Gapman® Gen3 for metal and CFRP Aircraft Assembly

By Robert Foster and Bryan Manning

Capacitec Gapman® Gen3 portable non-contact electronic gap tools have replaced feeler gauge measurement methods in aircraft assembly applications at Airbus, Boeing, Bombardier, Embraer and military aircraft such as JSF.

In the past several years there has been a growing demand for new gap measurement applications on assemblies with a heavy use of composite CFRP to CFRP gaps, difficult to access gaps and heightened interest in measuring large area designed shim locations requiring multiple sensor configurations.

Additional trends in the commercial aircraft market have driven the need to change to more efficient gap measurement solutions. The rapid growth in the use of composite materials in aircraft that lighten the planes weight while reducing fuel and maintenance cost is now a well established practice.

A more recent trend is the steep increase in aircraft demand, leading to heavy backlog of orders requiring both Airbus and Boeing to build 40 units per month of the most popular A320 and 737 models. New gap measurement tools are now in place that result in significantly faster production rates in critical applications such as main wing manufacture. See Figure 1: Aircraft gap applications

Figure 1: Aircraft gap applications

To date the Gapman has achieved a gap measurement/shimming operation build rate improvement of 5 times faster than manual feeler gauges. Benefits are: ease of operation, enhanced structural integrity of aircraft component join locations and a shim gap database to assist users in continuous process improvements.

Data logged gap values can now also be communicated from the Gapman via the wireless options to customer driven template data programs for direct control of the gap shimming manufacturing process.

Sensor Selection

The capacitive gap sensor wand model selection is application driven and chosen in reference to the following factors: minimum gap, gap range, target material combinations (metal/metal. metal/CFRP, CFRP/CFRP), difficulty of access to targets and large surface gap areas. There are dozens of standard models of both flexible wands and spring contact sabres along with the option of developing multiple sensor array models according to customer needs. Sensor positioning tools are also available to accurately place gap sensors into difficult measurement locations to greatly improve the results of Gauge R&R testing.

Flexible wands

Kapton® flexible wands are typically used to measure the thinnest gaps and where the flexibility of the wand improves accessibility to the target. (See Figure 2) The thinnest gap measurement available can be found in Model GPD- (3X1) I-A-225 that offers a range from 0.15 mm (0.006 ”) to 1.0 mm (0.0394”). The popular Model GPD-4.5 (.0075)-A-250 has a range of 0.20 mm (0.0079”) to 3.0 mm (0.118”). Other models can be specified to have a range up to 10 mm (0.394”).

Figure 2: Gapman with flexible gap wand

Flexible wands account for the majority of aircraft gap measurement and shimming processes. Examples of typical applications are joining of several fuselage skin subassemblies such as frame gaps, wing skins to stringers and ribs and VTP assembly. The Gapman typically measures a combination between CFRP and primer painted metal surfaces.

Self-grounded spring contact wands
Spring contact wands are typically used in applications where: one or both targets are non-conductive; a target width is <5 mm (0.2”); or the surface or shape of the target is irregular. These are also the most popular choice for CFRP/CFRP applications where the minimum gap is >0.64 mm (0.025”). The Spring Contact wand Model GPD-5 (0.22)-A-150 has a range of 0.64 mm (0.025”) to 3.0 mm (0.118”) while the range of the GPD-10 (.034)-A-350 is 0.86 mm (0.034”) to 10.0 mm (0.394”)

The horizontal stabilizer join areas typically use a design shim, which requires measuring gaps up to 5 mm (0.2”). In one application a non-contact or spring contact wand is built onto a 15 mm wide shim with a GPD10 sensor at the core.

Spring contact wands can also be found measuring gaps between large mating surfaces such as wing tie plates, hatches, doors and windows as well as cargo door alignment.

New gap wand positioning fixtures
In some cases airframe assemblers have thin gap applications where the target gaps are difficult to access. These tight measurement areas could be above, below or in difficult horizontal access locations. This makes it challenging for operators to be able to position flexible wands parallel to the measurement surfaces. When using non-contact capacitive gap sensor wands best practice is to align the top and bottom sensors parallel to the two measurement surfaces. Figure 3 shows an example of a hand held positioning fixture constructed with a flexible Urethane wand positioner to guide the sensors parallel to their target surfaces.

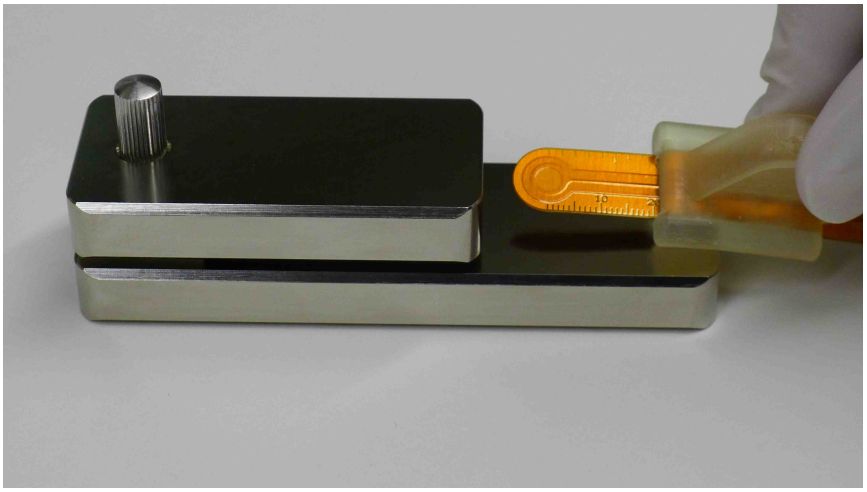

Figure 3: flexible wand holder

Tightly controlled composite sub assembly applications sometimes have limited entry access to critical gap measurements. Capacitec developed a dedicated hand positioning tool designed to allow the sensors to repeatedly gain access, parallel to the gap targets, helped by a 60 degree holder for tactile positioning. (See figure 4)

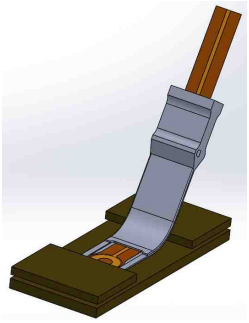

Figure 4: 60° angle wand positioner

Multiple sensor configurations for large area gaps
In applications such as main fuselage section joins and starboard and port wings to fuselage assembly, aircraft manufacturers have been searching for novel multiple gap sensor measurement solutions. Figure 5 shows an example of a 3 sensor contact wand array built in to a positioning fixture. The resulting benefit is ideal sensor positioning in critical join locations with much faster and higher quality inspection rates.

Looking toward the future, Capacitec is developing arrays up to 16 sensors for even wider area gap measurements.

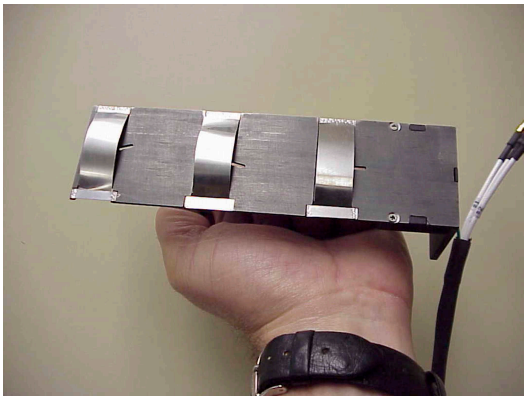

Figure 5: 3-gap sensor array