

**TRIBO.dsp**  
**Model U3600-QAL1**

*QAL1 Firmware Version 1.51*

***Instruction Manual***

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# Chapter 1: Overview

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## 1.1 General Description

The *TRIBO.dsp* U3600-QAL1 is an advanced, all digital, self checking particulate monitor for dust collector compliance, maintenance, and other process applications. It is an advanced design for monitoring fabric filter baghouses, dust collectors, cyclones and process particulate flow monitoring. It features an easy-to-read screen for real-time emission levels and the alarm status is continuously on display.

*TRIBO.dsp* proprietary core technology unifies DC impaction (triboelectric) *and* AC induction electrostatic signals for superior accuracy, reliability, and repeatability. Unlike electrodynamic and AC induction-only monitors which only use a portion of the triboelectric signal, *TRIBO.dsp* electrostatic particulate monitors provide high sensitivity and wide flexibility for harsh industrial environments.

Main features include:

- An easy-to-read 3"X3" backlit LCD with graphical, numerical and alarm status display
- Intuitive to use and easy to install
- Easily programmable with custom specifications including high/low alarm level with time delay, data smoothing, and calibration mode options
- Automatic 80% signal span and zero-signal checking (15267 / QAL standard)
- One independent SPDT relay output for alarm reporting with selectable fail safe mode
- One dedicated SPDT relay output for reporting when U3600-QAL1 is in zero/span-check
- LCD displays the selected analog output range or user-selectable linear output displays
- Adds DC-based processing algorithm for more stability and accuracy than AC-only technology
- Wider dynamic range: standard 1pA resolution and 500,000pA range with optional 0.1pA resolution and 50,000pA range available
- Self-monitoring of probe contamination and bridging
- Compatible with loop- and self-powered 4-20mA networks
- Optional modules for digital communication (Serial, Ethernet/IP, Modbus RTU, Modbus TCP )

The *TRIBO.dsp* U3600-QAL1 comes furnished in a NEMA 4X enclosure, with the LCD screen prominently displayed on the front cover. The unit is configured for "Remote" operation, supplied with a Series 2001 sensor for convenience in installation and set-up. See Appendix 360T-C-CN-2353 for enclosure and installation details. An optional metal enclosure is also available. Contact the factory for details.

## 1.2 Understanding the *TRIBO.dsp* U3600-QAL1

Auburn Filtersense uses the trade names *TRIBO.flow*, *TRIBO.guard*, *TRIBO.vision*, and *TRIBO.dsp*, etc. for many of its products, which employ the "Triboelectric Effect" as a means to monitor the flow of dry solid materials. The application of this unique technology was invented by Auburn Filtersense and has proven to be the simplest and most reliable method available for monitoring particulate flow.

### 1.2.1 The Triboelectric Effect

When two materials rub together or collide, a transfer of charge takes place from one material to the other. This is also referred to as frictional electrification. Triboelectric monitors operate by monitoring the small electrical charge generated when particles impact the sensor.

### 1.2.2 The *Tribo.dsp*'s Principle of Operation

The *Tribo.dsp* consists of a single display unit that outputs the information from a connected sensor probe. When the probe is inserted into a stream of particles it senses the dust levels in the collector exhaust gas and sends the information to the *TRIBO.dsp*, which provides a continuous analog output, which is scaled linearly.

# Chapter 2: Installation

## 2.1 Remote Electronics Installation

The U3600-QAL1 is housed in a NEMA 4X enclosure and should be protected from physical damage and temperatures higher than 185°F or lower than -22°F (85°C and -30°C). The unit should be mounted within a maximum cable distance of 300 ft. (92m) of the sensor. The unit should be accessible for user adjustments and the display should be visible to the operator. Standard power requirements are 120/240 VAC, 50/60 Hz. 12 and 24 VDC power options are also available.

**Note:** At lower temperatures, changes on the LCD may not occur as quickly as desired. Additional measures to protect the electronics may be necessary to achieve optimum viewing performance. The 4-20mA output will NOT be affected by the lower temperatures, however.

