading the changes to the S9 gauge, the GaugeToolsXL utility will show a status message “Saving to device..”

5. After the changes are uploaded, the gauge needs to be reset for them to take effect.



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Warranty

1. All sales of NDC Technologies products are subject to the contractual terms and conditions of the Order pursuant to which they were sold to Buyer, including Warranty terms. The following terms are a general summary of the contractual Warranty terms, NOT a revision or alternative to the contractual terms, and are presented as merely a point of reference for your information. The contractual Warranty is the complete and exclusive statement of all NDC Technologies warranties to Buyer. In the event the following terms are in conflict with any of the contractual Warranty terms, the contractual Warranty terms shall be deemed to control.

   The warranty terms contained herein are expressly in lieu of any and all other warranties, expressed or implied, including any warranty of merchantability or fitness for a particular purpose. In no event shall NDC Technologies be liable for any incidental, consequential or special damages, including but not limited to, any loss of business, income or profits, expenses incurred for time when the system is not in operation, and any labor costs relating to or arising out of the performance, functioning or use of the system.

   Purchaser assumes the risk for use of this product and agrees to indemnify and hold NDC Technologies harmless for any and all damage to person or to property resulting therefrom.

   NDC Technologies grants no license under any patent rights except the right, under only such patents as may be owned or acquired by NDC Technologies, to use the product sold hereby for the purpose for which it is sold. NDC Technologies does not warrant that the product or its use does not infringe any patent owned by persons other than NDC Technologies.

2. NDC Technologies guarantees all products to be free from defects in material and workmanship for the following periods[1]:

   - Product and peripherals – 2 years from shipment
   - Source lamp – 5 years from shipment
   - Filter wheel motor – 5 years from shipment
   - Spare parts – 1 year from shipment
   - Replacement lamps and motors supplied under warranty – 1 year or up to the original 5 year warranty from shipment of the sensor, whichever is longer

   [1] Refer to the contractual terms and conditions of the Order for usage of the warranty.

   During this period, NDC Technologies will repair or at its option replace, free of all charges for parts and labor, any NDC Technologies parts determined by it to have been broken or damaged due to causes other than improper application, abuse or negligence. NDC Technologies' obligation to repair or replace shall not extend to expendable parts which are subject to normal operating wear.

   Nothing in this paragraph 2 will require NDC Technologies to make repairs or replacements where:

A. The product has been repaired, other than by an authorized NDC Technologies dealer or an NDC Technologies employee, or altered in any way without the prior written consent of NDC Technologies; or

B. The product has not been properly maintained in accordance with any operating and maintenance manual supplied therewith; or

C. The product has been damaged as a result of fire, flood, war, insurrection, civil commotion, acts of God or any other cause beyond the control of NDC Technologies or Buyer.

3. NDC Technologies' liability shall be limited to the obligations set forth in Paragraph 2. These shall be the Buyer's sole and exclusive remedies, whether in contract, tort or otherwise, provided, however, that in lieu thereof, NDC Technologies at its option may replace the entire product on an exchange basis or refund the purchase price against the return of the defective product.

4. NDC Technologies will not be responsible for failure to provide service or parts due to shortage of materials, labor or transportation strikes or delays, or any causes beyond NDC Technologies' control.

5. Unless otherwise specified by NDC Technologies, all warranty repairs will be made at NDC Technologies' facility. The customer shall be responsible for all expenses of packing, freight and insurance in connection with the shipment of products to NDC Technologies for repair. NDC Technologies will pay the cost of returning the equipment to customer.

   If it is mutually determined by the buyer and NDC Technologies that the examination, replacement or repair takes place at the buyer's facility, then the buyer will be responsible for NDC Technologies' travel and living expenses incurred in traveling to and from the buyer's facility, and during the time of the visit, as well as the cost of field labor and replacement parts unless the parts being repaired or replaced are determined to have been defective, in which event the cost of said repaired or replacement parts shall be borne by NDC Technologies. These travel and living expenses will be billed to the buyer at actual cost to NDC Technologies.

6. No person, including any NDC Technologies distributor, agent or representative, is authorized to assume any liability on behalf or in the name of NDC Technologies, and NDC Technologies shall not be bound to any understandings, representations, or agreements with respect to warranties except as set forth in this policy.

7. NDC Technologies requests immediate notification of any claims arising from damage in transit in order to determine if carrier responsibility exists. If damaged equipment arrives, save the shipping container for inspection by the carrier and telephone NDC Technologies as soon as possible.