

FORCE ASSISTED ASSEMBLY OF THE AIRBUS A350 XWB

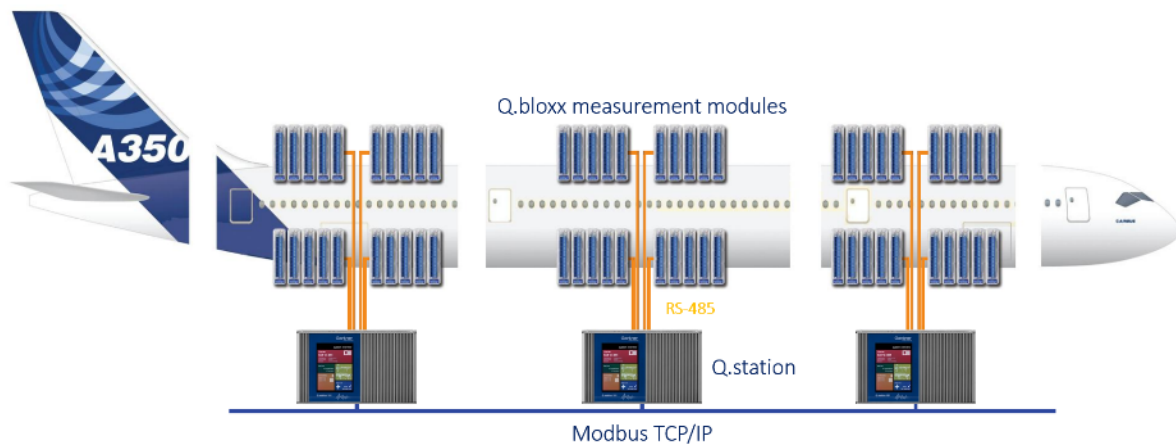
Qatar Airways expects to receive its first A350-1000 as launch operator in the second half of 2017. The A350-1000 is part of the A350 XWB family and is Airbus' largest and most powerful twin-engined airliner ever. The major A350 XWB sections like fuselage, wings, engines and tail are built by Airbus' European production facilities in France, Germany, Spain and the UK. At the A350 XWB final assembly line (FAL) in Toulouse the aircraft then comes together like a well-planned, high-tech puzzle.

The A350 XWB fuselage is made up of three main sections - front, center and aft. The sections are joined together at the first main assembly station, P50. The landing-gear is also joined here. Once this stage is completed, the fuselage is transferred to station P40 where the wings and tail sections are joined. For maximum flexibility, the final assembly line can be used for both A350-900 and -1000 models.



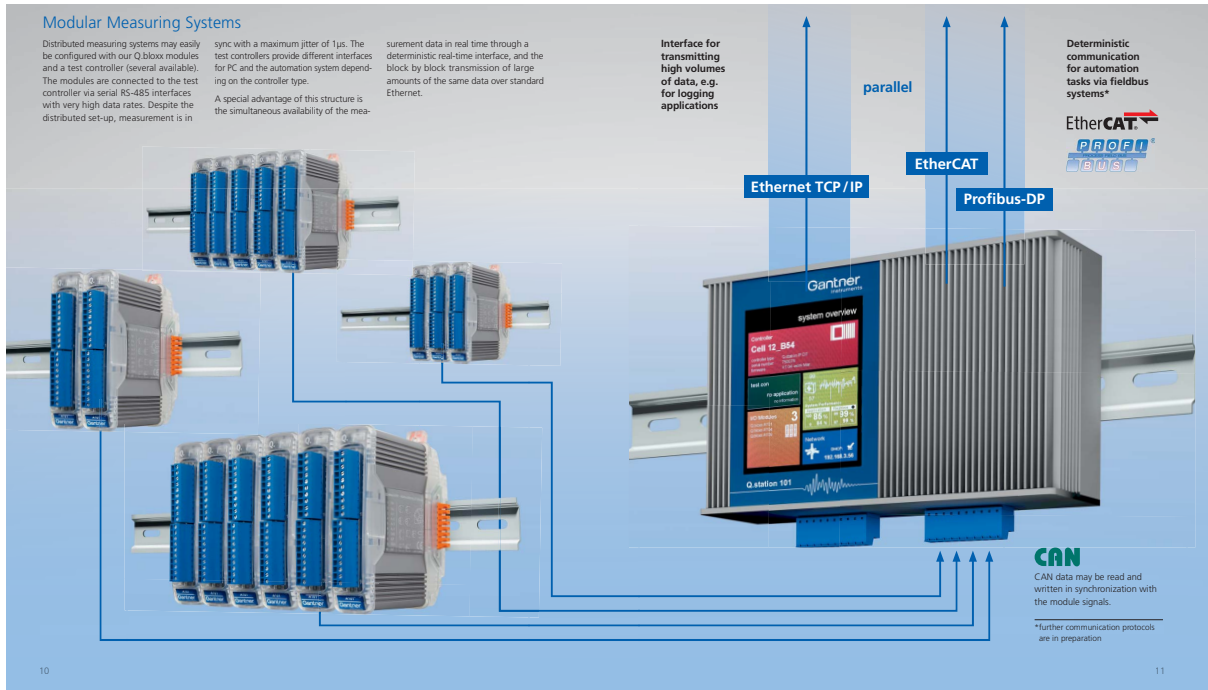
The process of mating and joining large airframe subassemblies is a complex task. Gravitation and environmental conditions cause geometric deformation. Particularly for components made of carbon fiber reinforced polymer (CFRP), which is used extensively on the A350 XWB. To overcome the challenges of locating and positioning large airframe structures, a measurement assisted assembly system is used. An array of multi-axis positioners lift, move, and align the fuselage and wing structures to guarantee best fit among them. Protecting the large structures during handling is of paramount importance. With the aid of load cells mounted in the positioner's drive mechanism, the forces acting on the structure are monitored during movement. This ensures strain-free handling, and thus prevents the parts from damaging. In addition, geometric deformations are monitored and compensated for during part-to-part assembly, ensuring unstressed joining of the airframe sections.

