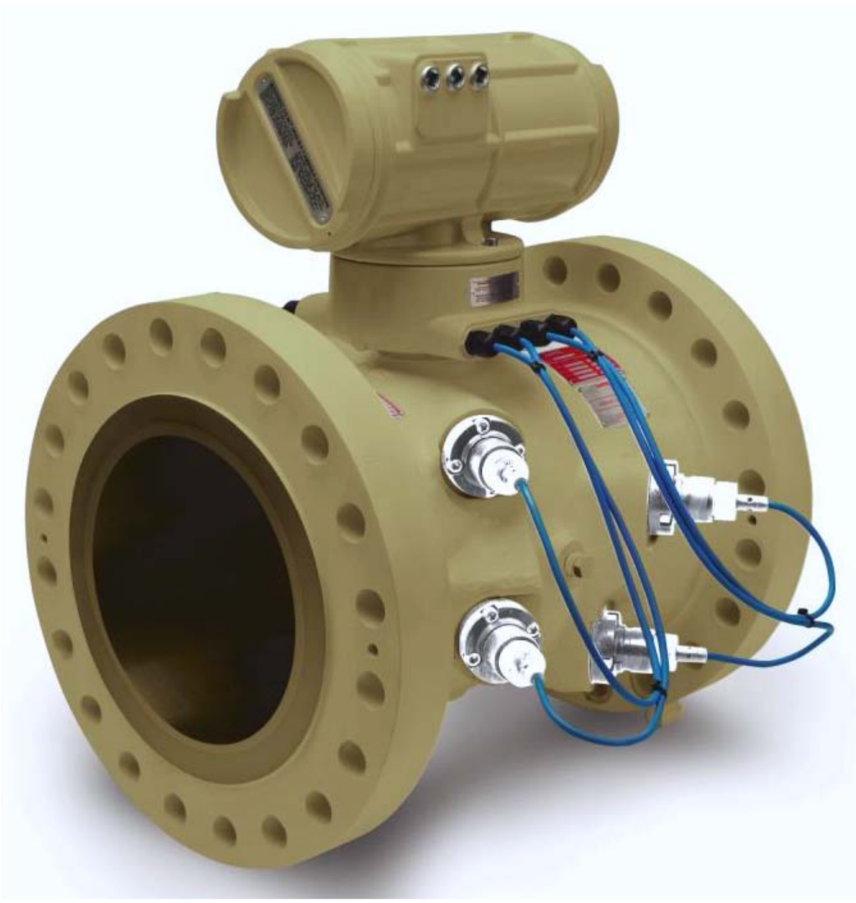
Reference, Installation, and Operations Manual

Part Number 3-9000-743 Revision S

June 2013

Daniel™ Ultrasonic Gas Flow Meters with Mark III Electronics

Supporting Multipath SeniorSonic™ - Model 3400, Multipath SeniorSonic™ - Model 3422
Single Path JuniorSonic™ - Model 3410, Dual Path JuniorSonic™ - Model 3420



DANIEL™

EMERSON™
Process Management

Daniel customer service

Location	Telephone number	Fax number
North America/Latin America	+1.713.467.6000	+1.713.827.4805
Daniel Customer Service	+1.713.827.6413	+1.713.827.6312
USA (toll free)	+1.888.356.9001	+1.713.827.3380
Asia Pacific (Republic of Singapore)	+65.6777.8211	+65.6777.0947.0743
Europe (Stirling Scotland, UK)	+44 (0)1786.433400	+44 (0)1786.433401
Middle East Africa (Dubai, UAE)	+971 4 8118100	+971 4 8865465

E-mail

- Customer Service: tech.service@emersonprocess.com
- Customer Support: daniel.cst.support@emerson.com
- Asia-Pacific: danielap.support@emerson.com
- Europe: DanielEMA.CST@EmersonProcess.com

Return Material Authorization (RMA)
A Return Material Authorization (RMA) number must be obtained prior to returning any equipment for any reason. Download the RMA form from the Support Services web page by selecting the link below. www2.emersonprocess.com/EN-US/BRANDS/DANIEL/SUPPORT-SERVICES/Pages/Support-Services.aspx?

Signal words and symbols

Pay special attention to the following signal words, safety alert symbols and statements:

⚠ Safety alert symbol

This is a safety alert symbol. It is used to alert you to potential physical injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠ DANGER

Danger indicates a hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

Warning indicates a hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

Caution indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE

Caution indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

Important

Important is a statement the user needs to know and consider.

Tip

Tip provides information or suggestions for improved efficiency or best results.

Note

Note is a “general by-the-way” content not essential to the main flow of information.

Important safety instructions

Daniel Measurement and Control, Inc. (Daniel) designs, manufactures and tests products to function within specific conditions. Because these products are sophisticated technical instruments, it is important that the owner and operation personnel strictly adhere both to the information printed on the product and to all instructions provided in this manual prior to installation, operation, and maintenance.

Daniel also urges you to integrate this manual into your training and safety program.

BE SURE ALL PERSONNEL READ AND FOLLOW THE INSTRUCTIONS IN THIS MANUAL AND ALL NOTICES AND PRODUCT WARNINGS.

⚠WARNING

Installing, operating or maintaining a Daniel product improperly could lead to serious injury or death from explosion or exposure to dangerous substances. To reduce this risk:

- Comply with all information on the product, in this manual, and in any local and national codes that apply to the product.
- Do not allow untrained personnel to work with this product.
- Use Daniel parts and work procedures specified in this manual.

Product owners (Purchasers):

- Use the correct product for the environment and pressures present. See technical data or product specifications for limitations. If you are unsure, discuss your needs with your Daniel representative.
- Inform and train all personnel in the proper installation, operation, and maintenance of this product.
- To ensure safe and proper performance, only informed and trained personnel should install, operate, repair and maintain this product.
- Verify that this is the correct instruction manual for your Daniel product. If this is not the correct documentation, contact Daniel at 1-713-827-6314. You may also download the correct manual from:

  http://www.daniel.com

- Save this instruction manual for future reference.
- If you resell or transfer this product, it is your responsibility to forward this instruction manual along with the product to the new owner or transferee.
- ALWAYS READ AND FOLLOW THE INSTALLATION, OPERATIONS, MAINTENANCE AND TROUBLESHOOTING MANUALS AND ALL PRODUCT WARNINGS AND INSTRUCTIONS.
- Do not use this equipment for any purpose other than its intended service. This may result in property damage and/or serious personal injury or death.

Product Operation Personnel:

- To prevent personal injury, personnel must follow all instructions of this manual prior to and during operation of the product.
- Follow all warnings, cautions, and notices marked on, and supplied with, this product.
- Verify that this is the correct instruction manual for your Daniel product. If this is not the correct documentation, contact Daniel at 1-713-827-6314. You may also download the correct manual from:

http://www.daniel.com

- Read and understand all instructions and operating procedures for this product.
- If you do not understand an instruction, or do not feel comfortable following the instructions, contact your Daniel representative for clarification or assistance.
- Install this product as specified in the INSTALLATION section of this manual per applicable local and national codes.
- Follow all instructions during the installation, operation, and maintenance of this product.
- Connect the product to the appropriate pressure and electrical sources when and where applicable.
- Ensure that all connections to pressure and electrical sources are secure prior to and during equipment operation.
- Use only replacement parts specified by Daniel. Unauthorized parts and procedures can affect this product's performance, safety, and invalidate the warranty. “Look-a-like” substitutions may result in deadly fire, explosion, release of toxic substances or improper operation.
- Save this instruction manual for future reference.

Notice

THE CONTENTS OF THIS PUBLICATION ARE PRESENTED FOR INFORMATIONAL PURPOSES ONLY, AND WHILE EVERY EFFORT HAS BEEN MADE TO ENSURE THEIR ACCURACY, THEY ARE NOT TO BE CONSTRUED AS WARRANTIES OR GUARANTEES, EXPRESSED OR IMPLIED, REGARDING THE PRODUCTS OR SERVICES DESCRIBED HEREIN OR THEIR USE OR APPLICABILITY. ALL SALES ARE GOVERNED BY DANIEL'S TERMS AND CONDITIONS, WHICH ARE AVAILABLE UPON REQUEST. WE RESERVE THE RIGHT TO MODIFY OR IMPROVE THE DESIGNS OR SPECIFICATIONS OF SUCH PRODUCTS AT ANY TIME.

DANIEL DOES NOT ASSUME RESPONSIBILITY FOR THE SELECTION, USE OR MAINTENANCE OF ANY PRODUCT. RESPONSIBILITY FOR PROPER SELECTION, USE AND MAINTENANCE OF ANY DANIEL PRODUCT REMAINS SOLELY WITH THE PURCHASER AND END-USER.

TO THE BEST OF DANIEL'S KNOWLEDGE THE INFORMATION HEREIN IS COMPLETE AND ACCURATE. DANIEL MAKES NO WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THIS MANUAL AND, IN NO EVENT, SHALL DANIEL BE LIABLE FOR ANY INCIDENTAL, PUNITIVE, SPECIAL OR CONSEQUENTIAL DAMAGES INCLUDING, BUT NOT LIMITED TO, LOSS OF PRODUCTION, LOSS OF PROFITS, LOSS OF REVENUE OR USE AND COSTS INCURRED INCLUDING WITHOUT LIMITATION FOR CAPITAL, FUEL AND POWER, AND CLAIMS OF THIRD PARTIES.

PRODUCT NAMES USED HEREIN ARE FOR MANUFACTURER OR SUPPLIER IDENTIFICATION ONLY AND MAY BE TRADEMARKS/REGISTERED TRADEMARKS OF THESE COMPANIES

Warranty and Limitations

1. LIMITED WARRANTY: Subject to the limitations contained in Section 2 herein, Daniel Measurement & Control, Inc. ("Daniel") warrants that the licensed firmware embodied in the Goods will execute the programming instructions provided by Daniel, and that the Goods manufactured by Daniel will be free from defects in materials or workmanship under normal use and care and Services will be performed by trained personnel using proper equipment and instrumentation for the particular Service provided. The foregoing warranties will apply until the expiration of the applicable warranty period. Goods are warranted for twelve (12) months from the date of initial installation or eighteen (18) months from the date of shipment by Daniel, whichever period expires first. Consumables and Services are warranted for a period of 90 days from the date of shipment or completion of the Services. Products purchased by Daniel from a third party for resale to Buyer ("Resale Products") shall carry only the warranty extended by the original manufacturer. Buyer agrees that Daniel has no liability for Resale Products beyond making a reasonable commercial effort to arrange for procurement and shipping of the Resale Products. If Buyer discovers any warranty defects and notifies Daniel thereof in writing during the applicable warranty period, Daniel shall, at its option, correct any errors that are found by Daniel in the firmware or Services or repair or replace F.O.B. point of manufacture that portion of the Goods or firmware found by Daniel to be defective, or refund the purchase price of the defective portion of the Goods/Services. All replacements or repairs necessitated by inadequate maintenance, normal wear and usage, unsuitable power sources or environmental conditions, accident, misuse, improper installation, modification, repair, use of unauthorized replacement parts, storage or handling, or any other cause not the fault of Daniel are not covered by this limited warranty, and shall be at Buyer's expense. Daniel shall not be obligated to pay any costs or charges incurred by Buyer or any other party except as may be agreed upon in writing in advance by Daniel. All costs of dismantling, reinstallation and freight and the time and expenses of Daniel's personnel and representatives for site travel and diagnosis under this warranty clause shall be borne by Buyer unless accepted in writing by Daniel. Goods repaired and parts replaced by Daniel during the warranty period shall be in warranty for the remainder of the original warranty period or ninety (90) days, whichever is longer. This limited warranty is the only warranty made by Daniel and can be amended only in a writing signed by Daniel. THE WARRANTIES AND REMEDIES SET FORTH ABOVE ARE EXCLUSIVE. THERE ARE NO REPRESENTATIONS OR WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, AS TO MERCHANTABILITY, FITNESS FOR PARTICULAR PURPOSE OR ANY OTHER MATTER WITH RESPECT TO ANY OF THE GOODS OR SERVICES. Buyer acknowledges and agrees that corrosion or erosion of materials is not covered by this warranty.

2. LIMITATION OF REMEDY AND LIABILITY: DANIEL SHALL NOT BE LIABLE FOR DAMAGES CAUSED BY DELAY IN PERFORMANCE. THE REMEDIES OF BUYER SET FORTH IN THIS AGREEMENT ARE EXCLUSIVE. IN NO EVENT, REGARDLESS OF THE FORM OF THE CLAIM OR CAUSE OF ACTION (WHETHER BASED IN CONTRACT, INFRINGEMENT, NEGLIGENCE, STRICT LIABILITY, OTHER TORT OR OTHERWISE), SHALL DANIEL'S LIABILITY TO BUYER AND/OR ITS CUSTOMERS EXCEED THE PRICE TO BUYER OF THE SPECIFIC GOODS MANUFACTURED OR SERVICES PROVIDED BY DANIEL GIVING RISE TO THE CLAIM OR CAUSE OF ACTION. BUYER AGREES THAT IN NO EVENT SHALL DANIEL'S LIABILITY TO BUYER AND/OR ITS CUSTOMERS EXTEND TO INCLUDE INCIDENTAL, CONSEQUENTIAL OR PUNITIVE DAMAGES. THE TERM "CONSEQUENTIAL DAMAGES" SHALL INCLUDE, BUT NOT BE LIMITED TO, LOSS OF ANTICIPATED PROFITS, REVENUE OR USE AND COSTS INCURRED INCLUDING WITHOUT LIMITATION FOR CAPITAL, FUEL AND POWER, AND CLAIMS OF BUYER'S CUSTOMERS.

Contents

Section 4: Optional features

Section 5: Startup and meter configuration

Section 7: Maintenance and troubleshooting

Appendix A Conversion factors

Appendix B Miscellaneous equations

Appendix C Upgrading a Mark II to a Mark III

Appendix D Troubleshooting comm., mech., and elec.

Appendix E Meter setup and configuration worksheet

List of Tables

List of Figures

Section 1: Introduction

1.1 Manual overview

The *Daniel Ultrasonic Gas Flow Meter* Daniel Mark III Ultrasonic Gas Flow Meter *Electronics Reference, Installation, and Operations Manual* (P/N 3-9000-743) provides descriptions and explanations of the Daniel Multipath SeniorSonic™ Model 3400 and Model 3422, Single Path JuniorSonic™, Model 3410 and the Dual Path JuniorSonic™ Model 3420.

The Daniel 3400 Series Gas Ultrasonic Flow Meter was originally developed and tested by British Gas. The unit was further developed by Daniel and features hardware and electronics designed for easy use and minimum maintenance. All parts and assemblies have been tested prior to shipment. Daniel holds an exclusive license from British Gas, obtained in 1986, to manufacture and sell this product.

This manual consists of the following sections and appendices:

Sections:

Appendices

1.2 Definitions, acronyms, abbreviations

The following terms, acronyms, and abbreviations are used in this document:

Table 1-1 Gas Ultrasonic Meter acronyms, abbreviations and definitions

Acronym or abbreviation	Definition
°	degree (angle)
°C	degrees celsius (temperature unit)
°F	degrees fahrenheit (temperature unit)
ADC	analog-to-digital converter
AGA	American Gas Association
AI	analog input
AMS™ Suite	Asset Management Software
AO	analog output
ASCII MODBUS	A Modbus protocol message framing format in which ASCII characters are used to delineate the beginning and end of the frame. ASCII stands for American Standard Code for Information Interchange.
boolean	a type of data point that can only take on values of TRUE or FALSE (generally TRUE is represented by a value of 1, FALSE is represented by a value of 0)
bps	bits per second (baud rate)
Btu	British thermal unit (heat unit)
cfh	cubic feet per hour
cPoise	centipoise (viscosity unit)
CPU	central processing unit
CTS	Clear-to-Send; the RS-232C handshaking signal input to a transmitter indicating that it is okay to transmit data — i.e., the corresponding receiver is ready to receive data. Generally, the Request-to-Send (RTS) output from a receiver is input to the Clear-to-Send (CTS) input of a transmitter.
DAC	Digital-to-Analog Converter
Daniel CUI	Daniel Customer Ultrasonic Interface
Daniel MeterLink	Daniel software application for ultrasonic flow meters
DI	digital input
DO	digital output
Daniel MeterLink	Daniel Customer User Interface
DHCP	Dynamic Host Configuration Protocol
dm	decimeter (10^{-1} meters, length unit)
ECC	Error Correction Code
EEPROM	Electrically-Erasable, Programmable Read-Only Memory
Flash	non-volatile, programmable read-only memory

Table 1-1 Gas Ultrasonic Meter acronyms, abbreviations and definitions

Acronym or abbreviation	Definition
ft	feet (length unit)
ft^3/d	cubic feet per day (volumetric flow rate)
ft^3/h	cubic feet per hour (volumetric flow rate)
ft^3/s	cubic feet per second (volumetric flow rate)
GC	gas chromatograph
g-mol	gram mole
HART®	Highway Addressable Remote Transducer
hr	hour (time unit)
Hz	hertz (cycles per second, frequency unit)
I/O	Input/Output
IS	Intrinsically Safe
K	kelvin (temperature unit)
$kcal/m^3$	kilocalories per cubic meter (heating value)
kg	kilogram (mass unit)
kg-mol	kilogram mole
kg/d	kilograms per day (mass rate)
kg/h	kilograms per hour (mass rate)
kg/s	kilograms per second (mass rate)
kHz	kilohertz (10^3 cycles per second, frequency unit)
kJ	kilojoule (10^3 joules, energy)
kJ/m^3	kilojoules per cubic meter (heating value)
kwh/m^3	kilowatt-hours per cubic meter (heating value)
LAN	Local Area Network
lbm	pound mass
lbm-mol	pound mass mole
lbm/d	pounds (mass) per day (mass rate)
lbm/h	pounds (mass) per hour (mass rate)
lbm/s	pound (mass) per second (mass rate)
LED	light-emitting diode
m	meter (length unit)
m^3/d	cubic meters per day (volumetric flow rate)

Table 1-1 Gas Ultrasonic Meter acronyms, abbreviations and definitions

Acronym or abbreviation	Definition
m^3/h	cubic meters per hour (volumetric flow rate)
m^3/s	cubic meters per second (volumetric flow rate)
mA	milliamp (current unit)
microinch (μinch)	microinch (10^{-6} in)
micron	micrometer (10^{-6} m)
MJ	megajoule (energy)
MJ/d	megajoules per day (energy rate)
MJ/m3	megajoules per cubic meter (heating value)
MJ/h	megajoules per hour (energy rate)
MJ/s	megajoules per second (energy rate)
MMBtu	million British Thermal Units (energy)
MMBtu/d	million Btu per day (energy rate)
MMBtu/h	million Btu per hour (energy rate)
MMBtu/s	million Btu per second (energy rate)
MMU	Memory Management Unit
MPa	megapascal (equivalent to 10^6 Pascal) (pressure unit)
N/A	not applicable
Nm^3/h	normal cubic meters per hour
NOVRAM	non-volatile random access memory
Pa	Pascal, equivalent to 1 newton per square meter (pressure unit)
Pa·s	Pascal Second (viscosity unit)
PC	Personal Computer
PFC	peripheral field connection (board)
P/N	part number
ppm	parts per million
PS	power supply (board)
psi	pounds per square inch (pressure unit)
psia	pounds per square inch absolute (pressure unit)
psig	pounds per square inch gage (pressure unit)
PWL	Piece-Wise Linearization
rad	radian (angle)
RAM	Random Access Memory

Table 1-1 Gas Ultrasonic Meter acronyms, abbreviations and definitions

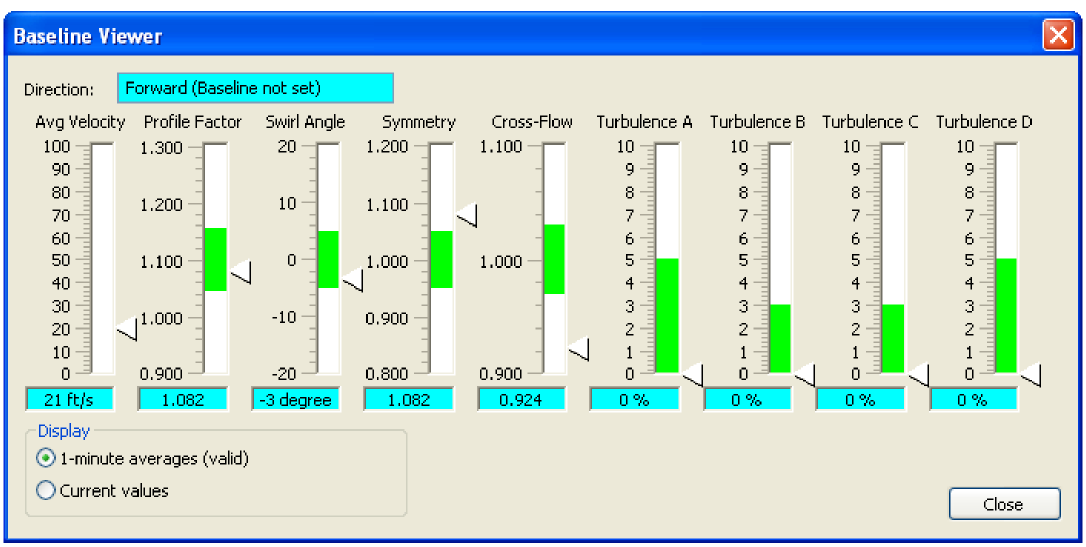
Acronym or abbreviation	Definition
RTS	Request-to-Send; the RS-232C handshaking signal output by a receiver when it is ready to receive data
RTU MODBUS	A Modbus protocol framing format in which elapsed time between received characters is used to separate messages. RTU stands for Remote Terminal Unit.
s	second (time unit, metric)
Scfh	seconds per cubic feet per hour
sec	second (time unit, u.s. customary)
time_t	seconds since Epoch (00:00:00 UTC Jan. 1, 1970) (time unit)
U.L.	Underwriters Laboratories, Inc. - product safety testing and certification organization
USM	Ultrasonic Gas Flow Meter
V	volts (electric potential unit)
W	watts (power unit)

1.3 What's new

Daniel MeterLink

This version of Daniel MeterLink has robust features for monitoring the health status of Daniel Ultrasonic Gas Flow Meters. Daniel MeterLink setup wizards guide you through the process of configuring Continuous Flow Analysis parameters and setting Baselines. The Baseline Viewer provides a graphical display of the meter's flow characteristics.

Figure 1-2 Baseline viewer



NOTICE

Daniel CUI version 4.21 is the final version that supports Daniel Mark II Gas Ultrasonic meters. If you are communicating with a Daniel Ultrasonic Mark II Gas Flow Meter, you do not need to uninstall version 4.21 or earlier versions of Daniel CUI before installing MeterLink. Version 4.21 and earlier versions of Daniel CUI should not be run simultaneously with MeterLink.

Continuous Flow Analysis

Continuous Flow Analysis provides operators and technicians with critical ultrasonic meter diagnostic capabilities with meter status alerts when problems occur with:

- Abnormal profile
- Blockage
- Internal bore buildup
- Liquids present in the gas meter
- Reverse Flow
- Speed of Sound comparison error

1.4 Daniel Ultrasonic Meter reference manuals

Table 1-2 Daniel reference manuals

Part Number	Title
P/N 3-9000-729	Ultrasonic Extractor Tool Operation Manual (Older “M” and “N”mounts)
P/N 3-9000-740	Daniel Ultrasonic Gas Flow Meter Reference, Installation and Operations Manual (Applies to Mark II meter)
P/N 3-9000-763	Daniel MeterLink Ultrasonic Meter Software Quick Start Manual
P/N 3-9000-743	Daniel Ultrasonic Gas Flow Meter Mark III Electronics Reference, Installation and Operations Manual (This manual.)
P/N 3-9000-744	Ultrasonic Split Clamp Extractor Tool Operation Manual (Newer “J” &“K” Mounts)
P/N 3-9000-746	Daniel Ultrasonic Mark III Electronic Upgrade Kit Instructions
P/N 3-9000-749	Daniel Ultrasonic Mark III Option Board “A” Field Installation Procedure (Series 100 Options Boards)
P/N 3-9000-751	Daniel Transducer Installation and Upgrade Procedure
P/N 3-9000-754	HART Field Device Specification Guide: Daniel Gas Ultrasonic Meters

All technical manuals are available for download in Adobe® PDF format from the Daniel website:

http://www2.emersonprocess.com/EN-US/BRANDS/DANIEL/FLOW/Pages/Flow.aspx

1.5 References

[1]*Gould Modbus Protocol Reference Guide*, Rev. B, PI-MBUS-300

[2]*Measurement of Fuel Gas By Turbine Meters*, American Gas Association, Transmission Measurement Committee Report No. 7, Second Revision, April 1996 (also referred to as AGA7)

[3]*Compressibility Factors of Natural Gas and Other Related Hydrocarbon Gases*, American Gas Association, Transmission Measurement Committee Report No. 8, Second Edition, Second Printing, July 1994 (also referred to as AGA8)

[4]*Manual of Petroleum Measurement Standards*, Chapter 21 – Flow Measurement Using Electronic Metering Systems, Section 1 – Electronic Gas Measurement, American Gas Association and American Petroleum Institute, First Edition, September 1993

Section 2: Product overview

2.1 Description

The Daniel Ultrasonic Gas Flow Meter measures the flow of gas, especially natural gas, by measuring the difference in signal transit time with and against the gas flow across one or more measurement path(s). A signal transmitted in the flow direction travels faster than one transmitted against the flow direction. Each measurement path is defined by a transducer pair in which each transducer alternately acts as transmitter and receiver. The meter uses the transit time measurements and transducer location information to calculate the mean gas velocity.

The Daniel Ultrasonic Gas Flow Meter offers bi-directional measurement capability (due to meter symmetry) over a wide range of flow rates with no pressure loss. Accuracy, safety, reliability, and ease-of-use are some of the many benefits of Daniel Ultrasonic Gas Flow Meters.

Computer simulations of various gas velocity profiles demonstrate that four measurement paths provide an optimum solution for measuring asymmetric flow. The Daniel SeniorSonic™ Meter (Models 3400 and 3422) utilizes four cross-bore, parallel-plane measurement paths to offer a high degree of accuracy, repeatability, and superior low-flow capabilities without the compromises associated with conventional technologies. These features make the SeniorSonic™ Meter the best choice for custody transfer applications.

Daniel offers two JuniorSonic™ Meter models (3410 and 3420) for applications that are cost-sensitive and/or do not require custody-transfer levels of accuracy. Model 3410 utilizes one measurement path; Model 3420 utilizes two measurement paths. Unlike the SeniorSonic™ Meter designs, the JuniorSonic™ design bounces the ultrasonic signal across the meter body. Each transducer is angled 60° from horizontal (60° included angle). The path is often referred to as a bounce-path (as the signal is bounced off the meter body) or a centerline path (as it goes through the center-line of the meter body). The 3420 model's two paths are configured at right angles to one another in a "bulls-eye" arrangement. The bounce-path method simplifies construction of the meter and makes the meter less susceptible to interference from pipeline liquids.

Since the JuniorSonic™ Gas Flow Meter utilizes center-line paths, an additional piece of information is needed to determine the average velocity of the moving gas (remember that not all gas is moving at the same velocity). A "flow profile correction factor", sometimes called the Reynold's Number correction factor, is needed to correct the velocity measured along the path(s) to the correct average for the cross sectional area. (see Section 5.6.11 and Equation 6-18 for Reynolds correction information). This can be accomplished by either using a fixed value or more accurately by measuring pressure and temperature, and then applying an active correction to the measured transit times.

The dual-path configuration (3420 model) provides a more representative measurement of the entire flow profile than the single-path configuration (3410 model).

The Daniel Ultrasonic Flow Gas Meter's U.L. safety listing is accomplished through a combination of an explosion-proof electronics enclosure, and intrinsically safe transducers. The transducers and transducer leads are designed for maximum safety in a Class 1, Division 1 area without need of further protection when installed in accordance with the field wiring diagram (Daniel P/N DE-21056, see Appendix I).

2.1.1 Advantages and Features

Advantages and features of the Daniel Ultrasonic Flow Meter include:

- Proven long term stability
- Field proven reliability
- No line obstruction
- No pressure loss
- No moving parts
- Low maintenance
- Bi-directional measurement
- Extractable transducers
- Superior "dirty vs. clean" operation
- Fully digital electronics
- Extensive self diagnostics
- Immediate alarm reporting
- Continuous Flow Analysis
  - Alarms
  - Abnormal Profile
  - Baselines - data configurable via Daniel MeterLink Baseline wizard
  - Blockage
  - Bore buildup
  - Liquid detection
  - SOS comparison with AGA10
  - Signal and Noise Energy Amplitude
- Auto-detected ASCII/RTU Modbus communications protocol
- Low power consumption
- Sophisticated noise reduction
- One electronics set fits all models
- Internet-ready communications
- Optional Ethernet access
- On-board LED status indicators
- Optional gas chromatograph interface
- Optional analog pressure and temperature inputs
- Series 100 Plus Option Board - two additional independently configurable analog outputs
- Series 100 Plus Option Board enables the meter to easily communicate with other field devices
- Communication via Emerson's AMS™ Suite and 375 Field Communicator

- Detailed and Gross AGA8 calculations
- Optional AGA10 sound velocity calculation and comparison
- Optional API Chapter 21 compliant event and data logging
- Daniel MeterLink (powerful Windows-based interface software)

Advantages and features of the SeniorSonic™ Model 3400 and Model 3422 include:

- Range exceeds 50-1 within ±0.1% after flow calibration
- Unsurpassed measurement accuracy
- Superior low-flow capabilities

Advantages and features of the Daniel JuniorSonic™ Gas Flow Meter:

- Cost advantage over SeniorSonic™
- Dual path redundancy (Model 3420)
- Large turn-down ratio
- Tolerant of wet gas

The ultrasonic meter can use measured flow condition temperature and pressure values for use in velocity profile-effect correction (for single-path and dual-path meters) and for volumetric flow rate conversion to a user-specified base temperature/pressure condition.

2.1.2 Mechanical installation requirements

Refer to Section 3.3.1 for mechanical installation requirements.

2.2 Component parts

The Daniel Ultrasonic Gas Flow Meters are available in various configurations to meet a broad range of customer requirements. Each meter comes fully assembled from Daniel.

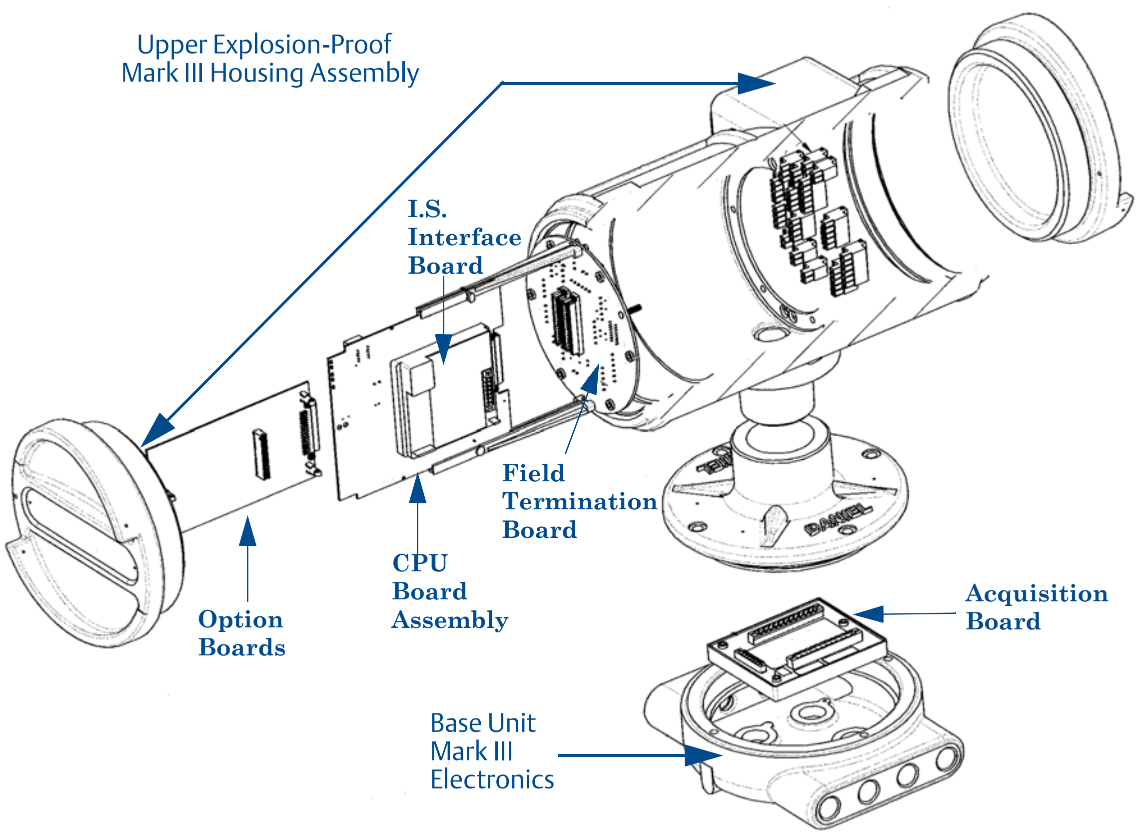
2.2.1 Daniel Mark III Ultrasonic Gas Flow Meters assembly

The Mark III electronics assembly consists of an upper explosion-proof housing and a lower intrinsically-safe base unit assembly (see Figure 2-2).

Upper explosion-proof housing

- a Daniel Mark III Ultrasonic Gas Flow Meter CPU (Central Processing Unit) Board
- a Field Connection Board (for making electrical connections)
- a Daniel Mark III Ultrasonic Gas Flow Meter I.S. (Intrinsically-Safe) Interface Board (permanently mounted on the CPU Board)
- Option Boards (Series 100 Option Board or Series 100 Plus Option Board).

Figure 2-2 Daniel Ultrasonic Gas Flow Meter Mark III Electronics



Lower intrinsically-safe base unit assembly

All Mark III meter models utilize the same lower intrinsically-safe base unit assembly (see Figure 2-2).

Base Unit

- encloses the intrinsically-safe Acquisition Board that interfaces with transducers
- connects the main electronics assembly to the meter body

NOTICE

When the analog Series 100 Option Board or the Series 100 Plus Option Board is installed, its corresponding I/O connectors on the Field Termination Board are automatically activated for use.

Figure 2-3 CPU Board (switch-side view)

Figure 2-4 CPU Board with I.S. Interface Board Mounted (I.S. Barrier-side view)

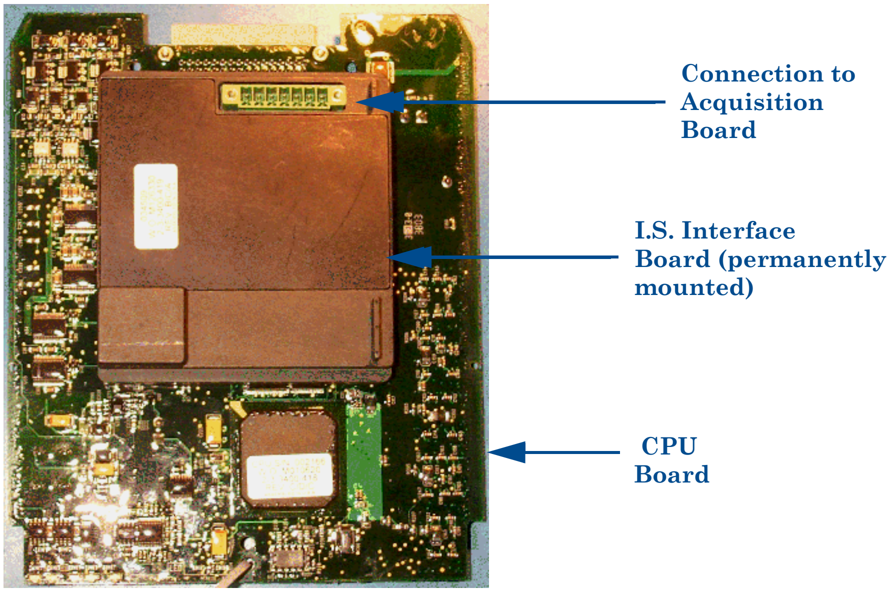


Figure 2-5 Series 100 Option board

Figure 2-6 Series 100 Plus Option Board

Figure 2-7 Daniel Mark III Ultrasonic Gas Flow Meter Field Connection board

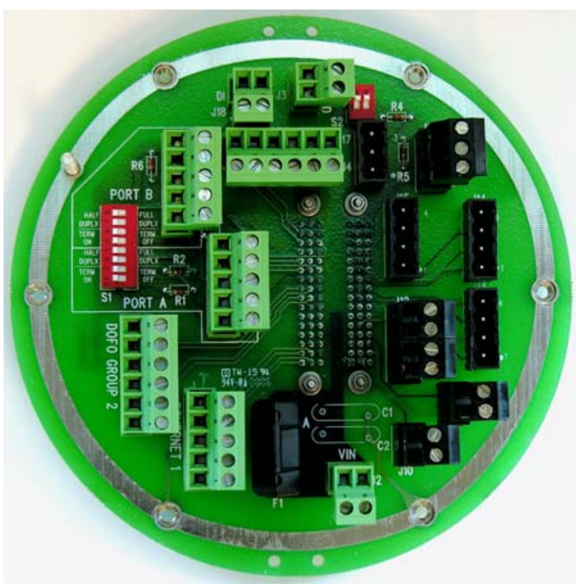
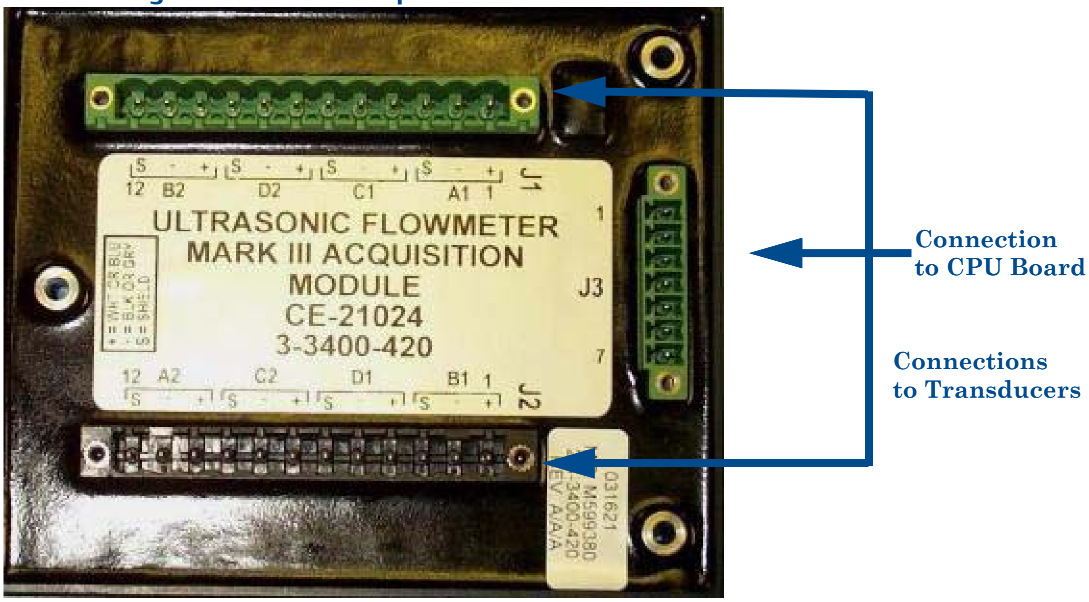


Figure 2-8 Mark III Acquisition Module

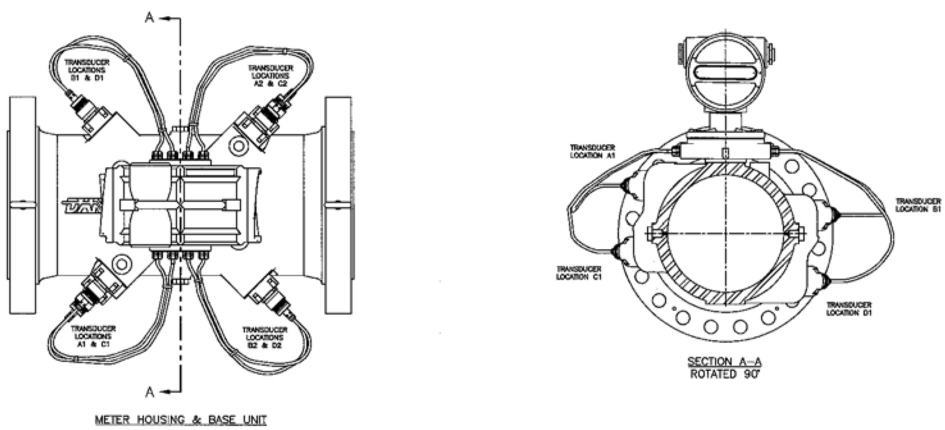


2.2.2 Model 3400 meter body

See Figure 2-9 **SeniorSonic^{TM}**

- Serves as the core of the unit
- Features the multipath, acoustic-signal scheme for measuring transit time on four parallel paths for calculating gas flow under asymmetric and swirl conditions
- Has port connections for mounting the unit's ultrasonic transducers
- Path location
  - located at ± 0.309 and ± 0.809
  - Two paths are located at 0.309-R from the center of the meter and two are located 0.809-R from the wall

Figure 2-9 SeniorSonic^{TM} Model 3400 meter body

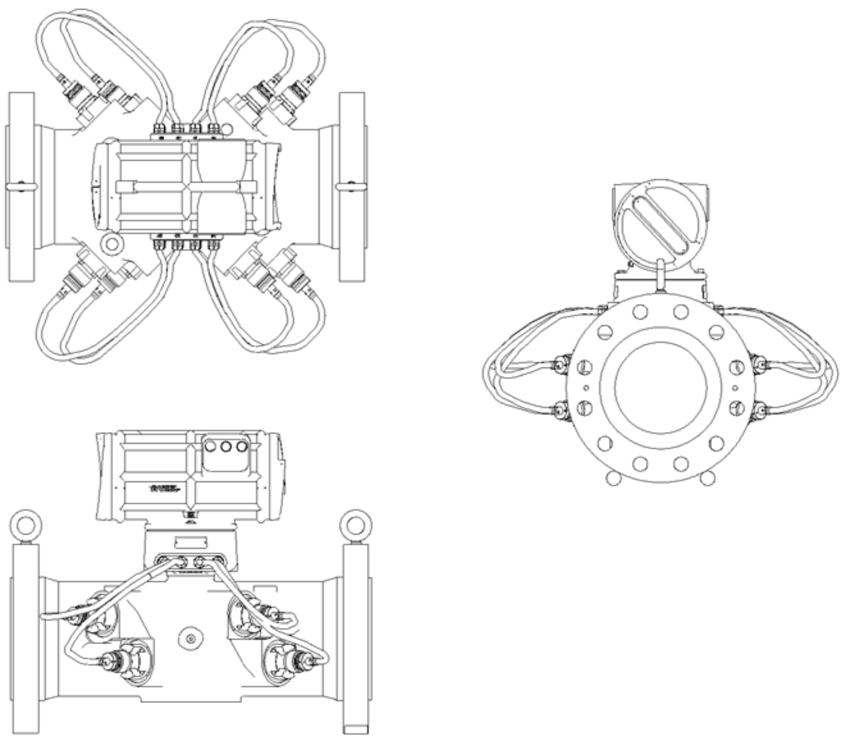


2.2.3 Model 3422 meter body

See Figure 2-10 **SeniorSonic™**

- Serves as the core of the unit
- Features an acoustic-signal scheme for measuring transit time on four equal-length parallel paths for calculating gas flow under asymmetric and swirl conditions
- Has port connections for mounting the unit's ultrasonic transducers
- Path location:
  all are located at ± 0.5-R from the center of the meter

Figure 2-10 SeniorSonic™ Model 3422 meter body

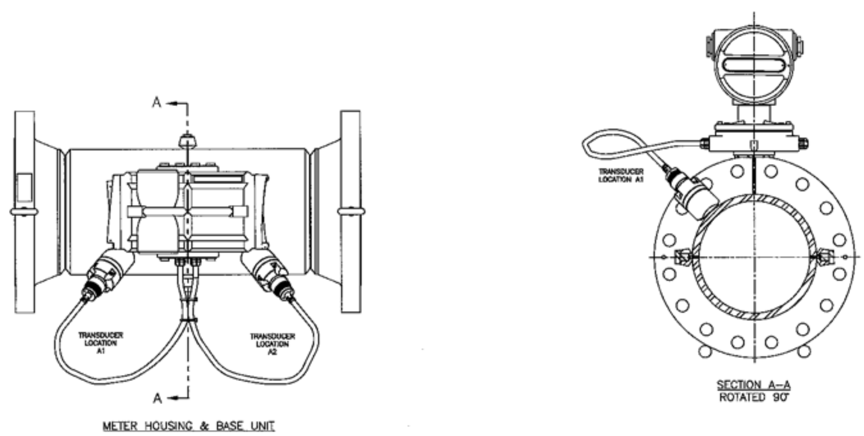


2.2.4 Model 3410 meter body

See Figure 2-11 **JuniorSonic™**

- Serves as the core of the unit
- Features an acoustic-signal scheme for measuring transit time on one bounce path for calculating gas flow
- Has port connections for mounting the unit's ultrasonic transducers
- Transducer location allows for natural drainage under wet gas conditions

Figure 2-11 JuniorSonic™ Model 3410 meter body

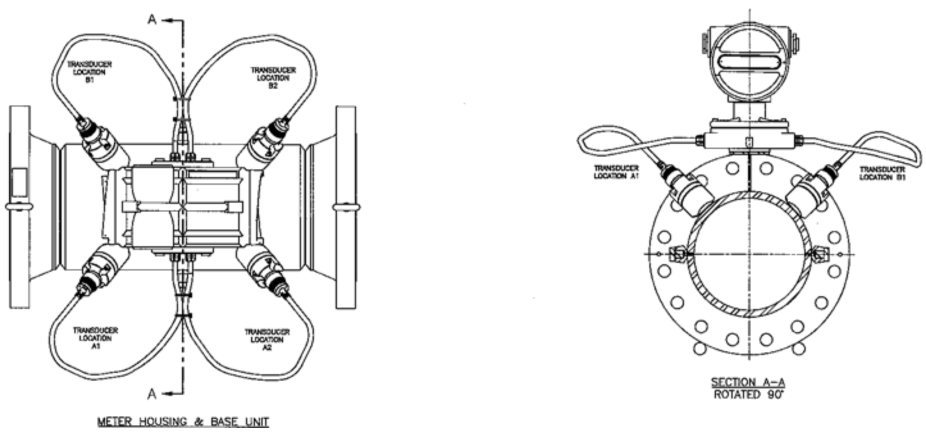


2.2.5 Model 3420 meter body

See Figure 2-12 **JuniorSonic™**

- Serves as the core of the unit
- Features:
  - two center paths (90^o apart)
  - acoustic-signal scheme measuring travel time for calculating gas flow
- Has port connections for mounting the unit's ultrasonic transducers
- Transducer location allows for natural drainage under wet gas conditions

Figure 2-12 JuniorSonic™ Model 3420 meter body



2.2.6 Transducers and cabling

The standard transducers are designated as T-11, T-12, T-21 and T-22. The T-11 is a direct replacement for the older T-2 transducers. The T-12 and T-22 is a small diameter version of the T-11 and the T-21, suitable for small meters such as a 4-inch meter, as well as the 8-inch, 10-inch and 12-inch 60° SeniorSonic™ meters

Figure 2-13 T-11 (left) Transducer and T-12 Transducer (right).

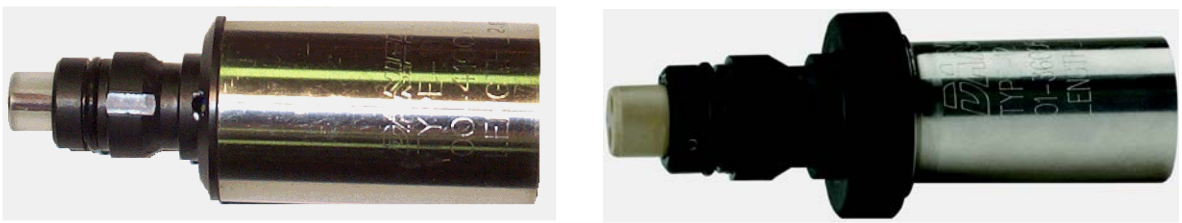


Figure 2-14 T-21 (left) and T-22 Transducer (right)

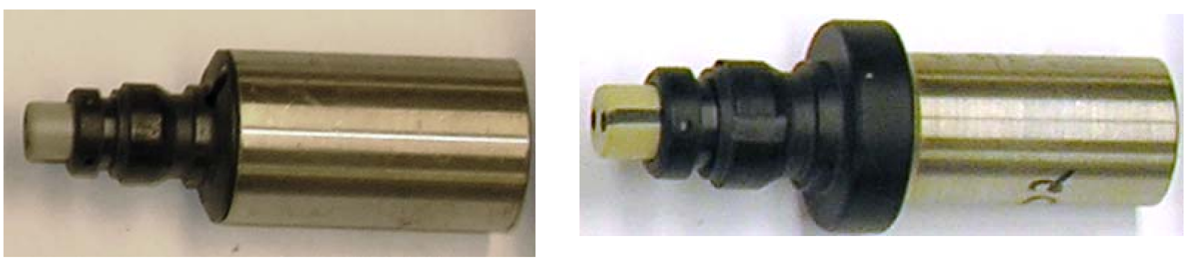


Table 2-1 Transducer connection ports and number of transducers

Model	Meter	Ports	Transducers
3400	SeniorSonic™ (Four Path)	8	8
3410	JuniorSonic™ (Single-Path)	2	2
3420	JuniorSonic™ (Dual-Path)	4	4
3422	SeniorSonic™ (with half-radius chords)	8	8

2.3 General unit specifications

The following section describes general specifications for all Daniel Mark III Ultrasonic Gas Flow Meters.

2.3.1 The application

The application is for high-pressure gases. Minimum operating pressure is typically 10 bar (150 psi).

NOTICE

Consult Daniel Measurement Services for applications less than 150 psig.

2.3.2 Available meter sizes

Both SeniorSonic™ and JuniorSonic™ meters are available in nominal meter body pipe sizes from 100 mm to 900 mm (4 inches to 36 inches).

NOTICE

Daniel should be consulted for larger pipe size availability.

2.3.3 Pressure range

In accordance with ANSI B16.5, the meter housings are available in ANSI pressure classes 300, 600, 900 and 1500.

NOTICE

Daniel should be consulted for lower or higher pressure applications.

2.3.4 Flow range limits

The reference condition flow range limits for SeniorSonic™ Meters (pipe sizes from 100 mm to 900 mm) are listed in the appendix tables (see Appendix F).

NOTICE

Daniel should be consulted before establishing the actual meter capacity for a particular application.

The meter capacity at reference (base) conditions of pressure and temperature may be calculated as shown in Equation 2-1.

Equation 2-1 Meter capacity - reference conditions of pressure and temperature

$$Q_{ref} = Q_f \frac{P_f T_{ref} Z_{ref}}{P_{ref} T_f Z_f}$$

where

Q_{ref} = flow rate at reference conditions (Nm^3/h; Scfh)

Q_f = flow rate at flowing conditions (m^3/h; cfh)

P_f = absolute pressure at flowing conditions (Pa; psia)

P_{ref} = absolute pressure at reference conditions (Pa; psia)

T_{ref} = absolute temperature at reference conditions (K; R)

T_f = absolute temperature at flowing conditions (K; R)

Z_{ref} = compressibility of gas at reference conditions (dimensionless)

Z_f = compressibility of gas at flowing conditions (dimensionless)

2.3.5 Flange types

The meter body is available with raised face or ring-type joint flange.

2.3.6 Gas temperature range

The gas temperature ranges for the standard T-11, T-12, T-21 and T-22 transducers are as show in Table 2-2.

Table 2-2 Temperature ranges for transducers, mounts and holders

Transducer type	Temperature range	Mount and holder type
T-11	-20 °C to +100 °C (-4 °F to 212 °F)	Standard mounts/Holders, NBR O-ring Inconel mounts/316L Holders, NBR O-ring Inconel Mounts/Inconel Holders/FKM O-ring
T-12	-20 °C to +100 °C (-4 °F to 212 °F)	Standard mounts/Holders, NBR O-ring Inconel mounts/316L Holders, NBR O-ring Inconel Mounts/Inconel Holders/FKM O-ring
T-21[1]	-20 °C to +100 °C (-4 °F to 212 °F)	Standard mounts/Holders, NBR O-ring Inconel mounts/316L Holders, NBR O-ring Inconel Mounts/Inconel Holders/FKM O-ring
T-22[2]	-50 °C to +100 °C (-58°F to 212 °F)	Standard mounts/Holders, NBR O-ring Inconel mounts/316L Holders, NBR O-ring Inconel Mounts/Inconel Holders/FKM O-ring

1. T-21 transducers use W-01 transformers
2. T-22 transducers use W-02 transformers

Temperatures below -20 °C may damage the transducers. In no-flow conditions for extended lengths of time or during meter storage, you should remove all transducer pairs if the temperature range is expected to exceed these limits.

Consult Daniel for higher temperature applications.

2.3.7 Repeatability

Repeatability precision is ±0.2% of reading in the specified velocity range for SeniorSonic™ Meters.

2.3.8 Accuracy limits

SeniorSonic™ accuracy limits typically are:

- AGA 9 compliant
- ± 1% without a flow calibration (10” and smaller)
  ± 0.7% without a flow calibration (for 12” and larger)
- ± 0.1% with a flow calibration
- JuniorSonic™ accuracy limits typically are:
  - ± 2% without a flow calibration

2.4 Electronic specifications

This section discusses the specifications for Daniel Mark III Ultrasonic Gas Flow Meters.

2.4.1 Power specifications

- 24 VDC nominal, range: 10.4 VDC to 36 VDC
- total power consumption less than 8 W

2.4.2 Temperature

Flameproof enclosure and Intrinsically safe base unit refer to Table 2-2 for temperature ranges.

Important

The process temperature must not exceed the operating temperature range of the transducers.

2.4.3 Inputs

- one general-purpose digital input
- optional analog inputs, one each for pressure and temperature (requires the Option Board)

2.4.4 Outputs

- two frequency output pairs (4 total)
- four digital outputs
- one optional analog output (requires the Option Board)
- two optional analog outputs (requires the Series 100 Plus Option Board)

2.4.5 Communications

- two serial ports (RS-232/RS-485 Full Duplex/RS-485 Half Duplex) with manually switched RS-485 terminations
- optional third serial port (RS-232/RS-485 Half Duplex) with manually switched RS-485 terminations (requires the Option Board or Series 100 Plus Option Board)
- one optional Ethernet port (10 BaseT)
- The optional third serial port can be used as a Modbus master to communicate with a Daniel Gas Chromatograph (GC) in Sim 2251 mode.

2.5 Hardware features

2.5.1 Inputs

Digital input

The meter provides a single general-purpose digital input. The input signal polarity is selectable via a configuration data point and its (polarity-configured) value is readable via another data point.

Pressure and temperature analog inputs

The meter provides two analog inputs (AIs) via the Option Board or the Series 100 Plus Option Board - one for temperature (AI1) and one for pressure (AI2). Each analog input is expected to be a 4-20mA signal.

The analog-to-digital conversion accuracy is within ±0.05% of full scale over the operating temperature range.

2.5.2 Outputs

frequency Outputs

The Daniel Mark III Ultrasonic Gas Flow Meter provides two pairs of frequency outputs where each pair is individually configurable. The first pair is comprised of FO1A and FO1B; the second pair is comprised of FO2A and FO2B. The information represented by each frequency pair is software selectable (with selections such as flow volume, gas velocity, sound velocity, energy rate, or mass rate - see Section 5.6.7). The frequency output range for each pair is individually software selectable as either 0-1000 Hz or 0-5000 Hz (with an overrange of 50%).

The worst case frequency output granularity is 1 Hz at 5000 Hz. When a frequency is configured to represent volume, the volume accuracy is within ±0.01%.

The meter provides two pairs of configurable frequency outputs (FO1A, FO1B, FO2A, and FO2B), four configurable digital outputs (DO1A, DO1B, DO2A, and DO2B), and an optional analog output (AO1).

The frequency and digital outputs are divided into two groups as follows:

- Group 1:FO1A, FO1B, DO1A, DO1B
- Group 2:FO2A, FO2B, DO2A, DO2B

Each group has a separate ground (i.e., Group1Gnd and Group 2 Gnd) and there is up to 50 V isolation between the two groups. Thus, all outputs within a group share a common ground. This allows each output group to be connected to a different flow computer. **Daniel should be consulted before establishing the actual meter capacity for a particular application.**

NOTICE

If outputs from both groups are to be connected to the same device, then the two group grounds must be connected together, either at the Daniel Mark III Ultrasonic Gas Flow Meter Field Connection Board or at the flow computer, whichever is more convenient.

All outputs are opto-isolated from the CPU Board (with a withstand of at least 500 Volt rms dielectric).

Each output is individually configurable as either internally powered (TTL) or externally powered (“open collector” e.g. O.C.). An output signal configured as “internally powered” is powered from an internal isolated 5 VDC bus and has voltage levels and drive capability as shown in Table 2-3.

Table 2-3 Voltage level and drive capability per logic level (TTL)

Logic Value	Voltage Level	Drive Capability
0	< 0.7 V	maximum sinking current:10 mA
1	> 3.5 V	maximum sourcing current:10 mA

An output signal configured as “open collector” (externally powered) must not exceed 60 VDC and must not be allowed to sink more than 50 mA.

Cable length TTL mode

The maximum cable length is 2000 feet when the “TTL” mode is selected.

Cable length open collector mode

For the “open collector” mode, the maximum cable length depends on the cable parameters, pull-up resistance used, the maximum frequency to output, and frequency input parameters being driven. The following table provides estimated cable lengths for different pull-up resistor values and different Max Frequency settings in the meter using the following cable parameters. The table also provides an estimated cable voltage drop which indicates how much voltage will be across the cabling and effectively indicates to what voltage level the frequency input can be pulled down to by the frequency output.

If the voltage drop is higher than the voltage required for the frequency input to see a LOW state, then the configuration will most likely not work for your system. Performance of Frequency Outputs will vary from this table with setup and frequency input being driven.

Table 2-4 Configurations for open collector frequency outputs

Cable	Cable Resistance	Cable	Pull-up	Total	Maximum	Sink	Cable Voltage Drop
Length	(2 Conductors)	Capacitance	Resistance	Resistance	Frequency	Current	(2 Conductors)
(x1000ft)	Ω	nF	Ω	Ω	(Hz)	(A)	VDC
0.5	16.8	10.00	1000	1016.8	5000	0.024	0.397
1	33.6	20.00	1000	1033.6	1000	0.023	0.780
2	67.2	40.00	1000	1067.2	1000	0.022	1.511
4	134.4	80.00	1000	1134.4	1000	0.021	2.843
0.5	16.8	10.00	500	516.8	5000	0.046	0.780
1	33.6	20.00	500	533.6	5000	0.045	1.511
1.7	57.12	34.00	500	557.12	5000	0.043	2.461
6.5	218.4	130.00	500	718.4	1000	0.033	7.296

The 22 AWG wire characteristics are as follows:

- Capacitance = 20 pF/ft or 20 nF/1000 ft (between two wires)
- Resistance = 0.0168 Ohms/ft or 16.8 Ohms/1000 ft
- Pull-up voltage is 24 VDC

Digital outputs

The Daniel Mark III Ultrasonic Gas Flow Meter provides four digital outputs arranged in two pairs. The first pair is comprised of DO1A and DO1B; the second pair is comprised of DO2A and DO2B. Each digital output is individually software configurable for content and polarity (see Section 5.6.10).

The maximum digital output cable length is 2000 feet.

Analog output(s)

A 4-20 mA analog output is provided via the Option Board. The analog output is software configurable (similar to the frequency outputs) and can represent volumetric flow rate, gas velocity, sound velocity, energy rate, or mass rate (see Figure 5.6.8).

Two 4-20 mA independently configurable analog outputs are available with the Series 100 Plus Board installed.

NOTICE

AI-1 and AI-2 are electronically isolated, independently configurable to operate in either sink or source mode and an additional 150 Ohms Loop impedance. Can be connected to HART® enabled transmitter.

The analog output zero scale offset error is within ±0.1% of full scale and gain error is within ±0.2% of full scale. The total output drift is within ±50 ppm of full scale per °C.

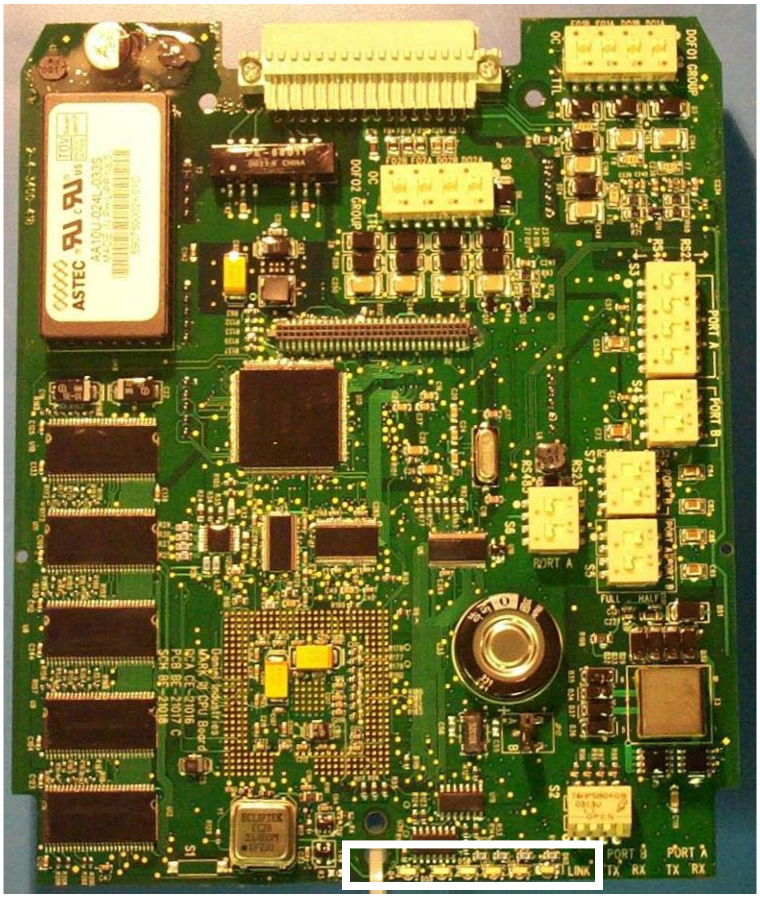
2.5.3 Status Indicators

The meter has several light-emitting diode (LED) status indicators on both the CPU Board and Option Board for general status and communication status indication.

CPU Board General Status Indicators

The meter indicates the status of the metrology mode and the status of the data transfer from the Acquisition Board to the CPU Board via LEDs located on the CPU Board (see Figure 2-13 and Figure 2-16). Additional LEDs are included for future use. Table 2-5 summarizes the CPU Board general status indicators.

Figure 2-15 Mark III CPU Board General Status LED Indicators



General Status LED Indicators

Figure 2-16 Mark III CPU Board General Status LED Indicators (I.S. Interface-Side View)

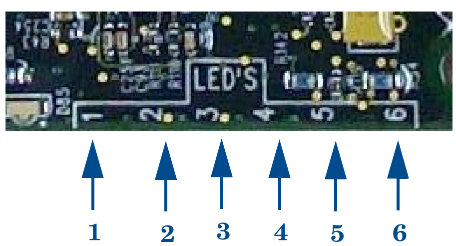


Table 2-5 CPU Board General Status Indicators

Label	Description	Color Indicator
LED 1	Color indicates the metrology mode	Red - Acquisition Mode Green - Measurement Mode
LED 2	Unassigned	Red
LED 3	Unassigned	Yellow
LED 4	Unassigned	Green
LED 5	Indicates when the CPU Board is receiving data from the Acquisition Board	Green - Blinking when data is being received
LED 6	Unassigned	Green

NOTICE

LED 5 is the surest indicator of the basic system health. If LED 5 is blinking, it indicates a good connection to the Acquisition Board and the overall operation of all firmware. LED 5 should blink even if no transducers are connected to the Acquisition Board.

CPU Board Communication Status Indicators

LED status indicators are provided on the CPU Board to indicate the serial Port A and B receive and transmit statuses and to indicate the Ethernet port connection status (see Figure 2-17). These indicators are summarized in Table 2-6.

Figure 2-17 Mark III CPU Board Communication Status Indicators (I.S. Interface-Side View)

Communication Status LED Indicators

Table 2-6 CPU Board Communication Status Indicators

Label	Description	Color	Activity Indication	No Activity Indication
PORT A RX	Port A receive status	Green	LED On Blinking	LED Off
PORT A TX	Port A transmit status	Green	LED On Blinking	LED Off
PORT B RX	Port B receive status	Green	LED On Blinking	LED Off
PORT B TX	Port B transmit	Green	LED On Blinking	LED Off
LINK	Ethernet port connection status	Green	LED On Solid	LED Off

Option Board General Status Indicators

As shown in Figure 2-18, the Option Board provides three general status indicators as summarized in Table 2-7.

Figure 2-18 Mark III Option Board General Status LED Indicators

Table 2-7 Option Board General Status Indicators

Label	Description	Color Indicator
24V CURR LIMIT	Indicates that the 24V source is current limited (approx. 70 mA)	Red
+24V	Indicates that the 24V supply is OK	Green
3.3V	Indicates that the 3.3V supply is OK	Green

Series 100 Plus Option Board General Status Indicators

As shown in Figure 2-19, the Series 100 Plus Option Board provides nine general status indicators as summarized in Table 2-8.

Figure 2-19 Series 100 Plus Option Board General Status LED Indicators

Table 2-8 Series 100 Plus Option Board General Status Indicators

Label	Description	Color Indicator
+24V	Indicates that the 24V supply is OK (Power On)	Green
24V CURR LIMIT	Indicates that the 24V source is current limited (approx. 85 mA)	Red
TX	HART® In - Pressure transmit data active	Green
RX	HART® In - Pressure receive data active	Green
TX	HART® In - temperature transmit data active	Green
RX	HART® In - temperature receive data active	Green
TX	HART® Out - (AO2) transmit data active	Green
RX	HART® Out - (AO2) receive data active	Green
3.3V	Indicates that the 3.3V supply is OK (Power On)	Green

Option Board Communication Status Indicators

The Option Board includes LEDs to indicate the serial Port C receive and transmit statuses (see Figure 2-20). These indicators are summarized in Table 2-9.

Figure 2-20 Mark III Option Board Communication Status LED Indicators

Table 2-9 Option Board Communication Status Indicators

Label	Description	Color	Activity Indication	No Activity Indication
PORT C RX	Port C receive status	Green	LED On Blinking	LED Off
PORT C TX	Port C transmit status	Green	LED On Blinking	LED Off

Series 100 Plus Option Board Communication Status Indicators

The Series 100 Plus Option Board includes LEDs to indicate serial Port C receive and transmit statuses (see Figure 2-21). These indicators are summarized in Table 2-10.

Figure 2-21 Series 100 Plus Option Board Communication Status LED Indicators

Table 2-10 Series 100 Plus Option Board Communication Status Indicators

Label	Description	Color	Activity Indication	No Activity Indication
PORT C RX	Port C receive status	Green	LED On Blinking	LED Off
PORT C TX	Port C transmit status	Green	LED On Blinking	LED Off

2.6 Communications

The Daniel Mark III Ultrasonic Gas Flow Meter provides two standard and one optional RS-232/RS-485 serial communication ports (referred to respectively as Port A, Port B, and Port C) and an optional Ethernet port (Eth1). Port A and B are expected to be used for (general) communication with flow computers and RTUs. Port C (included on the Option Board and the Series 100 Plus Option Board) can be used for general communication (such as with a flow computer or RTU) or for optional communication as a Modbus master with a Daniel Gas Chromatograph (GC). With the Series 100 Plus Option Board installed, you can establish communications with other devices via a Field Communicator (375) or AMS™ Suite). The Ethernet port is expected to be used for diagnostic purposes. See Section 5.8 for software configuration of communications protocols.

Port A is the preferred port for connection to a flow computer or RTU. If two flow computers are to be connected to the meter, then Port B should be used to connect to the second flow computer. If a computer running the Daniel MeterLink program is to be connected to a meter and the optional Ethernet port is enabled, it is the preferred port for the connection. If the Ethernet connection is not feasible, then Daniel MeterLink should be connected to the meter using Port B in full duplex configuration.

NOTICE

Daniel MeterLink will not communicate with a Mark III meter over a half-duplex serial connection.

Both Ports A and B are individually hardware-selectable for RS-232/RS-485 Full Duplex/RS-485 Half Duplex operation. Port A supports RS-232 RTS/CTS handshaking with software-configurable RTS on and off delay times. When handshaking is enabled, Port A drives the RTS output low and expects the CTS input to be active low. Both Ports A and B support individually software-configurable transmit delay times.

Port C (provided by the Option Board and the Series 100 Plus Option Board) is individually hardware-selectable for RS-232/RS-485 Half Duplex operation. Port C supports a software-configurable transmit delay time.

Ports A, B, and C support ASCII and RTU Modbus protocols (as detailed in Table 2-11) which are automatically detected on a per-port basis.

Table 2-11 Supported Modbus Protocols

Modbus Protocol	Number of Start Bits	Number of Data Bits	Parity Type	Number of Stop Bits
ASCII	1	7	odd or even	1
RTU	1	8	none	1

Modbus addresses are software configurable (from 1 to 247) on a per-port basis. Ports A and B operate only as Modbus slaves. Port C can operate as either a Modbus slave (for general communication) or a Modbus master (for GC communication).

Baud rates are software selectable on a per-port basis from the following:

- ASCII Modbus: 1200, 2400, 9600, 19200, 38400, 57600, 115000 bps
- RTU Modbus: 1200, 2400, 9600, 19200, 38400 bps

When Belden wire No. 9940 or equivalent is used, the maximum cable length for RS-232 communications at 9600 bps is 88.3 meters (250 ft.) at and the maximum cable length for RS-485 communication at 57600 bps is 600 meters (1970 ft.).

Port B supports a special override mode which forces the port to use known communication values (19200 baud, address 32) (see Section 5.6). (Note that the protocol is still auto-detected.) This mode is expected to be used during meter commissioning (to establish initial communication) and in the event that the user cannot communicate with the meter (possibly due to an inadvertent communication configuration change).

The Ethernet port IP address, subnet mask, and gateway address are software-configurable. In addition, a meter can be configured to act as a DHCP (Dynamic Host Configuration Protocol) server. The DHCP server facility is not intended to act as a general purpose DHCP server for a wider network. To this end, no user control is provided over the class or range of IP addresses the unit provides. A standard twisted pair (Cat-5) cable should be used for Ethernet wiring.

It is strongly recommended that the meter be configured using an independent (off-network) single host. After configuration of the Mark III flow meter, the DHCP option must be turned off if used on a LAN/WAN.

⚠ CAUTION

RESTRICT ETHERNET AND SERIAL CONNECTIVITY USAGE

Failure to restrict Ethernet and communication access to the Mark III flow meter can result in, among other things, unauthorized access, system corruption, and/or data loss.

User is responsible for ensuring that physical access and Ethernet or electronic access to the Mark III flow meter is appropriately controlled and any necessary security precautions, such as, establishing a firewall, setting password permissions and/or security levels are implemented.

2.7 Safety

The Daniel 3400 Series Gas Ultrasonic Flow Meter is suitable for use in U.L. Class 1, Division 1, Group D hazardous locations.

⚠WARNING

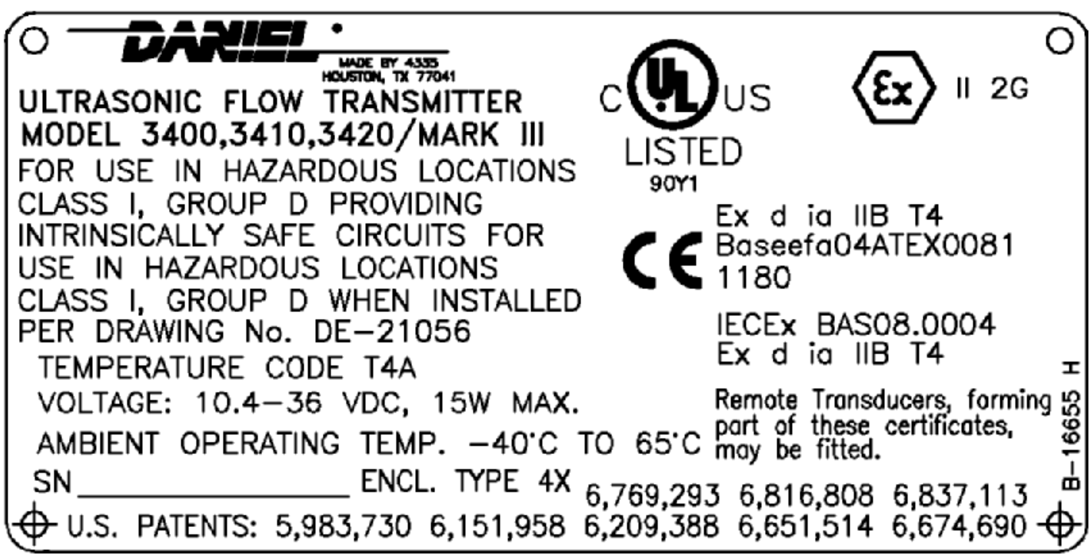
EQUIPMENT SAFETY

Follow all safety warnings and precautionary labels in this document and posted on meter.

Failure to do so may cause serious injury to personnel and equipment damage.

The meter is approved to the ATEX Directive 94/9/EC.

Figure 2-22 Mark III Ultrasonic flow transmitter U.L. and IECEx certification tag



2.8 FCC Compliance

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

NOTICE

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Section 3: Installation

3.1 Installation instructions

⚠WARNING

HAZARDOUS VOLTAGE INSIDE

Do not open enclosure in flammable gas area.

Failure to follow the instructions in this manual may result in serious injury or death.

⚠WARNING

EXPLOSION HAZARD

Do not disconnect equipment unless power has been removed or the area is known to be non-hazardous.

Substitution of components may impair intrinsic safety.

⚠WARNING

EXPLOSION OR FIRE HAZARD

Conduit runs must have a sealing fitting within 50mm (2 inches) of the enclosure to reduce the risk of an explosion or a fire.

- **During operation, keep covers tight.**
- **During equipment maintenance, disconnect power before opening transmitter or base electronics. Clean cover joints before replacing.**
- **DO NOT substitute meter components. Component substituting may compromise the intrinsic safety.**

Failure to do so may result in severe injury to personnel or cause damage to the equipment.

This section discusses the electronics configuration and mechanical installation of the meter.

NOTICE

After installation, immediately collect a set of log files at several velocities within the operating range of the meter to establish a baseline to be used for the trending of the meter diagnostics.

NOTICE

The internal grounding terminal shall be used as the primary equipment ground. The external terminal is only a supplemental bonding connection where local authorities permit or require such a connection.

3.2 Daniel 3400 Series Ultrasonic Flow Meter lifting instructions and precautions

⚠WARNING

DANGER TO PERSONNEL AND EQUIPMENT

Lifting a Daniel Ultrasonic Meter with other equipment

The following lifting instructions are for installation and removal of the Daniel Ultrasonic Meter ONLY. The instructions below do not address lifting the Daniel ultrasonic meter while it is attached, bolted, or welded to meter tubes, piping, or other fittings.

Using these instructions to maneuver the Daniel Ultrasonic Meter while it is still attached, bolted, or welded to a meter tube, piping, or other fitting may result in equipment damage, serious injury, or death.

The operator must refer to their company's hoisting and rigging standards, or the "DOE-STD-1090-2004 Hoisting and Rigging" standard if such company standards do not exist, for lifting and maneuvering any assembled meter tube and associated piping.

⚠WARNING

CRUSHING HAZARD

During meter installation or removal, always place the unit on a stable platform or surface that supports its assembled weight.

Failure to do so could allow the meter to roll, resulting in serious injury or equipment damage.

NOTICE

Prior to lifting the unit, refer to the Daniel Gas Ultrasonic Flow Meter nameplate or outline dimensional (general arrangement) drawing for the assembled weight.

A Daniel Ultrasonic Gas Flow Meter can be safely lifted and maneuvered into and out of a meter run for installation or service by obeying the following instructions.

When only lifting a Daniel Ultrasonic Meter by itself, Daniel recommends two methods. These methods are:

1. Using an appropriately rated Safety Engineered Swivel Hoist Rings Installed in the Daniel Ultrasonic Meter end flanges (Refer to Section 3.2.1)
2. Using appropriately rated lifting slings positioned at designated areas of the Daniel Ultrasonic Meter (Refer to Section 3.1.2)

Both methods must be used in conjunction with all appropriate company hoisting and rigging standards or the DOE-STD-1090-2004 HOISTING AND RIGGING standard if such company standards do not exist. Refer to the following sections for more information on these two methods.

⚠WARNING

LIFTING HAZARD

Lifting Hazard for Daniel Ultrasonic meters with Original Equipment Eyebolts

For Daniel Ultrasonic meters with threaded eyebolts, the eyebolts may be safely used to lift the meter if ALL of the following conditions are met:

- They have been inspected and show no signs of corrosion, scarring, or damage (including bending)
- They have not been left in the meter after installation and exposed to the environment
- A spread bar is used during lifting to eliminate angular loading

If any of the conditions described above can not be met, the operator must remove, destroy, and discard the "Eye Bolt" immediately and use slings around meter body as outlined in these instructions in conjunction with company approved hoisting and rigging procedures or the DOE-STD-1090-2004 HOISTING AND RIGGING standard if such company standards do not exist.

3.2.1 Use of appropriate safety engineered swivel hoist rings in meter end flanges

All Daniel Ultrasonic meters come equipped with a tapped hole located on the top of each meter body end flange. A flat machined surface surrounds each tapped hole (See Figure 3-1). This feature provides complete surface contact ONLY between the meter flange and an OSHA compliant Safety Engineered Swivel Hoist Ring as shown below (see Figure 3-2).

Operators SHALL NOT use Eye Bolts (see Figure 3-2) in the Daniel Ultrasonic Meter flange tapped holes to aid in lifting or maneuvering the unit.

Operators SHALL NOT use other Hoist Rings that do not fully seat flush with the counter bore on the top of the meter flanges.

Figure 3-1 Meter end flange with tapped flat-counterbore hole for hoist ring

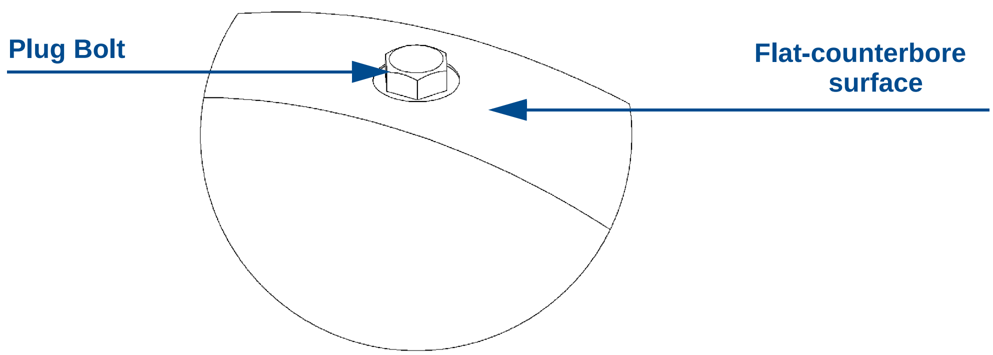
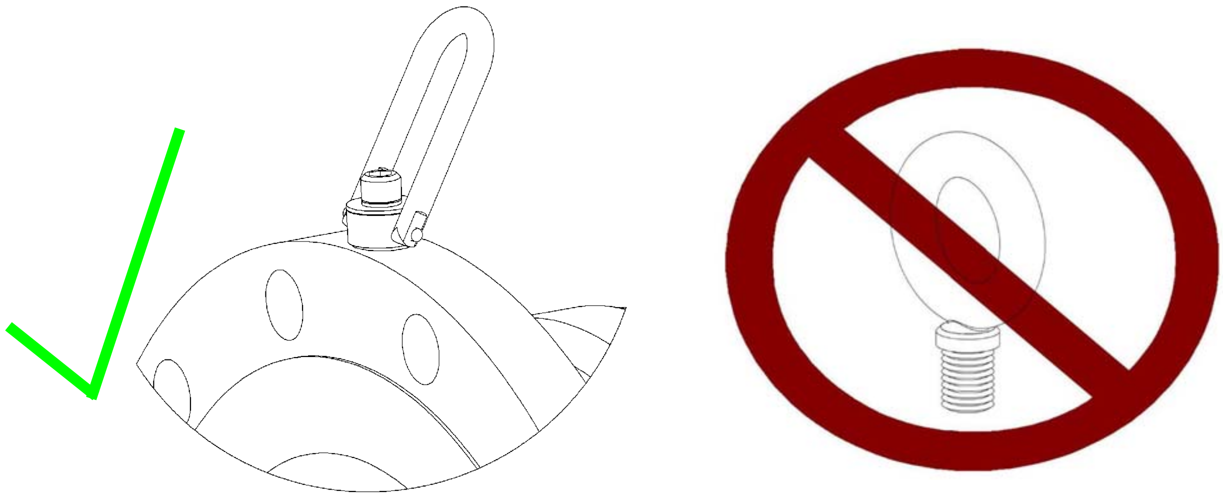


Figure 3-2 Safety approved hoist ring and non-compliant eye bolt



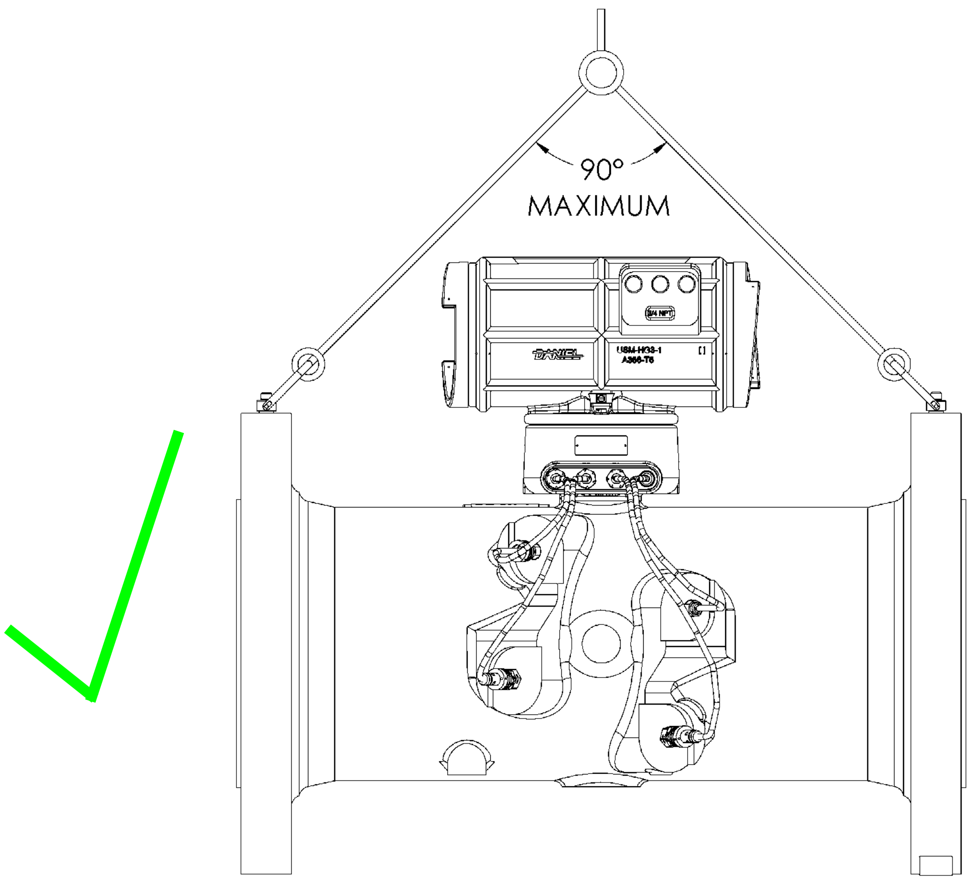
3.2.2 Safety precautions using safety engineered swivel hoist rings

Read and follow the Safety Precautions listed below:

1. Meters must only be lifted by personnel properly trained in the safe practices of rigging and lifting.
2. Remove the plug bolts installed in the tapped holes on the top of the flanges. Do not discard the bolts as they must be reinstalled once the lifting operation is complete to prevent corrosion of the tapped holes.
3. Make sure the tapped holes on the meter are clean and free of debris before installing the hoist rings.
4. Use only the Safety Engineered Swivel Hoist Rings that are rated for lifting the meter. Do not use any other type of hoist rings with the same screw size or heavy duty hoist rings. The meter tapping and counter bore size are suitable only for the hoist rings specified by Daniel.
5. When installing a hoist ring, make sure the base surface of the hoist ring fully contacts the machined flat surface of the tapped hole. If the two surfaces do not come in contact then the hoist ring will not hold its full rated load. Torque the hoist ring attachment bolts to the limit indicated on the hoist rings.

