Tu•Xchange™
User Manual

Version 1.89
20 May 2016

Revision History

Revision	Date	Description	Author
Version 1.3	06 March 2013	Updated Sensor Specifications	Dustin Olender
Version 1.4	20 June 2013	Edited for grammar and uniformity with other manuals	Jehan Zouak
Version 1.5	25 March 2014	Added Technical Drawing	Jehan Zouak
Version 1.6	15 July 2014	Updated Sensor Specifications	Jehan Zouak
Version 1.7	22 July 2014	Added averaging description	Chris Bueley
Version 1.8	16 Sept 2014	Updated default average	Dustin Olender
Version 1.81	19 Sept 2014	Updated technical drawing	Jehan Zouak
Version 1.82	30 June 2015	Turbidity averaging updates	Jehan Zouak
Version 1.83	24 September	Turbidity averaging updates	Jehan Zouak
Version 1.84	19 October 2015	Turbidity averaging updates	Dustin Olender
Version 1.85	19 November 2015	Added wiper information and maintenance	Lisa Bethell
Version 1.86	27 November 2015	Added response time characteristics and auto-range description	Kyle Cameron
Version 1.87	08 December 2015	Added new renderings	Kyle Cameron
Version 1.88	15 December 2015	Editing	Dustin Olender
Version 1.89	20 May 2016	Updates	Jehan Zouak

Table of Contents

General Description

AML Oceanographic's Tu•Xchange™ sensor is the industry's only field-swappable turbidity sensor. Tu•Xchange sensors store all pertinent manufacturing and calibration data internally. This allows the sensor to be swapped between any Xchange™ enabled instruments without manually updating the calibration coefficients. Calibration sheets can be printed on demand by any instrument connected to the SeaCast software. Re-calibrations only require the sensor, not the instrument, to be shipped to the service centre.

Tu•Xchange sensors are available with or without a replaceable silicone wiper. A wiper ensures that the optical surface is free of physical debris or air bubbles when the sensor takes a reading. The wiper is rated to a depth of 200 m. Sensors without a wiper have a maximum depth rating of 300 m.

Where Do I Start?

AML Oceanographic X•Series instruments and sensors ship with several manuals on the USB stick:

- An instrument manual providing an overview on how to use and maintain the instrument;
- A SeaCast manual providing instructions on how to use the software to configure the instrument and review instrument data;
- Xchange™ sensor manuals (CT•Xchange, C•Xchange, SV•Xchange, P•Xchange, T•Xchange, and Tu•Xchange) providing overviews on how to install and maintain each of the Xchange™ sensors;

If you are configuring an instrument for field use or lab testing, begin with the SeaCast manual.

If you are performing instrument maintenance, begin with the instrument manual.

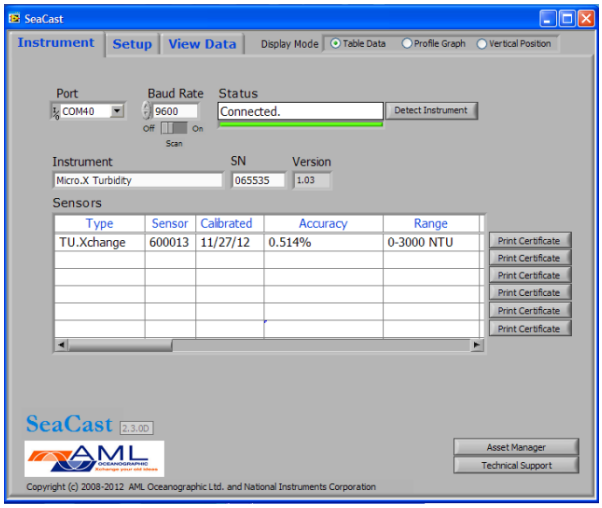
If you are planning to swap an Xchange™ sensor, read the Xchange™ manual corresponding to your sensors.

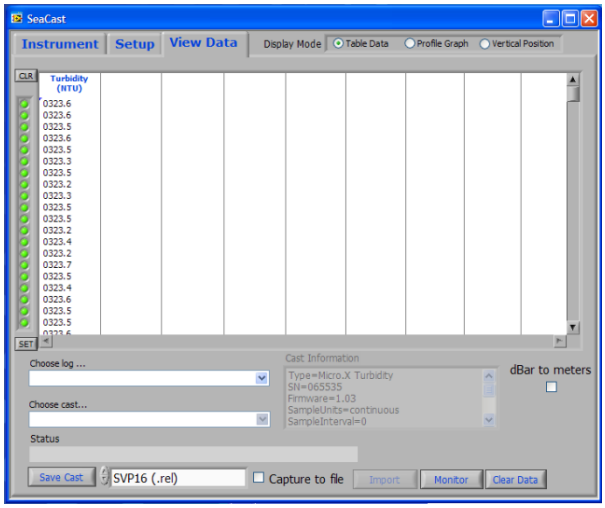
Shipping and Receiving

Receiving the Sensor

When receiving a new sensor, perform the following steps to ensure the sensor will be ready for deployment when required:

- Inspect the shipping container, looking for signs of damage. Damage to the shipping container could indicate damage to the sensor inside.
- Inspect for damage
    - Check the sensor for cracks or bends
    - Check the connector for corrosion, dirt, and salt deposits
- Connect the sensor to an instrument, ensuring it is installed tightly onto its mount. The blue locking sleeve should be tight, and sitting less than 1mm from the instrument end cap.
- Connect the instrument to a computer using the data cable. Launch SeaCast and verify that the *Instrument* tab is displaying accurate Tu•Xchange sensor information. The sensor's serial number and last calibration date should be displayed.
- On the *View Data* page select "Monitor," and allow the instrument to sample some data, as shown below. If the sensor is in air, it will read as zero. This will confirm the sensor is working.





Returning a Sensor to the Factory

- If shipping for repair or recalibration, obtain an RMA number from the service centre.
- Pack the instrument in its original shipping box to prevent damage during shipping.

An RMA number can be requested using the contact options given in the Support section of this manual.

