SigmaSense

Better Data is Everywhere

Digital Sensing Transformation

Software Defined Sensing

New Breakthrough Experiences Possible Everywhere

FEBRUARY 9, 2022

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The User Experience

Redefining Human Machine Interaction (HMI)

Human Factors and ***Experience*** are dominated by sensing data

Large Interactive Displays

IWB/Digital Signage/POS

Tablets, Notebooks, ePaper

Foldable, Rollable & Edge Display

Smartphones

Foldable, Rollable & Edge Display

Gaming

Handheld & Immersive

Automotive

Full Width Digital Dashboards

Biosensing / Medical Sensors

Bioimpedance & Telemedicine

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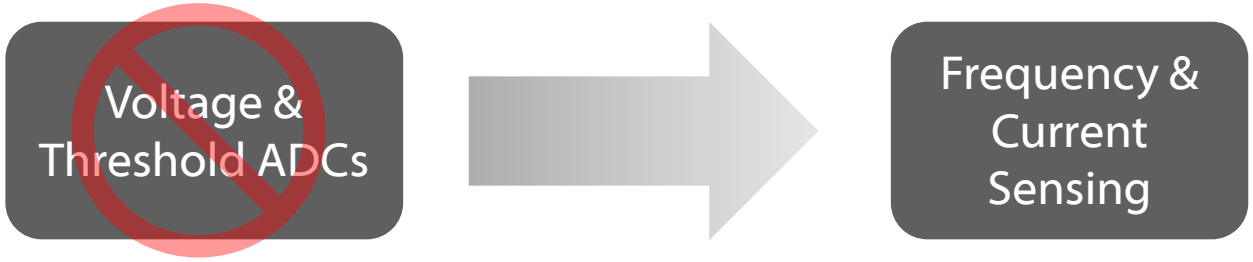
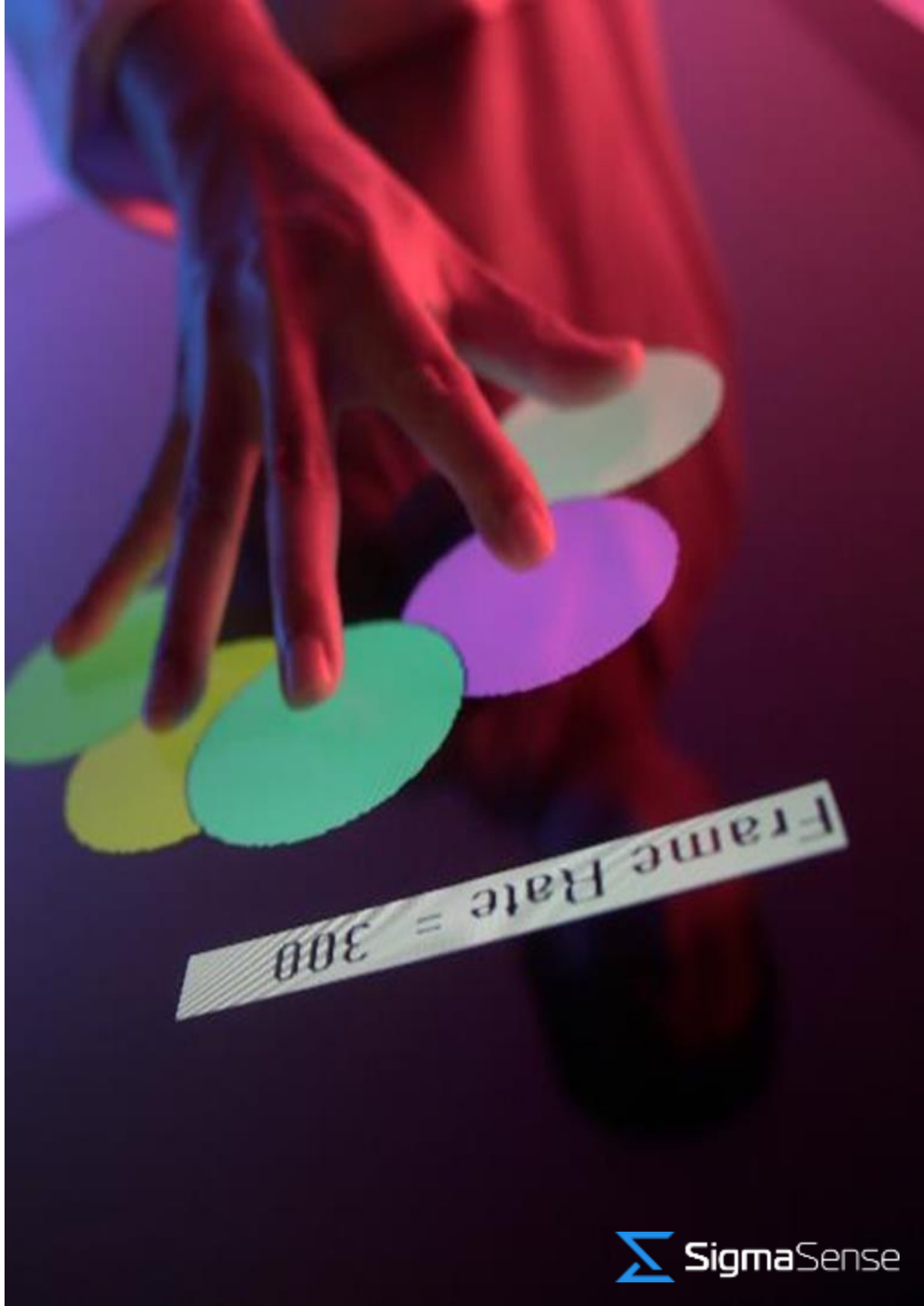
Digital Transformation

Moving past 40 years of voltage based ADCs
The worlds first "direct-to-digital" current based sensing…

Instantaneous Data Sensed from a Distance

- Disruptive technology improves data capture SNR 100X-1000X
- World's leading touch performance for $150B display industry
- Lead rapid growth in EV's, wearables, bio-sensing, IoT
- High quality sensing data … Everywhere!





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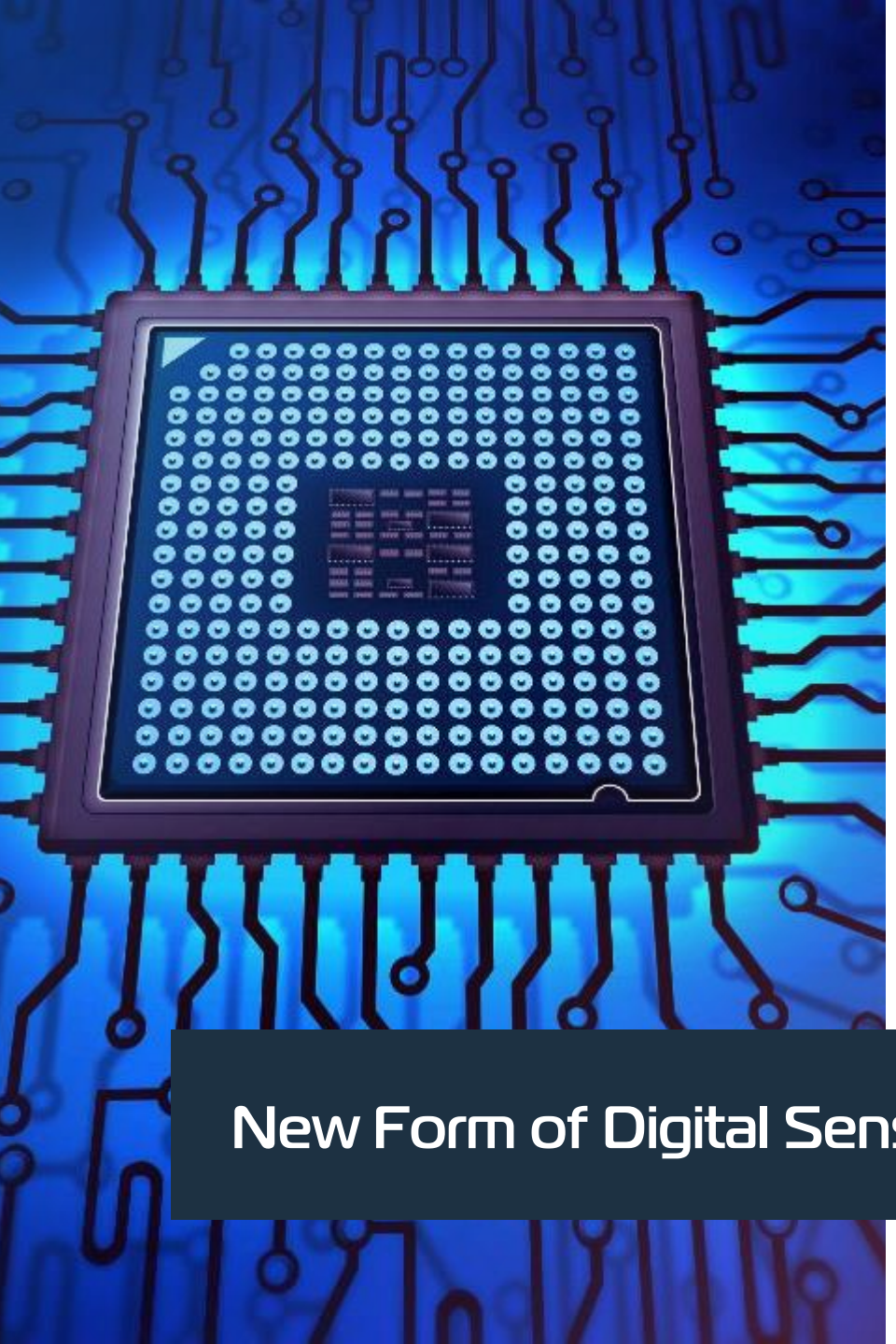

What we Assumed were "Facts" are No Longer True

"ADCs must be located close to the signal being sensed" - FALSE

"Analog function changes require HW changes" - FALSE

"Noise directly on our frequencies cannot be filtered" - FALSE

"Signal amplification also amplifies the noise" - FALSE

"High voltage signals are required to get above the noise" - FALSE

New Form of Digital Sensing Impacts Critical Design Choices

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Software Defined Sensing

Conceptually similar to
Software Defined Radios

Analog Radio → Digital Radio

Vast Frequency Data Processed in Software
Makes Radios programmable and adaptive

Analog to Digital Transformations Strike Fast with Massive Impact

Traditional ADC/DAC
Voltage & Time

VS

SigmaSense
Current & Frequency

Analog Phone
Voice call focus

VS

Digital Phone
Rich user experience

Vast Frequency Data Processed in Software
Makes Sensing Programmable and adaptive

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Concurrent on a Single Pin:

World's Only Concurrent & Adaptive Sensing Transceiver

On a single pin

90% digital

- Multi-frequency Transmit (Tx / Drive)
- Multi-frequency Receive (Rx / Sense)
- Digital communications
- Power delivery
- Continuously and concurrently on **one pin**

