Opal 300 Series
Flow and Temperature Monitoring Systems
Industrial Stack Monitoring for Flow and Temperature

OPAL 300 Series flow and temperature monitoring systems provide continuous flow data in industrial exhaust stacks and airflow systems for environmental monitoring and process control applications. With many unique design features, the 300 Series flowmeters offer proven reliability and versatility, in difficult applications, where other technologies fail to deliver.

Using the proven principles of differential pressure measurement as the basis to calculate stack velocity and volumetric flow, the Opal 300 Series systems process continuously measured data in accordance with formula and technique as specified in USEPA Test Method #2.

Volumetric flow is calculated and normalised to standard conditions as required for mass emission calculations, and all measured outputs can be selected as metric or imperial scaling.

Continuous sensor measurements are made for:
- Differential pressure
- Stack pressure, absolute
- Stack temperature

Additional programme inputted (fixed) values:
- Gas density variable concentrations
- Probe type and efficiency
- RATA test correlation factor
- Stack dimensions

Innovation

The Opal 300 designs include many innovative features for customer confidence and ease of operation. They include:

- Control units are available as standard wall mount, 19” rack, or portable carry case.
- A specially designed and patented span test module (STM), gives the 300 Series systems a unique upscale test capability that ensures sensor accuracy is maintained at all time.
- Probe cleaning – independent tube cleaning via programmable manual and automatic purge cycles.
- 300 sensor probes have a quick release clamping nut to allow easy removal and replacement during service inspections. Each probe has an integrated ‘SERVICEMODE’ switch to initiate a 30 minute output freeze period which allows removal for cleaning and inspections. During this period, local control of manual probe purging is activated.
- Optional annubar probe designs for turbulent flow profile applications.
- Sensor probes are available in a variety of insertion lengths, including cross stack probes.
Portability

Offering the same unique features as the standard 300 systems, the 300P portable flow and temperature monitoring system provides a cost effective solution for monitoring multiple stacks, on a periodic basis, to ensure plant efficiencies are maintained. They can also be used for independent validation of existing flow monitoring systems.

The total weight of each kit is less than 20kgs and can be easily transported by road or air to various test locations. Site testing can be set up within minutes by a single operator, and equipment is designed to be left in position to provide data for extended periods when necessary. Standard 300 system features such as probe purge cleaning, and automatic self test are also available in the 300P portable system.

Features

Each 300P system consists of:

- Control Unit – housed in a rugged carry case with easy connection of probe temperature sensor, DP airlines, and mains power supply. Real time data is displayed with optional analogue outputs also available.
- Sensor Probe – S-type pitot probe design in PVC carry case for safe transportation. Probe length and case supplied to customer specifications.
- DP airline set – standard 4 metre coiled airline set
- Mounting Flange – a user specified insertion flange provides hand clamped control of variable insertion depths. Alternative 4” BSP mounts are available for use in standard stack test ports.

Service Support

OPAL flow and temperature monitoring systems are designed for continuous operation and normally require only periodic inspections and cleaning maintenance. If required, convenient on-site service kits are available for:

- Manometer validation
- Leak testing
- Sensor test and calibration.

All OPAL products are fully supported by a factory trained international distributor network and backed by a readily available range of spare parts and accessories.
300S Technical Specification

CONTROL UNIT

Enclosure
IP65 weatherproof - Optional 19” rack mount: Size 3U

Wall Mount Dimensions:
400 x D250 x H500 (W15.7 x D9.8 x H19.6in)  Weight: 17.3 Kg (38.1lb)

Rack Mount Dimensions:
400 x D330 x H120mm (W15.7 x D13.0 x H4.7in) Weight: 15.4 Kg (33.9lb)

Ambient Temperature
-20°C to +55°C (-4°F to +131°F)

Power Supply
Specify 110 or 240vac for solenoid operation. Electronics is 85 - 265vac, (+/- 15%) 50/60Hz