Using the Sensor

Pressure Ratings

Tu•Xchange is rated to operate to a standard depth of 300 m for non-wipered and 200 m for wipered sensors. However, the instrument and other installed sensors will all have their own depth ratings. **Deployments should never exceed the lowest of these pressure ratings.**

Installing the Sensor

- Select a Tu•Xchange that is compatible with your deployment.
- Ensure that the instrument socket is clean and dry.
- Check the sensor's O-rings for cleanliness (see below, Inspecting and Replacing the O-Rings).
- Align the sensor to the sensor mount.
- Place the sensor into the mount.
- Rotate the sensor until it drops down into the mount enough to allow the blue locking sleeve threads to engage the mount threads.
- Screw down the blue locking sleeve until it stops. The bottom of the sleeve should be within 1 mm of the instrument end cap.



Removing the Sensor

- If the sensor has been used in salt water, rinse it in fresh water.
- Dry the sensor before removal to protect the connector.
- Unscrew the blue locking sleeve.
- Lift the sensor out of the mount.
- Ensure that the instrument socket is dry and clean, using compressed air if necessary.
- Immediately insert the blanking plug or a replacement sensor in the open socket.

T•Xchange, P•Xchange & Tu•Xchange Blanking Plug

Pre-Deployment Procedures

- Upon Receipt
    - Use the instrument Shipping and Receiving instructions to verify the condition of the instrument.
    - Verify the sensor calibration is valid for the duration of the deployment. If not, swap the sensor for one with valid calibrations or send it to a service centre for recalibration.
- Before leaving the jetty
    - Ensure the sensor is properly mounted on the instrument. The blue locking sleeve should be fully threaded onto the sensor mount of the instrument, sitting less than 1mm from the instrument end cap.
    - Test the instrument in water to ensure the sensor is functioning properly.

Post-Deployment Procedures

- Ensure the sensor is clean and dry before storage.

Maintaining the Sensor

Periodic Maintenance

Periodic maintenance will prolong the life of the sensor. The following is recommended:

- If the sensor is dirty or oily, allow it to soak in warm, soapy water before cleaning with a rag or soft brush. When finished, rinse with fresh water to remove any residual soap or dirt.
- Before each deployment
    - Check the sensor is properly seated on the instrument.
    - Check the sensor for cleanliness or damage.
- After each deployment
    - Clean and rinse the sensor using fresh water.
    - Inspect the optical surface at the tip of the sensor for fouling. Gently wipe the surface with moist lens cleaning paper if necessary.
- Before installing on an instrument
    - Check the sensor for cleanliness or damage.
    - Check the o-ring under the blue locking collar of the sensor for cleanliness and silicon grease.
- Removing from an instrument
    - Ensure the sensor is clean and dry before removing.
    - Install a new sensor or blanking plug into the instrument to protect the contacts of the sensor mount.
    - Safely store the sensor.
- Yearly
    - Send the sensor to a service centre for diagnostics and re-calibration.
- Long term storage preparation
    - Ensure the instrument has been thoroughly cleaned and dried.
    - Remove all Xchange™ sensors from the instrument and dry the connectors.
    - Lubricate the instrument and Xchange™ sensor connector contacts with a silicone spray.
    - Lubricate the retainer rings and o-rings with silicone grease.
    - Install connector and sensor blanking plugs in the instrument.

Field Calibration

Refer to "Appendix B – Tu•Xchange Field Calibration" in the SeaCast 4 User Manual.

Wiper Operation

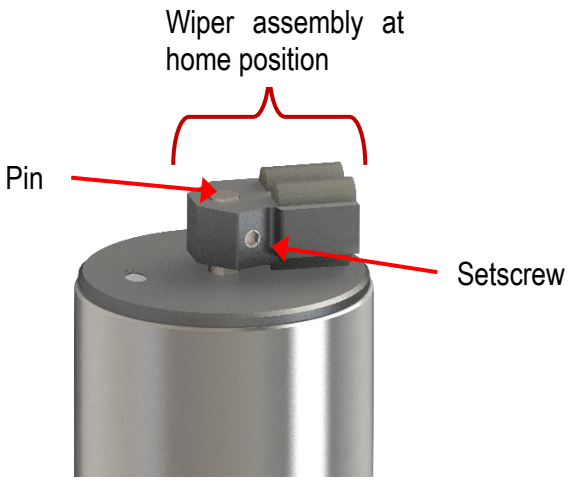
When activated, the wiper cycles through one 360 degree arc, and then returns to its home position. This process takes about 8 seconds. The wiper activates once during initial power up of the instrument, or when waking up from low power or sleep mode. If the instrument has a high enough sampling rate that it does not enter sleep mode, the wiper is set to activate once approximately every 17 minutes. Note: A power interruption will cause the wiper to stall, but it will return to the home position when power is regained.

Maintenance

The wiper is made of silicone and is very durable, but does degrade over time. AML recommends replacing the wiper periodically. Replacement frequency will depend on the water quality in which the sensor is being used. Annual maintenance is recommended in continuous in-situ use in a sediment heavy environment, such as turbid river deltas.

A replacement wiper and Allen key are supplied with the sensor. To change the wiper:

- Loosen the set screw and remove the old wiper.
- Place the replacement wiper on the pin so that the set screw is positioned perpendicular to the flat surface on the pin.
- Apply light pressure to the wiper and tighten the set screw to secure.

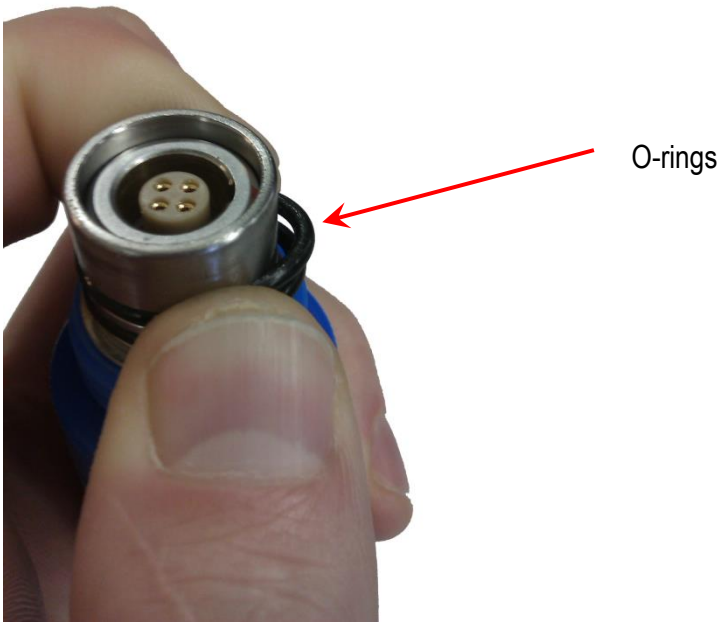


Inspecting and Replacing the O-rings

It is crucial to keep the Tu•Xchange sensor's O-rings clean and greased. Any fibres or dirt on or around the o-rings and grooves will allow water into the connector and damage both the sensor and the sensor mount. To gain access to the O-rings, perform the following steps:

