航空学报 » 2009, Vol. 30 » Issue (4) :706-712 DOI:

论文

基于时域反射法的航空导线绝缘故障检测与分析

张俊民[1]，魏娟[1]，谢华博[1]，曹大树[2]，姚红宇[2]

1.北京航空航天大学 自动化科学与电气工程学院 2.中国民用航空总局 航空安全技术中心

Detection and Analysis of Aerospace Wire Insulation Faults Based on TDR

Zhang Junmin[1], Wei Juan[1], Xie Huabo[1], Cao Dashu[2], Yao Hongyu[2]

1.School of Automation Science and Electrical Engineering, Beijing University of Aeronautics and Astronautics 2.Center of Aviation Safety Technology of China, General Administration of Civil Aviation of China

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摘要 基于时域反射法（TDR）建立了航空导线绝缘故障的数学模型及相应的仿真模型，计算与分析航空导线的绝缘层沿径向发生变化时其特征阻抗及反射系数的变化规律，仿真研究了脉冲波和阶跃波在导线中的传播规律，试验研究了导线特征阻抗的变化以及入射波上升时间对TDR波形的影响。结果表明:随着绝缘损坏量的增加，反射系数的变化率加快；对于相同的绝缘损坏量，绝缘层薄的导线反射系数大，易检测出来；在故障检测中阶跃波优于脉冲波；短路故障容易确定；特征阻抗降低到一定程度时，绝缘故障才能从TDR波形上辨别出来。对于小范围的绝缘故障检测，入射波上升时间越短，TDR波形越能反映故障的特征，但反射脉冲变窄，要求高采样频率；入射波上升时间增长，反射脉冲变宽，幅值降低，但一定程度上有利于检测出绝缘故障。

关键词： 航空导线 时域反射法 绝缘 入射波上升时间 特征阻抗

Abstract： A mathematic model of aerospace wire insulation faults and its corresponding simulation model are presented based on time domain reflectometry (TDR) in this article. The characteristic impedances and reflection coefficients are calculated as they vary with the insulation thickness of aerospace wires. Transmissions in a wire are simulated for pulse wave and step wave respectively. The influences of characteristic impedance of a wire and the rise time of incident wave on TDR are studied experimentally. The results show that the rate of reflection coefficient increases with the increase of frayed wire insulation. For the same amount of insulation frayed among the wires, the reflection coefficient of thin insulated wire is larger and its insulation fault is easier to detect than that in other wires. Step wave is better in TDR than pulse wave. Short circuits can be easily found on TDR wave. But the detection of insulation fault by TDR wave is difficult unless the characteristic impedance of a wire is reduced to a certain value. For the detection of small insulation faults of a wire, the shorter the rise time of incident wave is, the more the TDR wave reflects the fault characteristics, but the sampling frequency must be high due to the narrowed reflection pulse. The width of the reflection pulse is increased and its amplitude reduced as the rise time of incident wave delays, which may to some extent be good for the detection of insulation faults.

Keywords： aerospace wire time domain reflectometry insulation rise time of incident wave characteristic impedance

Received 2008-01-20; published 2009-04-25

Corresponding Authors: 张俊民

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Zhang Junmin;Wei Juan;Xie Huabo;Cao Dashu;Yao Hongyu. Detection and Analysis of Aerospace Wire Insulation Faults Based on TDR[J]. Acta Aeronautica et Astronautica Sinica, 2009, 30(4): 706-712.