

2-2a



The State of New Hampshire
Department of Environmental Services

Robert R. Scott, Commissioner



January 25, 2018

Ms. Diana Duffy
Coordinator of Energy and Administrative Services
Keene State College
229 Main Street
Keene, New Hampshire 03435

RE: Particulate Compliance Emissions Testing on EU02 and EU03

Dear Ms. Duffy:

The New Hampshire Department of Environmental Services, Air Resources Division (NHDES) has reviewed the stack test report for Keene State College's biofuel-fired boilers EU02 and EU03, received on January 17, 2018. The report presents the data and results of the testing conducted on December 12 and 13, 2017 by CEM Services, Inc.

NHDES finds the report to be technically acceptable and agrees that the test results show the measured particulate emissions from EU02 to be 0.007 pounds per million British thermal units (lb/MMBtu) and from EU03 to be 0.024 lb/MMBtu. The results comply with the limit of 0.3 lb/MMBtu specified in Keene State College's State Permit to Operate SP-0113. The facility is also within the threshold for eligibility to participate in the New Hampshire Public Utilities Commission Renewable Portfolio Standards.

If you have any questions, please contact me at the Air Resources Division's Compliance Bureau at (603) 271-6288 or by email at raymond.walters@des.nh.gov.

Sincerely,

Raymond Walters
Compliance Measurement and Data Programs Manager
Compliance Bureau
Air Resources Division

RAW/raw
PS# 17-0097 and 17-0098
cc: Source File AFS# 3300500003

2-2b



Rory Gaunt
Chief Executive Officer
PO Box 1144
Marblehead, MA 01945

rory@lifecyclerenewables.com
617.633.2101

Debra A. Howland
Executive Director
New Hampshire Public Utilities Commission
21 South Fruit Street, Suite 10
Concord, NH 03301-2429

April 4, 2016

Dear Debra:

This letter, describing LR100 a waste vegetable oil derived biofuel, is submitted in conjunction with a Renewable Energy Source Eligibility for Class I Thermal RECs application that will be submitted by Keene State College shortly. With an approval as a Class I Thermal REC producer, Keene State will be using LR100 to produce campus steam as a replacement for No. 6 oil.

Replacement of No. 6 oil with LR100 represents an over 80% reduction in greenhouse gas emissions, is virtually sulfur free and nonhazardous. LR100 is approved by NH DES as an advantageous replacement for traditional heating oil. Please see the following NOx and PM chart for comparison to other fuels:

Particulate matter is an important emission to reduce for Keene State due to air quality issues arising from winter wood burning in the stagnant air of the valley. Overall, LR100 replacement of traditional heating oil represents an 80% GHG emissions reduction.

| Fuel | PM (lb./MMBTU) |
|-------------|----------------|
| Marine Gas | 0.008 |
| LR100 | 0.012 |
| Dist. 2 Oil | 0.024 |
| No. 4 Oil | 0.041 |
| No. 6 Oil | 0.050 |

LR100 is an eligible liquid biofuel as it meets the definition of biomass fuels as defined in RSA 362-F:2, II that it is a "plant derived.... liquid biofuel." Also LR100 meets the particulate emissions hurdle of less than 0.10 lbs/mmbtu as the proposed biomass unit is less than 30mmbtu/hr in capacity.

The waste vegetable oil collection process and LR100 production process are focused on delivering a highly refined all-vegetable oil fuel product. For combustion performance and fuel quality reasons LR100 must be liquid at near or below 32F. The waste vegetable oil that we collect and process (soy and

canola) naturally has optimal cold flow properties. A pour point test is performed on each batch of LR100 and test results are consistent with soy and canola cold flow properties. Per the charts below, animal fats have the highest melting points among oils and fats and therefore would be solid at LR100 pour point specifications. Per the analyses listed below and enclosed herein, LR100's pour point is below 32F.

Melting points of animal fats:

| | Beef Tallow | Pork Lard | Poultry Fat |
|-------------------|-------------|-----------|-------------|
| Melting Point (F) | 104 – 122 | 93 – 111 | 73 – 104 |

Analyses of LR100 cold flow properties:

| LR100 - Analysis Number | Pour/Cloud Point |
|-------------------------|------------------|
| Saybolt 12-29-14 | 27F |
| Optimus | 24F |
| Saybolt 03-14-12 | 21F |
| Iowa 12-30-15 | 27F |

Please see enclosed analyses listed in the table above.

Sincerely,



Rory Gaunt

2-2b

LIFECYCLE RENEWABLES, INC.
PO BOX 1144
01945, MARBLEHEAD
United States



Attention of : Mr. R.G. Gaunt
Your reference : Rory Gaunt

Report nr : 13031/00015014.6/L/14
Print Date : 12-29-2014 16:33

Analysis Report

Issuer warrants that it has exercised due diligence and care with respect to the information and professional judgements embodied in this report. This report reflects only the findings at the time and place of the inspection and testing.

Issuer expressly disclaims any further indemnity of any kind. This report is not a guarantee of policy or insurance with respect to the goods or the contractual performance of any party. Any person relying upon this report should be aware that issuer's activities are carried out under their general terms and conditions.

Uncertainties apply in the evaluation of the test results specified above. Please also refer to ASTM D3244 (except for analysis of RFG) and IP 357 with respect to the utilization of test data to determine conformance with specifications.

2-2b

LIFECYCLE RENEWABLES, INC.
PO BOX 1144
01845, MARBLEHEAD
United States
223531001



Attention of : Mr. R.G. Gaunt
Your reference : Rory Gaunt

Analysis Report

| | | | |
|---------------------|--|---------------------|-----------------------------|
| Report number | : 13031/00015014.8/L/14 | Submitted date | : 12-18-2014 |
| Main Object | : LR100 Submitted Sample | Sample submitted at | : Whittemore-Wright Co. Inc |
| Report Date | : 12-29-2014 | Date received | : 12-24-2014 |
| Date of issue | : 12-29-2014 | Date completed | : 12-29-2014 |
| Sample object | : LR100 Submitted Sample | Sample number | : 2068010 |
| Sample type | : Submitted | | |
| Sample submitted as | : Biofuel Oil | | |
| Marked | : Received sample LR100 Submitted Sample for analysis only | | |

| NAME | METHOD | UNIT | RESULT |
|------------------------------|-------------|----------|--------|
| Pour point | ASTM D 97 | °C / F | -3/27 |
| Flash point (PM) | ASTM D 93 | | |
| Flash point (PM) procedure A | | ° F | 235+ |
| Water and sediment | ASTM D 1796 | vol % | 0.3 |
| Kinematic Viscosity at 100°C | ASTM D 445 | mm²/s | 8.549 |
| Density at 15 °C | ASTM D 1298 | kg/L | 924.9 |
| Acid Number | ASTM D 664 | mg KOH/g | <0.01 |
| Ash Content | ASTM D 482 | mass % | 0.001 |
| Sulphur (S) | ASTM D 4294 | mass % | 0.006 |
| Insoluble Impurities * | ASTM D 128 | mass % | 0.02 |
| Heat of Combustion | ASTM D 240 | | |
| Gross Heat of Combustion | | Btu/lb | 16872 |
| Titer, C * | ASTM D 1982 | | |
| Titer C | | | 24.0 |

* Analysis results are submitted by a third party laboratory. Saybolt was not present whilst the analysis was carried out, and has signed for receipt only with no liability accepted.

Signed by: Tara Klein - Laboratory Manager I
Issued by: Saybolt LP
Place and date of issue: Linden - 12-29-2014

Uncertainties apply in the evaluation of the test results specified above. Please also refer to ASTM D3244 (except for analysis of RFG) and IP 367 with respect to the utilization of test data to determine conformance with specifications.

Optimus Vector Fuel System

Fuel Property Specifications and Results Table

Version 1405-2

ABSTRACT

The Optimus Vector Fuel System enables the use of non-traditional fuels in diesel engines. This document details the fuel properties required for successful deployment of the Vector technology as well as the lab testing results on LR-100. Please treat this document as Confidential Business Information.



Vector System Fuel Property Specifications

| Property | ASTM Test Method (or equivalent) | Vector Proposed Limits | Lifecycle Renewables (LR-100) | Standards: ASTM D975 ASTM D6751 DIN 51601 | Units |
|--|--|------------------------------|-------------------------------------|--|------------------------|
| Cetane Number or Ignition Quality | D613 D6890 | 40 minimum | 49.2 | 40 minimum | - |
| Flash Point | D93 | 52 minimum | 113 | 52 minimum | °C |
| Ash | D482 or D874 (if additives present) | 0.02 maximum* | <0.001 | 0.02 maximum | % of weight |
| Water and Sediment Content | D2709 or D1796 (depending on fuel viscosity) | 0.05 maximum | 0.000 | 0.05 maximum | % of volume |
| Phosphorus | D4951 | 0.001 maximum | <0.001 | 0.001 maximum | % of weight |
| Kinematic Viscosity (at 40°C) | D445 | 45 maximum** | 36.93 | 4.1 maximum | cSt |
| Carbon Residue | D4530 | 0.50 maximum*** | 0.39 | 0.35 maximum | % of weight |
| Sulfur Content | D5453 | 15 maximum | 7.6 | 15 maximum | mg/kg |
| Oxidation Stability (at 110°C) | EN 14112 (no ASTM equiv.) | 3 minimum | 1.3 | 3 minimum | hours |
| Calcium and Magnesium Content (max) | EN 14538 (no ASTM equiv.) | 5 maximum | 3.8 | 4.0 maximum | ppm |
| Latexity (at 60°C) | D6079 | n/a | n/a | 520 maximum | micron |
| Distillation Temperature | D1160 | n/a | n/a | 338 maximum | °C |
| Copper Strip Corrosion Rating | D130 | 3 maximum | 1b | 3 maximum | Degree of corrosion |
| Conductivity | D2624 | 25 minimum | 280 | 25 minimum | pS/m |
| Cloud Point | D2500 | Report**** | -4 | 0.5 maximum | °C |

Ash*

Optimus initially did not include ash as a defined parameter as this was not measured in the European Standard for Rapeseed Oil (DIN 51605). EPA requested Optimus propose a limit for ash. Therefore, Optimus is proposing a limit of .02% to be in line with biodiesel specifications (ASTM D6751 and EN 14214).

Kinematic Viscosity at 40°C**

Based on good engineering judgment, the Optimus Vector system is suitable for use with fuels up to 45 centistokes. As a result, Optimus is proposing a maximum kinematic viscosity of 45 centistokes.

Carbon Residue***

Optimus initially did not include carbon residue as a defined parameter as this was not measured in the European Standard for Rapeseed Oil (DIN 51605). EPA requested Optimus propose a limit for carbon residue. Therefore, Optimus is proposing a limit of 0.50% to accommodate for commercially available and suitable fuels with the Optimus system.

Cloud Point****

Consistent with ASTM D975 and ASTM D6751, Optimus is proposing that fuel suppliers "report" the cloud point of their fuel. ASTM D975 does not specify a limit for cloud point as "it is unrealistic to specify low temperature properties that will ensure satisfactory operation at all ambient conditions." ASTM D975 goes on to say that "satisfactory operation below the cloud point [...] may be achieved depending on equipment design [and] operating conditions [...]."

¹ ASTM Standard D975, 2013, "Standard Specification for Diesel Fuel Oils," ASTM International, West Conshohocken, PA, 2013 DOI: 10.1520/D0975-13, www.astm.org.

2-2b



SAYBOLT LP
1026 W. ELIZABETH AVE
LINDEN, NJ 07036
908-523-2000 Telephone
908-474-1503 Facsimile

Fast To The Point

Saybolt LP

Certificate of Analysis

Client: Lifecycle Renewable

Report Date: 3/14/2012

Date Sampled: 3/9/2012

Job No: Allocation

Product: LR-100

Lab Number: 2012030099-01

Sample ID: LR-100

Client Ref: Saybolt Boston 13045-00002465

Location: Boston

| Test | Method | Result | Units |
|-----------------------------------|-----------------|---------------|-------------|
| API Gravity @ 60°F | ASTM D-4052 | 21.4 | °API |
| Flash Point, PMCC | ASTM D-93A | 230+ | °F |
| Distillation | ASTM D-86 | — * | °F |
| IBP | | 388 | |
| 10% Rec | | 600 | |
| 50% Rec | | 620 | |
| 90% Rec | | 680 | |
| End Point | | 680 | |
| Recovery | | 90 | Vol. % |
| Sum of Residue and Loss | | 10 | Vol. % |
| Viscosity, Kin @ 100.0°F | ASTM D-445 | 42.25 | cSt |
| Pour Point | ASTM D-97 | -8 / 21 | °C / °F |
| Cloud Point | ASTM D-2500 | -8 / 21 | °C / °F |
| Copper Corrosion, 3 hrs. @ 50°C | ASTM D-130 | 1A | |
| Sulfur Content | ASTM D-2622 | <20 / <0.0020 | ppm / wt% |
| Cetane Index (Calc.) | ASTM D-976 | 35.8 | |
| Cetane Index (Calc.) | ASTM D-4737A | 38.5 | |
| Ash Content | ASTM D-482 | 0.003 | Wt% |
| Carbon Residue-Ramsbottom 10% Res | ASTM D-524/D-86 | N/A* | Wt% |
| Water & Sediment (BS&W) | ASTM D-2709 | 0.005 | Vol. % |
| Lubricity (HFRR) | ASTM D-6079 | 360 | µm |
| Electrical Conductivity | ASTM D-2624 | 185 | pS/m @ 25°C |

Insurer warrants that it has exercised due diligence and care with respect to the information and professional judgments embodied in this report. This report reflects only the findings at the time and place of inspection and testing. Insurer expressly disclaims any further indemnity of any kind. This report is not a guarantee or policy of insurance with respect to the goods or the contractual performance of any party. Any person relying upon this report should be aware that insurer's activities are carried out under their general terms and conditions.

*Precision parameters apply in the evaluation of the test results specified above. Please also refer to ASTM D3244 (except for analysis of RFG) and IP 367 with respect to the utilization of the test data to determine conformance with specifications.

2-2b



SAYBOLT LP
1026 W. ELIZABETH AVE
LINDEN, NJ 07036
908-523-2000 Telephone
908-474-1503 Facsimile

Fast To The Point

Saybolt LP

Certificate of Analysis

Client: Lifecycle Renewable

Report Date: 3/14/2012

Date Sampled: 3/9/2012

Job No: Allocation

Product: LR-100

Lab Number: 2012030089-01

Sample ID: LR-100

Client Ref: Saybolt Boston 13045-00002465

Location: Boston

| Test | Method | Result | Units |
|------|--------|--------|-------|
|------|--------|--------|-------|

This amended certificate shall be passed on to any person to whom the original certificate has been provided.

This certificate revised for distillation results after moving apparatus to a fume hood and retesting.

Unable to recover 10% distillation residue for carbon residue test.

Approved By:

Steve Dirago
Steve Dirago
Sr. Lab Technician

Issuer warrants that it has exercised due diligence and care with respect to the information and professional judgments embodied in this report. This report reflects only the findings at the time and place of inspection and testing. Issuer expressly disclaims any further liability of any kind. This report is not a guarantee or policy of insurance with respect to the goods or the commercial performance of any party. Any person relying upon this report should be aware that issuer's activities are carried out under their general terms and conditions.

*Precision parameters apply to the evaluation of the test results specified above. Please also refer to ASTM D3244 (except for analysis of BPO) and IP 367 with respect to the utilization of the test data to determine conformance with specifications.

**Iowa Central Fuel Testing Laboratory
Four Triton Circle
Fort Dodge, Iowa, USA 50501**



| | |
|------------------------------|---|
| Customer Name: | Lifecycle Renewables Inc. |
| Customer Address: | 62 Alford Street Charlestown, MA 02129 |
| Customer's Sample ID: | LR100 |
| Sample Type: | Other |

Sample ID:
Customer ID:
Received on:
Completed:

| |
|------------|
| 122915I |
| Lifecycle |
| 12/29/2015 |
| 12/30/2015 |

[illegible]

Approval: Donald A. Harkin

Title: QMR or designee

Date: December 30, 2015

2-2c

RENEWABLE HEATING OIL PURCHASE AGREEMENT

July 1, 2018

| | | | | | | | | | | | | | | | |
|---|--|--|------------------------------|--|-----------------------|--|------------------------|------------------------|---------------------|----------------------|--------------------|-----------------------|------------------|------------------------|-------------------|
| BUYER: Keene State College 229 Main Street Keene, NH 03435 Frank Mazzola (603) 358-2242 fmazzola@keene.edu | | SELLER: Lifecycle Renewables, Inc. PO BOX 1144 Marblehead, MA 01945 Rory Gaunt 617-633-2101 rory@lifecyclerenewables.com | | | | | | | | | | | | | |
| I. PRODUCT: | Renewable Heating Oil | II. QUANTITY: | 934,807 gallons | | | | | | | | | | | | |
| III. CONTRACT TERM: | July 1, 2018 – June 30, 2019 | IV. PRICE: | LR100 Price: [REDACTED] | | | | | | | | | | | | |
| V. DELIVERY CHARGES: | Increases in SELLER delivery costs and surcharges during the CONTRACT TERM will be borne by the BUYER. | VI. PAYMENT TERMS: | [REDACTED] | | | | | | | | | | | | |
| VII. TAXES: | All applicable taxes are the responsibility of the BUYER. | VIII. DELIVERY: | Detailed in EXHIBIT A below. | | | | | | | | | | | | |
| IX. MONTHLY SCHEDULE: | <table> <tr> <td>July 2018: on-call, invoiced upon delivery</td> <td>January 2019: 149,354</td> </tr> <tr> <td>August 2018: on-call, invoiced upon delivery</td> <td>February 2019: 112,210</td> </tr> <tr> <td>September 2018: 41,574</td> <td>March 2019: 118,882</td> </tr> <tr> <td>October 2018: 55,648</td> <td>April 2019: 95,437</td> </tr> <tr> <td>November 2018: 92,628</td> <td>May 2019: 59,247</td> </tr> <tr> <td>December 2018: 174,613</td> <td>June 2019: 35,214</td> </tr> </table> | | | July 2018: on-call, invoiced upon delivery | January 2019: 149,354 | August 2018: on-call, invoiced upon delivery | February 2019: 112,210 | September 2018: 41,574 | March 2019: 118,882 | October 2018: 55,648 | April 2019: 95,437 | November 2018: 92,628 | May 2019: 59,247 | December 2018: 174,613 | June 2019: 35,214 |
| July 2018: on-call, invoiced upon delivery | January 2019: 149,354 | | | | | | | | | | | | | | |
| August 2018: on-call, invoiced upon delivery | February 2019: 112,210 | | | | | | | | | | | | | | |
| September 2018: 41,574 | March 2019: 118,882 | | | | | | | | | | | | | | |
| October 2018: 55,648 | April 2019: 95,437 | | | | | | | | | | | | | | |
| November 2018: 92,628 | May 2019: 59,247 | | | | | | | | | | | | | | |
| December 2018: 174,613 | June 2019: 35,214 | | | | | | | | | | | | | | |
| X. SPECIAL PROVISIONS: | BUYER expects deliveries to be offloaded by 8:00am on the day of delivery. BUYER agrees to execute the [REDACTED] in a timely manner upon request of SELLER | | | | | | | | | | | | | | |
| THIS PURCHASE IS SUBJECT TO THE TERMS AND CONDITIONS SET FORTH IN EXHIBIT A | | | | | | | | | | | | | | | |
| I acknowledge that the terms contained in this Renewable Heating Oil Purchase Agreement (the "AGREEMENT") constitute the entire agreement between the BUYER and SELLER, and there are no contracts, understandings, obligations, promises, assurances or conditions, precedent or otherwise, except those expressly set out herein. | | | | | | | | | | | | | | | |

In witness whereof the BUYER and SELLER have executed this AGREEMENT on the date first written herein.