- Remove the sensor from the instrument
- The O-rings should be slick with grease. If they are dry, apply silicone grease.
- Inspect the O-rings for dirt. Clean and reapply grease, if necessary
- Inspect the O-rings for nicks and cracks. If any are found, the O-rings must be replaced. Use 2-015-N70D Buna Nitrile O-rings. Apply silicone grease to the new O-rings before replacing.

Caution: Do not use a sharp instrument to remove the O-rings. If the O-ring grooves are scratched, the O-rings will not provide a waterproof seal. The O-rings can be removed easily with bare hands as shown below.



O-ring Removal

Communications

Tu•Xchange Commands

When using SeaCast, the full instrument command set is not usually necessary. However, the operator can issue text commands to the instrument and to specific sensors on an instrument. This can be done from SeaCast or any terminal emulation program such as HyperTerminal.

There is additional functionality on Tu•Xchange-equipped instruments with respect to the command set. To use these commands, direct communication with Tu•Xchange must be established. There are two ways to accomplish direct communication.

1. On a Micro•X instrument with the Tu•Xchange option, the Tu•Xchange commands can be given directly to the instrument by typing the commands into the terminal emulation program.
2. On all other X•Series instruments, the *TALK* command is used to direct communications to Tu•Xchange. Use the following procedure:

   Entering Talk Mode
   - Establish communications with the instrument
   - Send the *DETECT* command to the instrument. The instrument will return a list of sensors detected on each slot of the instrument. Note the slot number for the Tu•Xchange sensor.
   - Send the *TALK 2* command to the instrument. **Replace the "2" in the command with the appropriate slot number if required.** This command directs subsequent communications directly to the sensor board.

   Exiting Talk Mode
   - Press the *CTRL* and *C* keys simultaneously.

Specific Commands of Interest

Command	Description
DIS OPTIONS	Displays the current settings for Tu•Xchange.
DIS TURBIDITY CAL	Displays the calibration information for Tu•Xchange.
SET xxxxx FORMAT ab	Changes the numerical output format of the sensor. Where xxxxx=sensor type (SV, CONDUCTIVITY, TEMPERATURE, PRESSURE). a = number of digits ahead of the decimal place. b = number of digits after the decimal place I.e. SET SV FORMAT 42 changes the scan output format to 1475.25 **SEE BELOW**
SET TURBIDITY FORMAT 14	Sets the Tu format to 1 digit ahead of the decimal place and 4 digits after the decimal place.
SET TURBIDITY FORMAT 23	Sets the Tu format to 2 digits ahead of the decimal place and 3 digits after the decimal place.
SET TURBIDITY FORMAT 22	Sets the Tu format to 2 digits ahead of the decimal place and 2 digits after the decimal place.
SET TURBIDITY AVERAGE n	Applies a rolling average over n samples. n must be a power of 2 between 1 and 4096. (1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096). To turn off averaging set n to 1.

*For the full set of commands, please refer to the Commands section of an instrument manual.

Turbidity Averaging and Warm-up Period

When sampling with a slow sample rate, such as during long term in-situ monitoring, un-averaged turbidity values may appear jumpy. This is due to the sensor providing turbidity measurements within its sensing volume at one instant in time which may not be representative of turbidity conditions over a longer interval. For example, if a small particle drifts within the sensing volume of the sensor, the turbidity sensor will "see" the particle and respond accordingly despite the surrounding environment being potentially clear. One method to minimize this effect and smooth the data is to apply a rolling average to turbidity measurements, a functionality built into Tu•Xchange.

SET TURBIDITY AVERAGE n

Where n is the number of samples to average. This command instructs the instrument to apply a "cumulative moving" average to measurements which are reported by the sensor every 1 second. For example, *SET TURBIDITY AVERAGE 8* will average 8 scans.

It is also important to note that Tu•Xchange has a "warm-up" time of 6 seconds for sensors without a wiper and 14 seconds for sensors with a wiper, during which time it will read 0.0 NTU. This delay or warm-up period is adjustable with the following command, applied to the instrument (not in Talk Mode):

SET SCAN DELAY n

Where each n is 0.2 seconds. For example, to wait 14 seconds n should be set to 70 (14 s / 0.2 = 70). See recommended settings in the next section.

These settings are applied at the instrument level (in Talk Mode), not at the sensor level. This means that turbidity averaging settings will apply to any Tu•Xchange installed in the instrument.

Recommended Settings

With Wiper:

SET SCAN DELAY 70 - Set the scan delay to 14 s to account for wipe cycle.

Without Wiper:

SET SCAN DELAY 30 - Set the scan delay to 6 s.

For in-situ or long-term deployment applications, such as dredge monitoring:

TALK x - Enter talk mode to board x. Refer to Communications section of this manual.
SET TURBIDITY AVERAGE 8 - Apply an 8 scan cumulative rolling average with T95 of approximately 30 seconds
DIS O - Output configuration to confirm settings

For profiling applications, where fast response is important, no averaging is recommended:

TALK x - Enter Talk Mode to board x. Refer to Communications section of this manual.
SET TURBIDITY AVERAGE 1 – Turn off averaging
DIS O - Output configuration to confirm settings

Auto-Ranging

AML's Tu•Xchange has a built-in auto-range feature that allows the sensor to automatically switch from low to high range or vice versa while in operation; this takes 2-3 seconds. Auto-range sensors have the advantage of increased accuracy over a wider range of NTU.

