System Level Test Needs, Requirements, and Equipment

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Motivation

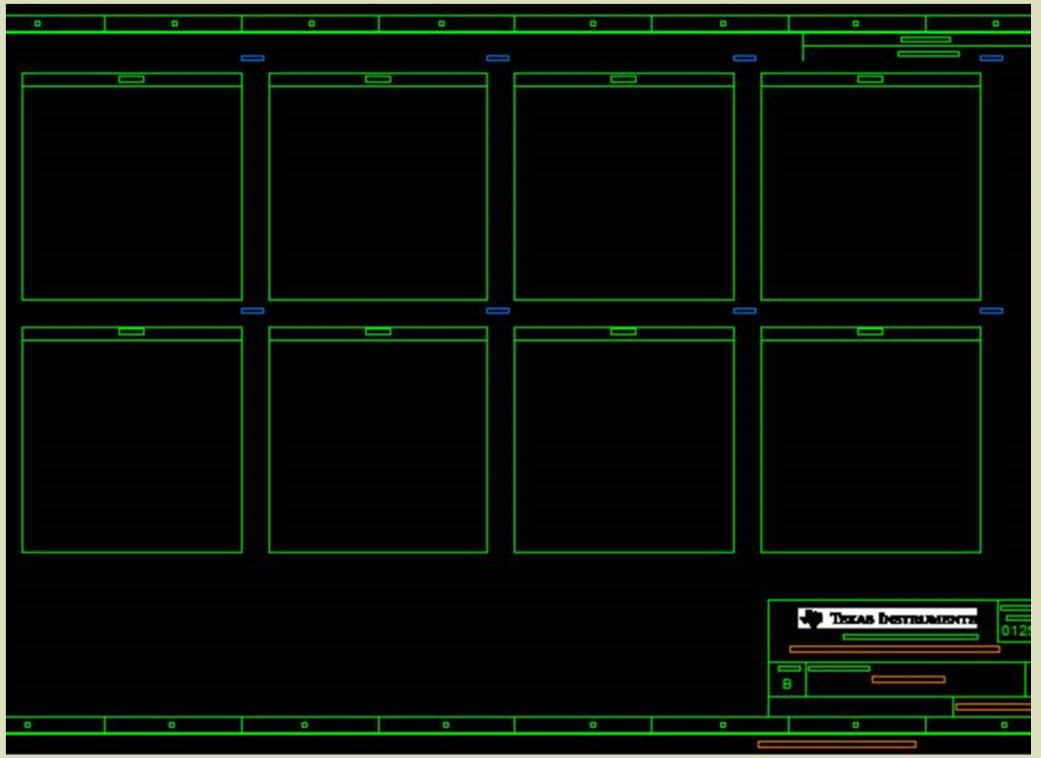
- Too Many Customer returns
  - 100% Pass ATE testing
  - 95% Fail EVM (EValuation Module) testing
    - Many fail at cold temp
- Most EVM fails require tremendous engineering resources to translate into ATE test requirements
- Investigate System Level Test to avoid EVM-to-ATE translation.

Team	Overhead vs New Product Creation
Test	4%
Validation	7%
Design	7%
Quality	8%
Total	***26%*** 

Cost analysis for incorporating customer application tests, that identify customer returns, into existing ATE programs.

System Level Test Description

- Utilize existing EVM as core test hardware.
  - Miniaturize & multiply/system
  - Use applications software
- Incorporate a controller per EVM to start, stop, and record test results.
- Automate Load/Unload EVM
- Multi-temp with one insertion



Evaluation Module and x8 Configuration

SLT System Requirements

- Die Temp: -40C to +135C
- DUT Power: 2W to 50W
- Package: 15x15mm – 25x25mm BGA
- Ball Pitch: 0.65mm - 0.8mm
- Package Theta JC: 0.84C/W to 0.5C/W
- Temp Accuracy: +/- 3C
- Insertion Test Time: 300s
- Safety: S2/S8 & CE minimum
- Data Collection: RITdb compliant
- Cost of Test: Proven Model
- Volume: 1MU+/Month/SLT Cell