BUYER: **Keene State College**

SELLER: **Lifecycle Renewables, Inc**

**Michael E.
Durkin**

Digitally signed by Michael E. Durkin
DN: cn=Michael E. Durkin, o=University
System of New Hampshire,
ou=Procurement and Contract
Services,
email=michael.durkin@usnh.edu, c=US
Date: 2018.07.10 10:08:14 -04'00'



BUYER Authorized Agent

SELLER Authorized Agent

By:

By: Rory Gaunt

Its: Chief Procurement Officer

Its: Chief Executive Officer

EXHIBIT A: TERMS AND CONDITIONS

- A. **PRICE:** The following definitions are used for the PRICE formula:
- "LR100 Price" [REDACTED] for gallons delivered under the MONTHLY SCHEDULE.
 - SELLER is entitled to [REDACTED]
- B. **DELIVERY:** BUYER and SELLER shall mutually agree to a delivery schedule for a particular month in a mutually agreeable time frame ("DELIVERY SCHEDULE"). The DELIVERY SCHEDULE will consist of tentative delivery dates, in minimum 8000 gallon delivery amounts, up to the number of gallons listed for the month in the MONTHLY SCHEDULE. The BUYER shall provide the SELLER with 24 hours advanced notice to revise the delivery schedule. BUYER shall provide adequate facilities for unloading PRODUCT, and pay all of carrier's demurrage, standby and minimum delivery (to the degree BUYER requires a delivery of less than the 8000 gallon delivery minimum) charges. Delivery by SELLER into any equipment or container furnished by BUYER at any point shall constitute delivery to BUYER. Quantities delivered shall be determined in accordance with SELLER's established practices at the shipping point. In the event that the delivery rates and surcharges increase from the date of this contract, the increased delivery rate and/or surcharge will be in addition to the PRICE and the cost shall be borne by the BUYER.
- C. **DELIVERY and BALANCING:** During any month, in the event BUYER receives quantities of the PRODUCT in excess of the monthly quantities listed in the MONTHLY SCHEDULE, such quantities may be priced by SELLER at current market value, plus all reasonable costs, including transportation. The current market value of a gallon shall be the NY Harbor ULSD open price on the day the gallons are shipped (the price can be found at <https://www.investing.com/commodities/heating-oil-historical-data> or another mutually approved source). In the event the BUYER fails to receive the monthly quantities listed in the MONTHLY SCHEDULE such quantities may at the sole discretion of the SELLER be carried forward or cashed out to a zero monthly balance. If at the end of the CONTRACT TERM or early termination by either party and BUYER has not received the agreed to QUANTITY, SELLER reserves the right, at its sole discretion to one of the following: a) Contract Extension: Under-delivered quantity of PRODUCT purchased by BUYER at the agreed PRICE plus a monthly storage fee and stored by SELLER until under-delivered PRODUCT is delivered to BUYER., b) Cashed out to Zero Balance: BUYER pays the SELLER the difference between the agreed PRICE and the LIQUIDATION PRICE (LIQUIDATION PRICE is the price that the SELLER liquidates the PRODUCT to another third-party buyer), SELLER shall have no obligation to deliver the cashed out volume., c) Terminate the Agreement: SELLER shall have no obligation to deliver the PRODUCT.
- D. **PAYMENTS/CREDIT:** BUYER agrees to make payments in accordance with the PAYMENT TERMS of this AGREEMENT, and to maintain creditworthiness or provide additional security as required by SELLER, BUYER agrees to allow SELLER to evaluate BUYER's creditworthiness and set a credit limit (the "CREDIT LIMIT") for the BUYER. Should the BUYER exceed the CREDIT LIMIT or fail to adhere to PAYMENT TERMS, SELLER shall be entitled to immediately suspend any delivery until at such time the default has been remedied. SELLER reserves the right to require collateral for fixed prices contracts due to market conditions. Such collateral requirements will be invoiced at the discretion of the SELLER and will be payable to the SELLER promptly. Should BUYER experience an adverse material change in financial condition (as determined in SELLER's sole discretion), SELLER may require additional security from BUYER. Failure of BUYER to provide such security within 5 days of notice from SELLER shall be deemed a breach of this AGREEMENT and subject to immediate termination and suspension of deliveries. If BUYER files for bankruptcy or is the subject of an involuntary bankruptcy, SELLER may immediately terminate this AGREEMENT. BUYER is responsible for all expenses and collection fees incurred by SELLER to collect any overdue amounts, including reasonable attorney's fees. Invoices not paid by the Customer within the PAYMENT TERMS of this AGREEMENT will be assessed finance charges 1.5% per month, 18% APR. A \$50.00 fee will be charged to BUYER for the return of any checks.
- E. **ASSIGNABILITY:** The BUYER may not assign this agreement or any of its rights or obligations under this agreement without SELLER's written consent. From time to time the SELLER may assign this AGREEMENT or any portion of this AGREEMENT or any of its rights or obligations under this AGREEMENT, by giving BUYER notice of such assignment. This AGREEMENT shall inure to and be binding upon the parties hereto and upon their respective successors, heirs and assigns. In the event BUYER sells, leases, or otherwise conveys the facilities in which the PRODUCT sold hereunder is utilized; BUYER shall require its successor to assume the obligations of this AGREEMENT.
- F. **GOVERNMENTAL REGULATIONS:** Any PRODUCT type or specifications change, tax, duty, or governmental charge now or hereafter imposed on the PRODUCT, SELLER, or required to be paid or collected by SELLER by reason of the manufacture, transportation, sale, delivery, or use of PRODUCT, shall be borne by BUYER, and such costs shall be in addition to the PRICE of the PRODUCT.
- G. **LIABILITIES-CLAIMS:** SELLER hereby warrants to BUYER that at the delivery of PRODUCT hereunder it will have good title and / or right to sell such PRODUCT and that such PRODUCT will be free and clear of all adverse claims. SELLER shall have no liability to BUYER for any defect in quality or shortage of any PRODUCT delivered, unless (a) BUYER gives SELLER notice to BUYER's claim, setting forth the facts on which it

is based, within 48 hours after BUYER's discovery of the defect, and (b) SELLER shall not have liability for any defect or shortage of any PRODUCT delivered in equipment or containers furnished by BUYER. The liability of a party breaching the provisions of this AGREEMENT shall be limited to direct damages only. Such direct actual damages shall be the sole and exclusive remedy hereunder and all other remedies or damages at law or in equity are waived. Direct damages include the difference in cost between the PRODUCT PRICE and No. 6 oil in the event that SELLER does not supply BUYER with contracted quantities. Neither party shall be liable for consequential, incidental, punitive, exemplary or indirect damages, lost profits, or other business interruption damages, in tort, contract, under any indemnity provision or otherwise.

- H. **WARRANTIES:** SELLER does not provide warranties for PRODUCT storage container conditions (internally or externally) underground leakage, soil contamination, miscalculation of ordering, PRODUCT spillage, facility safety and health.
- I. **FORCE MAJEURE:** Except as specifically provided to the contrary herein, inability or failure of SELLER to deliver or of BUYER to receive PRODUCT or of either party to perform pursuant to this AGREEMENT will not be the basis of claims for damages sustained by either party or for breach of contract when due to causes or contingencies reasonably beyond the control to either party hereto, including but not limited to Acts of God or governmental authority; the elements; labor disputes; fires; accidents, breakage, repair or change of or obstruction in supply, equipment or machinery; depletion or failure of PRODUCT supply; demands in excess of the capacity of transporter's equipment or supply. The party suffering the event of force majeure shall give notice of such event of force majeure in reasonably full particulars to the other party, as soon as reasonably possible. Any such event of force majeure shall, so far as possible, be remedied with all reasonable dispatch.
- J. **NOTICES:** All notices required or permitted under this AGREEMENT shall be in writing and shall be deemed to be delivered when delivered personally, by courier, by telefax or telecopier if received during normal business hours, or by mail if properly addressed and deposited in the United States mail, first class postage prepaid, to the applicable address shown on the first page of this AGREEMENT, or to such address as either party may from time to time designate as the address for such purpose by like notice addressed to the other party.
- K. **ENVIRONMENTAL ATTRIBUTES:** ENVIRONMENTAL ATTRIBUTES mean any credit, benefit, reduction, offset, financial incentive, tax credit and other beneficial allowance that is in effect as of the date of this AGREEMENT or may come into effect in the future related to the PRODUCT or use of the PRODUCT. All ENVIRONMENTAL ATTRIBUTES will accrue to the benefit of the SELLER. SELLER shall take all actions necessary to qualify for, register and provide required reporting for ENVIRONMENTAL ATTRIBUTES. At SELLER's request and expense, BUYER shall execute all such documents and instruments reasonably necessary or desirable to effect or evidence the ENVIRONMENTAL ATTRIBUTES and also the SELLER's right, title and interest in and to the ENVIRONMENTAL ATTRIBUTES.
- The BUYER understands that the PRICE reflects its current and continuing eligibility for New Hampshire Thermal Renewables Energy Credits, section Laws of 2012, Chapter 272, SB 218-FN – FINAL VERSION of the New Hampshire state code, the "PROGRAM". The BUYER warrants that it currently qualifies for the PROGRAM for LR100 gallons delivered under this AGREEMENT and also, that, to its knowledge, the PROGRAM is viable and expected to continue throughout the CONTRACT TERM.
- L. **CONFIDENTIALITY:** BUYER will not make use of or disclose SELLER formulations, specification or technical data without SELLER's prior written permission. BUYER and SELLER also agree that the specific terms and conditions of this AGREEMENT are strictly confidential, and will not be made available to any third parties without the prior written consent of the SELLER, except as may be required by law. SELLER shall ensure that its consultants, brokers and representatives shall be held to the same standard of confidentiality.
- M. **WAIVER:** No delay or omission by either party in exercising any right, power or remedy provided by law or under this AGREEMENT shall affect that right power or remedy or operate as a waiver of it.
- N. **INVALIDITY:** If at any time provisions of the AGREEMENT is or becomes illegal, invalid, void or unenforceable under the laws of the relevant jurisdiction, the legality, validity and enforceability of the remainder of this AGREEMENT shall not be affected.
- O. **ENTIRE AGREEMENT:** This AGREEMENT, including the first page and any exhibits, constitutes the entire AGREEMENT between the parties and there are no other representations, warranties, understandings or other agreements except as set forth herein. There will be no modification of this AGREEMENT except by written consent of the BUYER and SELLER.

ATTACHMENT 3.1: COMPONENT SPECIFICATION SHEETS

| Component | Calibration recommendation | Spec. Sheets Attached in Order |
|-----------------------------------|---|--|
| Steam Pressure Transmitter | Factory Calibrated - No additional calibration required. Annual inspection for operating accuracy is recommended | Setra |
| Fuel Oil Meter | Factory Calibrated - No additional calibration required. Annual inspection for operating accuracy is recommended | IsTec Corp. CONTROLL FUEL METER |
| Condensate Temp. Probe | Factory Calibrated - No additional calibration required. Annual inspection for operating accuracy is recommended | Level Pro |
| Feed Water Meter | Factory Calibrated - No additional calibration required. Annual inspection for operating accuracy is recommended | FlowTech |



Wisdom to make a difference.

Model 256

Pressure Transducers



NOTE: Setra quality standards are based on ANSI-Z540-1. The calibration of this product is NIST traceable.

U.S. Patent nos. 6019002; 6014800

DESCRIPTION

The Model 256 is one of the most rugged and reliable sensors available. Specifically designed for NEMA4/IP65 service the 256 is packaged in a die-cast aluminum enclosure and includes Setra's robust capacitive design, making it resistant to environmental effects such as shock, vibration, temperature and EMI/RFI.

Available in a wide variety of gauge pressure ranges, the 256 features adjustable potentiometers for zero and span settings.

Only 3.6" high x 4.0" wide, the Model 256 is designed for compact installations. The removable cover provides easy access to the internal terminal strip for wiring. Installation is quick and easy with 1/2 inch internal threaded conduit ports for electrical termination.

BENEFITS

- Low Cost
- High Accuracy
- NEMA-4/IP-65
- Wide Operating Temperature Range
- Compatible with a Wide Range of Gases or Liquids
- Corrosive Resistant All Stainless Steel Wetted Parts
- Choice of Voltage or Current Output
- Operates on Low Cost Unregulated Power Supply
- Meets CE Conformance Standards

APPLICATIONS

- Process Control
- Chemical Processing
- Agricultural Irrigation Systems
- Natural Gas Pipeline Monitoring
- Grain Processing
- Industrial Pressure Monitoring

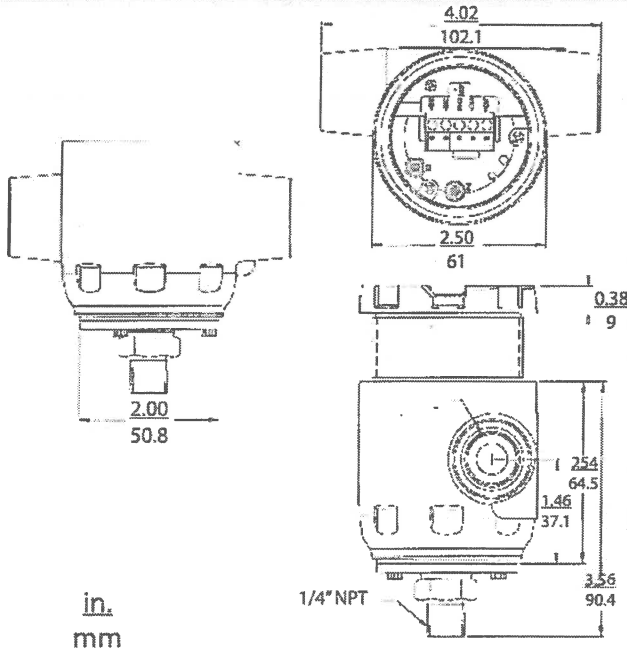
SPECIFICATIONS

| Performance Data | | | Environmental Data | | Electrical Data (Voltage) | |
|---|-----------------|------------------|---|---------------------------------|--|--|
| | Ranges | Ranges | Operating ¹ Temperature °F (°C) | -40 to +185 (-40 to +85) | Circuit | 3-Wire (Exc, Out, Com) |
| | 25 PSI & Higher | Less than 25 PSI | Storage Temperature °F (°C) | -40 to +185 (-40 to +85) | Excitation | 9 to 30 VDC |
| Accuracy RSS ¹ (at constant temp) ² | ±0.13% FS | ±0.25% FS | Shock ⁴ | 200g | Output ⁵ | 0.1 to 5.1 VDC for Ranges ≥ 25 PSI ⁶ |
| Non-Linearity, BFSI | ±0.10% FS | ±0.22% FS | Vibration ⁷ | 20g | Output Impedance | 100 ohms |
| Hysteresis | 0.08% FS | 0.10% FS | Environmental Protection | NEMA 4/IP65 | Power Consumption | <0.15 watts (approx. 5mA @ 24 VDC) |
| Non-Repeatability | 0.02% FS | 0.05% FS | Physical Description | | Electrical Data (Current) | |
| Thermal Effects | | | Case | Die Cast Aluminum | Circuit | 2-Wire |
| Compensated Range °F | -4 to +176 | -4 to 176 | Electrical Connections | Two 1/2" Internal Conduit Ports | Output ⁷ | 4 to 20mA ⁸ for All Ranges |
| Compensated Range °C | -20 to 80 | -20 to ±80 | Pressure Fittings | 1/4" NPT External | External Load | 0 to 800 ohms |
| Zero Shift %FS/100°F | 1.0 | 1.0 | Weight (approx.) | 13.4 Ounces | Minimum supply voltage (VDC) | 9 + 0.02 x (Resistance of receiver plus line). |
| Zero Shift %FS/100°C | ±0.9 | ±1.8 | Pressure Media | | Maximum supply voltage (VDC) | 30 + 0.004 x (Resistance of receiver plus line). |
| Span Shift %FS/100°F | 1.5 | ±1.5 | Liquids and gases compatible with 17-4 PH Stainless Steel. ⁴ | | <div>1 RSS of Non-Linearity, Hysteresis, and Non-Repeatability. 2 Units calibrated at nominal 70°F. Maximum thermal error computed from this datum. 3 Operating temperature limits of the electronics only. Pressure media temperature may be considerably higher or lower. 4 Note: Hydrogen not recommended for use with 17-4 PH Stainless Steel. Specifications subject to change without notice. 5 Calibrated into a 500 ohm load, operable into a 5000 ohm load or greater. 6 Zero output factory set to within ±25 mV. 7 Span (Full Scale) output factory set to within ±50 mV. 8 Zero output factory with a 24 VDC loop supply voltage and a 250 ohm load. Zero output factory set to within ±0.02 mA Span output factory set to within ±16 mA</div> | |
| Span Shift %FS/100°C | 1.4 | ±1.4 | Environmental Protection | Weather Resistant | | |
| Long Term Stability | 0.5% FS/YR | 0.5% FS/YR | Physical Description | | | |
| Warm-up Shift | 0.1% FS Total | 0.1% FS Total | Case | Stainless Steel & Valox | | |

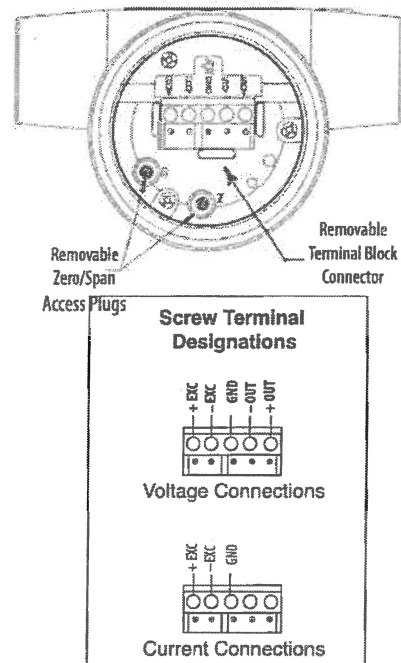
Model 256

Pressure Transducers

DIMENSIONS



Wiring



ORDERING INFORMATION

2 5 6 1 - - - - -

| Model | Range Code | Pressure Type | Pressure Fitting | Output | Options |
|------------|-------------------|---------------|------------------|-----------------|---------------------------|
| 2561 = 256 | See Table 1 Below | G Gauge | Ranges < 25 PSI | Ranges < 25 PSI | C Calibration Certificate |

Table 1. Range Specification

| RANGE CODE | PSI | RANGE CODE | BAR |
|------------|------------|------------|----------|
| 001P | 0 to 1 | 1R6B | 0 to 1.6 |
| 002P | 0 to 2 | 004B | 0 to 4 |
| 005P | 0 to 5 | 006B | 0 to 6 |
| 010P | 0 to 10 | 010B | 0 to 8 |
| 015P | 0 to 15 | 016B | 0 to 16 |
| 025P | 0 to 25 | 025B | 0 to 25 |
| 050P | 0 to 50 | 040B | 0 to 40 |
| 100P | 0 to 100 | 060B | 0 to 60 |
| 150P | 0 to 150 | 100B | 0 to 100 |
| 200P | 0 to 200 | 160B | 0 to 160 |
| 250P | 0 to 250 | 250B | 0 to 250 |
| 500P | 0 to 500 | 400B | 0 to 400 |
| 600P | 0 to 600 | 700B | 0 to 700 |
| 10CP | 0 to 1000 | | |
| 30CP | 0 to 3000 | | |
| 50CP | 0 to 5000 | | |
| 10KP | 0 to 10000 | | |

| | | | |
|-----------------|-------------------|-----------------|---------------|
| 2M | 1/4" NPT Male | 11 | 4-20 mA |
| 1M | 1/8" NPT Male | Ranges ≥ 25 PSI | |
| Ranges ≥ 25 PSI | | 11 | 4-20 mA |
| 2M | 1/4" NPT Male | 22 | 0.1 - 5.1 VDC |
| 4M | 1/2" NPT (Male) | | |
| 2F | 1.4" NPT (Female) | | |

Ordering Example: 2561001PG2M11C = Model 256, 0 to 1PSI, Gauge Pressure, 1/4" NPT Pressure Fitting, 4 to 20 MA Output, Calibration Certificate

6.0. RETURNING PRODUCTS FOR REPAIR

Please contact a Setra Systems application engineer (1-800-257-3872, 1-978-263-1400) before returning unit for repair to review information relative to your application. Many times only minor field adjustments may be necessary. When returning a product to Setra Systems, the material should be carefully packaged and shipped prepaid to:

Setra Systems, Inc.
159 Swanson Road
Boxborough, MA 01719-1304
Attn: Repair Department

To assure prompt handling, please supply the following information and include it inside the package or returned material:

1. Name and phone number of person to contact.
2. Shipping and billing instructions.
3. Full description of the malfunction.
4. Identify any hazardous material used with product.

Notes: Please remove any pressure fittings and plumbing that you have installed and enclose any required mating electrical connectors and wiring diagrams.

Allow approximately 3 weeks after receipt at Setra Systems for the repair and return of the unit. Non-warranty repairs will not be made without customer approval and a purchase order to cover repair charges.

Calibration Services

Setra maintains a complete calibration facility that is traceable to the National Institute of Standards & Technology (NIST). If you would like to recalibrate or recertify your Setra pressure transducers or transmitters, please call our Repair Department at 800-257-3872 (978-263-1400) for scheduling.

7.0. WARRANTY AND LIMITATION OF LIABILITY

SETRA warrants its products to be free from defects in materials and workmanship, subject to the following terms and conditions. Without charge, SETRA will repair or replace products found to be defective in materials or workmanship within the warranty period, provided that:

- a) the product has not been subjected to abuse, neglect, accident, incorrect wiring not in use, improper installation or servicing, or use in violation of inspection guidelines by SETRA;
- b) the product has not been repaired or altered by anyone except SETRA or its authorized service agent; or
- c) the serial number or date code has not been removed, altered, or otherwise changed and documentation sufficient, to the judgment of SETRA, the defect in materials or workmanship developed under normal installation, use and service;
- d) SETRA is notified in advance of all the product is returned to SETRA for inspection and repair.

Unless otherwise specified in a contract or warranty or if, or agreed to in writing and signed by a SETRA officer, SETRA personnel and acceleration products shall be warranted for one year from date of sale.

The foregoing warranty is limited to all warranties, express, implied or statutory, including but not limited to, any implied warranty of merchantability for a particular purpose. SETRA's liability for breach of warranty is limited to repair or replacement, or if the product cannot be repaired or replaced, to a refund of the purchase price. SETRA's liability for all other breaches is limited to a refund of the purchase price. In no instance shall SETRA be liable for incidental or consequential damages arising from a breach of warranty or from the use or malfunction of its products.

No representative or person is authorized to give any warranty other than as set out above or to assume for SETRA any other liability in connection with the sale of its products.

159 Swanson Road, Boxborough, MA 01719
Toll Free: (800) 257-3872, Fax: (978) 264-0292

Installation Guide

Model 256 Gage Pressure Transducer



Setra

1-800-257-3872 Toll Free
1-978-264-0292 Fax
www.setra.com Web Site



SS2033 Rev.F 02/04/02

Setra

3.2 Current Output Units

The 4-20 mA current output units are designed to have current flow in one direction only - **PLEASE OBSERVE POLARITY**.

We suggest that the electrical conduit shield be connected to the system's loop circuit ground to improve electrical noise rejection.

The Model 256 is a two-wire loop-powered 4 to 20mA current output unit and delivers rated current into any external load of 0-800 ohms. (See Diagram 2 for location of +EXC and -EXC current output screw terminals.) The current flows into the + terminal and returns back to the power supply through the - terminal. (The center GND terminal may be used for shielding.) The power supply must be a DC voltage source with a voltage range between 9 and 30 measured between the + and - terminals. The unit is calibrated at the factory with a 24 VDC loop supply voltage and a 250 ohm load.

Minimum Supply Voltage (VDC) = $9 + 0.02 \times$ (resistance of receiver plus line).
Maximum Supply Voltage (VDC) = $30 + 0.004 \times$ (resistance of receiver plus line).

4.0 CALIBRATION

The 256 transducer is factory calibrated and should require no field adjustment. Whenever possible, any zero and/or span offsets should be corrected by software adjustments in the user's control system. However, both zero and span adjustments are accessible by removing the screw top cover and the adjustment access cover and turning the potentiometer screw inside. (See Diagram 1 for the location of the Zero and Span potentiometers.)

4.1 Voltage Output Zero Adjustment

While monitoring the voltage between the positive output (+OUT) and negative output (-OUT), and with the pressure port open to atmosphere, or with zero pressure applied, the zero may be adjusted by turning the zero potentiometer screw. The factory setting is 0.1 VDC ($\pm 25\text{mV}$).
Note: -OUT and -EXC are commoned on the circuit.

4.2 Voltage Output Span Adjustment (Complete the zero adjustment before setting span.)

Span or full scale output adjustments should only be performed by using an accurate pressure standard (electronic manometer, digital pressure gage, etc.), with at least comparable accuracy to the 256 transducer. With full range pressure applied to the pressure port, the span may be adjusted by turning the span potentiometer screw. The factory setting is 5.1 VDC ($\pm 50\text{mV}$).

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| 2.3 Pressure Fittings | 4 |
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| 6.0 RETURNING PRODUCTS FOR REPAIR | 8 |
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Setra Model 256 Pressure Transducer

1.0 GENERAL INFORMATION

Every Model 256 has been tested and calibrated before shipment. Specific performance specifications are listed on Page 7 of this Guide.

Setra Systems 256 pressure transducers sense gage pressure and convert this pressure to a proportional high level analog output. Two output versions are offered: A voltage output of .1 to 5.1 VDC, and a current output of 4 to 20 mA.

2.0 MECHANICAL INSTALLATION

2.1 Media Compatibility

Model 256 transducers are designed to be used with any gas or liquid compatible with 17-4 PH Stainless Steel. (Hydrogen is not recommended for use with 17-4 PH SS.)