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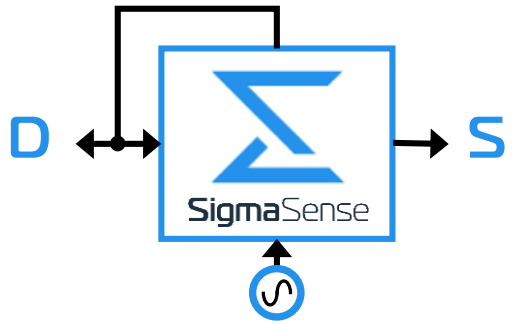
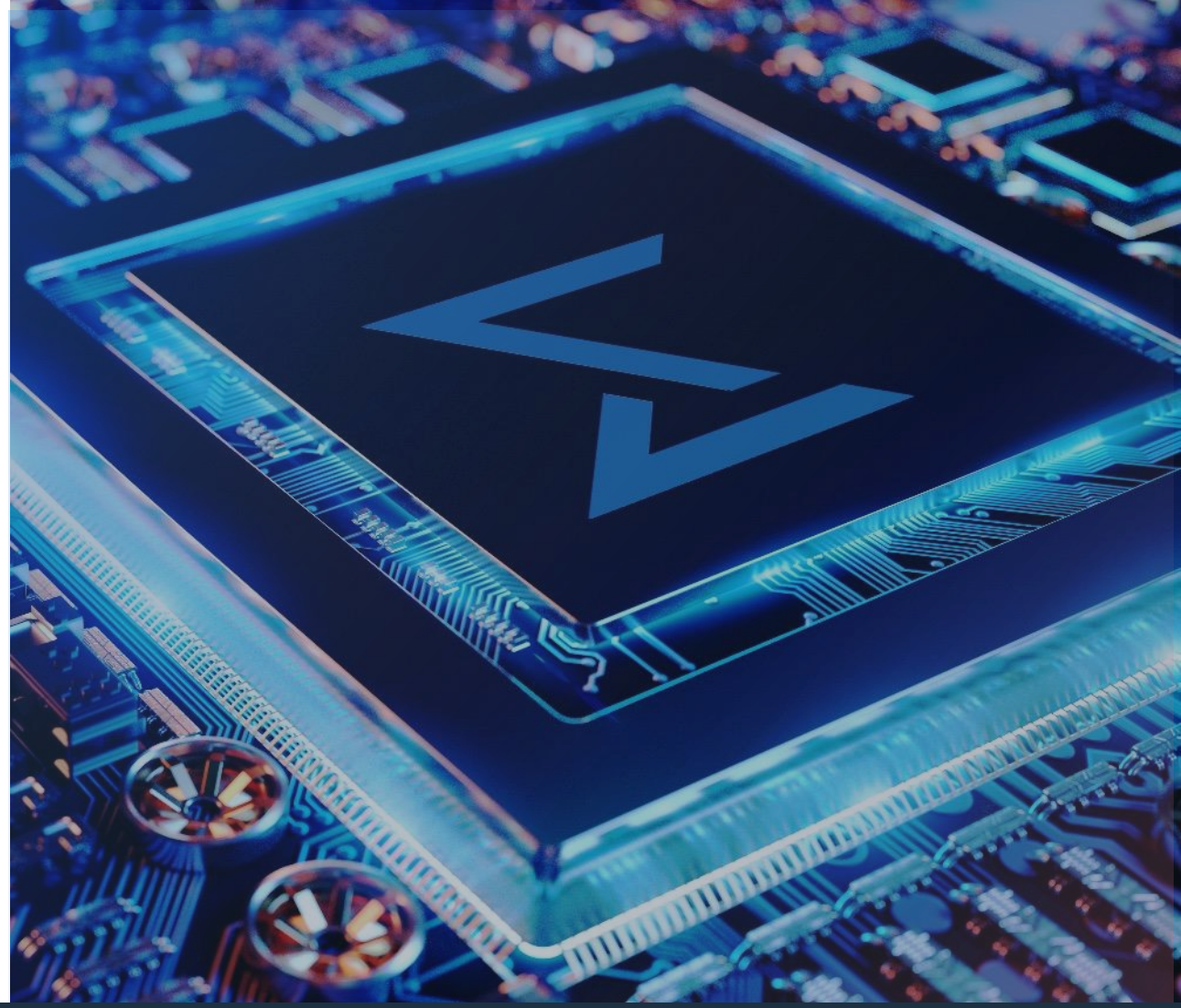
Breakthrough at the Source of Information Capture

"Frequency" based "Current Mode" Analog to Digital Conversion (ADC) delivers Instantaneous Sensing Data

Continuous and Concurrent drive and sense solves timing issues of high capacitance and high resistance loads

Vast amounts of "Instantaneous" Frequency based Data enables Software-Defined Sensing





Adaptive software controls for capturing analog data without traditional "Voltage" and "Time" based constraints

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Digital Transformation

Concurrent Adaptive Sensing Transceiver Technology

Touch, Force, Vibration, Fluids, Distance, Presence, Position, Motion, Temperature, Humidity, magnetics, MEMS, and more

SDM measured current directly

- No need to convert and amplify voltage
- Lowers thermal noise
- Lowers power and can sense pico amps of change
- Sense from a distance thru high resistance or high capacitance

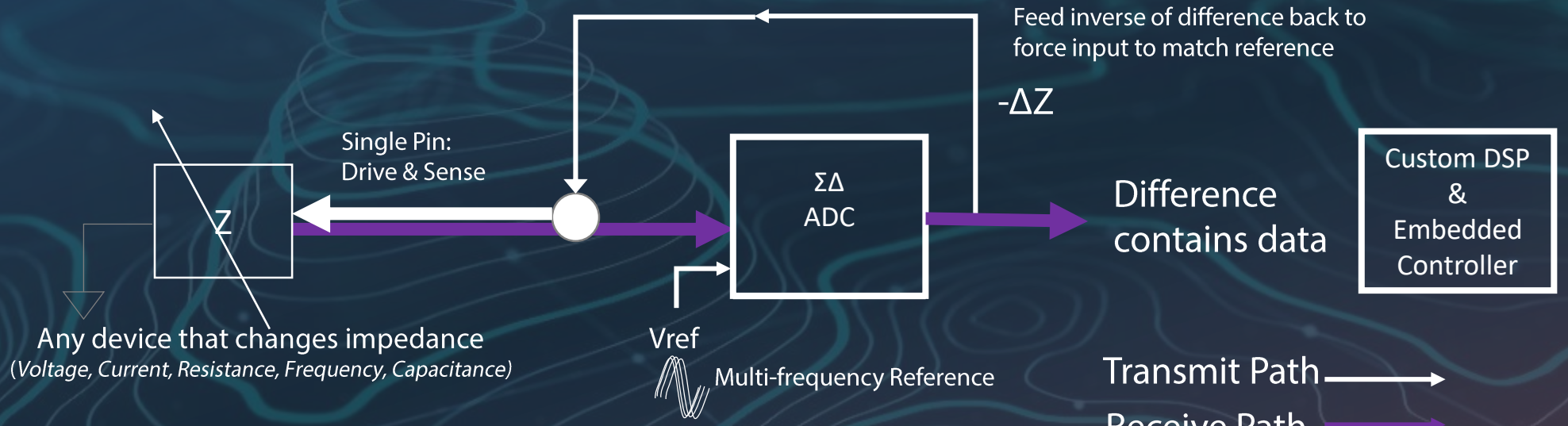
Large TX/RX arrays are concurrent & continuous on each pin

- Instantaneous multi-frequency data without scanning

Software Defined Sensing

- Vast Frequency Data processed in Software makes Systems Adaptive

SigmaDelta Modulator (SDM)



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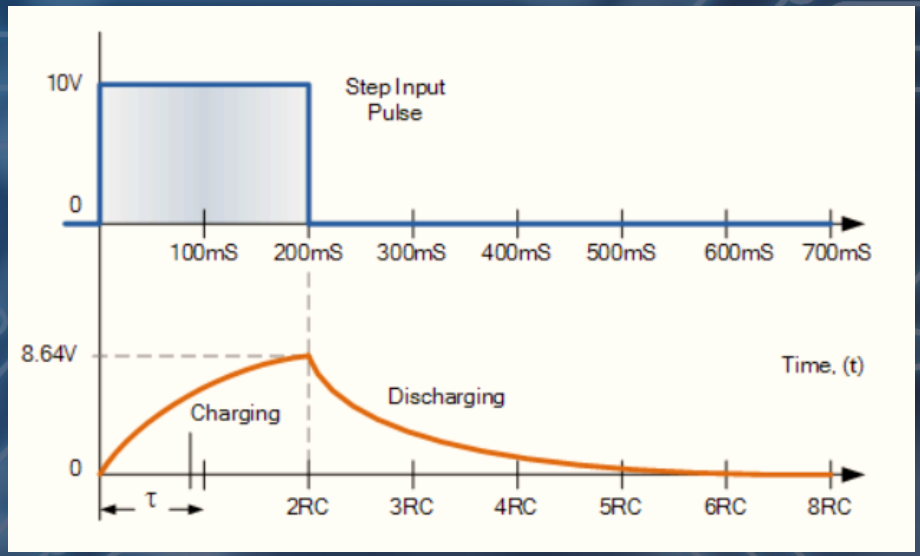
TRADITIONAL TOUCH CONTROLLERS

Typical PCAP touch controllers are at the mercy of how long it takes to charge the capacitor (i.e. achieve voltage threshold) at each cross point in the touch sensor

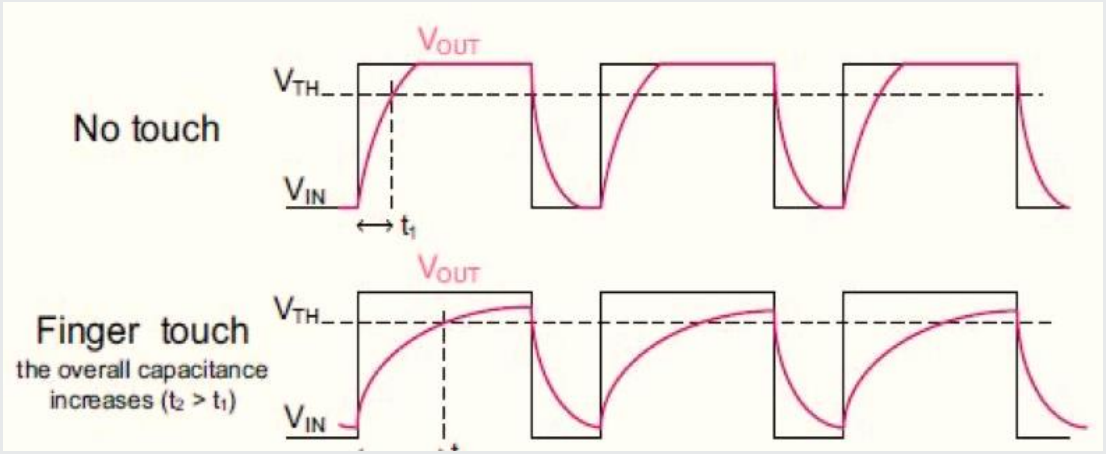
A baseline of charge times are stored for each cross point

