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Ungrounded Aircraft Power System Protection

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Abstract: Recent Studies are been made to implement the 270V DC/ Hybrid 115Vac electric Power Generating and distribution systems technology used in the small military aircrafts to domestic aircrafts. The studies are being made to design and build a high-efficiency, high-reliability, fault tolerant, low-weight, low-cost hybrid aircraft electrical system for future domestic airplanes. The system is distinguished as "Grounded" and "Un-grounded" depending upon whether the neutral point of the generator is connected to ground or not. The analysis indicate an Electrical Power generating system(EPGS) distribution system weight savings due to two wires for 270-Vdc rather than three or four wires for the typical 115V,400Hz ac system. The feeders, bus lengths, and wire sizes were chosen to be representative of what would be used in modern More Electric Aircraft (MEA).

Keywords: Aircraft System, Grounding, Ungrounded System.

I. INTRODUCTION

The Aerospace industry is recognized as one of the leading sectors in technology development, acting as a stimulus for growth and generating a substantial balance of trade surplus. This makes the Aerospace the most competitive manufacturing sector. Investment in R&T and R&D gives civilian aerospace sustainability and competitive winning advantage. One of these recognized areas is the More Electric Aircraft TVP (Technology Validation Program), which will develop the spectrum of underlying technologies for future electrical equipment deployed on civil aircraft.Fig.1. Shows the Electric Architecture Research Areas.

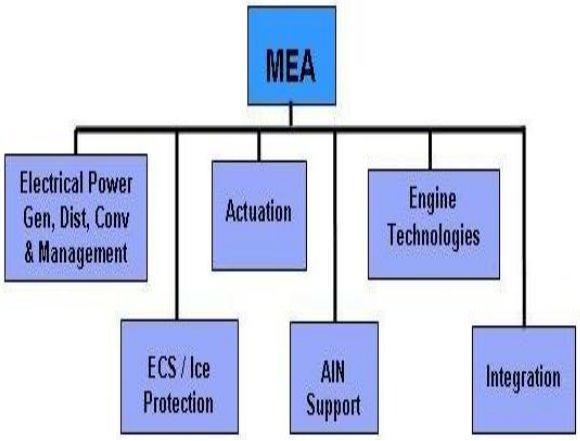

Fig.1. More Electric Architecture-Research Areas

Honeywell is a technological leader in the research and development of 'More Electric Architecture' (MEA). In fact, a number of more electric aircraft technologies are being developed at Honeywell. Unscheduled interruptions on Aircraft power system can have serious consequences. Because a single phase to ground fault in ungrounded system does not affect the phase to phase voltages, it is possible to continue operating either system in a faulted condition. However, the second line to ground fault occurring on one of the other two phases, will cause a double line to ground fault.

The fault current is very low for a single line to ground fault in the ungrounded system allowing continuous operation but also making fault detection difficult. In this work a method of ground fault detection using wavelets is introduced. The ground fault conditions will be simulated using MATLAB/SIMULINK and also the fault detection will implemented using Symlets Wavelets.

Tremendous Benefits

More electric architecture will have the following benefits.

1. Reduced weight and fuel consumption.
2. Require less maintenance, resulting in a more efficient and cost-effective aircraft.
3. Have increased reliability.
4. Reduce the cost of operation and ownership

The aim of this project is early detection and phase identification during the fault in an Ungrounded Aircraft power system. To reach this aim, the following sub aims have to be realized.

1. Understand the different grounding methods deployed for the Industrial power systems.
2. Simulate the Ungrounded Aircraft power system model in MATLAB/SIMULINK.
3. Understand the basic theory of wavelets.

Analyze the AC line currents with Wavelets through MATLAB Programming.

Factors Influencing the Choice of Grounded or Ungrounded System. Following are the Factors affecting the Choice of System Grounding.