2.2 Environment

The operating temperature limits of the 256 are as follows:

Operating Temperature Range °F (°C) -40 to +260 (-40 to +125)
Compensated Temperature Range °F (°C) -4 to +176 (-20 to +80)

2.3 Pressure Fittings

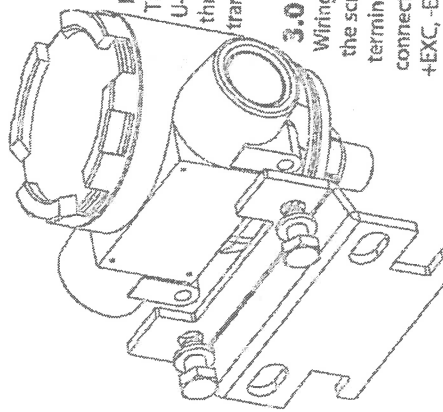
Typically, standard pipe fittings and installation procedures should be used. However, for very high pressure ranges in excess of 500 psig, we suggest the use of a sealant such as Loctite Hydraulic Sealant. Excessive high torquing of metal fittings may cause a slight shift of the output, but this shift can be trimmed out by the zero adjustment. Torquing does not significantly affect linearity or sensitivity.

2.4 Moisture Precautions

The Model 256 is provided with two 1/2" NPT female conduit ports for electrical termination. These tapered pipe threads are tapered deeper than the NPT standard, in accordance with industry guidelines. These ports must be sealed according to standard industry practice, in order to prevent moisture ingress into the Model 256.

2.5 Venting

The Model 256 is a true gage pressure transducer. This means that the reference side of the pressure sensing diaphragm must be vented to atmosphere. If the reference side of the diaphragm were sealed (as in a sealed gage transducer), temperature changes would cause the reference pressure to vary. This may affect the overall accuracy, especially in ranges lower than 500 psig. The Model 256 provides a vent from the reference side of the sensor to the inside of the housing and the conduit ports. The user-provided electrical conduit must be vented to atmosphere in a clean dry location. (It is important to prevent moisture ingress from the environment into the wiring chamber or reference side of the transducer.)



2.6 Mounting Accessories

The Model 256 is provided with a bracket and two hex bolts for mounting and a 1/2" NPT plug for the unused conduit opening. The bracket is suitable for mounting with a U-bolt or a band clamp. There are 1/4-20 UNC threaded holes on the back of the 256 transducer for direct mounting and/or grounding.

3.0 ELECTRICAL INSTALLATION

Wiring is through a 1/2" conduit opening. Remove the screw cover to access the removable wiring terminal block connector. The terminal block connector version has five terminals for wiring +EXC, -EXC, GND, -OUT, and +OUT (see Diagram 1).

Remove the terminal block connector to facilitate wiring to screw terminals. Refer to the terminal block connector label for terminal designations. (See Diagram 2 for screw terminal designations.) After wiring, plug connector back into pin socket and neatly tuck all wiring into wire recess cavity.

Diagram 1

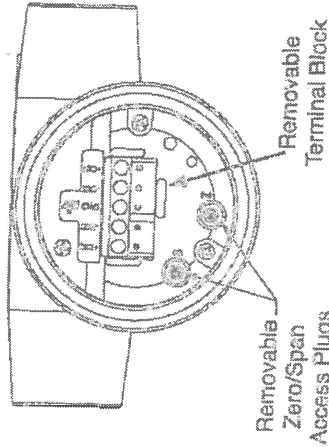
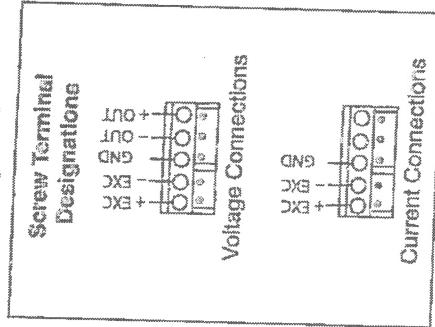


Diagram 2



3.1 Voltage Output Units

The Model 256 is a 3-wire circuit. The -EXC and -OUT are commoned on the circuit. The 256 can operate from a 12 to 28 VDC excitation. The 256 has a 0.1-5.1 VDC output.

- + Excitation; connect to 12-28 VDC power supply
- + Output; connect to controller or monitor
- Output; connect to controller or monitor
- Excitation; connect to return of 12-28 V power supply
- GND Connect to system or earth ground

The Model 256 can be wired as a three wire device by connecting - output, excitation and shield to a common ground. However, accuracy will be reduced with increase in lead resistance.

4.3 Current Output Zero Adjustment

While monitoring the current output, and with the pressure port open to atmosphere or with zero pressure applied, the zero may be adjusted by turning the zero potentiometer screw. The factory setting is 4mA ($\pm 0.08\text{mA}$).

4.4 Current Output Span Adjustment

Span or full scale output adjustments should only be performed by using an accurate pressure standard (electronic manometer, digital pressure gage, etc.) with at least comparable accuracy to the 256 transducer. With full range pressure applied to the pressure port, the span may be adjusted by turning the span potentiometer screw. The factory setting is 20mA ($\pm 0.16\text{mA}$).

5.0 MODEL 256 PERFORMANCE SPECIFICATIONS

| | For Ranges | |
|---|-------------------------|-------------------------|
| | 25 PSI and Higher | Less Than 25 PSI |
| Accuracy $\pm 0.5\%$ (at constant temperature.) | $\pm 0.13\%$ FS | $\pm 0.25\%$ FS |
| Non-Linearity, BFSL | $\pm 0.1\%$ FS | $\pm 0.22\%$ FS |
| Hysteresis | 0.08% FS | 0.10% FS |
| Non-Repeatability | 0.02% FS | 0.05% FS |
| $\pm 0.5\%$ of Non-Linearity, Non-Repeatability and Hysteresis. | | |
| Thermal Effects | | |
| Compensated Range $^{\circ}\text{F}/^{\circ}\text{C}$ | -4 to +176 (-20 to +80) | -4 to +176 (-20 to +80) |
| Zero Shift $\mu\text{PSI}/100^{\circ}\text{F}$ (50°C) | ± 1.0 (± 0.9) | ± 2.0 (± 1.8) |
| Span Shift $\mu\text{PSI}/100^{\circ}\text{F}$ (50°C) | ± 1.5 (± 1.4) | ± 1.5 (± 1.3) |
| Warm-up Shift | $\pm 0.1\%$ FS total | $\pm 0.1\%$ FS total |

Setra offers a complete line of products for these industries:

Industrial

HVAC

Test & Measurement

Barometric

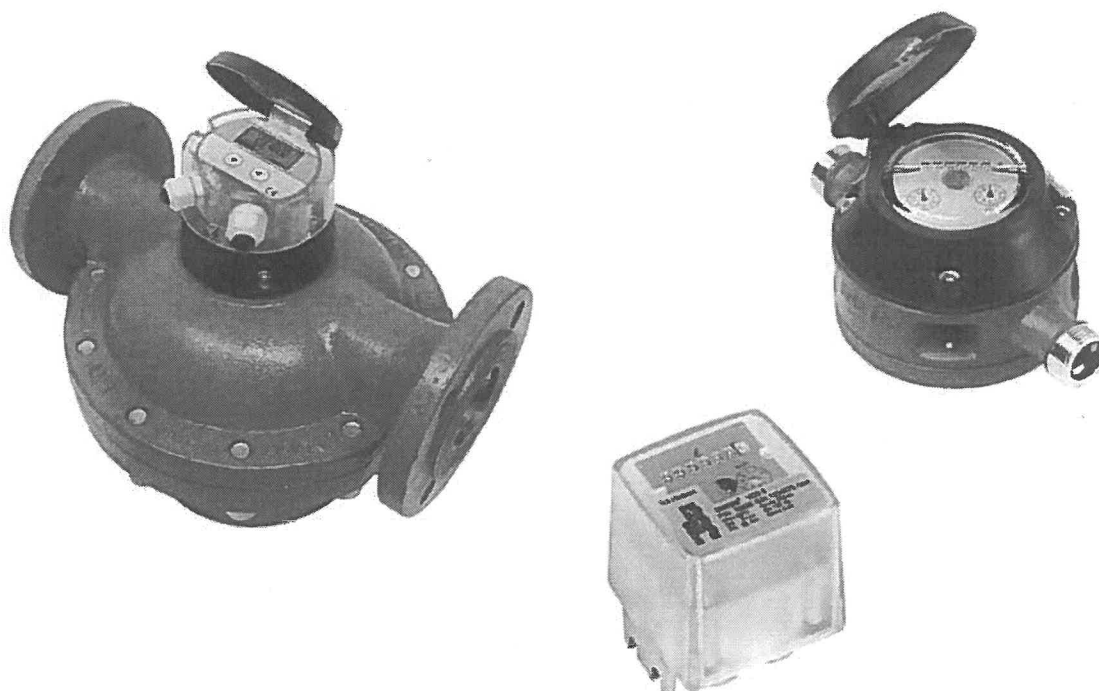
Ultra High Purity/Sanitary

CONTOIL®

Fuel oil meters

Applications

- Flow measurement of mineral oils such as heating or propellant fuels
- In burners, on board ships, land vehicles and fixed installations
- Marine and metrological type approvals (optional)



Features

- The complete range of products offering the best solutions for the measurement of oil consumption
- State-of-the-art design with electronic counter, flow indication, analogue and digital output signals and limiting value switch
- Mounting on the pressure or suction side of a pump, with no straight inlets or outlets required
- Independent of viscosity and temperature
- High vibration resistance
- Classical version with mechanical display

Your benefits

- The reliable solution with everything from a single supplier
- Reliable monitoring and flexible control of the system. Simplifies burner settings and optimising consumption
- Highly flexible mounting with very small space requirements
- Accurate measurements
- Maximum safety in the shipbuilding and automobile industries
- Cost-effective metering point

The right product for every application

Range CONTOIL® Control VZF 15...50



with multifunctional display and parameterisable outputs

Electronic display of

- totaliser, total and resettable volume
- actual flow rate
- other flow parameters

Output signals for

- volume pulses
- actual flow rate
- limiting values (Q_{min} , Q_{max})

Simple to operate

Interactive parameter input

External power supply

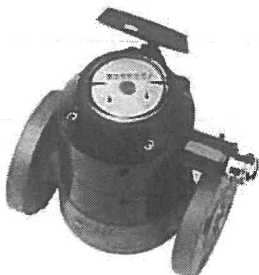
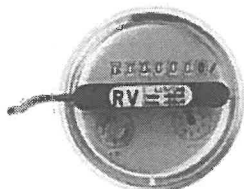
Housing with threaded or flanged connections

Main characteristic data:

- flow range 10...30 000 l/h
- temperature ranges 130 and 180 °C
- nominal pressure PN 16 and 25 bar (PN 40 on request)

Page 5

Range CONTOIL® Classic VZO 4...50



total volume display and remote transmission

Total volume display on roller counter

Option: Reed pulser RE or RV for remote totalisation

Option: Inductive IN pulser for control purposes

Housing with threaded or flanged connections

Main characteristic data:

- flow range 0.5...30.000 l/h
- temperature ranges 60, 130 and 180 °C
- nominal pressure PN 16, PN 25 and PN 40 bar

Page 9

**Range CONTOIL®
VZFA / VZOA**



optimal solution for special applications such as:

- differential measurement (VZFA / VZOA 15...50)
- certification/official verification for commercial transactions (VZOA 4...50)
- engine test benches (VZFA / VZOA 15...50)

VZFA

Electronic display of

- totaliser, total and resettable volume
- actual flow rate
- other flow parameters

Output signals for

- volume pulses
- actual flow rate
- limiting values (Q_{min} , Q_{max})

Simple to operate

Interactive parameter input

External power supply

VZOA 4 and 8

- Volume display on roller counter

VZOA 15...50

- Volume display on roller counter

Option: IN inductive pulser for control purposes

Option: RV Reed pulser for remote totalisation, integrated into the roller counter

Housing with threaded or flanged connections

Main characteristic data:

- flow range 10...30,000 l/h
- temperature ranges 130 and 180 °C
- nominal pressure PN 16 and PN 25 bar (PN 40 on request)

with special pairing for minimum measurement variance.

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Accessories

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APPENDIX:

Meter data

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Selection of the optimal meter

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Fuel oils

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How to obtain an optimal measurement

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Application examples

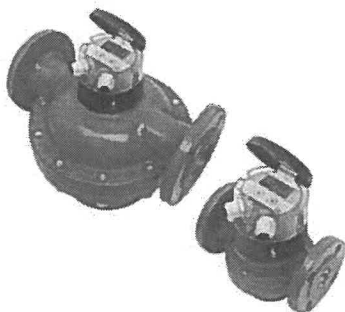
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If flow meters are needed for hazardous areas, please contact your nearest sales office.

CONTOIL® Control VZF 15...50

Technical data ¹⁾



- display of total volume, resettable volume, and flow rate in m³, litres or US gallons ²⁾
- user-friendly, interactive parameter input
- fuel oil meter with threaded or flanged connections
- for mounting in horizontal or vertical positions

Versions available on request:

- different flange drillings, such as ANSI, JIS

| Type | | | VZF 15 | VZF 20 | VZF 25 | VZF 40 | VZF 50 |
|--|---------------------------------|---|---|---------|--------|--------|--------|
| Nominal diameter | DN | mm | 15 | 20 | 25 | 40 | 50 |
| | | inch | 1/2 | 3/4 | 1 | 1 1/2 | 2 |
| Installation length | | mm | 165 | 165 | 190 | 300 | 350 |
| Nominal pressure with threaded ends | PN | bar | 16 | 16 | 16 | 16 | 16 |
| | with flanges | PN | 25 | 25 | 25 | 25 | 25 |
| Maximum temperature | T _{max} | °C | 130, 180 | | | | |
| Maximum flow rate | Q _{max} ³⁾ | l/h | 600 | 1500 | 3000 | 9000 | 30000 |
| Nominal flow rate | Q _{cont} ³⁾ | l/h | 400 | 1000 | 2000 | 6000 | 20000 |
| Minimal flow rate | Q _{min} | l/h | 10 | 30 | 75 | 225 | 750 |
| Approx. starting flow rate | | l/h | 4 | 12 | 30 | 90 | 300 |
| Max. permissible error | | ±1 % of actual value | | | | | |
| Repeatability | | ±0.2 % | | | | | |
| Safety filter mesh size | | mm | 0.400 | 0.400 | 0.400 | 0.800 | 0.800 |
| Dirt filter mesh size | | mm | 0.250 | 0.400 | 0.400 | 0.600 | 0.600 |
| Volume of measuring chamber | | approx. cm ³ | 12 | 36 | 100 | 330 | 1200 |
| Housing finish | | enamelled red RAL 3013 | | | | | |
| Weight with threaded ends ⁴⁾ | | approx. kg | 2.2 | 2.5 | 4.2 | 17.3 | — |
| | with flanges PN 25 | approx. kg | 3.8 | 4.5 | 7.5 | 20.3 | 41.0 |
| Smallest readable amount: | | | | | | | |
| Total volume | | l, m ³ | No decimal places | | | | |
| Resettable volume | | l, m ³ | 1 decimal place | | | | |
| Digital flow rate display | | l/h | 1 decimal place | | | | |
| Registration capacity | | l, m ³ | 8 digits | | | | |
| Registration time at Q _{cont} until overrunning to zero | | h | 128 000 | 100 000 | 50 000 | 16 667 | 5 000 |
| Outputs ⁵⁾ | | | | | | | |
| Pulse value for totalisator | | Vol./pulse | pulse value and width parameterisable | | | | |
| Current 4...20 mA for flowrate | | I ₁ /Q ₁ , I ₂ /Q ₂ | flow rates to 4 and 20 mA parameterisable | | | | |
| Frequency for flow | | f ₁ /Q ₁ , f ₂ /Q ₂ | frequency and flowrate parameterisable | | | | |
| Limiting switch | | Q _{min} , Q _{max} | minimum, maximum and hysteresis parameterisable | | | | |

¹⁾ Manufacturer's specification, valid for the reference conditions as specified under "APPENDIX: Meter data".

²⁾ 1 US gallon corresponds to 3.785 litres.

³⁾ For burners and engines or motors, the meter must be selected on the basis of the permanent flow rate. For higher viscosities, or if the meter is installed on the suction side, the pressure drop and any reduction in the measuring range must be taken into consideration.

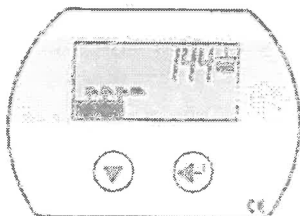
⁴⁾ Weight without couplings.

⁵⁾ Two freely selectable outputs are available, totally independent of each other.

Pressure drop curves

See "APPENDIX: Meter data"

Electronic display



- | | |
|--------------------|---|
| Display values: | <ul style="list-style-type: none"> • total volume, resettable volume, flow rate • In the Information menu, hours of operation and other information can be obtained |
| Display: | <ul style="list-style-type: none"> • 8-character LCD with identification of the parameter, height of numbers: 8 mm, flow rate (meter load) using bar indicator |
| Temperature: | <ul style="list-style-type: none"> • ambient temperature -25...+70 °C, • storage temperature -25...+85 °C |
| Safety: | <ul style="list-style-type: none"> • CE, vibration and shock test to DIN IEC 68 |
| Power supply: | <ul style="list-style-type: none"> • 24 VDC (6...30 VDC) |
| Data preservation: | <ul style="list-style-type: none"> • by non-volatile memory (EEPROM) |
| Protection class: | <ul style="list-style-type: none"> • IP 66 (IEC 60529) against dust and heavy seas |

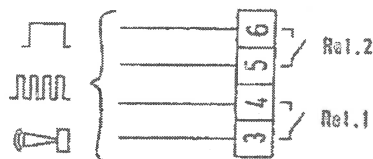
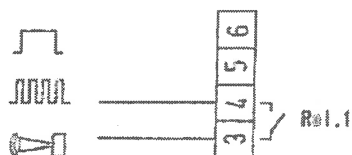
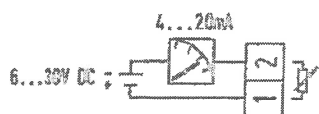
Outputs

Four different output functions are available:

- Pulser for volume pulses with programmable pulse value (for external totaliser)
- Analogue current output 4...20 mA corresponding to flow rate
- Frequency output 0...100 Hz corresponding to flow rate
- Switching function (limiting value switch) specified by programmable upper and lower flow rates

Except for the current output function, any two of the remaining three functions can always be used simultaneously. This results in two types of connection:

- 1 potential-free digital output (Rel. 1), parameterisable to one of the three functions described below.
- 1 passive analogue 4...20 mA output also used for powering the meter.



Specification of the outputs

Passive analogue output (1-2)

- Voltage range U: 6...30 VDC
- Maximum load R_L : $(U-5) \text{ V} / 0.0215 \text{ A} [\Omega]$
- Resolution: 16 Bit
- Max. error: $\pm 0.2 \text{ mA}$
- Update interval: $< 1 \text{ s}$

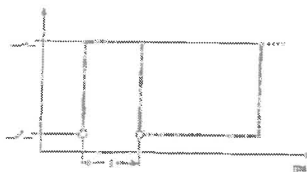
Digital outputs (3-4, 5-6)

- Max. voltage U_{max} : 48V AC/DC
- Max. current I_{max} : 50 mA
- Max. output frequency f_{max} : 100 Hz
- Update interval: $< 1 \text{ s}$
- ON-resistance R_o : $\leq 100 \Omega$
- OFF-resistance R_{oo} : $\geq 10 \text{ M}\Omega$
- Insulation voltage: $> 100 \text{ VAC/DC}$

Adjustable functions:

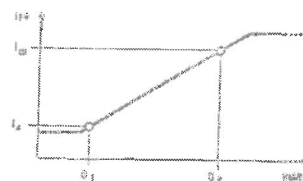
Volume pulses

- Pulse width t : 5, 50, 250, 500 ms
- Pulse value: parameterisable



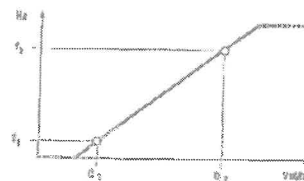
Current signal

- Flow rate at 4 mA Q_1 : parameterisable
- Flow rate 20 mA Q_2 : parameterisable
- Attenuation: parameterisable



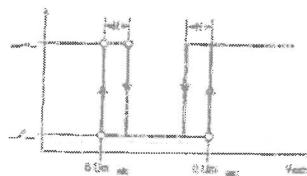
Frequency signal

- Output frequency f_{max} : 100Hz
- Pulse ratio: 1:1
- Frequency / Flowrate f_1/Q_1 : parameterisable
- Frequency / Flowrate f_2/Q_2 : parameterisable

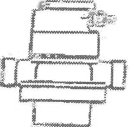


Limiting value switch

- Limit Q_{min} : parameterisable
- Limit Q_{max} : parameterisable
- Hysteresis H: parameterisable



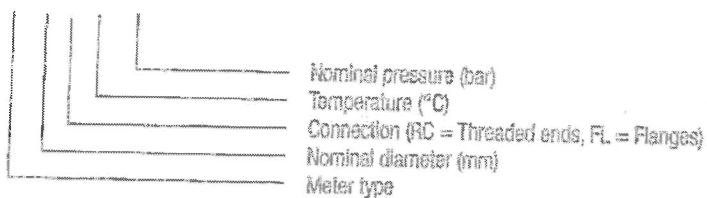
Dimensions

| Type | mm | VZF 15 | VZF 20 | VZF 25 | VZF 40 | VZF 50 |
|---|--------|--------|--------|--------|--------|--------|
|  | Length | 165 | 165 | 190 | 300 | 350 |
| | Width | 105 | 106 | 130 | 210 | 280 |
| | Height | 155 | 164 | 191 | 243 | 299 |


Detailed dimensional diagrams in "APPENDIX Meter data"


Type designation key

VZF 25 FL 130/25



Ordering specifications

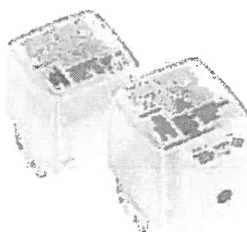
| | | | | |
|--|----------------------|------------------|-----------|--|
|  | Threaded ends, PN 16 | Type 130 °C | Order No. | |
| | | VZF 15 RC 130/16 | 93705 | |
| | | VZF 20 RC 130/16 | 93708 | |
| | | VZF 25 RC 130/16 | 93725 | |
| | | VZF 40 RC 130/16 | 93730 | |

| | | | | | |
|---|------------------|--|-----------|------------------|-----------|
|  | Flanges, PN 25 | Type 130 °C | Order No. | Type 180 °C | Order No. |
| | | VZF 15 FL 130/25 | 93706 | | |
| | | VZF 20 FL 130/25 | 93709 | VZF 20 FL 180/25 | 93710 |
| | | VZF 25 FL 130/25 | 93726 | VZF 25 FL 180/25 | 93727 |
| | | VZF 40 FL 130/25 | 93731 | VZF 40 FL 180/25 | 93732 |
| | | VZF 50 FL 130/25 | 93735 | VZF 50 FL 180/25 | 93736 |
| | Modification VZF | For marine type approval (e.g. GL, LRS, DNV) | | | 96295 |

CONTOIL® Classic VZO 4...50

VZO 4 and 8

Technical data 1)



- oil meter with internal threaded connections located on the bottom plate
- with mechanical roller counter, volume display in litres
- meters in US-Gallons ²⁾
- for mounting in horizontal, vertical and inclined positions
- VZO 4 and 8 with EEC legal verification

Option: Reed pulser 48 V

| Type | | VZO 4 | VZO 4 | VZO 8 |
|--|------------------------------------|----------------------------|--------------|--------------|
| | | Q_{min} 0.5 | | |
| Nominal diameter | mm | 4 | 4 | 8 |
| | inch | 1/8 | 1/8 | 1/4 |
| Connection threads of meter | inch | 1/8 | 1/8 | 1/4 |
| Nominal pressure | bar | 25 | | |
| Temperature | T _{max} °C | 60 | | |
| Maximum flow rate | Q _{max} ³⁾ l/h | 40 | 80 | 200 |
| Nominal flow rate | Q _{nom} ³⁾ l/h | 25 | 50 | 135 |
| Minimal flow rate | Q _{min} ⁴⁾ l/h | 0.5 | 1 | 4 |
| Approx. starting flow rate | l/h | 0.3 | 0.4 | 1.6 |
| Max. permissible error | ±1 % of actual value ⁴⁾ | | | |
| Repeatability | ±0.2 % | | | |
| Smallest readable amount | l | 0.001 | 0.001 | 0.01 |
| Registration capacity | m³ | 100 | 100 | 1000 |
| Registration at Q _{nom} until overrunning to zero | h | 4000 | 2000 | 7400 |
| Safety filter mesh size | mm | 0.125 | 0.125 | 0.160 |
| Dirt filter mesh size | mm | 0.080 | 0.080 | 0.100 |
| Volume of the measuring chamber | approx. cm³ | 5 | 5 | 12.5 |
| Weight without couplings | approx. kg | 0.65 | 0.65 | 0.75 |
| Reed pulsers | RE 1 | — | — | 1 |
| | RE 0.1 | — | 0.1 | — |
| | RE 0.00125 | — | 0.00125 | — |
| | RE 0.00311 | — | — | 0.00311 |
| Pulse frequency for | RE 0.00125 ⁵⁾ | at Q _{max} Hz | 17.777 | — |
| | | at Q _{min} Hz | 0.222 | — |
| Pulse frequency for | RE 0.00311 ⁵⁾ | at Q _{max} Hz | — | 17.864 |
| | | at Q _{min} Hz | — | 0.357 |

1) Manufacturer's specification, valid for the reference conditions as specified under "APPENDIX: Meter data".

