Thermo Scientific AquaSensors™ DataStick™ CANopen Communications

User Guide

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Contact Information

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Outside the United States call 978.232.6000 or fax 978.232.6031.
In Europe, the Middle East and Africa, contact your local authorized dealer.
Visit us on the web at www.thermo.com/processwater

CANopen Adapter Part Numbers:

- CA14B: 316 Stainless Steel Housing
- CA24B: CPVC Housing
- CA34B: PEEK® Housing
- AV38WB6YZ: AV38 Host Communications

1 Introduction

The Thermo Scientific AquaSensors CANopen Adapter is a gateway between any DataStick measurement system and a CANopen master. It converts the CANopen network power for use by the DataStick and provides full-featured interactive measurement, calibration, configuration, and diagnostic features without the need for an intermediate analyzer or controller.

This document describes the operation of the CANopen Adapter. It describes the unit configuration, unit initialization, and the CANopen Network Model.

The Adapter can be used for direct access to DataStick measure, calibrate, configure, and diagnose information, even when the Sensor Head is changed from one type of analytical measurement to another with power applied.

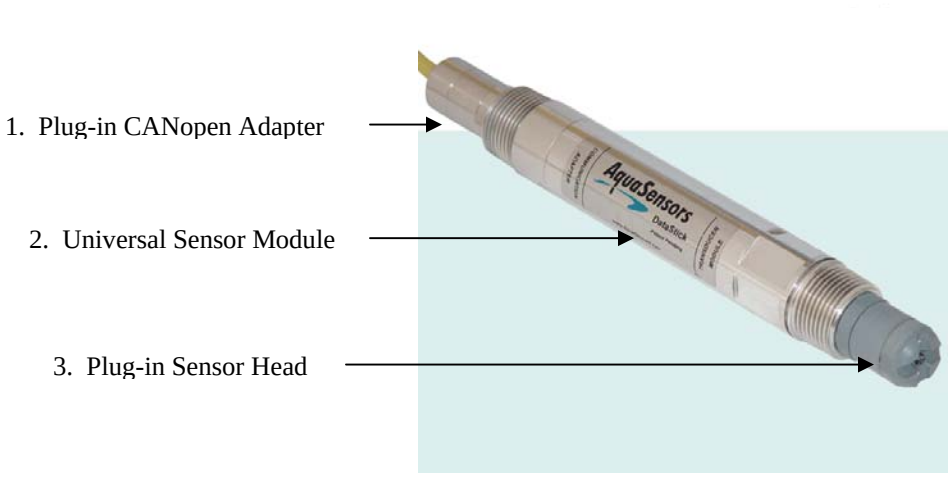
The Adapter must be configured with the correct Baud rate and Node ID. This can be done at the factory or in the field. The configured Baud rate and Node ID stay with the Adapter even when the DataStick is removed from the system.

The DataStick automatically supports multiple measurement types and, if all configuration and calibration objects are used, all sensor heads can be automatically supported.

Please refer to the DataStick Manual for detailed information on installation, maintenance, and operation of the DataStick.

2 Hardware Setup

The DataStick consists of three parts that are assembled at the factory:



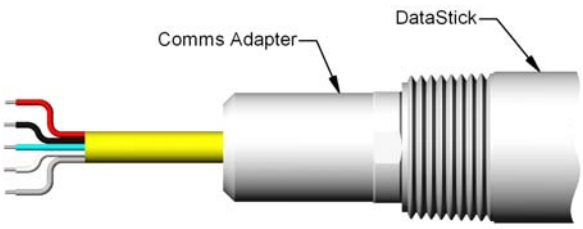
The cable for a CANopen Adapter comes with wires that are stripped and tinned for use with terminal blocks. A water-resistant label is placed at the end of the cable that provides a chart of wire colors and functions for use with CANopen.

Any Class II power supply that provides 10 to 30 volts DC may be used to power the DataStick measurement system.

