Dual Bridge Strain Gage Load Cells

Aircraft Structural & Fatigue Testing

Structural and fatigue testing of aircraft is performed to accelerate life-cycle testing on airframes and requires the use of dual bridge strain gage load cells mounted to hydraulic actuators. The load cells are used for active force feed back to hydraulic servo controllers that drive the aircraft structure during test in a 'closed loop.' The difference between the two bridge outputs is constantly monitored and if they exceed safe limits the test is slowly shut down in a controlled manner. The load cells are also used for measuring and recording the force level in a data acquisition system. Historically, multi-bridge load cell were used in the aerospace industry to provide a redundant output signal due to reliability issues.

Most structural and fatigue testing of aircraft occurs on large airframe, where the airframe is cycled through taxi, pressurization, take off, climb out, flight maneuvering, descent, final approach, landing and depressurization. This is repeated multiple times and when run non-stop for two to three years can simulate thousands of airframe hours and tens of years of aircraft life on the structure. Fatigue testing of aircraft is not limited to the airframe level, but also includes component level testing such as landing gear, flight control actuators, landing gear door connecting rods, and other parts.

Load cells are also used for landing gear drop testing to simulate loading and performance of the landing gear. In this test, the landing gear is raised to a pre-determined drop height and locked into position. Next, the wheel is spun up to rpm speeds that simulate the forward motion experienced during touch down. Finally, the landing gear is dropped at a controlled rate similar to an actual aircraft landing and data is captured on the load cells.

Additional measurements have been required in the test, such as shock absorber pressure and acceleration shock measurements. Typically, a low frequency MEMS sensor, such as Series 3741 from PCB is mounted on the drop test rig at the landing gear attachment point. Triaxial piezoelectric series 356 accelerometers are then mounted on the landing gear itself to obtain shock response measurements. Thin film technology pressure transducers, such as Series 1500, have also been used to measure the dynamic pressure response in side the shock absorbers.

The dual bridge Series 1400 includes a dual output feature that offers sensor redundancy and the ability to provide the necessary load feedback to hydraulic actuator servo controllers. These load cells are available in multiple ranges and are prepared for shipment with A2LA accredited calibration to ISO 17025 in both tension and compression directions. Additional features include corrosion resistant nickel finish, low deflection, high accuracy and repeatability, thermal compensation and barometric compensation.

The dual bridge load cells, made from a shear-web design taking the form of a cantilever beam, have been designed with a cross section larger than normal with respect to the rated load to be carried in order to minimize structural deflection. Strain gages are placed on the sides of the beam at the neutral axis, where the bending stress is zero. The state of stress on the beam side is one of pure shear, acting in the vertical and horizontal direction. This makes for a stronger design and has less error due to eccentric loading, creep, and off-axis or side loading. High gage factors of the bonded foil strain gage elements allow for full 2 mV/V sensitivity on their output.

Dual bridge load cells for structural and fatigue testing of aircraft are typically available with standard capacities ranging from 5000 lb to 100,000 lb (25 kN to 450 kN), with many other ranges available upon request. Fatigue rated styles are guaranteed for 100 million fully-reversed cycles of tension and compression. Also offered is a selection of SAE threads (with coarse or fine pitch) or Metric threads bayonet-style PT or screw-on PC connectors, and connector protection. In addition to dual bridge load cells for airframe structural test, other load cells are available from PCB Load & Torque Inc. (a wholly-owned subsidiary of PCB Piezotronics, Inc.), including low profile, rod end, S-beam, and hollow compression for applications such as weighing, material testing, press monitoring, process automation, rocket thrust, component testing, and automotive durability or drivability.