



# Automation Control Application

Tech Note – TN1007

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# Introduction:

Ctek's Automation Manager is an optional firmware application available for the Ctek Z4200/Z4400/Z4550/Z4500 Series Controllers. It provides the logic and control necessary to create sophisticated automation applications that evaluate analog, digital, and pulse discrete inputs, a full range of Modbus input types, and, based on input values apply programming logic to control output devices through both discrete and Modbus outputs.

The Automation Manager also provides a simple, GUI based rapid development environment used to create and deploy applications using the Automation Manager

# Theory of Operation

Figure 1 depicts the high-level operation of Ctek's Automation manager.

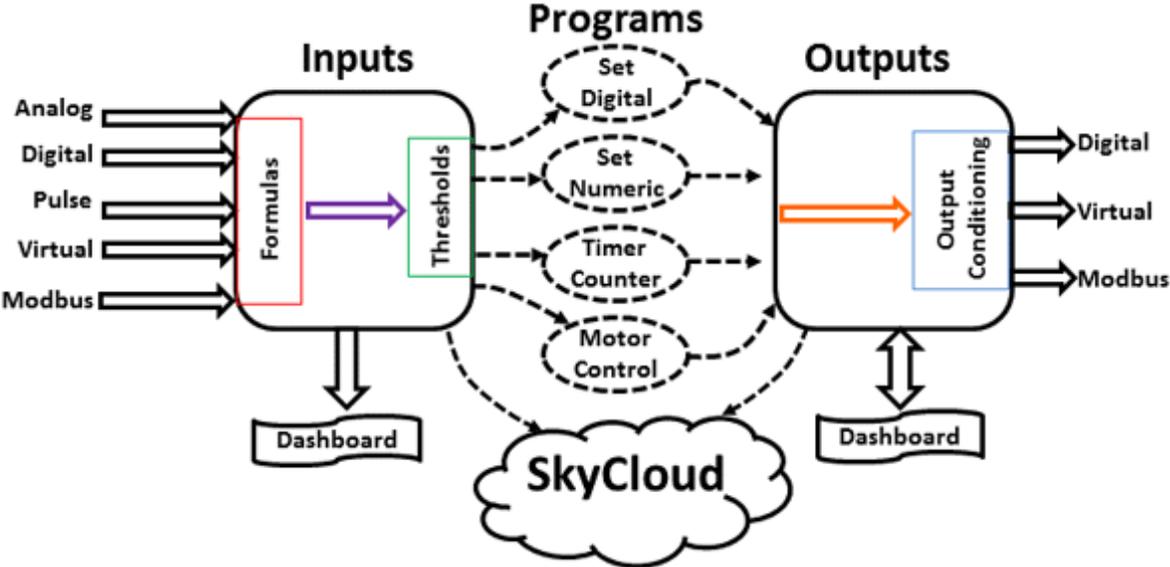


Figure 1 – Theory of Operation

# Building Blocks Overview

The Automation Control building blocks are all accessible from the Applications button on the controller's home screen. The only component not accessible from this screen is the Automation Dashboard.

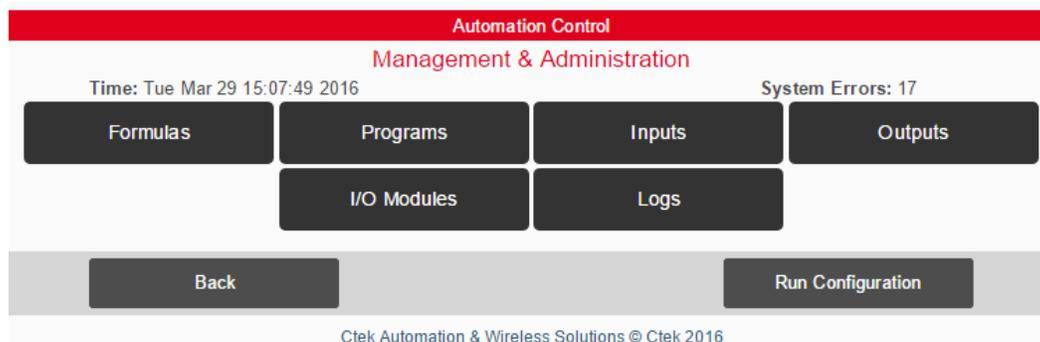


Figure 3 - Automation Control Menus

## Menu Selections

<i>Formulas</i>	Create and manage formulas made through a Reverse Polish notation (RPN) calculator interface. (Note: Reverse Polish notation is also referred to as Postfix Notation in documentation)
<i>Programs</i>	Create and manage programs made from an internal function library
<i>Inputs</i>	Configure and manage system inputs pulse, analog, numeric, digital, MODBUS
<i>Outputs</i>	Configure and manage system outputs; pulse, analog, numeric, digital, MODBUS
<i>I/O Modules</i>	Introduce data into the system from a MODBUS source, the Ctek controller, a Ctek Multi-Function IO Module or any number of third-party supported I/O modules
<i>Logs</i>	View application logs based on defined events or timed system snapshots
<i>Run Configuration</i>	Applies the most recent set of administrative changes to the currently running Automation application

# Setting up I/O Modules

Through the use of Input/Output modules, sensor data, MODBUS data, and local controller information can be brought into the application in order to develop monitoring and control solutions. There are 3 available module types: Virtual I/O Module, Ctek Multi-Function I/O Module, and MODBUS Module. All modules enumerate in configurations of 8 inputs and 8 outputs (16 ports). Multiple MODBUS modules can be created for the same address to increase the number of available inputs and outputs.