The shield wire must be connected to ensure proper electromagnetic immunity from other electrical equipment.

Table 1: CANopen wiring using an Open Connector

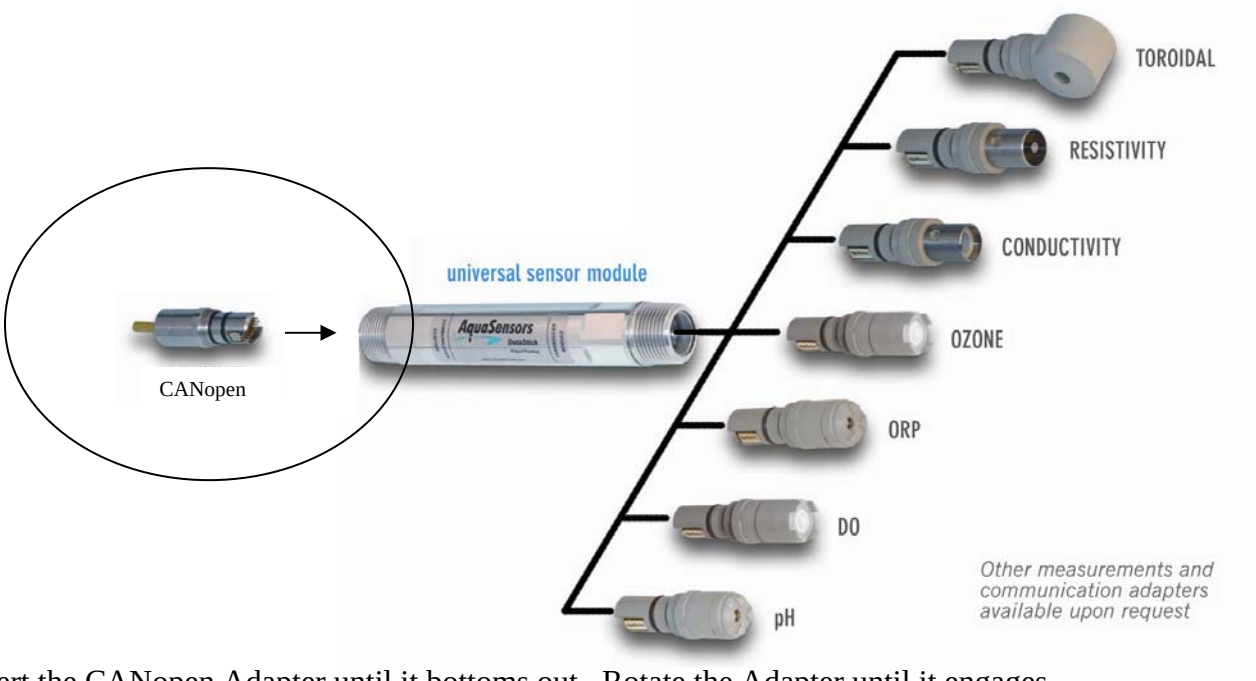
Pin	Function	Signal	Wire Color
1	Power Supply	V+	RED
2	High differential	CAN_H	WHITE
3	Shield	Shield	Bare
4	Low differential	CAN_L	BLUE
5	Common	V-	BLACK



The Adapter can be removed and replaced in the field. This may be desirable for any number of reasons including:

- Diagnostics: Temporarily plug in a USB adapter for PC diagnostics
- Feature Upgrade: Temporarily plug in a programming adapter to load new code
- Repair: Replace a damaged DataStick assembly without rewiring
- Change Measurement: Measure a different parameter simply by changing the sensor head

The CANopen Adapter is keyed and plugs into the end of the DataStick™ Universal Sensor Module that is marked "Communications Adapter".



Insert the CANopen Adapter until it bottoms out. Rotate the Adapter until it engages with the connector. Push the Adapter in gently, and then tighten the retaining ring with a 15/16-inch wrench. It is very important to tighten the retaining ring to ensure a reliable connection.

