



# - System Specification -

## for SYGEF Plus Piping Systems in High Purity Polyvinylidene fluoride (PVDF-HP)

### 1. Scope

This specification covers requirements for the GF PIPING SYSTEMS **SYGEF Plus (PVDF-HP)** Piping System intended for a wide range of applications including ultrapure and deionized water, as well a wide range of chemical applications. The components of the **SYGEF Plus (PVDF-HP)** piping systems are in accordance with the following standards.

### 2. Basic System Data

#### 2.1 Material Specification for SYGEF Plus (PVDF-HP)

**SYGEF Plus (PVDF-HP)** pipes, fittings and valves from GF Piping Systems are manufactured from a virgin polyvinylidene fluoride resin material, unpigmented and opaque, of which pipes and fittings are designed for 25 years of operational life with water at 20°C.

The raw material used is designed for use with pressure bearing piping systems with long term hydrostatic properties in accordance with EN ISO 10931, as supplied by GF Piping Systems.

#### 2.2 Characteristics of SYGEF Plus (PVDF-HP)

Characteristics	PVDF-HP	Units	Standards
Density	~ 1.78	g/cm <sup>3</sup>	EN ISO 1183-1/ ASTM D792
Yield stress at 23°C	≥ 48	N/mm <sup>2</sup>	EN ISO 527-1
Tensile E-modulus at 23°C	≥ 1800	N/mm <sup>2</sup>	ISO 527-1/ ASTM D D 638
Charpy notched impact strength at 23 °C	≥ 8	kJ/m <sup>2</sup>	EN ISO 179/1eA
Charpy notched impact strength at 0 °C	≥ 7	kJ/m <sup>2</sup>	EN ISO 179/1eA
Heat distortion temperature HDT A 1.80 MPa	≥ 104	°C	EN ISO 75-2
Crystallite melting point	≥ 168	°C	EN ISO 11375/ ASTM D3418
Thermal expansion coefficient	0.12 - 0.18	mm/mK	DIN 53752
Heat conductivity at 23°C	0.19	W/mK	EN 12664/ ASTM C 177
Water absorption at 23°C/24 h	< 0.04	%	EN ISO 62
Colour	opaque	-	-
Limiting oxygen index (LOI)	≥ 43	%	ISO 4589-1/ ASTM D2863
Inner surface finish for injection molded and extruded components	<b>SDR21/PN16</b> d ≤ 225, R <sub>a</sub> ≤ 0.25 μm d250-315, R <sub>a</sub> ≤ 0.45 μm <b>SDR33/PN10</b> d ≤ 225, R <sub>a</sub> ≤ 0.2 μm d= 250, R <sub>a</sub> ≤ 0.3 μm d280-315, R <sub>a</sub> ≤ 0.4 μm d355-450, R <sub>a</sub> ≤ 0.65 μm	μm	ISO 4287/ 4288
Temperature range in °C	-20 - +140	°C	-

### 2.3 SYGEF Plus Product Range

	PN	SDR	d16 DN10	d20 DN15	d25 DN20	d32 DN25	d40 DN32	d50 DN40	d63 DN50	d75 DN65	d90 DN80	d110 DN100	d125 DN100	d140 DN125	d160 DN150	d200 DN200	d225 DN200	d250 DN250	d280 DN250	d315 DN300	d355 DN350	d400 DN400	d450 DN450	
Pipes	16	21																						
	10	33																						
Butt fusion fittings IR and BCF compatible	16	21																						
	10	33																						
Diaphragm valves	16																							
	10																							
Butterfly valves	10																							
Pressure regulating valves	10																							
Automation																								
Flanges PP-V / PP - Steel																								
Flange seal																								
Pipe clips																								
IR fusion machine																								
BCF fusion machine																								

Available

### 2.4 Approvals/ Acceptance/ Conformance

This **SYGEF Plus (PVDF-HP)** material specification meets the directives of GF Piping Systems. Therefore GF Piping Systems is approved according to the different categories all over the world. For more information please see our approvals database on the GF website.

	SEMIF57	FM-4910 listing	DIBt	ASME BPE	FDA	USP 25 class VI	GOST-R	CE	BV
Raw Material									
Pipes									
Fittings									
Valves									
Backing Flanges									
Gaskets									

Available

### 3. Pipes

All **SYGEF Plus (PVDF-HP)** pipes in high purity polyvinylidene fluoride (PVDF-HP) shall be metric sizes d16 (3/8") – d450 (18"), manufactured in accordance with the requirements of EN ISO 10931, Furthermore the pipes shall be manufactured stress free and thermally annealed (max. internal stress of 2,5 N/mm<sup>2</sup>), without any voids and inclusions, allowing a high grade of roundness, high degree of straightness and an extreme smooth surface (see "2.2 Characteristics of high purity polyvinylidene fluoride (PVDF-HP) - Inner surface finish for injection molded and extruded components").

Pipes shall be produced under ISO 14644-1 Class 6 (U.S. Fed. Standard 209E Class 1'000) conditions and the inner surface of the pipes must only come in contact with clean room class 5 (100) quality air. Subsequent quality inspection and double bagging procedure shall be done under constant laminar flow in class 5 (100) conditions.