The screenshot displays a web interface titled "Configured Boards". It contains three rows of configuration for existing boards, each with a "Save" button, and one row for adding a new board with an "Add" button.

Board Name	Address	Enable Status	Action
1 16 Port Virtual I/O		*Enable	Save
2 16 Port I/O Module	99	*Enable	Save
3 16 Port Modbus	10	*Enable	Save
*Add New Board		4 Port Relay Module	Add

## 16-Port Virtual I/O

### **Characteristics**

Consists of 8 virtual inputs and 8 virtual outputs that can be defined as data type digital, numeric, or hex. Virtual I/O can be used to represent internal values of the controller such as temperature, GPS coordinates, voltage, etc., for intermediate calculations, and for displaying values and results.

### **Communications**

Since Virtual I/O modules are internal to the controller, communications is also internal. There are no off-box communications.

## Addressing

None

# 16-Port I/O Module

## Characteristics

This module type is configured for communication with Ctek's 16-Port Multi-Function I/O Modules. They consist of 8 physical inputs and 8 physical outputs. Inputs may be defined as data type digital, analog, or pulse through the Automation Control application. Outputs are of type digital.

## Communications

Ctek's 16-port I/O module uses 2-wire RS485 communications with a proprietary protocol. Appropriate settings are all pre-configured on TR2-/TR2+ (pins 15 & 16) of the controller.

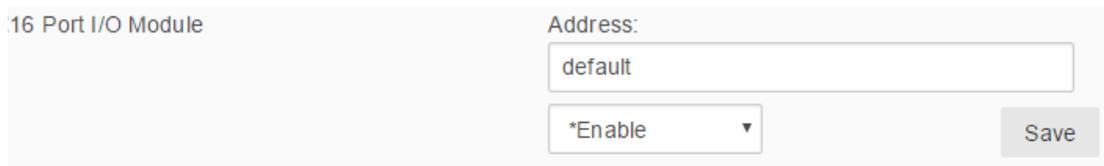
## Addressing

Addresses for 16-port I/O modules are hexadecimal numbers between 1 and FF. Modules are shipped from the factory with a default address of 99.

## Resetting an Unknown Address

To address a module with an unknown address perform the following steps

1. Disconnect all I/O modules except for the one having the unknown address.
2. Enter the text "default" for the address of the first physical (16-port) I/O module on the screen



16 Port I/O Module

Address: default

\*Enable

Save

3. Press Save
4. The connected module will now have an address of 99
5. Change the address of the target module to the desired address.
6. Press Save

**Note:** If multiple modules are connected during the default addressing described above, all will be set to address 99.

## **Replacing a 16-port I/O module**

To replace an I/O module while retaining its current configuration perform the following steps

1. Remove the module to be replaced from the RS485 string
2. Remove any module on the RS485 string having the address of 99
3. Connect the new (replacement) module to the string
4. Assign an address of 99 to that module
5. Press Save
6. Assign the desired address to that module
7. Press Save
8. Reconnect previously disconnected modules

## 16-Port Modbus Module

### **Characteristics**

A Modbus I/O module consists of 8 inputs and 8 outputs which can be mapped onto Modbus registers, holding registers, or coils through the Automation Control Application. Inputs and outputs may be defined as data type digital, numeric, or hex.

### **Communications**

A 16-Port MODBUS module supports either TCP/IP or 2-wire RS485 communications with a MODBUS protocol. TCP/IP connections will use Modbus TCP, while RS485 connections will use protocol Modbus RTU.

### **Addressing**

Addresses for 16-port Modbus I/O modules using Modbus RTU (RS485) are hexadecimal numbers between 01 and EF (must use caps for Hex). This address must match the I/O modules address assignment.

Example – 1F

Addresses for 16-port Modbus I/O modules using Modbus TCP are in the following format:

< IP Address >:< Port>:< Poll Rate >

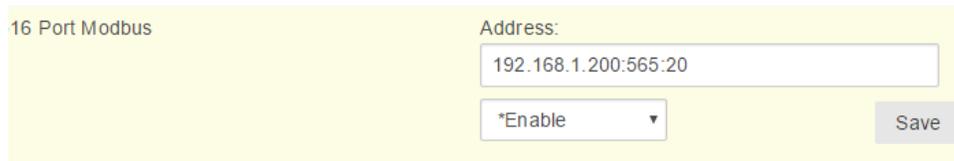
- **IP Address:** 4-octet V4 IP address of the Modbus device
- **Port:** Modbus port number (0 – 65535)

- **Poll Rate:** Optional polling time value for TCP communications with the Modbus device (1 – 9999 sec.). When not specified, the device will be polled at the system’s default polling rate.

