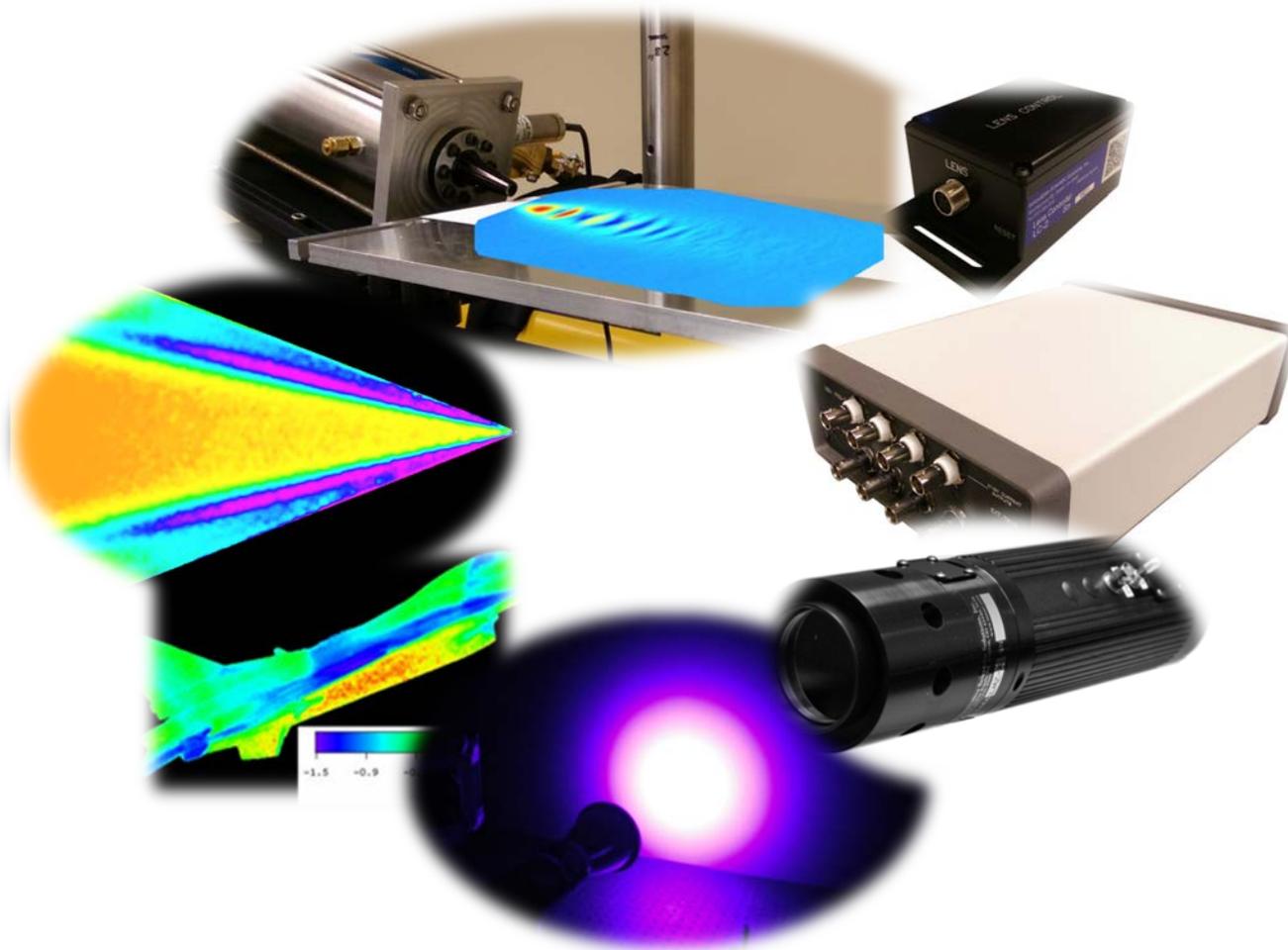
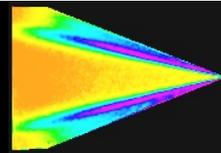




Innovative Scientific Solutions, Inc.



2017 PRODUCT CATALOG

Innovative Scientific Solutions, Inc.
www.psp-tsp.com



TABLE OF CONTENTS

1 PAINTS	5
1.1 SINGLE LUMINOPHORE PRESSURE SENSITIVE PAINT	6
1.2 BINARY PRESSURE SENSITIVE PAINT	8
1.3 FAST PRESSURE SENSITIVE PAINT	10
1.4 TEMPERATURE SENSITIVE PAINTS	13
1.5 BASE COATINGS	15
1.6 PAINT STARTER KIT	15
2 LIGHT SOURCES	16
2.1 AIR-COOLED	17
2.2 WATER-COOLED	22
2.3 SPECIAL APPLICATIONS	24
2.4 LED ACCESSORIES	28
3 CAMERAS	30
3.1 CCD CAMERAS	31
4 SYSTEM INTEGRATION	33
4.1 PULSE SEQUENCE GENERATOR	34
4.2 CCTV LENS CONTROLLER	35
4.3 EF LENS CONTROLLER	36
4.4 SYSTEM BOX	37
4.5 CALIBRATION SYSTEM	38
5 MOLECULAR IODINE CELLS	40
5.1 PERMANENTLY SEALED MOLECULAR IODINE CELL	41
5.2 MANIFOLD MOLECULAR IODINE CELL	42
6 PACKAGED SYSTEMS	43
6.1 SMALL-SCALE ACADEMIC PSP/TSP SYSTEMS	43
6.2 LARGE-SCALE COMMERCIAL PSP/TSP SYSTEMS	44
6.3 PARTICLE SHADOW VELOCIMETRY	45
7 SOFTWARE	46
7.1 ACQUISITION	46
7.2 MESH GENERATION	47
7.3 IMAGE PROCESSING	48
APPENDIX A	50
DETAILED DRAWINGS	50

ABOUT ISSI

Founded in 1995, Innovative Scientific Solutions, Inc. is an engineering research and development company providing innovative measurement and instrumentation solutions in the area of Fluid Dynamics, Aerodynamics, Combustion Analysis, and Pressure/Force quantification.

ISSI supports the US Dept. of Defense, US Navy, NASA, National Institutes of Health, and other federal customers, as well as U.S. industry and academic laboratories. We work with government and industry laboratories in Europe, Asia, and South America, as well as academic organizations worldwide.

ISSI is located 16 miles south of Wright-Patterson Air Force base, just south of downtown Dayton, Ohio near the Dayton Mall off of OH-725 in the South Park Office complex.



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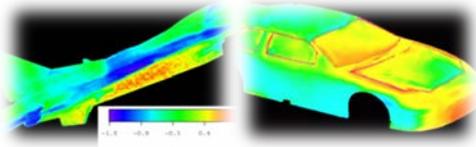
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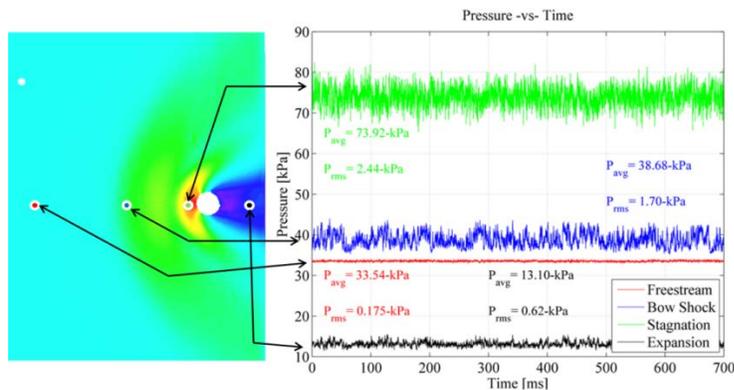
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1 | PAINTS

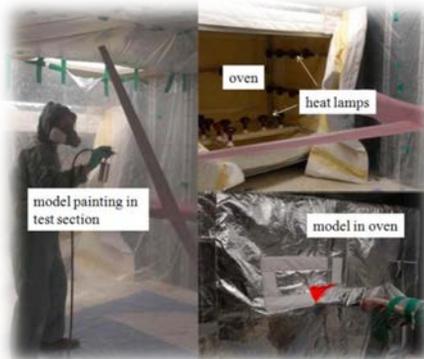
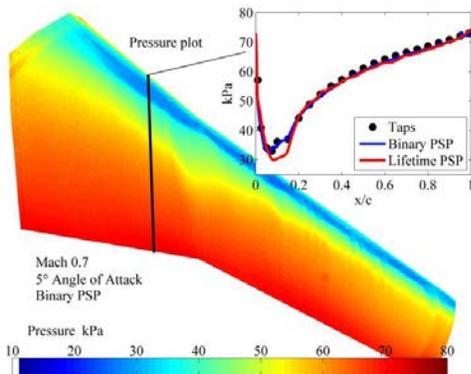
PRESSURE SENSITIVE PAINT



Traditional measurement techniques for acquiring surface pressure distributions on models or flight vehicles have utilized embedded arrays of pressure taps. This approach requires extensive construction time, and is prohibitively limited to several hundred transducers for the largest models, and hence, much of the surface pressure distribution has to be inferred from interpolation. An alternative approach is to use Pressure-Sensitive Paint (PSP) to measure the surface pressure distribution. With this approach, around 10^6 nonintrusive pressure taps provide sub millimeter spatial resolution of the entire model surface.



The time series data recorded can be analyzed using the same techniques available to traditional pressure taps. Hence, PSP data has the unique capability to compare pressures from any location regardless of geometry. Pressure measurements using PSP have been demonstrated in subsonic, transonic, and supersonic flows including the complex flow fields encountered on the suction surface of an advanced compressor blade and an aircraft wing in flight. The advantages of PSP include non-intrusive pressure measurements and high spatial resolution.



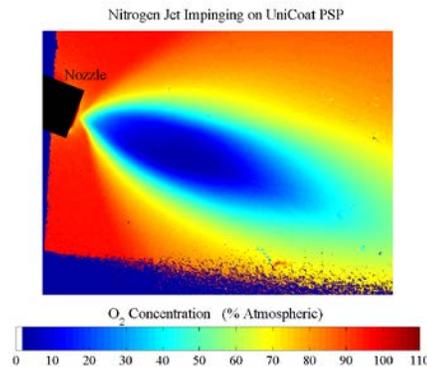
1.1 SINGLE LUMINOPHORE PRESSURE SENSITIVE PAINT

UNICOAT PRESSURE SENSITIVE PAINT

(Product ID: UNC-12)

UniCoat is a single-lumino-phore pressure sensitive paint (PSP) packaged in an aerosol can for ease of application. UniCoat has slightly higher temperature sensitivity and slightly lower pressure sensitivity than UniFIB PSP, but is a simple shake and spray application at a lower cost than other products and is ideal for academic purposes. This single coat application paint may be applied directly to most materials. UniCoat is an effective quantitative PSP well suited for

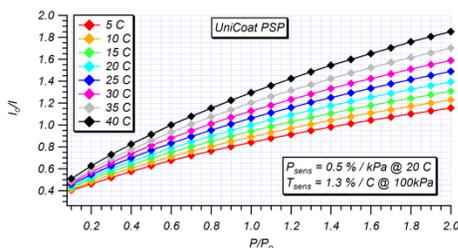
isothermal environments (large metal models and temperature controlled tunnels) or where strong pressure variations are present (transonic and supersonic flows). UniCoat is recommended for introductory PSP users who seek an inexpensive paint for the purpose of developing their PSP capabilities.



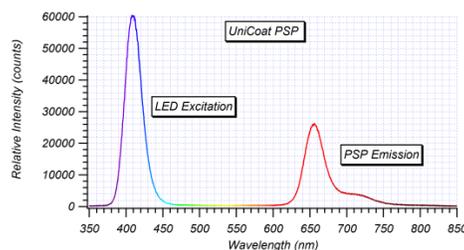
SPECIFICATIONS

Pressure sensitivity.....	0.5% per kPa
Pressure range.....	1-kPa to 200-kPa
Temperature sensitivity.....	1.3% per °C
Temperature range.....	-10°C to 60°C
Response time.....	750-ms
Excitation.....	380-nm to 520-nm
Emission.....	620-nm to 750-nm
Photo-degradation rate.....	1% per hour
Shelf life.....	12-months
ECCN.....	EAR99

Available Quantities: 12-oz aerosol spray can



Calibration

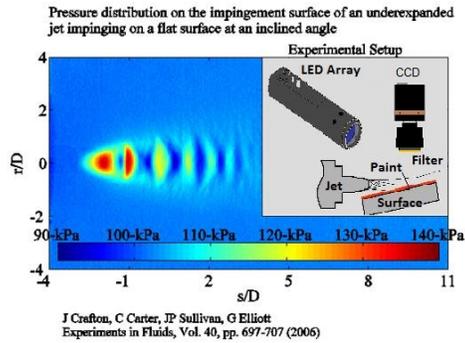


Spectral Response

UNIFIB PRESSURE SENSITIVE PAINT

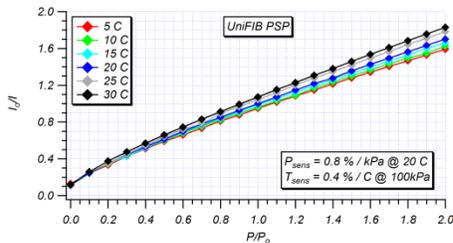
(Product ID: UF-XXX)

UniFIB is a bright single-luminophore pressure sensitive paint (PSP) formulated to be applied with paint spraying equipment as a single component PSP optimized for maximum luminescent signal while maintaining high pressure sensitivity and low temperature sensitivity. This paint formulation may be excited effectively from 370-nm to 520-nm, however, 400-nm radiation from LM2X-400 LED modules is recommended. The paint may be applied to most materials, though models constructed of materials that may be attacked by solvents, such as plastic or rapid prototyping resins, should be coated with a base coat such as SCR-100 (Screen layer) or FB (FIB basecoat). The calibration of UniFIB is very stable and repeatable thus UniFIB is recommended for advanced/professional PSP users who seek high-quality data up to transonic flow conditions.

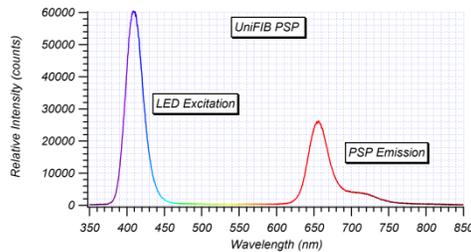


SPECIFICATIONS

- Pressure sensitivity 0.8% per kPa
- Pressure range 0-kPa to 200-kPa
- Temperature sensitivity 0.4% per °C
- Temperature range 0°C to 50°C
- Response time 300-ms
- Excitation 380-nm to 520-nm
- Emission 620-nm to 750-nm
- Photo-degradation rate 1% per hour
- Shelf life 12-months
- ECCN EAR99
- Available quantities: 200-, 400-, 750-ml



Calibration



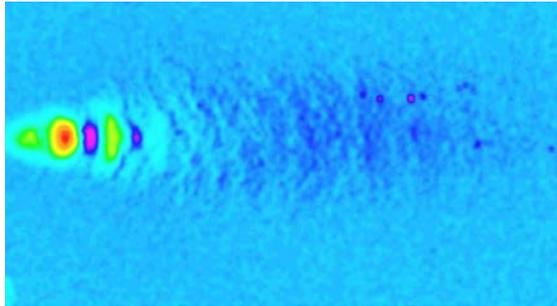
Spectral Response

1.2 BINARY PRESSURE SENSITIVE PAINT

BINARY UNICOAT PRESSURE SENSITIVE PAINT

(Product ID: BUNC-12)

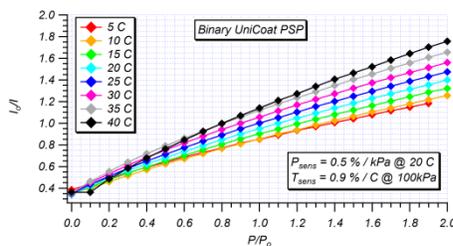
Binary UniCoat is a dual-luminophore pressure sensitive paint (PSP) packaged in an aerosol can for ease of application. The binary PSP approach involves acquiring data from two distinct luminescent dyes and using these signals to compensate for errors caused by model displacement and deformation.



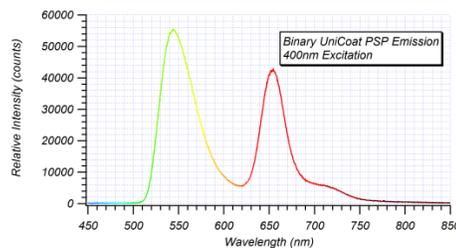
Binary UniCoat has higher temperature sensitivity and lower pressure sensitivity than BF based paints as shown in the calibration below. A desirable feature of Binary UniCoat is ease of application. Simply shake the can and spray the surface. The result is a single coat application paint that may be applied directly to most materials. Binary UniCoat is an effective quantitative PSP in isothermal environments (large metal models and temperature controlled tunnels) or where strong pressure variations are present (transonic flows). It is also effective in compensating for errors due to model displacement and deformation. Binary UniCoat is recommended for introductory PSP users who seek an inexpensive means to gain experience with binary paints.

SPECIFICATIONS

Pressure sensitivity 0.5% per kPa
 Pressure range 1-kPa to 200-kPa
 Temperature sensitivity 0.9% per °C
 Temperature range -10°C to 60°C
 Response time 750-ms
 Excitation 380-nm to 520-nm
 Emission 500-nm to 720-nm
 Photo-degradation rate 1% per hour
 Shelf life 12-months
 ECCN EAR99
 Available Quantities: 12-oz aerosol spray can



Calibration

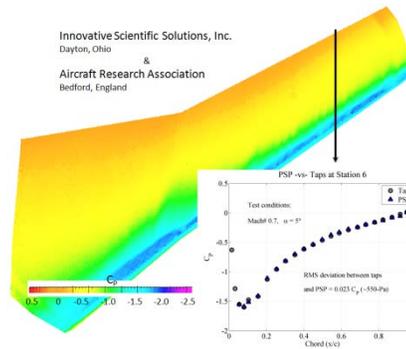


Spectral Response

BINARY FIB PSP

(Product ID: BF-XXX)

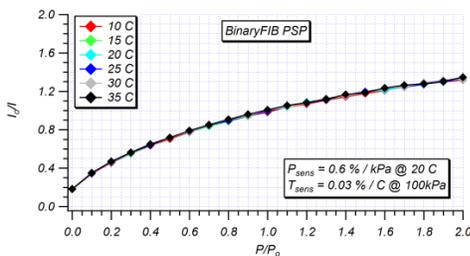
Binary FIB pressure sensitive paint (PSP) is a dual-luminophore, single application PSP formulated to be applied with paint spraying equipment. The binary paint approach involves acquiring data from two distinct luminescent dyes and using these signals to compensate for errors caused by model displacement and deformation as well as temperature. One dye is pressure and temperature sensitive and the other dye is temperature sensitive only. The ratio of the signals from the two dyes allows the temperature sensitive signal to be isolated from the pressure sensitive signal. The temperature sensitivity of the paint can be minimized over a wide range of temperatures and pressures as shown in the calibration below. The paint may be applied to most materials, however a white base coat such as SCR-XXX (Screen layer) or FB-XXX (FIB basecoat) is recommended. Models constructed of materials that may be attacked by solvents such as plastic or rapid prototyping resin should be coated with a screen layer or FIB basecoat. The calibration of Binary FIB is very stable, repeatable, and exhibits very little temperature sensitivity. Binary FIB is recommended for advanced/professional PSP users who seek high quality data in low-speed environments or where temperature gradients are larger and have a greater impact on the signal-to noise ratio.



