ORIEL® INSTRUMENTS
A Newport Company

2017 PV SELECTION GUIDE

Oriel Instruments, a Newport company, was founded in 1969 and quickly gained a reputation as an innovator in the fields of light sources and optical measurement. Today, the Oriel brand represents excellence in optical devices and instrumentation for a myriad of industries.

Oriel is recognized as a leader in solar simulation and photovoltaic measurement technologies. Any laboratory exploring the effects of solar radiation can benefit from product offerings such as solar simulators which closely simulate hours of solar radiation in a fraction of the time. In addition, researchers in the field of photovoltaic technology can benefit from a wide range of efficiency and performance measurement instruments.

Oriel continues to deliver innovative products and solutions to Newport customers around the world.

PHOTOVOLTAIC LABORATORY AND SAMPLE CELL TESTING

- Accredited by the American Association for Laboratory Accreditation (A2LA) to ISO / IEC 17025
- PV cell electrical performance measured under simulated sunlight according to ASTM standard E948
- PV cell spectral responsivity measurements measured according to ASTM standard E1021
- All measurements are traceable to the International System of Units (SI)

Newport Corporation is proud to house and manage one of the few commercial photovoltaic and calibration test laboratories in the world. The PV test lab uses state of the art equipment, including the Oriel Class AAA 8" x 8" Sol3A solar simulator and Oriel quantum efficiency systems.

All measurements are performed under standard reporting conditions (SRC) with a temperature of 25°C, a total irradiance of 1 sun (1000 W/m^2), and spectral irradiance AM 1.5G (IEC 60904-3).

Upon completion of testing, an ISO / IEC 17025 accredited calibration certificate is provided. Certificate includes:

- Measured total area of the device
- EQE and IV curves for the device
- Irradiance spectrum of the solar simulator used
- Spectral response of the reference detector used
- Expanded uncertainties
- Electrical performance parameters of the device: Short Circuit Current (I_{sc}), Open Circuit Voltage (V_{oc}), Current at Max Power (I_{max}), Voltage at Max Power (V_{max}), Max Power (P_{max}), Spectral Correction (M), Fill Factor (FF), and Efficiency (η).

The PV test lab welcomes requests for prototype PV device performance measurement or PV reference cell calibrations.

UV SOLAR SIMULATORS

- Patented optical design
- CTFASA / COLIPA / JCIA / CTFA / FDA / ISO compliant
- Independent third party lab certified for compliance
- Variable output (10 - 100%) of maximum available solar constants
- 5% uniformity of irradiance over the entire work plan
- Designed specifically for photo-biology applications

The Sol-UV family of solar simulators is designed for demanding applications in photobiology. All Sol-UV simulators incorporate a patented design which provides UV light output with irradiance non-uniformity better than 5% over the entire sampling area. Output power can be varied from 10 - 100% of the maximum available solar constants using the unique integrated attenuating device. All Oriel Sol-UV simulators use a black, non-reflective finish to minimize stray light, and safety interlocks prevent inadvertent exposure to UV light. Proprietary filters are applied to a Xenon lamp to meet all critical performance parameters.

The Sol-UV product line offers cost-effective systems designed for both laboratory and production environments. The rugged design incorporates Newport optical and mechanical expertise.

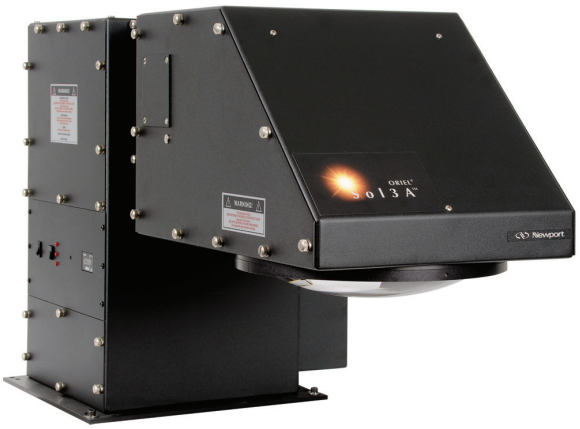
SPECIFICATIONS

Model	SOL-UV-2	SOL-UV-4	SOL-UV-6
Simulator Type	UV Solar Simulator	UV Solar Simulator	UV Solar Simulator
Beam Size	2 x 2 inches (51 x 51 mm)	4 x 4 inches (101.6 x 101.6 mm)	6 x 6 inches (152.4 x 152.4 mm)
Typical Power Output	8 solar constants	6 solar constants	4 solar constants
Lamp Power Rating	1000 W	1000 W	1600 W
Working Distance	4.0 $\pm$ 0.5 inches	4.0 $\pm$ 0.5 inches	6.0 $\pm$ 0.5 inches
Spectral Match Classification	FDA CFR Part 201.327, ISO 24444:2010(e), Intl SPF Test Method (CTFASA/COLIPA/JCIA/CTFA)		
Uniformity Classification	<5% non-uniformity	<5% non-uniformity	<5% non-uniformity
Temporal Instability Classification	<2% over 24 hours	<2% over 24 hours	<2% over 24 hours
Collimation Angle	(half angle) $<\pm 4^{\circ}$	(half angle) $<\pm 4^{\circ}$	(half angle) $<\pm 3^{\circ}$
Power Requirements	95-264 VAC/15A 50 - 60 Hz	95-264 VAC/15A 50 - 60 Hz	190-264 VAC/12A 50 - 60 Hz
Line Regulation	0.01%	0.01%	0.01%
Lamp Type	Xenon	Xenon	Xenon

In keeping with our commitment to continuing improvement, Oriel reserves the right to change specifications without notice or liability for such changes. For full specifications, please consult the product brochure.

