sensors

Emissions
Measurement
Solutions

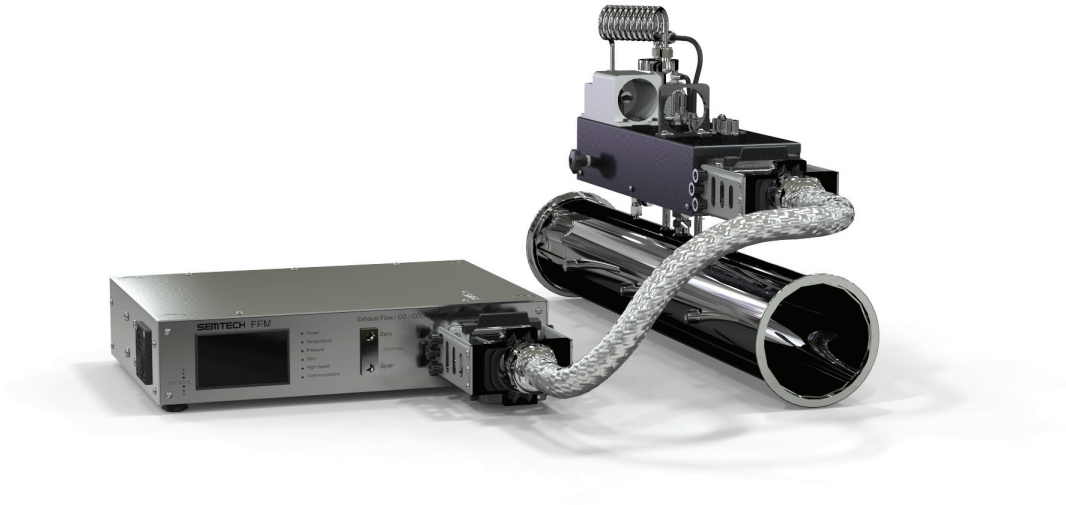
SEMTECH® FEM
Fuel Economy Meter
A SEMTECH ECOSTAR Product

On Board Emissions Analyzers

Test Cell Emissions Analyzers

Emissions Testing Services

Environmental Applications



The SEMTECH FEM is an all-new fuel economy meter with unsurpassed accuracy and ease of use. This patent pending design combines our high speed, high performance, exhaust flow meter with a CO/CO_2 gas analyzer, packaged into an integrated system, providing accurate, real-time fuel economy measurements using the carbon balance method. Sample handling is integrated into the system, with an internal sample probe, heated filter, water trap, and Nafion dryer. The dried and filtered sample then passes through a non-dispersive infrared analyzer for measurement of CO, CO_2 and HC as hexane. An electrochemical oxygen sensor, or an optional paramagnetic oxygen sensor completes the gas analysis. The system is easily controlled through an intuitive graphical touch screen on the electronics module, or through the host software. Gas concentrations and exhaust flow can be monitored live, along with exhaust pressure and temperature. The system accommodates standard flow tube sizes from 1" through 6" diameters, and is also scalable, enabling custom sizes upon request. The module can operate as a stand-alone analyzer, or as part of the SEMTECH ECOSTAR mobile test bench.

System Features and Benefits

High Speed Sampling: The SEMTECH FEM internally samples the differential pressure channels at up to 5 kHz, accounting for every pressure pulse from an engine, from idle to maximum rpm. Standard output rate is 1 Hz.

Sample Handling: Sample probe, heated filter, water trap and Nafion dryer are integrated into the tube electronics. An additional Nafion dryer is included in the control module.

Embedded Calibration: Calibration coefficients embedded in the flow tube electronics are automatically recognized on connection. Therefore, tubes of varying sizes can be interchanged with one control module.

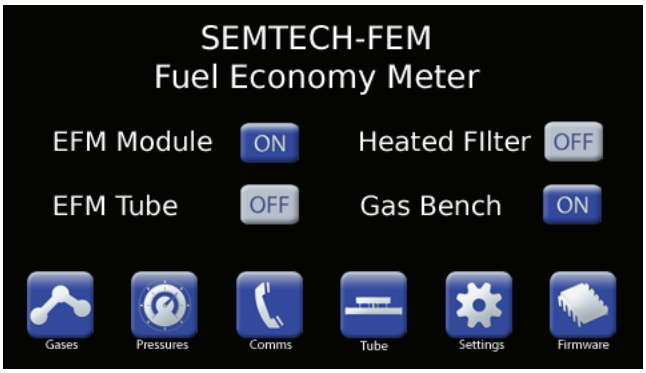
Multiple Tube Sizes: Eight flow tube sizes accommodate engines from less than 0.8L displacement up to 24L.