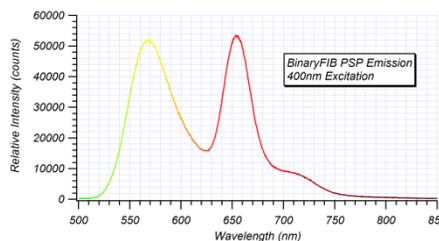
SPECIFICATIONS

Pressure sensitivity	0.6% per kPa
Pressure range.....	0-kPa to 200-kPa
Temperature sensitivity	0.03% per °C
Temperature range.....	0°C to 50°C
Response time.....	300-ms
Excitation.....	380-nm to 420-nm
Emission	500-nm to 720-nm
Photo-degradation rate.....	1% per hour
Shelf life	12-months
ECCN	EAR99

Available quantities: 200-, 400-, 750-ml



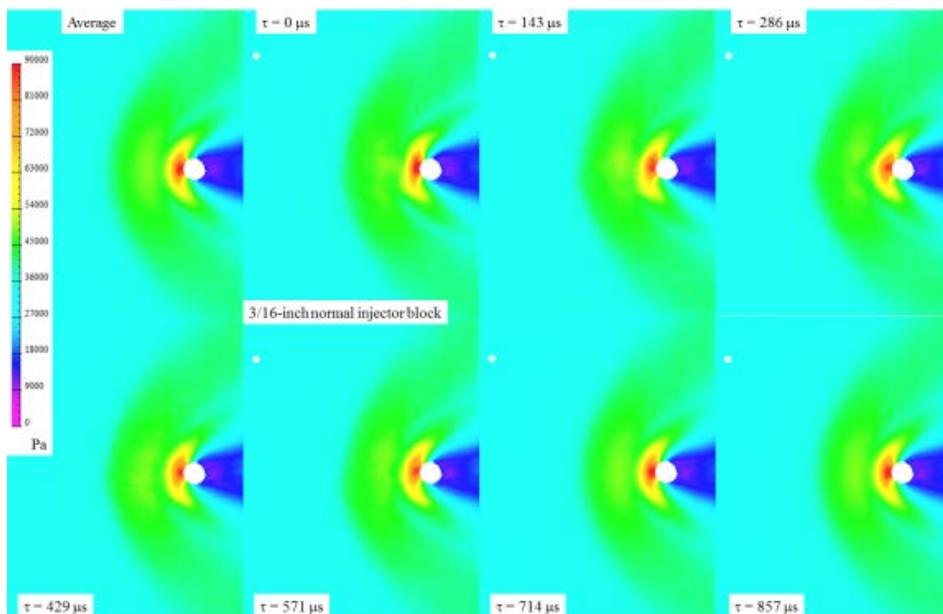
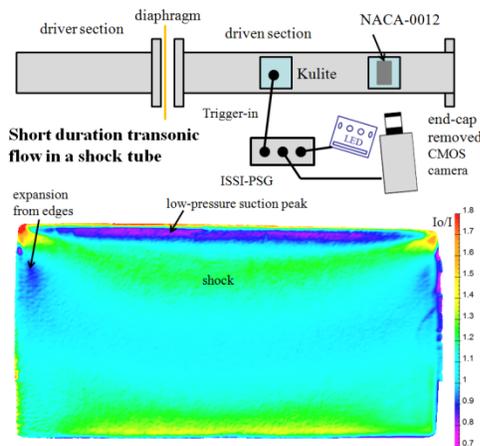
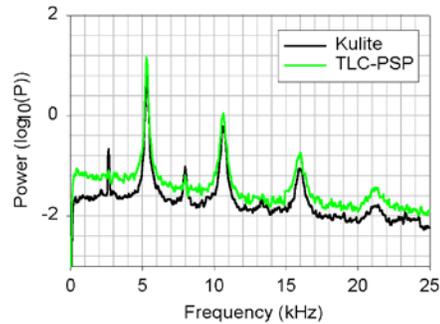
Calibration



Spectral Response

1.3 FAST PRESSURE SENSITIVE PAINT

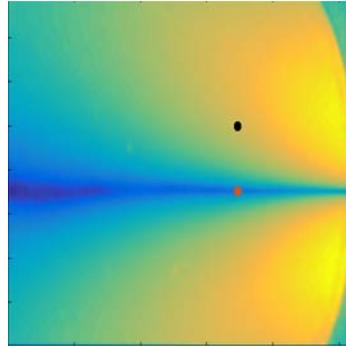
Conventional polymer-based paint formulations have response times on the order of 1 s, making them unsuitable for evaluating unsteady aerodynamic phenomena. The temporal-response characteristics of PSP are primarily governed by the thickness of the paint formulation and the diffusion coefficient of the binder material. The response time due to diffusion (τ_{diff}) increases with the paint thickness (h) squared and decreases with increasing diffusion coefficient (D_m). Some fast responding paints have focused on decreasing the thickness of the paint in order to improve the temporal response characteristics. This approach sacrifices luminescent output from the paint, and thus the signal-to-noise ratio, for a faster response time and a lower signal-to-noise ratio. Porous binders have been developed with the goal of enhancing the oxygen diffusion within the paint layer and, thus, improving the temporal response without reducing the signal-to-noise ratio. The PtTFPP-Porous Polymer formulation results in a system with good pressure sensitivity (more than 0.6%/kPa), strong signal and excellent temporal response (over 10-kHz). The paint may be applied to clean, dry, materials such as Aluminum, Glass, Plastic, or Steel, and no base coat or heat treating is required. PtPP is recommended for applications that require a bright paint with frequency response of up to 10-kHz.



TURBO FIB PRESSURE SENSITIVE PAINT

(Product ID: TF-XXX)

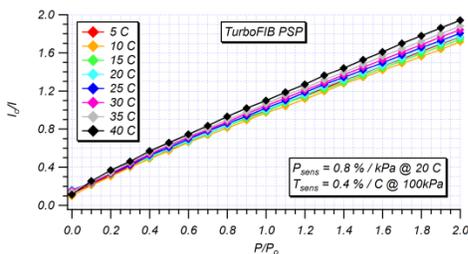
TurboFIB pressure sensitive paint (PSP) is a single-luminophore, single application PSP formulated to be applied with paint spraying equipment. TurboFIB provides many of the advantages of UNIFIB PSP, but with faster response (1 kHz) and reduced temperature sensitivity. This paint formulation may be excited effectively from 380-nm to 550-nm, however, 400-nm radiation from LM2X-DM-400 LED modules is recommended. The paint may be applied to most surfaces, though it is recommended that plastics and rapid prototyping resins first be coated with SCR-XXX (Screen layer) or FB-XXX (FIB basecoat) to protect the surface from solvent damage. The calibration of TurboFIB (shown below) is very stable and repeatable thus TurboFIB is recommended for advanced/professional PSP users who seek high quality data. Paint is sold in quantities of 200-ml, 400-ml. Custom quantities are available upon request. Surface coverage is approximately 1 m² per liter.



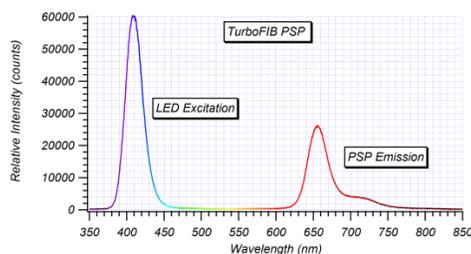
SPECIFICATIONS

Pressure sensitivity 0.8% per kPa
 Pressure range..... 0-kPa to 200-kPa
 Temperature sensitivity 0.4% per °C
 Temperature range 0°C to 50°C
 Response time..... <1-ms
 Excitation..... 380-nm to 550-nm
 Emission 620-nm to 750-nm
 Photo-degradation rate..... 1% per hour – Excitation
 Shelf life 12-months
 ECCN EAR99

Available quantities: 200-, 400-, 750-ml



Calibration

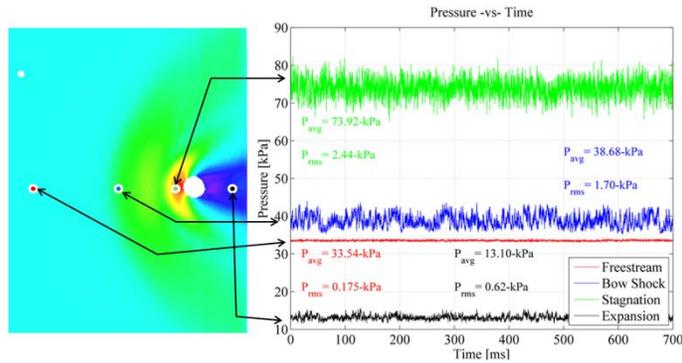


Spectral Response

POROUS FAST-RESPONSE PRESSURE SENSITIVE PAINT

(Product ID: FP-XXX)

Porous Fast-Response PSP is a three component, single-luminophore high speed pressure sensitive paint (PSP) formulated to provide high speed response (>10kHz) suitable for unsteady pressure measurements with high pressure sensitivity. The

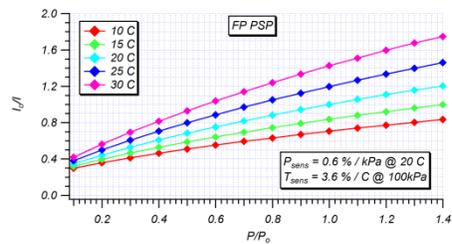


temperature sensitivity of these paints is higher than UniFIB or TurboFIB so this PSP is best suited for isothermal environments. This paint comes in three parts. Determine how much PSP you need for your application and measure out part A by volume. Part B will be measured out 4% by volume of part A (a reusable measuring syringe is provided with the order for convenience). Shake the part A and B mixture well. This mixture is to be sprayed with paint spraying equipment on to the surface of study with a wet application to achieve a smooth finish. This application is the base layer. Once the base layer is dry, apply part C with paint spraying equipment, the overspray. The overspray, part C, may be reapplied more than once. A typical order would be a 100mL kit which would consist of three containers: 100 mL of part A, 5 mL of part B, 100mL of part C, and a 5cc (mL) syringe.

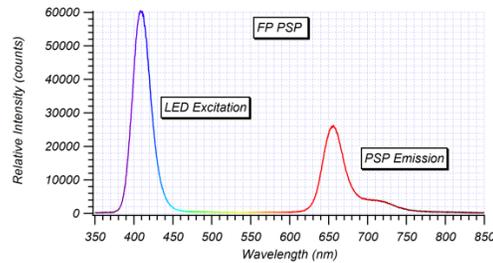
SPECIFICATIONS

Pressure sensitivity	0.6% per kPa
Pressure range.....	0-kPa to 200-kPa
Temperature sensitivity	3.6% per °C
Temperature range.....	0°C to 80°C
Response time.....	< 100- μ s
Excitation.....	380-nm to 420-nm
Emission	600-nm to 720-nm
Photo-degradation rate.....	1% per min
Shelf life	3-months
ECCN	EAR99

Available quantities: 100-ml



Calibration

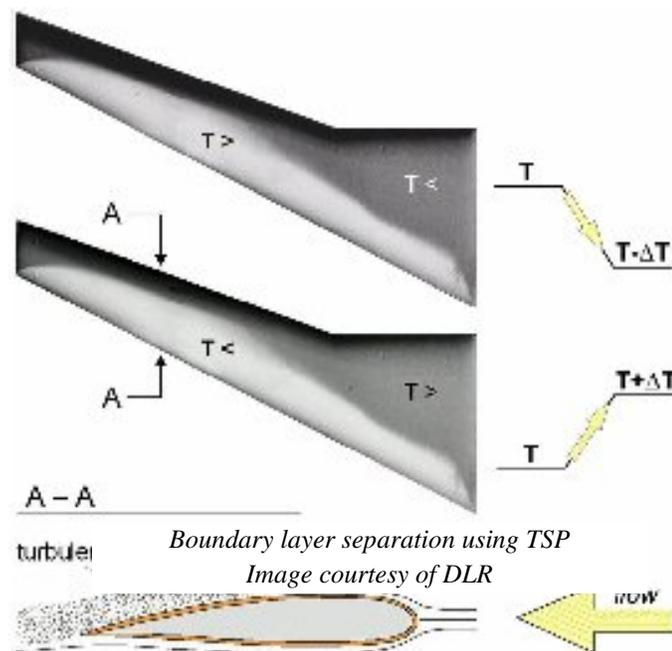


Spectral Response

TEMPERATURE SENSITIVE PAINT

Traditional measurement techniques for acquiring surface temperature distributions on models have utilized embedded arrays of thermocouples and RTD's. This requires significant construction and setup time while producing data with limited spatial resolution. An alternative approach is to use temperature sensitive paint (TSP) to measure surface temperature. The advantages of temperature sensitive paint include non-intrusive measurements and high spatial resolution when compared to conventional measurement techniques. Image based temperature measurements using TSP are accomplished by coating the model surface with the paint and illuminating the surface with light of the appropriate wavelength. The luminescence from the surface is recorded using a CCD camera through a long-pass filter to separate the luminescent signal from the excitation light. The luminescence from the TSP is a function of the local temperature, and therefore, each pixel on the camera acts as a thermocouple.

A typical TSP consists of the luminescent molecule and an oxygen impermeable binder. The basis of the temperature sensitive paint method is the sensitivity of the luminescent molecules to their thermal environment. The luminescent molecule is placed in an excited state by absorption of a photon. The excited molecule deactivates through the emission of a photon. A rise in temperature of the luminescent molecule will increase the probability that the molecule will return to the ground state by a radiation-less process, this is known as thermal quenching. The temperature of the painted surface can be measured by detecting the fluorescence intensity of the luminescent paint.



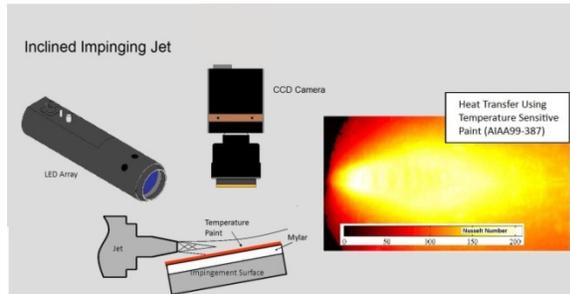
TSPs are used to measure surface temperature distributions to estimate heat transfer rates over a surface and to capture boundary layer transition from laminar to turbulent.

1.4 TEMPERATURE SENSITIVE PAINTS

UNITEMP TSP

(Product ID: UNT-XXX)

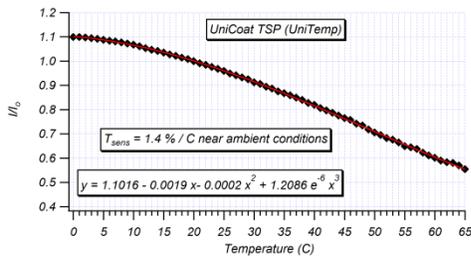
UniTemp is a single-luminophore, single application temperature sensitive paint. The TSP may be applied to most surfaces, but a screen layer such as SCR or FB is recommended for plastics and rapid prototyping resins to protect the surface from solvent damage. A desirable feature of UniTemp is ease of application. Simply shake the can and spray the surface. The result is a single coat application paint that may be applied directly to most materials. UniTemp is an effective quantitative TSP. It is also effective in compensating for errors due to model displacement and deformation. UniTemp is recommended for both advanced TSP users who seek quantitative data and users who seek to gain experience with temperature sensitive paints.



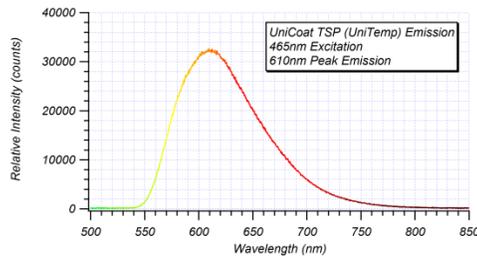
SPECIFICATIONS

Pressure sensitivity	0% per kPa
Pressure range.....	1-kPa to 10-MPa
Temperature sensitivity	0.9 % per °C
Temperature range.....	10°C to 80°C
Response time.....	750-ms
Excitation.....	380-nm to 520-nm
Emission	500-nm to 720-nm
Photo-degradation rate.....	1% per hour
Shelf life	12-months
ECCN	EAR99

Available Quantities: 12-oz aerosol can (UNT-12), or 200-, 400, 750-ml



Calibration



Spectral Response

1.5 BASE COATINGS

FIB BASECOAT

(Product ID: FB-XXX)

The FIB basecoat is a single application screen layer that is sprayed onto a model surface with paint spraying equipment to mask machining marks and stains or to mask surfaces that fluoresce and interfere with PSP or TSP data. FIB basecoat also provides a uniformly reflective surface to minimize illumination errors and enhance the emission of PSP and TSP. This formulation is recommended for surfaces where the screen layer and PSP or TSP absolutely must be removed from the surface using common mild solvents.

Available quantities: 200-, 400-, 750-ml

EPOXY SCREEN LAYER

(Product ID: SCR-XXX)

The epoxy-based screen layer (SCR) is a two part formulation designed to be applied to surfaces using conventional paint spraying equipment to mask machining marks and stains or to mask surfaces that fluoresce and interfere with PSP or TSP data. FIB basecoat also provides a uniformly reflective surface to minimize illumination errors and enhance the emission of PSP and TSP. SCR comes in two parts and is mixed 1:1. SCR provides the highest quality surface screen layer without superior solvent resistance and improved opacity. The solvent resistance means PSP can be applied over it and removed many times without the need to reapply the screen layer each time. SCR needs to be fully cured before the PSP is applied by curing at elevated temperatures (90C for 3 hours) or by allowing a few days to air cure to prevent the screen layer from interacting with the PSP and compromising data. SCR is a permanent screen layer. Shelf life is 3-months.

Available quantities: 200-, 400-, 750-ml

1.6 PAINT STARTER KIT

(Product ID: PSP-K)

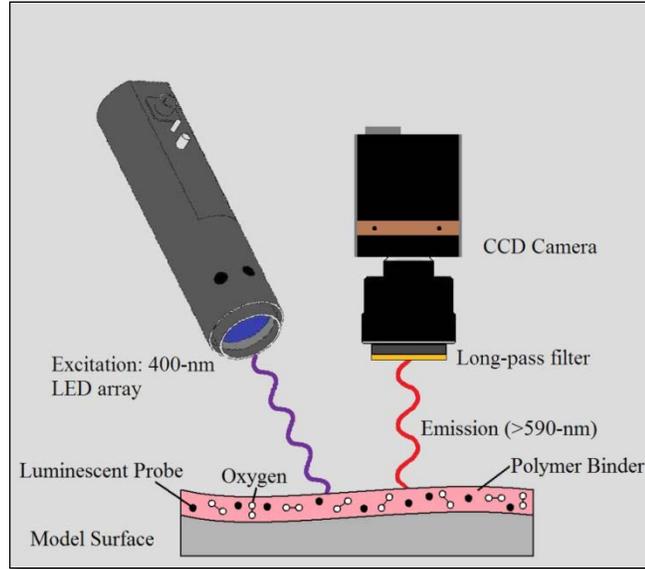
A PSP/TSP starter kit is available for purchase. The PSP/TSP starter kit contains each of the 12-oz aerosol spray cans: UNC-12, BUNC-12, UNT-12, 400-ml of Binary FIB, UniFIB and FIB Basecoat as well as an overhead paint gun, air brush and small air brush compressor.