6. After installation of the hoist rings, always check that the ring rotates and pivots freely in all directions.
7. NEVER attempt to lift the meter using only one hoist ring.
8. Always use separate slings to each hoist ring. NEVER reeve one sling through both hoist rings. The slings must be of equal length. Each sling must have a load rating that equals or exceeds the hoist ring load rating. The angle between the two slings going to the hoist rings must never exceed 90 degrees or the load rating of the hoist rings will be exceeded.

Figure 3-3 Ninety degree angle between slings



9. NEVER allow the slings to contact the electronics enclosure. Damage to the enclosure may occur. If the slings do come in contact with the electronic enclosure then remove the two bolts holding the enclosure to its base and temporarily remove the head from the meter during the lifting operation. You will need to unplug the cable from J3 on the Acquisition Module. Two screws hold this cable in place.

Once the lifting operation is complete, reattach and secure the electronics cable to J3 on the Acquisition Module, return the electronics enclosure to its original position, replace the bolts, and secure the enclosure in place. Lifting the meter with the upper enclosure installed but with out the bolts installed, may cause the electronics to fall and cause personal injury or equipment damage.

Figure 3-4 Incorrect sling attachment

10. NEVER apply shock loads to the meter. Always lift the meter gradually. If shock loading ever occurs, the hoist ring must be inspected per manufacturer's recommendations prior to be placed in any further service. If a proper inspection cannot be performed, discard the hoist ring.
11. NEVER lift with any device, such as hooks, chains, or cables that could create side pulls that could damage the ring of the hoist ring.
12. NEVER lift more than the ultrasonic meter assembly including electronics and transducers with the hoist rings. The only exception is that it is safe to lift the meter with one ASME B16.5 or ASME B16.47 blind flange bolted to each end flange of the meter. NEVER use the hoist rings on the meter to lift other components such as meter tubes, piping or fittings attached to the meter. Doing so will exceed the load rating of the hoist rings.
13. Remove the hoist rings from the meter after lifting is completed and store them in an appropriate case or container per their manufacturer's recommendation.
14. Apply heavy lubricant or anti-seize to the threads of the plug bolts and reinstall the plug bolts to keep the tapped holes free of debris and to prevent corrosion.

3.2.3 How to obtain safety engineered swivel hoist rings

The following is a list of manufacturers of approved safety engineered hoist rings:

- American Drill Bushing Company (www.americandrillbushing.com)
- Carr Lane Manufacturing Company (www.carrlane.com)

The following is a list of known suppliers that can supply these safety-engineered hoist rings. This is not intended to be a complete list.

- Fastenal (www.fastenal.com)
- Reid Tools (www.reidtool.com)

The appropriate hoist rings can also be purchased directly from Daniel. The following table provides part numbers for reference:

Table 3-1 Daniel hoist ring part numbers

Daniel Part Number*	Hoist Ring Thread Size & Load rating	American Drill Bushing Co. P/N*	Carr Lane Manufacturing Co. P/N*
1-504-90-091	**3/8"-16UNC, 1000 lb.**	**23053**	**CL-1000-SHR-1**
1-504-90-092	1/2"-13UNC, 2500 lb	23301	CL-23301-SHR-1
1-504-90-093	3/4"-10UNC, 5000 lb.	23007	CL-5000-SHR-1
1-504-90-094	1"-8UNC, 10000 lb.	23105	CL-10000-SHR-1
1-504-90-095	1-1/2"-6UNC, 24000 lb.	23202	CL-24000-SHR-1
* The part numbers include only one hoist ring. Two hoist rings are required per meter.			

What size safety engineered swivel hoist ring do you need

To determine the size of the hoist rings required for your meter, use the appropriate table below. Look down the column that matches the ANSI rating of your meter. Find the row that contains your meter size. Follow the row to the end to find the appropriate hoist ring part number.

Table 3-2 Hoist Ring lookup table for Daniel Gas SeniorSonic Meters*

ANSI 300	ANSI 600	ANSI 900	ANSI 1500	Daniel Part Number
4” to 10”	4” to 8”	4” to 8”	4” to 6”	1-504-90-091
12” to 18”	10” to 16”	10” to 12”	8” to 10”	1-504-90-092
20” to 24”	18” to 20”	16” to 20”	12”	1-504-90-093
30” to 36”	24” to 30”	24”	16” to 20”	1-504-90-094
	36”	30” to 36”	24” to 36”	1-504-90-095
* 4” to 6" 45 degree meters and 8” to 36" 60 degree meters				

Table 3-3 Hoist ring lookup table for Daniel Gas JuniorSonic Meters

ANSI 300	ANSI 600	ANSI 900	ANSI 1500	Daniel Part Number
4” to 12”	4” to 8”	4” to 8”	4” to 6”	1-504-90-091
16” to 18”	10” to 16”	10” to 12”	8” to 10”	1-504-90-092
20” to 30”	18” to 20”	16” to 20”	12”	1-504-90-093
36”	24” to 30”	24”	16” to 20”	1-504-90-094
	36”	30” to 36”	24” to 36”	1-504-90-095

3.2.4 Using appropriately rated lifting slings on Daniel Ultrasonic Meters

The following instructions are intended to provide general guidelines for proper slinging of a Daniel Ultrasonic meter by itself. They are intended to be followed in addition to your company's standards or the DOE-STD-1090-2004 HOISTING AND RIGGING standard if such company standards do not exist.

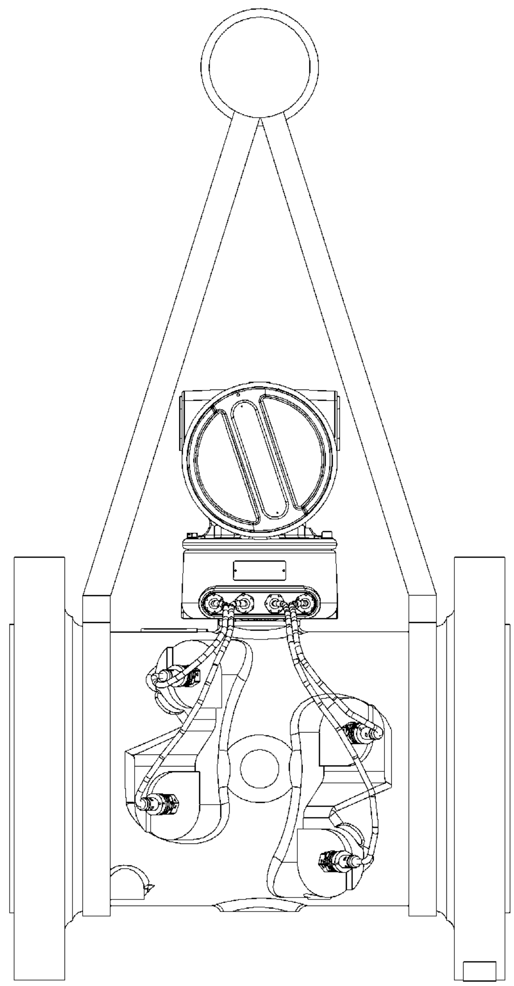
Safety precautions using appropriate rated lifting slings on Daniel Ultrasonic Meters

Read and follow the Safety Precautions listed below:

1. Meters must only be lifted by personnel properly trained in the safe practices of rigging and lifting.
2. NEVER attempt to lift the meter by wrapping slings around the electronics.

3. NEVER attempt to lift the meter using only one sling around the meter. Always use two slings wrapped around each end of the body as shown below. A choker style sling is recommended.

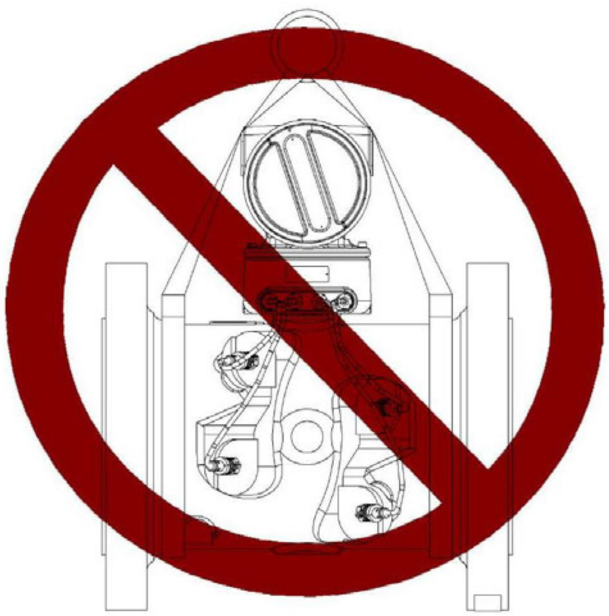
Figure 3-5 Correct sling attachment



4. Visually inspect the slings prior to use for any signs of abrasion or other damage. Refer to the sling manufacturer's procedures for proper inspection of the particular sling you are using.
5. Only use slings with ratings that exceed the weight to be lifted. Reference your company's standards for safety factors that must be included when calculating the load rating.
6. NEVER allow the slings to contact the electronics enclosure or transducer cabling. Damage to the enclosure or cabling may occur.
   If the slings do come in contact with the electronic enclosure then remove the two bolts holding the enclosure to its base and temporarily remove the head from the meter during the lifting operation. You will need to unplug the cable from J3 on the Acquisition Module. Two screws hold this cable in place.

Once the lifting operation is complete, reattach and secure the electronics cable to J3 on the Acquisition Module, return the electronics enclosure to its original position, replace the bolts, and secure the enclosure in place. Lifting the meter with the upper enclosure installed but with out the bolts installed, may cause the electronics to fall and cause personal injury or electronics damage.

Figure 3-6 Incorrect sling attachment



7. NEVER apply shock loads to the meter. Always lift the meter gradually. If shock loading ever occurs, the slings must be inspected per manufacturer's procedures prior to being placed in any further service.

3.3 Mechanical installation

The Daniel Ultrasonic Gas Flow Meters are assembled, configured, and tested at the factory. The meter assembly includes the transmitter electronics, base unit and the meter body with the transducer s and cable assemblies.

Figure 3-7 Daniel Ultrasonic Gas meter body

3.3.1 Meter body installation

Refer to the Daniel Gas Ultrasonic Meter Product Data Sheet (Daniel P/N DAN-USM-FAMILY-DS-0306) for piping information. The *SeniorSonic and JuniorSonic Ultrasonic Meter Datasheet* may be downloaded from the Daniel website:

http://www2.emersonprocess.com/en-US/brands/daniel/Flow/ultrasonics/Pages/Ultrasonic.aspx

NOTICE

To access the product manual, from the Daniel products page (above link), select the Daniel SeniorSonic 4-Path Gas Flow Meter link, click the Documentation tab, expand the Manuals & Guides tab, then select the manual.

For uni-directional flow, the minimum straight pipe length is as follows:

Table 3-4 Piping recommendations uni-directional flow

SeniorSonic	JuniorSonic
15D up stream (with a flow conditioner)	20D up stream
20D up stream (no flow conditioner)	
5D down stream	5D down stream

For bi-directional flow, the minimum straight pipe length is as follows:

Table 3-5 Piping recommendations bi-directional flow

SeniorSonic	JuniorSonic
15D (each direction) (with a flow conditioner)	20D (each direction)
20D (each direction) (no flow conditioner)	

- The bore of the mating piping should be within 1% in order to comply with AGA9.
- The meter is provided with dowel pins to align the meter body bore with the bore of the mating piping.
- The SeniorSonic™ meter must be mounted in horizontal piping with the chord paths horizontal. The JuniorSonic™ meter body should be oriented so that the chord paths are oriented 45° off vertical.

⚠ CAUTION

EQUIPMENT HANDLING

Observe all precautionary signs posted on the equipment.

Failure to do so may result in injury to personnel or cause damage to the equipment.

- Normally, the meter body is installed so that the electronics assembly is on the top of the meter. If there is insufficient space above the piping for this arrangement, the meter can be ordered with extra long transducer cables for remote mounting (JuniorSonic™ and SeniorSonic™ meters) *or* the meter housing can be installed with the electronics assembly on the bottom (SeniorSonic™ meters only).
- Two pressure taps are provided on the meter for pressure measurement.
- The mating piping should include temperature measurement connections located a minimum of two nominal pipe diameters length down stream of the meter.
- If the meter body is not fitted with a means to vent line pressure, the down stream piping section should be provided with a vent valve to allow line pressure to be vented for maintenance.

3.3.2 Mounting requirements for heated or cooled pipelines

The ambient operating temperature of the Daniel Mark III electronics (i.e. Flameproof enclosure and Intrinsically safe base enclosure) is -40° C (-40° F) to +65° C (+149° F). If the meter is installed into a pipeline which is heated or cooled outside this temperature range it is necessary to remove the electronics housing from the meter body (i.e. Spool piece acting as process fluid conduit) and mount it next to the meter body on a pipe stand or other rigid structure. Extended length transducer cables (P/N 2-3-3400-194, 15 ft. long) shall be used to connect the Daniel Mark III electronics to the transducers installed in the meter body. The process temperature must also not exceed the operating temperature range of the transducers. T-11, T-12, and T-21 transducers have an operating range from -20° C (-4° F) to +100° C (+212° F). T-22 transducers have an operating range from -50 °C to +100 °C (-58°F to 212 °F).

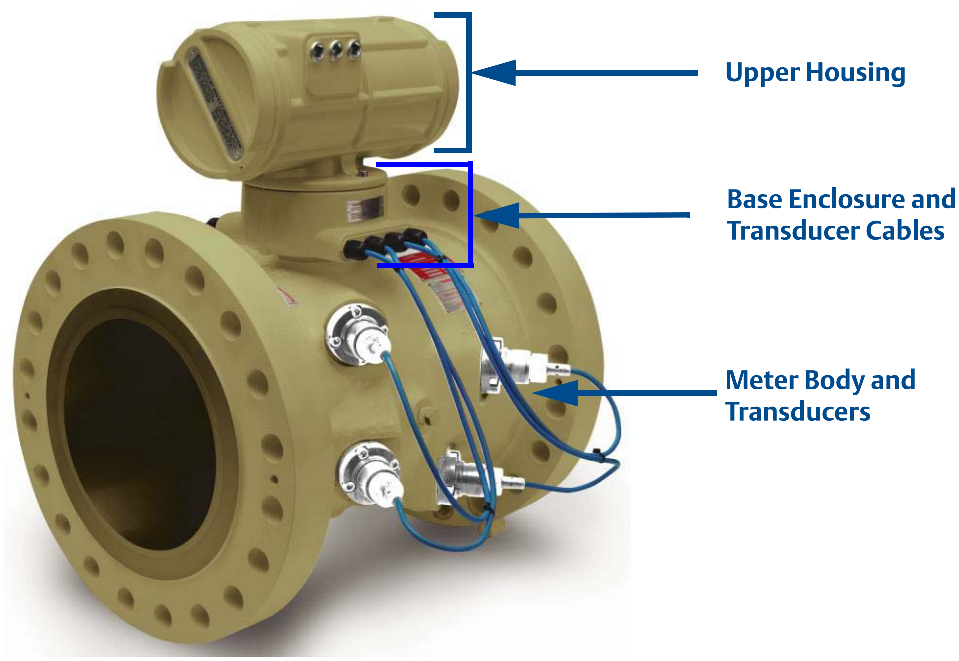
3.3.3 Accessing the Daniel 3400 Series Ultrasonic Flow Meter components

Should you need to access the Daniel 3400 Series Ultrasonic Flow Meter electronics in the field (i.e., check or replace boards, change switch settings, or replace transducers), follow the instructions below. Also, see Section 3.5.

NOTICE

The transducers are installed in matched pairs. Do not split-up a transducer pair. Also, if a transducer pair is moved from one chord position to another, the transducer pair's delay time and delta delay time configuration parameters must be properly re-configured.

Figure 3-8 Daniel Mark III Ultrasonic Gas Flow Meter



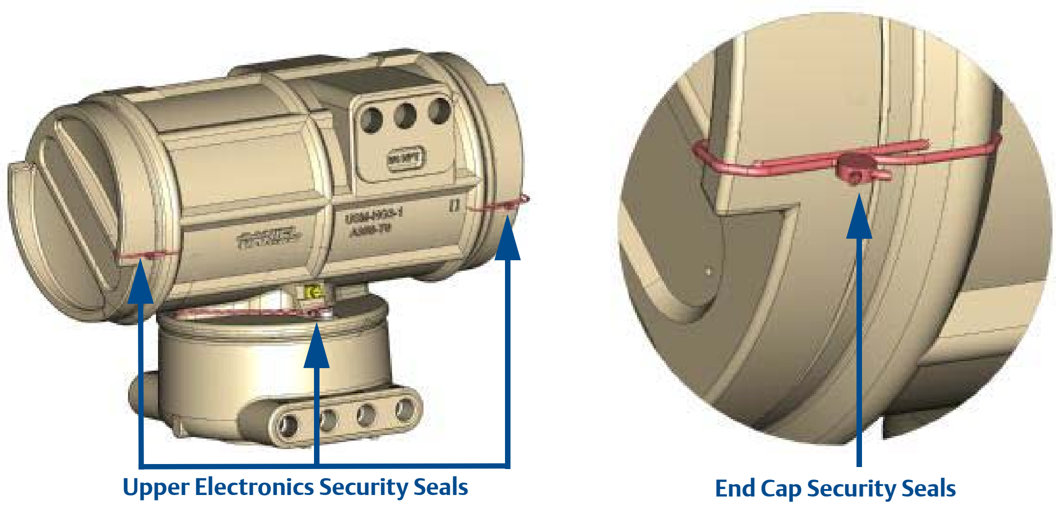
1. Before powering down the meter, run an *Edit/Compare Configuration* using Daniel MeterLink and save the configuration file.
2. Power down the PC, then remove power to the meter.
3. During the meter installation if changing electronic components or switch settings, remove the end caps from the Upper Electronics Housing. Remove and replace any of the Daniel 3400 Series Ultrasonic Flow Meter boards (CPU, I.S. Interface Board, Field Termination Board, Option Board, or Series 100 Plus Option Board.

NOTICE

If the meter is equipped with retention screws in the end caps, use a $\frac{5}{64}$ inch (2.0 mm) hexagon wrench to remove the screws.

If the meter is equipped with wire security seals on the Upper Electronics Housing (end caps and Base Unit cover), remove them before attempting to access the Upper Electronics Housing and Base Unit. Refer to Daniel drawing DMC-002733 for installation of security seals.

Figure 3-9 Upper electronics enclosure security seals



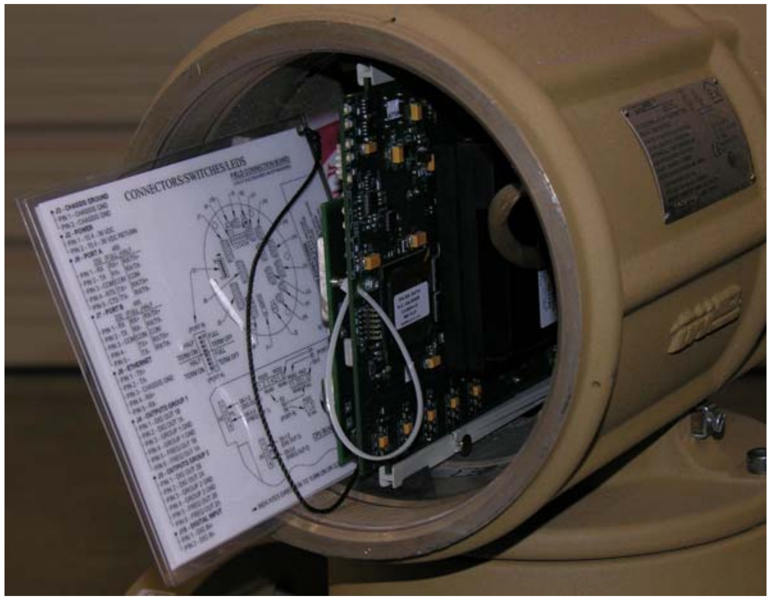
4. Refer to the wiring diagram card located inside the Upper Electronics Enclosure for switch settings and wiring instructions (see Figure 3-16 through Figure 3-19 and Appendix I). Also, for detailed instructions on replacing meter electronic components, refer to Daniel P/N 3-9000-749 *Daniel Series 100 Option Board Field Installation Procedure*. This manual may be accessed and downloaded from the Daniel website.

http://www2.emersonprocess.com/en-US/brands/daniel/Flow/ultrasonics/Pages/Ultrasonic.aspx

NOTICE

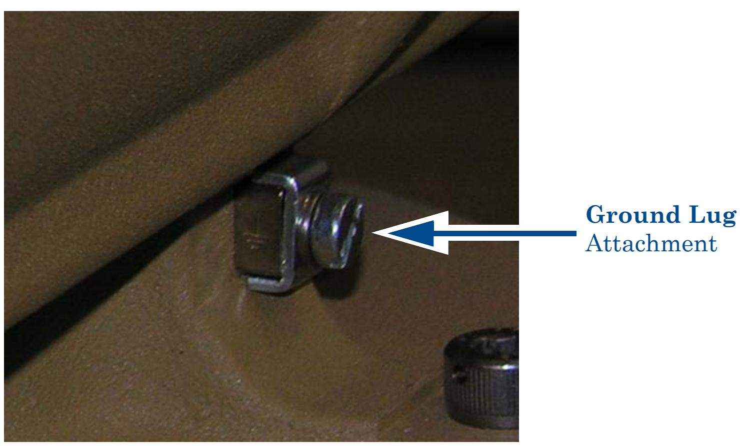
To access the product manual, from the Daniel products page (above link), select the Daniel SeniorSonic 4-Path Gas Flow Meter link, click the Documentation tab, expand the Manuals & Guides tab, then select the manual.

Figure 3-10 Upper enclosure wiring card



5. If accessing the Daniel 3400 Series Ultrasonic Flow Meter Base Unit electronics and wiring, remove the ground lug from the outside of the meter housing.

Figure 3-11 Ground lug upper electronics enclosure



6. If your meter is equipped with a security seal, remove the seal and then, remove the Upper Housing from the Base Unit.

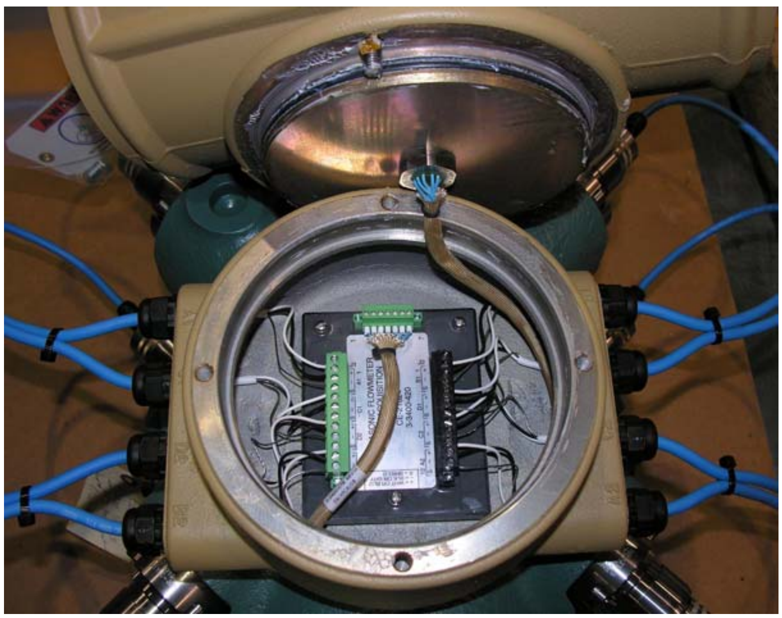
NOTICE

Refer to Daniel drawing DMC-002733 Notes 1- 3 for installation of the end cap retention screws and the Mark III Upper Electronics Housing and Base Unit security seals.

7. Use a 6mm Allen wrench to remove the four bolts attaching the Base Cover to the Base Electronics Housing.

   Lift the Upper Electronics Housing from the Base Unit to access the Acquisition Board and transducer wiring.

Figure 3-12 Mark III base unit electronics



8. Connect (or disconnect) the Acquisition cable from the Upper Electronics Housing to the Acquisition Board in the Base Unit enclosure.
9. Use a screwdriver and remove all of the screws from the Phoenix connectors holding the transducer wires.
10. Remove the two screws holding the Phoenix connectors to the board and remove the connectors.
11. Remove the three screws holding the Acquisition Board to the Base Unit and replace the Acquisition Board.

12. Re-assemble Base Unit electronics in reverse order (note the transducer wiring for J1 and J2 as shown on the Acquisition board label:

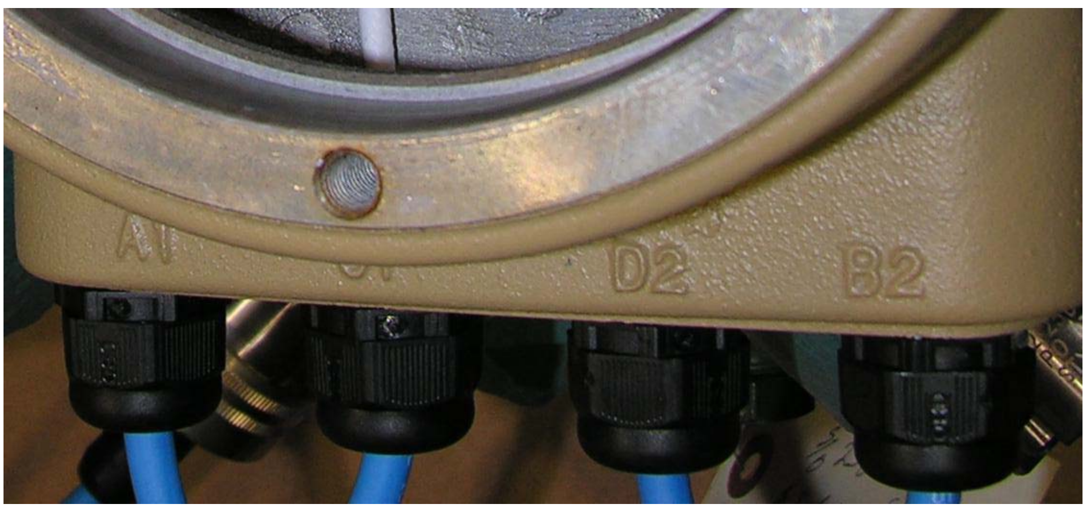
Table 3-6 Acquisition board wiring

Acquisition board wiring	
(+)	White or Blue
(-)	Black or Gray
S	Shield

3.3.4 Transducer cables/appropriate transducer

The A1 cable should be connected to the transducer assembled in the meter body transducer port A1. This procedure should then be repeated in numerical order for each one of the other transducers.

Figure 3-13 Transducer Ports and Cables Base Unit



The meter body ports are identified by stamped or cast lettering adjacent to the transducer port counter bore and on tags attached to the transducer flanges.

Remove the metal plug from the side of the electronics enclosure to expose the field wiring entry.

3.3.5 For systems using explosion-proof conduit

1. Assemble conduit to the electronics enclosure.

   If the conduit pipe is two inches or more, a conduit seal is required within 18 inches (150 mm) of the enclosure.
2. Remove the end cap nearest the conduit entry to gain access to the Field Connection Board.
3. Check to make certain that all power to the field wiring is turned OFF.

⚠WARNING

HAZARDOUS VOLTAGE INSIDE ENCLOSURE

Do not open enclosure in flammable gas area. Disconnect all power to the meter.

Failure to do so may result in injury to personnel or cause damage to the equipment.

4. Pull the wires.
5. Complete connections to the Field Connection Board (see Section 3.4).
6. Select the communications driver by setting the jumpers as shown in Table 3-7 through Table 3-21.
7. Replace the end cap. If desired, secure the end caps to the body with seal wires.
8. Apply the sealing compound to the conduit seal and allow to set in accordance with manufacturer specifications.

3.3.6 For systems that use flame-proof cable

⚠WARNING

HAZARDOUS VOLTAGE INSIDE ENCLOSURE

Do not open enclosure in flammable gas area. Disconnect all power to the meter.

Failure to do so may result in injury to personnel or cause damage to the equipment.

1. Check to make certain that all power to the field wiring is turned OFF.
2. Remove the end cap nearest the cable entries to gain access to the Field Connection Board.
3. Install the cable and cable gland.
4. Make all connections to the Field Connection Board.
5. Select the communications driver by setting the jumpers as shown in Table 3-7 through Table 3-21.
6. Replace the end cap. If desired, secure the end caps to the body with seal wires. Lock screws are also available on the end caps.
7. Connect a flow computer to the communications line on the Daniel Ultrasonic Gas Flow Meter.
8. Connect electrical power to the unit.
9. Set or configure the software using Daniel MeterLink. For additional installation information refer to the system wiring diagram (see Appendix I).

3.4 Wiring and Connections

Daniel MeterLink uses the TCP/IP protocol to communicate to the Daniel 3400 Series Gas Ultrasonic Flow Meter instead of Modbus ASCII or RTU. The TCP/IP protocol only works across either Ethernet, RS-485 full duplex (i.e., 4-wire), or RS-232. Daniel MeterLink can communicate with multiple meters if they are multi-dropped using 4-wire full duplex RS-485 mode. When installed, the Series 100 Plus Option Board provides communication flexibility with Daniel 3400 Series Gas Ultrasonic Flow Meters, enables the meter to easily communicate with other field devices Field Communicator (375) and AMS™ Suite), and ultimately communicate key diagnostic information through PlantWeb® architecture.

NOTICE

Daniel MeterLink cannot communicate with Daniel 3400 Series Gas Ultrasonic Flow Meter over RS-485 half duplex (i.e., 2-wire).

The Daniel 3400 Series Gas Ultrasonic Flow Meter can auto-detect the protocol used and automatically switch between TCP/IP, Modbus ASCII, and Modbus RTU so it is not necessary to make any meter configuration changes to change the protocol.

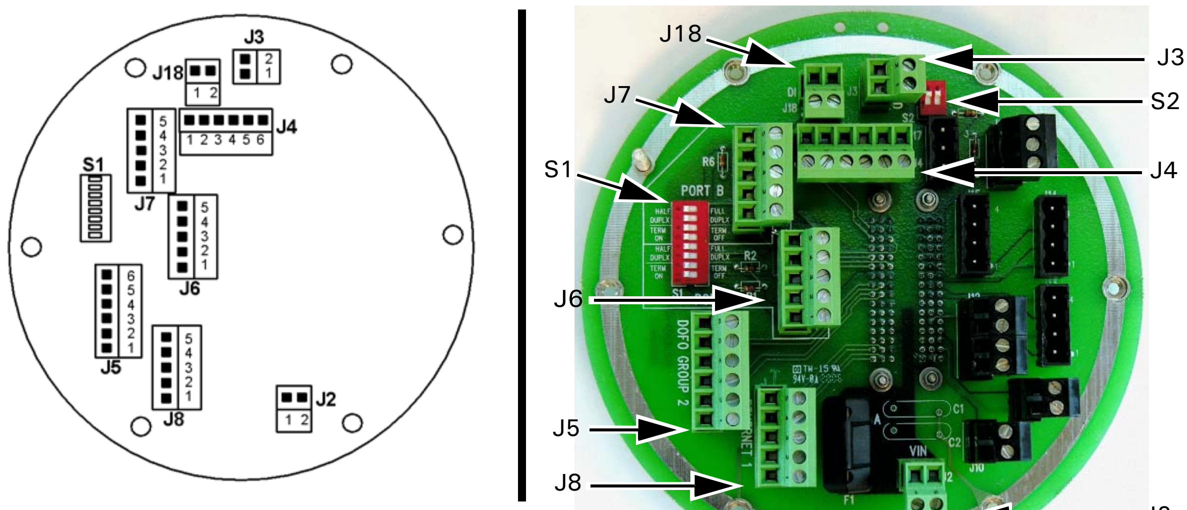
Use serial cable (Daniel P/N 3-2500-401) to connect to a PC running Daniel MeterLink. The cable is designed for RS-232 communications which is the serial Port B default configuration (see Appendix I field wiring diagram, Daniel Drawing DE-21056). The DB-9 end of the cable plugs directly into the PC running Daniel MeterLink. The three wires on the other end of the cable connect to the Field Connection Board at connector J7 (see Table 3-7 for Port B wiring).

Table 3-7 J7 Port B Wiring

Power and Communications Field Connection Board Wiring	
PC Connector	Field Connection Board
DB-9 cable	J7 Port B Wiring • Red - J7-Pin 1 • White - J7-Pin 2 • Black - J7-Pin 3

Alternately, when using Daniel MeterLink with the Ethernet port, use Ethernet cable (Daniel P/N 3-3400-079) to connect the PC to the meter as described in Section 5.4.3.

Figure 3-14 Field Connection Board Ethernet Connector Wiring



Note - **Switch positions shown are factory default settings**

Figure 3-15 Port B Switch S1 Ethernet Settings

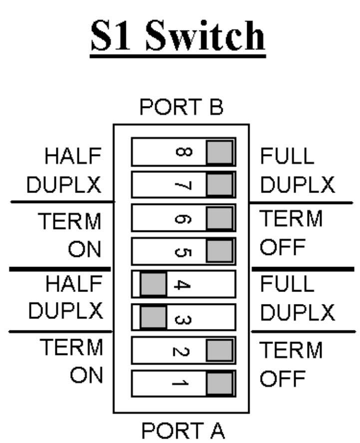


Table 3-8 J2 Power

Power and Communications Field Connection Board Wiring	
J2	Power
Pin	
1	10.4 - 36 VDC+
2	10.4 - 36 VDC Return

Table 3-9 J3 Chassis Ground

Power and Communications Field Connection Board Wiring	
J3	Chassis Ground
Pin	
1	Chassis Ground
2	Chassis Ground

Table 3-10 J18 Digital Input

Power and Communications Field Connection Board Wiring	
J18	Digital Input
Pin 1	DIN +
Pin 2	DIN -

Table 3-11 J11 Analog Output (AO1)

Power and Communications Series 100 Option Board Wiring	
Field Connection Board Jumper	Option Board Switches
J11 Pin	S14 4-20 mA Current
1	AOut 1+
2	AOut 1 -

Table 3-12 J12 Analog Input (AI1)

Power and Communications Series 100 Option Board Wiring	
Field Connection Board Jumper	Option Board Switches
J12 Pin	S12 4-20 mA Current
1	AIn1 + (Temperature)
2	AIn1 - (Temperature)

Table 3-13 J12 Analog Input 2 (AI2)

Power and Communications Series 100 Option Board Wiring	
Field Connection Board Jumper J12	**Option Board Switches** S12
Pin	4-20 mA Current
3	AIn2 + (Pressure)
4	AIn2 - (Pressure)

Table 3-14 J10 Analog Output Series 100 Plus Option Board (AO2)

Power and Communications Series 100 Plus Option Board Wiring	
Field Connection Board Jumpers J10	Series 100 Plus Option Board Switches S15
Pin	4-20 mA Current
1	AOut2 +
2	AOut2 -

Table 3-15 J11 Analog Output Series 100 Plus Option Board (AO1)

Power and Communications Series 100 Plus Option Board Wiring	
Field Connection Board Jumpers **J11**	**Series 100 Plus Option Board Switches** **S14**
Pin	**4-20 mA Current**
1	AOut +
2	AOut -

Table 3-16 J12 Analog Input Series 100 Plus Option Board (AI1)

Power and Communications Series 100 Plus Option Board Wiring	
Field Connection Board Jumpers J12	Series 100 Plus Option Board Switches S12
Pin	4-20 mA Current

Table 3-16 J12 Analog Input Series 100 Plus Option Board (AI1)

Power and Communications Series 100 Plus Option Board Wiring	
1	AIn1 + (Temperature)
2	AIn1 - (Temperature)

Table 3-17 J12 Analog Input Series 100 Plus Option Board (AI2)

Power and Communications Series 100 Plus Option Board Wiring	
Field Connection Board Jumpers J12	Series 100 Plus Option Board Switches S13
Pin	4-20 mA Current
3	AIn2 + (Pressure)
4	AIn2 - (Pressure)

Table 3-18 J6 Port A

Power and Communications Field Connection Board Wiring			
J6 Port A	RS-232	RS-422/485	
Pin		Full Duplex	Half Duplex
1	RX	RX +	RX/TX+
2	TX	RX -	RX/TX-
3	COMM_GND	COMM_GND	COMM_GND
4	RTS	TX +	RX/TX+
5	CTS	TX -	RX/TX-

Table 3-19 J7 Port B

Power and Communications Field Connection Board Wiring			
J7 Port B	RS-232	RS-485	
Pin		Full Duplex	Half Duplex
1	RX	RX +	RX/TX+
2	TX	RX -	RX/TX-
3	COMM_GND	COMM_GND	COMM_GND
4	NC	TX +	RX/TX+

Table 3-19 J7 Port B

Power and Communications Field Connection Board Wiring			
5	NC	TX -	RX/TX-

Table 3-20 J16 Port C

Power and Communications Field Connection Board Wiring		
J16 Port C	RS-232	RS-485
Pin		Half Duplex
1	RX	RX/TX+
2	TX	RX/TX-
3	COMM_GND	COMM_GND

Table 3-21 J8 Ethernet Port

Power and Communications Field Connection Board Wiring				
J8	Ethernet Port	RJ45 Connections		
Field Conn Bd.		PC	HUB	Wire Color
Pin		Pin	Pin	Wire
1	TX +	3	1	White w/Orange Stripe
2	TX -	6	2	Orange w/White Stripe
3	Chassis Gnd	Chassis Gnd	Chassis Gnd	White w/Green Stripe
4	RX +	1	3	Blue w/White Stripe
5	RX -	2	6	Green w/White Stripe

The default field connectors and pinouts for the Field Connection Board and the CPU Board are shown in the following tables (Table 3-22 through Table 3-24). (Refer to Daniel Drawing DE-21056, see Appendix I.)

A DIN 41612 48-pin connector is the interface from the CPU Board to the Field Connection Board (male end located on the back of the Field Connection Board).

Table 3-22 DC Power Jumper Settings

Jumper	Location	Description
J2	Field Conn. Bd.	PWR 1 +24V (polarity insensitive) PWR 2 24V RET-

Table 3-23 Case Ground Jumper Settings

Jumper	Location	Description
J3	Field Conn. Bd.	Pin 1 Case Gnd Pin 2 Case Gnd

Table 3-24 Digital Input Connector

Jumper	Location	Description
J18	Field Conn. Bd.	Pin 1 DIN+ Pin 2 DIN-

3.5 Hardware Switch Settings

Before beginning the mechanical installation, the various switches should be set to their correct position while they are easily accessible. Figure 3-16 through Figure 3-23 illustrates the configuration switch locations on the CPU Board, Expansion Board, Series 100 Plus Option Board, and Field Connection Board.

Figure 3-16 Daniel 3400 Series Gas Ultrasonic Flow Meter Wiring Switch Settings

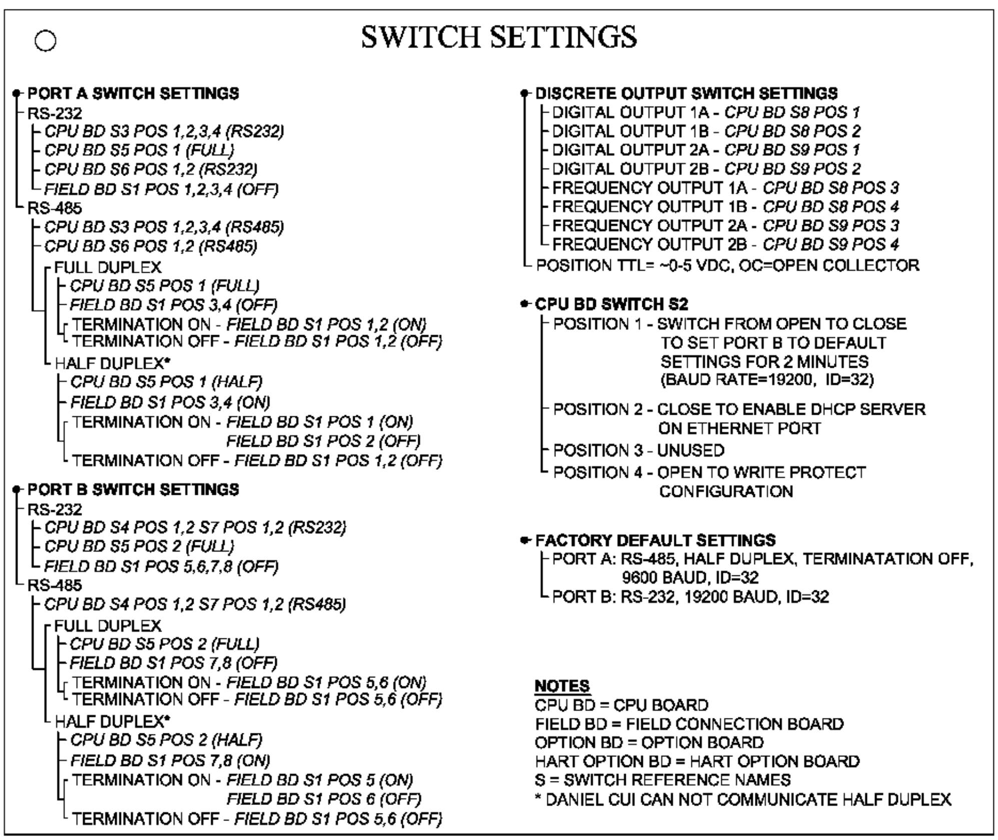


Figure 3-17 Daniel 3400 Series Gas Ultrasonic Flow Meter Wiring Connectors/Switches/LEDs

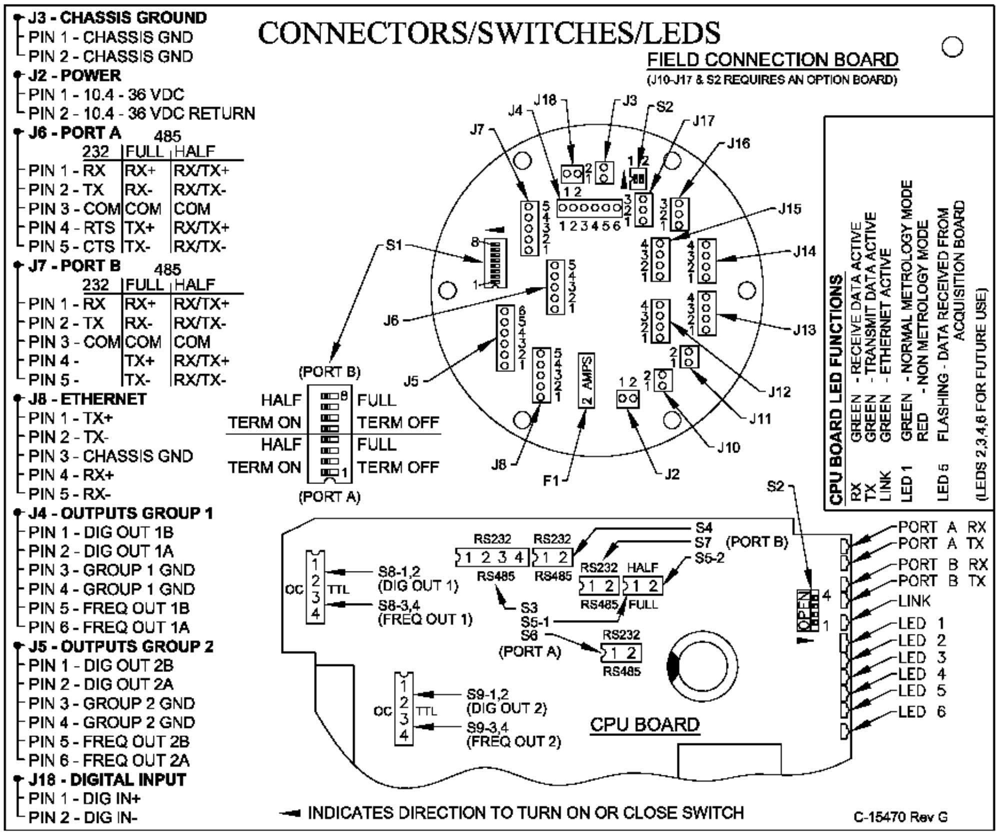


Figure 3-18 Option Board Wiring Connectors/Switches/LEDs

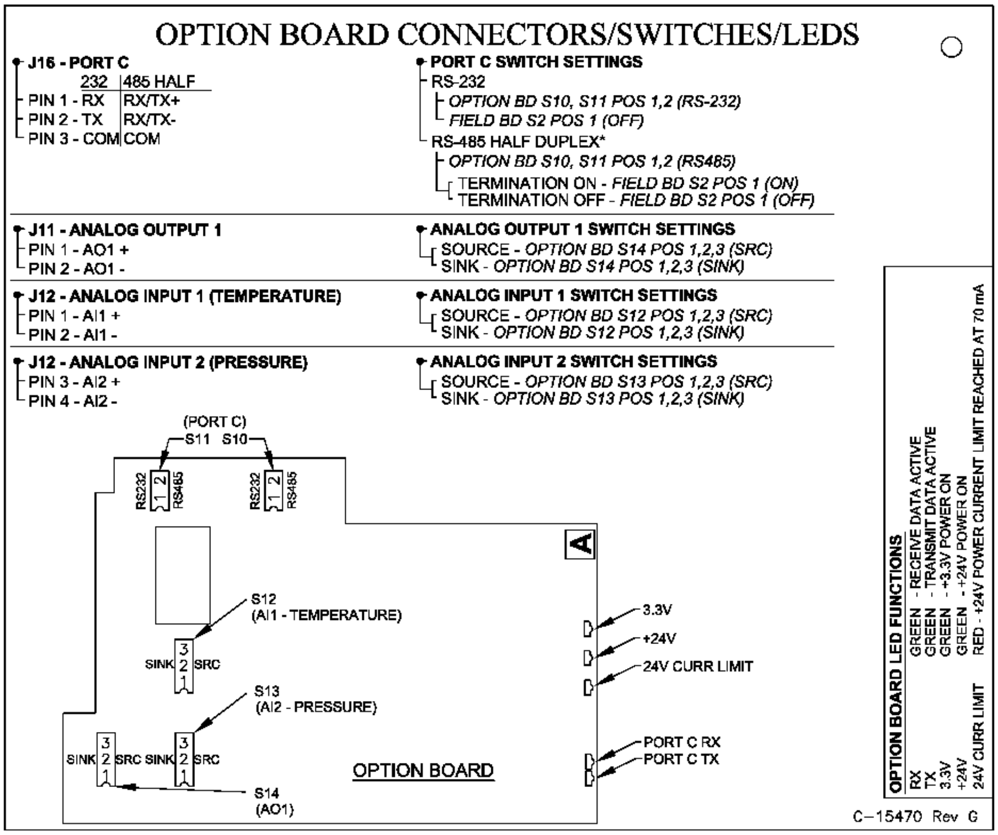


Figure 3-19 Series 100 Plus Option Board Wiring Connectors/Switches/LEDs

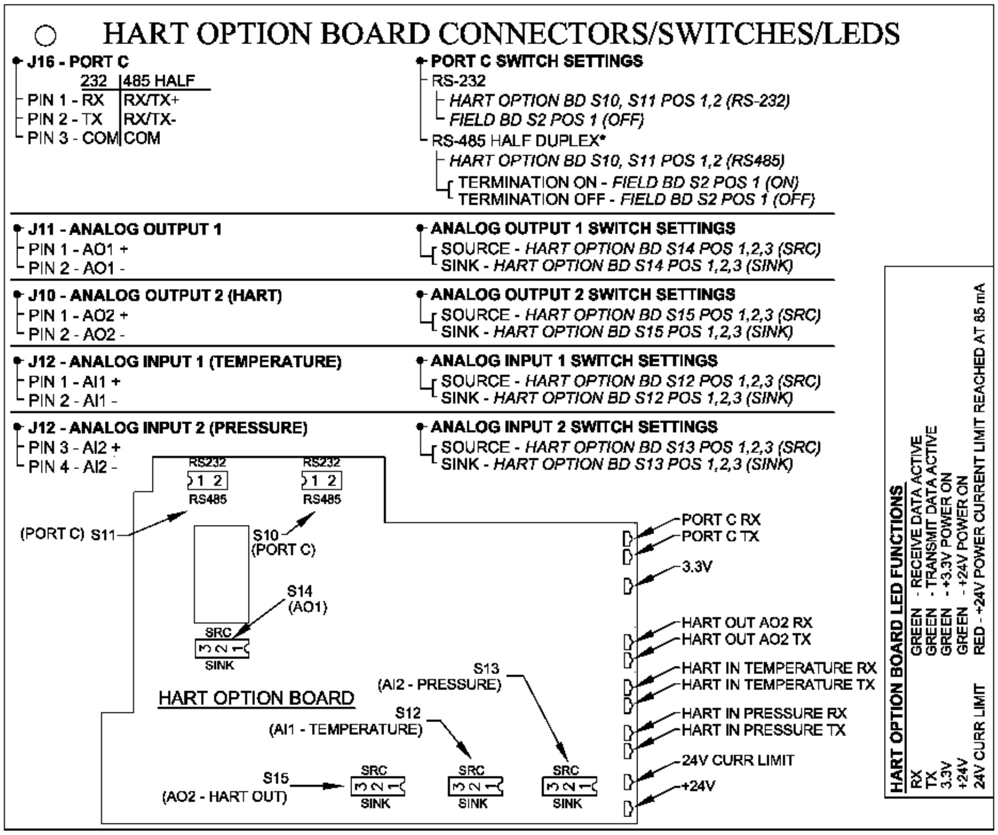


Figure 3-20 CPU Board Switches

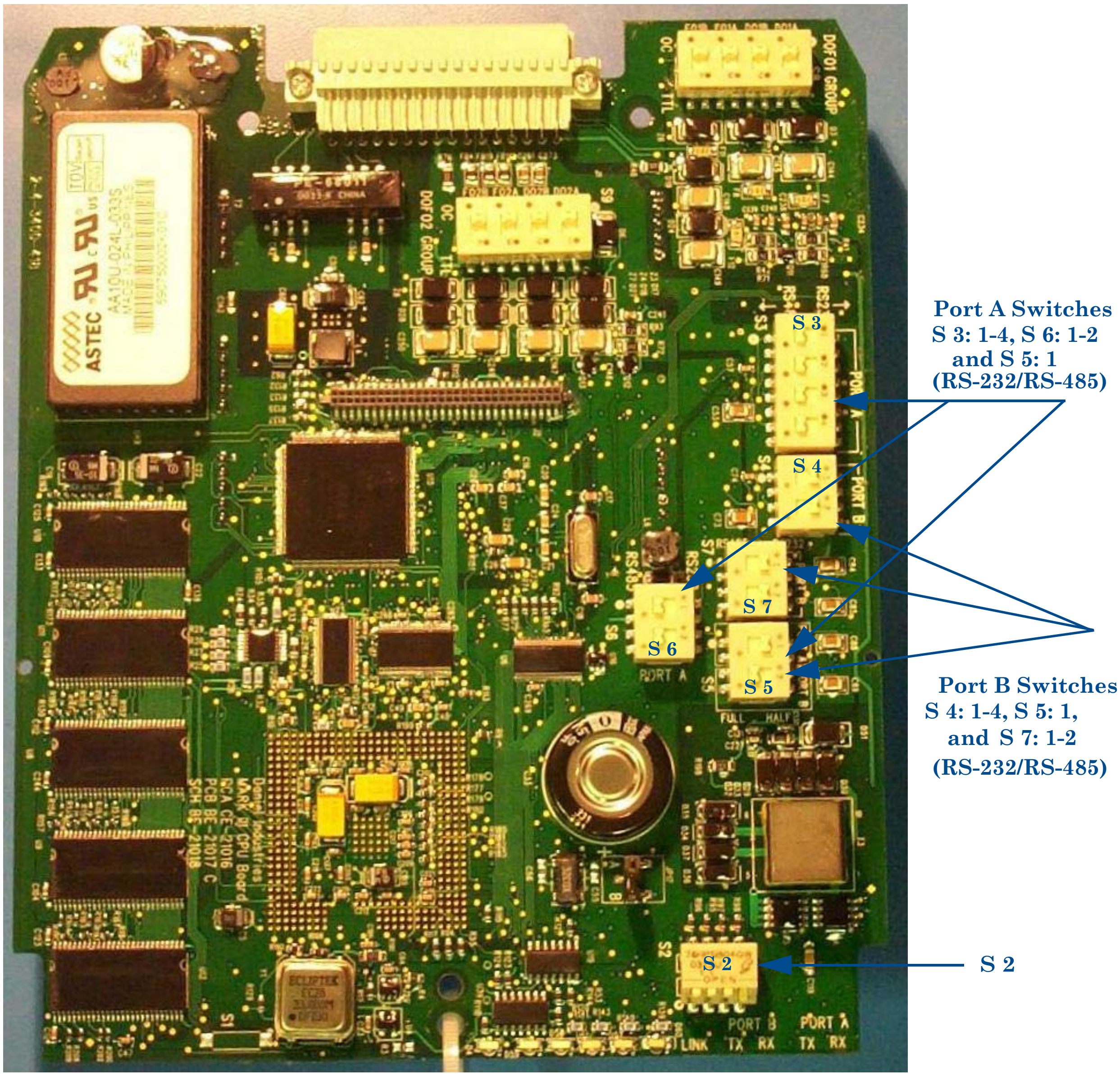


Figure 3-21 Series 100 Option Board Switches

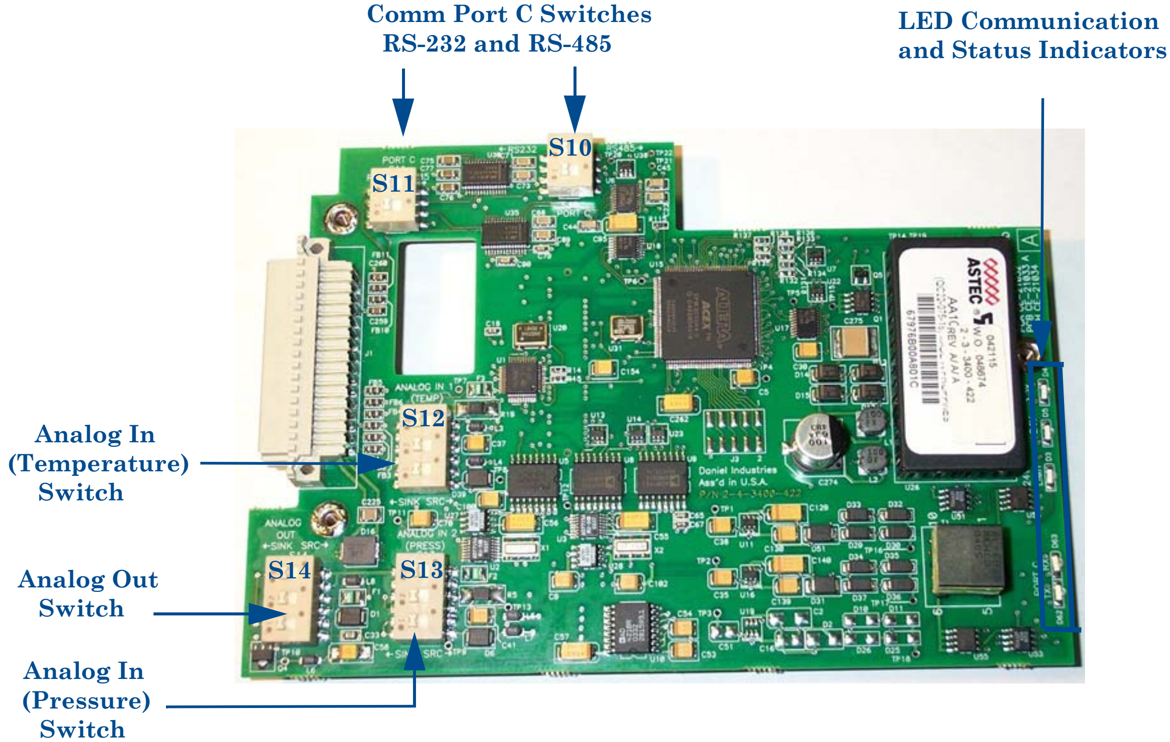


Figure 3-22 Series 100 Plus Option Board Switches

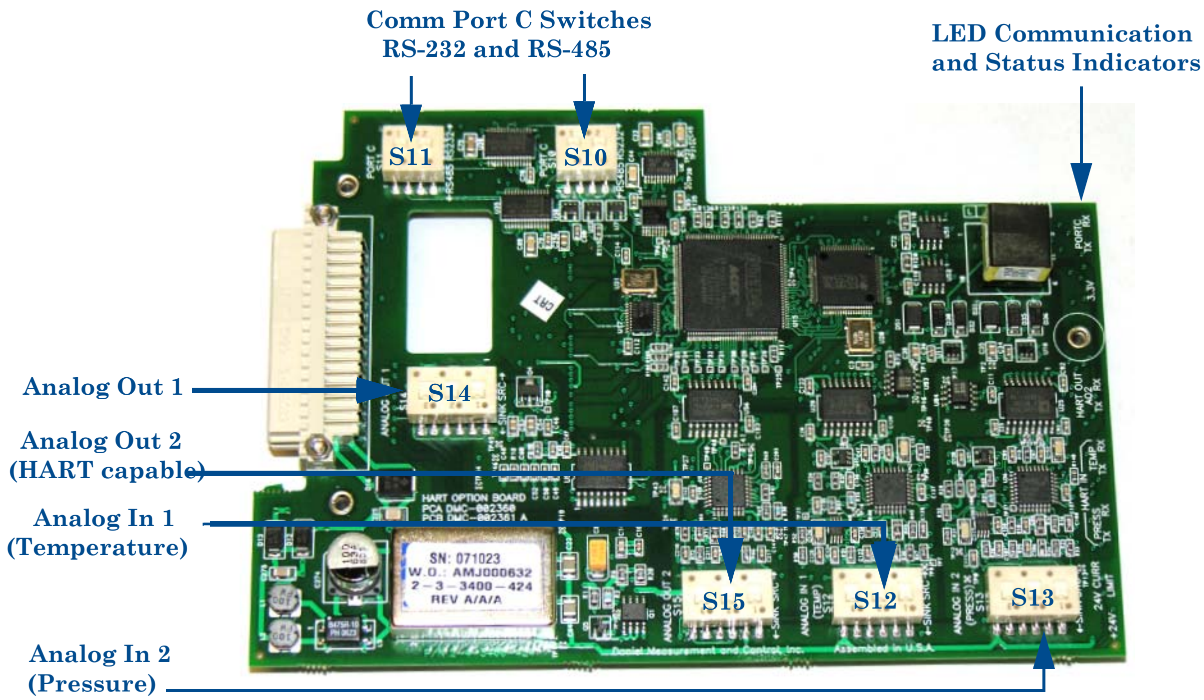
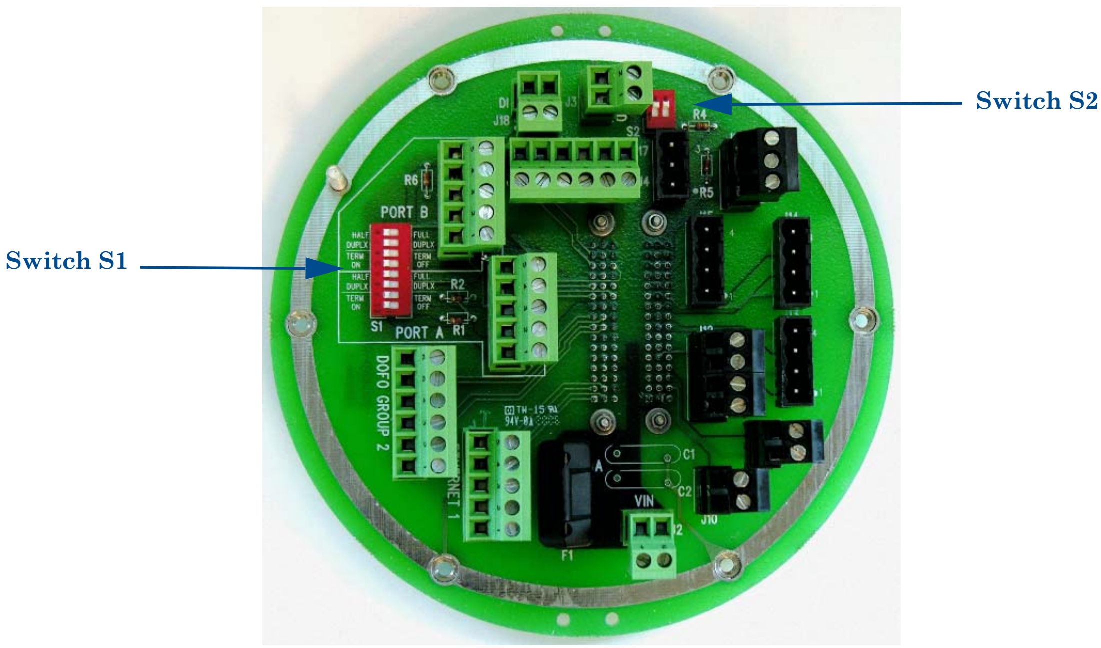


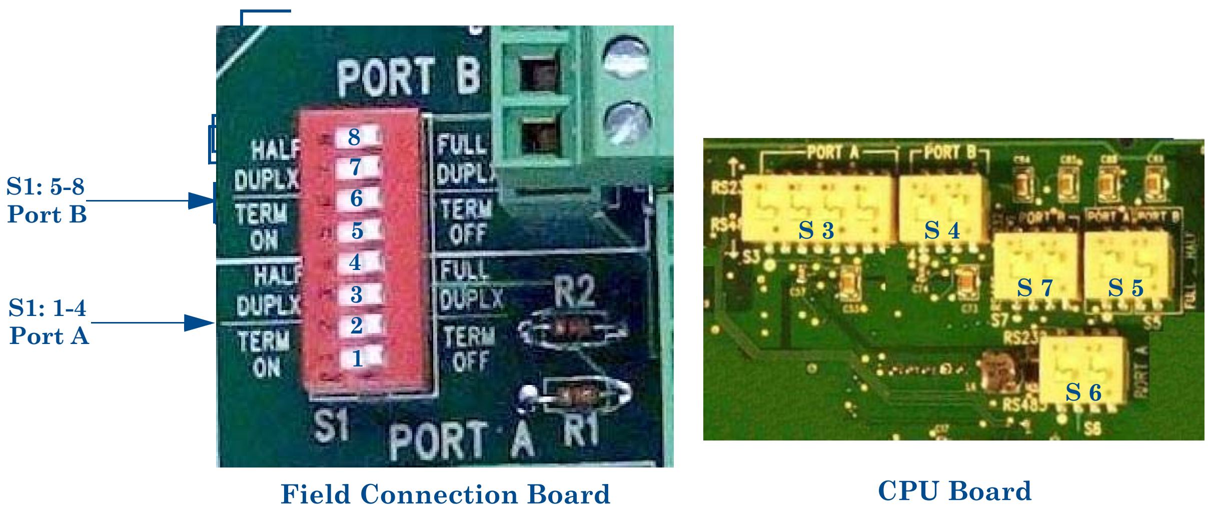
Figure 3-23 Field Connection board switches



3.5.1 Communication settings

Communication Ports A and B are configured via switches on both the CPU and Field Connection Boards (see Figure 3-24).

Figure 3-24 Field Connection and CPU Board communication configuration switch banks



Serial Communication Port Drivers

For serial communication Ports A and B, the driver to be used is individually selectable between RS-232, RS-485 Half Duplex, and RS485 Full Duplex.

NOTICE

Serial ports (Port A and Port B) have isolated and floating grounds (50 VDC isolation). Their grounds must be connected for reliable serial port operation. A shield may be connected to ground at the remote end and can be used to provide ground for each port. If both ports are connected to the same remote location, the shield may be used to provide a common ground back to the remote end.

Port A Driver Configuration

The serial communication Port A driver is configured via CPU Board switch banks S3, S5, and S6 and Field Connection Board switch bank S1.

To configure Port A for RS-232 operation, set the switches as indicated in the table below (see Figure 3-24 for switch bank locations).

Table 3-25 Port A driver settings

Board	Switch	Position
CPU	S3-1	RS232
	S3-2	RS232
	S3-3	RS232
	S3-4	RS232
	S5-1	FULL
	S6-1	RS232
	S6-2	RS232
Field Connection	S1-1	TERM OFF
	S1-2	TERM OFF
	S1-3	FULL DUPLX
	S1-4	FULL DUPLX

To configure Port A for RS-485 Full Duplex operation, set the switches as indicated in the table below (see Figure 3-24 for switch bank locations):

Table 3-26 Port A RS-485 full duplex settings

Board	Switch	Position	
CPU	S3-1	RS485	
	S3-2	RS485	
	S3-3	RS485	
	S3-4	RS485	
	S5-1	FULL	
	S6-1	RS485	
	S6-2	RS485	
Field Connection		Termination ON	Termination OFF
	S1-1	TERM ON (RX)	TERM OFF (RX)
	S1-2	TERM ON (TX)	TERM OFF (TX)
	S1-3	FULL DUPLX	
	S1-4	FULL DUPLX	

To configure Port A for RS-485 Half Duplex operation, set the switches as indicated in the table below (see Figure 3-24 for switch bank locations):

Table 3-27 Port A RS-485 half duplex settings

Board	Switch	Position	
CPU	S3-1	RS485	
	S3-2	RS485	
	S3-3	RS485	
	S3-4	RS485	
	S5-1	HALF	
	S6-1	RS485	
	S6-2	RS485	
Field Connection		Termination ON	Termination OFF
	S1-1	TERM ON	TERM OFF
	S1-2	TERM OFF	TERM OFF
	S1-3	HALF DUPLX	
	S1-4	HALF DUPLX	

NOTICE

Termination should only be enabled if the meter is the last drop in a multi-drop configuration or the only meter in a single-drop configuration.

Port B Driver Configuration

The serial communication Port B driver is configured via CPU Board switch banks S4, S5, and S7 and Field Connection Board switch bank S1.

Port B supports a special override mode which forces the port to use known communication values (19200 baud, address 32). (Note that the protocol is auto-detected.) This mode is expected to be used during meter commissioning (to establish initial communication) and in the event that the user cannot communicate with the meter (possibly due to an inadvertent communication configuration change).

The Port B communication override mode is entered by switching CPU Board S2-1 (switch bank 2, position 1) from the OPEN position to the CLOSED position. Port B remains in the override mode until either (1) the port configuration is changed (via software), (2) two minutes has elapsed (at which time the port reverts to its current configuration), or (3) the S2-1 switch is changed back to the OPEN position.

NOTICE

It is the action of *changing* S2-1 from the OPEN to CLOSED position (not *being* in the CLOSED position) that causes the override mode to be entered.

To configure Port B for RS-232 operation, set the switches as indicated in the table below (see Figure 3-24 for switch bank locations):

Table 3-28 Port B RS-232 driver settings

Board	Switch	Position
CPU	S4-1	RS232
	S4-2	RS232
	S5-2	FULL
	S7-1	RS232
	S7-2	RS232
Field Connection	S1-5	TERM OFF
	S1-6	TERM 0FF
	S1-7	FULL DUPLX
	S1-8	FULL DUPLX

To configure Port B for RS-485 Full Duplex operation, set the switches as indicated in the table below (see Figure 3-24 for switch bank locations):

Table 3-29 Port B RS-485 full duplex

Board	Switch	Position	
CPU	S4-1	RS485	
	S4-2	RS485	
	S5-2	FULL	
	S7-1	RS485	
	S7-2	RS485	
Field Connection		Termination On	Termination Off
	S1-5	TERM ON (RX)	TERM OFF (RX)
	S1-6	TERM ON (TX)	TERM OFF (TX)
	S1-7	FULL DUPLX	
	S1-8	FULL DUPLX	

To configure Port B for RS-485 Half Duplex operation, set the switches as indicated in the table below (see Figure 3-24 for switch bank locations):

Table 3-30 Port B RS-485 half duplex

Board	Switch	Position	
CPU	S4-1	RS485	
	S4-2	RS485	
	S5-2	HALF	
	S7-1	RS485	
	S7-2	RS485	
Field Connection		Termination On	Termination Off
	S1-5	TERM ON	TERM OFF
	S1-6	TERM OFF	TERM OFF
	S1-7	HALF DUPLX	
	S1-8	HALF DUPLX	

NOTICE

Termination should only be enabled if the meter is the last drop in a multi-drop configuration or the only meter in a single-drop configuration.

Port C Driver Configuration

NOTICE

Serial Port C has isolated and floating grounds (50 VDC isolation). Its grounds *must* be connected for reliable serial port operation. A shield may be connected to ground at the remote end and can be used to provide ground for the port.

Port C is provided via the Series 100 Option Board or the Series 100 Plus Option Board and can be used for either general purpose serial communication (similar to Ports A and B) or for optional serial communication with a Daniel Gas Chromatograph in Sim2251 mode.

The Port C driver is individually selectable between RS-232 and RS-485 Half Duplex via the Series 100 Option Board or the Series 100 Plus Option Board (if installed) switch banks S10 and S11 and Field Connection Board switch bank S2.

To configure Port C for RS-232 operation, set the switches as indicated in the table below (see Figure 3-21 for switch bank locations).

Table 3-31 Port C RS-232 settings

Board	Switch	Position
Option or Series 100 Plus Option Board	S10-1	RS232
	S10-2	RS232
	S11-1	RS232
	S11-2	RS232

To configure Port C for RS-485 Half Duplex operation, set the switches as indicated in the table below (see Figure 3-21 for switch bank locations):

Table 3-32 Port C RS-485 half duplex

<table>
<tr><th>Board</th><th>Switch</th><th colspan="2">Position</th></tr>
<tr><td rowspan="4">Expansion Board or
Series 100 Plus Option Board</td><td>S10-1</td><td colspan="2">RS485</td></tr>
<tr><td>S10-2</td><td colspan="2">RS485</td></tr>
<tr><td>S11-1</td><td colspan="2">RS485</td></tr>
<tr><td>S11-2</td><td colspan="2">RS485</td></tr>
<tr><td rowspan="2">Field Connection</td><td></td><td>Termination On</td><td>Termination Off</td></tr>
<tr><td>S2-1</td><td>ON (toward the outside of the board)</td><td>OFF (toward the inside of the board)</td></tr>
</table>

NOTICE

Termination should only be enabled if the meter is the last drop in a multi-drop configuration or the only meter in a single-drop configuration.

3.5.2 Frequency and Digital Output switch settings

The meter provides two pairs of configurable frequency outputs (FO1A, FO1B, FO2A, and FO2B) and four configurable digital outputs (DO1A, DO1B, DO2A, and DO2B). These outputs are divided into two groups as follows:

- Group 1: FO1A, FO1B, DO1A, DO1B
- Group 2: FO2A, FO2B, DO2A, DO2B

The frequency and digital outputs are individually configured for "internally powered" mode or "open collector" mode via CPU Board switch banks S8 and S9 (see Figure 3-25 and Figure 3-26). See Section 2.4.4 for information on these modes.

Figure 3-25 CPU Board Frequency and Digital Output configuration switch banks

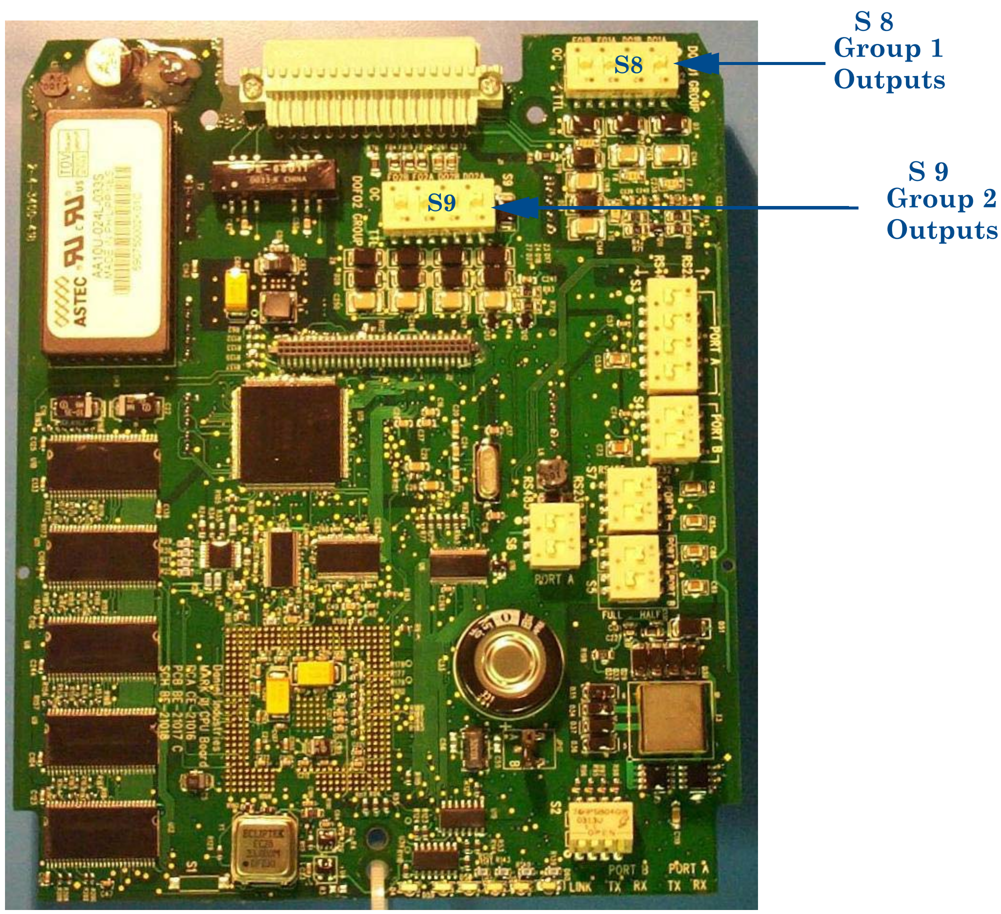
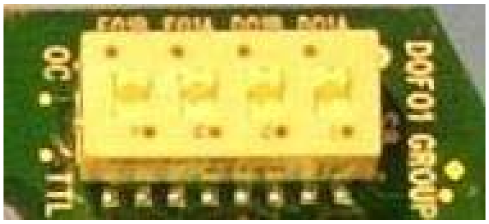
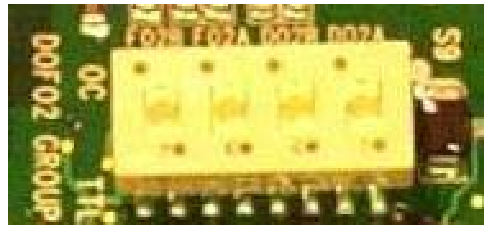


Figure 3-26 CPU Board Switch Banks S8 and S9



S8 (Group 1)



S9 (Group 2)

Group	Output	CPU Board Switch	Switch Position	
			Internally Powered	Open Collector
1	DO1	S8-1	TTL	OC
	DO2	S8-2	TTL	OC
	Freq1A	S8-3	TTL	OC
	Freq1B	S8-4	TTL	OC
2	DO3	S9-1	TTL	OC
	DO4	S9-2	TTL	OC
	Freq2A	S9-3	TTL	OC
	Freq2B	S9-4	TTL	OC

3.5.3 Option Board analog inputs switch settings

The Option Board provides the capability to sample analog temperature and pressure 4-20 mA signals. These input signals are individually configurable for sinking or sourcing current via Option Board switches as described in the tables below (Table 3-33 through Table 3-38) and in Daniel drawing DE-21056 (particularly page 3, notes 24, 25, and 28, see Appendix I).

NOTICE

If the analog input is configured for “Source” mode (i.e., powered by the meter), then it must be at the bottom of the loop (stack).

Table 3-33 Option Board Analog In 1 temperature sin k settings

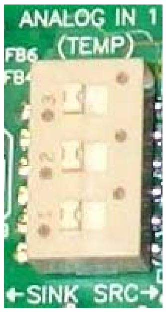
Board	Switch	Position
Option 	S12-1	SINK
	S12-2	SINK
	S12-3	SINK

Table 3-34 Option Board Analog In 1 temperature source settings

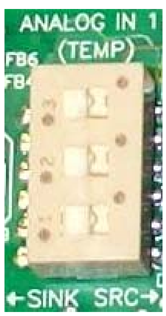
Board	Switch	Position
Option 	S12-1	SRC
	S12-2	SRC
	S12-3	SRC

Table 3-35 Option Board Analog In 2 pressure sink settings

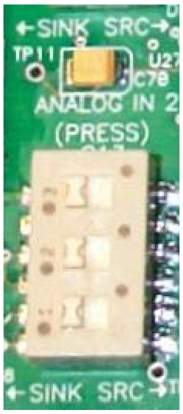
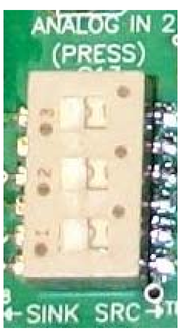
Board	Switch	Position
Option	S13-1	SINK
	S13-2	SINK
	S13-3	SINK

Table 3-36 Option Board Analog In 2 pressure source settings

Board	Switch	Position
Option	S13-1	SRC
	S13-2	SRC
	S13-3	SRC

3.5.4 Series 100 Option Board analog output switch settings

The Option Board provides a 4-20 mA analog output signal that is hardware configurable to either sink or source current as described in Table 3-37 and Table 3-46 below and in Daniel drawing DE-21056 (particularly page 3, notes 26 and 27, see Appendix I).

NOTICE

If the analog output is configured for ‘Source’ mode (i.e., powered by the meter), then it must be at the bottom of the loop (stack).

Table 3-37 Series 100 Option board Analog Out sink setting

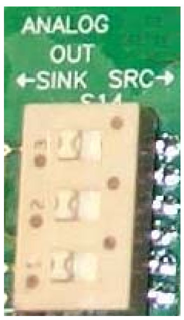
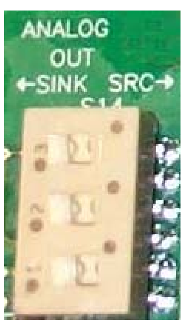
Board	Switch	Position
Series 100 Option 	S14-1	SINK
	S14-2	SINK
	S14-3	SINK

Table 3-38 Series 100 Option board Analog Out source setting

Board	Switch	Position
Option 	S14-1	SRC
	S14-2	SRC
	S14-3	SRC

3.5.5 Series 100 Plus Option Board Analog Input switch settings

The Series 100 Plus Option Board provides the capability to sample analog temperature (Analog Input 1) and pressure (Analog Input 2) 4-20 mA signals. These input signals are individually configurable for sinking or sourcing current via Series 100 Plus Option Board switches as described in the tables below (Table 3-39 through Table 3-46) and in Daniel drawing DE-21056 (particularly page 3, notes 24, 25, and 28 (see Appendix I). The Series 100 Plus Option Board provides two independent analog input circuits used in conventional 4-20 mA service.

NOTICE

If the analog input is configured for 'Source' mode (i.e., powered by the meter), then it must be at the bottom of the loop (stack).

Table 3-39 Series 100 Plus Option board Analog In 1 temperature sink setting

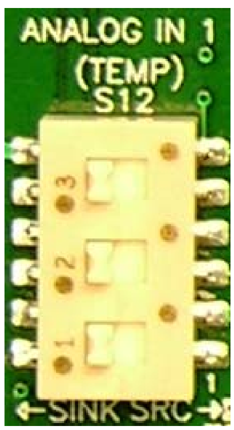
Board	Switch	Position
Series 100 Plus Option Board 	S12-1	SINK
	S12-2	SINK
	S12-3	SINK

Table 3-40 Series 100 Plus Option board Analog In 1 temperature source setting

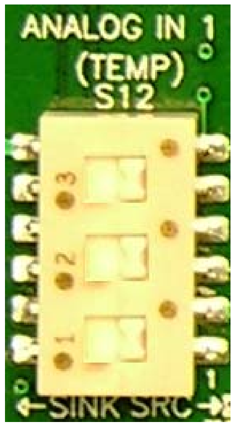
Board	Switch	Position
Series 100 Plus Option Board 	S12-1	SRC
	S12-2	SRC
	S12-3	SRC

Table 3-41 Series 100 Plus Option board Analog In 2 pressure sink setting

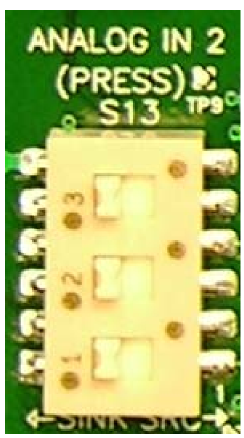
Board	Switch	Position
Series 100 Plus Option Board 	S13-1	SINK
	S13-2	SINK
	S13-3	SINK

Table 3-42 Series 100 Plus Option board Analog In 2 pressure source setting

Board	Switch	Position
Series 100 Plus Option Board 	S13-1	SRC
	S13-2	SRC
	S13-3	SRC

3.5.6 Series 100 Plus Option Board Analog Output switch settings

The Series 100 Plus Option Board provides two 4-20 mA analog output signals that are hardware configurable to either sink or source current as described in Table 3-43 and Table 3-44 below and in Daniel drawing DE-21056 (see Appendix I).

