ISO 5167 DIFFERENTIAL-PRESSURE PRIMARY ELEMENTS

Standard Orifice Plate Product Guide

Selection · Configurations · Installation · Commissioning · Maintenance

Precision-machined standard orifice plates

Accuracy	Turndown	Nominal size
±0.5%–1.0% of rate*	10:1 typical; up to 30:1	DN50–DN2000

**Typical application performance; beta ratio, Reynolds number, installation and transmitter selection apply.*

1. Product Overview

A standard orifice plate creates a defined restriction in a full circular pipe. As the fluid accelerates through the bore, static pressure falls and a differential pressure is produced between the upstream and downstream tapping locations. With the pipe bore, orifice bore, fluid properties and operating conditions known, the measured differential pressure is converted into mass or volumetric flow.

For concentric standard plates, Shizhong uses ISO 5167-1:2022 and ISO 5167-2:2022 as the international calculation and geometry basis. Correct performance depends on the complete measurement system: primary element, upstream flow profile, pressure taps, impulse lines, transmitter range, pressure/temperature compensation and commissioning practice.

Engineering qualification: The published accuracy is not a universal guarantee for every line. Final performance is confirmed against beta ratio, Reynolds number at minimum and maximum flow, tapping arrangement, pipe condition, disturbance layout, fluid properties and the selected differential-pressure transmitter.

Approved website performance data

Parameter	Published value	Application note
Accuracy	±0.5%–1.0% of rate	Beta-ratio and Reynolds-number dependent
Turndown	10:1 typical	Single differential-pressure transmitter
Extended turndown	Up to 30:1	Dual-range architecture and verified crossover
Nominal size	DN50–DN2000	Final construction and rating are project-specific
Reference	ISO 5167-1:2022 / ISO 5167-2:2022	Concentric standard orifice plates

Why standard orifice plates remain widely used

- Standards-based geometry and calculation without individual wet calibration when all applicability conditions are met.
- Simple construction with no moving parts in the primary element.
- Broad fluid coverage for clean liquids, gases and steam.
- Multiple pressure-tapping arrangements: corner, flange, and D and D/2 taps.
- Replaceable plate design and traceable dimensional inspection.
- Wide choice of materials, flange standards, pressure classes and transmitter arrangements.

2. Product Configurations

The following photographs show the available standard-orifice family and related project-specific configurations. The English captions are also used as the website image names and carousel labels.

2.1 Integrated Multivariable Orifice Flow Meter with Temperature and Pressure Compensation

Figure 1. Integrated Multivariable Orifice Flow Meter with Temperature and Pressure Compensation

An integrated differential-pressure measurement package combining the primary element, manifold, transmitter and compensation inputs. It is intended for gas and steam duties where operating density changes with pressure and temperature.

2.2 Integrated Standard Orifice Flow Meter

Figure 2. Integrated Standard Orifice Flow Meter

A spool-mounted standard orifice assembly with compact differential-pressure instrumentation. Factory integration reduces field impulse-line work and supports repeatable installation.

2.3 Built-in Orifice Flow Meter — Flanged Connection

Figure 3. Built-in Orifice Flow Meter — Flanged Connection

A compact built-in arrangement for small and medium process lines where a removable flanged connection is preferred for inspection and maintenance.

