



ENVIRONMENTAL TEST LAB CAPABILITIES

APPAREO



OVERVIEW

Appareo is a recognized leader in the custom design, development and manufacture of innovative electronic products for original equipment manufacturers, as well as direct-to-market consumer products.

Headquartered in Fargo, North Dakota with satellite facilities in Paris, France and Tempe, Arizona, Appareo delivers turn-key solutions through concept, engineering, manufacturing, sales, and support.

Appareo has extensive design and test laboratories at its Fargo headquarters. Engineers have complete access to electronics test equipment and a full suite of RF test equipment, including network analyzers, spectrum analyzers, GPS simulators, and waveform generators. Engineering labs include prototyping capabilities and 3D printing.

The test laboratory is fully equipped with RF test chambers, environmental chambers, vibration and shock test capabilities, along with electrical transients and other test equipment. Experienced test engineers and technicians are focused on environmental, system performance, software, and field testing with the capability of developing custom test environments. Tests are performed according to internationally recognized standards governed by RTCA, SAE, ISO and others.

The mission of test engineering is to give our customers confidence in their products with innovative, world-class testing.



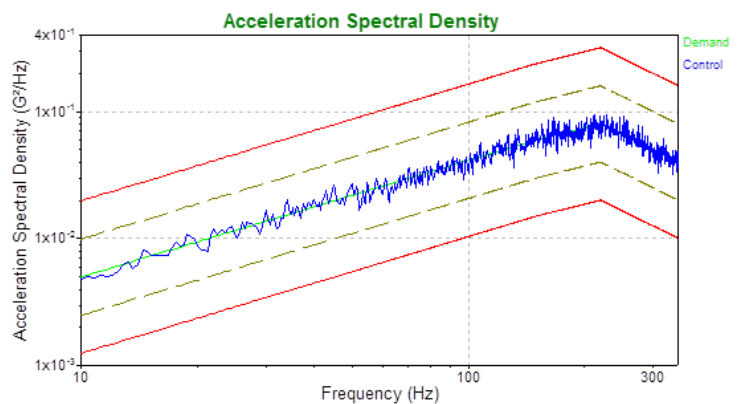
VIBRATION AND SHOCK

Equipment	Capabilities
ETS Solutions MPA403/M124M/GT600 Shaker and Table	2200 lbf max (4400 lbf shock), 100 g max acceleration (sine), DC to 4000 Hz freq. range, 2.0" max displacement
Vibration Research VR9500 Controller	26000 Spectral Lines, 100 dB dynamic range

Test Type	Standards Performed
Sinusoidal Vibration	ISO 15003 Section 5.6.2 ANSI/ASAE EP455 Section 15.15.2 DO-160G Section 8.0
Random Vibration	ISO 15003 Section 5.6.1 ANSI/ASAE EP455 Section 15.15.1 IEC 60068-2-64 DO-160G Section 8.0
Mechanical Shock	ISO 15003 Section 5.5.2 ANSI/ASAE EP455 Section 15.14.1 IEC 60068-2-27 DO-160G Section 7.2



Device mounted on shaker table for testing

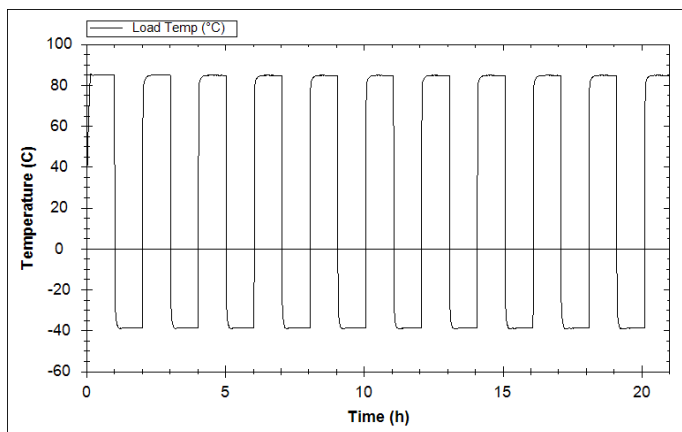


Example acceleration spectral density curve for random vibration

TEMPERATURE AND HUMIDITY

Equipment	Capabilities
Thermotron ATSS-30-2-2	Thermal Shock, -73 to 215 C Temperature Range
Thermotron SE-600-15-15	Temperature/Humidity, ~20.8 C/min heating rate, 13.8 C/min cooling rate
Thermotron SE-600-5-5	Temperature, ~11 C/min heating rate, 5 C/min cooling rate
Thermotron SM-8-8200	Temperature/Humidity, ~7.8 C/min heating rate, 3.4 C/min cooling rate

Test Type	Standards Performed
Thermal Shock	ISO 15003 Section 5.2.2 MIL-STD-202G (Method 107G)
Storage Temperature, Temperature	ISO 15003 Section 5.2 IEC 60068-2-30 ANSI/ASAE EP455 Section 5.1.2 DO-160G Section 4.0
Humidity	ISO 15003 Section 5.3 ANSI/ASAE EP455 Section 5.13.1 DO 160G Section 6.0
Combined Environment	ISO 15003 Section 5.3 IEC 60068-2-30



