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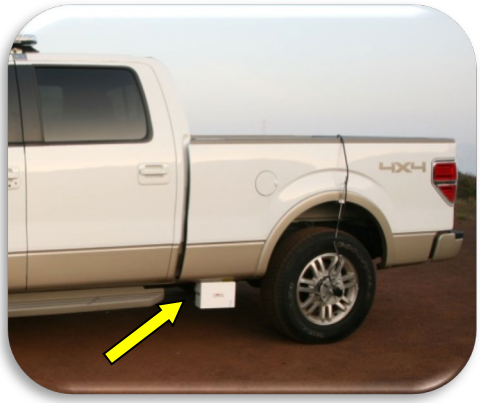
SSI INERTIAL PROFILING SYSTEMS
TECHNICAL SPECIFICATIONS

▲ **CS9300 Front/Rear Mount System** ▲



▲ **CS9100 Mid-Mount System** ▲

▲ **CS9400 Simple Profiler** ▲

- Measurement Principle: Inertial profiling system (with laser and accelerometer-established inertial reference and high-resolution optical encoder distance sensor or GPS based distance measurement (GPS-DMI).
- Device Rating: Meets or exceeds requirements of ASTM Standard E950 (Standard Test Method for Measuring the Longitudinal Profile of Traveled Surfaces with an Accelerometer Established Inertial Profiling Reference). Complies with DOT and other industry standards, including AASHTO M328, R054, R056 and R057.
- Data Sampling Interval: Variable sampling interval with default set to 25 mm (1.0 inch). One-inch (25 mm) sampling interval valid for all collection speeds. User configurable sampling interval to >1.0 inch (e.g., 6 inches).
- Distance Measurement: Optical encoder-based distance measurement system with longitudinal distance accurate to 0.1% or greater. Optional GPS-DMI accurate to within 0.05%.
- Height Measurement: Vertical measurements acquired with one or multiple non-contact laser range finder sensors unaffected by pavement texture, color, reflectivity or ambient lighting. Wide footprint lasers recommended to eliminate impact of grooves, tyning and coarse textures. Typical wide beam lasers sample at 5KHz with 260 points across 4" (100mm). Single point lasers sample at 32-64KHz. Laser vertical measurement accuracy: 0.00005 inches typical with 0.0005" resolution. Aerospace grade accelerometer sensors (rated for +/- 5 to 10g; resolution accuracy: 0.0001g).
- Laser Classification & Safety Admonition: The laser sensors on SSI inertial profiling systems utilize light sources that are semiconductor lasers emitting visible light. The lasers have a 3B/IIIb classification under the standards relating to laser products specified in IEC 60825-1[1] and U.S. FDA CFR Title 21 Part 1040[2] and Laser Notice No. 50, dated July 26, 2001.[3] Class 3B/IIIb components are ***UNSAFE*** for eye exposure. Usually only ocular protection would be required. Diffuse reflections are safe if viewed for less than 10 seconds. ***WARNING:*** DO NOT look directly into the laser beam. It is recommended that laser safety goggles (for Class 3B/IIIb lasers) be worn by the operator or others in close proximity of the profiling system hardware when the lasers are operational.

[1] **International Standard IEC 60825-1 (2001-08) Consolidated edition**, Safety of laser products – Part 1: Equipment classification, requirements and user's guide.
[2] **Technical Report TR 60825-10**, safety of laser products – Part 10. Application guidelines and explanatory notes to IEC 60825-1.
[3] **Laser Notice No. 50**, FDA and CDRH http://www.fda.gov/cdrh/rad-health.html

SSI INERTIAL PROFILING SYSTEM SPECIFICATIONS

- Profile Features and Preservation: Proven ability to measure and preserve fine surface features more accurately than any competing system. Profile wavelength preservation with SSI inertial profiling system from ~0.25 feet (76.2 mm) to ~8000 feet (2438 meters). With optional survey subsystem added to inertial profiling system, long wavelengths can be preserved to a theoretically infinite length. Optional control point merge supported for survey and machine control applications.
- Repeatability & Accuracy: Guaranteed to meet or exceed industry standards, specifications and certification protocols (including ASTM E950, AASHTO M328, R056, and Texas 1001-S).
- Specification Compliance: Guaranteed compliance with all commonly used agency specifications and test methods regarding use of inertial profiling systems for quality control or quality assurance.