2.4 Segmental Orifice Plate

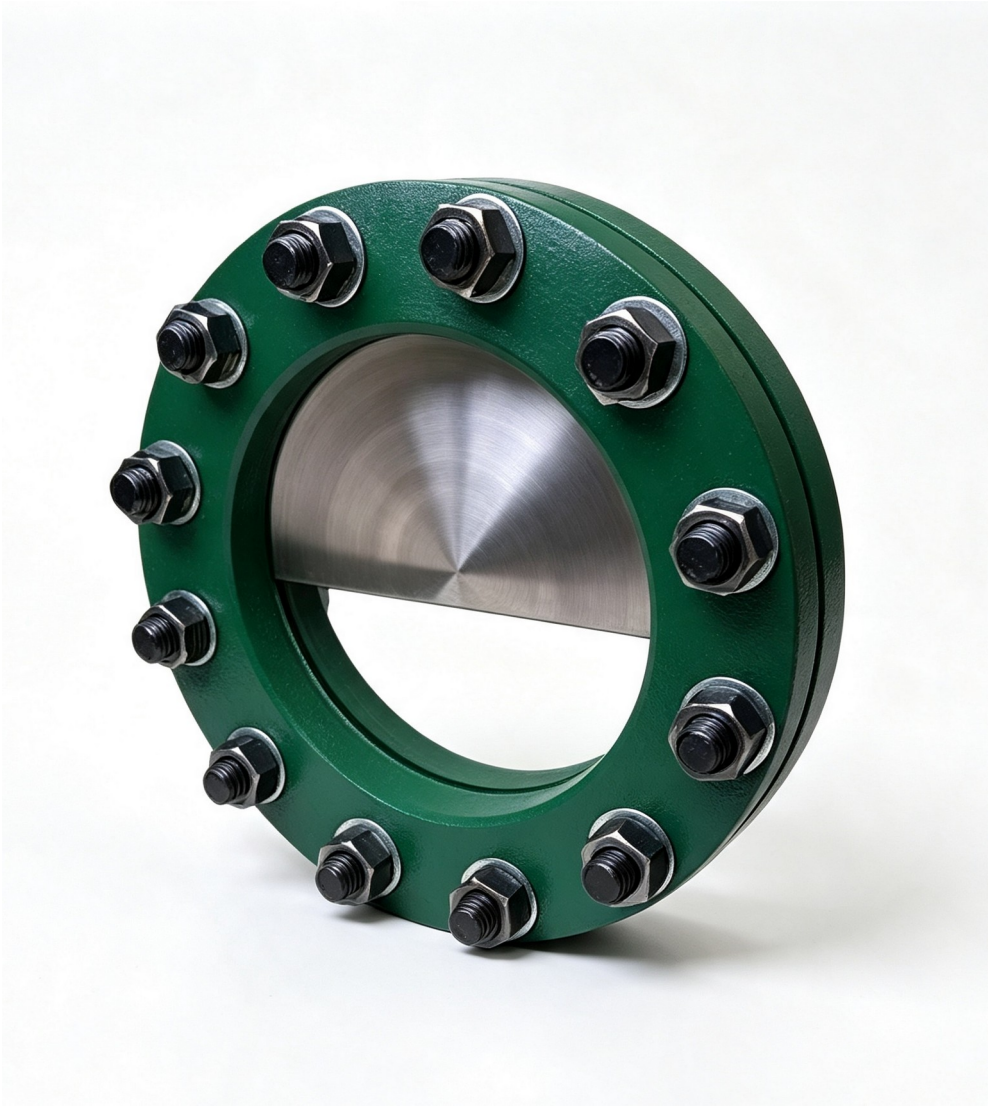

Figure 4. Segmental Orifice Plate

A segmental opening preserves a more open flow path for selected dirty-liquid or entrained-solids duties. This is an application-specific configuration and is not presented as an ISO 5167-2 standard concentric plate.

Standards boundary: A segmental plate is a related special-purpose differential-pressure element. It should not be described as an ISO 5167-2 standard concentric orifice plate. Its design basis, performance and calibration requirements must be confirmed for the project.

2.5 Standard Orifice Plates

Figure 5. Standard Orifice Plates

Precision-machined concentric plates are selected by pipe bore, beta ratio, tapping arrangement, material and project pressure class. The inlet edge, bore, flatness and surface finish are controlled inspection points.

2.6 Integrated Multivariable Orifice Flow Meter — Detailed View

Figure 6. Integrated Multivariable Orifice Flow Meter — Detailed View

A detailed view of the compact transmitter and manifold arrangement used to combine differential pressure with pressure and temperature compensation in one metering package.