Thermal shock test data



Thermal shock chamber

OTHER ENVIRONMENTAL

Equipment	Capabilities
Immersion Tank	One meter immersion
Weice WTS90 Salt Fog Chamber	1.0 to 2.0 mL per hour per 80 cm ² per hour deposition rate
Dust Chamber	Vacuum control, dust suspension through air nozzles or fans
Altitude Chamber	-2000 to 55000 ft, ambient to 100 °C temperature range
Rate Table	2-axis, up to 480 degrees/s rotational speed, less than 1% rate and 50 arc seconds positional error, -55 to 85°C liquid CO ₂ temperature control
Rainfall and Water Spray Chamber	~1 mm/min rainfall deposition rate 1 rev/min rotation rate 12.5-100 l/min spray flow rates

Test Type	Standards Performed
Immersion	IEC 60529
Salt Fog/Spray	DO-160G Section 14.0 ASTM B117
Dust Ingress	IEC 60529 DO-160G Section 12.0
Altitude	DO-160G Section 4.6.1, 4.6.2 ISO 15003 Section 5.9
Rainfall and Water Spray Chamber	IEC 60529 DO-160G Section 10.3.2

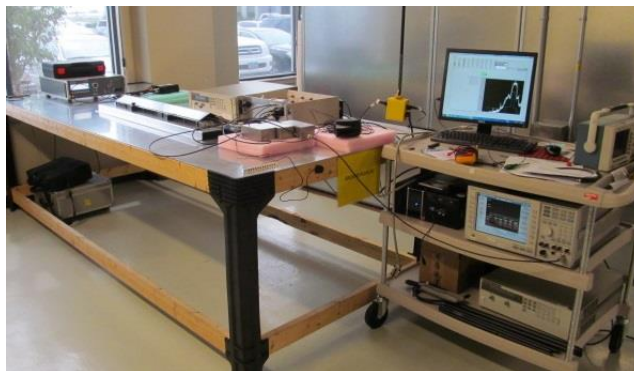


Salt fog chamber

ELECTRICAL AND ELECTRICAL TRANSIENTS

Equipment	Capabilities
EMTest UCS200N Transient Simulator	Programmable, pulses conform to ISO 7637
Solar Electronics Spike Generator 7054-1	10 to 600 V, adjustable repetition rate
Solar Electronics Type 2201-2 Pulse Transformer	Creates 50 ohm impedance up to 600 V
Techron 7560 Power Amplifier	DC to 40 KHz range, 1000 Watts
Agilent 33120A Function Generator	15 MHz bandwidth, arbitrary waveform capability
Schaffner NSG 438 ESD Simulator	Air/Contact discharge, 200 V to 30 kV
Load Dump Generator	Clamped or unclamped pulses up to 100 V peak
Solar 9354-1 Lightning Generator	Waveforms 3A, 4, 5B, Levels 1-5, various levels

Test Type	Standards Performed
Electrostatic Discharge (ESD)	DO-160G Section 25.0 ISO 10605
Electrical Transients	ISO 16750 ISO 7673 DO-160G Sections 17.0-19.0 ANSI/SAE EP 455 Section 5.11
Operating Voltage/ Short Circuit	ISO 15003 Sections 5.14.1-5.14.4 DO-160G Section 16.0 ANSI/SAE EP455 Section 5.10
Lightning Induced Transient Susceptibility	DO-160G Section 22.0

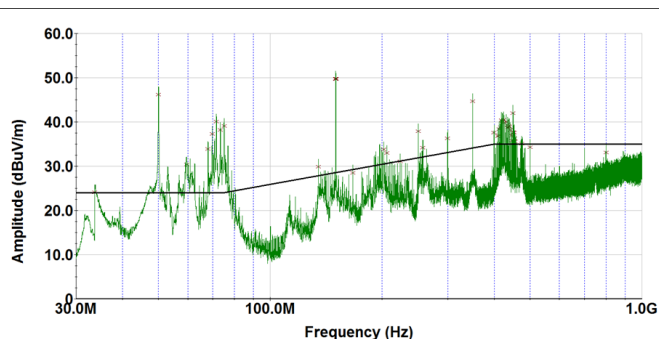


Ground plane set up for mutual coupling test

ELECTROMAGNETIC COMPATIBILITY

Equipment	Capabilities
Keene RF Chamber	Up to 30 V/m field strength, emissions measurements up to 18 GHz
TDK FAC-3 RD Chamber	Up to 30 V/m field strength, emissions measurements up to 18 GHz
ETS-Lindgren 5411 GTEM Cell	Up to 100 V/m field strength, emissions measurements up to 5 GHz
Parallel Plates Apparatus	For AC electric fields susceptibility, up to 30 kV/m
Stripline Apparatus	10 kHz to 400 MHz, up to 220 V/m

Test Type	Standards Performed
Radiated Susceptibility/ Immunity	DO-160G Section 20 ISO 14982/11452/11451 ANSI/ASAE EP455 Section 5.16.4 SAE J1113-26
Conducted Susceptibility/Immunity	DO-160G Section 20 ISO 14982/11452/11451 SAE J1113-4
Radiated Emissions	DO-160G Section 21.0 ISO 14982 CISPR 25
Conducted Emissions	DO-160G Section 21.0 ISO 14982 CISPR 25 SAE J1113-41



Radiated emissions data



ETS-Lindgren 5411 GTEM Cell

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APPAREO

FARGO | TEMPE | PARIS

AS9100D/ISO9001:2015 certified