SOL3A CLASS AAA SOLAR SIMULATORS

- Output beam sizes 2 x 2", 4 x 4", 6 x 6", 8 x 8", and 12 x 12"
- Factory certified Class AAA CW systems
- Calibration certificate validating Class AAA performance for all three standards: IEC, ASTM, and JIS
- Highly reliable instruments specifically designed for 24/7 production environments
- Integrated variable attenuator allows for output from 0.1 to 1.0 suns
- Easy lamp replacement
- Non-reflective black finish reduces stray light
- Temperature sensors and interlocks ensure operator safety



All Sol3A simulators are certified to IEC 60904-9 Edition 2 (2007), JIS C8912, and ASTM E927-05 standards for Spectral Match, Non-Uniformity of Irradiance, and Temporal Instability of Irradiance. Sol3A simulators use a single lamp design to meet all three performance criteria without compromising the 1 sun output power, providing true Class AAA performance. A partial sun attenuating device allows easy variation of the output from 0.1 - 1.0 suns with the simple turn of a knob. The design incorporates captive screws for all panels requiring user access which facilitates lamp replacements, alignment, and filter changes. A black, non-reflective finish minimizes stray light, and safety interlocks prevent inadvertent exposure. The rugged design incorporates Newport optical and mechanical expertise.

SPECIFICATIONS

Model	94023A	94043A	94063A	94083A	94123A
Illuminated Area	2" x 2" (51 mm x 51 mm)	4" x 4" (102 mm x 102 mm)	6" x 6" (152 mm x 152 mm)	8" x 8" (203 mm x 203 mm)	12" x 12" (305 mm x 305 mm)
Collimation Angle	(half angle) $<\pm 4^{\circ}$	(half angle) $<\pm 4^{\circ}$	(half angle) $<\pm 3^{\circ}$	(half angle) $<\pm 2^{\circ}$	(half angle) $<\pm 1^{\circ}$
Maximum Power Output	100 mW/cm^2 (1 sun) $\pm$10%	100 mW/cm^2 (1 sun) $\pm$10%	100 mW/cm^2 (1 sun) $\pm$10%	100 mW/cm^2 (1 sun) $\pm$10%	100 mW/cm^2 (1 sun) $\pm$10%
Uniformity Classification	A - IEC 60904-9 2007, JIS C8912, ASTM E927-05				
Temporal Instability	A - IEC 60904-9 2007, JIS C8912, ASTM E927-05				
Spectral Match	A - IEC 60904-9 2007, JIS C8912, ASTM E927-05				
Working Distance	12 $\pm$0.5 inches	6 $\pm$0.5 inches	7 $\pm$0.5 inches	15 $\pm$0.5 inches	12 $\pm$0.5 inches
Lamp Power Rating	450 W	450 W	1000 W	1600 W	1600 W
Power Requirements	95 - 264 VAC/15A 50 - 60 Hz	95 - 264 VAC/15A 50 - 60 Hz	95 - 264 VAC/15A 50 - 60 Hz	190 - 264 VAC/12A 50 - 60 Hz	190 - 264 VAC/12A 50 - 60 Hz
Line Regulation	0.01%	0.01%	0.01%	0.01%	0.01%

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For full specifications, please consult the product brochure.

SOL2A CLASS ABA SOLAR SIMULATORS

- Complete line of Class ABA products from 2″ x 2″ to 8″ x 8″ output beam size
- Factory certified CW systems per ICE 60904-9 2007 Edition, JIS C8912, and ASTM E927-05
- Long-lived, highly reliable instruments designed specifically for laboratory and production environments
- Temperature sensors and interlocks ensure operator safety
- Convenient user features simplify operation

Certified to IEC 60904-9 2007 Edition, JIS C8912, and ASTM E927-05 standards, the large area Sol2A simulators use a Xenon lamp and proprietary filter to meet Class ABA performance parameters without compromising a 1 Sun output power. A Class ABA system should be considered for applications less demanding of spatial uniformity. Class ABA systems retain the highest spectral match and temporal performance (Class A), as defined by the most recent standards from the IEC, JIS, and ASTM.

Sol2A simulators deliver a cost effective solar simulator while maintaining the trusted Oriel brand and Newport global support.

SPECIFICATIONS

Model	94022A	94042A	94062A	94082A
Illuminated Area	2″ x 2″ (51 mm x 51 mm)	4″ x 4″ (102 mm x 102 mm)	6″ x 6″ (152 mm x 152 mm)	8″ x 8″ (203 mm x 203 mm)
Collimation Angle	$<\pm 6^{\circ}$	$<4^{\circ}$	$<3^{\circ}$	$<2^{\circ}$
Typical Power Output	100 mW/cm² (1 sun) ±10% adjustable	100 mW/cm² (1 sun) ±10% adjustable	100 mW/cm² (1 sun) ±10% adjustable	100 mW/cm² (1 sun) ±10% adjustable
Uniformity Classification	B - IEC 60904-9 2007, JIS C8912, ASTM E927-05			
Temporal Instability	A - IEC 60904-9 2007, JIS C8912, ASTM E927-05			
Spectral Match	A - IEC 60904-9 2007, JIS C8912, ASTM E927-05			
Working Distance	2 ±0.5 inches	6 ±0.5 inches	7 ±0.5 inches	15 ±0.5 inches
Lamp Power Rating	150 W	450 W	1000 W	1600 W
Power Requirements	95 - 264 VAC/15A 50 - 60 Hz	95 - 264 VAC/15A 50 - 60 Hz	95 - 264 VAC/15A 50 - 60 Hz	190 - 264 VAC/12A 50 - 60 Hz
Line Regulation	0.01%	0.01%	0.01%	0.01%

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SOL1A CLASS ABB SOLAR SIMULATORS

- Complete line of Class ABB products from 2″ x 2″ to 8″ x 8″ output beam sizes
- Factory certified CW systems per IEC 60904-9 2007 Edition, JIS C8912, and ASTM E927-05
- Long-lived, highly reliable instruments designed for both laboratory and production environments
- Temperature sensors and interlocks ensure operator safety
- Convenient user features simplify operation

Certified to IEC 60904-9 2007 Edition, JIS C8912, and ASTM E927-05 standards, the large area Sol1A simulators use a Xenon lamp and proprietary filter to meet Class ABB performance parameters without compromising a 1 Sun output power. A Class ABB system should be considered for applications less demanding of spatial uniformity and temporal stability. Class ABB systems retain the highest spectral match performance (Class A), as defined by the most recent standards from the IEC, JIS, and ASTM.

