



ELECTRICAL TEST APPLICATIONS  
IN THE **AEROSPACE** INDUSTRY



[www.mktest.com](http://www.mktest.com)

## OVERVIEW

In the aerospace industry, production and equipment testing is an essential and, in many cases, mandatory element of the manufacturing and servicing cycle. The aim of many OEMs and MROs is to have equipment that both speeds up the process and provides additional guarantees of the equipment's reliability.

MK Test has been working within the aerospace industry for over 20 years and in that time has developed electrical test equipment, procedures and measurement standards that have supported a number of the industry's leading manufacturers, suppliers and MROs. This includes Airbus and Boeing, the world's leading aircraft manufacturers.

The applications developed by the MK Test team has produced a number of significant production and test results for many customers – for instance, reducing engine inspection and testing from two weeks to less than four minutes, or a harness test reduction from five

hours to less than three minutes, and the development of a test program in less than four minutes when previously it took up to 16 weeks.

There are very few elements on an aircraft that doesn't require comprehensive electrical testing and MK Test has been at the forefront of this. Our system's test electrical harnesses, distribution cabinets, equipped aircraft sections, wings, fuselage wiring and complete aircraft wiring on the final assembly line. Take a look at the applications overleaf which will provide a flavour of MK Test's application expertise.

**Further information can be obtained by visiting our website or sending in an enquiry to the MK Test team at [info@mktest.com](mailto:info@mktest.com). Alternatively, just give the team a call on +44 (0)1823 661100.**

## KEY APPLICATION AREAS

- 1 Aircraft engine test capabilities
- 2 Cable harness testing
- 3 Connector testing
- 4 Equipped assembly and function testing
- 5 Final assembly line (FAL)
- 6 Ground bond, loop & joint testing
- 7 High current bond test
- 8 Slip ring testing
- 9 Test management software



## 1 AIRCRAFT ENGINE TEST CAPABILITIES

This involves the automatic testing of electrical harness and components on engine or in the harness shop and automatic testing of electrical bond circuits, earth straps and shielded cables on engine.



## **AUTOMATIC HARNESS TESTING INCLUDES:**

- ✓ Continuity resistance
- ✓ Short circuit test
- ✓ High voltage insulation resistance test
- ✓ High voltage Hipot test
- ✓ Function test of relays, diodes, solenoids, sensors
- ✓ Automatic recording of all test results

## **TEST MANAGEMENT SOFTWARE:**

MK Test's easy-to-use, intuitive test management software provides customers with an ability to run test programs without the need for programming expertise. Our APG Automatic Program Generation is included in the MKAT test management software as standard which allows the user to re-map fields and use their existing data formats. See section 9 page ?? for further information.

“There was a reduction of inspection and test phase from two weeks to less than four minutes.”

### **Result**

There was a reduction of inspection and test phase from two weeks to less than four minutes. This customer improved turnaround time by an average of five days per engine.

## **AUTOMATIC ELECTRICAL EARTH BONDING TEST INCLUDES:**

- ✓ Earth bond LOOP resistance test
- ✓ Earth bond JOINT resistance test
- ✓ Structural earth bonding resistance test
- ✓ Automatic recording of all test results

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## **APPLICATION AND BENEFIT EXAMPLE**

A leading aircraft engine manufacturer had the following test process issues:

### **Result:**

A 32-man hour testing time was reduced to four hours and there was full traceability on all tests.

## **APPLICATION AND BENEFIT EXAMPLE:**

A leading aircraft MRO had a number of test process issues which affected engine testing and production.

### **Situation**

Electrical harness and components were stripped off the engine and sent to a component and harness shop for inspection and test. Testing was carried out manually and the results of the inspection was taking more than two weeks. This was seriously affecting the turnaround time (TAT) of engines.

### **Solution**

By using the MK D1500 engine test system, multiple models and variants of engine were tested with a single system. Once the system was connected to the engine harness, the test was completed within less than four minutes and a test report automatically generated. Any failures were clearly reported together with the nature of failure. The mobile system was used to test on-engine and in the harness shop.

### **Situation**

Engineers testing in different ways which was impacting test result conformity. Testing was taking too long with manual (pen and paper) data capture introducing test data errors. As a result, full traceability was not in place.