Testing will be done in accordance with EN 10204.

Outer diameter, ovality and wall thickness are defined according to Tables 1 and 2.

**Table 1: Measurements SDR21 / PN16**

In millimetres

Nominal outer diameter	Min. wall thickness	Tolerance limit of outer diameter	Maximum deviation for ovality	Tolerance limit of wall thickness	Standard Dimension Ratio	Pipe series
$d_n$	$e_{min}$			$a$	SDR	S
16	1.9	+0.3	0.2	+0.4	9	4
20	1.9	+0.3	0.3	+0.4	11	5
25	1.9	+0.3	0.3	+0.4	13.6	6.3
32	2.4	+0.3	0.4	+0.5	13.6	6.3
40	2.4	+0.3	0.5	+0.5	17	8
50	3.0	+0.3	0.6	+0.5	17	8
63	3.0	+0.4	0.8	+0.5	21	10
75	3.6	+0.4	0.9	+0.6	21	10
90	4.3	+0.4	1.1	+0.7	21	10
110	5.3	+0.5	1.3	+0.8	21	10
125	6.0	+0.6	1.5	+0.8	21	10
140	6.7	+0.8	1.7	+0.9	21	10
160	7.7	+1.0	1.9	+1.0	21	10
200	9.6	+1.2	2.4	+1.2	21	10
225	10.8	+1.4	2.7	+1.3	21	10
250	11.9	+1.6	3.0	+1.4	21	10
280	13.4	+1.8	3.4	+1.5	21	10
315	15.0	+2.0	3.8	+1.6	21	10

**Table 2: Measurements SDR33 / PN10**

In millimetres

Nominal outer diameter	Min. wall thickness	Tolerance limit of outer diameter	Maximum deviation for ovality	Tolerance limit of wall thickness	Standard Dimension Ratio	Pipe series
$d_n$	$e_{min}$			$a$	SDR	S
75	2.3	+0.4	0.9	+0.5	33	16
90	2.8	+0.4	1.1	+0.5	33	16
110	3.4	+0.5	1.3	+0.6	33	16
125	3.9	+0.6	1.5	+0.6	33	16
140	4.3	+0.8	1.7	+0.7	33	16
160	4.9	+1.0	1.9	+0.7	33	16
200	6.2	+1.2	2.4	+0.9	33	16
225	6.9	+1.4	2.7	+0.9	33	16
250	7.7	+1.6	3.0	+1.0	33	16
280	8.6	+1.8	3.4	+1.1	33	16
315	9.7	+2.0	3.8	+1.2	33	16
355	10.9	+2.2	4.1	+1.3	33	16
400	12.3	+2.4	4.5	+1.5	33	16
450	13.8	+2.7	5.1	+1.6	33	16

The mean outer diameter ( $d_{em}$ ) is the average value which results from the measurements of the outer diameter at an interval of  $d_n$  and  $0.1 d_n$  to the end of the test piece. It is determined by measuring the circumference to 0.1 mm accuracy with a measuring tape.

The minimum and maximum wall thickness is determined to 0.1 mm, whereby the measurement points should be distributed on the pipe circumference as evenly as possible. All measured values must be within the allowable tolerance limit.

Ovality is the difference between the measured maximum and the measured minimum external diameter ( $d_e$ ) at the same cross-section. It is calculated to 0.1 mm and measured immediately after production. The ovality requirement applies to the timepoint of manufacture.

### 3.1 Product Marking

The pipes are embossed with a permanent identification during the production process to ensure full traceability.

All pipes are marked permanently and consecutively

- Material identification: +GF+ SYGEF Plus
- Material code: PVDF
- Pipe diameter, wall thickness, SDR and PN
- Product standard: ISO 10931
- Manufacture date, shift and machine number
- Approvals / Conformance: DIBT-Approval, FM4910 listing

### 3.2 Packaging and Labelling

The packaging must ensure that the pipes are not damaged during transportation and the high purity properties and handling are maintained.

Packaging and labelling must meet the following requirements:

- Pipes capped on each end
- Each pipe double bagged in a specified inner and outer bag under clean room ISO 14644-1 Class 5 (U.S. Fed. Standard 209E Class 100) conditions
- Identification of the content, in type, quantity and product details
- Information about standards and approvals covered by the product
- Content of the label has to accomplish legal requirements
- Labels must be EAN coded for automatic identification
- Comply to GF standards as well as to international standards such as ISPM 15

### 4. Fittings

All **SYGEF Plus (PVDF-HP)** fittings shall be sizes d20 (1/2") – d450 (18") as butt fusion type and manufactured in accordance with the requirements of ISO 10931 and the Fittings shall have an extreme smooth surface (see "2.2 Characteristics of high purity polyvinylidene fluoride (PVDF-HP) - Inner surface finish for injection molded and extruded components").

All butt fusion fittings shall be manufactured with laying lengths designed for use with the manufacturer offered Infrared (IR) or BCF (Bead and Crevice Free) welding machines.

All threaded connections shall have pipe threads in accordance with the requirements of ISO 7-1.