Sol1A simulators deliver a cost effective solar simulator while maintaining the trusted Oriel brand and Newport global support.

SPECIFICATIONS

Model	94021A	94041A	94061A	94081A
Illuminated Area	2″ x 2″ (51 mm x 51 mm)	4″ x 4″ (102 mm x 102 mm)	6″ x 6″ (152 mm x 152 mm)	8″ x 8″ (203 mm x 203 mm)
Collimation Angle	<6°	<4°	<3°	<2°
Typical Power Output	100 mW/cm² (1 sun) ±10% adjustable	100 mW/cm² (1 sun) ±10% adjustable	100 mW/cm² (1 sun) ±10% adjustable	100 mW/cm² (1 sun) ±10% adjustable
Uniformity Classification	B - IEC 60904-9 2007, JIS C8912, ASTM E927-05			
Temporal Instability	B - IEC 60904-9 2007, JIS C8912, ASTM E927-05			
Spectral Match	A - IEC 60904-9 2007, JIS C8912, ASTM E927-05			
Working Distance	2 ±0.5 inches	6 ±0.5 inches	7 ±0.5 inches	15 ±0.5 inches
Lamp Power Rating	150 W	450 W	1000 W	1600 W
Power Requirements	95 - 264 VAC/15A 50 - 60 Hz	95 - 264 VAC/15A 50 - 60 Hz	95 - 264 VAC/15A 50 - 60 Hz	190 - 264 VAC/12A 50 - 60 Hz
Line Regulation	0.01%	0.01%	0.01%	0.01%

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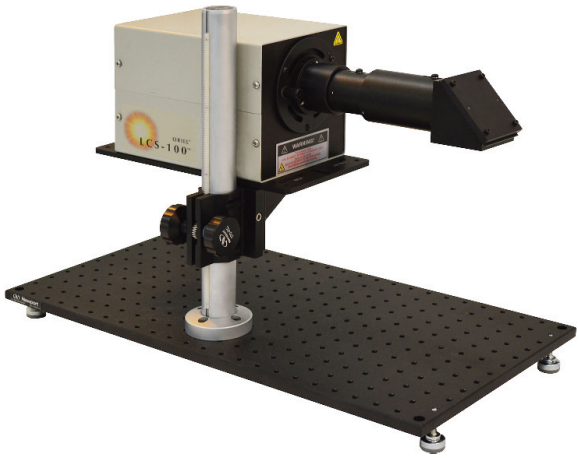
LOW COST COMPACT SOLAR SIMULATORS

- Low cost alternative for PV cell research requiring small area illumination
- Ideal for teaching laboratories
- Standards compliant to current ASTM and IEC for AM 1.5G operation at 1.0 sun output
- Compact design - integrated power supply, igniter, homogenizer, and lamp housing
- Variable attenuator allows partial sun irradiance
- Simple, "drop in" lamp assembly requires no lamp alignment
- Integrated 2" filter folder



The LCS-100 Series solar simulators are intended for researchers requiring the performance of a certified system over a small area of illumination. With an area of 1.5" x 1.5", the simulators meet Class ABB as defined by the ASTM and IEC standards. An AM 1.5G filter is included and a selection of other air mass filters are available as options.

This model is designed for simplicity and economy. The electronics are integrated into the lamp housing and are factory preset to operate the lamp at proper current and voltage settings, resulting in a simple, two-step operation: system power and lamp ignition. The system does not require high voltage cables, optimized power supply settings, or optical alignment. In addition, the system employs a 100W Xenon lamp with an integrated reflector so replacement lamp assemblies simply drop into place with no lamp adjustment required.

SPECIFICATIONS

General	
Beam Size	1.5 x 1.5 inches (38 x 38 mm)
Spectral Match Classification	A - IEC 60904-9 2007, JIS C 8912, ASTM E927-05
Beam Non-Uniformity	B - IEC 60904-9 2007, ASTM E927-05
Temporal Instability	B - IEC 60904-9 2007, JIS C 8912, ASTM E927-05
Collimation Angle	<6°, half angle
Working Distance	8.0 inches (203 mm)
Lamp Power Rating	100 W Xenon
Lamp Life	1000 hours
Input Power	100 - 240 VAC, 50/60 Hz, 130W

Shutter Options	
94011A LCS-100	Solar Simulator, Manual Shutter Only
94011A-ES LCS-100	Solar Simulator, Manual and Electronic Safety Shutter

In keeping with our commitment to continuing improvement, Oriel reserves the right to change specifications without notice or liability for such changes.
For full specifications, please consult the product brochure.

Accessories	Description
6252	Replacement 100 W Xenon Lamp Assembly
SA2-12	Solid Aluminum Optical Breadboard, 12 x 24 inches, 1/4 - 20 holes on 1 inch grid
M-SA2-12	Solid Aluminum Optical Breadboard, 300 x 600 mm, M6 holes on 25mm grid

LAMP BASED SOLAR SIMULATOR ACCESSORIES

SOL-UV SIMULATOR REPLACEMENT LAMPS, FILTERS, AND ACCESSORIES

Part Number	Description
6272	1000 Watt Xenon Short Arc Lamp, Ozone Free
62726	1600 Watt Xenon, Ozone Free Arc Lamp
70380NS	Total UV (A&B) Solar UV meter
70381NS	UVB Solar UV Meter
70382NS	Solar Index Solar UV Meter
70383NS	MED / hr Solar UV Meter
70384NS	Eeff / Ery Solar UV Meter
81057	UVC Blocking Filter
Sol-UV-A-F	UVA I Filter Sol-UV >320nm
Sol-UV-A-LONG-F	UVA II Filter Sol-UV >340nm