The auto-ranging feature transitions from low range to high range at 400 NTU. In order for the switching between ranges to be as smooth as possible, the sensor is calibrated from the factory so that the two ranges match as closely as possible at 400 NTU. However, it is not possible to make these two ranges match exactly so the sensor is noticeably noisier and slower to respond around 400 NTU as it switches back and forth between ranges.

Support

Troubleshooting

Instrument fails to detect the sensor:

- Is the sensor properly mounted on the instrument?
- Check the connector on both the sensor and the instrument for corrosion or damaged contacts.
- Cycle the instrument power.

Turbidity data is noisy:

- Check the connector on both the sensor and the instrument for corrosion or damaged contacts
- Is the instrument subject to vibrations?
- Are there turbidity eddies in the water being tested?
- Is there a nearby source of electromagnetic interference? Examples are arcing brushes on electric motors, radio transmitters, switching power supplies, and faulty cathode ray tube monitors.
- Check the power supply to the sensor for noise. Ideally the power supply should have less than 30mV of noise.
- Is there debris blocking sensor face?
- Is sensor face within 20mm of a surface or object?
- Is number format – number of digits in front and behind decimal place – correct?

Turbidity sensor does not fit on instrument:

- Tu•Xchange is not mechanically compatible with most Smart•X manufactured prior to 2015. Contact AML with your Smart•X serial number/s to determine model and compatibility.

SeaCast fails to recognize the sensor:

- Be sure to download the latest version of SeaCast.
    - Tu•Xchange requires SeaCast version 4.0 or greater for full functionality.

Contact AML Oceanographic

Service
To request an RMA or technical support

Email: service@AMLoceanographic.com
Phone: 1-250-656-0771
Phone : 1-800-663-8721 (NA)
Fax: 1-250-655-3655

Sales
For all general sales inquiries

Email: sales@AMLoceanographic.com
Phone: 1-250-656-0771
Phone : 1-800-663-8721 (NA)
Fax: 1-250-655-3655

Website
http://www.AMLoceanographic.com

Customer Portal
My AML Oceanographic is AML's online data centre. This secure area within our website is designed to offer one easy location for interested individuals and organizations - distributors, customers, prospects, and other members of our community - to manage their interactions with AML. *My AML Oceanographic* will allow you to:

- View and manage your assets (instruments and sensors)
- Consult instrument diagnostic summaries
- View and download calibration and conformity certificates
- View and manage your technical support cases
- Consult and download sales estimates, sales orders, and invoice copies
- View account balances and generate account statements
- Assess inventory availability at AML

To access the Customer Portal, please navigate to the *Support* button - located on the top right of the AML Oceanographic home page - select *Customer Centre* from the options on the drop down menu and follow the instructions provided.

Mailing and Shipping Address

AML Oceanographic
2071 Malaview Ave.
Sidney, BC, Canada
V8L 5X6

Technical Specifications

Range	Accuracy	Precision	Resolution	Response Time
0 to 3000 NTU	±2% or 0.2 NTU*	±0.5% or 0.1 NTU*	0.01 NTU	<0.7 s

*Whichever is greater

Mechanical Materials

Housing				
Status	Type	Depth Rating	Diameter	Length
Wiper	Titanium	200 m	28.7 mm (1.13")	142.6 mm (5.61 in.)
No wiper	Titanium	300 m	28.7 mm (1.13")	133.4 mm (5.25 in.)

Sampling Capabilities

- Samples up to 25 times per second (25 Hz)

Ordering Codes

XCH-TRB-A3000-03	Tu•Xchange™ (0-3000 NTU) Range, 300m
XCH-TRB-A3000-02W	Tu•Xchange™ (0-3000 NTU) Range, Wiper, 200m

Warranty

AML warrants the instrument for a period of TWO YEARS from the date of delivery. AML will repair or replace, at its option and at no charge, components which prove to be defective. The warranty applies only to the original purchaser of the instruments and only to instruments and sensors manufactured by AML Oceanographic. The warranty of third party sensors will apply as per the specific vendor's warranty policy. The warranty does not apply if the instrument has been damaged, by accident or misuse, and is void if repairs or modifications are made by other than authorized personnel.

This warranty is the only warranty for new product given by AML. No warranties implied by law, including but not limited to the implied warranties of merchantability and fitness for a particular purpose shall apply. In no event will AML be liable for any direct, indirect, consequential or incidental damages resulting from any defects or failure of performance of any instrument supplied by AML.

DISCLAIMER

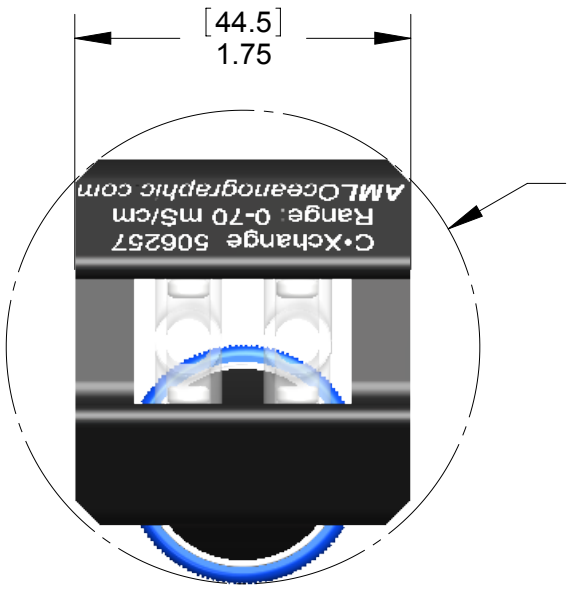
AML reserves the right to make any changes in design or specifications at any time without incurring any obligation to modify previously delivered instruments. Manuals are produced for information and reference purposes and are subject to change without notice.