Examples:

192.168.1.200:565:20

10.10.30.44:1017



16 Port Modbus

Address:

192.168.1.200:565:20

\*Enable ▼

Save

## Using Programs

---

Programs are groups of one or more built-in functions that can be assigned to inputs and outputs to perform monitoring, control, and alarming functions at set thresholds or states. Some of the functions that can be performed include the following:

- Set and clear inputs and output pins
- Perform arithmetic operations
- Set and clear input and output pins on remote controllers
- Execute a variety of timing and timer functions
- Managing motors and wear leveling
- Application status and reporting to Ctek’s SkyCloud
- Manage threshold configurations
- Manage application Geo-Fences

Programs are entered on the program definition screen as shown below. A pull down provides a list of available functions that can be applied and screen hints describe the function’s parameter or argument list. Parameters are entered with a space separator. A complete guide to the Automation Control programming and syntax is available in TechNote TN041-Automation Programming

**Set Warning LED Definition** 5/300 steps in use.

Program Name:

**1**

**Insert Step**

The list below is a complete list of available functions. Their use and a complete set of examples is available in TechNote TN041-Automation Programming

---

**Program Function List**

---

- |                          |                               |
|--------------------------|-------------------------------|
| Digital I/O – Set        | Timer/Counter – Start         |
| Numeric I/O – Set        | Timer/Watchdog – Start        |
| Hex I/O – Set            | Timer/Clock – Start           |
| Hex I/O - Set Bits       | Timer/Counter/Ext/Clk – Start |
| Hex I/O Clear Bits       | Timer/Alarm Override - Start  |
| Numeric I/O – Add        | Timer/Any – Stop              |
| Numeric I/O – Subtract   | Motor Group Control           |
| Numeric I/O – Multiply   | Application Status – Set      |
| Numeric I/O – Divide     | Input Threshold – Set         |
| Remote I/O - Set         | Execute New Configuration     |
| Remote Numeric I/O - Set | Geo-Fence – Set               |
| Remote Hex I/O - Set     | Reset Pin Formula             |
- 

Please refer to TechNote [TN041-Automation Programming](#) for complete documentation on developing programs and for the definitions of all available functions.

# Using Formulas

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Formulas allow mathematical pre-processing on all numeric, analog, and hex inputs and post-processing on numeric and hex outputs on Modbus type I/O modules. Formulas are developed using a stack calculator. The calculator mechanism uses postfix notation, a mathematical notation in which every operator follows all of its operands.

For example, to find the sum of 2 plus 2:

Infix Notation: 2 **[+]** 2 result 4

Postfix Notation: 2 **[Ent]** 2 **[+]** result 4

Ctek's Formula Screen: **[constant value=]** 2 **[Ent]** **[constant value=]** 2 **[Add]** result 4

Unless otherwise directed, the result of a formula calculation will be placed on the input or output pin invoking the formula.

---

## Formula Parameter List

---

Current Input Pin	Fn Average Mem 1
Other input Pin	Fn Average Mem 2
Output Pin	Fn Swap Words
Constant Value	Fn Swap Bytes
Constant Hex Value	Fn Reg16 to Signed
Correction	Fn Signed to Reg16
Min Range	Fn Reg32 to Signed
Max Range	Fn Signed to Reg32
[Max – Min] Range	Fn Reg32 to Float
Min Units	Fn Float to Reg32
Max Units	Fn Samples Sum
[Max – Min] Units	Fn Samples Difference
	Fn [If Not] Reset Event Goto
	Fn Reg32 M10K to Unsigned
	Fn Reg32 M10K to Signed
	Fn Save Value
	Fn Samples Sum [No Reset]
	Fn Samples Difference [No Reset]
	Fn Set Input Pin
	Fn Reset Pin Formula

<b>Formula Operators</b>	
Sub	Subtract
Add	Add
Mul	Multiply
Div	Divide
Xch	Exchange ( position of last 2 values in the stack )
And	Bit-wise And
Or	Bit-wise Or
Ent	Enter ( value into the stack )
Pop	Pop ( Bring value out of the stack )

## Formula Parameter Types and Usage

### Direct Variable Access

#### ***Current Input Pin***

Allows the use of the current value of the input invoking the formula

#### **Other Input Pin**

Allows the use of the current value of an input pin other than the one invoking the formula

#### **Output Pin**

Allows the use of the current value of the output pin invoking the formula

#### **Constant Value**

Allows a user defined numeric value to be used in the formula

#### **Constant Hex Value**

Allows a user defined hex value to be used in the formula

#### **Correction**

Allows the use of the Correction value that is defined for the input or output pin invoking the formula

### **Min Range**

Allows the use of the Min Range value of the analog input invoking the formula

### **Max Range**

Allows the use of the Max Range value of the analog input pin invoking the formula

### **[Max – Min] Range**

Allows the use of the value of the difference between the Max and Min Range of the analog input pin invoking the formula

### **Min Units**

Allows the use of the Min Units value of the input or output pin invoking the formula

### **Max Units**

Allows the use of the Max Units value of the input or output pin invoking the formula

### **[Max – Min] Units**

Allows the use of the value of the difference between the Max and Min Units of the input or output pin invoking the formula

## Formula Functions

### ***Fn Average Mem 1/ Mem 2***

Performs averaging on the invoking pin. The function parameter defines the sample size up to a maximum of 100 samples. Each function allows for this functionality to be applied to 1 pin, allowing for averaging on up to 2 pins in the system.

