QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) PLAN
FOR
THE MATT BREWING COMPANY
ANAEROBIC DIGESTER GAS (ADG) SYSTEM

Agreement # ADG-17957

Submitted to:

New York State Energy Research and Development Authority

17 Columbia Circle

Albany, NY 12203-6399

Submitted by:

Environmental Management Group International, Inc.

PO Box 1600

Media, PA 19063

May 28, 2013

PROJECT PARTICIPANTS

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NYS ERDA CHP Website & Monitoring Contractor (CHP Website Contractor; Monitoring Contractor)	Hugh Henderson CDH Energy Corp. PO Box 641 Cazenovia, NY 13035 315-655-1063 hugh@cdhenergy.com

1.0 INTRODUCTION

This Quality Assurance/Quality Control (QA/QC) plan describes the methods that will be used to monitor the efficiency of the Anaerobic Digester Gas (ADG)-to-Electricity system that has been installed at the Matt Brewing Company, Inc., located in Utica, NY (the "Brewery" or the "Facility" or the "Applicant"). The ADG-to-Electricity system is used for the pre-treatment of Facility wastewater, biogas production, and electric generation. Electricity generated by the Generator set (Genset) will be used onsite by the Brewery for production operations. A monitoring system was installed to measure and collect the data necessary to quantify the electric power produced by the Genset. This data serves as the basis for payment of performance incentive payments, for which the Brewery has applied under a Standard Performance Contract with the New York State Energy Research and Development Agency (NYS ERDA) based on a Total Contracted Capacity of 400 kW.

For this project, the Brewery engaged Environmental Management Group International, Inc. (EMG) to design, construct, and startup an onsite pre-treatment system to convert a portion of the organic material in the wastewater stream generated by the Brewhouse to methane biogas for use for on-site electricity generation. Effluent from this system will be discharged to the Oneida county sewer system under a modified Industrial User (IU) permit. The onsite pre-treatment system would allow the Brewery to decrease external energy demand while significantly improving the Facility's environmental stewardship.

2.0 ADG SYSTEM DESCRIPTION

The waste stream generated by the Facility is directed to a five-unit Anaerobic Fluidized Bed Digestser (AFBD) system. Mechanical and electrical components associated with the AFBD system were installed inside a newly-constructed pump house that houses system pumps, piping, chemical controls, Programmable Logic Controller (PLC) unit, System Control And Data Acquisition (SCADA) unit, and the Genset unit. Each AFBD unit contains immobilized anaerobic bacteria that will breakdown the organic wastes and produce biogas. Biogas generated by the system is directed to biogas handling equipment prior to combustion in a 400-kW synchronous Genset. Electricity generated by the Genset (3-phase, 480 Volts, 60 Hz) will be used by the Brewery as part of its power usage for production operations. The switch gear used to transmit electricity from the Genset includes protective relays and controls to automatically supply the Facility with electricity without interrupting the power supply from the utility grid to the Brewery. In the event of a utility power outage, the switch gear will automatically prevent any export of electricity from the Genset to the power grid. Excess heat generated by the Genset will be used to maintain the temperature of the AFBD system between 90 ^{o}F and 100 ^{o}F. When the Genset is shut down for maintenance, biogas will be directed to a flare unit for combustion.

Physical, chemical, and biological parameters are monitored in the ADG-to-Electricity system to ensure proper operation and maintain compliance with the sought treatment goals. The pre-treatment system is equipped with multiple pressure, flow, pH, and temperature indicators. These instruments are connected to a Supervisory Control and Data Acquisition (SCADA) unit

to monitor and record the data for viewing and evaluation by the system operator. In addition, the system measures the biogas flow rate and the Genset Power Production. A summary of the primary components of the AFBD system at the Brewery is provided in Table 1 below. Figure 1 below provides a few photos showing the primary components of the AFBD system.

Table 1. Primary Components of the Biogas-to-Electricity Systems Installed at the Facility.

Digester	Anaerobic Fluidized Bed Digesters, Insulated, Totally Enclosed, heated
Wastestream	Brewery Wastewater, average flow 140,000 gpd
Engine-Generator	2g Agenitor 212. 400 ekW/h output on biogas 480 VAC, 3 phase, 60 Hz.
Biogas Conditioning	Moisture knockout Hydrogen Sulfide filter, Chiller
Engine Backup/Startup Fuel	Natural Gas
Heat Recovery Use	Digester heating, Pump-house heating
Additional Heat Recovery	None at this time.

Genset System

Biogas Conditioning Components

Digester System and Biogas Flare

Heat Distribution Manifold

Figure 1. Photos of the Primary Digester System Components.

Biogas from the digesters is continuously used by the Genset. As part of biogas conditioning prior to combustion by the Genset, biogas is de-humidified and filtered for hydrogen sulfide via equipment located on the biogas conditioning pad (outside of the pump house). If there is an emergency shutdown of the Genset (e.g., power outage) or during Genset maintenance shutdowns, biogas is automatically directed to the flare (with automatic ignition) for burning. A schematic of the AFBD biogas-to-electricity system is provided in Figure 2 below.

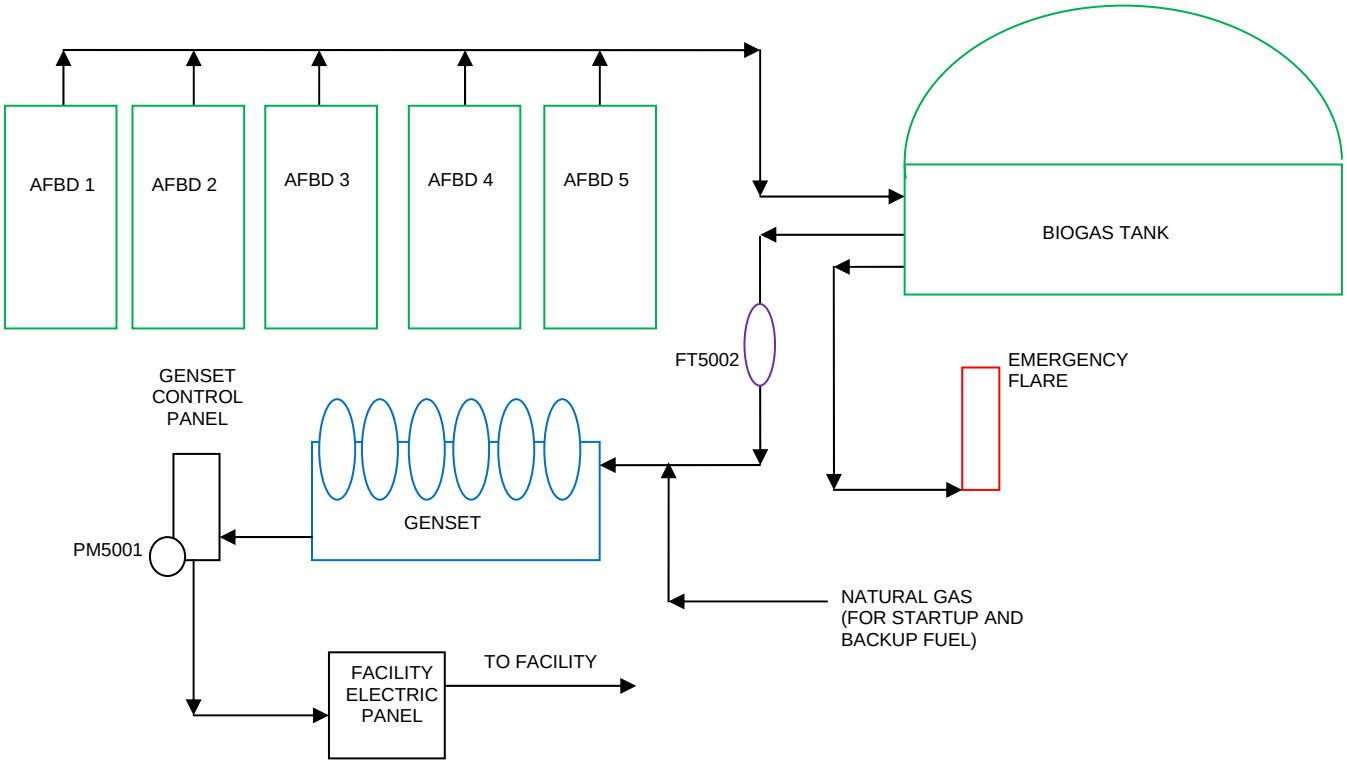

Figure 2. Schematic of AFBD Biogas to Electricity System.

3.0 MONITORING SYSTEM EQUIPMENT, INSTALLATION, OPERATION, AND MAINTENANCE

The locations of the two data monitoring points, FT5002 and PM5001, which are used to measure system performance are, shown in Figure 2. A biogas flow meter (**FT5002**) measures biogas input to the engine and a power meter (**PM5001**) measures the kilowatts generated by the Genset. The general properties of these two instruments is provided in Table 2 below. Additional information on these components is provided in Appendix A attached.

Table 2. General Properties of the Monitoring Instruments for the ADG System

Instrument Tag	Output	Description	Instrument	Engineering Units	Expected Range
PM5001	Pulse	Engine-Generator Power	DEIF Inc., Model GPU3 micro-processer, Class 1.0 Accuracy ±1%	kWh/interval	0-410 kW (0 - 9,840 kWh/day)
FT5002	4-20 mA	Digester Biogas Flow	FCI, LLC., Thermal Mass Flow Meter, Model ST-51, Accuracy ±2%	ft^3/interval	0 – 250 ft^3/min (0 - 360,000 ft^3/day)

The electrical output of the Genset is measured with a DEIF, Inc., GPU-3 micro-processer unit with pulse-output (**PM5001**). The GPU-3 is a compact microprocessor-based protection unit containing all necessary functions for protection of a synchronous/asynchronous generator. It contains all necessary galvanically separated 3-phase measuring circuits. This component counts the kW produced and totals it using impulse signals multiple times every second. This unit sends the information to the engine PLC where it is also displayed on the front of the panel. The GPU-3 unit is installed according to requirements of the manufacturer's Installation and Operation Manual (see Appendix A).

The biogas flow to the Genset system is measured by a Fluid Components International, LLC (FCI) thermal mass flow meter (**FT5002**). This meter provides 4-20mA output proportional to the biogas flow with temperature compensation between 0 ^oF and 250 ^oF. The FCI meter is installed in the horizontal biogas pipe between the biogas tank and the Genset system in accordance with the provisions of FCI's “ST51 Mass Flow Meter Installation and Operation Guide” provided in Appendix A.

The FT5002 unit is expected to require minimal maintenance because of its location in the process as well as the unit's simplified design. The unit is installed in a low traffic area, which mitigates the potential of harmful physical contact. FT5002 is designed with no moving or mechanical parts that are subject to wear and tear, and the sensor assembly is composed of type 316 stainless steel and Hastelloy C to prevent corrosive damage. If maintenance is required, FT5002 can be easily removed for cleaning and quickly re-installed with minimal or no interruption to engine operation. The system operator will also inspect the unit monthly for loose wiring or leaks. A log of any maintenance activities for the meter will be kept in the digester system logbook.

Based on past measurements of the CO_2 content, the lower heating value for the biogas stream is estimated to be 600 Btu/ft^3. This value will be verified weekly based on measurements of the biogas carbon dioxide content using a Fyrite Gas Analyzer Model No. 10-5032 for CO_2 (range 0-60%). The system operator will perform the CO_2 content analysis and record the results in the digester system logbook.

The backup/startup fuel at the Brewery is natural gas. The Brewery will maintain a daily log of natural gas usage at the Digester building and summarize it in a spreadsheet table for the Annual Performance Report in order to account for periods when the backup/startup fuel is used. The natural gas service to the digester building also fuels a space heater that controls

the ambient temperate in the digester equipment building during the winter months. Because the equipment building will also be heated by engine radiant heat and the digester piping, pump motors, etc., natural gas usage by the space heater is expected to be minimal relative to usage by the Genset. Thus, it will be assumed that all the natural gas usage at the digester building will be due to consumption by the Genset.

The biogas flow meter (FT5002) and the engine power monitor (PM5001) are monitored by the digester PLC and the engine PLC units, respectively. The PLC units are located in the control room in the digester equipment building. The Brewery will be responsible for the cost to purchase and install of any additional equipment, meters, or data loggers needed to collect and transmit the data or information required by NYS ERDA.

Once per day, the digester SCADA unit will e-mail the NYS ERDA Combined Heat and Power (CHP) Website Contractor (CDH Energy Corp.) a file that contains the daily biogas volume and the daily kWh generated by the system. CDH will use this file to upload these values to the NYS ERDA CHP Website. If communications are lost, the SCADA will store the last information collected, which will be available upon request. The SCADA will store the data for up to 60 days.

4.0 MANAGEMENT OF MONITORING SYSTEM DATA (BREWERY RESPONSIBILITIES)

The Brewery will perform the following quality assurance and quality control measures to ensure the data produced from the SCADA system accurately describe system performance:

1) On a daily basis, the digester system operator/manager (or other specified employee) will perform inspections of the digester and engine-generator equipment and record findings into the digester system logbook.

2) On a weekly basis, the digester system operator/manager will perform inspections of the QA/QC meters and complete the routine maintenance, noting any unusual or unexpected readings. The Brewery will also maintain a weekly log of the cumulative power generation (kWh) and biogas flow (standard cubic feet (SCF)) in the event that data transfer to the NYS ERDA CHP Website fails or other anomalies occur.

3) On a monthly basis, the Brewery staff will review the data available on the NYS ERDA CHP Website (chp.nyserda.org) to ensure it is consistent with their observed performance of the ADG system and logged readings. The Brewery will review the data using the reporting features at the website, including:

   - Monitored Data – Plots and Graphs and
   - RPS: Customer-Sited Tier Anaerobic Digester Gas-to-Electricity Program NYS ERDA Incentive Program Reports

4) Finally, the Brewery staff will also setup and use the email reports that are available at the CHP Website to help track the system performance, including:

- a periodic email report summarizing system performance and the estimated incentive,
- an email report if the digester system data are not received at the CHP website or do not pass the quality checks

The CHP website will automatically take the data collected from the digester SCADA system and evaluate the quality of the data for each interval using range and relational checks. The expected ranges for the sensors (see Table 2 herein) will be used for the range checks. The relational check will compare the kWh production data and biogas production data for each interval to ensure both meters always provide non-zero readings at the same time (i.e., to detect if a meter has failed). Only data that pass the range and relational quality checks are used in the incentive reports listed above. However, all data are available from the NYS ERDA CHP Website using the "Download (CSV file)" reporting option.

In the event of a communications or meter failure, the Brewery will work with CDH to resolve the issue as quickly as possible.

If unanticipated loss of data occurs when the Genset continues to produce electricity, the Brewery will follow the procedures outlined in Exhibit D of the RPS agreement, which calls for using data from similar periods – either just before or after the outage – to replace the lost data. The Brewery understands that it can use this approach for up to two 36-hour periods within each 12-month performance reporting period. If more than two such data outages occur, the Brewery will provide information from other acceptable data sources (e.g., weekly recorded logs, engine or digester PLC totalizers) to definitively determine the amount of power that was produced from the biogas stream during the period in question.

5.0 ANNUAL PERFORMANCE REPORTS

The Brewery will prepare an Annual Performance Report summarizing the monthly data over the previous 12-month performance period. This report will include a table showing the monthly kWh production, biogas used by the engine, and other data listed in Table 3 below. The Brewery may use the NYS ERDA Incentive Program Reports found on the CHP website. Alternatively, the Brewery may provide its own summary of the data (using CSV data downloaded from the Website) along with a narrative justifying why its data and calculations are more appropriate. The methods for calculating these values are provided below.

Table 3. Summary of Monthly Data for Annual Performance Report

Start Date of Reporting Period	No. of Days in Each Period	Electricity Production, $kWh_{generator}$	Biogas Used by Engine (cubic feet)	LHV_{biogas} (Btu/cf)	Natural Gas Used by Engine (cubic feet)	Biogas Energy Content, Q_{biogas} (Btu)	Natural Gas Energy Content, Q_{NG} (Btu)	Adjusted Electricity Production from Biogas $kWh_{adjusted}$
TOTAL								

The Brewery will calculate monthly values for lower heating value of the biogas (LHV_{biogas}), total energy content of the biogas (Q_{biogas}), total energy content of the natural gas (Q_{NG}), and adjusted kWh production ($kWh_{adjusted}$) as follows:

1) MONTHLY BIOGAS LOWER HEATING VALUE

The readings of CO_2 concentration in the biogas gathered weekly will be used to estimate the average monthly Biogas Lower Heating Value (LHV_{biogas}) using the following equation:

$$LHV_{biogas} = LHV_{methane} \cdot (1 - F_{CO_2})$$

where:

$LHV_{methane}$ is the lower heating value of methane
(910 Btu/ft^3 at standard conditions, 60 °F and 1 atm)

F_{CO2} is the fraction of biogas that is CO_2 (average of readings for each month)

2) MONTHLY BIOGAS ENERGY CONTENT

The average monthly Biogas Energy Content will be calculated using the following equation:

$$Q_{biogas} = CF \cdot LHV_{biogas}$$

where:

CF is the volume (cubic feet or ft^3) of biogas generated per month

3) MONTHLY NATURAL GAS ENERGY CONTENT

The average monthly Natural Gas Energy Content will be calculated using the following equation:

$$Q_{NG} = V_{NG} \cdot \left[930 \frac{Btu}{ft^3} \right]$$

where:

V_{NG} is the Volume of Natural Gas consumed in the period (ft^3)

4) MONTHLY ADJUSTED ELECTRICITY PRODUCTION

The monthly adjusted electricity production will be calculated using the following equation:

$$kWh_{adjusted} = kWh_{generator} \left[\frac{Q_{biogas}}{Q_{biogas} + Q_{NG}} \right]$$

where:

$kWh_{generator}$ is the actual electricity production

In some cases, natural gas data may not be available on a monthly basis (for example, once pr quarter). For such an event, the calculations to determine the adjusted electric production using Q_{NG} will be completed at the smallest possible interval (not to exceed 12 months).

Reasonable Electrical Efficiency

The Annual Performance Report will also provide a comparison of power output and fuel input for the engine to confirm their reasonableness. For instance:

$$\text{Electrical efficiency} = \frac{\text{Power Output } (kWh_{generator})}{\text{Total Input Fuel Energy Content } (Q_{biogas} + Q_{NG})}$$

The calculated electrical efficiency value should be approximately 25% over any interval for the Genset operation at the Brewery.

APPENDICES

APPENDIX A

CUT SHEETS AND MANUALS FOR THE POWER METER UNIT PM5001 MODEL GPU-3, DEIF, INC.

DEIF A/S

Type Certificate

4124030048C / ref. SKG

Type:	GPU – Generator Protection Unit GPU-3 – Generator Protection Unit GPU-3 REC – Grid Protection Unit Multi-line 2

Technical specifications		
*	Measuring Voltage:	100/110V AC to 690V AC +-20% Consumption max. 0,2VA / phase
*	Measuring. Current:	-/1 or -/5A AC Consumption max. 0,3VA / phase
*	Measuring frequency:	30….70Hz
*	Auxiliary supply GPU GPU-3	 Terminal 1-2 12/24V DC -25/+30% max. 11W consumption Terminal 1-2 12/24V DC -25/+50% max.11W consumption Terminal 98-99 12/24V DC -25/+50% max. 5W consumption
*	Binary input: GPU GPU-3	Optocoupler, bi-directional Impedance: 4.7kΩ Input voltage 8….32V DC Input voltage 8….36V DC
*	Relay outputs:	250V AC / 30V DC, 5A (Unit status output: 1A)
*	Open collector outputs: GPU GPU-3	 Supply 12…32V DC, max. 10mA Supply 8…36V DC, max. 10mA
*	Analogue inputs: GPU GPU-3	 -10….0….+10V DC, Impedance min. 90 kΩ Not galvanically separated 0…20mA, ±1%, Impedance: 50Ω PT100/1000: -40…250°C, ±1% to IEC/EN 60751 VDO: 0…1700Ω, ±2% 0…40V DC, ±1% Not galvanically separated
*	Galvanic separation:	Between AC voltage, AC current and other I/O's: 3250 V AC, 50Hz, 1 minute Between analogue outputs and other I/O's: 500V DC, 1 minute Between binary input groups and other I/O's: 500V DC, 1 minute
	Current overload:	4 x I_n continuously 20 x I_n, 10 sec. (max 75A) 80 x I_n, 1 sec. (max 300A)

DEIF A/S
Frisenborgvej 33, DK-7800 Skive, Denmark
*Tel: (+45) 96149614 * Fax: (+45) 96149615*
Further information:URL:http//www.deif.com

DEIF A/S

Type Certificate

4124030048C / ref. SKG

Type test specifications		*Tested according to:*
Temperature:	-25….70°C (operating) -40….70°C (storage)	IEC 60068-2-1 IEC 60068-2-2
Accuracy:	Class 1.0 Class 0.5 (option dependent in GPU-3)	IEC 60688
Climate:	97% RH	IEC 60068-2-30, test Db
Vibration:	3…13.2Hz: 2mm$_{pp}$ 13.2…100Hz: 0.7g 10…60Hz: 0.15mm$_{pp}$ 60…150Hz: 1g 10…150Hz: 2g	IEC 60068-2-6 & IACS UR E10 IEC 60255-21-1 Response (Class2) IEC 60255-21-1 Endurance (Class2)
Shock:	Base mounted 10g, 11msec. half sine 30g, 11msec. half sine 50g, 11msec. half sine Tested with 3 impacts in each direction in all 3 axes. Total 18 impacts per test.	 IEC 60255-21-2 Response (Class 2) IEC 60255-21-2 Endurance (Class 2) IEC 60068-2-27, test Ea
Bump	20g, 16msec. half sine Tested with 1000 impacts in each direction in all 3 axes.	IEC 60255-21-2 (Class 2)
Safety:	Installation Cat.III 600V Pollution degree 2	EN 61010-1
EMC:		EN 61000-6-1/2/3/4 IEC 60255-26 IEC 60533 power distr. zone IACS UR E10 power distr. zone
Materials:	All plastic parts are self-extinguishing to UL94 (V0)	
Protection:	Unit: IP20 Front: IP52 (IP54 with gasket – option L)	IEC/EN 60529

*) Tested on all units according to specifications. Remaining specifications are tested regularly by test sampling

5th Marts 2012
DEIF A/S

Martin S. Mallan
Type Approval Manager

DEIF A/S
Frisenborgvej 33, DK-7800 Skive, Denmark
*Tel: (+45) 96149614 * Fax: (+45) 96149615*
Further information:URL:http//www.deif.com

Generator Protection Unit, GPU-3
DATA SHEET



Generator Protection (ANSI)

- 2 x reverse power (32)
- 5 x overload (32)
- 6 x overcurrent (50/51)
- 2 x overvoltage (59)
- 3 x undervoltage (27)
- 3 x over-/underfrequency (81)
- Voltage dependent overcurrent (51V)
- Current/voltage unbalance (60)
- Loss of excitation/overexcitation (40/32RV)
- 9 x NEL groups

Busbar protection (ANSI)

- 3 x overvoltage (59)
- 4 x undervoltage (27)
- 3 x overfrequency (81)
- 4 x underfrequency (81)
- Voltage unbalance
- 3 x NEL groups

M-logic (Micro PLC)

- Simple logic configuration tool
- Selectable input/output events

Display

- Status texts
- Info messages
- Alarm indication
- Prepared for remote mounting
- Prepared for additional remote displays

General

- USB interface to PC
- Free PC utility software for commissioning
- Programmable parameter, timer and alarms
- User-configurable texts

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info@deif.com · www.deif.com

Document no.: 4921240352B
SW version: 3.0x.x or later

Application
The Generator Protection Unit (GPU-3) is a compact microprocessor-based protection unit containing all necessary functions for protection of a synchronous/ asynchronous generator. It contains all necessary galvanically separated 3-phase measuring circuits.

The GPU-3 is intended for land- and marine-based applications. It is well-suited for PLC-controlled systems, and the interfacing can be done via binary and analogue I/Os or via serial communication.

Display unit
The display unit is separate and can be installed directly on the main unit or in the front of the switchboard door (3m display cable included). Up to 2 additional displays can be installed within 200m.

The display unit shows all measured and calculated values as well as alarms and data from the event log.

Self-test
The GPU-3 automatically carries out a cyclical self-test at start-up. If any errors are found, they will be displayed in clear text in the display and indicated with a relay output (status output).

M-logic (Micro PLC)
This configuration tool is part of the PC utility software which is free of charge. With this tool, it is possible to customise the application to your needs. It is possible to dedicate specific functions or logical conditions to different inputs and outputs.

Setup
Setup is easily done via a menu structure in the display (password-protected) or via the USB PC connection and the Multi-line 2 Windows®-based PC utility software. The PC utility software can be downloaded free of charge from www.deif.com/Download_centre. The utility software offers additional features such as monitoring of all relevant information during commissioning, saving and downloading of settings and downloading of software updates.

Synchronisation
As an option, the GPU-3 can perform synchronisation of the generator. After closing of the breaker the regulation is switched OFF, and the GPU-3 will carry out all necessary protective functions.

Engine control and protection
With the engine control and protection option added, the GPU-3 will control the start and stop sequences of the engine and furthermore it can be used as engine protection unit providing full back-up of engine shutdown channels in case the main processor fails.

The option includes an engine interface I/O card with separate power supply and processor. The card is equipped with the following I/Os:

In-/outputs		Available
Multi-inputs (with wire-break)	4-20mA Digital input PT100 PT1000 VDO 0-40V DC	3 (3)
Digital inputs		7 (6)
MPU input w/wirebreak		1
Start prepare relay		1
Starter relay		1
Run coil		1
Stop coil w/wirebreak		1
CANbus comm.		2

The number in parenthesis indicates the number of user configurable in-/outputs.

The CANbus communication is for option H7 only.

Options
In order to perfectly match the product solution to specific applications, the functionality of the GPU-3 can be equipped with a number of available options. The options selected by the customer will be integrated in the standard GPU-3, hereby securing the same user interface unaffected by whether the application needs a highly complex or a more basic gen-set controller.

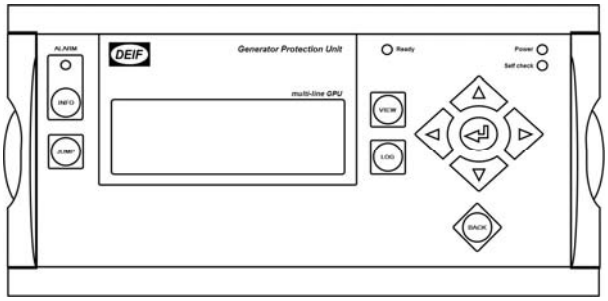
Please refer to pages 5 and 6 for the options available.

Approvals
The GPU-3 is marine approved by all major classification societies and is UL/cUL listed.

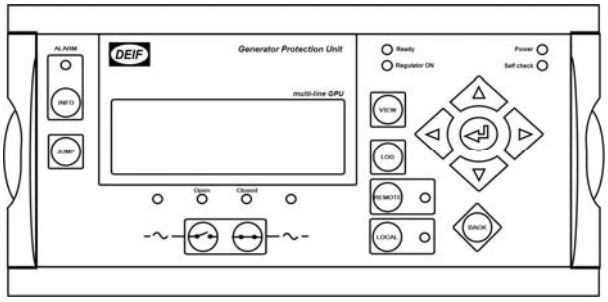
Please refer to www.deif.com for details and certificates.

Display layouts

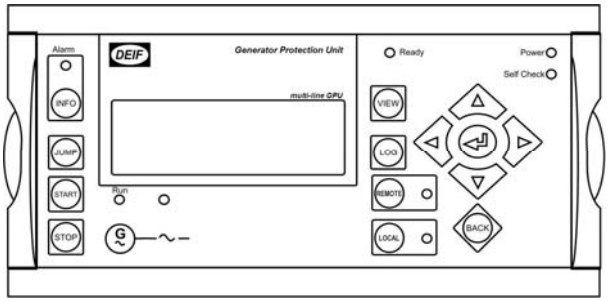
Standard delivery



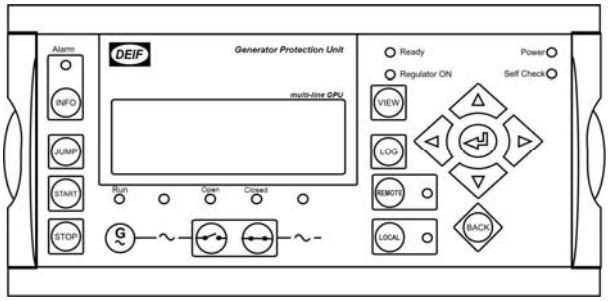
GB control
(option Y5)



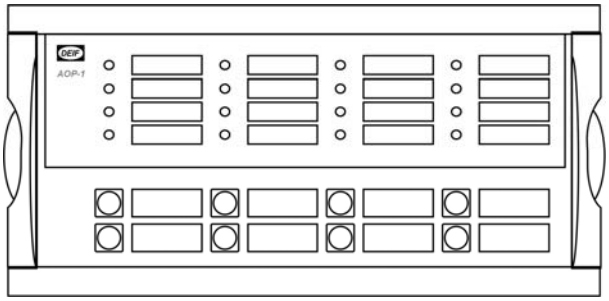
Engine control
(option Y7)



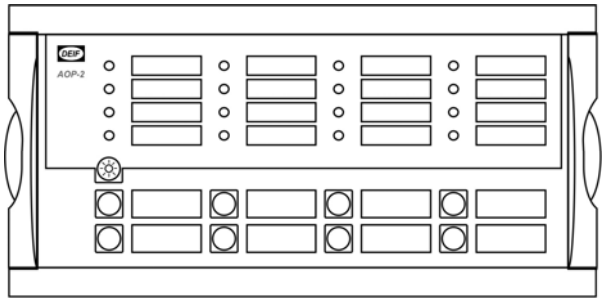
Engine and GB control
(option Y1)



Additional operator's panel - AOP-1 (option X3)

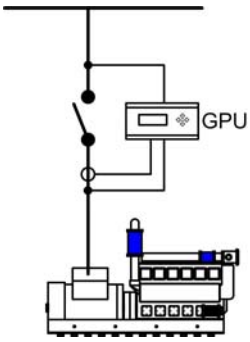


Additional operator's panel - AOP-2 (option X4)

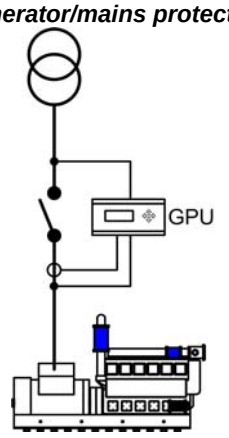


Application examples

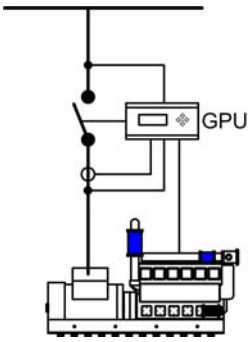
Generator protection



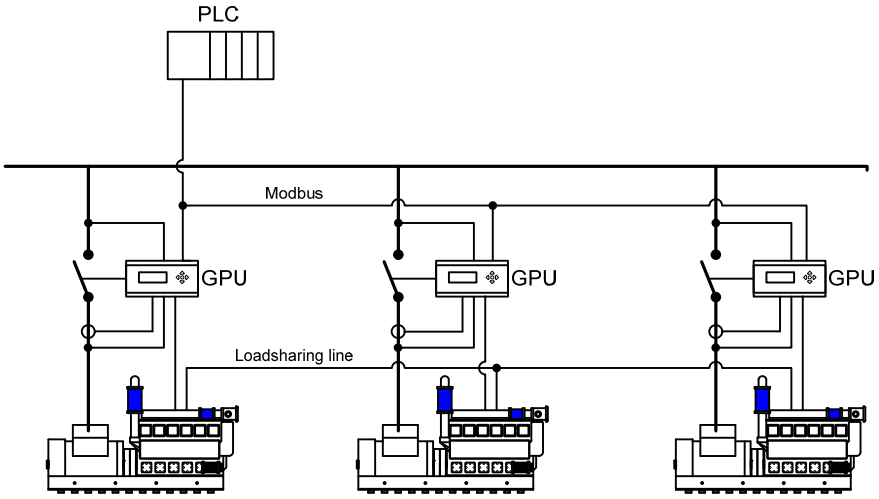
Generator/mains protection



Generator protection and synchronisation



PLC-controlled system



The GPU-3 can be used in simple or complex applications. The above shows very simple applications only, but due to the flexibility, the GPU-3 can be used in all types of applications.

Available options

Option	Description	Slot no.	Option type	Note
A	**Mains protection package**			
A1	Time-dependent undervoltage **(27t)** Undervoltage and reactive power low **(27Q)** Vector jump **(78)** df/dt (ROCOF) **(81)**		Software	
A4	Positive sequence (mains voltage low) **(27)**		Software	
A5	Directional overcurrent **(67)**		Software	
C	**Generator add-on protection package**			
C2	Negative sequence voltage high **(47)** Negative sequence current high **(46)** Zero sequence voltage high **(59)** Zero sequence current high **(50)** Power dependent reactive power import/export **(40)** Inverse time overcurrent **(51)**		Software	
D	**Voltage control**			
D1	Voltage control		Software	Requires G2
E and F	**Analogue controller and transducer outputs**			
E1	2 x +/-25mA *(GOV/AVR or transducer)*	4	Hardware	Not with E2, EF2, EF4, EF5 or M14.4 AVR output requires D1
E2	2 x 0(4)...20mA *(GOV/AVR or transducer)*	4	Hardware	Not with E1, EF2, EF4, EF5 or M14.4 AVR output requires D1
EF2	1 x +/-25mA *(GOV/AVR or transducer)* 1 x 0(4)...20mA *(GOV/AVR or transducer)*	4	Hardware	Not with E1, E2, EF4, EF5 or M14.4 AVR output requires D1
EF4	1 x +/-25mA *(GOV/AVR or transducer)* 2 x relay outputs *(GOV/AVR or configurable)*	4	Hardware	Not with E1, E2, EF2, EF5 or M14.4 AVR output requires D1
EF5	1 x PWM (Pulse Width Modulated) output for CAT GOV 1 x +/-25mA *(GOV/AVR or transducer)* 2 x relay outputs *(GOV/AVR or configurable)*	4	Hardware	Not with E1, E2, EF2, EF4 or M14.4 AVR output requires D1
F1	2 x 0(4)...20mA *(transducer)*	6	Hardware	Not with M13.6, M14.6 or M15.6
G	**Synchronisation**			
G2	Synchronisation *(GOV/AVR control)*		Software	Outputs for regulation are not included AVR control requires D1
H	**Serial communication**			
H2	Modbus RTU/ASCII (RS485)	2	Hardware	Not with H3, H8.2 or H9.2
H3	Profibus DP	2	Hardware	Not with H2, H8.2 or H9.2
H5	Engine comm.: MTU (ADEC/MDEC) and CANbus J1939 (H7)	8	Hardware	Not with H7, H8.8, M13.8, M14.8 or M15.8
H6	Cummins GCS	8	Hardware	Not with H5, H7, H8.8, M13.8, M14.8 or M15.8
H7	CANbus (J1939): Caterpillar / Perkins Cummins CM850/570 / Scania (EMS) Detroit Diesel (DDEC) / Scania (EMS S6) Deutz (EMR) / Volvo Penta (EMS) Iveco (NEF/CURSOR) / Volvo (EMS2) John Deere (JDEC)	7	Software	Requires M4 Not with H5
H8.X	External I/O modules	2, 8	Hardware	**H8.2:** Not with H2, H3, H8.8 or H9.2 **H8.8:** Not with H5, H6, H8.2, M13.8, M14.8 or M15.8
H9.2	Modbus RTU/ASCII (RS232) and GSM modem connection	2	Hardware	Not with H2, H3 or H8.2

(ANSI# as per IEEE Std. C37.2-1996 (R2001) in parenthesis).

