Measurement and Verification Plan

DG/CHP System at Union College

807 Union Street

Schenectady, NY 12308

1/16/17

CDH Energy Corporation

2695 Bingley Road

Cazenovia, NY 13035-0641

315-655-1063

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Union College
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Schenectady, NY 12308

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Table of Contents

Introduction

A 1.8 MW CHP system consisting of a Kawasaki GPB 17D natural gas fired combustion turbine and a Rentech heat recovery steam generator (HRSG) capable of producing up to 45,000 lb/h of 130-psig steam are being installed at Union College in Schenectady, NY. Clough Harbor and Associates and Cogen Power Technologies (CHA/CPT) are providing a design-built installation of the system.

Union College is installing a Kawasaki GPB 17D natural gas fired turbine CHP system that will produce 1.65 MW net of electrical power. The turbine is outfitted with a HRSG that can produce 11,000 lb/h of steam at 130-psig using only the turbine exhaust, or up to 45,000 lb/h of 130-psig steam when the HRSG duct burner is firing. The turbine and HRSG duct burner are fueled by natural gas at a rate of 21.4 MMBtu/h LHV (23,000 CFH) for the turbine alone, and 52.9 MMBtu/h LHV (56,485 CFH) with the turbine and duct burner operating. Based on the manufacturers ratings, the system has a rated CHP efficiency of 74.2% LHV without the duct burner firing, and 83.6% LHV with the duct burner firing.

Based on the DEA submittal, the system is anticipated to displace 1,156 kW of peak demand, and provide 13,064,970 kWh/year of electricity. This performance equals 7,258 EFLH of turbine operation. The total contracted base incentive for the project reaches the program cap of $2,000,000, with $1,306,497 tied to annual performance as determined by monitoring and verification (M&V). The facility is also eligible for $400,000 in bonus incentives; $200,000 for both the critical facility and superior performance bonus. The project has a 1,156 kW contract demand reduction (kWspc).

Instrumentation

To quantify the performance of the proposed CHP system, the CHP system fuel input, net electrical output, and useful thermal output must be measured. To capture these energy flows, an instrumentation plan was developed by CDH Energy and reviewed with the developer Cogen Power and system integrator Rovisys. The instrumentation plan covers the location and type of sensors necessary to provide the appropriate measurements of the energy flows of the system.

Data Logger

No dedicated data logger is used for the Union College CHP system. The Rovisys data integration platform will collect information from the remote PLCs located at each major component, assemble the data into a report conforming with the NYSERDA requirements, and deliver the report daily to the CDH Energy servers. The Rovisys system interfaces with PLCS at the turbine skid, HRSG, dearator / feedwater system, balance of plant (BOP) PLCs including electrical switchgear monitoring, and gas compressor skid, using the appropriate protocol for each PLC (ex: Modbus, BACnet, HART, etc).

In accordance to the instrumentation plan, Cogen Power will supply the instrumentation listed below for use in meeting the NYSERDA CHP program monitoring requirements. The table below provides a description of the monitored data points and sensors.

Table 1. Instrumentation Supplied By Cogen Power

Dwg. Label	CDH Point	Description	Units	Instrument / Transducer
	WT	Gross Generator Output	kWh	Schweitzer SEL 734
	WT_KW		kW	
DMMF-2	WP1	-	kWh	Schweitzer SEL 734
DMMF-2	WP_KW1		kW	
DMMF-3	WP2	Parasitic Loads - MCC3 - Gas Compressor	kWh	Schweitzer SEL 734
DMMF-3	WP_KW2		kW	
DMMF-4	WP3	Parasitic Loads - MCC4 - Chiller / Cooling Tower	kWh	Schweitzer SEL 734
DMMF-4	WP_KW3		kW	
	WB	Total Facility Load	kWh	Schweitzer SEL 735
	WB_KW		kW	
-	WG	Net Generator Output	kWh	Calculated
-	WG_KW		kW	
FT-3023	FGT	Gas to Turbine - Temp & Pressure	cf	Foxboro IMV30-T22BE01F
FIT-522	FGDB	Gas to Duct Burner - Temp & Pressure	cf	Rosemount 3051SFC
-	FG	Total Gas Input (Turbine + Duct Burner)		Calculated
DP-100	SV	Exhaust Bypas Conrol Valve Status	%	-
TE-140	TCR	Condensate Return Temperature	^{0}F	ABB 266HSH
FIT-2	FFW	HRSG Feedwater Flow	lb/hr	Rosemount 3051CD2A
PIT-114	PFW	HRSG Feedwater Pressure	psig	ABB 266HSH
FIT-1	FS	Steam Flow - From HRSG	lb/hr	Rosemount 3051SMV
PI-1	PS	Steam Pressure	psig	Rosemount 3051SMV
TI-1	TS	Steam Temperature	^{0}F	Rosemount 3051SMV
FE-101	FSDAHP	Steam Flow (90 psig) - To Deaerator	lb/hr	ABB SwirlMaster FSS450
FE-102	FSDALP	Steam Flow (35 psig) - To Deaerator		ABB SwirlMaster FSS450
FE-145	FSCH	Steam Flow - To Chiller	lb/hr	Niagara Meter XIHX
FE-149	FCHW	Chilled Water Loop Flow	gpm	Onicon F1210
TE-150	TCHWS	Chilled Water Loop - Supply Temp	^{0}F	-
TE-148	TCHWR	Chilled Water Loop - Return Temp	^{0}F	-
-	QU	Useful Heat Recovery	MBtu/h	Calculated
-	QCH	Chilled Water Output	Tons	Calculated

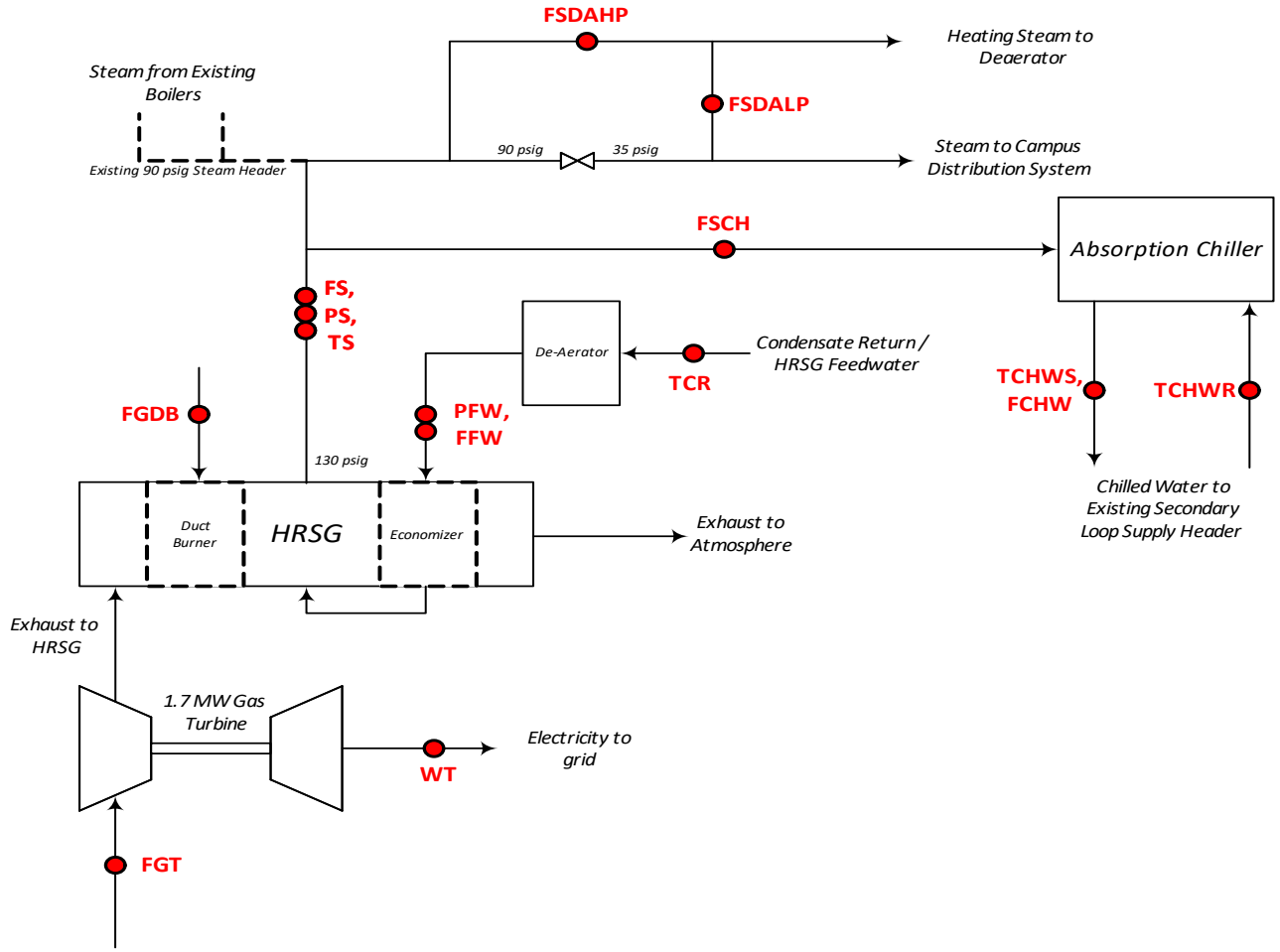


Figure 1. Union College CHP System Schematic

Onsite Installation

No onsite installation work is performed by CDH Energy.

Communications

All communications from the Rovisys system to the internet are supplied via Union College's internal network. The Rovisys system will upload the data report once per day to the CDH Energy server via sFTP using the following credentials:

- Protocol: sFTP (port 22)
- Server: data.cdhenergy.com
- Username: union_college
- Password: union_college_nyserda

On Site Support

The site will be responsible for providing access to all areas necessary for verification of sensors.

Data Analysis

The collected data will be used to determine the net power output of the system as well as the fuel conversion efficiency (FCE).

Peak Demand or Peak kW

The peak electric output or demand for each power reading will be taken as the average kW in a fixed 15-minute interval (0:00, 0:15, 0:30, etc), or

$$kW = \sum_{15min} \frac{kWh}{\Delta t} = \sum_{15min} \frac{kWh\ per\ interval}{0.25h}$$

and the net power output from the CHP system is defined as:

WG = WT – (WP1 + WP2)

Where:	WT	-	Gross gas turbine output (kWh or kW)
	WG	-	Net gas turbine output (kWh or kW)
	WP1	-	Parasitic load MCC-1 GTG Skid (kWh or kW)
	WP2	-	Parasitic load MCC-3 Gas Compressor (kWh or kW)

Heat Recovery Rates

Heat recovery from the CHP system is achieved in the form of steam production from the HRSG. Steam conditions (temperature and pressure) are monitored leaving the HRSG to set the enthalpy of steam delivered, and determine the amount of superheat delivered. Useful heat recovery in the form of 90-PSIG steam is calculated by:

$QU = [(h_g(TS) - h_f(TCR)) \times FS / 1000]$

Where:	QU	-	Useful heat recovery (MBtu or MBtu/h)
	$h_g(TS)$	-	Enthalpy of HRSG steam at 90-psig (stipulated) and steam temperature TS (Btu/lb)
	TS	-	HRSG steam temperature (°F)
	$h_f(TCR)$	-	Enthalpy of HRSG condensate (before deaerator) at 90 psig and average temperature TCR (Btu/lb)
	TCR	-	Condensate return temperature (°F)
	FS	-	Net Steam Flow (lb/h) (FS – FSDALP - FSDAHP)

Fuel Input

Fuel input to the CHP system is measured by two gas meters. The first meter is an orifice plate / differential pressure meter that measures the high-pressure gas leaving the gas compressor and entering the turbine. The second meter is another orifice plate / differential pressure meter that measures the low-pressure gas to the HRSG duct burner. Both meters are temperature compensated.

Total gas input to the CHP system is:

FG = FGT + FGDB

Where: FG - Total natural gas input (CF or CF/h)
FGT - Gas turbine natural gas input (CF or CF/h)
FGDB - Duct burner natural gas input (CF or CF/h)

Calculated Quantities

The fuel conversion efficiency of the CHP system, based on the higher heating value of the fuel, will be defined consistent with the NYSERDA CHP Systems Manual 2013 as:

$$FCE = \frac{\frac{QU}{0.8} + 3{,}412 \cdot WG}{HHV_{gas} \cdot FG}$$

Where:

QU - Useful heat recovery (Btu)
0.8 - Nominal boiler efficiency displaced by useful heat
WG - Net generator output (kWh)
FG - Generator gas consumption (Std CF)
HHV_{gas} - Higher heating value for natural gas (~1,030 Btu/CF).

The FCE can be calculated for any time interval. When converting to daily, monthly, or annual values, each value is summed and then the formula below is applied:

$$FCE = \frac{\frac{\sum^N QU}{0.8} + 3{,}412 \cdot \sum^N WG}{HHV_{gas} \cdot \sum^N FG}$$

Where N is equal to the number of intervals in the period of interest.

Appendix A - System Schematics

Appendix B - Cut Sheets for Key Sensors and Instruments

Appendix C - Site Photos

Gas turbine

Heat Recovery Steam Generator (HRSG)

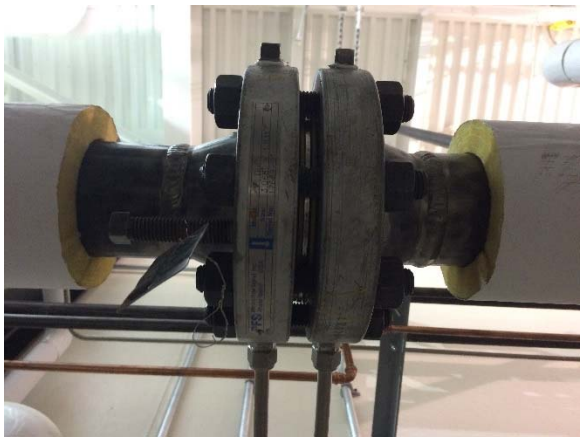
Gas Compressor Enclosure (next to gas turbine skid)

Turbine Gas Meter (FGT)

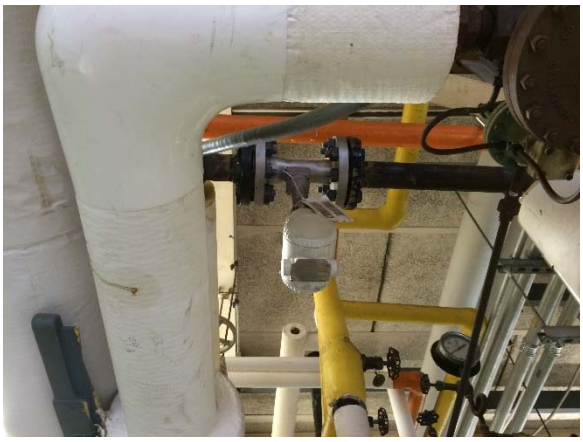
Duct Burner Gas Meter (FGDB)

Steam Flow Meter (FS)

Steam Flowmeter Display (FS)



HRSG Feedwater Flow Meter (FFW)



High Pressure Deaerator Steam Flow Meter (FSDAHP)

Steam to Chiller Flange (meter not yet installed) (FSCH)

Chilled Water Flow Meter

Turbine Gross Output (WT)

MCC4 Parasitic Load Meter – Typ. (WP3)

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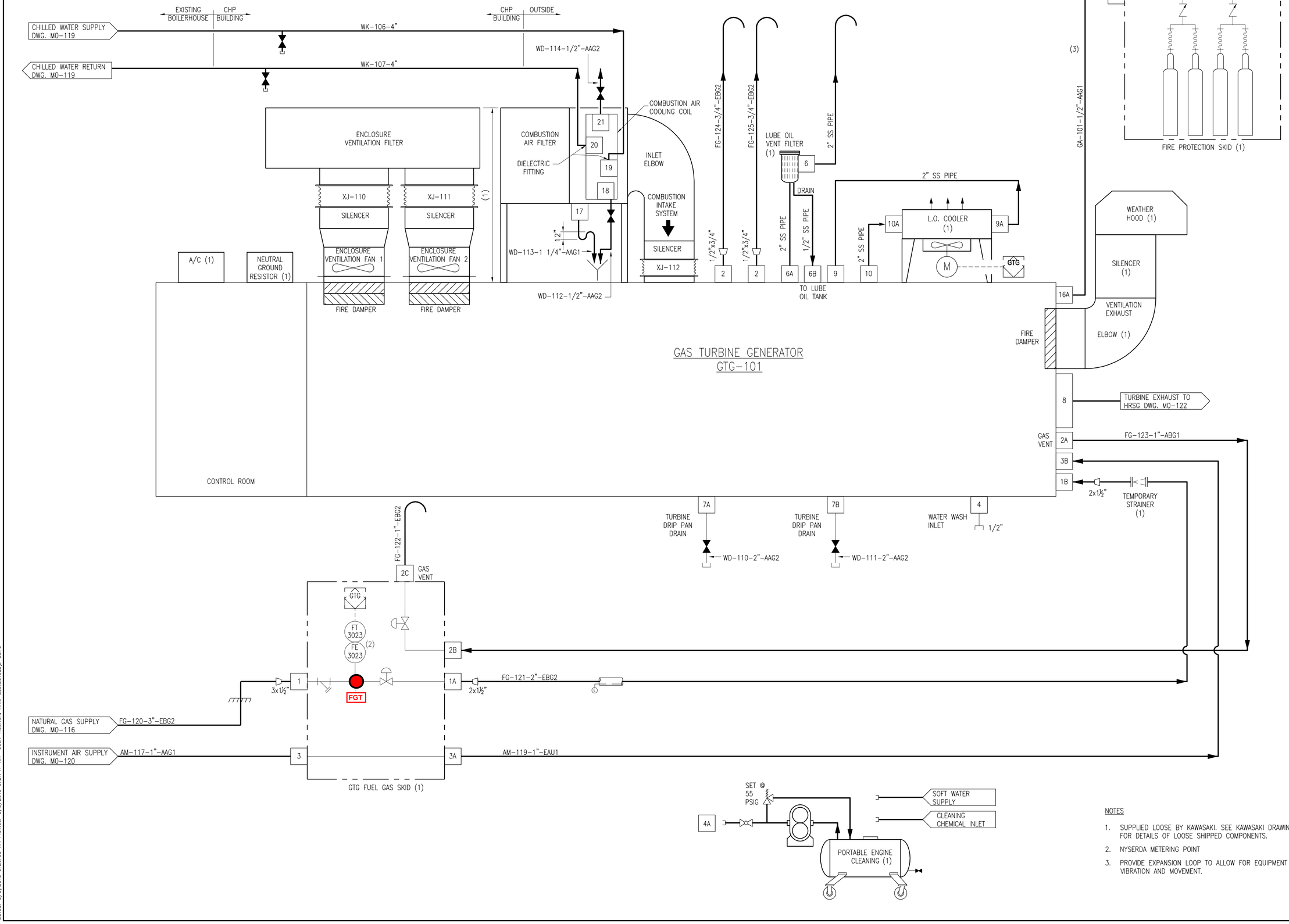

NOTES

1. SUPPLIED LOOSE BY KAWASAKI. SEE KAWASAKI DRAWINGS FOR DETAILS OF LOOSE SHIPPED COMPONENTS.
2. NYSERDA METERING POINT
3. PROVIDE EXPANSION LOOP TO ALLOW FOR EQUIPMENT VIBRATION AND MOVEMENT.

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00	ISSUED FOR CONSTRUCTION	AB	AK	20150506

P&ID
GAS TURBINE GENERATOR

Designed By:	Drawn By:	Checked By:
	SR	AB
Issue Date:	Project No:	Scale:
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Drawing No.:
M0-111

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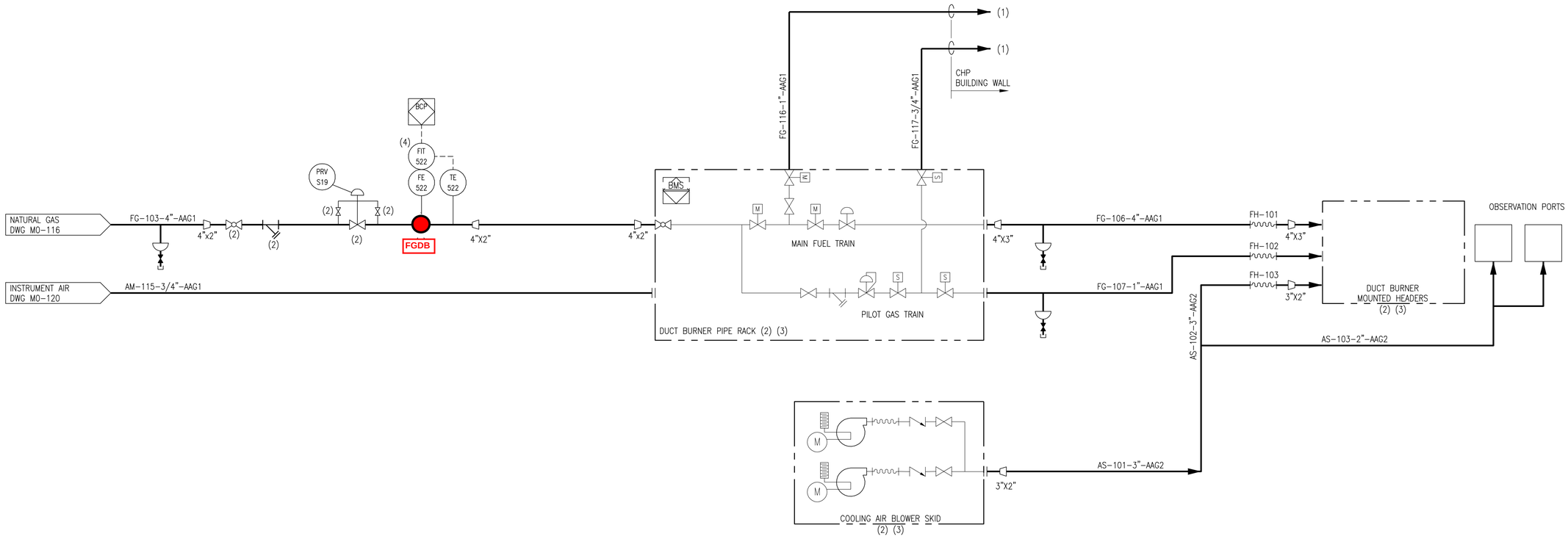

NOTES:

1. ALL NATURAL GAS VENTS SHALL BE VENTED TO ATMOSPHERE AND ROUTED TO A SAFE LOCATION AWAY FROM IGNITION SOURCES, BUILDING AIR INTAKES, COMBUSTION TURBINE INTAKES, ETC.
2. SUPPLIED BY HRSG SUPPLIER
3. REFER TO DUCT BURNER (JOHN ZINK) SUPPLIER DWG 9154245-151 FOR DETAILS OF DUCT BURNER PACKAGE.
4. NYSERDA METERING POINT

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P&ID
NATURAL GAS SYSTEM -
DUCT BURNER

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	RM	AB
Issue Date:	Project No:	Scale:
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Drawing No.:

M0-117

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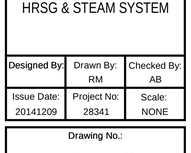

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P&ID
HRSG & STEAM SYSTEM

Designed By:	Drawn By:	Checked By:
	RM	AB
Issue Date:	Project No:	Scale:
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Drawing No.:

M0-112

90 PSIG

CAMPUS DISTRIBUTION CONTROL VALVES

35 PSIG

TO CAMPUS DISTRIBUTION SYSTEM

FI 101 · TI 101 · PI 101 · FIT 101 · TE 101 · FE 101 (3) · TP SL01 · FSDALP

HEATING STEAM TO DEAERATOR DWG M0-114

FI 102 · TI 102 · PI 102 · FIT 102 · TE 102 · FE 102 (3) · TP SM02 · FSDAHP

SM-104-6"-ABG1

TO ABSORPTION CHILLER DWG M0-119

CN-102-3/4"-AAG1

TO CONDENSATE SYSTEM DWG M0-118

8"x10" · TP SM01 · (4)

8"

EXISTING 10" STEAM HEADER (90 PSIG)

TO CONDENSATE SYSTEM · TA

EXISTING BOILER #1

EXISTING BOILER #2

SM-101-10"-ABG1

TA

TA-102

VENT SILENCER (2)

SD-117-6"-ABG1

BCP · PCV 3

SD-118-6"-AAG1

6"x4" (2) · 6"x4" (2)

EXISTING BOILER HOUSE

CHP BUILDING

SM-103-1/2"-FCG1

TO SAMPLE SYSTEM DWG M0-115

BCP · PI 1 · FC 1 · TI 1

SD-105-12"-AAG1

PSV 106 · SET @ 200 psig · DRAIN

SD-101-6"-AAG1 · SD-102-6"-AAG1 · SD-116-1"-AAG1

CN-131-3/4"-AAG1

TO CONDENSATE SYSTEM DWG M0-118 · TA · TA-118

TO CONDENSATE SYSTEM DWG M0-118 · CN-130-3/4"-AAG1 · TA · TA-117

(2) (3) FIT 1 · (2) (3) FE 1 · FS, PS, TS

TO LP STEAM DWG M0-113 · SM-102-1"-ABG1

ECC. RD. 10"x8" · ECC. RD. 8"x8" · SM-101-8"-ABG1

TO CONDENSATE SYSTEM DWG M0-118 · CN-101-3/4"-AAG1 · TA · TA-101

PSV 1 · SET @ 130 PSIG · DRAIN

PSV 2 · SET @ 135 PSIG · DRAIN

TG 8 · TG 7 · LCV 1 · BCP

FC 2 · BCP · FIT 2 · (2) (3) · FE 2

SLUDGE CONDITIONER DWG M0-121 · XA-101-1/2"-FCG1 · 3/4"x1/2"

STEAM DRUM

WF-108-3"-ABG1

FEEDWATER SUPPLY DWG M0-114 · FFW

TO SAMPLE SYSTEM DWG M0-115 · SD-110-1/2"-FCG1

HRSG-102 (1)

PSV 6 · SET @ 250 PSIG

TO BLOWDOWN TANK DWG M0-115 · CONTINUOUS BLOWDOWN · SD-108-3/4"-ABG1 · 3/4"x1/2"

MUD DRUM

ECONOMIZER

HEAT RECOVERY STEAM GENERATOR PACKAGE

SD-104-2"-AAG1

TO BLOWDOWN TANK DWG M0-115

MISC. HRSG INSTRUMENT & EQUIPMENT DRAIN

2"x1 1/2"

TO BLOWDOWN TANK DWG M0-115 · INTERMITTENT BLOWDOWN · SD-107-2"-ABG1

NOTES:

1. REFER TO HRSG SUPPLIER P&ID 14-22-21 FOR HRSG PIPING, INSTRUMENTS, VENTS & DRAINS.
2. SUPPLIED LOOSE BY HRSG SUPPLIER
3. NYSERDA METERING POINT
4. EXISTING FLANGED CONNECTION PREVIOUSLY USED FOR DEMOLISHED STEAM TURBINE GENERATOR TO BE REMOVED FOR NEW STEAM LINE CONNECTION

LEGEND

EXISTING

TP XXX — TIE-POINT

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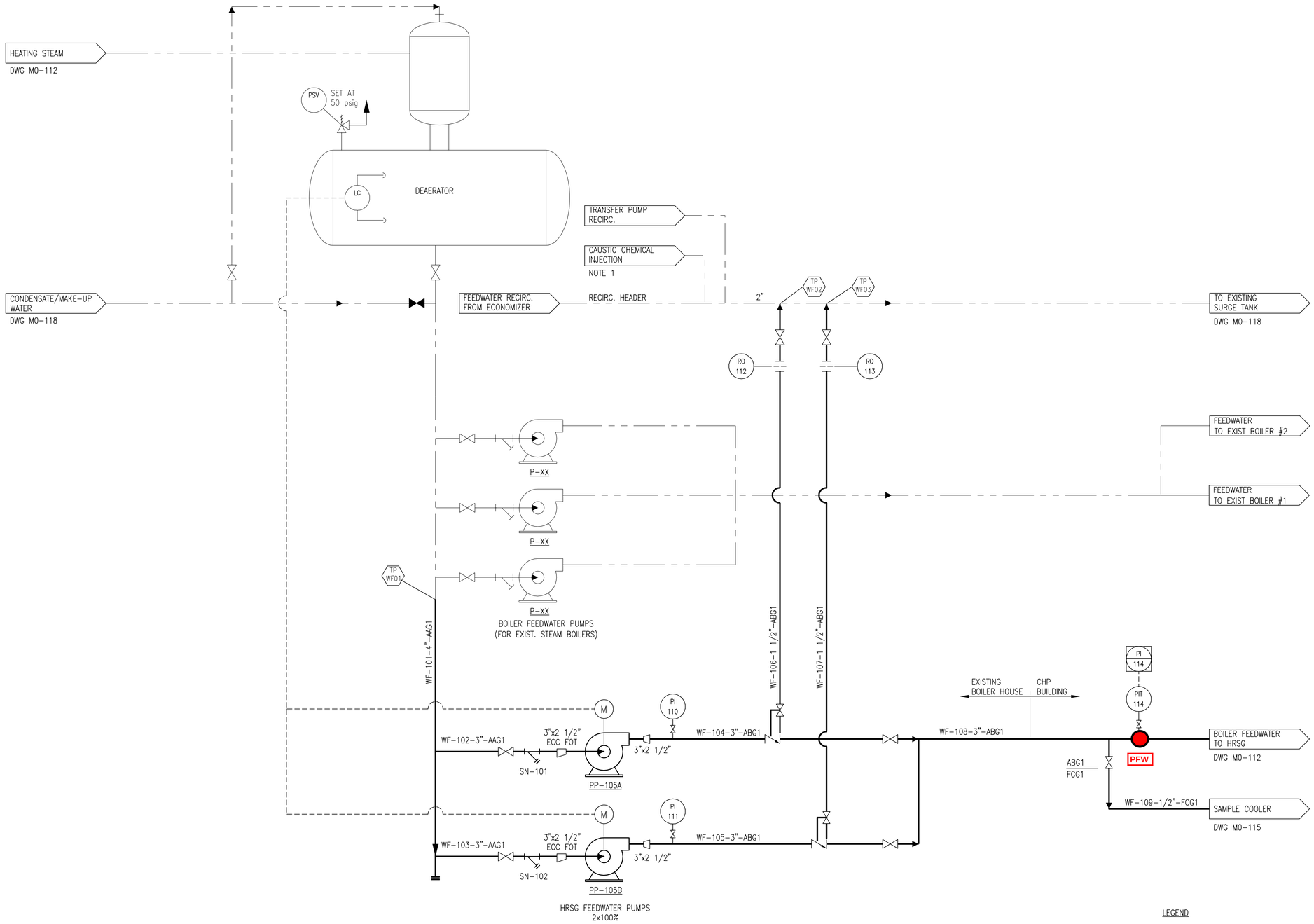

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00	ISSUED FOR CONSTRUCTION	AB	AK	20150506