Air Supply
Set value in range 4.0 – 8.0 bar, +/- 10% Pre-filtered

Control Panel
Membrane keypad for calibration and operational control with alphanumeric, 60 x 30 LCD display

Sensor – Differential Pressure
Piezoelectric 0 – 76mmWC (3” WC) Accuracy +/- 1% Temp stabilised

Sensor – Stack Pressure
Piezoelectric -18 – 0 – 18mmHg (10” WC) Accuracy +/- 1% Temp stabilised

Sensor – Temperature
K type thermocouple 0 – 800°C Accuracy +/- 2%

System Accuracy
Better than or equal to +/- 2%

Display – Indicator LEDs
Power, Alarm, Cal Test, Setup mode

Outputs – 4-20mA
Two (2) 4-20mA programmable outputs, maximum load impedance 1000 ohms:
1) Stack Velocity: Adjustable span 1 – 50 metres/sec (9,800ft/minute)
2) Volumetric Flow: Adjustable span 500 – 300,000 m³/hour (290–180,000 cf/minute)
3) Stack Temperature: Adjustable span 100 - 800°C
4) Stack Pressure: Adjustable span -850 – 1050 mbar (-12 - 15 psi)
5) Dynamic Pressure: Fixed range 0 – 76mmWC (3” WC)

Outputs – Digital
Serial interface RS232 / RS485 / MODBUS

Output Signal Averaging
Standard: 1 - 20 seconds  EPA: 1 – 60 minutes

Outputs – Relay*
One (1) programmable SPCO, 0.5A at 24vdc (50vac/30vdc maximum)
Three (3) programmable SP-NO, 0.5A at 24vdc (50vac/30vdc maximum)
Programmable for System Fault, Emissions or Procedure indication

Connections – Power
Wall: via 16mm cable gland
19” rack: via rear mounted IEC socket, 2 metre cable supplied

Connections – Control
K Type thermocouple compensating cable, maximum 200 metres.

Connections – Air
2 x 8mm airlines, maximum 200 metres
1 x 8mm air supply line
1 x 8mm vent airline – vent to atmosphere for pressurised room installation
All connections via SS316 compression fittings

Purge Cycle
Independent tube cleaning (50/50 cycle), programmable:
Duration: Adjustable 1 – 20 minutes
Interval: Selectable 1 – 2 – 4 – 12 - 24 hours

Auto Test Cycle
Independent zero and span (50/50 cycle), programmable:
Duration: Adjustable 2 – 20 minutes
Interval: Selectable 4 – 12 – 24 hours
Zero test: Equalised sensor ports
Span test: Via span adjustable STM (span test module) Alarm set +/- 1 - 10%

SENSOR PROBES

300 DP PITOT

Insertion Length
250, 500, 1000, 1500, 2000 mm

Construction
Enclosure: 100 x 100 x 80 Diecast enclosure with SERVICE MODE switch
Outer tube: One (1) x 32mm diameter SS316 tube, weld sealed
Inner tube: Two (2) x 1/4” SS316 pitot tubes
One (1) 1/4” SS316 thermocouple pocket

Ambient Temperature
-20°C to +55°C (-4°F to +131°F)

Process Temperature
Standard 600°C (1112°F), Maximum 900°C (1652°F) - consult factory

Installation
Quick release clamping nut mechanism, SS316
Via 90NB standard flange: 205mm (8 inch) diameter, 4 x 18 mm (0.15 x 0.7 in) holes on 165mm (6.5in) pcd.
Other flange formats available on request at time of order

Calibration
Factory tested to 0.84 efficiency

HOW TO ORDER

Control Unit
IP65 Wall Mount: S3F-01003/XXX (Voltage)
19” Rack Mount: S3F-01002/XXX (Voltage)

Sensor Probes
S-type SS316: S3F-09004/ XXXX (length)
S-type Hastelloy C-276: S3F-09003/XXX (length)
### CONTROL UNIT