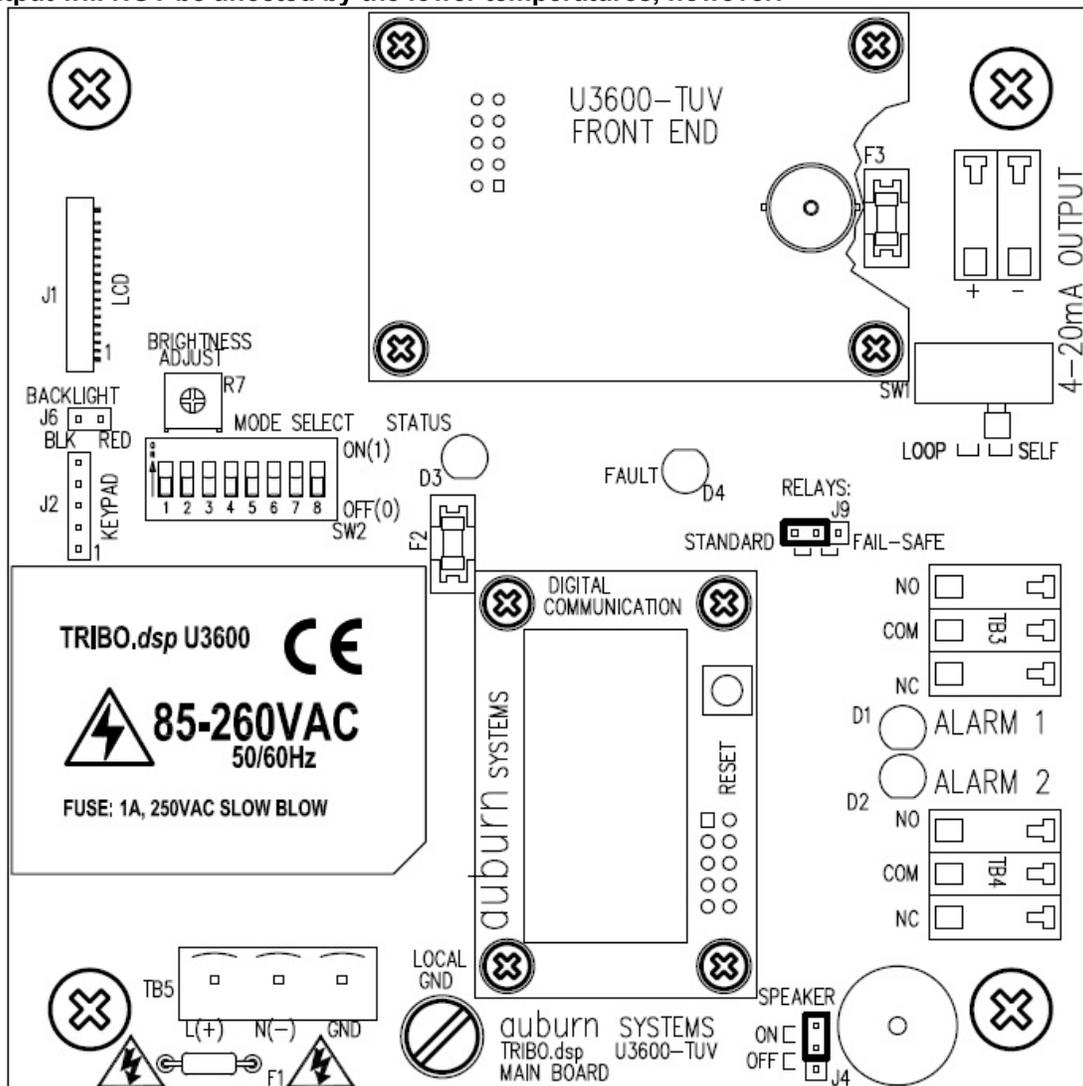


Figure 1 – Main Circuit Board Detail

**CAUTION:** The conduit connections to the hubs should be provided with the proper seals and/or drains to prevent water or other contaminants from entering the enclosure and to preserve the NEMA 4X enclosure rating.

### 2.1.1 Electrical Connections

The remote U3600-QAL1 provides separate hubs for each wiring requirement. The bottom-left hub should be used for the power inlet only. The top-right hub should be used for the coaxial cable alone, or the coaxial cable and the 4-20mA twisted-pair. The lower-right hub should be used for the relay wiring. When the U3600-QAL1 is ordered with a Digital Communication Output option, a fourth hub will be added to the bottom-right side of the enclosure, and should be dedicated to the digital communication wiring. Refer to Appendix 360T-C-CN-2353 for details.

The following steps should be used to properly connect the U3600-QAL1:

1. Unscrew the two captive panel screws on the right-hand side of the enclosure.
2. Remove the plug-in terminal block on the lower left-hand corner and connect double insulated power wiring to it. The customer-provided power cable must have a minimum conductor size of 1mm<sup>2</sup> (18 awg). The power input is marked "L(+)", "N(-)", and "GND" on the circuit board (see Figure 1). For 120/240VAC, use L (line), N (neutral), and GND (ground). For 24VDC input or 12VDC, use the (+) for positive 24V and the (-) for common. Additionally, when powering with DC voltage, it is recommended that a local earth ground be connected to the electronics. A green ground screw is provided next to the terminal block, marked "LOCAL GND".
3. To connect the optional 4-20mA output signal, identify the terminal block on upper right-hand corner of the circuit board. The terminal block is marked "+" and "-". This terminal block uses a spring-loaded tension clamp to ensure reliable electrical connection in the presence of vibration. To open the clamps, use a small (1/8") flat-head screwdriver to push the terminal lever toward the board, the clamp will spring open. Insert the wire into the opening and release the lever to seal it. Connect the positive lead from the twisted-pair to the terminal marked "+" and the negative lead to the terminal marked "-". The twisted-pair cable (provided by the customer) must have a minimum conductor size of 22AWG (0.75mm<sup>2</sup>). If the twisted-pair has a braided shield (a shielded twisted-pair is not required), that shield should be grounded at the PLC only.

The U3600-QAL1 can provide either a SELF powered or LOOP powered 4-20mA signal. Use the slide-switch below the terminal block to select the desired option. Before applying power to the unit, ensure that there is no external power source connected to the loop when using the SELF Powered option. Or, ensure that there is a 24VDC power source across the terminals when using the LOOP Powered option.

4. To connect to the relay contacts, identify the two terminal blocks on the lower right-hand corner of the circuit board. The terminal blocks are marked "NO" (normally open), "COM" (common), and "NC" (normally closed). These terminal blocks also use a spring-loaded tension clamps to ensure a reliable electrical connection in the presence of vibration. To open the clamps, use a small (1/8") flat-head screwdriver to push the terminal lever toward the board, the clamp will spring open. Insert the wire into the opening and release the lever to seal it. Wire the relays as required. The cable (provided by the customer) should have a minimum conductor size of 18AWG (1mm<sup>2</sup>).
5. Prepare the coaxial cable end according to the directions outlined in Appendix 3600-C-CL-1233. Connect the prepared BNC end to the female BNC connector on the 3600 Front End module.
6. To connect to the optional Digital Communication<sup>1</sup> card, run the Cat-5 cable through the bottom right-hand hub only. Prepare a standard male RJ-45 end and plug into the module.
7. Replace the cover to protect the electronics from damage.

When the installation is complete, refer to **Chapter 3, System Set-Up** to place the U3600-QAL1 in operation.

### 2.1.2 Circuit Board Adjustments and Connections

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<sup>1</sup> NOTE: If the U3600-QAL1 is initially purchased without a Digital Communication Card, this hub location will not be provided. A dedicated hub will need to be added by the customer when purchasing the Digital Communication card by itself.

There are several configurable options on the U3600-QAL1 Main Circuit Board. Additionally, should it become necessary to disconnect any of the cables that connect the electronics in the cover to the main circuit board, this will guide the user through the re-connection process.

### 2.1.2.1 Mode Selection

The 8-Position DIP Switch located in the center of the board, towards the left-hand side, controls several different options available on the U3600-QAL1. These options are shown below in Table 1:

**Table 1: Mode Selection**

	1 Frequency	2 Algorithm	3 Mode (Only Applies when 2 is "ON")	4 Automatic Gain Adjustment	5 Clear Settings	6 Error Flag Disable	7 Zero/ Span Check Duration	8 Force Zero/Span Check
<b>ON</b>	High Frequency	Manual (Use with DIP Switch Position 3)	AC Only	Disable (For Flow Applications)	Cycle Power with this Position "ON" to clear all settings	Probe fouling disable	Enters menu for setting zero/span check duration	Forces the unit into zero/span check
<b>OFF</b> (Default)	Low Frequency	Auto Algorithm (AC+DC Combined)	DC Only	Enable (Normal Operation)	Normal Operation	Normal Operation	Normal Operation	Normal Operation

**Position 1** (Frequency) will most commonly be used in the "OFF" position. This should be set "ON" only in special circumstances where the application relies more heavily on the AC portion of the signal (i.e. jacketed probes, ring sensors, etc).

**Position 2** (Algorithm) combines both AC and DC signals to achieve the best signal representation. Manual mode would be used only to isolate one portion of the signal from another. Used in conjunction with Position 3 to select DC-only or AC-only.