P&ID
FEEDWATER SYSTEM

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CONDENSATE SYSTEM

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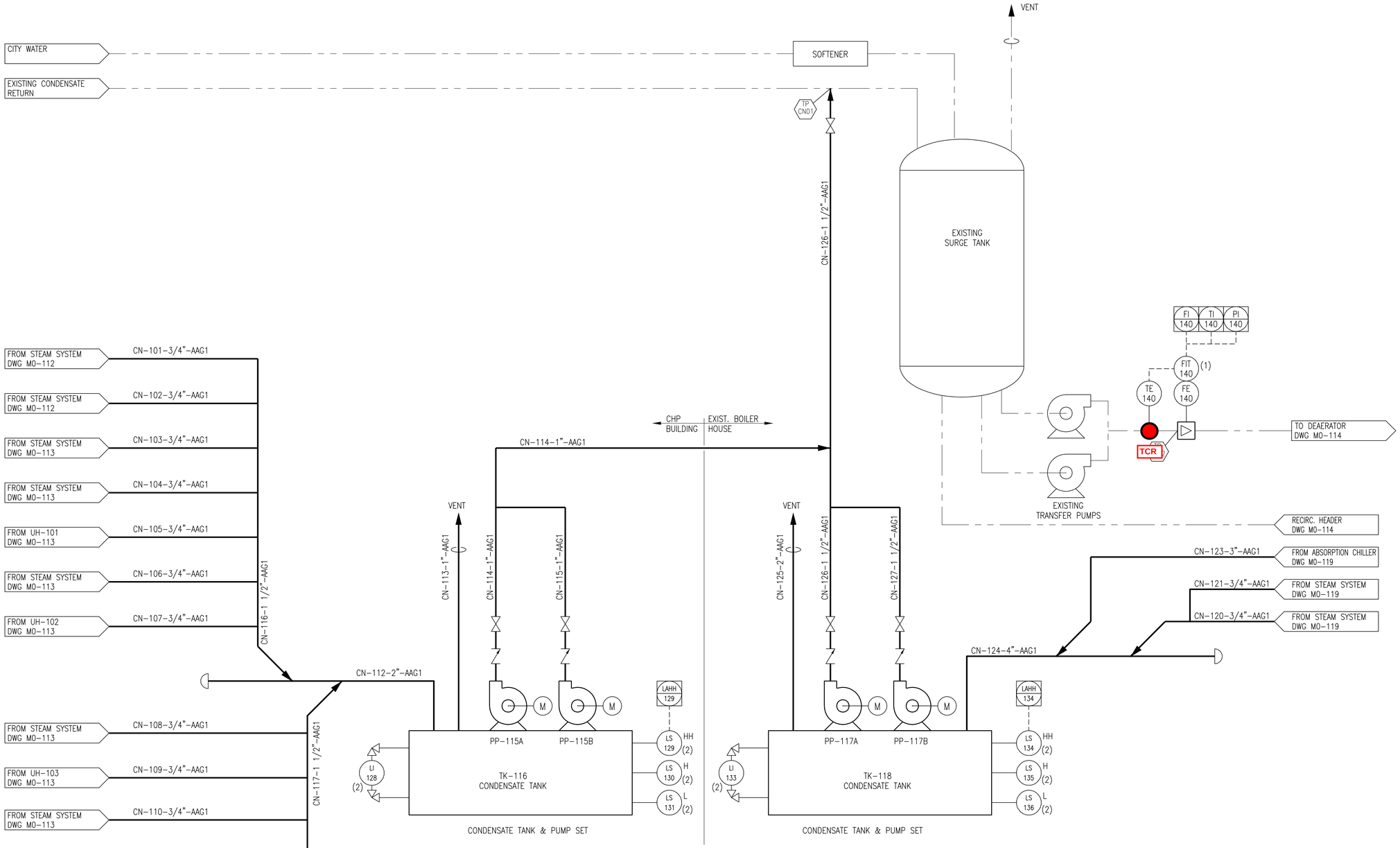
Drawing No.:
M0-118



LEGEND

——— – – – ——— EXISTING

TP XXX TIE-POINT

NOTES:

1. NYSERDA METERING POINT
2. SUPPLIED LOOSE BY CONDENSATE TANK SUPPLIER

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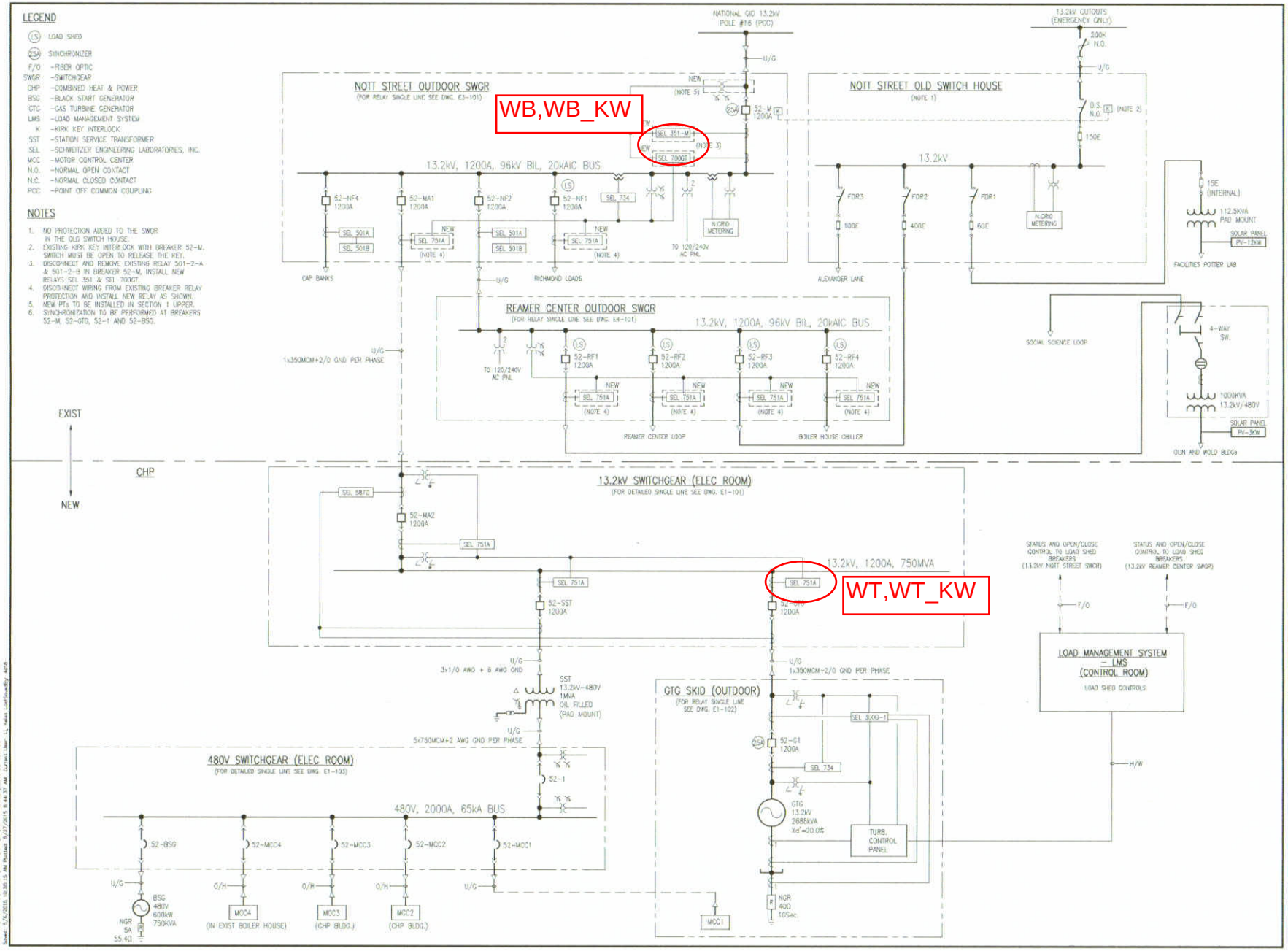

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00	ISSUED FOR CONSTRUCTION	SK	HL	20150626

ELECTRICAL SINGLE LINE DIAGRAM LMS OVERALL

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Issue Date	Project No.	Scale
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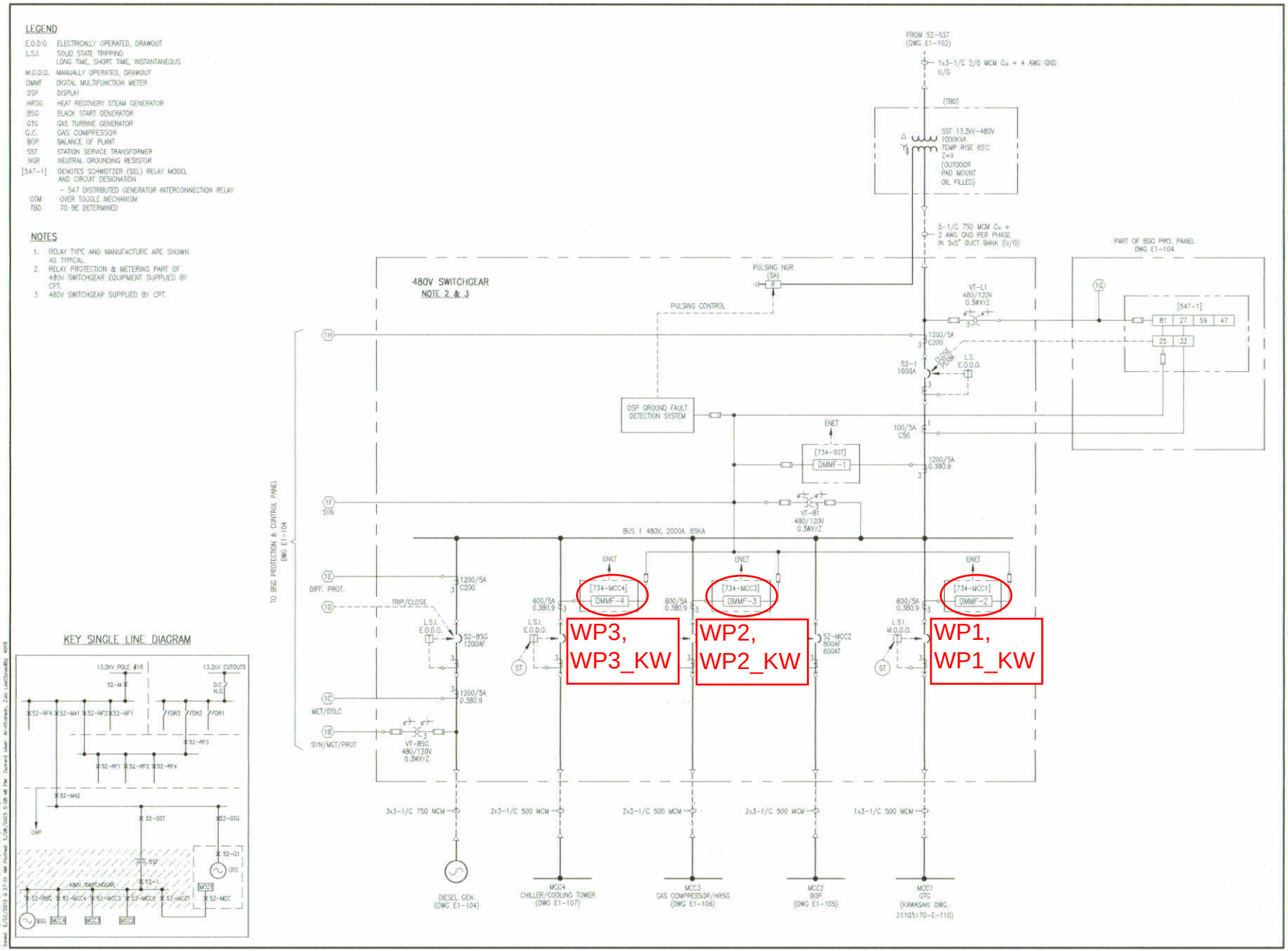
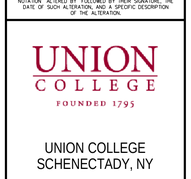
E0-101


LEGEND
E.O.D.O. ELECTRICALLY OPERATED, DRAWOUT
L.S.I. SOLID STATE TRIPPING
LONG TIME, SHORT TIME, INSTANTANEOUS
M.O.D.O. MANUALLY OPERATED, DRAWOUT
DMMF DIGITAL MULTIFUNCTION METER
DSP DISPLAY
HRSG HEAT RECOVERY STEAM GENERATOR
BSG BLACK START GENERATOR
GTG GAS TURBINE GENERATOR
G.C. GAS COMPRESSOR
BOP BALANCE OF PLANT
SST STATION SERVICE TRANSFORMER
NGR NEUTRAL GROUNDING RESISTOR
[547-1] DENOTES SCHWEITZER (SEL) RELAY MODEL AND CIRCUIT DESIGNATION
- 547 DISTRIBUTED GENERATOR INTERCONNECTION RELAY
OTM OVER TOGGLE MECHANISM
TBD TO BE DETERMINED
NOTES
1. RELAY TYPE AND MANUFACTURE ARE SHOWN AS TYPICAL.
2. RELAY PROTECTION & METERING PART OF 480V SWITCHGEAR EQUIPMENT SUPPLIED BY CPT.
3. 480V SWITCHGEAR SUPPLIED BY CPT.
KEY SINGLE LINE DIAGRAM
FROM 52-SST (DWG E1-102)
1x3-1/C 2/0 MCM Cu + 4 AWG GND U/G
SST 13.2kV-480V 1000kVA TEMP RISE 65°C Z=X (OUTDOOR PAD MOUNT OIL FILLED)
5-1/C 750 MCM Cu + 2 AWG GND PER PHASE IN 3x24" DUCT BANK (U/G)
480V SWITCHGEAR NOTE 2 & 3
PULSING NGR (5A)
PULSING CONTROL
PART OF BSG PRO. PANEL DWG E1-104
VT-L1 480/120V 0.3WXYZ
1200/5A C200
52-1 1600A
L.S. E.O.D.O.
DSP GROUND FAULT DETECTION SYSTEM
100/5A C50
[734-SST] DMMF-1
1200/5A 0.3B0.9
VT-B1 480/120V 0.3WXYZ
BUS 1 480V, 2000A, 65KA
TO BSG PROTECTION & CONTROL PANEL DWG E1-104
DIFF. PROT.
TRIP/CLOSE
MCT/DSLC
SYN/MCT/PROT
VT-BSG 480/120V 0.3WXYZ
52-BSG 1200AF
52-MCC2 800AF 600AT
[734-MCC4] DMMF-4
[734-MCC3] DMMF-3
[734-MCC1] DMMF-2
600/5A 0.3B0.9
WP3, WP3_KW
WP2, WP2_KW
WP1, WP1_KW
3x3-1/C 750 MCM
2x3-1/C 500 MCM
1x3-1/C 500 MCM
DIESEL GEN. (DWG E1-104)
MCC4 CHILLER/COOLING TOWER (DWG E1-107)
MCC3 GAS COMPRESSOR/HRSG (DWG E1-106)
MCC2 BOP (DWG E1-105)
MCC1 GTG (KAWASAKI DWG. 21105170-E-110)
CHA
COGEN POWER TECHNOLOGIES
BETTE & CRING CONSTRUCTION GROUP
UNION COLLEGE
UNION COLLEGE SCHENECTADY, NY
COMBINED HEAT & POWER PROJECT
ELECTRICAL SINGLE LINE DIAGRAM CHP 480V SWGR
Drawing No.
E1-103

CHA
111 Winners Circle, PO Box 5269
Albany, NY 12205-0269
518.453.4500 www.chacompanies.com

COGEN POWER TECHNOLOGIES

BETTE & CRING CONSTRUCTION GROUP



UNION COLLEGE
FOUNDED 1795

UNION COLLEGE
SCHENECTADY, NY

COMBINED
HEAT & POWER
PROJECT

No.	Submittal / Revision	App'd.	By	Date
00	ISSUED FOR CONSTRUCTION	AB	AK	20150506

P&ID
CHILLER & COOLING
TOWER SYSTEM

Designed By:	Drawn By:	Checked By:
	RM	AB
Issue Date:	Project No:	Scale:
20141209	28341	NONE

Drawing No.:
M0-119

Appendix B - Cut Sheets for Key Sensors and Instruments

SEL-751A Feeder Protection Relay

Major Features and Benefits

The SEL-751A Feeder Protection Relay provides an exceptional combination of protection, monitoring, control, and communication in an industrial package.

- **Standard Protection Features**. Protect lines and equipment with phase, negative-sequence, residual-ground, and neutral-ground overcurrent elements. Implement load shedding and other control schemes with current-based over- and underfrequency and breaker failure protection for one three-pole breaker.
- **Optional Arc-Flash Protection**. Use the SEL-751A with optional four-channel fiber-optic arc-flash detector inputs and protection elements. Settable arc-flash phase and neutral overcurrent elements combined with arc-flash light detection elements provide secure, reliable, and fast acting arc-flash event protection.
- **Optional Protection Features**. Use the SEL-751A with one of the voltage input options to provide over- and underfrequency, rate-of-change of frequency, fast rate-of-change of frequency (for Aurora vulnerability mitigation), measured residual current input CT, over- and undervoltage, synchronism-check, dc station battery monitor, arc-flash, power elements, and demand metering elements.
- **Operator Controls and Reclosing**. Easy tripping and closing of the breaker with four programmable front-panel pushbuttons. Implement remote and local control functions, and selectively reclose with synchronism and voltage checks (optional).
- **Relay and Logic Settings Software**. ACSELERATOR QuickSet® SEL-5030 Software reduces engineering costs for relay settings and logic programming. Tools in ACSELERATOR QuickSet make it easy to develop SELOGIC® control equations.
- **Metering and Monitoring**. Use built-in metering functions to eliminate separately mounted metering devices. Analyze Sequential Events Recorder (SER) reports and oscillographic event reports for rapid commissioning, testing, and post-fault diagnostics. Unsolicited SER protocol allows station-wide collection of binary SER messages. The arc-flash detection option provides light metering and event reports for commissioning and arc-flash event capture for analysis.
- **Wye or Delta Voltage Inputs**. Optional voltage inputs allow for either wye-connected, open-delta-connected, or single voltage inputs to the relay.
- **Additional Standard Features**. The SEL-751A also includes Modbus® RTU, Event Messenger support, MIRRORED BITS® communications, load profile, breaker wear monitoring, support for 12 external RTDs (SEL-2600), IRIG-B input, advanced SELOGIC, and IEEE C37.118-compliant synchrophasor protocol.
- **Optional Features**. Select from a wide offering of optional features, including IEC 61850, DNP3 serial and LAN/WAN, Modbus TCP/IP, Simple Network Time Protocol (SNTP), 10 internal RTDs, expanded digital/analog I/O, voltage inputs, arc-flash fiber-optic inputs, additional EIA-232 or EIA-485 communication ports, fiber-optic serial port, single or dual, copper-wire or fiber-optic Ethernet ports, and configurable labels.

Specifications

Compliance

ISO 9001:2008 Certified

UL, cUL*:	Protective Relay Category NRGU, NRGU7 per UL 508, C22.2 No. 14

* UL has not yet developed requirements for products intended to detect and mitigate an arc flash; consequently, UL has not evaluated the performance of this feature. While UL is developing these requirements, it will place no restriction on the use of this product for arc-flash detection and mitigation. For test results performed by an independent laboratory and other information on the performance and verification of this feature, please contact SEL customer service.

CSA:	C22.2 No. 61010-1
CE:	CE Mark–EMC Directive Low Voltage Directive IEC 61010-1:2001 IEC 60947-1 IEC 60947-4-1 IEC 60947-5-1
Hazardous Locations Approvals:	Complies with UL 1604, ISA 12.12.01, CSA 22.2 No. 213, and EN 60079-15 (Class I, Division 2).

General

AC Current Input

Phase, Neutral, and Residual Currents

I_{NOM} = 1 A, 5 A, 50 mA, or 2.5 mA (high sensitivity) secondary depending on model.

INOM = 5 A

Continuous Rating:	15 A, linear to 100 A symmetrical
1 Second Thermal	500 A
Burden (Per Phase):	< 0.1 VA @ 5 A

INOM = 1 A

Continuous:	3 A, linear to 20 A symmetrical
1 Second Thermal	100 A
Burden (Per Phase):	< 0.01 VA @ 1 A

INOM = 50 mA

Continuous Rating:	3 A, linear to 1000.0 mA symmetrical
1 Second Thermal	100 A
Burden (Per Phase):	< 2 mVA @ 50 mA

INOM = 2.5 mA

Continuous Rating:	3 A, linear to 12.50 mA symmetrical
1 Second Thermal	100 A
Burden (Per Phase):	< 0.1 mVA @ 2.5 mA
Measurement Category:	II

AC Voltage Inputs

VNOM (L-L) Setting Range:	20–250 V (if DELTA_Y := DELTA) 20–440 V (if DELTA_Y := WYE)
Rated Continuous Voltage:	300 Vac
10 Second Thermal:	600 Vac
Burden:	< 0.1 VA
Input Impedance:	10 MΩ differential (phase-phase) 5 MΩ common mode (phase-chassis)

Power Supply

125/250 Vdc or 120/240 Vac

Rated Supply Voltage:	110–240 Vac, 50/60 Hz 110–250 Vdc
Input Voltage Range:	85–264 Vac 85–300 Vdc
Power Consumption:	< 40 VA (ac) < 20 W (dc)
Interruptions:	50 ms @ 125 Vac/Vdc 100 ms @ 250 Vac/Vdc

24/48 Vdc

Rated Supply Voltage:	24–48 Vdc
Input Voltage Range:	19.2–60 Vdc
Power Consumption:	< 20 W (dc)
Interruptions:	10 ms @ 24 Vdc 50 ms @ 48 Vdc

Output Contacts

General

OUT103 is Form C Trip output, all other outputs are Form A, except for the SELECT 4 DI/3 DO card, which supports one Form B and two Form C outputs.

Mechanical Durability:	100,000 no load operations
Pickup/Dropout Time:	≤ 8 ms (coil energization to contact closure)

DC Output Ratings

Rated Operational Voltage:	250 Vdc
Rated Voltage Range:	19.2–275 Vdc
Rated Insulation Voltage:	300 Vdc
Make:	30 A @ 250 Vdc per IEEE C37.90
Continuous Carry:	6 A @ 70°C 4 A @ 85°C
Thermal:	50 A for 1 s
Contact Protection:	360 Vdc, 40 J MOV protection across open contacts

Breaking Capacity (10,000 Operations) per IEC 60255-0-20:1974:

24 Vdc	0.75 A	L/R = 40 ms
48 Vdc	0.50 A	L/R = 40 ms
125 Vdc	0.30 A	L/R = 40 ms
250 Vdc	0.20 A	L/R = 40 ms

Cyclic (2.5 Cycles/Second) per IEC 60255-0-20:1974:

24 Vdc	0.75 A	L/R = 40 ms
48 Vdc	0.50 A	L/R = 40 ms
125 Vdc	0.30 A	L/R = 40 ms
250 Vdc	0.20 A	L/R = 40 ms

AC Output Ratings

Maximum Operational Voltage (U_e) Rating:	240 Vac
Insulation Voltage (U_i) Rating (Excluding EN 61010-1):	300 Vac

Utilization Category:	AC-15 (control of electromagnetic loads > 72 VA)
Contact Rating Designation:	B300 (B = 5 A, 300 = rated insulation voltage)
Voltage Protection Across Open Contacts:	270 Vac, 40 J
Rated Operational Current (I_e):	3 A @ 120 Vac 1.5 A @ 240 Vac
Conventional Enclosed Thermal Current (I_{the}) Rating:	5 A
Rated Frequency:	50/60 ±5 Hz
Electrical Durability Make VA Rating:	3600 VA, cos ϕ = 0.3
Electrical Durability Break VA Rating:	360 VA, cos ϕ = 0.3

UL/CSA Digital Output Contact Temperature Derating for Operating at Elevated Temperatures

Digital Output Cards Installed	Operating Ambient	Maximum Value of Current (I_{the})	Duty Factor
1–3	less than or equal to 60°C	5.0 A	Continuous
1–3	between 60°C and 70°C	2.5 A	Continuous

Fast Hybrid (High-Speed, High-Current Interrupting)

Make:	30 A
Carry:	6 A continuous carry at 70°C 4 A continuous carry at 85°C
1 s Rating:	50 A
Open State Leakage Current:	< 100 µA
MOV Protection (Maximum Voltage):	250 Vac/330 Vdc
Pickup Time:	< 50 µs, resistive load
Dropout Time:	< 8 ms, resistive load

Break Capacity (10000 Operations):

48 Vdc	10.0 A	L/R = 40 ms
125 Vdc	10.0 A	L/R = 40 ms
250 Vdc	10.0 A	L/R = 20 ms

Cyclic Capacity (4 cycles in 1 second, followed by 2 minutes idle for thermal dissipation):

48 Vdc	10.0 A	L/R = 40 ms
125 Vdc	10.0 A	L/R = 40 ms
250 Vdc	10.0 A	L/R = 20 ms

NOTE: Per IEC 60255-23:1994, using the simplified method of assessment.
NOTE: Make rating per IEEE C37.90-1989.

Optoisolated Control Inputs

When Used With DC Control Signals

250 V:	ON for 200–312.5 Vdc OFF below 150 Vdc
220 V:	ON for 176–275 Vdc OFF below 132 Vdc
125 V:	ON for 100–156.2 Vdc OFF below 75 Vdc
110 V:	ON for 88–137.5 Vdc OFF below 66 Vdc
48 V:	ON for 38.4–60 Vdc OFF below 28.8 Vdc
24 V:	ON for 15–30 Vdc OFF for < 5 Vdc

When Used With AC Control Signals

250 V:	ON for 170.6–312.5 Vac OFF below 106 Vac
220 V:	ON for 150.2–275 Vac OFF below 93.3 Vac
125 V:	ON for 85–156.2 Vac OFF below 53 Vac
110 V:	ON for 75.1–137.5 Vac OFF below 46.6 Vac
48 V:	ON for 32.8–60 Vac OFF below 20.3 Vac
24 V:	ON for 14–30 Vac OFF below 5 Vac
Current Draw at Nominal DC Voltage:	2 mA (at 220–250 V) 4 mA (at 48–125 V) 10 mA (at 24 V)
Rated Impulse Withstand Voltage (U_{imp}):	4000 V

Analog Output (Optional)

	1A0	4A0
Current:	4–20 mA	±20 mA
Voltage:	—	±10 V
Load at 1 mA:	—	0–15 kΩ
Load at 20 mA:	0–300 Ω	0–750 Ω
Load at 10 V:	—	> 2000 Ω
Refresh Rate:	100 ms	100 ms
% Error, Full Scale, at 25°C:	< ±1%	< ±0.55%
Select From:	Analog quantities available in the relay	

Analog Inputs (Optional)

Maximum Input Range:	±20 mA ±10 V Operational range set by user
Input Impedance:	200 Ω (current mode) >10 kΩ (voltage mode)
Accuracy at 25°C:	
With User Calibration:	0.05% of full scale (current mode) 0.025% of full scale (voltage mode)
Without User Calibration:	Better than 0.5% of full scale at 25°C
Accuracy Variation With Temperature:	±0.015% per °C of full-scale (±20 mA or ±10 V)

Arc-Flash Detectors (Optional)

Multimode fiber-optic receiver/transmitter pair

Fiber Type:	1000 µm diameter, 640 nm wavelength, plastic, clear-jacketed or black-jacketed
Connector Type:	V-Pin

Frequency and Phase Rotation

System Frequency:	50, 60 Hz
Phase Rotation:	ABC, ACB
Frequency Tracking:	15–70 Hz

Time-Code Input

Format:	Demodulated IRIG-B
On (1) State:	$V_{ih} \geq 2.2$ V
Off (0) State:	$V_{il} \leq 0.8$ V
Input Impedance:	2 kΩ

Synchronization Accuracy

Internal Clock:	±1 µs
Synchrophasor Reports (e.g., **MET PM**):	±10 µs
All Other Reports:	±5 ms

Simple Network Time Protocol (SNTP) Accuracy

Internal Clock:	±5 ms
Unsynchronized Clock Drift Relay Powered:	2 minutes per year, typically

Communications Ports

Standard EIA-232 (2 Ports)

Location:	Front Panel Rear Panel
Data Speed:	300–38400 bps

EIA-485 Port (Optional)

Location:	Rear Panel
Data Speed:	300–19200 bps

Ethernet Port (Optional)

Single/Dual 10/100BASE-T copper (RJ45 connector)
Single/Dual 100BASE-FX (LC connector)

Multimode Fiber-Optic Port (Optional)

Location:	Rear panel
Data Speed:	300–38400 bps

Fiber-Optic Ports Characteristics

Port 1 (or 1A, 1B) Ethernet

Wavelength:	1300 nm
Optical Connector Type:	LC
Fiber Type:	Multimode
Link Budget:	16.1 dB
Typical TX Power:	–15.7 dBm
RX Min. Sensitivity:	–31.8 dBm
Fiber Size:	62.5/125 µm
Approximate Range:	~6.4 Km
Data Rate:	100 Mb
Typical Fiber Attenuation:	–2 dB/Km

Port 2 Serial

Wavelength:	820 nm
Optical Connector Type:	ST
Fiber Type:	Multimode
Link Budget:	8 dB
Typical TX Power:	–16 dBm
RX Min. Sensitivity:	–24 dBm
Fiber Size:	62.5/125 µm
Approximate Range:	~1 Km
Data Rate:	5 Mb
Typical Fiber Attenuation:	–4 dB/Km

Channels 1-4 Arc-Flash Detectors (AFDI)

Wavelength:	640 nm
Optical Connector Type:	V-Pin
Fiber Type:	Multimode
Link Budget:	27 dB
Typical TX Power:	–12 dBm
RX Min. Sensitivity:	–39 dBm
Fiber Size:	1000 µm
Approximate Range:	To 35 m (Point Sensor) To 70 m (Clear-Jacketed Fiber Sensor)
Data Rate:	NA
Typical Fiber Attenuation:	–0.15 dB/m

Optional Communications Cards

Option 1:	EIA-232 or EIA-485 communications card
Option 2:	DeviceNet communications card

Communications Protocols

SEL, Modbus, DNP3, FTP, TCP/IP, Telnet, SNTP, IEC 61850, MIRRORED BITS, EVMSG, C37.118 (synchrophasors) and DeviceNet.

Operating Temperature

IEC Performance Rating (Per IEC/EN 60068-2-1 & 60068-2-2):	–40° to +85°C (–40° to +185°F)

NOTE: Not applicable to UL applications.
NOTE: LCD contrast impaired for temperatures below –20°C and above +70°C.

DeviceNet Communications Card Rating:	+60°C (140°F) maximum

Operating Environment

Pollution Degree:	2
Overvoltage Category:	II
Atmospheric Pressure:	80–110 kPa
Relative Humidity:	5–95%, noncondensing
Maximum Altitude:	2000 m

Dimensions

144.0 mm (5.67 in.) x 192.0 mm (7.56 in.) x 147.4 mm (5.80 in.)