2) 1 US gallon corresponds to 3.785 litres

3) For burners and engines or motors, the meter must be selected on the basis of the permanent flow rate. For higher viscosities, or if the meter is installed on the suction side, the pressure drop and any reduction in the measuring range must also be taken into consideration.

4) Max. permissible error: VZO 4 Q_{min} 0.5; 0.5 l/h ... 2 l/h: m + 1 % / - 2 %; VZO 4 1 l/h ... 2 l/h: m + 1 % / - 2 %.

5) Note: pulses of short duration!

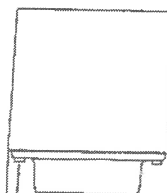
VZOA 4 and 8 with EEC legal verification D 04/5.232.14

| Data according to type approval specifications | | | VZOA 4 | VZOA 8 |
|--|--------------------|-----|--------|--------|
| Temperature max. | T_{max} | °C | 50 | 50 |
| Maximum flow rate | Q_{max} | l/h | 20 | 140 |
| Nominal flow rate | Q_{nort} | l/h | 20 | 140 |
| Minimal flow rate | Q_{min} | l/h | 2 | 14 |
| Max. permissible error | ±% of actual value | | 0.5 | 0.3 |

Pressure drop curves

See "APPENDIX: Meter data"

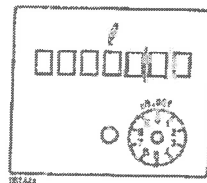
Dimensions in mm



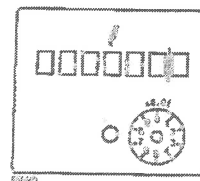
height = 78
width = 68
depth = 68

Dial

VZO 4

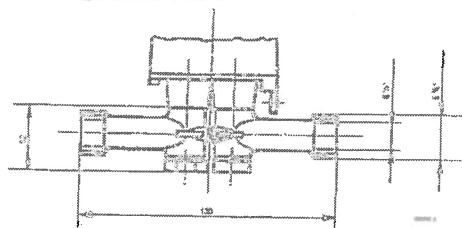


VZO 8

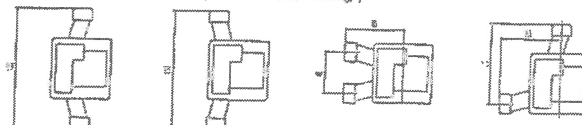


Detailed dimensional drawings in "APPENDIX: Meter data"

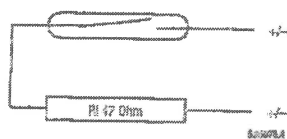
Mounting kit for VZO 8



Order No. 81130: some possible mounting positions



RE Pulsers




Switching element:
Switching voltage:
Switching current:
Quiescent current:
Switching power:
ON-time:

Temperature:
Protection class:

Connections:

- Reed switch with dry contact (inert gas)
- Max. 48 VAC/DC, Protection class III (SELV)
- Max. 50 mA
- Open Contact
- Max. 2 W
- VZO 4-RE 0.00125: 30...70 % (17...39 ms bei 80 l/h)
- VZO 4-RE 0.1: 40...60 %
- VZO 8-RE 0.00311: 30...70 % (17...39 ms bei 200 l/h)
- VZO 8-RE 1: 40...60 %
- Ambient -10 ... +60 °C
- IP 50 (IEC 60529) against harmful dust deposits
- Option: IP 54 additional against splashing water
- On plug connector with cable, 3,5 - 5 mm Ø

Ordering specifications

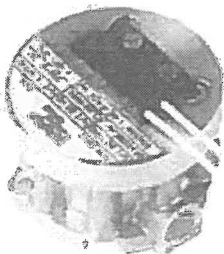
|  | Type | Order No. | Type | Order No. |
|---|----------------------------|------------------------------|------------------|-----------|
| | VZO 4 | 92680 | VZO 8 | 92630 |
| | VZO 4 RE 0.00125 | 99763 | VZO 8 RE 0.00311 | 99733 |
| | VZO 4 RE 0.1 | 99761 | VZO 8 RE 1 | 99731 |
| | VZO 4 Q _{min} 0.5 | 92678 | | |
| | VZOA 4 | 93668 | VZOA 8 | 93669 |
| Modification | | Increased Protection (IP 54) | | 90368 |

Special versions with FPM fluoroelastomer gaskets

VZO 4 V Order No. 92487
VZO 4 V - RE 0.1 Order No. 92489

VZO 4 and 3 OEM

Technical data 1)



- fuel oil meters for OEMs (original equipment manufacturers), to be mounted under the burner cover
- meters with lateral internal threaded connections
- with 230 V Reed pulser to display measurement values on remote totaliser or on burner control unit
- for mounting in horizontal, vertical or inclined positions

| Type | | VZO 4 OEM | VZO 3 OEM |
|---------------------------------|------------------------------------|------------------------------------|--------------|
| Nominal diameter | mm | 4 | 8 |
| | inch | 1/8 | 1/4 |
| Connection threads of meter | inch | 1/8 | 1/4 |
| Nominal pressure | bar | 32 | 25 |
| Temperature | T _{max} °C | 60 | 60 |
| Maximum flow rate | Q _{max} ²⁾ l/h | 80 | 200 |
| Nominal flow rate | Q _{nom} ²⁾ l/h | 50 | 135 |
| Minimal flow rate | Q _{min} ²⁾ l/h | 1 | 4 |
| Approx. starting flow rate | l/h | 0.4 | 1.6 |
| Max. permissible error | | ±1 % of actual value ³⁾ | |
| Repeatability | | ±0.2 % | |
| Safety filter mesh size | mm | - | 0.150 |
| Dirt filter mesh size | mm | 0.080 | 0.100 |
| Volume of the measuring chamber | approx. cm ³ | 5 | 12.5 |
| Weight | approx. kg | 0.65 | 0.75 |
| Reed pulsers | RE | V/pulse | 0.005 |
| Pulse frequency | | | 0.0025 |
| | at Q _{max} | Hz | 4.444 |
| | at Q _{min} | Hz | 0.056 |
| | | | 0.089 |

1) Manufacturer's specification, valid for the reference conditions as specified under "APPENDIX: Meter data".

2) For burners and engines or motors, the meter must be selected on the basis of the permanent flow rate. For higher velocities, or if the meter is installed on the suction side, the pressure drop and any reduction in the measuring range must also be taken into consideration.

3) Max. permissible error: VZO 4 OEM: 1 l/h ... 2 l/h = +1 %/-2 %.

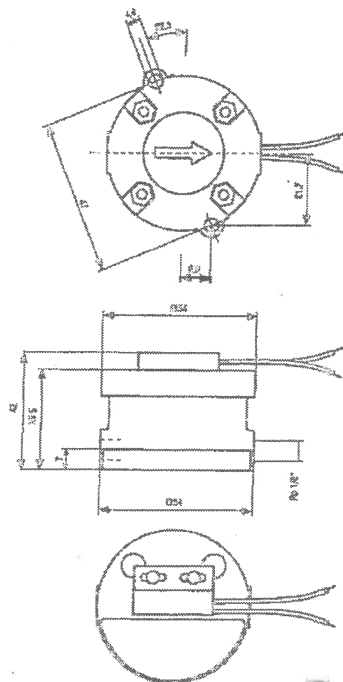
Safety precaution

When connecting the Reed pulser to a low-voltage power source (50...250 VAC/DC), the specialist installing the equipment is responsible for ensuring that all local regulations are observed (e.g. regulations for electrical installations, personnel safety).

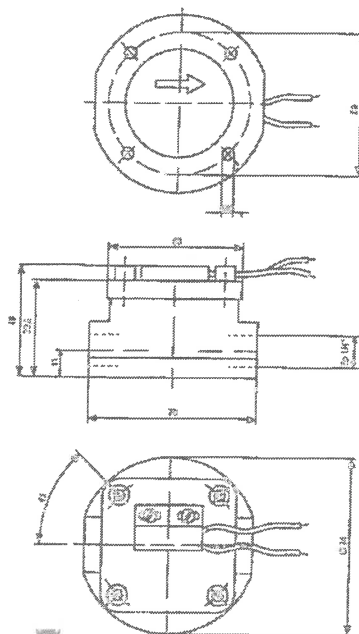
Pressure drop curves

See "APPENDIX: Meter data"

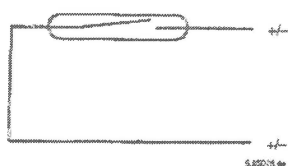
Dimensions in mm VZO 4 OEM



VZO 8 OEM



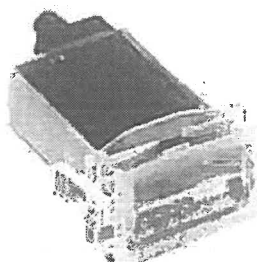
RE Pulsers



Switching element:
Switching voltage:
Switching current:
Quiescent current:
Switching power:
ON-time:
Temperature:
Protection class:
Connections:

- Read switch with dry contact (inert gas)
- max. 230 V AC/DC
- max. 50 mA
- Open Contact
- max. 3 VA
- 40...55 %
- Ambient -10 ... +60 °C
- IP 65 (IEC 60529) against dust and water-jets
- Cable cross section 2 x 0.5 mm², length 480 mm

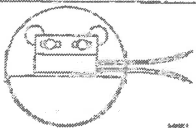
Remote totaliser for VZO 4 OEM



Power supply:
Pulse value (input):
Smallest readable amount:
Registration capacity:
Registration:
Panel cut-out:
Installation depth:

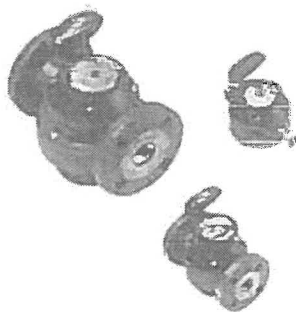
- 230 V, 50/60 Hz
- 0.005 l
- 0.005 l
- 10 000 l
- at 0 before return to zero 200 h
- 27 x 14.4 - 0/+ 0.2 mm
- 56 mm

Ordering specifications

|  | Type | Description | Order No. |
|---|---------------------|--------------------------------|-----------|
| | VZO 4 OEM-RE 0.005 | Version for OEMs | 89765 |
| | | Remote totaliser for VZO 4 OEM | 93349 |
| | VZO 8 OEM-RE 0.0125 | Version for OEMs | 89771 |

VZO 15 ... 50

Technical data ¹⁾



- Volume display on roller counter, in litres
- fuel oil meter with threaded or flanged ends
- for horizontal, vertical or inclined mounting

Option: Reed pulser or RV / IN pulser

Versions available on request:

- different flange drillings, such as ANSI, JIS
- meters in US gallons ²⁾ (option)

| Type | | VZO 15 | VZO 20 | VZO 25 | VZO 40 | VZO 50 |
|---|--------------------------------|------------------------|--------|--------|--------|---------|
| Nominal diameter | DN | 15 | 20 | 25 | 40 | 50 |
| | inch | 1/2 | 3/4 | 1 | 1 1/2 | 2 |
| Installation length | mm | 165 | 165 | 190 | 300 | 350 |
| Nominal pressure with threaded ends with flanges | PN | 16 | | | | |
| | bar | 25, 40 | | | | |
| Maximum temperature | T _{max} | 130, 180 | | | | |
| Maximum flow rate | Q _{max} ³⁾ | 600 | 1500 | 3000 | 9000 | 30000 |
| Nominal flow rate | Q _{nom} ⁴⁾ | 400 | 1000 | 2000 | 6000 | 20000 |
| Minimal flow rate | Q _{min} | 10 ⁵⁾ | 30 | 75 | 225 | 750 |
| Approx. starting flow rate | | 4 | 12 | 30 | 90 | 300 |
| Max. permissible error | | ±1 % of actual value | | | | |
| Repeatability | | ±0.2 % | | | | |
| Safety filter mesh size | mm | 0.400 | 0.400 | 0.400 | 0.800 | 0.800 |
| Dirt filter mesh size | mm | 0.250 | 0.400 | 0.400 | 0.600 | 0.600 |
| Volume of the measuring chamber | approx. cm ³ | 12 | 36 | 100 | 330 | 1200 |
| Housing finish | | enamelled red RAL 3013 | | | | |
| Weight with threaded ends ⁶⁾ | approx. kg | 2.2 | 2.5 | 4.2 | 17.3 | — |
| | with flanges PN 25 | approx. kg | 3.6 | 4.5 | 7.5 | 20.3 |
| | with flanges PN 40 | approx. kg | 4.4 | 5.5 | 7.8 | 20.5 |
| Smallest readable amount | l | 0.01 | 0.1 | 0.1 | 0.1 | 1 |
| Registration capacity | m ³ | 1000 | 10 000 | 10 000 | 10 000 | 100 000 |
| Registration time at Q _{nom} until overrunning to zero | h | 2500 | 10 000 | 5000 | 1667 | 5000 |
| Pulse values of pulsers: | | | | | | |
| IN inductive according to IEC 60947-5-6 | V/pulse | 0.01 | 0.01 | 0.1 | 0.1 | 1 |
| RV Reed | V/pulse | 0.1 | 1 | 1 | 1 | 10 |
| RV Reed | V/pulse | 1 | — | — | 10 | 100 |
| Pulse frequency IN | at Q _{max} | Hz | 16.667 | 8.333 | 25.000 | 8.333 |
| | at Q _{min} | Hz | 0.278 | 0.833 | 0.208 | 0.208 |

¹⁾ Manufacturer's specification, valid for the reference conditions as specified under "APPENDIX: Meter data".

²⁾ 1 US gallon corresponds to 3.785 litres.

³⁾ For burners and engines or reactors, the meter must be selected on the basis of the permanent flow rate. For higher viscosities, or if the meter is installed on the suction side, the pressure drop and any reduction in the measuring range must also be taken into consideration.

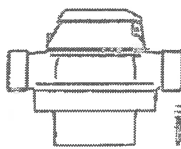
⁴⁾ Min. flow rate VZO 15 with IN-pulser: 15 Vh

⁵⁾ Weight without coupling.

Pressure drop curves

See "APPENDIX: Meter data"

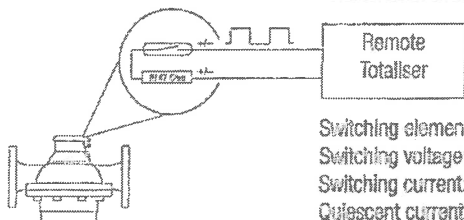
Dimensions

| Type | mm | VZO 15 | VZO 20 | VZO 25 | VZO 40 | VZO 50 |
|---|-----------------------|--------|--------|--------|--------|--------|
|  | Length | 165 | 165 | 190 | 300 | 350 |
| | Width | 105 | 105 | 130 | 210 | 280 |
| | Typ ... 130 °C | | | | | |
| | Height | 106 | 115 | 142 | 235 | 291 |
| | Height -RV | 130 | 139 | 166 | 259 | 315 |
| | Height -IN | 185 | 194 | 221 | 273 | 329 |
| | Typ ... 180 °C | | | | | |
| | Height | 147 | 156 | 183 | 235 | 291 |
| | Height -RV | 171 | 180 | 207 | 259 | 315 |
| | Height -IN | 225 | 234 | 261 | 313 | 369 |

Detailed dimensional diagrams in "APPENDIX: Meter data".

RV Pulsers

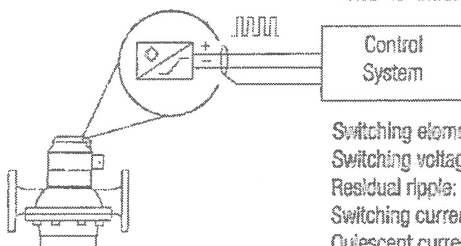
This type of pulser is integrated into the roller counter and thus is especially appropriate for remote totalisation. For other applications the IN Inductive pulser is preferable.



| | |
|----------------------|---|
| Switching element: | • Reed switch with dry contact (Inert gas) |
| Switching voltage: | • max. 48 VAC/DC, Protection class III (SELV) |
| Switching current: | • max. 50 mA (Ri = 47 Ω/0.5 W) |
| Quiescent current: | • Open Contact |
| Switching power: | • max. 2 W |
| ON-time: | • 50 % ± 10 % |
| Temperature: | • Ambient -10...+70 °C |
| Protection class: | • IP 65 (IEC 60529) against dust and water-jets |
| Connections: | • Cast-in cable, length 3 m |
| Cable cross section: | • 2 x 0.14 mm ² |

IN Pulsers

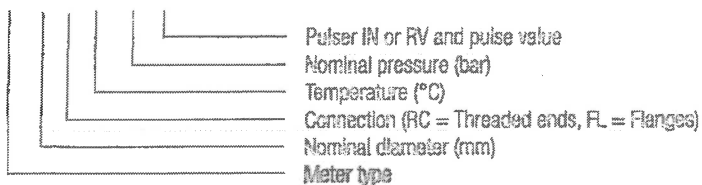
Pulser for Industrial applications. Supplied with plug-in pulser sensor.



