



SIERRA[®]
CP ENGINEERING

EMISSIONS PRODUCTS



ABOUT US

Our mission is to be your engine particulate emissions specialist. We give our customers throughout the world a complete engine PM emissions sampling solution using our flagship BG3 as the hub of this effort.

Our goal is to develop world-class Particulate Partial Flow Sampling Systems (PPFSS) that provide the highest quality sample data, greatly increase testing efficiency, drastically reduce costs, and improve test-cell safety.

Sierra has a great track record. Throughout the 1990's, Sierra's BG[®]1 and BG[®]2 became the leading PPFSS in the world. We now support hundreds of BG systems used by customers located all over the world.

Sierra has forged unique partnerships with Caterpillar and CP Engineering. Together, engineers worked as a team to develop, design, and test the BG3 to meet the stringent needs of engine manufacturers through cutting-edge technology and patented inventions.

These partnerships have allowed Sierra to design the most innovative and state-of-the-art PM product offering on the market. Sierra owns the exclusive worldwide license to Caterpillar's patented micro-dilution technology Patent #5,058,440 and system flow control features described in United States patent #6,615,677 along with two additional US patents.

Our goal is to offer customers throughout the world a single choice for their particulate measurement needs, offering solutions from sample collection to final processing for customers using the gravimetric method currently written in the regulations. Our team is set up to rapidly provide any customer with standard or custom solutions.

BG[®]3

The BG[®]3 is a Particulate Partial Flow Sampling System (PPFSS) that provides accurate, repeatable Particulate Matter (PM) measurements for transient and steady-state engine and vehicle testing. More than three years of research, development and testing at Caterpillar, John Deere and other engine manufacturers, as part of the proven adherence to ISO 16183, have demonstrated the BG's ability to maintain transient cycle PM correlation to within +/- 5% of full flow CVS results.

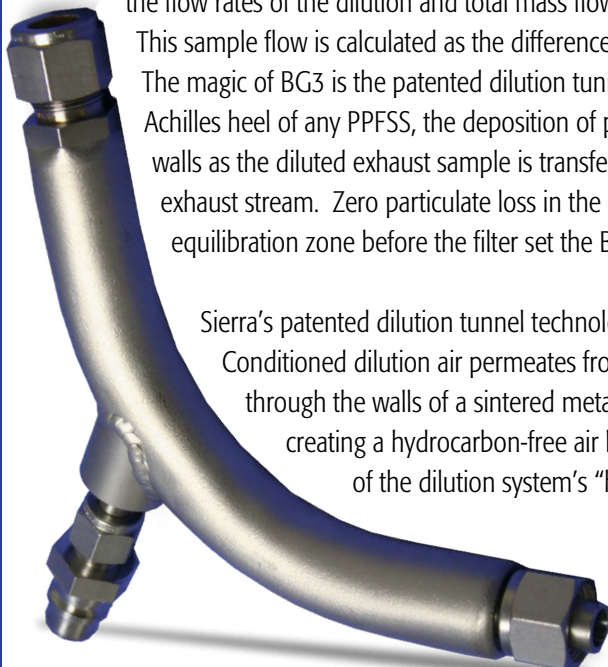
During a transient test cycle, engine speed, load, airflow and fuel flow values exhibit high rates of change over very short time frames. The magnitude of engine inlet air mass flow excursions can approach 10:1 within less than two seconds. The challenge for any PPFSS is to maintain constant proportional flow from an exhaust stream with a highly variable mass flow rate throughout a typical test cycle.

The primary purpose of the BG3 is to control the flow rate of a representative sample of exhaust during an engine test cycle. In order to ensure that the total mass of particulate trapped at the filter is equivalent to that obtained by the use of a full flow CVS, the sample flow rate must be controlled in real-time to be proportional to the exhaust mass flow. Further, it is necessary to control this sample flow rate to ensure that the filter temperature does not exceed the regulatory defined limit while the dilution air temperature is maintained in the range required by the regulations.

The BG3 is an integrated product that incorporates two flow devices supplying and extracting gas from patented radial inflow partial flow dilution technology used in the dilution tunnel design. The mass flow of raw exhaust sampled at the probe is the difference between the flow rates of the dilution and total mass flow meters.