**Enclosure**
- IP66 weatherproof carry case – ABS plastic, colour yellow

**Wall Mount Dimensions:**
- W450 x D350 x H150 (W17.7 x D13.8 x H5.9in)
- Weight: 9.3 Kg (20.5lb)

**Rack Mount Dimensions:**
- Not applicable

**Ambient Temperature:**
- -20°C to +55°C (-4°F to +131°F)

**Power Supply:**
- Specify 110 or 240vac for solenoid operation. Electronics is 85 - 265vac, (+/- 15%) 50/60Hz

**Air Supply:**
- Set value in range 4.0 – 8.0 bar, +/- 10% Pre-filtered

**Control Panel**
- Membrane keypad for calibration and operational control with alphanumeric, 60 x 30 LCD display.
- Programme selection for top line and lower line display items - in metric or imperial measures.

**Sensor – Differential Pressure**
- Piezoelectric
- 0 – 76mmWC (3" WC)
- Accuracy +/- 1%
- Temp stabilised

**Sensor – Stack Pressure**
- Piezoelectric
- -18 – 0 – 18mHg (10" WC)
- Accuracy +/- 1%
- Temp stabilised

**Sensor – Temperature**
- K type thermocouple
- 0 – 800°C
- Accuracy +/- 2%

**System Accuracy**
- Better than or equal to +/- 2%

**Display – Indicator LEDs**
- Power, Alarm, Cal Test, Setup mode

**Outputs – 4-20mA**
- Two (2) 4-20mA programmable outputs, maximum load impedance 1000 ohms:
  1. Stack Velocity: Adjustable span 1 – 50 metres/sec (9,800ft/minute)
  2. Volumetric Flow: Adjustable span 500 – 300,000 m³/hour (290–180,000 cf/minute)
  3. Stack Temperature: Adjustable span 100 - 800°C
  5. Dynamic Pressure: Fixed range 0 – 76mmWC (3" WC)

**Outputs – Digital**
- Three (3) wire serial interface RS232/RS485/MODBUS (Optional output socket)

**Connections – Power**
- Via fascia mounted IEC socket, 2 metre cable supplied

**Connections – Control**
- K Type thermocouple compensating cable, standard 4 metre – supplied with sensor probe

**Connections – Air**
- Two (2) pieces 4 metre x 8mm airlines, colour coded/spring coiled – supplied standard with sensor probe
- 1 x 8mm air supply line
- All connections via SS316 compression fittings

**Purge Cycle**
- Independent tube cleaning (50/50 cycle), programmable:
  - Duration: Adjustable 1 – 20 minutes
  - Interval: Selectable 1 – 2 – 4 – 12 – 24 hours

**Auto Test Cycle**
- Independent zero and span (50/50 cycle), programmable:
  - Duration: Adjustable 2 – 20 minutes
  - Interval: Selectable 4 – 12 – 24 hours
  - Zero test: Equalised sensor ports Alarm set +/- 1 - 10%
  - Span test: Via span adjustable STM (span test module) Alarm set +/- 1 - 10%

### SENSOR PROBES

#### 300AP ANNUBAR

**Insertion Length**
- 250, 500, 1000, 1500, 2000 mm
- Option: Cross stack manufactured to suit customer specifications

**Construction**
- Enclosure: 100 x 100 x 80 Diecast enclosure with SERVICE MODE switch
- Outer tube: One (1) x 25 x 25mm square SS316 tube, weld sealed
- Inner tube: One (1) x 1/4" SS316 pressure tube
- One (1) 1/4" SS316 thermocouple pocket

**Ambient Temperature**
- -20°C to +55°C (-4°F to +131°F)

**Process Temperature**
- Standard 600°C (1112°F), Maximum 900°C (1652°F) - consult factory

**Installation**
- User specified flange with insertion port and hand clamp mechanism
- Optional: User specified threaded port with hand clamp mechanism (standard is 4" BSP Male)

**Calibration**
- Factory tested to 0.55 efficiency

### HOW TO ORDER

**Control Unit**
- Portable: S3F-08001/XXX (Voltage)
- Portable: (with optional output socket+ 2mtr cable) S3F-08002/XXX (Voltage)

