PATENTED MULTI-POINT VELOCITY-ARRAY MEASUREMENT

Full-Section Matrix Flowmeter

Product · Architecture · Selection · Installation · Validation · Maintenance

Cross-section coverage	Signal flexibility	Metrology basis
Circular pipe or rectangular duct	Independent channels or engineered pneumatic averaging	Project calibration and/or site correlation

Measure the section—not one convenient point

Shizhong matrix systems distribute sensing locations across documented subareas of a large pipe or duct. The objective is to represent a non-uniform velocity field more defensibly than a single-point probe while preserving low permanent pressure loss and serviceable DP instrumentation.

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1. Product Position and Evidence Basis

The product is an engineered measurement system, not a universal probe with one coefficient. A complete supply can include the sensing array, supports, isolation and purge hardware, differential-pressure transmitters, pressure and temperature inputs, a flow computer, documentation, calibration data and site-correlation support.

Evidence level	What it establishes	What it does not establish
Granted utility patent CN212082473U	A protected arrangement of grid conditioner, pressure branches, forward probes, downstream reference sensing and interconnection hardware	Universal accuracy, straight-run length, maintenance interval or suitability for every medium
Design calculation and drawing	Grid locations, subarea basis, materials, supports and channel allocation	Field accuracy without a validated coefficient and representative profile basis
Calibration / comparative test	Performance for the tested assembly, range and test configuration	Unconditional transfer to a materially different duct, profile or signal architecture
Site correlation	Relationship to the agreed reference method under actual operating conditions	Permanent immunity to future fouling or process changes

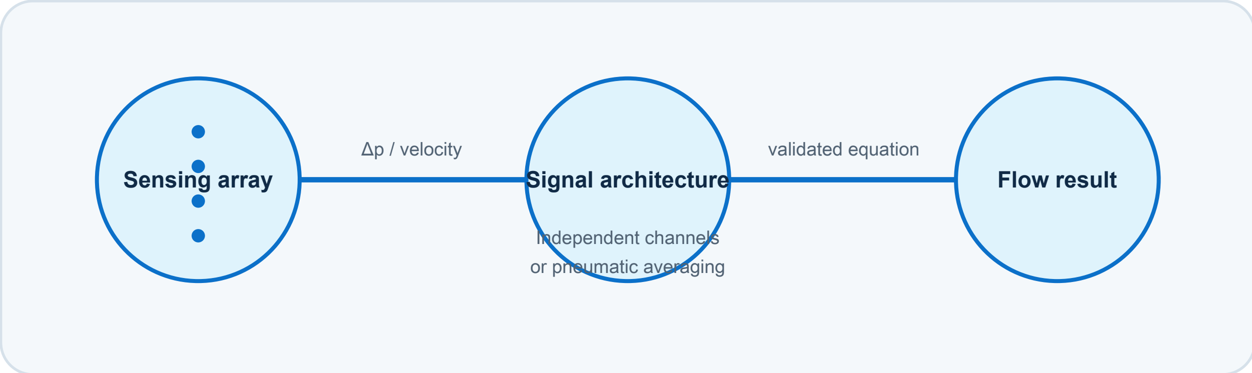
Standards boundary

Matrix probes are not ISO 5167 primary devices. ISO 3966:2025 and ISO 16911 provide velocity-area and stationary-source measurement principles; HJ 75/76 and GB/T 16157 provide emissions-monitoring and reference-method context. None of these documents automatically assigns one product coefficient or one guaranteed accuracy to every matrix arrangement.

Best-fit applications

- Large circular gas pipes where a single insertion point cannot represent the profile.
- Rectangular flue-gas, combustion-air and process-gas ducts.
- Stationary-source flow monitoring that requires a documented cross-sectional sampling plan.
- Retrofits where low obstruction and accessible transmitters are important.

2. Measurement Principle and Signal Architectures



Each sensing location produces a local differential pressure. A local velocity model may be written as v_i = K_i × sqrt(2 deltaP_i / rho). The section flow is then obtained by integrating velocity over area. The correct processing method depends on how the pressure signals reach the transmitter or computer.