**Position 3** (AC/DC only) is not active when Position 2 is "OFF". When Position 2 is "ON", Position 3 set low ("OFF") will only register the DC portion of the signal. Position 3 set high ("ON") will only register the AC portion of the signal.

**Position 4** (Auto-Gain) will be used in the "OFF" position for general applications. Turning this selection "ON" will disable the Automatic Gain Adjustment and may be used for applications with high signal levels (i.e. flow).

**Position 5** (Clear) will clear all the settings entered by the customer and return to the default settings. To use this option, Position 5 should be set "ON" and then the power will need to be cycled. Be sure to set the bit "OFF" when done to prevent unwanted loss of settings.

**Position 6** This switch setting is used to disable the probe fouling indicator on the 4-20mA output (see Section 3.4.1). With Position 6 "ON" the 4-20mA output will continue transmitting the scaled output percentage, rather than the 24.0mA error condition. The relays will also still remain active, however the probe error light will continue to flash and the speaker will still beep if an error condition is detected.

**Position 7** This switch setting is used to set the duration of the zero and span checks. The default setting is 3 minutes. Setting this jumper to "ON" will allow the user to enter a menu which shows "dur" and a flashing number. Pressing up or down will increment or decrement the number, defining the length of time spent on each check (in minutes). Since span and zero checks occur in pairs, the total check time will be equal to two times the set duration. The minimum value is 2 minutes each

(4 minutes total) and the maximum value is 5 minutes each (10 minutes total). There is a five second gap between the span and zero checks. The frequency of the zero and span checks are fixed at once per day, occurring every 24hrs after the unit is powered up.

**Position 8** This switch setting will normally be set to “OFF.” If the customer wishes to manually force a zero and span check to happen prior to the normally scheduled once-per-day, this switch can be set to “ON” and the test will begin within five seconds, with the duration defined by the menu from switch position 7. Span and zero checks will continue to occur until the switch is set to “OFF”. If the switch is set to “OFF” while a check is in progress, the current check will run to completion before normal operation is resumed. See section 3.5 for more information on span and zero checks.

#### *2.1.2.2 Speaker and Fail-Safe Jumpers*

The speaker located in the lower right-hand corner of the main circuit board will beep when a button is pressed, or to alert when Alarm 1 or Alarm 2 are activated. If this sound is unwanted by the user, the speaker can be silenced with the jumper “J4”. This jumper comes factory-set to “ON”, but simply removing the jumper and relocating it to the “OFF” position will silence the speaker.

The relay contacts come factory set to “STANDARD” mode with the jumper marked “J10”, however they can be set to “FAIL-SAFE” mode if desired. This will reverse the sense of the Normally Open (**NO**) and Normally Closed (**NC**) contacts under normal conditions, but will return them to their **NO** or **NC** setting upon the loss of power.

**NOTE: Both relays are controlled by the “Fail-Safe” jumper. They cannot be individually set to Fail-Safe mode.**

#### *2.1.2.3 LCD Contrast Adjustment*

To adjust the brightness of the LCD backlight, the variable resistor (potentiometer) labeled “BRIGHTNESS ADJUST” is used. With a small Phillips-head screwdriver, turn the dial clockwise to increase the brightness, and counter-clockwise to decrease the brightness.

#### *2.1.2.4 LCD, Backlight, and Keypad Cable Connections*

There are three connections to the main circuit board from the electronics mounted in the cover: a 32-position FPC (Flex Printed Circuit) Cable for the LCD, a two-conductor wire for the backlight, and a five-position FPC for the outer keypad.

The 32-position FPC cable plugs into a ZIF (Zero Insertion Force) socket with a locking mechanism, “J1” (marked **LCD**). To disconnect the cable from the main board, lift up the outer edge around the top of the socket (this may be done with a fingernail or small screwdriver). This small plastic piece will only raise approximately 1/20” (1.27mm). This will allow the cable to be easily removed from the socket. When re-connecting the cable, be sure the locking mechanism is raised. The end of the cable has a stiffener piece to allow for easy connection. On the opposite side of the stiffener are thin copper conductors: these will face the center of the circuit board. Insert into the socket until the cable stops (approximately half of the stiffener piece will still be exposed), and push the locking mechanism back down towards the circuit board.

The backlight cable consists of two loose wires: red and black, with a socket at the end. Plug them into the header “J6” (marked **BACKLIGHT**), such that the black conductor is on the left, which is marked on the board as **BLK**. The red conductor should be on the right, marked **RED**.

**NOTE: The backlight may be permanently damaged if connected improperly.**

The keypad cable is a five-position FPC, which plugs into the header “J2” (marked **KEYPAD**). A small “1” and “5” can be noted on the socket at the end of the keypad FPC. Insert the socket onto the header such that the “1” on the socket is in the down position, marked with a **1** on the circuit board.

### **2.1.3 Interconnecting Remote Sensor Cable**

The following instructions must be followed carefully *using only cable supplied by Auburn Systems*:

Read the cable installation requirements thoroughly and then run conduit, following the specified requirements, from the electronics to the sensor.

#### ***Cable Installation Requirements***

The cable must be run at least 1.5 ft. (0.5m) away from all power lines, motors and strong electrical or magnetic fields.

Ideally, the cable should be run in its own separate plastic or non-conductive conduit. It should not be run in long continuous lengths of metal conduit. However, short portions of the run may be in metal conduit or liquid tight flexible metal conduit for greater physical protection or ease of installation. If a long continuous run of metal conduit is used, the conductive path it forms between the sensor and the electronics should be broken at the sensor, and periodically along the conduit with non-conductive bushings. This requirement is to minimize the possibility of ground loop noise pick up.

Multiple U3600-QAL1 coaxial cables may be run together in the same conduit. 4-20mA twisted-pair wire may also be run in the same conduit, but no power wires or cables can be run with them.

Use a loop of flexible conduit at the sensor to allow for easy sensor removal. Be sure to provide enough cable to fully withdraw the probe for inspection and cleaning.

Do not coil large amounts of excess cable; cut cable to length. Up to 1.5 ft. of excess (0.5m) in a pull box or 3 inches (75mm) at the electronics is acceptable.

Do not leave excess cable in either the sensor or U3600-QAL1 housings, as this may generate false signals.

Do not run cable such that it hangs and sways or is subject to a source of high vibration.