Back Purge: A software controlled back purge pump is included in the flow tube assembly, along with solenoids that route high pressure air backward through the pitot tube, purging contaminants and any condensation in the pressure lines. No dismantling is required.

Auto Zero: With a single software command, internal solenoids open the pressure sensors to ambient air, allowing fast and easy zeroing while the engine is still operating.

Graphical Panel Display: A full color, graphic touch screen displays live data, and enables system setup and basic functions, such as zero and span.

Power Supply Monitoring: Power can be either 12 VDC, 110 VAC, or 220 VAC, with both current and voltage monitoring.



Graphical Touch Screen

1065 Compliant: The SEMTECH FEM meets the US EPA's 1065 compliance requirements for laboratory and in-use testing.

Weatherproof Construction: The unit can be used in harsh environments, including, for example, off-highway testing. All components meet IP54 (NEMA 3) standards.

Heated Components: The averaging pitot tube and pressure lines are heated at the flow tube assembly in order to prevent condensation and freezing in cold weather. The differential pressure sensors are housed in a temperature controlled manifold in the control module for added stability.

Design Details: Over a decade of experience in in-use emissions testing has gone into the design details of the SEMTECH ECOSTAR system, including:

- EMI protection, including gaskets, filters and capped connectors
- Stress relief for pneumatic connections
- Channels for cable management
- Standard Swagelok™ bulkhead connectors
- Rugged Deutsch connectors for power and auxiliary connectors
- Handles that lock to other SEMTECH ECOSTAR modules for stable system integration

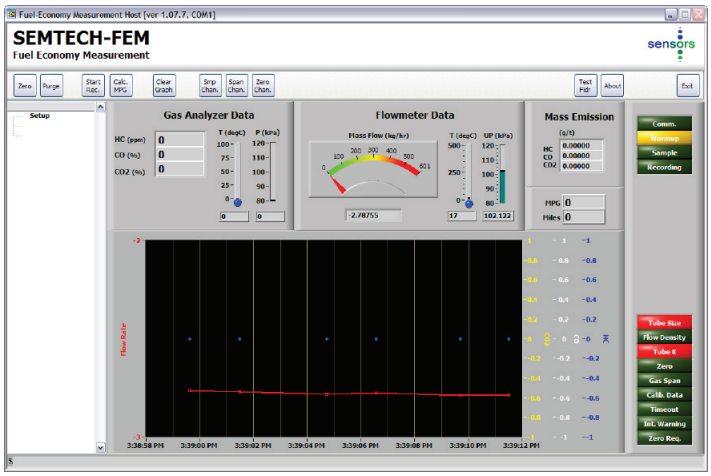
The Technology

Exhaust Flow

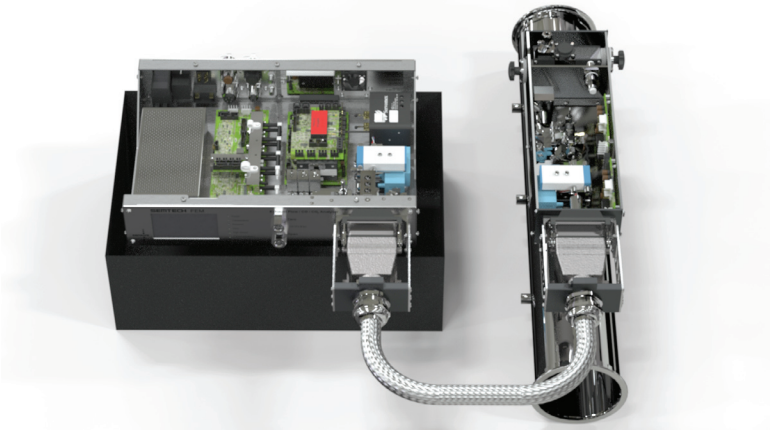
Operating under the Bernoulli principle, the SEMTECH FEM uses four high performance, dual-stage, differential pressure transducers, sampling continuously at up to 5 kHz, measuring every pressure pulse from an engine. The sensors are housed in a heated manifold, eliminating thermal drift. The eight combined differential pressure ranges span nearly five orders of magnitude, allowing accurate measurements over a wide range of flow rates. The smallest transducer range is 0.025 kPa with a resolution of $5x10^{-5}$ kPa, while the highest range is 16.5 kPa.