Profiling System Electronics and Computer Hardware:

- Profiling System Core Electronics Module: Custom profiling system core electronics module fabricated in ISO 9001 compliant facility. Single module connects to all profiling system sensors with dedicated micro-processors for each sensor. Profiling system core electronics is portable, modular, and sized for express shipment worldwide for prompt in-field replacement.
- Profiling System Sensors: Industrial / aerospace grade sensors. System supplied with durable shielded cables with Amphenol or other durable connectors. Quick-disconnect configuration supported for removable sensors.
- Operator Interface Computer: Mil-Spec Panasonic Toughbook 31/55 ruggedized notebook computer. Typical configuration: Intel i5 processor, Microsoft Windows 10 Professional operating system, minimum 16GB RAM; 512GB solid state hard drive, Gigabit Ethernet LAN, wireless 802.11 a/b/g/n, Bluetooth, 14.1" HD display with outdoor readable touch screen; lithium-ion internal battery. Additional options and accessories available for Toughbook computer.
- In-Vehicle Workstation: Pedestal mount system and docking station for operator interface computer and power supply. Computer position adjustable between driver or passenger for safe one-person operation.

Profiling System Mount Hardware:

- Mount Hardware: Professionally engineered mount hardware for attachment of inertial profiling system components onto front, rear or middle of industry standard vehicles. Front or rear mount systems attach to standard 2 inch (5.08cm) square receiver tube and operate from host vehicle's 12V power supply.
- Flexible DMI Hardware: Hardware supplied for attachment of high-resolution distance measurement interface to rear wheel of host vehicle. Multiple vehicle flexible collets or dedicated lug-extenders supplied. Optional GPS based distance measurement (accurate to within 0.05%).
- Sensor Adjustment: Dove-tail hardware supplied for horizontal and vertical adjustment of sensor modules as required or needed.
- Hardware Design Services: Custom hardware design and fabrication available for system attachment according to customer requirements or specifications (front, rear, or mid-vehicle mount).

Profiling System Software:

- SSI Profiler Software Suite: SSI internally developed software routines for profiling system calibration, data collection, data analysis and reporting. On-screen instructions for system calibration and data collection. Feature rich data analysis software. Current versions built on over 25 years of continuous development.
- Programs Fully Compatible with Microsoft Windows: All software fully integrated with Microsoft Windows 10 Professional operating system).
- Multiple Calibration / Diagnostic Routines: Menu driven calibration routines for distance, proprietary accelerometer static calibration (in-field), bounce test (data file saved), laser height verification

(0.25”/0.5”/1.00”/2.00”), rut-depth (if equipped) and cross-slope (if equipped). Internal diagnostics provide real-time monitoring of profiling system health.

- User-Selectable Parameters: English or Metric units for both data acquisition and reporting; new file parameters become default (no recurring new file setup). Industry standard and user definable parameters to facilitate identification, authentication and sharing of profile data.
- Real Time Display: Real time display of vehicle position and surface profile trace during data collection.
- Multiple Data Collection Triggers: 3 data collection triggers: (i) SSI Reverse Direction Trigger (proprietary procedure that collects exact stations without pre-marking test sections and post-testing cone removal), (ii) Electric Eye, and (iii) On-the-Fly.
- Event Marking: Entry of location notes by (i) push button or electric eye, with text editing by operator after safe finish of data collection, or (ii) user configurable hot keys (assigning unique event types to particular keyboard buttons).
- Urban Area Data Collection: Zero-Speed option enables collection at speeds 0-100 mph, through vehicle stoppages, and with no lead-in or run out sections. Without zero-speed option, Continuous Collection software suspends inertial data collection at speeds below 5 mph (distance collection continues).
- Pause Function with Data Retained: Pause data collection manually or with electric eye. Data from paused sections retained for reporting separately or combined with non-paused areas.
- Multiple Profile Indexes: Profile data reported in International Roughness Index (IRI)(by segment or continuous), Mean IRI (MRI), Half Car Ride Index (HRI), Profile Ride Index (PRI), and Ride Number (RN).
- Localized Roughness: Multiple outputs of localized roughness supported. IRI areas of localized roughness (ALR) reported according to user configurable thresholds; profilograph must-grind bump/dip template; rolling straightedge; Texas 1001-S localized roughness. Dimensions of localized roughness calculated by length of defect and maximum amplitude.
- Re-Writeable Data with Variable Data Analysis Parameters: Raw profile data infinitely rewritable for outputting reports and profile traces under user adjustable parameters.
- Configurable Filtering: Raw inertial profile data can be analyzed with configurable low pass, high pass or band pass filters (Butterworth, moving average or custom filters).
- Multiple Trace Reporting: Patented multiple profile trace data acquisition and reporting capability. Single sensor systems report dual tracks (separately collected in either direction).
- Data Conversion Sub-Routines Supplied: Export routines for conversion of profile data to industry specified formats (ERD, PPF, PRO, ASCII, CSV, Excel, configurable text, Survey, GPS/GIS and customized per request).
- One Touch PDF Images: Create universally readable PDF images of profile traces and reports directly within SSI Profiler program.
- Multiple Software Licenses: Data analysis software licenses provided for profiling system and desktop computer usage.
- Data Encryption: Encrypted raw data files for data integrity security, raw data by repeat analysis under adjusted parameters.