### **Solution**

Using the MK test solution ensured all engineers carried out the test in the same way, through an on-screen test guide. This reduced a two-engineer process to a single-engineer process and reduced testing times by 80%. Automate test result data capture and uploads test results on completion Ensure full traceability and test data integrity.

### **Tests required:**

- ✓ 171 Loop resistance measurements
- ✓ 692 Joint resistance measurements
- ✓ 82 Bond resistance measurements

This involves the automatic testing of electrical harnesses and assemblies.



### AUTOMATIC HARNESS TESTING

- ✓ Continuity resistance test and measurement
- ✓ Short circuit test
- ✓ High voltage insulation resistance test at voltages 500VDC to 15000VDC
- ✓ High voltage Hipot test at voltages 500VAC to 8500VAC
- ✓ Function test of relays, diodes, solenoids, sensors
- ✓ Automatic recording of all test results
- ✓ Available in portable and rugged format

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### PORTABLE

MK Test systems are available in rugged and portable format. They are weather resistant and lightweight providing simplicity for a one person carry one person test requirements.

### APPLICATION AND BENEFIT EXAMPLE

A leading aircraft harness manufacturer was considering introducing automatic testing into a traditional process.

#### Situation

The customer was building complex harnesses, of up to 600 connections, and testing manually. Continuity testing was taking two hours and was a simple "bell out" test with no measurement record. No short circuit test was carried out (a true short test would require 360000 "bell out" measurements).

The high voltage test was incomplete and taking over three hours. It was taking over five hours to achieve an incomplete test, with no digital record, and not compliant with aircraft manufacturing standards.

#### Solution

By using the MK D1500 automatic harness test system, test programmes were created automatically using the MK APG (Automatic Program Generation) and the test system carried out a complete continuity resistance measurement, short circuit test and high voltage insulation test of 100% of the wires.

#### RESULT:

This reduced inspection and test phase from 5 hours to 146 seconds per harness. The test was 100% complete and compliant, eliminating the risk of shipping defective product. The test system automatically generated a full test report and logs all measurements thereby guaranteeing traceability.

## 3 CONNECTOR TESTING

This involves the automatic testing of electrical connector assemblies.



### **AUTOMATIC CONNECTOR TESTING INVOLVES:**

- ✓ 4-Wire (Kelvin) continuity resistance measurement
- ✓ Low voltage isolation test
- ✓ Capacitance measurement
- ✓ High voltage insulation resistance test up to 500GΩ
- ✓ High voltage Hipot test at voltages 500VAC to 8500VAC
- ✓ Automatic recording of all test results

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### **APPLICATION AND BENEFIT EXAMPLE**

A manufacturer of high specification electrical connectors approached MK Test Systems with a requirement to improve their test processes.

#### **Situation**

The customer was testing by hand using traditional two-point test instruments and only testing batch samples. Measurement process and results were not precise enough or controlled. Of importance, a number of quality escapes had occurred.

#### **Solution**

By using the MK F3500 automatic 4 wire (Kelvin) test system, test programmes are created automatically using the MK APG (Automatic Program Generation) and the test system carries out a range of precision measurements on every connector produced.

Tests include contact resistance, insert capacitance and high voltage insulation at 3000VDC measuring up to 100GΩ. 100% of connectors are tested and all faults are quickly identified, eliminating quality escapes.

#### **RESULT:**

Elimination of quality escapes and improved customer satisfaction. The R&D department is now using the same test system in the development of improved product.

This involves the automatic testing of electrical assemblies and active components.



#### EQUIPPED ASSEMBLY & FUNCTION TESTING INVOLVES:

- ✓ Function test of relays, diodes, solenoids, sensors, actuators, contactors, lamps
- ✓ Continuity resistance test and measurement
- ✓ Short circuit test
- ✓ High voltage insulation resistance test at voltages 500VDC to 15000VDC
- ✓ High voltage Hipot test at voltages 500VAC to 8500VAC
- ✓ Automatic recording of all test results

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#### APPLICATION AND BENEFIT EXAMPLE:

A manufacturer of electrical management power and signal distribution cabinets was experiencing quality escapes and consequently, shipping faulty product. The faults were being discovered by their customer during final test.