2.7 Built-in Orifice Flow Meter — Welded Connection

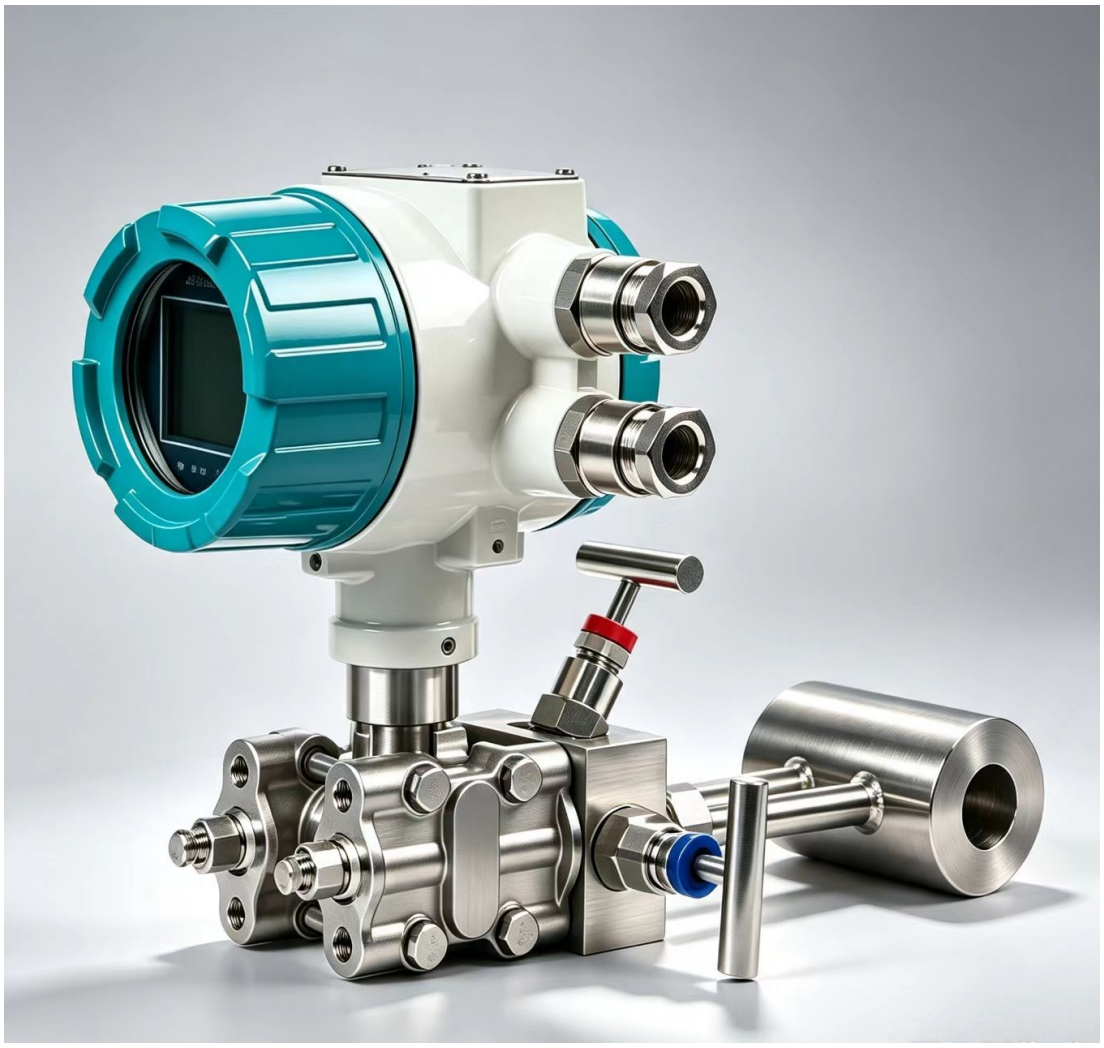

Figure 7. Built-in Orifice Flow Meter — Welded Connection

A compact welded process connection for project-specific installations where permanent integration, small footprint and reduced external impulse piping are priorities.

