



# Operation Manual

## PRODUCT NAME

Ethernet ITV – Modbus TCP

## MODEL / Series / Product Number

ITVXXXX-SMB-XX-DUQ00833-XXXX

**SMC Corporation**



# Contents

1.	Safety Instructions.....	- 4 -
2.	About this Manual.....	- 9 -
2.1.	Purpose.....	- 9 -
3.	Terminology.....	- 10 -
4.	Product Summary.....	- 11 -
5.	How to Order.....	- 12 -
5.1.	Accessories .....	- 12 -
6.	Summary of Product Elements.....	- 13 -
7.	Quick Start.....	- 14 -
7.1.	Power Cable.....	- 14 -
7.2.	Network Cable.....	- 14 -
7.3.	IP Address.....	- 14 -
7.4.	Modbus Registers.....	- 15 -
7.5.	Setpoint .....	- 15 -
7.6.	Login .....	- 15 -
7.7.	Default Parameters .....	- 16 -
8.	Installation and Wiring .....	- 17 -
8.1.	Installation.....	- 17 -
8.2.	Connecting Cables .....	- 18 -
9.	Web Page Access.....	- 20 -
9.1.	Initial Power-up.....	- 20 -
9.2.	Configuring the PC.....	- 21 -
9.3.	Connecting to the ITV Web Page.....	- 25 -
9.4.	Changing the ITV IP Address.....	- 27 -
10.	Power Over Ethernet (POE).....	- 30 -
10.1.	Configuring POE.....	- 30 -
10.2.	Connecting ITVs for a POE Group.....	- 32 -
11.	LED Indication and Settings.....	- 34 -
12.	Web Pages Accessible Without Login .....	- 36 -
12.1.	System Page .....	- 36 -
12.2.	IO Data Page.....	- 37 -
12.3.	Version Page.....	- 39 -
12.4.	ITV Status Page.....	- 40 -
12.5.	Login Page.....	- 41 -
12.6.	Contact Page.....	- 42 -
13.	Web Pages Requiring Login.....	- 43 -
13.1.	Regulator Configuration Page .....	- 44 -
13.2.	Network Page .....	- 47 -
13.3.	Time Page .....	- 50 -
13.4.	Logout Page.....	- 51 -

14.	Counts and Pressure Units .....	- 52 -
14.1.	Count Value Sent TO ITV .....	- 52 -
14.2.	Count Value Received FROM ITV.....	- 53 -
15.	ITV Modbus Communications Setup .....	- 54 -
15.1.	Supported Modbus Registers .....	- 54 -
15.2.	Supported Modbus Function Codes.....	- 54 -
15.3.	Send Setpoint to ITV .....	- 55 -
15.4.	Read Status from ITV .....	- 56 -
15.5.	Message Sequence .....	- 57 -
16.	Modbus Examples .....	- 58 -
16.1.	Wago PLC.....	- 58 -
16.2.	LabVIEW .....	- 61 -
	Appendix.....	- 63 -
17.	Troubleshooting .....	- 63 -
17.1.	Problem: ITV Does Not Power Up .....	- 63 -
17.2.	Problem: ITV Does Not Operate .....	- 63 -
17.3.	Problem: Unable to Communicate with ITV.....	- 64 -
17.4.	Problem: ITV Web Page Pressure Value Differs from Master Calculated Value .....	- 65 -
17.5.	Problem: ITV Does Not Reach Set Pressure .....	- 65 -
18.	Recovering the IP Address of SMC ITV Module.....	- 66 -
19.	Specifications.....	- 67 -
19.1.	General Specifications .....	- 67 -
19.2.	Initial Configuration Parameters .....	- 67 -

# 1. Safety Instructions

These safety instructions are intended to prevent hazardous situations and/or equipment damage. These instructions indicate the level of potential hazard with the labels of "Caution", "Warning" or "Danger". They are all important notes for safety and must be followed in addition to International standards (ISO/IEC), and other safety regulations.

- \*1) ISO 4414: Pneumatic fluid power -- General rules relating to systems.
- ISO 4413: Hydraulic fluid power -- General rules relating to systems.
- IEC 60204-1: Safety of machinery -- Electrical equipment of machines. (Part 1: General requirements)
- ISO 10218-1992: Manipulating industrial robots -- Safety.
- etc.

 <b>Caution :</b>	CAUTION indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.
 <b>Warning:</b>	WARNING indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.
 <b>Danger :</b>	DANGER indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.

## Warning

### **1. The compatibility of the product is the responsibility of the person who designs the equipment or decides its specifications.**

Since the product specified here is used under various operating conditions, its compatibility with specific equipment must be decided by the person who designs the equipment or decides its specifications based on necessary analysis and test results. The expected performance and safety assurance of the equipment will be the responsibility of the person who has determined its compatibility with the product. This person should also continuously review all specifications of the product referring to its latest catalog information, with a view to giving due consideration to any possibility of equipment failure when configuring the equipment.

### **2. Only personnel with appropriate training should operate machinery and equipment.**

The product specified here may become unsafe if handled incorrectly. The assembly, operation and maintenance of machines or equipment including our products must be performed by an operator who is appropriately trained and experienced.

### **3. Do not service or attempt to remove product and machinery/equipment until safety is confirmed.**

1. The inspection and maintenance of machinery/equipment should only be performed after measures to prevent falling or runaway of the driven objects have been confirmed.
2. When the product is to be removed, confirm that the safety measures as mentioned above are implemented and the power from any appropriate source is cut, and read and understand the specific product precautions of all relevant products carefully.
3. Before machinery/equipment is restarted, take measures to prevent unexpected operation and malfunction.

### **4. Contact SMC beforehand and take special consideration of safety measures if the product is to be used in any of the following conditions.**

1. Conditions and environments outside of the given specifications, or use outdoors or in a place exposed to direct sunlight.
2. Installation on equipment in conjunction with atomic energy, railways, air navigation, space, shipping, vehicles, military, medical treatment, combustion and recreation, or equipment in contact with food and beverages, emergency stop circuits, clutch and brake circuits in press applications, safety equipment or other applications unsuitable for the standard specifications described in the product catalog.
3. An application which could have negative effects on people, property, or animals requiring special safety analysis.
4. Use in an interlock circuit, which requires the provision of double interlock for possible failure by using a mechanical protective function, and periodical checks to confirm proper operation.

## **Caution**

### **The product is provided for use in manufacturing industries.**

The product herein described is basically provided for peaceful use in manufacturing industries. If considering using the product in other industries consult SMC beforehand and exchange specifications or a contract if necessary.  
If anything is unclear, contact your nearest sales branch.

## **Limited warranty and Disclaimer/Compliance Requirements**

The product used is subject to the following "Limited warranty and Disclaimer" and "Compliance Requirements".

Read and accept them before using the product.

### **Limited warranty and Disclaimer**

1. The warranty period of the product is 1 year in service or 1.5 years after the product is delivered.<sup>\*1)</sup> Also, the product may have specified durability, running distance or replacement parts. Please consult your nearest sales branch.
2. For any failure or damage reported within the warranty period which is clearly our responsibility, a replacement product or necessary parts will be provided.  
This limited warranty applies only to our product independently, and not to any other damage incurred due to the failure of the product.
3. Prior to using SMC products, please read and understand the warranty terms and disclaimers noted in the specified catalog for the particular products.

\*1) Vacuum pads are excluded from this 1 year warranty.

A vacuum pad is a consumable part, so it is warranted for a year after it is delivered.

Also, even within the warranty period, the wear of a product due to the use of the vacuum pad or failure due to the deterioration of rubber material are not covered by the limited warranty.

### **Compliance Requirements**

When the product is exported, strictly follow the laws required by the Ministry of Economy, Trade and Industry (Foreign Exchange and Foreign Trade Control Law).

## **Operator**

- ◆ This operation manual has been written for those who have knowledge of machinery and apparatus that use pneumatic equipment and have full knowledge of assembly, operation and maintenance of such equipment.
- ◆ Please read this operation manual carefully and understand it before assembling, operating or providing maintenance to the product.

## ■ Precautions

### **Warning**

- Do not disassemble, modify (including changing the printed circuit board) or repair.  
An injury or failure can result.
- **Do not operate the product outside of the specifications.**  
**Do not use for flammable or harmful fluids.**  
**Fire, malfunction, or damage to the product can result.**  
**Verify the specifications before use.**
- Do not operate in an atmosphere containing flammable or explosive gases.  
Fire or an explosion can result.  
This product is not designed to be explosion proof.
- If using the product in an interlocking circuit:
  - Provide a double interlocking system, for example a mechanical system.
  - Check the product regularly for proper operation.Otherwise malfunction can result, causing an accident.
- The following instructions must be followed during maintenance:
  - Turn off the power supply.
  - Stop the air supply, exhaust the residual pressure and verify that the air is released before performing maintenance.Otherwise an injury can result.

### **Caution**

- After maintenance is complete, perform appropriate functional inspections.  
Stop operation if the equipment does not function properly.  
Safety cannot be assured in the case of unexpected malfunction.
- Provide grounding to assure the safety and noise resistance of the Serial System.  
Individual grounding should be provided close to the product with a short cable.

## ■NOTE

- Follow the instructions given below when designing, selecting and handling the product.
- The instructions on design and selection (installation, wiring, environment, adjustment, operation, maintenance, etc.) described below must also be followed.

### Product specifications

- When conformity to UL is necessary the SI unit must be used with a UL1310 Class2 power supply.
- The SI unit is a  approved product only if they have a  mark on the body.
- Use the specified voltage.  
Otherwise failure or malfunction can result.
- Reserve a space for maintenance.  
Allow sufficient space for maintenance when designing the system.
- Do not remove any nameplates or labels.  
This can lead to incorrect maintenance, or misreading of the operation manual, which could cause damage or malfunction to the product.  
It may also result in non-conformity to safety standards.

### ●Product handling

#### Installation

- Do not drop, hit or apply excessive shock to the Ethernet ITV system.  
Otherwise damage to the product can result, causing malfunction.
- Tighten to the specified tightening torque.  
If the tightening torque is exceeded the mounting screws may be broken.  
IP65 protection cannot be guaranteed if the screws are not tightened to the specified torque.
- Never mount a product in a location that will be used as a foothold.  
The product may be damaged if excessive force is applied by stepping or climbing onto it.

#### Wiring

- Avoid repeatedly bending or stretching the cables, or placing heavy load on them.  
Repetitive bending stress or tensile stress can cause breakage of the cable.
- Wire correctly.  
Incorrect wiring can break the product.
- Do not perform wiring while the power is on.  
Otherwise damage to the fieldbus system and/or I/O device can result, causing malfunction.
- Do not route wires and cables together with power or high voltage cables.  
Otherwise the fieldbus system and/or I/O device can malfunction due to interference of noise and surge voltage from power and high voltage cables to the signal line.  
Route the wires (piping) of the fieldbus system and/or I/O device separately from power or high voltage cables.
- Confirm proper insulation of wiring.  
Poor insulation (interference from another circuit, poor insulation between terminals, etc.) can lead to excess voltage or current being applied to the product, causing damage.
- Take appropriate measures against noise, such as using a noise filter, when the fieldbus system is incorporated into equipment.  
Otherwise noise can cause malfunction.

## Environment

- Select the proper type of protection according to the operating environment.  
IP65 protection is achieved when the following conditions are met:
  - (1) The units are connected properly with fieldbus cable with M12 connector and power cable with M12 connector.
  - (2) Suitable mounting of each unit (if using the optional manifold mount).
  - (3) All unused connectors are closed with a properly installed seal cap.  
If using in an environment that is exposed to water splashes, please take measures such as using a cover.
- Do not use in a place where the product could be splashed by oil or chemicals.  
If the product is to be used in an environment containing oils or chemicals such as coolant or cleaning solvent, even for a short time, it may be adversely affected (damage, malfunction etc.).
- Do not use the product in an environment where corrosive gases or fluids could be splashed.  
Otherwise damage to the product and malfunction can result.
- Do not use in an area where surges are generated.  
If there is equipment which generates a large amount of surge (solenoid type lifter, high frequency induction furnace, motor, etc.) close to the fieldbus system, this may cause deterioration or breakage of the internal circuit of the fieldbus system. Avoid sources of surge generation and crossed lines.
- When a surge-generating load such as a relay or solenoid is driven directly, use a fieldbus system with a built-in surge absorbing element.  
Direct drive of a load generating surge voltage can damage the fieldbus system.
- The product is **NOT** immune to lightning strikes. Take measures against lightning strikes in the system.
- Prevent foreign matter such as remnant of wires from entering the fieldbus system to avoid failure and malfunction.
- Mount the product in a place that is not exposed to vibration or impact.  
Failure or malfunction can result.
- Do not expose the product to direct sunlight.  
If using in a location directly exposed to sunlight, shade the product from the sunlight. Failure or malfunction can result.
- Keep within the specified operating temperature range. Malfunction can result.
- Do not operate close to a heat source, or in a location exposed to radiant heat.  
Otherwise malfunction can result.

### Adjustment and Operation

- Perform settings suitable for the operating conditions.  
Incorrect setting can cause operation failure.
- Please refer to the PLC manufacturer's manual etc. for details of programming and addresses.  
For the PLC protocol and programming refer to the relevant manufacturer's documentation.

### Maintenance

- Turn off the power supply, stop the supplied air, exhaust the residual pressure and verify the release of air before performing maintenance.  
There is a risk of unexpected malfunction.
- Perform regular maintenance and inspections.  
There is a risk of unexpected malfunction.
- After maintenance is complete, perform appropriate functional inspections.  
Stop operation if the equipment does not function properly.  
Otherwise safety is not assured due to an unexpected malfunction or incorrect operation.
- Do not use solvents such as benzene, thinner etc. to clean the unit.  
They could damage the surface of the body and erase the markings on the body. Use a soft cloth to remove stains. For heavy stains, use a cloth soaked with diluted neutral detergent and fully squeezed, then wipe up the stains again with a dry cloth.

## 2. About this Manual

### 2.1. Purpose

The purpose of this manual is to provide the user with necessary information to install, configure, and use the ITVXXXX-SMB-XX-DUQ00833-XXXX.

The ITV is typically operated under the control of a master device (usually a PLC). The ITV may also be operated under the control of a LabVIEW program (see an example program in [LabVIEW \(Section 16.2\)](#)). Finally, the ITV may also be operated using the built-in ITV web interface. The web interface is documented in this manual.

This manual provides information for ITV setup and configuration, examples of the web interface, a LabVIEW program, and a brief overview of the Wago 750 PLC. Please see the manufacturer's documentation for detailed instructions on the setup and use of your Wago or other PLCs. Please see the LabVIEW documentation for more information on using LabVIEW.

### 3. Terminology

	Terms	Meaning
100	100BASE-TX	Standard LAN transmission line with communication speed of 100 Mbps.
A	Auto negotiation	The function that automatically optimizes the common communication parameters such as speed, duplex mode, and flow control between Ethernet devices.
B	Bus In / Bus Out	M12 Ethernet communication connectors located on top of the ITV.
C	Counts	The ITV controls and reports pressure or vacuum internally in <b>Counts</b> . The counts are used by hardware devices to control and measure the pressure or vacuum regulated by the ITV.
	Current consumption	The current necessary to operate each unit or device using a 24 volt power supply.
D	Downstream	Relative to your ITV, a downstream device receives power and/or communication signals which originate <i>from</i> or are <i>passed through</i> your ITV.
F	Fieldbus	The protocol that uses digital communication to exchange signals between field equipment (instruments and actuators).
	Full duplex	Communication system that can send and receive data at the same time bi-directionally (similar to standard telephone).
H	Half duplex	Communication system that sends and receives data in one direction at a time (similar to two-way radio).
I	IP address	A 32 bit digit sequence which is assigned to identify devices which are connected to the network. This address must be unique for each device to ensure proper operation of the network.
	IPxy	International Ingress Protection standard. xy indicates the level of protection from external objects (hands, steel balls, steel wire, dust, water, etc.) applied to the product.
M	MAC address	A unique number inherent to all devices which are connected to Ethernet.
	Master	The master is the device which controls the ITV. Typically a master is a PLC. It may also be a PC (using the ITV web pages or a LabVIEW program) or it may be another device capable of controlling the ITV.
	Modbus	The specific Fieldbus (network) communication protocol used by the ITV to communicate with the PLC, and any other connected devices. Modbus TCP is a well-documented, standard communications protocol.
P	PC	Personal Computer.
	PLC	Abbreviation for Programmable Logic Controller. A digital computer/controller used for automation of electromechanical processes.
	Power Cycle	A Power Cycle involves briefly removing power from the ITV and then restoring power.
S	Setpoint	The specified pressure or vacuum value which the ITV has been directed to maintain.
	Serial Interface (SI)	A communication interface between two digital systems that transmits data as a series of voltage pulses down a wire. Each pulse represents a single bit of data.
	SI unit	Abbreviation for Serial Interface unit. A unit connected to a device to communicate input and output data. The ITV connection to another device is a Serial Interface Unit (SI Unit).
T	Topology	Connection configuration of the network.
U	Upstream	Relative to your ITV, an upstream device provides power and/or communication signals to your ITV.

Figure 1 - Definitions and Terminology

## 4. Product Summary

The ITVXXX-SMB-XX-DUQ00833-XXXX (ITV) is a pressure / vacuum regulator which is controlled by a serial interface. Pressure ITVs (ITVX010, ITVX030, and ITVX050) and Vacuum ITVs (ITV2090) regulate supplied pressure or vacuum to an output value specified by the user.

The serial interface allows a user to configure, control, and monitor the ITV over an Ethernet communication link. The user can set the ITV pressure or vacuum and monitor the ITV operating status using the ITV web page or a PLC.

The connectors on the ITV are: one (1) 24 volt DC power supply connector (A-Coded M12 5-pin female connector) and two (2) Ethernet communications connectors (D-Coded M12 4-pin male connectors). (See [Connecting Cables \(Section 8.2\)](#) for cable pin information).

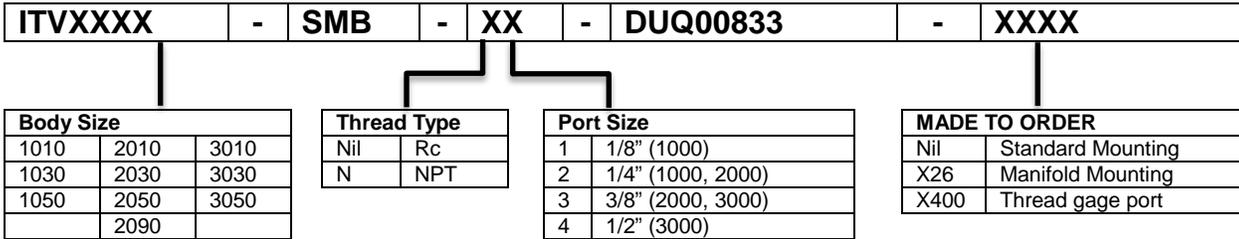
There are several options for the thread and port sizes. (For information on the various options, see [How to Order \(Section 5\)](#)).

### **Caution**

Be **SURE** you understand the location and function of these ports **BEFORE** connecting the ITV to an air or vacuum line. **VERIFY** that these lines are properly connected **BEFORE** enabling pneumatic pressure or vacuum and **BEFORE** powering the ITV.

## 5. How to Order

The part number describes the ITV as follows:



**Figure 2 - ITV Part Number**

Note 1: Body Size 2090 is an -80 KPa vacuum ITV.

All other Body Sizes are pressure ITVs (x010 – 0.1 MPa, x030 – 0.5 MPa, x050 – 0.9 MPa).

Note 2: Port Size refers to the size of the supply, output, and exhaust ports for all body sizes.

Note 3: Unless otherwise noted, this manual applies to all options. This document describes the standard Ethernet ITV connection and setup. The additional functionality of the X-Options is described on the SMC website and in the SMC product catalog. If further clarification is required, contact SMC for additional information on the X-Options.