SOL1A, 2A, and 3A SIMULATOR REPLACEMENT LAMPS

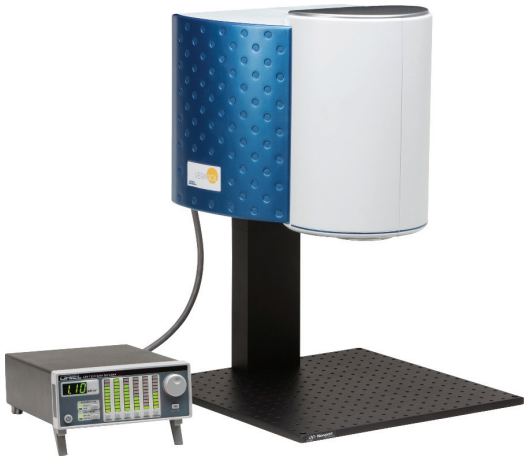
Part Number	Description
6255	150 Watt Xenon, Ozone Free
6279NS	450 Watt Xenon Short Arc Lamp, Ozone Free
6280NS	450 Watt Xenon Short Arc Lamp, Ozone Free
6272	1000 Watt Xenon Short Arc Lamp, Ozone Free
62726	1600 Watt Xenon, Ozone Free Arc Lamp

AIR MASS FILTERS

Part Number	Filter Type	Compatible Systems	Function
81311	AM 0	All Class 1A, 2A, 3A	Corrects the output of a Xenon lamp to match the solar spectrum found outside the Earth's atmosphere
81011-LCS	AM 0	LCS-100	Corrects the output of a Xenon lamp to match the solar spectrum found outside the Earth's atmosphere
81388	AM 1.5 Global	All Class 1A, 2A, 3A	Matches the total (direct and diffuse) spectrum when the sun is at a zenith angle of 48.2° (ASTM E892)
81088A-LCS	AM 1.5 Global	LCS-100	Matches the total (direct and diffuse) spectrum when the sun is at a zenith angle of 48.2° (ASTM E892)
81389	AM Direct	All Class 1A, 2A, 3A	Simulates the solar spectrum at ground level when the sun is directly overhead
81389-LCS	AM Direct	LCS-100	Simulates the solar spectrum at ground level when the sun is directly overhead

VERASOL-2 CLASS AAA LED SOLAR SIMULATOR

- Output beam sizes 2″ x 2″
- Factory certified IEC, ASTM, JIS AAA rated; CE certified
- Variable output adjustment from 0 to 1.0 sun
- Fast turn on time, <100 ms - no shutter required
- User settable spectral control through 19 individual spectral bands
- 10,000 hour LED lifetime - no bulb replacement required
- Flexible mounting orientation



Oriel Instruments proudly offers the first in a series of innovative LED-based solar simulator designs. The VeraSol-2 includes the LSS-7120 controller and the revolutionary LSH-7520 LED source head. The system provides a variable output from 0.1 sun to 1.0 sun over a 2″ x 2″ illumination area. The LSH-7520 is certified AAA rated to IEC 60904-9, JIS-C8912, and ASTM E927-10 for Spectral Match, Non-Uniformity of Irradiance, and Temporal Stability. Each LED simulator is rigorously tested for all aspects of the standards to ensure compliance. The innovative design independently drives multiple LEDs at nineteen individual wavelength bands, from 400 nm to 1100 nm, to ensure a spectral match. The independent control of each LED allows for custom tuning of the output to the specific requirements of a test.

SPECIFICATIONS

LSH-7520 Light Source

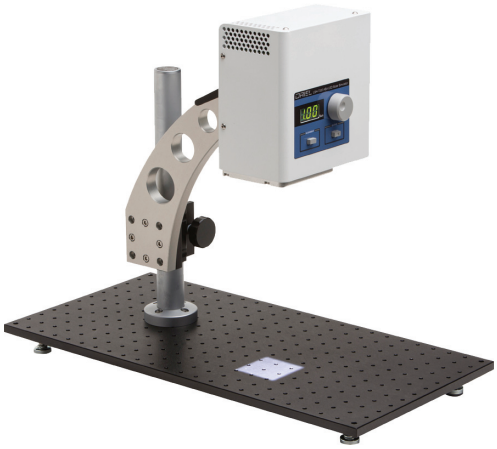
Illumination Area	2 x 2 inches (51 x 51 mm)
Total Power Output	100 mW / cm^2 (1.0 sun)
Uniformity Classification	A - IEC 60904-9 2007, JIS C8912, ASTM E927-10
Temporal Stability	A - IEC 60904-9 2007, JIS C8912, ASTM E927-10
Spectral Match	A - IEC 60904-9 2007, JIS C8912, ASTM E927-10
Source Orientation	0°, 90° (with adapter), 180°
Weight (head only)	38.0 lbs. (17.2 kg.)
Working Plane Distance	8 inches (203.2 mm)
Height Adjustment	8.9 - 14.1 inches (226 - 358 mm)

LSS-7120 LED Solar Simulator

TTL Turn On/Off Transition Time	100 ms
Independent Band Control	6 Bands (400-500 nm, 500-600 nm, 600-700 nm, 700-800 nm, 800-900 nm, 900-1100 nm)
Variable Output Control	0.1 to 1.0 sun
Auxiliary Functions	10 user settable presets, user settable output calibration, LED fault detection, 19 LED wavelength bands - programmable settings
I/O Connectors	USB 2.0 (B-type); DB-60; LSH interconnect port
Power Requirements	100 - 240 VAC, 50 - 60 Hz, 300W
Size	4.0 x 8.5 x 14.0 inches (102 x 216 x 356 mm)
Weight	10.8 lbs. (4.9 kg.)
Operating Temperature Range	20°C to 30°C
Storage Temperature Range	-40°C to 70°C
Humidity	<85%, relative, non-condensing
Compliance	CE

