HUMANIZING THE DIGITAL EXPERIENCE

TDK Developers Conference 2018

TDK InvenSense EPCOS tronics microsystems Chirp MICRONAS

HUMANIZING THE DIGITAL EXPERIENCE

Proliferation of Fingerprint Authentication beyond Mobile

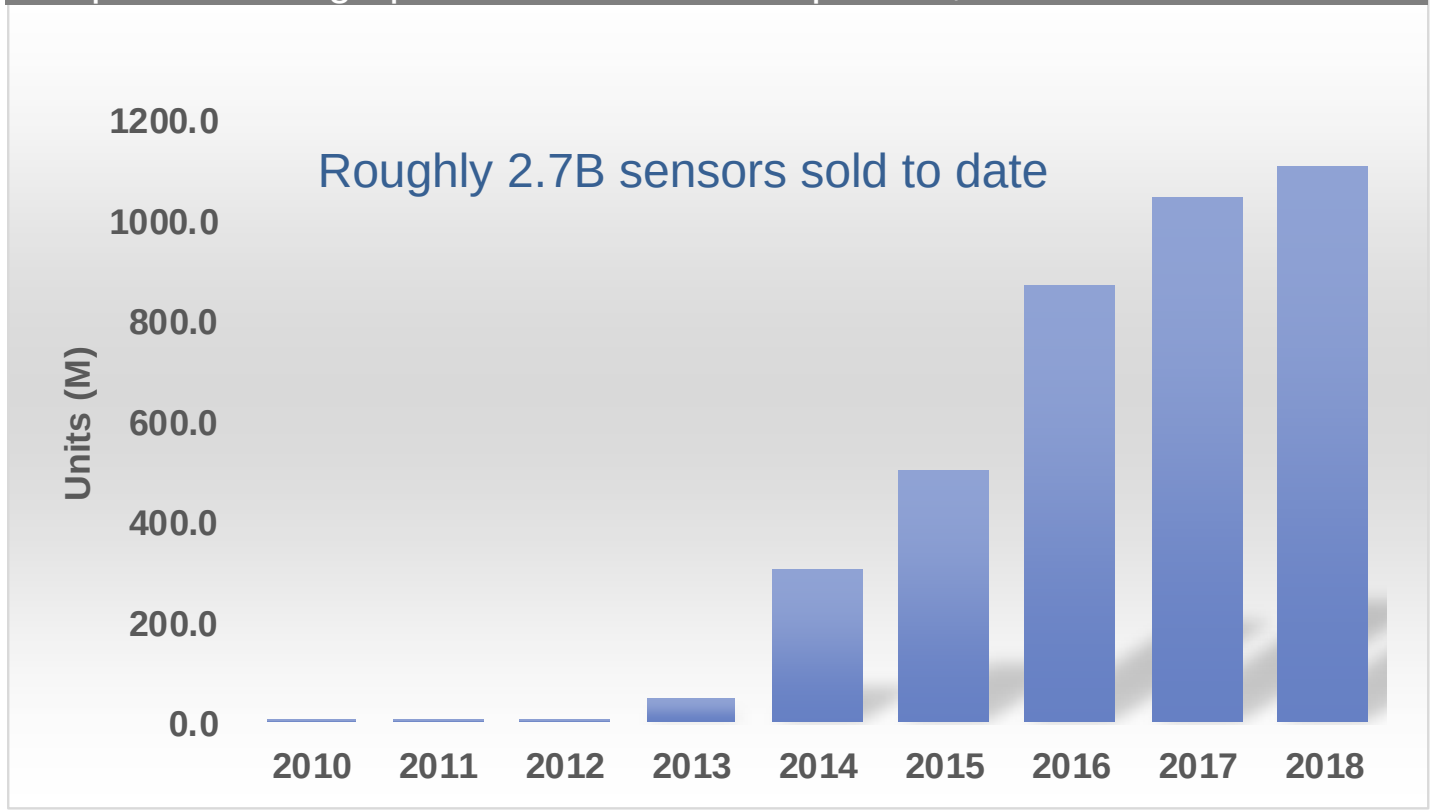
9-18-2018

TDK Developers Conference
September 17-18, 2018
Santa Clara Marriott

Fingerprint Authentication Adoption by Consumers

- Mainstream Consumer use of fingerprint authentication emerged with the debut of the Apple iPhone 5S in 2013
- To date, over 2.7B sensors have been sold into the mobile market
- This combined shipped volume has enabled many people to become accustomed to accessing or purchasing content using a fingerprint
- This familiarity is enabling fingerprint authentication on other consumer applications like PC, access controls and automotive – these markets have certain requirements that are not well served by capacitive-based sensors

Shipment of Fingerprint Sensors in Smartphones, Tablets and Notebook



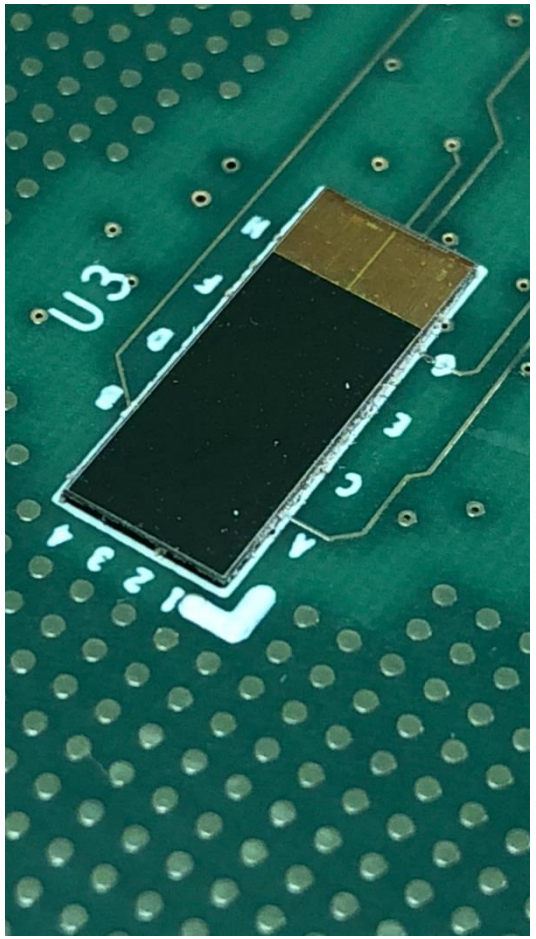
Source: IHS Markit 2018

TDK-Invensense's UltraPrint sensing solution is better suited for these non-mobile applications

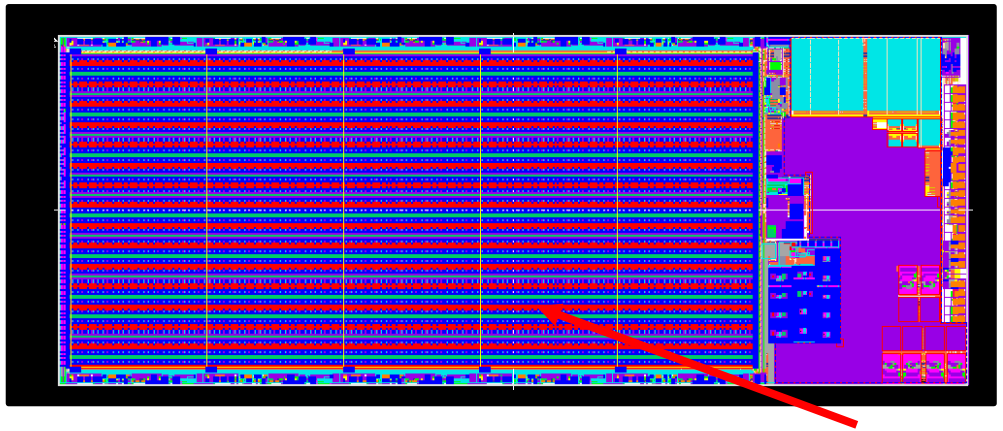
UltraPrint Ultrasonic Technology Closer Look