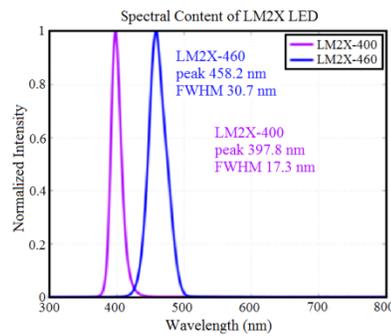
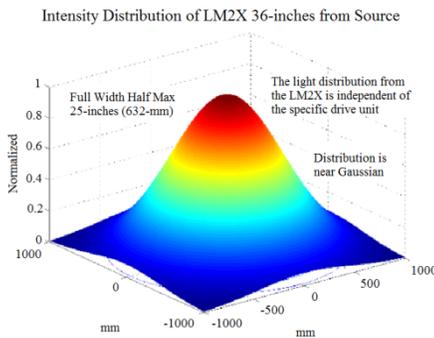
2 | LIGHT SOURCES

LED ILLUMINATION LAMPS

Light emitting diode (LED) arrays are the most convenient and cost effective means to excite the pressure and temperature sensitive paints to fluorescence. Using the correct light source is critical to the accuracy of the measurement. PSP and TSP require a sufficiently energetic, low noise, stable illumination source if quality pressure data is to be acquired. ISSI LED arrays contain proprietary optical and electrical filtering to achieve very stable illumination for excitation of our products.



Molecules within the paint layer are excited by a narrow band LED light source of a specific peak wavelength. Once excited, these molecules will either fluoresce, emitting a photon of a longer wavelength, are quenched by local oxygen molecules (pressure sensitive paint) or are thermally quenched (temperature sensitive paint). This quenching rate determines the fluorescent intensity of the paint layer. The fluorescent levels can be used to estimate pressure or temperature using a previously determined calibration of the paint.



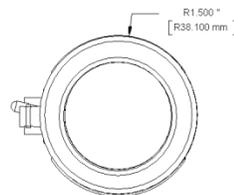
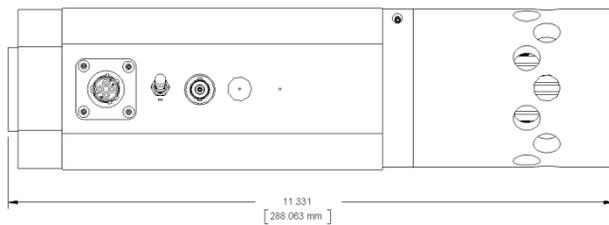
LEDs are available in 2- and 4-inch sizes and with either air- or water-cooling. Each model is also available with one of two drivers. The DM driver is used to operate the LED in long-pulse or continuous mode and the DMHP driver is used for short-pulse, high power mode. Each LED head can be driven with either of the available drivers. All models of LEDs are available in 400- and 460-nm wavelengths.

2.1 AIR-COOLED LEDs

2-INCH LONG PULSE / CONTINUOUS

(Product ID: LM2X-DM-400, LM2X-DM-460)

The LM2X is an LED based light source that provides uniform, stable illumination, for Pressure and Temperature Sensitive Paint measurements. The LM2X-DM has been designed for radiometric PSP and TSP systems. The LM2X-DM can operate continuously or in a long pulsed mode, the operation mode is set using an external toggle switch. Pulsed mode operation is controlled by applying a TTL voltage to the external BNC on the DM module. In this mode, the rise time is less than 5- μ s and the fall time is less than 250- μ s and the duty cycle may be set to from 0% to 100%. The light distribution from the unit is approximately Gaussian for distance greater than 18-inches [45-cm] from the source. The units are available in 400-nm and 460-nm packages, however, other wavelenths are available upon request. The unit may be operated for radiometric or lifetime based systems by interchanging the driver module (DM module for radiometric, DMHP module for lifetime).



SPECIFICATIONS

Output power	> 3-4 W
Stability.....	~0.1 % per hour after warm-up
Maximum duty cycle	100%
Rise time (10% - 90%)	< 5- μ s
Fall time (90% - 10%)	~ 250- μ s
Operating temperature range	-10°C to 60°C
Wavelength.....	400-nm and 460-nm
ECCN	EAR99

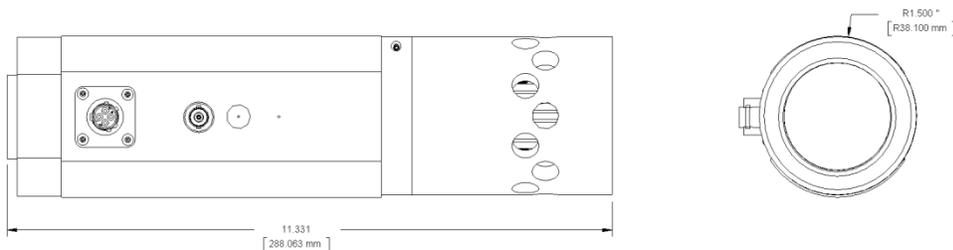
2-INCH SHORT-PULSE / HIGH-POWER

(Product ID: LM2X-DMHP-400, LM2X-DMHP-460)

The LM2X-DMHP has been designed for lifetime based PSP and TSP systems. The LM2X-DMHP operates only in high power short pulse mode. The pulse width and duty cycle are controlled by applying a TTL voltage to the external BNC on the DMHP module. The



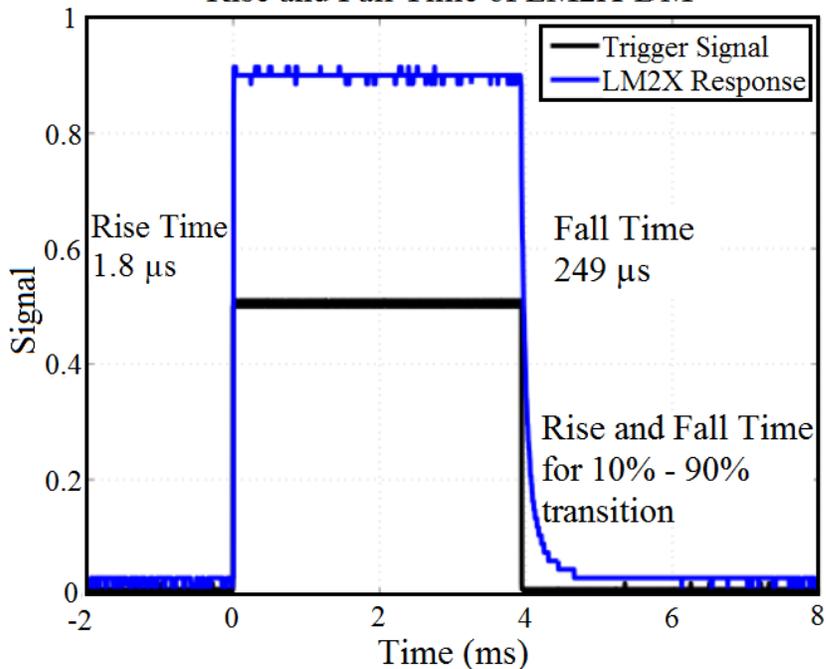
rise time is less than 200-ns and the fall time is less than 100-ns. The LM2X-DMHP is operated at a high current, therefore, the duty cycle must be kept below 5%. A governor circuit is included in the system to prevent damage from exceeding this specification. The light distribution from the unit is approximately Gaussian for distances greater than 18-inches [45-cm] from the source. The units are available in 400-nm and 460-nm packages, however, other wavelenths are available upon request. This unit supersedes the LM2 and LM4 systems because it offers a significant increase in power (10X compared to an LM2, 2.5X compared to an LM4).



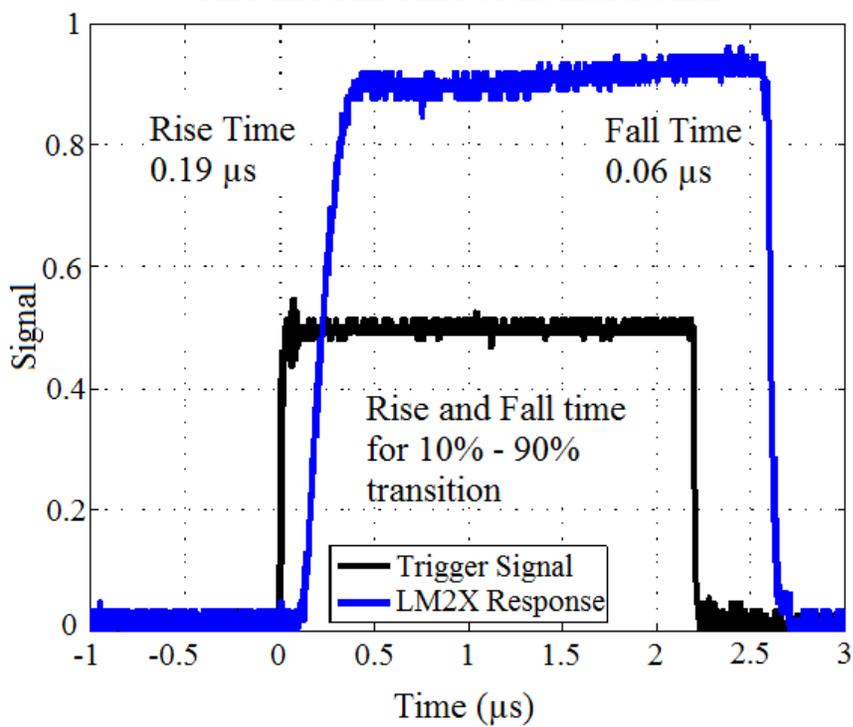
SPECIFICATIONS

Output power	> 1.1 W
Stability.....	~0.1 % per hour after warm-up
Maximum duty cycle	5%
Rise time (10% - 90%)	< 200-ns
Fall time (90% - 10%)	~ 100-ns
Operating temperature range	-10°C to 60°C
Wavelength.....	400-nm and 460-nm
ECCN	EAR99

Rise and Fall Time of LM2X-DM



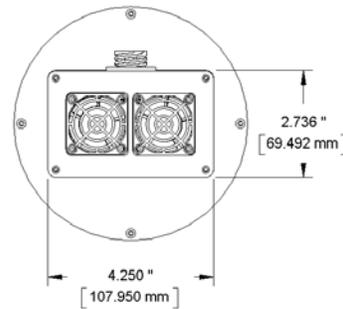
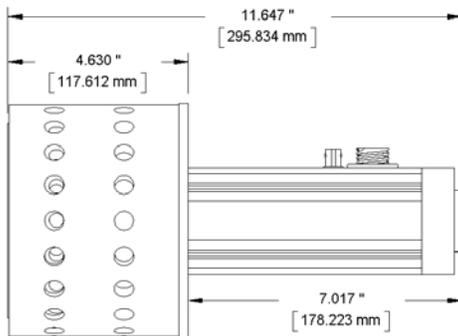
Rise and Fall Time of LM2X-DMHP



4-INCH LONG-PULSE / CONTINUOUS

(Product ID: LM4X-DM-400, LM4X-DM-460)

Where water-cooling is not an option, the 4-inch, air-cooled LED is the choice. The LM4X-DM is a 4-inch, air-cooled LED light source offering uniform, stable illumination and continuous output with excellent output power. The LM4X-DM can operate CW or pulsed, the operation mode is set using an external toggle switch. Pulsed mode operation is controlled by setting the voltage to an external BNC on the lamp housing, the rise and fall times are less than 100- μ s, and the duty cycle may be set to from 0% to 100%. These units supersede the LM2X-DM LED systems as they offer a 3-4X increase in power, 5X faster rise and fall times for pulsed operation, and increased temperature range of operation.



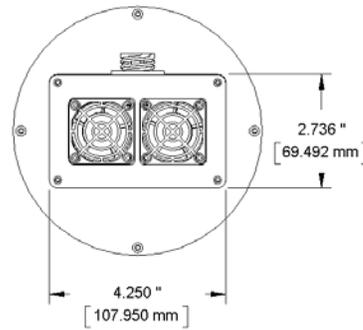
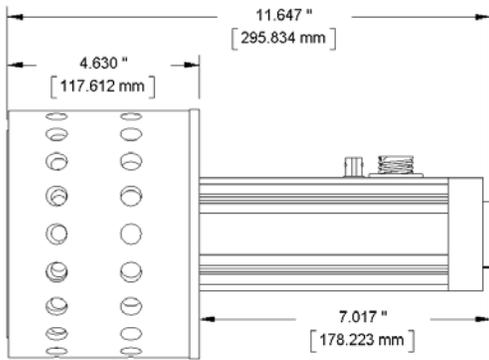
SPECIFICATIONS

Output Power.....	12.0 W
Stability.....	0.2% per hour
Maximum Duty Cycle	100%
Rise and Fall time	< 100- μ s
Temperature range.....	-10°C to 60°C
Wavelength.....	400-nm and 460-nm
ECCN	EAR99

4-INCH SHORT-PULSE / HIGH-POWER

(Product ID: LM4X-DMHP-400, LM4X-DMHP-460)

The LM4X-DMHP is a 4-inch, air-cooled LED light source. The LM4X series of light sources offer uniform, stable with excellent output power for short-duration pulses. The LM4X-DMHP has been designed for lifetime based PSP and TSP systems. The LED's are driven beyond spec to increase the light output, however, the duty cycle is restricted to 5%. The operation of the LM4X-DMHP is controlled by setting the voltage to an external BNC on the lamp housing and the rise and fall time is less than 500-ns. These units supercede the LM2X-DMHP LED systems as they offer a 3X increase in power, 5X faster rise and fall times for pulsed operation, and increased temperature range of operation.



SPECIFICATIONS

Output Power (5% duty cycle)	3.0 W
Stability.....	0.2% per hour
Maximum Duty Cycle	5%
Rise and Fall time	< 500-ns
Temperature range.....	-10°C to 60°C
Wavelength.....	400-nm and 460-nm
ECCN	EAR99

2.2 WATER-COOLED LEDS

Water-cooled LEDs provide a significant increase in output power needed in large test facilities. Large test sections require more excitation light because the model is further from the data acquisition system. Water-cooled LEDs provide 3-4 times the output power of their comparable 2-inch air-cooled varieties. Three parts compose the water-cooled LED: the control module, the LED head and the umbilical. The control module contains the trigger control and the drive electronics for the LED as well as the water-circulation system to cool the LED head. The umbilical supplies the cooling water and the electrical connection between the control module and the LED head. Umbilical cables are available in 10- and 20-foot lengths. External water is supplied to the control module.



2-INCH LONG PULSE / CONTINUOUS

(Product ID: LM2XX-DM-400, LM2XX-DM-460)

The LM2XX-DM is an LED based light source that provides uniform, stable illumination, for Pressure and Temperature Sensitive Paint measurements. The unit is designed for radiometric systems by connecting to the DM driver box (module for radiometric). The LM2XX-DM can operate continuously or in long-pulse mode. The operation mode is set using



an external toggle switch on the DM module. Pulse mode operation is controlled by applying a TTL voltage to the external BNC on the DM module. In this mode the rise time is less than 1- μ s and the fall time is less than 1- μ s and the duty cycle may be set from 0% to 100%. The light distribution from the unit is approximately Gaussian for distance greater than 18-inches [45-cm] from the source. The units are available in 400-nm and 460-nm packages, however, other wavelenths are available upon request. This unit surpasses the performance of an LM2X-DM air-cooled system as it offers a significant increase in power (3-4 times that of an LM2X-DM).

SPECIFICATIONS

Output power	~ 8-12 W
Stability.....	~0.1 % per hour after warm-up
Maximum duty cycle	100%
Rise time (10% - 90%)	< 300-ns
Fall time (90% - 10%)	< 125-ns
Operating temperature range	-10°C to 60°C
Wavelength.....	400-nm and 460-nm
ECCN	EAR99

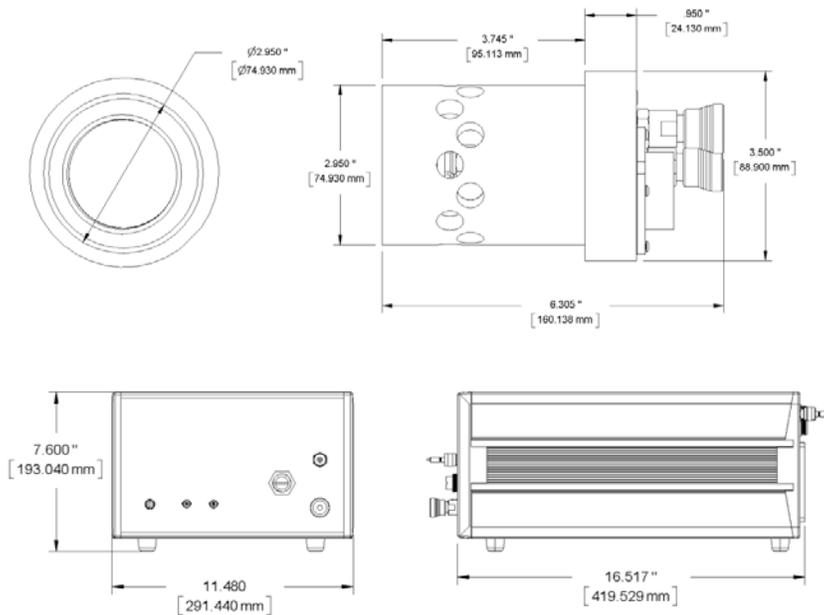
2-INCH SHORT-PULSE, HIGH-POWER

(Product ID: LM2XX-DMHP-400, LM2XX-DMHP-460)

The LM2XX-DMHP is an LED based light source that provides uniform, stable illumination for Pressure and Temperature Sensitive Paint measurements. The unit is designed for lifetime systems by connecting to the DMHP driver box (module for lifetime). Operation is controlled by applying a TTL voltage to the external BNC on the DMHP



module. In this mode the rise and fall times are less than 1- μ s and the duty cycle is 5%. The light distribution from the unit is approximately Gaussian for distance greater than 18-inches [45-cm] from the source. The units are available in 400-nm and 460-nm packages, however, other wavelenths are available upon request. This unit surpasses the performance of an LM2X-DMHP air-cooled system as it offers a significant increase in power (~2 times that of an LM2X-DMHP).



SPECIFICATIONS

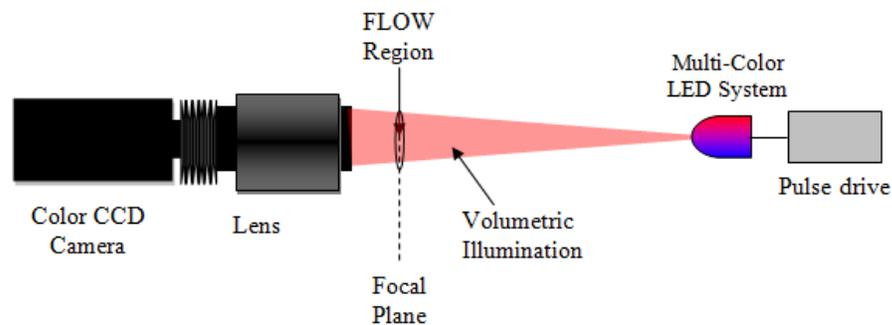
Output power ~ 1.6-2.4 W @ 5% duty factor
 Stability..... ~0.1 % per hour after warm-up
 Maximum duty cycle 5%
 Maximum pulse width 1.0-ms
 Rise time (10% - 90%) < 600-ns
 Fall time (90% - 10%) < 300-ns
 Operating temperature range -10°C to 60°C
 Wavelength..... 400-nm and 460-nm
 ECCN EAR99

2.3 SPECIAL APPLICATIONS

ISSI provides custom made LEDs upon request and also several models for different experimental applications. We work with customers to provide solutions to their applications.