- EVM Interfaces:
  - EMIF: DDR3
  - MMC: SD Card, eMMC
  - USB: USB1, USB2, USB-C
  - QSPI: SPI Flash
  - PCIE: PCIE1,2 SSD Memory
  - SATA: SSD Memory
  - GPMC: Nand, Nor Flash
  - MLB: INIC Processor
  - Ethernet: Ethernet1,2
  - DSS: LCD1,2,3
  - VIP: VIP1,2,3
  - UART: UART1,3
  - I2C, HDMI, JTAG

SLT Equipment Survey

Vendor	Revenue	DUT Power	EWS	Multi-Slot Chamber	Automated Hnadling	Temp Range	Systems	DUT per System	DUT per Slot	Slot per System	Run Rate	Slot Availability	Field Service	PM Time Hrs/Yr	A/T Local Service	Real Time Monitor	Auto Slot Decertify	MTBF	Warranty
A																			
B																			
C																			
D																			
E																			

Vendor	Supervisor per DUT	Supr OS	Supr Cmd	Data Out	Tools	DUT Tracking	SLT System Protocols	SLT DUT Protocols	SLT Structural Test	Thermal Heater Power	Thermal DUT PWR	Thermal DUT Temp	Carrier Dims	Motherboard Dims	Daughter Card Dims	Full System Cost	Automation Cost	EWS Cost	Delivery
A																			
B																			
C																			
D																			
E																			

Attribute Categories

- Capacity: Throughput, DUT/System
- Maintenance: MTBF, Warranty, Field Service
- Capability: OS, Protocols, Supervisor
- Thermal: DUT Power, DUT Temp
- Cost: System, Delivery, Recurring

SLT Equipment Evaluation

Section	Requirement	Measurement	Acceptance Criteria	Pass Fail
CFE Items	Miniaturized EVM, Motherboard, Firmware, Sockets, DUTs, etc.	Known Good	20	Pass
Safety	Safety Covers	Functional	Verify	Pass
Error-Free Initialization	Hardware, Software, Infrastructure	Activation displays	Verify	Pass
Test Prep	Power check, PDB GUI, System Controller, HDWR	Mechanical / Logging Checks	Verify	Pass
Test Execution	Slot Communication, Test Accuracy/Repeatability, Power delivery, Static/Dynamic Thermal	Test / Site / Thermal Performance	100% DUT correlation, Verify Thermal Criteria	Fail
Version Check	OS and all tool firmware	DLL; Thermal, PDB, EVM	Verify	Pass
Misc	Specifications/Instructions , EWS Functional Performance, Delivery, Installation	Remote Log-in Functionality; Ops, Maint, Pgmming, Facilities Manuals; On Time Delivery, Complete Install, Overall Performance	Verify	Pass

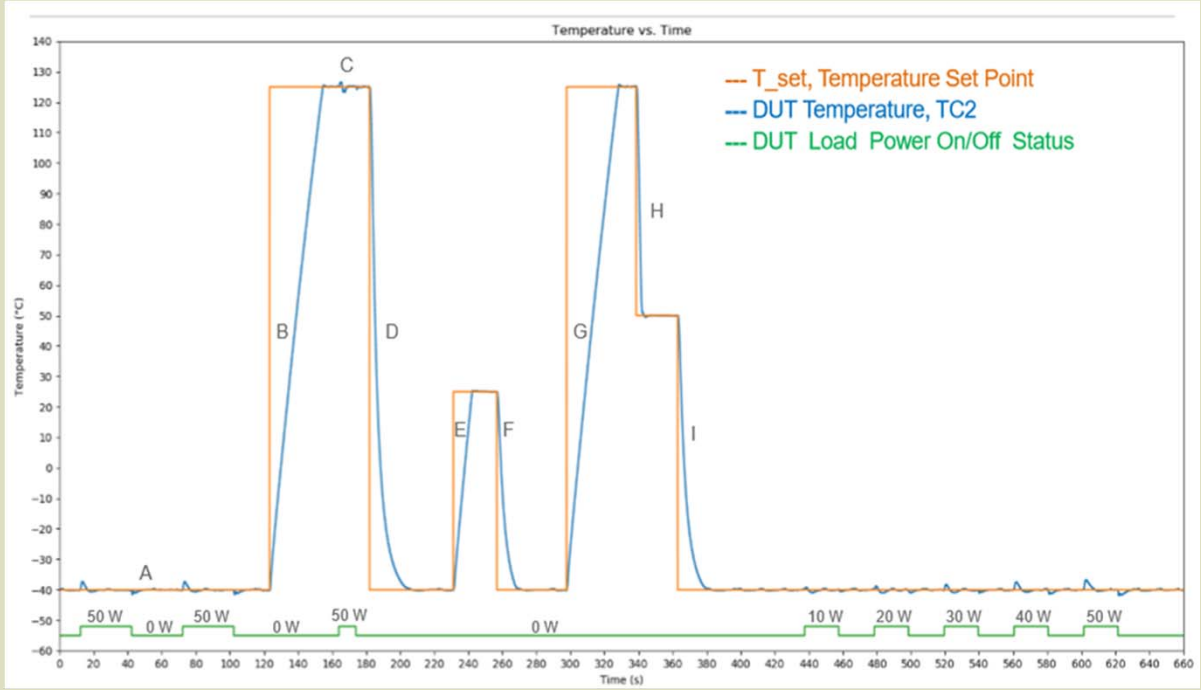
- Vendor A chosen for initial evaluation.
- Utilize EWS for proof of concept.
- No DUT Load/Unload Automation.
- All customer rejects confirmed fail on system.
- Minor throughput problem encountered during temp ramp.