[Current Input] [Ent]

[Fn Average Mem 1] 50

### ***Fn Swap Words***

Performs a 16 bit swap on 32-bit MODBUS register reads when necessary.

Example: ABCD1234 becomes 1234ABCD.

[Current Input] [Ent]

[Fn Swap Words]

### ***Fn Swap Bytes***

Performs 8 bit swap on 16 or 32-bit MODBUS register reads when necessary.

Example: ABCD1234 becomes CDAB3412.

[Current Input] [Ent]

[Fn Swap Bytes]

### ***Fn Reg16 to Signed/ Reg32 to Signed***

Performs the conversion of a 16/32 bit hex value to a signed integer value. The value to be converted is taken from the last value in the calculator's stack.

Example 1: Assume the invoking pin is an input of a MODBUS module configured as hex and the source is a 16-bit Holding register. Use the register value as a signed integer.

[Current Input] [Ent]

[Fn Reg16 to Signed]

Example 2: Assume the invoking pin is the input of a MODBUS module configured as hex and the source is a 32-bit Holding register. Use the register value as a signed integer.

[Current Input] [Ent]

[Fn Reg32 to Signed]

### ***Fn Signed to Reg16/ Signed to Reg32***

Performs the conversion of a signed integer value to a 16/32 bit hex value. The value to be converted is taken from the last value in the calculator's stack.

Example: Assume the invoking pin is a numeric output and its value will be use to write to a 16-bit Holding register configured to hold a signed integer.

[Current Input] [Ent]

[Fn Signed to Reg16]

### ***Fn Reg32 to Float***

Performs the conversion of a 32 bit hex value to a float value. The value to be converted is taken from the last value in the calculator's stack.

Example 1: Assume the invoking pin is an input of a MODBUS module configured as hex and the source is a 32-bit Holding register. Use the register value as a float.

[Current Input] [Ent]

[Fn Reg32 to Float]

### ***Fn Float to Reg32***

Performs the conversion of a float value to a 32 bit hex value. The value to be converted is taken from the last value in the calculator's stack.

Example: Assume the invoking pin is a numeric output and its value will be use to write to a 32-bit Holding register configured to hold a float.

[Current Input] [Ent]

[Fn Float to Reg32]

### ***Fn Reg32 M10K to Signed***

Performs the conversion of a 32 bit hex value in Modulo 10000 (M10K) format to a signed integer. The value to be converted is taken from the last value in the calculator's stack.

Example:

[Current Input] [Ent]

[Fn Reg32 M10K to Signed]

### ***Fn Reg32 M10K to Unsigned***

Performs the conversion of a 32 bit hex value in Modulo 10000 (M10K) format to an unsigned integer. The value to be converted is taken from the last value in the calculator's stack.

Example:

[Current Input] [Ent]

[Fn Reg32 M10K to Unsigned]

### ***Fn Samples Sum***

Performs a summation on the data samples coming into the pin and at every interval (in minutes) from the top of the hour will trigger the “On Value Change” threshold if set. Additionally, the current value of the invoking pin will also be reset to 0. To use this function, first specify the source of the data that will be summed, usually the current pin. Next, set a constant value to define the interval in minutes. A value of 0 will trigger “On Value Change” at every sample.

Example: Apply a formula to a pulse input that will log the number of pulses counted every 15 minutes from the top of the hour.

```
[Current Input]
[Constant value=] 15 [Ent]
[Fn Samples Sum]
```

### ***Fn Samples Sum [No Reset]***

Performs exactly as Fn Samples Sum with the exception that the invoking pin will not be reset to 0 at the interval.

Example: Apply a formula to a pulse input that will log the raw pulse count every 15 minutes from the top of the hour.

```
[Current Input]
[Constant value=] 15 [Ent]
[Fn Samples Sum [No Reset]]
```

### ***Fn Samples Difference Sum***

Performs a summation on the difference of the data samples coming into the pin for a set interval from the top of the hour. At every interval the current value will be logged and the value of the invoking pin will be reset to 0. To use this function, first specify the source of the data that will be used to find the difference and added, usually the current pin. Next, set a constant value to define the interval. A value of 0 will not set an interval, thereby creating a continual summation and triggering “On Value Change” at every sample

Example: Apply a formula to a MODBUS pulse register that will log the number of pulses every 15 minutes from the top of the hour.

```
[Current Input]
```

[Constant value=] 15 [Ent]

[Fn Samples Difference Sum:] 4294967295

### ***Fn Samples Difference Sum [No Reset]***

Performs exactly as Fn Samples Difference Sum with the exception that the invoking pin will not be reset to 0 at the interval.

Example: Apply a formula to a MODBUS pulse register that will log the total current pulse count every 15 minutes from the top of the hour.

[Current Input]

[Constant value=] 15 [Ent]

[Fn Samples Difference Sum [No Reset]:] 4294967295

### ***Fn [If Not] Reset Event Goto***

Allows the formula to perform certain operations only in the case that a formula reset event is triggered. The formula function takes 1 parameter which tells the formula to skip to the specified line and continue execution in the case of normal operation (not a reset event).

Example: Define an operation that skips to line 10 of the formula in normal operation when there is no reset event to handle.

