


W  **L** 20 42758  **ME**  **AUST**  **N**



CONNECTION

2023 AUSTIN



The image is a split-panel composition. The left panel shows a woman in profile, wearing a white and black VR headset, with her right hand raised in a gesture. The right panel shows a man in profile, wearing glasses and a white shirt, interacting with a large, glowing blue digital display. The overall theme is futuristic technology and user interaction.

Future Of Displays & Other LED Technologies

Seshank Malap – Offering Manager

Armen Kirakosyan – System Architect

Buy a TV/Monitor recently?

What's An Ideal Display?



Vibrant Colors **High Contrast**

Blackest Blacks **Brightest Whites**

High Dynamic Range

Wide Viewing Angles

Flexible Display Sizes

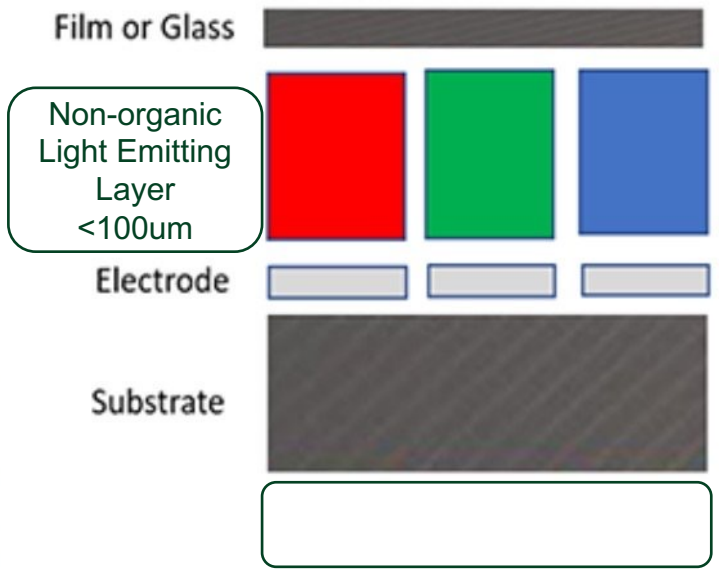
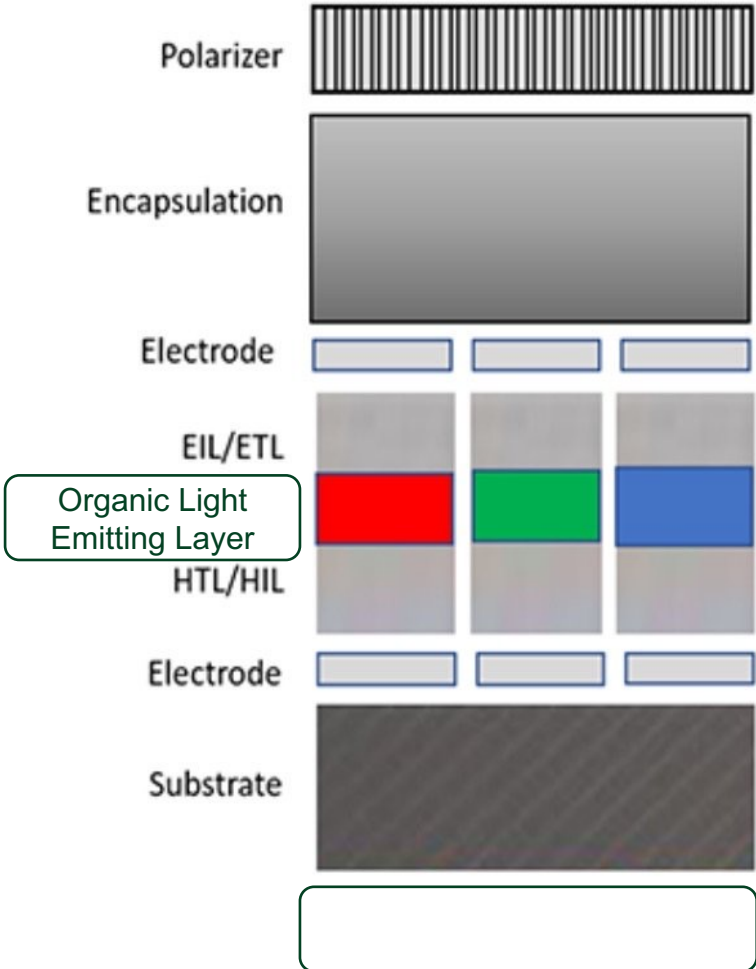
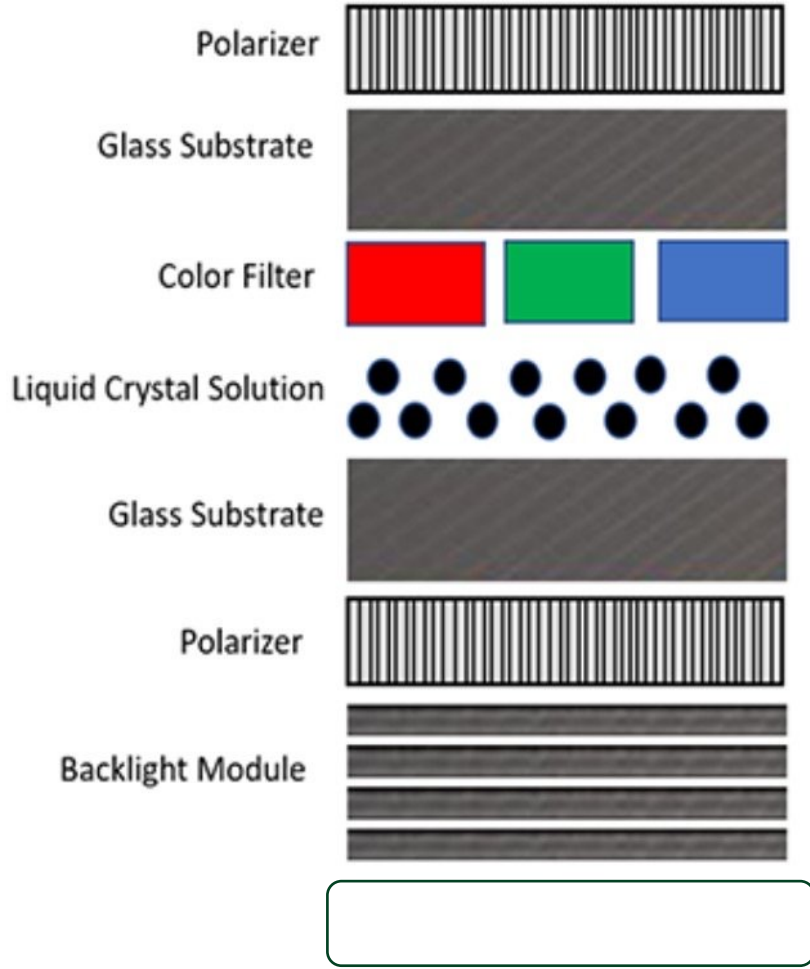
Low Power Consumption

