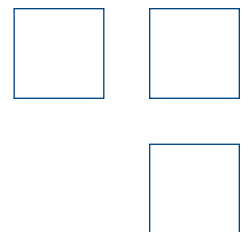


Modbus Operation Manual

**ST100 Series
Thermal Mass Flow Meter**



Notice of Proprietary Rights

This document contains confidential technical data, including trade secrets and proprietary information which is the property of Fluid Components International LLC (FCI). Disclosure of this data to you is expressly conditioned upon your assent that its use is limited to use within your company only (and does not include manufacture or processing uses). Any other use is strictly prohibited without the prior written consent of FCI.

© Copyright 2013 by Fluid Components International LLC. All rights reserved. FCI is a registered trademark of Fluid Components International LLC. Information subject to change without notice.

Table of Contents

Introduction.....	1
ST100 Modbus Basic Setup	1
Setting the ST100 for Modbus Operation.....	1
ST100 Modbus Commands.....	2
ST100 Process Data Registers	2
Totalizer Description.....	2
Process Data - Table 1.....	2
ST100 Modbus Service Registers	4
Examples of Totalizer Service Registers using MODSCAN 32.....	4
Service Data - Table 2.....	4
APPENDIX A	
Engineering Unit Codes Table	7
APPENDIX B	
Instrument Faults Codes Table.....	9
APPENDIX C	
Customer Service / Technical Support.....	11

INTENTIONALLY LEFT BLANK

Introduction

The ST100 offers MODBUS as one of its digital communication protocols, but unlike the other digital communication protocols MODBUS only offers set up and configuration for the totalizer variable.

The ST100 MODBUS physical layer uses the asynchronous RS485 serial port of the ST100. There is no high speed MODBUS over Ethernet.

The ST100 offers the two basic traditional transmission serial interface modes: RTU and ASCII message coding.

The ST100 offers the process variable parameters (value) in floating point form, which are organized as single or double precision floating point registers. There are two groups of registers used, the 4000 series and the 5000 registers, they both can be accessed using MODBUS 03, and 04 function codes. For details see table 1.

ST100 Modbus Basic Setup

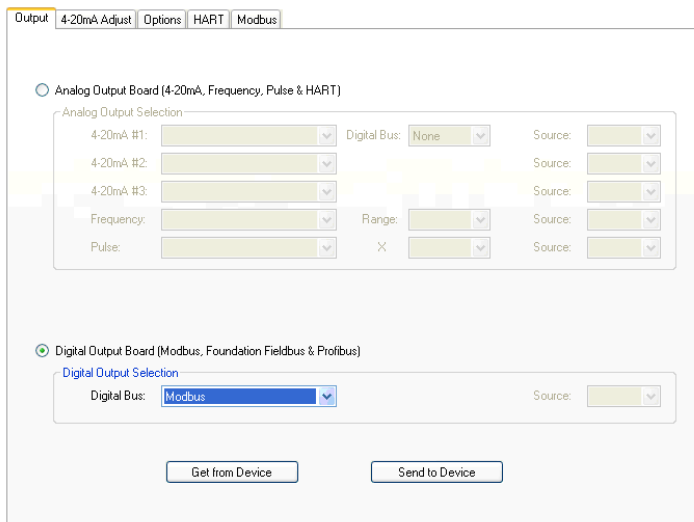
For details on connecting the ST100 see Appendix B of the "Operation & Maintenance Manual" for the ST100 Series Thermal Mass Flow Meter, document number 06EN003400.

Setting the ST100 for Modbus Operation

Note: If the ST100 was ordered from the factory as a Modbus device, the factory will have configured the instrument for Modbus, and it will not be necessary to do any instrument configuration.