[Fn [If Not] Reset Event Goto] 10

### ***Fn Reset Pin Formula***

Allow the invoking pin to trigger a reset event on another pin. Doing it from the formula rather than a program function call will keep the event synchronous across multiple, dependent pins. The function takes the pin number that will be reset as the parameter

Example:

[Fn Reset Pin Formula] 5

### ***Fn Save Value***

Takes the value in the stack and saves at a specified interval. This function requires one parameter that defines an interval time value in seconds at which the value will be saved. A value of zero will save at every change.

Example:

```
[Fn Save Value] 15
```

### ***Fn Set Input Pin***

Takes the value in the stack and pushes it to the designated input pin at every interval from the top of the hour. This function requires a constant value preceding it that defines an interval time value in minutes. The function call then requires a parameter that defines the number of the input pin to push the value into.

Example:

```
[Constant value=] 10 [Ent]  
[Fn Set Input pin] 5
```

## Data Types

---

Ctek's automation control supports three basic data types; digital, numeric, and hex. These data types are defined as follows:

### ***Digital***

A single bit binary representation

### ***Numeric***

A floating-point decimal value having user selectable precision of 0, 2, or 6 decimal places.

### ***Hex***

A 16-bit binary value represented in hexadecimal notation.

## Pin Types (Data Source)

---

The three basic data types found in automation control are expressed in slightly different ways, with varying nomenclature depending on the type of input or output (pin) representing the basic data type. Inputs and outputs (pins) may be either virtual or physical. Physical pin types can be further subdivided into either digital, analog, pulse, or Modbus.

## ***Virtual Inputs and Outputs***

Since virtual pins exist solely within the automation platform, they represent the three data types in their native form, digital, numeric, or hex. Hex pins may be assigned to, or copied to numeric pins and have the correct conversion applied. For instance, assigning a hex pin having a value of 7E to a numeric pin will place a value of 126 on the numeric pin.

## ***Digital Inputs and Outputs (physical)***

Digital inputs sense the digital data type, true/false, open/closed, on/off, etc. Digital outputs present the digital data type to external devices.

## ***Analog Inputs***

Analog inputs sense an electrical value from a sensor, and based on the settings applied represent the sensor's input as an appropriately scaled numeric, known as an engineering value.

## ***Pulse Inputs***

Pulse inputs detect transitions or pulsed on the input and represent a count of these transitions as a numeric value that can be scaled by both time and a multiplication factor. A pulse input's value is a numeric that represents a count of pulses occurring over some period that has been converted to an engineering value such as gallons per minute or revolutions per hour.

## ***Modbus Inputs and Outputs***

Modbus pins represent the defined Modbus types of coil, discrete, input register, and holding register. In Ctek's automation logic the Modbus types are mapped onto the defined automation types of digital, numeric, and hex. Much like virtual pins discussed previously, Modbus registers may be cast as hex or numeric as needed. For instance, casting a hex pin having a value of 7E as a numeric value will result in a value of 126 on the numeric pin.

### ***Digital (Modbus)***

Inputs will be of Modbus type discrete, or coil

Outputs will be of Modbus type coil

### ***Numeric or Hex Modbus***

Inputs will be of Modbus type input register, or holding register (16 or 32 bit)

Outputs will be of Modbus type holding register (16 or 32 bit)

# Input Pin Configuration

The screens used to define individual input pins are subdivided into four major categories. They are:

9. Input Source – Assigns a pin or value to become the input of this pin
10. Pin Options – Used to assign initial values, logging rates, polarity, and formulas
11. Display Options – Assigns the pin to a dashboard column and or SkyCloud display
12. Thresholds – On/Off for digital, otherwise used to assign numeric or hexadecimal thresholds, the programs that will run, and the alarms that may be sent

## Input Source

### **Primary Source**

Assign an input source to this digital pin. Can be the pin itself, another input or output, or one of the internally available parameters listed in the table below:

<b>Internal Digital Input Sources</b>	
Relay In	Digital Input Signal from Pin 17
GPS Status	Availability of GPS
WWAN Status	Availability of Cellular Data Service
Fence (1/ 2) Alarm	Alarm State of selected geo-fence
Fence (1/ 2) On	Enable State of selected geo-fence
Fence (1/ 2) Off	Disable State of selected of geo-fence
Serial DCD	RS232 DCD Signal State via Pin 17
<b>Internal Numeric Input Sources</b>	
Voltage In	Value of DC Voltage in the Controller
Temp °C	Controller Temperature in °C
Temp °F	Controller Temperature in °F

WWAN RSSI	Controller Cellular Signal Strength (dBm)
GPS LAT	Latitude Value of Controller location
GPS LON	Longitude Value of Controller location
GPS Speed	Speed Value from GPS
GPS Course	Course Value from GPS
Sys Errors	Automation Error Count
Day Hour	Total Hours elapsed in current day
Day Minutes	Total Minutes elapsed in current day
Time HHMM	Current Time in HHMM format
Analog In	Analog Input Value from Pin 18
Hour Minutes	Total Minutes elapsed in current hour

### ***Additional Modifiers (Digital Types Only)***

The Additional Modifiers fields provide a mechanism to combine, using Boolean logic, the selected Primary Source with one or more other inputs, outputs, or internally available parameters.