Architecture	Calculation meaning	Where it is strongest	Critical control
Independent multi-channel	Q = sum(v_i × A_i); each channel is square-rooted before area weighting	Traceable grid studies, non-uniform profiles, diagnostics	Channel count, transmitter matching, subarea weights and data validation
Zoned channels	Several sensing points are grouped into documented zones; zone results are area weighted	Cost/performance balance on medium and large sections	Zone geometry and group coefficient must be validated
Pneumatic averaging	Pressures combine before one DP measurement; the result is not automatically the arithmetic area-average velocity	Simple instrumentation where the profile and manifold behavior are validated	Use a system coefficient; do not apply independent-channel equations unchanged

Why the square root matters

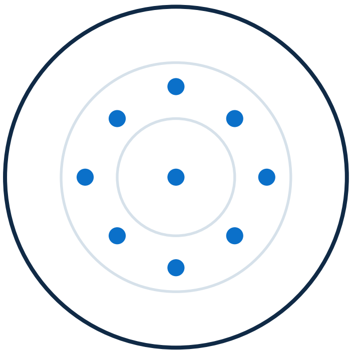
Averaging dynamic-pressure signals and then taking a square root produces an RMS-like velocity response. It equals the arithmetic area average only for a uniform profile. This is why manifold geometry, coefficient determination and site correlation are part of the measurement system—not optional paperwork.

Gas and emissions outputs

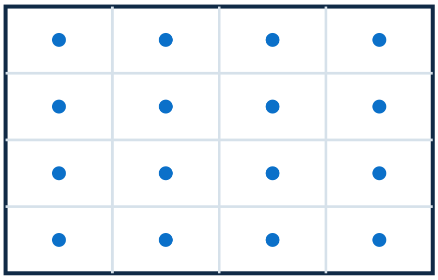
Actual volume flow follows the measured area and velocity. Standard-volume or mass-flow outputs additionally require static pressure, temperature, gas composition, water-vapor treatment, compressibility and the agreed reference conditions. These inputs must be synchronized and included in the uncertainty budget.

3. Grid Design for Circular Pipes and Rectangular Ducts

Circular equal-area concept



Rectangular area-cell concept



Design question	Engineering response
How many points?	Enough to represent the expected profile and meet the agreed uncertainty objective. More points are not automatically better if channels are poorly weighted, fouled or unmatched.
Where are points placed?	At centroids of equal-area or otherwise justified subareas, avoiding walls and structural obstructions that invalidate the assumed representative area.
How is a round section divided?	Concentric equal-area rings and angular sectors, or a traverse arrangement derived from the selected velocity-area method.
How is a rectangular section divided?	Rows and columns or unequal cells matched to known profile gradients, with every channel tied to a documented cell area.
When is CFD useful?	To understand expected profile gradients and support grid design. CFD does not replace calibration, field correlation or an uncertainty budget.

Project deliverable

The approved drawing should identify section dimensions, coordinate origin, probe direction, every sensing location, assigned subarea, support details, access clearances, purge connections, channel numbers and the calculation file revision.

Avoid false precision

A grid can reduce spatial sampling bias, but it cannot correct unknown density, transmitter drift, pressure-line leakage, condensation, plugged ports, pulsation or a changed operating profile. These effects belong in commissioning and maintenance planning.

4. Selection Workflow and Required Data

Step	Decision	Required output
1. Define the result	Actual volume, standard volume, dry standard volume, mass flow or emissions-related output	Units, reference conditions and reporting interval
2. Define the envelope	Minimum/normal/maximum flow or velocity, pressure, temperature, composition, moisture and transient behavior	Operating matrix and upset conditions
3. Map the section	Internal dimensions, wall build-up, access, supports, upstream disturbances and available straight run	As-built sketch or site survey
4. Classify contamination	Dust loading, particle size, droplets, condensate, crystallization, corrosion and cleaning method	Material, port, purge and maintenance concept
5. Choose architecture	Independent, zoned or pneumatic averaging	P&ID;, channel list and equation basis
6. Define evidence	Factory calibration, reference-method comparison, site correlation and uncertainty target	Acceptance plan and traceability package

Data required with the enquiry

- Duct or pipe internal dimensions and shape; material, lining and corrosion allowance.
- Gas composition, moisture, dust or aerosol characteristics; pressure and temperature range.
- Minimum, normal and maximum actual velocity/flow plus desired reporting conditions.
- Upstream/downstream fittings, dampers, fans, bends, expansions and straight lengths.
- Accuracy/uncertainty target, governing method, calibration or site-test requirement.
- Power, outputs, communications, hazardous-area classification and CEMS/DCS interface.
- Access platform, insertion/removal constraints, allowable shutdown and purge supply.

Selection hold point

Shizhong does not release a final grid, coefficient or accuracy statement until the measurement objective, section geometry, signal architecture and evidence plan are agreed.

5. Public Design Envelope

The values below are an enquiry-screening envelope. The final datasheet governs every supplied assembly.