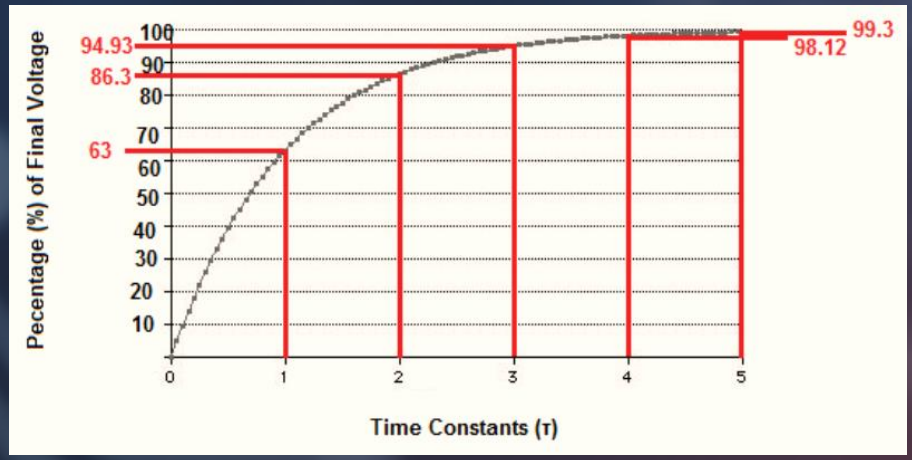
When a finger touches a crosspoint, it adds capacitance, therefore it takes longer to charge each cross point capacitor



Higher resistance (or capacitance) can prevent the channel from charging in the time available

The RC Time Constant = Resistance * Capacitance





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SigmaVision® Continuous CAPACITIVE IMAGING

Image the entire sensor matrix at the same time (NO scanning)

SDM on every channel (rows & columns)

All frequencies digitally created and processed

Transmits and processes multiple frequencies on each channel

Process Self, Mutual & Pen concurrently (NO multiplexing)

Advantages

Continuous mode operation – no muxes

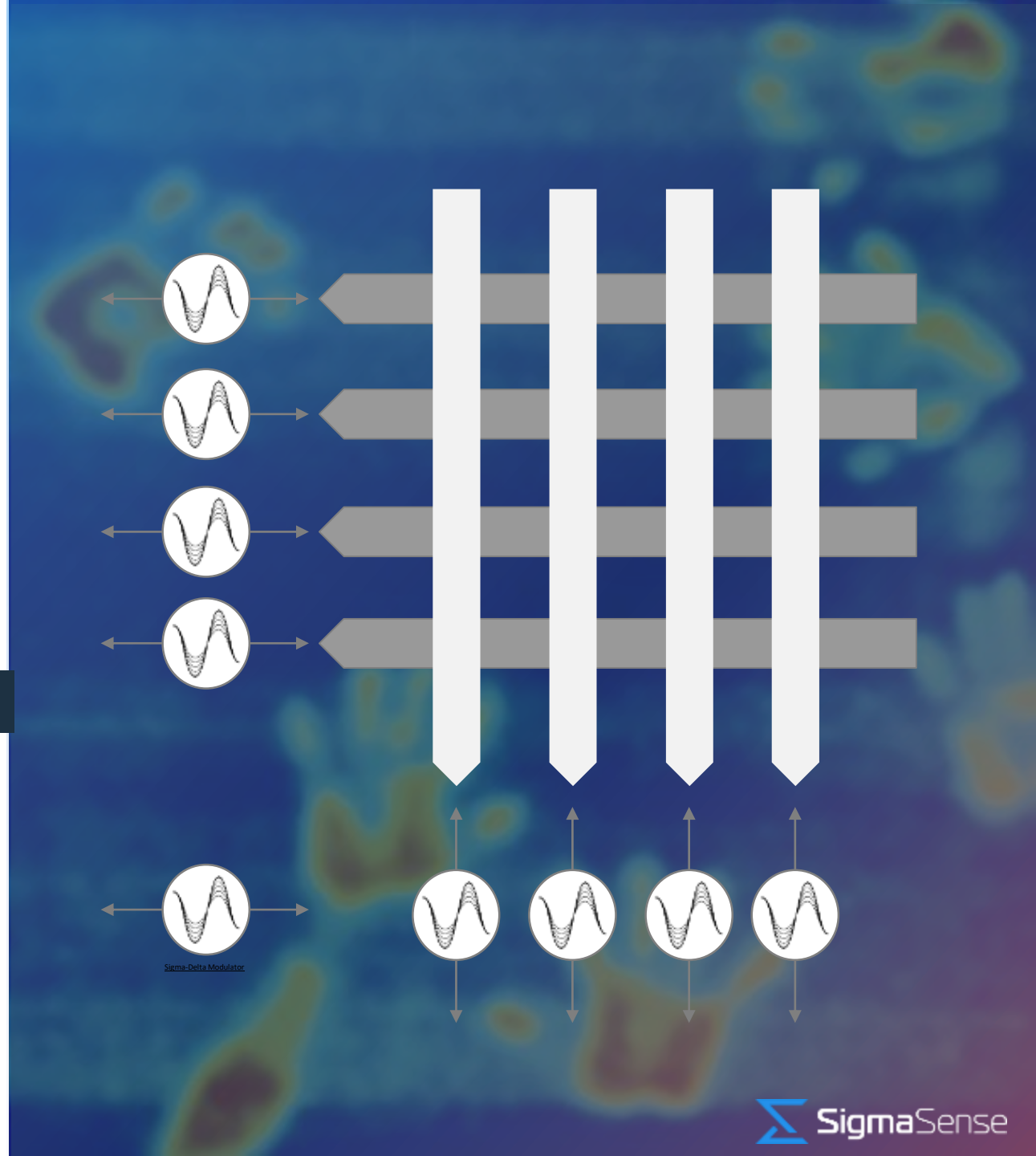
Dynamic, software controlled configurations

Active Noise Mitigate - much easier

Eliminates parasitics in self mode

Mitigates parasitics in mutual mode

Gaming class performance 300 Hz reporting



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SNR is Measure of "Data out of Chaos"

Current Mode ADCs provide better noise tolerance

SNR (Signal-to-Noise Ratio)

- Signal is increased by driving with higher voltage
- Noise is decreased by averaging samples over time

Current mode ADCs are faster and low voltage

- Transmit **VOLTAGE** and **TIME** must be benchmarked

SNR/V * t_n (SNR per Volt normalized for time)

"Give me a place to stand and I will move the Earth"
– Archimedes

SNR is the lever that moves data... Data moves the world

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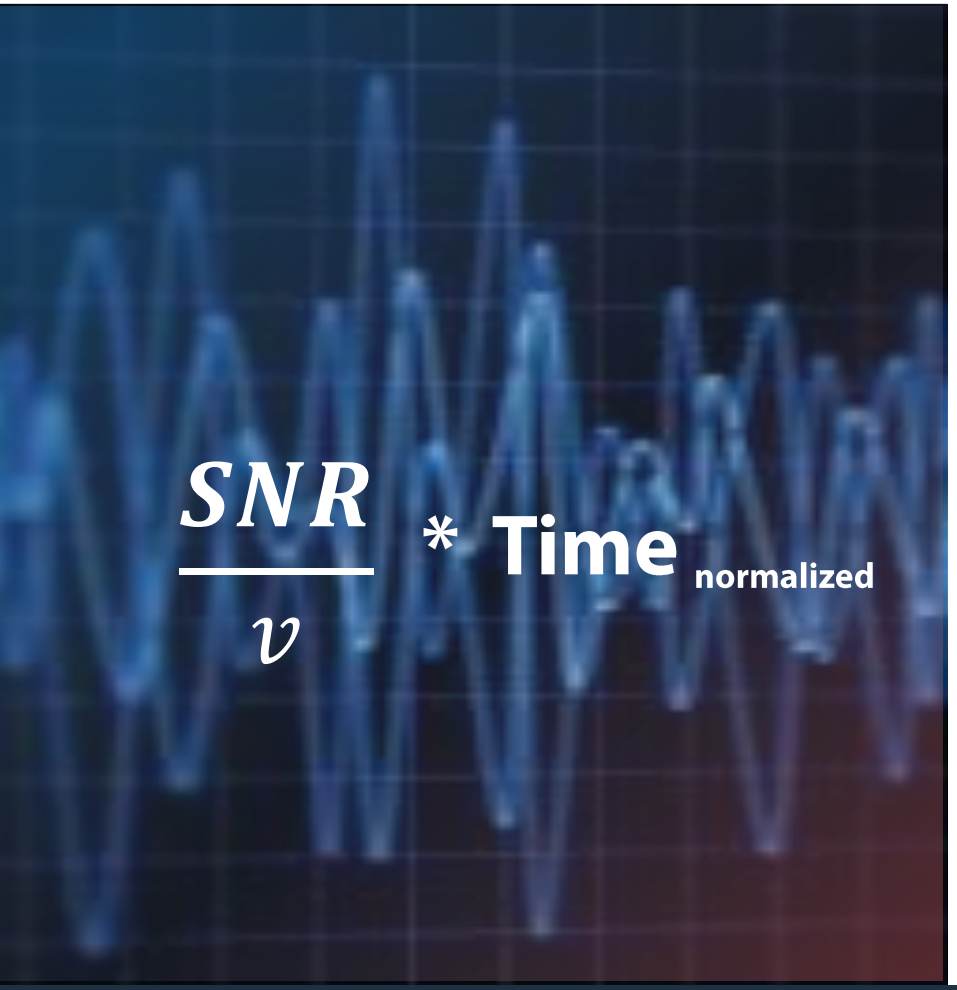
Better Data Starts with Better SNR (Signal-to-Noise Ratio)

Touch Screen Example:



Competitors vs. SigmaSense

32” Touch Sensor: 786.2/0.2812 = *2,796x better SNR/v*

15dB SNR, using 20.0V @ 120 Hz

$\frac{10\text{^}(15dB/20)}{20V} = \mathbf{.2812}\ \frac{SNR}{v}$

Time $_{normalized} = \sqrt{(120/120)} = 1$

$0.2812 * 1 = \mathbf{0.2812}\ \frac{SNR}{v} * t$

52dB SNR, using 0.8V @ 300 Hz

$\frac{10\text{^}(52dB/20)}{0.8V} = \mathbf{497.6}\ \frac{SNR}{v}$

Time $_{normalized} = \sqrt{(300/120)} = 1.58$

$497.6 * 1.58 = \mathbf{786.2}\ \frac{SNR}{v} * t$

100” Touch Sensor: 100.8/0.2857 = *353x better SNR/v*

20dB SNR, using 35.0V @ 60 Hz

$\frac{10\text{^}(20dB/20)}{35V} = \mathbf{.2857}\ \frac{SNR}{v}$

Time $_{normalized} = \sqrt{(60/60)} = 1$

$0.2857 * 1 = \mathbf{0.2857}\ \frac{SNR}{v} * t$

36dB SNR, using 1.4V @ 300 Hz

$\frac{10\text{^}(36dB/20)}{1.4V} = \mathbf{45.07}\ \frac{SNR}{v}$

Time $_{normalized} = \sqrt{(300/60)} = 2.24$

$45.07 * 2.24 = \mathbf{100.8}\ \frac{SNR}{v} * t$

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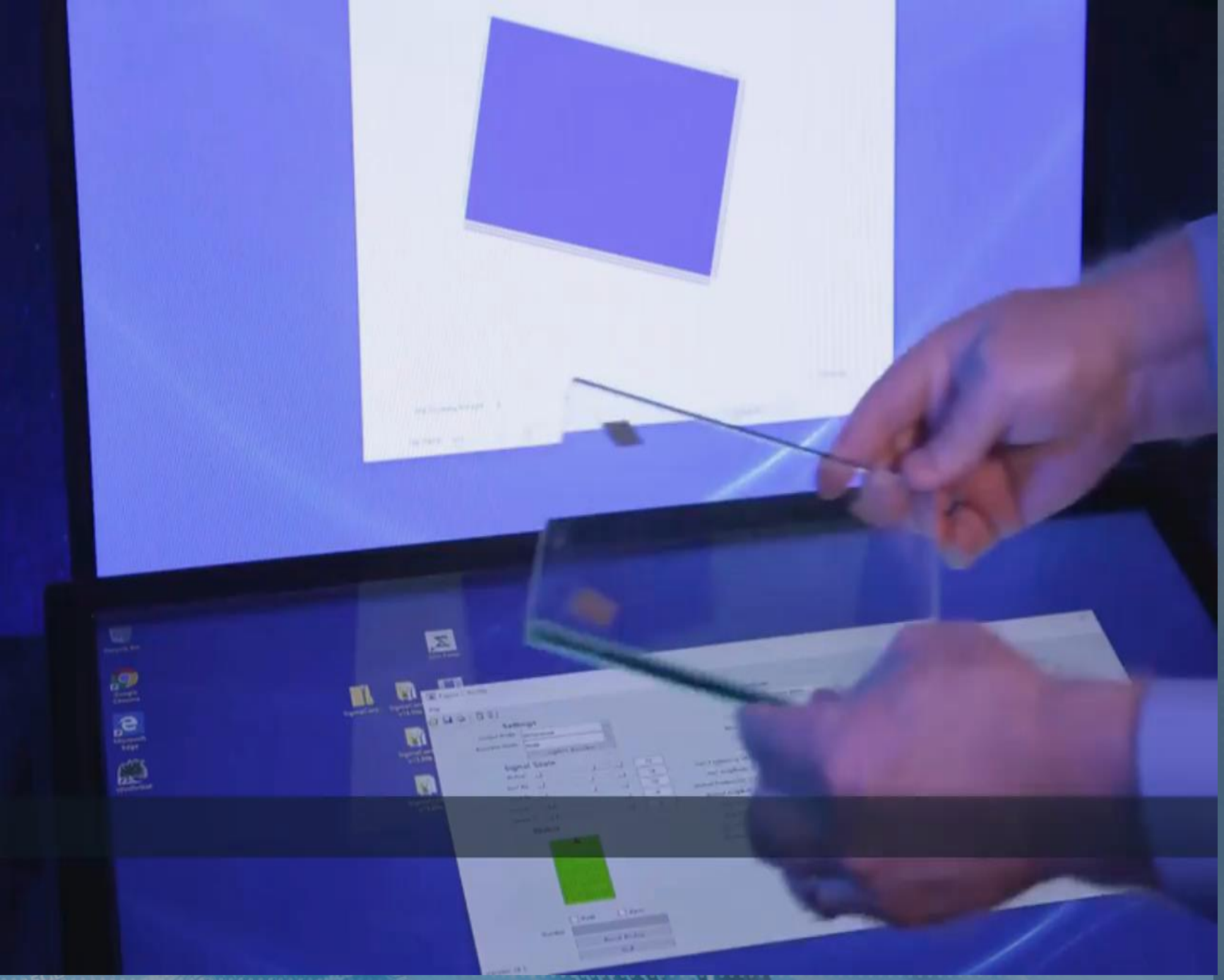

10mm GLASS

32 inch 3mm sensor

Touch through glass, even through gloves

10mm Glass & Gloves

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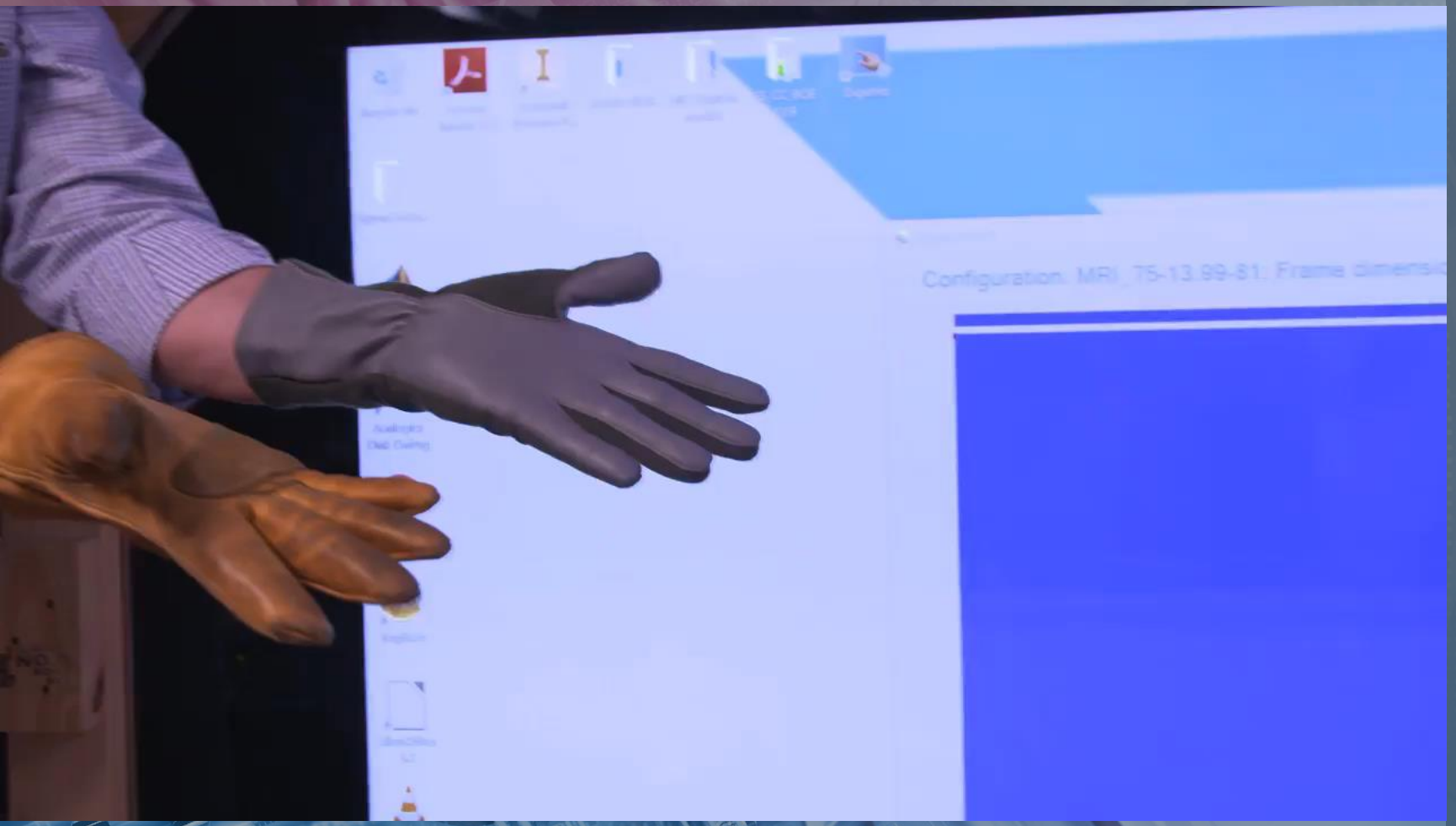

THICK GLOVES

High sensitivity – touch through multiple layers of gloves

Winter gloves

Mil standard flight gloves

Thick Gloves

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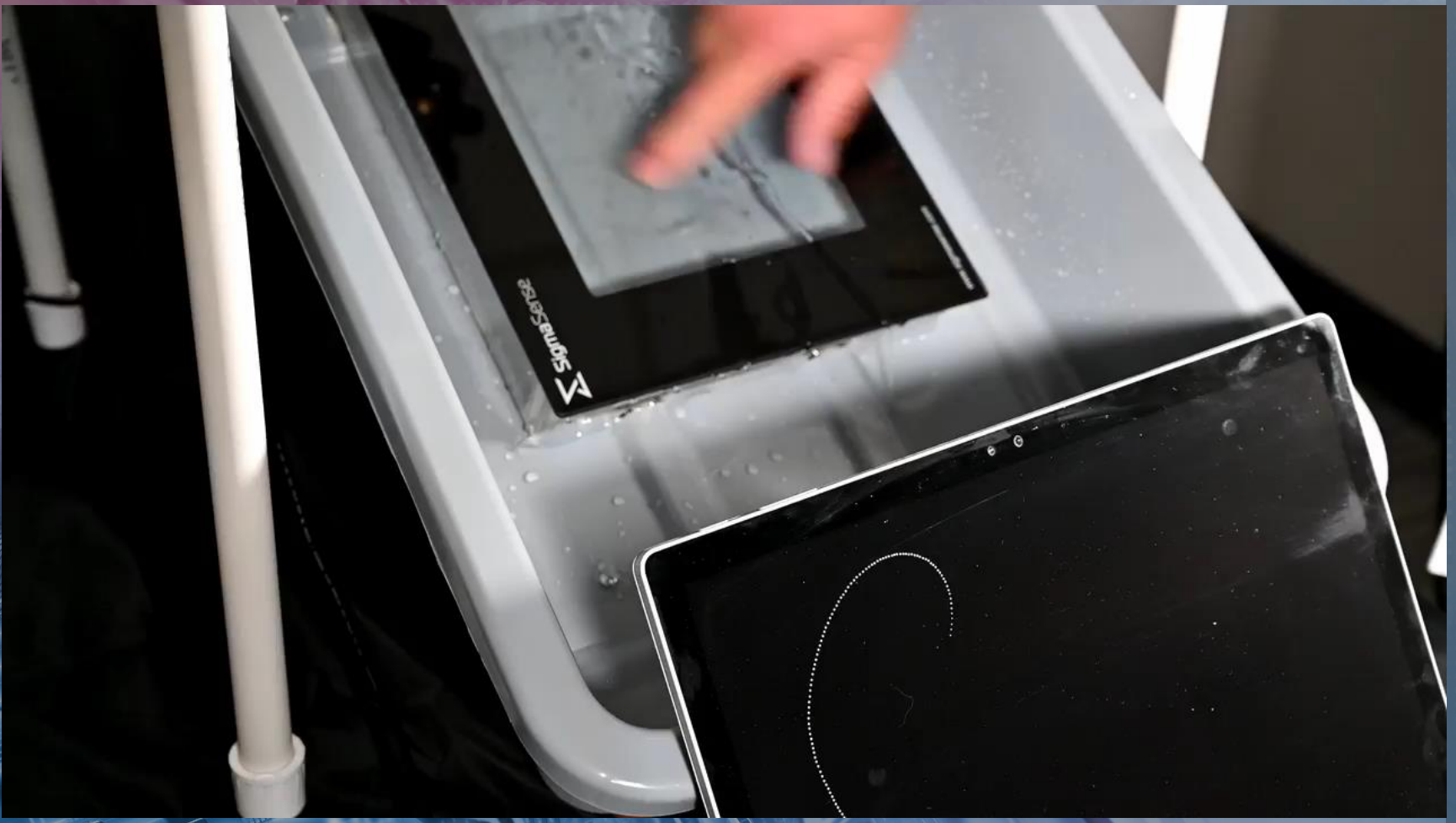
SigmaDrive™ TECHNOLOGY



