



Optical Single-Phase Flowmeter

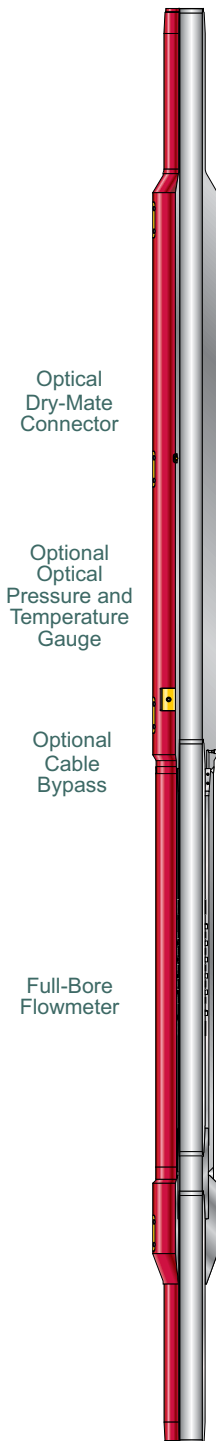
Weatherford's optical single-phase flowmeter delivers accurate, real-time measurements of downhole liquid or gas flow rate. The flowmeter enables better management of production or injection and increased flexibility in well completion options. Typical applications for the single-phase flowmeter include injectors (water or gas) in multi-zone completions and single-phase producers. The flowmeter is production tubing deployed and is typically integrated with one or two Weatherford optical pressure and temperature gauges ported to tubing and/or annulus.

Each flowmeter is designed to fit specific completion requirements. The flowmeter is available in tubing sizes ranging from 2-3/8 to 5-1/2 in. Other sizes are available on request.

Weatherford's optical flowmeters are field-proven in installations ranging from oil producers to high-rate gas condensate wells to multi-zone water-alternating-gas (WAG) injectors. Weatherford also offers a multiphase flowmeter for downhole oil/water or liquid/gas measurement.

Applications

- Zonal allocation of water or gas (or WAG) injection in multi-zone intelligent completions.
- Zonal allocation of gas production in multi-zone completions.
- Identification and localization of injection or production anomalies in real time.
- Direct determination of well productivity index.
- Enables reduction of surface well tests and surface facilities.
- Subsea installations with fiber in the umbilical; Weatherford offers wet-mate fiber-optic connectors for both horizontal and vertical trees. The optical flowmeter allows for up to 31-mi (50-km) step-outs.



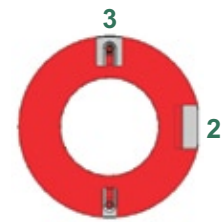


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Features, Advantages and Benefits

- Flowmeter is completely non-intrusive and allows for full through-bore access.
- The flowmeter is 100 percent optical, with no sensors exposed to well fluids. This design ensures high resilience to erosion and corrosion and measurement that is not affected by solid content in the flow.
- Low component count, no moving parts, and passive sensors make the flowmeter highly reliable; all complex components are located at the surface.
- The flowmeter measures gas or liquid with no changes to the hardware and offers a robust and accurate measurement that is ideal for WAG injectors.
- Flowmeter measurement cannot drift and offers excellent long-term stability.
- Bi-directional flow measurement makes the flowmeter capable of measuring inter-zonal crossflow in multi-zone completions.
- Full-bore design means no permanent pressure loss.
- Rugged, shock-resistant design can handle perforating and hydraulic fracturing operations.
- The flowmeter is intrinsically safe, with no electrical energy downhole or at the wellhead.
- Multiple optical sensors, including pressure and temperature, seismic, distributed temperature sensing (DTS), and single-phase and multiphase flow, can be combined on a single cable for completion design flexibility.
- Flowmeter software offers integrated pressure-volume-temperature (PVT) for volume conversions and reports flow rate at downhole and surface conditions.
- Flowmeter is integrated with Weatherford's Reservoir Monitoring System (RMS) and offers numerous options for data interface, storage, and analysis.

Cross-Sectional View



- 1** Annulus or Tubing Ported Pressure and Temperature Gauge
- 2** Cable Bypass
- 3** Optical Dry-Mate Connector

Options

- Integrated optical pressure and temperature gauge. One or two gauges can be connected and ported to annulus and/or tubing. Flowmeter and pressure and temperature gauges share one optical fiber and a single dry-mate optical connector.
- Cable bypass slots for control lines.



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Specifications

Performance Data	
Volumetric flow rate accuracy	±1% (of measurement)
Turndown ratio (maximum/minimum flow rate)	>20
Minimum flow velocity	Liquid: 3 ft/sec (0.9 m/sec)
	Gas: 10 ft/sec (3 m/sec)
Pressure rating	10,000 psi (690 bar) ^a
Operating temperature	Standard: 77° to 257°F (25° to 125°C)
	High Temp: 77° to 302°F (25° to 150°C)
Storage temperature	Standard: -58° to 257°F (-50° to 125°C)
	High Temp: -58° to 302°F (-50° to 150°C)
Vibration	15 g rms, random
	10 to 2,000 Hz (Nav Mat)
Shock	100 g, 10 ms half sine
Material	INCONEL® 718
	Super Duplex 25 Chrome
Maximum tension and compression load	Contact Weatherford
Connections (pin × pin)	Premium ^b
Maximum fiber step-out length	31 mi (50 km) ^c
Fiber-optic connector	3-pin dry-mate

^aPressure rating depends on flowmeter size, material, and options. Contact Weatherford for pressure rating of a specific design.

^bPremium connections are manufactured to client specifications.

^cMaximum step-out length depends on well design.

Dimensions and Data ^{a, b}									
Size ^c (in.)	Weight (lb/ft)	Minimum ID		Maximum ID		Standard OD ^d		Minimum Flow Rate ^e	
		(in.)	(mm)	(in.)	(mm)	(in.)	(mm)	(bbl/d)	(m ³ /d)
2-3/8	4 to 5.8	1.867	47.4	2.041	51.8	4.375	111.1	1,000	159
2-7/8	6.4 to 8.6	2.259	57.4	2.441	62.0	4.875	123.8	1,500	239
3-1/2	9.2 to 10.2	2.922	74.2	2.992	76.0	5.500	139.7	2,150	342
4-1/2	12.75 to 15.1	3.758	95.5	3.958	100.5	6.500	165.1	3,500	557
5-1/2	17 to 20	4.778	121.4	4.892	124.3	7.500	190.5	6,000	954

^aFlowmeter dimensions are designed to client specifications.

^bFor gas or multiphase, contact Weatherford for a detailed analysis.

^cOther sizes are available on request.

^dStandard ODs without cable bypass or integrated pressure/temperature gauge.

^eMinimum flowrate assumes liquid flow at flowmeter conditions.

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