Thin

Fast Response

Can you name some of the display technologies?

Can You Guess The Display Technology?



Focusing on smallest microLED dimensions with high volume applications



→ Strongly increasing technological challenge →

Applications



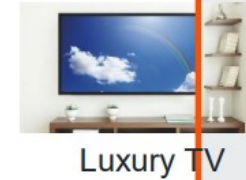
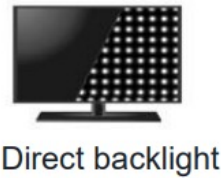
Smartwatch Smartphone AR/VR microdisplay

Luxury TV 4k TV 8k TV

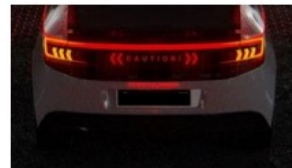
Rear light External displays Door display Dashboard

ams OSRAM microLED focus

Displays:



Automotive:



2021 “microLED” products are actually based on miniLED

microLED demo products shown

Home / Televisions Home Theater / Tvs / 110" Class MICRO LED Samsung 4K With Smart Hub

110" CLASS* MICRO LED Samsung 4K with Smart Hub (*109.2" measured diagonally)

MNA110MS1ACXZA

Total

\$149,999.99⁰¹**ADD TO CART**[OVERVIEW](#) [BENEFITS](#) [SPECS](#) [REVIEWS](#) [SUPPORT](#) [Chat with an Expert](#) 

No. 1 in Overall
Customer
Satisfaction



110" CLASS* MICRO LED Samsung 4K with Smart Hub (*109.2" measured diagonally)

MNA110MS1AC / MNA110MS1ACXZA (0) [Write a review](#) [Share your product experience](#)

- Welcome to a bold new world of luxury entertainment: MICRO LED.
- With sound this powerful, you might wonder where all the speakers are hidden.
- Keep up with it all—all on one convenient screen, all in real-time with 4Vue.
- Your Hollywood experience turns larger than life with nearly infinite color gradations.

Free Shipping: Ships by Apr. 25 **Special Handling** **Return Policy**

Ship to: 10001

Micro LED : Advantages Vs Challenges

Advantages

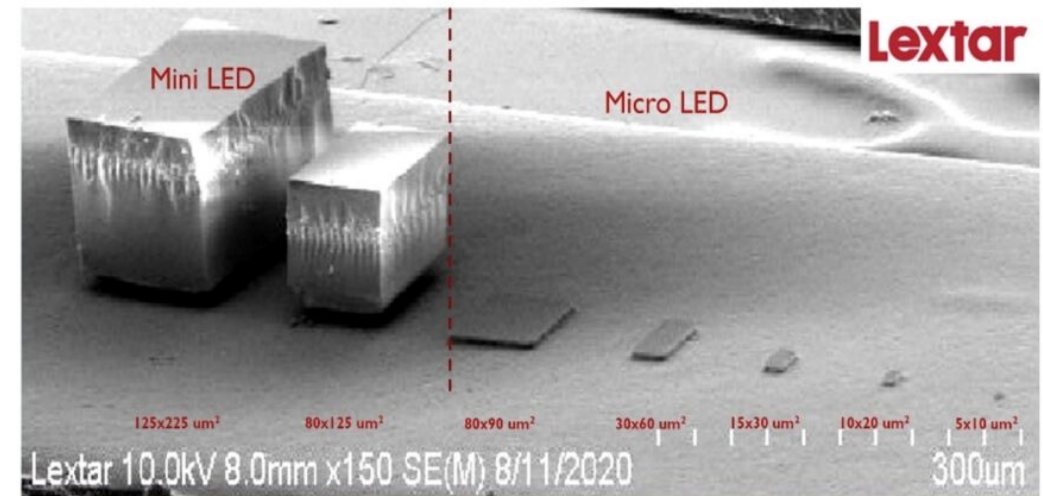
- 1 pixel = 1 (LED) light source
- Individual Pixel (Light) control
- Highest Dynamic/Contrast range
- Most Vibrant colors / High luminance
- Wide viewing angles / Highly Scalable
- Better performance than mini-LEDs & OLED
- Modular & scalable