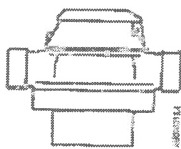
| | |
|----------------------|---|
| Switching element: | • Inductive slot initiator according to IEC 60947-5-6 |
| Switching voltage: | • 5...15 VDC |
| Residual ripple: | • max. 5 % |
| Switching current: | • >3 mA at 8 VDC / 1 kΩ |
| Quiescent current: | • <1 mA at 8 VDC / 1 kΩ |
| ON-time: | • 50 % ± 10 % |
| Ambient temperature: | • -10...+70 °C |
| Protection class: | • IP 65 (IEC 60529) against dust and water-jets |
| Connections: | • Pulser supplied with special plug. Required cable min. 2 x 0.35 mm ² and 4...6 mm external diameter or the cable is already mounted if the option "Order No. 80019" is chosen. |
| Option: | • Cable mounted, 2 x 0.5 mm ² , PVC black, length 3 m (Order No. 80019) |

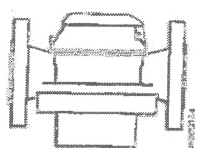
Type designation key

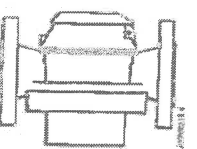
VZO 25 FL 130/25-IN 0.1

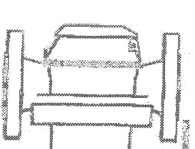


Ordering specifications

| Threaded ends, PN 15 | Type 130 °C | Order No. | Type 130 °C | Order No. |
|---|--------------------------|-----------|-------------------------|-----------|
|  | VZO 15 RC 130/16 | 92041 | VZO 25 RC 130/16 | 92057 |
| | VZO 15 RC 130/16-RV 0.1 | 92042 | VZO 25 RC 130/16-RV 1 | 92058 |
| | VZO 15 RC 130/16-RV 1 | 92043 | VZO 25 RC 130/16-IN 0.1 | 91913 |
| | VZO 15 RC 130/16-IN 0.01 | 91900 | | |
| | VZO 20 RC 130/16 | 92047 | VZO 40 RC 130/16 | 92004 |
| | VZO 20 RC 130/16-RV 1 | 92048 | VZO 40 RC 130/16-RV 1 | 92018 |
| | VZO 20 RC 130/16-IN 0.01 | 91902 | VZO 40 RC 130/16-IN 0.1 | 91906 |

| Flanges, PN 25 | Type 130 °C | Order No. | Type 130 °C | Order No. |
|---|--------------------------|-----------|-------------------------|-----------|
|  | VZO 15 FL 130/25 | 92044 | VZO 40 FL 130/25 | 92005 |
| | VZO 15 FL 130/25-RV 0.1 | 92045 | VZO 40 FL 130/25-RV 1 | 92020 |
| | VZO 15 FL 130/25-RV 1 | 92046 | VZO 40 FL 130/25-IN 0.1 | 91907 |
| | VZO 15 FL 130/25-IN 0.01 | 91910 | | |
| | VZO 20 FL 130/25 | 92049 | VZO 50 FL 130/25 | 92007 |
| | VZO 20 FL 130/25-RV 1 | 92050 | VZO 50 FL 130/25-RV 10 | 92024 |
| | VZO 20 FL 130/25-IN 0.01 | 91903 | VZO 50 FL 130/25-IN 1 | 91909 |
| | VZO 25 FL 130/25 | 92059 | | |
| | VZO 25 FL 130/25-RV 1 | 92060 | | |
| | VZO 25 FL 130/25-IN 0.1 | 91914 | | |

| Flanges, PN 25 | Type 180 °C | Order No. | Type 180 °C | Order No. |
|--|--------------------------|-----------|-------------------------|-----------|
|  | VZO 15 FL 180/25 | 92250 | VZO 40 FL 180/25 | 92274 |
| | VZO 15 FL 180/25-RV 0.1 | 92251 | VZO 40 FL 180/25-RV 1 | 92275 |
| | VZO 15 FL 180/25-RV 1 | 92252 | VZO 40 FL 180/25-IN 0.1 | 92276 |
| | VZO 15 FL 180/25-IN 0.01 | 92253 | | |
| | VZO 20 FL 180/25 | 92258 | VZO 50 FL 180/25 | 92280 |
| | VZO 20 FL 180/25-RV 1 | 92259 | VZO 50 FL 180/25-RV 10 | 92281 |
| | VZO 20 FL 180/25-IN 0.01 | 92260 | VZO 50 FL 180/25-IN 1 | 92282 |
| | VZO 25 FL 180/25 | 92264 | | |
| | VZO 25 FL 180/25-RV 1 | 92265 | | |
| | VZO 25 FL 180/25-IN 0.1 | 92266 | | |

| Flanges, PN 40 | Type 180 °C | Order No. | Type 180 °C | Order No. |
|---|--------------------------|-----------|-------------------------|-----------|
|  | VZO 15 FL 180/40 | 92254 | VZO 40 FL 180/40 | 92277 |
| | VZO 15 FL 180/40-RV 0.1 | 92255 | VZO 40 FL 180/40-RV 1 | 92278 |
| | VZO 15 FL 180/40-RV 1 | 92256 | VZO 40 FL 180/40-IN 0.1 | 92279 |
| | VZO 15 FL 180/40-IN 0.01 | 92257 | | |
| | VZO 20 FL 180/40 | 92261 | VZO 50 FL 180/40 | 92283 |
| | VZO 20 FL 180/40-RV 1 | 92262 | VZO 50 FL 180/40-RV 10 | 92284 |
| | VZO 20 FL 180/40-IN 0.01 | 92263 | VZO 50 FL 180/40-IN 1 | 92285 |
| | VZO 25 FL 180/40 | 92267 | | |
| | VZO 25 FL 180/40-RV 1 | 92268 | | |
| | VZO 25 FL 180/40-IN 0.1 | 92269 | | |

DN 15 only when the plate has a dirt filter with a max. 0.1 mm mesh size.

| | | |
|--------------------|--|-------|
| Modification VZO | For marine type approval (e.g. GL, LRS, DNV) | 96235 |
| Option / Accessory | Cable mounted on IN | 80019 |

CONTOIL® VZFA/VZOA 15...50, versions for special requirements / applications

For applications requiring an increased accuracy of $\pm 0.5\%$ or better, such as:

- Measurement of EL heating fuel or diesel in testing facilities
- Differential measurement
- Commercial transactions for which the meters are legally required to have type approval or official verification.

These products require dirt filters with smaller mesh size.

Versions for differential measurements

For differential measurements, the flow is measured in the supply and return pipes. The difference between the two measurements is regarded as the consumption.

To obtain optimal measurement results, VZFA or VZOA CONTOIL® fuel oil meters calibrated in pairs should only be used, which are adapted precisely to the plant/system operating conditions. The flow rate occurring in each meter, the permissible pressure drop and the viscosity of the fluid must all be considered during the design phase. The load on the meter is obtained as follows: flow in supply section less consumption = flow in return section.

When the order is placed, the following information is required:

- | | |
|-------------------------------|---|
| • application | e.g. differential measurement for diesel engines in an emergency power system |
| • fuel type | e.g. diesel fuel |
| • temperature | e.g. 15...40° C |
| • operating pressure | e.g. 4 bar |
| • flow rate in supply section | e.g. fixed pumping rate 200 l/h |
| • flow rate in return section | e.g. 120...190 l/h (for a consumption of 10...80 l/h) |

The meters are marked "supply" and "return" during calibration and final testing in the factory. They must then be installed in the correct pipes.

For further information on the subject of differential measurement, see the sections "How to obtain an optimal measurement" and "Application examples".

Versions with type approval or official verification

CONTOIL® fuel oil meters are used almost exclusively for the measurement of the consumption of fuel oil. The metrological standards (such as MID or EC guideline 71/319/EEC), however, regulate the requirements for meters and systems used for commercial transactions as well as the procedures for design approval and official verification. Measuring installations where a fluid is sold are regarded as transfer points that require official verification. These include petrol pumps at petrol stations, measuring devices for road tankers and measuring stations for loading and unloading all types of road vehicles. As a rule, a metering system must be ready for use and be checked and sealed by the local office responsible for transfer verification.

Typical of these applications is the narrow range of use with regard to liquid, flow rate and temperature. Subject to type approval restrictions, CONTOIL® oil meters are also available with metrological type approval or official verification. The differences in products relate only to the design or specifications of the meter and not to the quality of the product.

Technical data ¹⁾



- Versions for optimal results from differential measurement or for fiscal or commercial transactions
- VZFA with electronic display of total volume, resettable volume and flow rate; units of measurement: litres, US gallons ²⁾ or m³.
- VZOA with display of total volume on roller counter; units of measurement: litres. Optional versions with counter in US gallons.
- VZOA option: with RV reed or IN inductive pulser
- threaded or flanged connections available
- mounting in horizontal or vertical positions possible (for calibrated meters horizontally only).
- VZFA: User-friendly, interactive parameter input. Easy integration into control systems.

Further Versions available on request:

- different flange drillings, such as ANSI, JIS

| Type | VZFA/VZOA | | | | | | |
|---|---|-------------------------|---|---------|--------|--------|---------|
| Nominal diameter | DN | mm | 15 | 20 | 25 | 40 | 50 |
| | | inch | 1/2 | 3/4 | 1 | 1 1/2 | 2 |
| Installation length | | mm | 165 | 165 | 190 | 300 | 350 |
| Nominal pressure with threaded ends | PN | bar | 16 | | | | |
| with flanges | PN | bar | 25 | | | | |
| Maximum temperature | T _{max} | °C | 130, 180 | | | | |
| Maximum flow rate | Q _{max} ³⁾ | l/h | 600 | 1500 | 3000 | 9000 | 30 000 |
| Nominal flow rate | Q _{count} ⁴⁾ | l/h | 400 | 1000 | 2000 | 6000 | 20 000 |
| Minimal flow rate | Q _{min} | l/h | 10 ⁴⁾ | 30 | 75 | 225 | 750 |
| Approx. starting flow rate | | l/h | 4 | 12 | 30 | 90 | 300 |
| Max. permissible error | | | <0.5 % of actual value | | | | |
| Repeatability | | | ±0.1 % | | | | |
| Safety filter mesh size | | mm | 0.400 | 0.400 | 0.400 | 0.800 | 0.800 |
| Dirt filter mesh size | | mm | 0.100 | 0.100 | 0.250 | 0.250 | 0.250 |
| Volume of the measuring chamber | | approx. cm ³ | 12 | 36 | 100 | 330 | 1200 |
| Housing finish | | | enamelled red RAL 3013 | | | | |
| Weight with threaded ends ⁵⁾ | | approx. kg | 2.2 | 2.5 | 4.2 | 17.3 | — |
| with flanges PN 25 | | approx. kg | 3.8 | 4.5 | 7.5 | 20.3 | 41.0 |
| VZFA | | | | | | | |
| Smallest readable amount: | | | | | | | |
| Total volume | | l, m ³ | No decimals | | | | |
| Resettable volume | | l, m ³ | 1 decimal place | | | | |
| Digital flow rate display | | l/h | 1 decimal place | | | | |
| Registration capacity | | l, m ³ | 8 digits | | | | |
| Registration time at Q _{count} until overrunning to zero | | h | 128 000 | 100 000 | 50 000 | 16 667 | 5 000 |
| Outputs ⁶⁾ | | | | | | | |
| Pulse value for totaliser | V/Imp | | pulse value and width parameterisable | | | | |
| Current 4...20 mA for flow rate | I ₁ / Q ₁ , I ₂ / Q ₂ | | flow rates to 4 and 20 mA parameterisable | | | | |
| Frequency for flow rate | f ₁ / Q ₁ , f ₂ / Q ₂ | | frequency and flowrate parameterisable | | | | |
| Limiting value switch | Q _{min} , Q _{max} | | minimum, maximum and hysteresis parameterisable | | | | |
| VZOA | | | | | | | |
| Smallest readable amount | | l | 0.01 | 0.1 | 0.1 | 0.1 | 1 |
| Registration capacity | | m ³ | 1000 | 10 000 | 10 000 | 10 000 | 100 000 |
| Registration time at Q _{count} until overrunning to zero | | h | 2 500 | 10 000 | 5 000 | 1 667 | 5 000 |
| Pulse values of pulsers: | | | | | | | |
| IN inductive according to IEC 60947-5-6 | | l/pulse | 0.01 | 0.01 | 0.1 | 0.1 | 1 |
| RV Reed | | l/pulse | 0.1 | 1 | 1 | 1 | 10 |
| RV Reed | | l/pulse | 1 | — | — | 10 | 100 |

1) Manufacturer's specification, valid for the reference conditions as specified under "APPENDIX: Meter data".

2) 1 US gallon corresponds to 3.785 litres.

3) For burners and engines or motors, the meter must be selected on the basis of the permanent flow rate. For higher viscosities, or if the meter is installed on the suction side, the pressure drop and any reduction in the measuring range must also be taken into consideration.

4) 100% flow rate 1/20 15 with 40-pulse/15 l/h.

5) Weight without coatings.

6) Two freely selectable outputs are available, totally independent of each other.

Technical data for VZOA with PTB certification: 5.232 / 04.37 Class 1

| Type | | | VZOA 15 | VZOA 20 | VZOA 25 | VZOA 40 | VZOA 50 |
|------------------------|---------------------|-----|------------|------------|------------|------------|------------|
| Temperature max. | T _{max} | °C | 130 | | | | |
| Maximum flow rate | Q _{max} 1) | l/h | 400 | 1000 | 2000 | 6000 | 20000 |
| Nominal flow rate | Q _{nom} 1) | l/h | 400 | 1000 | 2000 | 6000 | 20000 |
| Minimal flow rate | Q _{min} | l/h | 40 | 100 | 200 | 600 | 2000 |
| Accuracy class | | | | 1 | 1 | 1 | 1 |
| Max. permissible error | ±% of actual value | | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |

Technical data for VZOA with EEC legal verification: D 04 / 5.232.14

| Type | | | VZOA 15 | VZOA 20 | VZOA 25 | VZOA 40 | VZOA 50 |
|------------------------|---------------------|-----|------------|------------|------------|------------|------------|
| Temperature max. | T _{max} | °C | 50 | | | | |
| Maximum flow rate | Q _{max} 1) | l/h | 400 | 1000 | 2000 | 6000 | 20000 |
| Nominal flow rate | Q _{nom} 1) | l/h | 400 | 1000 | 2000 | 6000 | 20000 |
| Minimal flow rate | Q _{min} | l/h | 40 | 100 | 200 | 600 | 2000 |
| Accuracy class | | | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Max. permissible error | ±% of actual value | | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |

Two items are required when ordering: the VZOA meter and EEC legal verification, Order No. 98025.

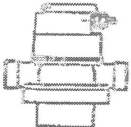
1) For buyers and origins or install, the meter must be selected on the basis of the permissible flow rate. For higher viscosities, or if the meter is installed on the suction side, the pressure drop and any reduction in the measuring range must also be taken into consideration.

Electronic display and Outputs VZFA: see page 6

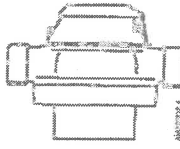
RV Pulsers and IN Pulsers: see page 15

Pressure drop curves: See "APPENDIX: Meter data"

Dimensions VZFA

| Type | mm | VZFA 15 | VZFA 20 | VZFA 25 | VZFA 40 | VZFA 50 |
|---|--------|---------|---------|---------|---------|---------|
|  | Length | 165 | 165 | 190 | 300 | 350 |
| | Width | 105 | 105 | 130 | 210 | 280 |
| | Height | 155 | 184 | 191 | 243 | 293 |

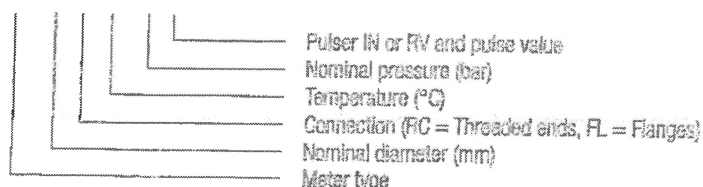
Dimensions VZOA

| Type | mm | VZOA 15 | VZOA 20 | VZOA 25 | VZOA 40 | VZOA 50 |
|---|-----------------|---------|---------|---------|---------|---------|
|  | Length | 165 | 165 | 190 | 300 | 350 |
| | Width | 105 | 105 | 130 | 210 | 280 |
| | Type ... 130 °C | | | | | |
| | Height | 108 | 115 | 142 | 235 | 291 |
| | Height -RV | 130 | 139 | 166 | 259 | 315 |
| | Height -IN | 185 | 194 | 221 | 273 | 329 |
| | Type ... 160 °C | | | | | |
| | Height | 147 | 156 | 183 | 235 | 291 |
| | Height -RV | 171 | 180 | 207 | 259 | 315 |
| | Height -IN | 225 | 234 | 261 | 313 | 369 |

Detailed dimensional diagrams in "APPENDIX: Meter data"

Type designation key

VZOA 25 FL 130/25-IN 0.1



Information required to process orders

When the order is placed, information is required on the plant operating conditions (as stated at the beginning of this section). For fiscal and commercial transactions only VZOA type meters may be used.

Example for differential measurement:

| | | |
|--------------|-----------------|---|
| Application: | | Differential measurement diesel, supply 200 l/h, return 120...190 l/h |
| 2 Units | Order No. 93758 | CONTOIL® fuel oil meter, type VZFA 20 RC 130/16 |
| 2 Units | Order No. 96112 | Modification for differential measurement |


Example for fiscal or commercial transactions:


| | | |
|--------------|-----------------|---|
| Application: | | Commercial transactions in Germany, extra light heating oil, flow rate 200...400 l/h, temperature approximately 20 °C |
| 1 Unit | Order No. 92290 | CONTOIL®, fuel oil meter, type VZOA 20 RC 130/16 |
| 1 Unit | Order No. 96026 | Modification with EC official verification |

Example for standard applications without options:

| | | |
|--------------|-----------------|---|
| Application: | | Measurement of Diesel fuel on testing facility, flow rate 200...400 l/h, temperature 20...50 °C |
| 1 Unit | Order No. 93758 | CONTOIL®, fuel oil meter, type VZFA 20 RC 130/16 |

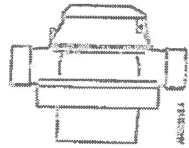
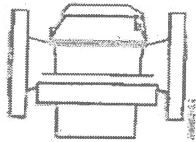
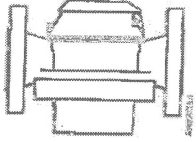
Ordering details for VZFA (meters with electronic counters and parameterisable outputs)

| Threaded ends, PN 16 | Type 130 °C | Order No. |
|--|-------------------|-----------|
|  | VZFA 15 RC 130/16 | 93755 |
| | VZFA 20 RC 130/16 | 93758 |
| | VZFA 25 RC 130/16 | 93763 |
| | VZFA 40 RC 130/16 | 93768 |

| Flanges, PN 25 | Type 130 °C | Order No. | Type 180 °C | Order No. |
|---|-------------------|-----------|-------------------|-----------|
|  | VZFA 15 FL 130/25 | 93756 | VZFA 15 FL 180/25 | 93757 |
| | VZFA 20 FL 130/25 | 93759 | VZFA 20 FL 180/25 | 93760 |
| | VZFA 25 FL 130/25 | 93764 | VZFA 25 FL 180/25 | 93765 |
| | VZFA 40 FL 130/25 | 93769 | VZFA 40 FL 180/25 | 93770 |
| | VZFA 50 FL 130/25 | 93773 | VZFA 50 FL 180/25 | 93774 |

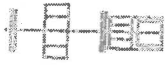


| | | |
|---------------|---|-------|
| Modifications | Paired for differential measurement | 96112 |
| | Type approval for ships (e.g. GL, LRS, DNV) | 96296 |

Ordering details for VZOA (meter with roller counter)



| Threaded ends, PN 16 | | Type 130° C | Order No. | Type 130° C | Order No. |
|--|--|---|-----------|--------------------------|-----------|
|  | | VZOA 15 RC 130/16 | 92286 | VZOA 25 RC 130/16 | 92283 |
| | | VZOA 15 RC 130/16-RV 0.1 | 92287 | VZOA 25 RC 130/16-RV 1 | 92284 |
| | | VZOA 15 RC 130/16-RV 1 | 92288 | VZOA 25 RC 130/16-IN 0.1 | 92285 |
| | | VZOA 15 RC 130/16-IN 0.01 | 92289 | | |
| | | VZOA 20 RC 130/16 | 92290 | VZOA 40 RC 130/16 | 92286 |
| | | VZOA 20 RC 130/16-RV 1 | 92291 | VZOA 40 RC 130/16-RV 1 | 92297 |
| | | VZOA 20 RC 130/16-IN 0.01 | 92292 | VZOA 40 RC 130/16-IN 0.1 | 92298 |
| | | | | | |
| Flanges, PN 25 | | Type 130° C | Order No. | Type 130° C | Order No. |
|  | | VZOA 15 FL 130/25 | 92299 | VZOA 40 FL 130/25 | 92309 |
| | | VZOA 15 FL 130/25-RV 0.1 | 92300 | VZOA 40 FL 130/25-RV 1 | 92310 |
| | | VZOA 15 FL 130/25-RV 1 | 92301 | VZOA 40 FL 130/25-IN 0.1 | 92311 |
| | | VZOA 15 FL 130/25-IN 0.01 | 92302 | | |
| | | VZOA 20 FL 130/25 | 92303 | VZOA 50 FL 130/25 | 92312 |
| | | VZOA 20 FL 130/25-RV 1 | 92304 | VZOA 50 FL 130/25-RV 10 | 92313 |
| | | VZOA 20 FL 130/25-IN 0.01 | 92305 | VZOA 50 FL 130/25-IN 1 | 92314 |
| | | VZOA 25 FL 130/25 | 92306 | | |
| | | VZOA 25 FL 130/25-RV 1 | 92307 | | |
| | | VZOA 25 FL 130/25-IN 0.1 | 92308 | | |
| Flanges, PN 25 | | Type 180° C | Order No. | Type 180° C | Order No. |
|  | | VZOA 15 FL 180/25 | 92315 | VZOA 40 FL 180/25 | 92325 |
| | | VZOA 15 FL 180/25-RV 0.1 | 92316 | VZOA 40 FL 180/25-RV 1 | 92326 |
| | | VZOA 15 FL 180/25-RV 1 | 92317 | VZOA 40 FL 180/25-IN 0.1 | 92327 |
| | | VZOA 15 FL 180/25-IN 0.01 | 92318 | | |
| | | VZOA 20 FL 180/25 | 92319 | VZOA 50 FL 180/25 | 92328 |
| | | VZOA 20 FL 180/25-RV 1 | 92320 | VZOA 50 FL 180/25-RV 10 | 92329 |
| | | VZOA 20 FL 180/25-IN 0.01 | 92321 | VZOA 50 FL 180/25-IN 1 | 92330 |
| | | VZOA 25 FL 180/25 | 92322 | | |
| | | VZOA 25 FL 180/25-RV 1 | 92323 | | |
| | | VZOA 25 FL 180/25-IN 0.1 | 92324 | | |
| Modifications | | Paired for differential measurement | | 96112 | |
| | | Type approval for ships (e.g. GL, LRS, DNV) | | 96295 | |
| | | With EEC legal verification | | 96026 | |
| Option / Accessory | | Cable mounted on IN | | 80019 | |

Accessories

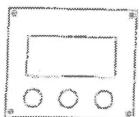
Ordering details for accessories

| | Type | Description | Order No. |
|---|--------------------------|-----------------|---|
|  | Threaded connections | VSR 1/2" | for DN 15 |
| | | VSR 3/4" x 1/2" | for DN 20 |
| | | VSR 3/4" | for DN 20 |
| | | VSR 1" | for DN 25 |
| | | VSR 1 1/2" | for DN 40 |
|  | Threaded connections kit | PS-Kit VZO 4 | 1/8" - 8 |
| | | | |
|  | Mounting kit | PS-Kit VZO 8 | 81130 |
| | | VSR 3/8" | Threaded connections to suit PS-Kit VZO 8 |
| | | | 81156 |

Order details for supplementary equipment

| | Type | Description | Order No. |
|---|---------------------------|---------------|--|
|  | Remote totaliser | Pulse counter | Pulse counter, with or without zeroing, adjustable |
| | | | 93374 |
|  | Isolated switch amplifier | Ex version | with relay output, max. 10 Hz |
| | | Ex version | with electronic output, max. 5 kHz |
| | | | 81705 |
| | | | 80013 |

Order details for supplementary equipment with mounting kits

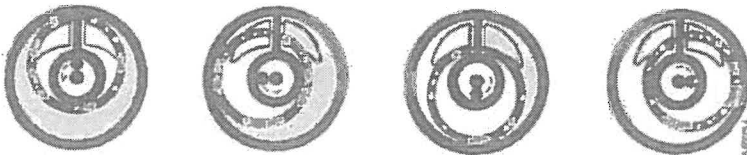
| | Type | Description | Order No. |
|---|-------------|--|--|
|  | Transducers | Flow calculator | freely programmable, with analogue output |
| | | | 4...20 mA, indication of flow rate, limiting values |
| | | Differential flow calculator | freely programmable, with analogue output |
| | | | 4...20 mA, indication of flow rate, limiting values. |
| | | | Both inputs can be read out individually. |
| | | Frequency current converter | freely programmable. |
| Mounting kit | Kit | for wall mounting or on DIN-35 mm rail | 92439 |
| | | | on request |

Meter data

Function

CONTOIL® flow meters work on the volumetric principle of rotary piston meters (positive displacement meters).

The main features of this measuring principle are large measuring ranges, high accuracy, suitability for high viscosities and independence from power supply; flow disturbances do not influence proper operation.



Construction

Rotary piston, guide roller and drive are the only moving parts in contact with the liquid. Their movement is transmitted by a magnetic coupling through a sealing plate. The hydraulic part is completely separated from the totalling module.