Weight

2.7 kg (6.0 lbs)

Relay Mounting Screws (#8-32) Tightening Torque

Minimum:	1.4 Nm (12 in-lb)
Maximum:	1.7 Nm (15 in-lb)

Terminal Connections

Terminal Block

Screw Size:	#6
Ring Terminal Width:	0.310” maximum

Terminal Block Tightening Torque

Minimum:	0.9 Nm (8 in-lb)
Maximum:	1.4 Nm (12 in-lb)

Compression Plug Tightening Torque

Minimum:	0.5 Nm (4.4 in-lb)
Maximum:	1.0 Nm (8.8 in-lb)

Compression Plug Mounting Ear Screw Tightening Torque

Minimum:	0.18 Nm (1.6 in-lb)
Maximum:	0.25 Nm (2.2 in-lb)

Type Tests

Environmental Tests

Enclosure Protection:	IEC 60529:2001 + CRDG:2003 IP65 enclosed in panel IP20 for terminals IP54 rated terminal dust protection assembly (SEL Part #915900170). 10°C temperature derating applies to the temperature specifications of the relay.
Vibration Resistance:	IEC 60068-2-6:2007 3 G, 10–150 Hz IEC 60255-21-1:1988, Class 1 IEC 60255-21-3:1993, Class 2
Shock Resistance:	IEC 60255-21-2:1988, Class 1
Cold:	IEC 60068-2-1:2007 –40°C, 16 hours
Damp Heat, Steady State:	IEC 60068-2-78:2001 40°C, 93% relative humidity, 4 days
Damp Heat, Cyclic:	IEC 60068-2-30:2005 25–55°C, 6 cycles, 95% relative humidity
Dry Heat:	IEC 60068-2-2:2007 85°C, 16 hours

Dielectric Strength and Impulse Tests

Dielectric (HiPot):	IEC 60255-5:2000 IEEE C37.90-2005 2.5 kVac on current inputs, ac voltage inputs, contact I/O 2.0 kVac on analog inputs 1.0 kVac on analog outputs 2.83 kVdc on power supply
Impulse:	IEC 60255-5:2000 IEEE C37.90-2005 0.5 J, 4.7 kV on power supply, contact I/O, ac current and voltage inputs 0.5 J, 530 V on analog outputs

RFI and Interference Tests

EMC Immunity

Electrostatic Discharge Immunity:	IEC 61000-4-2:2008 IEC 60255-22-2:2008 Severity Level 4 8 kV contact discharge 15 kV air discharge
Radiated RF Immunity:	IEC 61000-4-3:2010 IEC 60255-22-3:2007 10 V/m IEEE C37.90.2-2004 35 V/m
Digital Radio Telephone RF Immunity:	ENV 50204:1995
Fast Transient, Burst Immunity:	IEC 61000-4-4:2004 IEC 60255-22-4:2008 4 kV @ 5.0 kHz 2 kV @ 5.0 kHz for comm. ports
Surge Immunity:	IEC 61000-4-5:2005 IEC 60255-22-5:2008 2 kV line-to-line 4 kV line-to-earth
Surge Withstand Capability Immunity:	IEC 60255-22-1:2007 2.5 kV common mode 1 kV differential mode 1 kV common mode on comm. ports IEEE C37.90.1-2002 2.5 kV oscillatory 4 kV fast transient
Conducted RF Immunity:	IEC 61000-4-6:2008 IEC 60255-22-6: 2001 10 Vrms
Magnetic Field Immunity:	IEC 61000-4-8:2009 1000 A/m for 3 seconds 100 A/m for 1 minute IEC 61000-4-9: 2001 1000 A/m
Power Supply Immunity:	IEC 60255-11:2008

EMC Emissions

Conducted Emissions:	EN 55011:1998, Class A IEC 60255-25:2000
Radiated Emissions:	EN 55011:1998, Class A IEC 60255-25:2000

Electromagnetic Compatibility

Product Specific:	EN 50263:1999

Processing Specifications and Oscillography

AC Voltage and Current Inputs:	16 samples per power system cycle
Frequency Tracking Range:	15–70 Hz
Digital Filtering:	One-cycle cosine after low-pass analog filtering. Net filtering (analog plus digital) rejects dc and all harmonics greater than the fundamental.
Protection and Control Processing:	Processing interval is 4 times per power system cycle (except for math variables and analog quantities, which are processed every 100 ms)
Arc-Flash Processing:	Arc-flash light is sampled 32 times per cycle. Arc-flash current, light, and 2 fast hybrid outputs are processed 16 times per cycle.

Oscillography

Length:	15 or 64 cycles
Sampling Rate:	16 samples per cycle, unfiltered 4 samples per cycle, filtered
Trigger:	Programmable, using Boolean expressions
Format:	ASCII and Compressed ASCII
Time-Stamp Resolution:	1 ms
Time-Stamp Accuracy:	±5 ms

Sequential Events Recorder

Time-Stamp Resolution:	1 ms
Time-Stamp Accuracy (With Respect to Time Source):	±5 ms

Relay Elements

Instantaneous/Definite-Time Overcurrent (50P, 50G, 50N, 50Q)

Pickup Setting Range, A Secondary

5 A Models:	0.50–100.00 A, 0.01 A steps
1 A Models:	0.10–20.00 A, 0.01 A steps
50 mA Models:	5.0–1000.0 mA, 0.1 mA steps
2.5 mA Models:	0.13–12.50 mA, 0.01 mA steps

(The 50N elements in the 2.5 mA and 50 mA models have a built-in 30 ms security qualifier time delay.)

Accuracy:	±5% of setting plus ±0.02 • I_{NOM} A secondary (steady-state pickup)
Time Delay:	0.00–5.00 seconds, 0.01 seconds steps
Pickup/Dropout Time:	<1.5 cycles

Arc-Flash Instantaneous Overcurrent (50PAF, 50NAF)

Pickup Setting Range, A Secondary

5 A Models:	0.50–100.00 A, 0.01 A steps
1 A Models:	0.10–20.00 A, 0.01 A steps
Accuracy:	0 to +10% of setting plus ±0.02 • I_{NOM} A secondary (steady-state pickup)
Pickup/Dropout Time:	2–5 ms/1 cycle

Arc-Flash Time-Overlight (TOL1–TOL4)

Pickup Setting Range, % of Full Scale:	3.0–20.0% (Point Sensor) 0.6–4.0% (Fiber Sensor)
Pickup/Dropout Time:	2–5 ms/1 cycle

Inverse-Time Overcurrent (51P, 51G, 51N, 51Q)

Pickup Setting Range, A Secondary:

5 A Models:	0.50–16.00 A, 0.01 A steps
1 A Models:	0.10–3.20 A, 0.01 A steps
50 mA Models:	5.0–160.0 mA, 0.1 mA steps
2.5 mA Models:	0.13–2.00 mA, 0.01 mA steps
Accuracy:	±5% of setting plus ±0.02 • I_{NOM} A secondary (steady-state pickup)
Time Dial:	
U.S.:	0.50–15.00, 0.01 steps
IEC:	0.05–1.00, 0.01 steps
Accuracy:	±1.5 cycles, plus ±4% between 2 and 30 multiples of pickup (within rated range of current)

Undervoltage (27)

Vnm := VNOM if DELTA_Y := DELTA;
Vnm := VNOM/1.732 if DELTA_Y := WYE

Setting Range:	Off, 0.02–1.00 • Vnm
Accuracy:	±1% of setting plus ±0.5 V (±5% of setting ±2 V with the *xx*71*xx* card)
Pickup/Dropout Time:	< 1.5 cycles

Overvoltage (59, 59G, 59Q)

Vnm := VNOM if DELTA_Y := DELTA;
Vnm := VNOM/1.732 if DELTA_Y := WYE

Setting Range:	Off, 0.02–1.20 • Vnm
Accuracy:	±1% of setting plus ±0.5 V (± 5% of setting ± 2 V with the *xx*71*xx* card)
Pickup/Dropout Time:	< 1.5 cycles

Power Elements (32)

Instantaneous/Definite Time, 3 Phase Elements Type:	+W, –W, +VAR, –VAR

Pickup Setting Range, VA Secondary:

5 A Models:	1.0–6500.0 VA, 0.1 VA steps
1 A Models:	0.2–1300.0 VA, 0.1 VA steps
Accuracy:	±0.10 A • (L-L voltage secondary) and ±5% of setting at unity power factor for power elements and zero power factor for reactive power elements (5 A nominal) ±0.02 A • (L-L voltage secondary) and ±5% of setting at unity power factor for power elements and zero power factor for reactive power elements (1 A nominal)
Pickup/Dropout Time:	< 10 cycles

Power Factor (55)

Setting Range:	Off, 0.05–0.99
Accuracy:	±5% of full scale for current ≥ 0.5 • I_{NOM}

Frequency (81)

Setting Range:	Off, 20.00–70.00 Hz
Accuracy:	±0.01 Hz (V1 > 60 V) with voltage tracking ±0.05 Hz (I1 > 0.8 • I_{NOM}) with current tracking
Pickup/Dropout Time:	< 4 cycles

Rate-of-Change of Frequency (81R)

Setting Range:	Off, 0.10–15.00 Hz/s
Accuracy:	±100 mHz/s, plus ±3.33% of pickup

Synchronism Check (25)

Pickup Range, Secondary Voltage:	0.00–300.00 V
Pickup Accuracy, Secondary Voltage:	±1% plus ±0.5 volts (over the range of 12.5–300 V)
Slip Frequency Pickup Range:	0.05 Hz–0.50 Hz
Slip Frequency Pickup Accuracy:	±0.05 Hz
Phase Angle Range:	0–80°
Phase Angle Accuracy:	±4°

Synchronism-Check Undervoltage (27S)

Setting Range:	Off, 2.00–300.00 V
Accuracy:	±1% of setting plus ±0.5 V (over the range of 12.5–300 V)
Pickup/Dropout Time:	< 1.5 cycles

Synchronism-Check Overvoltage (59S)

Setting Range:	Off, 2.00–300.00 V
Accuracy:	±1% of setting plus ±0.5 V (over the range of 12.5–300 V)
Pickup/Dropout Time:	< 1.5 cycles

Station Battery Voltage Monitor

Operating Range:	0–350 Vdc (300 Vdc for UL purposes)
Pickup Range:	20.00–300.00 Vdc
Pickup Accuracy:	±2% of setting plus ±2 Vdc

Timers

Setting Range:	Various
Accuracy:	±0.5% of setting plus ±1/4 cycle

RTD Protection

Setting Range:	Off, 1–250°C
Accuracy:	±2°C
RTD Open-Circuit Detection:	> 250°C
RTD Short-Circuit Detection:	< –50°C
RTD Types:	PT100, NT100, NI120, CU10
RTD Lead Resistance:	25 ohm max. per lead
Update Rate:	< 3 s
Noise Immunity on RTD Inputs:	To 1.4 Vac (peak) at 50 Hz or greater frequency
RTD Trip/Alarm Time Delay:	Approx. 6 s

Metering

Accuracies are specified at 20°C, nominal frequency, ac currents within (0.4–20.0) • I_{NOM} A secondary, and ac voltages within 50–250 V secondary unless otherwise noted.

Phase Currents:	±2% of reading, ±2°
3-Phase Average Current:	±2% of reading
Current Imbalance (%):	±2% of reading
IG (Residual Current):	±3% of reading, ±2°
IN (Neutral Current):	±2% of reading, ±2°
3I2 Negative-Sequence Current:	±3% of reading
System Frequency:	±0.01 Hz of reading for frequencies within 20.00–70.00 Hz (V1 > 60 V) with voltage tracking ±0.05 Hz of reading for frequencies within 20.00–70.00 Hz (I1 > 0.8 • I_{NOM}) with current tracking
Line-to-Line Voltages:	±1% of reading (±2% with the *xx*71*xx* card), ±1° for voltages within 24–264 V
3-Phase Average Line-to-Line Voltage:	±1% of reading (±2% with the *xx*71*xx* card) for voltages within 24–264 V
Line-to-Ground Voltages:	±1% of reading (±2% with the *xx*71*xx* card), ±1° for voltages within 24–264 V
3-Phase Average Line-to-Ground Voltages:	±1% of reading (±2% with the *xx*71*xx* card) for voltages within 24–264 V
Voltage Imbalance (%):	±1% of reading (±2% with the *xx*71*xx* card) for voltages within 24–264 V
3V2 Negative-Sequence Voltage:	±3% of reading for voltages within 24–264 V
Real 3-Phase Power (kW):	±5% of reading for 0.10 < pf < 1.00
Reactive 3-Phase Power (kVAR):	±5% of reading for 0.00 < pf < 0.90
Apparent 3-Phase Power (kVA):	±2% of reading
Power Factor:	±2% of reading
RTD Temperatures:	±2°C

Notes

SCHWEITZER ENGINEERING LABORATORIES, INC.
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PDS751A-01

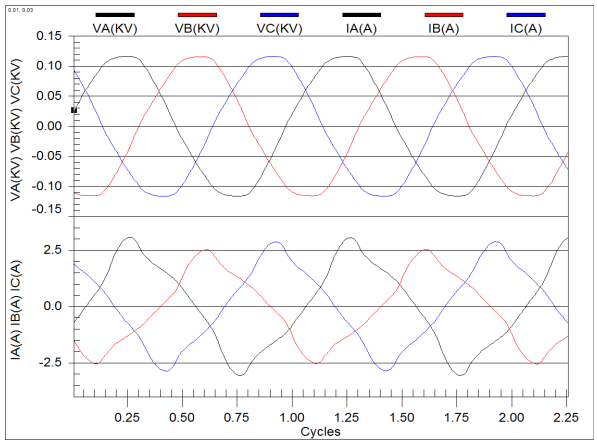
SEL-734 Advanced Metering System

Advanced Power Quality and Revenue Metering

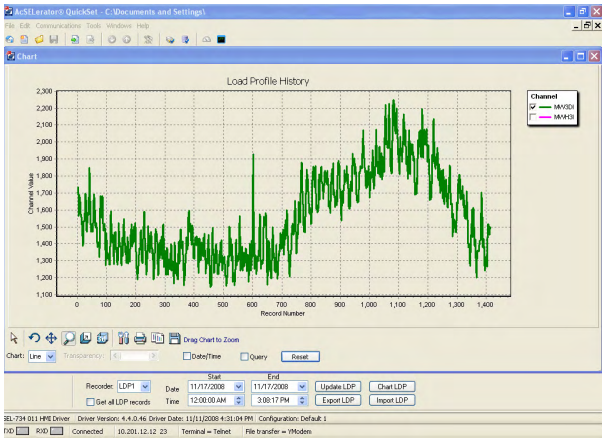
Now With More Memory!

- 32 MB on SEL-734
- 128 MB on SEL-734P

Accurate, comprehensive, and reliable metering for new installations and retrofits.



Use high-resolution waveform capture to analyze interruptions, sags, swells, harmonics, and unbalance.



ACSELERATOR QuickSet LDP and .HHF export tool

Features and Benefits

- **Power Quality Monitoring**
  Record voltage sag/swell/interruption (VSSI) disturbances, monitor harmonics to the 50th order, capture waveforms, measure flicker, and record sequential events.
- **Accurate, Bidirectional Metering**
  Exceeds ANSI C12.20 0.2 and IEC 62053-22 0,2 S accuracy class with bidirectional, full four-quadrant energy metering for generation, interchange, transmission, distribution, or industrial applications.
- **Standard Software Tools**
  Easily configure, test, monitor, and retrieve data using ACSELERATOR QuickSet® SEL-5030 Software. ACSELERATOR QuickSet quickly programs, retrieves, plots, and exports billing data to .HHF or .CSV formats.
- **Time-of-Use (TOU) Metering**
  Provides flexible, time-differentiated energy and demand registers, with multiple day types, rates, seasons, and a 20-year programmable calendar. Automation functions include programmable self-reads and peak demand resets.
- **High-Speed Load Profile Data (LDP) Records**
  Multiple LDP recorders store billing data and power quality data in separate records with a maximum update rate of once every three seconds. ACSELERATOR QuickSet quickly retrieves, plots, and stores load profile data to a laptop computer or remotely over any communications port.
- **Transformer and Line-Loss Compensation**
  Enter transformer nameplate and line impedance information directly into the meter to automatically compensate for transformer or line losses and move the billing point.
- **Complete Automation**
  Customize alarms and automate control based on measured load information using advanced SELOGIC® control equations. Integrate with communications processors for single-point station access.
- **Industry Standard Compliance**
  Fully comply with ANSI and IEC standards with voltage and current ranges of: 57–132 V, 132–277 V; CL2, CL10, CL20, IEC 1 A, 5 A I_{NOM}.

Specifications

Compliance

Designed and manufactured under an ISO 9001 certified quality management system

ANSI C12.20:2002; Class 0.2, CL2, and CL10/CL20
Radiated Emissions: FCC Part 15; Class A

IEC 62053-22:2003; Class 0,2 S

IEC 62052-11; rack-mounted meters

IEC 62053-23:2003; Class 0,2 S

C22.2 No. 61010-1-04

C22.2 No. 142

UL Listed to U.S. and Canadian safety standards (File E220228; NRAQ, NRAQ7, File E475839; NRAG, NRAG7)

ERCOT Compliant

CFG G0000-48-1999 Compliant per LAPEM

CE: Mark–EMC Directive, Low-Voltage Directive

Note: Optional modem not CE compliant.

General

AC Voltage Inputs

Meter Form 9 and Meter Form 5

Maximum Rating:	300 V continuous 600 V for 10 seconds
Range:	
Revenue Accuracy	
120 V Option:	57–132 V
240 V Option:	132–277 V
Measurement	
120 V Option:	0–150 V
240 V Option:	0–300 V
Burden:	0.003 VA @ 120 V 0.02 VA @ 240 V
Meter Form 9	300 V_{L-N}, three-phase, four-wire (wye) connection
Meter Form 5	300 $V_{L-L,}$ three-phase, three-wire (delta) connection

25 V Low Energy Analog (LEA) Voltage Inputs[a]

Burden:	10 MΩ
Range:	0.40–25 V
Accuracy at Power Factor 1.0:	0.2%, 0.4–25 V
Accuracy at Power Factor 0.5:	1.0%, 0.4–25 V

AC Current Signal Inputs (Current Transformer Inputs)

Measurement Category:	II

IA, IB, IC Channels

Range:	
CL10/CL20 Option:	0.15–20 A
CL2 Option:	0.010–6 A
Maximum Rating:	22 A continuous 500 A for 1 second
Burden:	≤ 0.5 VA
Starting Load per ANSI C12.20:	
CL10/CL20 Option:	10 mA
CL2 Option:	1 mA

Neutral Channel IN

Range:	
CL10/CL20 Option:	0.15–2.5 A
CL2 Option:	0.010–0.75 A
Maximum Rating:	22 A continuous 500 A for 1 second
Burden:	≤ 0.5 VA

12 V Low Energy Analog (LEA) Current Inputs[a]

Burden:	1 MΩ
Range:	0.1–12.5 V
Accuracy at Power Factor 1.0:	2%, 0.1–1 V 0.2%, 1–12.5 V
Accuracy at Power Factor 0.5:	4.0%, 0.1–1 V 0.3%, 1–12.5 V

150 V Low Energy Analog (LEA) Current Inputs[a]

Burden:	10 MΩ
Range:	0.4–150 V
Accuracy at Power Factor 1.0:	1%, 0.4–2 V 0.2%, 2–150 V
Accuracy at Power Factor 0.5:	1.5%, 0.4–2 V 0.5%, 2–150 V

Frequency and Rotation

60/50 Hz system frequency must be specified at time of order. ABC/ACB phase rotation is user settable.
Frequency tracking range: 45 to 65 Hz
(V_A or V_C required for frequency tracking).

Power Supply

Continuous Operating Limits

125/250 Volt Supply:	85–264 Vac (50/60 Hz) 85–275 Vdc
24/48 Volt Supply:	19–58 Vdc
12/24 Volt Supply:	9.6–36 Vdc
VA Rating:	<40 VA/15 W maximum <20 VA/7 W typical

Interruption (IEC 60255-11:1979)

100 ms at 250 Vac/Vdc
50 ms at 125 Vac/Vdc

50 ms at 48 Vdc
10 ms at 24 Vdc

Ripple (IEC 60255-11:1979):	5% for dc inputs
Terminal Voltage Dropout:	<40 V within 1 minute of power removal
Rated Insulation Voltage (IEC 60664-1:2002):	300 Vac
Dielectric Test Voltage:	2.8 kVdc
Rated Impulse Voltage (IEC 60664-1:2002):	4000 V

UPS With Auxiliary 15 Vdc Power Supply[a]

Input

Power:	52.5 W, maximum
Volt Supply:	85–264 Vac (50/60 Hz) 85–275 Vdc

DC Supply Output

Power:	24 W nominal (42 W when charging, maximum)
Voltage Output:	14.4–15.6 Vdc (15 Vdc, nominal)
Ripple:	300 mV (peak-to-peak), maximum
Typical Ride-Through Time (with 58F SuperCap and 25 W load):	95 seconds
Load Regulation (10% to 100% rated load):	600 mV (peak-to-peak), maximum

Load Test Digital Input

Rated Operating Voltage:	12 Vdc
Pickup:	9.6–13.2 Vdc
Dropout:	Below 6.0 Vdc

Auxiliary 15 Vdc Power Supply[a]

Input

Power:	52.5 W, maximum
Volt Supply:	85–264 Vac (50/60 Hz) 85–275 Vdc

DC Supply Output

Power:	24 W nominal
Voltage Output:	14.4–15.6 Vdc (15 Vdc, nominal)
Ripple:	300 mV (peak-to-peak), maximum
Load Regulation (10% to 100% rated load):	600 mV (peak-to-peak), maximum

Output Contacts

Output ratings were determined with IEC 60255-23:1994, using the simplified method of assessment.

Standard Electromechanical

Make:	30 A per IEEE C37.90-1989
Carry:	3 A at 120 Vac, 50/60 Hz 1.5 A at 240 Vac, 50/60 Hz
1 s Rating:	50 A
Make Rating:	3.6 kVA, COS θ = 0.3
Break Rating:	360 VA, COS θ = 0.3
Durability:	>10,000 cycles at rated conditions
Pickup/Dropout Time:	<35 ms
Maximum Operating Voltage (Ue):	250 V
Rated Insulation Voltage (Ui) (excluding EN 61010):	300 V

Breaking Capacity (10000 operations):

24 Vdc	0.75 A	L/R = 40 ms
48 Vdc	0.50 A	L/R = 40 ms
125 Vdc	0.30 A	L/R = 40 ms
250 Vdc	0.20 A	L/R = 40 ms

Cyclic Capacity (2.5 cycles/second):

24 Vdc	0.75 A	L/R = 40 ms
48 Vdc	0.50 A	L/R = 40 ms
125 Vdc	0.30 A	L/R = 40 ms
250 Vdc	0.20 A	L/R = 40 ms

Optional Solid-State Operational Voltage, Continuous 250 Vac/Vdc

Maximum On Resistance:	100 mA	
	typical:	50 Ω
	guaranteed:	75 Ω
	30 mA	
	typical:	75 Ω
	guaranteed:	125 Ω
	10 mA	
	typical:	125 Ω
	guaranteed:	200 Ω
Minimum Off Resistance:	10 MΩ	
Pickup/Dropout Time:	<25 ms	

Optional Electromechanical 30 Amp Contact Outputs (UL Pending)[a]

Make Rating:	10 kVA, COS θ = 1
Break Rating:	10 kVA, COS θ = 1
Carry:	30 A at 120 Vac/240Vac, 50/60 Hz
Durability:	>100,000 cycles at rated conditions
Pickup/Dropout Time:	<35 ms
Maximum Operating Voltage:	240 V
Rated Insulation Voltage:	300 V

Optional Solid-State 30 Amp DC Digital Outputs[a]

Make Operating Voltage:	250 Vdc
Rated Current:	30 Adc at rated duty and operating voltage
Rated Duty:	Intermittent, 30 Adc for 0.3 s every 5 minutes
Pickup/Dropout Time:	<25 ms

Battery Monitor Input[a]

12 Vdc Option

Full-scale input voltage range:	–20.47 to +20.48 Vdc
Error (at 25°C):	0.3% of full-scale
Voltage input overload withstand, continuous:	2 x full-scale
Input impedance:	10 MΩ ±0.5%
Resolution:	62.6 µV/LSB

Analog Outputs

Maximum Firmware Update Rate:	100 ms
Maximum settling time for full-range change to 0.1% full-scale:	500 ms
Bandwidth:	0 to 4 Hz

±1 mA Output

Current Range:	±1.2 mA
Minimum Output Impedance:	100 MΩ
Maximum Load:	10 kΩ, 100 µH
Accuracy:	±0.15% ±0.5 µA

4–20 mA Output

Current Range:	±24 mA
Minimum Output Impedance:	100 MΩ

Maximum Load: 500 Ω, 100 µH

Accuracy: ±0.15% ±10 µA

Optoisolated Input Ratings

DC Control Signal

250 Vdc:	Pickup 200–275 Vdc Dropout 150 Vdc
220 Vdc:	Pickup 176–242 Vdc Dropout 132 Vdc
125 Vdc:	Pickup 100–137.5 Vdc Dropout 75 Vdc
110 Vdc:	Pickup 88–121 Vdc Dropout 66 Vdc
48 Vdc:	Pickup 38.4–52.8 Vdc Dropout 28.8 Vdc
24 Vdc:	Pickup 15–30 Vdc Dropout <5 Vdc
12 Vdc:	Pickup 9.6–13.2 Vdc Dropout <6 Vdc

AC Control Signal

250 Vac:	Pickup 170.6–300 Vac Dropout 106 Vac
220 Vac:	Pickup 150.3–264 Vac Dropout 93.2 Vac
125 Vac:	Pickup 85–150 Vac Dropout 53 Vac
110 Vac:	Pickup 75.1–132 Vac Dropout 46.6 Vac
48 Vac:	Pickup 32.8–57.6 Vac Dropout 20.3 Vac
24 Vac:	Pickup 14–27 Vac Dropout <5 Vac

AC mode is selectable for each input via Global settings IN101D–IN102D and IN401D–IN404D.

Current draw at nominal dc voltage: 2–6 mA, except for 220 Vdc and 250 Vdc (2 mA) and 24 Vdc (10 mA).

Time-Code Input

Meter accepts demodulated IRIG-B time-code input at EIA-232 **Port 3**, **Port 2**, or 2-pin Phoenix connector. Meter time is synchronized to within ±10 µs of time-source input.

Nominal Voltage: 5 Vdc ±10%

Maximum Voltage: 8 Vdc

Synchronized Phasor Measurement

Max. Message Rate: 20 messages/second (Fnom = 60 Hz)
10 messages/second (Fnom = 50 Hz)

Specification is with respect to **MET PM** command and SEL Fast Message Synchrophasor Protocol.

Voltage and Current Accuracy: Fnom = 60 Hz ± 5 Hz
TVE = 1%

Fnom = 50 Hz ± 5 Hz
TVE = 1% for V1 and I1
TVE = 1% + |50–Fl/10% for VA, VB, VC, IA, IB, IC, VAB, VBC, VCA, IAB, IBC, and ICA

Frequency Accuracy: ± 5 mHz for Fnom ± 9 Hz

Operating Temperature

IEC 60068-2: –40° to + 85°C (–40° to +185°F)

Note: Not applicable to UL applications.

LCD: –20° to +70°C (–4° to +158°F)

Operating Environment

Pollution Degree: 2
Overvoltage Category: II

Indoor Use

Maximum Altitude: 2000 M
Maximum Humidity: 95% RH

Weight

2.3 kg (5.0 lbs)

Dimensions

Refer to *Figure 2.1* for meter dimensions.

Routine Dielectric Test

Current Inputs:	2.75 kVac for 1 s
Voltage Inputs:	2.2 kVac for 1 s
Optoisolated Inputs and Output Contacts:	2.2 kVac for 1 s
Power Supply:	3.11 kVdc for 1 s
EIA-485 Port:	1.5 kVdc for 1 s
IEC 60255-5:2000 Dielectric tests performed on all units with the CE mark:	2200 Vdc for 1 s on EIA-485 communications port. 2000 Vac for 1 s on contact inputs, contact outputs, and analog inputs.

Terminal Connections

Rear Screw-Terminal Tightening Torque

Current Input Terminal Block (ring terminals are recommended)

Minimum:	0.9 Nm (8 in-lb)
Maximum:	1.4 Nm (12 in-lb)

Connectorized®

Minimum:	0.5 Nm (4.4 in-lb)
Maximum:	1.0 Nm (8.8 in-lb)

Connectorized terminals accept wire size 12–24 AWG.

User terminals or stranded copper wire should be at a minimum temperature rating of 105° C (221°F).

Processing Specifications

AC Voltage and Current Inputs

16 samples per power system cycle for instantaneous quantities.

8000 samples per second for rms quantities and harmonics.

3 dB low-pass filter cut-off frequency of 3000 Hz.

Control Processing

25 ms processing interval

SELOGIC Pickup and Accuracies

SELOGIC Timers: ±25 ms

Analog Values: ±3%

Timers

Pickup Ranges: 0.000–1000000.000 s, 25 ms steps

Pickup and Dropout Accuracy (for all timers): ±1 processing interval (25 ms)

Metering/Monitoring

Metering Accuracy, One-Second Average (rms)

ANSI C 12.20 (1998) Accuracies are specified at 23°C and at nominal system frequency, nominal voltage, and nominal current unless noted otherwise.

Voltages V_A, V_B, V_C: ±0.15%

Voltages V_{AB}, V_{BC}, V_{CA}:	±0.15%
Currents I_A, I_B, I_C:	±0.15%
Current, Neutral I_N:	±1.0%
Frequency:	±0.01 Hz
Energy (kWh), Imported/Exported Total:	class 0.2
Peak Power Demand (kW):	class 0.2
Power (kW) Total:	class 0.2
Power (kW), per Phase:	class 0.2
Reactive Energy (kVARh) Import/ Export per Phase and Total:	class 0.2
Apparent Energy (kVAh):	class 0.2
Reactive Power (kVAR) per Phase and Total:	class 0.2
Apparent Power (kVA) per Phase and Total:	class 0.2
Reactive Power (kVAR) Peak Demand:	class 0.2
Apparent Power (kVA) Peak Demand:	class 0.2

Metering Accuracy, Instantaneous (25 ms)

Accuracies are specified at 23°C and at nominal system frequency unless noted otherwise.

Voltages V_A, V_B, V_C:	±1%
Voltages V_{AB}, V_{BC}, V_{CA}:	±1%
Currents I_A, I_B, I_C:	±1%
Current, Neutral I_N:	±2%
Frequency:	±0.01 Hz
Power (kW) per Phase and Total:	±2%
Reactive Power (kVAR) per Phase and Total:	±2%
Apparent Power (kVA) per Phase and Total:	±2%
Power Factor, at Unity PF:	±2%

Harmonic Accuracy per IEC 61000-4-7 (2002-08)

Quantity	Condition	Max Error for n ≤ 25
Voltage	$UH_n \geq 1\%\ U_N$	5% UH_n
	$UH_n < 1\%\ U_N$	0.05% U_N
Current	$IH_n \geq 3\%\ I_N$	5% IH_n
	$IH_n < 3\%\ I_N$	0.15% I_N
Power	$PH_n > 150$ W sec	PH_n • 5%
	$PH_n < 150$ W sec	PH_n ±7.5 W

Note: U_N and I_N are nominal voltage and current. UH_n, IH_n, and PH_n are *n*th order harmonic voltage, current, and power.

U_N = 120 V or 240 V (metering voltage option)

I_N = 0.5 A (CL2) or 5.0 A (CL10 and CL20)

THD and THDG:	±5% typical, ±10% worst case
K-Factor:	±5% typical, ±10% worst case
Distortion Power:	±3% typical, ±10% worst case

Flicker

P_{ST}:	±5% over the range 0.5–25 P_{ST} (10-min. interval)
P_{LT}:	±5% over the range 0.5–25 P_{LT} (2-hour interval)

Integration/Automation

Communications Ports

A total of five ports is available.

bps:	300 to 115200

Standard Ports

Optical (ANSI C12.18 Type 2):	Front Panel
EIA-232:	Rear Panel

Optional Ports

EIA-232/ EIA-485/Modem:	Rear Panel, 1.5 kVdc isolation for EIA-485/Modem
10/100BASE-T Ethernet Port:	Rear Panel

Fiber-Optic Ethernet Port

Wavelength:	1300 nm
Optical Connector Type:	LC
Fiber Type:	Multimode
Link Budget:	16.1 dB
Typical TX Power:	–15.7 dBm
RX Min. Sensitivity:	–31.8 dBm
Fiber Size:	62.5/125µm or 50/125µm
Approximate Range:	~6.4 Km
Data Rate:	100 Mb
Typical Fiber Attenuation:	–2 db/Km

Note: The EIA-232/EIA-485 Modem card functions as a single port, therefore, only one port is available at a time. The optional internal modem complies with Part 68 of the FCC Rules and Regulations.