**Sensor Probes**
- Annubar SS316:S3F-09002/ XXXX (length)
- Annubar Hastelloy C-276: S3F-09001/ XXXX (length)
Commonly Asked Questions

Q. Velocity or volumetric flow?
If the application is related to stack emissions, you would normally need to determine volumetric flow, (m³/hr), normalised to standard atmospheric conditions, at sea level. This information is then used in further calculations to ultimately determine the mass emission flow rate for each specific flue gas component. For example:

\[
\text{Known dust concentration} \quad 10\text{mg/m}^3 \\
\text{Measured volumetric flow} \quad 2000\text{m}^3/\text{hr} \\
\text{Mass emissions flowrate} = \quad 20\text{kg/hr}
\]

However, if your application is process related, air speed may be the critical issue when it is used for product handling and transportation.

The Opal 300 systems provide both – velocity and volumetric flow – calculated in accordance with USEPA Test Method 2 methodology.

Q. What periodic maintenance is required for DP flowmeters to ensure accuracy and reliability?
300 Series flowmeter systems are relatively rugged systems with daily automatic self test and purge cleaning to ensure accuracy and reliability.

Recommended maintenance would be periodic probe removal, inspection and cleaning to ensure constant pitot efficiency. The frequency of inspections and cleaning will be determined by the process conditions involved – the cleaner the flue gas stream, the less maintenance required.

Q. I have been told that pitot tube systems are affected by dirty process gases and water content?
True, but it's more correct to say that all flow monitoring systems are affected by flue gas contaminants such as condensed water and particulate flow. The advantage of DP measurement technology is that sensor probes can be designed with very effective self-cleaning to minimise downtime.

In the case of the Opal 300 there are several features designed into the cleaning system that have significant benefits in such applications:

1. Pitot tubes are cleaned individually by the backflushing effect of the purge cleaning cycle. This ensures that a difficult blockage in one tube will not simply divert the cleaning air to the other tube.
2. Each automatic purge cycle can be extended as long as 20 minutes with pause intervals as short as every hour. This flexibility gives the sensor probe cleaning cycle the opportunity to perform in the worst of applications.

In general terms, DP flow technology is capable of longer periods of operation, with less downtime, than other common flow meter technologies.

Q. Are pitot probes calibrated?
According to the USEPA Test Method 2 the standard S-type pitot tube design has an accepted efficiency factor of 0.84. This means the measured differential pressure values are only 84% of actual values and therefore all DP based calculations are adjusted accordingly.

Probe tips may change over time due to the effect of abrasive dust or corrosive gases in flue gas streams. These factors will affect pitot design efficiency and should be carefully monitored during inspections. If significant physical changes are detected it is recommended to have the probe either replaced or tested for a new pitot efficiency. Any new efficiency value can be simply entered into the 300 Series control unit program.

For more information on any of the above discussion, contact your regional Opal sales and service representative.
300 Series Accessories

Sensor Line Set
Part # S3F-01001/XXX (length options)

Dual 8mm (5/16) nylon airline set, plus 2 wire thermocouple compensating cable. This airline set is supplied loose for site installation and is available in a standard range of lengths:

- 25 metre (80’)
- 50 metre (150’)
- 100 metre (300’)
- 150 metre (450’)
- 200 metre (600’)

Note: SS316 compression fittings are supplied with main control unit and sensor probe.

Sensor Cable
Part # S3F-01004/XXX (length options)

Dual 8mm (5/16) nylon airline set, plus 2 wire thermocouple compensating cable in 25mm (1”) PVC flexible conduit.

Note: SS316 compression fittings are supplied with main control unit and sensor probe.

Manometer
Part # S-51913

Manometer set, 0 – 60 mmWC, including silicone airlines. This unit can be simply installed inside the wall mounted control unit and connected in-line for continuous monitoring if required.

Service Kit
Part # S-51913/LTK

Field service kit includes 300mmWC manometer set, plus silicone airline set – for periodic on-site system validation, calibration of sensors, and system leak testing.