LOW COST CLASS ABA LED SOLAR SIMULATORS

- Compact, simple design ideal for teaching laboratories
- Output beam sizes 2" x 2"
- Factory certified IEC, ASTM, JIS ABA rated; CE certified
- Variable output adjustment from 0 to 1.0 sun
- Fast turn on time, <100 ms - no shutter required
- 10,000 hour LED lifetime - no bulb replacement required
- Flexible mounting orientation
- USB intensity control and calibration self-check
- Trigger-in on / off control



The compact and easy to use LSH-7320 incorporates the benefits of LED technology in a value-priced, flexible solar simulator. The completely independent head includes all controls, LEDs and optics allowing researchers flexible mounting and orientation options. External remote on/off triggering and long lamp life make remote mounting practical and bring LED technology to applications requiring only ABA ratings. Unlike typical lamp based solar simulators, LED based solar simulators have lamp lifetimes that can exceed 10,000 hours and do not require a long warm up time. Shuttering can be accomplished by simply turning the output on and off; no mechanical shutter is required. Careful attention to the design and the use of solid state LEDs allows the LSH-7320 to be oriented in any position to suit a myriad of applications.

SPECIFICATIONS

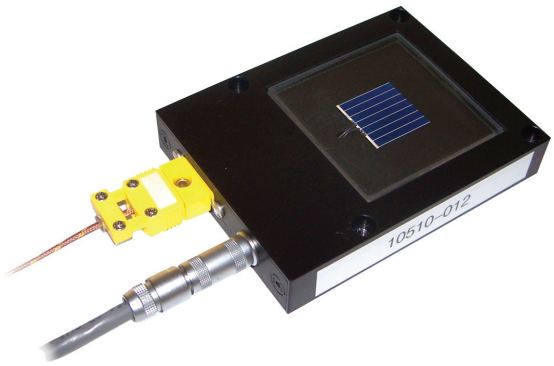
** Breadboard not included*

Illumination Area	2 x 2 inches (51 x 51 mm)
Total Power Output	110 mW / cm^2 (1.1 sun)
Variable Output Control	0.1 to 1.1 sun
Wavelength Range	400 - 1100 nm
Temporal Stability	A - IEC 60904-9 2007
Uniformity Classification	B - IEC 60904-9 2007, JIS C8912, ASTM E927-10
Spectral Match	A - IEC 60904-9 2007, JIS C8912, ASTM E927-10
Working Plane Adjustment	12 inches (305 mm)
Alignment	Laser diode based optical alignment
Z Axis Head Adjustment from Base	7.5 - 17.75 inches (190 - 450 mm)
Head Rotation	0° - 360°
Remote Interface	USB 2.0 (B-Type) or BNC TTL for ON / OFF
TTL Turn On/Off Transition Time	10 ms
Weight (head on assembly stand)	9.3 lbs. (4.2 kg.)
Stand	9.0 lbs. (4.1 kg.)
Power Supply	1.8 lbs. (0.8 kg.)
Size (on assembly stand)	15.25 - 25.5 inches (387 - 648 mm) H x 7.25 inches (184 mm) W x 14.0 inches (362 mm) D
Operating Temperature Range	10°C to 40°C
Storage Temperature Range	-40°C to 70°C
Humidity	<85%, relative, non-condensing
Compliance	CE, RoHS
Power Requirements	100 - 240 VAC, 47 - 63 Hz, 2.8A max

I-V REFERENCE CELL

- Reference solar cell and meter
- Reads calibrated sun irradiance and temperature
- Easily integrated with Oriel PVIV test station
- IEC and ISO compliant, NREL and SI traceable

The Oriel Reference Cell is an integral part of solar simulator calibration and solar cell I-V characterization. The primary purpose of the reference cell is to enable testing of photovoltaic cells under standard test conditions. It consists of a digital meter and a 2 x 2 cm calibrated solar cell constructed of monocrystaline silicon. The cell is also equipped with a thermocouple assembled in accordance with the IEC 60904-2 standard. In addition to a digital read-out, the meter includes two BNC connectors which enable analog output of the sun and irradiance values.



Each reference cell is provided with a certificate which is accredited by A2LA to the ISO 17025 standard and is traceable both to the National Renewable Energy Laboratory (NREL) and to the International System of Units (SI). It reads solar simulator irradiance in Sun units, where one sun is equal to 1000 W/m^2 at 25°C and Air Mass 1.5 Global reference.

SPECIFICATIONS

General	
Dimensions (Cell)	2.8″ W x 0.6″ H x 3.5″ D (92 mm x 70 mm x 16 mm)
Dimensions (Meter)	5.9″ W x 3.8″ H x 7.0″ D (151 mm x 95 mm x 178 mm)
Weight	4 lbs. (1.8 kg.)
Operating Temperature	10°C - 40°C
Operating Humidity	0 - 90% RH non-condensing

Irradiance Readout	
Range	0 - 3.500 Sun
Resolution	0.0001 Sun @ 0 - 1.9500 Sun (low display range) 0.001 Sun @ 1.900 - 3.500 Sun (high display range)
Temperature Coefficient	±150 ppm / °C Max
Settling Time	<1 second for <0.25% (=6τ)
Sampling Rate	3 readings / second
Autoranging	Switches to higher display range above 1.950 Sun; lower range below 1.900 Sun