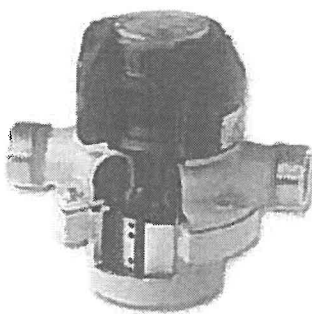
VZF/VZFA 15 ... 50

Connections are made radially with two cable entries underneath the display unit which can be mounted and rotated through 90° steps.



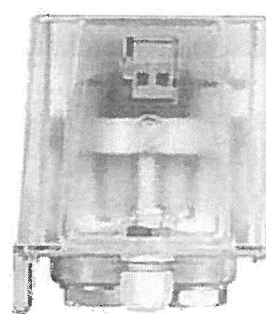
VZO/VZOA 15 ... 50

With the exception of the counter with the RV Reed pulser, the roller counter can be rotated through 360° for optimum readability.



VZO/VZOA 4 and 3

The connections for the inlet and outlet are situated vertically from below in the base plate. With the OEM meter version the connections are situated on the side.



Measuring error limits: Reference conditions

Measuring error limits according to technical data of meter in % of actual value for the whole measuring range.

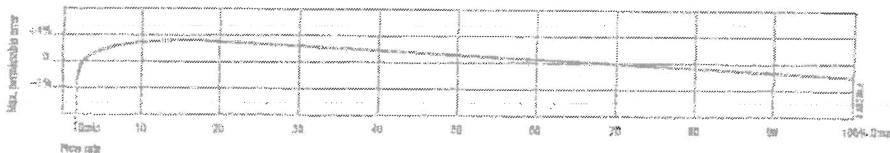
Reference conditions

Liquid: Calibration oil similar to extra light heating oil, density at 20 °C = 814 kg/m³
Viscosity = 5.0 mm²/s according to DIN 51757 / ISO 3104 (corresponds to 4.1 mPa.s)

Temperature: 18...25 °C

Horizontal mounting, readings from counter.

CONTOIL® Oil meters are never to be tested with water, otherwise they will get damaged.



Pressure drop curves

Viscosity information

Kinematic viscosity

Dynamic viscosity

Stokes, Centi-Stokes, mm^2/s

Pascal seconds, millipascal seconds

Poise, Centipoise (outmoded)

St, cSt, mm^2/s

Pas, mPa.s

P, cP

Conversion

$\text{cSt} \times \text{density} = \text{mPa.s}$

Engler degrees °E to mPa.s: only use conversion table

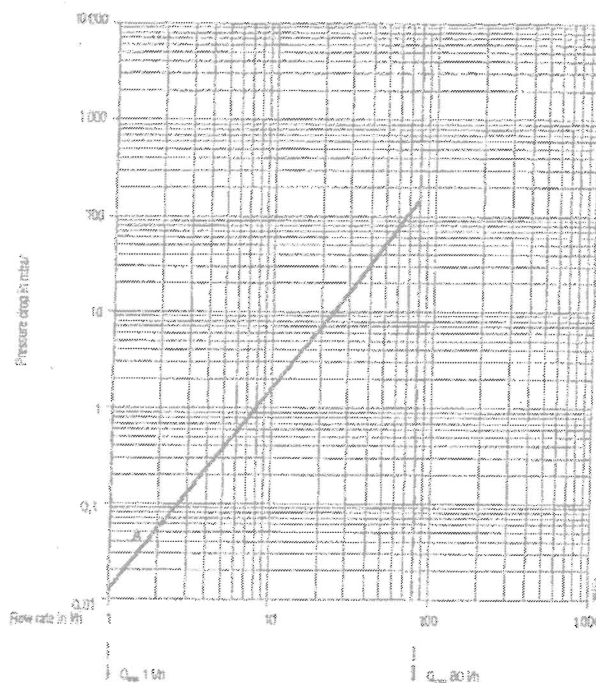
Saybolt units to mPa.s: only use conversion table

Redwood units to mPa.s: only use conversion table

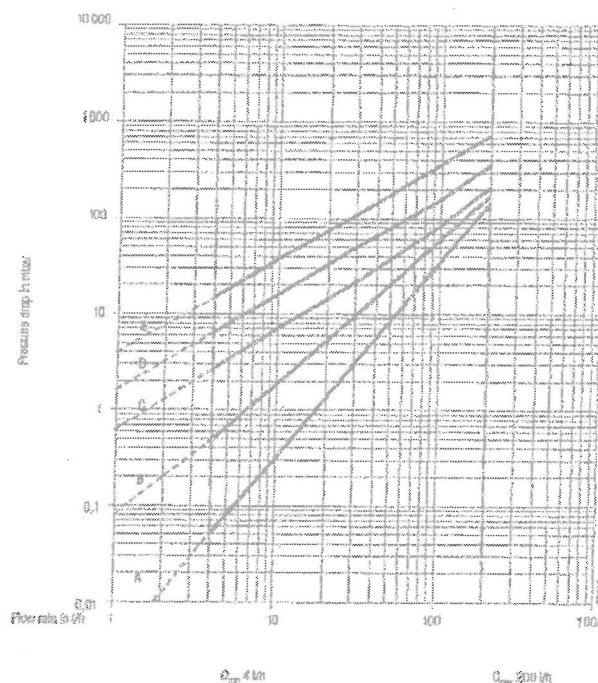
Rule of thumb

$1 \text{ cSt} \rightarrow 1 \text{ mm}^2/\text{s} \rightarrow 1 \text{ mPa.s}$

DN 4



DN 8



Viscosity diagrams:

A = 5 mPa.s

B = 50 mPa.s

C = 100 mPa.s

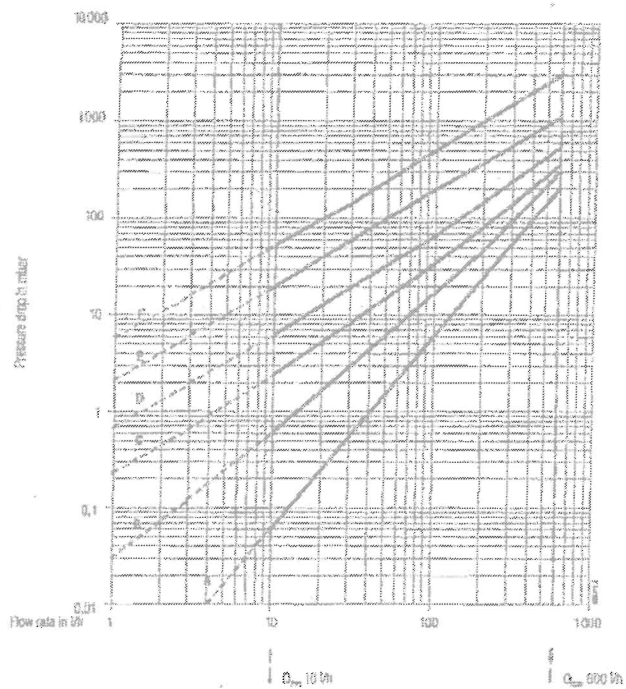
D = 200 mPa.s

E = 500 mPa.s

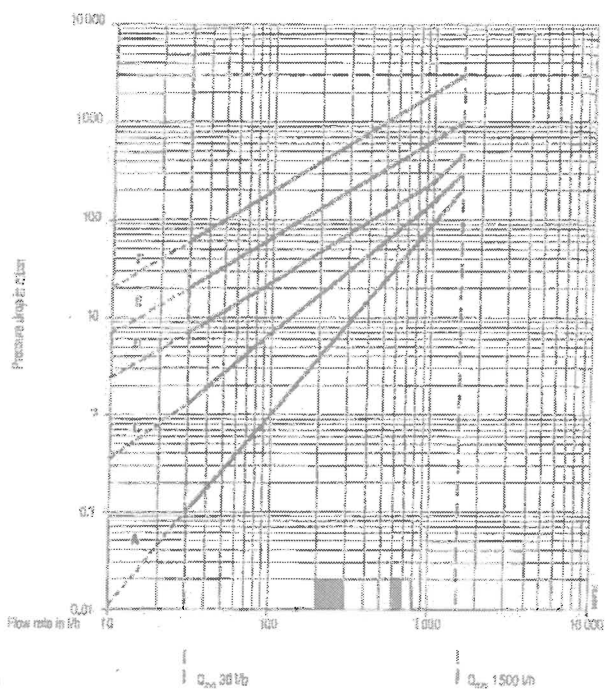
For a pressure drop of more than 1 bar, it is recommended to use the next larger meter size.

Maximum permissible pressure drop = 3 bar

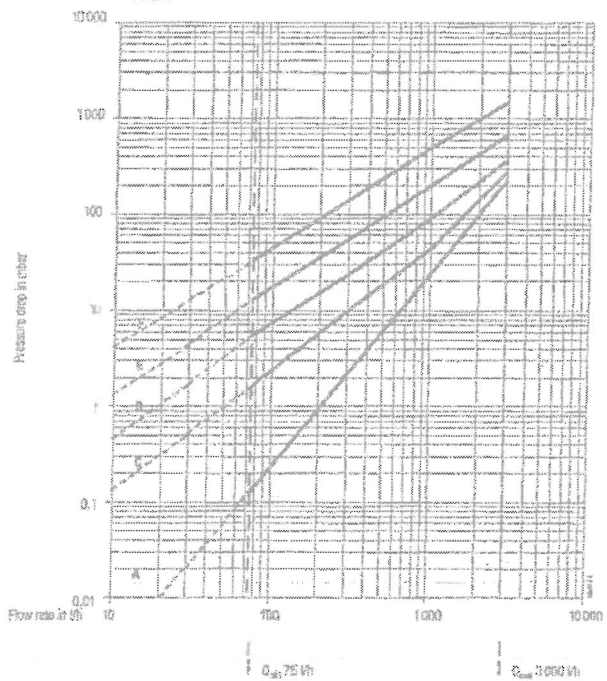
DN 15



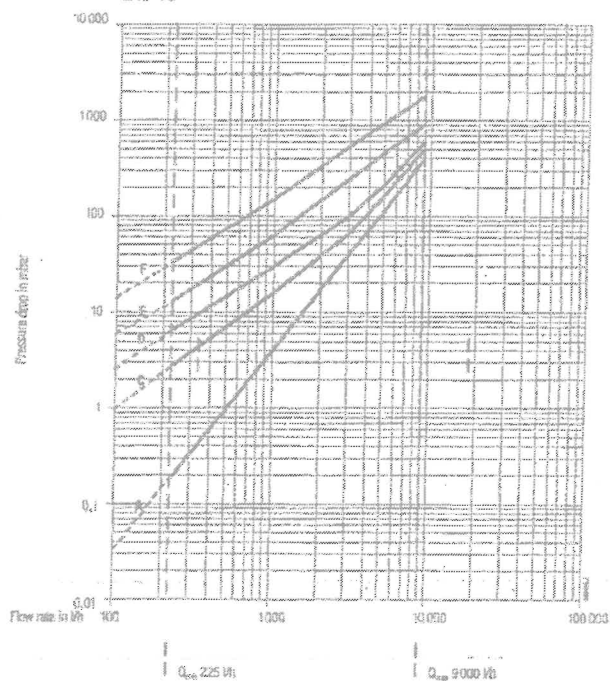
DN 20



DN 25



DN 40



Viscosity diagrams:

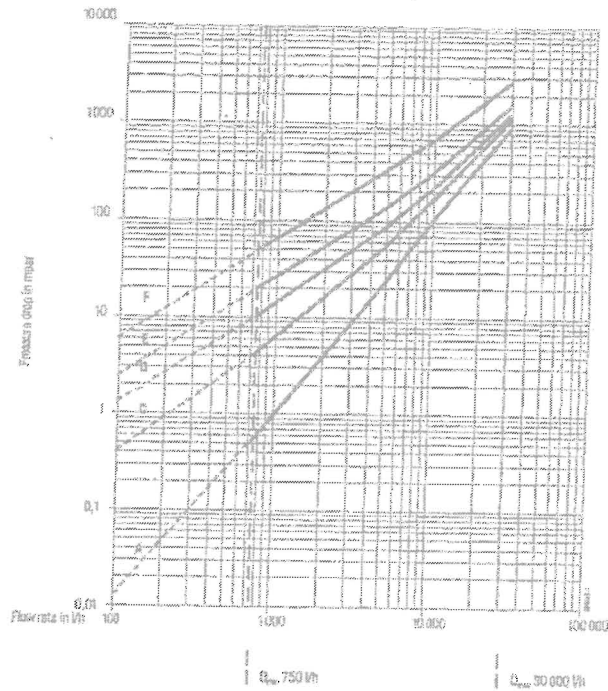
A = 5 mPa.s
B = 25 mPa.s

C = 50 mPa.s
D = 100 mPa.s

E = 200 mPa.s
F = 500 mPa.s

For a pressure drop of more than 1 bar, it is recommended to use the next larger meter size.
Maximum permissible pressure drop = 3 bar

DN 50



Example



Mineral oil, viscosity 450 mPa.s
VZO 25 mounted on pressure side of pumps

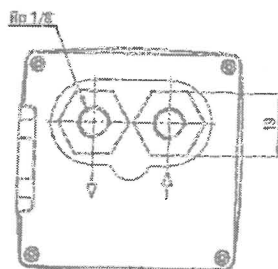
- ① Viscosity curves DN 25
select closest curve
 $F = 500 \text{ mPa.s}$
- ② Assume max. permissible pressure drop = 1 bar
- ③ The intersection of curve F with the line corresponding to 1 bar gives a flow rate of 2000 l/h.

| Materials | | Meter Size DN | | | | | | |
|-----------------------------------|------------------------------|---------------|---|----|----|----|----|----|
| Part | Material | 4 | 8 | 15 | 20 | 25 | 40 | 50 |
| Housing / Measuring unit | Brass | ● | ● | | | | | |
| Housing with threaded ends | Cast brass | | | ● | ● | ● | | |
| | Spheroidal graphite iron GGG | | | | | | ● | |
| Housing with flanges | Spheroidal graphite iron GGG | | | ● | ● | ● | ● | ● |
| Measuring chamber - PN 16 / 25 | Cast brass | | | ● | ● | ● | ● | |
| | Red brass | | | | | | | ● |
| - PN 40 | Stainless steel | | | ● | ● | ● | ● | ● |
| Seals | NBR butadiene-acrylonitril | ● | | | | | | |
| | FPM fluorelastomer | S | ● | ● | ● | ● | ● | ● |
| Rotary piston | Anodized aluminium | ● | ● | ● | ● | ● | ● | ● |
| Ancillaries | Plastic | | | ● | ● | ● | ● | ● |
| Cover of meter | Plastic | ● | ● | | | | | |

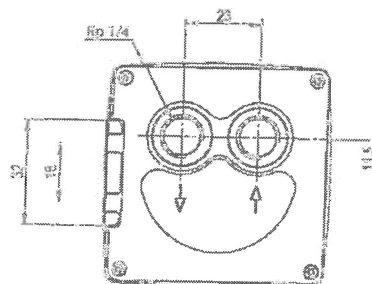
S = Special versions

Dimensions in mm

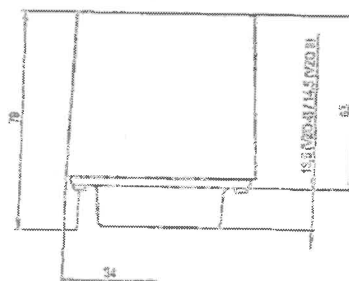
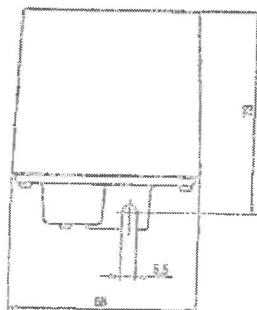
VZO/VZDA 4 and 8
DN 4



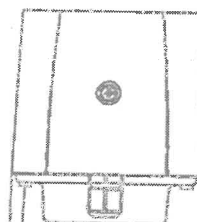
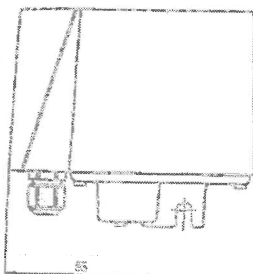
DN 8



without pulser



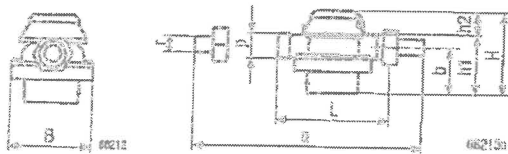
with pulser



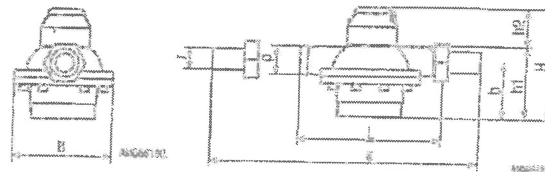
Dimensions in mm

Flow sensors (all types)

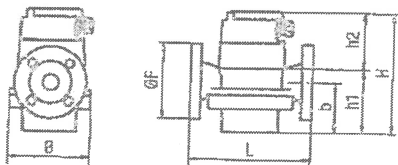
DN 15, 20, 25: with threaded ends (ISO 228-1)



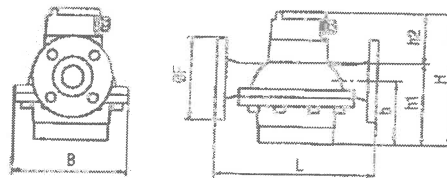
DN 40: with threaded ends (ISO 228-1)



DN 15, 20, 25: with flanges (DIN 2501/SN 21843)



DN 40, 50: with flanges (DIN 2501/SN 21843)

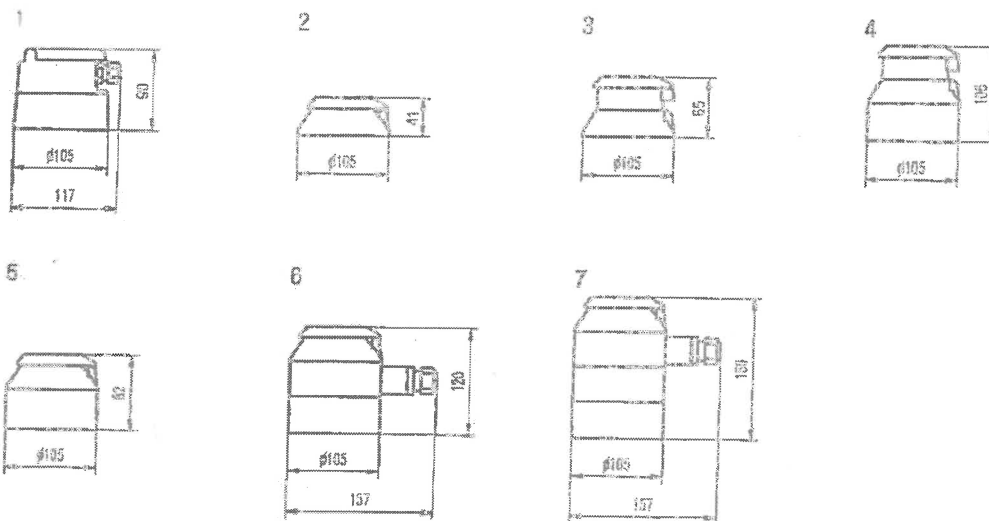


| Nominal size | L | B | a | Ø F | b | h1 | p | r |
|--------------|-----|-----|-----|-----|-----|-----|----------|----------|
| DN 15 | 165 | 105 | 260 | 95 | 45 | 65 | G 3/4" | G 1/2" |
| DN 20 | 165 | 105 | 260 | 105 | 54 | 74 | G 1" | G 3/4" |
| DN 25 | 190 | 130 | 305 | 115 | 77 | 101 | G 1 1/4" | G 1" |
| DN 40 | 300 | 210 | 440 | 150 | 116 | 153 | G 2" | G 1 1/2" |
| DN 50 | 350 | 280 | — | 165 | 166 | 209 | — | — |

Dimensions of transducer groups / measurement transducer

| Oil flow meter | VZF / VZFA | VZO 15 - 25 | | | | | | VZO 40 - 50 / VZOA 15 - 50 | | | | | |
|---------------------|------------|-------------|----|----|-------|----|----|----------------------------|----|----|-------|----|----|
| Max. temperature | 130/180°C | 130°C | | | 180°C | | | 130°C | | | 180°C | | |
| Pulsers | all | - | RV | IN | - | RV | IN | - | RV | IN | - | RV | IN |
| Dimensional drawing | 1 | 2 | 3 | 6 | 5 | 4 | 7 | 5 | 4 | 6 | 5 | 4 | 7 |

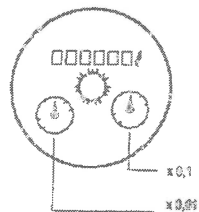
VZF(A), VZO(A) Dimensional drawings 1 - 7 from table above



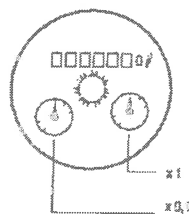
Display / Roller counter VZF / VZFA



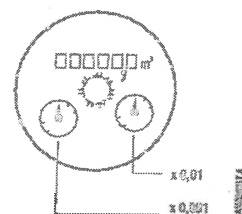
VZO / VZOA 15



VZO / VZOA 20, 25, 40



VZO / VZOA 50



Selection of the optimal meter

| Type | | VZF 15-50 | VZO 4-8 | VZO 15-50 | VZFA 15-50 | VZOA 4-8 | VZDA 15-50 |
|---|-------------------------|--------------|------------|--------------|---------------|-------------|---------------|
| Application | | | | | | | |
| Direct consumption measurement | | ● | ● | ● | ● | ● | ● |
| Differential measurement | | — | — | — | ● | — | ● |
| Measuring points with metrolog. approval / calibration (optional) | | — | — | — | — | ● | ● |
| Measuring points with marine type approval (optional) | | ● | — | ● | ● | — | ● |
| Most frequent areas of use | | | | | | | |
| Domestic / Industrial burner | light/medium oil | ● | ● | ● | ● | ● | ● |
| | heavy oil 1) | ● | — | ● | ● | — | ● |
| Diesel engines | diesel oil | ● | ● | ● | ● | — | ● |
| Ship motors | heavy oil 1) | ● | — | ● | ● | — | ● |
| Petrol engines | | | 2) | | | | |
| Common applications | | | | | | | |
| Heating systems | | ● | ● | ● | | | |
| Ships | | ● | | ● | ● | | ● |
| Diesel locomotives | | ● | ● | ● | ● | | ● |
| Trucks/coaches/construction machinery | | | ● | ● | | | ● |
| Fuel types | | | | | | | |
| Light heating fuel | | ● | ● | ● | ● | ● | ● |
| Medium heating fuel | | ● | ● | ● | ● | ● | ● |
| Heavy heating fuel | | — | — | — | — | — | — |
| Diesel | | ● | ● | ● | ● | ● | ● |
| Petrol 2) | | | 2) | | | | |
| Display of flow data | | | | | | | |
| Total volume | | ● | ● | ● | ● | ● | ● |
| Resettable volume | | ● | — | — | ● | — | — |
| Instantaneous flow rate | | ● | — | — | ● | — | — |
| Method of display | | | | | | | |
| LCD Electronic display | | ● | — | — | ● | — | — |
| Total volume display on roller counter | | — | ● | ● | — | ● | ● |
| Measuring error limits | | | | | | | |
| ±1 % of actual value | | ● | ● | ● | — | ● | — |
| ±0,5 % of actual value or smaller | | — | — | — | ● | — | — |
| PTB approval | Class 1 | — | — | — | ● | — | ● |
| EC approval/verification | Class 1 | — | — | — | — | DN 4 | — |
| | Class 0.5 | — | — | — | — | DN 8 | ● |
| Outputs 4) | | | | | | | |
| Current output | 4...20mA | ● | — | — | ● | — | — |
| Digital outputs | volume pulses | ● | — | — | ● | — | — |
| | frequency signal | ● | — | — | ● | — | — |
| | min/max limiting values | ● | — | — | ● | — | — |
| Pulsar (Option) | | | | | | | |
| Inductive, with decadic pulse value | | — | — | ● | — | — | ● |
| Reed pulsar for remote totalisation | | — | ● | ● | — | ● | ● |

● applicable

— not applicable

| Fuels and suitable Meter sizes | DN 4 | DN 8 | DN 15 | DN 20 | DN 25 | DN 40 | DN 50 |
|-----------------------------------|------|------|-------|-------|-------|-------|-------|
| Light heating fuel | ● | ● | ● | ● | ● | ● | ● |
| Medium heating fuel | ● | ● | ● | ● | ● | ● | ● |
| Heavy heating fuel | — | — | 3) | ● | ● | ● | ● |
| Diesel | ● | ● | ● | ● | ● | ● | ● |
| Petrol | 2) | 2) | — | — | — | — | — |

1) Only in accordance with the maximum mesh size of the dirt filter as per technical data.
2) Extreme conditions of use with exception (after measured values).