#### Situation

The customer was building power management cabinets consisting of electrical harnesses and a wide array of components including relays, contactors, LEDs, lamps and circuit breakers. The harnesses were tested prior to install, components were assumed to be good as they were received with a certificate of conformity. Once the cabinet was built, no further testing was carried out until it was integrated into the vehicle and systems failed to function. This created major reputational issues for the supplier and production delays for the end customer.

#### Solution

By using the MK M2500 Multibus automatic harness and function test system, test programmes are created automatically using the MK APG (Automatic Program Generation) and the test system carries out a complete circuit continuity, high voltage insulation and component function test.

The test system tests all active components and guides the operator to switch breakers, switches and manual components. Faults are clearly reported and quickly corrected. The completed cabinet is 100% function tested, eliminating costly and embarrassing failures.

#### RESULT:

Reduction of quality escapes and faults found after delivery, resulting in an improved supplier relationship and reputation, and increased order book.

## 5 FINAL ASSEMBLY LINE (FAL) TESTING

This involves the automatic testing of complete aircraft, rail cars and vehicles.



### **AUTOMATIC TESTING AT THE FAL FINAL ASSEMBLY LINE INVOLVES:**

- ✓ High speed continuity resistance measurement
- ✓ Low voltage isolation test
- ✓ Capacitance measurement
- ✓ High voltage insulation resistance test at voltages 500VDC to 15000VDC
- ✓ High voltage Hipot test at voltages 500VAC to 8500VAC
- ✓ Active XRef random hookup (connect interface cable anywhere on the system)
- ✓ Up to 256000 test points per system
- ✓ Distributed switching to reduce interface cabling
- ✓ Compact switching satellites for use in tight spaces
- ✓ Active LRU format switching modules for direct interface to avionics cabinets
- ✓ Automatic recording of all test results

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### **APPLICATION AND BENEFIT EXAMPLE:**

A French fighter aircraft manufacturer, a long-term user of existing automatic harness testing equipment, carried out a strategic bench-marking exercise of test equipment for use on their latest generation aircraft project.

#### **Situation**

The customer had been using automatic testing for many years, but the system was difficult to use. Test program creation was complex requiring specialist programmers, and fault reporting and diagnosis was basic and provided little guidance to operators.

**“Test program creation has been reduced from 16 weeks (manual programming) to 90 seconds.”**

#### **Solution**

By using the MK D1500 automatic test system, test programmes are created automatically and rapidly, using the MK APG (Automatic Program Generation) from the customer's existing design data in existing data formats.

Operators are guided through the test and when faults are found they are reported and highlighted clearly. The nature and location of failures is diagnosed, measurement results are logged and analysed to highlight repeat failures and trends.

### **RESULT:**

The test programs are created using latest revisions of design data so for the first time the customer was able to carry out 100% test of aircraft wiring. The fault diagnostics tools have resulted in dramatic improvements in efficiency and eliminated the test bottleneck.

The primary aim of electrical bonding on an aircraft or vehicle is to ensure a low resistance current path exists between electrically conductive parts, in order to allow fault current and lightning strike current to be routed safely to electrical ground. Composite aircraft particularly rely on effective bonding paths to prevent localised heating at high resistance joints and the potentially catastrophic delamination failures of composite aircraft materials.

MK Test Systems has worked with both Boeing and Airbus to develop a range of simple to use automatic portable bond, loop and joint resistance testing tools – the BLTU, BLRT and ExLRT.



### GROUND BOND, LOOP AND JOINT TESTING INVOLVES:

- ✓ Earth bond loop resistance test
- ✓ Earth bond joint resistance test
- ✓ Structural earth bonding resistance test
- ✓ Integrated computer and test management software

### TEST MANAGEMENT SOFTWARE:

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### APPLICATION AND BENEFIT EXAMPLE

A major manufacturing OEM needed a quicker and more repeatable way of testing bonds, loops and joints on aircraft wing structures.

#### Situation

A large number of measurements were required per wing (188 loop resistance measurements and 718 and resistance measurements) and this resulted in a long test time. The engineers making the tests were all testing in different ways which impacted upon test result conformity. They needed to ensure that they were all testing consistently and that all the required tests were completed. In addition, the testing routine meant that manual (pen and paper) data capture introduced test data errors and poor traceability.