Parameter	Selection basis
Section shape	Circular pipe or rectangular duct; non-circular or obstructed sections require a dedicated survey
Historical size envelope	Round sections: 25–6000 mm; rectangular sections: 50 × 50 to 4000 × 4000 mm. Large or unusual sections require structural and access review
Historical velocity envelope	0.2–60 m/s as a project screening range; minimum usable velocity is governed by DP signal, density, transmitter stability and uncertainty target
Accuracy statement	Project-specific. Historical ±0.5%, ±1.0% and ±1.5% classes may be offered only when supported by the approved architecture, calibration/correlation and installation basis
Temperature / pressure	Selected from probe, seals, valves, transmitter, purge and pressure-boundary materials; no universal extreme limit is published
Materials	304/316 series stainless steel and project alloys; corrosion, erosion, chloride and temperature review required
Outputs	4–20 mA, digital protocols, pulse/totalization or CEMS/DCS data by project

No universal 0D/1D claim

Required straight run depends on section shape, disturbances, swirl, grid density, signal architecture and evidence. Where the available run is constrained, use a documented site survey, flow-profile test, CFD-supported grid study and/or representative calibration—not a generic short-run slogan.

Typical supply scope

Matrix array, process connections, supports, isolation and optional purge hardware; DP or multichannel transmitters; temperature and pressure measurement; flow computer or CEMS interface; drawings, material records, calculation files, calibration/correlation records and commissioning instructions as specified.

6. Applications, Limits and Configuration Choices

Duty	Why matrix measurement is considered	Selection emphasis
CEMS flue-gas flow	Large section, profile distortion and need for representative reporting	Reference method, moisture/reference conditions, purge and correlation plan
Power-plant FGD / SCR ducts	Large rectangular ducts with bends, dampers and temperature gradients	Grid survey, corrosion/condensation, access and structural support
Steel and coking process gas	Large gas headers and potentially non-uniform profiles	Dust/tar/condensate risk, purge, materials and maintenance access
Cement and kiln exhaust	Dust-laden, large-section gas measurement	Erosion, build-up, cleaning method and verification interval
Combustion air / large fans	Low-loss measurement across broad ducts	Low-end DP, swirl, fan proximity and transmitter stability
Process control in large ducts	Stable repeatable section signal is needed for control	Response time, channel diagnostics and control-system integration

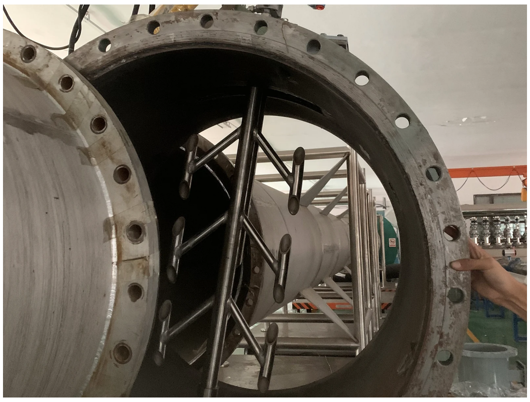
When not to select without further study

- Two-phase or strongly pulsating flow, or operation near condensation/phase-change boundaries.
- Severe deposition, crystallization, tar or sticky dust without a proven purge/cleaning strategy.
- Very low velocity where usable DP is comparable to transmitter zero drift or environmental effects.
- An inaccessible duct with no safe means to inspect, clean or validate the array.
- Custody transfer or regulatory duty without an accepted method, traceability route and uncertainty budget.

Alternative technologies

Depending on the duty, evaluate a single Lierba/averaging Pitot probe, ultrasonic flow measurement, thermal mass measurement, a standard velocity traverse or a redesigned meter run. Matrix measurement is selected because it solves the dominant uncertainty and maintainability problem—not because it has the most sensing points.

7. Installation, Commissioning and Validation



Phase	Minimum controls
Before fabrication	Confirm as-built dimensions, coordinates, insertion direction, supports, access, materials, loads, transmitter location and purge routing
Mechanical installation	Verify orientation, insertion depth, sealing, channel labels, leak tightness, impulse-line slope, supports and safe withdrawal clearance
Instrument setup	Zero/equalize DP channels, verify range and damping, pressure-test manifolds, confirm temperature/pressure tags and communication mapping
Functional commissioning	Compare channel patterns, identify blocked/reversed lines, test purge and alarms, verify equations, units and reference conditions
Performance validation	Compare with the agreed reference method across representative load points; document coefficient, residual bias and uncertainty
Baseline record	Save clean-array channel map, zero data, reference results and photos for future maintenance comparison

Site-correlation discipline

Do not tune a coefficient to one convenient operating point and call it full-range validation. The test should cover the intended load range, stable process periods and the agreed reference method, with uncertainty and repeatability reported.