Fittings shall be produced under ISO 14644-1 Class 5 (U.S. Fed. Standard 209E Class 100) conditions. The quality inspection, cleaning procedure with 18MΩ pure water, and the double bagging procedure shall be done under clean room ISO 14644-1 Class 5 (U.S. Fed. Standard 209E Class 100) conditions.

Testing will be done in accordance with EN 10204.

Unions in high purity polyvinylidene fluoride (PVDF-HP) shall be designed to have the O-ring seals flush with the interior surface of the pipeline. O-rings used for this Union shall be FKM-white and conform to USP 25 class VI and FDA.

#### 4.1 Product Marking

The fittings are embossed with a permanent identification during the production process to ensure full traceability.

Each part is marked according to EN ISO 10931:

- Logo of the manufacturer
- SDR (Standard Dimension Ratio) rating or PN (Nominal Pressure) or s (pipe series)
- Dimension
- Material
- Permanently embossed date indicating the year and the production series

## 4.2 Packaging and Labelling

The packaging must ensure that the fittings are not damaged during transportation and the high purity properties and handling are maintained.

Packaging and labelling must meet the following requirements:

- Each component double bagged in a specified inner and outer bag under clean room ISO 14644-1 Class 5 (U.S. Fed. Standard 209 E Class 100) conditions
- Identification of the content, in type, quantity and product details
- Information about standards and approvals covered by the product
- Content of the label has to accomplish legal requirements
- Labels must be EAN coded for automatic identification
- Comply to GF standards as well as to international standards such as ISPM 1

## 5. Accessories

### 5.1 Backing Flanges

Backing flanges in metric sizes DN15-400 shall be designed according to ISO 9624, in a thermo plastic-oriented design, consisting of 100% glass fibre reinforced polypropylene, PP-GF30, graphite black and UV stabilized. These flanges are manufactured in a seamless technology injection moulding process by GF Piping Systems. The flange is optimized with a V-groove in the inner diameter to ensure an evenly distributed force on the thermo plastic flange adapter. The backing flanges shall be marked with dimension, PN-value, standards, brand and lot number. Connecting dimensions metric according to ISO 7005, EN 1092; Bolt circle diameter PN10; Inch: ANSI B 16.5, BS 1560; class 150 (1/2" – 12").

As an alternative backing flanges in metric sizes DN15-400 shall be designed according to ISO 9624, in a thermo plastic-oriented design, consisting of glass fibre reinforced polypropylene, PP-GF30, graphite black and UV stabilized with steel inserts. The backing flanges shall be marked with dimension, PN-value, standards, brand and lot number. Connecting dimensions metric according to ISO 7005, EN 1092; Bolt circle diameter PN10 (DN15-400) + PN16 (DN15-400); Inch: ANSI B 16.5, BS 1560; class 150 (1/2" – 8").

As an alternative backing flanges ANSI sizes d355 DN350 14" – d450 DN450 18" shall be designed in a thermo plastic-oriented design, consisting of PVDF coated steel. Connecting dimensions Inch ANSI B16.5, BS1560, class 150 (14"-16").

### 5.2 Gaskets

Gaskets in metric sizes DN10–450 shall consist of elastomeric material according to EN681, designed with or without metal reinforcement for use with flange adaptors according ISO 10931. Gaskets with reinforcement shall be designed to be centred by the outer diameter. Gaskets without reinforcement >DN100 shall provide fixation aids to fit on the flange bolts.

### 5.3 Pipe Support System

Pipe Support System shall be KLIP-IT, sizes d16-400, supplied by GF Piping Systems.

## 6. Valves

All **SYGEF Plus (PVDF-HP)** valves shall be produced and pressure tested under ISO 14644-1 Class 5 (U.S. Fed. Standard 209E Class 100) conditions. The quality inspection, cleaning procedure with 18M $\Omega$  pure water, and the double bagging procedure shall be done under clean room ISO 14644-1 Class 5 (U.S. Fed. Standard 209E Class 100) conditions.

### 6.1. Ball Valves

Ball valves are not offered in SYGEF Plus (PVDF-HP), but they are available in SYGEF Standard (PVDF). Please refer to this specification template.

### 6.2 Diaphragm Valves

#### 6.2.1 Manual Diaphragm Valves

##### 6.2.1.1 Diaphragm Valves DN15 to DN100

All **SYGEF Plus (PVDF-HP)** diaphragm Valves, with metric sizes DN15-100, shall be either:

- Type 514 (true double union design, DN15-50), or
- Type 515 (spigot design, DN15-50), or
- Type 517 (flange design, DN15-50), or
- Type 519 (T-type design, DN15-15 to DN100-50)

All diaphragm Valves shall be manufactured by GF Piping Systems in accordance with EN ISO 16138. The upper body shall be PPGF (polypropylene glass fibre reinforced) connected to the lower body with a central union avoiding exposed screws.

A two coloured position indicator integrated into the hand wheel must be present to determine diaphragm position. The hand wheel shall have an integrated locking mechanism.