Type Tests

Electromagnetic Compatibility Immunity

Surge Withstand Capability:	IEEE C37.90.1-2002 Elec. relays, 2.5 kV oscillatory, 4 kV fast transient IEC 60255-22-1:2007, 2.5 kV peak common and 2.5 kV peak differential mode 1.0 kV peak common mode on communications ports
Surge Immunity:	IEC 62052-11:2003, 4 kV for Current, Voltage, and Power Supply Mains 1 kV for Auxiliary Circuits
Power Frequency Magnetic Field Immunity:	IEC 61000-4-8:2009, 1000 A/m for 3 seconds, 100 A/m for 1 minute excludes optional modem
Pulse Magnetic Field Immunity:	IEC 61000-4-9:1993, 1000 A/m
Electrostatic Discharge Immunity:	IEC 61000-4-2:2008 Elec. disturb., Section 2: ESD, Severity Level: 4 IEC 60255-22-2:2008 Elec. disturb. Section 2: ESD, Severity Level:4; both polarities at Levels 1, 2, 3, and 4

Radiated Radio Frequency Immunity:	IEC 61000-4-3:2010, Severity Level: X (15 V/m) IEC 60255-22-3:2007 Elec. relays, Section 3: Radiated electromagnetic field disturb., Severity Level: 3 (10 V/m) ANSI C12.20 (1998), Severity Level: 15 V/m
Conducted Radio Frequency Immunity:	IEC 61000-4-6:2008, Severity Level: 3
Fast Transient Burst Immunity:	IEC 61000-4-4:2011, Severity Level: 4

Environmental Tests

Cold:	IEC 60068-2-1, 2007 Envir., Test Ad, Severity: 16 hours at –40°C
Dry Heat:	IEC 60068-2-2:2007, Envir., Part 2: Test Bd, Severity: 16 hours at +85°C
Damp Heat, Cyclic:	IEC 60068-2-30:2005 Basic envir., Part 2: Test Db, Severity: 25° to 55°C, 6 cycles, 95% humidity
Enclosure Protection:	IEC 60529:2001, IP65, enclosed in panel with available gasket (P/N: 915900097); IP41 without gasket; IP20 for rear panel
Vibration, Shock, and Bump:	IEC 60255-21-1:1988 Elec. relays, Part 21: Vibration, shock, bump, and seismic, Section 1, Severity: Response: Class 2 Endurance: Class 1 IEC 60255-21-2:1988 Elec. relays, Part 21: Vibration, shock, bump, and seismic, Section 2, Severity: Response: Class 2 Endurance: Class 1 IEC 60255-21-3:1993 Elec. relays, Part 21: Vibration, shock, bump, and seismic, Section 3, Severity: Class 2

Safety

Dielectric Strength/Impulse:	IEC 60255-5:2000 Elec. relays, Part 5: Insulation, Section 6: 2.5 kVac on AC current inputs, contact inputs, and contact outputs, 3.1 kVdc on power supply, and 2.2 kVdc on EIA-485 port for 60 sec. dielectric, Severity: 2500 Vac on analog inputs, contact inputs, and contact outputs; 3100 Vdc on power supply IEC 60255-5:2000 0.5 Joule, 5 kV on power supply, contact inputs, contact outputs, ac current inputs, and voltage inputs Section 8: Impulse Voltage, 2200 Vdc on EIA-485, Severity Level: 0.5 Joule, 5 kV
High-Voltage Line Surges:	IEEE C62.41-1991 100 kHz Ring Wave for Location Category B3, Peak Voltage of 6 kV and Short-Circuit Peak Current of 3 kA 1.2/50 µs Combination Wave for Location Category B3, Peak Voltage of 6 kV and Short-Circuit Peak Current of 3 kA
Impulse Voltage Test:	IEC 687:1992–06 6 kV on power supply, ac current inputs, and voltage inputs

[a] Only available on the SEL-734B model.

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www.selinc.com • info@selinc.com

PDS734-01

Product Data Sheet
00813-0100-4485, Rev EC
June 2013

Rosemount DP Flowmeters and Primary Elements

- *MultiVariable capabilities allow for real time fully compensated mass and energy flow*
- *Fully-Integrated Wireless Flowmeters allow for easy installation*
- *Minimize permanent pressure loss and save energy with Annubar® Technology*
- *Reduce straight pipe requirements to two diameters upstream and downstream from flow disturbances with Conditioning Orifice Plate Technology*
- *Improve accuracy and repeatability in small line sizes with Integral Orifice Plate Technology*

Contents

DP Flowmeter Selection Guide

Rosemount integrated DP Flowmeters arrive fully assembled, configured, and leak tested for out-of-the-box installation.

Rosemount 3051SF Flowmeters enable best-in-class flow measurement utilizing advanced functionality

- Up to 0.80% mass flow rate accuracy
- Multivariable capabilities allow for real time fully compensated mass and energy flow
- Advanced diagnostics predict and prevent abnormal process conditions
- Installation ready wireless flow solution
- Ultra for Flow measures %-of-reading performance over 14:1 flow turndown
- 10-year stability, 12-year warranty

Rosemount 3051CF Flowmeters combine the proven 3051C pressure transmitter and the latest primary element technology

- Up to 1.65% volumetric flow accuracy at 8:1 turndown
- Available with HART®, FOUNDATION™ fieldbus, and Profibus Protocols
- 5-year stability

Rosemount 2051CF Flowmeters combine the 2051C pressure transmitter and the latest primary element technology

- Up to 2.00% volumetric flow accuracy at 5:1 turndown
- Available with HART, and FOUNDATION fieldbus Protocols
- 2-year stability

Rosemount Annubar Primary Element Technology

- Energy savings gained through minimal permanent pressure loss
- Innovative T-shape design that increases accuracy to up to ±0.75% of flow rate
- Variety of sensor materials for optimal compatibility with the process fluid
- Handles applications where conditions exceed the structural limitations of other primary elements
- Symmetrical sensor design allows bi-directional flow measurement
- Reduce installation costs with the 405A Compact Annubar

Rosemount Conditioning Orifice Plate Technology

- Reduce straight pipe requirements to two diameters upstream and downstream from flow disturbances
- Discharge coefficient uncertainty of ±0.5%
- Integral thermowell enables fully compensated mass flow with a single pipe penetration
- Reduce installation costs compared to traditional orifice plates with the compact design
- Conditioning orifice plate is based on AGA, ASME and ISO industry standards
- Available in various plate styles providing installation flexibility

Rosemount Integral Orifice Plate Technology

- Improves accuracy and repeatability in 1/2-in., 1-in., and 1 1/2-in. line sizes
- Self-centering plate design eliminates installation errors that are magnified in small line sizes
- Precision honed pipe sections allow accuracy of up to ±0.75% of flow rate
- Installation flexibility with numerous process connections
- Integral thermowell enables fully compensated mass flow

Rosemount 3051SF DP Flowmeters

Rosemount 3051SF Flowmeters integrate industry leading transmitters with industry leading primary elements. Capabilities include:

- Flowmeters are factory configured to meet your application needs (Configuration Data Sheet required)
- MultiVariable capabilities allow scalable flow compensation (Measurement Types 1-7)
- HART 4-20, Wireless, and FOUNDATION fieldbus protocols
- Ultra for Flow for improved flow performance across wider flow ranges
- Integral temperature measurement (Option Code T)
- Advanced Diagnostics (Option Code DA2)
- Direct or remote mount configurations available

Additional Information
Specifications: page 26
Dimensional Drawings: page 140.

Rosemount 3051SFA Annubar Flowmeter

- Annubar flowmeters reduce permanent pressure loss by creating less blockage in the pipe
- Ideal for large line size installations when cost, size and weight of the flowmeter are concerns

Table 1. Rosemount 3051SFA Annubar Flowmeter Ordering Information

★ The Standard offering represents the most common options. The starred options (★) should be selected for best delivery.
The Expanded offering is subject to additional delivery lead time.

Model	Product Description	Measurement Type		• = Available — = Unavailable
		D	1-7	
3051SFA	Annubar Flowmeter	•	•	
Measurement Type				
Standard				**Standard**
1	Fully Compensated Mass & Energy Flow Calculations – Differential & Static Pressures w/ Temperature	—	•	★
2	Compensated Flow Calculations – Differential & Static Pressures	—	•	★
3	Compensated Flow Calculations – Differential Pressure & Temperature	—	•	★
4	Compensated Flow Calculations – Differential Pressure	—	•	★
D	Differential Pressure	•	—	★
Expanded				**Expanded**
5	Process Variables Only (No Flow Calculations) – Differential & Static Pressures with Temperature	—	•	
6	Process Variables Only (No Flow Calculations) – Differential & Static Pressures	—	•	
7	Process Variables Only (No Flow Calculations)	—	•	
Fluid Type				
Standard				**Standard**
L	Liquid	•	•	★
G	Gas	•	•	★
S	Steam	•	•	★

3051SF Series Specifications

3051SF PERFORMANCE SPECIFICATIONS

Performance assumptions include: measured pipe I.D, transmitter is trimmed for optimum flow accuracy, and performance is dependent on application parameters.

Table 4. MultiVariable Flow Performance - Flow Reference Accuracy (Measurement Type 1)(1)(2)

3051SFA Annubar Flowmeter			
		Classic MV (8:1 flow turndown)	**Ultra for Flow (14:1 flow turndown)**
Ranges 2-3		±1.15% of Flow Rate	±0.80% of Flow Rate
3051SFC_A Compact Annubar Flowmeter - Annubar Option A			
		Classic MV (8:1 flow turndown)	**Ultra for Flow (14:1 flow turndown)**
Ranges 2-3	Uncalibrated	±1.60% of Flow Rate	±1.55% of Flow Rate
	Calibrated	±1.00% of Flow Rate	±0.80% of Flow Rate
3051SFC_C Compact Orifice Flowmeter - Conditioning Option C			
		Classic MV (8:1 flow turndown)	**Ultra for Flow (14:1 flow turndown)**
Ranges 2-3	β =0.4	±1.10% of Flow Rate	±0.75% of Flow Rate
	β =0.65	±1.45% of Flow Rate	±1.15% of Flow Rate
3051SFC_P Compact Orifice Flowmeter - Orifice Option P(3)			
		Classic MV (8:1 flow turndown)	**Ultra for Flow (14:1 flow turndown)**
Ranges 2-3	β =0.4	±1.45% of Flow Rate	±1.30% of Flow Rate
	β =0.65	±1.45% of Flow Rate	±1.30% of Flow Rate
3051SFP Integral Orifice Flowmeter			
		Classic MV (8:1 flow turndown)	**Ultra for Flow (14:1 flow turndown)**
Ranges 2-3	β <0.1	±2.65% of Flow Rate	±2.60% of Flow Rate
	0.1< β <0.2	±1.60% of Flow Rate	±1.40% of Flow Rate
	0.2< β <0.6	±1.25% of Flow Rate	±0.95% of Flow Rate
	0.6< β <0.8	±1.80% of Flow Rate	±1.60% of Flow Rate

(1) Measurement Types 2 - 4 assume that the unmeasured variables are constant. Additional uncertainty will depend on the variation in the unmeasured variables. DP Calibrated at up to 1/10th full scale to optimize accuracy over range of use.

(2) Range 1 flowmeters experience an additional uncertainty up to 0.9%. Consult your Emerson Process Management Representative for exact specifications.

(3) For line size less than 2 in. (50 mm) or greater than 8 in. (200 mm), add an additional 0.5% uncertainty.

Table 5. Flow Performance - Flow Reference Accuracy (Measurement Type D)(1)(2)(3)

3051SFA Annubar Flowmeter				
		Classic (8:1 flow turndown)	**Ultra (8:1 flow turndown)**	**Ultra for Flow (14:1 flow turndown)**
Ranges 2-3		±1.25% of Flow Rate	±0.95% of Flow Rate	±0.80% of Flow Rate
3051SFC_A Compact Annubar Flowmeter-Annubar Option A				
		Classic MV (8:1 flow turndown)	**Ultra (8:1 flow turndown)**	**Ultra for Flow (14:1 flow turndown)**
Ranges 2-3	Uncalibrated	±1.70% of Flow Rate	±1.65% of Flow Rate	±1.55% of Flow Rate
	Calibrated	±1.25% of Flow Rate	±0.95% of Flow Rate	±0.80% of Flow Rate
3051SFC_C Compact Orifice Flowmeter – Conditioning Option C				
		Classic (8:1 flow turndown)	**Ultra (8:1 flow turndown)**	**Ultra for Flow (14:1 flow turndown)**
Ranges 2-3	β =0.4	±1.10% of Flow Rate	±0.9% of Flow Rate	±0.75% of Flow Rate
	β =0.65	±1.40% of Flow Rate	±1.25% of Flow Rate	±1.15% of Flow Rate
3051SFC_P Compact Orifice Flowmeter – Orifice Option P(4)				
		Classic (8:1 flow turndown)	**Ultra (8:1 flow turndown)**	**Ultra for Flow (14:1 flow turndown)**
Ranges 2-3	β =0.4	±1.80% of Flow Rate	±1.35% of Flow Rate	±1.30% of Flow Rate
	β =0.65	±1.80% of Flow Rate	±1.35% of Flow Rate	±1.30% of Flow Rate
3051SFP Integral Orifice Flowmeter				
		Classic (8:1 flow turndown)	**Ultra (8:1 flow turndown)**	**Ultra for Flow (14:1 flow turndown)**
Ranges 2-3	β <0.1	±2.70% of Flow Rate	±2.65% of Flow Rate	±2.60% of Flow Rate
	0.1< β <0.2	±1.80% of Flow Rate	±1.45% of Flow Rate	±1.40% of Flow Rate
	0.2< β <0.6	±1.50% of Flow Rate	± 1.10% of Flow Rate	±0.95% of Flow Rate
	0.6< β <0.8	±2.00% of Flow Rate	±1.70% of Flow Rate	±1.60% of Flow Rate

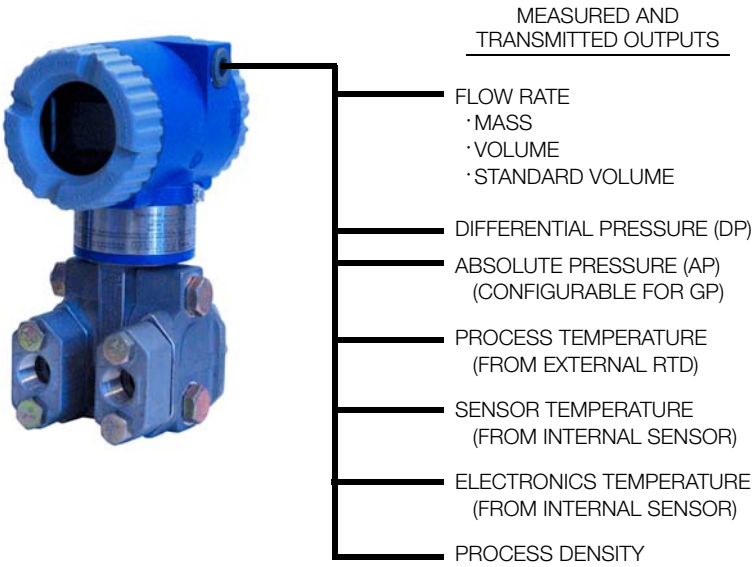
FIELD DEVICES - PRESSURE

Product Specifications

INVENSYS PROCESS SYSTEMS

PSS 2A-1C15 A

Model IMV30
I/A Series® Multivariable Transmitters for P, DP, and T Measurements with HART or FoxCom™ Communication Protocol



The Foxboro® brand Model IMV30 Multivariable Transmitter is available from Invensys Process Systems (IPS). It is an intelligent two-wire transmitter that provides precise and reliable measurement of pressure, differential pressure, sensor and electronics temperatures, and process temperature (from an external RTD). It transmits a 4 to 20 mA or digital output signal, as applicable, using HART or FoxCom Communication for remote configuration, calibration, and monitoring. When used with a primary flow element, it also calculates process density and flow rate, and provides transmission of all the measured and calculated values.

FEATURES

- One transmitter for many applications:
  - Individual measurements on a 2-wire loop.
  - Multiple measurements digitally.
  - Assigns 4 to 20 mA to any measurement.
- Complete configuration using a Model PCMV PC-based configurator; limited configuration with optional LCD indicator, or HART communicator.
- Calculates mass, volume, or standard volume flow rate based on multiple measurements, using a primary flow element.
- Standard 5-year warranty.
- Convenient module change allows easy migration between communication protocols.
- Designed for hazardous area installations; versions available to meet Agency flameproof and zone requirements.
- CE marked; complies with EMC, ATEX, and PED European Directives; and NAMUR NE 21 interference immunity requirement, and NAMUR 105 overrange and underrange annunciations.
- One transmitter replaces three separate transmitters, saving initial purchase costs.

FOXBORO

BENEFITS

- Reduced process penetrations save money and reduce chances of fugitive emissions.
- Fewer transmitters, less wiring, and fewer shutoff valves reduce installation costs.
- Greater reliability due to fewer devices and less wiring means less chance of losses from downtime or process upsets.
- Flow rate values from the transmitter eliminate allocation of system resources for flow rate calculations, reducing system costs.
- High functionality and high performance provide exceptional value.
- Dual Seal certified by CSA to meet ANSI/ISA 12.27.01-2003 requirements.
- Numerous options and accessories offered to expand the capabilities of these transmitters.

I/A Series PRESSURE TRANSMITTER FAMILY

These Transmitters are part of a complete family of gauge, absolute, d/p Cell®, multirange, multivariable, and premium performance transmitters, as well as transmitters with remote or direct mount pressure seals. They all use field-proven silicon strain gauge sensors and common topworks. See below for electronic versions offered with the IMV30.

DIGITAL FoxCom OR 4 to 20 mA dc (VERSION -D ELECTRONICS)

FoxCom Digital Output
Provides Measurement Integration with I/A Series systems, transmission of multiple measurements and diagnostics. Also provides digital communications with a Model PCMV PC-based Configurator, or an optional LCD Indicator with on-board pushbuttons.

FoxCom 4 to 20 mA Output
Allows direct analog connection to common receivers while still providing full Intelligent Transmitter Digital Communications with a Model PCMV PC-based Configurator, applicable I/A Series system FBMs, or optional LCD Indicator.

DIGITAL HART AND 4 to 20 mA dc (VERSION -T ELECTRONICS)

4 to 20 mA with HART communications. Allows direct analog connection to common receivers while still providing full digital communications using a HART Communicator, PC-based Configurator, or optional LCD Indicator.

For complete configuration capability, Foxboro Model PCMV PC-based configurator is required. A HART Communicator PC-based configurator, or optional LCD indicator can be used for routine transmitter functions such as rezeroing or changing damping settings. See Figure 17 for more information on Option -L1, LCD Indicator.

OPTIONAL CUSTOM FACTORY CONFIGURATION (OPTION -C2)

As stated previously, changes can be made to the IMV30 using a HART Communicator, PC-Based Configurator, or the optional local display. It must be understood that these configuration methods cannot configure the IMV30 for a specific application, but can only modify some parameter values after the initial configuration. Therefore IPS recommends that IMV30 transmitters be factory configured at time of shipment if the application information is known. In order to supply the necessary information to the factory, an Option -C2 Configuration Wizard must be run and the results must be available to BuyAutomation. If the Factory Configuration Option (Option -C2) is not selected in the Model Code, the user must then have Model PCMV configuration software to fully configure the IMV30 transmitter for flow rate applications. The Device Descriptions and Device Type Manager files available from IPS can modify some configuration parameters, but only the Model PCMV will calculate the necessary coefficients related to the process liquid and pass them to the transmitter.

MULTIPLE MEASUREMENTS/CALCULATIONS

- Differential Pressure (DP)
- Pressure (P)
- Process Temperature (from external RTD)
- Flow Rate (Mass, Volume, or Standard Volume)
- Density
- Sensor Temperature
- Electronics Temperature

EXCEPTIONALLY HIGH PERFORMANCE

- Accuracy to ±0.05% of Span
- Long term stability with drift less than ±0.05% URL per Year over a 5-year Period
- Minimized static pressure effect on DP by using pressure to compensate the DP measurement
- Excellent Ambient Temperature Effect Compensation due to Characterization and Microprocessor-Based Compensation
- Total Probable Error (TPE) significantly better than typical competitive transmitters

FLOW RATE MEASUREMENT

- Can be used with primary flow devices such as orifice plates (see Figure 1), flow nozzles, Venturi tubes, and averaging pitot elements
- Flow equations for liquids, gases, and vapors (also natural gas and steam) reside in the IMV30
- With a separate RTD for Process Temperature Measurement, the IMV30 can calculate Mass Flow Rate, fully compensated for changes in absolute pressure and temperature
- Selection of Volume and Standard Volume Flow Rate, in addition to Mass Flow Rate
- Supports connection of a 2-, 3-, or 4-wire RTD, user-entered temperature, or calculation from saturation pressure (steam)
- Eliminates the need for a separate computer to make the flow rate calculations
- Flow rate transmission can be either in selectable EGU, such as kg/min (for the digital signal), or in Current (for the 4 to 20 mA analog signal), representing a specified flow rate range
- Continuous dynamic compensation for all variables, including:
  - Changes in fluid density
  - Dimensional changes in primary device and adjacent piping with temperature
  - Changes in discharge coefficient based on Reynolds Number (corrected for velocity, density, and viscosity)

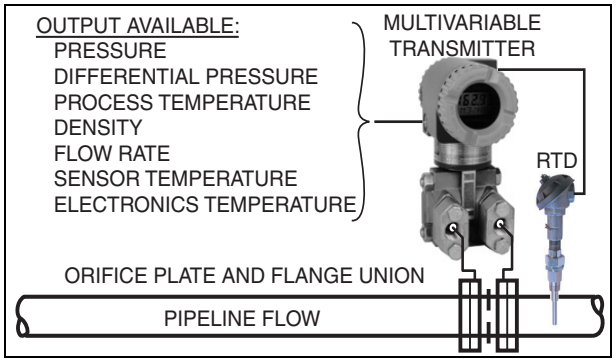
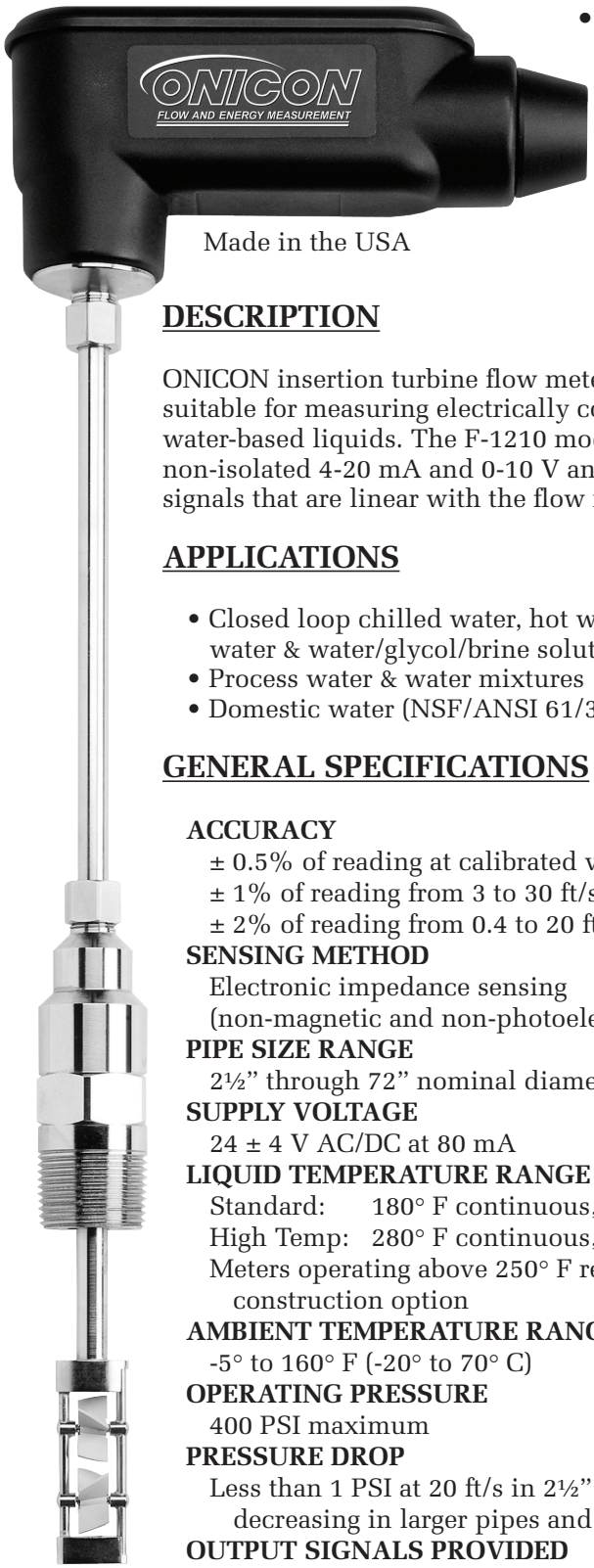


Figure 1. Flow Rate Measurement with Orifice Plate

MODEL PCMV MULTIVARIABLE TRANSMITTER CONFIGURATOR (REFER TO PSS 2A-1Z3 F)

- Windows-based software package to configure IMV30 Transmitter for flow rate applications
- Determines a set of application-specific coefficients to be downloaded to transmitter for use in the transmitter's flow rate equations
- Provides configuration for:
  - Choice of primary flow device (i.e., orifice, nozzle, Venturi, averaging pitot)
  - Choice of pressure tap location (i.e., flange, corner, or D and D/2)
  - Process fluid, from a database of density-temperature relationships for over 275 fluids, or from user-entered density and temperature data
  - Operating pressure and temperature ranges
  - Industry flow rate standards, such as AGA, API, ISO, and ASME



Made in the USA

• F-1210 DUAL TURBINE •
INSERTION FLOW METER
ANALOG OUTPUT

ONICON
FLOW AND ENERGY MEASUREMENT

DESCRIPTION

ONICON insertion turbine flow meters are suitable for measuring electrically conductive water-based liquids. The F-1210 model provides non-isolated 4-20 mA and 0-10 V analog output signals that are linear with the flow rate.

APPLICATIONS

- Closed loop chilled water, hot water, condenser water & water/glycol/brine solutions for HVAC
- Process water & water mixtures
- Domestic water (NSF/ANSI 61/372 version*)

GENERAL SPECIFICATIONS

ACCURACY
± 0.5% of reading at calibrated velocity
± 1% of reading from 3 to 30 ft/s (10:1 range)
± 2% of reading from 0.4 to 20 ft/s (50:1 range)

SENSING METHOD
Electronic impedance sensing
(non-magnetic and non-photoelectric)

PIPE SIZE RANGE
2½" through 72" nominal diameter

SUPPLY VOLTAGE
24 ± 4 V AC/DC at 80 mA

LIQUID TEMPERATURE RANGE
Standard: 180° F continuous, 200° F peak
High Temp: 280° F continuous, 300° F peak
Meters operating above 250° F require 316 SS construction option

AMBIENT TEMPERATURE RANGE
-5° to 160° F (-20° to 70° C)

OPERATING PRESSURE
400 PSI maximum

PRESSURE DROP
Less than 1 PSI at 20 ft/s in 2½" pipe, decreasing in larger pipes and lower velocities

OUTPUT SIGNALS PROVIDED
Analog Outputs (Non-Isolated)
Jumper selectable: 4-20 mA / 0-10V / 0-5V
Frequency Output
0 – 15 V peak pulse

(continued on back)

CALIBRATION

Every ONICON flow meter is wet calibrated in our flow laboratory against primary volumetric standards that are directly traceable to N.I.S.T. A certificate of calibration accompanies every meter.

FEATURES

Unmatched Price vs. Performance -
Custom calibrated, highly accurate instrumentation at very competitive prices.

Excellent Long-term Reliability -
Patented electronic sensing is resistant to scale and particulate matter. Low mass turbines with engineered jewel bearing systems provide a mechanical system that virtually does not wear.

Industry Leading Two-year "No-fault" Warranty -
Reduces start-up costs with extended coverage to include accidental installation damage (miswiring, etc.) Certain exclusions apply. See our complete warranty statement for details.

Simplified Hot Tap Insertion Design -
Standard on every insertion flow meter. Allows for insertion and removal by hand without system shutdown.

OPERATING RANGE FOR COMMON PIPE SIZES
0.17 TO 20 ft/s
±2% accuracy begins at 0.4 ft/s

Pipe Size (Inches)	Flow Rate (GPM)
2½	2.5 - 230
3	4 - 460
4	8 - 800
6	15 - 1,800
8	26 - 3,100
10	42 - 4,900
12	60 - 7,050
14	72 - 8,600
16	98 - 11,400
18	120 - 14,600
20	150 - 18,100
24	230 - 26,500
30	360 - 41,900
36	510 - 60,900

11451 Belcher Road South, Largo, FL 33773 • USA • Tel +1 (727) 447-6140 • Fax +1 (727) 442-5699
www.onicon.com • sales@onicon.com

F-1210 SPECIFICATIONS (cont.)