- UltraPrint sensors image a fingerprint using Ultrasonic pulses through a cover material
- UltraPrint sensors are comprised of a MEMS wafer bonded to CMOS, a mature TDK-Invensense fabrication process
- Each has an array of Piezoelectric Micromachined Ultrasonic Transducers or PMUTS, individually addressable, also have an onboard MCU and memory

TCFS-2000 SMT Package



TCFS-2000 Silicon Top View

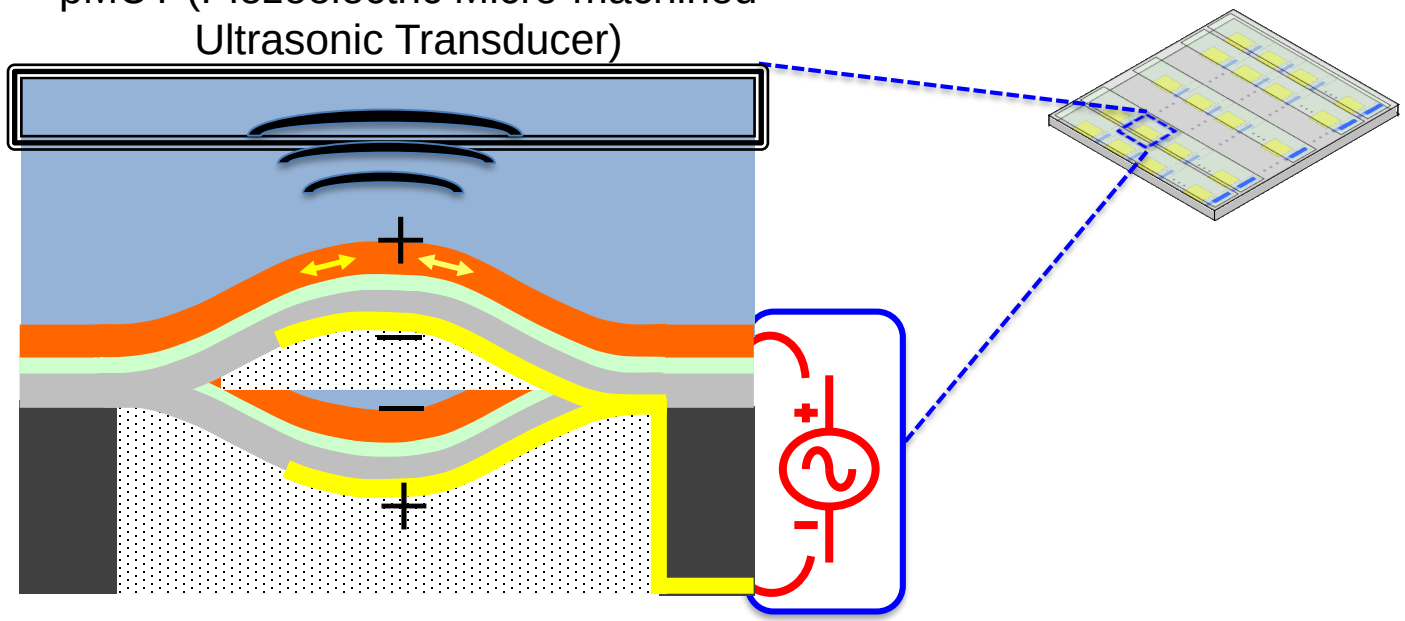


Over 8000 PMUTs in a 9.4 x 4.2mm sensing area

What is a PMUT?

pMUT (Piezoelectric Micro-machined Ultrasonic Transducer)

pMUT Array Over CMOS Electronics



Transmit:

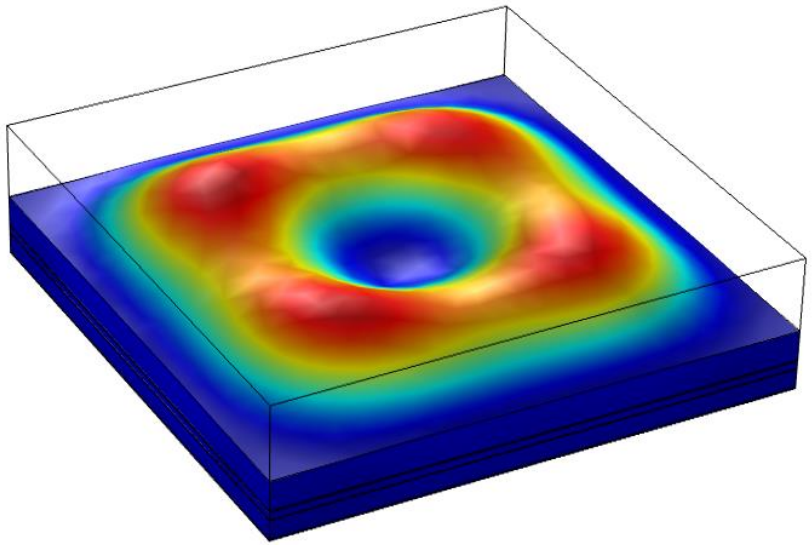
voltage signal → flexural strain → pressure wave

Receive:

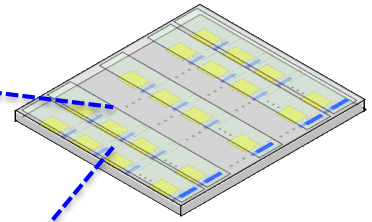
pressure waves → flexural strain → voltage signal

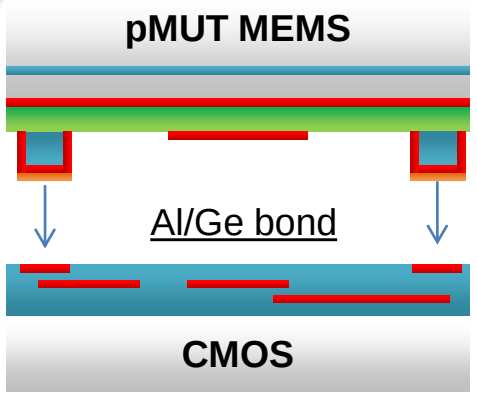
What is a PMUT? (cont.)

pMUT (Piezoelectric Micro-machined Ultrasonic Transducer)