Alternative Equipment Investigation

Test Group Mission:

Strengthen competitive advantage in test by identifying, developing and deploying infrastructure at optimized cost and quality.

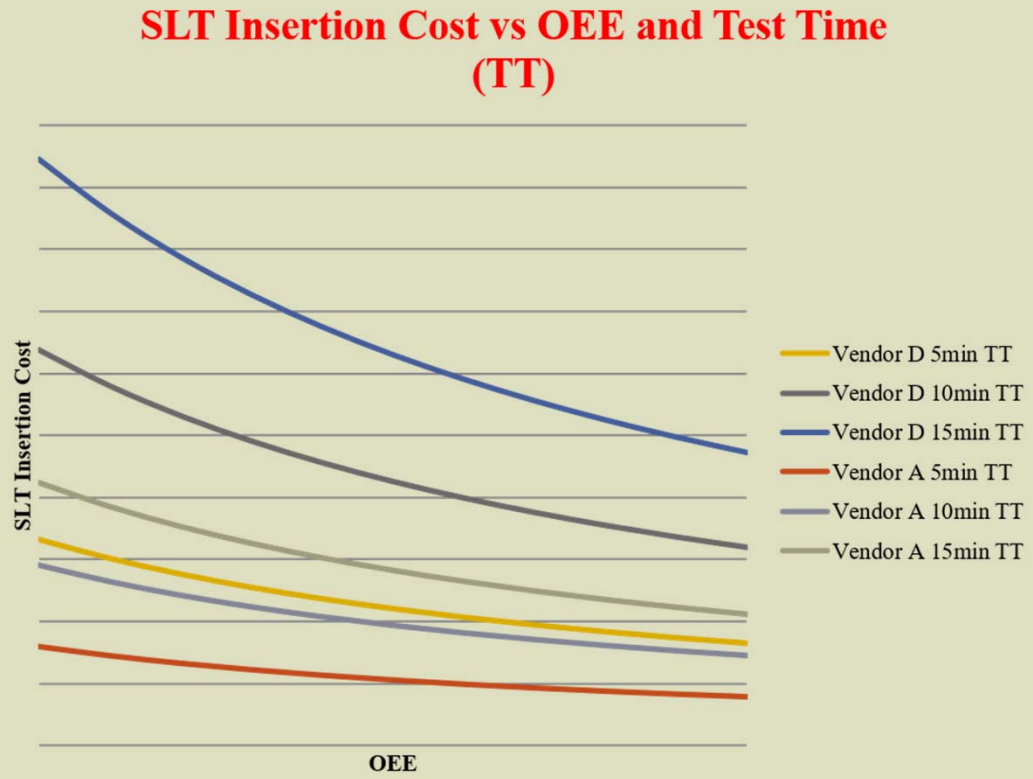
- The Vendor A equipment had issues with both temp range and dwell time.
- Vendor E was given the opportunity to display their equipment thermal performance.