The total assembly system includes 300 load cells. Single axis load cells monitor lift (Fz) and tri-axial load cells monitor the force during assembly (Fx, Fy and Fz). All load cells have dual-bridge output to allow for redundancy in the system. The load cells are connected to a Gantner Q.bloxx measurement system. A total of 150 Q.bloxx A101 modules are used to perform the primary force monitoring tasks. In addition, 300 Q.bloxx A102 modules are used for redundant monitoring.



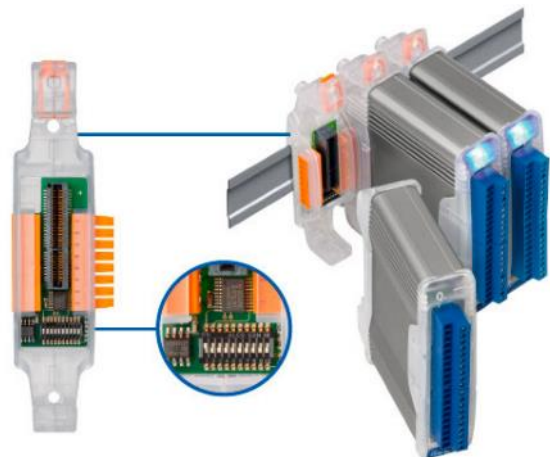
The distance between a load cell and monitoring system may be as far apart as 75 meters. Locating the signal conditioners close to the actual points of measurement is one of the key requirements when designing a measurement assisted assembly system. The Q.bloxx's optimum channel granularity, combined with the flexibility to freely mix and distribute modules, offers Airbus maximum flexibility. The modules communicate to a centrally located Q.station controller via RS-485. The Q.station controller handles all the data acquisition, synchronization, and control tasks. The data transmission follows a very efficient protocol with a baud rate of up to 48 MBaud. Despite the distributed set-up, measurement is in sync with a jitter less than 1 μ s. This architecture warrants reliable measurement results in an industrial environment, avoiding cable complexity.

The assembly line monitoring system includes a Schneider Electric Safety PLC. The open-architecture Q.station controller communicates with the Safety PLC via Modbus TCP/IP. By separating the Q.station controller from the measurement modules, communication and interoperability with the monitoring system is significantly optimized. In addition, as interface or performance requirements evolve, it is easy for Airbus to upgrade the controller alone leaving much of the system investment intact and 'future proof'.



The Q.bloxx A101 and A102 have on-board microprocessors, 24-bit A/D converters, anti-alias hardware filters and full 3-way isolation up to 500 VDC on every channel. The measurement modules support sampling rates of up to 100 kHz per channel. But, transmitting enormous amounts of raw data over a network puts tremendous load on network resources. Each Q.bloxx module comes with an FPGA that allows for full signal conditioning and data processing at the point at which the sensor data enters the measurement system. Only the data that has process-relevant information, like mean average, min/max and peak spike measurement, is sent to the assembly line monitoring system. This avoids network latency and thus improving response times.

Airframe assembly can account for as much as 40% of the total aircraft manufacturing costs. Operational availability of the assembly system is of utmost importance. Each Q.bloxx module connects to a socket that has a built-in flash memory chip. A copy of the entire module configuration is stored in the socket. So, when replacing a faulty module there is no need for manually re-configuring the new module or the monitoring system. Modules can be replaced while they are in actual operation, without the need of shutting down power. It takes the system 5 seconds to clone the configuration from the socket to the new module. Measurement will continue automatically when the configuration has been restored. The Q.bloxx “Hot Swap” feature allows for efficient service & maintenance of the measurement system, minimizing downtime and increasing efficiency of the Final Assembly Line. ♦



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Fig 1 A350 XWB Main Assembly Station P50

Fig 2 Q.bloxx Measurement System for Assembly Line Monitoring

Fig 3 Q.bloxx for Decentralized, Fast and Accurate Measurement

Fig 4 Q.bloxx Innovative 'Hot Swap' Functionality