Practical Application of Flying Probe for Functional Test and Design Validation

Marco Barahmand
Director of European Business
Introduction to Flying Probe Technology

- What is a Flying Probe Test System
- Where does FP fit into the Test Cycle
- Robotic Movement Types and Implications
- Measurements you can do in a conventional Flying Probe
- Accessibility Gained by Flying Probe Systems
- Functional Test Implementation with Flying Probe system
What is a Flying Probe Tester

- A Flying Probe Tester is a test system which does not need a bed of nail test fixture.

- Four to twenty-two precision probes can move anywhere above the board under test and perform electrical tests.

- Probe placement precision is much better than any bed of nail probes. Targets can be as small as 4 mils (0.1mm) and a fiducial system automatically calculates board placement.

- A Flying Prober extends in-circuit and functional test benefits to applications where bed of nail is impossible to use (no access), too long to build (prototype) or too expensive to justify (high mix/low volume).

- A Flying Probe tester is a powerful electro-mechanical assembly, it moves probes instead of switching relays for the fixed probes. (fixture)
What is driving the Flying Probe Market

**Implications:**
1. Lower yields at the end of the Assembly line require test!
2. Human intervention is increasingly becoming less consistent, less accurate and costly.
3. Loss of electrical access decreases efficiency of bed-of-nails test technologies.
Why is a Flying Probe Tester very effective for Production Test?

SMT board assembly process

- Screen Print
- Pick/Place
- Reflow
- Thru-hole load
- Wave
- MDA/ICT Electrical
- Board Functional Test

Typical SMD Fault Pareto
Defective Materials

- Bridges/Shorts 21%
- Insufficient Solder 15%
- Manual Assembly Step 13%
- Non Functioning Parts 13%
- Opens 11%
- Missing Part 9%
- Wave Solder Related 4%
- Misplaced Part 4%
- Lifted Lead 4%
- Defective Materials 2%
- Wrong Part 2%
- Misc. Solder 2%

Total solder 53%
Total solder, assy 70%

SMD Defect Survey of 28 Large OEM/CM’s (285 SMD lines)
Source Circuits and Assembly, "Inspection Strategies for Process Control"
**Flying Probe can access where other testers cannot**

- Test Pads, Vias, Thru-hole very easy to probe with FP
- You can also probe
  - **SMD Device Leads**
    - Resistors, Capacitors, Diodes, Transistors
    - IC Leads for SMD parts
    - J-Lead Device pins
    - Connector Pins, tail and tip

**Full double sided Flying Probe will allow additional access for**

- Guarding
- Via verification
- Connector Contact verification
- Boundary Scan and Functional Tests
Access Challenges!

- Small pad size or probing vias
- Access through tall components
- Warped boards
- Probing connectors
- Handling multiple power supplies
- Signal Integrity
- Probe specific functionality
Fixed/Variable Angle Probes Test Accessibility

Variable angle

Fixed angle

Tall component clearance area

Pin not accessible

16°
Flying Probe Measurement Types - Basic

- **Network Shorts:**

- **Passive Components:**
  - Resistors (R)
  - Capacitors (C)
  - Inductors (L)

- **Discrete Semiconductor:**
  - Diode
  - Zener diode (to 100V)
  - Transistors
  - FET
  - Thyristor
  - Triac
  - Transorb

- **Other Devices:**
  - Bridges
  - Switches
  - Relay
  - Optocoupler
Flying Probe Measurement Types - Advanced

- **Active analog and hybrid Components:**
  - Comparator and Regulator
  - Operational Amplifier

- **Other Tests:**
  - Power Up and Functional Test
  - Flash and ISP
  - Boundary Scan
  - AOI
  - Nodal impedance

- **Vectorless Opens Test:**
  - Junction Diode/ Parasitic Diodes
  - Capacitive Field Coupling

- **Network Analysis:**
  - BodeScan
Flying Probe Systems
- Access is through flying probes – no fixtures
- Helps solve access issues
- Program times typically run 1-2 days
- Test times are typically 1-5 minutes
- Cost 180K 400K
- New techniques allow for added speed and connections to the DUT
- Used for low, mid volumes high mix, prototypes, first articles, etc.

BONs Testers
- Uses a fixture specific to the Device Under Test
- Fixture costs can run $5K-30K or higher
  - Typical two week turn around on a fixture
- Program times and debug are typically 3-5 days
- Test times are typically 15-30 seconds average
- Cost 50K-600K
- Used for high volume low mix
Flying Probe with Functional Test Capabilities

- **AccuFast™** Closed Loop Drive System
- **ScanProbe™** Technology
- **Integrated Device Programming**
- **Flying Fixture™**
- **Standard Double Side 8 Probe Configuration**
- **Expanded Measurement System**
**Conventional Flying Prober’s Architecture use Linear Guides and Drive System**

- Four probes require a very complicated architecture
- The four probe holders are in two different planes
  - The probes have different angles
  - The probes have different lengths
  - The movement of the probes in the bottom plane (green mechanism) is limited by the position of the probes in the top plane (yellow mechanism)
Two motors are built in the head for X and Y directions.