Challenges:

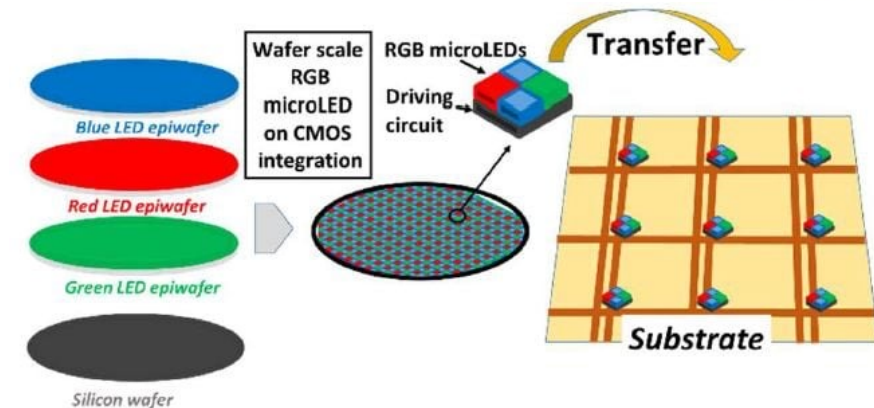
- Cost /Manufacturability
- Traditional Led/mini-LED testing too slow for uLED.
- Testing complexity and yield

MINILED VS MICROLED

Source: MicroLED Displays - Market, Industry and Technology Trends report, Yole Intelligence, 2021



Courtesy of Lextar



Testing Challenges

Traditional 'High Speed' LED Testing Not Fast Enough!



Traditional LED Tests:

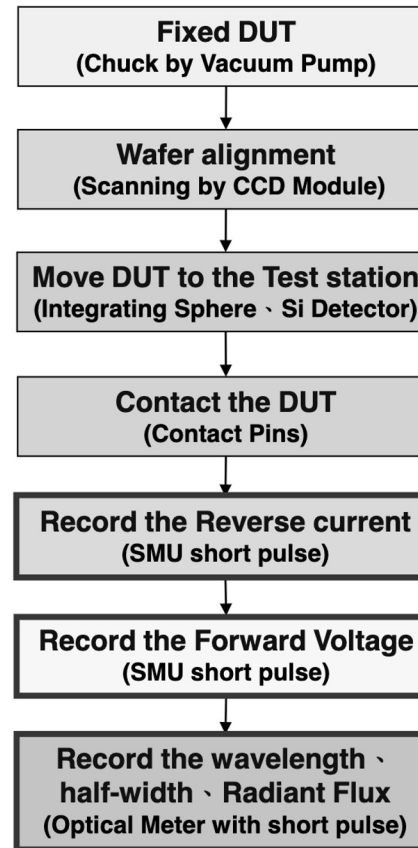
- Reverse Current (I_r)
- Forward Voltage Test (V_f)
- Reverse Voltage Test (V_r)
- Current Leakage Test (I_L)

Optical Test

- Intensity
- Wavelength

Mini/Micro LED Challenges:

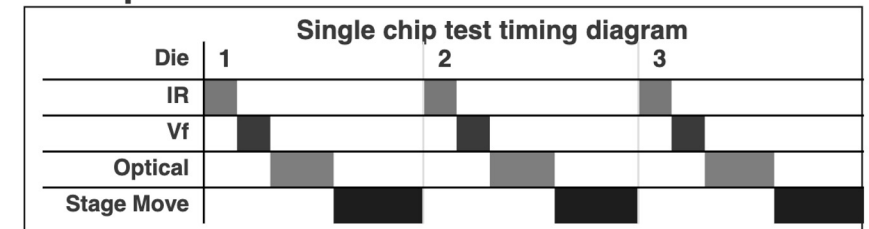
- Millions of LED chips per wafer
- Traditional LED testing techniques too slow
- Increased cost and test time from hours to days



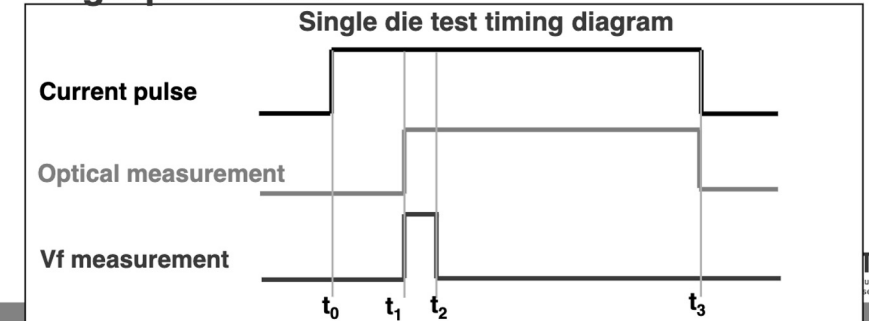
Short pulses measurements :

- Provide high speed testing
- Avoid current heating effect of the DUT
- Measurement comparability between different labs
- Electrical property testing time < 10ms (per pulse)
- Optical property testing time < 100ms (per pulse)
- Total testing time per chip depends on the number of testing items, mostly close to 300ms (including stage move time).