PARTICLE SHADOW VELOCIMETRY

Particle shadow velocimetry (PSV) is a novel technique that utilizes low-power pulsed light sources such as LEDs to measure the displacement of seed particles in a flow. PSV images can also be used to characterize particle parameters such as size and shape. Since this is a volumetric illumination technique, it relies on the receiver optics to optimize the depth of field for the measurement. Any pulsed light system can be used as the light source; however, LEDs are particularly well suited since they can be overdriven in a short-pulse mode to produce intense sub-microsecond light pulses. Furthermore, the use of LEDs combined with a high speed camera results in a high-speed system with bandwidth of 10's of kHz. Because the technique does not rely upon weak-particle light scattering, lasers are neither necessary nor recommended for use with this approach.



PSV uses light extinction (particle shadows) rather than light scattering in a laser sheet, resulting in high-quality particle imaging at much lower illumination levels. These safe illumination levels can be generated by a pulsed-LED system at a fraction of the cost of a pulsed laser. Multi-color LED illumination permits the use of a low-speed camera, further reducing system cost. Different color LEDs are sequentially pulsed, at high speed, and the sequential particle images are captured in a single frame on the camera's three color planes. Narrow depth-of-field optics are employed to image a two-dimensional plane within the flow volume, similar to what is achieved with a laser sheet. Measurement close to surfaces is possible because the system is not degraded by surface reflections which severely limit laser-based systems. The PSV approach is fully compatible with the seeding approaches and specifications used with conventional PIV systems.

PSV is not an alternative to Particle Image Velocimetry (PIV), but a complementary technique. PSV is advantageous over PIV close to structures or surfaces where laser scatter may cause issues with data collection.

3-COLOR LED

(Product ID: LM2X-DMHP-RGB)

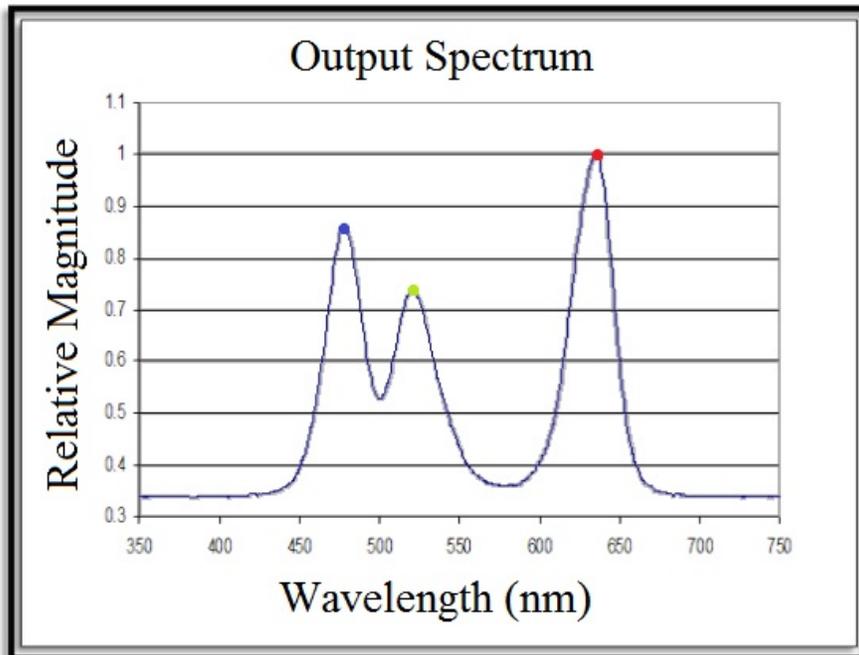
The LM2X-DMHP-RGB is a 2-inch, air-cooled LED light source that provides three-color (Red, Green, and Blue) outputs from its LED head. This LED is used



for Particle Shadow Velocimetry (PSV) to illuminate small seed particles in a flow field to measure velocity and particle density. The LM2X-DMHP-RGB has three BNC inputs to control the timing and pulse width of each of the output colors from an external pulse generator. The pulsed LED operation is controlled by applying a TTL voltage to the external BNC(s) on the module. The rise time is less than 200-ns and the fall time is less than 100-ns and the duty cycle is 5%. The light distribution from the unit is approximately Gaussian for distance greater than 18 inches from the source.

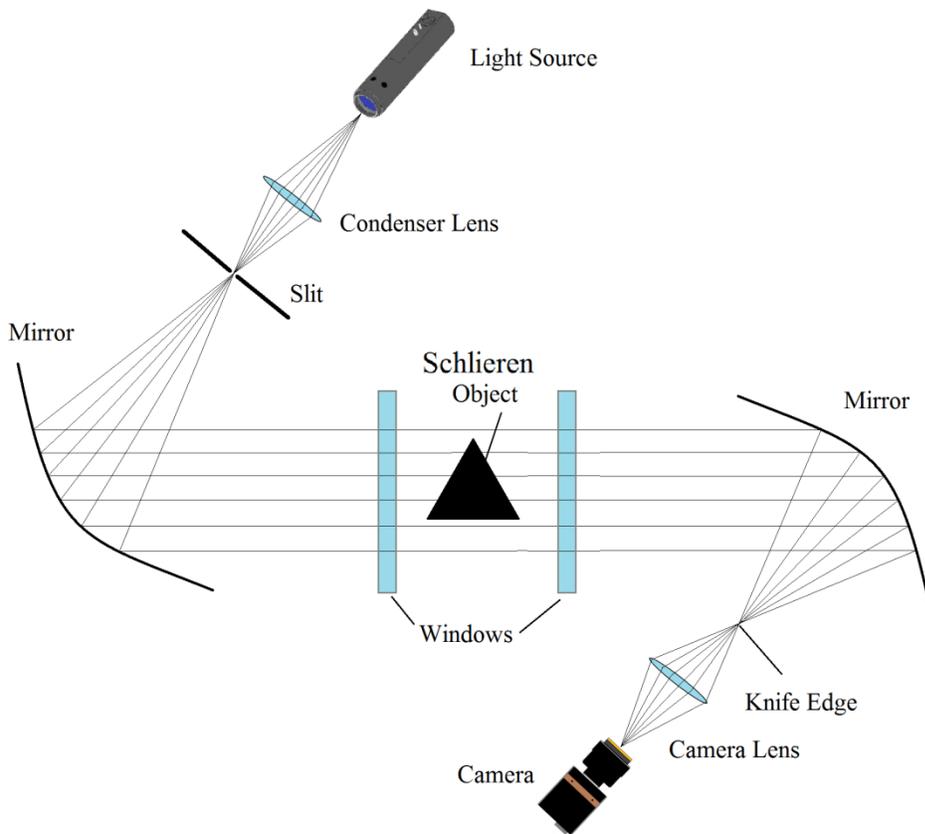
SPECIFICATIONS

- Output power~2 W
- Stability..... ~0.1 % per hour after warm-up
- Maximum duty cycle 5%
- Rise time (10% - 90%) < 200-ns
- Fall time (90% - 10%) <100-ns
- Operating temperature range-10°C to 60°C
- Wavelength..... 470-nm, 520-nm, 650-nm
- ECCN EAR99



SCHLIEREN

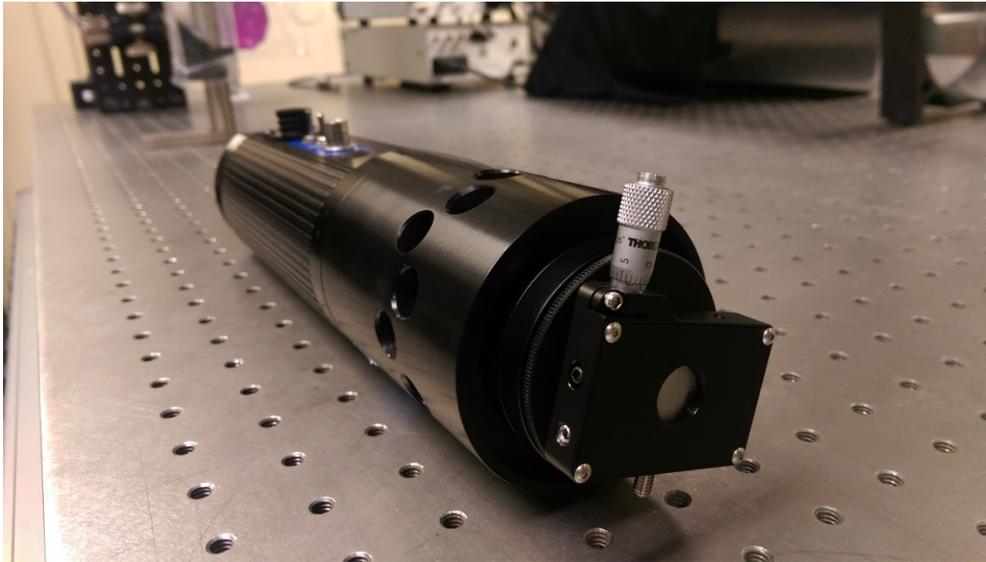
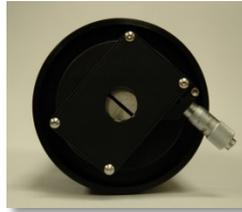
Schlieren photography is a technique utilized to image fluid density gradients. The density gradient of the fluid gives rise to refractive index changes which distort the collimated beam of light between two mirrors and thus the point of focus. Using a knife edge, variable density slide or color slides at the focus to exploit this effect allows high-contrast imaging of otherwise nearly invisible density gradients. At the focus, the light intensity is cut in half by the knife edge. Refractive index changes in one direction are brighter and in the other direction are darker. This type of imaging is widely used in wind tunnel, heating, ventilation and air conditioning (HVAC) research.



The ISSI product line includes a high-intensity LED point source with a variable slit attachment for use in schlieren photography. This LED is available in continuous/long-pulse and short-pulse/high-power mode. Output wavelength can be set to user specifications.

SCHLIEREN LED

(Product ID: LM2XX-DM-400, LM2XX-DM-460)



The LMS-XXX LED is a 2-inch, air-cooled LED light source used for schlieren and shadowgraph applications. The LMS-XXX uses the same module as the LM2X-DMHP.

SPECIFICATIONS

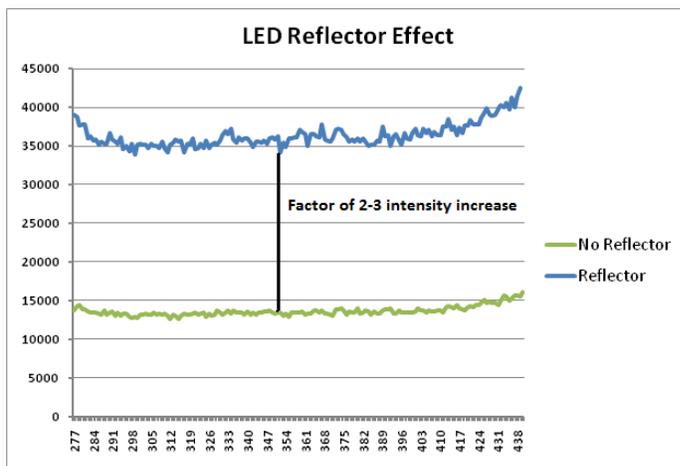
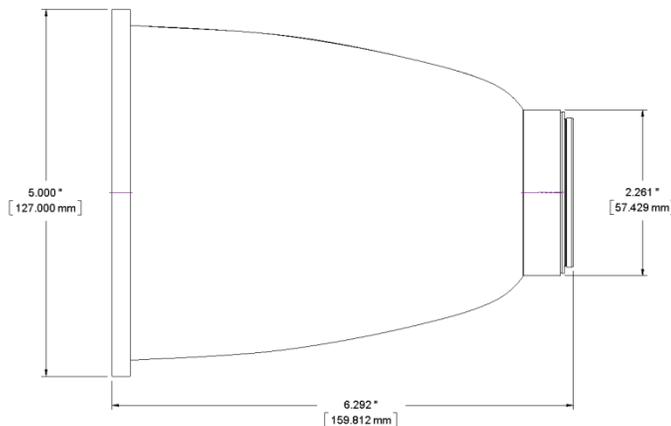
Output Power	~2-3 W
Stability	~0.1 % per hour after warm-up
Maximum duty cycle	5%
Rise time (10% - 90%)	< 200-ns
Fall time (90% - 10%)	< 100-ns
Operating temperature range	-10°C to 60°C
Wavelength	User Specified
ECCN	EAR99

2.4 LED ACCESSORIES

PARABOLIC REFLECTOR & DIFFUSER

(Product ID: LM2X-10R40-D)

The LED reflector and diffuser is a 10-degree reflector for concentration of output light from an LM2 LED. The intensity output on the illuminated surface is 2-3 times greater in the focused area when using the reflector. The diffuser creates a more uniform Gaussian light distribution and reduces the structure pattern of the individual LEDs. The overall length is 4.75-inches (120.65 mm) and diameter of the diffuser section is 5-inches (127 mm).



The reflector screws onto the front of any 2-inch ISSI LED (LM2 Series). Remove the retaining ring on the front of the LED but be sure to leave the filter glass on the LED.

Thread the reflector on the LED to hold the filter glass in place. ECCN is EAR99.

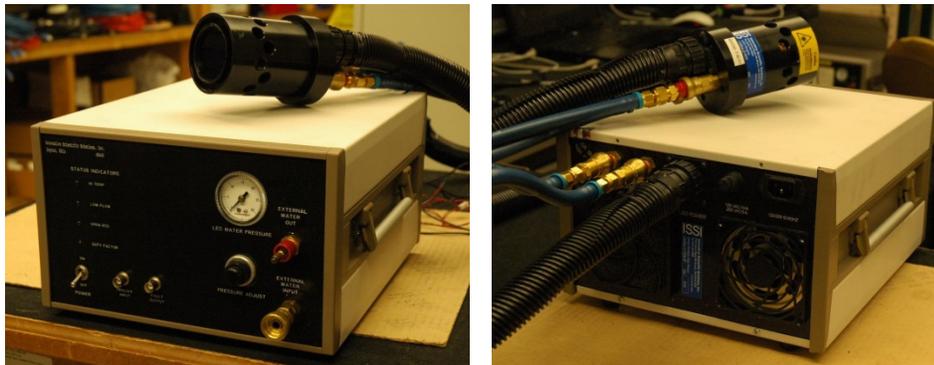
LED DRIVERS

(Product ID: DC2X, PUL2X, DC4X, PUL4X, DC2XX, PUL2XX)

LED models can be interchanged between long-pulse/continuous drivers and short-pulse, high-power drivers. We refer to these drivers as “DC” and “Pulsed” respectively. DC and pulsed drivers can be purchased individually and are simple to swap. DC and pulsed drivers are available for all LED models. DC and pulsed drivers have different power requirements and power supplies are included with each.



For the water-cooled LEDs, the driver is located in the control module for water circulation. For air-cooled, it's in the module itself and needs to be sent back to ISSI to change the driver.



The LM2XX LED illuminator is purchased with one of the two drive modules available. These drive modules are standardized to permit the operator the ability to change operating modes from DC/DC pulsed to high power pulse at a later time. The standard umbilical cable is ten (10) feet length but lengths up to twenty (20) feet can be provided

3 | CAMERAS

PSP & TSP CAMERAS

Charged coupled device (CCD) cameras are used to acquire images of paint response to pressure or temperature changes. Using the right sensitive scientific camera is paramount to making an accurate measurement with PSP and TSP.

CCD cameras suited for PSP and TSP measurements are characterized by:

1. Low Noise
2. High Signal-to-Noise Ratio (SNR)
3. High Linearity
4. High Dynamic Range
5. High Quantum Efficiency

These characteristics are required to produce high-quality and accurate PSP and TSP data from experiments. Ignoring these factors in a camera will lead to poor results from any PSP or TSP test.

CCD cameras used for PSP are referred to as “interline transfer” CCD cameras. Interline transfer CCD cameras mask every other row of the CCD sensor. After exposure the CCD shifts the charge from the active pixels to the masked pixels and the information is read out to memory or transferred from the camera to an external hard drive on a computer. This transfer to masked pixels is very fast ($\sim 1 \mu\text{s}$) and eliminates the need for a shutter.

The camera acquires fluorescence from PSP or TSP paints through a long-pass filter and stores or transfers the information for conversion to pressure or temperature using a previously determined calibration of the paint used.

3.1 CCD CAMERAS

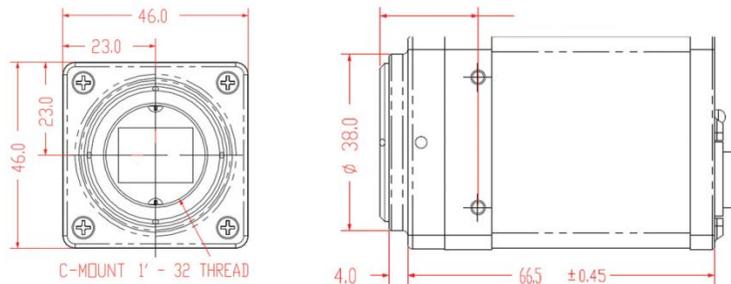
MONOCHROME CCD CAMERA

(Product ID: PSP-CCD-M)

The PSP-CCD-M is a 2-megapixel, c-mount, monochrome CCD camera designed to operate with single luminophore PSPs and TSPs. The camera is small and lightweight at 210g, allowing for an array of cameras to be mounted in a tight place for larger scale models and applications. The monochrome camera takes advantage of the full resolution of the array as all pixels act as pressure sensors.

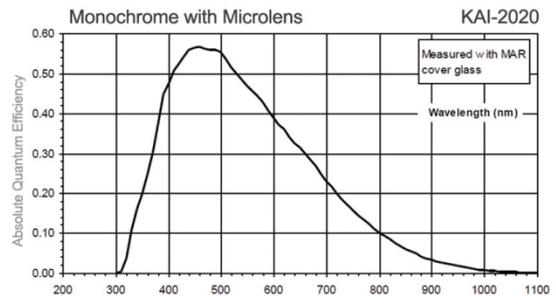


The camera communicates over a Gigabit Ethernet connection with the acquisition computer. The camera has no on-board memory so data is streamed directly to the hard drive. The normal frame rate is 35 fps but can operate at 44 fps in overclock mode. The camera features a software trigger and external TTL trigger over BNC. The camera is compatible with Windows 7, Vista and XP both 32- and 64-bit.