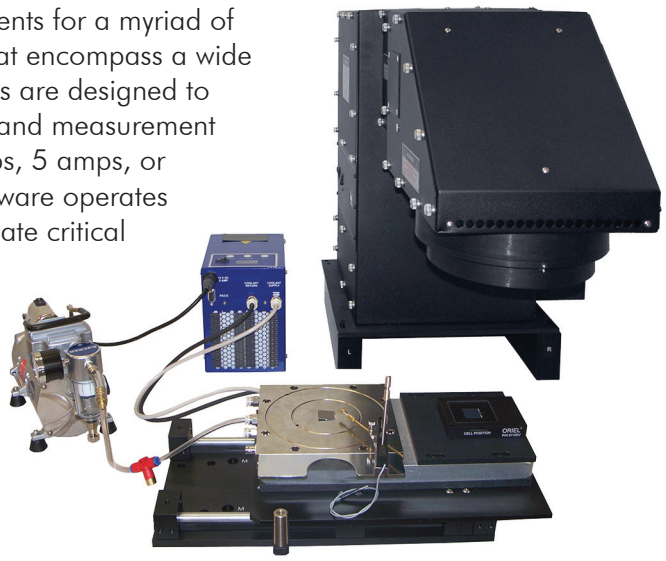
Part Number	**Description**
91150-KG5	Calibrated reference cell and meter, KG5 window
91150V	Calibrated reference cell and meter, Quartz window

PVIV TEST STATION

- Complete I-V measurement solutions for photovoltaic cells
- Works with all Oriel solar simulators
- Easily integrated with Oriel solar simulators in the field
- Easy to use LabVIEW™ based I-V characterization software

The PVIV Test Station provides reliable, accurate I-V measurements for a myriad of photovoltaic cell configurations. PV samples are researched that encompass a wide range of efficiencies and sizes. To address this, the PVIV systems are designed to incorporate an appropriate source / meter, cabling, interface, and measurement software into separate models to accommodate 1 amp, 3 amps, 5 amps, or 10 amps of current generated by the device. The PVIV 2.0 software operates with all configurations to perform I-V measurements and calculate critical parameters, such as:

- Short circuit current (Isc)
- Current density (Jsc)
- Open circuit voltage (Voc)
- Fill factor (ff)
- Maximum output power (Pmax)
- Cell efficiency



SPECIFICATIONS

Model	PVIV-1A	PVIV-3A	PVIV-5A	PVIV-10A
Electrical Interface	4-Wire	4-Wire	4-Wire	4-Wire
Voltage Range	±200 V	±60 V	±40 V	±2.5 V
Software	LabVIEW® based application			
Measurements Performed	Voc, Isc, Jsc, Vmax, Imax, Pmax, efficiency, fill factor, Rsc, Roc, Rshunt			

In keeping with our commitment to continuing improvement, Oriel reserves the right to change specifications without notice or liability for such changes. For full specifications, please consult the product brochure.

Part Number	Description
PVIV-1A	I-V Test Station, 1 amp
PVIV-3A	I-V Test Station, 3 amp
PVIV-5A	I-V Test Station, 5 amp
PVIV-10A	I-V Test Station, 10 amp

Accessories	
PVIV-PROBE-KIT	Magnetic Electrical Probe Kit with X-Y micro control
PROBE-TIP-RPL	Replacement Tungsen Probe Tips; package of five (5)
PVIV-TC-VAC	Cell Holder with Temperature Control and Vacuum Positions for 2 x 2 through 6 x 6
PVIV-VAC-CHUCK	Height Adjustable Basic Cell Holder, Vacuum Plate, 2 x 2 through 6 x 6
PVIV-VAC-PUMP	PVIV Vacuum Pump, Oil Free, Cool Air Output, 110 VAC
PVIV-VAC-PUMP-220	PVIV Vacuum Pump, Oil Free, Cool Air Output, 220 VAC
PVIV-CHILLER	Circulating Water Bath Chiller for Temperature Control of PVIV-TC-VAC

WHAT ARE QE AND IPCE?

Quantum Efficiency (QE) and Incident Photo to Charge Carrier Efficiency (IPCE) indicates the ratio of the number of generated charge carriers to the number of photons incident on a solar cell. Quantum efficiency is a measure of external efficiency, while IQE considers the internal efficiency; that is, the photons reflected back from the surface of the cell are not considered.

The EQE/IQE measurements are critical especially during the materials research and cell design stage because it is of great importance for a device to have an optimal spectral response at the point at which the spectral component of the sunlight is abundant. The system is built by an industry leader in light sources and spectroscopy, so you can rely on our expertise to ensure accuracy of the measurement.

The key to accurately measure the QE/IPCE of a solar cell is to quantify the intensity of monochromatic light incident to the deive under test and how much current is generated. We use a turnkey solution that allows one button data acquisition and control of all hardware.

QEPVSI-b MEASUREMENT SYSTEM

- Complete, tested solution for EQE measurement and characterization
- Accurate and repeatable data using an industry standard lock-in amplifier to exclude background noise
- TracQ™ Basic software for simple operation and fast data collection
- Convenient adjustable spot size to fit your test
- Compliant to ASTM E1021-15 standard and test methods

The QEPVSI-b is a preconfigured, yet flexible solution for measuring Quantum Efficiency (QE), also known as Incident Photon to Charge Carrier Efficiency (IPCE). Industry leading components ensure accuracy and repeatability. The Oriel TracQ™ Basic software provides instrument setup, control, data collection, and export. The complete system is optically aligned, tested and calibrated to simplify setup and data collection. The QEPVSI-b system combines all the components needed for free space QE measurement including:

- 300W Xenon light source
- Automated filter wheel with order sorting filters
- Monochromator
- Optics and optomechanical components
- Optical chopper with lock-in amplifier
- Silicon detector

QuantX QUANTUM EFFICIENCY MEASUREMENT SOLUTION

- Complete, turn-key PV efficiency measurement solution
- Robust, compact design; small footprint of 0.85 m x 0.39 m to minimize lab space
- Simultaneous IQE, EQE, and spectral response measurements
- Integrated beam chopper with virtual digital lock-in amplifier capable of 4 Hz for high signal-to-noise
- Achromatic optics; maintains spot size throughout the entire spectral range
- User-friendly, icon based software interface for simple calibration and IQE measurements
- Sturdy 3-axis (Z, tip, tilt) optical mounting for precise alignment and stability
- Integrated vacuum chuck with thermistor for simple cell staging

The QuantX series Quantum Efficiency Measurement Solutions leverage Newport's expertise in optical design, spectroscopy, precision motion control, and electronics technologies. These proficiencies have been focused into a complete, sophisticated measurement system for Quantum Efficiency (EQE and IQE). The solution empowers researchers to measure Internal Quantum Efficiency (IQE) and quantify External Quantum Efficiency (EQE), also known as Incident Photon to Charge Carrier Efficiency (IPCE), for any photovoltaic device. Employing industry leading, durable components for optical performance, QuantX instruments are preconfigured, assembled, and calibrated at the factory. The product is a turn-key solution which includes all necessary components.

