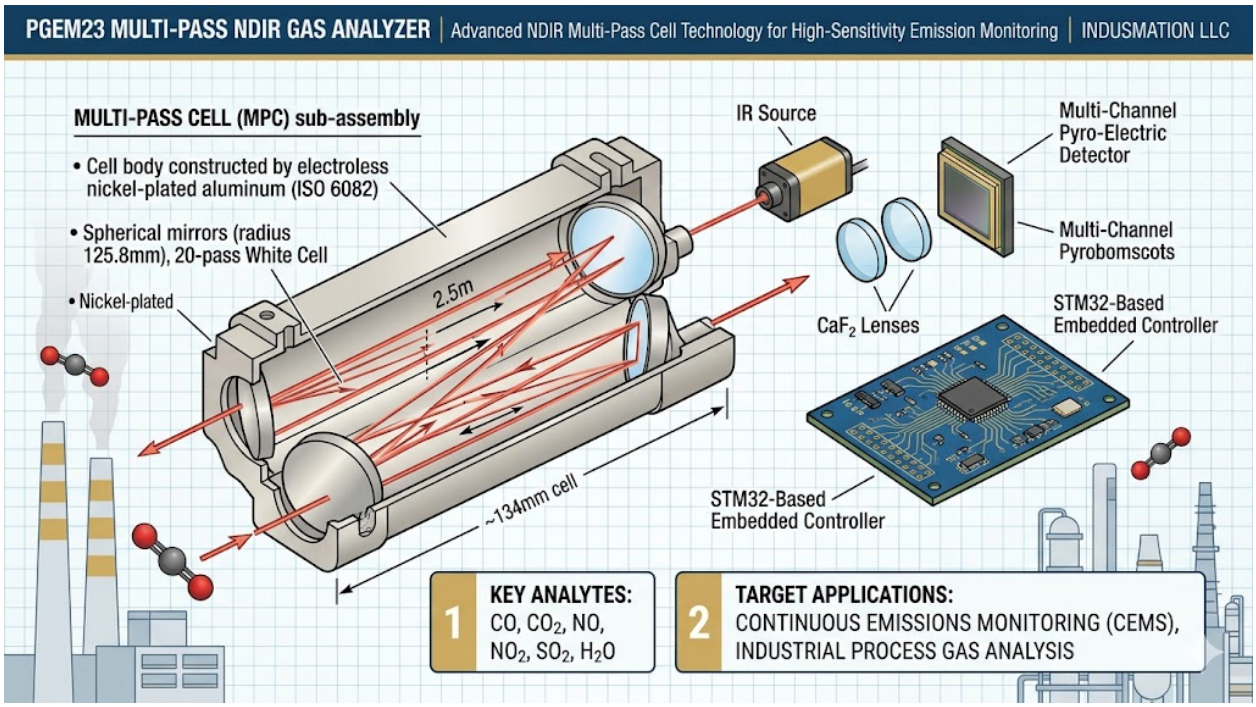


Technical White Paper: PGEM23 HYBRID GAS ANALYZER using MPC

Advanced Multi-Pass Cell Technology for High-Sensitivity Emission Monitoring

Author: Narayanasamy Ravichandran, Indusmation LLC

Date: May 2026

Subject: Advanced Monitoring & Technology Transfer

1. Executive Overview

This optical design uses three spherical mirrors— one field mirror and two objective mirrors—all sharing an identical radius of curvature (R = 125.8

The PGEM23 Hybrid Gas Analyzer represents a mm).

significant leap in Non-Dispersive Infrared (NDIR) technology. Designed specifically for Continuous Emission Monitoring Systems (CEMS) and industrial process gas analysis, it combines a compact footprint with the high sensitivity usually reserved for laboratory-grade spectrometers. By utilizing a sophisticated Multi-Pass Cell (MPC), the PGEM23 achieves extended optical path lengths essential for measuring low-concentration stack gases such as CO, NO, and SO2.

By folding the infrared beam back and forth within the cell, the PGEM23 achieves a total effective path length of 2.5 meters within a physical cell body of only 134 mm. This 20-pass configuration provides the necessary absorption depth to satisfy stringent environmental regulations while maintaining a fast response time due to the low internal volume.

2. Design Philosophy

Industrial stack monitoring requires an analyzer that is both rugged and precise. The PGEM23 was developed with a modular design philosophy, allowing for easy technology transfer and field maintenance. Key to this design is the integration of the Multi-Pass Cell directly into the optical bench, ensuring mechanical stability and alignment even in harsh industrial environments.

At the heart of the PGEM23 is the Multi-Pass Cell (MPC), based on the classic White Cell configuration.

4. Spectroscopy & Analytes

The PGEM23 operates in the 2 to 15 micrometer infrared band, targeting the primary absorption lines of industrial pollutants. The system is capable of simultaneous measurement of:

• Carbon Monoxide (CO)

• Carbon Dioxide (CO2)

• Nitrogen Oxides (NO, NO2) • Sulfur Dioxide (SO2)

• Water Vapor (H2O)

5. Electro-Optics Assembly

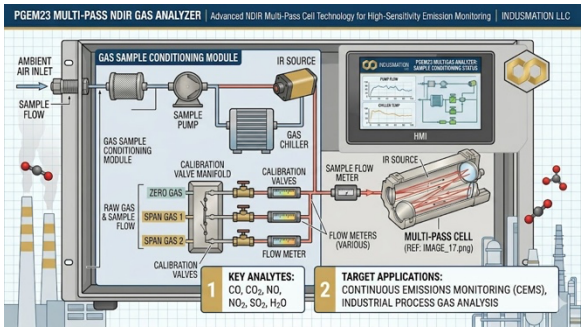
The analyzer utilizes high-intensity IR sources and Calcium Fluoride (CaF2) lenses to ensure maximum

throughput across the spectral range. The detector module features dual-channel pyroelectric sensors

3. Optical Configuration: The White Cell

with integrated interference filters, providing high selectivity and thermal stability.

6. Sample Conditioning & Integration



The system includes a dedicated gas conditioning module with an integrated pump, particulate filters, and flow control. This ensures that the gas entering the MPC is free from contaminants and moisture that could interfere with the spectroscopic measurement.

7. Technical Specifications

Optical Configuration	20-Pass White Cell
Path Length	2.5 Meters
Cell Length	134 mm
Mirror Curvature	125.8 mm
Spectral Range	2 - 15 µm
Housing	Electroless Nickel Plated Al
Enclosure	19-inch Rack-mount

8. Conclusion

The PGEM23 Hybrid Gas Analyzer offers a robust solution for manufacturing partners seeking a competitive edge in the emissions monitoring market. Its unique combination of compact size and extended path length makes it ideal for the next generation of industrial stack analyzers.