Air bearings have no friction resulting in no wear hence no loss of accuracy over time.
Acculogic Advancements and Solutions

- **Full Function Double Sided**
- **Mono-Planar Linear Motor**
- **Up to 22 Position Configurable Flying Probes**
  - Flying Mini Fixture
  - Smart carrier for side access
- **User Friendly Programming Environment**
  - CAD Translator
  - Debug Environment
  - Offline Troubleshooting Station
- **Integrated Boundary Scan and Functional Tests**
Open Architecture Robotic Platform

- Each Stator supports up to 4 Shuttes (Probe Module Carrier)
- Double sided system utilizes two symmetrical drive system.
System Architecture

- Configurable with 8 Shuttles
- Up-to 22 Probe Modules
- Two cameras (up-to 8)
  - Each probe/shuttle
  - Stim/Measure/Guard
  - Vectorless test
  - Digital/Bscan JTAG
  - Power (up-to 100V)
  - ThermoScan
  - TraceScan
Innovative Patented Joystick Probe Module

Each Independent Probe:

- **Stimulus**
- **Measurement**
- **Guard**
- **Boundary Scan**
- **Power up & Functional Test**
If you can not probe it you can not test it

- **BPM 700** Basic fixed angle
- **APM 800** Advanced variable angle
- **APM 900** Advanced high speed

System supports mixed probe population
**Unique and patented system architecture**

- **FLS900 Single/double sided** (single pass)
- **Multiple Probes (up-10/22)**
  - Fewer probe movement results in shorter test time
  - Closed Loop Probe Modules
- **3D joy-stick like Probing** – one probe movement multiple point access
- **FLS 940 Sxi Single-sided Max. 10 Probes**
- **FLS 980Dxi Double-sided 22 Probes**

*Each probe cover 50mmx50mm” area With no shuttle movements*
1 or 2 Stators - Topside and Bottom-side

Up to 4 Shuttles per Stator

3 Probes per Shuttle

Max Probes 11 Topside / 11 Bottom-side

Total Maximum Probes 22
3-D multi-probe system you can probe
1. **Maximum Fault coverage**
   - Double-sided test pads/components

2. **Maximum Speed**
   - All tests in a single pass
   - No mechanical set-up

3. **Maximum Probing Reliability**
   - Free to choose best contact point
Shorts Test

- Shorts tests require a contact test
- Shorts tests are based on adjacencies test
- The number of shorts tests are typically 3 times the number of nets
- Higher the Probe count results in faster Shorts Test

\[ n P k = \frac{n!}{(n-k)!} = \frac{n(n-1)}{2} \]
Why Higher Probe Count Matters? Functional Test

- Fixtureless access with unparalleled test flexibility
- Functional test up to 20MHz directly through articulating probe module
- Board Power; up to 2A per probe
- Advance Boundary Scan with ScanProbe
- Static Digital and Analog tests with built-in Instrumentation
- Dynamic Digital and Analog tests with third party instrumentation.
- Device Programming with both built-in and third party programmers
- Fault Tracing and Design Validation
Functional Test (20Mhz)

32 external channels for integration with third party instrumentations
Advance Boundary Scan Test with ScanProbe™
Powerfull Functional Test & Fault Tracing

UUT Power Connector

Multi-Nail Probe Module

BS TAP Port
**Boundary Scan and Functional Test Benefits**

- **Enhanced test coverage**
- **Accurate fault diagnosis**
- **Significantly improved test time**
- **Off line program debug – more efficient use of capital asset**
- **Less mistakes and less labour cost**
- **Do more, in less time with Automated means.**
High Frequency Functional Test

- **Distributed Instrumentation based on FlyingInstrument**
- **Power up; with no current restrictions**
- **Delivery interface for variety of communication protocols.** (Ethernet, Fiber Optics, USB, RS232 …)
- **Dynamic Digital and Analog tests with third party instrumentation**
- **Functional tests at speeds greater than 4GHz**
- **Device programming with any third party programmer**
Embedded Test Controllers based on LXI, USB and etc.

Functional Test Interface
FlyingInstrument .. brings instrument closer

Interchangeable mini-fixture

Third Party Instruments

Pneumatic or Electric actuator mini-fixture
Distributed Test Instrumentation

- Ultimate system flexibility
  - Plug-in or distributed
  - On-demand deployment strategy
- High performance design
  - Ease of utilization with sophisticated applications
Distributed Test Instrumentation
Conventional Design Validation Approach
**Automated Design Validation Approach**

- Flying Active Probe
- Exceptional Signal Quality
- Bandwidth above 4Ghz
- Digital waveform analysis
- Possibility of RF test above 4Ghz

![Graph showing frequency response](image)

**NORDIC TEST FORUM 2012**
Strategic Deployment of Flying Probe

Low / Medium Volumes

Selective Testing

Batch Sample Testing

Rework Diagnosis

Event Driven Testing
Flying Probe is a very effective test method:

- For high mix low-mid volume
- For mix volume high complexity production
- For production where access by fixture is limited
- Better fault coverage & fault diagnosis
- Single Pass double sided test system for both ICT and Functional tests.
- Test system with full automation for both ICT and Functional tests. -cost saving in terms of labour
- Effective fault tracing system
- Ideal system for automation of Design validation.