### 5.1. Accessories

**Connector cables** (recommended – not included with ITV)

ITV unit connection	Description	Compatible cable		
		Part number	Len	Specifications
Fieldbus interface	Cables	EX9-AC010EN-PSRJ	1m	One end: molded M12 straight connector. Other end: RJ45 connector (Ethernet).
		EX9-AC020EN-PSRJ	2m	
		EX9-AC030EN-PSRJ	3m	
		EX9-AC050EN-PSRJ	5m	
		EX9-AC100EN-PSRJ	10m	
		PCA-1446566	5m	One end: molded M12 right angle connector. Other end: flying leads.
		EX9-AC005EN-M12M12	0.5m	Both ends: molded M12 straight connectors.
	EX9-AC050EN-M12M12	5m		
	Field wire-able Connector	PCA-1446553	--	Connector: M12 straight plug connector. Use with PCA-1446566 to make a cable of desired length.
Power supply	Cables	EX500-AP010-SE	1m	One end: molded M12 straight connector. Other end: flying leads.
		EX500-AP050-S	5m	
		EX500-AP010-A	1m	One end: molded M12 right angle connector. Other end: flying leads.
		EX500-AP050-A	5m	
	Cable with Speedcon connector	PCA-1401804	1.5m	One end: molded M12 straight connector. Other end: flying leads.
		PCA-1401805	3m	
PCA-1401806		5m		

**Figure 3 - Recommended Cables**

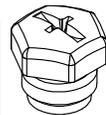
Note: More options are available. Contact SMC for information on these options.

#### Seal cap

Seal caps are used to protect the M12 size connector openings. It is recommended that seal caps be used on all unused M12 connector openings. Use of seal caps is required for all unused connections for IP65 rating.

(One Ethernet and one Power seal cap are attached to the ITV when shipped from factory.)

Description	Part No.	Specification	
Seal cap	EX9-AWTS	For M12 connector socket: 10pcs.	Bus Port
Seal cap	P5033-88	For M12 connector socket: 1pcs.	Bus Port
Seal cap	UIUSP-A05-DUQ00833	Cap and Gasket for M12 Female Connector 1 pcs.	Power Port



**Figure 4 - Seal Cap Part Numbers**

## 6. Summary of Product Elements

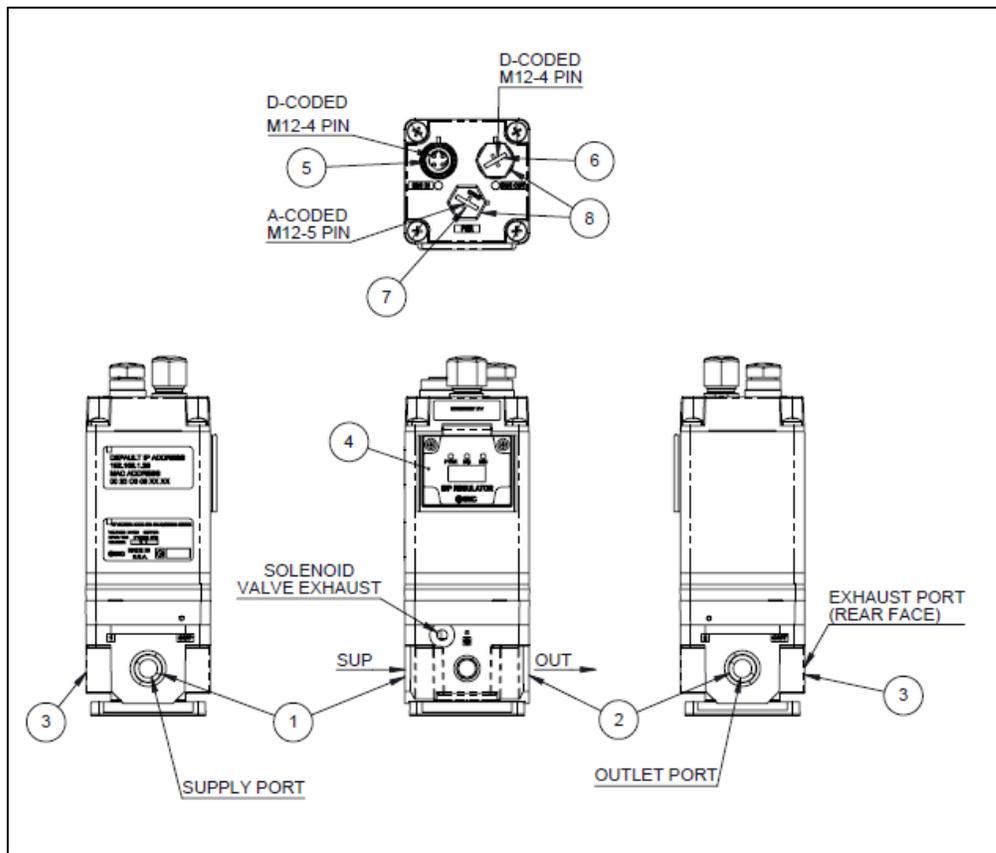


Figure 5 - ITV Drawing

No.	Element	Description
1	Supply Port Connection	Input Pressure Line Connection (X010, X030, X050) / Atmosphere Pressure (2090) * <sup>1</sup>
2	Outlet Port Connection	Output Pressure Line Connection (X010, X030, X050) / Application Vacuum Line Connection (2090) * <sup>1</sup>
3	Exhaust / Vacuum Port	Exhaust Port (X010, X030, X050) / Vacuum Line Connection (2090) * <sup>1</sup>
4	LED Display window	Network and operating status LEDs * <sup>2</sup>
5	Fieldbus interface connector (Bus In)	Ethernet connection (M12, 4-pin socket, D-coded) * <sup>3</sup>
6	Fieldbus interface connector (Bus Out)	Ethernet connection (M12, 4-pin socket, D-coded) * <sup>3</sup>
7	Power supply connector	24 Volt DC input power supply * <sup>3</sup>
8	Seal Cap (Accessory)	Seal cap for unused Fieldbus interface connector (Bus Out); Seal cap for unused power supply connector * <sup>3</sup>

\*1: X is 1, 2, or 3 and designates the body type for the ITV. (See [How to Order \(Section 5\)](#) for more information)

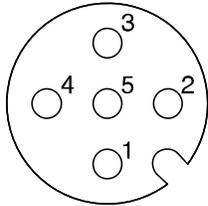
\*2: See [LED Indication and Settings \(Section 11\)](#) for the LED indication.

\*3: See [How to Order \(Section 5\)](#) for connecting cables and seal caps part numbers.

## 7. Quick Start

### 7.1. Power Cable

#### 7.1.1. Power supply connector layout - PWR: M12 5-pin Plug A-coded connector



No.	Designation	Description
1	24 VDC	Power (Brown Wire +24 VDC + terminal)
2	-	Do Not Connect
3	0 VDC	Common (Blue Wire – Common - terminal)
4	-	Do Not Connect
5	FG	Field Ground (Gray Wire – ground) – resistance to ground must be 100 ohms or less

Figure 6 - ITV Power Cable Pin Connections

(Note: The wire colors above are for a standard SMC power cable. Power cables from other sources may use different colors.) For Power Cable selection see [Accessories \(Section 5.1\)](#).

### Warning

**ALL** pins on the M12 5-pin power connector **ARE** connected internally in the ITV. Only pins 1 and 3 are used for power. Pin 5 is used for field ground. The user **MUST** insure that pins 2 and 4 are **NOT connected (OPEN)** in the power cable to prevent possible injury to personnel and possible hazardous operation of the ITV and controlled equipment.

Failure to ensure that **pins 2 and 4 are OPEN (NOT connected)** could cause abnormal ITV operation. Abnormal ITV operation could result in injury or death.

### 7.2. Network Cable

#### 7.2.1. Network Bus In and Bus Out: M12 4-pin socket D-coded connectors

Select the appropriate cables to mate with the communication connectors mounted on the ITV.



No.	Designation	Description
1	TD+	Transmit Data +
2	RD+	Receive Data +
3	TD-	Transmit Data -
4	RD-	Receive Data -

Figure 7 - ITV Ethernet Cable Pin Signals

Use a standard industrial Ethernet cable. For cable selection see [Accessories \(Section 5.1\)](#).

You may use either port (“Bus In” or “Bus Out”) for the Ethernet connection to the ITV **EXCEPT when using Power Over Ethernet (POE)**. POE **REQUIRES** that the input cable is connected to “Bus In” and the output cable is connected to “Bus Out”. (See [Power Over Ethernet \(POE\) \(Section 10\)](#) for more information.)

### 7.3. IP Address

The IP address is set to (192.168.1.20) at the factory. The IP address can be changed using the built in ITV web server. (See [Web Page Access \(Section 9\)](#)).

## 7.4. Modbus Registers

Modbus uses a set of registers to pass data between devices. Although several different types of registers are supported by Modbus, the ITV uses only the two types of registers given here: Holding Registers and Input Registers.

Function Code	Address Offset	Size	Description
Write Holding Register(0x06)	0x0000	16 bits	Pressure set-point.
Read Input Register(0x04)	0x0000	16 bits	Measured pressure
Read Input Register(0x04)	0x0001	16 bits	Status flags

Figure 8 - IO Data Key

- **Pressure Set-point:** 16 bit value sent from the master (usually a PLC) to the ITV. The top 4 bits **must** be set to 0. The lower 12 bits (counts) cover the full supported ITV pressure or vacuum range (0 – 4095 or 0x0000 – 0x0fff).
- **Measured Pressure:** 16 bit value sent to the master from the ITV. The top 4 bits are 0. The lower 12 bits (counts) indicate the current pressure or vacuum regulated by the ITV.
- **Status Flags:** 16 bit value (see [Status Bits \(Section 12.2.1\)](#) for information on ITV Status bits).

## 7.5. Setpoint

**Setpoint** is the requested value for the ITV’s regulated pressure or vacuum output. An external master (typically a PLC) sends the setpoint value (in counts) to the ITV. During machine start up or troubleshooting, the ITV web page can be used to enter a setpoint value (see [Regulator Configuration Page \(Section 13.1\)](#)).

## 7.6. Login

ITV login is required to access many of the ITV web pages and features. The factory default login is Username: “**user**”, Password: “**user**”. The ITV login provides access to features that can be monitored during operation or modified to meet the application requirements. (See [Login Page \(Section 12.5\)](#) for more information).

## 7.7. Default Parameters

The default values of ITV settings are given below. The user can change these values, if needed, as part of the ITV setup process.

- 7.7.1. Pressure Ranges. Pressure setpoints sent to the ITV are specified in counts. The range is 0 – 4095. 4095 corresponds to full range for the ITV. The actual pressure corresponding to 4095 counts depends on the ITV body type, is set by the factory, and cannot be changed.

Body Type	X010	X030	X050	2090
Pressure at 4095 Counts	100 KPa	500 KPa	900 KPa	-80 KPa

- 7.7.2. Pressure (Vacuum) setpoint is 0 upon system power up.
- 7.7.3. Power Over Ethernet (POE). By default this setting is OFF. The setting is preserved across power cycles. To change this value, see [Power Over Ethernet \(POE\) \(Section 10\)](#).
- 7.7.4. Hold on Connection Loss. By default this setting is OFF. Loss of data communication will cause the ITV to return to a pressure or vacuum of 0 counts. This setting is preserved across power cycles. See [Network Page \(Section 13.2\)](#) to change this setting.
- 7.7.5. By default, the ITV web pages, [ITV Status Page \(Section 12.4\)](#) and [Regulator Configuration Page \(Section 13.1\)](#), display pressure and vacuum values in PSI.
- 7.7.6. The default factory IP address is 192.168.1.20.
- 7.7.7. The default factory MAC address is printed on the ITV label.
- 7.7.8. Modbus ITVs use Modbus register mode communications only.
- 7.7.9. See [Specifications \(Section 19\)](#) for a summary of default ITV settings and ITV hardware specifications.

## 8. Installation and Wiring

### 8.1. Installation

1. For standard mounting, properly install pneumatic fittings in the threaded ports of the ITV base. For additional details see *SMC Best Pneumatics* version 5 (or later), volume 5, ITV Section Series ITV0000/1000/2000/3000. For information about SMC fittings see <http://www.smcusa.com/top-navigation/cad-models.aspx/87051>.
  - a. See [Figure 5 - ITV Drawing](#) for the description of fitting locations.
  - b. Torque the fittings as indicated:

Connection thread	1/8	1/4	3/8	1/2
Torque (N•m)	7 to 9	12 to 14	22 to 24	28 to 30

Figure 9 - Recommended proper connection torque: N•m

2. Install pneumatic tubing. When installing this tubing, be sure that the air pressure or vacuum source is **LOCKED OFF** at the closest shutoff valve before the ITV. There must be **NO AIR PRESSURE OR VACUUM** in the pneumatic line until all connections are complete.

### Caution

**DO NOT** enable air pressure or vacuum until **ALL** pneumatic lines in the circuit have been properly connected and the connections have been verified to be correct. Failure to follow this requirement can result in injury or equipment damage.

Be **SURE** you understand the location and function of the ports **BEFORE** connecting the ITV to an air or vacuum line. **VERIFY** that these lines are properly connected **BEFORE** enabling pneumatic pressure or vacuum and **BEFORE** powering the ITV.

## 8.2. Connecting Cables

### 8.2.1. Fieldbus interface connector layout

Select the appropriate cables to mate with the communication connectors mounted on the ITV.

#### Bus In and Bus Out: M12 4-pin socket D-coded connectors



No.	Designation	Description
1	TD+	Transmit Data +
2	RD+	Receive Data +
3	TD-	Transmit Data -
4	RD-	Receive Data -

Figure 10 - ITV Ethernet Cable Pin Signals

Connect one connector (“Bus In” or “Bus Out”) to the upstream device and connect the other connector (“Bus Out” or “Bus In”) to the downstream device. For cable selection see [Accessories \(Section 5.1\)](#).

If Power Over Ethernet (POE) is **NOT** in use, either communications port can be used for input or output. It is recommended that “Bus In” be used for the input (upstream) connection to the ITV and “Bus Out” be used for the output (downstream) connection from the ITV. It is also recommended that unused connectors be capped with a seal cap. For more information see [Accessories \(Section 5.1\)](#).

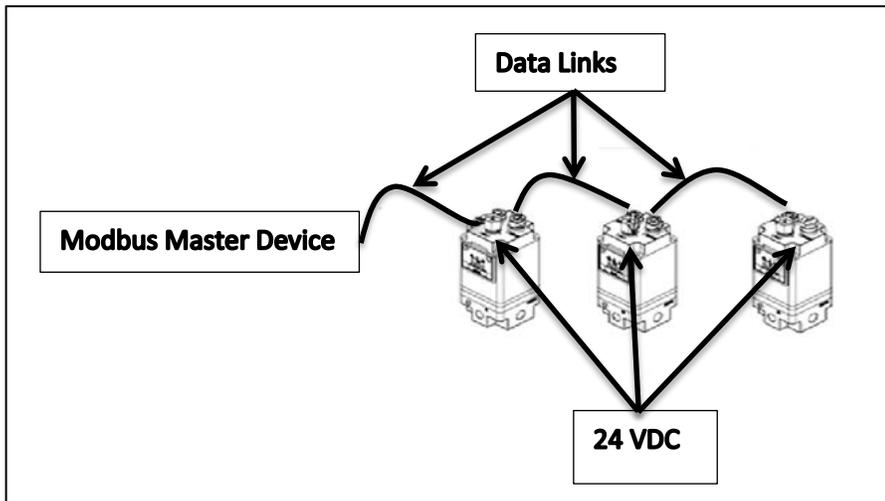


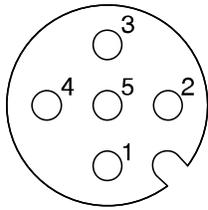
Figure 11 - Example (non-POE) ITV Data and Power Connections

### Caution

If using POE, **STRICTLY FOLLOW** the connections given in [Power Over Ethernet \(POE\) \(Section 10\)](#). Failure to follow the required connections could result in injury or equipment damage.

## 8.2.2. Power supply connector layout

### PWR: M12 5-pin Plug A-coded connector



No.	Designation	Description
1	24 VDC	Power (Brown Wire +24 VDC + terminal)
2	-	Do Not Connect
3	0 VDC	Common (Blue Wire – Common - terminal)
4	-	Do Not Connect
5	FG	Field Ground (Gray Wire – ground) – resistance to ground must be 100 ohms or less

Figure 12 - ITV Power Cable Pin Connections

(Note: The wire colors above are for a standard SMC power cable. Power cables from other sources may use different colors.) For Power Cable selection see [Accessories \(Section 5.1\)](#).

### Warning

**ALL** pins on the M12 5-pin power connector **ARE** connected internally in the ITV. Only pins 1 and 3 are used for power. Pin 5 is used for field ground. The user **MUST** insure that pins 2 and 4 are **NOT connected (OPEN)** in the power cable to prevent possible injury to personnel and possible hazardous operation of the ITV and controlled equipment.

Failure to ensure that **pins 2 and 4 are OPEN (NOT connected)** could result in abnormal ITV operation. Abnormal ITV operation could result in injury or death.

## 9. Web Page Access

### 9.1. Initial Power-up

The ITV web page is the mechanism used to configure an ITV and prepare it for installation. The ITV web page may also be used to operate and control the ITV.

New ITVs come from the factory preconfigured with a unique MAC address which matches the MAC address printed on the label of the ITV. New ITVs have a preset static IP address of 192.168.1.20. Use this IP address initially to access the ITV web page.

Both MAC addresses and IP addresses must be unique on a network. The factory sets the same static IP address for *all* ITVs; therefore, the IP address *may need to be changed* as part of the setup process. The IP address change procedure is discussed in this section.

#### 9.1.1. Connection and Power Up

In order to initially access the ITV web page, you will need the following items (see [Connecting Cables \(Section 8.2\)](#) for more details):

- (1) One (1) power cable (with a 5-pin female M12 A-Coded connector).
- (2) One (1) Ethernet cable (with a 4-pin male M12 D-Coded connector on one end and a standard LAN Ethernet cable plugin connector (RJ45) on the other end).
- (3) A PC with a LAN port. The PC is either directly connected to the ITV using the Ethernet cable in item 2, or it may be connected to the ITV via a separate cable and switch.
- (4) Web browser installed on the PC. Internet Explorer (IE 9 or later), Chrome, or Firefox are supported.

Connect the Ethernet cable to the “Bus In” port of the ITV. Connect the LAN connector to your PC LAN port or switch.

Turn on the PC (and switch, if used).

Connect the power cable to a 24 VDC power supply and to the ITV (see [Power supply connector layout \(Section 8.2.2\)](#)).

Turn on the 24 VDC power supply.

The ITV should power up, the Power and MS LEDs should be solid green, and the NS LED should be flashing green. If this does not occur, turn off the 24 VDC power supply or disconnect the ITV power cable. Verify all connections. See [Troubleshooting \(Section 17\)](#) of this document for more information.

## 9.2. Configuring the PC

As noted, the IP address is initially set statically in the factory to 192.168.1.20. This is an address on subnet 192.168.1.#.

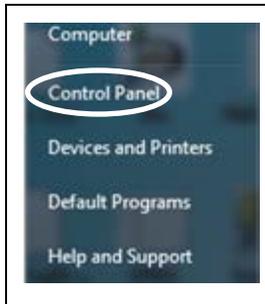
In order to access the ITV web page, the PC must also be configured to use subnet 192.168.1.#. The following steps (using Windows 7 – other versions of Windows may differ) describe how to set the PC to subnet 192.168.1.#. Note: If the PC is already configured to use subnet 192.168.1.#, you may skip this section.

This procedure assumes that you have appropriate access privileges on your PC. If not, please consult your PC Administrator.