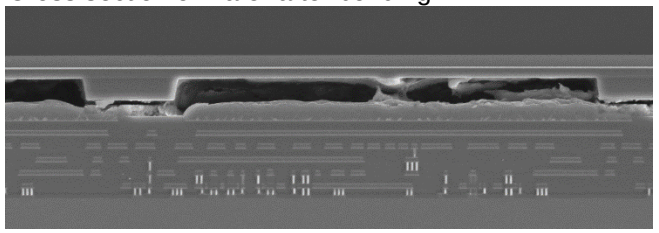


“Donut” pMUT

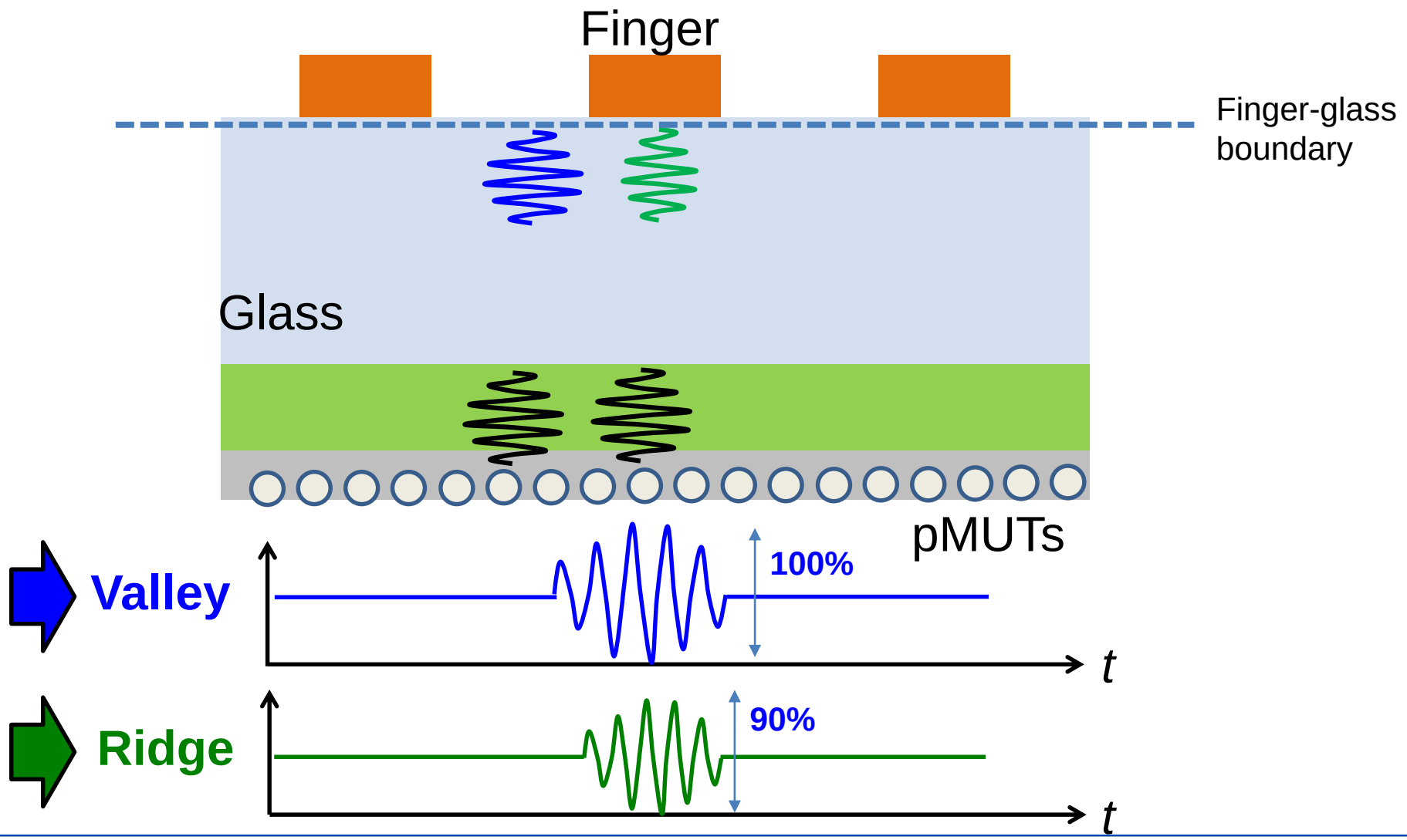




Cross section of wafer after bonding

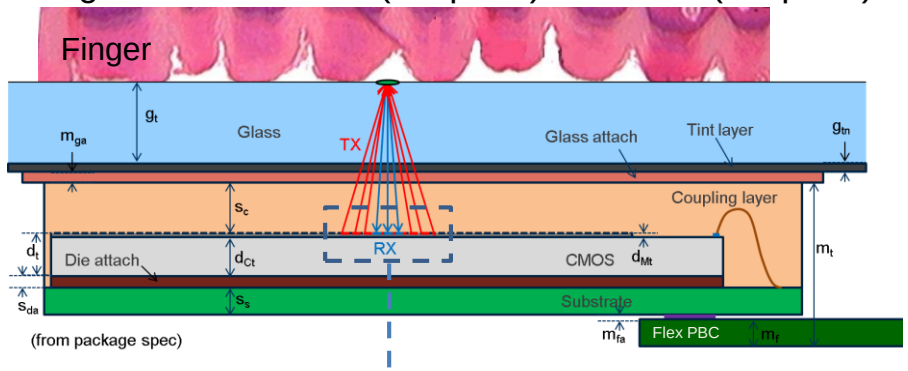


Ultrasonic “Pulse-Echo” Sensing



Ultrasonic Imaging w/ 2D Beam-forming

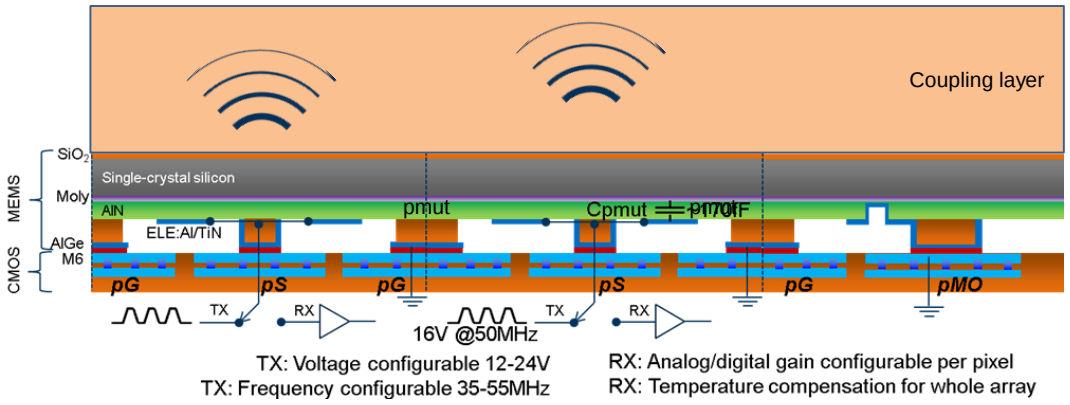
Ridge Pitch: ~ 290um (3.5lpmm) to 800um (1.3lpmm)



Key Technology Concepts for Functionality:

1. Array of pmuts generates ultrasound pressure wave
2. Acoustic impedance mismatch at each interface determines energy transmitted / reflected
3. Pulse-echo w/ time gating to look for signal delta w/ time-of-flight corresponding to finger-glass interface
4. High frequency ultrasound to reduce diffraction in glass
5. Beam-forming time delay to focus energy
6. Scanning to collect full image