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1. Service Continuity
2. Multiple Faults to Ground
3. Arcing Fault Burn downs
4. Location of Faults
5. Safety

Abnormal Voltage Hazards

II. GROUNDED AND UNGROUNDED SYSTEM

Accidental contact of line to structure would not create an electric fault, provided the system and all components remain above structure potential. Positive and negative conductors can be run close together and twisted, if necessary, to reduce electromagnetic interference. Electrolytic action between various materials in areas of high current concentration is reduced or eliminated. Better circuit connections are probably possible by making connections wire-to-wire in lieu of wire to- structure, since structure finish or paint must he removed. Variations in sensitive circuits caused by differential voltage on the structure are eliminated. Methods of System Grounding as shown in Fig.2.

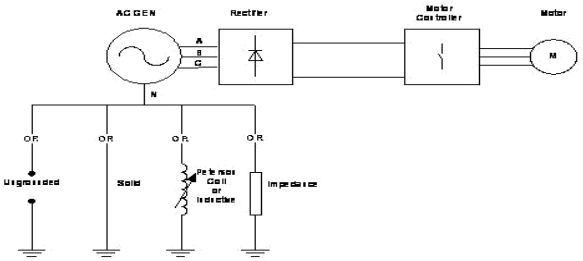


Fig.2. Grounded and Ungrounded System

The System Neutral can be grounded, Effectively- Solid Grounding and Non-Effectively Grounded.

1. Resistance Grounding
- Low Resistance Grounding(If=400A)
- High Resistance Grounding(If=10A)

2. Reactance Grounding
- Resonant Grounding

.

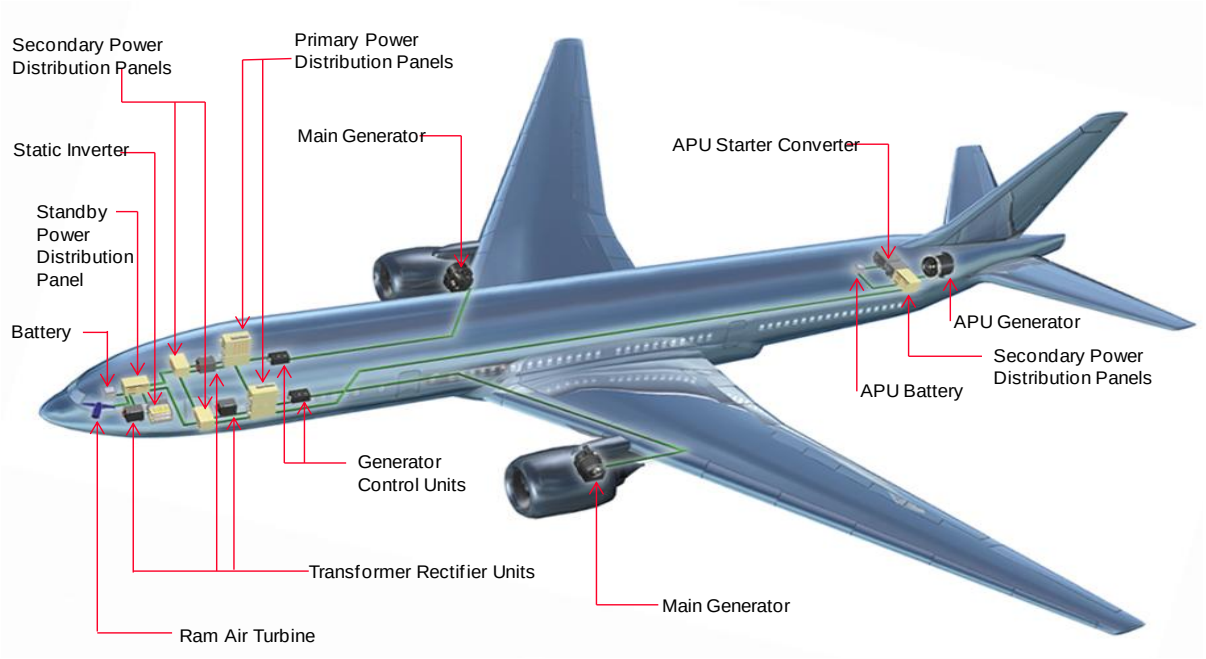
III.AIRCRAFT OVERVIEW - UNGROUNDED AIRCRAFT ELECTRICAL POWER SYSTEM

Electrical Power generating system (EPGS) architectures using 270Vdc distribution have been studied to various depths by several Organizations. Cursory analyses indicates an EPGS distribution system weight savings due to two wires for 270Vdc rather than three or four wires for the typical 115V , 400Hz ac systems.