MATERIAL

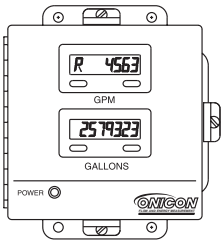
Wetted metal components:
- Standard: Electroless nickel plated brass
- Optional: 316 stainless steel
- Optional: NSF/ANSI 61/372 version*

ELECTRONICS ENCLOSURE
- Standard: Weathertight aluminum enclosure
- Optional: Submersible enclosure

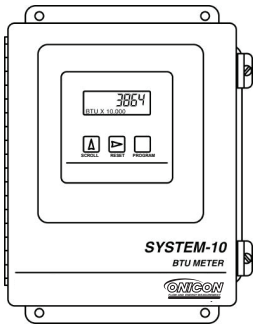
ELECTRICAL CONNECTIONS

4-wire recommended for analog output
- Standard: 10' of cable with ½" NPT conduit connection
- Optional: Indoor DIN connector with 10' of plenum rated cable

ALSO AVAILABLE



Display Modules



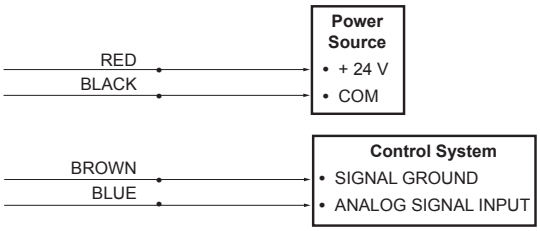
Btu Measurement Systems

F-1210 WIRING INFORMATION

WIRE COLOR	DESCRIPTION	NOTES
RED	(+) 24 V AC/DC supply voltage, 50 mA	Connect to power supply positive
BLACK	(-) Common ground (Common with pipe ground)	Connect to power supply negative & analog input ground
GREEN	(+) Frequency output signal: 0-15 V peak pulse	Required when meter is connected to local display or Btu meter
BLUE	(+) Analog signal	Jumper Selectable: 4-20 mA / 0-10V / 0-5V
BROWN	(-) Analog signal	
DIAGNOSTIC SIGNALS		
ORANGE	Bottom turbine frequency	These signals are for diagnostic purposes - connect to local display or Btu meter
WHITE	Top turbine frequency	

F-1210 WIRING DIAGRAM

Flow meter into control system (no display or Btu meter)



NOTE:

1. Black wire is common with the pipe ground (typically earth ground).

2. Frequency output required for ONICON display module or Btu meter, refer to wiring diagram for peripheral device.

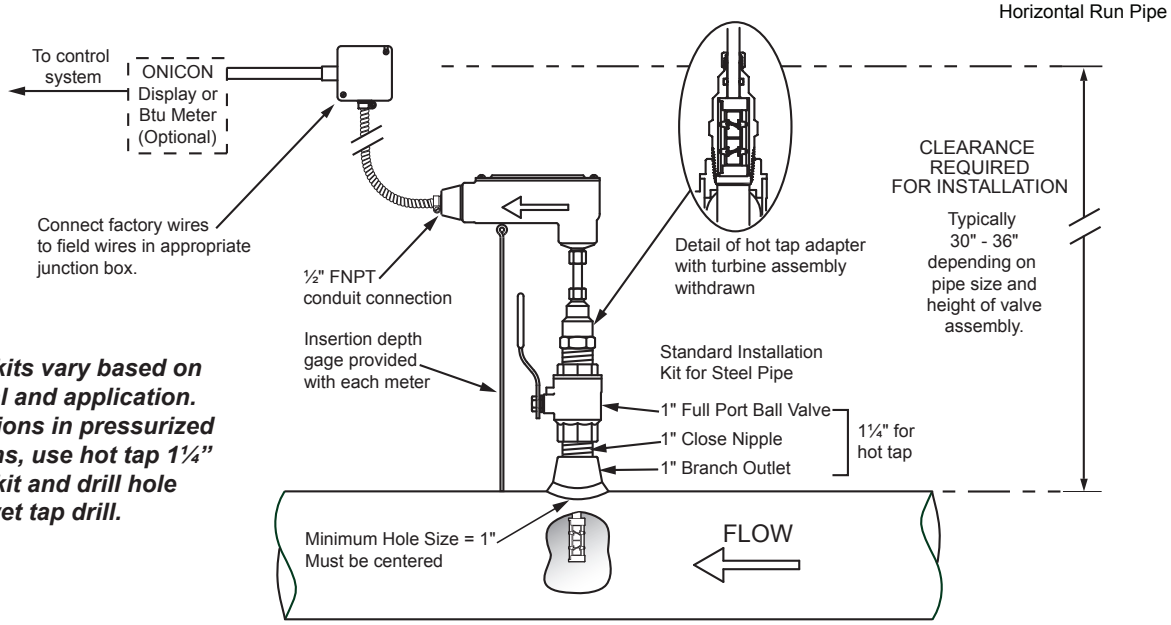
* CLASSIFIED UL C US WATER QUALITY

TURBINE INSERTION FLOW METER NSF/ANSI 61 <MH60590> ALSO CLASSIFIED IN ACCORDANCE WITH NSF/ANSI 372

TYPICAL METER INSTALLATION

(New construction or scheduled shutdown)

- Acceptable to install in vertical pipe
- Position meter anywhere in upper 240° for horizontal pipe



NOTE:
Installation kits vary based on pipe material and application. For installations in pressurized (live) systems, use hot tap 1¼" installation kit and drill hole using a 1" wet tap drill.

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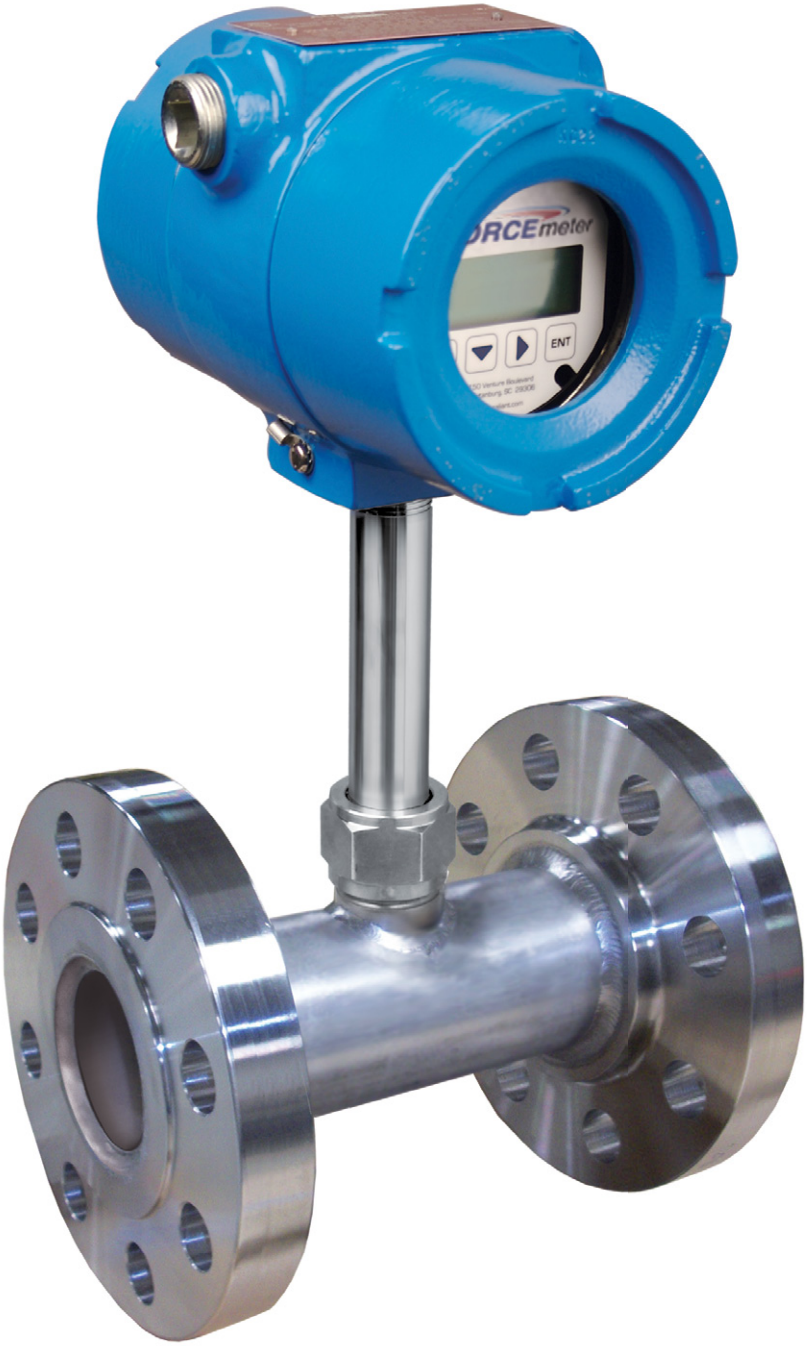
FORCEmeter™



LIQUID • GAS • STEAM

FORCEmeter™ Features/Benefits

INSTALL IT & FORGET IT

The ForceMeter™ offers the same rugged design for which the Niagara Meters brand is known. The ForceMeter is ideal for applications including water, compressed air, gases, super-heated steam and saturated steam.

FEATURES & BENEFITS

Quick Response Time

- Displays the flow rate from zero to full range of flow in less than a second or a dampening value can be used to slow the response time

Rugged Design

- No frictional moving parts to wear out
- Withstands thermal shock
- All welded flow sensor construction
- Hermetically sealed
- Extreme temperature ranges: -320° to 500° F
- Not damaged by over range

Easy to Maintain

- Calibration verification without a flow stand
- No maintenance needed
- Ability to change flow ranges by changing targets

Flexible

- Warning and fault history stored
- Option for bidirectional
- 2 line, 4 button display
- HART™ compliant communication
- 4-20mA output
- 2-wire, loop powered or 3-wire version available

Approvals

- CE, FM

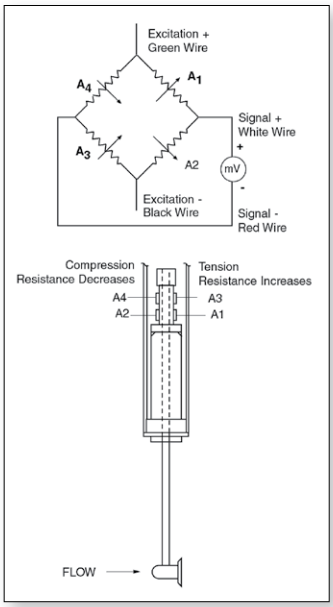
Approved for Hazardous Locations

ForceMeter Display

FORCEmeter Principle of Operation

HOW A FORCEMETER WORKS:

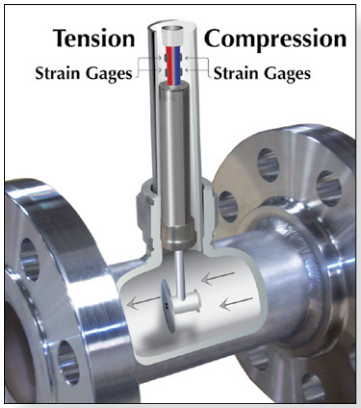
The ForceMeter is a liquid, steam or gas flow meter. The force of the fluid is sensed on the target in the flow stream using a hermetically sealed strain gage bridge circuit. The transmitter converts the force to a 4-20 mA output that is proportional to the flow rate.



Bridge Circuit Diagram

How the Bridge Circuit Works

- Force from the fluid flow is transferred from the target to the sensing tube
- Four interconnected, 5000 Ohm strain gages are attached to the sensing tube in a bridge circuit
- At zero flow, the bridge circuit is balanced producing zero output
- Force from the flow produces strain on the sensing tube
- The bridge circuit senses the force (strain) producing an output



Basic Principle of Operation

$$\text{Force} = C_d A \rho \frac{V^2}{2g}$$

C_d = Drag Coefficient
A = Target Area
ρ = Fluid Density

$\frac{V^2}{2g}$ = Velocity Head

TRANSMITTER OPTIONS

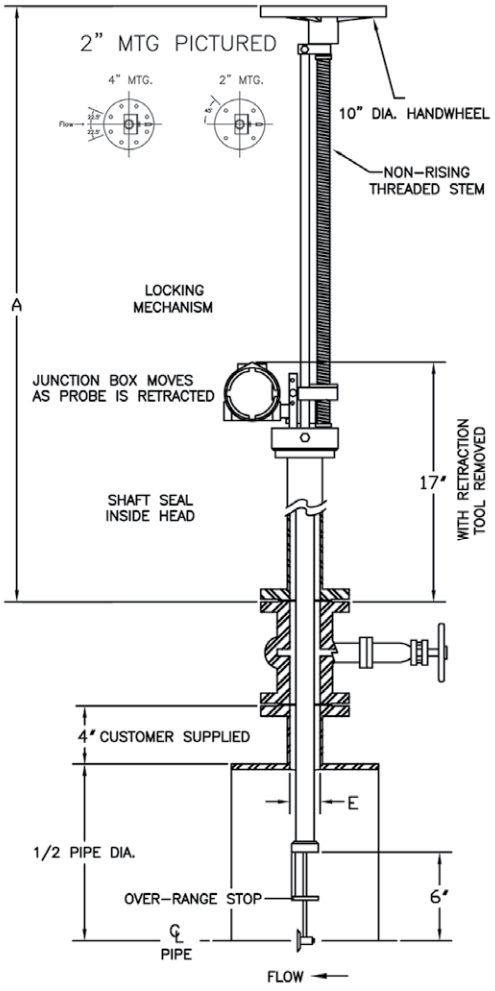
2-Wire: A 2-wire loop powered meter with a 4-20mA output and HART communication. It has a turndown ratio of 15:1, and is used where 2-wire loop powered is required.

3-Wire: The 3-wire has a power, signal (4-20mA and HART communication), and ground connection. With more power available, the meter produces a higher signal-to-noise ratio, minimizing electrical interference. This increases the turndown ratio to 20:1, allowing lower flow rates to be measured.

ONE METER, MANY SOLUTIONS

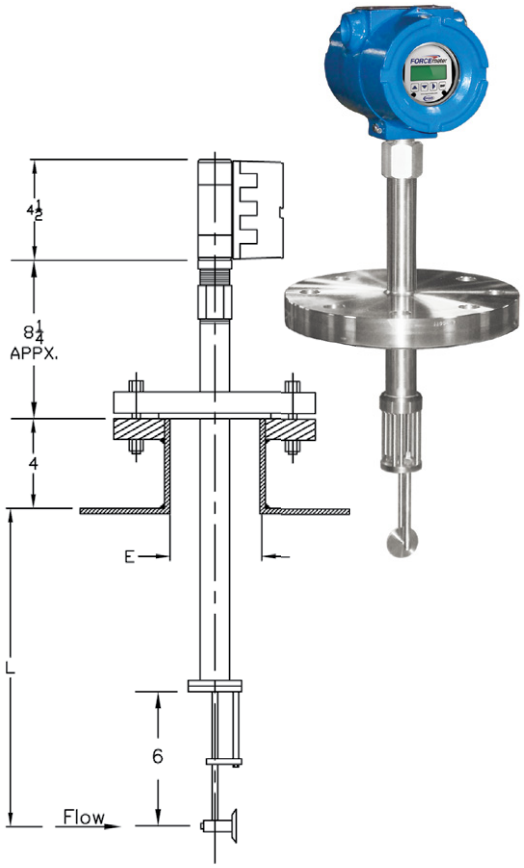
The ForceMeter insertion meter is used in applications with 4″ line sizes and larger. A fixed or retractable insertion installation is very useful and economical. The retractable insertion allows for a hot tap installation for processes where the line cannot be interrupted.

Retractable Insertion

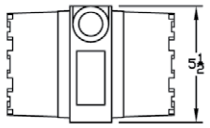


Dimensions A (Retractable)		
LINE SIZE	RETRACTION TOOL	DIM. A
4″, 5″, 6″	RT4-18	46 7/16
8″, 10″, 12″	RT4-18	46 7/16
14″, 16″, 18″	RT4-18	46 7/16
20″, 22″, 24″	RT20-36	55 7/16
26″, 28″, 30″	RT20-36	55 7/16
32″, 34″, 36″	RT20-36	55 7/16

Fixed Insertion



Typical Integral Enclosure



1. Hot tap available.
2. Shown with customer supplied valves and pipe.

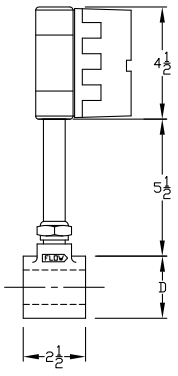
IDEAL FOR LIQUIDS, GASES OR STEAM

The ForceMeter inline flow meter is used in applications with line sizes of 0.5″ to 6.0″. The meter is supplied with the housing in all typical mounting configurations, such as wafer, MNPT, AN 37° Flare Tube, and flanged.

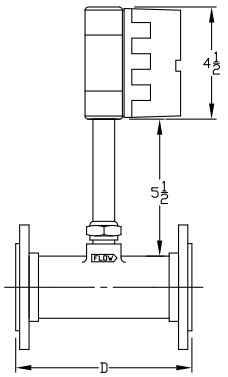
Standard Mounting Options:

Wafer, Flanged, MNPT, AN 37° Flare Tube

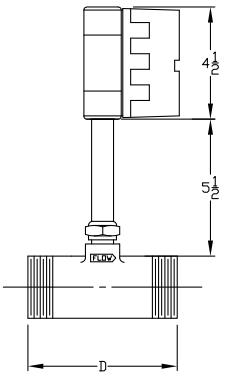
150# Wafer[1]



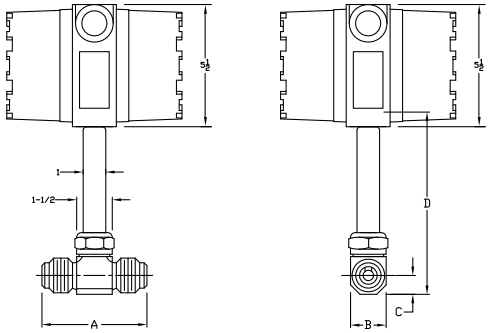
150# RF ANSI Flange[1]



SCH 40 MNPT[1]



AN 37° Flare Tube[2]



SIZE	D DIMENSION				
	Wafer	150# RF		MNPT	
		Dim.	Product Wt. (lbs.)	Dim.	Product Wt. (lbs.)
1/2”	1-3/4”	5”	8	4”	6
3/4”	2-1/8”	5”	9	4”	6
1”	2 -1/2”	5”	9	5”	6
1-1/4”	2-7/8”	6”	11	6”	7
1-1/2”	3-1/4”	6”	12	6”	7
2”	4”	8”	18	8”	7
3”	5-1/4”	9”	28	9”	9
4”	6-3/4”	10-1/2”	40	-	-
6”	8-5/8”	12-1/2”	60	-	-

SIZE	DIMENSIONS				
	A	B	C	D	Product Wt. (lbs.)
1/2”	3.600”	1-3/8"	11/16”	7-5/8"	2.250
3/4"	3.600”	1-3/8"	11/16”	7-5/8"	2.250
1"	3.666"	1-3/8"	11/16”	7-5/8"	2.250
1-1/4"	3.666"	1-11/16"	7/8"	7-5/8"	2.500
1-1/2"	3.760"	1-15/16"	1"	8-1/8"	3.000
2"	4.260"	2-9/16"	1-5/16"	8-5/8"	4.500

1. Drawings shown as remote displays.
2. Drawing shown as integral display.

NFP - _____ - _____ - _____ - _____ - _____ - _____ - _____ - _____ - _____ - _____

Model Type
V = Standard
D = Custom

Approvals
B = Hazardous Approval
Z = None

Flow Direction
1 = Unidirectional
2 = Bidirectional

Transmitter Mounting
V = Integral
R = Remote
B = Hazardous Remote

Transmitter Type
1 = ForceMeter
3 = ForceMeter w/ blind cover
4 = ForceMeter, 3 wire
6 = ForceMeter, 3 wire w/blind cover

Body Material
Y = 316/316L Stainless Steel

Flange Rating
01 = 150# RF ANSI
02 = 300# RF ANSI

Mounting Connection
H = 4.0″ flange retractable probe
M = 2.0″ flange fixed probe
P = 4.0″ flange fixed probe
U = 2.0″ flange retractable probe

Line Size: 4.0″ to 60″

ForceMeter Insertion

NFI - _____ - _____ - _____ - _____ - _____ - _____ - _____ - _____ - _____ - _____

Model Type
V = Standard
D = Custom

Approvals
B = Hazardous Approval
Z = None

Flow Direction
1 = Unidirectional
2 = Bidirectional

Transmitter Mounting
V = Integral
R = Remote
B = Hazardous Remote

Transmitter Type
1 = ForceMeter
3 = ForceMeter w/ blind cover
4 = ForceMeter, 3 wire
6 = ForceMeter, 3 wire w/blind cover

Body Material
C = Carbon Steel
X = 304 Stainless Steel
Y = 316/316L Stainless Steel

Flange Rating
00 = NA (mounting connection J)
01 = 150# RF ANSI (mounting connection F)
02 = 300# RF ANSI (mounting connection F)

Mounting Connection
F = Flanged
J = MNPT
A = AN 37° Flare Tube
W = Wafer

Line Size: 0.5″ to 6.0″

ForceMeter Inline

FORCEmeter™ Options

ADAPTABLE AND FLEXIBLE TO YOUR ENVIRONMENT

Approvals

- Designed to meet military standards for shock and vibration
- FM hazardous locations
- CE

Variety of Materials

- Carbon steel
- 304 Stainless steel
- 316/316L Stainless steel
- Alloy C276
- Inconel
- Brass target only - oxygen applications

All-Welded Construction Available

Remote Transmitter

- High temperature applications
- Location, display not visibile

Remote Transmitter Enclosure

Operating Temperatures

- -65° to 425° F (-54° to 218° C) standard
- -65° to 500° F (-54° to 260° C) extended temp
- -320° to 250° F (-195° to 121° C) cryogenic

FORCEmeter™ Technical Data

FUNCTIONAL	
Fluid Types	Liquids (Reynolds numbers greater than 2000), gases and steam
Bridge Resistance	5000 ohms ± 30 ohms
Operating Pressure	Up to 5000 PSI maximum working pressure Mounting Type / Connections: according to the appropriate ANSI specifications
Operating Temperature	-65° to 425° F (-54° to 218° C) standard -65° to 500° F (-54° to 260° C) extended temp -320° to 250° F (-195° to 121° C) cryogenic
Transmitter Ambient Temperature	-4° to 158° F (-20° to 70° C)
PERFORMANCE	
Accuracy	± 1.0% of rate
Repeatability	± 0.15% of rate
Turn Down	15:1 for 2 wire version; 20:1 for 3 wire version
Response Time	0.3 seconds
Damping	User adjustable 0 to 99 samples
Flow Direction	Unidirectional or bidirectional
Communications	HART® communication signal (superimposed on a 4-20 mA DC signal)
PHYSICAL	
Housing / Flanges	316L stainless steel (standard), others available
Rating	NEMA 4X
Mounting Positions	Horizontal, vertical or on an angle
Typical Straight Pipe Requirements	10 x pipe diameter of straight uninterrupted pipe upstream 5 x pipe diameter of straight uninterrupted pipe downstream
Process Connections	MNPT (0.5” to 3.0”) ANSI Raised Face Flange (Class 150# standard, 0.5” to 6.0”) Wafer (0.5” to 6.0”) AN 37 Degree Flare Tube (0.5” to 2.0”) Fixed Insertion Probes, 2” or 4” ANSI Raised Face Flange (Class 150# standard) Retractable Insertion Probes, 2” or 4” ANSI Raised Face Flange (Class 150# standard)
Transmitter Housing	Integral: Polyester powder coated aluminum, dual cavity Remote: Compression-molded fiberglass Remote Hazardous: Polyester powder coated aluminum, dual cavity
Power	18 to 36 VDC
Line Sizes	Inline 0.5” to 6.0”, Insertion 4.0” to 60”
Electrical Connections	0.75” NPT
Remote Enclosure Rating	NEMA 4X
Remote Enclosure Dimensions	7 x 8.5 x 4.5 inches (17.8 x 21.5 x 11.4 cm) (with tabs)
Maximum Remote Distance	200 ft (61 m)
ACCESSORIES	
	Rate / Total Indicator, Batch Controller, Mass Flow Computer (gases or steam)

Approvals

- CE Electromagnetic Compatibility Directive (EMC)
- FM
  XP Class I, Div 1, Groups B, C, D
  DIP Class II & III, Div 1, Groups E, F, G

NIAGARA® meters

150 Venture Boulevard · Spartanburg, SC 29306
800-778-9251
864-574-3327
sales@niagarameters.com
www.niagarameters.com

FM201106 Rev. E

Submittal Transmittal

Detailed, Grouped by Each Number

UNION COLLEGE COGEN
807 Union Street
Schenectady, NY 12305

Project # 1417
Tel: 518 213-1047 Fax: 518 213-1050

Bette & Cring, LLC

Date: 11/6/2015 **Reference Number: 0246**

Transmitted To:	Aaron Bolhous CHA Power Team 80 King Street Suite 404 St. Catherines, ON L2R 7G1 Tel: (905) 984-8383 Fax: (905) 984-8394	**Transmitted By:**	Patrick Gebbie Bette & Cring, LLC 22 Century Hill Drive Suite 201 Latham, NY 12110 Tel: 518-213-1010 Fax: 518-213-1050

Qty	Submittal Package No	Description	Due Date	Package Action
40 pgs w/covers	0001 - 15120 - 02	Vortex Flowmeter (FIT-101, -102 & -140)	11/13/2015	For Review

Transmitted For	Delivered Via	Tracking Number
Approval	email	FPI#1r2 10/26

Items	Qty	Description	Notes	Item Action
01	38 pgs	Vortex Flowmeter (FIT-101, -102 & -140)		For Review

Cc:	Company Name	Contact Name	Copies	Notes
	CHA Power Team	Aaron Bolhous	1	

Remarks

Signature **Signed Date**

Submittal Packages

Detailed, Grouped by Each Number

UNION COLLEGE COGEN
807 Union Street
Schenectady, NY 12305

Project # 1417
Tel: 518 213-1047 Fax: 518 213-1050

Bette & Cring, LLC

0001-15120-02 Vortex Flowmeter (FIT-101, -102 & -140) **Closed No**

Author Company	Contact	Author Package #	Trade	Importance
FPI Mechanical Inc.	Todd LaFreniere	FPI #1r2 - 10/26	Piping Specialities	Normal

Items

Item No	Register No	Rev	Description	Type	Action	Logged By	Returned	Closed
01	00487	2	Vortex Flowmeter (FIT-101, -102 & -140)	Product Data	For Review	Gebbie	No	No

Reviewers

From Company	To Company	Sent Date	Due Date	Rec'd Date	+/-	Action	Sent For
FPI Mechanical Inc.	Bette & Cring, LLC			10/26/2015			
Bette & Cring, LLC	CHA Power Team	11/6/2015	11/13/2015		-7	For Review	Approval
CHA Power Team	Bette & Cring, LLC						
Bette & Cring, LLC	FPI Mechanical Inc.						

Package Notes:

Second re-submittal of FIT-101, FIT-102 & FIT-140 per previous comments.

Reviewer's General Comments:

PROJECT NAME: **Union College – Combined Heat & Power Project**

SUBMITTAL COVER

Owner:	**Union College**
Engineer:	**CHA**
Contractor:	**Bette & Cring**
Attn:	**Dick White**
Project No.	
FPI Project No. 15519	

Contractor: FPI Mechanical, Inc.

Address: 11 Green Mountain Drive
Cohoes, NY 12047

Trade **Mechanical**

SUBMITTAL No. 01R2 **DATE OF SUBMITTAL: 10-26-2015**

(*CHECK ONE)*

(X) Product Data ( ) Schedule ( ) Performance Data

( ) Sample ( ) Warranty ( ) Operations & Maintenance Data

( ) Color Selection ( ) Test Report ( ) _____

_____

( ) Record Document

DESCRIPTION OF SUBMITTAL

Product Name: **Vortex & Swirl Flowmeters**

Manufacturer: ABB

Subcontractor: **N/A**

Supplier: **RL Stone**

REFERENCES

Section No(s): **Drawing No(s):**

Part/Paragraph: **Detail Ref:**

ARCHITECT'S/ENGINEER'S ACTION

Checked for Fit and Conformity to Specification
FPI Mechanical, Inc.
By: T. LaFreniere
Date: 10-26-2015
Item:
Ref:

RECEIVED STAMPS

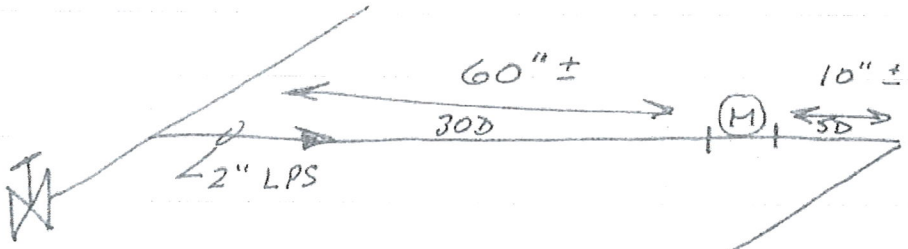
Meters will be provided with 3-point calibration and calibration certificates.
3-valve manifolds are not required since these meters are not pressure devices.
See attached documentation of available straight lengths.
NOTE - FIT-102 to be changed to a Swirl Meter based on available straight length.

Flow Meters

10/22/15

FT-101

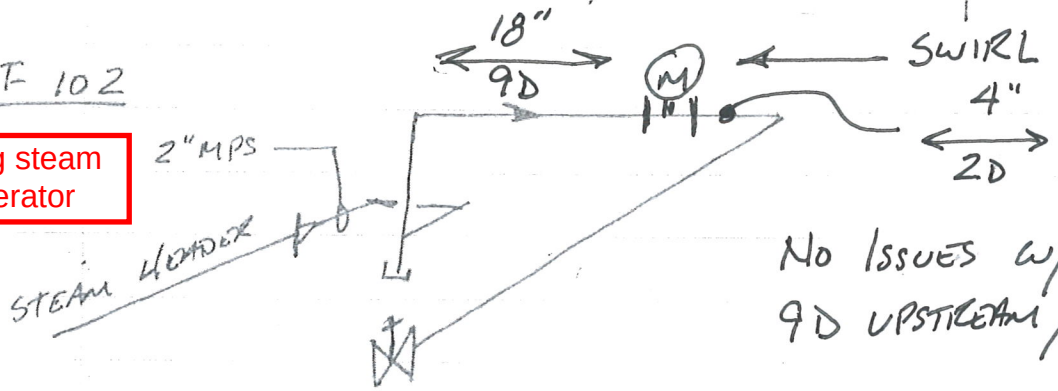
35 psig steam to deaerator



No issue w/ straight lengths
30D upstream / 5D Downstream

FT 102

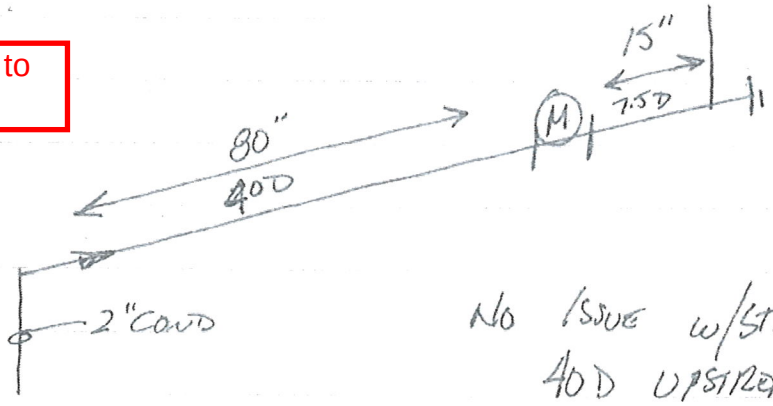
90 psig steam to deaerator



No Issues w/ straight lengths
9D upstream / 2D Downstream

FT-140

Condensate return to deaerator?



No Issue w/ straight lengths
40D upstream / 7.5D Downstream.

Data Sheet DS/FSS430/450-EN Rev. C

SwirlMaster FSS430, FSS450
Swirl flowmeter

Two-wire swirl flowmeter for measurement of the flow of gas, vapor and liquid

Measurement made easy

Easy assembly
- Only the shortest possible straight pipe lengths are required before and after the flowmeter.
- The measuring ranges have been well adapted to the flow rates common in piping systems today.