This sample flow is calculated as the difference between the total and dilute flow. The magic of BG3 is the patented dilution tunnel which eliminates the major Achilles heel of any PPFSS, the deposition of particulate on dilution chamber walls as the diluted exhaust sample is transferred to the filter from the raw exhaust stream. Zero particulate loss in the dilution tunnel and a very short equilibration zone before the filter set the BG apart from all other PPFSS.

Sierra's patented dilution tunnel technology is a chamber under pressure. Conditioned dilution air permeates from the outside of the chamber in through the walls of a sintered metal tube carrying the diluted sample, creating a hydrocarbon-free air barrier. This eliminates the effect of the dilution system's "history" on the test sample.



(Patented Radial Inflow Partial Flow Dilution Tunnel)

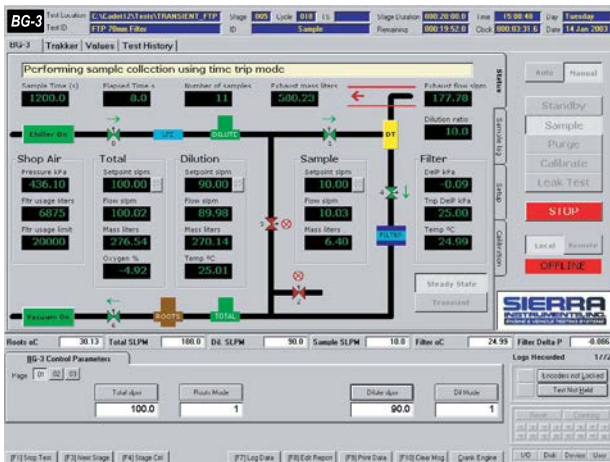
TDAC™ FOR TRANSIENT TESTING

The Patented Transient Dilution Airflow Control (TDAC™) utilizes partial flow dilution tunnel design advances and a unique flow apportionment and control system to effectively execute proportional sampling. The flow delay at the particulate sample probe is considerably less than the 500-millisecond delay specification elaborated in ISO 16183. The BG3 utilizes a real-time measurement of exhaust flow to ensure correlation with full-flow constant volume sampling measured and controlled by the system's dilution air mass flow controller located inside the TDAC™ module. A flow control valve system in a feedback loop with an ultra-fast response (<300 millisecond) provides control of the proportional flow control valve. The dilution air mass flow controller and its ancillary instrumentation are maintained in a thermally stable environment in close proximity to the dilution tunnel. TDAC™ input is provided by a 0-5 volt linear output from the engine with Sierra's AIRTRAK™ (200 millisecond response-time thermal mass flow meter specifically designed for the application).

BG[®]3 SOFTWARE

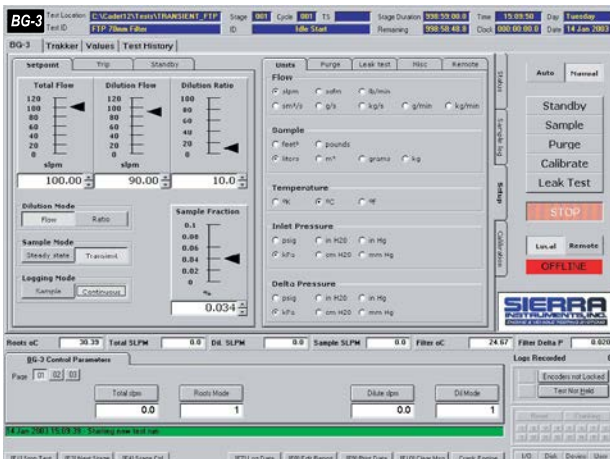
The BG3 software is a user friendly application that allows the engineer to work independently of a host system or interfaced with a host. The BG3 software was designed by test cell engineers, for test cell engineers. The BG3 software allows the knowledgeable engineer the diversity of testing any size or fueled engine for particulates, calibration and troubleshooting of the system.