Bring up the Network and Sharing Center using the Control Panel from the Start menu:



First, select the **Start** button on your PC toolbar



Next, select **Control Panel** on the **Start Menu**



**Network and Sharing  
Center**

Finally select **Network and Sharing Center** on the **Control Panel** menu

**Figure 13 - Link to Windows Network Connection**

## Section 9.2 (Continued)

Your **Network and Sharing Center** will depict the specific network configuration for your PC and its network(s). As a result, your view may be somewhat different from the following window. If you have questions, please review the documentation for your PC. If you have additional questions, please consult your PC or Network Administrator for information and assistance.

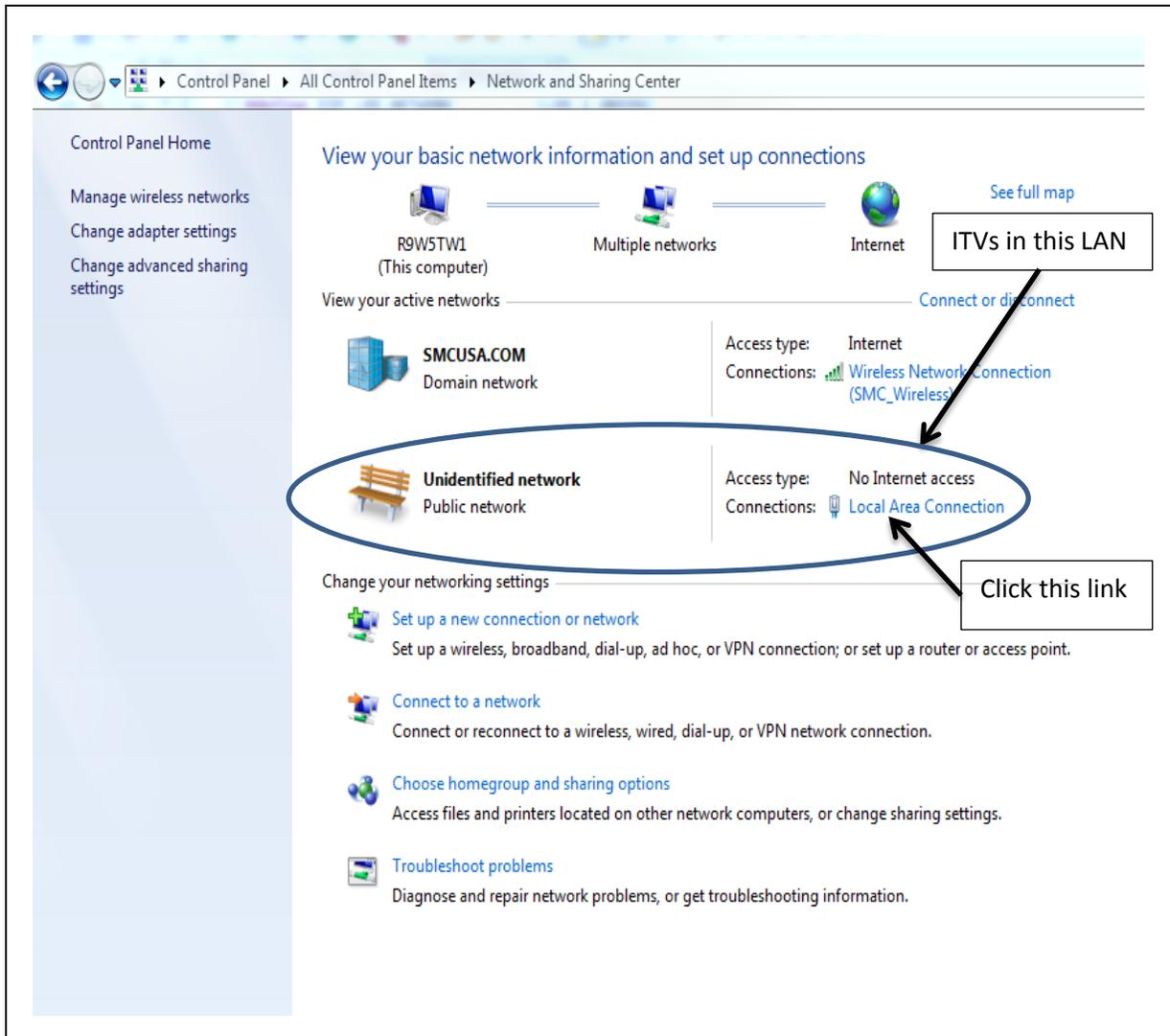


Figure 14 - Windows Network and Sharing Center

## Section 9.2 (Continued)

Press the “**Local Area Connection**” link (in [Figure 14 - Windows Network and Sharing Center](#)) and the **Local Area Connection Status** window will appear. Then press the “**Properties**” button and the **Local Area Connection Properties** window will appear:

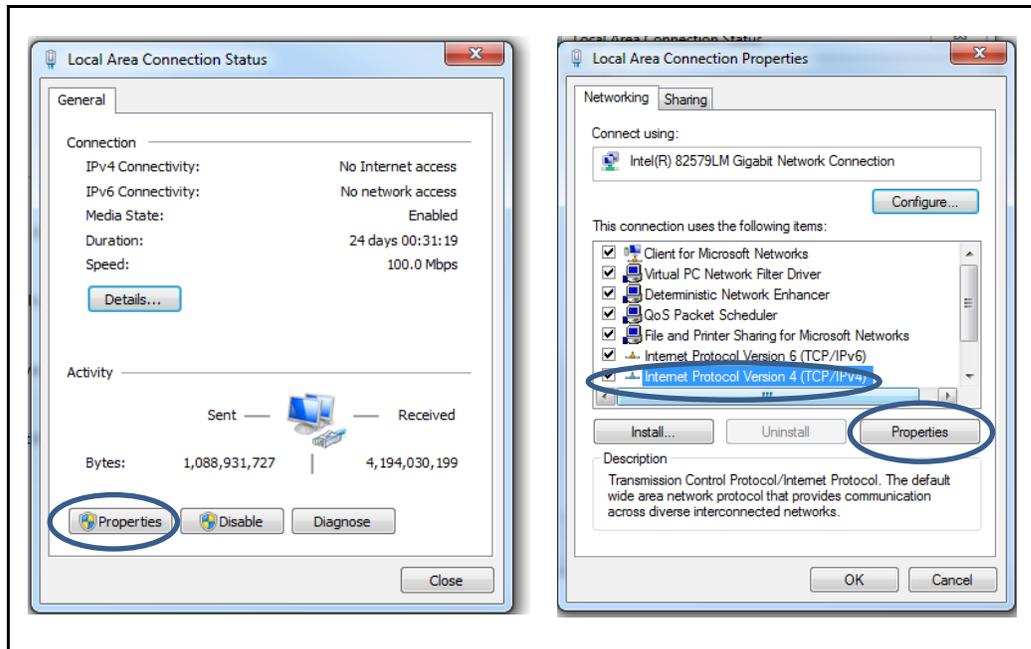


Figure 15 - Windows Local Area Connection and Local Area Connection Properties

Next select **Internet Protocol Version 4 (TCP/IPv4)** and the press **Properties** button. The **Internet Protocol Version 4 (TCP/IPv4) Properties** window will appear:

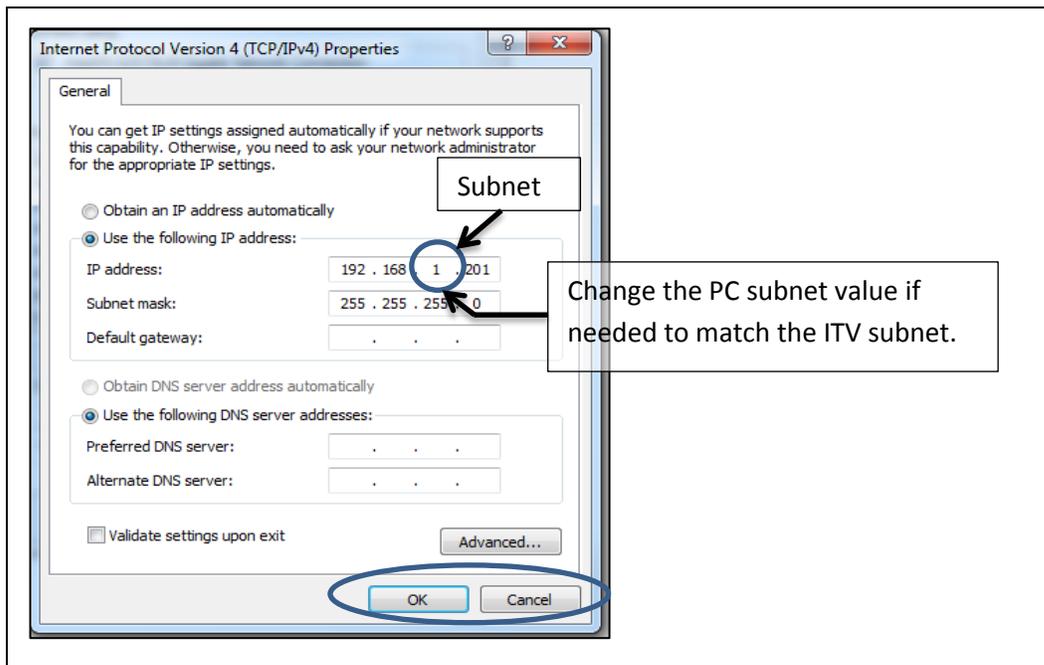


Figure 16 - Windows Internet Protocol - IPv4 – Properties

## Section 9.2 (Continued)

The **Subnet** field is circled ([Figure 16](#)). Verify that the PC Subnet value matches the Subnet in use on your ITV. Note: The PC and ITV **must** have different IP addresses.

**DO NOT MODIFY ANY OTHER FIELD IN THE IPv4 PROPERTIES WINDOW.**

If the Subnet field must be changed, **double click** the Subnet field entry (circled in [Figure 16](#)) and type the new value. Do NOT hit the keyboard “Enter” key. That has the effect of pressing the OK button, but does not give you the opportunity to review your Subnet change to ensure it is correct before you accept it.

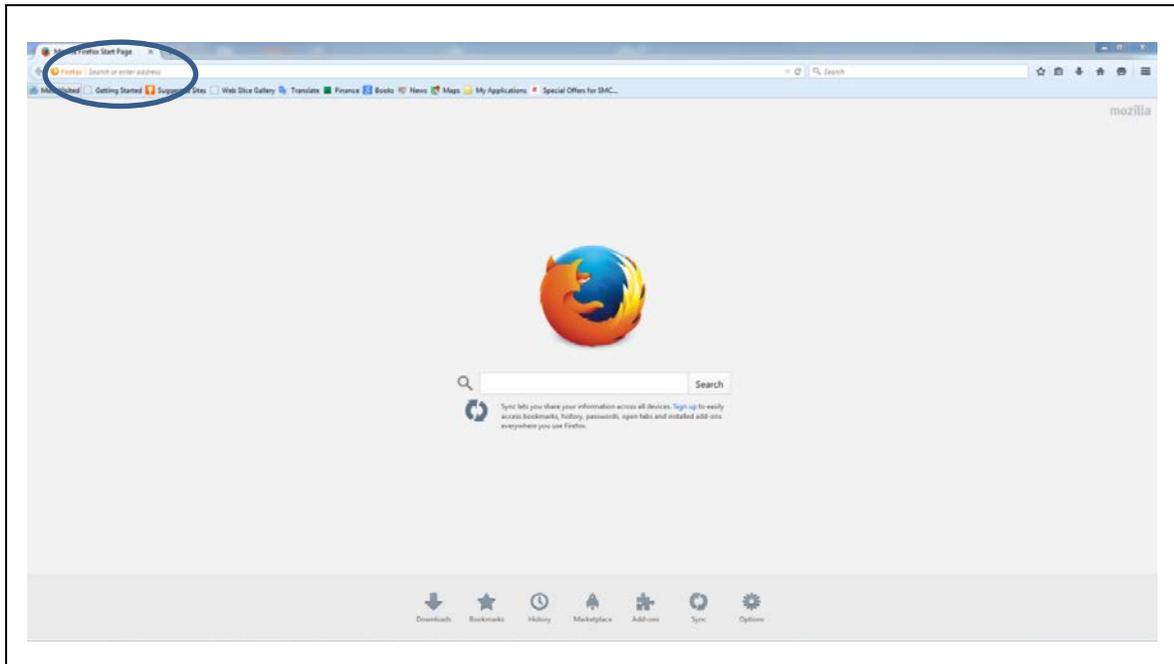
Verify that the **ONLY** change is the Subnet field. If **ANYTHING** other than the Subnet field has changed, restore the initial value **BEFORE** you press OK.

Once you have verified the values in the *IPv4 Properties* window, press the OK button to complete the PC subnet change. This will close the IPv4 Properties window.

Next, continue to [Connecting to the ITV Web Page \(Section 9.3\)](#).

### 9.3. Connecting to the ITV Web Page

After you have confirmed that the PC and ITV are on the same Subnet, launch your preferred browser. The following examples use Firefox. IE and Chrome are similar.



**Figure 17 - Firefox Browser Homepage**

In order to bring up the ITV web page, type the ITV IP address on the browser URL line. The “System Information” page should appear.

## Section 9.3 (Continued)

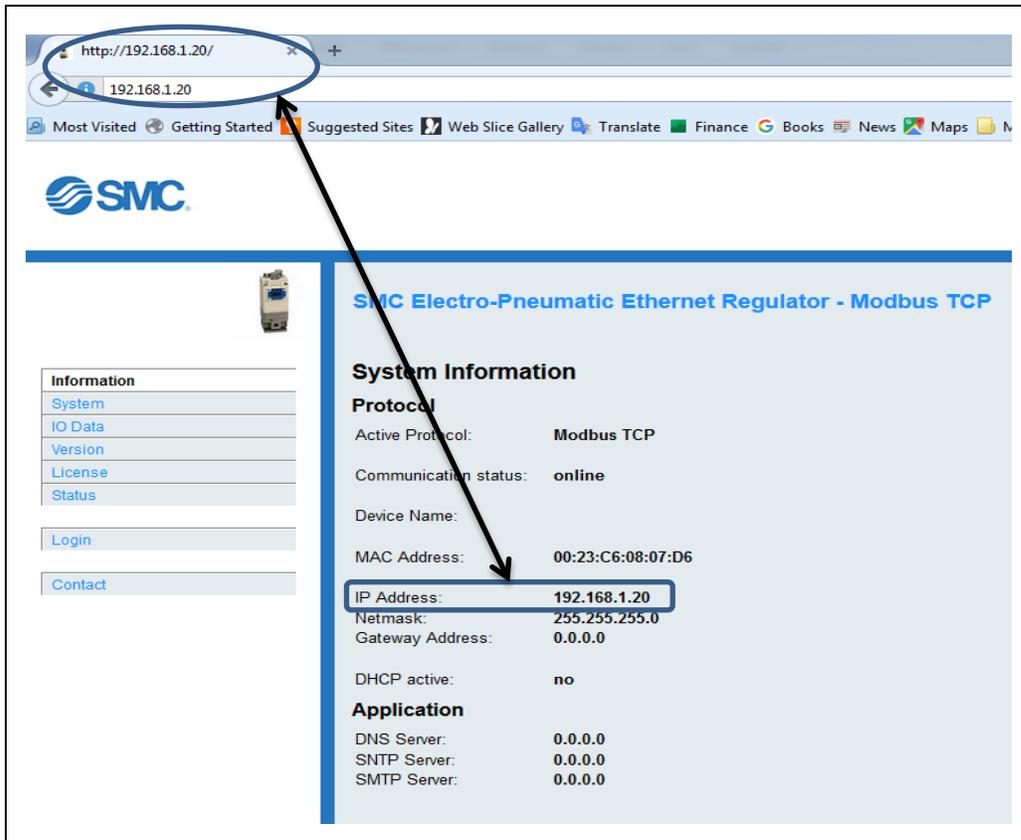


Figure 18 - ITV "System Information" Page with Factory Default IP Address

If the System Information page does **NOT** appear please check the following items:

- Verify all connections.
- Verify that the ITV is powered up.
- Confirm that the URL entered matches the IP address of the ITV.
- Verify that the PC subnet matches the ITV subnet.
- If necessary, contact SMC Technical Support for assistance.

## 9.4. Changing the ITV IP Address

If the ITV address must be changed, follow the steps in this section.

You may change the IP address and subnet to any address supported by your network that is not currently in use. In this example, the ITV IP address is changed from 192.168.0.20 to 192.168.1.26. This example includes a change from Subnet 0 to Subnet 1.

First, login to the ITV. Follow the instructions in [Login Page \(Section 12.5\)](#) to login to the Modbus TCP ITV.

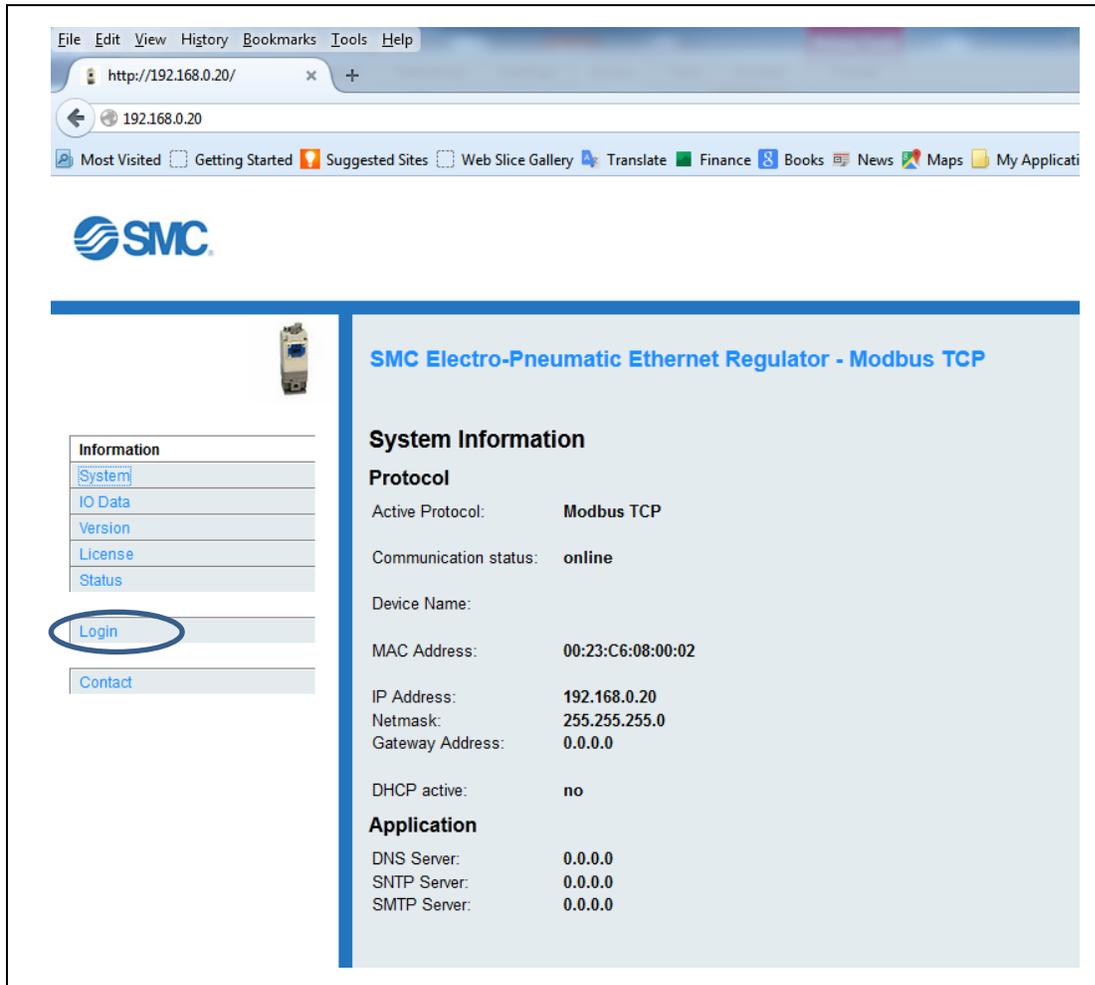
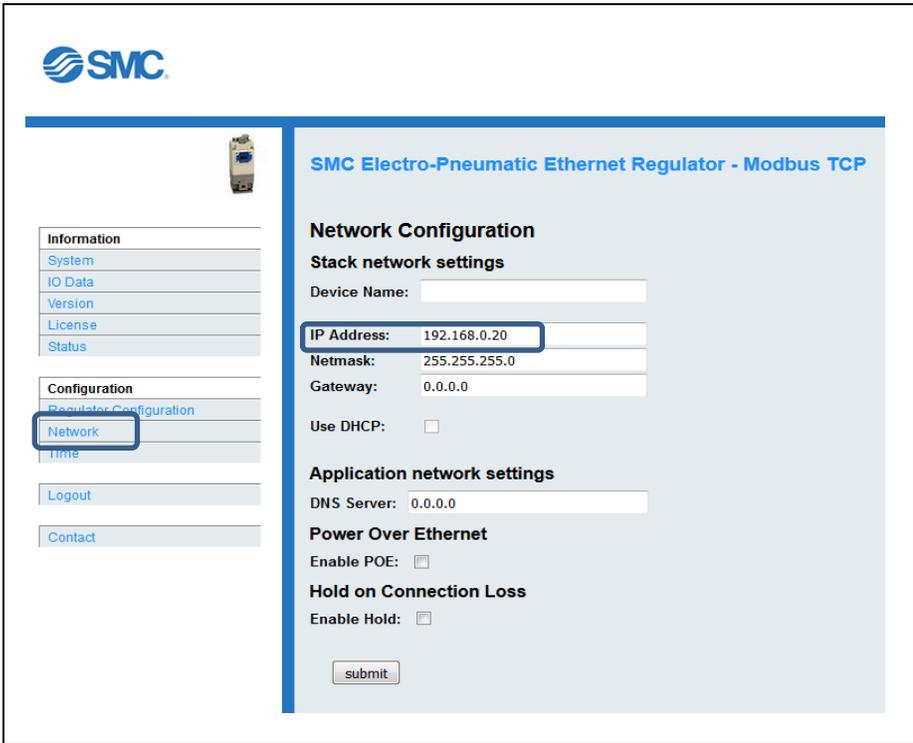


Figure 19 - ITV Preparing to Login

**Section 9.4 (Continued)**

After you have successfully logged in to the ITV, press the “**Network**” menu item to load the “**Network Configuration**” web page. The “**Network Configuration**” web page should appear.



