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Design of DC-Link VSCF AC Electrical Power System for the Embraer 190/195 Aircraft

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Abstract

A proposed novel DC-Link VSCF AC-DC-AC electrical power system converter for Embraer 190/195 transport category airplane is presented. The proposed converter could replace the existing conventional system based on the CSCF IDGs. Several contemporary production airplanes already have VSCF as a major or backup source of electrical power. Problems existed with the older VSCF systems in the past; however, the switched power electronics and digital controllers have matured and can be now, in our opinion, safely integrated and replace existing constant-speed hydraulic transmissions powering CSCF AC generators. IGBT power transistors for medium-level power conversion and relatively fast efficient switching are used. Electric power generation, conversion, distribution, protection, and load management utilizing VSCF offers flexibility, redundancy, and reliability not available with a conventional CSCF IDG systems. The proposed DC-Link VSCF system for E190/195 delivers several levels of 3-ϕ AC and DC power, namely 330/270/28 VDC and 200/ 115/26 VAC utilizing 12-pulse rectifiers, Buck converters, and 3-ϕ 12-step inverters with D-Y, Y-Y, and Y-D 3-ϕ transformers. Conventional bipolar double-edge carrier-based pulse-width-modulation using three reference AC phase signals and up to 100 kHz triangular carriers are used in a manner to remove all even and many odd super-harmonics. Passive low-pass filters are used to remove higher harmonics. The RL AC loads are active in connection with the synchronous and induction AC motors and also include passive AC loads. The overall power factor exceeded 85%. Total harmonic distortions for voltages and currents are below 5%, thus satisfying the MIL-STD-704F and the IEEE Std. 519 power-quality standards, while avoiding the need for active filters. Several PI and PID controllers that regulate synchronous generator DC excitation and inverter banks were designed and tuned using the continuous–cycle tuning method to offer required performance and stability of the feedback loop. Mathworks's SimulinkTM software was used for simulation of electrical components and circuits. Several critical scenarios of aircraft operations were simulated, such as go-around, to evaluate the transient behavior of the VSCF system.

Recommended Citation

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airplanes Post-Mod. The system will remain disconnected for the remainder of the flight and ground maintenance is required to reset the disconnect unit. Page 27. Left elevator surface. Design of DC-Link VSCF AC Electrical Power System for the Embraer 190/195 Aircraft. Eduardo Francis Carvalho Freitas, Nihad E. Daidzic. Engineering. 2017. A new generation of buck-boost resonant AC-link DC-DC converters. Hamidreza Keyhani, Hamid A. Toliyat. Engineering. 2013 Twenty-Eighth Annual IEEE Applied Power Electronics Conference and Exposition (APEC). 2013. Closed form line to line voltage THD of the cascade multilevel inverter including device voltage drops. Naeem Farokhnia, Muneer Mohammad, Mehrdad Ehsani. Engineering. Comparative study of AC/DC converters for more electric aircraft. K.W.E. Cheng. IEE Power Electronics and Variable Speed drives Conference, pp. 299-304, Sep.