#### Solution

By using the BLRT the engineers were able to follow a test sequence downloaded to the test equipment using the on-screen test guide, ensuring all the engineers tested in the same way. Test results are recorded automatically, with failures isolated to enable efficient retesting. Following a 100% pass the results are uploaded automatically. This ensures full traceability and test data integrity.

**“This solution reduced time-per-measurement, producing an overall efficiency gain of 66%.”**

#### RESULT:

The testing reduced a 32-man hour test time to 5 hours thereby speeding up the test process considerably. Data entry errors were eliminated, producing 100% accuracy. Engineers were also able to switch from test sequence to test sequence, and able to pick-up where they left off without confusion. This also allowed a shift change to not impact the testing.

The primary aim of electrical bonding on an aircraft or vehicle is to ensure a current path exists between electrically conductive parts, in order to assure low resistance electrical continuity. Composite aircraft rely on effective bonding paths to prevent heating at high resistance joints and the potentially catastrophic delamination failures of composite Aircraft materials.

The MK High Current Bond Tester is used to test critical electrical bonds between major aircraft structural elements.



#### HIGH CURRENT BOND TEST INVOLVES:

- ✓ Accurate micro-ohm measurement at currents up to 350A
- ✓ Test program can be automatically created from customer database
- ✓ Manual test program creation via MK test management software
- ✓ Operator logon ensures traceability
- ✓ Automatic accurate (Kelvin) measurement of volt drop and joint temperature (if required).
- ✓ Test results automatically captured, stored locally and uploaded to server/database via network
- ✓ Complete test carried out by one person
- ✓ Mobile rugged construction for shop floor environment
- ✓ Simple automatic calibration via built in software-controlled calibration tool

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#### APPLICATION AND BENEFIT EXAMPLE

A major manufacturing OEM needed a safer, faster and more repeatable way of performing high current bond testing.

##### Situation

The engineers performing the tests had to be specifically trained to operate a high current power source and perform accurate and mandatory volt drop measurements along the structure. Testing was unsafe and methods varied between operators, resulting in varying test results. Results were manually recorded.

##### Solution

By using the MK high current bond tester engineers were guided through the test sequence. Measurements were made automatically and consistently. Test current was controlled automatically and routed safely through the structure, enabling test to be carried out by a single operator. Pass or Fail analysis is automatic and test results can be uploaded automatically to guarantee traceability and variance analysis.

#### RESULT:

The High Current Bond tester provided a safer means of testing and consistently accurate results. The equipment proved to be more reliable than the old test equipment. Data entry errors were eliminated, producing 100% accuracy and compliance.

## 8 SLIP RING TESTING

The MK slip ring test system automates your testing process, offering isolation and insulation testing between rings, dynamic continuity resistance and noise measurement. Measurement results are delivered on test reports and a full oscilloscope trace can be shown. Time-base and trigger are fully programmable (dynamic resistance and noise).



### SLIP RING TESTING INVOLVES:

- ✓ Maximising efficiencies by automating the electrical test process
- ✓ 100% electrical test with minimal manual intervention
- ✓ High voltage isolation test between rings and groups
- ✓ Dynamic resistance measurement per ring and multiple rings
- ✓ Dynamic noise measurement per ring and multiple rings
- ✓ Test dynamic continuity resistance under rotation, to  $m\Omega$  accuracy.
- ✓ Automatic delivery of resistance measurement and noise trace results

### TEST MANAGEMENT SOFTWARE:

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### APPLICATION AND BENEFIT EXAMPLE:

A major manufacturer of slip rings needed a way to speed up testing and improve how diagnosis was performed.

#### Situation

The company was testing manually with an oscilloscope and Hipot tester. They were testing one ring at a time and analysing a trace on the oscilloscope. Fault diagnostics was difficult, and the complete test was massively time consuming.

#### Solution

By using the MK F3500 with SRT slip ring test module, the complete test was automated. The system measures isolation resistance between every ring at voltages up to 3500 VDC, measures and reports average dynamic resistance of every ring, and measures and reports electrical noise of every ring.

Measurement values are automatically reported and logged, dynamic resistance and noise values delivered as a trace. The test system interfaces with and controls a rotating motorised test fixture. All of this with zero manual intervention.