**Figure 20 - Network Configuration Page Loaded**

## Section 9.4 (Continued)

To update the IP Address on the “Network Configuration” page, follow the instructions in section [IP Address \(Section 13.2.2\)](#).

The **only** item being changed is the IP Address. **DO NOT** change any other item on the page.

It is **STRONGLY RECOMMENDED** that you record the new IP address.

After the IP address has been changed, press “Submit” or the keyboard Enter key.

If the subnet was changed on the ITV, the PC subnet will need to be changed to again access the ITV web page. Set the PC subnet to match the ITV subnet by repeating the steps in section [Configuring the PC \(Section 9.2\)](#).

Finally, enter the new IP address in the URL bar. The “System Information” page should load with the new IP Address.

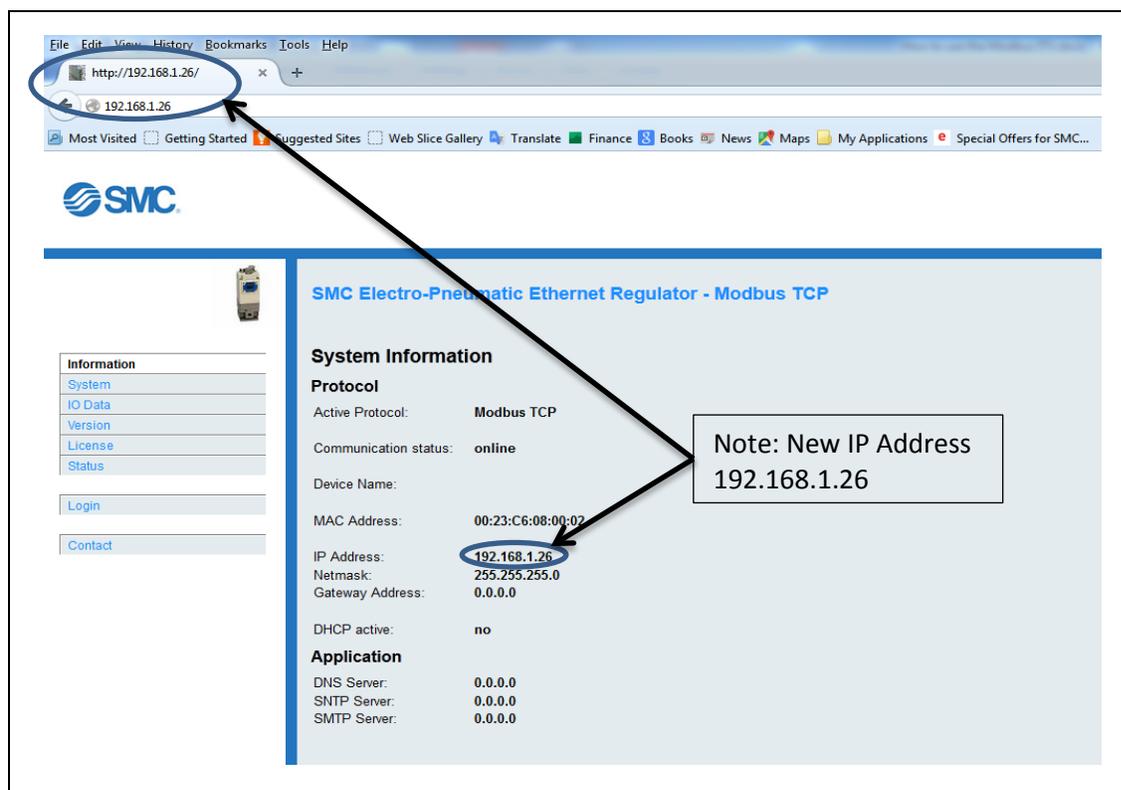


Figure 21 - New ITV IP Address In Effect

If the “System Information” page does NOT appear see section [Connecting to the ITV Web Page \(Section 9.3\)](#).

## 10. Power Over Ethernet (POE)

The Power Over Ethernet (POE) feature is an *optional* way to power ITV units eliminating the need to run a power cable to all ITVs. When POE is enabled, power is provided to the ITV by the “**Bus In**” cable. The ITV factory *default* condition is **POE disabled**.

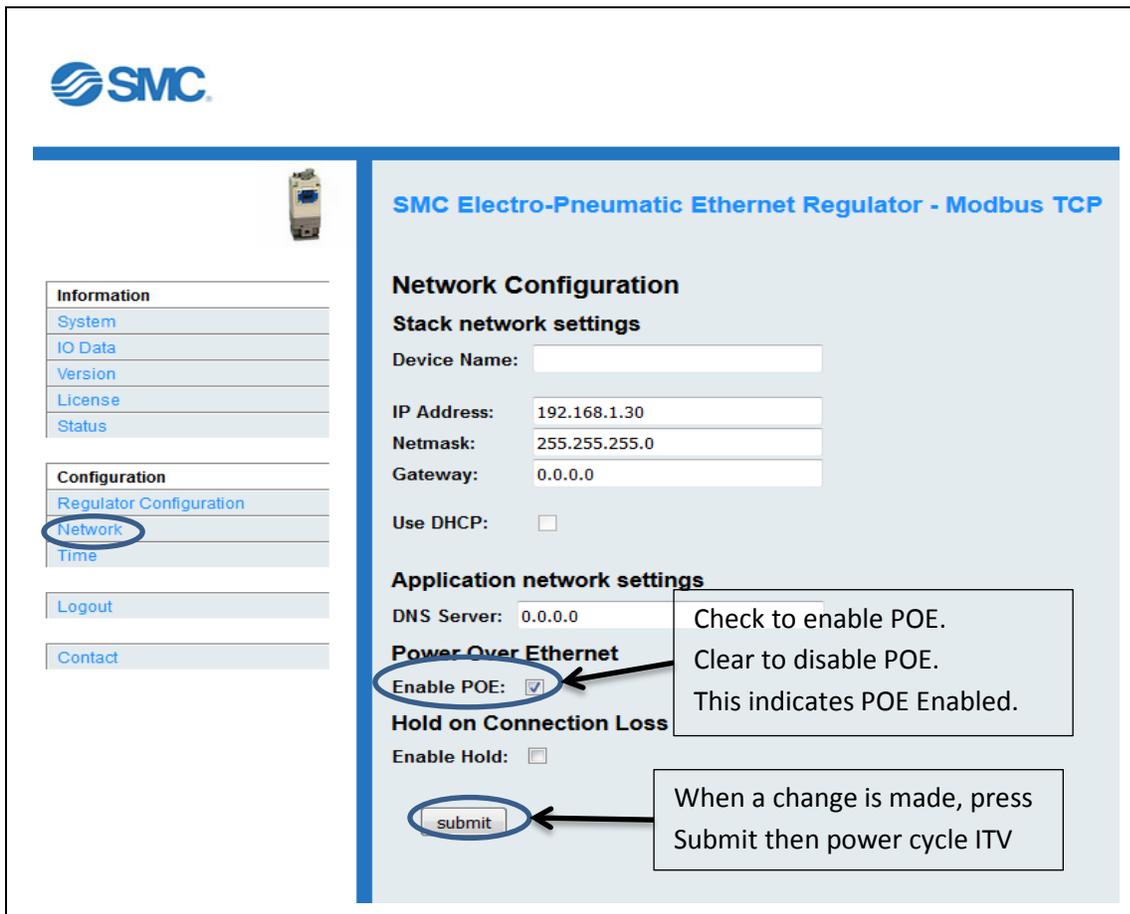
### Caution

By default, POE is **DISABLED**. Be sure that you **FULLY** understand this section **BEFORE** enabling POE on your ITV network. Improper use or configuration of POE can pose a safety hazard.

This Power Over Ethernet (POE) implementation is unique to the SMC ITV. Do **NOT** operate other devices using the ITV POE. Do **NOT** use POE from other devices to operate the ITV.

### 10.1. Configuring POE

POE is enabled or disabled using the “Enable POE” checkbox on the [Network Page \(Section 13.2\)](#). Login to the ITV (see [Login Page \(Section 12.5\)](#)) and press the “Network” menu item (see [Network Page \(Section 13.2\)](#)). (The “Enable POE” check box is highlighted in the example below).



The screenshot displays the SMC Electro-Pneumatic Ethernet Regulator - Modbus TCP configuration interface. On the left, a navigation menu includes 'Information' (System, IO Data, Version, License, Status) and 'Configuration' (Regulator Configuration, **Network**, Time), with 'Network' highlighted in blue. The main content area is titled 'Network Configuration' and contains 'Stack network settings' (Device Name, IP Address: 192.168.1.30, Netmask: 255.255.255.0, Gateway: 0.0.0.0) and 'Application network settings' (DNS Server: 0.0.0.0). Under 'Power Over Ethernet', the 'Enable POE' checkbox is checked and circled in blue. Below it, the 'Hold on Connection Loss' section has an 'Enable Hold' checkbox. A 'submit' button is circled in blue at the bottom. Annotations with arrows point to the 'Enable POE' checkbox and the 'submit' button, providing instructions on how to enable POE and what to do after a change.

Figure 22 ITV in POE Mode

To change the POE state of an ITV, press “**Submit**” or the keyboard **Enter** key and then power cycle the ITV.

**NOTE: A power cycle will temporarily disrupt control of the ITV. It will disrupt the ITV’s control of air pressure / vacuum to the devices it regulates and it will temporarily disrupt communication and control of devices downstream of the power cycled ITV.**

Once the ITV has powered up, the “**Bus Out**” connection will be changed to the POE state indicated by the “Enable POE” checkbox: **enabled** – 24 VDC **on** (checked) or **disabled** – 24 VDC **off** (unchecked).

If POE is set during IP configuration, it is recommended that a mark be made on the ITV to indicate POE has been enabled. This will allow future verification of the ITV’s POE state for proper cable connections.

### **Warning**

When changing the POE state of an ITV, it is necessary to **POWER CYCLE** the ITV for the change to take effect. Changing the POE configuration **MUST** be done when the ITV can be **SAFELY POWER CYCLED**.

**NEVER** perform this action when equipment controlled by the ITV is in use. The power cycle will temporarily **DISRUPT THE AIR SUPPLY** to the equipment being controlled. Additionally, power cycling an ITV will temporarily interrupt Ethernet communication and control of other devices and/or equipment downstream of the ITV. This could result in abnormal operation of the downstream devices and/or equipment.

**ALL** equipment which may be affected by a power cycle **MUST** be in a safe state **BEFORE** the power cycle is started. The user **MUST** verify the safety of the system **BEFORE** power cycling any ITV.

**Failure to safely execute the power cycle could result in abnormal equipment operation. Abnormal equipment operation could result in injury or death.**

## 10.2. Connecting ITVs for a POE Group

The cable connections are critical for proper operation of POE. The following is an example of proper POE cable connections.

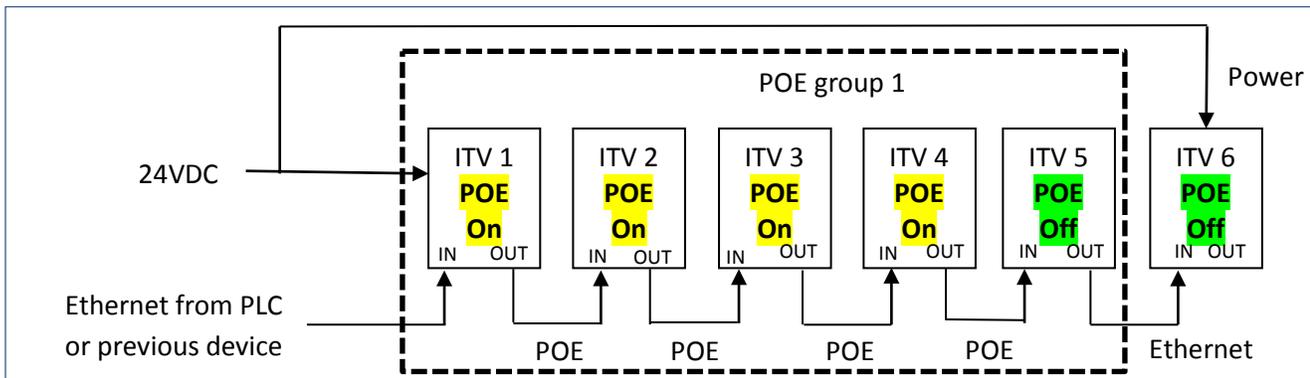


Figure 23 - ITV POE Group Ethernet Connections

The diagram illustrates the Ethernet communication and 24 VDC power cable connections required to support 6 ITVs when Power Over Ethernet (POE) is in use. The ITVs in the dashed box form a single POE group. Note that POE supports a **maximum** of five (5) ITVs in one POE group.

The following rules **MUST** be followed for proper operation of POE:

- (1) Ethernet cable from the PLC or other device (source) must be connected to the “**Bus In**” on the first ITV in a POE group.
- (2) Ethernet cable between the ITV’s within the POE group must be connected between the “**Bus Out**” port of the **upstream** ITV and the “**Bus In**” port of the **downstream** ITV for **ALL** ITVs.

### **Caution**

**NEVER** connect “**Bus Out**” of an ITV which has POE Enabled to **ANYTHING** other than “**Bus In**” of another ITV. “**Bus Out**” of a POE Enabled ITV provides a 24 VDC power source for the next ITV. Failure to follow this precaution can result in injury or equipment damage.

- (3) A maximum of 5 ITV’s are allowed in each POE group.
- (4) The “**Bus Out**” port on the last ITV (**POE disabled**) in the group may be connected as the **communication source** to a downstream device.
- (5) The first ITV within a POE group **must** have a power connection to a 24 VDC power supply. The first ITV is the **ONLY** ITV in the group with a connection to the 24 VDC power supply.
- (6) Every ITV in the group (**EXCEPT THE FINAL ITV**) **MUST** have POE **ENABLED**. The **FINAL** ITV **MUST** have POE **DISABLED**. (see [Configuring POE \(Section 10.1\)](#))

### **Caution**

POE for the FINAL ITV in a POE group **must be** disabled for proper operation.

- (7) A power supply connection is **required** for the first ITV following a POE group.

(8) Multiple POE groups can be used and the number of ITV's in each POE group can vary as necessary (maximum of 5 ITV's per group).

## **Warning**

- **NEVER** enable POE unless you understand the discussion above and have **verified** the ITV's are connected properly as indicated in the drawing. Injury or equipment damage can occur if POE is enabled and the ITV's are not connected properly.
- Changing the POE state requires the ITV to be power cycled.
- **During a power cycle, it is not possible to control the ITV.** This loss of control will disrupt the air pressure or vacuum regulated by the ITV. This loss of control could result in abnormal behavior of the equipment controlled by the ITV. **This abnormal behavior could cause injury or death.**
- **During an ITV power cycle, downstream communication will be lost with other ITV's or other devices.** This loss of communication could result in abnormal behavior of the equipment controlled by those devices. **This abnormal behavior could cause injury or death.**
- *Disabling POE on an ITV disconnects 24 VDC electrical power from the "Bus Out" connection. Any remaining ITV's within the POE group will not operate. Unpowered ITV's cannot regulate equipment and cannot be controlled. This could cause abnormal equipment behavior resulting in injury or death*
- Always **DISABLE** POE on the final ITV of a POE Group.
  - Failure to disable POE on the final ITV will result in 24 VDC power on the "Bus Out" port.
  - If "Bus Out" of a POE enabled ITV is connected to a downstream device (other than "Bus In" of another, unpowered, ITV), abnormal behavior, device damage, equipment damage or **possible injury or death could occur.**
- Only change POE state and power cycle an ITV when the ITV and **ALL** downstream devices are in a **VERIFIED SAFE STATE**. Loss of air pressure/vacuum, communication, power, and/or control of the ITV and downstream devices can pose risk of injury or damage.

## 11. LED Indication and Settings

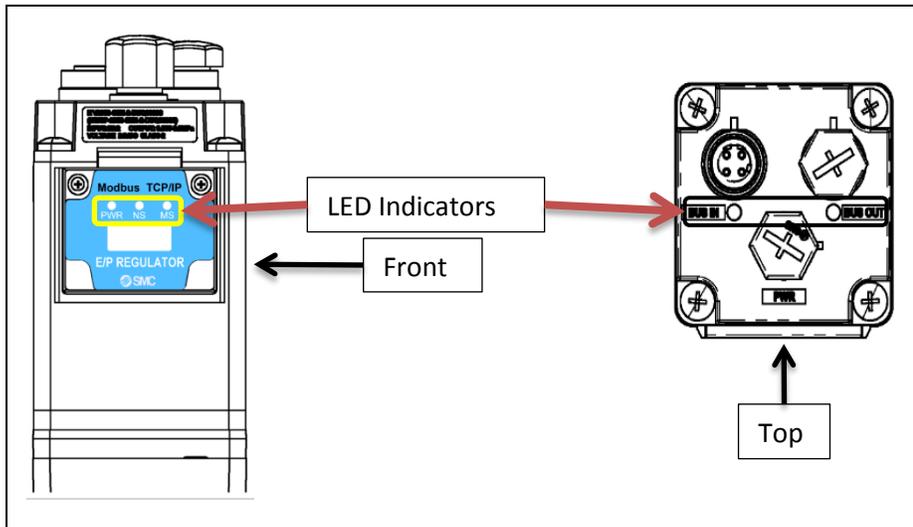


Figure 24 - ITV LED Placement

Front LED Indicators



PWR NS MS

LED	LED Status	Description
PWR	 Green ON	Load voltage for the ITV is supplied.
	 OFF	Load voltage for the ITV is not supplied or is outside the tolerance range (24 VDC $\pm$ 10%)
NS	 OFF	The SI unit operating voltage is not supplied.
	 Green ON	Communication established.
	 Green flashing	Idle link
	 Red flashing	Communication time out.
	 Red ON	IP address duplicated.
MS	 OFF	The SI unit operating voltage is not supplied.
	 Green ON	Operating normally.
	 Red flashing	Recoverable error – Possible low voltage
	 Red ON	Unrecoverable error.