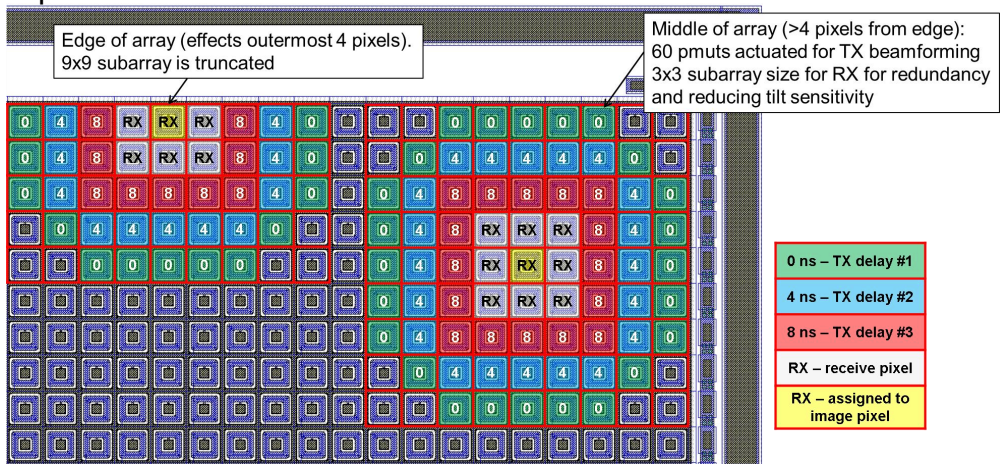
Cross-section



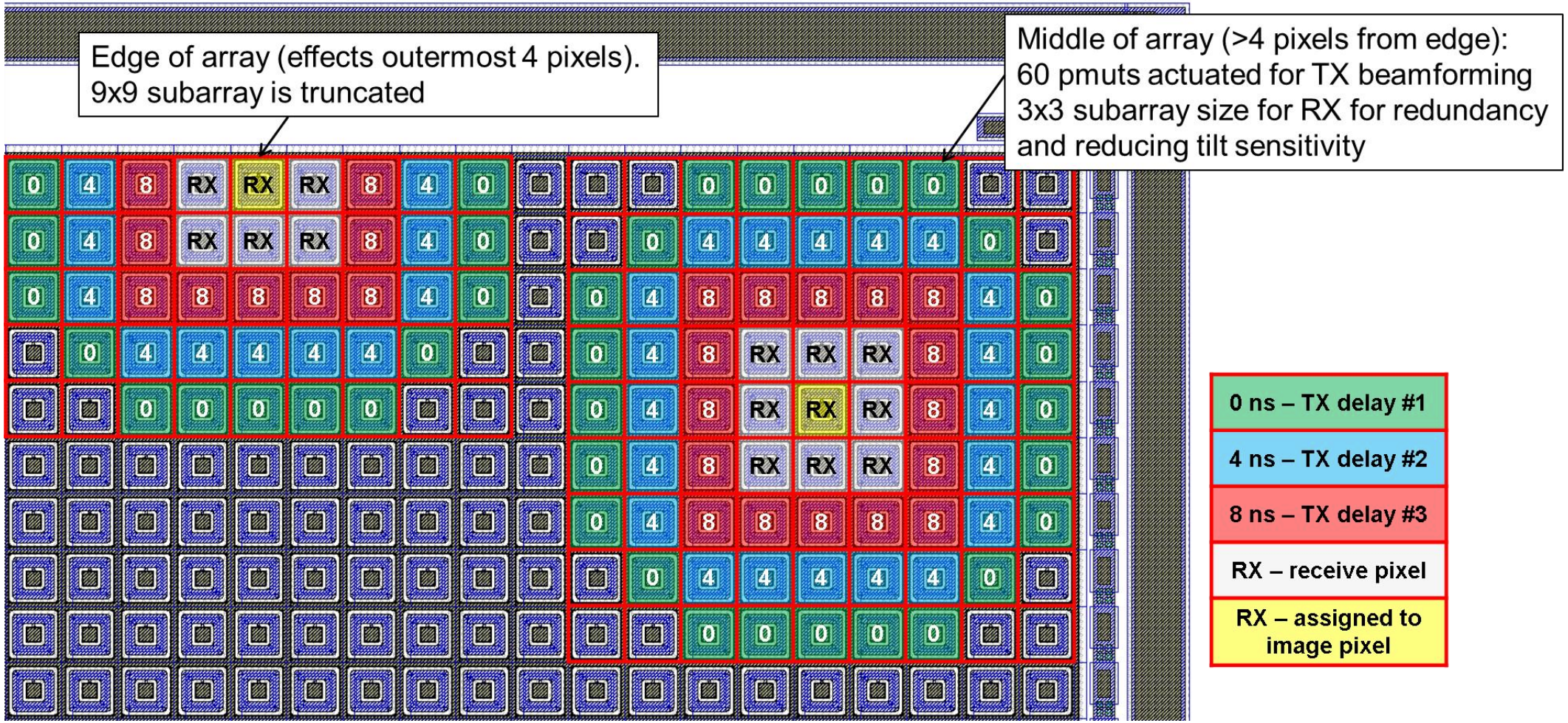
TX: Voltage configurable 12-24V
TX: Frequency configurable 35-55MHz

RX: Analog/digital gain configurable per pixel
RX: Temperature compensation for whole array