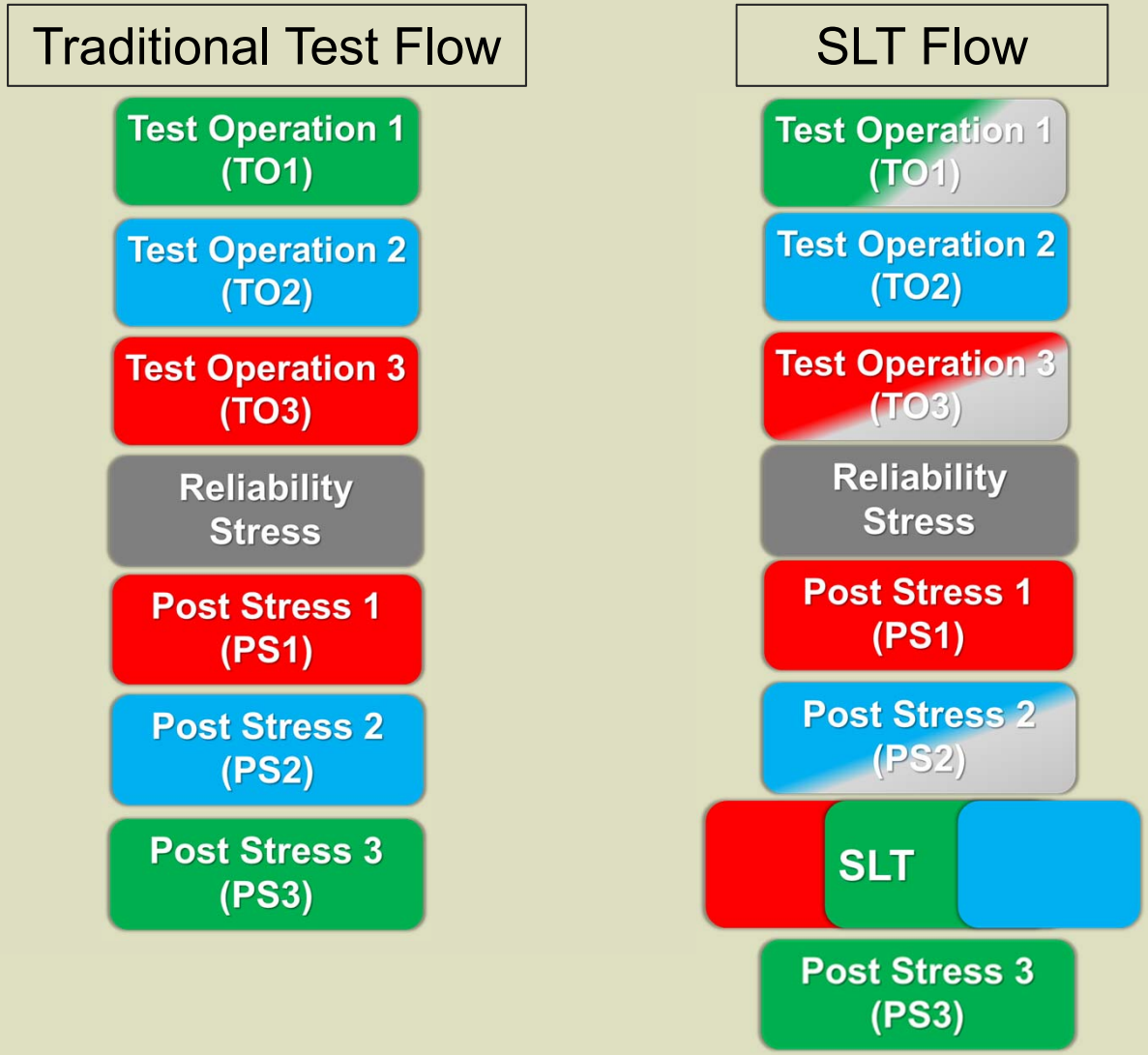
Vendor E data shows acceptable equipment thermal performance.