Option	Description	Slot no.	Option type	Note
J	**Cables**			**One 3m display cable per GPU-3 unit is included as standard**
J2	Display cable with plugs, 6m UL94 (V1) approved		Other	Not with J6 Will replace the std. display cable
J4	PC cable for option N-programming UL94 (Ethernet cable crossed), 3m UL94 (V1) Listed		Other	
J6	Display cable with plugs, 1m UL94 (V1) approved		Other	Not with J2 Will replace the std. display cable
J7	PC cable for utility software (USB) 3m UL94 (V1) approved		Other	
K	**Documentation**			
K1	Designer's Reference Handbook (hard copy)		Other	
K2	CD-ROM with complete documentation		Other	
L	**Display gasket for IP54**		Other	Standard is IP52
M	**Engine control, digital and analogue I/Os**			
M4	Engine control and protection (safety system) OR I/O extension	7	Hardware	
M12	13 binary inputs, configurable 4 relay outputs, configurable	3	Hardware	
M13.X	7 binary inputs, configurable	6, 8	Hardware	**M13.6:** Not with F1, M14.6 or M15.6 **M13.8:** Not with H5, H6, H8.8, M14.8 or M15.8
M14.X	4 relay outputs, configurable	4, 6, 8	Hardware	**M14.4:** Not with E1, E2, EF2, EF4 and EF5 **M14.6:** Not with F1, M13.6 or M15.6 **M14.8:** Not with H5, H6, H8.8, M13.8 or M15.8
M15.X	4 analogue inputs, configurable, 4...20mA	6, 8	Hardware	**M15.6:** Not with F1, M13.6 or M14.6 **M15.8:** Not with H5, H6, H8.8, M13.8 or M14.8
N	**Ethernet TCP/IP communication**			
N	Ethernet TCP/IP Modbus comm. and alarms via SMS or e-mail		Hardware/ software	
Q	**Measurement accuracy**			
Q1	Verified class 0.5		Other	
X	**Display**			**One display per GPU-3 unit is included as standard**
X2	Additional standard display. CANbus comm.		Other	Two X2 options can be ordered for each GPU unit
X3	Additional operator's panel (AOP-1): 16 configurable LEDs and 8 configurable push-buttons		Other	Max. one AOP-1 for each display unit
X4	Additional operator's panel (AOP-2): 16 configurable LEDs, 8 configurable buttons and 1 status relay. CANbus comm.		Other	Five X4 options can be ordered for each GPU unit
Y	**Display layout**			
Y1	Engine and GB control		Other	Requires G2 and M4
Y5	GB control		Other	Requires G2
Y7	Engine control		Other	Requires M4

Please notice that not all options can be selected for the same unit. Please refer to page 7 in this data sheet for further information about the location of the HW options in the unit.

Hardware overview

Slot #4, term. 65-72
GOV/AVR/transducer output

M14.4:	4 x relay outputs
E1:	2 x +/-20mA out
E2:	2 x 0(4)…20mA out
EF2:	1 x +/-20mA out 1 x 0(4)…20mA out
EF4:	1 x +/-20mA out 2 x relay
EF5:	1 x PWM output 1 x +/-20mA out 2 x relay

Slot #2, term. 29-36
Communication

H2:	Modbus RTU (RS485)
H3:	Profibus DP
H8.2:	Ext. I/O modules
H9.2:	Modbus RTU/ASCII (RS232)

Slot #1, term. 1-28 (std.)
Power supply

8-36V DC supply, 11W
1 x status output relay
5 x relay outputs
2 x pulse outputs (kWh, kVArh)
5 x digital inputs

Slot #3, term. 37-64
In-/outputs

M12:	13 x digital inputs 4 x relay outputs

Ethernet

N:	TCP/IP Modbus comm. and alarm via SMS or e-mail

Slot #6, term. 90-97
In-/outputs

F1:	2 x 0(4)…20mA out
M13.6:	7 x digital inputs
M14.6:	4 x relay outputs
M15.6:	4 x 4…20mA inputs

Slot #8, term. 126-133
Engine comm., in-/outputs

H5:	MTU (MDEC) + J1939
H6:	Cummins GCS
H8.8:	Ext. I/O modules
M13.8:	7 x digital inputs
M14.8:	4 x relay outputs
M15.8:	4 x 4-20 mA input

Slot #7, term. 98-125
Engine I/F

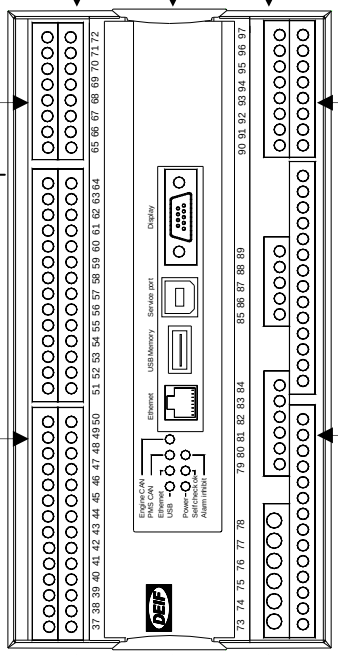
M4:	8-36V DC supply, 5W 1 x magnetic pick-up (MPU) 3 x multi-inputs 7 x digital inputs, configurable 4 x relay outputs
H7:	CANbus J1939 (requires M4)

Slot #5, term. 73-89 (std.)
AC measuring

3 x generator voltage
3 x generator current
3 x busbar/mains voltage

LED & I/F (std.)

Display connection
Service port (USB)
Power LED
Self check LED
Alarm inhibit LED



There can only be one hardware option in each slot. It is e.g. not possible to select option H2 and option H3 at the same time, because both options require a PCB in slot #2.

Besides the hardware options shown on this page, it is possible to select the software options mentioned in the chapter 'Available options'.

Technical specifications

Accuracy: Class 1.0

Positive, negative and zero sequence alarms:
Class 1 within 5% voltage unbalance

Class 1.0 for negative sequence current

Fast overcurrent:
3% of 350%*In

Analogue outputs:
Class 1.0 according to total range

Option EF4:
Class 4.0 according to total range

To IEC/EN 60688

Operating temp.: -25…70°C (-13...158° F)
(UL/cUL Listed: Max. surrounding air temp.: 55°C/131°F)

Storage temp.: -40…70°C (-40...158° F)

Climate: 97% RH to IEC 60068-2-30

Meas. voltage: 100-690V AC +/-20%
(UL/cUL Listed: 480V AC phase-phase)

Consumption: Max. 0.25VA/phase

Meas. current: -/1 or -/5A AC
(UL/cUL Listed: From CTs 1-5A)

Consumption: Max. 0.3VA/phase

Current overload: 4 x I_n continuously
20 x I_n, 10 sec. (max. 75A)
80 x I_n, 1 sec. (max. 300A)

Meas. frequency: 30…70Hz

Aux. supply: Terminals 1 and 2:
12/24V DC (8...36V continuously, 6V 1 sec.)
Max. 11W consumption

Terminals 98 and 99:
12/24V DC (8...36V continuously, 6V 1 sec.)
Max. 5W consumption

The aux. supply inputs are to be protected by a 2A slow-blow fuse

(UL/cUL Listed: AWG 24)

Binary inputs: Optocoupler, bi-directional
ON: 8…36V DC
Impedance: 4.7kΩ
OFF: <2V DC

Analogue inputs: 0(4)…20mA

Impedance: 50Ω
Not galvanically separated

RPM (MPU): 2…70V AC,
10…10000Hz, 250…3000Ω

Multi-inputs: 0(4)…20mA:
0-20mA, +/-1%
Not galvanically separated

Binary:
Max. resistance for ON detection: 100Ω
Not galvanically separated

PT100/1000:
-40…250°C, +/-1%
Not galvanically separated
To IEC/EN 60751

VDO:
0…1700Ω, +/-2%
Not galvanically separated

V DC:
0…40V DC, +/-1%
Not galvanically separated

Relay outputs: Electrical rating:
250V AC/30V DC, 5A
(UL/cUL Listed: 250V AC/24V DC, 2A resistive load)

Thermal rating @ 50°C:
2A: Continuously
4A: t_{ON} = 5 sec., t_{OFF} = 15 sec.

(Unit status output: 1A)

Open collector outputs: Supply: 8…36V DC, max. 10mA

Analogue outputs: 0(4)...20mA and +/-25mA
Galvanically separated
Active output (internal supply)
Load max. 500Ω
(UL/cUL Listed: Max. 20mA output)

Update rate:
Transducer output: 250ms
Regulator output: 100ms

Galv. separation:

Between AC voltage, AC current and other I/Os:
3250V AC, 50Hz, 1 min.

Between analogue outputs and other I/Os:
500V DC, 1 min.

Between binary input groups and other I/Os:
500V DC, 1 min.

Response times:
(Delay set to minimum)

Busbar:

Over-/undervoltage:	< 50ms
Over-/underfrequency:	< 50ms
Voltage unbalance:	<200ms

Generator:

Reverse power:	<200ms
Overcurrent:	<200ms
Fast overcurrent:	< 40ms
Over-/undervoltage:	<200ms
Over-/underfrequency:	<300ms
Overload:	<200ms
Current unbalance:	<200ms
Voltage unbalance:	<200ms
React. power import:	<200ms
React. power export:	<200ms
Overspeed:	<400ms
Digital inputs:	<250ms
Emergency stop:	<200ms
Multi-inputs:	<800ms
Wire failure:	<600ms

Mains:

df/dt (ROCOF):	<130ms (4 periods)
Vector jump:	< 40ms
Positive sequence:	< 60ms

Mounting:

DIN-rail mount or base mount with 6 screws

Safety:

To EN 61010-1, installation category (overvoltage category) III, 600V, pollution degree 2

To UL 508 and CSA 22.2 no. 14-05, overvoltage category III, 300V, pollution degree 2

EMC/CE:

To EN 61000-6-1/2/3/4
IEC 60255-26
IEC 60533 power distr. zone
IACS UR E10 power distr. zone

Vibration:

3…13.2Hz: 2mm$_{pp}$
13.2…100Hz: 0.7g
To IEC 60068-2-6 & IACS UR E10

10…60Hz: 0.15mm$_{pp}$
60…150Hz: 1g
To IEC 60255-21-1 Response (class 2)

10…150Hz: 2g
To IEC 60255-21-1 Endurance (class 2)

Shock (base mount):

10g, 11msec, half sine
To IEC 60255-21-2 Response (class 2)

30g, 11msec, half sine
To IEC 60255-21-2 Endurance (class 2)

50g, 11msec, half sine
To IEC 60068-2-27

Bump:

20g, 16msec, half sine
To IEC 60255-21-2 (class 2)

Material:

All plastic materials are self-extinguishing according to UL94 (V1)

Plug connections:

AC current:
0.2-4.0 mm^2 stranded wire
(UL/cUL Listed: AWG 18)

AC voltage:
0.2-2.5 mm^2 stranded wire
(UL/cUL Listed: AWG 20)

Relays:
(UL/cUL Listed: AWG 22)

Terminals 98-116:
0.2-1.5 mm^2 stranded wire
(UL/cUL Listed: AWG 24)

Other:
0.2-2.5 mm^2 stranded wire
(UL/cUL Listed: AWG 24)

Display:
9-pole sub-D female

Service port:
USB A-B

Protection:

Unit: IP20
Display: IP52 (IP54 with gasket: Option L)
(UL/cUL Listed: Type Complete Device, Open Type)

To IEC/EN 60529

Governors:

Multi-line 2 interfaces to all governors, including GAC, Barber-Colman, Woodward and Cummins

See interfacing guide at www.deif.com

Approvals: Marine approved by all major classification societies
UL/cUL Listed to UL508

UL markings: Wiring:
Use 60/75°C copper conductors only

Mounting:
For use on a flat surface of type 1 enclosure

Installation:
To be installed in accordance with the NEC (US) or the CEC (Canada)

AOP-2: Maximum ambient temperature:
60°C

Wiring:
Use 60/75°C copper conductors only

Mounting:
For use on a flat surface of type 3 (IP54) enclosure
Main disconnect must be provided by installer

Installation:
To be installed in accordance with the NEC (US) or the CEC (Canada)

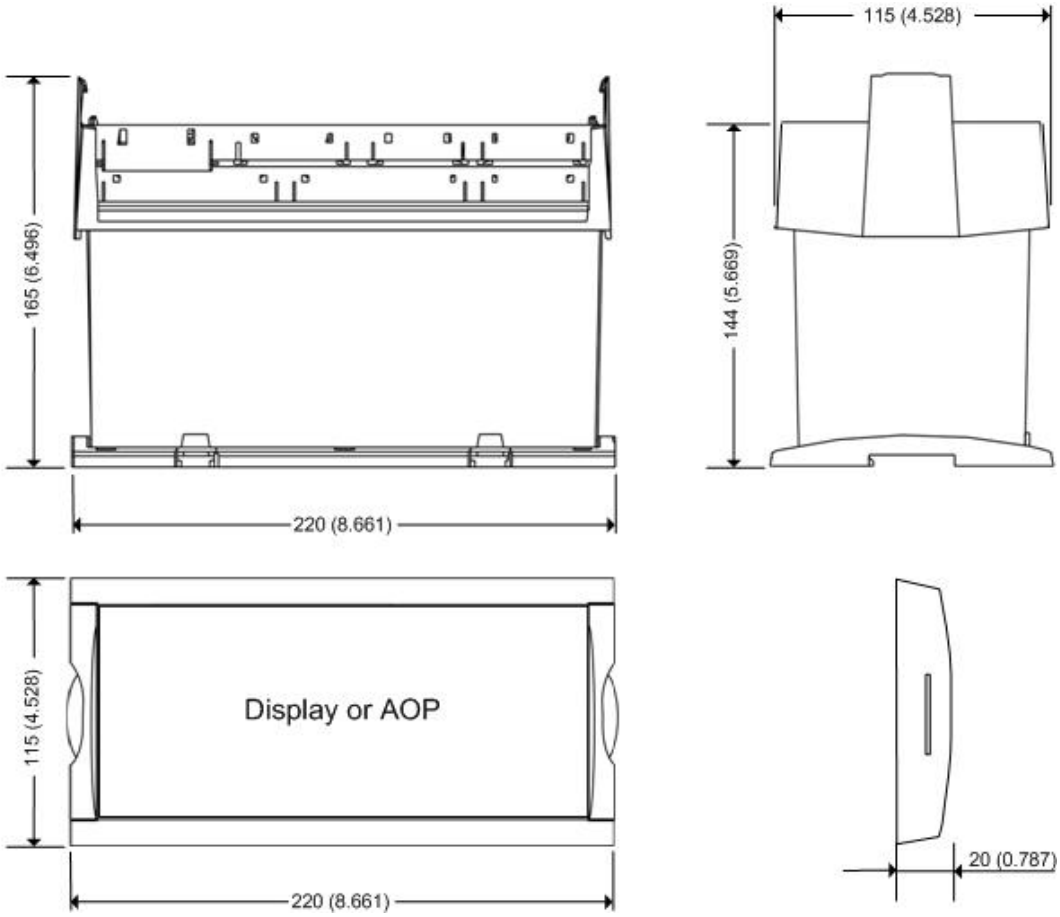
DC/DC converter for AOP-2:

Tightening torque:	0.5Nm (4.4lb-in)
Wire size:	AWG 22-14

Weight:

Base unit:	1.6 kg (3.5 lbs.)
Option J1/J3/J6:	0.2 kg (0.4 lbs.)
Option J2:	0.4 kg (0.9 lbs.)
Display:	0.4 kg (0.9 lbs.)

Unit dimensions in mm (inches)



Order specifications

Type	Version	Option	Option	Option	Option	Displays
GPU						

Example:

Type	Version	Option	Option	Option	Option	Displays
GPU	3	C2	H2	M13.6		213

Displays: 213

- Total number of displays:
  1: 1 std. display (always included)
  2: 1 std. + 1 add. display (option X2)
  3: 1 std. + 2 add. displays (option X2)
- Total number of AOP-1 (Option X3)
- Total number of AOP-2 (Option X4)

Due to our continuous development we reserve the right to supply equipment which may vary from the described.

***DEIF A/S**, Frisenborgvej 33*
DK-7800 Skive, Denmark

Tel.: +45 9614 9614, Fax: +45 9614 9615
E-mail: deif@deif.com, URL: www.deif.com

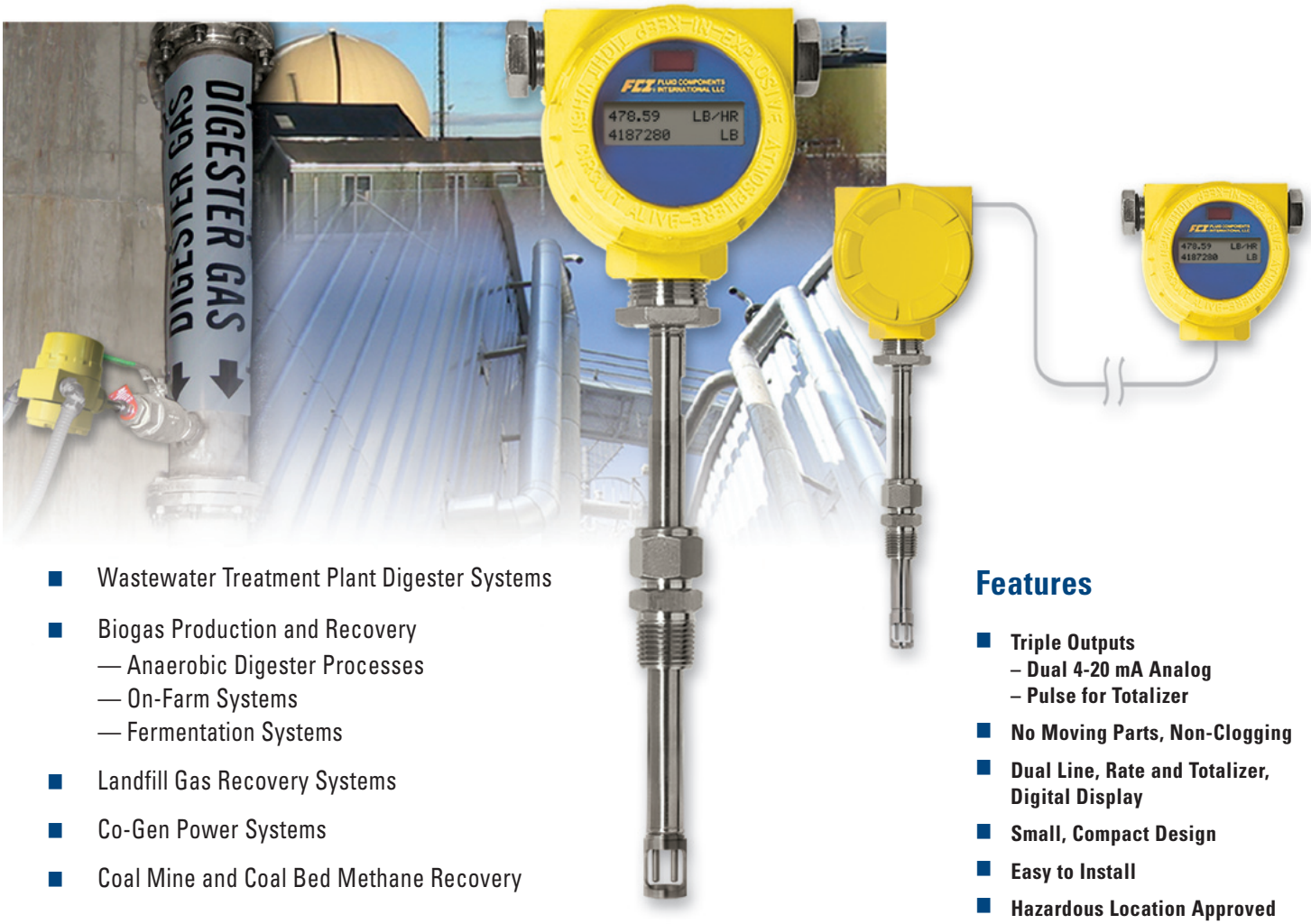
APPENDIX B

CUT SHEETS AND MANUALS FOR THE BIOGAS FLOW METER FT5002 MODEL ST-51, FCI, LLC.

ST51 Mass Flow Meter

FLUID COMPONENTS INTERNATIONAL LLC

For Biogas, Digester Gas, Methane and Natural Gas



- Wastewater Treatment Plant Digester Systems
- Biogas Production and Recovery
  - — Anaerobic Digester Processes
  - — On-Farm Systems
  - — Fermentation Systems
- Landfill Gas Recovery Systems
- Co-Gen Power Systems
- Coal Mine and Coal Bed Methane Recovery

Features

- **Triple Outputs**
  - **– Dual 4-20 mA Analog**
  - **– Pulse for Totalizer**
- **No Moving Parts, Non-Clogging**
- **Dual Line, Rate and Totalizer, Digital Display**
- **Small, Compact Design**
- **Easy to Install**
- **Hazardous Location Approved**
- **Integral and Remote Mount**

The Model ST51 Flow Meter is an accurate, easy to install, no moving parts solution for measuring and controlling biogases, digester gases, methane and natural gas flow. Model ST51 utilizes FCI proven thermal dispersion technology to provide direct mass flow measurement resulting in higher performance at a lower cost than orifice plates, DP, Vortex shedding and other thermal devices.

Biogas and digester gas applications are challenged by wide flow variations and dirty, wet gas. Flow variation is experienced as these processes move from low production start-up phases to a consistent, sustainable process and by seasonal temperature change, where cold temperatures slow gas production and higher temperature accelerate gas production. While the primary composition of these gases is methane and CO_2, residual H_2S and wet vapor leave deposits and corrode surfaces. ST51 provides the solution to these challenges. It features a wide-turndown ratio, up to 100:1 and is highly sensitive to low flow measurement. To measure correctly in fluctuating temperatures, flow meters must include temperature compensation circuitry and it is standard in ST51. ST51 has no moving parts to foul or clog and is easily pulled from the pipe for occasional cleaning.

Model ST51 installs in line sizes ranging from 2 inch to 24 inch [51 mm to 610 mm] with 1/2 inch or 3/4 inch NPT.

The Model ST51 uses precision, lithography structured platinum RTD sensors embedded in FCI's equal mass small diameter thermowells. Combined with microprocessor electronics and precision calibration, the Model ST51 achieves excellent accuracy, fast response and virtually maintenance free operation.

Biogas, digester gas and landfill gas compositions are dominated by methane (CH_4) and present a potentially hazardous installation environment. Sound engineering practice and often regulations mandate that instrumentation meet guidelines and have agency approvals for installation zone safety. Depending on actual installation location, at a minimum the environment will require Class I, Division II and often a more rigorous Class I, Division I [Zone 1 II2GD Ex d IIC] approvals. FCI Model ST51 meets all of these and has obtained the global agency approvals that ensure your installation is always safe and complies with regulations. And, unlike manufacturers who merely provide their transmitter electronics in an approved OEM enclosure, FCI submits its entire instrument to agency testing. FCI product approvals are different because they are comprehensive system approvals that also take into account the sensor and seal requirements as well the "T" (temperature) ratings. FCI agency approvals are on the total instrument. With ST51 you are assured of the integrity of total instrument approvals that meet or exceed safe engineering practice for your applications.

ST51 Specifications

Instrument

Media Compatibility: Biogas, Digester Gas, Methane, Natural Gas, Air, Compressed Air, Nitrogen

Pipe/Line Size Compatibility: 2″ to 24″ [51 mm to 610 mm] [1]

Flow Range: 0.3 SFPS to 400 SFPS [0,08 MPS to 122 MPS]

Accuracy: (at ≥ 0.75 SFPS [≥ 0,21 NMPS] [2])

Standard: ±2% reading ±0.5% full scale

Optional: ±1% reading ±0.5% full scale

Repeatability: ±0.5% reading

Temperature Compensation:

Standard: 40 °F to 100 °F [4 °C to 38 °C];

Optional: 0 °F to 250 °F [-18 °C to 121 °C]

Turndown Ratio: 3:1 to 100:1

Agency Approvals:

FM, CSA/CRN: Class I, Div. 1, Groups B, C, D; Class I, Div. 2, Groups A-D

ATEX/IECEx: Zone 1, II 2 G Ex d IIC T6...T3, II 2 D Ex tD A21 IP67 T90°C...T300°C

Warranty: 1 year

[1] *For line sizes 2" or smaller, see FCI ST75 Series*

[2] *Contact FCI for accuracy below 0.75 sfps [0,21 nmps]*

Flow Element

Installation: Insertion, variable length with 1/2″ or 3/4″ MNPT compression fitting

Type: Thermal Dispersion

Material of Construction: 316L stainless steel body with Hastelloy-C22 thermowell sensors, 316 stainless steel compression fitting with Teflon or stainless steel ferrule

Pressure (Maximum Operating without Damage):

Stainless steel ferrule: 500 psig [34 bar(g)]

Teflon ferrule: 150 psig [10 bar(g)]

Operating Temperature:

Stainless steel ferrule: 0 °F to 250 °F [-18 °C to 121 °C]

Teflon ferrule: 0 °F to 200 °F [-18 °C to 93 °C]

Process Connection: 1/2″ MNPT or 3/4″ MNPT with stainless steel or Teflon ferrule.

Insertion Length (Field Adjustable):

1″ to 6″ [25 mm to 152 mm]

1″ to 12″ [25 mm to 305 mm]

1″ to 18″ [25 mm to 457 mm]

Flow Transmitter

Enclosure: NEMA 4X [IP67], aluminum, dual conduit ports with either 1/2″ FNPT or M20x1.5 entries; epoxy coated.

Operating Temperature: 0 °F to 140 °F [-18 °C to 60 °C]

Input Power:

DC: 18 Vdc to 36 Vdc (6 watts max.)

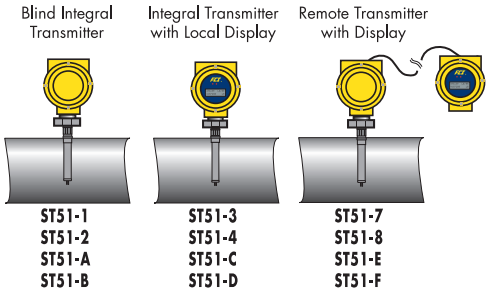
AC: 85 Vac to 265 Vac (12 watts max.; CE Mark Approval from 100 Vac to 240 Vac)

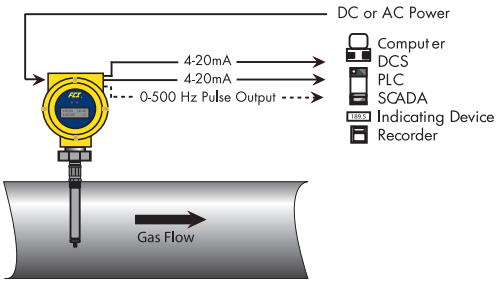
Analog Output Signals: Dual 4-20 mA, user assignable to flow rate and/or temperature and a 0-500 Hz pulse output for total flow

Communication Port: RS-232C. Wireless IR to PDA with optional digital display models

Digital Display: Two-line x 16 character LCD; displays measured value and engineering units; top line assigned to flow rate, second line user assignable to temperature reading, as flow totalizer or alternating; display can be rotated in 90° increments for optimum viewing orientation

Installation and Mounting: Integral with sensor element or remote mountable up to 50′ [15 m]





FCI FLUID COMPONENTS INTERNATIONAL LLC

Locally Represented By:

Visit FCI online at www.FluidComponents.com | FCI is ISO 9001:2000 and AS9100 Certified

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

FCI Measurement and Control Technology (Beijing) Co., LTD | www.fluidcomponents.cn
Room 107, Xianfeng Building II, No.7 Kaituo Road, Shangdi IT Industry Base, Haidian District | Beijing 100085, P. R. China
Phone: 86-10-82782381 **Fax:** 86-10-58851152

FLUID COMPONENTS INTERNATIONAL LLC

ST51 MASS FLOW METER
Installation and Operation Guide

Pre-Installation

The ST51 can be specified with integral or remote electronics. The flow element has a serial number etched into the side of the extension pipe as shown on figure A. The transmitter circuit card has a serial number noted on the board as shown in figure B. The flow sensor and transmitter circuit have been calibrated as a matched set and should be paired together in service unless otherwise approved by a factory technician.

Flow Direction Alignment

All sensor elements have a flow arrow indicator marked on the element assembly at the reference flat. These flow elements have been calibrated in a particular direction and are designed to be used in service with the flow arrow facing in the same direction as flow in the pipe stream. See Appendix C for orientation and factory calibration details.

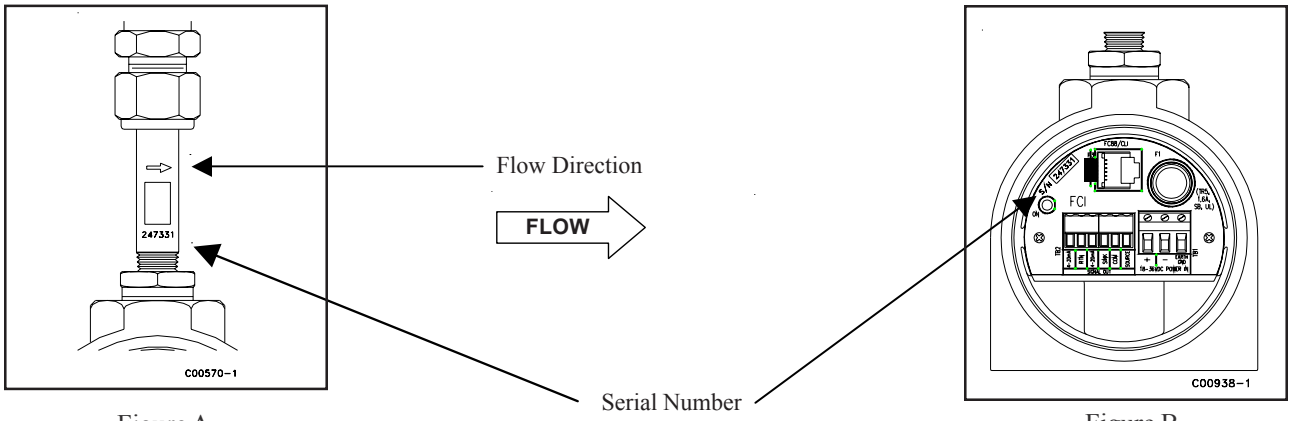


Figure A

Figure B

Recommended Straight Run

To optimize flow meter system performance, FCI recommends installation with a minimum of 20 pipe diameters upstream straight run and 10 pipe diameters of downstream straight run. Where straight run limitations significantly reduce the available pipe diameters, FCI utilizes Vortab flow conditioners to produce a transferable flow profile from the calibration installation to actual field installations. FCI's proprietary AVAL software is available to make flow meter installation evaluations where straight run limitations are considered. See Fig C for recommended installation.

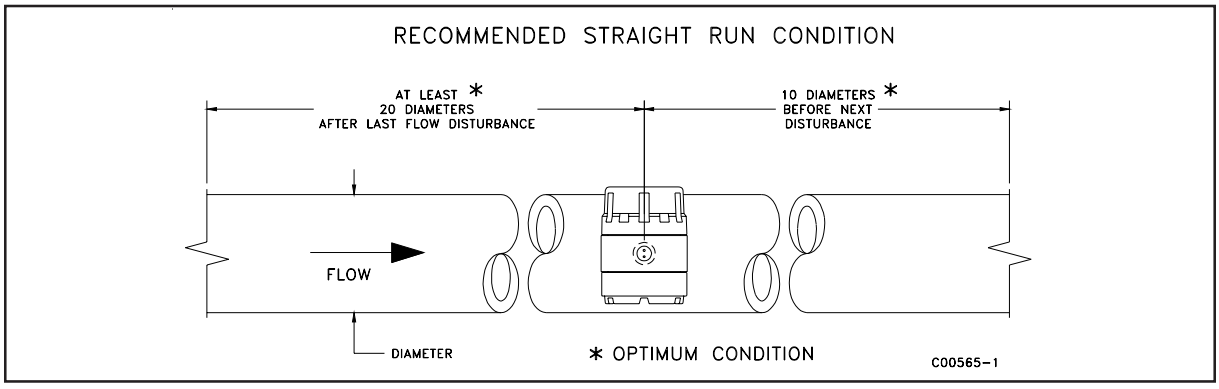


Figure C

FCI Flow Meters may be installed with less than the recommended straight run, but may have performance limitations. FCI offers Vortab flow conditioners for use in applications that have significant straight run limitations. FCI uses the AVAL application modeling software to predict meter performance in each installation. AVAL outputs are available to review prior to order placement and will indicate performance expectations both with and without Vortab Flow Conditioning.

Specifications

Instrument

Media Compatibility: Biogas, Digester Gas, Methane, Natural Gas, Air, Compressed Air, Nitrogen

Pipe/Line Size Compatibility: 2" to 24" [51 mm to 610 mm]

Flow Range: 0.3 sfps to 400 sfps [0,08 mps to 122 mps]

Accuracy: (at >0.75 sfps [>0,21 nmps])
Standard: ± 2% reading ± 0.5% full scale
Optional: ± 1% reading ± 0.5% full scale

Repeatability: ± 0.5% reading

Temperature Compensation:
Standard: 40 °F to 100 °F [4 °C to 38 °C]
Optional: 0 °F to 250 °F [-18 °C to 121 °C]

Turndown Ratio: 3:1 to 100:1

Agency Approvals:

ATEX/IEC Ex:	II 2 G Ex d IIC T6...T3 II 2 D Ex tD A21 IP67 T90°C...T121°C
FM, CSA:	Class I, Div. 1, Groups B, C, D (Enclosure only) Class I, Div. 2 Pending
CRN No.:	0F0303

Warranty: 1 year

Flow Element

Installation: Insertion, variable length with 1/2" or 3/4" NPT(M) compression fitting.