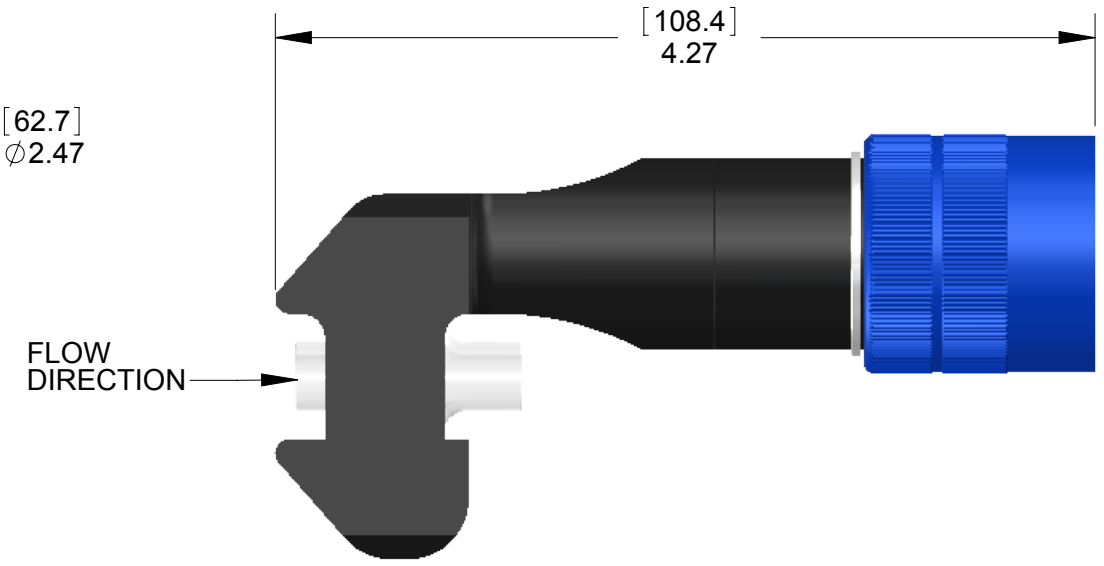
Technical Overview Drawings

REVISION TABLE

REV	DESCRIPTION	BY	DATE
B	ADDED CTX	ABT	15AUG2015
C	UPDATED TUX & ADDED SENSOR WEIGHTS	LB	27NOV2015
D	UPDATED UVX	MS	11MAY2016