SLT ROI

- Vendor cost curves based on dedicated SLT insertion.
- Vendor cost curves based on single temp test
- Assume 99% Test Yield
- Non-equipment costs are estimated.
- ***Is Cost of Test increase for SLT insertion acceptable?***



SLT Implementation Plans



- Goal is cost neutrality.
- Need to Replace portions of Non-SLT test operations with SLT to offset SLT cost.
- Current cost of SLT is too high for cost neutrality, driving alternative traditional ATE approaches for eliminating customer applications failures.

Conclusions

- Dedicated SLT Equipment is very costly.
- There is little enthusiasm for adding another test insertion to an already costly test flow.
- Reuse of existing obsolete testers as EVM supervisors in SLT testers was investigated and found unacceptable.
- The need for cost effective SLT is getting stronger as devices outside of high end processors also need applications testing such as Drift for high-end voltage references, Switching Reliability testing of HV power devices, and orientation strength testing of Magnetic devices.
- *Tremendous resources are currently employed to find traditional ATE alternatives to SLT for cost avoidance.*

Acronyms

- SLT: System Level Test
- ROI: Return on Investment
- MTBF: Mean Time Between Failures
- ATE: Automated Test Equipment
- EVM: EValuation Module
- PE: Product Engineer
- DV: Device Verification
- CQE: Customer Quality Engineer
- DFT: Design For Test
- DUT: Device Under Test
- OS: Operating System
- EWS: Engineering Work Station
- OEE: Operational Efficiency and Effectiveness
- HV: High Voltage

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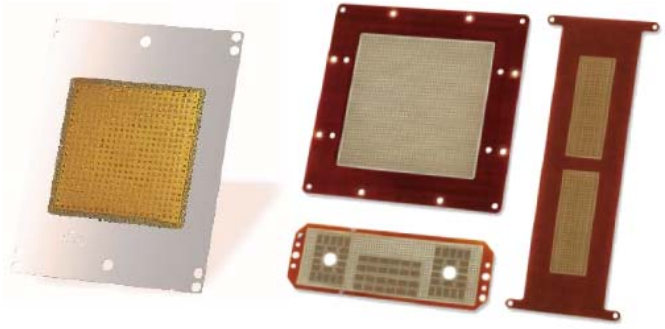
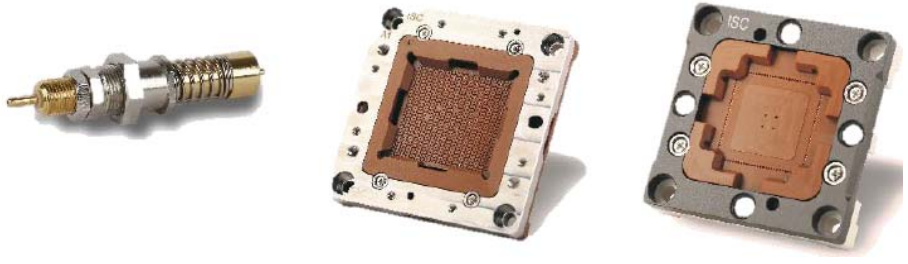


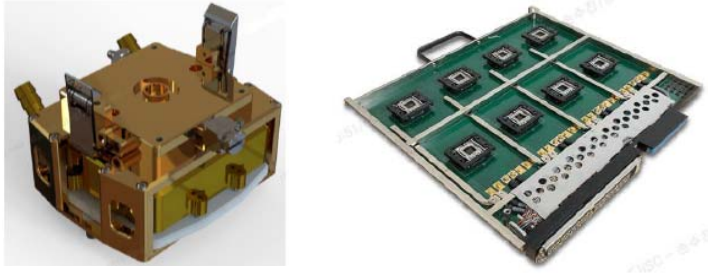
POGO SOCKET SOLUTIONS

- Excellent gap control & long lifespan
- High bandwidth & low contact resistance



THERMAL CONTROL UNIT

- Extreme active temperature control
- Safety auto shut-down temperature monitoring of the device & thermal control unit
- Full FEA analysis & Price competitiveness



BURN-IN SOLUTIONS

- Direct inserting on the board without soldering
- Higher performance BIB solution