3) DN 15 only when the plant has a dirt filter with a max. 0.1 mm mesh size.
4) Two thereby selectable independent outputs are always available.

Application note

For viscosities higher than 5mPa.s or for installations on the suction side of a pump, pressure drop and possible limitation of flow range must be taken into consideration.

Fuel oils

Characteristics of different fuels

| Fuel | | | extra light | light | medium | heavy | Bunker C |
|------------------------------------|------|--------|-------------|-------|--------|-------|----------|
| Density at 15°C | min. | kg/dm³ | 0.82 | 0.82 | 0.82 | 0.82 | 0.90 |
| | max. | kg/dm³ | 0.86 | 0.95 | 0.96 | 0.99 | 1.01 |
| Specific volume at average density | | l/kg | 1.19 | 1.12 | 1.12 | 1.11 | 1.08 |
| Viscosity at 20°C | | mPa.s | 8 | 14 | 50 | 420 | 4200 |
| 40°C | | mPa.s | 3 | 5 | 16 | 60 | 360 |
| 100°C | | mPa.s | — | — | 3 | 10 | 35 |
| Energy value | | kWh/kg | 11.8 | 10.6 | 11.4 | 11.2 | 11.0 |

Indicative values on power for burners and engines

Burners

| Burner | Fuel oil meter | | | | Size |
|----------------|---------------------------|--------|---|--|------|
| Power up to kW | Flow rate heating fuel EL | | Flow rate | | DN |
| | kg/h | l/h | Q _{min} ...Q _{cont} l/h | | |
| 500 | 42 | 50 | 1...50 | | 4 |
| 1 300 | 113 | 135 | 4...135 | | 8 |
| 4 000 | 336 | 400 | 10...400 | | 15 |
| 10 000 | 840 | 1 000 | 30...1 000 | | 20 |
| 20 000 | 1 680 | 2 000 | 75...2 000 | | 25 |
| 60 000 | 5 040 | 6 000 | 225...6 000 | | 40 |
| 200 000 | 16 800 | 20 000 | 750...20 000 | | 50 |

Formula for consumption in litres/hour:

Example:

$$\frac{\text{Burner power in kW}}{\text{Energy value of fuel in kWh/kg} \times \text{density in kg/dm}^3} = \text{62 l/h}$$

$$\frac{600 \text{ kW}}{11.8 \text{ kWh/kg} \times 0.82 \text{ kg/dm}^3} = 62 \text{ l/h}$$

Engines

| Engine | Diesel fuel consumption | | Fuel oil meter ¹⁾ | | Size |
|------------------------|-------------------------|--------|---|--|------|
| Power up to approx. PS | ca. kW | l/h | Flow rate | | DN |
| | | | Q _{min} ...Q _{cont} l/h | | |
| 250 | 184 | 50 | 1...50 | | 4 |
| 680 | 500 | 135 | 4...135 | | 8 |
| 2 000 | 1 470 | 400 | 10...400 | | 15 |
| 5 000 | 3 680 | 1 000 | 30...1 000 | | 20 |
| 10 000 | 7 360 | 2 000 | 75...2 000 | | 25 |
| 30 000 | 22 000 | 6 000 | 225...6 000 | | 40 |
| 100 000 | 73 600 | 20 000 | 750...20 000 | | 50 |

1) For differential measurement the flow meter has to be selected according to the pump flow rate and the flow in the return pipe.

Formula:

$$1 \text{ HP} = 0.736 \text{ kW}$$

$$1 \text{ kW} = 1.36 \text{ HP}$$

$$1 \text{ kg Diesel at } 0.84 \text{ kg/dm}^3 = 1.19 \text{ l}$$

Rule of thumb:

$$\text{approx. } 190 \text{ g/kWh correspond to } 0.226 \text{ l/kWh}$$

$$\text{approx. } 140 \text{ g/HP correspond to } 0.167 \text{ l/HP/h}$$

How to obtain an optimal measurement

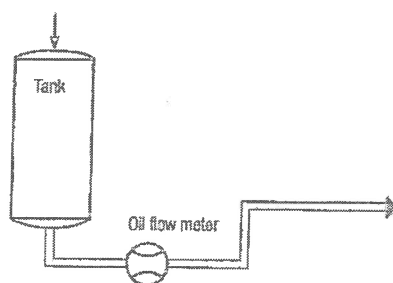
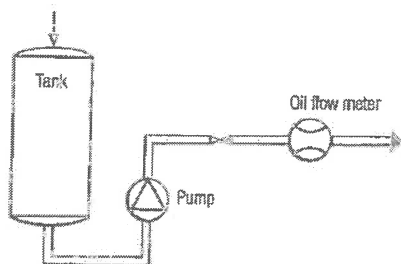
Planning

Flow meters are precision measuring instruments. They achieve optimal results if

- a few important rules are observed during plant design,
- mounting and commissioning are carried out with care,
- the meters are used for their defined purpose only.

Layout of Pipework

- The quantities consumed by all consumers must be registered by the meter.
- Rotary piston meters do not require flow conditioners or inlet runs (after bends, T-pieces or fittings). They may be mounted in horizontal, vertical or inclined position, except with the head pointing downwards.
- The layout of piping must ensure that the meter is at all times filled with liquid and that no inclusions of air or gas may occur. Do not install the instrument at the highest point of the installation.
- Meter and accessory equipment must be easily accessible.



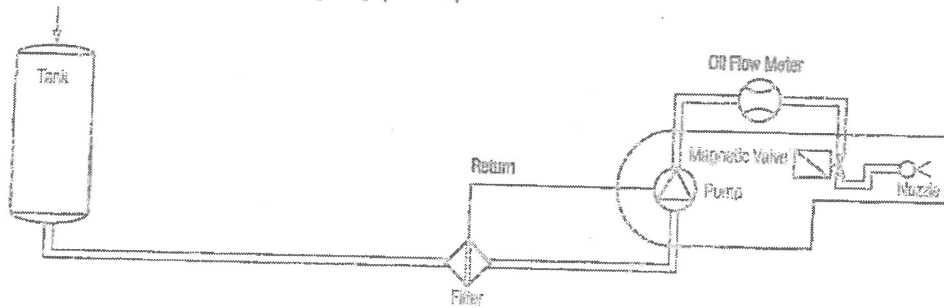
Selection of the Meter and Ancillaries

To be considered when selecting the meter:

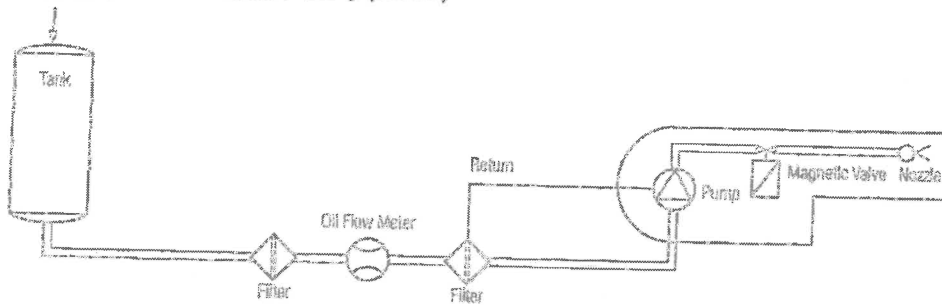
- Operating temperature
- Viscosity of the medium
- Operating pressure
- Flow rate
- Resistance of the material against fuel to be metered and working conditions

The technical data are valid for the following reference conditions: EL heating fuel / diesel at 20° C. For higher viscosities or if the meter is mounted on the suction side of a pump, it is necessary to determine the pressure drop and the flow rate that can still be attained by using the pressure loss curves (page 25ff). If the pressure drop is more than 1 bar, it is advised to use the next larger meter size. Maximum permissible pressure drop = 3 bar.

Mounting on pressure side of pump (burners)



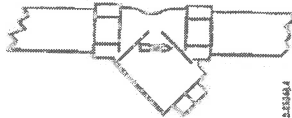
Mounting on suction side of pump (burners)



Impurities in plant or fuel

Should impurities occur in the plant or in the fuel, a dirt filter has to be installed before the meter. The filter mounted in the meter inlet is only a safety filter and is too small to act as a dirt filter.

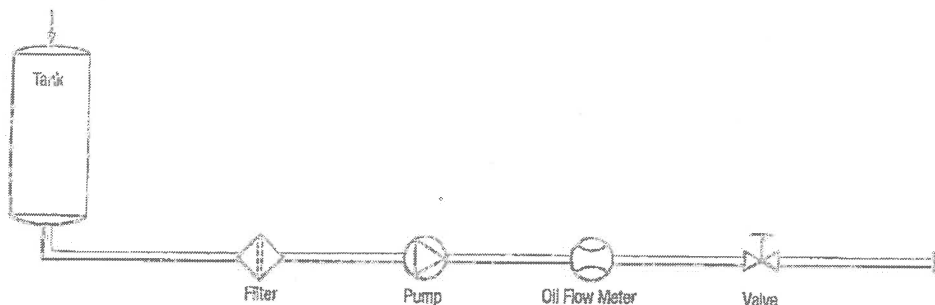
| Maximum mesh size of dirt filter | Meter | VZF | VZO | VZFA/VZOA |
|----------------------------------|-------|----------|----------|-----------|
| | DN 4 | — | 0,030 mm | 0,080 mm |
| | DN 8 | — | 0,100 mm | 0,100 mm |
| | DN 15 | 0,250 mm | 0,250 mm | 0,100 mm |
| | DN 20 | 0,400 mm | 0,400 mm | 0,100 mm |
| | DN 25 | 0,400 mm | 0,400 mm | 0,250 mm |
| | DN 40 | 0,600 mm | 0,600 mm | 0,250 mm |
| | DN 50 | 0,600 mm | 0,600 mm | 0,250 mm |



100000

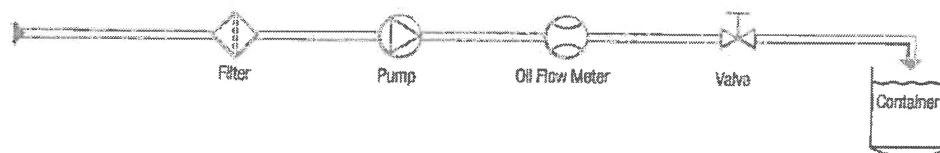
Stop valves or cocks

In order to avoid backflow and draining, stop valves have to be mounted after the meter. Backflow and draining cause measuring errors and can damage the meter.



Filling/Dosing

For filling and dosing the valve has to be mounted between meter and outlet. The shorter the pipe section between meter and outlet, the higher the accuracy. Fast opening and shutting of the valve should be avoided (pressure hammer).



Remote Processing/Ancillaries

Any backflow must be avoided on meters equipped with pulsers for remote processing. If this cannot be achieved by appropriate plant design, a non-return valve should be fitted.

Electrical wiring and installations

Electrical wiring and installations are subject to statutory regulations which must be taken into account when planning the system. For installations in zones subject to explosion hazards, consult an appropriate expert.

The following factors should be taken into account during plant design:

- ancillaries connected to the meter
- environmental interference
- maximum permissible cable lengths (with or without amplifier)
- junction boxes, cable guides

Cable lengths on the VZF meter outputs

A cable with wire diameter of 0.5mm is generally suitable up to 25 m and such of 0.8 mm will go up to 100 m. In all other cases the limiting factors should be considered.

- for the analogue current output: (4...20mA)

Limiting factors are supply voltage (U) and resistance of the load (RL). To ensure the maximum current signal of 21.5 mA with sufficient operating voltage for the meter the following formula is used to calculate the maximum permissible resistance (RL) which consists of the resistance of the cable plus the resistance of other components within the circuit. Knowing the resistance of the other components, the maximum permissible length for the cable can then be calculated.

$$R_L = \frac{(U - 5) V}{0.0215 A} \quad [\Omega]$$

Example:

Supply voltage
U = 24 V

$$R_L = \frac{(24 - 5) V}{0.0215 A} = \frac{19 V}{0.0215 A} = 883 \Omega$$

- for the semi conductor relay output: (volume pulses, frequency signal, limit switch)

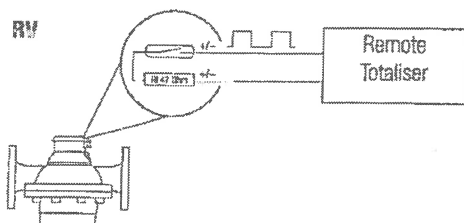
Limiting factors depend on the input specification of the higher system or the totalizer. The ability of the input to detect the actual state of the switch is specified by the system manufacturer.

For the relay switch a maximum of 100 Ω at ON-state has to be considered together with the cable's resistance. A minimum of 10M Ω at OFF-state has to be considered together with the cable's capacity. The maximum permissible length of the cable depends on the individual properties for resistance and capacity.

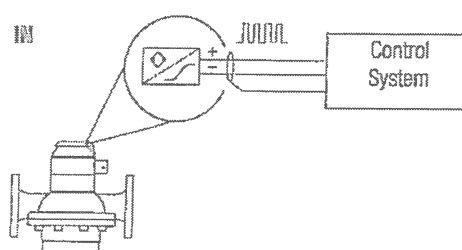
Pulsers IN and RV

Power supply

Our range of products includes passive pulsers for the remote processing of flow data. The pulser generates one pulse per unit of volume and is to be supplied with power from the pulse processing device.



Power supply 5...48 VAC/DC



Power supply 5...15 VDC

Selection of the appropriate pulser

The selection of the most appropriate pulser and pulse value depends on the application. As a rule, remote totalisation demands rather large pulse values, whereas analogue signals, dosing control or indication of actual flow rate tend to need small values. Battery supplied devices can only be used together with Reed pulsers.

Selection of the processing device

The pulse length depends on the flow rate. Continuous contact may occur at zero flow. The device connected must therefore be able to accept continuous load; otherwise, protective measures have to be taken. For remote totalisation, it is recommended to use an electronic pulse counter with a low power consumption and bounce filter.

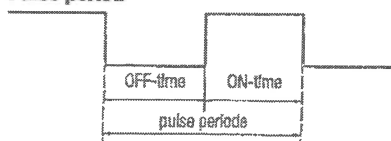
Correct pulse processing

Interrupted flow may cause hydraulic oscillation of the liquid in certain plants (hydraulic vibration with minimal backward/forward flow). The pulses which can occur in such cases may be interpreted as forward flow by the connected device. Such faulty pulses do not affect the indication of the actual value since they can only occur at almost zero flow. However, if the pulser controls a counting device, hydraulic vibration must be avoided by an appropriate modification or layout of the plant.

Pulse values

Pulse values depend on type and nominal size of the meter. They are listed in the technical information of the meter concerned.

Pulse period



Pulse period as well as on- and off-times can be calculated with the following formula:

$$\text{Pulse period in s} = \frac{\text{pulse value in litres} \times 3600}{\text{flow } Q \text{ in l/h}}$$

$$\text{On-time} = \frac{\text{pulse period in s} \times \text{on-time in \% of pulse period}}{100}$$

$$\text{Off-time} = \text{pulse period in s minus on-time}$$

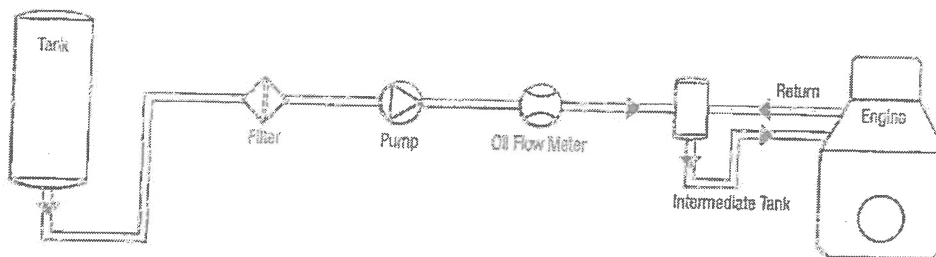
We recommend that this calculation be carried out for the highest and lowest expected flow rates.

Application examples

Diesel engine

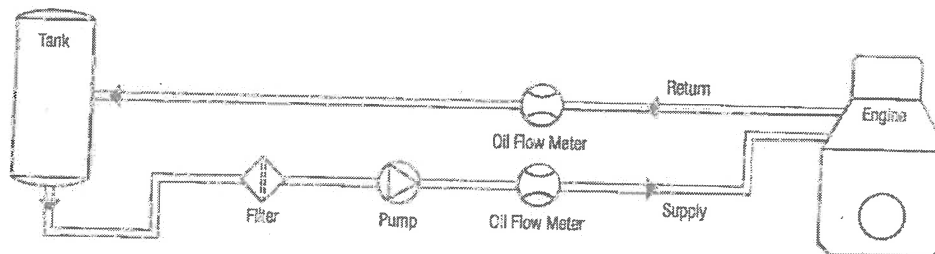
Direct consumption measurement

Instead of returning the fuel back into the main tank, an intermediate tank equipped with a heat exchanger should be installed on the supply side of the system. The flow measurement is taken in the supply pipe to the intermediate tank. The load on the meter and the measuring result correspond precisely to the consumption.



Differential measurements

For differential measurements, the piping remains unchanged, with circulation back into the tank. A flowmeter is installed in both supply and return pipes. The consumption is determined as the difference between the amount in the supply section and the amount in the return section. The meter loads therefore correspond to the supply and return flow rates.



Reasons for using special meters for differential measurements

Standard meters feature a large measuring range and a max. permissible error of $\pm 1\%$. This makes them unsuitable for differential measurements, as the following example shows:

Full load

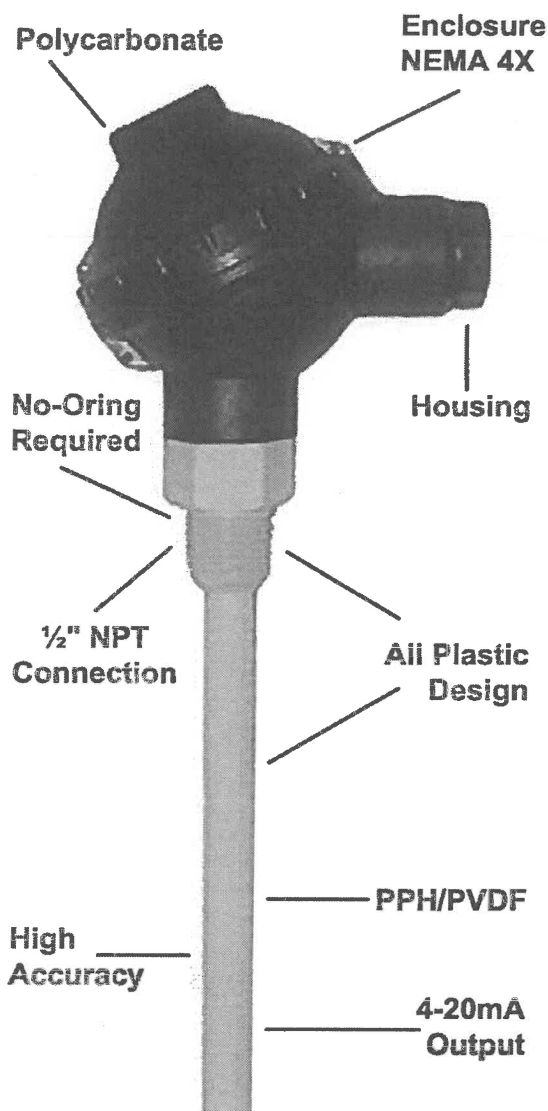
| | | | |
|--------------------|--------------------------------------|-----------------|-----------------------|
| Supply | 400 l/h | Error $\pm 1\%$ | = nominal ± 4.0 l |
| Return | 150 l/h | Error $\pm 1\%$ | = nominal ± 1.5 l |
| Consumed | 250 l/h | Divergence | nominal ± 5.5 l |
| Maximum divergence | | | |
| Consumed | $= 5.5 \times 100 : 250 = \pm 2.2\%$ | | |

Min. load

| | | | |
|--------------------|------------------------------------|-----------------|-----------------------|
| Supply | 400 l/h | Error $\pm 1\%$ | = nominal ± 4.0 l |
| Return | 360 l/h | Error $\pm 1\%$ | = nominal ± 3.6 l |
| Consumed | 40 l/h | Divergence | nominal ± 7.6 l |
| Maximum divergence | | | |
| Consumed | $= 7.6 \times 100 : 40 = \pm 19\%$ | | |

For an optimal result, special meters are therefore used for differential measurements. These are precisely matched to the operating conditions and are calibrated in pairs. This means that the measurement error can be significantly reduced (for example: $\pm 0.1\%$ at constant flow rates on the supply side and $\pm 0.3\%$ with slightly variable flow rates on the return side).