RUNNING WATER TORTURE TEST

Touch through running water

300 Hz reporting

Water Drip Test

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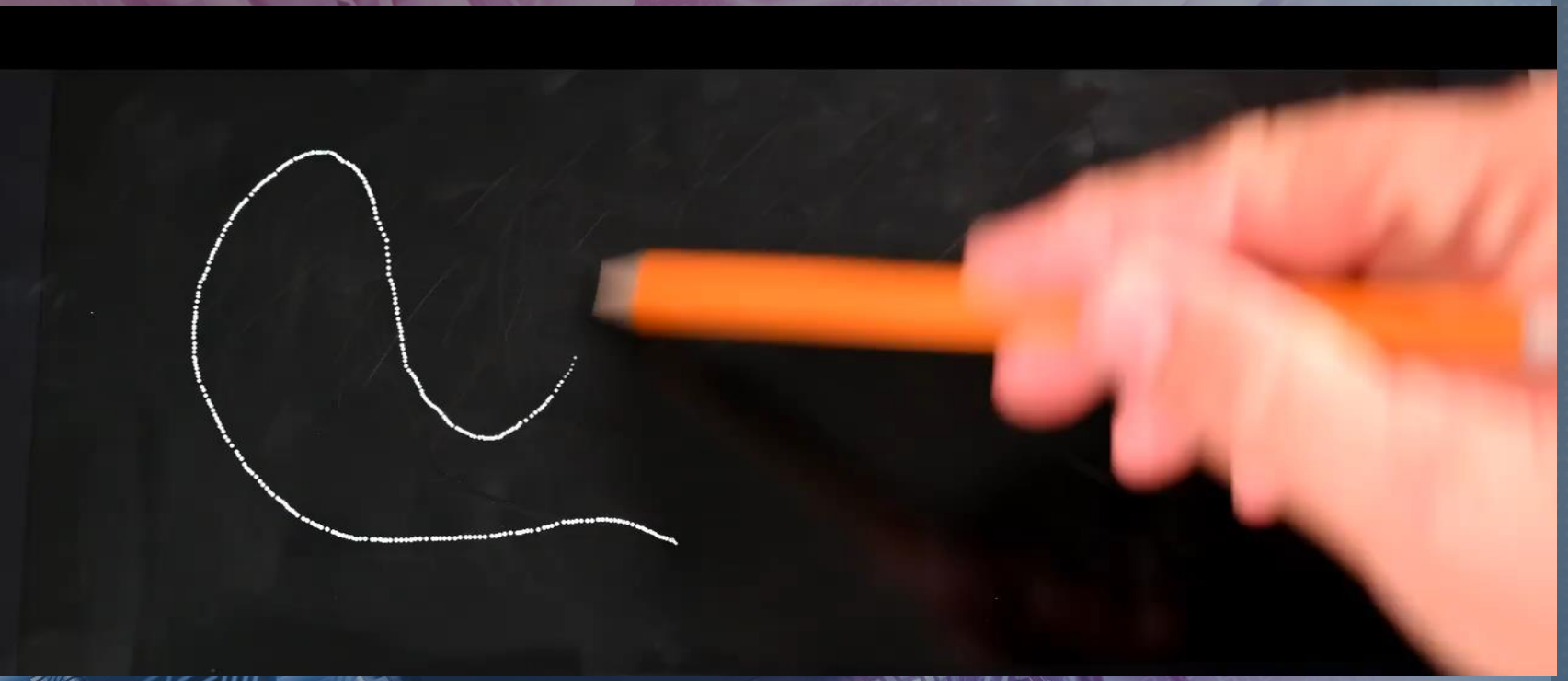

PASSIVE STYLUS

Common Pencil
300 Hz HID reports

Passive Stylus with 300Hz Reporting

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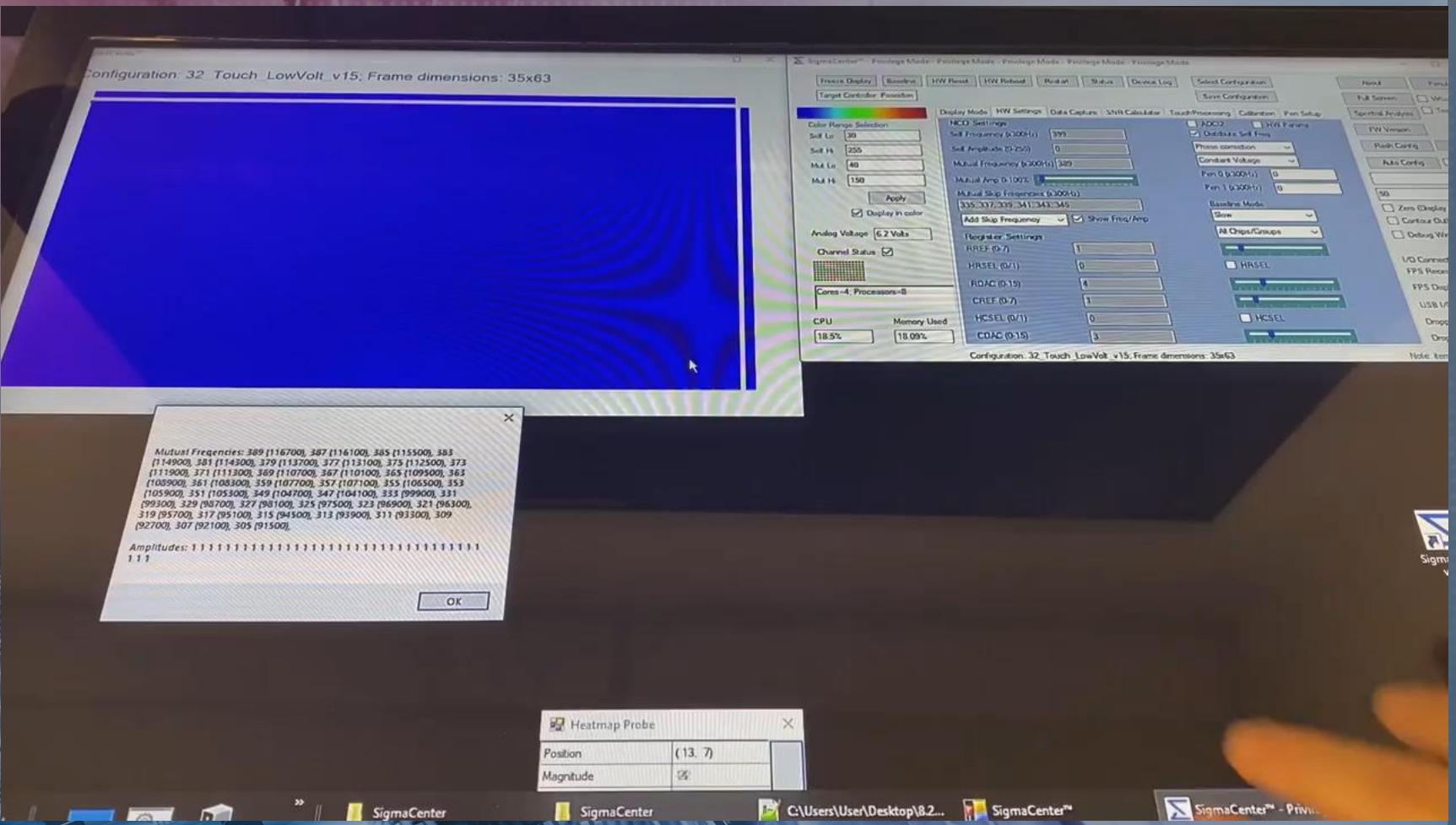

LOW VOLTAGE OPERATION

32" ITO Sensor driven with 0.02V

(1000X lower voltage)

24db touch SNR

300 Hz reporting

Low Voltage Drive

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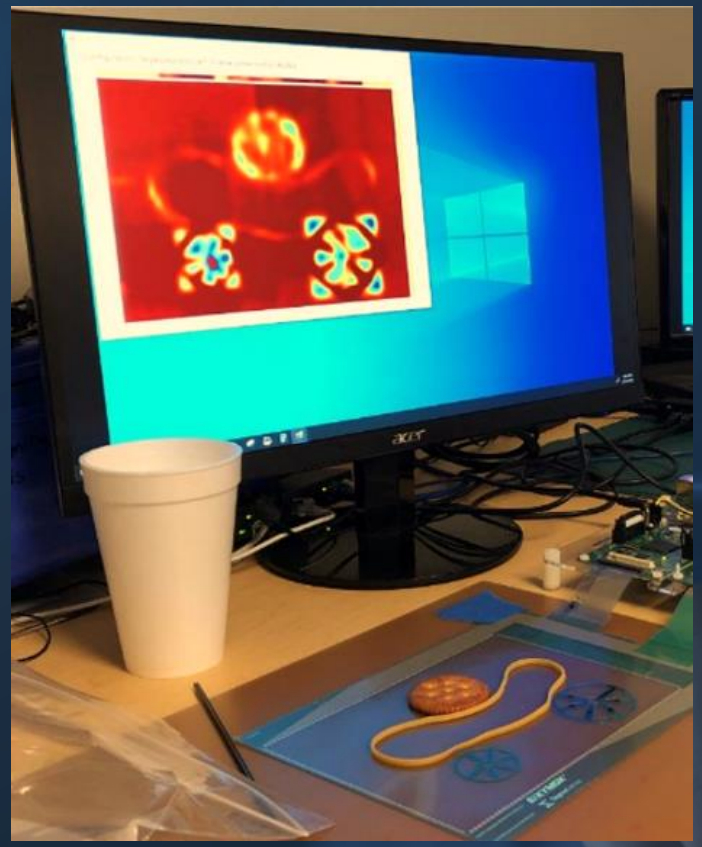
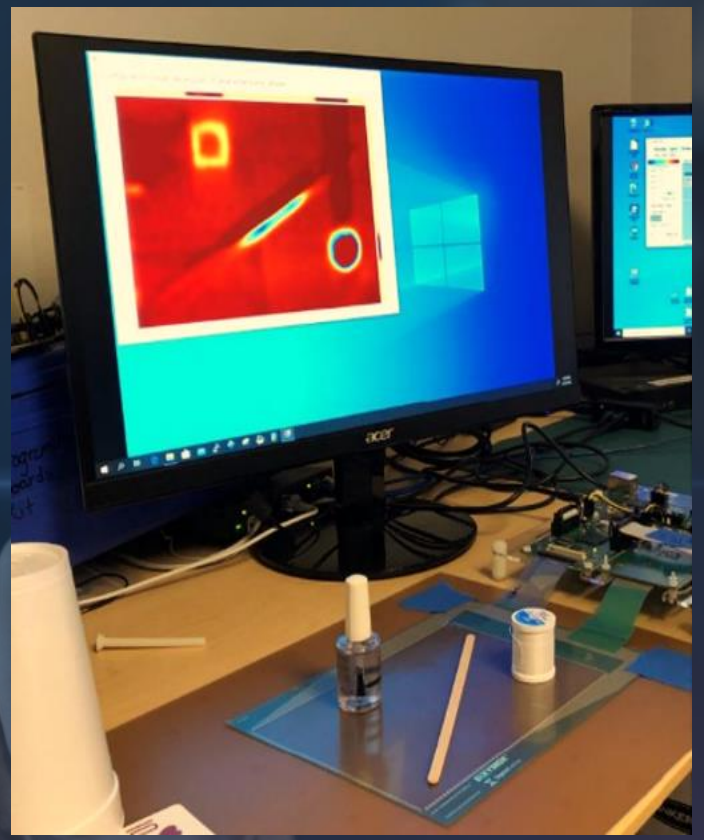
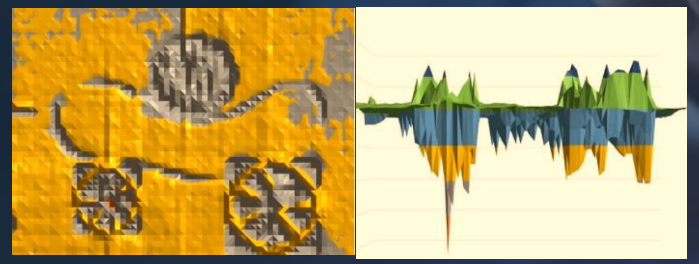
Dielectric Detection

