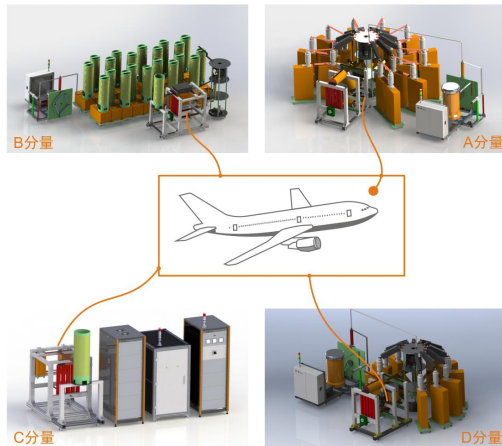


Lightening direct effect test system

LCG 464C



As per

- > MIL-STD-464C
- > SAE ARP5412
- > RTCA / DO - 160G
- > HB 6129 - 1987
- > GJB 3567-1999

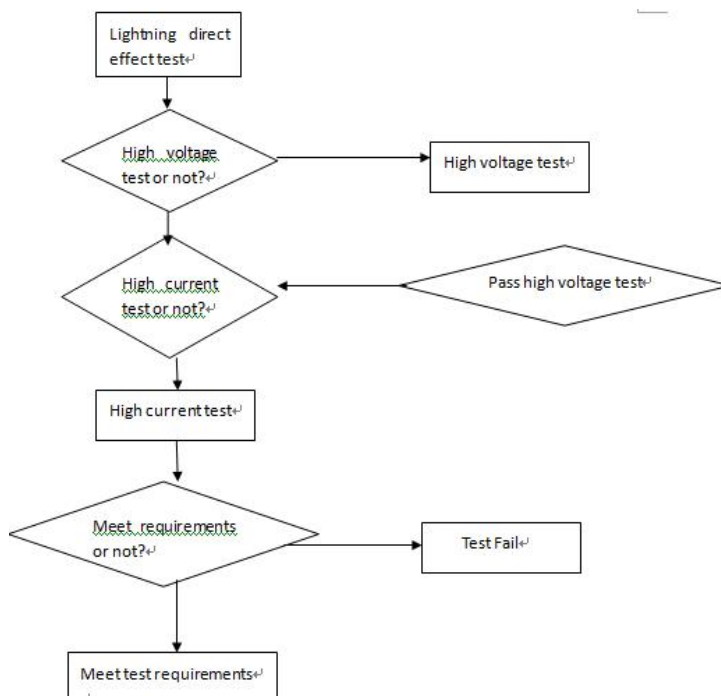
Summary

Aircraft is vulnerable to lightning direct adhesion in severe convection weather, which will produce over temperature, high voltage and strong electromagnetic force to cause the aircraft to be on fire, corrosion, explosion, structure distortion and strength reduction, etc. The lightning direct effect test system our company independent research and develop is a very complicated pulse current test system, mainly used in lightning direct effect tests for system, components and materials as per national military standards like GJB1389A,GJB3567, also American military standards MIL-STD-464C, ARP5412 and DO160 section23, etc. This system can be used for aircraft, aerospace materials, naval ships, missile, military vehicles and radar.

This lightning direct effect test system includes high voltage attachment points partition test system and high current physical damage test system. High voltage attachment points partition test system can simulate the possibility that equipments like aircraft are lightning attacked in different areas on the surface of aircraft and find the attachment points which are vulnerable to lightning attack. High current physical damage test system can be used to simulate the damage effect of aircraft structure caused by the over temperature and strong electromagnetic force which are produced when the attachment points are suffered to high current.

Lightning test flow chart

This system can be configured according to customers test requirements and provide full test solutions.



High voltage attachment points partition test system

This system is composed of three parts including high voltage generator, waveform regulation unit and control measurement system, four kinds of waveforms A, B, C, D are output by regulating different waveform regulation units, meet MIL-STD-464C , DO160 S23 and other standards about direct lightning high voltage test, also used for other similar lightning and withstand voltage tests and research.