Retaining Ring Use a 15/16-inch wrench and rotate clockwise to tighten.

O-Ring Seal It should be free of dirt when inserted into the DataStick™.

Potted **Part Number** (this side) and **Serial Number** (opposite side)

3 Configuring the Adapter

The CANopen Adapter stores parameters and other information in its own non-volatile memory. You must, therefore, access the Adapter to view and edit its parameters. A CANopen configuration tool can be used to access the Adapter parameters.

Be sure to register the Electronic Data Sheet (EDS) for the CANopen Adapter with the configuration tool that you will be using. EDSs can be found on the CD accompanying the CANopen Adapter.

Changes to the Node ID and Baud rate require that you reset the Adapter before the new settings take effect. You can reset the Adapter by cycling its power.

> **Attention: Determine how your control system will respond before resetting a connected Adapter.**

4 Specifications

This section presents the specifications for the CANopen Adapter.

4.1 Communications

Network	
Protocol	CANopen
Data Rates	125k, 250k, 500k bps
DataStick	
Protocol	Thermo Scientific AquaSensors Open
Data Rate	ASCII 9600 bps, 8 data bits, 1 stop bit, no parity

4.2 Electrical

Consumption	
Adapter	< 20 mA @ 24 VDC
DataStick	< 50 ma @ 5 VDC

Power for the DataStick is supplied by the network power supply via the CANopen Adapter.

4.3 Mechanical

Dimensions	
Height	1 inch (25.4 mm)
Length	3 inch (76.2 mm)
Width	1 inch (25.4 mm)
Weight (with 20 ft. cable)	< 1 lb. (0.5 kg) CPVC < 2 lbs. (1 kg) Stainless Steel

4.4 Regulatory

UL	UL 61010-1

5 CANopen Interface

5.1 Overview

CANopen™ is a low-cost and open industrial network that links industrial devices (such as limit switches, photoelectric sensors, and motion controllers) to machine controllers over the Controller Area Network (CAN). CANopen eliminates expensive hardwiring and provides improved communication between devices as well as important device-level diagnostics.

This section describes the CANopen Object Dictionary that completely describes the interface from the CANopen network point-of-view. For a detailed explanation of the objects, please see the description of the associated Thermo Scientific AquaSensors Command in the DataStick Measurement System Instruction.

Refer to the CANopen specification for more information about CANopen objects. Information about the CANopen specification is available on the CANopen Website (http://www.canopen.org).

In this document, the index and subindex of an object are conveyed using a shorthand notation as follows:

[2003h, Dh]

In the above example, the first value, 2003h, is the index and the second value, Dh, is the subindex. Both values are in hexadecimal as indicated by the "h" suffix. This document also uses the "0x" prefix to indicate hexadecimal.

The supported data types are shown in Table 2.

Table 2: Supported data types

Data Type	Description
REAL32	32-bit floating point
SHORT_STRING	1-byte length indicator + number of characters
UINT16	16-bit unsigned integer
UINT32	Unsigned Double Integer (32-bit unsigned integer)
UINT8	Unsigned Short Integer (8-bit)
VISIBLE_STRING	A sequential collection of printable characters

5.2 Configuration

The unit supports Thermo Scientific AquaSensors factory configuration parameters and user configuration parameters.

The unit supports the standard CANopen Node ID and Baud rate selections. Node ID and Baud rate can be selected through CANopen configuration software.

All configuration data is stored in non-volatile storage.

5.3 Operating Modes

The CANopen Adapter can operate in two different modes (see object “Mode Configuration” [2006h, 3h]). The Mode is set to the appropriate value at the factory and typically does not need to be changed.

5.3.1 Standard Mode (CANopen Adapter attached to DataStick)

By default the CANopen Adapter is configured to operate in Standard mode. In this mode, the CANopen Adapter is attached directly to a DataStick. The objects described in Section 5.4, Object Dictionary, are accessible.