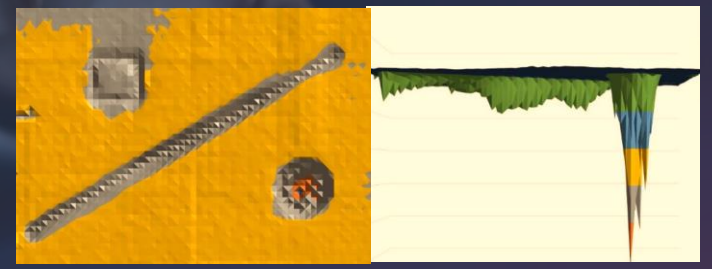
Ability to capacitive image non-conductive objects

Wooden objects, cookies, rubber bands can all be imaged at high speeds









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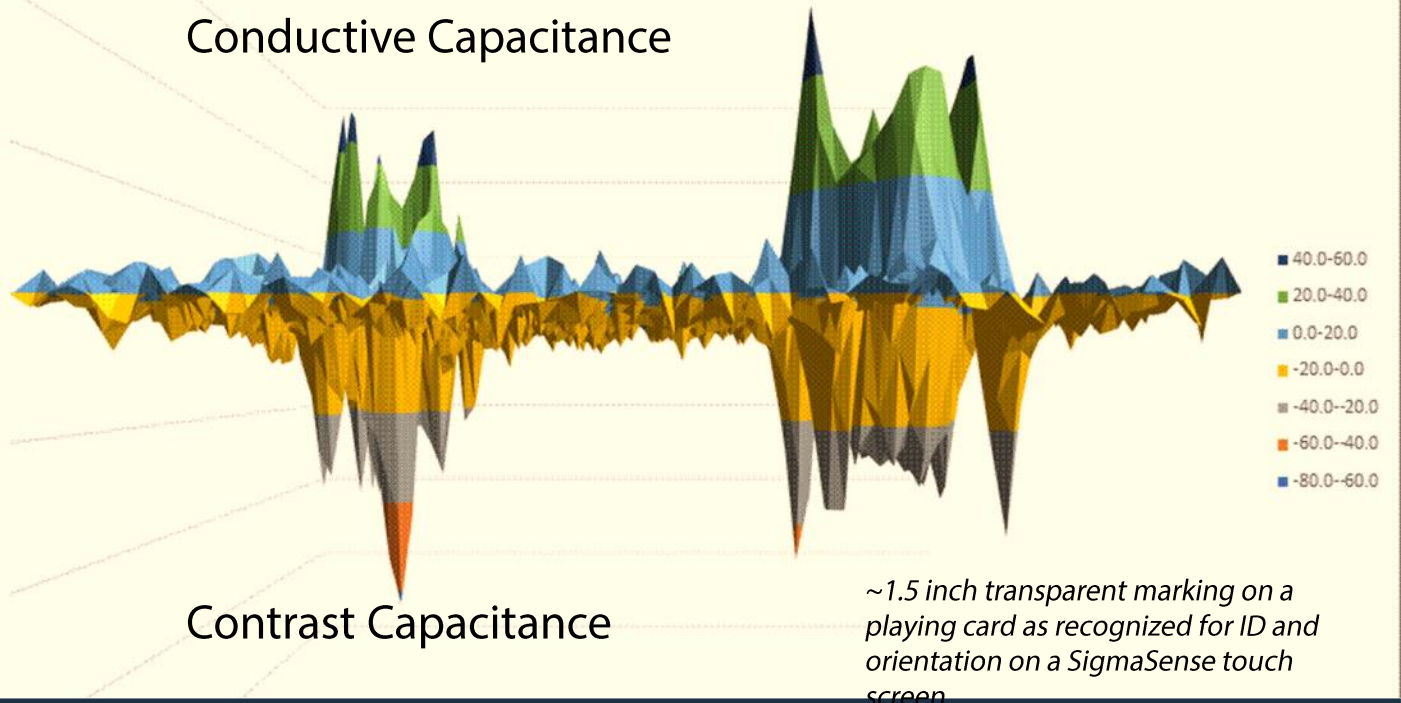
CAPACITIVE IMAGING

SigmaVision™ Yields High Fidelity Data

Capacitive Imaging of Ungrounded Objects



~1.5 inch transparent marking on a playing card as recognized for ID and orientation on a SigmaSense touch screen

Small object recognition on the screen: Capacitive Imaging "sees" conductive and non-conductive objects on a surface

Presence Detection (up to 12 ft.)

Hand Detection (up to 3 ft.)

3D Hover Z-Axis

X/Y Touch ((( ))) Pressure

3D Contrast Capacitance

Classify objects such as hands, pens, playing cards, note pads, drinks, spills, plates, phones, pucks, and game pieces on a surface

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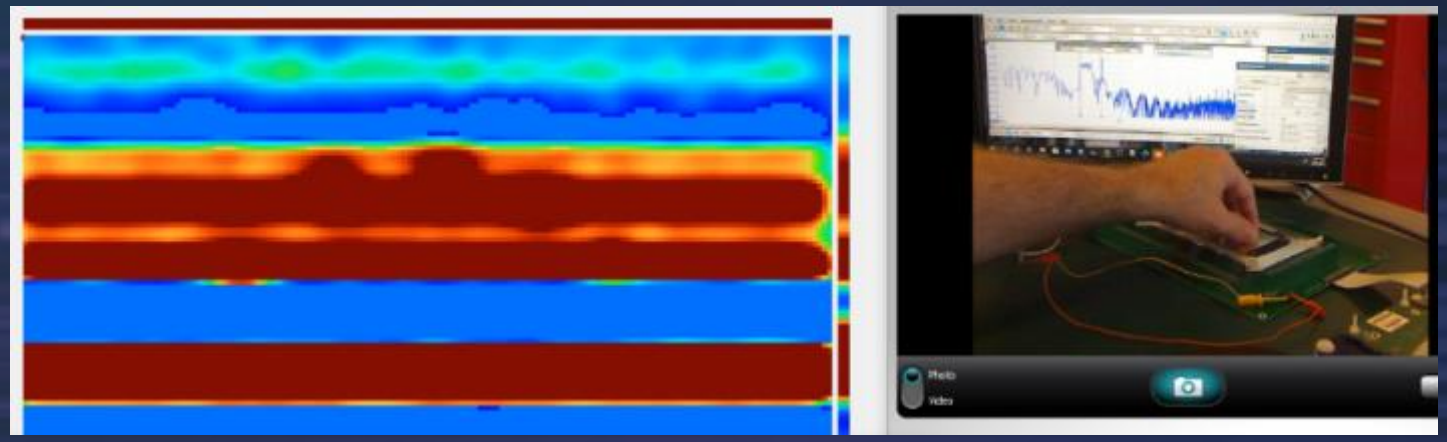
Advanced Noise Cancellation >46dB Noise Reduction

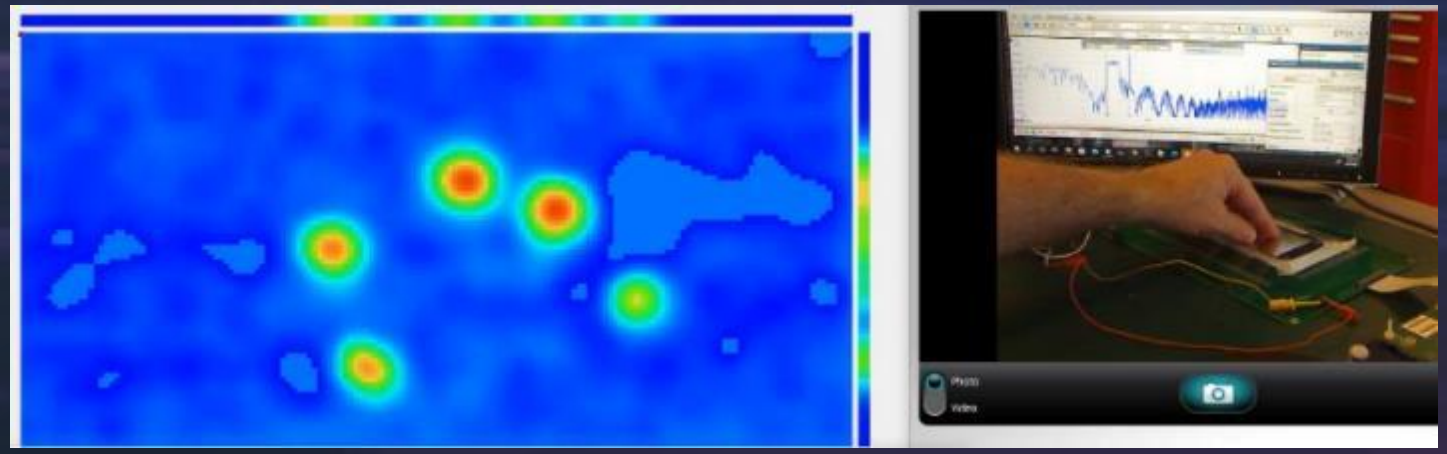
Before

Noise generated by OLED display – common to all touch controllers



After

Noise filtered out by SigmaSense controller



PCB based touchscreen

- 800pf row and
- 450pf column load,
- 650ohm delivery resistance

Heatmap before and after OLED noise mitigation applied

OLED noise

- injected directly into a floating back plane
- Injected noise is continually changing