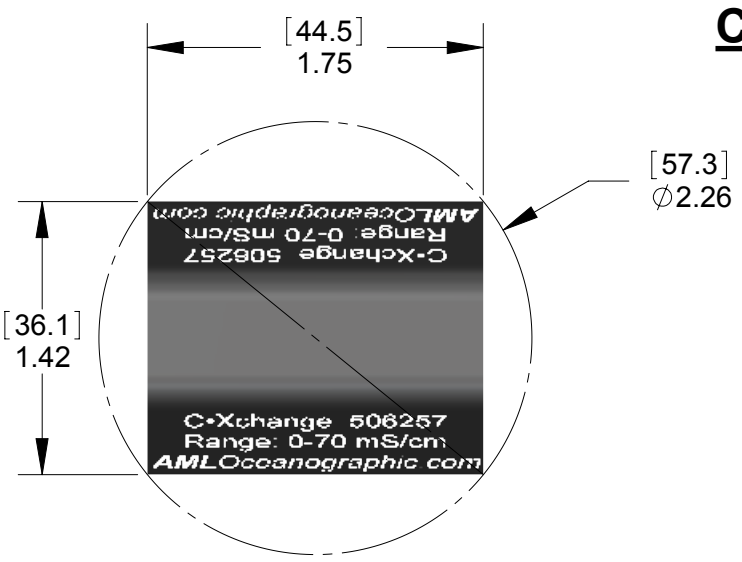
C Xchange Right Angle

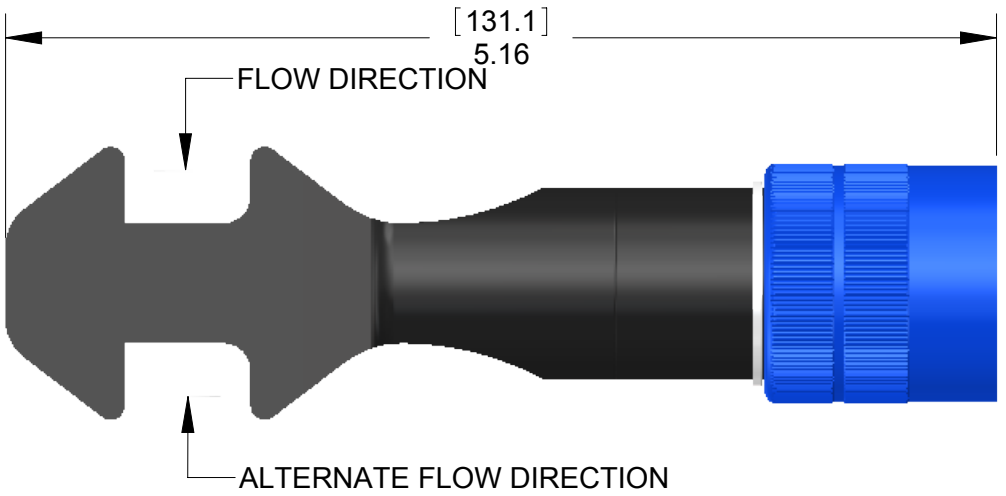




NOTE: WEIGHT = 120 g

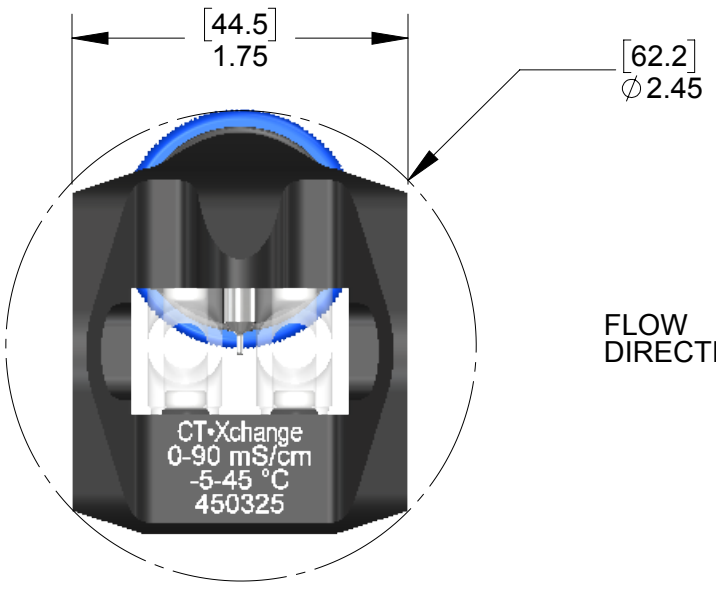
C Xchange Straight

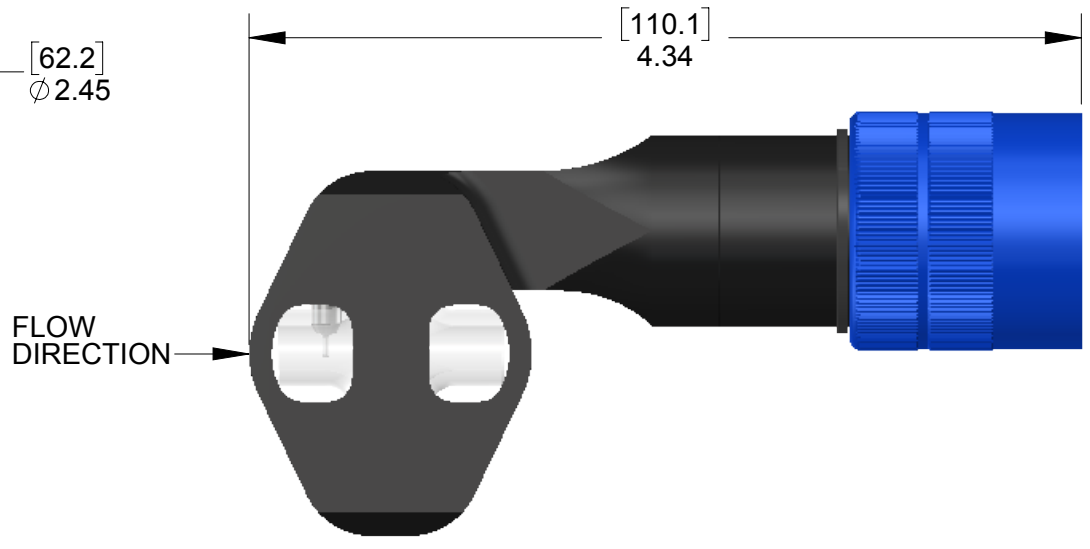




NOTE: WEIGHT = 132 g

CT Xchange





NOTE: WEIGHT = 110 g

NOTE: ALL WEIGHTS MEASURED IN AIR

AML OCEANOGRAPHIC
Xchange your old ideas
2071 Malaview Avenue W., Sidney B.C. Canada V8L 5X6 (250) 656 0771 Fax: (250) 655 3655

TOLERANCES:
ANGLES: ± 1°
FRACTIONS: ± 1/32
HOLE SIZES: ± 0.005(0.13)
0.00: ± 0.015(0.38)
0.000: ± 0.005(0.13)

UNLESS OTHERWISE SPECIFIED:
ORIGINAL SCALE:1:1
DIM'S ARE IN INCHES (MM)
SURFACE FINISH: 63

TITLE: Xchange Sensor / Device Overview

DRAWN	DRAWING NO.:	REV	AML NO.
I.L.	SNS-GA-03351-D		N/A

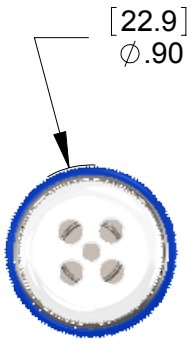
DATE	MATERIAL:
26FEB2010	N/A

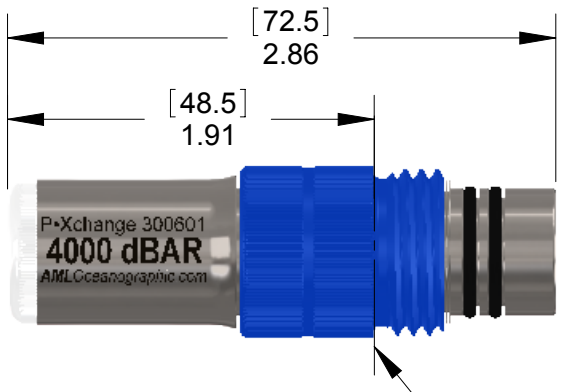
3rd ANGLE PROJECTION | SIZE B | SLD FILE NO.: N/A | SHEET NO.: Sheet 1 of 3

REVISION TABLE

REV	DESCRIPTION	BY	DATE
B	ADDED CTX	ABT	15AUG2015
C	UPDATED TUX & ADDED SENSOR WEIGHTS	LB	27NOV2015
D	UPDATED UVX	MS	11MAY2016

P Xchange

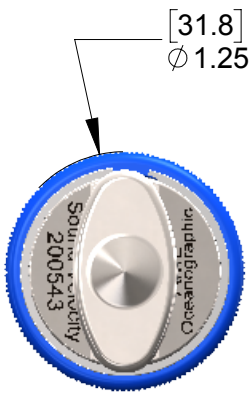


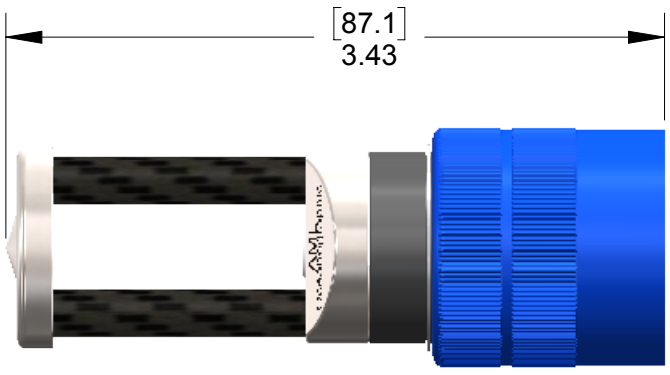


NOTE: WEIGHT = 57 g

ENDCAP FACE LEVEL WHEN INSTALLED ON INSTRUMENT OR BULKHEAD.