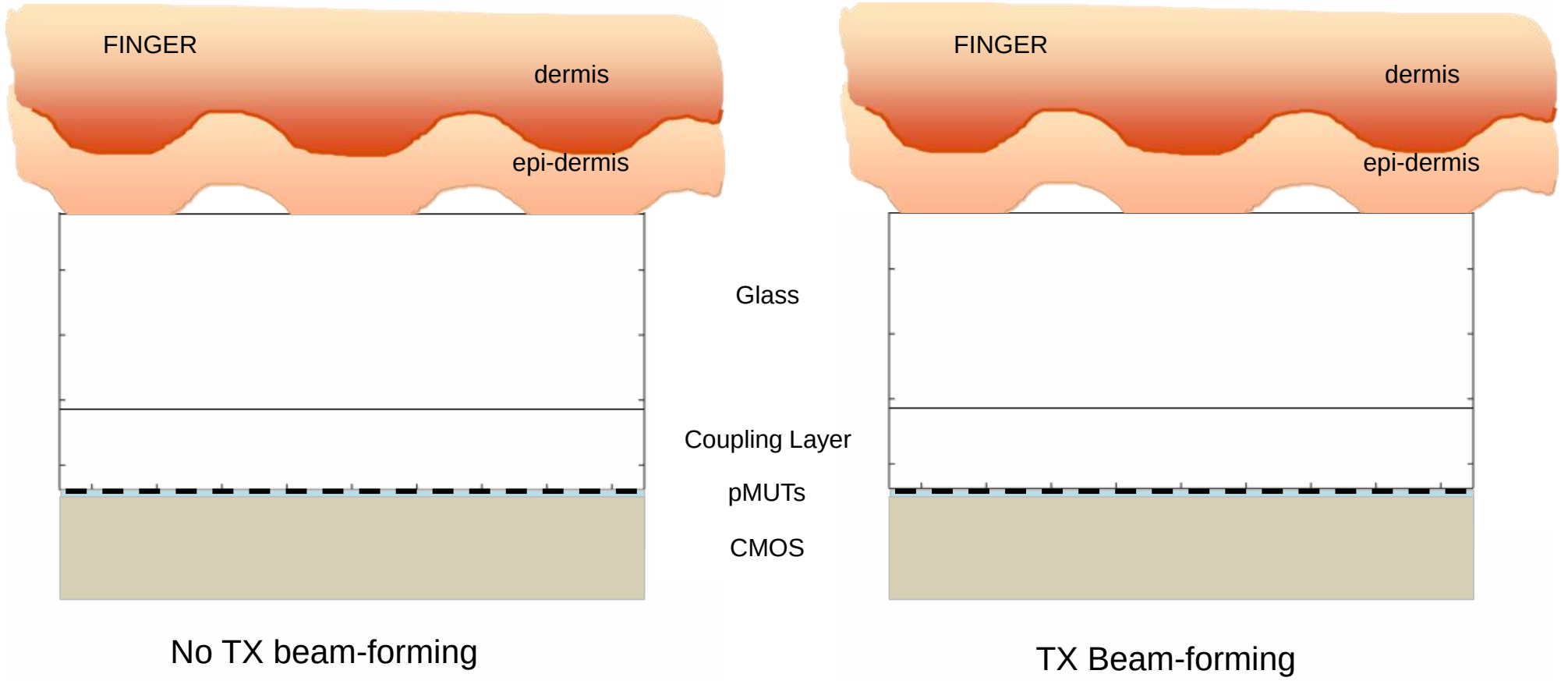
Top-View of corner of die



Beamforming Close-up



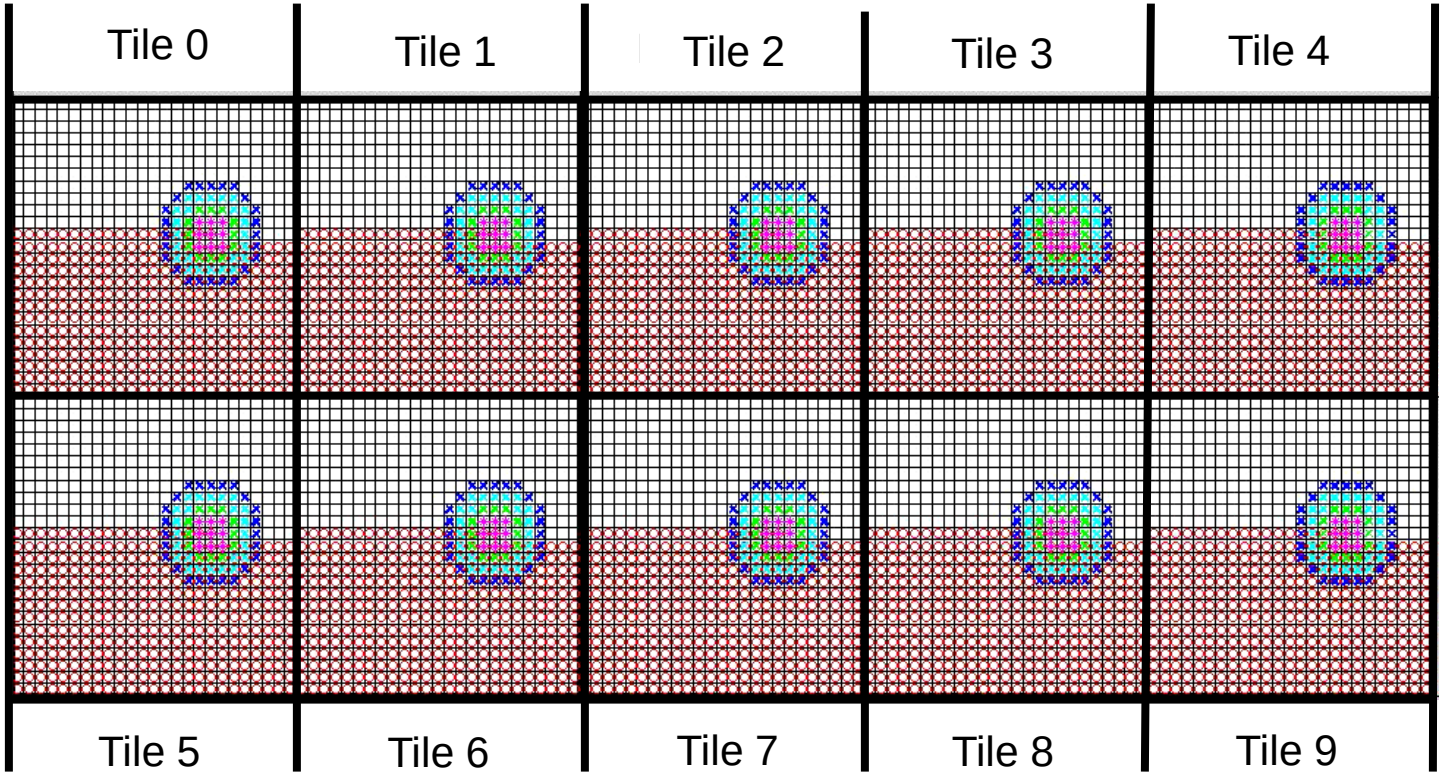
Beamforming Side View Animation



Beamforming focuses ultrasonic energy to improve resolution and increase acoustic power.

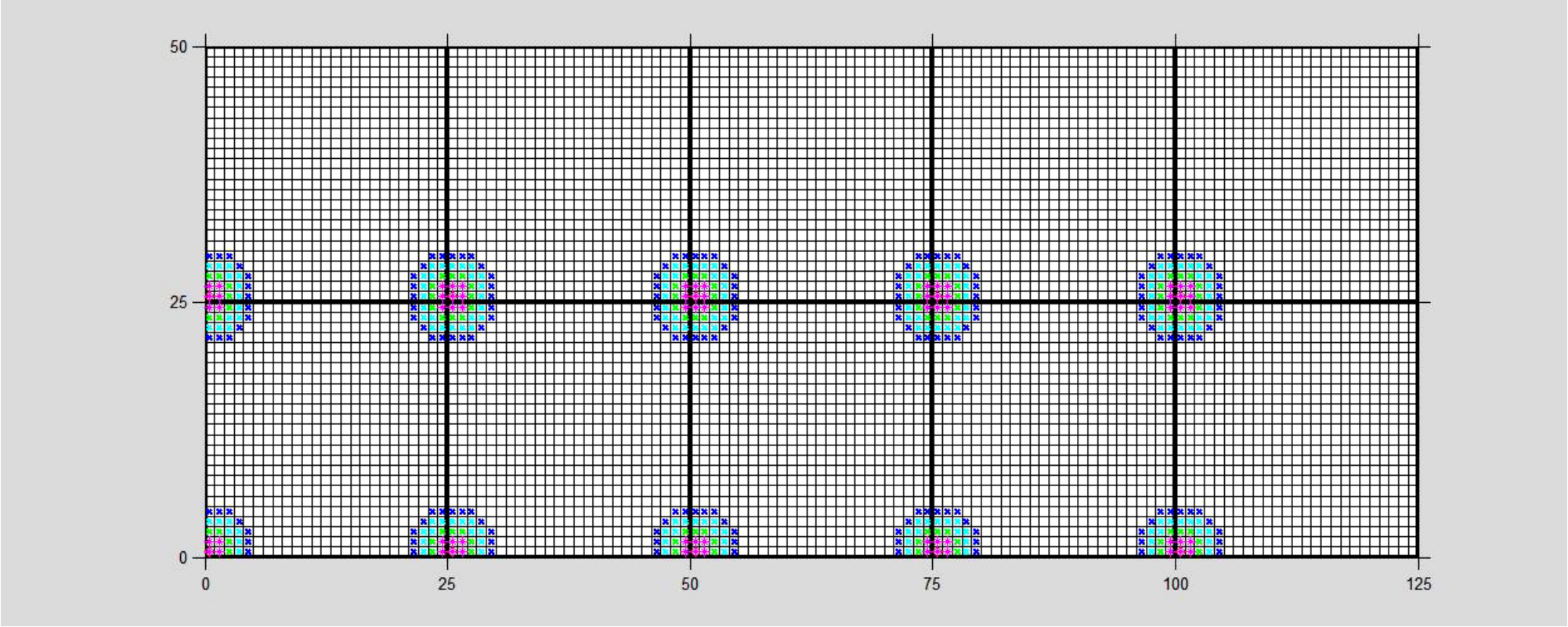
Array Configuration & Image Acquisition

- Simultaneous scanning in to minimize scan time
  - ¬ Limited by separation needed between TX beams to avoid cross-talk
  - ¬ Array is segmented into 2xN identical rectangular portions or tiles, each operating in parallel and having an associated receive signal path