Sample Handling and Gas Analysis

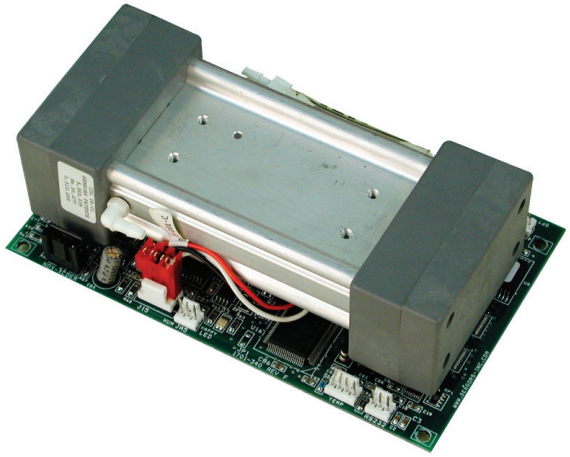
The exhaust sample is filtered and dried directly at the exhaust flow tube, with an additional dryer located in the control module. The intake manifold on the control module is custom built of stainless steel, to mitigate leaks. The gas analyzer uses NDIR technology, incorporating a heated sample cell and relative humidity sensor, along with the interface electronics and control electronics. Fuel economy is measured using the carbon balance method.



SEMTECH FEM Host Software



Internal Packaging



Non-Dispersive Infrared gas analyzer measures CO, CO_2 and HC

User Support

As with all SEMTECH products, the Fuel Economy Meter comes with a wide range of customer support. Sensors' Remote Support, powered by WebEx, enables our trained technicians to view your SEMTECH unit in real-time, to help answer your questions, diagnose issues, and evaluate data, without requiring any additional software. The customer portal contains a forum for users to share insights on best practices for in-use emissions testing, and to stay up to date with the latest software releases, manuals, technical service bulletins and tips and tricks.

SEMTECH FEM
Fuel Economy Meter

Flow Tube Available Sizes

Flow Tube Outer Diameter								
in mm	1 25	1.5 38	2 51	2.5 64	3 76	4 102	5 127	6 152
Flow Tube Length (Length including extension)								
in mm	20 (26) 508 (660)	20 (26) 508 (660)	20 (26) 508 (660)	25 (32.5) 635 (825)	25 (34) 635 (864)	25 (37) 635 (940)	30 (45) 762 (1143)	36 (54) 914 (1372)

Available Sizes and Flow Rates at 100°C and 400°C

400°C flow rates fall between the orange markers
100°C flow rates extend the full length of the line

Exhaust temperature range:	-5 to 700°C standard construction (higher temperature capability available upon request)
Exhaust temperature accuracy:	± 1% of reading or ± 2°C, whichever is greater
Flow measurement linearity:	< 1.0% of full scale Exceeds 1065 Subpart D and ISO 16183 standards
Flow measurement accuracy*:	± 2% of reading or ± 0.5% of full scale, whichever is greater
Communications:	Ethernet, USB
OBDII Comms:	Serial
Control module dimensions:	43.6cm x 30.8cm x 9.1cm
Control module weight:	10 kg
Power:	12VDC, 110-220VAC

*As measured on calibration flow stand
** Optional paramagnetic O_2 sensor

NOTE: Specifications are subject to change without notice. While due caution has been exercised in the production of this document, possible errors and omissions can occur.

Gas Analyzer Specifications

Gas	CO	CO_2	O_2**
Range	0 - 8%	0 - 20%	0-25%
Resolution	10 ppm	0.01%	0.1%
Accuracy	±50 ppm or ±2% rdg	±0.1% or ±2% rdg	±2%rdg or 0.3%FS
Linearity	Intercept ≤ 0.5% range 0.990 ≤ Slope ≤ 1.01 SEE ≤ 1.0% range $R^2 \geq 0.998$		
Repeatability	±2% rdg or ± 20 ppm	±2% rdg or ± 0.05%	±0.1% O_2
Noise	± 20 ppm	±0.02%	±0.1% O_2
Span Drift (8hrs)	±2% of span or ± 20 ppm	±2% of span or ± 0.1%	<2% FS
Zero Drift (1hrs)	±0.005% (25 ppm)	±0.1%	<0.1% O_2
Analyzer Rise Time	T_{10-90}< 2.5s	T_{10-90}< 2.5s	T_{10-90}< 2.5s
System Rise Time	T_{10-90}< 3.5s	T_{10-90} < 3.5s	T_{10-90} < 3.5s
Data Rate	<10 Hz programmable		1 Hz
Flow Rate (nominal)	2-3 lpm	2-3 lpm	0.2 lpm

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