Enables thinner stackups with high capacitive load

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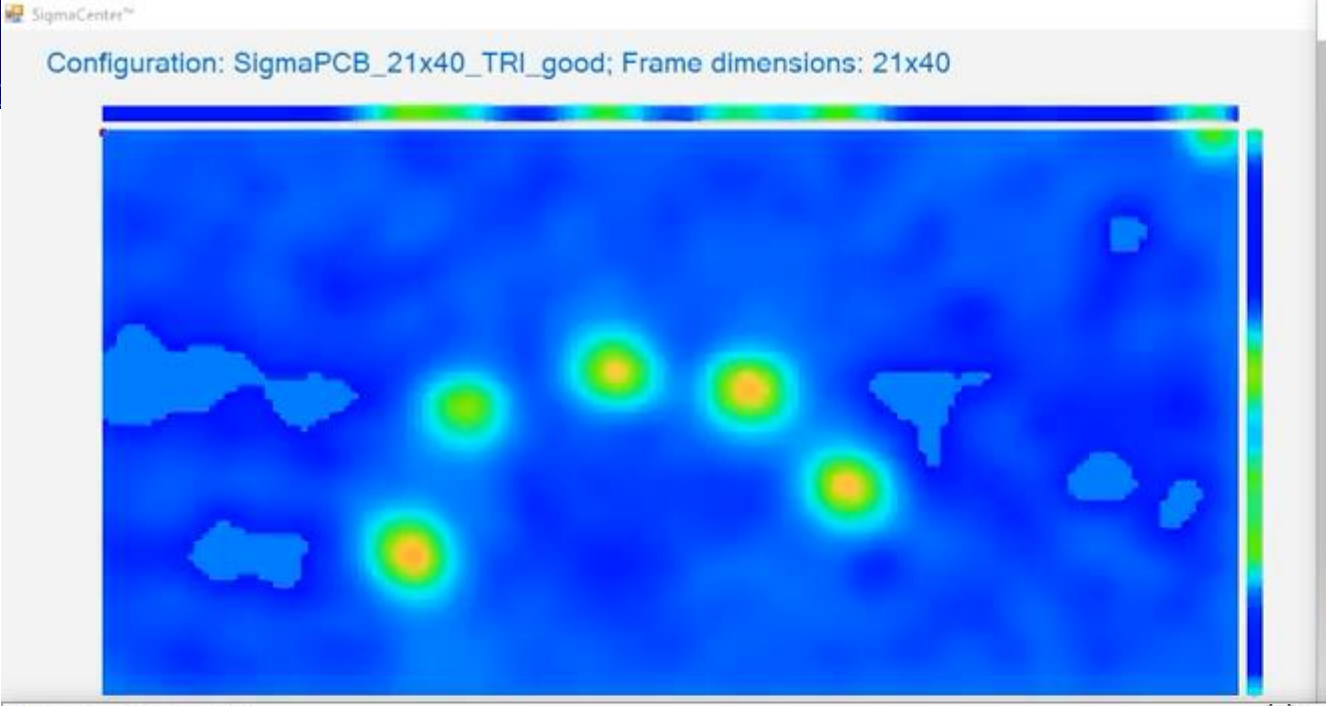

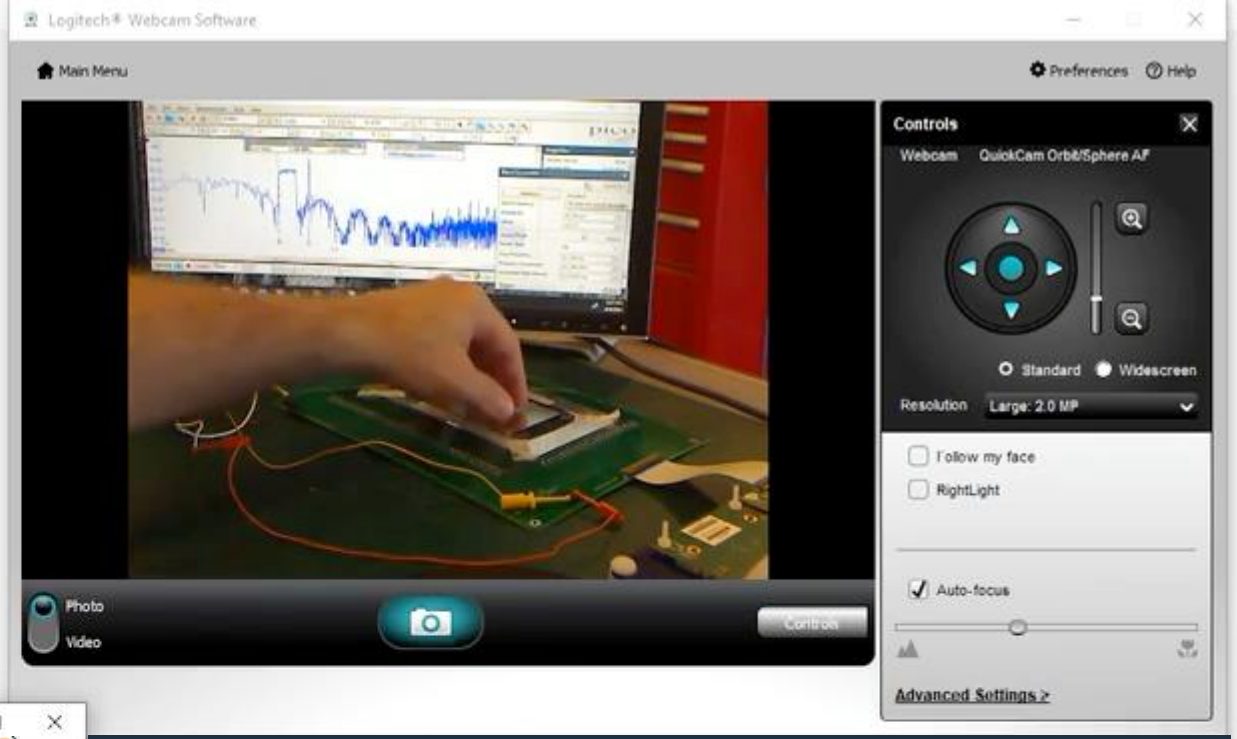

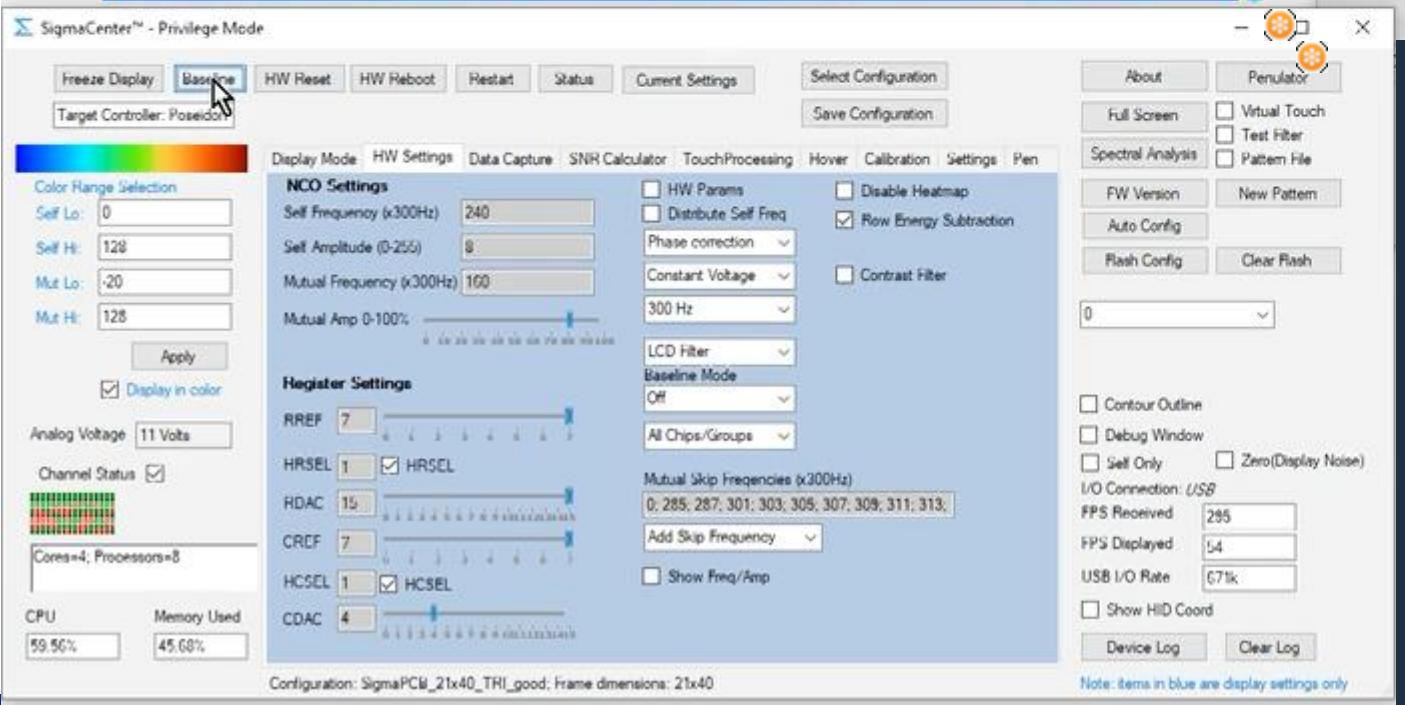

(ANCT)
Active Noise Cancellation Technology

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Digital Transformation

Replacing Analog with Digital

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FLEXIBILITY& FEATURES

SOFTWARE DEFINED SENSING

1. All channels are physically identical in hardware
2. Functionality of each channel is software configurable (Tx / Rx)
3. Frequencies (TX & RX) are software/dynamically assigned
4. All channels processed in parallel
5. Continuously evaluate noise, automatically adjust frequencies
6. Data resolution (n bits) is software selected and optimized
7. Data precision (which n bits) is software controlled
8. Software controlled digital filters and signal processing provides capabilities not possible in analog
9. Digital post processing features enable better data/information

Flexible Data Sets Drive Adaptive Results

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Achieving Experience

Concurrent Capacitive Imaging of the ENTIRE screen

Highest Touch SNR/v in the Industry

passive stylus, thick gloves, in rain, finger pressure, high hover, conductive or dielectric

Ultra-low voltage Current/Frequency based touch sensing

300-600Hz reporting Gaming Class performance

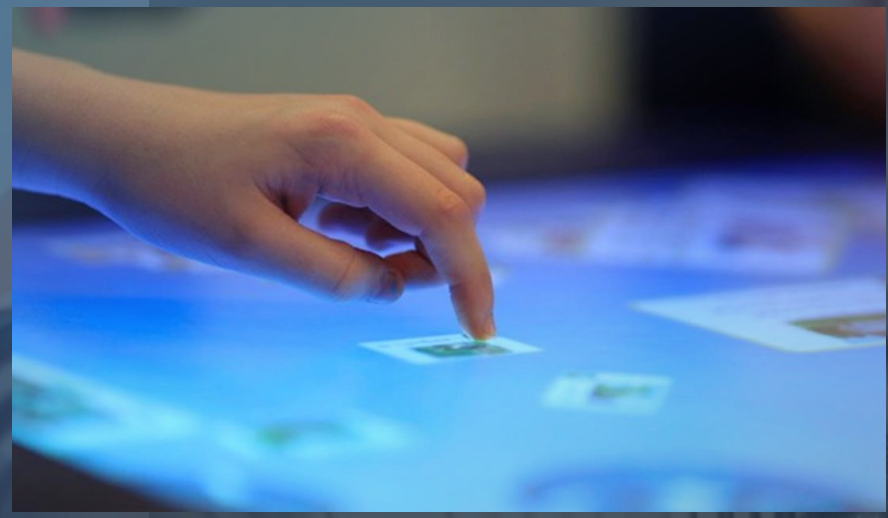
Supports high resistance **Polymer Conductors**

Presence detection at **over 3 feet**

Channel Reuse - Sensor fusion

One controller - multiple screens/surfaces

Data Thru Touch



Better Data… Better Results

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SENSING TECHNOLOGY

ADAPTIVE HMI Experience for Hand Held Gaming Device

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Industry Awards & HMI Leadership Recognition