The Electronic Data Sheet called 265CO.eds is the appropriate EDS to use for this mode.

Note that the “DataStick Station Address” [2003h, Eh] is not available when the Adapter is operating in standard mode.

5.3.2 Gateway Mode (CANopen Adapter embedded inside AV38)

The Adapter optionally may be configured to operate in Gateway mode. In this mode, the DataStick Station Address [2003h, Eh] is accessible along with the objects described in Section 5.4, Object Dictionary.

The Electronic Data Sheet called 265CO_GW.eds is the appropriate EDS to use for this mode.

Normally, the CANopen Adapter is attached directly to a DataStick. Gateway mode is selected when the CANopen Adapter is located on the host-side of the AV38 Local Display. It allows a CANopen master to communicate with a network of Modbus DataSticks on the other side of the AV38. See the AV38 Instruction Manual for more information about the AV38.

The CANopen master can communicate with the Modbus DataStick at station 2, for instance, by setting attribute “DataStick Station Address” [2003h, Eh] in the User Configuration object to 2. The desired data can then be obtained from that DataStick by reading the appropriate objects. To communicate with a different DataStick, set the DataStick Station Address to the appropriate value. The range of acceptable values for the DataStick Station Address is 1 to 247. The AV38 eavesdrops on the communications between the CANopen master and the DataStick and displays the relevant data on its local display.

When using Gateway mode, set attribute “DataStick Timeout” [2003h, Dh] in the User Configuration object to at least 100 (1 second) to account for the additional latency introduced by the AV38 being between the CANopen Adapter and the DataStick.

5.4 Object Dictionary

Index	Name	Sub Index	Description	Aqua Sensors Command	Aqua Sensors Offset	Data Type	Data Value	Access Rule
0x1000	Device Type	0x00	N/A			UINT32	0	Get
0x1001	Error Register	0x00	N/A			UINT8	0	Get
0x1002	MFR Status Register	0x00	32-bitmap Bit0 = serial timeout			UINT32	0x00000000	Get
0x1008	Manufacturer's Device Name	0x00				VISIBLE_ STRING	0x41532020	Get
0x1009	Hardware Version	0x00				VISIBLE_ STRING	0x31303030	Get
0x100A	Manufacturer's Software Version	0x00	Same as Revision Number [2006h, 4h]			VISIBLE_ STRING	0x31303035	Get
0x1018	Identity Object	0x00	Number of sub-index entries			UINT8	4	Get
		0x01	Vendor ID			UINT32	0x00000219	Get
		0x02	Product Code			UINT32	11605[1]	Get
		0x03	Revision Number[2]			UINT32	0x00010005	Get
		0x04	Serial Number			UINT32	0xnnnnnnnn	Get
0x1800	TPDO Comm Param 1	0x00	Number of sub-index entries			UINT8	5	Get
		0x01	COB-ID Used by PDO			UINT32	Node ID + 0x180	Get / Set[3]
		0x02	Transmission Type			UINT8	255	Get / Set
		0x03	Inhibit Time (in milliseconds)			UINT16	50	Get / Set
		0x04	Reserved			UINT8	0	Get
		0x05	Event Timer (in milliseconds)			UINT16	30000	Get / Set
0x1A00	TPDO 1 Mapping	0x00	Number of used map entries			UINT8	2	Get
		0x01	Map Entry 1 (Index, Subindex, # bits)			UINT32	0x60000120	Get
		0x02	Map Entry 2 (Index, Subindex, # bits)			UINT32	0x60000220	Get
0x2000	System Status	0x00	Number of sub-index entries			UINT8	4	Get
		0x01	Sensor Memory Status	GSTATUS	0	UINT8	0	Get
		0x02	Configuration Memory Status	GSTATUS	2	UINT8	0	Get
		0x03	Calibration memory Status	GSTATUS	4	UINT8	0	Get
		0x04	Run Status	GSTATUS	6	UINT8	0	Get
0x2001	Sensor Installation	0x00	Sensor Type	GSTYPE	0	UINT16		Get
0x2002	Sensor Value	0x00	Number of sub-index entries			UINT8	2	Get
		0x01	Sensor Value	GSNSR	0	REAL32	0	Get
		0x02	Temperature Value	GTEMP	0	REAL32	0	Get
0x2003	User Config	0x00	Number of sub-index entries			UINT8	14	Get
		0x01	Main Serial Number	GMSNO/	0	SHORT_S		Get / Set