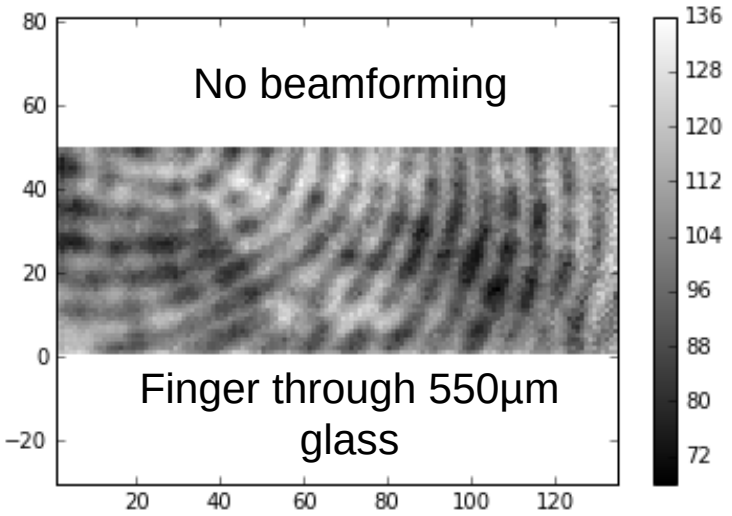


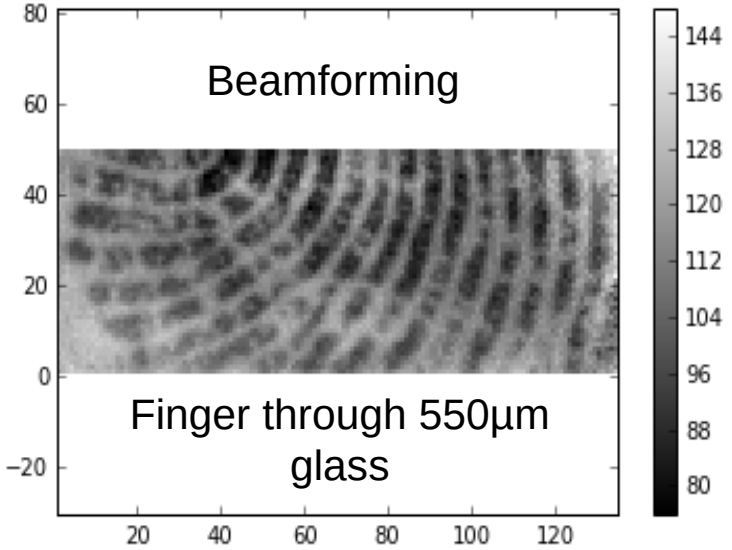
Array Configuration & Image Acquisition

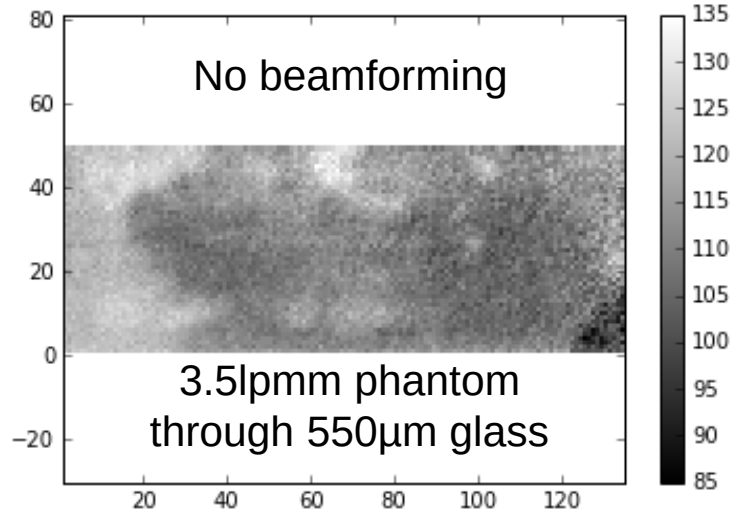
Simulation of active scanning

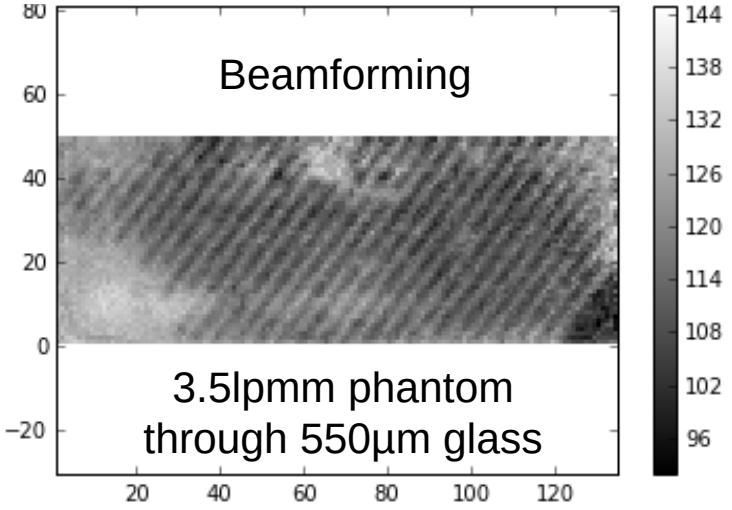


Beamforming Comparison









UltraPrint Cover Materials

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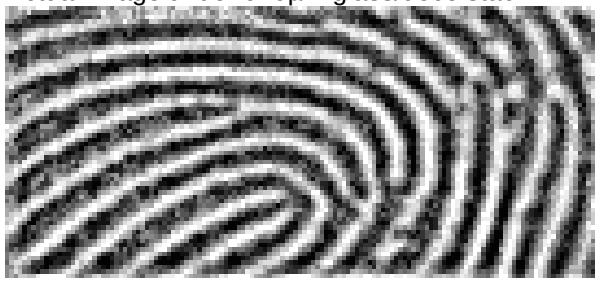
- Currently, UltraPrint sensors can provide superior raw images through the following materials and thicknesses:
  - ¬ Aluminum up to 600µm
  - ¬ Glass/Tint up to 1mm
  - ¬ Glass/Deco film over 900µm
  - ¬ ABS plastic up to 1.5mm
  - ¬ Acrylic up to 1.5mm

- All above materials that have a 3D curve shape above the UltraPrint sensor, an industry first