Diaphragms are to be EPDM, FKM, NBR, PTFE with EPDM or FKM backing diaphragm. Following options shall be available:

- PN16 pressure rating (upper body shall be black PPS GF (polyphenylene sulphide glass fiber reinforced) for water applications only)
- Electrical feedback unit with either AgNi or AU contacts
- Pressure proof housing

The diaphragm valve shall have following KV values:

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d [mm]	DN [mm]	KV [l/min @ ΔP=1 bar]
20	15	125
25	20	271
32	25	481
40	32	759
50	40	1263
63	50	1728

### 6.2.1.2 Diaphragm Valves DN65 to DN150

All **SYGEF Plus (PVDF-HP)** diaphragm valves, with metric sizes, shall be Type 317 (flanged design, DN 65-150)

All diaphragm valves shall be manufactured by GF Piping Systems in accordance with EN ISO 16138. The upper body shall be PPGF (polypropylene glass fibre reinforced) connected to the lower body with exposed stainless steel bolts. A position indicator integrated into the hand wheel must be present to determine diaphragm position. Diaphragms are to be EPDM, FKM, NBR, or PTFE with EPDM or FKM backing diaphragm.

### 6.2.2 Pneumatic Diaphragm Valves

#### 6.2.2.1 Pneumatic Diaphragm Valves DN15 to DN50

All **SYGEF Plus (PVDF-HP)** diaphragm Valves, with metric sizes DN15-50, shall be either:

- true double union design, DN15-50, or
- spigot design, DN15-50, or
- flange design, DN15-50
- T-type design, DN15-15 to DN100-50

All diaphragm Valves shall be manufactured by GF Piping Systems in accordance with EN ISO 16138. The upper body shall be connected to the lower body with a central union avoiding exposed screws. Diaphragms are to be EPDM, FKM, NBR, PTFE with EPDM or FKM backing diaphragm

The diaphragm valve shall have following KV values:

d [mm]	DN [mm]	KV [l/min @ ΔP=1 bar]
20	15	125
25	20	271
32	25	481
40	32	759
50	40	1263
63	50	1728

Pneumatic actuators shall be GF Piping Systems Type DIASTAR or 604/605 and shall be available as



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- DIASTAR Ten for PN up to 10 bar (one side)
- DIASTAR TenPlus for PN up to 10 bar (both sides)
- DIASTAR Sixteen for PN up to 16 bar (one side)

The mode of operation shall be fail safe close (FC), fail safe open (FO) and double acting (DA). The valves shall have an integrated optical position indicator. Actuator housing shall be made of PPGF (polypropylene glass fibre reinforced). Actuators with FC mode shall contain a preloaded galvanised steel spring assembly to ensure safe actuator operation and maintenance. The actuator DIASTAR Ten and DIASTAR Sixteen shall have following accessories available:

- Solenoid pilot valve remote or direct mounted in voltages 24VDC/AC, 110VAC, 230VAC
- Positioner Type DSR 500-1
- Feedback with following limit switches AgNi, Au, NPN, PNP, NAMUR
- Stroke limiter & emergency manual override
- ASI controller

### 6.2.2.2 Pneumatic Diaphragm Valves DN65 to DN150

All **SYGEF Plus (PVDF-HP)** diaphragm valves, with metric sizes shall be flanged design, DN65-150.

All diaphragm valves shall be manufactured by GF Piping Systems in accordance with EN ISO 16138. The upper body shall be connected to the lower body with exposed stainless steel bolts. Diaphragms are to be EPDM, FKM, NBR, or PTFE with EPDM or FKM backing diaphragm.

Pneumatic diaphragm actuators shall be GF Piping Systems Type DIASTAR Type 025. The mode of operation shall be fail safe close (FC), fail safe open (FO) and double acting (DA). The valves shall have an integrated optical position indicator. Actuator housing shall be made of PPGF (polypropylene glass fibre reinforced). Actuators with FC mode shall contain a preloaded galvanised steel spring assembly to ensure safe actuator operation and maintenance. The actuator DIASTAR 025 shall have following accessories available:

- Solenoid pilot valve remote or direct mounted in voltages 24VDC/AC, 110VAC, 230VAC
- Positioner Type DSR 500-2
- Feedback with following limit switches AgNi, Au, NPN, PNP, NAMUR
- Stroke limiter & emergency manual override

### 6.3. Butterfly Valves

#### 6.3.1 Butterfly Valve Type 365

The 365 valve shall have a bi-directional bubble tight pressure rating of 150 PSI at 160°C (320°F) in accordance with: EN-12266-1 leak rate A (UHMWPE leak rate B). Sizes are from d63 (2") – d315 (12").

Disc shall be PFA encapsulated stainless steel. The inner liner shall be made of PTFE. The non-wetted valve body shall be ductile iron with a polyester coating. Non-wetted shaft shall be stainless steel. Non wetted O-rings shall be made of FKM. Valve shall employ two spring loaded seals at the top and bottom of the disc preventing the need of wetted O-rings to separate the process fluid from the stem and other components. The spring loaded seals shall provide a seal that does not require lubricants. The liner and disc shall be molded then machined to ensure close tolerances, low torque, and less stress and deformation of liner during opening and closing. Valves shall be cleaned and manufactured for ultra-high purity applications. Valve shall be available with lever or gear operator.

Non-encapsulated stainless steel disc polished (Ra 1.6) shall be available. Electric and Pneumatic actuation shall be available for the 365 butterfly valve.