TPP Series ALL PLASTIC TEMPERATURE PROBE



- Completely Corrosion Resistant
- Easy to Install
- High Impact NEMA 4X Plastic Enclosure
- PPH or PVDF Probe
- 3 Wire Design
- 3-Different Temperature Ranges
0-100°C 32°F-212°F
- 4-20mA Output
- Standard Probe Lengths.
- Accuracy $\pm 0.5\%$

The Levelpro TPP Series Plastic Temperature probe is designed to handle industry's most corrosive applications. The TPP measures temperature by implementing a bimetal system inside the thermometer probe. The bimetal is non-wetted and consists of two thin strips of long term stability heat treated metals that are bonded together, both having different coefficients of thermal expansion. As the temperature increases the metal will begin to expand or contract, these changes are predictable and the resistive change per degree is used to determine temperature.

The R vs T relationship is defined as the amount of resistance change of the sensor per degree of temperature change, and varies only marginally providing excellent repeatability.

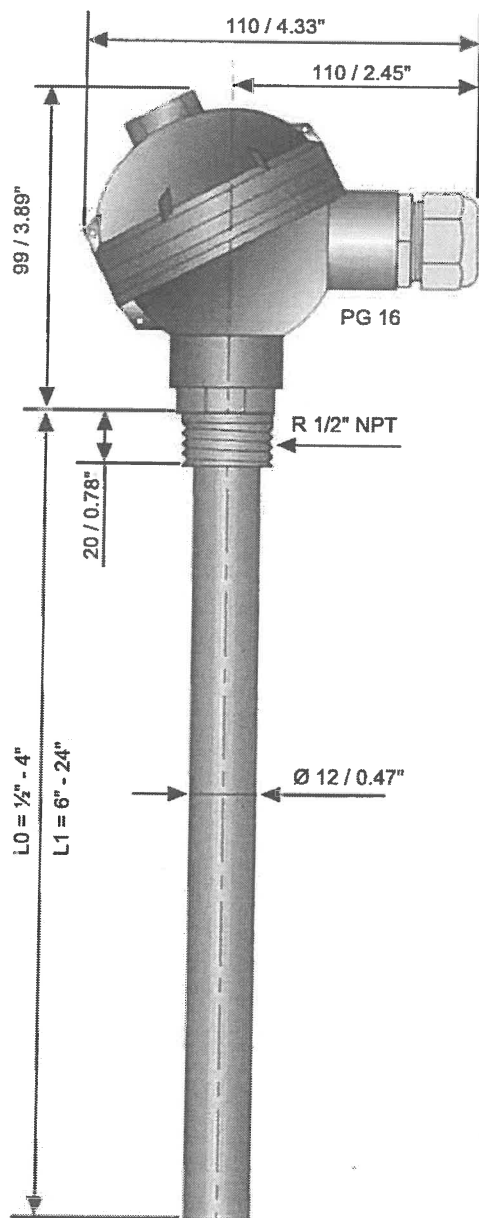
The resistance is then converted into a 4-20mA output signal the can be sent to local or remote display, valve, pump, and used to control or monitor your process.

CODE NUMBERS AND REFERENCES

| Ordering Cord | Material | Range |
|---------------|----------|------------|
| 720 403 | PPH | 152 0-115° |
| 720 503 | PVDP | 162 0-212° |



Pt 100 Ω - PLASTIC TEMPERATURE PROBE



Operating Limits

PVC: -10...60 °C
PPH: -10...105 °C
PVDF: -20...140 °C

- PVC, PP, PVDF
- Pt 100 Ω at 0°C
- Operating range: -20...+140 °C
- Wetted parts: aggressive fluids
- All Plastic Designed to Handle

DESCRIPTION & FEATURES

Fitting
Without
1/2" NPT

0
1

Probe material
PVC
PPH
PVDF

P
H
V

Plunger length
L0 = 1/2" - 4"
L1 = 6" - 24"

XXX

Sensor

Simple 3 wires Output
Simple 4 wires Output

3
4
6

Connection

Ceramic terminal box
4-20 mA transmitter

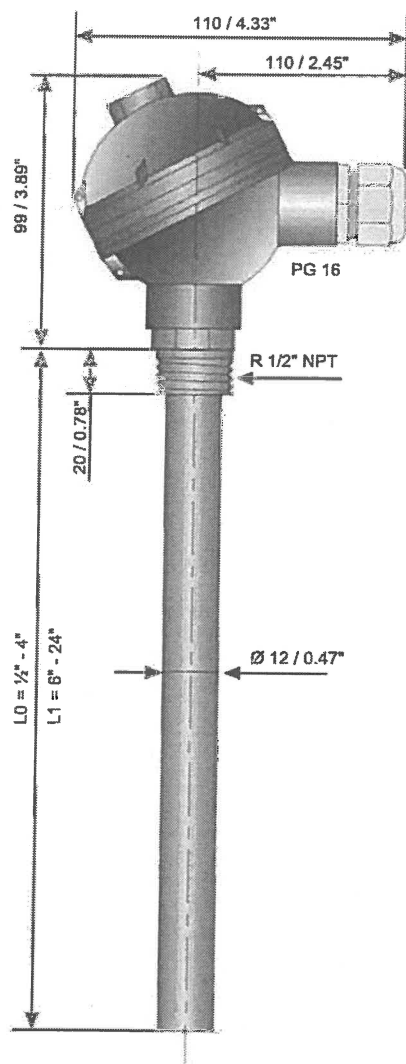
C
T

TPP

TS 13 12



Pt 100 Ω - PLASTIC TEMPERATURE PROBE



Industrial probes and boards are base on :
 $R_o = 100 \text{ Ohms}$
 $R_{100^\circ\text{C}} = 138,5 \text{ Ohms}$

STANDARDS AND TOLERANCES

INTERNATIONAL CEI 751

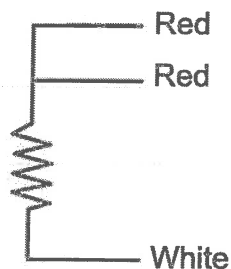
acceptable tolerances in $^\circ\text{C} \pm (0,15 + 0,002[t])$ for class A

acceptable tolerances in $^\circ\text{C} \pm (0,3 + 0,005[t])$ for class B

[t] is temperature value in $^\circ\text{C}$.

| Temperature in $^\circ\text{C}$ | Acceptable Tolerance | |
|------------------------------------|----------------------|------------------|
| | Ω | $^\circ\text{C}$ |
| -200 | $\pm 0,24$ | $\pm 0,55$ |
| -100 | $\pm 0,14$ | $\pm 0,35$ |
| 0 | $\pm 0,06$ | $\pm 0,15$ |
| 100 | $\pm 0,13$ | $\pm 0,35$ |
| 200 | $\pm 0,20$ | $\pm 0,55$ |
| 300 | $\pm 0,27$ | $\pm 0,75$ |
| 400 | $\pm 0,33$ | $\pm 0,95$ |
| 500 | $\pm 0,38$ | $\pm 1,15$ |
| 600 | $\pm 0,43$ | $\pm 1,35$ |
| 700 | $\pm 0,46$ | $\pm 1,45$ |

SETTINGS AND CONNECTIONS



2 / 3 wires setting
 for industrial applications.
 This setting limits the effect of lines
resistances

Two-Wire 4-20 mA Transmitter

Description

The Two-Wire Frequency Input Transmitter is loop-powered, providing a 4-20 mA analog process signal. The 4-20 mA signal is proportional to the flow rate and is calibrated using the zero and span adjustments to correlate with the input frequency generated by the flowmeter.

An exclusive feature provided by the transmitter is its ability to be configured for either magnetic or RF modulated carrier frequency inputs. RF pickoffs eliminate magnetic drag on turbine rotors, increasing the rangeability and providing improved accuracies at lower flow rates.

The compact transmitter, using surface mount technology, is offered in a potted module, polypropylene head, NEMA 4X housing or Class I, Division 1 & 2, Group A, B, C & D; Class II, Groups E, F & G; and Class III; Type 4X enclosure.

Features

- Isolated 4-20 mA output
- Reverse polarity protected
- Frequency input from modulated carrier or magnetic pickoffs
- Available in potted module or polypropylene, NEMA 4X and explosion-proof enclosures
- Long range transmission with noise immunity
- Loop-powered 12-50 VDC
- Compact module utilizing surface mount technology
- Approvals: FM/CSA approved for intrinsically-safe requirements and CE conformity per the EU EMC Directive



Two-Wire 4-20 mA Transmitter

Specifications

Input

| | |
|-----------------|---------------------|
| Frequency Range | 5-3500 Hz |
| Sensitivity | 7 mV RMS (Magnetic) |

Output

| | |
|--|---|
| Range | 4-20 mA |
| Linearity | ±0.1% of reading |
| Overall Accuracy (Including Linearity, Repeatability & Hysteresis) | ±0.1% of span |
| Temperature Stability | ±0.01% of reading per degree C |
| Zero Adjust | ±0.2 mA |
| Operating Temperature Range | -40° C to +85° C (-40° F to +185° F) |
| Storage Temperature Range | -55° C to +125° C (-67° F to +257° F) |
| Relative Humidity | 5 to 95% |
| Maximum Load Resistance | $R_{max} = \frac{(V_{supply} - 12)}{20 \text{ mA}}$ |

Power

| | |
|-----------------|------------------------|
| External Supply | 12-50 VDC Loop-Powered |
|-----------------|------------------------|

Approvals

Meets intrinsically-safe hazardous outdoor (NEMA 4X) locations when installed per FTI drawing 76-61827, which requires approved barrier.

CE approval on qualified FTI models (consult factory).



Model Numbering System

T W A - - - - -

Basic Model No.

Input Options

- A = Magnetic
- B = Pulse (requires "017" Special Code)
- C = 1 mH Carrier (RF)

Enclosure Options

- 3 = Polypropylene
- 4 = Potted Module With Mounting Holes
- B 6 = NEMA 4X
- 9 = Class I, Div. 1 & 2, Group A, B, C & D

Frequency Range

- 1 thru 12 from chart (optional).
- Factory select when purchased with meter.

Special Configuration

CE = CE conformity marked

- Notes: 1) Only available with "- 9" enclosure option.
- 2) With CE mark the enclosure is a double-sided instrument housing.

IS = FM and CSA Intrinsically-Safe

- Notes: 1) Available with enclosure options "B6" and "- 9" only.
- 2) Must be used with IS rated pick-off.

017 = Special configuration for pulse input

Frequency Range Chart

Twelve different operating frequency ranges are available from 5 Hz up to 3500 Hz. If the Two-Wire Transmitter is purchased with a turbine flowmeter, the transmitter with the appropriate frequency range will be selected at the time of calibration. Otherwise, one of the 12 listed ranges must be specified in the model number.

| Range Number | Operating Frequency* | Span Adjust | Response Time** |
|--------------|----------------------|-------------|-----------------|
| 01 | 50 - 3500 | 3001 - 3500 | <100 msec |
| 02 | 50 - 3000 | 2100 - 3000 | <100 msec |
| 03 | 50 - 2099 | 1470 - 2099 | <100 msec |
| 04 | 25 - 1469 | 1030 - 1469 | 150 msec |
| 05 | 25 - 1029 | 720 - 1029 | 150 msec |
| 06 | 25 - 719 | 500 - 719 | 150 msec |
| 07 | 15 - 499 | 350 - 499 | 500 msec |
| 08 | 15 - 349 | 245 - 349 | 500 msec |
| 09 | 15 - 244 | 170 - 244 | 1.5 sec |
| 10 | 5 - 169 | 120 - 169 | 1.5 sec |
| 11 | 5 - 119 | 81 - 119 | 4 sec |
| 12 | 5 - 80 | 50 - 80 | 4 sec |

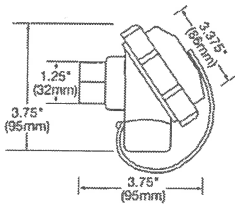
* Frequencies below the operating range may cause output ripple to be in excess of 2 mV RMS

** Response time for frequency step changes from 0 to 90%

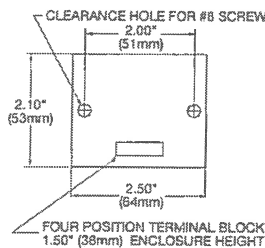
Specifications are for reference only and are subject to change without notice.

Drawings not to scale.

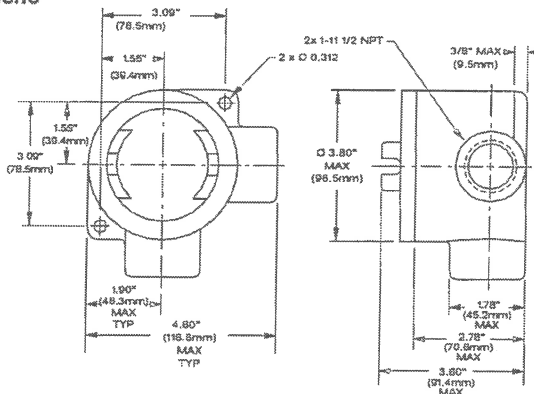
Enclosure Options



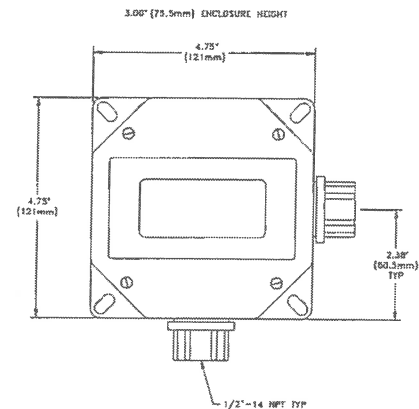
3 = Polypropylene



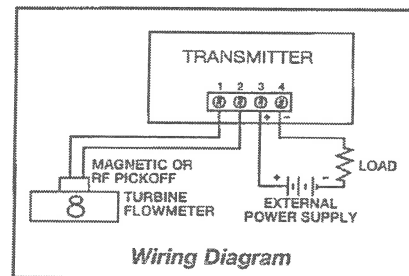
4 = Potted Module



9 = Class I, Div. 1 & 2, Group A, B, C & D



B6 = NEMA 4X



Wiring Diagram

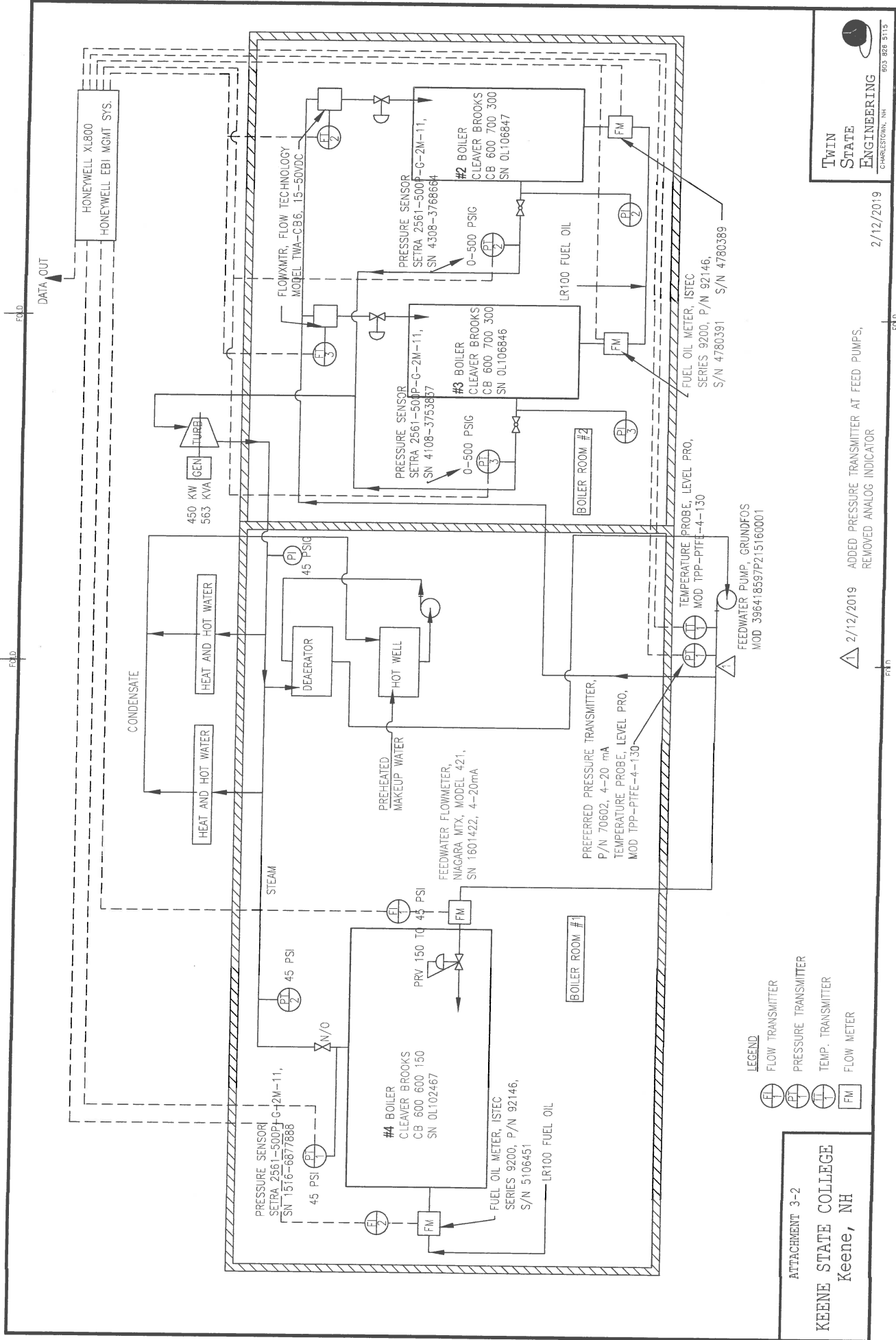
Local Representative:



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3-16





ATTACHMENT 3-2

Calculation Summary for Useful Thermal Energy From LR 100 Bio Fuel

The calculations are based on the difference between the steam leaving the boiler, to the various parasitic loads, and the temperature of the feed water supplied to the boiler. Feed water to the boiler is made up of the condensates returned from the various steam users, returned to the deaerator tank, replenished with make-up water, heated with steam and then sent to the boiler feed pumps.

The temperature of the boiler feed water is taken at the boiler feed pumps, thereby excluding the deaerator from the monitoring system, as required by PUC 2506.04m7.

The equation used for calculating the useful thermal energy shall be as follows:

$$Q_g = (((dm_{out}/dt * h_{out} * t) - (dm_{in}/dt * h_{in} * t)) * .999) * .98$$

- Q_g = Useful thermal energy generated, BTU
- dm_{out}/dt = Mass flow of steam out of the boiler and to the parasitic loads, #/hr
- dm_{in}/dt = Mass flow of feed water into the boiler, #/hr. Measured at FT-2.
- h_{out} = Enthalpy of steam vapor at the pressure transmitter leaving the boiler, BTU/#.
Measured at PT-2
- h_{in} = Enthalpy of feed water at the entrance to the boiler, BTU/#. Measured at TT-1.
- t = Metering and recording intervals, hrs
- .98 = The default discount rate for calculating the REC for the boiler steaming load.
- .999 = Correction used for consideration of loss through boiler blowdown.

The specific weight of the boiler feed water, based on feed water temperature, shall be required to be used for the mass flow into the boiler. Enthalpy values of the boiler feed water into the boiler and steam vapor shall be taken from IAPWS or other accepted steam tables.

3-3a,d

**TWIN
STATE
ENGINEERING**



P.O. Box 1260

Charlestown, NH 03603

January 4, 2019

Ms. Deandra Perruccio
Sustainable Energy Division
NH Public Utilities Commission
21 Fruit Street, Suite 10
Concord, NH 03301-2429

Dear Ms. Perruccio:

The following relates to the #3 hi-pressure boiler installed at Keene State College, located in Keene, NH. The boiler is a Cleaver Brooks package boiler of 700 horsepower capacity and installed in 2009.

Please be advised that the #3 boiler, as existing, gathers boiler and steam parameters in the same manner and with similar equipment as the existing #2 and #4 boilers, which have already been approved for RECs, on April 10, 2018. As of September 14, 2018 boiler #3 has been converted to burn LR 100 recycled vegetable oil, as supplied by Lifecycle Renewables of Marblehead, MA. Number 3 boiler has also been stack tested with LR100 oil.

Feed water to the boilers is from returned condensate to a deaerator and hot well and is pumped using Grundfos multi-stage feed water pumps, capable of 300 PSIG. The discharge from the feed water pump(s) is monitored by a pressure transmitter and temperature transmitter. The feed water enters into the boiler through a flow control valve and is monitored by a totalizing flow meter and transmitter.

The data from the water pressure transmitters, steam pressure transmitters and feed water flow meters is sent to a Honeywell XL800 controller and then processed to the Honeywell EBI energy management system. Number 2 and 4 boilers, currently burning LR100 oil send their energy data to the same systems. All pressure transmitters, temperature transmitters and flowmeters have a manufacturer's stated accuracy of $\pm 1\%$, or better.

Steam discharged from the boilers is at 265 PSIG. The steam is discharged to a steam turbine, coupled to a 450 KW generator. The generator produces 400 KW at 265 PSIG steam pressure. The turbine is a back pressure unit with 45 PSIG exhaust discharging to the 45 PSI heating and hot water distribution systems.

603-826-5115
twinsteng@aol.com

**TWIN
STATE
ENGINEERING**



3-3 a.d

P.O. Box 1260

Charlestown, NH 03603

The MWh calculations for #3 boiler shall be as required in PUC 2506.04, the same calculations as performed and approved for #2 and #4 boilers Renewable Energy Certificates. The data shall be downloaded, by the Independent Monitor, to the GIS on a quarterly basis and yearly to the Commission, as required as required per PUC 2505.09.

Please call with questions.

TWIN STATE ENGINEERING

Roger Thibodeau, PE, SECB
(Independent Monitor)

5
Part Affidavits

Owners Affidavit

The following affidavit must be completed by the owner attesting to the accuracy of the contents of the application pursuant to PUC 2505.02 (b) (14).

AFFIDAVIT

I, DIANA TOFFY have reviewed the contents of this application and attest that it is accurate and is signed under the pains and penalties of perjury.
Applicant's Signature [Signature] Date 2/20/19
Applicant's Printed Name DIANA TOFFY
Subscribed and sworn before me this 20 Day of February (month) in the year 2019
County of Cheshire State of N.H.

[Signature]
Notary Public/Justice of the Peace Seal

My Commission Expires _____

PATRICIA A. HITCHNER, Notary Public
My Commission Expires March 9, 2021

NH Professional Engineer Affidavit

AFFIDAVIT

I, ROGER THIBODEAU attest that this facility meets the requirements of the thermal REC eligibility requirements of Puc 2500, including the thermal metering and measurement methodologies and standards and REC calculation methodologies.
Professional Engineer's Signature [Signature] Date 2/20/2019
Professional Engineer's Printed Name ROGER THIBODEAU

NH Professional Engineer License Number

6873

PE Stamp