Figure 25 - ITV Front LED Indicator Status Key

Top LED Indicators



BUS IN BUS OUT

LED	LED Status	Description
Bus In / Bus Out	 Off	Load voltage not supplied, terminal is not connected to another operating device, or terminal failed
Bus In / Bus Out	 Green ON	Terminal is connected to another operating device
Bus In / Bus Out	 Yellow Flashing	Intermittently blink yellow - data transfer in progress

**Figure 26 - ITV Top Bus Connection LED Indicator Status Key**

See [Troubleshooting \(Section 17\)](#) for information on dealing with problems indicated by these status LEDs.

## 12. Web Pages Accessible Without Login

Using a browser, the user can view and/or modify various ITV settings.

### 12.1. System Page

Enter the IP address of the ITV into your internet browser as shown below.

The “System Information” page will open.

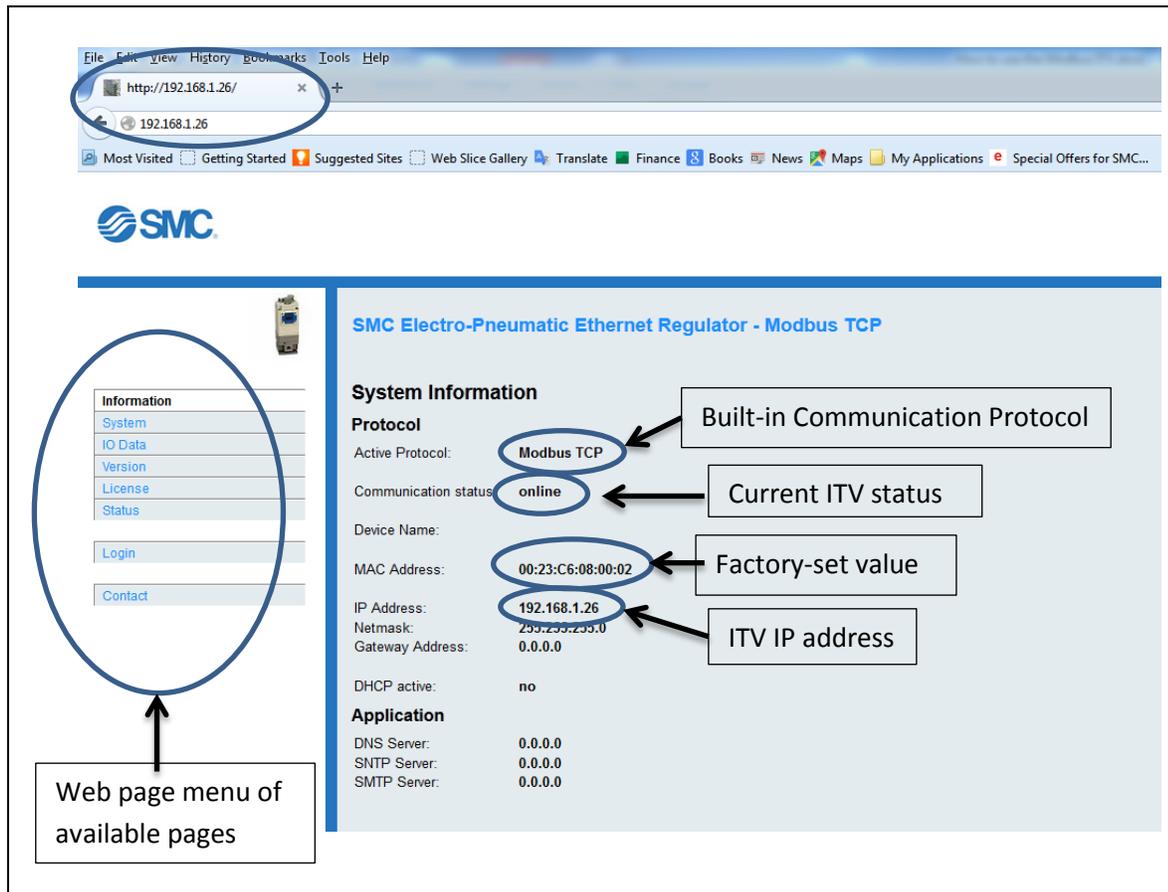


Figure 27 - ITV System Information web page

This page displays the current ITV communication settings.

Some of these settings can be changed by logging into the ITV. See the instructions on the [Network Page \(Section 13.2\)](#).

## 12.2. IO Data Page

Press “IO Data” to view the pressure setpoint sent to the ITV, current ITV pressure and status information sent from the ITV to the master device (usually a PLC).

Current Pressure (counts) and Status flags sent from the ITV.

Pressure Setpoint (counts) sent to the ITV

#	Unit ID	Type	Data status	Data size	Data
0	0x00000000	Holding Register	good	1	0x001f
1	0x00000001	Input Register	good	2	0x00070040
2	0x00100002	Holding Register	bad	1	0x0000
3	0x00200003	Holding Register	bad	1	0x0000
4	0x00300004	Holding Register	bad	1	0x0000
5	0x00400005	Holding Register	bad	1	0x0000
6	0x00500006	Holding Register	bad	1	0x0000
7	0x00600007	Holding Register	bad	1	0x0000
8	0x00700008	Holding Register	bad	1	0x0000
9	0x00200009	Input Register	good	2	0x00000000
10	0x0040000a	Input Register	good	2	0x00000000
11	0x0060000b	Input Register	good	2	0x00000000
12	0x0080000c	Input Register	good	2	0x00000000

Unused in this version

Figure 28 - ITV IO Data web page

The Data Status column indicates if data has been communicated on the bus after power up. (“Bad” indicates that the data **has not** been written; “Good” indicates the data **has** been written.)

The top row of data, **Unit 0** (Holding Register), is the most recent setpoint sent to the ITV. This value is the requested pressure or vacuum setpoint in counts (here 0x001f = 31).

The second row of data, **Unit 1** (Input Register) is the current ITV pressure in counts (here 0x0007 = 7) and status flags (here 0x0040). This data is sent **FROM** the ITV.

Counts are discussed in [Counts and Pressure Units \(Section 14\)](#) and status flags are discussed in [Status Flags \(Section 12.2.1\)](#).

The remaining items on the IO Data display are currently **unused**.

### 12.2.1. Status Flags

**Status flags** is a 16 bit value with 1 bit per status condition. If the bit is set (1), the condition is currently in effect. If the bit is clear (0), the condition is not in effect. (**Bits are numbered from the right to left**).

Bit order:

Most Significant Bit	. . .	Least Significant Bit
15	. . .	0

- bit 0 future use
- bit 1 future use
- bit 2 Pressure error – indicates pressure more than 20% outside 0 - 4095 count window
- bit 3 future use
- bit 4 future use
- bit 5 future use
- bit 6 always set to 1 – future use
- bit 7 future use
- bit 8 future use
- bit 9 future use
- bit 10 future use
- bit 11 future use
- bit 12 future use
- bit 13 future use
- bit 14 future use
- bit 15 future use

### 12.3. Version Page

Press “Version” to see the versions of the firmware of the ITV.

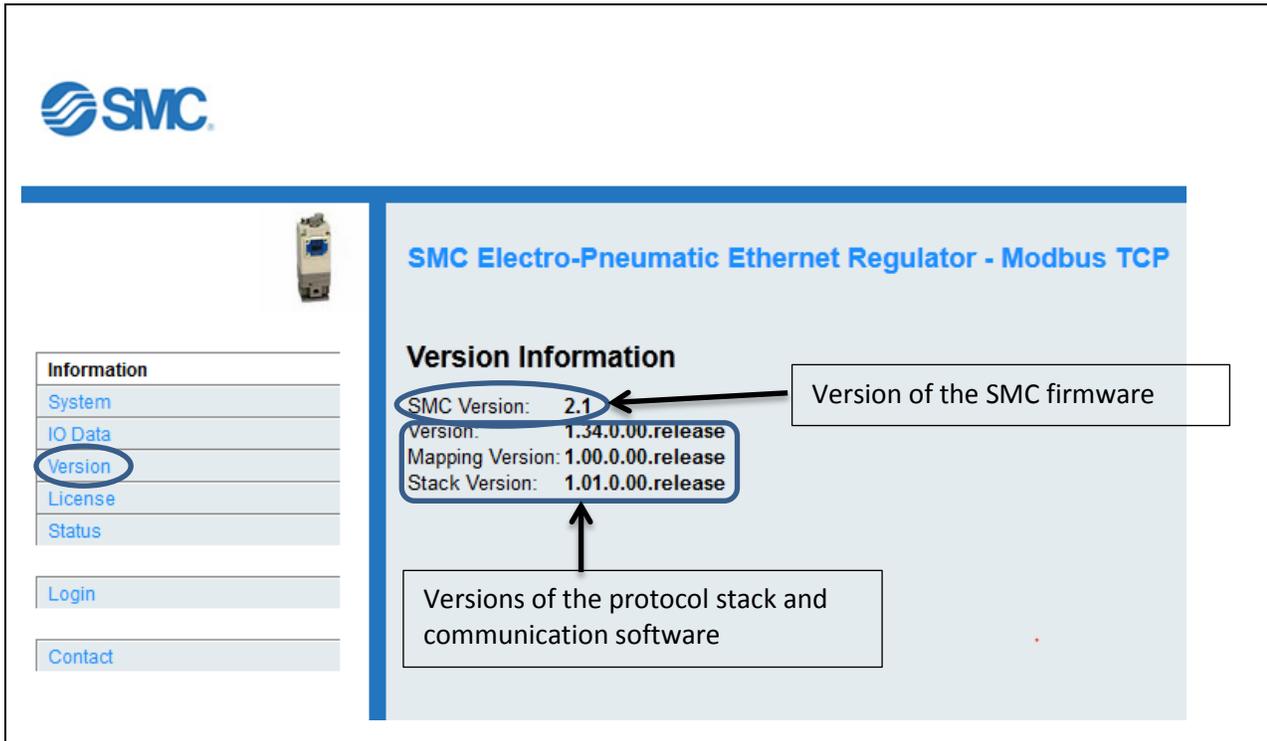


Figure 29 - ITV Version web page

This information is displayed *even if the user is not logged in*. Please make note of this information if contacting SMC for technical support.

## 12.4. ITV Status Page

Press “Status” to see the current ITV pressure or vacuum value, pressure units, and status of LEDs.

Note: The “ITV Status” page displays the current ITV pressure or vacuum value based on the indicated pressure units. The page automatically translates count values into the current pressure displayed.

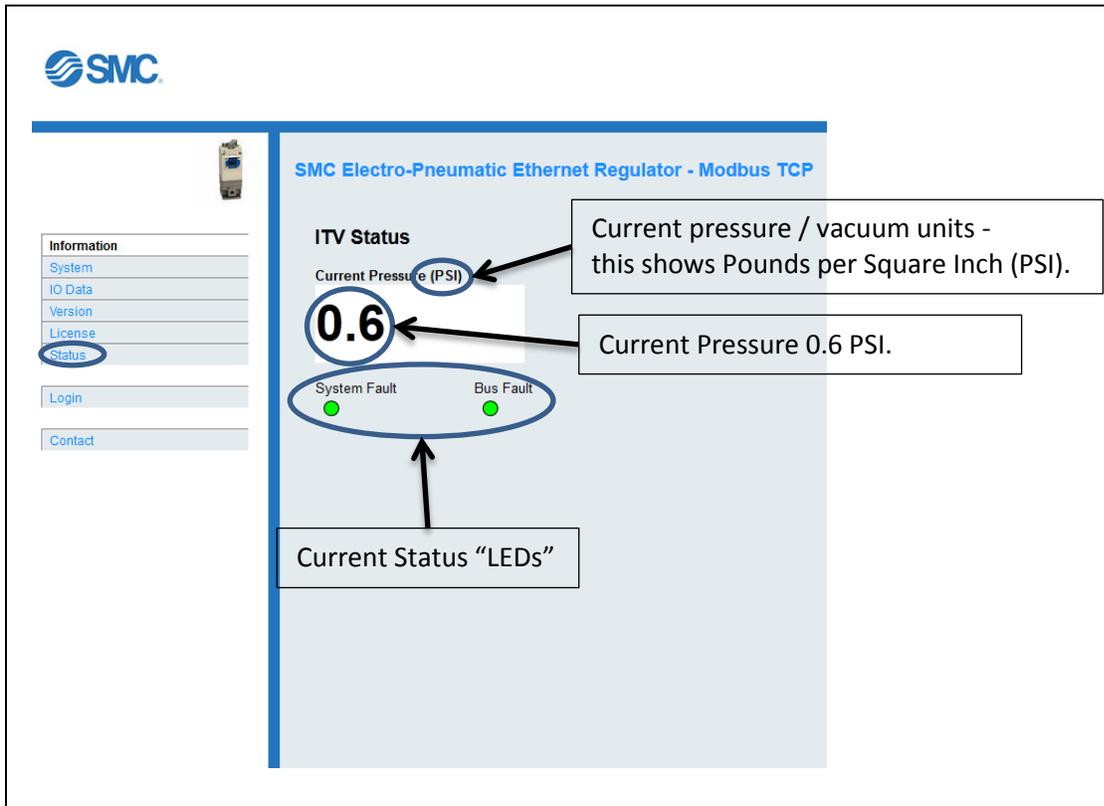


Figure 30 - ITV Status web page

Note: the LEDs **MAY NOT** reflect the actual current state of the ITV. There is a potential delay between the occurrence of an event (alarm condition or status) and the screen refresh rate. Also, if for any reason communication between the ITV and the web browser is disrupted, the display will indicate the last state of the ITV **BEFORE** communication was lost. The LEDs on the front of the ITV **DO** reflect the current state of the ITV (see [LED Indication and Settings \(Section 11\)](#)).

## 12.5. Login Page

Press “Login” and enter “user” as both the Username and the Password.

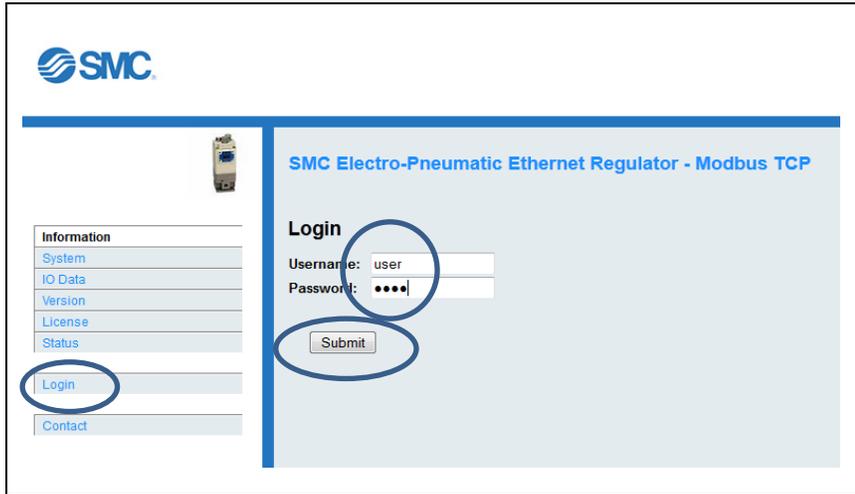


Figure 31 - ITV User Login

Login with user privileges allows the user to control the ITV.

This is a successful User (configuration) login.

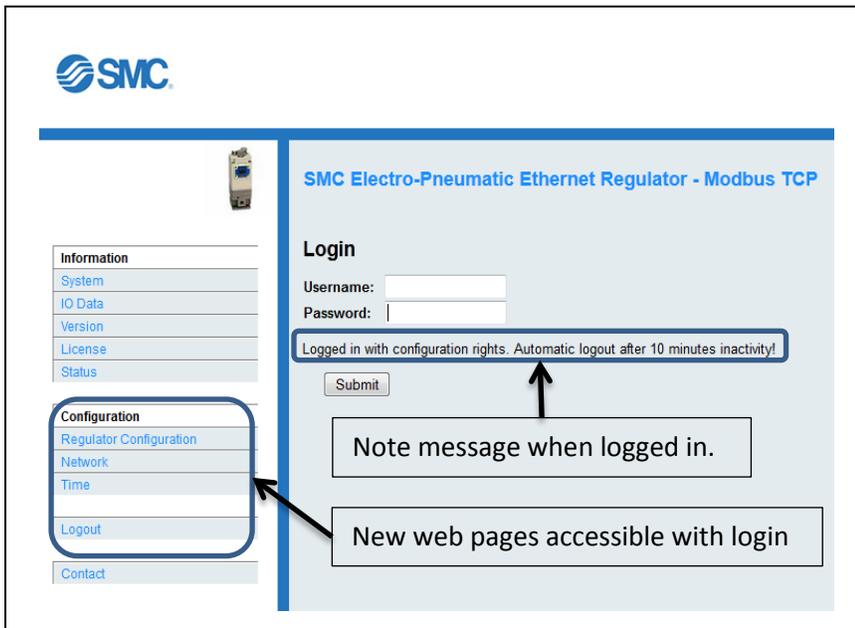


Figure 32 - ITV - Successful User Login

## 12.6. Contact Page

Press “Contact” to find the telephone numbers and email addresses for SMC Product Sales and Technical Support.

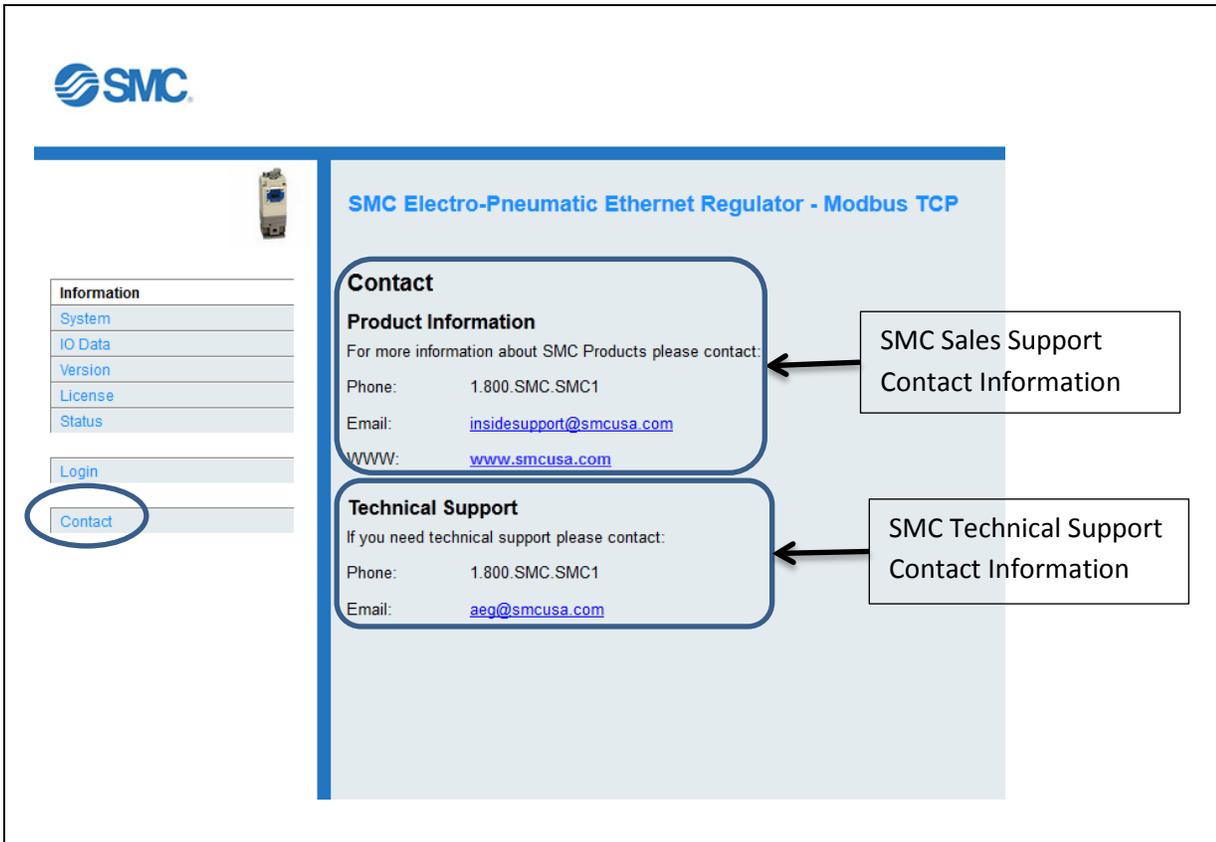


Figure 33 - ITV Support Contact Information Page

The “**Product Information**” contacts will connect you to the SMC sales team. Sales can help you order accessories for your ITV and other SMC products to support your application. Sales can also help you obtain documentation for your ITV.