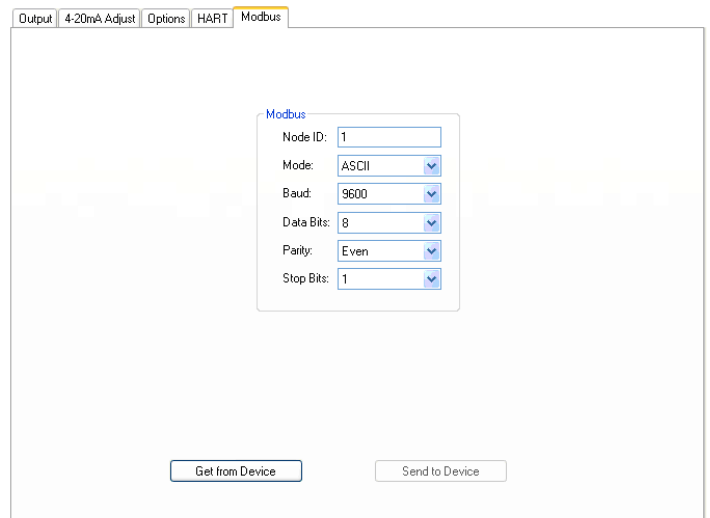
The ST100 PC configurator is used to select the communication protocol.

Connect the PC with the configurator software to the ST100 USB port using FCI's USB cable (P/N 022646).



To configure the ST100 for Modbus invoke the ST100 Configurator, then from the tree menu, on the left side, select "Configurator", then select the "Output" tab. In the Output Tab select "DigitalOutput Board" and then from the pull down menu select "Modbus".

To change configuration for the Modbus by using ST100, select "Modbus" tab and set Node ID, Mode, Baud, Data Bits, Parity and Stop Bits.



ST100 Modbus Commands

With the Modbus protocol the instrument data is read and written via multiple register access. The following public function numbers are defined for communication with the ST100; 03, 04.

FUNCTION CODE	FUNCTION DESCRIPTION
03	Holding Register Read Only - Process Data
	Holding Register Read/Write - Service Data
04	Read Input Register for all Process Data
	Read Input Register for all Service "Start/Stop" Totalizer

ST100 Process Data Registers

Two data type registers were setup in the ST100 to access the process data. One uses integer data registers (4000) and the other uses the Daniel Extension data registers (5000).

All designated registers must be read for each variable value in order to extract the floating-point number. Conversion must be started manually with the 4000 registers. The Daniel extension handles the read and conversion automatically. To use the Daniel Extension the master must support the Daniel Extension function.

Totalizer Description

The ST100 through the MODBUS channel offers the flow Totalizer value through three different register groups organized into two forms of floating point data types. Registers 5103 and 5104, offer the flow Totalizer as a double precision floating point value in the MODBUS Daniel Extension form. Registers 4105, 4106, 4107, and 4108 offer the flow Totalizer as a double precision floating point value in the MODBUS Standard Integer register form. And lastly registers 4111, 4112, 4113, and 4114 offer the flow totalizer as a single precision floating point value in the MODBUS Standard register form. Because the Totalizer values can become a very large number, the Single precision floating point presents the data as two register groups. Group 1 called TOTALIZER 1 holds the lower count with a defaulted count limit of 65,535.996. TOTALIZER 1 resets back to zero when the count limit is reached. Group 2 called TOTALIZER 2 holds the upper count and it increments by 1 every time the group 1 registers reach the 65,535.996 count or the set "Totalizer Max Limit" count. TOTALIZER 2 has a maximum count of 4,294,967,295, after which it resets back to zero.

The TOTALIZER 1 group maximum count value can be set to a lower value of the default value by the user. This is control by the service register 4115 and 4116, values above 65,535.996 are not permitted. The default value of 65,535.996 for TOTALIZER 1 provides a resolution 0.01 to the Totalizer value of the ST100.

To reconstruct the double precision floating point value of the Totalizer using the single precision floating point registers do the following; TOTALIZER (DPFP)= TOTALIZER 2 value * TOTALIZER 1 MAX value + TOTALIZER 1 value.

Process Data - Table 1

Process Variable Values - Daniel Extension			
Variable / Parameter	Modbus Slave Register	Data Type	Access
FLOW (VALUE)	5101	FLOAT	READ
TEMP (VALUE)	5102	FLOAT	READ
TOTALIZER (VALUE) MS	5103	FLOAT (D)	READ
TOTALIZER (VALUE) LS	5104	FLOAT (D)	READ
PRESSURE (VALUE)	5105	FLOAT	READ

Process Data - Table 1, cont.

