

ADVANTEST DEVELOPER CONFERENCE

High Parallelism Probe Card on V93000 Direct-Probe™ System to Increase Testing Throughput on Automotive ICs

Johann Heitzer, Way Jam Chen, Norbert Effenberg, Infineon Peter Hirschmann, Alexander Zuendorf, Advantest Alan Liao, Patrick Phipps, Form Factor

Direct-Probe is a trademark of Advantest, and TrueMatrix is a trademark of FormFactor Inc.

Õ



Overview

- Key Industry Trends and Market Requirements
- A Solution to Enable High Parallelism Test on V93000 Direct-Probe Systems
 - V93000 Direct-Probe tester configuration for high parallelism automotive test
 - Touch down analysis with different DUT array configuration
 - Probe card thermal planarity challenges
 - FFI probe card mechanical design to improve thermal planarity
 - Probe card AOT/POT study for high probe count contact stability
- Final Result in Production Test Environment
 - Thermal electrical planarity measurement result
 - Test correlation data
- Summary and Future Development



Automotive Semiconductor Market Overview

Drive Demand of New Testing Solution

- Automotive electronic is a fast-growing market
 - Predictions are between 3%~12% CAGR over next 5 years
 - Average number of semiconductors in a car increases significantly in modern cars
 - Key drivers for automotive IC growth
 - Critical safety system
 - Increased fuel efficiency
 - Navigation and communication
 - Comfort & entertainment features

Market drives high parallelism testing solution to meet large volume demand and competitive cost in automotive consumer market

Worldwide Electronic System CAGRs (\$, 2015-2020)



Advantest V93000 Direct-Probe Tester Configuration for High Parallisim Automotive IC Test

Details of Tester Configuration:

- Device Power Supplies DPS128HC x384
- Signal Channels PS1600 x1024

Standard V93000 stiffener frame with FFI custom inner design







Automotive High Parallelism Test Challenge

Probe Card Requirements and Challenges

- High parallel probe card on V93000 Direct-Probe
 - Probe Card active area within V93000 standard stiffener
 - Touch down efficiency to be improved
 - Inner tester side stiffener design
 - Largest probing area on V93000 platform
 - Probe over-travel control vs. Z direction deflection force
 - Probe card test metrology (active area limitation)
- Wide Range Dual Temp Test
 - 170°C temperature range (-40°C to 130°C)
 - Thermal probe card planarity control

FormFactor TrueScale[™] Matrix Probe Card



02014 FormFactor Inc. |Confidential - Propriet





Touch Down Efficiency Analysis Maximize Number of DUTs to Reduce Number of TDs

- Design probe layout and DUTLet
 Create V93000 active area library on FFI touch down optimization tool
- V93000 larger active area enable 2x DUT count
 - Touch down efficiency improves 40%
 - 19 columns x 9 row -> 95 devices parallel -> 12 touch downs
 => test optimum identified

TDs	DUTs	MergeDUTs	Effic	Fabric Pattern Type	Fabric Pattern Height	Fabric Pattern Width
8	152	152	75.7	RectanglePattern	15	37
12	95	95	80.7	RectanglePattern	9	37
12	114	114	67.3	RectanglePattern	11	37
12	133	133	57.6	RectanglePattern	13	37
12	136	136	56.4	RectanglePattern	15	33
12	144	144	53.2	RectanglePattern	15	35
12	153	153	50.1	RectanglePattern	17	33
12	162	162	47.3	RectanglePattern	17	35
16	76	76	75.7	RectangiePattern	7	37
16	80	80	71.9	RectanglePattern	15	19
16	88	88	65.3	RectanglePattern	15	21
16	90	90	63.9	RectanglePattern	9	35



Managing 'High Number of Probe Contacts' Probe-Card Forces & Dimensions

Mechanical/Contact Force Challenges:

- Higher Probe Card weight
- High number of Probe Contacts (< 2000)
- High number of Tester Pogo's
- Higher total of probing forces
- -> To be handled by Probe Card & Prober
- High Temperature range

Electrical and Production Test Challenges:

- High currents on contacts (< 384A)
- High Signal quality ... precise results
- Large probe area ... To be handled by automatic probe card changer of prober







TrueScale Matrix on V93000 Direct-Probe Tester Thermal Planarity Control

- Thermal gradients in probe card produce differential expansion across probe card components and can produce probe card bow
- Design and build the probe card for better thermal planarity control
 - Mechanical simulation to understand thermal behavior
 - Design automation (real-time probe card deformation simulation) to optimize Mechanical Coupling Link location for planarity control
 - Added flexible shim kit design on inner tester side stiffener
 - Bridge beam hardware added to PC outgoing PXI metrology tool to simulate test head docking condition for planarity adjustment
 - AOT/POT analysis on field to further understand deflection force





Probe Card Mechanical Design

Simulation show thermal bowing effect due to temperature change



-> Add flexible shim kit on inner TSS design to enhance engagement with V93000 DD bridge beam reduce deflection







Actual Over-Travel vs. Program Over-Travel Analysis

Using Scrub mark length to analysis probe actual over-travel

Probe Mark at POT 60, 80, 100 and 120 um

Probe Mark Length Analysis





Actual Over-Travel vs. Program Over-Travel Analysis



AOT/POT Results:

- All wafer TDs run on prober PMI
- Slope of AOT/POT is 0.0876
- Theoretical scrub ratio is 0.19
- AOT/POT is 0.0876/0.19 ≈ 46%
 - The ratio means when we request prober to rise 100 um Z-high but the real move distance only about 46 um



Production Thermal Planarity Performance

• From room temperature to hot temperature electrical planarity change within **10 um**

Room temperature electrical planarity achieved at 45 um OD



DUTs in electrical contact

Hot temperature (125°C) electrical planarity achieved 55 um OD





Production Testing Result: Re-Test Quality

V93000 vs V93000 Bin-Flip Map





• Correlation : V93000 vs V93000: > 99%

 Correlation : Other ATE vs V93000: > 99%

Summary

- Advantest and FormFactor together have demonstrated automotive chip testing solution on V93000 Direct-Probe tester platform with:
 - High parallelism (x95 DUT)
 - Large active area
 - Wide range of temperature
- -> to reduce number of touch downs per wafer
- -> to minimize number of touch downs per wafer
- -> to meet the automotive test requirement

Future Development Options:

- TrueScale Matrix 300 mm full size PC on V93000 Direct-Probe tester
- Expand to wider temperature range











The End. Thank you for your attention!