3. Measurement Principle and Calculation Basis

The relationship between differential pressure and flow follows conservation of mass and energy. For a given primary element and fluid state, flow is approximately proportional to the square root of differential pressure. This square-root relationship is why transmitter selection and low-flow signal quality strongly affect usable turndown.

$$q_m = (C / \sqrt{(1 - \beta^4)}) \cdot \varepsilon \cdot (\pi d^2 / 4) \cdot \sqrt{(2 \Delta p \rho_1)}$$

Symbol	Meaning
q_m	Mass flow rate
C	Discharge coefficient
$\beta = d / D$	Diameter ratio
ε	Expansibility factor for compressible fluids
d	Orifice bore at operating conditions
D	Upstream pipe bore at operating conditions
Δp	Measured differential pressure
ρ_1	Upstream fluid density

For gases and steam, pressure, temperature, compressibility and density compensation may be required. For every application, the Reynolds-number range must be checked at minimum, normal and maximum flow. The calculation file should retain the pipe bore, orifice bore, beta ratio, discharge coefficient, expansibility factor, differential-pressure range and fluid property basis.

4. Selection and Application

Decision item	Engineering review
Fluid	Phase, composition, density, viscosity, solids, corrosiveness and fouling tendency
Flow range	Minimum, normal and maximum flow; operating duration at each condition
Pipe	Actual internal bore, schedule, roughness, ovality and available straight run
Pressure and temperature	Minimum, normal, maximum and design values
Performance	Required accuracy, repeatability, turndown and allowable pressure loss
Tapping	Corner, flange, or D and D/2 taps selected within the applicable standard limits
Materials	Plate, carrier, flange, gasket, fastener and impulse-line compatibility
Instrumentation	Transmitter range, static-pressure rating, manifold and compensation method
Documentation	Calculation sheet, drawing, inspection plan, certificates and data book

Application fit

- Clean liquid, gas and steam services with a stable, full-pipe flow condition.
- Utility and process measurement where standards-based geometry and familiar maintenance are valued.
- High-pressure and high-temperature duties with project-specific materials and pressure classes.
- Integrated multivariable packages where density compensation and compact installation are required.

Conditions requiring additional review

- Pulsating flow, two-phase flow, flashing, cavitation or rapidly changing composition.
- Insufficient straight run, strong swirl, asymmetric velocity profile or upstream control valves.
- Very low Reynolds number, highly viscous fluids, deposits, erosion or corrosive attack.
- Segmental, eccentric or other non-standard plate geometries requiring a project-specific basis.

5. Installation Requirements

Primary element and piping

- Verify the flow-direction mark before installation. The sharp inlet edge must face upstream.
- Keep the plate perpendicular to the pipe axis and the bore concentric with the pipe bore.
- Use gaskets with an inside diameter that does not protrude into the flow passage.
- Confirm upstream and downstream straight-run lengths from the applicable ISO 5167 table for the actual beta ratio and disturbance layout.
- The adjacent pipe bore must be clean, circular and free from steps, deposits, weld intrusion or visible distortion.
- Install flow-control valves downstream of the required straight run whenever practical.
- Place temperature measurement where it represents the fluid state without disturbing the required upstream flow profile.

Pressure taps and impulse lines

- Keep tapping holes clean, square to the wall and free from burrs.
- For liquid service, arrange taps and lines to prevent trapped gas; for gas service, prevent liquid pockets.
- For steam service, use equal condensate-leg elevation and consistent thermal conditions.
- Route positive and negative impulse lines together with a continuous slope and the shortest practical length.
- Leak-test every fitting, valve and manifold connection before zeroing the transmitter.
- Provide freeze protection, heat tracing or insulation only when required, and avoid overheating the impulse fluid.

6. Commissioning Procedure

1. Confirm the approved drawing, calculation sheet, flow direction, tag number and pressure class.
2. Inspect the plate bore, inlet edge, flatness, cleanliness and orientation before closing the joint.
3. Flush or blow the process line so that weld slag and debris cannot strike the primary element.
4. Pressure-test the assembly and verify that both impulse paths are open and leak-free.
5. Equalize the transmitter manifold, establish a stable static pressure, and perform the zero check.
6. Open the positive and negative isolation valves in the correct sequence, then close the equalizing valve.
7. Check the transmitter range, square-root configuration, engineering units and any pressure/temperature compensation.
8. Compare indicated flow with process expectations at stable operating points and record the as-commissioned baseline.