Multi-pulse mode :



Single pulse mode :



Test Methodology – PL vs. EL

	PL	EL
Machine Cost	Higher	Lower
Example Testing Item	LOP: Light Output Power WLD: White Light Degradation WLP: White Light Power etc	LOP: Light Output Power WLD: White Light Degradation WLP: White Light Power Ir, Vf, Vr, Ileakeage, etc
Testing Time	Fast	Slow
Pros	<ul style="list-style-type: none"> • Whole wafer testing • Non-contact • All size 	<ul style="list-style-type: none"> • Comprehensive chip testing • Better Accuracy & yield info
Cons	<ul style="list-style-type: none"> • Unable to measure leakage current • Unable to distinguish single LED operation • Limited yield info 	<ul style="list-style-type: none"> • Limited by chip size • Limited by number of chips/wafer • Potential defects from needle touch down

MicroLED Test Requirements

Specification	LED	Customer Validated
		uLED (1uA range)
Current Accuracy	5 nA	500 pA-1 nA
Current Resolution	100 pA	10 pA
Voltage Range	+/- 48 V	+/- 48 V
Voltage Resolution	200 uV	200 uV
Settling time	60 ms	20-30 ms

NI SMUs for Mini/MicroLED Testing

1-8 Channels

8-20 Channels

1000s of Channels



PXIe-4137

- 1 Channel
- +/- 200 V, +/- 1 A
- 100 fA Current Sensitivity

MiniLED



PXIe-4143

- 4 Channel
- +/- 24 V*, +/- 150 mA
- 10 pA Current Sensitivity



PXIe-4162/3

- 12/24 Channel
- +/- 24 V*, +/- 50 mA
- 100 pA Current Sensitivity

MicroLED



4162/63 (10pA)

- 12/24 Channel
- +/- 24 V*, +/- 50 mA
- 10 pA Current Sensitivity

*Stacked SMU Architecture to achieve +/- 48 V



PXIE-4162/3 10 pA SMUs

Great for Mixed Signal IC & μ LED Test

Channel Count:

PXIE-4162: 12 + Guard

PXIE-4163: 24

Max Voltage: +/- 24 V

Voltage Resolution: 200 μ V

Voltage Accuracy: 0.05% + 5 mV

Max Current:

PXIE-4162: +/- 100 mA

PXIE-4163: +/- 50 mA

Current Resolution: 10 pA

Current Accuracy: 0.1% + 100 pA

Minimum Current Range: 1 μ A



NI PXIE-4162/3 10 pA SMUs

Released

Current

Range	Resolution and Noise (0.1 Hz to 10 Hz, peak-to-peak, typical)	Accuracy (23 °C \pm 5 °C) \pm (% of Current + Offset) ^[6]	Tempco ^[6] \pm (% of Current + Offset)/°C, 0 °C to 55 °C
		T _{cal} \pm 5 °C	
1 μ A	10 pA	0.10% + 100 pA	0.004% + 20 pA
10 μ A	100 pA	0.10% + 1 nA	0.004% + 20 pA
100 μ A	1 nA	0.10% + 10 nA	0.004% + 100 pA
1 mA	10 nA	0.10% + 100 nA	0.004% + 1 nA
10 mA	100 nA	0.10% + 1 μ A	0.004% + 10 nA
30 mA or 50 mA ^[7]	500 nA	0.10% + 5 μ A	0.004% + 50 nA

Table 5. PXIE-4163 (10 pA) Current Programming and Measurement Accuracy/Resolution, Warranted