SPECIFICATIONS

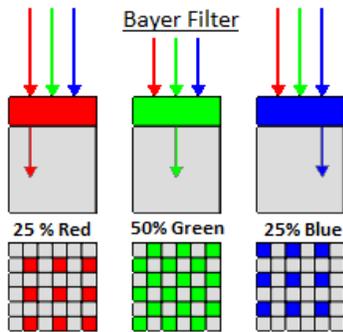
Resolution.....	1608 x 1208
Max Frame Rate (normal/overclock).....	35/44 FPS
Pixel Size.....	7.4 μm by 7.4 μm
Dynamic range.....	14-bit
Maximum Signal-to-Noise Ratio.....	60 db
Exposure.....	5-μs global shutter
Trigger in.....	TTL
Exposure out.....	TTL/Programmable
Interface.....	Gigabit Ethernet
Lens.....	c-mount
Sensor.....	2/3" CCD
Operating Temperature.....	-40 °C to 85 °C
Weight.....	210g
Dimensions.....	46 x 46 x 66 mm
ECCN.....	EAR99



COLOR CCD CAMERA

(Product ID: PSP-CCD-C)

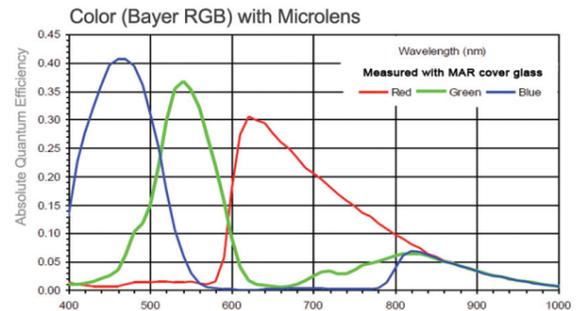
The PSP-CCD-C is a 2-megapixel CCD camera designed to operate within a PSP system. The camera is small and lightweight at 210g allowing for an array of cameras to be mounted in a tight place for larger scale models and applications. The PSP-CCD-C is used in Binary PSP and particle shadow velocimetry. One approach that allows binary pressure sensitive paint data to be acquired using a single camera involves the use of a color camera. Rather than use optical filters in front of the camera lens, the filtering is applied on the chip using a standard Bayer filter. In the case of Binary FIB, the pressure-sensitive signal is acquired on the red pixels and the reference signal is acquired on the green pixels. All images are acquired through a single camera and lens minimizing image alignment errors. This single chip system also accomplishes a second goal; all data is acquired simultaneously, and thus the stability of the illumination source is a less significant issue. The major



drawback of this approach is the loss of spatial resolution. In a color chip, only $\frac{1}{4}$ of the pixels are sensitive to the signal channel (red pixels) on the standard Bayer filter. Despite the loss of spatial resolution, the color camera approach produces excellent results at low speeds. The normal frame rate is 35 fps but can operate at 44 fps in overclock mode. The camera features a software trigger and external TTL trigger over BNC. The camera is compatible with Windows 7, Vista and XP both 32- and 64-bit.

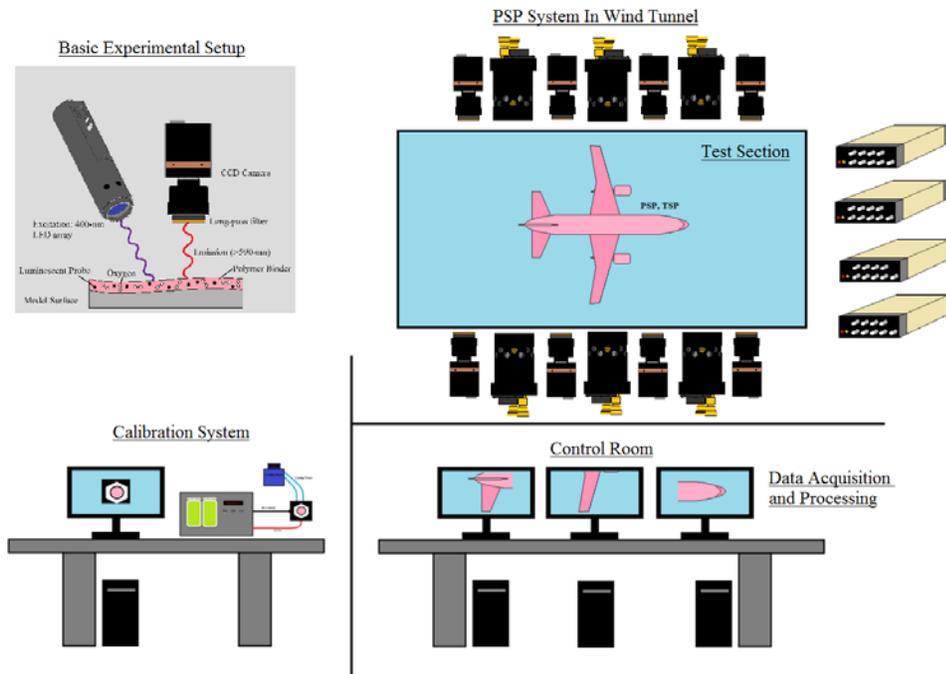
SPECIFICATIONS

Resolution.....1608 x 1208
 Max Frame Rate (normal/overclock).....35/44 FPS
 Pixel Size.....7.4 μ m by 7.4 μ m
 Dynamic range.....14-bit
 Maximum Signal-to-Noise Ratio.....60 db
 Exposure.....5- μ s global shutter
 Trigger in.....TTL
 Exposure out.....TTL/Programmable
 Interface.....Gigabit Ethernet
 Lens.....c-mount
 Sensor.....2/3" CCD
 Operating Temperature.....-40 $^{\circ}$ C to 85 $^{\circ}$ C
 Weight.....210g
 Dimensions.....46 x 46 x 66 mm
 ECCN.....EAR99



4 | SYSTEM INTEGRATION

Communication between all components of a system is paramount to the operation of the system as a whole. Instrument control devices make operating large-scale integrated systems more time-efficient, expand their capability and reduce time needed on-condition or in the test facility in general. Small-scale systems also benefit from instrument control devices allowing for faster data acquisition.



PSP and TSP data acquisition systems can communicate with the test facility and can be remotely operated from a control room after installation. Remote control of each component of the system saves one of the most expensive commodities in experimental or production testing: time. ISSI devices can all be operated over a network which also reduces the amount of cabling to be installed during a test. With each device being uniquely identifiable, a large scale PSP/TSP test can be operated on a single computer or by a small data acquisition team.

INSTRUMENT CONTROL

4.1 PULSE/DELAY GENERATOR

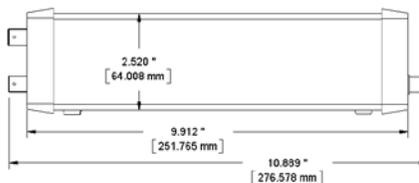
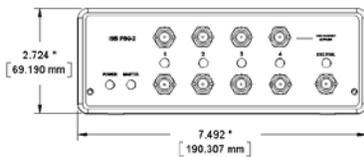
(Product ID: PSG-3)

The PSG-3 is a four-channel pulse/delay generator. It can be used as a master clock for timing and delay control. It can be externally triggered or gated by an external event. Pulse width, delay, repetition rate, and other timing parameters can be controlled by one of two available interfaces



Features

- Two dual-channel independently programmable pulse generators
 - PSG-3 can produce two separate frequency outputs either synchronously or asynchronously.
- Four high-current TTL level outputs
 - Extends the utility of this generator by allowing it to drive low impedance loads (50 Ohms) such as solenoids and drive logic over long cable runs
- Threshold of trigger input (0.05-5V) to PSG-3
- Divide-by circuit (2-255) trigger input
- Remotely programmable through Ethernet
- Multiple timing bases (s, ms, μ s, ns)
- Multiple PSG-3s can be cascaded to increase the number of channels
- BNC inhibit input (TTL high level) to allow the PSG-3 to be gated by an external source
- Firmware upgrade through USB



SPECIFICATIONS

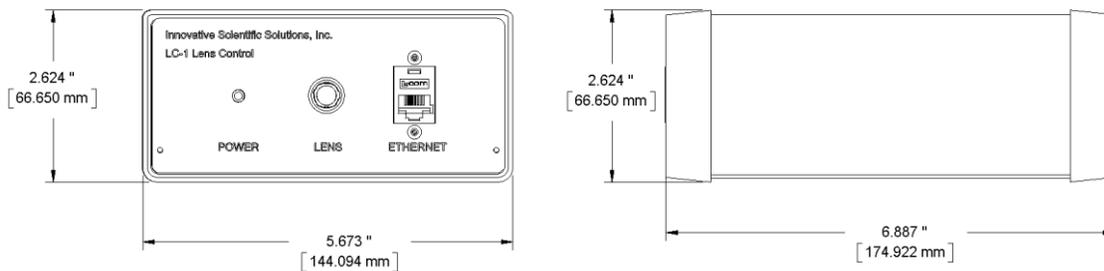
Input Power	85-264V, 50-60Hz
Interface	Ethernet, USB 2.0
Counter Timers	2
Pulse Width	20 ns to 10 s
Repetition Rate	0.1 Hz to 20 kHz
Output Voltage	5V TTL
Trigger Threshold	0.05-5V
Divide-by	2-255
Clock Speed	20-ns, 40-ns, 80-ns, 160-ns
Inhibit	TTL High
Burst Mode	user defined
ECCN	EAR99

4.2 ZOOM LENS CONTROLLER

(Product ID: LC-1)

The ISSI Ethernet lens controller (LC-1) is a control device for motorized lenses. The LC-1 can operate lenses with up to three motors with or without presets. The Ethernet connection makes communication much simpler than traditional serial lens controllers and also allows it to be operated over a longer distance than serial devices.

- Control lenses with 9-12V motors
- Accurate control of 1x lens with Zoom, Focus, and Iris
- Interfaces for Ethernet (UDP)
- Multiple devices can be connected and simultaneously controlled over a network
- Easy to use software interface or API commands
- Unlimited programmable preset capability to easily store and recall saved positions on the lens
- Keyed connection for lens communication



Uses for this device include Closed-circuit television systems (CCTV), event monitoring, machine vision, and optical based measurements in wind tunnels or other large test facilities.

SPECIFICATIONS

Input Power85-264V, 50-60Hz, 0.3A
Lens voltage range..... 9-12V
Interface..... Ethernet
Lens inputs.....1
Software..... Windows GUI
ECCNEAR99

4.3 CANON® LENS CONTROLLER

(Product ID: LC-2, LC-2A-C, LC-2A-M42)

The ISSI Canon® EF/EFS lens controller (LC-2) is an Ethernet control device. The LC-2 is small and compact and can operate lenses with most Canon® EF/EFS lenses. The Ethernet connection makes communication much simpler than traditional serial lens controllers and also allows it to be operated over a longer distances.

- Remotely control Canon® EF/EFS lenses
- Accurate control of Focus, and aperture
- Auto-detection of attached lens and F-number with included LC-2A lens adapter for C- or M42 mounting.
- Interfaces for Ethernet
- Integrate with API command structure
- Multiple devices can be connected and simultaneously controlled over a network
- Easy to use software interface
- Unlimited programmable preset capability to easily store and recall saved positions on the lens



SPECIFICATIONS

Power	85-264V, 50-60Hz
Input.....	6V = 1.5A, 5W
Max Temperature	0-60 °C
Interface	Ethernet
Lens inputs.....	1
Lens Adapter	M42, c
Presets.....	Unlimited, programmable
Software.....	Windows GUI
ECCN	EAR99

SYSTEM INTEGRATION

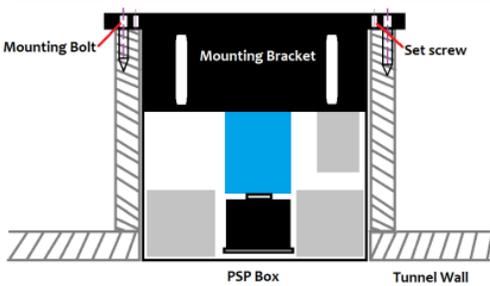
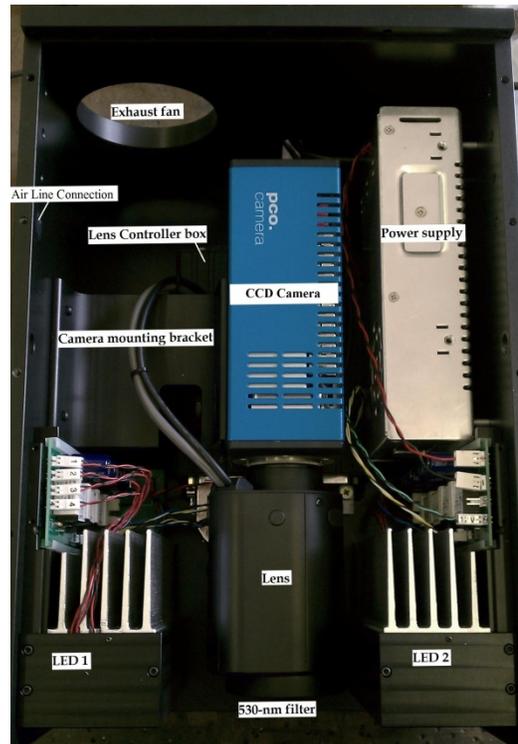
4.4 SYSTEM BOX

(Product ID: SYS-BOX)

The System Box is designed to mount in a test facility with all acquisition components required for PSP/TSP contained inside. The System Box makes installation and removal of the system much easier than individually mounting all components. The System Box contains custom-built LEDs with drivers and power supply, CCD camera, remote focus zoom lens, lens control and optional pan and tilt. Connections for power and communication are made on the top of the box for access to them while installed.

The system box mounts to a test facility using adjustable slotted brackets. This allows the window of the box to be mounted flush with the inside of the test facility wall to minimize disturbances to the test environment.

The System Box is made to be very durable and is constructed with 3/8" aluminum plates with a black anodized finish. Boxes are shipped in their own shipping containers and assembled on-site. All tooling and hardware is included with each System Box. Modifications to facilities are the responsibility of the end-user.



4.5 CALIBRATION SYSTEM

CALIBRATION SYSTEM

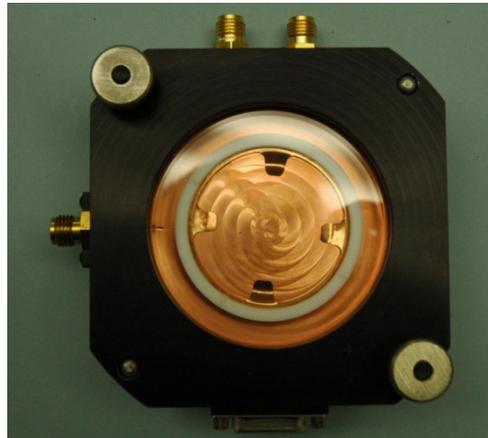
(Product ID: CAL-04)

CAL-04 is a multi-function system designed for controlling the mass-flow of two gases and temperature within a sealed cell. This evolution of ISSI's pressure and temperature sensitive paint calibration system utilizes a gas flow design whereby the nitrogen to oxygen mass flow ratio is controlled to simulate pressure. The advantage of this technique is the ability to simulate pressures from approximately 0 to 4.0 bar without the noise and complexity



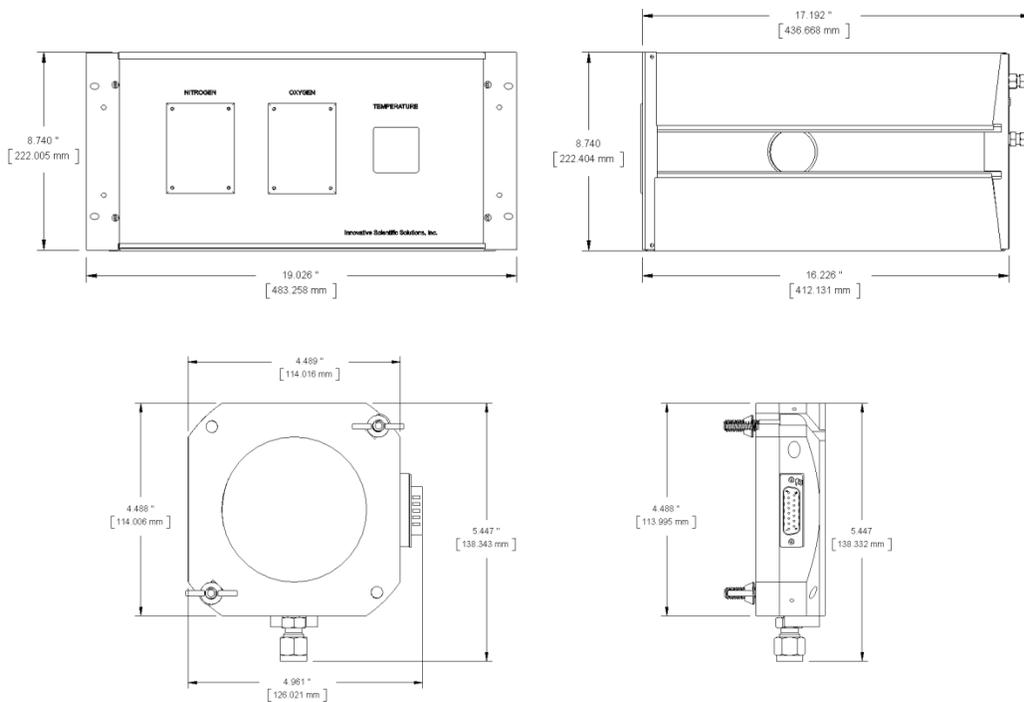
of the diaphragm pump. Nitrogen and oxygen from gas bottles flow into the gas inlet fittings on the calibration box via appropriate dual stage regulators (ISSI does NOT supply bottle gas or regulators). The mixed gas exits the calibration system box via the output rear fitting and then into the calibration head where the gas flows over the sample. The temperature control has been upgraded to provide faster temperature control and improved stability. All of the displays are backlit and colored for ease of recognition.

Operation of the system can be completely manual via the front panel interface for custom calibration purposes or in an automatic mode via software where the customer collects calibration data over a chosen set of conditions in an automated fashion. ISSI provides a graphical user interface for manual or automatic control of the calibration system. The system sends a TTL level trigger to the camera to acquire an image once it is on condition via a trigger output BNC connection. The camera returns a TTL level pulse to the trigger input BNC connection once it frames, signaling the calibration system that an image has been acquired and to move to the next condition.



Calibration Cell

Another advantage of the system is the Ethernet interface which simplifies communication with a computer, especially over long distances. The calibration system can be installed in a convenient location and communicated with over an existing network. Firmware updates and support by ISSI personnel are possible from our offices to where the system is installed. The system can also be used to control mass flow ratios of other gases within the cell. The system is capable of handling many other gases. The cell is for gases only, no liquids.



