



AEROSPACE





Capacitec®

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Aerospace is a major market for Capacitec's non-contact displacement, gap measurement and portable gap sensing systems. Our customers build/rebuild commercial and military aircraft and engines. For over 35+ years we have worked closely with manufacturing and quality engineers as well as R&D to enhance their product designs, production and quality control methods. Capacitec technology replaces mechanical measurement tools such as feeler gauges and go/no gauges with electronic alternatives.

FOR EXAMPLE:

- The GAPMAN® product line provides the capabilities of a high accuracy non-contact “electronic feeler gage” with a built-in data logger, the only way to comply with SPC/Six Sigma product improvements.
- The LiniGage engine eccentricity tool improves rebuild centering of aircraft engines in vertical and horizontal reassembly positions.
- Capacitec's portable “non-contact or contact wand” blade length measurement system measures gaps between fan blades and the engine cowling.

These solutions provide you with compelling time/cost reductions and quality enhancements that easily support very rapid payback on your investment

Major Applications Include:

AIRCRAFT ENGINES

- HPC/HPT rebuild eccentricity for CFM56, CF34-10 and others
- Fan blade length and blade tip gap measurement for GE90, GEnx, CF6, RR Trent and others
- High temperature runout and thermal expansion for P&W 4000 & F135 (JSF) and MTU engines

AEROSPACE STRUCTURES

- Gap measurement for shim selection for:
 - + Wing tie plates, skin to frame and frame gaps
 - + Gaps in airframe between subsections and mating surfaces
 - + Tail section tie plates and horizontal stabilizer gaps
 - + For Boeing 737, 747, 777x, 787 and the Airbus A220, A320, A321, A350
- Outer skins/frame fastening for Delta IV launch and other payload vehicles

LiniGage

Aircraft Engine Rotor Eccentricity Realignment

The Capacitec LiniGage is an Aircraft Engine Rotor Eccentricity Realignment System that is used to set the concentricity of engine rotor assemblies such as in the HPC and HPT sections. An 8mm non-contact displacement sensor is temporarily attached to the tip of one of the blades with a lead typically exiting the engine enclosure through a borescope hole. The rotor is rotated 360° allowing the sensor to measure the gap between the blade tip and the housing inside circumference. The LiniGage custom software takes displacement values, polar plots the circumferential blade gap and calculates the eccentricity magnitude with its resultant angle. An out-of-spec eccentricity plot then allows the engine rebuild technician to easily identify where to make adjustments by retorquing case segments into specification simultaneously creating a permanent quality record.

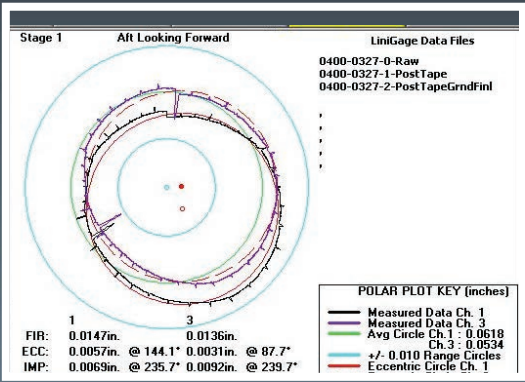
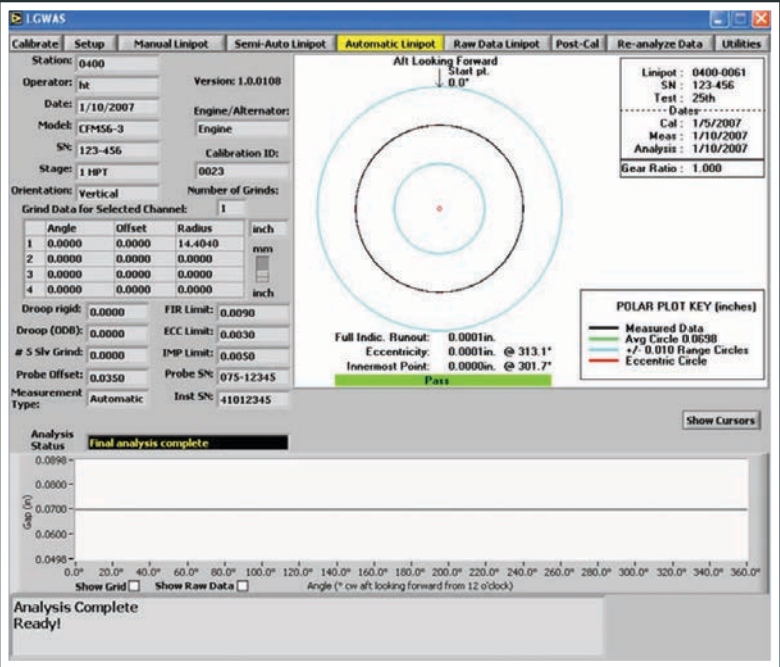
Capacitec's original LGDAS (DOS-based) system introduced in the late 1980s, and the current LGWAS (Windows-based) system supports the CFM and GE families of engines in rebuild centers and during their design. This is a custom version of the LiniGage to help support continued quality initiatives for these aircraft engines.