Type: Thermal Dispersion

Material of Construction: 316L stainless steel body with Hastelloy-C22 thermowell sensors, 316 stainless steel compression fitting with Teflon or stainless steel ferrule.

Pressure (Maximum Operating without Damage):
Stainless steel ferrule: 500 psig [34 bar(g)]
Teflon ferrule: 150 psig [10 bar(g)]

Operating Temperature:
Stainless steel ferrule: 0 °F to 250 °F [-18 °C to 121 °C]
Teflon ferrule: 0 °F to 200 °F [-18 °C to 93 °C]

Process Connection: 1/2" MNPT or 3/4" MNPT with stainless steel or Teflon ferrule.

Insertion Length (Field Adjustable):
1" to 6" [25 mm to 152 mm]
1" to 12" [25 mm to 305 mm]
1" to 18" [25 mm to 457 mm]

Flow Transmitter

Enclosure: NEMA 4X [IP67], aluminum, dual conduit ports with either 1/2" Female NPT or M20x1.5 entries. Epoxy coated.

Operating Temperature: 0 °F to 140 °F [-18 °C to 60 °C]

Input Power:
DC: 18 Vdc to 36 Vdc (6 watts max.)
AC: 85 Vac to 265 Vac (12 watts max.; CE Mark Approval for 100 Vac to 240 Vac)

Analog Output Signals: Dual 4-20 mA, configurable to flow rate and/or temperature (500 ohm max impedance) and a pulse output for total flow.

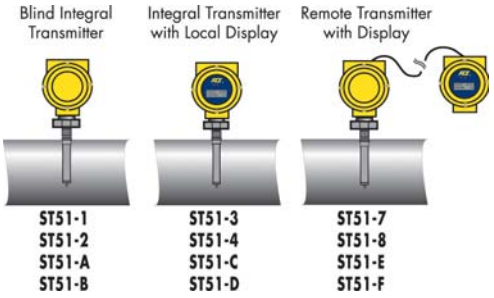
Output Pulse Source: Totalized flow or alarm set point. 15VDC. Pulse width at 50% duty cycle for rates 1 to 500Hz, 0.5 second pulse width for pulse rates below 1Hz. 25mA maximum load pulsed, 10mA maximum load if state set to normally on.

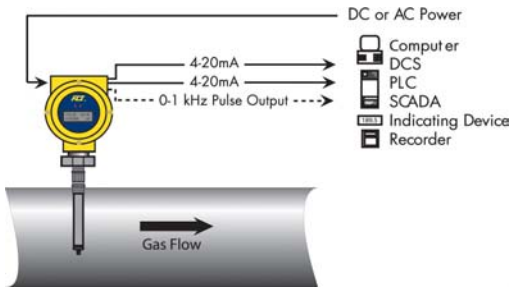
Output Pulse Sink: Totalized flow or alarm set point. Pulse width at 50% duty cycle for rates 1 to 500Hz, 0.5 second pulse width for rates below 1Hz. Customer power source and load not to exceed 40VDC and 150mA.

Communication Port: RS-232C. Wireless IR to PDA with optional digital display models.

Digital Display: Two-line x 16 character LCD; displays measured value and engineering units. Top line assigned to flow rate, second line user assignable to temperature reading, flow totalizer or alternating. Display can be rotated in 90° increments for optimum viewing orientation.

Installation and Mounting: Integral with sensor element or remote mountable
up to 50' [15 m].





Installing Flow Element

Insertion Depth

Warning: The element is shipped with a protective sleeve surrounding the flow element. After removing the sleeve, take care to prevent the element from sliding through the compression fitting and contacting the opposing wall with any force as it may cause damage to the element and potentially upset the calibration.

The ST51 is available with both Teflon compression fitting ferrules and metal ferrules. While the Teflon ferrule configuration can be readjusted, it is possible that over tightening may result in permanent positioning or damage to the extension pipe and will make future adjustment difficult. While Teflon provides for some adjustability, it has a lower process pressure rating and is not designed for continuous adjustments. The metal ferrule version can only be tightened down once and it becomes permanently positioned. The Ferrule type is indicated in the instrument part number displayed on the instrument tag. This can be cross referenced to the ordering information sheet.

All flow meters have been calibrated with the flow element located at the centerline of the pipe and flow stream as indicated in Figure D. Couplings and threadolets come in various dimensions. Proper installation requires that the element be measured with consideration to process connection dimensions and pipe centerline. FCI recommends that the element be first installed in the line with the compression fitting lightly tightened around the extension, then slowly move the pipe extension forward until the element is at centerline as shown.

Warning: On top mount installations, particularly, take care to prevent the element from sliding through the compression fitting and contacting the opposing wall with any force as it may cause damage to the element and potentially upset the calibration.

FLOW ELEMENT INSTALLATION & "U" LENGTH ADJUSTMENT

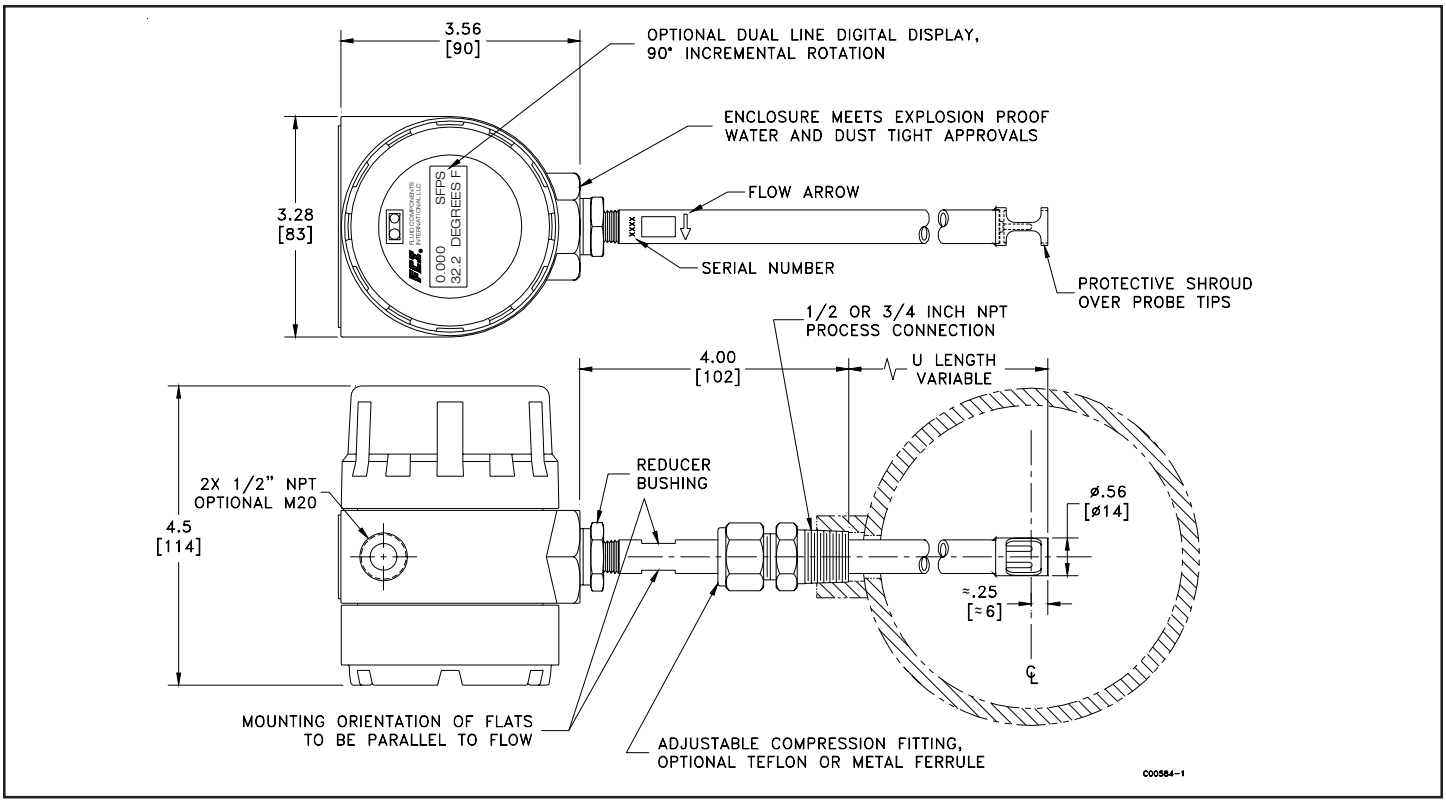


Figure D

Note: For proper performance, element shall be installed so that tip of probe is .25 inches [6mm] past pipe centerline. Instrument is specifically calibrated for centerline referenced installation. Critical for line sizes 4" [25mm] and smaller.

To assist in final installation, FCI suggests making a readable mark on the extension pipe to indicate the final desired compression fitting position that will place the element at the centerline reference once the system is tightened down into place. With the compression fitting lightly tightened , hold the element assembly along the outside of the installation, or directly above, to visually verify the compression fitting location will ensure centerline installation. To calculate the actual "U" length dimension, take the inside diameter of the pipe or duct divide by 2 , then add 0.25", then add for the pipe wall thickness and the process fitting offset that allows the compression fitting to securely seat in the process port. See Figure D above.

Align the flat parellel to flow and adjust the instrument depth. Upon determination of the final compression fitting location on the extension pipe, apply the proper thread sealant to the NPT threads, firmly tighten the compression fitting into the mating process connection. Torque varies per application. Tighten the compression nut to the torque indicated with the corresponding ferrule material. Manufacturer recommends 1-1/4 turns from hand tight baseline.

Ferrule	Torque
Teflon	65 in – lbs
316 SST	65 ft – lbs

Instrument Wiring

Before the instrument is opened to connect power and signal, FCI recommends that the following ESD precautions be observed:

Use a wrist band or heel strap with a 1 megaohm resistor connected to ground. If the instrument is in the shop setting, there should be a static conductive mat on the work table or floor with a 1 megaohm resistor connected to ground. Connect the instrument to ground. Apply antistatic agents such as Static free made by Chemtronics (or equivalent) to hand tools to be used on the instrument. Keep high static producing items away from the instrument.

The above precautions are minimum requirements. The complete use of ESD precautions can be found in the U.S. Dept of defense handbook 263.

Warning: Only Qualified personnel are to wire or test this instrument. The operator assumes all responsibility for safe practices while wiring and trouble shooting.

FCI recommends installing and input power disconnect switch and fuse near the instrument to interrupt power during installation and maintenance. Operator must have power disconnected before wiring.

See Safety instructions in Appendix A for the use of the ST51 series (AC and DC versions) in Hazardous Areas Category II (Zone 1). Approval, KEMA 08ATEX0045/IECEx KEMA08.0012 for Category 2 GD protection Ex d IIC T6..T1, Ex tD A21 IP67 T 90°C...T 121°C.

Input Power

The ST51 is available with both VDC and VAC input power configurations. Customers selecting VDC input power will have a VDC input board only. Similarly, the VAC power board is supplied only with VAC powered units. In addition, both boards are marked for either AC or DC power. Only connect the power specified on the wiring module as shown on Figures E and F respectively. Both VAC and VDC inputs require a Gnd wire to be connected. Input power terminal blocks are rated for 14-26 AWG.

To wire the instrument, ensure that the power is off. Pull the power and signal output wires through the port, using care not to damage wires. FCI recommends using crimp lugs on the output wires to ensure proper connection with the terminal strip. Connect the output wires as shown on figures E and F. Note that when the 4-20mA outputs are used simultaneously, a single return lead is used.

Analog Output

4-20mA: The instrument is provided with a standard set up, of two 4-20mA outputs. Output 1 configured for flow and Output 2 configured for temperature. Terminal blocks rated for 14-28 AWG., 500 ohm max load per output.

Pulse Output Activation

The ST51 provides a pulse output feature. Instruments ordered with volumetric or mass flow units will be factory set with totalizer and pulse output activated. The mode can be changed in the field. Wiring either sink or source mode is shown in Figures E and F below. Though only one configuration is shown with the VAC and VDC power supplies, the source or sink can be utilized with either power input.

Sink Mode: 40 VDC Max, 150 mA max. Customer supplied power source
Source Mode: 15 VDC output, 50 mA max

VDC Power Connection

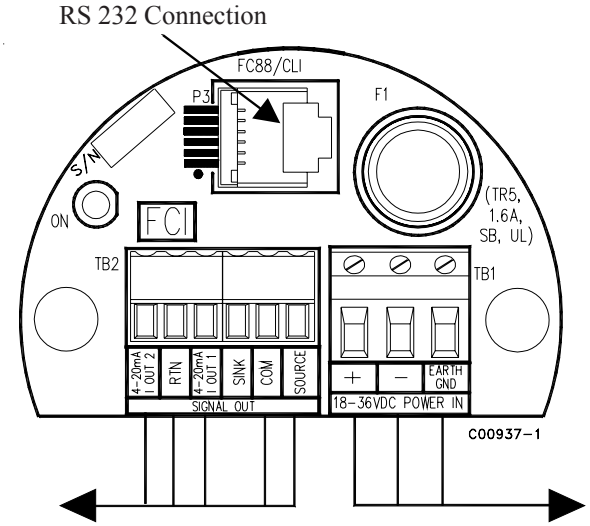


Figure E

VDC Power
As Shown:

18-36VDC power connected with gnd
4-20mA connected for flow and temperature
Pulse Out in source mode

Note: In source mode, 15VDC Output max, 50mA max.

VAC Power Connection

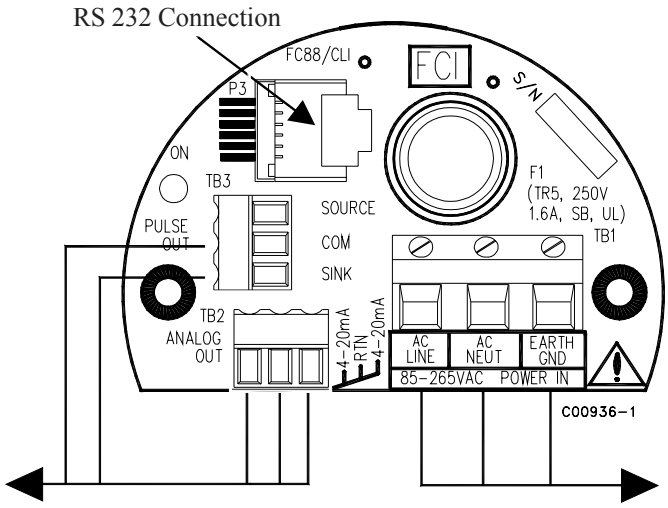


Figure F

VAC Power
As Shown:

85-265 VAC power connected with gnd
4-20mA connected for flow and temperature
Pulse Out in sink mode

Note: In sink mode, 40VDC max, 150mA max customer supplied power source.

Power Disspation

AC Version
Power dissipation values under nominal conditions:
Instrument (Electronics + Sensor): 11.6 Watts
Sensor only: 0.25 Watts

Power dissipation values under maximum load conditions:
Instrument (Electronics + Sensor): 12 Watts
Sensor only: 0.30 Watts

DC Version
Power dissipation values under nominal conditions:
Instrument (Electronics + Sensor): 4.5 Watts
Sensor only: 0.25 Watts

Power dissipation values under maximum load conditions:
Instrument (Electronics + Sensor): 6 Watts
Sensor only: 0.30 Watts

Setup Interface

All parameters on this meter are set through the RS232 interface connection (P3 plug) or PDA IR interface. A jumper selection determines which communication mode is active. The factory default communication mode is set for the RS232 interface. This setting allows the instrument to be setup with either a FC88 hand held communicator or a computer. The FC88 is powered through the meter and comes with the serial interface cable. If a computer interface is used, an adapter (RJ to 9 pin Computer Serial Port) is required and may be obtained from FCI: Part No. 014108-02.

Using Windows Terminal (usually located in Accessories) execute the program by double-clicking on the Terminal Icon.

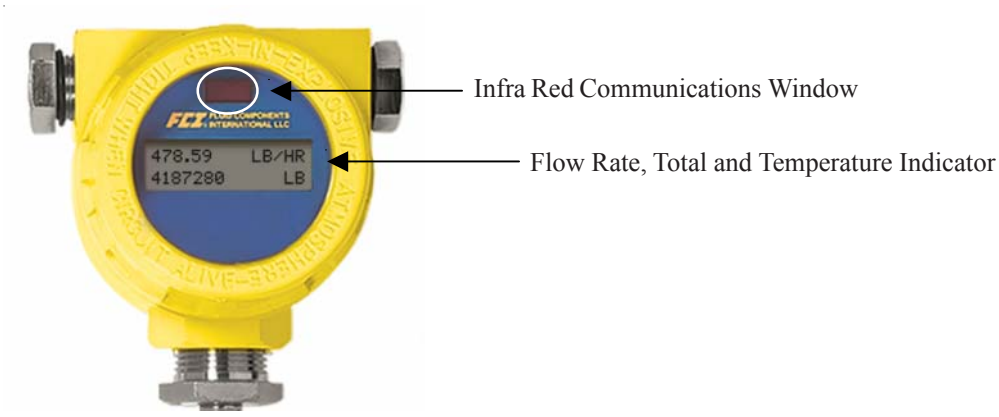
1. Go to *Settings*.
2. Click on *Communication.*
3. Set for COM1 or COM2, 9600 Baud, 8 Bit, and No Parity. Press OK
4. Press the *ENTER* key to see the *Input Mode?* prompt.
5. Enter any of the meters single letter commands to execute a function (reference complete function menu in Appendix B).

If the PDA IR interface is used for communication, then jumper JP5 needs to be moved to the alternate position, see Figure G and H. See PDA IR Communication Interface section for more details.

An additional command line interface (CLI) is available through the RS232 port. This interface is accessed with the "Y" command using a computer or FC88. The command line password is "357". See Appendix B - Table 6 for command line details.

Figure G
JP5 factory set for RS232 interface

Figure H
JP5 set for PDA IR interface



Start up and Commissioning

1. Verify all Input power and output signal wiring is correct and ready for initial power start up.
2. Apply power to instrument. The instrument will initialize in the Normal Operation Mode. All outputs will be active and instruments with the display option will indicate flow with the factory set flow unit. Allow 10 minutes for the instrument to warm up and come to the thermal equilibrium.

The following FC88 commands are typical commands that are used during start up and commissioning:

Command	Name	Description
T	Normal Operation Mode	All outputs are active
Z	Flow Unit Set-Up	Select Flow Units(4 English, 4 Metric)Pipe Dimensions
W	Totalizer	Enable/Disable
V	Output Configuration	Select one of 4 Configurations: Pulse and/or AlarmPulse factor and/or setpoint
F	K-Factor (default=1)	Flow factor
N	Warm Re-set	Re-initialize C/B
S	Totalizer Menu	Enables W menu (Option)

If the instrument is installed, and the process flow is zero, the instrument should indicate 0.000.

Flow Unit Modification

Example: SCFM Flow Units and 3 inch Sch 40 round pipe size set up:

Enter	Display	Description
Enter	menu: >	From Normal Operation Mode
Z	E for English M for Metric >	Flow Unit Set-Up menu
E	0=SFPS, 1=SCFM, 2=SCFH, 3=LB/H, 4=GPM #	English units
1	R round duct or S rectangular>	Select Standard Ft_3/Min (SCFM)
R	Dia.: 4.0260000 Change? (Y/N)>	Select Round Duct
Y	Enter value: #	
3.068	area: 7.3926572 CMinflow: 0.0000000 Change? (Y/N)>	3 inch Sch. 40 pipe I.D.
N	Maximum flow: 462.04 Enter to continue	
Y	Cmaxflow: 462.04 Change? (Y/N)>	
Y	#	
462.04	CMintemp (F): -40.00000 Change? (Y/N)>	
N	CMaxtemp (F): 250.00000 Change? (Y/N)>	
N	Percent of Range is: OFF Change to ON?>	
N	LCD Mult Factor x1 Change? (Y/N)>	
N	100.0 SCFM	Instrument will end up in Normal Operation Mode

RS232 / FC88

Menu Control and Organization

Most entries require at least two key strokes; a Capital letter and the [ENTER] key, or one or more numbers and the [ENTER] key. All user entries begin at the input mode prompt ">",except when the instrument is in the Main Function Mode (just press the desired function letter and [ENTER] to make an entry).
Backspaces are made using the backspace [BKSP] key. Some entries are case sensitive between numbers and letters. Be sure the SHIFT key is pressed to indicate the correct case. A square after the prompt caret indicates the FC88 is in lower case. A slightly raised rectangle in the same spot indicates the FC88 is in the upper case.
It is recommended that the FC88 be plugged into the instrument before power is applied. If the FC88 is plugged in while the instrument power is on and the FC88 does not respond, press [ENTER], if there is still no response Press [N] or cycle the power.

Note: The Zero and Span may be changed from the original calibration, provided the new values are within the original calibrated range. i.e. If the original calibration was 1 to 100 SCFM (4-20mA), the new zero (4mA) must be equal to or greater than 1 SCFM, the new span (20mA) must be equal to or less than 100 SCFM.

Some entries require a Factory pass code. If this occurs contact FCI Field Service to continue programming the instrument. The instrument will prompt the user when this is necessary. Do not change any parameters that require this code unless there is an absolute understanding of the instrument's operation. The user can not exit some routines unless all entries are completed or the power is recycled.

The top level of the menu is shown in Appendix B - Table 5. Enter the large letter in the tables below to activate a command. The user may exit a command at any time entering "Q" [ENTER] in the menus: D, K, V, W, or Z.

C Calibration Information
Display only: A/D, Delta-R, Ref-R data values

D Diagnostics
Display only: List of unit prameters.

K Factory Calibration Settings
Display only: Cal. parameters, i.e. linearization and temperature compensation coefficients.

R Factory Reset
Replaces user data with factory calibration data

Table 1. Diagnostics and Factory Settings

Units

Select	E=English	M=Metric
Select	0= SFPS	5 = SMPS
or	1 = SCFM	6 = NCMH
or	2 = SCFH	7 = NCMM
or	3 = LBS/H	8 = KG/H
or	4 = GPM	9 = LPM
	For Volumetric or Mass Flow	
Select	R = Round pipe or duct	
or	S = Square duct	
Set	Diameter or Wide X High (in inches or mm)	
Set	CMaxflow = Maximum flow rate (span)	
Set	CMinflow = Minimum flow rate (zero)	

Note: Changing units requires rescaling the unit (set new zero and span).

Table 2. "Z" Flow Units Set-Up and Scaling

Analog out					
	Select	**1**	**2**	**3**	**4**
4-20mA out 1		**Flow**	**Flow**	**Temp**	**Temp**
4-20mA out 2		**Temp**	**Flow**	**Flow**	**Temp**
Pulse out					
	Select	**1**	**2**	**3**	**4**
Source out		**Pulse**	**Pulse**	**Alarm0**	**Alarm0**
	Set	Factor	Factor	Set pt.0	Set pt.0
	Set	Period	Period	State0	State0
	Set	State0	State0		
Sink		**Pulse**	**Alarm1**	**Pulse**	**Alarm1**
	Set		Set pt.1	Factor	Set pt.1
	Set	State1	State1	Period	State1
				State1	

Table 3. "V" Output Configuration Set-Up

"V" Menu Output Configuration Set Up

*NOTE: The display comes up to the last setting saved and stays for 2 seconds. If **N** or [ENTER] is entered, the menu proceeds to the Pulse out. If **Y** is entered, the display moves to the selection options and/or asks for confirmation. If you miss the option, select [Enter] repeatedly to loop around.*

Analog out
Output Mode
Selected

4-20mA #1: Flow
4-20mA #2: Temp

Change? (Y/N)>

4-20mA #1: Flow
4-20mA #2: Temp
Enter 1 to make the selection__
4-20mA #1:
4-20mA #2: Flow
Enter 2 to make the selection__
4-20mA #1: Temp
4-20mA #2: Flow
Enter 3 to make the selection__
4-20mA #1: Temp
4-20mA #2: Temp
Enter 4 to make the selection__

Pulse out
Pulse Out
Selected

Source: Pulse
Sink: Pulse

Change? (Y/N)>
Source: Pulse
Sink: Pulse
Enter 1 to make the selection #__
Source: Pulse
Sink: Alarm1
Enter 2 to make the selection #__
Source: Alarm0
Sink: Pulse
Enter 3 to make the selection #__
Source: Alarm0
Sink: Alarm1
Enter 4 to make the selection #__

PFactor: 1.000
Change? (Y/N)>
if yes
Enter new factor: ____
Sample Period: 1 second
Change? (Y/N)>
if yes
Enter new Sample Period: ____

If alarm is a selected output
Set point1: 000 Set points are in the same units as the flow or temp.
Change? (Y/N)>
if yes
Enter new set point: ____
Resume normal operation

Source state:
High to Low

Change to Low to High?>

Example: COMMAND V (Reference Table 3)

Case: 4-20mA #1 = flow, 4-20mA #2 = Temperature, Source Out = Pulse, Sink = Alarm

Pressing **[V] [ENTER]** will display "**Output Mode Selected"** followed by:
"4-20mA #1 = Flow" **" 4-20mA #2 = Temp"** followed by
"Change? (Y/N)"
Press [ENTER] (no change).

The last saved mode will display at this point. i.e.,

"Source: Pulse"	**"Sink: Pulse"**	followed by,
"Change? (Y/N)"	Select **Y [Enter].**	The display reads,
"Source: Pulse"	**"Sink: Pulse"**	followed by,
"Enter 1 to make the selction #."	Select **[ENTER].**	The next display reads,
"Source: Pulse"	**"Sink: Alarm"**	followed by,
"Enter 2 to make the selction #."	Select **2** and **[ENTER].**	The next prompt reads,
"PFactor: 1.000"	**"Change? (Y/N)>"**	(this factor can be anywhere from 0.001 to 1000 - A pulse factor of 1.000 will output 1 pulse per unit of flow.)

If no change, select **N** and/or **[ENTER]** to continue.
The next prompt is, **"Sample Period"**
"Change? (Y/N)>" (this value may be set from 0.5 to 5 seconds)
If no change, select **N** and/or **[ENTER]** to continue.
The next prompt is, "**Source state:** " **"High to Low" Change to "Low to High?>"** (this selection toggles the pulse signal normally high or normally low).

[ENTER] to read display.
"Switchpt1" **"0.0000000"** the current set point.
"Change? (Y/N)>" enter **Y [ENTER]** and enter #_____ . Set Point Value , i.e. 50 (value is in same units as the flow and must be within the calibrated range). **[ENTER].** The next prompt is,
"**Sink state:** " **"High to Low" Change to "Low to High?>"**. Set the output signal to be normally "High" or normally "Low." Pressing **[Y]** **[ENTER]** toggles the current setting. Pressing **[ENTER]** resumes normal operation.

PDA IR Communication Interface

The IR interface software is an optional accessory kit and can ordered using FCI part number 019819-01. The software is compatible with PALM OS 4.1 or greater. If the software was ordered with the instrument, a CD should be located with the instrument documentation.

The factory has verified the following 3 PDA models. All commands meet their intended purpose and function properly.

1. Palm, Tungsten E, E2:Palm OS 5.2.1, 5.4.7
2. Palm, Zire 71, Palm OS 5.2.1
3. ecom instruments, m 515-EX, Intrinsically-safe. Palm OS 4.1

Procedure:

1. Down load the software into the target PDA. When complete, a yellow and blue FCI icon will be available.
2. Verify JP5 jumper is set in the PDA IR interface position, see Figure H.
3. Select FCI icon on PDA device.
4. The opening menu is displayed, select start.
5. Five menu groups are displayed.

Process: displays current process variables (Flow and Temperature)
ID-Unit: displays model, firmware version, serial no. …
Set-up: allows access to the following areas

Units	K Factor
Line size	Temp/Flow min/max
Totalizer	Output Cal
LCD	Output Config

Diagnostics: A/D values
Utilities: allows access to the following areas

- Reset
- Parameter memory
- Calibration coefficients
- Factory restore
- Process and System Faults

6. After entering into specific menu areas, point the PDA IR port towards the Instrument display. Begin with the PDA device within 5 feet of the instrument display. Select the “Get All” or “Get” button to retrieve information from the instrument. If a value needs to be changed, the value must first be retrieved.

Example: reading standard process variable information

1. Verify instrument and PDA are functioning.
2. Select FCI icon on the PDA.
3. Select the start button on the opening screen.
4. Select the “Process” button.
5. Point the PDA at the instrument display, start with the PDA no futher that 5 feet from the instrument.
6. Select the “Get Data” button.
7. Flow and temperature Data will begin streaming to the PDA.
8. If the IR link is interrupted, a “Command response timed out” message will be displayed.
9. Repeat the process if the link is interrupted.

Maintenance

The FCI instrument requires little maintenance. There are no moving parts or mechanical parts subject to wear in the instrument. The sensor assembly which is exposed to the process media is composed of 316 SS and Hastelloy C.

Without detailed knowledge of the environmental parameters of the application surroundings and process media, FCI cannot make specific recommendations for periodic inspection, cleaning, or testing procedures. However, some suggested general guidelines for maintenance steps are offered below. Use operating experience to establish the frequency of each type of maintenance.

Calibration

Periodically verify the calibration of the output and recalibrate if necessary. FCI recommends every 18 months at a minimum.

Electrical Connections

Periodically inspect cable connections on terminal strips and terminal blocks. Verify that terminal connections are tight and physically sound with no sign of corrosion.

Remote Enclosure

Verify that the moisture barriers and seals protecting the electronics in the local enclosure is adequate and that no moisture is entering the enclosure.

Electrical Wiring

FCI recommends occasional inspection of the system's interconnecting cable, power wiring and flow element wiring on a "common sense" basis related to the application environment. Periodically the conductors should be inspected for corrosion and the cable insulation checked for signs of deterioration.

Flow Element Connections

Verify that all seals are performing properly and that there is no leakage of the process media. Check for deterioration of the gaskets and environmental seals used.

Insertion Type Flow Element Assembly

Periodically remove the flow element for inspection based on historical evidence of debris, foreign matter, or scale build-up and appropriate plant shutdown schedules and procedures. Check for corrosion, stress cracking, and/or build-up of oxides, salts, or foreign substances. The thermowells must be free of excessive contaminants and be physically intact. Any debris or residue build-up could cause inaccurate flow indication. Clean the flow element, as necessary, with a soft brush and available solvents (compatible with Stainless Steel).

Troubleshooting

Application Verification

After verifying that the flow meter is functioning, review the application parameters as shown below to verify the calibration matches the process media.

Equipment Needed

Flow Instrument Calibration Data
Process Parameters and Limits

Check Serial Numbers

Verify that the serial number of the flow element and the flow transmitter electronics are the same. The flow element and the flow transmitter are a matched set and cannot be operated independently of each other.

Check the Instrument Installation

Verify correct mechanical and electrical installation. Verify the flow element is mounted at least 20 diameters downstream and 10 diameters upstream from any bends or interference in the process pipe or duct.

Check for Moisture

Check for moisture on the flow transmitter. Moisture may cause intermittent operation. Check for moisture on the flow element. If a component of the process media is near its saturation temperature it may condense on the flow element. Place the flow element where the process media is well above the saturation temperature of any of the process gases.

Check Application Design Requirements

Application design problems may occur with first time application instruments, although the design should also be checked on instruments that have been in operation for some time. If the application design does not match field conditions, errors occur.

1. Review the application design with plant operation personnel and plant engineers.
2. Ensure that plant equipment such as pressure and temperature instruments conform to the actual conditions.
3. Verify operating temperature, operating pressure, line size, and gas medium.

Verify Standard Versus Actual Process Conditions

The flowmeter measures the mass flow rate. The mass flow rate is the mass of the gas flowing through a pipe per time. Other flow meters, such as an orifice plate or a pitot tube, measure the volumetric flow rate. The volumetric flow rate is the volume of gas per time. If the readings displayed do not agree with another instrument, some calculations may be necessary before comparing them. To calculate the mass flow rate, the volumetric flow rate, and the pressure and temperature, the point of measurement must be known. Use the following equation to calculate the mass flow rate (Standard Volumetric Flow rate) for the other instrument:

Equation:

$$Q_S = Q_A \times \frac{P_A}{T_A} \times \frac{T_S}{P_S}$$

(Metric: Where bar(a) and °K are used for pressure and temperature.)

Where:

Q_A= Volumetric Flow Q_S= Standard Volumetric Flow
P_A= Actual Pressure T_A= Actual Temperature
P_S= Standard Pressure T_S= Standard Temperature
PSIA and °R are used for pressure and temperature units.

Example:

(Metric: P_S = 1.01325 bar(a) T_S = 21.1°C (294.1K))

Q_A= 1212.7 ACFM Q_S= 1485 SCFM
P_A= 19.7 PSIA T_A= 120°F (580°R)
P_S= 14.7 PSIA T_S= 70°F (530°R)

$$\left(\frac{1212.7 \text{ ACFM}}{1}\right)\left(\frac{19.7 \text{ PSIA}}{580^\circ \text{ R}}\right)\left(\frac{530^\circ \text{ R}}{14.7 \text{ PSIA}}\right) = 1485 \text{ SCFM}$$

Calibration Parameters Verification

The instrument uses a set of predetermined calibration parameters to process flow signals. Most of these parameters should not change. A data package located with this manual contains the "ST51 Delta R Data Sheet". This contains the calibration parameters stored in the flow transmitter at the factory. To verify that these parameters have not changed, complete the following:

1. Identify the appropriate Delta R Data sheets by serial number of the instrument.
2. Press [D] [ENTER] to examine each of the parameters. The [ENTER] key allows scrolling one message at a time. Use Table 4 to verify parameters with the Delta R Data sheet ST51 Parameters.