#### ***Cable Testing Procedure***

After the cable has been installed or, in the case of a field assembled cable, the lugs have been attached; the complete assembly should be checked as follows:

1. Ensure that the push-on terminals at the sensor and the BNC connector at the U3600-QAL1 are isolated from each other, any other conductors, and ground. They should not be connected to the sensor for this testing.
2. Using a DVM or VOM, check for an open circuit between the center conductor and braided shield of the cable (shell of the BNC). There should be no detectable conductivity.
3. If any conductivity does exist, examine the push-on terminals at the sensor end and for a conductive path through the black conductive layer between the braid and center conductor terminal. Second, check for physical damage to the cable. If neither exists, the BNC connector may have been crimped improperly.
4. If no conductivity is found, short the terminals at one end of the cable together and measure the resistance from the center conductor to the shield. The resistance should not exceed 10 Ohms per 100 ft. (30m). If it does, check for incorrect make-up of the push-on terminals as described above. Also, check for physical damage to the cable.
5. If a fault is found and repaired, repeat steps 1, 2 and 4.

## 2.2 Remote Sensor Installation

### 2.2.1 Remote Sensor Location

The series 2001 sensor is designed to be mounted directly on the filter outlet duct or stack for monitoring dust collectors or mounted directly on the pipe for flow applications. See Appendix 2001-C-IN-1539 or 2001-C-IN-1620.

The criteria for the preferred installation site when monitoring a dust collector is as follows:

1. The location must be accessible to permit routine maintenance.
2. The location must be downstream from particulate control equipment and free of high vibration. Ideally, installed in a straight section of duct after the equipment but before the fan or blower.
3. The location should be preceded by an unobstructed straight section of duct of at least (2) diameters in length and followed by an unobstructed straight section of at least (1) diameter. If the duct is rectangular, use the diagonal dimension in place of the diameter dimension to determine the length of the required straight sections. Obstructions include such items as bends, transitions, valves and blowers.
4. The location should be a sufficient distance from the stack exit so that outside atmospheric conditions will not affect the sensor. For example, a heavy rainstorm may cause a false signal if the sensor is located near the exit of an open vertical stack.

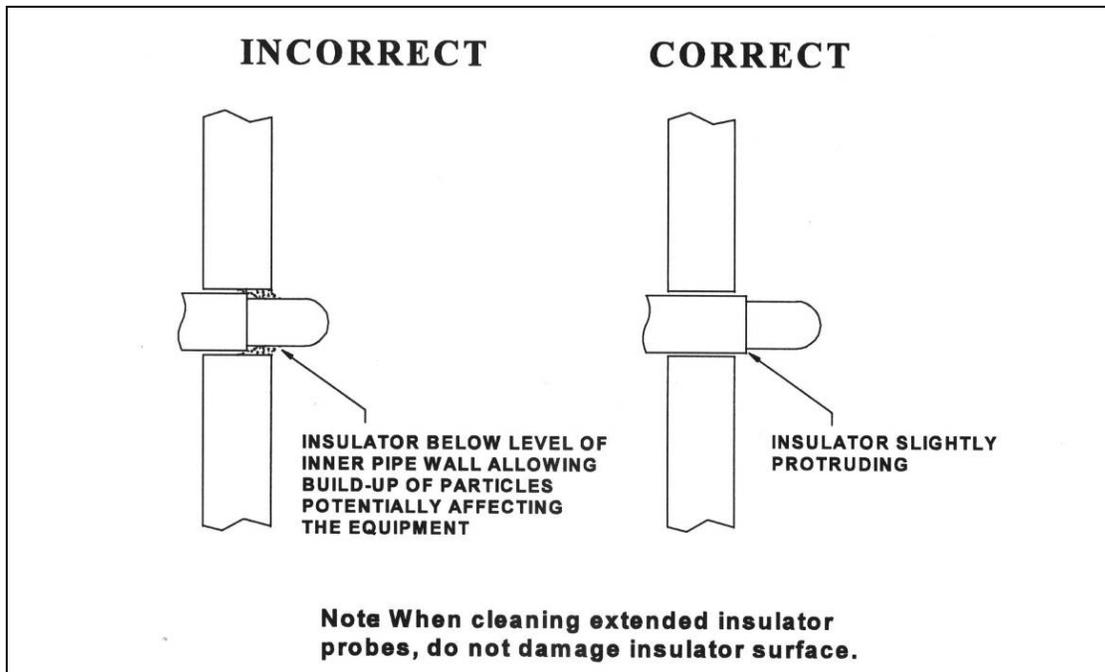
If the above conditions cannot be met, try to select a location that balances accessibility and consistent flow conditions or consult the factory for recommendations.

### 2.2.2 Remote Sensor Mounting

For horizontal lines, it is recommended that the sensor not be installed at the bottom of the duct to avoid build-up of material around the probe insulator. An optional air purge is available to keep the sensor insulator from being bridged by conductive solids. Consult the factory for the proper application of the air purge option.

The mounting requirements detailed in Figure 2 are designed to provide proper installation of the sensor. When installed, the insulator sleeve should not be recessed from the inner wall but should protrude into the flow stream (refer to Figure 2, on the following page). This eliminates space that would otherwise allow solids to pack around the probe.

Figure 2: Remote Probe Insertion Detail



If the sensor is to be mounted in a *non-metallic* pipe or duct, the following special precautions must be taken to prevent the detection of stray electric fields.

1. If the U3600-QAL1 is to be installed after a dust collector or where only a light dust loading is present an electrostatic (Faraday) shield must surround the pipe or duct for three diameters both up and down stream. **The shield must make electrical contact with the sensor body and an earth ground.**
2. If a heavy dust or solids loading is present, the **Remote Sensor must be installed in a section of metallic pipe or duct.** The section should extend as far up stream as possible, two diameters downstream and **must be earth grounded.**

Failure to correctly install the sensor may prevent the unit from operating reliably; therefore, any modifications to the procedure should be discussed with the factory.

**NOTE: The Remote Sensor must be provided with an earth ground, either through the ductwork or by a separate means.**

### 2.2.3 Remote Sensor Connection

If the sensor is mounted with a “Quick Release” fitting, sufficient flexible conduit lengths must be provided so that the sensor probe may be withdrawn from the duct for inspection without disconnecting the conduit.

1. Remove the screw-on cover.
2. Crimp the large push-on terminal onto the prepared cable braid as shown in Appendix 3600-C-CL-1233.
3. Crimp the small push-on terminal onto the prepared coaxial center conductor. Ensure the black semi-conductive layer has been scraped away from the terminal leaving the white Teflon insulator exposed.
4. Connect the large push-on terminal to the large spade (connected to the probe housing) and the small push-on terminal to the small spade (connected directly to the probe).
5. Replace the screw-on cover to protect connections.