SPECIFICATIONS

Pressure Range	0.0 - 4.0 bar
Temperature Range.....	0 – 70 °C
Pressure Accuracy	0.5% of full scale
Temperature Accuracy	0.1 °C
Interface.....	Ethernet (RJ45)
Power.....	120-240 VAC, 50/60 Hz
Trigger Input/Output.....	TTL
Warranty.....	1 year limited
ECCN	EAR99

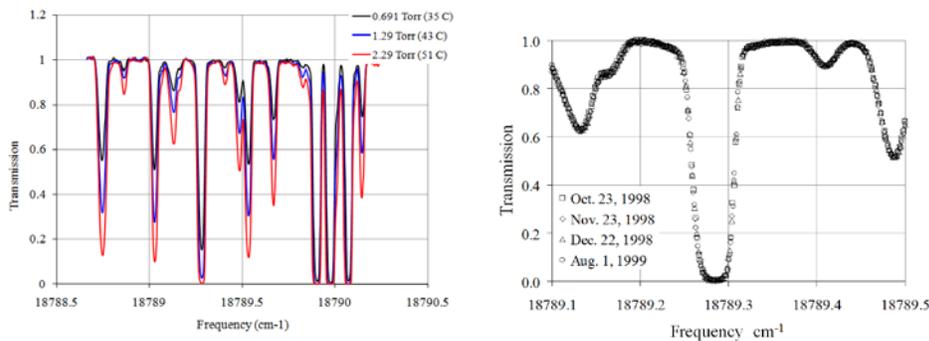
ACCESSORIES

1. Calibration Cell Head (1)
2. RTD cable for temperature control (1)
3. Ethernet patch cable (1)
4. BNC cable for camera trigger (2)
5. Gas fittings for back panel (3)
6. ¼” tubing for supply and output to head (3)
7. Thermal compound (1)
8. Power Cable (2)
9. *PT Controller* software for operation of system (1)
10. *OMS Calibrate* software
11. Koolance cooling unit with power adapter (1)
12. Fittings and hose for cooling water (2)

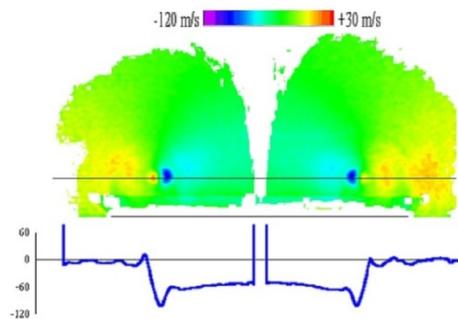
MOLECULAR IODINE CELLS

BACKGROUND

Molecular iodine cells are used in spectroscopic applications, precise wavelength calibration and as a frequency reference. The spectrum of molecular Iodine includes discrete rotational and vibrational bands with very fine structure in the visible (490-650 nm) spectrum. More recently, Iodine has been used as frequency discriminators in Planar Doppler Velocimetry (PDV) and Filtered Rayleigh Scattering (FRS) systems. When used in PDV/FRS systems, the stability of the Iodine cell transmission-vs-frequency profile has been identified as a significant source of error. This instability is caused by variations in the Iodine number density. The number density (pressure) of the Iodine vapor is a strong function of temperature, and therefore, small changes in cell temperature (~ 0.1 °C) can have significant impact on the transmission-vs-frequency profile.



Planar Doppler Velocimetry (PDV, also known as Doppler Global Velocimetry, DGV) is an image-based technique that is capable of producing three component velocity measurements in a plane. With PDV, one measures the Doppler shift of light scattered by seed particles in the flow, similar to LDV. To perform PDV, the flow is seeded with scattering particles and a laser sheet is used to illuminate the interrogation region. The interrogation region is imaged through molecular absorption filters by several CCD cameras and the images are post-processed using a set of calibration images to determine velocities. With PDV, one measures the Doppler shift of light scattered by seed particles in the flow, similar to LDV. The Doppler shift is dependent on the incident light wavelength, the velocity of the scattering particle, and the observation and incident light directions. With LDV, the Doppler shift is determined using heterodyne detection of the beat frequency between the incident and scattered (Doppler shifted) light. For PDV, a molecular or atomic vapor filter is used as the frequency discriminator.



5.1 PERMANENTLY SEALED MOLECULAR IODINE CELL

(Product ID: I2S-5, I2S-10)

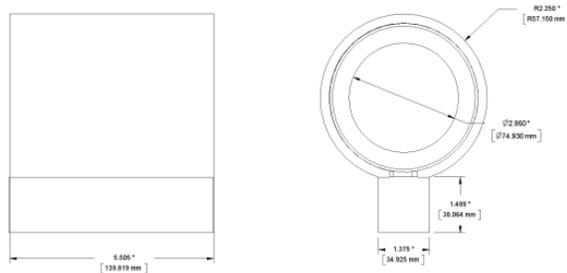
To create the permanently sealed starved cell, the cell is evacuated and cold-finger filled with Iodine is brought to the desired vapor pressure (cold-finger operating temperature). The stem between the cold-finger and cell is then permanently sealed with a torch, isolating the Iodine in the cell body and fixing the number density. The cell is then operated 10-20 °C above the cold-finger set temperature and the Iodine in the cell is a super-heated vapor with a set number density. The result is a molecular cell with a very stable absorption spectra.



Permanently sealed iodine-vapor cells are 3-in.-dia, 5-in.-long or 10-in.-long Pyrex cells. These cells are manufactured with a prescribed iodine partial pressure (specified by user at time of order). In addition, the transitions can be pressure broadened with nitrogen partial pressure (specified at time of order).

Standard Sealed Unit Includes:

1. Pyrex cell with optical-grade Pyrex windows.
2. Anodized-aluminum housing with post-mounting surface and 1/4 -20 threaded holes.
3. Heating mat and one type-K thermocouple.
4. Insulation to limit heat transfer to aluminum housing.
5. Absorption scan to document iodine conditions.



5-inch iodine vapor cell

SPECIFICATIONS FOR I2S-5 & I2S-10

Length.....125-mm, 250-mm
 Diameter 76-mm
 Housing.....Anodized Aluminum
 Mounting 1/4 -20 Threaded
 Maximum Operating Temperature 130 °C
 Thermocouple.....Type T
 Set Point.....30°C – 50 °C

5.2 MANIFOLD MOLECULAR IODINE CELL

(Product ID: I2M-5, I2M-10)

To create a sealed starved cell with a flexible set point, a glass cell with an attached cold-finger and vacuum port is constructed. The vacuum port and cold-finger include stopcocks. The cell is evacuated and cold-finger filled with Iodine is brought to the desired vapor pressure (cold-finger operating temperature). The stem between the cold-finger and cell is then closed by closing the stopcock, isolating the Iodine in the cell body and fixing the number density. The cell is then operated 10-20 °C above the cold-finger set temperature and the Iodine in the cell is a super-heated vapor with a set number density. The result is a molecular cell with a very stable absorption spectra.



Iodine-vapor cells with a manifold are 3-in.-dia, 5-in.-long or 10-in.-long Pyrex cells. Standard cells are manufactured with 1/4 gm of iodine (actual pressure determined by temperature of water cooling jacket at the time of operation). In addition, transitions can be pressure broadened with buffer gas supplied by user through a fill-port.

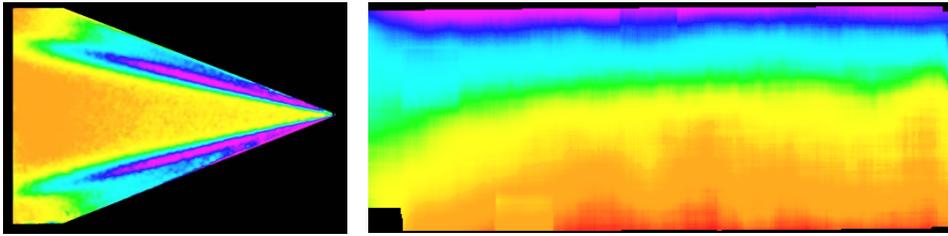
Standard Manifold Unit Includes:

1. Pyrex cell with optical-grade Pyrex windows.
2. Anodized-aluminum housing with 1/4 -20 mounting holes.
3. Water-jacketed iodine reservoir with Teflon valve.
4. Evacuation/fill port with Teflon valve.
5. Cell-heating mat, manifold-heating mat, and two type-K (or user-specified) thermocouples.
6. Two 1/4 -in.-tubing fittings for connection to temperature-controlled water source (user supplied).
7. One 1/4 -in.-tubing fitting for evacuation and buffer-gas (user supplied) filling.
8. Insulation to limit heat transfer to aluminum housing.

SPECIFICATIONS FOR I2M-5 & I2M-10

Length.....	125-mm, 250-mm
Diameter	76-mm
Housing.....	Anodized Aluminum
Mounting	1/4 -20 Threaded
Maximum Operating Temperature	130 °C
Thermocouple.....	Type T
Set Point.....	30°C – 50 °C

6 | PACKAGED SYSTEMS



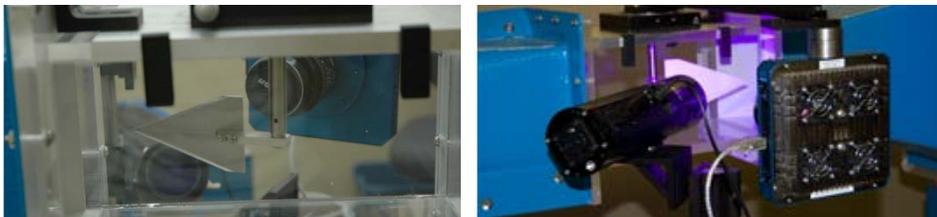
6.1 SMALL-SCALE ACADEMIC PSP/TSP SYSTEMS

(Product ID: RM-01, RMF-01, LT-01)

A version of the Pressure and Temperature Sensitive Paint system is available for small facilities. This system is designed for use in academic laboratories but is not limited to just academic use. This system provides high spatial resolution, excellent dynamic range, but lower data capture rates than higher-end systems. For applications where time in the wind tunnel is not a critical issue, it represents an excellent cost/performance trade-off. This system provides full capability for undergraduate demonstrations, training, and laboratory exercises. It will support all but the most demanding graduate and faculty research programs requiring distributed pressure and temperature measurements in wind tunnel environments. The system employs proven ISSI LED technology for excitation of the luminophores in the paints. The camera is based on a color CCD chip, eliminating the need for a filter wheel when using dual-luminophore paints. The OMS-Lite software package is easy to use and fully supports the educational and research capabilities of the PSP/TSP system.

Components Include:

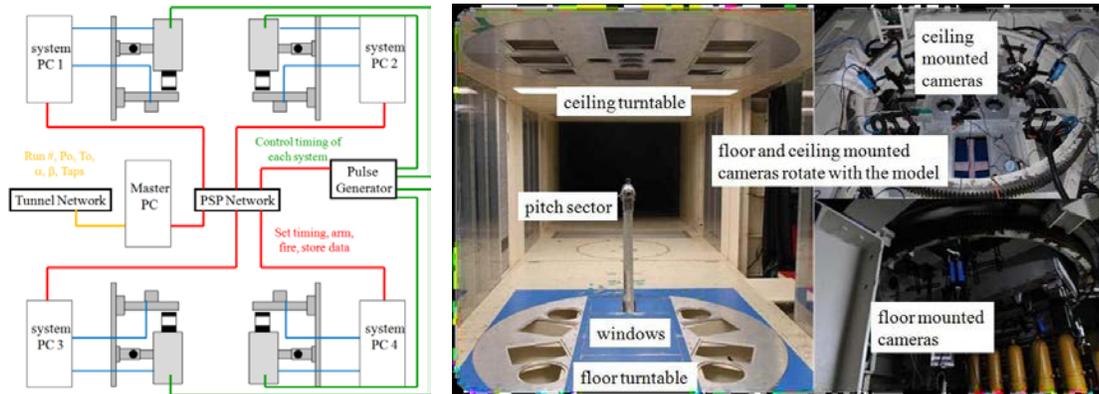
1. PSP-CCD-C/M Color CCD Camera
2. LM2X-DM-400 2-inch air-cooled LED for radiometric PSP/TSP
3. PSG-3 Pulse/delay generator
4. PSP-K Pressure and Temperature Sensitive Paint starter kit
5. OP-K-C/EF Optical kit with lenses and appropriate long-pass filters for PSP/TSP
6. Wing models
7. Laptop computer
8. OMS-Lite single-user license



6.2 LARGE-SCALE COMMERCIAL PSP/TSP SYSTEMS

(Product ID: RM-02, RMF-02, LT-01)

The distinction from the small-scale system is the level of integration and number of components. Large-scale Pressure and Temperature Sensitive Paint systems have been deployed in several transonic wind tunnels such as AEDC at Arnold Air Force Base and Aircraft Research Association in the UK as a standard instrument for production testing. Several successful tests in small low speed tunnels have also been demonstrated. These demonstrations generally require careful experimental procedures that are not practical in larger production tunnels.



A large scale production test typically will involve multiple cameras and lamps to capture the entire surface of the model. The images from each camera are stored on a master PC for post-processing. The individual images are then stitched together to create the entire model surface. Systems such as this are integrated into the tunnel and move with the model as it changes yaw or angle of attack.

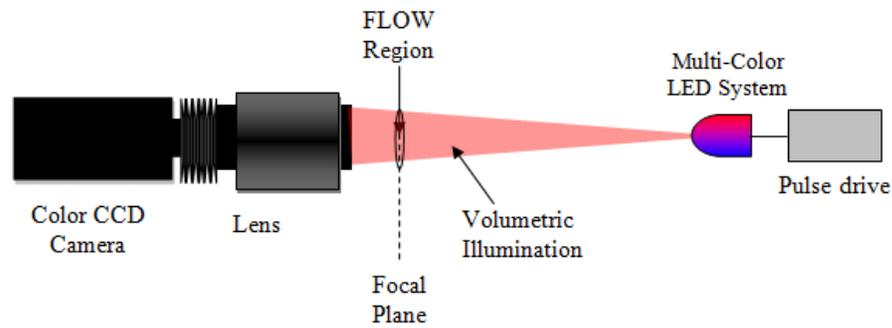
Components May Include Multiples of:

1. PSP-CCD-C/M Color CCD Camera
2. LM2X-DM-400 2-inch air-cooled LED for radiometric PSP/TSP
3. LM4X-DM-400 4-inch air-cooled LED for radiometric PSP/TSP
4. LM2XX-DM-400 2-inch water-cooled LED for radiometric PSP/TSP
5. PSG-3 Pulse/delay generator
6. PSP-K Pressure and Temperature Sensitive Paint starter kit
7. OP-K Optical kit with lenses and appropriate long-pass filters for PSP/TSP
8. SYS-BOX containing PSP/TSP acquisition hardware
9. LC-1 Ethernet based lens controller for remote focus zoom lens (larger facilities)
10. LC-2 Ethernet based lens controller for EF lenses (smaller facilities)
11. Full OMS post-processing software package
12. Multi-camera control acquisition software

6.3 PARTICLE SHADOW VELOCIMETRY

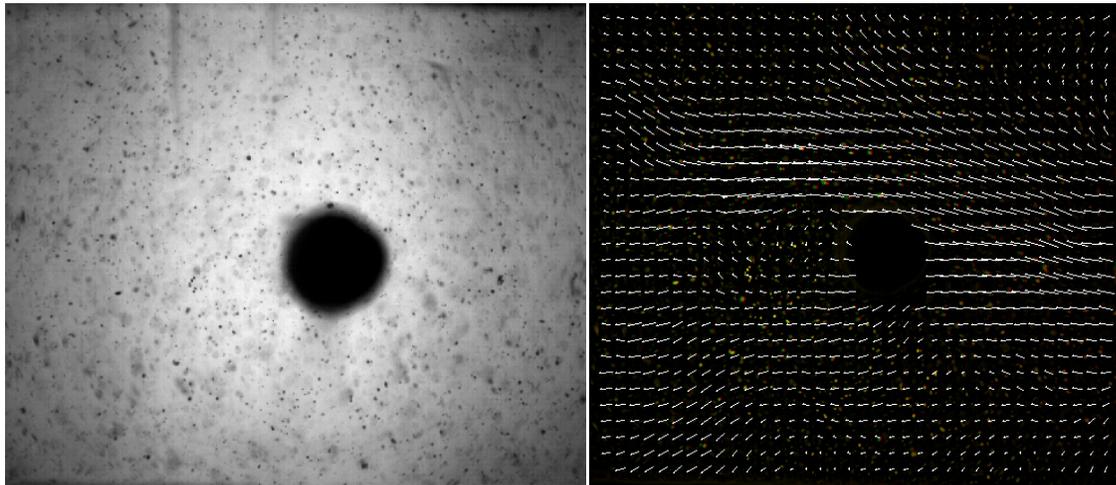
(Product ID: PSV-SYS)

Cost and safety issues associated with laser-based particle image velocimetry systems effectively eliminate their use in undergraduate student training. ISSI has developed a cost-effective alternative, Particle Shadow Velocimetry (PSV), illustrated below:



PSV systems are packaged for both academic and research purposes. PSV is a novel technique that utilizes low-power pulsed light sources such as LEDs to measure the displacement of seed particles in a flow. PSV images can also be used to characterize particle parameters such as size and shape

Cylinder in Cross Flow



Components Include:

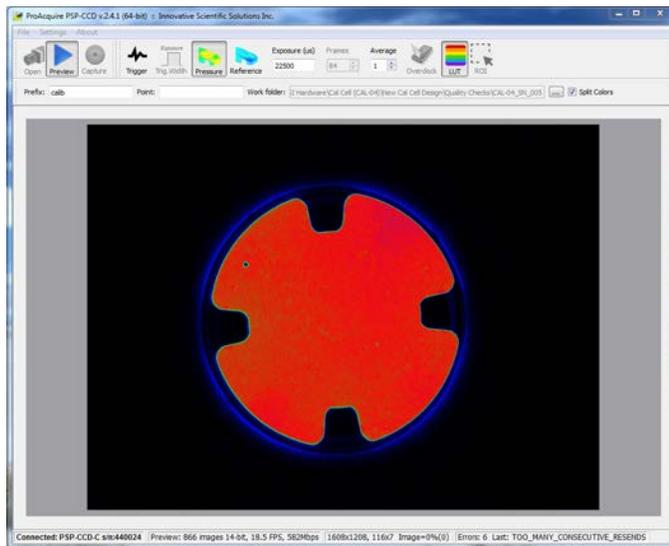
1. PSP-CCD-C CCD Color Camera
2. LM2X-DMHP-RGB 2-inch air-cooled 3-color LED
3. PSV Optical kit
4. Camera acquisition software license

7 | SOFTWARE

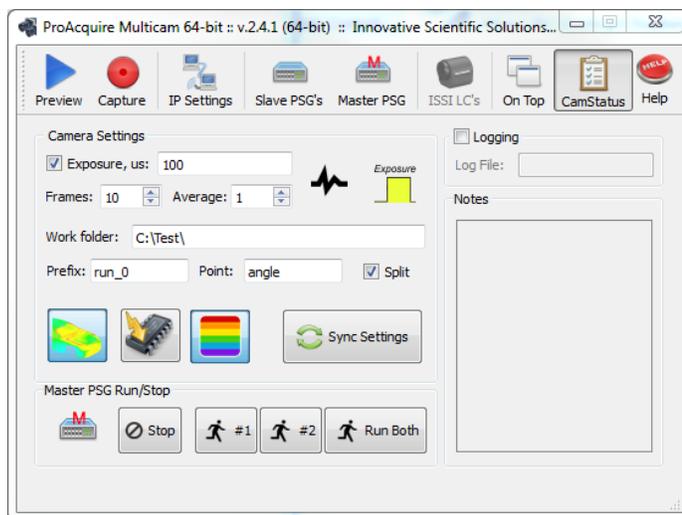
7.1 ACQUISITION

(Product ID: OMS-30a)

ProAcquire is a data acquisition software package used with the PSP-CCD series cameras. The software features options for radiometric and lifetime PSP/TSP data acquisition. An individual ProAcquire license is sold with each PSP-CCD camera. Pro Acquire can operate with either the color or monochrome camera. ProAcquire requires Windows XP or newer operating systems and is compatible with 32- and 64-bit.