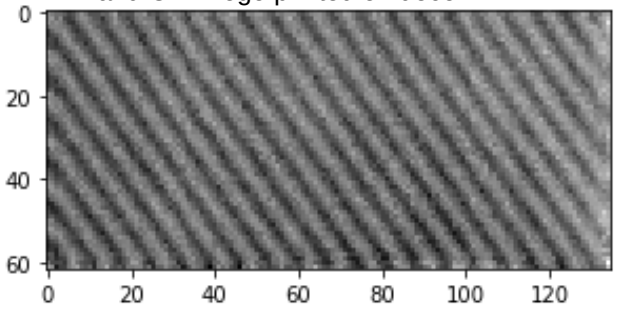
- TDK-Invensense provides module test capability to our module partners
  - ¬ Performed after lamination to calibrate to the specific thickness of the stackup
  - ¬ Enables standard thickness tolerances of the cover materials, reducing cost, ensuring high mfg yield
  - ¬ No calibration issue with injection molded plastic parts that are created from multiple cavities each having some thickness variation or thickness drift over the life of the tool

Actual Image under 940µm glass/deco stack

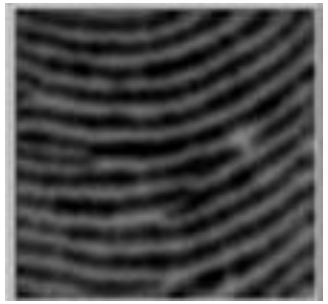


Sweat pores clearly visible

Test target image though 700µm glass with deco film and OEM logo printed on deco film



Actual Image under 1.5mm Acrylic

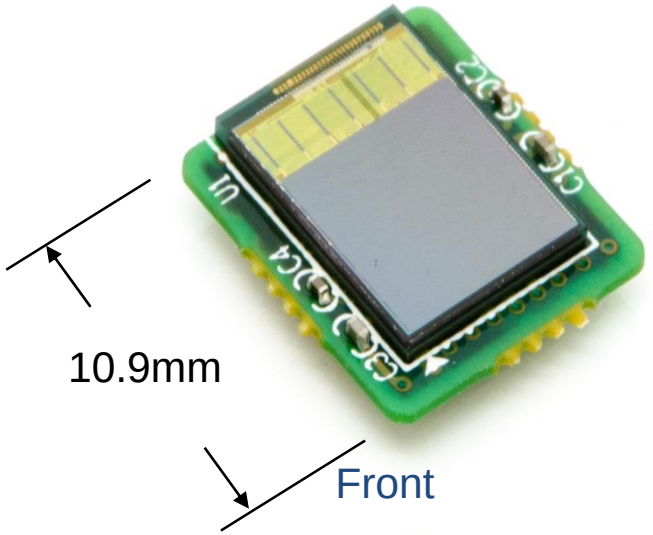


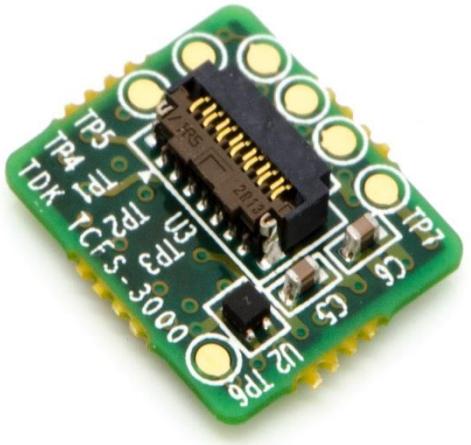
UltraPrint can be integrated into Consumer products with minimal impact to material selection or processing

Embedded / IoT Trends

- Strong opportunity seen in other markets such as:
  - Access Controls and Asset Management for Residential, Hospitality, Enterprise, Consumer
- Existing products seeking to add fingerprint authentication yet sensitive on retail price uplift
- Capability to sense under thick plastic or aluminum required for durability, capacitive sensors are limited on this

TCFS-3000 Module





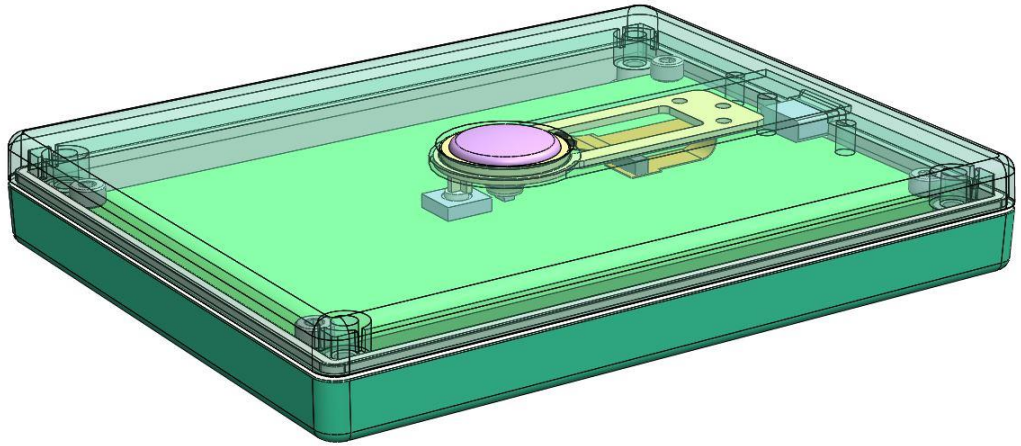
Back

- **TDK Advantage:**
  - **Leverage superior raw image capability to take advantage of lower cost, less capable MCUs for authentication**
  - **Ability to sense under thicker materials enables laminating the UltraPrint sensor behind the enclosure as opposed to requiring a hole that compromises durability**
  - **Superior Performance in the presence of water, needed for outdoor use**
  - **Simple module design**

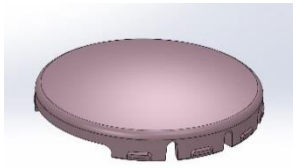
Power Button Design Eval Kit

- TDK-Invensense has created a power button evaluation kit to enable testing in advance or in parallel of the OEM's industrial design

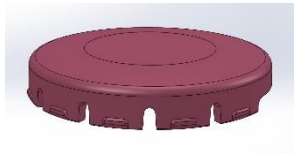
- Platform has the following features:
  - 120MHz ARM Cortex M4 MCU loaded with an embedded authentication software stack allowing enroll/verify testing
  - Eight different keycap designs to mimic desired design language
  - USB Powered
  - RGB illumination around keycap
    - Blue during Enrollment
    - Green for Match
    - Red for No-Match
  - Tactile switch under keycap assembly
    - Can be configured to draw zero power when not in use, or wake on finger mode
    - Different actuation forces available
  - Header on side of housing to enable connecting the UltraPrint sensor to different host MCU
  - BLE Radio (future Smartphone guided enrollment)
  - WiFi Radio (future push notification capability)



Keycap Design Examples



Convex



Concave

Flat

Available to direct, qualified Customers, not available online

Fingerprint Integration for PC

- Up until now, fingerprint sensor integration accomplished by making a hole in the palmrest or C-panel, largely used for Enterprise only
- ‘Click to buy’ feature forcing a difficult to forecast dual SKU for the palmrest
- Causes confusion to customers that mistake a color matched plug as a fingerprint sensor
- Other fingerprint sensor integrations have included:
  - ¬ Keycap in keyboard – UltraPrint can sense under same 3D curve as the other keys on the keyboard
  - ¬ Co-located with touchpad - thinning of glass face sheet not required with UltraPrint
  - ¬ Power button – Capacitive requires drawing at least sleep mode power to stay calibrated, UltraPrint can be used in a zero power configuration when integrated with a tact switch
  - ¬ Display ‘apron’ on Convertible Notebooks – no thinning of glass required for UltraPrint