Process Variable Values - Integral Registers			
Variable / Parameter	Modbus Slave Register	Data Type	Access
Flow MS (VALUE)	4101	SPECIAL1	READ
Flow LS (VALUE)	4102	SPECIAL1	READ
Temperature MS (VALUE)	4103	SPECIAL1	READ
Temperature LS (VALUE)	4104	SPECIAL1	READ
Totalizer MS (VALUE)	4105	SPECIAL2 (D)	READ
Totalizer MS2 (VALUE)	4106	SPECIAL2 (D)	READ
Totalizer LS2 (VALUE)	4107	SPECIAL2 (D)	READ
Totalizer LS (VALUE)	4108	SPECIAL2 (D)	READ
Pressure MS (VALUE)	4109	SPECIAL1	READ
Pressure LS (VALUE)	4110	SPECIAL1	READ
Totalizer Value - Single Precision Floating Point (16 bits)			
Variable / Parameter	Modbus Slave Register	Data Type	Access
Totalizer 1 MS (VALUE)	4111	FLOAT	READ
Totalizer 1 LS (VALUE)	4112	FLOAT	READ
Totalizer 2 MS (VALUE)	4113	FLOAT	READ
Totalizer 2 LS (VALUE)	4114	FLOAT	READ
Process Variables - Engineering Unit Codes			
Variable / Parameter	Modbus Slave Register	Data Type	Access
FLOW ENG. UNITS CODE	4020	INTEGER	READ
TEMP ENG. UNITS CODE	4021	INTEGER	READ
TOTALIZER ENG. UNITS CODE	4022	INTEGER	READ
PRESSURE ENG UNITS CODE	4023	INTEGER	READ
Instrument Status Codes			
Variable / Parameter	Modbus Slave Register	Data Type	Access
DEVICE (SENSOR 1) STATUS CODE #1	4025	INTEGER	READ
DEVICE (SENSOR 1) STATUS CODE #2	4026	INTEGER	READ

Note: (D) indicated double precision (64 bits)

NOTE: DATA TYPE "SPECIAL 1": This is a collection of discrete registers that contain a single precision (32 bit) floating point value, and must be treated and interpreted as a single precision floating point number by the DCS or the PLC.

DATA TYPE "SPECIAL 2": This is a collection of discrete registers that contain a double precision (64 bit) floating point value, and must be treated and interpreted as a double precision floating point number by the DCS or the PLC.

ST100 Modbus Service Registers

The ST100 Modbus supports the new service registers which are 'Reset Totalizer' and 'Start-Stop totalizer'.

- **Reset Command for Totalizer**
The ST100 can manually 'reset' the totalizer number by using Function 03 holding command through 4117 integer register. This is a write only command. If another master has control on write, then function will return with a "write protected" error message.
- **Start and Stop Command for Totalizer**
The ST100 can manually 'start' or 'stop' the totalizer number by using Function 03 holding command through 4118 integer register. This is a read/write command. If another master has control on write, then function will return with a "write protected" error message.

Service Data - Table 2

Service and Setup Functions			
Variable / Parameter	Modbus Slave Register	Data Type	Access
Totalizer Reset To reset the totalizer write the value of	4117	INTEGER	WRITE ONLY (Function 03)
Totalizer Start/Stop To start the totalizer enter a value of 1 To stop the totalizer enter a value of 0	4118	INTEGER	READ/WRITE (Function 03) READ (Function 04)
Totalizer 1 Max MS	4115	FLOAT	READ/WRITE (Function 03)
Totalizer 1 Max LS	4116	FLOAT	READ/WRITE (Function 03)

Examples of Totalizer Service Registers using MODSCAN 32

1. How to check the totalizer value?
 - 1A. To read the totalizer value, open ModScan32 program and set the data definition (register #4111 and #4112) as shown in Figure A below.