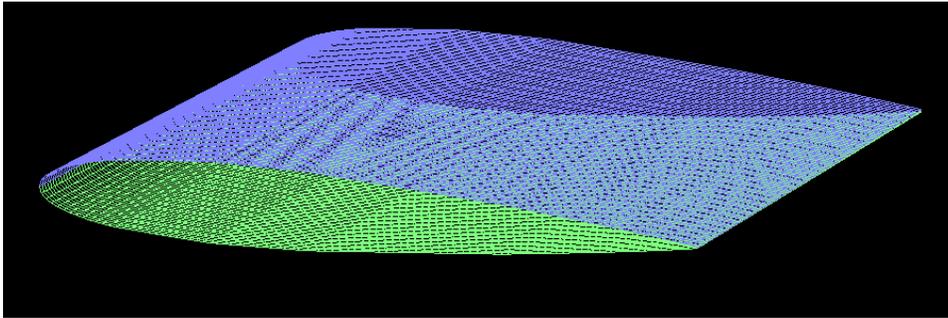
A multi-camera master-controller version of ProAcquire is used in large-scale integrated PSP/TSP systems for advanced users who require this type of operation. This allows the user to step the entire acquisition system through each test condition from one location and greatly speeds up production.



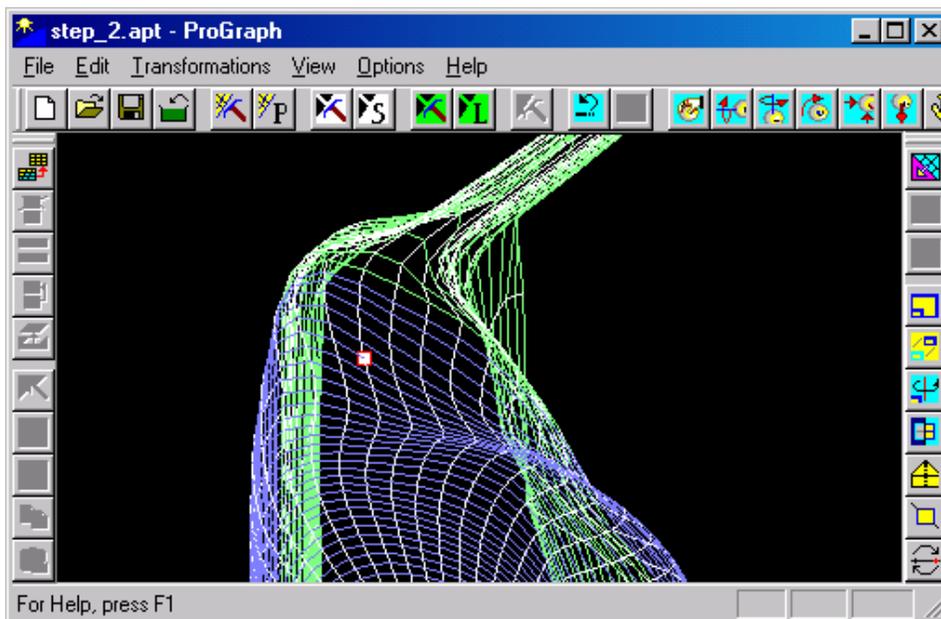
7.2 MESH GENERATION

PRO GRAPH

(Product ID: OMS-30g)



OMS ProGraph is a mesh generation and manipulation program specifically designed for use with Pressure-Sensitive Paint. ProGraph includes a GUI with interactive tools for creating and modifying a surface mesh that is then used for advanced processing of Pressure-Sensitive Paint data in the ProFiled program. ProGraph allows the user to read the mesh from a variety of CFD formats and extract the surface mesh of the model. This mesh may then be refined by converting the mesh from an unstructured format to a structured format, defining blocks, or adding node density. These operations may be performed on specific regions of the model. This allows the user to build a mesh that is customized for PSP processing in ProField. ProGraph will output *.dat* and *.apt* meshes, the major difference being the structure of the grid. ProGraph is compatible with *.stl* files to create a mesh from. Structured meshes can be created and instruction is available in the ProGraph user manual in greater detail.

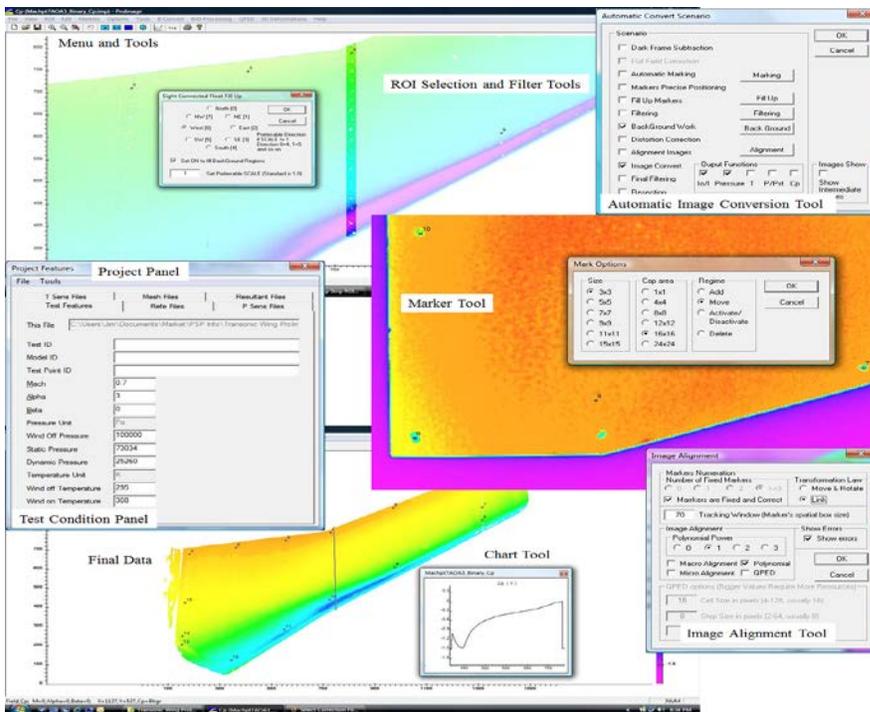


7.3 IMAGE PROCESSING

PRO IMAGE

(Product ID: OMS-30i)

OMS ProImage is an image processing program for use with Pressure-Sensitive Paint data. ProImage includes a GUI with interactive tools such as image math, image filters, ROI selection, marker recognition, image alignment, and automatic resection. Project files that include test conditions, source images, image processing procedures, calibration files, and surface mesh files can be created, modified, and saved. Batch processing of these project files is supported in ProImage by loading a series of the project files. ProImage allows the user to interactively modify images at any stage of the data reduction process.

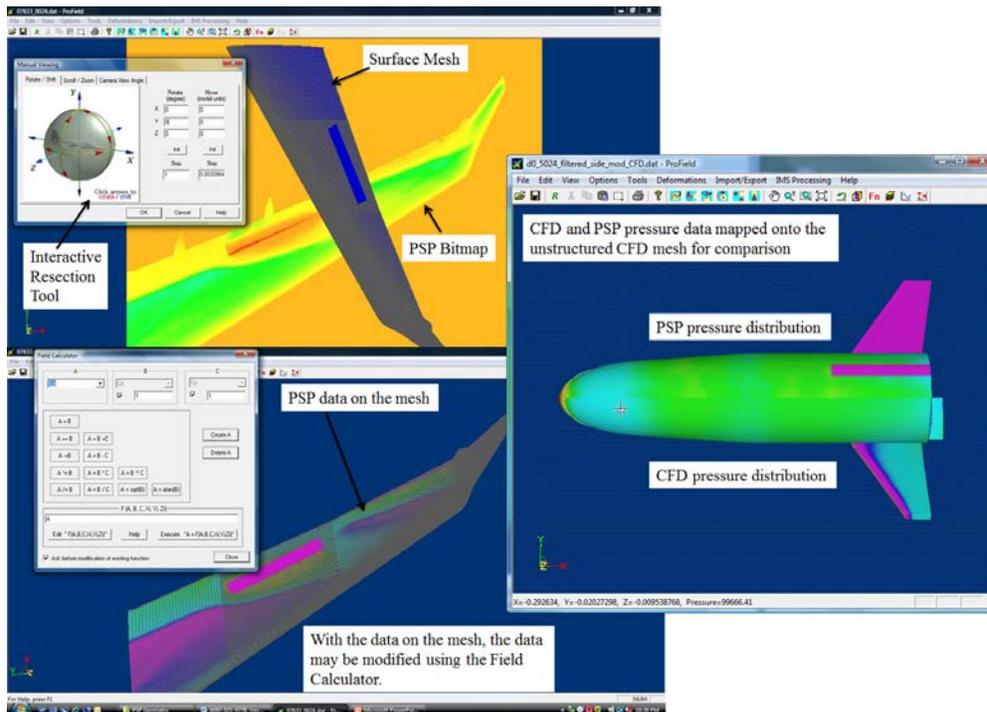


Features such as paint scratches, model screw holes, or markers can be interactively filtered to remove them from the final data. The purpose of ProImage is to provide an interactive interface for PSP users. This will allow the user to focus on the use of PSP for experimental measurements rather than the data reduction procedure. Advanced ProImage tools include the correcting PSP data using in-situ pressure taps and mapping the final data onto a surface mesh of the model using automatic image registration. ProImage is recommended for fundamental research, large wind tunnels, or production wind tunnel testing.

PRO FIELD

(Product ID: OMS-30f)

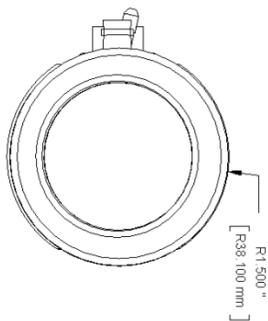
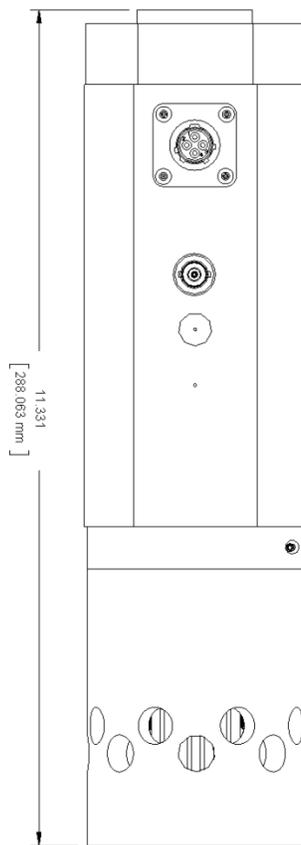
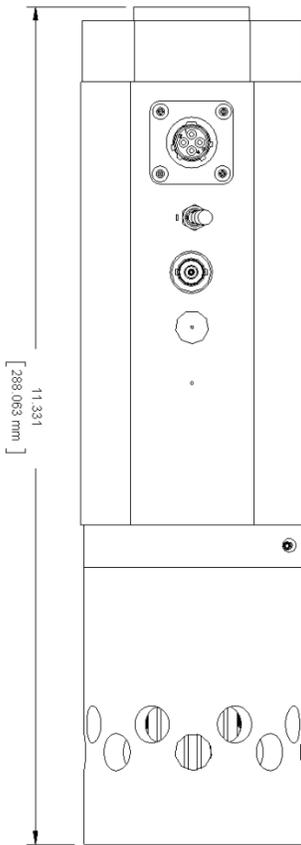
OMS ProField is a data processing program for use with Pressure-Sensitive Paint data. ProField is similar to ProImage, but operations are performed on the surface mesh rather than the bitmap. ProField includes a GUI with interactive tools such as mesh math, mesh filters, ROI selection, interactive resection, mesh to mesh mapping, and pressure tap corrections. Project files from ProImage that include test conditions, source images, image processing procedures, calibration files, and surface mesh files can be created or read and then modified, and saved. ProField allows the user to interactively modify data on the mesh, or apply filters to specific blocks on the mesh. The purpose of ProField is to provide an interactive interface for PSP users, allowing data to be mapped to a surface mesh and exported for loads calculations, or comparison to CFD predictions. This will allow the user to focus on the use of PSP for experimental measurements rather than the data reduction procedure. ProField is recommended for fundamental research, large wind tunnels, or production wind tunnel testing.



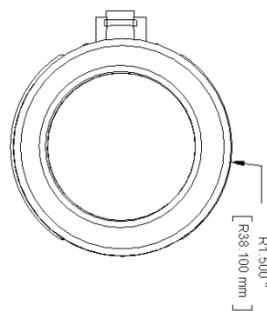
APPENDIX A

DETAILED DRAWINGS

LM2X SERIES LEDS

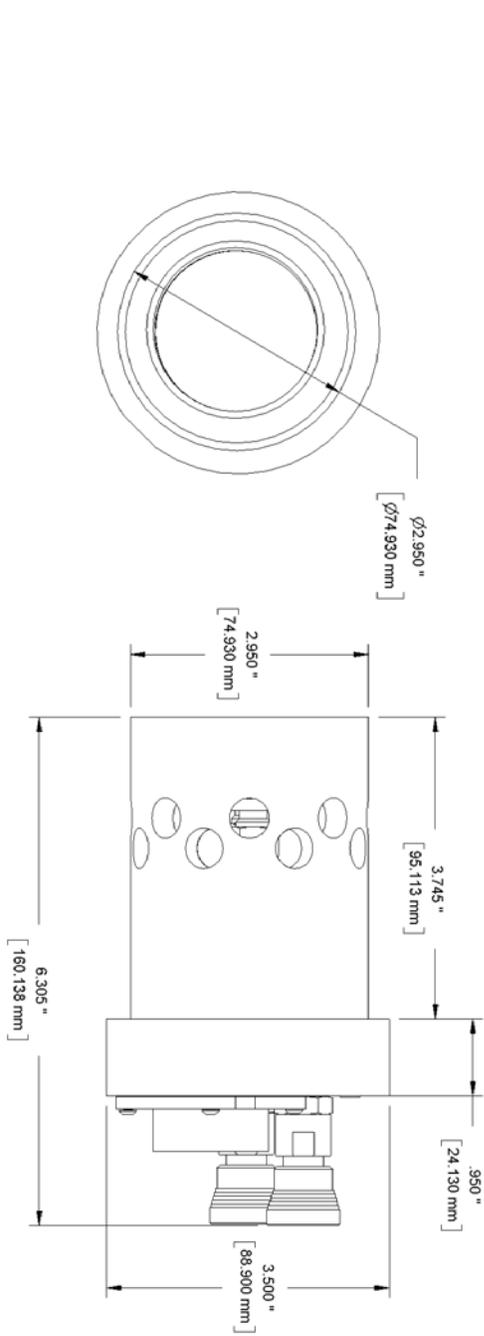


LM2X-DM

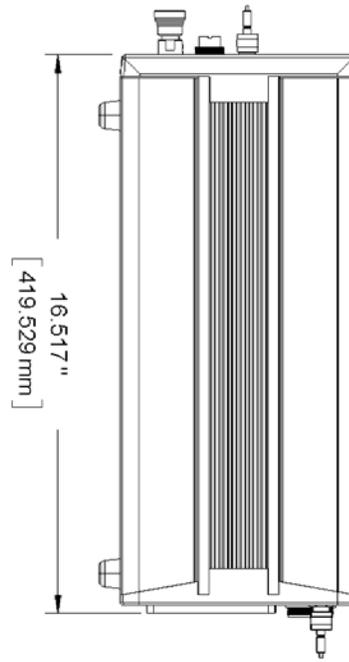
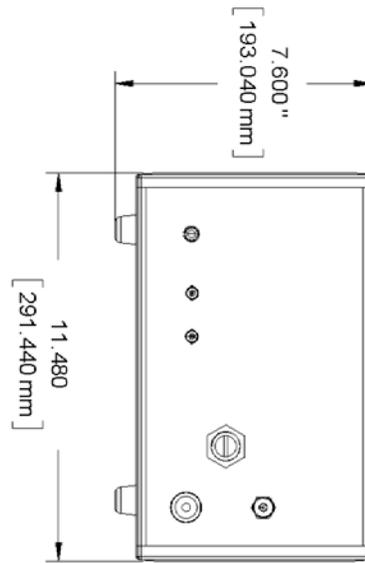


LM2X-DMHP

LM2XX SERIES LEDS

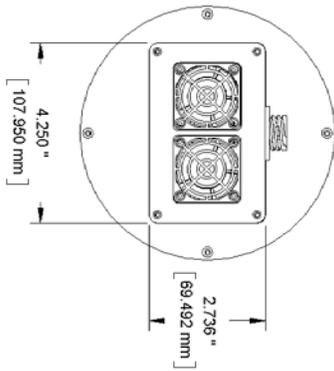
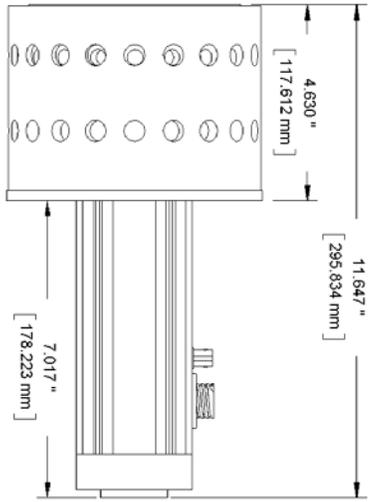


LM2XX Head

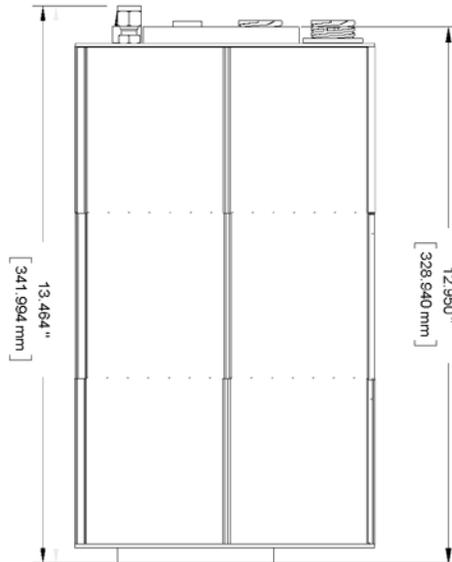
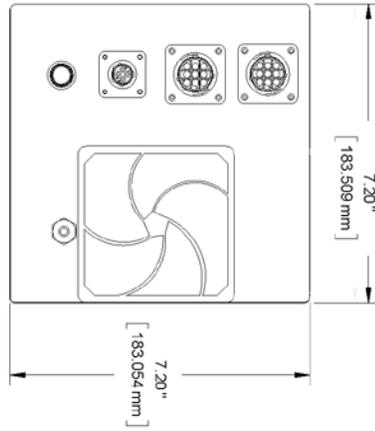