**NOTE: The OVP connected between the probe and housing must remain connected. If you suspect that the OVP is causing false signals, contact the factory for a replacement or to return the probe for inspection.**

# Chapter 3: System Operation

## 3.1 Understanding the U3600-QAL1 screen

When in operation, only the relevant screen parts will be lit and / or flashing. In the following diagram all parts have been lit for easier viewing:

Figure 3: Main Display Screen



**Note:** Logarithmic scaling is not available and menu items have been disabled.

## 3.2 Number entry guidelines and shortcuts

To adjust the range, view alarm thresholds, or otherwise navigate the U3600-QAL1 menu, it is not necessary to access the inside of the enclosure. The outer label (shown below in Figure 4) has built-in keys for access to the menu and settings.

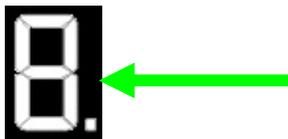
Figure 4: Outer Label with Push-Button Keys



- When in input mode, the item you are programming will light up and blink. At this time you can press the  or  key on the keypad, to reveal the blinking underscore ( \_ ) in the number input area.
- Use  or  to set number. Press  to go to next digit.
- To skip an entry, press  when there is an underscore, it will skip to the next place. For example, you can enter \_\_\_\_10 instead of 000010 by pressing  for the first 4 digits.
- The negative sign will only be an option if a negative number is allowed and can only be the first character. It will appear for selection between the 0 and the 9.
- The decimal point will only appear if allowed and can only appear once in any number. The first digit cannot be a decimal point, if you need to start with a decimal point enter 0 first, then the decimal point.
- If the Decimal point is available, it will appear between the 0 and the 9, and it will look like this during selection mode:



If selected it will become a decimal point:



- When you are finished with the last digit, the numbers will flash. Press  to accept, press  or  to start over.
- If you press  or  by mistake and want to go back to the last setting, press  to go back to the last setting.

### 3.3 Reviewing and programming the configuration

The **U3600-QAL1** has 4 states that can be accessed using the buttons on the enclosure:

1. **Run-time State:** The default state and the normal operational state of the **U3600-QAL1**.
2. **Calibration Display State:** In this state you can review and select the display units if a calibration factor has been entered – otherwise only pA is displayed.
3. **Configuration Review State:** In this state you can review, but not change, all the set parameters in the Alarm, Smoothing, and Calibration sections of the **U3600-QAL1**.
4. **Editing State:** This state allows you to view and change all set parameters, including the password.

#### 3.3.1 Run-time state

##### **Reaching the run-time state:**

The U3600-QAL1 will power on in the run-time state. If you are in another state, pressing  will return you to the run-time state.

### **Available actions:**

 will scroll between % mode (measured in %) and absolute mode (measured in **pA** or **mg/m<sup>3</sup>** depending on whether a calibration factor has been entered)

 will take you to the **calibration display state**

 will take you to the **configuration review state**

 will take you to the **editing state** (password required if set)

### **3.3.2 Calibration Display State**

To reach the **calibration display state** from the run-time state, press .

#### **Navigating this state:**

- Pressing the  or  buttons will cycle through calibrations (**pA**, **Cal**, **Cal2**).
- Only pA is displayed unless a factor (Cal, Cal2) has been entered to calibrate to mg/m<sup>3</sup>
- If you do not press any buttons for ten seconds you will time-out and be returned to the run-time state.
- Pressing  will return you to the run-time state.

#### **Selecting the calibration:**

1. Use the  or  buttons to cycle through enabled calibrations.
2. When the calibration you want is flashing, it is selectable.
3. Press  enter to select it, then press  again to lock in your choice.
4. If a password is required you will be prompted to enter it. Once you enter the password, the calibration will be locked in and you will be taken back to Run-time mode.
5. The system will only display the choices for enabled calibrations. A calibration can be enabled in the calibration editing screen (see section 3.3.5, Calibration selection) by setting the slope to a value other than 0. Both Cal and Cal2 calibrations are disabled by default at the factory.

### **3.3.4 Configuration Review State (Read only)**

- To reach **configuration review state** from the run-time state, press .

#### **Navigating this state:**

- Pressing the  or  buttons will cycle through the parameters of the Alarm, Smoothing and Calibration Sections.
- If you do not press any buttons for ten seconds you will time-out and be returned to the run-time state.
- Pressing  will return you to the run-time state.

### 3.3.5 Editing State

To reach the **editing state** from the run-time state, press  (password required if set)

#### Navigating this state:

- Pressing the  or  buttons will cycle through the editable items within the section.
- If you do not press any buttons for one minute you will time-out and be returned to the run-time state.
- Pressing  will save changes for the item you are editing and take you to the next item.
- Pressing  will discard any changes to the item you are currently setting and return you to the run-time state.

#### Editing items:

Pressing the  or  buttons will cycle through the editable items in each section. There are six sections: Scaling, Alarms, Smoothing, Calibration, IP Address, and Password. If you do not want to make any changes in a section, pressing  will advance you to the next item. In order to save your settings, you must advance all the way through to the next section. If you return to Run Time State before the end of a section, any changes will be lost.

#### 1. Scaling mode section:

The scaling factor is depicted in scientific notation and is used to calculate the maximum range of the unit.

- Use  and  to set the significant digit (1-9), then press . Use  and  to set the exponent (0-3), then press  to save and go to Alarm selection. Setting an exponent of 3 will limit the significant digit to a maximum value of 5 (range 0-5 with exponent 3).

**Scaling/Range Selection Chart**  
Linear Mode (relative full scale = 100)

Scaling	Full Scale Range (pA)	Scaling (n = 1 ~ 9)	Full Scale Range(pA)
X 1 E 0	100	X n E 0	n * 100
X 1 E 1	1,000	X n E 1	n * 1,000
X 1 E 2	10,000	X n E 2	n * 10,000
X 1 E 3	100,000	X n E 3	n * 100,000

**Note:** Full-scale range of U3600-QAL1 is 500,000pA. “n” will only increment to 5 when set to X n E 3.

## 2. Alarm section:

The U3600-QAL1 has one customizable alarm scheme which controls the relay Alarm 1. The Alarm scheme has three components: < or >, Threshold, and Delay.

- 2.1. **Alarm 1:**  and  toggle the selection between > (high alarm) and < (low alarm). Press  to select the alarm type and go to the next choice. Use  and  to select the threshold number, and press  to select the digits. Press  again to enter the threshold and go to the next choice.
- 2.2. **Alarm 1 Delay** (seconds): Use  and  to select the seconds of time delay, and press  to select the digits. Press  again to enter the Alarm 1 Delay settings and go to the next editable parameter.
- 2.3. **Alarm 2:** is not customizable. This relay is switched when the U3600-QAL1 goes into the routine zero and span checks.