MicroLED – High Channel Density @ 48V with 10pA Resolution

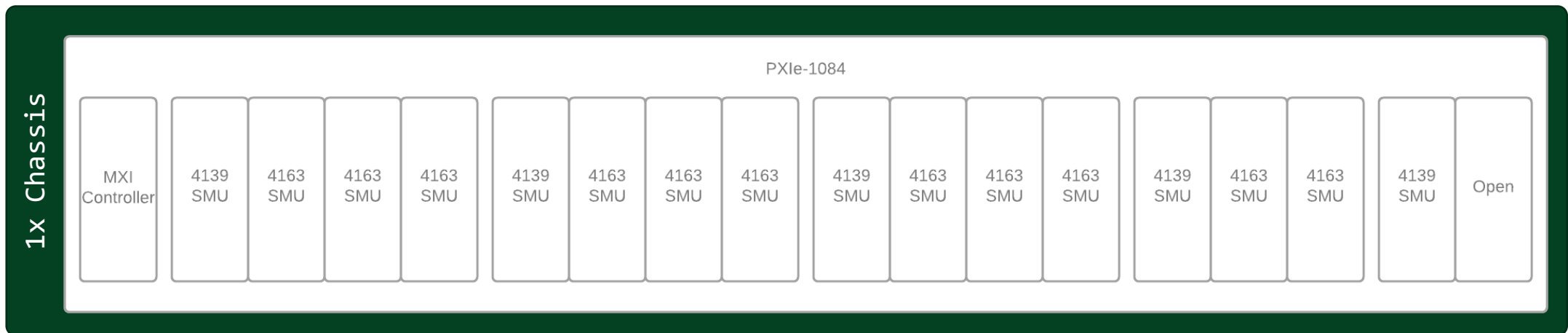
- Up to 384 Ch's / Chassis ; 2184ch/ 40u Rack
- Example shows 288ch config @ 26mA/ch
- Up to +/- 48 Volts
- 1 PXIe-4139 for every 2.5 PXIe-4163
- All channels tied to the same PXIe-4139 will have to perform the same test
- Characterize leakage current for each channel for reverse current test to improve accuracy

12x
PXIe-4163 – 24ch
Bias: 24V @ 26mA

5x
PXIe-4139 – 1ch
Bias: 25V @ 1.6A

Requirement	PXIe-4163* +4139
Current Accuracy	500 pA-750 pA
Current Resolution	10 pA
Voltage Range	48 V*
Settling time	20-30 ms

Stacked Architecture



*Requires updated PXIe-4163 + PXIe-4139

New* - High Density -100V mini/uLED Low Cost Solution

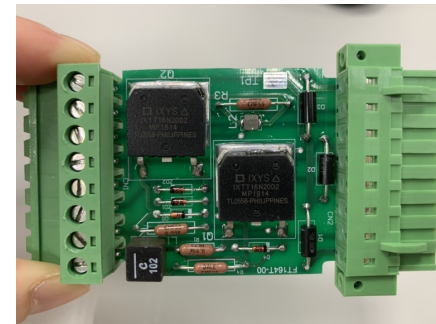
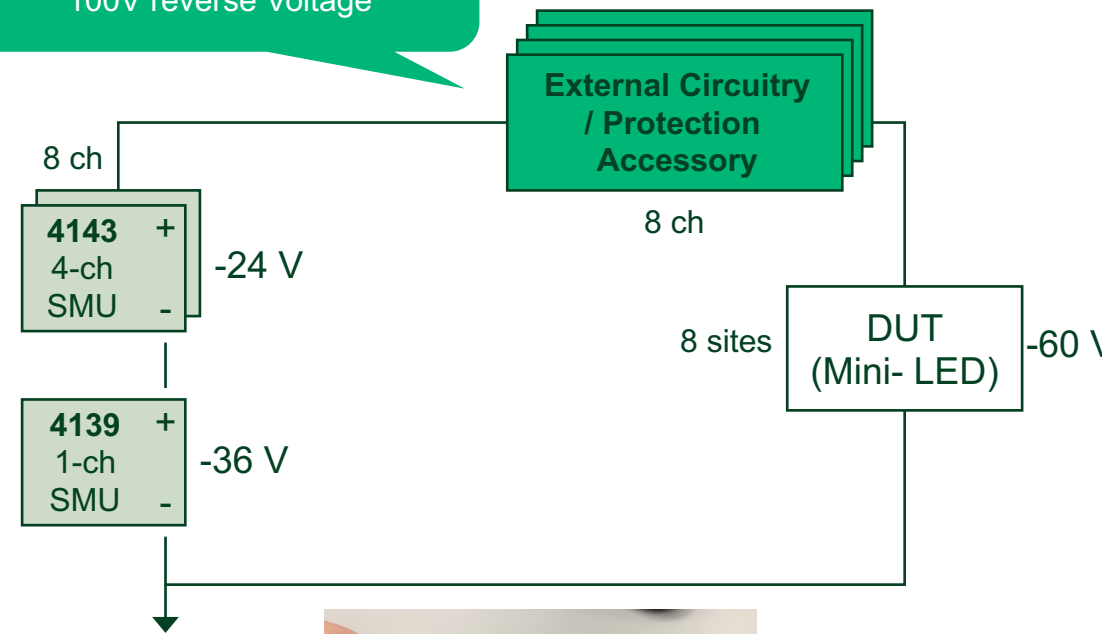
Requirements:

- Low-cost high-density tester
- -60V minimum capability for reverse breakdown testing
- Similar test time/throughput as 4137-based solution
- Lower accuracy (VS 4137) is acceptable

New Marketecture:

- Multiple 4143 stacked atop 4139 to allow up to 60V of reverse voltage capability
- NEW protection block design to protect PXIe-4143 from >30 V difference between LO and any other pin resulting from DUT failures and sudden shorts

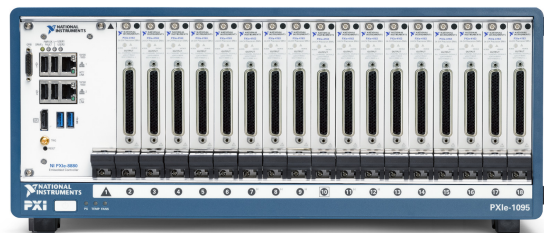
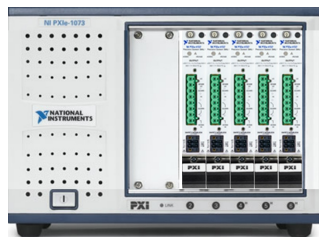
New design based on 4163 protection block to allow up to -100V reverse Voltage