S/W Version:		dR Min:		T SpanIDAC 0:	
Flow Factor:		dR Max:		T ZeroIDAC 0:	
Cmin Flow:		Cal Ref:		T SpanIDAC 1:	
Cmax Flow:		Tcslp:		T ZeroIDAC 1:	
Eng Units:		Tcslp 0:		State 0:	
Line Size 0:		Tcslp 2:		Switch Pt 0:	
Line Size 1:		Tot Menu:		State 1:	
Cmin Temp:		Tot Flag:		Switch Pt 1:	
Cmax Temp:		Totalizer:		K factor 1:	
Min Flow:		Rollover Cnt:		K factor 2:	
Max Flow:		Fix Pt Flag:		K factor 3:	
Density:		Pulse Factor:		K factor 4:	
*C1 [1]:		Pulse Out:		I factor:	
*C1 [2]:		Hours:		Temp Flag:	
*C1 [3]:		Sample Period:		Out Mode:	
*C1 [4]:		dR Slope:		Boxcar Max:	
*C1 [5]:		dr Off Set:		RTD-SLP-385:	
Break Pt:		Refr Slope:		% of Range:	
*C2 [1]:		Refr Off Set:		User Name:	
*C2 [2]:		SpanIDAC 0:		Shop Order #:	
*C2 [3]:		ZeroIDAC 0:		Serial No.:	
*C2 [4]:		SpanIDAC 1:		Model#:	
*C2 [5]:		ZeroIDAC 1:			

Table 4. Diagnostic Test Sequence on Display

If parameters that have an asterisk (*) have changed, this may indicate a problem. Customer Service should be contacted. If the parameters have not changed, continue with the next section.

Hardware Verification

Equipment Required:

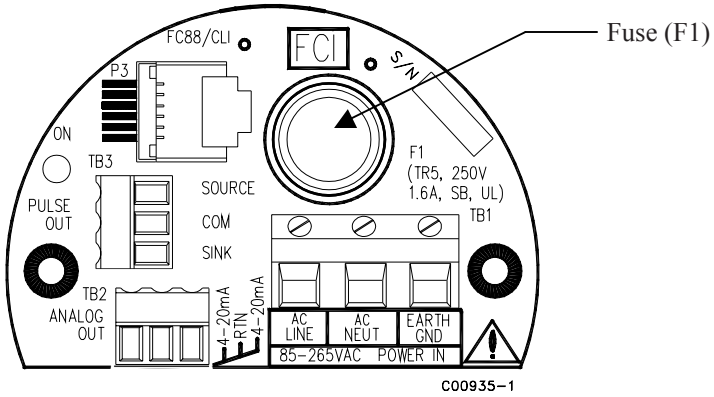
Digital Multimeter
Screw Driver

The ST51 Flowmeter is comprised of 4 basic components:
1. Sensor element.
2. Customer interface circuit board
3. Control circuit assembly circuit board module.
4. Electronics enclosure.

Step 1

Verify fuse (F1) located on the customer interface circuit board is in normal working condition.

Remove power from the instrument. Open the electronics enclosure exposing the customer interface circuit board. This circuit board is located under the shorter enclosure lid along with all of the power and input/output connections. Unscrew the clear cover on the fuse and pull the fuse out of the fuse holder. Check the fuse for continuity. If fuse reads open, replace with equivalent component (FCI part no. 019933-01), Wickmann Inc. series 374, amp code 1160, package 41.

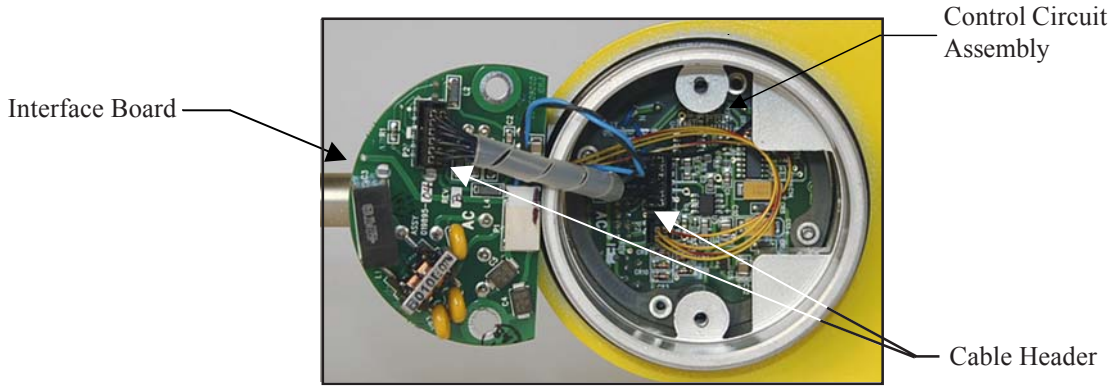


Ac power customer interface circuit board shown. Fuse (F1) on DC power customer interface circuit board located in similar position.

Step 2

Verify interconnecting cable from the customer interface board and the control circuit board assembly module are correctly seated into the appropriate header.

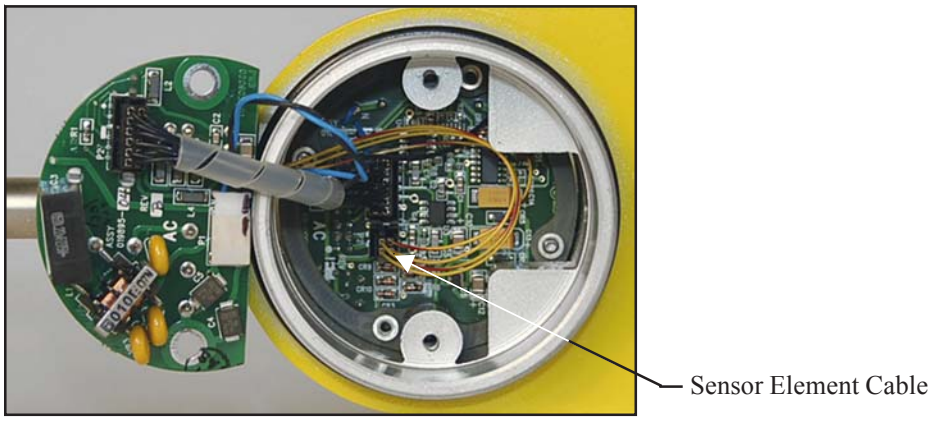
Remove power from the instrument. Open the electronics enclosure exposing the customer interface circuit board. This circuit board is located under the shorter enclosure lid along with all of the power and input/output connections. Remove the 2 screws securing the interface circuit board to the electronics enclosure. Carefully lift the interface face board exposing the interconnecting cable between the interface board and the control circuit assembly. Verify cable is seated firmly at both ends of the cable header.



Step 3

Verify sensor element continuity and resistance.

Remove sensor element cable from the bottom of the control circuit assembly. Note that 2 of the wires have a red stripe and are located closest to the interconnecting cable header. Using an ohm meter verify that resistance between the 2 red striped wires is approximately 1100 ohms +/- 20. This resistance is temperature dependant. The resistance at 70 degrees F should be 1082 ohms. Verify the resistance between the 2 natural colored wires are approximately the same.



FCI provides full in-house technical support. Additional technical representation is also provided by FCI field representatives. Before contacting a field or in-house representative, please perform the troubleshooting techniques outlined in this document. If problems persist, contact the FCI Customer Service department at 1-800-854-1993 or 1-760-744-6950.

If the instrument is to be returned to FCI, please obtain an Return Authorization. The form contains a declaration of decontamination cleaning information that the instrument must comply with before it is shipped to FCI.

Transmitter Circuit Calibration Check (Delta R Verification)

References

Delta 'R' Data Sheet

Equipment

FC88 Communicator or equivalent.©

DMV

Delta R Data Sheet-Match by serial numbers

2 Precision Decade Resistance boxes, 0.1% (Largest steps: 1K Ohm, smallest steps 0.01 Ohms)

Small flat Blade Screwdriver, 3/32 inches wide blade

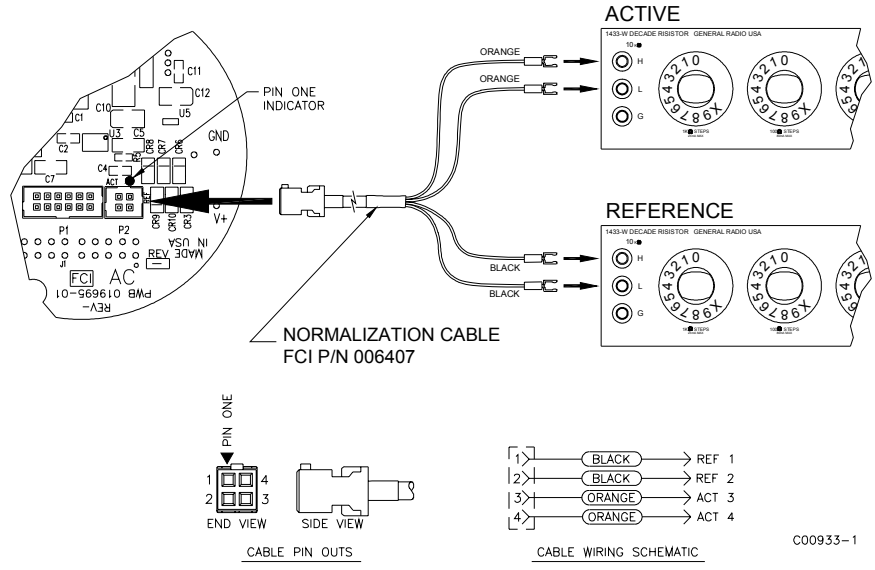
FCI Normalization Cable, FCI part number 006407

Procedure

1. Verify all "D" mode calibration parameters are correct according to the meters Delta R Data Sheet, before starting verification.
2. Turn power off
3. Mark all sensor element wires connected to the circuit board, so they may be reconnected to the proper terminals. Disconnect the wires.
4. Connect the resistance decade box to the electronics as per the appropriate diagram for the ST51.

NOTE: Interconnector wiring (resistance decade box to electronics) must be 24 AWG and 45 inches long, to avoid any inaccuracies in the Delta R verification, caused by improper wire lengths or wire gauges.

5. Set both decade boxes for the nominal resistance value (1000 ohms) +/- .01%
6. Connect DVM to the meters output termination and monitor the meter output.
7. Turn the power ON and allow the instrument 5 mins. To stabilize
8. With the FC88 connected, Press [T] [Enter] to view the Normal Operating Mode.
9. Adjust the Active Decade Box (Reference decade box remains fixed @ 1000 ohms) to achieve the appropriated Delta R for the displayed flow value and output, noted on the meters Delta R Data Sheet.
10. Note the [C] mode and verify the meters displayed TCDR and REFR values corresponding to the displayed flow rate as per the meters Delta R Data Sheet.
11. Return to the [T] mode to continue the verification.



Appendix A - Approval Information

EC Information

FLUID COMPONENTS INTERNATIONAL LLC

EC DECLARATION OF CONFORMITY Model ST51 / ST75

We, *Fluid Components International LLC,* located at 1755 La Costa Meadows Drive, San Marcos, California 92078-5115 USA, declare under our sole responsibility that the **ST51/ST75 Flowmeter Product Family,** to which this declaration relates, are in conformity with the following standards and Directives.

Directive 94/9/EC ATEX
IECEx Scheme

Certified by KEMA Quality B.V. (0344): Utrechtseweg 310, 6812 AR, Arnhem, The Netherlands

EC-Type Examination Certificates:

KEMA 08ATEX0045 satisfies EN 60079-0: 2006, EN 60079-1: 2004, EN 61241-0: 2006, EN 61241-1: 2004 requirements for use in hazardous areas.

IECEx KEMA08.0012 satisfies IEC 60079-0: 2004, IEC 60079-1: 2007-04, IEC 61241-0: 2004, IEC 61241-1: 2004 requirements for use in hazardous areas.

Hazardous Areas Approval KEMA 08ATEX0045/IEC KEM08.0012 for:
Category II 2 G for Gas protection Ex d IIC T6…T3
Category II 2 D for Dust protection Ex tD A21 IP67 T90ºC…T121ºC

Directive 89/336/EEC EMC

Immunity specifications: EN 61000-6-2: 2001; EN 61000-4-2 1995; EN 61000-4-3: 1996; EN 61000-4-4 1995; EN 61000-4-5 1995; EN 61000-4-6 2003; EN 61000-4-8 1995; EN 61000-4-11 1994.

Emissions specification: EN 61000-6-4: 2001; EN55011 1998 Group1 Class A; CISPR 11 1997 Group 1 Class A.

Directive 97/23/EC Pressure Equipment

The ST51 Model does not have a pressure bearing housing and is therefore not considered as pressure equipment by itself according to article 1, section 2.1. The Model ST75 is in conformity with the sound engineering practices as defined in the Pressure Equipment Directive 97/23/EC article 3, paragraph 3.

Issued at San Marcos, California USA
August, 2008

Eric Wible
2008.09.03
09:26:40 -07'00'

Eric Wible, Engineering Manager

Flow/Liquid Level/Temperature Instrumentation
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European Office: Persephonestraat 3-01 5047 TTTilburg – The Netherlands – Phone 31-13-5159989 • Fax 31-13-5799036

Doc no. 23EN000019-

Safety Instructions for the use the ST51/75 flowmeter in Hazardous Areas
Approval KEMA 08ATEX0045/IEC KEM08.0012 for:

Category II 2 G for Gas protection Ex d IIC T6…T3
Category II 2 D for Dust protection Ex tD A21 IP67 T90ºC…T121ºC

The ST51/75 series consist of a sensing element and associated integral or remote mounted electronics mounted in a type “d” flameproof enclosure.

Relation between ambient temperature, process temperature and temperature class is as follows:

Ambient temperature range (Ta): T6 [85ºC] for : -40ºC <Ta< + 65ºC

Process temperature range (Tp): T6 [85ºC] for : -40ºC <Tp< + 65ºC
T5 [100ºC] for : -40ºC <Tp< + 100ºC
T4 [135ºC] for : -40ºC <Tp< + 135ºC
T3 [200ºC] for : -40ºC <Tp< + 200ºC

Electrical data: Power supply: 85 to 265 VAC, 50/60 Hz, 12 Watt max; 24 VDC, 12 VA Max

Dansk	Sikkerhedsforskrifter	Italiano	Normative di sicurezza
Deutsch	Sicherheitshinweise	Nederlands	Veiligheidsinstructies
English	Safety instructions	Português	Normas de segurança
Υπ	Υπ_δεί_εις ασφαλείας	Español	Instrucciones de seguridad
Suomi	Turvallisuusohjeet	Svenska	Säkerhetsanvisningar
Français	Consignes de sécurité		

DK Dansk- Sikkerhedsforskrifter

Disse sikkerhedsforskrifter gælder for Fluid Components, ST51/75 EF-typeafprøvningsattest-nr. KEMA 08ATEX0045/IEC KEM08.0012 (attestens nummer på typeskiltet) er egnet til at blive benyttet i eksplosiv atmosfære kategori II 2 GD.
1) Ex-anlæg skal principielt opstilles af specialiseret personale.
2) ST51/75 skal jordforbindes.
3) Klemmerne og elektronikken er monteret i et hus, som er beskyttet af en eksplosionssikker kapsling med følgende noter:
• Gevindspalten mellem huset og låget er på en sådan måde, at ild ikke kan brede sig inden i det.
• Ex-„d“ tilslutningshuset er forsynet med et 1/2" NPT og/eller M20x1.5 gevind for montering af en Ex-„d“ kabelindføring, der er attesteret iht. IEC/EN 60079-1
• Det er vigtigt at sørge for, at forsyningsledningen er uden spænding eller eksplosiv
atmosfære ikke er til stede, før låget åbnes og når låget er åbent på „d” huset (f.eks. ved tilslutning eller servicearbejde).
• Låget på „d” huset skal være skruet helt ind, når apparatet er i brug. Det skal sikres ved at dreje en af låseskruerne på låget ud.

DA Deutsch-Sicherheitshinweise

Diese Sicherheitshinweise gelten für die Fluid Components, ST51/75 flowmeter gemäß der EG-Baumusterprüfbescheinigung Nr. KEMA 08ATEX0045/IEC KEM08.0012 (Bescheinigungsnummer auf dem Typschild) der Kategorie II 2 GD.
1) Die Errichtung von Ex-Anlagen muss grundsätzlich durch Fachpersonal vorgenommen werden.
2) Der ST51/75 muß geerdet werden.
3) Die Klemmen und Elektroniken sind in einem Gehäuse in der Zündschutzart druckfeste Kapselung („d“) eingebaut.
• Der Gewindespalt zwischen dem Gehäuse und dem Deckel ist ein zünddurchschlagsicherer Spalt.
• Das Ex-“d“ Anschlussgehäuse besitzt ein 1/2“ NPT und/oder M20x1.5 Gewinde für den Einbau einer nach IEC/EN 60079-1 bescheinigten Ex-“d“ Kabeleinführung.
• Es ist sicherzustellen, dass vor dem Öffnen und bei geöffnetem Deckel des „d“ Gehäuses (z.B. bei Anschluss oder Service- Arbeiten) entweder die Versorgungsleitung spannungsfrei oder keine explosionsfähige Atmosphäre vorhanden ist.
• Der Deckel des „d“ Gehäuses muss im Betrieb bis zum Anschlag hineingedreht sein. Er ist durch eine der Deckelarretierungsschrauben zu sichern.

GB IRL English- Safety instructions

These safety instructions are valid for the Fluid Components, ST51/75 flowmeter to the EC type approval certificate no KEMA 08ATEX0045/IEC KEM08.0012 (certificate number on the type label) for use in potentially explosive atmospheres in Category II 2 GD.
1) The installation of Ex-instruments must be made by trained personnel.
2) The ST51/75 must be grounded.
3) The terminals and electronics are installed in a flame proof and pressure-tight housing with following notes:
• The gap between the housing and cover is an ignition-proof gap.
• The Ex-“d“ housing connection has a 1/2” NPT and/or M20x1.5 cable entry for mounting an Ex-d cable entry certified acc. to IEC/EN 60079-1.
• Make sure that before opening the cover of the Ex”d“ housing, the power supply is disconnected or there is no explosive atmosphere present (e.g. during connection or service work).
• During normal operation: The cover of the “d“ housing must be screwed in completely and locked by tightening one of the cover locking screws.

GR Υπ_δεί_εις ασφαλείας

Αυτές οι οδηγίες ασφαλείας ισχύουν για τα Ροόμετρα της Fluid Components τύπου ST51/75 που φέρουν Πιστοποιητικό Εγκρίσεως Ευρωπαϊκής Ένωσης, με αριθμό πιστοποίησης KEMA 08ATEX0045/IEC KEM08.0012 (ο αριθμός πιστοποίησης βρίσκεται πάνω στην ετικέτα τύπου του οργάνου) για χρήση σε εκρηκτικές ατμόσφαιρες της κατηγορίας II 2 GD.
1) Η εγκατάσταση των οργάνων με αντιεκρηκτική προστασία πρέπει να γίνει από εξειδικευμένο προσωπικό.
2) Το όργανο τύπου ST51/75 πρέπει να είναι γειωμένο.
3) Τα τερματικά ηλεκτρικών συνδέσεων (κλέμες) και τα ηλεκτρονικά κυκλώματα είναι εγκατεστημένα σε περίβλημα αντιεκρηκτικό και αεροστεγές σύμφωνα με τις ακόλουθες παρατηρήσεις:
• Το κενό ανάμεσα στο περίβλημα και στο κάλυμμα είναι τέτοιο που αποτρέπει την διάδοση σπινθήρα.
• Το “Ex-d” αντιεκρηκτικό περίβλημα, έχει ανοίγματα εισόδου καλωδίου με διάμετρο ½” NPT ή/και M20x1.5, κατάλληλα για τοποθέτηση υποδοχής αντιεκρηκτικού καλωδίου πιστοποιημένης κατά IEC/EN 60079-1
• Βεβαιωθείτε ότι πριν το άνοιγμα καλύμματος του του “Ex-d” αντιεκρηκτικού περιβλήματος, η τάση τροφοδοσίας είναι αποσυνδεδεμένη ή ότι δεν υφίσταται στη περιοχή εκρηκτική ατμόσφαιρα (π.χ. κατά τη διάρκεια της σύνδεσης ή εργασιών συντήρησης)
• Κατά τη διάρκεια ομαλής λειτουργίας: Το κάλυμα του “d” καλύμματος αντιεκρηκτικού περιβλήματος πρέπει να είναι εντελώς βιδωμένο και ασφαλισμένο, σφίγγοντας μία από τις βίδες ασφαλείας του περιβλήματος.

FIN Suomi - Turvallisuusohjeet

Nämä turvallisuusohjeet koskevat Flud Components, ST51/75 EY-tyyppitarkastustodistuksen nro. KEMA 08ATEX0045/IEC KEM08.0012 (todistuksen numero näkyy tyyppikilvestä) käytettäessä räjähdysvaarallisissa tiloissa luokassa II 2GD.
1) Ex-laitteet on aina asennettava ammattihenkilökunnan toimesta.
2) ST51/75 on maadoitettava.
3) Syöttöjännitteen kytkemisessä tarvittavat liittimet ja elektroniikka on asennettu koteloon jonka rakenne kestää räjähdyspaineen seuraavin lisäyksin :
• Kotelon ja kannen välissä on räjähdyksen purkausväli.
• Ex-d liitäntäkotelossa on 1/2“ NPT ja/tai M20x1.5 kierre IEC/EN 60079-1 mukaisen Ex-d kaapeliläpiviennin asennusta varten
• Kun “d“-kotelon kansi avataan (esim. liitännän tai huollon yhteydessä), on varmistettava, että joko syöttöjohto on jännitteetön tai ympäristössä ei ole räjähtäviä aineita.
• “d“ -kotelon kansi on kierrettävä aivan kiinni käytön yhteydessä ja on varmistettava kiertämällä yksi kannen lukitusruuveista kiinni.

(F)(B)(L) Consignes de sécurité

Ces consignes de sécurité sont valables pour le modèle ST51/75 de la société Fluid Components (FCI) conforme au certificat d'épreuves de type KEMA 08ATEX0045/IEC KEM08.0012 (numéro du certificat sur l'étiquette signalétique) conçu pour les applications dans lesquelles un matériel de la catégorie II2GD est nécessaire.
1) Seul un personnel spécialisé et qualifié est autorisé à installer le matériel Ex.
2) Les ST51/75 doivent être reliés à la terre.
3) Les bornes pour le branchement de la tension d'alimentation et l'électronique sont logées dans un boîtier à enveloppe antidéflagrante avec les notes suivantes :
• Le volume entre le boîtier et le couvercle est protégé en cas d'amorçage.
• Le boîtier de raccordement Ex-d dispose d'un filetage1/2'' NPT et/ou M20x1.5 pour le montage d'un presse-étoupe Ex-d certifié selon la IEC/EN 60079-1.
• Avant d'ouvrir le couvercle du boîtier « d » et pendant toute la durée où il le restera (pour des travaux de raccordement, d'entretien ou de dépannage par exemple), il faut veiller à ce que la ligne d'alimentation soit hors tension ou à ce qu'il n'y ait pas d'atmosphère explosive.
• Pendant le fonctionnement de l'appareil, le couvercle du boîtier « d » doit être vissé et serré jusqu'en butée. La bonne fixation du couvercle doit être assurée en serrant une des vis d'arrêt du couvercle.

(I) Italiano - Normative di sicurezza

Queste normative di sicurezza si riferiscono ai Fluid Components, ST51/75 secondo il certificato CE di prova di omologazione n° KEMA 08ATEX0045/IEC KEM08.0012 (numero del certificato sulla targhetta d'identificazione) sono idonei all'impiego in atmosfere esplosive applicazioni che richiedono apparecchiature elettriche della Categoria II 2 GD.
1) L'installazione di sistemi Ex deve essere eseguita esclusivamente da personale specializzato.
2) I ST51/75 devono essere collegati a terra.
3) I morsetti per il collegamento e l'elettronica sono incorporati in una custodia a prova di esplosione („d") con le seguenti note:
• La sicurezza si ottiene grazie ai cosidetti „interstizi sperimentali massimi", attraverso i quali una eventuale accensione all'interno della custodia non può propagarsi all'esterno oraggiungere altre parti dell'impianto.
• La scatola di collegamento Ex-d ha una filettatura 3/4" e/o 1" NPT per il montaggio di un passacavo omologato Ex-d secondo IEC/EN 60079-1.
• Prima di aprire il coperchio della custodia „d" (per es. durante operazioni di collegamento o di manutenzione) accertarsi che l'apparecchio sia disinserito o che non si trovi in presenza di atmosfere esplosive.
• Avvitare il coperchio della custodia „d" fino all'arresto. Per impedire lo svitamento del coperchio é possibile allentare una delle 2 viti esagonali poste sul corpo della custodia, incastrandola nella sagoma del coperchio.

(NL)(B) Nederlands - Veiligheidsinstructies

Deze veiligheidsinstructies gelden voor de Fluid Components, ST51/75 overeenkomstig de EG-typeverklaring nr. KEMA 08ATEX0045/IEC KEM08.0012 (nummer van de verklaring op het typeplaatje) voor gebruik in een explosieve atmosfeer volgens Categorie II 2GD.
1) Installatie van Ex-instrumenten dient altijd te geschieden door geschoold personeel.
2) De ST51/75 moet geaard worden.
3) De aansluitklemmen en de electronika zijn ingebouwd in een drukvaste behuizing met de volgende opmerkingen:
• De schroefdraadspleet tussen de behuizing en de deksel is een ontstekingsdoorslagveilige spleet.
• De Ex-d aansluitbehuizing heeft een 1/2" of een M20x1.5 schroefdraad voor aansluiting van een volgens IEC/EN 60079-1 goedgekeurde Ex- 'd' kabelinvoer.
• Er moet worden veilig gesteld dat vóór het openen bij een geopende deksel van de 'd' behuizing (bijv. bij aansluit- of servicewerkzaamheden) hetzij de voedingsleiding spanningsvrij is, hetzij geen explosieve atmosfeer aanwezig is.
• De deksel van de 'd' behuizing moet tijdens bedrijf tot aan de aanslag erin geschroefd zijn.
Hij moet door het eruit draaien van een van de dekselborgschroeven worden geborgd.

(P) Português - Normas de segurança

Estas normas de segurança são válidas para os Fluid Components, ST51/75 conforme o certificado de teste de modelo N.º KEMA 08ATEX0045/IEC KEM08.0012 (número do certificado na plaqueta com os dados do equipamento)
são apropriados para utilização em atmosferas explosivas categoria II 2 GD.
1) A instalação de equipamentos em zonas sujeitas a explosão deve, por princípio, ser executada por técnicos qualificados.
2) Os ST51/75 Flexmasster precisam ser ligados à terra.
3) Os terminais e a electrónica para a conexão da tensão de alimentação estão instalados num envólucro com protecção contra ignição á prova de sobrepressão com as seguintes notas :
• A fenda entre o envólucro e a tampa deve ser á prova de passagem de centelha.
• O envólucro de conexão Ex-“d“ possui uma rosca 1/2“ NPT e/ou M20x1.5 para a entrada de cabos Ex-“d“ certificado conforme a norma IEC/EN 60079-1.
• Deve-se assegurar que, antes de abrir a tampa do armário „d“ (por exemplo, ao efectuar a conexão ou durante trabalhos de manutenção), o cabo de alimentação esteja sem tensão ou que a atmosfera não seja explosíva.
• Durante a operação, a tampa do envólucro „d“ deve estar aparafusada até o encosto. A tampa deve ser bloqueada, por um dos parafusos de fixação.

(E) Español - Instrucciones de seguridad

Estas indicaciones de seguridad son de aplicación para el modelo ST51/75 de Fluid Components, según la certificación CE de modelo Nº KEMA 08ATEX0045/IEC KEM08.0012 para aplicaciones en atmósferas potencialmente explosivas según la categoría II 2 GD (el número decertificación se indica sobre la placa informativa del equipo).
1) La instalación de equipos Ex tiene que ser realizada por personal especializado.
2) Los ST51/75 tienen que ser conectados a tierra.
3) Los bornes de conexión y la unidad electrónica están montados dentro de una caja con protección antideflagrante y resistente a presión, considerándose los siguientes puntos:
• La holgura entre la rosca de la tapa y la propia de la caja está diseñada a prueba contra ignición.
• La caja tiene conexiones eléctricas para entrada de cables con rosca 1/2” NPTy/o M20x1.5, donde deberán conectarse prensaestopas certificados Exd según IEC/EN60079-1.
• Antes de la apertura de la tapa de la caja "Exd“ (p. ej. durante los trabajos de conexionado o de puesta en marcha) hay que asegurar que el equipo se halle sin tensión o que no exista presencia de atmósfera explosiva.
• Durante el funcionamiento normal: la tapa de la caja antideflagrante tiene que estar cerrada, roscada hasta el tope, debiendose asegurar apretando los tornillos de bloqueo.

(S) Svenska - Säkerhetsanvisningar

Säkerhetsanvisningarna gäller för Fluid Components, Flödesmätare typ ST51/75 enligt EG-typkontrollintyg nr KEMA 08ATEX0045/IEC KEM08.0012 (intygsnumret återfinns på typskylten) är lämpad för användning i explosiv gasblandning i kategori II 2 GD.
1) Installation av Ex- klassade instrument måste alltid utföras av fackpersonal.
2) ST51/75 måste jordas.
3) Anslutningsklämmorna och elektroniken är inbyggda i en explosions och trycktät kapsling med följande kommentar:
• Spalten mellan kapslingen och lockets gänga är flamsäker.
• Ex-d kapslingen har en 1/2“ NPT och / eller M20x1.5 gänga för montering av en IEC/EN 60079-1 typkontrollerad
Ex- „d“ kabel förskruvning
• När Ex- „d“-kapslingens lock är öppet (t.ex. vid inkoppling - eller servicearbeten) ska man se till att enheten är spänningslös eller att ingen explosiv gasblandning förekommer.
• Under drift måste Ex - d“-kapslingens lock vara iskruvad till anslaget. För att säkra locket skruvar
man i en av lockets insex låsskruvar .

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Appendix B - List Commands

COMMAND MNEMONIC	COMMAND FUNCTION	COMMAND DECRIPTION
A	R	AvgDelta_r, AvgRef
B	R	Delta_r, Ref_r
C	R	Tcdelta_r, Ref_r
D	R	Diagnostics
F	R/W	Kfactors
G	R/W	Clear FlashEE, Boxcar Count, ADC to Ohms Cal
K	R/W	Cal Parameters
L	R/W	Output Cal
N	W	Warm Restart
R	W	Factory Restore
S	R/W	Totalizer Menu On/Off
T	R	Normal Mode
V	R/W	Output Config
W	R/W	Totalizer
Y	W	Command Line Interface
Z	W	Flow units, Pipe Size, and LCD Scaling

Table 5. ST51 List of Single Letter Commands

COMMAND MNEMONIC	COMMAND FUNCTION	COMMAND DESCRIPTION	DATA TYPE
BK	R/W	Break Point	Float
BM	R/W	Boxcar Filter Max	Integer
CM	R/W	Cminflow	Float
CR	R/W	Calibration Ref	Float
CX	R/W	Cmaxflow	Float
C1[1-5]	R/W	Coefficients set1	Float
C2[1-5]	R/W	Coefficients set2	Float
DI	R	Diagnostics	Null
DM	R/W	DeltaR Minimum	Float
DN	R/W	Density	Float
DR	R	Delta R	Float
DX	R/W	DeltaR Maximum	Float
DS	R/W	DeltaR Slope	Float
DF	R/W	DeltaR Offset	Float
EU	R/W	Engineering Units	Integer
FF	R/W	Flow Factor	Float
FP	R/W	Fix Point Flag	Integer
F0	R/W	Pulse Out State0	Integer
F1	R/W	Pulse Out State1	Integer
HR	R/W	Tot Dump Hours Cntr	Integer
IF	R/W	I Factor	Float

Table 6. ST51 List of CLI Commands

Table 6. ST51 List of CLI Commands, Cont.

COMMAND MNEMONIC	COMMAND FUNCTION	COMMAND DESCRIPTION	DATA TYPE
K[1-4]	R/W	K Factors	Float
L0	R/W	Line Size0	Float
L1	R/W	Line Size1	Float
MN	R/W	Minflow	Float
MX	R/W	Maxflow	Float
OM	R/W	Outmode	Integer
PF	R/W	Pulse Factor	Float
PL	R/W	Pulse Out	Integer
PS	R/W	Pulse Sample Period	Float
PW	R/W	Pulse Width	Float
P0	R/W	Switch Point0	Integer
P1	R/W	Switch Point1	Integer
RO	R/W	RollOver Cntr	Long
RR	R	Reference R	Float
RS	R/W	RefR Slope	Float
RF	R/W	RefR Offset	Float
SF	R	SFPS Flow	Float
SN	R/W	Serial Number	String (16 chars max.)
SO	R/W	Shop Order Number	String (16 chars max.)
S0	R/W	SpanDAC0 for 4-20mA #1	Integer
S3	R/W	SpanDAC1 for 4-20mA #2	Integer
S2	W	Save FACTORY	N/A
TC	R	TCdeltar	Float
TD	R/W	Tcslp	Float
TF	R/W	Totalizer OFF/ON Flag	Integer
TM	R/W	Cmintemp	Float
TP	R/W	Totalizer Temperature Flag	Integer
TT	R/W	Totalizer Value	Float
TX	R/W	Cmaxtemp	Float
TZ	R	Temperature	Float
T0	R/W	Tcslp0	Float
T2	R/W	Tcslp2	Float
T3	R/W	TSpanDAC0 for 4-20mA #1	Integer
T7	R/W	TSpanDAC1 for 4-20mA #2	Integer
T5	R/W	TZeroDAC0 for 4-20mA #1	Integer
T8	R/W	TZeroDAC1 for 4-20mA #2	Integer
UF	R	User Flow	Float
UK	R	User FlowK	Float
UN	R/W	User Name	String (16 chars max.)
VN	R	Version Number	String (16 chars max.)
XX	R/W	Test Flow Rate (SFPS)	Float
XY	W	Delete Test Flow Rate	Float
Z0	R/W	ZeroDAC0 for 4-20mA #1	Integer
Z2	R/W	ZeroDAC1 for 4-20mA #2	Integer

Command Line Password: 357

NOTE: When invoking a Write Function, there must be a space separating the Command characters and the data value. All Read and Write Functions are completed with a <CR>. To exit CLI, press <CR> following the last Command <CR>.

