

Temperature Probing Process Achieving thermal stability at extreme conditions





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Imran Ahmed Texas Instruments



- Intro
- Objectives
- Methods
- Projects/Results
- Summary

Intro / Background

- Wafer probing on a production manufacturing level has evolved beyond just room temperature. It has expanded its limits to extremes at both ends of the temperature spectrum, with applications demanding test from -50C all the way up to 200+C.
- With these extreme requirements now in play in the thermal environment, physical probe mark integrity has also become a challenge to maintain, specifically relating to horizontal and vertical probe accuracy on the bond pads.

Intro / Background

- Introduction of more advanced vertical card technologies in the industry has helped tremendously with these factors, with probes that are designed to better perform in these conditions.
- Another component that becomes important to implement and optimize is the prober's automatic alignment routine. Having these standardized control systems in periodic intervals is the best way to ensure thermal compensation for the probes in an extreme temperature environment.

Objectives

• This paper will give an overview of:

- how these automatic re-alignment functions work together on the Accretech TSK prober
- other control systems (both hardware and process) put in place to best achieve thermal stability during temperature probing.

Probe Overview at TI

- TI probes at a variety of temperatures on production test floors
 - Ranging from extreme low temp \rightarrow extreme high temp
- Many physical and process recipes are required for proper probing

• Why do we do it?

- Device requirements from the customer
- Verify electrical, physical, and functional integrity of the chip @ various temps, depending on the application
 - Automotive



Methods / Requirements to probe at temp.

• <u>Hardware:</u>

- Accretech TSK prober
- Hot chuck
 - ERS, Accretech, ATT
- Temp. Controller Unit for prober
- Chiller Unit (ERS, Accretech)
 - CDA, purge
- Qualified Probe Card technology
 - Vertical card suppliers
 - Pcb stiffeners, heat shields

• <u>Process:</u>

- Prober Automatic Download Logic (by device spec)
 - Temp. Range settings
 - Soak/Needle realignment intervals







Automation solutions for a production probe floor

AUTOMATION IS RUNNING

Please do not disturb the prober or the workstation while automation is running

Starting-0% AUTOMATION IS RUNNING

Please do not disturb the prober or the workstation while automation is running

Probe Card Checks-12%

AUTOMATION IS RUNNING Please do not disturb the prober or the workstation while automation is running

Cleaning Media Check-17%

AUTOMATION IS RUNNING

Please do not disturb the prober or the workstation while automation is running

Prober State Check-35%

AUTOMATION IS RUNNING

Please do not disturb the prober or the workstation while automation is running

Getting Cleaning Configuration-46%

AUTOMATION IS RUNNING

Please do not disturb the prober or the workstation while automation is running

Getting Temperature Settings-76%

AUTOMATION IS RUNNING

Please do not disturb the prober or the workstation while automation is running

Downloading Standard Dataids-86%



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 By specifying the probe card technology within production automation scripts, the prober settings can be optimized for production needs.

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 Automatic prober download script (dataID's for temperature settings, Needle Re-alignment intervals, etc.)

Methods

- Probing @ temperature requires Needle Realignments (X, Y, Z corrections), due to thermal fluctuations of the prober and probe card
 - At set, downloaded intervals:
 - 4 pin-average realignment
 - At start of wafer
 - Every x mins for initial time period of wafer,
 - Every y mins after, for the rest of the wafer
 - To keep probe marks controlled, <u>centered</u> on pad (X, Y)
 - To maintain proper probing overdrive throughout the lot (Z), in order to prevent:
 - Unexpected added probing over travel
 - Contact related issues
 - Crashed probe cards







Re-alignment action on TSK UF3000

1. E1 camera checks beam position of E2 camera

- E1 camera: wafer alignment
- E2 camera: needle alignment
- E1 + E2 = full re-alignment sequence





Focal position

-

Needle Optical Re-alignment video



Methods

• All the prober's Needle Re-alignments (corrected X, Y, Z positions) can be pulled from the prober's dump logs

 Prober Log Compiler utility extracts this raw data and spits it out into an interactive graphical interface

Prober Log Compiler graphs – Needle Re-alignments

- Re-alignment every X mins for beginning of wafer, every Y mins thereafter, and @ start of wafer
- Used for investigating needle thermal movement data, characterizing prober, and new card technologies @ temp.







Example: Cold temp setup stabilization



Takes ~5 hours for prober environment to stabilize in Z-movement when going to cold temp

Example: Large needle movements at high temp

Same probe card showed different thermal curves on 2 testers



140um Z-movement

40um Z-movement

Found the probe card pan hardware was causing changes in thermal movement

Projects / Results

Project Examples using Prober Log Compiler re-alignment data

Project 1

- <u>Problem</u>: Probe mark shifts at start of every wafer for Cantilever style probe cards @ high temp
- Solution: Switch from Row mode to Column mode probing (next slide)





Device A test study; prober needle movement data



19

Project 2:

- Problem: Going from CT/HT → RT setup causing probe mark drifting (since no needle realignments at RT)
- Solution: Enable Needle Realignments every X mins for the 1st 5 hours when going from HT/CT → RT setup (next slide)



Beta testing: $CT \rightarrow RT$ (activate re-alignment settings)



 Automatic Download Logic: Needle Realignment activated every X mins for 1st 5 hours, and at beginning of every wafer for the 1st RT lot only

(zoomed in)





- <u>Problem:</u> Current prober pan material causing high Z-movement for ultra high temp applications (175C)
- Solution: New prober pan material characterization (INVAR) reduces thermal movement



Original probe card pan



INVAR probe card pan

120-160 um in Z drop @ 175C

60 um in Z drop @ 175C



- Probing at temperature requires hardware/process configurations and recipes to achieve thermal stability
- On the process side, prober needle re-alignment routines are crucial to sustain probe mark stability, electrical yield, and die/probe card health
- Prober's logs can be extracted via automatic scripts to view thermal movement data
- Specific device situations call for different thermal compensation/re-alignment routines, as well as newer hardware solutions

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