### ***Modbus Type (Modbus Types only)***

Discrete (read only) or Coil (read/write) – 1-bit

### ***Modbus Register (Modbus Types only)***

The decimal register address of the coil or discrete input assigned to this pin

## Input Options

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### ***Initial Value***

The Initial Value field defines the value that the pin will be set to upon startup, either from a reboot, initiating the Run Configuration function from the configuration screen, or executing the Execute New Configuration function within programming logic.

### ***Log Rate***

There are three possible settings for a digital pin log rate:

- Setting = 0, Do not log

- Setting = 1, Log only upon a change of state
- Setting = 2 – 9999, log this pin every n seconds where n is the specified number

### ***Input Options – Digital Only***

**Digital Pin Options**

Initial Value: <input style="width: 90%;" type="text" value="0"/>	Polarity: <input style="width: 90%;" type="text" value="0=Off"/>	Log Rate: <input style="width: 90%;" type="text" value="0"/>
--	---	---

### ***Polarity***

Settings are 0 = Off or 1 = Off

### ***Input Options - Analog, Pulse, Modbus, Numeric, Hex***

**Numeric Pin Options**

Initial Value: <input style="width: 90%;" type="text" value="0.00"/>	Initial Reference: <input style="width: 90%;" type="text" value="0.00"/>	Log Rate: <input style="width: 90%;" type="text" value="0"/>
Formula: <input style="width: 90%;" type="text" value="None"/>		

### ***Initial Reference***

The Initial Reference field defines the value at which the evaluation of thresholds will begin upon startup, either from a reboot, initiating the Run Configuration function from the configuration screen, or executing the Execute New Configuration function within programming logic.

### ***Formula***

See Formulas above. This pull-down selects a previously defined formula to be applied to this pin.

## Input Options - Analog Only

Analog Pin Options		
Initial Value: <input type="text" value="0.00"/>	Initial Reference: <input type="text" value="0.00"/>	Log Rate: <input type="text" value="0"/>
Min Range: <input type="text" value="7"/>	Max Range: <input type="text" value="4095"/>	Calculated Range: 0 - 0
Min Units: <input type="text" value="0.00"/>	Max Units: <input type="text" value="0.00"/>	
Formula: <input type="text" value="Standard Conversion"/>	Correction: <input type="text" value="1.00"/>	

### Min Range/Max Range

The Minimum and Maximum Range fields define the portion of 12-bit (0 – 4095) A/D conversion that will be evaluated during A/D conversion and subsequent conversion to engineering units.

### Min Units/Max Units

The Minimum and Maximum Units fields define the numeric range of the engineering units to be presented. When combined with the Units of Measure field from the Display section provides a complete representation of engineering values. For instance, 1 – 22 Feet or 0 -300 PSI.

### Correction

The Correction field defines a constant to be applied to an input inside of a formula. For most applications, the Correction value will be 1.00.

## Input Options - Pulse Only

Pulse Pin Options		
Initial Value: <input type="text" value="0.00"/>	Initial Reference: <input type="text" value="0.00"/>	Log Rate: <input type="text" value="0"/>
Multiplier: <input type="text" value="1.00"/>	Interval: <input type="text" value="0"/>	

### Multiplier

The Multiplier field defines a value by which each pulse will be multiplied by to arrive at an engineering value. For instance, if each pulse equates to 10 gallons the multiplier would be 10.

## **Interval**

The Interval field defines the period of time over which the value [Pulse Count \* Multiplier] will be evaluated to arrive at a complete pulse driven engineering value. When combined with the Units of Measure field from the Display section this provides a complete representation of engineering values, for instance, 63 GPM or 3700 RMP.

# Input Display Options

---

## **Input Name**

Input name is a text field containing the name that will be assigned to this input for presentation on the dashboard and on SkyCloud.

## **SkyCloud**

The SkyCloud pull-down selects which of the eight SkyCloud application parameters will be used to display this pin's value and/or threshold alert.

## **Dashboard Group**

The Dashboard pull-down selects the Dashboard Display Group that will be used to display this pin's value and/or threshold alert. See Device Profile in SkyRouter User manual.

## **Display Value**

The Display Value pull-down determines what will be displayed on configuration screens, the dashboard, in reports and alarms, and on the SkyCloud display. The choices are:

1. Input Source – The engineering value of the input
2. Threshold Alert – A text alert defined for a particular threshold
3. Both

## **Display Options - Digital Only**

The screenshot shows a configuration form titled "Display Options" with the following fields:

- Input Name:** A text input field.
- [ON] Label:** A text input field containing "On".
- [OFF] Label:** A text input field containing "Off".
- [ON] Indicator:** A dropdown menu with "No Color" selected.
- [OFF] Indicator:** A dropdown menu with "No Color" selected.
- SkyCloud:** A dropdown menu with "Off" selected.
- Dashboard Group:** A dropdown menu with "00 - Off" selected.
- Display Value:** A dropdown menu with "Input Source" selected.