Intuitive operation
- "Easy Set-up" function
- Clear text display
- Meter configuration through the front glass with closed cover
- Meter diagnosis with help texts in the display

Approvals for explosion protection
- ATEX
- IECEx
- cFMus
- NEPSI

Optional binary output for use as a limit switch, pulse output or frequency output

Optional analog input for connecting external pressure and temperature transmitters or gas analyzers

Integrated flow measurement computer functionality
- Gas standard volume and mass flow
- Vapor mass flow
- Direct energy calculation for vapor and water
- Natural gas calculation in accordance with AGA / SGERG standards

SwirlMaster FSS430, FSS450
Swirl flowmeter

Overview – models

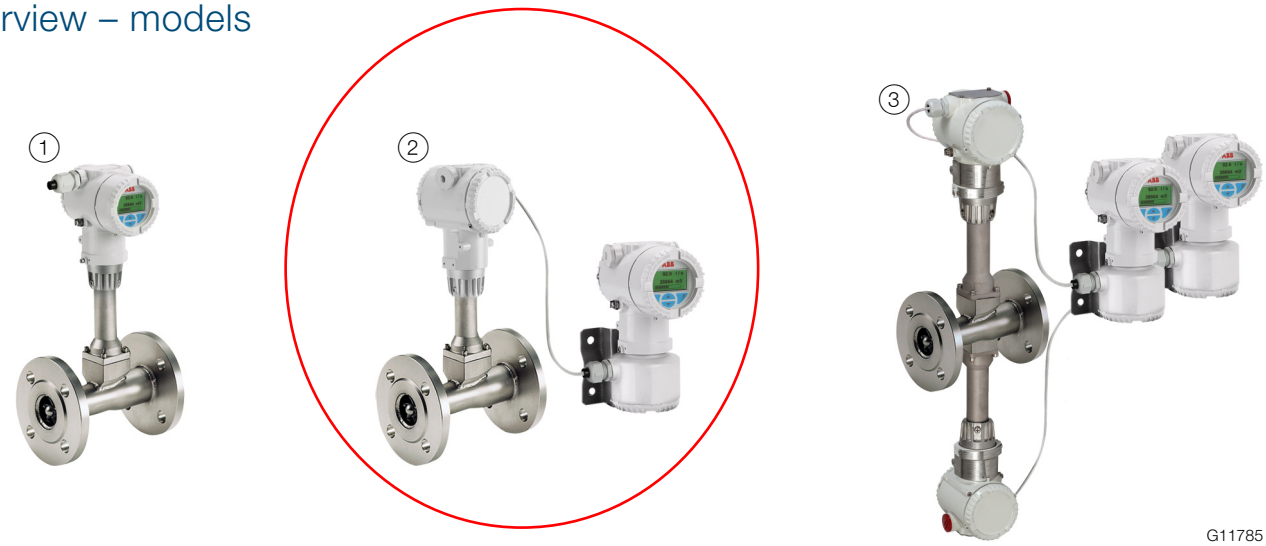


Fig. 1: FSS430 / FSS450
(1) Integral mount design (2) Remote mount design with transmitter (3) Remote mount design with double sensor

Sensor		
Model number	**FSS430**	**FSS450**
Design	Integral mount design, remote mount design	
IP degree of protection in accordance with EN 60529	IP 66 / 67, NEMA 4X	
Measuring accuracy for liquids [1]	≤ ±0.5 % under reference conditions	
Measuring accuracy for gases and vapors [1]	≤ ±0.5 % under reference conditions	
Repeatability [1]	DN 15 ≤ ±0.3 %, from DN 20 ≤ ±0.2 %	
Permissible viscosity for fluids	DN 15 ... 32 ≤ 5 mPa s, DN 40 ... 50 ≤ 10 mPa s, from DN 80 ≤ 30 mPa s	
Measuring span (typical)	1:25	
Process connections	Flange DN 15 .. 400 (0.5" ... 16")	Flange DN 15 .. 400 (0.5" ... 16")
Inlet / outlet sections (typical)	Inlet section: 3 x DN, outlet section 1 x DN, see also chapter „Inlet and outlet sections“ on page 9.	
Temperature measurement	Resistance thermometer Pt100 class A optional, installed in Piezo sensor, can be retrofitted	Resistance thermometer Pt100 class A standard, fixed installation in Piezo sensor
Permissible measuring medium temperature	-55 ... 280 °C (-67 ... 536 °F)	-55 ... 280 °C (-67 ... 536 °F)
Wetted material		
— Sensor	Stainless steel, optional Hastelloy C / titanium	
— Inlet / outlet pipes	Stainless steel, optional Hastelloy C	
— Gasket	PTFE, optional Kalrez or graphite	
— Sensor housing	Stainless steel, optional Hastelloy C	
Sensor design	Piezo sensor with two pairs of sensors for flow measurement and vibration compensation	
Approvals for explosion protection	ATEX / IECEx, cFMus, NEPSI	

1) Indication of accuracy in % of the measured value (% of measured value)

Transmitter		
Model number	**FSS430**	**FSS450**
Display	Optional LCD indicator with 4 push buttons for operation through front glass (option)	Standard LCD indicator with 4 push buttons for operation through front glass
Digital output	Optional, can be configured as pulse output, frequency output, or alarm output via software	Standard, can be configured as pulse output, frequency output, or alarm output via software
Inputs for external sensors	— HART input (HART burst mode) for external pressure transmitter or temperature transmitter	— Analog input 4 ... 20 mA for external pressure transmitters - / temperature transmitter or gas analyzer — HART input (HART burst mode) for external pressure transmitter - / temperature transmitter or gas analyzer
Current output, communication	4 ... 20 mA, HART protocol (HART 7)	
Power supply	12 ... 42 V DC, for devices in explosion-proof design, see chapter „Use in potentially explosive atmospheres“ on page 19.	
SensorMemory	Saves sensor and process parameters for easy commissioning after transmitter replacement	
Housing material	— Aluminum (copper content < 0.3 %), component epoxy coating — Optional: stainless steel CF3M, corresponds to AISI 316L	
IP degree of protection in accordance with EN 60529	IP 66 / 67, NEMA 4X	

SwirlMaster FSS430, FSS450
Swirl flowmeter

Model variants

FSS430

Swirl flowmeter for vapor, liquid and gas, with optional graphical display, optional binary output and optional integrated temperature measurement.

FSS450

Swirl flowmeter for vapor, liquid, and gas, with integrated digital output, temperature compensation and flow computer functionality.
The device offers the option of directly connecting external temperature transmitters, pressure transmitters, or gas analyzers.

Measuring principle

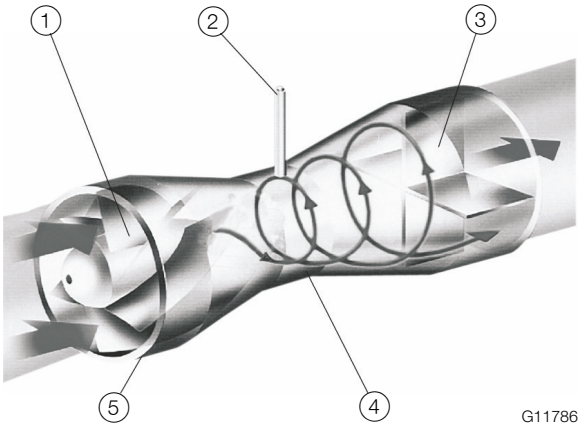


Fig. 2: Measuring principle
(1) Inlet pipe (2) Piezo sensor (3) Outlet pipe
(4) Housing (5) Stagnation point

The inlet pipe converts the axial flow of the incoming measuring medium into rotational movement. In the center of this rotation a vortex core is formed which is forced into a secondary spiral-shaped rotation by the backflow.

The frequency of this secondary rotation is proportional to the flow and, if the internal geometry of the meter measuring device exhibits an optimum design, will be linear over a wide measuring range.
This frequency is measured by a Piezo sensor. The frequency signal from the flowmeter sensor, which is proportional to the flow, undergoes downstream processing in the transmitter.

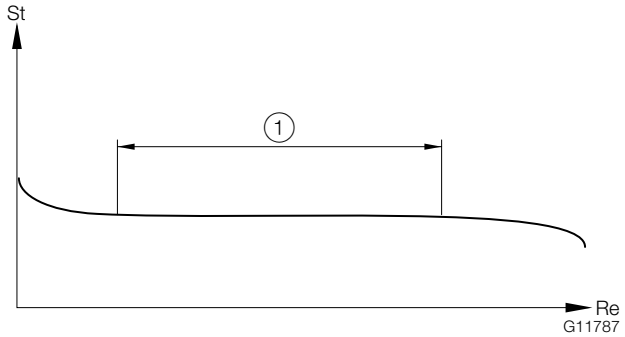


Fig. 3: Dependency of the Strouhal number on the Reynolds number
(1) Linear flow area

Due to the dimensions of the inlet pipe and the inner geometry, the Strouhal number (St) is constant over a very wide range of the Reynolds number (Re).

General data

Nominal diameter selection

The nominal diameter is selected on the basis of the maximum operating flow Qv max. If maximum [measuring] spans are to be achieved, this should not be less than half the maximum flow rate for each nominal diameter (QvmaxDN), although reduction to approx. 0.15 QvmaxDN is possible.
The linear lower range value is dependent on the Reynolds number (see chapter „Measured error and repeatability“ on page 6).

If the flow to be measured is present as a standard flow (standard status: 0 °C (32 °F), 1013 mbar) or mass flow, it must be converted into an operating flow and, from the measuring range tables (see chapter „Measuring range table“ on page 7), the most suited device nominal diameter must be selected.

Formula elements used	
ρ	Operating densities (kg/m^3)
ρ_N	Standard density (kg/m^3)
P	operating pressure (bar)
T	operating temperature (°C)
Q_v	Operating flow (m^3/h)
Q_n	Standard flow (m^3/h)
Q_m	mass flowrate (kg/h)
η	dynamic viscosity (Pas)
ν	Kinematic viscosity (m^2/s)

Conversion of standard density to operating density

$$\rho = \rho_n \times \frac{1{,}013 + \rho}{1{,}013} \times \frac{273}{273 + T}$$

Conversion to operating flow

1. From standard flow (Q_n)

$$Q_V = Q_n \frac{\rho_n}{\rho} = Q_n \frac{1{,}013}{1{,}013 + \rho} \times \frac{273 + T}{273}$$

2. From mass flow (Q_m)

$$Q_V = \frac{Q_m}{\rho}$$

Conversion of dynamic viscosity --> kinematic viscosity

$$\nu = \frac{\eta}{\rho}$$

Calculation of the Reynolds number

$$\mathrm{Re} = \frac{Q}{(2827 \cdot \nu \cdot d)}$$

Q Flow in m3/h
d Pipe diameter in m
ν kinematic viscosity (m^2/s)

The current Reynolds number can also be calculated using the ABB Product Selection Assistant (PSA tool).

Measuring accuracy

Reference conditions

Flow measurement	
Set flow range	0.5 ... 1 x Q_{vmax}DN
Ambient temperature	20 °C (68 °F) ±2 K
Relative humidity	65 %, ±5 %
Air pressure	86 ... 106 kPa
Power supply	24 V DC
Signal cable length (for remote mount design)	30 m (98 ft)
Current output load	250 Ω (only 4 ... 20 mA)
Measuring medium for calibration	Water, approx. 20 °C (68 °F), 2 bar (29 psi)
Calibration loop internal diameter	= internal diameter of meter
Unobstructed straight upstream section	3 x DN
Downstream section	1 x DN
Pressure measurement	3 x DN ... 5 x DN downstream of the flowmeter
Temperature measurement	2 x DN ... 3 x DN downstream after the pressure measurement

Measured error and repeatability

Flow measurement

Measured error in percentage terms from the measured value under reference conditions (including the transmitter) in the linear measuring range between R_{emin} and Q_{max} (see the chapter „Measuring range table“ on page 7).

Measured error (including transmitter)	
Fluids	≤ ± 0.5 %
Gases / Steam	≤ ± 0.5 %
Current output	Additional measuring error < 0.1 %
Temperature effect	< 0.05 % / 10 K

A pipe offset in the inlet or outlet can influence the measured error.
Additional measured errors may occur if there are deviations from the reference conditions.

Reproducibility	
DN 15 (1/2")	0.3 %
DN 25 ... 150 (1 ... 6")	0.2 %
DN 200 ... 400 (8 ... 12")	0.2 %

Temperature measurement

Measured error (including transmitter): ±1 K
Repeatability: ≤ 0.2 % of measured value.

Permitted pipe vibration

The values specified for acceleration g are intended as guide values.
The actual limits will depend on the nominal diameter and the measuring range within the entire [measuring span] and the frequency of the pipe vibration. Therefore, the acceleration value g has only limited meaning.

- Maximum acceleration 20 m/s, 2, 0 ... 150 Hz.
- Acceleration up to 1 g (10 ... 500 Hz) in accordance with IEC 60068-2-6

Ambient conditions

Ambient temperature

In accordance with IEC 60068-2-78

Explosion protection design	$T_{amb.}$
No explosion protection	-40 ... 85 °C (-40 ... 185 °F)
Ex ia, Ex nA	Ex ia and Ex nA: -40 °C < Ta < +85 °C, dependent on Tclass
Ex d, ia, XP	-40 ... 75 °C (-40 ... 167 °F)
IS, NI	-40 ... 75 °C (-40 ... 167 °F)

Relative humidity

Version	Relative humidity
Standard	Maximum 85 %, annual average ≤ 65 %

Measuring medium temperature range

T_{medium}: -55 ... 280 °C (-67 ... 536 °F)

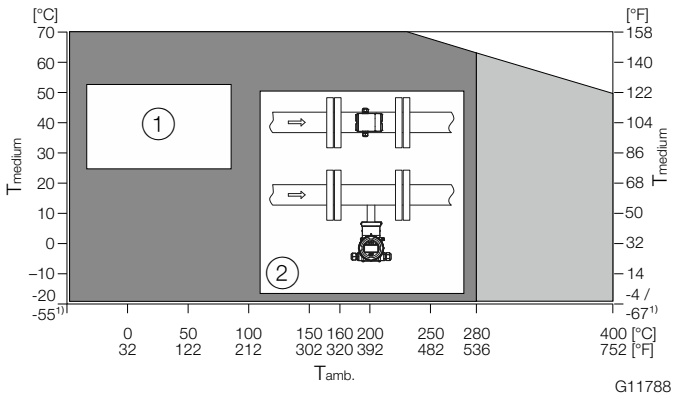


Fig. 4: Measuring medium temperature T_{medium} dependent on the ambient temperature $T_{amb.}$

(1) Permitted temperature range for standard design
(2) Installation for measuring medium temperatures > 150 °C (> 302 °F)

Measuring range table

Flow measurement for liquids

Nominal Diameter	Minimum Reynolds number		Q_{max}DN[3]		Frequency for Q_{max}[4]
	Re1[1]	Re2[2]	[m3/h]	[Usgpm]	[Hz, ±5 %]
DN 15 (1/2")	2100	5000	2.5	11	297
DN 20 (3/4")	3130	5000	4	18	194
DN 25 (1")	5000	7500	8	35	183
DN 32 (1 3/4")	6900	7500	16	70	150
DN 40 (1 1/2")	8400	10000	20	88	116
DN 50 (2")	6000	10000	30	132	100
DN 80 (3")	9000	10000	120	528	89
DN 100 (4")	17500	18000	180	793	80
DN 150 (6")	28500	28500	400	1760	51
DN 200 (8")	30300	30300	700	3082	37
DN 300 (12")	114000	114000	1,600	7045	24
DN 400 (16")	163000	163000	2,500	11000	19

1) Minimum Reynolds number from which the function takes effect. For the precise flowmeter dimensions, use the PSA selection and design tool.
2) Minimum Reynolds number from which the specified accuracy is achieved. Below this value, the measuring error is 0.5 % of Q_{max}.
3) Medium velocity approx. 10 m/s (33 ft/s).
4) For information only, precise values can be found in the test log delivered with the device.

Flow measurement of gases and vapors

Nominal Diameter	Minimum Reynolds number		Q_{max}DN[3]		Frequency for Q_{max}[4]
	Re1[1]	Re2[2]	[m3/h]	[ft3/min]	[Hz, ±5 %]
DN 15 (1/2")	2360	5000	20	12	2380
DN 20 (3/4")	3510	5000	44	26	2140
DN 25 (1")	4150	5000	90	53	2060
DN 32 (1 3/4")	3650	5000	230	135	2150
DN 40 (1 1/2")	6000	7500	300	177	1740
DN 50 (2")	7650	10000	440	259	1450
DN 80 (3")	16950	17000	1160	683	860
DN 100 (4")	11100	12000	1725	1015	766
DN 150 (6")	23300	24000	3800	2237	510
DN 200 (8")	18400	20000	5800	3414	340
DN 300 (12")	31600	32000	13600	8005	225
DN 400 (16")	33500	34000	21500	12655	180

1) Minimum Reynolds number from which the function takes effect. For the precise flowmeter dimensions, use the PSA selection and design tool.
2) Minimum Reynolds number from which the specified accuracy is achieved. Below this value, the measuring error is 0.5 % of Q_{max}.
3) Medium velocity approx. 90 m/s (295 ft/s). For devices with nominal diameter DN 15 (1/2"), the maximum medium velocity is 60 m/s (180 ft/s).
4) For information only, precise values can be found in the test log delivered with the device.

Process connections

Nominal Diameter	Pressure rating
DN 15 ... 200 (1/2" ... 8")	Flange in accordance with DIN: PN 10 ... 40[1)] Flange in accordance with ASME: class 150 / 300[1)]
DN 300 ... 400 (12" ... 16")	Flange in accordance with DIN: PN 10 ... 16[1)] Flange according to ASME: class 150[1)]

1) Higher pressure ratings up to PN 160 / class 900 on request

Materials

Materials for the sensor

Wetted components	Temperature range
Meter tube / conduit body: — Stainless steel 1.4571 (AISI 316 Ti) / AISI 316L / CF8 / CF8C — Hastelloy C (optional)	—
Sensor: — Stainless steel 1.4571 (AISI 316 Ti) — Hastelloy C (optional)	—
Sensor gasket:[1)]	
— PTFE O-ring	-55 ... 260 °C (-67 ... 500 °F)
— Kalrez 6375 O-ring (optional)	-20 ... 275 °C (-4 ... 527 °F)
— Graphite (optional for high-temperature design)	-55 ... 280 °C (-67 ... 536 °F)

Housing	Temperature range
— Stainless steel 1.4571 (AISI 316 Ti) / AISI 316L / CF8 / CF8C — Hastelloy C (optional)	-55 ... 280 °C (-67 ... 536 °F)

1) Other designs on request.

Transmitter

Housing	Temperature range
— Die-cast aluminum, copper content < 0.3 % — Stainless steel CF3M, corresponds to AISI 316L (optional)	-55 ... 85 °C (-67 ... 185 °F)

Material load for process connections

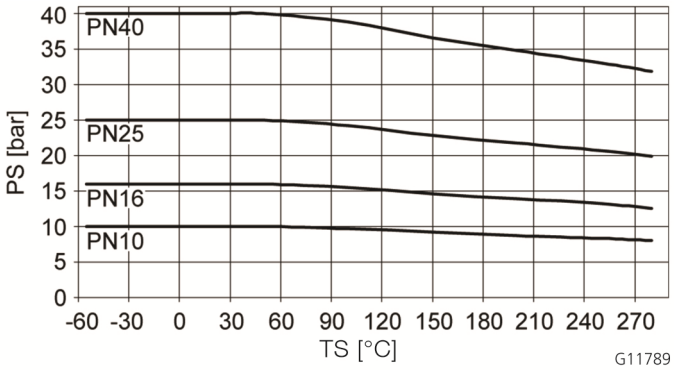


Fig. 5: DIN flange process connection

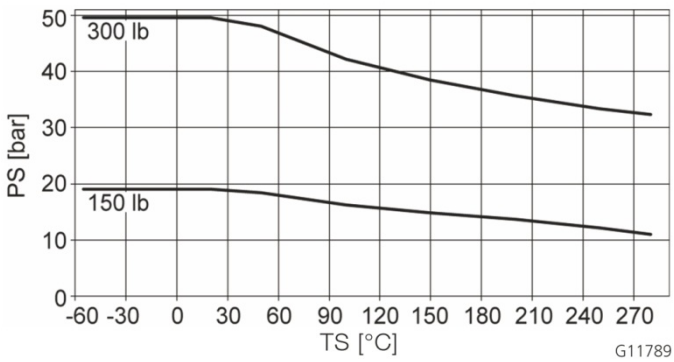


Fig. 6: ASME flange process connection

Installation conditions

General information

A Vortex or Swirl flowmeter can be installed at any point in the pipeline system. However, the following installation conditions must be considered:

- Compliance with the ambient conditions
- Compliance with the recommended inlet and outlet sections
- The flow direction must correspond to that indicated by the arrow on the sensor
- Compliance with the required minimum interval for removing the transmitter and replacing the sensor
- Avoidance of mechanical vibrations of the piping (by fitting supports if necessary)
- The inside diameter of the sensor and the piping must be identical
- Avoidance of pressure oscillations in long piping systems at zero flow by fitting gates at intervals
- Attenuation of alternating (pulsating) flow during piston pump or compressor conveying by using appropriate damping devices. The residual pulse must not exceed 10 %. The frequency of the conveying equipment must not be within the range of the measuring frequency of the flowmeter.
- Valves / gates should normally be arranged in the flow direction downstream of the flowmeter (typically: 3 x DN). If the measuring medium is conveyed through piston pumps / plunger pumps or compressors (pressures for fluids > 10 bar [145 psi]), it may be subject to hydraulic vibration in the piping when the valve is closed. If this does occur, the valve absolutely has to be installed in the flow direction upstream of the flowmeter. Suitable damping devices (e.g. air vessels) might need to be fitted.
- When fluids are measured, the sensor must always be filled with measuring medium and must not run dry.
- When fluids are measured and during damping, there must be no evidence of cavitation.
- The relationship between the measuring medium and the ambient temperature must be taken into consideration (see data sheet).
- At high measuring medium temperatures > 150 °C (> 302 °F), the sensor must be installed so that the transmitter or terminal box is pointing to the side or downward.

Inlet and outlet sections

On account of its operating principle, the swirl flowmeter functions virtually without inlet and outlet sections.
The figures below show the recommended inlet and outlet sections for various installations.

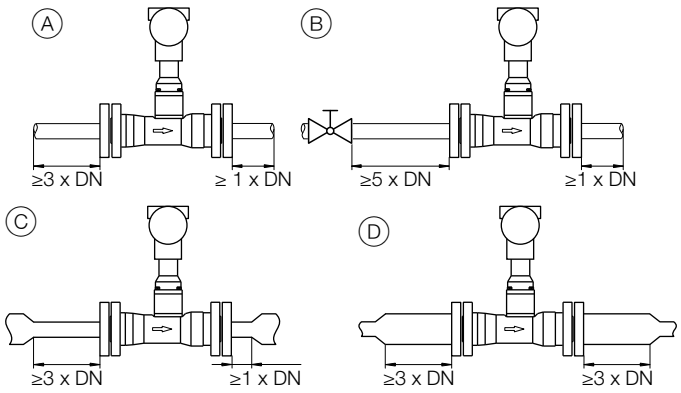


Fig. 7: Straight pipe sections

Installation	Inlet section	Outlet section
(A) Straight pipe section	min. 3 x DN	min. 1 x DN
(B) Valve upstream of the meter tube	min. 5 x DN	min. 1 x DN
(C) Pipe reduction	min. 3 x DN	min. 1 x DN
(D) Pipe extension	min. 3 x DN	min. 3 x DN

Additional inlet and outlet sections are not required downstream of reductions with flange transition pieces in accordance with DIN 28545 (α/2 = 8°).

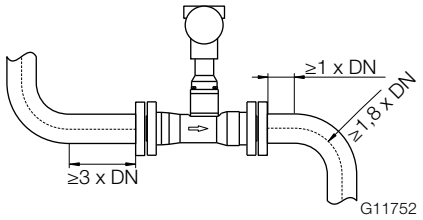


Fig. 8: Pipe sections with pipe elbows

Installation	Inlet section	Outlet section
Single pipe elbow upstream or downstream of the meter tube	min. 3 x DN	min. 1 x DN

If the elbow radius of single or double pipe elbows positioned upstream or downstream of the device is greater than 1.8 x DN, inlet and outlet sections are not required.

Avoiding cavitation

To avoid cavitation, a static overpressure is required downstream of the flowmeter (downstream pressure). This can be estimated using the following formula:

$p_1 \geq 1{,}3 \times p_2 + 2{,}6 \times \Delta p'$

ρ_1 Static gauge pressure downstream of the device (mbar)

ρ_2 Steam pressure of fluid at operating temperature (mbar)

$\Delta\rho'$ Pressure drop, measuring medium (mbar)

Installation at high measuring medium temperatures

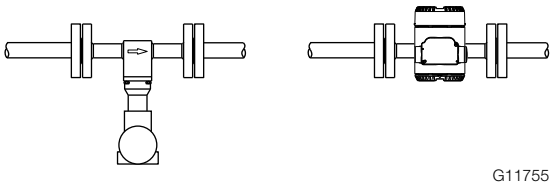


Fig. 9: Installation at high measuring medium temperatures

At high measuring medium temperatures > 150 °C (> 302 °F), the sensor must be installed so that the transmitter is pointing to the side or downward.

Installation for external pressure and temperature measurement

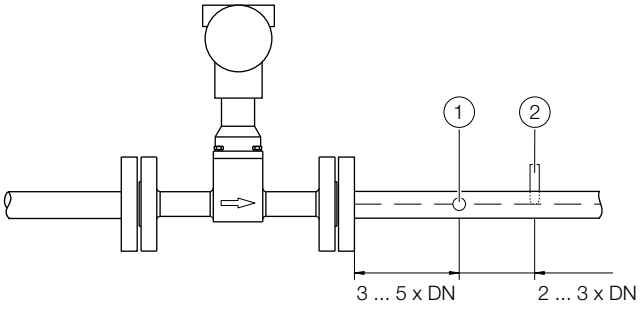


Fig. 10: Arrangement of the temperature and pressure measuring points

(1) Pressure measuring point (2) Temperature measuring point

As an option, the flowmeter can be fitted with a Pt100 for direct temperature measurement. This temperature measurement enables, for example, the monitoring of the measuring medium temperature or the direct measurement of saturated steam in mass flow units.
If pressure and temperature are to be compensated externally (e.g. with the flow computer unit), the measuring points must be installed as illustrated.

Installation of final controlling equipment

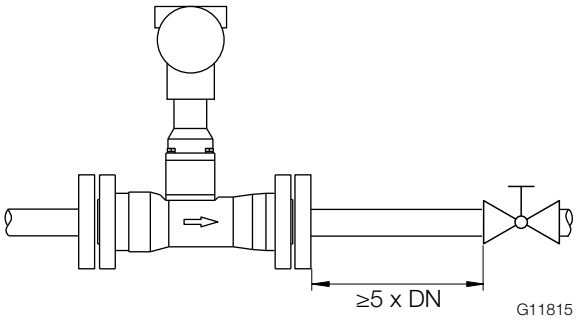


Fig. 11: Installation of final controlling equipment

Final controlling equipment must be arranged at the outflow end spaced at a minimum 5 x DN.
If the measuring medium is conveyed through piston pumps / plunger pumps or compressors (pressures for fluids > 10 bar [145 psi]), it may be subject to hydraulic vibration in the piping when the valve is closed.
If this does occur, it is essential that the valve be installed in the flow direction upstream of the flowmeter.
Suitable damping devices (such as air vessels if using a compressor for conveying) may need to be used.

The SwirlMaster FSS400 is particularly well suited for such arrangements.

Sensor insulation

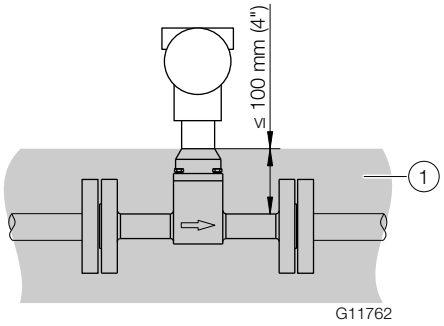


Fig. 12: Insulation of the meter tube
(1) Insulation

The piping can be insulated up to a thickness of 100 mm (4 inch).

Use of trace heating

Trace heating may be used under the following conditions:
- If it is installed directly on or around the piping
- If, in the case of existing pipeline insulation, it is installed inside the insulation (the maximum thickness of 100 mm [4 inch] must not be exceeded)
- If the maximum temperature the trace heating is able to produce is less than or equal to the maximum medium temperature.

NOTE
The installation requirements set out in EN 60079-14 must be observed.
Please note that the use of trace heaters will not impair EMC protection or generate additional vibrations.