### RESULT:

The slip ring manufacturer was able to automate slip ring testing and test at higher voltages which were not possible with manual testing. This improved quality and significantly reduced testing times. The company is also benefitting from the ability to perform variance analysis.

Test management software controls the test system hardware and provides a program framework through which continuity and resistance, short circuits, high voltage insulation resistance in DC and AC, capacitance, and component stimulus can be checked.

Whilst MK Test prides itself on the robustness and reliability of our hardware, it is our MKAT (MK Automatic Test) Test Management Software which makes our systems stand out from our competitors.

The philosophy behind our software has, from day one, been to enable an engineer to create a test program without having to learn a programming language. Our software makes use of standard wiring input of Netlist, connection tables and interface adaptor tables to create test programmes. Tests are enabled or disabled by simple click of a button.

Test results and nature of failure descriptions are clear and graphical. The user can use a variety of diagnostic and retest tools to diagnose failure. Retest single failures, retest all failures, use the single point diagnostics tool or the probe function.

#### TEST MANAGEMENT SOFTWARE FEATURES AND BENEFITS:

- ✓ Easy to use
- ✓ Intuitive with no programming language requirement
- ✓ AutoLearn - automatically create test program from a known good harness
- ✓ One software tool for all applications in wire Harness Test and/or function test
- ✓ Set and adjust test parameters per test, per group, wire connection
- ✓ APG - automatically create test programs
- ✓ Customise the APG data import structure via the included field mapping tools
- ✓ Diagnostic tools and real-time retest for rapid fault analysis
- ✓ Automatic Mode & Single Point diagnostics test mode
- ✓ Set up operator prompts and Instructions throughout the test
- ✓ Set up user input prompts throughout the test
- ✓ Customise and reformat test reports

When used in combination with MK Test's Multibus test systems the Active APG tool provides world leading function test capability. Simple to use, powerful, flexible.

#### APG:

APG Automatic Program Generation is included in the MKAT test management software as standard.

MK Test's APG toolset allows the user to re-map fields and use their existing data formats. If you have a wiring schedule or connection table in electronic format you can set the APG tool to suit that format and import the table to automatically create a test programme.

If the assembly is made up of many connection tables (harnesses) connected together you can set the interconnect rules so that MK Test's APG knows what harnesses are connected and automatically creates an end-to-end test programme.

If you have active components in your assembly you can populate the MKAT component library. Now, when the APG tool sees a component in your imported connection table it will refer to the component library and automatically create a test programme that exercises and tests that active component.

APG should be the target of all users of automatic test systems. APG ensures rapid and correct creation of test programmes. APG allows the user to include late design changes by allowing import of latest connection tables. APG eliminates manual programming errors.

## ABOUT MK TEST SYSTEMS

MK Test Systems have been a leading manufacturer and supplier of automatic harness testing systems since 1991.

We have successfully delivered and implemented over 3000 electrical test systems into 34 countries and have built an enviable reputation for excellence in Automatic Test Equipment (ATE) solutions and the way in which we support our customers.

Many of the world's leading aerospace, defence, and rail companies rely on our systems every day of the week to test their products.

### ADDRESS DETAILS:

#### Global Headquarters

MK Test Systems.  
ATE House,  
26 Westpark, Chelston,  
Wellington,  
TA21 9AD,  
United Kingdom

Tel: +44 (0)1823 661100  
Fax: +44 (0)1823 661160  
Email: [sales@mktest.com](mailto:sales@mktest.com)

#### Regional Office - Americas

MK Test Systems - Americas  
22102 Pepper Road  
Lake Barrington  
Illinois 60010  
USA

Tel. +1 773 5693778  
Mob. +1 773 6961060  
Email: [sales@mktest.com](mailto:sales@mktest.com)

#### Regional Office – Asia Pacific

MK Test Systems - Asia Pacific  
Block 5 Emerald Villa  
328 Mong Tseng Tsuen  
Yuen Long, NT  
Hong Kong

Tel +852 93030048  
Email: [sales@mktest.com](mailto:sales@mktest.com)

For worldwide agents and distributors visit [www.mktest.com](http://www.mktest.com)