Examples:	RBK<CR>	(Read Breakpoint)
	WBK 2222<CR>	(Write Breakpoint 2222)
	RC11<CR>	(Read Coefficient C1,1)
	WC11 –234.567<CR>	(Write Coefficient C1,1, -234.567)
	<CR>	(Leave Command Line Mode)

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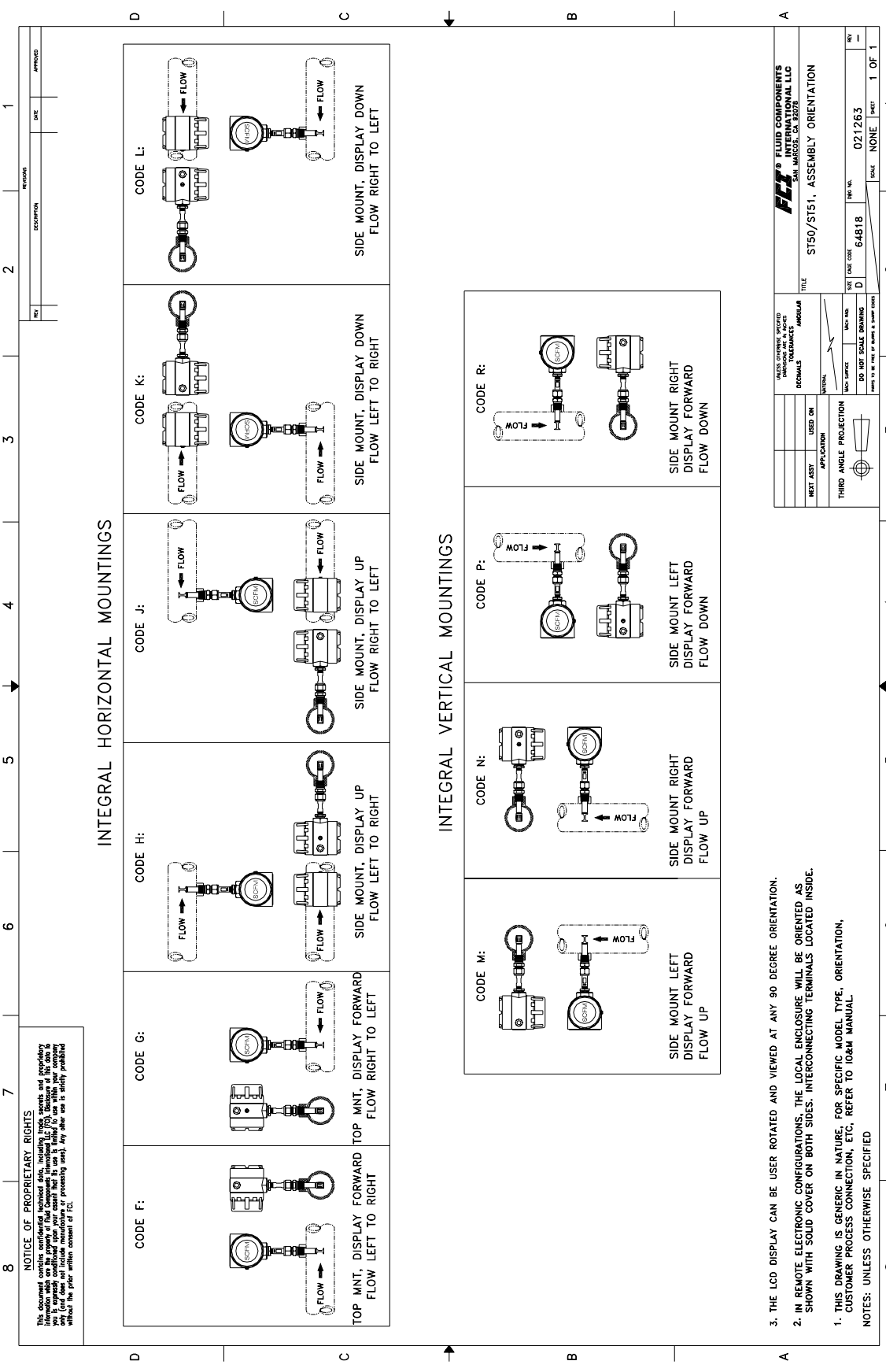
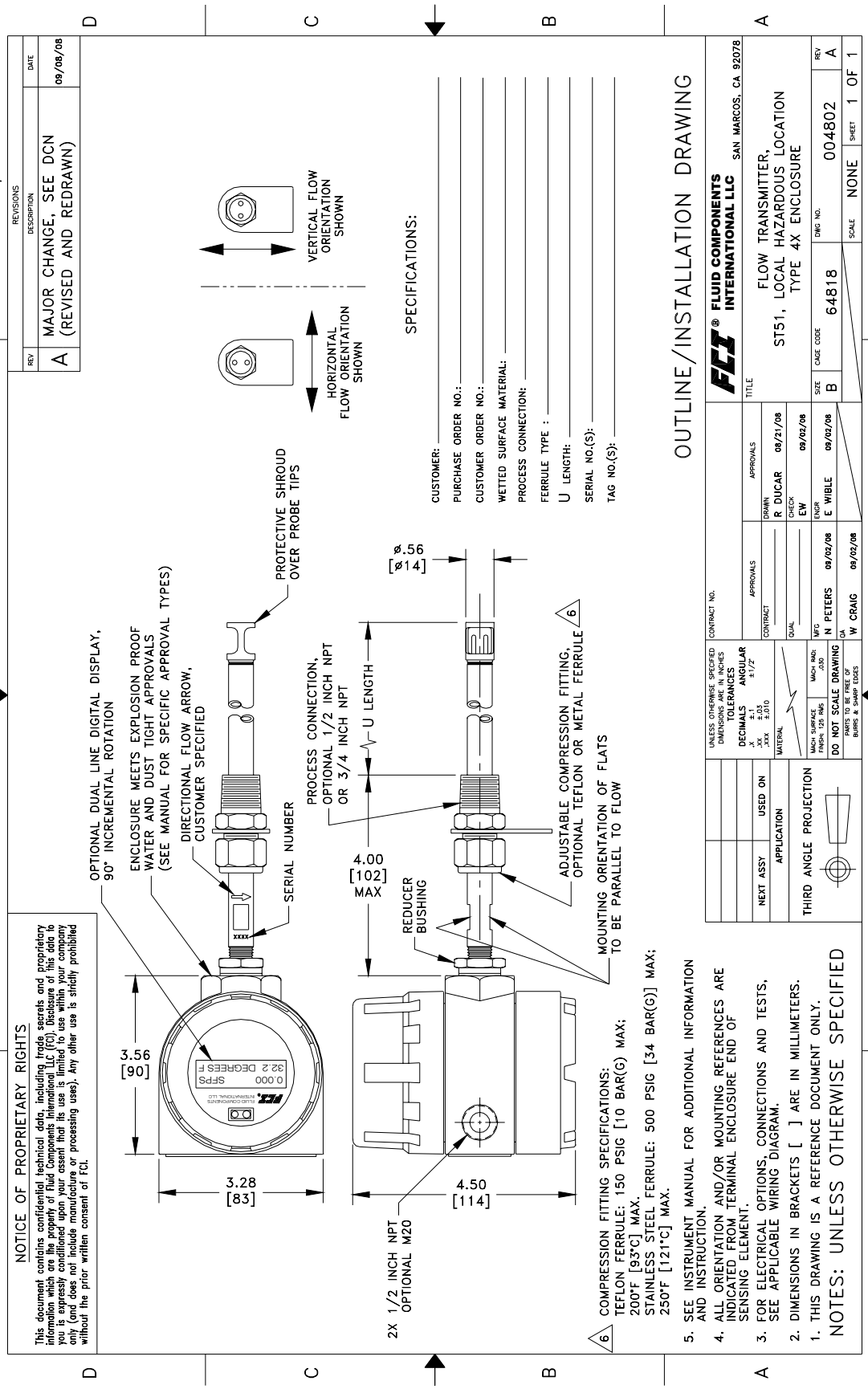
Appendix C - Drawings




OUTLINE/INSTALLATION DRAWING
NOTICE OF PROPRIETARY RIGHTS
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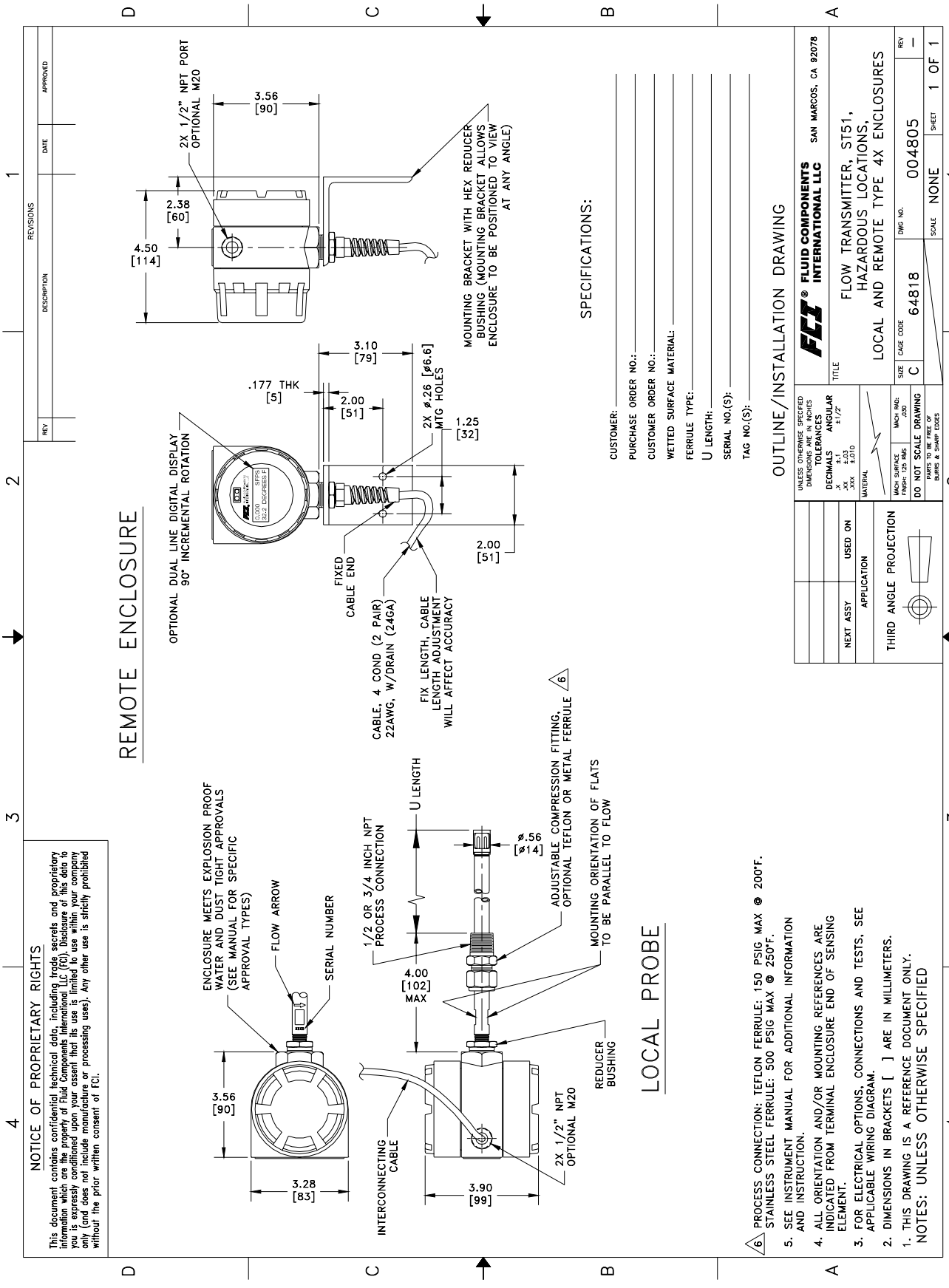
REVISIONS
REV DESCRIPTION DATE
A MAJOR CHANGE, SEE DCN (REVISED AND REDRAWN) 09/08/08
OPTIONAL DUAL LINE DIGITAL DISPLAY, 90° INCREMENTAL ROTATION
ENCLOSURE MEETS EXPLOSION PROOF WATER AND DUST TIGHT APPROVALS (SEE MANUAL FOR SPECIFIC APPROVAL TYPES)
DIRECTIONAL FLOW ARROW, CUSTOMER SPECIFIED
SERIAL NUMBER
PROTECTIVE SHROUD OVER PROBE TIPS
PROCESS CONNECTION, OPTIONAL 1/2 INCH NPT OR 3/4 INCH NPT
U LENGTH
ø.56 [ø14]
4.00 [102] MAX
REDUCER BUSHING
ADJUSTABLE COMPRESSION FITTING, OPTIONAL TEFLON OR METAL FERRULE 6
MOUNTING ORIENTATION OF FLATS TO BE PARALLEL TO FLOW
2X 1/2 INCH NPT OPTIONAL M20
3.56 [90]
3.28 [83]
4.50 [114]
HORIZONTAL FLOW ORIENTATION SHOWN
VERTICAL FLOW ORIENTATION SHOWN
SPECIFICATIONS:
CUSTOMER:
PURCHASE ORDER NO.:
CUSTOMER ORDER NO.:
WETTED SURFACE MATERIAL:
PROCESS CONNECTION:
FERRULE TYPE :
U LENGTH:
SERIAL NO.(S):
TAG NO.(S):
6 COMPRESSION FITTING SPECIFICATIONS: TEFLON FERRULE: 150 PSIG [10 BAR(G) MAX; 200°F [93°C] MAX. STAINLESS STEEL FERRULE: 500 PSIG [34 BAR(G)] MAX; 250°F [121°C] MAX.
5. SEE INSTRUMENT MANUAL FOR ADDITIONAL INFORMATION AND INSTRUCTION.
4. ALL ORIENTATION AND/OR MOUNTING REFERENCES ARE INDICATED FROM TERMINAL ENCLOSURE END OF SENSING ELEMENT.
3. FOR ELECTRICAL OPTIONS, CONNECTIONS AND TESTS, SEE APPLICABLE WIRING DIAGRAM.
2. DIMENSIONS IN BRACKETS [ ] ARE IN MILLIMETERS.
1. THIS DRAWING IS A REFERENCE DOCUMENT ONLY.
NOTES: UNLESS OTHERWISE SPECIFIED
NEXT ASSY USED ON
APPLICATION
THIRD ANGLE PROJECTION
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES
DECIMALS ANGULAR
.X ±.1 ±1°
.XX ±.03 ±1/2°
.XXX ±.010
MATERIAL
MACH SURFACE FINISH 125 RMS
MACH RAD: .030
DO NOT SCALE DRAWING
PARTS TO BE FREE OF BURRS & SHARP EDGES
CONTRACT NO.
APPROVALS
CONTRACT
QUAL
MFG N PETERS 09/02/08
CH W CRAIG 09/02/08
APPROVALS
DRAWN R DUCAR 08/21/08
CHECK EW 09/02/08
ENGR E WIBLE 09/02/08
FLUID COMPONENTS INTERNATIONAL LLC SAN MARCOS, CA 92078
TITLE
FLOW TRANSMITTER, ST51, LOCAL HAZARDOUS LOCATION TYPE 4X ENCLOSURE
SIZE B
CAGE CODE 64818
DWG NO. 004802
REV A
SCALE NONE
SHEET 1 OF 1


REMOTE ENCLOSURE
OPTIONAL DUAL LINE DIGITAL DISPLAY 90° INCREMENTAL ROTATION
2X 1/2" NPT PORT OPTIONAL M20
3.56 [90]
2.38 [60]
4.50 [114]
MOUNTING BRACKET WITH HEX REDUCER BUSHING (MOUNTING BRACKET ALLOWS ENCLOSURE TO BE POSITIONED TO VIEW AT ANY ANGLE)
3.10 [79]
.177 THK [5]
2.00 [51]
2X ø.26 [ø6.6] MTG HOLES
1.25 [32]
2.00 [51]
FIXED CABLE END
CABLE, 4 COND (2 PAIR) 22AWG, W/DRAIN (24GA)
FIX LENGTH, CABLE LENGTH ADJUSTMENT WILL AFFECT ACCURACY
LOCAL PROBE
ENCLOSURE MEETS EXPLOSION PROOF WATER AND DUST TIGHT APPROVALS (SEE MANUAL FOR SPECIFIC APPROVAL TYPES)
FLOW ARROW
SERIAL NUMBER
1/2 OR 3/4 INCH NPT PROCESS CONNECTION
U LENGTH
ø.56 [ø14]
ADJUSTABLE COMPRESSION FITTING, OPTIONAL TEFLON OR METAL FERRULE 6
MOUNTING ORIENTATION OF FLATS TO BE PARALLEL TO FLOW
4.00 [102] MAX
3.56 [90]
3.28 [83]
INTERCONNECTING CABLE
2X 1/2" NPT OPTIONAL M20
REDUCER BUSHING
3.90 [99]
SPECIFICATIONS:
CUSTOMER:
PURCHASE ORDER NO.:
CUSTOMER ORDER NO.:
WETTED SURFACE MATERIAL:
FERRULE TYPE:
U LENGTH:
SERIAL NO.(S):
TAG NO.(S):
OUTLINE/INSTALLATION DRAWING
FLUID COMPONENTS INTERNATIONAL LLC SAN MARCOS, CA 92078
FLOW TRANSMITTER, ST51, HAZARDOUS LOCATIONS, LOCAL AND REMOTE TYPE 4X ENCLOSURES
CAGE CODE 64818
DWG NO. 004805
REV –
SCALE NONE
SHEET 1 OF 1
THIRD ANGLE PROJECTION
DO NOT SCALE DRAWING
PARTS TO BE FREE OF BURRS & SHARP EDGES
NEXT ASSY
USED ON
APPLICATION
MATERIAL
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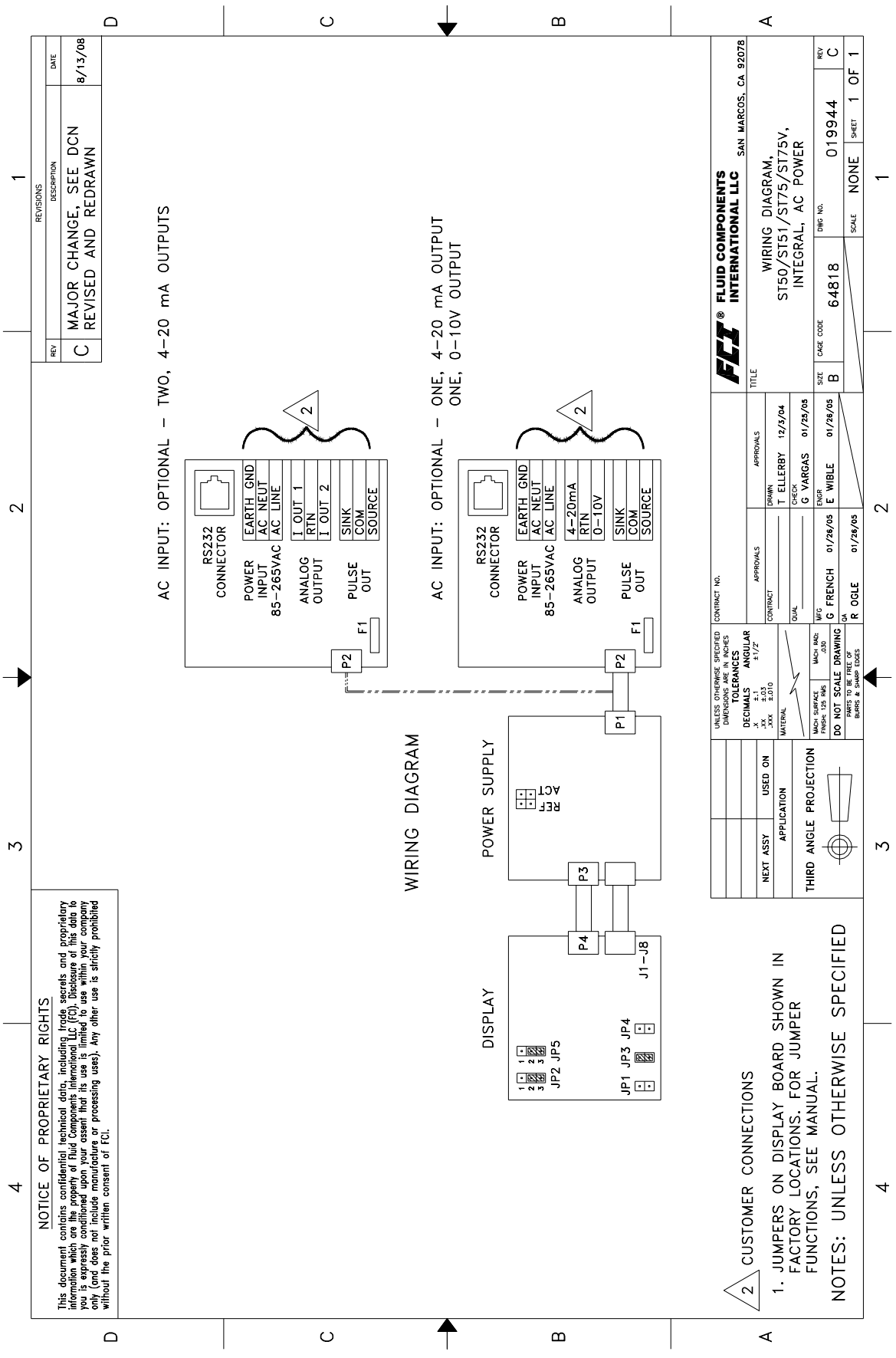
6 PROCESS CONNECTION: TEFLON FERRULE: 150 PSIG MAX @ 200°F. STAINLESS STEEL FERRULE: 500 PSIG MAX @ 250°F.
5. SEE INSTRUMENT MANUAL FOR ADDITIONAL INFORMATION AND INSTRUCTION.
4. ALL ORIENTATION AND/OR MOUNTING REFERENCES ARE INDICATED FROM TERMINAL ENCLOSURE END OF SENSING ELEMENT.
3. FOR ELECTRICAL OPTIONS, CONNECTIONS AND TESTS, SEE APPLICABLE WIRING DIAGRAM.
2. DIMENSIONS IN BRACKETS [ ] ARE IN MILLIMETERS.
1. THIS DRAWING IS A REFERENCE DOCUMENT ONLY.
NOTES: UNLESS OTHERWISE SPECIFIED


REVISIONS
REV DESCRIPTION DATE
C MAJOR CHANGE, SEE DCN REVISED AND REDRAWN 8/13/08
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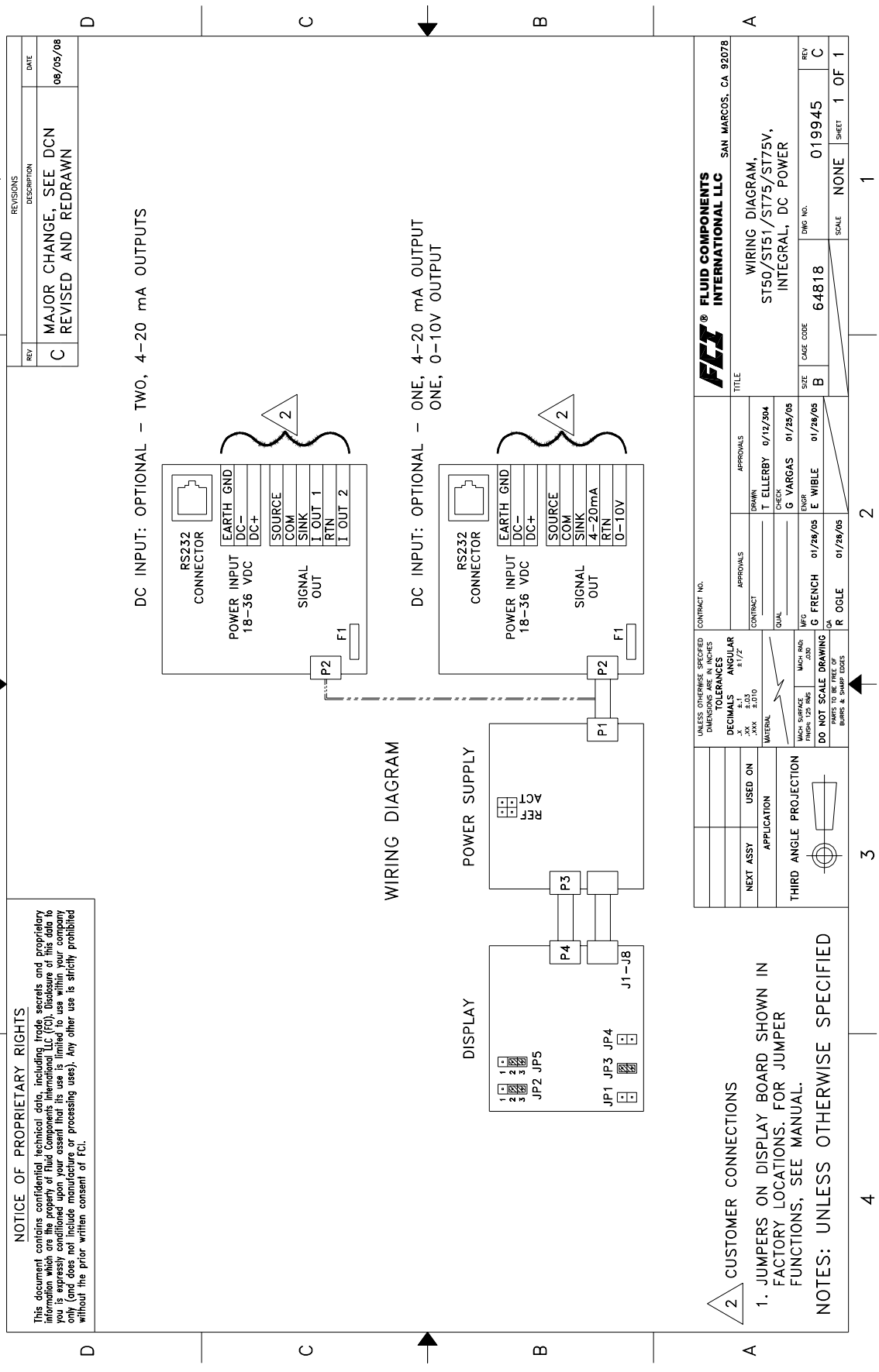
AC INPUT: OPTIONAL – TWO, 4–20 mA OUTPUTS
RS232 CONNECTOR
POWER INPUT 85–265VAC
EARTH GND
AC NEUT
AC LINE
ANALOG OUTPUT
I OUT 1
RTN
I OUT 2
PULSE OUT
SINK
COM
SOURCE
P2
F1
2
AC INPUT: OPTIONAL – ONE, 4–20 mA OUTPUT
ONE, 0–10V OUTPUT
RS232 CONNECTOR
POWER INPUT 85–265VAC
EARTH GND
AC NEUT
AC LINE
ANALOG OUTPUT
4–20mA
RTN
0–10V
PULSE OUT
SINK
COM
SOURCE
P2
F1
2
WIRING DIAGRAM
POWER SUPPLY
P1
P3
P4
J1–J8
DISPLAY
JP1 JP3 JP4
JP2 JP5
2 CUSTOMER CONNECTIONS
1. JUMPERS ON DISPLAY BOARD SHOWN IN FACTORY LOCATIONS. FOR JUMPER FUNCTIONS, SEE MANUAL.
NOTES: UNLESS OTHERWISE SPECIFIED
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMALS ANGULAR
X ±.1 ±1/2°
.XX ±.03
.XXX ±.010
MATERIAL
MACH SURFACE FINISH: 125 RMS
MACH RADII .030
DO NOT SCALE DRAWING
PARTS TO BE FREE OF BURRS & SHARP EDGES
THIRD ANGLE PROJECTION
NEXT ASSY USED ON
APPLICATION
CONTRACT NO.
APPROVALS
CONTRACT
QUAL
MFG G FRENCH 01/26/05
DA R OGLE 01/26/05
APPROVALS
DRAWN T ELLERBY 12/3/04
CHECK G VARGAS 01/25/05
ENGR E WIBLE 01/25/05
FLUID COMPONENTS INTERNATIONAL LLC
SAN MARCOS, CA 92078
TITLE
WIRING DIAGRAM, ST50/ST51/ST75/ST75V, INTEGRAL, AC POWER
SIZE B
CAGE CODE 64818
DWG NO. 019944
REV C
SCALE NONE
SHEET 1 OF 1


REVISIONS
REV
DESCRIPTION
DATE
C MAJOR CHANGE, SEE DCN REVISED AND REDRAWN 08/05/08
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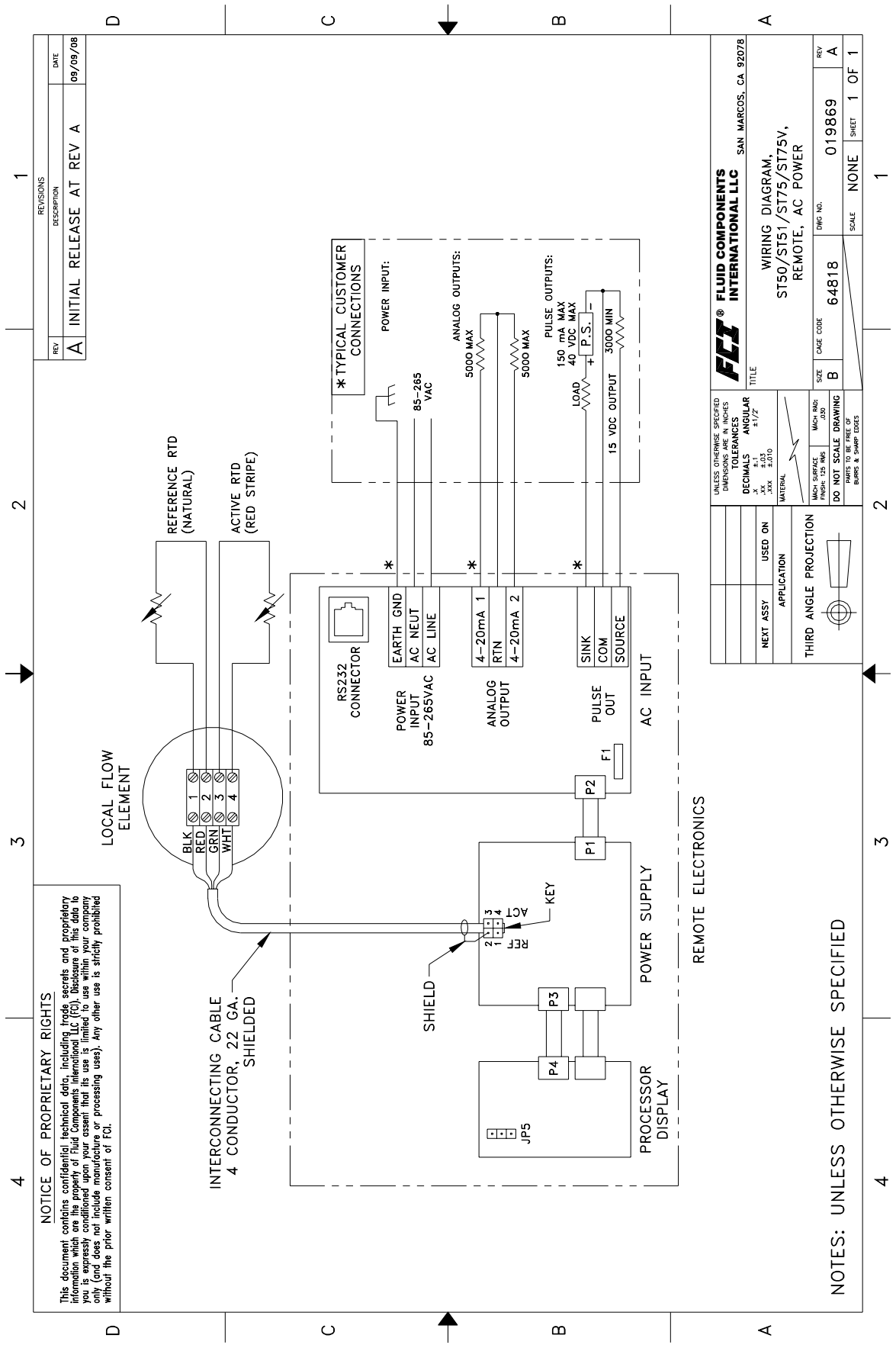
DC INPUT: OPTIONAL – TWO, 4–20 mA OUTPUTS
DC INPUT: OPTIONAL – ONE, 4–20 mA OUTPUT ONE, 0–10V OUTPUT
RS232 CONNECTOR
POWER INPUT 18–36 VDC
SIGNAL OUT
EARTH GND
DC–
DC+
SOURCE
COM
SINK
I OUT 1
RTN
I OUT 2
4–20mA
0–10V
P1
P2
P3
P4
F1
WIRING DIAGRAM
POWER SUPPLY
DISPLAY
REF
ACT
JP1 JP3 JP4
JP2 JP5
J1–J8
2 CUSTOMER CONNECTIONS
1. JUMPERS ON DISPLAY BOARD SHOWN IN FACTORY LOCATIONS. FOR JUMPER FUNCTIONS, SEE MANUAL.
NOTES: UNLESS OTHERWISE SPECIFIED
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMALS X ±.1 .XX ±.03 .XXX ±.010
ANGULAR ±1/2°
MATERIAL
MACH SURFACE FINISH 125 RMS
MACH RAD .030
DO NOT SCALE DRAWING
PARTS TO BE FREE OF BURRS & SHARP EDGES
THIRD ANGLE PROJECTION
NEXT ASSY
USED ON
APPLICATION
CONTRACT NO.
APPROVALS
CONTRACT
QUAL
MFG G FRENCH 01/26/05
QA R OGLE 01/26/05
DRAWN T ELLERBY 0/12/304
CHECK G VARGAS 01/25/05
ENGR E WIBLE 01/26/05
FLUID COMPONENTS INTERNATIONAL LLC SAN MARCOS, CA 92078
TITLE
WIRING DIAGRAM, ST50/ST51/ST75/ST75V, INTEGRAL, DC POWER
SIZE B
CAGE CODE 64818
DWG NO. 019945
REV C
SCALE NONE
SHEET 1 OF 1