Existing 4163 protection block

LED Test System Concepts

From MiniLED to MicroLED



Low Channel Count System Spec

Chassis	PXIe-1073
SMU	PXIe-4137
Max IV Ch.	5
V Range	200 V
V Resolution	100 nV
I Range	3 A
I Resolution	100 fA
Size (in)	11 x 9 x 7

Medium Channel Count System Spec

Chassis	PXIe-1073
SMU	PXIe-4143, 4139
Max IV Ch.	16-32
V Range	48 V*
V Resolution	20 μ V
I Range, Acc.	150 mA
I Resolution	10 pA
Size	11 x 9 x 7

High Channel Count System Spec

Chassis	PXIe-1085
SMU	PXIe-4163, 4139
Max IV Ch/Rack	Up to 2184* (@4mA)
V Range	48 V*
V Resolution	200 μ V
I Range, Acc.	50 mA
I Resolution	100 pA**
Size (in)	19 x 19 x 11

*Stacked SMU Architecture to achieve +/- 48 V

** 384 ch/ chassis @4mA max current/ch

Mini LED Case Study with FitTech

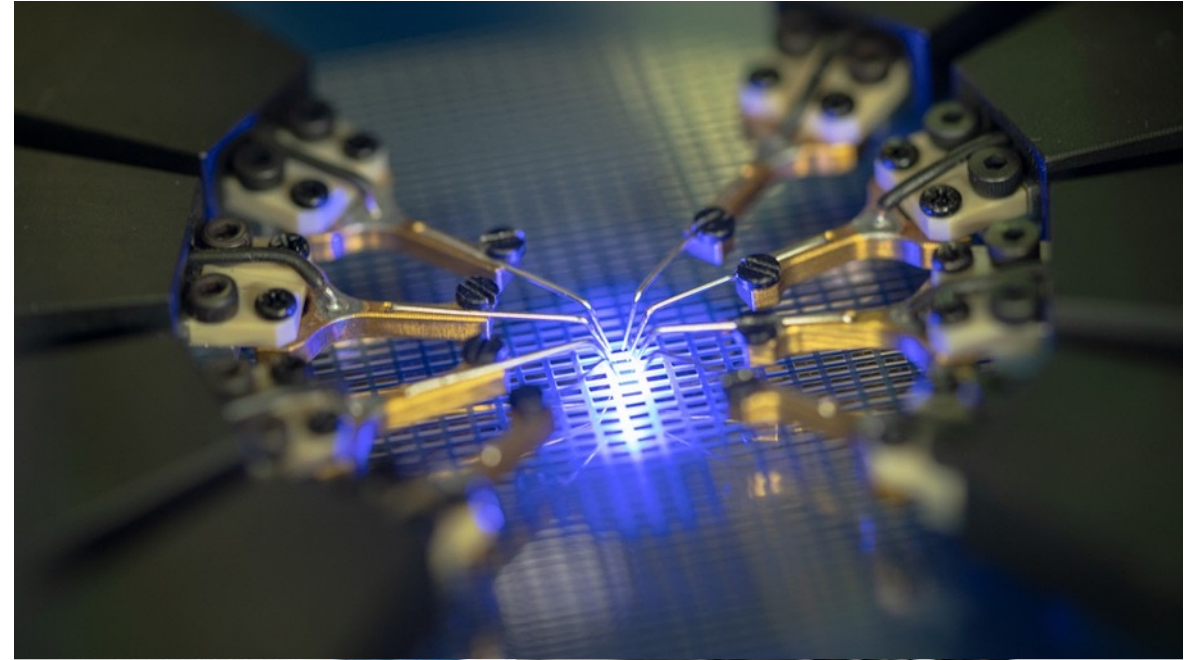


Challenge:

- Millions of LED chips per wafer
- Traditional LED testing techniques too slow
- Increased cost and test time from hours to days

Solution:

- Fittech with NI built 8x site parallel mini-LED wafer tester with NIs High density SMUs.
- Quadrupled throughput while maintaining high accuracy and performance.