[1] The Product Code depends on the type of the Sensor Head installed in the DataStick body. See Section 5.4.1, Product Codes, for a complete list.
[2] This value is fixed at 0x00010005. See [2006h, 4h] for the actual Revision Number.
[3] Only bit 31 is settable (enable/disable TPDO)

Index	Name	Sub Index	Description	Aqua Sensors Command	Aqua Sensors Offset	Data Type	Data Value	Access Rule
				SMSNO		TRING		
		0x02	Code Version	GCVSN	0	SHORT_STRING		Get
		0x03	Sensor Units	GSUNITS / SSUNITS	0	UINT16		Get / Set
		0x04	Temperature Units	GTUNITS / STUNITS	0	UINT16		Get / Set
		0x05	Sensor Filter	GSFIL / SSFIL	0	UINT16		Get / Set
		0x06	Temperature Filter	GTFIL / STFIL	0	UINT16		Get / Set
		0x07	pH Buffer Type	GPHBUF / SPHBUF	0	UINT16		Get / Set
		0x08	DO Salinity	GSALT / SSALT	0	REAL32		Get / Set
		0x09	DO Pressure	GPRESS / SPRESS	0	REAL32		Get / Set
		0x0A	Conductivity Reference Temperature	GCRTEMP / SCRTEMP	0	REAL32		Get / Set
		0x0B	Conductivity Compensation Slope	GCCSLOPE / SCCSLOPE	0	REAL32		Get / Set
		0x0C	Node Address	GADDR / SADDR	0	UINT16		Get / Set
		0x0D	DataStick TimeOut (2 to 200) 10 msec. tick	N/A	0	UINT16	0	Get / Set
		0x0E	DataStick Station Address (Gateway Mode only)	GDSA / SDSA	0	UINT16	0	Get / Set
0x2004	Generic Sensor Calibration	0x00	Number of sub-index entries			UINT8	11	Get
		0x01	Calibrate Sensor Zero	CALSZERO		UINT8 [1]		Set
		0x02	Calibrate 1-Point Sample Value	CALS1PS, data		REAL32		Set
		0x03	Calibrate Sensor 2-Point Sample Point	N/A		UINT16		Get / Set
		0x04	Calibrate Sensor 2-Point Sample Value	CALS2PS, data		REAL32		Set
		0x05	Calibrate Sensor 1-Point Buffer	CALS1PB		UINT8 [1]		Set
		0x06	Calibrate Sensor 2-Point Buffer	CALS2PB, DATA		UINT16		Set
		0x07	Calibrate Sensor in Air	CALSAIR		UINT8 [1]		Set
		0x08	Calibrate Sensor Temperature 1-Point Sample	CALST1PS		REAL32		Set
		0x09	Calibration Type	CALSTATUS	3	UINT16		Get
		0x0A	Calibration Status	CALSTATUS	6	UINT16		Get
		0x0B	Calibration Abort	CALABORT	N/A	UINT8 [1]		Set
0x2005	Conductivity Sensor Cal		Cell Constant	GCELL / SCELL	0	REAL32		Get/Set
0x2006	Unit Config.	0x00	Number of sub-index entries			UINT8	4	Get
	Node ID	0x01	Range 1 to 127 (Reboot after changing)	N/A		UINT8		Get/Set
	Baud	0x02	0=125K, 1=250K, 2=500K (Reboot after changing)	N/A		UINT8		Get/Set
	Mode	0x03	0=Standard,1=Gateway	N/A		UINT8		Get/Set