REVISIONS
REV
DESCRIPTION
DATE
A
INITIAL RELEASE AT REV A
09/09/08
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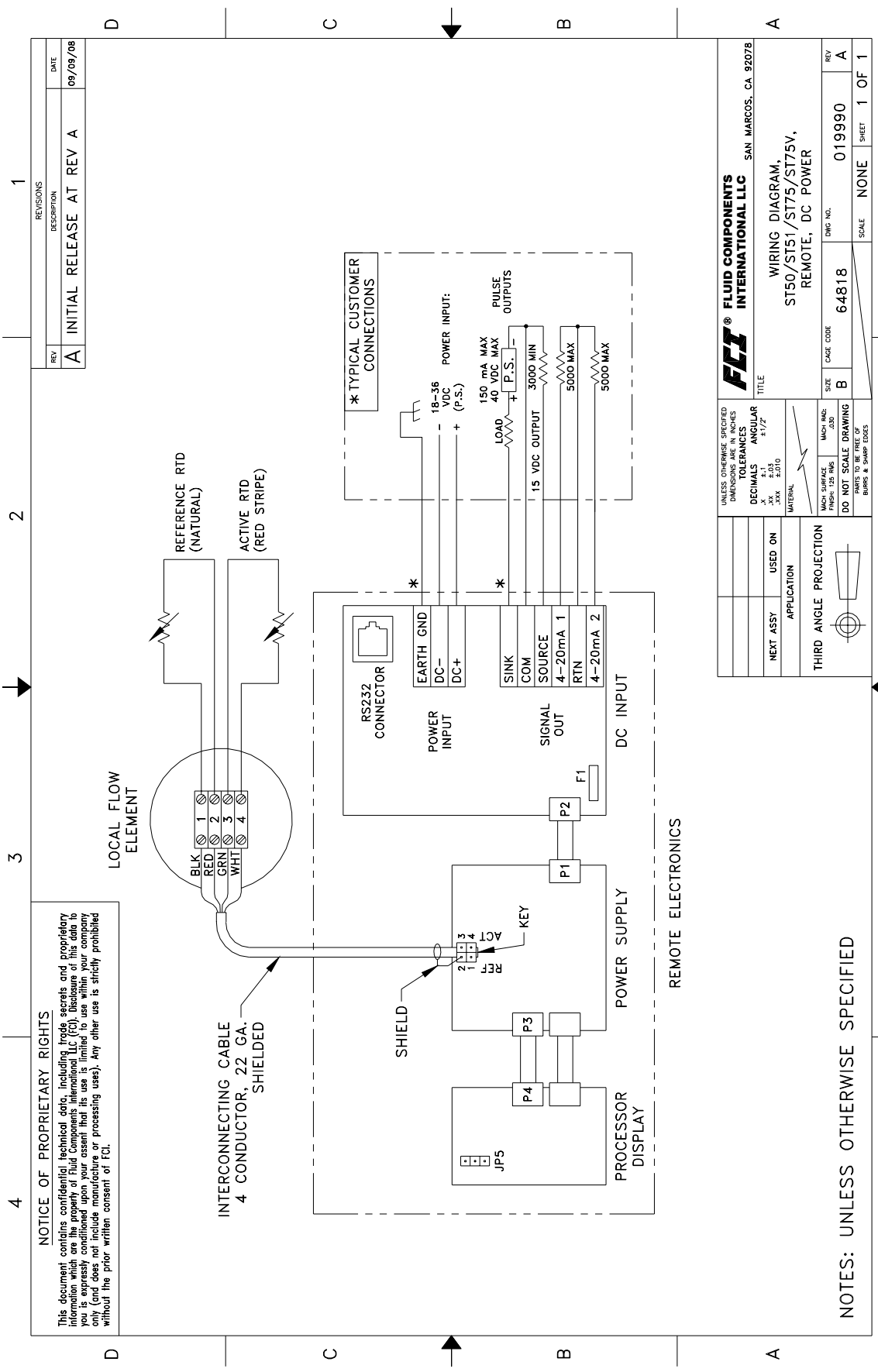
LOCAL FLOW ELEMENT
REFERENCE RTD (NATURAL)
ACTIVE RTD (RED STRIPE)
BLK
RED
GRN
WHT
1
2
3
4
INTERCONNECTING CABLE
4 CONDUCTOR, 22 GA.
SHIELDED
SHIELD
REF
ACT
KEY
JP5
P1
P2
P3
P4
F1
RS232 CONNECTOR
POWER INPUT 85-265VAC
EARTH GND
AC NEUT
AC LINE
ANALOG OUTPUT
4-20mA 1
RTN
4-20mA 2
PULSE OUT
SINK
COM
SOURCE
AC INPUT
POWER SUPPLY
PROCESSOR DISPLAY
REMOTE ELECTRONICS
*TYPICAL CUSTOMER CONNECTIONS
POWER INPUT:
85-265 VAC
ANALOG OUTPUTS:
500Ω MAX
500Ω MAX
PULSE OUTPUTS:
150 mA MAX
40 VDC MAX
LOAD
15 VDC OUTPUT
3000 MIN
P.S.
NOTES: UNLESS OTHERWISE SPECIFIED
FLUID COMPONENTS INTERNATIONAL LLC
SAN MARCOS, CA 92078
TITLE
WIRING DIAGRAM,
ST50/ST51/ST75/ST75V,
REMOTE, AC POWER
SIZE
B
CAGE CODE
64818
DWG NO.
019869
REV
A
SCALE
NONE
SHEET
1 OF 1
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMALS
ANGULAR
MACH SURFACE FINISH: 125 RMS
MACH RADII: .030
DO NOT SCALE DRAWING
PARTS TO BE FREE OF BURRS & SHARP EDGES
MATERIAL
NEXT ASSY
USED ON
APPLICATION
THIRD ANGLE PROJECTION


REVISIONS
REV DESCRIPTION DATE
A INITIAL RELEASE AT REV A 09/09/08
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LOCAL FLOW ELEMENT
REFERENCE RTD (NATURAL)
ACTIVE RTD (RED STRIPE)
BLK 1
RED 2
GRN 3
WHT 4
INTERCONNECTING CABLE 4 CONDUCTOR, 22 GA. SHIELDED
SHIELD
REMOTE ELECTRONICS
POWER SUPPLY
PROCESSOR DISPLAY
DC INPUT
RS232 CONNECTOR
POWER INPUT
EARTH GND
DC–
DC+
SIGNAL OUT
SINK
COM
SOURCE
4–20mA 1
RTN
4–20mA 2
F1
P1
P2
P3
P4
JP5
KEY
REF
ACT
* TYPICAL CUSTOMER CONNECTIONS
18–36 VDC (P.S.)
POWER INPUT:
150 mA MAX
40 VDC MAX
P.S.
LOAD
15 VDC OUTPUT
PULSE OUTPUTS
3000 MIN
5000 MAX
5000 MAX
NOTES: UNLESS OTHERWISE SPECIFIED
FLUID COMPONENTS INTERNATIONAL LLC SAN MARCOS, CA 92078
TITLE
WIRING DIAGRAM, ST50/ST51/ST75/ST75V, REMOTE, DC POWER
SIZE B
CAGE CODE 64818
DWG NO. 019990
REV A
SCALE NONE
SHEET 1 OF 1
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES
DECIMALS .X ±.1 .XX ±.03 .XXX ±.010
ANGULAR ±1/2°
MATERIAL
MACH SURFACE FINISH: 125 RMS
MACH RAD: .030
DO NOT SCALE DRAWING
PARTS TO BE FREE OF BURRS & SHARP EDGES
NEXT ASSY
USED ON
APPLICATION
THIRD ANGLE PROJECTION

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Appendix D - Customer Service

Customer Service/ Technical Support

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

By Mail

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

By Phone

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

By Fax

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

By E-Mail

FCI Customer Service can be contacted by e-mail at: techsupport@fluidcomponents.com.
Describe the problem in detail making sure a telephone number and best time to be contacted is stated in the e-mail.

International Support

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

After Hours Support

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

Point of Contact

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

Warranty Repairs or Returns

FCI prepays ground transportation charges for return of freight to the customer's door. FCI reserves the right to return equipment by the carrier of our choice.

International freight, handling charges, duty/entry fees for return of equipment are paid by the customer.

Non-Warranty Repairs or Returns

FCI returns repaired equipment to the customer either collect or prepaid and adds freight charges to the customer invoice.

Return to Stock Equipment

The customer is responsible for all shipping and freight charges for equipment that is returned to FCI stock from the customer site. These items will not be credited to customer's account until either all freight charges are cleared or until the customer agrees to have any freight costs incurred by FCI deducted, along with applicable return to stock charges, from the credit invoice. (Exceptions are made for duplicate shipments made by FCI.)

If any repair or return equipment is received at FCI, freight collect, without prior factory consent, FCI bills the sender for these charges.

Field Service Procedures

Contact an FCI field representative to request field service.

A field service technician is dispatched to the site from either the FCI factory or one of the FCI representative offices. After the work is complete, the technician completes a preliminary field service report at the customer site and leaves a copy with the customer.

Following the service call, the technician completes a formal, detailed service report. The formal report is mailed to the customer within five days of the technician's return to the factory or office.

Field Service Rates

All field service calls are billed at the prevailing rates as listed in the FCI Price Book unless specifically excepted by the FCI Customer Service Manager. FCI reserves the right to bill for travel times at FCI's discretion.

Customers are charged for shipping costs related to the transfer of equipment to and from the job site. They are also invoiced for field service work and travel expenses by FCI's Accounting Department.

FLUID COMPONENTS INTERNATIONAL LLC

Fax Cover Sheet

Company: _____ Date: _____

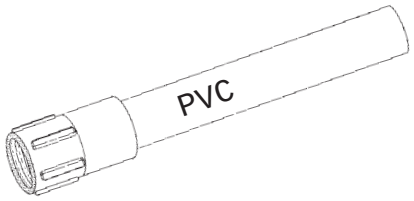
Attention: _____ Dept: _____

Fax No: _____ Direct Phone: _____

From: _____ No. of Pages: _____

To expedite repairs the following Return Authorization Request form ***must be completed and faxed back to FCI before*** a Return Authorization Number will be issued. The Decontamination Statement ***must be signed*** and Applicable MSDS Sheets ***must be included with the shipment.*** FCI will either fax or telephone you with the Return Authorization Number upon receipt of the completed form.

Anti-Static Bag



Probe protector

Packing Procedures

1. **Electronics** should be wrapped in an **anti-static** or **static-resistant** bag (FCI can provide), then wrapped in protective bubble wrap and surrounded with appropriate dunnage* in a box. Instruments weighing up to **50 lbs**., should be wrapped in protective wrap and surrounded with appropriate dunnage* in a box. Instruments weighing **more than 50 lbs**., **or extending more than four feet** should be secured in wooden crates by bolting the assemblies in place.
2. **The sensor element must be protected** with tubing or other sturdy wrapping or, when applicable, retracted completely and secured into the Packing Gland Assembly. FCI will supply suitable probe protectors at your request (see diagram - right).
3. FCI can supply crates at a nominal fee.
4. No more than **four (4)** small units packaged in each carton.
5. Packages weighing in excess of **70 lbs**., **or with the combined length and girth of more than 138"** cannot be shipped via UPS and should be shipped via carriers who specialize in the transport of industrialized instrumentation.
6. FCI will not be held liable for damage caused during shipping.
7. To ensure immediate processing **mark** the RA number on the outside of the box. Items without an RA number marked on the box or crate may be delayed.
8. Freight **Must be "PrePaid"** to FCI receiving door.

Factory Return Shipping Address:

Fluid Components International LLC
1755 La Costa Meadows Drive
San Marcos, CA 92078-5115
Attn: Repair Department,
RA #_____

* *Approriate dunnage as defined by UPS, will protect package contents from a drop of 3 feet.*

Visit FCI on the Worldwide Web: www.fluidcomponents.com
1755 La Costa Meadows Drive, San Marcos, California 92078 USA ‡ Phone: 760-744-6950 ‡ 800-854-1993 ‡ Fax: 760-736-6250

FCI FLUID COMPONENTS INTERNATIONAL LLC
1755 La Costa Meadows Drive, San Marcos, CA 92078-5115 USA
760-744-6950 / 800-854-1993 / Fax: 760-736-6250
Web Site: www.fluidcomponents.com / E-mail: techsupport@fluidcomponents.com

RA #_____

Return Authorization Request

1. Return Customer Information

Returning Company's Name:_____ Fax # _____

Return Contact Name: _____ Phone #_____

Email Address: _____

2. Return Address

Bill To: _____ Ship To: _____

_____ _____

_____ _____

_____ _____

3. Return Product Information

Model No: _____ Serial No(s): _____

Failure Symptoms *(Detailed Description Required):* _____

_____

What Trouble Shooting Was Done Via Phone or Field Visit by FCI: _____

_____

FCI Factory Technical Service Contact: _____

4. Reason For Return ❑ Sensor Element ❑ Electronics ❑ As Found Testing ❑ Credit
❑ Recalibrate (Old Data) ❑ Recalibrate (New Data) ❑ Other

(Note: A new Application Data Sheet (ADS) must be submitted for all recalibrations and re-certifications)

5. Payment Via ❑ Faxed Purchase Order ❑ VISA ❑ MasterCard

(Note: A priced quotation is provided for all Non-Warranty repairs after equipment has been evaluated.
All Non-Warranty repairs are subject to a minimum evaluation charge)

❑ Sensor Element Protector Requested ❑ Electronics Anti-Static Bag Requested

Decontamination Information ! This Section Must Be Completed !

Exposure to hazardous materials is regulated by Federal, State (California), County and City laws and regulations. These laws provide FCI's employees with the "Right to Know" the hazardous or toxic materials or substances in which they may come in contact while handling returned products. Consequently, our employees must have access to data regarding the hazardous or toxic materials or substances which the equipment has been exposed to in your process(es). Accordingly, prior to returning your instrument for evaluation/repair, please read then sign the certification below and thoroughly comply with the applicable instructions.

I certify that the returned item(s) has(have) been thoroughly and completely cleaned. If the returned item(s) has(have) been exposed to hazardous or toxic materials or substances, the undersigned attests that the attached Material Safety Data Sheet(s) (MSDS) which cover said materials or substances are complete and accompany the returned item(s). Furthermore, I understand that this Certificate, or providing a MSDS, shall not waive our responsibility to provide a neutralized, decontaminated, and clean product for evaluation/repair to FCI. Cleanliness of a returned item or the acceptability of the MSDS shall be at the sole discretion of FCI. Any item returned which does not comply with these instructions shall be returned to your location Freight Collect and at your risk.

Process Flow Media _____

Authorized Signature _____ Date _____

FCI Document No. 05CS000004A

Instrument Warranty

Goods furnished by the Seller are to be within the limits and of the sizes published by the Seller and subject to the Seller's standard tolerances for variations. All items made by the Seller are inspected before shipment, and should any of said items prove defective due to faults in manufacture or performance under Seller approved applications, or fail to meet the written specifications accepted by the Seller, they will be replaced or repaired by Seller at no charge to Buyer provided return or notice of rejection of such material is made within a reasonable period but in no event longer than one (1) year for non-calibration defects and one (1) year for calibration defects from date of shipment to Buyer, and provided further, that an examination by Seller discloses to Seller's reasonable satisfaction that the defect is covered by this warranty and that the Buyer has not returned the equipment in a damaged condition due to Buyer's or Buyer's employees', agents', or representatives' negligence and Buyer has not tampered, modified, redesigned, misapplied, abused, or misused the goods as to cause the goods to fail. In addition, this warranty shall not cover damage caused by Buyer's exposure of the goods to corrosive or abrasive environments. Moreover, Seller shall in no event be responsible for (1) the cost or repair of any work done by Buyer on material furnished hereunder (unless specifically authorized in writing in each instance by Seller), (2) the cost or repair of any modifications added by a Distributor or a third party, (3) any consequential or incidental damages, losses, or expenses in connection with or by reason of the use of or inability to use goods purchased for any purpose, and Seller's liability shall be specifically limited to free replacement, or refund of the purchase price, at Seller's option, provided return or rejection of the goods is made consistent with this paragraph, and the Seller shall in no event be liable for transportation, installation, adjustment, loss of good will or profits, or other expenses which may arise in connection with such returned goods, or (4) the design of products or their suitability for the purpose for which they are intended or used. Should the Buyer receive defective goods as defined by this paragraph, the Buyer shall notify the Seller immediately, stating full particulars in support of his claim, and should the Seller agree to a return of the goods, the Buyer shall follow Seller's packaging and transportation directions explicitly. In no case are the goods to be returned without first obtaining a return authorization from the Seller. Any repair or replacement shall be at Seller's factory, unless otherwise directed, and shall be returned to Seller transportation prepaid by Buyer. If the returned goods shall prove defective under this clause they will be replaced or repaired by Seller at no charge to Buyer provided the return or rejection of such material is made within a reasonable period, but in no event longer than (1) year from the date of shipment of the returned goods or the unexpired terms of the original warranty period whichever is later. If the goods prove to be defective under this paragraph, the Buyer shall remove the goods immediately from the process and prepare the goods for shipment to Seller. Continued use or operation of defective goods is not warranted by Seller and damage occurring due to continued use or operation shall be for Buyer's account. Any description of the goods contained in this offer is for the sole purpose of identifying them, and any such description is not part of the basis of the bargain, and does not constitute a warranty that the goods will conform to that description. The use of any sample or model in connection with this offer is for illustrative purposes only, is not part of the basis of the bargain, and is not to be construed as a warranty that the goods will conform to the sample or model. No affirmation of that fact or promise made by the Seller, whether or not in this offer, will constitute a warranty that the goods will conform to the affirmation or promise. THIS WARRANTY IS EXPRESSLY IN LIEU OF ANY AND ALL OTHER EXPRESS OR IMPLIED WARRANTIES WITH RESPECT TO THE GOODS OR THEIR INSTALLATION, USE, OPERATION, REPLACEMENT OR REPAIR, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS OF PURPOSE; AND THE GOODS ARE BEING PURCHASED BY BUYER "AS IS". SELLER WILL NOT BE LIABLE BY VIRTUE OF THIS WARRANTY OR OTHERWISE FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL LOSS OR DAMAGE RESULTING FROM THE USE OR LOSS OF USE OF THE GOODS.

FCI's Complete Customer Commitment. Worldwide
ISO 9001:2000 and AS9100 Certified

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

1755 La Costa Meadows Drive, San Marcos, California 92078 USA - 760-744-6950 - 800-854-1993 - Fax 760-736-6250

APPENDIX C

CUT SHEETS AND MANUALS FOR THE CO_2 CONTENT FYRITE GAS ANALYZER MODEL 10-5032, BACHARACH, INC.

Fyrite®
Gas Analyzers

Fast, accurate and easy to use instruments for measuring and analyzing carbon dioxide or oxygen. Fyrite Analyzers are available for either CO_2 or O_2 analysis, and each model is produced in three scale ranges.

All six instruments are similar in appearance and size, but differ in important construction details, as well as in the absorbing fluids.

Each model, therefore, is suitable only for the particular gas analysis or scale range for which it has been manufactured. Accuracy is within $\pm$1/2% CO_2 or O_2.

Operation

Fyrite absorbing fluid is selective in the chemical absorption of carbon dioxide or oxygen, respectively. Therefore, the Fyrite's accuracy, which is well within the range required for industrial and professional applications, does not depend upon complicated sequential test procedures. In addition, Fyrite readings are unaffected by the presence of most background gases in the sample.

The number of tests possible with one fluid charge depends on the concentration of samples being tested. At midpoint scale reading the CO_2 fluid is good for approximately 300 gas samples and the O_2 fluid for 100 tests. The need to replace fluid can be easily determined with a simple test, and replacement is an easy procedure. These test procedures, as well as other good information, are provided in the Fyrite manual 11-9026.

Features

Fyrite Indicators have a broad range; they may be exposed to ambient temperatures from -30° to 150°F, and gases up to 850°F may be tested with standard aspirator sampling equipment (special sampling equipment for higher gas temperatures or dry gases is available). Order Fyrite Instruction Manual 11-9026. For temperatures above 1400°F, a ceramic sampling tube (Bacharach Part # 11-0164) is available.

Applications

0-7.6% CO_2 –
CO_2 tests of controlled atmospheres in fruit, vegetable, meat storage rooms, and incubator monitoring.

0-7.6% O_2 –
Oxygen determination in flammable gases; oxygen tests to check inertness of atmosphere in silos, fuel tanks, etc.

0-20% CO_2 –
Flue gas combustion tests; CO_2 tests of heat treating atmospheres.

0-21% O_2 –
Flue gas combustion tests, oxygen deficiency test. Checking oxygen concentrations in hydrogen cooled generators and oil sealed inert gas transformers.

0-60% CO_2 –
Checking CO_2 in inert gas blankets in tankers and barges carrying gasoline and other combustibles; CO_2 tests on lime kilns; checking CO_2 in sewage plant digesters.

0-60% O_2 –
Oxygen test in connection with oxygen and gas anesthesiology.

Note: United States and Foreign Postal Regulations prohibit Fyrite fluid, in or out of any unit, from being shipped parcel post.

Single Kits - Single Kits contain either a Fyrite CO_2 or a Fyrite O_2 Indicator, Sampling Assembly and a carrying case.

Duplex Kits - Special Fyrite Kits containing various combinations of Oxygen and Carbon Dioxide Indicators, Sampling Assembly and a carrying case.

Repair Kits - One bottle of Fyrite fluid, valve plunger gasket, top gasket, screws, diaphragm, and envelope of filtering material.

Refill Kits - Two bottles of Fyrite fluid, top gasket, screws, and envelope of filtering material.

USA

COMPLETE KIT ITEM NO.[1]	SCALE RANGE	FYRITE	ASPIRATOR ASSEMBLY
CO_2 Testing			
10-5053	0-7.6%	11-7042	11-7039
10-5000[2]	0-20%	11-7032	11-7029
10-5032	0-60%	11-7034	11-7029
O_2 Testing			
10-5054	0-7.6%	11-7044	11-7039
10-5011	0-21%	11-7036	11-7029
10-5046	0-60%	11-7038	11-7029

EXPORT

COMPLETE KIT ITEM NO.[3]	SCALE RANGE	FYRITE (DRY)	ASPIRATOR ASSEMBLY
CO_2 Testing			
10-5083	0-7.6%	11-7041	11-7039
10-5001	0-20%	11-7031	11-7029
10-5033	0-60%	11-7033	11-7029
O_2 Testing			
10-5084	0-7.6%	11-7043	11-7039
10-5012	0-21%	11-7035	11-7029
10-5042	0-60%	11-7037	11-7029

DUPLEX KITS

COMPLETE KIT ITEM NO.[4]	CO_2 FYRITE	OXYGEN FYRITE	ASSEMBLY ITEM NO.
10-5020	0-20%	0-21%	11-7029
10-5021[4]	0-20%	0-21%	11-7029
10-5090[5,6]	0-7.6%	0-7.6%	11-7039
10-5106[5,6]	0-7.6%	0-21%	11-7039
10-5111[5,6]	0-60%	0-21%	11-7029

[1]Domestic shipments only
[2]Also includes Fire Efficiency Finder
[3]Export use only. Kits shipped without fluid.
[4]Export only
[5]Special order only: check factory for price and availability
[6]No export equivalent. Order components separately

FYRITE FLUID*

GAS TYPE	RANGE	ITEM NO. 3 BOTTLE CTN.
Carbon Dioxide		
	0-7.6%	10-5100 (11-0053)
	0-20%	10-5057 (11-0057)
	0-60%	10-5057 (11-0057)
Oxygen		
	0-7.6%	10-5103 (11-0059)
	0-21%	10-5060 (11-0169)
	0-60%	10-5060 (11-0169)

REPAIR KITS

GAS TYPE	RANGE	ITEM NO.
Carbon Dioxide	0-7.6%	11-7053
	0-20%	11-7052
	0-60%	11-7052
Oxygen	0-7.6%	11-7055
	0-21%	11-7054
	0-60%	11-7054

REFILL KITS

GAS TYPE	RANGE	ITEM NO.
Carbon Dioxide	0-7.6%	not available
	0-20%	11-7047
	0-60%	11-7047
Oxygen	0-7.6%	not available
	0-21%	11-7050
	0-60%	11-7050

**Note: Only genuine Bacharach Fyrite Fluid is to be used in your Fyrite Analyzer. Substitute fluids may cause the Fyrite to be inaccurate or inoperative. Numbers in parentheses are old part numbers for reference only and not to be used for ordering.*

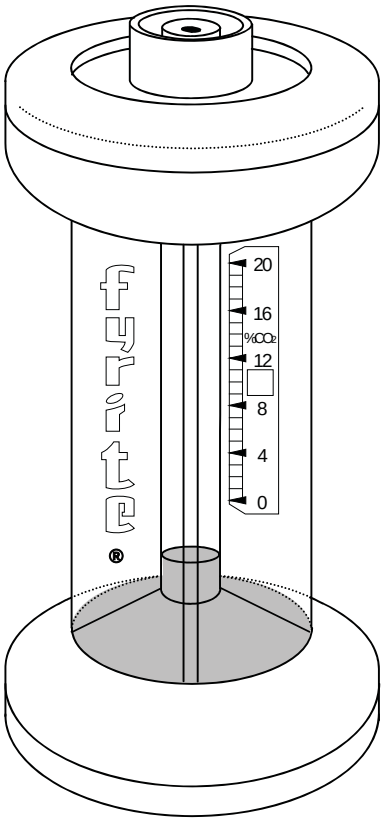
BACHARACH®
The Measurable Difference

INSTRUCTION 0011-9026

FYRITE® Gas Analyzer

CO_2 and O_2 Indicators

Operation/Maintenance
Rev. 11 – May 2010



Printed in U.S.A.

WARRANTY

Bacharach, Inc. warrants to Buyer that at the time of delivery this Product will be free from defects in material and manufacture and will conform substantially to Bacharach Inc.'s applicable specifications. Bacharach's liability and Buyer's remedy under this warranty are limited to the repair or replacement, at Bacharach's option, of this Product or parts thereof returned to Seller at the factory of manufacture and shown to Bacharach Inc.'s reasonable satisfaction to have been defective; provided that written notice of the defect shall have been given by Buyer to Bacharach Inc. within one (1) year after the date of delivery of this Product by Bacharach, Inc.

Bacharach, Inc. warrants to Buyer that it will convey good title to this Product. Bacharach's liability and Buyer's remedy under this warranty of title are limited to the removal of any title defects or, at the election of Bacharach, to the replacement of this Product or parts thereof that are defective in title.

The warranty set forth in paragraph 1 does not apply to parts the Operating Instructions designate as having a limited shelf-life or as being expended in normal use.

THE FOREGOING WARRANTIES ARE EXCLUSIVE AND ARE GIVEN AND ACCEPTED IN LIEU OF (I) ANY AND ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION THE IMPLIED WARANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE: AND (II) ANY OBLIGATION, LIABILITY, RIGHT, CLAIM OR REMEDY IN CONTACT OR TORT, WHETHER OR NOT ARISING FROM BACHARACH'S NEGLIGENCE, ACTUAL OR IMPLIED. The remedies of the Buyer shall be limited to those provided herein to the exclusion of any and all other remedies including, without limitation incidental or consequential damages. No agreement varying or extending the foregoing warranties, remedies or this limitation will be binding upon Bacharach, Inc. unless in writing, signed by a duly authorized officer of Bacharach.

NOTE: Gaskets are considered consumable items and are excluded from the terms of this warranty.

Register Your Warranty by Visiting
www.mybacharach.com

CAUTION

Corrosive fluid is contained inside this unit.
These instructions should be thoroughly
read before operation is attempted.

FYRITE SAFETY PRECAUTIONS

The operator (s) of this instrument should thoroughly familiarize themselves with the applicable safety precautions before handling or using the FYRITE for gas analysis.

Review Figures 1a,1b, 1c and 1d on this page. Make certain to follow the steps outlined below and read the fluid handling precautions for your personal safety.

1) Always use protective equipment such as safety goggles, gloves, and protective clothing as illustrated in Figure 1a.

2) Read the instruction manual thoroughly. When filling the FYRITE with the applicable fluid charge, use safety equipment and perform the operation in the vicinity of running tap water (Figure 1b).

3) The FYRITE fluid should always be in the bottom reservoir before and during sample introduction to the FYRITE. When venting the FYRITE to atmosphere, hold the instrument in the vertical position and at a location away from your face (Figure 1c).

4) NEVER vent FYRITE in the inverted position (with the plunger facing downward). This will cause fluid to spill, which is corrosive and contains harmful elements (Figure 1d).

   NOTE: In the event of fluid spill - refer to Section 2.2 (FYRITE Handling Precautions). For Maintenance - refer to Section 6.0.

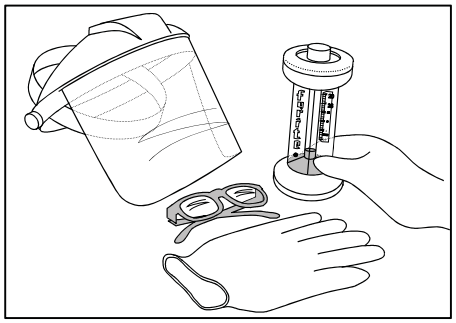


Figure 1a. Protective equipment required before attempting gas analysis.

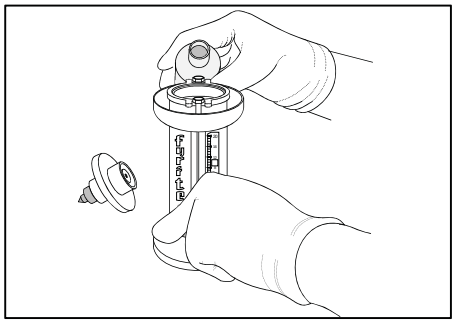


Figure 1b. Preparing to fill FYRITE using recommended protective safety equipment.

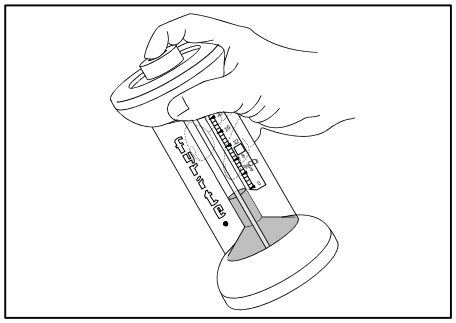


Figure 1c. Venting FYRITE to atomsphere at 45° angle.

Figure 1d. NEVER vent FYRITE in the inverted position, which will cause fluid to spill.

TABLE OF CONTENTS

INSTRUCTIONS 0011-9026
OPERATION/MAINTENANCE
BACHARACH FYRITE MODELS
CO_2 and O_2 INDICATORS

1.0 DESCRIPTION (Refer to Figure 1)

The FYRITE employs the well-known "Orsat" method of volumetric analysis involving chemical absorption of a sample gas, such as carbon dioxide or oxygen. The reagent used to absorb carbon dioxide (CO_2) is potassium hydroxide (dyed red), and chromous chloride (blue) is the absorbent for oxygen (O_2). The unique feature of the FYRITE is that the absorbing fluid is also used as the indicating fluid so that one vessel takes the place of both measuring burette and absorption pipette.

The body of the FYRITE is molded of clear high-strength plastic, comprises top and bottom reservoirs and a center tube connecting the two reservoirs. The bottom of the lower reservoir is sealed off by a synthetic rubber diaphragm that rests on a perforated metal plate. The upper reservoir is covered by a molded plastic cap that contains a double-seated plunger valve. A spring holds this valve against a carefully finished seat in the top cap providing a perfect seal which makes the instrument spill-proof in any position. When the valve is partially depressed, the entire instrument is open to the atmosphere and the instrument is, of course, is no longer spill-proof.

The bottom reservoir is filled with the absorbing fluid, which extends about 1/4 inch into the bore of the center tube when the instrument is held upright. The scale position, mounted to one side of the center tube, is adjustable.

2.0 FYRITE INSPECTION BEFORE AND DURING TEST

CAUTION

Corrosive fluid is contained inside unit, instructions should be thoroughly read before operation is attempted.

2.1 Pre-Operational Check

To ensure proper FYRITE operation and reliable results, check the following:

(a) With FYRITE vented and in a vertical position, it should be possible to adjust scale zero to the top of the fluid column. Refer to FYRITE Operation for proper setup (Section 3.0 Steps 1 through 5). If this is not possible, add or remove a small amount of fluid per Section 6.1.

(b) FYRITE Fluid Strength

To check fluid strength.

NOTE: When repeating procedures as outlined in Section 3.0 Steps 7 through 9 (absorbing and reading percent O_2 and absorbing and reading percent CO_2) and before venting FYRITE to atmosphere for next sample, if the reading increases by more than 1/2 percent for either CO_2 or O_2, replace the fluid.

It is often desirable to check fluid strength before taking the FYRITE to a location where it will be used. It can be tested on sample atmospheric air (which contains 20.9% O_2). Be certain to wet Filter Saturator when checking atmospheric air for maximum accuracy. (See Section 6.9)

O_2 (Oxygen) Fluid - Fresh FYRITE fluid will absorb all O_2 from approximately 100 samples containing 10% O_2.

CO_2 (Carbon Dioxide) Fluid - Fresh FYRITE Fluid will absorb all CO_2 from approximately 350 samples containing 10% CO_2.

(c) FYRITE Sampling Assembly - Always check sampling assembly for proper (leak-free) operation as outlined in Section 6.7 before proceeding with test.

(d) Make certain wool in Filter Saturator Tube is moistened with water if using either O_2 or CO_2 FYRITE in a noncombustible application where the gas sample is not fully saturated with water vapor. Examples where filter-saturator must be wetted include measuring CO_2 or O_2 in ambient air or from compressed gas samples. Refer to Section 6.9 when replacing or moistening saturator (wool) filter is required.

FYRITE OPERATION PRECAUTION: To prevent fluid spill, never depress Plunger Valve to vent FYRITE when unit is in the inverted or any other non-upright position. When depressing Plunger Valve in the upright position to vent FYRITE, hold at a slight angle away from the operator's face.

2.2 FYRITE FLUID HANDLING PRECAUTIONS

CAUTION

FYRITE fluids used in the CO_2 and O_2 analyzers are corrosive and contain poisonous elements which must not be taken internally. In the event of a spill or accidental body contact with FYRITE fluid, read the following carefully.

HAZARDS

Corrosive liquid causes burns. May cause blindness if splashed in eyes. Vapors are irritating and may be harmful.

PRECAUTIONS

Prevent contact with eyes, skin and clothing. Wear eye protection and gloves. Do not vent instrument until fluid has drained from top well. Do not vent instrument (FYRITE) in inverted position.

FIRST AID

For contact with eyes: Immediately flush eyes with water 20 minutes. Get immediate medical attention.

For contact with skin: Immediately flush skin with water 20 minutes. Get immediate medical attention.

For inhalation overexposure: If irritation develops, move victim to fresh air.

For swallowing: Do not induce vomiting. Give two glasses of water or milk if conscious and not convulsing. Get immediate medical attention.

Refer to the material safety data sheet for further information.

3.0 BASIC FYRITE OPERATION PERCENT CO_2 AND 0_2

Four basic steps are required when making an analysis, many being common to both the CO_2 and O_2 FYRITE.

FYRITE MODEL CO_2 (Red Fluid)	**FYRITE MODEL O_2 (Blue Fluid)**
(a) Vent and adjust scale zero.	(a) Vent and adjust scale zero.
(b) Pump sample into FYRITE.	(b) Pump sample into FYRITE.
(c) Absorb CO_2 from sample.	(c) Absorb O_2 from sample.
(d) Read % CO_2 on scale.	(d) Read % O_2 on scale.

NOTE: To prevent warming of FYRITE fluid during analysis, hold FYRITE by the fins only.