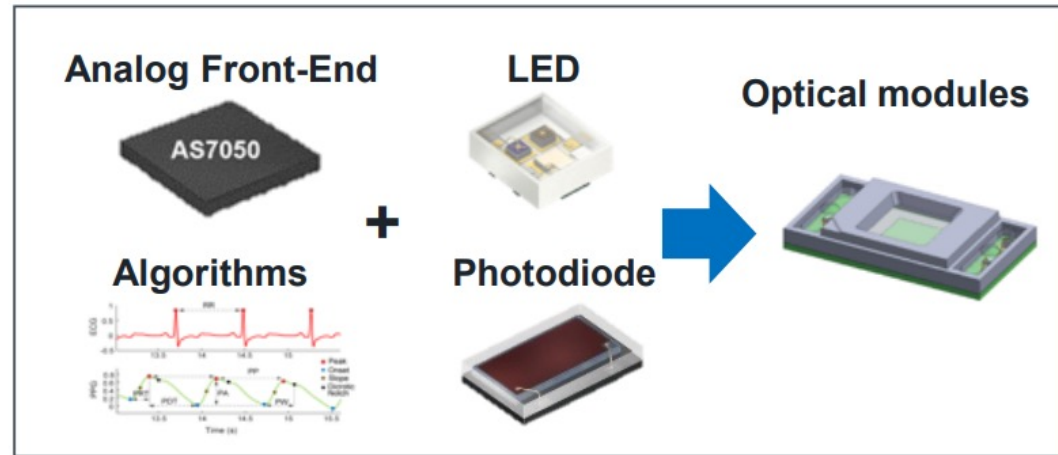


Other LED Technology Targets



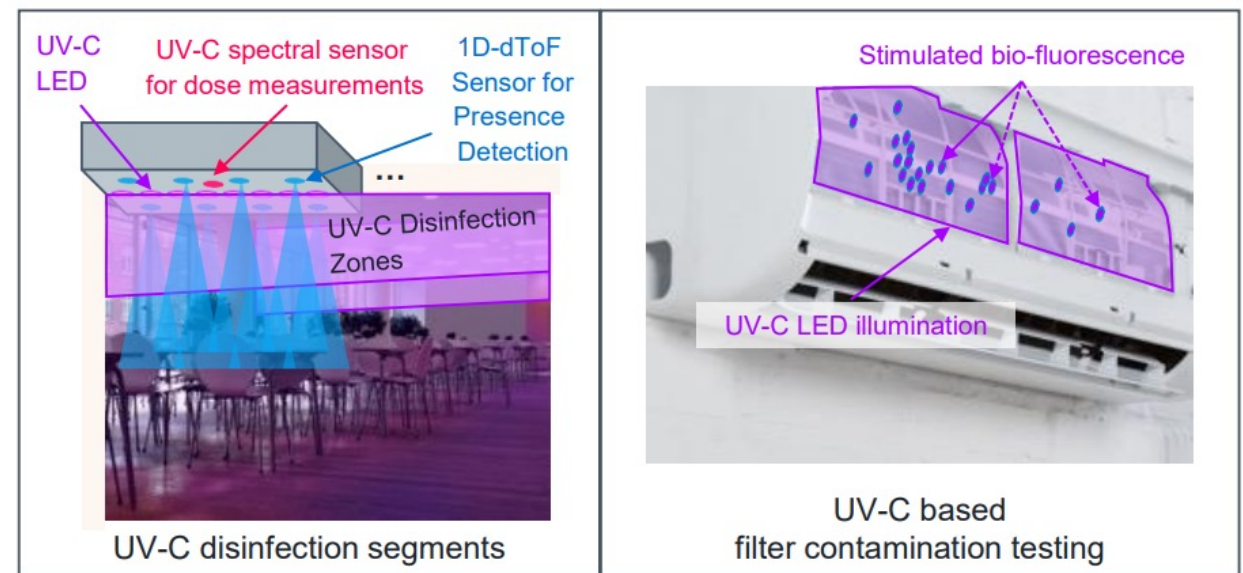
Solutions combining light source, optics, detectors and driver ICs

Integrated Vital Signs Monitoring Module

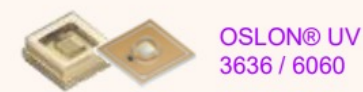


- Optical module integrating light source, receiver and driver & signal processing IC in miniaturized module
- ams OSRAM is uniquely positioned
 - Leader in individual components, only player with all in-house
 - High-volume optical module assembly capability
 - Reference designs including system-level algorithm support

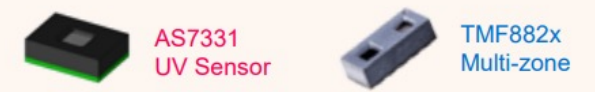
Adaptive UV-C LED disinfection



• UV-C LED

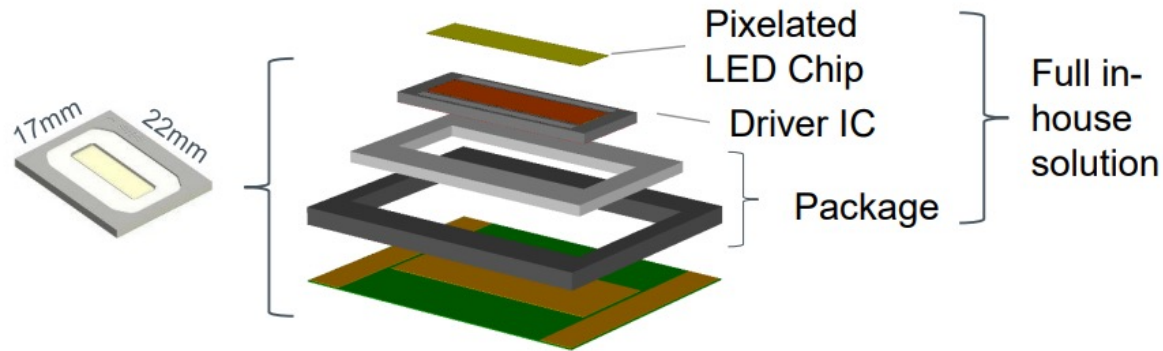


- UV-C sensor
- 1D dToF presence detection



Key growth drivers – (1) Dynamic Forward Lighting (EVIYOS)