Significant weight savings in utilization equipment is realized due to elimination of individual ac-dc conversion through the use of centralized ac-dc converter in the generating system.

A. System Architecture

The system is distinguished as “Grounded” and “Un-grounded” depending upon whether the neutral point of the generator is connected to ground or not. MATLAB version 7.1.0.246(R14) Service Pack 3 and Simpower and Signal Processing Block sets are planned to use in this Project work. Fig3 and 4 shows the electric power in aircraft system and overview of aircraft system.



EP Location In Generic Aircraft

Fig.3. Electric power Location in Generic Aircraft

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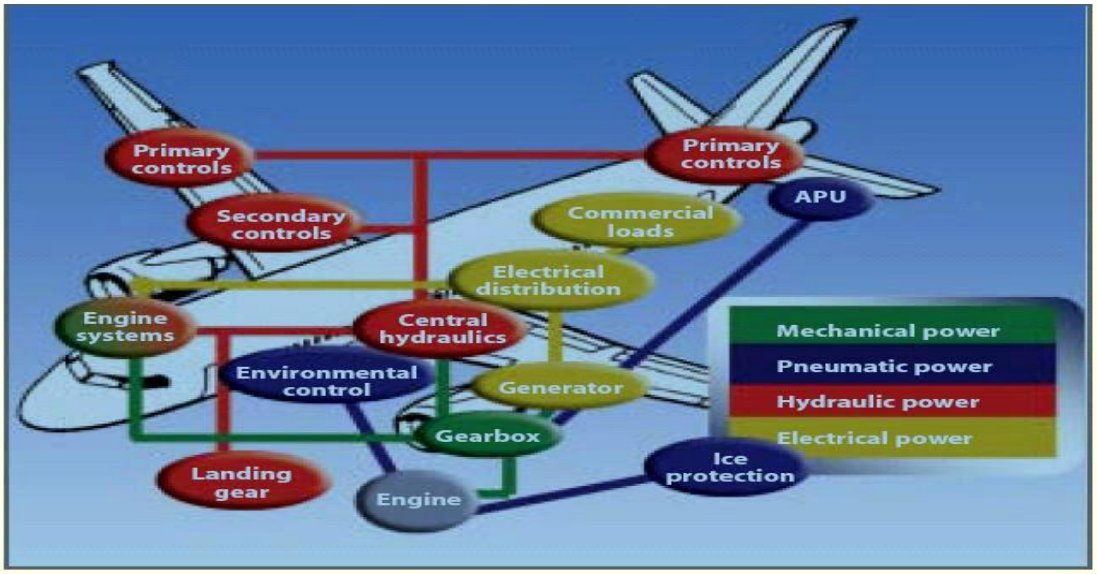

Fig.4. Aircraft overview

IV. CONCLUSION

Thus Aircraft Electrical Systems demand extremely high reliability and safety. Rapid detection and location of the first ground fault is important for the Ungrounded Aircraft power system to isolate the faulted circuit and thus avoid cross country faults which further adverse the conditions. In this work discrete wavelet transform is applied to the Aircraft Power system for detection of faults in an Ungrounded AC system using Symlet as mother wavelets.

It will be shown that wavelet analysis can be used to detect line to ground faults for early detection of lint to ground fault and line to line faults. Since the analyzing functions are localized in time and frequency, wavelet analysis offers important advantages over Fourier methods for power signals containing high frequency transients. Wavelet analysis is an important tool that should be further investigated and developed by power engineers. The most obvious area for future work in this thesis is to implement the digital design in a DSP Processor/FPGA with supporting circuitry on a PCB.

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