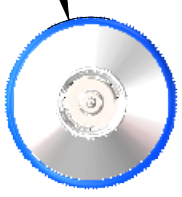
SV Xchange

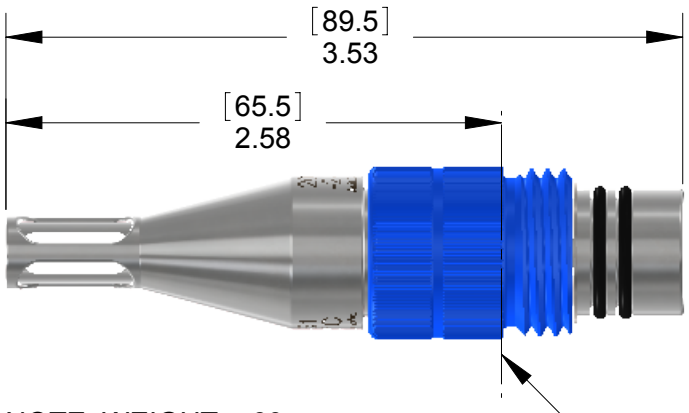




NOTE: WEIGHT = 62 g

T Xchange





NOTE: WEIGHT = 60 g

ENDCAP FACE LEVEL WHEN INSTALLED ON INSTRUMENT OR BULKHEAD.

NOTE: ALL WEIGHTS MEASURED IN AIR

AML OCEANOGRAPHIC
Xchange your old ideas
2071 Malaview Avenue W., Sidney B.C. Canada V8L 5X6 (250) 656 0771 Fax: (250) 655 3655

TOLERANCES:

ANGLES:	± 1°
FRACTIONS:	± 1/32
HOLE SIZES:	± 0.005(0.13)
0.00:	± 0.015(0.38)
0.000:	± 0.005(0.13)

UNLESS OTHERWISE SPECIFIED:
ORIGINAL SCALE:1:1
DIM'S ARE IN INCHES (MM)
SURFACE FINISH: 63

TITLE: Xchange Sensor / Device Overview

DRAWN	DRAWING NO.:	REV	AML NO.
I.L.	SNS-GA-03351-D		N/A
DATE: 26FEB2010	MATERIAL: N/A		
3rd ANGLE PROJECTION / SIZE B	SLD FILE NO.: N/A		SHEET NO.: Sheet 2 of 3

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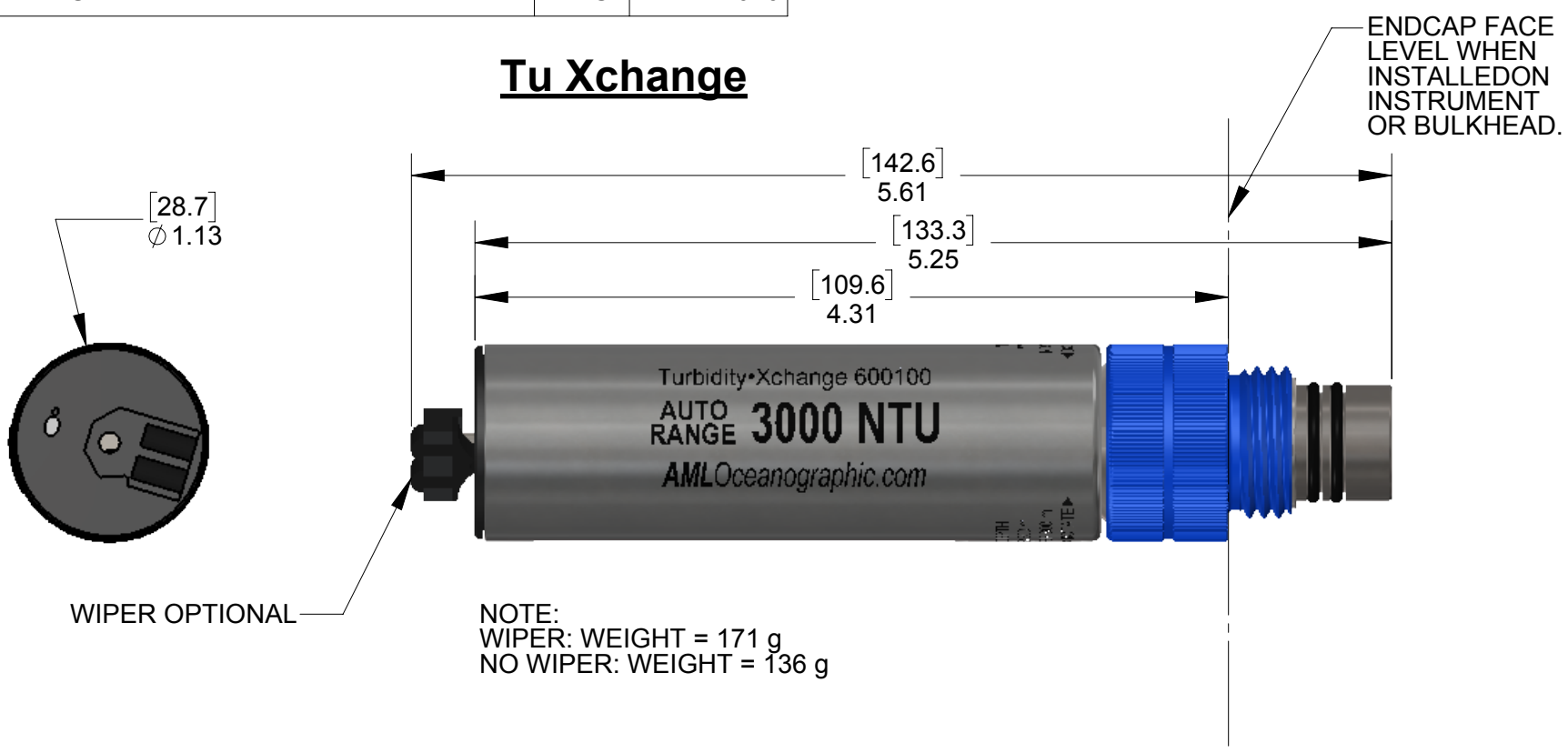
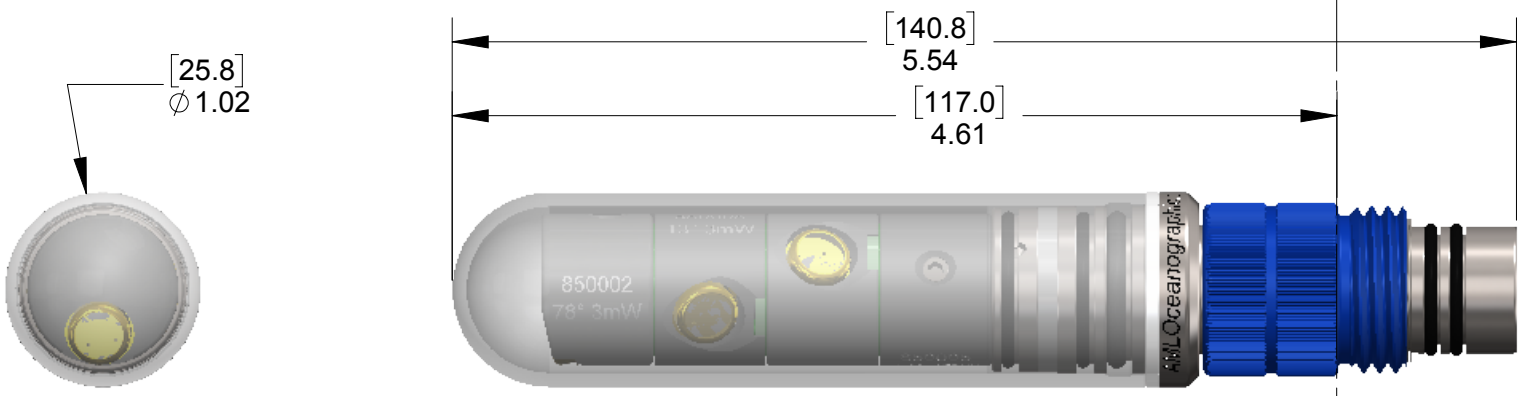
B	ADDED CTX	ABT	15AUG2015
C	UPDATED TUX & ADDED SENSOR WEIGHTS	LB	27NOV2015
D	UPDATED UVX	MS	11MAY2016