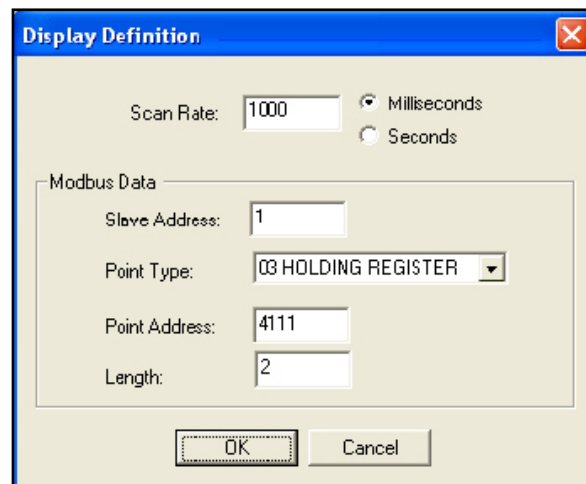


Figure A

- 1B. Once you defined the data, go to the “Connection tab” and click on the “Connect”. Below window will appear. Set the all parameters as per the settings.

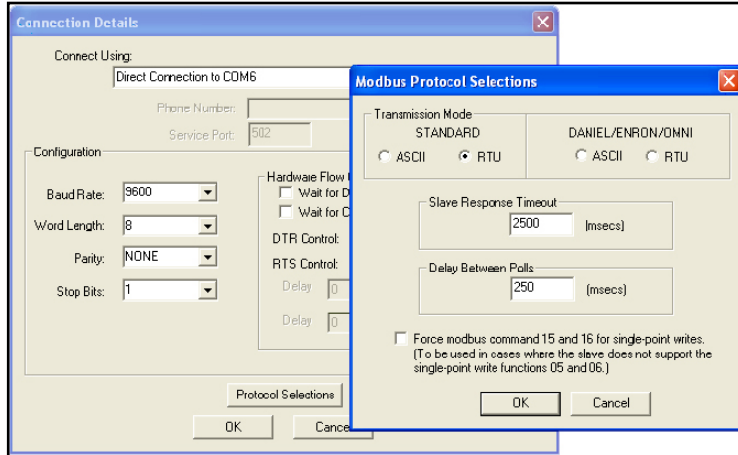


Figure B

- 1C. After user finishes all the above steps, ModScan32 master should communicate with the device (ST100). See below Figure C for the successful communication.

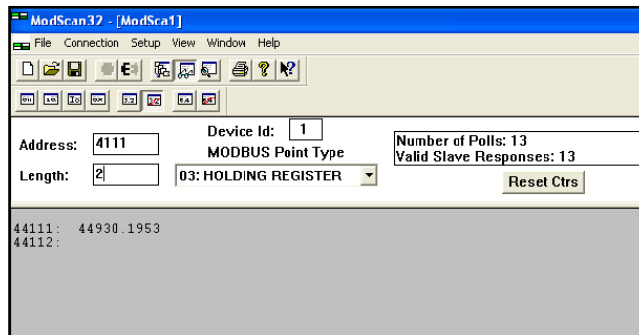


Figure C

2. How to check the “Totalizer Counter” number?
 - Repeat the step (1A) with the different register numbers. Set the registers #4113 and #4114.
 - Repeat step (1B) and (1C).
 - See below Figure D for the “Roll-over count” number.

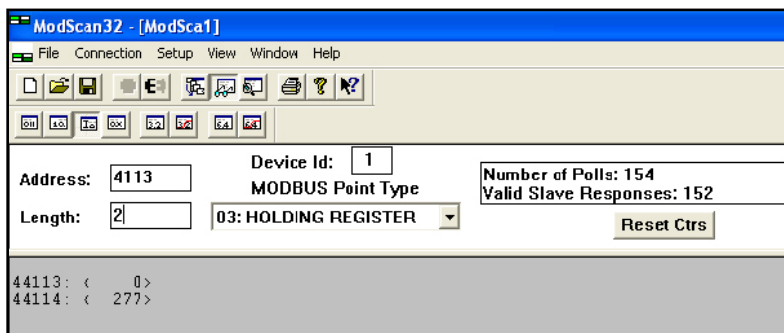


Figure D

3. How to check/set the "Totalizer Max" value?
 - Repeat the step (1A) with the different register numbers. Set the registers #4115 and #4116.
 - Repeat steps (1B) and (1C).
 - See the below Figure E for the "Ceiling value".