Main Status Screen



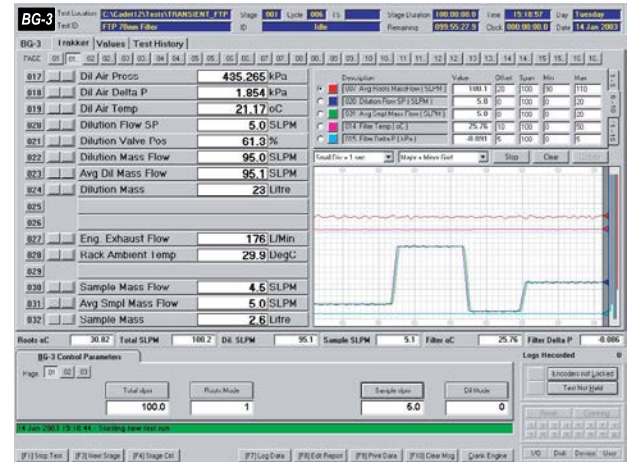
The status screen displays the system layout and all of the real-time parameters before and throughout the test. The operations display is a useful tool for the operator as the test is being performed and after completion.

Setup Screen



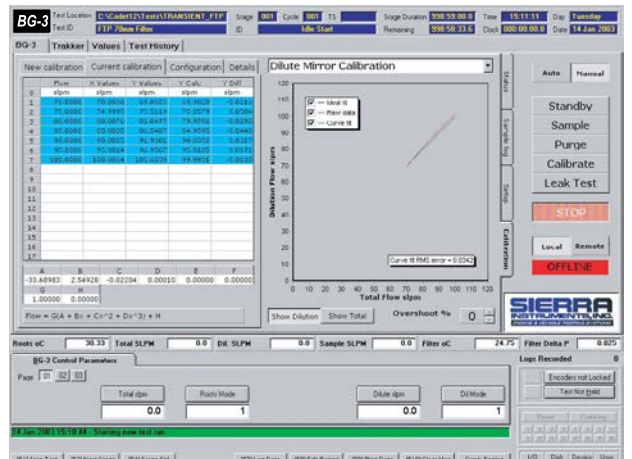
The BG3 set-up screen is unique in that it can be modified for any test situation. Altering the units of measure is one of the easily adjustable features of the set-up screen. The easily accessed (tab) screen allows the engineer the rapid change of any test parameter.

Tracker Screen



The "Tracker" function is a tool that every engineer will find irreplaceable. This screen can be used by the engineer to track any of the functions (diluted mass flow, delta pressure, engine exhaust flow versus sample mass flow) or other immediate test functions for immediate reference or archival of data.

Calibration Screen



The engineer will find the calibration of the system very manageable and efficient. The fully automated calibration routine can be performed at any time.

BG[®]3 SPECIFICATIONS

Range	Any size engine, regardless of RPM or stack size.
Sample Time	2 to 5 minutes per filter for single filter/mode testing on a 0.1 g/hp-hr 8-mode cycle-weighted emissions engine.
Input Power	110 VAC/ 60HZ or 220 VAC/50HZ
Dilution Air Supply	90 PSI. 4 SCFM (6 Bar, 7 m ³ /hr).
Measurement Repeatability	Typically better than +/- 3% with dilution ratios of 10:1 or less depending on engine performance, filter loading and engine operating mode.
Correlation with Full Dilution	Meets ISO correlation requirements; (see ISO 16183 information below).
Transient Testing Capability	The Transient Dilution Airflow Control (TDAC) system (patent pending) monitors voltage from the engine intake air and fuel mass flow measurement systems. Accurate data is gained using this signal. Correlation quality is dependent on the speed of response of the engine exhaust flow measurement.
Communications	TCP/IP and Serial communications are available in both REMOTE and LOCAL mode; allows user to operate the system from a remote location via an Ethernet connection.
Weight	600 lbs. (275 kg)
Dimensions	24" W x 36" D x 72" H (60 cm W x 90 cm D x 2m H)
Sampling Probes	A single sampling probe is included with each system. Sampling probes are available for any size engine exhaust stack or specialized application.