CO_2 FYRITE OPERATION (RED FLUID)

1. Hold upright (Fig. 1) and away from face. Depress Plunger Valve (momentarily) to vent FYRITE, and release.

2. Invert FYRITE (Fig. 2). Hold at slight angle to drain fluid into top reservoir.

3. Turn upright. Hold FYRITE at 45° angle (Fig. 3) momentarily to allow fluid droplet drainage into bottom reservoir.

4. Hold FYRITE in upright (Fig. 4) position and away from face. Depress Plunger Valve (momentarily) and release.

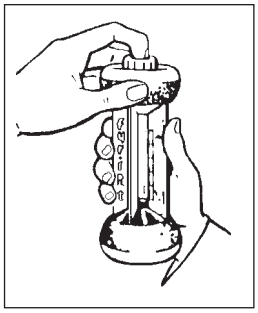


Figure 1

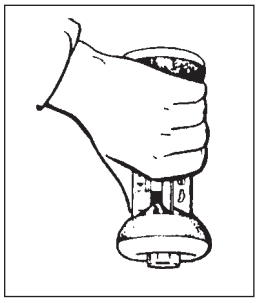


Figure 2

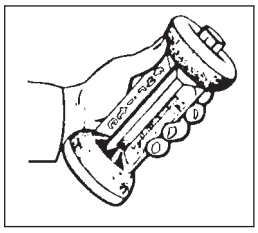


Figure 3

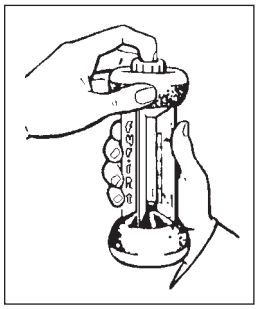


Figure 4

O_2 FYRITE OPERATION (BLUE FLUID)

1. Hold upright (Fig. 1) and away from face. Depress Plunger Valve (momentarily) to vent FYRITE, and release.

2. Invert FYRITE (Fig. 2) to absorb O_2 drawn into FYRITE whenever Plunger Valve is depressed). Hold at slight angle to drain fluid into top reservoir.

3. Turn upright. Hold FYRITE at 45° angle to drain fluid into bottom reservoir. Turn upright. Repeat sequence of Steps 1, 2, and 3 twice until fluid level does not drop more that 1/2% when Plunger Valve is depressed. Turn upright. Hold FYRITE at 45° angle (Fig. 3) momentarily until excess fluid droplets have been drained from inside surfaces.

4. Hold FYRITE in upright (Fig. 4) position and away from face. Note fluid level in column. Depress Plunger Valve (momentarily), and release.

CO_2 FYRITE OPERATION (RED FLUID)

5. Holding FYRITE upright (Fig. 5), loosen locknut at rear of scale. Slide scale (Fig. 5a) until top of fluid column lines up with zero line on scale (Fig. 5b). Tighten scale locknut.

   NOTE: When setting scale zero, hold FYRITE vertically as shown and level with eyes while sighting across scale to top of fluid column.

6. To pump gas sample into FYRITE (Fig. 6), insert open end of metal sampling tube into area bearing gas for analysis. Hold FYRITE in upright position and place sampling assembly rubber connector tip over the Plunger Valve.

   Depress Plunger Valve firmly with connector tip.

   Pump sample by squeezing and releasing aspirator bulb 18 times. During 18th bulb squeeze (with bulb held deflated) release connector tip and Plunger Valve.

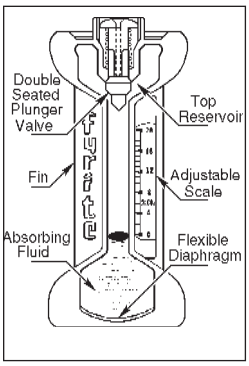


Figure 5

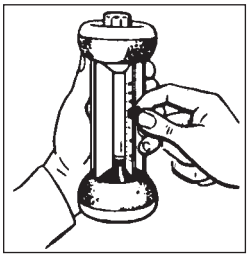


Figure 5a

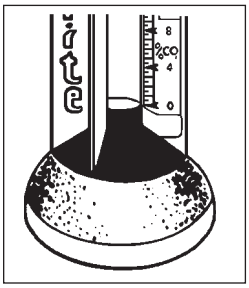


Figure 5b

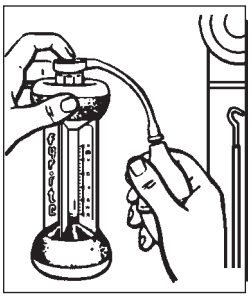


Figure 6

O_2 FYRITE OPERATION (BLUE FLUID)

5. Holding FYRITE upright (Fig. 5), loosen locknut at rear of scale. Slide scale (Fig. 5a) until top of fluid column lines up with zero line on scale (Fig. 5b). Tighten scale locknut.

   NOTE: When setting scale zero, hold FYRITE vertically as shown and level with eyes while sighting across scale to top of fluid column.

6. To pump gas sample into FYRITE (Fig. 6), insert open end of metal sampling tube into area bearing gas for analysis. Hold FYRITE in upright position and place sampling assembly rubber connector tip over the Plunger Valve.

   Depress Plunger Valve firmly with connector tip.

   Pump sample by squeezing and releasing aspirator bulb 18 times. During 18th bulb squeeze (with bulb held deflated) release connector tip and Plunger Valve.

CO_2 FYRITE OPERATION
(RED FLUID)

7. Absorb sample gas into FYRITE by inverting until fluid drains into top reservoir (Fig. 7). Then turn upright (Fig. 8) to drain fluid into bottom reservoir. Repeat this step once.

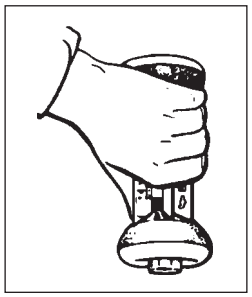


Figure 7

8. Hold FYRITE at 45° angle (Fig. 9) momentarily to allow fluid droplets to drain into the bottom reservoir.

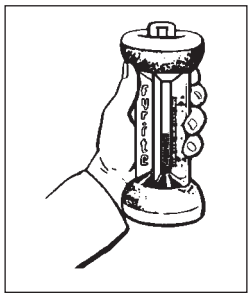


Figure 8

9. With FYRITE held upright (Fig. 10), permit fluid in column to stabilize a few seconds, then immediately read % carbon dioxide on scale at the point corresponding to top of the fluid column.

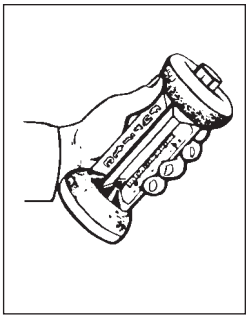


Figure 9

O_2 FYRITE OPERATION
(BLUE FLUID)

7. Absorb sample gas into FYRITE by inverting until fluid drains into top reservoir (Fig. 7). Then turn upright (Fig. 8) to drain fluid into bottom reservoir. Repeat this step three (3) more times (four complete inversions total).

8. Hold FYRITE at 45° angle (Fig. 9) momentarily to allow fluid droplets to drain into the bottom reservoir.

9. With FYRITE held upright (Fig. 10), permit fluid in column to stabilize a few seconds, then immediately read % oxygen on scale at the point corresponding to top of the fluid column.

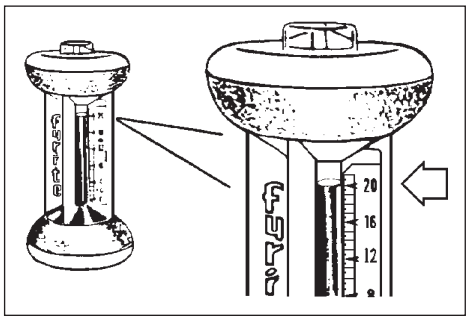


Figure 10

10. This step completes CO_2 or O_2 FYRITE gas sample analysis. A few points to remember when reading the FYRITE:
    (a) FYRITE accuracy is within ±1/2% CO_2 or O_2 compared to actual value.

    (b) Always handle FYRITE by fins to ensure body heat is not absorbed by fluid.

    (c) A delay in reading of 5 or 10 seconds may decrease accuracy of reading slightly but longer delays may cause substantial error.

    (d) The FYRITE is calibrated to indicate on a "dry" basis for flue gas samples, which are normally fully saturated with moisture. Failure to artificially moisten wool packing in Filter Saturator Tube when actual sample is not fully saturated will cause FYRITE to read slightly low.

    Therefore, make certain wool packing in Filter Saturator Tube is sufficiently moistened with water for accurate results on non-flue gases. Avoid excessive moisture which can be drawn into the Aspirator Bulb and forced into the FYRITE during sampling.

CAUTION

Never depress plunger valve to vent FYRITE in the inverted position. This will cause fluid to spill, which is corrosive and contains poisonous elements. In the event of a spill, read Instructions in Section 2.2 FYRITE fluid handling precautions.

3.1 Determining CO_2 and O_2 FYRITE Fluid Strength

FYRITE Fluid strength can be conveniently checked immediately after the first sample reading. Without venting, repeat the absorbing operations (Steps 7 through 9) by inverting FYRITE again and positioning upright until all fluid drains to the bottom reservoir. Observe scale reading. An increase of more than 1/2% CO_2 or O_2 in the second reading as compared to the first indicates a need for fluid replacement.

3.2 Operating Precautions to Ensure Maximum Accuracy

Locate top of fluid column (refer to Fig. 11). The surface at the top of the fluid column (meniscus) in the small, center bore will be dish-shaped as shown in Figure 11. Either the high or low point of this dish-shaped surface may be used to locate top of fluid column providing the same point is always used both for setting scale zero and reading percent CO_2 or O_2. Obviously, using high point for one operation and low point for the other will cause an error.

Best practice is to use high point of this fluid surface just at the small center bore wall. In setting scale zero or reading percent CO_2 or 0_2, hold FYRITE vertically and level with eyes and sight across scale to top of fluid column.

3.2.1 Draining Fluid Droplets

For maximum accuracy, it is important to form the habit of following a standard procedure in this operation and to use the same procedure both before adjusting scale zero and before reading percent CO_2 or O_2 .

3.3 FYRITE Temperature

The FYRITE temperature should be at or close to the temperature of the working environment where the analysis is being made and should not be subject to sudden temperature changes. If FYRITE is carried from cooler to warmer location or vice versa, expose FYRITE to new temperature condition to permit uniform temperature stabilization. Usually 15 or 20 minutes will suffice, except when extreme temperature variations are involved. Temperature stabilization can also be accelerated by inverting FYRITE frequently.

3.3.1 Temperature of Gas Sample

The gas sample as it enters FYRITE should be cooled (or warmed if sampling cool gases) to same (ambient) temperature as the FYRITE.

Capacity of Standard Aspirator Bulb and Sampling Assembly (Part # 11-7029) to cool the gas sample is sufficient if the temperature of gas being sampled does not exceed 850°F (454°C), even where a large number of consecutive samples are required if there is an interval of not less than 5 minutes between samples.

FYRITE indicators operate over a wide temperature range. They may be exposed to ambient temperatures from –30° to 150°F (–34° to 66° C). Gases up to 850° F (454° C) may be tested with Standard Aspirator Sampling Assembly (11-7029). Special sampling equipment for high temperatures and unsaturated gas samples are listed in Section 7.2. FYRITE Sampling Assemblies.

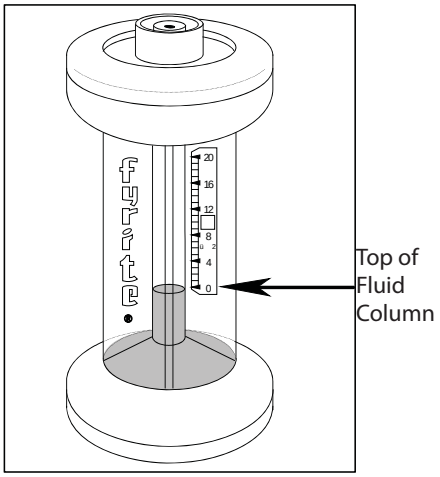


Figure 11. Locating Top of Fluid Column.

4.0 PRINCIPLE OF OPERATION

(Refer to Figures 12, 13, and 14)

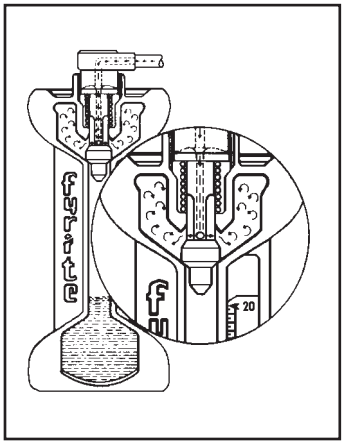


Figure 12. When plunger valve is depressed, a gas sample is pumped through top reservoir with center bore is sealed off.

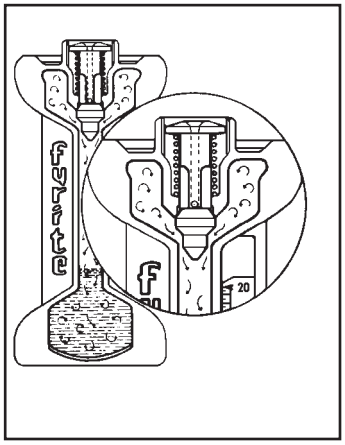


Figure 13. When plunger valve is released, the gas sample is locked into FY-RITE and the top reservoir is opened to center bore so that gas sample can pass through absorbing fluid.

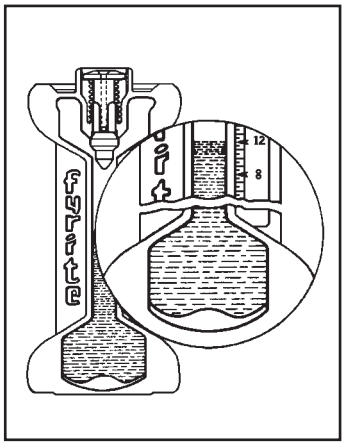


Figure 14. Absorption of gas sample by fluid creates suction, which causes diaphragm to flex up and fluid to rise in center bore to replace gas absorbed.

To make a test with the FYRITE, the metal Sampling Tube at one end of Sampling Assembly Hose is inserted into the gas to be analyzed. The rubber Connector Plug at the other end of the Rubber Hose is then firmly pressed down on the spring-loaded Valve of the instrument (See Figure 12). This simultaneously opens a passage into the Top Reservoir and seals off the center bore.

Next, a sample of the gas is pumped into the Top Reservoir by squeezing the rubber Aspirator Bulb. At least 18 bulb squeezes are required to assure that the rubber Sampling Hose and the Top Reservoir of the FYRITE are thoroughly purged of the previously analyzed sample. During the 18th Aspirator Bulb squeeze and immediately before releasing Bulb, the finger is lifted from the Connector Plug, which automatically returns the Plunger Valve to upper position against its top seat.

Refer to Figure 13. With the Valve in this position, the final 60 cc of the gas sample is locked into the FYRITE and the Top Reservoir is opened to the center bore so that the gas sample can pass to the absorbing fluid. The FYRITE is then inverted, forcing the gas sample to bubble through the absorbing solution which absorbs either CO_2 or O_2 depending on the type FYRITE in use.

Refer to Figure 14. The instrument is then turned and held upright. Absorption of the CO_2 or O_2 by the absorbing fluid creates a suction, which causes the Diaphragm at the bottom to flex upward permitting the level of the absorbing fluid to rise in the center tube an amount proportional to the gas absorbed. The scale indication corresponding to the top of the fluid column is then read as a percentage of gas absorbed by the FYRITE fluid.

5.0 APPLICATION INFORMATION

FYRITE Analyzers are available for either Carbon Dioxide or Oxygen analysis, and each of these models is made in the three scale ranges shown in Section 5.3. All six instruments are similar in appearance and size, but they differ in important construction details, as well as in absorbing fluids.

5.1 FYRITE Absorbing Fluid

FYRITE absorbing fluid is selective in the chemical absorption of carbon dioxide or oxygen respectively. Therefore, the FYRITE's accuracy is well within the range required for industrial and professional applications, and does not depend upon complicated sequential test procedures. Furthermore, the FYRITE readings are unaffected by the presence of most background gases in the sample.

The appearance of a dark red fluid floating on top of CO_2 FYRITE solution is entirely normal. The darker fluid consists of a small amount of material added to prevent excessive foaming at the meniscus and improves readability.

5.1.1 FYRITE Refill Fluid (Storage Life, etc.)

FYRITE refill bottles should be stored at room temperature (70° F [21° C]) in the carton provided, and placed in use within one year.

> NOTE: Before opening refill bottle, read the label and make certain to observe all precautions.

FYRITE CO_2 refill fluid may develop a white insoluble precipitate upon aging. The precipitate does not affect fluid performance in any way, but if present, should be filtered out to prevent adherence to internal surfaces of the FYRITE.

To filter, place a clean piece of thin cloth or netting loosely over the open CO_2 FYRITE and slowly pour refill contents into top reservoir. Before disposing of cloth, rinse thoroughly with water. FYRITE fluid is corrosive!

FYRITE O_2 refill fluid reacts very rapidly with oxygen in air. Oxidation of absorbent can be prevented by purging the FYRITE body with Nitrogen, natural gas or other oxygen-free gas, just before filling, and by maintaining a stream of this gas around mouth of the bottle (see Figure 21) while its contents are emptied into the FYRITE.

Another method for refilling the O_2 FYRITE (and still limiting the oxidation of the absorbent) is to invert the unit and place it over the 60 cc bottle of fluid. Then invert both so that the FYRITE is now upright and the O_2 fluid is filling the instrument (see Figure 21a). Immediately install plastic Top Cap Ring without delay. This method helps to minimize oxidation and improve the life of the fluid.

5.2 FYRITE Operating Temperature Range

The FYRITE indicators operate over a wide temperature range, and may be exposed to ambient temperatures from –30° to 150° F. (–34° to 66°C). Gases up to 850° F (454° C) may be tested with standard aspirator sampling equipment (11-7029).

Special sampling equipment to reduce high combustion gas temperatures (2000° F [1093° C]) to usable FYRITE temperature (ambient) and assemblies with extra large saturators for dry gas sampling are listed in Section 7.2, FYRITE Sampling Assemblies.

> NOTE: Remember, for most accurate results, the FYRITE must be at temperature equilibrium with its surroundings (ambient temperature) and the incoming gas sample at the same temperature as the FYRITE.

5.3 Typical FYRITE Applications

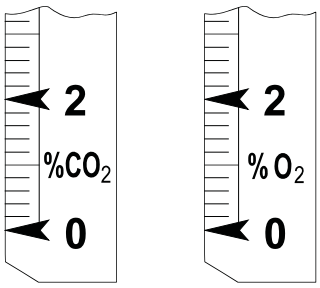
Listed below are six models of FYRITE Indicators and two Aspirator Sampling Assemblies with part numbers identifying their application.

	Bacharach Part Numbers				
For Testing	Scale Range	FYRITE	Aspirator Sampling Assy.	Fluid	Complete Kit with Case
Carbon Dioxide	0 - 7.6%	11-7042	11-7029	10-5100	10-5053
	0 - 20%	11-7032	11-7029	10-5057	10-5000
	0 - 60%	11-7034	11-7029	10-5057	10-5032
Oxygen	0 - 7.6%	11-7044	11-7039	10-5103	10-5054
	0 - 21%	11-7036	11-7029	10-5060	10-5011
	0 - 60%	11-7038	11-7029	10-5060	10-5046

TYPICAL APPLICATIONS WITH FULL SIZE
SECTIONS OF FYRITE SCALES

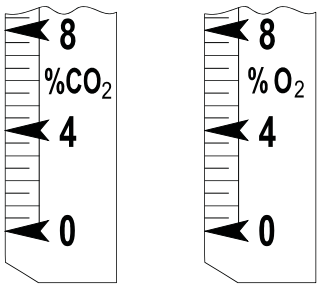
0-7.6% CO_2 or O_2

CO_2 tests of controlled atmospheres in fruit, vegetable, and meat storage rooms. Oxygen determination in flammable gases. Oxygen tests to check atmospheres made inert with nitrogen (silos, fuel tanks, etc.)



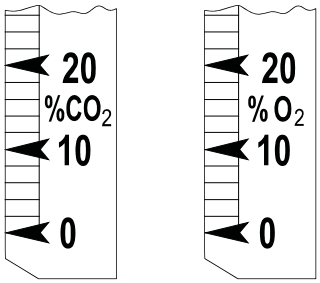
0-20% CO_2 or 0-21% O_2

Flue gas combustion tests, oxygen deficiency tests, and CO_2 tests of heat treating atmospheres. Checking oxygen concentrations in hydrogen-cooled generators and oil-sealed inert-gas transformers.



0-60% CO_2 or O_2

Checking CO_2 in inert gas blankets in tankers and barges carrying gasoline and other combustibles. CO_2 tests on lime kilns. Checking CO_2 in sewage plant digesters. Oxygen tests in connection with oxygen and gas anesthesiology.



5.4 CO_2 FYRITE Only Combustion Testing

5.4.1 Percent CO_2 Shows Volume of Excess Air (Refer to Figure 15)

For any given fuel, theoretical maximum percent CO_2 (Ultimate CO_2) would be produced when exactly enough air (but no excess air whatsoever) is supplied to burn all of the fuel. As increasing amounts of excess air are supplied, percentage CO_2 naturally decreases from theoretical Ultimate CO_2 due to the diluting effect of excess air.

Thus, measuring percent CO_2 is also a method of indicating excess air to ensure that enough is supplied to permit clean combustion without adding so much that combustion efficiency is unnecessarily decreased.

5.4.2 Too Much Excess Air Means Inefficient Combustion

Excess combustion air is heated and carries some of this heat to the flue where it is wasted. The FYRITE CO_2 Analyzer is used to adjust combustion excess air to a minimum (maximum CO_2), which will permit clean efficient combustion.

Calculation of combustion efficiency is possible (assuming complete combustion) if percentage of CO_2 and net temperature of combustion products are known.

5.4.3 What is Proper CO_2 Value?

Proper CO_2 is that which will ensure complete, clean combustion with some safety margin for variations in fuel, draft, atmospheric conditions, and mechanical wear.

Consult manufacturer of heating equipment for specific recommendations. Generally accepted values for good combustion practice in residential furnaces and boilers when firing the following fuels are:

Natural Gas .....8 to 9.5% CO_2

No.2 Oil .....10 to 12.5% CO_2

These are only guidelines, however, and in all cases recommendations of the equipment or fuel supplier would also include recommendations for allowable smoke (oil firing) or combustibles (gas firing), which are undesirable combustion by-products. Testing for smoke, CO, or combustibles is important since in extreme fuel rich firing, high CO_2 values also occur (see Figure 16).

5.4.4 How To Calculate Combustion Efficiency

Measure percent CO_2 in flue gases with FYRITE. Then measure flue gas temperature with a suitable thermometer (e.g., TEMPOINT) at the same sampling point. Deduct temperature of basement or combustion air supplied from measured flue gas temperature to obtain net flue gas temperature. Use a Bacharach FIRE EFFICIENCY FINDER to calculate combustion efficiency. Instructions for using the FIRE EFFICIENCY FINDER are printed on the face of this slide rule calculator.

5.5 O_2 FYRITE Only Combustion Testing

5.5.1 Percent O_2 Shows Volume of Excess Combustion Air (Refer to Fig. 15)

All fuels require some excess air (in addition to air theoretically required to burn the fuel) to ensure clean, complete combustion. As the amount of this excess air increases, the percentage of O_2 in combustion products increase.

5.5.2 Too Much Excess Air Means Inefficient Combustion

Excess combustion air is heated and carries some of this heat to the flue where it is wasted. The FYRITE O_2 analyzer is used when adjusting combustion air to minimum excess air (minimum O_2) which will permit clean, efficient combustion.

5.5.3 What is Proper O_2 Value?

Proper O_2 content for any fuel fired is the lowest O_2 value that will ensure complete, clean combustion with adequate safety margin for variations in fuel, draft, atmospheric conditions, and mechanical wear. Consult manufacturer of heating equipment or local authorities for specific recommendations. Figure 15 illustrates the relationship between CO_2, excess air and oxygen for gas and oil.

For guidance, it should be added that modern boilers are capable of 80% or greater combustion efficiency. Rough guidelines for setting conventional power burners are 10-15% excess air for natural gas and 15-20% excess air for oil, with little or no smoke and carbon monoxide formation.

5.5.4 Measuring O_2 in Addition to CO_2

Figure 16 illustrates why it is good practice to measure oxygen, in addition to carbon dioxide, when firing gaseous fuels. Note that the same CO_2 reading can be obtained on both sides of the stoichiometric (or perfect) mixture. Carbon dioxide alone cannot define proper excess air operation for gaseous fuels.

A check must also be made for the presence of oxygen, which confirms operation with excess air. Gaseous fuels should also be checked for presence of carbon monoxide (CO) in the flue gases and adjusted for either "no CO" or to conform to applicable safety regulations.

5.5.5 Where is Percent CO_2 or O_2 Measured? (Refer to Figure 17)

For residential and most commercial and industrial combustion units, percent CO_2 or O_2 is measured by analyzing gas sample obtained through a 1/4-inch diameter hole located between the flue outlet (breeching) and any mechanical opening in the flue such as the barometric draft regulator or draft diverter. Best practice is to locate sampling hole at least six inches upstream from such flue openings. The metal FYRITE Sampling Tube should extend at least 2-1/2 inches into the flue gases.

For larger installations, consult manufacturer of combustion equipment for special instructions regarding sampling point, special sampling tube required, or advice on averaging readings.

Residential gas furnaces with built-in draft diverter (gas designed) will require the FYRITE metal Sampling Tube to be inserted as illustrated in Figure 17 to avoid dilution of flue gas sample.

Additional information on residential furnace combustion testing may be obtained from the following Bacharach publication:

Bulletin 4097 - Technical Combustion Brochure

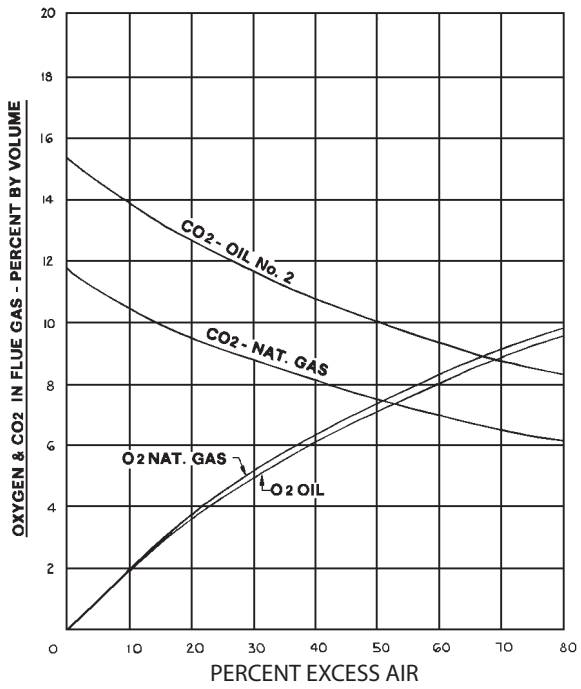


Figure 15. Relation between Oxygen, CO_2 and excess air in flue gases for Natural Gas and Fuel Oil.

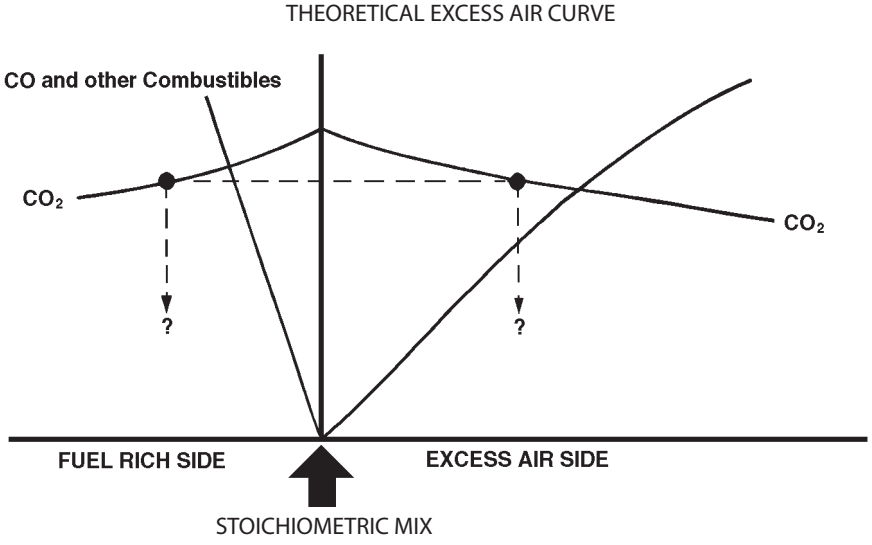


Figure 16. CO_2 measurements alone do not determine combustion air setting when firing gaseous fuels.

5.6 Background Gases Affecting FYRITE Readings

As a rule of thumb, background gases/vapors may be present in concentrations up to 1/2% by volume (5000 ppm) before they present a significant interference problem to the CO_2 or O_2 FYRITE (20/21% ranges).

An exception exists with the action of ammonia on Oxygen FYRITE Fluid. Ammonia neutralizes the acidic solution of chromous chloride, and therefore use of the O_2 FYRITE with even trace amounts of ammonia in the backgrounds is not advised unless suitable filters are used.

Inert gases, even in concentrations approaching 100% by volume, do not interfere with either the CO_2 or O_2 FYRITE. In general, interferences can be of a chemical (chemical reaction initiated) or a mechanical nature, with resultant error, but are also given up by the solution when the sample no longer contains the interfering substance. They can therefore be compensated for by saturating the FYRITE solution with samples containing the mechanical interferant as long as the background stays reasonably constant. Usually 3 or 4 tests are sufficient to saturate FYRITE solution with the mechanical interferant in question.

TYPICAL INTERFERENCE (CO_2 FYRITE)	TYPE OF INTERFERENCE	APPROXIMATE EFFECT
All Acid Gases (SO_2, H_2S, Hydrocyanic Acid, Cyanogen, etc.).	Chemical	1:1
TYPICAL INTERFERENCE (O_2 FYRITE)	**TYPE OF INTERFERENCE**	**APPROXIMATE EFFECT**
Acetone	Chemical	1:1
Acetylene	Chemical	1:1
and other unsaturated hydrocarbons		
CO_2	Mechanical, 20% CO_2 background can be zeroed out in 3 to 4 tests if background remains constant.	Can be zeroed out up to approximately 30% CO_2 background.
Ammonia	Chemical	Ammonia neutralizes O_2 FYRITE solution and instrument use on this background is not advised unless suitable filters are used.
Nitrous Oxide (N_2O)	Mechanical	- - -

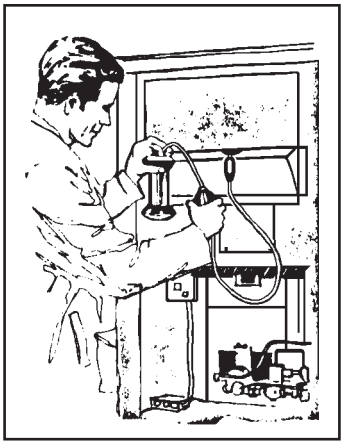


Figure 17. Checking CO_2 of gas designed furnace (sampling tube inserted through draft diverter; flue gas temperature test can be made at same point).

5.7 General FYRITE Applications

It is only possible to specify a few general rules for such applications. Where possible, sample should be obtained at a point where the gases are well mixed to a uniform composition. Where this is impossible; it will be necessary to average a number of measurements taken at different locations to obtain representative average. Where gases being sampled are not saturated with moisture (many non-combustion applications), it is very important to maintain the wool packing of Filter Saturator Tube in a moist condition.

> NOTE: The FYRITE is calibrated to analyze gases which are normally saturated with moisture. Failure to moisten wool packing in filter saturator tube with water will cause FYRITE to indicate slightly lower than actual gas concentration.

Where special length sampling lines are required, add one more bulb squeeze to the 18 required with standard Sampling Assembly for each additional 3 cubic inches (50cc) volume of special sampling line.

> EXAMPLE: For each 9 ft. of 3/1 6 inch (I.D.) additional length of sampling line, add one more bulb squeeze.

If it is necessary to trap a sample over water for later analysis, a minimum of 900 cc of sample will be required. If sample is trapped over water, it is good practice to use 10 to 15% NaCl (table salt) in the water to minimize absorption of CO_2 or O_2 by water.

Trapping a sample over mercury will eliminate any possible error due to absorption of CO_2 or O_2.

5.8 Altitude Correction Table

The gas concentration read on the FYRITE is directly dependent upon the mass of air in the sample. The aspirator bulb used in the FYRITE is a constant-volume pump, not a constant-mass pump. Altitude, therefore, affects the FYRITE reading due to the air's density changing with altitude, thus requiring higher CO_2 or O_2 concentrations to reach the same mark on the scale.

Use the following table to find the altitude correction (e.g., add the correction to the reading to get the correct concentration).

TABLE 5-1. ALTITUDE CORRECTION TABLE

Altitude Ft. (Meters)		Correction % 20% CO_2	21% O_2	7% O_2 or CO_2
1000	(305)	0.0	0.0	0.0
2000	(610)	0.0	0.0	0.0
3000	(914)	0.1	0.1	0.0
4000	(1575)	0.1	0.2	0.1
5000	(1219)	0.2	0.2	0.2
6000	(1829)	0.2	0.3	0.2
7000	(2134)	0.3	0.3	0.3
8000	(2438)	0.4	0.4	0.3
9000	(2743)	0.4	0.5	0.4
10,000	(3048)	0.5	0.6	0.5
11,000	(3353)	0.6	0.7	0.5
12,000	(3658)	0.7	0.8	0.6
13,000	(3962)	0.7	0.8	0.6
14,000	(4267)	0.8	0.9	0.7

6.0 FYRITE MAINTENANCE

NOTE: With FYRITE vented and in a vertical position, it should be possible to adjust scale zero to the top of the fluid column. Refer to FYRITE Operation (Section 3.0) Steps 1 through 4 (for CO2) or Steps 1 through 5 (for O2) for proper setup. If this is not possible, add or remove a small amount of fluid as described below.

6.1 Increasing FYRITE Fluid To Proper Level

Refer to Figure 18. Hold FYRITE upright and cover hole in center of Plunger Valve with finger. Add clean water, a few drops at a time (dripping water faucet is convenient) into space around Plunger Valve. Work Plunger Valve up and down several times. Repeat process until fluid is at proper level.

6.1.1 Decreasing FYRITE Fluid to Proper Level

Refer to Figure 19. To remove excess fluid, insert small diameter glass tube into FYRITE fluid through the small center FYRITE bore (with Top Cap Assembly removed). Seal open end of glass tube with finger and dip out fluid with glass tube until FYRITE fluid is at proper level. Avoid unnecessary exposure of O_2 fluid to air since it will rapidly absorb O_2 and become exhausted.