- **TDK Advantage..**
  - ¬ **Can sense under ABS up to 1.5mm thick, aluminum up to 600µm**
  - ¬ **Ability to sense under a 3D curved surface, enables Industrial Design differentiation**
    - o **Under palmrest, display apron, keycap or power button**

Windows Security Certification Schedule

- Windows 10 Hello Driver Certification Passed July 17
  - ¬ All WHQL tests passed
  - ¬ Microsoft Spoof Criteria also Passed

- Windows 10 SecureBio Match on Module Release in development now
  - ¬ Uses ARM Cortex M7 MCU for TPM
  - ¬ Certification planned for Mid-Nov 2018 – On track
  - ¬ TDK-Invensense can either provide binary and source to enable third party integration with a different TPM or perform the integration using our CE team

Microsoft

Hardware certification report **Approved**

Private product ID:	**14411713004824131**
Shared product ID:	**1152921504607532104**
Submission ID:	**1152921504627732112**
Submission date:	**7/11/2018**
Completion date:	**7/17/2018**
Company:	**InvenSense, Inc.**
Product name:	**UPrintWinBio Dongle v0.4.0.1**
Category:	**Device**
Product type:	**Finger Print Reader**
Qualification level:	**Certified for Microsoft Windows 10 Client family version 1709, x64** **Certified as Declarative INF**
Marketing name:	**N/A**

Fingerprint Integration into Automotive

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- Personalization and access has been recently implemented through identification by Smartphone or NFC card.
  - ¬ Access can be limited by the presence of the owner's phone or NFC card at the moment of vehicle entry
  - ¬ The owner's fingerprint is a constant when attempting vehicle entry

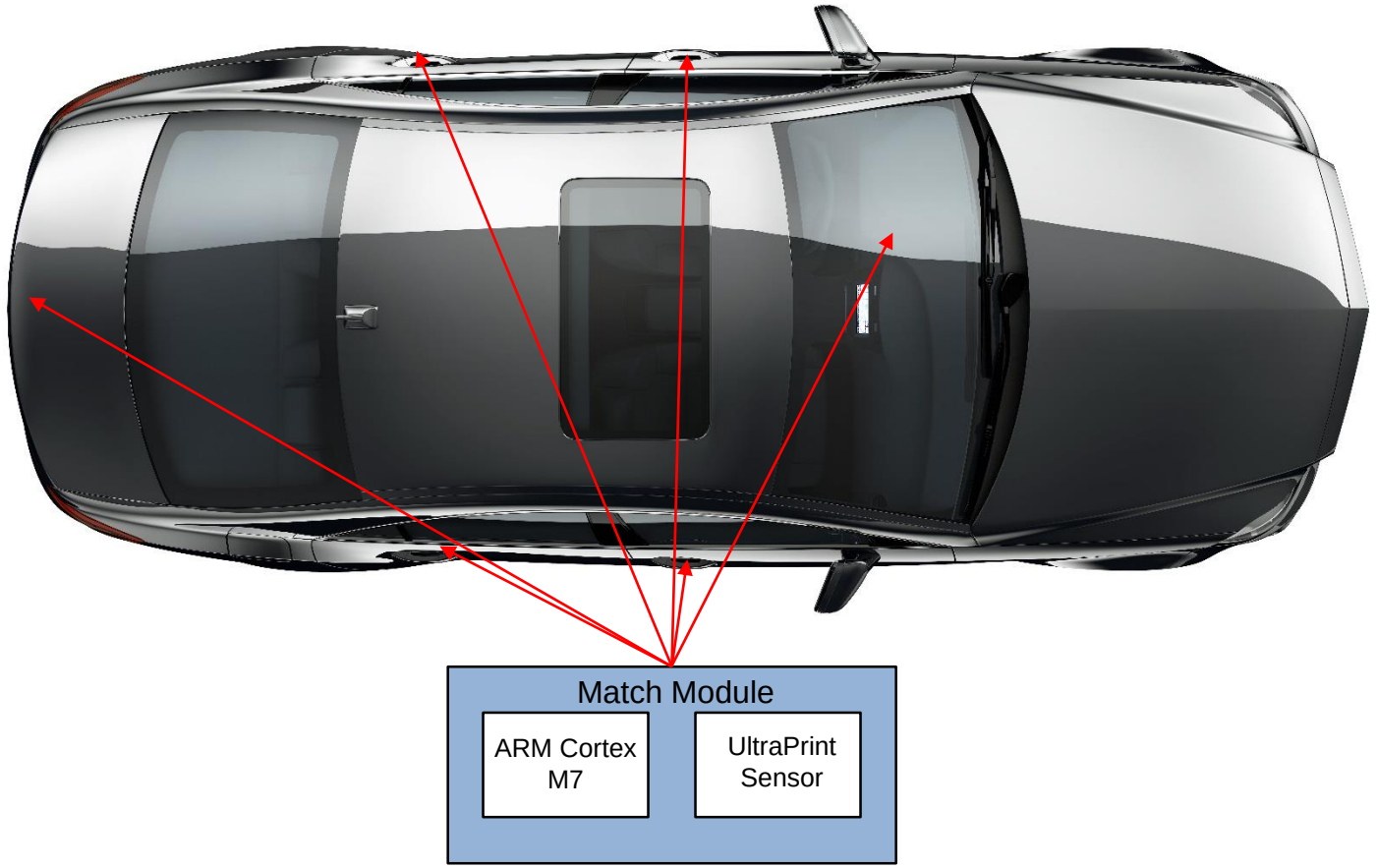
- Fingerprint authentication integration emerging in…
  - ¬ Door handles, Trunk Lid, Start/Stop button, B-pillar

- Multiple sensors requires secure sharing of authentication information within the vehicle to…
  - ¬ …enable repair or replacement of a sensor in the event of collision or sensor failure
  - ¬ …enroll a finger on one sensor, then securely share to all sensors in the vehicle to benefit user experience

- **TDK Advantage..**
  - ¬ **Superior performance in the presence of water**
  - ¬ **Ability to be laminated behind a durable surface eliminating chance for water ingress**
  - ¬ **Ability to sense through a 3D curved surface, important for best biometric usability**
  - ¬ **Securely Architected for template sharing and repairability**

Automotive Integration

- Match Modules located in the doors, trunk lid and console
- Match is performed at each location
- Enrollment on the sensor in the console
- Enrolled templates shared securely via a private CAN bus
- Allows for immediate use on all of the other sensors in the vehicle



Superior Wet Performance makes UltraPrint the ideal colution shoice for Automotive

UltraPrint Solution Readiness

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- All
  - Available now – TCFS-2000 and TCFS-3000 modules mounted into mockup housings with Data Collection software to perform usability testing
- PC
  - Available now – Windows Hello Certification, Windows Hello Evaluation Dongle using TCFS-2000
  - Coming this fall – Windows 10 SecureBio Match on Module Certification, Power Button Evaluation Kit
- Automotive
  - Coming this fall – Waterproof (IP66 rated) housing with an UltraPrint sensor mounted under PC-ABS, Data Collection Software for usability testing
  - January 2019 – AEC-Q100 Grade 1 Certification
  - June 2018 – AEC-Q100 Grade 2 Certification
- IoT
  - Coming this fall – Power Button Evaluation Kit, iOS and Android Smartphone App for Enrollment management and Push Notifications

Thank You!