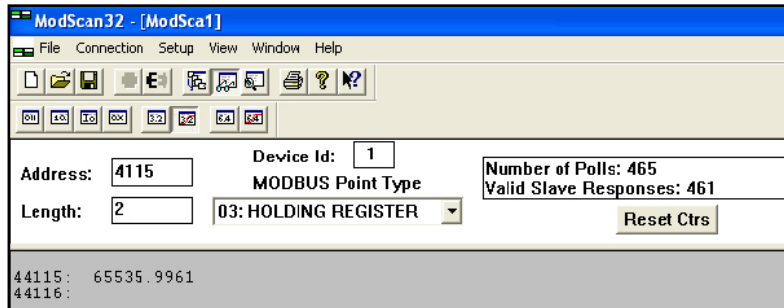


Figure E

4. How to reset the totalizer value?
 - Repeat step (1A) with the register number 4117.
 - Repeat step (1B).
 - Double click on the register number as shown in the Figure F. New window will pop-up. Write the defined value (ABCD in Hexadecimal form),

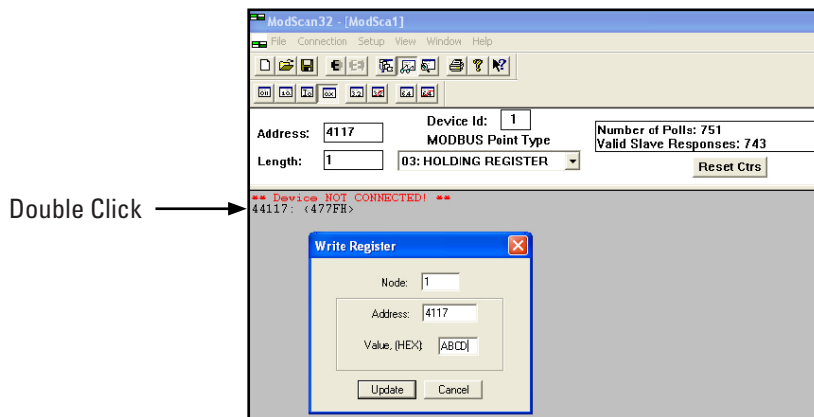


Figure F

5. How to Start and Stop the totalizer value?
 - Repeat step (1A) with the register number 4118.
 - Repeat step (1B).
 - Double click on the register number as shown in the Figure G. New window will pop-up. Write the defined value ("1" to start and "0" to stop.)

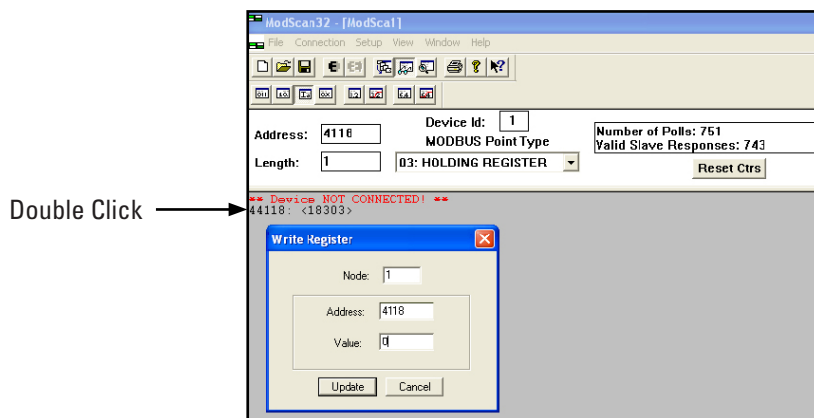


Figure G

APPENDIX A**Engineering Unit Codes Table**

Temperature Units	
Modbus	Description Unit Code
66	Degrees Celsius
71	Degrees Fahrenheit