Approved manufacturer is GF with no equal.

### 6.4. Check Valves

Check valves are not offered in **SYGEF Plus (PVDF-HP)**, but they are available in **SYGEF Standard (PVDF)**. Please refer to this specification template.

#### 6.4.1 Wafer Check Valves

Wafer Check Valves are not offered in **SYGEF Plus (PVDF-HP)**, but they are available in **SYGEF Standard (PVDF)**. Please refer to this specification template.

### 6.5 Pressure Regulating Valves

All **SYGEF Plus (PVDF-HP)** pressure regulating valves consist of valve body out of PVDF body and PPGF housing top.

All pressure regulating valves as supplied by GF Piping Systems shall have the following characteristics:

Pressure ranges for all pressure regulating valves are the following:

- DN10–50 from 0 up to max. 10 bar
- DN65–80 from 0 up to max. 6 bar
- DN100 from 0 up to max. 4 bar

### 6.5.1 Pressure Reducing Valves

As supplied by GF Piping Systems reduces the pressure within the system to a pre-set value. By using the differential pressure, the pressure reducing valve adjusts itself to the set working pressure.

The outlet pressure (working pressure) is not directly related to the inlet pressure. If the outlet pressure increases above the set value, the diaphragm is lifted against the spring force. If the outlet pressure falls below the set value, the diaphragm is pressed down by the spring force. The pressure reducing valve begins to close/open until a state of equilibrium is re-established; in other words, the outlet pressure remains constant irrespective of an increasing or decreasing inlet pressure. Following types and sizes are available:

- Type 582 (High purity version), compact Pressure Reducing Valve, sizes DN10–50  
Features:
  - Metal free central housing union nut
  - Elastomer free piston
  - Set pressure selectable 0 - 9 bar or 0.3 – 3 bar
  - Manometer optional
  - Manometer assembly possible on both sides
  - Selection of direct manometer assembly or with gauge guard
  - Possibility to show either inlet or outlet pressure
  - Injection molded directional arrow for direction of flow
  - Threaded inserts for assembly
- Type V82, Pressure Reducing Valve with an integrated manometer, sizes DN65-100

### 6.5.2 Pressure Retaining Valves

Pressure Retaining Valves are not offered in **SYGEF Plus (PVDF-HP)**, but they are available in **SYGEF Standard (PVDF)**. Please refer to this specification template.

### 6.6 Direct-acting Solenoid Valves

Supplied by GF Piping Systems serves to regulate and control fluids, if no compressed air is available or not wanted. They are used for diverse functions, e.g. opening, shutting, dosing, distribute and mixing. The medium flow is switched directly by the armature moved by the magnetic force.

- Safety position shall be available

Following type and sizes are available:

- Type 157, sizes DN4-8
- Type 160/161, sizes DN10-20
- Type 166, sizes DN3-5

### 6.7 Servo-assisted Solenoid Valves

Supplied by GF Piping Systems serves to regulate and control fluids, if no compressed air is available or unwanted. They are used for miscellaneous functions, e.g. opening, shutting, dosing, distributing and mixing. Opening large orifices using the direct-acting method would require enormous and expensive coils. Servo assisted valves use the power of the fluid to open the flow channel by controlling a small pilot channel to alter the forces on a larger main seal. A  $\Delta p$  0.5 bar is mandatory with servo-assisted valves.

- Type, 165, sizes DN10-50

### 6.8 Ventilating- and Bleed Valves

Ventilating- and Bleed valves are not offered in **SYGEF Plus (PVDF HP)**.

## 7. Welding and assembly

All butt fusion fittings and valves in **SYGEF Plus (PVDF-HP)** shall be manufactured with laying lengths designed for use with fusion machines IR-63 Plus, IR-225 Plus, IR-315 Plus and IR-450 from GF Piping Systems, providing welds with increased mechanical and chemical stability than conventional welding methods.

The IR Plus fusion machines use overlap controlled non-contact radiant heating. The cooling time for is calculated on the basis of ambient temperature and the bead surface temperature for uniform reproducible weld beads for easy weld bead inspection. To increase the cooling capacity, an additional cooling fan is included in the IR-225 Plus and IR-315 Plus.

Only authorised welders by GF Piping Systems are allowed to perform fusion on the IR Plus machines.

As an alternative to IR fusion, conventional butt fusion according to DVS 2207-15 may be used, preferably with automated CNC controllers and weld recorders. Special care needs to be taken to prevent the pipe and fitting ends from sticking to the heater plate.

The BCF fusion technology joins **SYGEF Plus (PVDF-HP)** piping components of dimensions from DN20-110 without any irregularities, beads or crevices. The extremely compact fusion machine, which is also ideal for on-site fusion, is very reliable, easy to handle and creates reproducible and very strong fusion welds.

Only authorized welders by GF Piping Systems are allowed to perform fusion on the BCF Plus machines manufactured by GF Piping Systems.

The welding and the installation should be in accordance with GF Piping Systems Guide to the Installation and Use of Plastic Pipeline.

## 8. Measurement & Control / Instrumentation

The following parameters can be measured (Sensors), indicated and/ or transmitted (transmitters) to PLC, PC and other Data Acquisition Systems. All products comply with the CE standard.