SPECIFICATIONS

Model	QuantX-200	QuantX-300
Light Source	100W Xenon lamp	100W Xenon lamp
Spot Size	0.76 x 1.0 mm rectangular at focus	1.1 mm x 1.2 mm at focus
Working Distance	75 mm	75 mm
Wavelength Range	320 - 1100 nm	320 - 1800 nm
Spectral Bandwidth of Monochromator Output	5 nm minimum	5 nm minimum
Wavelength Accuracy	0.5 nm	±0.5 nm
Monochromator Filters	Automated, 5-position filter wheel	Automated, 5-position filter wheel
Detectors	Silicon detector	Patented Si/Ge bounce detector
Chopper Frequency	4 - 100 Hz, 0.1 Hz resolution	2 - 100 Hz
Voltage Bias	-10 to +10 V @ 0.5A, 0.1 V resolution	-10 to +10 V @ 0.5A, 0.1 V resolution
QE Calibration Test Cell	Included	Included
Reflectance Calibration Standards	Included	Included
Computer	Included; Dell Latitude (recent model)	Included; Dell Latitude (recent model)
Electrical / Mechanical		
Input Voltage	100 - 115 VAC, 3A; 220 - 240 VAC, 1.5A	90 - 264 VAC
Input Frequency	48 - 66 Hz	48 - 66 Hz
Ambient Operation Temperature	23 ± 5°C operating	23 ± 5°C lab environment
Humidity	<85% relative humidity, non-condensing	<85% relative humidity, non-condensing
Weight	70 lbs. (32 kg.)	75 lbs. (34 kg.)
Dimensions (W x D x H)	33.3 x 15.4 x 19.1 inches	33.4 x 14.6 x 21.1 inches

TECHNICAL LITERATURE

Oriel photovoltaic products are well documented, and a wide variety of technical literature exists. Thorough manuals and technical brochures exist for every product. In addition, several Application and Technical notes can be accessed on the Newport website, www.newport.com/oriel, or by contacting a Newport representative. The literature is designed to answer technical questions or to explain the variety of applications for which the products have provided solutions.

EXCERPT FROM APPLICATION NOTE 56: COMPARISONS OF IV CURVES BETWEEN XENON LAMP-BASED AND LED-BASED SOLAR SIMULATORS

INTRODUCTION: Photovoltaic (PV) devices have an essential role in global renewable energy production. Photovoltaic technology can be classified into three types of PV cells:

1. Wafer-based crystalline silicon,
2. Thin filiment amorphous silicon, cadmium telluride, or copper indium gallium selenide, and
3. A new generation of organic PV cells (not covered in this application note) (Gangopadhyay et al. (2013))

Currently, PV research is rapidly advancing and diversifying to improve PV cell efficiency, material, and cost. Simultaneously, researchers continue to investigate new and better instrumentation for PV cell characterization. Advancements in LED technology are providing novel test and measurement equipment to aid research in new PV cells. The new AAA VeraSol from Oriel Instruments is an LED-based solar simulator which offers numerous advantages over previous, lamp-based AAA solar simulators. With an equivalent spectral match, irradiance uniformity, and temporal stability, the VeraSol has a filter-free, variable intensity output from 0 to 1 sun. The LEDs are electrically gated and can be turned on or off in less than 100ms without requiring a mechanical shutter for PV IV characterization. The user is granted custom spectral control over the entire AM1.5G spectrum. Functionally, the LEDs have inherently longer lamp lifetime, consume less power, and require less mechanical cooling, which further simplified the instrument. The lack of additional radiant heat also helps prevent artifacts associated with heating of the PV cells under test. In general, as compared to lamp-based technology, the VeraSol offers a more diverse and equally reliable solar illumination source to characterize and test PV cells.

This application note compares the IV sweep results of a Xenon lamp-based solar simulator to the LED-based Oriel VeraSol solar simulator. In the first section, the spectral outputs of the two simulators are considered.

In the second section, the IV response is compared for a series of PV cells:

- Monocrystalline Silicon
- Polycrystalline Silicon
- Thin Film Amorphous Silicon
- Thin Film Copper Indium Gallium Selenide

Fundamental parameters which characterize an IV curve were generated with Oriel PVIV software: Short Circuit Current (I_{sc}), Open Circuit Voltage (V_{oc}), Fill Factor (FF), and Efficiency (η).