The “**Technical Support**” contacts will connect you to the SMC technical support team. Tech support can help you resolve technical questions or problems with the operation and use of your ITV. Tech support can also help you deal with questions related to the initial setup of your ITV. (Also see [Web Page Access \(Section 9\)](#) for initial setup instructions.)

If you need to contact SMC, the contact information above is:

### Sales Support:

Phone: 1-800-SMC-SMC1 (1-800-762-7621)  
Email: [insidesupport@smcusa.com](mailto:insidesupport@smcusa.com)  
Webpage: [www.smcusa.com](http://www.smcusa.com)

### Technical Support:

Phone: 1-800-SMC-SMC1 (1-800-762-7621)  
Email: [aeg@smcusa.com](mailto:aeg@smcusa.com)

### 13. Web Pages Requiring Login

The following web pages are only accessible after a user has logged in to the ITV. Upon logout, these pages will no longer be accessible.

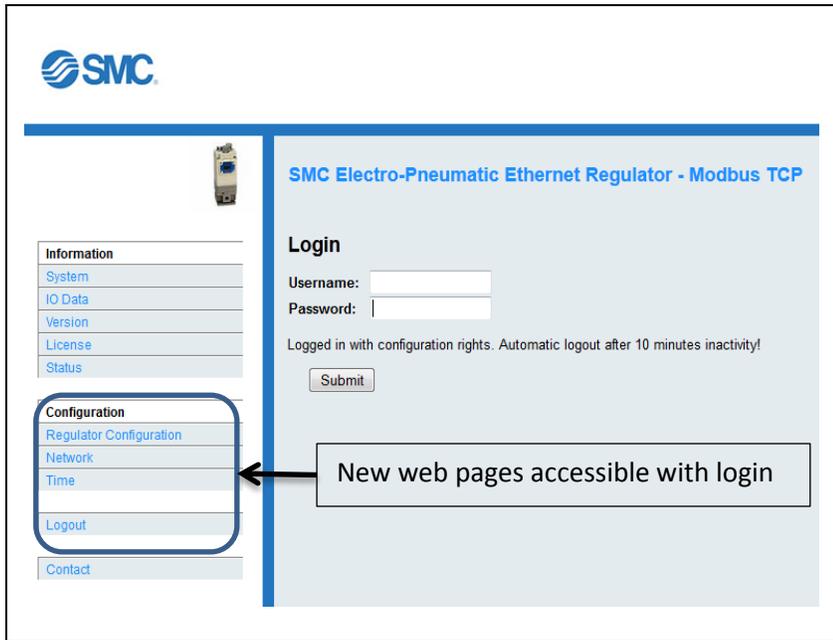


Figure 34 – Accessible Web Pages After Login

### 13.1. Regulator Configuration Page

Below is a view of the “Regulator Configuration” page.

The top of the page (“ITV Status” window) displays the current ITV pressure value and LED status indicators (the same as the [ITV Status Page \(Section 12.4\)](#)).

The bottom of the page (“ITV Configuration” window) allows the user to Override PLC Control, change pressure and change pressure units.

When the web page is initially launched, the set pressure value will match the current pressure value.

Note: The page automatically translates count values into the current pressure displayed.

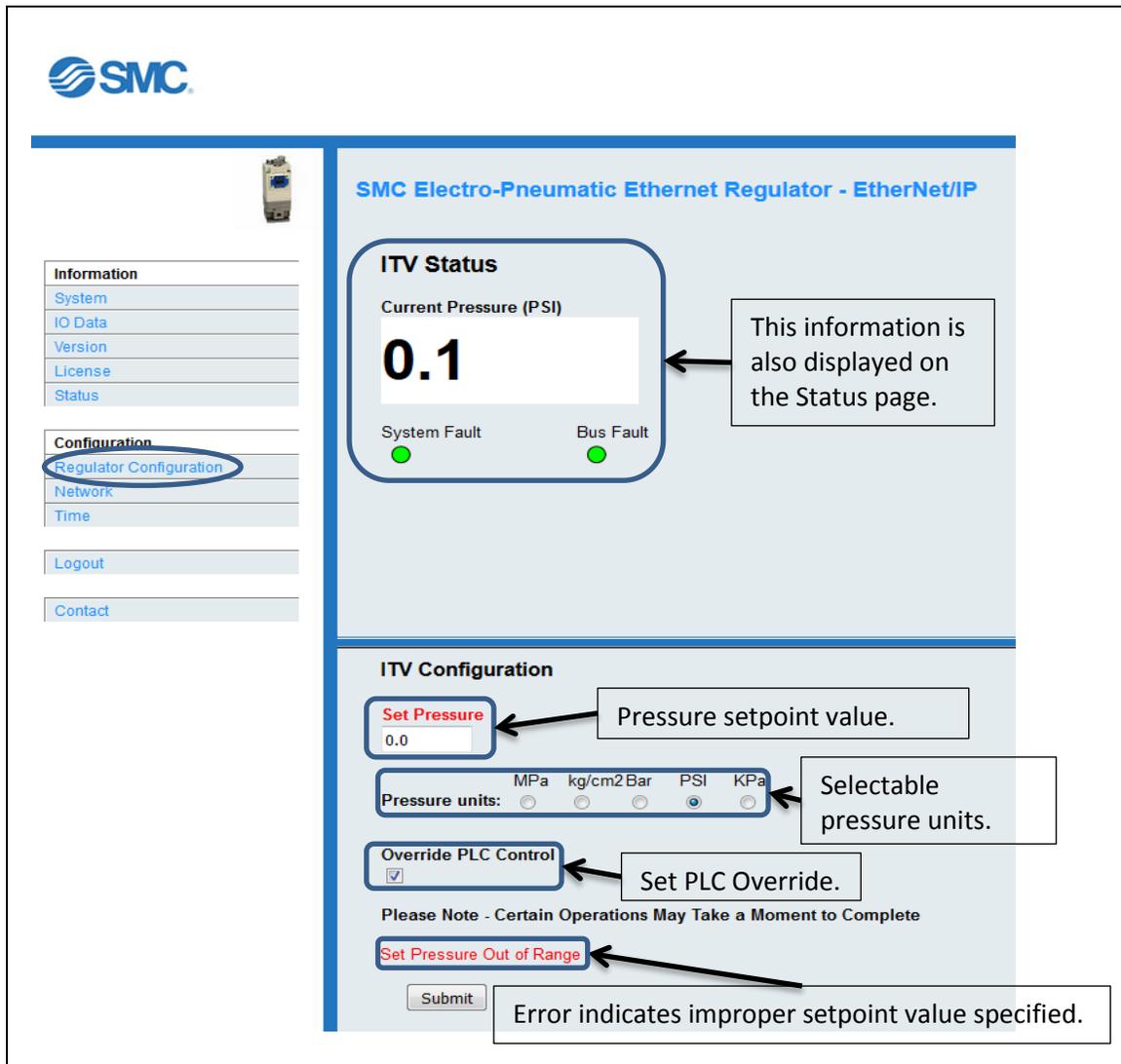


Figure 35 - ITV Regulator Configuration Page

The “ITV Configuration” window has the following user selectable controls:

1. **Override PLC Control:** This is a checkbox. If the box is clear (unchecked), the ITV is controlled externally (typically from a PLC). When the ITV is externally controlled, the user cannot set the ITV pressure or change the pressure units from the web page.

When the Override PLC Control checkbox is changed, press “**Submit**” or the keyboard **Enter** key for the change to take effect.

Changing ITV control from the master to the web page (checking the Override PLC Control checkbox) gives the user control of the ITV. There is **no pressure change** until the user enters a pressure setpoint in the Set Pressure window.

Changing ITV control from the web page to the master (clearing the Override PLC Control checkbox) gives the master device control of the ITV. There may be an **immediate pressure change** to the pressure setpoint sent from the master device.

**Note: Be sure that ITV controlled equipment is in a SAFE STATE when you change Override PLC Control. There may be an IMMEDIATE change in regulated pressure when control is returned to the master device. This pressure change may cause IMMEDIATE AND UNEXPECTED changes in the behavior of controlled equipment.**

**Note: Override PLC Control will remain in the same state when you exit this page.**

2. **Pressure Units:** This is a set of radio buttons indicating the current pressure unit. When Override PLC is set, the user can change the pressure unit.

When Pressure Units is changed, press “**Submit**” or the keyboard **Enter** key for the change to take effect.

The pressure value displayed in the “ITV Status” window and in the “Set Pressure” box will change to match the new Pressure Unit selection. **No pressure change will occur.**

3. **Set Pressure:** This is a data entry box in the ITV “Configuration” window. When Override PLC Control is set, the user can enter any legitimate setpoint value.

When the value of Set Pressure is changed, press “**Submit**” or the keyboard **Enter** key for the change to take effect.

If the setpoint value entered is legitimate, the ITV will regulate to this new pressure or vacuum value. (The pressure displayed in the “ITV Status” window will change to the new value.)

If the value is out of range, the ITV pressure will not change. The setpoint will change back to the previous value and the “Current Pressure” value will not change. The title of “**Set Pressure**” will be displayed in **RED**, and the error message “**Set Pressure Out of Range**” will also be displayed in **RED** immediately above the Submit button. [Figure 35 - ITV Regulator Configuration Page](#) shows an example.

Note: To change **BOTH pressure units AND the setpoint value**, pressure units **MUST** be changed first.

## Warning

**BEFORE** changing the pressure used by the ITV, verify that all equipment affected is in a **safe state**. Be **sure** that **ALL PERSONNEL** are clear of **ALL EQUIPMENT** that may be affected by the pressure change. **Unexpected changes in equipment motion or behavior can result in injury or death.**

When Override PLC is enabled (checked), entering a valid value into the “Set Pressure” field and pressing “**Submit**” or the keyboard **Enter** key will cause the ITV to change pressure. This will result in an **IMMEDIATE CHANGE** in regulated pressure. This change may cause an **immediate unexpected change in the behavior of equipment controlled by the ITV. This change could cause injury or death.**

When Override PLC is changed to the disabled state (cleared), control will return to the master device (typically a PLC). The current pressure will change to the setpoint value sent by the master device. This will result in an **IMMEDIATE CHANGE** in regulated pressure. This change may cause an **immediate unexpected change in the behavior of equipment controlled by the ITV. This change could cause injury or death.**

## 13.2. Network Page

Press “Network” to view or change various network and operating parameters.

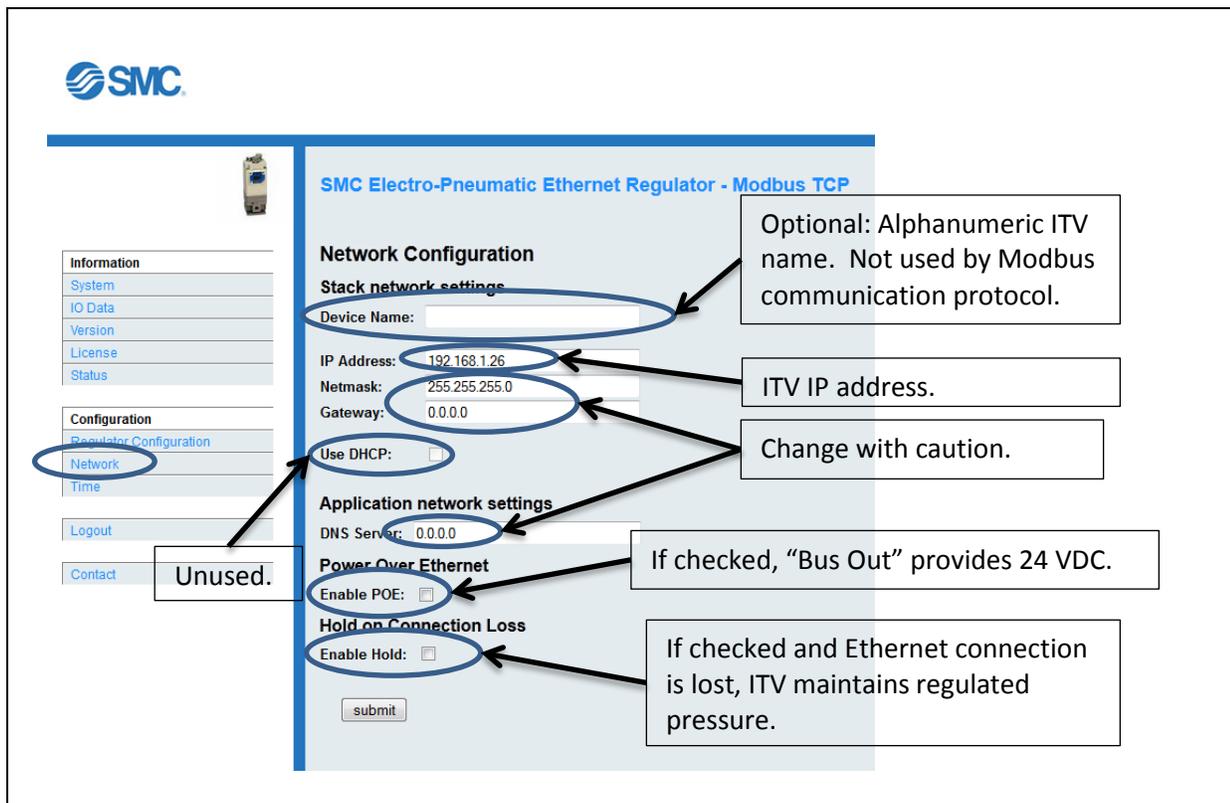


Figure 36 - Network Configuration

The following sections describe the items that can be changed on the “Network Configuration” page. Multiple items can be changed at a time. When one or more items are changed, press “**Submit**” or the keyboard **Enter** key for the change to take effect.

Note for some changes to take effect, an ITV power cycle is required. **A power cycle will result in temporary loss of ITV control. A power cycle will also result in temporary loss of communication to all downstream devices connected to the ITV. This may result in a loss of the regulated air pressure or vacuum control and could result in unexpected dangerous behavior of controlled devices.**

### 13.2.1. Device Name

Device Name is optional. It may be left blank since it is not used by the Modbus TCP protocol.

When Device Name is changed, press “**Submit**” or the keyboard **Enter** key and then power cycle the ITV to set the name. (Note: Pressure or vacuum control will be interrupted during a power cycle.)

### 13.2.2. IP Address

IP Address is used to communicate with the ITV. It **MUST** be unique on a network or subnet.

Note: Use the **SAME** Subnet for **ALL** ITVs for proper communication.

If you change the IP address, it is ***STRONGLY RECOMMENDED*** that you record the new IP address **before** you press “**Submit**” or the keyboard **Enter** key.

A new IP Address will take effect in the ITV **immediately** when you press “**Submit**” or the keyboard **Enter** key. Control of the ITV and communication between the ITV and the PC (or master device) will be lost. To reconnect the PC to the ITV web page, see [Configuring the PC \(Section 9.2\)](#) and [Connecting to the ITV Web Page \(Section 9.3\)](#). Also note, the ITV IP address used in the master device (typically a PLC) must match the new ITV IP address.

### **13.2.3. Netmask**

It is recommended that Netmask be left at the default value (255.255.255.0). Improperly configuring the Netmask can cause problems communicating with the ITV. The capability to communicate with the ITV may be lost. The ITV will need to be returned to SMC for repair.

### **13.2.4. Gateway Server**

If the ITV is not connected to a Gateway Server, the Gateway Server should be left as 0.0.0.0. If another address is specified, the ITV will attempt to use the indicated Gateway Server to manage network communication. If no Gateway Server is present at the specified address, the capability to communicate with the ITV may be lost. The ITV will need to be returned to SMC for repair.

### **13.2.5. DHCP**

**Use of DHCP** is **NOT** supported on Modbus ITVs. The DHCP checkbox is greyed out and is not accessible.

### **13.2.6. DNS Server**

If the ITV is not connected to a DNS Server (Domain Name System Server), the DNS Server should be left as 0.0.0.0. If another address is specified, the ITV will attempt to use the indicated DNS Server to manage network communication. If no DNS Server is present at the specified address, the capability to communicate with the ITV may be lost. The ITV will need to be returned to SMC for repair.

### **13.2.7. Enable POE**

The “**Enable POE**” checkbox is used to control Power Over Ethernet. When the checkbox is set (checked), POE is enabled. When the checkbox is cleared (unchecked), POE is disabled.

Follow the instructions in [Power Over Ethernet \(POE\) \(Section 10\)](#). If the instructions are not properly followed, changing the state of POE may result in undesired performance, abnormal equipment operation, or product damage.

When the POE checkbox is changed, press “**Submit**” or the keyboard **Enter** key and then power cycle the ITV to set the POE state. (Note: Pressure or vacuum control will be interrupted during a power cycle.)

### **13.2.8. Hold on Connection Loss**

The “**Enable Hold**” checkbox is used to control ITV behavior in the event Ethernet communication is lost.

If Ethernet communication is lost with “**Enable Hold**” checked and the ITV is powered, the ITV will continue to regulate to the pressure setpoint.

If Ethernet communication is lost with “**Enable Hold**” unchecked and the ITV is powered, the ITV will set the pressure setpoint to 0, the output pressure will be immediately exhausted, and the pressure will quickly drop to 0.

If **power is lost**, the ITV will stop regulating to the setpoint.

To change the state of “**Hold on Connection Loss**”, change the state of the “**Enable Hold**” checkbox, press “**Submit**” or the keyboard **Enter** key and then power cycle the ITV. (Note: Pressure or vacuum control will be interrupted during a power cycle.)

### **Warning**

***Several setting changes in this section require an ITV power cycle. Only power cycle an ITV when all devices and equipment controlled by the ITV and all devices receiving communication through the ITV are in a verified safe state. Verify that all personnel are clear of all equipment which may be affected by power cycling an ITV.***

When an ITV is power cycled, communication to and control of the ITV is lost. When an ITV is power cycled, communication to and control of **ALL** devices downstream of the ITV is lost. Air pressure or vacuum regulation by the ITV is lost during a Power Cycle.

Loss of communication to and control of the ITV or downstream devices or loss of ITV air pressure or vacuum regulation could cause an **immediate unexpected change in the behavior of equipment controlled by the ITV or the downstream devices. This change could cause injury or death.**

### 13.3. Time Page

Press “Time” to set date and time.