World's 1st Gaming Class
Touch Performance
Touch Taiwan Show 2021

Display Component
of the Year Award
Display Week 2021

"The new SDC100 Digital Touch Controller is a dream come true, solving all of the negative issues of the past decade"
- Bill Dunn – CEO , LG-MRI

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SENSING IS KEY TO AI

Better Data Means Better AI Results

Extraordinary signal-to-noise ratio (SNR), active noise mitigation, and instantaneous response

To accurately train models, DATA is absolutely vital

Results demand speed, quantity, and quality of data

Garbage-in… Garbage-out

All devices depend on sensing data… FIDELITY

Breakthrough converts analog chaos into high-fidelity data for machine learning and AI

Better HMI Requires Better AI… requires Better Data

100X-1000X Better SNR Performance

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Solves OLED Problems

Continuous, high impedance sensing delivers OLED promise of better experiences

SigmaSense solves multiple issues:

- Thinner stack-ups – *high capacitive loads*
- Foldable & rollable displays – *use of polymer conductors*
- Curved glass – *no impedance matching*
- Lower power – *new power modes*
- Game speeds – *300Hz multi-touch*
- Optical quality – *high resistance materials*
- Edge and backside sensing
- Replaces buttons/sensors
- Pen/writing notes
- Material costs

World's 1st to support polymer conductors for foldables

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Sensing that was Impossible… is Now Proven:

Large Screens with High Resistance Conductors, 300Hz Touch Reports

Small Screens with High Capacitive Loads, 2-micron Touch Stack-up

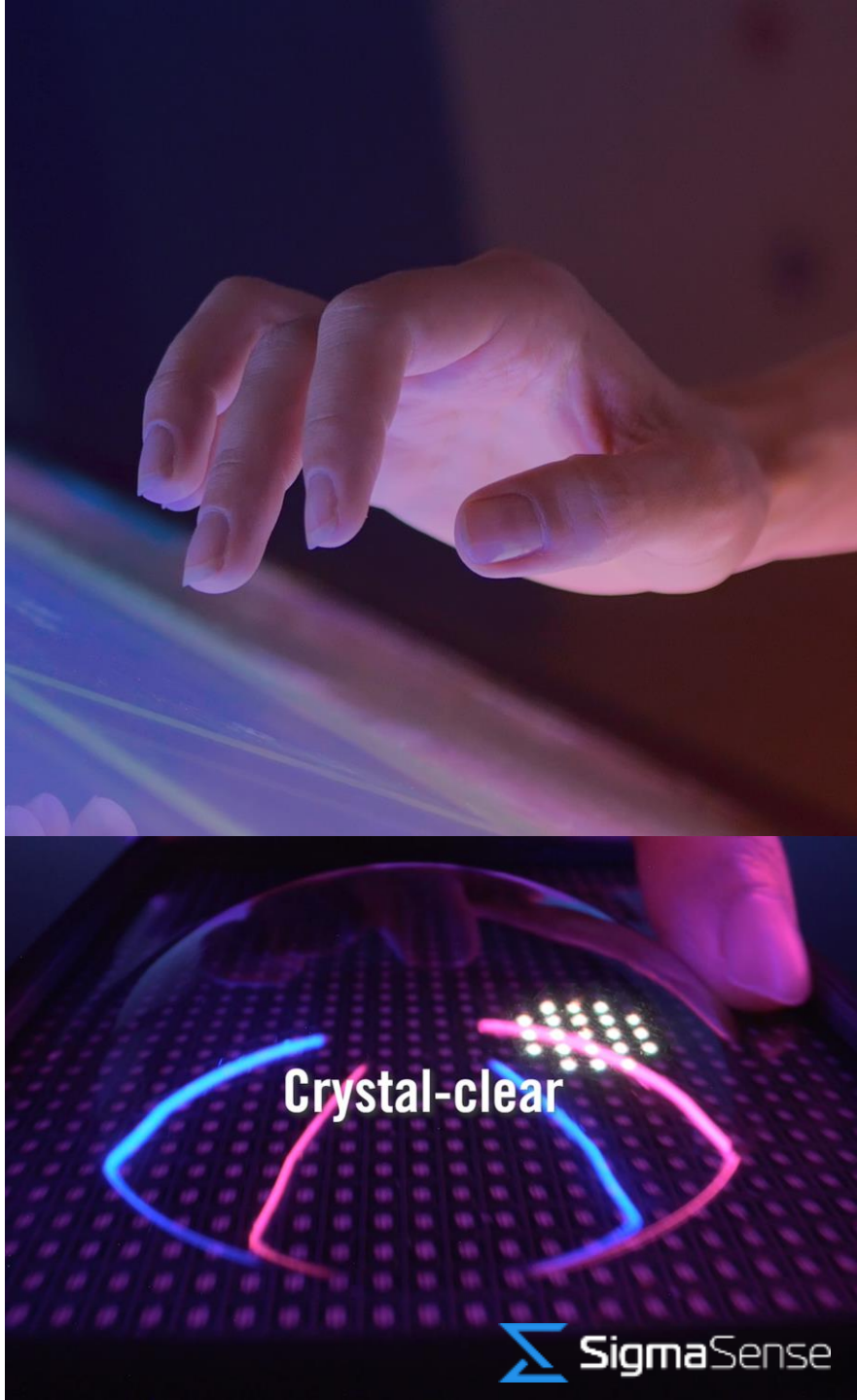
OLED Noise Filtering even at Gaming Speeds

Active Noise Mitigation Techniques Performed in Line with Reports

Touch Sensing over Curved Surfaces, or While Folding the Display

Low-cost Conductors Replace Expensive Materials

One Touch Controller Supports Multiple Screens, Buttons, and Sliders



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POLYMER SENSOR OPTIONS

World's first to support large screen high resistance polymer conductors

Lower cost

Rollable, foldable, wearable devices

Optical improvements

Technology that is proven up to 86" displays

Heraeus and ecosystem partners able to support polymer touch sensors for screens of almost any size

Demonstrated industry's first 86" polymer touch screen

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Software Defined Sensing in the Vehicle Cockpit

All surfaces become adaptable/programmable

- One controller vs. many
- Works thru gloves, spills
- Hand detection at ~2 feet
- Simplifies interior design
- Works over curves/bends
- Predictable, reliable through noise
- Driver vs. Passenger touch ID
- Ultra-low voltage/emissions

World's 1st long line, multi-surface touch sensing

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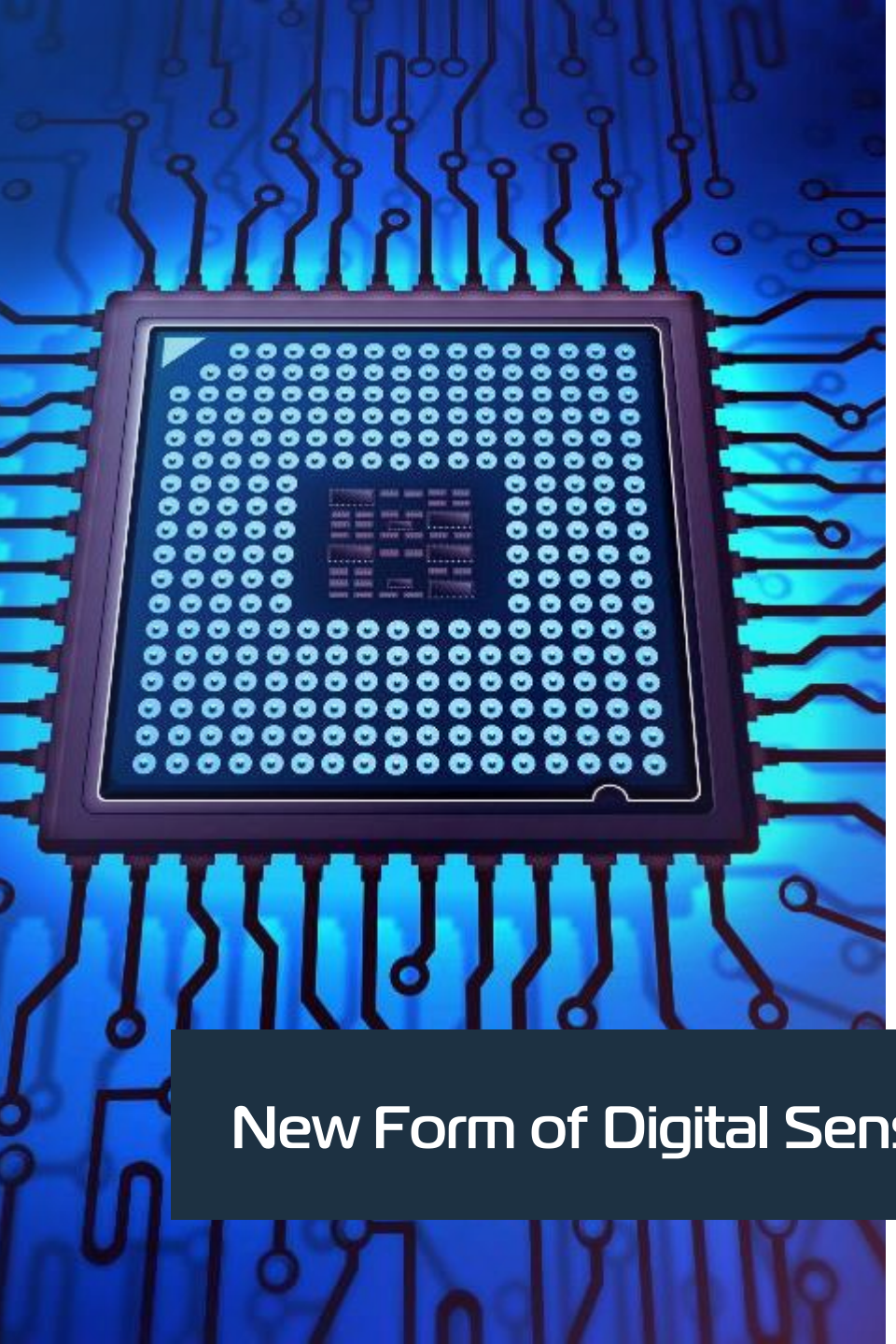

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"Noise directly on our frequencies cannot be filtered" - FALSE

"Signal amplification also amplifies the noise" - FALSE

"High voltage signals are required to get above the noise" - FALSE

New Form of Digital Sensing Impacts Critical Design Choices

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Summary of SigmaSense HMI Experience Advantages

Instantaneous and continuous sensing at the signal transmission source

- Measure changes concurrently with transmit signal, high sensitivity measurements at electrode
- Instantaneously sense disturbances on electrode at great distances without need of high voltage
- Enables digital noise filtering and active noise mitigation techniques

Sense ultra-low voltage AND ultra-low current

- No need to amplify signals → Don't amplify the noise
- Ultra-Low EMI → Transmit pure tone sine waves
- Directly drive/sense current → Even with high resistance, high capacitive load

>100X Far better Signal-to-Noise (SNR/V*t) allows much better system designs

- Ultra low noise floor → Significant SNR delivers better HMI, new features
- Enables advanced digital filtering → Capture unprecedented data fidelity even in high noise
- Active noise mitigation → Very narrow band and massively parallel digital filtering, noise cancelling, noise energy subtraction

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