Tu Xchange

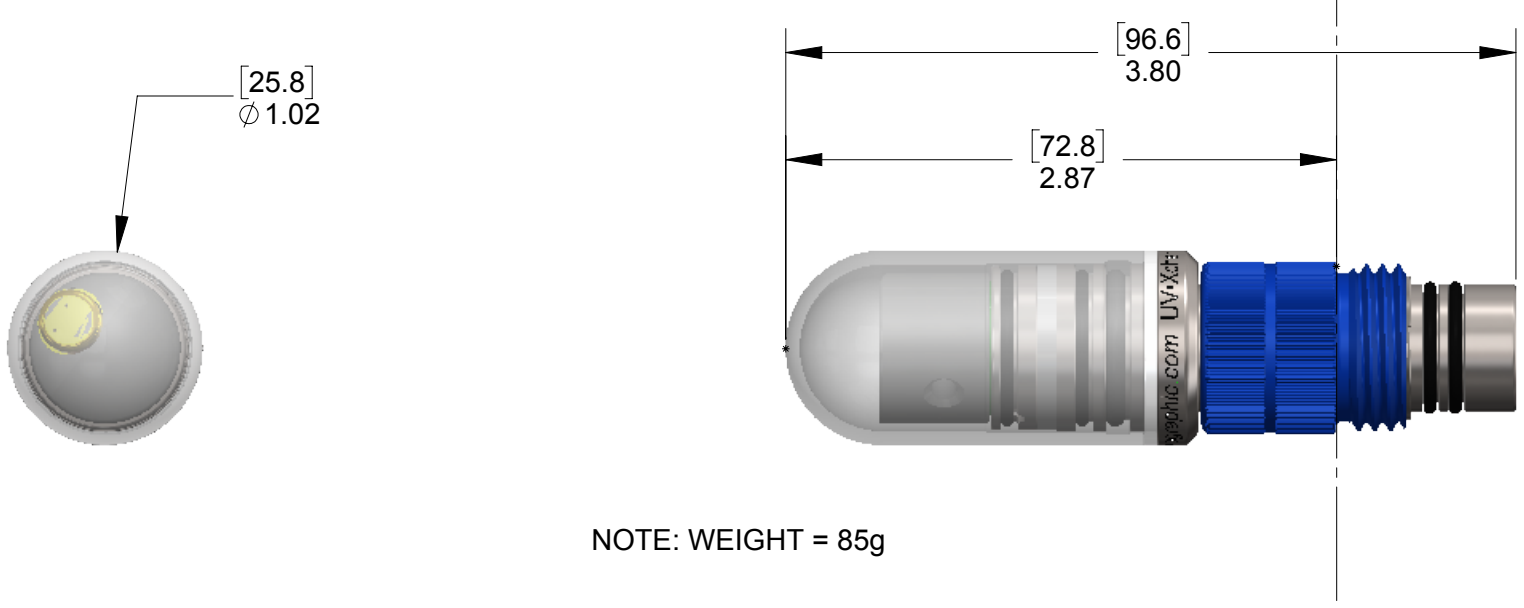


NOTE:
WIPER: WEIGHT = 171 g
NO WIPER: WEIGHT = 136 g

UV Xchange



NOTE: WEIGHT = 129g



NOTE: WEIGHT = 85g

NOTE: ALL WEIGHTS MEASURED IN AIR

AML OCEANOGRAPHIC
Xchange your old ideas
2071 Malaview Avenue W., Sidney B.C. Canada V8L 5X6 (250) 656 0771 Fax: (250) 655 3655

TOLERANCES:

ANGLES:	± 1°
FRACTIONS:	± 1/32
HOLE SIZES:	± 0.005(0.13)
0.00:	± 0.015(0.38)
0.000:	± 0.005(0.13)

UNLESS OTHERWISE SPECIFIED:
ORIGINAL SCALE:1:1
DIM'S ARE IN INCHES (MM)
SURFACE FINISH: 63

TITLE: Turbidity Xchange Sensor

DRAWN	DRAWING NO.:	REV	AML NO.
I.L.	SNS-GA-03351-D		N/A
DATE: 26FEB2010	MATERIAL: N/A		
3rd ANGLE PROJECTION	SIZE B	SLD FILE NO.: N/A	SHEET NO.: Sheet 3 of 3