Parameter	Technology	Compatible liquids (*)
Flow	Paddlewheel	clean liquids
	Rotameter	clean liquids
	Magmeter	contaminated liquids
Level	Hydrostatic/Ultrasonic/Radar	all liquids
pH-ORP	Glas electrodes	all liquids
Conductivity	Contact	all liquids
Pressure	Piezoresistive	all liquids
Temperature	Pt1000	all liquids

(\*) please check first the sensors limitations in material, pressure and temperature (data sheet) and chemical resistance list

### 8.1 Sensors

The sensors listed hereafter will transfer the measured value to a Transmitter, to indicate the measured value and allowing simple calibration and maintenance of the devices. Alternatively the measured values of the sensors can be sent directly to a PLC, PC or other local made electronics using either an analogue signal (4-20 mA, open collector or sinusoidal voltage) or a digital signal called S3L.

#### 8.1.1 Installation Fittings

Depending on the sensor type, special installation fittings shall be used for connection to the pipeline: Instrument-Installation Fitting metric sizes DN50-300 with union ends for socket or butt fusion, Screw-On Saddle metric sizes DN65-300, Adaptor Sockets metric sizes DN20-50 and Wafer Fittings metric sizes DN65-300. Sensor thread connection for flow- and pH-sensors shall be 1 ¼" NPSM. For all further sensors standard threaded fittings, as well as adaptor sockets or nipples with ½", ¾" ISO, or ¾" NPT thread shall be used.

#### 8.1.2 Flow sensors

##### 8.1.2.1 Paddlewheel sensors

##### Sinusoidal sensors:

This sensor requires no external power source to produce a signal. Internal to the body of the sensor is a wire coil which when excited by the rotor assembly produces a small sinusoidal signal. The rotor assembly consists of four paddles; inserted into each of the paddles of the rotor are

magnets. As liquid flows past the rotor assembly it rotates each of the four paddles produces a sine wave signal as it passes the centre of the body (two paddles of the rotor produces a full AC sine wave). The sensors produce a signal output which is proportional to the flow rate. A K-factor (number of pulses generated by the sensor per 1 liter or 1 gallon of fluid the sensor) is used to define the size of the pipe that the sensor is inserted into.

### **Hall Effect sensors:**

Internal to the manufacturer body is an open collector relay. The sensor is supplied with a voltage from the transmitters or an external power supply ranging from 5 to 24 volts. This voltage is switched through the open collector relay as the paddlewheel (rotor) of the sensor rotates. The sensor's rotor assembly has four paddles. Inserted in two of the paddles is a magnet. As the paddles pass the centre of the sensors body, the magnetic field switches the open collector relay on and off which generates a square wave pulse. Two pulses indicates a complete rotation (on/off cycle) of the open collector relay. The pulse output is directly proportional to the fluid velocity. A K-factor (number of pulses generated by the sensor per 1 liter or 1 gallon of fluid passing the sensor) is used to define the size of the pipe that the sensor is inserted into.

### **8.1.2.2 Rotameters**

As supplied by manufacturer are radially installed dismountable meters for flow rate measuring in industrial piping applications. If needed, minimum or maximum flow can also be monitored via limit switches. Also, analogue flow measurement with a 4...20 mA Signal is possible.

The working principle of the rotameter is based in gravity and equilibrium of forces. If a medium flows upwards at a sufficient flow rate through the vertically mounted taper tube, the float is raised to the point at which a state of equilibrium sets in between the lifting force of the medium and the weight of the float. Since the mean rate of flow is proportional to the quantity flowing through per unit of time, this state of equilibrium corresponds to the measurement of the instantaneous flow rate.

Following types and sizes are available:

- Length 165, 185, 200, DN10–32mm
- Length 335, DN25 –65mm
- Length 350, DN25 –65mm

### **8.1.2.3 Magmeter**

The Magmeter sensor consists of two metallic pins that produce a small magnetic field across the inside of the pipe. The The Magmeter measures the velocity of a conductive liquid (20  $\mu$ S or greater) as it moves across the magnetic field produced

by the Magmeter. A voltage occurs on the sensor tips, which is directly proportional to the flow rate of the fluid. The magnetic signal is conditioned and translated in to a pulse signal. A K-factor (number of pulses generated by the sensor per 1 liter or 1 gallon of fluid passing the sensor) is used to define the size of the pipe that the sensor is inserted into. The Magmeter is offered as a blind frequency, 4-20 mA or digital S3L output, or with integral display and control relays.

### 8.1.2.4 Ultrasonic Flowmeter

They are transit time ultrasonic flow meter designed to work with clamp-on transducers, to provide accurate measurement of liquid flowing within a closed pipe, without the need for any mechanical parts to be inserted through the pipe wall or to protrude into the flow system. It takes just a few minutes to install and there is no need to shut down flow or drain the system!

From process control in industrial applications, to water management from raw to deionized water for fixed installation and for portable flow monitoring cover a wide spectrum of flow monitoring and process control in many industries.