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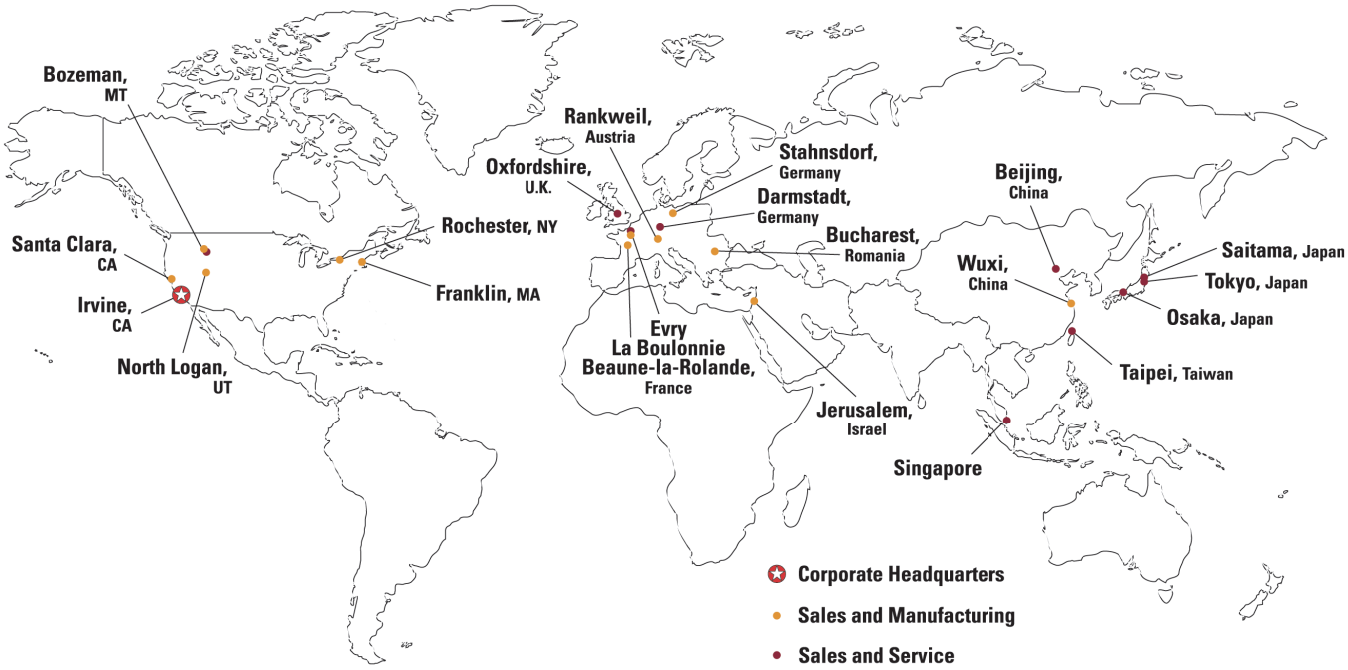

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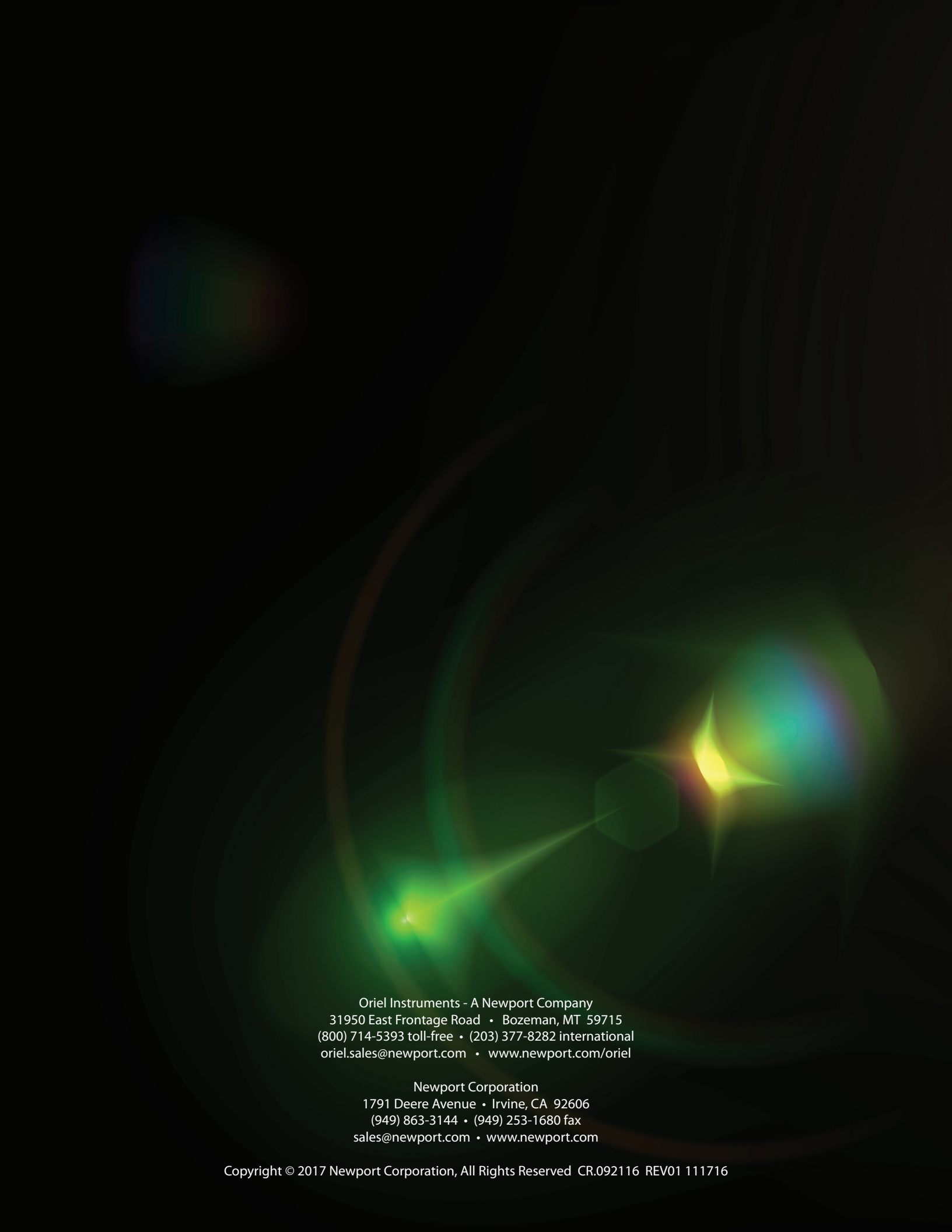

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