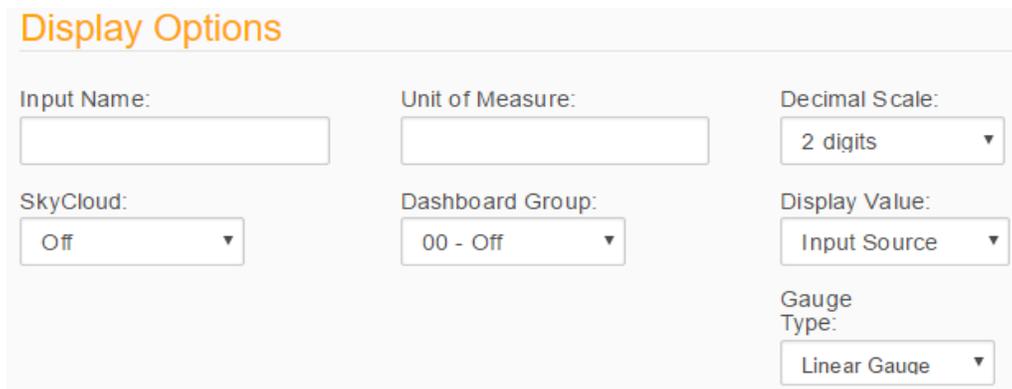
## ***ON/OFF Label***

The ON and OFF label fields contain text that will be displayed to indicate the state of the input for presentation on the dashboard and on SkyCloud.

## ***ON/OFF Indicator***

The Indicator Type pull-down determines what kind of indicator will be displayed on the dashboard for the ON and OFF states.

## ***Display Options - Analog, Pulse, Modbus, Numeric, Hex***



**Display Options**

Input Name:

Unit of Measure:

Decimal Scale:

SkyCloud:

Dashboard Group:

Display Value:

Gauge Type:

## ***Unit of Measure***

The Unit of Measure field defines text that will be appended to the numeric engineering value displayed.

## ***Decimal Scale***

The Decimal Scale field defines the decimal precision with which an engineering value will be displayed.

## ***Gauge Type:***

The Gauge Type pull-down determines what kind of gauge will be displayed on the dashboard. The choices are:

1. Linear Gauge
2. Radial Gauge

# Input Thresholds

## **Thresholds – Digital (Alarms/Programs)**

The Alarms/Programs panel is a special representation of Thresholds, unique to digital inputs. The following fields are replicated for both the ON and OFF state, and will be acted upon when the input enters that state.

The screenshot shows a configuration panel titled "Alarms/Programs". It is divided into two main sections: "Off State" and "On State". Each section contains three rows of settings:

- Alarm:** A dropdown menu with "No Alarms" selected, a "Repeat:" field with "0", and an "Interval:" field with "0".
- Threshold Alert:** A text input field.
- Program:** A dropdown menu with "00 - Off" selected, a "Repeat:" field with "0", and an "Interval:" field with "0".

## **Thresholds – Common Parameters**

### **Alarm**

The Alarm pull-down is used to enable or disable alarms for the input and to select an alarm group to which the SMS and email alarms will be sent. See Device Profile in SkyRouter User manual.

### **Program**

The Run Program pull-down is used to enable or disable programs for the input, and to select a program from the list of previously defined programs that will be executed at this threshold/state.

### **Repeat**

The Repeat field defines the number of times that an alarm or program will be repeated. A value of 0 means do-not-repeat.

### **Interval**

The Interval field defines the interval in minutes between repeated alarms or program executions.

## Threshold Alert

The Threshold Alert field is used to define a text string that will be displayed on configuration screens, the dashboard, in reports and alarms, and on the SkyCloud display if threshold alerts or both are selected as a display value.

## Thresholds - Analog, Pulse, Modbus/Virtual Numeric

Numeric thresholds may be either edge triggered or level triggered. An edge-triggered event occurs when a measured value (input) passes through the threshold point in the specified direction. It will not be reset (re-armed) until the input value passes through the specified reset value. An edge-triggered threshold is a one-shot event that can occur while the input value is also within a specified level sensitive threshold.

A level triggered event occurs whenever an input enters into the specified area ( $< N$ ,  $> N$ ), and will remain in effect until the input value passes through the specified reset value, or the input value enters into another specified level sensitive threshold region.

Possible values for this pull-down are:

1. Disabled
2. Less than Edge Sensitive
3. Less than Level Sensitive
4. Greater than Edge Sensitive
5. Greater than Level Sensitive

Threshold 01:	Send Alarm:	Repeat:	Interval:
Disabled ▼	No Alarms ▼	0	0
Trigger Value:	Threshold Alert:		
0.00			
Reset Value:	Run Program:	Repeat:	Interval:
0.00	00 - Off ▼	0	0
	Options ... ▼		

## **Thresholds – Modbus/Virtual Hex**

Thresholds for hex inputs are exact matches of the input value after the mask value has been applied as a Boolean And.

Example:

Input = 0X000F

Mask = 0X0003

Possible thresholds met = 0X0001, 0X0002, and 0X0003

**Thresholds**

Threshold 01:  
Disabled ▼

Trigger Value:  
0

Mask Value:  
0

Send Alarm: No Alarms ▼ Repeat: 0 Interval: 0

Threshold Alert:  
[Text Input Field]

Run Program: 00 - Off ▼ Repeat: 0 Interval: 0

Options ... ▼

### **Trigger Value**

The trigger value field defines a threshold level and can execute programs and/or send alarms.

### **Reset Value (Analog, Pulse, Modbus numeric, and Virtual numeric)**

The reset value field defines the numeric value at which a threshold will be reset or re-armed.

