TECHNICAL DATA SHEET

HARD AT WORK

Transient & Steady-State

BG-3™

Particulate Partial Flow Sampling System

SIERRA INSTRUMENTS, INC.

ENGINE & VEHICLE TESTING SYSTEMS

Setting New Industry Standards in PM Measurement Since 1990

MODEL BG-3™ With TDAC™

The Model BG-3 with TDAC (Transient Dilution Airflow Control) system 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 Southwest Research Institute and Caterpillar, as part of the development of ISO 16183, have

demonstrated BG-3's ability to maintain transient cycle PM correlation to within ± 5% of full tunnel (CVS) results. The state of the art system is designed for transient test cycles of diesel, gasoline or natural gas engines of any size to be used in both engine and chassis test cells. The Model BG-3 is exceptionally suited for steady-state test cycles as well.

During a transient test cycle, engine speed, load, airflow and fuel flow values exhibit high rates of change over very short time frames. Because of these ever changing variables, the BG-3 with TDAC is the only system up to the task. The magnitude of engine inlet air mass flow excursions can approach 10:1 within less than two seconds. The challenge for a PPFSS is to maintain constant proportional flow from an exhaust stream with a highly variable mass flow rate.

TDAC FOR TRANSIENT TESTING

Patented Transient Dilution Airflow Control (TDAC) utilizes 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. Unlike other systems that require a "look ahead" measurement to compensate for system time delays, the Model BG-3 utilizes a real-time measurement of exhaust flow to ensure correlation with full-flow constant volume sampling.

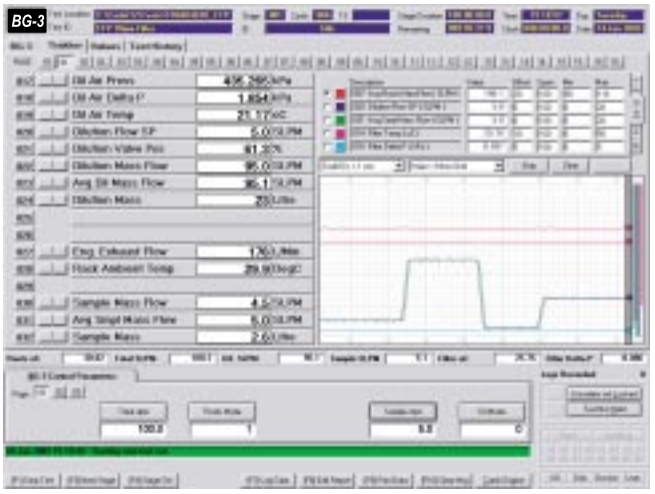
In the Model BG-3, conditioned dilution air is measured and controlled by the system's dilution air mass flow controller located inside TDAC module. A flow control valve system in a feedback loop with an ultra-fast response (<300 millisecond) mass flow meter provides feedback loop control of the proportional 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 exhaust mass flow sensor, like Sierra's Exhaust-Trak meter.

Ultimate System Flexibility

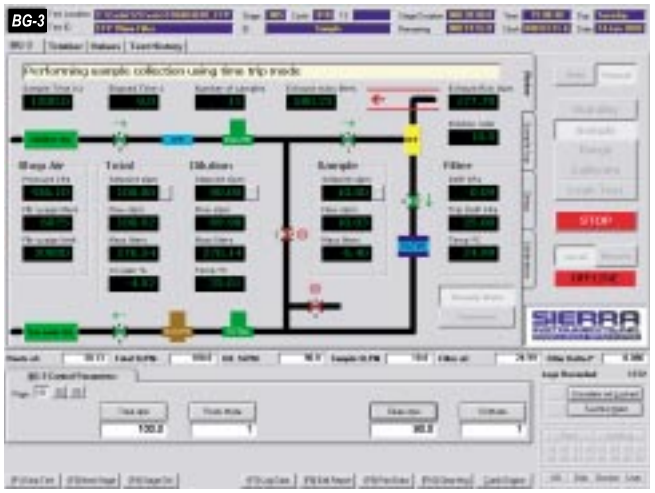
SOFTWARE

The BG-3 software is a user friendly application that allows the engineer to work independently of a host system or interfaced with a host. The BG-3 software allows the knowledgeable engineer the diversity of testing any size or fueled engine for particulates, calibration and troubleshooting of the system.