NOTICE

If the analog output is configured for 'source' mode (i.e., powered by the meter), then it must be at the bottom of the loop (stack). The HART® output cannot be multi-dropped when configured for source mode.

Full HART® functionality is provided so that any commercially available HART® transmitter which meets the specifications of the HART® Communications Foundation can be connected to the Daniel® Ultrasonic Gas Flow Meter.

Table 3-43 Series 100 Plus Option Board Analog Out 1 sink settings

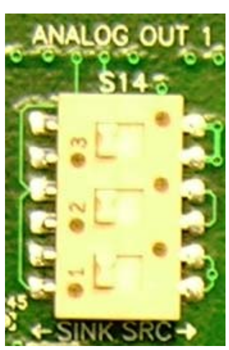
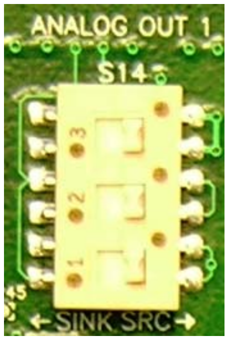
Board	Switch	Position
Series 100 Plus Option Board 	S14-1	SINK
	S14-2	SINK
	S14-3	SINK

Table 3-44 Series 100 Plus Option Board Analog Out 1 source settings

Board	Switch	Position
Series 100 Plus Option Board 	S14-1	SRC
	S14-2	SRC
	S14-3	SRC

Analog Output 2 (AO2) is user-configurable (via a configuration parameter) as either a conventional 4-20 mA output (like AO1) or as a HART® slave.

Table 3-45 Series 100 Plus Option Board Analog Out 2 sink settings

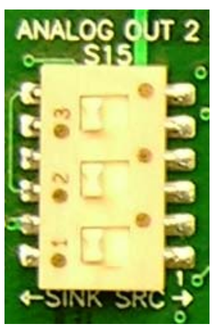
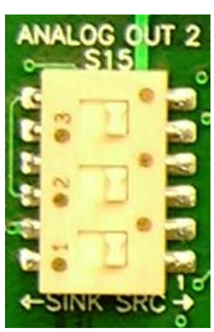
Board	Switch	Position
Series 100 Plus Option Board 	S15-1	SINK
	S15-2	SINK
	S15-3	SINK

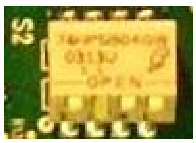
Table 3-46 Series 100 Plus Option Board Analog Out 2 source settings

Board	Switch	Position
Series 100 Plus Option Board 	S15-1	SRC
	S15-2	SRC
	S15-3	SRC

3.5.7 DHCP server switch settings

The meter can be configured to act as a DHCP server (see Section 2.6 for further details). The DHCP server is enabled/disabled via CPU Board switch S2 position 2 as follows:

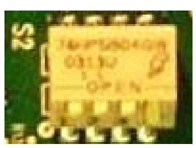
Table 3-47 DHCP server settings

CPU Board Switch	DHCP Server Disabled	DHCP Server Enabled
S2-2 	OPEN	CLOSED

3.5.8 Configuration protection switch settings

The meter's configuration parameters and firmware can be protected against changes via CPU Board switch S2 position 4 as follows:

Table 3-48 CPU configuration protection switch

CPU Board Switch	Configuration Protected	Configuration Unprotected
S2-4 	OPEN	CLOSED

A complete reference of write-protected parameters are listed in Appendix G.1. Also see Section 5.7.

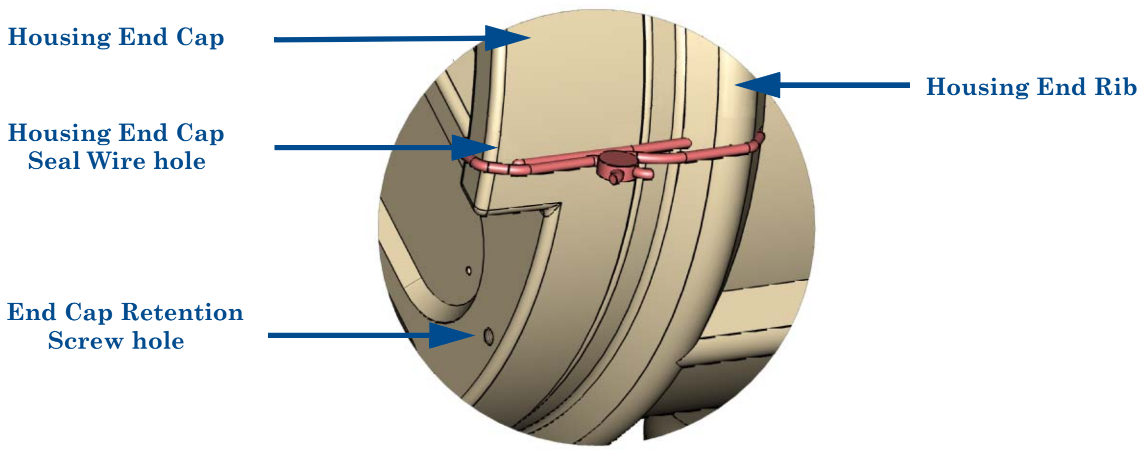
3.6 Security seal installation

The following sections detail how to properly seal the ultrasonic meter after commissioning. Be sure to set Switch S2 - Position 4 on the CPU board to the **OPEN** position prior to sealing the enclosure (to write-protect the meter's configuration).

3.6.1 End cap security seal installation

Use the following instructions to install the retention screws and security seal wires on the Upper Electronics Housing. The security seal wires referenced below are commercially available.

Figure 3-27 Upper electronics end cap security seals

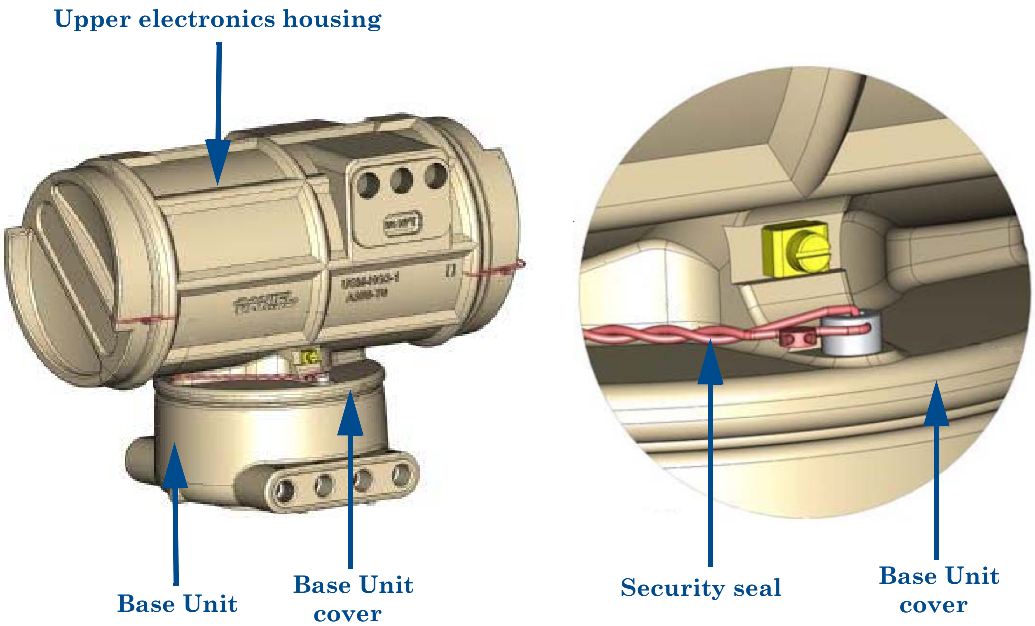


1. Rotate end cap clockwise fully closing and compressing the end cap seal.
2. Use a $\frac{5}{64}$ inch (2.0 mm) hexagon wrench to tighten the set screw. When tightened, the retention screw prevents vibration from loosening the end cap and discourages unauthorized entry into the electronics housing.
3. Install the security seal wire into and through one of the two holes in the Housing End Rib and through one of the two holes of the outer edge of the Housing End Cap. Choose holes that minimize counterclockwise rotation of the end cap when the security wire is taut (maximum wire diameter 0.078 inch; 2.0mm) (see Figure 3-27).
4. Adjust wire, removing all slack and seal. Remove excess wire.

3.6.2 Upper electronics housing to base unit security seal

Use the following instructions to install the security seal wire from the Upper Electronics Housing Base Unit Cover to the Base Unit.

Figure 3-28 Upper electronics housing to base unit security seal

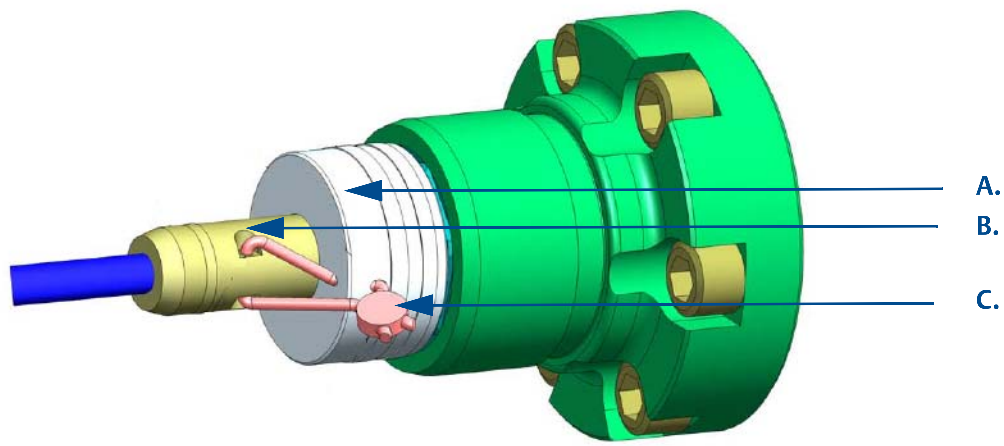


1. Install security wire seal into and through the holes in the two socket head screws on the Base Unit cover (maximum wire diameter 0.078 inch; 2.0mm) (see Figure 3-28).
2. Position the wire to prevent counterclockwise rotation of the screws when the seal wire is taut.
3. Twist and adjust wire removing all slack and seal.
4. Remove excess wire.

3.6.3 Transducer assembly security seal installation

Use the following instructions to install the security seal wires on the Transducer Assembly (see Section 7.2 for transducer removal instructions).

Figure 3-29 Transducer housing, cable nut and security seal



A. Transducer cable nut
B. Transducer cable chordset
C. Security wire seal

1. Check the installation of the following parts:
   - Transducer Housing - securely tightened and flush with the meter body
   - Transducer cable nut - snugly tightened and flush with Transducer Housing
2. For each Transducer Assembly, install a security seal wire (maximum wire diameter 0.09 inch; 2.3mm) on the Transducer Cable Connector to the Transducer Cable Nut by rotating the Transducer Cable Nut clockwise; compressing the seal on the Transducer Cable Connector (see Figure 3-29).
3. Twist and adjust wire removing all slack and seal. Remove excess wire (see Figure 3-29).

Section 4: Optional features

4.1 Overview

The Mark III meter offers many industry-leading features including Ethernet access, Chapter 21-compliant data log access, gas chromatograph (GC) interface, AGA10 sound velocity calculation (with comparison to measured sound velocity) and Continuous Flow Analysis. Daniel recognizes that these features are valuable to many, but not all customers. The optional Continuous Flow Analysis key may be purchased with the meter or at a later time and this key enables all optional features available.

NOTICE

If you currently have a valid key with an expiration date, the key shall be converted into a non-expiring key upon firmware upgrade (v1.70).

The Continuous Flow Analysis optional feature is enabled via a software “key” value that is specific to the meter’s CPU Board. This software feature key consists of 16 characters divided into four hyphen-separated, 4-character groups (such as 1234-5678-90AB-CDEF). This dialog is only available while connected to a meter with firmware that contains option keys to enable.

4.1.1 Managing optional feature keys

The Daniel MeterLink program **Key Manager** screen (accessed via **Meter/Key Manager**) is used to view/change the key values and view the key statuses. For expiring keys (firmware v1.6X and below), the expiration data is shown as part of the status.

4.1.2 Obtaining optional keys

If you do not have a valid key to enter to enable a feature, you must have the CPU board serial number available, which displays in the **Meter Menu|Key Manager** dialog and the **Meter Menu|Meter Information** dialog, when you contact Daniel to obtain the key. The keys can be given verbally over the phone or they can be e-mailed in a Key file for easy entry.

- E-mail: tech.service@emersonprocess.com
- Web: http://www2.emersonprocess.com/en-US/brands/daniel/SUPPORT-SERVICES/Pages/Support-Services.aspx (select the "Contact Us" link)
- Also see, Daniel MeterLink **Help|Technical Support**

4.1.3 Optional Ethernet key

The optional Ethernet access feature allows the meter to communicate with the Daniel MeterLink software via the meter's Ethernet port. This feature is enabled/disabled via the **Eth1Key** data point.

NOTICE

For Ethernet communication, the optional Mark III Ethernet adapter cable (Daniel P/N 3-3400-079) is required.

4.1.4 Optional data log access key

The optional data log access feature allows the reading of the meter's hourly, daily, audit, alarm, and system log data using Daniel MeterLink. This feature is enabled/disabled via the **LogAccessKey** data point.

4.1.5 Optional GC interface key

The optional GC interface feature allows the meter to read gas property data (composition and heating value) from a Daniel gas chromatograph. The meter can use the gas composition data to (a) calculate AGA8 compressibilities for converting volumetric flow rate and volumes to standard (base) condition, (b) calculate AGA8 density for calculating mass rate and mass totals, and (c) to optionally calculate the AGA10 sound velocity (see below). The meter can use the GC-reported gas heating value to calculate the energy rate and totalized energy values. This feature is enabled/disabled via the **GCKey** data point.

NOTICE

The optional GC interface feature requires the use of the Option Board serial port (Port C).

4.1.6 Optional Aga10 key (sound velocity calculation)

The optional AGA10 sound velocity calculation feature allows the meter to calculate the predicted sound velocity based upon the gas composition and compare this value to the measured average sound velocity. The gas composition can be either specified via data points or optionally read live from a GC (see above). This feature is enabled/disabled via the **AGA10Key** data point.

4.1.7 Key status

The Status column will indicate if the key entered is a Valid key or if the key is disabled.

Leaving the Key field empty or entering 0000-0000-0000-0000 will disable the feature once **Write to Meter** is clicked.

4.2 Key expiration warnings (firmware v1.6X and below)

Daniel MeterLink (firmware version 1.6X and below) provides two key-expiration-related warnings: one when any optional feature key is within 30 days of expiring (via the **IsAnyKey-AboutToExpire** data point) and another when any optional feature key has expired (via the **IsAnyKeyExpired** data point).

Each warning data point is individually acknowledgeable from within the Daniel MeterLink **Meter/Monitor** page via the '**Check Status**' button. Once a warning is acknowledged, it will not become active again until a different key is within 30 days of expiring or has expired.

The **IsAnyKeyAboutToExpire** and **IsAnyKeyExpired** data points are both audit-logged and alarm-logged.

4.3 Grandfathered features (firmware v1.6X and below)

Prior to firmware version 1.30, the Ethernet access and data log access features were included at no extra charge. For customers with firmware v1.30 and below wishing to upgrade to newer (1.30 or later) firmware, the newer firmware automatically "grandfathers" these optional features by assigning non-expiring key values to the **Eth1Key** and **LogAccessKey** data points based upon the CPU Board serial number. GC interface and AGA10 sound velocity calculation features are not "grandfathered."

4.4 Trial period (firmware v1.6X and below)

All optional features with disabled keys are automatically enabled via expiring keys for a trial period that ends 90 days after continuous flow is established (firmware v1.6X and below). Continuous flow is established when the meter average flow velocity is continuously above the low-flow limit for eight hours.

Section 5: Startup and meter configuration

5.1 Communications

This section provides instructions and guidelines for communicating with and configuring the meter, performed either as part of meter installation or as needed for meter operations adjustment.

Instructions are provided for establishing *initial* communications with the meter, in order to begin meter configuration using Daniel MeterLink software.

NOTICE

Refer to Refer to HART® Field Device Specification Guide: Daniel GAS Ultrasonic Flow Meters P/N 3-9000-754 for communications with the Series 100 Plus Option Board.

The most significant portion of this section consists of guidelines for configuring flow meter parameters, or data points.

Refer to Appendix C to upgrade a Mark II meter to a Daniel Mark III Ultrasonic Gas Flow Meter Electronics meter using the Daniel MeterLink configuration conversion feature.

⚠CAUTION

UNAUTHORIZED ACCESS, DATA LOSS, OR SYSTEM CORRUPTION MAY OCCUR

Restrict ethernet and serial connectivity usage.

Failure to restrict Ethernet and communication access to the Liquid Ultrasonic Meter can result in, among other things, unauthorized access, system corruption, and/or data loss. User is responsible for ensuring that physical access and Ethernet or electronic access to the Series 100 Option Board is appropriately controlled and any necessary security precautions, such as, establishing a firewall, setting password permissions and/or security levels are implemented.

Daniel MeterLink provides setup “Wizards” to simplify meter communications and configurations (see Table 5-1).

Table 5-1 Daniel MeterLink setup wizards

Daniel MeterLink Setup Wizards	
Wizard	**Description**
Communications	Meter Menu: For establishing communication parameters for the Daniel Ultrasonic Gas Flow Meter. This includes both the serial and Ethernet ports. Only ports and parameters available in the meter will be enabled and configurable. The base meter contains two serial ports and one Ethernet Port. See Section 5.2 through Section 5.5
Field Setup	Meter Menu: The Field Setup Wizard allows you to enter site specific information into the meter and is only available while connected to a meter. It is designed to be used once during initial startup of the meter to enter information unique to the meter’s installation. It can be used at a later time to change the meter configuration. The Field Setup Wizard is the only way in Daniel MeterLink to change the following parameters: • Meter units system • Volumetric flow rate time • Gage or Absolute Pressure type Depending on the version of firmware running on the meter, some options may be disabled or unavailable in the Field Setup Wizard if the firmware can not support the option.

Table 5-1 Daniel MeterLink setup wizards

Daniel MeterLink Setup Wizards	
Set Baseline Wizard	Tools Menu: This allows you to select the direction to baseline and what data to use to perform the baseline. Select baseline flow direction: Select the direction to baseline. You will need to rerun the wizard a second time to baseline the other direction if this is for a bi-directional meter application. Whether the baseline has been set or not will also be indicated next to the direction. Select baseline data source: Select one of the data sources: • 1-minute averages from the meter - This is the preferred option when setting the baseline for a new meter. The meter must be under typical flowing conditions when the baseline is set. Upon click Next, the meter will verify the 1-minute averages from the meter are valid before continuing to the next page. • Daniel MeterLink maintenance log - This option is intended to be used if the meter has already been installed in the field for a period of time and a Daniel MeterLink maintenance log is available from the initial startup that was taken during normal flowing conditions. Upon clicking Next, you will be prompted to select the Maintenance log file to use. Daniel MeterLink will verify this is a valid file and will gather as much data as possible from this file. If the maintenance log does not contain certain values, you will have the opportunity to keep the default values or manually enter your own. • Manual entry - This option allows you to manually enter data for each of the parameters. This could be used to modify a single parameter for a baseline already set or it could be to enter data from a historical record from when the meter was first put into service.
Signal Analyzer Wizard	Meter Menu: The Signal Analyzer Wizard is used to adjust the behavior of the meter's signal sampling and output updates. This dialog is only available while connected to a meter.

5.2 Communications setup

The Daniel 3410 Series Gas Ultrasonic Flow Meter provides three standard RS-232/RS-485 serial communication ports (referred to respectively as Port A, Port B, and Port C) and an Ethernet port (Eth1). Port A and Port B are expected to be used for (general) communication with flow computers and RTUs. Port C (included on the Series 100 Plus Option Board) can be used for general communication (such as with a flow computer or RTU). The Series 100 Plus Option Board, if installed is capable of communicating with other devices via a 375 Field Communicator or AMS™ Suite.

The Ethernet port is expected to be used for diagnostic purposes. See Section 3.5 for hardware configuration of communications protocols. See Section 5.1 for software configuration of communications protocols.

Port A is the preferred port for connection to a flow computer or RTU. If two flow computers are to be connected to the meter, then Port B should be used to connect to the second flow computer. If a computer running the Daniel MeterLink program is to be connected to a meter the Ethernet port is the preferred port for the connection.

If the Ethernet connection is not feasible, then Daniel MeterLink should be connected to the meter using Port B in full duplex configuration.

NOTICE

Daniel MeterLink will not communicate with a Daniel 3410 Series Gas Ultrasonic Flow Meter over a half-duplex serial connection.

Both Ports A and B are individually hardware-selectable for RS-232/RS-485 Full Duplex/RS-485 Half Duplex operation. Port A supports RS-232 RTS/CTS handshaking with software-configurable RTS on and off delay times. When handshaking is enabled, Port A drives the RTS output low and expects the CTS input to be active low. Both Ports A and B support individually software-configurable transmit delay times.

Port C (provided by the Series 100 Plus Option Board) is individually hardware-selectable for RS-232/RS-485 Half Duplex operation. Port C supports a software-configurable transmit delay time.

Refer to Daniel P/N 3-9000-754 *HART® Field Device Specification Guide: Daniel Gas Ultrasonic Meters* manual for Series 100 Plus Option Board details.

Ports A, B, and C support ASCII and RTU Modbus protocols (as detailed in Table 5-2) which are automatically detected on a per-port basis.

Table 5-2 Supported Modbus Protocols

Modbus Protocol	Number of Start Bits	Number of Data Bits	Parity Type	Number of Stop Bits
ASCII	1	7	odd or even	1
RTU	1	8	none	1

Modbus addresses are software configurable (from 1 to 247) on a per-port basis. Ports A and B operate only as Modbus slaves. Port C can operate as either a Modbus slave (for general communication) or a Modbus master.

Baud rates are software selectable on a per-port basis from the following:

- ASCII Modbus: 1200, 2400, 9600, 19200, 38400, 57600, 115000 bps
- RTU Modbus: 1200, 2400, 9600, 19200, 38400 bps

When Belden wire No. 9940 or equivalent is used, the maximum cable length for RS-232 communications at 9600 bps is 88.3 meters (250 ft.) and the maximum cable length for RS-485 communication at 57600 bps is 600 meters (1970 ft.).

Port B supports a special override mode which forces the port to use known communication values (19200 baud, address 32) (see Section 5.7). (Note that the protocol is still auto-detected.) This mode is expected to be used during meter commissioning (to establish initial communication) and in the event that the user cannot communicate with the meter (possibly due to an inadvertent communication configuration change).

The Ethernet port IP address, subnet mask, and gateway address are software-configurable. In addition, a meter can be configured to act as a DHCP (Dynamic Host Configuration Protocol) server. The DHCP server facility is not intended to act as a general purpose DHCP server for a wider network. To this end, no user control is provided over the class or range of IP addresses the unit provides. A standard twisted pair (Cat-5) cable should be used for Ethernet wiring.

5.3 Communications setup wizard

NOTICE

These instructions for establishing initial communications apply to scenarios in which meter communications parameters (e.g., IP address or serial baud rate) are unknown.

This section discusses initial communications, Ethernet connectivity, serial connections and direct connections.

5.3.1 Advantages of Ethernet communication

NOTICE

For Ethernet communication, the Ethernet adapter cable (Daniel P/N 3-3400-079) is required.

If possible, consider using the optional Ethernet access for Daniel 3410 Series Gas Ultrasonic Flow Meter communications (versusMay, 1998 serial communications).

Ethernet communications for the Daniel 3410 Series Gas Ultrasonic Flow Meter affords these advantages:

- Significantly higher transmission speed of data
- Near real-time display of wave forms at receiving workstation (using Daniel MeterLink)
- Fewer parameters to configure for data transmission control
- Multiple simultaneous Daniel MeterLink connections to the Daniel 3410 Series Gas Ultrasonic Flow Meter
- Company-wide Intranet LAN-based access
- One second updates on Daniel MeterLink Monitor display and maintenance logs.
- Rapid access to meter archive logs (particularly over long cable lengths).

5.3.2 Initial Ethernet communications connection

For Ethernet communications, configure these data points (listed in the table below):

Table 5-3 Data Points for Ethernet Port Configuration

Daniel MeterLink Display Name	Data Points, Options and Guidelines
IP Address	Data points affected: • Eth1IPAddr Options: • Enter a value (stored as a string)
Subnet mask	Data points affected: • Eth1SubnetMask Options: • Enter a value (stored as a string)
Default gateway	Data points affected: • EthDfltGatewayAddr Options: • Enter a value (stored as a string)

5.3.3 Ethernet communications connection

NOTICE

These instructions involve setting Mark III switches. Refer to Section 3.4 for further information on switch settings.

Refer to Appendix D for communication troubleshooting information.

NOTICE

It is strongly recommended that the meter be configured using an independent (off-network) single host computer. After configuration of the meter, the DHCP option should be disabled.

Ethernet Initial Connection Material Checklist

To complete the steps in the subsections that follow, obtain the following materials and information:

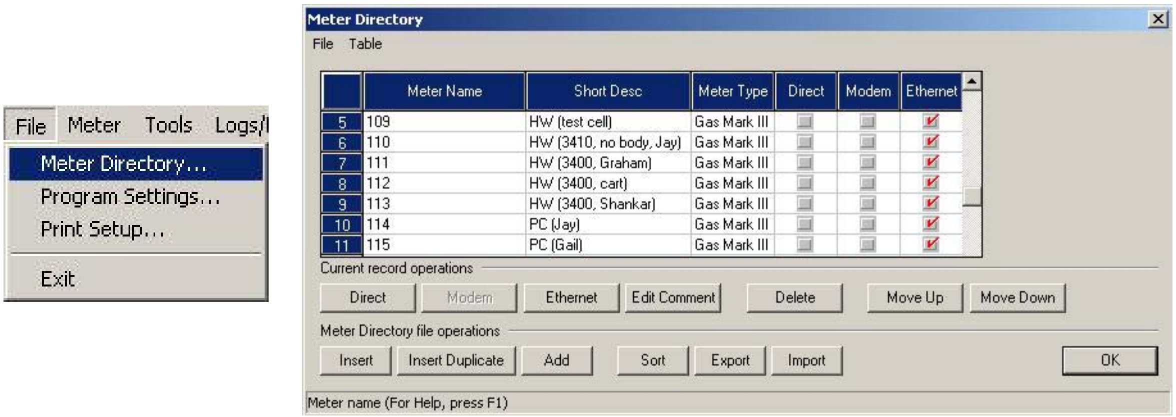
- Daniel 3410 Series Gas Ultrasonic Flow Meter Ethernet adapter cable (Daniel P/N 3-3400-079)
- Personal computer (PC) configured as follows:
- Daniel MeterLink software installed (version 3.0 or higher)
- Ethernet LAN adapter
- Configure to automatically obtain an IP address (via DHCP)
- Desired meter(s) communication configuration parameters:
  - IP address
  - serial communication parameters such as baud rate and Modbus ID (if desired)

5.3.4 Ethernet initial connection steps

1. Power up the meter.
2. Shutdown the PC.
3. Plug the Ethernet adapter cable Phoenix end into the meter Field Connection Board connector J8 and connect the RJ-45 end into the PC Ethernet connector.
4. Enable the Ethernet LAN connector DHCP server on the CPU Module by moving the DHCP (switch-1) to the **ON** position (see direction arrow on the CPU Module label).
5. Power up (boot) the PC and log in to the initial Windows logon prompt.
6. Verify the Ethernet connection status by the CPU Module "LINK" LED which should be on solid green.
7. Launch Daniel MeterLink.

8. Use the **File>Meter Directory** menu path to create a new meter directory record with the following parameters:

Figure 5-1 Program directory

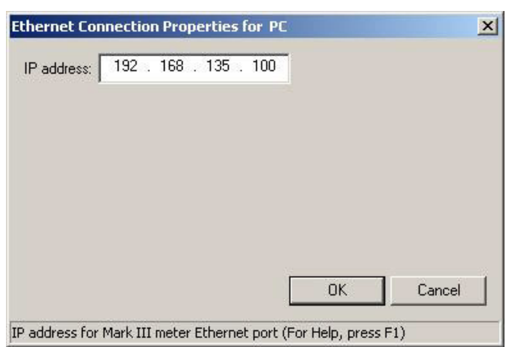


a. Select **Meter Type** as **Mark III**.

b. Check the **Ethernet** box and uncheck the **Direct** and **Modem** boxes.

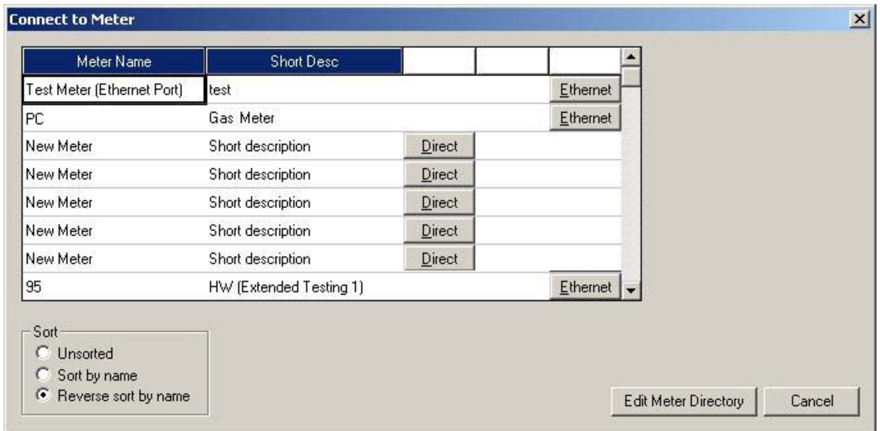
c. Click the Ethernet button and the Ethernet Connections dialog displays. Set the Ethernet IP address to 192.168.135.100. Click the **OK** button to apply the settings and return to the Meter Directory window

Figure 5-2 Ethernet connections parameters



9. Use the **Meter|Connect** menu path and select **Connect**. The Connect to Meter window displays.

Figure 5-3 Meter connect

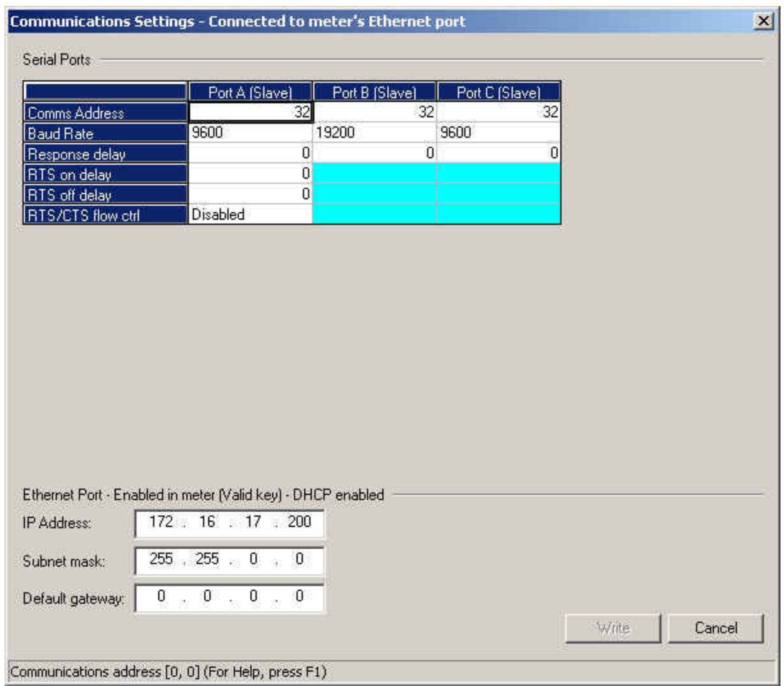


10. Click the Ethernet button for the meter record established in the previous step. Daniel MeterLink connects to the meter using the user-specified Ethernet settings.

11. After a connection to the meter is established, use the **Meter|Communications Settings** menu path to access the **Communication Settings** window. Use the drop down menu to select options for baud rate or to enable or disable RTS/CTS flow control.

    When you finish the communications settings, click the Write button to apply the settings.

Figure 5-4 Communications settings Ethernet port



12. Disconnect the standard Ethernet patch cable from the meter (if desired) and disable the Mark III DHCP server by setting the meter CPU Board switch S2-2 to the OPEN position (up away from the board).

NOTICE

At this point, the Mark III meter will only communicate at the user-configured IP address and will not reply at the DHCP default address of 192.168.135.100.

13. In Daniel MeterLink, edit the meter directory record established above so that the Ethernet connection uses the user-specified Ethernet settings. If desired, set the **Direct** and/or **Modem** connection settings to the user-specified values.

5.4 Ethernet PC, HUB, or LAN connections

This section provides information on how to connect the Daniel 3410 Series Gas Ultrasonic Flow Meter for communication using Ethernet directly to a PC, to a PC via an Ethernet hub, or to a LAN via an Ethernet hub.

5.4.1 Direct connection from a Mark III to a PC

When connecting a Daniel 3410 Series Gas Ultrasonic Flow Meter directly to a personal computer (PC), an Ethernet adapter cable (Daniel P/N 3-3400-079) is required.

Plug the Mark III Ethernet adapter cable Phoenix end into the meter Field Connection Board connector J8 and connect the RJ-45 end into the PC Ethernet connector.

Using Daniel MeterLink on the PC, either modify an existing meter directory record for the meter (such as from initial communication set-up) or create a new meter directory record for the meter. Modify the record's Ethernet parameters to the user-configured values.

5.4.2 Connect a Mark III to a PC via an Ethernet hub

When connecting a Daniel 3410 Series Gas Ultrasonic Flow Meter to a PC via an Ethernet hub, refer to the wiring diagram (see Appendix I, drawing DE-21056) for instructions on wiring the Daniel Mark III Ultrasonic Gas Flow Meter Ethernet connector to one of the Ethernet hub ports.

Plug one end of a straight-through patch cable into another of the hub ports and the other end into the PC Ethernet connector.

NOTICE

The Ethernet adapter cable (Daniel P/N 3-3400-079) is specifically for connecting the Daniel 3410 Series Gas Ultrasonic Flow Meter to a PC Ethernet connector. It cannot be used to connect the meter to an Ethernet hub.

NOTICE

Do not connect either the Daniel 3410 Series Gas Ultrasonic Flow Meter or the PC to the hub UPLINK port. Also, most hubs do not allow use of the port immediately next to the hub UPLINK port when the UPLINK port is used to connect the hub to a LAN.

Using Daniel MeterLink on the PC connected to a LAN, either modify an existing meter directory record for the meter (such as from initial communication set-up) or create a new meter directory record for the meter. Modify the record's Ethernet parameters to the user-configured values.

5.4.3 Connect a Mark III Meter to a LAN via an Ethernet Hub

When connecting a Daniel 3410 Series Gas Ultrasonic Flow Meter to a LAN via an Ethernet hub, refer to the wiring diagram (see Appendix I, drawing DE-21056) for on wiring instructions the Daniel Mark III Ultrasonic Gas Flow Meter Ethernet connector to one of the Ethernet hub ports.

NOTICE

The Ethernet adapter cable (Daniel P/N 3-3400-079) is specifically for connecting the Daniel 3410 Series Gas Ultrasonic Flow Meter to a PC Ethernet connector. It cannot be used to connect the meter to an Ethernet hub.

NOTICE

Do not connect the Series 100 Option Board to the hub UPLINK port. Also, most hubs do not allow use of the port immediately next to the hub UPLINK port when the UPLINK port is used to connect the hub to a LAN.

Plug one end of the straight-through patch cable (from the LAN) into the hub UPLINK port.

Using Daniel MeterLink on the PC, either modify an existing meter directory record for the meter (such as from initial communication set-up) or create a new meter directory record for the meter. Modify the record's Ethernet parameters to the user-configured values.

5.5 Serial port connections using RS-232 serial cable

Serial port configurations

NOTICE

Serial Port A is usually reserved for connection to an external flow computer or RTU. Serial Port B is usually reserved for connection to a device, such as a personal computer, that can be used to perform meter diagnostics, meter configuration, and other tasks not requiring dedicated connection. Serial Port C, provided by the Series 100 Plus Option Board, can be used for connection to a flow computer/RTU.

For serial port communications, configure the data points listed in the table below using Daniel MeterLink **Meter|Communications Settings** menu path. Note that only Port A offers RTS/CTS handshaking. All ports (when in slave mode) provide automatic protocol detection for the following protocols:

- ASCII Modbus (7 data bits, even or odd parity, 1 stop bit)
- RTU Modbus (8 data bits, no parity, 1 stop bit)
- TCP/IP

Table 5-4 Data Points for serial ports configuration

Daniel MeterLink Display Name	Data Points, Options and Guidelines
Comms Address	Data points affected: • ModbusIDPortA • ModbusIDPortB • ModbusIDPortC Options: • Enter a value (integer) within the range [1,247]
Baud rate	Data points affected: • BaudPortA • BaudPortB • BaudPortC Options: • 1200 • 2400 • 9600 • 19200 • 38400 • 57600 • 115200
Response delay	Data points affected: • CommRspDlyPortA • CommRspDlyPortB • CommRspDlyPortC Options: • Enter an integer value (milliseconds) within the range [0,100]
RTS on delay	Data points affected: • RTSOnDelayPortA Options: • Enter an integer value (milliseconds) within the range [0,1000]
RTS off delay	Data points affected: • RTSOffDelayPortA Options: • Enter an integer value (milliseconds) within the range [0,1000]
RTS/CTS flow ctrl	Data points affected: • **IsHWFlowControlEnabledPortA** Options: • Disable (FALSE) • Enable (TRUE)

5.5.1 RS-232 serial connection setup

NOTICE

These instructions involve setting Mark III switches. Refer to Section 3.4 for further information on switch settings.

Refer to Appendix D for communication troubleshooting information.

RS-232 serial initial connection material checklist

To complete the steps in the subsections that follow, obtain the following materials and information:

- Ultrasonic serial cable (Daniel P/N 3-2500-401)
- Wiring Diagram (Daniel drawing DE-21056 Appendix I)
- Personal computer (PC) with Daniel MeterLink software installed (version 3.0 or higher)
- Desired Mark III meter(s) communication configuration parameters:
  - IP address (if desired)
  - Serial communication parameters such as baud rate and Modbus ID

RS-232 serial initial connection steps

1. Power up the Mark III meter and the PC.
2. Plug the DB-9 end of the cable directly into the PC running Daniel MeterLink. The three wires on the other end of the cable connect to J7 (FTB) for Port B. The Digital Out wire goes to J7-Pin 1, the Digital In wire goes to J7-Pin 2, and the COMMON wire goes to J7-Pin 3.
3. Start the Daniel MeterLink program on the PC and create a new meter directory record with the following parameters:
   a. Select **Meter Type** as Mark III.
   b. Check the **Direct** box and uncheck the **Modem** and **Ethernet** boxes.
   c. Set the Direct connection properties for **Baud Rate** of 19200 and **Comms Address** (Modbus ID) of 32.

4. Configure the Mark III Port B for RS-232 operation by setting the CPU board and Field Connection board switches as indicated in the table below (see Figure 3-24 for switch bank locations):

Table 5-5 Serial Port B RS-232 Configuration Switch Settings

Board	Switch	Position
CPU	S4-1	RS232
	S4-2	RS232
	S5-2	FULL
	S7-1	RS232
	S7-2	RS232
Field Connection	S1-5	TERM OFF
	S1-6	TERM 0FF
	S1-7	FULL DUPLX
	S1-8	FULL DUPLX

5. Override the Mark III Serial Port B parameters to 19200 baud and Modbus ID 32 by setting CPU Board switch S2-1 to the CLOSED position (down toward the board) (or toggle the switch S2-1 if already in the CLOSED position).

NOTICE

Note that Serial Port B remains in the override mode until either (1) the port configuration is changed (via software), (2) two minutes has elapsed (at which time the port reverts to its current configuration), or (3) CPU Board switch S2-1 is changed back to the OPEN position.

6. From Daniel MeterLink **Connect to Meter** window, click the **Direct** button to connect to the meter record established above. Daniel MeterLink will now connect to the meter with the user-specified serial communication settings.
7. Configure the Mark III meter with the desired communication parameters via the Daniel MeterLink **Communication Settings** window.
8. Disconnect Daniel MeterLink from the Mark III meter.
9. Disable the Port B override by setting CPU Board switch S2-1 to the OPEN position (up away from the board).

NOTICE

At this point, the Mark III meter will only communicate at the user-configured settings

In Daniel MeterLink, edit the meter directory record established above so that the **Direct** connection uses the user-specified serial communication settings. If desired, set the **Modem** and/or optional **Ethernet** connection settings to the user-specified values.

5.5.2 RS-485 serial connection setup

NOTICE

These instructions involve setting Daniel 3410 Series Ultrasonic Gas Flow Meter switches. Refer to Section 3.5 for further information on switch settings.

Refer to Appendix C for communication troubleshooting information.

RS-485 serial initial connection material checklist

To complete the steps in the subsections that follow, obtain the following materials and information:

- Ultrasonic serial cable (Daniel P/N 3-2500-401)
- Wiring Diagram (Daniel drawing DE-21056 see Appendix I)
- Personal computer (PC) with Daniel MeterLink software installed (version 4.10 or higher)
- Desired Liquid Ultrasonic Meter communication configuration parameters:
  - IP address (if desired)
  - serial communication parameters such as baud rate and Modbus ID

RS-485 serial initial connection steps

1. Power up the Daniel Mark III Ultrasonic Gas Flow Meter meter and the PC.
2. Plug the DB-9 end of the cable directly into the PC running Daniel MeterLink. The three wires on the other end of the cable connect to J7 (Field Connection Board) for Port B. The Digital Out wire goes to J7-Pin1, the Digital In wire goes to J7-Pin2, and the COMMON wire goes to J7-Pin3.
3. Run Daniel MeterLink on the PC and create a new meter directory record with the following parameters:
   a. Select **Meter Type** as Mark III.
4. Check the **Direct** box and uncheck the **Modem** and **Ethernet** boxes.
5. Click the **Direct** button and set the Direct connection properties for **Baud Rate** of 19200 and **Comms Address** (Modbus ID) of 32.
6. Configure the Mark III Port A for RS-485 operation use the following instructions.
   a. To configure Port A for RS-485 **Full Duplex operation**, set the CPU board and Field Connection board switches as indicated in the table below (see Figure 3-24 for switch bank locations):

Table 5-6 Serial Port A RS-485 Full duplex configuration switch settings

Board	Switch	Position	
CPU	S3-1	RS485	
	S3-2	RS485	
	S3-3	RS485	
	S3-4	RS485	
	S5-1	FULL	
	S6-1	RS485	
	S6-2	RS485	
Field Connection		Termination ON	Termination OFF
	S1-1	TERM ON (RX)	TERM OFF (RX)
	S1-2	TERM ON (TX)	TERM OFF (TX)
	S1-3	FULL DUPLX	
	S1-4	FULL DUPLX	

b. To configure Port A for RS-485 **Half Duplex operation**, set the CPU board and Field Connection board switches as indicated in the table below (see Figure 3-24 for switch bank locations):

Table 5-7 Serial Port A RS-485 half duplex configuration switch settings

Board	Switch	Position	
CPU	S3-1	RS485	
	S3-2	RS485	
	S3-3	RS485	
	S3-4	RS485	
	S5-1	HALF	
	S6-1	RS485	
	S6-2	RS485	
Field Connection		Termination ON	Termination OFF
	S1-1	TERM ON	TERM OFF
	S1-2	TERM OFF	TERM OFF
	S1-3	HALF DUPLX	
	S1-4	HALF DUPLX	

NOTICE

Termination should only be enabled if the meter is the last drop in a multi-drop configuration or the only meter in a single-drop configuration.

c. To configure Port B for RS-485 **Full Duplex operation**, set the switches as indicated in the table below (see Figure 3-24 for switch bank locations):

Table 5-8 Serial Port B RS-485 full duplex configuration switch settings

Board	Switch	Position	
CPU	S4-1	RS485	
	S4-2	RS485	
	S5-2	FULL	
	S7-1	RS485	
	S7-2	RS485	
Field Connection		Termination On	Termination Off
	S1-5	TERM ON (RX)	TERM OFF (RX)
	S1-6	TERM ON (TX)	TERM OFF (TX)
	S1-7	FULL DUPLX	NA
	S1-8	FULL DUPLX	NA

d. To configure Port B for RS-485 **Half Duplex operation**, set the CPU board and Field Connection board switches as indicated in the table below (see Figure 3-24 for switch bank locations):

Table 5-9 Serial Port B RS-485 half duplex configuration switch settings

Board	Switch	Position	
CPU	S4-1	RS485	
	S4-2	RS485	
	S5-2	HALF	
	S7-1	RS485	
	S7-2	RS485	
Field Connection		Termination On	Termination Off
	S1-5	TERM ON	TERM OFF
	S1-6	TERM OFF	TERM OFF
	S1-7	HALF DUPLX	
	S1-8	HALF DUPLX	

NOTICE

Termination should only be enabled if the meter is the last drop in a multi-drop configuration or the only meter in a single-drop configuration.

7. Override the Mark III Serial Port B parameters to 19200 baud and Modbus ID 32 by setting CPU Board switch S2-1 to the CLOSED position (down toward the board) (or toggle the switch S2-1 if already in the CLOSED position).

NOTICE

Serial Port B remains in the override mode until either (1) the port configuration is changed (via software), (2) two minutes have elapsed at which time the port reverts to its current configuration), or (3) CPU Board switch S2-1 is changed back to the OPEN position.

8. From Daniel MeterLink **Connect to Meter** window, click the **Direct** button to connect to the meter record established above. Daniel MeterLink connects to the meter with the user-specified serial communication settings.
9. After connecting to the meter, configure the Mark III with the desired communication parameters via the Daniel MeterLink **Meter>Communications Settings m**enu path.
10. Disconnect Daniel MeterLink from the Mark III meter.
11. Disable the Port B override by setting CPU Board switch S2-1 to the OPEN position (up away from the board).

NOTICE

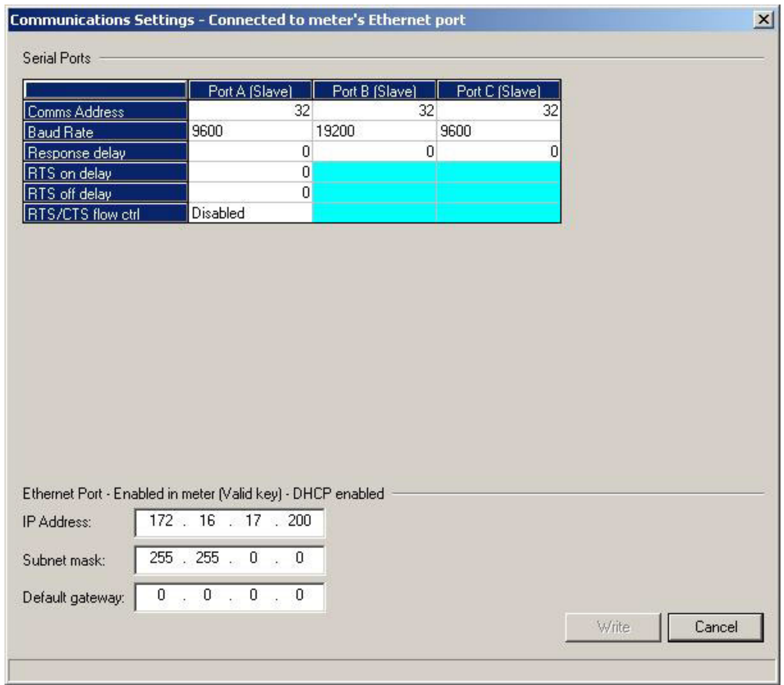
At this point, the Daniel 3410 Series Ultrasonic Gas Flow Meter will only communicate at the user-configured settings.

12. In Daniel MeterLink, edit the meter directory record established above so that the **Direct** connection uses the user-specified serial communication settings. If desired, set the **Modem** and/or optional **Ethernet** connection settings to the user-specified values.

5.5.3 Writing changes while connected to the meter

To configure a communications port on the flow meter that is connected (currently in-use) use the **Meter>Communications Settings** menu path. The Communications Settings Connected to meter's Ethernet port dialog displays.

Figure 5-5 Writing Ethernet port communications settings



The dialog identifies the following:

- Former and new communications parameters for the port

The dialog also offers these options for writing configuration changes to the flow meter, then reconnecting:

- Update meter directory record with these settings and reconnect
- Create new meter directory record with these settings and reconnect
- Disconnect from meter after writing changes

5.6 Meter configuration setup wizard

NOTICE

Configuration protection must be disabled when configuring a Mark III meter, such as via the Daniel MeterLink Field Setup Wizard. See Section 3.5.8 and Section 5.6 for further information on configuration protection.

NOTICE

If you are configuring the Mark III flow meter through the use of Modbus communications, see guidelines in this section about configuration, but also see Section 5.8.

NOTICE

If you are upgrading a Mark II meter to a Mark III meter, refer to Appendix C for instructions on converting a Mark II configuration file for use in a Mark III.

5.6.1 Daniel MeterLink meter configuration overview

The Field Setup Wizard allows you to enter site specific information into the meter and is only available while connected to a meter. It is designed to be used once during initial startup of the meter to enter information unique to the meter's installation. It can be used at a later time to change the meter configuration. The Field Setup Wizard is the only way in Daniel MeterLink to change the following parameters:

- Meter units system
- Volumetric flow rate time
- Gage or Absolute Pressure type

Depending on the version of firmware running on the meter, some options may be disabled or unavailable in the Field Setup Wizard if the firmware can not support the option. The Field Setup Wizard provides an overall guide to configuring the Daniel Mark III Ultrasonic Gas Flow Meter.

It identifies the groups of data points that must be configured, along with interrelations and dependencies that should be considered when configuring the meter.

The data displayed in the Field Setup Wizard is from the connected meter. If you use the Field Setup Wizard more than once, you only have to change the properties desired and you will not have to completely reconfigure the meter. Clicking the **Finish** button on the final page of the wizard will write the changes to the meter.

Daniel MeterLink prompts you to save the meter configuration (if configured), under Program Settings.

NOTICE

For Daniel Mark III Ultrasonic Gas Flow Meter meters, the Security switch S2 position 4 on the CPU board must be closed or down towards the board to enable writes to protected configuration registers.

Daniel MeterLink provides context-sensitive help for each screen via the **F1** shortcut key. For help at any time, press the **F1** key and Daniel MeterLink opens a pop-up window with information or detailed instructions about any topic.

This Register Reference help file provides a description of all of the registers in the ultrasonic meter. Table 5-10 gives a description of each topic that can be found for each register.

Table 5-10 Register reference help file

Register Topic	Description
Register Number	This is the internal data point number for the register. This is not the same number as the Modbus register number.
Data Type	This is data type in which the register is stored inside the meter. Examples are UNIT32 is a Unsigned 32-bit Integer and FLOAT32 is a 32-bit floating point register.
Internal Units	This is the units in which the databank is stored internally in the meter. This is not the units read back necessarily with Daniel MeterLink or using Modbus.
Access	Shows if the point is read-only or readable and writable.
Write Protected by Switch	Indicates if this writable register is protected by the write-protect switch inside the meter. Switch S2 position 4 on the CPU board must be closed or down towards the board in order to write to these registers.
Warm Start After Change	Indicates if this writable register requires the meter to be restarted before a change to the register will take effect.
Configuration Register	Indicates if this register is collected when using Daniel MeterLink to collect a configuration.
Minimum Value	This is the minimum value that can be written to this register. The value is in the Internal Units.
Maximum Value	This is the maximum value that can be written to this register. The value is in the Internal Units.
Default Value	This the initial value the register is set to when the meter is first cold started. The value is in the Internal Units. Any value in parentheses indicates the numerical equivalent read or written using Modbus.
Available Selections	These are available selections to which this register can be set. Any values in parentheses indicates the numerical equivalent read or written using Modbus.
Modbus Register Number	The Modbus register number for this databank.
Modbus Register Type	This is the data type in which the register will be returned using Modbus.
Modbus Access Type	This is the access type for the register. RD_ONLY is for read only registers and RD_WR is for registers that can be read or written.
Modbus US Units	This is the units in which the register will be returned using Modbus if the UnitsSystem register is set to U.S. Customary.
Modbus Metric Units	This is the units in which the register will be returned using Modbus if the UnitsSystem register is set to metric.

Following completion of the meter setup, see Section 7 Maintenance and Troubleshooting for information on recording initial meter data.

Conventions used for data points reference

This section identifies the groups of data points that must be configured, along with interrelations and dependencies that should be considered when configuring the meter. This section assumes that the Mark III meter communication parameters have been configured as described in Section 5.3. Therefore, in the discussions that follow, the data points are grouped in the same way they are displayed in Daniel MeterLink screens. Also, the groups of data points are presented in a sequence that is recommended for configuring a new or unconfigured flow meter. References to specific data points, or data point labels, are printed in bold, sans serif type. The following data point labels are examples:

- **BaudPortA**
- **EnablePressureInput**

NOTICE

Data points labels are used extensively in Daniel MeterLink online and printed reports, such as Edit/Compare Configuration.

Also in the sections that follow, references to *options* for each of the data points are printed as they are displayed in Daniel MeterLink, along with the actual values or the data type (e.g., string, integer) or units of measurement (e.g., Kelvin, meters) that may be associated with the data point. The actual values, data type, or units of measurement are printed in parentheses. The following are example data point *options* for
InputPressureUnit:

- Gage (FALSE)
- Absolute (TRUE)

In the above example, Gage and Absolute are the data point options displayed in Daniel MeterLink (in a dropdown list). The actual values associated with the data point are FALSE and TRUE, respectively, as shown in the parentheses.

5.6.2 Configuration protection

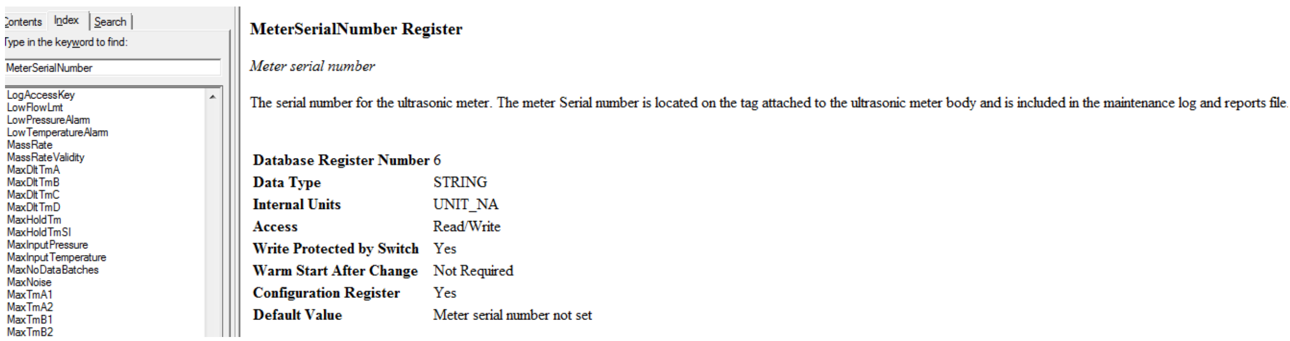
The Mark III meter provides configuration protection which is a means of protecting the firmware and certain configuration data points from changing. The configuration protection is enabled/disabled via a CPU Board switch as described in Section 3.5.8. Also see Appendix E.

In general, the data points that are protected by configuration protection fall within these groups:

- Meter identification
- Units system
- Operational (i.e., transducers control, etc.)
- Meter correction parameters
- Alarm parameters
- AGA8 configuration
- Frequency outputs configuration
- Digital outputs configuration

To determine whether a *particular* data point is write- protected, consult Daniel MeterLink online help. (There is a help topic for each data point, and each topic indicates whether the data point is one that is protected when configuration protection is enabled. From Daniel MeterLink, click on Help, click on Mark III **Registers Reference**, select the Index tab, start typing the data point name until the desired point is highlighted, and then click the Display button.)

Figure 5-6 Write protected registers



5.6.3 Configuration checksum value and date

The Mark III meter maintains a configuration checksum value (**CnfgChksumValue**) and associated date (**CnfgChksumDate**). These values can be used to determine if and when the meter configuration has last changed. In general, the data points included in the configuration checksum consist of the write-protected configuration points and the communication-related configuration points.

To determine whether a *particular* data point is included in the configuration checksum, consult Daniel MeterLink online help. (There is a help topic for each data point, and each topic indicates whether the data point is one that is included in the configuration. From Daniel MeterLink, click on Help, click on Mark III **Registers Reference**, select the **Index** tab, start typing the data point name until the desired point is highlighted, and then click the **Display** button.)

5.6.4 Meter configuration using Daniel MeterLink

The Daniel MeterLink Field Setup Wizard takes you through several pages to configure the ultrasonic flow meter. Selections on the first page may limit which pages you go through. Following is a list of pages in the Field Setup Wizard and the order in which they appear.

To view or edit a configuration in table format, use the Daniel MeterLink **Tools>Edit/Compare Configurations** menu path:

- Startup Page Section 5.6.5
- General Page Section 5.6.6
- Frequency Outputs Page (Series 100 Option Board) Section 5.6.7
- Current Outputs Page Section 5.6.8
- HART® Output Page (Series 100 Plus Option Board) Section 5.6.9
- Meter Digital Outputs Page Section 5.6.10
- Meter Corrections Page Section 5.6.11

- Temperature and Pressure Page Section 5.6.12
- Gas Chromatograph Setup Page Section 5.6.13
- AGA8 Setup Page Section 5.6.14
- Continuous Flow Analysis Page Section 5.6.15
- Update Time Wizard Section 5.7.1

Table 5-11 Daniel MeterLink Field Setup Wizard

Page	Description
Startup See Section 5.6.5	Meter name Enter an alphanumeric name for the meter. When connecting, this name can be used as the filename for logs and reports collected. This field is only available for Daniel Mark III Ultrasonic Gas Flow Meters. Serial # Enter the serial number from the meter body. This will be included in the Inspection Report of Maintenance logs. This field is only available for Daniel Mark III Ultrasonic Gas Flow Meters. Station Name Enter the station name for the meter's location. This is included in the Inspection Report of Maintenance logs. This field is only available for Daniel Mark III Ultrasonic Gas Flow Meters. Address Enter the address for the meter's location. This is included in the Inspection Report of Maintenance logs. This field is only available for Daniel Mark III Ultrasonic Gas Flow Meters. City Enter the city for the meter's location. This is included in the Inspection Report of Maintenance logs. This field is only available for Daniel Mark III Ultrasonic Gas Flow Meters. State and country Enter the state and country for the meter's location. This is included in the Inspection Report of Maintenance logs. This field is only available for Daniel Mark III Ultrasonic Gas Flow Meters. Temperature for meter corrections Temperature is required for flow and for meter internal diameter Temperature expansion correction. If a temperature transmitter is connected to the meter, select Live for this option. If a temperature transmitter is not connected to the meter but either Base condition correction or Temperature expansion correction is required, select Fixed. You will enter in a fixed temperature on a later page. If neither of the corrections is required, select Not used. Pressure for meter corrections Pressure is required for flow and for meter internal diameter Pressure expansion correction. If a pressure transmitter is connected to the meter, select Live for this option. If a pressure transmitter is not connected to the meter but either Base condition correction or Pressure expansion correction is required, select Fixed. You will enter in a fixed pressure on a later page. If neither of the corrections is required, select Not used.

Table 5-11 Daniel MeterLink Field Setup Wizard

Page	Description
General See Section 5.6.6	The General Page contains the following properties. Meter units system: Select the units for Modbus communications. Selects the units for Modbus communications. Available options are U.S. Customary and Metric. These are the units in which the software Field Setup Wizard displays properties. These are also the units with which the meter reports all of its rates and volumes using Modbus communications. The selected units system applies only to registers above 10000 and in the 2000-8999 range, other registers below 10000 are read in metric units only to maintain Mark II compatibility. US customary units is the default setting. Outside of the Field Setup Wizard, Daniel MeterLink always performs the necessary conversions to display values in the units defined under Program Settings. These are also the units with which the meter reports all of its rates and volumes using Modbus communications. Outside of the Field Setup Wizard, Daniel MeterLink always performs the necessary conversions to display values in the units defined under Program Settings. Flow rate time unit: Select the time base for the meter to use for the volumetric flow rate. Volume cut-off threshold: Enter the cut-off threshold. If the average flow velocity for a batch is below this value, the volume accumulated for the batch is set to zero. Contract hour for daily log: Enter the hour at which a daily log record is recorded and the new daily log is started. You can either type in the hour and AM/PM selection or use the Up and Down arrows to select the hour. Meter Time The time displayed is the time from the Ultrasonic Meter. To change the meter time, click Set Time to bring up the Set Time dialog box Notepad Use this as a scratch pad for making notes about the meter or its location. The scratch pad can handle approximately 2000 characters.

Table 5-11 Daniel MeterLink Field Setup Wizard

Page	Description
Frequency Outputs Page Series 100 Option Board See Section 5.6.7	The Frequency Outputs Page with the Series 100 Option Board allows you to configure the frequency outputs. This page is only displayed if either the Frequency outputs was selected on the Startup Page. Properties on this page are individually disabled according to selection made on the Startup Page. • Content: Uncorrected (Actual) flow rate Corrected (Standard) flow rate Average Flow Velocity Average Sound Velocity Energy Rate Mass Rate • Direction: These properties are only enabled if Frequency outputs or Current output was selected on the Startup page. Select from the following options: — **Reverse:** The output only reports flow in the reverse direction. For frequency outputs, Phase B of the output is 90 degrees out of phase with Phase A. — **Forward:** The output only reports flow in the forward direction. For frequency outputs, Phase B of the output is 90 degrees out of phase with Phase A. — **Absolute:** The output reports flow in both directions. For frequency outputs, Phase B of the output is 90 degrees out of phase with Phase A. — **Bidirectional:** The output reports flow on Phase A only in the forward direction and on Phase B only in the reverse direction. • Channel B zero on error: Select this check box if you want Phase B of the frequency output to go to zero while a meter validity alarm is active. Phase A will continue to output as normal. If selected, Phase B will go to zero when the associated output is put into Test mode indicating the meter validity alarm is active. • Channel B phase: Select the option to determine if you would either like Phase B to lag Phase A while reporting forward flow and lead Phase A while reporting reverse flow or if you would like to do the opposite. This selection only matters if the device to which the frequency outputs are connected are configured for Dual Pulse security and phase detection. Else, selecting either will have no effect on totalization. • Maximum frequency for frequency output: Select the maximum frequency for the frequency outputs. Valid options are 1000 Hz and 5000 Hz. For Daniel Mark III Ultrasonic Gas Flow Meters, each frequency output has its own register. This property is disabled if Frequency outputs was cleared on the Startup Page. The Daniel Mark III Ultrasonic Gas Flow Meter will over range up to 7500 Hz.

Table 5-11 Daniel MeterLink Field Setup Wizard

Page	Description
Frequency Outputs Page Series 100 Option Board (continued) See Section 5.6.7	• Volumetric flow The following fields are used to configure the frequency or current outputs selected to output a volumetric flow rate. The fields are only enabled if the associated output's Content is set to Uncorrected (Actual) or Corrected (Standard). • Full scale volumetric flow rate used with output: Enter the flow rate to be equivalent to the maximum frequency of the frequency output. For Daniel Mark III Ultrasonic Gas Flow Meters, each frequency output has its own register. This property is disabled if Frequency outputs was cleared on the Startup Page. • K-factor: A read-only value showing the calculated K-factor from the Full scale volumetric flow rate used with frequency outputs and the Maximum frequency for frequency output. This property is disabled if Frequency outputs was cleared on the Startup Page. • Vol/pulse: A read-only value showing the calculated inverse of the K-factor. This property is disabled if Frequency outputs was cleared on the Startup Page. • Velocity Maximum scale velocity used with output: Enter the velocity to be equivalent to the maximum frequency of the frequency output. These values are only enabled for Daniel Mark III Ultrasonic Gas Flow Meters and if the Content is set to Average flow velocity or Average sound velocity. This property is disabled if Frequency outputs was cleared on the Startup Page. • Minimum scale velocity used with output: Enter the velocity to be equivalent to the minimum frequency (i.e. 0Hz) of the frequency output. These values are only enabled for Daniel Mark III Ultrasonic Gas Flow Meters and if the Content is set to Average flow velocity or Average sound velocity. This property is disabled if Frequency outputs was cleared on the Startup Page.

Table 5-11 Daniel MeterLink Field Setup Wizard

Page	Description
Current Outputs Page	The Current Outputs Page allows you to configure the current outputs. This page is only displayed if the Current outputs was selected on the Startup Page. Properties on this page are individually disabled according to selection made on the Startup Page. • Content: Uncorrected (Actual) flow rate Corrected (Standard) flow rate Average Flow Velocity Average Sound Velocity Energy Rate Mass Rate • Direction: Reverse Forward Absolute • Volumetric flow Full scale volumetric flow rate • Velocity Maximum scale velocity Minimum scale velocity • Energy Rate Full scale energy rate • Mass Rate Full scale mass rate • Alarm action: High -20 mA Low - 4 mA Hold last value Very low- 3.5 mA Very high - 20.5 mA None

Table 5-11 Daniel MeterLink Field Setup Wizard

Page	Description
HART Output Page Series 100 Plus Option Board See Section 5.6.9	The HART Output Page allows you to configure the HART output of the Daniel Ultrasonic meter. This page is only displayed if the HART Output was selected on the Startup Page. If the meter does not support the HART protocol on its analog output, the HART Output selection on the Startup Page will be disabled and this dialog will not be displayed as you go through the Field Setup Wizard. • **Process variables** - These are the four dynamic HART variables which you can configure for the Daniel Ultrasonic meter. The Primary variable is set to match the Content set for Current output 2. If you want a different Primary variable, you will need to go back to the Current Output Page and select a different selection for its Content control for Current output 2. • **Identification** - These are the common variables in HART devices used to identify the particular device. • **Tag** - This is the tag name for the HART device which may be used by host systems to uniquely identify the meter. The tag may be up to 8 characters in length. • **Date** - This is a numeric date value that must be between 0 and 1677215. • **Message** - This is a string value that can be no more than 32 characters in length. • **Descriptor** - This is a string value that can be no more than 16 characters in length. • Final assembly number - This is a numeric value that must be between 0 and 1677215. • **Polling address -** This is the HART address for the meter. By default the meter is 0 but the address can range from 0 to 15. • HART units - These controls allow you to configure the units that values will be read in over the HART interface.
Digital Outputs Page See Section 5.6.10	The Digital Outputs Page allows you to configure the digital outputs for Daniel Mark III Ultrasonic Gas Flow Meter. This page is only displayed if connected to a Daniel 3410 Series Gas Ultrasonic Flow Meter and Digital outputs was selected on the Startup Page. • Content: Select the function for which the digital output should be configured. Available options are validity and direction. • Inverted operation: This option is useful if the output of the ultrasonic meter is reversed from what a flow computer is expecting. Selecting the check box will invert the digital output. This means that if the output normally outputs a HIGH for a TRUE condition, selecting this check box will change the output to output a LOW for a TRUE condition.

Table 5-11 Daniel MeterLink Field Setup Wizard

Page	Description
Temperature and Pressure Page See Section 5.6.12	The Temperature and Pressure Page allows you to set the scaling for analog inputs, enter fixed values, and set alarm limits for both temperature and pressure. This page is only displayed if either temperature or pressure was set to Live or Fixed on the Startup Page.
	• Temperature — Live temperature Enabled if Live was selected for Temperature for meter corrections on the Startup Page. Enter in the scaling for the transmitter connected to the analog input. Min. input is the zero scale temperature of the transmitter (i.e. 1 Volt or 4 mA). Max. input is the full scale temperature of the transmitter (i.e. 5 Volts or 20 mA). — Fixed temperature: Enabled if Fixed was selected for Temperature for meter corrections on the Startup Page. Enter an average temperature of the process fluid.
	• Temperature alarm Enter the low and high alarm limits. A temperature reading outside of these limits causes a Temperature Validity alarm.
	• Pressure — Is pressure gage or absolute Select either Gage or Absolute for the type of pressure reading desired. If a live pressure transmitter is connected, select the type of reading the transmitter outputs. If Absolute is selected, you must also enter the Atmospheric pressure. • Live pressure — Enabled if Live was selected for Pressure for meter corrections on the Startup Page. Enter in the scaling for the transmitter connected to the analog input. Min. input is the zero scale pressure of the transmitter (i.e. 1 Volt or 4 mA). Max. input is the full scale pressure of the transmitter (i.e. 5 Volts or 20 mA). • Fixed pressure — Enabled if Fixed was selected for Pressure for meter corrections on the Startup Page. Enter an average pressure of the process fluid. • Pressure alarm — Enter the low and high alarm limits. A pressure reading outside of these limits causes a Pressure Validity alarm.

Table 5-11 Daniel MeterLink Field Setup Wizard

Page	Description
Gas Chromatograph Setup Page	• Serial Port • GC protocol — ASCII Modbus: 7 data bits, Even parity, and 1 stop bit — RTU Modbus: 8data bits, No parity, and 1 stop bit • GC baud rate • GC comms address • Modbus ID of the GC • GC stream number • GC heating value units • GC heating value type — BTU-Dry — BTU-Saturated — BTU-Actual • Use which gas composition on GC alarm — Last good value — Fixed value
AGA8 Page	AGA8 Calculations: • Internally (by the meter) Enter values for Base temperature and Base pressure • Select Method to be used: — Gross Method 1 — Gross Method 2 — Detail • Use which gas composition: — Fixed — Live GC • Base temperature — Base pressure • Volumetric gross heating value — Volumetric gross heating value ref temperature — Molar density ref temperature — Molar density ref pressure • Externally (by Daniel MeterLink or a flow computer or SCADA system) — Flow mass density — Flow compressibility — Base compressibility
Continuous Flow Analysis Page	• Flow Limits • SOS comparison (requires AGA 8 Detail method to be used) • Liquid detection • Abnormal profile • Blockage • Internal bore buildup

5.6.5 Startup page

In Daniel MeterLink, to begin the meter configuration, use the **Meter|Field Setup Wizard** menu. The **Field Setup Wizard - Startup** page displays first. If your meter has the Series 100 Option Board installed, see Figure 5-7. If your meter has the Series 100 Plus (HART®) Option Board installed, see Figure 5-8.

Figure 5-7 Field Setup Wizard - Startup Page (Series 100 Option Board)

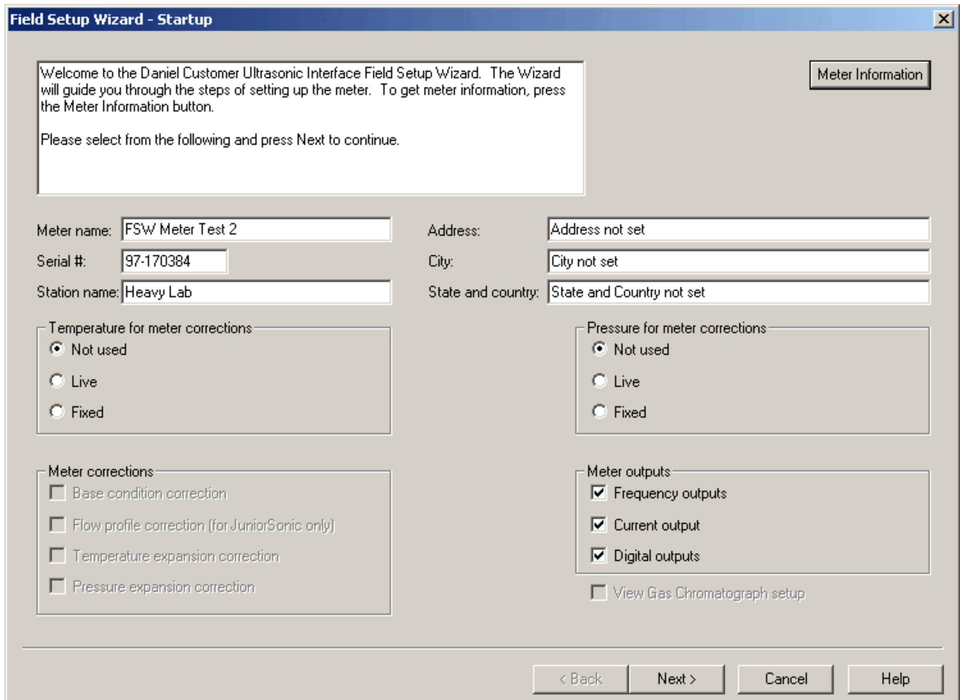
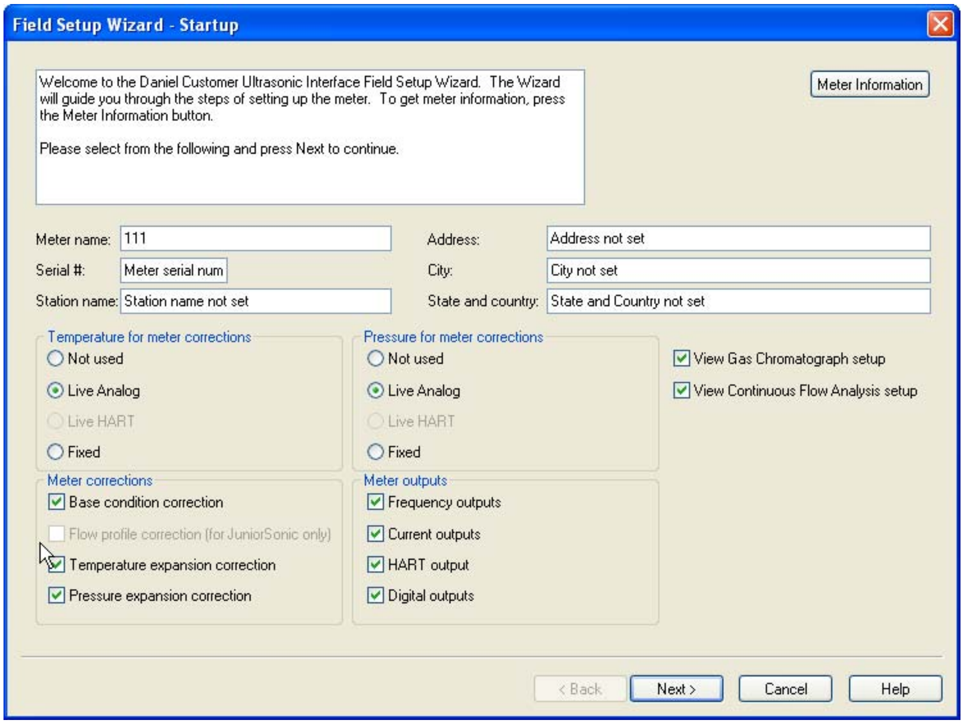


Figure 5-8 Field Setup Wizard - Startup Page (Series 100 Plus Option Board



1. For meter identity on the **Field Startup Page** enter the following:
   - Meter name
   - Serial number
   - Address
   - City
   - State and country
   - Station name
2. Select desired Temperature for Meter Corrections:
   - Not used
   - Live Analog
   - Live HART (grayed out if not supported)
   - Fixed
3. Select desired Pressure for Meter Corrections:
   - Not used

- Live Analog
- Live HART (grayed out if not supported)
- Fixed

NOTICE

Note on Pressure and Temperature for Daniel JuniorSonic Gas Ultrasonic Meters -
The pressure and temperature are required for the meter to calculate a Flow profile correction. If a pressure and temperature transmitter are not connected to the meter, it is recommended to set the pressure and temperature to Fixed and to later enter a fixed pressure and temperature as close as possible to the pressure and temperature of the process gas. Setting pressure and temperature to Not used limits your options for Flow profile correction to a default correction factor or to a Fixed correction factor that you must enter.

NOTICE

The Daniel Mark II Gas Ultrasonic meter does not support Live HART inputs.

4. Click the checkbox(s) to enable or disable the desired Meter Corrections:
   - Base condition correction
   - Flow profile correction (for JuniorSonic® only)
   - Temperature expansion correction:

NOTICE

For Daniel Mark II Gas Ultrasonic meters only, the Temperature expansion correction is only available for DFI boards running version 3.10 or later firmware.

- – Linear expansion coefficient: Enter the linear expansion coefficient of the meter body material
- – Linear expansion coefficient reference temperature: Enter the reference temperature for the Linear expansion coefficient.
- – Pressure expansion correction:

- Pressure expansion correction: Only enabled if Live or Fixed was selected for Pressure for meter corrections and Pressure expansion correction was selected on the Startup Page.
  - Pipe outside diameter: Enter the outside diameter of the meter body.
  - Youngs modulus: Enter the Young's Modulus value (ratio of tensile stress to tensile strain)
  - Poissons ratio: Enter the Poisson's Ratio value (the absolute ratio of the pipe material lateral strain over axial strain)

NOTICE

For Daniel Mark II Gas Ultrasonic meters only, the Pressure expansion correction is only available for DFI boards running version 3.10 or later firmware.

Table 5-12 Enabling Meter Corrections

Daniel MeterLink Display Name	Data Points, Options and Guidelines
Base condition correction	Data points affected: • None (enables/disabled access to other Daniel MeterLink configuration screens, data fields) Options: • Disabled if unchecked • Enabled if checked Guidelines: • This selection enables/disables access to other Daniel MeterLink configuration screens and/or data fields. • For options and guidelines, see Daniel MeterLink online help.
Flow profile correction (for JuniorSonic™ only)	Data points affected: • None (enables/disables access to other Daniel MeterLink configuration screens, data fields) Options: • Disabled if unchecked • Enabled if checked Guidelines: • For options and guidelines, see Daniel MeterLink online help.
Temperature expansion correction	Data points affected: • EnableExpCorrTemp Options: • Disable (FALSE) • Enable (TRUE) Guidelines: • For options and guidelines, see Daniel MeterLink online help.

Table 5-12 Enabling Meter Corrections

Daniel MeterLink Display Name	Data Points, Options and Guidelines
Pressure expansion correction	Data points affected: • EnableExpCorrPress Options: • Disable (FALSE) • Enable (TRUE) Guidelines: • For options and guidelines, see Daniel MeterLink online help.

To enable / identify the source of temperature / pressure for meter corrections, configure these data points listed in the table below (requires the Option Board):

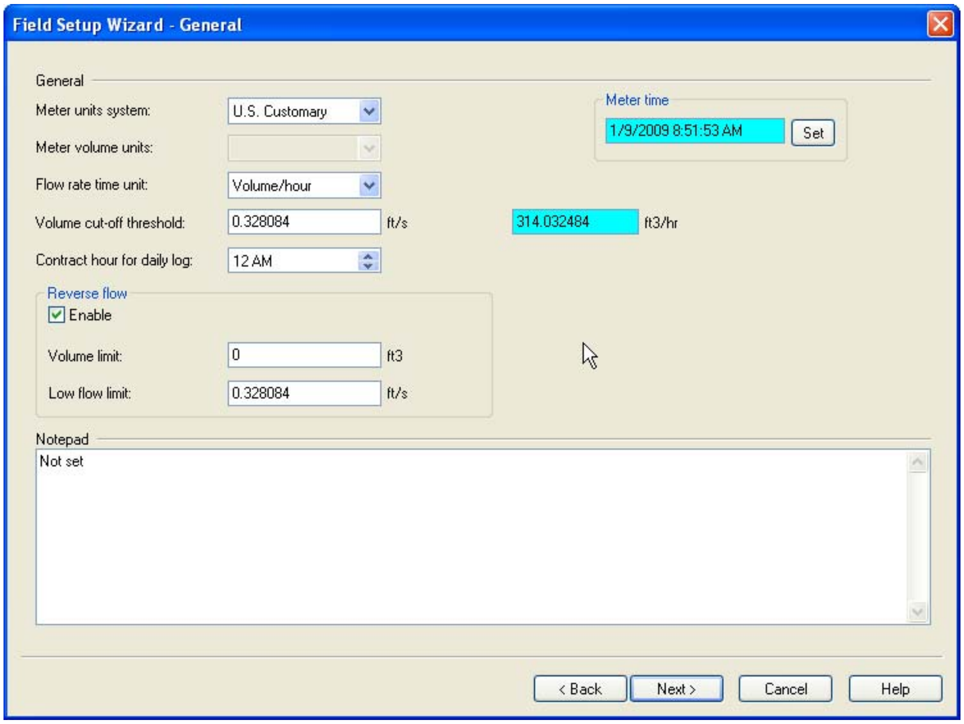
Table 5-13 Enable Temperature/Pressure Meter Corrections Data Points, Source

Daniel MeterLink Display Name	Data Points, Options and Guidelines
Temperature for meter corrections	Data points affected: - EnableTemperatureInput Options: • Not used (0) • Live (1) (only available with the Option Board) • Fixed (2) Guidelines: • For options and guidelines, see Daniel MeterLink online help.
Pressure for meter corrections	Data points affected: - EnablePressureInput Options: • Not used (0) • Live (1) (only available with the Option Board) • Fixed (2) Guidelines: • For options and guidelines, see Daniel MeterLink online help.

5. Click the checkbox(s) to enable or disable the desired Meter Outputs:
   - Frequency outputs
   - Current outputs
   - HART® outputs (if the Series 100 Plus Option Board is installed)
   - Digital outputs
6. Click the checkbox(s) to enable or disable:
   - View Gas Chromatograph Setup
   - View Continuous Flow Analysis
7. Click the **Next** button to continue the meter configuration. Daniel MeterLink displays the **Field Setup - General Page.**

5.6.6 General Page

Figure 5-9 Field Setup Wizard - General Page



1. From the **General Page**, choose the desired settings:
   - Meter units system (U.S. Customary or Metric)
   - Meter time (click the Set Time button to display the Set Time dialog box)
2. To set the meter real-time clock, configure these data points for meter time (listed in the table below):

Table 5-14 Data Points for Meter Real-Time Clock

Daniel MeterLink Display Name	Data Points, Options and Guidelines
Meter Time	Data points affected: • **RTCSecondsSinceEpochSet** Options: • Click the **SET TIME** button to bring up the **SET TIME** dialog box for setting the meter clock. Guidelines: • For options and guidelines, see Daniel MeterLink online help.