There are more than 100 LGWAS systems currently in operation worldwide at engine manufacturers and rebuild centers.



CFM56 Family

HPC & HPT Runout Measurement System



Polar Plot showing two engine stages simultaneously

The new LiniGage running on Windows 10® offers even more benefits to engine manufacturers and users due to the following features:

Features	Benefits
Single rotor and custom multi-rotor, multi-engine HPC/HPT gap measurements	Simultaneous gap, eccentricity and FIR measurement using one system can be easily programmed for any new engine style
Microsoft Windows 10® software platform	Very easy user interface, PDF and exportable data files to standard software packages
Multiple ID grinds	Compensation for multiple internal grinds w/o affecting FIR (full indicated runout)
Measure engine in vertical or horizontal positions	Mathematical compensation for gravity "droop" in horizontal position
Higher resolution encoder	Better data fidelity
ISO9001 certified calibration method	Measurements traceable to worldwide standards

GAPMAN® Gen 4

Used in Shimming Operation



GAPMAN® is the world's first high precision, non-contact, portable electronic gap measurement gage. It features a dual capacitive sensor for position-compensated measurement and easy insertion into very narrow gaps down to 0.004" (105 microns) in a wide range of aerospace applications.

The most popular aerospace application for the GAPMAN® is the assembly of Commercial and Military aircraft, and in particular, its use in the shimming process. It has been documented that the use of the GAPMAN® has reduced the time required for shimming by 5X over the previous method using feeler gauges. Over a thousand units have been in use over the past 30 + years and the robust units are holding up well in this tough shop floor environment.



Key Features Include:

- Measures gaps between all metal and composite surfaces
- Simplified PC user application
- Records and stores up to 10,000 data points for easy transfer to SPC and other quality systems via USB or Bluetooth (may be deleted for high security areas)
- Higher resolution output (0.00001" / 0.254 μ m) with $\pm$ 0.5% FS (12.7 μ m) typical accuracy with a GPD-5F wand and 0.100" (2.54mm) gap
- Extended battery life doubled (now 22 hours minimum with 3 primary AA lithium batteries) with GEN4's additional internal lithium ion rechargeable battery