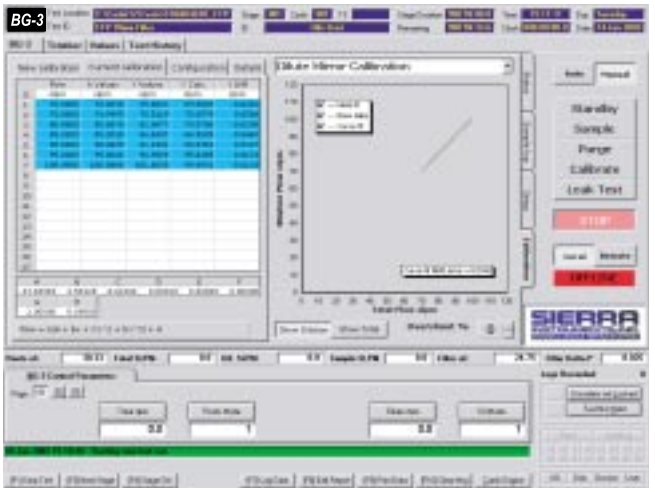
BG-3 Tracker Screen

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.



BG-3 Main Status Screen

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

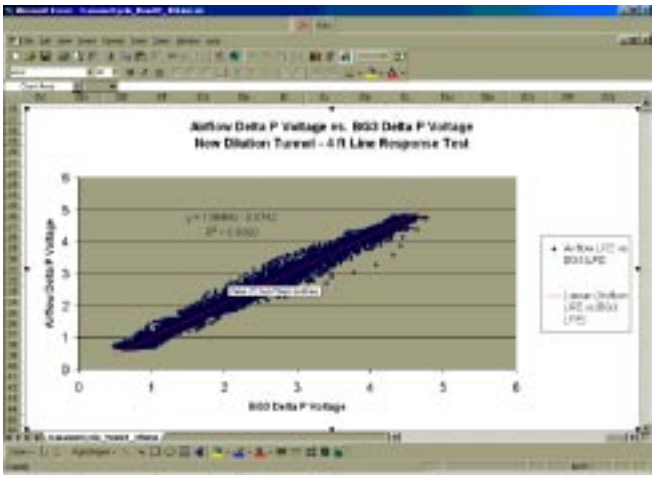


BG-3 Calibration Screen

The engineer will find the calibration of the system very manageable and efficient.

BG-3 Setup Screen

The BG-3 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.



Engine intake airflow laminar flow element (LFE) Delta P Voltage versus BG-3 Delta P Voltage; Figure 2.3, Scatter plot; depicts the regression of the engine intake airflow Delta P versus the BG-3 Delta P during an actual USEPA heavy-duty on-highway transient cycle. Plot shows the excellent proportionality between the two. The BG-3 probe flow was measured by an instrumented miniature LFE. This comparison was performed with the small laminar flow element attached directly to the BG-3 tunnel when disconnected from the exhaust stack and sampling test cell air.

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 or 220 VAC, 50/60 Hz (specify with order).
Dilution Air Supply	90 PSI. 4 SCFM (6 Bar, 7 m3/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**	**Sierra BG-3**
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@(Gexhw = Gairw + Gfuel) 3.Tracer measurement method 4.Air flow and air to fuel ratio measurement method	Any of the 4
Proportionality	Correlation coefficient R2 of the linear regression between Gp,i and GEXH,i shall not less than 0.9. The standard error of estimate of Gp,i on GEXH,i shall not exceed 5% of Gp maximum. Gp intercept of the regression line shall not exceed +/- 2% of Gp 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
Primary and back-up filters	The diluted exhaust shall be sampled by a pair of filters placed in series (one primary and one secondary) 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 Gtotw	+/- 2%	+/- 2% or less
Accuracy of Gdilw	+/- 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

SIERRA INSTRUMENTS, INC.
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www.sierraemissions.com

ISO REGISTERED 9001

HEADQUARTERS:
5 Harris Court
Monterey, CA 93940
Tel 800/866.0200 or 831/373.0200
Fax 831/373.4402
Email d_pier@sierrainstruments.com

DETROIT OFFICE:
P.O. Box 969
Walled Lake, MI 48390
Tel 248/926.0358
Fax 248/926.0379
Email service@sierrainstruments.com