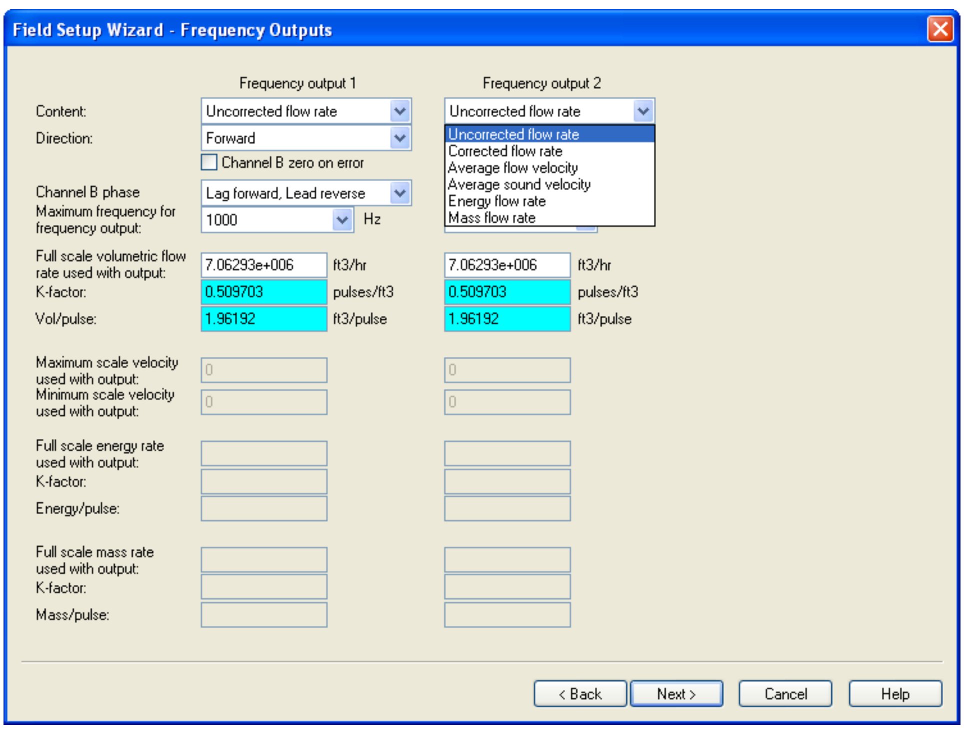
- Flow rate time unit:
  - Volume/second
  - Volume/hour
  - Volume/day
- Volume cut-off threshold

- Contract hour for daily log
- Reverse flow: Select to Enable configure the meter to generate a reverse flow alarm if it accumulates more volume in the reverse direction than what is set in the Volume limit. For flow to be counted as reverse flow for this check, it must be flowing at a velocity about the Low flow limit. This low flow limit is different from the Volume cut-off threshold below which flow in not counted as flow for volume accumulation. Every time the flow direction changes from forward to reverse, the reverse flow accumulated volume is reset to zero. If the meter is a bi-directional meter, this alarm should not be enabled in order to avoid this alarm becoming active during periods of expected reverse flow.

3. Enter additional information as desired in the Notepad field.
4. Click the **Next** button to continue the meter configuration. Daniel MeterLink displays the **Field Setup Wizard - Frequency Outputs Page.**

5.6.7 Frequency Outputs Page

Figure 5-10 Field Setup Wizard - Meter Frequency Outputs Page

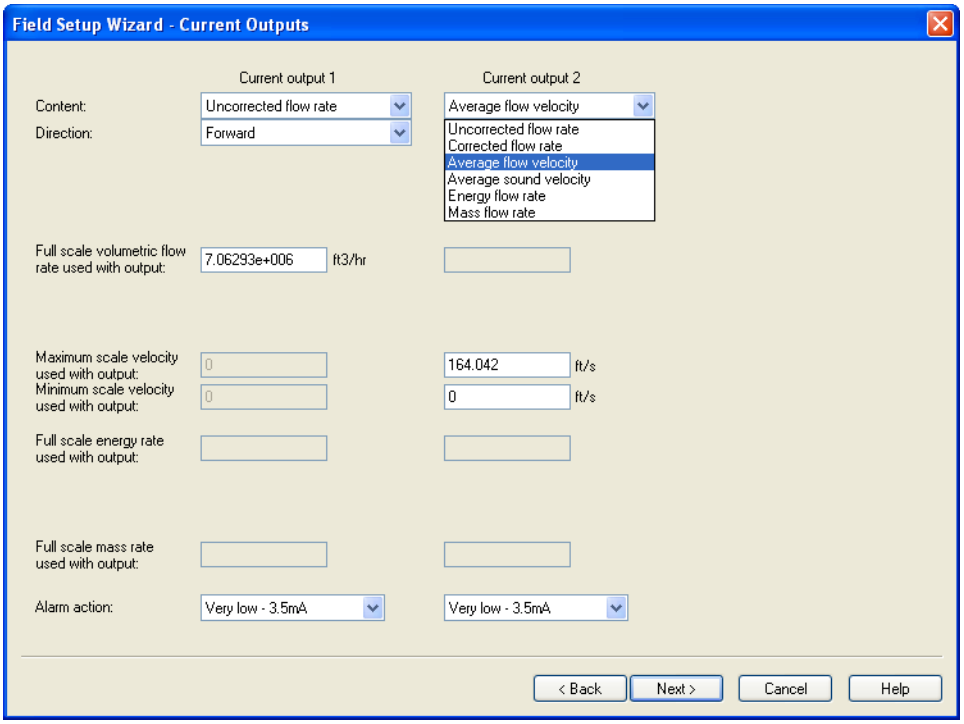


1. From the **Frequency Outputs Page**, choose the desired settings (Refer to Section 6.2.1 for a detailed discussion on configuring the frequency outputs.)
   - Content:
     - Frequency output 1
     - Frequency output 2
   - Options:
     - Actual flow rate (Uncorrected), Standard flow rate (Corrected), Average flow velocity, Average sound velocity, Energy rate, or Mass rate
     - Direction:
       Reverse, Forward, Absolute, or Bidirectional
   - Channel B zero on error Options:
     - unchecked - Not Forced to Zero When Invalid (FALSE) checked - Force to Zero When Invalid (TRUE) This option controls whether the frequency channel B output is zeroed when the frequency content is invalid.
   - Channel B phase:
     - Options: Lag Fwd, Lead Rev, Lead Fwd, Lag Rev
       Guidelines: This option determines the frequency channel B phase relative to the corresponding channel A phase depending upon the flow direction.
   - Maximum frequency for frequency output:
     - Options: 1000 Hz (1000) 5000 Hz (5000)
   - Full scale volumetric flow rate used with output:
     - Options: Enter a flow rate value (m^3/hr or ft^3/hr)
       Guidelines: This option specifies the volumetric flow rate associated with the maximum frequency (discussed above) and with the maximum frequency determines the frequency's K-factor.
   - K-factor: (see Appendix A)
     - Freq1KFactor
     - freq2KFactor

     Options: Non-configurable, calculated value (pulses/m^3 or pulses/ft^3)
   - Vol/pulse:
     - Freq1InvKFactor
     - Freq2InvKFactor
     - Options: Non-configurable, calculated value (m^3/pulse or ft^3/pulse)

5.6.8 Current Outputs Page

Figure 5-11 Field Setup Wizard - Meter Current Outputs Page



1. From the **Current Outputs Page**, choose the desired settings:
   - Content:
     – Current output 1
     Current output 2
     Options: Actual flow rate (Uncorrected), Standard flow rate (Corrected), Average flow velocity, Average sound velocity, Energy rate, or Mass rate (Energy rate or Mass rate available if selected on Frequency outputs page)
   - Direction:
     – Reverse
     – Forward
     – Absolute
   - Full scale volumetric flow rate used with output:
     – Options: US Customary - ft^3/sec.,hr, day or Metric - m^3/sec.,hr, day
   - Alarm Action:
     – High - 20 mA
     – Low - 4 mA
     – Hold Last Value
     – Very Low - 3.5 mA
     – Very High - 20.5 mA
     – None

Table 5-15 Data Points for Analog (Current) Output Configuration

Daniel MeterLink Display Name	Data Points, Options and Guidelines
Content: Series 100 Option Board Series 100 Plus Option Board (if installed)	Data points affected: • AO1Content • AO2Content Options: • Uncorrected (Actual) flow rate (0) • Standard (corrected) flow rate (1) • Average flow velocity (2) • Average sound velocity (3) • Energy rate (4) • Mass rate (5) Guidelines: • For options and guidelines, see Section 6.2.1 and Daniel MeterLink online help.
Direction: Series 100 Option Board Series 100 Plus Option Board (if installed)	Data points affected: • AO1Dir • AO2Dir Options: • Reverse (0) • Forward (1) • Absolute (2) Guidelines: • For options and guidelines, see Section 6.2.1 and Daniel MeterLink online help.
Full scale volumetric flow rate: Series 100 Option Board Series 100 Plus Option Board (if installed)	Data points affected: • AO1FullScaleVolFlowRate • AO2FullScaleVolFlowRate Options: • Enter a flow rate value (m^3/hour or ft^3/hour) Guidelines: • This point is only used when the current (analog) output content is either the actual (uncorrected) or standard (corrected) flow rate. • This point specifies the volumetric flow rate associated with the maximum current (20 mA). • For options and guidelines, see Section 6.2.1 and Daniel MeterLink online help.

Table 5-15 Data Points for Analog (Current) Output Configuration

Daniel MeterLink Display Name	**Data Points, Options and Guidelines**
Maximum scale velocity: Series 100 Option Board Series 100 Plus Option Board (if installed)	Data points affected: • AO1MaxVel • AO2MaxVel Options: • Enter a velocity value (m/sec or ft/sec) Guidelines • This point is only used when the analog output content is either the average flow or sound velocity. • This point specifies the (flow or sound) velocity associated with the maximum current (20 mA). • For options and guidelines, see Section 6.2.3 and Daniel MeterLink online help.
Minimum scale velocity: Series 100 Option Board Series 100 Plus Option Board (if installed)	Data points affected: • AO1MinVel • AO2MinVel Options: • Enter a velocity value (m/sec or ft/sec) Guidelines • This point is only used when the analog output content is either the average flow or sound velocity. • This point specifies the (flow or sound) velocity associated with the minimum current (4 mA). • For options and guidelines, see Section 6.2.3 and Daniel MeterLink online help.
Full scale energy rate: Series 100 Option Board Series 100 Plus Option Board (if installed)	Data points affected: • AO1FullScaleEnergyRate • AO2FullScaleEnergyRate Options: • Enter an energy rate (MJ/hr or MMBTU/hr) Guidelines • This point is only used when the analog output content is energy rate. • This point specifies the energy rate associated with the maximum current (20 mA). • For options and guidelines, see Section 6.2.3 and Daniel MeterLink online help.

Table 5-15 Data Points for Analog (Current) Output Configuration

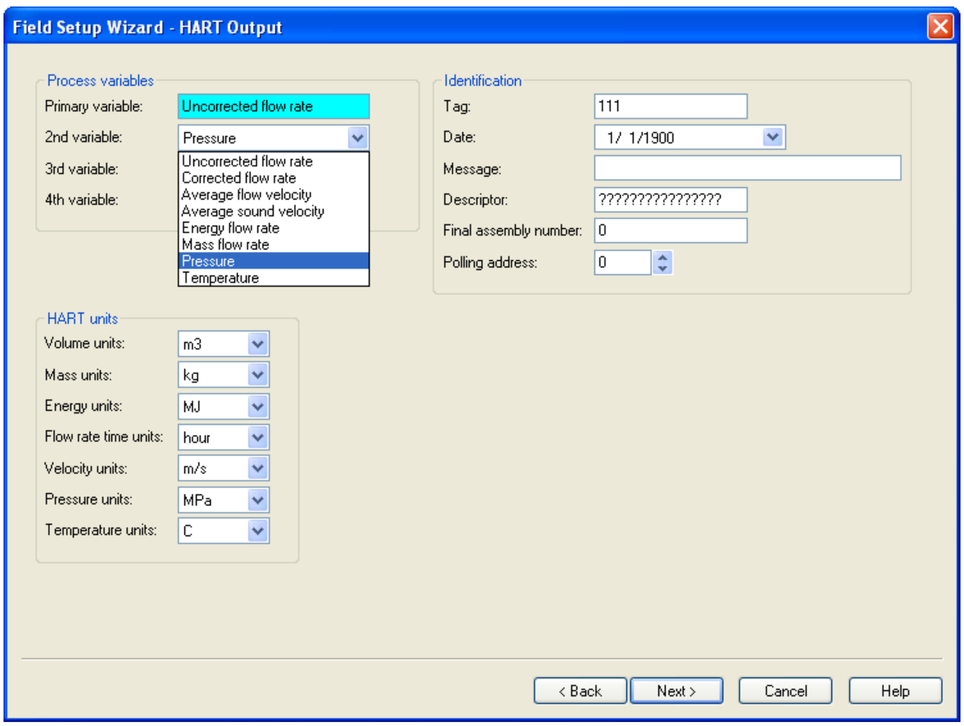
Daniel MeterLink Display Name	Data Points, Options and Guidelines
Full scale mass rate: Series 100 Option Board Series 100 Plus Option Board (if installed)	Data points affected: • AO1FullScaleMassRate • AO2FullScaleMassRate Options: • Enter a mass rate (kg/hr or lbm/hr) Guidelines • This point is only used when the analog output content is mass rate. • This point specifies the mass rate associated with the maximum current (20 mA). • For options and guidelines, see Section 6.2.3 and Daniel MeterLink online help.
Alarm Action: Series 100 Option Board Series 100 Plus Option Board (if installed)	• AO1ActionUponInvalidContent • AO2ActionUponInvalidContent Options: • High (0) • Low (1) • Hold Last Value (239) • Very Low - 3.5 mA (240) • Very High - 20.5 mA (241) • None (251)

5.6.9 HART® Output Page

The HART® Output Page allows you to configure the HART® output of the Daniel Ultrasonic meter. This page is only displayed if the HART® Output was selected on the **Startup Page**. If the meter does not support the HART® protocol on its analog output, the HART® Output selection on the Startup Page will be disabled and this dialog will not be displayed as you go through the Field Setup Wizard.

If the Series 100 Plus Option Board is installed and you selected the HART® Output on the Startup Page, Daniel MeterLink displays the **Field Setup Wizard - HART Output Page.**

Figure 5-12 Field Setup Wizard - HART Output Page (Series 100 Plus Option Board)



1. From the **HART Output Page**, choose the desired settings (Refer to Daniel P/N 3-9000-754 *HART® Field Device Specification Guide: Daniel Gas Ultrasonic Meter* manual for a detailed discussion on configuring the HART® outputs.) The manual is available on the Daniel website:

http://www2.emersonprocess.com/en-US/brands/daniel/Flow/ultrasonics/Pages/Ultrasonic.aspx

Process variables are the four dynamic HART variables which you can configure for the Daniel Ultrasonic Gas meter. The Primary variable is set to match the Content set for **Current Output 2**. If you want a different Primary variable, you will need to go back to the **Current Output Page** and choose a different selection for its Content control for **Current Output 2**.

a. Process Variable:
   - Primary variable
   - 2nd variable
   - 3rd variable
   - 4th variable

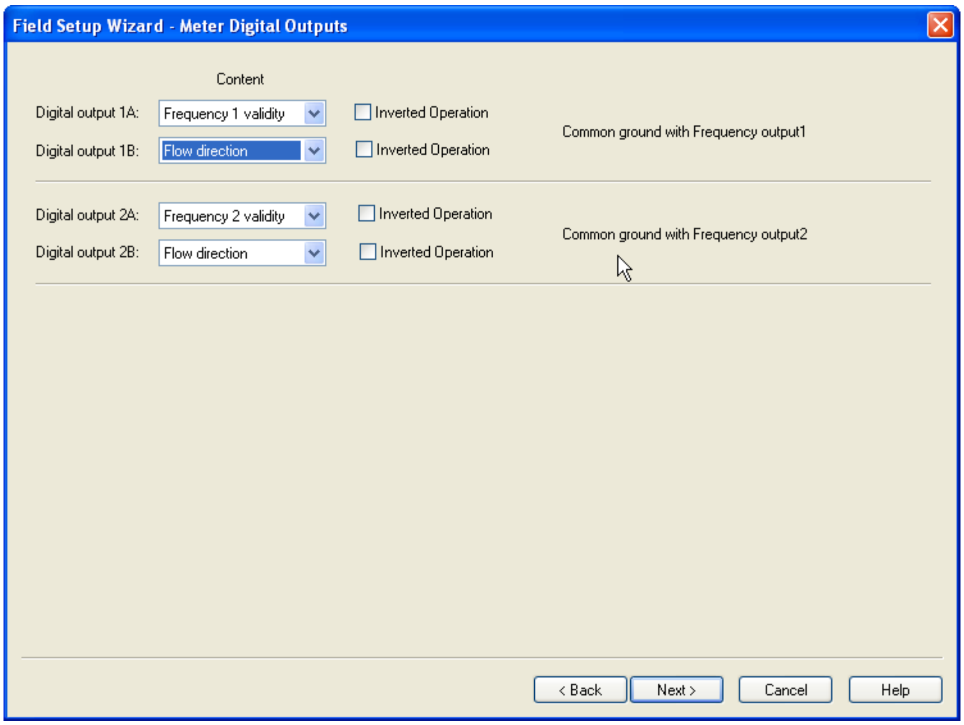
b. Options: Uncorrected (Actual) flow rate, Corrected flow rate, Average flow velocity, or Average sound velocity, Energy rate, Mass rate, Pressure rate, or Temperature rate
   - Identification: Tag -
   - Date -
   - Message -
   - Descriptor -
   - Final assembly number -
   - Polling address -

c. HART® units:
   - Volume units -
   - Flow rate time units -
   - Velocity units -
   - Pressure units -
   - Temperature units -

2. Click the **Next** button to continue the meter configuration. Daniel MeterLink displays the **Field Setup Wizard - Meter Digital Outputs Page.**

5.6.10 Meter Digital outputs

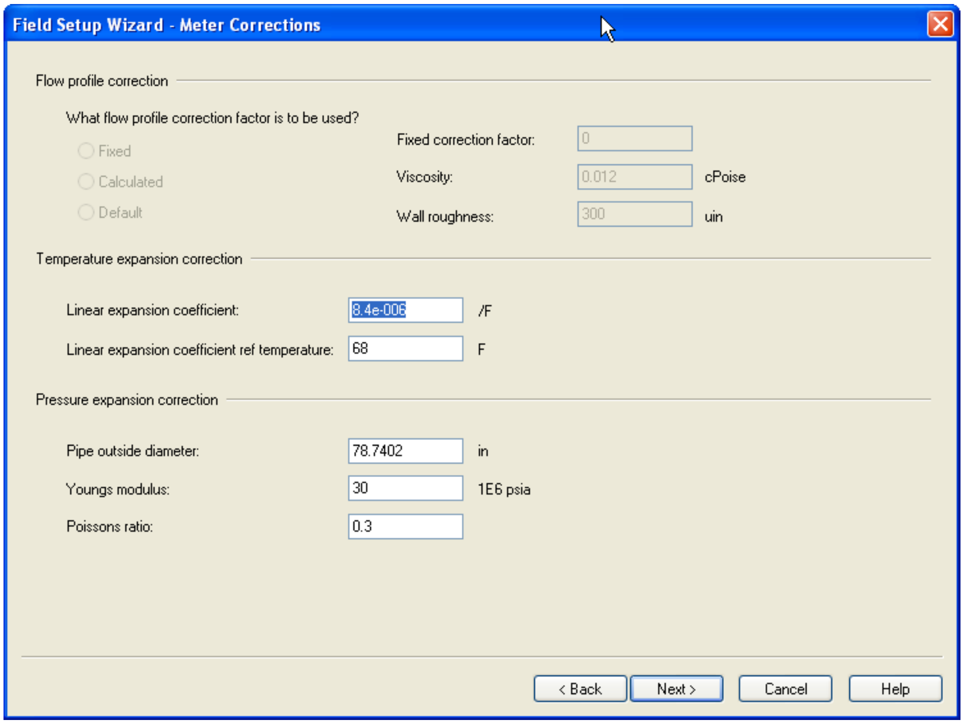
Figure 5-13 Field Setup Wizard - Digital Outputs Page



1. From the **Field Setup Wizard - Meter Digital Outputs Page**, choose the desired settings:
   a. Digital output group 1A, 1B, 2A, and 2B
      – For DO1AContent, choose Freq1 Validity (0) or Flow Direction (2)
      – For DO1BContent, choose Freq1 Validity (0) or Flow Direction (2)
      – For DO2AContent, choose Freq2 Validity (1) or Flow Direction (2)
      – For DO2BContent, choose Freq2 Validity (1) or Flow Direction (2)
      – For additional guidelines, see Section 5.6.7 and Daniel MeterLink online help.
   b. Inverted Operation (for any or all of the four digital outputs)
      For **DO1AContent**, choose Freq1 Validity (0) or Flow Direction (2)
      – DO1AIsInvPolarity
      – DO1BIsInvPolarity
      – DO2AIsInvPolarity
      – DO2BIsInvPolarity unchecked - Normal (FALSE) checked - Inverted (TRUE)
      These data points allow the digital outputs polarity to be inverted from the normal (described in Section 5.6.7).
2. Click the **Next** button to continue the meter configuration. Daniel MeterLink displays the **Field Setup Wizard - Meter Corrections Page.**

5.6.11 Meter Corrections page

Figure 5-14 Field Setup Wizard - Meter Corrections page



1. From the **Field Setup Wizard - Meter Corrections Page**, choose the desired settings:
   a. Flow profile correction - Only enabled for Daniel JuniorSonic® Ultrasonic Gas Flow Meters and if Flow profile correction (for JuniorSonic® only) was selected on the Startup Page.
   b. Flow profile correction factor is to be used - If Live or Fixed was selected for both temperature and pressure on the Startup Page, then you can choose from Calculated or Fixed for a correction factor. Selecting Fixed requires you to enter a value from 0.9 to 1.0 for Fixed correction factor. If Not used was selected for either temperature or pressure on the Startup Page, then you can choose from Fixed or Default for a correction factor. Calculated will be disabled. Selecting Fixed requires you to enter a value from 0.9 to 1.0 for Fixed correction factor. The default value is 0.95.

      For Daniel Mark II Ultrasonic Gas Flow Meters only, the Fixed option is only available for DFI boards running version 3.72 or later firmware.

NOTICE

Daniel CUI version 4.21 is the final version that supports Daniel Mark II Gas Ultrasonic meters. If you are communicating with a Daniel Ultrasonic Mark II Gas Flow Meter, you do not need to uninstall version 4.21 or earlier versions of Daniel CUI before installing MeterLink. Version 4.21 and earlier versions of Daniel CUI should not be run simultaneously with MeterLink.

c. Temperature expansion correction - Only enabled if Live or Fixed was selected for Temperature for meter corrections and Temperature expansion correction was selected on the Startup Page.

d. Linear expansion coefficient: Enter the linear expansion coefficient of the meter body material.

e. Linear expansion coefficient reference temperature: Enter the reference temperature for the Linear expansion coefficient.

   For Daniel Mark II Ultrasonic Gas Flow Meters only, the Temperature expansion correction is only available for DFI boards running version 3.10 or later firmware. See the Notice above regarding support for Mark II Gas Ultrasonic Flow Meters.

f. Pressure expansion correction - Only enabled if Live or Fixed was selected for Pressure for meter corrections and Pressure expansion correction was selected on the Startup Page.

g. Pipe outside diameter: Enter the outside diameter of the meter body.

h. Youngs modulus: Enter the Young's Modulus value (ratio of tensile stress to tensile strain)

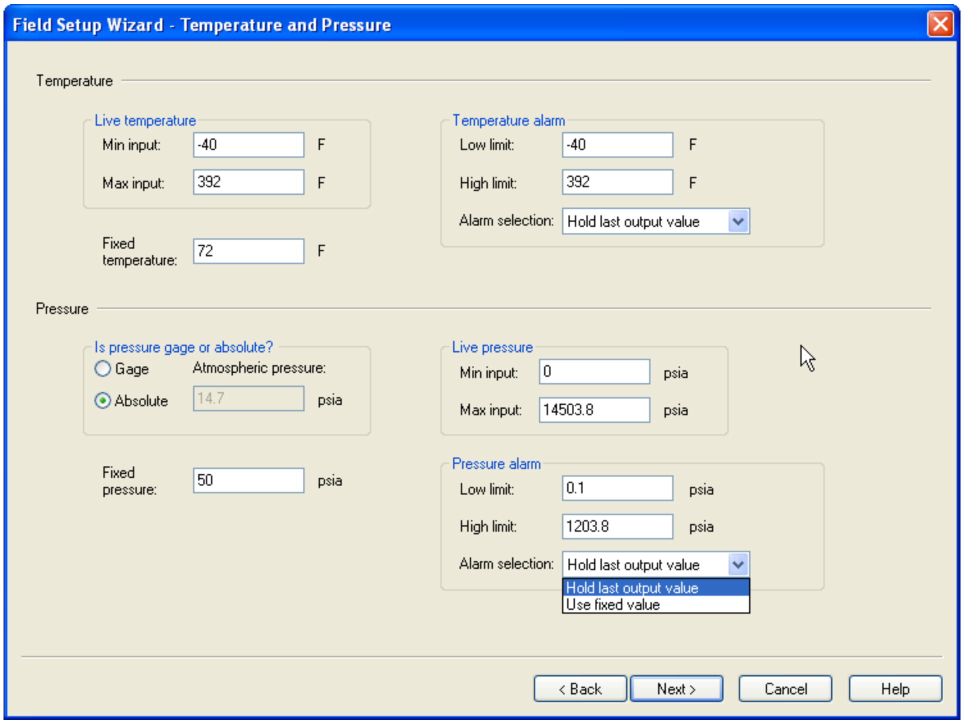
i. Poissons ratio: Enter the Poisson's Ratio value (the absolute ratio of the pipe material lateral strain over axial strain)

   For Daniel Mark II Ultrasonic Gas Flow Meters only, the Pressure expansion correction is only available for DFI boards running version 3.10 or later firmware.

2. Click the **Next** button to continue the meter configuration. Daniel MeterLink displays the **Field Setup Wizard - Temperature and Pressure Page.**

5.6.12 Temperature and Pressure page

Figure 5-15 Daniel MeterLink Field Setup Wizard - Temperature and Pressure Page



The **Field Setup Wizard - Temperature and Pressure Page** is only displayed if the temperature and/or pressure is **Live** or **Fixed** (as selected in the earlier **Field Setup Wizard - Startup** page, see Section 5.6.5).

1. To configure the **Live Temperature**, plus associated alarms, choose the settings listed in the table below):

Table 5-16 Live Temperature Inputs

Daniel MeterLink Display Name	Options and Guidelines
Live temperature, Min input	• Enter the temperature (°C or °F) that corresponds to a 4 mA input signal. The temperature must be within the range [-273.15 °C, 200 °C].
Live temperature, Max input	• Enter the temperature (°C or °F) that corresponds to a 20 mA input signal. The temperature must be within the range [-273.15 °C, 200 °C].
Temperature alarm, Low limit	• Enter a value (°C or °F) within the range [-130 °C, 200 °C]. An alarm is generated when the temperature is at or below this limit value.
Temperature alarm, High limit	• Enter a value (°C or °F) within the range [-130 °C, 200 °C]. An alarm is generated when the temperature is at or above this limit value.
Alarm Selection	• The Alarm selection determines what value to use while a live input is in alarm. This value is common with the pressure Alarm selection so when one is changed, the other will change to match. • Choose Last good value or Fixed value

2. If Fixed was selected for **Temperature for meter corrections** on the Startup Page, enter an average temperature of the process fluid:

Table 5-17 Fixed Temperature Inputs

Daniel MeterLink Display Name	Options and Guidelines
Fixed temperature	• Enter the flow-condition temperature (°C or °F) within the range [-130 °C, 200 °C]
Temperature alarm, Low limit	• Enter a value (°C or °F) within the range [-130 °C, 200 °C]. An alarm is generated when the temperature is at or below this limit value.
Temperature alarm, High limit	• Enter a value (°C or °F) within the range [-130 °C, 200 °C]. An alarm is generated when the temperature is at or above this limit value.
Alarm Selection	• The Alarm selection determines what value to use while a live input is in alarm. This value is common with the pressure Alarm selection so when one is changed, the other will change to match. • Choose Last good value or Fixed value

3. To configure **Live Pressure**, plus associated alarms, choose the setting listed in the table below):

Table 5-18 Live Pressure Inputs

Daniel MeterLink Display Name	Options and Guidelines
Is pressure gage or absolute?	• Gage (FALSE) • Absolute (TRUE)
Atmospheric pressure	• Enter a value (KPaa or psia) within the range [30.0, 108.40 KPaa] • This data point is only applicable when the input pressure unit is specified as gage.
Live pressure, Min input	• Enter the pressure (KPag or psig if gage, KPaa or psia if absolute) that corresponds to a 4 mA input signal. The pressure must be within the range [0, 280e3 KPag or KPaa].
Live pressure, Max input	• Enter the pressure (KPag or psig if gage, KPaa or psia if absolute) that corresponds to a 20 mA input signal. The pressure must be within the range [0, 280e3 KPag or KPaa].
Pressure alarm, Low limit	• Enter a value (KPag or psig if gage, KPaa or psia if absolute) within the range [0, 280e3 KPag or KPaa]. An alarm is generated when the pressure is at or below this limit value.
Pressure alarm, High limit	• Enter a value (KPag or psig if gage, KPaa or psia if absolute) within the range [0, 280e3 KPag or KPaa]. An alarm is generated when the pressure is at or above this limit value.
Alarm Selection	• The Alarm selection determines what value to use while a live input is in alarm. This value is common with the pressure Alarm selection so when one is changed, the other will change to match. • Choose Last good value or Fixed value

4. To configure the fixed pressure, plus associated alarms, choose the settings listed in the table below):

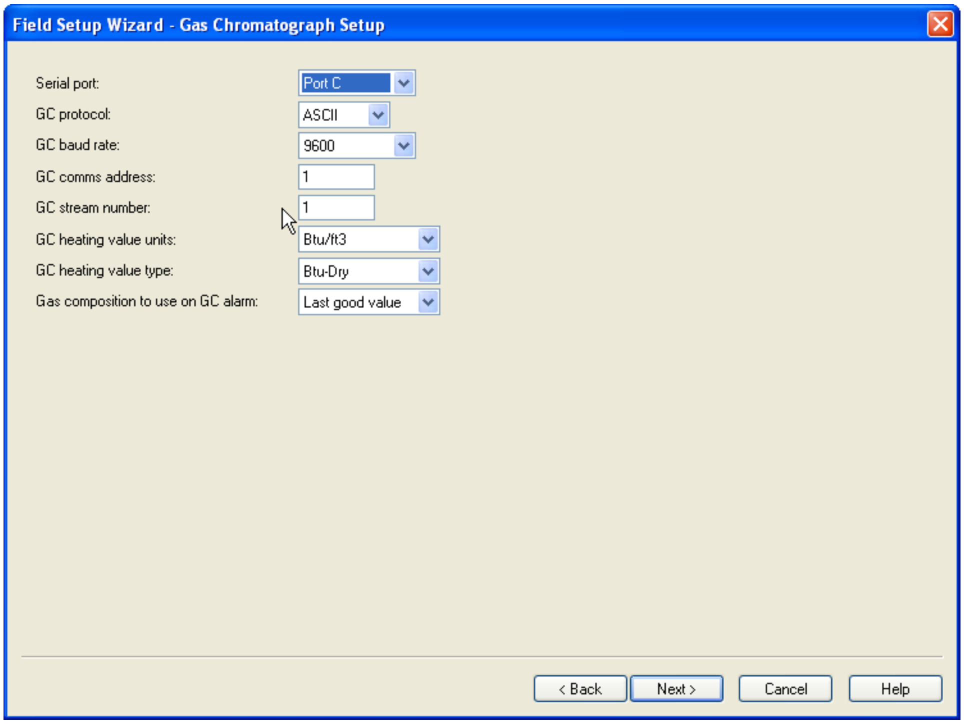
Table 5-19 Fixed Pressure Inputs

Daniel MeterLink Display Name	Options and Guidelines
Is pressure gage or absolute?	• Gage (FALSE) • Absolute (TRUE) • For additional guidelines, see Appendix C.4.10 and Daniel MeterLink online help.
Atmospheric pressure	• Enter a value (KPaa or psia) within the range [30.0, 108.40 KPaa] • This data point is only applicable when the input pressure unit is specified as gage.
Fixed pressure	• Enter the flow-condition pressure (KPag or psig if gage, KPaa or psia if absolute) within the range [0, 280e3 KPag or KPaa].
Pressure alarm, Low limit	• Enter a value (KPag or psig if gage, KPaa or psia if absolute) within the range [0, 280e3 KPag or KPaa]. An alarm is generated when the pressure is at or below this limit value.
Pressure alarm, High limit	• Enter a value (KPag or psig if gage, KPaa or psia if absolute) within the range [0, 280e3 KPag or KPaa]. An alarm is generated when the pressure is at or above this limit value.
Alarm Selection	• The Alarm selection determines what value to use while a live input is in alarm. This value is common with the pressure Alarm selection so when one is changed, the other will change to match. • Choose Last good value or Fixed value

5. Click the **Next** button and Daniel MeterLink displays the **Field Setup Wizard - Gas Chromatograph Setup page**.

5.6.13 Gas Chromatograph Setup page

Figure 5-16 Field Setup Wizard - Gas Chromatograph Setup page



The **Live gas composition from GC** check box is only available if the optional GC interface feature is enabled on the **Field Setup Wizard - Startup Page**, a Series 100 Option Board (or Series 100 Plus Option Board) is installed and a you have a valid **GCKey** (see Section 430).

1. From the **Field Setup Wizard - Gas Chromatograph Page**, choose the desired settings:
   a. Serial Port: Select which serial port will be connected to the GC. While the port is configured for communications to a GC, it will not act as a Modbus slave device for communications from Daniel MeterLink or a SCADA system.
   b. GC protocol: Select the protocol for which the GC is configured. The Mark III uses 7 data bits, Even parity, and 1 stop bit for ASCII Modbus and 8 data bits, No parity, and 1 stop bit for RTU Modbus.
   c. GC baud rate: Select the baud rate for which the GC is configured.
   d. GC comms address: Enter the Modbus ID of the GC.
   e. GC stream number: Enter the stream number for the gas composition the Daniel Mark III Gas Ultrasonic meter will read.
   f. GC heating value units: Select the units for which the heating value is configured in the GC.
   g. GC heating value type: Select the type of heating value the GC will return.

h. Use which gas composition on GC alarm: Select which gas composition the Daniel Mark III Gas Ultrasonic meter will use if the GC goes into alarm.

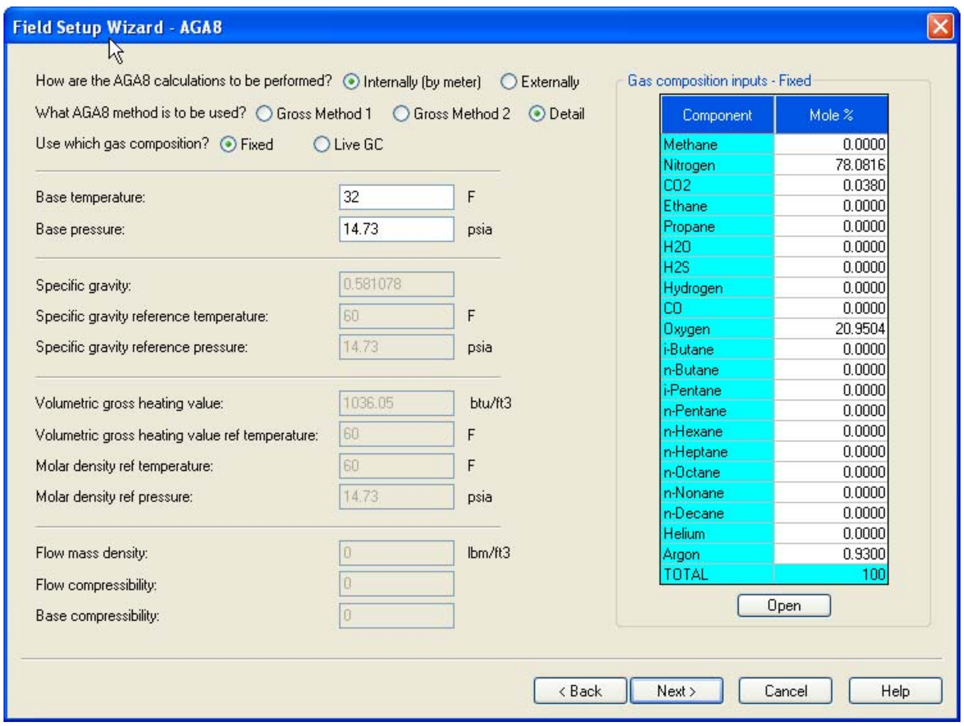
If Fixed value is selected, the meter will start using the fixed gas composition stored in the meter.

If Last good value is selected, the meter will use the last gas composition collected from the GC before the GC started to report alarms.

2. Click the **Next** button to continue the meter configuration. Daniel MeterLink displays the **Field Setup Wizard - AGA-8 Page.**

5.6.14 AGA 8 Setup page

Figure 5-17 Field Setup Wizard - AGA8 Setup page



The **Field Setup Wizard - AGA8** page is only displayed if both temperature and pressure are set to **Live** or **Fixed** and **Base condition correction** is selected in the earlier **Field Setup Wizard - Startup** page (see Section 5.6.5). Configuring AGA8 parameters is necessary for obtaining the desired AGA8 flow-condition compressibility calculation results and for optionally calculating the sound velocity (using AGA10 calculations).

1. From the **Field Setup Wizard - AGA 8 Page**, choose the desired settings:
   - AGA8 calculations to be performed:
     - Internally (by meter)
       - Base temperature
       - Base pressure
       - Base absolute pressure
     - Externally
       - Fixed
       - Live

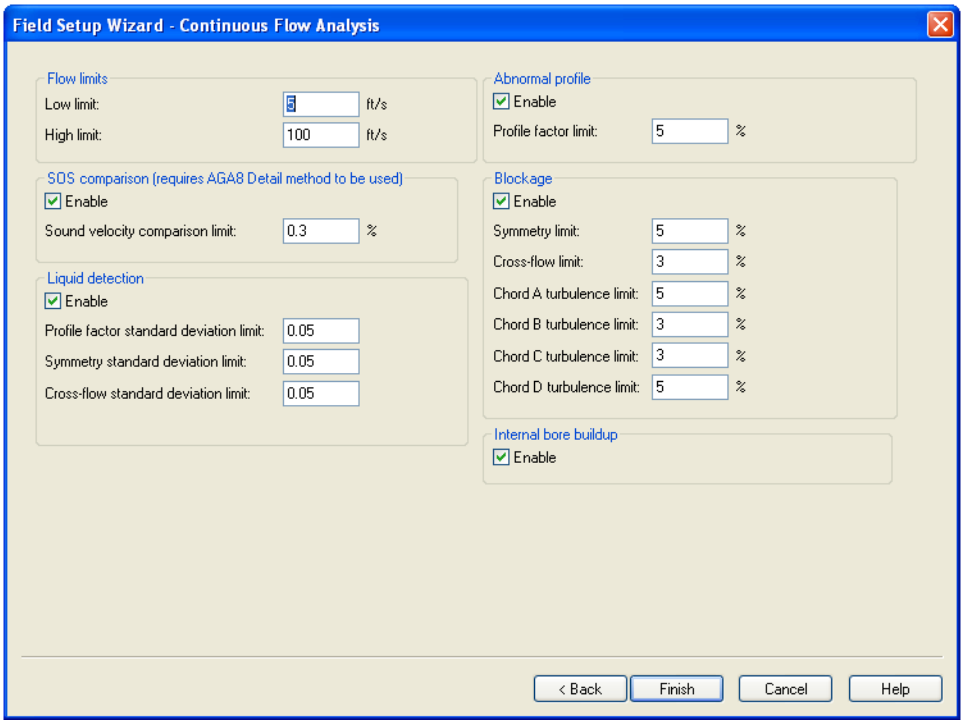
Table 5-20 Field Setup Wizard - AGA 8 Setup

AGA8 method	Configuration Parameters
Gross Method 1	Specific gravity: Relative density; used as input to the AGA8 Gross Methods 1 and 2 calculations • Reference temperature - for the specific gravity • Reference pressure - for specific gravity • CO2 - Mole percentage CO2 in the natural gas mixture • Hydrogen - Mole percentage of hydrogen • CO - Mole percentage of carbon monoxide Volumetric gross heating • Molar density ref temperature: Reference temperature for the molar density; used as input to the AGA8 Gross Method 1 calculation • Molar density ref pressure: Reference pressure for the molar density; used as input to the AGA8 Gross Method 1 calculation
Gross Method 2	Specific gravity: Relative density; used as input to the AGA8 Gross Methods 1 and 2 calculations • Reference temperature - for the specific gravity • Reference pressure - for the specific gravity • CO2 - Mole percentage CO2 in the natural gas mixture • Hydrogen - Mole percentage of hydrogen • CO - Mole percentage of carbon monoxide • Nitrogen - Mole percentage of nitrogen in the natural gas mixture (AGA8 Gross Method 2 calculation)
AGA8 method	**Configuration Parameters**
Detail	Enter the amount of each of the 21 gas components as a percentage. This option is only available in Mark III meters • Gas composition - Select either the Fixed or Live GC. — Fixed: Select this option to use the fixed gas composition stored in the meter for all calculations for which they are required. — Live GC: Select this option to use a gas composition collected by the meter from a gas chromatograph for all calculations for which they are required. This option is only available for Mark III meters with a valid GCKey
Externally	• Select if AGA8 calculations are done externally. The calculated values must then be written to the meter using Daniel MeterLink or a flow computer. The following properties must be entered. If a flow computer or SCADA system is used to write these values to the meter, they do not have to be entered at this time. — Flow mass density — Flow compressibility — Base compressibility
Note: Mark II meters - Externally calculating the AGA8 calculations is only available for DFI boards running version 3.40 or later firmware.	

2. Click **Next** and Daniel MeterLink displays the **Field Setup Wizard - Continuous Flow Analysis Page.**

5.6.15 Continuous Flow Analysis page

Figure 5-18 Field Setup Wizard - Continuous Flow Analysis



The Continuous Flow Analysis Page allows you to configure the Continuous Flow Analysis features of the Daniel Ultrasonic meter. This page is only displayed if the View Continuous Flow Analysis setup was selected on the Startup Page.

1. From the **Field Setup Wizard - Continuous Flow Analysis Page**, choose the desired settings:

   — Flow Limits - The low and high flow velocity limits defines the velocity range in which the Continuous Flow Analysis features are active. If the meter is flowing outside this range, the Continuous Flow Analysis features will not generate alarms. This is because the meter's flow characteristics can change significantly at these extremes.

   — SOS comparison (requires AGA 8 Detail method to be used) - The SOS Comparison analysis compares the meter average speed of sound to the AGA 10 calculated speed of sound. If the % difference between these two values is more than the Sound velocity comparison limit over an hourly average, the alarm will become active. Enable is used to enable or disable this alarm. This feature will be disabled if the meter does not support this functionality.

   — Liquid detection - Liquid detection identifies when liquids may be present in the bottom of the meter run base on the meter's flow characteristics. Standard deviation limits can be configured to adjust the operation of this function if necessary but it is recommended to consult with a Daniel service representative before making any changes. Enable is used to enable or disable this alarm. This feature will be disabled if the meter does not support this functionality.

   — Abnormal profile - Abnormal profile identifies if the meter flow profile has shifted from the original baseline profile of the meter. This check is performed on an hourly average of the meter's flow characteristics and will be set or cleared on an hourly basis. The limit can be configured to adjust the operation of this function if necessary but it is recommended to consult with a Daniel service representative before making any changes. This feature requires that the meter baseline be set using the **Tools]|Set Baseline Wizard**. Enable is used to enable or disable this alarm. This feature will be disabled if the meter does not support this functionality.

   — Blockage - Blockage identifies a possible blockage of an upstream flow conditioner. This check is performed on an hourly average of the meter's flow characteristics and will be set or cleared on an hourly basis. Limits can be configured to adjust the operation of this function if necessary but it is recommended to consult with a Daniel service representative before making any changes. This feature requires that the meter baseline be set using the **Tools|Set Baseline Wizard**. Enable is used to enable or disable this alarm. This feature will not be disabled if the meter does not support this functionality.

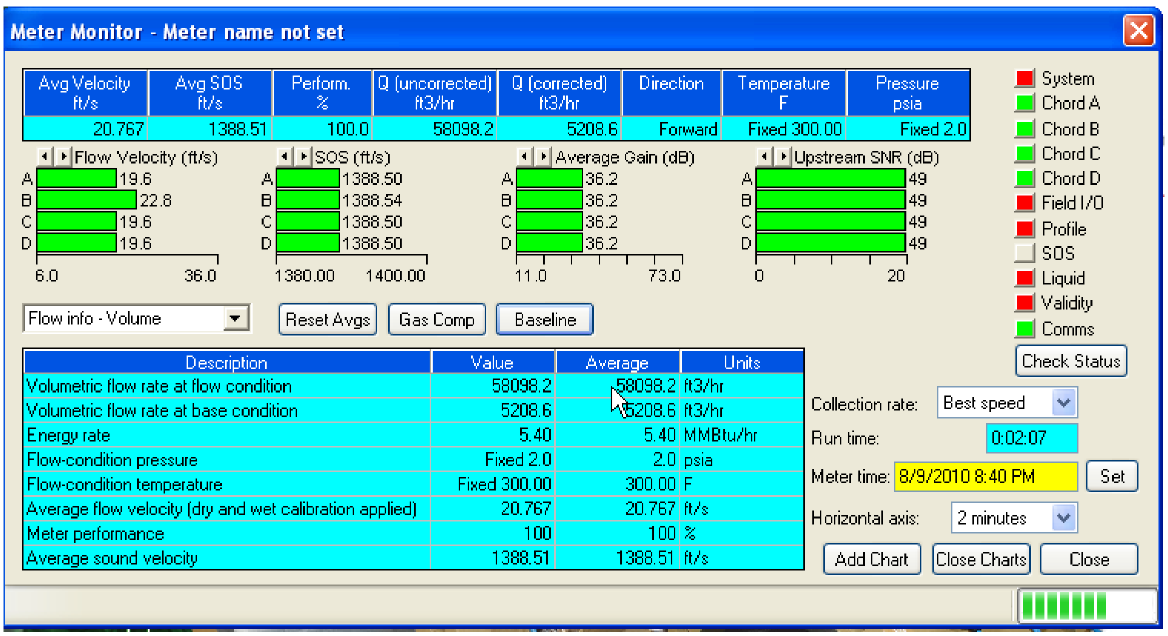
   — Internal bore buildup - Internal bore buildup indicates that the flow characteristics have changed indicating a build up on the internal bore of the meter. The function is checked on a daily basis using the daily logs to identify a long term trend. This feature requires that the meter baseline be set using the **Tools]Set Baseline Wizard**. Enable is used to enable or disable this alarm. This feature will be disabled if the meter does not support this functionality.

2. Click the **Finish** button to write the changes to the meter.

5.6.16 Set Baseline Wizard

Use the **Tools|Set Baseline Wizard** command in Daniel MeterLink 5 to configure the baseline options (see Table 5-1). The Baseline Viewer is used to view the meter's flow characteristics including: Flow Velocity, Profile Factor, Swirl Angle, Symmetry, Cross-flow, and Path Turbulences. This dialog is available from the Monitor screen when a valid Continuous Flow Analysis key is entered in the Key Manager. Select the **Baseline** button on the Meter Monitor page to access the Baseline Viewer.

Figure 5-19 Meter Monitor - Baseline Viewer



5.7 Process parameters and calibration configuration

5.7.1 Update Time Wizard

In Daniel MeterLink, to configure batch cycle processing, or update time parameters, use the **Meter|Update Time** menu. Details about Mark III flow meter batch cycle processing are provided in the “Meter Operation” Section 6.1.3.

Figure 5-20 Daniel MeterLink Update Time Wizard

For controlling how batches are run, configure these data points which are displayed in the Daniel MeterLink **Update Time Wizard** (listed in the table below):

Table 5-21 Data Points for Batch Cycle Processing, or Update Time Control

Daniel MeterLink Display Name	Data Points, Options and Guidelines
Update Rate	Data points affected: • SpecBatchUpdtPeriod Options: • Standard (1000 ms) • Rapid (250 ms) Guidelines: • For additional guidelines, see Section 6.1.3 and Daniel MeterLink online help.
Stack Size	Data points affected: • StackSize Options: • None (1) • 2 (2) • 4 (4) • 8 (8) • 16 (16) Guidelines: • Stacking (i.e., stack size other than None) is only available with the Standard update rate. • For additional guidelines, see Section 6.1.3 and Daniel MeterLink online help.
Filter	Data points affected: • Filter Options: • Off (FALSE) • On (TRUE) Guidelines: • Filtering is only available with the Standard update rate. It is not available with the Rapid update rate. • For additional guidelines, see Section 6.1.3 and Daniel MeterLink online help.

Table 5-21 Data Points for Batch Cycle Processing, or Update Time Control

Daniel MeterLink Display Name	Data Points, Options and Guidelines
Smoothing%	Data points affected: • BatchPercentSmoothing Options: • 0% (0) • 20% (20) • 40% (40) • 60% (60) • 80% (80) Guidelines: • For additional guidelines, see Section 6.1.3 and Daniel MeterLink online help.

5.7.2 Calculated results

The Daniel MeterLink **Update Time Wizard** displays the following meter-calculated values:

- Update time
- Samples/update
- Emission rate
- Stacked Emission rate
- Past samples used
- Total samples used

The samples per update is the average number of new samples (waveforms per transducer) collected during an update period. The past samples used shows how many samples from previous update periods will be used in the current update period. The total samples used is the total of past and new samples used in the current update period. Refer to Section 6.1.3 for further information on these update-time related values.

Beginning with Daniel MeterLink version 3.10, the **Update Time Wizard** also displays the path signal-to-noise ratios (SNRs) and waveforms to facilitate determining if applying stacking and/or filtering improves the signals. Generally, signal improvement is indicated by an increase in the SNR. Note that the SNRs and waveforms are for the parameters currently used by the meter; parameter changes do not take affect until the **Write** button is clicked.

5.7.3 Set calibration parameters

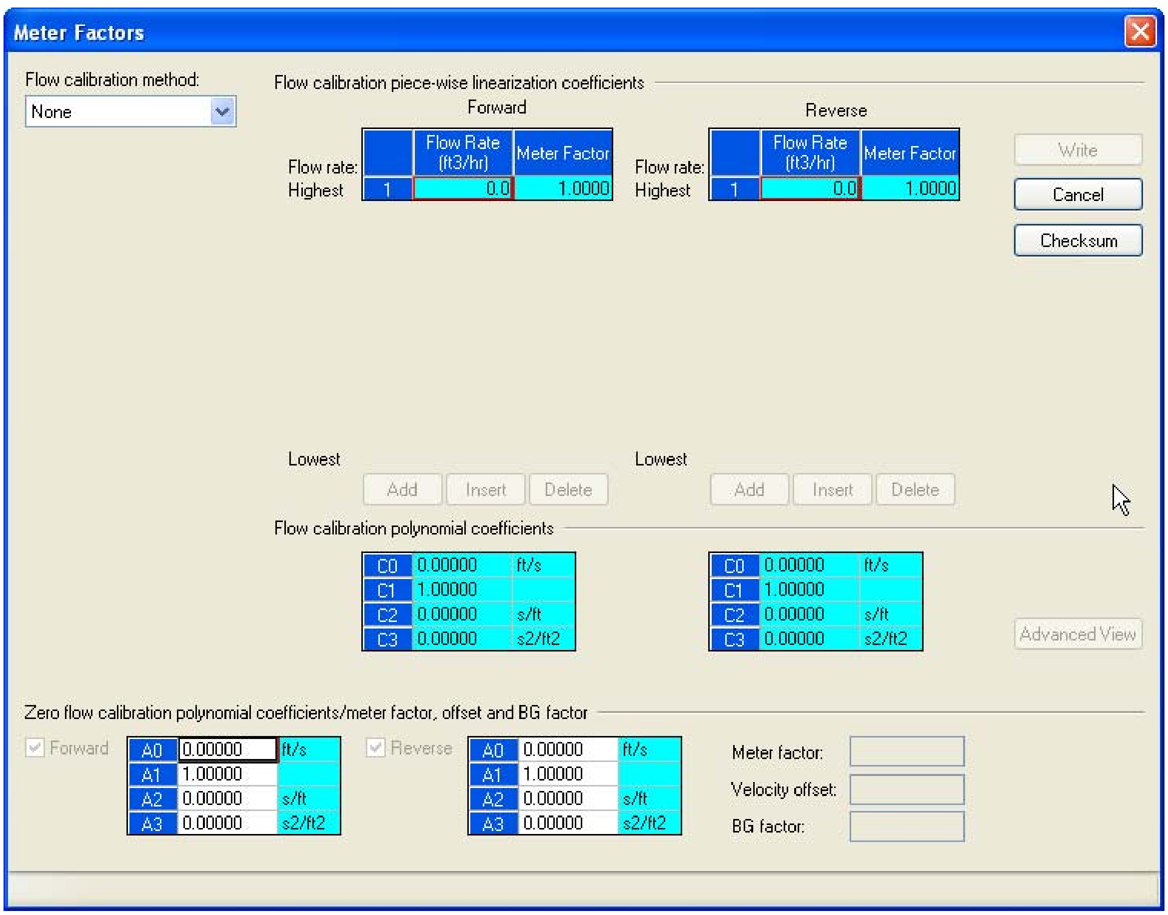
The Daniel Mark III Ultrasonic Gas Flow Meter meter provides for both “dry” calibration and “wet” calibration. Dry calibration refers to calibration methods that use factory-set calibration parameters. Wet calibration refers to calibration methods that use calibration parameters from a flow calibration.

NOTICE

Security switch S-2, Position 4 (on the CPU Board) must be closed or pushed towards the board before writing calibration factors to the meter.

1. Select the **Calibration|Meter Factors** menu and Daniel MeterLink displays the Meter Factors dialog.

Figure 5-21 Calibration - Meter Factors Page



2. Choose a Flow Calibration Method:
   - Polynomial
   - Piece-wise linear
   - None
3. Enter the appropriate forward and reverse meter factors and click the **Write** button to send the factors to the meter.
4. Click the **Cancel** button to close the dialog box. If you made changes, click the **Write** button to apply the changes.

NOTICE

After the meter is configured, set S-2 Position 4 (on the CPU Board) back to the open position to write-protect the configuration.

Dry calibration

The meter uses a third-order polynomial for dry calibration as shown in Equation 6-8. Click the **Advanced View** button to display the zero flow calibration polynomial coefficients. Regardless of what flow calibration method is selected, the zero flow calibration polynomial coefficients will be applied first.

⚠CAUTION

Modification of dry calibration parameters is not recommended. The dry calibration parameters should not be modified unless directed by Daniel personnel.

The meter provides separate dry calibration coefficients for each flow direction as listed in the table below.

Table 5-22 Data Points for Dry Calibration

Daniel MeterLink Display Name	Data Points, Options and Guidelines
Forward A0	Data points affected: • FwdA0 Options: • Enter a value (m/s or ft/s) within the range [-1,1 m/s]. Guidelines: • This value should only be modified under direction of Daniel personnel. • For additional guidelines, see Section 6.1.8 and Daniel MeterLink online help.
Forward A1	Data points affected: • FwdA1 Options: • Enter a value (dimensionless) within the range [0.95,1.05]. Guidelines: • This value should only be modified under direction of Daniel personnel. • For additional guidelines, see Section 6.1.8 and Daniel MeterLink online help.
Forward A2	Data points affected: • FwdA2 Options: • Enter a value (s/m or s/ft) within the range [-0.1,0.1 s/m]. Guidelines: • This value should only be modified under direction of Daniel personnel. • For additional guidelines, see Section 6.1.8 and Daniel MeterLink online help.

Table 5-22 Data Points for Dry Calibration

Daniel MeterLink Display Name	Data Points, Options and Guidelines
Forward A3	Data points affected: • FwdA3 Options: • Enter a value (s^2/m^2 or s^2/ft^2) within the range [-0.1,0.1 s^2/m^2]. Guidelines: • This value should only be modified under direction of Daniel personnel. • For additional guidelines, see Section 6.1.8 and Daniel MeterLink online help.
Reverse A0	Data points affected: • RevA0 Options: • Enter a value (m/s or ft/s) within the range [-1,1 m/s]. Guidelines: • This value should only be modified under direction of Daniel personnel. • For additional guidelines, see Section 6.1.8 and Daniel MeterLink online help.
Reverse A1	Data points affected: • RevA1 Options: • Enter a value (dimensionless) within the range [0.95,1.05]. Guidelines: • This value should only be modified under direction of Daniel personnel. • For additional guidelines, see Section 6.1.8 and Daniel MeterLink online help.
Reverse A2	Data points affected: • RevA2 Options: • Enter a value (s/m or s/ft) within the range [-0.1,0.1 s/m]. Guidelines: • This value should only be modified under direction of Daniel personnel. • For additional guidelines, see Section 6.1.8 and Daniel MeterLink online help.
Reverse A3	Data points affected: • RevA3 Options: • Enter a value (s^2/m^2 or s^2/ft^2) within the range [-0.1,0.1 s^2/m^2]. Guidelines: • This value should only be modified under direction of Daniel personnel. • For additional guidelines, see Section 6.1.8 and Daniel MeterLink online help.

Wet calibration

NOTICE

In Daniel MeterLink, to wet calibration parameters, use the **Calibration|Meter Factors** menu path.

Use the **Calibration}Meter Factors** menu path to select the Mark III calibration method.

Daniel MeterLink offers two “wet calibration” methods (in addition to selecting no wet calibration method):

- Piece-Wise Linearization (PWL) Method
- Polynomial Method

Select the desired wet calibration by configuring the data points listed below from the Daniel MeterLink **Calibration - Meter Factors** page:

Table 5-23 Data Point for wet calibration method

Daniel MeterLink Display Name	Data Points, Options and Guidelines
Flow calibration method	Data points affected: • CalMethod Options: • Piece-wise (2) • Polynomial (1) • None (0) Guidelines: • This value should only be modified under direction of Daniel personnel. • For additional guidelines, see Section 6.1.8 and Daniel MeterLink online help.

Piece-Wise linearization- wet calibration

When the Piece-Wise linearization wet calibration method is selected, the meter uses a 12-point piece-wise linearization on the dry-calibration velocity. Up to twelve flow rate and meter factor pairs can be specified for each flow direction from the Daniel MeterLink **Calibration - Meter Factors** page as shown in the table below.

Table 5-24 Data Points for Piece-Wise linearization calibration

Daniel MeterLink Display Name	Data Points, Options and Guidelines
Forward Flow Rate	Data points affected: • FwdFlwRate1...FwdFltRate12 Options: • Enter a value (m^3/h or ft^3/h) within the range [0, 200000 m^3/h]. Guidelines: • The flow rates must be entered from highest to lowest. • For additional guidelines, see Section 6.1.8 and Daniel MeterLink online help.
Forward Meter Factor	Data points affected: • FwdMtrFctr1...FwdMtrFctr12 Options: • Enter a value (dimensionless) within the range [0.95,1.05]. Guidelines: • For additional guidelines, see Section 6.1.8 and Daniel MeterLink online help.
Reverse Flow Rate	Data points affected: • RevFlwRate1...RevFltRate12 Options: • Enter a value (m^3/h or ft^3/h) within the range [0, 200000 m^3/h]. Guidelines: • The flow rates must be entered from highest to lowest. • For additional guidelines, see Section 6.1.8 and Daniel MeterLink online help.
Reverse Meter Factor	Data points affected: • RevMtrFctr1...RevMtrFctr12 Options: • Enter a value (dimensionless) within the range [0.95,1.05]. Guidelines: • For additional guidelines, see Section 6.1.8 and Daniel MeterLink online help.

Polynomial Wet Calibration

When the Polynomial wet calibration method is selected, the meter uses a third-order polynomial on the dry-calibration velocity as shown in Equation 6-11.

Three coefficients are specified for each flow direction from the Daniel MeterLink **Calibration - Meter Factors** page as shown in the table below:

Table 5-25 Data Points for Polynomial Wet Calibration

Daniel MeterLink Display Name	Data Points, Options and Guidelines
Forward C0	Data points affected: • FwdC0 Options: • Enter a value (m/s or ft/s) within the range [-1,1 m/s]. Guidelines: • For additional guidelines, see Section 6.1.8 and Daniel MeterLink online help.
Forward C1	Data points affected: • FwdC1 Options: • Enter a value (dimensionless) within the range [0.95,1.05]. Guidelines: • For additional guidelines, see Section 6.1.8 and Daniel MeterLink online help.
Forward C2	Data points affected: • FwdC2 Options: • Enter a value (s/m or s/ft) within the range [-0.1,0.1 s/m]. Guidelines: • For additional guidelines, see Section 6.1.8 and Daniel MeterLink online help.
Forward C3	Data points affected: • FwdC3 Options: • Enter a value (s^2/m^2 or s^2/ft^2) within the range [-0.1,0.1 s^2/m^2]. Guidelines: • For additional guidelines, see Section 6.1.8 and Daniel MeterLink online help.
Reverse C0	Data points affected: • RevC0 Options: • Enter a value (m/s or ft/s) within the range [-1,1 m/s]. Guidelines: • For additional guidelines, see Section 6.1.8 and Daniel MeterLink online help.

Table 5-25 Data Points for Polynomial Wet Calibration

Daniel MeterLink Display Name	Data Points, Options and Guidelines
Reverse C1	Data points affected: • RevC1 Options: • Enter a value (dimensionless) within the range [0.95,1.05]. Guidelines: • For additional guidelines, see Section 6.1.8 and Daniel MeterLink online help.
Reverse C2	Data points affected: • RevC2 Options: • Enter a value (s/m or s/ft) within the range [-0.1,0.1 s/m]. Guidelines: • For additional guidelines, see Section 6.1.8 and Daniel MeterLink online help.
Reverse C3	Data points affected: • RevC3 Options: • Enter a value (s^2/m^2 or s^2/ft^2) within the range [-0.1,0.1 s^2/m^2]. Guidelines: • For additional guidelines, see Section 6.1.8 and Daniel MeterLink online help.

5.8 Saving the meter configuration

It is recommended that, following meter set-up, the meter configuration be saved to a file for future reference. To save the configuration file,

1. Use the **Tools]Edit/Compare Configuration** menu.
2. Click the **Meter Read** button and, after the configuration data points are read, click the **File Save** button.

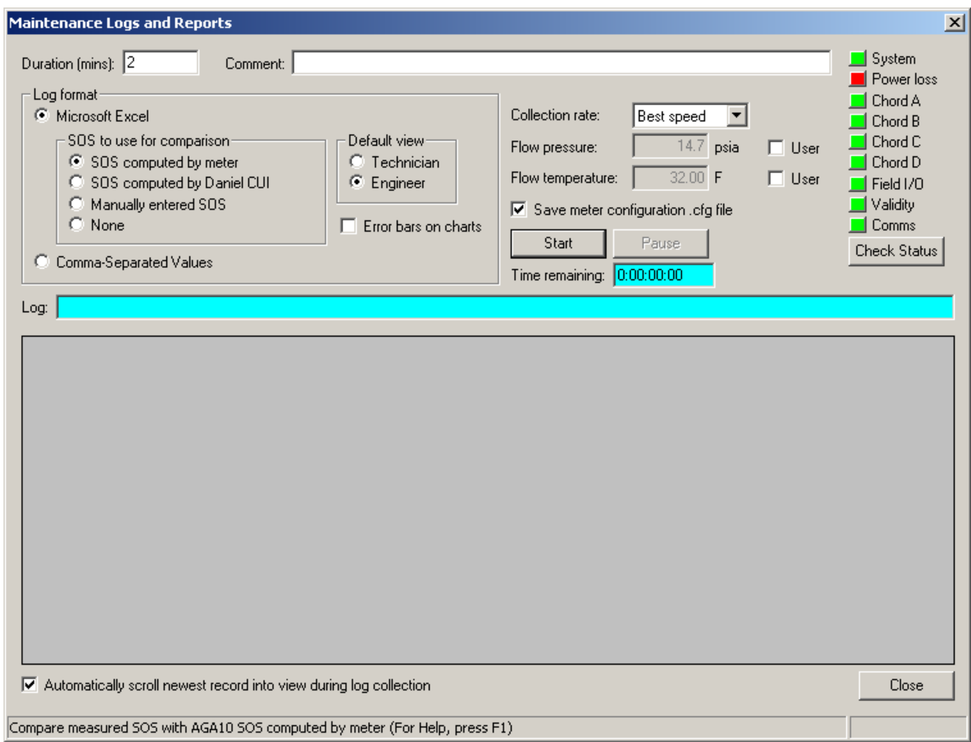
5.9 Maintenance logs and reports (Logs/Reports Menu)

The Maintenance Logs and Reports dialog box allows you to monitor a meter for a user-defined set of time and then display the data and results in a series of logs and charts.

To create a Maintenance log,

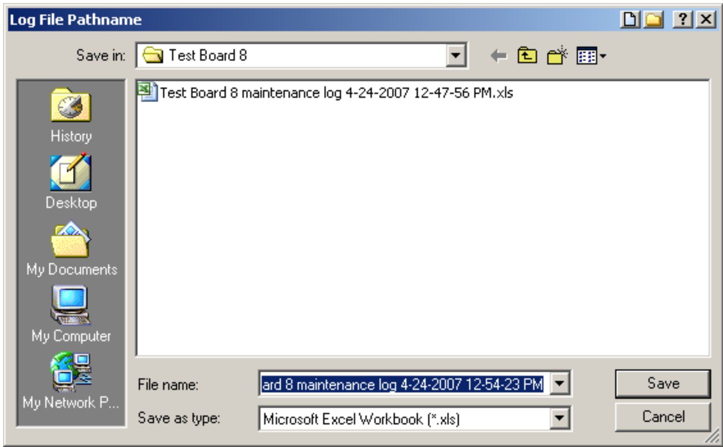
1. Use the **Logs/Reports | Maintenance Logs and Reports** menu path. The Maintenance and Logs window displays.

Figure 5-22 Maintenance logs and reports



2. Click the **Start** button and the Log File Pathname dialogs appears.

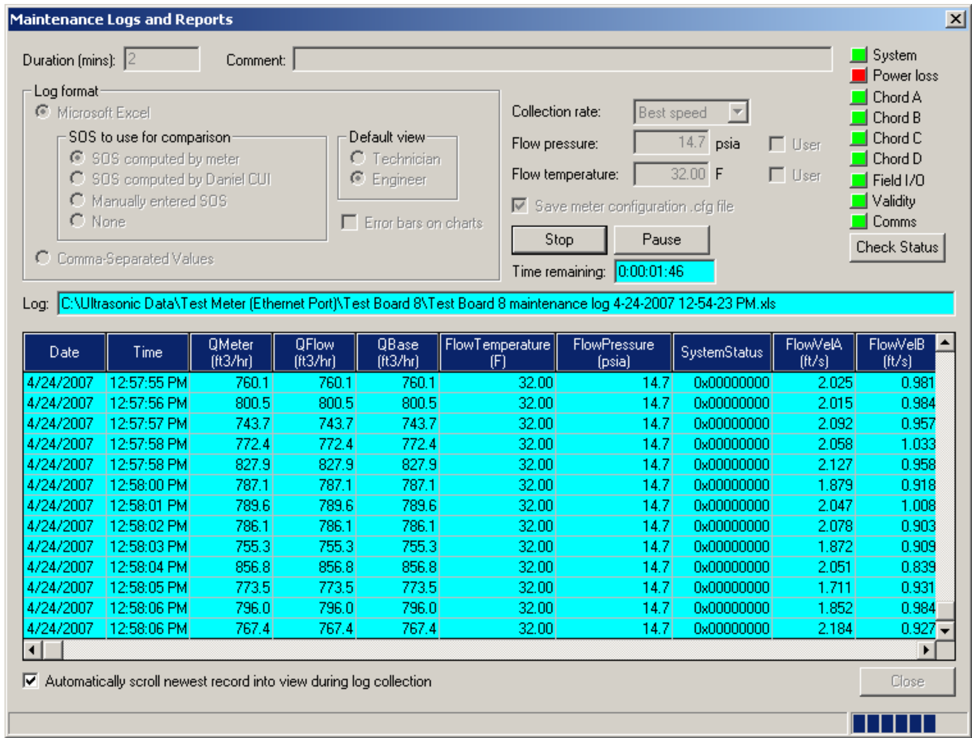
Figure 5-23 Log file pathname



You may choose a name for the Maintenance log or use the default name based on the Meter Name and PC date and time that is suggested. Change the name or default location if desired and click the **SAVE** button to apply your changes. The Log file shows the file and location of the Maintenance log being generated.

3. Daniel MeterLink begins to collect the information requested from the meter. Time Remaining shows the time left in the data collection period in a **Day: Hour:Minute:Second** format. A progress bar at the bottom of the dialog shows the progress for each record being collected. The table is updated after each record is collected (see Figure 5-22).

Figure 5-24 Maintenance Logs and Reports - Data Collection

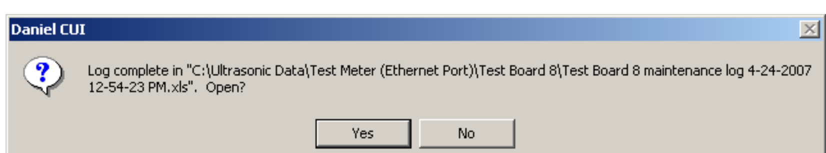


At anytime, click the **Stop** button to abort the log collection. Daniel MeterLink stops collecting data when the current record is collected and gives you the option to save the maintenance log generated on the data collected.

There is also a Pause/Resume feature for halting and continuing the log collection.

4. If you choose to perform a SOS comparison, a second dialog may be displayed after the log collection to enter more information.

5. A Log complete in "C:\Ultrasonic Data**<Meter name>** maintenance log **<Date> <Time>.xls**". Open? message box then appears after the Maintenance log has been created and if you generated an Excel® file.



6. Click the **Yes** button to open the Excel® file or click the **No** button if you do not wish to open the file at this time.

Daniel MeterLink also saves a configuration file from the meter with the same filename except with a .cfg extension.

NOTICE

While a Maintenance log is running with the Microsoft Excel format be careful not to close the instance of the Excel® application that is collecting data. Doing so causes Daniel MeterLink to abort the Maintenance log and all data will be lost.

Table

The largest area of this dialog is for the displaying of collected data. The table is updated after each record is collected. Once the data collection completes, additional rows are added to find the average, minimum, and maximum for each data column. Scroll bars are provided to allow you to view the data even while the data collection is in progress. The data and time columns are fixed to the left so that they are always visible even when scrolling to the far right. The header row is also fixed so that it is always visible while scrolling down through the record list columns for System Status and StatA through StatD are alarm bit maps displayed as a hexadecimal format. A 0x0000 indicates no alarms present. If a cell is showing an alarm, you can move the mouse cursor over the value on the table in order to display a tip explaining exactly which alarms are present.

Duration (mins):

Enter the amount of time for Daniel MeterLink to collect information from the meter. Daniel MeterLink collects as many sets of records as it can during the time specified. You can only enter whole numbers for this value up to 999999.

NOTICE

While the duration can be set up to 999999 minutes, the Maintenance log record collection will automatically stop once 3600 records have been collected. A prompt will be displayed saying the limit has been reached and clicking OK will generate report with the records collected.

5.9.1 Log Format

Maintenance logs can be generated in one of two formats: Microsoft® Excel® and Comma-Separated Values.

Microsoft® Excel

This is the recommend format for Maintenance logs in order to get the full benefits of this utility. This option however is only available if you have Microsoft® Excel® 2000 or later installed on your PC. The Excel® file generated by this utility has up to five worksheets as follows:

- Charts - Contains charts of the data collected and stored on the Raw Data worksheet. This worksheet is laid out to print two sheet per page on a standard 8 ½ x 11 sheet of paper.
- Inspection Report -The inspection report is a one page summary of the configuration and status of the meter. The report contains site information, meter configuration information, alarms, and meter status. Click here for information on customizing this worksheet.
- SOS Sheet - (Available in Deluxe Edition of Daniel MeterLink Only) If a Computed SOS value was entered, it will be included on this sheet.
- Config - Contains the meter's configuration. This configuration is called an extended configuration because is contains registers that are read-only and are not viewable in the **Edit/Compare Configuration** tool. These are registers used in the other worksheets of the Maintenance logs.
- Raw Data - Contains all of the data collected from the meter. Each row is a record polled from the meter. Each record contains a date and time stamp based on the meter's time when the record was completely received. Each column of data following the date and time stamps is a data point collected from the meter. Below all of the polled records are rows that analyze the data and detail the minimum, maximum, average, the difference from minimum to average, and the difference from maximum to average for each column of data. The cells for **SystemStatus** and StatA through StatD will contain a comment that can be displayed by moving the mouse cursor over the marker in the upper-right corner of the cell. The marker is only present if the cell is indicating an alarm (i.e. non 0x0000 value).
- When using the Microsoft® Excel® log format, the following options are available:
    - SOS to use for comparison - To include a comparison of the meter's measured SOS to a calculated SOS, select one of the following methods for entering this data.
    - Manually entered SOS - Allows you to enter a speed of sound calculated from a 3rd party package. This option is always available. After the Maintenance Log is complete a dialog will be displayed in which you will enter a speed of sound to compare against the meter. This data will be saved in the Maintenance log.
    - None - No speed of sound comparison will be performed or included in the Maintenance log.
        - Default view -The Technician view displays the following data:
        - Meter Volumes, Temperature, Pressure, System Status, Flow Velocities, Sound Velocities, Chord Statuses, Performance, Gains, Validity alarms, Flow direction.

- Chord Status, Performance, Gains, S/N Ratios, Max Signals, Max Noise, Profile Factor, Flow Velocity Ratios.
- In addition to the data displayed in Technician view, Engineer view also displays:
  - Transit Times: Maximum, Minimum, Mean
  - Delta Times: Maximum, Minimum, Average
  - Standard Deviations: Transit Times, Delta Times
  - Piece-wise Linearization Meter Factor

NOTICE

Starting with Daniel MeterLink v2.00, the Maintenance logs actually collects all of the data for both the Technician and Engineer view regardless of this setting. Two custom views are setup in the Excel® file and the default view displayed when the Excel® file is opened matches the Default view selection. This view can be changed in Excel® by going to Custom Views under the View drop-down menu.

- Error bars on charts - Select to include maximum and minimum error bars on bar charts on the Charts worksheet.

Comma-Separated Values

This format creates a file with data separated by commas. Each log record collected is put on a separate line in the file. No charts can be created with this log format. The meter configuration is followed by the raw data separated by a blank line.

NOTICE

Starting with Daniel CUI v2.00, the Maintenance logs actually collects all of the data for both the Technician and Engineer mode. The Data log type is no longer available for this Log format.

- Collection rate - Sets the rate at which records are collected for the maintenance log.
  - The Collection rate allows the user to set how often Daniel MeterLink will collect a new set of data to refresh the screen.
  - For the Daniel Mark III Ultrasonic Gas Flow Meter, available options are Best speed, 5 seconds, 10 seconds, 30 seconds, 1 minute, and 5 minutes.
  - Best speed means that Daniel MeterLink will begin collecting a new set of data as soon as it finishes collecting and displaying the last set of data. Daniel MeterLink will not exceed 1 collection per second with this setting which is only possible for the Daniel Mark III Ultrasonic Gas Flow Meters.

Flow Pressure

If the pressure in the meter is disabled, this text box is enabled to allow you to enter a pressure for the process fluid if desired. If the pressure in the meter is set to fixed or live, this text box is disabled and the information is collected from the meter during the log collection by default. You can override this by selecting the User check box next to the input value to enable the text box and enter a value to log in place of reading it from the meter.

Flow Temperature

If the temperature in the meter is disabled, this text box is enabled to allow you to enter a temperature for the process fluid if desired. If the temperature in the meter is set to fixed or live, this text box is disabled and the information is collected from the meter during the log collection by default. You can override this by selecting the User check box next to the input value to enable the text box and enter a value to log in place of reading it from the meter.

Save meter configuration .cfg file

Saves the meter configuration file when a Maintenance Log is run if selected. The filename will be the same name as the Maintenance Log except the file extension will be .cfg.

Comment

Enter a comment here to be included in the Maintenance Log. The comment is a column towards the end of the Table. The comment is included with each record collected. Use the Pause button to halt the maintenance log to change the comment if desired during the collection.

Meter Status Alarms

The status alarms give a visual indication of the status of the meter. In this dialog box, the alarms are read when the dialog box is first opened. Then they are only updated while a Maintenance log is running.

Pause/Resume

Clicking Pause during a maintenance log collection will halt the collection after the current collection in progress is finished. While paused, you can edit the Comment field to be used once the maintenance log is resumed. The Pause button changes to Resume once the log is halted. Clicking Resume, continues the maintenance log.

Scroll to Newest Record During Log Collection

Select this option to allow Daniel MeterLink to scroll the table so that the most recent log record collected is always displayed during the log collection. Clear the selection to scroll through older log records while the collection is still in process.

5.10 Trend maintenance logs (Logs/reports Menu)

NOTICE

This feature is available in the Deluxe Edition of Daniel CUI and Daniel MeterLink.

The Trend Maintenance Logs dialog box allows you to merge two or more Maintenance logs together into a single Trend file in order to build a historical database of the performance of ultrasonic meters. Maintenance logs can also be merged with existing Trend files to form a new Trend file of the combined data. The Trend feature can be useful to see how the meter performance changes with changing flow conditions over time. It can also be useful to detect performance issues when the meter performance is deteriorating slowly over time but the flow conditions have not changed in a manner to account for it.

The Trend Maintenance Logs dialog box contain two list boxes. The tree list Microsoft Excel workbooks will show all the directories on your PC, but will only show files in them that are Maintenance Logs in Microsoft® Excel® format or Trend files and only if they are not currently open in Microsoft® Excel®.

To display all files in the Microsoft Excel workbooks directory tree, clear the Show only maintenance log and trend workbooks option. Add files to the Workbooks to trend list by either double-clicking on the file or by selecting the file and clicking **Add**.

You can add an entire folder by selecting the folder and clicking **Add All** or by double-clicking on the folder in the tree list. This will include only the files in this folder and not any files contained in subfolders. You can remove files from the Workbooks to trend list by selecting the file and clicking **Remove**. Click **Remove All** to clear the Workbooks to trend list of all files.

NOTICE

Maintenance logs or Trend files to be trended must all have matching column headings. This means the logs must be in the same units (i.e. U.S. Customary or Metric), must have the same pressure type (i.e. gage or absolute), and must have the same time base (1/sec, 1/min, 1/hr, 1/day). If not, an error message will be displayed stating the column headings do not match and the file will not be added to the Workbook to trend list.

NOTICE

Make sure any Maintenance Log file or Trend file that you would like to add to the Workbooks to trend list is not opened in Microsoft® Excel®. If it is open, Daniel MeterLink will not be able to add it to the list of files to trend.

NOTICE

The Show only maintenance log and trend workbook checkbox may not work properly on Windows® 2000 machines running SP4 or Windows® XP machines with Security Update for Windows® XP (823980).

At least two Maintenance logs or one Trend file must be added to the Workbooks to trend list before the Trend button becomes enabled. Click Trend to open a Save As dialog box to allow you to choose a name for the Trend file. A default name that consists of the Meter Name of the first file selected to trend followed by “trend” and ending with the PC’s date and time is suggested.

NOTICE

If the first file selected to trend does not have a standard filename starting with either <Meter Name> maintenance log... or <Meter Name> trend... then the default filename suggested will be just “trend <Date> <Time>.xls”.

Make changes as desired and also include a Comment to include in the trend file. Clicking Save will start the Trend file creation. When the Trend file is finished, a prompt stating Log complete in “C:\Ultrasonic Data\<Meter Name>\<Meter Name> trend <Date> <Time>.xls”. Open? Click **YES** to close the prompt and open the Excel® file. Click **NO** to close the prompt but not open the Excel® file at this time.

The Microsoft® Excel® Trend file contains two worksheets. The following is a brief description of each.

Charts

Contains charts of the data collected and stored on the Raw Data worksheet. This worksheet is laid out to print one chart per page on a standard 8 ½ x 11 sheet of paper. Click here for information on customizing this worksheet.

Raw Data

This worksheet contains the Averages row from Maintenance Log Raw Data worksheets and the rows or data from a Trend file Raw Data worksheet. Only the Technician level data values are included in a Trend file. The rows are sorted from oldest to newest. The first column in each row contains the filename of the Maintenance log the data comes from followed by the date and time columns for when the Maintenance log was created.

5.10.1 Meter Archive Logs (Logs/Reports Menu)

The Meter Archive Logs dialog box allows you to collect historical log information from an ultrasonic meter. This dialog box is only available while connected to a meter. If connected to a Daniel Mark III Gas Ultrasonic meter, a valid LogAccessKey may be required before logs can be collected. See the Key Manager for more information on enabling keys.

Ultrasonic Meter Archive log types

There are up to five different types of logs stored in the meter depending on the type of meter which are described below.

Table 5-26 Ultrasonic Meter Archive Log Types

Log type	Description
Daily Logs	The ultrasonic meter stores a log record in the Daily Log memory once per day at the Contract hour for daily log set under Field Setup Wizard. The Daily Log has a readable semi-fixed configuration that stores the volumes and associated data accumulated over the past 24 hours. For Daniel Mark III Gas Ultrasonic meters, the data registers stored in the Daily logs are listed in Table 6-18. The ultrasonic meter can store 365 Daily Log records.
Hourly Logs	The ultrasonic meter stores a log record in the Hourly Log memory every hour at the top of the hour. The Hourly Log has a readable semi-fixed configuration that stores the volumes and associated data accumulated over the past hour. For Daniel Mark III Gas Ultrasonic meters, the data registers stored in the Hourly logs are listed in Table 6-19. The ultrasonic meter can store 2400 Hourly Log records.
Audit Logs	For Daniel Mark III Gas Ultrasonic meters, the parameters which affect the gas flow measurement are listed in Table 6-20. The ultrasonic meter can store 3000 Audit Log records.
Alarm Logs	The ultrasonic meter stores a log record in the Alarm Log memory whenever an alarm or error condition becomes active or is cleared. For Daniel Mark III Gas Ultrasonic meters, the alarm and error conditions that are logged are listed in Table 6-21. The ultrasonic meter can store 3000 Alarm Log records.
System Alarm Logs	System logs are only available in Daniel Mark III Gas Ultrasonic meters. This log shows system related errors such as firmware issues and reasons why writes to the configuration may have failed. The meter can store 100 System alarm records.