Safety: Never loosen a flange, manifold, transmitter or impulse-line connection while it is pressurized or at an unsafe temperature. Apply the site isolation, depressurization, drainage and lockout/tagout procedure.

7. Inspection and Maintenance

Inspection point	What to check	Typical action
Orifice inlet edge	Rounding, nicks, erosion or corrosion	Replace or re-machine only to an approved drawing
Orifice bore	Diameter change, deposits and circularity	Clean and dimensionally inspect
Plate flatness	Warping or permanent deformation	Replace if outside drawing tolerance
Pressure taps	Blockage, burrs or deposits	Clean without enlarging the tapping hole
Impulse lines	Leakage, blockage, freezing or trapped phase	Repair, drain, vent or flush as applicable
Manifold	Valve leakage and equalizing-valve condition	Service and function-test
Transmitter	Zero shift, range and static-pressure condition	Zero check or calibration
Pipe bore	Deposits, corrosion, weld steps or gasket intrusion	Restore the required flow passage

Maintenance frequency depends on fluid cleanliness, erosion/corrosion risk, operating severity and the quality system for the measurement point. Record every inspection result so changes in the plate edge, bore, impulse system and transmitter zero can be trended.

8. Troubleshooting

Symptom	Likely causes	Checks and corrective action
No differential pressure	Closed isolation valve; equalizing valve open; both lines blocked; no flow; transmitter fault	Verify process flow and valve sequence, clear lines, then test the transmitter
Differential pressure too low	Positive line leak/blockage; oversized transmitter range; plate reversed; flow below design	Leak-test, inspect orientation and bore, verify transmitter range and actual flow
Differential pressure too high	Negative line leak/blockage; undersized range; deposits; actual flow above design	Inspect negative line, primary element and transmitter range
Unstable signal	Pulsation, two-phase flow, trapped gas/liquid, valve disturbance, vibration or poor damping	Check process condition, line routing, disturbance location and transmitter settings
Flow bias after maintenance	Wrong plate, reversed plate, gasket intrusion, changed zero or unequal condensate legs	Recheck tag/bore/orientation, joint assembly and transmitter zero
Low-flow error	Differential pressure near noise floor; Reynolds-number limit; impulse-line imbalance	Review minimum-flow calculation and consider a verified dual-range architecture

9. Ordering Data

Provide the following information for an engineering review and quotation. Missing process data can lead to an unsuitable beta ratio, transmitter range, material or pressure class.

- Fluid name, composition and phase.
- Minimum, normal and maximum flow with units and reference conditions.
- Minimum, normal, maximum and design pressure and temperature.
- Pipe size, schedule, actual internal diameter, material and flange standard.
- Required accuracy, turndown, allowable permanent pressure loss and metrology requirement.
- Fluid density, viscosity, compressibility and isentropic exponent where applicable.
- Available upstream/downstream straight run and nearby fittings, valves or branches.
- Preferred tapping arrangement, transmitter/manifold arrangement and communication protocol.
- Material, corrosion allowance, inspection, NDE and certification requirements.
- Required deliverables: calculation sheet, GA drawing, certificates, ITP, test records and data book.

Standard deliverables

Deliverable	Typical content
Engineering calculation	Pipe/orifice bore, beta ratio, Reynolds range, DP range and fluid-property basis
General arrangement drawing	Dimensions, tapping, flow direction, materials and connection details
Inspection records	Critical dimensions, surface/edge condition and pressure test where applicable
Material documentation	Certificates as specified in the purchase order
Installation guidance	Orientation, straight run, impulse-line and commissioning requirements

10. Contact

Jinan Shizhong Automation Instruments Co., Ltd.

7036 Jingshi West Road, Jinan, Shandong, China 250022

Email: info@shizhongflow.com

Website: https://www.shizhongflow.com

Office: +86-531-82909656 | Mobile / WhatsApp: +86-188-0531-6689

Document status: This guide is a product and application reference, not a substitute for the approved project calculation, drawing, purchase specification or site safety procedure. Final specifications are confirmed per order.