Waveform parameter definition

According to MIL-STD-464C and SAE ARP5412, etc, four voltage waveforms shown as below:

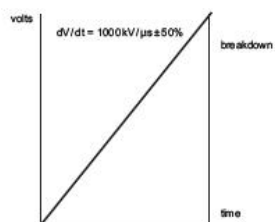


FIGURE 5 - VOLTAGE WAVEFORM A

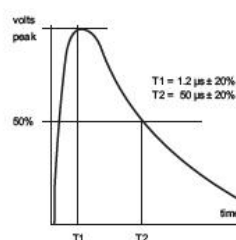


FIGURE 6 - VOLTAGE WAVEFORM B

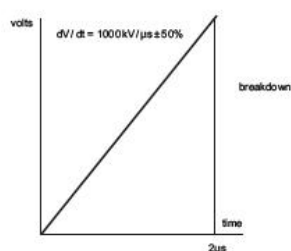


FIGURE 7 - VOLTAGE WAVEFORM C

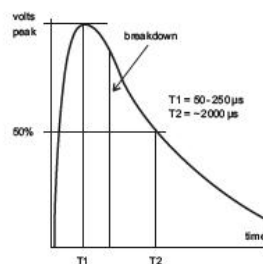


FIGURE 8 - VOLTAGE WAVEFORM D

Requirements:

A component rising slope: 1000 (-0+50%) kV/μs, rising stop when test device breakdown or flashover and turn to zero. If no flashover for test device, there is no regulation for the waveform drop.

B component open circuit voltage waveform with rising slope: 1.2μs (±20%) and duration: 50μs (±20%)

C component the voltage waveform cut off at 1.2μs, no requirements for rise time and peak value.

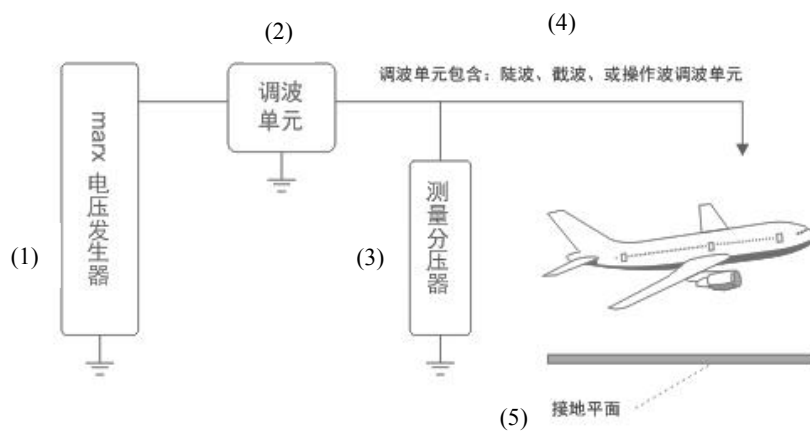
D component open circuit voltage waveform with rising slope: 50-250μs and duration: > 2000μs. The waveform is used for testing the time characteristic, when the waveform is used for the analysis of lightning attachment area probability, the conclusion is higher than the actual value (please see GJB3567 5.1.1.3).

Technical parameters and features

Technical parameters of LVG3000				
Output waveform	A waveform	B waveform	C waveform	D waveform
Front time	1000 (+500) kV/μs	1.2μs±20%	2μs±20%	50-250μs
Decay time	--	50±20%	--	大于 2000
peak efficiency	> 90%	> 90%	> 80%	> 60%
Charging voltage	200kV (two-side charging)			
Levels	15			
Discharging switch	copper ball , three-gap ignition			
Switch type	linear driving 0 ~ 100mm adjustable, accuracy 0.1mm			
Waveform shaping	Form a long wave tail by Crowbar feedback circuit			
General data				
Power supply	AC220V 100A			
Charging voltage	20 ~ 200kV			
Polarity	+/-			
Voltage measurement	Damped voltage divider			
Features:				

● LVG 3000 with open style main circuit design and H shaped tower structure to achieve a compact size
● Artistic and simple appearance
● parallel charging and series discharging by Max generator
● Automatically adjust ball gap distance within the charging voltage, 0.1mm resolution adjustable
● Automatic safety protection procedure, audible and visual alarm