Pressusre Units	
Modbus	Description Unit Code
1	PSIA
2	PSIG
3	in H2O (at 60°F)
5	bar A
6	bar G
7	kPa A
8	kPa G
9	cm H2O
11	torr

Volumetric Flow Units	
Modbus	Description Unit Code
90	Standard Cubic Feet per Sec
67	Standard Cubic Feet per Min
72	Standard Cubic Feet per Hr
91	Standard Cubic Feet per Day
94	Normal Cubic Meter per Sec
79	Normal Cubic Meter per Min
78	Normal Cubic Meter per Hour
95	Normal Cubic Meter per DAY
68	Normal Liter per Second
96	Normal Liter per Minute
97	Normal Liter per Hour
98	Normal Liter per Day

Mass Flow Units	
Modbus	Description Unit Code
80	Pounds per Second
65	Pounds per Minute
76	Pounds per Hour
92	Pounds per day
73	Kilograms per Second
74	Kilograms per Minute
75	Kilograms per hour
93	Kilograms per day
99	Metric Tonnes per Second
100	Metric Tonnes per Minute
101	Metric Tonnes per Hour
102	Metric Tonnes Per Day

Velocity Flow Units	
Modbus	Description Unit Code
70	SFPS
83	SFPM
84	SFPH
85	SFPD
86	SMPS
87	SMPM
88	SMPH
89	SMPD

Totalizer Units	
Modbus	Description Unit Code
190	Normal Cubic Feet
194	Normal Cubic Meters
168	Normal Liters
180	Pounds
173	Kilograms
199	Metric Tonnes

INTENTIONALLY LEFT BLANK

APPENDIX B**Instrument Faults Codes Table****Devices (Sensor 1) Status Codes #1 Register**

Bit	Status Description	Fault Class
0 (LSB)	CORE: If any of these errors occurs: I2C error, UART error, Mutex error, watch-dog reset.	F
1	FCI RESERVED (Bit not used)	NF
2	FCI RESERVED (Bit not used)	NF
3	CORE unable to update process data (PD_NO_FE_DATA). Unable to obtain/use data from any Active FEs.	F
4	FCI RESERVED (Bit not used)	NF
5	CORE detects FRAM/SPI error	F
6	CORE reports SD card error. Either initialization (corrupt card) error, or card became full (error while writing).	NF
7	FCI RESERVED (Bit not used)	NF
8	FCI RESERVED (Bit not used)	NF
9	FCI RESERVED (Bit not used)	NF
10	FCI RESERVED (Bit not used)	NF
11	FCI RESERVED (Bit not used)	NF
12	FCI RESERVED (Bit not used)	NF
13	CORE unable to communicate with one or more FEs (PD_COMM_ERROR)	F
14	FCI RESERVED (Bit not used)	NF
15(MSB)	CORE: averaged flow out of range of "Flow Min" or "Flow Max"	NF

Devices (Sensor 1) Status Codes #2 Register

Bit	Status Description	Fault Class
0 (LSB)	FCI RESERVED (Bit not used)	NF
1	FCI RESERVED (Bit not used)	NF
2	FCI RESERVED (Bit not used)	NF
3	CORE: averaged temperature above "Temperature Max"	F
4	CORE: averaged temperature below "Temperature Min"	F
5	(Any) FE reports SENSOR_HEATER_1_SHORTED_FAULT	F
6	(Any) FE reports SENSOR_HEATER_2_SHORTED_FAULT	F
7	(Any) FE reports SENSOR_HEATER_1_OPEN_FAULT	F
8	(Any) FE reports SENSOR_HEATER_2_OPEN_FAULT	F
9	(Any) FE reports SENSOR_ABOVE_MAX_A_D_FAULT	NF
10	(Any) FE reports SENSOR_BELOW_MIN_A_D_FAULT	NF
11	FCI RESERVED (Bit not used)	NF
12	(Any) FE reports SENSOR_ABOVE_MAX_FLOW_FAULT	NF
13	(Any) FE reports ABOVE_dR_MAX_FAULT	NF
14	FCI RESERVED (Bit not used)	NF
15(MSB)	(Any) FE reports TMP100_ADC_FAULT	NF