5.10.2 Compare Excel Meter Configurations (Logs/Reports Menu)

This utility provides the ability to compare configurations stored in Excel® Maintenance logs, Archive Logs, Flow Calibration Logs, and Zero Flow Calibration logs. The default location for saving the compare results will be the directory from which the first file selected to compare is located. This utility can not compare configurations stored in different system units. (i.e. U.S Customary vs. Metric). Only Excel® log files can be compared.

Daniel MeterLink will prompt you to select the files to compare. Once the files are selected, a dialog will display providing options to further customize the compare operation.

Section 6: Meter operation

The purpose of this section is to instruct the user on the operation of the 3410 Series Ultrasonic Flow Meters meter, particularly for features not discussed in Section 5. It is assumed, in this section, that the user is familiar with basic ultrasonic metering.

6.1 Measurement

The Ultrasonic Gas Flow Meter precisely measures the transit time of an ultrasonic wave passing through the gas to determine the mean axial velocity of the gas through the unit. The measurement paths (also referred to as "chords") are angled to the pipe axis, and each chord has two transducers acting alternately as transmitter and receiver as shown in Figure 6-1 (for SeniorSonic^{TM} meters) and Figure 6-2 (for JuniorSonic^{TM} meters). This permits the transit times to be measured both with and against the flow.

The transducers are mounted on the meter body at accurately known locations for each pipe size so the distance L between opposing transducers and the angle are precisely defined for the measurement path.

Figure 6-1 SeniorSonic measurement principle

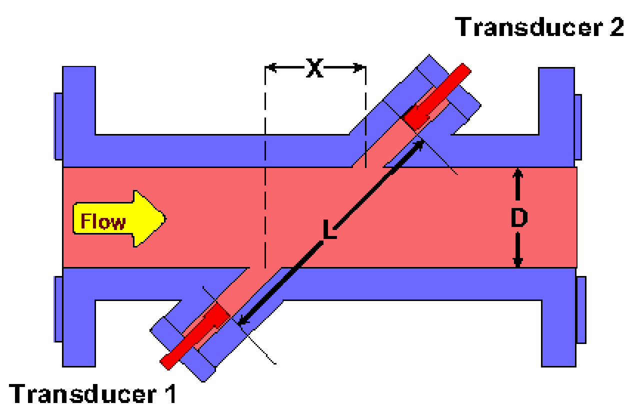
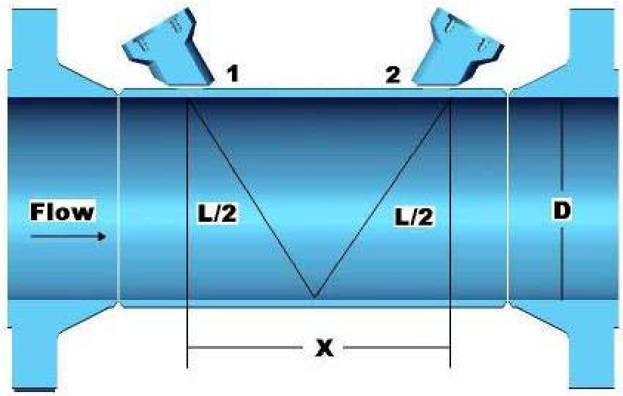


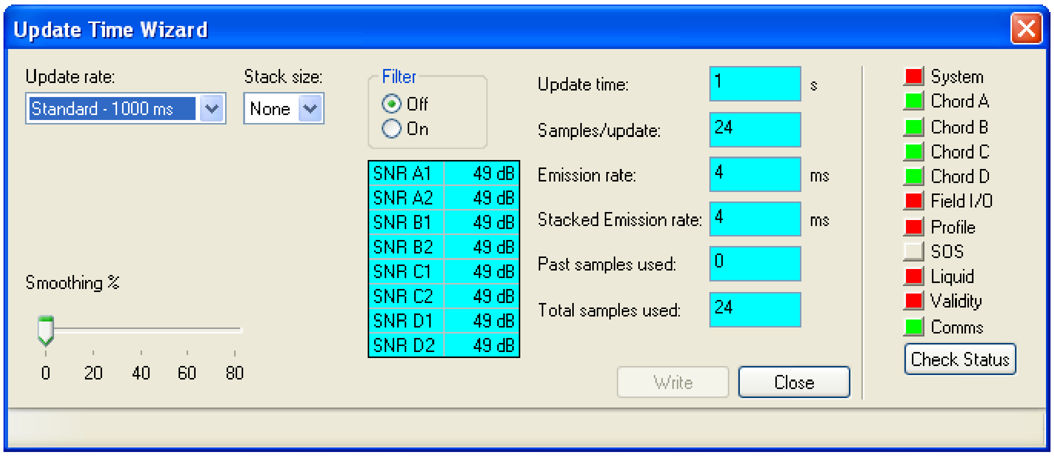
Figure 6-2 Juniorsonic Measurement principle



6.1.1 Terminology

The following terms are used in explaining the effects of transducers timing control and the performance of batch data collection and calculation updates in the Mark III flow meter.

Figure 6-4 Update time, stack size, emission rate and filter



- **Sequence** - a complete cycle of firing all enabled transducers in a single round of transducers operation (For example, in a four-chord SeniorSonic^{TM} meter, there are eight transducers, and when all eight transducers have been fired in a single round of operation, it signifies the completion of one sequence.)
- **Stacking** - the process of modifying a sequence so that each individual transducer is fired x times (where x equals the stack size) before the next transducer in the sequence is fired
- **Stack size** - the multiple of times each transducer is fired before the next transducer within the sequence is fired (When stacking is absent or disabled, the stack size is actually 1, because each enabled transducer is fired once during the sequence. When stacking is applied or enabled, it is applied in increments of 2, 4, 8, and 16 and are the only stack size choices, so that each enabled transducer is fired 2, 4, 8, or 16 times before the next transducer in the sequence is fired.)
- **Emission rate** - the time elapsed before the next transducer in a sequence is fired, regardless of stack size (Minimum emission rate is 4 milliseconds.)
- **Stack emission rate** - the time elapsed before a single transducer is re-fired when stacking is enabled (Minimum stack emission rate is 4 milliseconds.)
- **Chords inactive or active** - the exclusion or inclusion of a chord-forming pair of transducers in the sequence of transducers operation
- **Update time** - the time elapsed, in seconds, between each processing, or recalculation of data that is collected from sequences of transducer firings
- **Batch period, or batch cycle** - synonymous with Update time, as defined above
- **Sample** - the data that is collected from one Sequence of transducers operation (This term is displayed in the Daniel MeterLink **Update Time Wizard** screen, and is nearly synonymous with Sequence, as defined above. That is, “Samples/update,” as displayed in the Daniel MeterLink **Update Time Wizard** screen, could be interpreted as Sequences/update.)

6.1.2 Signal processing

The signal at the receiving transducer is digitized and digital signal processing techniques are used to provide accurate transit time measurement.

A measure of the signal "goodness" is the signal-to-noise ratio (SNR). The higher the SNR, the better the signal. In general there are two types of noise: asynchronous "white" noise and synchronous "colored" noise. Asynchronous noise is noise that occurs across the frequency spectrum. Synchronous noise is concentrated around a particular frequency. The meter provides two methods for improving the received signal waveform SNR by reducing the noise energy: Stacking and Filtering.

Stacking

Stacking is a method of firing a transducer multiple times and averaging the received signals on a point-by-point basis. Stacking is effective on asynchronous noise such as is typically seen with valve noise. This method is not useful for removing synchronous noise and should not be used when there is a great deal of signal "jitter." Meters are configured by default with a stack size of 2. Care should be taken when turning off stacking and it is recommended to consult with Daniel Customer Service if you are unsure of how stacking a signal can effect the meter's operation. Refer to Technical Support under the Help menu of Daniel MeterLink for contact information.

The number of consecutive times to fire each transducer is specified via the **StackSize** data point. Available stack sizes are 1 (None), 2, 4, 8, and 16. A stack size of 1 selects no stacking (i.e., stacking disabled). *Stacking is only available when the standard update rate is selected (see* Section 6.1.3 *below).*

Filtering

Filtering applies a bandpass filter that removes noise that is above and below the transducer frequency. Filtering is effective on noise outside of the frequency passband of the filter (e.g., filtering works on any noise outside of the passband of the filter). Filtering is enabled/disabled via the **Filter** data point (TRUE=enable filtering, FALSE=disable filtering). Meters are configured by default for filtering disabled. Care should be taken when turning on filtering and it is recommended to consult with Daniel Customer Service if you are unsure of how filtering a signal can effect the meter's operation. Refer to Technical Support under the Help menu of Daniel MeterLink for contact information.

6.1.3 Batch cycle processing

Batch update period

Calculation updates performed by the meter, for deriving volume and velocity, are based on batches of data samples collected from sequences of transducer firings. The batch update period is dependent upon the user specified batch update period (**SpecBatchUpdtPeriod**) and the stack size (**StackSize**) as shown in Table 6-1. The Standard batch update period is the default.

Table 6-1 Actual meter update period

		StackSize				
		1 (None)	**2**	**4**	**8**	**16**
SpecBatchUpdtPeriod	Rapid (250 ms)	0.25 sec	N/A	N/A	N/A	N/A
	Standard (1000 ms)	1 sec	1 sec	1.5 sec	3 sec	5 sec

The actual batch update period is readable via the **BatchUpdatePeriod** data point.

Emission rates

The emission rate is the period between firing two different transducers. The stacked emission rate is the period between consecutive firings of a single transducer when stacking is used (i.e., the stack size is not set to 'None').

The actual emission rates used (readable via the **EmRateActual** and **StackEmRateActual** data points) are functions of the desired emission rates, meter type, firing sequence, stack size, and filter status.

The user specifies the desired emission rates via the **EmRateDesired** and **StackEmRateDesired** data points. If a desired emission rate is set to zero, the meter uses the fastest possible emission rate (which can be as short as 4 milliseconds). Otherwise, the meter uses the fastest possible emission rate that is *not less than* the desired value.

When using the Daniel MeterLink **Update Time Wizard** to configure the meter (as discussed in Section 5.7.1), **EmRateDesired** and **StackEmRateDesired** are set to zero to achieve the most transducer firings per batch update.

Smoothing

The Daniel Mark III Ultrasonic Gas Flow Meter meter introduces a method for smoothing the output (particularly the frequency output) by averaging samples (i.e., waveforms) collected from past batch periods with new samples for the current batch period.

Smoothing can be applied in the following increments: 0 (i.e., smoothing is disabled), 20, 40, 60, or 80%.

For example, setting Smoothing to 20% means that of the samples used for the current update, 20% will be from previously collected samples and 80% will be from the newly collected samples. Thus, if 8 new samples are collected, then those 8 samples along with the last 2 previous samples would be used together for the current update period calculations.

Meters are configured by default for Smoothing of 0% (only new samples are used for the current update period).

6.1.4 Acquisition mode

The Mark III meter has two modes of normal operation: Acquisition and Measurement. The Acquisition mode is used to acquire the ultrasonic signals. This mode is entered upon powering up the meter. Once the ultrasonic signals are acquired, the Measurement mode is entered and the flow velocity is measured. The meter remains in the Measurement mode as long as at least one chord is operational. If all chords fail while in the Measurement mode, then the Acquisition mode is re-entered.

The meter operation mode is indicated by the **IsAcqMode** data point. When TRUE, the meter is in the Acquisition mode; when FALSE, the meter is in the Measurement mode.

The Acquisition mode uses the chords' “L” dimensions (**Laird** as appropriate to the meter type) and the specified minimum and maximum sound velocities (**SSMin** and **SSMax**) to determine the signal search range.

6.1.5 Chord gas and sound velocity measurements

At each batch update period, each firing path's transit time measurements are averaged. The average (mean) value for each path is available via data points **MeanTmA1** ... **MeanTmD2** (as appropriate for the meter type).

NOTICE

The data point names often use a "short-hand" way of identifying the receiving transducer. The last two characters identify the chord (A...D) and the transducer (1=upstream, 2=downstream). For example, MeanTmA1 is the mean transit time for the chord A upstream transducer.

The difference between a chord's average upstream transit time and average downstream transit time is the average delta time. The chord's average times and the chord "X" and "L" dimensions are used to calculate the gas velocity and sound velocity measured by the chord as shown in Equation 6-1 and Equation 6-2.

Equation 6-1 Chord Gas Velocity

$$V_{chord} = \frac{L^2_{chord}}{2X_{chord}} \left[\frac{t_1 - t_2}{t_1\ t_2} \right]$$

Equation 6-2 Chord Sound Velocity

$$C_{chord,classic} = \frac{L_{chord}}{2} \left[\frac{t_1 + t_2}{t_1\ t_2} \right]$$

$$C_{chord} = C_{chord,classic} \times PortAngleFactor$$

where the *PortAngleFactor* is a dimensionless factor that is dependent upon the chord port angle with respect to the meter body:

For 60 degree port angles,

$$PortAngleFactor = \left(1 + \left[0.5 \times \left(\frac{V^2_{chord}}{C^2_{chord,classic}}\right) \times \left(\frac{X^2_{chord}}{L^2_{chord}}\right) \times \tan^2(60°)\right]\right)$$

for 75 degree port angles,

$$PortAngleFactor = \left(1 + \left[0.5 \times \left(\frac{V^2_{chord}}{C^2_{chord,classic}}\right) \times \left(\frac{X^2_{chord}}{L^2_{chord}}\right) \times \tan^2(75°)\right]\right)$$

For all other port angles,

$$PortAngleFactor = 1$$

where

V_{chord}	=	chord average gas velocity (m/s) (**FlowVelA** ... **FlowVelD**)
C_{chord}	=	chord average sound velocity (m/s) (**SndVelA** ... **SndVelD**)
L_{chord}	=	chord "L" dimension (m) (**LA** ... **LD**)
X_{chord}	=	chord "X" dimension (m) (**XA** ... **XD**)
t_1	=	chord average transit time in the upstream direction (s) (**MeanTmA1** ... **MeanTmD1**)
t_2	=	chord average transit time in the downstream direction (s) (**MeanTmA2** ... **MeanTmD2**)

Note that a positive chord gas velocity indicates flow in the forward direction whereas a negative chord gas velocity indicates flow in the reverse direction.

6.1.6 Average weighted sound velocity

The average weighted sound velocity is calculated as the average of the active chord sound velocity measurements as shown in the equation below:

Equation 6-3 Average weighted sound velocity

$$C_{Avg} = \frac{\sum_{ActiveChords} Wt_{chord} \cdot C_{chord}}{NumActiveChords}$$

where

C_{Avg}	=	average weighted sound velocity (m/s) (**AvgSndVel**)
Wt_{chord}	=	chord weight (dimensionless) (**WtA** ... **WtD**)
C_{chord}	=	chord average sound velocity (m/s) (**SndVelA** ... **SndVelD**)
$NumActiveChords$	=	number of active chords

Optional AGA10 sound velocity calculation and comparison

The Daniel Mark III Ultrasonic Gas Flow Meter offers an option to calculate the sound velocity (using AGA10 equations and gas property data) and compare the result to the meter-measured sound velocity on an hourly basis. This feature is enabled via the AGA10Key (see Section 4.1.6). The gas property data required for using this feature can be specified via data points or optionally read from a Daniel GC (see Section 6.1.16). The AGA8 Detailed Method must be selected (via the **HCH_Method** data point, see Section 5.6.14) in order for the AGA10 calculations to be performed (as the AGA10 calculations require AGA8 Detailed method calculation intermediate results).

Every five seconds the meter updates the AGA10-calculated sound velocity. This value is readable via the **AGA10SndVel** data point and the calculation status value is readable via the **AGA10SndVelStatus** data point. The status values are as listed in the table below:

Table 6-2 AGA10 calculation status

AGA10SndVelStatus Value	Description
0	Calculation OK (no errors).
1	Calculation not performed as the feature is not enabled (see Section 4.1.6). AGA10SndVel is set to zero.
2	Calculation not performed as the selected AGA8 method is not the Detailed method (HCH_Method not set to Detailed Method(3)). AGA10SndVel is set to zero.
3	Calculation not performed due to invalid AGA8 calculation results. AGA10SndVel is set to zero.
4	Calculation error due to division by zero. AGA10SndVel is set to zero.

Over the course of an hour (starting from the top of the hour), the meter calculates the average measured sound velocity (the average of the average weighted sound velocity) and the average AGA10-calculated sound velocity. At the end of the hour, the two averages are compared; the comparison error (%) is readable via the **SndVelCompErr** data point.

Note that the comparison error is only calculated at the end of the hour if during the hour all of the following are true:

- no AGA10 sound velocity calculation errors occurred (i.e., **AGA10SndVelStatus** always equal to 0),
- the measured flow velocity was always above the minimum sound-speed-check flow velocity (specified via the **SndSpdChkMinVel** data point which has a default value of 1 m/s), and
- the measured sound velocity was always valid (as indicated by the **QMeterValidity** data point).

6.1.7 Average weighted gas flow velocity

When all active chords are non-failed, the average weighted gas flow velocity is a weighted sum of the chord velocity measurements as shown in Equation 6-4 where the chord weights are determined by the meter geometry.

Equation 6-4 Average weighted gas flow velocity

$$V_{AvgWtd} = \sum_{ActiveChords} Wt_{chord} V_{chord}$$

where

V_{AvgWtd}	=	average weighted gas flow velocity (m/s) (AvgWtdFlowVel)
Wt_{chord}	=	chord weight (dimensionless) (WtA ... WtD)
V_{chord}	=	chord average gas velocity (m/s) (FlowVelA ... FlowVelD)

Average weighted flow velocity using chord proportions

In the event of one or more chord failure(s), the meter operation is dependent upon the number of non-failed chords. If there is at least one operating chord, then the meter uses a velocity estimation method described in the following paragraphs. If all chords fail, then the meter re-enters the Acquisition mode as described in the “Re-Acquisition” section below.

The meter partitions the velocity range (for forward and reverse flow) into ten consecutive, non-overlapping “bins” (where the velocity range is as specified via the **MeterMaxVel** data point). The meter maintains a set of bins for each active chord where each bin contain three data values: (1) the chord’s average velocity (within the bin’s velocity range), (2) the chord’s average proportion value, and (3) a “trained” indicator. A chord proportion value is the ratio of the chord velocity to the average weighted flow velocity as shown in Equation 6-5 below. The “trained” indicator is used to determine if a bin’s velocity and proportion data values have been updated from their initialized values. The bins are initialized with the average velocity over the bin’s range and meter-geometry-dependent proportion values. All “trained” indicators are initialized to FALSE. The bin data is stored in non-volatile memory.

Equation 6-5 Chord proportion calculation

$$Prop_{chord} = \frac{V_{chord}}{V_{AvgWtd}}$$

where

$Prop_{chord}$ = chord proportion (dimensionless)

V_{chord} = chord velocity (m/s) (**FlowVelA** ... **FlowVelD**)

V_{AvgWtd} = average weighted gas flow velocity (m/s) (**AvgWtdFlowVel**)

When the meter has operated for a user-specified number of consecutive batches without any chord failures, the meter updates each chord's data values for the bin containing the chord velocity as shown in Equation 6-6 and sets the bin's "trained" indicator to TRUE. The **PropUpdtBatches** data point, configurable via the Daniel MeterLink **Edit/Compare Configuration** screen, specifies the number of consecutive failure-free batches required for updating the bin data (range: [1, 1000], default: 24). The **NumVals** data point (that determines how quickly an average value changes) is also configurable via the **Edit/Compare Configuration** screen (range: [1, 1000], default: 10).

Equation 6-6 Updating chord proportion bin data values

$$AvgVel_{ChordBin_{n+1}} = \frac{(AvgVel_{ChordBin_n} \cdot (NumVals - 1)) + V_{chord}}{NumVals}$$

$$AvgProp_{ChordBin_{n+1}} = \frac{(AvgProp_{ChordBin_n} \cdot (NumVals - 1)) + Prop_{chord}}{NumVals}$$

where

$AvgVel_{ChordBin_{n+1}}$ = chord bin (n+1)st average velocity (m/s)

$AvgVel_{ChordBin_n}$ = chord bin nth average velocity (m/s)

$NumVals$ = update factor data point (dimensionless) (**NumVals**)

V_{chord} = chord velocity (m/s) (**FlowVelA** ... **FlowVelD**)

$AvgProp_{ChordBin_{n+1}}$ = chord bin (n+1)st average proportion value (dimensionless)

$AvgProp_{ChordBin_n}$ = chord bin nth average proportion value (dimensionless)

$Prop_{chord}$ = chord proportion (dimensionless)

In the event of a chord failure with at least one operating chord, the meter's average weighted flow velocity is estimated as shown in Equation 6-7.

Equation 6-7 Estimating average flow velocity using proportion values

$$V_{AvgWtd_{est}} = \frac{\sum_{\substack{Non-Failed \\ Chord(s)}} V_{chord}}{\sum_{\substack{Non-Failed \\ Chord(s)}} InterpProp_{chord}}$$

where

$V_{AvgWtd_{est}}$	=	estimated average weighted flow velocity (m/s) (**AvgWtdFlowVel**)
V_{chord}	=	(non-failed) chord velocity (m/s) (**FlowVelA ... FlowVelD**)
$InterpProp_{chord}$	=	(non-failed) chord interpolated proportion value (dimensionless)

For each non-failed chord, the interpolated proportion value used in Equation 6-7 is calculated as follows:

- if the chord's velocity is surrounded by trained (average velocity, average proportion) data pairs, then the interpolated proportion is the linear interpolation between the two data pairs
- if the chord's velocity has a trained (average velocity, average proportion) data pair on one side of it but not the other, then the interpolated proportion is the data pair average proportion
- if there are no trained (average velocity, average proportion) data pairs, then the interpolated proportion is the corresponding bin's default average proportion value

Re-acquisition

If all active chords fail, then the meter re-enters the Acquisition mode. If the **VelHold** data point is set to a value greater than zero, then, while in the Acquisition mode, the meter holds the average weighted flow velocity to the last good value for up to the **VelHold** number of batches before setting the velocity to zero. The **VelHold** default value is 0.

6.1.8 Calibration

The Daniel Mark III Ultrasonic Gas Flow Meter meter uses two calibration steps: “dry” calibration and “wet” calibration.

In this methodology, the “dry-calibration” values are set by Daniel at the factory and are not expected to be modified; the “wet-calibration” values are expected to be set as the result of a user flow calibration (if desired). These two calibration methods are explained in further detail below.

Dry calibration

The dry-calibration gas flow velocity is the result of applying a third-order polynomial equation to the average weighted gas flow velocity as shown in Equation 6-8.

Equation 6-8 Dry-calibration gas flow velocity

$$V_{DryCal} = A_0 + A_1 V_{AvgWtd} + A_2 V_{AvgWtd}^2 + A_3 V_{AvgWtd}^3$$

where

V_{DryCal}	=	dry-calibration gas flow velocity (m/s) (**DryCalVel**)
V_{AvgWtd}	=	average weighted gas flow velocity (m/s) (**AvgWtdFlowVel**)
A_0	=	dry-calibration 0th order coefficient (m/s) (**FwdA0** or **RevA0**)
A_1	=	dry-calibration 1st order coefficient (dimensionless) (**FwdA1** or **RevA1**)
A_2	=	dry-calibration 2nd order coefficient (s/m) (**FwdA2** or **RevA2**)
A_3	=	dry-calibration 3rd order coefficient (s^2/m^2) (**FwdA3** or **RevA3**)

Note that the meter provides two sets of dry calibration coefficients - one set for each flow direction.

Wet Calibration

The Daniel Mark III Ultrasonic Gas Flow Meter meter offers three selections for wet calibration: 12-point piece-wise linearization, a third-order polynomial, or none. The wet calibration method to use is selected via the **CalMethod** data point with “None” being the default value. The wet calibration gas flow velocity is calculated from the dry calibration gas flow velocity as shown in Equation 6-9.

Equation 6-9 Wet-calibration gas flow velocity

$$V_{WetCal} = WetCalFunction(V_{DryCal})$$

where

V_{WetCal} = wet-calibration gas flow velocity (m/s) (**AvgFlow**)

V_{DryCal} = dry-calibration gas flow velocity (m/s) (**DryCalVel**)

$WetCalFunction(x)$ = selected wet calibration function

Piece-wise linearization

If the 12-point piece-wise linearization (PWL) wet calibration method is selected, then the dry-calibration gas flow velocity is calculated as shown in Equation 6-10.

The inputs to the 12-point piece-wise linearization are the (up to) 12 pairs of volumetric flow rate and meter factor for each flow direction ([**FwdFlwRt1**, **FwdMtrFctr1**], ..., [**FwdFlwRt12**, **FwdMtrFctr12**] for forward flow; [**RevFlwRt1**, **RevMtrFctr1**], ..., [**RevFlwRt12**, **RevMtrFctr12**] for reverse flow). Refer to Section 5.7.3 for information on using the Daniel MeterLink **Field Setup Wizard** for entering these data point values.

NOTICE

The input flow rates should be entered in descending order (highest first) with their corresponding meter factors. If these are entered in the wrong order, the meter will still work but the accuracy may be affected. The meter will not accept negative values, so only positive values should be entered for both forward and reverse flow rates. If fewer than 12 points are to be used, the unused flow rate and meter factor pairs should be set to 0 and 1 respectively.

Equation 6-10 Wet Calibration - 12-Point Piece-wise linearization

$$V_{WetCal} = V_{DryCal} \times LinearMeterFctr$$

where

V_{WetCal} = wet-calibration gas flow velocity (m/s) (**AvgFlow**)

V_{DryCal} = dry-calibration gas flow velocity (m/s) (**DryCalVel**)

$LinearMeterFctr$ = linear meter factor (dimensionless) (**LinearMeterFctr**)

The linear meter factor is determined by the PWL inputs, the flow direction, and the dry-calibration gas flow velocity.

Third-order polynomial

If the third-order polynomial wet calibration method is selected, then the wet-calibration gas flow velocity is calculated as shown in Equation 6-11.

Equation 6-11 Wet calibration - third-order polynomial

$$V_{WetCal} = C_0 + C_1 V_{DryCal} + C_2 V^2_{DryCal} + C_3 V^3_{DryCal}$$

where

V_{WetCal}	=	wet-calibration gas flow velocity (m/s) (**AvgFlow**)
V_{DryCal}	=	dry-calibration gas flow velocity (m/s) (**DryCalVel**)
C_0	=	wet-calibration 0th order coefficient (m/s) (**FwdC0** or **RevC0**)
C_1	=	wet-calibration 1st order coefficient (dimensionless) (**FwdC1** or **RevC1**)
C_2	=	wet-calibration 2nd order coefficient (s/m) (**FwdC2** or **RevC2**)
C_3	=	wet-calibration 3rd order coefficient (s^2/m^2) (**FwdC3** or **RevC3**)

Note that the meter provides two sets of wet calibration polynomial coefficients - one set for each flow direction.

No wet calibration

If no wet calibration is selected, then the wet calibration gas flow velocity is equal to the dry calibration gas flow velocity.

6.1.9 Volumetric flow rate

The Daniel Mark III Ultrasonic Gas Flow Meter meter provides three volumetric flow rate values: raw, (expansion-corrected and/or profile-effect corrected) flow-condition, and base-condition. Note that a positive volumetric flow rate indicates flow in the forward direction whereas a negative volumetric flow rate indicates flow in the reverse direction.

Raw volumetric flow rate

The “raw” volumetric flow rate is calculated from the average gas flow velocity (wet-calibration gas flow velocity) as shown in Equation 6-12.

Equation 6-12 Raw volumetric flow rate

$$Q_{Raw} = V_{WetCal} \times \left[\frac{\pi D_{in}^2}{4}\right] \times 3600\ s/hr$$

where

Q_{Raw} = “raw” volumetric flow rate (m^3/h) (**QMeter**)

V_{WetCal} = wet-calibration gas flow velocity (m/s) (**AvgFlow**)

π = geometric constant, pi (dimensionless) (3.14159...)

D_{in} = pipe inside diameter (m) (**PipeDiam**)

Flow-condition volumetric flow rate

The flow-condition volumetric flow rate is the result of applying expansion correction and flow-profile correction to the raw volumetric flow rate as shown in Equation 6-13 subject to the low-flow cut-off. *If the resulting value is below the low-flow cut-off value, it is set to zero.* The low-flow cut-off volumetric flow rate (**CutRate**) is the specified low-flow velocity threshold (**ZeroCut)** converted to a volumetric flow rate.

Equation 6-13 Flow-condition volumetric flow rate

$$Q_{Flow} = (Q_{Raw})(ExpCorr_P)(ExpCorr_T)(CorrFctr)$$

where

Q_{Flow}	=	flow-condition volumetric flow rate (m^3/h) (**QFlow**)
Q_{Raw}	=	“raw” volumetric flow rate (m^3/h) (**QMeter**)
$ExpCorr_P$	=	expansion correction factor due to pressure (dimensionless) (**ExpCorrPressure**) calculated as shown in Equation 6-14
$ExpCorr_T$	=	expansion correction factor due to temperature (dimensionless) (**ExpCorrTemperature**) calculated as shown in Equation 6-16
$CorrFctr$	=	profile-effect correction factor (**CorrectionFactor**) calculated as shown in Equation 6-17

Pressure-effect expansion correction

The meter is capable of correcting the raw volumetric flow rate for the effect of pipe expansion due to pressure changes. Note that for the pressure-effect expansion correction factor to be calculated, the correction must be enabled (via the **EnableExpCorrPress** data point) and the flow-condition pressure must be available (i.e., the **EnablePressureInput** data point must be set to ‘Live’(1) or ‘Fixed’(2), see Section 5.6.12). The pressure-effect calculation is shown in Equation 6-14. If the pressure-effect expansion correction factor is *not* calculated, it is set to 1.0.

Equation 6-14 Pressure-effect expansion correction

$$ExpCorr_P = 1 + [3 \times \beta \times (P_{abs,f} - P_{ref})]$$

where

$ExpCorr_P$	=	expansion correction factor due to pressure (dimensionless) (**ExpCorrPressure**)
β	=	pipe strain per unit stress ($MPaa^{-1}$) (**StrainPerUnitStress**) calculated as shown in Equation 6-15
$P_{abs,f}$	=	flow-condition absolute pressure (MPaa) (**AbsFlowPressure**) calculated as shown in Equation 6-23
P_{ref}	=	reference absolute pressure (MPaa) (0.101325 MPaa)

Equation 6-15 Pressure-effect strain per unit stress

$$\beta = \frac{[D_{out}^2(1+\upsilon)] + [D_{in}^2(1-2\upsilon)]}{E \cdot (D_{out}^2 - D_{in}^2)}$$

where

β	=	pipe strain per unit stress (MPaa^{-1}) (**StrainPerUnitStress**)
D_{out}	=	outside diameter of the meter or pipe (m) (**PipeOutsideDiameter**)
D_{in}	=	inside diameter of the meter or pipe (m) (**PipeDiam**)
υ	=	Poisson's Ratio (dimensionless) (**PoissonsRatio**)
E	=	Young's Modulus of elasticity (MPaa) (**YoungsModulus**)

Temperature-effect expansion correction

The meter is capable of correcting the raw volumetric flow rate for the effect of pipe expansion due to temperature changes. Note that for the temperature-effect expansion correction factor to be calculated, the correction must be enabled (via the **EnableExpCorrTemp** data point) and the flow-condition temperature must be available (i.e., the **EnableTemperatureInput** data point must be set to 'Live'(1) or 'Fixed'(2), see Section 5.6.12). The temperature-effect calculation is shown in Equation 6-16. If the temperature-effect expansion correction factor is *not* calculated, it is set to 1.0.

Equation 6-16 Temperature-Effect Expansion Correction

$$ExpCorr_T = 1 + [3 \times \alpha \times (T_f - T_{ref})]$$

where

$ExpCorr_T$	=	expansion correction factor due to temperature (dimensionless) (**ExpCorrTemperature**)
α	=	pipe linear expansion coefficient due to temperature (K-1) (**LinearExpansionCoef**)
T_f	=	flow-condition temperature (K) (**FlowTemperature**)
T_{ref}	=	reference temperature for the pipe linear expansion coefficient (K) (**RefTempLinearExpCoef**)

Profile-effect correction

JuniorSonic™ meters (device numbers 3410, 3420, and 3450) require profile-effect correction. All other meters do not require profile-effect correction and the profile-effect correction factor is set to 1.

For meter types that require profile-effect correction, the correction factor can be either user-specified or meter-calculated depending upon the value of the **SpecCorrectionFactor** data point: if set to 0.0, then the correction factor is meter-calculated; if set within [0.90, 1.05], then the specified value is used.

Calculating the meter factor requires that the flow-condition pressure and temperature be live or fixed and that the AGA8 calculations are performed either internally or externally. If the profile-effect correction factor is to be meter-calculated *but* either the flow-condition pressure and/or temperature are/is disabled or the AGA8 calculations are not performed, then the flow-condition correction factor is set to the default value of 0.95. Otherwise, it is calculated as shown in Equation 6-17.

Equation 6-17 Profile-effect correction factor

$$CorrFctr = 1 + \frac{0.242}{\log\left(0.2703\frac{WR}{D_{in}} + \frac{0.835}{Re^{0.8}}\right)}$$

where

$CorrFctr$	=	flow-profile correction factor (**CorrectionFactor**)
WR	=	pipe wall roughness (m) (**WallRoughness**)
D_{in}	=	pipe inside diameter (m) (**PipeDiam**)
Re	=	Reynolds Number (dimensionless) (**ReynoldsNumber**) calculated as shown in Equation 6-18

Reynolds number

Reynolds Number is a dimensionless value that represents the nature of the gas flow within the pipe. Although the primary reason for calculating Reynolds Number is for JuniorSonic™ meter profile-effect correction, the value is calculated for all meter types.

Reynolds Number is calculated as shown in Equation 6-18.

Equation 6-18 Reynolds number

$$Re = MAX\left[(PathFactor)\left(\frac{4}{\pi}\right)\left(\frac{Q_{Raw}\ \rho_{(P_f,T_f)}}{D_{in}\ \mu}\right), 10^4\right]$$

where

Re	=	Reynolds Number (dimensionless) (**ReynoldsNumber**)
MAX	=	maximum function that takes the maximum of the values within the brackets
$PathFactor$	=	factor to (approximately) correct for velocity profile effects (0.94 for JuniorSonic™ meters, 1.00 for SeniorSonic™ meters) (dimensionless)
π	=	geometric constant, pi (dimensionless) (3.14159...)
Q_{Raw}	=	"raw" volumetric flow rate (m^3/h) (**QMeter**)
$\rho_{(P_f,T_f)}$	=	natural gas mixture mass density at the flow condition (either calculated as part of internal AGA8 calculations or specified via **SpecRhoMixFlow**) (kg/m3) (**RhoMixFlow**)
D_{in}	=	pipe inside diameter (m) (**PipeDiam**)
μ	=	dynamic viscosity (Pa • s) (**Viscosity**)

Base-condition volumetric flow rate

The base-condition volumetric flow rate is the result converting the flow-condition volumetric flow rate to the base pressure-temperature condition. This conversion requires (1) AGA8 calculations to be either performed internally (i.e., by the meter) or externally (with the resulting compressibilities specified to the meter via the **SpecZFlow** and **SpecZBase** data points), and (2) the flow-condition temperature and pressure to be live or fixed. If AGA8 calculations are not performed (i.e., neither internally nor externally) or the flow-condition temperature and/or pressure are/is not enabled, then the base-condition volumetric flow rate is set to zero.The base-condition volumetric flow rate is calculated as shown in Equation 6-19.

Equation 6-19 Base-condition volumetric flow rate

$$Q_{Base} = Q_{Flow}\left(\frac{P_{abs,\,f}}{P_{abs,\,b}}\right)\left(\frac{T_b}{T_f}\right)\left(\frac{Z_b}{Z_f}\right)$$

where

Q_{Base} = “raw” volumetric flow rate (m^3/h) (**QMeter**)

Q_{Flow} = flow-condition volumetric flow rate (m^3/h) (**QFlow**)

$P_{abs,\,b}$ = base-condition absolute pressure (MPaa) (**PBase**)

$P_{abs,\,f}$ = flow-condition absolute pressure (MPaa) (**AbsFlowPressure**) calculated as shown in Equation 6-23

T_b = base-condition temperature (K) (**TBase**)

T_f = flow-condition temperature (K) (**FlowTemperature**)

Z_b = base-condition compressibility factor (**ZBase**)

Z_f = flow-condition compressibility factor (**ZFlow**)

6.1.10 Volume

The Daniel Mark III Ultrasonic Gas Flow Meter meter provides forward and reverse volume accumulators for each of the three volumetric flow rate values: raw, flow-condition (raw with expansion and/or profile correction), and base-condition. Each volume accumulator is actually stored as a data pair: (64-bit unsigned integer portion, 32-bit floating point fractional portion). For example, a volume of 12345.750 m^3 is stored as 12345 m^3 for the integer portion and 0.750 m^3 as the fractional portion. Note that while a volumetric flow rate can be positive (indicating forward flow) or negative (indicating reverse flow), the volume accumulators are always positive values.

The non-volatile volume accumulator data points are as listed in the table below:

Table 6-3 Volume Accumulation Data Points

Volumetric flow rate type	Forward direction		Reverse direction	
	Integer	Fraction	Integer	Fraction
Raw	PosVolUncorr	PosVolUncorrFrac	NegVolUncorr	NegVolUncorrFrac
Flow-condition	PosVolFlow	PosVolFlowFrac	NegVolFlow	NegVolFlowUncorr
Base-condition	PosVolBase	PosVolBaseFrac	NegVolBase	NegVolBaseUncorr

6.1.11 Triggered Delta Volumes

The “triggered delta volume” feature provides the ability to measure total gas flow volume (flow- and base-condition) between two successive external event triggers.

To trigger an event, set the **DoUpdtTrigDeltaVols** data point to TRUE. This causes the meter to save the current accumulated flow- and base-condition volume values (forward and reverse). The meter then calculates the difference between these values and the corresponding values saved from the previous event trigger. Finally the meter writes the delta volume values to the appropriate data points (**TrigDeltaPosVolFlow**, **TrigDeltaNegVolFlow**, **TrigDeltaPosVol-Base**, and **TrigDeltaNegVolBase**) and sets the **DoUpdtTrigDeltaVols** data point to FALSE to clear the trigger and indicate the calculation completion.

The triggered delta volume functionality is retained across power cycles as the accumulated volumes values at the last event trigger are saved in non-volatile memory.

The delta volume data points are stored internally in non-volatile memory as double-precision floating point numbers. The delta volume data points can be read via Modbus as either 32-bit floating point values or as integer values (using the [overflow,lower] LONG register pair in a manner similar to reading the accumulated volumes).

Suggested user access logic

The following pseudo-code demonstrates the logic to access the triggered delta volume functionality:

INITIAL SET-UP:

Ensure Modbus units are set-up as desired: set Modbus register 10026 (**UnitsSystem**) to 0 for U.S. Customary units or to 1 for metric units.

PERIODIC LOOP:

Wait for external event for synchronizing the start of the meter delta volumes.

Send trigger Modbus message: set Modbus register 12199 (**DoUpdtTrigDeltaVols**) to 1 (TRUE).

Read trigger Modbus register 12199 (**DoUpdtTrigDeltaVols**) in a loop until it is read as 0 (FALSE) indicating that the delta volumes have been updated.

Read delta volume registers (either the FLOAT registers or the LONG register pairs) in a single Modbus read. If the delta volume registers are read as LONG register pairs, calculate each delta volume as follows:

Equation 6-20 Triggered Delta volume

$$DeltaVolume = (Overflow \times 1e9) + Lower$$

where

$DeltaVolume$	=	triggered delta volume (forward or reverse, flow-condition or base-condition) (m^3 or ft^3) (**TrigDeltaPosVolFlow, TrigDeltaNegVolFlow, TrigDeltaPosVolBase, TrigDeltaNegVolBase**)
$Overflow$	=	triggered delta volume overflow integer value (forward or reverse, flow-condition or base-condition) ($1e^9m^3$ or $1e^9ft^3$)
$Lower$	=	triggered delta volume lower integer value (forward or reverse, flow-condition or base-condition) (m^3 or ft^3)

Repeat "**PERIODIC LOOP**"

6.1.12 Energy rate and totals

The Daniel Mark III Ultrasonic Gas Flow Meter meter calculates the energy rate and energy totals (forward and reverse). These calculations requires that the flow-condition pressure and temperature are available (either fixed or optional analog inputs, see Section 6.1.15), the gas property data (composition and heating value) are available (either fixed or optionally read from a GC, see Section 6.1.16), and the AGA8 calculations are performed (internally by the meter or externally with the results written to the meter, see Section 6.1.17).

The energy rate is calculated as shown in Equation 6-22.

Equation 6-21 Energy rate

$$Q_E = Q_{Base} \times HV \times \frac{1MJ}{1000kJ} \times \frac{1000dm^3}{1m^3}$$

where

Q_E	=	energy rate (MJ/h) (**EnergyRate**)
Q_{Base}	=	base-condition volumetric flow rate (m^3/h) (**QBase**)
HV	=	“in-use” heating value (kJ/dm^3) (**HeatingValueInUse**)

The sign of the energy rate indicates the flow direction: a positive value indicates flow in the forward direction, a negative value indicates flow in the reverse direction.

The energy rate validity is indicated by the **EnergyRateValidity** data point TRUE(1) indicates valid). The energy rate is valid if the base-condition volumetric flow rate is valid (indicated by **QBaseValidity** where TRUE(1) indicates valid) and if the in-use gas properties are valid (indicated by **AreGasPropertiesInvalidInUse** where FALSE(0) indicates valid).

The energy rate is accumulated into the corresponding direction energy total regardless of the energy rate validity.

The forward and reverse direction energy totals are each stored in non-volatile memory as a data pair: a 64-bit unsigned integer portion and a 32-bit floating point fractional portion. For example, an energy total of 12345.750 MJ is stored as 12345 MJ for the integer portion and 0.750 MJ as the fractional portion. Note that while the energy rate can be positive (indicating forward flow) or negative (indicating reverse flow), the energy totals are always positive values.

The non-volatile energy total data points are as listed in the table below:

Table 6-4 Energy total data points

Forward direction		Reverse direction	
Integer	**Fraction**	**Integer**	**Fraction**
PosEnergy	**PosEnergyFrac**	**NegEnergy**	**NegEnergyFrac**

6.1.13 Mass rate and totals

The Daniel Mark III Ultrasonic Gas Flow Meter meter calculates the mass rate and mass totals (forward and reverse). These calculations requires that the flow-condition pressure and temperature are available (either fixed or optional analog inputs, see Section 6.1.15), the gas composition is available (either fixed or optionally read from a GC, see Section 6.1.16), and the AGA8 calculations are performed (internally by the meter or externally with the results written to the meter, see Section 6.1.17).

The mass rate is calculated as shown in Equation 6-22.

Equation 6-22 Mass rate

$$MassRate = Q_{Flow} \times \rho_{Flow}$$

where

$MassRate$ = mass rate (kg/h) (**MassRate**)

Q_{Flow} = flow-condition volumetric flow rate (m^3/h) (**QFlow**)

ρ_{Flow} = “in-use” flow-condition gas mass density (kg/m^3) (**RhoMixFlow**)

The sign of the mass rate indicates the flow direction: a positive value indicates flow in the forward direction, a negative value indicates flow in the reverse direction.

The mass rate validity is indicated by the **MassRateValidity** data point (TRUE(1) indicates valid). The mass rate is valid if the flow-condition volumetric flow rate is valid (indicated by **QFlowValidity** where TRUE(1) indicates valid) and if the AGA8 flow-condition calculation is valid (indicated by **AGA8FlowCalcValidity** where TRUE(1) indicates valid).

The mass rate is accumulated into the corresponding direction mass total regardless of the mass rate validity.

The forward and reverse direction mass totals are each stored in non-volatile memory as a data pair: a 64-bit unsigned integer portion and a 32-bit floating point fractional portion. For example, a mass total of 12345.750 kg is stored as 12345 kg for the integer portion and 0.750 kg as the fractional portion. Note that while the mass rate can be positive (indicating forward flow) or negative (indicating reverse flow), the mass totals are always positive values.

The non-volatile mass total data points are as listed in the table below:

Table 6-5 Mass Total Data Points

Forward direction		Reverse direction	
Integer	**Fraction**	**Integer**	**Fraction**
PosMass	**PosMassFrac**	**NegMass**	**NegMassFrac**

6.1.14 Seniorsonic flow characterizations

For Daniel Mark III Ultrasonic Gas Flow Meter SeniorSonic meters only, the following flow characterizations are calculated/estimated: symmetry, cross-flow, chord turbulence, profile factor, and swirl angle. Alarm limits are provided for the chord turbulence and swirl angle values.

Symmetry

Symmetry is a dimensionless measure of the flow symmetry comparing the upper chords to the lower chords and is readable via the **Symmetry** data point. Ideally the Symmetry should be 1.0.

Cross-flow

Cross-flow is a dimensionless measure of the flow symmetry comparing the chords on one side of the meter to the chords on the other side. It is readable via the **CrossFlow** data point. Ideally the Cross-flow should be 1.0.

Chord turbulence

Chord Turbulence is a estimate of the turbulence (percentage) at a chord location. A value is calculated for each active chord and is readable via the **TurbulenceA**, **TurbulenceB**, **TurbulenceC**, or **TurbulenceD** data points. A value of 0% indicates no appreciable turbulence.

Profile Factor

The profile factor is a dimensionless ratio of the inner chord velocities to the outer chord velocities. It is readable via the **ProfileFactor** data point. Ideally the Profile Factor should be 1.0 for Dual-X meters (model 3422) and 1.17 for British Gas-style meters (model 3400).

Swirl angle

The swirl angle is an estimate of the swirl (to the nearest degree) and is readable via the **SwirlAngle** data point. It is calculated as a function of the meter body style and Profile Factor (see above). A value of 0 degrees indicates no appreciable swirl.

6.1.15 Flow-condition pressure and temperature

The flow-condition pressure and temperature are used by the Daniel Mark III Ultrasonic Gas Flow Meter for various calculations such as

- expansion correction
- flow profile correction (JuniorSonic™ meters only)
- calculation of base (standard) condition volumetric flow rate and volumes
- optional AGA10 sound velocity calculation

Configuration

The flow-condition pressure and temperature are individually configurable (via the **EnablePressureInput** and **EnableTemperatureInput** data points) to be

- disabled (0),
- live (1) (4-20 mA input signal, requires the Option Board), or
- fixed (2).

If an input is live, then the values corresponding to the minimum and maximum input (4 and 20 mA, respectively) are specified via data points (**MinInputPressure**, **MaxInputPressure**, **MinInputTemperature**, **MaxInputTemperature**).

If an input is fixed, then its value is specified via a data point (**SpecFlowPressure**, **SpecFlowTemperature**).

Alarm limits can be specified for each input (**LowPressureAlarm**, **HighPressureAlarm**, **LowTemperatureAlarm**, **HighTemperatureAlarm**). Additionally, the flow-condition pressure is configurable to be gage or absolute (via the **InputPressureUnit** data point). If the pressure is gage, then the atmospheric pressure must be specified (via the **AtmosphericPress** data point). See Section 5.6.12 for details on configuring the flow-condition pressure and temperature.

Another data point (**FlowPOrTSrcUponAlarm**), common to both pressure and temperature, is used to specify the data source to use when the selected input data is invalid (i.e., value at or outside its alarm limits or a live input in calibration) as either

- last good value (0), or
- fixed value (1).

This data point (**FlowPOrTSrcUponAlarm**) is *not* configurable via the Daniel MeterLink **Field Setup Wizard**; however, it *is* configurable via the Daniel MeterLink **Edit/Compare Configuration** screen (**Tools→Edit/Compare Configuration**). The default is to use the last good value.

Data updates

When the Option Board is used, the Daniel Mark III Ultrasonic Gas Flow Meter samples the input analog signal(s) and updates the corresponding data point(s) (**LiveFlowPressure**, **LiveFlowTemperature**) once per second *regardless of the input selection* (disabled, live, or fixed).

Every five seconds, the meter updates the "in-use" flow-condition pressure and temperature values (**FlowPressure**, **AbsFlowPressure**, **FlowTemperature**) depending upon the input selection, validity of the input data, and the selected data source upon alarm according to Table 6-6.

Table 6-6 Flow-condition pressure and temperature data source

Input Type (**EnablePressureInput or EnableTemperatureInput**)	**Data Validity** (**PressureValidity or TemperatureValidity**)	**Data Source Upon Alarm** (**FlowPOrTSrcUponAlarm**)	**"In-Use" Data Source** (**FlowPressure or FlowTemperature**)
Disabled	N/A	N/A	"In-Use" value unchanged
Live	Valid	N/A	Average of live values (**LiveFlowPressure** or **LiveFlowTemperature**)
	Invalid*	Last good value	"In-Use" value unchanged
		Fixed	Fixed data point (**SpecFlowPressure** or **SpecFlowTemperature**)
Fixed	Valid	N/A	Fixed data point (**SpecFlowPressure** or **SpecFlowTemperature**)
	Invalid	Last good value	"In-Use" value unchanged
		Fixed	Fixed data point (**SpecFlowPressure** or **SpecFlowTemperature**)

*Live input can be invalid due to (a) one or more live values is/are at or outside the alarm limits, or (b) the input is being calibrated.

The flow-condition absolute flow pressure is calculated as shown in Equation 6-23.

Equation 6-23 Flow-Condition Absolute Pressure

$$P_{abs,f} = P_f + P_{Atmosphere} \qquad InputPressureUnit = FALSE(Gage)$$

$$P_{abs,f} = P_f \qquad InputPressureUnit = TRUE(Absolute)$$

where

$P_{abs,f}$	=	flow-condition absolute pressure (MPaa) (**AbsFlowPressure**)
P_f	=	flow-condition pressure (MPa if **InputPressureUnit**=FALSE, MPaa if **InputPressureUnit**=TRUE) (**FlowPressure**)
$P_{Atmosphere}$	=	(specified) atmospheric pressure (MPaa) (**AtmosphericPress**)

Live (Analog) Input Calibration

NOTICE

The Option Board is required for live (analog) inputs (flow-condition pressure and/or temperature).

NOTICE

Configuration protection must be disabled when calibrating a Mark III live (analog) input.

NOTICE

In Daniel MeterLink, to calibrate a live (analog) input, use the **Calibration|Analog** *Inputs Wizard* menu path. The *Start* screen is displayed first.

An analog input can be calibrated *regardless* of the corresponding input type (**EnablePressure-Input** or **EnableTemperatureInput**). However, if the corresponding input type is selected as *Live*, then the input being calibrated is considered to be invalid and the in-use value depends upon the **FlowPOrTSrcUponAlarm** selection (see above). In this case, the appropriate data point (**FlowPressureWhileCal**, **FlowTemperatureWhileCal**) is set to the in-use value so that it can be logged in the optional Audit log.

On the Daniel MeterLink **Analog Inputs Wizard Start** screen, select the analog input to calibrate and click on the **Next** button. The **Current Calibration** screen shows the current offset and gain and the input scaling (i.e., the pressures or temperatures corresponding to the minimum (4 mA) input and maximum (20 mA) inputs).

The offset and gain can be reset to the default values (0 and 1, respectively) by clicking the **Reset Defaults** button.

⚠CAUTION

Clicking the Reset Defaults button writes the offset and gain immediately - the previous values cannot be restored.

Click the **Edit Scaling** button to modify the input scaling.

⚠CAUTION

Changes to an analog input's offset, gain, and scaling values are written to the audit log.

From the **Current Calibration** screen, click the **Next** button to proceed to the **Calibration Method** screen to select between the offset and two-point calibration methods. The offset method requires a single calibration point and only affects the input's calibration offset parameter. The two-point calibration requires calibrating at two different points (ideally far apart in value) and affects the input's calibration offset and gain parameters. Depending upon the selected calibration method, either one or two screens will follow when the **Next** button is clicked. The screen(s) will show the current (live) reading. When the input is stable, click on the **Hold** button to freeze the current reading. Enter the correct value in the **Actual** edit box. Finally, the **Finish** screen shows the new calculated offset and gain values. Click on the **Finish** button to write the values to the meter. If the meter is not configured to use live values from the analog input for calculation, a prompt is displayed asking if the configuration should be changed to use the live input.

6.1.16 Gas properties

Gas property data (composition and heating value) are used by the meter for AGA8 calculations (for converting to base or standard volumes and for mass calculation), for energy calculation, and for optional AGA10 calculations (sound velocity calculation and comparison). The data are also used by JuniorSonic meters when the profile correction factor is to be calculated by the meter (rather than fixed or a default value). See Table 6-15 for GC registers polled by the meter.

The gas property data can either be fixed (specified via data points) or optionally read from a Daniel gas chromatograph (GC). Reading the gas property data from a GC requires both the Option Board (Port C) and a valid GC feature key (see Section 4.1.5).

Fixed gas property data

If the data is fixed, then the heating value and its reference temperature are specified via the **MeasVolGrossHeatingVal** and **RefTemperatureHV** data points, respectively; the gas components are specified via the data points listed in Table 6-7 below. Fixed gas property data is always assumed to be valid.

NOTICE

if the gas composition is specified from within Daniel MeterLink, the data points' unit is mole percentage, not mole fraction (as the data point name would imply).

Table 6-7 Fixed gas composition data points

Gas composition data points
MoleFractionN2Method2
MoleFractionCO2
MoleFractionH2
MoleFractionCO
MoleFractionMethane
MoleFractionEthane
MoleFractionPropane
MoleFractionIsoButane
MoleFractionNButane
MoleFractionIsoPentane
MoleFractionNPentane
MoleFractionNHexane
MoleFractionNHeptane
MoleFractionNOctane
MoleFractionNNonane
MoleFractionNDecane
MoleFractionH2S
MoleFractionHelium
MoleFractionWater
MoleFractionOxygen
MoleFractionArgon

Live (GC) gas property data

The purpose of this section is to give a brief overview of the gas property data read from a GC. Refer to Section 5.2 for information on configuring the Daniel Mark III Ultrasonic Gas Flow Meter (using the Daniel MeterLink program) for communicating with a Daniel GC. Refer to Section 6.5 for detailed information on interfacing the Daniel Mark III Ultrasonic Gas Flow Meter meter with a Daniel GC.

If the gas components are read from the GC, then the GC-reported heating value is readable via the **HeatingValueGC** data point. Note that type of heating value to be read from the GC must be specified via the **GCHeatingValueType** data point as either Btu-Dry, Btu-Saturated, or Btu-Actual.so that the correct GC register is read. Also, the heating value unit must be specified via the **GCHeatingValueUnit** data point as either Btu/ft^3, kJ/m^3, kJ/dm^3, MJ/m^3, kCal/m^3, or kWh/m^3. The GC-reported gas composition is readable via the data points listed in Table 6-8 below:

Table 6-8 GC-reported gas composition data points

GC reported composition data points
N2GC
CO2GC
H2GC
COGC
MethaneGC
EthaneGC
PropaneGC
IsoButaneGC
NButaneGC
IsoPentaneGC
NPentaneGC
NHexaneGC
NHeptaneGC
NOctaneGC
NNonaneGC
NDecaneGC
H2SGC
Heeling
WaterGC
OxygenGC
ArgonGC
C6PlusGC (C6PlusGCComponentID)
NeoPentaneGC

The validity of the GC-read gas property data is readable via the **AreGasPropertiesInvalidGC** data point where TRUE(1) indicates invalid data and FALSE(0) indicates valid data. Refer to Section 6.5.5 for further information on how the data validity is determined.

"In-Use" gas property data

The "In-Use" gas property data is the actual data used by the meter for calculations.

The **GasPropertiesSrcSel** data point is used to select the gas property data source as either *Fixed* (0) or *Live - GC* (1). If the data source is *Live - GC* and the GC-read data is invalid, then the **GasPropertiesSrcSelGCAlarm** data point is used to select the data source as either *Last good value* (0) or *Fixed value* (1). When *Last good value* is selected, the "In-Use" gas property data is not updated with the invalid GC-read gas property data. When *Fixed value* is used, the "In-Use" gas property data is updated with the fixed gas property data.

The meter maps the appropriate input gas property data points (fixed or GC-reported as discussed above) to the corresponding "In-Use" data points (the **HeatingValueInUse** data point and the gas composition data points listed in the Table 6-9 below).

Table 6-9 "In-Use" gas composition data points

"In-Use" gas composition data points
N2InUse
CO2InUse
H2InUse
COInUse
MethaneInUse
EthaneInUse
PropaneInUse
IsoButaneInUse
NButaneInUse
IsoPentaneInUse
NPentaneInUse
NHexaneInUse
NHeptaneInUse
NOctaneInUse
NNonaneInUse
NDecaneInUse
H2SInUse
HeliumInUse
WaterInUse
OxygenInUse
ArgonInUse

The fixed gas component data points map directly to the corresponding “In-Use” gas component data points. The GC-reported gas component data points map directly to the corresponding “In-Use” gas component data points except for the **C_6PlusGC** and **NeoPentaneGC** components. The **C_6PlusGC** quantity is divided among the **NHexaneInUse**, **NHeptaneInUse**, and **NOctaneInUse** data points according to the component ID (**C_6PlusGCComponentID**) as listed in Table 6-10 below:

Table 6-10 C_6+ breakdown to standard components by component ID

C_6+ Component ID (C_6PlusGCComponentID)	Percentage to NHexaneInUse	Percentage to NHeptaneInUse	Percentage to NOctaneInUse
108	47.466	35.340	17.194
109	50.000	50.000	0.000
110	60.000	30.000	10.000
111	57.143	28.572	14.285

For example, if the **C_6PlusGC** mole percentage is 1% and its component ID is 110, then 60% of the C_6+ mole percentage (0.60x1%=0.60%) is added to **NHexaneInUse**, 30% (0.30x1%=0.30%) is added to **NHeptaneInUse**, and 10% (0.10x1%=0.10%) is added to **NOctaneInUse**.

The GC-reported NeoPentane component (**NeoPentaneGC**) quantity is added to the IsoPentane component (**IsoPentaneInUse**).

The validity of the “In-Use” gas property data is readable via the **AreGasPropertiesInvalidInUse** data point where TRUE(1) indicates invalid data and FALSE(0) indicates valid data. The validity of the “In-Use” gas property data is a function of the validity of the selected source data. If the source data is selected as *Fixed*, then the “In-Use” gas property data is valid (since the fixed data is assumed to be valid). If the source data is selected as *Live - GC*, then the “In-Use” gas property data is valid only if the GC-read gas property data is valid.

6.1.17 AGA8 compressibility calculations

The Mark III meter utilizes AGA8 compressibility calculation results for profile-effect correction (for JuniorSonic™ meters) and flow-condition-to-base-condition of the volumetric flow rate.

The Mark III meter provides for five AGA8 method selections via the **HCH_Method** data point:

- external (0) with results specified to the meter (via the **SpecRhoMixFlow**, **SpecZFlow**, and **SpecZBase** data points)
- internal via Gross Method 1 (1)
- internal via Gross Method 2 (2)
- internal via Detail Method (3)
- None (4) (AGA8 calculations are not performed)

Refer to Section 5.6.14 for information on configuring the meter for AGA8 calculations via the Daniel MeterLink program.

6.2 Frequency, digital, and analog outputs

The Mark III meter provides two pairs of individually configurable frequency outputs (FO1A, FO1B, FO2A, and FO2B), four individually configurable digital outputs (DO1A, DO1B, DO2A, and DO2B), and an optional analog output (AO1 via the Option Board). The frequency and digital outputs are divided into two groups as follows:

- Group 1:FO1A, FO1B, DO1A, DO1B
- Group 2:FO2A, FO2B, DO2A, DO2B

The two members of a frequency output pair are referred to as channel “A” and the channel “B”.

Each group has a separate ground (i.e., Group1Gnd and Group2Gnd) thus allowing each output group to be connected to a different flow computer. Refer to Section 2.5.2 for further information on the hardware configuration options for these outputs.

The frequency, digital, and analog outputs are updated at the batch update period.

6.2.1 Frequency outputs

The following paragraphs describe the frequency output pair options in detail. Since each frequency output pair is individually configurable, the data point names are identical except for the pair identifier (‘1’ or ‘2’). For example, the frequency pair content data points are **Freq1Content** and **Freq2Content**. For brevity, they are identified as **Freq*X*Content** where ***X*** represents **1** or **2**.

Refer to Section 5.6.7 for information on configuring these outputs using the Daniel MeterLink **Field Setup Wizard**. The associated configuration data points can also be configured via the Daniel MeterLink **Edit/Compare Configuration** screen.

Frequency data content

Each frequency pair is configured via the **Freq*X*Content** data point to represent actual (uncorrected) flow rate (0), standard (corrected) flow rate (1), average flow velocity (2), average sound velocity (3), energy rate (4), or mass rate (5).

Frequency data flow direction

The frequency pair output represents the data content (selected via **Freq*X*Content**) when the flow direction is in the selected direction (selected via **Freq*X*Dir**). This option is available for all frequency content options *except* average sound velocity. The options are:

- REVERSE (0): the selected data content is output when the flow is in the reverse direction.
- FORWARD (1): the selected data content is output when the flow is in the forward direction.
- ABSOLUTE (2): the selected data content is output regardless of the flow direction.
- BI-DIRECTIONAL (3): the selected data content is output on channel “A” only when the flow is in the forward direction and on channel “B only when the flow is in the reverse direction.

Channel “B” operation on error

The frequency channel "B" can be configured to go to zero when the frequency data content is invalid by setting the **IsFreq*X*BZeroedOnErr** data point to TRUE (1). Setting this data point to FALSE (0) causes channel “B” to remain a copy of the “A” channel upon error. This option is available for all frequency data flow direction options *except* bi-directional.

Channel “B” phase

The Frequency Channel “B” phase relative to the channel “A” phase is selectable (via the **Freq*X*BPhase** data point) from the following options:

Table 6-11 FreqXB phase options

FreqXBPhase Value	Flow Direction	Phase Relationship		
0	forward	channel “B”	lags	channel “A” by 90 degrees
	reverse	channel “B”	leads	channel “A” by 90 degrees
1	forward	channel “B”	leads	channel “A” by 90 degrees
	reverse	channel “B”	lags	channel “A” by 90 degrees

This option is available for all frequency data flow direction options *except* bi-directional.

This selection only matters if the device to which the frequency outputs are connected are configured for Dual Pulse security and phase detection.

Maximum frequency

The maximum frequency is selectable as either 1000 Hz or 5000 Hz (via the **Freq*X*MaxFrequency** data point). The Mark III meter can overrange the selected maximum frequency up to 150% of the selected maximum frequency.

Frequency value data points

The value of each frequency output is readable via a data point (**Freq1ChnlA**, **Freq1ChnlB**, **Freq2ChnlA**, and **Freq2ChnlB**).

Volumetric flow rate content output scaling

When the frequency output pair represents either uncorrected or corrected volumetric flow rate (selected via the **Freq*X*Content** data point), then the full-scale volumetric flow rate is specified via the **FreqXFullScaleVolFlowRate** data point. This is the volumetric flow rate that corresponds to the selected maximum frequency and determines the frequency output pair's K-Factor value (readable via the **Freq*X*KFactor** data point). The minimum frequency output (0 Hz) corresponds to zero flow rate.

Velocity content output scaling

When the frequency output pair represents either average gas or sound velocity (selected via the **Freq*X*Content** data point), then the maximum scale velocity is specified via the **Freq*X*MaxVel** data point and the minimum scale velocity is specified via the **Freq*X*MinVel** data point. These points respectively correspond to the maximum frequency output (selected via **Freq*X*MaxFrequency**) and the minimum frequency output (0 Hz).

Energy rate output scaling

When the frequency output pair represents the energy rate (selected via the **Freq*X*Content** data point), then the full-scale energy rate is specified via the **Freq*X*FullScaleEnergyRate** data point. This is the energy rate that corresponds to the selected maximum frequency and determines the frequency output pair's "energy K-Factor" value (readable via the **Freq*X*EnergyKFactor** data point). The minimum frequency output (0 Hz) corresponds to zero energy rate.

Mass rate output scaling

When the frequency output pair represents the mass rate (selected via the **Freq*X*Content** data point), then the full-scale mass rate is specified via the **Freq*X*FullScaleMassRate** data point. This is the mass rate that corresponds to the selected maximum frequency and determines the frequency output pair's "mass K-Factor" value (readable via the **Freq*X*MassKFactor** data point). The minimum frequency output (0 Hz) corresponds to zero mass rate.

Frequency feedback

Frequency feedback is applicable only when the frequency represents a rate (actual or standard volumetric flow rate, energy rate, or mass rate). When frequency feedback is used, the frequency output signal is fed-back into the processor so that error (due to frequency quantization) can be corrected. Frequency quantization is what happens when the desired frequency cannot be exactly represented (since infinite granularity cannot be achieved). The **Freq*X*FeedbackCorrectionPcnt** data point specifies the percentage of the error correction. Typically, this percentage is quite small since in most cases the error is quite small and fluctuates "naturally" about zero. This point is not modifiable via the Daniel MeterLink **Field Setup Wizard** but is editable via the **Edit/Compare Configuration** screen. It is recommended that the **FreqXFeedbackCorrectionPcnt** *not* be modified from its default value of 1%. Setting **Freq*X*FeedbackCorrectionPcnt** to zero effectively disables frequency feedback.

Frequency test mode

The Mark III meter provides a mode of operation for individually testing the frequency output signal pairs. Entering, configuring, and exiting this mode is accomplished by setting data points using the Daniel MeterLink **Tools - Outputs Test** screen as described in the table below. Note that when a frequency output pair is in the test mode, the frequency output is considered to be invalid since it does not represent the selected frequency content.

Table 6-12 Data points for frequency outputs test

Daniel MeterLink Display Name	Data Points, Options and Guidelines
Frequency output 1 Output setting or Frequency output 2 Output setting	Data points affected: • Freq1TestModeOutputPercent • Freq2TestModeOutputPercent Options: • Enter the integer percentage of full scale for the corresponding frequency output pair within the range [0, 150 %] where full scale is as specified via the corresponding **Freq1MaxFrequency** or **Freq2MaxFrequency** data point. Guidelines: • The specified test value takes effect within one batch period of clicking the Start button (see below). • For options and guidelines, see timeout discussion below and Daniel MeterLink online help.
Frequency output 1 Start(Stop) or Frequency output 2 Start(Stop)	Data points affected: • IsFreq1EnableTest • IsFreq2EnableTest Options: • Click on the Start button to enter the test mode (TRUE) (Note: the Start button will become the Stop button after clicking on it.) • Click on the Stop button to exit the test mode (FALSE) (Note: the Stop button will become the Start button after clicking on it.) Guidelines: • The specified test value takes effect within one batch period of clicking the Start button (see below). • For further information, see timeout discussion below and Daniel MeterLink online help.

The maximum length of time that a frequency output pair can remain in the test mode is specified via the **NonNormalModeTimeout** data point. Note that this data point applies to *both* frequency output pairs (as well as various other tests). The **NonNormalModeTimeout** data point can be changed using the Daniel MeterLink **Edit/Compare Configuration** screen. It can be set within the range [1, 30 min] and has a default value of 2 min.

6.2.2 Digital outputs

The following paragraphs describe the digital output configuration options.

Refer to Section 5.6.10 for information on configuring these outputs using the Daniel MeterLink **Field Setup Wizard**. The associated configuration data points can also be configured via the Daniel MeterLink **Edit/Compare Configuration** screen.

Digital output data content

The group 1 digital outputs are configured via the **DO1AContent** and **DO1BContent** data points to represent the Frequency 1 data validity (0) or the flow direction (2).

The group 2 digital outputs are configured via the **DO2AContent** and **DO2BContent** data points to represent the Frequency 2 data validity (1) or the flow direction (2).

Digital output data polarity

When a digital output represents frequency data validity, the normal polarity is for the signal to be:

- a logic ‘high’ when the frequency is valid, and
- a logic ‘low’ when the frequency is invalid.

When a digital output represents the flow direction, the normal polarity is for the signal to be:

- a logic ‘high’ when the flow is in the forward direction, and
- a logic ‘low’ when the flow is in the reverse direction.

The **DO1AIsInvPolarity**, **DO1BIsInvPolarity**, **DO2AIsInvPolarity**, and **DO2BIsInvPolarity** data points are used to configure the digital output polarities as follows:

- FALSE - normal polarity (default setting), or
- TRUE - inverted polarity

Digital output value data points

The value of each digital output is readable via a data point (**DO1A**, **DO1B**, **DO2A**, and **DO2B**).

Digital output test mode

The Mark III meter provides a mode of operation for individually testing the digital output signal pairs. Entering, configuring, and exiting this mode is accomplished by setting data points using the Daniel MeterLink **Tools - Outputs Test** screen as described in the table below.

Table 6-13 Data points for digital outputs test

Daniel MeterLink Display Name	Data Points, Options and Guidelines
Digital output 1 Output 1A or Digital output 1 Output 1B or Digital output 2 Output 2A or Digital output 2 Output 2B	Data points affected: • DO1ATestVal • DO1BTestVal • DO2ATestVal • DO2BTestVal Options: • Select either Test Low(0) to force the corresponding output low or Test High(1) to force the corresponding output high. Guidelines: • The selected test value takes effect within one batch period of clicking the Start DO1 or Start DO2 button (see below). • For options and guidelines, see timeout discussion below and Daniel MeterLink online help.
Start(Stop) DO1 or Start(Stop) DO2	Data points affected: • DO1PairTestEnable • DO2PairTestEnable Options: • Click on the Start button to enter the test mode (TRUE) (Note: the Start button will become the Stop button after clicking on it.) • Click on the Stop button to exit the test mode (FALSE) (Note: the Stop button will become the Start button after clicking on it.) Guidelines: • The selected test value (see above) takes effect within one batch period of clicking the Start DO1 or Start DO2 button. • For further information, see timeout discussion below and Daniel MeterLink online help.

The maximum length of time that a digital output pair can remain in the test mode is specified via the **NonNormalModeTimeout** data point. Note that this data point applies to *both* digital output pairs (as well as various other tests). The **NonNormalModeTimeout** data point can be changed using the Daniel MeterLink **Edit/Compare Configuration** screen. It can be set within the range [1, 30 min] and has a default value of 2 min.

6.2.3 Analog (Current) output

When the Option Board is used, the Daniel Mark III Ultrasonic Gas Flow Meter provides a configurable 4-20 mA analog output signal. For the following discussion, the minimum output is assumed to be 4 mA and the maximum output is assumed to be 20 mA although the actual output range is [3.5, 21 mA].

Refer to Section 5.6.8 for information on configuring this output using the Daniel MeterLink **Field Setup Wizard**. The associated configuration data points can also be configured via the Daniel MeterLink **Edit/Compare Configuration** screen.

With the Expansion Board with HART® is installed, an additional Analog Output is HART® capable that can be configured as a conventional analog output or used to communicate with the meter via a 375 Field Communicator or using AMS™ Suite software. Refer to Section 3.4 and *Daniel HART Field Device Specification for Daniel Gas Ultrasonic Flow Meters Manual (*P/N 3-9000-754) for analog output configuration details.

Analog output data content

The analog output is configured via the **AO1Content** data point to represent uncorrected flow rate (0), corrected flow rate (1), average flow velocity (2), average sound velocity (3), energy rate (4), or mass rate (5).

Analog output data flow direction

The analog output represents the data content (selected via **AO1Content w**ith the Expansion Board or **AO2Content** with the Expansion Board with HART® installed) when the flow direction is in the selected direction (selected via **AO1Dir** with the Expansion Board or **AO2Dir** with the Expansion Board with HART® installed).

The options are:

- REVERSE (0): the selected data content is output when the flow is in the reverse direction.
- FORWARD (1): the selected data content is output when the flow is in the forward direction.
- ABSOLUTE (2): the selected data content is output regardless of the flow direction.

Analog output value data point

The analog output value is readable via the **AO1Output** data point with the Expansion Board or **AO2Output** data point **(**with the Expansion Board with HART® installed).

Volumetric flow rate content output scaling

When the analog output represents either uncorrected or corrected volumetric flow rate, selected via the **AO1Content** or **AO2Content** (with the Expansion Board with HART® installed) data point(s), then the full-scale volumetric flow rate is specified via the **AO1FullScaleVolFlowRate** data point or via **AO2FullScaleVolFlowRate** with the Expansion Board with HART® installed. This is the volumetric flow rate that corresponds to the maximum current output (20 mA). The minimum current output (4 mA) corresponds to zero flow rate. The analog output is forced to 3.5 mA when the selected data content is invalid.

Velocity content output scaling

When the analog output represents either average gas or sound velocity (selected via the **AO1Content** data point or **AO2Content** with the Expansion Board with HART® installed), then the maximum scale velocity is specified via the **AO1MaxVel** or **AO2MaxVel** (with the Expansion Board with HART® installed) data point and the minimum scale velocity is specified via the **AO1MinVel or AO2MinVel** with the Expansion Board with HART® installed) data point. These points respectively correspond to the maximum output (20 mA) and the minimum output (4 mA). The analog output is forced to 3.5 mA when the selected data content is invalid.

Energy rate output scaling

When the analog output represents the energy rate (selected via the **AO1Content** data point or **AO2Content** with the Expansion Board with HART® installed), then the full-scale energy rate is specified via the **AO1FullScaleEnergyRate** data point or **AO2FullScaleEnergyRate** (with the Expansion Board with HART® installed). This is the energy rate that corresponds to the maximum output (20 mA). The minimum output (4 mA) corresponds to zero energy rate. The analog output is forced to 3.5 mA when the energy rate is invalid.

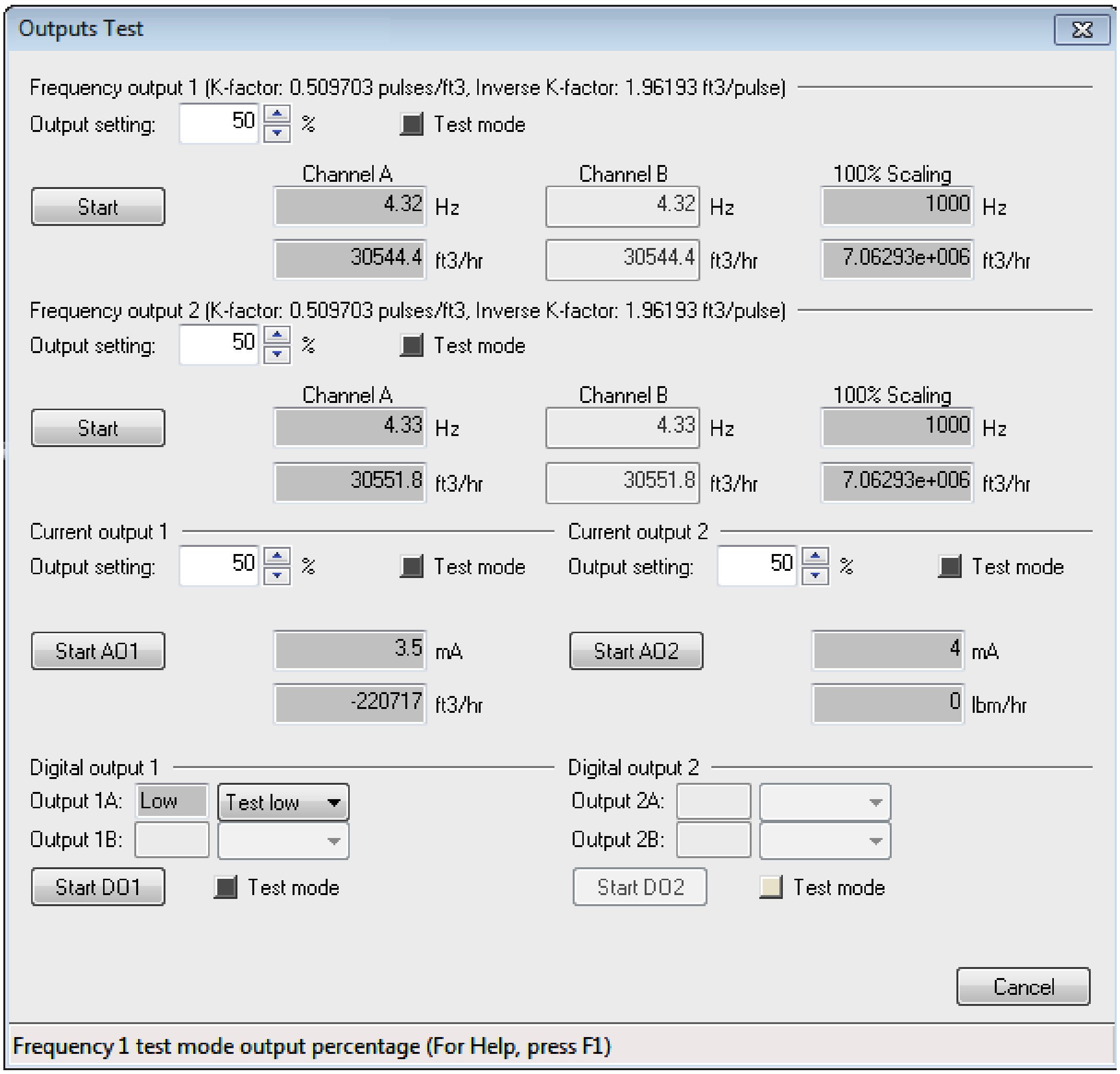
Mass rate output scaling

When the analog output represents the mass rate (selected via the **AO1Content** data point or **AO2Content** with the Expansion Board with HART® installed), then the full-scale mass rate is specified via the **AO1FullScaleMassRate** data point or **AO2FullScaleMassRate** (with the Expansion Board with HART® installed). This is the mass rate that corresponds to the maximum output (20 mA). The minimum output (4 mA) corresponds to zero mass rate. The analog output is forced to 3.5 mA when the mass rate is invalid.

Outputs test mode

The Daniel 3410 Series Gas Ultrasonic Flow Meter provides a mode of operation for testing the frequency, current (analog) and digital output signals. Group 1:FO1A, FO1B, DO1A, DO1B Group 2:FO2A, FO2B, DO2A,

Figure 6-5 Meter Outputs Test page



The Outputs Test dialog box allows you to monitor the live values of all the frequency, current (analog) and digital outputs. Additionally the outputs can be set into a Test mode to force the outputs to a specific user defined value. This dialog box is only available while connected to a meter.

When the dialog box first opens, the available Outputs show the current "Live" values the outputs are driving. The LED Test mode will remain gray while not in Test mode.

To fix the frequency and current outputs to a user-defined value, enter the desired percentage of full-scale into the Output setting. Each output available has individual output control and can be set from 0 to 150%. The 100% Scaling indicates the full scale value for the frequency outputs and can be changed from the **Field Setup Wizard**.

Click the **Start** button to enter Test mode. Each output has its own start button so each available output can be tested one at a time. The frequency and current outputs will not be updated until the end of the next batch cycle. Once the Test mode LED turns green, the values displayed for the outputs will represent the values the outputs are driving under test.

For the frequency outputs, the frequency for both the A and B channels are displayed. If **Channel B zero on error** is selected in the Field Setup Wizard the Channel B phase will show zero because the frequency output is considered invalid during test mode.

The K-Factor and Inverse K-Factor will be displayed for the frequency outputs configured for Volumetric flow rate. The values will be displayed next to the label for the associated frequency output.

To set the digital outputs to a known state, select the Test High or Test Low for the appropriate digital output and click the **Start** button for the digital output. Once the Test mode LED turns green, the value displayed for the outputs will represent the values the outputs are driving under test.

For Daniel Gas Ultrasonic meters, the timeout for each output in test mode is reset by Daniel MeterLink each time the values are updated. As long as this dialog is open with an output in test mode, the output will remain in test mode or until the **Stop** button is clicked to end the test.

In the event communications are lost between Daniel MeterLink and the meter (before a test mode is stopped), the meter will automatically end the test mode after the **NonNormalMode-Timeout** has expired. This can be from 1 to 30 minutes depending on its settings. By default, the timeout is set to two minutes.

The Output setting can only be changed while out of Test mode. To end the Test mode, click **Stop** and wait for the end of the batch and the Test mode LED to turn gray to indicate the Outputs are driving live values.

Click **Cancel** to close the dialog box. If the meter is currently in Test mode when Cancel is clicked, Daniel MeterLink will first end the test mode before returning to the Main Screen.

Entering, configuring, and exiting this mode is accomplished by setting data points using the Daniel MeterLink **Tools - Outputs Test** screen as described in Table 6-14.

Table 6-14 Data points for output test mode

Daniel MeterLink Display Name	Data Points, Options and Guidelines
Current output Output setting (Option Board)	Data points affected: • AO1TestModeOutputPercent Options: • Enter the integer percentage of full scale for the analog output within the range [0, 100 %] where 0% corresponds to the minimum output (4 mA) and 100% corresponds to the maximum output (20 mA). Guidelines: • The specified test value takes effect within one batch period of clicking the Start button (see below).

Table 6-14 Data points for output test mode

Daniel MeterLink Display Name	Data Points, Options and Guidelines
Current output Start(Stop)AO1 (Option Board)	Data points affected: • IsAO1EnableTest Options: • Click on the StartAO1 button to enter the test mode (TRUE) (Note: the Start button will become the Stop button after clicking on it.) • Click on the StopAO1 button to exit the test mode (FALSE) (Note: the Stop button will become the Start button after clicking on it.) Guidelines: • The specified test value takes effect within one batch period of clicking the Start button (see below).
Current output Output setting (Expansion Board with HART®)	Data points affected: • AO2TestModeOutputPercent Options: • Enter the integer percentage of full scale for the analog output within the range [0, 100 %] where 0% corresponds to the minimum output (4 mA) and 100% corresponds to the maximum output (20 mA). Guidelines: • The specified test value takes effect within one batch period of clicking the Start button (see below).
Current Output Start/StopAO2 (Expansion Board with HART®)	Data points affected: • IsAO2EnableTest Options: • Click on the StartAO2 button to enter the test mode (TRUE) (Note: the Start button will become the Stop button after clicking on it.) • Click on the StopAO2 button to exit the test mode (FALSE) (Note: the Stop button will become the Start button after clicking on it.) Guidelines: • The specified test value takes effect within one batch period of clicking the Start button (see below).

The maximum length of time that the analog output can remain in the test mode is specified via the **NonNormalModeTimeout** data point. Note that this data point applies to other tests as well. The **NonNormalModeTimeout** data point can be changed using the Daniel MeterLink **Edit/Compare Configuration** screen. It can be set within the range [1, 30 min] and has a default value of 2 min.