[1] Data value is ignored. It is not possible to send zero bytes of data with CANopen
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Index	Name	Sub Index	Description	Aqua Sensors Command	Aqua Sensors Offset	Data Type	Data Value	Access Rule
	Configuration		(Reboot after changing)					
	Revision Number	0x04				UINT32	0x00010005	Get
0x3F55		0x00	Number of sub-index entries			UINT8	5	Get
		0x01	Not supported					
		0x02	Not supported					
	CANopen Stack Version	0x03	Same as Revision Number [2006h, 4h]			UINT32	1004	Get
	Software Version	0x04	of DataStick			UINT32	317	Get
		0x05	Not supported					
0x3FBB	IdentCode	0x00	Number of sub-index entries			UINT8	8	Get
		0x01				VISIBLE_ STRING	0x20202020	Get
		0x02				VISIBLE_ STRING	0x20202020	Get
		0x03				VISIBLE_ STRING	0x20202020	Get
		0x04				VISIBLE_ STRING	0x20202020	Get
		0x05				VISIBLE_ STRING	0x20202020	Get
		0x06				VISIBLE_ STRING	0x20202020	Get
		0x07				VISIBLE_ STRING	0x20202020	Get
		0x08				VISIBLE_ STRING	0x20202020	Get
0x6000	Sensor Value	0x00	Number of sub-index entries			UINT8	2	Get
		0x01	Sensor Value	GSNSR	0	REAL32	0	Get
		0x02	Temperature Value	GTEMP	0	REAL32	0	Get

5.4.1 Product Codes

Sensor Type [2001h, 0h]	Product Code [1018h, 2h] (Standard Mode)	Product Code [1018h, 2h] (Gateway Mode)	Comment
timeout	11,605	12,605	DataStick absent
0	11,606	12,606	DataStick present but Sensor Head absent
1	11,607	12,607	pH
2	11,608	12,608	ORP
3	11,609	12,609	D.O.
4	11,610	12,610	Contacting Conductivity
5	11,611	12,611	Toroidal Conductivity
6	11,612	12,612	Ozone
7	11,613	12,613	Drinking Water Turbidity
8	11,614	12,614	Future use
9	11,615	12,615	Raw Water Turbidity
10	11,616	12,616	Chlorine
11	11,617	12,617	Suspended Solids
≥12	≥11,618	≥12,618	Future use

5.5 CAN ID's

11-bit Can Header (COB ID)	Message Description
0x000	NMT (Network Management)
0x080	SYNC
0x080 + Node ID	Emergency Message
0x100	Time Stamp
0x180 + Node ID	Tx PDO 1 – Sensor / Temperature
0x580 + Node ID	Transmit SDO
0x600 + Node ID	Receive SDO
0x700 + Node ID	NMT Error Control / Heartbeat

6 Glossary

Adapter	Devices such as drives, controllers, and computers usually require an adapter to provide a communication interface between them and a network such as CANopen. An adapter reads data on the network and transmits it to the connected device. It also reads data in the device and transmits it to the network. The CANopen Adapter connects a Thermo Scientific AquaSensors DataStick to a CANopen network. Adapters are sometimes also called "gateways".
EDS (Electronic Data Sheet) Files	EDS files are simple text files that are used by network configuration tools for CANopen to describe products so that you can easily commission them on a network. EDS files describe a product device type, revision, and configurable parameters.
NaN	Not a Number, a specific value for IEEE floating point to indicate NO DATA
Node ID	A CANopen network can have as many as 127 devices connected to it. Each device on the network must have a unique node address between 1 and 127.
NVS (Non-Volatile Storage)	NVS is the permanent memory of a device. Devices such as the Adapter store parameters and other information in NVS so that they are not lost when the device loses power. NVS is sometimes called "EEPROM."