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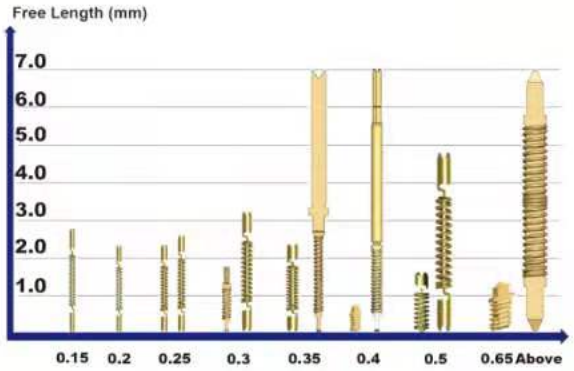
IWIN Co., Ltd. The test probe for high signal integrity at extremely high speed test

Spring probe by stamping



250 kinds of spring probe pin

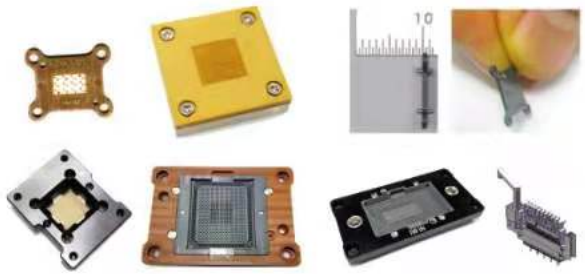
300 kinds of test socket (44,000 Pin count socket possible)

One piece spring probe

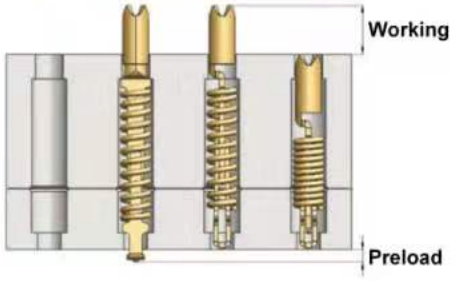
Three piece spring probe

High speed product → 0.63mm free length spring probe pin available

Finest Pitch → 0.15mm Pitch



Spring probe by stamping

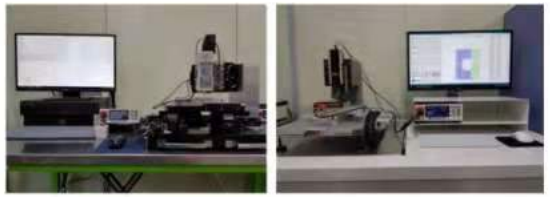


Patented

Pitch(mm)	Free Length(mm)	Current Carrying(Amps)
0.15/0.2/0.25	2.17~	0.5~
0.3	1.5~	1.5~
0.35	2.08~	1.8~
0.4	0.8~	2.5~
0.5	1.5~	3.0~
0.65	1.13~	9.0~
0.8	3.14~	3.0~

Automation

Pin assembly and Quality control



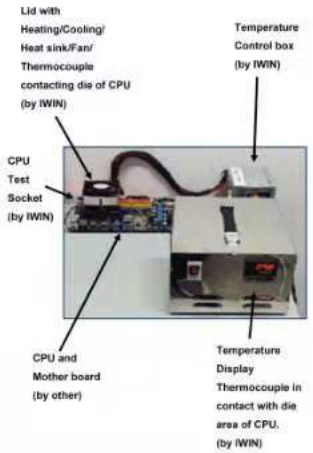
Top Figure: Socket CRES, Force, Stroke test

Bottom Figure: Data displayed

Top Figure: Socket CRES test

Bottom Figure: Data display 5,903 pins socket

Socket and Lid



Pin assembly

(Fully automated machines)

- Stamped piece parts attached to a reel fed into the assembly machine

- Assembled pins can be attached to a reel, or, supply in separate for socket assembly.

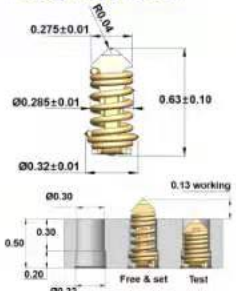
Spring probe pins for High speed

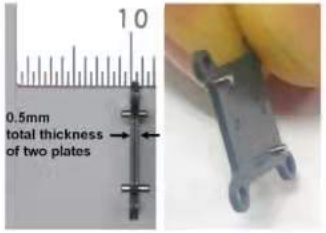
Extremely short spring probes by stamping

One piece spring probe

Three piece spring probe

Design approach





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