Acceptance records

Approved drawings and calculation revision; material/pressure records; transmitter calibration; leak and purge tests; channel health check; reference test procedure and results; coefficient/configuration file; uncertainty statement; maintenance and re-verification plan.

8. Fouling Control and Lifecycle Maintenance

Risk	Design / operating response	Verification signal
Dry particulate	Larger openings where feasible, wear-resistant orientation, purge and accessible cleaning	Channel drift, asymmetric pattern, reduced DP or purge backpressure
Condensation / droplets	Heated or sloped lines, drains, insulation and controlled purge	Slow response, zero shift, liquid during equalization
Sticky tar / crystallization	Dedicated materials, heat tracing or wash/purge concept; short inspection interval	Rapid channel imbalance or recurring blockage
Corrosion / erosion	Material and thickness review, replaceable sensing parts where practical	Visual/NDT trend, changed coefficient or leakage
Transmitter/manifold drift	Matched ranges, periodic zero and traceable calibration	Inter-channel disagreement and baseline deviation

Maintenance interval

The initial interval is conservative and based on contaminant loading, dew point, access and criticality. It is extended only after clean inspection and stable comparison data. No universal ‘maintenance-free’ or multi-year interval is claimed.

Recommended diagnostics

- Independent-channel deviation from the clean commissioning profile.
- Zero and equalization checks, purge pressure/flow trend and impulse-line leak checks.
- Comparison against plant balance, fan curve or scheduled reference traverse.
- Inspection photos and deposit description linked to operating hours and process changes.
- Configuration and coefficient revision control after any probe, transmitter or duct change.

Lifecycle value

A matrix system earns its value when it remains diagnosable and maintainable. Channel visibility, documented baselines and safe cleaning access can be more important than adding extra sensing points.

9. Standards and Reference Framework

Reference	Relevant role in a project
ISO 3966:2025	Velocity-area method using Pitot-static tubes in closed conduits; defines method conditions and integration concepts
ISO 16911-1 / ISO 16911-2	Manual reference and automated stationary-source velocity/volume-flow measurement, including site correlation of automated systems
ISO 14164	Quality-assurance context for automated stationary-source flow measurement systems
ISO 15259	Requirements for measurement sections and sites for stationary-source emissions
GB/T 16157	Chinese reference methods for particulate and gaseous pollutant sampling and flow-related measurements in stationary-source exhaust
HJ 75 / HJ 76	Chinese CEMS installation, acceptance, operation and system performance context
US EPA Performance Specification 6	Performance specification context for continuous emission-rate monitoring systems where contractually applicable
CN212082473U	Shizhong patent evidence for the described matrix measurement structure; patent scope is not a metrological guarantee

Edition control

Contracts, drawings and validation procedures should identify the exact standard edition and jurisdiction. This guide summarizes engineering intent and does not reproduce or replace a licensed standard.

Primary technical insight

Flow-profile distortion and sampling strategy are coupled. Published research on velocity-area and multi-point DP measurement shows that installation effects, point placement and aggregation method can materially change the result. Shizhong therefore treats the array, pressure network, calculation and site evidence as one measurement system.

10. Ordering Worksheet and Deliverables

RFQ item	Customer input
Measurement objective	Actual / standard / dry standard volume, mass flow, process control or emissions reporting
Section	Round ID or rectangular width × height; drawing, lining, obstructions and access
Process envelope	Gas composition, moisture, dust, P/T, min/normal/max flow or velocity, transient range
Installation	Upstream/downstream disturbances and distances, orientation, platform and shutdown constraints
Performance	Uncertainty/accuracy target, response, availability, reference method and validation points
Mechanical	Materials, flange/nozzle standard, pressure class, purge, insertion/removal and hazardous area
Electrical / data	Power, outputs, protocol, CEMS/DCS tags, data averaging and reference conditions
Documents	Drawing, calculation, ITP, materials, calibration, correlation, uncertainty and commissioning scope

Shizhong project deliverables

Controlled datasheet and model code; general arrangement and sensing-coordinate drawing; channel and subarea schedule; material and pressure-boundary documents; signal/equation description; calibration or site-correlation package as ordered; installation, commissioning and maintenance instructions.

Engineering review

Send the completed process data, duct drawing and performance objective to info@shizhongflow.com. Shizhong will return the recommended grid, signal architecture, evidence plan and commercial scope after technical review.

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Technical basis: internal product records and patent CN212082473U; ISO 3966:2025; ISO 16911-1/-2; ISO 14164; ISO 15259; GB/T 16157; HJ 75/76; and peer-reviewed research on velocity-area and multi-point differential-pressure measurement. Always verify the governing edition and project contract.