Well positioned to profit from being the innovation leader



- As next big step in dynamic forward lighting, EVIYOS enables adaptive driving beam and projection capabilities (e.g. construction lighting, traffic signs)
- Integrated intelligent light source based on a monolithic structured LED chip with >25k individually addressable pixels
- Very positive market traction: on the road from 2023 onwards
- Only player with all required capabilities in-house including driver IC; very limited number of capable competitors
- EVIYOS leading vs. competing technologies on key performance criteria: energy efficiency, system size, system cost

Common Semiconductor Applications



Parametric Test
Materials Research
Wafer Level Reliability



Semiconductor
Validation &
Characterization



Semiconductor &
Optoelectronics
Production Test

Questions?



VCSEL I-V Test Instrument

2 channels in 1 PXI Slot

Pulsed Forward Current:

- Max Pulse currents: 10 A
- Min. Pulse periods: 5 μ s
- DUT voltages: 0 to +15 V
- Measure Apertures: $\geq 0.5 \mu$ s
- Trigger for photodiode measurements

Reverse Leakage Current:

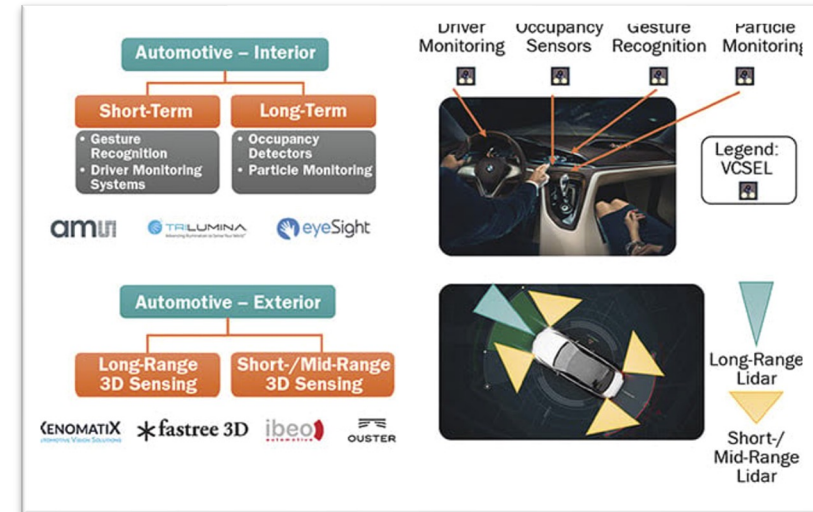
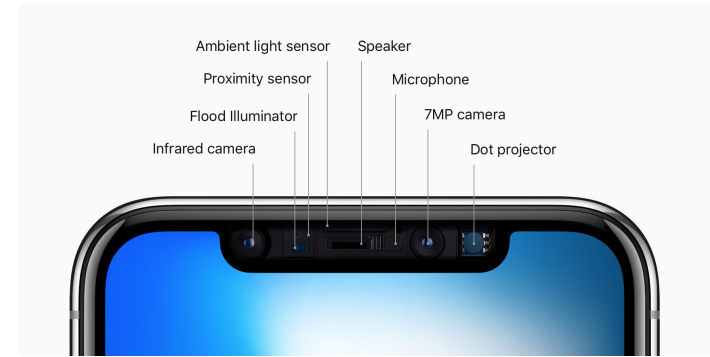
- Configure bias: 0 V to -40 V
- Measure current: 0 nA to -100 μ A
- Measurement resolution: 1 nA

Reverse Voltage:

- Configure bias: -10 nA to -100 μ A
- Measure voltage: 0 V to -100 V

Gangable for Higher Current or Higher Duty Cycle %

Coming Q3 2023





PXIE-4162/3 10 pA SMUs

Great for Mixed Signal IC & μ LED Test

Channel Count:

PXIE-4162: 12 + Guard

PXIE-4163: 24

Max Voltage: +/- 24 V

Voltage Resolution: 200 μ V

Voltage Accuracy: 0.05% + 5 mV

Max Current:

PXIE-4162: +/- 100 mA

PXIE-4163: +/- 50 mA

Current Resolution: 10 pA

Current Accuracy: 0.1% + 100 pA

Minimum Current Range: 1 μ A



NI PXIE-4162/3 10 pA SMUs

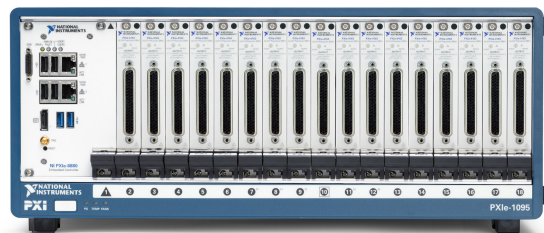
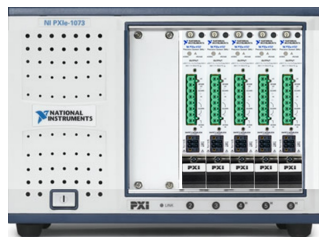
Current

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