Operational & Physical Attributes:

- One Person Operation: All data collection, analysis and reporting functions can be performed by one person without leaving the vehicle).
- Speed Range: Standard systems: 5 mph (8 kph) to 100 mph (160 kph) with 1” (25 mm) sampling interval. With Zero-Speed option: 0-100 mph (160 kph), through stoppages and without lead-in, lead-out sections.
- Temperature: Operating ambient temperature range: ~25° to 110° F (-3.9°-51.6°C); cold weather option available for sub-freezing operation; non-laser component operating temperature range: 0° to 140° F (18-60°C). Storage temperature range: -25° to 160° F (-32-71°C).
- Humidity: Operating humidity should not exceed 90 percent (noncondensing); non-operating humidity range shall not exceed 100 percent (noncondensing).

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- Moisture: Profiling system components impervious to moisture. Quality of measured profile degrades with excessive moisture (active rainfall, standing water or ponding on surface.
- Dimensions: CS9300 Portable System: 60" L x 8" W x 24" H (152 cm L x 20.3 cm W x 61 cm H).
- Weight: CS9300 System hardware: ~75 lbs. (34 kg) • CS9100/CS9400 System: 35 lbs. (16 kg).
- Electrical Ratings:
    - Input: 5-14 volts DC.
    - Operating: ~3 amps.

Options & Accessories:

- GPS & Advanced GPS Toolkit: Embedded GPS options with accuracies from 2 meters to ~1-2 centimeters. GPS positions correlated with profile stationing (chainage), Google Earth/Maps and dynamic profile trace navigation supported. Real-time GPS based editing of station locations/equations, paused sections, and event marking.
- Wide Footprint Lasers: Wide beam lasers available for improved testing on tyned concrete, grooved or coarse textured pavements.
- Rut Depth Measurement: Available configurations: (i) 3 point (South Dakota method), (ii) 5 point (AASHTO PP 38 compliant), or (iii) full lane width transverse profile (AASHTO R87 and R88).
- Texture: Pavement texture measurement and reporting (ASTM E1845 mean profile depth or 3D data capture). One or multiple tracks of texture data supported.
- Cross-Slope: INS-GNS instrumentation supports accurate crossfall measurements (degrees or radians).
- Camera: HD digital camera for forward ROW or pavement-facing images merged with profile data at user specified intervals. Image viewer with reporting of adjacent ride, rut, GPS and other configurable details.
- Mobile Surveying: Add instrumentation for mobile 2D/3D survey functionality. Available with RTK post-processing and control point merger with inertial profile and cross-slope data for high resolution surface topographies. Three track or full lane width profile configurations supported. Survey and CAD formats supported (e.g., PNEZD, LAS. PLLHD. GPGGA, etc.) for use in third party surface design and machine control applications.
- Terrain Profiling: CS9450 Simple Roughness Meter available with axle mounted accelerometer-based profile measurement; ideal for IRI/RMS assessment on unpaved roads, trails or surfaces with extreme roughness.
- Cold Weather Operation: Thermal sensor insulation option supports sub-freezing data collections.
- Humidity/Temperature: Instrumentation available for recording relative humidity and temperature (ambient and pavement surface) during profile measurements.
- Multiple-System Integration: Support available for SSI system integration with third-party instrumentation (distress measurement, camera imaging, LCMS/LRMS, GPR, GPS/GIS, etc.).
- Printer: Optional on-board thermal or mobile printers (roll or sheet feed).

Support:

- Operator Training: Worldwide multi-lingual on-site operator training available.
- Real Time Diagnostics: Profiling system health monitored by real-time diagnostics to verify integrity of main profiling system electronics, all sensors, and data communication interface. Visual and audible feedback.
- Software Updates: Self-executing program updates overwrite prior versions. Supplied by internet download.
- In-Field Component Replacement: All collection system components portable, modular for in-field replacement.
- Warranty: Industry standard limited warranty on all profiling system components and accessories.
- Customer Support Representatives: Customer assistance available worldwide by telephonic, e-mail and on-site assistance (24x7 support available as requested or needed).

Patented Technology:

SSI profiling systems include technology within the scope of patents granted by (or filed with) the U.S. Patent and Trademark Office. Contact SSI for further patent or other technical information.