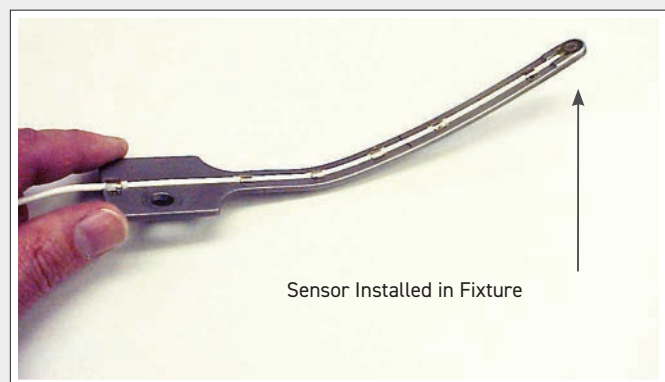
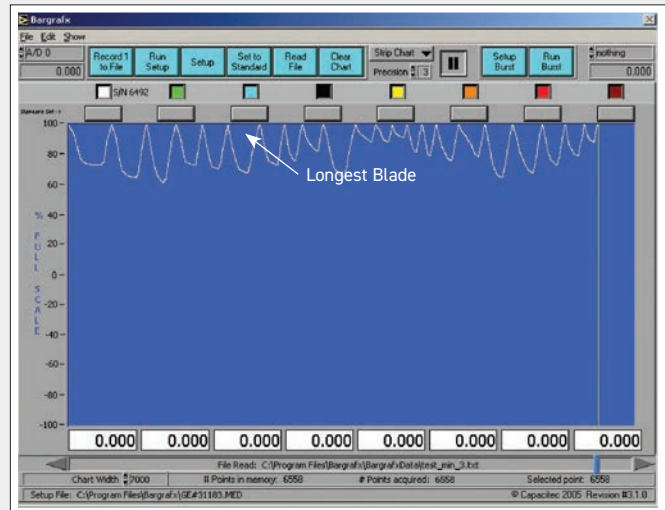
Engine Fan Blade Length Measurement

Non-Contact and Contact Methods

FIXED POSITION NON-CONTACT METHOD

To enhance efficiency and safety, aircraft manufacturers need to know the fan blade lengths during initial assembly and after engine rebuild. Current mechanical gap measurement methods, such as step gauges and shims, cannot meet the latest quality requirements such as Six Sigma since they fail to pass Gauge R&R. In response, Capacitec has developed a special “electronic blade length gage” (recording the results on a laptop) that operates as follows:

- An HPB-150 non-contact displacement sensor is installed in a custom fixture that precisely positions the sensor onto the engine cowling interior with the sensor facing up under the fan blades.
- The fan blades are rotated 360° with each blade passing over the sensor. (Two sensors can be installed in the fixture if leading and trailing edge measurements are required.)
- A single channel electronics package including a Bargrafx™ peak read software application interrogates each sensor signal and displays the blade length while recording the results on a laptop

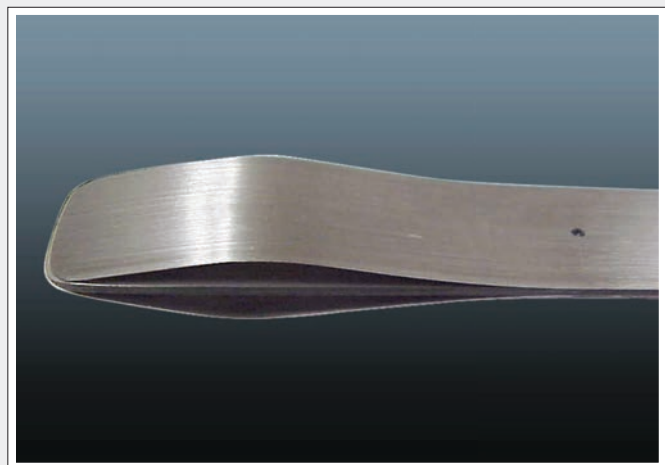


PORTABLE CONTACT WAND METHOD

The portable “contact wand” blade length measurement system is used to measure gaps between fan blades and the engine cowling. The advantage of this system is that it does not require grounding of the target, and the hand-held wand and electronics can easily access any of the fan blade gaps without the need to rotate the blades.

Contact Wand operates As follows:

- A double-sided GPD-4 non-contact displacement sensor is installed onto a metal wand with two flexible leaf springs placed on top and bottom to provide the target.
- When the wand is introduced into the gap, the leaf springs bend inward toward the sensors giving a precise reading of the gap.



- The sensor wand can either be integrated into a portable GAPMAN® unit or alternatively into a Gapmaster3® electronics package with a remote wand option

Portable and Flexible Measurement

One of the primary advantages of the Gapman® line of portable battery-operated Gap Measurement systems is their flexibility and ease of use. These devices can

be easily moved across the production line to be used at different points in the process.



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