6.3 Digital Input

The Mark III meter provides one digital input (referred to as DI1). The polarity of the input is configured via the **DI1IsInvPolarity** data point as follows:

- FALSE - normal polarity (default setting), or
- TRUE - inverted polarity

The digital input is not configurable via the Daniel MeterLink **Field Setup Wizard**. It must be configured via the Daniel MeterLink **Edit/Compare Configuration** screen.

The value of the input is accessible via the **DI1** data point.

6.4 Modbus communication

The Mark III meter supports ASCII and RTU Modbus communication. For ASCII Modbus, both 7E1 and 7O1 are supported. For RTU Modbus, 8N1 is supported. The communication ports provide automatic protocol detection - only the baud rate and Modbus ID need to be specified. Refer to Section 5.2 for details on configuring the meter communication parameters.

Also, refer to the Daniel website:

http://www2.emersonprocess.com/EN-US/BRANDS/DANIEL/FLOW/Pages/Flow.aspx

for the current Modbus map file (Mark III Modbus Table 386K.xls), navigate to the following web pages:

Flow Meters>Daniel Liquid and Gas Ultrasonic Flow Meters>Daniel Seniorsonic 4-Path Ultrasonic Flow Meter>Documentation>Software Downloads>Software Updates

Flow Meters>Daniel Liquid and Gas Ultrasonic Flow Meters>Daniel Juniorsonic Gas Flow Meter>Documentation>Software Downloads>Software Updates

6.4.1 Mapping data points to Modbus Registers

The Mark III stores data in data points. The meter uses a Modbus map file to provide Modbus access to the data points. The Modbus map file contains information that cross references the Modbus registers with the associated Mark III data points and access units.

A different map file can be specified for each serial communication port. The default map file configuration is Map.txt for Port A, Map1.txt for Port B, and Map2.txt for optional Port C; however, at this time all the files are identical.

The Mark III maintains backward compatibility to Mark II Modbus registers whenever possible. Mark III data points that do not map to Mark II Modbus registers have been assigned register numbers outside of the range used by the Mark II. String-type data points are not accessible via Modbus since Modbus does not support that data type.

For backward compatibility to the Mark II, Modbus registers within the range 1-9999 are always read in metric units. All other registers (i.e., those numbered 10000 and above) can be read in either U.S. Customary or metric units depending upon the selected meter units system. The volumetric flow rate registers units also depend upon the selected volumetric flow rate time unit. These selections are configured via the Daniel MeterLink **Field Setup Wizard - General** page (see Section 5.6.6).

For example, if the Mark III meter is configured for U.S. Customary units and volume-per-day, then **QFlow** will be read via Modbus register 10624 in units of cubic feet per day.

For Modbus access information for a *particular* data point, consult Daniel MeterLink online help. (There is a help topic for each data point. From Daniel MeterLink click on Help, click on Mark III Registers Reference, select the Index tab, start typing the data point name until the desired point is highlighted, and then click the Display button.)

6.4.2 Log record access

Due to the Mark III meter's enhanced log retrieval methods, accessing log records via Modbus communication is not supported. All log records (daily, hourly, audit, alarm, and system) are accessible via Daniel MeterLink (see Section 6.6) when the optional Log Access feature is enabled (see Section 4.1.4).

6.5 Optional gas chromatograph interface

The Daniel Mark III Ultrasonic Gas Flow Meter can optionally interface with any Daniel gas chromatograph (GC) that supports the SIM2251 mode to read gas property data (such as for AGA8, AGA10, energy rate, mass rate, and/or JuniorSonic™ profile correction calculations).

NOTICE

The gas chromatograph interface is an optional feature that requires both the Option Board (for Serial Port C) and a valid GC feature key (see Section 4.1.5).

The following table lists the Gas Chromatograph SIM registers polled by the meter. Also refer to Daniel Engineering Specification Part Number ES-17128-005 Rev. B.

Table 6-15 Gas Chromatograph Sim 2251 Registers

Sim 2251 Register	Description
3034	Stream identifier
3041	Cycle time start - month (1-12)
3042	Cycle time start - day (1-31)
3043	Cycle time start - last two year digits
3044	Cycle time start - hour (0-23)
3045	Cycle time start - minutes (0-59)
3046	GC alarm bitmap 1
3047	GC alarm bitmap 2
3001 - 3016	Component codes
7001 - 7016	Mole fractions for corresponding component codes
7033	BTU (dry)
7034	BTU (sat)
7035	Specific gravity)
7038	Total unnormalized mole percent
7054	BTU (actual)

6.5.1 Hardware configuration

The Daniel Mark III Ultrasonic Gas Flow Meter communicates serially with the Daniel GC using Option Board Port C in either RS-232 or RS-485 (half duplex) mode. Refer to "Port C Driver Configuration" in Section 3.5.1 for further information on connecting the two devices.

6.5.2 Software configuration

It is recommended that the Daniel MeterLink **Field Setup Wizard** be used to configure the GC interface (see Section 5.6.13).

The **GasPropertiesSrcSel** data point is used to select whether the gas property data is live (read from a GC) or fixed. The **GCSerialPort** data point is used to either disable the GC interface or select (Option Board) Port C for communicating with the GC. These two points are automatically set via the Daniel MeterLink **Field Setup Wizard**.

The following information is required in order to configure the Daniel Mark III Ultrasonic Gas Flow Meter to interface with a GC:

- the GC Modbus communication configuration:
  - protocol (**GCProtocol**)
  - baud rate (**GCBaud**)
  - Modbus address (**GCModbusID**)
- the desired stream number (**GCStreamNumber**) and the length of time to wait for the desired stream number (**GCDesiredStreamTimeout**), and
- heating value configuration:
  - type of heating value (**GCHeatingValueType**)
  - unit (**GCHeatingValueUnit**)

The software configuration also allows for the selection of how the meter is to respond when the GC-read data is considered invalid (**GasPropertiesSrcSelGCAlarm**): whether to 'freeze' the 'in-use' gas property data to the last good GC-read data or to use fixed gas property data instead.

The length of time to wait for the desired stream (**GCDesiredStreamTimeout**) is *not* configurable within the Daniel MeterLink **Field Setup Wizard**. It is, however, configurable using the Daniel MeterLink **Edit/Compare Configuration** utility. Its default value is 100 minutes and limits are [6, 255 min]. The total number of streams and the update time per stream should be taken into account when updating this parameter.

6.5.3 Gas property data

The gas property data read from the GC includes gas composition, heating value, and specific gravity (relative density).

The gas composition includes the 21 standard components plus C_6+ and Neopentane (see Table 6-8 for a list of data point names). Refer to Section 6.1.16 for further information on how the GC-read gas properties are mapped to the 'in-use' gas property data points.

The GC-read heating value and specific gravity are stored in the **HeatingValueGC** and **Specific-GravityGC** data points, respectively.

6.5.4 Data polling

The meter periodically polls the GC looking for data updates. If the meter is communicating normally with the GC, then it polls the GC every one minute looking for an update (i.e., a change in the GC analysis time). Otherwise, the meter polls the GC every 15 seconds.

When the meter determines that a GC update is available for the specified stream number, it then reads the GC data using multiple reads one second apart until all the data is read. The GC analysis time is read again at the end of the data collection to determine if another update occurred during the data collection (i.e., the data is not all from the same update). If so, the meter discards the gas property data just read and begins looking immediately for the next update.

If the meter cannot successfully communicate with the GC after four consecutive polls (15 seconds apart), then the meter indicates the communication alarm via the **IsGCComErr** data point with the **GCCommStatus** data point indicating an error code (listed in Table 6-16 below).

Table 6-16 GC Communication status list

GCComm status value	Error description
0	No error.
1	Desired stream not found.
2	GC controller is busy (error defined by Modbus protocol).
3	GC detected an illegal Modbus function code from the meter.
4	GC detected an illegal Modbus data address from the meter.
5	GC detected an illegal data value from the meter.
6	Failure in associated device (Modbus defined error).
7	GC has accepted the meter's request but is still processing.
8	A firmware logic error was detected.
9	Modbus address mismatch.
10	Modbus function code mismatch.
11	GC reports an exception code that is unrecognized.
12	The meter's Modus request message is too long (exceeds the maximum allowable length).
13	The GC's Modbus response message is too long (exceeds the maximum allowable length).
14	GC response message has incorrect number of registers.
15	GC does not support the requested message data type.
16	GC does not support the requested data protocol.
17	GC response not received within the communication timeout.
18	GC response message (ASCII protocol) incomplete.

Table 6-16 GC Communication status list

GCComm status value	Error description
19	GC response message (RTU protocol) incomplete.
20	GC gas property data spans more than one update.

6.5.5 GC data validity

The GC-read gas property data validity is indicated by the **AreGasPropertiesInvalidGC** data point. The data is considered invalid if any of the conditions listed in Table 6-17 is true. These conditions are indicated by the Daniel MeterLink **Monitor** page **Field I/O** indicator.

Table 6-17 GC-read gas property invalid conditions

Indication Data Point	Condition
IsGCAlarmPresent	Invalid or expired GC feature key (see Section 4.1.5).
	Option Board Port C is not available (Option Board probably disconnected).
	Option Board Port C improperly configured (such as if configured without using the Daniel MeterLink **Field Setup Wizard**).
	Unrecognized gas component ID.
	Specified gas stream (**GCStreamNumber**) not found within the specified period (**GCDesiredStreamTimeout**).
	GC reported alarm (GC Alarm1 bits 14 and/or 15 set, GC Alarm2 bits 0, 1, 2, and/or 3 set).
IsGCWarningPresent	Not presently used - reserved for future use.
IsGCCommErr	Refer to communication error conditions listed in Table 6-16.
IsGCDataErr	The total unnormalized gas composition mole percentage is not within [85%, 115%].
	An individual gas composition mole percentage is not within [0%, 100%].
	The specific gravity is not within [0.2, 0.8].
	The heating value is greater than 50 kJ/dm^3.

6.5.6 GC alarm handling

The following data points are included in the meter's alarm log (see Section 6.6.4): **AreGasPropertiesInvalidGC**, **IsGCAlarmPresent**, **IsGCCommErr**, **GCCommStatus**, and **IsGCDataErr**.

6.6 Archive logs

The Mark III meter provides five types of data logs (daily, hourly, audit, alarm, and system logs) which meets the requirements set forth in the American Gas Association / American Petroleum Institute *Manual of Petroleum Measurement Standards*, Chapter 21.1, Flow Measurement Using Electronic Metering Systems (ref. [4]).

Each log type is discussed in detail below (Section 6.6.1 through Section 6.6.5) followed by instructions on using Daniel MeterLink to read (and optionally save) meter log records (Section 6.6.6).

NOTICE

Note that reading log records is an optional feature as described in general in Section 430 and in detail in Section 4.1.4.

Daily and hourly log data point actions

Five different log data point actions are supported by the daily and hourly logs: snapshot, average, flow-gated (average), totalize, and macro as described below:

- **Snapshot**: causes the data point's value at the log time to be recorded.
- **Average**: causes the data point's average value over the log interval (day or hour) to be recorded.
- **Flow-Gated**: causes the data point's flow-gated average value over the log interval (day or hour) to be recorded. A point's flow-gated average is the average of its values when the flow is above the low-flow cut-off. If the flow does not exceed the cut-off during the interval, then the data point's flow-gated average is the same as its regular (non-flow-gated) average.
- **Totalize**: causes the data point's accumulated value over the log interval (day or hour) to be recorded.
- **Macro**: causes the (boolean) data point's 'latched' value over the log interval (day or hour) to be recorded. A (boolean) data point's latched value indicates if the point was ever TRUE during the log interval (where a TRUE value is represented by a 1 and a FALSE value is represented by a 0). This allows a group of boolean data points to be grouped into a single integer value where each bit represents the latched value of a single boolean data point.

6.6.1 Daily log

The Mark III meter stores a daily log record once per day at the specified contract hour. (Refer to Section 5.10.1 for information on specifying the **ContractHour** data point.)

The meter can store up to 365 daily records. The user can select whether old, unread records can be overwritten by new records when the log becomes full via the data point **DoOverwriteUnreadDailyLog**. This point can be modified using the Daniel MeterLink Tools - Edit/Compare Configuration screen. The default is to overwrite old, unread records. Refer to Section 6.6.6 for information on reading records and marking records as read. The data point **IsDailyLogFull** indicates whether or not the daily log is full and cannot overwrite old, unread records.

The data points included in the daily log and the corresponding log action are as shown in the table below. Data points required by the API Chapter 21 standard are marked with an asterisk (*). (Refer to Section 6.6 for information on the log action types.) For information on a *particular* data point, consult Daniel MeterLink online help. (There is a help topic for each data point. From Daniel MeterLink, click on Help, click on Mark III Registers Reference, select the Index tab, start typing the data point name until the desired point is highlighted, and then click the Display button.)

Table 6-18 Daily log content

Data Point	Log action
PosVolFlow*	Totalize and Snapshot
NegVolFlow*	Totalize and Snapshot
PosVolBase*	Totalize and Snapshot
NegVolBase*	Totalize and Snapshot
PosEnergy	Totalize and Snapshot
NegEnergy	Totalize and Snapshot
PosMass	Totalize and Snapshot
NegMass	Totalize and Snapshot
FlowTemperature*	Flow-Gated
FlowPressure*	Flow-Gated
AbsFlowPressure*	Flow-Gated
AccumFlowTime*	Totalize
AvgSndVel*	Flow-Gated
RhoMixFlow*	Flow-Gated
ZFlow*	Flow-Gated
ZBase*	Flow-Gated

Table 6-18 Daily log content (Continued)

Data Point		Log action
PrevDayMacro1*:		Macro
bit 31	(unused)	
bit 30	Is1BitMemoryError	
bit 29	DI1	
bits 28-26	(unused)	
bit 25	IsDetectionErr	
bit 24	IsCommErrAcqBd	
bit 23	DidPowerFail	
bit 22	DidCnfgChksumChg	
bit 21	IsElecTempOutOfRange	
bit 20	IsElecVoltOutOfRange	
bit 19	IsGCAlarmPresent	
bit 18	IsGCCommErr	
bit 17	PressHARTIsCommErr	
bit 16	TempHARTIsCommErr	
bit 15	PressHartIsDevMalfunction	
bit 14	TempHartIsDevMalfunction	
bit 13	PressHARTIsConfigChanged	
bit 12	TempHARTIsConfigChanged	
bit 11	PressHARTDidColdStart	
bit 10	TempHARTDidColdStart	
bits 9-0	(unused)	
PrevDayMacro2*:		Macro
bit 31	(unused)	
bit 30	IsMeasSndSpdRange	
bit 29	IsAvgSoundVelRangeErr	
bit 28	IsMeterVelAboveMaxLmt	
bit 27	IsHardFailedA	
bit 26	IsHardFailedB	
bit 25	IsHardFailedC	
bit 24	IsHardFailedD	
bit 23	(unused)	
bit 22	IsSNRTooLow	
bits 21-19	(unused)	
bit 18	PressureInvalid	
bit 17	TemperatureInvalid	
bit 16	IsAnyLogFull	
bit 15	(unused)	
bit 14	IsGCWarningPresent	
bit 13	PressHARTIsPVOutOfLimits	
bit 12	TempHARTIsPVOutOfLimits	
bit 11	PressHARTIsMoreStatusAvailable	
bit 10	TempHARTIsMoreStatusAvailable	
bit 9	IsBlockageDetected	
bit 8	IsBoreBuildupDetected	
bit 7	IsLiquidDetected	
bit 6	IsAbnormalProfileDetected	
bit 5	IsReverseFlowDetected	
bit 4	IsSoundVelCompErr	
bit 3-0	(unused)	

Table 6-18 Daily log content (Continued)

Data Point	Log action
SndVelA, **SndVelB,** **SndVelC,** **SndVelD**	Flow-Gated
FlowVelA, **FlowVelB,** **FlowVelC,** **FlowVelD**	Flow-Gated
AvgFlow	Flow-Gated
(Percent of good batch signals) **PctGoodA1, PctGoodA2** **PctGoodB1, PctGoodB2,** **PctGoodC1, PctGoodC2,** **PctGoodD1, PctGoodD2**	Average
QFlow	Flow-Gated
QBase	Flow-Gated
(Transducer Gain) **GainA1, GainA2,** **GainB1, GainB2,** **GainC1, GainC2,** **GainD1, GainD2**	Average
(Signal Energy) **SEA1, SEA2,** **SEB1, SEB2,** **SEC1, SEC2,** **SED1, SED2**	Average
(Noise Energy) **NEA1, NEA2,** **NEB1, NEB2,** **NEC1, NEC2,** **NED1, NED2**	Average
(Transit time standard deviation) **SDevTmA1, SDevTmA2,** **SDevTmB1, SDevTmB2,** **SDevTmC1, SDevTmC2,** **SDevTmD1, SDevTmD2**	Flow-Gated

Table 6-18 Daily log content (Continued)

Data Point	Log action
MethaneInUse **N2InUse** **CO_2InUse** **EthaneInUse** **PropaneInUse** **WaterInUse** **H2SInUse** **H2InUse** **COInUse** **OxygenInUse** **IsoButaneInUse** **NButaneInUse** **IsoPentaneInUse** **NPentaneInUse** **NHexaneInUse** **NHeptaneInUse** **NOctaneInUse** **NNonaneInUse** **NDecaneInUse** **HeliumInUse** **ArgonInUse**	Flow-Gated
HeatingValueInUse	Flow-Gated
CnfgChksumValue	Snapshot
CnfgChksumDate	Snapshot
TurbulenceA TurbulenceB TurbulenceC TurbulenceD	Flow-Gated (only used for Senior-Sonic^{TM} meters)
ProfileFactor	Flow-Gated (only used for Senior-Sonic^{TM} meters)
Symmetry	Flow-Gated (only used for Senior-Sonic^{TM} meters)
CrossFlow	Flow-Gated (only used for Senior-Sonic^{TM} meters)
AGA10SndVel	Flow-Gated (optionally calculated)

6.6.2 Hourly log

The Mark III meter stores an hourly log record once per hour on the hour. The meter can store up to 2400 hourly records (100 days' worth). The user can select whether old, unread records can be overwritten by new records when the log becomes full via the data point **DoOverwriteUn-readHoulyLog**. This point can be modified using the Daniel MeterLink Tools - Edit/Compare Configuration screen. The default is to overwrite old, unread records. Refer to Section 6.6.6 for information on reading records and marking records as read. The data point **IsHourlyLogFull** indicates whether or not the hourly log is full and cannot overwrite old, unread records.

The data points included in the hourly log and the corresponding log action are as shown in the table below. Data points required by the API Chapter 21 standard are marked with an asterisk (*). (Refer to Section 6.6 for information on the log action types.) For information on a *particular* data point, consult Daniel MeterLink online help. (There is a help topic for each data point. From Daniel MeterLink, click on Help, click on Mark III Registers Reference, select the Index tab, start typing the data point name until the desired point is highlighted, and then click the Display button.)

Table 6-19 Hourly log content

Data Point	Log Action
PosVolFlow*	Totalize and Snapshot
NegVolFlow*	Totalize and Snapshot
PosVolBase*	Totalize and Snapshot
NegVolBase*	Totalize and Snapshot
PosEnergy	Totalize
NegEnergy	Totalize
PosMass	Totalize
NegMass	Totalize
FlowTemperature*	Flow-Gated
FlowPressure*	Flow-Gated
AbsFlowPressure*	Flow-Gated
AccumFlowTime*	Totalize
AvgSndVel*	Flow-Gated
CompAvgMeterSndVel	Snapshot (the value is itself an hourly average)
CompAvgAGA10SndVel	Snapshot (the value is itself an hourly average)

Table 6-19 Hourly log content

Data Point		Log Action
RhoMixFlow*		Flow-Gated
ZFlow*		Flow-Gated
ZBase*		Flow-Gated
PrevDayMacro1*:		Macro
bit 31	(unused)	
bit 30	Is1BitMemoryError	
bit 29	DI1	
bits 28-26	(unused)	
bit 25	IsDetectionErr	
bit 24	IsCommErrAcqBd	
bit 23	DidPowerFail	
bit 22	DidCnfgChksumChg	
bit 21	IsElecTempOutOfRange	
bit 20	IsElecVoltOutOfRange	
bit 19	IsGCAlarmPresent	
bit 18	IsGCCommErr	
bit 17	PressHARTIsCommErr	
bit 16	TempHARTIsCommErr	
bit 15	PressHartIsDevMalfunction	
bit 14	TempHartIsDevMalfunction	
bit 13	PressHARTIsConfigChanged	
bit 12	TempHARTIsConfigChanged	
bit 11	PressHARTDidColdStart	
bit 10	TempHARTDidColdStart	
bits 9-0	(unused)	

Table 6-19 Hourly log content

Data Point		Log Action
PrevDayMacro2*:		Macro
bit 31	(unused)	
bit 30	IsMeasSndSpdRange	
bit 29	IsAvgSoundVelRangeErr	
bit 28	IsMeterVelAboveMaxLmt	
bit 27	IsHardFailedA	
bit 26	IsHardFailedB	
bit 25	IsHardFailedC	
bit 24	IsHardFailedD	
bit 23	(unused)	
bit 22	IsSNRTooLow	
bits 21-19	(unused)	
bit 18	PressureInvalid	
bit 17	TemperatureInvalid	
bit 16	IsAnyLogFull	
bit 15	(unused)	
bit 14	IsGCWarningPresent	
bit 13	PressHARTIsPVOutOfLimits	
bit 12	TempHARTIsPVOutOfLimits	
bit 11	PressHARTIsMoreStatusAvailable	
bit 10	TempHARTIsMoreStatusAvailable	
bit 9	IsBlockageDetected	
bit 8	IsBoreBuildupDetected	
bit 7	IsLiquidDetected	
bit 6	IsAbnormalProfileDetected	
bit 5	IsReverseFlowDetected	
bit 4	IsSoundVelCompErr	
bit 3-0	(unused)	
SndVelA, SndVelB, SndVelC, SndVelD		Flow-Gated
FlowVelA, FlowVelB, FlowVelC, FlowVelD		Flow-Gated
AvgFlow		Flow-Gated
(Percent of good batch signals) **PctGoodA1, PctGoodA2 PctGoodB1, PctGoodB2, PctGoodC1, PctGoodC2, PctGoodD1, PctGoodD2**		Average
QFlow		Flow-Gated
QBase		Flow-Gated

6.6.3 Audit log

The Mark III meter stores an audit log record whenever any parameter affecting the gas flow measurement is modified. The audit log record indicates which data point changed, the date and time of the change, and both the 'as-found' and 'as-left' values.

The meter can store up to 3000 audit records. The user can select whether old, unread records can be overwritten by new records when the log becomes full via the data point **DoOverwriteUnreadAuditLog**. This point can be modified using the Daniel MeterLink Tools - Edit/Compare Configuration screen. The default is to overwrite old, unread records. Refer to Section 6.6.6 for information on reading records and marking records as read. The data point **IsAuditLogFull** indicates whether or not the audit log is full and cannot overwrite old, unread records.

The data points monitored for the audit log are as shown in Table 6-20 below. The points are grouped and, within each group, are listed alphabetically.

The groupings are as follows:

- AGA8
- Calibration
- Chord Proportions
- Data Logging
- Expansion Correction
- Flow Profile Correction
- Frequency, Digital and Analog Signals
- GC Interface
- General
- Indicators
- Meter Information
- Optional Features
- Pressure and Temperature
- Signal Processing
- Tracking

For information on a *particular* data point, consult Daniel MeterLink online help. (There is a help topic for each data point. From Daniel MeterLink, click on Help, click on Mark III Registers

Reference, select the Index tab, start typing the data point name until the desired point is highlighted, and then click the Display button.)

Table 6-20 Audit log content

Data group	Data point
AGA8	HCH_Method
	MeasVolGrossHeatingVal
	MoleFractionMethane MoleFractionN2Method2 MoleFractionCO2 MoleFractionEthane MoleFractionPropane MoleFractionWater MoleFractionH2S MoleFractionH2 MoleFractionCO MoleFractionOxygen MoleFractionIsoButane MoleFractionNButane MoleFractionIsoPentane MoleFractionNPentane MoleFractionNHexane MoleFractionNHeptane MoleFractionNOctane MoleFractionNNonane MoleFractionNDecane MoleFractionHelium MoleFractionArgon
	PBase
	RefPressureGr
	RefPressureMolarDensity
	RefTemperatureGr
	RefTemperatureHV
	RefTemperatureMolarDensity
	SpecificGravity
	TBase

Table 6-20 Audit log content

Data group	Data point
Calibration	AvgDlyA ... AvgDlyD
	CalFlag
	CalMethod
	DltDlyA ... DltDlyD
	FwdA0 ... FwdA3
	FwdC0 ... FwdC3
	FwdFlwRt1 ... FwdFlowRt12
	FwdMtrFctr1 ... FwdMtrFctr12
	LA ... LD
	PipeID
	RevA0... RevA3
	RevC0 ... RevC3
	RevFlwRt1 ... RevFlwRt12
	RevMtrFctr1 ... RevMtrFctr12
	SystemDelay
	WtA ... WtD
	XA ... XD
Chord Proportions	LowFlowLmt
	NumVals
	PropUpdtBatches
	ResetProp
Data Logging	AlarmTurnOffHysterisisCount
	AlarmTurnOffHysterisisTimeSpan
	ContractHour

Table 6-20 Audit log content

Data group	Data point
Expansion Correction	**EnableExpCorrPress**
	EnableExpCorrTemp
	LinearExpansionCoef
	PipeOutsideDiameter
	PoissonsRatio
	RefTempLinearExpCoef
	YoungsModulus
Flow Profile Correction	**SpecCorrectionFactor**
	Viscosity
	WallRoughness
Frequency, Digital, & Analog Signals	AO1Content
	AO1Dir
	AO1FullScaleEnergyRate
	AO1FullScaleMassRate
	AO1FullScaleVolFlowRate
	AO1MaxVel
	AO1MinVel
	AO1TestModeOutputPercent
Frequency, Digital, & Analog Signals	AO2Content
(With Series 100 Plus Board)	AO2Dir
	AO2FullScaleEnergyRate
	AO2FullScaleMassRate
	AO2FullScaleVolFlowRate
	AO2MaxVel
	AO2MinVel
	AO2TestModeOutputPercent
	DI1IsInvPolarity
	DO1AContent ... DO1BContent
	DO1AIsInvPolarity ... DO1BIsInvPolarity
	DO1PairTestEnable

Table 6-20 Audit log content

Data group	Data point
	DO2AContent … DO2BContent
	DO2AIsInvPolarity … DO2AIsInvPolarity
	DO2PairTestEnable
	Freq1BPhase
	Freq1Content
	Freq1Dir
	Freq1FeedbackCorrectionPcnt
	Freq1FullScaleEnergyRate
	Freq1FullScaleMassRate
	Freq1FullScaleVolFlowRate
	Freq1MaxFrequency
	Freq1MaxVel
	Freq1MinVel
	Freq1TestModeOutputPercent
	Freq2BPhase
	Freq2Content
	Freq2Dir
	Freq2FeedbackCorrectionPcnt
	Freq2FullScaleEnergyRate
	Freq2FullScaleMasRate
	Freq2FullScaleVolFlowRate
	Freq2MaxFrequency
	Freq2MaxVel
	Freq2MinVel
	Freq2TestModeOutputPercent
	IsAO1EnableTest

Table 6-20 Audit log content

Data group	Data point
(With Series 100 Plus Board)	IsAO2EnableTest
	IsFreq1BZeroesOnErr
	IsFreq1EnableTest
	IsFreq2BZeroesOnErr
	IsFreq2EnableTest
General	AlarmDef
	AvgSoundVelHiLmt
	AvgSoundVelLoLmt
	AsyncEnable
	ChordInactvA ... ChordInactvD
	DampEnable
	DeviceNumber
	DitherEnable
	FlowDir
	MaxNoDataBatches
	MeterMaxVel
	MinChord
	MinPctGood
	NonNormalModeTimeout
	RTCSecondsSinceEpochSet
	SSMax
	SSMin
	VelHold
	ZeroCut

Table 6-20 Audit log content

Data group	Data point
GC Interface	GasPropertiesSrcSel
	GasPropertiesSrcSelGCAlarm
	GCBaud
	GCCommTimeout
	GCDesiredStreamTimeout
	GCHeatingValueType
	GCHeatingValueUnit
	GCModbusID
	GCProtocol
	GCSerialPort
	GCStreamNumber
Indicators	CnfgChksumDate
	CnfgChksumValue
	DidCnfgChksumChg
	DidColdStart
	DidPowerFail
	DoWarmStart
	Is1BitMemoryError
	IsConfigProtected
	IsCorePresent
	PowerFailTime
	WatchDogReset
Meter Information	AcquisitionBdRevNum
	CPUBdSwVer
	Eth1IPAddr
	Eth1SubnetMask
	EthDfltGatewayAddr
	FileSysVer

Table 6-20 Audit log content

Data group	Data point
	MeterSerialNumber
(With **Series 100 Plus Board**)	OptBdRevNum
	OSVer
	UserScratch1
	UserScratch2
Optional Features	AGA10Key
	Eth1Key
	GCKey
	ContinuousFlowAnalysisKey
	LogAccessKey

Table 6-20 Audit log content

Data group	Data point
Pressure & Temperature	AtmosphericPress
	EnablePressureInput
	EnableTemperatureInput
	FlowPOrTSrcUponAlarm
	FlowPressureWhileCal
	FlowTemperatureWhileCal
	HighPressureAlarm
	HighTemperatureAlarm
	InputPressureUnit
	LiveFlowPressureCalCtrl
	LiveFlowPressureGain
	LiveFlowPressureOffset
	LiveFlowTemperatureCalCtrl
	LiveFlowPressureGain
	LiveFlowPressureOffset
	LowPressureAlarm
	LowTemperatureAlarm
	MaxInputPressure
	MaxInputTemperature
	MinInputPressure
	MinInputTemperature

Table 6-20 Audit log content

Data group	Data point
Signal Processing	BatchPercentSmoothing
	BatchSize
	CRange
	DltChk
	EmRate
	EmRateDesired
	Filter
	FireSeq
	GainHighLmt
	GainLowLmt
	MaxHoldTm
	MaxNoise
	MinHoldTime
	MinSigQlty
	NegSpan
	Pk1Pct
	Pk1Thrsh
	Pk1Wdth
	PosSpan
	SampInterval
	SampPerCycle
	SndSpdChkMaxVel
	SndSpdChkMinVel
	SNRatio
	SpecBatchUpdtPeriod
	StackSize
	StkEmRate
	StkEmRateDesired
	TmDevFctr1

Table 6-20 Audit log content

Data group	Data point
Tracking	ResetTrkParam
	Tamp
	TampHi
	TampLo
	TampSen
	TampWt
	Tspe
	TspeHi
	TspeLmt
	TspeLo
	TspeSen
	TspeWt
	Tspf
	TspfHi
	TspfLo
	TspfMatch
	TspfSen
	TspfWt

Determining meter power-up and power-down times

The audit log can be used to determine the meter start (or re-start) time and the meter power-down time by examining the **PowerFailTime** record(s). The **PowerFailTime** record time stamp indicates (to within a few seconds) the time that the meter was started. The 'as-left' value indicates the time (to within a few seconds) that the meter was powered-down.

6.6.4 Alarm log

The Mark III meter monitors several data points with respect to each point's alarm limit(s). Non-boolean data points can have low and high alarm limits. Boolean data points only have a single alarm limit (i.e., either TRUE or FALSE). There are two statuses associated with alarms: set and cleared. An alarm is set when the data point is at or exceeds its alarm limit. An alarm is cleared when the data point is within its alarm limit(s).

The Mark III meter stores an alarm log record whenever any monitored data point's alarm status (cleared or set) changes. The alarm log record indicates the data point, date and time, alarm status, corresponding alarm limit, and data point value.

The meter can store up to 3000 alarm records. The user can select whether old, unread records can be overwritten by new records when the log becomes full via the data point **DoOverwriteUnreadAlarmLog**. This point can be modified using the Daniel MeterLink Tools - Edit/Compare Configuration screen. The default is to overwrite old, unread records. Refer to Section 6.6.6 for information on reading records and marking records as read. The data point **IsAlarmLogFull** indicates whether or not the alarm log is full and cannot overwrite old, unread records.

The user-settable data points **AlarmTurnOffHysterisisCount** and **AlarmTurnOffHysterisis-TimeSpan** are used to prevent very repetitive alarms from filling up the alarm log. When an alarm is set **AlarmTurnOffHysterisisCount** times within **AlarmTurnOffHysteresisTimeSpan** seconds, then the alarm is suppressed until the alarm frequency drops below the specified rate (counts per time span) at which point the next alarm clearing "unsuppresses" the alarm. The alarm log records indicate when an alarm suppression is started and ended. The default values are 8 occurrences in 240 seconds.

The data points monitored for the alarm log are as shown in Table 6-21 and Table 6-22 below. Note that the alarm limits are themselves data points. The user-settable alarm limits are listed by data point name. Non-settable alarm limits are listed by data point value.

Table 6-21 Alarm log non-boolean data points monitored

Data Point	Low Alarm Limit	High Alarm Limit
GainAUp, GainADn, GainBUp, GainBDn, GainCUp, GainCDn, GainDUp, GainDDn	GainLowLmt	GainHighLmt
AvgSndVel	AvgSoundVelLoLmt	AvgSoundVelHiLmt
AGA8BaseCalcStatus		1
AGA8FlowCalcStatus		1
SpecFlowPressure	LowPressureAlarm	HighPressureAlarm
SpecFlowTemperature	LowTemperatureAlarm	HighTemperatureAlarm
LiveFlowPressure	LowPressureAlarm	HighPressureAlarm
LiveFlowTemperature	LowTemperatureAlarm	HighTemperatureAlarm

Table 6-21 Alarm log non-boolean data points monitored

Data Point	Low Alarm Limit	High Alarm Limit
AvgFlow	**MeterMaxNegVel**	**MeterMaxVel**
GCCommStatus		1
SysTemp	-40°C	100°C
SysVoltage2V5	2.225 V	2.775 V
SysVoltage3V3	2.937 V	3.663 V
SysVoltage5V	4.45 V	5.55 V

Table 6-22 Alarm log boolean data points monitored

Data Point	Boolean Alarm Limit
IsHardFailedA ... IsHardFailedD	TRUE
IsMeasSndSpdRangeA ... IsMeasSndSpdRangeD	TRUE
Freq1DataValidity ... Freq2DataValidity	FALSE
QMeterValidity	FALSE
QFlowValidity	FALSE
QBaseValidity	FALSE
EnergyRateValidity	FALSE
AGA8BaseCalcValidity	FALSE
AGA8FlowCalcValidity	FALSE
IsCommErrAcqBd	TRUE
IsHourlyLogFull, IsDailyLogFull, IsAuditLogFull, IsSystemLogFull	TRUE
IsBatchDataRcvFailed	TRUE
Is1BitMemoryError	TRUE
IsClkInvalid	TRUE
IsAnyKeyAboutToExpire (valid for firmware v1.61 and above)	TRUE
IsAnyKeyExpired (valid for firmware v1.61 and above)	TRUE
IsOptionalContinuousFlowAnalysisEnabled	TRUE

Table 6-22 Alarm log boolean data points monitored

Data Point	Boolean Alarm Limit
AreGasPropertiesInvalidGC	TRUE
AreGasPropertiesInvalidInUse	TRUE
IsGCCommErr	TRUE
IsGCDataErr	TRUE
IsGCWarningPresent	TRUE
IsGCAlarmPresent	TRUE

6.6.5 System log

The Mark III meter logs all system messages in the system log. The meter can store up to 100 system records. The user can select whether old, unread records can be overwritten by new records when the log becomes full via the data point **DoOverwriteUnreadSystemLog**. This point can be modified using the Daniel MeterLink Tools - Edit/Compare Configuration screen. The default is to overwrite old, unread records. Refer to Section 6.6.6 for information on reading records and marking records as read. The data point **IsSystemLogFull** indicates whether or not the system log is full and cannot overwrite old, unread records.

Repetitive system messages are prevented from filling up the system log. When a particular system message occurs 3 times within 60 seconds, that system message is suppressed until that message's frequency drops below the 3 times-per-60 sec rate. The system log records indicate when a system message suppression is started and ended.

NOTICE

The System log is for Daniel use and interpretation.

6.6.6 Reading log records

NOTICE

Note that reading log records is an optional feature as described in general in Section 430 and in detail in Section 4.1.4.

Mark III meter log records are read using the Daniel MeterLink Logs/Reports - Meter Archive Logs screen. The are three log groups:

- daily
- hourly
- event (audit, alarm, and system logs)

Select the desired log group(s) via the **Collect daily log/Collect hourly log/Collect event log** check boxes. If the event group is selected, the audit, alarm, and system logs are individually selectable. Whenever any log is collected, the current meter configuration is also collected.

Options for reading daily and/or hourly log records

The options for reading daily and hourly log records are the same. The Daniel MeterLink Logs/Reports - Meter Archive Logs screen indicates the number of days' records that are available to read. Select the log type(s) to be collected via the Collect daily log and/or Collect hourly log check boxes. Select whether to collect either all log records or the last specified number of days' records. Also, select whether to collect all log data or just the data points required by the API Chapter 21 standard. Table 6-18 lists the daily log data points and Table 6-19 lists the hourly log data points. For both tables, data points required by the API Chapter 21 standard are marked with an asterisk (*).

Options for reading audit, alarm, and/or system log records

The options for reading audit, alarm, and system log records are the same. The Daniel MeterLink Logs/Reports - Meter Archive Logs screen indicates the number of records available for each log type. Select whether to collect either all the records or just the last specified number of days' records for the selected log type.

Collecting and viewing log records

Three log formats are available:

- **Microsoft Excel -** This is the recommended format for collecting/saving log records in order to get the full benefits of the data logging feature. This option, however, is only available if Microsoft® Excel® 2000 or later is installed on the PC. The Excel® file generated by this utility has up to six worksheets depending upon the logs collected: Daily Log, Hourly Log, Alarm Log, Audit Log, System Log, and Meter Config. The collected log data is also displayed on the screen.
- **Comma-separated values -** This format creates a file with data separated by commas. Each log record collected is put on a separate line in the file. Each log type is separated by a blank line. The meter configuration follows the log data separated by a blank line. The collected log data is also displayed on the screen.
- **Don't log to file -** This option will not save any of the collected log data to a file but will display it on the screen.

After selecting the desired log type(s) and the log format, click on the **Collect** button to initiate the log data collection. If a format that saves the data to a file is selected, then a **Save As** dialog box is opened to allow specifying the file name. A default file name is suggested but can be modified. A comment may also be entered to be included with the data file.

If a log type to be read is configured so that unread records are *not* over-written, then Daniel MeterLink queries the user as to whether or not that log's records should be marked as 'read'.

Once the data collection is completed, the data is displayed in the **Meter Archive Logs** dialog box one log type at a time. Select the log type to be displayed via the **View log** box. The data may be sorted by selecting either **Oldest first** or **Newest first** in the **Sort order** box.

6.7 Viewing transducer waveforms

The Mark III meter includes a feature for streaming transducer waveforms that can be viewed using the Daniel MeterLink **Tools - Waveform Viewer** screen. The speed at which the waveforms update is dependent upon the type of connection between the PC and the meter. With the optional Ethernet connection and Daniel MeterLink, several updates per second are possible. With a serial connection, updates may occur only every 15 to 30 seconds.

Up to three types of waveform signals can be displayed per chord:

- **Raw -** the sampled waveform received by the transducer (with gain applied)
- **Stacked -** the result of applying stacking to the raw signal(s). Note that when stacking is not used (**StackSize** is set to 1), the stacked signal is the same as the raw signal.
- **Filtered -** the result of applying the bandpass filter on the stacked signal. This waveform is only available when the filter is enabled (via the **Filter** data point).

For diagnostic purposes, the transducer waveform signals can be stored to a file using the **Diagnostic Collection - Stream to file** check box. This utilizes the Mark III meter's patented "snapshot-and-playback" feature to accurately record the flow conditions that can then be later reproduced for detailed analysis.

6.8 Upgrading the meter program

The Mark III meter program is stored in flash memory so that it can be easily upgraded.

NOTICE

The Mark III program can only be upgraded if the configuration is *not* protected via the Configuration Protection switch. Refer to Section 3.5.8 for information on the Configuration Protection switch.

The Mark III program consists of three components: the operating system kernel, the file system, and the firmware. The program file to download to the meter is a ".zip" file that contains all three components. Do not unzip this file with PKZIP or WinZIP.

To upgrade the Mark III meter program, use the Daniel MeterLink **Tools - Program Download** screen. When the screen is first opened, the **Currently Installed Versions** table shows the version and date for each of the currently installed components.

To download a program file to the meter, click **Open** to display an **Open Download File** dialog. Select the desired file and click **Open**. The filename is displayed in the **File** edit box under **Upgrade**. The version and date of the components to download will be displayed in the table under **Upgrade**. Each component is identified as either older, newer, or the same as what is currently installed in the meter. Only components that are newer than what is currently installed are checked for **Download** by default. Select or clear any component's checkbox under **Download** to override the default selections.

At least one component must be checked for download before the **Download** button is enabled. Click the **Download** button to initiate the download. The status is displayed in the **Upgrade Progress** section of the screen.

Normal meter operation continues while the new program is being downloaded and stored in FLASH memory. A new program generally does not affect the meter configuration and archive logs.

Once the program download is complete, the Mark III meter restarts in order to run the new program components. Daniel MeterLink issues a message that it must disconnect from the meter due to the meter re-start. Once the meter is re-started, re-connect to the meter with Daniel MeterLink.

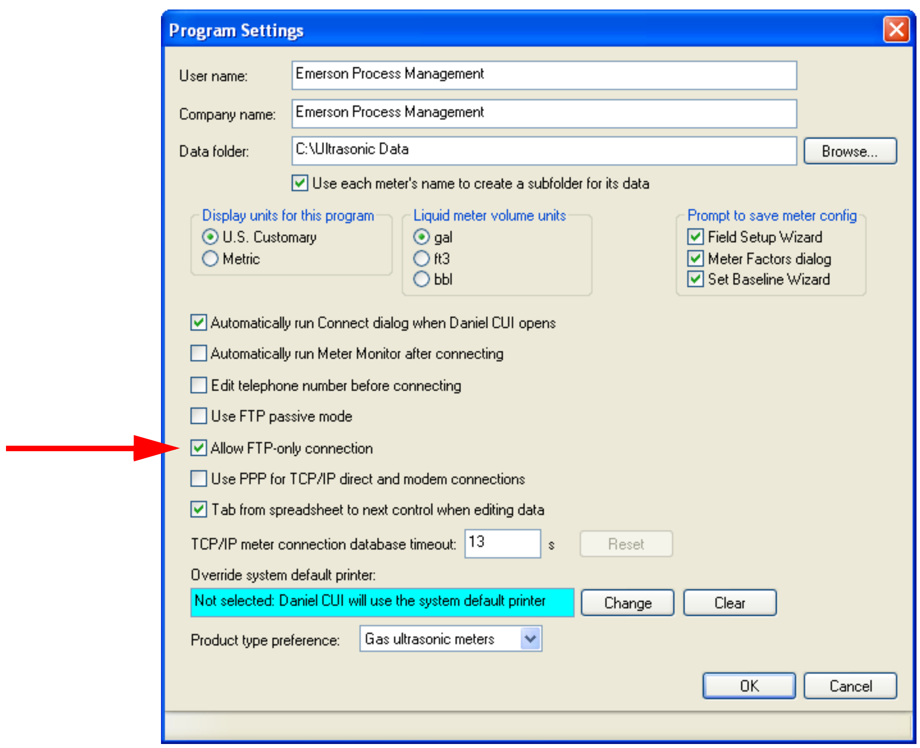
6.8.1 Power disruption during firmware upgrade

If the program failed to download to a Daniel Mark III Ultrasonic Gas Flow Meter during a firmware upgrade, Daniel MeterLink can no longer connect to the meter or a message **"Attempt FTP-only connection...."** is displayed when trying to connect.

It is possible for the meter to lose its programming if the meter power fails during a firmware upgrade process. If this occurs, follow the special procedure known as a Backup Upgrade described below, to make a connection to the meter and re-attempt the download process.

1. In Daniel MeterLink, use the **File | Program Settings** menu and select **Allow FTP-only connection**.

Figure 6-6 Program settings dialog FTP-only connection

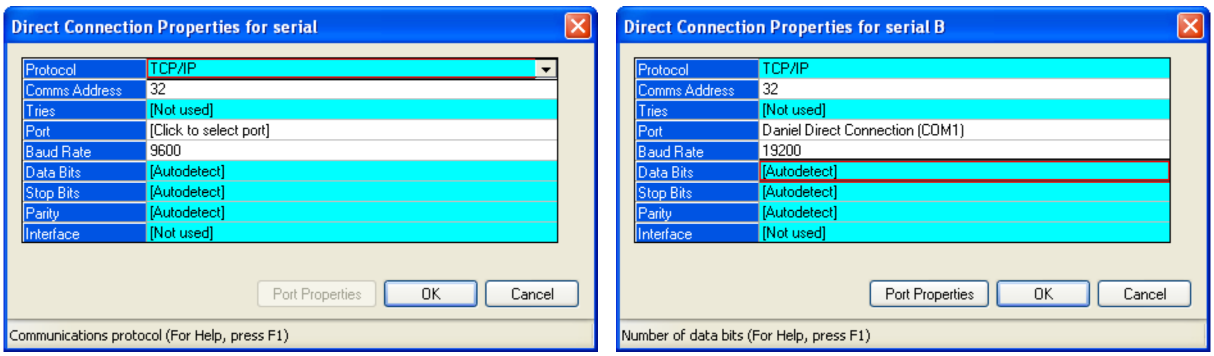


2. Click the **OK** button to close Program Settings dialog.

3. For Serial Port Connections: If you are connecting to the meter over a serial port, make sure you are connected to Port A or Port B on the meter Field Connection Board. Note: You can not program the meter from Port C if the meter is not currently running a program.

You may need to adjust your Meter Directory settings for the connection so that they match the port default settings. For Windows® 2000 or XP there could be multiple drivers installed called **Communications cable between two computers**, one for each COM port on the machine. For Windows Vista™ you can not use the Communication cable between two computers at this time and must use the Daniel Direct Connection driver.
Port A will default to 9600 baud and Port B will default to 19200 baud. Both ports will have an address of 32.

Figure 6-7 Port A and B direct connection settings



Port A Settings **Port B Settings**

4. For Ethernet Connections: If you are connecting to the meter over an Ethernet port, you should be able to connect with the same IP address as normal. If this is unsuccessful, the meter may have defaulted to 192.168.135.100 with a subnet of 255.255.255.0. Make sure your PC has a compatible address and attempt a connection using this IP address.
5. Once your cabling and Meter Directory record are setup, attempt the connection to the meter. You will receive a message "**Error 10001 opening database connection to ...**".
   - Click the **OK** button and you will be prompted to **Attempt FTP-only connection ....**
   - Click the **Yes** button and if successful, Daniel MeterLink displays the message, **...Connected to <meter name>...**
6. Next, use the **Tools** pull down menu and select **Program Download** to re-start the firmware upgrade process.

   If the firmware upgrade is successful and the meter's configuration is not lost, the meter should start working correctly.

   If the meter configuration is lost, use the **Edit/Compare Configuration** screen to write the configuration file, saved by the Program Download utility on the initial firmware upgrade, to the meter.

   If the firmware upgrade fails again, please contact Daniel Technical Support for assistance. Contact information can be found in Daniel MeterLink from the *Help* pull down menu and selecting Technical Support.

6.9 Self-tests and data reliability

The Mark III electronics has extensive built-in self-test and monitoring features that ensure reliable system operation. These features are a generation leap beyond those found in the Mark II and other existing industry products:

6.9.1 RAM integrity

The Mark III utilizes "ECC" (Error Correction Code) SDRAM memory. Every 4 bytes of system memory have 7 bits of a CRC-like "Hamming code" stored with it. This code is checked every time any byte of system SDRAM memory is accessed. Additionally, this code is sufficiently advanced that it can correct single bit memory errors on-the-fly and flag multi-bit memory errors with a non-maskable interrupt.

This type of check is an enterprise and server class; type of integrity monitoring and goes far beyond a simple start-up “walking one's” memory test.

6.9.2 Program integrity

All Mark III firmware is stored with a CRC code in non-volatile FLASH memory. The firmware is only executed if the CRC code calculated on start-up matches the one stored with each firmware program.

The CRC code is also checked for new firmware downloads before any firmware upgrades are made in the Mark III. Additionally, after each firmware upgrade, the Mark III firmware upgrade task double-checks the integrity of the stored program against the downloaded program file.

6.9.3 Stored data integrity

All Mark III non-volatile data is stored with CRC codes in the non-volatile memory. Additionally, all data is stored in the form of write "transactions". Thus, not only is the integrity of any individual data guaranteed, but also the associativity of multiple data written together is guaranteed across power fails. Thus if power fails in the middle of any transaction, either all of the older data or all of the newer data is guaranteed to be present in the system. Under no situation will part old and part new data be present when power is restored. This functionality has been thoroughly tested by performing thousands of asynchronous power fail cycles while storing data in the system.

6.9.4 Hardware watchdog

The Mark III electronics contains a hardware watchdog circuit that must be reset periodically by the firmware. A watchdog task monitors the health of the system. Any detected anomaly or inadvertent lockup of the firmware will always cause a warm start. Thus the meter will never remain in a non-performing situation (say due to a transient) for more than a few tens of seconds.

6.9.5 Program execution integrity

The Mark III utilizes a microprocessor with a hardware MMU (Memory Management Unit). This MMU is fully utilized by an enterprise-class “protected-mode” operating system- Linux.

This combination allows for increased operation reliability of the entire system as critical tasks are protected from any non-critical task erroneous operation.

The Mark III meter firmware is segregated into distinct “tasks”, each of which is protected from the operation of the other tasks by the hardware MMU and the operating system. Any attempt of a task to access memory allocated to another task results in the shutting down of the errant task and a log of the task shutdown. The watchdog then performs a system warm start.

6.9.6 Log transfer integrity

The Mark III optionally generates logs in standards-based XML files. These XML files are compressed into binary files and CRC protected for transfer from the meter to the user's PC where they are checked for CRC integrity and de-compressed before being further processed into reports for the user.

6.9.7 Data value limit checks

All Mark III stored data resides in an internal database in which each data point has pre-programmed "sanity limits." The database enforces these limits on all values written to it, thus ensuring that under no circumstances will any data take on an illegal value.

6.9.8 Configuration dependency checks

The Mark III checks for and enforces configuration dependency checks on most configuration values written to it (either by Modbus or to the native data point using Daniel MeterLink). For example, the AGA8 Detail method cannot be selected if the temperature input is disabled. This provides enhanced protection against inadvertent misconfiguration by the user.

Section 7: Maintenance and troubleshooting

This section includes discussion of transducer replacement, meter repair and maintenance, and troubleshooting communications and meter diagnostics.

Daniel Ultrasonic Flow Meters are supplied with T-Slot transducer assemblies which are extractable while the line is pressurized.

T-Slot transducer assemblies are available on 4-inch and larger meters for the Mark III meters. The T-Slot assemblies are available on all meter sizes for the Daniel JuniorSonic™ Meters (Models 3410 and 3420). See Section 2.2.6 for the types of transducers available.

7.1 Field hydrostatic pressure testing procedures

T-Slot transducer assembly and mount

1. Slowly vent all line pressure on the Daniel Mark III Ultrasonic Gas Flow Meter to atmosphere.
2. Disconnect transducer cabling from the transducer holders.
3. If installed, remove the mount cover by loosening the two mount cover screws. These screws are captive.
4. Loosen the T-Slot transducer assembly with a 1 1/4 wrench or socket. Carefully remove the T-Slot transducer assembly.
5. Place a label on the transducer assembly to marks its location (i.e., A1, A2, B1, B2, C1, C2, D1, or D2). Port locations are marked on the transducer cable as well as on cast meter housings.
6. Ensure the transducer mount threads are clean and free of debris.
7. Apply a small amount of Nickel antiseize compound (P/N 3-9960-134) to the threads of the hydro-test plug (from kit P/N 1-360-01-220) and install it into the mount.
8. Repeat Steps 3 through 7 for the other transducer(s) being careful to note the location of each transducer in the meter assembly.
9. Run the field hydrostatic test.
10. Reverse the steps above to re-install the transducers into their appropriate ports. Before reinstalling the transducer assemblies, ensure the transducer ports, mounts, and transducer holders are clean and free of debris. Apply a small amount of Nickel antiseize compound to the outer threads of the transducer holders before installing into the mounts.

7.2 T-Slot Transducer Removal and Installation Procedures

The T-Slot transducer assembly is an improvement to the direct mount transducer. It offers improved transducer alignment and superior acoustic isolation between the transducer and the meter housing. The net result is improved performance and stability. The assembly is used on both SeniorSonic™ and JuniorSonic™ Meters and is line pressure vented.

7.2.1 Removal with Extractor Tool

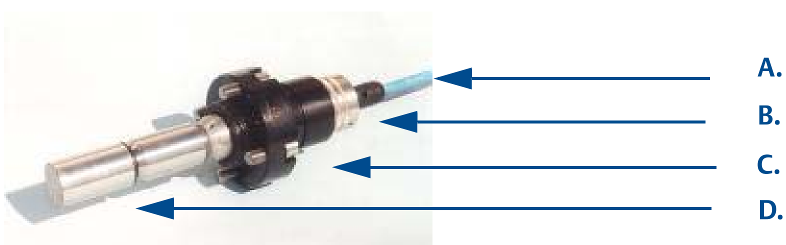
To replace transducers under pressure, refer to the *Daniel Ultrasonic Extractor Tool Operation Manual* (Daniel P/N 3-9000-729) for installation and removal of the older style transducers (e.g. M-Mount, P-Mount, and Q-Mount). For J-Mount and K-Mount transducers, refer to *Ultrasonic Split Clamp Extractor Tool Operation Manual* (Daniel P/N 3-9000-744) available to download from the Daniel website:

http://www2.emersonprocess.com/EN-US/BRANDS/DANIEL/FLOW/Pages/Flow.aspx

NOTICE

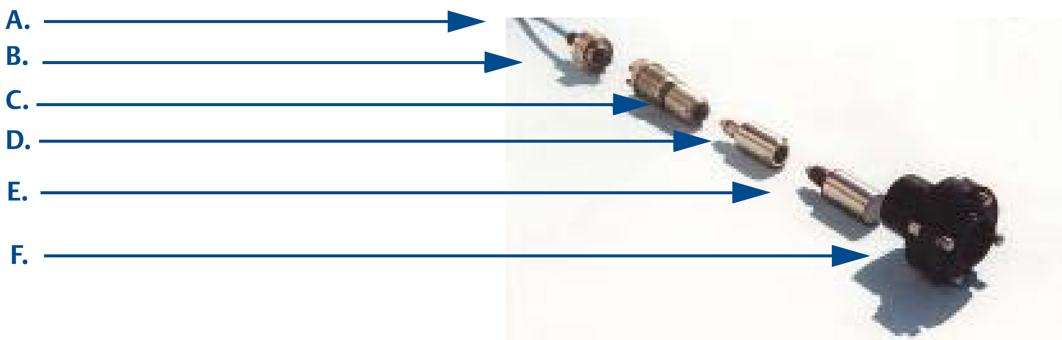
To access the product manual, from the Daniel products page (above link), select the Daniel SeniorSonic 4-Path Gas Flow Meter link, click the Documentation tab, expand the Manuals & Guides tab, then select the manual.

Figure 7-1 J-Mount Transducer Assembly



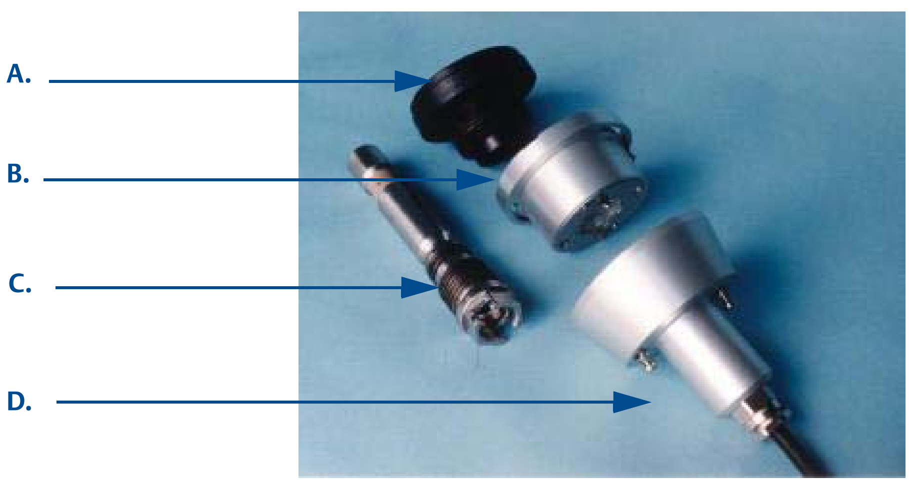
A. Transducer cable (max. length 15 ft.)
B. Transducer cable nut and chordset
C. Mount
D. Transducer assembly, stalk and holder,

Figure 7-2 J-Mount Transducer Disassembly



A. Transducer cable (max. length 15 ft.)
B. Transducer cable nut and chordset
C. Transducer holder
D. Transducer stalk (optional)
E. Transducer
F. Mount

Figure 7-3 M-Mount Transducer Disassembly



A. Mount
B. Mount cover
C. Transducer and stalk assembly
D. Transducer chordset

Figure 7-4 M-Mount Transducer Disassembly

A. Transducer chordset
B. Mount cover
C. Mount
D. Transducer and stalk assembly

7.2.2 Removal without Extractor Tool

NOTICE

The following instructions are for transducer removal and installation without the use of an extractor tool. It is recommended that one work on one transducer assembly at a time to reduce the possibility of improper assembly with respect to transducer lengths and location.

- **Transducers are always replaced in pairs.**
- **Update the calibration parameters for every chord when replacing a pair of transducers. Refer to** Section 7.2.5**.**

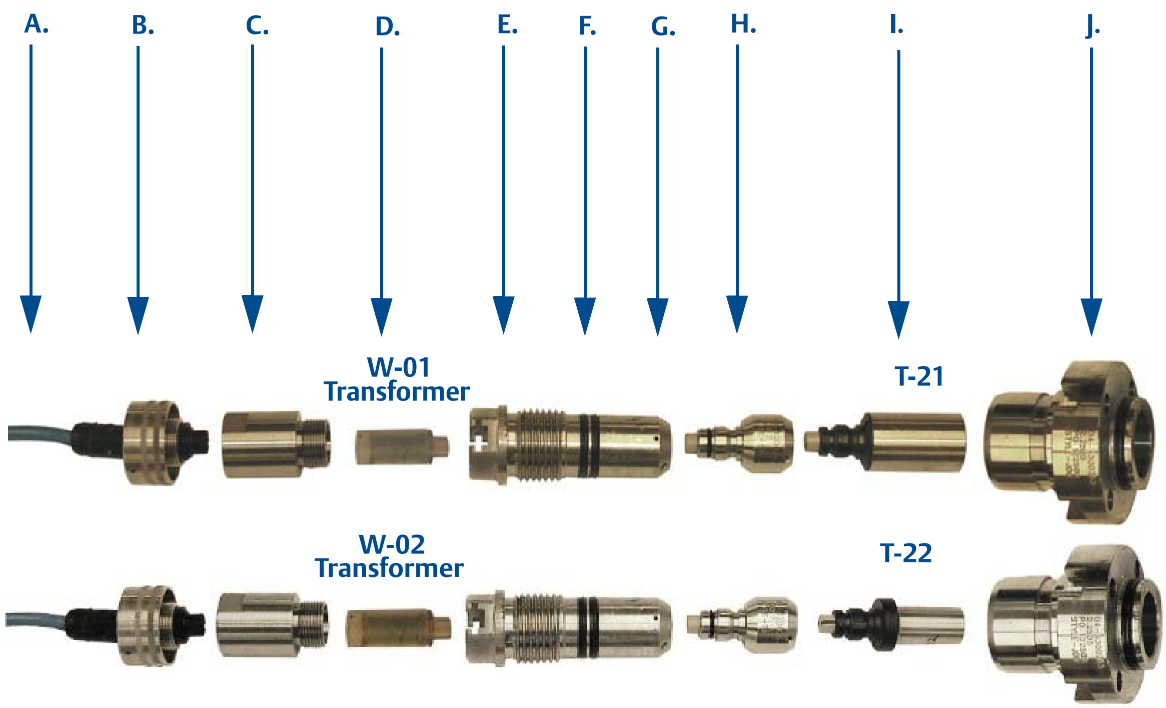
Table 7-1 Tools and supplies for disassembly and assembly

Tool list, shop supplies and reference documents
3/8” drive ratchet
3/8” drive extension
3/8” drive 7/16” deep socket
3/8” drive 5/16” hex socket
3/8” drive 1/2” hex socket
3/8” to 1/2” driver adapter
1/2” drive ratchet
1/2” drive 1 1/4” Socket
1 1/4” combination wrench
1 1/8” combination wrench
1” combination wrench
3/16” flat Blade screw driver
1/16” Xcelite Hex driver
6mm Allen wrench
N.A.S. Loctite Nickel Anti-Seize 16 oz. Brush Top P/N 77164
Molykote 111
Shop supplies
Shop rags
Adhesive stickers for the cable nuts Sharpie Fine Point Permanent Marker (Black) Series # 30000, to label transducers: • A1, A2, B1, B2, C1, C2, D1 and D2 for SeniorSonic meters • A1, A2, B1 and B2 for Juniorsonic meters)

Procedure

1. Blow the line down according to the site standard operating procedures.
2. Ensure that the line pressure is down to atmospheric pressure prior to disassembly.
3. Disconnect transducer cabling and chordset from the transducer assembly by turning the cable nut counter-clock wise.
4. Meters with M-mounts or P-mounts, remove the mount cover by loosening the two mount cover captive screws with a flathead screw driver (see Figure 7-4).
5. Disconnect the transducer cable nut. Pull the chordset from the transducer assembly. Note: Do not twist the chordset as you disconnect it from the transducer assembly.
6. If the meter is equipped with T-21 or T-22 transducers, remove the transducer retainer using a 1 1/8" wrench and then disconnect and remove the transformer (Figure 7-5). Note: T-21 transducers use W-01 transformers and T-22 transducers use W-02 transformers.

Figure 7-5 T-21 and T-22 transducer assembly



A. Transducer cable (max. length 15 ft.)
B. Transducer cable nut and chordset
C. Transformer retainer (Standard P/N 1-360-01-958 or HIgh Temperature P/N 1-360-01-978)
D. Transformer assembly T-21 (W-01 P/N 1-360-03-090) or T-22 (W-02 P/N 1-360-03-110)
E. Transducer holder
F. Transducer holder O-rings
G. Set screw holes (end of transducer holder)
H. Transducer stalk (optional)
I. Transducer assembly
J. Mount and backup O-ring

7. Loosen the T-Slot transducer holder assembly with a 1 1/4” socket. Carefully remove the T-Slot transducer assembly.
8. Loosen the three Allen setscrews with a 1/16” hex driver securing the transducer assembly and stalk, if installed. Carefully remove the old transducer by pulling it from the T-Slot transducer holder assembly without rotating.

Important

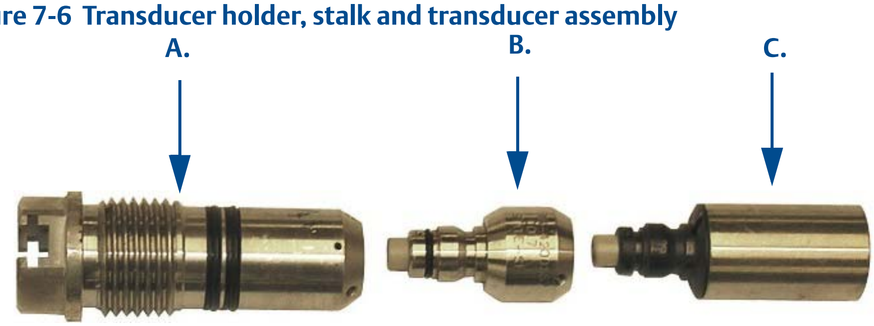
Record the “L” dimension of the removed transducers which is used to update the meter configuration after all of the transducers are replaced. Make sure you have the report sheet containing the “L” dimension, Delay Time, and Delta Delay Time for the replacement pair of transducers to use during the Transducer Swap-out procedure in Daniel MeterLink.

9. Clean the transducer holder with a dry cloth.

7.2.3 Installing the transducers

1. Ensure that the Daniel 3400 Series Gas Ultrasonic Flow Meter transducer port, mount, and T-Slot transducer holder assembly are clean and free of debris.
2. Apply a small amount of Molykote 111to the female contacts on the transducer.
3. Install the transducer assembly into the transducer holder or into the stalk (if required). The parts are keyed and can only be assembled one way. As the transducers are installed into the holder or stalk assembly, they must be labeled with a marker for future reference (i.e., transducer #1 would be A-1 and transducer #2 would be A-2).
4. Use a 1/16” hex driver to equally tighten the three Allen set screws on the transducer holder to secure the transducer assembly and the stalks (if installed).

Figure 7-6 Transducer holder, stalk and transducer assembly



A. Transducer holder
B. Stalk
C. Transducer assembly

Note: Do not apply lubricant to the transducer or stalk O-rings.

NOTICE

Ensure that the transducers identified as belonging to end 1 are installed on end 1 of the meter housing and those identified as belonging to end 2 are installed on end 2 of the meter housing.

5. Replace the O-ring and Backup O-ring on the transducer holder. It is highly recommended that the O-rings be replaced when the transducer is removed from the holder or stalk. Make sure that the contoured side of the ring is facing away from the mount. Lubricate with Molykote111 Silicone Grease or equivalent.

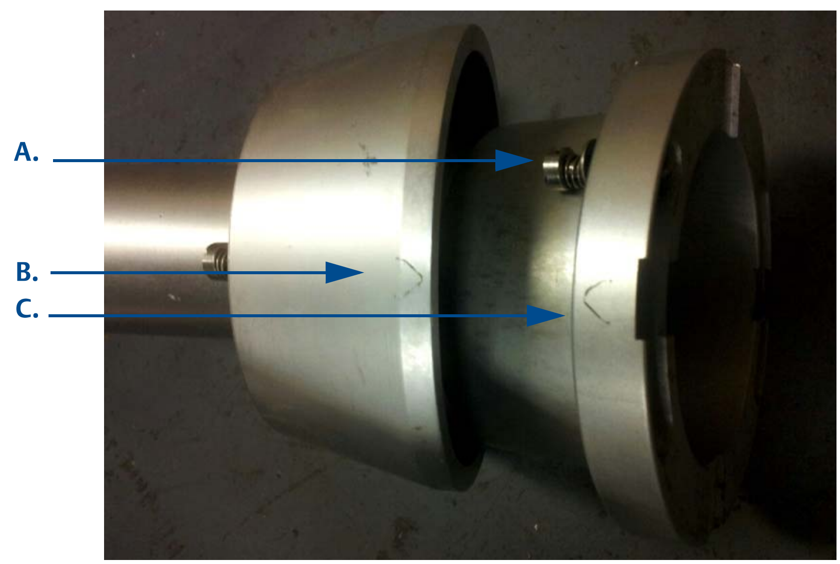
   Note: Replacing the O-rings at this point minimizes the chances of damaging the transducer by dropping it.

6. Apply a small amount of nickel anti-seize (N.A.S.) compound (P/N 2-9-9960-134) to the outer threads of the transducer holder (see Figure 7-6).

7. Carefully install the transducer holder assembly into the transducer mount. Make sure the threads of the holder and mount are correctly aligned. Use a 1 1/4” socket and screw the transducer assembly into the mount. Tighten to securely seat the assembly in the mount. Do not over tighten (see Figure 7-8).

8. If applicable, install the mount cover by rotating the tag and sliding the mount cover over the 1 1/4” hex head of the transducer holder. Align the mount’s two screws with their respective screw holes and tighten. The screw holes can be located as they are marked with an arrowhead, “V” on the mount rim.

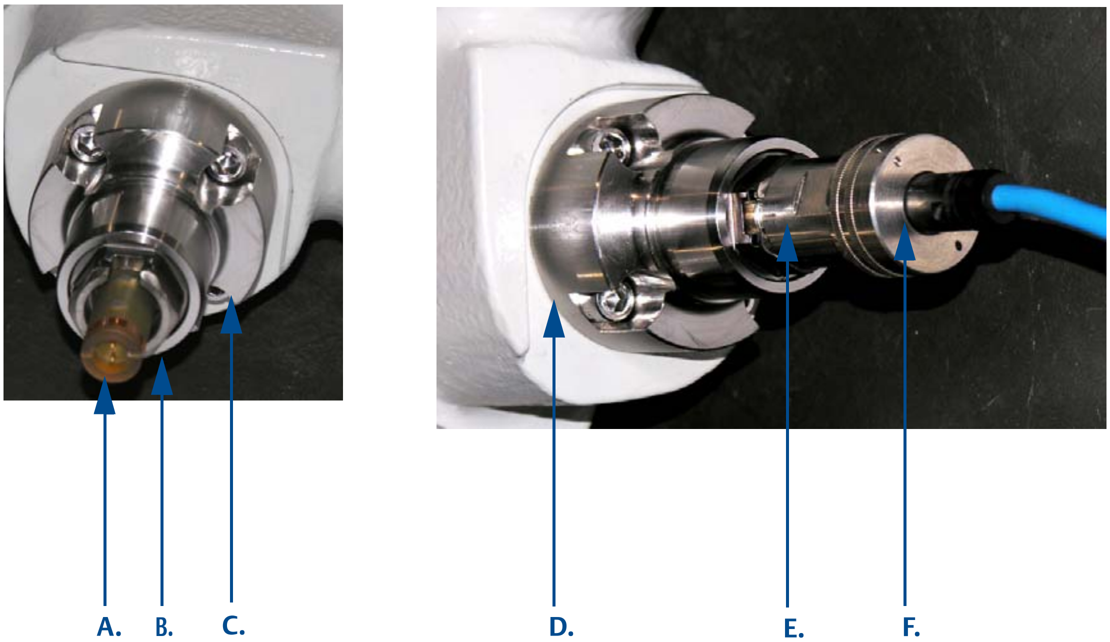
Figure 7-7 M-mount cover and chordset with “V” arrowhead mark



A. Mount cover captive screws
B. Mount cover “V” alignment arrowhead
C. Chordset “V” alignment arrowhead

9. If replacing T-21 or T-22 transducers, install the keyed transformer assembly into the transducer holder (see Figure 7-8).
   a. Apply a small amount of Molykote 111 to the transformer assembly O-ring.
   b. Insert the keyed transformer into the back end of the transducer holder.

Figure 7-8 T-22 transducer assembly, holder, transformer, retainer, cable nut and chordset



A. T-21 transformer assy. (W-01 P/N 1-360-03-090) or T-22 transformer assy. (W-02 P/N 1-360-03-110)
B. Transducer holder (Type - H1 P/N 1-360-01-128, H2 P/N 1-360-01-228)
C. Mount and holder
D. Transducer port (meter body)
E. Transducer retainer (Standard P/N 1-360-01-958) High temperature (P/N 1-360-01-978)
F. Cable nut and chordset:
100 ^{o}C - 5' length P/N 2-3-3400-190)
100 ^{o}C -15' length (P/N 2-3-3400-194
200 ^{o}C - Straight backshell (P/N 1-36-01-800)
200 ^{o}C - 90^{o} backshell (P/N 1-360-01-801)

10. For T-21 and T-22 transducers, place the retainer over the transformer assembly. Ensure the retainer threads are aligned correctly and hand-tighten. Use a 1 1/8" wrench and turn clockwise until the transformer assembly is fully seated in the transducer holder. Note: Do not over tighten the retainer.

11. Reconnect the transducer chordset to the transducer holder or the retainer if installing T-21 or T-22 transducers. The internal connector of the transducer chordset is keyed and will only go on one way. Secure the transducer cabling nut by turning clock-wise. Ensure the cable nut threads are correctly aligned.

12. Repeat Step 1 through Step 12 for the remaining transducer assemblies which were replaced.
13. Check that the Daniel 3400 Series Gas Ultrasonic Flow Meter is pressure tight. Pressurize the meter to line pressure. Check for leaks around all mounts and transducer holders, which were removed, using soapy water or other recognized leak detector. If leaks are found, the meter must be vented to atmosphere and the problem corrected. Check for leaks again. Continue the process until there are no leaks.
14. Continue with Section 7.2.5 to use the Daniel MeterLink Transducer Swap- out Wizard.

7.2.4 Replace the transformers

If your meter is equipped with T-21 or T-22 transducers and you need to replace the transformer assemblies, use the following procedure. Refer to Figure 7-5 and Figure 7-8.

Procedure

1. Disconnect the transducer chordset from the transducer retainer by turning the cable nut counter-clock wise. Note: Do not twist the chordset as you disconnect it from the transformer.
2. Unscrew the retainer from the holder using a 1 1/8” wrench.
3. Pull the transformer assembly from the transducer holder assembly.
4. Apply a small amount of Molykote 111 to the O-rings on the replacement transformer assembly.
5. Plug the replacement transformer assembly into the transducer holder assembly. The transformer is keyed and can only be installed one way.

   Note: T-21 transducers use W-01 transformers and T-22 transducers use W-02 transformers.
6. Place the retainer over the transformer assembly. Ensure the retainer threads are aligned correctly and hand-tighten. Use an 1 1/8” wrench and turn clockwise until fully seated in the transducer holder. Note: Do not over tighten the retainer.
7. Plug the keyed chordset into the transformer assembly.
8. Thread the cable nut onto the transducer retainer. Ensure the cable nut threads are aligned correctly and hand-tighten.

7.2.5 Modifying the Calibration Parameters

When transducer pairs are replaced, the corresponding meter calibration parameters must be updated for accurate operation. This means modifying the affected chord "L" dimension (**LA** ... **LD**) (see Determining the “L” Value below), average delay time (**AvgDlyA** ... **AvgDlyD**) and delta delay time (**DltDlyA** ... **DltDlyD**) using the Daniel MeterLink Transducer Swap-out Wizard.

After running the Daniel MeterLink Transducer Swap- out Wizard and writing the new chord parameters to the meter, collect and save a Maintenance log (**Logs/Reports menu**) and a Configuration file (**Tools>Edit/Compare Configuration**).

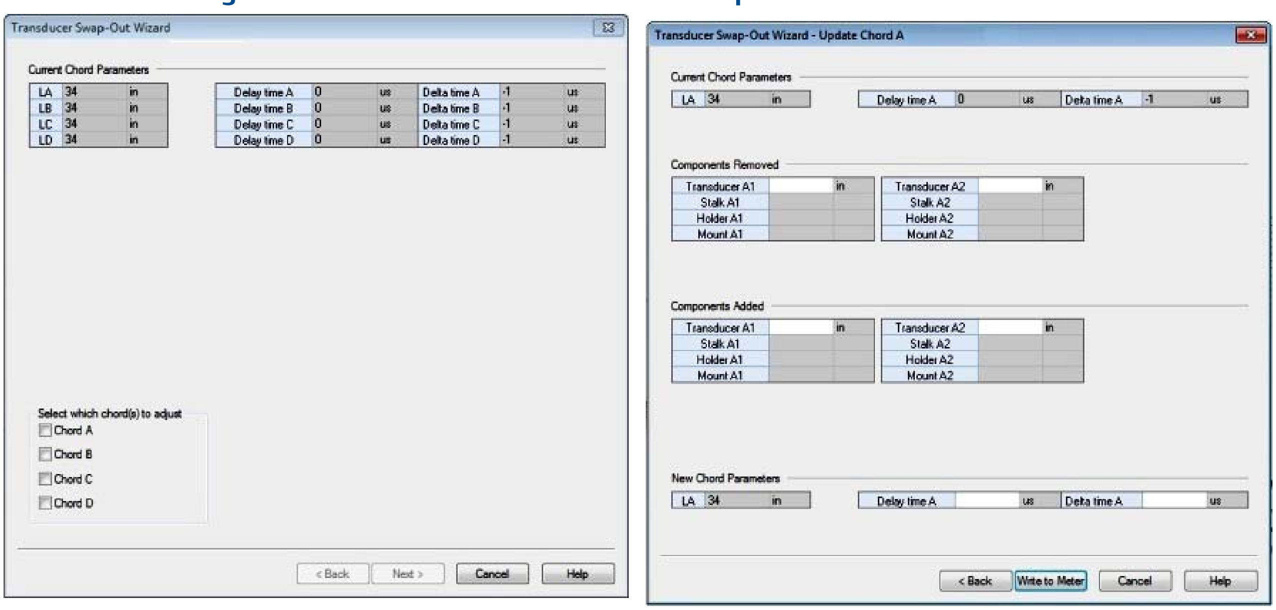
Average Delay Time and Delta Delay Time Modifications

The transducer pair average delay time and delta delay time are located on the transducer pair calibration sheet. These values must be downloaded to the appropriate meter data points (**AvgDlyA** ... **AvgDlyD**, **DltDlyA** ... **DltDlyD**). The lengths of the transducers are also included on the calibration sheet and are etched on the transducers. Likewise the lengths of the stalk assemblies, transducer holders, and mounts are etched on the individual components. The length of the meter body is found on the original calibration sheet supplied with the meter.

Determining the “L” Value

The value “L” is determined by adding the length of the meter body to the lengths of the two mounts and subtracting the lengths of the transducer holders, stalk assemblies, and transducers. This value should be written to the appropriate meter data points for each chord that received new transducers (**LA** ...**LD**). See Equation B-5 for the “L” dimension calculation.

Figure 7-9 Daniel MeterLink Transducer Swap-out Wizard



7.3 Replacing the Mark III Electronics

The Daniel Mark III Ultrasonic Gas Flow Meter electronics consists of the following:

- Acquisition board (Base unit)
- CPU board (Upper Explosion-proof Housing Assembly)
- I.S. Interface board (Upper Explosion-proof Housing Assembly)
- Field Termination board (Upper Explosion-proof Housing Assembly)
- Series 100 Option board or Series 100 Plus Option Board (Upper housing)

See Figure 2-2 for board locations within the assembly. Also, see Section 3.3.3 for accessing the Mark III electronics.

Should the Daniel 3400 Series Gas Ultrasonic Flow Meter require disassembly in the field (i.e., check boards, change switch settings, or replace boards), follow the instructions in the *Daniel Ultrasonic Mark III Electronic Upgrade Kit Instructions Manual* (P/N 3-9000-746) and the *Daniel Series 100 Option Boards Field Installation Procedure Manual* (P/N 3-9000-749) to disassemble the meter. Both manuals may be downloaded from the Daniel website.

http://www2.emersonprocess.com/EN-US/BRANDS/DANIEL/FLOW/Pages/Flow.aspx

NOTICE

To access the product manual, from the Daniel products page (above link), select the Daniel SeniorSonic 4-Path Gas Flow Meter link, click the Documentation tab, expand the Manuals & Guides tab, then select the manual.

In the event the Daniel Ultrasonic Gas Flow Meter needs repair, the user is advised to contact Daniel Customer Service. The contact information is noted in the preface of this manual.

Record the following information when replacing the meter electronics.

Table 7-2 Electronics serial numbers

Board type	Serial number
Acquisition board	
Backplane	
I.S. Interface board	
Power supply	
CPU module	

7.4 Troubleshooting Communications

The Communications Analyzer (via Daniel MeterLink **Tools> Menu>Communications Analyzer menu path**) displays communications between Daniel MeterLink and the ultrasonic meter. This utility can be useful for troubleshooting communications to the meter. It displays many of the TCP/IP commands between Daniel MeterLink and the connected meter.

For troubleshooting communications with the Field Communicator (375) for the HART® Protocol, refer to Section 5 of the *Emerson 375 Field Communicator User's Manual P/N 00375-0047-0001, Rev D*. This manual may be downloaded from the following location:

http://www.fieldcommunicator.com/documents/manuals/allma0501e_375ManRevD.pdf

For troubleshooting communications with AMS™ Suite, refer to the *AMS™ Books Online* help documentation and support at the following web site:

http://www.emersonprocess.com/ams/suppinde.htm

7.4.1 Unable to Connect Direct Serial or External Serial Modem

If you are using Windows® 2000, Windows® XP or Windows® Vista make sure that you do not have more than one modem driver installed to the same COM port. Typically this will only be necessary if you use one COM port to talk direct (serial communications) and use the same COM port to connect to an external modem. This is an apparent limitation in Microsoft®'s Dial-up Networking. If more than one modem driver is installed for a particular COM port, Dial-up Networking will always use the last driver installed regardless of what is selected. The only work around is to only install one modem driver per COM port on the PC at a time. To check if this is the issue, follow the steps below.

Refer to the *Daniel MeterLink Ultrasonic Meter Software Quick Start Manual* (P/N 3-9000-763) for phone and modem details. These manuals may be downloaded from the Daniel website:

http://www2.emersonprocess.com/en-US/brands/daniel/Flow/ultrasonics/Pages/Ultrasonic.aspx

7.4.2 Unable to Connect to Meter

If you receive the error message "Unable to connect to meter" when trying to connect to a Mark III Series 100 Option Board, refer to the following:

- Ethernet Connections
- Direct Serial Connections

Ethernet Connections

If you received this message while trying to connect over Ethernet, verify you have the correct IP address in the Meter Directory record. If the meter is to assign the IP address, make sure the IP address is set to 192.168.135.100 and that the switch S2 Position 2 is in the **CLOSED** position on the CPU board. If the meter has a fixed IP address, verify the IP address, Subnet, and Gateway are correct in the meter. Verify your wiring to make sure you have a crossed-over cable for a direct connection between the meter and the computer. If going through a hub, verify that the computer and meter are connected to the hub with straight through patch cables.

Direct Serial Connections

Verify the switch settings on the CPU Board and Field Connection Board (see Section 3.4). Use the wiring diagram cards inside the electronics to verify the settings. Also verify your wiring between the meter and the computer running Daniel MeterLink using the Field Wiring drawing DE-21056 (see Appendix I). Verify the Comms Address and Baud rate are correct in the Meter Directory record.

For additional information on wiring and configuring the meter for the various communication options see Section 3.4.

7.4.3 Maintenance log files and trend files

Files do not appear in workbook

Maintenance Log files and Trend files that exist on the PC do not appear in the Microsoft® Excel® workbooks tree under Trend Maintenance Logs.

This is most likely caused by the fact that the desired file or files are already open in Microsoft® Excel®. Open files can not be verified as Maintenance Log files or Trend Files by Daniel MeterLink and are left out of the list. Simply close the files in Microsoft® Excel® and then close and reopen the Trend Maintenance Logs dialog box to include them in the list.

Microsoft® excel® log/export options are not available

In order for the Excel® log/export options to be available, Excel® 2000 or later must be installed on the machine and at least one printer must be installed under Windows®.