ISO 16183 INFORMATION

Parameters	Current ISO DIS 16183 Permissible Limit	BG3
Accuracy of Dilution Air Flow	+/- 2% of reading	+/- 1.5% of reading
Accuracy of Diluted Exhaust Gas Flow	+/- 2% of reading	+/- 1.5% of reading
System Response time	≤ 0.5 second	0.3 second
Input method of Exhaust gas mass flow	1.Direct method 2.Air & fuel measurement methods@ $(G_{exhw} = G_{airw} + G_{fuel})$ 3.Tracer measurement method 4.Air flow and air to fuel ratio measurement method	Any of the 4
Proportionality	Correlation coefficient R ² of the linear regression between G _{p,i} and GEXH _i shall not be less than 0.9. The standard error of estimate of G _{p,i} on GEXH _i shall not exceed 5% of G _p maximum. G _p intercept of the regression line shall not exceed +/- 2% of G _p maximum.	>0.98 1-2% Meets requirement
Filter size	Particulate filters must have a minimum diameter of 47mm. Larger diameter filters are acceptable.	47mm, 70mm
Sample filters	The diluted exhaust shall be sampled by a single filter media placed within the filter holder during the test sequence.	Meets requirement
Filter face velocity	A gas face velocity through the filter of 35 to 100 cm/s The pressure drop increase between the beginning and the end of the test shall be no more than 25kPa.	Meets requirement
Filter loading	Minimum filter loading shall be 0.25 mg for filter size of 70mm and below.	Meets requirement
Accuracy of G _{totw}	+/- 2%	+/- 2% or less
Accuracy of G _{dilw}	+/- 2%	+/- 2% or less
Additional specifications	All parts of the dilution system in contact with raw and diluted exhaust gas must be designed to minimize deposition or alteration of the particulates.	Meets requirement
SP Sampling probe	The minimum I.D. shall be 4mm. The minimum diameter ratio between exhaust pipe and probe shall be 4.	Meets requirement True down to 1.0" exhaust pipe
Type of probe	Open tube facing to upstream or downstream, or Multiple hole or hatted probe facing to upstream	All

BG[®]3 DATA QUALITY

The highest possible data quality is generated through sophisticated software and hardware in four key areas.

1) Patented TDAC™ Technology.

TDAC™ technology (Transient Dilution Airflow Control) allows engine manufacturers to collect extremely accurate data, very quickly. TDAC™ allows the speed of the dilute mass flow controller to correctly correlate the sample flow with the actual engine exhaust mass flow.

2) Sample Flow Rate Confirmation.

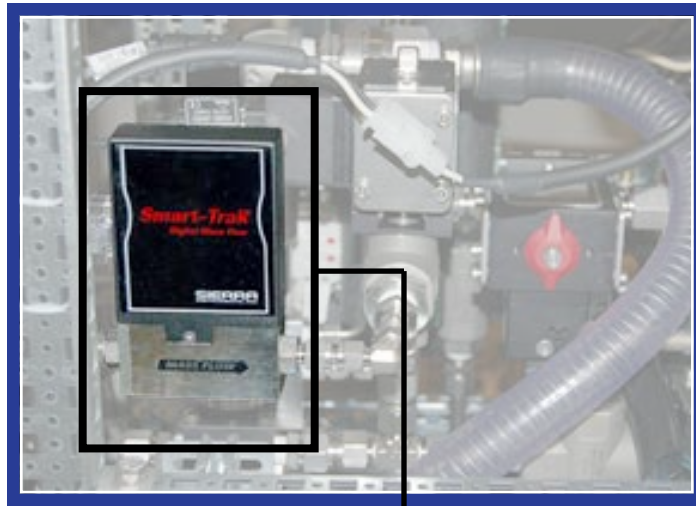
A third mass flow meter confirms the sample flow rate by comparing the measured flow to the set flow of the BG3. This serves as a Go/No Go sample flow check before or after each test. For example: one can compare this to the zero/span function commonly performed on a gaseous analyzer.

3) Validation.

The BG3 continuously controls and validates all critical operational and calibration data parameters and readings so that test engineers can make decisions during as well as after a test.

4) Calibration.

- Fully automated daily calibration between each test.
- Fully automated leak check, zero/span check of the system.
- Filter face velocity (sample mass flow rate) for filter size.



Sample Flow Rate Confirmation

The SmartTrak[®] 100 Digital Mass Flow Meter inside the BG3 confirms sample flow rate before each test to assure the highest possible sample data quality.

AIRTRAK™

The AirTrak™ 628S was originally designed to work specifically with Sierra's BG3 engine emissions sampling system as an extremely fast, accurate, and repeatable engine air intake mass flow meter. The instrument has proven to be an excellent solution across the board in all engine testing applications.