High voltage attachment points partition test diagram:



(1)Max voltage generator

(2)Regulation waveform unit

(3)Measurement voltage divider

(4)Regulation waveform unit includes steep slope, chopped wave or operation wave

(5)Grounding plane

High current injection system

Summary

Aircraft is vulnerable to lightning direct adhesion in severe convection weather, which will produce over temperature, high voltage and strong electromagnetic force to cause the aircraft to be on fire, corrosion, explosion, structure distortion and strength reduction, etc. The aircraft lightning protection test system researched and developed independently by 3ctest is a very complicated pulse current test system, fully meets American military MIL-STD-464C, SAE ARP5412 and DO160 section23, the direct adhesion lightning area of the aircraft should bear the continuous waveforms composed of A, B, C and D, this system includes four pulse current generators.

Feature

- Six waveforms generated by four generators
- Charging polarity automatic switching by using rotating mechanism
- Electrical safety interlock, automatic short circuit capacitor and protect personal safety
- Non-gap Crowbar feedback circuit, waveform without oscillation
- Optical isolation of control signal between control and itself
- Every generator used independently with independent control system
- Many test modes can be programmed freely, meet kinds of test waveform requirements within test range
- Centralized control system can operate four generators and complete the test with one key
- High voltage switching by using multi-way air-operated units, waveforms switching over automatically

As per

- > MIL-STD-464C
- > SAE ARP5412
- > RTCA / DO - 160G
- > HB 6129 - 1987
- > GJB 3567-1999

About Waveforms

Test waveforms include 6 waveforms: A, A_H, B, C, C* and D, shown as below:



Component A: peak current $200\text{kA} \pm 10\%$, action integral $2 \times 10^6 \text{A}^2 \cdot \text{s} \pm 20\%$ (within $500\mu\text{s}$), rise time (10%-90% before peak) $\leq 50\mu\text{s}$, decay to 1% of peak wave $\leq 500\mu\text{s}$. Current could be one-way or oscillatory.

Component A_H: peak current $150\text{kA} \pm 10\%$, action integral $0.8 \times 10^6 \text{A}^2 \cdot \text{s} \pm 20\%$ (within $500\mu\text{s}$), rise time (10%-90% before peak) $\leq 37.5\mu\text{s}$, decay to 1% of peak wave $\leq 500\mu\text{s}$. Current could be one-way or oscillatory.

Component B: current amplitude average $2\text{kA} \pm 10\%$, max. electric charge $< 10\text{C} \pm 10\%$, duration $\leq 5\text{ms}$. Current could be one-way square wave or replaced by exponential current or linear decay current.

Component C: current amplitude $200\text{-}800\text{A}$, electric charge $200\text{C} \pm 20\%$, duration $0.25\text{-}1\text{s}$. Current could be one-way square wave or replaced by exponential current or linear decay current.

Component C*: current amplitude average $\geq 400\text{A}$, duration = dwell time of combination wave $\geq 5\text{ms}$. Duration of combination wave: $1\text{-}50\text{ms}$. Current could be one-way square wave or replaced by exponential current or linear decay current.

Component D, peak current $100\text{kA} \pm 10\%$, unidirectional current or oscillatory current, rise time (10%-90% before peak) $\leq 25\mu\text{s}$, decay to 1% of peak $\leq 500\mu\text{s}$, action integral $0.25 \times 10^6 \text{A}^2 \cdot \text{s} \pm 20\%$ (within $500\mu\text{s}$).

MIL-464C/DO-160G Section 23 Aircraft lightning protection system configuration:

This lightning system includes 5 set control system, 1 set measurement analysis system, 4 generators used to produce four components A, B, C, D, communication among generators by industry field bus to achieve independent experiments for 4 generators and centralized total control function.

Generator A and D use non-gap self-adaption Crowbar units, for non-gap Crowbar switch, there is no need to trigger by impulse voltage generator, no need to ignite by secondary delay control, it is a real self-adaption trigger. For non-gap switch, the noise is reduced greatly and the output reliability of equipments is improved.





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