Devices (Sensor 1) Status Codes #3 Register

Bit	Status Description	Fault Class
0 (LSB)	(Any) FE reports AD5754_DAC_FAULT	F
1	FCI RESERVED (Bit not used)	NF
2	(Any) FE reports CURR_SENSORS_ADC_FAULT	NF
3	(Any) FE reports HTRS_PRESSNS_ADC_FAULT	NF
4	(Any) FE reports HTRS_FAULTS_ADC_FAULT	F
5	(Any) FE reports FE_ARM7_UNDEFINE_FAULT	NF
6	(Any) FE reports FE_ARM7_SWI_FAULT	NF
7	(Any) FE reports FE_ARM7_PREFETCH_ABORT_FAULT	NF
8	(Any) FE reports FE_ARM7_DATA_ABORT_FAULT	NF
9	(Any) FE reports FE_ARM7_FIQ_FAULT	NF
10	(Any) FE reports FE_ARM7_SPURIOUS_INT_FAULT	NF
11	FCI RESERVED (Bit not used)	NF
12	FCI RESERVED (Bit not used)	NF
13	FCI RESERVED (Bit not used)	NF
14	FCI RESERVED (Bit not used)	NF
15(MSB)	FCI RESERVED (Bit not used)	NF

APPENDIX C

Customer Service / Technical Support

FCI provides full in-house technical support. Additional technical representation is also provided by FCI field representatives. Before contacting a field or in-house representative, please perform the troubleshooting techniques outlined in this document.

By Mail

Fluid Components International LLC
1755 La Costa Meadows Dr.
San Marcos, CA 92078-5115 USA
Attn: Customer Service Department

By Phone

Contact the area FCI regional representative. If a field representative is unable to be contacted or if a situation is unable to be resolved, contact the FCI Customer Service Department toll free at 1 (800) 854-1993.

By Fax

To describe problems in a graphical or pictorial manner, send a fax including a phone or fax number to the regional representative. Again, FCI is available by facsimile if all possibilities have been exhausted with the authorized factory representative. Our Fax number is 1 (760) 736-6250; it is available 7 days a week, 24 hours a day.

By E-Mail

FCI Customer Service can be contacted by e-mail at: techsupport@fluidcomponents.com.

Describe the problem in detail making sure a telephone number and best time to be contacted is stated in the e-mail.

International Support

For product information or product support outside the contiguous United States, Alaska, or Hawaii, contact your country's FCI International Representative or the one nearest to you.

After Hours Support

For product information visit FCI at www.fluidcomponents.com. For product support call 1 (800) 854-1993 and follow the prerecorded instructions.

Point of Contact

The point of contact for service, or return of equipment to FCI is your authorized FCI sales/service office. To locate the office nearest you, please go to www.fluidcomponents.com.



*Flow & Level Instrumentation
Solutions for Industrial Processes*

**FCI's Complete Customer Commitment. Worldwide
ISO 9001 and AS9100 Certified**

Visit FCI on the Worldwide Web: www.fluidcomponents.com

FCI World Headquarters

1755 La Costa Meadows Drive | San Marcos, California 92078 USA | Phone: 760-744-6950 Toll Free (US): 800-854-1993 Fax: 760-736-6250

FCI Europe

Persephonestraat 3-01 | 5047 TT Tilburg, The Netherlands | Phone: 31-13-5159989 Fax: 31-13-5799036

FCI Measurement and Control Technology (Beijing) Co., LTD | www.fluidcomponents.cn

Room 107, Xianfeng Building II, No.7 Kaituo Road, Shangdi IT Industry Base, Haidian District | Beijing 100085, P. R. China
Phone: 86-10-82782381 Fax: 86-10-58851152

Notice of Proprietary Rights

This document contains confidential technical data, including trade secrets and proprietary information which is the property of Fluid Components International LLC (FCI). Disclosure of this data to you is expressly conditioned upon your assent that its use is limited to use within your company only (and does not include manufacture or processing uses). Any other use is strictly prohibited without the prior written consent of FCI.