**Note:** The **default** factory settings for Alarm 1 set to be a high alarm, and the level is set at 50% of the user selected full scale.

**Note:** To disable a high alarm, set the level to 100%, or to disable a low alarm, set the level to 0%.

## 3. Signal smoothing selection:

This feature adds a time constant to average the signal data. It is used to “smooth out” a signal to help prevent false alarms and provide better signal control.

- 3.1. Signal smoothing (**Del 2**): use  and  to select the **Signal smoothing** (seconds). Press  to select the digits. This parameter has a maximum value of 30 seconds. Press  again to enter the Signal Smoothing settings and go to Calibration selection.

**Note:** Using too much smoothing will over dampen the signal and possibly mask events

## 4. Calibration section:

The U3600-QAL1 can display the signal in mg/m<sup>3</sup> if the pico amp signal has been correlated using stack test data. (ie EPA Method 5) The unit can store two calibration factors, displayed as Cal and Cal2. The correlation is entered in two parts: Slope and Offset. These fields are decimal point enabled, and the Offset also has the negative sign (-) enabled.

- 4.1. Calibration 1 (**Cal**): is used to create a straight-line correlation. The output is calculated by the following equation: Output = Slope \* pA reading + Offset (where Slope and Offset are entered by the user).  
Use  and  to select the **Slope**, pressing  to enter the digits  
Press  again to enter the **Slope** and to go to the next choice. Repeat the process to select and enter the **Offset**. Press  to save and go to Calibration2.
- 4.2. Calibration 2 (**Cal2**): is used to create a curved correlation. The output is calculated by the following equation: Output = Slope \* (pA reading ^ Offset). Both Slope and Offset are entered by the user, however in this case the Offset entered is working as an exponent.  
Use  and  to select the **Slope**, pressing  to enter the digits Press  again to enter the **Slope** and go to the next choice Repeat the process to select and enter the **Offset**. Note that **Offset** has a maximum value of “2”. Any entered number above this threshold will be displayed and saved as “2” by default. Press  to save and go to Password (if Digital communication card is not installed) or IP address selection (if Digital communication card is installed).

**Note:** If the slope of either calibration parameter is set to ‘0.0’, the calibration is disabled.

## 5. IP address section:

If the U3600-QAL1 includes the digital output module, you will need to enter an IP address so that the unit can be recognized on a network. The IP address is broken out into 4 segments, each segment containing up to three digits.

**Note:** The Ethernet cable should not be plugged in when changing the IP address.

- 5.1. IP address segment 1 (IP1): use  and  to select digits, press  to accept each digit and pressing  again to enter the **IP address segment 1** and advance to IP address segment 2.
- 5.2. IP address segment 2 (IP2): use  and  to select digits, press  to accept each digit and pressing  again to enter the **IP address segment 2** and advance to IP address segment 3.
- 5.3. IP address segment 3 (IP3): use  and  to select digits, press  to accept each digit and pressing  again to enter the **IP address segment 3** and advance to IP address segment 4.
- 5.4. IP address segment 4 (IP4): use  and  to select digits, press  to accept each digit and pressing  again to enter the **IP address segment 4** and advance to the Password.

**Note:** The address will take effect without further action, however it may take up to a full minute before the address will fully program into the module and become active on the network.

## 6. Password section:

**The password must be a number 1-4 digits in length with a value between 1 and 9,999.**

- 6.1. If a password is already set, press  to keep the same password and return to Run Time State.
- 6.2. To select a new password use the  and  to select digits, press  to accept digits to enter the new password, then press  to save and since this is the last section you will return to Run Time State.

**Note:** if password is set to '0', the password protection is disabled.

## 3.4 Understanding errors and alarms

### 3.4.1 Probe error light

If the U3600-QAL1 experiences a probe error or malfunction, it will indicate a probe error by lighting up the red X in the upper right-hand corner of the display:



Additionally, a special 24.0mA error flag will be transmitted on the 4-20mA output unless disabled by DIP switch position 6 (see Section 2.1.2.1 for more information on disabling the 4-20mA error flag).

A probe error can be caused by various reasons including:

- Battery effect - when contaminant passing across the insulator generates some voltage, acting like a battery
- Bridging effect – particles building-up across the insulator are conductive

**CAUTION:** When the probe error light is on, the unit is not functioning properly. Investigate and resolve the cause of the malfunction.

### 3.4.2 Alarms

When an alarm is tripped, the corresponding alarm name and warning icon will light up and flash.

**Note:** Alarm parameters are set by the user. When an alarm is triggered, follow the appropriate protocol for your particular Alarm settings.



**Alarm 1** and the Alarm 1 Icon will flash when Alarm 1 threshold is triggered.

## 3.5 Span and zero checks

The U3600-QAL1 performs automated span and zero checks once every day in accordance with EN 15267 specifications. Every 24 hours after the unit has been powered on, one span check and one zero check will trigger and each run for the duration set in the duration menu (DIP switch 7, see section 2.1.2). The default duration for each check is 3 minutes.

### 3.5.1 Span check

24 hours after the U3600-QAL1 has been powered on, the unit will automatically begin a span check.

The start of a check will clear any active alarm (probe error or Alarm 1), and the word “span” will briefly appear on the screen as the check is initialized. Alarm 2 will activate during the duration of the check, and normal signals from the probe will not be processed.

During a span check, the unit will send itself a pA value equal to 80% of the device’s set range (see section 3.3.5 for information on device range). Note that although regular alarm settings and ranges may be altered during a check, the unit will calculate check passing based upon the range set at the start of the check.

If the average reading over the duration of the check falls within the allowable limits, the unit will display “pass” briefly and prepare for a zero check. If a check has not passed, the Alarm 1, Alarm 2 and Probe Error lights will flash and the word “fail” will display on the screen. The unit will then launch another span check. See section 3.5.3 below for information on check failures.

### 3.5.2 Zero check

Five seconds after the successful completion of a span check, a zero check will automatically trigger.

At the start of a zero check, the word “zero” will briefly display on the screen. The duration of the zero check will be the same as the duration of the span check (set with DIP switch 7, see section 2.1.2 for details). As with the span check, the U3600-QAL1 will not receive sensor readings for the duration of the check.

If the unit has successfully stayed below the allowable signal limit for the duration of the check, the word “pass” will display on the screen and normal device operation will resume. Like with the span check, a failed zero check will force the Alarm 1, Alarm 2 and Probe Error lights to flash and the word “fail” will display on the screen. The unit will then trigger another zero check. See section 3.5.3 below for information on check failure.