7 References

a) CiA 301 DS V4.0.2: CANopen application layer and communication profile

b) CiA 305 DSP V1.1: CANopen Layer Setting Services and Protocol (LSS)

c) IEEE Standard for Binary Floating-Point Arithmetic, IEEE Std 754-1985

d) DataStick™ Measurement System Instruction Manual

e) Modbus Application Protocol Specification, V1.1a

8 Limited Warranty

WARRANTY/REPLACEMENT PLAN

Thermo Fisher Scientific warrants its Smart Communications Adapters against material and workmanship defect for a period of one year from the date of shipment.

In the event that a defect is discovered during the warranty period, Thermo Fisher Scientific agrees, at its option, to repair or replace the defective product. Any product repaired or replaced under this warranty will be warranted only for the remainder of the original product warranty period.

This warranty does not apply to consumable products associated with this product including, but not limited to, chemical reagents and salt bridges.

Products may not be returned without authorization from Thermo Fisher Scientific. To obtain authorization, please call Thermo Fisher Scientific for a return material authorization number.

Limitations:
This warranty does not cover:

1. Damage caused by misuse, neglect (lack of appropriate maintenance), alteration, accident or improper application or installation.
2. Damage caused by any repair or attempted repair not authorized by Thermo Fisher Scientific.
3. Any product not used in accordance with the instructions furnished by Thermo Fisher Scientific.
4. Damage caused by acts of God, natural disaster, acts of war (declared or undeclared), acts of terrorism, work actions, or acts of any governmental jurisdiction.
5. Freight charges to return merchandise to Thermo Fisher Scientific.
6. Travel fees associated with on-site warranty repair.

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Thermo Fisher Scientific reserves the right to change or modify this warranty at any time.

9 Terms and Conditions

Terms and Conditions of Sale

The following terms and conditions will be presumed acceptable unless changes are made in writing and accepted by both parties in a reasonable amount of time.

Any standard or boilerplate terms and conditions supplied with a written purchase order will not be applicable unless accepted in writing by both parties.

Quotations: All quotations shall be in writing. Written quotations shall be valid for 30 days from the date issued. Verbal quotations or price lists are not valid.

Pricing: All pricing is in US Dollars. Thermo Fisher Scientific reserves the right to change pricing without notice.

Terms: Payment terms are net 30 days from the date of invoice with approved credit. Thermo Fisher Scientific reserves the right to deny credit or revoke previously extended credit. Past due accounts are subject to interest charges. Other acceptable payment terms are cash, certified check, money order, credit card or letter of credit confirmed by any United States of America bank. Other payment terms are not valid unless accepted in writing.

Sales taxes shall be included on the invoice unless a valid tax exemption certificate is supplied.

Return Material Authorization: Contact Thermo Fisher Scientific Customer Service for a Return Material Authorization (RMA) number. Items returned without an RMA number will be rejected.

All returned merchandise must be in unused, resalable condition, and must not be contaminated with hazardous materials.

Cancelled orders must be returned within 30 days of the date on the invoice and shall be subject to expenses incurred that may include, but are not limited to, inspection and restocking fees. Items returned within 60 days shall be subject to a restocking charge that is equal to 15% of the purchase price. Items returned after more than 60 days shall be subject to a restocking charge equal to 25% of the purchase price. Thermo Fisher Scientific reserves the right to reject any return that is not under warranty after 60 days. Non-stock items are normally not returnable.

Transportation: Orders are shipped FOB Thermo Fisher Scientific, or factory, by the most efficient means available. Appropriate charges, such as freight and insurance will be added to invoices. All shipments will be insured. Goods damaged in shipment must be reported by the recipient to the freight carrier for claims.

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