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DISTRIBUTED DATA ACQUISITION ARCHITECTURE WITH PRECISE TIME SYNCHRONIZATION FOR CONTROL AND MONITORING PROCESS PARAMETERS DURING STRUCTURAL TESTING OF CRYOGENIC PROPELLANT TANKS

Abstract

Structural testing of Cryogenic propellant tanks of launch vehicles is conducted to evaluate the capacity of structure to withstand foreseeable loads during different phases of flight regimes. These tanks are in general designed with low safety design margins considering the payload gain. During qualification testing, strain developed at different locations of tank under different loading conditions is measured and their design margins are ensured. These tanks are structurally qualified in cryogenic temperature condition. The quantity and number of strain gauges are decided based on the tank design. In general, at weld joints, chemical milling locations and in rework locations, more measurements are done. This requires high density monitoring and recording system. For such critical applications, distributed architecture for data acquisition system is more warrant than other architectures. A high sampling rate for strain measurement is used in aerospace structural qualification. High channel count and high sampling rate calls for the requirement of precise time synchronization. When channel count exceeds thousands, then multiple controller synchronization is challenging. The time accuracy can be achieved only with tight synchronization.

In this paper, a distributed data acquisition system with precise time synchronization that can be used for not only monitoring but also for control of process during structural testing is discussed. The system architecture can cater to monitoring of 2200 channels with time synchronization of less than 200 microsecond which is limited by the sampling rate of the system. The system architecture with time synchronization scheme and its testing methodology is discussed. Also process control capabilities are also tested and demonstrated.

With the presented approach, the system performed appropriately when it was called upon with fast reaction time and with increased reliability.