### 3.5.3 Check failure

Multiple failed checks of either variety are an indication of hardware failure. The U3600-QAL1 will continuously trigger the failed check type until either the unit is powered off or the check is passed. If a unit is stuck in a specific check, please contact Auburn Systems for assistance. Cycling power will reset the device and allow normal operation until the next 24 hour check.

### 3.5.4 Forcing a check

The operation of span and zero checks may be triggered before the automatic 24 hour test by toggling DIP switch position 8 to “ON”. 5 seconds after the switch is toggled, a span check will begin. As with normal check operation, a zero check will occur immediately after a successful span check. If the DIP switch is toggled back to the “OFF” position in the middle of a check, the current check type (meaning single span or zero check) will run to completion until the U3600-QAL1 resumes normal operation.

**NOTE:** Forcing a check before the automatic 24 hour check will not affect the daily test: a span and zero check will still occur every 24 hours after the unit has been powered on.

# Chapter 4: Sensor Options

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## 4.1 Probe Length

For dust monitoring applications, the probe should extend approximately halfway across the duct. The standard available lengths are: 1/2, 3, 6, 12, 18, 30, and 36 inches (1, 8, 15, 30, 45, 76, and 91 cm). Other special lengths are available.

## 4.2 Abrasion Resistance

The standard probe material is 316 stainless steel, although other probe materials are also available. Particularly abrasive conditions are rarely present in dust collectors; however, when high abrasion may be present such as when process flow streams are monitored, solid tungsten-carbide probes are available up to 3 inches (7.6 cm), and for probes longer than 3 inches (7.6 cm), tungsten-carbide coated probes are available to strengthen the probe surface.

## 4.3 Jacketed Probes

Conductive solids such as some coal materials, or wet powders, can cause failure in the form of creating a conductive path from the duct wall to the metallic probe surface, thus "bridging" the sensor to ground. Incorporation of an optional insulated "jacketed" sensor probe in these applications will prevent, sensor bridging, in most cases.

**NOTE:** It is important to contact Auburn Technical Support for proper application of the insulated "jacketed" probe.

## 4.4 Special Sensors

In addition, many other special sensor configurations are available to resolve unique applications that may interfere with normal operation; Some examples include: In-line pin or ring sensors for small diameter pipes; Venturi sensors for monitoring ambient dust in an enclosed area; Square or V-shaped sensors in special flow applications. Please call Technical Support to discuss unique application issues not discussed here.

## 4.5 Ambient Air Monitoring

The U3600-QAL1 when combined with an Air Amplifier probe can also be used to monitor ambient dust levels in a room, rather than in an enclosed duct. The relative amount of particulate in a room is sampled by using compressed air to induce a draft across a probe. Although this device monitors the buildup of dust concentrations, it does NOT detect the onset of an explosion.

# Chapter 5: Routine Maintenance

Establish a routine maintenance program for the U3600-QAL1 using the following guidelines:

## 5.1 Cleaning

The sensor probe and insulator should be checked periodically to determine if, and at what intervals, cleaning may be required. When monitoring a dust collector, the sensor should also be checked after a major filter break, bag change out or other major process upset. The conditions to look for when inspecting the probe are:

- Build-up of material on the probe – establish cleaning intervals to avoid heavy build up of material on the leading edge of the probe. While such leading edge build-up has occurred, it is rare. Build-up on the trailing edge is of no concern.
- Examine the probe for the presence of wet material, condensed liquids or conductive materials. If these conditions are found to be present, consult Auburn Technical Support.

To clean the sensor, wipe down the probe and insulator with a clean, dry rag. Do not use liquids or abrade the insulator. This is especially important, as abrading the insulator will allow material to adhere to it and potentially bridge the probe to the housing, causing a false signal.

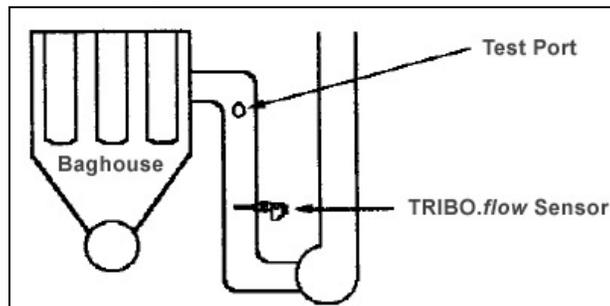
## 5.2 Functional Check

If the process conditions permit, Auburn recommends the installation of an upstream test port as described below. This port can be used to simulate anomalies within the collector system by introducing a small amount of dry powder into the process, (i.e. talcum powder) to test the system response. If possible, the test material should be the same, or similar, to the material being monitored or processed. Inject enough material to register at the receiving device.

The test port requirements are:

- access to the duct several diameters upstream of the U3600-QAL1
- negative pressure at the test point (vacuum side of the fan)
- small re-closable opening in the duct work (i.e. ½ NPT plug or similar)

Figure 5: Test Port Installation



## 5.3 System Zero Check and False Signal Isolation Procedures

### 5.3.1 System Zero Check Procedure

The U3600-QAL1 does not require manual zeroing adjustments. The unique, fully-digital front-end features very low drift with temperature and is automated such that it will perform an automatic calibration upon start-up and at routine intervals.

### 5.3.2 Remote Sensor False Signal Isolation Procedure

1. Disconnect only the center conductor terminal at the remote sensor head and ensure that it is not in contact with anything. It must be completely isolated.
  - A. Place the cap back on the sensor housing.
  - B. If the signal drops down to below 3pA, the false signal was coming entirely from the probe. If the signal drops, but not to below 3pA, there is some false signal from the probe, but also some is coming from the electronics and/or cable.
  - C. In either case, the next step is to clean the sensor probe and especially the insulator **with a clean dry rag**. Do not use liquids. Then, re-install the sensor and reconnect the push-on terminals.
  - D. If cleaning didn't change the signal, check for conductivity across the small, round OVP component in the remote sensor housing using a DVM or VOM. If any conductivity is indicated, the OVP should be replaced.

**CAUTION: Do not remove the OVP and leave the probe in service. Contact the factory for replacement or repair.**

- E. If the OVP is an open circuit and the cleaning didn't change the false signal, proceed to Step 2.
2. If the reading did not drop to 3pA or less in Step 1 after disconnecting the center conductor, either the cable or electronics is creating a false signal.
  - A. Remove the braided shield and the center conductor from inside the sensor probe and completely isolate them from each other as well as from the probe housing.
  - B. If the remaining false signal is eliminated, it was coming from the cable. Check the cable terminals and verify that the cable is run in conduit and away from electrical or magnetic fields as described in **Section 2.1.3, Cable Installation Requirements**.
  - C. If a signal remains with the cable disconnected at the sensor probe, the cable should then be disconnected at the electronics.
  - D. With no cable connected at the electronics, an output of approximately 2-3pA is not uncommon. If the output signal is much higher than that, the false signal is coming from the electronics. Check that line voltage is not present near the front end module. Otherwise contact the factory for assistance.