LM2XX Driver/Control Box

LM4X SERIES

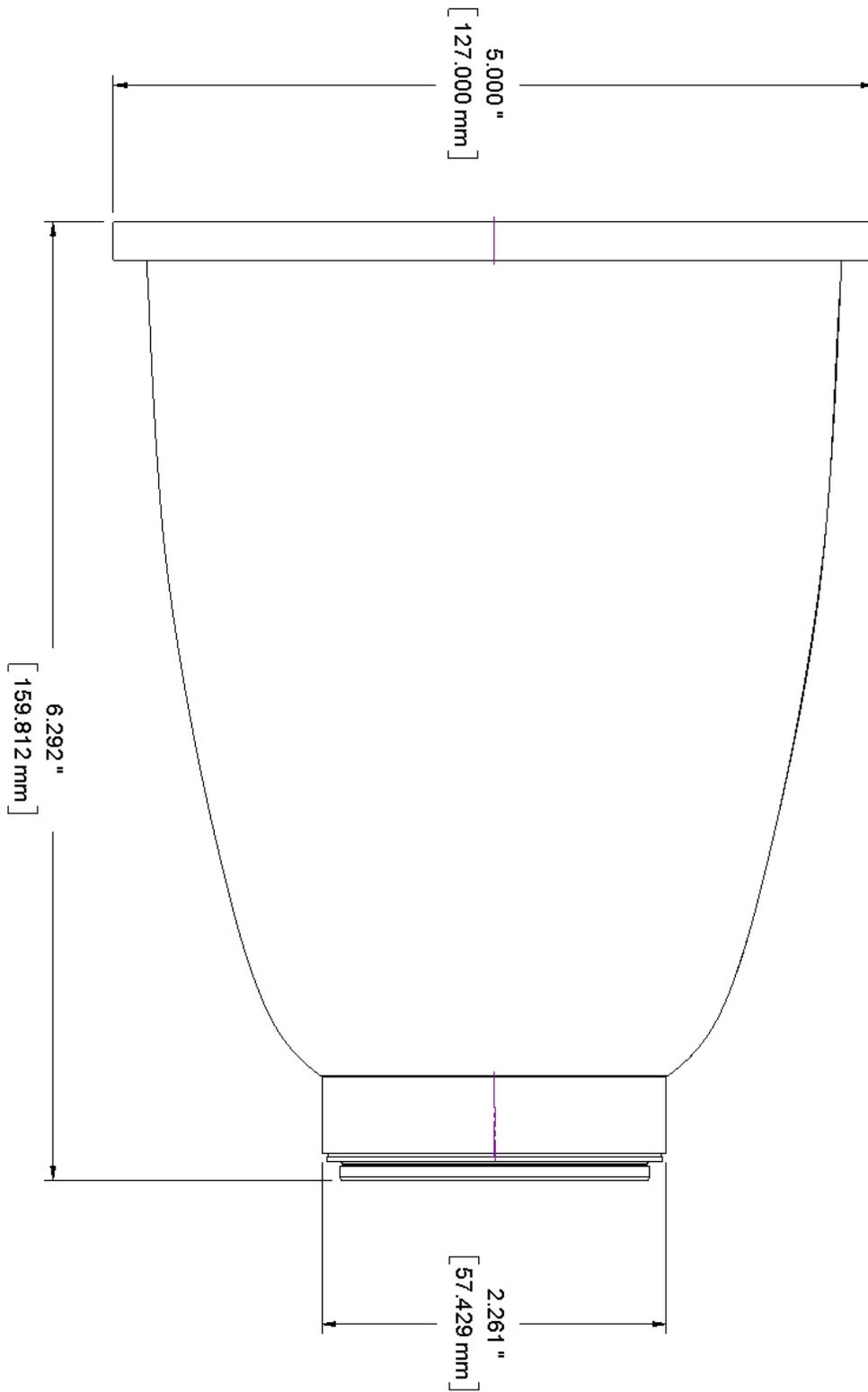


LM4X LED



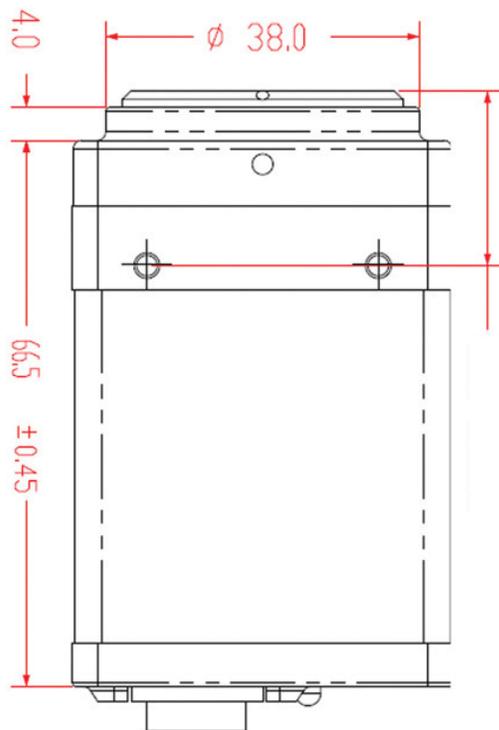
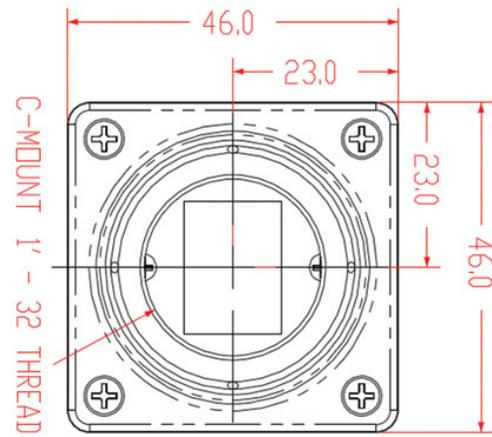
LM4X Dual Power Supply

PARABOLIC REFLECTOR & DIFFUSER



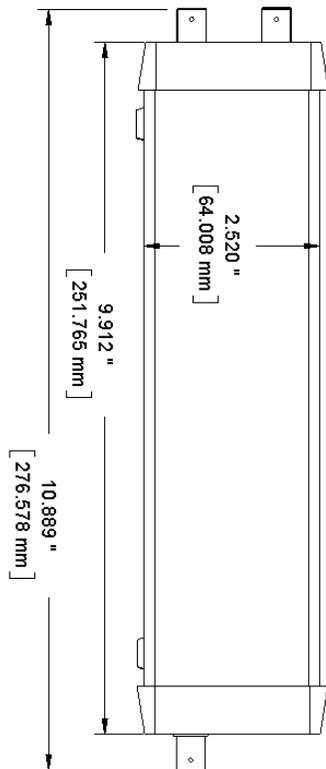
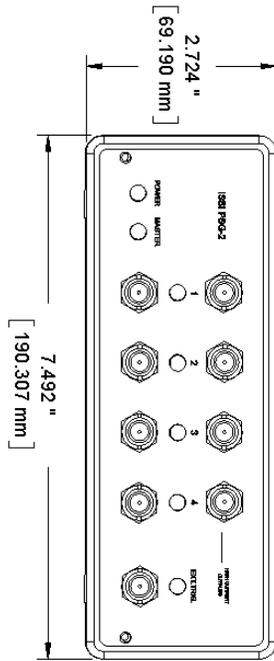
Parabolic Reflector and Diffuser

CAMERAS



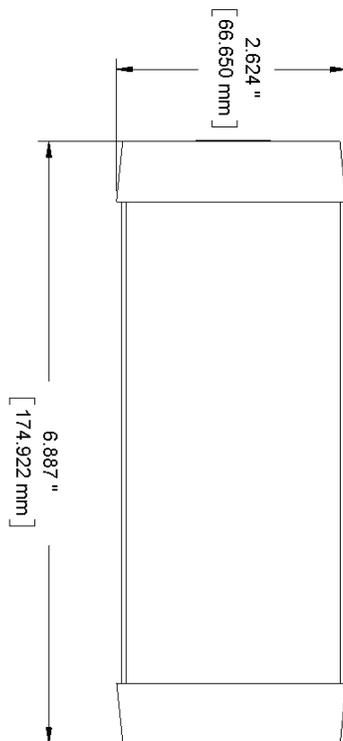
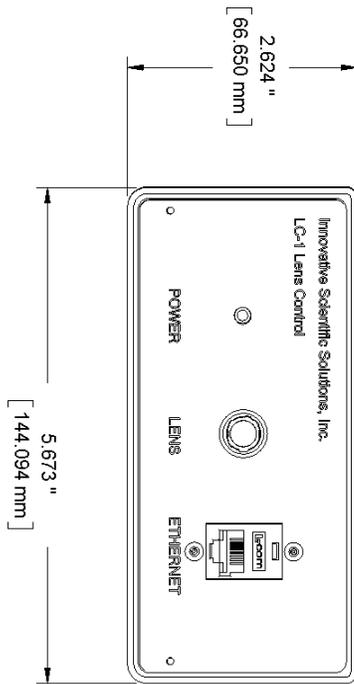
PSP-CCD-C/M Camera

PULSE/DELAY GENERATOR



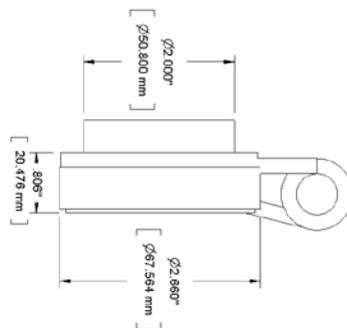
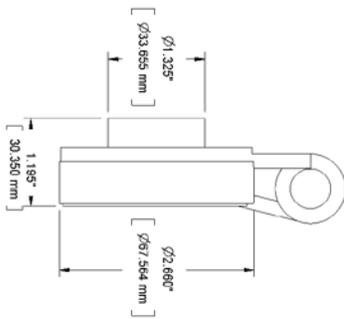
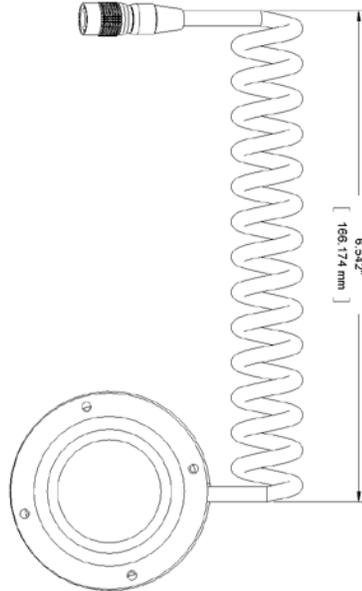
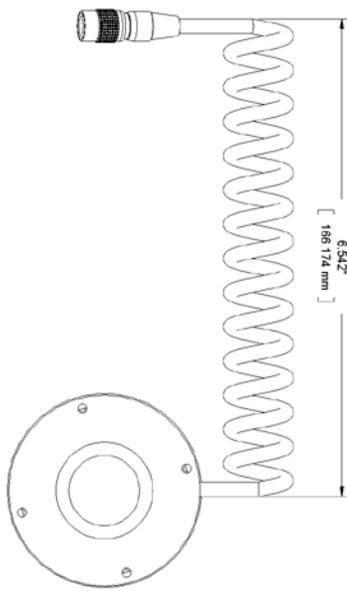
Pulse/Delay Generator

LENS CONTROLLER



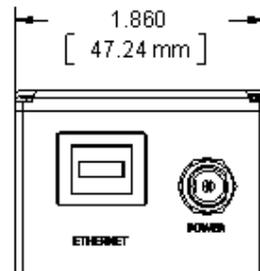
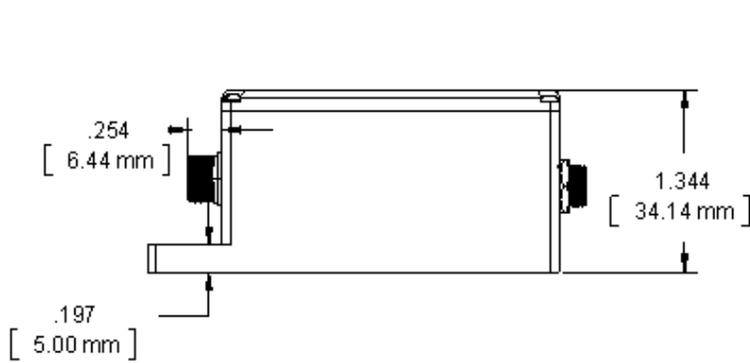
Ethernet Lens Controller

EF LENS CONTROLLER



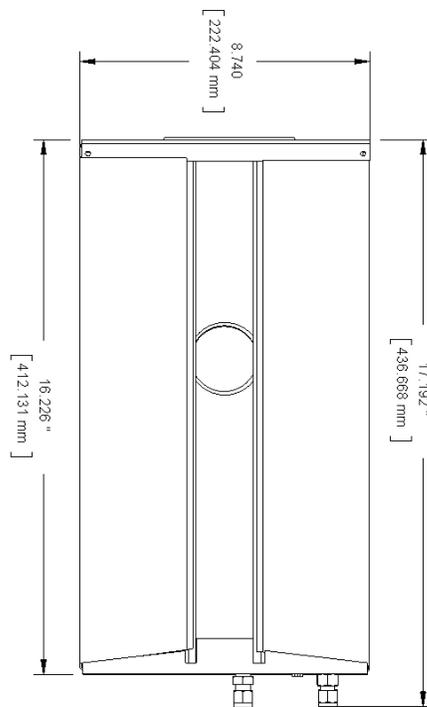
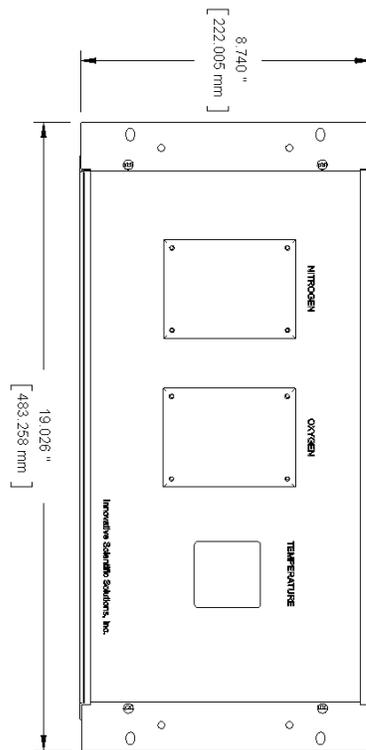
LC-2A-C

LC-2A-M42

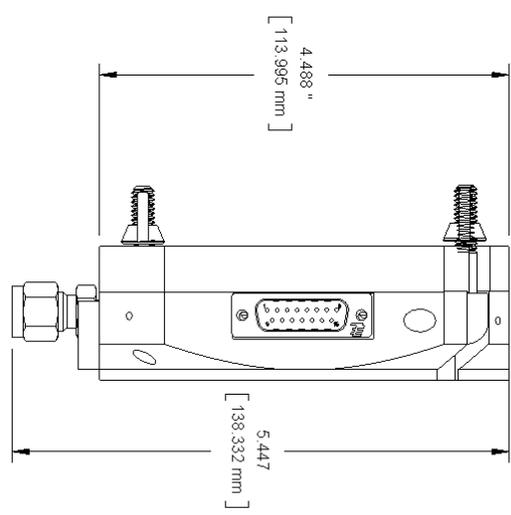
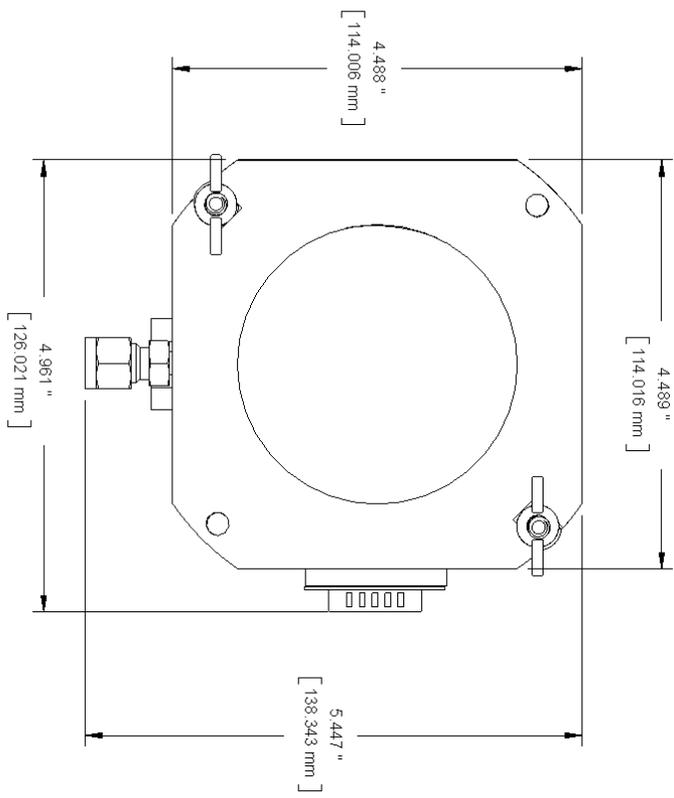


LC-2 Canon® EF Lens Controller

CALIBRATION SYSTEM

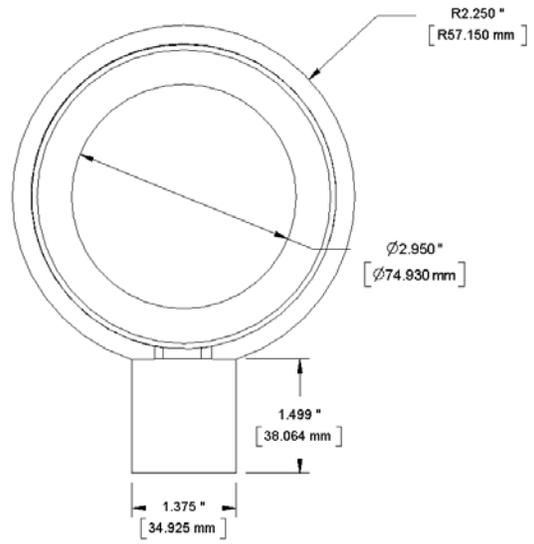


Calibration Control Box

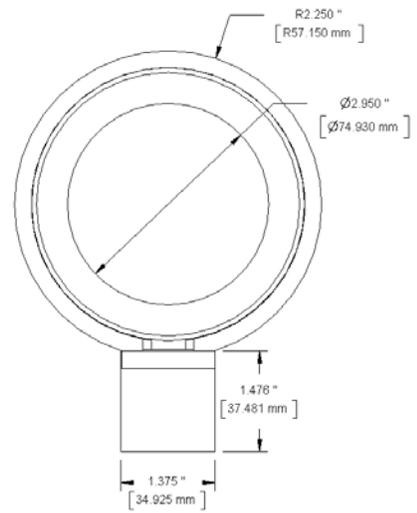
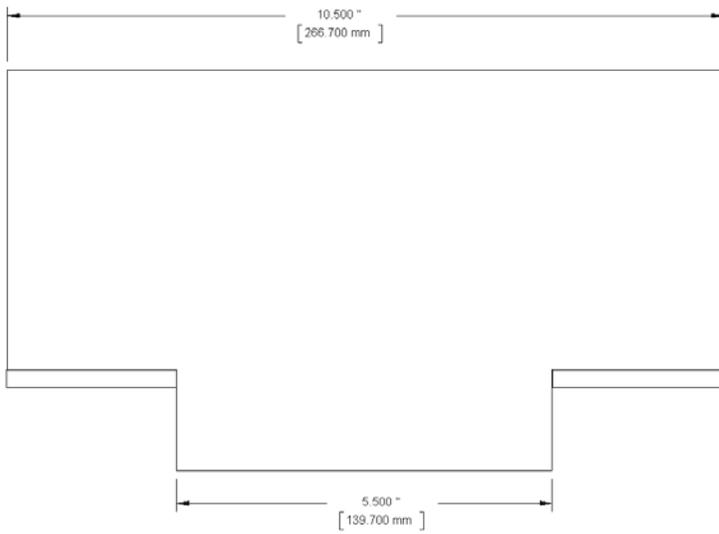


Calibration Cell Head

IODINE VAPOR CELLS



5-inch Sealed Cell



10-inch Sealed Cell