AirTrak™ is specifically designed to measure engine air intake mass flow rate. The meter uses Sierra's Fast-Flo™ Sensor Technology for an extremely fast 200 millisecond response-time making it ideal for the toughest transient test cycles where flow excursion can approach 10:1 within less than two seconds.

Integral Dual-Plate laminar flow conditioning elements and wide 15:1 turndown make AirTrak™ a flexible solution for the constrained piping environments commonly found in today's engine test cells.

In addition, the versatile microprocessor-based instrument integrates the functions of flow-range adjustment, meter validation and diagnostics in a probe-mounted NEMA 4X (IP65) housing.

THE FUTURE OF BG[®]2

The Sierra BG2 system has an installed base of several hundred systems and has been an excellent steady-state particulate partial flow sampler for engine test engineers since the early 1990's. Although Sierra no longer manufactures the BG2, we do offer a hardware/software upgrade and continue to offer full support of the BG2 systems through out the world.



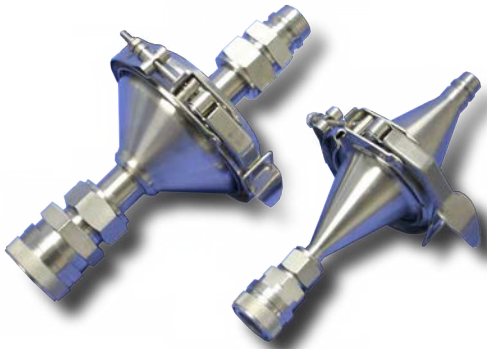
FILTER & AIR HANDLING SOLUTIONS

AUTOMATIC FILTER CHANGER

Our Automatic Filter Changer allows the engineer to remain outside of the test cell during testing as several tests are done in succession. Our automatic filter changer works seamlessly with the BG3 to fully automate particulate collection to greatly improve testing efficiency and more importantly, testing safety. The system can hold up to 17 (dependent on filter size, 47mm, 70mm, or 90mm) single filter cartridges. Sierra will customize the filter changer for 47mm, 70mm or 90mm applications. For example, Sierra has designed the changer to work interchangeably with both 47mm and 70mm.



(Shown without cover)

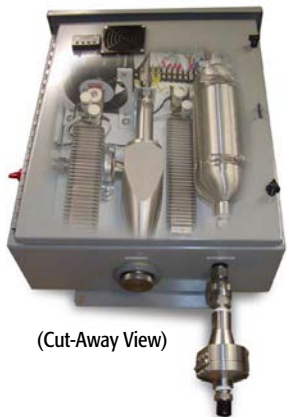
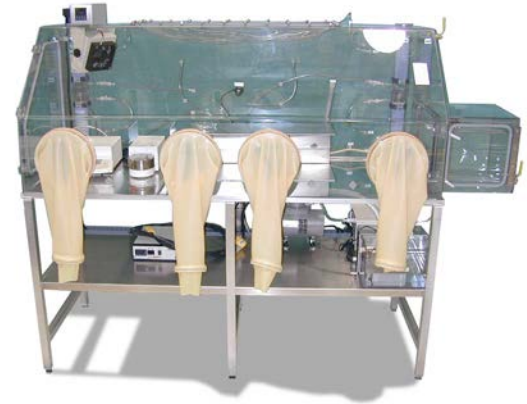


FILTER HOLDERS

Sierra stocks 47mm, 70mm, and 90mm Filter Holders as well as filter media for use in our customers' ongoing particulate testing. All filter holders are made of 316L Stainless Steel and meet requirements set forth in the Federal Register. Filter element cartridges are also available in 47mm and 70mm sizes. Cartridges are designed to fit into an individual filter holder or into Sierra's automatic filter changer.

FILTER WEIGH CHAMBERS

Our filter post-processing Weigh Chamber is a compact, complete ready to run package that allows sample filter media to be accurately weighed per requirements set forth in the Federal Register. Our weigh station is a dual chamber design that allows the operator to stabilize and accurately weigh sample filter media from any size engine. A precision balance, such as the Sartorius, is supplied by Sierra as an option.