If the preceding procedures do not prove sufficient, contact the manufacturer:

#### **Auburn FilterSense**

800 Cummings Center, Suite 355W, Beverly, MA 01915

Tel: (978) 777-2460 in Massachusetts

**Toll Free: 1-800-255-5008 in U.S.**

# Chapter 6: Troubleshooting

## 6.1 Troubleshooting Procedures

Trouble	Corrective Action
The U3600-QAL1 will not turn on when power is applied	<p>Check the fuse F1 located next to the power terminal block. If it is open, contact the factory for replacement.</p> <p>Check that proper voltage is present on the power terminal block.</p>
The display shows signal, but there is no 4-20mA output	<p>Check the fuse F2 (when using Self-Pwr), located below the STATUS LED. This may require needle-nose tweezers. If it is open, contact the factory for replacement.</p> <p>Check the fuse F3 next to 4-20mA terminal block. If it is open, contact the factory for replacement.</p> <p>Ensure that there is no external power supply when using SELF power option.</p> <p>Ensure that there is 24V on the terminal block when using LOOP power option.</p>
Unit does not respond to flow variation	<p>Check that the probe protrudes at least half-way across the duct.</p> <p>Check that the center conductor is firmly connected inside the remote probe head and that the BNC connector is properly made up.</p> <p>Check that the scaling is set to provide proper resolution.</p> <p>Check that the signal smoothing (<b>Del 2</b>) is not set too high.</p>
Unit shows 100% signal with no flow or little flow across the sensor	<p>Check that the cable ends are made up properly. See Appendix 3600-C-CL-1233.</p> <p>Check that the scaling is set to provide proper resolution.</p> <p>See Section 5.3.2 for false signal isolation procedure.</p>
There is nothing displayed on the LCD but the STATUS LED is still blinking	<p>Check that the FPC cable is securely plugged into J1, with the exposed conductors facing the center of the board. (Refer to section 2.1.2.4)</p> <p>Check that the brightness is not set too low.</p>
4-20mA is outputting less than 4.0mA	<p>The 4-20mA output on the U3600-QAL1 is designed to output currents below 4.0mA if the scaled output is less than 0 with a minimum of 3.2mA. If the output current is less than 3.2mA, contact Auburn Systems.</p>

## 6.2 Recommended Spare Parts

Item Description	Reference Designator	Value	Part Number
Power Fuse	F1	1A, 250V	190-MCPMP-1A-250V
4-20mA Self-Pwr Circuit Fuse	F2	375mA, 125V Slow	190-0452.375MRL
4-20mA Circuit Fuse	F3	62mA, 125V Fast	190-0451.062MRL
Power Plug	TB5	3-Position Plug	723-231-203/037-000
Front End Card			116-3600-QAL1-FE
BNC Field Kit			094-BNC-Field-Kit
Cable			089-1CSTJLON01

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## Contact Auburn Systems

For questions, concerns, or to order more products, please contact us:

**Auburn FilterSense**

800 Cummings Center, Suite 355W, Beverly, MA 01915

**Tel:** + 978.777.2460

**Toll Free:** 1.800.255.5008 in U.S. or Canada

**Fax:** + 978.777.8820

**Email:** [Sales@auburnsys.com](mailto:Sales@auburnsys.com)

# TRIBO.dsp U3600-QAL1 Modbus Register Mapping

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U3600-QAL1's real time data device ID is 64 on the destination IP address, all data are mapped to holding registers

Register Number 4xxxx (Address)	Length (Number of Registers)	Data Type	Parameter
5 (4)	2	Floating point	Raw current
7 (6)	2	Floating point	Real-time data for Calibration 1
9 (8)	2	Floating point	Real-time data for Calibration 2
11 (10)	1	16-bit Integer	Relative real-time data (0 ~ 65535, as % of range)
12 (11)	1	16-bit Integer	Alarm flag: Alarm1: 0x01; Alarm2: 0x02; Probe error: 0x04
17 (16)	1	16-bit Integer	Working mode flag: Hi res: 0x01; Hi speed: 0x02; Hi gain: 0x04
18 (17)	1	16-bit Integer	Padding "0"
19 (18)	2	Floating point	Current BOV
21 (20)	2	Floating point	Reference BOV
23 (22)	2	Floating point	ACDC ratio

U3600's configuration data device ID is 32 on the destination IP address, all data are mapped to holding registers

Register Number 4xxxx (Address)	Length (Number of Registers)	Data Type	Parameter
4 (3)	1	none	gap
5 (4)	2	Floating point	Scale Factor
7 (6)	1	16-bit Integer	Averaging Window/Time Constant (in seconds)
8 (7)	1	none	gap
9 (8)	2	Floating point	Calibration 1 Slope
11 (10)	2	Floating point	Calibration 1 Offset
13 (12)	2	Floating point	Calibration 2 Slope
15 (14)	2	Floating point	Calibration 2 Exponent
17 (16)	1	16-bit Integer	Calibration Parameter Set (0: raw current; 1: calibration parameter set 1; 2: calibration parameter set 2)

# TRIBO.dsp EtherNet/IP Configuration

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TriboDSP U3600-QAL1 uses the ExLink 6102 module as MODBUS slave.

- We use node 64 for data update
- Please Use the Generic Ethernet Module.
- Data format: Data Int
- Please use the Node 32 No Handshaking Pair:

Input Instance: 101  
Input Size: 200 (400 bytes)

Output Instance: 113  
Output Size: 200 (400 bytes)

Configuration Instance: 128  
Configuration Size: 0

- Use an RPI: 50ms.

The usage of registers is following MODBUS practice, the detailed register definition is listed below.

Register Number	Length (Number of Registers)	Data Type	Parameter
40005 (4)	2	Floating point	Raw current
40007 (6)	2	Floating point	Real-time data for Calibration 1
40009 (8)	2	Floating point	Real-time data for Calibration 2
40011 (10)	1	16-bit Integer	Relative real-time data (0 ~ 65535, as % of range)
40012 (11)	1	16-bit Integer	Alarm flag: Alarm1: 0x01; Alarm2: 0x02; Probe error: 0x04
40017 (16)	1	16-bit Integer	Working mode flag: Hi res: 0x01; Hi speed: 0x02; Hi gain: 0x04
40018 (17)	1	16-bit Integer	Padding "0"
40019 (18)	2	Floating point	Current BOV
40021 (20)	2	Floating point	Reference BOV
40023 (22)	2	Floating point	ACDC ratio