Using ultrasonic transit time techniques enables to be used with pipes having an outside diameter range d13-2000 as standard and up to d5000 as an option. The instruments will also operate over a wide range of fluid temperatures. All of the Ultrasonic Flowmeters should have the same basic features. However, the standard can also perform data logging and allows site details and flow data to be reordered with a memory, that shall be able to log more than 150.000 separate readings. The standard shall be also capable of downloading the stored data via the USB or RS232 interface to the Portagraph software supplied with the unit.

## 8.2 Level Sensor

### 8.2.1 Hydrostatic Level Sensors

Hydrostatic pressure is the pressure exerted on a column of fluid by the weight of the fluid above it. Internal to the PVDF sensor body is a ceramic diaphragm sensor and capillary tube/cable assembly. The ceramic diaphragm sensor exposed to the fluid senses the hydrostatic pressure of the fluid and compares the pressure to the atmospheric pressure monitored the capillary tube/cable assembly. The hydrostatic level sensor only senses the hydrostatic pressure of the fluid. The Level Sensor is offered as a blind output 4-20 mA or digital S3L output connected Transmitter.

### 8.2.2 Ultrasonic Level Sensors

Ultrasonic level sensors are non-contact devices, using the travel time of sound and its reflection, for measuring the distance to a liquid or solid surface. Based on this information, GF Piping Systems sensors are capable of calculating a liquid level or volume. Their outstanding narrow 5° beam, allow reliable measurement even at the



presence of disturbing objects or when space is limited. The GF Piping Systems portfolio contains sensing ranges 4 m, 6 m and 15 m.

Sensors with integrated display or blind sensors are available and provide 4-20 mA, HART protocol or relay outputs. GF Piping Systems ultrasonic level sensors are compatible with GF Piping Systems transmitters, indicators, controllers and valve actuators.

### 8.3 Radar

#### 8.3.1 Radar

The 25 GHz (K-band) Pulse Radars are the most progressive non-contact level transmitters for industrial processes. With an excellent accuracy, compact antennas and a user-friendly set-up the 2290 is an effective, simple, low cost choice for demanding level applications. GF's new K-band radar featuring  $\pm 3$  mm ( $\pm 0.1$ inch) accuracy and short dead band excels with its robust full plastic housing. Its antenna range incorporates a stainless steel horn and enclosed plastic tube choices. The enclosed antenna versions can be replaced without removing the antenna enclosure from the process. Local programming is aided by a plug-in display module. The signal processing algorithm of the 2290 is based on years of experience with non-contact level measurement making it an excellent choice for applications simple and challenging alike. Process enclosures are available in PTFE, PP & PE.

#### 8.3.2 Radar

With its ability to read accurately when other non-contacting or invasive methods fail, the guided level transmitter using GWR (guided wave radar) is the solution to your level needs.

The radar signal is sent down the probe assembly eliminating the interferences caused by low dielectric liquids, heavy fuming, slightly conductive foams, internal tank obstructions, etc. By focusing its energy along the probe can be installed in tanks with limited space. It is also less sensitive to turbulence that would normally upset the readings in ultrasonic and unguided radar technologies. The probes are also available as coated options in FEP & PFA.

### 8.4 Point Level

#### 8.4.1 Point Level Switches

The GF Piping Systems portfolio of point level switches contains various different detection technologies, to provide a solution for various liquids and application requirements.

- Vibration Forks detect a liquid level with two vibrating stainless steel wings. In air they vibrate with a specific, calibrated frequency. By the contact with a



liquid the frequency changes which forces an electrical output to switch. GF Piping Systems vibration forks are equipped with digital PNP/NPN or relay output. Versions with ATEX or WHG approval are available.

- Conductive Multipoint Switch contains up to 5 stainless steel electrodes, which allow to detect 4 different liquid levels in a tank. Up to 2 external relay pairs allow to switch pumps or valves. GF Piping Systems conductive multipoint switches work with liquids of min. 10 $\mu$ S conductivity. Their four-in-one design allows fast installation and provides attractive solutions concerning costs.
- Guided Float Switches are equipped with an air filled float with embedded magnet. Rising liquid lifts up the float. The magnetic field forces a reed contact to switch. GF Piping Systems guided float switches are available in PP and PVDF to provide best chemical compatibility to corrosive liquids.
- Ultrasonic Gap Switches are equipped with an ultrasonic transducer and receiver in their fork tips. Based on the switch design, the sound waves are damped in air. Thus the output is disabled. In contact with liquid the sound waves start to travel from transmitter to receiver, which enables the output. GF Piping Systems ultrasonic gap switches provide an electronic relay output which allows to control pumps and valves. Thanks to their PPS full-plastic body they provide a very high resistance against mechanical impacts and corrosive liquids. They work with no moving parts, so they do not require any maintenance.
- Float Switches are primarily used in open basins and pump shafts for detecting liquid level. In an empty tank they hang in vertical position, attached to the tank wall at their cable. Rising liquid carry them on the liquid surface. At an angle of approximately 45° an integrated switch is enabled. GF Piping Systems float switches are double chambered and equipped with a mercury-free switch. Hence they may be used for drinking and for waste water applications.