Dimensions

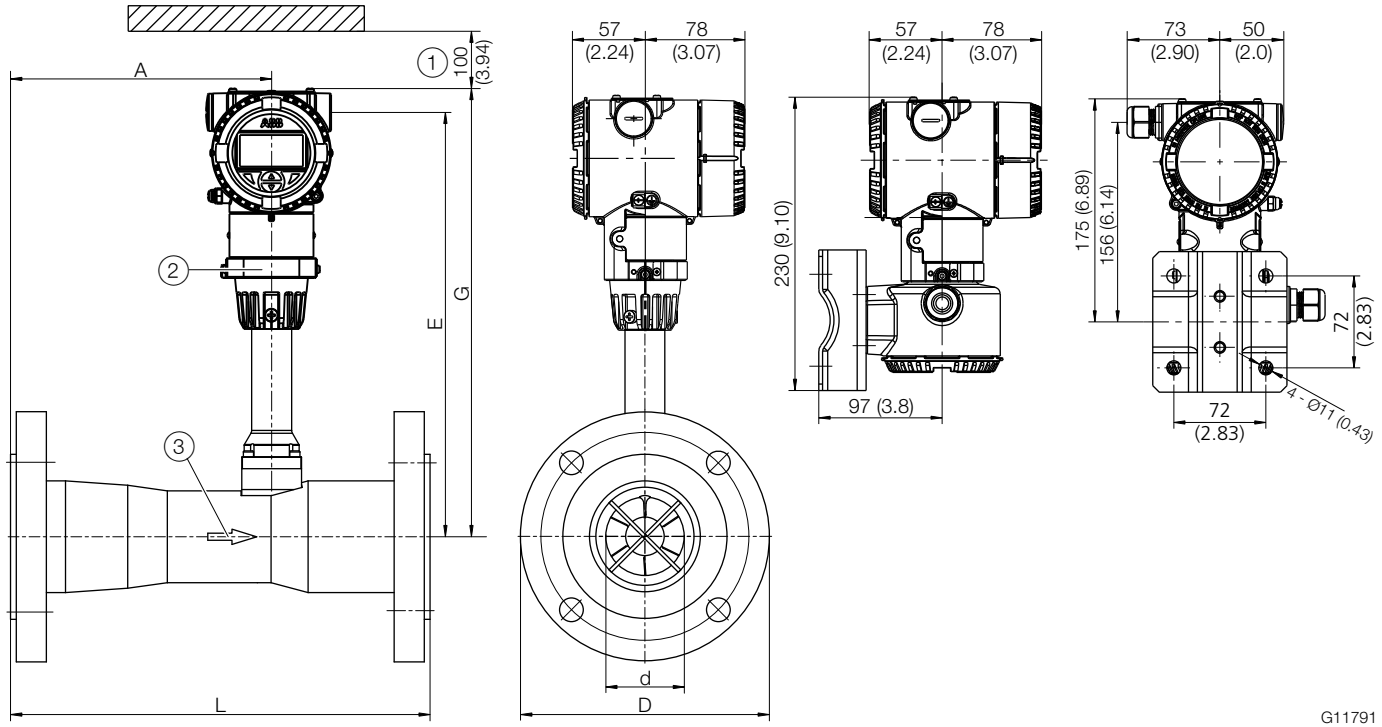


Fig. 13: Dimensions in mm (inches)
(1) Required minimum distance for removal of the transmitter and removal of the sensor unit (2) Can be rotated up to 360° (3) Flow direction

Dimensions for sensors with DIN flanges

Nominal Diameter	Pressure rating	L	G	E	A	D	d	Weight [kg (lb)]
DN 15	PN 10 ... 40	200 (7.87)	346 (13.62)	327 (12.87)	83 (3.27)	95 (3.74)	17.3 (0.68)	5.8 (12.8)
DN 20	PN 10 ... 40		349 (13.74)	330 (12.99)	68 (2.68)	105 (4.13)	22.6 (0.89)	2.4 (5.3)
DN 25	PN 10 ... 40	150 (5.91)	348 (13.70)	329 (12.95)	67 (2.64)	115 (4.53)	28.1 (1.11)	3.5 (7.7)
DN 32	PN 10 ... 40		346 (13.62)	327 (12.87)	68 (2.68)	140 (5.51)	37.1 (1.46)	4.7 (10.4)
DN 40	PN 10 ... 40	200 (7.87)	350 (13.78)	331 (13.03)	79 (3.11)	150 (5.91)	42.1 (1.66)	8 (17.6)
DN 50	PN 10 ... 40		353 (13.89)	334 (13.15)	106 (4.17)	165 (6.50)	51.1 (2.01)	7.2 (15.9)
DN 80	PN 10 ... 40	300 (11.81)	356 (14.01)	337 (13.26)	159 (6.26)	200 (7.87)	82.6 (3.25)	12.2 (26.9)
DN 100	PN 10 ... 16	350 (13.78)	360 (14.17)	341 (13.42)	189 (7.44)	220 (8.66)	101.1 (3.98)	14.2 (31.3)
	PN 25 ... 40					235 (9.25)	101 (3.98)	18 (39.7)
DN 150	PN 10 ... 16	480 (18.90)	384 (15.12)	365 (14.37)	328 (12.91)	285 (11.22)	150.1 (5.91)	28.5 (62.8)
	PN 25 ... 40					300 (11.81)	150.1 (5.91)	34.5 (76.1)
DN 200	PN 10 / PN 16	600 (23.62)	404 (15.90)	385 (15.15)	436 (17.17)	340 (13.39)	203.1 (8.00)	50 (110.2)
	PN 25 / PN 40					360 / 375 (14.17 / 14.76)	203.1 (8.00)	59 / 66 (130.1 / 145.5)
DN 300	PN 10 / PN 16	1000 (39.37)	450 (17.71)	431 (16.97)	662 (26.06)	445 / 460 (17.52 / 18.11)	309.7 (12.19)	171 / 186 (377.0 / 410.1)
DN 400	PN 10 / PN 16	1274 (50.16)	486 (19.13)	467 (18.38)	841 (33.11)	565 / 580 (22.24 / 22.83)	390.4 (15.37)	245 / 266 (540.1 / 586.4)

Tolerance for dimension L: DN 15 ... 200 +0 / -3 mm (+0 / -0.12 inch), DN 300 ... 400 +0 / -5 mm (+0 / -0.20 inch)

Dimensions for sensors with ASME flanges								
Nominal Diameter	Pressure rating	L	G	E	A	D	d	Weight [kg (lb)]
1/2"	CL 150	200 (7.87)	346 (13.62)	327 (12.87)	83 (3.27)	88.9 (3.5)	15.8 (0.62)	5.3 (11.7)
	CL 300					95.2 (3.75)		5.8 (12.8)
3/4"	CL 150	220 (8.66)	349 (13.74)	330 (12.99)	68 (2.68)	98.4 (3.87)	22.6 (0.89)	2.1 (4.6)
	CL 300	230 (9.06)				117.5 (4.63)		3.0 (6.6)
1"	CL 150	150 (5.91)	348 (13.70)	329 (12.95)	67 (2.64)	108 (4.25)	28.1 (1.1)	3.4 (7.5)
	CL 300					124 (4.88)		3.6 (7.9)
1 1/4"	CL 150	150 (5.91)	346 (13.62)	327 (12.87)	68 (2.68)	118 (4.65)	37.1 (1.46)	3.7 (8.2)
	CL 300					133 (5.24)		5.4 (11.9)
1 1/2"	CL 150	200 (7.87)	350 (13.78)	331 (13.03)	79 (3.11)	127 (5)	42.1 (1.66)	6.8 (15)
	CL 300					155.6 (6.13)		8.9 (19.6)
2"	CL 150	200 (7.87)	353 (13.89)	334 (13.15)	106 (4.17)	152.4 (6)	51.1 (2.01)	7.1 (15.7)
	CL 300					165 (6.5)		9.8 (21.61)
3"	CL 150	300 (11.81)	356 (14.01)	337 (13.26)	159 (6.26)	190.5 (7.5)	82.6 (3.25)	11.7 (25.8)
	CL 300					209.5 (8.25)		16.2 (35.7)
4"	CL 150	350 (13.78)	360 (14.17)	341 (13.26)	189 (7.44)	228.6 (9)	101.1 (3.98)	18.0 (39.7)
	CL 300					254 (10)		27.5 (60.6)
6"	CL 150	480 (18.9)	384 (15.12)	365 (14.37)	328 (12.9)	279.4 (11)	150.1 (5.91)	30.0 (66.1)
	CL 300					317.5 (12.5)		46.0 (101.4)
8"	CL 150	600 (23.62)	404 (15.90)	385 (15.15)	436 (17.17)	343 (13.5)	203.1 (8)	45.0 (99.2)
	CL 300					381 (15)		75 (165.4)
12"	CL 150	1000 (39.37)	450 (17.71)	431 (16.97)	662 (26.1)	482.6 (19)	309.7 (12.19)	182 (401.2)
16"	CL 150	1274 (50.16)	486 (19.13)	467 (18.38)	841 (33.1)	596.9 (23.5)	390.4 (15.37)	260 (573.2)

Tolerance for dimension L: 1/2" ... 8" +0 / -3 mm (+0 / -0.12 inch), 12" ... 16" +0 / -5 mm (+0 / -0.20 inch)

Transmitter specifications

General remarks

The transmitter uses two-wire technology. The same wires are used for the power supply and the analog and digital communication.

Features

- 4 ... 20 mA current / HART 7 output.
- Current output for an alarm can be configured to 21 ... 23 mA (NAMUR NE43).
- Measuring range: Can be configured between 0.15 ... 1 x Q_{max}DN.
- Operating mode can be configured for the flow measurement (see chapter „Operating modes“ on page 14).
- Programmable digital output. Can be configured as frequency output, pulse output or binary output (option for FSx430, standard for FSx450).
- Programmable analog input 4 ... 20 mA for connection of external sensors, e.g. pressure or temperature sensor (only for FSx450).
- Parameterization by means of HART communication.
- Damping: 0.2 ... 100 s configurable (1 τ).
- Low flow cut-off: 0 ... 5 % for current and pulse output.
- Measuring medium parameters can be changed at any time (pressure and temperature influence, density, units, etc.).
- Simulation of current and binary output (manual process execution).

Operating modes

The following operating modes can be selected depending on the design.

Liquid measuring medium	Gas / vapor measuring medium
— Liquid volumes	— Gas volumes
— Liquid standard volumes (temperature-compensated)	— Gas standard volumes
— Liquid mass	— Gas mass
— Liquid energy[1)]	— Gas energy[1)]
	— Biogas volumes
	— Biogas standard volumes
	— Vapor volumes
	— Vapor mass
	— Vapor energy[1)]

1) For FSx450 only

LCD indicator (option)

- High-contrast LCD indicator.
- Display of the current flow rate as well as the total flow rate or the temperature of the measuring medium (optional).
- Application-specific visualizations which the user can select. Four operator pages can be configured to display multiple values in parallel.
- Plain text fault diagnostics
- Menu-guided parameterization with four buttons.
- "Easy Set-up" function for fast commissioning.
- Parameterization of the device through the front glass with the housing closed.
- During ongoing operation, the LCD indicator can be connected or disconnected and therefore also used as a configuration tool for other devices.

IP decree of protection

- IP 66 / 67 in accordance with EN 60529
- NEMA 4x
- "Dual seal device" in accordance with ANSI/ISA 12.27.01. Only for devices with explosion-proof design with hazardous area electrical certification "Ex d" or "XP".

Electromagnetic compatibility

Electromagnetic compatibility of equipment for process and lab control technology 5/93 and EMC Directive 2004/108/EC (EN 61326-1).
The transmitter is optionally available with EMC protection in accordance with NAMUR NE 21.

NOTE

When the housing is open, EMC protection or protection against accidental contact is restricted.

EMC / HF effect on the current output

Tested in accordance with EN 61326.
Output error of less than ±0.025 % of the measuring range for twisted pair cables in the range:

- 80 ... 1000 MHz for radiated field strength of 10 V/m;
- 1.4 ... 2.0 GHz for radiated field strength of 3 V/m;
- 2.0 ... 2.7 GHz for radiated field strength of 1 V/m.

Magnetic field disruptions in the current output

Tested in accordance with EN 61326.
Output error of less than ±0.025% of the measuring range at 30 A/m (eff.).

Remote mount design

In remote mount design, the sensor and transmitter are connected by a signal cable up to 30 m (98 ft) long.
The signal cable is permanently connected to the transmitter and can be made shorter if required.

Electrical connections

Electrical connection

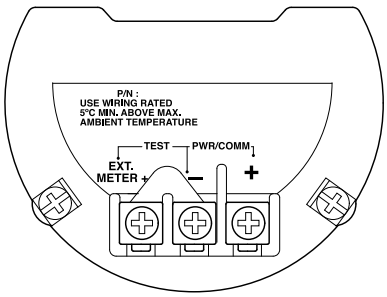


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Fig. 14: Terminals without digital output

Terminal	Function / comment
PWR/COMM +	Power supply, current output / HART output
PWR/COMM -	
EXT. METER	Not assigned

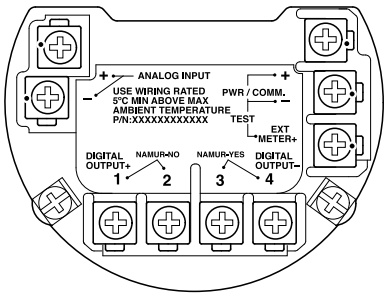

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Fig. 15: Terminals with digital output and analog input

Terminal	Function / comment
PWR/COMM +	Power supply, current output / HART output
PWR/COMM -	
EXT. METER +	Current output 4 ... 20 mA for external display
DIGITAL OUTPUT 1+	Digital output, positive pole
DIGITAL OUTPUT 2	Bridge after terminal 1+, NAMUR output deactivated
DIGITAL OUTPUT 3	Bridge after terminal 4-, NAMUR output activated
DIGITAL OUTPUT 4-	Digital output, negative pole
ANALOG INPUT +	Analog input 4 ... 20 mA for remote transmitter, e.g. for temperature, pressure, etc.
ANALOG INPUT -	

Connection examples

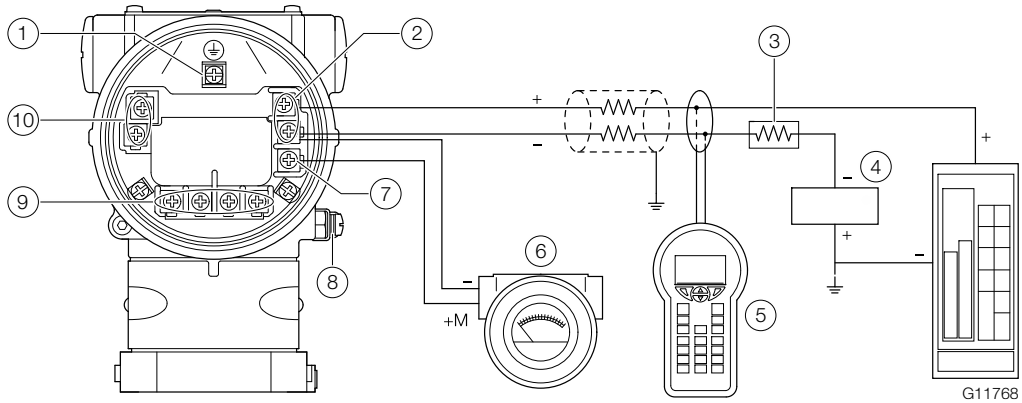

Fig. 16: Connection example
(1) **Internal earthing terminal** (2) **Power supply, current / HART output** (3) **Load resistance** (4) **Power supply** (5) **Handheld terminal** (6) **External display** (7) **Terminal for external display** (8) **External earthing terminal** (9) **Digital output** (10) **Analog input**

For connecting the signal voltage / supply voltage, twisted cables with a conductor cross-section of 18 … 22 AWG / 0.8 … 0.35 mm^2 and a maximum length of 1500 m (4921 ft) must be used. For longer leads a greater cable cross section is required.
For shielded cables the cable shielding must only be placed on one side (not on both sides).
For the earthing on the transmitter, the inner terminal with the corresponding marking can also be used.
The output signal (4 20 mA) and the power supply are conducted via the same conductor pair.
The transmitter works with a supply voltage between 12 ... 42 V DC. For devices with the type of protection "Ex ia, intrinsic safety" (FM, CSA, and SAA approval), the supply voltage must not exceed 30 V DC. In some countries the maximum supply voltage is limited to lower values. The permissible supply voltage is specified on the name plate on the top of the transmitter.

The possible lead length depends on the total capacity and the total resistance and can be estimated based on the following formula.

$$L = \frac{65 \times 106}{R \times C} - \frac{Ci + 10000}{C}$$

L	Lead length is meters
R	Total resistance in Ω
C	Lead capacity
C_i	Maximum internal capacity in pF of the HART field devices in the circuit

Avoid installing the cable together with other power leads (with inductive load, etc.), as well as the vicinity to large electrical installations.
The HART handheld terminal can be connected to any connection point in the circuit if a resistance of at least 250 Ω is present in the circuit. If there is resistance of less than 250 Ω, an additional resistor must be provided to enable communication. The handheld terminal is connected between the resistor and transmitter, not between the resistor and the power supply.

Electrical data for inputs and outputs
Power supply, current output / HART output

Power supply, current output / HART output	
Supply voltage	12 ... 42 V DC
Residual ripple	Maximum 5 % or ±1.5 Vpp
Power consumption	< 1 W

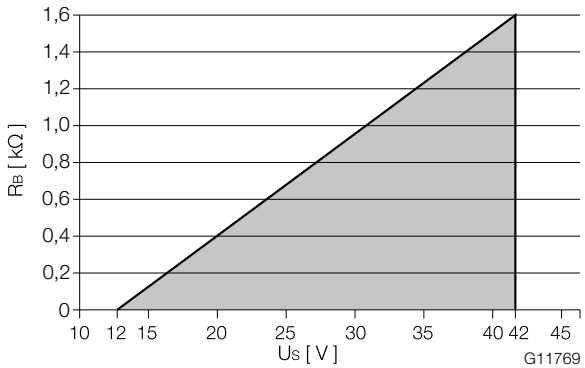

Fig. 17: Load diagram of the current output; load vs. supply voltage

In HART communication, the smallest load is 250 Ω. The load R_B is calculated as a function of the available supply voltage U_S and the selected signal current I_B as follows:

$R_B = U_S / I_B$

R_B Load resistance

U_S Supply voltage

I_B SignalStrom

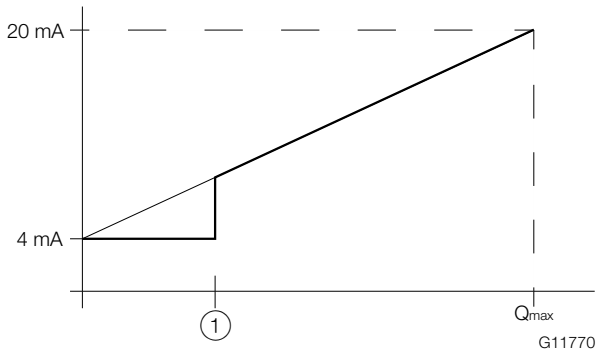

Fig. 18: Behavior of the current output
(1) Low flow cut-off

The measured value at the current output behaves as shown in the figure.
The current curve proceeds above the low flow as a straight line, which in the Q = 0 operating mode has the value 4 mA and in the Q = Q_{max} operating mode has the value 20 mA.
Due to the low flow cut-off, the flow is set to below x % Qmax or the low flow is set to 0, meaning the current is 4 mA.

Digital output

The devices can be ordered with an optional digital output. This output can be configured by software as:

— Frequency output (up to 10.5 kHz)
— Pulse output (up to 2 kHz)
— Logic output (on / off, e.g. to display an alarm signal)

Digital output	
Operating voltage	16 ... 30 V DC
Output current	Maximum 20 mA
Output "closed"	0 V ≤ U_{low} ≤ 2 V 2 mA ≤I_{low} ≤ 20 mA
Output "open"	16 V ≤ U_{high} ≤ 30 V 0 mA ≤I_{high} ≤ 0.2 mA
Pulse output	f_{max}: 10 kHz Pulse width: 0.05 ... 2000 ms
Frequency output	f_{max}: 10.5 kHz

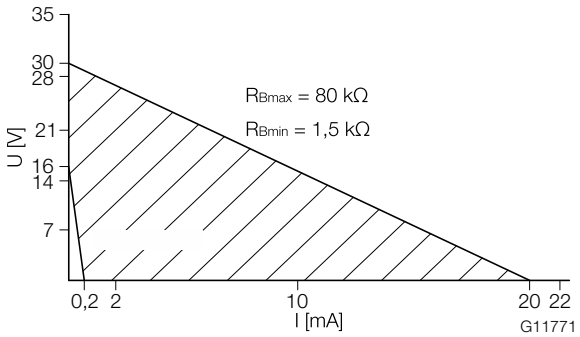

Fig. 19: Range of the external supply voltage and current

The external resistance R_B is in the range of 1.5 kΩ ≤ R_B ≤ 80 kΩ, as shown in Fig. 19.

Analog input 4 ... 20 mA

At the analog input (4 ... 20 mA), an external pressure transmitter (e.g. ABB pressure transmitter model 261 / 266), an external temperature transmitter, a gas analyzer for the net methane content in the case of biogas, a density meter or a mass meter for a density signal can be connected.
The analog input can be configured using the relevant software as:

- Input for the pressure measurement for pressure compensation for the flow measurement of gases and vapor.
- Input for the return temperature measurement for energy measurement.
- Input for the gas content for the net metering of methane (biogas).
- Input for the density measurement for calculation of the mass flow.

Current input	
Terminals	ANALOG INPUT+ / ANALOG INPUT-
Operating voltage	16 ... 30 V DC
Input current	3.8 ... 20.5 mA
Equivalent resistance	90 Ω

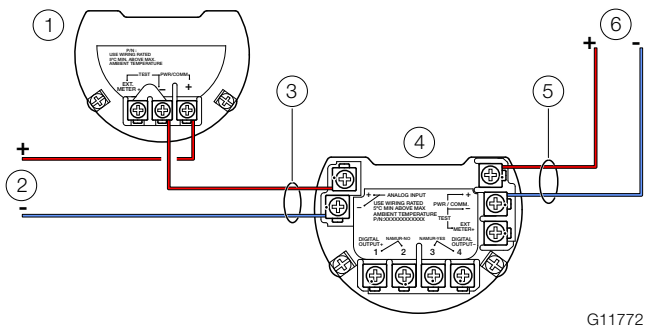

Fig. 20: Connection of transmitters at the analog input (example)
(1) Remote transmitter (2) Power supply for the remote transmitter
(3) Cable entry for the analog input (4) SwirlMaster FSS430, FSS450
(5) Cable entry for the current output
(6) Power supply SwirlMaster FSS430, FSS450

HART communication with remote transmitter

As the device has a two-wire technology design, an external pressure or temperature transmitter with HART communication (e.g. ABB pressure transmitter model 261 / 266) can be connected via the current / HART output (4 ... 20 mA).
The remote transmitter must be operated in HART burst mode.
The SwirlMaster FSS430, FSS450 transmitter supports HART communication up to the HART7 protocol.

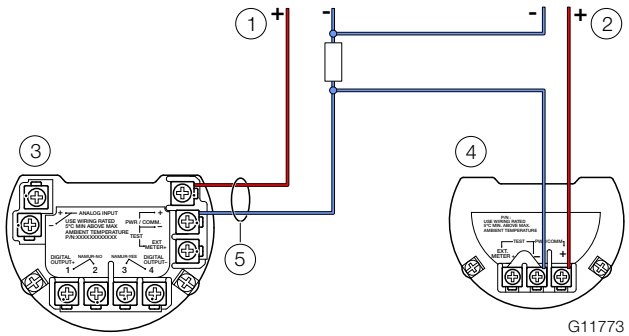

Fig. 21: Connection of transmitters with HART communication (example)
(1) Power supply SwirlMaster FSS430, FSS450
(2) Power supply for the remote transmitter
(3) SwirlMaster FSS430, FSS450 (4) Remote transmitter
(5) Cable entry for the current output

Use in potentially explosive atmospheres

Zone 2, 22 - type of protection "non-sparking"

Ex-marking

ATEX	
Order code	B1
Type examination certificate	FM13ATEX0056X
II 3G Ex nA IIC T4 to T6 Gc	
II 3 D Ex tc IIIC T85 °C DC	
For electrical parameters, see certificate FM13ATEX0056X	

IECEx	
Order code	N1
Certificate of conformity	IECEx FME 13.0004X
Ex nA IIC T4 to T6 Gc	
Ex tc IIIC T85 °C DC	
For electrical parameters, see certification IECEx FME 13.0004X	

FM approval for USA and Canada	
Order code	F3
CL I, ZONE 2 AEx/Ex nA IIC T6, T5, T4	
CL I/DIV 2/GP ABCD	
NI CL 1/DIV 2/GP ABCD, DIP CL II,III/DIV 2/GP EFG	
Housing: TYPE 4X	

NEPSI	
Order code	S2
Ex nA IIC T4 to T6 Gc	
DIP A22 Ta 85 °C	
For electrical parameters, see certificate GYJ14.1088X	

Power supply

Ex nA U_B = 12 ... 42 V DC

Switch output

The switch output is designed as an optoelectronic coupler or a NAMUR contact (in accordance with DIN 19234).

— When the NAMUR contact is closed, the internal resistance is approx. 1000 Ω.
— When the contact is open, the internal resistance is > 10 kΩ.

The switch output can be changed over to "optoelectronic coupler" if required.

— NAMUR with switching amplifier
— Switch output
  Ex nA: U_B = 16 ... 30 V, I_B = 2 ... 30 mA

Electrical data

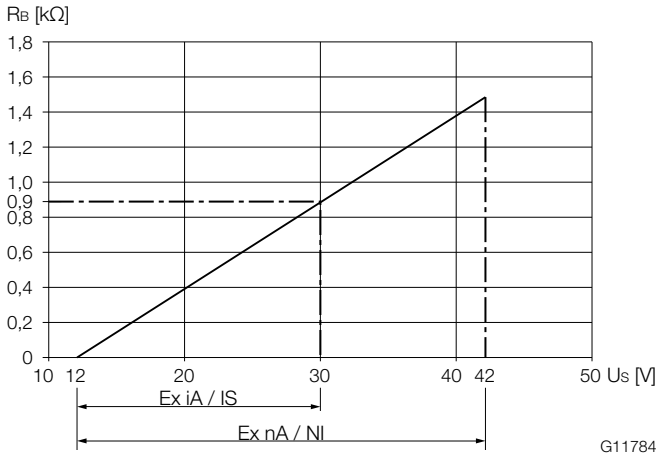

Fig. 22: Power supply in Zone 2, explosion protection, non-sparking

The minimum voltage U_S of 12 V is based on a load of 0 Ω.

U_S Supply voltage

R_B Maximum permissible load in the power supply circuit, e.g. indicator, recorder or power resistor.

Power supply / current output / HART output	
Terminals	PWR/COMM + / PWR/COMM -
U_M	45 V
Zone 2: Ex nA IIC T4 to T6 Gc	
T_{amb} = -40 ... 85 °C*	
Zone 22 Ex tc IIIC T85 °C Dc	
T_{amb} = -40 ... 75 °C	
CL I, ZONE 2 AEx/Ex nA IIC T6, T5, T4	
CL I/DIV 2/GP ABCD TYPE 4X	
NI CL 1/DIV 2/GP ABCD, DIP CL II,III/DIV 2/GP EFG	
Housing: TYPE 4X	

Digital output	
Terminals	DIGITAL OUTPUT 1+ / DIGITAL OUTPUT 4-
U_M	45 V
Zone 2: Ex nA IIC T4 to T6 Gc	
Zone 22 Ex tc IIIC T85 °C Dc	
T_{amb} = -40 ... 75 °C [1)]	
CL I, ZONE 2 AEx/Ex nA IIC T6, T5, T4	
CL I/DIV 2/GP ABCD TYPE 4X	
NI CL 1/DIV 2/GP ABCD, DIP CL II,III/DIV 2/GP EFG	

1) See temperature ranges in the chapter titled „Temperature data“ on page 20.

Analog input	
Terminals	ANALOG INPUT + / ANALOG INPUT -
U_M	45 V
Zone 2: Ex nA IIC T4 to T6 Gc	
Zone 22 Ex tc IIIC T85 °C Dc	
T_{amb} = -40 ... 85 °C	
CL I, ZONE 2 AEx/Ex nA IIC T6, T5, T4	
CL I/DIV 2/GP ABCD TYPE 4X	
NI CL 1/DIV 2/GP ABCD, DIP CL II,III/DIV 2/GP EFG	

Special Requirements

The devices must be installed in a protected environment in accordance with the specific conditions on the test certificate. Pollution degree 3 (see IEC 60664-1) must not be exceeded for the macro environment of the device.
The devices are in accordance with the IP rating IP66 / IP67. If the device is installed correctly, this requirement is met by the housing as standard.
When connected to the power supply / not connected to the power supply, the electrical circuits must not exceed overvoltage category III / II.

Temperature data

Operating temperature ranges:

- The ambient temperature range $T_{amb.}$ is -40 ... 85 °C (-40 ... 185 °F).
- This is dependent on the temperature class and measuring medium temperature, as listed in the following tables.
- The measuring medium temperature T_{medium} is -200 ... 400 °C (-328 ... 752 °F).

Without LCD indicator

Temperature class	$T_{amb.}$ max.	T_{medium} max.
T4	≤ 85 °C	90 °C
	≤ 82 °C	180 °C
	≤ 81 °C	280 °C
	≤ 79 °C	400 °C
T4	≤ 70 °C	90 °C
	≤ 67 °C	180 °C
	≤ 66 °C	280 °C
	≤ 64 °C	400 °C
T5	≤ 56 °C	90 °C
	≤ 53 °C	180 °C
	≤ 52 °C	280 °C
	≤ 50 °C	400 °C
T6	≤ 44 °C	90 °C
	≤ 41 °C	180 °C
	≤ 40 °C	280 °C
	≤ 38 °C	400 °C

With LCD indicator, order code L1

Temperature class	$T_{amb.}$ max.	T_{medium} max.
T4	≤ 85 °C	90 °C
	≤ 82 °C	180 °C
	≤ 81 °C	280 °C
	≤ 79 °C	400 °C
T4	≤ 70 °C	90 °C
	≤ 67 °C	180 °C
	≤ 66 °C	280 °C
	≤ 64 °C	400 °C
T5	≤ 40 °C	90 °C
	≤ 37 °C	180 °C
	≤ 36 °C	280 °C
	≤ 34 °C	400 °C
T6	≤ 40 °C	90 °C
	≤ 37 °C	180 °C
	≤ 36 °C	280 °C
	≤ 34 °C	400 °C

With LCD indicator, order code L2 (operation through the front glass)

Temperature class	$T_{amb.}$ max.	T_{medium} max.
T4	≤ 60 °C	90 °C
	≤ 57 °C	180 °C
	≤ 56 °C	280 °C
	≤ 54 °C	400 °C
T4	≤ 60 °C	90 °C
	≤ 57 °C	180 °C
	≤ 56 °C	280 °C
	≤ 54 °C	400 °C
T5	≤ 56 °C	90 °C
	≤ 53 °C	180 °C
	≤ 52 °C	280 °C
	≤ 50 °C	400 °C
T6	≤ 44 °C	90 °C
	≤ 41 °C	180 °C
	≤ 40 °C	280 °C
	≤ 38 °C	400 °C

Zone 0, 1, 20, 21 - type of protection "intrinsically safe" Ex-marking

ATEX	
Order code	A4
Type examination certificate	FM13ATEX0055X
II 1 G Ex ia IIC T4 to T6 Ga	
II 1 D Ex ia IIIC T85 °C	
For electrical parameters, see certificate FM13ATEX0055X	

IECEx	
Order code	N2
Certificate of conformity	IECEx FME 13.0004X
Ex ia IIC T4 to T6 Ga	
Ex ia IIIC T85 °C	
For electrical parameters, see certificate IECEx FME 13.0004X	

FM approval for USA and Canada	
Order code	F4
IS/S. Intrinseque(Entity) CL I,	
Zone 0 AEx/Ex ia IIC T6, T5, T4	
Cl I/Div 1/ABCD IS-CL II, III/DIV 1/EFG TYPE 4X	
IS Control Drawing: 3KXF065215U0109	

NEPSI	
Order code	S6
Ex ia IIC T4 to T6 Ga	
Ex iaD 20 T85 °C	
For electrical parameters, see certificate GYJ14.1088X	

Power supply

Ex ia: U_i = 30 V DC

Switch output

The switch output is designed as an optoelectronic coupler or a NAMUR contact (in accordance with DIN 19234).

— When the NAMUR contact is closed, the internal resistance is approx. 1000 Ω.
— When the contact is open, the internal resistance is > 10 kΩ.

The switch output can be changed over to "optoelectronic coupler" if required.

— NAMUR with switching amplifier
— Switch output:
  Ex ia: U_i = 30 V DC

Electrical and temperature data

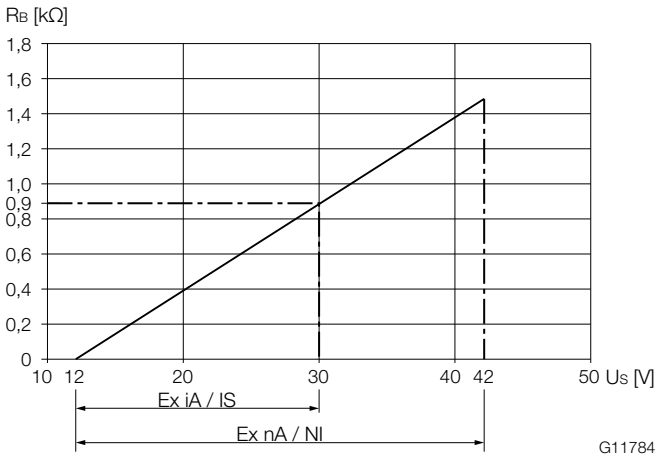

Fig. 23: Power supply in Zone 2, explosion protection, intrinsic safety

The minimum voltage U_S of 12 V is based on a load of 0 Ω.

U_S Supply voltage

R_B Maximum permissible load in the power supply circuit, e.g. indicator, recorder or power resistor.

Power supply / current output / HART output	
Terminals	PWR/COMM + / PWR/COMM -
Zone 0: Ex ia IIC T4 to T6 Ga T_{amb} = -40 ... 85 °C [1]	
U_{max}	30 V
I_{max} P_i	See the chapter titled „Limit value tables“ on page 23
C_i	— 13 nF for indicator option L1 — 17 nF for all other options
L_i	10 µH
Zone 20: Ex ia IIIC T85 °C T_{amb} = -40 ... 85 °C [1]	
IS/S. Intrinseque (Entity) CL I, Zone 0 AEx/Ex ia IIC T6, T5, T4 Cl I/Div 1/ABCD IS-CL II, III/DIV 1/EFG TYPE 4X IS Control Drawing: 3KXF065215U0109	

1) See temperature ranges in the chapter titled „Limit value tables“ on page 23.