### **Mask Value (Modbus and Virtual hex only)**

The mask value is combined with the input's value using a Boolean And to define a specific hex threshold. (See Threshold above.)

### **Options (pull-down menu)**

Allows you to choose 5 options

1. Add below – will create a new empty threshold below
2. Add above – will create a new empty threshold above

3. Copy – will copy that thresholds information
4. Paste – will paste a copied threshold settings
5. Delete – will remove this threshold settings (**Note:** not to be confused with the Delete button at the bottom which will delete the entire Pin).

## Output Pin Configuration

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The screens used to define individual output pins are subdivided into two major categories. They are:

1. Pin Options – Used to assign initial values, logging rates, polarity, and formulas
2. Display Options – Assigns the pin to a dashboard column and or SkyCloud display

## Output Pin Options

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### ***Output Pin Options - Digital***

Digital Pin Options

Initial Value:	State:
Last	Off
Log:	Shutoff Timer:
Off	0
On Program:	Off Program:
00 - Off	00 - Off

### ***Initial Value***

The Initial Value pull-down assigns a value of either 0 or 1 to the output at start-up and when a new configuration is loaded.

### ***State***

The State pull-down provides a mechanism to change the output's state (On/Off) from the configuration screen. Program execution will override this setting.

### ***Log***

The Log pull-down enables the logging of an output when it is updated.

## ***Shut Off Timer***

The Shut-off timer is used to specify (in **seconds**) the length of time that an output remains active before it is automatically reset.

## ***On/Off Program (Virtual only)***

The On and Off state program pull-downs assign a program to the virtual output that will be executed when the output transitions to that state.

## ***Polarity***

The Polarity pull-down provides a mechanism to reverse the logical value (0 = Off/1 = Off) of an output.

## ***Modbus Type (Modbus Only)***

The Modbus type pull-down assigns a value of either disabled or coil to the Modbus output.

## ***Modbus Register (Modbus Only)***

The decimal register address of the coil assigned to this output

## ***Output Pin Options - Numeric and Hex***

### **Numeric Pin Options**

Initial Value: <input type="text" value="Previous"/>	Min Value: <input type="text" value="Not Set"/>	Max Value: <input type="text" value="Not Set"/>
Current Value: <input type="text" value="0.00"/>	Log: <input type="text" value="Off"/>	Program: <input type="text" value="00 - Off"/>

## ***Initial Value***

The Initial Value field defines the value that the output will be set to upon startup, either from a reboot, initiating the Run Configuration function from the configuration screen, or executing the Execute New Configuration function within programming logic.

1. Previous – uses the last value it had
2. Set – choosing set will give a new option of value below it. The value you input will be the start up value for the pin.

## ***Min/Max Value (Numeric Only)***

The Min and Max Value fields are used to define the limits of an output value

1. Not Set

2. Set – choosing set will give a new option of value below it. The value you input will be the start up value for the pin.

### **Current Value**

The Current Value field contains the value assigned to the output.

### **Program**

Pull-down allows you to select a program to run that is controlled by this output pin.

### **Formula (Modbus Only)**

See Formulas above. This pull-down selects a previously defined formula to be applied to this output.

### **Modbus Type (Modbus Only)**

The Modbus Type pull-down is used to assign the data representation on the Modbus output. Choices are:

1. Disabled
2. 16-Bit Holding
3. 32-Bit Holding

### **Modbus Register (Modbus Only)**

The decimal register address of the holding register assigned to this output.

## Output Display Options

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### Display Options

Output Name: <input type="text"/>	Unit of Measure: <input type="text"/>	Decimal Scale: 2 digits ▼
SkyCloud: Off ▼	Dashboard Group: 00 - Off ▼	Gauge Type: Linear Gauge ▼

### **Output Name**

The Input Name field defines the name that will be assigned to this output on configuration screens, the dashboard, in reports and alarms, and on the SkyCloud display.

### ***Unit of Measure***

The Unit of Measure field defines text that will be appended to the numeric engineering value displayed.

### ***Decimal Scale***

The Decimal Scale field defines the decimal precision with which an engineering value will be displayed.

### ***SkyCloud***

The SkyCloud pull-down selects which, if any of the 8 available SkyCloud attributes will be used to display the value of this output.

### ***Dashboard Group***

The Dashboard Group pull-down selects which dashboard group (panel) will be used to display the output.

### ***Gauge Type:***

The Gauge Type pull-down determines what kind of gauge will be displayed on the dashboard. The choices are:

1. Linear Gauge
2. Radial Gauge

## Logs

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### Overview

The Automation Control log records the value or state of inputs and outputs over time. Inputs and outputs to be logged are selected during the set up process. The log may be displayed online using a web screen, and will be emailed to defined addresses on a schedule. The log file transmitted by email is formatted as comma-separated values (CSV). CSV files may be viewed using a spreadsheet client, or can be entered into a database for subsequent processing and reporting.

### Enabling Application Logging

Logging is enabled in the Device Profile screen of the controller's main menu. This screen is also used to assign email addresses for scheduled delivery, and to define the scheduled intervals.

The behavior of logging for an individual input or output is defined on that pin's setup screen under Automation configuration. See input and output configuration details above.