6.2 Checking FYRITE Fluid Strength

6.2.1 CO_2 FYRITE Fluid Only

Fresh FYRITE fluid will absorb all CO_2 from more than 350 samples containing 10% CO_2. Where it is desirable to check fluid strength before taking FYRITE to the test location to be used, or when a questionable (low) FYRITE reading is obtained the instrument may be tested on any sample of CO_2. Exhaled breath (containing approximately 4% CO_2) is often most convenient.

Disconnect the rubber bushing and Sampling Hose Assembly from the Filter Saturator Tube. Place the rubber connector tip over the Plunger Valve and depress Plunger Valve down firmly with rubber connector tip. Take a deep breath, hold for 3 or 4 seconds and exhale at a steady rate into the rubber bushing end of the Sampling Hose Assembly. Simultaneously squeeze the Aspirator Bulb several times while exhaling breath. Release rubber connector tip from Plunger Valve while still exhaling breath. Perform steps outlined below to absorb exhaled breath into FYRITE fluid.

1. Absorb sample gas into FYRITE by inverting until fluid drains into top reservoir, then turn upright to drain fluid into bottom reservoir. Repeat this step once more (two complete inversions total).

2 Hold FYRITE at 45° angle momentarily to allow fluid droplets to drain into bottom reservoir.

3. With FYRITE held upright, permit fluid in column to stabilize a few seconds, then immediately read % carbon dioxide on scale at point corresponding to top of fluid column.

To check CO_2 FYRITE fluid strength - DO NOT VENT FYRITE but reabsorb sample gas by inverting and turning upright. Repeat this step once more (two complete inversions total). If reading increases by more than 1/2 percent CO_2 as compared to initial reading; replace fluid.

Formation of a frothy, persistent foam on FYRITE fluid also indicates need for fluid replacement. A few "beads" or small air bubbles floating near the small center bore wall is not considered foaming. FYRITE fluid may be colored for ease in readings. Color has no bearing on fluid strength or ability to absorb CO_2 .

Cloudy fluid or small flakes of solid material in fluid do not necessarily mean CO_2 fluid is exhausted. Precipitate may form in CO_2 Refill Bottles due to extended storage, and can be filtered through cheese cloth or other screen like material when refilling FYRITE.

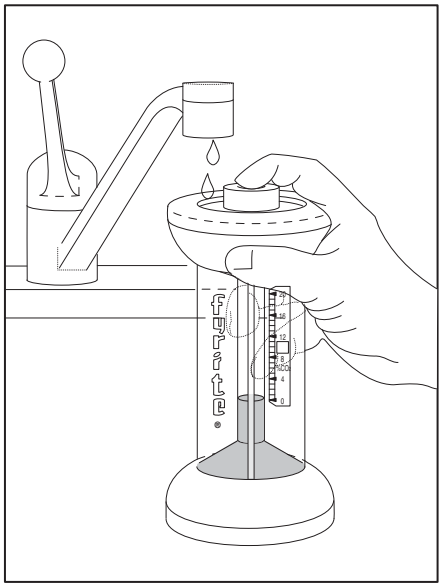


Figure 18. Increasing FYRITE fluid to proper level.

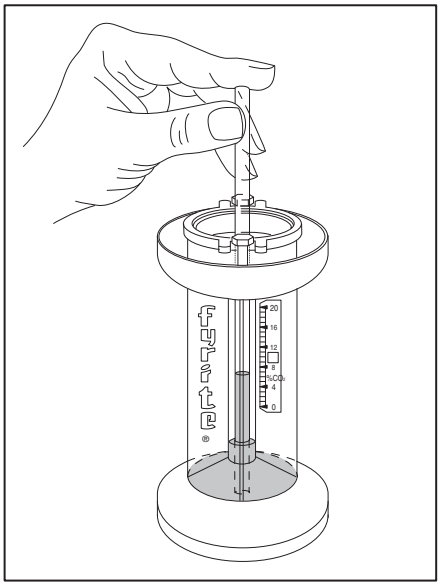


Figure 19. Decreasing FYRITE fluid to proper level

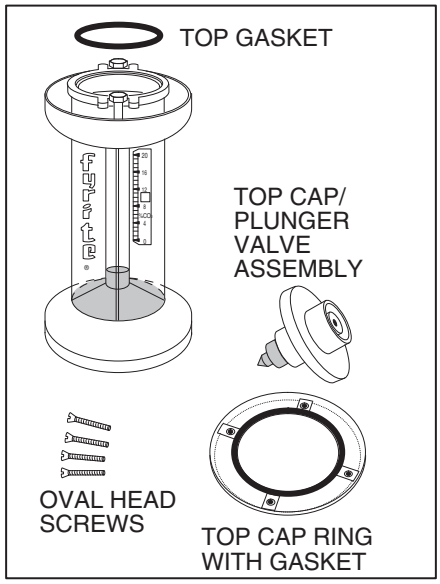


Figure 20. Removing top gasket.

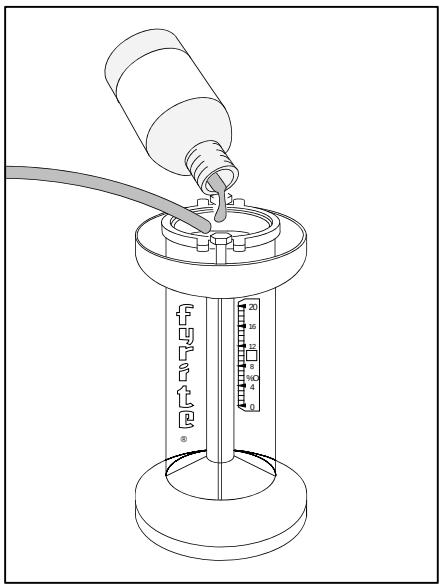


Figure 21. Flushing FYRITE with a stream of O_2 free, inert gas (Also see Fig. 21a for alternate method).

NOTE: If compressed gas standards are used to check FYRITE accuracy don't forget to saturate filter saturator wool packing as such gas standards are usually supplied "bone dry".

6.2.2 O_2 FYRITE Fluid Only

Fresh FYRITE fluid will absorb all O_2 from approximately 100 samples containing 10% O_2. After completing test (as outlined in Section 3.0 Steps 1 through 9) O_2 FYRITE Fluid strength can be checked by performing steps outlined below:

1. DO NOT VENT FYRITE, but reabsorb sample gas into FYRITE by inverting until fluid drains into top reservoir, then turn upright to drain fluid into bottom reservoir. Repeat this step three (3) more times (four complete inversions total).

2. Hold FYRITE at 45° angle momentarily to allow fluid droplets to drain into bottom reservoir.

3. With FYRITE held upright, permit fluid in column to stabilize a few seconds, then immediately read % oxygen on scale at the point corresponding to top of fluid column. If reading increases by more than 1/2 percent O_2 as compared to the initial reading, replace fluid.

When it is desirable to check fluid strength before taking the FYRITE to a location where it will be used, it can be conveniently tested on a sample of atmospheric air which contains 20.9% O_2.

NOTE: Make certain wool in filter saturator tube is moistened with water when using FYRITE in a non-combustible application where the gas sample is not fully saturated with water vapor.

Formation of a frothy, persistent foam on FYRITE fluid also indicates need for fluid replacement. A few "beads" or small air bubbles floating near the small center bore wall is not considered foaming. Color of FYRITE O_2 (blue) fluid is not an index of ability to absorb oxygen although towards the end of fluid life, a greenish cast can be detected.

NOTE: If compressed gas standards are used to check FYRITE accuracy, don't forget to saturate filter saturator wool packing as such gas standards are usually supplied "bone dry".

6.3 Replacing FYRITE Fluid (Refer to Figs 20, 21, and 22)

CAUTION

Because of the corrosive effect of the FYRITE fluid, always change FYRITE fluid in immediate vicinity of a sink with running water available as shown in Figure 18.

Remove 4 screws, metal Top Cap Ring, plastic Top Cap Assembly and Top Gasket. Drain old fluid from FYRITE and rinse all parts in clean, lukewarm water.

> NOTE: FYRITE fluid is corrosive to skin, clothing, some metals, and painted or lacquered surfaces. Dispose of these fluids in accordance with Local, State and Federal Laws. If draining into a porcelain sink is permitted, keep water faucet turned on while draining and flush for at least 1/2 minute afterwards.

> NOTE: Examine top gasket for warpage, if distorted as shown in Figure 22, replace gasket with part # 11-0143 before proceeding.

Drain all parts of excess water. Stand FYRITE Body upright to center replacement Top Gasket in recess provided in top flange of body.

O_2 FYRITE Only: Before adding fluid, flush FYRITE with a stream of O_2 - free, inert gas (Figure 21) or be prompt in reassembling Top Cap to prevent excessive fluid contact with air.

Uncap FYRITE fluid bottle, invert FYRITE and place over the bottle. Invert both FYRITE and bottle (Figure 21a) so that FYRITE comes to an upright position and the fluid is filling the unit. Immediately install plastic Top Cap Assembly and metal Top Cap Ring without delay.

CO_2 FYRITE Only: Uncap CO_2 Refill Bottle and pour entire contents into FYRITE. Reinstall plastic Top Cap Assembly and metal Top Cap Ring.

CO_2 / O_2 FYRITEs: Make certain that Top Cap Ring Gasket (11-0109, Figure 33) is in place between metal Top Cap Ring and plastic Top Cap. Draw the 4 machine screws down with light screwdriver force.

Then, going from one screw to the next, draw down 1/4 turn until all are firmly tightened. Avoid excessive force in tightening which may damage plastic parts.

6.4 Inspection of FYRITE for Fluid Leakage

Gradual loss of fluid, moisture or dried encrustation around Plunger Valve does not indicate fluid leakage. Gas enters and leaves unit during sampling with considerable velocity and some fluid vapor is carried out during normal sampling. To check Top Assembly for fluid leakage in upright position, depress Plunger Valve and release.

Note the scale reading at top of fluid column, and then stand FYRITE upside down overnight in glass or porcelain test dish (See Figure 23). Then, return FYRITE to upright position and, after allowing 5 minutes for drainage, depress and release Plunger Valve. Leakage will be evidenced by lower scale reading. Extreme leakage will be apparent by presence of fluid in test dish.

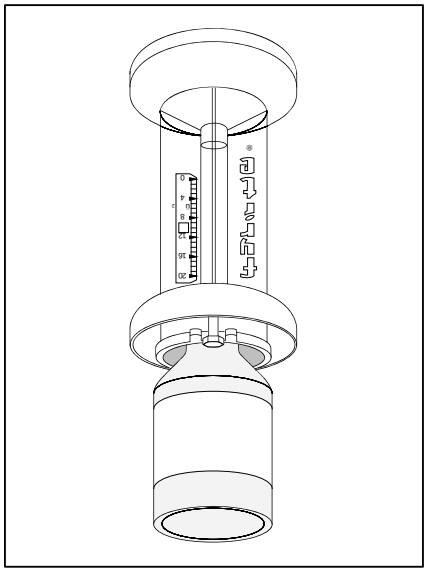


Figure 21a. Alternate filling method. Invert FYRITE (with bottle in place) to upright position.

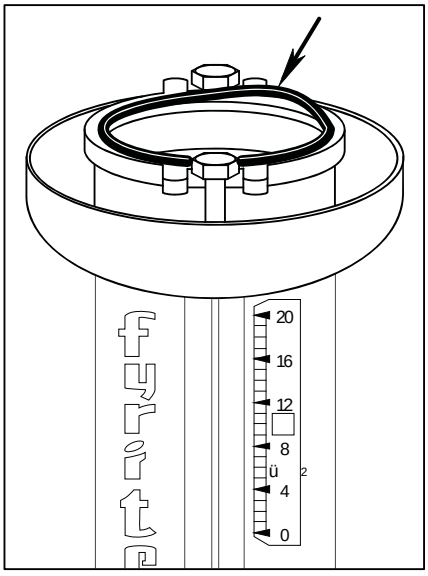


Figure 22. Examining top gasket for warpage.

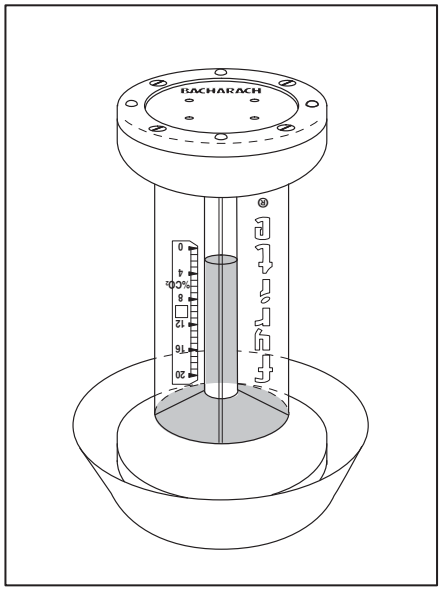


Figure 23. FYRITE inverted in test disk (overnight) for leakage test.

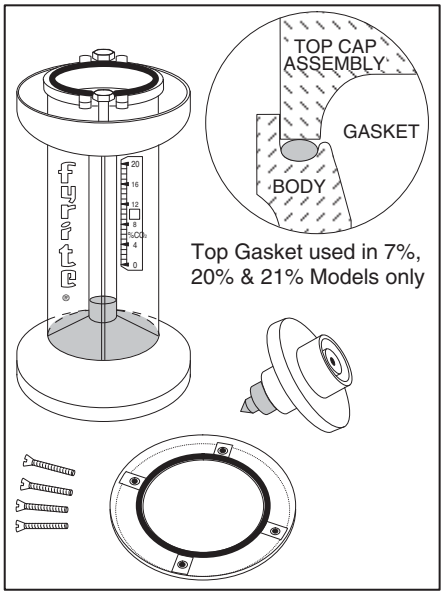


Figure 24. Top gasket properly centered in top flange of body.

Follow the same procedure to check fluid leakage from Bottom Cap Assembly with FYRITE stood overnight in the upright position.

When leakage is proven, examine plastic and rubber parts for deterioration to determine replacement parts necessary for repair, or drain instrument and return if factory service or repair is desired.

6.5 Cleaning FYRITE

Use only soapy lukewarm water if cleaning is required (lukewarm water is usually sufficient).

> NOTE: Use of gasoline, naptha, carbon tetrachloride or any other organic solvent or oil will destroy plastic and rubber parts.

6.6 Replacing FYRITE Plastic and Rubber Parts (Refer to Illustrated Parts List FYRITE CO_2/O_2 [Section 7.0 and Fig. 33])

Replace plastic parts when cracked or crazed in location exposed to fluid and rubber parts when badly swollen, warped or showing other evidence of deterioration.

In replacing Top Gasket, make certain it is properly centered in the recess provided in top flange of FYRITE Body (See Figure 24). When installing plastic Top Cap Assembly, be sure that assembly is centered on Top Gasket.

To remove Top Cap Assembly or replace Top Cap, Plunger Valve, or Plunger Tip Gasket, use the procedure as outlined in Section 6.3.

When replacing Plunger Tip Gasket, simply depress Plunger Valve against its spring limit and strip old Gasket from the end of Plunger Valve.

Before assembling new Gasket, wet inside surface of Tip Gasket, then force it over the end of Plunger Valve (after depressing Plunger Valve against the spring limit).

Make certain that new Tip Gasket is seated uniformly against the mating surface in plastic Top Cap.

To replace Diaphragm, stand FYRITE upside down, remove 4 screws and metal Bottom Cap.

Refer to Figure 25a. Remove old Diaphragm and center new replacement with the lettering facing you, so that after the FYRITE Bottom Cap is installed the letters will face up into its recess. Center Bottom Cap Assembly in Body Recess and reinstall 4 screws, observing same precautions in tightening as outlined in Section 6.3.

To replace Body, remove the 4 hex head Bezel screws and 4 Bezels. Install Bezels on new Body.

> NOTE: Make certain the rubber bezel gaskets are properly seated and clamped between bezel and body as shown in Figure 25.

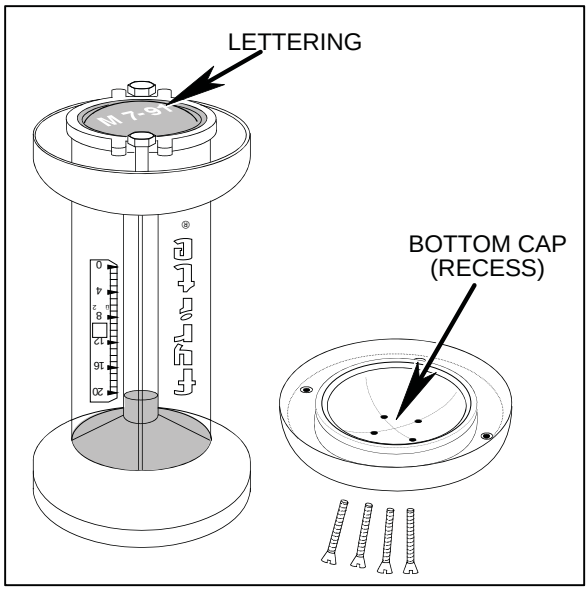


Figure 25a. Replacement Diaphragm properly installed.

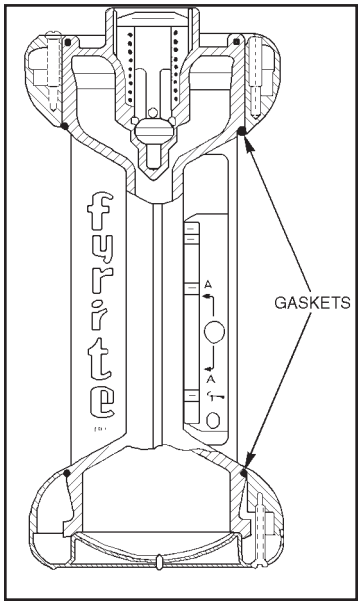


Figure 25. Locating Bezel Rubber Gaskets.

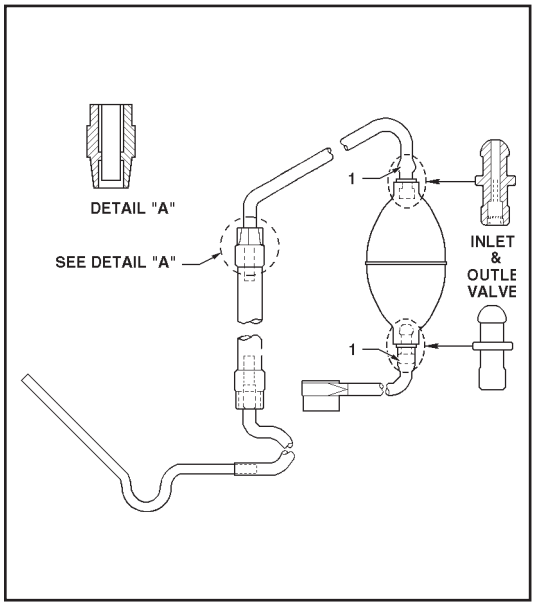


Figure 26. FYRITE Sampling Assembly; Locating Inlet/Outlet Check Valves.

6.7 Aspirator Bulb - Sampling Assembly (Refer to Figs. 26, 27, & 28)

Defective Check Valves or a leaking Sampling Assembly can result in sample loss, or sample dilution with resultant loss of accuracy.

To inspect Sampling Assembly, seal hole in the center of rubber Connector Tip firmly with finger and squeeze Aspirator Bulb (Figure 27). Bulb should remain firm. If Bulb collapses, check Bulb and Hose to Connector Tip for cracks or other source of leakage. Replace defective parts. If there are no apparent leaks in the Sampling Assembly, replace Inlet Check Valve. Small hole end of Inlet Check Valve fits in Hose and large hole end fits in the Aspirator Bulb (Figure 26).

Now seal end of metal Sampling Tube with finger, and collapse Aspirator Bulb. (Figure 28). If the Bulb returns to original shape in less than 15 seconds, inspect Hose, Filter, Saturator Tube and Metal Sampling Tube for leaks. If none are found, replace the Outlet Check Valve. Small hole end of Outlet Check Valve fits in Aspirator Bulb and large hole end fits in the Hose (Figure 26).

Discard Filter Packing when it becomes dirty or clogged. Push old packing out of, and new packing into, Filter Saturator Tube with a pencil or small rod (See Section 6.9).

6.8 Storing FYRITE and Refill Fluid

When FYRITE is not used over periods between tests, store it and its Sampling Assembly in a cool, dry place. Prolonged storage, for example, at high temperatures reached in an automobile trunk over the Summer is not recommended. When stored unused over the Summer, it is good practice to drain old fluid and replace with fresh charge (fluid) when needed in the Fall.

FYRITE Refill Fluid should also be stored in a cool, dry location in the carton provided. A recommended practice is to accumulate stock only sufficient for one year requirement and to use oldest stock first. Fluid can be tested for performance according to Section 6.2.

Use only Bacharach CO_2 or O_2 Fluid Refills for the range FYRITE selected. The Kits below contain three Refill Bottles each.

7% CO_2 range	Refill Kit 10-5100
20% and 60% CO_2 range	Refill Kit 10-5057
7% O_2 range	Refill Kit 10-5103
21% and 60% O_2 range	Refill Kit 10-5060

6.9 Replacing Saturator Filter Packing Part #11-0121 (Refer to Figs 29 thru 32)

Remove the filter tube nipple and bushing (See Figure 29) from each end of the tube. Use a pencil or similar object to remove packing when it becomes dirty or clogged.

Wrap replacement packing around the hand (See Figure 30). If testing unsaturated gases (most non-combustion applications), saturate packing in water as shown in Figure 3, and squeeze out excess moisture.

Insert saturated packing using a pencil or small rod into filter tube (See Figure 32); then reassemble nipple and bushing.

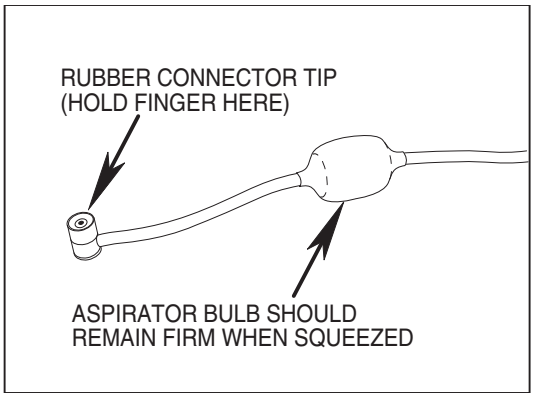


Figure 27. Testing Sampling Assembly (outlet side) for leaks.

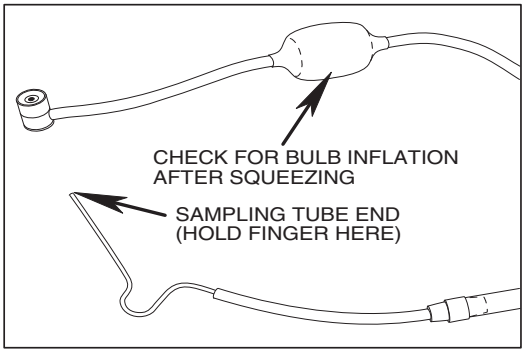


Figure 28. Testing Sampling Assembly (inlet side) for leaks.

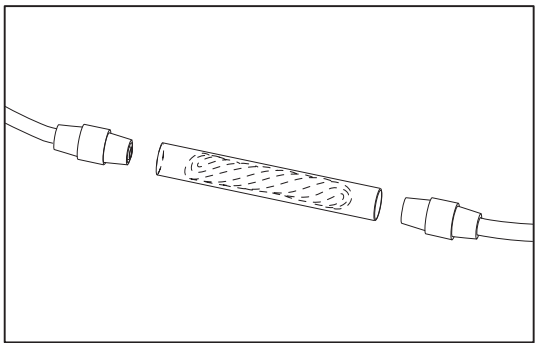


Figure 29. Removing End Plugs from Saturator Filter Tube.

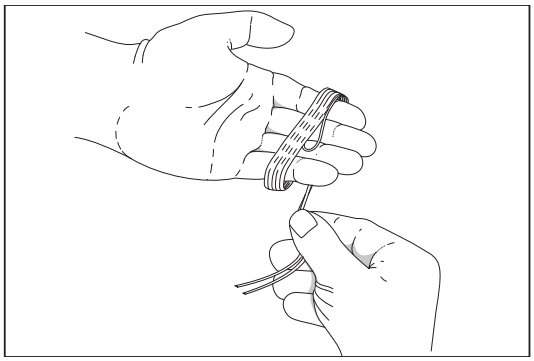


Figure 30. Wrapping Replacement Filter Material.

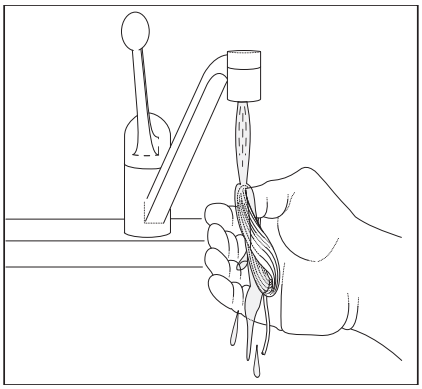


Figure 31. Wet Filter Material then squeeze out excess water.

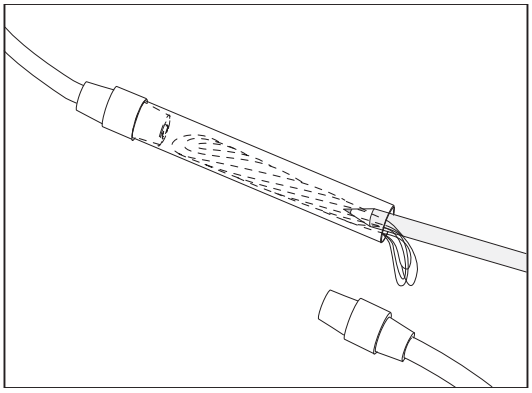


Figure 32. Installing wetted Filter Material into Saturator Tube.

7.0 ILLUSTRATED PARTS LIST FYRITE CO_2/O_2
(Refer to Figure 33 FYRITE Parts Breakout)

Part #	Description	Qty-Rq'd
11-0102	Bezel	4
01-0661	Oval Head Screw	8
11-0110	Bezel Screw	4
11-0109	Top Cap Ring Gasket (Optional, Part of 11-0136)	1
11-0105	Scale Screw	1
02-3690	Scale Screw Nut	1
11-0021	Diaphragm	1
11-0126	Bottom Cap	1
11-0132	Top Cap	1
11-0019	Valve Plunger	1
11-0026	Valve Plunger Spring	1
11-0020	Valve Plunger Gasket	1
11-0136	Top Cap Ring with Gasket	1
11-0143	Top Gasket (7%, 20% & 21% Models only)	1
11-0140	FYRITE Body (All Models except 7.0% CO_2 / O_2)	1
11-0154	FYRITE Body (7% Models only)	1
11-0062	Filler 60% FYRITE (Adapter Plug)	1
05-5134	Bezel Gasket "O" Ring	2
05-5169	O-Ring Filler (Outer 60%)	1
05-5155	O-Ring Filler (Inner 60%)	1
11-0144	CO_2 Scale 20%	1
11-0145	O_2 Scale 21%	1
11-0147	CO_2 Scale 60%	1
11-0150	O_2 Scale 60%	1
11-0155	CO_2 Scale 7%	1
11-0157	O_2 Scale 7%	1
10-5057	Carton of FYRITE CO_2 Fluid (3 Bottles) 20/60% range Models	1
10-5060	Carton of FYRITE O_2 Fluid (3 Bottles) 21/60% range Models	1
10-5100	Carton of FYRITE CO_2 Fluid (3 Bottles) 7% range Models	1
10-5103	Carton of FYRITE O_2 Fluid (3 Bottles 7% range Models	1

7.1 FYRITE ILLUSTRATED PARTS

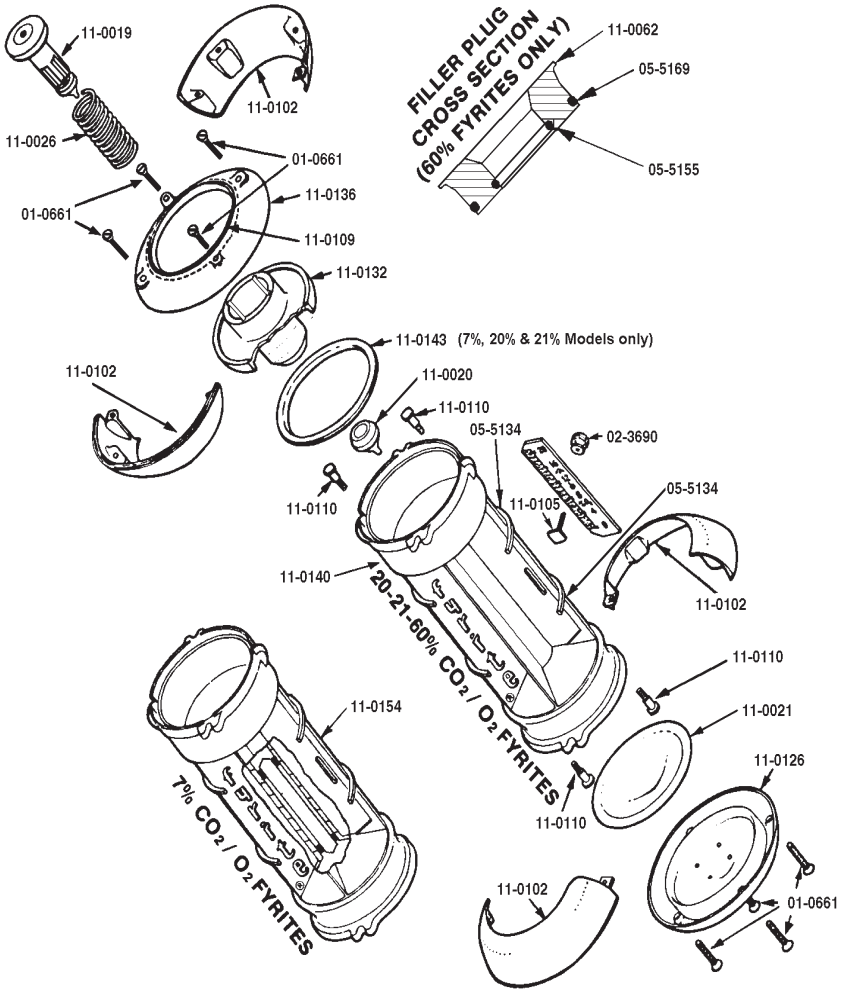
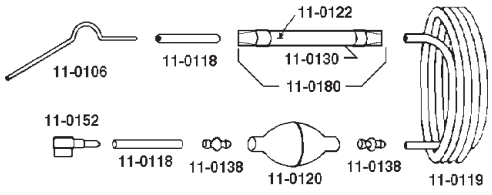


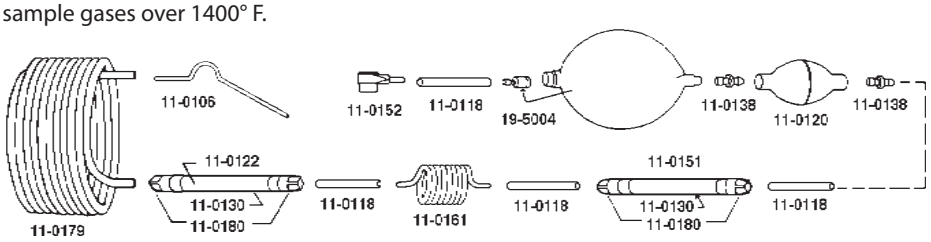
Figure 33. FYRITE parts breakout.

7.2 PARTS LIST FOR FYRITE SAMPLING ASSEMBLIES

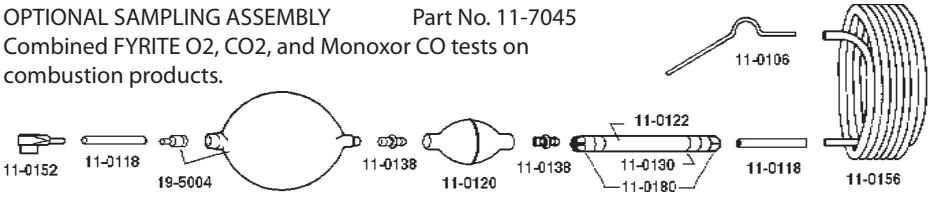
STANDARD SAMPLING ASSEMBLY
Part No. 11-7029
Gases saturated with water vapor (combustion products). Dry gases when filter material is wetted.



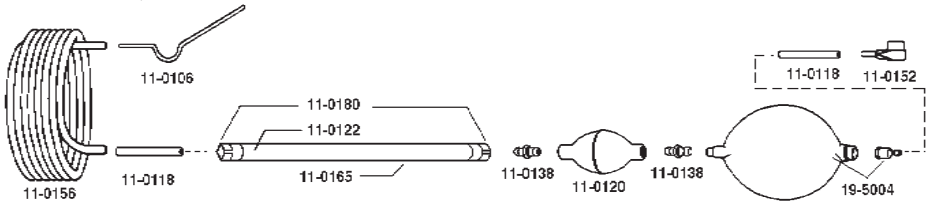
OPTIONAL INDUSTRIAL SAMPLING ASSEMBLY Part No. 11-7046
High temperature combustion applications where heat radiation and high localized ambients are factors. Optional ceramic High Temperature Sampling Tube for sample gases over 1400° F.



OPTIONAL SAMPLING ASSEMBLY Part No. 11-7045
Combined FYRITE O2, CO2, and Monoxor CO tests on combustion products.



OPTIONAL SAMPLING ASSEMBLY Part No. 11-7039
Large Filter-Saturator Assembly provides artificial sample saturation for non-combustion FYRITE applications. Bacharach Indicator Tubes may be used with this Assembly.



Current Part #	Former List #	Description	# Req'd
11-0152	10-0019	Connector Tip with Tube	1
11-0156	10-0029	Rubber Tubing, 10' Length	1
11-0118	10-0020	Rubber Tubing, 6" Length	2
11-0165	10-0030	Filter Tube, Aluminum	1
19-5004	19-9004	Gas Collecting Bladder with Orifice	1
11-0120	10-0022	Aspirator Bulb	1
11-0138	10-0023	Inlet/Outlet Valve (Red)	2
11-0119	10-0024	Rubber Tubing, 3' length	1
11-0180	10-0025	Filter Nipple with Bushing	2
11-0130	10-0026	Filter Tube, Plastic	1
11-0106	10-0027	Sampling Tube	1
11-0161	10-0040	Condenser Coil	1
11-0151	10-0041	Moisture Trap Assembly	1
11-0179	10-0042	Rubber Tubing, 15' length	1
11-0121	10-0033	Envelope of Filtering Material (10 per pack)	
11-0164	10-0047	Ceramic High Temperature Gas Sampling Probe, 18" length (optional)	
11-0181	10-0032	Filter Saturator (Aluminum) Assembly Comprising 11-0180, 11-0122, and 11-0165	

Notes

Notes

Notes

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