If Excel® 2000 or later is installed and you have printers installed but the Excel® option is still unavailable, it may be because Excel® cannot access the printer driver information of the Windows® default printer. If the Windows® default printer is a network printer and you are not currently connected to the network, then Excel® will most likely not be able to access the printer driver information and Daniel MeterLink cannot use Excel® to generate reports or logs.

One solution is to install a local printer on your machine tied to port LPT1. The local printer driver you installed can be for any printer and the printer does not actually have to exist or be connected to the PC. If you install a local printer, you can configure Daniel MeterLink to temporarily change your Windows® default printer over to this local printer while running Daniel MeterLink. Do this by selecting this local printer for the Override system default printer selection in the Program Settings dialog. Daniel MeterLink will automatically change the Windows® default printer to the selected override printer when it starts and will set the Windows® default printer back to its original printer when it closes.

Maintenance logs or trend files are not created

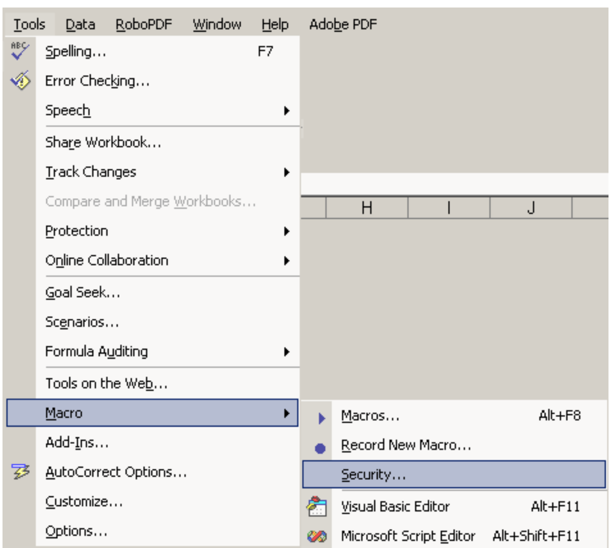
When using Excel® XP or later, some of the worksheets in the Maintenance Logs or Trend files are not created.

If the Inspection sheet of the Maintenance Log file or the Charts sheet of a Trend files is not generated, it is probably because Excel® is not configured to allow Daniel MeterLink to run the Visual Basic® script that generates the page. Excel® can be configured to allow Daniel MeterLink to run the Visual Basic® script by following the instructions below.

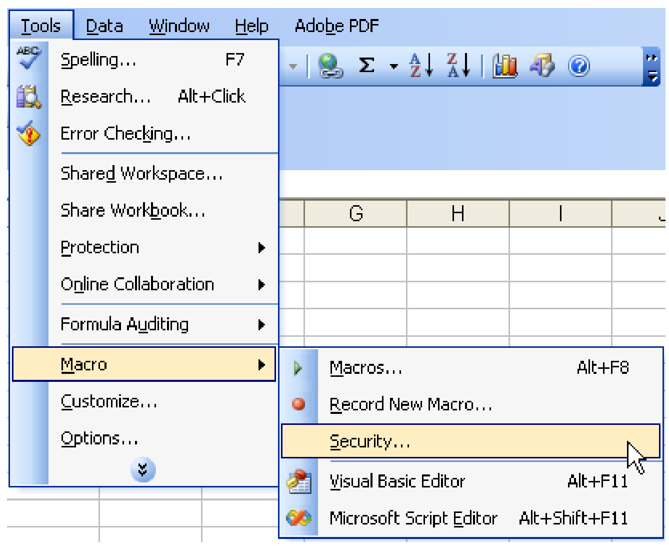
To enable Excel® to work with Daniel MeterLink, open Microsoft® Excel,

1. Select the **Tools|Macr|>Security** menu.

Figure 7-10 Excel® Tools Menu



Windows 2000 Excel® Menu

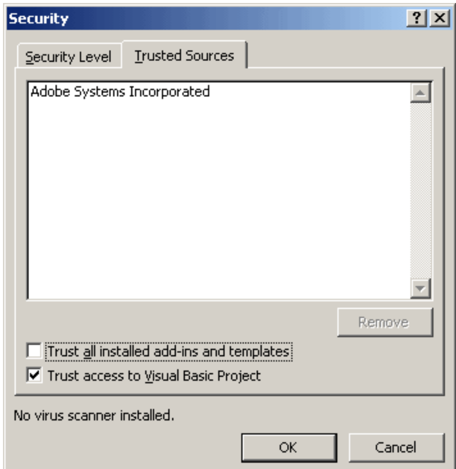


Windows XP Excel® Menu

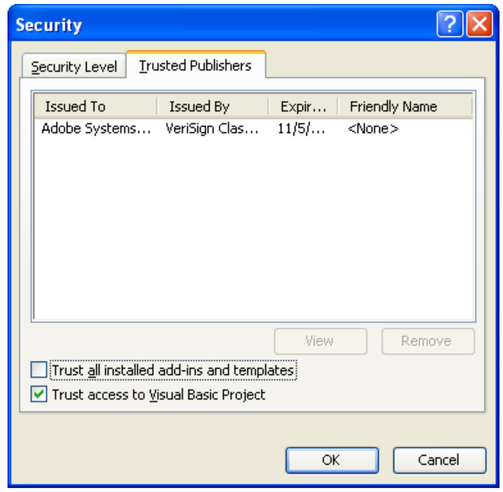
2. The Security dialog appears. Select the **Trusted Sources** (or if you are using Microsoft® XP, **Trusted Publishers)**tab.

3. Select the **Trust access to Visual Basic Project** checkbox and click the **OKAY** button to apply your selections.

Figure 7-11 Excel® Trusted Access Setting



Windows 2000 Excel® Menu



Windows XP Excel® Menu

7.4.4 Daniel MeterLink fails to connect or crashes using Windows® 2000

Daniel MeterLink fails to connect or crashes on a Windows® 2000 machine with *Service Pack 4* when attempting a direct serial or modem connection with a Series 100 Option BoardDaniel 3410 Series Ultrasonic Gas Flow Meter.

Windows® 2000 Service Pack 4 has a problem that will prevent Daniel MeterLink from connecting or cause Daniel MeterLink to crash when attempting a direct serial or modem connection to a Daniel 3400 Series Gas Ultrasonic Flow Meter. This is a *Known Issue* documented in the Microsoft® Knowledge Base Article 824301 “Script Error”- Error Message When You Try to Connect to a Server by Using a Remote Access Connection. A Hotfix is available from Microsoft®. See below, to find out where to find this patch.

7.4.5 Windows® Hotfixes – Obtaining Hotfixes for Microsoft® Windows®

For English North American versions of Windows® 2000

If you are using an English North American version of Windows® 2000, the Hotfixes can be found on the Daniel MeterLink Installation CD under a directory called Windows® Hotfixes. Just run the Hotfix for the appropriate Windows® operating system and Knowledge Base Article Number. Daniel Customer Service can also provide these Hotfixes if you do not have a Daniel MeterLink Installation CD available.

For All Other Versions of Windows® 2000

For all other versions of Windows® 2000, go to the link below for the particular Knowledge Base Article to find out how to contact Microsoft® for Hotfixes for your version of Windows®.

- **KB82430**: For the Windows® 2000 Service Pack 4 Issue that will prevent Daniel MeterLink from connecting to a Series 100 Option Board over serial or dial-up, go to the following link:
  http://support.Microsoft.com/default.aspx?scid=kb;[LN];824301

- **KB824136**: For the Excel® Issue go to the following link:
  http://support.Microsoft.com/default.aspx?scid=kb;[LN];824136

It is necessary to address this issue if you intend to communicate with one of these meters with Daniel MeterLink using a serial port or modem. If you are only communicating to these meters using Ethernet, then no action is required.

7.4.6 Windows® 2000 SP-4 or a Windows® XP with security update

Daniel MeterLink on a Windows® 2000 machine with Service Pack 4 or a Windows® XP machine with Security Update for Windows® XP (KB 823980) takes a long time to add files to the trend list under the Trend Maintenance Logs dialog or displays files that are not valid files to trend.

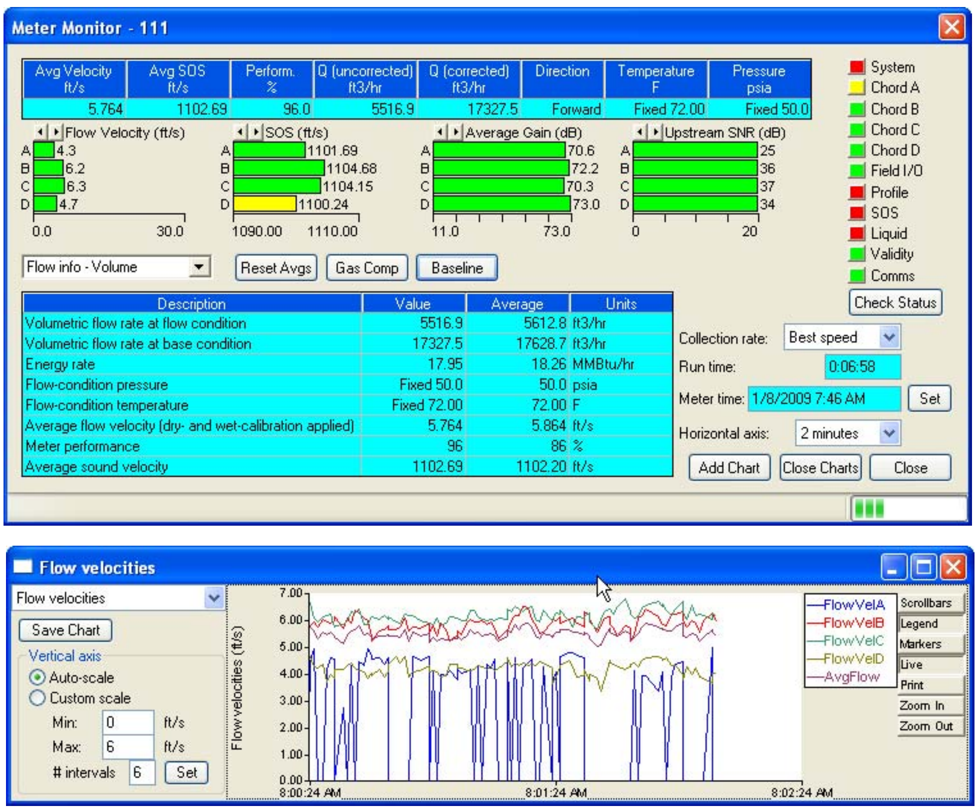
Windows® 2000 Service Pack 4 and the Security Update for Windows® XP (KB 823980) have a problem that causes the Show only maintenance log and trend workbooks check box in Daniel MeterLink Deluxe Edition to be ineffective. Additionally, it may take longer to validate a workbook when you attempt to add it to the Workbooks to trend list. This is a known Issue documented in the Microsoft® Knowledge Base Article 824136 Windows® Explorer Quits Unexpectedly or You Receive an Error Message When You Right-Click a File. For Windows® XP, simply install Service Pack 2 for Windows® XP to resolve the issue. For Windows® 2000, a hotfix is available from Microsoft®. See Windows® Hotfixes above to find out where to find this patch. It is not necessary to take action on this issue to use the Trend Maintenance Logs dialog, but you should be aware of possible slow downs if the issue is unresolved.

7.5 Troubleshooting Meter Status

7.5.1 Meter Status Alarms

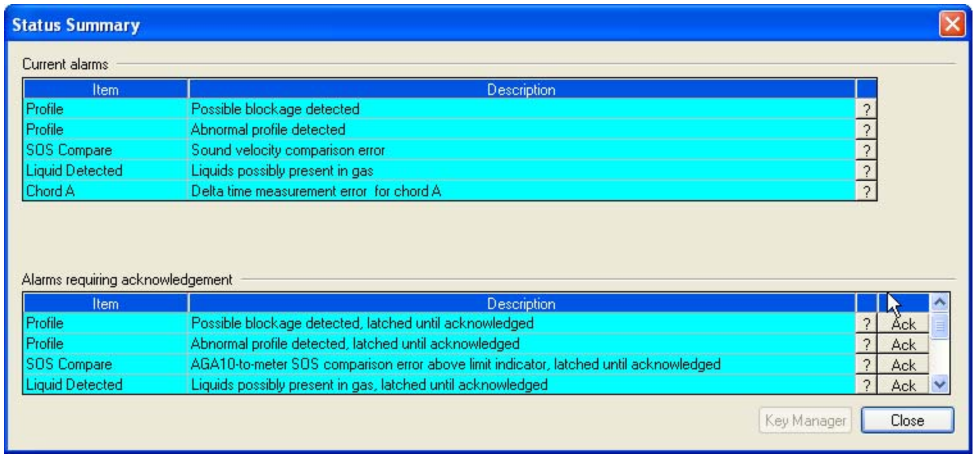
The Status alarms give a visual indication of the status of the meter. A green LED means no alarm, a yellow LED indicates a warning, while a red LED means an alarm is present. Gray indicates the chord has manually been set to inactive.

Figure 7-12 Meter Monitor Status Alarms



Click the **Check Status** button and Daniel CUI opens the Meter Monitor Status Summary dialog box that gives a short description of the current alarms present and alarms that require acknowledgement. Click **Check Status** if any of the LEDs are yellow or red to see more specific information causing the status alarm. The alarms are grouped in two tables: one for active alarms and one for acknowledgeable alarms. The alarms are also sorted in each table with the highest severity first. Active alarms do not require an acknowledge and will clear automatically when the alarm condition goes away. Alarms that require a user to acknowledge them will have a button to the right titled **ACK**. Clicking this button changes the button text to **Wait** and sends a request to the meter to clear the alarm. The alarm will disappear from the **Check Status** dialog once the alarm actually clears. Clicking the Question mark icon to the right of an alarm displays a help topic providing more detail on the alarm as well as possible causes and solutions. For complete descriptions and possible solutions, refer to P/N 3-9000-754 HART Field Device Specification Guide: Daniel Gas Ultrasonic Meters manual, Annex F.

Figure 7-13 Meter Monitor Status Summary



Following is a list and a brief description of the types of alarms:

- System
- Chord A - Chord D
- Field I/O
- Profile
- SOS
- Liquid
- Validity
- Comms

7.5.2 System Alarm

The System alarm indicates a failure in the hardware that should be addressed by a service technician. This includes memory checksum errors and communication errors within the hardware. Red and green are the only colors used for this alarm.

7.5.3 Chord A to Chord D

Chord(s) A through D - These alarms indicate how a chord is functioning Red and green are the only colors used for this alarm.

Table 7-3 Chord alarms

LED Color	Problem
Green	No alarms are present. Chord is operating properly.
Yellow	At least one sample in the batch caused an alarm but it did not cause the chord to fail. The sample will not be used in the batch. Discarding occasional samples can occur during normal operation such as during flow velocity changes.
Red	The chord has failed or is in acquisition. This chord is not used for this batch. Chords that have failed or are shown to be in acquisition for repeated batches indicates that the meter should be inspected by a service technician.
Gray	The chord has manually been set to inactive.

7.5.4 Field I/O Alarm

Reports various field I/O devices that are in alarm. Click the **Check Status** button for more details on specific alarms. The field is grayed out if the Daniel 3400 Series Gas Ultrasonic Flow Meter does not support this alarm.

7.5.5 Validity Alarm

This alarm indicates that the meter may not be measuring accurately. Click **Check Status** to see a description of which validity alarms are active. The validity alarms **QMeter** and **QFlow** indicate an issue with the meter collecting enough information from the chords to make an accurate measurement. The validity alarms for pressure and temperature indicate that the value is above or below the alarm limits for these values. Red and green are the only colors used for this alarm.

7.5.6 Comms Alarm

The Comms alarm indicates that communications between Daniel MeterLink and the meter failed. This could be due to a poor communication link. Daniel MeterLink continues to retry communications. Red and green are the only colors used for this alarm.

7.5.7 Check Status

Click **Check Status** if any of the LEDs are yellow or red to see more specific information causing the status alarm. Some alarms do not require an acknowledge and will clear automatically when the alarm condition goes away. Alarms that require a user to acknowledge them will have a button to the right titled **ACK**. Clicking the **ACK** button changes the button text to **Wait** and sends a request to the meter to clear the alarm. The alarm will disappear from the Check Status dialog once the alarm actually clears.

7.6 Maintenance logs and reports

To monitor the health of the Daniel 3400 Series Gas Ultrasonic Flow Meter, and ensure it is operating within acceptable specifications, routine diagnostics should be performed. The results of these diagnostic checks should be trended to indicate changes from the original installation of the meter, or over time. Looking at a single inspection report, that is either collected monthly or quarterly, can give you an indication of the meter's health.

This is important since many diagnostics change slowly over time. Trending helps identify these changes and makes problems much more obvious than merely viewing a single inspection report. The Trending feature is integral to Daniel CUI (Deluxe Edition) or Daniel MeterLink which allows all important parameters to be trended.

Also, it is recommended that a diagnostic log file be collected after an upset in the system, where a slug of contaminants may have been introduced into the system.

In establishing a baseline to be used for the trending of the meter diagnostics, it is very helpful if a set of log files are collected immediately after the meter has been installed in the field. Preferably, collect the log files at several velocities within the operating range of the meter. This helps establish that the flow profile is relatively constant throughout the meters operating range (except velocities below 3 ft/sec where the profile may vary).

Table 7-4 Maintenance log collection

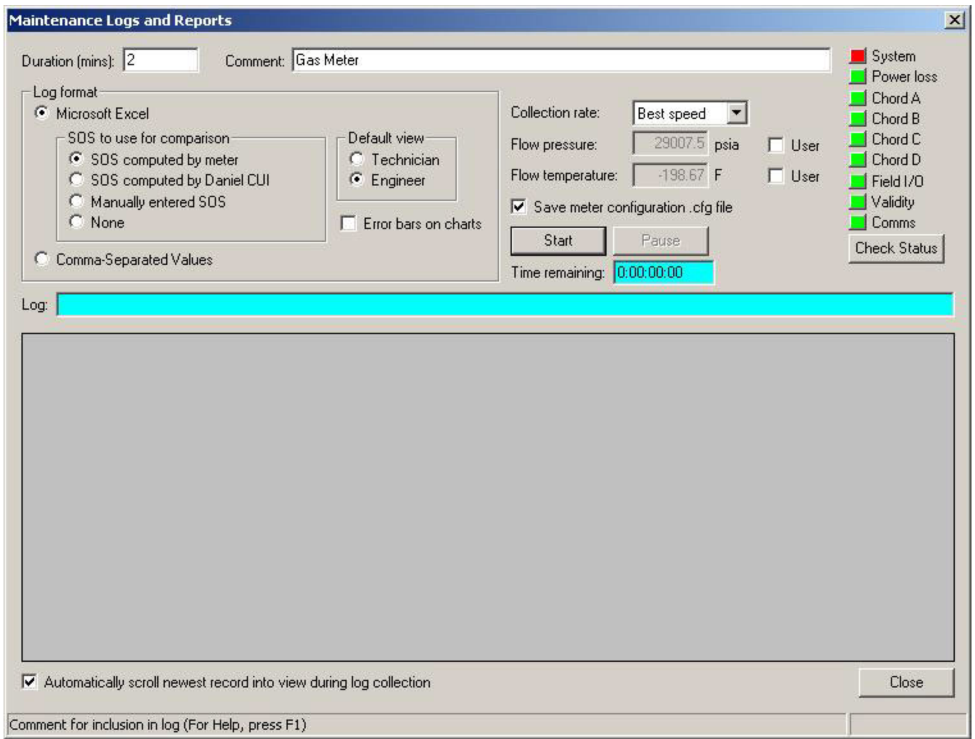
Collection rate	Maximum Duration (based on 3600 records)
Best Speed	n/a
5 sec.	300 min (5 hours)
10 sec	600 min (10 Hours)
30 sec.	1800 min (30 hours or 1.25 days)
1 min	3600 min (60 Hours or 2.5 days)
5 min	18000 min (300 Hours or 12.5 days)

7.6.1 Collecting logs and viewing Excel reports

To collect Maintenance and Trend Logs for meter diagnostics,

1. Establish communication with the meter via Daniel CUI.
2. From Daniel CUI main window, use the **Logs/Reports | Maintenance Logs and Reports menu path.** The Maintenance Logs and Reports dialog appears.

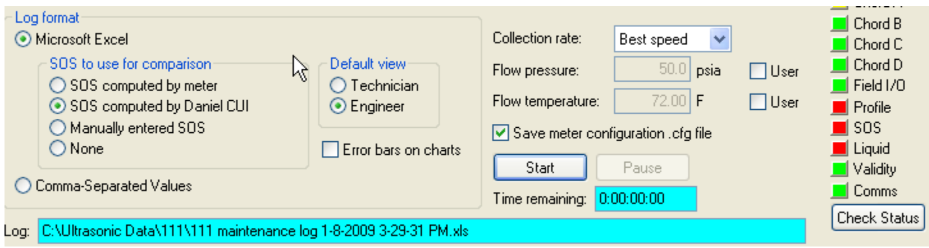
Figure 7-14 Maintenance Logs and Reports Dialog



3. Set the log collection Duration (mins) (2 minutes is the default value which is normally adequate to capture a good snapshot of the meter's current diagnostic parameters). To get a good representation of the meter performance, it is recommended that there be at least 30 records (lines of data). The actual number of records collected are a function of the type of communication (Serial or Ethernet), Stack Size (if stacking is turned on), and the Collection speed selected. The duration value can be changed by clicking the number in the display/edit box and entering a new value.
4. If desired, a comment may be included in the log file by entering it in the display/edit box provided.
5. In the Log Format field, select Microsoft® Excel. DO NOT select Comma Separated Values (CSV), as this format is not compatible with the generation of graphics, trending and analysis offered by Daniel CUI and Microsoft® Excel. CSV should only be used if the computer does not have Microsoft® Excel. Once the file is collected in the CSV format, it can not be converted to a Microsoft® Excel format.

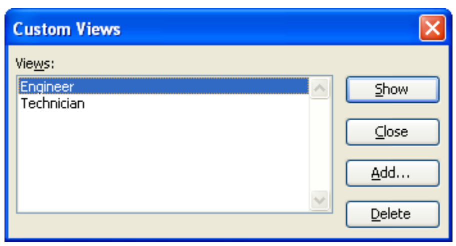
6. Select the Default view radio button for either Technician or Engineer.

Figure 7-15 Log collection parameters



The log file captures all the data regardless of the view setting selected. If the Technician view is selected, some of the data will be hidden. The view can be changed when the Microsoft® Excel file is opened and selecting **View|Custom Views** (see fFigure 7-16) or by un-hiding the columns by selecting **Format|Column|Unhide**.

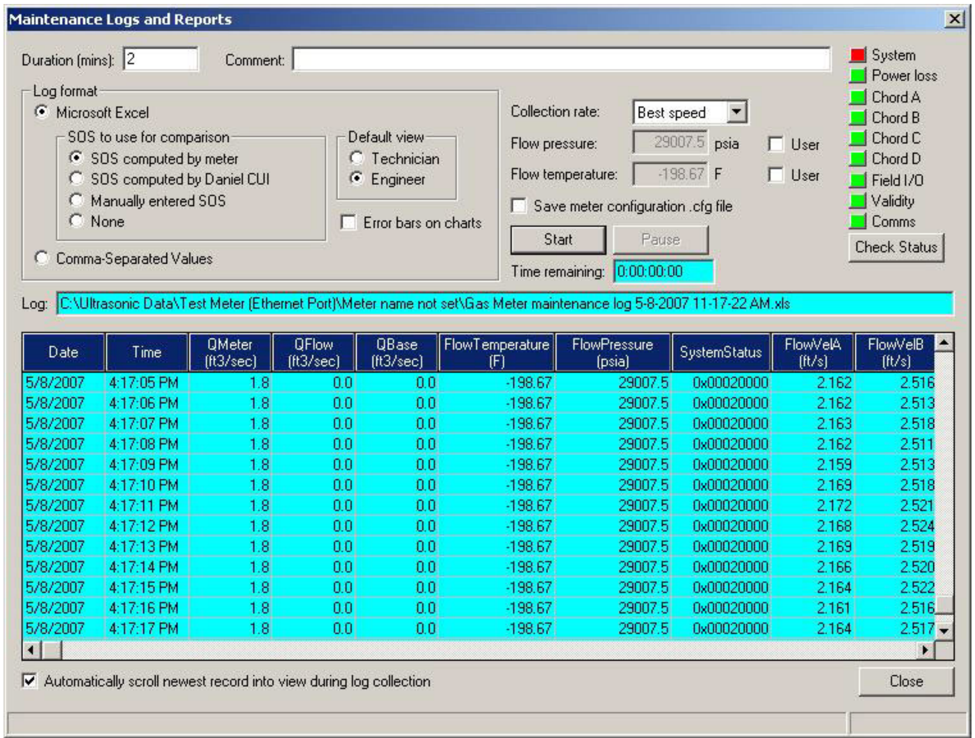
Figure 7-16 Excel custom view settings



7. Click the checkbox for **Error Bars on Charts** if you want to display this feature in the Excel® spreadsheet.

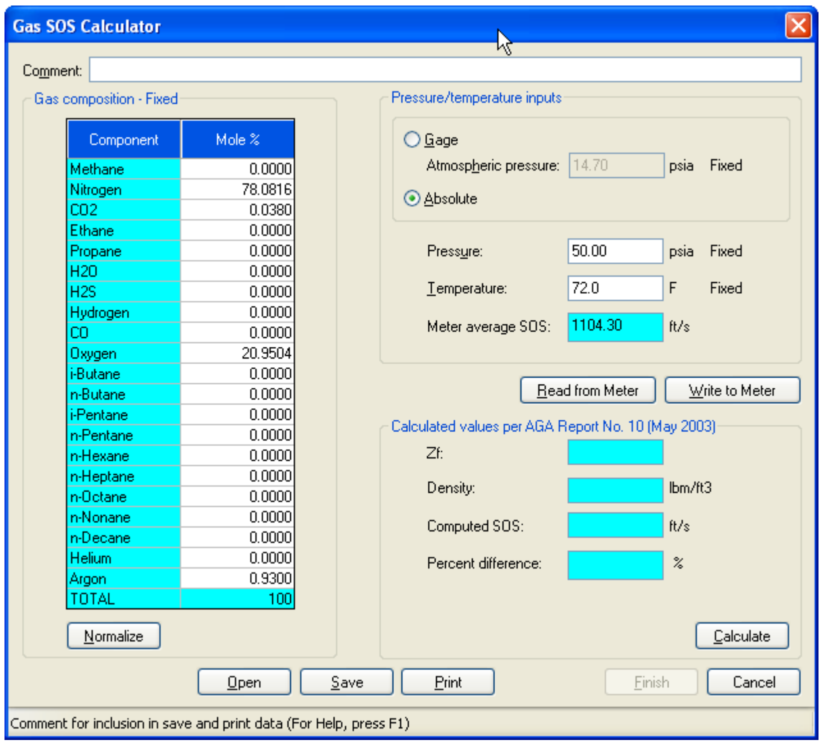
8. To begin collecting logs, click the **Start** button. Daniel CUI or Daniel MeterLink collects the meter's configuration and then begins collecting all the data from the meter.

Figure 7-17 Maintenance logs and reports start dialog



9. When all of the data is collected, the SOS Calculator dialog appears (if a Computed SOS value was entered, it will be included or if Manually entered SOS has been selected). Click the **Calculate** button and the SOS data is included in the Maintenance log spreadsheet.

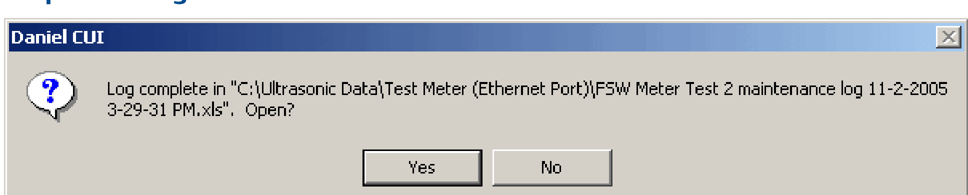
Figure 7-18 Speed of Sound dialog



10. Click the **Finish** button for the Speed of Sound calculations.

11. Daniel CUI displays a message that the log data collection is complete and allows to you open the file now or open it at a late time.

Figure 7-19 Log complete dialog



12. Click the **Yes** button to view the Microsoft® Excel file or click the **NO** button to view the reports at a later time. Daniel MeterLink returns you to the Maintenance and Reports dialog box.

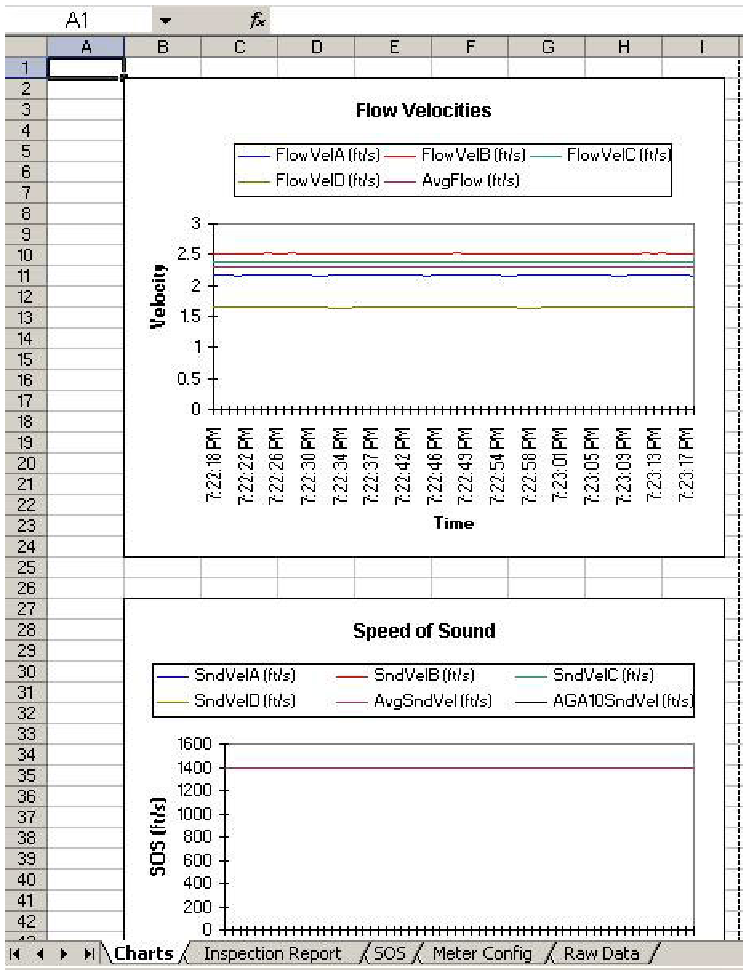
13. If you clicked the **Yes** button in the previous step, Microsoft® Excel opens the log reports.

14. Select the Workbook report view from the lower left Microsoft® Excel toolbar. Tab selections include:
    - Charts
    - Inspection Report
    - SOS
    - Meter Config
    - Raw Data

Figure 7-20 Microsoft® Excel report view toolbar

15. The Microsoft® Excel default report view is Charts. The Charts Report includes:
    - Flow Velocities
    - Speed of Sound
    - SOS Diff from Avg
    - Flow Profile
    - Flow Velocity Ratios
    - Profile Factor
    - Average Gain
    - Average Performance
    - Turbulence
    - Uncorrected Flow Rate
    - Corrected Flow Rate
    - Pressure and Temperature
    - Mass Rate and Flow Mass Density

Figure 7-21 Microsoft® Excel charts view

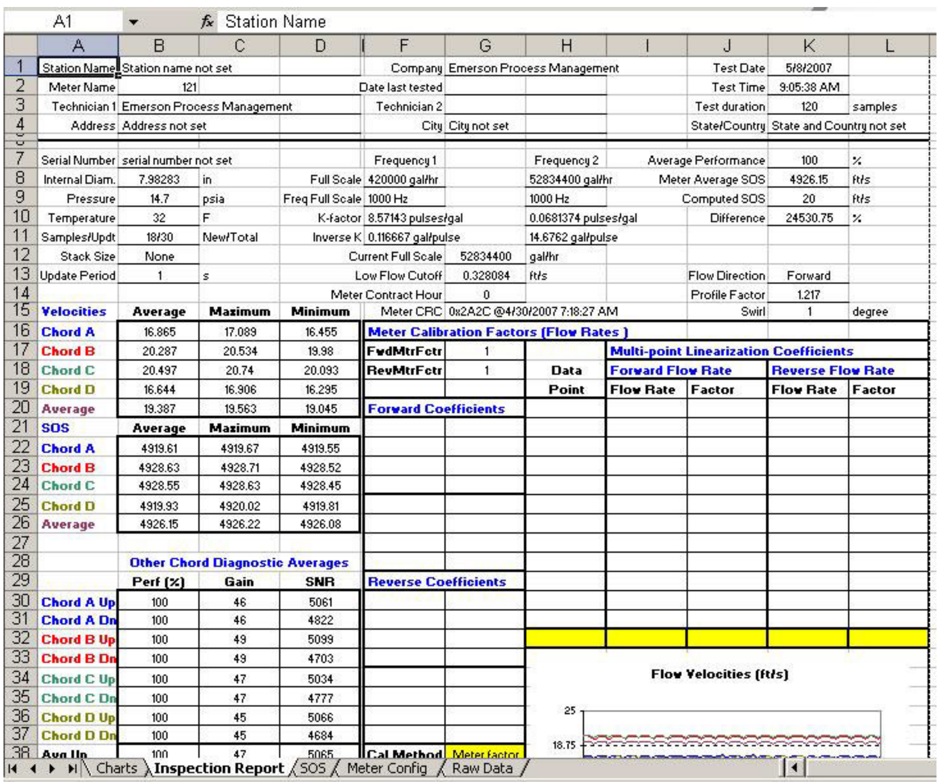


16. The next Microsoft® Excel report view is the Inspection Report. The Inspection Report includes:

- Meter Identification
- Velocities (Average, Maximum and Minimum)
- Other Chord Diagnostic Averages
  - Performance percentage
  - Gain
  - Signal to Noise Ratio
- Meter Calibration Factors

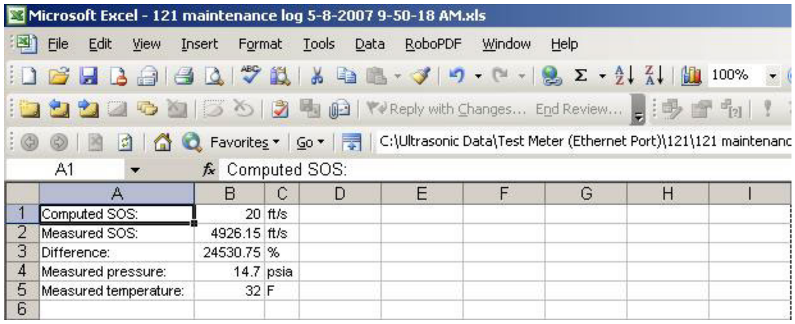
- Status Codes
- Comments
  - Configuration Verified
  - Meter Contract Hour
  - Event(s) Alarm(s)
  - Signatures
  - Tester
  - Witness
  - Date

Figure 7-22 Microsoft® Excel inspection report view



17. The next Microsoft® Excel report view is Speed of Sound. The Speed of Sound Report includes:
    - Computed SOS
    - Measured SOS
    - Difference (percentage) in Computed and Measured SOS
    - Measured pressure
    - Measured temperature

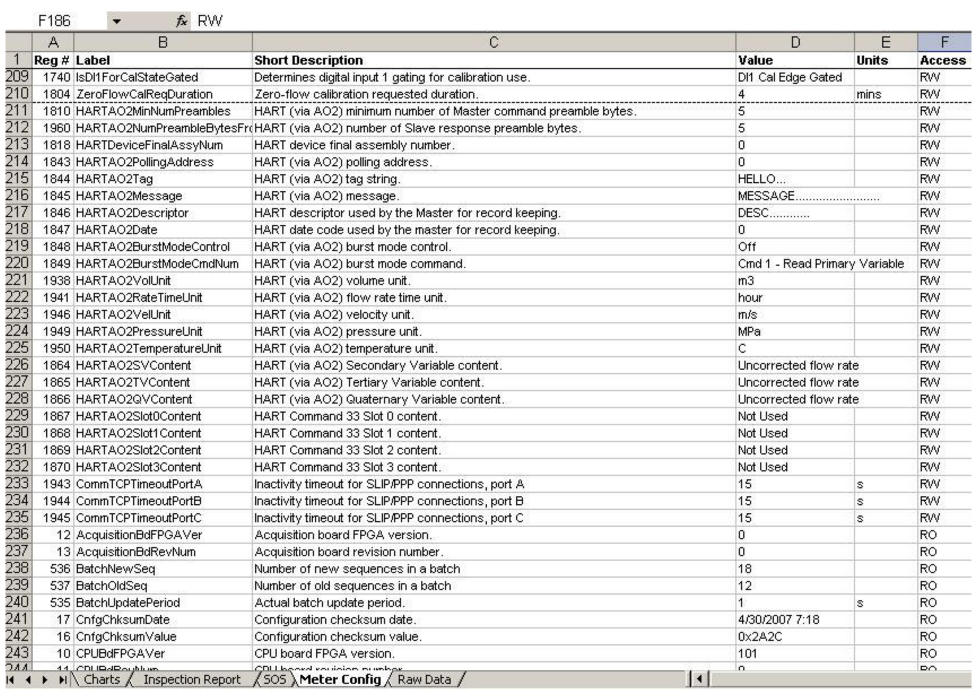
Figure 7-23 Microsoft® Excel Speed of Sound View



	A	B	C
1	Computed SOS:	20	ft/s
2	Measured SOS:	4926.15	ft/s
3	Difference:	24530.75	%
4	Measured pressure:	14.7	psia
5	Measured temperature:	32	F

18. The next Microsoft® Excel report view is Meter Configuration. The Meter Configuration Report includes:
    - Modbus Register Number
    - Label
    - Short Description
    - Value
    - Units (of Measure)
    - Access (Read Only or Read Write)

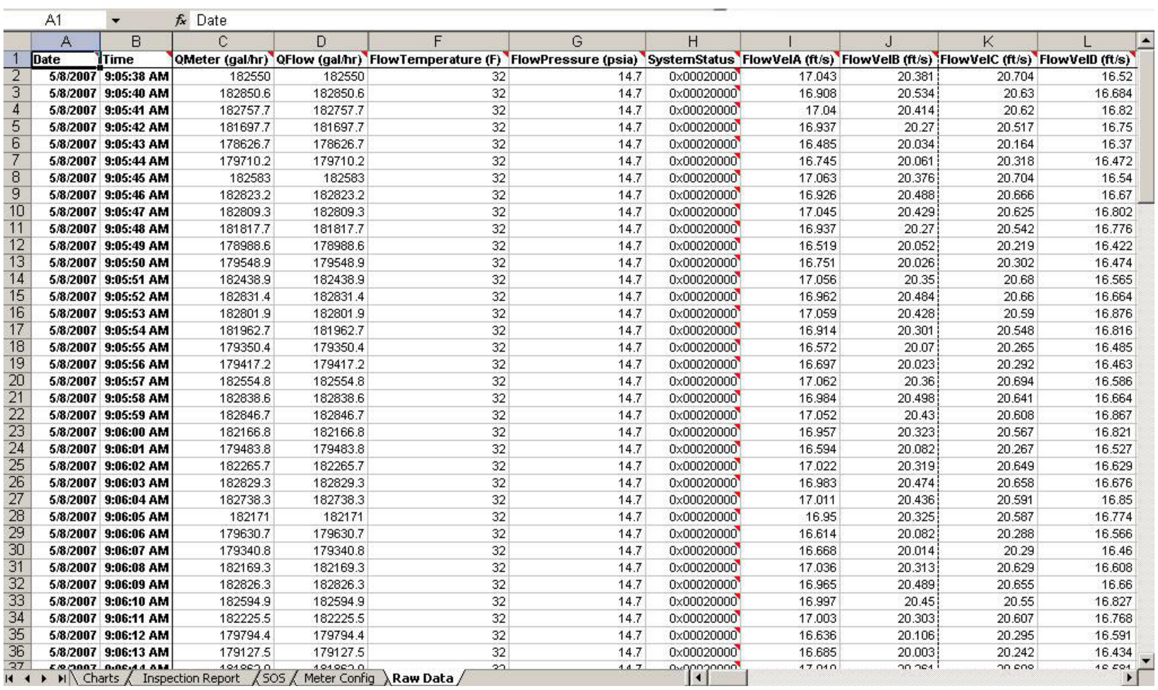
Figure 7-24 Microsoft® Excel Meter Config View



	Reg #	Label	Short Description	Value	Units	Access
209	1740	IsDI1ForCalStateGated	Determines digital input 1 gating for calibration use.	DI1 Cal Edge Gated		RW
210	1804	ZeroFlowCalReqDuration	Zero-flow calibration requested duration.	4	mins	RW
211	1810	HARTAO2MinNumPreambles	HART (via AO2) minimum number of Master command preamble bytes.	5		RW
212	1960	HARTAO2NumPreambleBytesFr	HART (via AO2) number of Slave response preamble bytes.	5		RW
213	1818	HARTDeviceFinalAssyNum	HART device final assembly number.	0		RW
214	1843	HARTAO2PollingAddress	HART (via AO2) polling address.	0		RW
215	1844	HARTAO2Tag	HART (via AO2) tag string.	HELLO...		RW
216	1845	HARTAO2Message	HART (via AO2) message.	MESSAGE........................		RW
217	1846	HARTAO2Descriptor	HART descriptor used by the Master for record keeping.	DESC...........		RW
218	1847	HARTAO2Date	HART date code used by the master for record keeping.	0		RW
219	1848	HARTAO2BurstModeControl	HART (via AO2) burst mode control.	Off		RW
220	1849	HARTAO2BurstModeCmdNum	HART (via AO2) burst mode command.	Cmd 1 - Read Primary Variable		RW
221	1938	HARTAO2VolUnit	HART (via AO2) volume unit.	m3		RW
222	1941	HARTAO2RateTimeUnit	HART (via AO2) flow rate time unit.	hour		RW
223	1946	HARTAO2VelUnit	HART (via AO2) velocity unit.	m/s		RW
224	1949	HARTAO2PressureUnit	HART (via AO2) pressure unit.	MPa		RW
225	1950	HARTAO2TemperatureUnit	HART (via AO2) temperature unit.	C		RW
226	1864	HARTAO2SVContent	HART (via AO2) Secondary Variable content.	Uncorrected flow rate		RW
227	1865	HARTAO2TVContent	HART (via AO2) Tertiary Variable content.	Uncorrected flow rate		RW
228	1866	HARTAO2QVContent	HART (via AO2) Quaternary Variable content.	Uncorrected flow rate		RW
229	1867	HARTAO2Slot0Content	HART Command 33 Slot 0 content.	Not Used		RW
230	1868	HARTAO2Slot1Content	HART Command 33 Slot 1 content.	Not Used		RW
231	1869	HARTAO2Slot2Content	HART Command 33 Slot 2 content.	Not Used		RW
232	1870	HARTAO2Slot3Content	HART Command 33 Slot 3 content.	Not Used		RW
233	1943	CommTCPTimeoutPortA	Inactivity timeout for SLIP/PPP connections, port A	15	s	RW
234	1944	CommTCPTimeoutPortB	Inactivity timeout for SLIP/PPP connections, port B	15	s	RW
235	1945	CommTCPTimeoutPortC	Inactivity timeout for SLIP/PPP connections, port C	15	s	RW
236	12	AcquisitionBdFPGAVer	Acquisition board FPGA version.	0		RO
237	13	AcquisitionBdRevNum	Acquisition board revision number.	0		RO
238	536	BatchNewSeq	Number of new sequences in a batch	18		RO
239	537	BatchOldSeq	Number of old sequences in a batch	12		RO
240	535	BatchUpdatePeriod	Actual batch update period.	1	s	RO
241	17	CnfgChksumDate	Configuration checksum date.	4/30/2007 7:18		RO
242	16	CnfgChksumValue	Configuration checksum value.	0x2A2C		RO
243	10	CPUBdFPGAVer	CPU board FPGA version.	101		RO

19. The last Microsoft® Excel report view is Raw Data. Contains all of the data collected from the meter. Each row is a record polled from the meter. Each record contains a date and time stamp based on the meter's time when the record was completely received. Each column of data following the date and time stamps is a data point collected from the meter. Below all of the polled records are rows that analyze the data and detail the minimum, maximum, average, the difference from minimum to average, and the difference from maximum to average for each column of data. The cells for SystemStatus and StatA through StatD will contain a comment that can be displayed by moving the mouse cursor over the marker in the upper-right corner of the cell. The marker is only present if the cell is indicating an alarm (i.e. non 0x0000 value).

Figure 7-25 Microsoft® Excel Raw Data View



A1 | Date

	A	B	C	D	F	G	H	I	J	K	L
1	Date	Time	QMeter (gal/hr)	QFlow (gal/hr)	FlowTemperature (F)	FlowPressure (psia)	SystemStatus	FlowVelA (ft/s)	FlowVelB (ft/s)	FlowVelC (ft/s)	FlowVelD (ft/s)
2	5/8/2007	9:05:38 AM	182550	182550	32	14.7	0x00020000	17.043	20.381	20.704	16.52
3	5/8/2007	9:05:40 AM	182850.6	182850.6	32	14.7	0x00020000	16.908	20.534	20.63	16.684
4	5/8/2007	9:05:41 AM	182757.7	182757.7	32	14.7	0x00020000	17.04	20.414	20.62	16.82
5	5/8/2007	9:05:42 AM	181697.7	181697.7	32	14.7	0x00020000	16.937	20.27	20.517	16.75
6	5/8/2007	9:05:43 AM	178626.7	178626.7	32	14.7	0x00020000	16.485	20.034	20.164	16.37
7	5/8/2007	9:05:44 AM	179710.2	179710.2	32	14.7	0x00020000	16.745	20.061	20.318	16.472
8	5/8/2007	9:05:45 AM	182583	182583	32	14.7	0x00020000	17.063	20.376	20.704	16.54
9	5/8/2007	9:05:46 AM	182823.2	182823.2	32	14.7	0x00020000	16.926	20.488	20.666	16.67
10	5/8/2007	9:05:47 AM	182809.3	182809.3	32	14.7	0x00020000	17.045	20.429	20.625	16.802
11	5/8/2007	9:05:48 AM	181817.7	181817.7	32	14.7	0x00020000	16.937	20.27	20.542	16.776
12	5/8/2007	9:05:49 AM	178988.6	178988.6	32	14.7	0x00020000	16.519	20.052	20.219	16.422
13	5/8/2007	9:05:50 AM	179548.9	179548.9	32	14.7	0x00020000	16.751	20.026	20.302	16.474
14	5/8/2007	9:05:51 AM	182438.9	182438.9	32	14.7	0x00020000	17.056	20.35	20.68	16.565
15	5/8/2007	9:05:52 AM	182831.4	182831.4	32	14.7	0x00020000	16.962	20.484	20.66	16.664
16	5/8/2007	9:05:53 AM	182801.9	182801.9	32	14.7	0x00020000	17.059	20.428	20.59	16.876
17	5/8/2007	9:05:54 AM	181962.7	181962.7	32	14.7	0x00020000	16.914	20.301	20.548	16.816
18	5/8/2007	9:05:55 AM	179350.4	179350.4	32	14.7	0x00020000	16.572	20.07	20.265	16.485
19	5/8/2007	9:05:56 AM	179417.2	179417.2	32	14.7	0x00020000	16.697	20.023	20.292	16.463
20	5/8/2007	9:05:57 AM	182554.8	182554.8	32	14.7	0x00020000	17.062	20.36	20.694	16.586
21	5/8/2007	9:05:58 AM	182838.6	182838.6	32	14.7	0x00020000	16.984	20.498	20.641	16.664
22	5/8/2007	9:05:59 AM	182846.7	182846.7	32	14.7	0x00020000	17.052	20.43	20.608	16.867
23	5/8/2007	9:06:00 AM	182166.8	182166.8	32	14.7	0x00020000	16.957	20.323	20.567	16.821
24	5/8/2007	9:06:01 AM	179483.8	179483.8	32	14.7	0x00020000	16.594	20.082	20.267	16.527
25	5/8/2007	9:06:02 AM	182265.7	182265.7	32	14.7	0x00020000	17.022	20.319	20.649	16.629
26	5/8/2007	9:06:03 AM	182829.3	182829.3	32	14.7	0x00020000	16.983	20.474	20.658	16.676
27	5/8/2007	9:06:04 AM	182738.3	182738.3	32	14.7	0x00020000	17.011	20.436	20.591	16.85
28	5/8/2007	9:06:05 AM	182171	182171	32	14.7	0x00020000	16.95	20.325	20.587	16.774
29	5/8/2007	9:06:06 AM	179630.7	179630.7	32	14.7	0x00020000	16.614	20.082	20.288	16.566
30	5/8/2007	9:06:07 AM	179340.8	179340.8	32	14.7	0x00020000	16.668	20.014	20.29	16.46
31	5/8/2007	9:06:08 AM	182169.3	182169.3	32	14.7	0x00020000	17.036	20.313	20.629	16.608
32	5/8/2007	9:06:09 AM	182826.3	182826.3	32	14.7	0x00020000	16.965	20.489	20.655	16.66
33	5/8/2007	9:06:10 AM	182594.9	182594.9	32	14.7	0x00020000	16.997	20.45	20.55	16.827
34	5/8/2007	9:06:11 AM	182225.5	182225.5	32	14.7	0x00020000	17.003	20.303	20.607	16.768
35	5/8/2007	9:06:12 AM	179794.4	179794.4	32	14.7	0x00020000	16.636	20.106	20.295	16.591
36	5/8/2007	9:06:13 AM	179127.5	179127.5	32	14.7	0x00020000	16.685	20.003	20.242	16.434

Charts / Inspection Report / SOS / Meter Config / Raw Data

Use these reports to compare with previously saved reports as a Meter Health check and for trending of the meter's diagnostics.

Appendix A Conversion factors

A.1 Conversion factors per unit of measurement

The following table includes conversion factors for many of the Metric and U.S. Customary units of measure used with Daniel Ultrasonic Gas Flow Meters and Daniel MeterLink.

Table A-1 Conversion Factors per unit of measurement

Conversion Factors	Unit of Measurement
(°F-32)x(5/9)–>°C (°C+273.15)–>K	
1	K/°C
5/9	°C/°F
10^{-6}	MPa/Pa
0.006894757	MPa/psi
0.1	MPa/bar
0.101325	MPa/atm
0.000133322	MPa/mmHg
0.3048	m/ft
0.0254	m/in
10^{3}	dm^3/m^3
10^{-6}	m^3/cc (=m^3/cm^3)
$(0.3048)^3$	m^3/ft^3
$(0.0254)^3$	m^3/in^3
3600	s/h
86400	s/day
10^{3}	g/kg
0.45359237	kg/lbm
4.1868	kJ/kcal
1.05505585262	kJ/ BtuIT
10^{-3}	Pa • s/cPoise
1.488	Pa • s/(lb/(ft • s))

Appendix B Miscellaneous equations

B.1 Miscellaneous conversion factors

K-Factor and Inverse K-Factor

Equation B-1 Frequency Volumetric Flow Rate K-Factor

$$KFactor = \frac{(MaxFreq)(3600s/hr)}{FreqQ_{FullScale}}$$

and

Equation B-2 Frequency Volumetric Flow Rate Inverse K-Factor

$$InvKFactor = \frac{FreqQ_{FullScale}}{(MaxFreq)(3600s/hr)}$$

where

$KFactor$	=	frequency “K-Factor” (pulses/m^3 or pulses/ft^3) (**Freq1KFactor** and **Freq2KFactor**)
$InvKFactor$	=	frequency “Inverse K-Factor” (m^3/pulse or ft^3/pulse) (**Freq1InvKFactor** and **Freq2InvKFactor**)
$FreqQ_{FullScale}$	=	frequency full-scale volumetric flow rate (m^3/h or ft^3/h) (**Freq1FullScaleVolFlowRate** and **Freq2FullScaleVolFlowRate**)
$MaxFreq$	=	maximum frequency (Hz = pulses/s) (Either 1000 or 5000 Hz) (**Freq1MaxFrequency** and **Freq2MaxFrequency**)

Volumetric Flow Rate

Equation B-3 Volumetric Flow Rate - U.S. Customary Units

$$Q_{ft^3/hr} = V_{ft/s} \times 3600\ s/hr \times \left[\frac{\pi D_{in}^2}{4}\right] \times \left[\frac{1ft}{12in}\right]^2$$

$$= V_{ft/s} \times D_{in}^2 \times \left[\frac{3600 \times \pi}{4 \times 12^2}\frac{s\ ft^2}{hr\ in^2}\right]$$

$$= V_{ft/s} \times D_{in}^2 \times 19.63495((s\ ft^2)/(hr\ in^2))$$

where

$Q_{ft^3/hr}$ = volumetric flow rate (ft^3/h) (**QMeter**)

$V_{ft/s}$ = gas flow velocity (ft/s) (**AvgFlow**)

π = geometric constant, pi (dimensionless) (3.14159265...)

D_{in} = pipe inside diameter (in) (**PipeDiam**)

Equation B-4 Volumetric Flow Rate - Metric Units

$$Q_{m^3/hr} = V_{m/s} \times 3600\ s/hr \times \left[\frac{\pi D_m^2}{4}\right]$$

$$= V_{m/s} \times D_m^2 \times \left[\frac{3600 \times \pi}{4}(s/hr)\right]$$

$$= V_{m/s} \times D_m^2 \times 2827.433(s/hr)$$

where

$Q_{m^3/hr}$ = volumetric flow rate (m^3/h) (**QMeter**)

$V_{m/s}$ = gas flow velocity (m/s) (**AvgFlow**)

π = geometric constant, pi (dimensionless) (3.14159265...)

D_m = pipe inside diameter (m) (**PipeDiam**)

B.2 Chord "L" dimension calculation

The chord "L" dimension is calculated from the meter housing length as well as the transducer pair lengths, mount lengths, holder lengths, and stalk lengths as shown in Equation B-5. The transducer lengths are etched on the transducers. Likewise, the lengths of the mounts, stalk assemblies, and transducer holders are also etched on the individual components. The length of the meter body is found on the original calibration sheet supplied with the meter.

Equation B-5 Chord "L" Dimension

$$
\begin{aligned}
L_{chord} = {} & L_{MeterHousing} + L_{Mount1} + L_{Mount2} \\
& - L_{Xdcr1} - L_{Stalk1} - L_{Hldr1} \\
& - L_{Xdcr2} - L_{Stalk2} - L_{Hldr2}
\end{aligned}
$$

where

L_{chord}	=	chord "L" dimension (in) (**LA** ... **LD**)
$L_{MeterHousing}$	=	meter housing length (in)
L_{Mount1}	=	transducer 1 mount length(in)
L_{Mount2}	=	transducer 2 mount length (in)
L_{Xdcr1}	=	transducer 1 length (in)
L_{Xdcr2}	=	transducer 2 length (in)
L_{Stalk1}	=	transducer 1 stalk length (in)
L_{Stalk2}	=	transducer 2 stalk length (in)
L_{Hldr1}	=	transducer 1 holder length (in)
L_{Hldr2}	=	transducer 2 holder length (in)

Appendix C Upgrading a Mark II to a Mark III

C.1 Meter electronics upgrade

This section describes the important differences between the Daniel Mark II and Mark III meters. This section also includes instructions on how to upgrade a Mark II meter to use the Mark III electronics using the Daniel MeterLink configuration conversion feature.

NOTICE

Daniel CUI version 4.21 is the final version that supports Daniel Mark II Gas Ultrasonic meters. If you are communicating with a Daniel Ultrasonic Mark II Gas Flow Meter, you do not need to uninstall version 4.21 or earlier versions of Daniel CUI before installing MeterLink. Version 4.21 and earlier versions of Daniel CUI should not be run simultaneously with MeterLink.

C.2 What's new In Mark III

The Mark III meter electronics offers many new and improved features over the previous Mark II design as discussed below:

- FASTER UPDATE RATES. The Mark III uses a newer, faster processor with a double-precision hardware floating-point unit. This allows for faster transducer firing rates resulting in faster data updates. The Mark III meter offers two update rates: rapid (0.25 sec) and standard (1 sec) versus the typical Mark II update rate of about 5 seconds (for a SeniorSonic™ meter).
- AGA8 DETAIL METHOD. The Mark III meter adds the AGA8 Detail method for calculating compressibilities.
- OPTIONAL AGA10 SOUND VELOCITY CALCULATION AND COMPARISON. The Mark III meter optionally calculates the AGA10 sound velocity and compares it on an hourly averaged basis to the meter-measured sound velocity.
- ENERGY RATE CALCULATION. The Mark III meter calculates the energy rate (if the heating value is available). The energy rate is available for output on the frequency outputs and optional analog output.
- MASS RATE CALCULATION. The Mark III meter calculates the mass rate if the gas flow-condition mass density is available (either specified or calculated as part of AGA8). The mass rate is available for output on the frequency outputs and optional analog output.
- OPTIONAL GAS CHROMATOGRAPH INTERFACE. The Mark III meter optionally interfaces to a Daniel gas chromatograph via Modbus for retrieving live gas property data. This feature requires use of the Option Board.

- SeniorSonic™ flow characterization calculations. The SeniorSonic™ Mark III meter calculates/estimates flow-characterization information such as symmetry, cross-flow, turbulence, profile factor and swirl angle.
- Improved velocity estimation. The Mark III utilizes an improved algorithm for using chord proportion history to estimate the flow velocity in the event of a chord failure. (Applicable on SeniorSonic™ models 3400 and 3422 and JuniorSonic™ model 3420.)
- 12-Point Piecewise-Linearization. The Mark III offers up to 12 points for piece-wise linearization whereas the Mark II offers 10 points.
- Two independent frequency output pairs. The Mark III offers two *independent* frequency output pairs, a feature particularly useful in custody transfer applications. Each frequency pair is individually configurable and utilizes a separate ground so that each pair can be wired to a separate flow computer.
- New frequency content options. The Mark III meter adds four new frequency content options (gas velocity, sound velocity, energy rate, and mass rate) to the standard options (actual or standard flow rate).
- Frequency bi-directional option. This new option allows a frequency pair to be configured so that the selected content is represented by the "A" channel when flowing in the forward direction and by the "B" channel when flowing in the reverse direction.
- Configurable "B" channel phase. Each frequency pair "B" channel phase is individually configurable so that its phase (relative to the "A" channel) can be used to determine the flow direction.
- Batch data smoothing. The Mark III meter offers a method for "smoothing" batch data that is particularly useful for applications that rely on the frequency output signals.
- Two individually configurable digital outputs per frequency pair. Each frequency output pair has two associated, individually configurable digital outputs. Each digital output is individually configurable for content and logic polarity. A test mode is available for testing each digital output pair.
- Ethernet connectivity. The Mark III meter adds an optional Ethernet port in addition to two RS-232/RS-485 serial ports. This allows for multi-user, network-based access over an intranet.
- High-speed serial communication ports. The Mark III supports independently selectable baud rates on each of its serial communication ports up through 115200 bits/sec.
- Full-duplex serial communication. The two standard RS-232/RS-485 serial ports can be configured for either half-duplex or full-duplex operation. Full-duplex communication allows a highly reliable TCP/IP protocol to be used by Daniel MeterLink which provides full functionality as is available via the optional Ethernet connection, including log access and waveform viewing.
- Automatic communication-protocol detection. The Mark III meter automatically detects all supported communication protocols which simplifies communication set-up.
- Operating system. The Mark III utilizes an enterprise-class, protected-mode Linux operating system for enhanced reliability and future upgradability.

- FEWER BOARDS. The Mark III consists of fewer boards than the Mark II resulting in increased reliability, easier servicing, and fewer spare parts to keep on hand.
- EASIER FIRMWARE UPGRADING. The Mark III meter offers easy, fast firmware upgrades via the Daniel MeterLink program and does not require a programming key.
- FIRMWARE UPGRADE PRESERVES ARCHIVE LOGS. The Mark III firmware can be upgraded without deleting existing archive logs.
- IMPROVED WAVEFORM VIEWING AND EXPORT. Whereas the Mark II meter offered the ability to retrieve a single waveform for each chord, the Mark III meter offers the ability to output a succession of waveforms for each chord. With Daniel MeterLink connected to the meter via the optional Ethernet, several waveform updates per second are possible.
- SYSTEM LOG. In addition to the hourly, daily, audit, and alarm logging capabilities offered by the Mark II, the Mark III meter adds system log capability to provide more detailed information on the health and status of the meter.
- LOG-OVERWRITE CONTROL. For each log, the user can select whether or not new records can overwrite older, unread records.
- COMPRESSED XML-BASED LOG FILES. The Mark III optionally exports log data in industry-standard and highly-flexible XML format. This allows the Mark III log files to be forward compatible with features that may be added in the future. The files are then optionally transferred to the PC using Daniel MeterLink in compressed format for fast transfers.
- CONFIGURATION CHECKSUM AND DATE TIMESTAMP. The Mark III meter checksums the configuration parameters and maintains a checksum change date timestamp for easy determination of a configuration change. Both checksum value and date timestamp are audit logged for traceability. They are also Modbus-readable for remote monitoring.
- IMPROVED PARAMETER CONFIGURATION FEEDBACK. When using Daniel MeterLink to configure a Mark III meter, informative messages are displayed when trying to set an invalid parameter configuration. For example, when trying to set a data point to a value outside the point's valid range, a message is displayed identifying the data point, the valid range, and the invalid value.
- MONITORED SYSTEM TEMPERATURE AND VOLTAGE RAILS. The Mark III monitors the internal enclosure temperature and voltage rails and generates alarms when out of preset limits.
- **DRY-CONTACT CLOSURE INPUT**. The Mark III provides an uncommitted dry-contact closure (configurable for logic polarity) that can be monitored via Modbus.

C.3 Modbus Communication

C.3.1 Protocols

The Mark III meter supports ASCII and RTU Modbus communication. For ASCII Modbus, both 7E1 and 7O1 are supported. For RTU Modbus, 8N1 is supported. The communication ports provide automatic protocol detection - only the baud rate and Modbus ID need to be specified. Refer to Section 5.1 for details on configuring the meter communication parameters.

C.3.2 Registers

The Mark III uses a database for managing its information in which each piece of information is stored in a *database point*. The meter utilizes a mapping file for cross-referencing database points with Modbus registers for Modbus data access. Refer to Section 6.4 for further details.

The Mark III maintains backward compatibility to Mark II Modbus registers whenever possible. The **UnitsSystem** register selects the units for Modbus communications. Available options are U.S. Customary and Metric. These are the units in which the software Field Setup Wizard displays properties. These are also the units with which the meter reports all of its rates and volumes using Modbus communications. The selected units system applies only to registers above 10000 and in the 2000-8999 range, other registers below 10000 are read in metric units only to maintain Mark II compatibility. US customary units is the default setting.

For Modbus access information for a *particular* data point, consult Daniel MeterLink online help. (There is a help topic for each data point. From Daniel MeterLink, click on Help, click on Mark III Registers Reference, select the Index tab, start typing the data point name until the desired point is highlighted, and then click the Display button.)

The Modbus map is available in Microsoft Excel format (MARK III Modbus Table.xls) on the Daniel MeterLink CD and the Daniel website http://www2.emersonprocess.com/en-US/brands/daniel/Flow/ultrasonics/Pages/Ultrasonic.aspx). Note that on the website, the file name may include the file size (MARK III Modbus Table 386KB.xls).

The Daniel MeterLink program includes a means of converting a Mark II meter configuration to a Mark III meter configuration for use in upgrading electronics heads. This feature is discussed in Section C.4 below.

C.3.3 Log Access

Due to the Mark III meter's enhanced log retrieval methods, accessing log records via Modbus communication is not supported. All log records (daily, hourly, audit, alarm, and system) are optionally accessible via Daniel MeterLink (see Section 6.6.6).

C.4 Configuration conversion

NOTICE

When upgrading a Mark II electronics head with a Mark III electronics head, the Mark II configuration must first be saved to a file using Daniel MeterLink.

When a Mark II electronics head is going to be replaced by a Mark III, Daniel MeterLink can be used to convert the configuration and download it to the Mark III. To do this, first connect to the Mark II electronics. Collect and save the configuration using the Edit/Compare Configuration dialog box. Replace the electronics with the Mark III electronics. Connect to the Mark III meter (see Section 5.3 for establishing initial communication) and open the Edit/Compare Configuration dialog. Open the configuration collected from the Mark II electronics. The Convert button becomes active after the Mark II configuration is read.

NOTICE

The Convert button is active only when a Mark II configuration is opened and Daniel MeterLink is connected to a Mark III meter.

Click on the Convert button to convert the Mark II configuration to a Mark III configuration. A message appears requesting confirmation for the conversion - click the Yes button to continue. The table now shows the proposed Mark III configuration. All values highlighted in yellow are values from the Mark II configuration. Review the proposed Mark III configuration and make any necessary modifications. Click on the Write All button to write the changes to the Mark III meter. Once the configuration is written, you can choose to compare the displayed configuration with the configuration in the meter by selecting Meter and clicking Compare. This will verify everything was written correctly.

All *applicable* Mark II configuration parameters are converted for the Mark III. The following sections describe in detail several key points about the conversion.

C.4.1 Metrology - meter body and transducer calibration values

The Daniel MeterLink configuration conversion feature copies the Mark II meter body parameters and transducer delay time parameters directly to the Mark III data points (**PipeDiam**, **XA**...**XD**, **LA**...**LD**, **AvgDlyA**...**AvgDlyD**, **DltDlyA**...**DltDlyD**).

Note that the Mark II CableDly parameter is *not* copied to the Mark III as the value is specific to the Mark II electronics. The Mark III accounts for electronics delay via the **SystemDelay** data point. Isolating the electronics delay from the transducer delays allows for the transducer delay times to be directly copied from a Mark II to a Mark III.

The Mark III sets the chord weights based upon the specified device number (**DeviceNumber**) so these data points are not Mark III configuration points. Thus, the Mark II chord weights (WtA...WtD) are not copied to the Mark III but, instead, are used to set the proper Mark III **DeviceNumber**.

C.4.2 Metrology - calibration equation parameters

The Mark III calibration calculations are slightly different than those of the Mark II. The purpose of this section is to illustrate the differences and show how the Mark II calibration values are converted for use in the Mark III to achieve the same results.

Mark II Calibration

The Mark II calibration is comprised of three basic steps:

1. application of the "British Gas" (BG) Factor (see Equation C-1)
2. application of either the "A" polynomial coefficients (see Equation C-2) or the (Velocity Offset, Meter Factor) parameters (see Equation C-3)
3. application of the 10-point linearization (optional)

Equation C-1 Mark II Application of the British Gas Factor

$$v_{BG} = BG \cdot v_{AvgWtd}$$

Equation C-2 Mark II Application of the "A" Polynomial Coefficients

$$\begin{aligned} v_{DryCal} &= A_0 + A_1 v_{BG} + A_2 v_{BG}^2 + A_3 v_{BG}^3 \\ &= (A_0 + (A_1 \cdot BG \cdot v_{AvgWtd}) + (A_2 \cdot BG^2 \cdot v_{AvgWtd}{}^2) + (A_3 \cdot BG^3 \cdot v_{AvgWtd}{}^3)) \end{aligned}$$

Equation C-3 Mark II Application of the [VelOffset, MeterFactor]

$$\begin{aligned} v_{DryCal} &= (v_{BG} - VelOffset) \cdot MeterFactor \\ &= ((v_{AvgWtd} \cdot BG) - VelOffset) \cdot MeterFactor \end{aligned}$$

Mark III Calibration

The Mark III calibration is comprised of two basic steps:

1. application of the “dry-calibration” “A” polynomial coefficients (see Equation C-4)
2. application of one of the following “wet-calibration” methods (or none at all):
    - “C” polynomial coefficients (see Equation C-5)
    - 12-point linearization

In this methodology, the “dry-calibration” values are set by Daniel at the factory and are not expected to be modified; the “wet-calibration” values are expected to be set as the result of a user flow calibration (if desired).

Equation C-4 Mark III Application of the “A” Polynomial Coefficient

$$v_{DryCal} = A_0 + A_1 v_{AvgWtd} + A_2 v_{AvgWtd}^2 + A_3 v_{AvgWtd}^3$$

Equation C-5 Mark III Application of the “C” Polynomial Coefficient

$$v_{WetCal} = C_0 + C_1 v_{DryCal} + C_2 v_{DryCal}^2 + C_3 v_{DryCal}^3$$

Calibration Parameter Conversions

The calibration parameter conversion involves the Mark II British Gas Factor (BG) and either the Mark II “A” polynomial coefficients or the (Velocity Offset, Meter Factor) depending upon which values were used. If the Mark II “A” polynomial coefficients were not equal to [0,1,0,0] nor [0,0,0,0], then the Mark II used the “A” polynomial coefficients; otherwise it used the Velocity Offset and Meter Factor. The conversions are described in detail below.

If the Mark II meter did not utilized piece-wise linearization (PWL), then the Mark III meter’s calibration method (**CalMethod**) is set to ‘None’. Otherwise, the Mark II PWL values are converted for the Mark III as follows:

- The Mark III meter’s calibration method (**CalMethod**) is set to select the piece-wise linear wet-calibration method.
- The Mark II meter’s ten PWL points (flow rate and meter factor) are copied directly to the Mark III meter’s first ten PWL points. The Mark III meter’s 11^{th} and 12^{th} PWL points are set for flow rate of 0 and meter factor of 1.

Converting Mark II “BG” and “A” Polynomial Coefficients

The Mark II British Gas Factor (BG) and “A” polynomial coefficients are converted to equivalent Mark III dry-calibration “A” polynomial coefficients as shown in Equation C-6 below. Note that both the forward and reverse “A” polynomial coefficients are converted using the same equations.

Equation C-6 Conversion of the Mark II "A" Polynomial Coefficients

$$A_{0(MarkIII)} = A_{0(MarkII)}$$
$$A_{1(MarkIII)} = A_{1(MarkII)} \cdot BG$$
$$A_{2(MarkIII)} = A_{2(MarkII)} \cdot BG^2$$
$$A_{3(MarkIII)} = A_{3(MarkIII)} \cdot BG^3$$

Substituting Equation C-6 into Equation C-4 results in the following equation:

Equation C-7 Mark III Application of Converted Mark II "A" Polynomial Coefficients

$$v_{DryCal} = A_{0(MarkII)} + [(A_{1(MarkII)} \cdot BG) \cdot v_{AvgWtd}] + \\ [(A_{2(MarkII)} \cdot BG^2) \cdot v^2_{AvgWtd}] + [(A_{3(MarkII)} \cdot BG^3) \cdot v^3_{AvgWtd}]$$

Inspection of Equation C-2 and Equation C-7 illustrates that the Mark II "A" polynomial coefficient conversion to Mark III "A" polynomial coefficients does indeed yield the same result as the Mark II.

Converting Mark II "BG" and Velocity Offset, Meter Factor

The Mark II British Gas Factor (BG) and Velocity Offset, Meter Factor are converted to equivalent Mark III dry-calibration "A" polynomial coefficients as shown in Equation C-8 below. The equations are the same for calculating both the forward and reverse Mark III dry-calibration "A" polynomial coefficients.

Equation C-8 Conversion of the Mark II "A" Polynomial Coefficients

$$A_{0(MarkIII)} = -(VelocityOffset \cdot MeterFactor)$$
$$A_{1(MarkIII)} = MeterFactor \cdot BG$$
$$A_{2(MarkIII)} = 0$$
$$A_{3(MarkIII)} = 0$$

Substituting Equation C-8 into Equation C-4 results in the following equation:

Equation C-9 Mark III Application of Converted Mark II (Velocity Offset, Meter Factor)

$$\begin{aligned} v_{DryCal} &= -(VelocityOffset \cdot MeterFactor) + [(MeterFactor \cdot BG) \cdot v_{AvgWtd}] \\ &= -(VelocityOffset \cdot MeterFactor) + (v_{AvgWtd} \cdot BG \cdot MeterFactor) \\ &= ((v_{AvgWtd} \cdot BG) - VelocityOffset) \cdot MeterFactor \end{aligned}$$

Inspection of Equation C-3 and Equation C-9 illustrates that the Mark II (Velocity Offset, Meter Factor) conversion to Mark III "A" polynomial coefficients does indeed yield the same result as the Mark II.

C.4.3 Gain

The Mark III signal gain values (**GainA1**...**GainD2**) and limits (**GainLowLmt** and **GainHighLmt**) are read in hardware gain units. Daniel MeterLink converts the hardware gain units to decibels (dB) for display purposes using the conversion equation:

Equation C-10 Mark III Gain Conversion Equation

$$Gain_{dB} = 20 \cdot \log(Gain_{Hardware})$$

The Mark III gain units differ from those used by the Mark II. Therefore, the Daniel MeterLink configuration conversion does not convert the Mark II GainLowLmt and GainHighLmt parameters. The Mark III **GainLowLmt** and **GainHighLmt** data points should be at their default values (the widest allowable gain limits) and are unmodified by the Daniel MeterLink configuration conversion. These data points can be modified using the Daniel MeterLink Edit/Compare Configuration screen.

C.4.4 Batch update period and stack size

The Mark III batch update occurs at a fixed timed interval whereas the Mark II batch update occurs after each BatchSize firing sequences are completed.

For the Mark III, the batch update period is a function of the **SpecBatchUpdtPeriod** and **StackSize** data points (as described in Section 6.1.3).

When using Daniel MeterLink to convert a Mark II configuration for use in a Mark III, the Mark II BatchSize parameter is not converted. The Mark III **SpecBatchUpdtPeriod** should be at its default value (standard update period of 1 sec) and is unmodified.

The Mark III does not support “stacking-by-chord.” The Mark II StackSize parameter is converted to the Mark III **StackSize** data point as follows:

StackSize (Mark II)	StackSize (Mark III)
0, 1, 128 or 129	1 (none)
2 or 130	2
4 or 132	4
8 or 136	8
16, 32, 144, or 160	16

C.4.5 Emission rate, stacked emission rate, and firing sequence

The emission rate is the period between firing two different transducers. The stacked emission rate is the period between consecutive firings of a single transducer when stacking is used (i.e., the stack size is not set to 'None').

For the Mark II meter, the default emission rate is 32 ms and the default stacked emission rate is 8 ms. For the Mark III meter, the desired emission rate and stacked emission rate are set via the **EmRateDesired** and **StackEmRateDesired** data points, respectively. Setting these data points to zero (their default value) indicates that the meter should use the fastest available emission rates which are typically between 2 and 8 ms.

In order to achieve the fastest possible emission rates, the default transducer firing sequence (selected via **FireSeq**) should be used.

When converting a Mark II configuration for use in a Mark III, the Daniel MeterLink configuration conversion feature does *not* modify the Mark III meter's **EmRateDesired**, **StackEmRateDesired**, and **FireSeq** data points (which should be at default values).

C.4.6 Chord failure threshold

The Mark II PctFail parameter specifies the maximum threshold for the percentage of discarded chord firings in a batch before a chord is flagged as failed. The Mark III utilizes a similar threshold but with different perspective: the **MinPctGood** data point specifies the minimum threshold for the percentage of good chord firings in a batch for a chord to be considered good (i.e., not failed). Thus, **MinPctGood** is calculated as (100-PctFail).

C.4.7 Flow velocity estimation when a chord is failed

The Mark III uses an improved method for estimating the average weighted flow velocity in the event of a chord failure. The new method is described in detail in Section 6.1.6.

C.4.8 Inactive chords

The Mark II ChordInactv (bitfield) parameter is converted to the Mark III **IsInactiveA**...**IsInactiveD** data points as follows:

Table C-1 Mark II chord inactive conversion to Mark III data points

Mark II ChordInactv		Mark III Data Point	
Bit Position	**Bit Value**	**Name**	**Value**
0	0	IsInactiveA	0 (FALSE)
	1		1 (TRUE)
1	0	IsInactiveB	0 (FALSE)
	1		1 (TRUE)
2	0	**IsInactiveC**	0 (FALSE)
	1		1 (TRUE)
3	0	**IsInactiveD**	0 (FALSE)
	1		1 (TRUE)

C.4.9 AlarmDef

In the Mark II, the AlarmDef parameter is used for two purposes:

- It specifies the number of consecutive batches that a chord must be failed before the chord failure is indicated in the DataQlty register.
- It specifies the number of consecutive batches that all active chords must be without failure for updating the chord proportions.

The Mark III provides a separate data point for each of these purposes: **AlarmDef** for the first purpose and **PropUpdtBatches** for the second. Since the Mark III batch update period is much faster than that of the Mark II, the Daniel MeterLink configuration conversion feature does *not* modify the Mark III **AlarmDef** or **PropUpdtBatches** data points (which should be at default values). These points' values can be read and modified via the Daniel MeterLink Edit/Compare Configuration screen.

C.4.10 Frequency output configuration

The Mark III, like the Mark II, provides two frequency output pairs:

- Freq1A and Freq1B
- Freq2A and Freq2B

While the Mark II allows for some frequency output parameters to be specified independently for each pair, the Mark III allows *all* frequency output parameters to be specified independently for each pair. Thus, the Mark II frequency configuration points that apply to both frequency output pairs are copied to both corresponding Mark III frequency data points as specified below:

- FreqFlowRateCondition is copied to **Freq1Content** and **Freq2Content**.
- MaxFrequency is copied to **Freq1MaxFrequency** and **Freq2MaxFrequency**.
- TestModeOutputPct is copied to **Freq1TestModeOutputPercent** and **Freq2TestModeOutputPercent**.
- FreqFullScaleVolFlowRate is copied to **Freq1FullScaleVolFlowRate** and **Freq2FullScaleVolFlowRate.**

The Mark II Freq*X*Content parameters includes information for both the frequency data content direction and the "B" channel operation in the event of an error. The Mark III provides separate data points for these parameters, **Freq*X*Dir** and **IsFreq*X*BZeroedOnErr**. The conversion for the Freq*X*Content parameters is as follows:

Table C-2 FreqXContent Conversion Mapping

Freq*X*Content	Freq*X*Dir	IsFreq*X*BZeroedOnErr
0 (reverse flow rate, zero "B" channel on error)	0 (reverse)	1 (TRUE)
1 (forward flow rate, zero "B" channel on error)	1 (forward)	1 (TRUE)
2 (absolute flow rate, zero "B" channel on error)	2 (absolute)	1 (TRUE)
3 (reverse flow rate, don't zero "B" channel on error)	0 (reverse)	0 (FALSE)
4 (reverse flow rate, don't zero "B" channel on error)	1 (forward)	0 (FALSE)
5 (absolute flow rate, don't zero "B" channel on error)	2 (absolute)	0 (FALSE)

The Mark II uses two parameters for controlling the frequency feedback on both frequency pairs: **EnableFrequencyFeedback** to enable/disable the feedback, and **FreqFeedbackCorrectionPct** to specify the feedback correction percentage. The Mark III combines these two parameters into a single data point for each frequency pair, **Freq*X*FeedbackCorrectionPcnt**. If the Mark II had frequency feedback enabled, then the FreqFeedbackCorrectionPct value is copied into both **Freq*X*FeedbacMkCorrectionPcnt** data points. Otherwise, the **Freq*X*FeedbackCorrectionPcnt** data points are set to zero.

C.4.11 Flow pressure and temperature

If the Mark II configuration EnablePressureInput or EnableTemperatureInput parameter is set to 0 (None) or 2 (Specified/Fixed), then the Mark II parameter is copied to the corresponding Daniel 3410 Series Ultrasonic Gas Flow Meter data point (**EnablePressureInput**, **EnableTemperatureInput**).

If the Mark II meter is configured for live input (i.e., EnablePressureInput or EnableTemperatureInput parameter is set to 1 (Live)), the conversion depends upon whether or not the Daniel 3410 Series Ultrasonic Gas Flow Meter supports live input. If the Daniel 3410 Series Ultrasonic Gas Flow Meter supports live input (i.e., the Option Board is present and the CPU firmware is version 1.30 or later), then the Mark II parameter is copied to the corresponding Daniel 3410 Series Ultrasonic Gas Flow Meter data point (**EnablePressureInput**, **EnableTemperatureInput**). Otherwise, the corresponding Daniel 3410 Series Ultrasonic Gas Flow Meter data point is set to 2 (Fixed).

C.4.12 AGA8 method

The Mark III **HCH_Method** data point allows for the selection of no AGA8 calculations (a selection that the Mark II does not provide).

If the Mark II HCH_Method parameter is set to External(0) *and* the Mark II SpecRhoMixFlow, SpecZFlow, and SpecZBase parameters are equal to zero, then the Mark III **HCH_Method** is set to None(4). Otherwise the Mark II HCH_Method is copied to the Mark III **HCH_Method** data point.

C.4.13 Minimum hold time

For some older Daniel 3410 Series Ultrasonic Gas Flow Meter firmware versions, the hold time lower limit is longer than that of the Mark II. Thus, if the Mark II MinHoldTime parameter is less than the Mark III hold time lower limit, the Mark III **MinHoldTime** data point is set to its lower limit. Otherwise, the Mark II MinHoldTime is copied to the Mark III **MinHoldTime** data point.

C.4.14 Log Format parameters

Mark III archive logs (daily, hourly, audit, alarm, and system) are *not* readable via Modbus. They are optionally read using a faster, more efficient method via the Daniel MeterLink Logs/Reports - Meter Archive Logs screen. See Section 6.6 for further information on Mark III log retrieval using Daniel MeterLink. Thus, the Mark II **LogDateTimeFormat**, **LogDailyVolumeFormat**, and **LogHourlyVolumeFormat** parameters are not converted.

Appendix D Troubleshooting comm., mech., and elec.

D.1 Communications troubleshooting

Q1. Why won't the CPU board LINK LED come on when connecting to the Mark III meter via the Ethernet?

A1. The LINK light indicates good electric connectivity between two LAN ports. It also indicates proper polarity in the Ethernet connection.

WHEN CONNECTING DIRECTLY: Check to ensure that the Ultrasonic cable (P/N 2-3-3400-079) "cross-over" type cable is properly connected.

WHEN USING A HUB: When using a hub between the Mark III meter and the PC, a straight-through patch cable is required between the Mark III and the hub and a straight-through patch cable is required between the hub and the PC. Do not connect either the Mark III or PC to the hub UPLINK port. Most hubs do not allow use of the port immediately next to the hub UPLINK port when the UPLINK port is used to connect the hub to a LAN. Ensure the Mark III and PC are not plugged in to a hub non-usable UPLINK port.

Verify that the Mark III meter is powered up by checking that CPU board LED 1 is on (either solid red or green). If the LED is not on, check power to the meter. If the LED is on, check the Ethernet cable connections.

Q2. My CPU board LINK LED is on but I can't communicate with the meter using Ethernet. What's wrong?

A2. If you are connecting for the first time, refer to Section 5.3.2 for instructions on initial communication (via Ethernet) setup.