(Cut-Away View)

HEATPAK™

Our HeatPak™ is a heated and controlled particulate package built to the EPA CFR 1065 regulation. The HeatPak takes the diluted exhaust sample through a cyclonic separator, and controls the temperature and residence time to the filter face. It can be controlled and verified by the BG3 or used in a manual mode with other devices.

AIRPAK™

Our AirPak™ is an air handling & scrubbing system designed to clean compressor air (used for dilution air in the BG3) before it enters the BG system. The AirPak system can also be used for other analytical equipment within the test laboratory. Though the BG3 has an adequate air purifying system (on-board) it has been found that many test facilities require this added measure of purification.



(Cut-Away View)

COMMISSIONING, FIELD SERVICE & REPAIR

Sierra's goal is to be your engine particulate emissions sampling specialist. We offer a complete array of customer support services for the BG3 and all associated particulate measurement devices found in a typical engine test cell. Our staff of field engineers are ready to support customers on-site in any aspect of engine particulate emissions sampling.

We offer the following to every customer:

- Complete commissioning and training for all Sierra products
- Worldwide service & repair
- Spare & replacement parts for all products
- Yearly certification of all products
- Telephone support on all products
- On Site field support for all customers and all products
- Credible assistance and expert consultation on all emissions related equipment in a test cell

Your Engine Particulate Emissions Specialist.

CUSTOMERS, APPLICATIONS & REGULATIONS

The BG[®] is a workhorse in emissions research and certification applications throughout the world. Aftertreatment and oil additive suppliers as well as automotive, on-road/off-road light & heavy duty diesel, motorcycle, locomotive, airplane, and marine engine & vehicle manufacturers depend on the BG3.

Customers

- On-road/off-road light and heavy-duty engine & vehicle manufacturers
- Small engine, automotive and motorcycle manufacturers
- Locomotive and marine engine & vehicle manufacturers
- After treatment, oil & additive suppliers
- Universities and Government

Applications & Regulations

- Stationary Certification
- Steady-State
- Transient Certification
- Transient Engine Development
- ISO-16183
- ISO 8178
- EPA CFR 1065
- ETC (European Transient Cycle)
- ESC (European Stationary Cycle)





SIERRA'S GLOBAL LOCATIONS

USA

MAIN OFFICES:

- Monterey, CA
- Lansing, MI

SALES OFFICES:

- Golden, CO

EUROPE

MAIN OFFICE:

- Egmond, Netherlands
- Malvern, UK (CP ENGINEERING)

ASIA

MAIN OFFICE:

- Shanghai, China



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Our Mission

The mission of Sierra Instruments Emissions Systems group is to be your engine particulate emissions specialist. We drive all parts of our business to be the leading manufacturer of [BG-3 partial flow sampling technology](#) in the world in terms of quality, delivery, price, innovation, and customer support.

Core Product & Services

We manufacture engine emissions testing products that give our customers the ability to develop and certify cleaner engines faster and more efficiently. Our Model [BG-3](#), which is protected by nine patents with several pending and is our flagship product. To complement the BG-3, our [filter and air handling](#), [flow measurement](#) and [test cell automation](#) solutions offer the customer a single focused choice for all particulate measurement needs.

Local Service & Lifetime Support

By combining superior product quality with a talented global support network of experts in over 150 locations in over 50 countries, Sierra consistently delivers quality measurement solutions for each customer and [supports customers](#) for the life of the product.

Background

In 1991, Caterpillar Inc. and Sierra Instruments formed a joint agreement to commercialize several Caterpillar patents to produce the Model BG-1 Partial Flow Sampling System (PFSS). Sierra followed this effort up with the [Model BG-2 PFSS](#) which features advanced software.

Our BG-3 technology was developed in 2003 in response to pending requirements for transient cycle development and certification of non-road engines. The flagship Sierra Model BG-3 transient PFSS is protected by nine patents with several pending. Due to their expanded power output levels, higher mass flow rates and elevated test cycle exhaust heat content, off-road engines present a unique set of challenges to the continued use of CVS systems. Further, a need was expressed by after treatment and engine development personnel for a transient particulate sampling system deployable upstream and downstream of after treatment systems for concurrent particulate sampling to enable particle removal device efficiency studies. [Read More...](#)

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