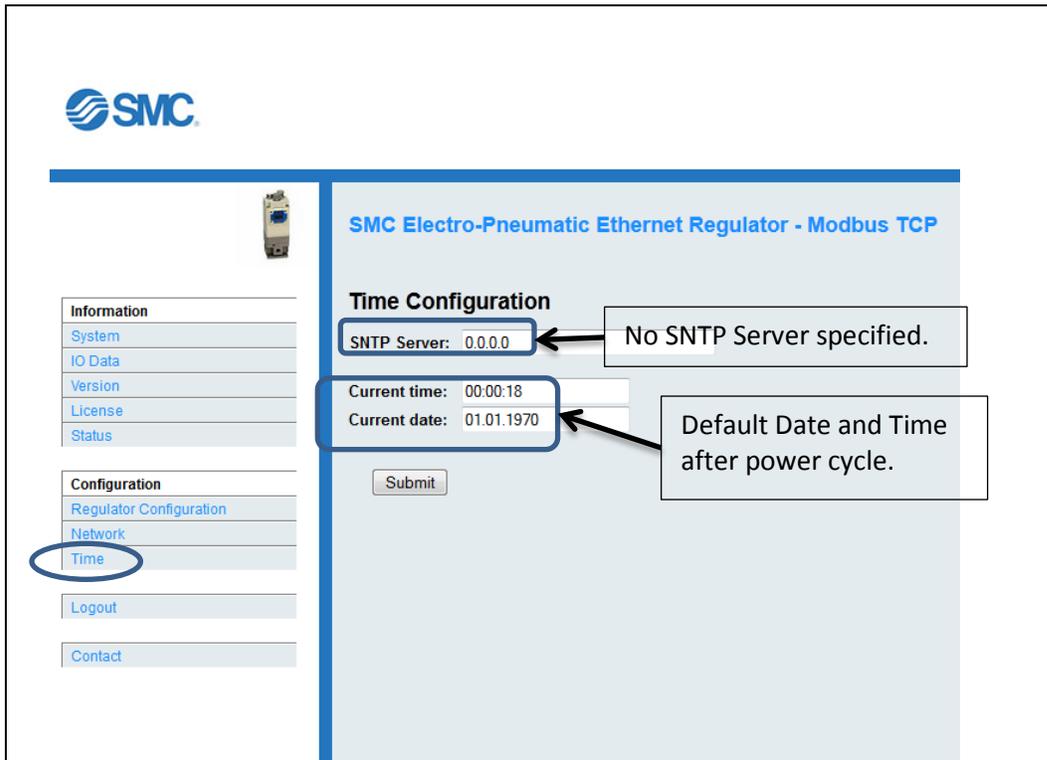


Figure 37 - ITV Time Page

Connection to a SNTP (Simple Network Time Protocol) Server is optional. The SNTP Server can communicate the date and time over the Ethernet connection to the ITV.

Setting date and time is **not** required for normal ITV operation. If the date or time is changed, press “**Submit**” or the keyboard **Enter** key for the change to take effect.

Current time is entered as **hh:mm:ss** in 24-hour format. (To enter 8:30:25 PM, enter 20:30:25). Current date is entered as **dd.mm.yyyy**. (To enter November 23, 2015, enter 23.11.2015).

Note: the current date and time are reset each time the ITV is power cycled. The default date and time at restart are 01.01.1970 at 00:00:00 (January 1, 1970 at 12:00:00 Midnight).

### 13.4. Logout Page

Press “Logout” to log out of the Configuration web pages. Note: The ITV will **automatically** log out **after 10 minutes** of web page inactivity.

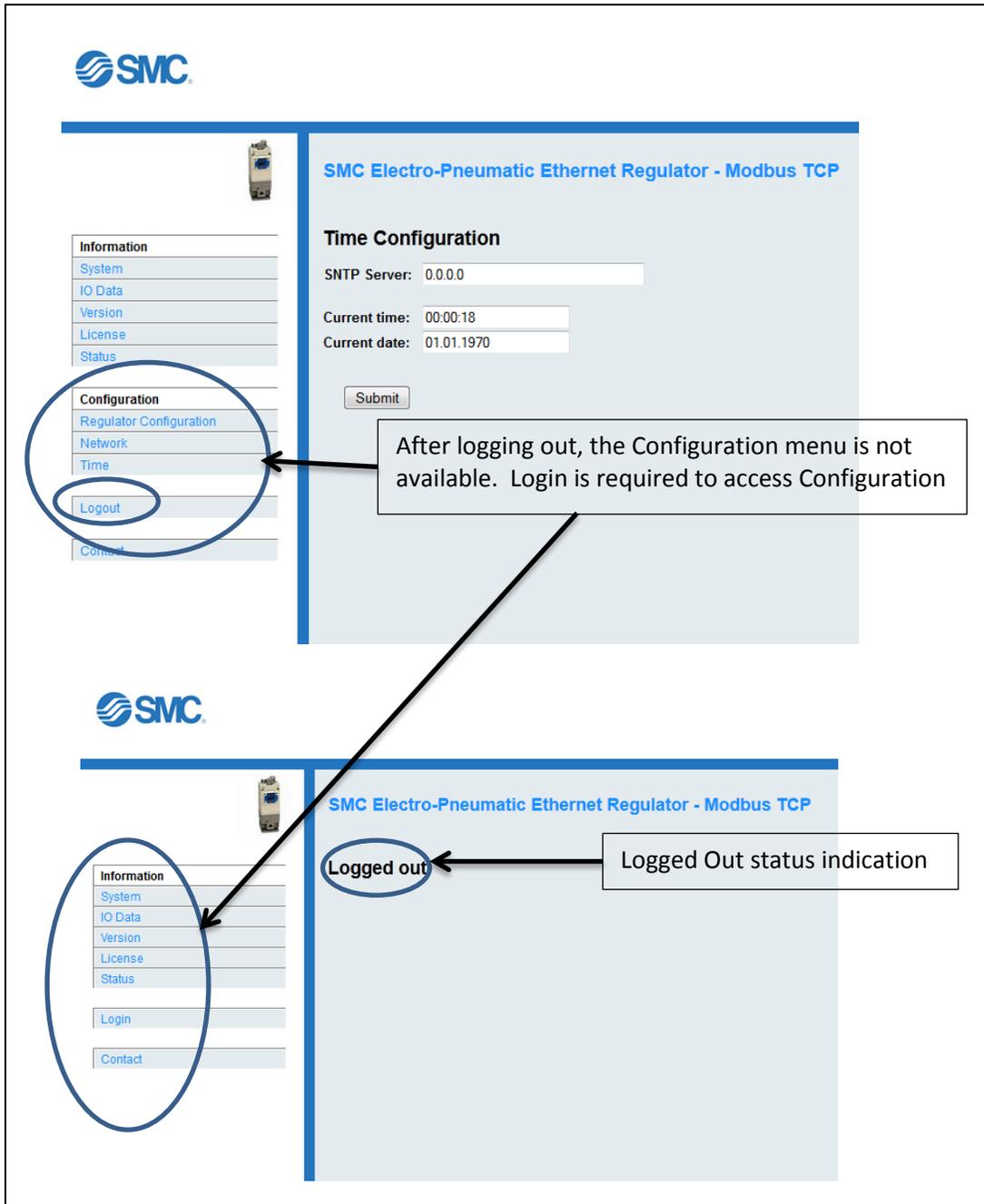


Figure 38 - ITV Logout Procedure

## 14. Counts and Pressure Units

See an introduction to the ITV **Setpoint** in [Quick Start \(Section 7\)](#).

Counts are used to control the ITV pressure. The master device must send counts to the ITV for the desired pressure. The ITV reports the current pressure value back to the master device in counts.

The count range is 0 to 4095 (12 bits). The count range is the same for all ITVs. The maximum pressure or vacuum corresponds to 4095 counts. For example, a X010 ITV body size has a pressure range from 0 to 0.1 MPa. The maximum pressure would correspond to 4095 counts.

The ITV web pages ([ITV Status Page \(Section 12.4\)](#) and [Regulator Configuration Page \(Section 13.1\)](#)) display pressure values. The pages automatically convert pressure values to counts.

### 14.1. Count Value Sent TO ITV

Count values sent to the ITV are 16-bit values. The upper 4 bits must be 0. The lower 12 bits represent the count value. If a value greater than 4095 counts is sent to the ITV, the ITV will ignore the value (it is out of range) and will not change its current pressure or vacuum setpoint.

Counts sent to the ITV for a desired pressure or vacuum output must be scaled. Note: The count value sent between the master and the ITV is an integer value. **Round the calculated count value to an integer** if necessary.

The “Maximum Pressure Scaling Formula” for converting pressure to counts is:

$$\text{Counts} = \left( \frac{\text{desired pressure}}{\text{maximum pressure}} \right) \times 4095$$

The following table shows the **maximum pressure (or minimum vacuum)** values supported by the various ITV body types. These limits are determined by the hardware used to build the ITV and cannot be changed.

Pressure	MPa	kg/cm2	Bar	PSI	KPa
X010	0.1	1.02	1.0	14.504	100.0
X030	0.5	5.10	5.0	72.52	500.0
X050	0.9	9.18	9.0	130.536	900.0
2090 (Vacuum)	-0.08	-0.82	-0.8	-11.6032	-80.0

Figure 39 - ITV Body Type and Maximum Pressure

For example: The desired output pressure is 0.05 MPa for a X010 ITV. From the table, the maximum pressure for this ITV body type is 0.1 MPa. Use the “Maximum Pressure Scaling Formula” to obtain the count value.

$$\text{Counts} = \left( \frac{0.05}{0.1} \right) \times 4095 = 2047.5 \cong 2048 = 0x0800$$

Note: Counts are passed in hexadecimal form (0x0800) between the ITV and the master.

Counts can also be determined by using the “Scale Factor Table Formula”:

$$\mathbf{Counts = desired\ pressure \times scale\ factor}$$

The following table shows the scale factors for the ITV body types and pressure units.

Pressure \ Body Type	MPa	kg/cm2	Bar	PSI	KPa
X010	40950.0	4014.70	4095.0	282.33	40.95
X030	8190.0	802.94	819.0	56.46	8.19
X050	4550.0	446.07	455.0	31.37	4.55
2090 (Vacuum)	-51187.5	-4993.90	-5118.75	-352.92	-51.18

**Figure 40 - ITV Scale Factors**

For example: The desired output pressure is 10 PSI for an X030 ITV. From the table, the scale factor for this body type is 56.46. Use the “Scale Factor” formula to obtain the count value.

$$\mathbf{Counts = 10 \times 56.46 = 564.6 \cong 565 = 0x0235}$$

The calculated count value must be rounded if necessary and converted to hexadecimal.

#### 14.2. Count Value Received FROM ITV

Count values received from the ITV are 16-bit values. The upper 4 bits are 0. The lower 12 bits represent the count value. Count values received from the ITV by the master indicate the current pressure output of the ITV. The count values can be converted to pressure units using the following formulas:

“Maximum Pressure Scaling Formula” (using [Figure 39 - ITV Body Type and Maximum Pressure](#)):

$$\mathbf{Reported\ Pressure = \left( \frac{counts \times maximum\ pressure}{4095} \right)}$$

“Scale Factor Table Formula” (using [Figure 40 - ITV Scale Factors](#)):

$$\mathbf{Reported\ Pressure = \frac{counts}{scale\ factor}}$$

## 15. ITV Modbus Communications Setup

The general Modbus communications requirements for controlling an ITV with a master device (typically a PLC) are described in this section. Note that all communication is initiated by the master device.

### 15.1. Supported Modbus Registers

The ITV operates only in RTU (binary) register mode. As a result, only a subset of the Modbus registers is used for communication between a master device (PLC) and an ITV.

1. Input registers – 16-bit input data (read only)
2. Holding registers – 16-bit I/O data (write only).

The meaning of the registers used for Modbus communication is shown below.

**A single Holding Register** is used to send the setpoint to the ITV.

**Two consecutive Input Registers** are used to retrieve the current pressure and status flags from the ITV.

The address values (register numbers) for each register type are shown below. Do not use a different register number for the ITV commands.

1. Holding Registers

Register	Process Data	Contents
0x0000	Output data	Setpoint from Master to ITV

2. Input Registers

Register Range	Process Data	Contents
0x0000 – 0x0001	Input data	Status data from ITV to Master

### 15.2. Supported Modbus Function Codes

The Modbus protocol uses function codes to specify the meaning of messages between Master and Slave devices. The ITV only uses a small subset of the available Modbus function codes to communicate with its master device (generally a PLC).

Function Code Name	Function Code
Write Single Holding Register	0x06
Read Input Registers	0x04

**Write Single Holding Register** (Function Code 0x06) is used by the master to send the pressure setpoint value **TO** the ITV.

**Read Input Register** (Function Code 0x04) is used by the master to read data values **FROM** the ITV. Two 16-bit data values are read by the master from the ITV: current pressure and status flags.

### 15.3. Send Setpoint to ITV

- **Request (from Master to ITV)**

Register type: Holding Register; Write Single Register (0x06)

This table contains the specific information to send a setpoint request to the ITV.

Function Code	1 byte	0x06
Holding Register number <sup>1</sup>	2 bytes	0x0000
Register value <sup>2</sup>	2 bytes	0x0000 to 0x0fff

1: The ITV uses Register 0 for the pressure setpoint (see [Supported Modbus Registers \(Section 15.1\)](#)).

2: Register value = Count setpoint value (0 – 4095) (see [Counts and Pressure Units \(Section 14\)](#)).

- **Response (From ITV to Master)**

When a request is sent from the master to the ITV, the ITV will respond with either message received or with an error.

- **Normal Response (Message Received)**

The **normal** response echoes the request back to the master.

Function Code	1 byte	0x06
Holding Register number <sup>3</sup>	2 bytes	0x0000
Register value <sup>4</sup>	2 bytes	0x0000 – 0x0fff

3: The holding register is the **same** value sent in the request

4: Register value is the **same** value sent in the request

- **Communications Exception Response (Message Error)**

A **message error** response indicates that there was a communication error and the ITV did not act upon the request.

Error Function Code	1 byte	0x86 - error
Exception Code	1 bytes	0x01 - 0x04 <sup>5</sup>

5: Exception Code Meaning:

0x01 – Unsupported Function Code sent

0x02 – Invalid Register Address (see [Supported Modbus Registers \(Section 15.1\)](#))

0x03 – Invalid Register Value (outside 0x0000 ≤ value ≤ 0xffff)

0x04 – Write Single Register failed.

## 15.4. Read Status from ITV

- **Request (from Master to ITV)**

Register type: Input Registers; Read Input Registers (0x04). The ITV uses 2 **consecutive** registers.

This table contains the specific information to send a read status request to the ITV.

Function Code	1 byte	0x04
Starting Input Register number <sup>1</sup>	2 bytes	0x0000
Quantity of input registers <sup>2</sup>	2 bytes	0x0002

1: The ITV uses Registers 0 and 1 for status requests from the master (see [Supported Modbus Registers \(Section 15.1\)](#)).

2: Two consecutive registers are required for this action.

- **Response (From ITV to Master)**

When a request is sent from the master to the ITV, the ITV will respond with the requested data or an error message.

- **Normal Response (From ITV to Master)**

A **normal** response message is 6 bytes.

Function Code	1 byte	0x04
Byte count	1 byte	0x04 <sup>3</sup>
Input registers <sup>4</sup>	4 bytes (2 bytes current pressure; 2 bytes status flags)	

3: Number of data bytes returned to master. 4 bytes indicates that the 2 consecutive registers in the request hold the data returned.

4: First input register is scaled current pressure in counts (0 – 4095) (see [Counts and Pressure Units \(Section 14\)](#)); second register is status flags (see [Status Flags \(Section 12.2.1\)](#)).

- **Communication Exception Response (From ITV to Master)**

A **message error** response indicates that there was a communication error and the ITV does not return any ITV status information.

Error Function Code	1 byte	0x84 - error
Exception Code	1 byte	0x01 - 0x04 <sup>5</sup>

5: Exception Code Meaning:

0x01 – Unsupported Function Code sent

0x02 – Invalid Starting Register Address (see [Supported Modbus Registers \(Section 15.1\)](#)) or Starting Register Address + Register Count Invalid

0x03 – Invalid Register Count (outside  $0x0001 \leq \text{Register Count} \leq 0x007d$ )

0x04 – Read Input Registers failed.

## 15.5. Message Sequence

To start controlling the ITV from a master device (typically a PLC), first send out a setpoint (see [Send Setpoint to ITV \(Section 15.3\)](#)).

If the setpoint is a valid value, the ITV will begin to regulate to this value.

The master can then send a request for ITV status. The ITV will return the current pressure and status flags to the master (see [Read Status from ITV \(Section 15.4\)](#)) Note: The ITV will return the **current** pressure value. If a request for status is sent immediately following a requested pressure change, the ITV may not yet be at the requested pressure.

The master device can send setpoint or status requests in any order whenever desired. The ITV does not require periodic requests from the master.

## 16. Modbus Examples

### 16.1. Wago PLC

This is an example of a Wago 750-880 PLC program used to control an ITV using Modbus. Unless your PLC is a Wago 750-880, the specific program as written here may not work on your PLC. The purpose of the example is to illustrate the items which **must** be present in your PLC program.

The Wago PLC uses a combination of Function Blocks (FB) and variable declarations for its main program. The screenshots illustrate the variable declarations and the function blocks. Note the function blocks are implemented using the traditional ladder logic approach, but they do not specify the individual actions which may be specified using traditional ladder logic.

```
0001 PROGRAM PLC_PRG
0002 VAR
0003     B0 AT %MB0: BYTE := 1;
0004     B1 AT %MB1: BYTE := 2;
0005     B2 AT %MB2: BYTE := 1;
0006     B3 AT %MB3: BYTE := 2;
0007
0008     OutDataINT AT %MW1: INT;
0009     OutDataCal: INT;
0010     SetPressure: REAL;
0011     (* W1 WORD: *)
0012
0013     FB1: ETHERNET_MODBUSMASTER_TCP;
0014     PortNum: WORD := 502;
0015     Node2ID: STRING := '192.168.1.26';
0016     FunctionCode: BYTE := 6;
0017     FunctionCodeR: BYTE := 4;
0018     StartReadAddr: WORD := 0;
0019     RegsToRead: WORD := 2;
0020     StartWriteAddr: WORD := 0;
0021     RegsToWrite: WORD := 1;
0022     InData: ARRAY [1..128] OF WORD;
0023     OutData: ARRAY [1..128] OF WORD;
0024     Start: BOOL := TRUE;
0025     Start2: BOOL := TRUE;
0026     Reset: BOOL;
0027     ready: BOOL := FALSE;
0028     T1: TON;
0029     Refresh: TIME := T#500ms;
0030     ErrCode: WORD;
0031
0032
0033     SW1: BOOL := TRUE;
0034     ID: BYTE;
0035     Send: BOOL := TRUE;
0036     CalData: REAL;
0037     FB2: ETHERNET_MODBUSMASTER_TCP;
0038     CalDataINT AT %MW0: INT;
0039     CalDataSW: INT;
0040
0041
0042 END_VAR
0043
```

The diagram shows a screenshot of a Wago PLC program with several variables highlighted in yellow. Callouts with arrows point from these variables to descriptive text boxes on the right:

- PortNum: WORD := 502;** points to "Modbus Port (502)".
- Node2ID: STRING := '192.168.1.26';** points to "ITV IP Address".
- FunctionCode: BYTE := 6;** points to "Write Single Holding Register (FC 6)".
- FunctionCodeR: BYTE := 4;** points to "Read Input Registers (FC 4)".
- RegsToRead: WORD := 2;** points to "Read Register 0 & Register Count (2)".
- RegsToWrite: WORD := 1;** points to "Write Register 0 & Register Count (1)".
- InData: ARRAY [1..128] OF WORD;** and **OutData: ARRAY [1..128] OF WORD;** point to "Input & Output data buffers".
- T1: TON;** and **Refresh: TIME := T#500ms;** point to "Timers and Ladder Logic Repeat Time."