Digital output	
Terminals	DIGITAL OUTPUT 1+ / DIGITAL OUTPUT 4-
Zone 0: Ex ia IIC T4 to T6 Ga	
U_{max}	30 V
I_{max}	30 mA
C_i	7 nF
L_i	0 mH
Zone 20: Ex ia IIIC T85 °C Tamb = -40 ... 85 °C [1]	
IS/S. Intrinseque (Entity) CL I, Zone 0 AEx/Ex ia IIC T6, T5, T4 Cl I/Div 1/ABCD IS-CL II, III/DIV 1/EFG TYPE 4X IS Control Drawing: 3KXF065215U0109	

Analog input	
Terminals	ANALOG INPUT + / ANALOG INPUT -
Zone 0: Ex ia IIC T4 to T6 Ga	
U_{max} I_{max}	See the chapter titled „Limit value tables“ on page 23
C_i	7 nF
L_i	0 mH
Zone 20: Ex ia IIIC T85 °C T_{amb} = -40 ... 85 °C [1]	
IS/S. Intrinseque (Entity) CL I, Zone 0 AEx/Ex ia IIC T6, T5, T4 Cl I/Div 1/ABCD IS-CL II, III/DIV 1/EFG TYPE 4X IS Control Drawing: 3KXF065215U0109	

1) See temperature ranges in the chapter titled „Limit value tables“ on page 23.

Special Requirements

The devices must be installed in a protected environment in accordance with the specific conditions on the test certificate. Pollution degree 3 (see IEC 60664-1) must not be exceeded for the macro environment of the device.

The devices are in accordance with the IP rating IP66 / IP67. If the device is installed correctly, this requirement is met by the housing as standard.

When connected to the power supply / not connected to the power supply, the electrical circuits must not exceed overvoltage category III / II.

For input limits or analog input limits, see the chapter titled „Limit value tables“ on page 23.

Limit value tables

Operating temperature ranges:

— The ambient temperature range T_{amb} of the devices is -40 ... 85 °C.

— The measuring medium temperature range T_{medium} is -200 ... 400 °C.

Devices without LCD indicator

Power supply, current / HART output, analog input

Temperature class	T_{amb} max.	T_{medium} max.	U_{max}	I_{max}	P_i max
T4	≤ 85 °C	90 °C	30 V	100 mA	0.75 W
	≤ 82 °C	180 °C			
	≤ 81 °C	280 °C			
	≤ 79 °C	400 °C			
T4	≤ 70 °C	90 °C	30 V	160 mA	1.0 W
	≤ 67 °C	180 °C			
	≤ 66 °C	280 °C			
	≤ 64 °C	400 °C			
T5	≤ 56 °C	90 °C	30 V	100 mA	1.4 W
	≤ 53 °C	180 °C			
	≤ 52 °C	280 °C			
	≤ 50 °C	400 °C			
T6	≤ 44 °C	90 °C	30 V	50 mA	0.4 W
	≤ 41 °C	180 °C			
	≤ 40 °C	280 °C			
	≤ 38 °C	400 °C			

Digital output

Temperature class	T_{amb} max.	T_{medium} max.	U_{max}	I_{max}	P_i max
T4	≤ 85 °C	90 °C	30 V	30 mA	1.0 W
	≤ 82 °C	180 °C			
	≤ 81 °C	280 °C			
	≤ 79 °C	400 °C			
T4	≤ 70 °C	90 °C	30 V	30 mA	1.0 W
	≤ 67 °C	180 °C			
	≤ 66 °C	280 °C			
	≤ 64 °C	400 °C			
T5	≤ 56 °C	90 °C	30 V	30 mA	1.0 W
	≤ 53 °C	180 °C			
	≤ 52 °C	280 °C			
	≤ 50 °C	400 °C			
T6	≤ 44 °C	90 °C	30 V	30 mA	1.0 W
	≤ 41 °C	180 °C			
	≤ 40 °C	280 °C			
	≤ 38 °C	400 °C			

Devices with LCD indicator, order code L1

Power supply, current / HART output, analog input

Temperature class	T_{amb} max.	T_{medium} max.	U_{max}	I_{max}	P_i max
T4	≤ 85 °C	90 °C	30 V	100 mA	0.75 W
	≤ 82 °C	180 °C			
	≤ 81 °C	280 °C			
	≤ 79 °C	400 °C			
T4	≤ 70 °C	90 °C	30 V	160 mA	1.0 W
	≤ 67 °C	180 °C			
	≤ 66 °C	280 °C			
	≤ 64 °C	400 °C			
T5	≤ 40 °C	90 °C	30 V	100 mA	1.4 W
	≤ 37 °C	180 °C			
	≤ 36 °C	280 °C			
	≤ 34 °C	400 °C			
T6	≤ 40 °C	90 °C	30 V	50 mA	0.4 W
	≤ 37 °C	180 °C			
	≤ 36 °C	280 °C			
	≤ 34 °C	400 °C			

Digital output

Temperature class	T_{amb} max.	T_{medium} max.	U_{max}	I_{max}	P_i max
T4	≤ 85 °C	90 °C	30 V	30 mA	1.0 W
	≤ 82 °C	180 °C			
	≤ 81 °C	280 °C			
	≤ 79 °C	400 °C			
T4	≤ 70 °C	90 °C	30 V	30 mA	1.0 W
	≤ 67 °C	180 °C			
	≤ 66 °C	280 °C			
	≤ 64 °C	400 °C			
T5	≤ 40 °C	90 °C	30 V	30 mA	1.0 W
	≤ 37 °C	180 °C			
	≤ 36 °C	280 °C			
	≤ 34 °C	400 °C			
T6	≤ 40 °C	90 °C	30 V	30 mA	1.0 W
	≤ 37 °C	180 °C			
	≤ 36 °C	280 °C			
	≤ 34 °C	400 °C			

Devices with LCD indicator, order code L2 (operation through the front glass)

Power supply, current / HART output, analog input

Temperature class	T_{amb} max.	T_{medium} max.	U_{max}	I_{max}	P_i max
T4	≤ 60 °C	90 °C	30 V	100 mA	0.75 W
	≤ 57 °C	180 °C			
	≤ 56 °C	280 °C			
	≤ 54 °C	400 °C			
T4	≤ 60 °C	90 °C	30 V	160 mA	1.0 W
	≤ 57 °C	180 °C			
	≤ 56 °C	280 °C			
	≤ 54 °C	400 °C			
T5	≤ 56 °C	90 °C	30 V	100 mA	1.4 W
	≤ 53 °C	180 °C			
	≤ 52 °C	280 °C			
	≤ 50 °C	400 °C			
T6	≤ 44 °C	90 °C	30 V	50 mA	0.4 W
	≤ 41 °C	180 °C			
	≤ 40 °C	280 °C			
	≤ 38 °C	400 °C			

Digital output

Temperature class	T_{amb} max.	T_{medium} max.	U_{max}	I_{max}	P_i max
T4	≤ 60 °C	90 °C	30 V	30 mA	1.0 W
	≤ 57 °C	180 °C			
	≤ 56 °C	280 °C			
	≤ 54 °C	400 °C			
T4	≤ 60 °C	90 °C	30 V	30 mA	1.0 W
	≤ 57 °C	180 °C			
	≤ 56 °C	280 °C			
	≤ 54 °C	400 °C			
T5	≤ 56 °C	90 °C	30 V	30 mA	1.0 W
	≤ 53 °C	180 °C			
	≤ 52 °C	280 °C			
	≤ 50 °C	400 °C			
T6	≤ 44 °C	90 °C	30 V	30 mA	1.0 W
	≤ 41 °C	180 °C			
	≤ 40 °C	280 °C			
	≤ 38 °C	400 °C			

Zone 1, 21 - type of protection "flameproof (enclosure)" Ex-marking

ATEX	
Order code	A9
Type examination certificate	FM13ATEX0057X
II 2 G Ex d ia IIC T6 Gb/Ga – II 2 D Ex tb IIIC T85 °C Db (-40 °C < Ta < +75 °C) supply voltage 42 V DC, Um: 45 V	

IECEx	
Order code	N3
Certificate of conformity	IECEx FME 13.0004X
Ex d ia IIC T6 Gb/Ga-Ex tb IIIC T85 °C Db (-40 °C < Ta < +75 °C) supply voltage 42 V DC, Um = 45 V	

FM approval for USA and Canada	
Order code	F1
XP-IS (US) CL I/DIV I/GP BCD, DIP CL II, III/DIV I/GP EFG XP-IS (Canada) CL I/DIV I/GP BCD, DIP CL II, III/DIV I/GP EFG CL I, ZONE 1, AEx/Ex d ia IIC T6 -40 °C < Ta < +75 °C TYPE 4X Tamb = 85 °C "Dual seal device"	

NEPSI	
Order code	S1
Ex d ia IIC T6 Gb / Ga DIP A21 Ta 85 °C For electrical parameters, see certificate GYJ14.1088X	

Power supply

Ex d ia Gb/Ga: U_B = 12 ... 42 V DC

Switch output

The switch output is designed as an optoelectronic coupler or a NAMUR contact (in accordance with DIN 19234).

- When the NAMUR contact is closed, the internal resistance is approx. 1000 Ω.
- When the contact is open, the internal resistance is > 10 kΩ.

The switch output can be changed over to "optoelectronic coupler" if required.

- NAMUR with switching amplifier
- Switch output:
  Ex d ia: Ui = 45 V

IMPORTANT

The power supply and the digital output must be either only intrinsically safe or only non-intrinsically safe. A combination of the two is not permitted.
Intrinsically safe circuits must have potential equalization in place along the entire length of the cable of the circuit.

Electrical and temperature data

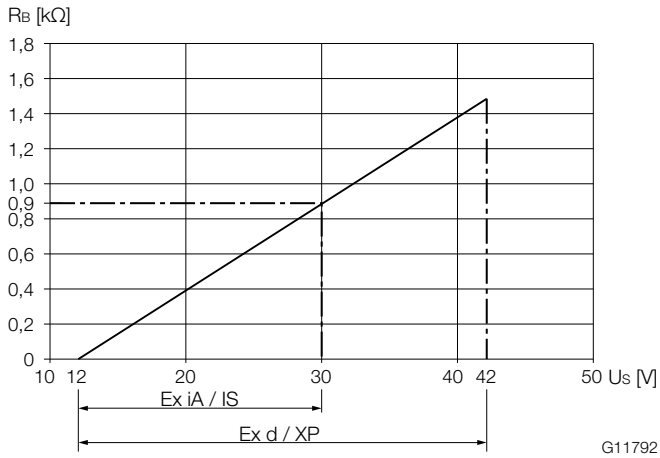

Fig. 24: Power supply in Zone 1, explosion protection

The minimum voltage U_S of 12 V is based on a load of 0 Ω.

U_S Supply voltage

R_B Maximum permissible load in the power supply circuit, e.g. indicator, recorder or power resistor.

Power supply / current output / HART output	
Terminals	PWR/COMM + / PWR/COMM -
U_M	45 V
Zone 1: Ex d ia IIC T6 Gb/Ga	
T_{amb} = -40 ... 75 °C	
Zone 21 Ex tb IIIC T85 °C Db	
T_{amb} = -40 ... 75 °C	
XP-IS (US) CL I/DIV I/GP BCD, DIP CL II, III/DIV I/ GP EFG	
XP-IS (Kanada) CL I/DIV I/GP BCD, DIP CL II, III/ DIV I/GP EFG	
CL I, ZONE 1, AEx/Ex d ia IIC T6 -40 °C < Ta < +75 °C	
TYPE 4X Tamb = 75 °C „Dual seal device“	

Digital output	
Terminals	DIGITAL OUTPUT 1+ / DIGITAL OUTPUT 4-
U_M	45 V
Zone 1: Ex d ia IIC T6 Gb/Ga	
T_{amb} = -40 ... 75 °C	
Zone 21 Ex tb IIIC T85 °C Db	
T_{amb} = -40 ... 75 °C	
XP-IS (US) CL I/DIV I/GP BCD, DIP CL II, III/DIV I/ GP EFG	
XP-IS (Kanada) CL I/DIV I/GP BCD, DIP CL II, III/ DIV I/GP EFG	
CL I, ZONE 1, AEx/Ex d ia IIC T6 -40 °C < Ta < +75 °C	
TYPE 4X Tamb = 75 °C „Dual seal device“	

Analog input	
Terminals	ANALOG INPUT + / ANALOG INPUT -
U_M	45 V
Zone 1: Ex d ia IIC T6 Gb/Ga	
T_{amb} = -40 ... 75 °C	
Zone 21 Ex tb IIIC T85 °C Db	
T_{amb} = -40 ... 75 °C	
XP-IS (US) CL I/DIV I/GP BCD, DIP CL II, III/DIV I/ GP EFG	
XP-IS (Kanada) CL I/DIV I/GP BCD, DIP CL II, III/ DIV I/GP EFG	
CL I, ZONE 1, AEx/Ex d ia IIC T6 -40 °C < Ta < +75 °C	
TYPE 4X Tamb = 75 °C „Dual seal device“	

Special Requirements

The devices must be installed in a protected environment in accordance with the specific conditions on the test certificate. Pollution degree 3 (see IEC 60664-1) must not be exceeded for the macro environment of the device.

The devices are in accordance with the IP rating IP66 / IP67. If the device is installed correctly, this requirement is met by the housing as standard.

When connected to the power supply / not connected to the power supply, the electrical circuits must not exceed overvoltage category III / II.

Temperature resistance for the connecting cables

The temperature at the cable entries of the device is dependent on the measuring medium temperature T_{medium} and the ambient temperature $T_{amb.}$.
For electrical connection of the device, cables suitable for temperatures up to 110 °C (230 °F) can be used without restriction.

Use in category 2 / 3G

For cables suitable only for temperatures up to 80 °C (176 °F), the connection of both circuits must be checked in the event of a fault. Otherwise, the restricted temperature ranges listed in the following table shall apply.

Use in category 2D

For cables suitable only for temperatures up to 80 °C (176 °F), the restricted temperature ranges listed in the following table shall apply.

T_{amb} [1]	T_{medium} maximum	Maximum cable temperature
40 ... 82 °C (-40 ... 180 °F)2)	180 °C (356 °F)	110 °C (230 °F)
-40 ... 40 °C (-40 ... 104 °F)2)	272 °C (522 °F)	80 °C (176 °F)
-40 ... 40 °C (-40 ... 104 °F)	400 °C (752 °F)	
-40 ... 67 °C (-40 ... 153 °F)	180 °C (356 °F)	

1) The permissible limits for the ambient temperature are dependent on approval and design (default: -20 °C [-4 °F])
2) Category 2D (dust-ignition proof), maximum 60 °C (140 °F)

Electrical connections

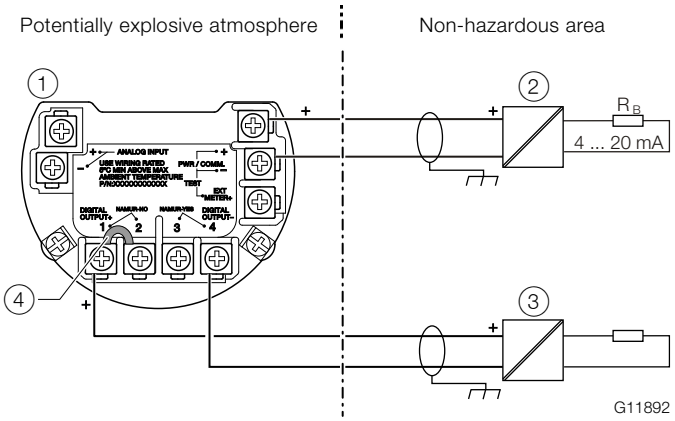

Fig. 25: Electrical connection (example)
(1) **SwirlMaster FSS430, FSS450** (2) **Supply isolator**
(3) **Switching amplifier** (4) **Bridge**

Output configuration	Bridge
Optoelectronic coupler output	1—2
NAMUR output	3—4

Terminal	Function
PWR/COMM + / PWR/COMM -	Power supply / current output / HART output
DIGITAL OUTPUT+ / DIGITAL OUTPUT-	Digital output as optoelectronic coupler or NAMUR output

In the factory setting, the output is configured as an optoelectronic coupler output.
If the digital output is configured as a NAMUR output, a suitable NAMUR switching amplifier must be connected.

Ordering Information

Main ordering information SwirlMaster FSS430, FSS450

Base model									
SwirlMaster FSS430 Swirl Flowmeter	FSS430	XX	XX	XXXXXX	XX	XX	XX	XX
SwirlMaster FSS450 Intelligent Swirl Flowmeter	FSS450	XX	XX	XXXXXX	XX	XX	XX	XX
Explosion Protection Certification						Continued see next page		
Without		Y0						
ATEX Ex nA / Ex tc (Zone 2 and 22)		B1						
ATEX Ex ia / Ex ia (Zone 0 and 20)		A4						
ATEX Ex d ia / Ex tb (Zone 0/1 and 21)		A9						
IECEx Ex nA / Ex tc (Zone 2 and 22)		N1						
IECEx Ex ia / Ex ia (Zone 0 and 20)		N2						
IECEx Ex d ia / Ex tb (Zone 0/1 and 21)		N3						
cFMus XP Cl I,II,III Div 1 / Zone 1		F1						
cFMus IS Cl I,II,III Div 1 / Zone 0		F4						
cFMus NI Cl I Div 2, Cl II,III Div 1,2 / Zone 2		F3						
System Design								
Integral single sensor			C1					
Remote single sensor, 5 m (16 ft) signal cable included			R1					
Integral dual sensor			C2					
Remote dual sensor, 2 x 5 m (16 ft) signal cable included			R2					
Process Connection Type / Meter Size / Connection Size								
Flange / DN 15 (1/2 in.) / DN 15 (1/2 in.)				F015R0				
Flange / DN 20 (3/4 in.) / DN 20 (3/4 in.)				F020R0				
Flange / DN 25 (1 in.) / DN 25 (1 in.)				F025R0				
Flange / DN 32 (1-1/4 in.) / DN 32 (1-1/4 in.)				F032R0				
Flange / DN 40 (1-1/2 in.) / DN 40 (1-1/2 in.)				F040R0				
Flange / DN 50 (2 in.) / DN 50 (2 in.)				F050R0				
Flange / DN 80 (3 in.) / DN 80 (3 in.)				F080R0				
Flange / DN 100 (4 in.) / DN 100 (4 in.)				F100R0				
Flange / DN 150 (6 in.) / DN 150 (6 in.)				F150R0				
Flange / DN 200 (8 in.) / DN 200 (8 in.)				F200R0				
Flange / DN 300 (12 in.) / DN 300 (12 in.)				F300R0				
Flange / DN 400 (16 in.) / DN 400 (16 in.)				F400R0				
Pressure Rating								
PN 10					D1			
PN 16					D2			
PN 25					D3			
PN 40					D4			
PN 63					D5			
PN 100					D6			
PN 160					D7			
ASME CL 150					A1			
ASME CL 300					A3			
ASME CL 600					A6			
ASME CL 900					A7			
Others					Z9			

SwirlMaster FSS430, FSS450
Swirl flowmeter

Main ordering information

SwirlMaster FSS430 Swirl Flowmeter	XX	XX	XX
SwirlMaster FSS450 Intelligent Swirl Flowmeter	XX	XX	XX
Temperature Range of Measuring Medium			
Standard -55 ... 280 °C (-67 ... 536 °F)	A1		
Housing Material / Cable Glands			
Aluminium / 2 pcs. metric, M20 x 1.5, cable glands mounted		A1	
Aluminium / 2 pcs. 1/2 in. NPT threads, cable glands not included		B1	
Stainless steel 316L / 2 pcs. metric, M20 x 1.5, cable glands mounted		S1	
Stainless steel 316L / 2 pcs. 1/2 in. NPT threads, cable glands not included		T1	
Output Signal			
HART digital communication and 4 ... 20 mA		1)	H1
HART digital communication, 4 ... 20 mA + digital contact output			H5

Additional ordering information

SwirlMaster FSS430 Swirl Flowmeter	XX	XXX	XXX	XXX	XX	XX	XXX
SwirlMaster FSS450 Intelligent Swirl Flowmeter	XX	XXX	XXX	XXX	XX	XX	XXX
Integrated Digital Display (LCD)							
With Integrated LCD Display with Push Buttons TTG 1)	L2						
Piezo Sensor Sealing Material							
PTFE (-20 ... 260 °C / -4 ... 500 °F) 2)		SP0					
Kalrez 6375 (-20 ... 275 °C / -4 ... 527 °F) 3)		SP1					
Graphite (-55 ... 280 °C / -67 ... 536 °F) 4)		SP2					
Ambient Temperature Range							
Extended -40 ... 85 °C (-40 ... 185 °F)			TA4				
Signal Cable Length							
10 m (approx. 32 ft)			5)	SC2			
20 m (approx. 64 ft)			5)	SC4			
30 m (approx. 96 ft)			5)	SC6			
Others			5)	SCZ			
Calibration Type Standard Three Point Calibration							
5-point calibration					R5		
3-point calibration including application-specific k-factor to Reynolds number optimization				6)	RR		
Surge / Transient Protector							
With integral surge / transient protector					1)	S1	
Sensor Material							
Piezo sensor material Hastelloy C-276							SM1
All inner parts material Hastelloy C-276							SM2
All wetted parts material Hastelloy C-276							SM3

Additional ordering information

SwirlMaster FSS430 Swirl Flowmeter	XX	XXX	XX	XX	XX	XX
SwirlMaster FSS450 Intelligent Swirl Flowmeter	XX	XXX	XX	XX	XX	XX
Certificates						
Material monitoring with inspection certificate 3.1 acc. EN 10204	C2					
Material monitoring NACE MR 01-75 with inspection certificate 3.1 acc. EN 10204	CN					
Declaration of compliance with the order 2.1 acc. EN 10204	C4					
Inspection certificate 3.1 acc. EN 10204 of visual, dimensional and functional test	C6					
Inspection certificate 3.1 acc. EN 10204 of positive material identification PMI with material analysis	C5					
Inspection certificate 3.1 acc. EN 10204 of positive material identification PMI	CA					
Pressure test acc. to factory test plan	CB					
Test package (pressure test, non-destructive test, welder an welding procedure certificate)	CT					
Device Identification Plate						
Stainless steel plate with TAG no.		TC1				
Adhesive label with TAG no.		TCC				
Supplemental wired-on stainless steel plate		TCS				
Others		TCZ				
Documentation Language						
German			M1			
English			M5			
Chinese			M6			
Russian			MB			
Language package Western Europe / Scandinavia			MW			
Language package Eastern Europe			ME			
Special Applications						
Degreased for oxygen applications				P1		
Hardware Options						
Integral RTD				1)	G1	
Operation Mode						
Steam Mass #/ft. 3					6)	NS2
Water energy flow					6)	N2
Natural gas flow AGA / SGERG					6)	N3

1) Optional with SwirlMaster FSS430, standard with SwirlMaster FSS450
2) Application range -20 … 260 °C / -4 … 500 °F
3) Application range -20 … 275 °C / -4 … 527 °F
4) Application range -55 … 280 °C / -67 … 536 °F
5) For remote sensor only
6) Only available with SwirlMaster FSS450

SwirlMaster FSS430, FSS450
Swirl flowmeter

Main ordering information FST450 Transmitter for SwirlMaster FSS430, FSS450

Base model					
FST450 Transmitter	FST450	XX	XX	XX	XX
Explosion Protection Certification					
Without		Y0			
System Design					
FST450 transmitter kit 1; spare transmitter for FSS430 / FSS450			K1		
FST450 transmitter kit 2 for conversion of integral mount design to remote mount design			K2		
FST450 transmitter kit 3 for conversion of FS4000-ST4 to FSS450 integral mount design			K3		
FST450 transmitter kit 4 for conversion of FS4000-ST4 / SR4 to FSS450 remote mount design			K4		
FST450 transmitter kit 5 for conversion of 10ST1000 to FSS450 integral mount design			K5		
FST450 transmitter kit 6 for conversion of 10ST1000 / 10SR1000 / 10SM1000 to FSS450 remote mount design			K6		
Housing Material / Cable Glands					
Aluminium / 2 pcs. metric, M20 x 1.5, cable glands mounted				A1	
Aluminium / 2 pcs. 1/2 in. NPT threads, cable glands not included				B1	
Stainless steel 316L / 2 pcs. metric, M20 x 1.5, cable glands mounted				S1	
Stainless steel 316L / 2 pcs. 1/2 in. NPT threads, cable glands not included				T1	
Others				Z9	
Output Signal					
HART digital communication, 4 ... 20 mA + digital contact output					H5

Additional ordering information

FST450 Transmitter		XX	XXX	XXX	XXX
Integrated Digital Display (LCD)					
With Integrated LCD Display with Push Buttons TTG		L2			
Piezo Sensor Design					
Standard temperature, Pt100, PED design (-55 ... 280 °C / -67 ... 536 °F)	1)		SD1		
Standard temperature, Pt100, non PED (-55 ... 280 °C / -67 ... 536 °F)	2)		SD3		
Piezo Sensor Sealing Material					
PTFE (-20 ... 260 °C / -4 ... 500 °F)			3)	SP0	
Kalrez 6375 (-20 ... 275 °C / -4 ... 527 °F)			4)	SP1	
Graphite (-55 ... 400 °C / -67 ... 752 °F)			5)	SP2	
Signal Cable Length					
10 m (approx. 32 ft) (For remote sensor only)				12)	SC2
20 m (approx. 64 ft) (For remote sensor only)				12)	SC4
30 m (approx. 96 ft) (For remote sensor only)				12)	SC6
Others (For remote sensor only)				12)	SCZ

Additional ordering information						
FST450 Transmitter	XX	XX	XXX	XX	XX	XX
Surge / Transient Protector						
With integral surge / transient protector	S1					
Certificates						
Declaration of compliance with the order 2.1 acc. EN 10204		C4				
Device Identification Plate						
Stainless steel plate with TAG no.			TC1			
Adhesive label with TAG no.			TCC			
Supplemental wired-on stainless steel plate			TCS			
Others			TCZ			
Documentation Language						
German				M1		
English				M5		
Chinese				M6		
Russian				MB		
Language package Western Europe / Scandinavia				MW		
Language package Eastern Europe				ME		
Hardware Options						
Integral RTD					G1	
Analog input					G2	
HART Input					G3	
Operation Mode						
Steam energy flow						N1
Water energy flow						N2
Natural gas flow AGA / SGERG						N3

1) For VT4/ST4 delivered after 05/2002, 6 hole design
2) For VT4/ST4 delivered before 05/2002 and all VT1000 / ST1000, 4 hole design
3) Application range -20 ... 260 °C / -4 ... 500 °F
4) Application range -20 ... 275 °C / -4 ... 527 °F
5) Application range -55 ... 400 °C / -67 ... 752 °F
6) For remote sensor only

Trademarks

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™ Hastelloy C is a trademark of Haynes International

SwirlMaster FSS430, FSS450
Swirl flowmeter

Questionnaire

Customer:	**Date:**
Ms. / Mr.:	**Department:**
Telephone:	**Fax:**

Measuring system:	☐ SwirlMaster FSS430	**Optional** ☐ Integrated resistance thermometer Pt100 ☐ Digital output (switch, pulse, frequency output)
	☐ SwirlMaster FSS450	(with integrated resistance thermometer Pt100, digital output, and analog input)

Measuring medium: (Aggregate state)	_____	☐ Liquid	☐ Gas	☐ Steam	
Flow rate: (min., max., operating point)	_____	**Operating condition** ☐ m^3/h ☐ US gal/min	**Standard condition** ☐ m^3/h ☐ ft^3/h	**Mass** ☐ kg/h ☐ lb/h	**Energy** ☐ kW ☐ MJ/h
Density: (min., max., operating point)	_____	☐ kg/m^3 ☐ lb/ft^3	☐ Operating condition ☐ Standard condition		
Viscosity:	_____	☐ mPas/cP ☐ cst			
Measuring medium temperature: (min., max., operating point)	_____	☐ °C ☐ °F			
Ambient temperature:	_____	☐ °C ☐ °F			
Pressure: (min., max., operating point)	_____	☐ bar ☐ psi			
Nominal diameter/pressure rating of the piping:	_____	☐ DN ☐ PN			
Effective internal diameter of the piping:	_____	☐ mm			

Transmitter design / communication:	☐ 4 ... 20 mA, HART (two-wire technology)	☐ PROFIBUS PA (Two-wire technology)	☐ FOUNDATION Fieldbus (two-wire technology)
Explosion protection:	☐ Without ☐ Zones 2, 22 / Cl. 1, Div. 2 ☐ Zones 0, 1, 20, 21 / Div. 1 (Ex ia / IS) ☐ Zone 0, 1, 20, 21 / Div. 1 (Ex d / XP)		

Notes

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3KXF320001R1001

FSS430 FSS450 Service

DS/FSS430/450-EN Rev. C 07.2015

Power and productivity
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Appendix C - Site Photos

Gas turbine

Heat Recovery Steam Generator (HRSG)

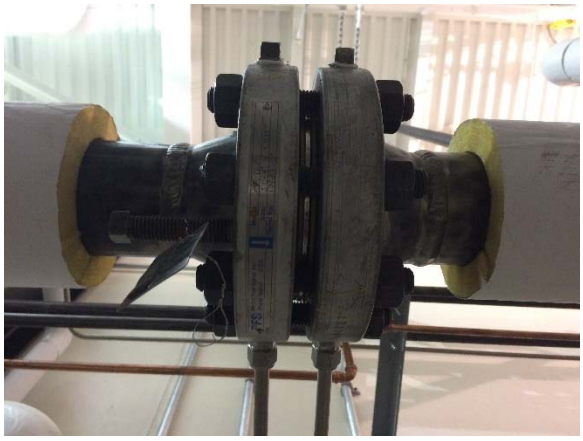
Gas Compressor Enclosure (next to gas turbine skid)

Turbine Gas Meter (FGT)

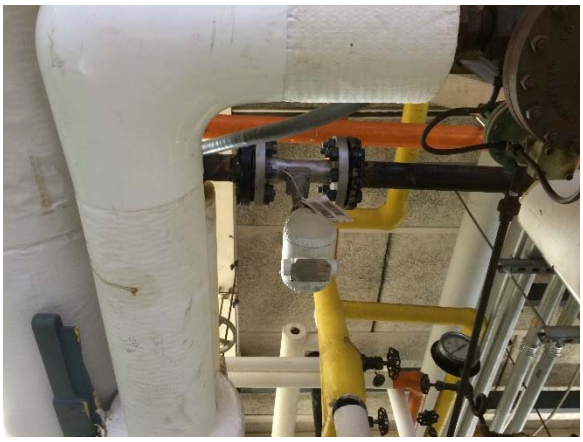
Duct Burner Gas Meter (FGDB)

Steam Flow Meter (FS)

Steam Flowmeter Display (FS)



HRSG Feedwater Flow Meter (FFW)



High Pressure Deaerator Steam Flow Meter (FSDAHP)

Steam to Chiller Flange (meter not yet installed) (FSCH)

Chilled Water Flow Meter

Turbine Gross Output (WT)

MCC4 Parasitic Load Meter – Typ. (WP3)