If you are using the Daniel MeterLink program, ensure that the optional Ethernet connection is enabled.

Ensure that the Mark III meter's DHCP server is enabled (CPU board switch S2-2 CLOSED). Verify that the PC has received an IP address from the meter as follows:

- bring up DOS prompt window (Start->Run->(type)cmd)
- in the DOS prompt window, type ipconfig.

You should then see something like:

```
Windows 2000 IP Configuration

Ethernet adapter Local Area Connection 1:

Connection-specific DNS Suffix:
IP Address: 192.168.135.35 (note: the last .35 can be up to .44)
Subnet Mask: 255.255.255.0
Default Gateway:
```

If you get the following:

```
Ethernet adapter Local Area Connection 1:

IP Address: 0.0.0.0
```

then the PC has *not* yet received an IP address from the DHCP server and you should wait (up to 30 seconds) to receive an IP address before attempting to connect to the Mark III meter. If after 30 seconds the PC has not received an IP address from the Mark III meter DHCP server or the IP address shown above (from ipconfig) is different from the range of 192.168.135.35 through 192.168.135.44, verify that the PC is configured to receive its IP address automatically (via DHCP).

To ensure connection to the Mark III from the PC, at the DOS prompt type:

```
ping 192.168.135.100 <enter>
```

If the Mark III meter is reachable, then you will see a message like:

```
Pinging 192.168.135.100 with 32 bytes of data:

Reply from 192.168.135.100: bytes=32 time < 10ms TTL=64
```

etc.

If the Mark III is not reachable, then you will see something like:

```
Pinging 192.168.135.100 with 32 bytes of data:

Request Timed Out
```

etc.

Q3. How do I connect to multiple Mark III meters via Ethernet when they are on the same LAN?

A3. Before connecting multiple Mark III meters via Ethernet on a LAN, each meter must be configured with a unique user-specified IP address (following the initial communication quick start instructions in Section 5.3). Contact your IT department for valid IP addresses for your LAN and Gateway address if required. Once a meter's IP address is configured, the meter may be connected to the intranet LAN and accessed using that IP address.

Mark III meters connected to an intranet LAN should not have their DHCP servers enabled.

Q4. How do I connect to multiple Mark III meters via Ethernet when they are on the same hub but not connected to an intranet LAN?

A4. The PC may receive its IP address from an external DHCP server; in this case, one and only one Mark III meter must have its DHCP server enabled. This DHCP server will serve up to 10 IP addresses to PCs attempting to talk to all meters on the hub.

Before connecting multiple Mark III meters via Ethernet on a hub, each meter must be configured with a unique user-specified IP address (following the initial communication quick start instructions in Section 5.3). Assign each meter on the hub a unique IP address within the range 192.168.135.150 through 192.168.135.254. The Gateway address for each meter may be left unconfigured as 0.0.0.0. Once a meter's IP address is configured, the meter may be connected to the hub and accessed using that IP address.

D.2 MARK III mechanical/electrical troubleshooting

This section is meant to assist site maintenance and operations personnel trained in the operation of the ultrasonic flow meter and knowledgeable in basic mechanical and electronic/ electrical troubleshooting techniques, using lap top computers as well as digital volt/ohm meters. Great care should be taken not to “short out” a given electronic/electrical circuit when Troubleshooting.

Table D-1 Mark III Mechanical/Electrical Troubleshooting

Problem	Solution(s)
no power to the unit	• Check for correct voltage (AC or DC) to the input of the Field Connection Board. (see Appendix I, System Wiring Diagram). • Check the main power source for blown fuse or tripped circuit breaker. Reference your “as built” installation drawings for your location. • Check the fuses on the Field Connection Board. Reference fuse F1 and F2 locations.
cannot communicate with Daniel MeterLink program	• Ensure that the meter is properly powered. • Ensure that the computer cable is properly connected to the field connection board (see Appendix I) for the connector and check your interface pins (RS-485 or RS-232). • Verify that the communication parameters of the Daniel MeterLink program are set according to jumpers on the meter CPU board. See Section 5.3 of this manual for instructions on configuring communications. • Check switch S-1 on the field connection board and ensure that it is in the correct position (RS-485 or RS-232 communication). Note that S1 is located at the top left side of the board.
one or more of the chords is not indicating a reading (reporting zeros)	• Check for loose connections at the cable connectors. (see Appendix I). • Check the resistance of the transducers (should be approximately 1-2 Ω). • Problem also may be caused by a bad Acquisition board or interconnect cable. See Appendix I drawing for more information • Check system status in the Daniel MeterLink program for any flagged errors. See Section 6.1.5 for system status information. • Check the CPU board.
wave form contains an excessive amount of noise	Increase the **StackSize** till noise level decreases (settings can be 1 (none), 2, 4, 8, or 16). See Section C.4.5 for instructions on changing register values. If increasing the **StackSize** is not successful, try turning on the filter or consult with Daniel Customer Service if you are unsure of how stacking a signal can effect the meter's operation. Refer to Technical Support under the Help menu of Daniel MeterLink for contact information.
connected communication line to the flow computer but no signal is received	• Check for loose connections at the flow meter and the flow computer (see Appendix I). • Check the switch settings on the CPU board, Field Connection board and the Option board. Make sure the switches are in the correct position (see Table 3-27 through Table 3-38 for RS-485 or RS-232 communication).

Table D-1 Mark III Mechanical/Electrical Troubleshooting

Problem	Solution(s)
communicating with meter but all chords display failures	• Verify that the resistance of transducers is within Specification (1-2 Ω). • Check the Acquisition board (see Appendix E). • Check the interconnect cables between the base assembly and the head assembly (see Appendix E).
chord is not indicating	• Check the resistance of the failed transducer. • If Chord A is not indicating, change the transducer cables from Chord D to chord A. If Chord D then fails, the transducers are bad on Chord A (see Appendix E). • The same test procedure can be accomplished by swapping Chords B and C if a chord fails in either chord (see Appendix E). Note that the outside chord cables cannot be exchanged with inner chord cables.

Appendix E Meter setup and configuration worksheet

E.1 Meter setup and configuration worksheet

Use the reference sheet, Table E-1, to assist you in the Daniel 3400 Series Gas Ultrasonic Flow Meter hardware and configuration setup and using the Daniel MeterLink Field Setup Wizard (refer to the Daniel MeterLink Help files at any time for details about Liquid Ultrasonic Meters.)

Table E-1 Daniel 3400 Series Gas Ultrasonic Flow Meter setup and configuration reference sheet (Sheet 1 of 6)

Refer to noted manual pages for the following installation/setup activities and write your choices in the "User Notes" column.			
Hardware Installation			
Type	**Description or P/N**	**Manual Reference**	**User Notes**
• Hoist Slings	• Determine Sling Size requirement for your meter	• Use of appropriate safety engineered swivel hoist rings in meter end flanges, Page 3-43 in Section 3.2	
• Meter Body Setup	• Uni-directional Or • Bi-directional	• Do you want a Uni-directional or Bi-directional setup? • Section 3.3.1	
• Hazardous Area Installations	• Explosion-proof conduit connections and Switch Settings for communications drivers	• Section 3.3.5	
• Flame-proof Cable	• Cable wiring to Field Connection board	• Section 3.3.6	

Table E-1 Daniel 3400 Series Gas Ultrasonic Flow Meter setup and configuration reference sheet (Sheet 2 of 6)

Type	Description or P/N	Manual Reference	User Notes
Wiring and Connections			
Determine hardware settings to communicate with the Daniel 3410 Series Gas Ultrasonic Flow Meter			
• Communications Choices and Hardware Switch Settings on CPU Board, Option Board, HART® Option Board and Field Connection Board	• Ethernet Communications Or • Serial Communications	• Section 3.5.1 • Section 5.1 through Section 5.5	
• Ethernet Connection	• RJ-45; Ethernet adapter cable (Daniel P/N 3-2500-401) • Connect directly to a PC, via an Ethernet hub, or to a LAN via an Ethernet hub.	• Section 3.4, Figure 3-14, and Table 3-21. • Also see Initial Ethernet communications connection, Page 5-103, Ethernet initial connection steps, Page 5-104 • Section 5.4.1, Section 5.4.2, and Section 5.4.3	
• DHCP Server switch settings (for Ethernet connection)	• Configure meter to act as a DHCP server. Enabled/disabled via CPU Board switch S2 position 2	• DHCP server switch settings, Page 3-88 • Table 3-47 and Table 3-48	

Table E-1 Daniel 3400 Series Gas Ultrasonic Flow Meter setup and configuration reference sheet (Sheet 3 of 6)

Type	Description or P/N	Manual Reference	User Notes
• Serial Connections	• Serial cable DB-9 (Daniel P/N 3-2500-401) • CPU and Field Connection Boards	• Section 3.4 • Table 3-7 • Figure 3-24	
• Port A Driver Configuration	• RS-232 • RS-485 Full Duplex • RS-485* Half Duplex	• Table 3-25 and Figure 3-24 • Table 3-26 and Figure 3-24 • Table 3-27 and Figure 3-24	
• Port B Driver Configuration	• RS-232 • RS-485 Full Duplex • RS-485 * Half Duplex	• Table 3-28 and Figure 3-24 • Table 3-29 and Figure 3-24 • Table 3-30 and Figure 3-24	
Note: Port B supports a special override mode expected to be used during meter commissioning (to establish initial communication) and in the event that the user cannot communicate with the meter (possibly due to an inadvertent communication configuration change). Port B Driver Configuration, Page 3-76			

Table E-1 Daniel 3400 Series Gas Ultrasonic Flow Meter setup and configuration reference sheet (Sheet 4 of 6)

Type	Description or P/N	Manual Reference	User Notes
• Port C Series 100 Option Board or Series 100 Plus Option Board	• RS-232 RS-485 * Half Duplex	• Table 3-20, Table 3-31, "Port C Driver Configuration" on page 78, Section 5.3.3 • Table 3-32,	
• Frequency and Digital Output Switch Settings	• Group 1 - frequency and digital outputs (FO1A, FO1B, DO1A, and DO1B) • Group 2 - frequency and digital outputs (FO2A, FO2B, DO2A, and DO2B)	• Section 3.5.2, Figure 3-25, Figure 3-26, and Figure 3-27	
• Analog (current) input for temperature and pressure 4-20 mA signals via Option Board or HART® Option Board	• Switch settings configurable for sinking or sourcing current via Option Board switches	• Option Board: Section 3.5.3 Series 100 Plus Option Board Analog Output switch settings, Page 3-86 Table 3-33 through Table 3-36 • Series 100 Option Board analog output switch settings, Page 3-83, Table 3-37 through Table 3-46 • Appendix Appendix I Daniel drawing DE-21056	
*RS-485 Half Duplex can be used for Modbus Communications with a flow computer but **cannot be used for communication with a PC running Daniel MeterLink.**			
• Configuration Protection setting	• Protect configuration parameters and firmware against changes via CPU Board switch S2 position 4	• Section 3.5.8 • Section 5.6	

Table E-1 Daniel 3400 Series Gas Ultrasonic Flow Meter setup and configuration reference sheet (Sheet 5 of 6)

Daniel MeterLink Software Startup and Meter Configuration			
Type	**Description or P/N**	**Manual Reference**	**User Notes**
• Communications Wizard	• Establish communication parameters for the Liquid Ultra-sonic Meter. This includes both the serial and Ethernet ports.	• Table 5.1 • Section 5.1 through Section 5.6	
• Field Setup Wizard - Meter Configuration - Communications Parameters - Startup - General - Frequency Outputs - Current Outputs - HART® Outputs - Meter Digital Outputs - Meter Corrections - Temperature and Pressure - GC Setup - AGA 8 Setup - Continuous Flow Analysis	• Available while connected to a meter used to enter site specific information during **initial startup** or to change: - Meter units system - Volumetric flow rate time - Gage or Absolute Pressure type	• Table 5-1 • Table 5-11 • Section 5.3	
• Update Time	• The Update Time Wizard is used to adjust the behavior of the meter's signal sampling and output updates.	• Table 5-1 • Section 5.7.1	
• Baseline Setup	• Used to establish a baseline of the meter's flow characteris-tics after installation. The baseline can then used by the Continuous Flow Analysis features to monitor the health of the meter.	• Table 5-1	

Table E-1 Daniel 3400 Series Gas Ultrasonic Flow Meter setup and configuration reference sheet (Sheet 6 of 6)

Type	Description or P/N	Manual Reference	User Notes
• Calibration	• Using Meter Factors for calibrating the meter. • Factory calibration coefficients for each flow direction • Customer flow calibration method	• Section 5.7.2 and Section 5.7.3 • Table 5-22 • Table 5-23 to Table 5-25	
• Maintenance Logs and Reports	• Monitor a Liquid Ultrasonic Meter for a user-defined set of time and display the data and results in a series of logs and charts.	• Section 5.9	

E.2 Meter to Flow Computer Communication Worksheet

Fill in the worksheet, Table E-2, to use as a quick reference in setting up the Daniel 3400 Series Gas Ultrasonic Flow Meter communications (refer to the Daniel MeterLink context sensitive Help (**F1)** files at any time for details)

Table E-2 Meter to Flow Computer Communication Worksheet (Sheet 1 of 9)

Description					
The meter has three serial communication ports (Port A, Port B, and Port C) and one Ethernet port. Ports A and B can be configured for RS 232, RS 485 Full Duplex, and RS 485 Half Duplex communication. Port C can be configured for RS 232 and RS 485 Half Duplex. A PC running Daniel MeterLink can be connected to the meter via RS 232, RS 485 Full Duplex or Ethernet (i.e., not via RS 485 Half Duplex). A flow computer or RTU can be connected to the meter via any serial port (i.e., not the Ethernet port).					
Serial Port A	User Selection (Circle one)				**Results (Enter here)**
Connection to	• <Flow computer, RTU, etc.>	• PC running Daniel MeterLink	• Not used		

Table E-2 Meter to Flow Computer Communication Worksheet (Sheet 2 of 9)

Description					
Hardware connection	• RS-232	• RS-485 Half Duplex (cannot be used for connection to Daniel MeterLink)	• RS-485 Full Duplex		
Baud Rate	• 115200 57600 38400 19200 9600* 2400 1200				
	*Note: Start with a Baud rate of 9600 and test to see if higher or lower rates are acceptable.				
Modbus Protocol (auto-detected by meter)	• ASCII 7Even1	• ASCII 70dd1	• RTU 8None1		
Serial Port B	User Selection (Circle one)				**Results (Enter here)**
Connection to	• <Flow computer, RTU, etc.>	• PC running Daniel MeterLink	• Not used		
Hardware connection	• RS-232	• RS-485 Half Duplex (cannot be used for connection to Daniel MeterLink)	• RS-485 Full Duplex		
Baud Rate	• 115200 57600 38400 19200 9600* 2400 1200				
	*Note: Start with a Baud rate of 9600 and test to see if higher or lower rates are acceptable.				
Modbus Protocol (auto-detected by meter)	• ASCII 7Even1	• ASCII 70dd1	• RTU 8None1		
Serial Port C	User Selection (Circle one)				Results (Enter here)
Connection to	• <Flow computer, RTU, etc.>	• PC running Daniel MeterLink	• Not used		
Hardware connection	• RS-232	• RS-485 Half Duplex (cannot be used for connection to Daniel MeterLink)	• RS-485 Full Duplex		
Baud Rate	• 115200 57600 38400 19200 9600* 2400 1200				
	*Note: Start with a Baud rate of 9600 and test to see if higher or lower rates are acceptable.				
Modbus Protocol (auto-detected by meter)	• ASCII 7Even1	• ASCII 70dd1	• RTU 8None1		

Table E-2 Meter to Flow Computer Communication Worksheet (Sheet 3 of 9)

Description					
Ethernet					
Ethernet IP address					
Subnet mask					
Default gateway					
Modbus volume and flow rate units	User Selection (Circle one)				Results (Enter here)
Units system	• US Customary	• Metric			
Volume (US Customary)	• ft^3				
Volume (Metric)	• m^3				
Mass	• lbm	• kg			
Energy	• MMBtu	• MJ			
Flow rate time unit	• Per second	• Per hour	• Per day		
For volumetric flow rates, the unit is determined by all of the above settings. For example, if the metric units system, m^3 volume, and "per hour" volumetric flow rate time unit are selected, then the volumetric flow rates are read in m^3/hr.					
Note: Digital outputs 1A and 1B share a common ground with Frequency outputs 1A and 1B. Digital outputs 2A and 2B share a common ground with Frequency outputs 2A and 2B. When connecting the ultrasonic meter to two different devices, it is recommended to connect Frequency outputs 1A and 1B and Digital outputs 1A and 1B to one device and Frequency outputs 2A and 2B and Digital outputs 2A and 2B to the other device. This will prevent ground loops.					
Frequency Outputs	User Selection (Circle one)				Results (Enter here)
Electrical Configuration	• TTL “Internally Powered”	• OC “Open Collector”			

Table E-2 Meter to Flow Computer Communication Worksheet (Sheet 4 of 9)

Description					
Freq 1 Direction Group 1 FO1A, FO1B	• Forward: FO1A and FO1B output pulses only when flow is in the forward direction.	• Reverse: FO1A and FO1B output pulses only when flow is in the reverse direction.	• Absolute: FO1A and FO1B output pulses regardless of flow direction. Note: Both outputs report flow regardless of the flow direction. Suggest configuring one of the associated digital outputs to indicate direction or use phase relationship.	• Bidirectional: FO1A pulses only when flow is in the forward direction. FO1B pulses only when flow is in the reverse direction. The phase relationship setting is ignored.	
Freq B (FO1B Phase Relationship	• FO1B lags FO1A by 90^{O} if forward flow, or leads if reverse flow.	• FO1B leads FO1A by 90^{O} if forward flow, or lags if reverse flow.			
Max Freq	• 1000 Hz (overrange to 1500Hz max).	• 5000 Hz (overrange to 7500Hz max).			
Full Scale Flow Rate	Refer to note in Modbus volume and flow rate units section of this table				
Digital Output Group 1 DO1A	User Selection (Circle one)				Results (Enter here)
Electrical Configuration	• TTL “Internally Powered”	• OC “Open Collector”			
Content	• Flow Direction	• Flow Validity			
Polarity	• Normal	• Inverted*			

*Note: Inverted operation - use if the output of the meter is reversed from what a flow computer is expecting. Selecting the check box inverts the digital output. This means that if the output normally outputs a HIGH for a TRUE condition, selecting this check box changes the output to output a LOW for a TRUE condition.

Table E-2 Meter to Flow Computer Communication Worksheet (Sheet 5 of 9)

Description					
Digital Output Group 1 DO1B	User Selection (Circle one)				Results (Enter here)
Electrical Configuration	• TTL "Internally Powered"	• OC "Open Collector"			
Content	• Flow Direction	• Flow Validity			
Polarity	• Normal	• Inverted (see note above)			
Note: Digital outputs 1A and 1B share a common ground with Frequency outputs 1A and 1B. Digital outputs 2A and 2B share a common ground with Frequency outputs 2A and 2B. When connecting the ultrasonic meter to two different devices, it is recommended to connect Frequency outputs 1A and 1B and Digital outputs 1A and 1B to one device and Frequency outputs 2A and 2B and Digital outputs 2A and 2B to the other device. This will prevent ground loops.					
Frequency Output	User Selection (Circle one)				Results (Enter here)
Electrical Configuration	• TTL "Internally Powered"	• OC "Open Collector"			

Table E-2 Meter to Flow Computer Communication Worksheet (Sheet 6 of 9)

Description					
Freq 2 Direction Group 2 FO2A, FO2B	• Forward: FO2A AND FO2B output pulses only when flow is in the forward direction.	• Reverse: FO2A AND FO2B output pulses only when flow is in the reverse direction.	• Absolute: FO2A AND FO2B output pulses regardless of flow direction. Note: Both outputs report flow regardless of the flow direction. Suggest configuring one of the associated digital outputs to indicate direction or use phase relationship.	Bidirectional:* FO2A pulses only when flow is in the forward direction. FO2B pulses only when flow is in the reverse direction. The phase relationship setting is ignored.	
Freq B (FO2B Phase Relationship	• FO2B lags FO2A by 90^{O} if forward flow, or leads if reverse flow.	• FO2B leads FO2A by 90^{O} if forward flow, or lags if reverse flow.			
Max Freq	• 1000 Hz (overrange to 1500Hz max).	• 5000 Hz (overrange to 7500Hz max).			
Full Scale Flow Rate	Refer to note in Modbus volume and flow rate units section of this table				

Table E-2 Meter to Flow Computer Communication Worksheet (Sheet 7 of 9)

Description					
Digital Output Group 2 DO2A					
Electrical Configuration	• TTL “Internally Powered”	• OC “Open Collector”			
Content	• Flow Direction	• Flow Validity			
Polarity	• Normal	• Inverted * (see note below)			
*Note: Inverted operation - Use if the output of the ultrasonic meter is reversed from what a flow computer is expecting. Selecting the check box inverts the digital output. This means that if the output normally outputs a HIGH for a TRUE condition, selecting this check box changes the output to output a LOW for a TRUE condition.					
Full Scale Flow Rate	• Enter the flow rate to be equivalent to the maximum frequency of the frequency output.				
Digital Output Group 2 DO2B					
Electrical Configuration	• TTL “Internally Powered”	• OC “Open Collector”			
Content	• Flow Direction	• Flow Validity			
Polarity	• Normal	• Inverted * (see note below)			
*Note: Inverted operation - Use if the output of the ultrasonic meter is reversed from what a flow computer is expecting. Selecting the check box will invert the digital output. This means that if the output normally outputs a HIGH for a TRUE condition, selecting this check box will change the output to output a LOW for a TRUE condition.					
Full Scale Flow Rate	• Enter the flow rate to be equivalent to the maximum frequency of the frequency output.				

Table E-2 Meter to Flow Computer Communication Worksheet (Sheet 8 of 9)

Description					
Analog Output AO1 (Option Board or Series 100 Option Board)	User Selection (Circle one)				Results (Enter here)
Electrical Configuration	• Sink	• Source (i.e., powered by the meter) If the analog output is configured for source mode, then it must be at the bottom of the loop (stack).			
Direction	• Forward	• Reverse	• Absolute		
Full Scale Flow Rate	Refer to note in Modbus volume and flow rate units section of this table.				
Analog Output AO2 (Series 100 Option Board)	User Selection (Circle one)				Results (Enter here)
Electrical Configuration	• Sink	• Source (i.e., powered by the meter) If the analog output is configured for source mode, then it must be at the bottom of the loop (stack).			
Direction	• Forward	• Reverse	• Absolute		
Analog Input AI1 (Temperature)	Live or specified temperature can be used for bulk volume correction.				
Electrical Configuration	• Sink	• Source (i.e., powered by the meter) If the analog input is configured for source mode, then it must be at the bottom of the loop (stack).			
Minimum Input (temperature corresponding to 4mA input)	• ______°C (if metric units system selected)	• ______°F (if US Customary units system selected)			
Maximum Input (temperature corresponding to 20mA input)	• ______°C	• ______°F			
Low Alarm	• ______°C	• ______°F			
High Alarm	• ______°C	• ______°F			
Note: If the temperature is at or outside these limits, an alarm is generated					
Note: Temperature is required for optional meter internal diameter Temperature expansion correction. If a temperature transmitter is connected to the meter, select Live for this option. If a temperature transmitter is not connected to the meter but temperature expansion correction is required, select Fixed. You will enter in a fixed temperature on a later page. If the correction is not required, select Not used.					

Table E-2 Meter to Flow Computer Communication Worksheet (Sheet 9 of 9)

Description				
Analog Input AI2 (Pressure)	User Selection (Circle one)			Results (Enter Here)
Electrical Configuration	• Sink	• Source (i.e., powered by the meter) If the analog input is configured for source mode, then it must be at the bottom of the loop (stack).		
Pressure Type	• gage	• absolute		
Atmospheric Pressure (if absolute selected)				
Minimum Input (pressure corresponding to 4mA input)	• _____ psig (if gage is selected)	• ______psia (if absolute is selected)		
Maximum Input (pressure corresponding to 20mA input)	• ______psig	• ______psia		
Low Alarm	• ______psig	• ______psia		
High Alarm	• ______psig	• ______psia		
Note: If the pressure is at or outside these limits, an alarm is generated				
Note: Pressure is required for optional meter internal diameter Pressure expansion correction. If a pressure transmitter is connected to the meter, select Live for this option. If a pressure transmitter is not connected to the meter but pressure expansion correction is required, select Fixed. You will enter in a fixed pressure on a later page. If the correction is not required, select Not used.				
Digital Input DI1	User Selection (Circle one)			Results (Enter Here)
The Digital Input (DI1) may used to bring prover detector switches into the meter for “proving” against a ball prover (required only if input is used for gated calibrations). Note: When using the digital method, the frequency output is not used for proving.				
Calibration Type	• Gated	• Timed		
Is DI1ForCalActiveLow	• Active High	• Active Low		
Is DI1ForCalStateGated	• Edge	• State		

Appendix F Flow rate summary charts

F.1 Flow Rate Summary Charts

Flow Rates (MSCFH) Based Upon 100 ft/s										
PSIG	4	6	8	10	12	16	20	24	30	36
100	247	561	971	1,532	2,174	3,432	5,398	7,807	12,607	18,154
200	468	1,065	1,845	2,908	4,127	6,515	10,248	14,822	23,935	34,467
300	696	1,584	2,743	4,325	6,137	9,690	15,240	22,043	35,596	51,258
400	931	2,118	3,668	5,782	8,206	12,955	20,377	29,472	47,593	68,534
500	1,172	2,667	4,619	7,282	10,334	16,315	25,661	37,114	59,934	86,305
600	1,421	3,232	5,597	8,823	12,522	19,770	31,095	44,973	72,626	104,582
700	1,676	3,813	6,602	10,409	14,772	23,322	36,682	53,055	85,677	123,374
800	1,938	4,409	7,635	12,036	17,082	26,968	42,417	61,349	99,070	142,661
900	2,207	5,021	8,694	13,706	19,452	30,710	48,302	69,861	112,816	162,455
1000	2,482	5,646	9,777	15,414	21,875	34,536	54,320	78,565	126,872	182,696
1100	2,763	6,286	10,885	17,161	24,355	38,451	60,478	87,471	141,254	203,405
1200	3,050	6,939	12,015	18,943	26,883	42,443	66,756	96,551	155,917	224,521
1300	3,341	7,602	13,164	20,753	29,453	46,500	73,137	105,781	170,822	245,983
1400	3,637	8,274	14,327	22,587	32,055	50,608	79,599	115,127	185,915	267,718
1500	3,935	8,953	15,504	24,442	34,688	54,765	86,137	124,583	201,184	289,706
1600	4,235	9,635	16,685	26,305	37,331	58,938	92,700	134,076	216,515	311,781
1700	4,536	10,321	17,871	28,175	39,986	63,128	99,291	143,608	231,908	333,948
1800	4,836	11,002	19,052	30,036	42,627	67,298	105,850	153,094	247,227	356,006
1900	5,134	11,681	20,226	31,888	45,255	71,448	112,376	162,534	262,471	377,958
2000	5,429	12,350	21,386	33,716	47,849	75,543	118,818	171,851	277,516	399,623

Flow Rates (MSCMH) Based Upon 30 m/s										
kPag	4	6	8	10	12	16	20	24	30	36
1000	9.67	22.01	38.11	60.07	85.27	134.6	211.7	306.2	494.5	712.1
1500	14.22	32.34	56.00	88.27	125.3	197.8	311.1	450.0	726.7	1046
2000	18.85	42.89	74.28	117.1	166.2	262.4	412.7	596.9	963.9	1388
2500	23.59	53.67	92.94	146.5	207.9	328.3	516.4	746.9	1206	1737
3000	28.43	64.68	112.0	176.5	250.6	395.6	622.3	900.0	1453	2093
3500	33.37	75.92	131.5	207.2	294.1	464.4	730.4	1056	1706	2457
4000	38.41	87.39	151.3	238.5	338.6	534.6	840.8	1216	1964	2828
4500	43.56	99.10	171.6	270.5	384.0	606.2	953.5	1379	2227	3207
5000	48.81	111.1	192.3	303.1	430.3	679.3	1068	1545	2495	3593
5500	54.17	123.2	213.4	336.4	477.4	753.8	1186	1715	2769	3987
6000	59.62	135.6	234.9	370.2	525.5	829.7	1305	1887	3048	4389
6500	65.17	148.3	256.8	404.7	574.5	907.0	1427	2063	3332	4798
7000	70.82	161.1	279.0	439.8	624.3	985.6	1550	2242	3621	5214
7500	76.56	174.2	301.6	475.4	674.8	1065	1676	2424	3914	5636
8000	82.38	187.4	324.6	511.6	726.2	1146	1803	2608	4212	6065
8500	88.28	200.9	347.8	548.2	778.2	1229	1932	2795	4513	6499
9000	94.25	214.4	371.3	585.3	830.8	1312	2063	2984	4818	6939
9500	100.28	228.1	395.1	622.7	883.9	1396	2195	3175	5127	7382
10000	106.36	242.0	419.0	660.4	937.5	1480	2328	3367	5437	7830

Flow Rates (MMSCFD) Based Upon 100 ft/s										
PSIG	4	6	8	10	12	16	20	24	30	36
100	5.9	13.5	23.3	36.8	52.2	82.4	129.5	187.4	302.6	435.7
200	11.3	25.6	44.3	69.8	99.0	156.4	245.9	355.7	574.4	827.2
300	16.8	38.0	65.8	103.8	147.3	232.6	365.8	529.0	854.3	1,230
400	22.4	50.8	88.0	138.8	196.9	310.9	489.0	707.3	1,142	1,645
500	28.2	64.0	110.8	174.8	248.0	391.6	615.9	890.7	1,438	2,071
600	34.2	77.6	134.3	211.8	300.5	474.5	746.3	1,079	1,743	2,510
700	40.3	91.5	158.5	249.8	354.5	559.7	880.4	1,273	2,056	2,961
800	46.6	105.8	183.2	288.9	410.0	647.2	1,018	1,472	2,378	3,424
900	53.1	120.5	208.7	328.9	466.8	737.0	1,159	1,677	2,708	3,899
1000	59.7	135.5	234.6	369.9	525.0	828.9	1,304	1,886	3,045	4,385
1100	66.5	150.9	261.2	411.9	584.5	922.8	1,451	2,099	3,390	4,882
1200	73.4	166.5	288.4	454.6	645.2	1,019	1,602	2,317	3,742	5,389
1300	80.4	182.4	315.9	498.1	706.9	1,116	1,755	2,539	4,100	5,904
1400	87.5	198.6	343.8	542.1	769.3	1,215	1,910	2,763	4,462	6,425
1500	94.7	214.9	372.1	586.6	832.5	1,314	2,067	2,990	4,828	6,953
1600	101.9	231.3	400.4	631.3	896.0	1,415	2,225	3,218	5,196	7,483
1700	109.1	247.7	428.9	676.2	959.7	1,515	2,383	3,447	5,566	8,015
1800	116.4	264.1	457.2	720.9	1,023	1,615	2,540	3,674	5,933	8,544
1900	123.5	280.3	485.4	765.3	1,086	1,715	2,697	3,901	6,299	9,071
2000	130.6	296.4	513.3	809.2	1,148	1,813	2,852	4,124	6,660	9,591

Flow Rates (MMSCMD) Based Upon 30 m/s										
kPag	4	6	8	10	12	16	20	24	30	36
1000	0.232	0.528	0.915	1.442	2.046	3.231	5.082	7.350	11.869	17.091
1500	0.341	0.776	1.344	2.119	3.007	4.748	7.468	10.801	17.441	25.116
2000	0.453	1.029	1.783	2.810	3.989	6.297	9.904	14.325	23.133	33.311
2500	0.566	1.288	2.231	3.516	4.991	7.879	12.393	17.924	28.946	41.682
3000	0.682	1.552	2.688	4.237	6.014	9.495	14.935	21.600	34.882	50.230
3500	0.801	1.821	3.155	4.973	7.059	11.145	17.530	25.354	40.943	58.958
4000	0.922	2.097	3.632	5.725	8.126	12.830	20.179	29.186	47.131	67.869
4500	1.045	2.378	4.119	6.492	9.215	14.549	22.883	33.097	53.447	76.963
5000	1.171	2.664	4.615	7.275	10.326	16.302	25.641	37.086	59.889	86.240
5500	1.300	2.957	5.121	8.072	11.459	18.091	28.454	41.154	66.458	95.699
6000	1.431	3.254	5.637	8.885	12.612	19.912	31.319	45.298	73.150	105.336
6500	1.564	3.557	6.162	9.713	13.787	21.767	34.236	49.517	79.964	115.148
7000	1.700	3.866	6.696	10.555	14.982	23.653	37.203	53.808	86.893	125.126
7500	1.837	4.179	7.239	11.410	16.196	25.570	40.218	58.168	93.934	135.265
8000	1.977	4.497	7.789	12.278	17.428	27.515	43.277	62.592	101.078	145.553
8500	2.119	4.819	8.347	13.157	18.676	29.485	46.376	67.075	108.318	155.978
9000	2.262	5.145	8.912	14.047	19.939	31.479	49.512	71.611	115.642	166.524
9500	2.407	5.474	9.482	14.945	21.214	33.492	52.679	76.191	123.038	177.175
10000	2.553	5.805	10.056	15.851	22.500	35.522	55.871	80.808	130.494	187.911

Appendix G Write-protected configuration parameters

G.1 Write-protected configuration

This appendix contains a table of configuration parameters and firmware that are write protected against changes when the CPU Board switch S2 position 4 is closed (see Section 3.5.8).

Write-protected configuration parameters and firmware
Address
AlarmDef
AO1ActionUponInvalidContent
AO1Content
AO1Dir
AO1FullScaleEnergyRate
AO1FullScaleMassRate
AO1FullScaleVolFlowRate
AO1MaxVel
AO1MinVel
AO1TrimCurrent
AO1TrimGainExtMeasCurrent
AO1TrimZeroExtMeasCurrent
AO2ActionUponInvalidContent
AO2Content
AO2Dir
AO2FullScaleEnergyRate
AO2FullScaleMassRate
AO2FullScaleVolFlowRate
AO2MaxVel
AO2MinVel
AO2TrimCurrent

Write-protected configuration parameters and firmware
AO2TrimGainExtMeasCurrent
AO2TrimZeroExtMeasCurrent
AsyncEnable
AtmosphericPress
AvgDlyA
AvgDlyB
AvgDlyC
AvgDlyD
AvgSoundVelHiLmt
AvgSoundVelLoLmt
BatchSize
CalMethod
ChordInactvA
ChordInactvB
ChordInactvC
ChordInactvD
City
ContractHour
CRange
DailyLogInterval
DampEnable
DeviceNumber
DI1IsInvPolarity
DitherEnable
DltChk
DltDlyA
DltDlyB
DltDlyC
DltDlyD
DO1AContent

Write-protected configuration parameters and firmware
DO1AIsInvPolarity
DO1BContent
DO1BIsInvPolarity
DO1PairTestEnable
DO2AContent
DO2AIsInvPolarity
DO2BContent
DO2BIsInvPolarity
DO2PairTestEnable
EmRateDesired
EnableExpCorrPress
EnableExpCorrTemp
EnablePressureInput
EnableTemperatureInput
FireSeq
FlowDir
FlowPOrTSrcUponAlarm
Freq1BPhase
Freq1Content
Freq1Dir
Freq1FeedbackCorrectionPcnt
Freq1FullScaleEnergyRate
Freq1FullScaleMassRate
Freq1FullScaleVolFlowRate
Freq1MaxFrequency
Freq1MaxVel
Freq1MinVel
Freq2BPhase
Freq2Content
Freq2Dir

Write-protected configuration parameters and firmware
Freq2FeedbackCorrectionPcnt
Freq2FullScaleEnergyRate
Freq2FullScaleMassRate
Freq2FullScaleVolFlowRate
Freq2MaxFrequency
Freq2MaxVel
Freq2MinVel
FwdA0
FwdA1
FwdA2
FwdA3
FwdC0
FwdC1
FwdC2
FwdC3
FwdFlwRt1
FwdFlwRt10
FwdFlwRt11
FwdFlwRt12
FwdFlwRt2
FwdFlwRt3
FwdFlwRt4
FwdFlwRt5
FwdFlwRt6
FwdFlwRt7
FwdFlwRt8
FwdFlwRt9
FwdMtrFctr1
FwdMtrFctr10
FwdMtrFctr11

Write-protected configuration parameters and firmware
FwdMtrFctr12
FwdMtrFctr2
FwdMtrFctr3
FwdMtrFctr4
FwdMtrFctr5
FwdMtrFctr6
FwdMtrFctr7
FwdMtrFctr8
FwdMtrFctr9
GasPropertiesSrcSel
GasPropertiesSrcSelGCAlarm
GCBaud
GCCommTimeout
GCDesiredStreamTimeout
GCHeatingValueType
GCHeatingValueUnit
GCModbusID
GCProtocol
GCSerialPort
GCStreamNumber
HARTAO2Date
HARTAO2Descriptor
HARTAO2EnergyUnit
HARTAO2MassUnit
HARTAO2Message
HARTAO2MinNumPreambles
HARTAO2PollingAddress
HARTAO2PressureUnit
HARTAO2QVContent
HARTAO2RateTimeUnit

Write-protected configuration parameters and firmware
HARTAO2Slot0Content
HARTAO2Slot1Content
HARTAO2Slot2Content
HARTAO2Slot3Content
HARTAO2SVContent
HARTAO2Tag
HARTAO2TemperatureUnit
HARTAO2TVContent
HARTAO2VelUnit
HARTAO2VolUnit
HARTDeviceFinalAssyNum
HCH_Method
HighPressureAlarm
HighTemperatureAlarm
HourlyLogInterval
InputPressureUnit
IsAO1EnableTest
IsAO2EnableTest
IsFreq1BZeroedOnErr
IsFreq1EnableTest
IsFreq2BZeroedOnErr
IsFreq2EnableTest
LA
label
LB
LC
LD
LinearExpansionCoef
LiveFlowPressureCalCtrl
LiveFlowPressureGain

Write-protected configuration parameters and firmware
LiveFlowPressureOffset
LiveFlowTemperatureCalCtrl
LiveFlowTemperatureGain
LiveFlowTemperatureOffset
LowFlowLmt
LowPressureAlarm
LowTemperatureAlarm
MaxHoldTm
MaxInputPressure
MaxInputTemperature
MaxNoDataBatches
MaxNoise
MeasVolGrossHeatingVal
MeterMaxVel
MeterName
MeterSerialNumber
MinChord
MinHoldTime
MinInputPressure
MinInputTemperature
MinPctGood
MinSigQlty
NegSpan
NonNormalModeTimeout
NumVals
PBase
PipeDiam
PipeOutsideDiameter
Pk1Pct
Pk1Thrsh

Write-protected configuration parameters and firmware
Pk1Wdth
PoissonsRatio
PosSpan
PressureLiveInput
PropUpdtBatches
RefPressureGr
RefPressureMolarDensity
RefTemperatureGr
RefTemperatureHV
RefTemperatureMolarDensity
RefTempLinearExpCoef
RevA0
RevA1
RevA2
RevA3
RevC0
RevC1
RevC2
RevC3
RevFlwRt1
RevFlwRt10
RevFlwRt11
RevFlwRt12
RevFlwRt2
RevFlwRt3
RevFlwRt4
RevFlwRt5
RevFlwRt6
RevFlwRt7
RevFlwRt8

Write-protected configuration parameters and firmware
RevFlwRt9
RevMtrFctr1
RevMtrFctr10
RevMtrFctr11
RevMtrFctr12
RevMtrFctr2
RevMtrFctr3
RevMtrFctr4
RevMtrFctr5
RevMtrFctr6
RevMtrFctr7
RevMtrFctr8
RevMtrFctr9
SampInterval
SampPerCycle
SndSpdChkMaxVel
SndSpdChkMinVel
SNRatio
SpecBatchUpdtPeriod
SpecificGravity
SSMax
SSMin
StackEmRateDesired
StateAndCountry
StationName
SystemDelay
SysTempHiLmt
SysTempLoLmt
Tamp
TampHi

Write-protected configuration parameters and firmware
TampLo
TampSen
TampWt
TBase
TemperatureLiveInput
TmDevFctr1
TmDevLow1
Tspe
TspeHi
TspeLmt
TspeLo
TspeSen
TspeWt
Tspf
TspfHi
TspfLo
TspfMatch
TspfSen
TspfWt
UnitsSystem
VelHold
VolFlowRateTimeUnit
VolUnitMetric
VolUnitUS
WallRoughness
XA
XB
XC
XD
XdcrFreq
YoungsModulus
ZeroCut

Appendix H Open source licenses

H.1 Open source licenses

Source code for executable files or libraries included in this product is provided per the indicated license in the table below. Hyperlinks to the controlling organization's websites are included in Appendix H.1.1 through Appendix H.1.4.

Table H-1 Open source licenses

Executables or Library	Open Source Licenses
Linux kernel (2.4.21)	• GPL v2
busybox	• GPL v2
rolo boot loader	• GPL v2
file system	• GPL v2
pppd	• Public domain • BSD License • GPL v2
mird Copyright Mirar Hagland	• M.I.T. License • GPL v2
jffs2 kernel drive	• GPL v2

The link below, to the Daniel® Ultrasonic Gas Products GPL web page, provides additional information and zipped source code files.

http://www2.emersonprocess.com/en-US/brands/daniel/Pages/GPL3400.aspx

H.1.1 GNU General Public License

For more details about GNU GPL (General Public License), follow the link below:
http://www.gnu.org/

Daniel uses GNU GPL version 2.
http://www.gnu.org/licenses/old-licenses/gpl-2.0.html

The GNU GPL is currently version 3
http://www.gnu.org/licenses/quick-guide-gplv3.html.

For older versions of the GNU General Public Licenses, follow the link below:
http://www.gnu.org/licenses/old-licenses/old-licenses.html#GPL

See GPL license on the following pages.

GNU GENERAL PUBLIC LICENSE

Version 2, June 1991

Preamble

The licenses for most software are designed to take away your freedom to share and change it. By contrast, the GNU General Public License is intended to guarantee your freedom to share and change free software--to make sure the software is free for all its users. This General Public License applies to most of the Free Software Foundation's software and to any other program whose authors commit to using it. (Some other Free Software Foundation software is covered by the GNU Lesser General Public License instead.) You can apply it to your programs, too.

When we speak of free software, we are referring to freedom, not price. Our General Public Licenses are designed to make sure that you have the freedom to distribute copies of free software (and charge for this service if you wish), that you receive source code or can get it if you want it, that you can change the software or use pieces of it in new free programs; and that you know you can do these things.

To protect your rights, we need to make restrictions that forbid anyone to deny you these rights or to ask you to surrender the rights.

These restrictions translate to certain responsibilities for you if you distribute copies of the software, or if you modify it.

For example, if you distribute copies of such a program, whether gratis or for a fee, you must give the recipients all the rights that you have. You must make sure that they, too, receive or can get the source code. And you must show them these terms so they know their rights.

We protect your rights with two steps: (1) copyright the software, and (2) offer you this license which gives you legal permission to copy, distribute and/or modify the software.

Also, for each author's protection and ours, we want to make certain that everyone understands that there is no warranty for this free software. If the software is modified by someone else and passed on, we want its recipients to know that what they have is not the original, so that any problems introduced by others will not reflect on the original authors' reputations.

Finally, any free program is threatened constantly by software patents. We wish to avoid the danger that redistributors of a free program will individually obtain patent licenses, in effect making the program proprietary. To prevent this, we have made it clear that any patent must be licensed for everyone's free use or not licensed at all.

The precise terms and conditions for copying, distribution and modification follow.

GNU GENERAL PUBLIC LICENSE

TERMS AND CONDITIONS FOR COPYING, DISTRIBUTION AND MODIFICATION

0. This License applies to any program or other work which contains a notice placed by the copyright holder saying it may be distributed under the terms of this General Public License. The "Program", below, refers to any such program or work, and a "work based on the Program" means either the Program or any derivative work under copyright law: that is to say, a work containing the Program or a portion of it, either verbatim or with modifications and/or translated into another language. (Hereinafter, translation is included without limitation in the term "modification".) Each licensee is addressed as "you". Activities other than copying, distribution and modification are not covered by this License; they are outside its scope. The act of running the Program is not restricted, and the output from the Program is covered only if its contents constitute a work based on the Program (independent of having been made by running the Program). Whether that is true depends on what the Program does.

1. You may copy and distribute verbatim copies of the Program's source code as you receive it, in any medium, provided that you conspicuously and appropriately publish on each copy an appropriate copyright notice and disclaimer of warranty; keep intact all the notices that refer to this License and to the absence of any warranty; and give any other recipients of the Program a copy of this License along with the Program.

You may charge a fee for the physical act of transferring a copy, and you may at your option offer warranty protection in exchange for a fee.

2. You may modify your copy or copies of the Program or any portion of it, thus forming a work based on the Program, and copy and distribute such modifications or work under the terms of Section 1 above, provided that you also meet all of these conditions:

a) You must cause the modified files to carry prominent notices stating that you changed the files and the date of any change.

b) You must cause any work that you distribute or publish, that in whole or in part contains or is derived from the Program or any part thereof, to be licensed as a whole at no charge to all third parties under the terms of this License.

c) If the modified program normally reads commands interactively when run, you must cause it, when started running for such interactive use in the most ordinary way, to print or display an announcement including an appropriate copyright notice and a notice that there is no warranty (or else, saying that you provide a warranty) and that users may redistribute the program under these conditions, and telling the user how to view a copy of this License. (Exception: if the Program itself is interactive but does not normally print such an announcement, your work based on the Program is not required to print an announcement.)

These requirements apply to the modified work as a whole. If identifiable sections of that work are not derived from the Program, and can be reasonably considered independent and separate works in themselves, then this License, and its terms, do not apply to those sections when you distribute them as separate works. But when you distribute the same sections as part of a whole which is a work based on the Program, the distribution of the whole must be on the terms of this License, whose permissions for other licensees extend to the entire whole, and thus to each and every part regardless of who wrote it.

Thus, it is not the intent of this section to claim rights or contest your rights to work written entirely by you; rather, the intent is to exercise the right to control the distribution of derivative or collective works based on the Program.

In addition, mere aggregation of another work not based on the Program with the Program (or with a work based on the Program) on a volume of a storage or distribution medium does not bring the other work under the scope of this License.

3. You may copy and distribute the Program (or a work based on it, under Section 2) in object code or executable form under the terms of Sections 1 and 2 above provided that you also do one of the following:

a) Accompany it with the complete corresponding machine-readable source code, which must be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange; or,

b) Accompany it with a written offer, valid for at least three years, to give any third party, for a charge no more than your cost of physically performing source distribution, a complete machine-readable copy of the corresponding source code, to be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange; or,

c) Accompany it with the information you received as to the offer to distribute corresponding source code. (This alternative is allowed only for noncommercial distribution and only if you received the program in object code or executable form with such an offer, in accord with Subsection b above.)

The source code for a work means the preferred form of the work for making modifications to it. For an executable work, complete source code means all the source code for all modules it contains, plus any associated interface definition files, plus the scripts used to control compilation and installation of the executable. However, as a special exception, the source code distributed need not include anything that is normally distributed (in either source or binary form) with the major components (compiler, kernel, and so on) of the operating system on which the executable runs, unless that component itself accompanies the executable.

If distribution of executable or object code is made by offering access to copy from a designated place, then offering equivalent access to copy the source code from the same place counts as distribution of the source code, even though third parties are not compelled to copy the source along with the object code.

4. You may not copy, modify, sublicense, or distribute the Program except as expressly provided under this License. Any attempt otherwise to copy, modify, sublicense or distribute the Program is void, and will automatically terminate your rights under this License. However, parties who have received copies, or rights, from you under this License will not have their licenses terminated so long as such parties remain in full compliance.

5. You are not required to accept this License, since you have not signed it. However, nothing else grants you permission to modify or distribute the Program or its derivative works. These actions are prohibited by law if you do not accept this License. Therefore, by modifying or distributing the Program (or any work based on the Program), you indicate your acceptance of this License to do so, and all its terms and conditions for copying, distributing or modifying the Program or works based on it.

6. Each time you redistribute the Program (or any work based on the Program), the recipient automatically receives a license from the original licensor to copy, distribute or modify the Program subject to these terms and conditions. You may not impose any further restrictions on the recipients' exercise of the rights granted herein. You are not responsible for enforcing compliance by third parties to this License.

7. If, as a consequence of a court judgment or allegation of patent infringement or for any other reason (not limited to patent issues), conditions are imposed on you (whether by court order, agreement or otherwise) that contradict the conditions of this License, they do not excuse you from the conditions of this License. If you cannot distribute so as to satisfy simultaneously your obligations under this License and any other pertinent obligations, then as a consequence you may not distribute the Program at all. For example, if a patent license would not permit royalty-free redistribution of the Program by all those who receive copies directly or indirectly through you, then the only way you could satisfy both it and this License would be to refrain entirely from distribution of the Program.

If any portion of this section is held invalid or unenforceable under any particular circumstance, the balance of the section is intended to apply and the section as a whole is intended to apply in other circumstances.

It is not the purpose of this section to induce you to infringe any patents or other property right claims or to contest validity of any such claims; this section has the sole purpose of protecting the integrity of the free software distribution system, which is implemented by public license practices. Many people have made generous contributions to the wide range of software distributed through that system in reliance on consistent application of that system; it is up to the author/donor to decide if he or she is willing to distribute software through any other system and a licensee cannot impose that choice.

This section is intended to make thoroughly clear what is believed to be a consequence of the rest of this License.

8. If the distribution and/or use of the Program is restricted in certain countries either by patents or by copyrighted interfaces, the original copyright holder who places the Program under this License may add an explicit geographical distribution limitation excluding those countries, so that distribution is permitted only in or among countries not thus excluded. In such case, this License incorporates the limitation as if written in the body of this License.

9. The Free Software Foundation may publish revised and/or new versions of the General Public License from time to time. Such new versions will be similar in spirit to the present version, but may differ in detail to address new problems or concerns.

Each version is given a distinguishing version number. If the Program specifies a version number of this License which applies to it and "any later version", you have the option of following the terms and conditions either of that version or of any later version published by the Free Software Foundation. If the Program does not specify a version number of this License, you may choose any version ever published by the Free Software Foundation.

10. If you wish to incorporate parts of the Program into other free programs whose distribution conditions are different, write to the author to ask for permission. For software which is copyrighted by the Free

Software Foundation, write to the Free Software Foundation; we sometimes

make exceptions for this. Our decision will be guided by the two goals

of preserving the free status of all derivatives of our free software and

of promoting the sharing and reuse of software generally.

NO WARRANTY

11. BECAUSE THE PROGRAM IS LICENSED FREE OF CHARGE, THERE IS NO WARRANTY FOR THE PROGRAM, TO THE EXTENT PERMITTED BY APPLICABLE LAW. EXCEPT WHEN OTHERWISE STATED IN WRITING THE COPYRIGHT HOLDERS AND/OR OTHER PARTIES PROVIDE THE PROGRAM "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE ENTIRE RISK AS TO THE QUALITY AND PERFORMANCE OF THE PROGRAM IS WITH YOU. SHOULD THE PROGRAM PROVE DEFECTIVE, YOU ASSUME THE COST OF ALL NECESSARY SERVICING, REPAIR OR CORRECTION.

12. IN NO EVENT UNLESS REQUIRED BY APPLICABLE LAW OR AGREED TO IN WRITING WILL ANY COPYRIGHT HOLDER, OR ANY OTHER PARTY WHO MAY MODIFY AND/OR REDISTRIBUTE THE PROGRAM AS PERMITTED ABOVE, BE LIABLE TO YOU FOR DAMAGES,

INCLUDING ANY GENERAL, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE THE PROGRAM (INCLUDING BUT NOT LIMITED TO LOSS OF DATA OR DATA BEING RENDERED INACCURATE OR LOSSES SUSTAINED BY

YOU OR THIRD PARTIES OR A FAILURE OF THE PROGRAM TO OPERATE WITH ANY OTHER PROGRAMS), EVEN IF SUCH HOLDER OR OTHER PARTY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

END OF TERMS AND CONDITIONS

How to Apply These Terms to Your New Programs

If you develop a new program, and you want it to be of the greatest possible use to the public, the best way to achieve this is to make it free software which everyone can redistribute and change under these terms. To do so, attach the following notices to the program. It is safest to attach them to the start of each source file to most effectively convey the exclusion of warranty; and each file should have at least the "copyright" line and a pointer to where the full notice is found.

<one line to give the program's name and a brief idea of what it does.>

Copyright (C) <year> <name of author>

This program is free software; you can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation; either version 2 of the License, or (at your option) any later version.

This program is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU General Public License for more details.

You should have received a copy of the GNU General Public License along with this program; if not, write to the Free Software Foundation, Inc., 51 Franklin Street, Fifth Floor, Boston, MA 02110-1301 USA.

Also add information on how to contact you by electronic and paper mail.

If the program is interactive, make it output a short notice like this

when it starts in an interactive mode:

Gnomovision version 69, Copyright (C) year name of author

Gnomovision comes with ABSOLUTELY NO WARRANTY; for details type `show w'.

This is free software, and you are welcome to redistribute it

under certain conditions; type `show c' for details.

The hypothetical commands `show w' and `show c' should show the appropriate

parts of the General Public License. Of course, the commands you use may

be called something other than `show w' and `show c'; they could even be

mouse-clicks or menu items--whatever suits your program.

You should also get your employer (if you work as a programmer) or your

school, if any, to sign a "copyright disclaimer" for the program, if

necessary. Here is a sample; alter the names:

Yoyodyne, Inc., hereby disclaims all copyright interest in the program

`Gnomovision' (which makes passes at compilers) written by James Hacker.

<signature of Ty Coon>, 1 April 1989

Ty Coon, President of Vice

This General Public License does not permit incorporating your program into

proprietary programs. If your program is a subroutine library, you may

consider it more useful to permit linking proprietary applications with the

library. If this is what you want to do, use the GNU Lesser General

Public License instead of this License.

H.1.2 BSD Open Source License

For more details about the Open Source™ BSD license or the Open Source Initiative, follow the link below:

http://www.opensource.org/licenses/bsd-license.php

Copyright (c) <YEAR>, <OWNER>

All rights reserved.

Redistribution and use in source and binary forms, with or without modification, are permitted provided that the following conditions are met:

Redistributions of source code must retain the above copyright notice, this list of conditions and the following disclaimer.

Redistributions in binary form must reproduce the above copyright notice, this list of conditions and the following disclaimer in the documentation and/or other materials provided with the distribution.

Neither the name of Daniel® nor the names of its contributors may be used to endorse or promote products derived from this software without specific prior written permission.

THIS SOFTWARE IS PROVIDED BY THE COPYRIGHT HOLDERS AND CONTRIBUTORS "AS IS" AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE DISCLAIMED. IN NO EVENT SHALL THE COPYRIGHT OWNER OR CONTRIBUTORS BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

H.1.3 M.I.T. License

For more details about the Open Source™ MIT license or the Open Source Initiative, follow the link below:

http://www.opensource.org/licenses/mit-license.php

The MIT License

Copyright (c) <year> <copyright holders>

Permission is hereby granted, free of charge, to any person obtaining a copy of this software and associated documentation files (the "Software"), to deal in the Software without restriction, including without limitation the rights to use, copy, modify, merge, publish, distribute, sublicense, and/or sell copies of the Software, and to permit persons to whom the Software is furnished to do so, subject to the following conditions:

The above copyright notice and this permission notice shall be included in all copies or substantial portions of the Software.

THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY,

FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER

LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM, OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.

H.1.4 Mird License

License

The Mird database library may be freely distributed and used with these limits[1]:

* The database library may be distributed with or without source.

* There is no promise that this software works. (But if you find any bugs, please let me know!)

* You can use this software for whatever you want. You don't have to pay me.

* You may not pretend that you wrote this software. If you use it in a program, you must acknowledge it somewhere in your documentation.

In legalese:

The authors make NO WARRANTY or representation, either express or

implied, with respect to this software, its quality, accuracy,

merchantability, or fitness for a particular purpose. This software is

provided "AS IS", and you, its user, assume the entire risk as to its

quality and accuracy.

Reserved except as specified below.

Permission is hereby granted to use, copy, modify, and distribute this software (or portions thereof) for any purpose, without fee, subject to these conditions:

(1) If any part of the source code for this software is distributed, then this license must be included, with this copyright and no-warranty notice unaltered; and any additions, deletions, or changes to the original files must be clearly indicated in accompanying documentation.

(2) If only executable code is distributed, then the accompanying documentation must state that "this software is utilizing the Mird database".

(3) Permission for use of this software is granted only if the user accepts full responsibility for any undesirable consequences; the authors accept NO LIABILITY for damages of any kind.

These conditions apply to any software derived from or based on the Mird database code, not just to the unmodified library. If you use this work, you ought to acknowledge it.

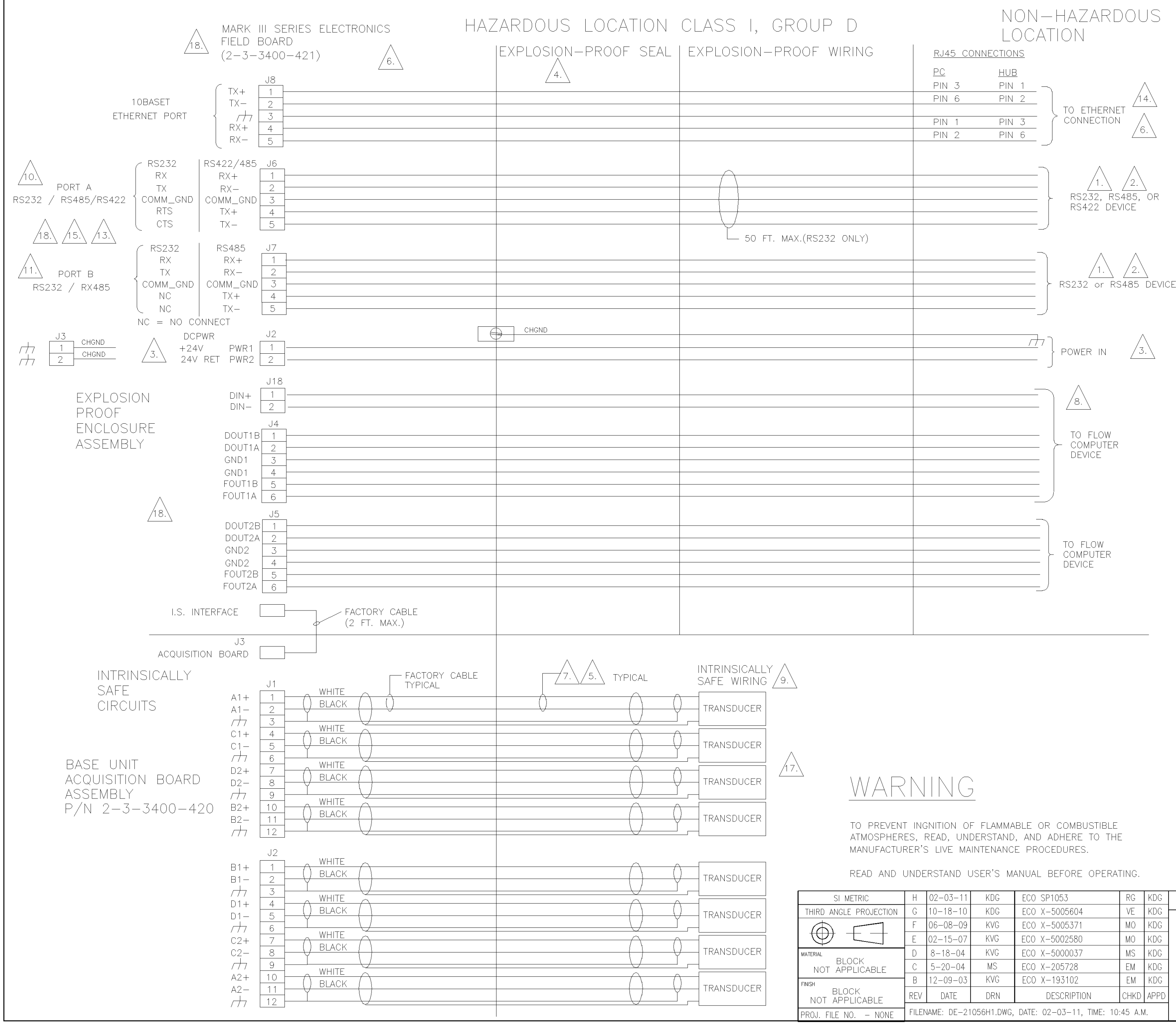
I permit and encourage the use of this software as the basis of commercial products, provided that all warranty or liability claims are assumed by the product vendor.

Appendix I Engineering drawings

I.1 Ultrasonic Meter Drawings

This appendix contains the following engineering drawing(s) for the ultrasonic meter:

DE-21056 Mark III Ultrasonic System Wiring Diagram Ultrasonic Flow Meter Model 3400, 3410, and 3420 (Sheets 1-3)



WARNING

TO PREVENT INGNITION OF FLAMMABLE OR COMBUSTIBLE ATMOSPHERES, READ, UNDERSTAND, AND ADHERE TO THE MANUFACTURER'S LIVE MAINTENANCE PROCEDURES.

READ AND UNDERSTAND USER'S MANUAL BEFORE OPERATING.

REV	DATE	DRN	DESCRIPTION	CHKD	APPD
H	02-03-11	KDG	ECO SP1053	RG	KDG
G	10-18-10	KDG	ECO X-5005604	VE	KDG
F	06-08-09	KVG	ECO X-5005371	MO	KDG
E	02-15-07	KVG	ECO X-5002580	MO	KDG
D	8-18-04	KVG	ECO X-5000037	MS	KDG
C	5-20-04	MS	ECO X-205728	EM	KDG
B	12-09-03	KVG	ECO X-193102	EM	KDG

SI METRIC
THIRD ANGLE PROJECTION
MATERIAL BLOCK NOT APPLICABLE
FINISH BLOCK NOT APPLICABLE
PROJ. FILE NO. - NONE
FILENAME: DE-21056H1.DWG, DATE: 02-03-11, TIME: 10:45 A.M.

GEOMETRIC TOLERANCES & DIMENSIONS PER ANSI Y14.5 LATEST REVISION

UNLESS OTHERWISE NOTED ALL DIMENSIONS IN INCHES
X.XX ±.015
X.XXX ±.005
ANGULAR ±0 30'
FINISH 200 RA MAX

BREAK ALL SHARP CORNERS TO .003-.015 RADIUS AND REMOVE ALL BURRS

DANIEL
Daniel Measurement and Control

TITLE MARK III ULTRASONIC SYSTEM WIRING DIAGRAM ULTRASONIC FLOWMETER MODEL 3400, 3410 AND 3420

DRN KVG	DATE 4-25-03	DWG NO. DE-21056	REV H
CHKD EM	DATE 7/29/03		
APPD KDG	DATE 7/29/03	SCALE NA	P/N SEE ORDER	SHT 1 OF 3

NOTES:

1. MAX LENGTH OF RS-485 WIRING IS 2,000 FT.

2. RS-422 IS THE PREFERRED COMMUNICATIONS INTERFACE. OPTIONALLY, RS-232 MAY BE USED FOR SHORT DISTANCES, (50 FT.) COM_GND MUST BE CONNECTED TO REMOTE COMM DEVICE FOR RELIABLE OPERATION

3. POWER INPUT IS NOMINAL 24 VDC. RANGE 10.4-36V DC. POLARITY INSENSITIVE

4. AN EXPLOSION-PROOF SEAL IS REQUIRED WITHIN 50 MM(2 INCHES) OF THE ENCLOSURE.

5. TRANSDUCER CABLE IS 20 AWG. SHIELDED PAIR, 20 AWG DRAIN, BRAIDED SHIELD, REMKE INDUSTRIES OR EQUIVALENT, 15 FT. MAX.

6. FOR OPTIMUM DIAGNOSTIC INTERFACE, WIRING ETHERNET PORT IS RECOMMENDED. USE CAT5 ETHERNET CABLE

7. INTRINSICALLY SAFE WIRING SHALL BE INSTALLED IN ACCORDANCE WITH THE ARTICLE 504 OF THE NATIONAL ELECTRICAL CODE OR RULE 18-066 OF THE CANADIAN ELECTRICAL CODE.

8. CONTACT CLOSURE ONLY.

9. TRANSDUCER PAIRS REQUIRED

MODEL NO.	TRANSDUCER PAIRS REQUIRED	TYPICAL CHORDS USED
3400/3422	4	A,B,C,D
3410	1	A
3420	2	A,B

10. PORT A SWITCH SETTINGS
- RS-232
  - CPU BD S3 POS 1,2,3,4 (RS232)
  - CPU BD S5 POS 1 (FULL)
  - CPU BD S6 POS 1,2 (RS232)
  - FIELD BD S1 POS 1,2,3,4 (OFF)
- RS-485
  - CPU BD S3 POS 1,2,3,4 (RS485)
  - CPU BD S6 POS 1,2 (RS485)
  - FULL DUPLEX
    - CPU BD S5 POS 1 (FULL)
    - FIELD BD S1 POS 3,4 (OFF)
    - TERMINATION ON - FIELD BD S1 POS 1,2 (ON)
    - TERMINATION OFF - FIELD BD S1 POS 1,2 (OFF)
  - HALF DUPLEX
    - CPU BD S5 POS 1 (HALF)
    - FIELD BD S1 POS 3,4 (ON)
    - TERMINATION ON - FIELD BD S1 POS 1 (ON) FIELD BD S1 POS 2 (OFF)
    - TERMINATION OFF - FIELD BD S1 POS 1,2 (OFF)

11. PORT B SWITCH SETTINGS
- RS-232
  - CPU BD S4 POS 1,2 S7 POS 1,2 (RS232)
  - CPU BD S5 POS 2 (FULL)
  - FIELD BD S1 POS 5,6,7,8 (OFF)
- RS-485
  - CPU BD S4 POS 1,2 S7 POS 1,2 (RS485)
  - FULL DUPLEX
    - CPU BD S5 POS 2 (FULL)
    - FIELD BD S1 POS 7,8 (OFF)
    - TERMINATION ON - FIELD BD S1 POS 5,6 (ON)
    - TERMINATION OFF - FIELD BD S1 POS 5,6 (OFF)
  - HALF DUPLEX
    - CPU BD S5 POS 2 (HALF)
    - FIELD BD S1 POS 7,8 (ON)
    - TERMINATION ON - FIELD BD S1 POS 5 (ON) FIELD BD S1 POS 6 (OFF)
    - TERMINATION OFF - FIELD BD S1 POS 5,6 (OFF)

12. FREQUENCY AND DIGITAL OUTPUT SWITCH SETTINGS

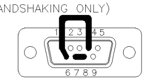
SWITCH	LOCATION	DESCRIPTION		
S8 : 1	CPU BD	DIG 1A OUTPUT TYPE	TTL	O.C.
S8 : 2	CPU BD	DIG 1B OUTPUT TYPE	TTL	O.C.
S9 : 1	CPU BD	DIG 2A OUTPUT TYPE	TTL	O.C.
S9 : 2	CPU BD	DIG 2B OUTPUT TYPE	TTL	O.C.
S8 : 3	CPU BD	FREQ 1A OUTPUT TYPE	TTL	O.C.
S8 : 4	CPU BD	FREQ 1B OUTPUT TYPE	TTL	O.C.
S9 : 3	CPU BD	FREQ 2A OUTPUT TYPE	TTL	O.C.
S9 : 4	CPU BD	FREQ 2B OUTPUT TYPE	TTL	O.C.

SWITCH POSITION : O.C. = OPEN COLLECTOR (SINK); TTL = 0-5V (SOURCE)

13. COMM SIGNAL NAMING CONVENTION IS WITH RESPECT TO METER. (I.E. PC - TXD -> METER - RXD)

14. RJ45 SOCKET NUMBERING

15. PC SIDE SERIAL CONNECTION MUST BE WIRED FOR COMPLETE NULL MODEM FOR SUCCESSFULL HOOKUP TO METER
NULL MODEM CONNECTIONS FOR PC END OF CABLE (RS232 WITH NO HANDSHAKING ONLY)



FEMALE 9 PIN DSUB CONNECTOR (BACK VIEW)

MARK III J6/J7		DB9 (Female)
PIN 1(RX)	-->	PIN 3
PIN 2(TX)	-->	PIN 2
PIN 3(COMM_GND)	-->	PIN 5
		PIN 1 / PIN 4 / PIN 6
		PIN 7 / PIN 8

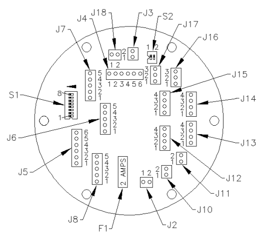
16. S2 DIP SWITCH SETTINGS

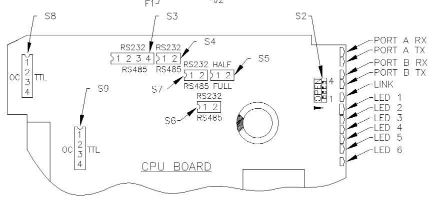
SWITCH	LOCATION	DESCRIPTION	OPEN	CLOSED
S2 : 1	CPU BD	PORT B OVERRIDE	OFF	ON
S2 : 2	CPU BD	DHCP SERVER ENABLE	OFF	ON
S2 : 3	CPU BD	NO DESC	OFF	ON
S2 : 4	CPU BD	MEMORY PROTECT	ON	OFF

TO ENABLE THE PORT B OVERRIDE, SWITCH MUST BE MOVED FROM THE OPEN TO CLOSED POSITION. PORT B WILL BE SET TO 19200,8,N,1 ID 32 FOR TWO MINUTES.

17. 3400 SERIES TYPE 1, 2, 11, 12, 17, 21 OR 22.

18. PICTORIAL DIAGRAM FOR LOCATION OF SWITCHES, JUMPERS AND LED. REFERENCE DRAWING CE-15470 FOR MORE INFORMATION





CPU BOARD

► INDICATES DIRECTION TO TURN ON OR CLOSE SWITCH

19. PORT C SWITCH SETTINGS
- RS-232
  - OPTION BD S10, S11 POS 1,2 (RS-232)
  - FIELD BD S2 POS 1 (OFF)
- RS-485 HALF DUPLEX
  - OPTION BD S10, S11 POS 1,2 (RS485)
  - TERMINATION ON - FIELD BD S2 POS 1 (ON)
  - TERMINATION OFF - FIELD BD S2 POS 1 (OFF)

20. ANALOG OUTPUT 1 SWITCH SETTINGS
- SOURCE - OPTION BD S14 POS 1,2,3 (SRC)
- SINK - OPTION BD S14 POS 1,2,3 (SINK)

21. ANALOG OUTPUT 2 SWITCH SETTINGS (HART OPTION BD)
- SOURCE - HART OPTION BD S15 POS 1,2,3 (SRC)
- SINK - HART OPTION BD S15 POS 1,2,3 (SINK)

22. ANALOG INPUT 1 SWITCH SETTINGS
- SOURCE - OPTION BD S12 POS 1,2,3 (SRC)
- SINK - OPTION BD S12 POS 1,2,3 (SINK)

23. ANALOG INPUT 2 SWITCH SETTINGS
- SOURCE - OPTION BD S13 POS 1,2,3 (SRC)
- SINK - OPTION BD S13 POS 1,2,3 (SINK)

24. S10-S14 ON SERIES 100 AND HART OPTION BOARD HAVE IDENTICAL FUNCTIONALITY AND SETTINGS. S15 HAS BEEN ADDED TO HART OPTION BOARD FOR ANALOG OUTPUT 2.

25. SERIES 100 OPTION BOARD LED FUNCTIONS

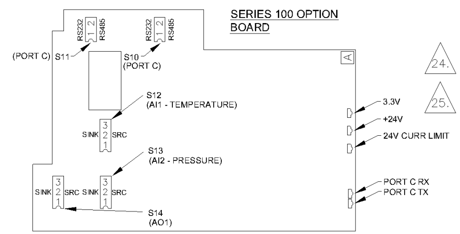
RX	GREEN	- PORT C RECEIVE DATA ACTIVE
TX	GREEN	- PORT C TRANSMIT DATA ACTIVE
3.3V	GREEN	- +3.3V POWER ON
+24V	GREEN	- +24V POWER ON
24V CURR LIMIT	RED	- +24V POWER CURRENT LIMITED

26. HART OPTION BOARD LED FUNCTIONS

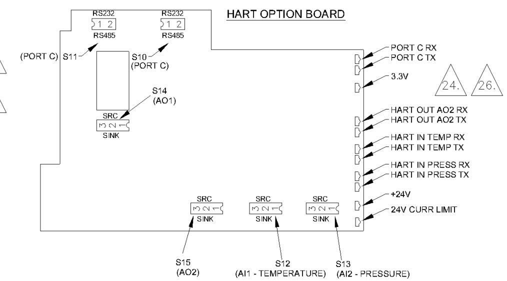
RX	GREEN	- PORT C RECEIVE DATA ACTIVE
TX	GREEN	- PORT C TRANSMIT DATA ACTIVE
3.3V	GREEN	- +3.3V POWER ON
RX	GREEN	- HART OUT RECEIVE DATA ACTIVE
TX	GREEN	- HART OUT TRANSMIT DATA ACTIVE
RX	GREEN	- HART IN TEMP RECEIVE DATA ACTIVE
TX	GREEN	- HART IN TEMP TRANSMIT DATA ACTIVE
RX	GREEN	- HART IN PRESS RECEIVE DATA ACTIVE
TX	GREEN	- HART IN PRESS TRANSMIT DATA ACTIVE
+24V	GREEN	- +24V POWER ON
24V CURR LIMIT	RED	- +24V POWER CURRENT LIMITED

OPTION BD = SERIES 100 OPTION BOARD OR HART OPTION BOARD
FIELD BD = MARK III FIELD CONNECTION BOARD
S = SWITCH REFERENCE NAMES

SERIES 100 OPTION BOARD



HART OPTION BOARD



REV	DATE	DRN	DESCRIPTION	CHKD	APPD
H	02-03-11	KDG	ECO SP1053	RG	KDG
G	10-18-10	KDG	ECO X-5006004	VE	KDG
F	06-08-09	KVG	ECO X-5005371	MO	KDG
E	02-15-07	KVG	ECO X-5002580	MO	KDG
D	08-18-04	KVG	ECO X-5000037	MS	KDG
C	05-20-04	MS	ECO X-205728	EM	KDG
B	12-09-03	KVG	ECO X-193102	EM	KDG

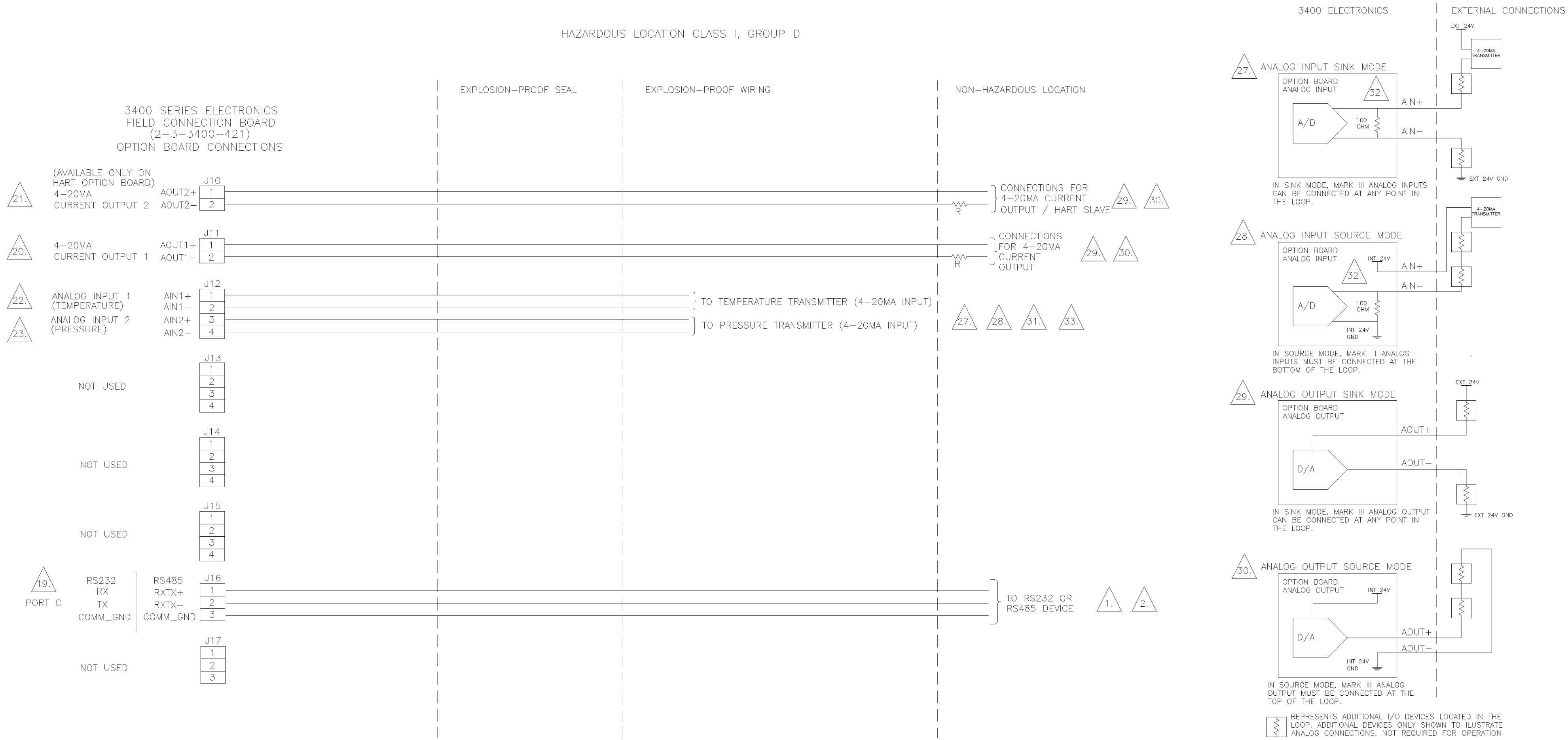
SI METRIC
THIRD ANGLE PROJECTION
MATERIAL: BLOCK NOT APPLICABLE
FINISH: BLOCK NOT APPLICABLE
PROJ. FILE NO. - NONE
FILENAME: DE-21056H2.DWG, DATE: 02-03-11, TIME: 11:10 A.M.

GEOMETRIC TOLERANCES & DIMENSIONS PER ANSI Y14.5 LATEST REVISION
UNLESS OTHERWISE NOTED ALL DIMENSIONS IN INCHES X.XX ±.015 X.XXX ±.005 ANGULAR ±0 30' FINISH 200 RA MAX
BREAK ALL SHARP CORNERS TO .003-.015 RADIUS AND REMOVE ALL BURRS

DANIEL
Daniel Measurement and Control

TITLE: MARK III ULTRASONIC SYSTEM WIRING DIAGRAM ULTRASONIC FLOWMETER MODEL 3400, 3410 AND 3420

DRN KVG DATE 4-25-03 | DWG NO. DE-21056 | REV H
CHKD EM DATE 7/29/03
APPD KDG DATE 7/29/03 | SCALE NA | P/N SEE ORDER | SHT 2 OF 3



31. ANALOG INPUT 1 AND ANALOG INPUT 2 ARE FUNCTIONALLY IDENTICAL, BUT ARE ELECTRICALLY ISOLATED FROM EACH OTHER. EACH ANALOG INPUT CAN BE CONFIGURED TO OPERATE INDEPENDENTLY IN EITHER SINK OR SOURCE MODE.

32. ON HART OPTION BD, ANALOG INPUT 1 AND ANALOG INPUT 2 HAVE ADDITIONAL 150 OHMS LOOP IMPEDANCE FOR COMPLIANCE WITH HART COMMUNICATION REQUIREMENTS.

33. ON HART OPTION BD, ANALOG INPUT 1 AND ANALOG INPUT 2 CAN BE CONNECTED TO HART ENABLED TRANSMITTER.

WARNING

TO PREVENT INGNITION OF FLAMMABLE OR COMBUSTIBLE ATMOSPHERES, READ, UNDERSTAND, AND ADHERE TO THE MANUFACTURER'S LIVE MAINTENANCE PROCEDURES.

READ AND UNDERSTAND USER'S MANUAL BEFORE OPERATING.

REV	DATE	DRN	DESCRIPTION	CHKD	APPD
H	02-03-11	KDG	ECO SP1053	RG	KDG
G	10-18-10	KDG	ECO X-5006004	VE	KDG
F	06-08-09	KVG	ECO X-5005371	MO	KDG
E	02-15-07	KVG	ECO X-5002580	MO	KDG
D	08-18-04	KVG	ECO X-5000037	MS	KDG
C	05-20-04	MS	ECO X-205728	EM	KDG
B	12-09-03	KVG	ECO X-193102	EM	KDG

FILENAME: DE-21056H3.DWG, DATE: 02-03-11, TIME: 11:15 A.M.

SI METRIC
THIRD ANGLE PROJECTION
MATERIAL: BLOCK NOT APPLICABLE
FINISH: BLOCK NOT APPLICABLE
PROJ. FILE NO. - NONE

GEOMETRIC TOLERANCES & DIMENSIONS PER ANSI Y14.5 LATEST REVISION

UNLESS OTHERWISE NOTED ALL DIMENSIONS IN INCHES
X.XX ±.015
X.XXX ±.005
ANGULAR ±0 30'
FINISH 200 RA MAX

BREAK ALL SHARP CORNERS TO .003-.015 RADIUS AND REMOVE ALL BURRS

DANIEL
Daniel Measurement and Control

TITLE: MARK III ULTRASONIC SYSTEM WIRING DIAGRAM ULTRASONIC FLOWMETER MODEL 3400, 3410 AND 3420

DRN KVG	DATE 4/25/03	DWG NO. DE-21056	REV H
CHKD EM	DATE 7/29/03		
APPD KDG	DATE 7/29/03	SCALE NA	P/N SEE ORDER

Appendix J Index

J.1 Manual Index

A

B

C

N

O

P

R

S

P/N 3-9000-743 Rev R
2013

Daniel Measurement and Control, Inc.
11100 Brittmoore Park Drive
Houston, TX 77041 USA

T+1 713-467-6000
F+1 713-827-4805
USA Toll Free 1 888-356-9001
Daniel Measurement Services, Inc.
T +1 713-827-6413
www.Daniel.com

Europe: Stirling, Scotland, UK
T + 44-1786-433400
Middle East: Africa: Dubai, UAE
T +971-4-811-8100
Asia Pacific: Singapore
T +65-677-8211

This product is a core component of the PlantWeb digital plant architecture.

DANIEL™

EMERSON. Process Management