Figure 41 - Example Wago PLC Variables Section

The highlighted variables above, especially the IP address, function codes, register counts, and buffers are key components of any Wago Modbus program. The refresh rate above is an example. You will need to set an appropriate rate. Note that Modbus starts addressing registers at 0.

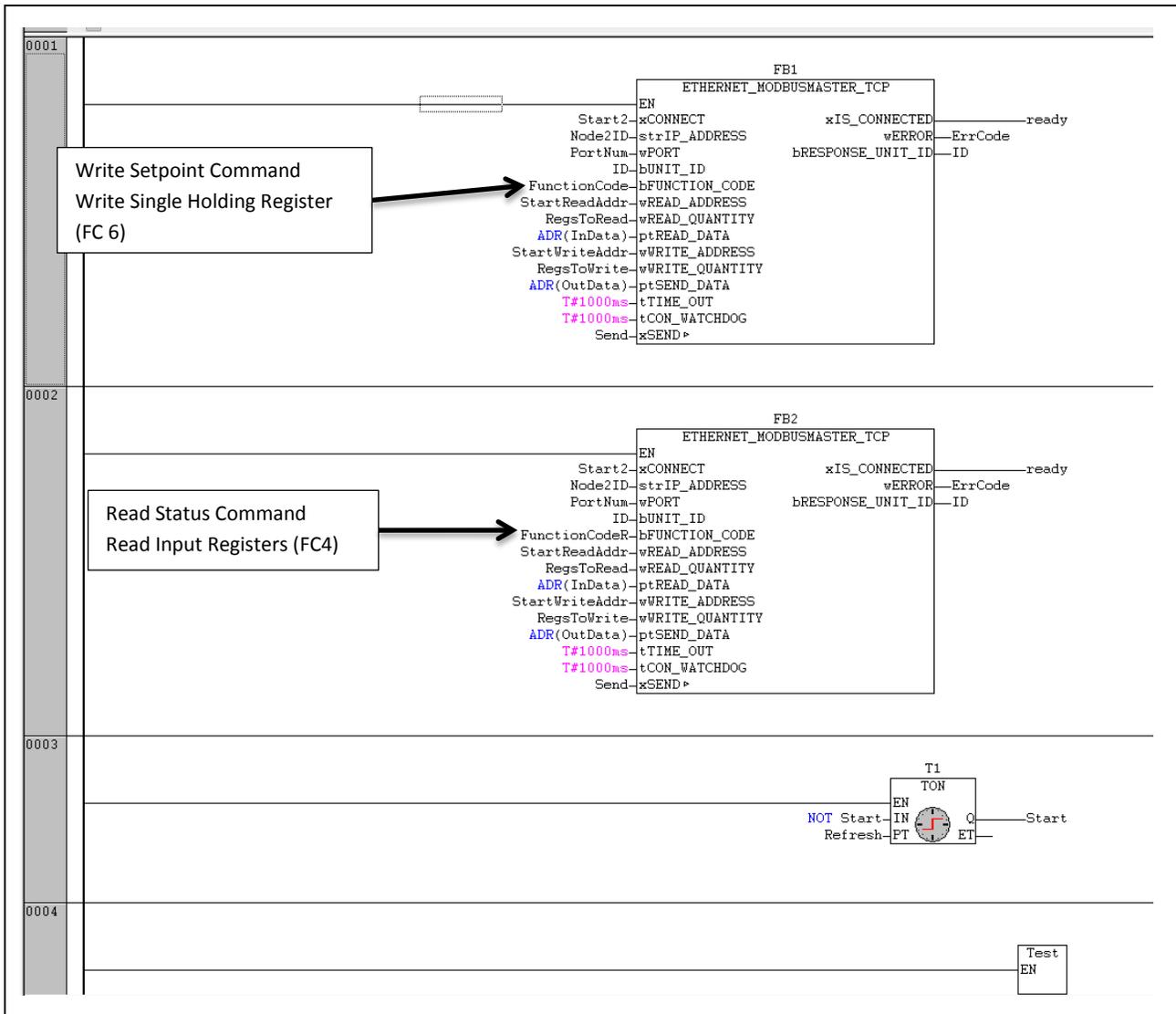


Figure 42 - Example Wago PLC Function Block Ladder Logic

Note that sending the setpoint to the ITV and reading the status from the ITV are separate rungs of the ladder. The operation is determined by the function code specified for the function block.

```

0001 IF T1.Q THEN
0002 Send := TRUE;
0003 END_IF
0004
0005 (* Output == Set Point TO ITV *)
0006 (* Input == Pressure FROM ITV *)
0007
0008 CalDataINT := InData[1];
0009
0010 (* All pressure/vacuum values in PSI on a 500 KPa ITV *)
0011
0012 CalDataSW := CalDataINT;
0013
0014 (*Calculate PSI In and Out*)
0015 (* use 282.4 for 100 KPa unit, 56.5 for 500 KPa, 31.4 for 900 KPa, -352.9 for Vacuum *)
0016
0017 CalData := CalDataSW /56.5;
0018 OutDataInt := REAL_TO_INT(SetPressure * 56.5);
0019
0020 OutData[1] := OutDataInt;
0021

```

**Figure 43 - Example Wago PLC Pressure Scaling Routine**

This is an example of the routine used to scale the user specified pressure (here in PSI) to counts for transmission to the ITV. See [Counts and Pressure Units \(Section 14\)](#) for more details.

## 16.2. LabVIEW

It is possible to control the ITV with a LabVIEW program.

The following is a simple example of a LabVIEW front panel and its associated block diagram. The program can send a pressure or vacuum setpoint value to the ITV and will read the ITV pressure and status.

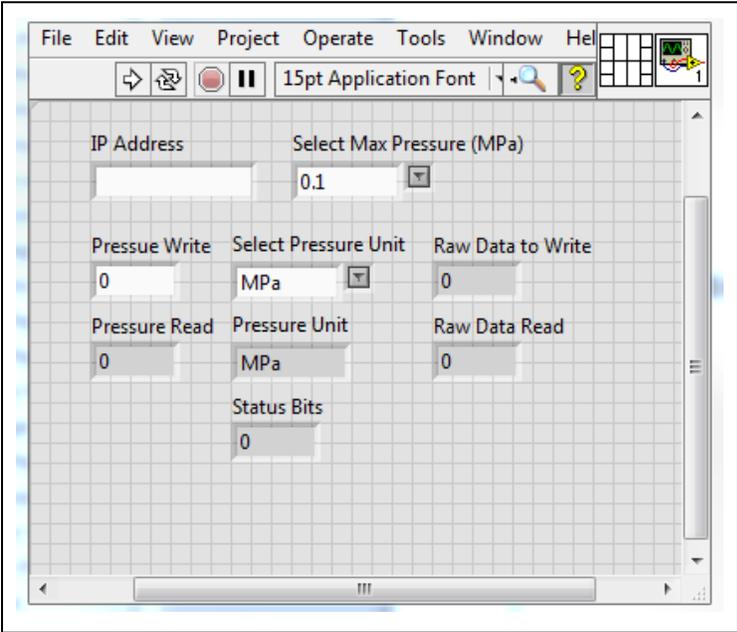


Figure 44 - Sample LabVIEW Front Panel

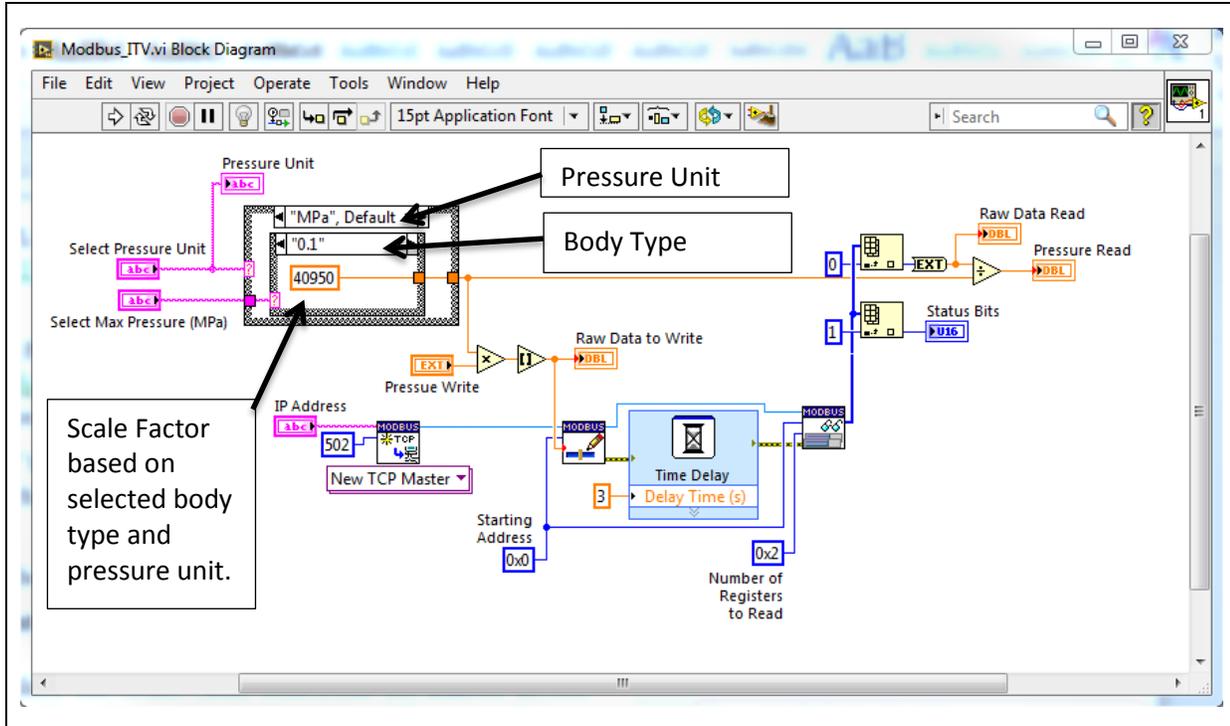


Figure 45 - Sample LabVIEW Block Diagram

This is the Block Diagram which implements the Front Panel from [Figure 44](#).

The nested **Case Structures** in the Block Diagram are used to implement pressure unit selection (outer structure) and body type selection (inner structure). The scale factor in the inner case structure (40950) is taken from [Figure 40 - ITV Scale Factors](#). It is the scale factor used for the particular pressure units and body type shown on the Front Panel ([Figure 44](#)). In the case of this example, this is the scale factor for an X010 ITV using MPa pressure units.

# Appendix

## 17. Troubleshooting

This is a brief set of troubleshooting tools for the SMC Modbus ITV. The intent of this section is to provide steps that a user can follow to diagnose and correct common issues. This set is by no means exhaustive. Refer to [LED Indication and Settings \(Section 11\)](#) for LED state information.

### 17.1. Problem: ITV Does Not Power Up

#### 17.1.1. Symptom: All 3 Front LEDs and both top cover LEDs are not lit

##### 17.1.1.1. Possible Cause: Power Supply Problem or Incorrect Power Connection

1. Check power supply. Be sure it is providing 24 VDC  $\pm$  10%. Check the output voltage provided by the power supply using a calibrated voltage meter.
2. Check the power cable. Ensure the cable conforms to the requirements of [Power supply connector layout \(Section 8.2.2\)](#). Be sure 24 VDC is available at the ITV connector on the cable pins indicated in the power cable pin-out ([Figure 12 - ITV Power Cable Pin Connections](#)). Ensure the power cable is securely connected to the ITV. Be sure there are no breaks or cuts in the power cable.
3. If the ITV is being powered using POE, be sure that the requirements of [Power Over Ethernet \(POE\) \(Section 10\)](#) are met. In particular, ensure that the upstream ITV has POE enabled and that the Ethernet cable is properly connected to the upstream ITV “Bus Out” connector and the “Bus In” connector of the ITV that doesn’t power up.
4. If POE is being used to power the ITV that is not powering up, connect a 24 VDC power supply with a properly configured power cable to the power connector of the ITV. If the ITV powers up, verify POE setting and communication cable from the upstream ITV. (Note: For normal operation **do not** operate ITV with the power cable and POE enabled on the upstream ITV (see [Power Over Ethernet \(POE\) \(Section 10\)](#)).
5. If the problem persists, contact SMC Technical Support (see [Contact Page \(Section 12.6\)](#)).

### 17.2. Problem: ITV Does Not Operate

#### 17.2.1. Symptom: One of the front LEDs is Red

##### 17.2.1.1. Possible Cause: Power LED is Green and NS and/or MS LEDs are solid Red

1. Solid Red **NS LED** indicates a **duplicate** IP address has been detected. The ITV displaying the red NS LED has the same IP address as another device on the network. See [Changing the ITV IP Address \(Section 9.4\)](#).
2. Solid Red **MS LED** indicates an **unrecoverable error**. Power cycle the ITV.
3. If the problem persists, contact SMC Technical Support (see [Contact Page \(Section 12.6\)](#)).

**17.2.1.2. Possible Cause: Power LED is Green and NS and/or MS LEDs are flashing Red**

1. Flashing Red **NS LED** indicates loss of communication with the master device. Check the LED on top of the ITV (Bus Connector LED).
  - 1.1. If the **Bus Connector LED is OFF**, the physical connection with the master device has been lost. Verify the communication cable connections. Verify that the master device is operating.
  - 1.2. If the **Bus Connector LED is GREEN**, the physical connection is operational. The master device has stopped responding to the ITV. Verify the state of the master device.
2. Flashing Red **MS LED** indicates a possible low voltage condition. The voltage is high enough for the ITV to power up but may not be high enough for the ITV to operate properly. Verify the ITV power is within specification. (See power specifications in [Figure 46 - ITV Device Specifications](#)).
3. If the problem persists, contact SMC Technical Support (see [Contact Page \(Section 12.6\)](#)).

**17.3. Problem: Unable to Communicate with ITV**

**17.3.1. Symptom: ITV does not respond to commands – Power is green, NS flashing green, the LED on top of the ITV for the incoming signal is green**

**17.3.1.1. Possible Cause: Incorrect IP address**

1. Verify that the master device is using the correct IP address for the ITV.
2. If the problem persists, contact SMC Technical Support for assistance (see [Contact Page \(Section 12.6\)](#)).

**17.3.2. Symptom: LED on top of the ITV for the incoming signal is off.**

Note: It is **normal** for a connector LED to be **OFF** if there is no physical connection to another device.

**17.3.2.1. Possible Cause: Connector not connected or not powered.**

1. If a communication cable is not connected to the connector associated with the LED, the LED will be off. If this connection is not required, putting a seal cap on the connector is recommended.
2. The cable is not connected to another operating device. Verify the communication cable is properly connected between the other device and the ITV. Also, verify the other device is operational.
3. If the problem persists, contact SMC Technical Support for assistance (see [Contact Page \(Section 12.6\)](#)).

## 17.4. Problem: ITV Web Page Pressure Value Differs from Master Calculated Value

Note: The master device reported pressure is calculated from the pressure count value received by the master from the ITV.

### 17.4.1. Possible Cause: The selected pressure unit displayed on the ITV web page is different from the pressure unit used to calculate the pressure value from the counts sent to the master device.

1. Confirm the pressure unit displayed on the ITV web page matches the pressure unit used to calculate the pressure value from the counts sent to the master. See [ITV Status Page \(Section 12.4\)](#) or [Regulator Configuration Page \(Section 13.1\)](#). Also refer to the conversions in [Counts and Pressure Units \(Section 14\)](#).

### 17.4.2. Possible Cause: Incorrect Count Calculation

1. Verify the correct formula for calculating pressure is used for determining pressure value. (See the conversions in [Counts and Pressure Units \(Section 14\)](#)).

### 17.4.3. Possible Cause: Pressure Change in Progress

1. If the master requested a pressure value change and the ITV has not settled to the new pressure value, the web page may display a different pressure value than the calculated value. Check the pressure value once the ITV has settled to the new pressure value.
2. If the problem persists, contact SMC Technical Support for assistance. See [Contact Page \(Section 12.6\)](#).

## 17.5. Problem: ITV Does Not Reach Set Pressure

### 17.5.1. Symptom: ITV “Buzzes” When Directed to Set a Pressure

#### 17.5.1.1. Possible Cause: Inadequate Supply Pressure

1. Verify that supply pressure is at least set at Minimum Pressure (**Set pressure + 0.1 MPa - or Set Pressure – 13.3 kPa for ITV2090 Vacuum ITVs**) - see [Figure 46 - ITV Device Specifications](#)).
2. If the problem persists, contact SMC Technical Support for assistance. See [Contact Page \(Section 12.6\)](#).

### 17.5.2. Symptom: ITV Makes “Hissing” Sound when Operated at Pressure

#### 17.5.2.1. Possible Cause: Air or Vacuum Leak

1. Verify that fittings are properly installed in the correct ports. See [Summary of Product Elements \(Section 6\)](#) and [Figure 9 - Recommended proper connection torque: N•m](#).
2. Verify that air lines are properly installed.
3. Verify that air lines are not cut or punctured.
4. Verify that air is not being unexpectedly exhausted from the ITV exhaust port.
5. If the problem persists, contact SMC Technical Support for assistance. See [Contact Page \(Section 12.6\)](#).

This is **not** an exhaustive troubleshooting guide. SMC Technical Support may request that you check additional things, depending on the problem experienced.

## 18. Recovering the IP Address of SMC ITV Module

Note: ITVs have a factory preset static IP address when sent from SMC (192.168.1.20). Any time you change the IP address please **record and save the new IP address** for your ITV. The Modbus TCP protocol **does not** provide information which can be used to determine the IP address of an ITV. If the address cannot be determined, your ITV will need to be returned to SMC to have the IP address reset.

## 19. Specifications

### 19.1. General Specifications

Model	ITV1010	ITV1030	ITV1050	
	ITV2010	ITV2030	ITV2050	ITV2090
	ITV3010	ITV3030	ITV3050	
Minimum supply pressure	Set pressure + 0.1 MPa			Set pressure -13.3 kPa
Maximum supply pressure	0.2 MPa	1.0 MPa	1.0 MPa	-101 kPa
Set pressure range	0.005~0.1 MPa	0.005~0.5 MPa	0.005~0.9 MPa	-1.3~-80 kPa
Power supply	Voltage	24 VDC ± 10%		
	Current Consumption	0.12 A or less		
Linearity	± 1% F.S. or less			
Hysteresis	0.5% F.S. or less			
Repeatability	±0.5% F.S. or less			
Sensitivity	0.2% F.S. or less			
Temperature characteristics	±0.12% F.S. /°C or less			
Operating temperature	0 to 50°C (No condensation)			
Standards	Contact SMC			
Enclosure	IP65 Equivalent			

Figure 46 - ITV Device Specifications

Please see the SMC Best Pneumatics catalog, Volume 5 ITV section, for additional information on how the ITV functions. The catalog is the source of information for ITV working principles, operating range parameters, accessories, and other information useful for the operation and maintenance of your ITV.

For ITV weight and enclosure measurement information, please see the ITV design drawing.

### 19.2. Initial Configuration Parameters

Model	ITV1010	ITV1030	ITV1050	
	ITV2010	ITV2030	ITV2050	ITV2090
	ITV3010	ITV3030	ITV3050	
IP Address	192.168.1.20 static address			
Power Over Ethernet (POE)	Off			
DHCP Mode	Not Supported for Modbus TCP ITVs			
Configuration Login ID	"user"			
Configuration Login Password	"user"			
Hold Pressure on Connection Loss	Off			
Modbus Communication Type	Register (only type supported for Modbus TCP ITVs)			

Figure 47 - ITV Initial Configuration

Revision History			
Revision	Description	Date	Author(s)
0	Initial release for Modbus TCP ITV.	06/07/2016	T. Zabel

## **SMC Corporation of America**

10100 SMC Boulevard

Noblesville, IN 46060

Phone: 1-800-SMC-SMC1 (1-800-762-7621)

URL: [www.smcusa.com](http://www.smcusa.com)

---