## 8.5 Analytic

### 8.5.1 pH Sensors

All pH sensors are constructed commonly called combination electrodes. The measuring cell is constructed of hydrogen sensitive glass that can detect the concentration of hydrogen ions (+H) in a solution. The concentration of +H ions directly determines the pH of the fluid. The reference cell is used to provide a stable reference signal. The pH signal is measured against the stable reference signal. The reference junction allows the reference cell to come in contact with the fluid being measured. The measured signals are then conditioned and sent as a blind 4-20 mA or as a digital S3L signal Transmitter.

### 8.5.2 ORP Sensors

All ORP sensors are constructed similar to the pH sensors, except that a noble metal like platinum or gold replaces the silver chloride element of the measuring and reference cell of the pH electrode. Temperature compensation is not used in ORP measurements as well. ORP is an abbreviation for Oxidation-Reduction Potential. Oxidation is a term used to denote the occurrence of a molecule losing an electron. Reduction occurs as a molecule gains an electron. The “potential” is simply an indication of a solution’s propensity to contribute or accept electrons. ORP reactions (sometimes referred to as REDOX) always take place simultaneously. There is never oxidation without reduction, and ORP electrodes are used to detect electrons exchanged by molecules as these reactions occur.

The measured signals are then conditioned and sent as a blind 4-20 mA or as a digital S3L signal to Transmitter.

### 8.5.3 Conductivity Sensors

All Conductivity sensors are manufactured using two stainless steel electrodes. Alternative materials are available in case of chemical incompatibility. Conductivity sensors measure the ability of a fluid to conduct an electrical current between two electrodes. The proper term for this ability of a solution is electrolytic conductivity, since only ions conduct electric current in solution. Electrolytic conductivity (or simply conductivity) is therefore an indirect measure of the ionic concentration of a solution. Generally, conductivity increases and decreases with the concentration of ions.

Most conductivity electrodes consist of two measuring half-cells. The geometry of the half-cells can be tailored to provide highly accurate measurements over a specific conductivity range. Cell constants help to describe electrode geometry for the purpose of selecting the appropriate electrode for a given application. A cell constant is defined as the length between the two halfcells divided by the area of the cells. All conductivity sensors have a temperature compensation circuits in order to increase the sensors accuracy.

The measured signals are then conditioned and sent as a blind 4-20 mA or as a digital S3L signal to the Transmitter.

## 8.6 Multi Parameter Instruments

### 8.6.1 Transmitters

The Transmitter should provide a single channel interface for many different parameters including Flow, pH/ORP, Conductivity/Resistivity, Salinity, Pressure, Temperature, Level and other sensors that output a 4 to 20 mA signal. The display shows separate lines for units, main and secondary measurements as well as a dial-type digital bar graph.

The transmitter is offered in both panel or field mount versions. Both configurations can run on 12 to 32 VDC power (24 VDC nominal). The transmitter can also be loop powered with compatible sensors.

Derived measurements include difference, sum, ratio, percent recovery, percent rejection, percent passage and BTU. The menu system can be programmed to display in multi-languages including English, German, French, Spanish, Italian, and Portuguese.

- 2,4 or 6 sensor input (Flow, Level, pH-ORP, Conductivity, Pressure Temperature)
- 0,2 or 4 analogue output (4-20 mA or 0-10 Volts)
- 0,2,4,6 or 8 relay output
- Power supply 12-30 VDC or 110-230 VAC

### 8.7 Batch Control

A batch controller shall allow batching a pre-selected quantity of liquid. After selection of the quantity to be dosed, a start signal (local or remote) will close a batch controller contact to energize or de-energize a valve and/or switch on a pump. The batch controller count the pulses coming from any sensor with frequency output and stop the batch process as the pre-selected quantity is reached.

Advanced features include a user-set security code, an automatic calibration option, and overrun compensation. The batch process is repeatable and is designed for intensive industrial applications.

## 9. Quality

### 9.1 Production conditions

**SYGEF Plus (PVDF-HP)** Pipes, fittings, valves and accessories are manufactured in an environment operating a Quality Assurance System to ISO 9001 and an Environmental Management System conform to ISO 14001.

**SYGEF Plus (PVDF-HP)** products are produced under ISO 14644-1 Class 5 (U.S. Fed. Standard 2.09E Class 100) conditions. Subsequent quality inspection and cleaning is to be carried out using 18MΩ pure water under clean room ISO 14644-1 Class 5 (U.S. Fed. Standard 2.09E Class 100) conditions.

### 9.2 Marking

All components are embossed with a permanent identification during the production process to ensure full traceability. The following information will be mentioned:

- Manufacturers name or trade mark
- Production lot number
- Material
- Dimension
- Pressure rating

### 9.3 Uniformity

Pipes, fittings, valves and welding machines shall be supplied from one manufacturer, namely GF Piping Systems to ensure correct and proper jointing between components and uniform chemical and physical properties of the piping system.

### 9.4 CAD Library

All components shall be available in GF Piping Systems CAD and BIM library. Available at: <http://cad.georgfischer.com> & <http://bim.gfps.com>

### 9.5 Training, Certification and Installation

Site personnel, involved with **SYGEF Plus (PVDF-HP)** piping installation shall undergo training and certification from an authorized local institution prior to performing any jointing operations on site. For further information and training please contact GF Piping Systems support under

#### Contact:

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